Introduction to GOES-R and User Readiness

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Contributions from GOES-R AWG Team Leads and members of the AWG teams, GOES-R Satellite Liaisons, GOES-R3 leads, and others

WMO Training Lecture on GOES-R

The Sixth Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC)

9-13 November 2015, Tokyo, Japan

Overview

- The GOES-R Mission
  - *GOES-R Program News*
  - *GOES-R Architecture*
  - *GOES-R Data Distribution Information*
  - *Post-Launch Test (PLT) Plans*
- GOES-R Sensors and Data Products
  - *Focus on ABI, GLM*
- Product <u>Applications</u> and Capability Demonstrations
  - *Highlight product examples*
  - *Focus on application of products by users*
- Training

GOES-R MISSION

NOAA-NESDIS Mission & Challenge

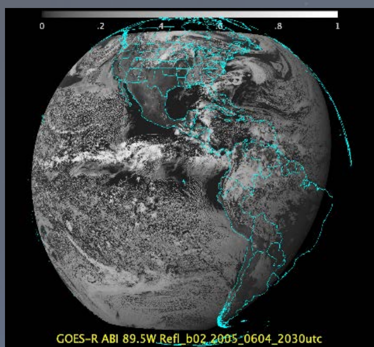
Our <u>mission</u> is to deliver accurate, timely, and reliable satellite observations and integrated products and to provide long-term stewardship for global environmental information in support of our Earth observation mission.

Our <u>challenge</u> is to provide these observations and products reliably while improving the information content and evolving to stay current with the expanding complexity of the Earth observing contributors.

Expectations for GOES-R

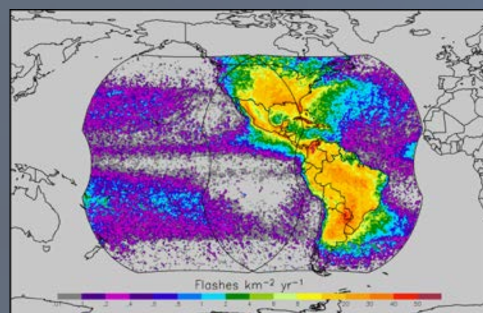
The GOES-R series will provide significant improvements in the detection and observation of meteorological phenomena that directly impact public safety, protection of property, and our Nation's economic health and prosperity

ABI



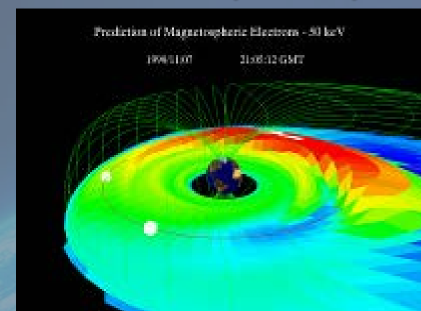
Visible & IR Imagery

GLM



Lightning Mapping

SEISS, SUVI, EXIS, Magnetometer



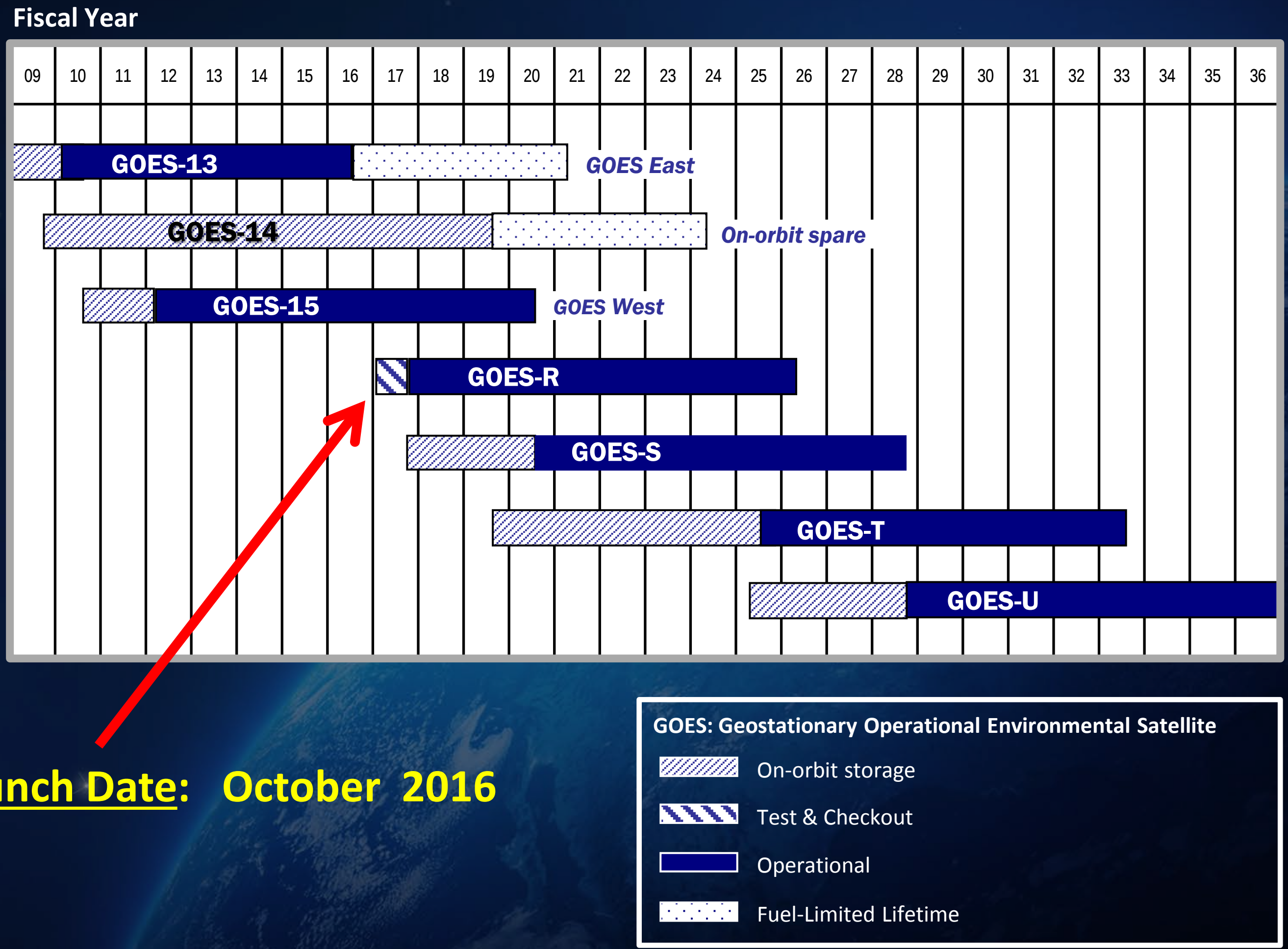
Space Weather Monitoring

Solar Imaging

- ✓ Improves hurricane track & intensity forecasts
- ✓ Increases thunderstorm & tornado warning lead time
- ✓ Improves aviation flight route planning
- ✓ Data for long-term climate variability studies
- ✓ Low latency (30 sec ABI, 20 sec GLM)

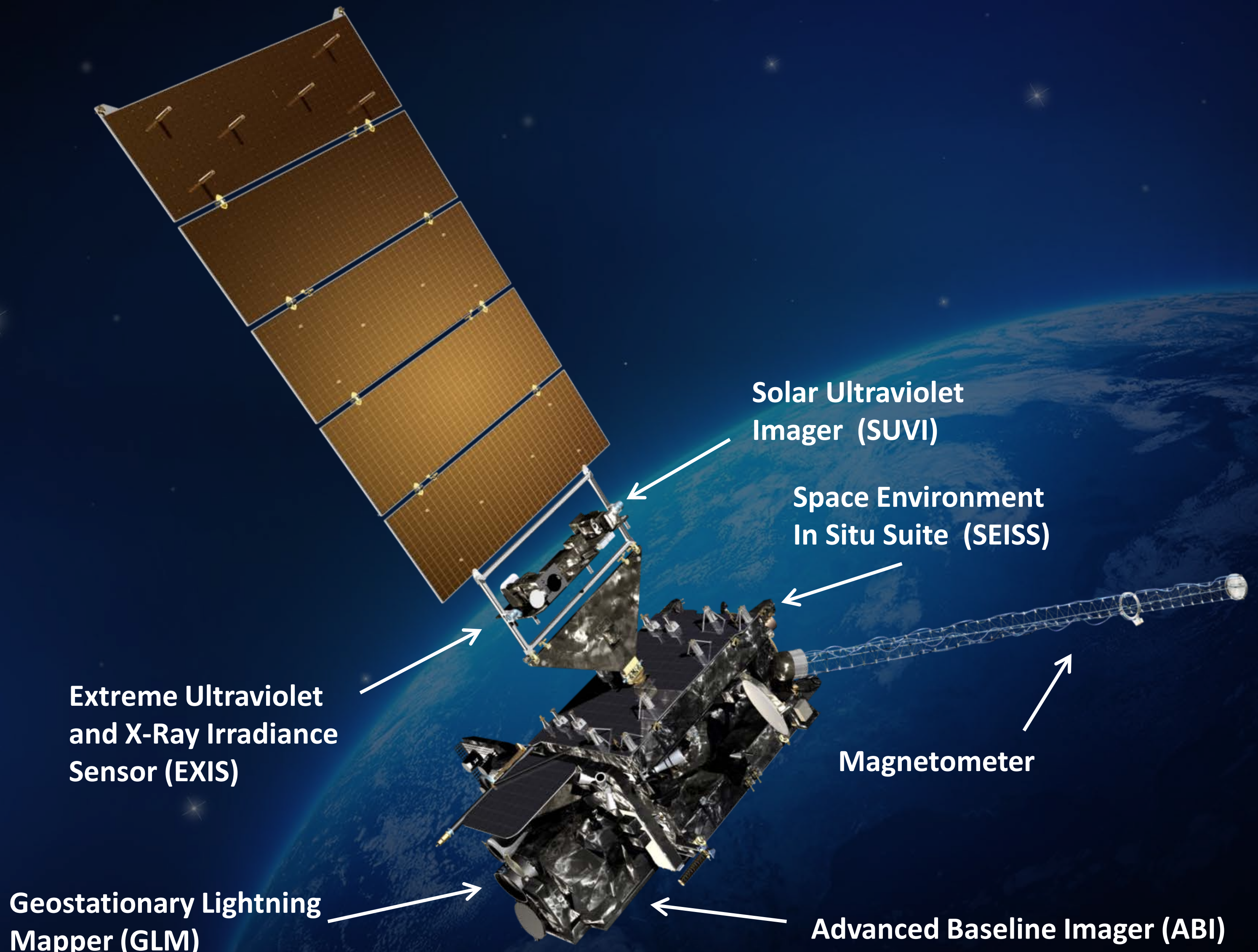
- ✓ Improves solar flare warnings for communications and navigation disruptions
- ✓ More accurate monitoring of energetic particles responsible for radiation hazards to humans and spacecraft
- ✓ Better monitoring of Coronal Mass Ejections to improve geomagnetic storm forecasting

Continuity of GOES Operational Satellite Program

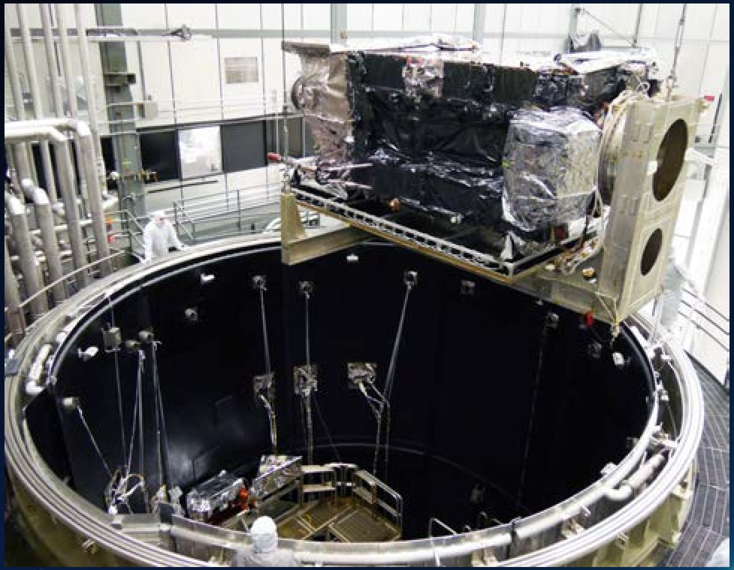


Updated Launch Date: October 2016

GOES-R Spacecraft



Program Accomplishments: Flight Project



Credit: Lockheed Martin

LEFT: The GOES-R satellite is lowered into the 29' x 65' vacuum chamber where it will undergo environmental testing.

RIGHT: The GOES-R satellite is transported from the clean room to the testing chamber at Lockheed Martin.

Credit: Lockheed Martin

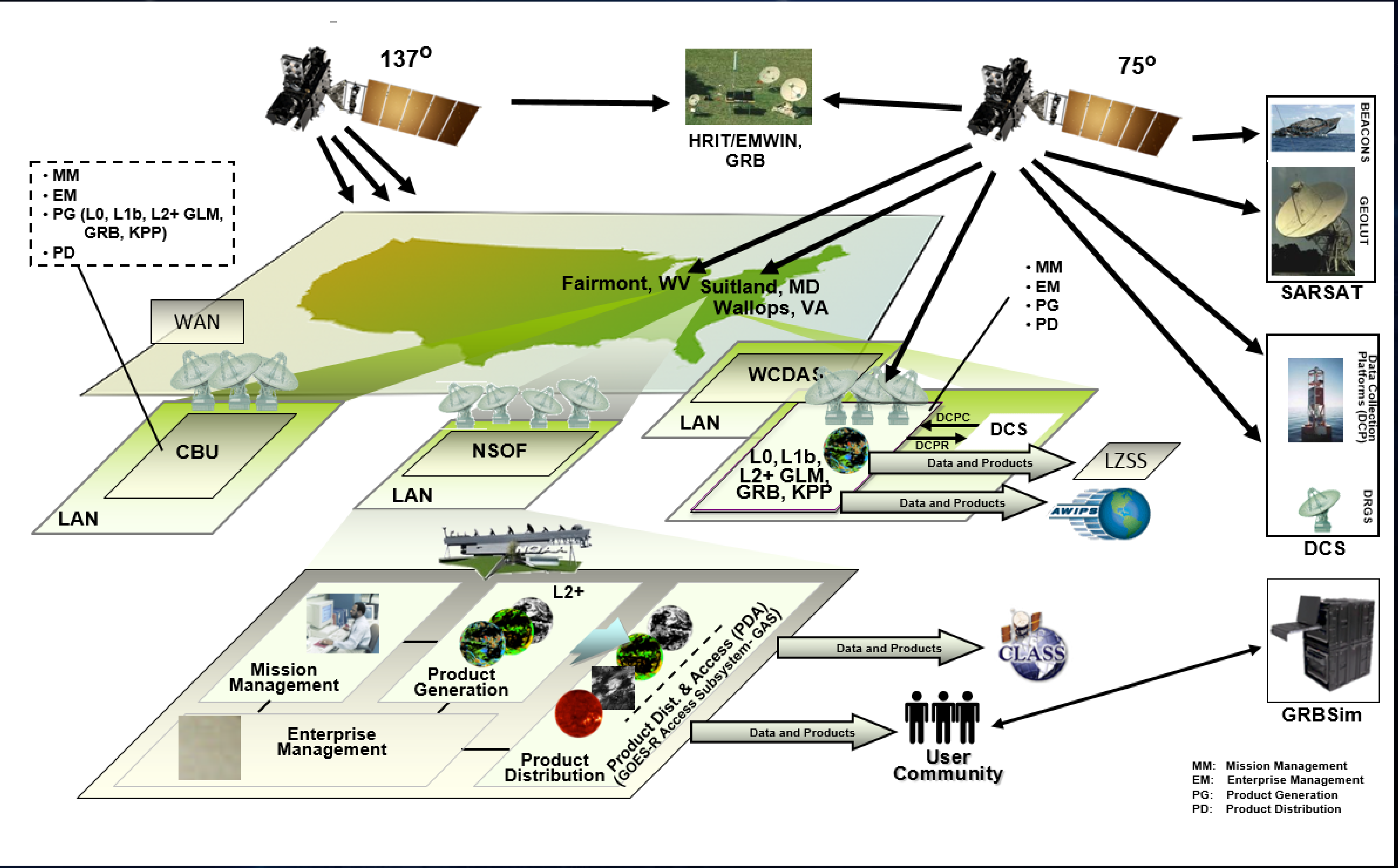
- GOES-R spacecraft integration completed (May 2015)
- Successful Pre-Environmental Review (May 2015)
- Environmental testing in progress

Program Accomplishments: Flight Project

Credit: Lockheed Martin

- The fully-deployed GOES-R solar array panel.
- Solar array panel will generate more than 4000 Watts of electricity from sunlight to power GOES-R

The GOES-R Ground System



Program Accomplishments: Ground Segment Project

Release Mission Management Flight Ready and Release Final Product Set handover on April 30th

New GOES-R Antenna at the Wallops Command and Data Acquisition Station

NESDIS Satellite Operations Facility (NSOF) antennas complete!

User System Readiness

Acronym	System Name	Description
AWIPS	Advanced Weather Interactive Processing System	Interactive computer system that integrates meteorological and hydrological data, enabling forecasters to prepare forecasts and issue warnings. GOES-R will provide selected products to AWIPS.
CLASS	Comprehensive Large Array-data Stewardship System	Web-based data archive and distribution system for NOAA's environmental data. CLASS will provide retrospective data access and distribution services of GOES-R data to all users.
PDA	Product Distribution and Access	The Environmental Satellite Processing and Distribution System (ESPDS) system responsible for receiving and storing real-time environmental satellite data and products and making them available to authorized users. The PDA will provide real-time distribution and access services for GOES-R users.
GRB	GOES Rebroadcast	One channel of the space data relay service of GOES-R for Level 1b data products. These data are available to all users with GRB receivers in view of a GOES-R series satellite at the East or West operational longitudes

Direct Broadcast

Transitioning from GOES-N/O/P to GOES-R…

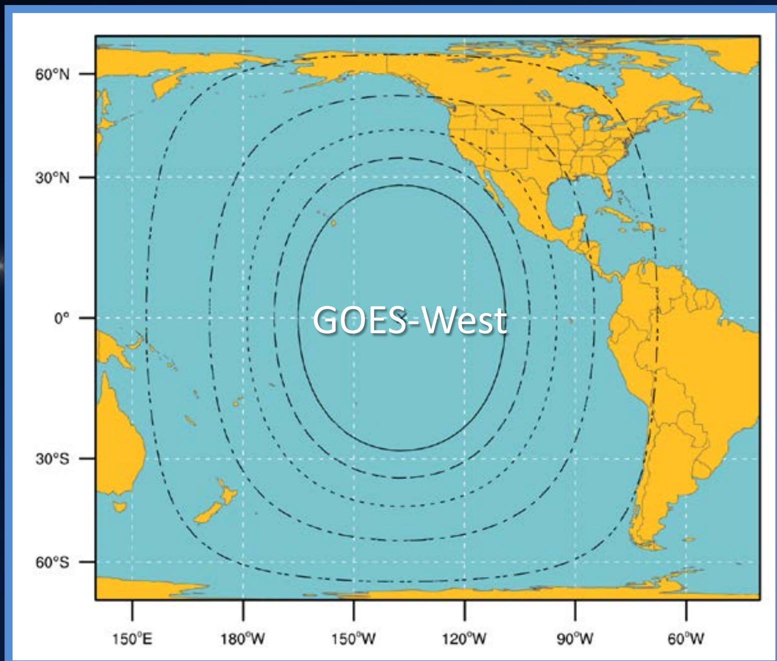
- GRB allows real time distribution of all Level-1b GOES-R data products for direct read out users.
- Direct Readout users need to upgrade their equipment *(antenna and accompanying system)* for GOES-R:
  - Significant increase in data rate!!!
    - from 2.11 Mbps (GVAR) to 31 Mbps (GRB)
  - New data format!!!
- GRB down link specifications and data format specifications have been published.
- Updates are posted on the GOES-R web site:
  - **http://www.goes-r.gov/**

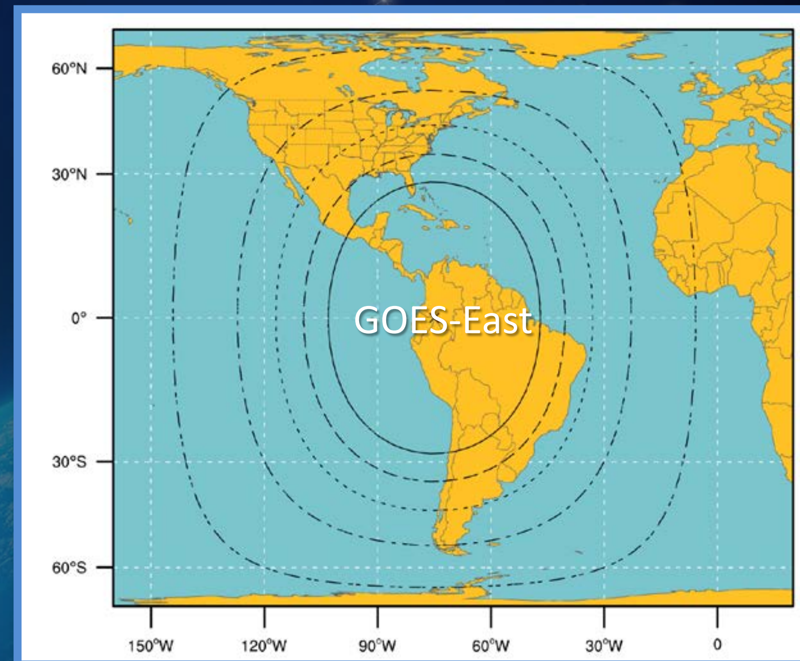
Transition from GVAR to GRB

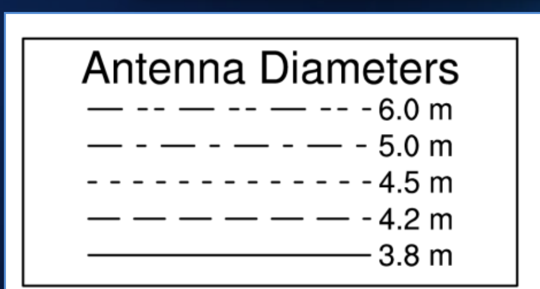
Specification	GOES Variable (GVAR)	GOES Rebroadcast (GRB)
Full Disk Image	30 Minutes	5 Minutes (Mode 4) 15 min (Mode 3)
Other Modes	Rapid Scan, Super Rapid Scan	3000 km X 5000 km (CONUS: 5 minute) 1000 km X 1000 km (Mesoscale: 30 seconds)
Polarization	None	Dual Circular Polarized
Receiver Center Frequency	1685.7 MHz (L-Band)	1686.6 MHz (L-Band)
Data Rate	2.11 Mbps	31 Mbps
Antenna Coverage	Earth Coverage to 5^0	Earth Coverage to 5^0
Data Sources	Imager and Sounder	ABI (16 bands), GLM, SEISS, EXIS, SUVI, MAG
Space Weather	None	~2 Mbps
Lightning Data	None	0.5 Mbps

Upgrade or Replace GVAR?

GRB Ground Antenna Sizes







Courtesy Satya Kalluri

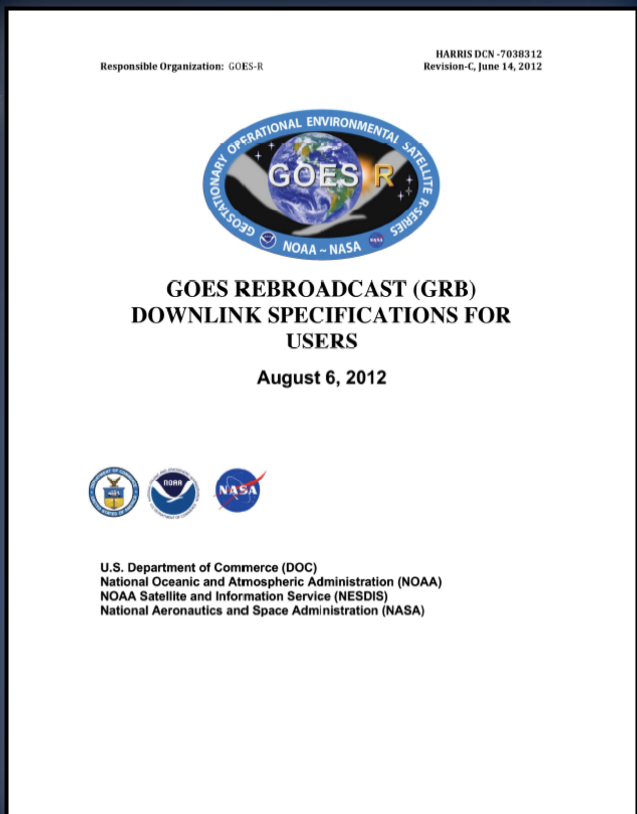
NOTES:

1. Calculations based on available data as of May 2011
2. Each antenna size is usable within the indicated contour
3. Rain attenuations included are: 1.3/1.6/2.0/2.2/2.5 dB (3.8 to 6 m)
4. An operating margin of 2.5 dB is included as the dual polarization isolation is likely to vary within each antenna size area

GRB Resources and Documentation

http://www.goes-r.gov/resources/docs.html

- GRB Downlink Specification



HARRIS DCN -7038312
Revision-C, June 14, 2012

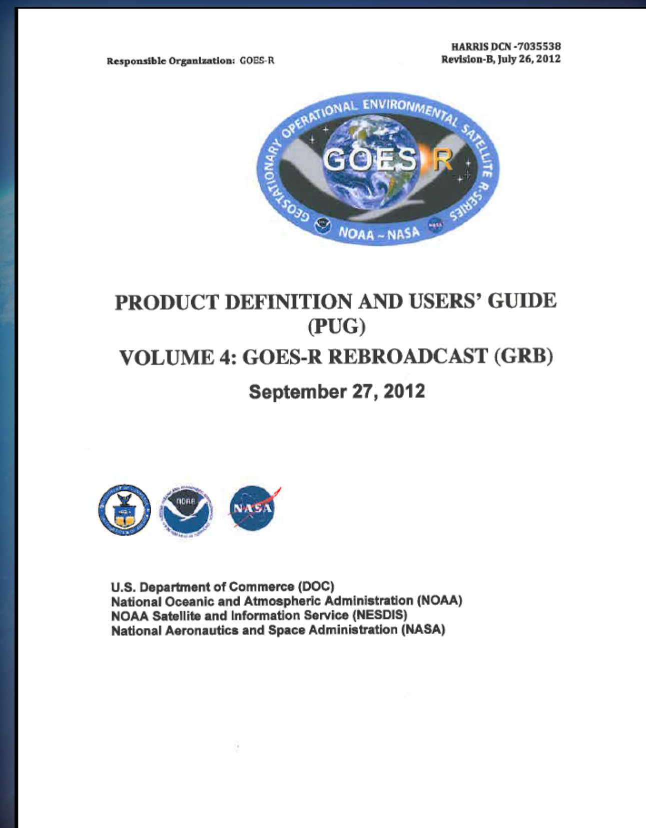
Responsible Organization: GOES-R

GOES REBROADCAST (GRB) DOWNLINK SPECIFICATIONS FOR USERS

August 6, 2012

U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite and Information Service (NESDIS)
National Aeronautics and Space Administration (NASA)

- Product Users Guide (PUG) for GRB



HARRIS DCN -7035538
Revision-B, July 26, 2012

Responsible Organization: GOES-R

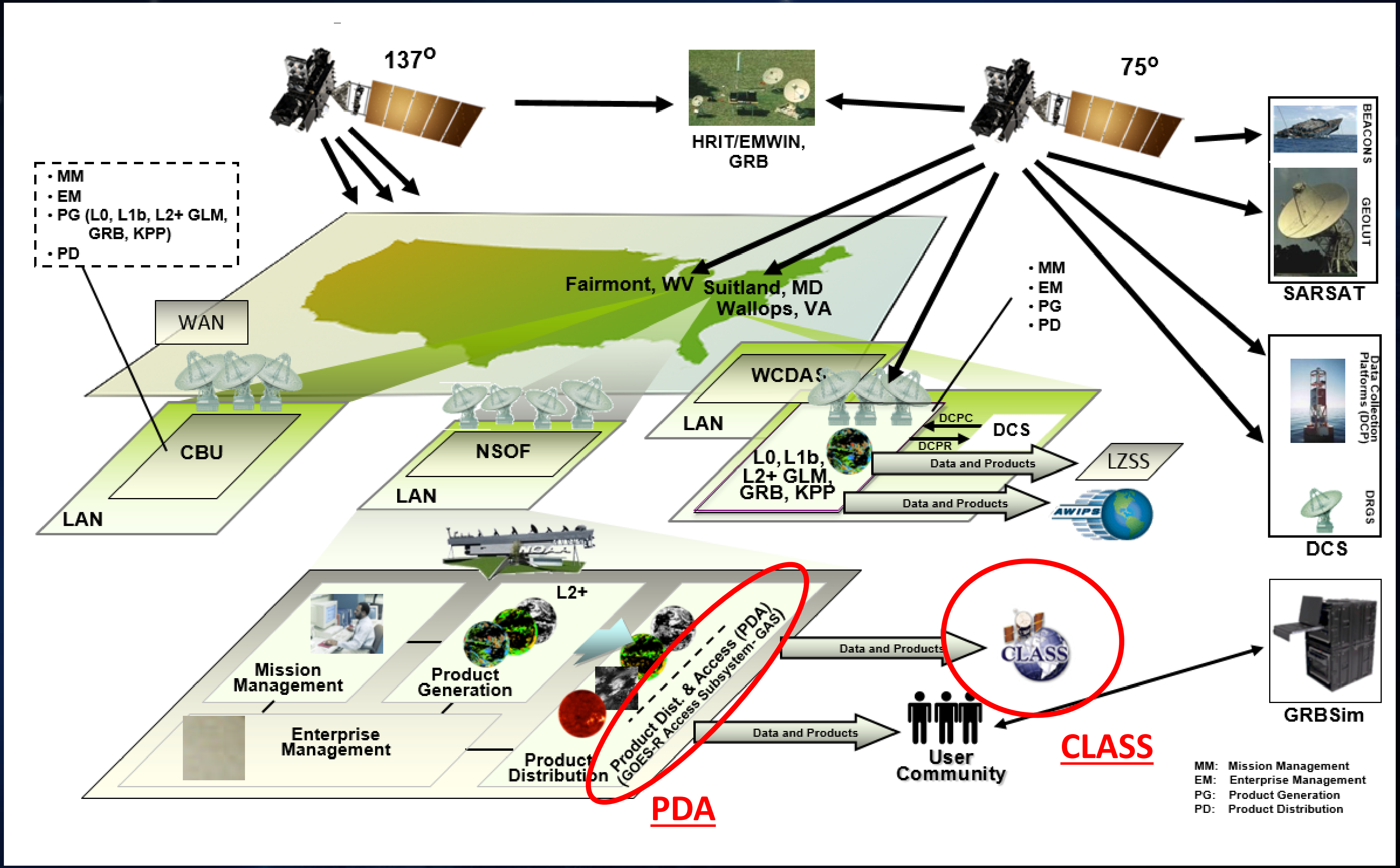
PRODUCT DEFINITION AND USERS' GUIDE (PUG)

VOLUME 4: GOES-R REBROADCAST (GRB)

September 27, 2012

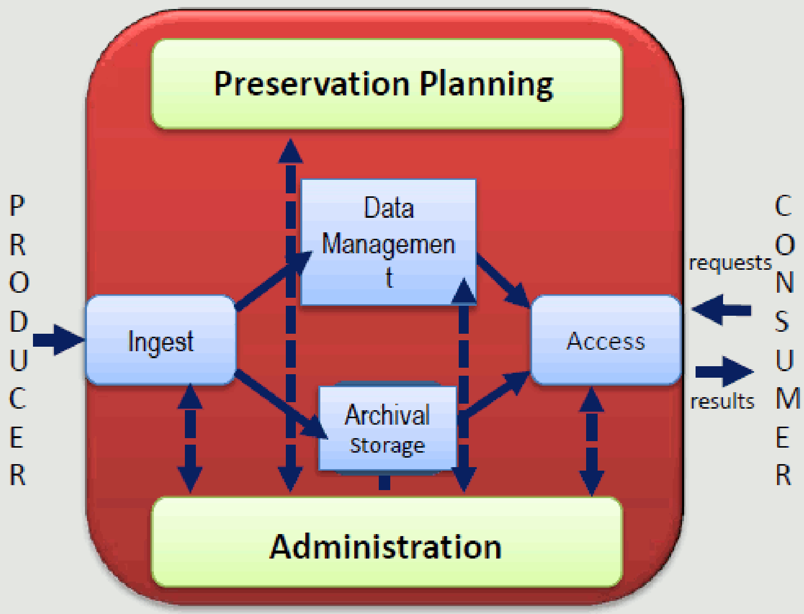
U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite and Information Service (NESDIS)
National Aeronautics and Space Administration (NASA)

The GOES-R Ground System

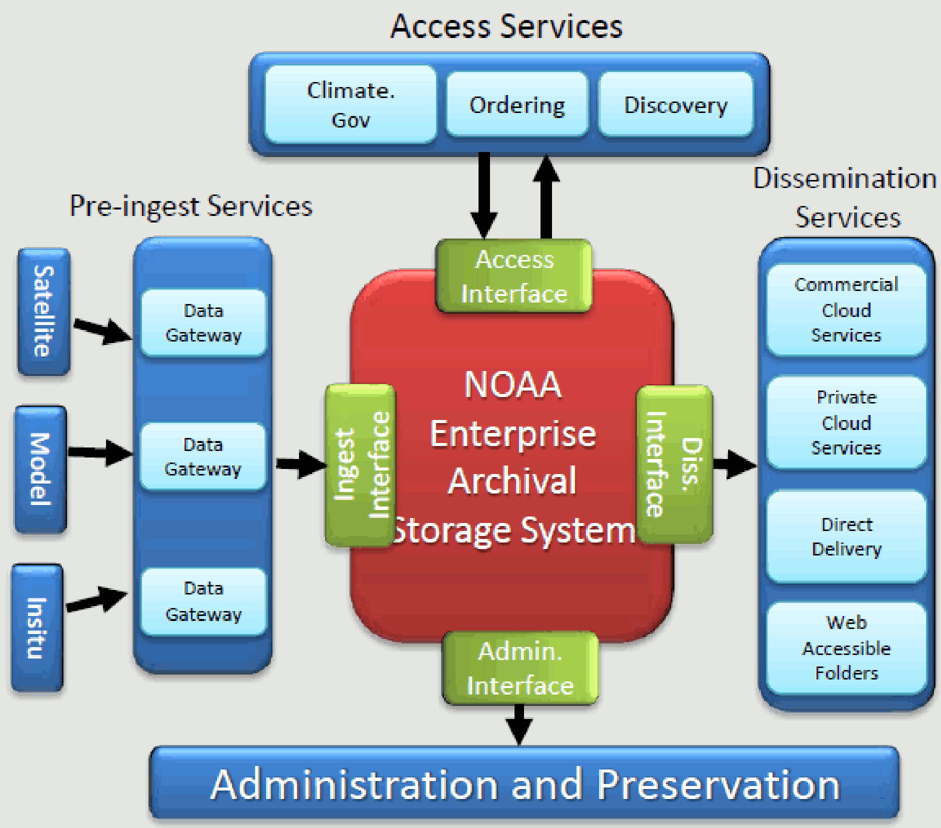


CLASS's Evolution to an Enterprise Archival Storage System

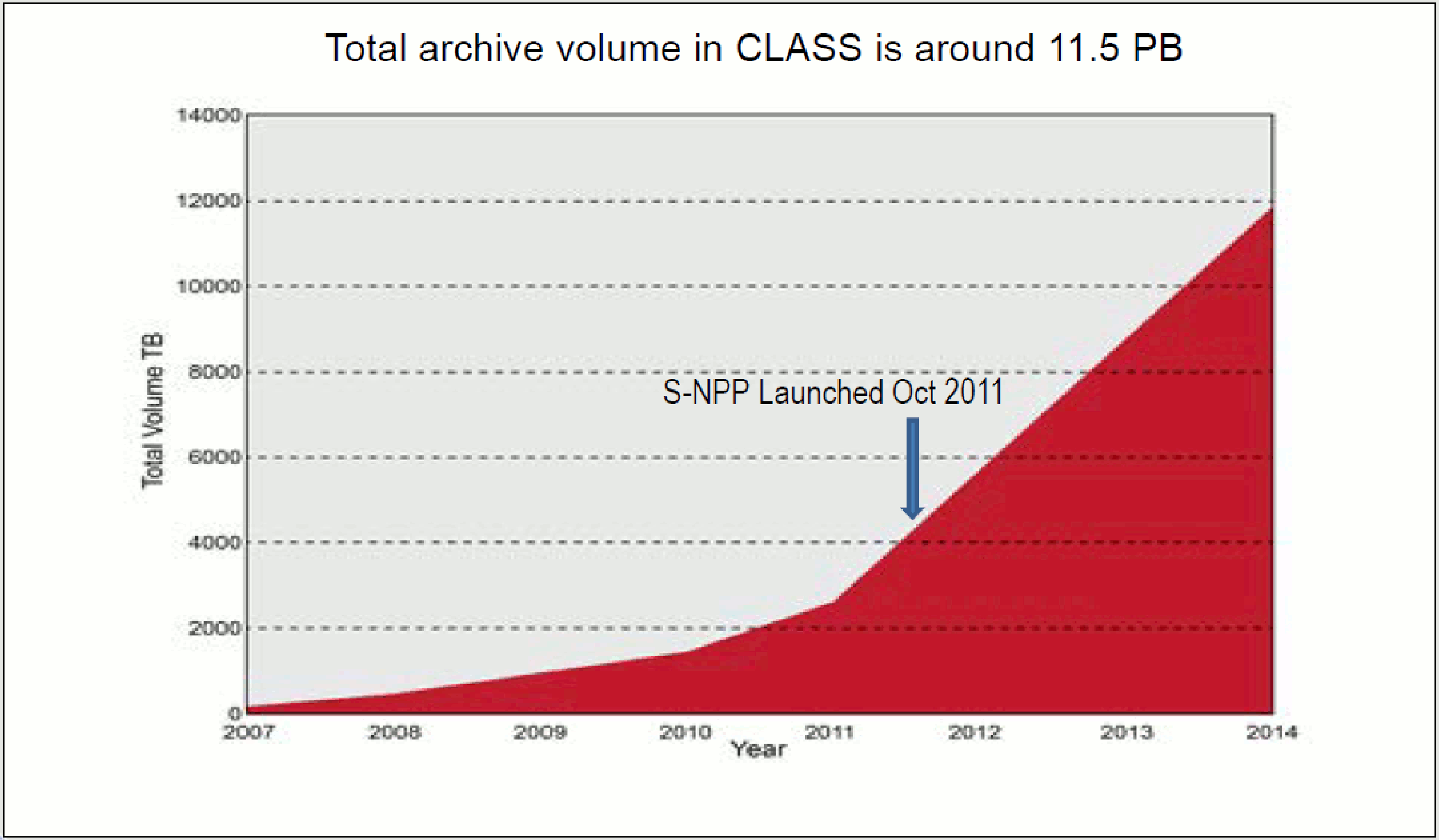
Present CLASS



Future CLASS (in red)



Total Archive Growth in CLASS



How do I access data from CLASS?

Step 1: Register for a user id account at www.class.noaa.gov (minimal information: your name, e-mail address, a password)

Step 2: Select from the drop down product menu and highlight a dataset

Step 3: On the Search page make your selections (geographic region, start/end dates and times, and data types).

