The Key Product Parameter (KPP): Imagery from the Advanced Baseline Imager (ABI) on GOES-R

Timothy J. Schmit (tim.j.schmit@noaa.gov)

NOAA/NESDIS

Satellite Applications and Research
Advanced Satellite Products Branch (ASPB)
Madison, WI

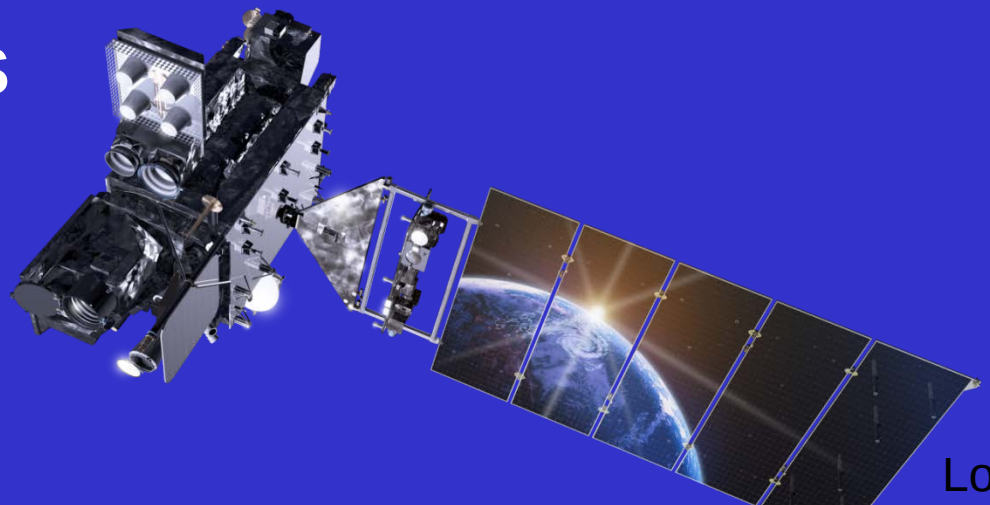
Mathew M. Gunshor, Kaba Bah, Steven J. Goodman, Daniel T. Lindsey, Robert M. Rabin, Kristopher M. Bedka, John L. Cintineo, Christopher S. Velden, A. Scott Bachmeier, Scott S. Lindstrom,, Christopher C. Schmidt, Jordan Gerth, and many, many others

GOES-R Brown Bag series

May 28, 2014

Outline

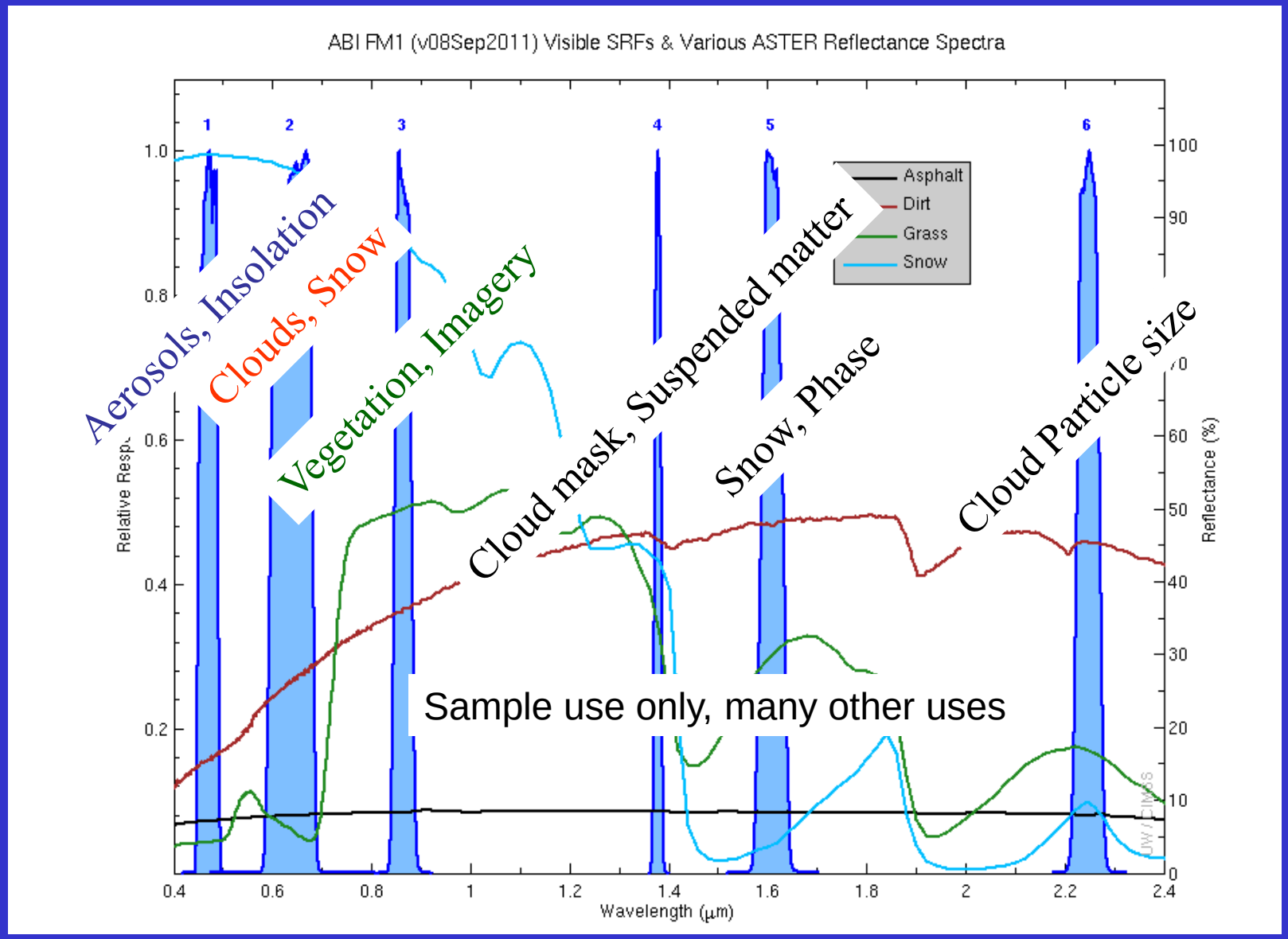
- ABI (Advanced Baseline Imager)
  - Spectral
  - Spatial
  - Temporal
    - GOES-14 SRSOR (2012 and 2013 and 2014)
- Scan Modes
  - Flex mode and Continuous Full Disk
  - Exploratory Scan Modes
- References
- Summary



ABI bands 1-6

Future GOES imager (ABI) band	Wavelength range (μm)	Central wavelength (μm)	Nominal subsatellite IGFOV (km)	Sample use	Heritage instrument(s)
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping	MODIS
2	0.59–0.69	0.64	0.5	Daytime clouds fog, inso-lation, winds	Current GOES imager/ sounder
3	0.846–0.885	0.865	1	Daytime vegetation/burn scar and aerosol over water, winds	VIIRS, spectrally modified AVHRR
4	1.371–1.386	1.378	2	Daytime cirrus cloud	VIIRS, MODIS
5	1.58–1.64	1.61	1	Daytime cloud-top phase and particle size, snow	VIIRS, spectrally modified AVHRR
6	2.225–2.275	2.25	2	Daytime land/cloud properties, particle size, vegetation, snow	VIIRS, similar to MODIS

Visible and near-IR channels on the ABI

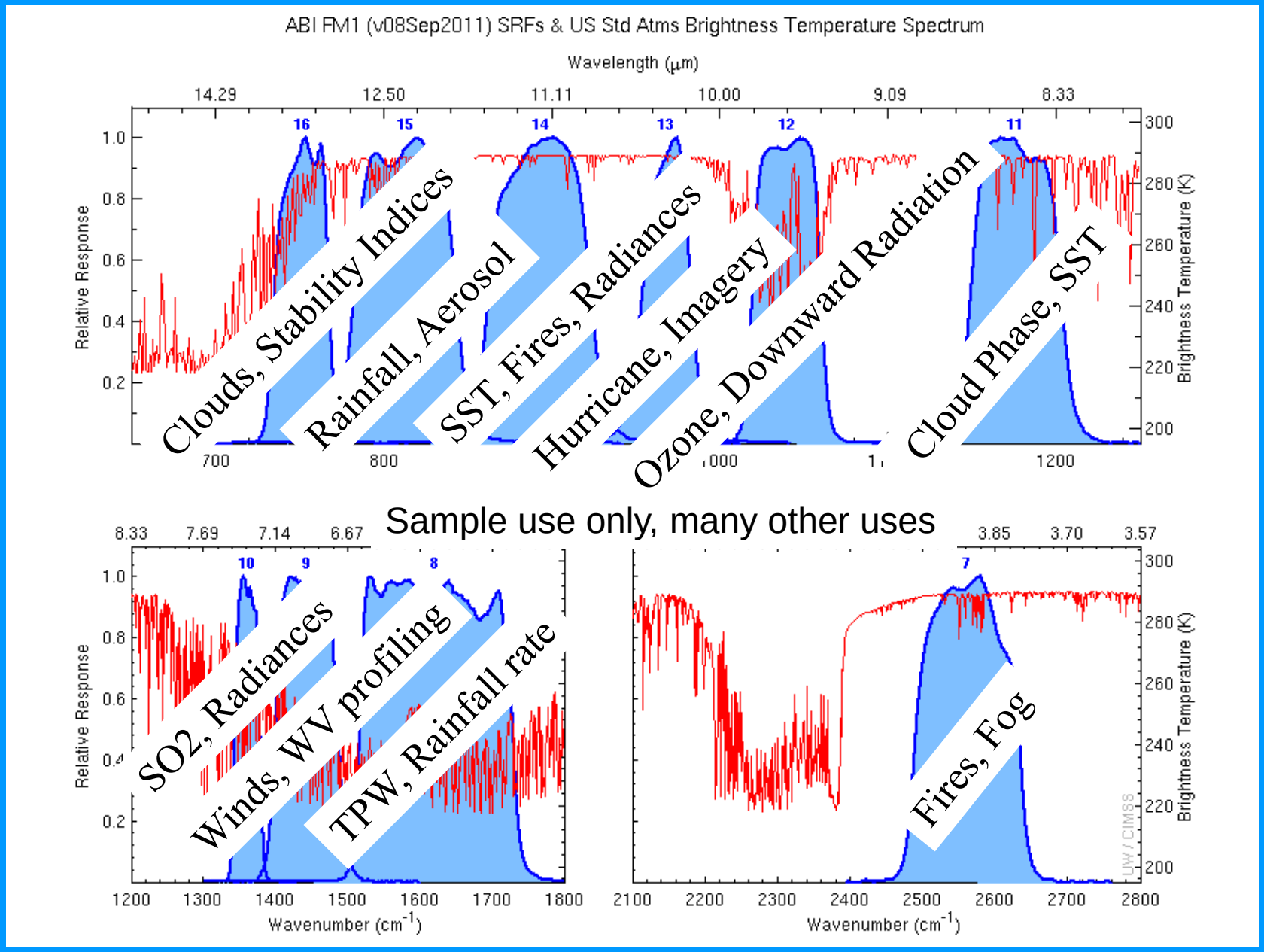


The ABI visible and near-IR bands have many uses.

ABI bands 7-16

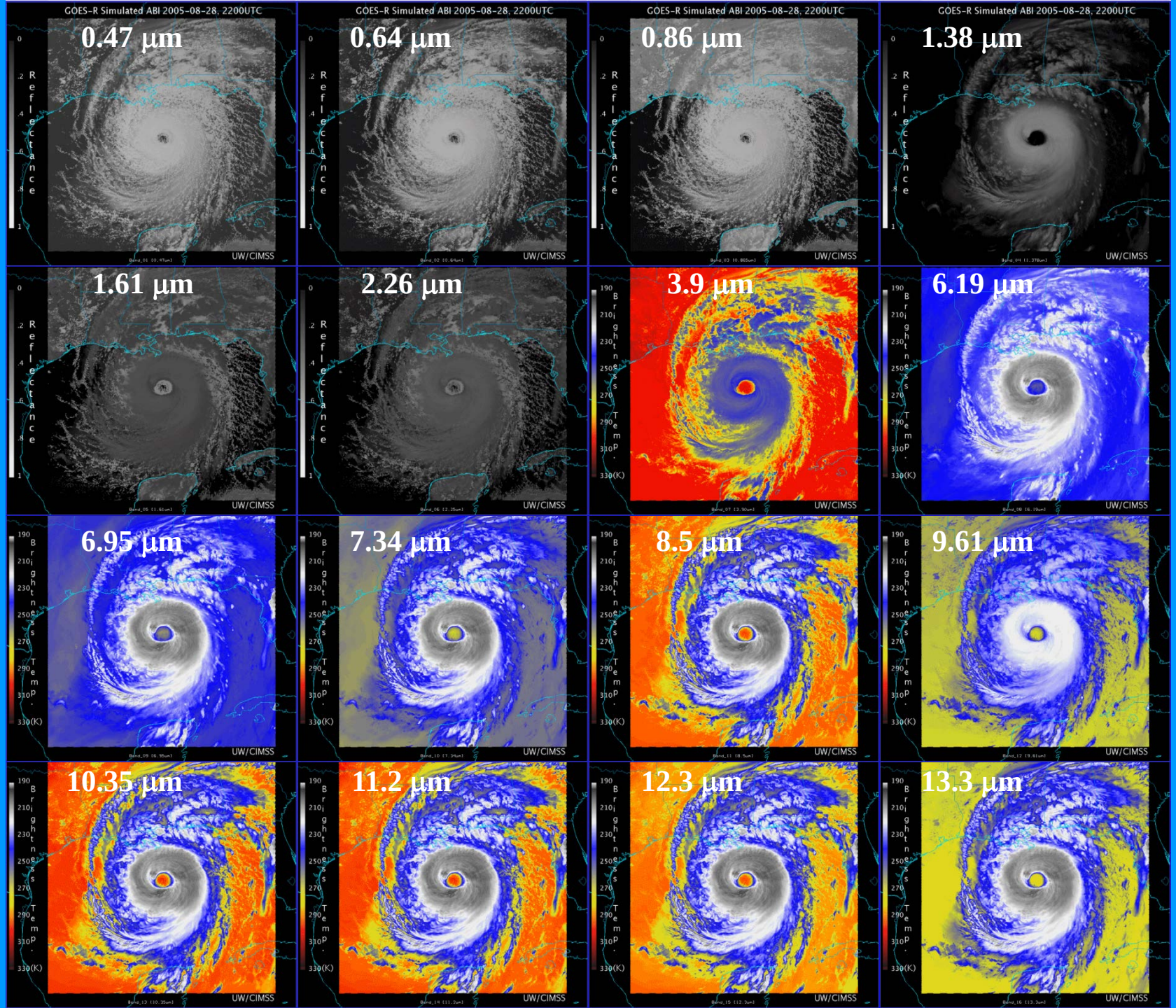
7	3.80–4.00	3.90	2	Surface and cloud, fog at night, fire, winds	Current GOES imager
8	5.77–6.6	6.19	2	High-level atmospheric water vapor, winds, rainfall	Current GOES imager
9	6.75–7.15	6.95	2	Midlevel atmospheric water vapor, winds, rainfall	Current GOES sounder
10	7.24–7.44	7.34	2	Lower-level water vapor, winds, and SO_2	Spectrally modified current GOES sounder
11	8.3–8.7	8.5	2	Total water for stability, cloud phase, dust, SO_2 rainfall	MAS
12	9.42–9.8	9.61	2	Total ozone, turbulence, and winds	Spectrally modified current sounder
13	10.1–10.6	10.35	2	Surface and cloud	MAS
14	10.8–11.6	11.2	2	Imagery, SST, clouds, rainfall	Current GOES sounder
15	11.8–12.8	12.3	2	Total water, ash, and SST	Current GOES sounder
16	13.0–13.6	13.3	2	Air temperature, cloud heights and amounts	Current GOES sounder/ *GOES-12+* imager
Future GOES imager (ABI) band	**Wavelength range (μm)**	**Central wavelength (μm)**	**Nominal subsatellite IGFOV (km)**	**Sample use**	**Heritage instrument(s)**

The IR channels on the ABI



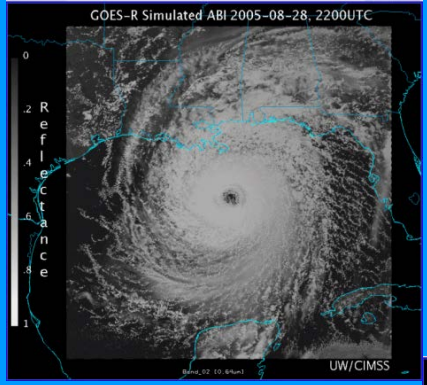
ABI has many more bands than the current operational GOES imagers.

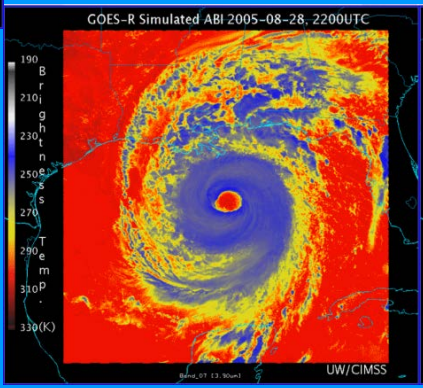
AWG Proxy ABI Simulations of Hurricane Katrina

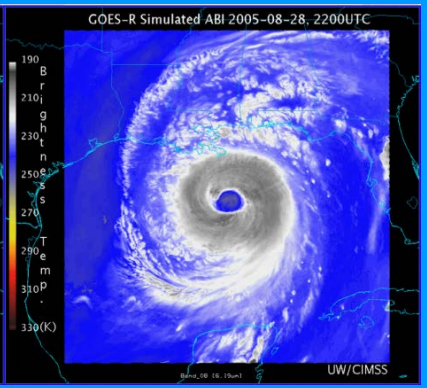


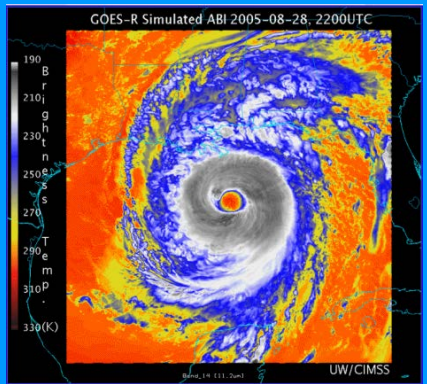
NOAA/NESDIS STAR and GOES-R Imagery Team

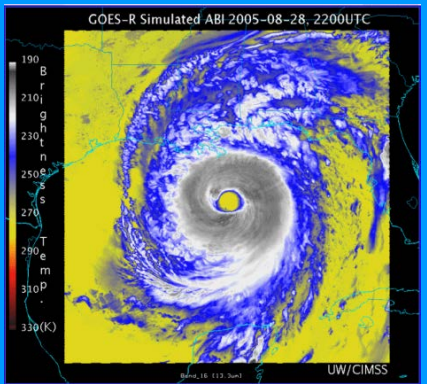
Corresponding current Imager bands of Hurricane Katrina

