GOES-16 Data and Products around the Great Lakes

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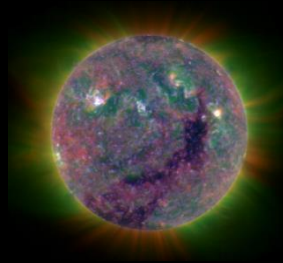
Thank you to Many People

- Tim Schmit, NOAA
- Scott Bachmeier, CIMSS
- Bill Line, NWS PUB
- Dan Lindsey, NOAA
- Jordan Gerth, CIMSS
- Lee Cronce, CIMSS
- Mat Gunshor, CIMSS
- Kathryn Mozer, PRO
- Chad Gravelle, OPG
- ……

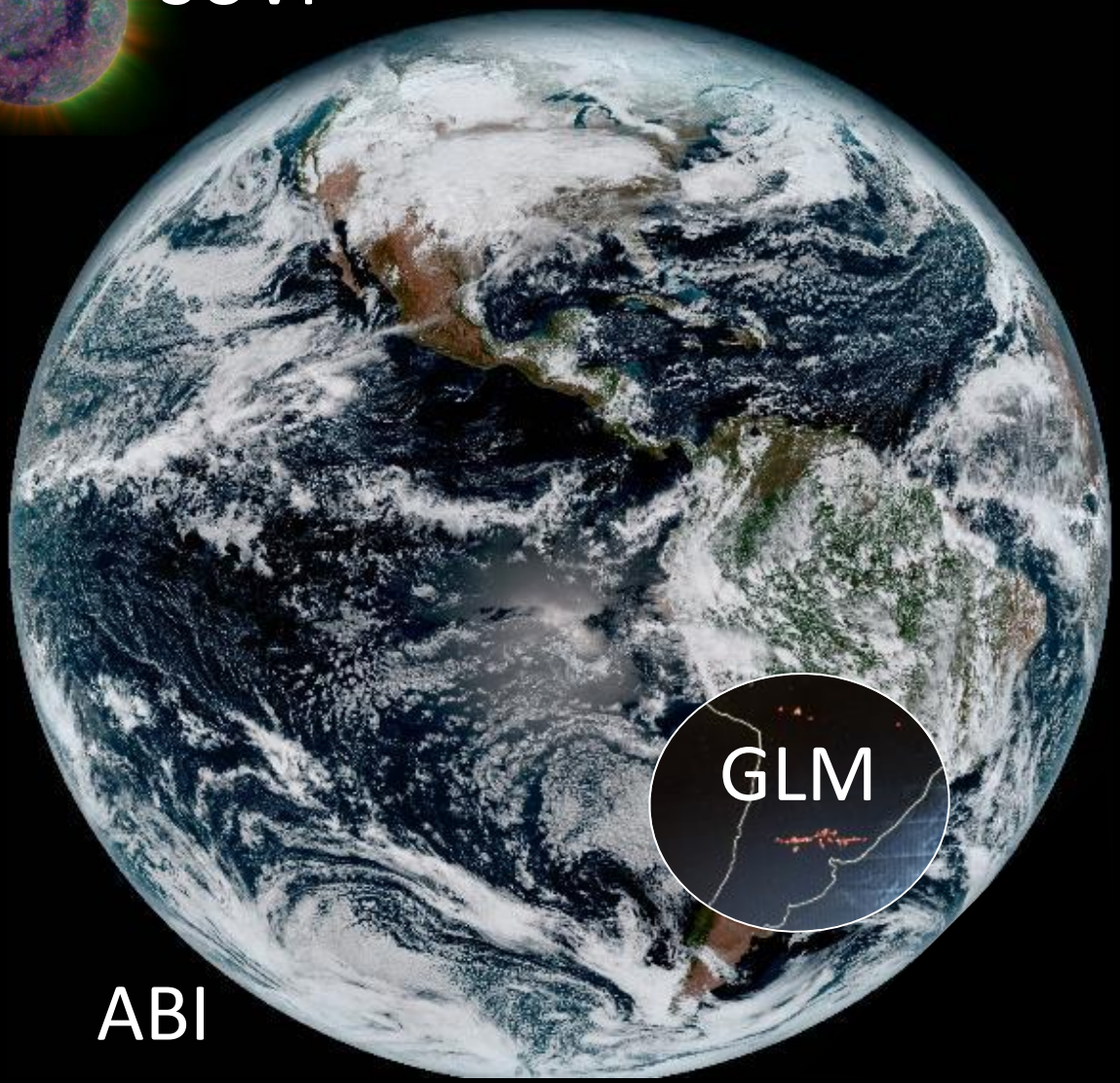
Advertisement!

- FDTD GOES-16 Applications Webinars
  - Forecaster-led discussions on something related to GOES-16.
  - Have you seen something interesting with GOES-16 data? Tell your peers about it!
  - Every other Wednesday, sometime around 18z
  - 15 minutes in length, then 15 minutes (or so, sometimes less) of questions and discussions
  - Contact Dan.bikos@colostate.edu or scott.lindstrom@ssec.wisc.edu!

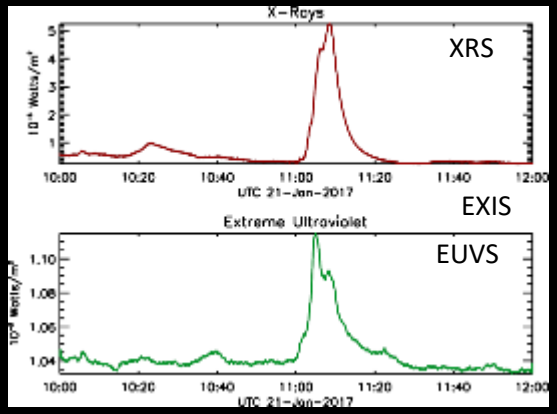
GOES-R Series Instruments

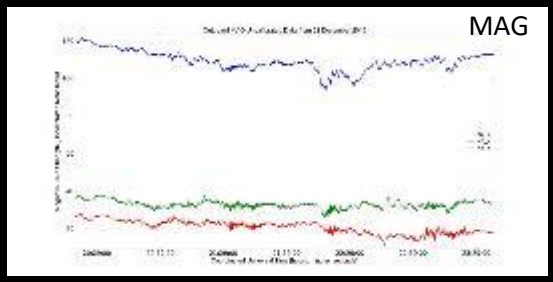


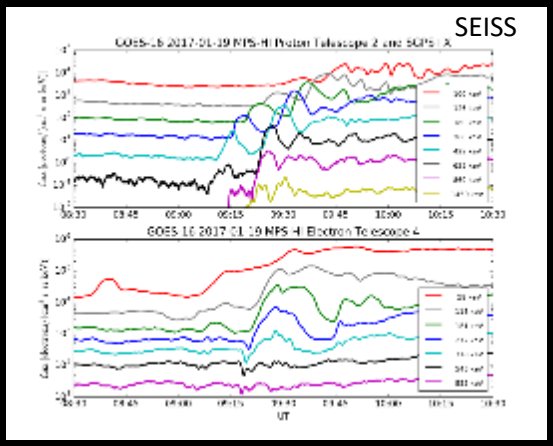
SUVI



ABI

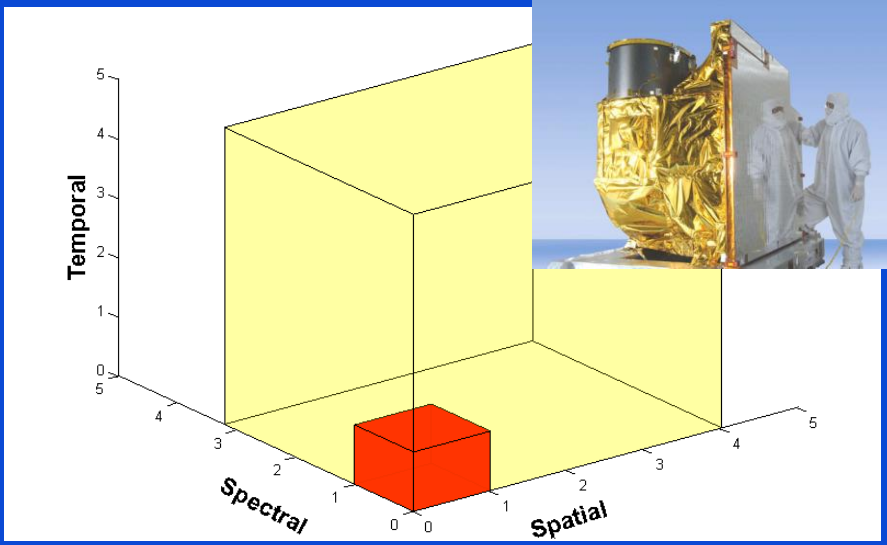






GOES-R Program Office

Advanced Baseline Imager (ABI)



5x Faster coverage (5-minute full disk vs. 25-minute)

4x Improved spatial resolution (2 km IR vs. 4 km)

3x More spectral bands (16 on ABI vs. 5 on the current imager)

Plus improved radiometrics and higher bit depths, etc.

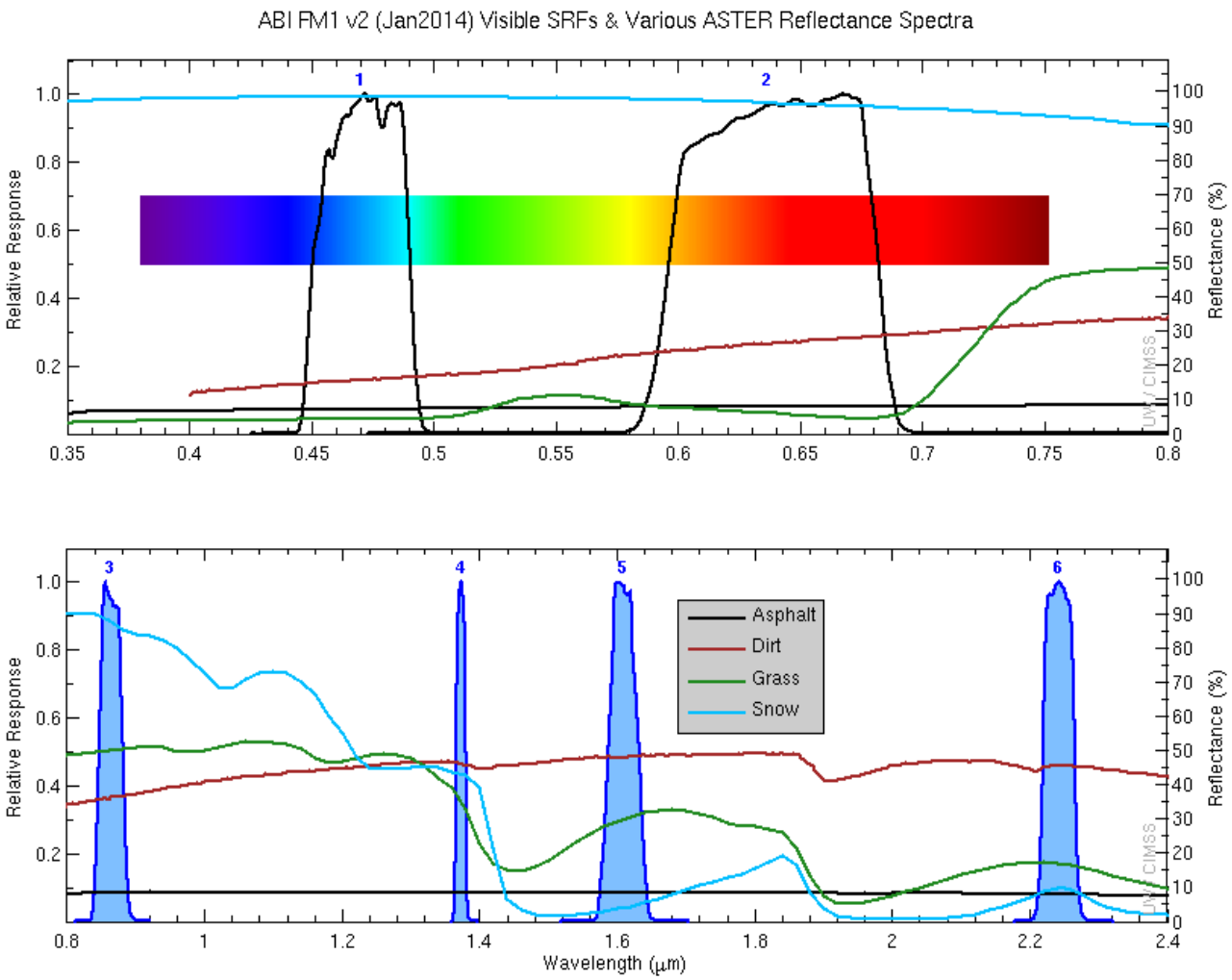
GOES-17

- First Light Imagery Press Release is scheduled for May ~~9~~ 14
- Fixed-grid format data flowing to SBN in July (July 9th, right now). ("**Once data are beta-mature**, the GRB is populated and data flows to SBN")
- Preliminary non-operational data until it moves to station (137 W) in October. Provisional is scheduled for late August.

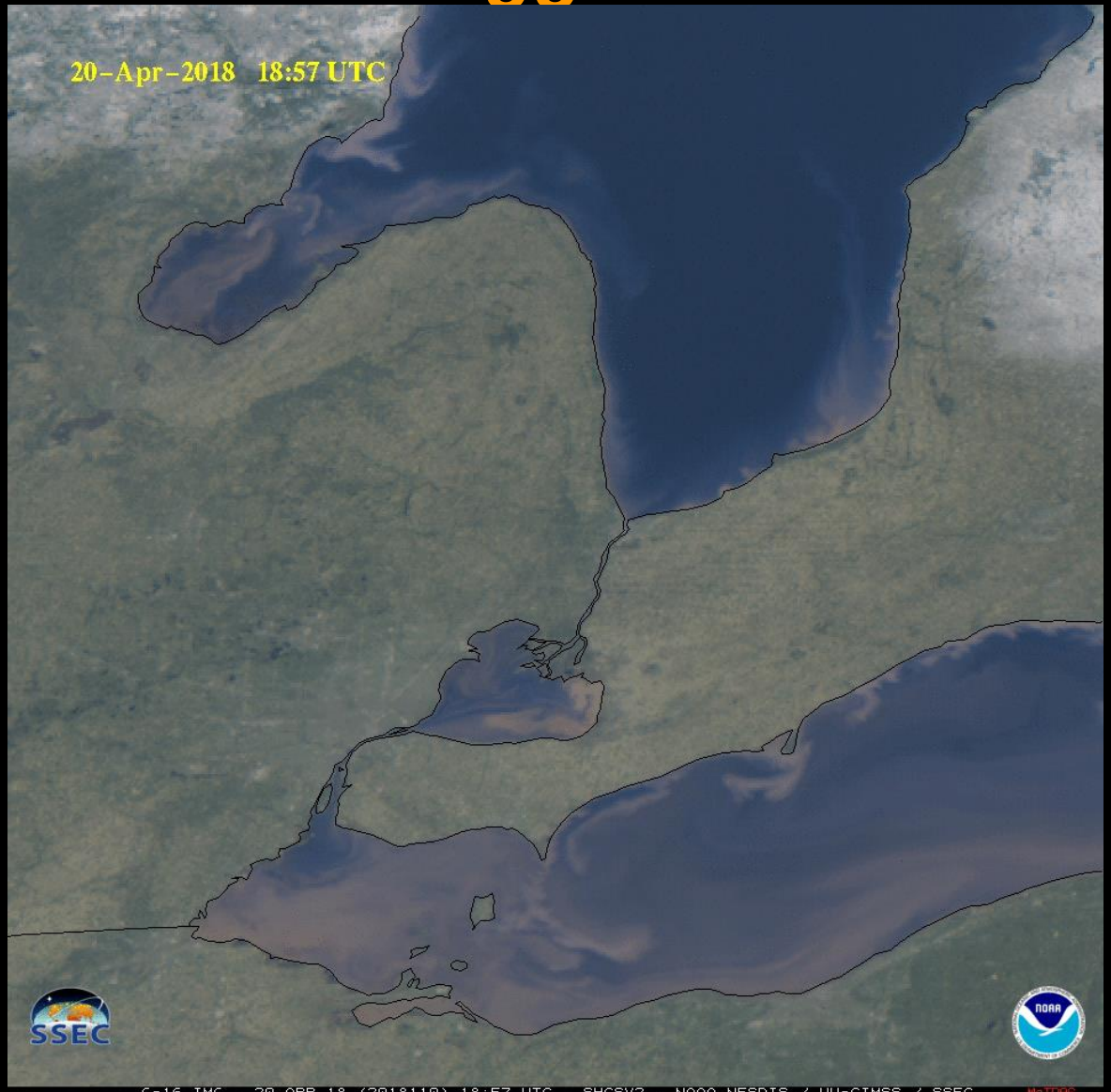
16 Bands: Do you use them all?

Band Number	Central Wavelength	Nickname	Principal Use
1	0.47 μm	“Blue Visible”	Smoke, Aerosols
2	0.64 μm	“Red Visible”	Everything visible
3	0.86 μm	“Veggie”	Land/Water, Burn scars
4	1.37 μm	“Cirrus”	High Clouds
5	1.61 μm	“Snow/Ice”	Water/Ice discrimination
6	2.24 μm	“Cloud Particle Size”	Cloud Particle Size

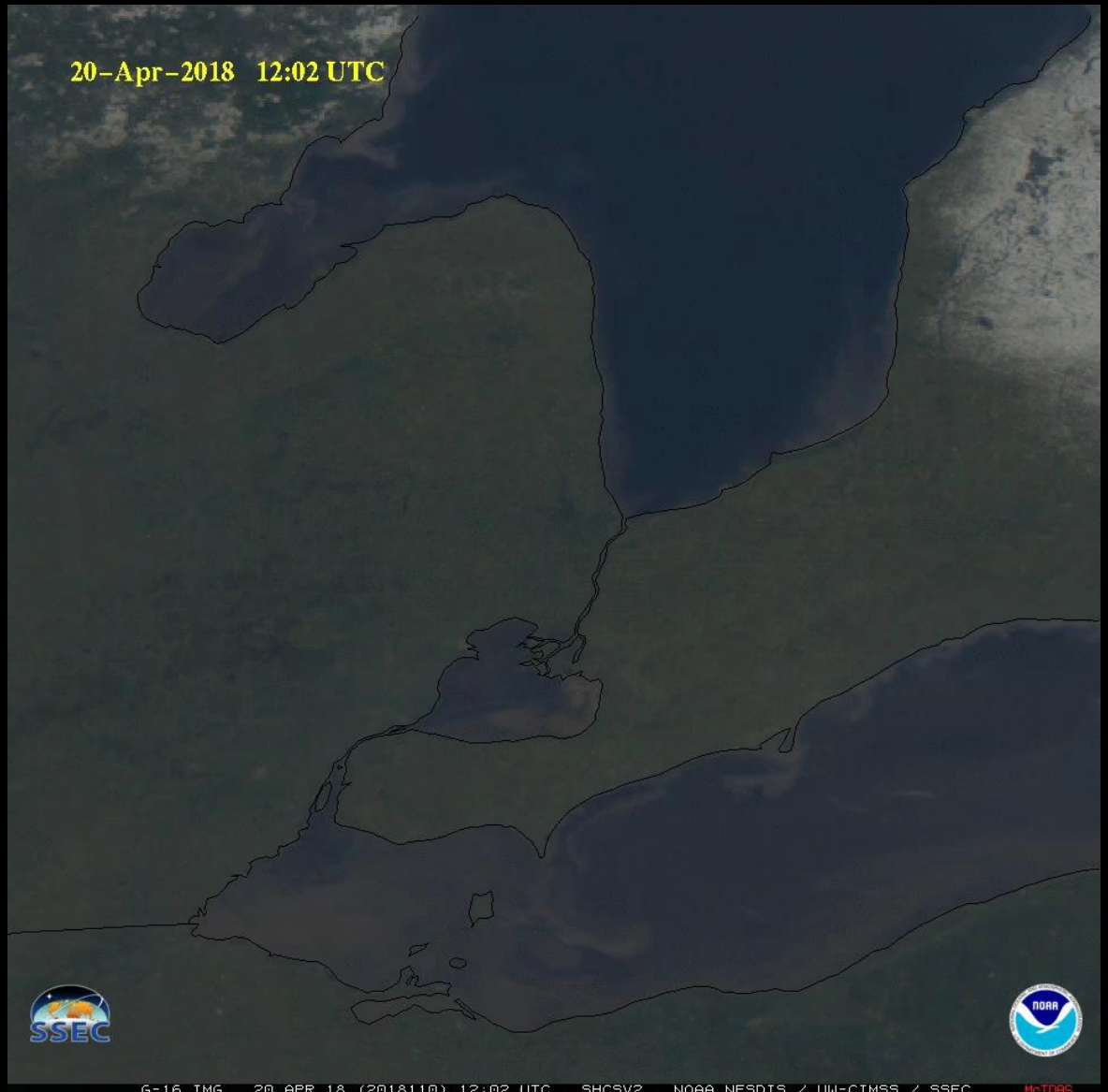
How can you make a true color image with GOES-R?

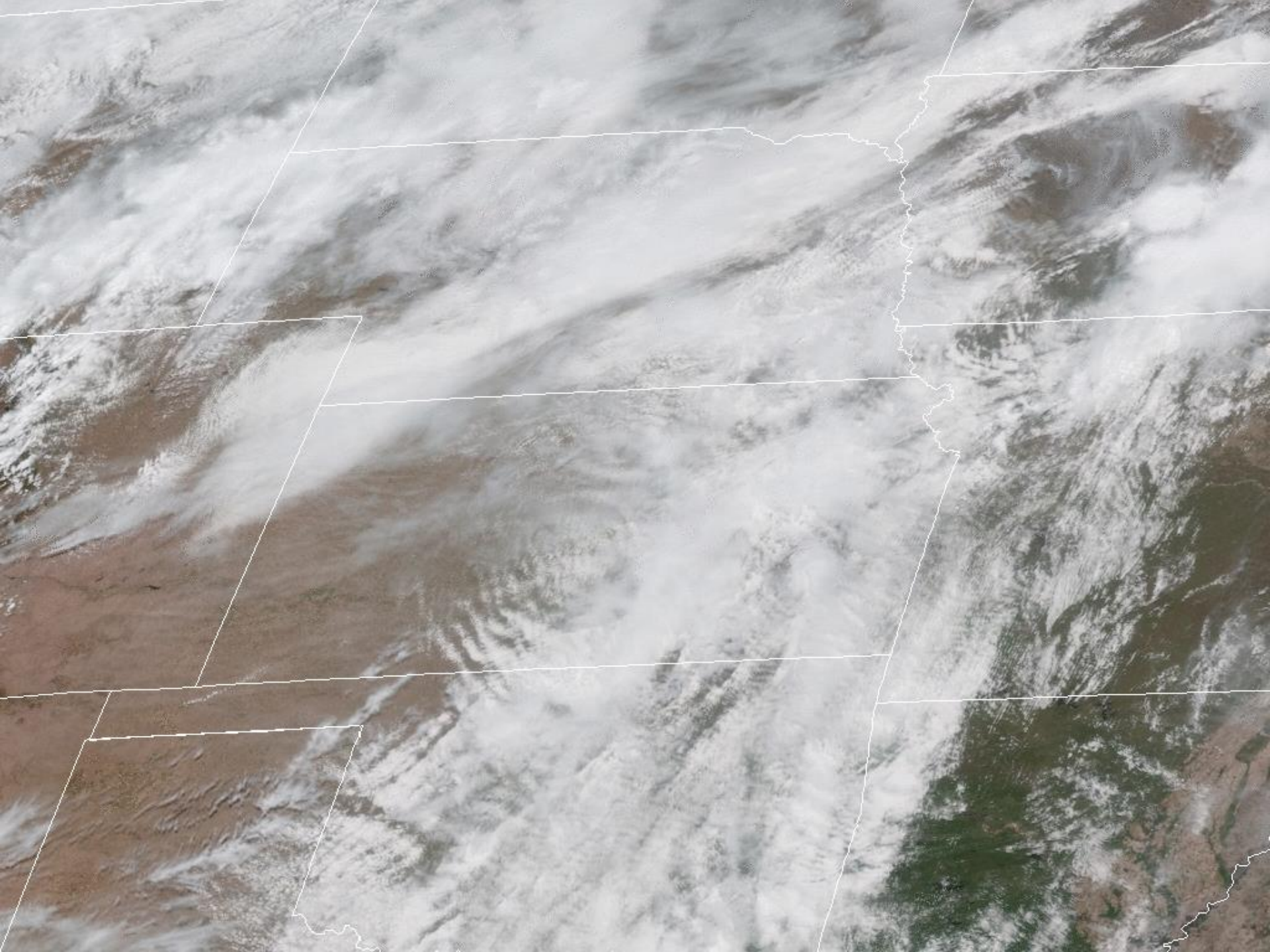


Combine the two vis and the veggie band



Animated!