Step 4: Determine if you need greater access or a subscription

Note: Always provide your user ID when contacting the CLASS helpdesk

Levels of Access Services (1)

CLASS order types:	Average completion time	Average File Limit	Contact the CLASS Help Desk?
Ad hoc orders (Use Search button to obtain inventory)	Usually within 12 to 24 hours	Up to 500 files	No
Large orders (use Quick Search button to skip inventory)	24 to 48 hours	1000 to 3000	No
Block orders (use Quick Search button)	> 48 hours	3000 to 6000	Yes
Subscription (standing orders)	< 6-7 hours	No limit	Yes

Assistance and Support

For technical questions regarding access in CLASS:

class.help@noaa.gov

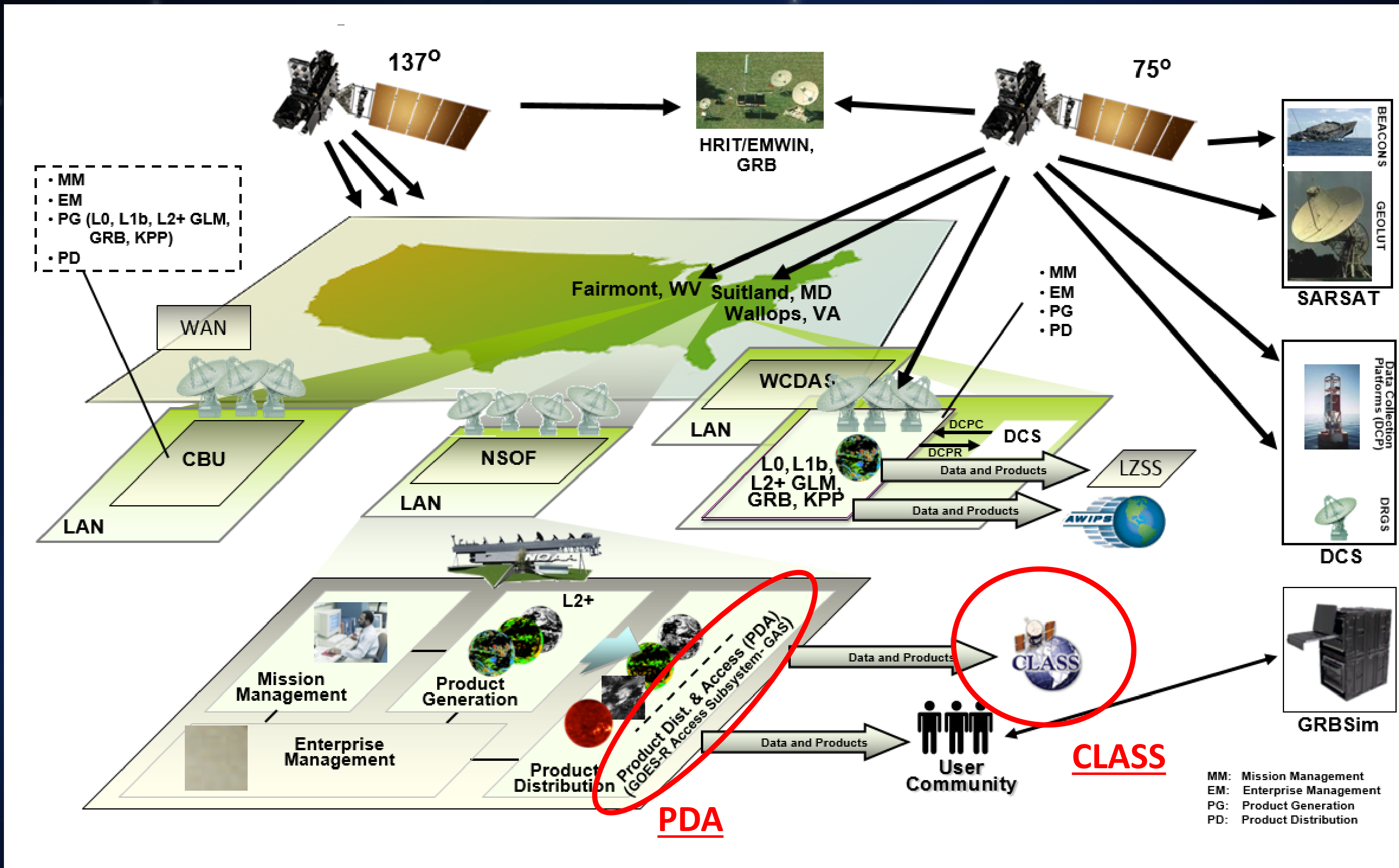
axel.graumann@noaa.gov

Tutorial on using CLASS:

SNPP Access tutorial - on CLASS Home Page in the News section

Please see me for a hands on overview of CLASS website!

The GOES-R Ground System



Product Distribution and Access (PDA) Overview

- Represents NESDIS's enterprise distribution for real-time users.
- Provides NESDIS with a scalable Service Orientated Architecture (SOA) based architecture that functions as both a high availability and high performance distribution system.
- Enhances IT security posture utilizing in-depth to defend against evolving threats.
- Enables users to tailor products in order to meet their unique mission requirements, including latency.
- User managed subscriptions; User managed search and tailoring

Data Volume Capacity:

Ingress: 14.25 TB/day

Egress: 35.92 TB/day

Peak Throughput:

From Externals to PDA: 7.23 Gbps

From PDA to Externals: 57.5 Gbps

Network to Edge – scalable to 120 Gbps

Data Access Policy: http://www.ospo.noaa.gov/Organization/About/access.html

GOES-R Data & PDA

- GOES-R data will be served in netCDF4 format
- Users will be able to utilize PDA tailoring capabilities for GOES-R data:
  - Data sectorization
    - Geographic coordinate corner points, spatial resolution, bit depth scaling
  - Remapping to Mercator, Lambert Conformal, Polar Stereographic or Platte Carre projections
  - Layer extraction

Existing users with further questions should contact:

Donna McNamara (Data Access Manager) donna.mcnamara@noaa.gov
Chris Sisko (JPSS Data Operations Manager) chris.a.sisko@noaa.gov
Matt Seybold (GOES-R Data Operations Manager) matthew.seybold@noaa.gov

New users with questions should contact NESDIS Satellite User Services:

NESDIS.Data.Access@noaa.gov

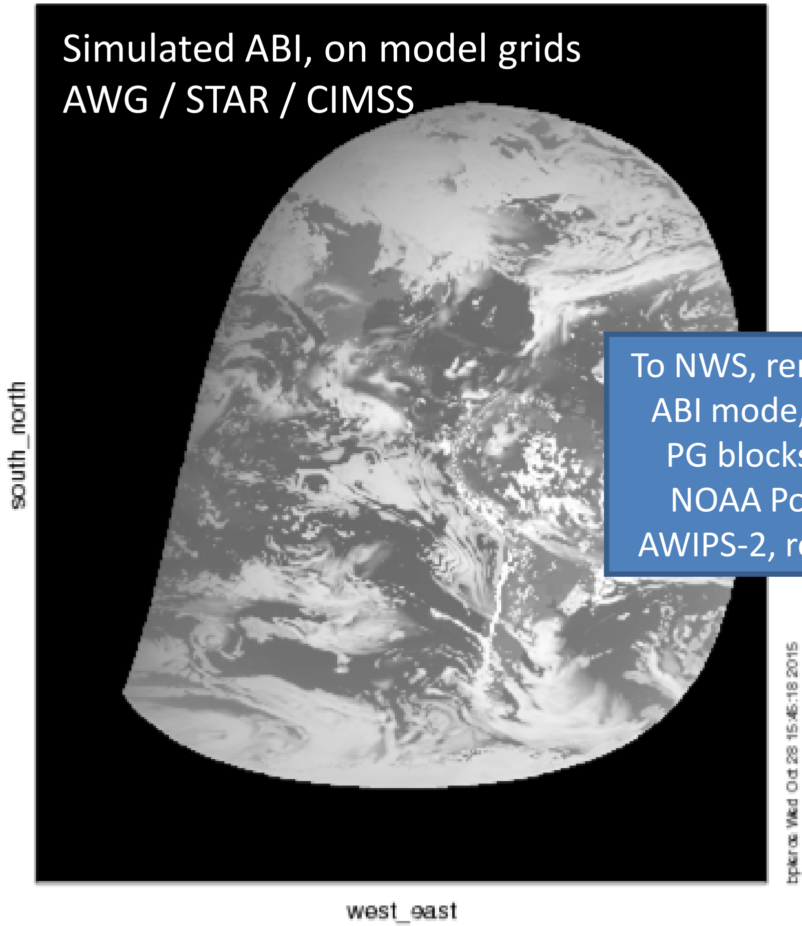
Ground Segment Data Operations Exercises (DOEs)

Testing, Testing, Testing…

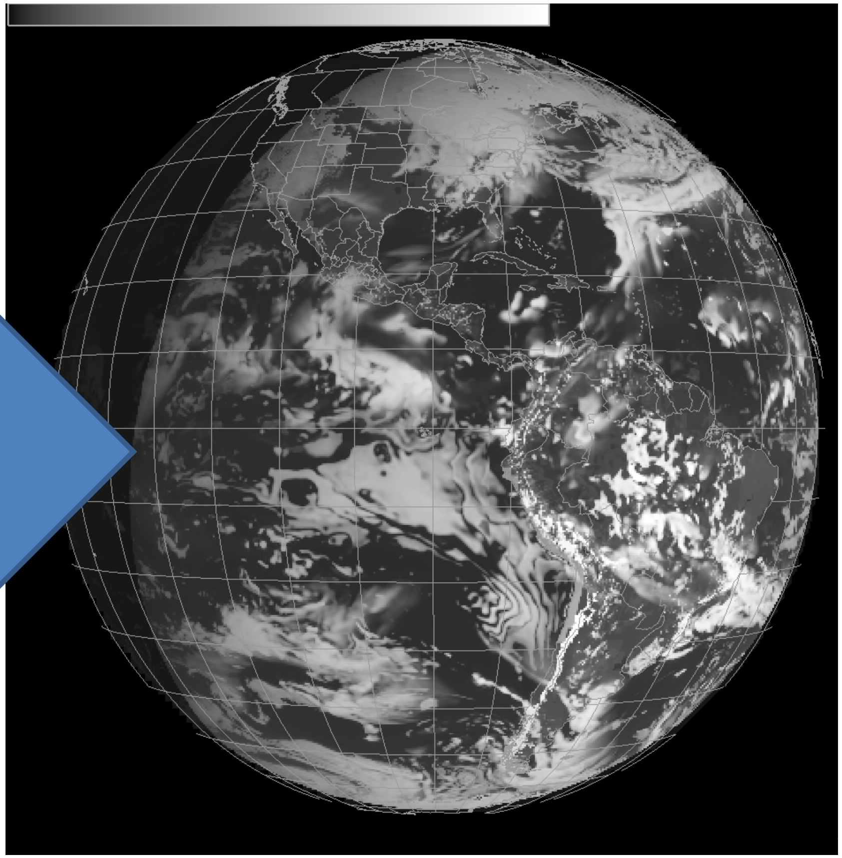
- DOEs are mission rehearsals executed by the Data Operations team
- DOEs provide incremental readiness to prepare systems, operators, processes, and teams to support mission operations
- Conducted in a "rehearse like we fly" manner
- Both nominal and anomalous conditions are exercised
- Goal is to ultimately exercise the entire ground system by processing various data sets from end-to-end, from L0 through L2+, including PDA in DOE-3 and DOE-4
- DOE-4 will include participation by the NWS TOWR-S (Total Operational Weather Readiness - Satellites) project which is incorporating distribution to elements of the AWIPS community

CBU: Consolidated Back-Up in Fairmont, WV

Cloud and Moisture Imagery: Daily Real-time End-to-End Testing (from NWP to AWIPS-2)

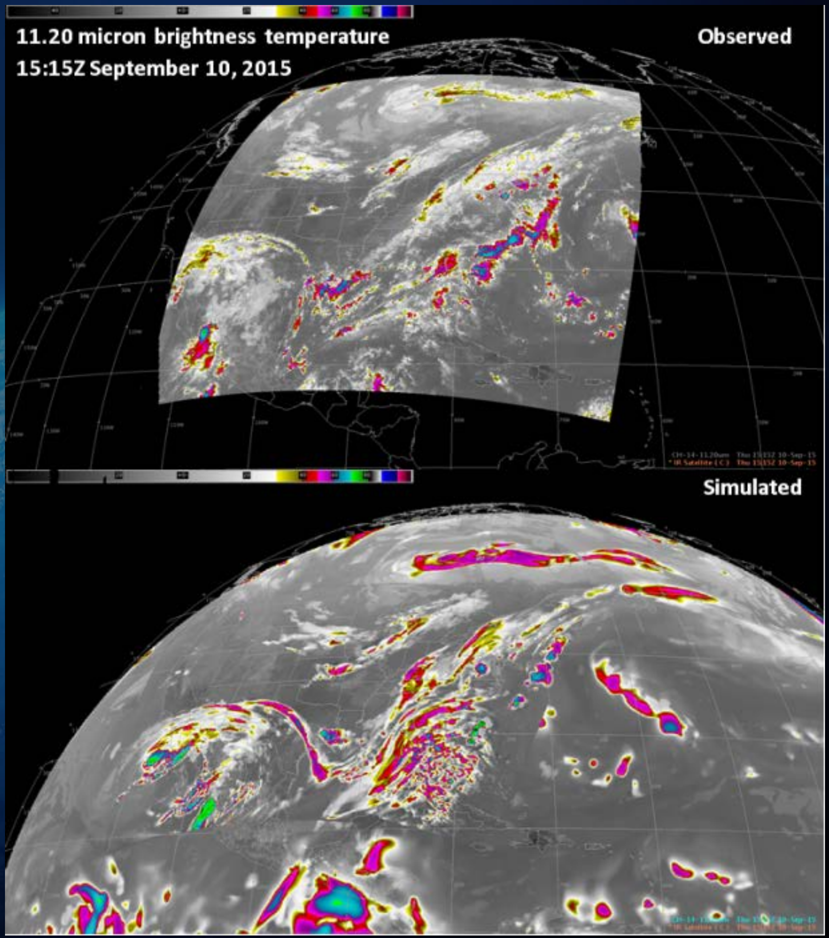


To NWS, remap, emulate ABI mode, released as PG blocks, sent over NOAA Port and into AWIPS-2, re-assembled.



Program Accomplishments: Ground Segment Project

- Data Operations Exercises (DOE) 1 and 2 were conducted (June 2015)
  - First tests of the ground system using the Release Final Product Set software that was delivered to the government
  - Testing occurred at all three GOES-R ground system facilities for 6-days (consecutive)
  - Simulated data was delivered to the National Weather Service (NWS), the Product Distribution and Access system, and the Level Zero Storage System
- Data Operations Exercise 3 (DOE 3) was conducted (August 2015)
  - 14-day (consecutive) exercise
  - Exercised the data operations team's processes/procedures and the ground system's science data processing and distribution capabilities.
  - Data flowed to the National Weather Service (NWS) and the Product Distribution and Access system from both the primary and backup GOES-R science data-processing nodes.



Validation and Availability for GOES-R Baseline Products

Milestone:	GOES-R Launch to 89.5° West	Operations Handover (includes Products)	On-Orbit East/West Operations
			6-month Extended Validation
Program Phase:	Pre-Launch	PLT (6 months)	Post-Handover

L1b Product Activities

- L1b Validation - Products recertified against pre-launch instrument performance
- 'First Light' Data captures shared from Instruments
- Insertion of L1b products into GRB service is controlled by ground system and will occur as products are certified

L2+ Product Activities

- L2+ Validation – Same certification process as L1b products
- However, L2+ certification begins after L1b products and the portfolio will mature at an overall slower rate with some products certified post-Operations Handover

Distribution Testing

- Testing of Distribution Requirements for GRB, AWIPS, and PDA will occur with Integration & Test Customers, utilizing a terrestrial test-purpose data flow from Wallops to NSOF

Mission Notifications

- Mission notifications will inform users of new product operations and caveats (e.g. GOES maneuver data caveats) leading up to, during, and after Operations Handover

GOES-R SENSORS AND DATA PRODUCTS

NEW AND ENHANCED CAPABILITIES

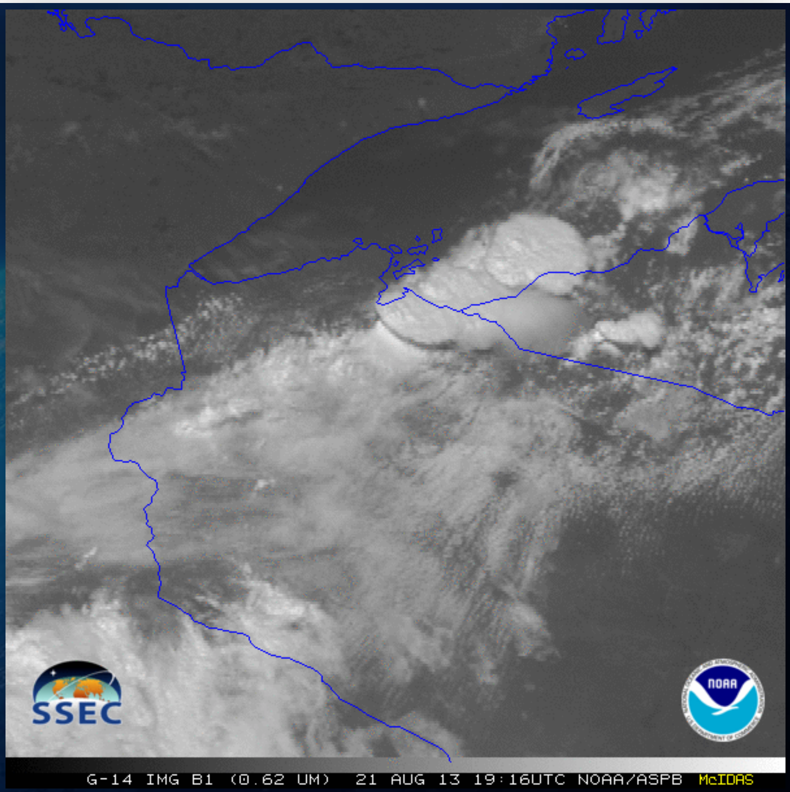
NEW OPPORTUNITIES

GOES-R ABI

GOES-R ABI Enhanced Capabilities Expected to Bring Improved Products

- **Higher Spectral Resolution**
  - 16 channels
  - Can see and retrieve new phenomena
- **Higher Spatial Resolution**
  - Higher fidelity imagery and L2 products; information at smaller scales now observed
- **Higher Temporal Resolution**
  - Physical and dynamical processes are now captured; new information to exploit and be used by user community
- **Improved Radiometrics**
  - Translate to more accurate products
- **Improved Navigation and Registration**
  - More accurate products and improved utilization of them

All of these things contribute to one being able to observe and retrieve phenomenon not previously possible

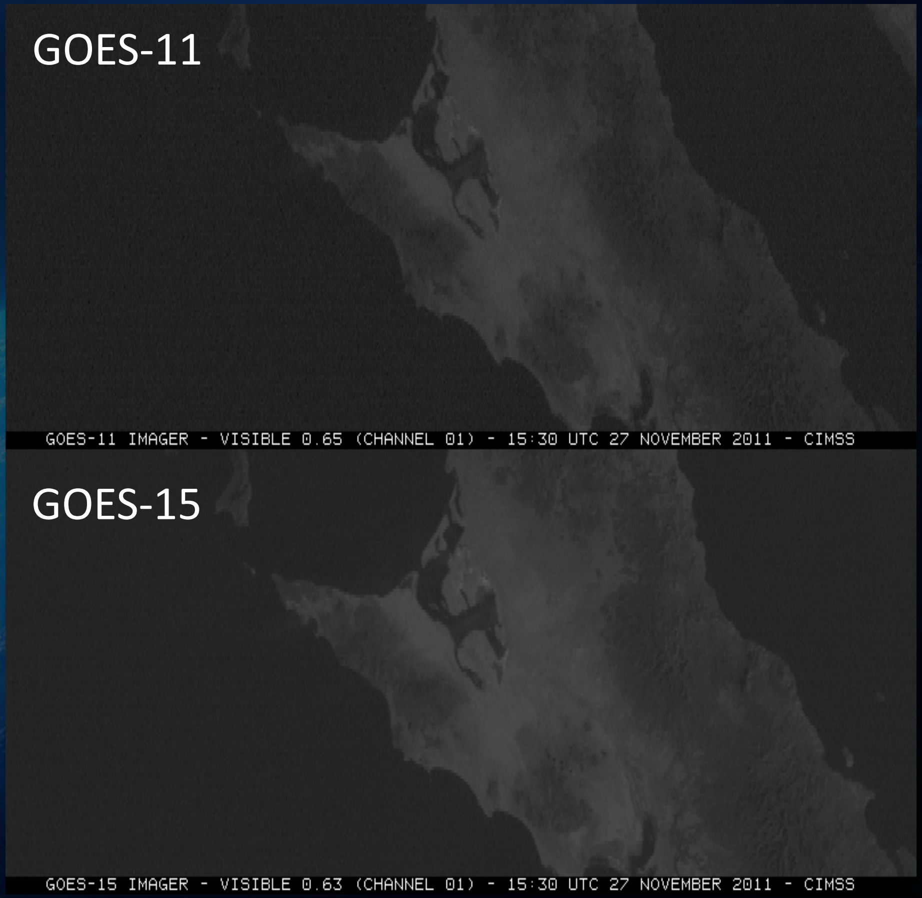


GOES-14 provided very unique information and offers a glimpse into the possibilities that will be provided by the ABI on GOES-R.

GOES-R ABI Enhanced Capabilities Expected to Bring Improved Products

- **Higher Spectral Resolution**
  - Can see and retrieve new phenomena
- **Higher Spatial Resolution**
  - Higher fidelity imagery and L2 products; information at smaller scales now observed
- **Higher Temporal Resolution**
  - Physical and dynamical processes are now captured; new information to exploit and be used by user community
- **Improved Radiometrics**
  - Translate to more accurate products
- **Improved Navigation and Registration**
  - More accurate products and improved utilization of them

GOES-15 provides a hint of ABI's INR quality…



GOES-R vs. Current GOES

	ABI	Current GOES Imager
Spectral Coverage	16 bands	5 bands
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible/near-IR	1.0 km	n/a
Bands (>2 μm)	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 per hour	Scheduled (3 hrly)
CONUS	12 per hour	~4 per hour
Mesoscale	Every 30 sec	n/a
Visible (reflective bands)		
On-orbit calibration	Yes	No

ABI Visible/Near-IR Bands

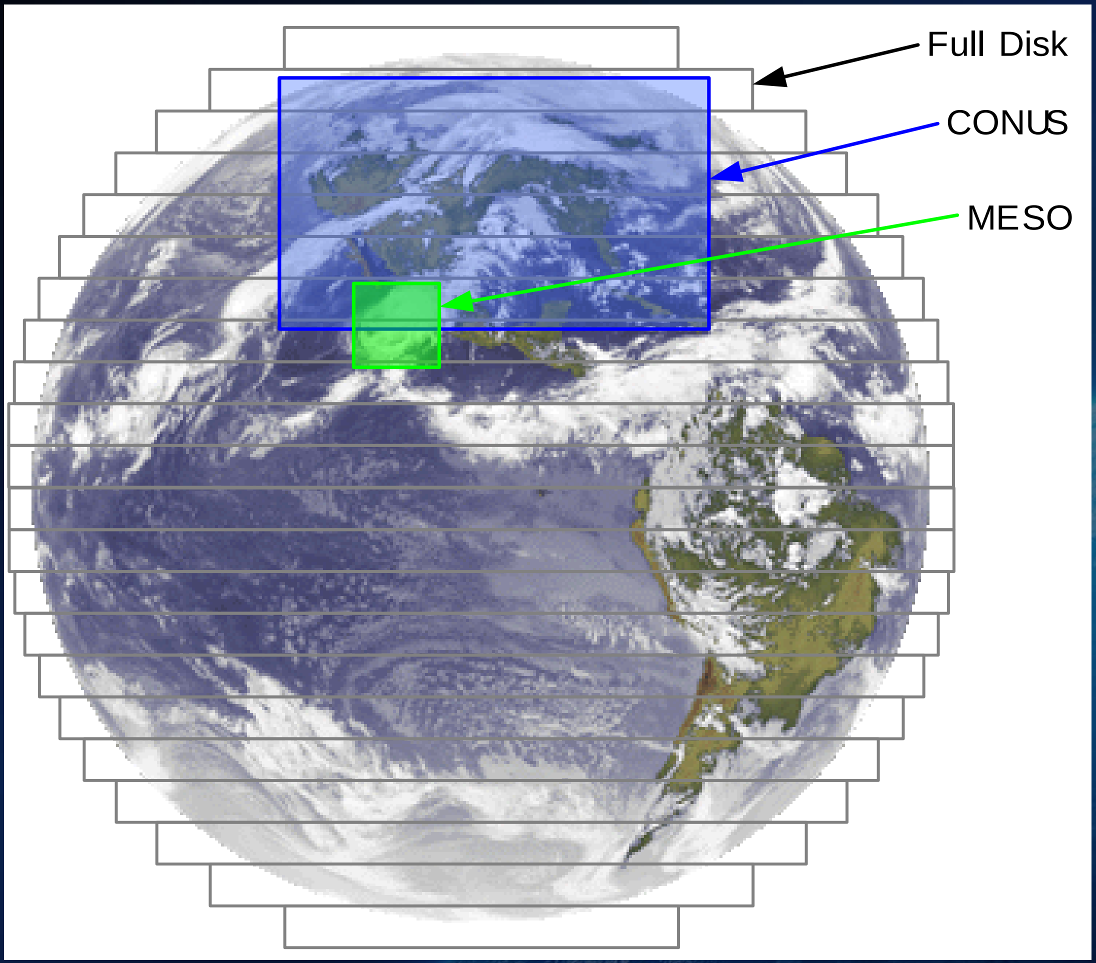
Future GOES imager (ABI) band	Wavelength range (µm)	(Approximate) Central wavelength (µm)	Nominal subsatellite IGFOV (km)	Sample use
1	0.45–0.49	0.47	1	Daytime aerosol over land, coastal water mapping
2	0.59–0.69	0.64	0.5	Daytime clouds fog, insolation, winds
3	0.846–0.885	0.865	1	Daytime vegetation/burn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

Schmit, T. J., M. M. Gunshor, W. P. Menzel, J. J. Gurka, J. Li, and A. S. Bachmeier, 2005: Introducing the next-generation Advanced Baseline Imager on GOES-R. Bull. Amer. Meteor. Soc., 86, 1079-1096.

ABI IR Bands

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

Advanced Baseline Imager (ABI)



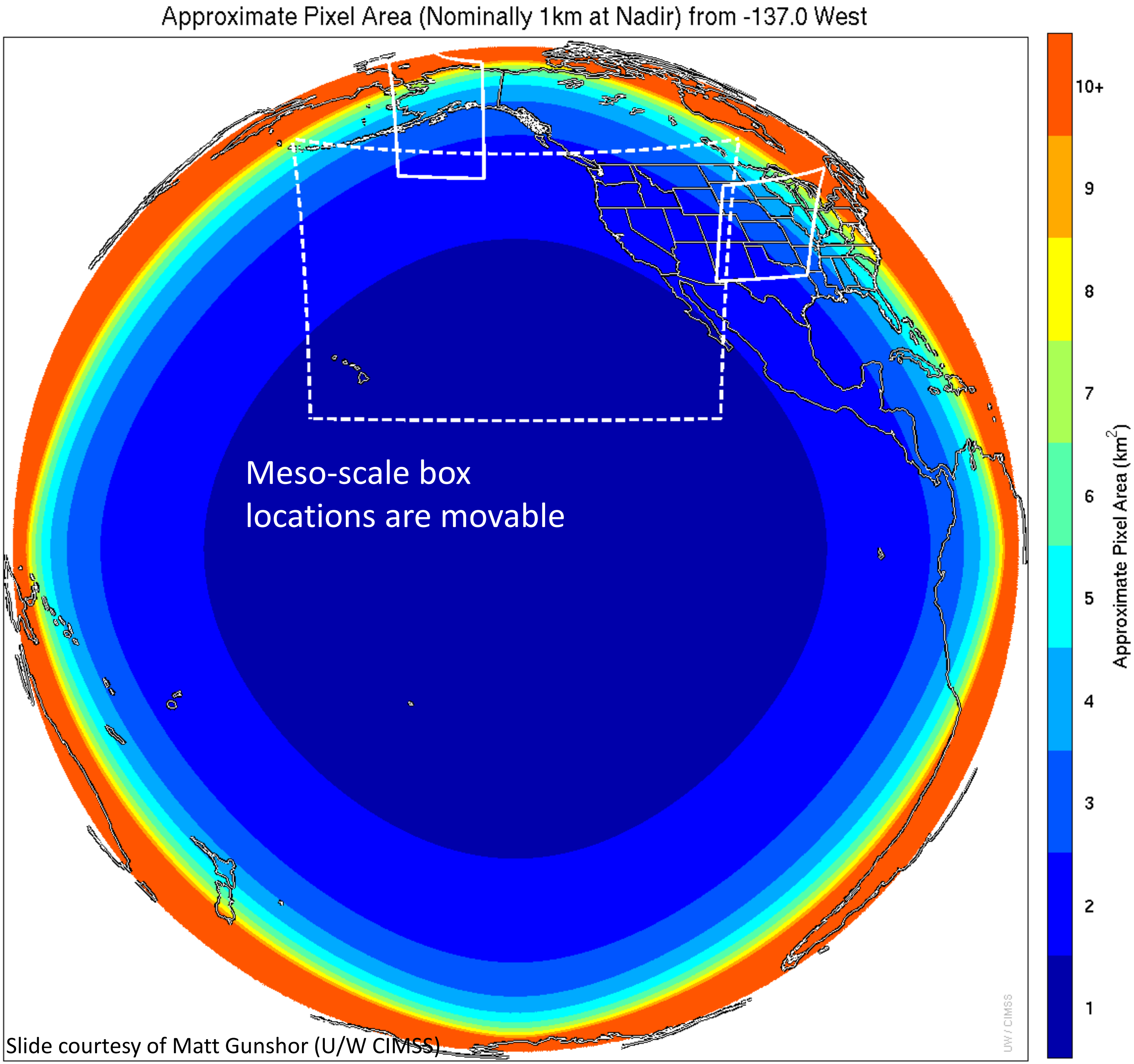
Scan modes for the ABI:

Mode 3:

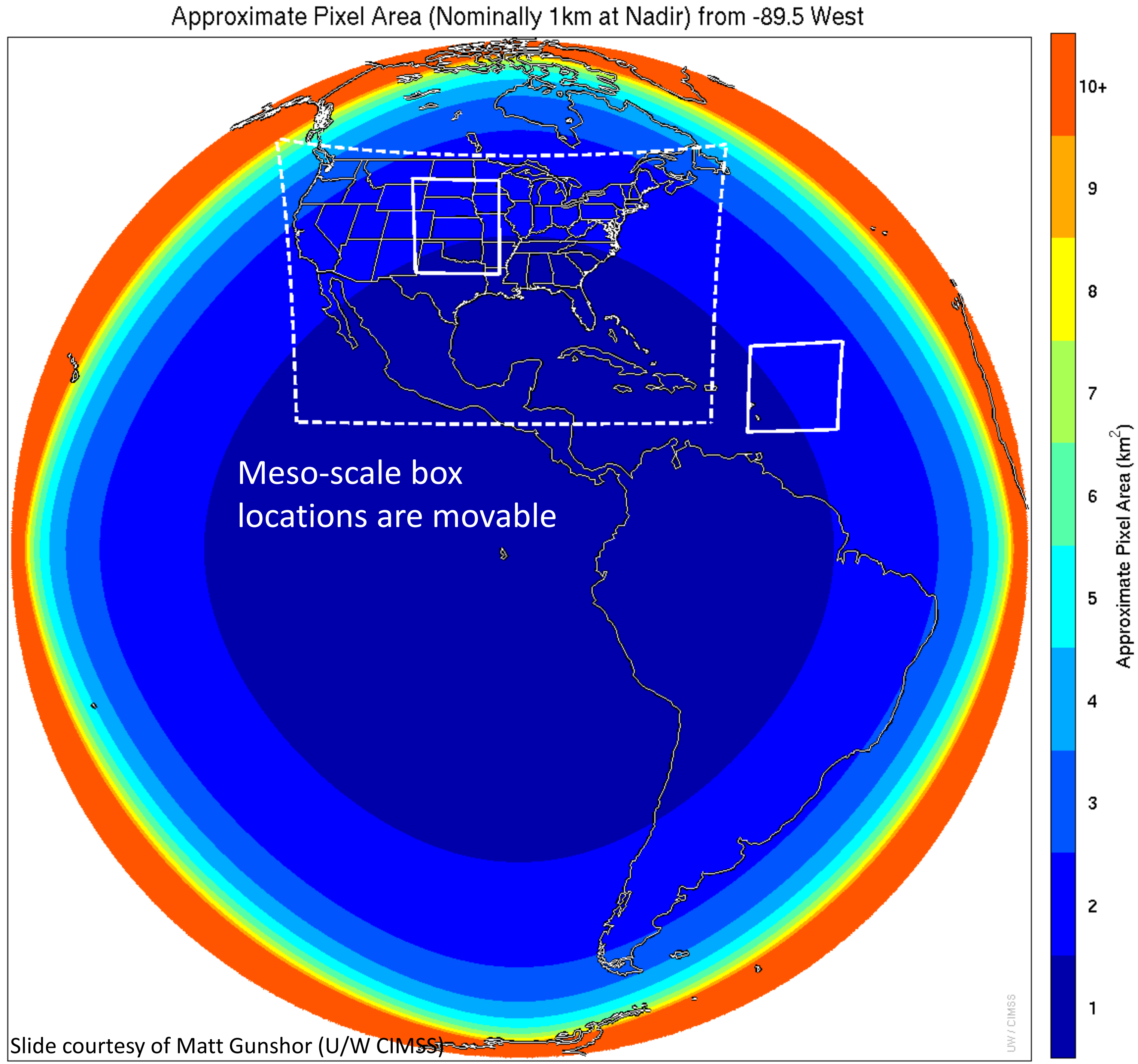
Full disk images every 15 minutes
CONUS images every 5 minutes
Mesoscale images (2) every 1 minute

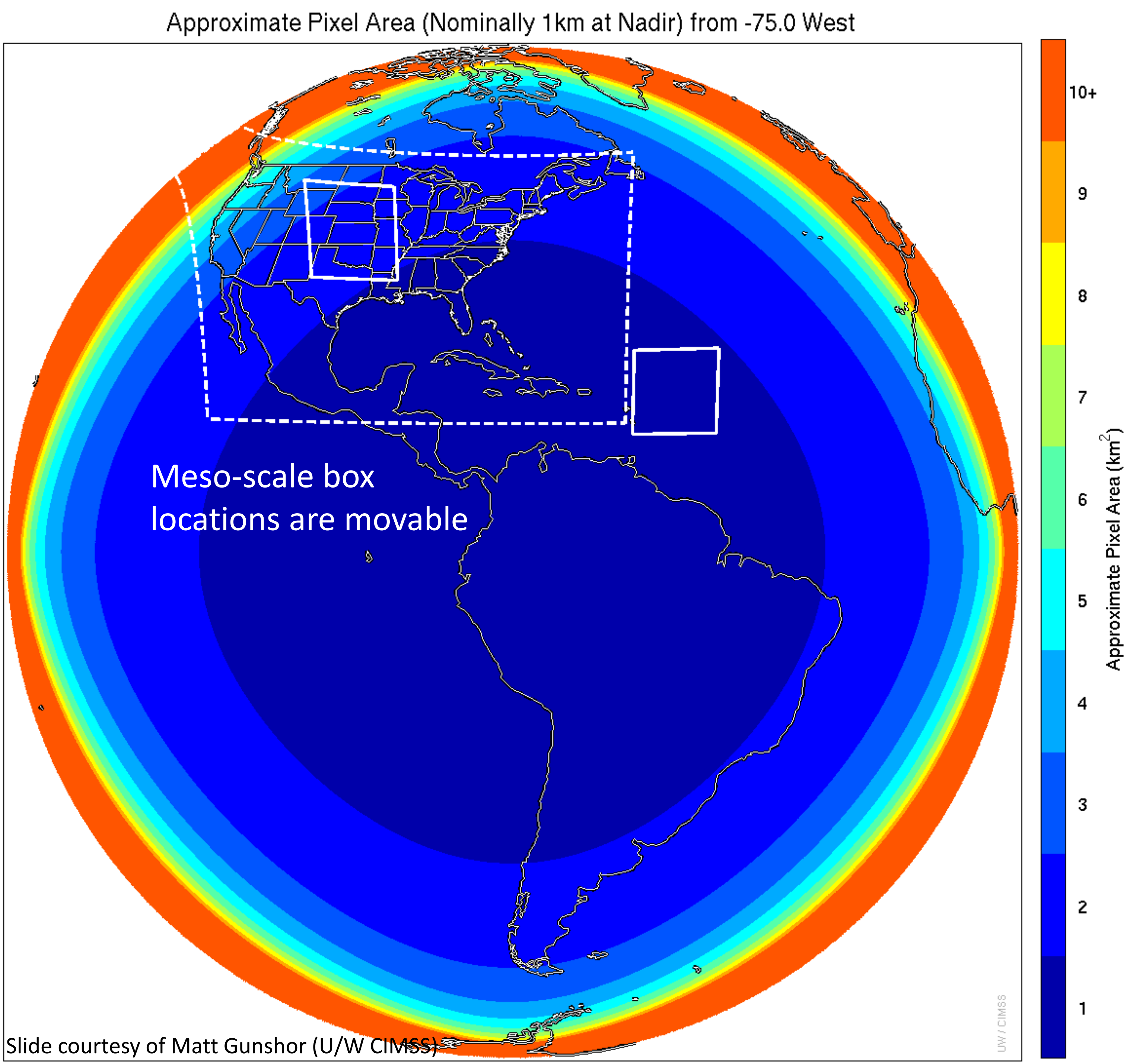
Mode 4:

Full disk images every 5 mins



Slide courtesy of Matt Gunshor (U/W CIMSS)


Approximate Pixel Area (Nominally 1km at Nadir) from -89.5 West
Meso-scale box
locations are movable
10+
9
8
7
6
5
4
3
2
1
Approximate Pixel Area (km^2)
UW / CIMSS
Slide courtesy of Matt Gunshor (U/W CIMSS)



Slide courtesy of Matt Gunshor (U/W CIMSS)

Advanced Baseline Imager (ABI)

Improved Temporal Resolution *(Faster Scanning)*

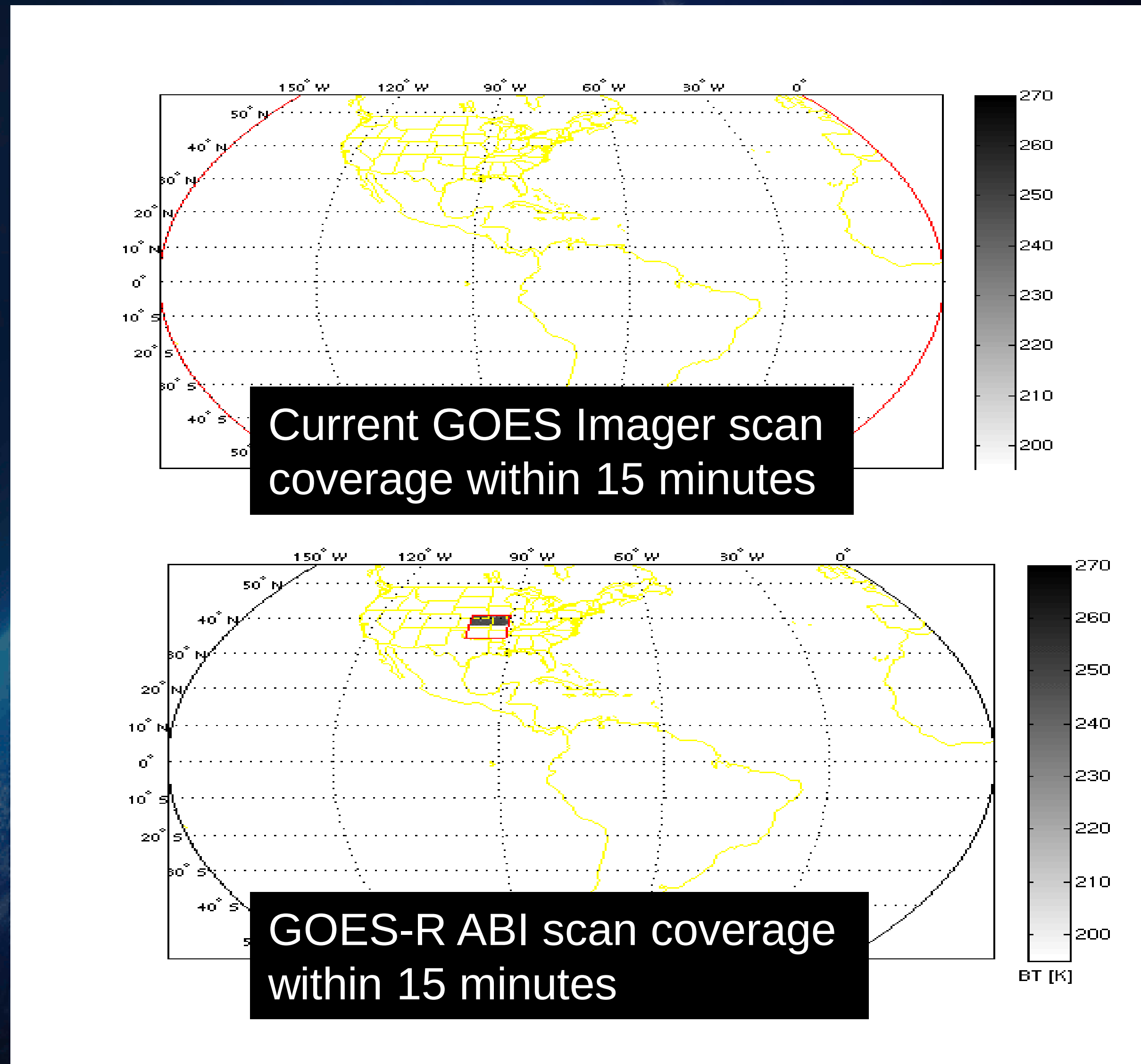
In 15 Minutes the current GOES Imager can scan:

- Most (3/5) of a Full Disk (Hemisphere) Image

ABI scans about 5 times faster than the current GOES imager

In 15 Minutes the ABI (Flex Mode) will scan:

- 30 Images of localized severe weather events
- 3 Images of the Continental US
- 1 Full Disk Image



Exploratory ABI Scan Mode

- The ABI instrument is very flexible, with respect to possible scan modes.
- At some point, after launch, another ABI scan mode could be considered, but this would require an upgrade to the ground system.
- One option is to use the “idle time” of when the ABI instrument is not scanning in mode 3 (‘flex’).
- Using this extra time, a mode could be investigated that allows a FD scan every 10 min (plus the CONUS and meso-scale scans).