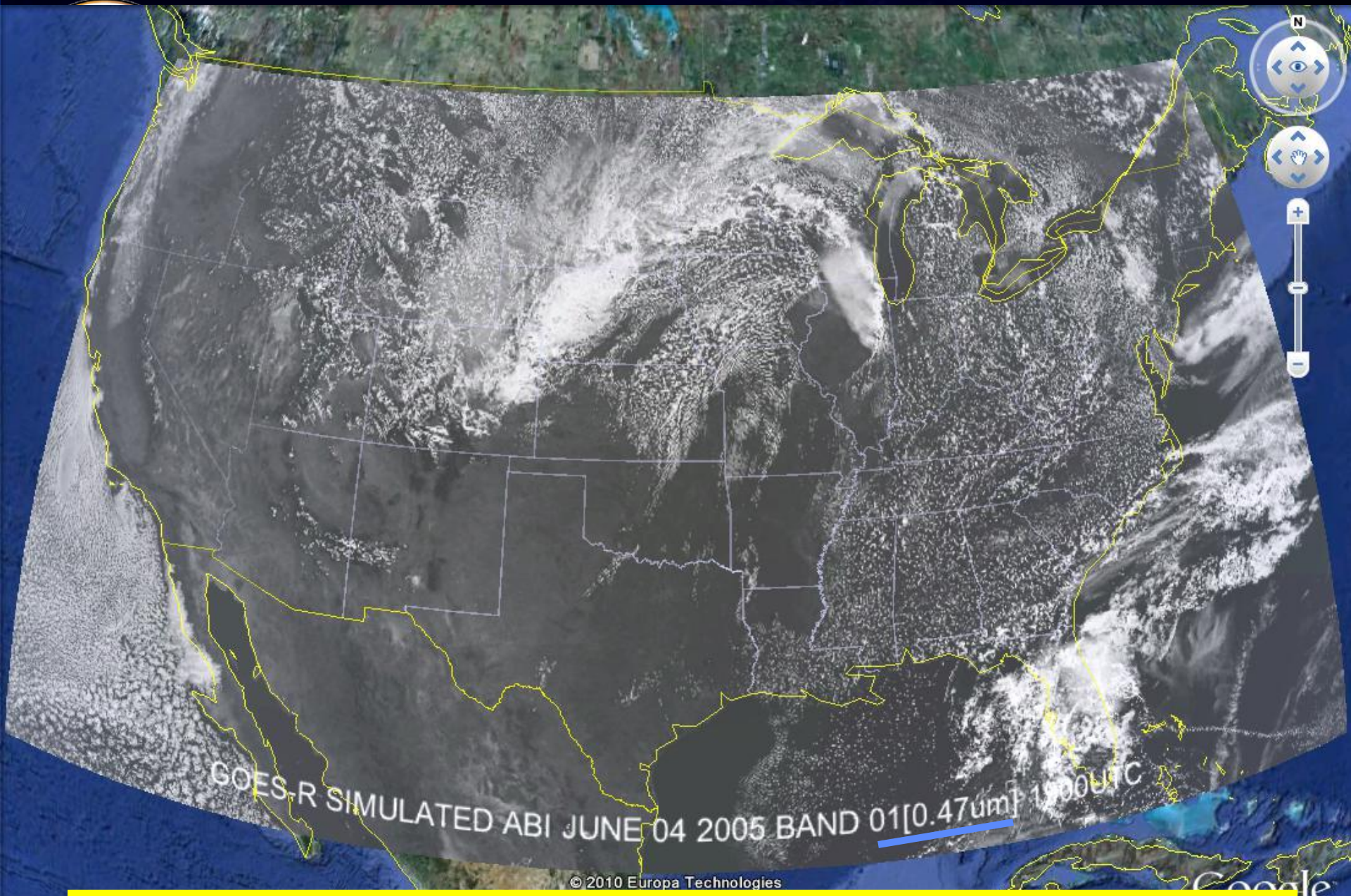




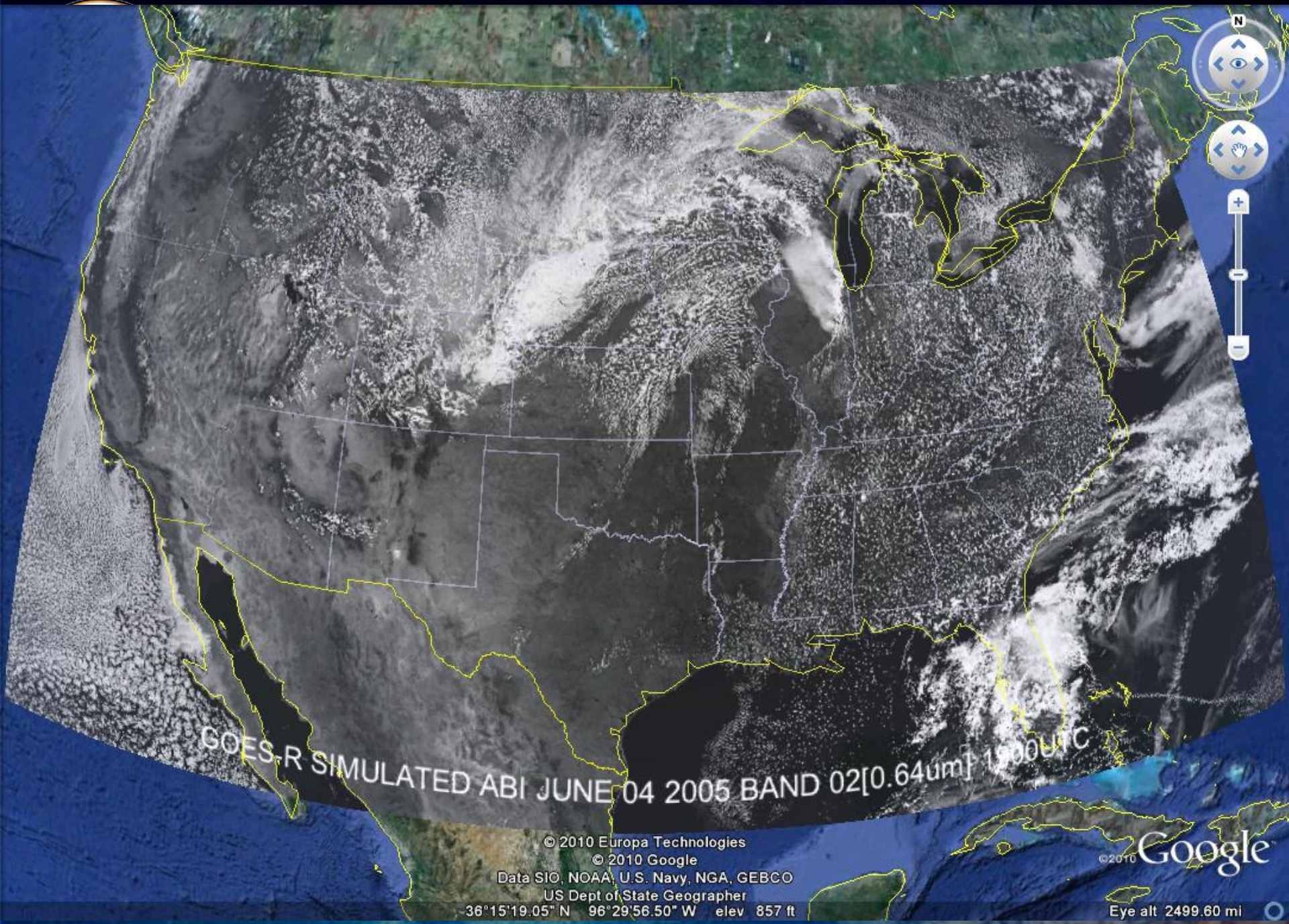








These NWP model simulations were performed on the 'cobalt' supercomputer at the National Center for Supercomputing Applications at the University of Illinois.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Eye alt 2499.60 mi
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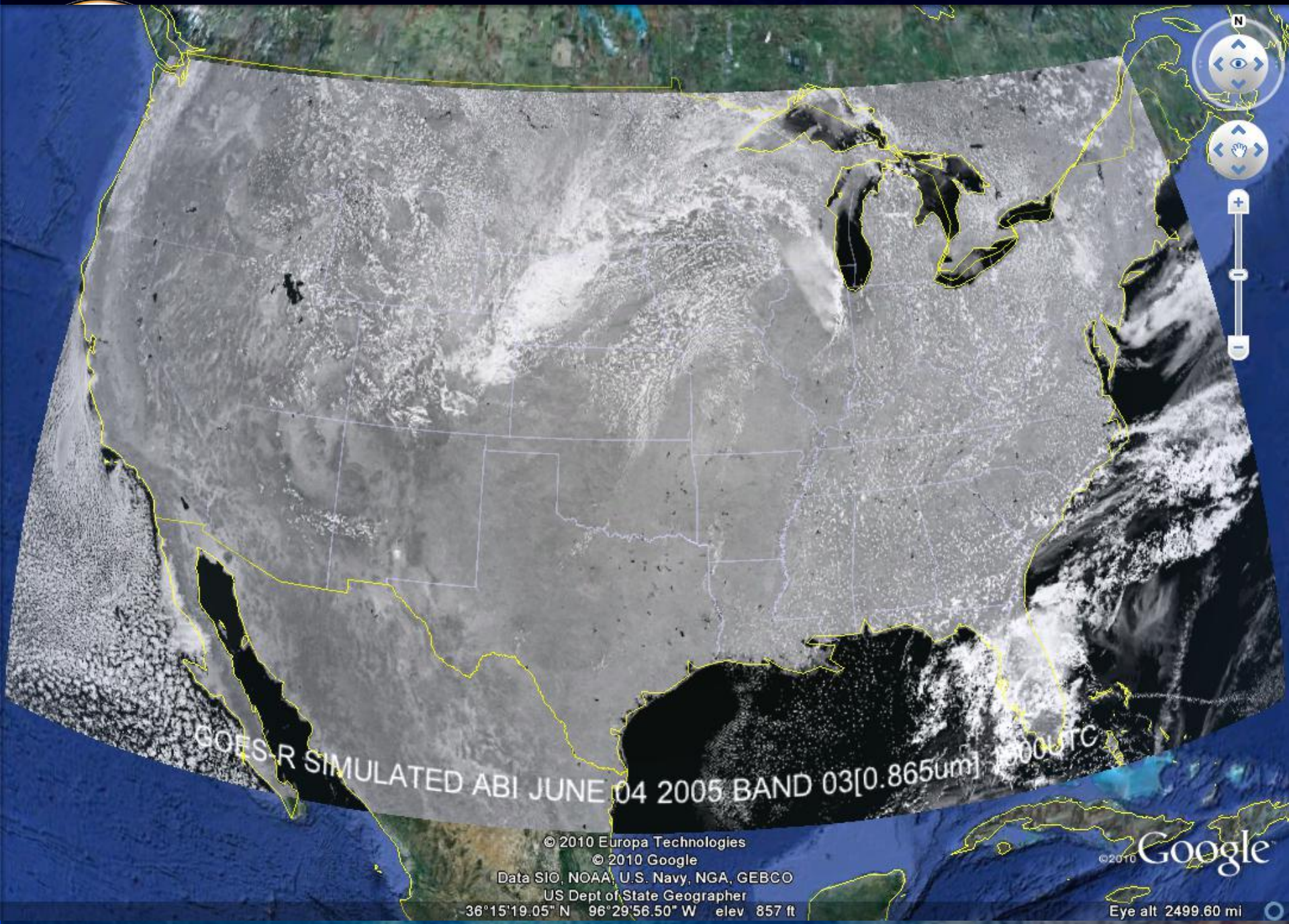
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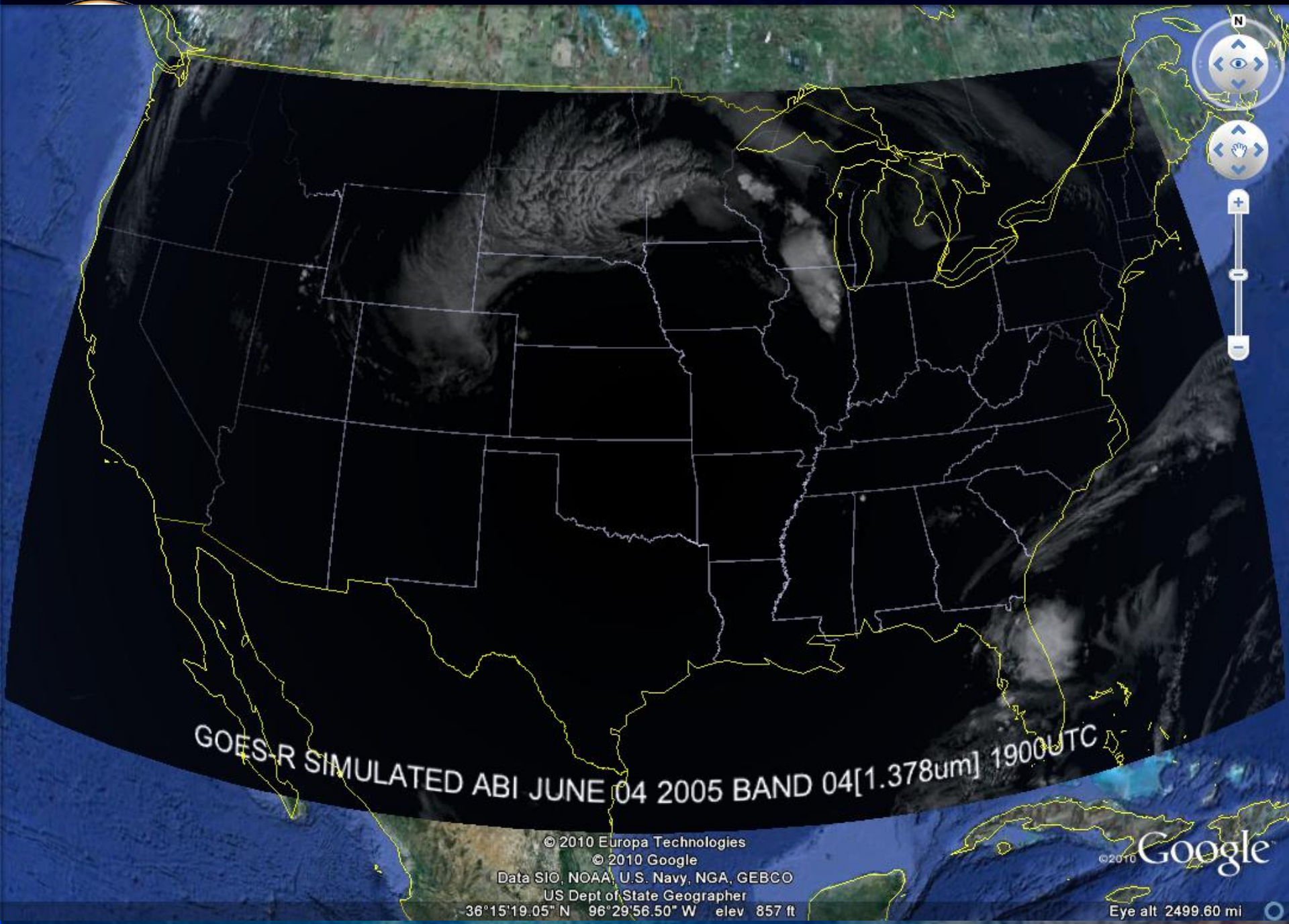
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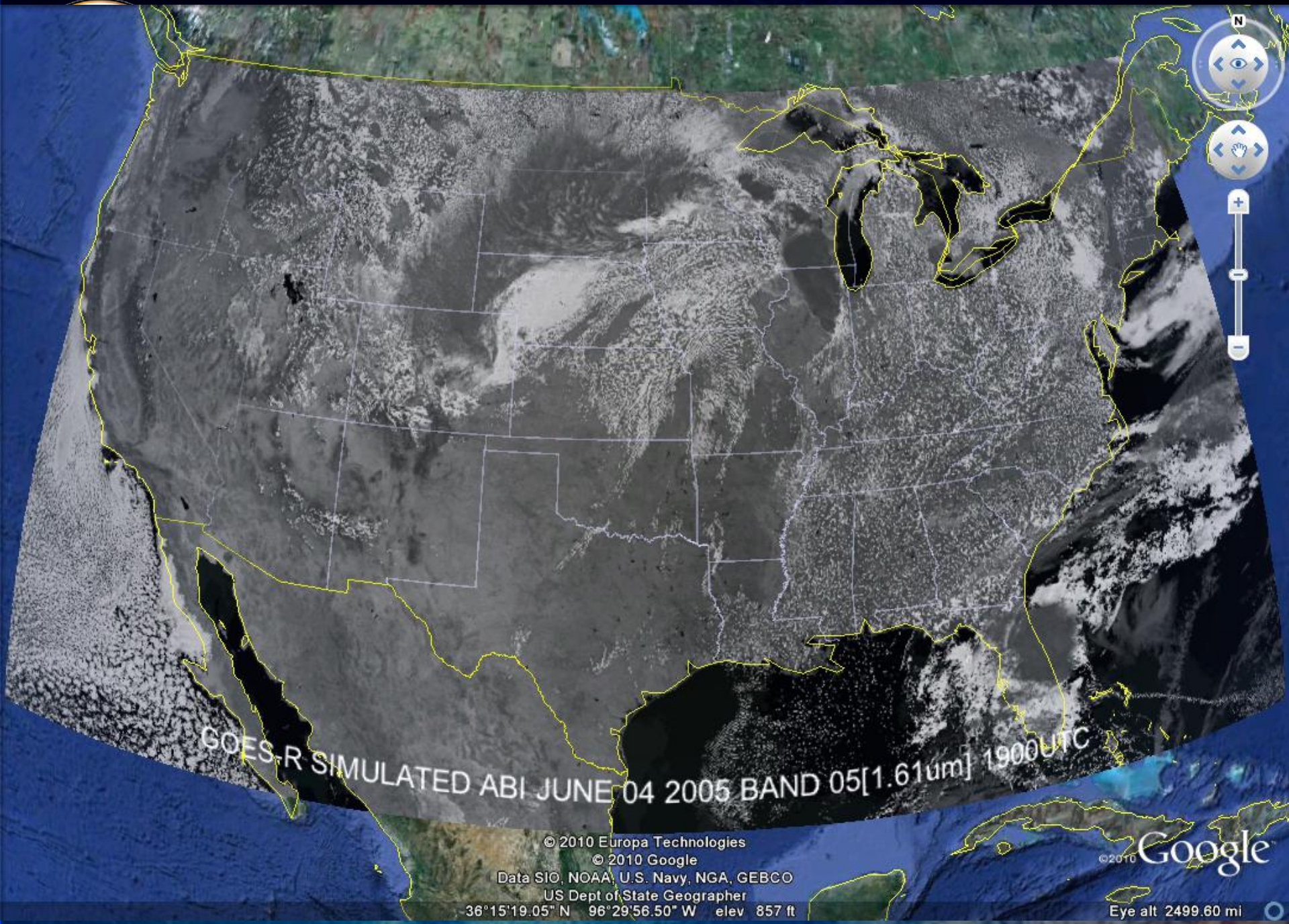
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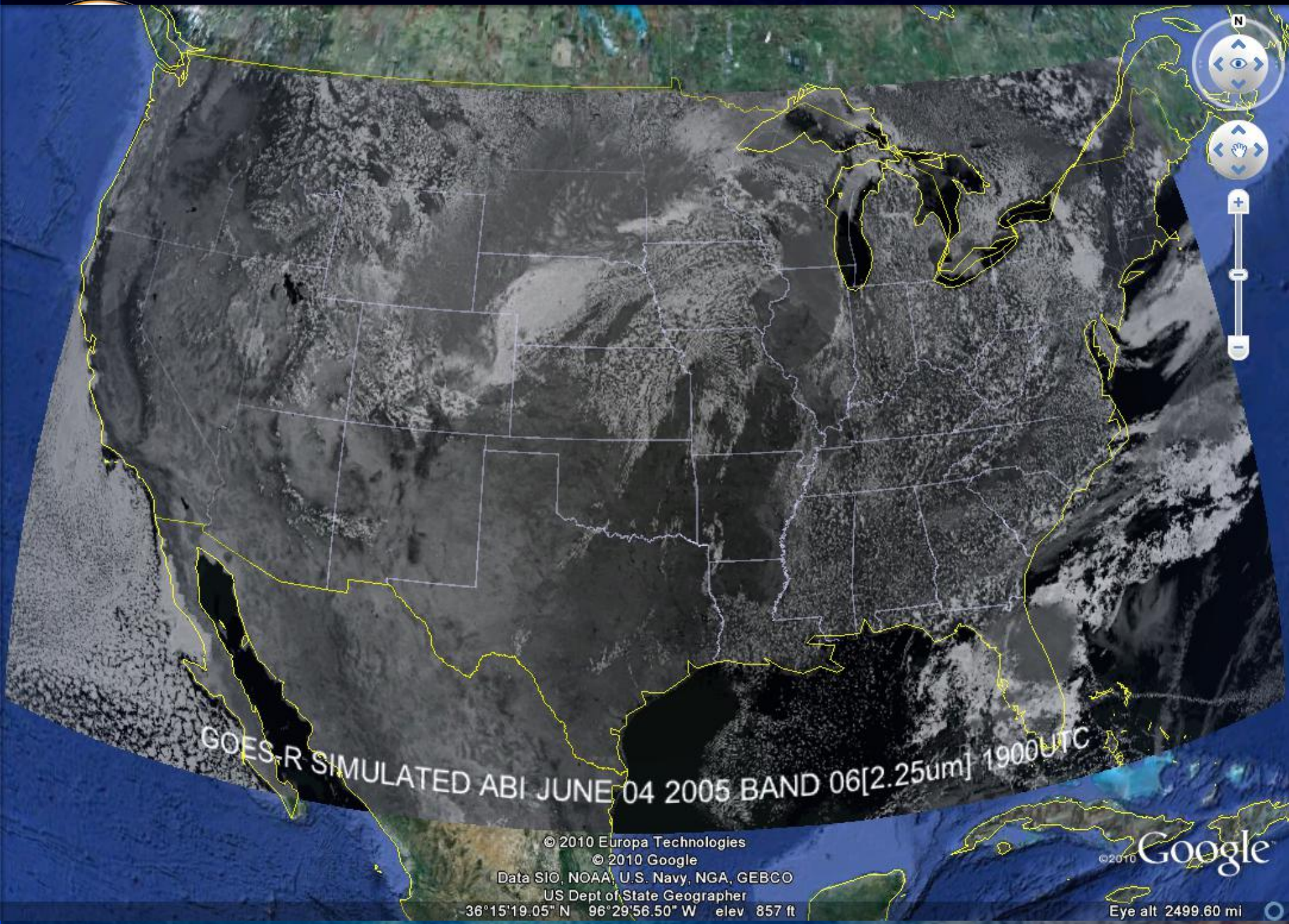
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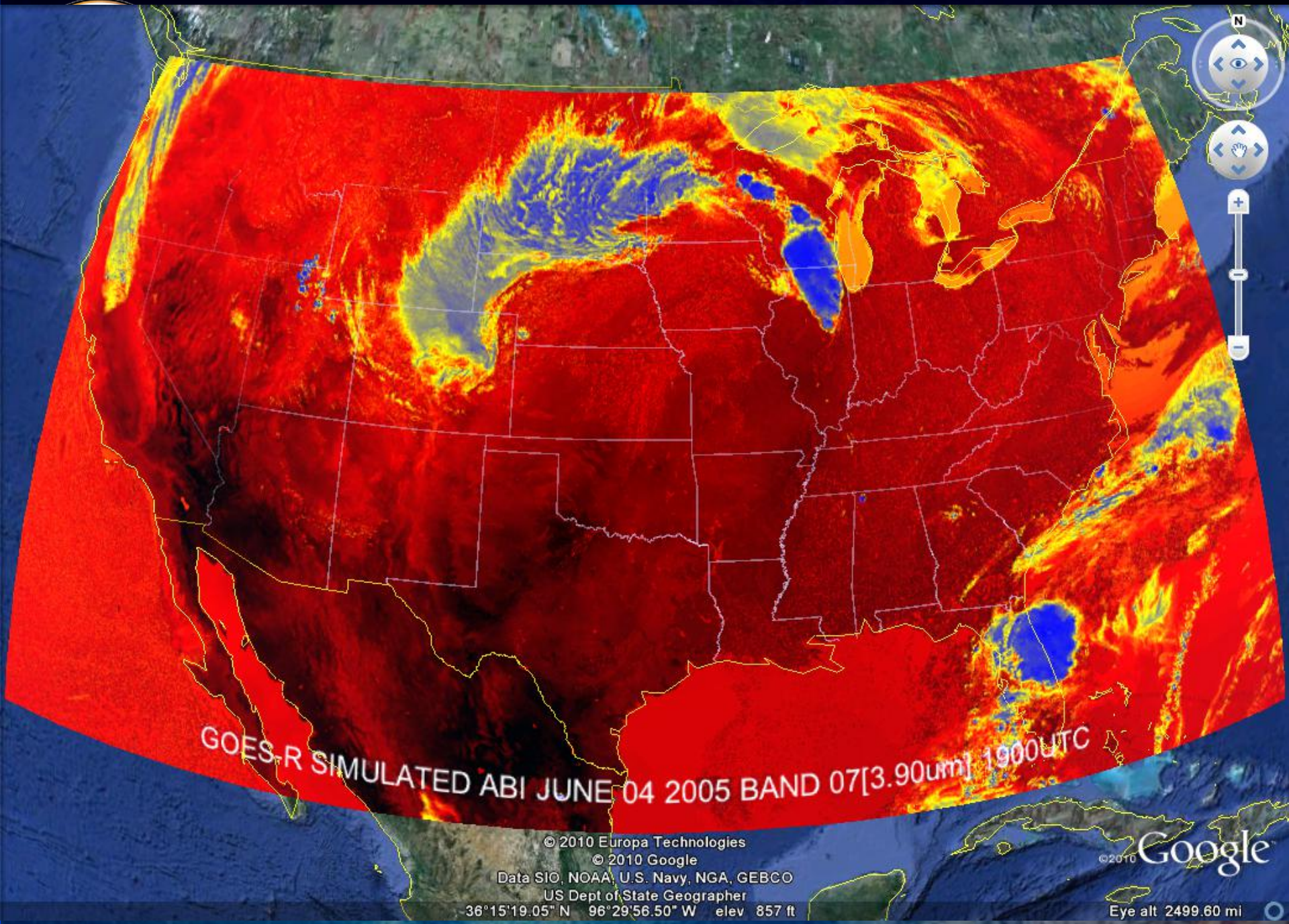
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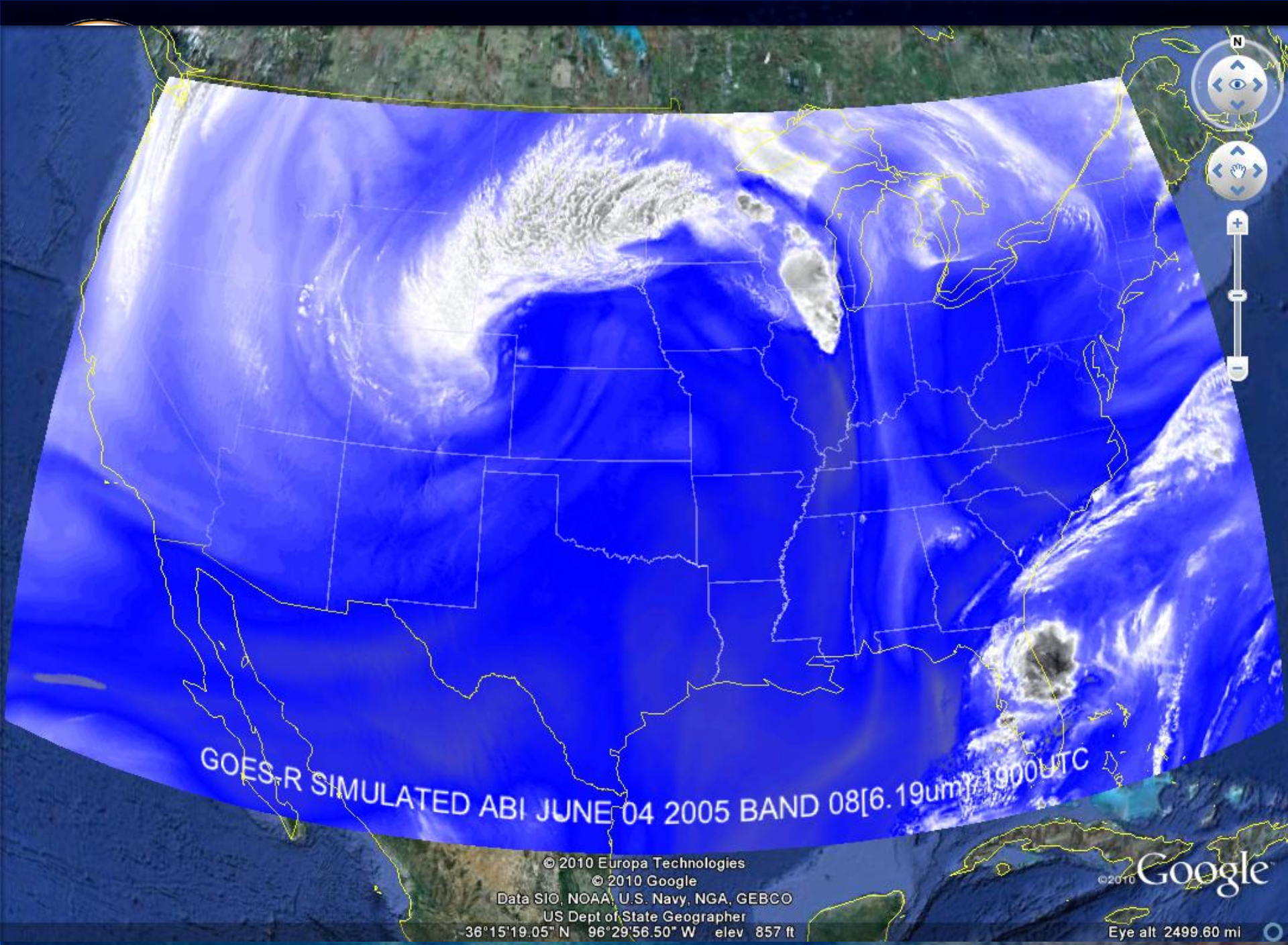