20-Apr-2018 12:02 UTC
SSEC
NOAA
G-16 IMG . 20 APR 18 (2018110) 12:02 UTC . SHCSV2 . NOAA NESDIS / UW-CIMSS / SSEC
McIDAS

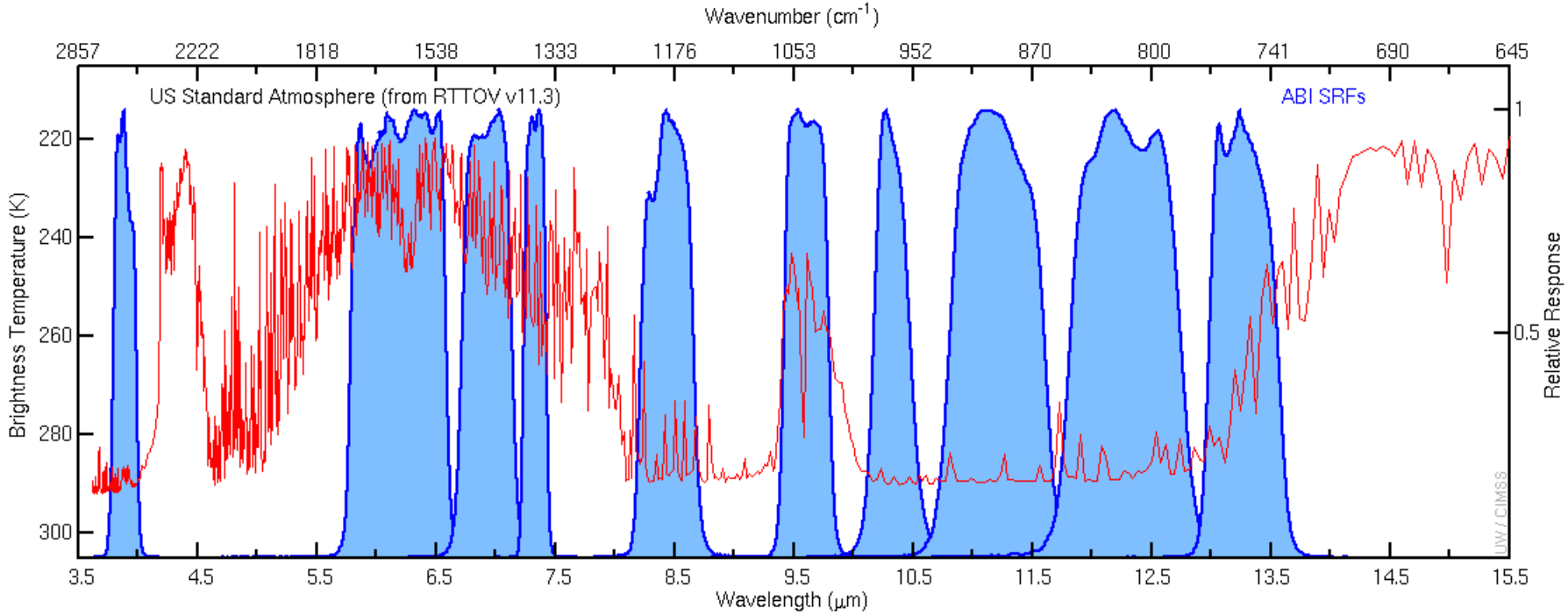


16 Bands: Do you use them all?

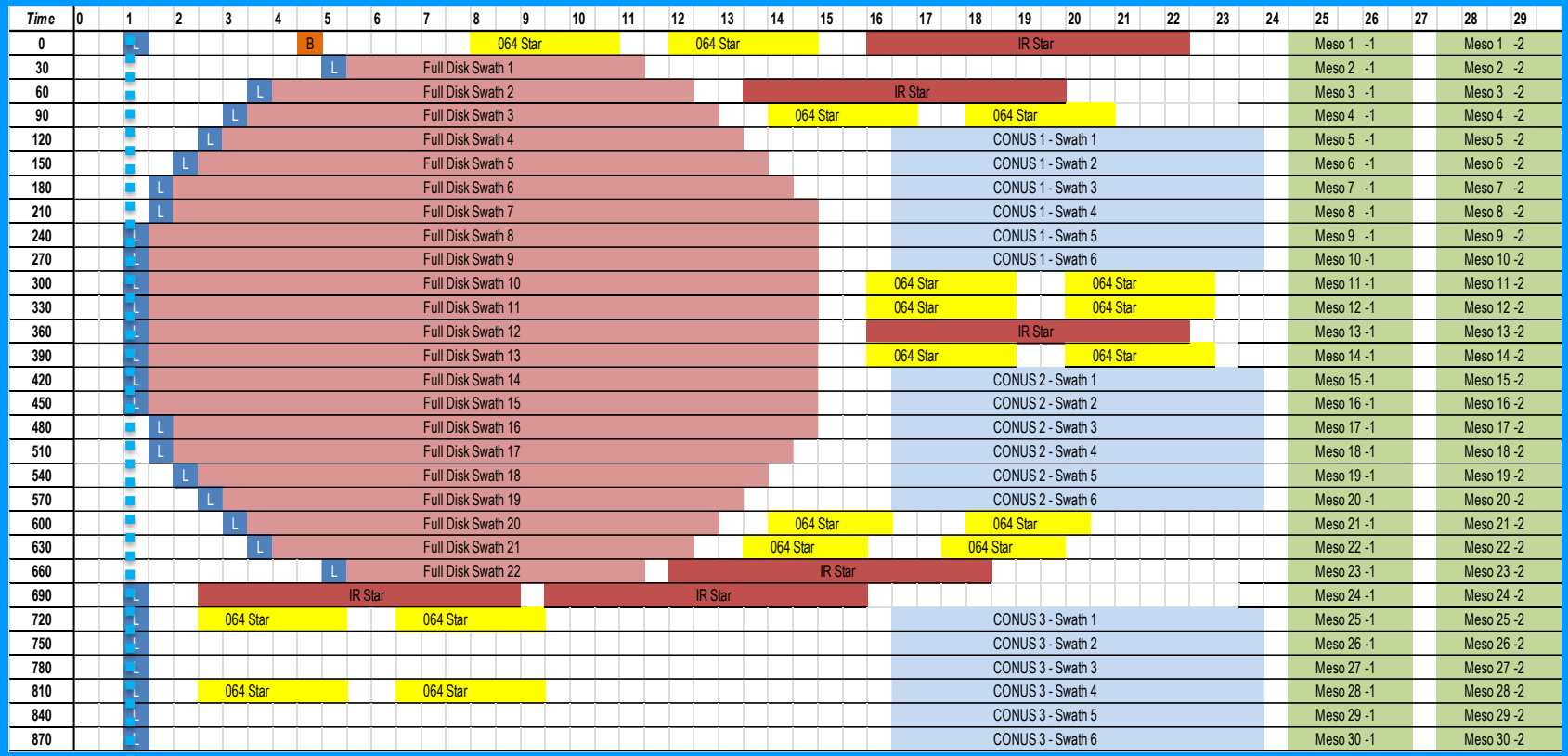
Band Number	Central Wavelength	Nickname	Principal Use
7	3.9 μm	"Shortwave IR"	Fire, Fog
8	6.19 μm	"Upper-level WV"	Jet streaks, cirrus
9	6.95 μm	"Mid-level WV"	Cyclogenesis
10	7.34 μm	"Low-level WV"	EMLs
11	8.5 μm	"Cloud Phase"	SO2
12	9.6 μm	"Ozone"	Ozone
13	10.3 μm	"Clean Window"	Fog, weather
14	11.2 μm	"Window"	Convection
15	12.2 μm	"Dirty Window"	Moisture
16	13.3 μm	"CO2"	Tropopause Temperature

Confession: I don't! But some are used in products!

Why so many Infrared Bands?



ABI Mode 3 (Flex mode)



‘White’ space in the graph is instrument idle time: 4+ minutes out of 15

Each CONUS scan takes 42 seconds total over the course of 2.5 minutes

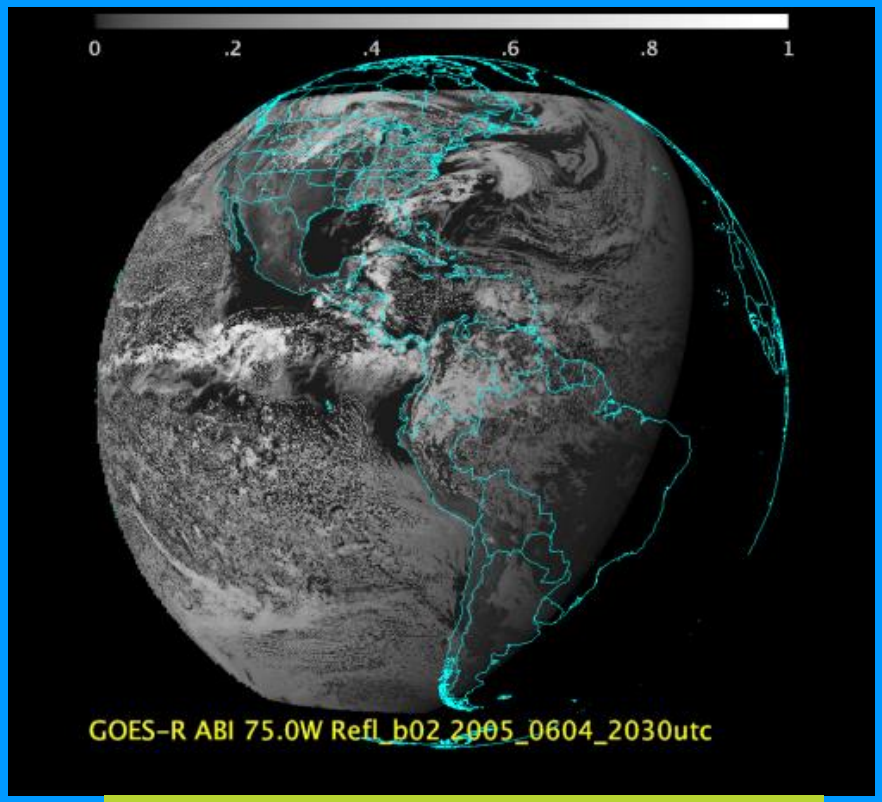
This is likely the default Scanning Mode on ABI

This chart shows a series of 30-second strips over 15 minutes

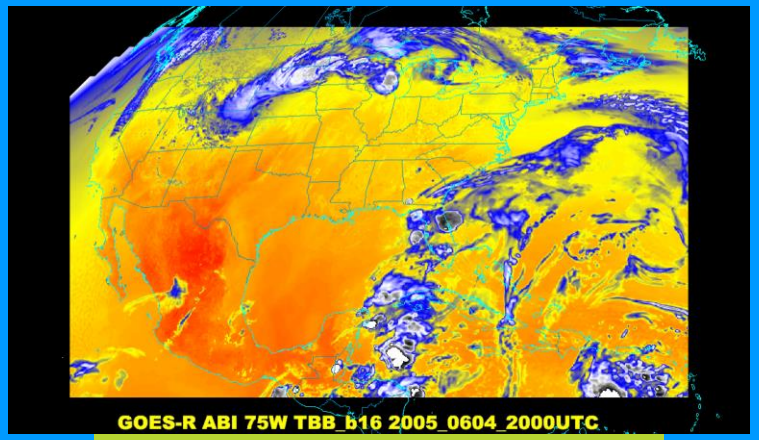
Easier than that chart

- In 15 minutes, you get
  - 1 Full Disk
  - 3 CONUS Images
  - 30 Mesoscale Sector scans
  - Plenty of Idle Time
- Note that the image scanning is all interleaved.
  - A CONUS scan occurs during the northern Hemisphere part of the Full Disk, and during the southern Hemisphere part, and after the FD scan
  - The Mesos are happening all the time too.

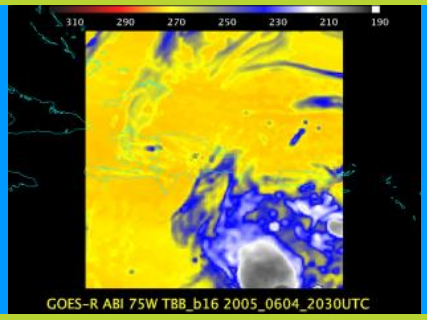
Baseline ABI Sectors



Flex Mode/Mode 3:
Full Disk every 15 minutes
Continuous Full Disk/Mode 4:
Full Disk every 5 minutes

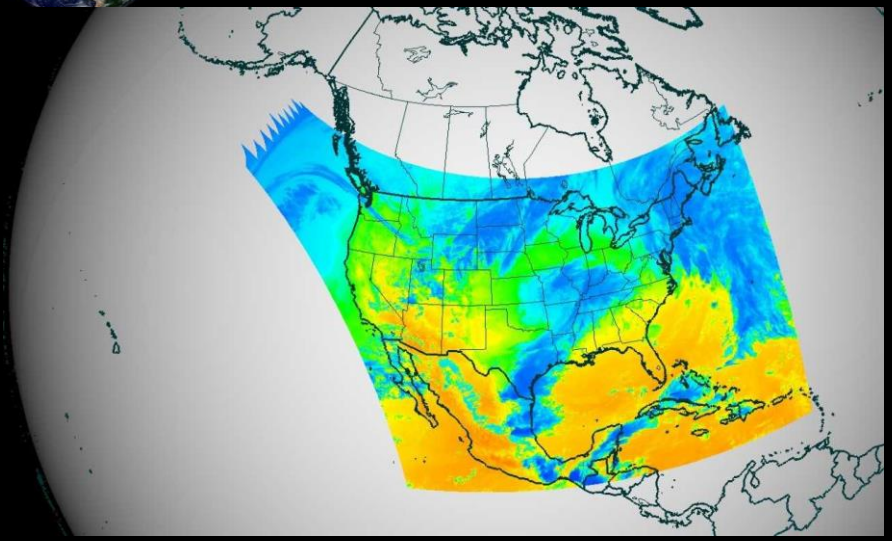


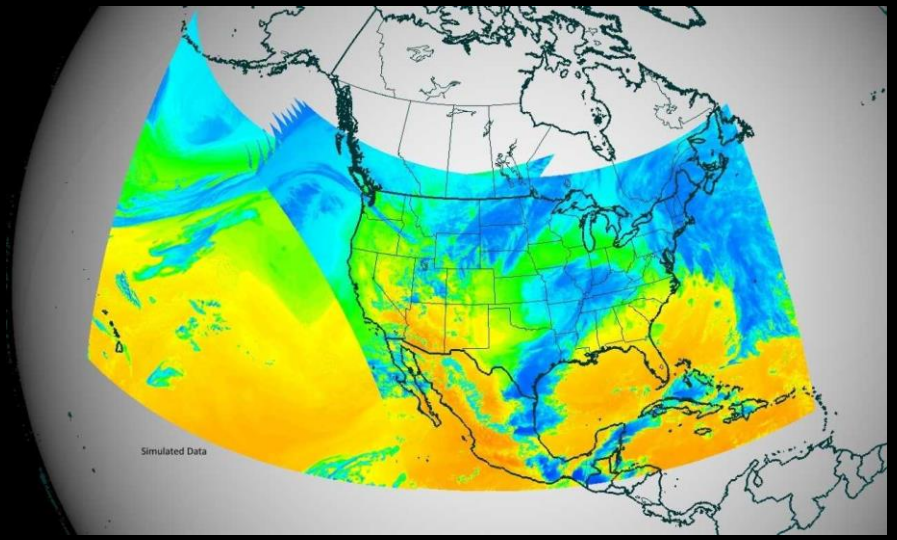
Flex Mode/Mode 3:
CONUS every 5 minutes

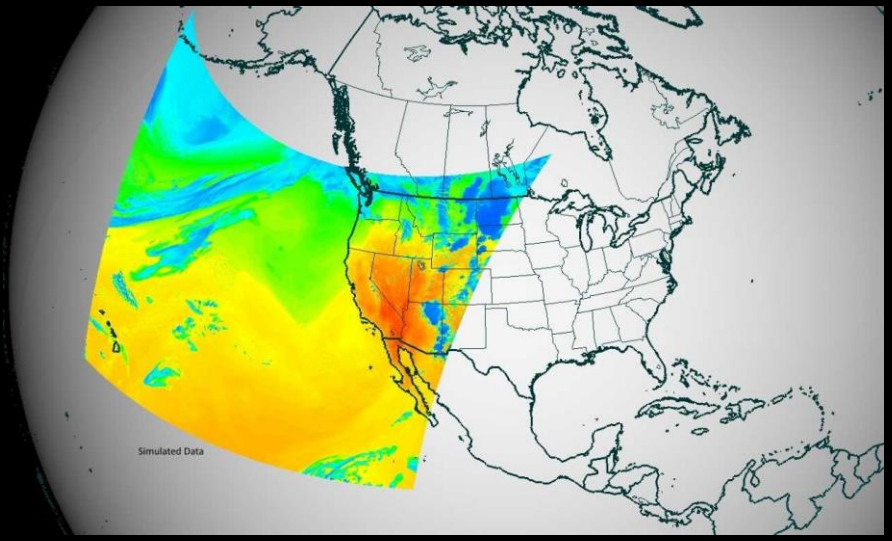


Flex Mode/Mode 3:
2 Meso sectors every minute
(This example is over Puerto Rico)

CONUS Domains





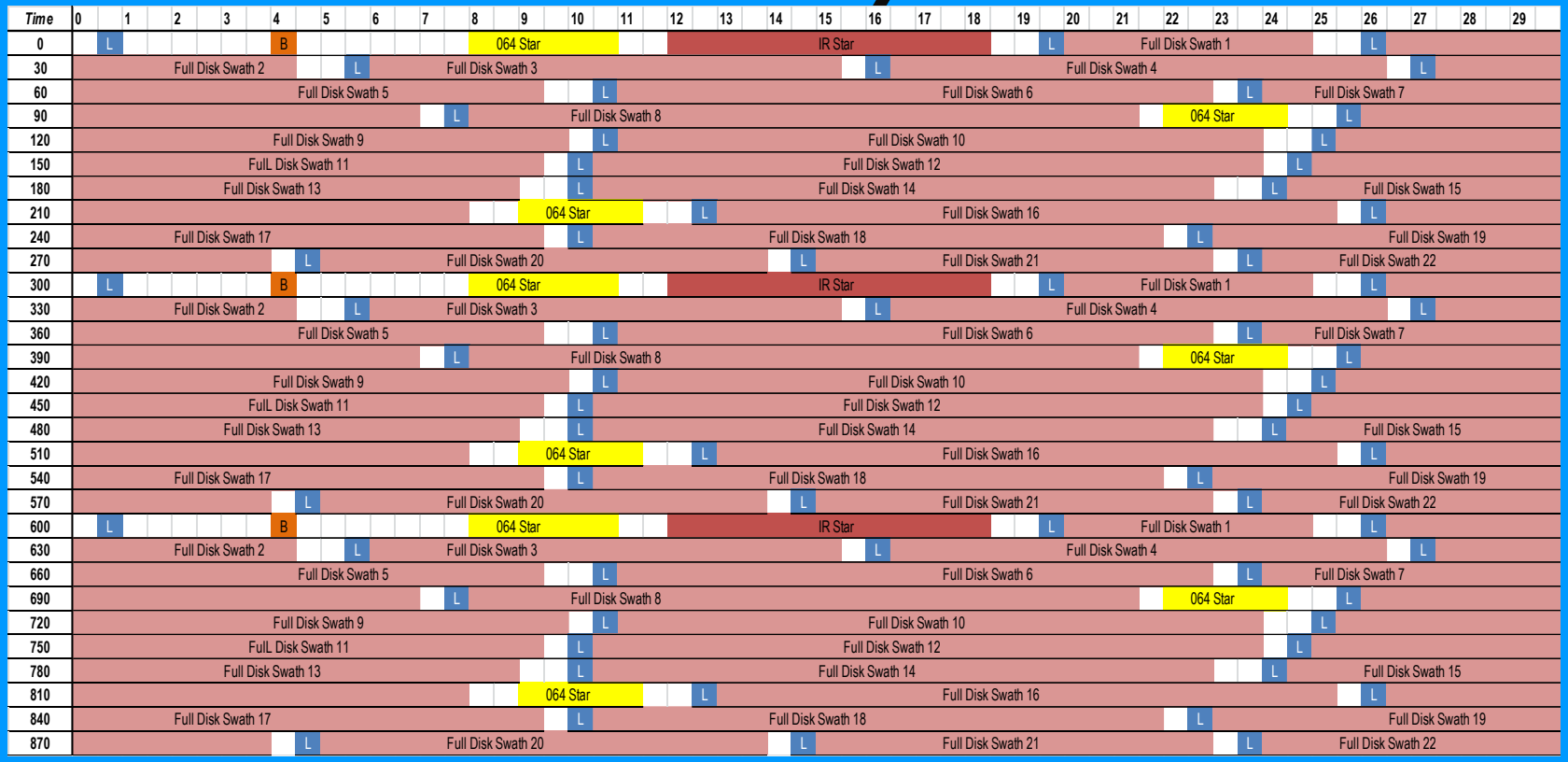


Mesoscale Domain Sector Request Priority List

1. SPC High or Moderate Risk
2. Volcanic ash eruption and plume directly over or approaching the US or US Territories
3. SPC Enhanced Risk
4. Hurricane warning(s) and/or watch(es) in effect for US or US Territories
5. Event or circumstance with national importance requiring elevated DSS (e.g… large outdoor sporting events, large hazmat event, radar outage with high-impact weather forecast, etc…)
6. SPC Extreme Fire Weather criteria or Incident Meteorologist (IMET) deployment for wildfire support
7. SPC Marginal or Slight Risk or Severe Thunderstorm or Tornado Warnings
8. SPC Critical Fire Weather or OCONUS Fire Weather Watch with at least one active wildfire occurring
9. WPC High or Moderate Risk of Excessive Rainfall or WFO issuance of Flash Flood Watch
10. 40% or greater tropical cyclone development in next 48hrs/recon flight scheduled in 12 hrs
11. LIFR Conditions (widespread) at Large and/or Medium FAA Hub Airports
12. Winter Storm Warning criteria (including blizzard and ice storm warning criteria)
13. Tropical Storm watch(es) and/or warning(s) in effect for US or US Territories
14. Hurricane watch(es) and/or warning(s) in effect for international land areas in NHC's area of responsibility
15. Two or more Tropical Storms (or Hurricanes) outside of the CONUS domain invoking a switch to Mode 4
16. Volcanic ash plume not directly over or approaching the US or US Territories
17. Two or more volcanic eruptions outside of the CONUS domain invoking a switch to Mode 4
18. Blowing dust or sand conditions with ¼ mile or less visibility
19. LIFR or worse conditions (widespread) over small FAA Hub Airports
20. Winter Weather Advisory criteria
21. SPC General Thunder
22. Other NWS requests
23. DoD requests

Feedback should be directed to Mike Bettwy, NWSOC MIC

ABI Mode 4 -- (Continuous Full Disk)



This is the Continuous Full Disk (every 5 min) mode
This is the highest data rate. Only 1m 15s idle time each 15 minutes
Might be used in Single Satellite Mode

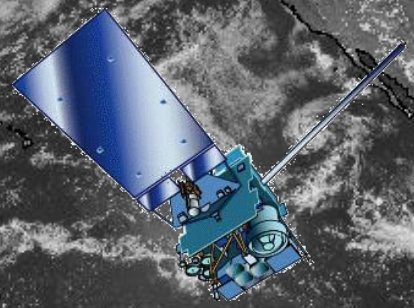
Mode 6

- This is being tested with GOES-17
- 10-minute Full Disks, 5-minute CONUS, 2 mesoscale sectors.
- A lot less idle time

NOAA GOES Constellation (2018)

GOES-15
(135W)

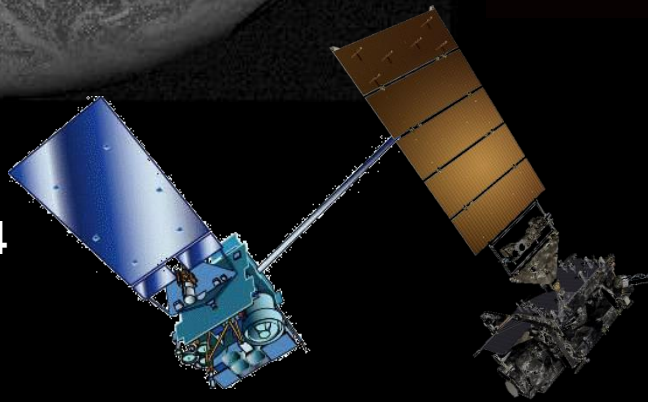
Operational



GOES-16
(75W)