Exploratory Scan Mode "6" w/ 10-min FD

- In 10-min:
  - 1 Full Disk +
  - 2 CONUS +
  - 20 Meso-scale

Figure 1 Scan Mode 6 Time-Time Diagram

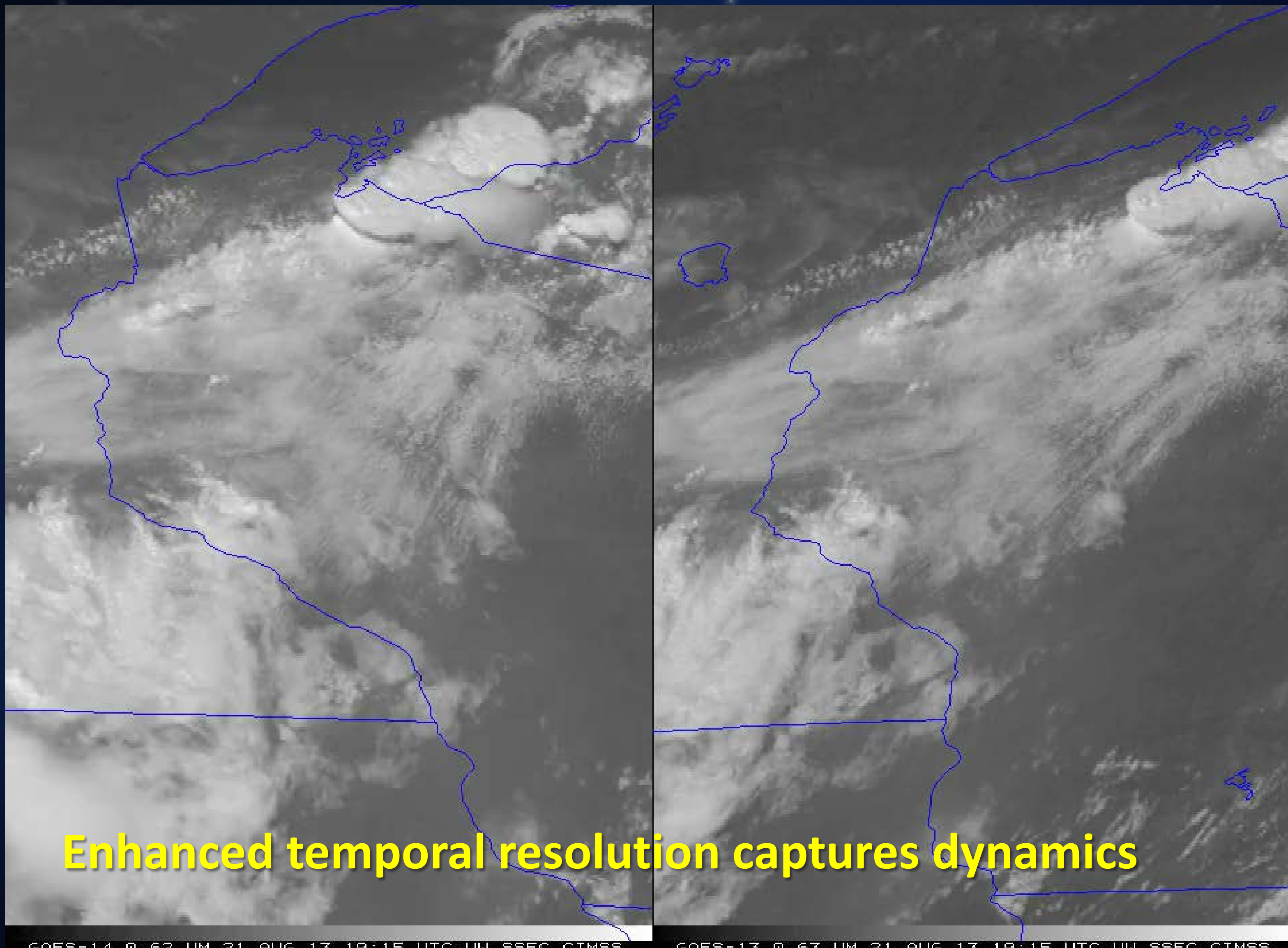
Time-time diagram from Exelis

- The 10-min Full Disk (mode 6) would offer synergy with other GEOs, improved AMVs and coverage outside of CONUS. This would allow improvements in imagery, and monitoring precipitation and volcanoes; all the while, still allowing for regional/meso-scale observations.

Future vs Current GOES Imagery

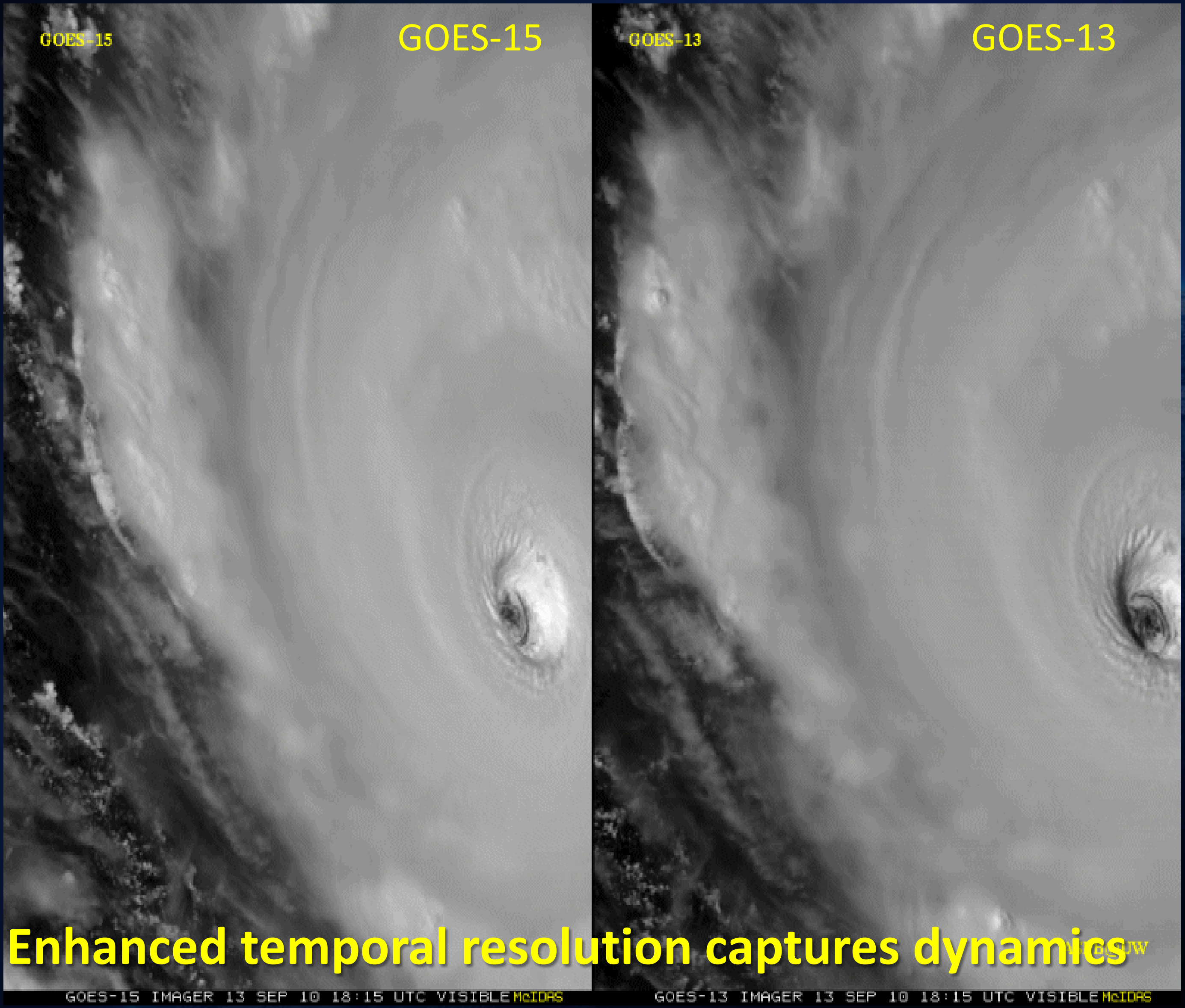
A demonstration of the improved temporal resolution…

GOES-14 (SRSOR) **GOES-13 (RSO)**



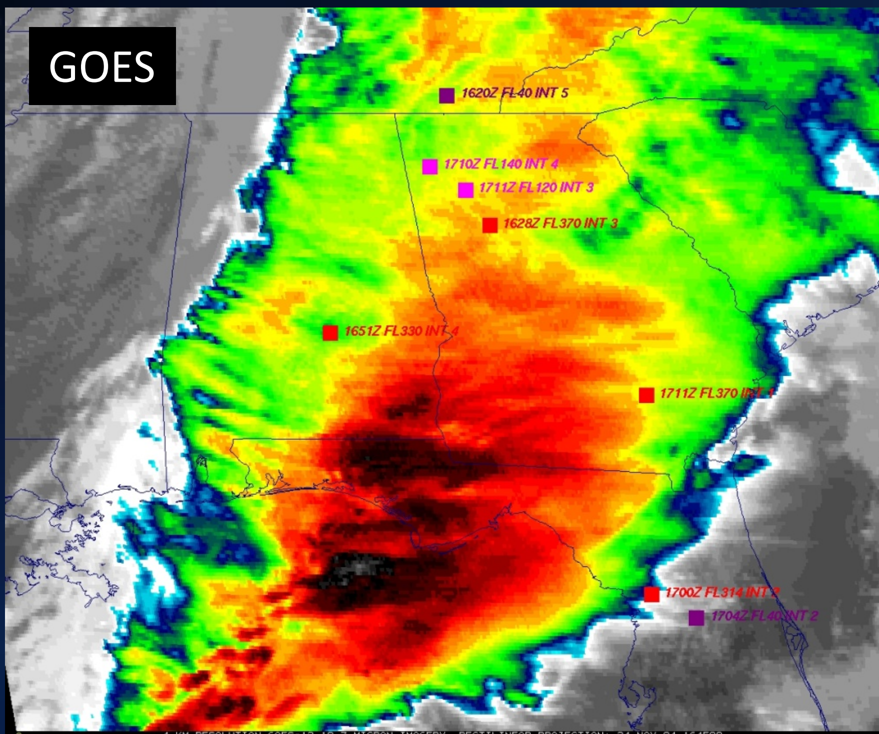
GOES-15: Sample "1-min" imagery

A hint of what GOES-R will routinely provide…

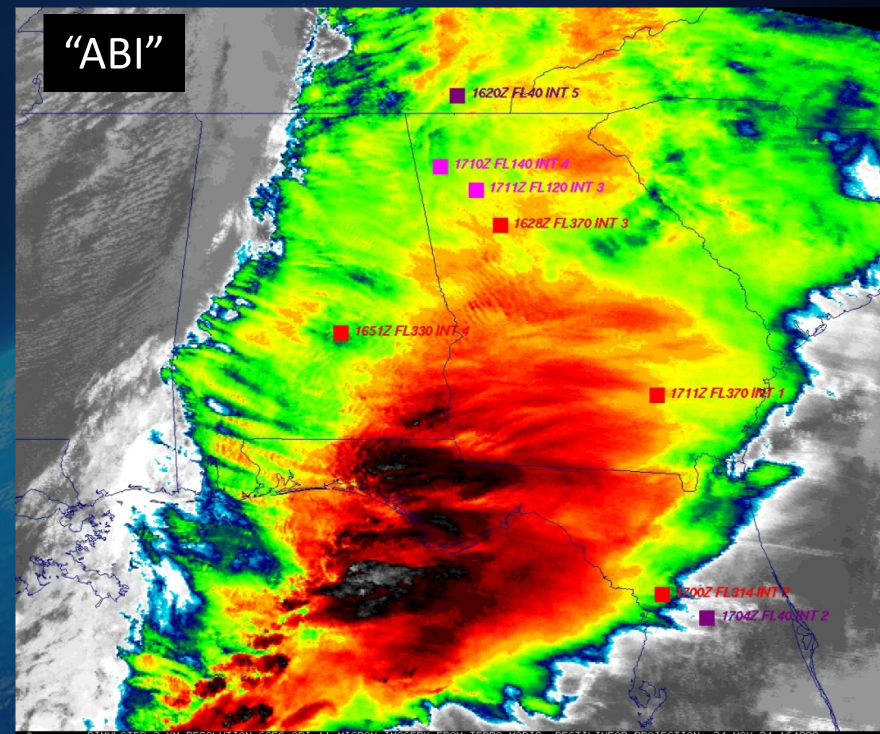


Hurricane Igor (Sept 13, 2010)

ABI: 4X Greater Spatial Resolution



4 km IR

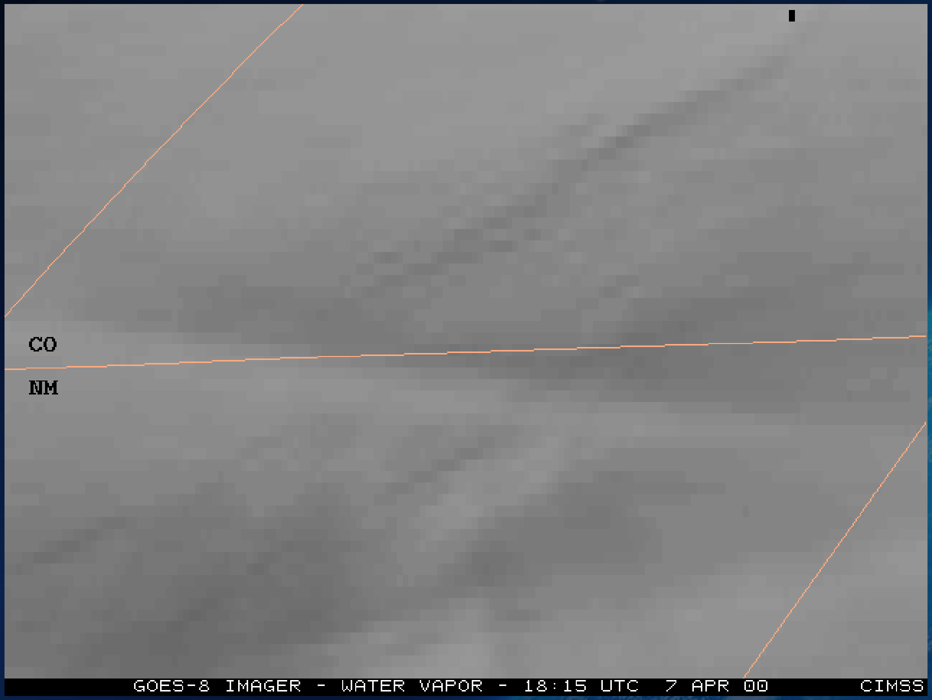


2 km IR

Enhanced Resolution of Cloud Top Features in the IR

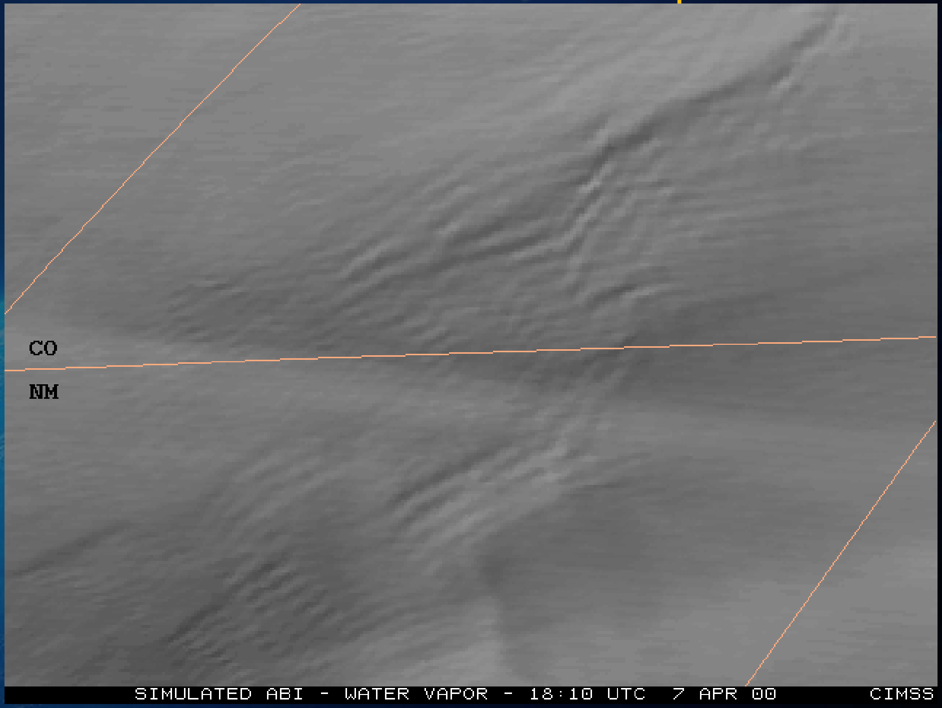
ABI: 4X Greater Spatial Resolution

Actual GOES-8 Water Vapor



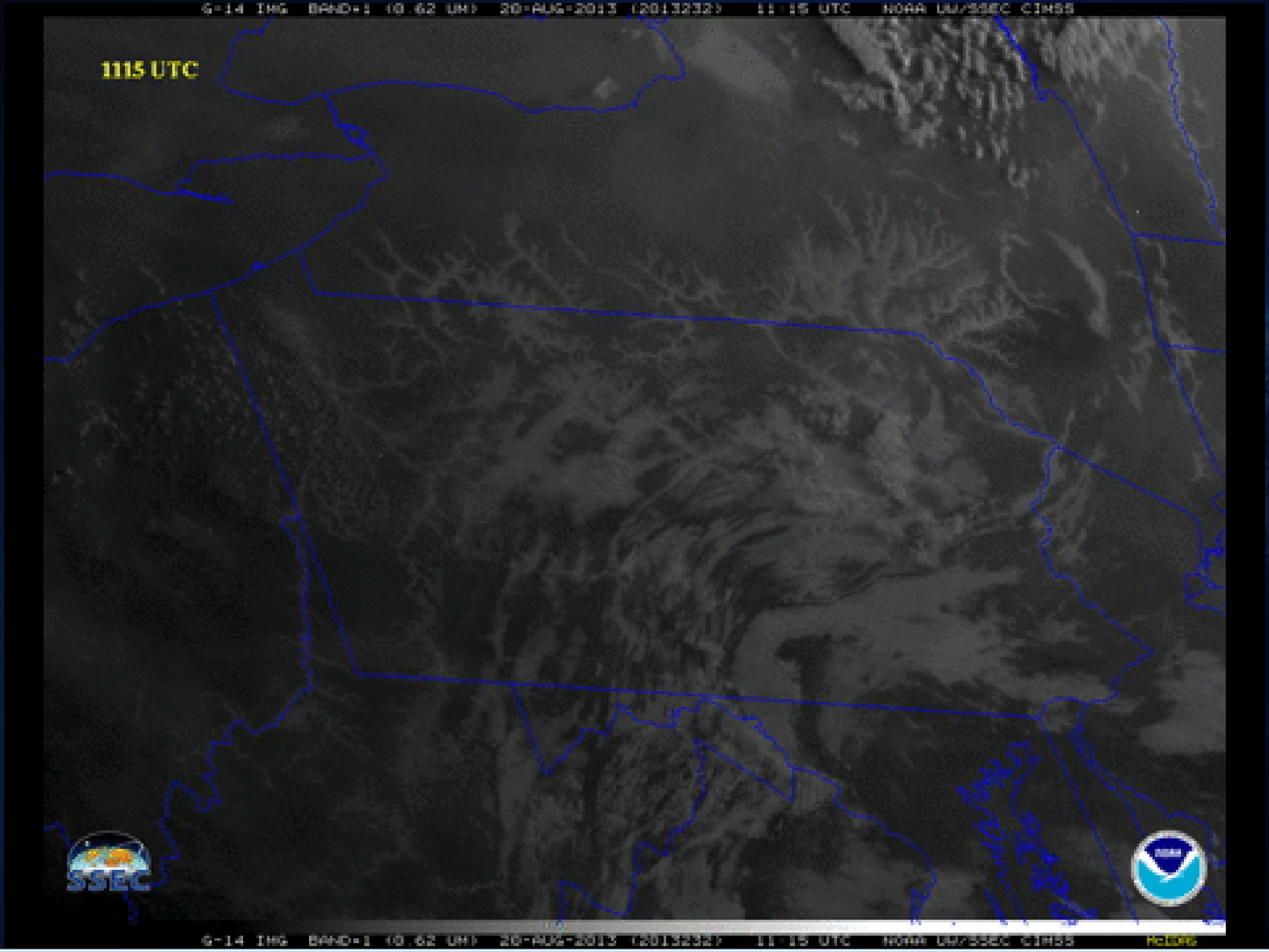
8 km IR

Simulated ABI Water Vapor



2 km IR

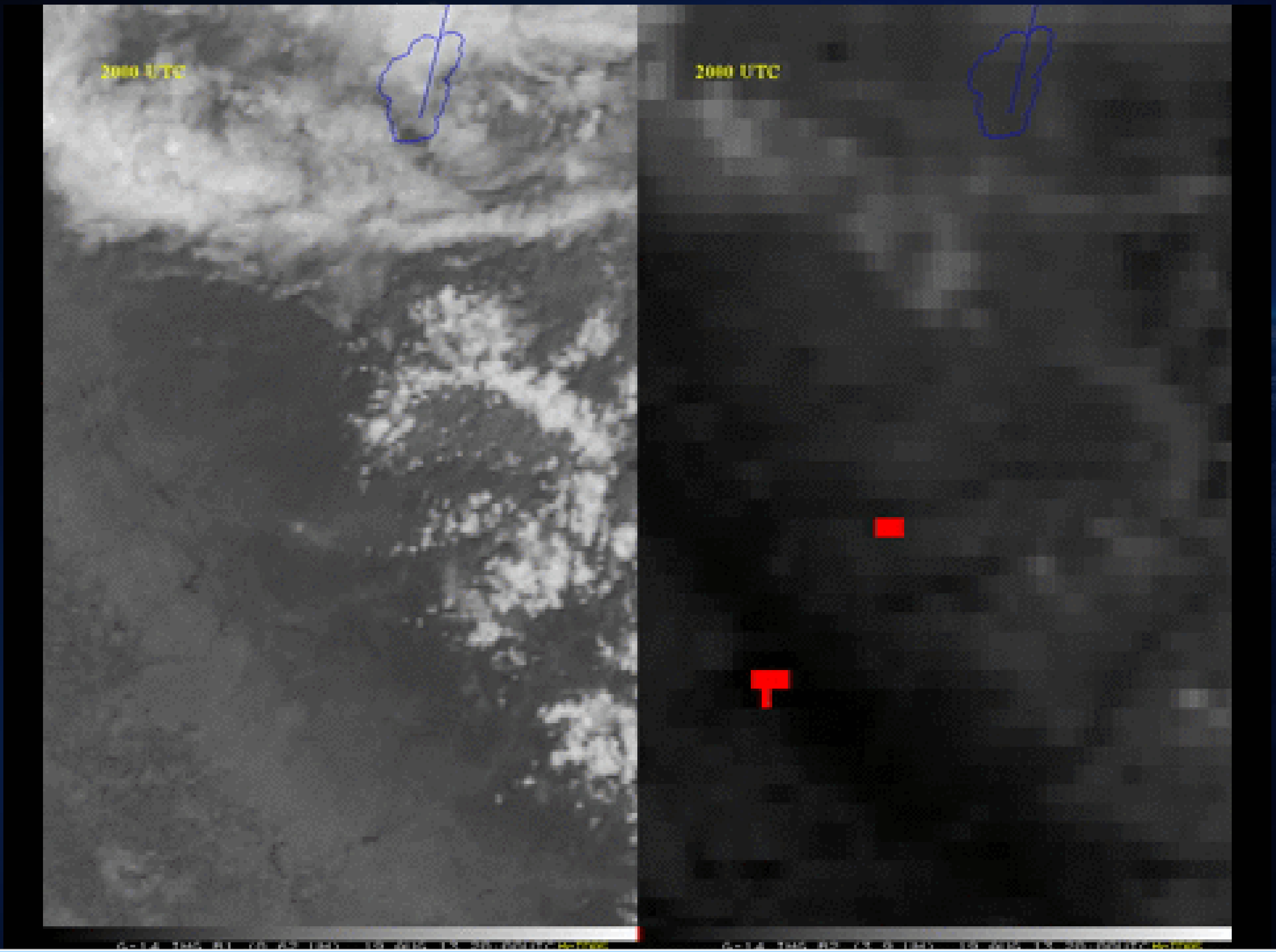
Fog Detection, Formation, and Dissipation



ABI's finer spectral, spatial, and temporal resolution will enable improvements in fog detection, formation, and dissipation.

We expect immediate and positive impacts on domestic transportation systems.

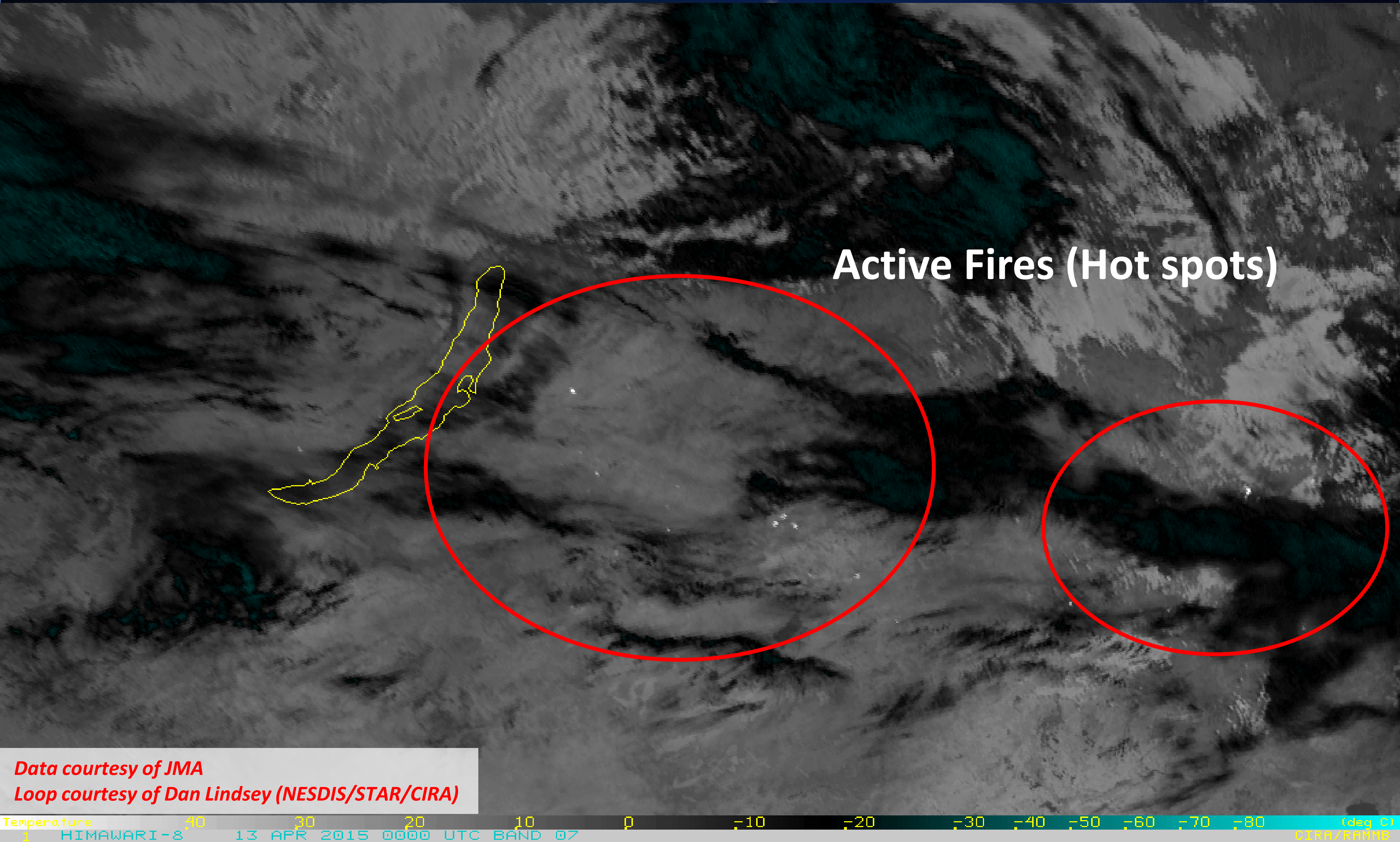
California Rim Fire



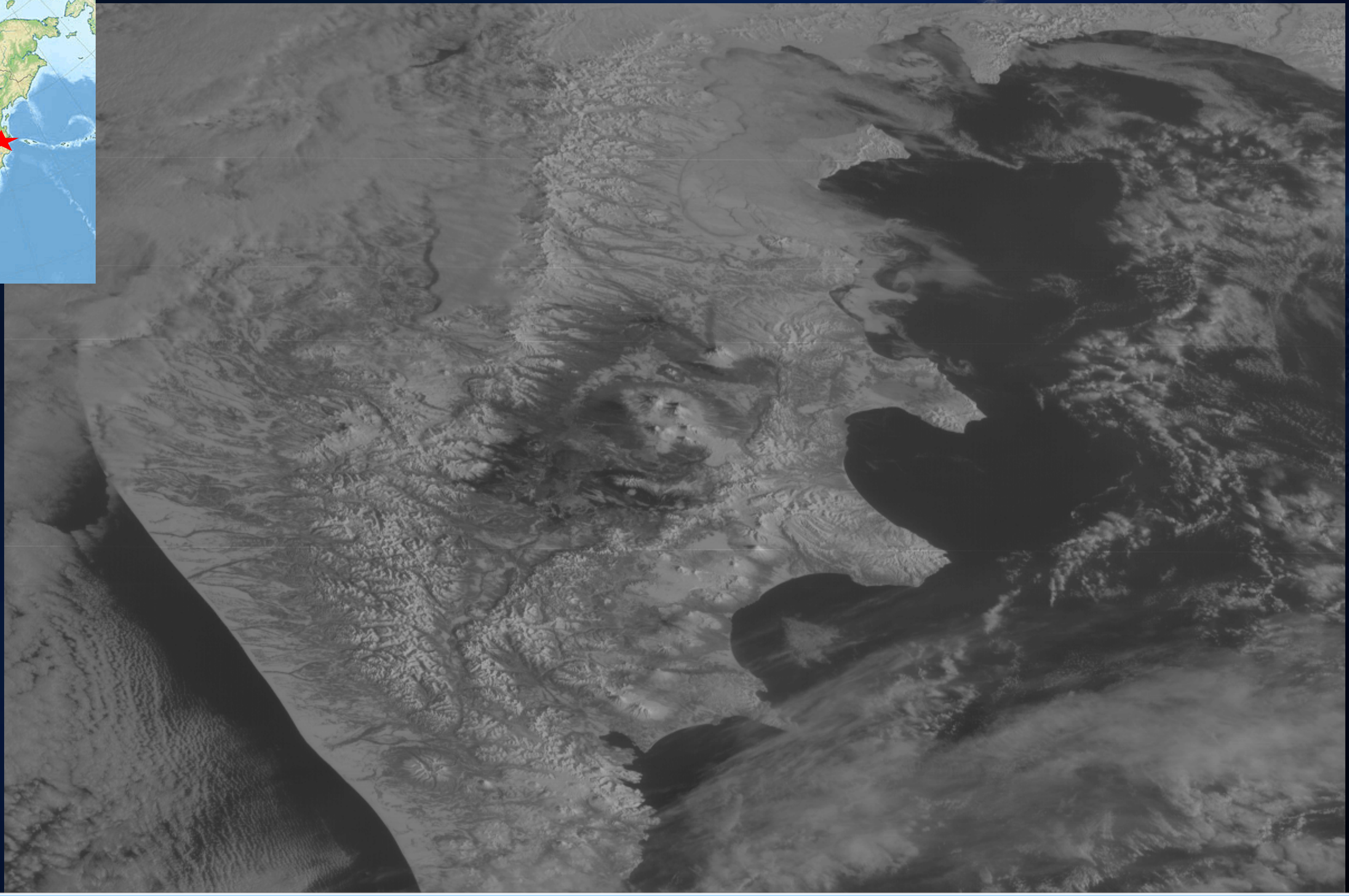
ABI's finer spectral, spatial, and temporal resolution will enable improvements in fire detection, characterization, monitoring, and forecasting.

We expect immediate and positive impacts on NWS Fire Operations

Himawari-8 Band 7 (3.9 µm; 2km) Loop, 4/13 @ 00 UTC through 4/15 @ 04 UTC



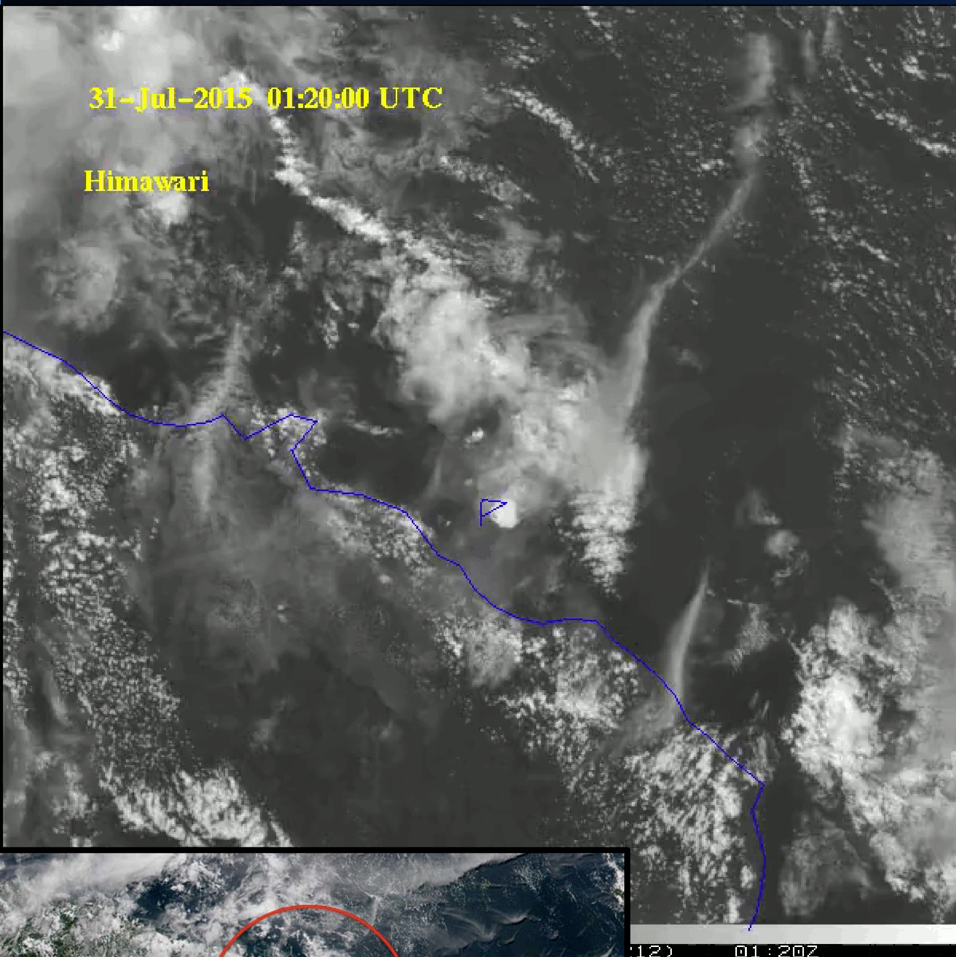
Himawari Imagery of Erupting Shiveluch Volcano

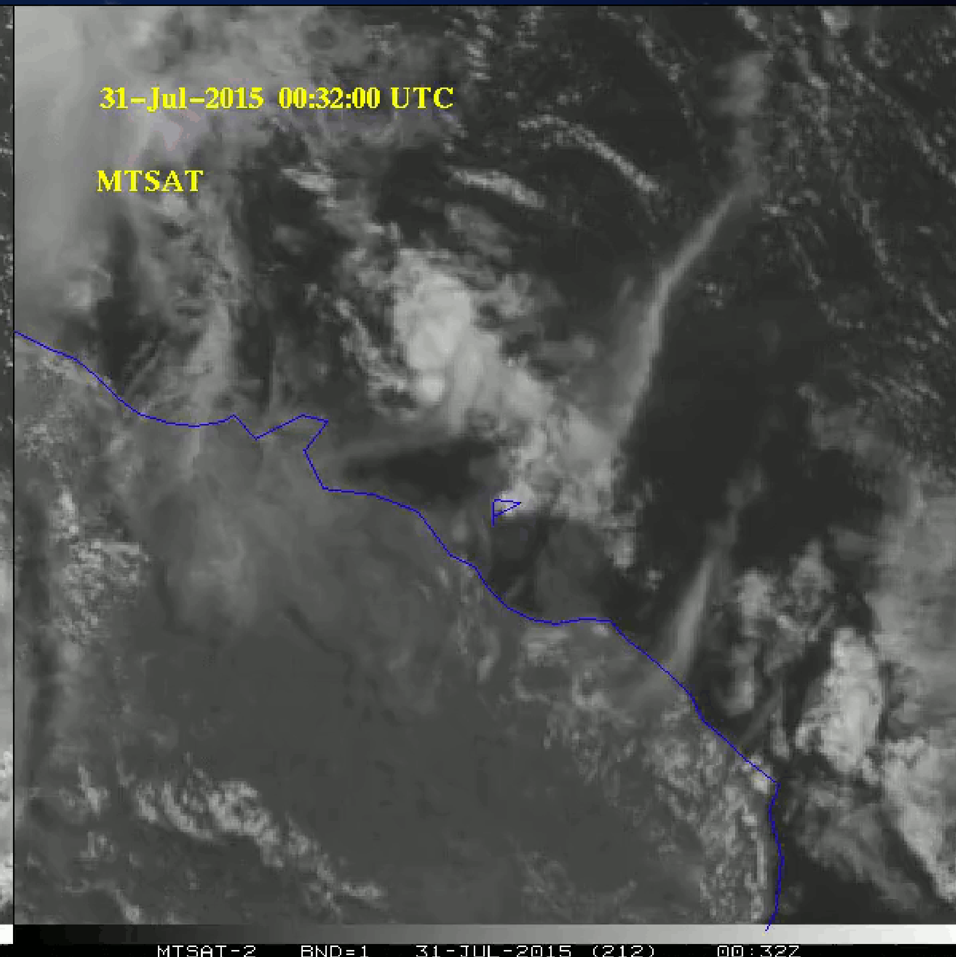


Courtesy of JMA

Shiveluch volcano on Russia's Kamchatka Peninsula. This is one of the first active eruptions viewed by Himawari. 10 minute data visible (0.64um) band at 500m resolution using the AHI is similar to what we will see on the GOES-R ABI. This will allow Volcanic Ash Advisories to be issued much more quickly.