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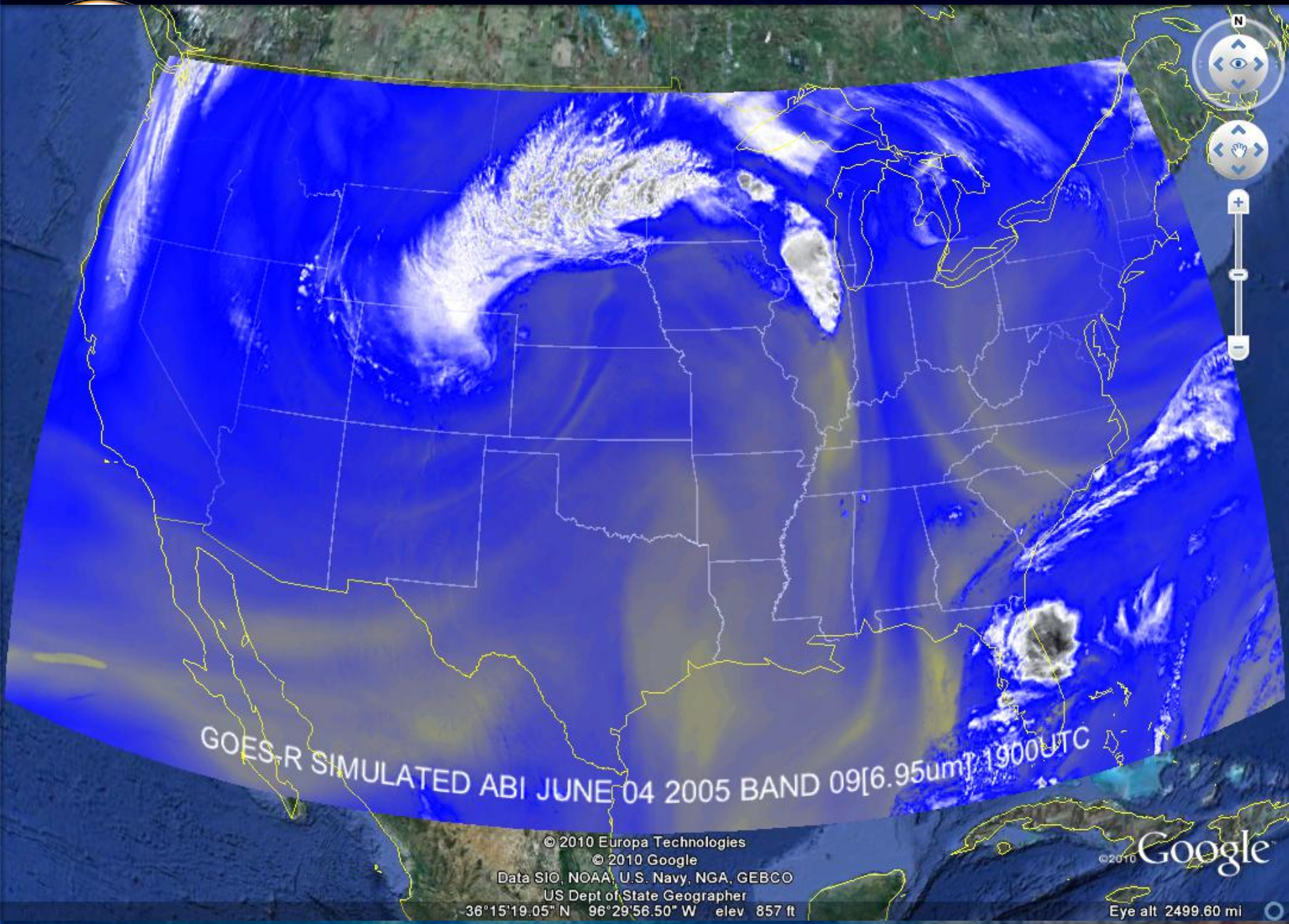
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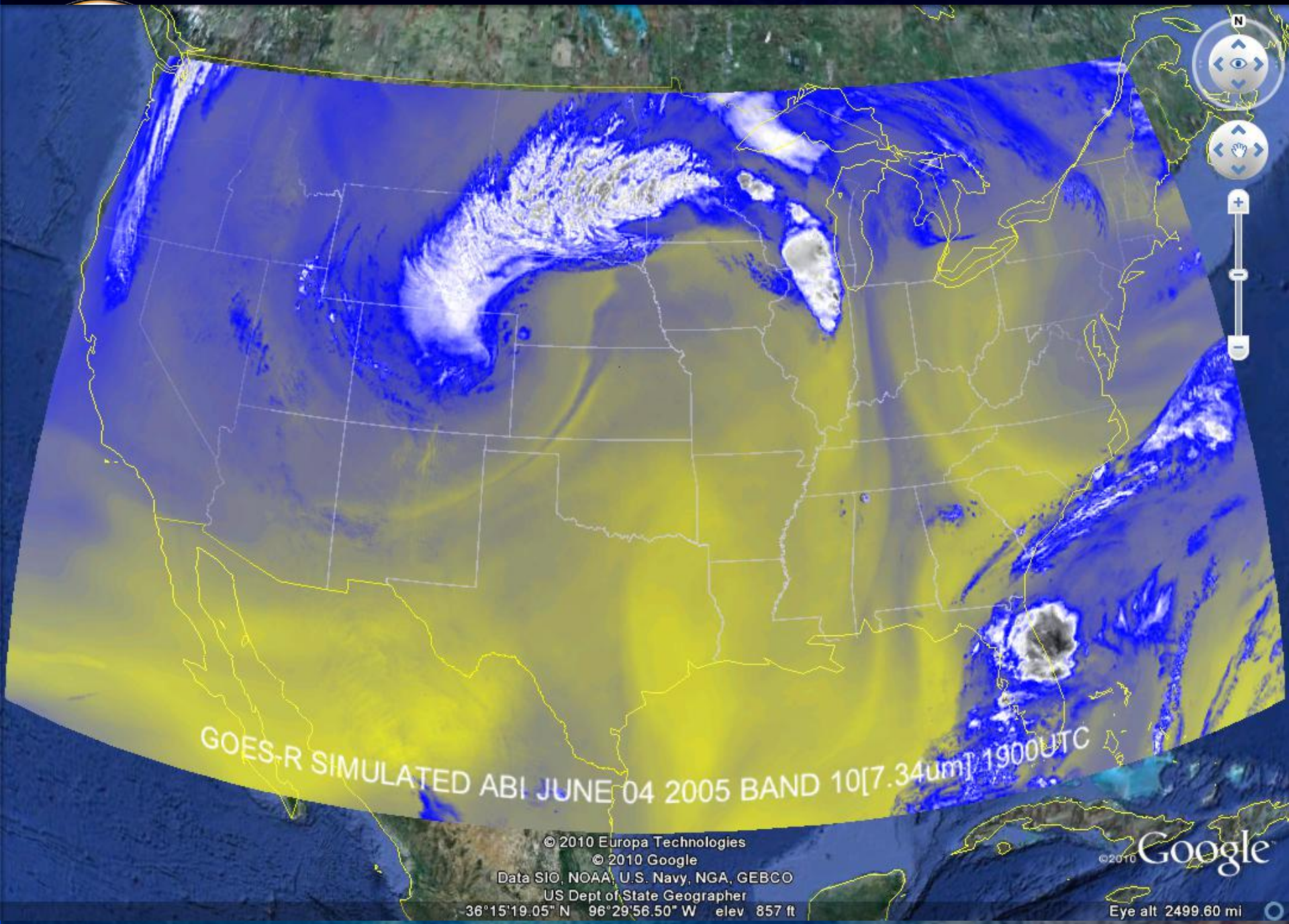
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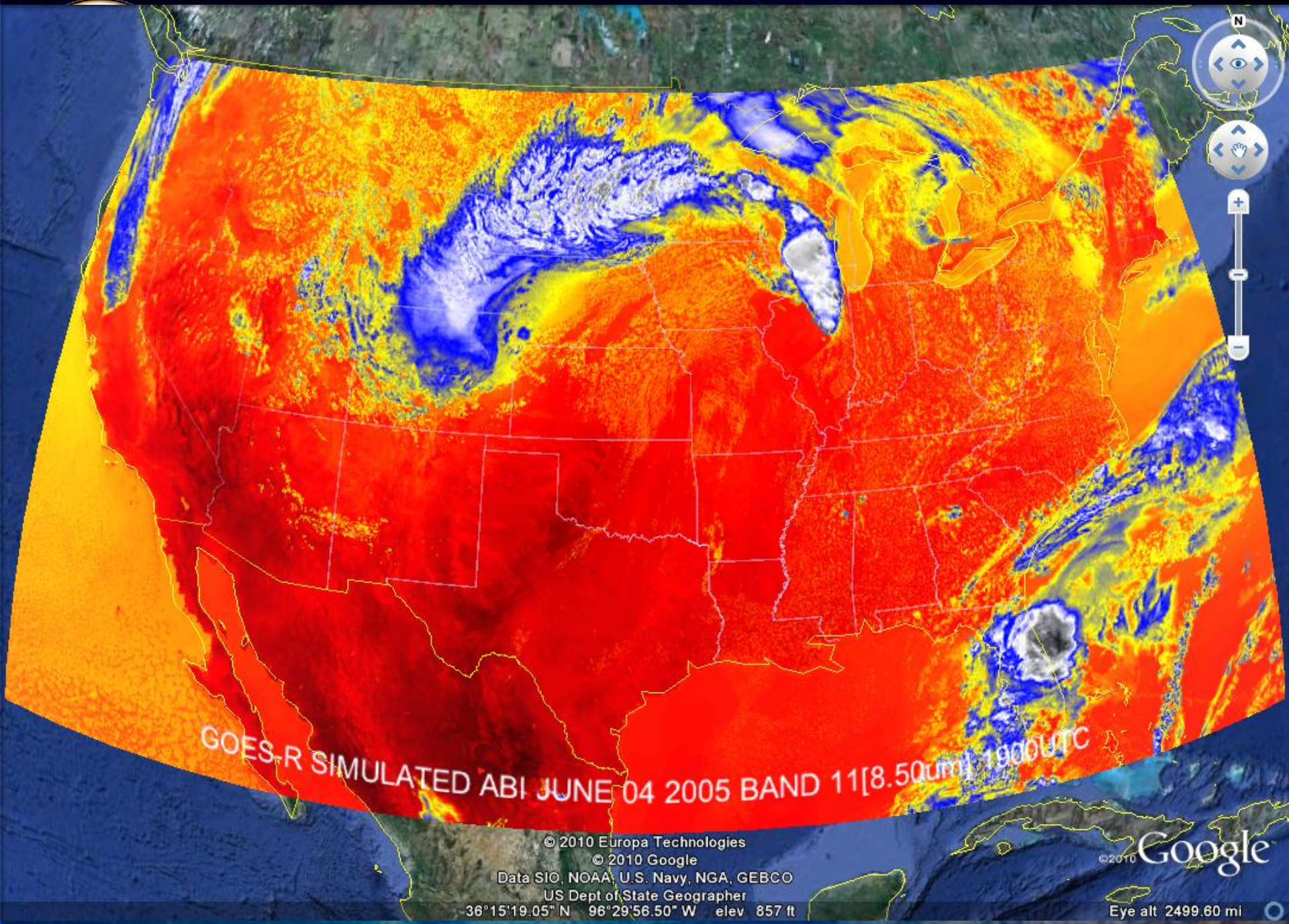
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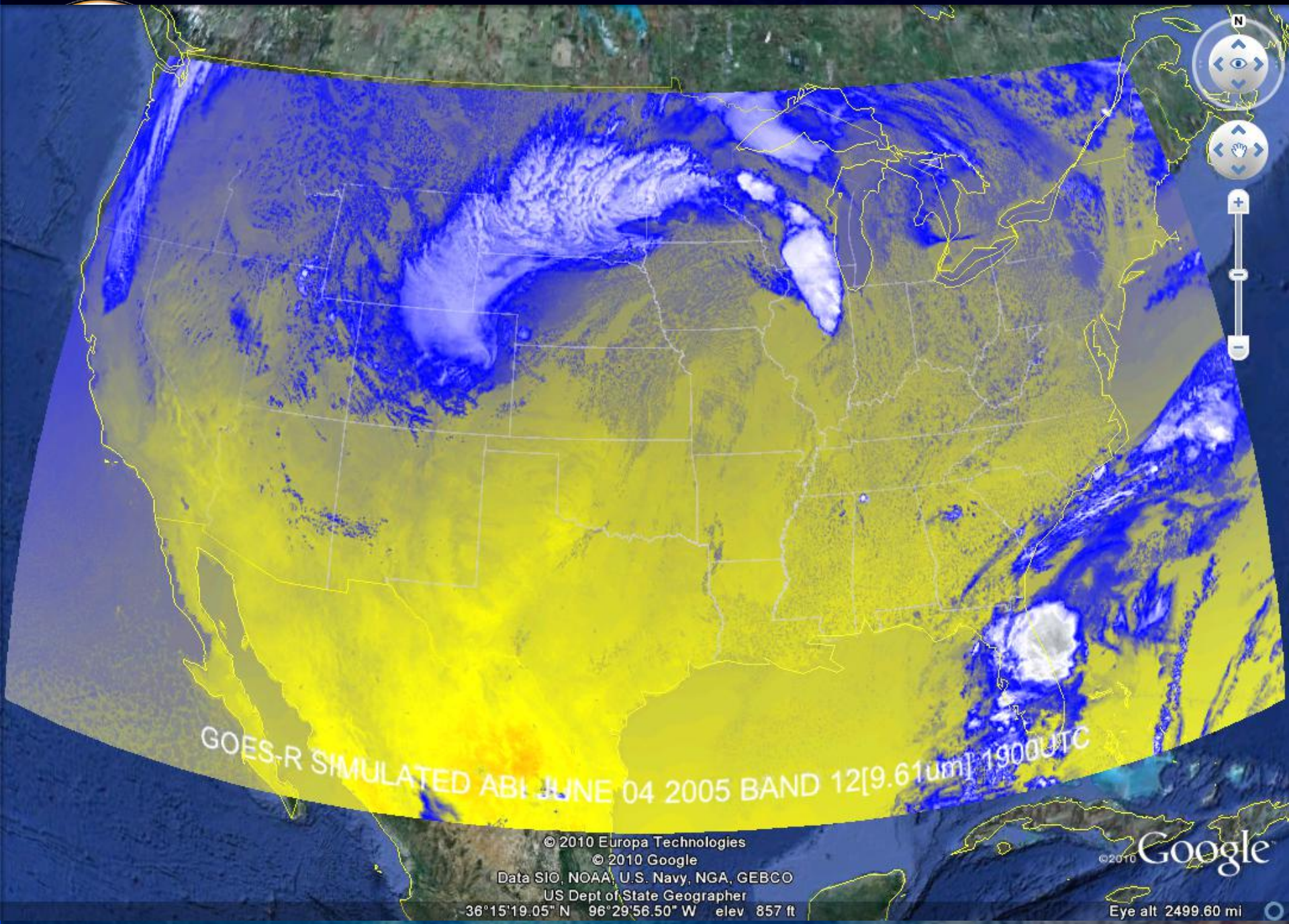
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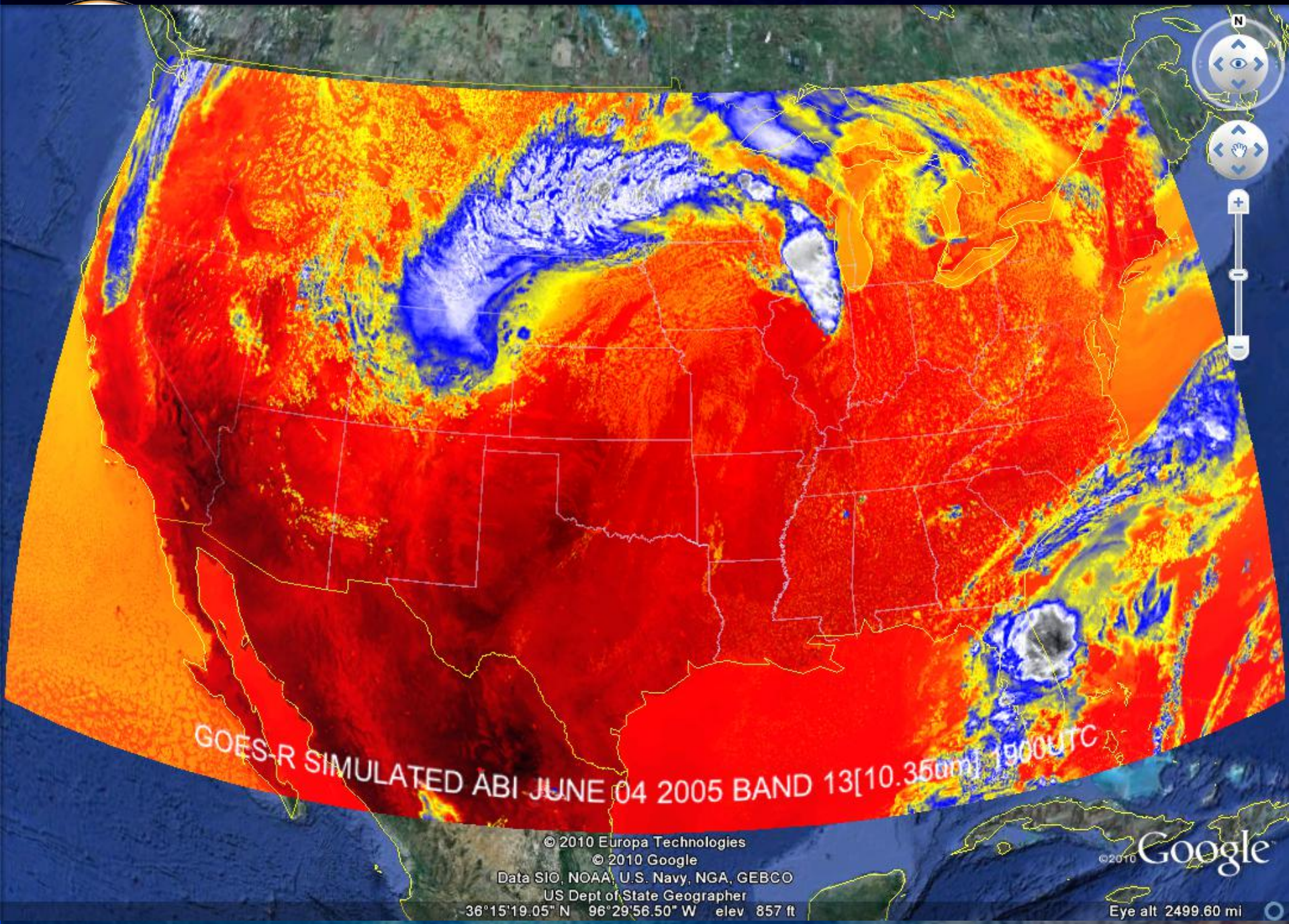
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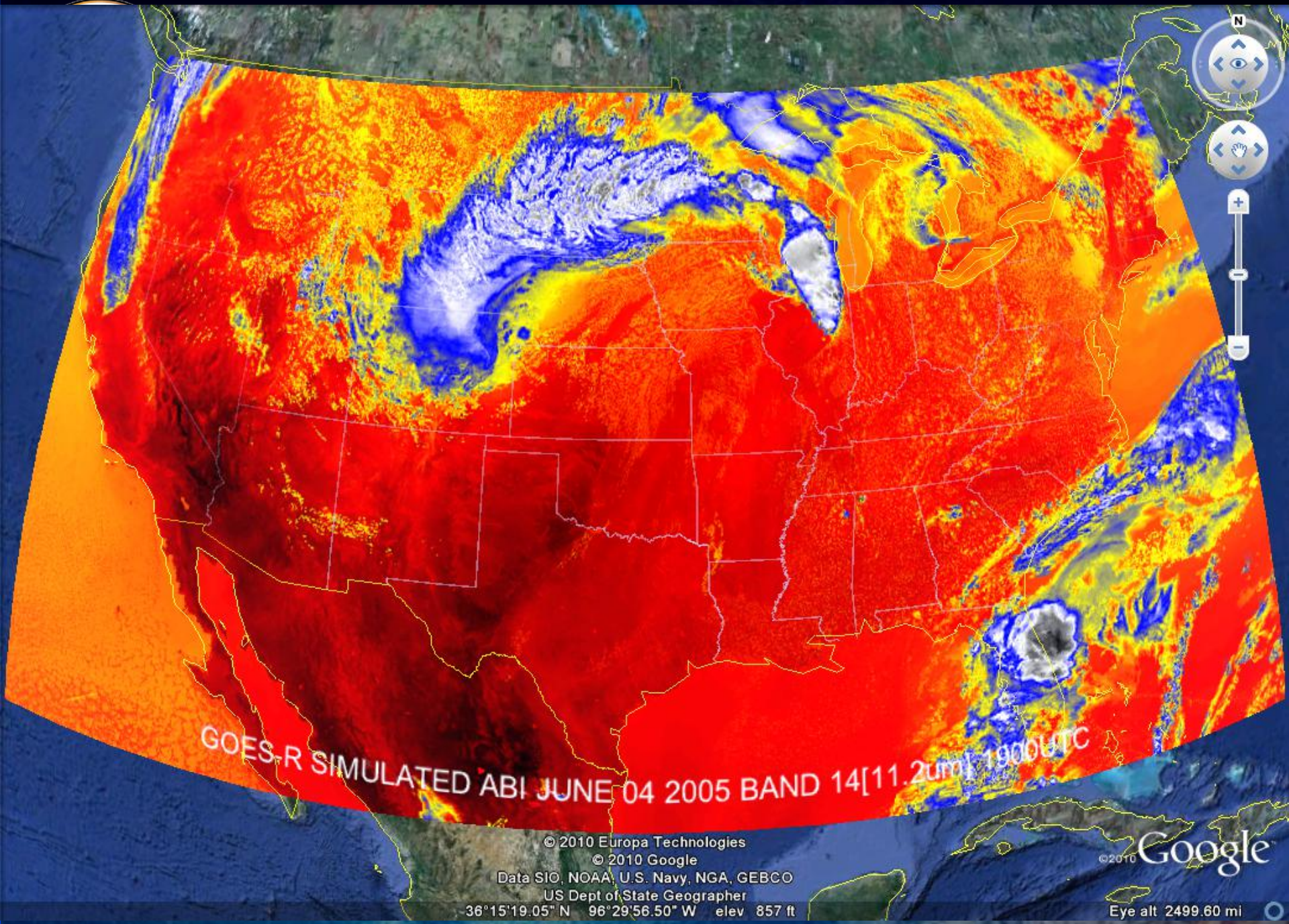
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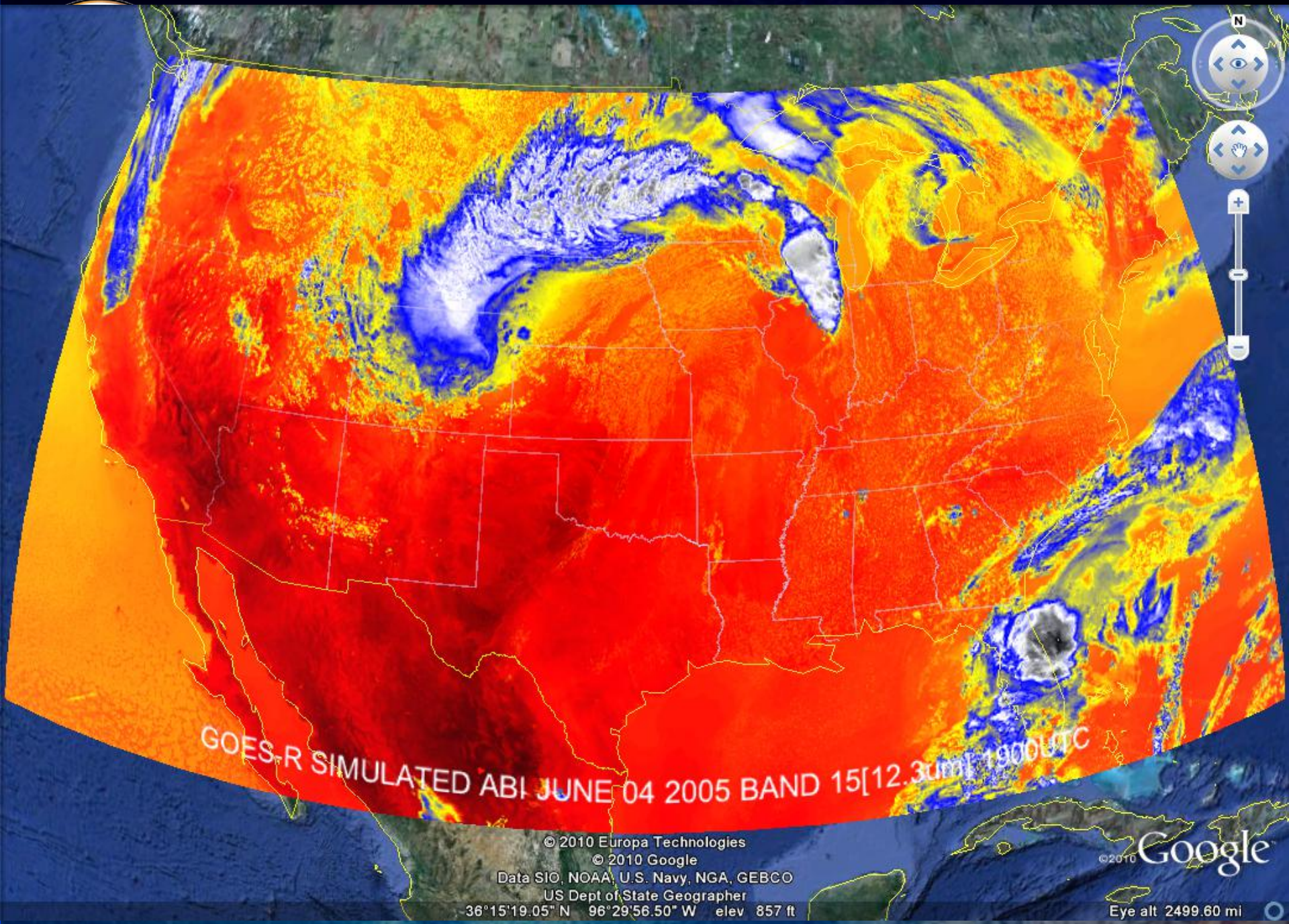
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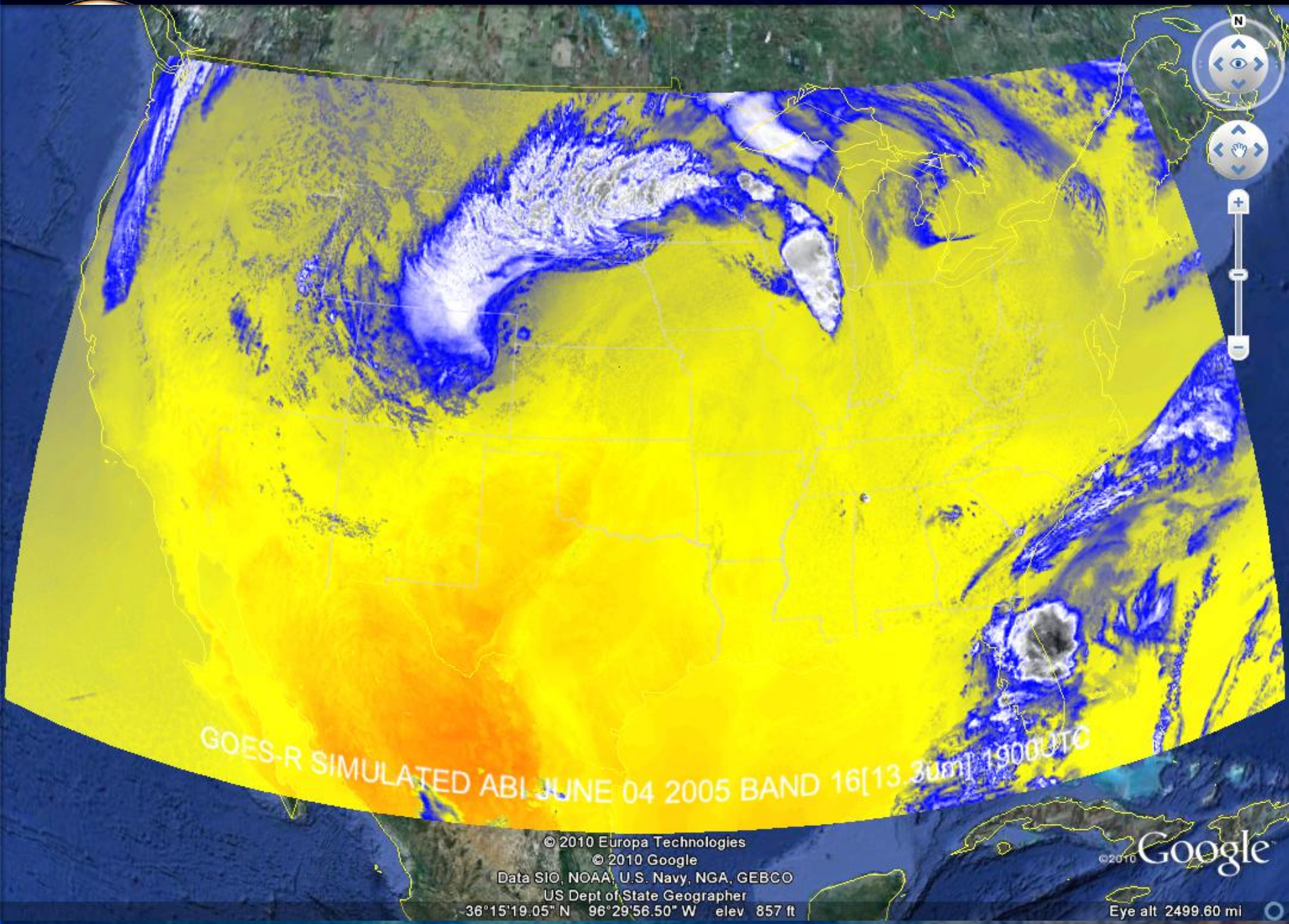
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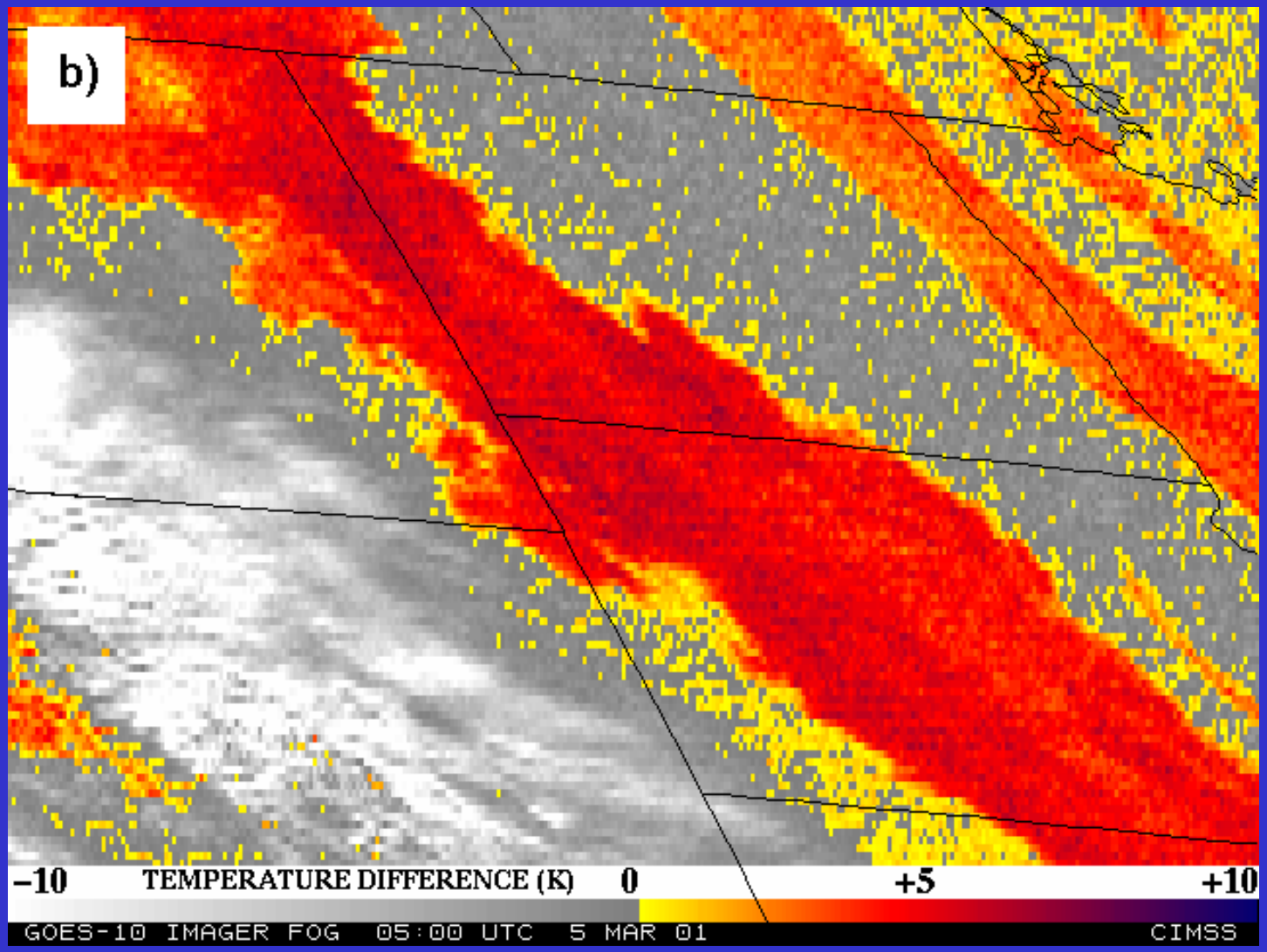
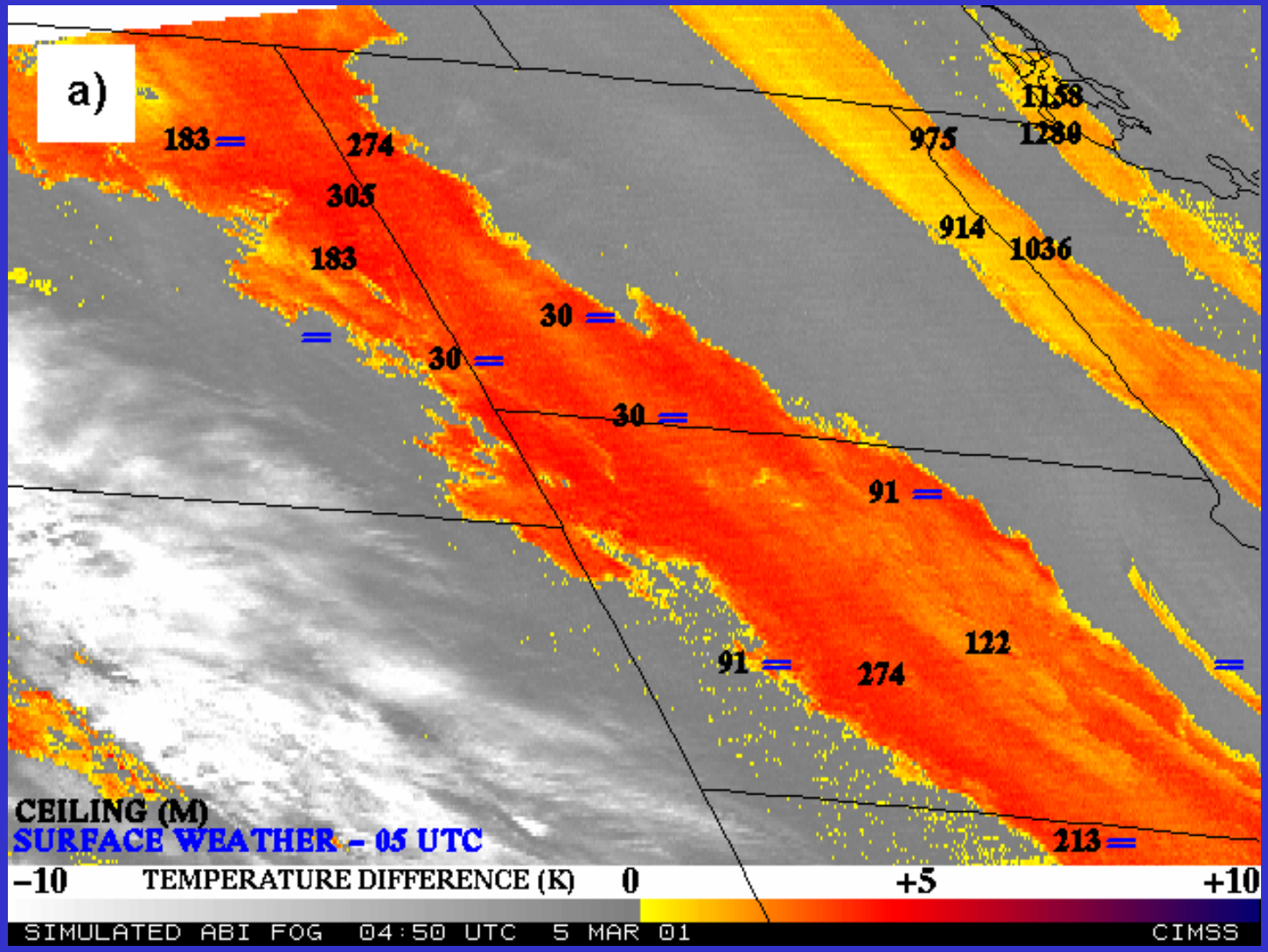
Nocturnal Fog/Stratus Over the Northern Plains