Operational

GOES-14
(105W)
Back-up

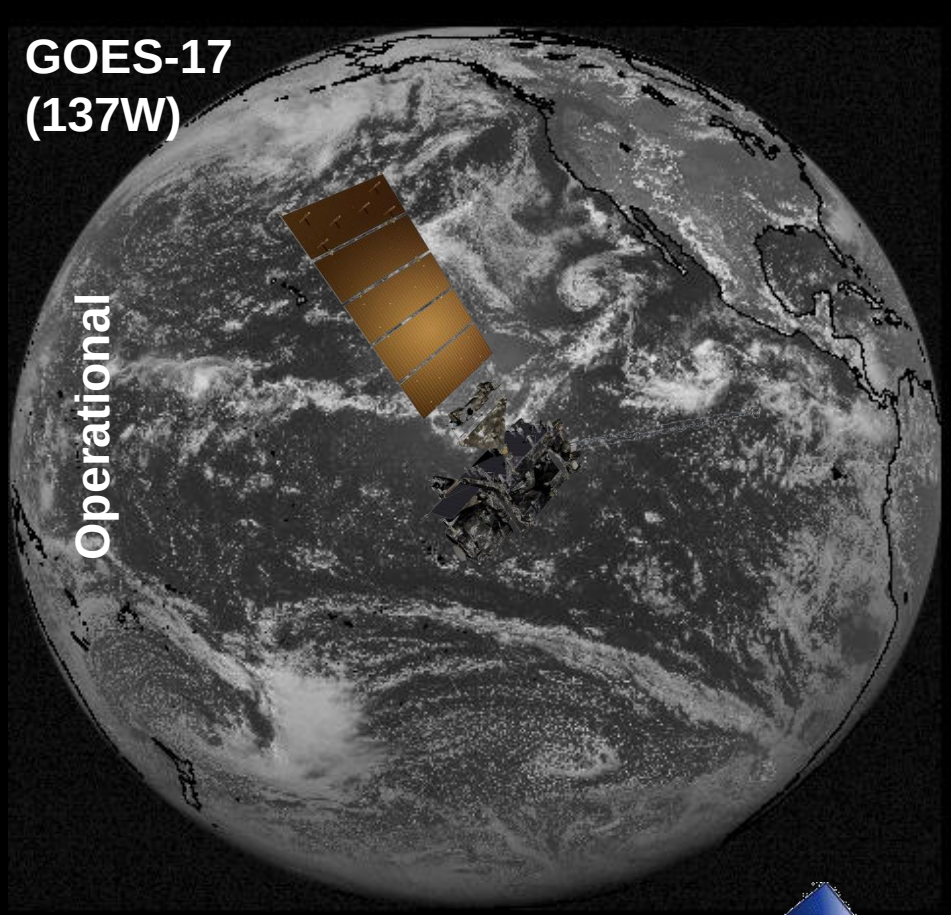


GOES-17
(90W)
Testing

NOAA GOES Constellation (2019)

GOES-17
(137W)

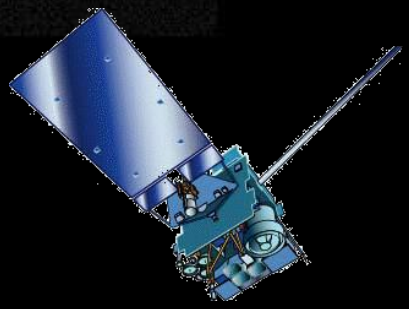
Operational



GOES-16
(75W)

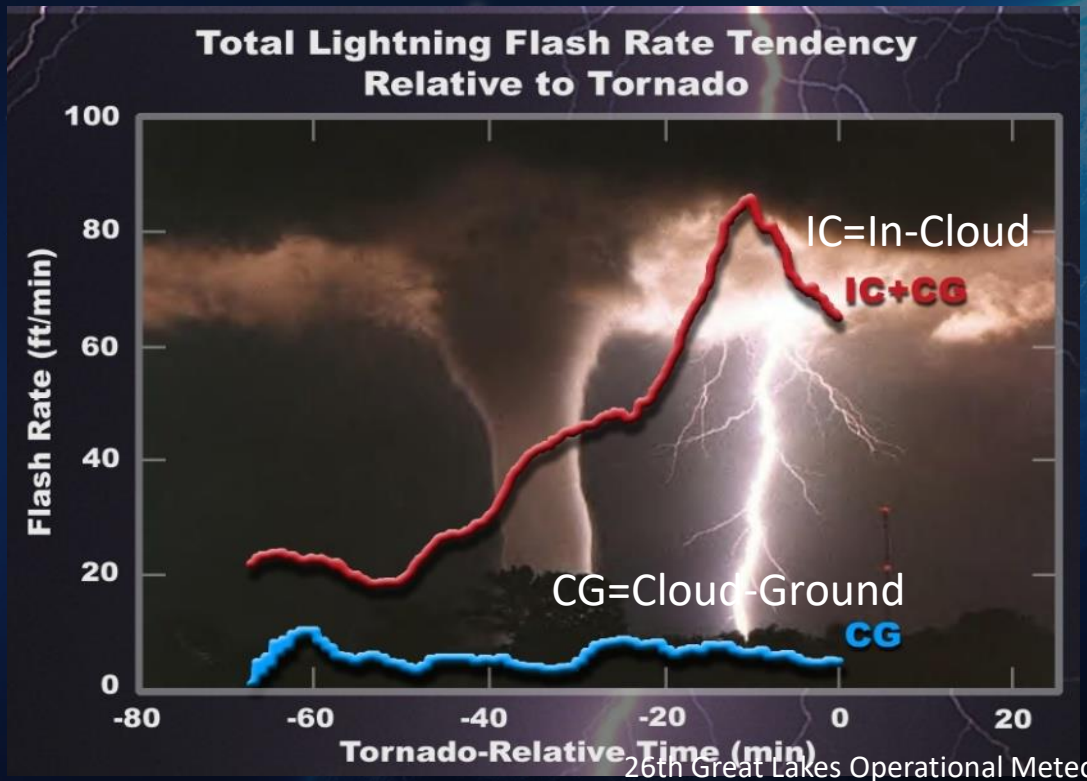
Operational

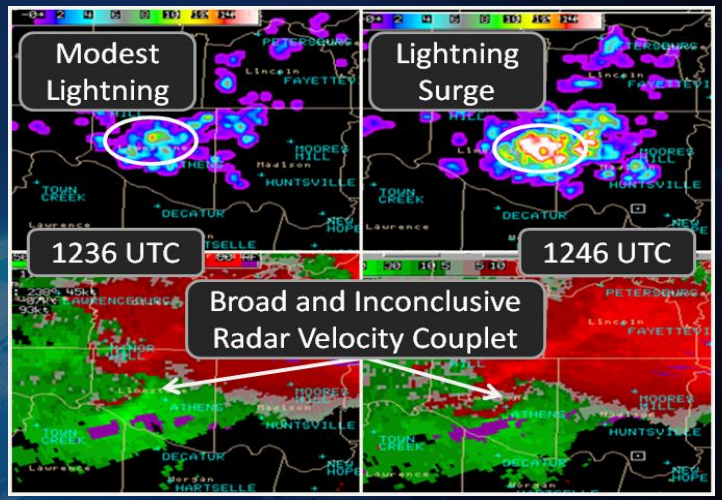
GOES-14
(105W)
Back-up

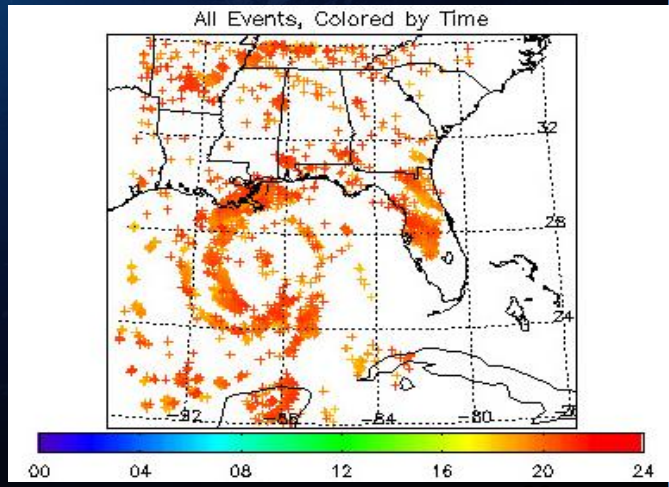


GLM Mission Benefits

- Improved forecaster situational awareness and confidence resulting in more accurate severe storm warnings (improved lead time, reduced false alarms) to save lives and property
- Diagnosing convective storm structure and evolution
- Aviation and marine convective weather hazards
- Tropical cyclone intensity change







Hurricane Katrina

What's Next with Getting GLM into NWS WFOs?

NWS WFO Preliminary Test & Evaluation (PT&E) to evaluate experimental GLM Flash Extent Density (FED) grids, transmitted via the LDM, began Thursday, April 26th.

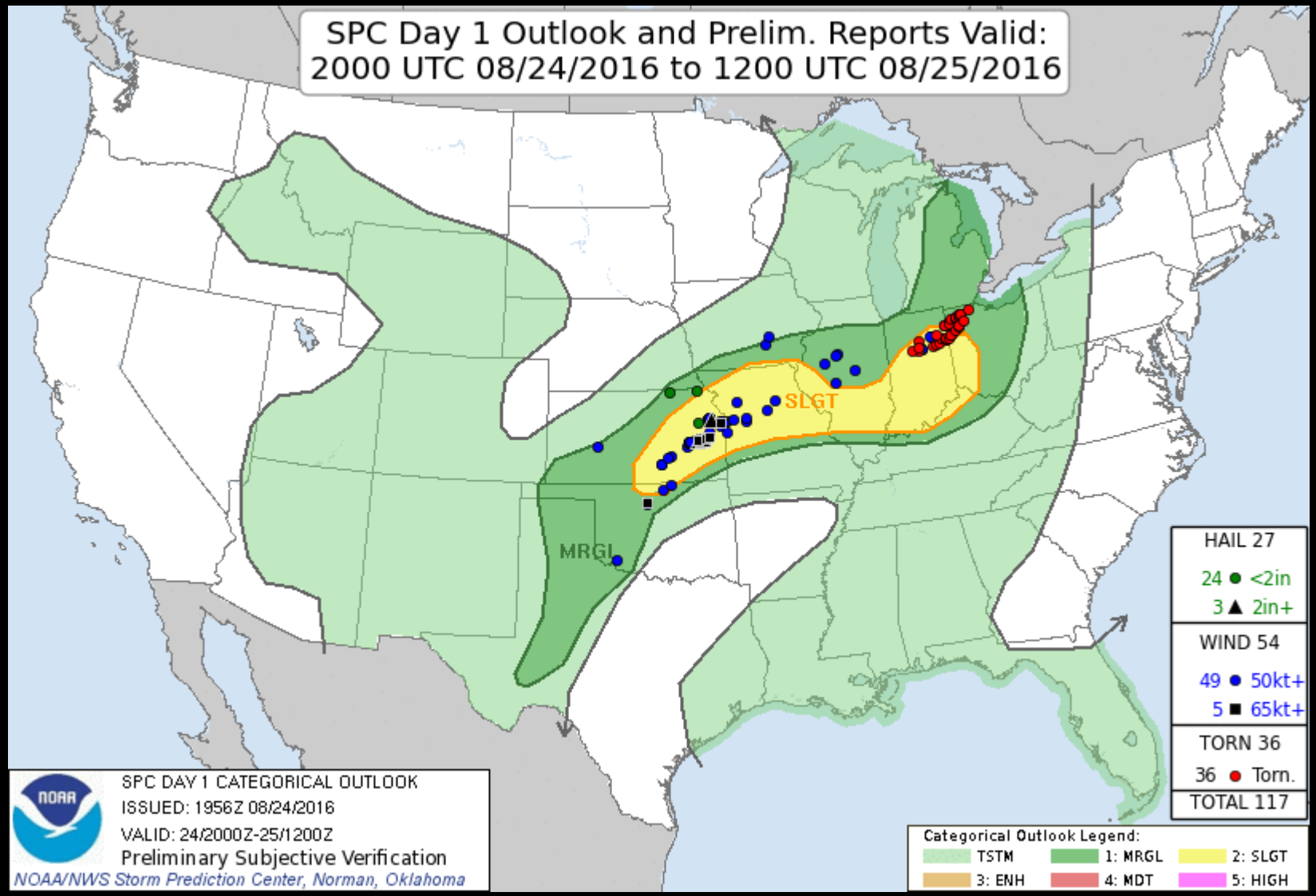
PT&E WFOs: *HUN, MLB, LWX/ZDC, LUB, BOU/ZDV, HGX/ZHU, RAH, OUN, FWD/ZFW* (These are stations that had experience with LMAs in the past)

PT&E Goal: *To confirm stability of the experimental GLM grids with respect to missing data, latency, AWIPS performance, and AWIPS display.*

If the PT&E is successful, details about a wider rollout of the GLM FED to all WFOs via the LDM will be communicated in mid May.

The operational GLM FED Product is tentatively scheduled for dissemination to WFOs via the SBN in September 2018.

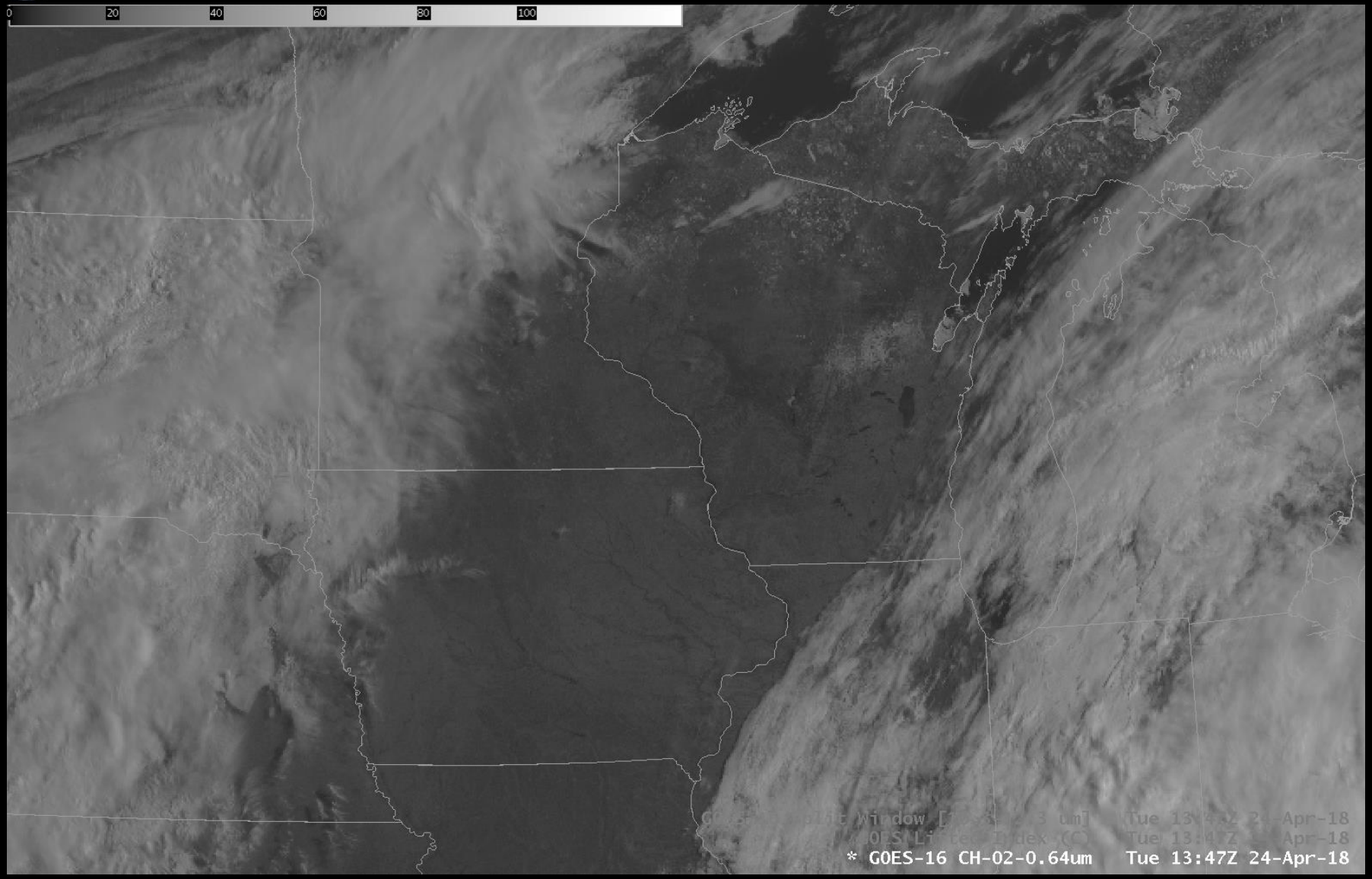
The goal: Prevent Surprises!



Convection is Possible?

- Visible and IR for situational awareness
  - Boundaries at surface and in 3 water vapor channels!
  - Is Moisture changing? How can satellite help?
    - Split Window Difference
    - Derived Stability Indices
    - Moving Boundaries
- Convection is starting
  - Mesoscale Sector for 1-minute imagery
    - Make requests often! Acquire the “Office that Called the most Mesos” Badge and wear it proudly!
    - When does Glaciation occur? How are cloud-tops cooling?
  - ProbSevere?
  - GLM?

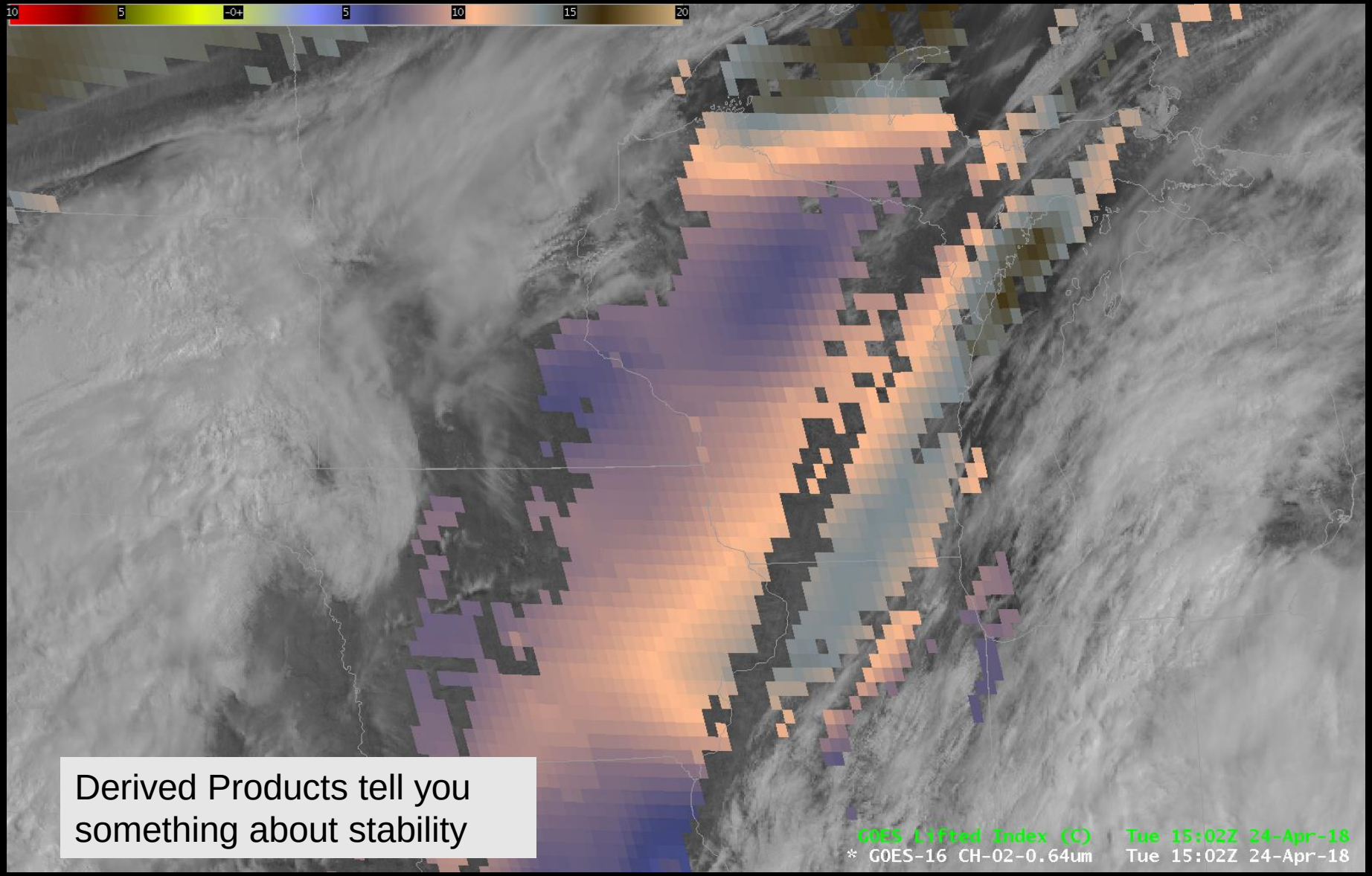
Convection is Possible?



GOES-16 Gives Flexibility

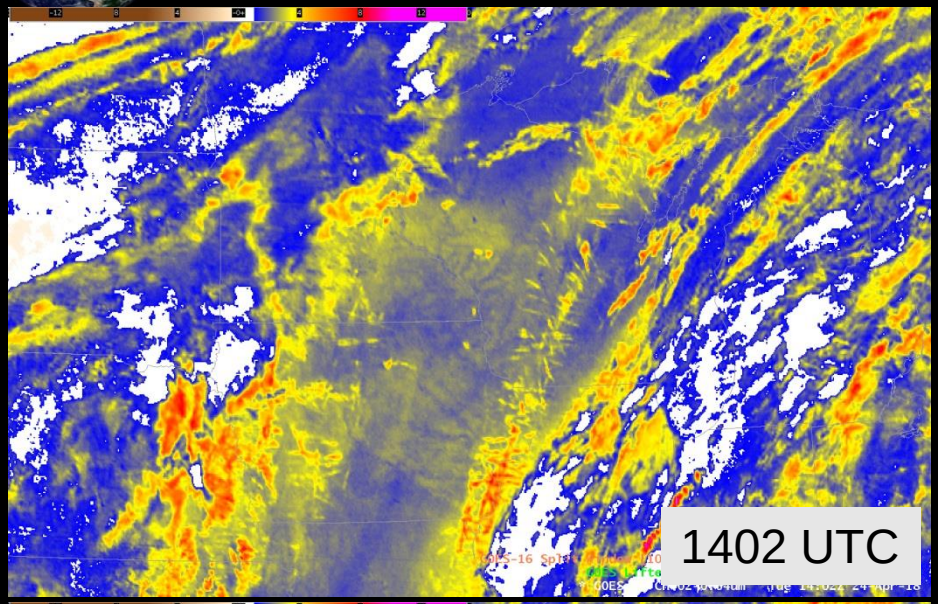
- Choose the product that you like, and use it
  - Understand any limitations
- Derived Stability Indices
  - 10-km resolution
  - Adjustment to GFS initial field, and ABI doesn't offer much in the way of temperature information, but it does give moisture information
- Split Window Difference
  - Highlights moisture, but also changes in boundary layer