Himawari-8 and MTSAT-2 Imagery of Manam Volcanic Eruption

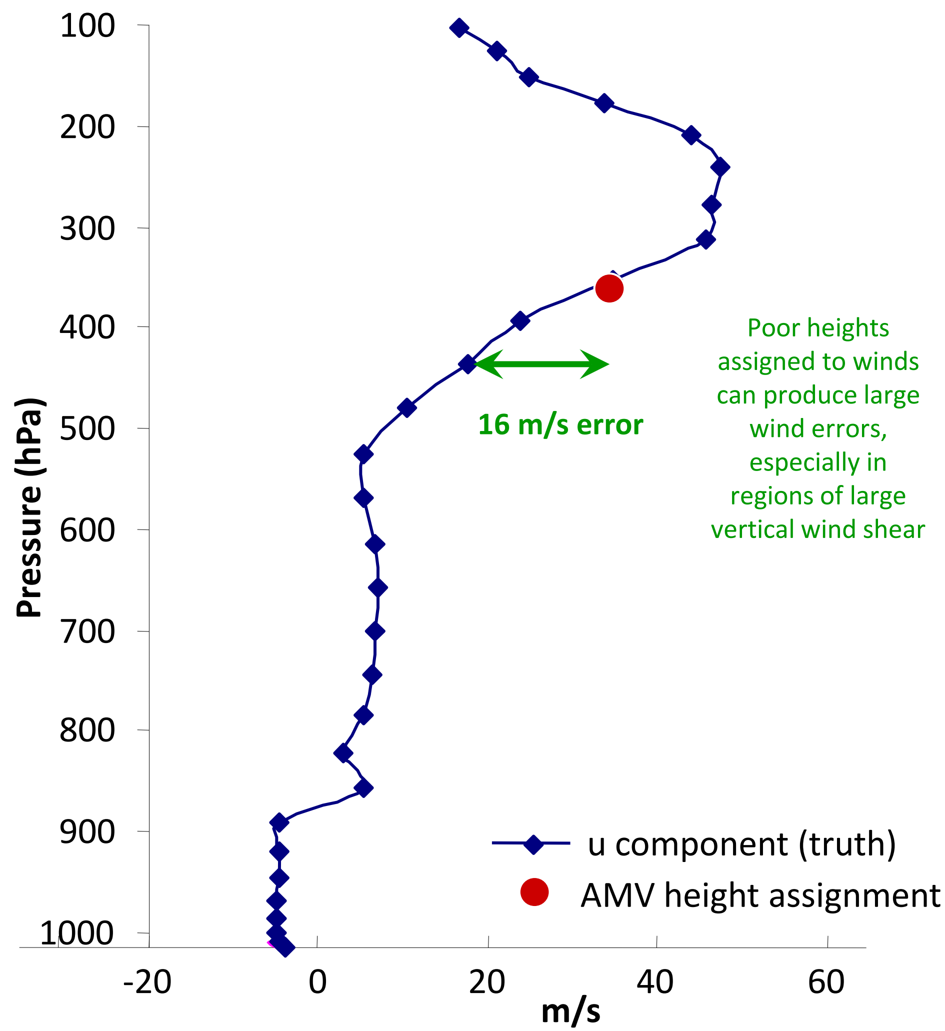




A volcanic ash plume is shown off the coast of Papua New Guinea on Friday, July 31, 2015, after the Manam volcano erupted. (Photo/Himawari-8/Japanese Meteorological Agency/NOAA).

Improved Radiometric Performance together with Improved Spectral and Spatial Resolution

Expected to lead to improved wind height assignments and a more accurate wind product



GOES-R SENSORS AND DATA PRODUCTS

NEW AND ENHANCED CAPABILITIES

NEW OPPORTUNITIES

GLM

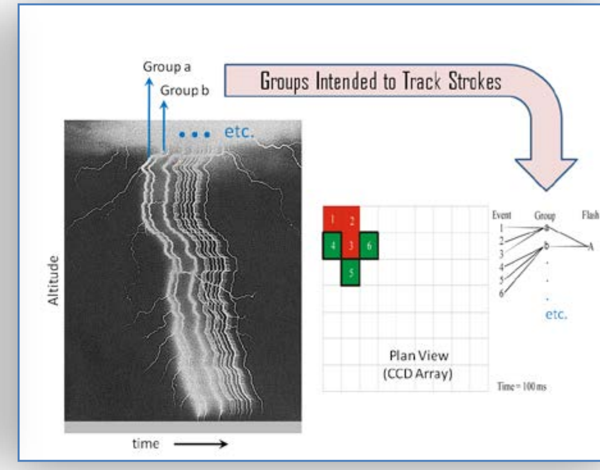
GOES-R Geostationary Lightning Mapper (GLM)

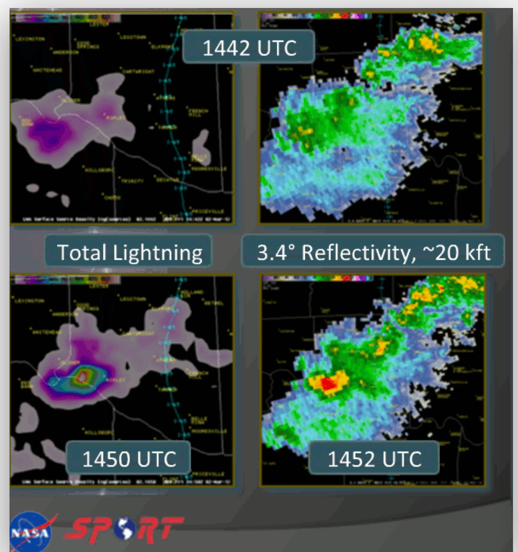
Totally new capability in a geostationary orbit!!

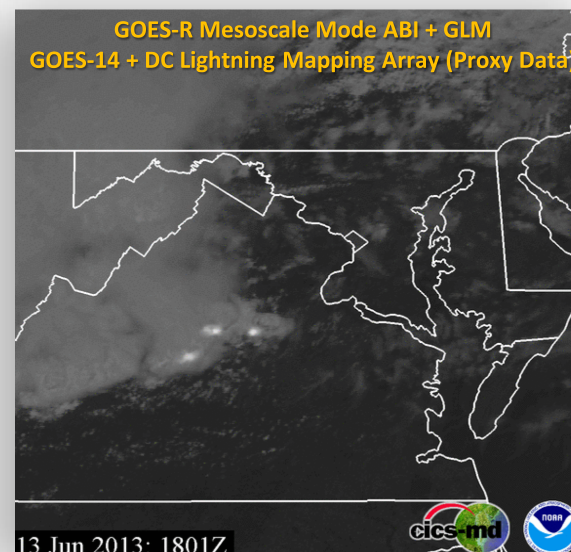
- GLM will observe intra-cloud (IC) and cloud-to-ground (CG) lightning at storm scale resolution across most of the Western Hemisphere with low latency (< 20 sec)

- GLM data is processed into lightning data products (Events, Groups, Flashes) that are more easily utilized by users

- Exciting new applications for improving severe weather forecasting and lightning awareness/safety

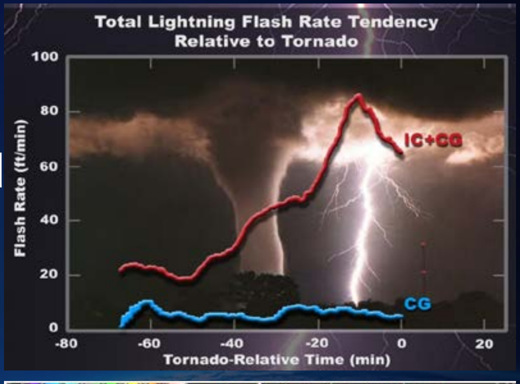


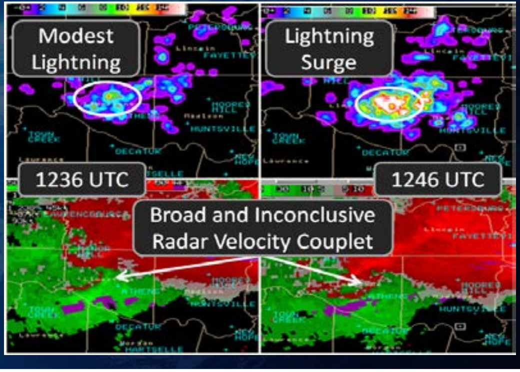


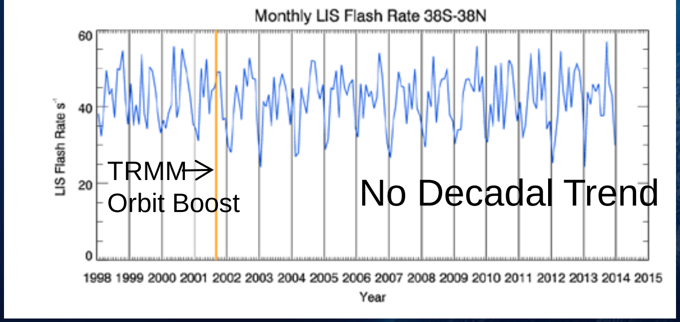


GLM Mission Benefits

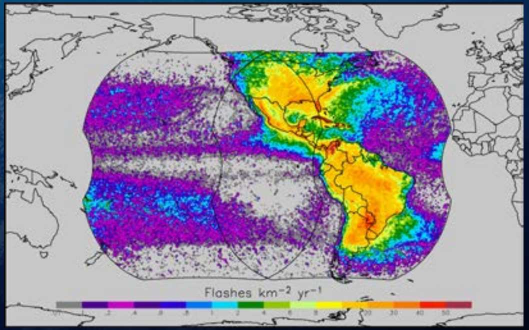
- Improved forecaster situational awareness and confidence resulting in more accurate severe storm warnings (improved lead time, reduced false alarms) to save lives and property
- Diagnosing convective storm structure and evolution
- Aviation and marine convective weather hazards
- Tropical cyclone intensity change
- Decadal changes of extreme weather – thunderstorms/ lightning intensity and distribution
- Extends 17-yr TRMM LIS Climate Data Set for 2+ decades
- GLM data latency only 20 sec



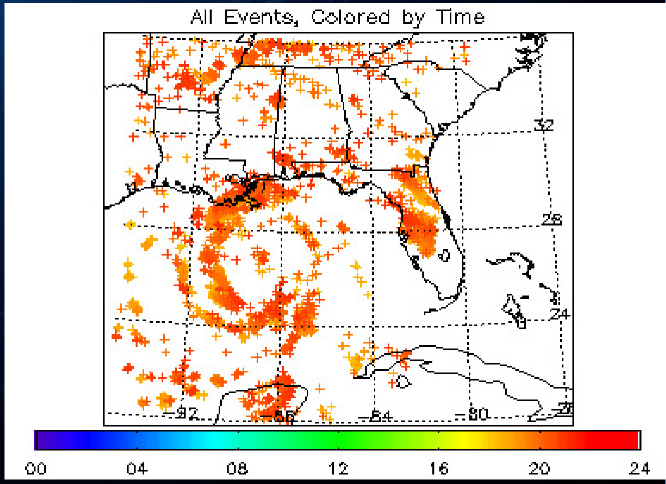




Global flash rate
from LIS/OTD (1995-2014)



Lightning Climatology

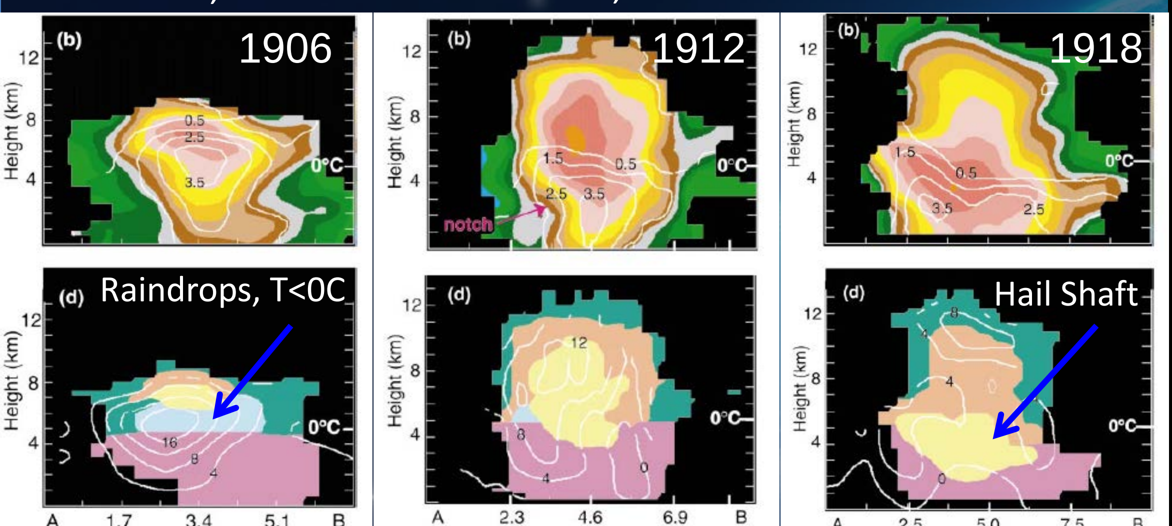


Hurricane Katrina

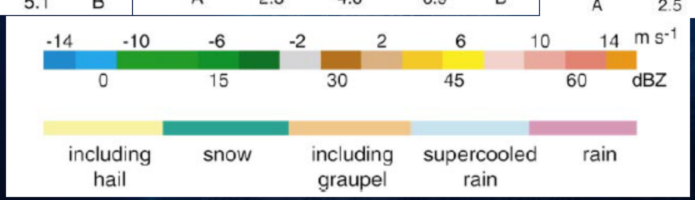
Lightning Connection to Storm Updraft, Storm Growth and Decay

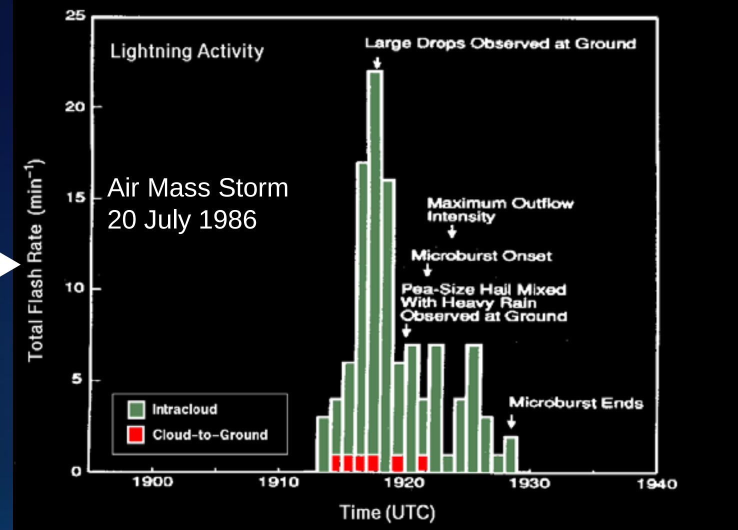
- Total Lightning —responds to updraft velocity and concentration, phase, type of hydrometeors, integrated flux of particles
- Dual-Pol WX Radar — responds to concentration, size, phase, and type of hydrometeors- integrated over small volumes

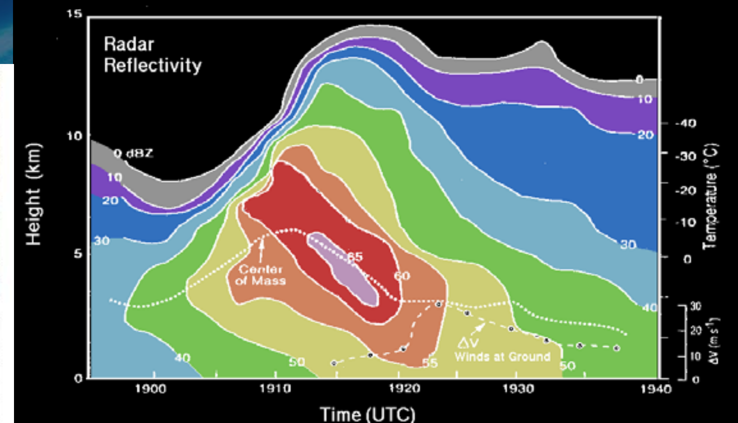
Growth, Zdr>0 Glaciated, Zdr<0

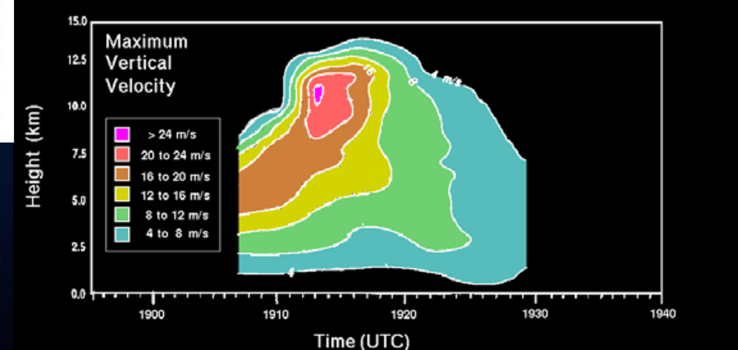


w, dBZ, HID









Adapted from Goodman et al, GRL, 1988; Wakimoto and Bringi, MWR, 1988; Kingsmill and Wakimoto, MWR,1991, Zeng et al., 2001, Gatlin and Goodman, JTECH, 2010

Reducing Societal Impacts of High Impact Weather: Most-Promising GLM Contributions

- Improved Convective Warnings (combine TL, radar, other)
  - Reduced FAR, Increased POD, Increased Lead Time for Tornado Warnings and other Severe Convective Warnings
  - Enhanced Situational Awareness for Aviation Services over broad geographic area (especially trans-oceanic flights)
  - Enhanced Situational Awareness for Convective Precipitation (Flash-Flood)
- Improved Forecasts of Rapid Intensification (RI) and Rapid Weakening (RW) in Tropical Storms
- Short-term numerical weather prediction improvement
  - Assimilation of TL as proxy for strong convection
  - Better initialization of storms approaching CONUS from offshore (e.g. winter storms, heavy precipitation)

ABI & GLM

PRODUCTS, APPLICATIONS, AND CAPABILITY DEMONSTRATIONS

- Use of proxy data for product development
- Product Illustrations *(Imagery & Level-2)*
- Product & Algorithm highlights
- ABI attributes leveraged
- Operational applications

GOES-R 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

Geostationary Lightning Mapper (GLM)

- Lightning Detection: Events, Groups & Flashes

Space Environment In-Situ Suite (SEISS)

- Energetic Heavy Ions
- Magnetospheric Electrons & Protons: Low Energy
- Magnetospheric Electrons: Med & High Energy
- Magnetospheric Protons: Med & High Energy
- Solar and Galactic Protons

Magnetometer (MAG)

- Geomagnetic Field

Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)

- Solar Flux: EUV
- Solar Flux: X-ray Irradiance

Solar Ultraviolet Imager (SUVI)

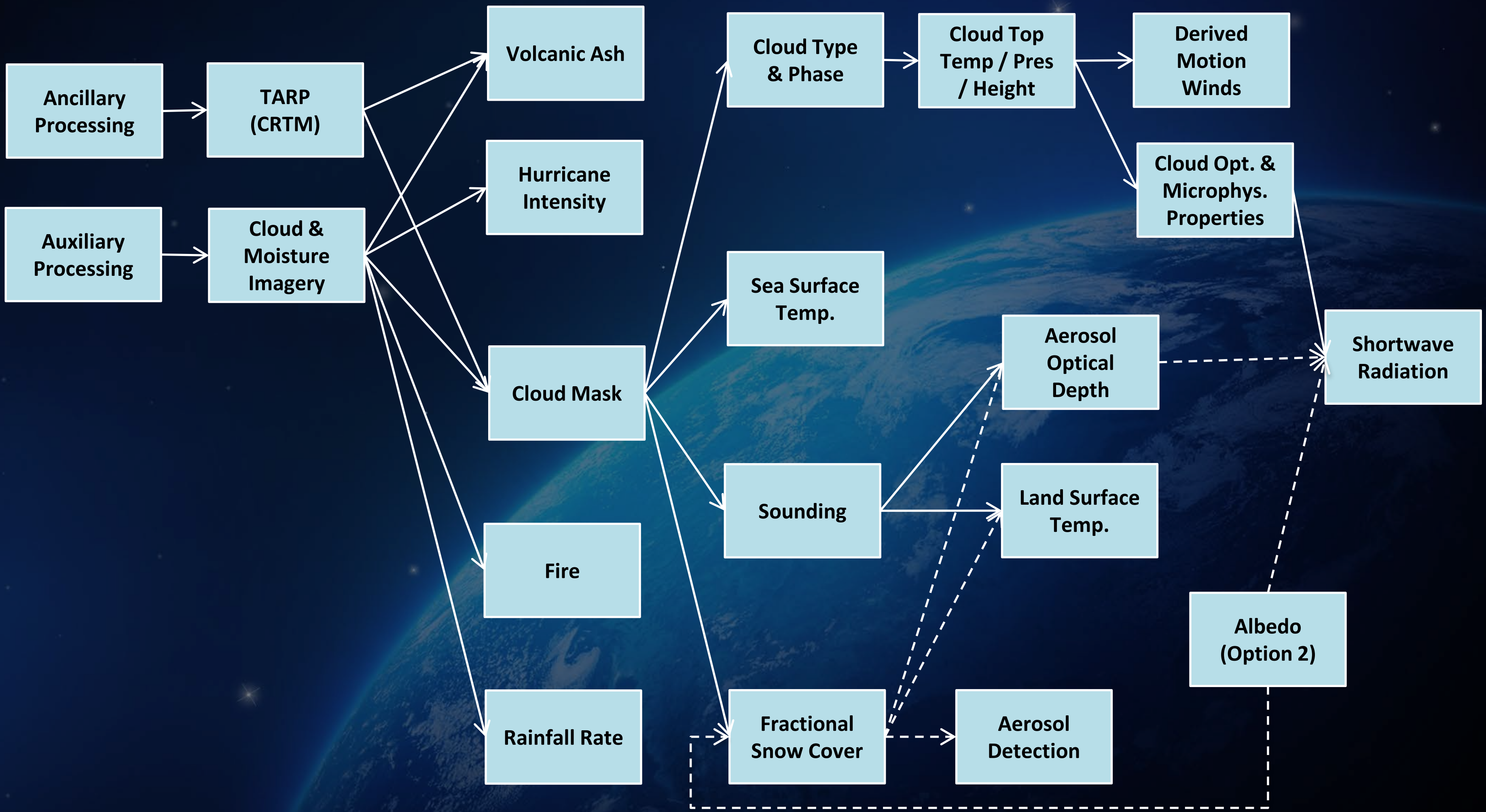
- Solar EUV Imagery

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

ABI L2+ Product Precedence

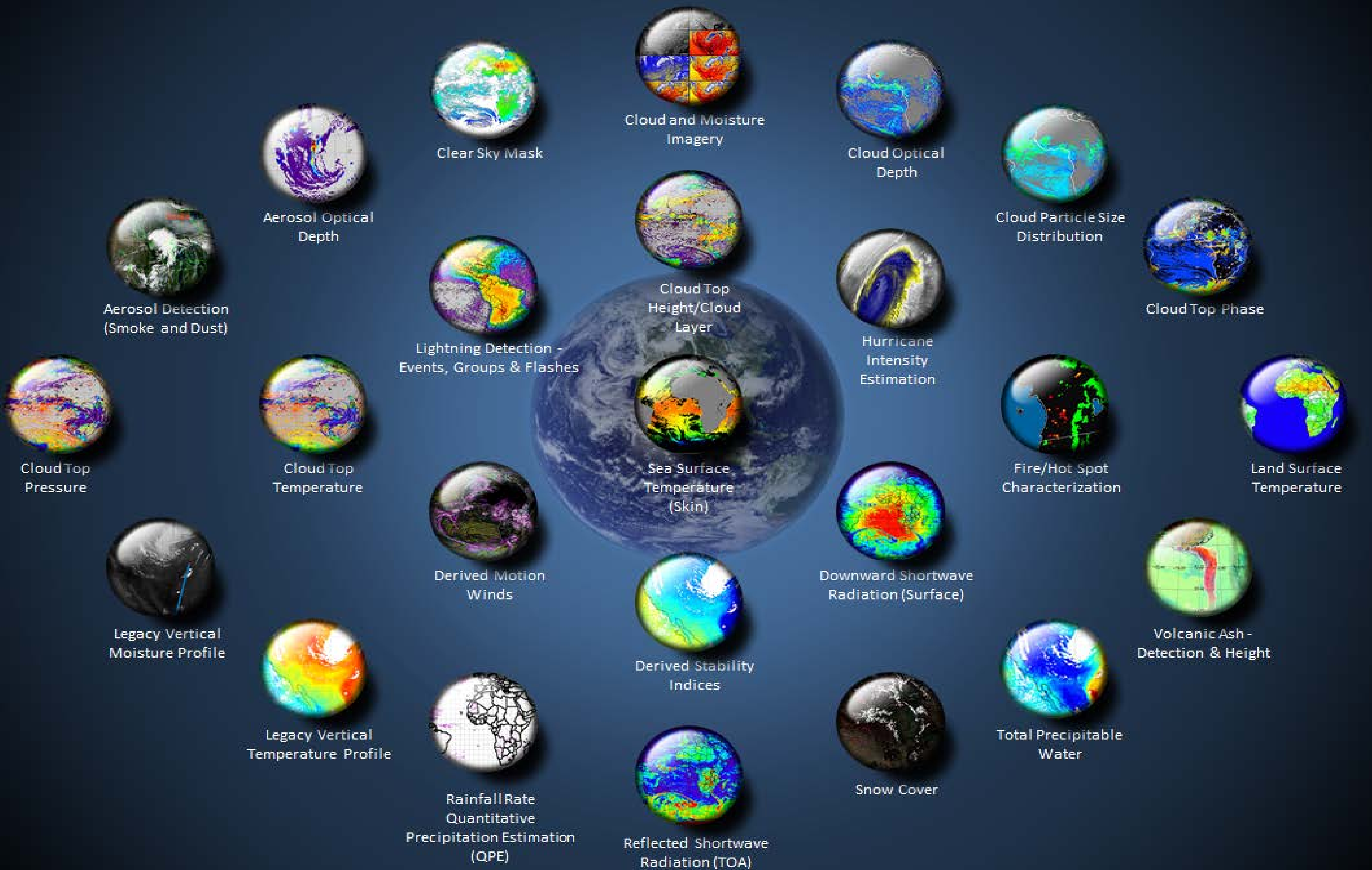


ABI "Baseline" L2 Products Take Advantage of ABI Spectral Information

ABI Baseline L2 Products

Wavelength Micrometers	0.47	0.64	0.865	1.378	1.61	2.25	3.90	6.185	6.95	7.34	8.5	9.61	10.35	11.2	12.3	13.3
Channel ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Baseline Products																
Aerosol Detection	✓	✓	✓	✓	✓	✓	✓							✓	✓	
Aerosol Optical Depth	✓	✓	✓		✓	✓										
Clear Sky Masks		✓		✓	✓		✓		✓	✓	✓			✓	✓	
Cloud & Moisture Imagery	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cloud Optical Depth		✓				✓	✓							✓	✓	
Cloud Particle Size Dist.		✓				✓	✓							✓	✓	
Cloud Top Phase										✓	✓			✓	✓	
Cloud Top Height														✓	✓	✓
Cloud Top Pressure														✓	✓	✓
Cloud Top Temperature														✓	✓	✓
Hurricane Intensity													✓			
Rainfall Rate/QPE								✓		✓	✓			✓	✓	
Legacy Vertical Moisture Profile								✓	✓	✓	✓	✓	✓	✓	✓	✓
Legacy Vertical Temp Profile								✓	✓	✓	✓	✓	✓	✓	✓	✓
Derived Stability Indices								✓	✓	✓	✓	✓	✓	✓	✓	✓
Total Precipitable Water								✓	✓	✓	✓	✓	✓	✓	✓	✓
Downward Solar Insolation Surf	✓	✓	✓		✓	✓										
Reflected Solar Insolation TOA	✓	✓	✓		✓	✓										
Derived Motion Winds		✓					✓	✓	✓	✓				✓		
Fire Hot Spot Characterization		✓					✓							✓	✓	
Land Surface Temperature														✓	✓	
Snow Cover	✓	✓	✓		✓	✓	✓						✓			
Sea Surface Temperature							✓				✓		✓	✓	✓	
Volcanic Ash: Detection/Height										✓	✓			✓	✓	✓
Radiances	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

GOES-R Baseline Products



http://www.goes-r.gov/products/baseline.html

http://www.goes-r.gov/

Applications

- Applications utilize science and technology to provide products and services.
  - Weather forecasting is the application of science and technology to predict the atmospheric state for a given place and time.

- For GOES-R and JPSS, NESDIS provides sensor (L1b) and environmental data records (L2), but the ***real value*** is realized when the data records are used in user applications. "Realizing the last mile…"

NWS Operational Advisory Team (NOAT)

- Team Makeup: NWS Scientific Services Division (SSD) Chiefs who are responsible for NWS Regions in the U.S.
- Develop guidance for the NESDIS Science and Demonstration Executive Board (SDEB) to ensure science development and demonstration activities (GOES-R, JPSS) are aligned with NWS operational priorities.
- Provides guidance on future products
- Guidance used by Program Scientists (GOES-R, JPSS) in their planning associated with their Risk Reduction and Proving Ground portfolios

NOAT
NWS Operational Advisory Team

The SSD Chief Science Vision (Key Themes)

- Convective initiation/Warn on Forecast
- Best state of the Atmosphere (e.g., 3-d analysis)
- Next Generation Forecast System
- Decision Support Information Systems
- Integrating Social Science
- Risk Reduction, testbeds, and dynamic training

All within DS framework - The “service” is decision support for community leaders, partners and individuals to better help them anticipate, respond to, and recover from meteorological and hydrologic events and minimize impacts to the economy.

NOAT
NWS Operational Advisory Team

Next big science challenge: Initiation/explicit handling of convection

Challenge – better boundary layer depiction, especially low level distribution of moisture

Some impacts

- Enables concept of "Warn on Forecast"
- Improved QPE/QPF
- Development of general convection anticipated
- Improved boundary layer forecasts of cloud, fog and visibility

How do you fit?

CI
Overshooting Tops
Enhanced V
Lightning Jump
Stability Indices
Hurricane Intensity
Moisture profile
Nearcast, Satcast, etc

NOAT
NWS Operational Advisory Team

Best state of the atmosphere and boundary conditions (3-d analysis of the current state)

Challenge – boundary layer and integration of various datasets

Basis for:

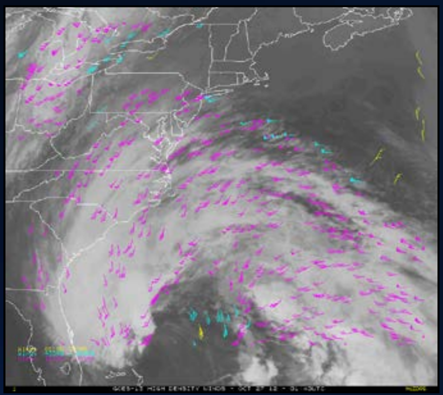
- Initial zero hour of the forecast database
- Initial conditions to next generation modeling systems
- Assisting the forecaster for monitoring /QCing the forecast database
- Situational awareness
- Verification

How do you fit?

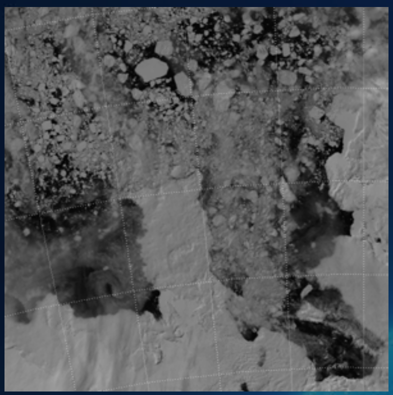
Smoke and dust
Moisture/clouds
Derived winds
Fire hot spots
QPE
SST
TPW
Snow/ice cover
Sea ice
Volcanic ash
Low clouds/fog
Visibility

Satellite Proving Ground

Supporting demonstration and utilization of new capabilities by the end users
Facilitating the transition of GOES-R and JPSS to operations
Incorporating user feedback for product improvements

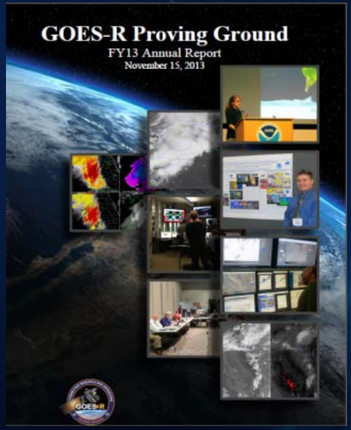


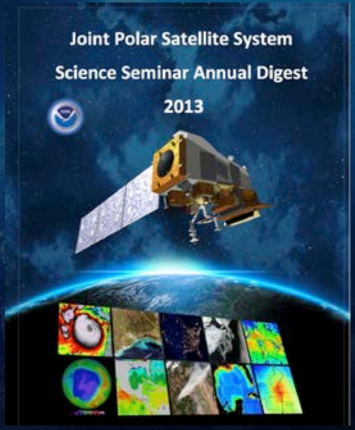
Hurricane Sandy-
GOES High Density
Atmospheric Motion Vectors

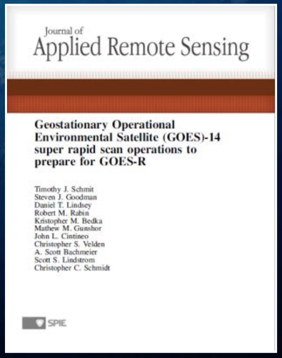


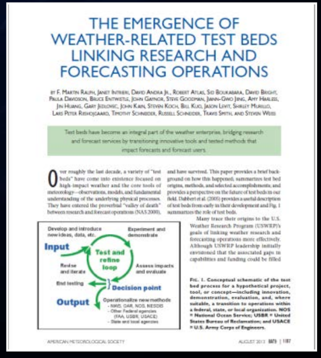
S-NPP Day/Night Band
Ice Detection

NOAA Hazardous Weather Testbed (HWT)







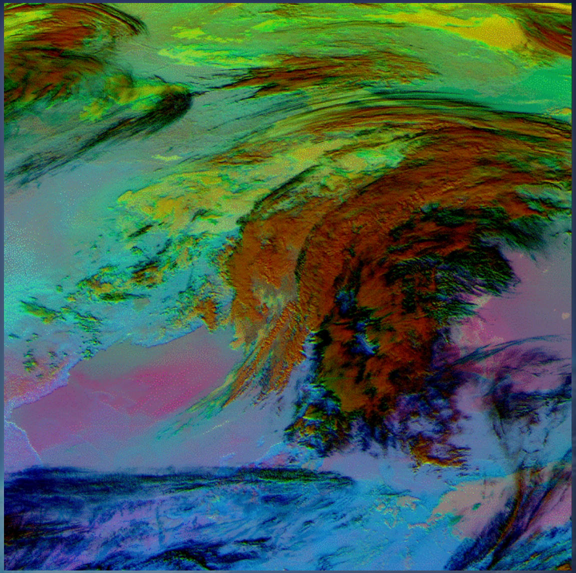


http://www.goes-r.gov/users/proving-ground.html

RGB Imagery

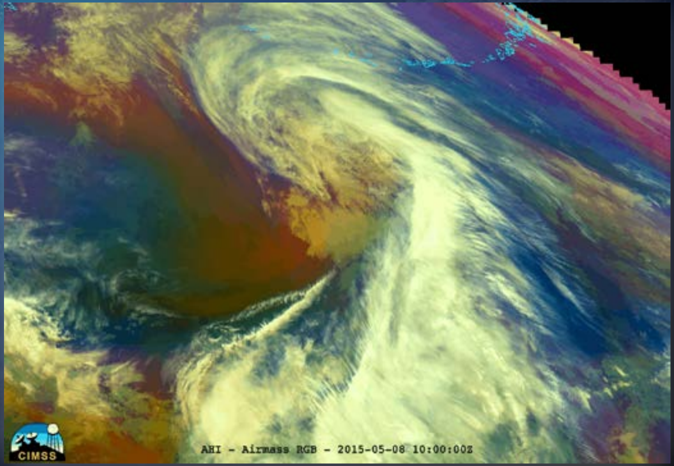
- Multi-spectral instruments such as MODIS, VIIRS, SEVIRI, AHI, ABI provide a unique opportunity to synthesize “spectral signatures” of key features.

- Over the past several years, GOES-R and JPSS Proving Ground partners have developed various true or false color (RGB) products to address specific needs, such as:
  - ❑ Separating cloud from snow in daytime imagery
  - ❑ Using true color imagery to identify smoke and ash
  - ❑ Aiding in the detection of low stratus, or fog
  - ❑ Providing cloud height information to visible data through blending of the infrared brightness temperatures



Credit: Andrew Molthan (NASA/SPORT)

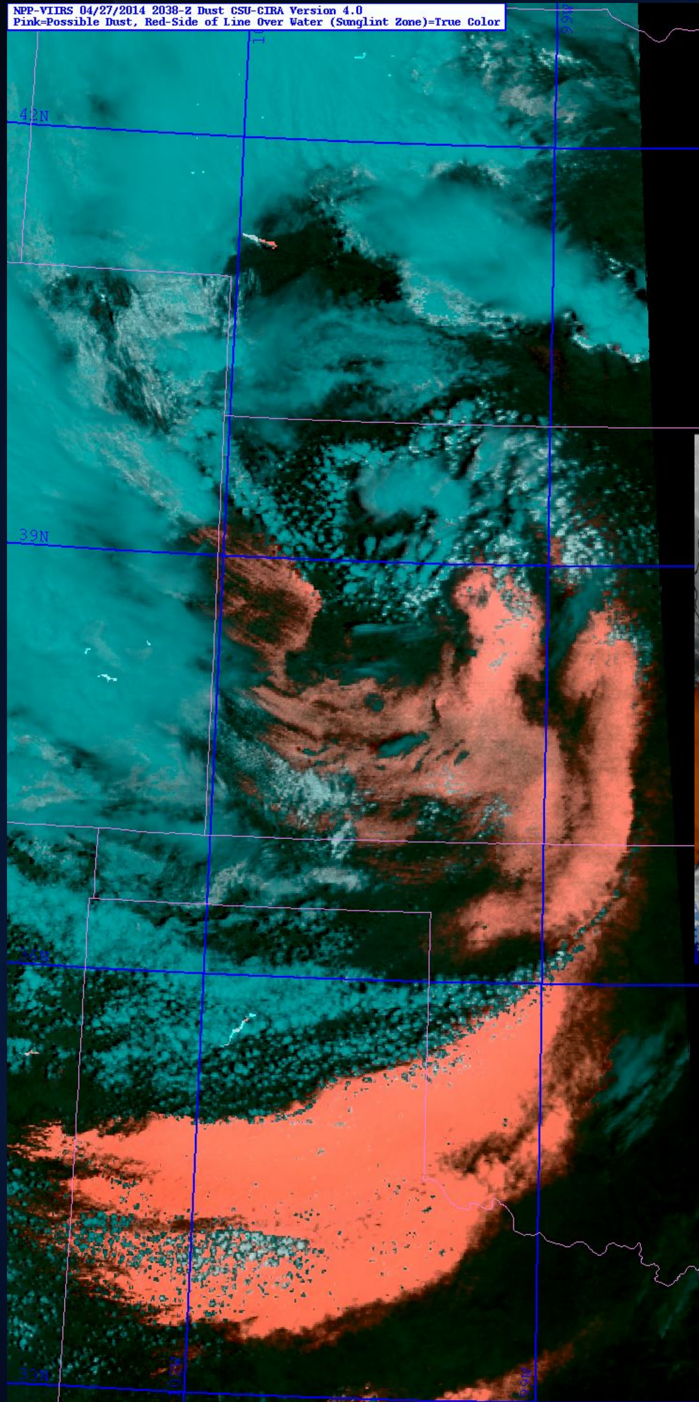
Prototype AHI “24-Hour Microphysics” RGB from April 23, 2015.