GOES-10 4 minus 11 μm Difference

ABI image (from MODIS) shows greater detail in structure of fog.

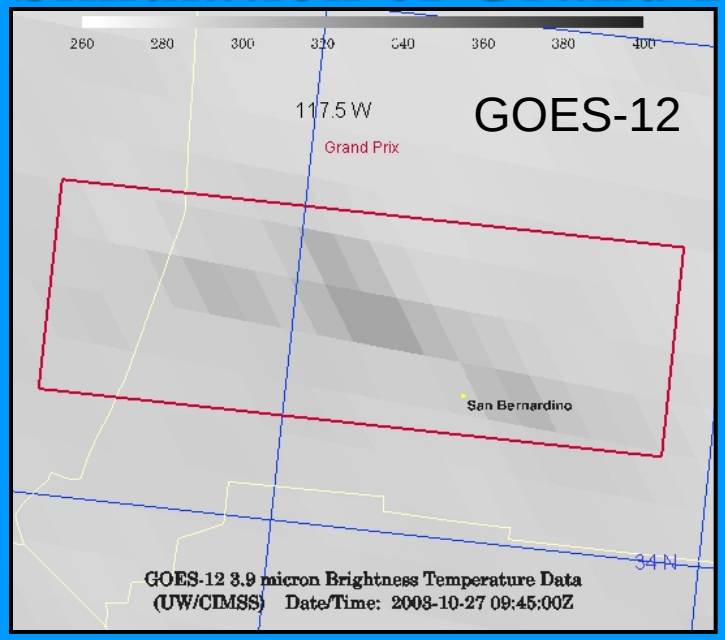
Nocturnal Fog/Stratus Over the Northern Plains

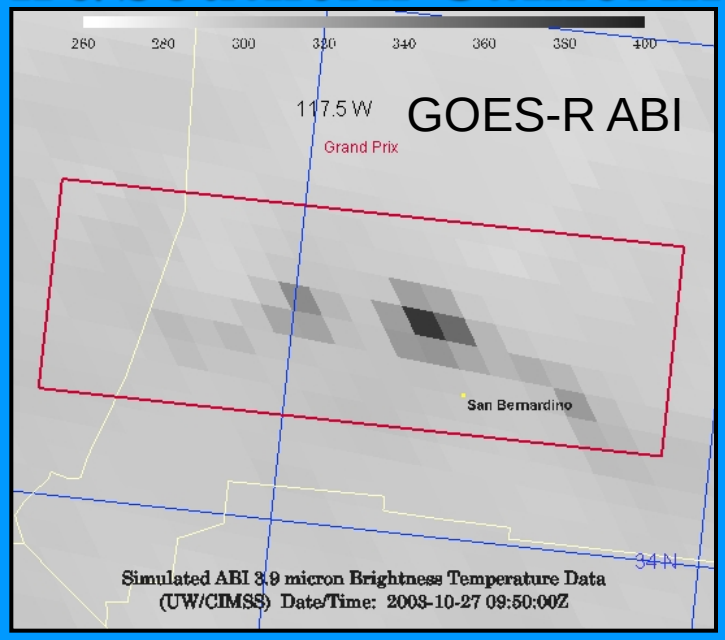


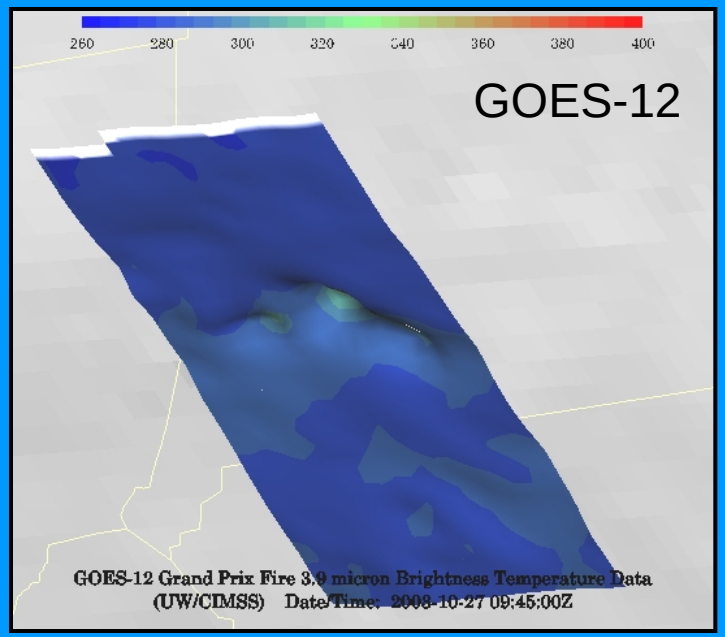
"ABI" 4 minus 11 μm Difference

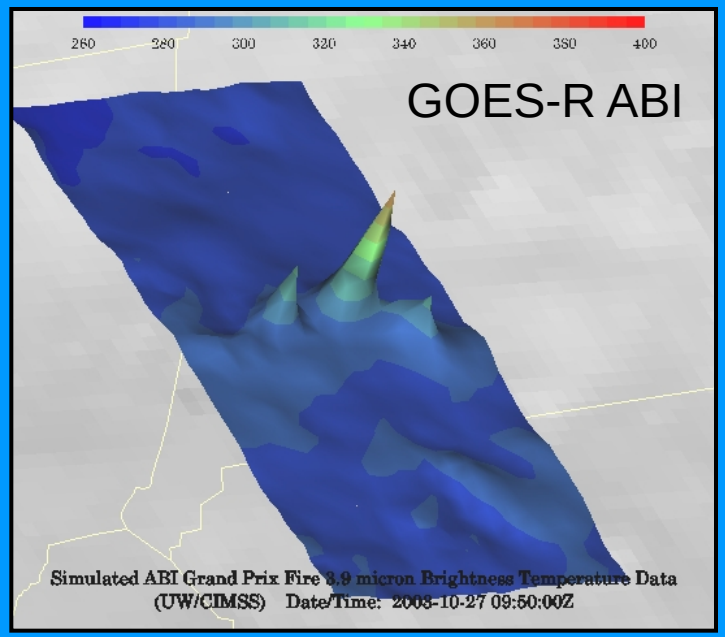
ABI image (from MODIS) shows greater detail in structure of fog.