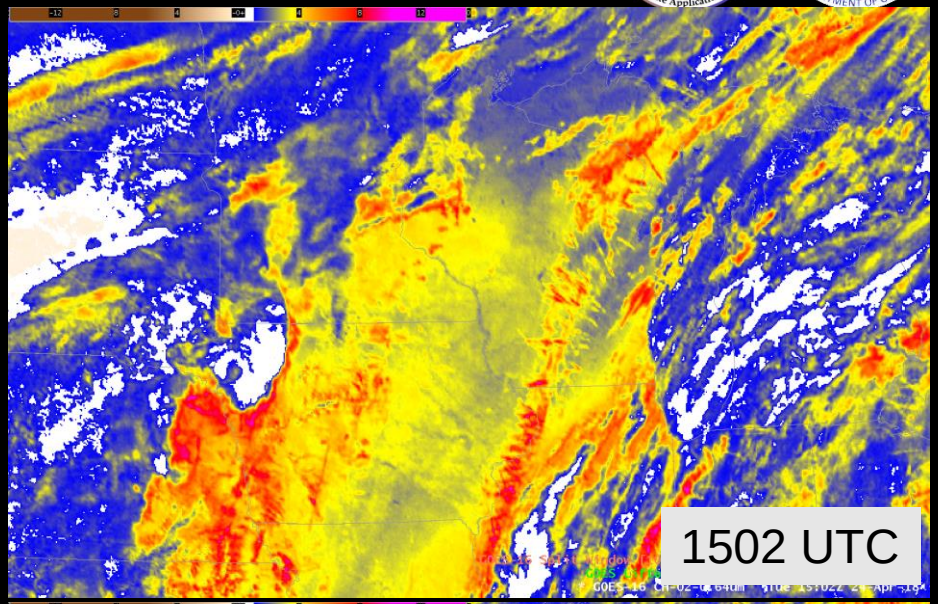
GOES-16 Gives Flexibility

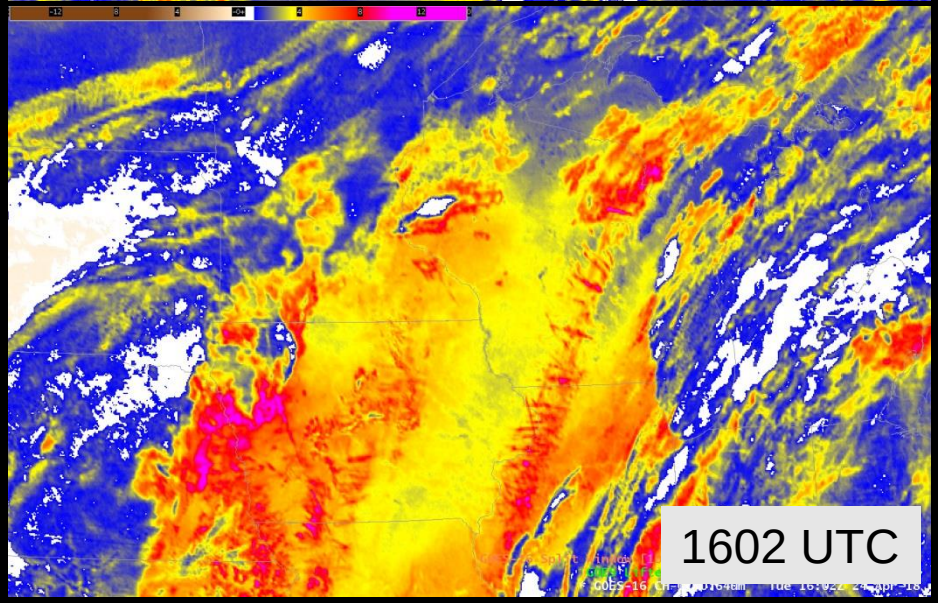


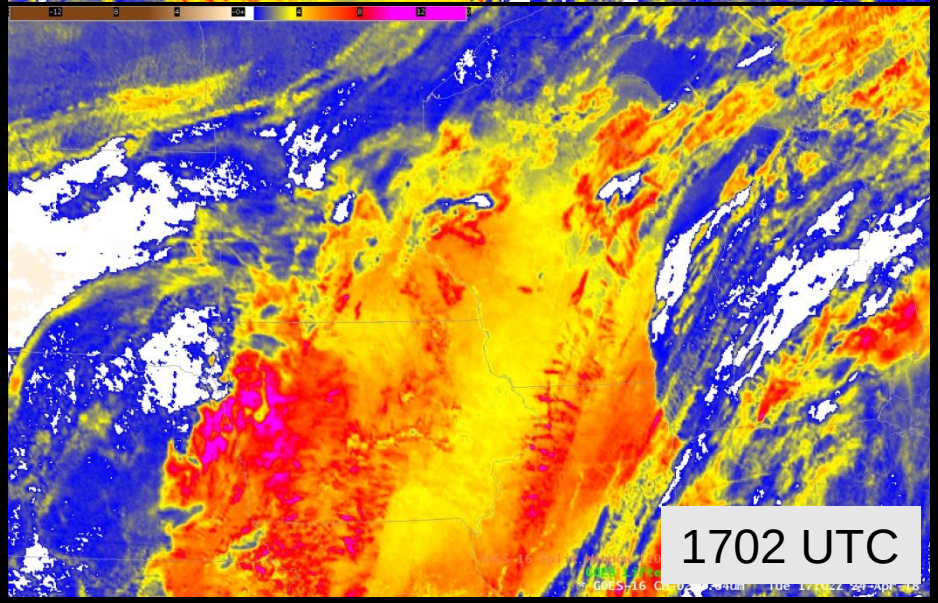
Derived Products tell you something about stability

GOES-16 Gives Flexibility



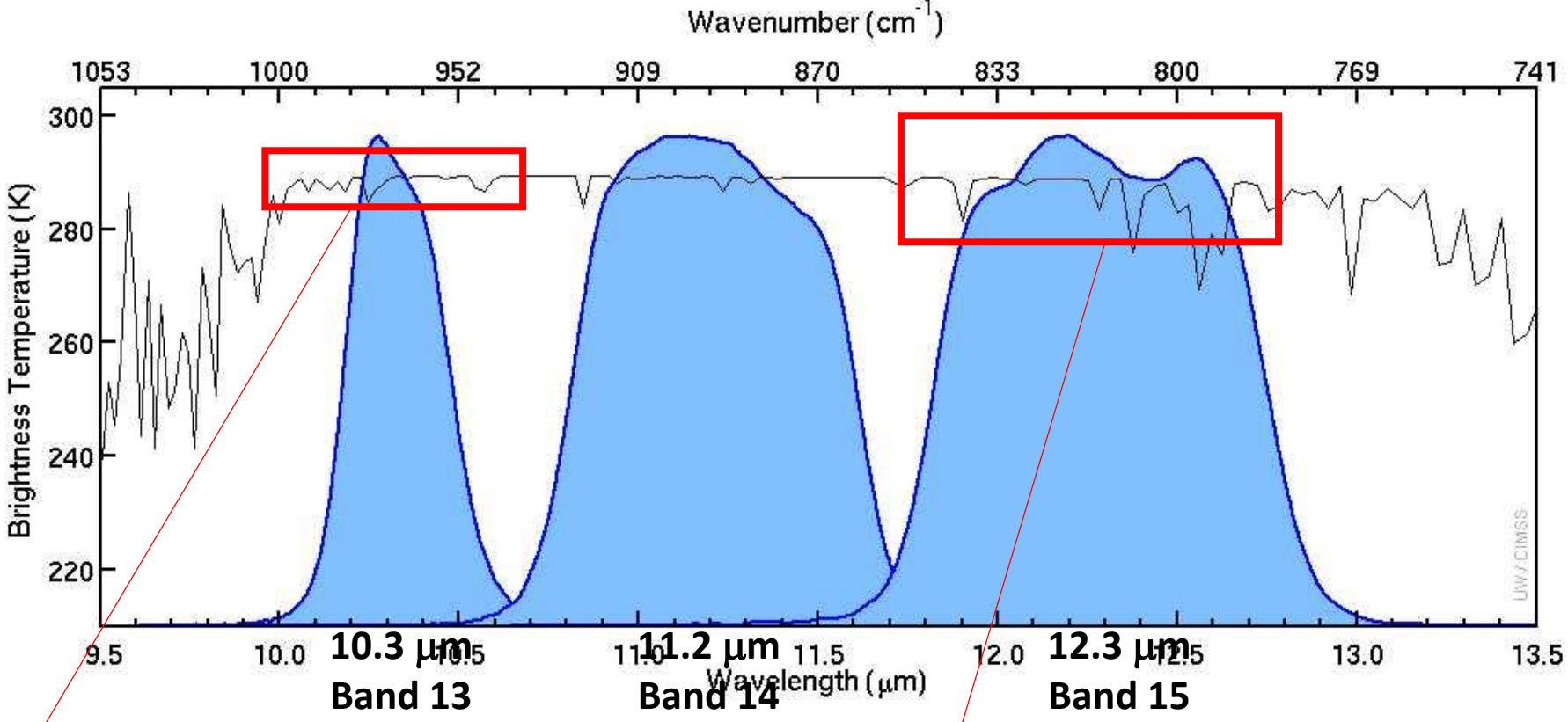






Split Window Difference (10.3μm – 12.3μm)

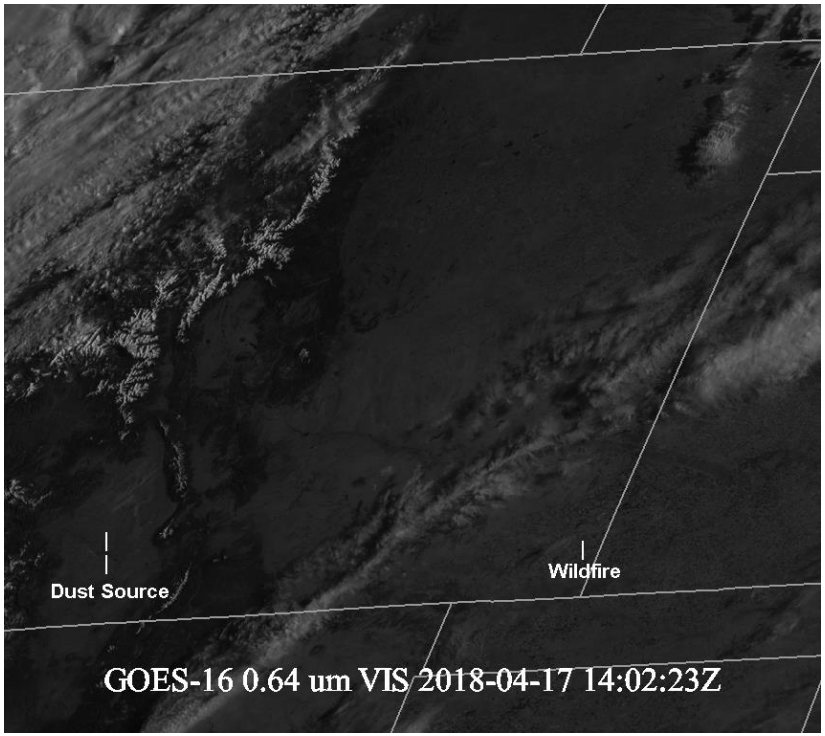
10.3 μm – 12.3 μm
Water Vapor Absorption

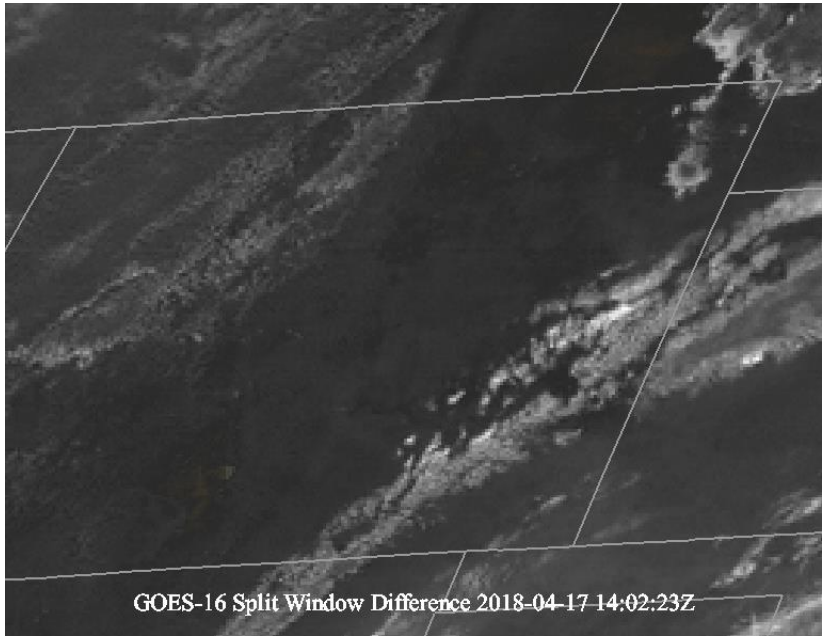


Little cooling due to H_2O vapor absorption

More cooling due to H_2O vapor absorption

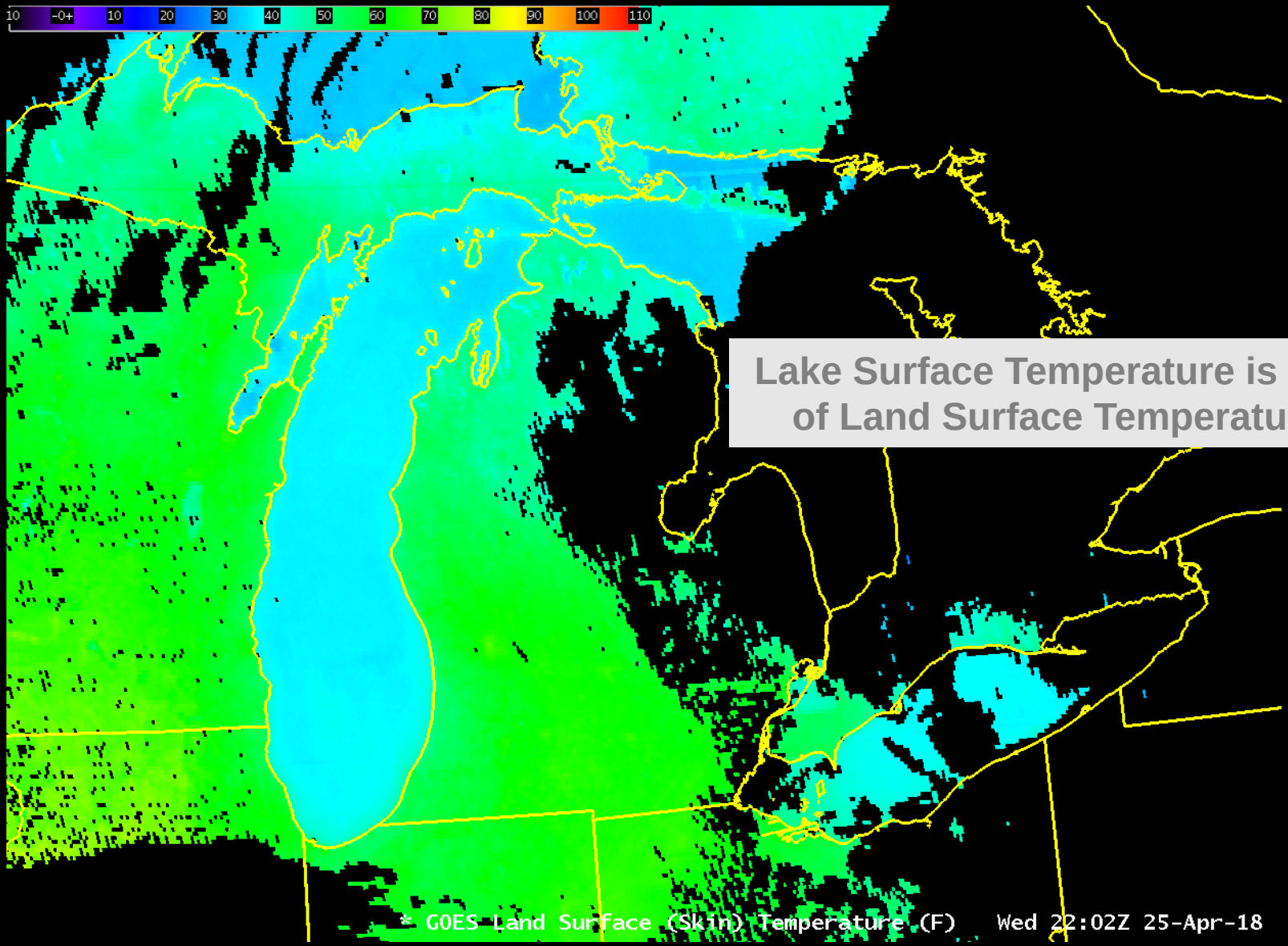
Split Window: Also sees dust (but not smoke)





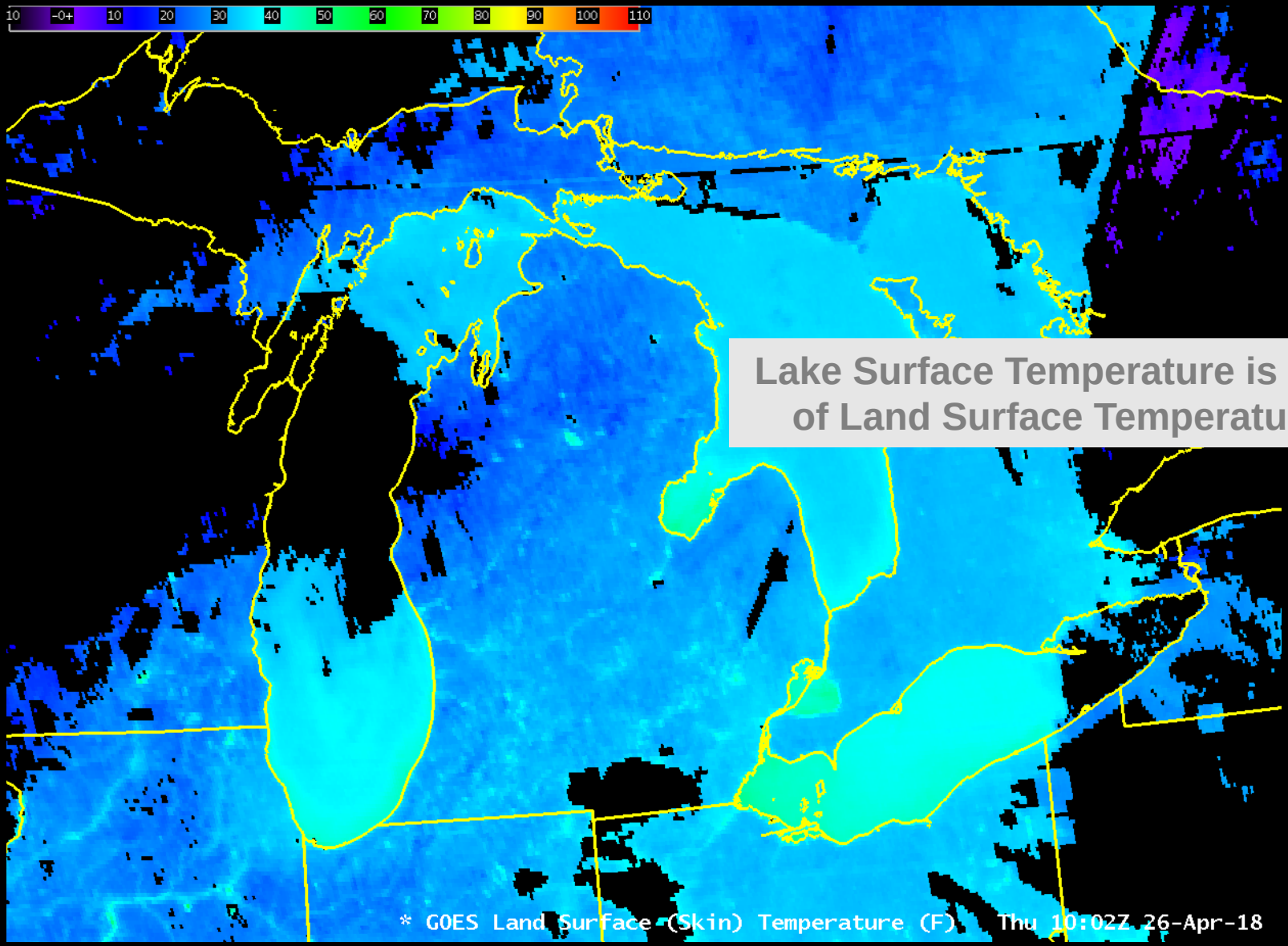
(Image Credit: Bill Line)

GOES-16 Products



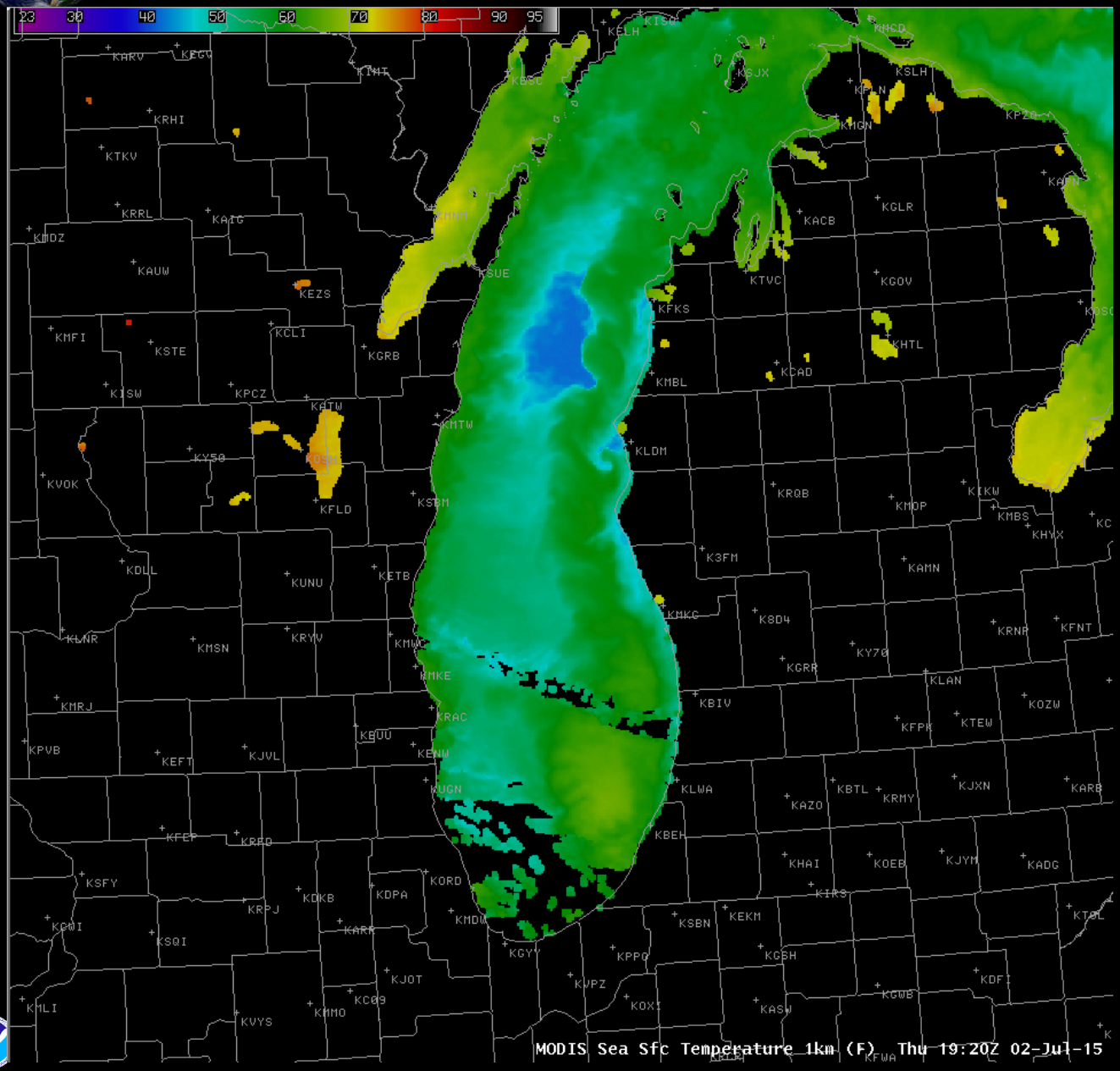
Lake Surface Temperature is part of Land Surface Temperature

GOES-16 Products!!



Lake Surface Temperature is part of Land Surface Temperature

Fine Scale Water Features



AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE
GRAND RAPIDS MI
326 PM EDT THU JUL 2 2015

LATEST UPDATE...

SYNOPSIS/SHORT TERM/LONG TERM/MARINE

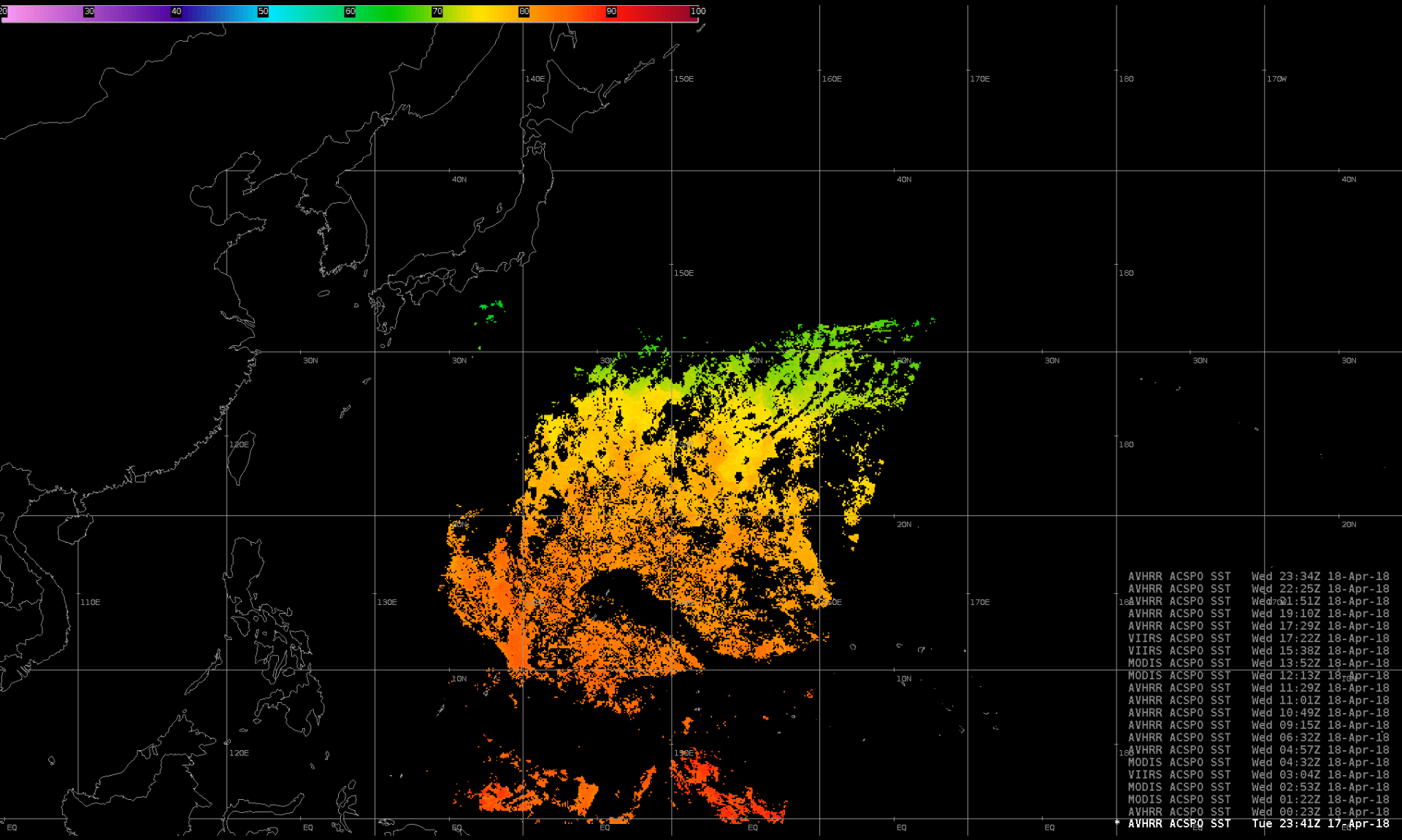
.MARINE...