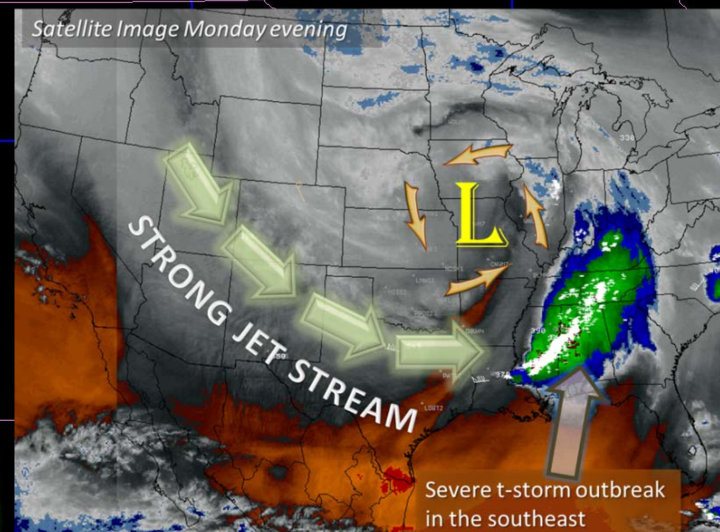


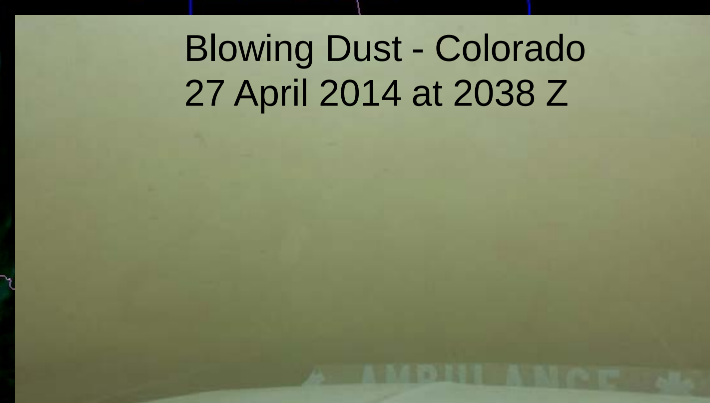
Courtesy of CIMSS/SSEC/JMA and Eventually NASA SPoRT

RGB User Readiness at OPC
Prototype AHI Airmass RGB
May 8, 2015

GOES-R ABI: 16 Channels for Improved Feature Discrimination





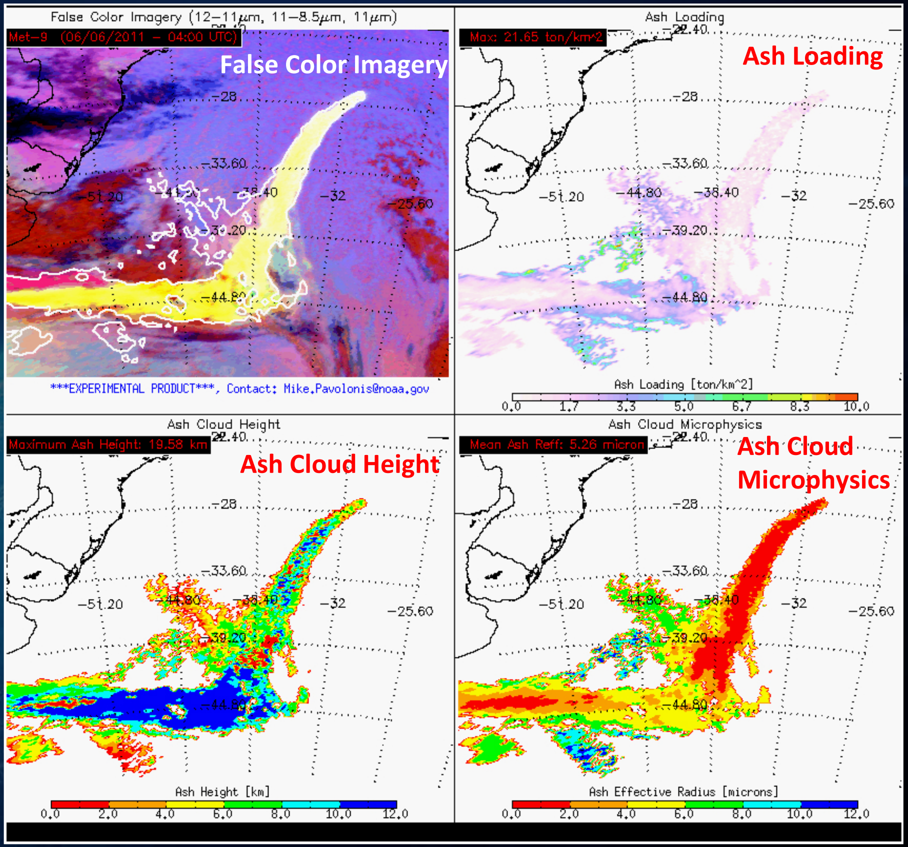


Blowing Dust - Colorado
27 April 2014 at 2038 Z

Blowing Dust courtesy of S. Miller

Volcanic Ash

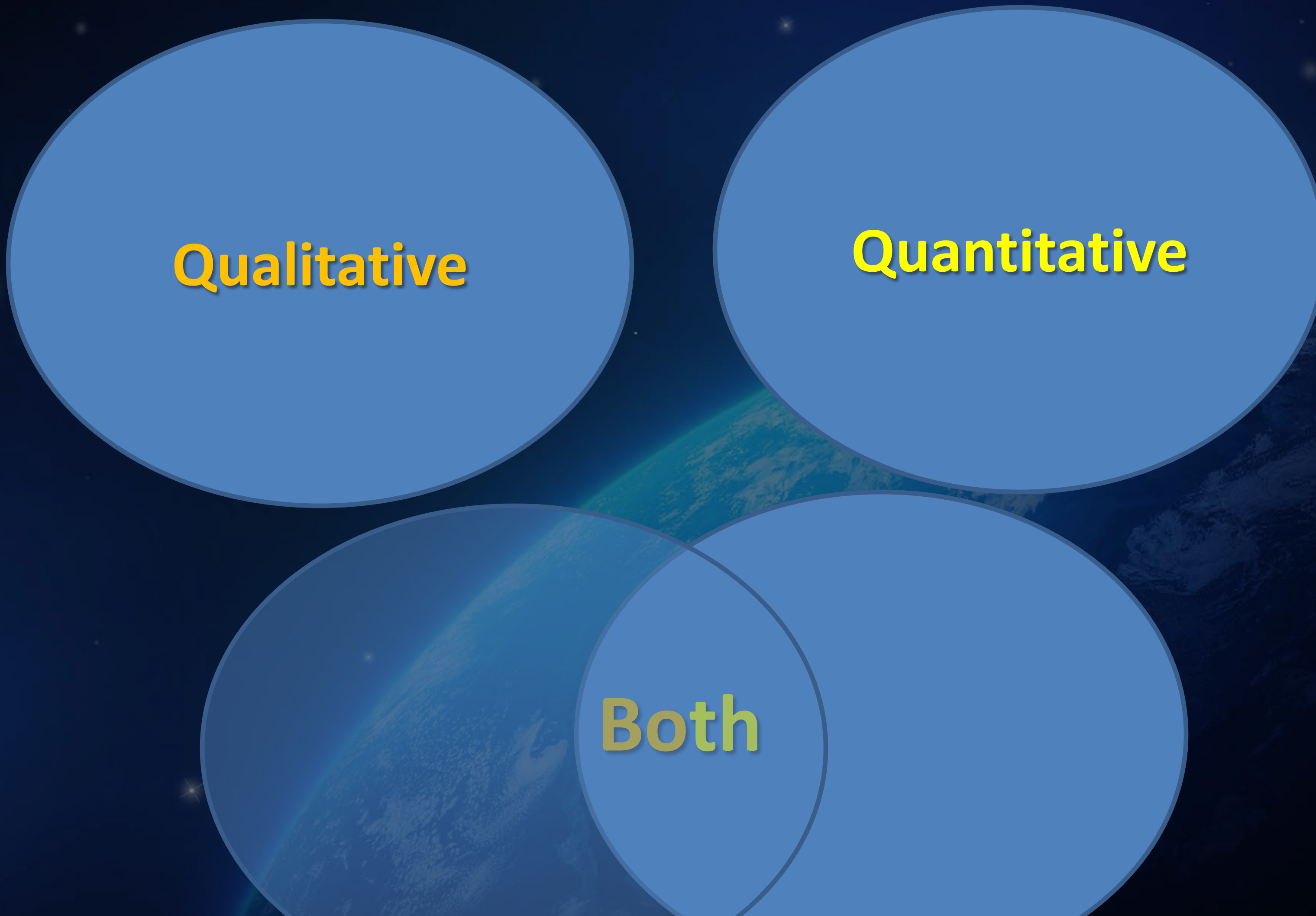
- **The VolAsh height detection and product is a big step forward for operations**
  - The impacts to aircraft operations and the associated costs should be reduced with this capability alone
  - Automated alerts will aid forecasters in the production of warning products
- **The GOES-R Proving Ground provides near real-time volcanic ash retrieval products (Meteosat SEVIRI proxy for the ABI)**
  - to the London Volcanic Ash Advisory Center (VAAC) during the eruption of Eyjafjallajökull in Iceland in May 2010 impacting aviation operations with many cancelled flights..
- **GOES-R VolAsh algorithm implemented at JMA in 2013 in preparation for Himawari 8.**



Chile's Puyehue-Cordón Caulle Volcano erupted on June 4, 2011, forming a tall ash plume above the Andes Mountains

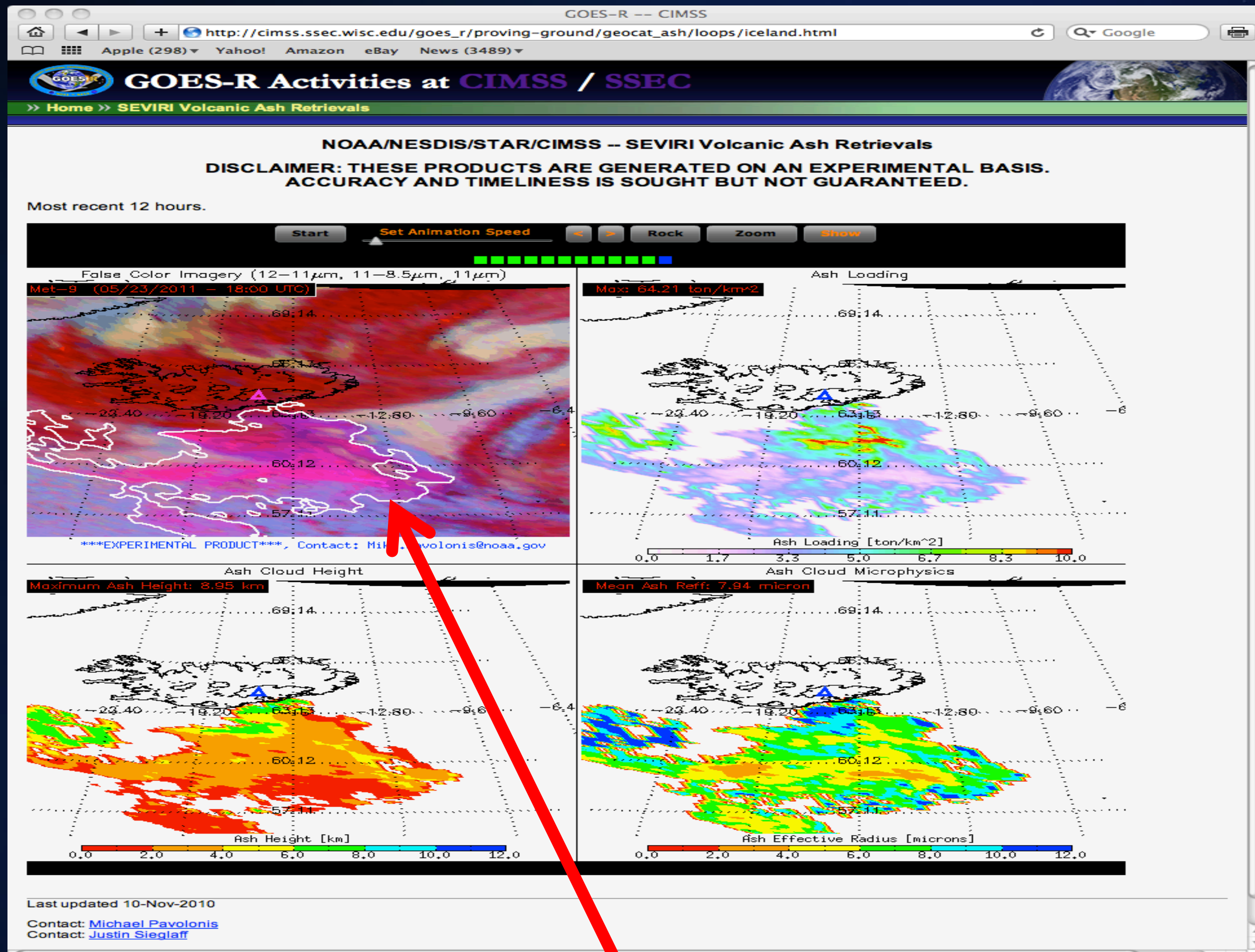
Mike Pavolonis (NESDIS/STAR/CIMSS)

Bridging the Gap Between Imagery and Quantitative Products



Right now most views are either qualitative images OR quantitative derived products.
How best to combine the strengths of each?

Bridging the Gap Between Imagery and Quantitative Products



Grimsvotn

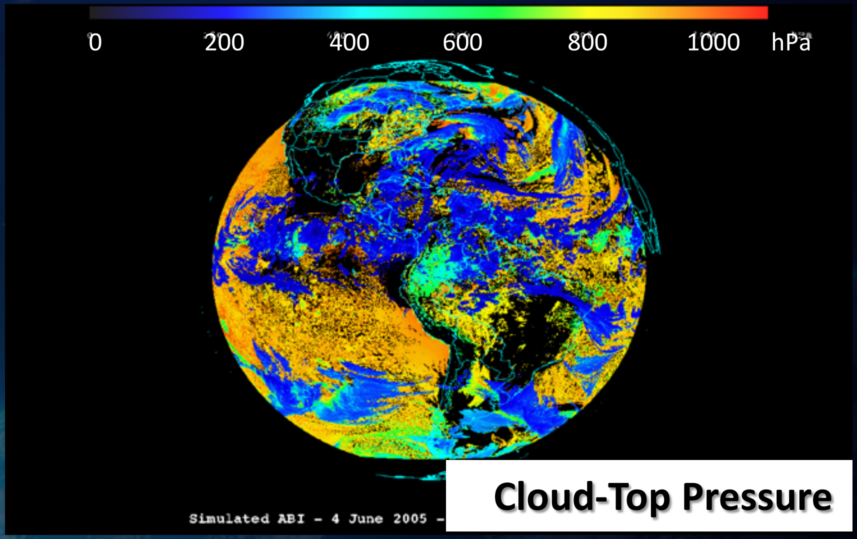
Using contours to highlight quantitative product (over RGB)

http://cimss.ssec.wisc.edu/goesr/proving-ground/geocat_ash

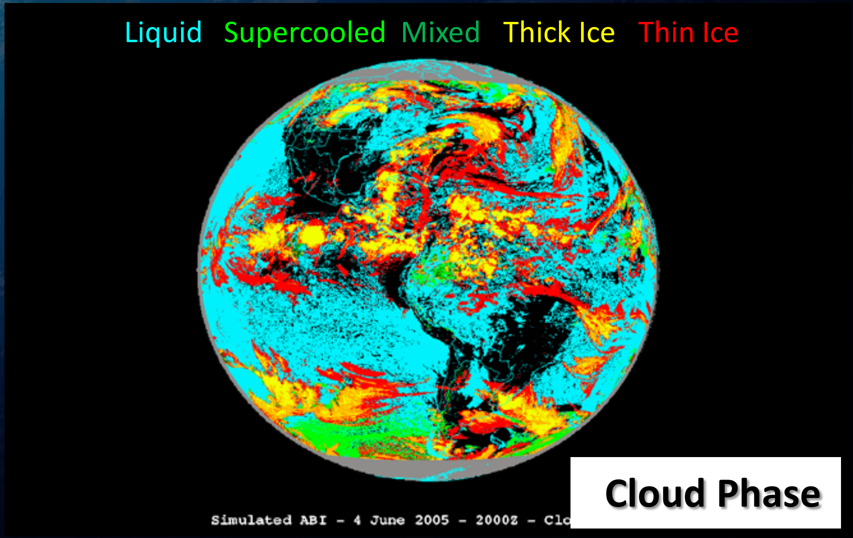
Mike Pavolonis (NESDIS/STAR/CIMSS)

Cloud Products

- **Algorithm Highlights**
  - Cloud algorithms take advantage of the ABI's spectral, spatial, and temporal resolution; and good radiometrics
  - ABI 7.3, 8.5, 11, 12 and 13.3μm channels are used to estimate cloud–top temperature, cloud emissivity, and cloud microphysical properties
  - Cloud-top height algorithm uses an ***optimal estimation approach*** that provides retrieval error estimates; provides multi-layer solutions
  - Cloud pressure and height are computed using NWP forecast temperature profiles.
- **Operational Applications**
  - Aviation Terminal Aerodrome Forecasts (TAFs)
  - Support for the Issuance of Collaborative Aviation Weather Statements (CAWS)
  - Severe storm nowcasting
  - Supplements Automated Surface Observing System (ASOS) with upper-level cloud information
  - Cloud initialization and cloud verification in NWP
  - Climate prediction
  - Height assignment of Derived Motion Winds



Cloud-Top Pressure



Cloud Phase

Andrew Heidinger (NESDIS/STAR/CIMSS)
Mike Pavolonis (NESDIS/STAR/CIMSS)

Cloud Products

- **Algorithm Highlights**
  - Cloud algorithms take advantage of the ABI's spectral, spatial, and temporal resolution; and good radiometrics
  - ABI 7.3, 8.5, 11, 12 and 13.3µm channels are used to estimate cloud–top temperature, cloud emissivity, and cloud microphysical properties.
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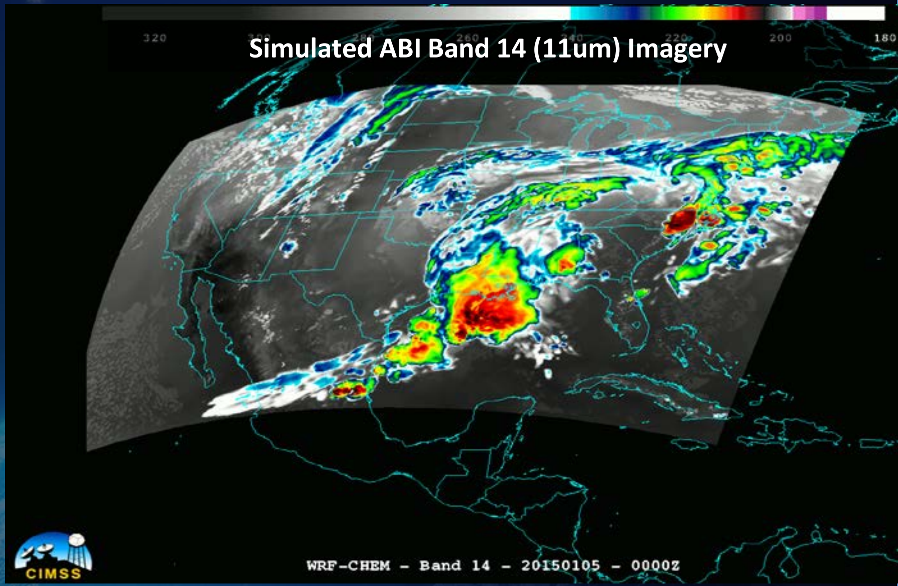
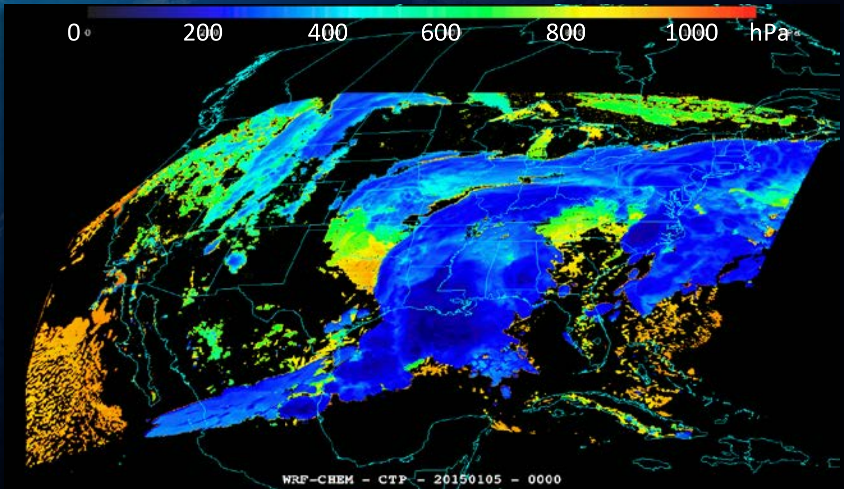
  - Support for the Issuance of Collaborative Aviation Weather Statements (CAWS)
  - Severe storm nowcasting
  - Supplements Automated Surface Observing System (ASOS) with upper-level cloud information
  - Cloud initialization and cloud verification in NWP
  - Climate analysis and prediction
  - Height assignment of Derived Motion Winds



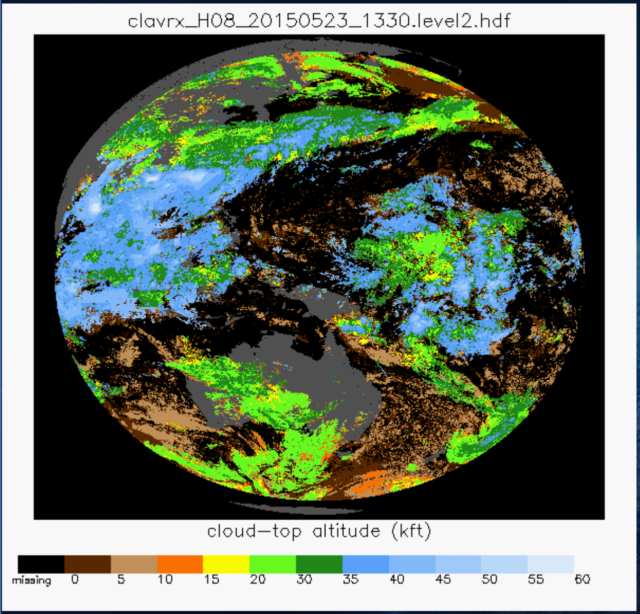


Andrew Heidinger (NESDIS/STAR/CIMSS)
Mike Pavolonis (NESDIS/STAR/CIMSS)

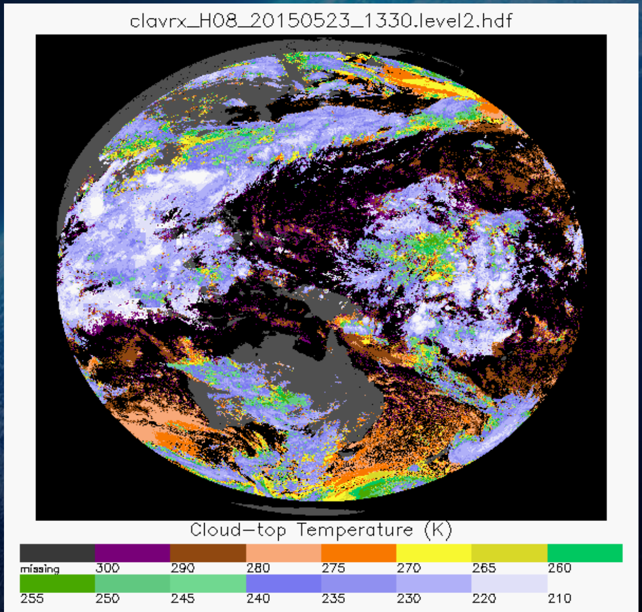
Cloud Products Going into NOAA's Aviation Weather Center (AWC) Today

- AWG cloud team has been serving Geo cloud products to the AWC since 2014.
- Sensors include GOES-13, GOES-15, MSG-10, COMS and MTSAT.
- Products: 3 hourly Global Geo Composites and hourly NHEM composites. Satellites are GOES E/W, MSG, COMS and MTSAT; In 2015, 15 minute CONUS service added
- Product List: Cloud Pressure Altitude, Cloud Temperature and Cloud Phase. (*only a subset of level-2 cloud products*)
- Amanda Terborg says altitudes are often used, cloud phase less so and cloud temperatures are seldom used.

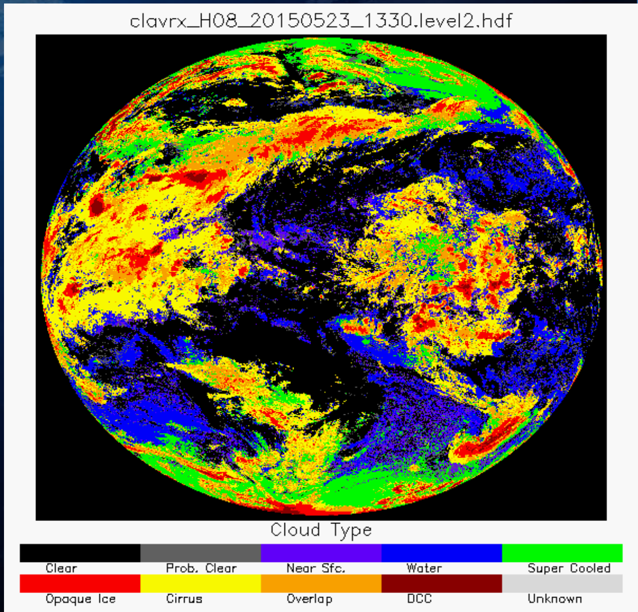
Cloud Pressure Altitude



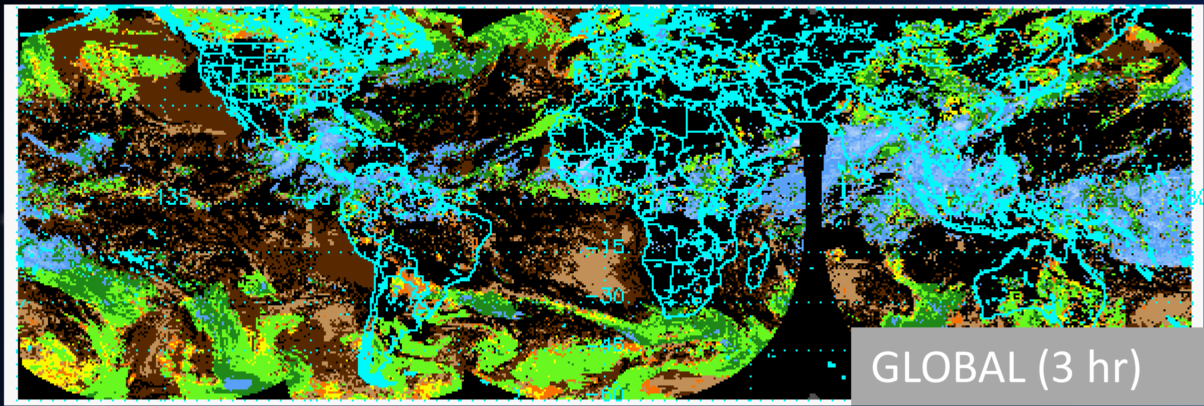
Cloud Temperature



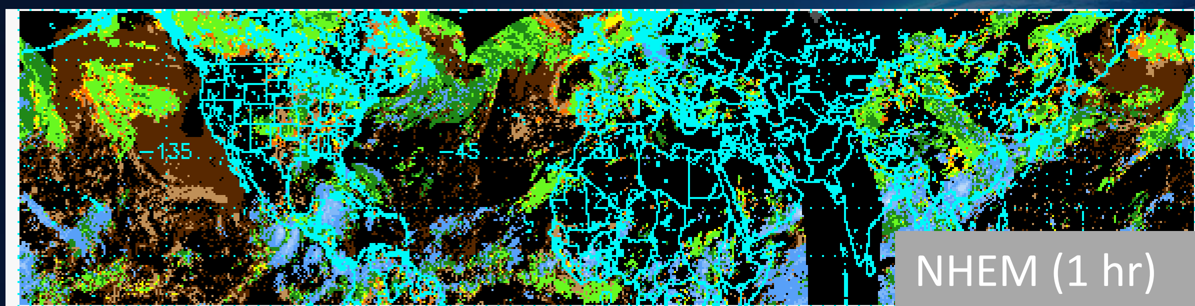
Cloud Type



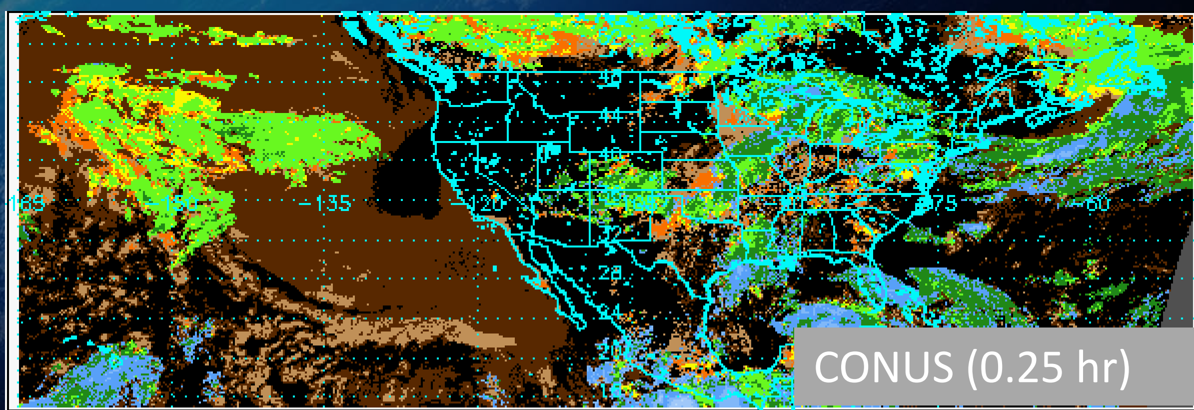
Examples of AWC Cloud Altitude Products

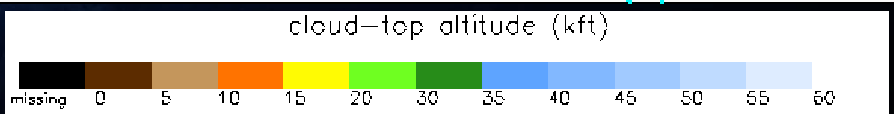


Roughly 2 days of data shown



Cloud pressure altitude is a simple extension of the baseline cloud-height product but not in the baseline.





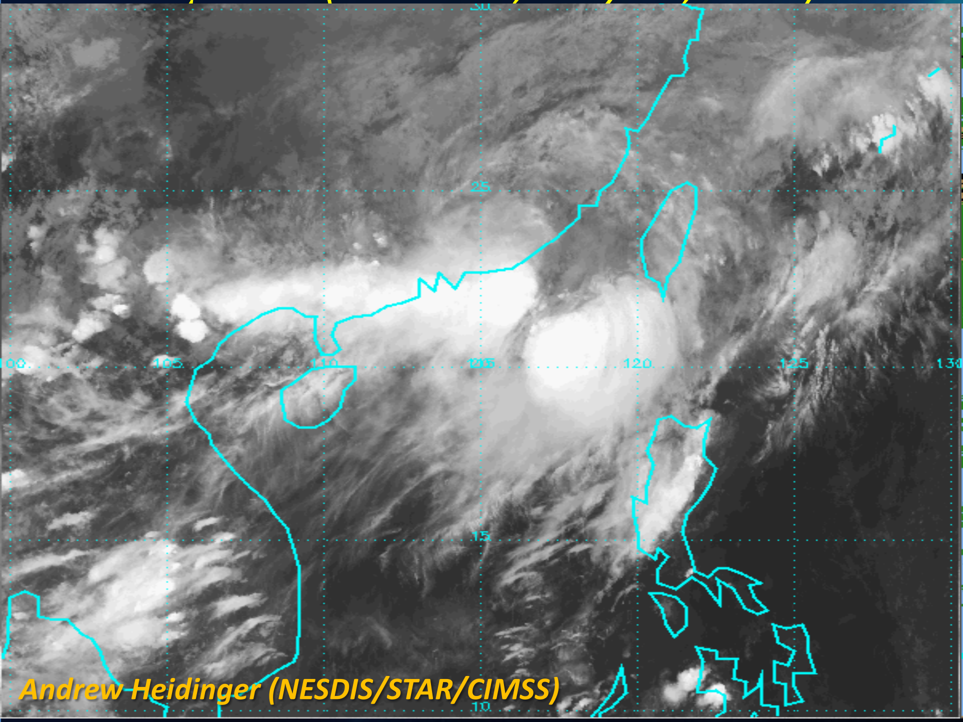
Cloud Products Going into AWC Soon

- Replace MTSAT-2 with HIMAWARI-8/AHI
- NWS Operational Advisory Team (NOAT) asked the cloud team to:
  - Align our pressure levels for H/M/L cloud to match that used in National Digital Forecast Database (NDFD). H < 350 hPa, L > 642 hPa.
  - Make 2 km imagery of the column cloud fraction in these layers.
- AWC feedback included a request for a product to identify convective clouds.
- We are making these products now and will work with AWC to optimize their performance and visualization.
- Examples of these new products come from HIMAWARI-8 observations on May 23, 2015 during Singapore Airlines Flight SQ836 which experienced a loss of engine power due to extreme exposure to ice crystal icing.

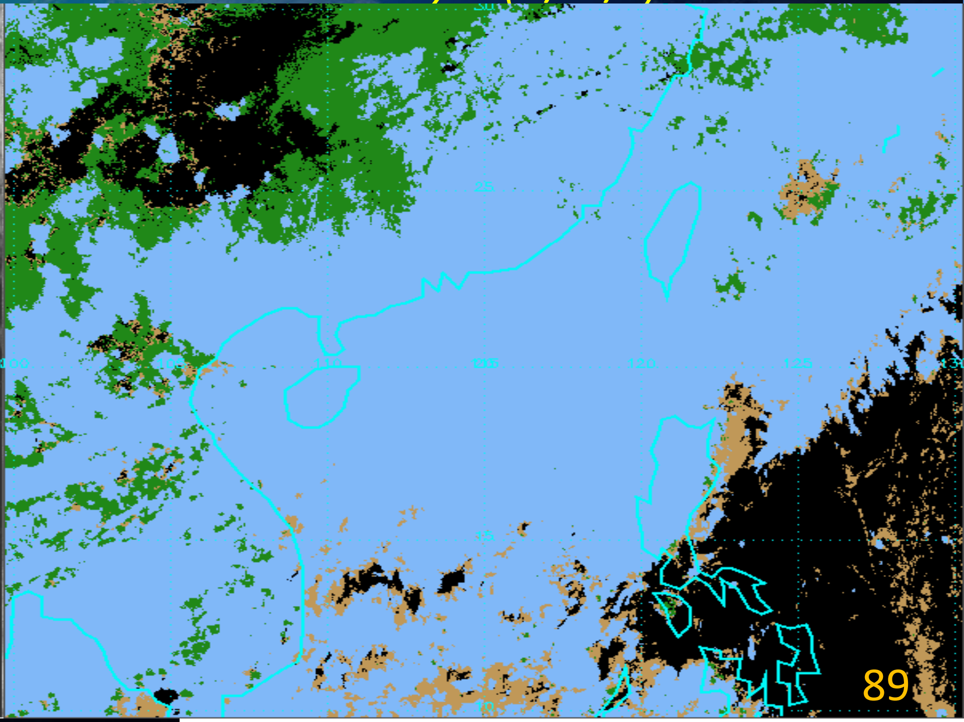
Cloud Layer

- We were requested to make 2km imagery of cloud fraction in H/M/L layers,
  where: H < 350 hPa, 350 hPa < M < 642 hPa; L > 642 hPA.
- Original CCL was 10 km in resolution and used different levels.
- Image below shows an example that we can make now. Image uses color scheme similar to NAWIPS altitude scheme.
- At 2km, most fractions are 0 or 1.0. We compute fraction as mean over 3x3 array.
- Plan is to implement this into the GOES-R core ground system.

11 μm BT (11 – 13 Z, May 23, 2015)



Cloud Layer (H/M/L)

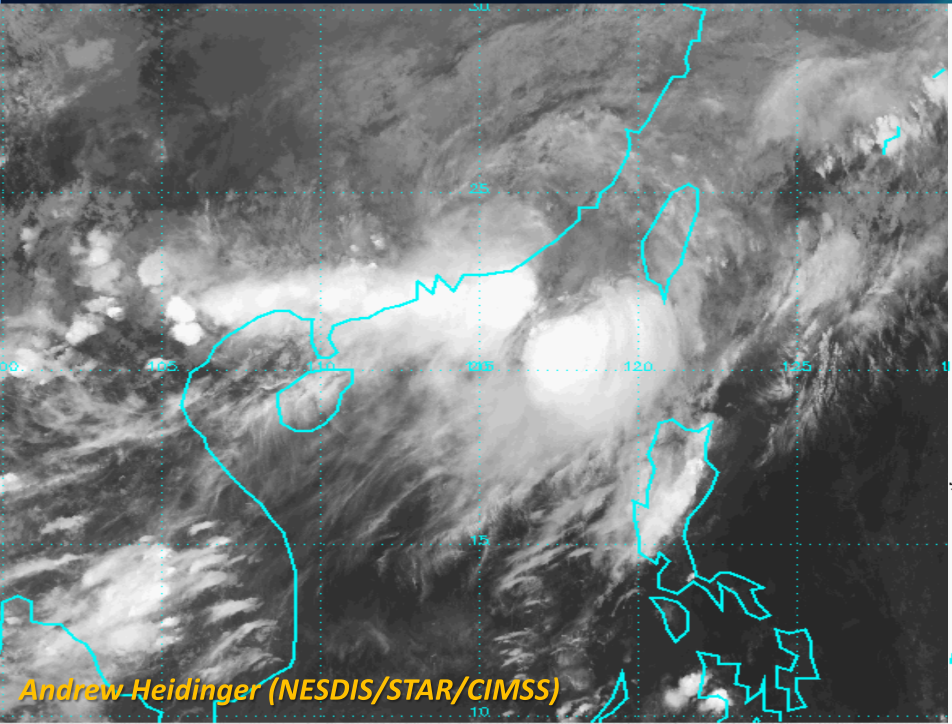


Andrew Heidinger (NESDIS/STAR/CIMSS)

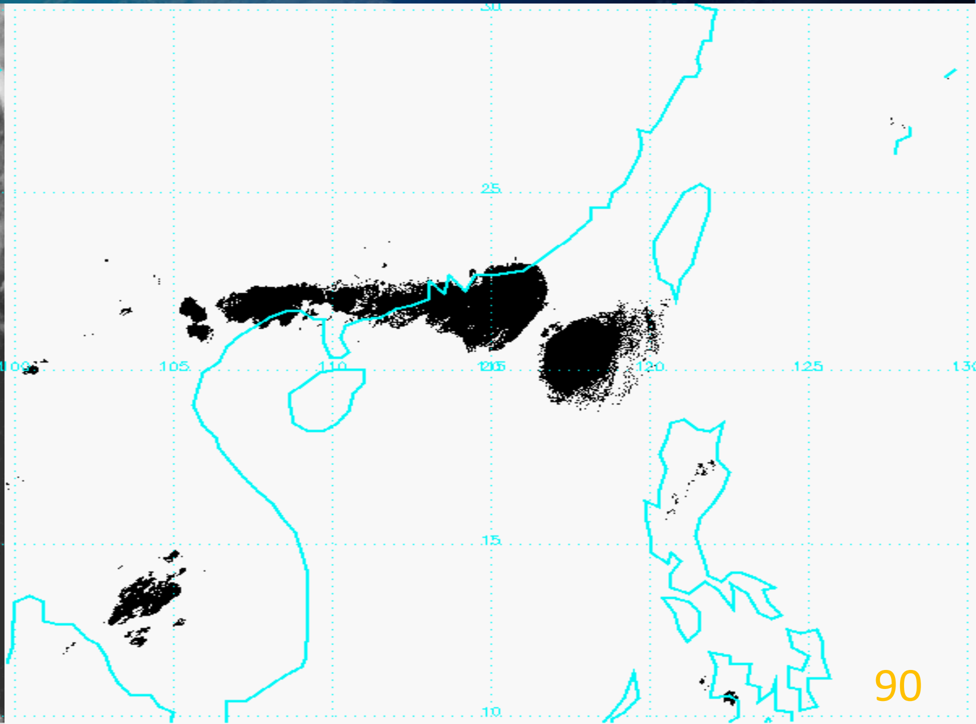
Deep Convective Cloud Mask

- The Aviation Weather Center (AWC) requested that we add a deep convective mask.
- Our goal is to identify convection that reaches Tropopause.
- Geo imagers provide two ways to accomplish this:
  - Clouds with temperatures close to the NWP Tropopause temperature
  - Clouds with BT 6.7 μm > BT 11 μm
- Potentially available now to AWC and we will optimize it based on PG feedback.
- Considering adding detection of “growing” and “dying” convection at least for CONUS.