GOES-12 and GOES-R ABI
Simulation of Grand Prix Fire/Southern California

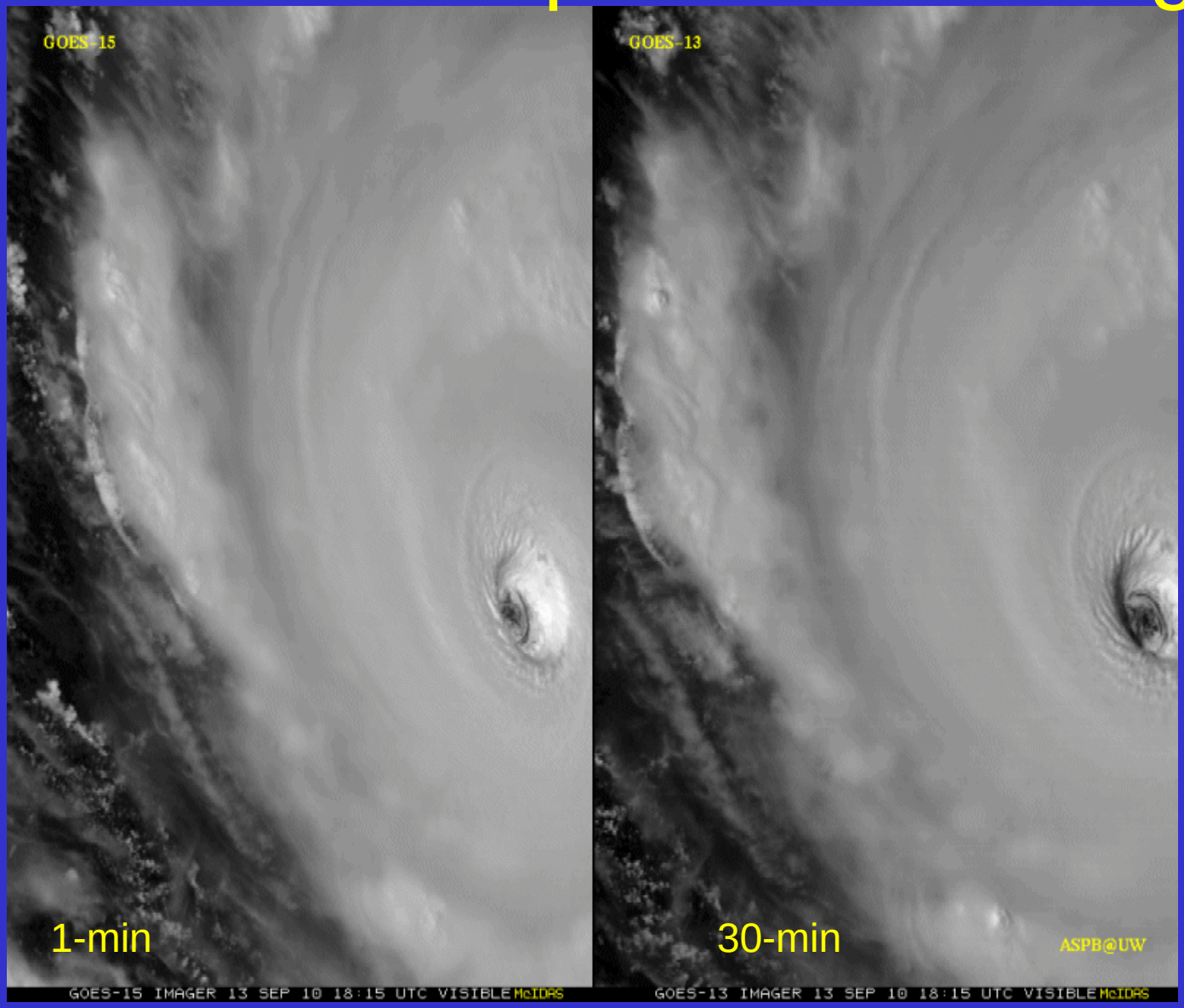








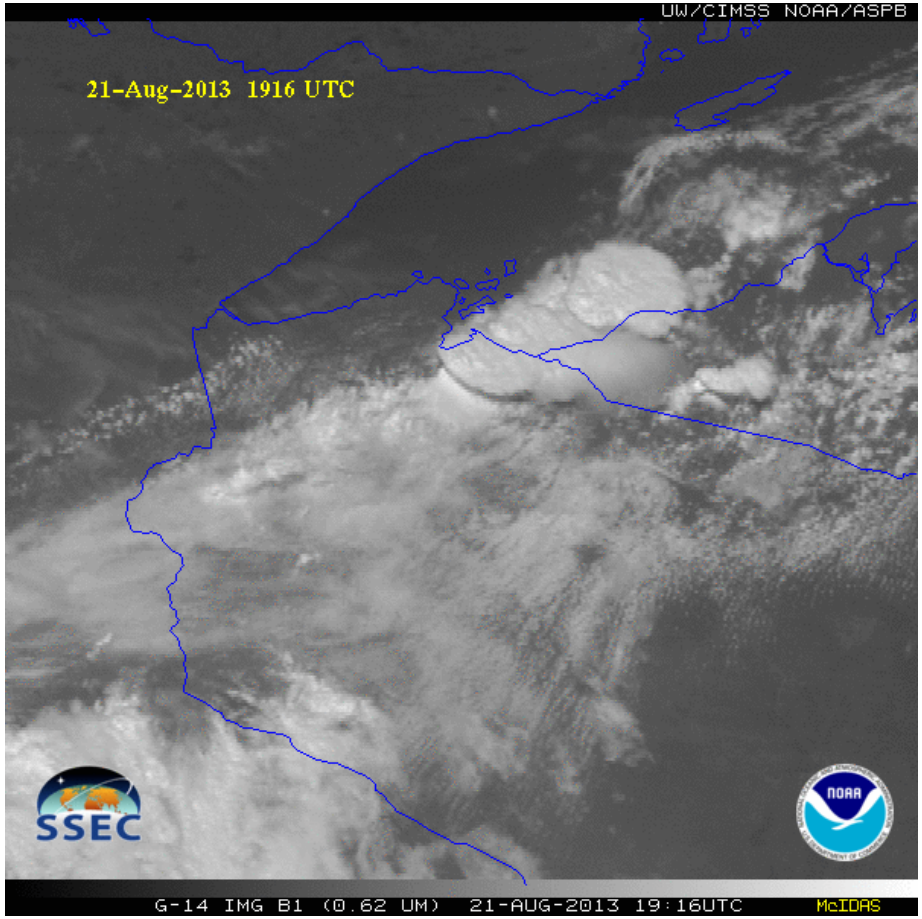
GOES-15: Sample “1-min” imagery



Visible data from the GOES-15 NOAA Science Test, lead by Hillger and Schmit

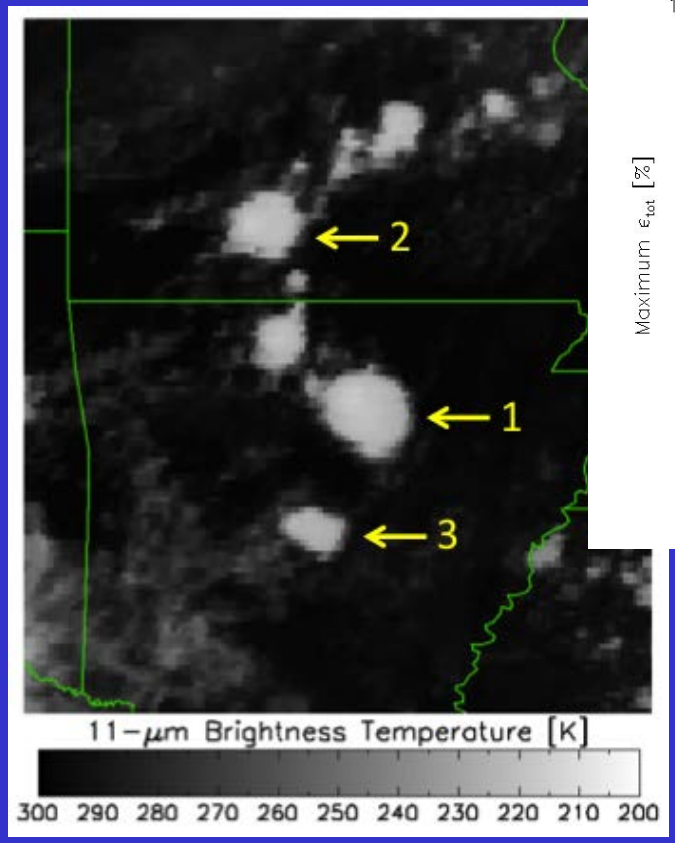
GOES-14 Super Rapid Scan Operations to Prepare for GOES-R

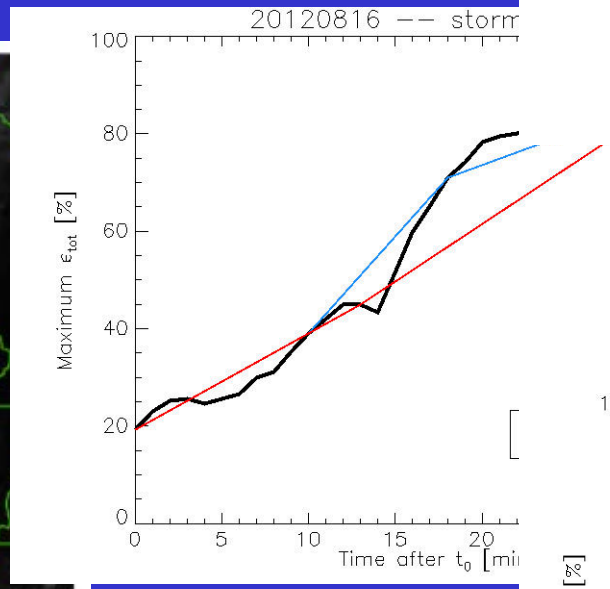
- SRSOR (Super Rapid Scan Operations for GOES-R) from GOES-14 imager
- Data between mid-August and September 24th and late October 2012; and two days in June and 12 days in mid-August, 2013; and mid-May (8-24), 2014
  - *http://cimss.ssec.wisc.edu/goes/srsor/GOES-14_SRSOR.html and*
  - *http://cimss.ssec.wisc.edu/goes/srsor2013/GOES-14_SRSOR.html*
  - *http://cimss.ssec.wisc.edu/goes/srsor2014/GOES-14_SRSOR.html*
- GOES-14 provided very unique data and offered a glimpse into the possibilities that will be provided by the ABI on GOES-R in one minute mesoscale imagery
- Many phenomena were observed

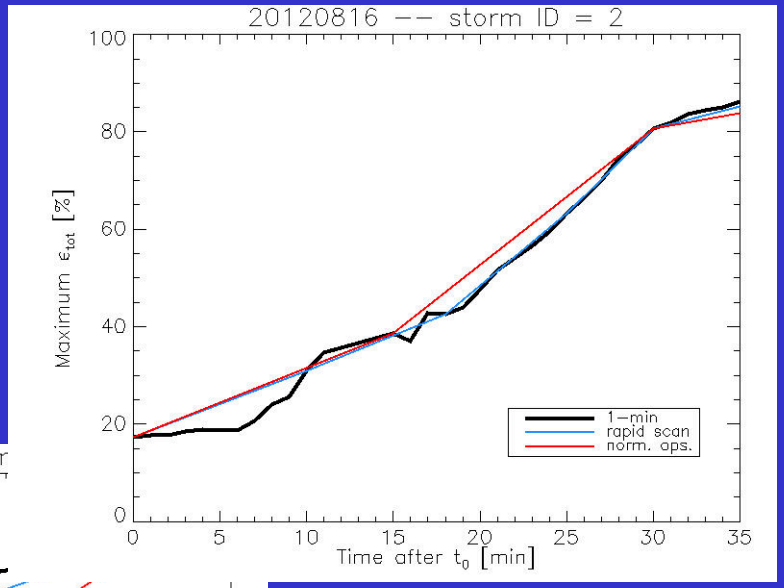


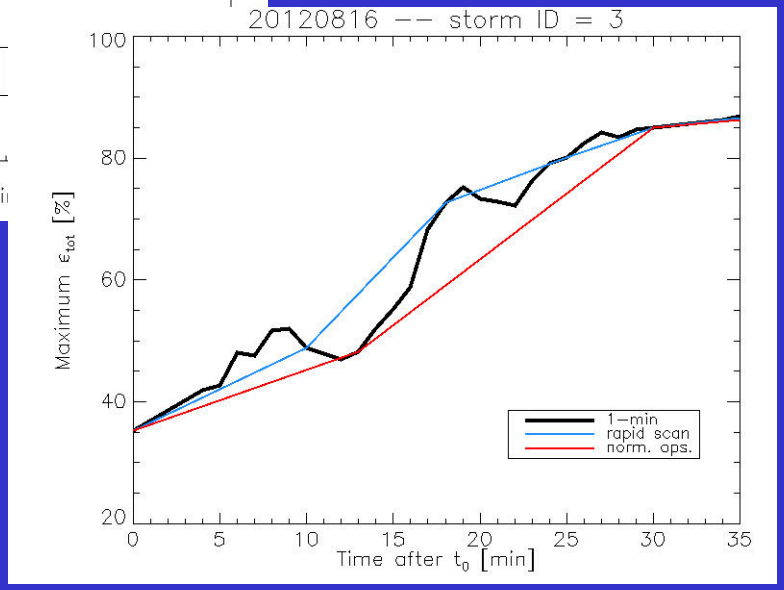
GOES-14 visible image showing rapid convective development

Rate of temporal cooling in the longwave infrared band

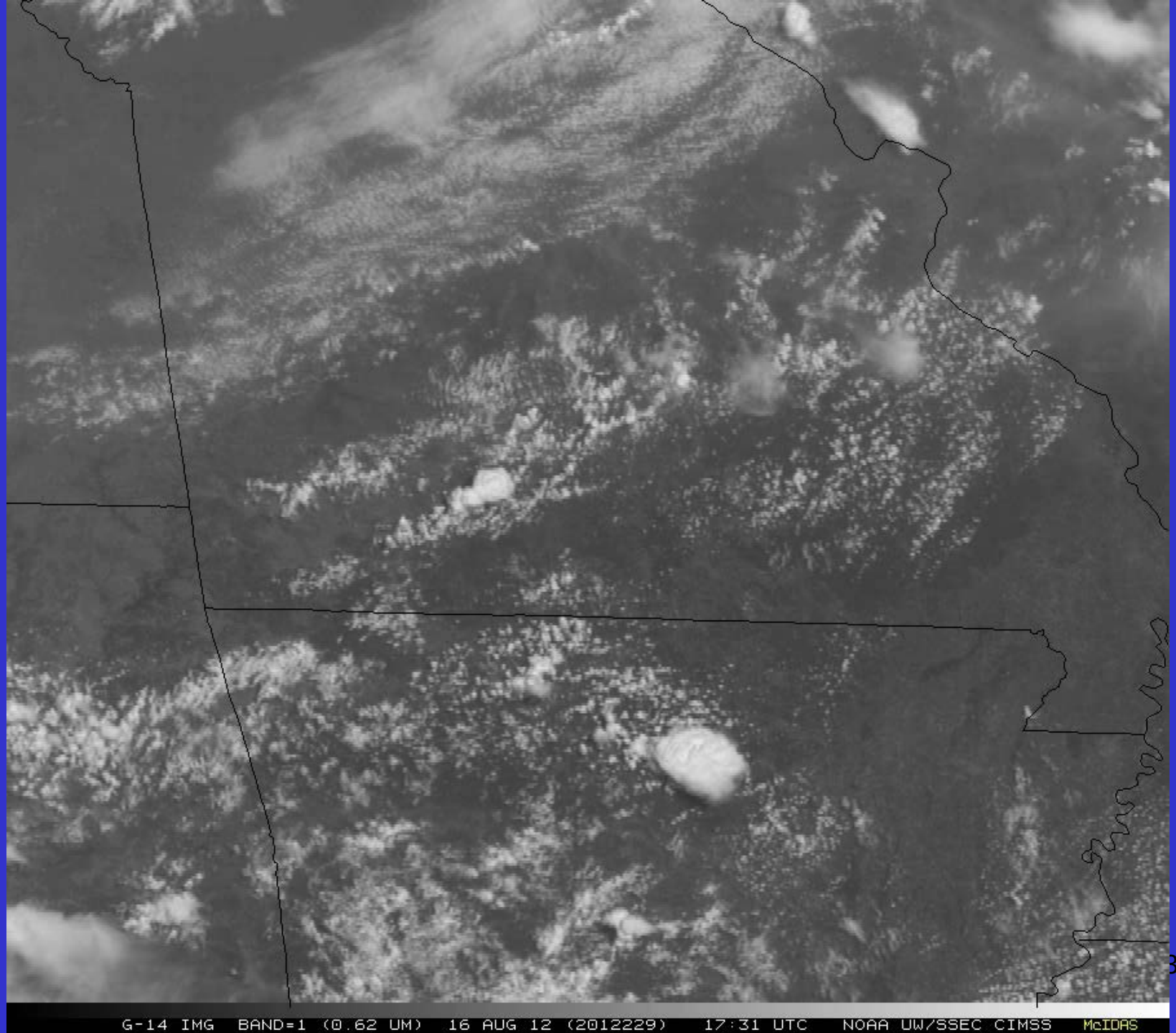








Cintineo et al., 2013 (CIMSS)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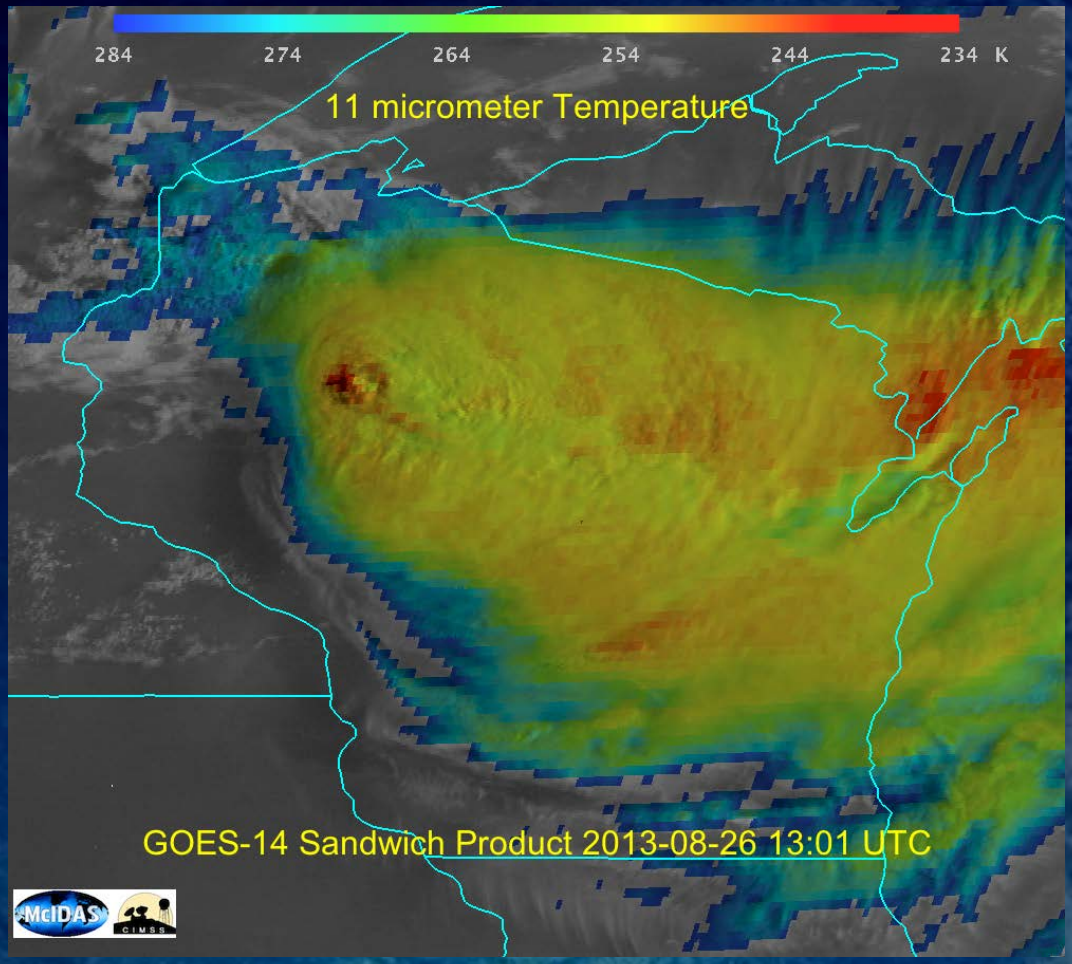
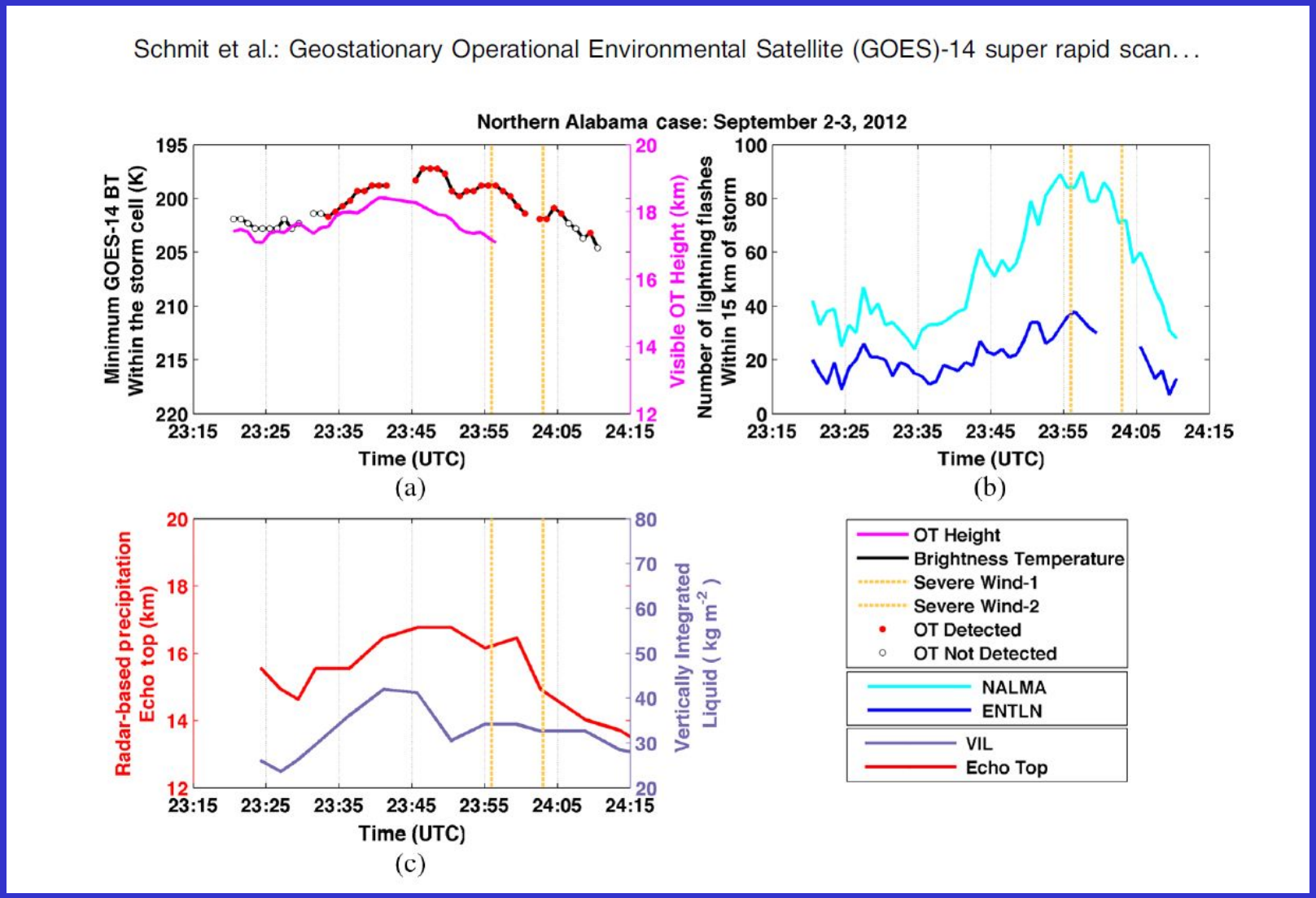
Validation – image combination