ISSUED AT 326 PM EDT THU JUL 2 2015

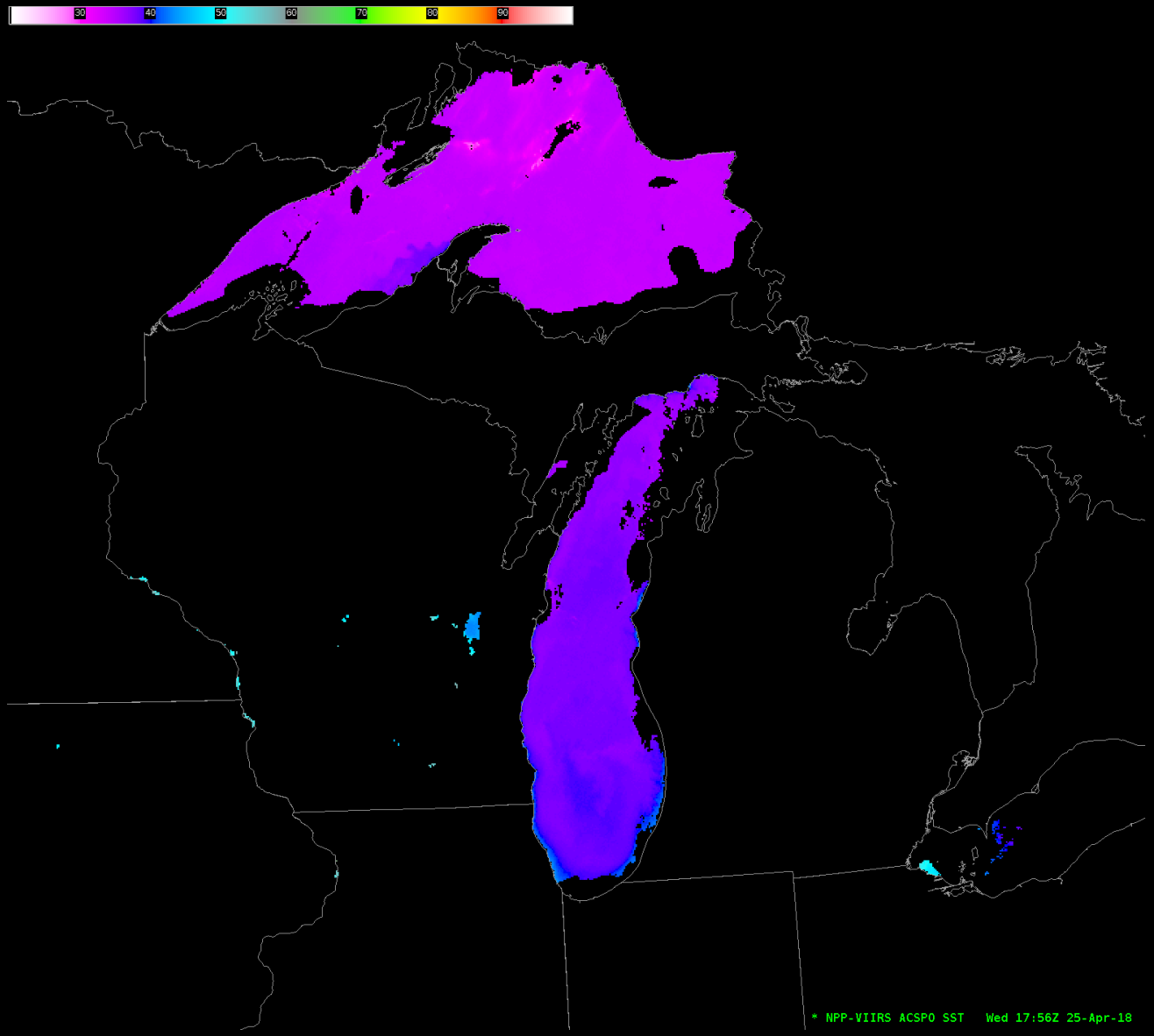
....

ON ANOTHER NOTE...SOME UPWELLING HAS OCCURRED AT THE SHORELINE WITH THE NNE WINDS OVER THE LAST DAY. SOME WATER TEMPS HAVE DROPPED TO NEAR 40F ALONG THE SHORE PER LATEST WATER OBSERVATIONS FROM THE SITES ALONG THE COAST THIS MORNING AND MODIS SATELLITE IMAGERY.

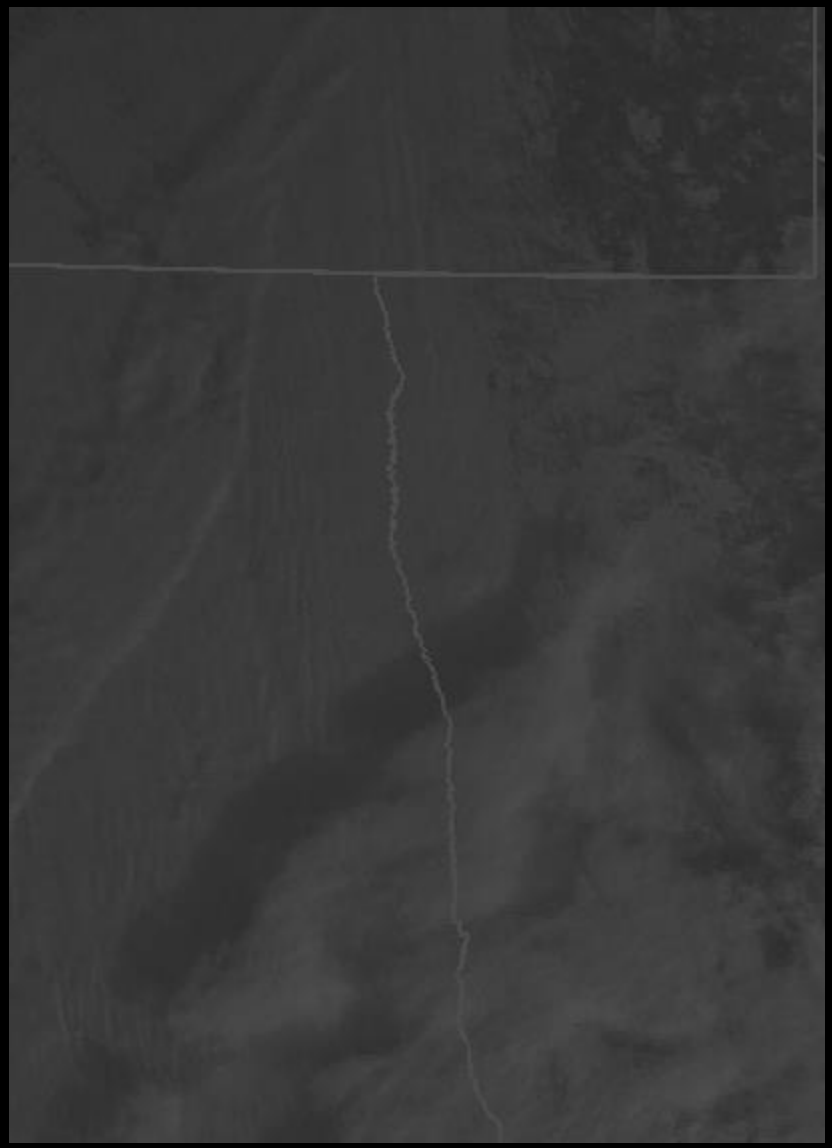
(There's also a JPSS SST)



ACSPO SSTs 25 April

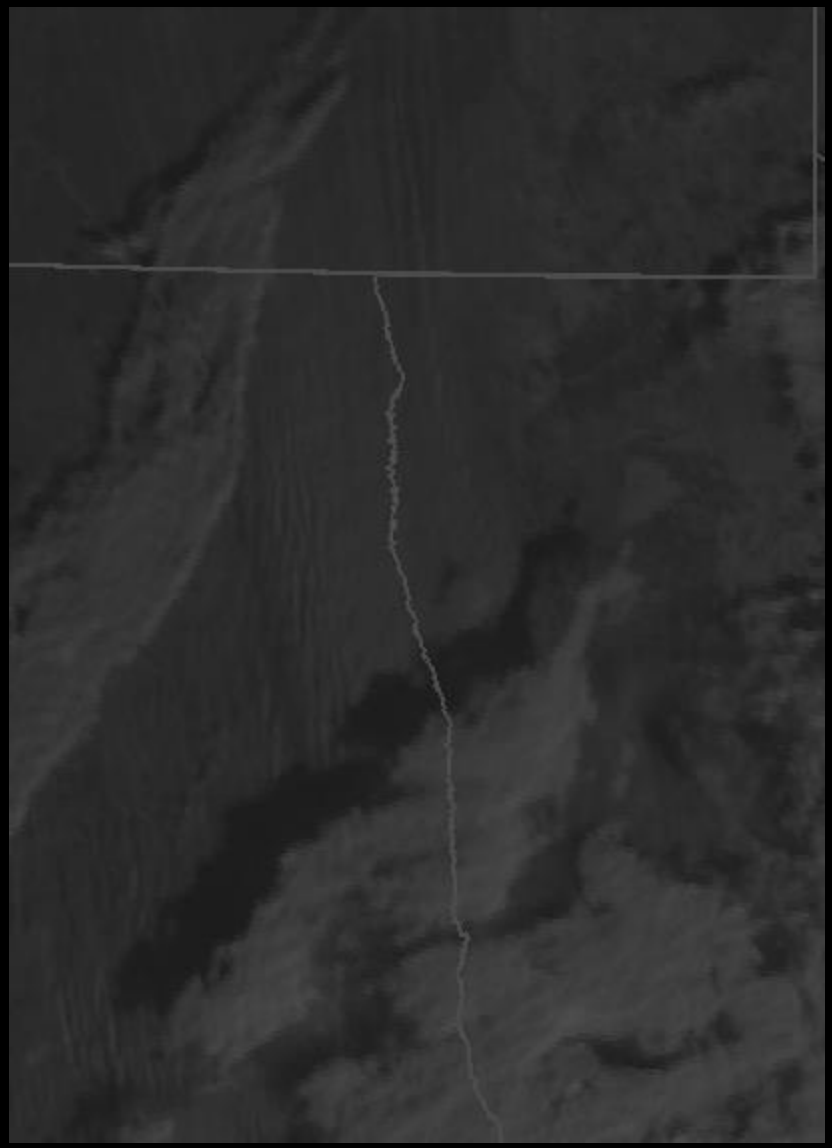


Blowing Snow



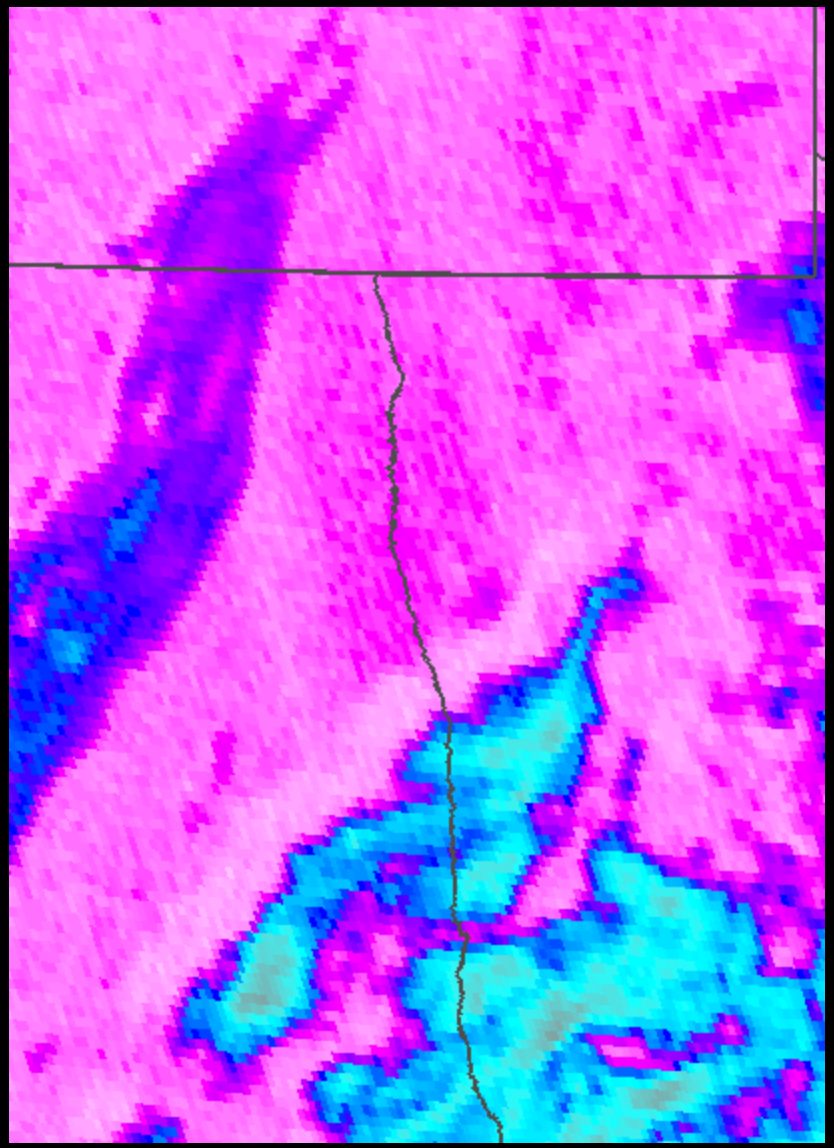
- Can you use GOES-16 to see blowing snow?
- The image at left is from January 15th, from 1457-2257 UTC.
- (Thanks to Phil Schumacher/Tommy Grafenauer for this case)

Blowing Snow



- The Snow/Ice Channel (1.61 μm) has a brighter character in the region of blowing snow
- Particle Size effect? Smaller crystals will be more reflective

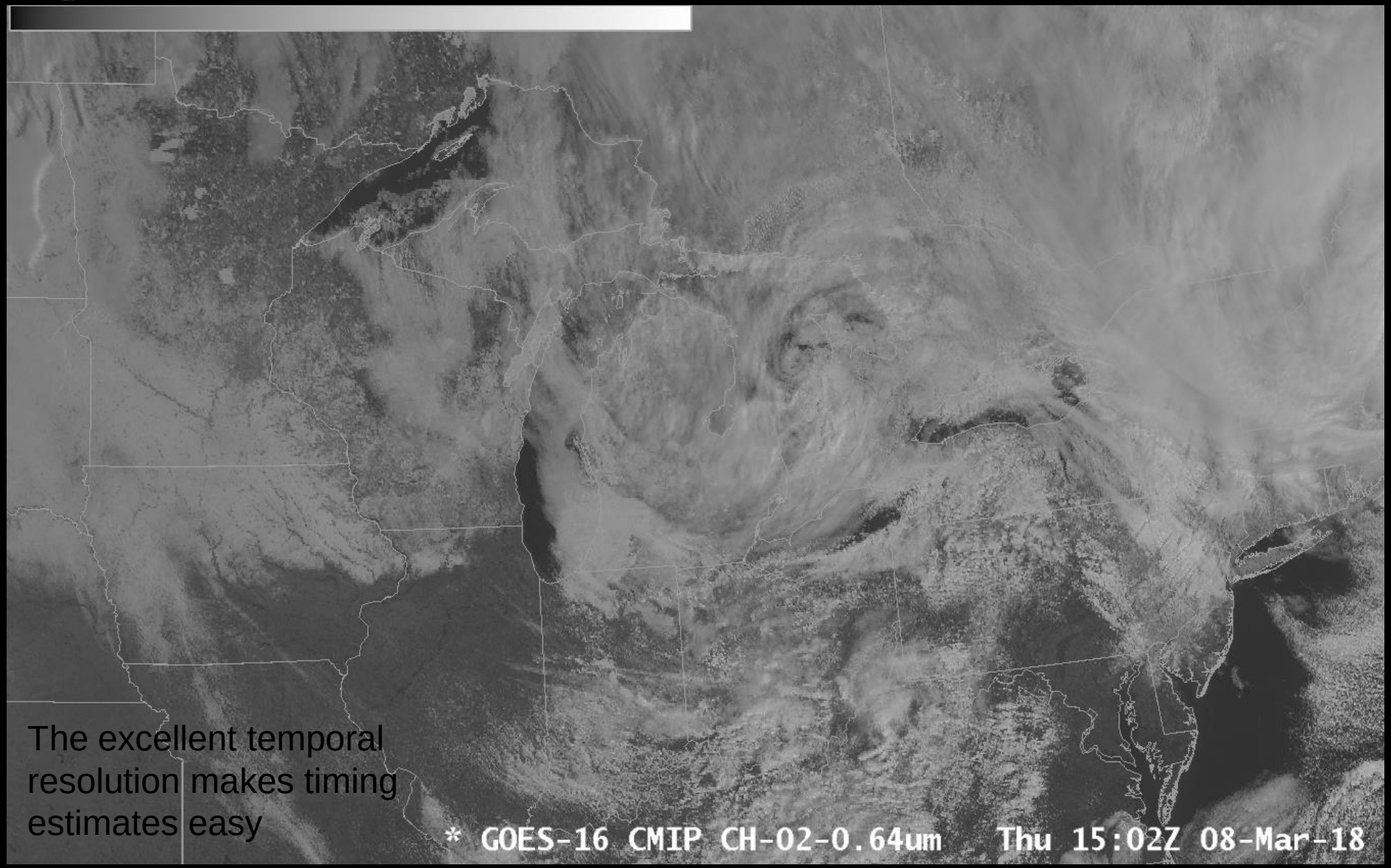
Blowing Snow



- Day Fog Brightness Temperature Difference (10.3 – 3.9) shows a different value over the blowing snow
- More reflectance at 3.9 by small ice crystals

Blowing Snow

Compelling visual imagery

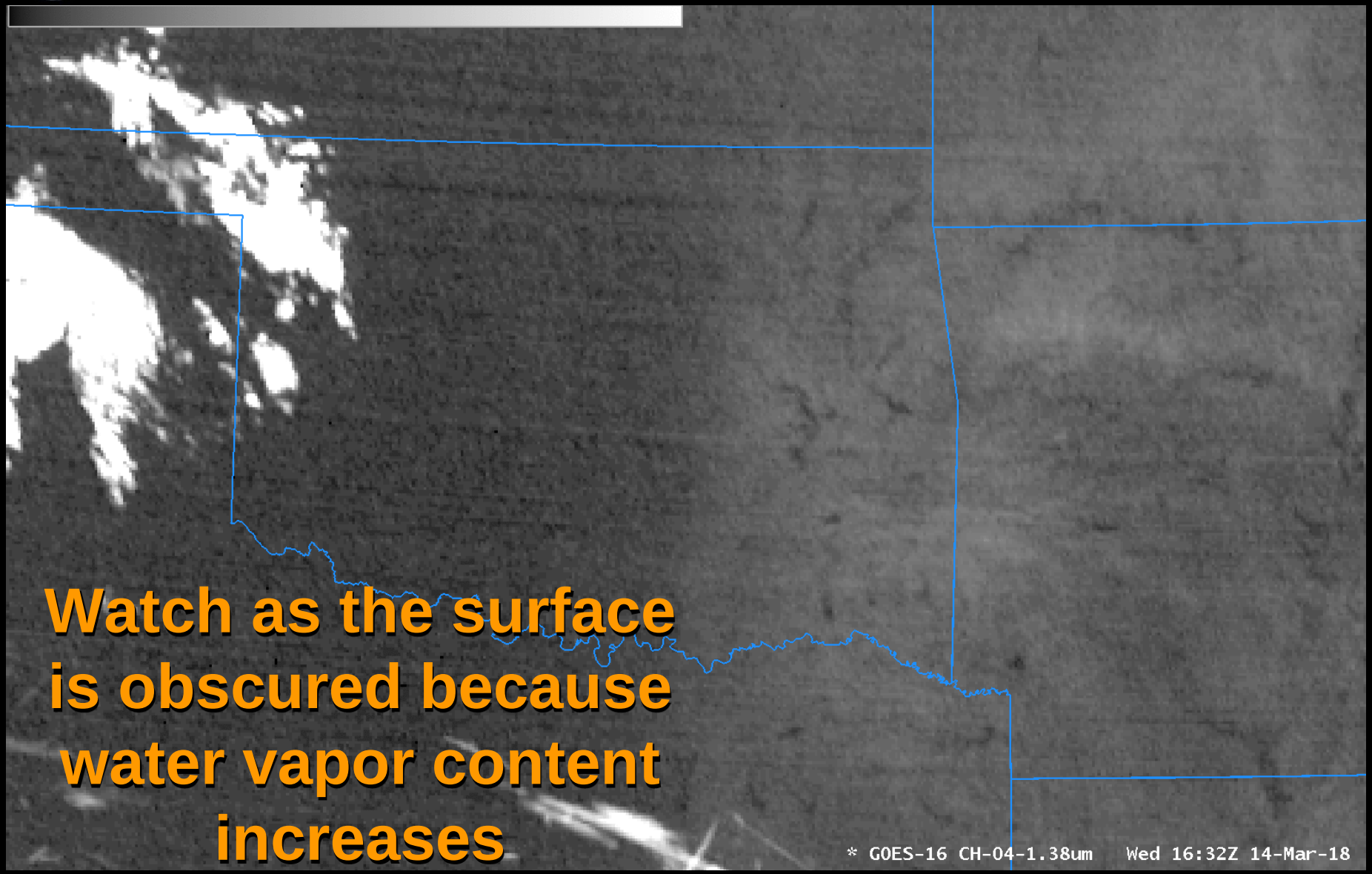


The excellent temporal resolution makes timing estimates easy

New Channels, New Information

- (New to Geostationary, that is)

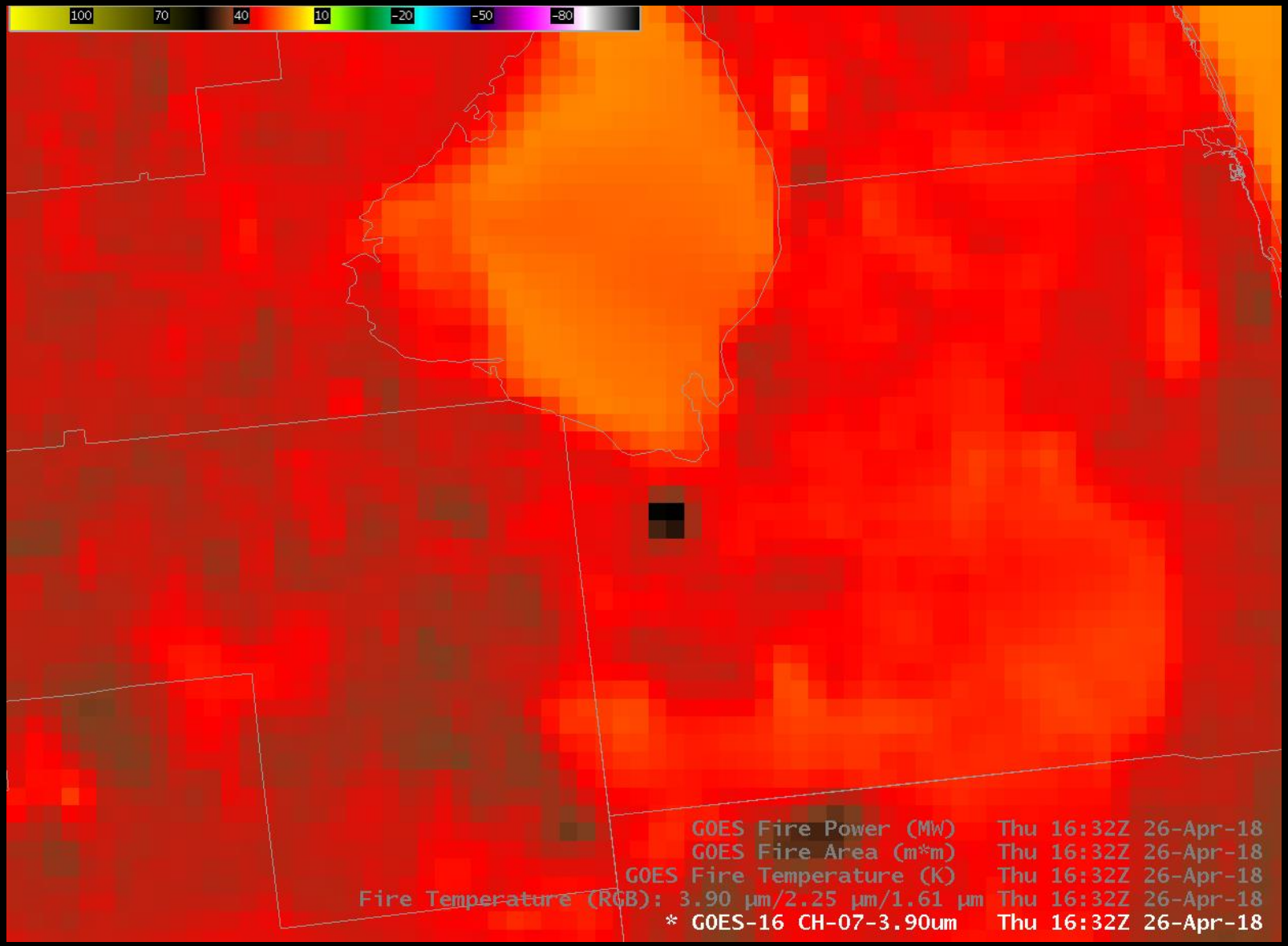
- 1.61 μm
  - My favorite! So many applications to use: snow/ice detection, glaciation in clouds,
- 1.37 μm
  - The ‘cirrus’ channel – indicates moisture content, to some extent, because water vapor strongly absorbs energy with this wavelength.