11 μm BT (11 – 13 Z, May 23, 2015)



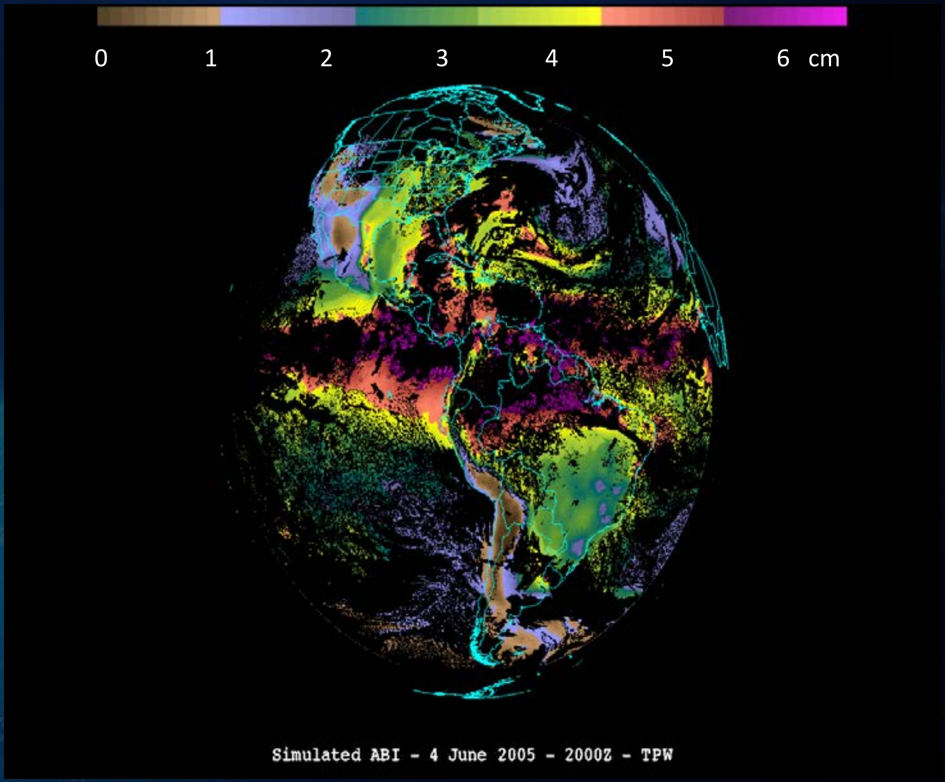
Deep Convective Mask



Andrew Heidinger (NESDIS/STAR/CIMSS)

Total Precipitable Water (TPW)

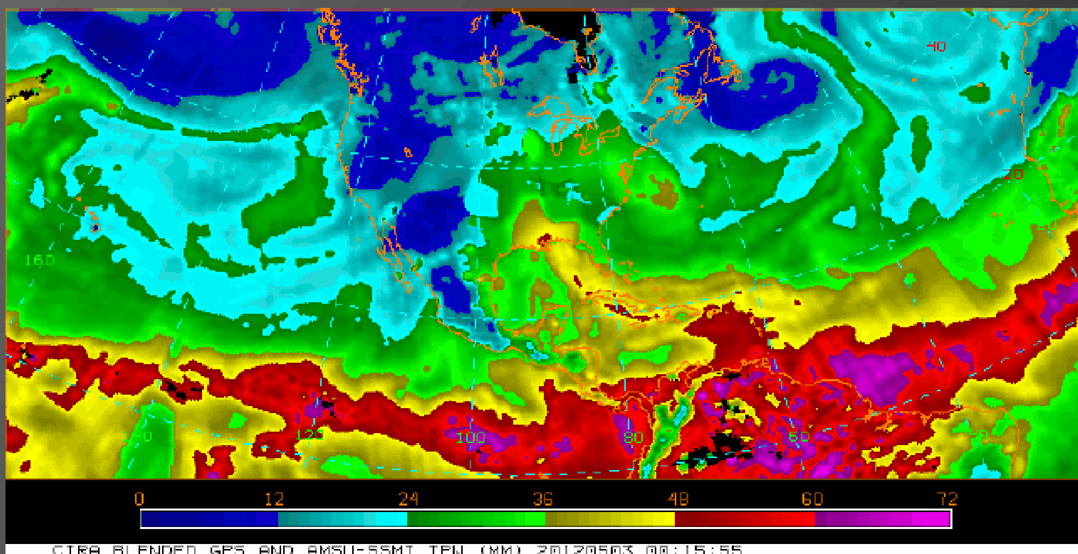
- **Algorithm Highlights**
  - 1D-variational physical retrieval algorithm that has heritage with MODIS and current operational GOES sounder physical retrieval algorithms
  - Regression-based initial guess T/Q profiles
  - Utilizes the 6.15, 7.0, 7.4, 8.5, 9.7, 10.35, 11.2, 12.3, and 13.3 μm bands)
  - Exploits recent improvements in fast clear-sky radiative transfer models
- **Operational Nowcasting Applications**
  - Situational awareness for potential watch/warning scenarios for heavy rain and flash flooding
  - “Atmospheric Rivers” originating from the Pacific Ocean, Gulf of Mexico return flow, Southwest US monsoon
  - Future contributor to NESDIS’ Blended TPW product



NESDIS Operational Blended TPW Product

An Operational Example: Blended TPW

Multisensor (GPS, AMSU-SSMI) product well used by forecasters because it dealt with a significant issue: moisture distribution

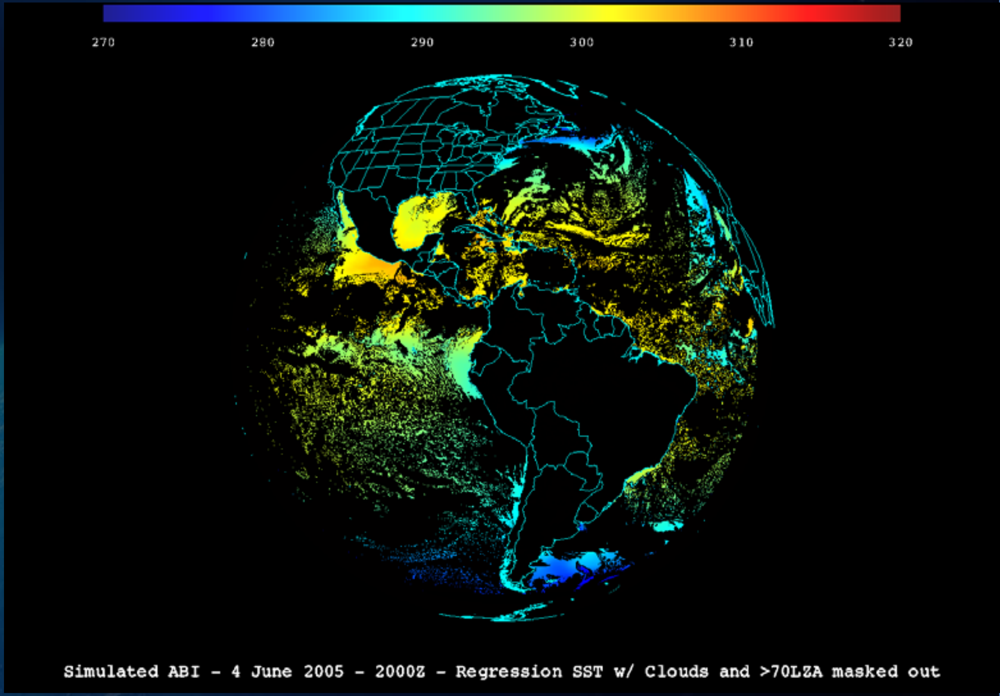


Why we need this?

Atmospheric Rivers
Heavy rain/snow
Flood/Blizzard
Drought
Convective Storms

Sea Surface Temperature

- **Algorithm Highlights**
  - Hybrid approach that combines the advantages of regression (heritage approach) with a physical retrieval approach (optimal estimation)
  - Utilizes the 3.9, 8.5, 10.35, 11.2, 12.3μm bands
  - Exploits recent improvements in fast clear-sky radiative transfer models
  - Leverages increased ABI spectral, spatial, and temporal resolution
- **Operational Applications**
  - Assimilation into atmospheric,oceanic models
  - Contributor to blended SST product
  - Climate monitoring/forecasting
  - NOAA' Coast Watch Program
  - Harmful Algal Bloom monitoring
  - Sea turtle tracking
  - Upwelling identification
  - Commercial fisheries management
  - NOAA's Coral Reef Watch Program
  - Coral bleach warnings and assessments



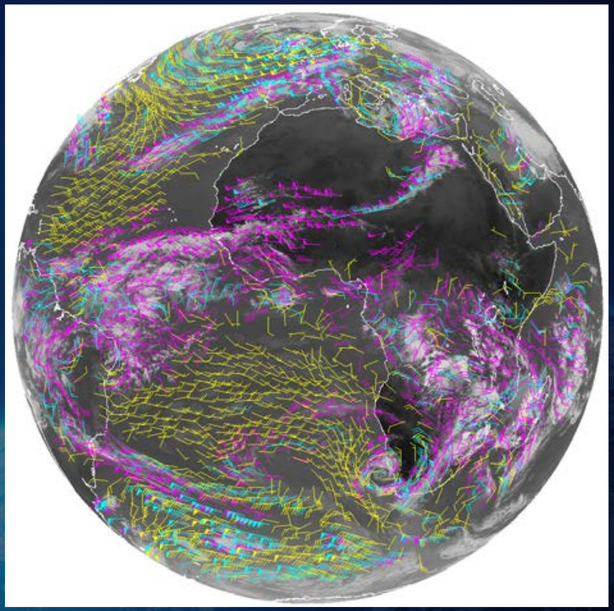
Alexander Ignatov (NESDIS/STAR)

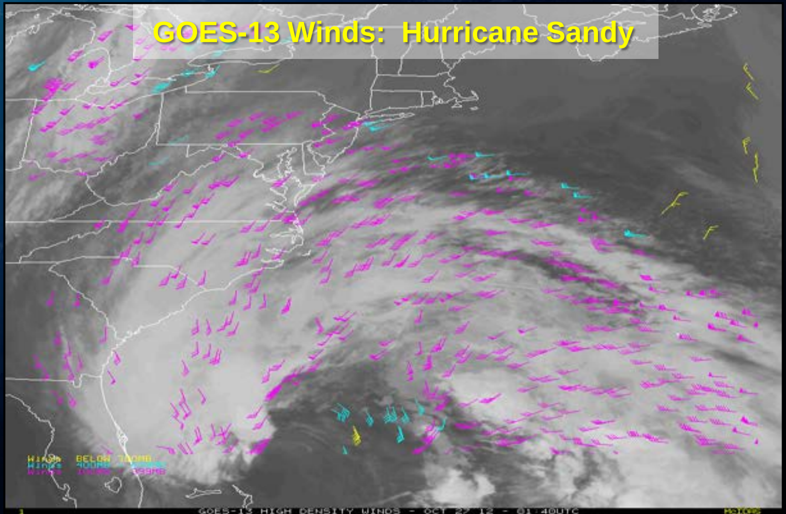
Derived Motion Winds

- **Algorithm Highlights**
  - New nested tracking algorithm improves feature tracking; reduction of speed bias
  - Wind height assignment relies on utilization of pixel level cloud heights generated upstream
  - Leverages ABI's higher spatial and temporal resolution data; image navigation and registration

- **Operational Applications**
  - Field Forecasters (NWS WFOs and National Centers)
    - Situational awareness of the atmospheric wind field
    - Verification of model guidance
    - Atmospheric monitoring
  - Numerical Weather Prediction Centers
    - Satellite winds used to support the initialization of the atmospheric wind field in global and regional models

LWIR (10.8um)





High-Level 100-400 mb Mid-Level 400-700 mb Low Level > 700 mb

Jaime Daniels (NESDIS/STAR/CIMSS)

Use of Water Vapor Imagery and GOES Winds at NHC

Tropical Storm Cristobal 25 Aug 2014 13 UTC

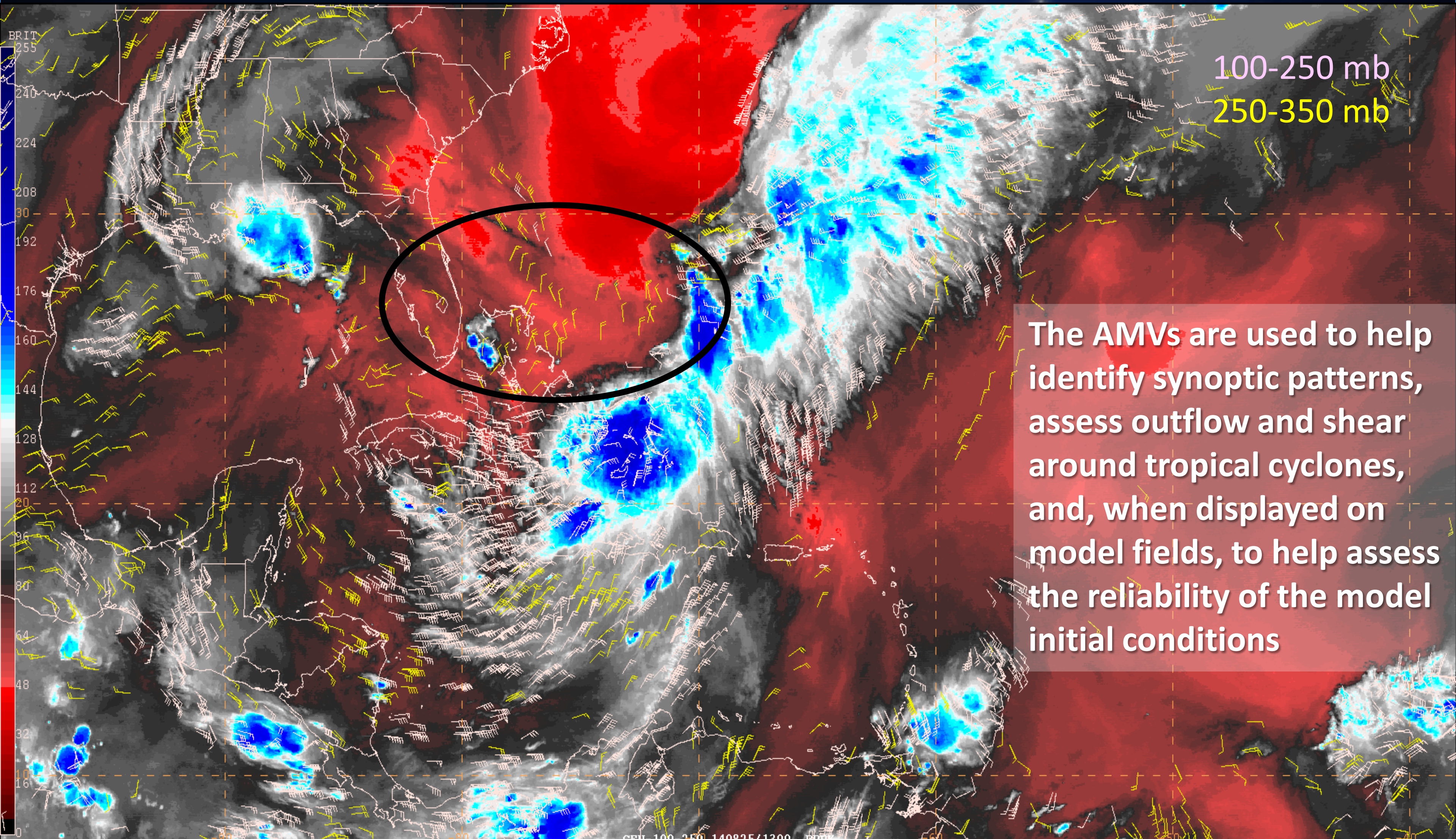


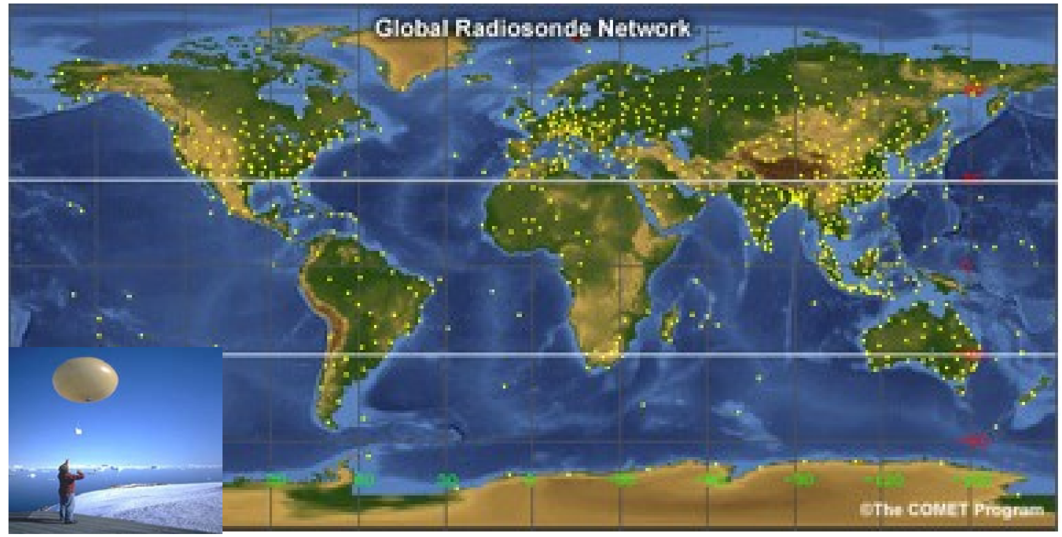
Figure courtesy of Mark DeMaria (NWS/NHC)

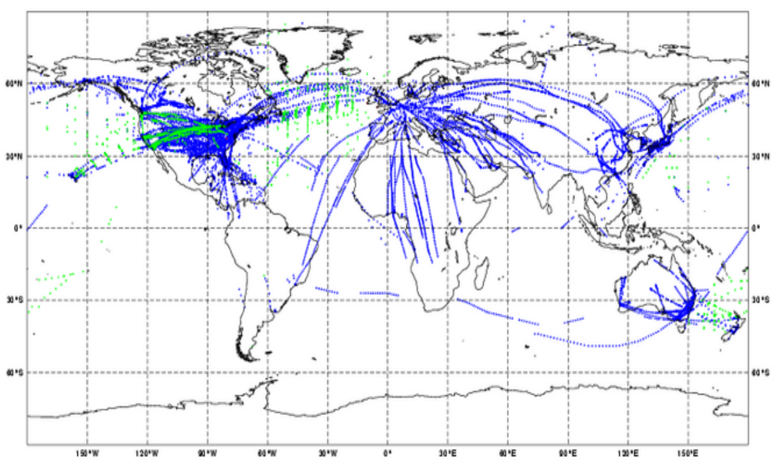
Importance of Satellite Wind Observations

Satellite Derived Winds are a Key Component of the Global Observing System (GOS)

- Provide vital tropospheric wind information over expansive regions of the earth that are devoid of in-situ wind observations that include oceans, polar regions, and Southern Hemisphere land masses.
- Provide key wind observations to operational NWP data assimilation systems where their use has been demonstrated to improved numerical weather prediction forecasts including tropical cyclones
- Provide key wind observations to NWS field forecasters at NWS WFOs and National Centers
    - Situational awareness of wind field
    - Verification of model output

Global Radiosonde Network





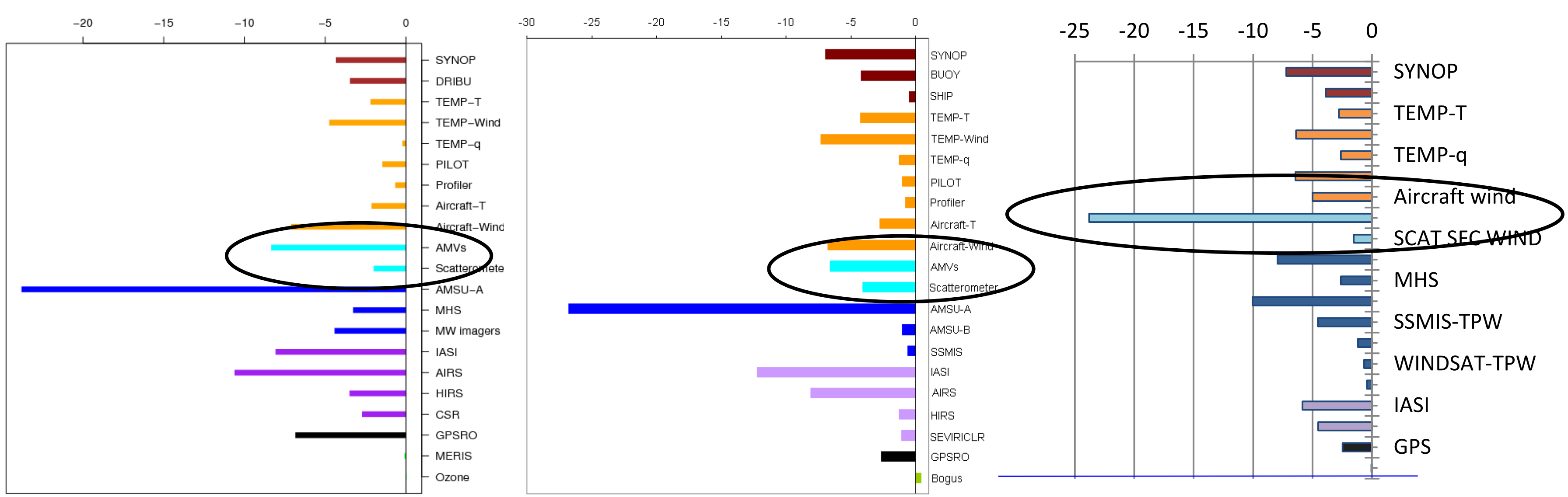
Aircraft Winds

Coordinated Study of AMV Impact

Highlights from IWWG Study…

Forecast Sensitivity to Observations (FSO)

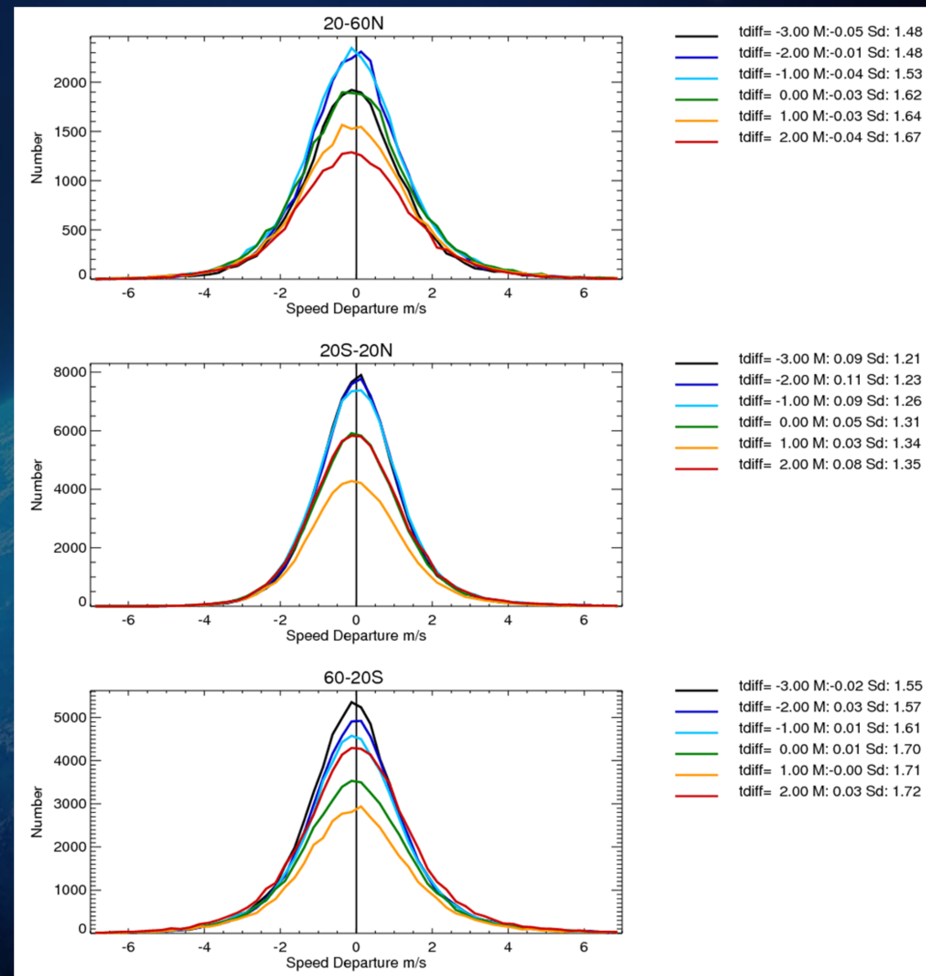
- Adjoint-based FSO method gives estimate of the contribution of each observation towards reducing the 24-hour forecast error
- Satellite winds reduce 24 hour forecast error on the order of 7-11% *(NRL was exception)*
- Places satellite winds among the top global observing system observations that contribute in a positive way to NWP global forecast impact



ECMWF Met Office NRL

Preparing NWS/NCEP for GOES-R AMVs

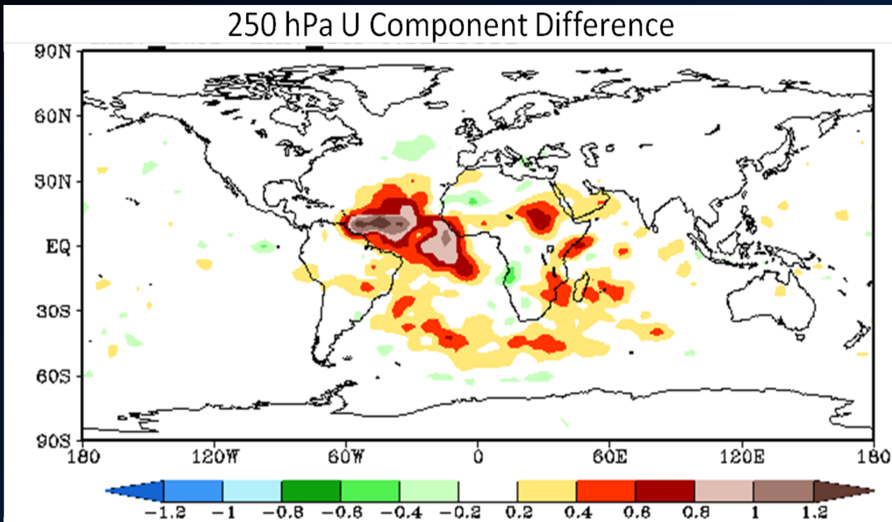
- Used Meteosat/SEVIRI as a proxy for GOES-R
- Ingest AMV BUFR data
- Assess and develop QC procedures in the NCEP/GSI
- Tune AMV observation errors
- Assess innovations (AMV obs – background)
- Run assimilation experiments to assess hourly AMV datasets

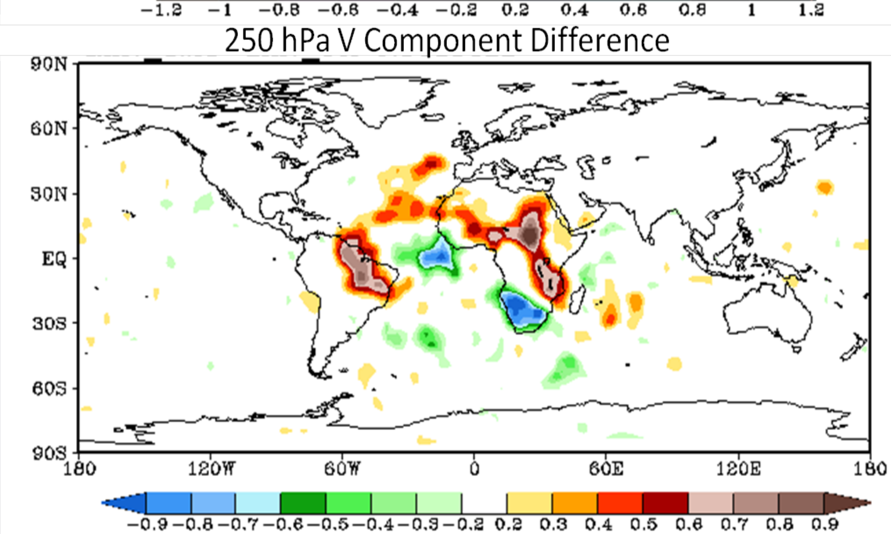


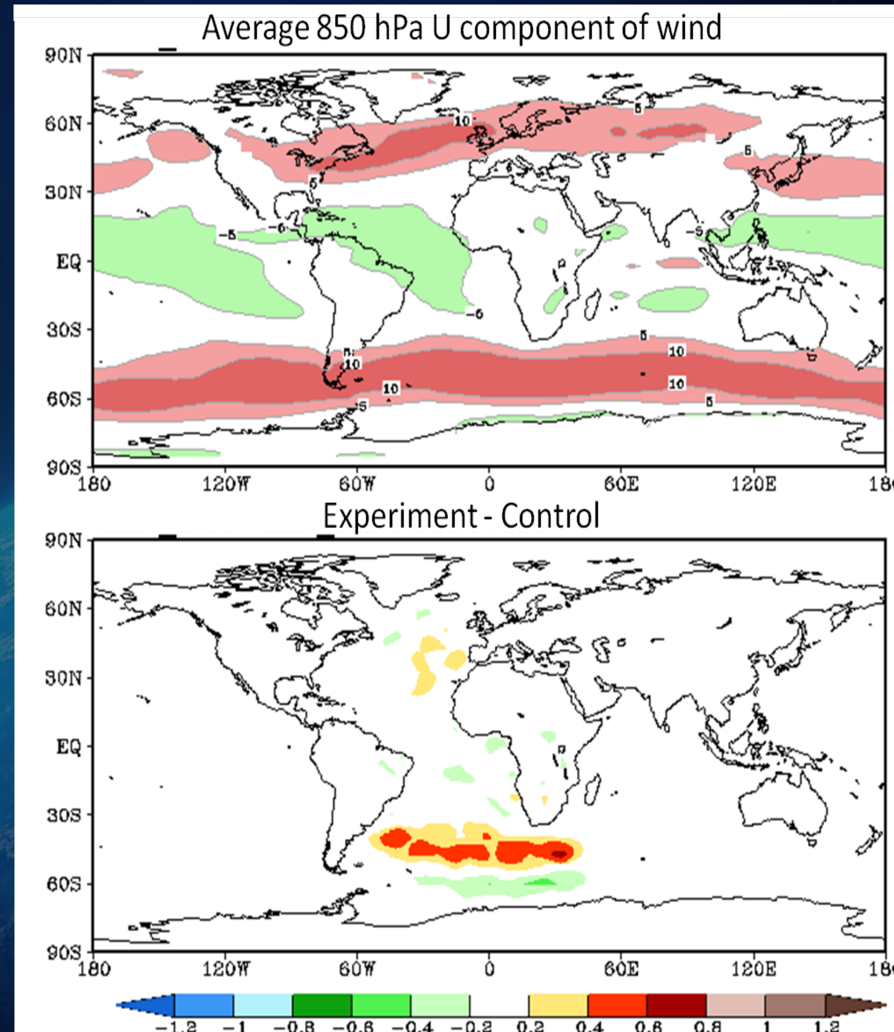
Preparing NWS/NCEP for GOES-R AMVs

Seasonal Experiment minus Control Differences

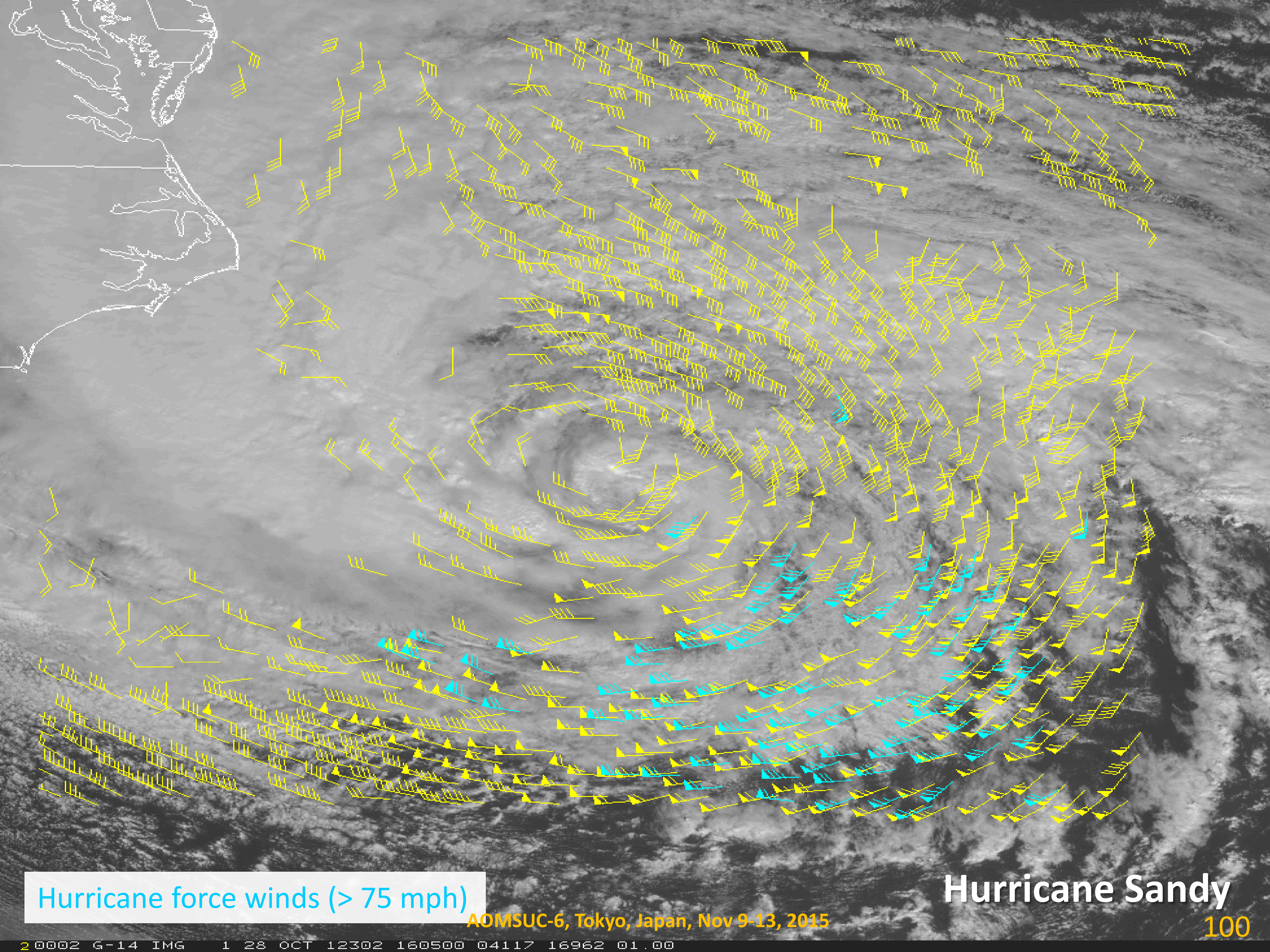
Control - No SEVIRI Winds
Experiment – With SEVIRI Winds







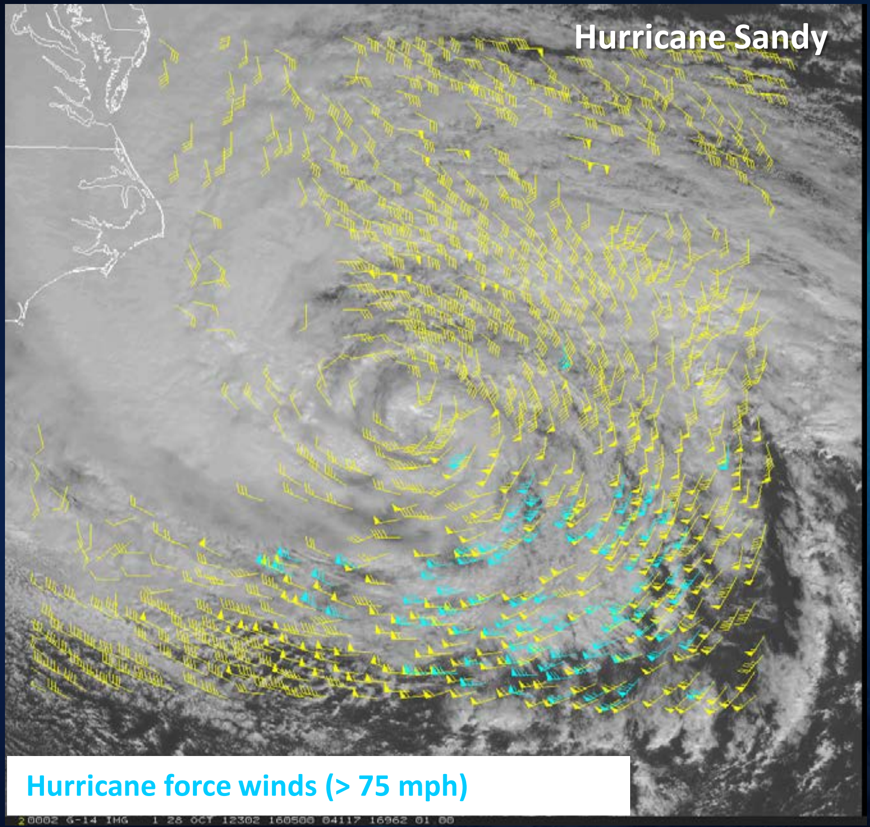
Assimilating the GOES-R like AMVs produced several interesting impacts on the model analysis/initialization wind fields.