- Visible and IR ‘sandwich’ product…

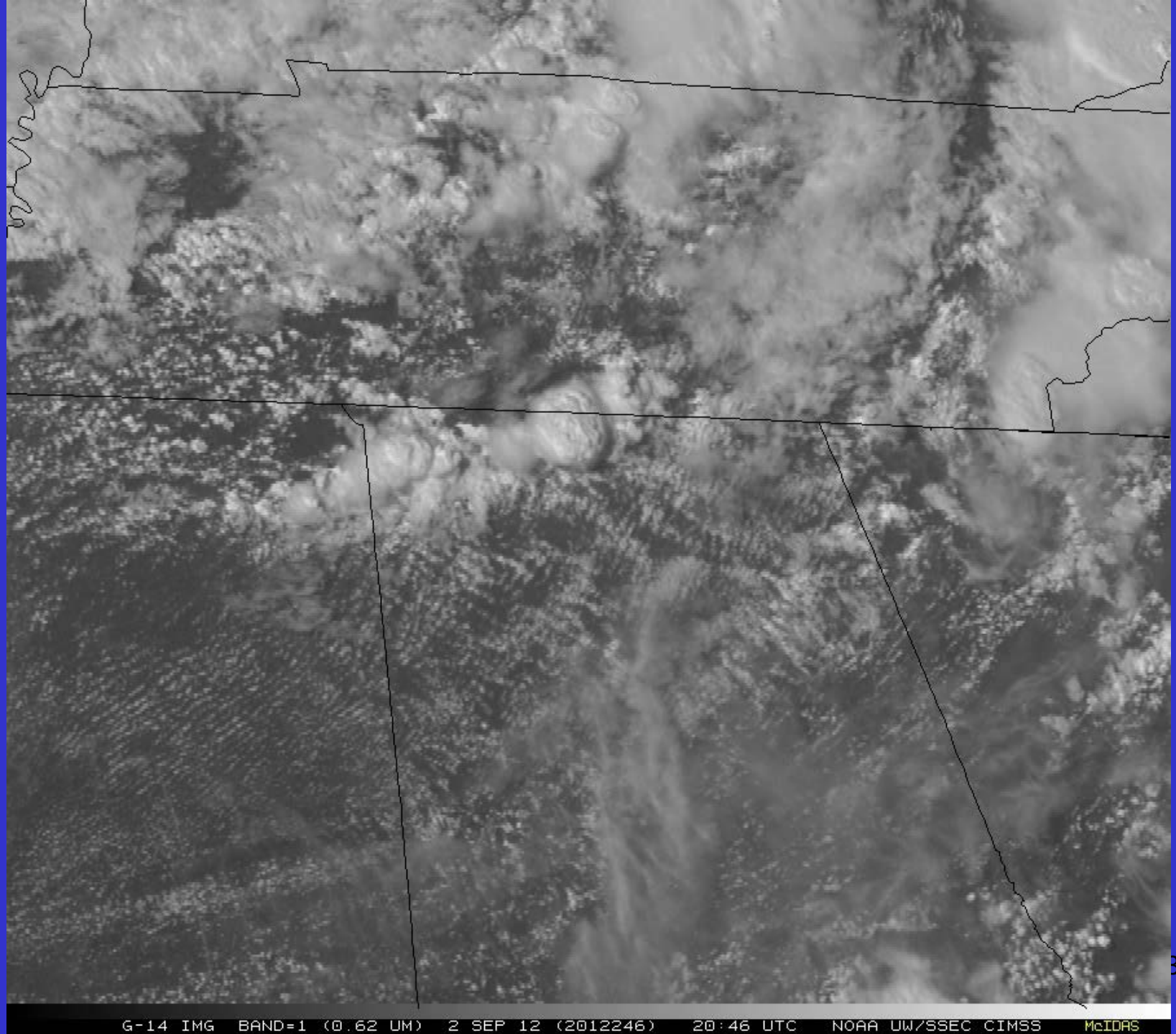


Created in McIDAS-V by Joleen Feltz; similar to the method of Martin Setvak

Visible+Infrared



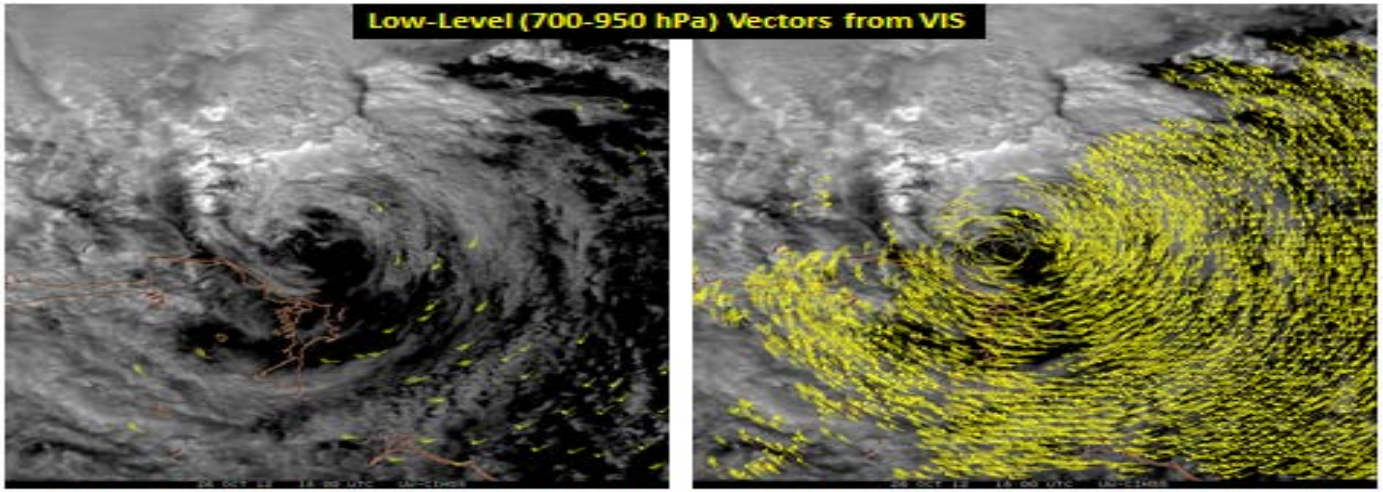
The combined presence of continuous OTs, high/increasing VIL, and high/increasing flash rate may be indicative of impending high impact weather and may improve the forecaster's situational awareness


G-14 IMG BAND=1 (0.62 UM) 2 SEP 12 (2012246) 20:46 UTC NOAA UW/SSEC CIMSS McIDAS

AMVs in High Impact Weather

Atmospheric Motion Vectors from GOES-R

Proxy: AMVs from special GOES-14 super-rapid-scan ops during *Hurricane Sandy*

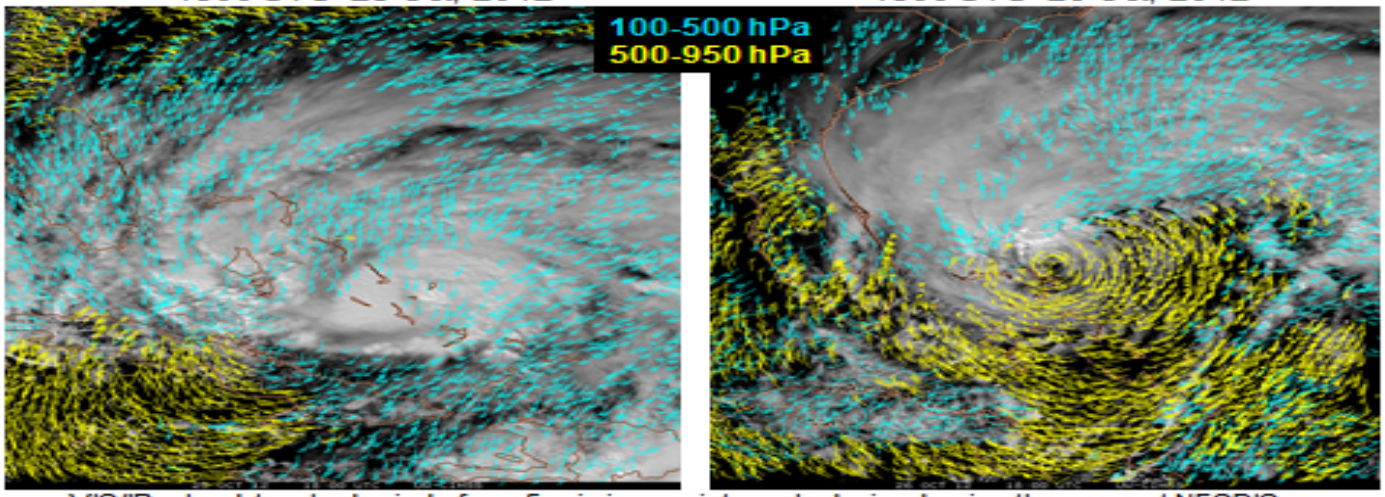


AMVs from 15-min images (routine GOES sampling) AMVs from 1-min images (meso GOES-R sampling)

1800 UTC 26 Oct, 2012

C. Velden (CIMSS)

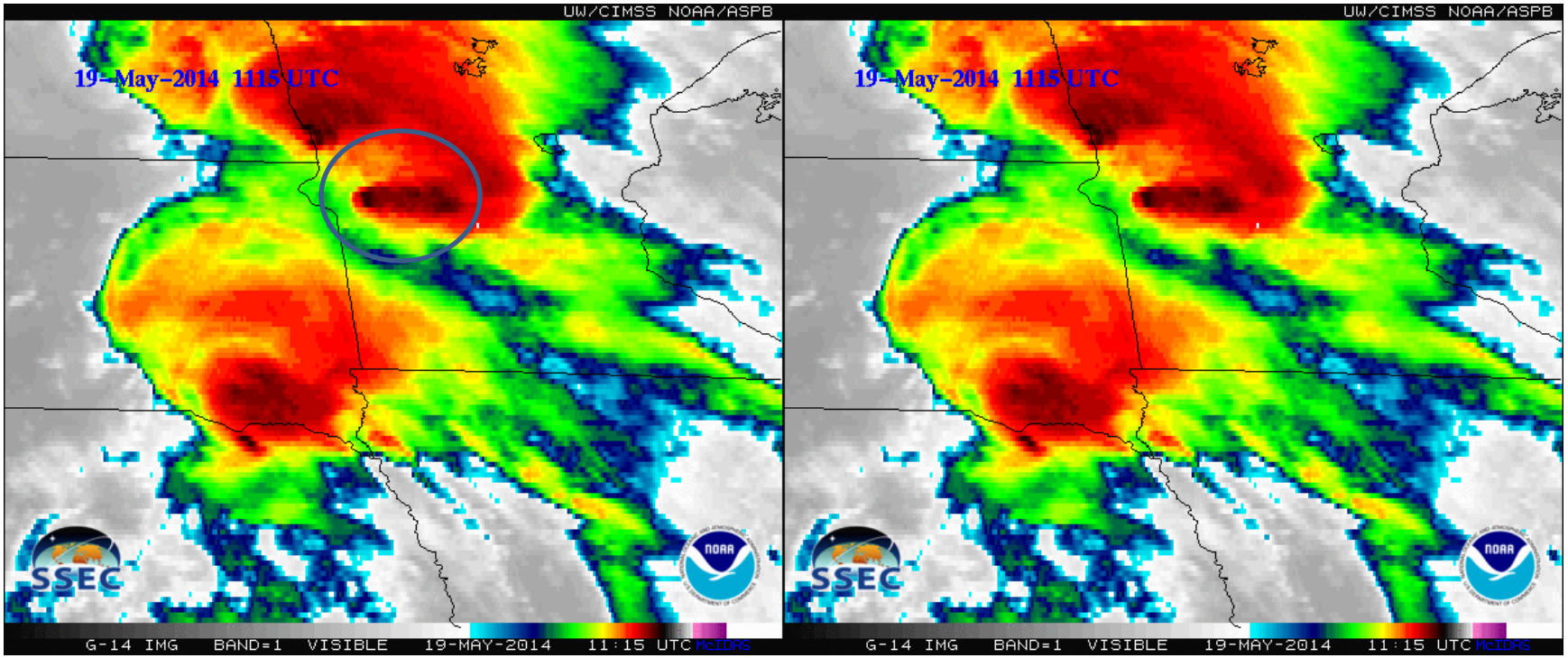
1800 UTC 25 Oct, 2012 1800 UTC 26 Oct, 2012



VIS/IR cloud-tracked winds from 5-min image intervals derived using the current NESDIS operational AMV algorithm. Tests using the new GOES-R tracking algorithm are underway. Data assimilation and model forecast impact experiments are planned.

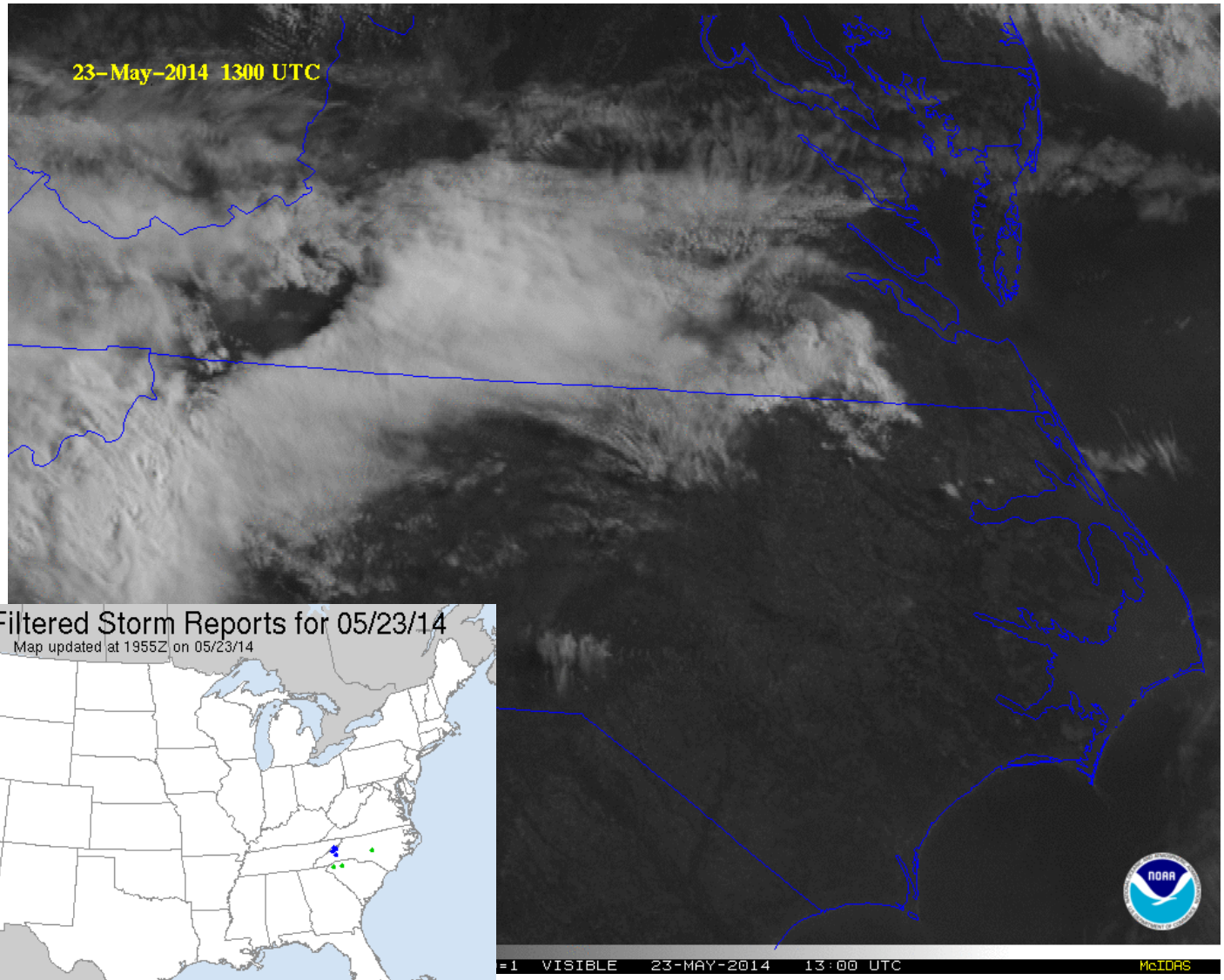
C. Velden (CIMSS)

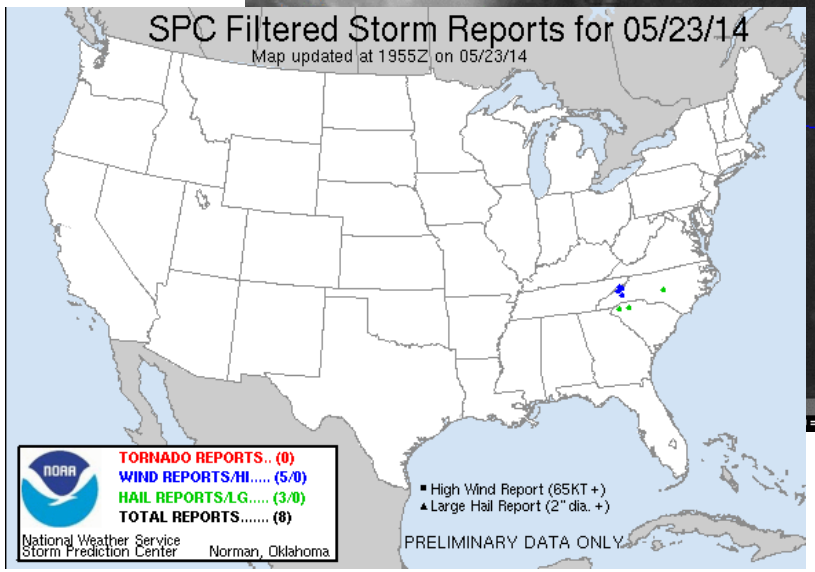
SRSOR GOES-14 2014
Color-enhanced infrared window
(1 vs 15 min)



Note the ‘enhanced-v’ is seen first on the 1 minute data.

SRSOR (NC)


23-May-2014 1300 UTC
=1 VISIBLE 23-MAY-2014 13:00 UTC
McIDAS


SPC Filtered Storm Reports for 05/23/14
Map updated at 1955Z on 05/23/14
TORNADO REPORTS.. (0)
WIND REPORTS/HI..... (5/0)
HAIL REPORTS/LG..... (3/0)
TOTAL REPORTS..... (8)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT+)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

GOES-R ABI Products

Baseline Products

Advanced Baseline Imager (ABI)

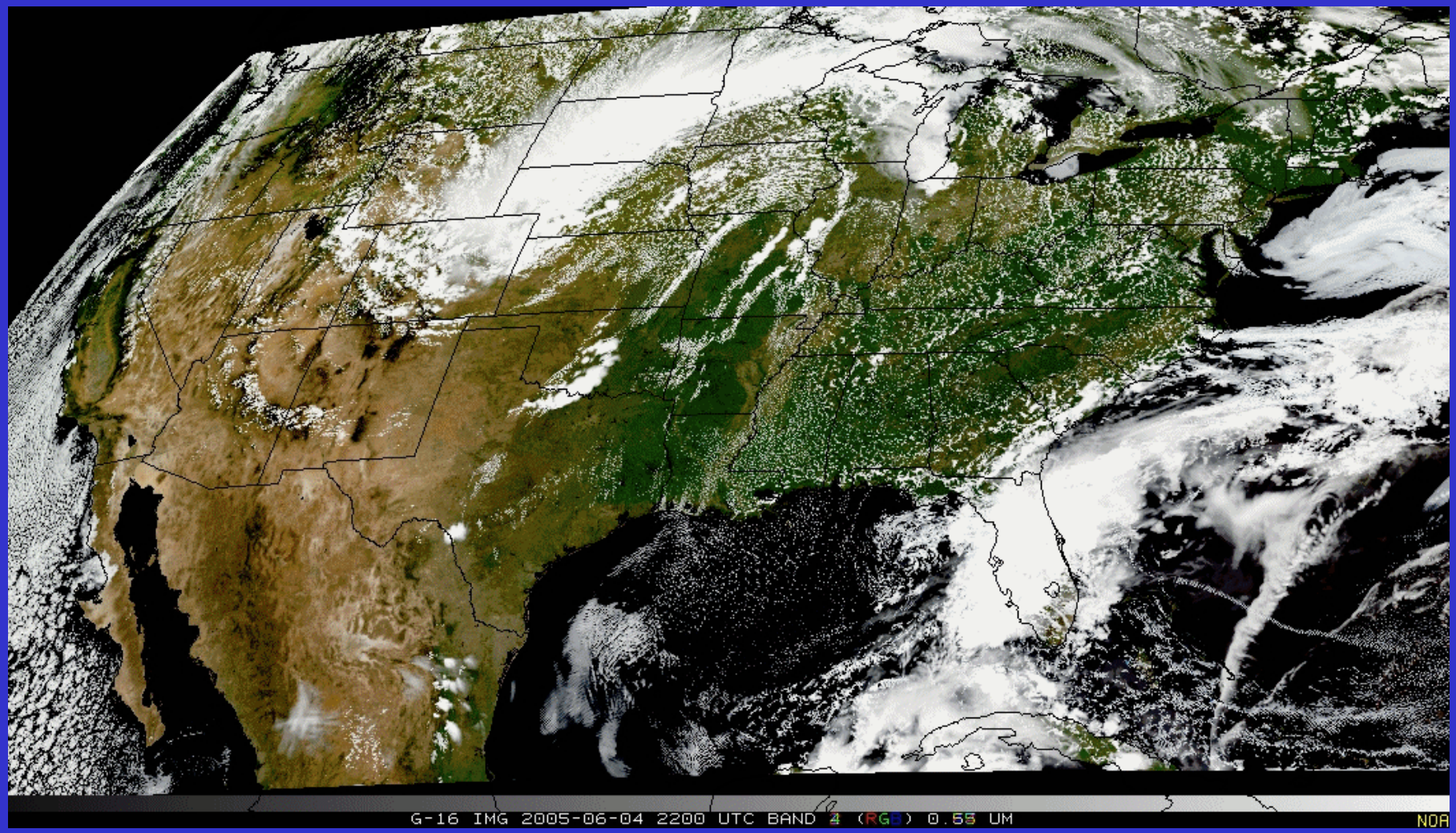
Aerosol Detection (Including Smoke and Dust)
Aerosol Optical Depth (AOD)
Clear Sky Masks
Cloud and Moisture Imagery
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Top Height
Cloud Top Phase
Cloud Top Pressure
Cloud Top Temperature
Derived Motion Winds
Derived Stability Indices
Downward Shortwave Radiation: Surface
Fire/Hot Spot Characterization
Hurricane Intensity Estimation
Land Surface Temperature (Skin)
Legacy Vertical Moisture Profile
Legacy Vertical Temperature Profile
Radiances
Rainfall Rate/QPE
Reflected Shortwave Radiation: TOA
Sea Surface Temperature (Skin)
Snow Cover
Total Precipitable Water
Volcanic Ash: Detection and Height

Future Capabilities

Advanced Baseline Imager (ABI)

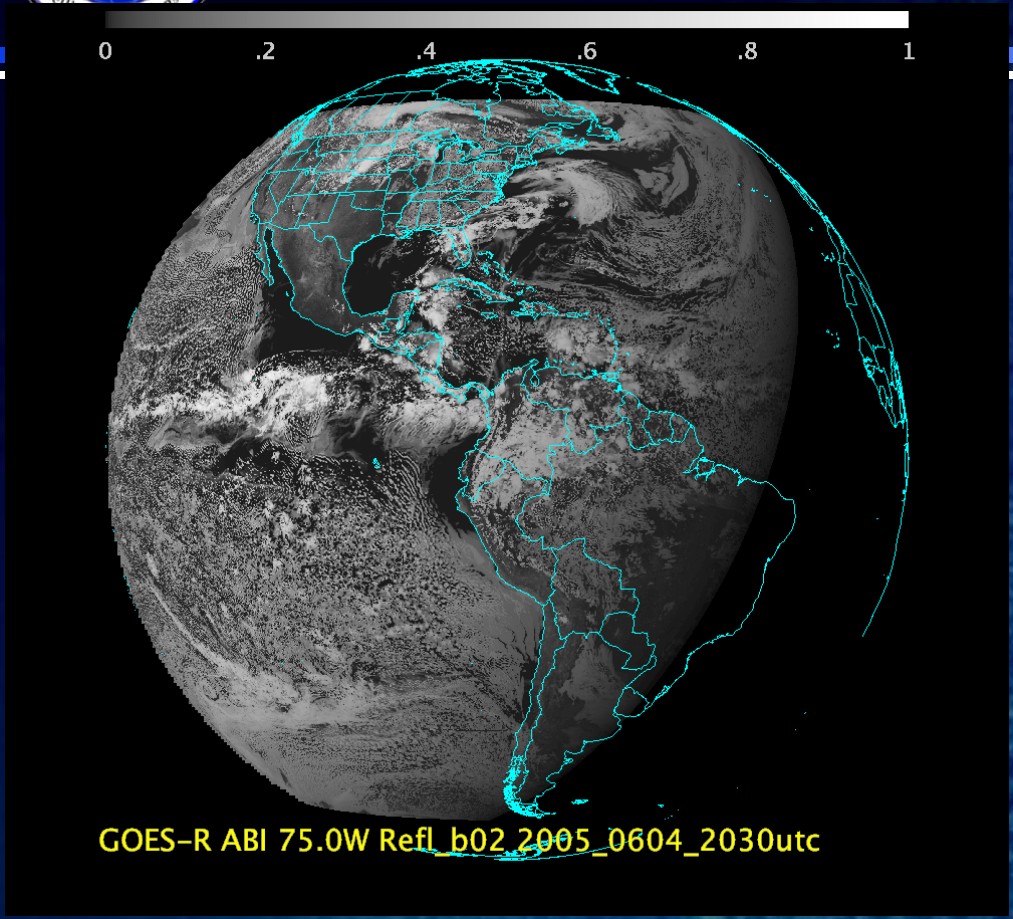
Absorbed Shortwave Radiation: Surface
Aerosol Particle Size
Aircraft Icing Threat
Cloud Ice Water Path
Cloud Layers/Heights
Cloud Liquid Water
Cloud Type
Convective Initiation
Currents
Currents: Offshore
Downward Longwave Radiation: Surface
Enhanced “V”/Overshooting Top Detection
Flood/Standing Water
Ice Cover
Low Cloud and Fog
Ozone Total
Probability of Rainfall
Rainfall Potential
Sea and Lake Ice: Age
Sea and Lake Ice: Concentration
Sea and Lake Ice: Motion
Snow Depth (Over Plains)
SO_2 Detection
Surface Albedo
Surface Emissivity
Tropopause Folding Turbulence Prediction
Upward Longwave Radiation: Surface
Upward Longwave Radiation: TOA
Vegetation Fraction: Green
Vegetation Index
Visibility