Watch as the surface is obscured because water vapor content increases
* GOES-16 CH-04-1.38um Wed 16:32Z 14-Mar-18

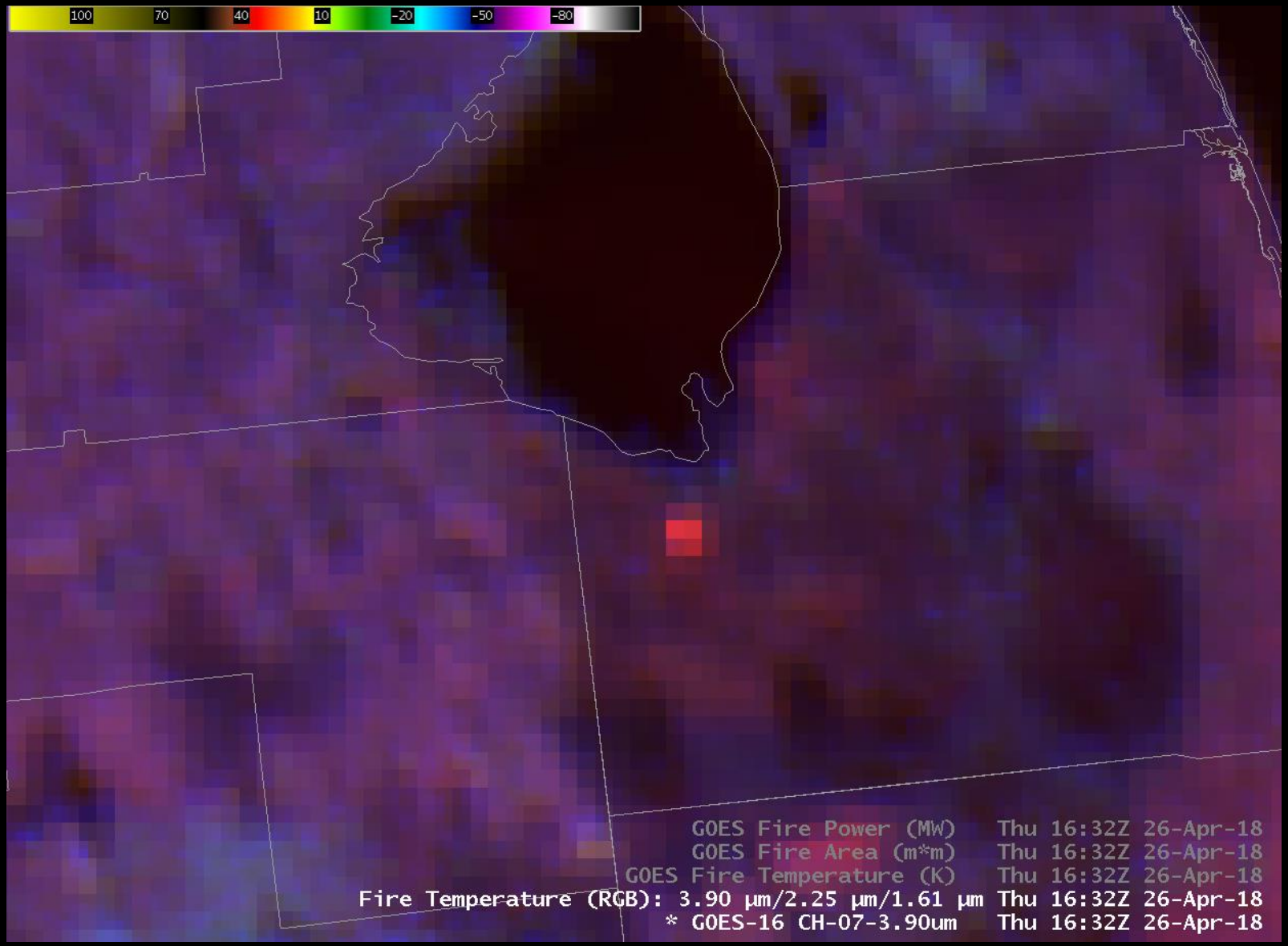
Choices in Fire Detection

- There are many ways to detect fires
  - 3.9 μm imagery
  - Fire RGB product that includes the 3.9 μm
  - Quantitative Derived Products
    - Fire Temperature
    - Fire Power
    - Fire Area

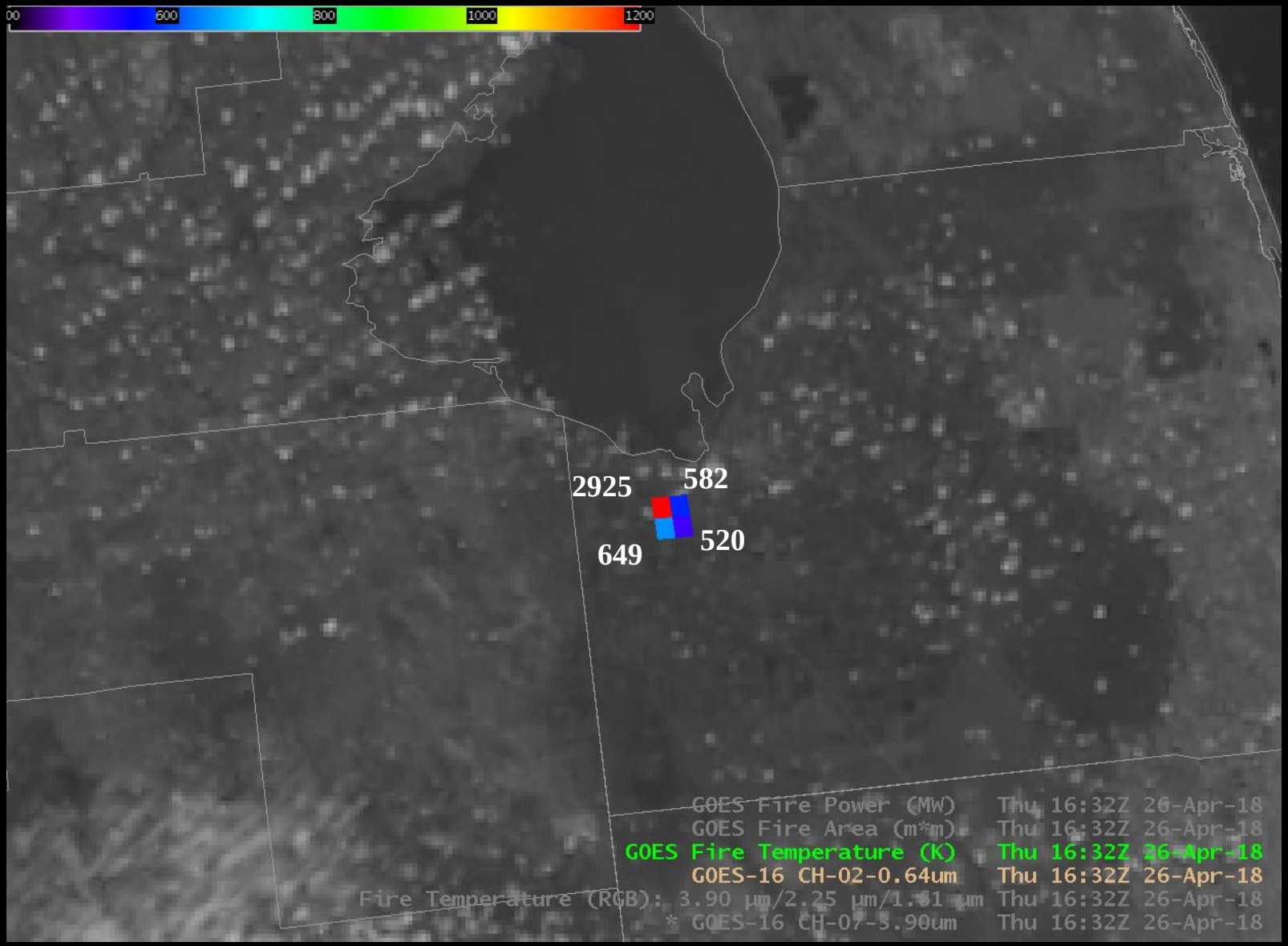
ABI Band 07


100
70
40
10
-20
-50
-80
GOES Fire Power (MW) Thu 16:32Z 26-Apr-18
GOES Fire Area (m*m) Thu 16:32Z 26-Apr-18
GOES Fire Temperature (K) Thu 16:32Z 26-Apr-18
Fire Temperature (RGB): 3.90 µm/2.25 µm/1.61 µm Thu 16:32Z 26-Apr-18
* GOES-16 CH-07-3.90um Thu 16:32Z 26-Apr-18

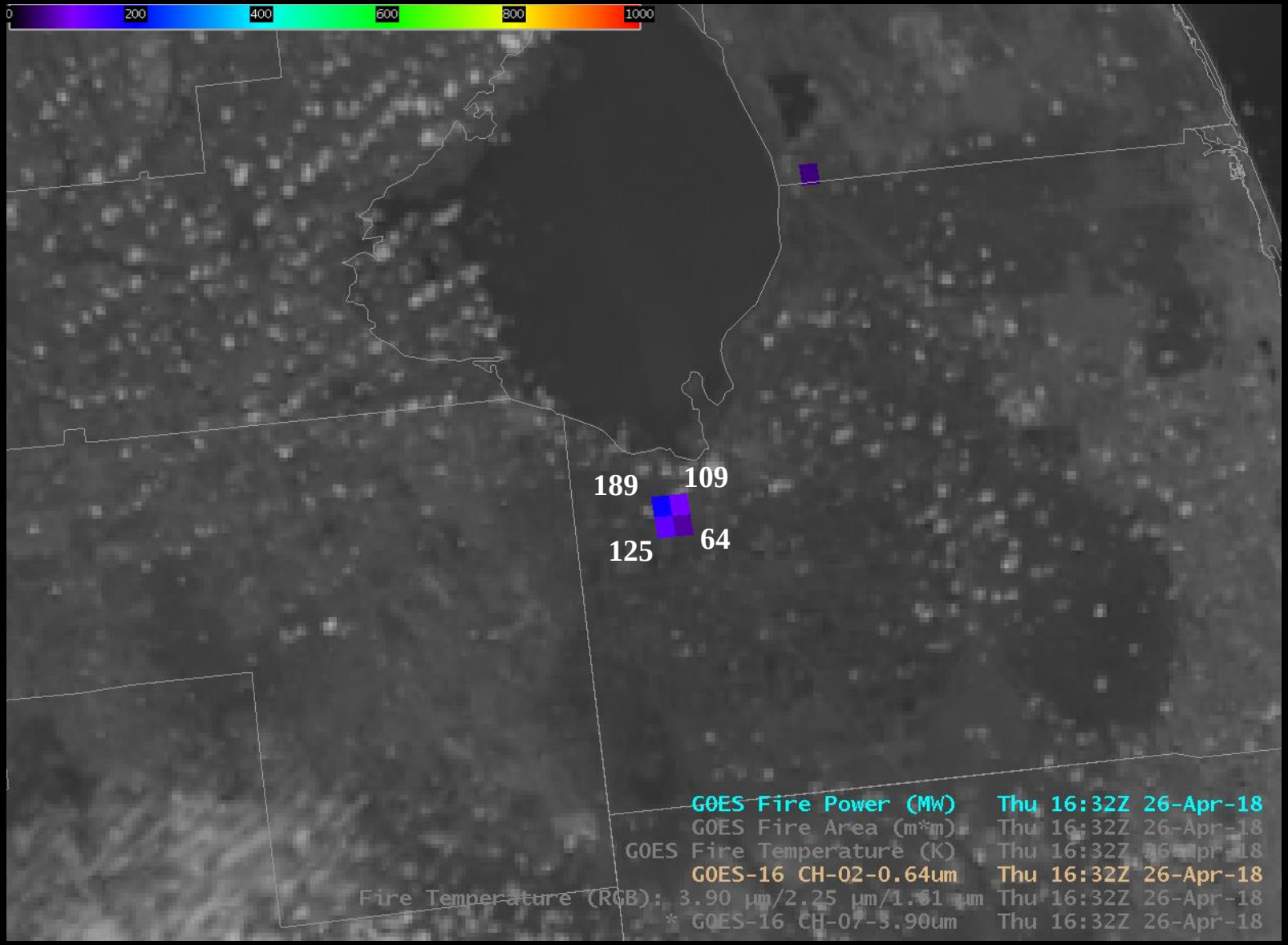
Fire RGB


100
70
40
10
-20
-50
-80
GOES Fire Power (MW) Thu 16:32Z 26-Apr-18
GOES Fire Area (m*m) Thu 16:32Z 26-Apr-18
GOES Fire Temperature (K) Thu 16:32Z 26-Apr-18
Fire Temperature (RGB): 3.90 µm/2.25 µm/1.61 µm Thu 16:32Z 26-Apr-18
* GOES-16 CH-07-3.90um Thu 16:32Z 26-Apr-18

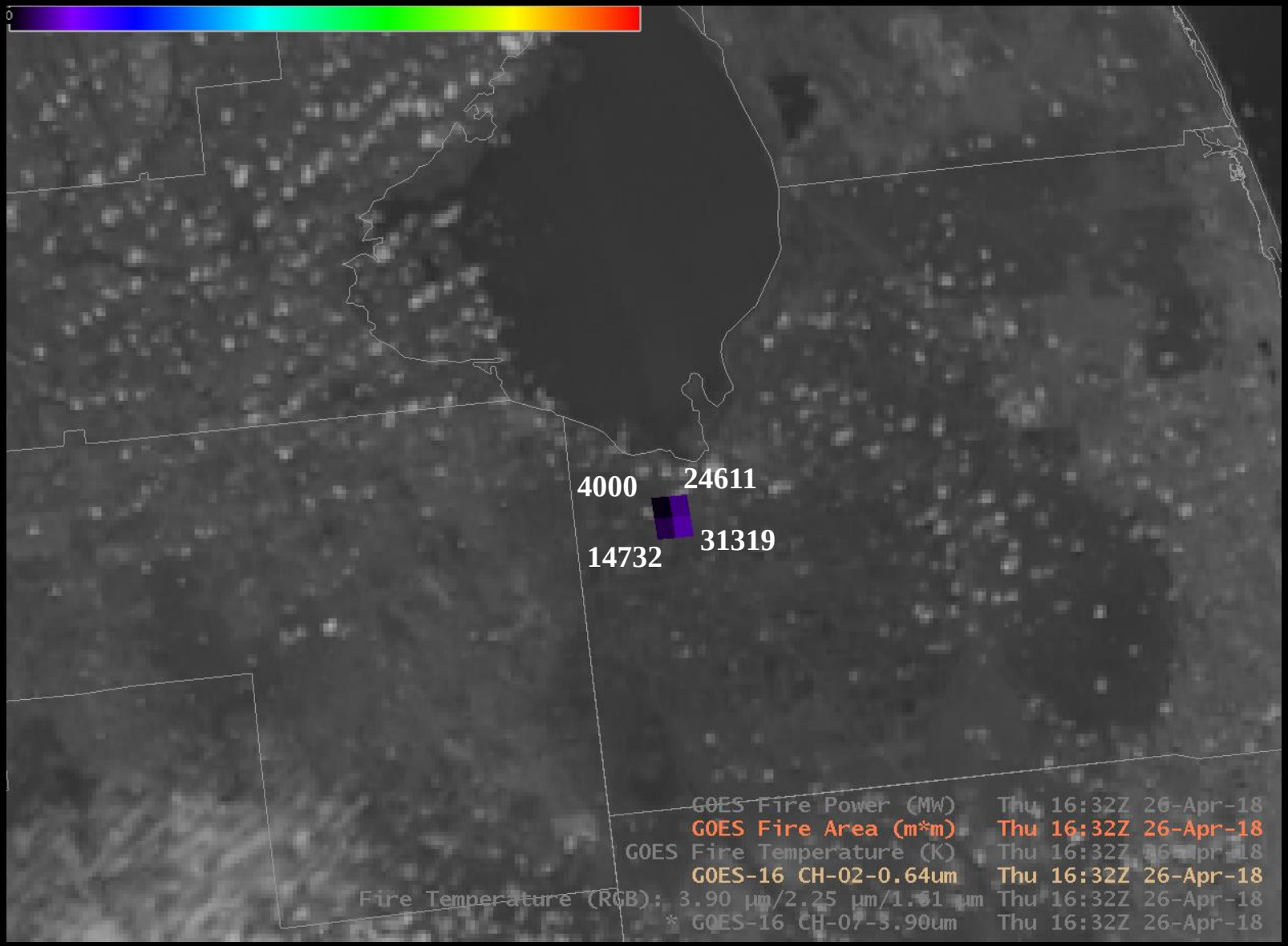
L2 Fire Temperature



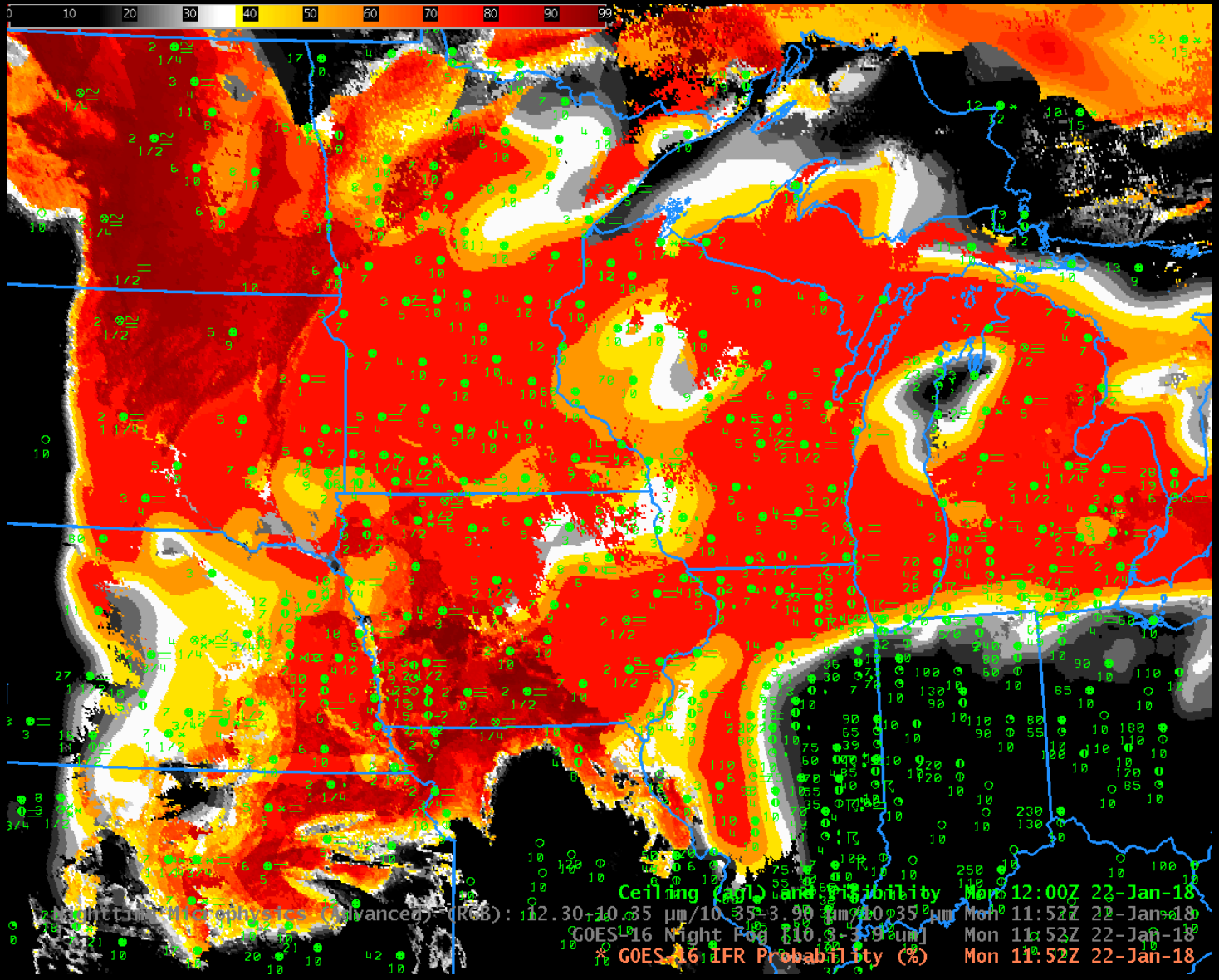
L2 Fire Power



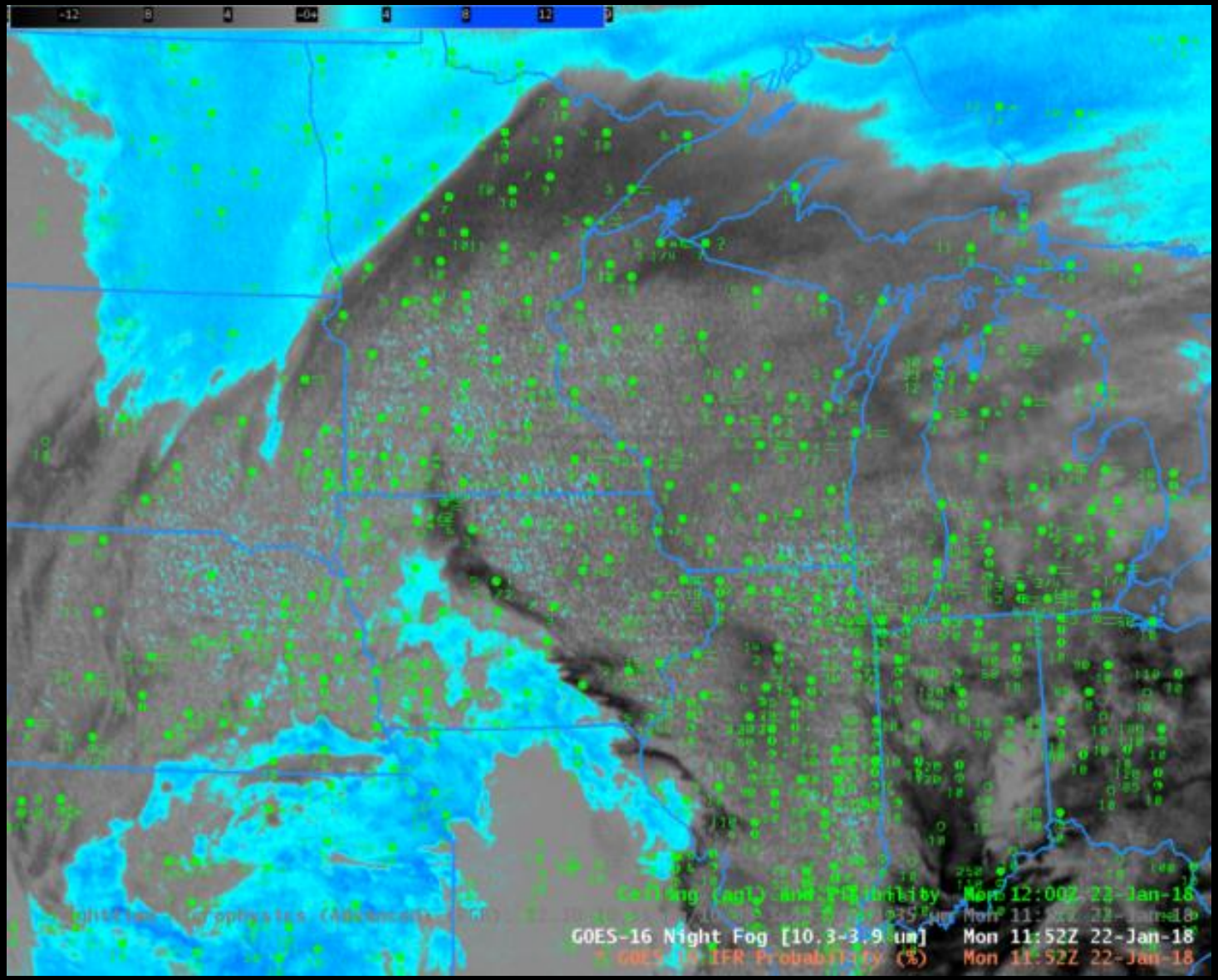
L2 Fire Area


4000
24611
31319
14732
GOES Fire Power (MW) Thu 16:32Z 26-Apr-18
GOES Fire Area (m*m) Thu 16:32Z 26-Apr-18
GOES Fire Temperature (K) Thu 16:32Z 26-Apr-18
GOES-16 CH-02-0.64um Thu 16:32Z 26-Apr-18
Fire Temperature (RGB): 3.90 µm/2.25 µm/1.61 µm Thu 16:32Z 26-Apr-18
* GOES-16 CH-07-3.90um Thu 16:32Z 26-Apr-18