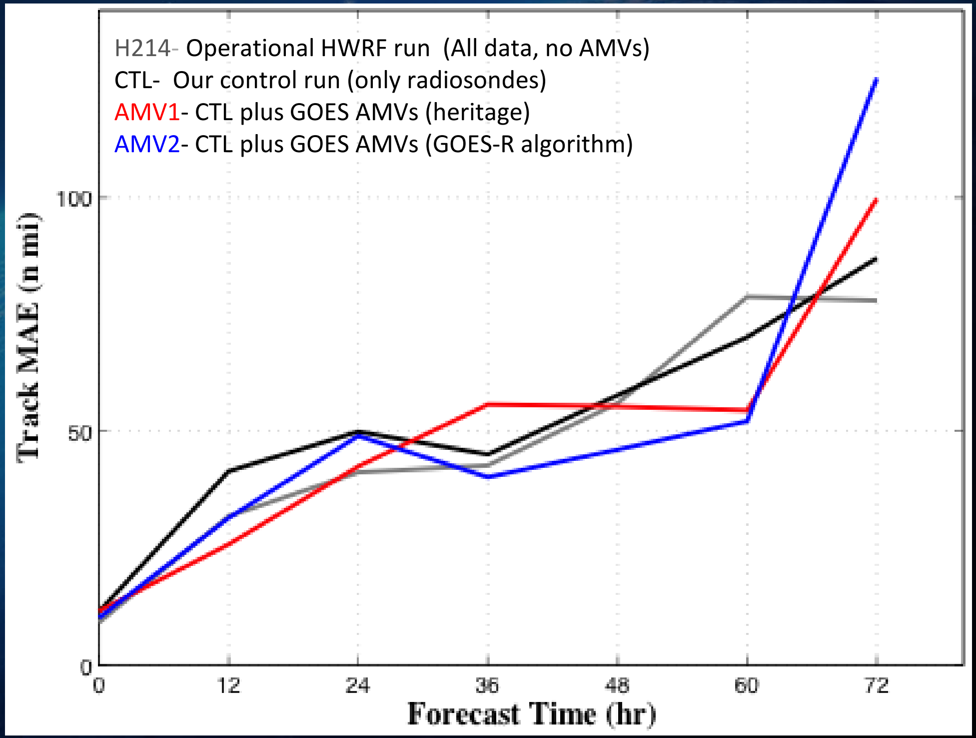

Hurricane force winds (> 75 mph)
Hurricane Sandy
2 00002 G-14 IMG 1 28 OCT 12302 160500 04117 16962 01.00

High Resolution Atmospheric Motion Vectors (AMVs) for Application in High Impact Weather Events in the GOES-R era

Christopher Velden, Jaime Daniels, Wayne Bresky, Steve Wanzong, and David Stettner

Development and optimization of mesoscale Atmospheric Motion Vectors (AMVs) using novel GOES-R processing algorithms on GOES-14 SRSO imagery and demonstrating the impact of assimilating these AMVs in the NCEP HWRF/GSI System





Hurricane Sandy 1-minute mesoscale AMVs (left), and results of Sandy assimilation experiments (above)

101

GOES-R 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

Geostationary Lightning Mapper (GLM)

- Lightning Detection: Events, Groups & Flashes

Space Environment In-Situ Suite (SEISS)

- Energetic Heavy Ions
- Magnetospheric Electrons & Protons: Low Energy
- Magnetospheric Electrons: Med & High Energy
- High Energy

- Geomagnetic Field

Extreme Ultraviolet and X-ray Irradiance Suite (EXIS)

- Solar Flux: EUV
- Solar Flux: X-ray Irradiance

Solar Ultraviolet Imager (SUVI)

- Solar EUV Imagery

NOAT Recommended High priority GOES-R products for the NOAA's NWS

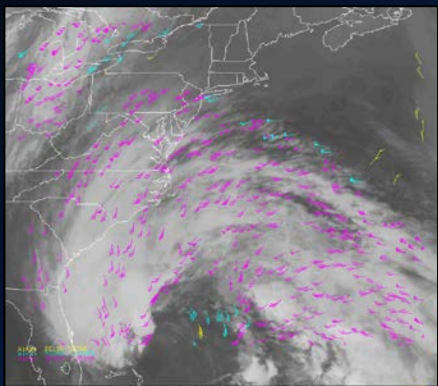
Future Capabilities

Advanced Baseline Imager (ABI)

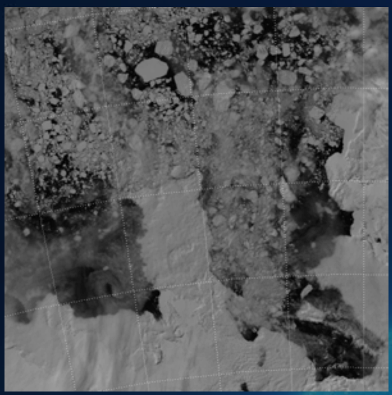
- Absorbed Shortwave Radiation: Surface
- Aerosol Particle Size
- Aircraft Icing Threat
- Cloud Ice Water Path
- Cloud Layers/Heights
- Cloud Liquid Water
- Cloud Type
- Convective Initiation
- Currents
- Currents: Offshore
- Downward Longwave Radiation: Surface
- Enhanced "V"/Overshooting Top Detection
- 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

Satellite Proving Ground

Supporting demonstration and utilization of new capabilities by the end users
Facilitating the transition of GOES-R and JPSS to operations
Incorporating user feedback for product improvements

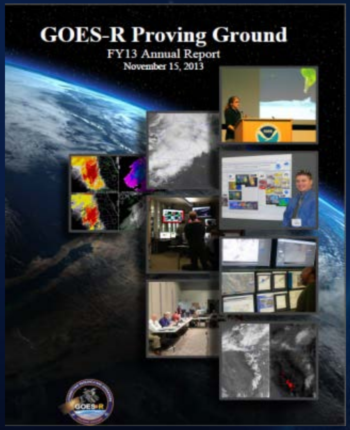


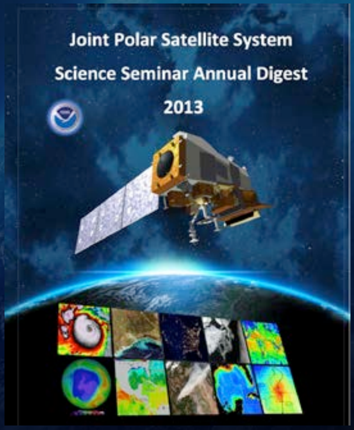
Hurricane Sandy-
GOES High Density
Atmospheric Motion Vectors

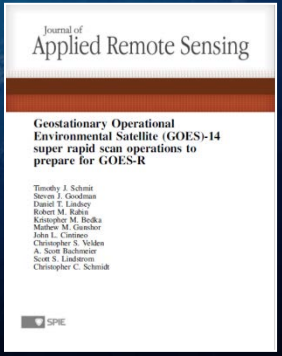


S-NPP Day/Night Band
Ice Detection

NOAA Hazardous Weather Testbed (HWT)



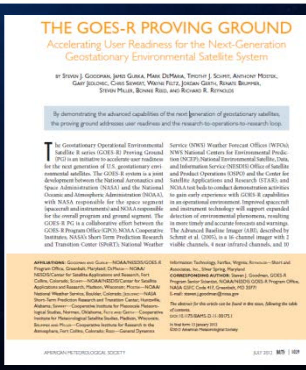




Journal of Applied Remote Sensing

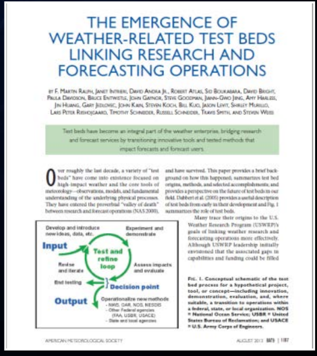
Geostationary Operational Environmental Satellite (GOES)-14 super rapid scan operations to prepare for GOES-R

Timothy J. Schmit
Steven J. Goodman
Daniel T. Lindsey
Robert M. Rabin
Kristopher M. Bedka
Mathew M. Gunshor
John L. Cintineo
Christopher S. Velden
A. Scott Bachmeier
Scott S. Lindstrom
Christopher C. Schmidt



THE GOES-R PROVING GROUND

Accelerating User Readiness for the Next-Generation Geostationary Environmental Satellite System



THE EMERGENCE OF WEATHER-RELATED TEST BEDS LINKING RESEARCH AND FORECASTING OPERATIONS

http://www.goes-r.gov/users/proving-ground.html

Aviation Weather Testbed (AWT) 2015 Summer Experiment

- A Satellite (GOES-R/JPSS) Proving Ground Demonstration Activity (Aug 10-21, 2015)

- **Focus Areas.**
  - Improvements to the Collaborative Aviation Weather Statement (CAWS)
  - Improvements to the National Cloud & Visibility grids
  - Tropical forecast graphics
  - Utilization of GOES-R/Satellite data

- **~100 Total participants**
  - >75 Participants at the NWS/Aviation Weather Center (AWC)
  - >20 participants at the Federal Aviation Administration (FAA) Tech Center

- **Multitude of collaborations**

  FAA, EMC, GSD, MDL, CWSUs, WFOs, SPC, AK & Pac. Regions,
  NCAR, MIT/LL, Air Force, UKMet, UPS, FedEx, Delta, Academia, & Others

See: http://goesrawt.blogspot.com/

Collaborative Aviation Weather Statement (CAWS)

Satellite/GOES-R

Amanda Terborg, GOES-R liaison

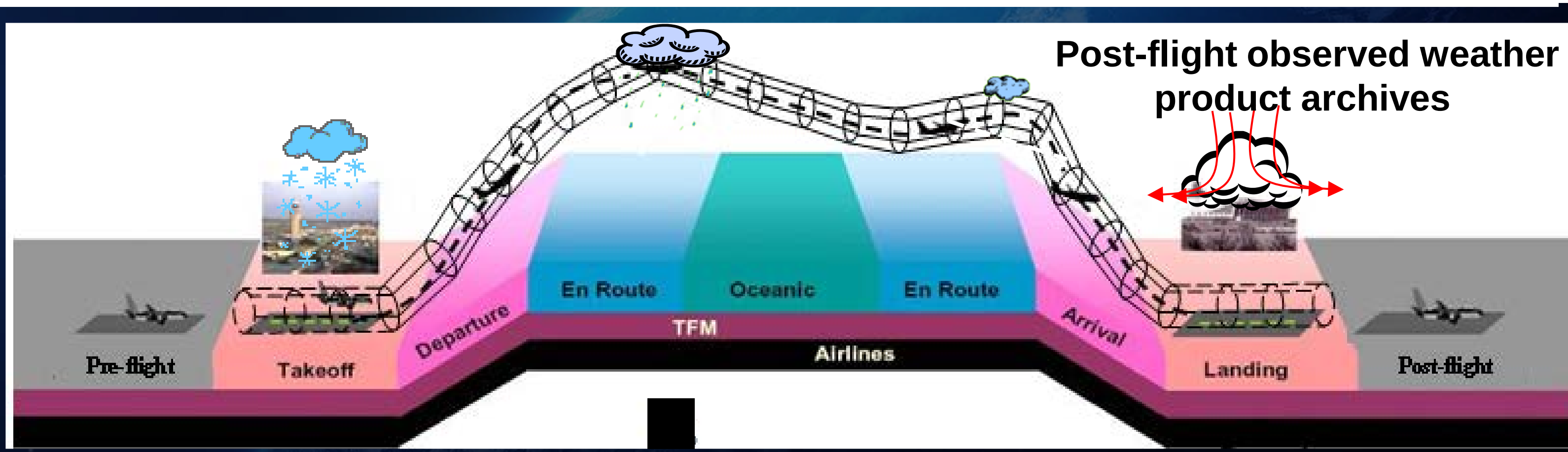
Tropical Forecast

Cloud & Visibility

WT Summer Experiment 20

GOES-R: Helps provide advanced weather Information to enable collaborative planning and efficient utilization of airspace routes through entire trajectory

Fog and Low Stratus Nowcasting Convective Initiation Cloud-Top Cooling NWP Forecasts Solar Storms	Cloud Classification Convective Initiation Cloud & Moisture Imagery Low Ceiling & Visibility Overshooting Top Precipitation Snow	Cloud Classification, Jet Stream, Volcanic Ash, Turbulence, Icing, Winds, Convective Initiation Mountain Waves Imagery Cloud Top Information SO2 Detection Radiances	Cloud Classification Lightning Convective Initiation Low Ceiling & Visibility Overshooting Top Icing Precipitation Snow



The GOES-R Proving Ground at the Aviation Weather Testbed

The National Oceanic and Atmospheric Administration Aviation Weather Center and Aviation Weather Testbed provide the GOES-R Proving Ground with a pre-operational environment in which to deploy and demonstrate algorithms associated with its next generation GOES-R geostationary satellite system.

Monday, August 10, 2015

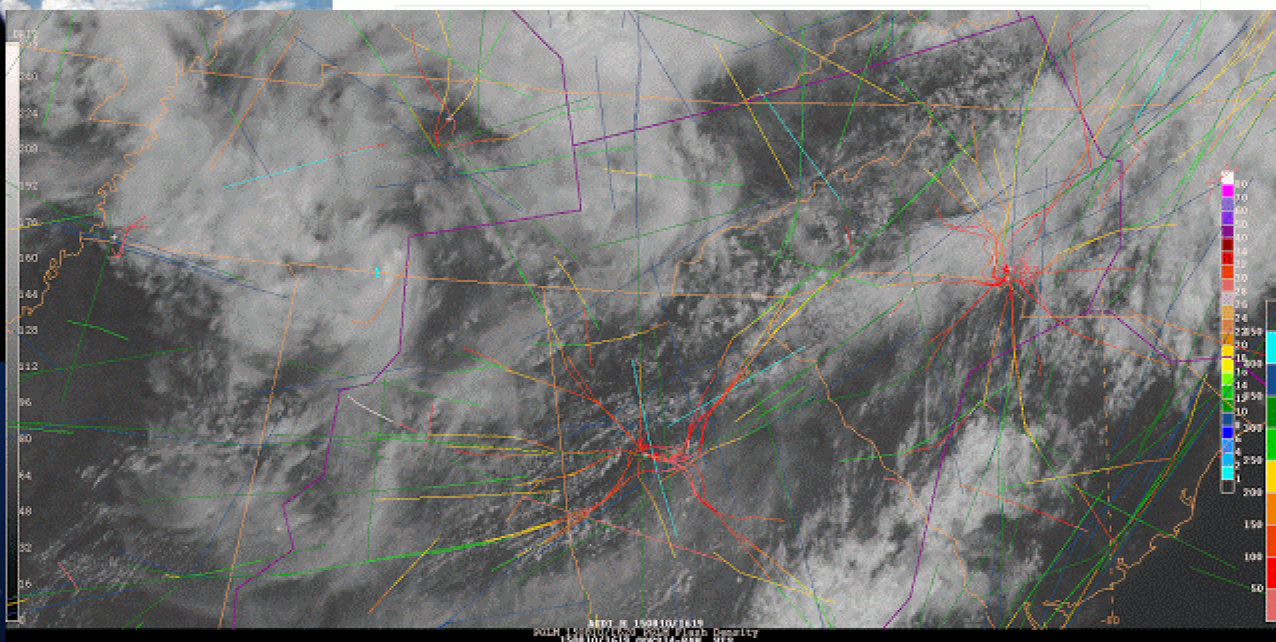
Gridded PGLM and 1-minute SRSOR imagery from GOES-14

Today marked the second of two GOES-14 SRSOR 1-minute imagery experiments in 2015. The chosen sector encompassed much of the Golden Triangle area and was in perfect position to view developing convection in that area. It was also of particular use with the gridded data from the Pseudo Geostationary Lightning Mapper (LMA networks). Previously available as an image only in the AWC's N-AWIPS systems, it is now available as a grid and can be used as an overlay.

The animation below shows GOES-14 1-minute imagery with the PGLM gridded data overlaid in the NALMA network, and also includes ASDI flight tracking in the Southeast U.S.

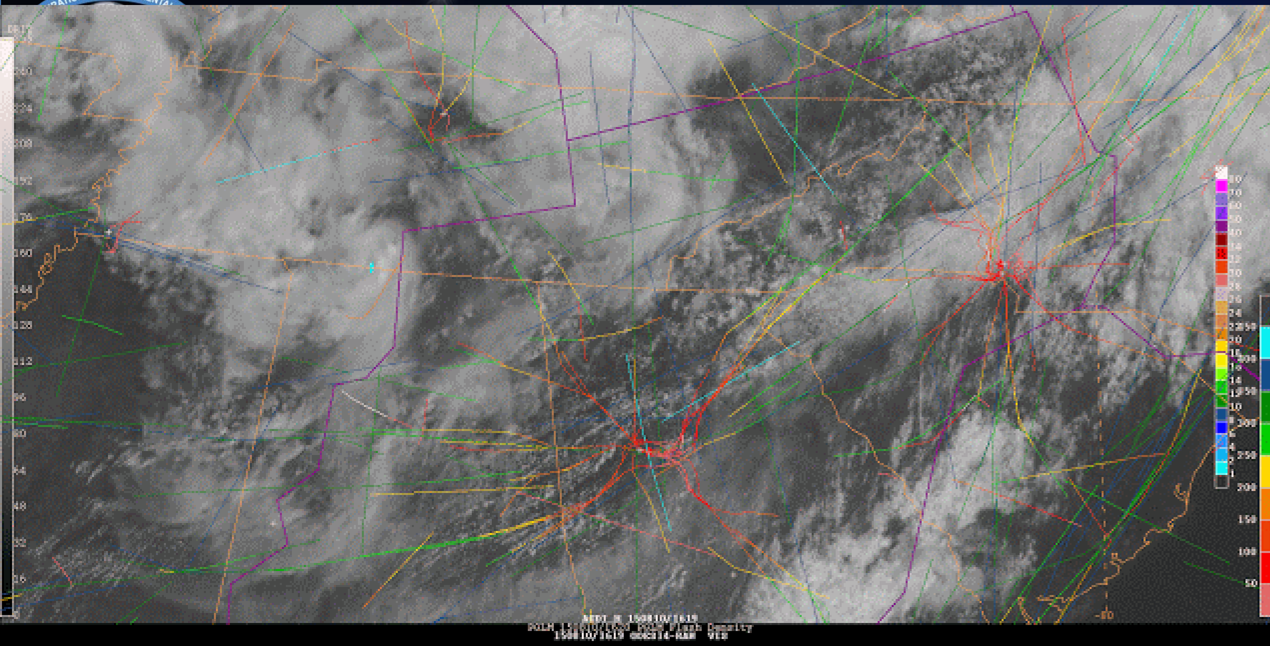
Aviation Weather Testbed Blog

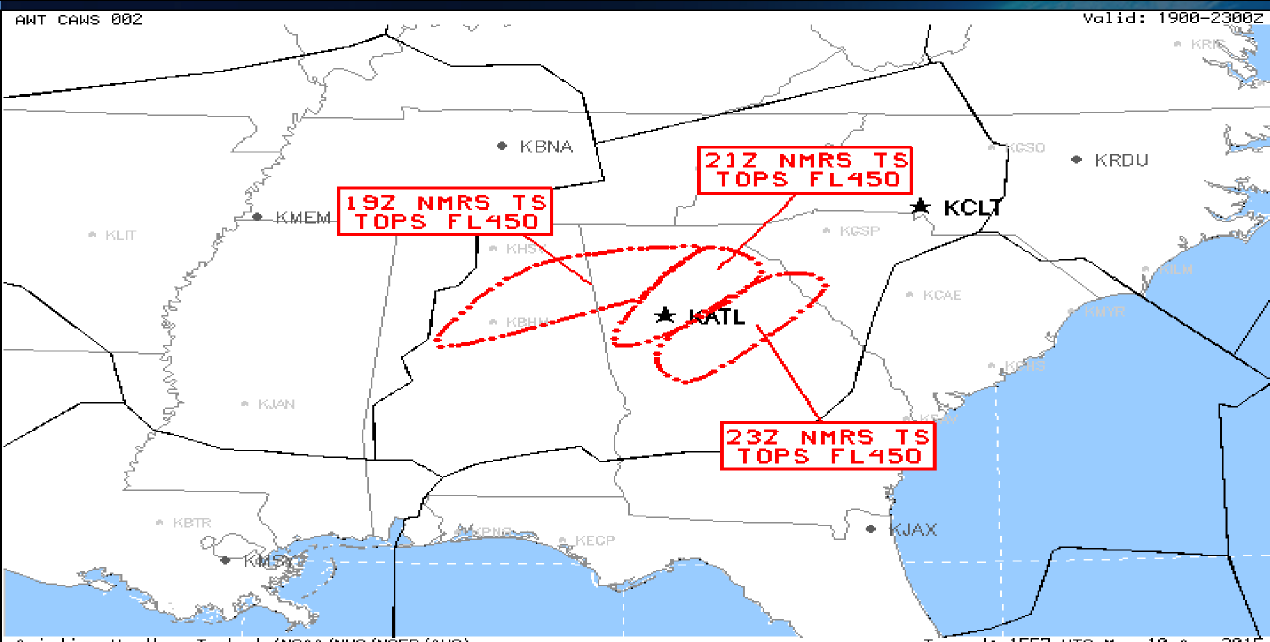
- A "Perfect"



The animation below shows GOES-14 SRSO 1-minute imagery with the PGLM gridded data overlaid in the North Alabama Lightning Mapping Array (NALMA) network, and also includes ASDI flight tracking in the Southeast U.S.

http://goesrawt.blogspot.com/2015/08/gridded-pglm-and-1-minute-srsor-imagery.html



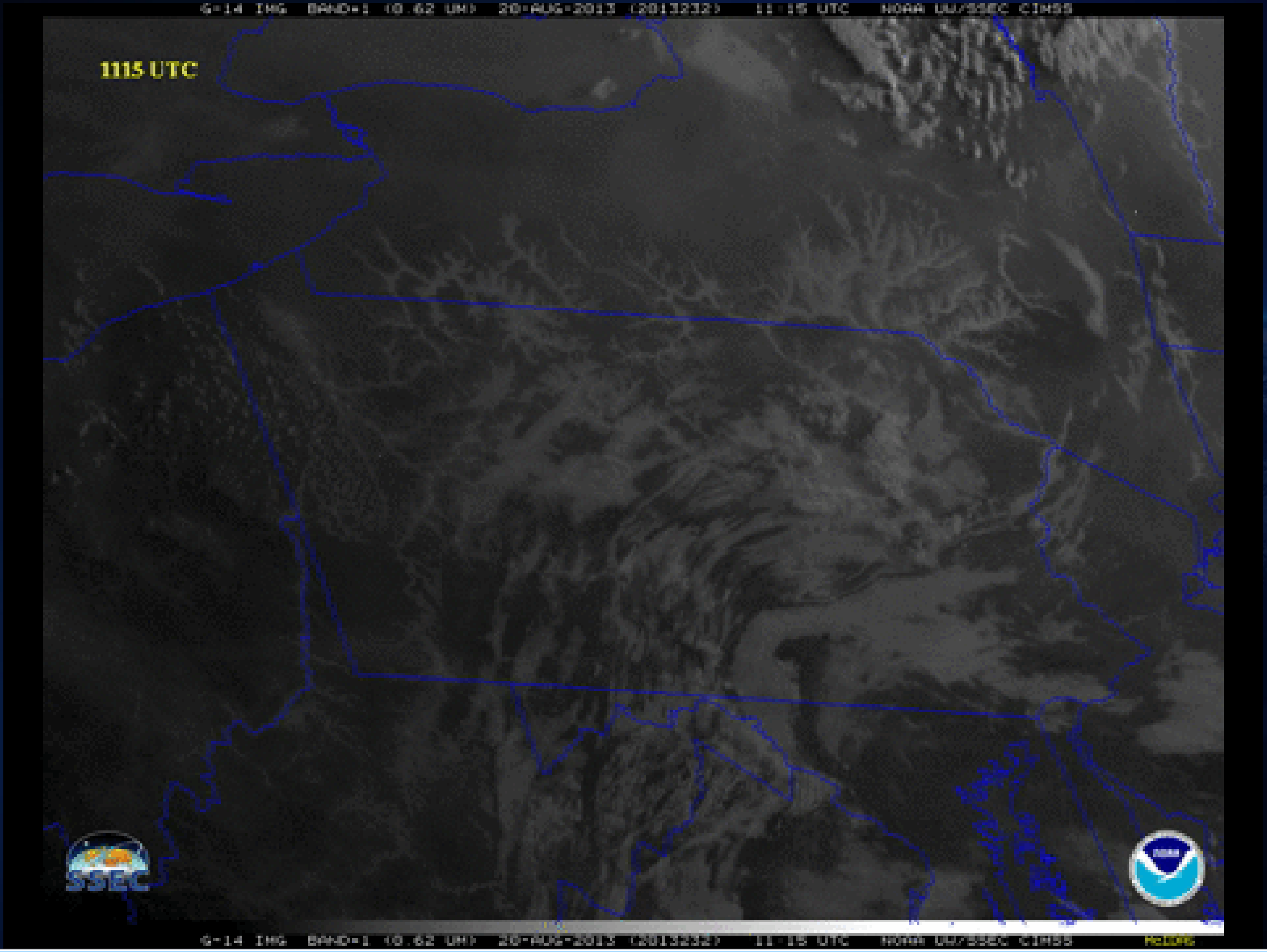


This particular area was noted this morning as being of interest for convective development near Atlanta Center. After some additional exploration of the various models and other parameters, forecasters did end up issuing an experimental **Collaborative Aviation Weather Statement (CAWS)** for this area.

CAWS is a forecasting tool that focuses on high impact thunderstorms that will affect aviation

http://goesrawt.blogspot.com/2015/08/gridded-pglm-and-1-minute-srsor-imagery.html

Fog Detection, Formation, and Dissipation

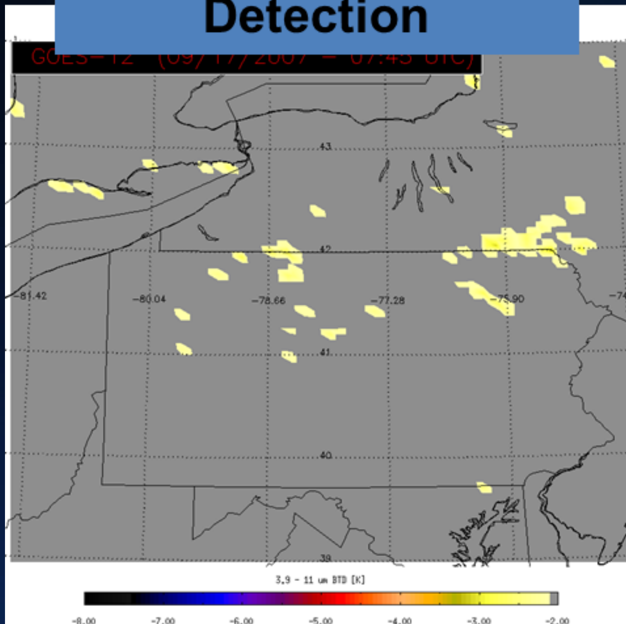


ABI's finer spectral, spatial, and temporal resolution will enable improvements in fog detection, formation, and dissipation.

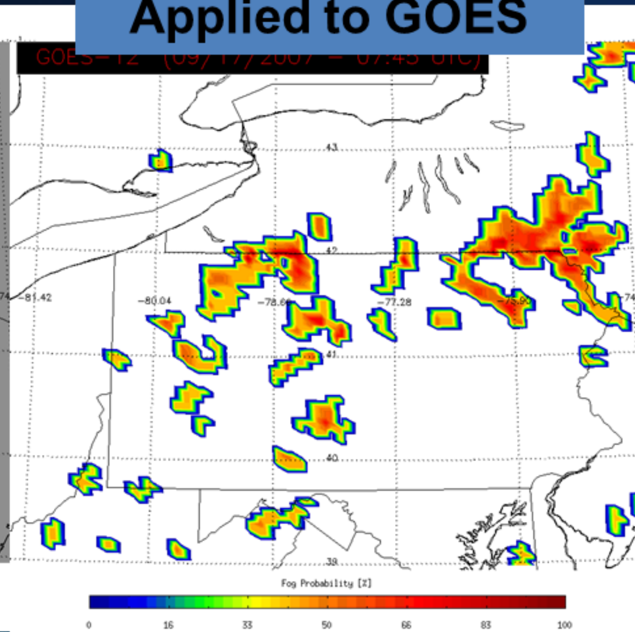
We expect immediate and positive impacts on domestic transportation systems.

Fog Detection

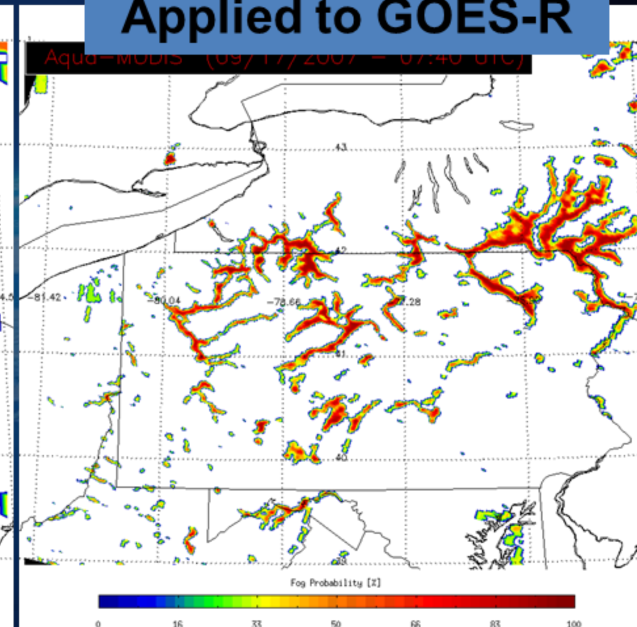
Heritage GOES Fog Detection



GOES-R Algorithm Applied to GOES



GOES-R Algorithm Applied to GOES-R



Courtesy: Mike Pavolonis/NESDIS STAR

What is Fog/Low Stratus (FLS)?

- **FLS = Fog/low stratus**

- **There is no widely accepted definition of fog/low stratus so the GOES-R definition of FLS was based off aviation flight rules**

- ***The primary goal of the GOES-R fog/low cloud detection algorithm is to identify IFR, or lower, conditions.***

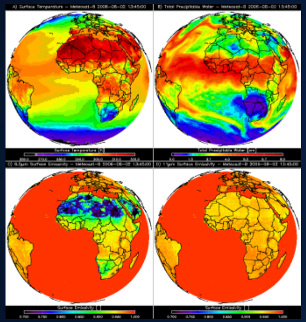
- **VFR - Visual flight rules**
  ceiling > 3000 ft and vis > 5 mi
- **MVFR - Marginal visual flight rules**
  1000 ft < ceiling < 3000 ft or 3 mi < vis < 5 mi
- ***IFR - Instrument flight rules***
  ***500 ft < ceiling < 1000 ft* or 1 mi < vis < 3 mi**
- ***LIFR - Low instrument flight rules***
  ceiling < 500 ft or vis < 1 mi

Mike Pavolonis (NESDIS/STAR/CIMSS)

Fused Fog/Low Cloud Detection Approach

Satellite Data	Static Ancillary Data	Daily SST Data	NWP

\+



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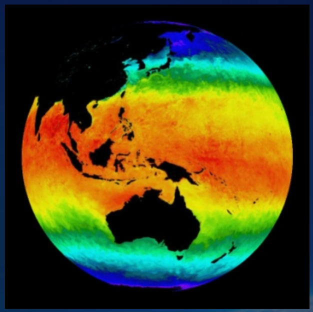

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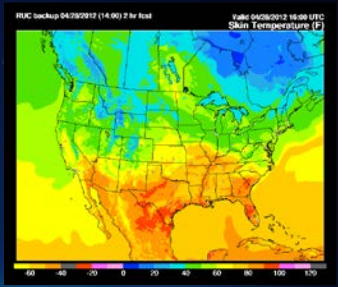


Satellite Data

-Minimum channel requirement: 0.65, 3.9, 6.7/7.3, 11, and 12/13.3 µm
-Previous image for temporal continuity (GEO only)
-Cloud Phase

Static Ancillary Data

-Digital Elevation Model (DEM)
-Surface Type
-Surface Emissivity

Daily SST Data

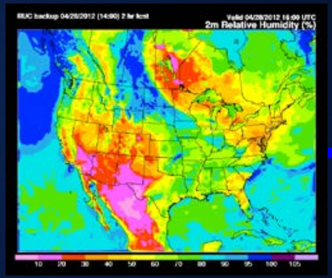
0.25 degree OISST

NWP

-Surface Temperature
-Profiles of T and q
-RUC/RAP (2-3 hr forecast) or GFS (12 hr forecast)

Clear Sky RTM

NWP RH Profiles

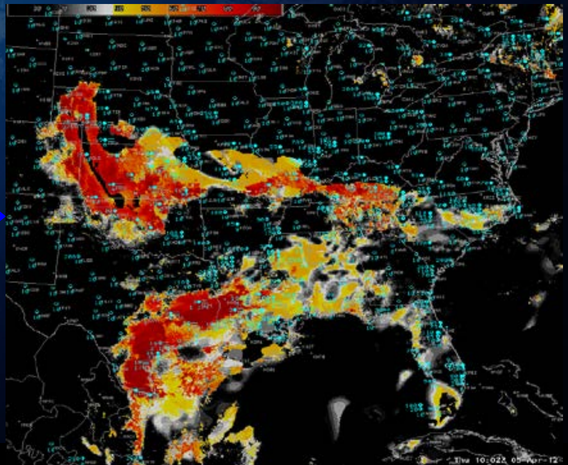


-RUC/RAP (2-3 hr forecast) or GFS (12 hr forecast)

Naïve Bayesian Model

Total run time: 2 - 3 minutes

IFR and LIFR Probability



***IMPORTANT: Other sources of relevant data (e.g. sfc obs) influence results through the model fields*

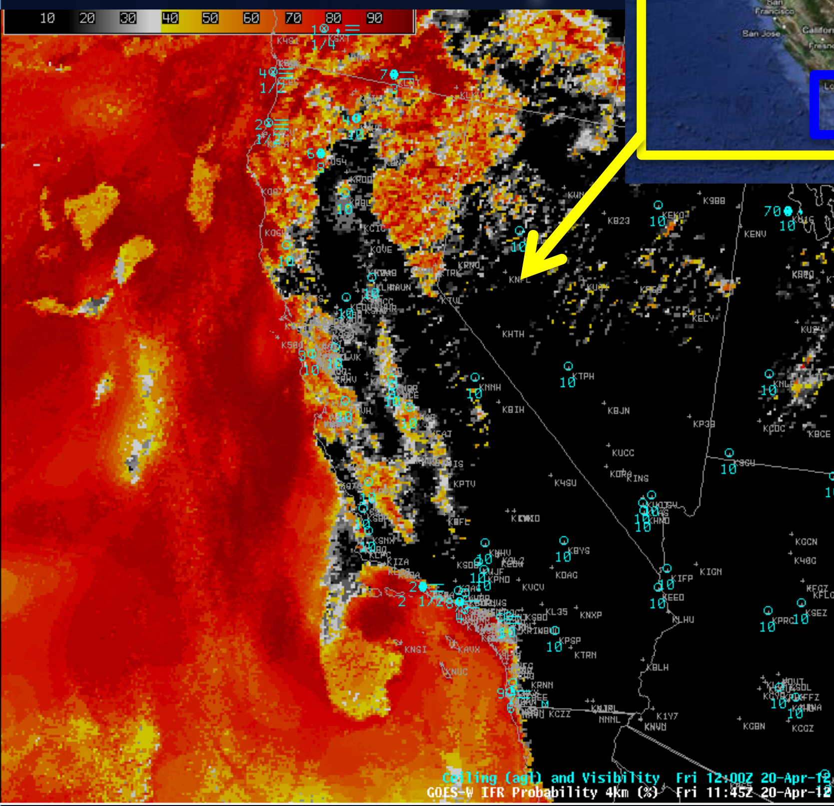
Mike Pavolonis (NESDIS/STAR/CIMSS)

GOES-R Fog/Low Stratus Product Applications

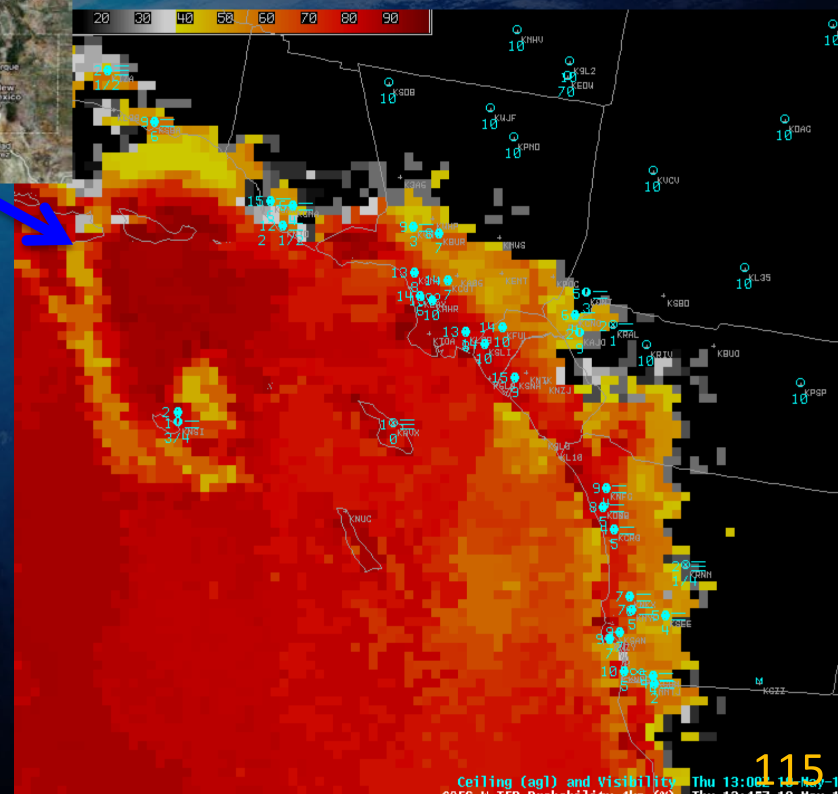
The GOES-R FLS products can be used to diagnose large scale areas of low ceiling/visibility which is useful when generating AIRMET's (AWC and AAWU) and constructing sky cover grids (NWS WFO's)

The GOES-R FLS products can also be used to diagnose smaller-scale variability related to ceiling and visibility (useful for TAF issuance, identifying mountain obscuration, filling in gaps between surface stations).