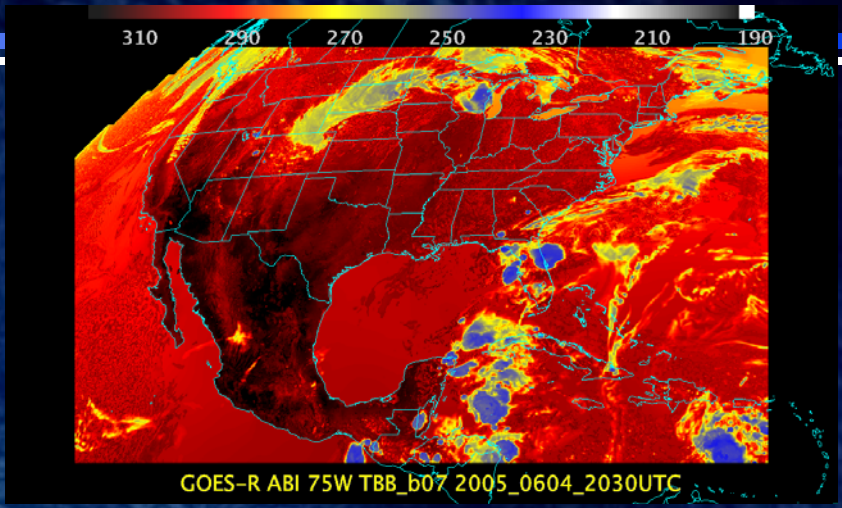
Pseudo-Natural Color

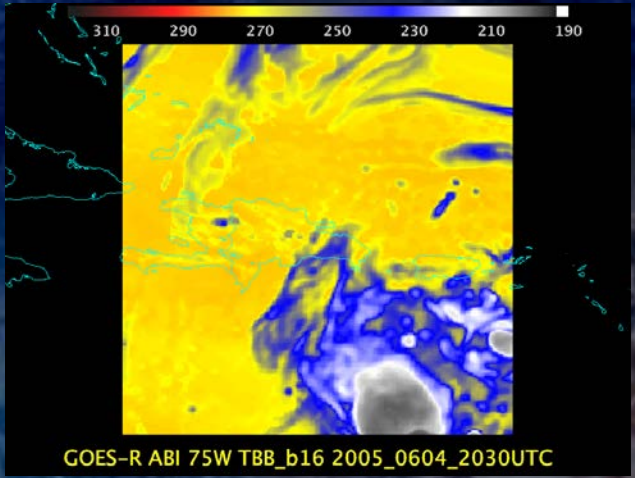


“True Color” with “synthetic” green band from ABI simulated data (from CIMSS); image from Don Hillger, RAMMB.

ABI Scan Modes



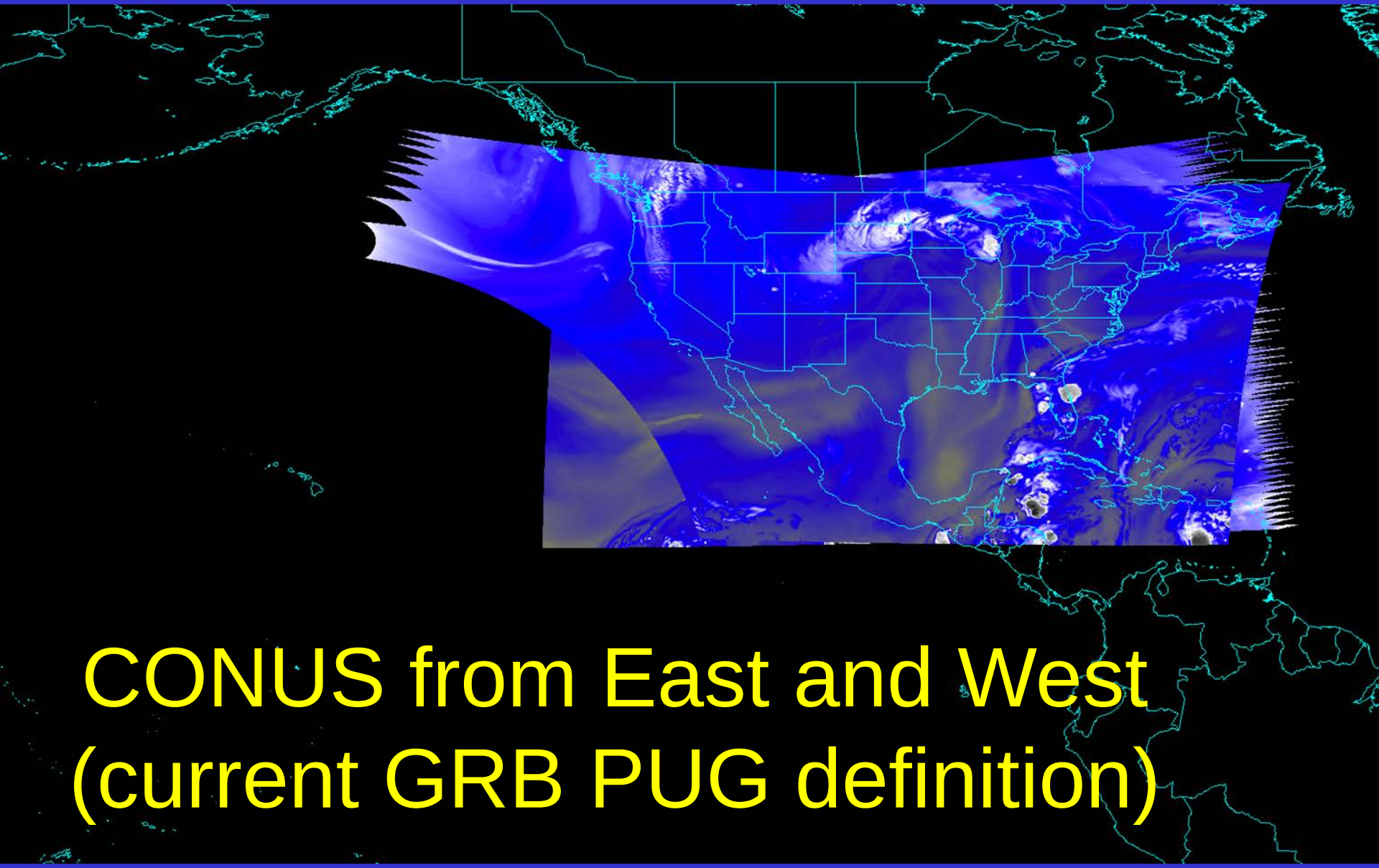




Scan mode (3) or 'flex mode' for the ABI:
- Full disk every 15 minutes + 5 min CONUS
  + 1-min mesoscales (2 locations).

[Scan mode (4) or 'Continuous Full Disk' (CFD) is a full disk every 5 min]

ABI CONUS sectors from East and West (proposed)



CONUS from East and West (current GRB PUG definition)

Exploratory ABI Scan Mode (draft)

At some point, other ABI scan mode could be possible. This would mean an upgrade to the ground system.

One option is to use the ‘white space’ of when the instrument is not scanning in mode 3 (flex). For example, increase to an ‘extended CONUS’ image.

The ABI instrument is capable of supporting other scan modes.

Original Mode 3 “Time-Time” chart

| Time | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | | |

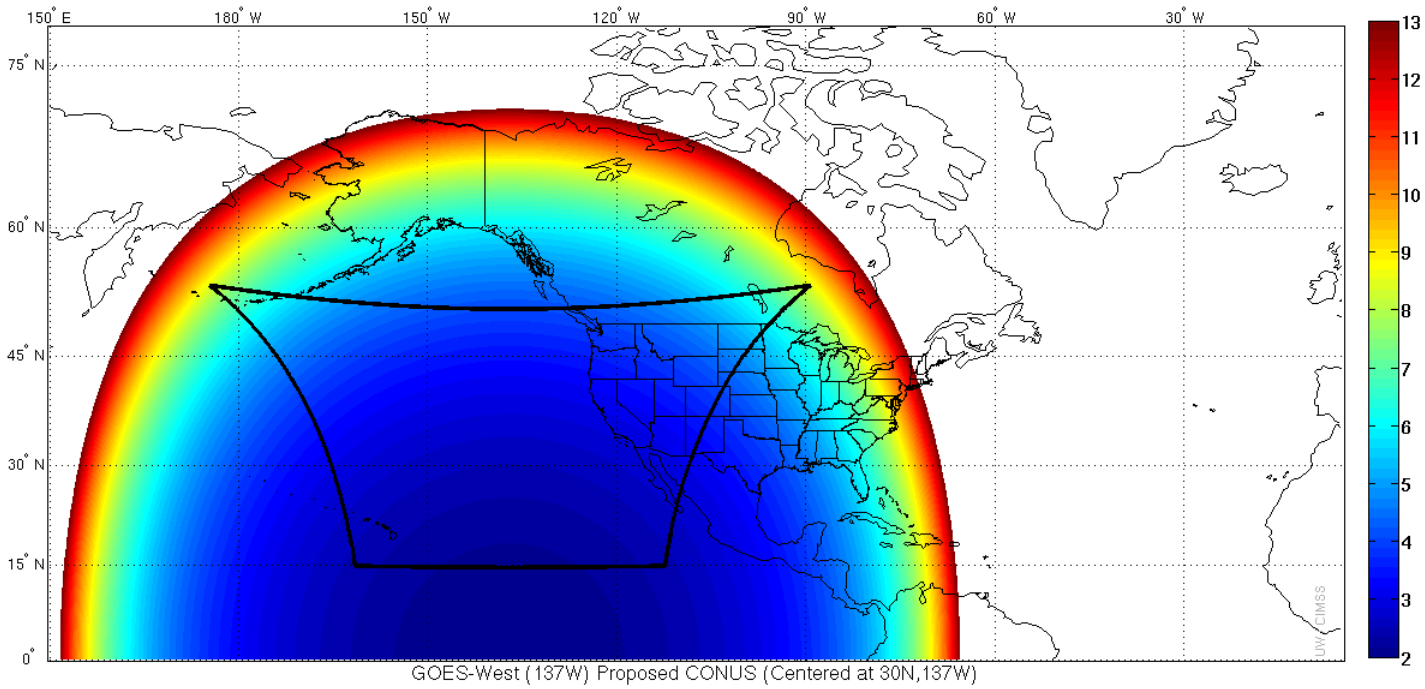
Mode 3 with Extended CONUS

Time	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
0		L			B			064 Star				390 Star					Extended CONUS 1 - Swath 1									Meso 1 -1			Meso 1 -2	
30						L	Full Disk Swath 1										Extended CONUS 1 - Swath 2									Meso 2 -1			Meso 2 -2	
60					L	Full Disk Swath 2											Extended CONUS 1 - Swath 3									Meso 3 -1			Meso 3 -2	
90				L	Full Disk Swath 3												Extended CONUS 1 - Swath 4									Meso 4 -1			Meso 4 -2	
120			L	Full Disk Swath 4													Extended CONUS 1 - Swath 5									Meso 5 -1			Meso 5 -2	
150		L	Full Disk Swath 5														Extended CONUS 1 - Swath 6									Meso 6 -1			Meso 6 -2	
180		L	Full Disk Swath 6														Extended CONUS 1 - Swath 7									Meso 7 -1			Meso 7 -2	
210		L	Full Disk Swath 7														Extended CONUS 1 - Swath 8									Meso 8 -1			Meso 8 -2	
240		L	Full Disk Swath 8														Extended CONUS 1 - Swath 9									Meso 9 -1			Meso 9 -2	
270	L	Full Disk Swath 9															064 Star			390 Star						Meso 10 -1			Meso 10 -2	
300	L	Full Disk Swath 10															Extended CONUS 2 - Swath 1									Meso 11 -1			Meso 11 -2	
330	L	Full Disk Swath 11															Extended CONUS 2 - Swath 2									Meso 12 -1			Meso 12 -2	
360	L	Full Disk Swath 12															Extended CONUS 2 - Swath 3									Meso 13 -1			Meso 13 -2	
390	L	Full Disk Swath 13															Extended CONUS 2 - Swath 4									Meso 14 -1			Meso 14 -2	
420	L	Full Disk Swath 14															Extended CONUS 2 - Swath 5									Meso 15 -1			Meso 15 -2	
450	L	Full Disk Swath 15															Extended CONUS 2 - Swath 6									Meso 16 -1			Meso 16 -2	
480	L	Full Disk Swath 16															Extended CONUS 2 - Swath 7									Meso 17 -1			Meso 17 -2	
510	L	Full Disk Swath 17															Extended CONUS 2 - Swath 8									Meso 18 -1			Meso 18 -2	
540	L	Full Disk Swath 18															Extended CONUS 2 - Swath 9									Meso 19 -1			Meso 19 -2	
570	L	Full Disk Swath 19															064 Star			390 Star						Meso 20 -1			Meso 20 -2	
600	L	Full Disk Swath 20															Extended CONUS 3 - Swath 1									Meso 21 -1			Meso 21 -2	
630	L	Full Disk Swath 21															Extended CONUS 3 - Swath 2									Meso 22 -1			Meso 22 -2	
660	L	Full Disk Swath 22															Extended CONUS 3 - Swath 3									Meso 23 -1			Meso 23 -2	
690	L																Extended CONUS 3 - Swath 4									Meso 24 -1			Meso 24 -2	
720	L																Extended CONUS 3 - Swath 5									Meso 25 -1			Meso 25 -2	
750	L																Extended CONUS 3 - Swath 6									Meso 26 -1			Meso 26 -2	
780	L																Extended CONUS 3 - Swath 7									Meso 27 -1			Meso 27 -2	
810	L																Extended CONUS 3 - Swath 8									Meso 28 -1			Meso 28 -2	
840	L																Extended CONUS 3 - Swath 9									Meso 29 -1			Meso 29 -2	
870	L																									Meso 30 -1			Meso 30 -2	

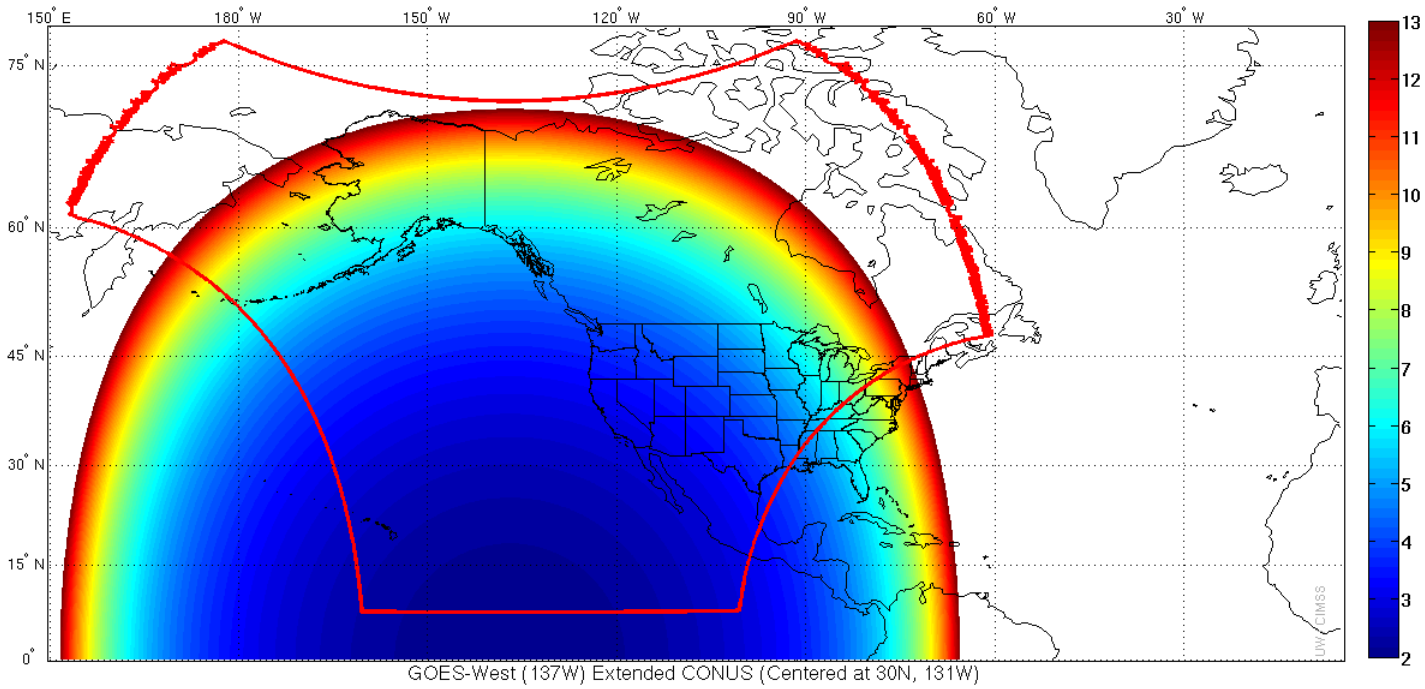
Note larger CONUS scans, while keeping full disk and meso-scale scans

DRAFT!!!!!

Proposed ABI CONUS: West (with increasing pixel size)



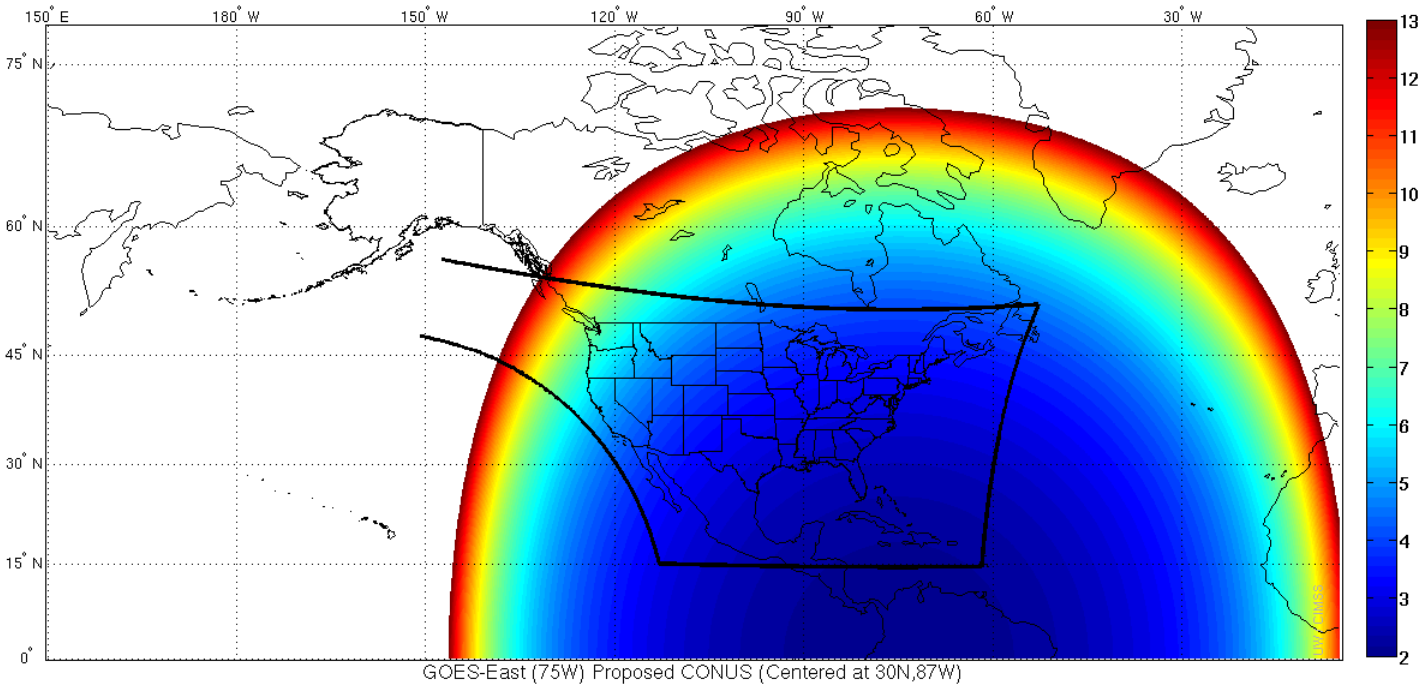
Proposed ABI –Extended CONUS: West (with increasing pixel size)



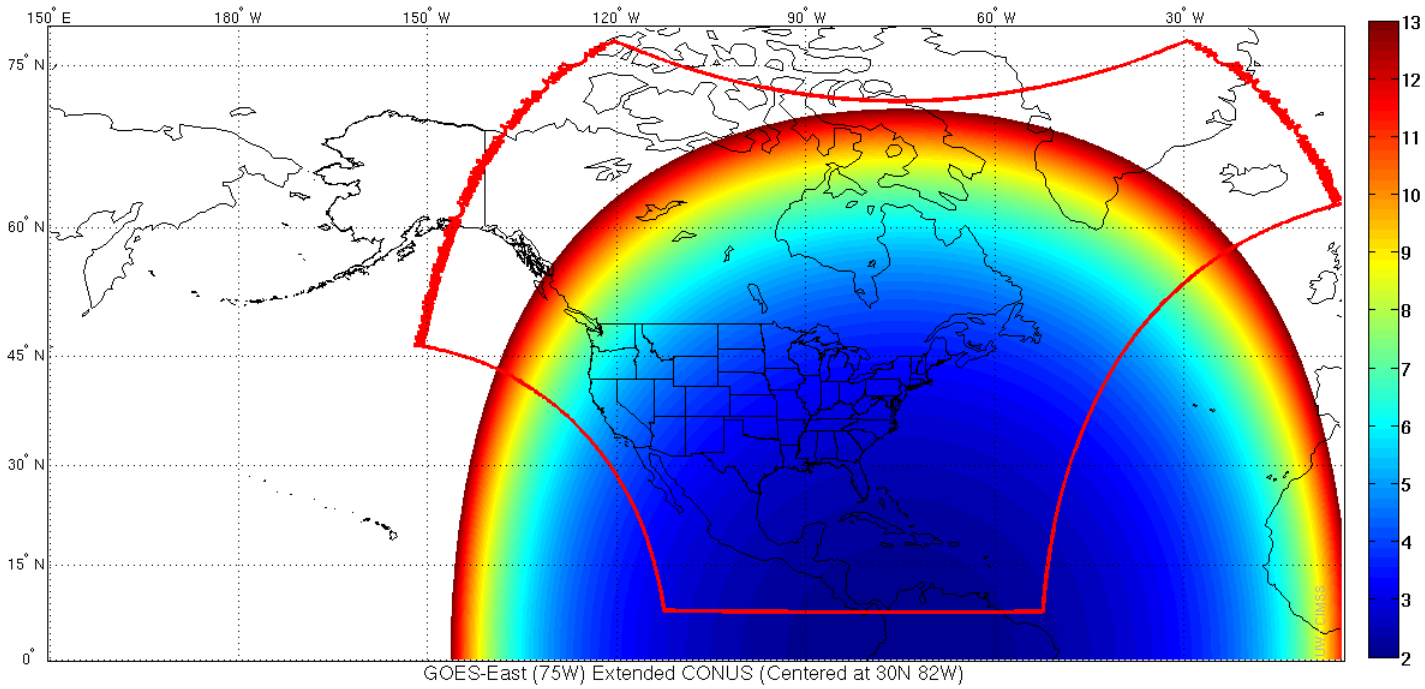
Note Alaska could be covered as part of the 'CONUS' ABI scan

DRAFT scan mode!