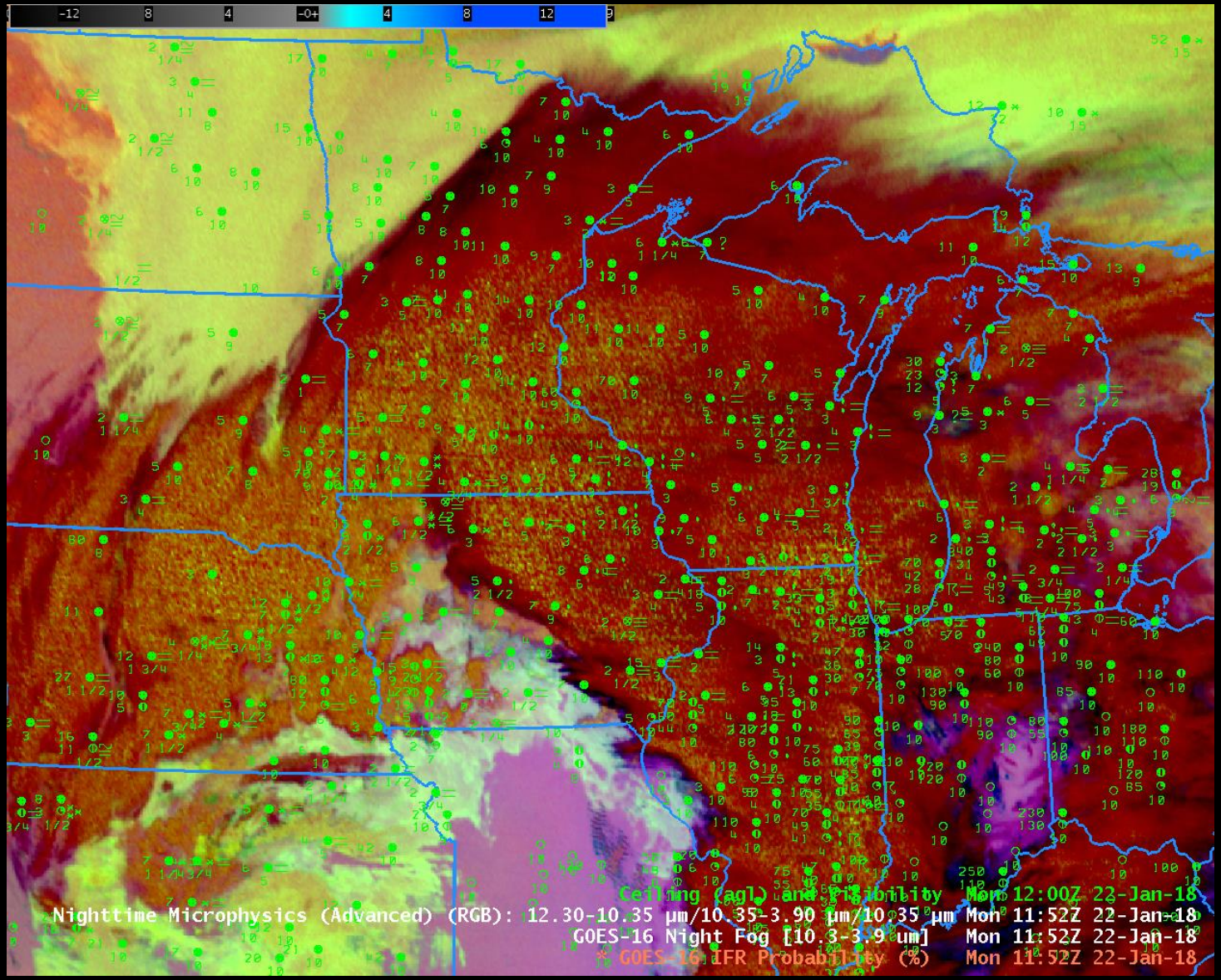
Choices in Fog Detection!



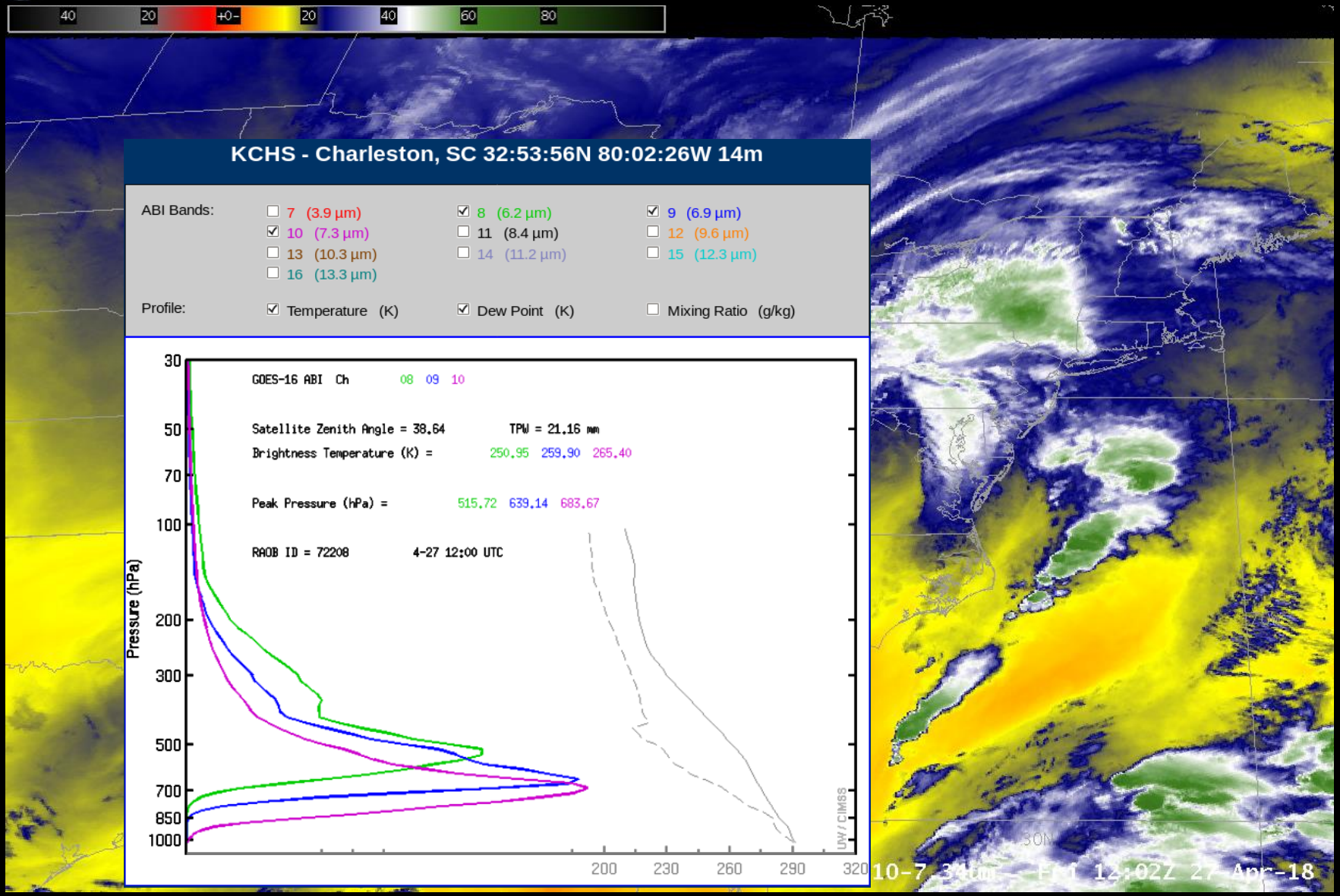
Choices in Fog Detection



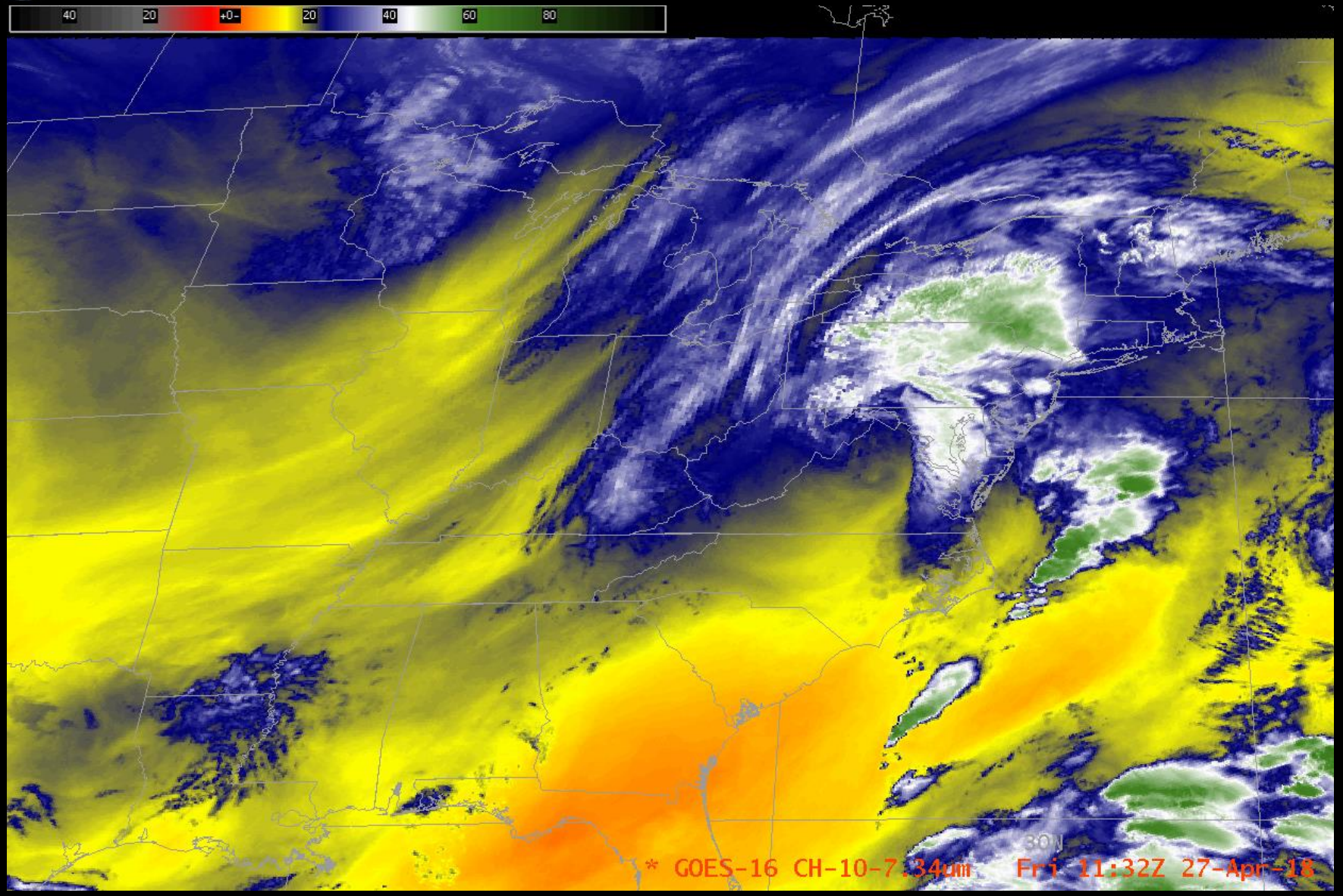
Choices in Fog Detection



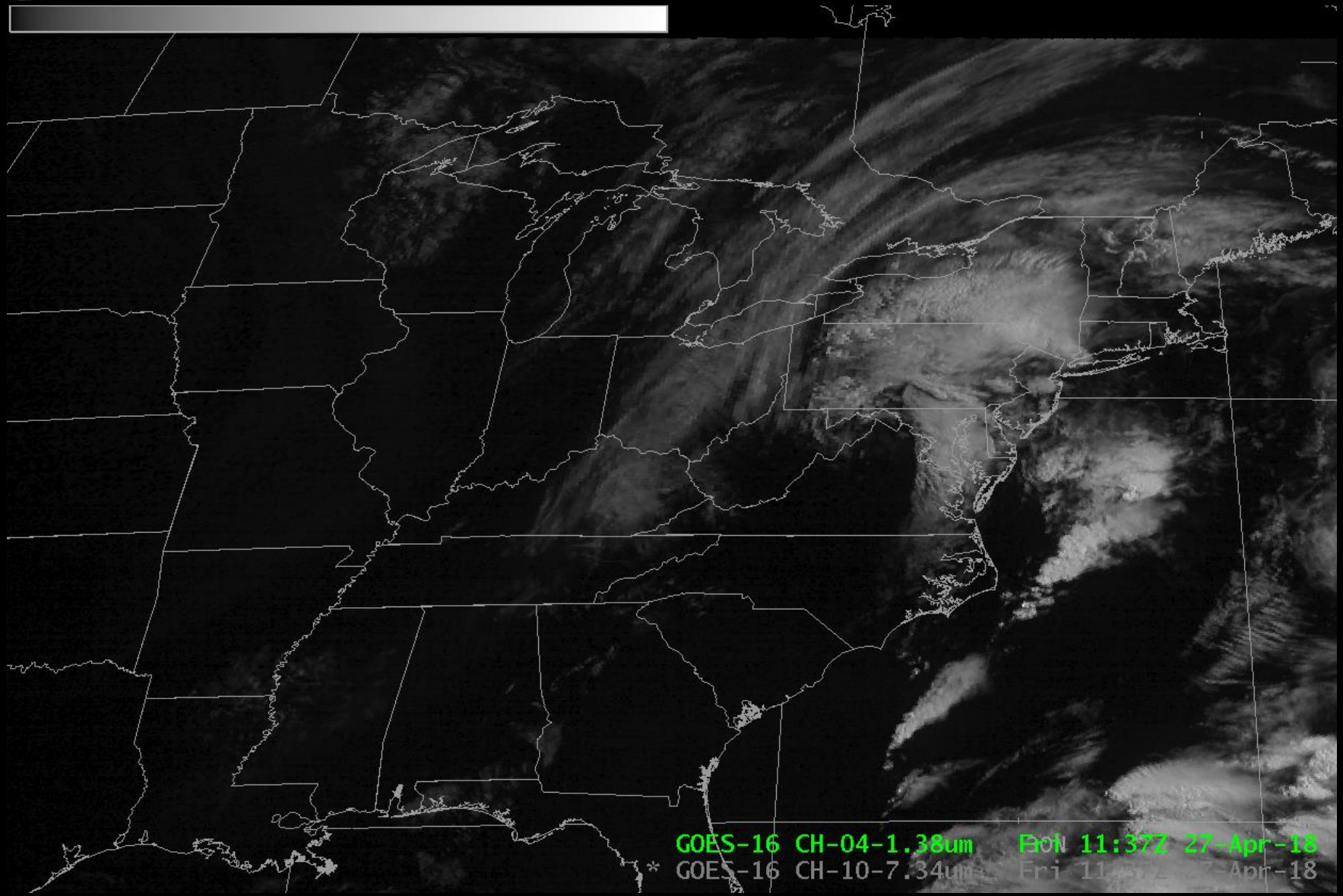
Water Vapor


40 20 +0- 20 40 60 80
KCHS - Charleston, SC 32:53:56N 80:02:26W 14m
ABI Bands:
7 (3.9 µm)
8 (6.2 µm)
9 (6.9 µm)
10 (7.3 µm)
11 (8.4 µm)
12 (9.6 µm)
13 (10.3 µm)
14 (11.2 µm)
15 (12.3 µm)
16 (13.3 µm)
Profile:
Temperature (K)
Dew Point (K)
Mixing Ratio (g/kg)
GOES-16 ABI Ch 08 09 10
Satellite Zenith Angle = 38.64
TPW = 21.16 mm
Brightness Temperature (K) = 250.95 259.90 265.40
Peak Pressure (hPa) = 515.72 639.14 683.67
RAOB ID = 72208
4-27 12:00 UTC
Pressure (hPa)
30
50
70
100
200
300
500
700
850
1000
200
230
260
290
320
UW/CIMSS