Proposed ABI CONUS: East (with increasing pixel size)



Proposed ABI –Extended CONUS: East (with increasing pixel size)



Note more of Canada and the Atlantic could be covered as part of the 'CONUS' ABI scan

DRAFT scan mode!

Exploratory ABI Scan Strategies

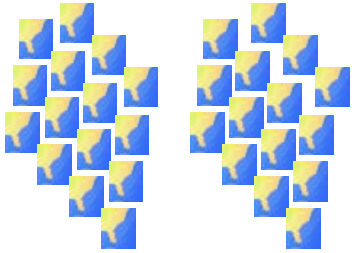
There are some alternative ABI scan strategies to Mode 3 and Mode 4.

Option A

Every **15** minutes **&**

One **extended** "CONUS" sector every **5** minutes

&



One mesoscale sector every **30** seconds (or 1 minute at two locations)

Option B

Every **3** minutes
(with 6 min gap)

&

One **wider** "CONUS" sector in 6 minute gaps

Every **15** minutes

CONUS covered every 3 minute!

&

One mesoscale sector every **30** seconds (or 1 minute at two locations)

Summary

1. The GOES-R ABI provides mission continuity
   - Imagery is the Key Product Parameter

2. Two times the image navigation quality

3. Three times the number of imaging bands

4. Four times the spatial resolutions

5. Five times the coverage rate

   - Special GOES-14 1-min data pathfinder

   - http://cimss.ssec.wisc.edu/goes/srsor2014/GOES-14_SRSOR.html

Three Groups of Users

- Direct use of radiances/imagery
  - Numerical models
  - Forecasters
  - Broadcasters
  - General public/private sector/Internet
- Direct use of satellite products
  - Numerical models
  - Forecasters
  - Blended products, etc.
  - General public/private sector/Internet
- Use of services which use data/products
  - Basically everyone!

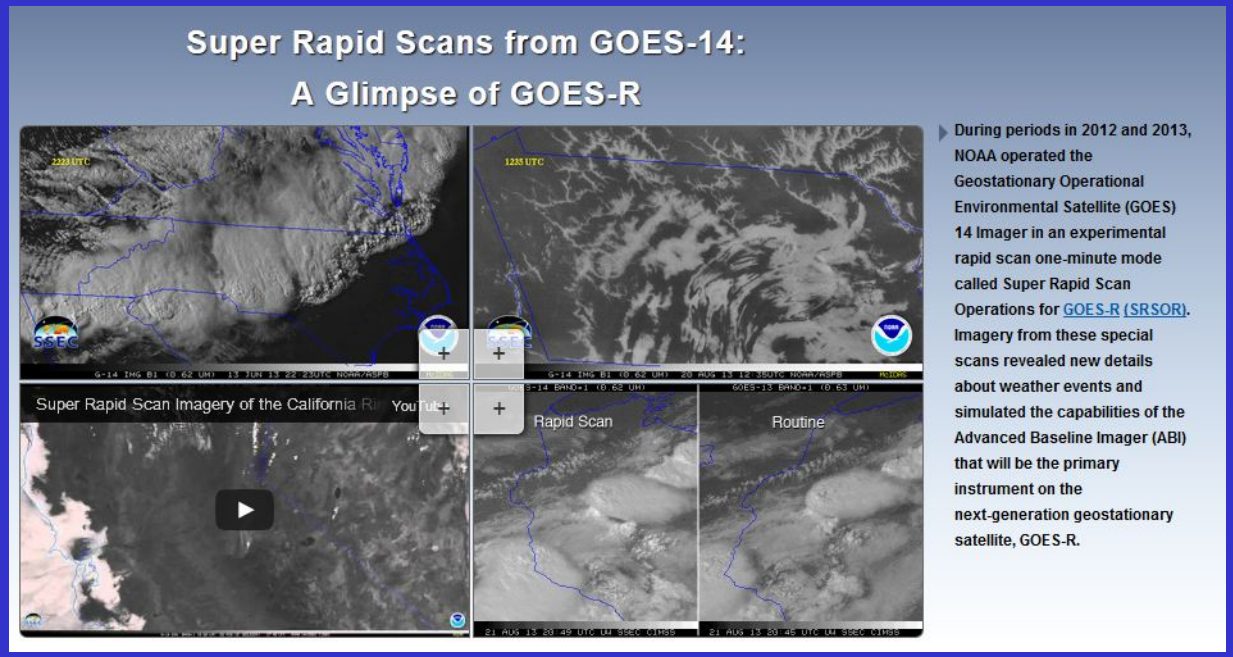
SRSOR Links

http://cimss.ssec.wisc.edu/goes/srsor/GOES-14_SRSOR.html

http://cimss.ssec.wisc.edu/goes/srsor2013/GOES-14_SRSOR.html

http://cimss.ssec.wisc.edu/goes/srsor2014/GOES-14_SRSOR.html

http://www.nesdis.noaa.gov/fourbox/09-23-13/



References

Schmit T.J., Goodman S.J., Lindsey D.T., R. M. Rabin, K. M. Bedka, M. M. Gunshor, J. L. Cintineo, C. S. Velden, A. S. Bachmeier, S. S. Lindstrom, and C. C. Schmidt, 2013: **Geostationary operational environmental satellite (GOES)-14 super rapid scan operations to prepare for GOES-R**. *J. Appl. Remote Sens.* 0001;7(1):073462. doi:10.1117/1.JRS.7.073462.

http://remotesensing.spiedigitallibrary.org/article.aspx?articleid=1790703

Schmit, Timothy J.; Gunshor, Mathew M.; Menzel, W. Paul; Gurka, James J.; Li, Jun and Bachmeier, A. Scott. **Introducing the next-generation Advanced Baseline Imager on GOES-R.** Bulletin of the American Meteorological Society, Volume 86, Issue 8, 2005, pp.1079-1096.

http://journals.ametsoc.org.ezproxy.library.wisc.edu/doi/pdf/10.1175/BAMS-86-8-1079

More information

GOES:

- http*://www.ospo.noaa.gov/Operations/GOES/schedules_3col.html*

GOES-R:

- http://www.goes-r.gov
- http://www.meted.ucar.edu/index.htm

UW/SSEC/CIMSS/ASPB:

- http://cimss.ssec.wisc.edu/goes_r/proving-ground.html
- http://cimss.ssec.wisc.edu/goes_r/proving-ground/nssl_abi/nssl_abi_rt.html
- http://cimss.ssec.wisc.edu/goes_r/proving-ground/wrf_chem_abi/wrf_chem_abi.html
- http://cimss.ssec.wisc.edu/goes/abi/
- http://cimss.ssec.wisc.edu/goes/blog/

AMS BAMS Article on the ABI

INTRODUCING THE NEXT-GENERATION ADVANCED BASELINE IMAGER ON GOES-R

BY TIMOTHY J. SCHMIT, MATHEW M. GUNSHOR, W. PAUL MENZEL, JAMES J. GURKA, JUN LI, AND A. SCOTT BACHMEIER

The ABI will begin a new era in U.S. environmental remote sensing with more spectral bands, faster imaging, and higher spatial resolution than the current imager.

The Advanced Baseline Imager (ABI) is being developed as the future imager on the Geostationary Operational Environmental Satellite (GOES) series, slated to be launched in approximately 2012 with GOES-R (Gurka and Dittberner 2001). Similar to the current GOES imager, ABI will be used for a wide range of qualitative and quantitative weather, oceanographic, climate, and environmental applications. ABI will offer more spectral bands, higher spatial resolution, and faster imaging than the current GOES imager. ABI spatial resolution will be nominally 2 km for the infrared bands and 0.5 km for the 0.64-μm visible band. While the instrument will allow a flexible scanning scenario, two basic modes are envisioned. One mode is that every 15 min ABI will scan the full disk (FD), plus continental United States (CONUS) 3 times, plus a selectable 1000 km × 1000 km area every 30 s. The second mode is that the ABI can be programmed to scan the FD iteratively. The FD image can be acquired in approximately 5 min. Given that the current GOES imager takes approximately 25 min for a FD, this implies there will be a fivefold increase in the coverage rate.

ABI has 16 spectral bands; five are similar to the 0.6-, 4-, 11-, and 12-μm windows and the 6.5-μm water vapor band on the current *GOES-8/-9/-10/-11* imagers (Menzel and Purdom 1994; Elliod et al. 1998), and another is similar to the 13.3 μm on the *GOES-12/-N/-O/-P* imagers and the *GOES-8/-P* sounders (Hillger et al. 2003; Schmit et al. 2001, 2002). Additional bands on ABI are 0.47 μm for aerosol detection and visibility estimation; 0.865 μm for aerosol detection and estimation of vegetation health; 1.378 μm to [illegible] cirrus clouds; 1.6 μm for snow/cloud [illegible]; 2.25 μm for aerosol and cloud [illegible] estimation, vegetation, cloud properties/screening, hot-spot detection, moisture

AFFILIATIONS: SCHMIT—NOAA/NESDIS, Office of Research and Applications, Advanced Satellite Products Team, Madison, Wisconsin; GUNSHOR, LI, AND BACHMEIER—Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin—Madison, Madison, Wisconsin; MENZEL—NOAA/NESDIS, Office of Research and Applications, Madison, Wisconsin; AND GURKA—NOAA/NESDIS, Office of Systems Development, Silver Spring, Maryland

CORRESPONDING AUTHOR: Timothy J. Schmit, 1225 West Dayton St., Madison, WI 53706

E-mail: Tim.J.Schmit@noaa.gov

DOI: 10.1175/BAMS-84-8-1079

In final form 14 March 2005

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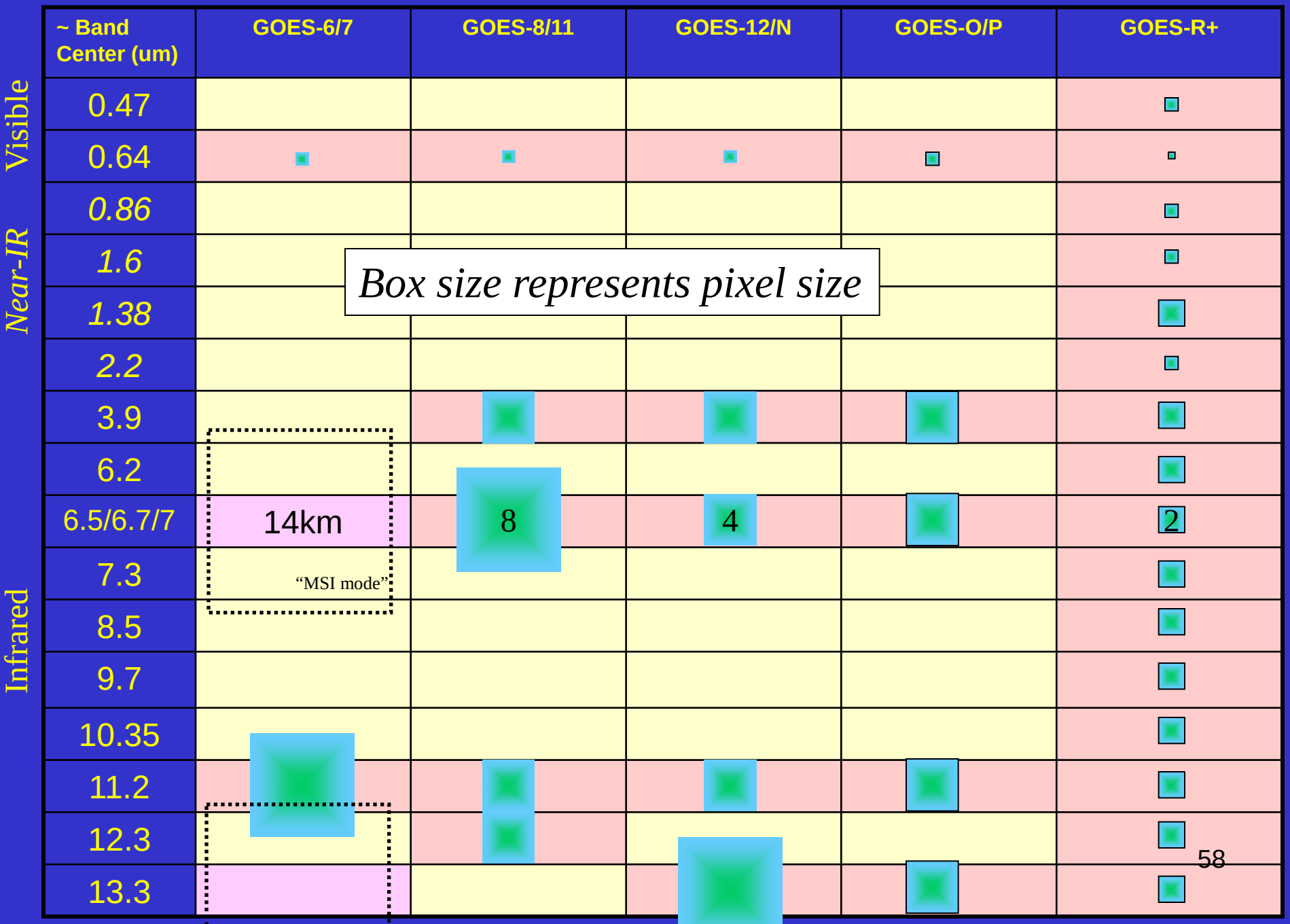
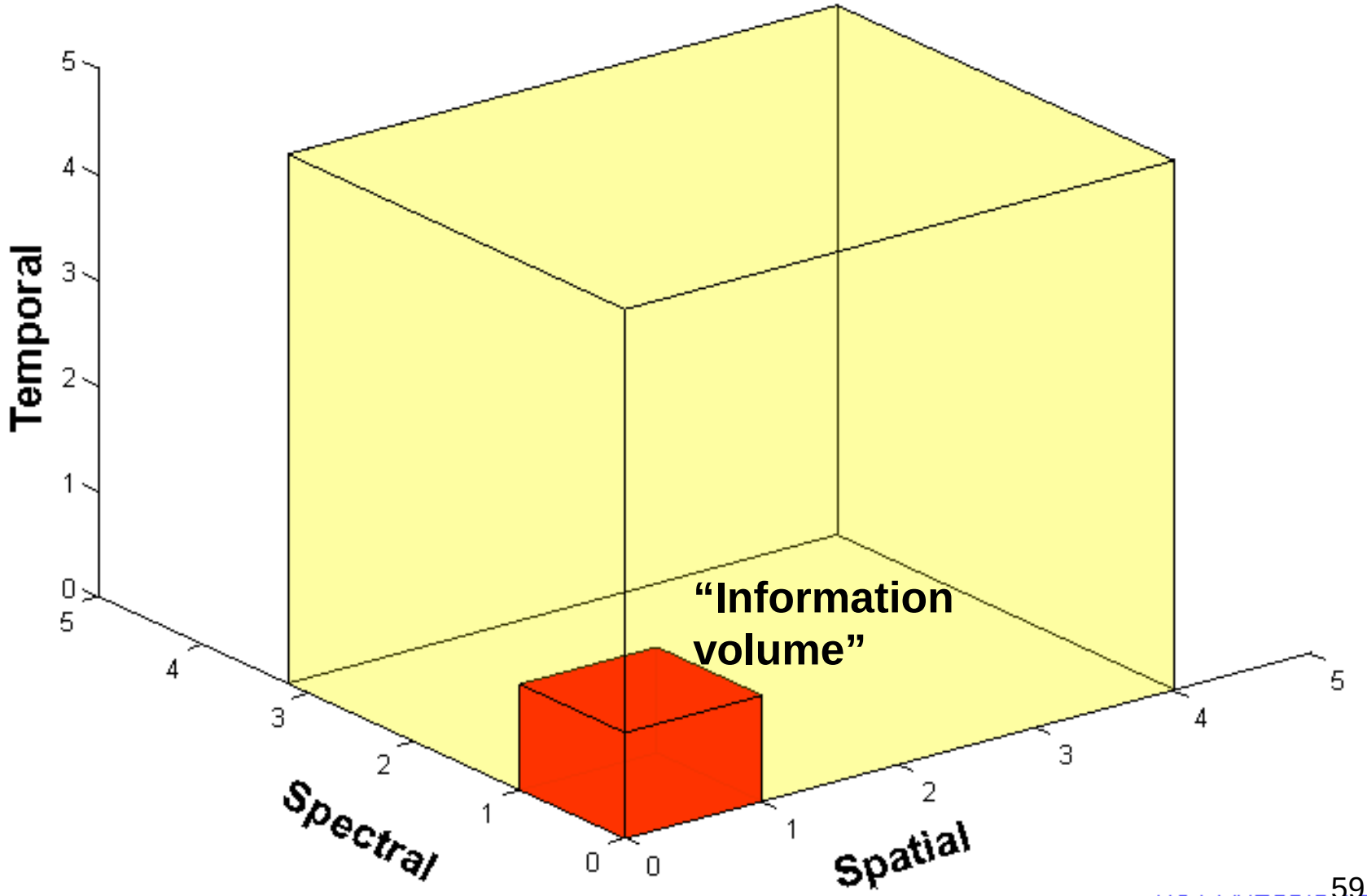
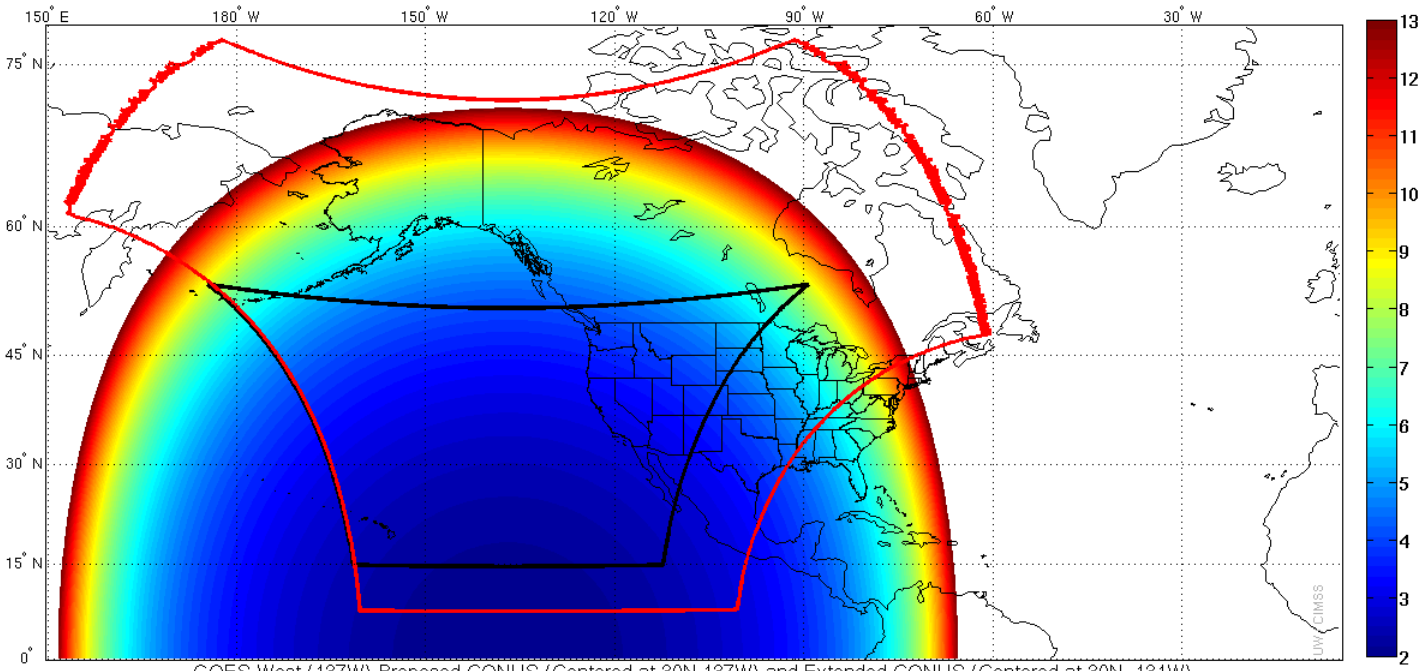
AMERICAN METEOROLOGICAL SOCIETY AUGUST 2005 BAMS | 1079

Approximate spectral and spatial resolutions of US GOES Imagers

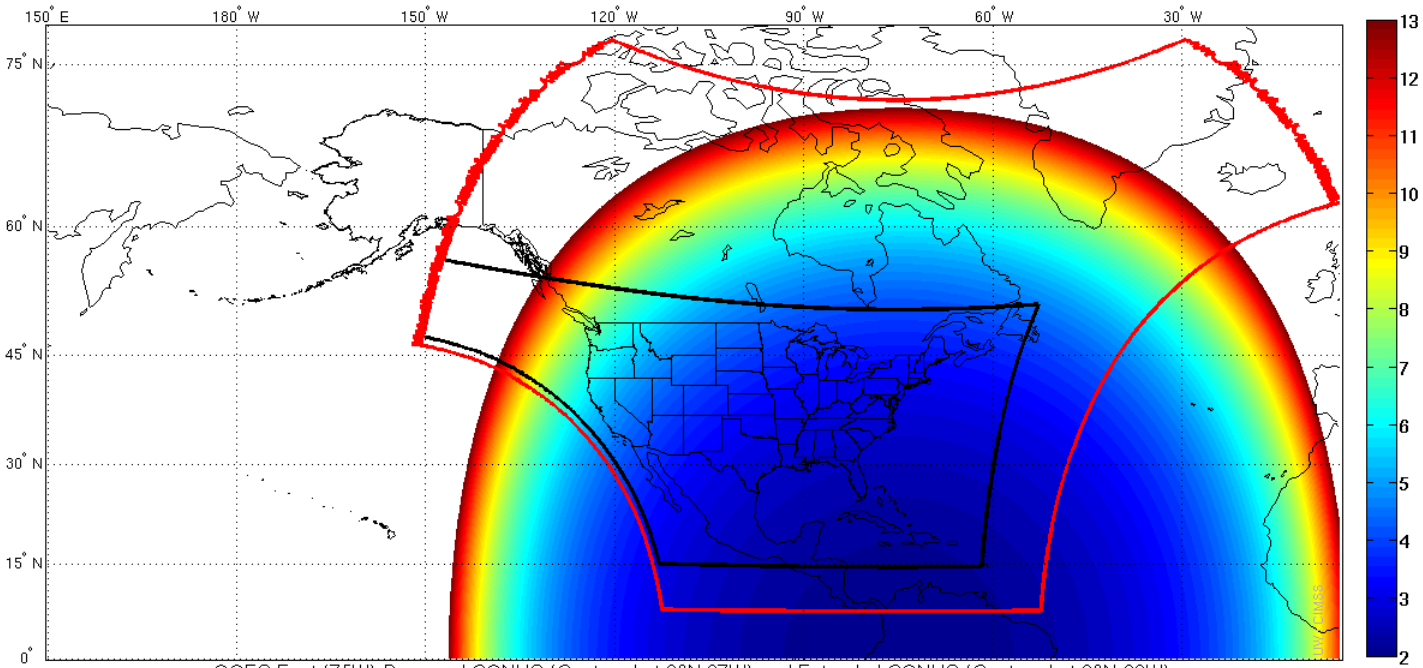


Improved attributes with the Future GOES Imagers





GOES-West (137W) Proposed CONUS (Centered at 30N,137W) and Extended CONUS (Centered at 30N, 131W)



GOES-East (75W) Proposed CONUS (Centered at 30N,87W) and Extended CONUS (Centered at 30N 82W)