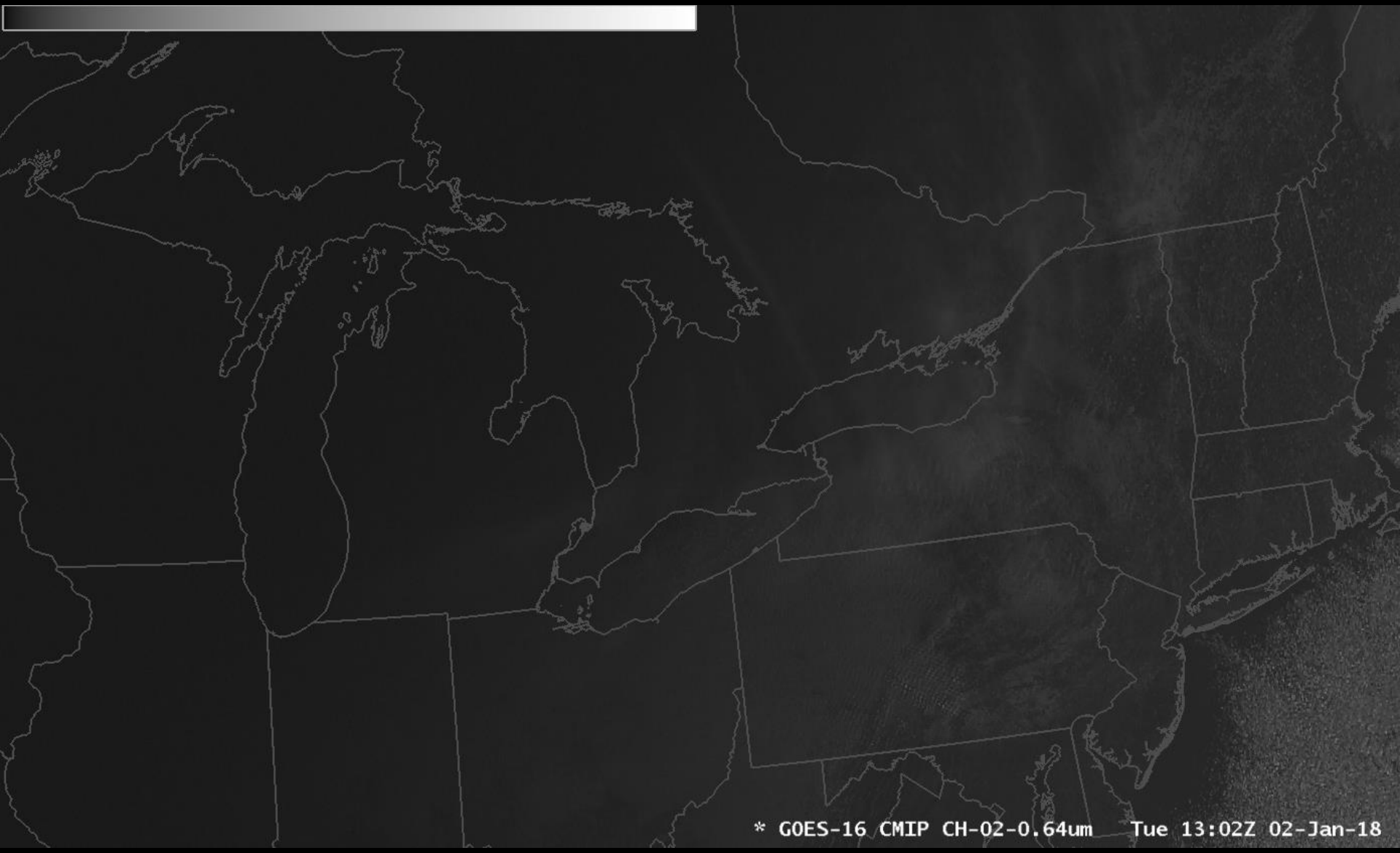
Water Vapor Animations



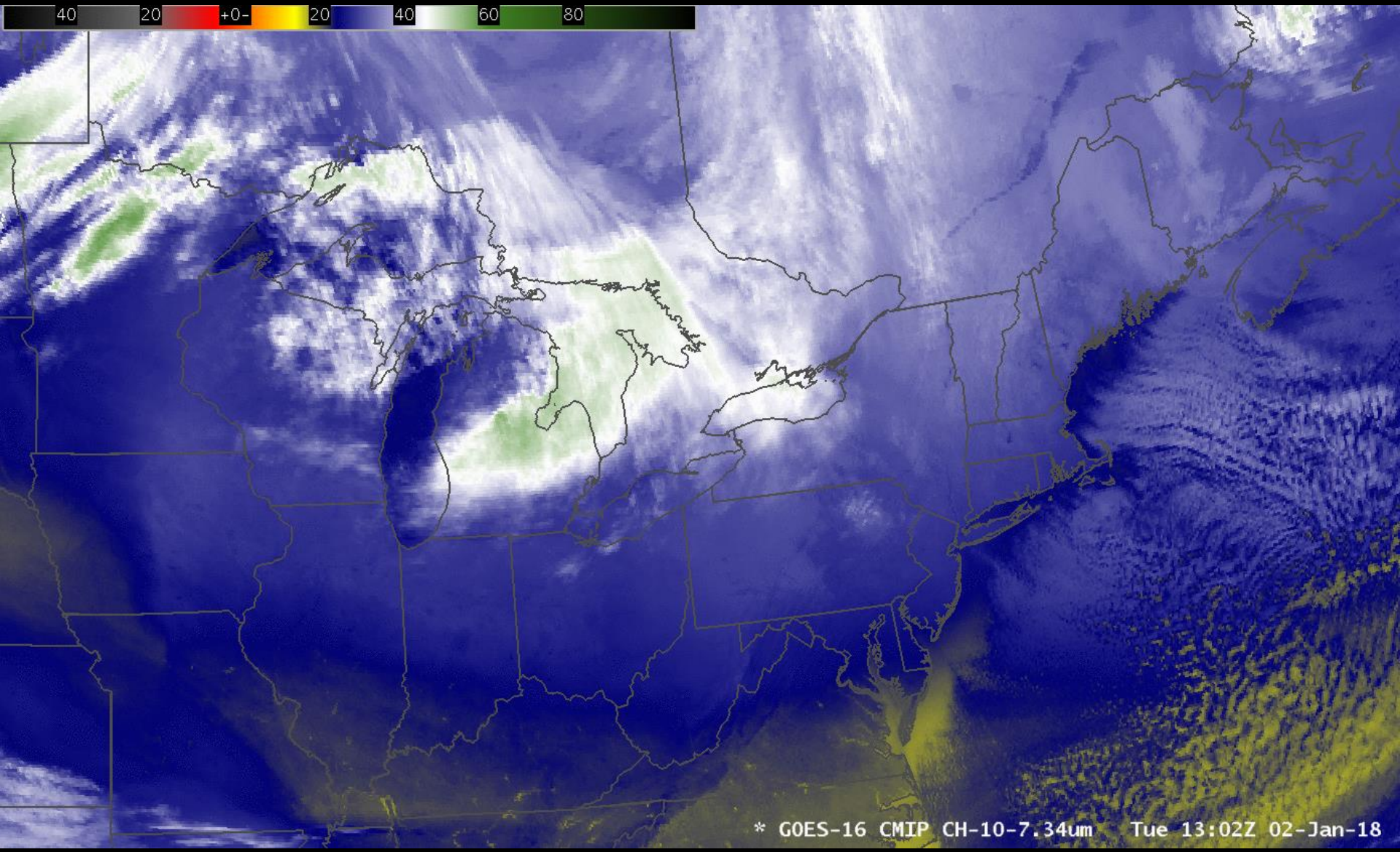
Cirrus Channel



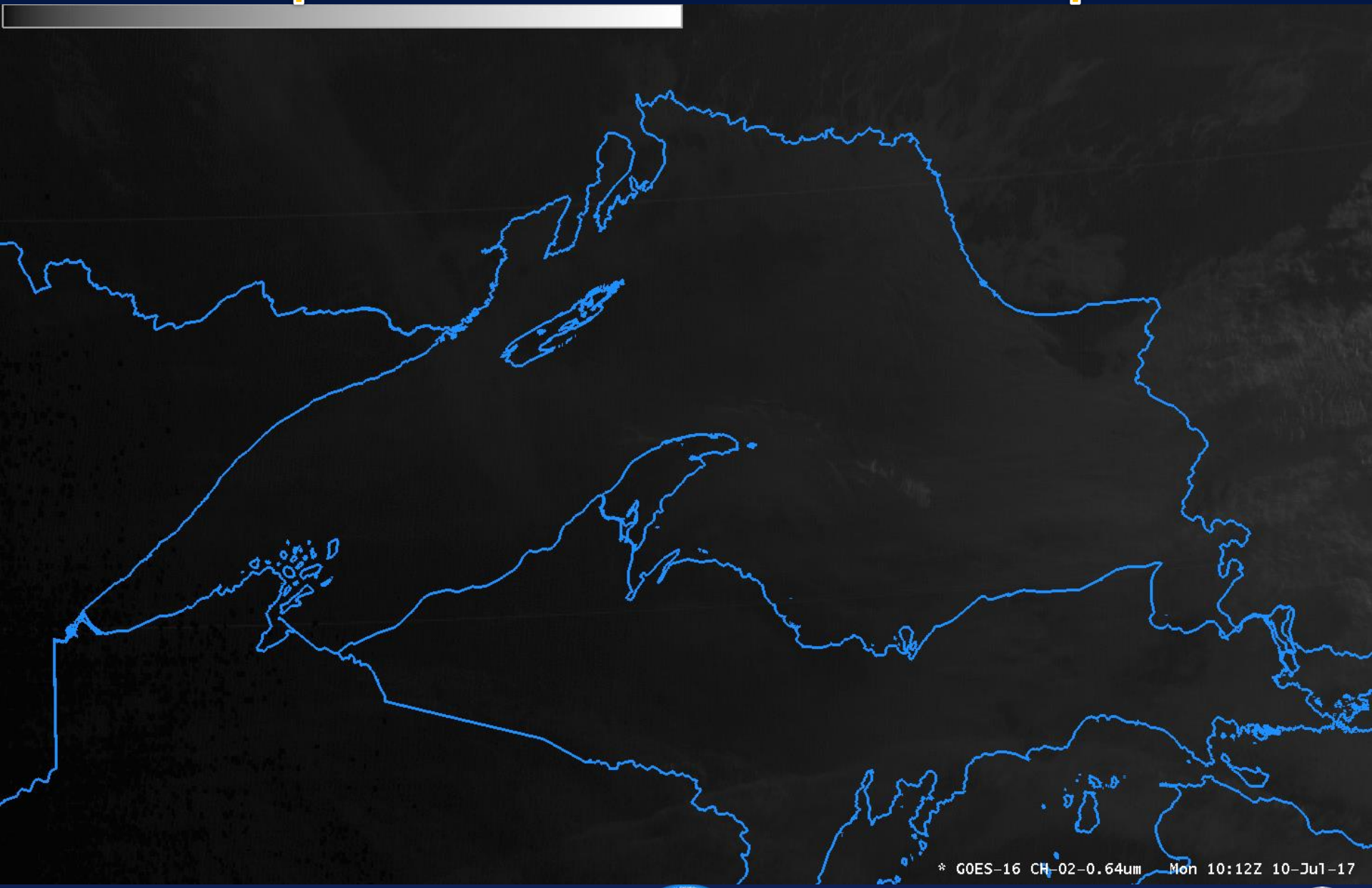
Lake Effect 2 Jan 2018



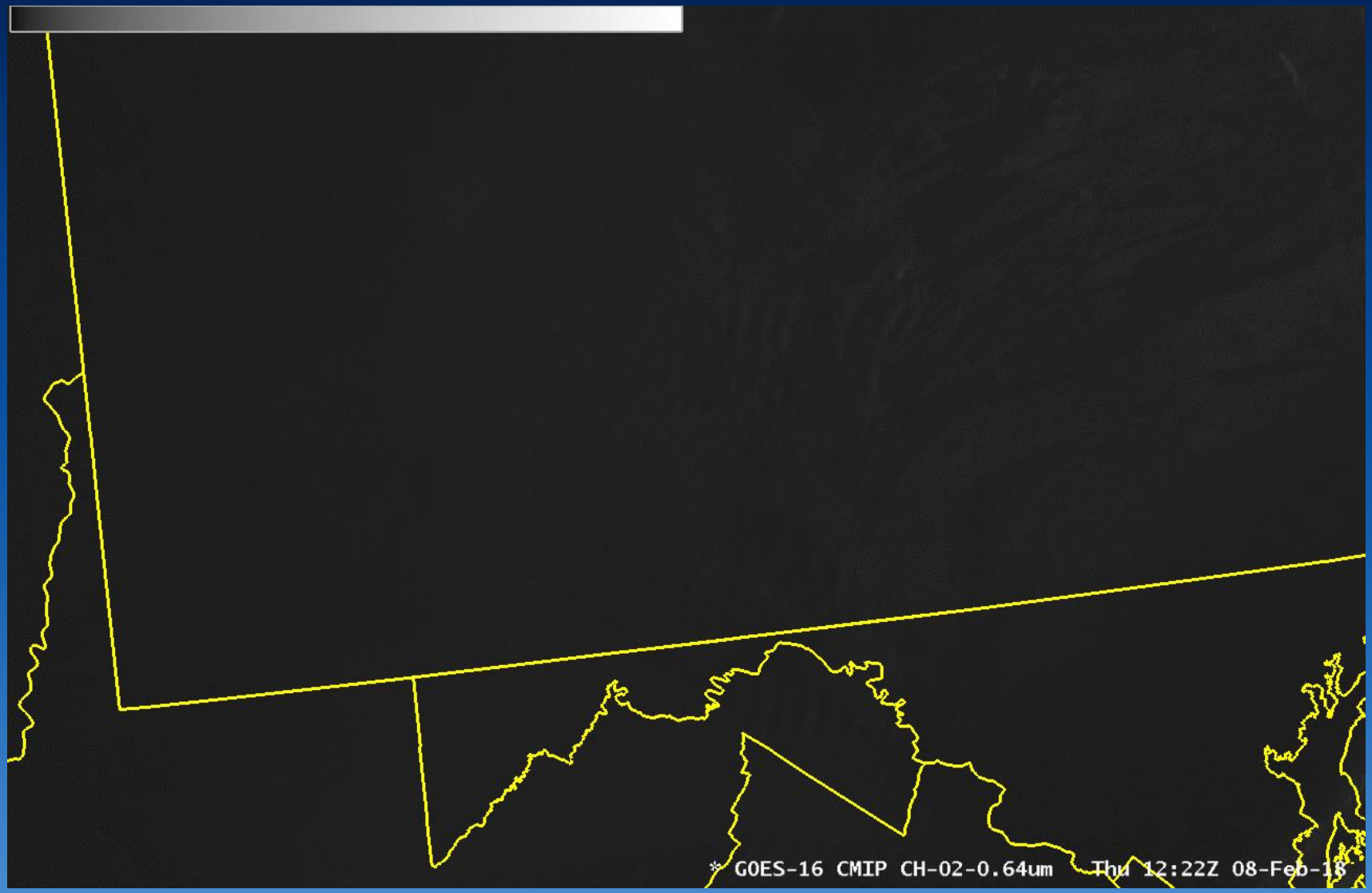
ABI Band 10 (Low level WV)



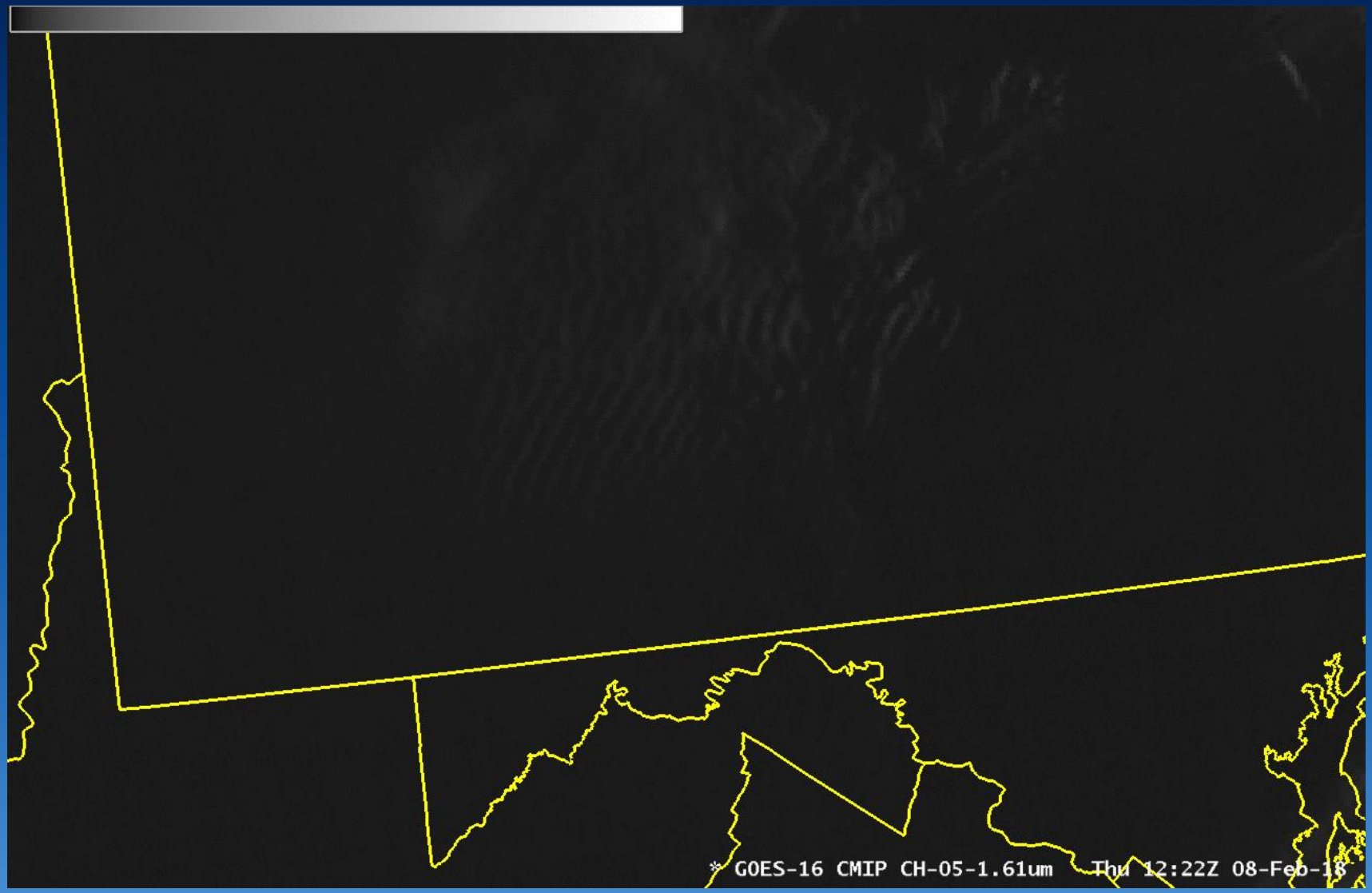
Atmospheric Bores over Lake Superior



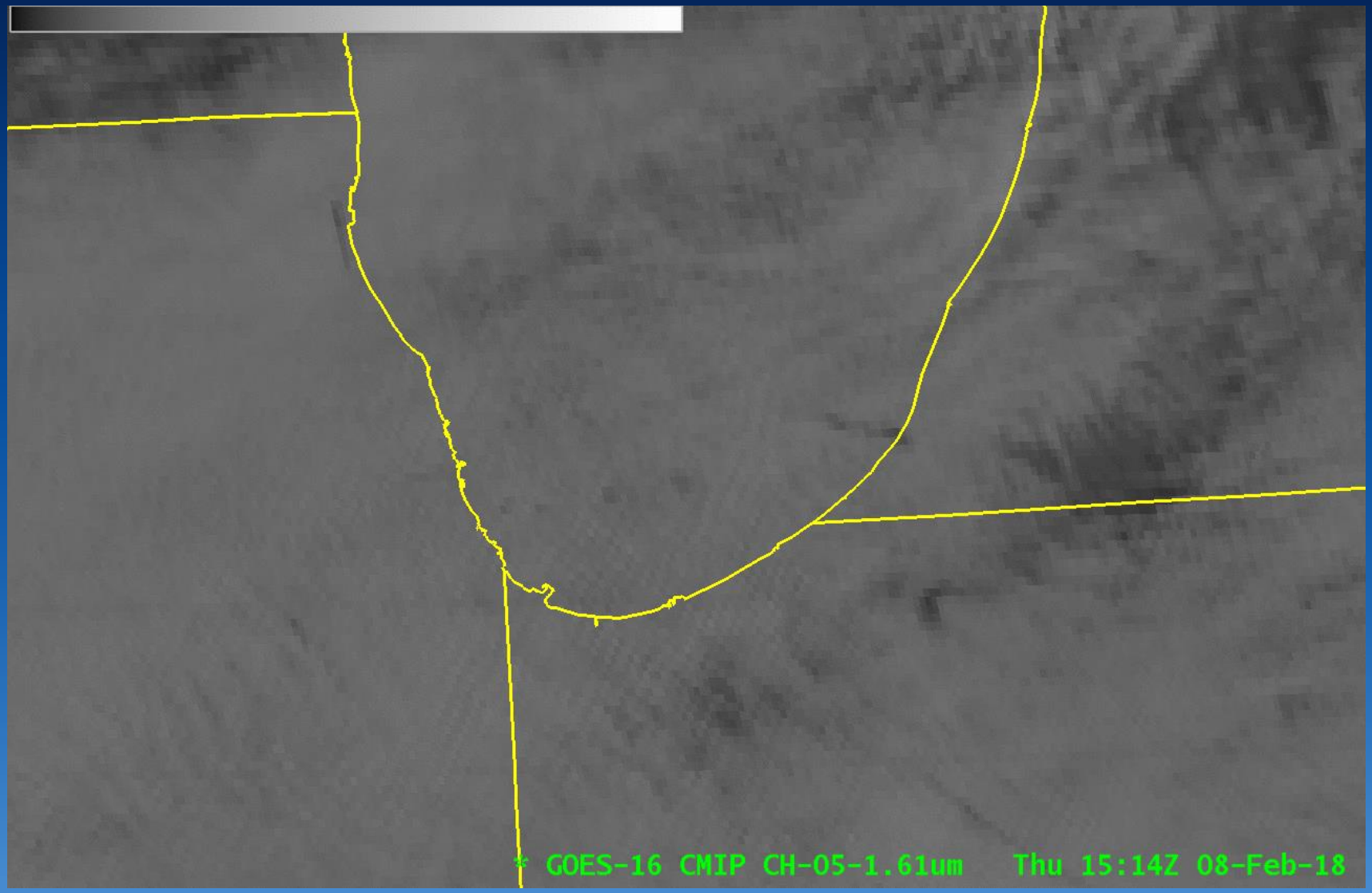
Red Vis over SW PA showing plumes



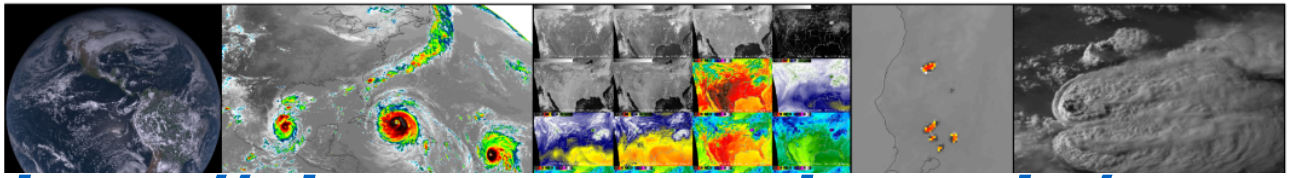
Snow/Ice showing glaciated plumes



When an airplane penetrates a stratus deck



GOES-R Series web sites



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

GOES-16 ABI (Advanced Baseline Imager) Realtime Imagery

- NOAA STAR GOES-16 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
- geo imagery (SSEC Real Earth TM) All bands, CONUS and Full Disk and both meso-scale sectors *(can save a*
- UW-Madison AOS Many sectors (including Southern Wisconsin) and several enhancements
- RAMMB Slider GeoColor, all bands and all sectors *(can save URL)*
- GOES-16 imagery (CIRA) Meso-scale sectors plus Colorado and Central Plains
- ABI GOES-16 imagery (SPORT) 16 bands, RGBs, Full Disk and CONUS and Meso-scale sectors
- College of DuPage Select bands for the three domains
- 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.

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
- GOES Spectral Response functions Plots and files: GOES-16 and other GOES
- GOES-16 ABI Weighting functions both static and realtime

GOES-16 ABI Data

- NOAA CLASS (GRABIPRD) Need to register. More info
- Amazon AWS (and OCC) data fetcher from @blaylockbk
- OCC Environmental Data Commons
- UNIDATA: Publically Accessible McIDAS ADDE servers (LEAD.UNIDATA.UCAR.EDU)

(Free) Software

- McIDAS-V (UW Madison)
- SIFT--Satellite Information Familiarization Tool (UW Madison) More info
- Python notebook displaying ABI data from @blaylockbk
- SSEC's HYDRA (use single band CMIP files)
- GOES-16 Manipulation Tools from GNC-A
- Manipulating GOES-16 with GDAL from the OCC
- NCview a netCDF visual (quicklook) browser
- CSPP Geo Community Satellite Processing Package for Geostationary Data (for use with local GRB ingest)

(Free) Phone apps

- SSEC GOES-16 ABI app: iOS and Android
- Real Earth apps
- WxSat Android
- MapSat (CPTEC/INPE) iOS
- MapSat (CPTEC/INPE) Android

GOES-R/16 ABI Training / Education

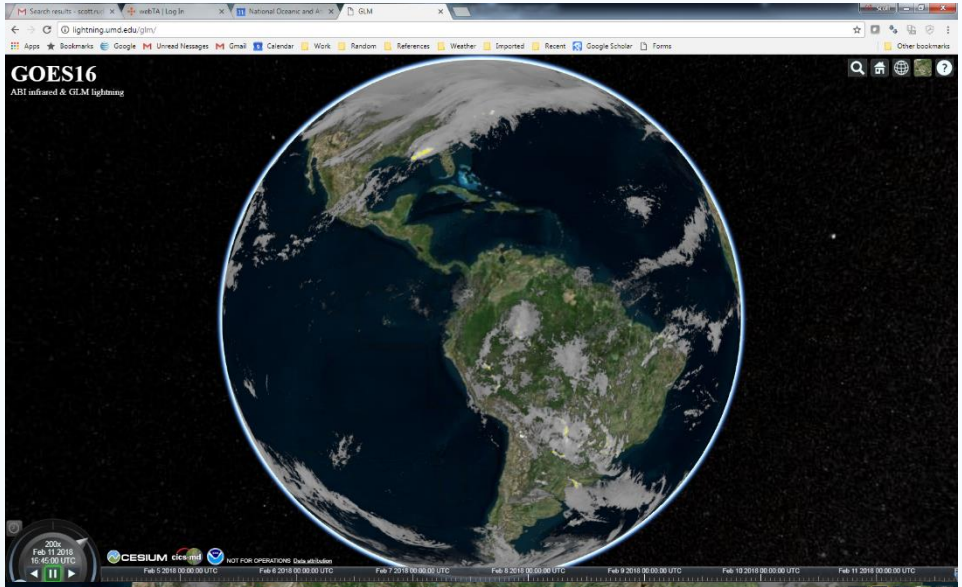
- GOES-R Education Proving Ground and GOES-R Series Countdown Calendar for Educator
- CIMSS Education Webapps
- GOES-R Fact Sheets (quick guides) with both pre-launch and post-launch data.
- CIMSS Satellite Blog
- CIRA Loop of the Day
- CIMSS GOES-R Fog Products Blog
- GOES-R VISIT Foundational Course
- Satellite Liaison Blog
- GOES East and Roof Top Cameras (SSEC in Madison, WI)

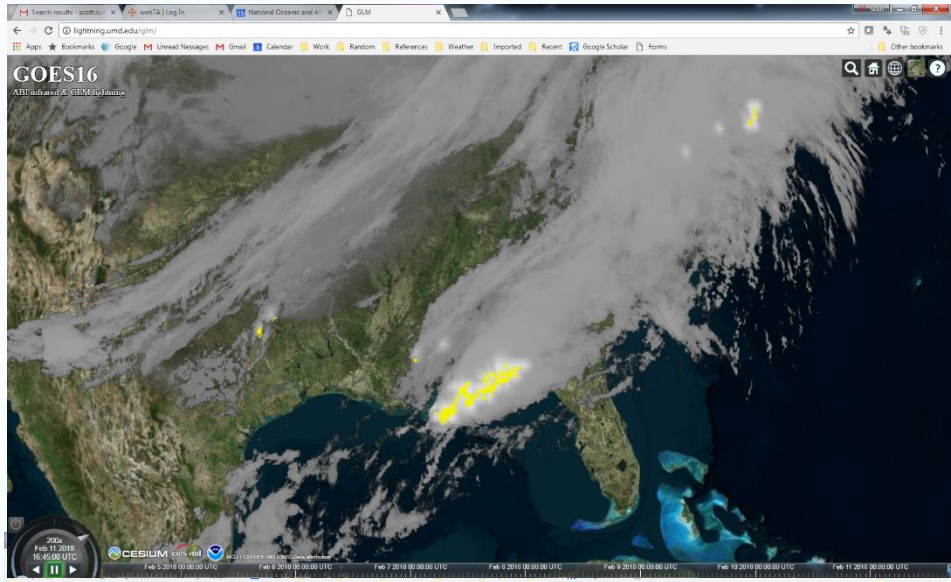
GOES-R/16 ABI Info

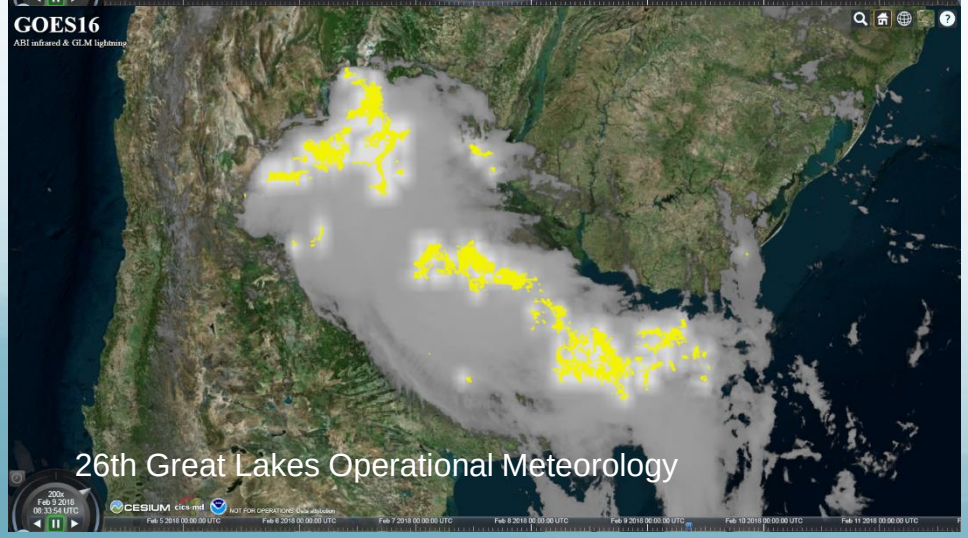
- GOES-R Program
- GOES-R Docs F&PS, ATBDs, PUGs, etc.
- SSEC GOES-16 links.
- GOES-16 tweets
- GOES-S tweets
- BAMS article on the ABI including ABI Band Table
- GOES-R Series Publications List

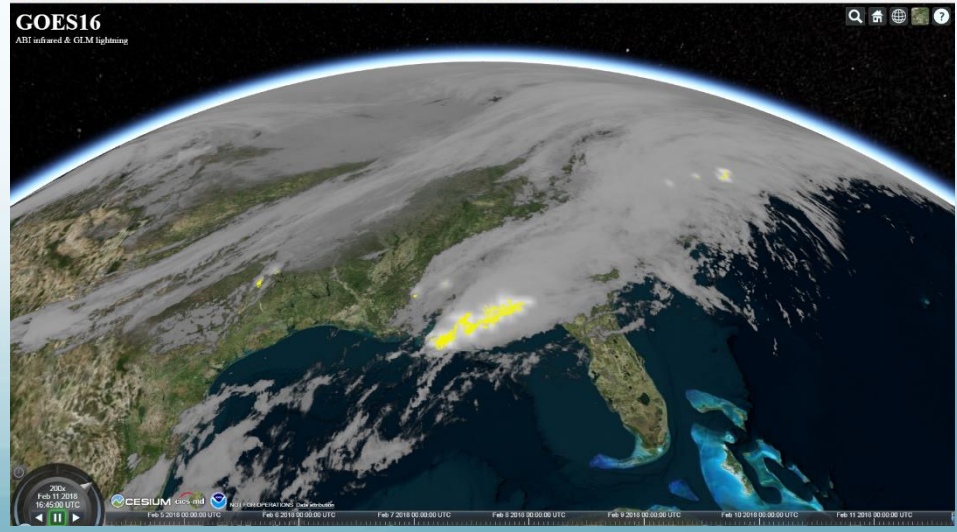
GLM Website (http://lightning.umd.edu)

- Provides most recent seven days of GLM and ABI observations
- Also viewable in Virtual Reality (with headset or mobile phone)









GOES-16 (and soon, GOES-17)

- Many different ways to view the same thing
- Find the one that makes sense to you, and understand and employ it.
- Know the limitations of the bands, channel differences, RGBs and Level 2 Products
- Questions / Comments:

scott.lindstrom@noaa.gov

- http://www.goes-r.gov
- http://cimss.ssec.wisc.edu/goes/goesdata.html

Thank you!

*Lockheed Martin

Some of the ABI images shown were during the pre-operational check-out period.