GOES-R IFR probability (%)
Large-scale view



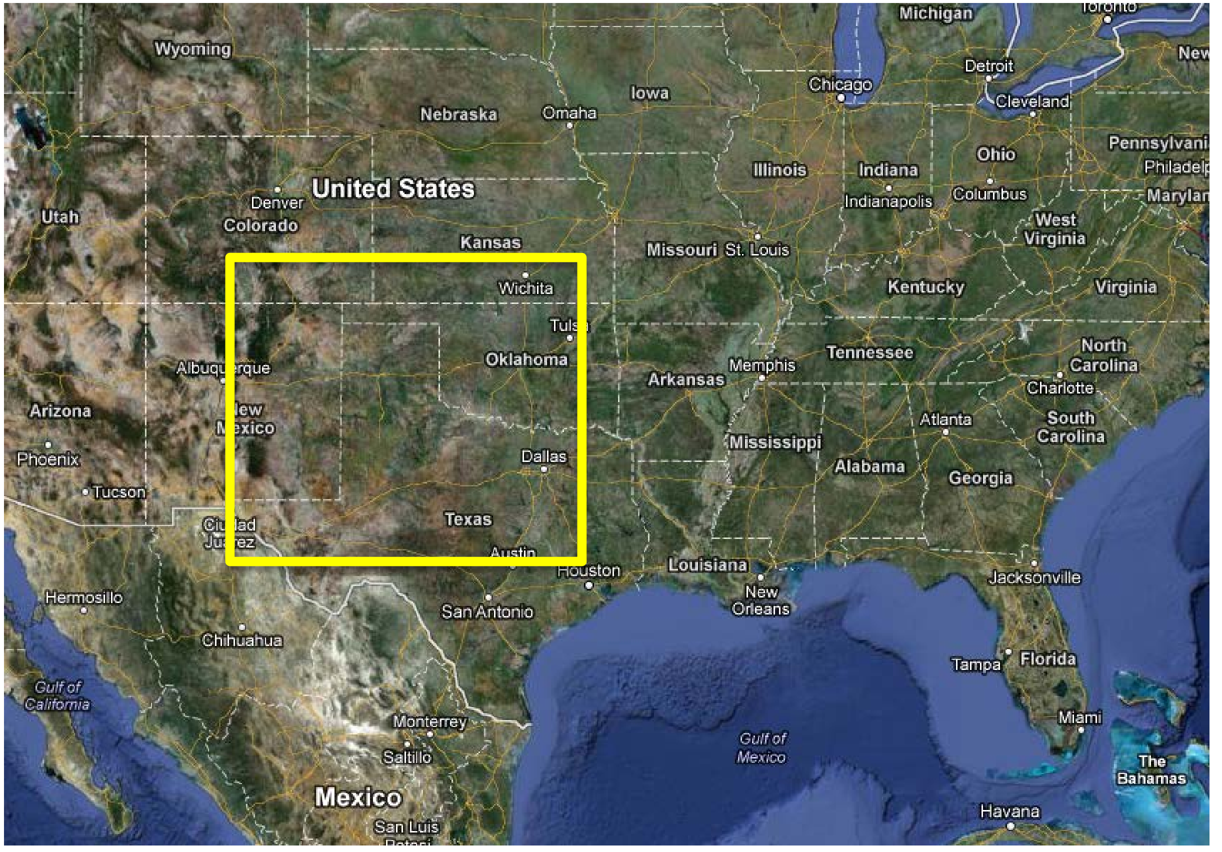
GOES-R IFR probability (%)
Zoomed-in view



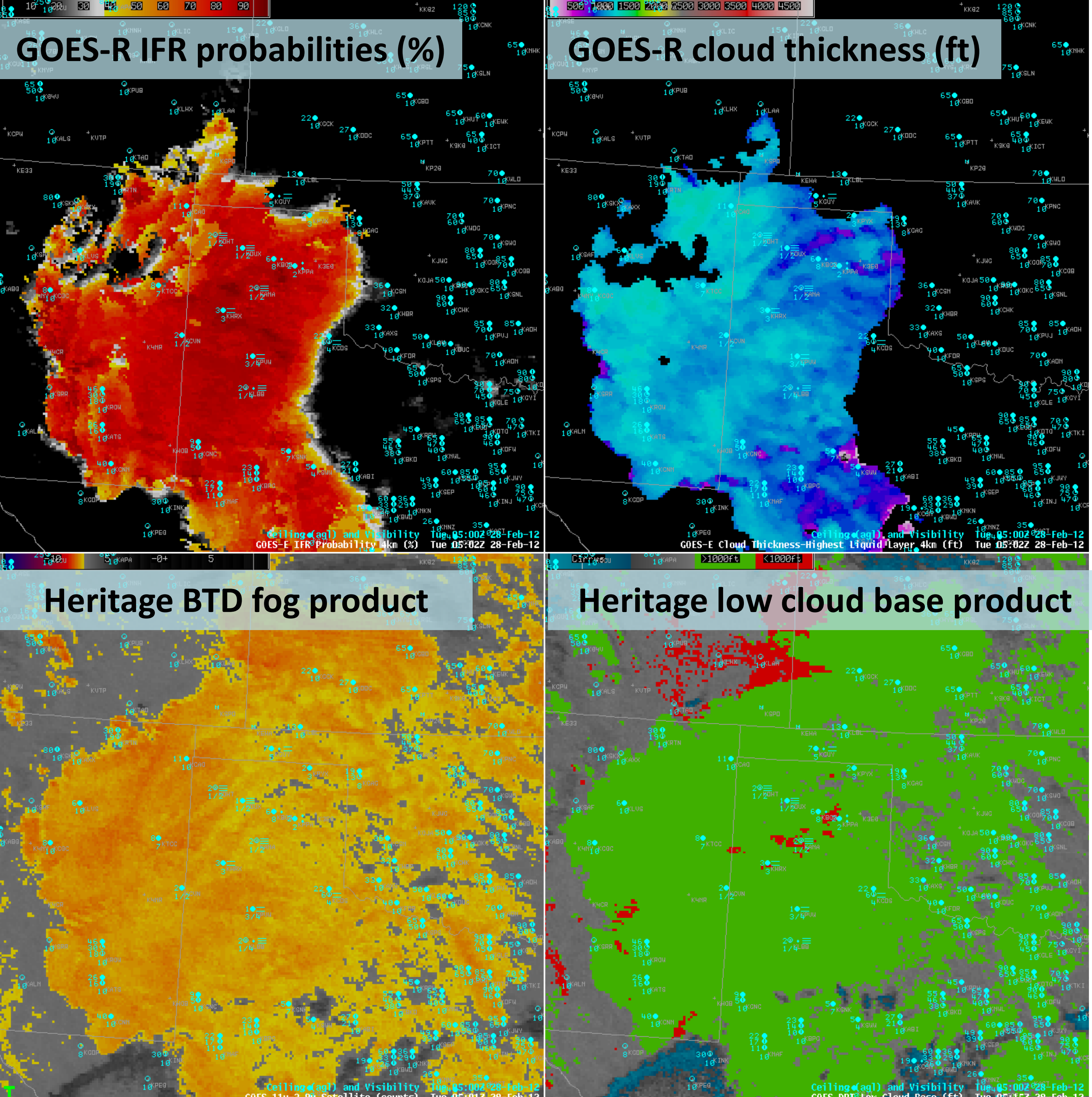
Advecting Stratus Over the Texas Panhandle

FLS Training Material
Mike Pavolonis (NESDIS/STAR/CIMSS)
Corey Calvert (UW/CIMSS)

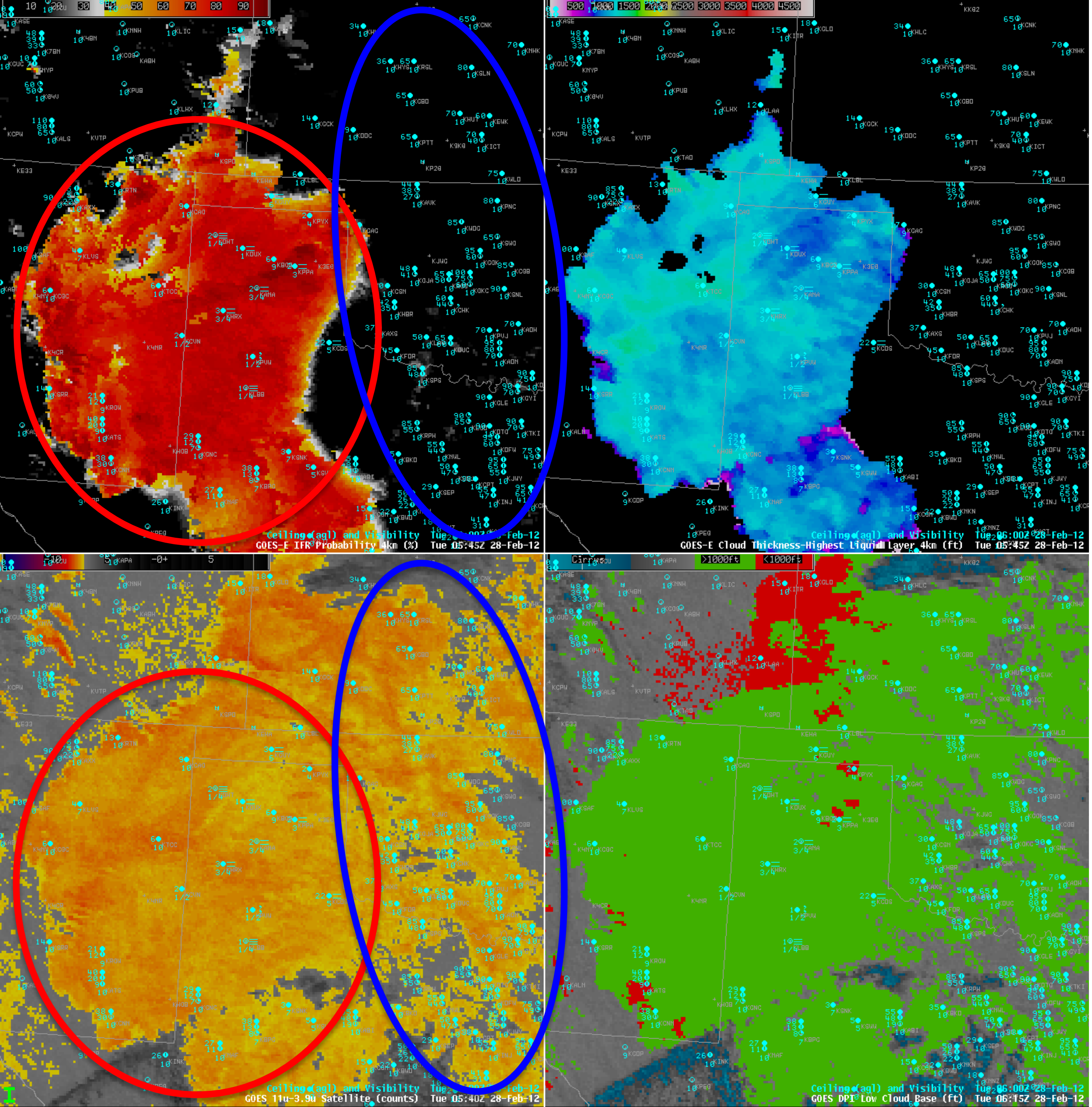
- **Low visibilities and ceilings were forecasted for this region overnight and into the morning of Feb. 28, 2012**
- **A dense fog advisory was discussed by the NWS, but never issued although several surface stations reported visibilities of ¼-½ mile throughout the night**
- **The GOES-R IFR probabilities did a good job capturing the spatial extent of the low stratus deck producing high probabilities (>75%) where the IFR conditions were reported by surface stations**



The traditional low cloud base product had trouble identifying which areas of the stratus deck met IFR criteria



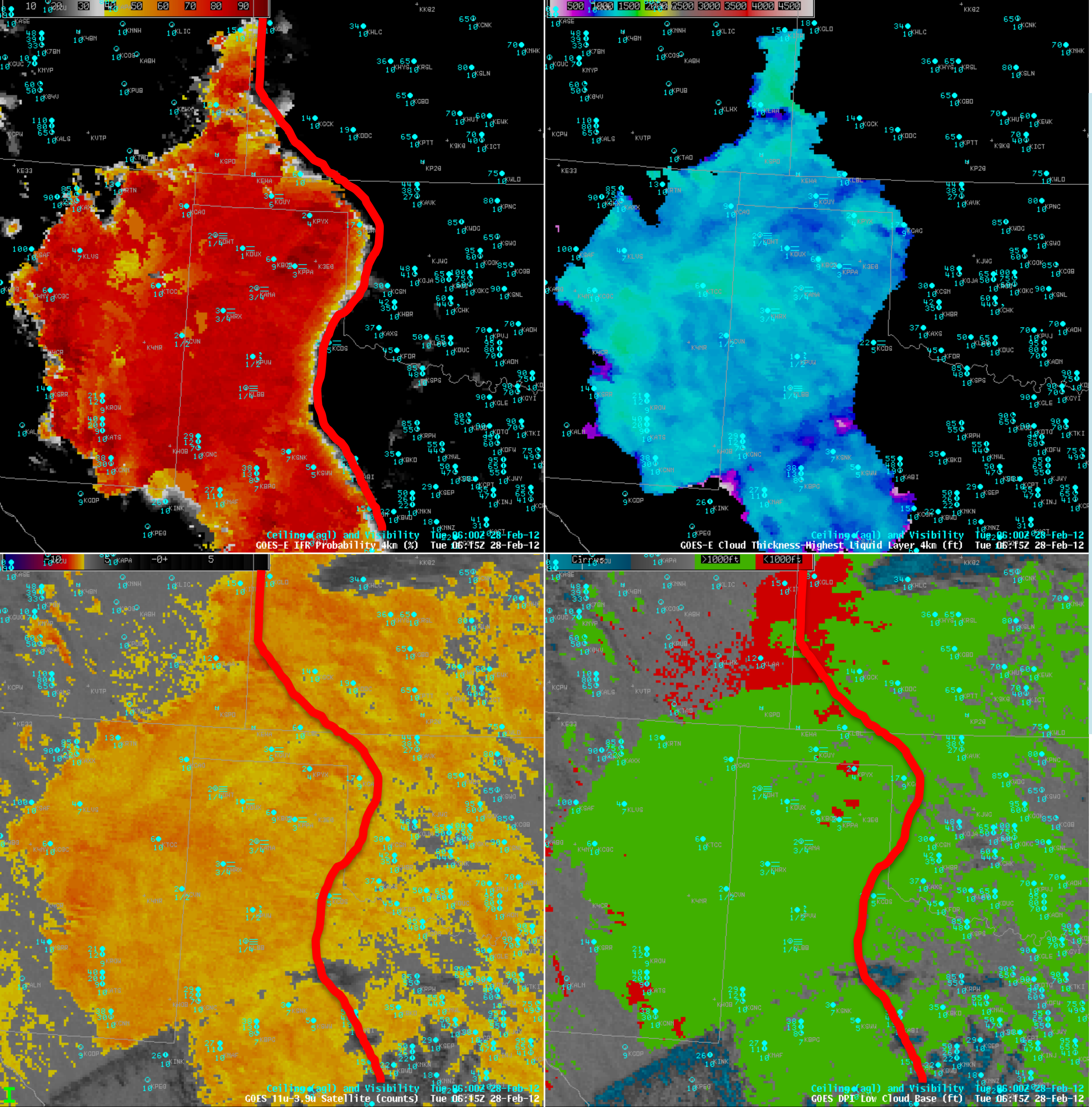
2/28/2012
05:02 UTC



The majority of the surface stations located where the GOES-R IFR probabilities were elevated (red circle) reported ceilings and/or visibilities that met the IFR criteria

None of the surface stations east or northeast of the elevated GOES-R IFR probabilities (blue circle) reported IFR conditions

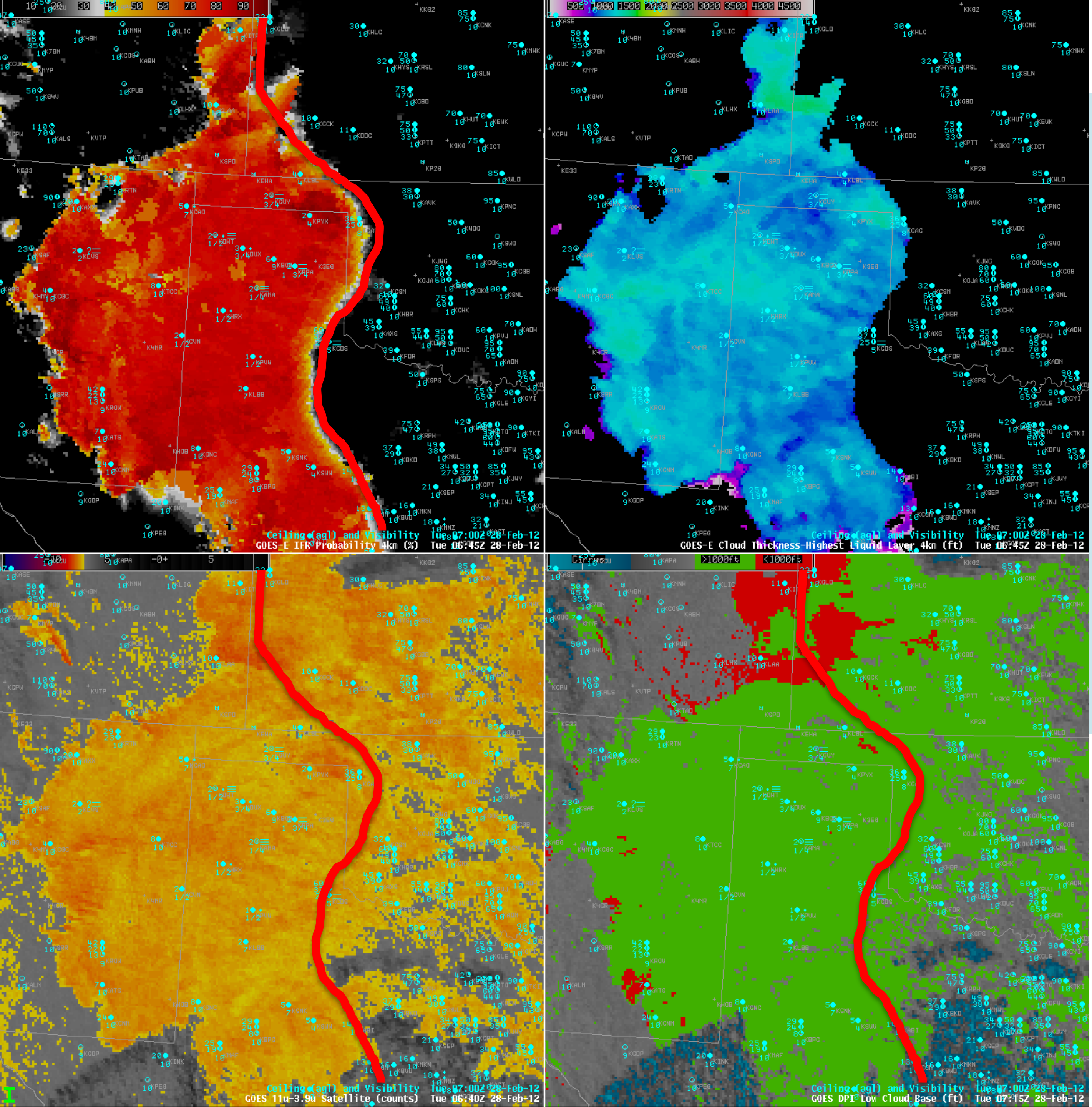
2/28/2012
05:45 UTC



Note the clear separation the GOES-R IFR probabilities show between the hazardous low stratus deck to the west of the red line and the non-hazardous elevated stratus deck to the east

This separation is not seen in the traditional products

2/28/2012
06:15 UTC



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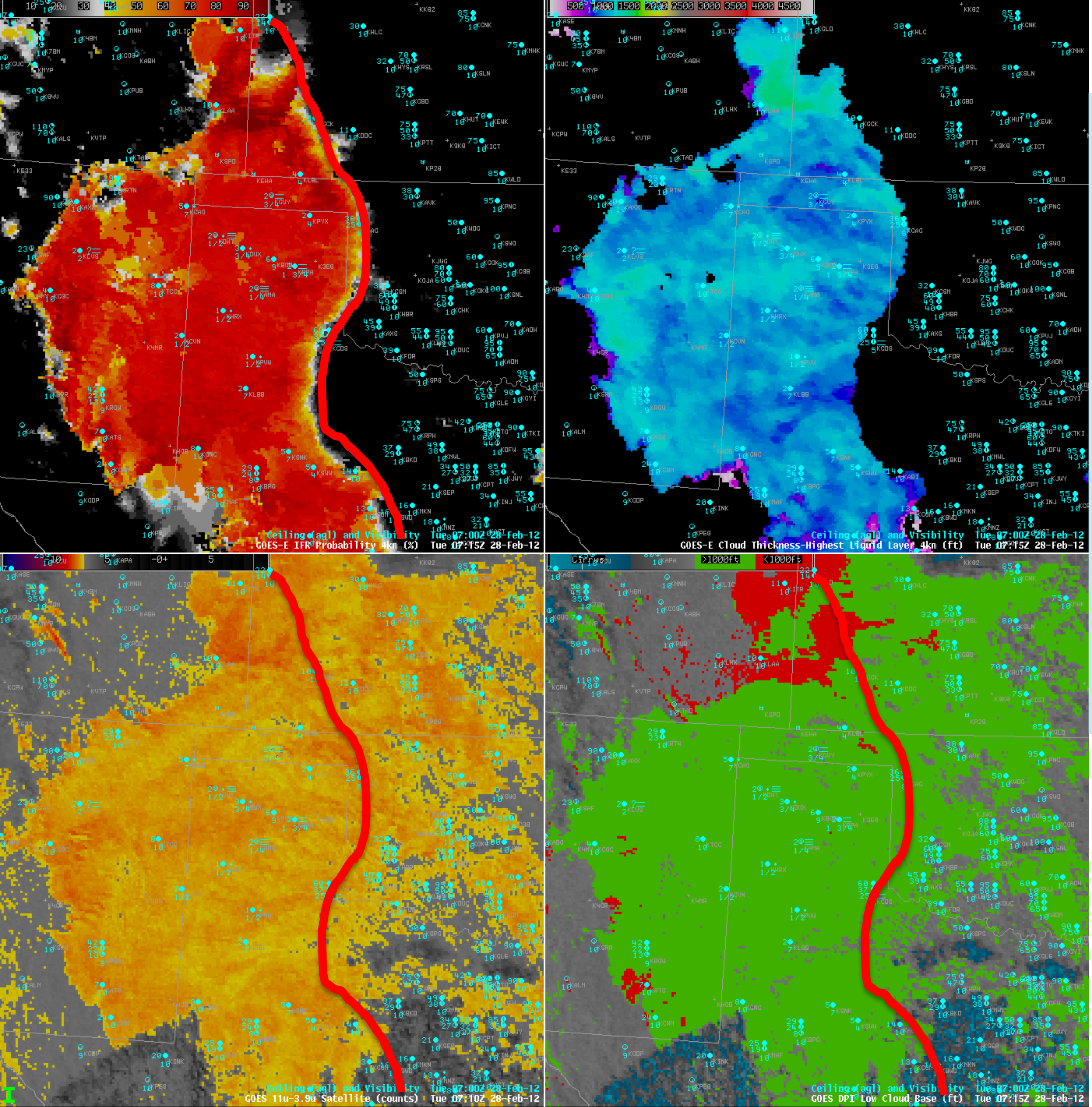

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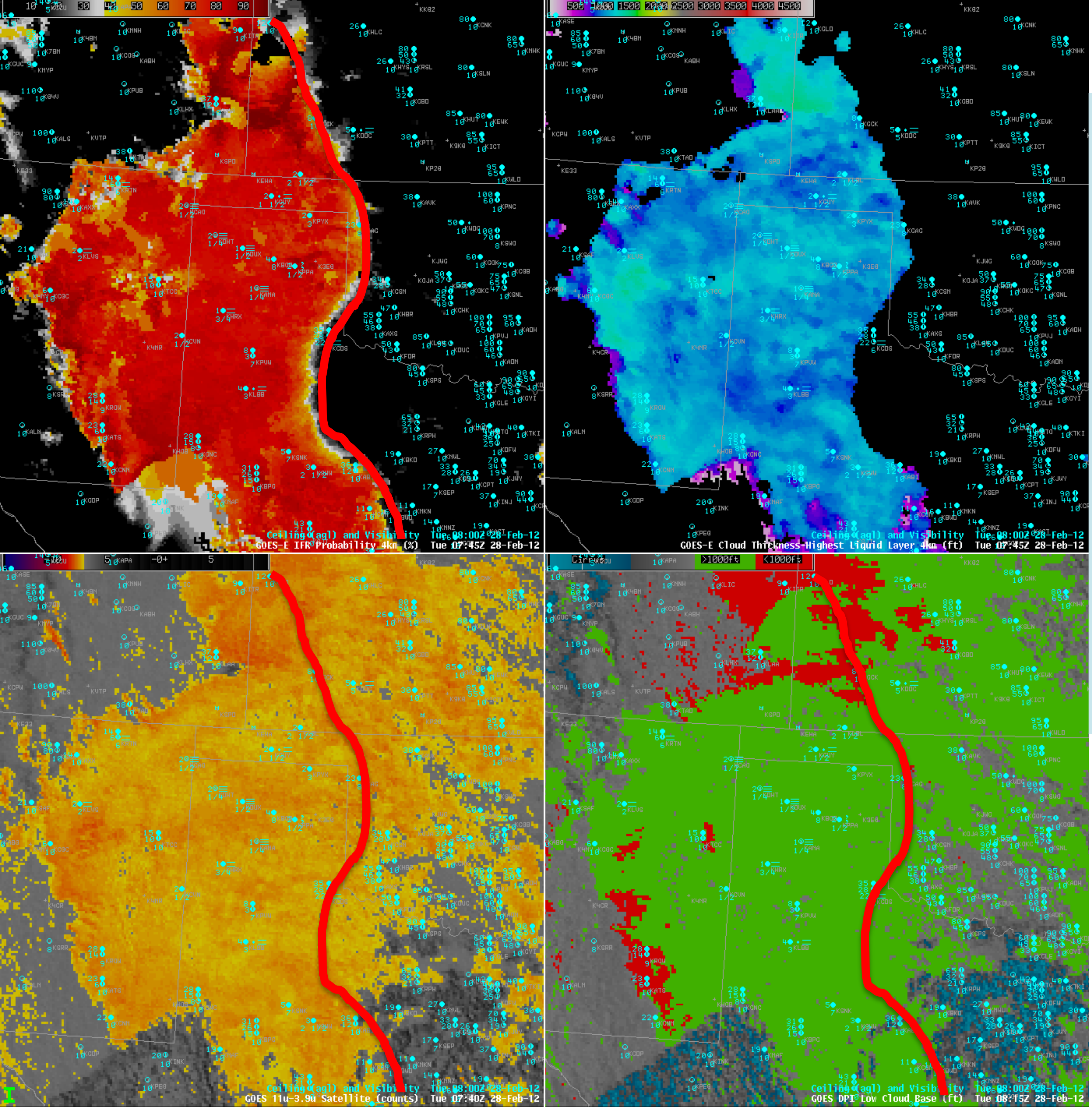
2/28/2012
07:15 UTC



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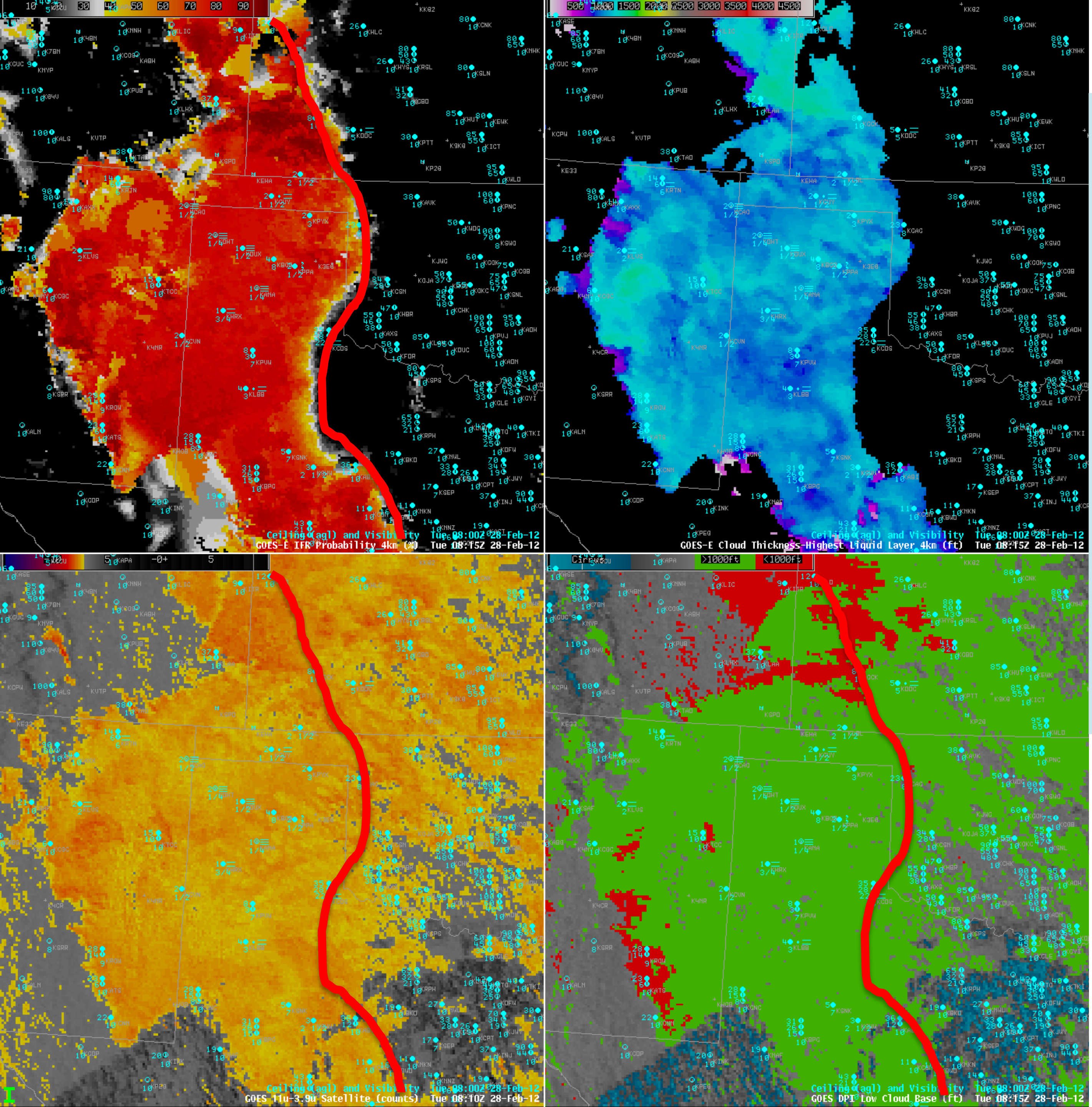
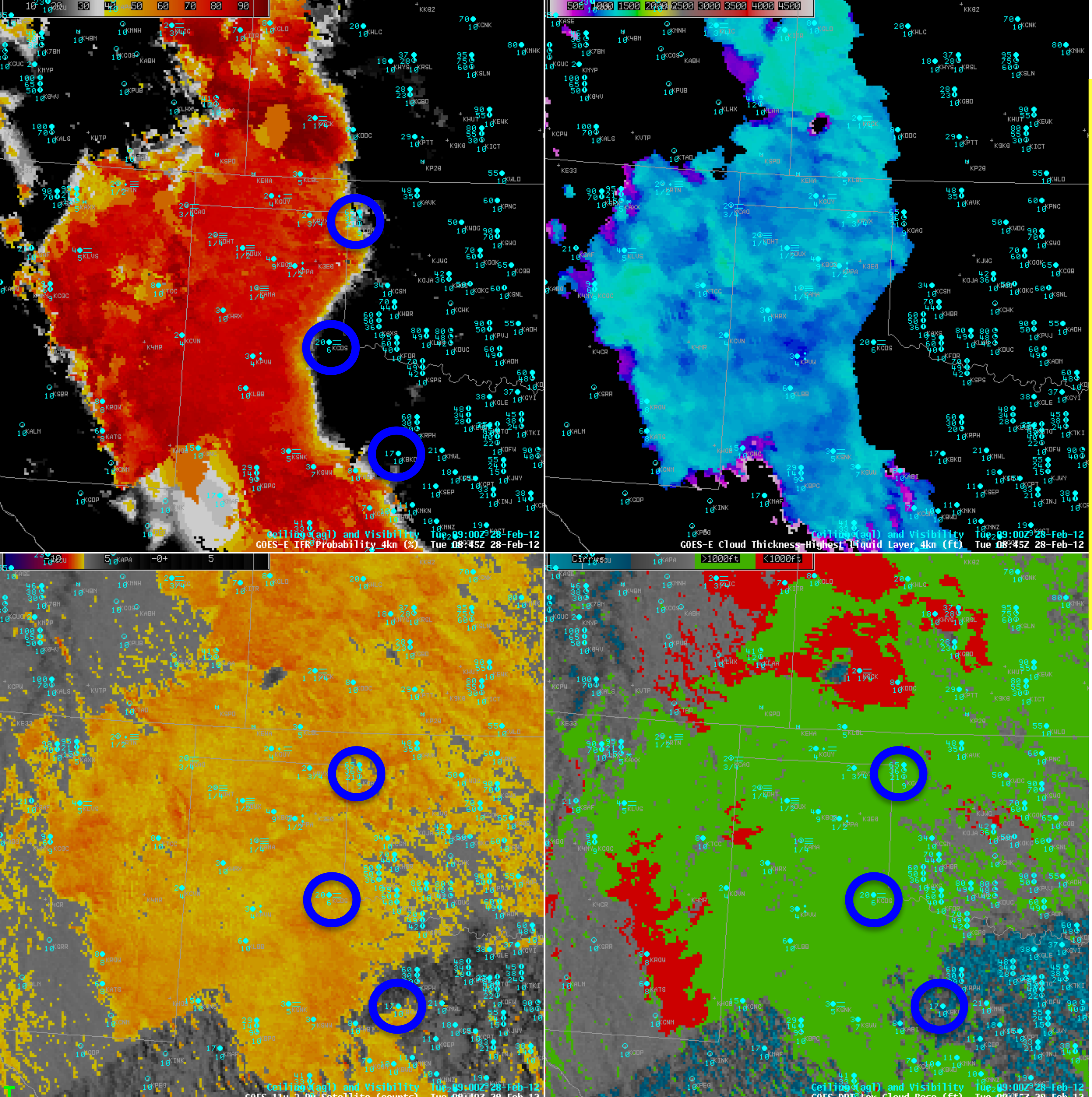


Note the clear separation the GOES-R IFR probabilities show between the hazardous low stratus deck to the west of the red line and the non-hazardous elevated stratus deck to the east

This separation is not seen in the traditional products

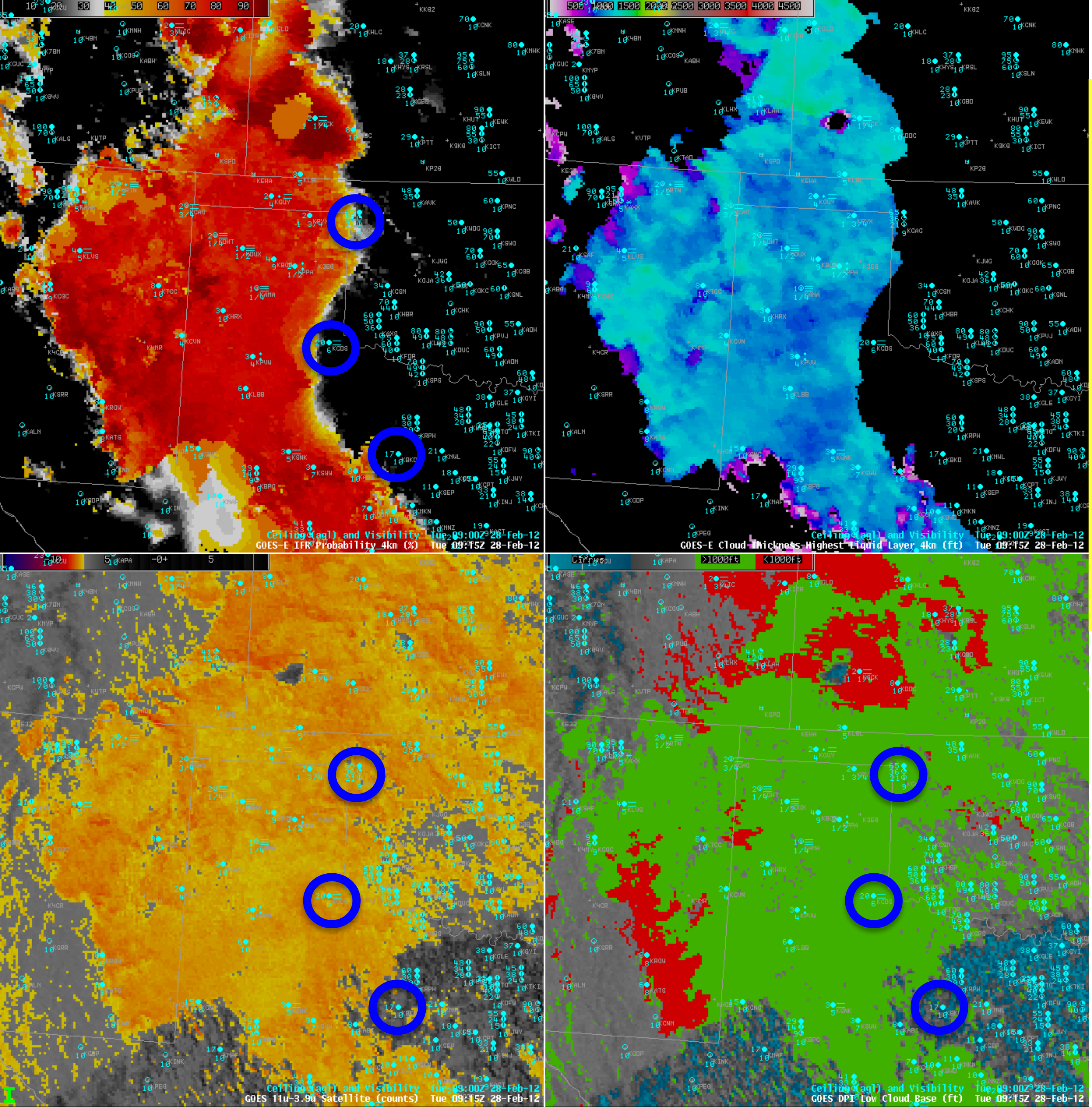
2/28/2012
08:15 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

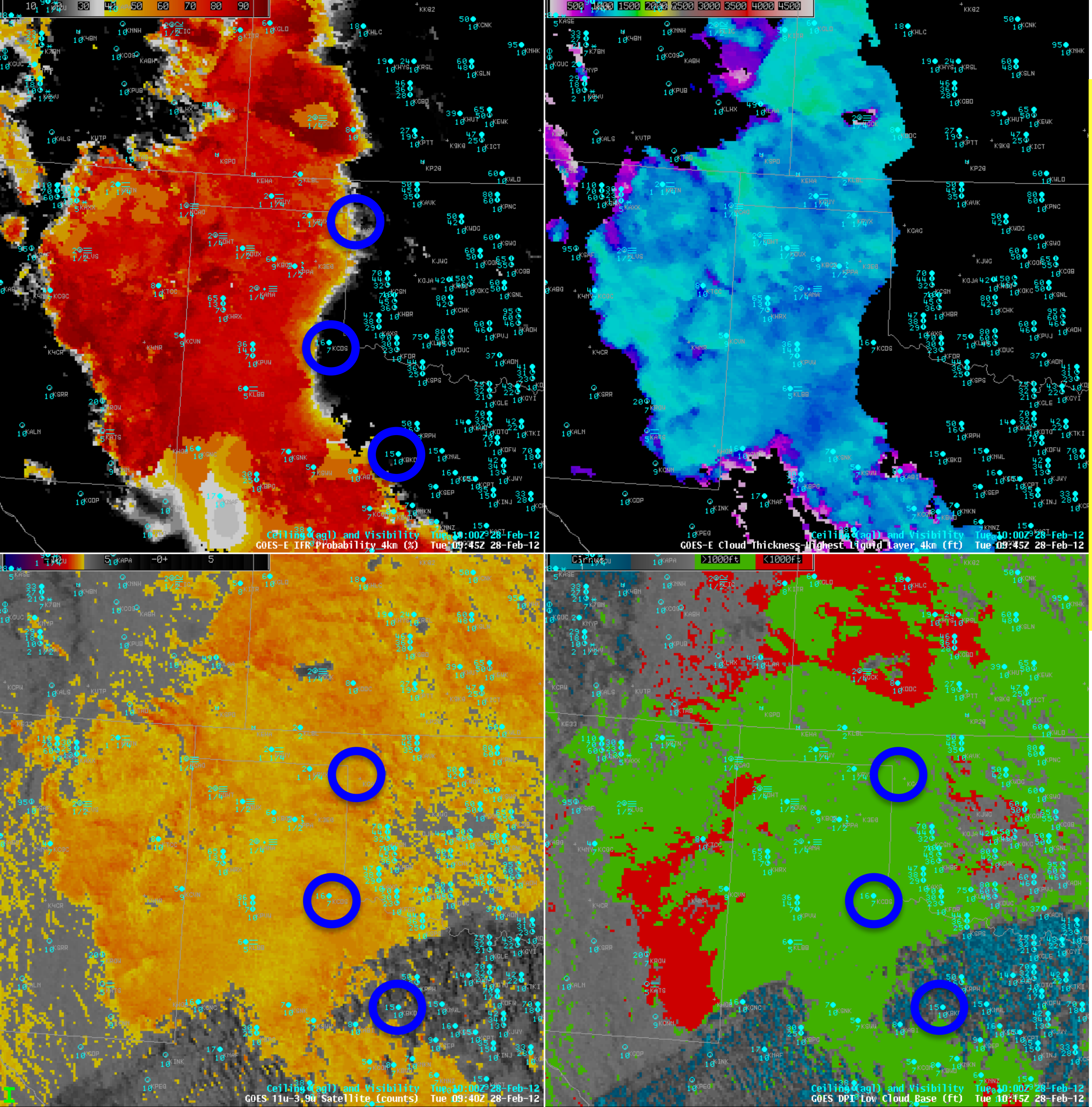
2/28/2012
08:45 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

2/28/2012
09:15 UTC



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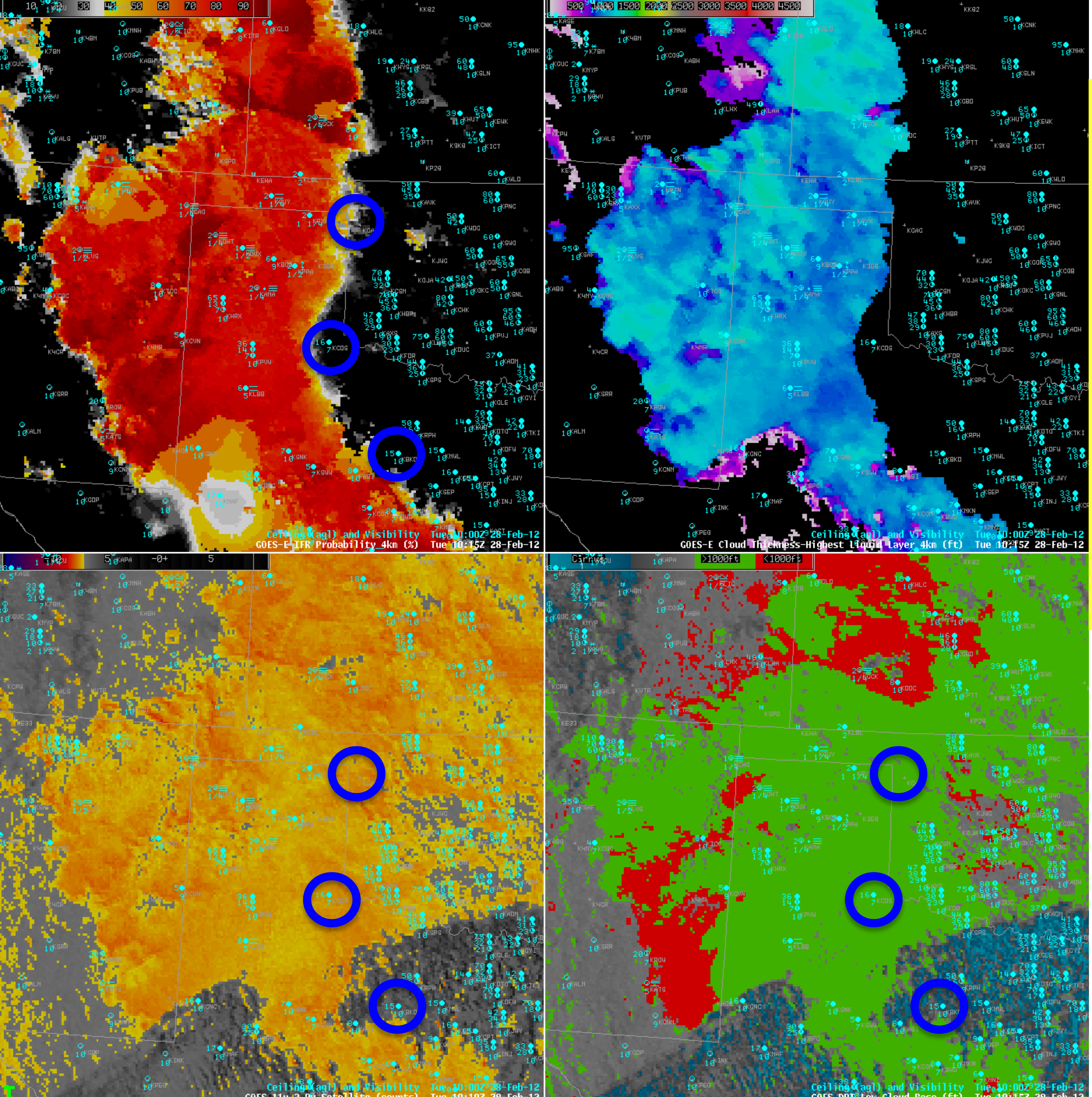
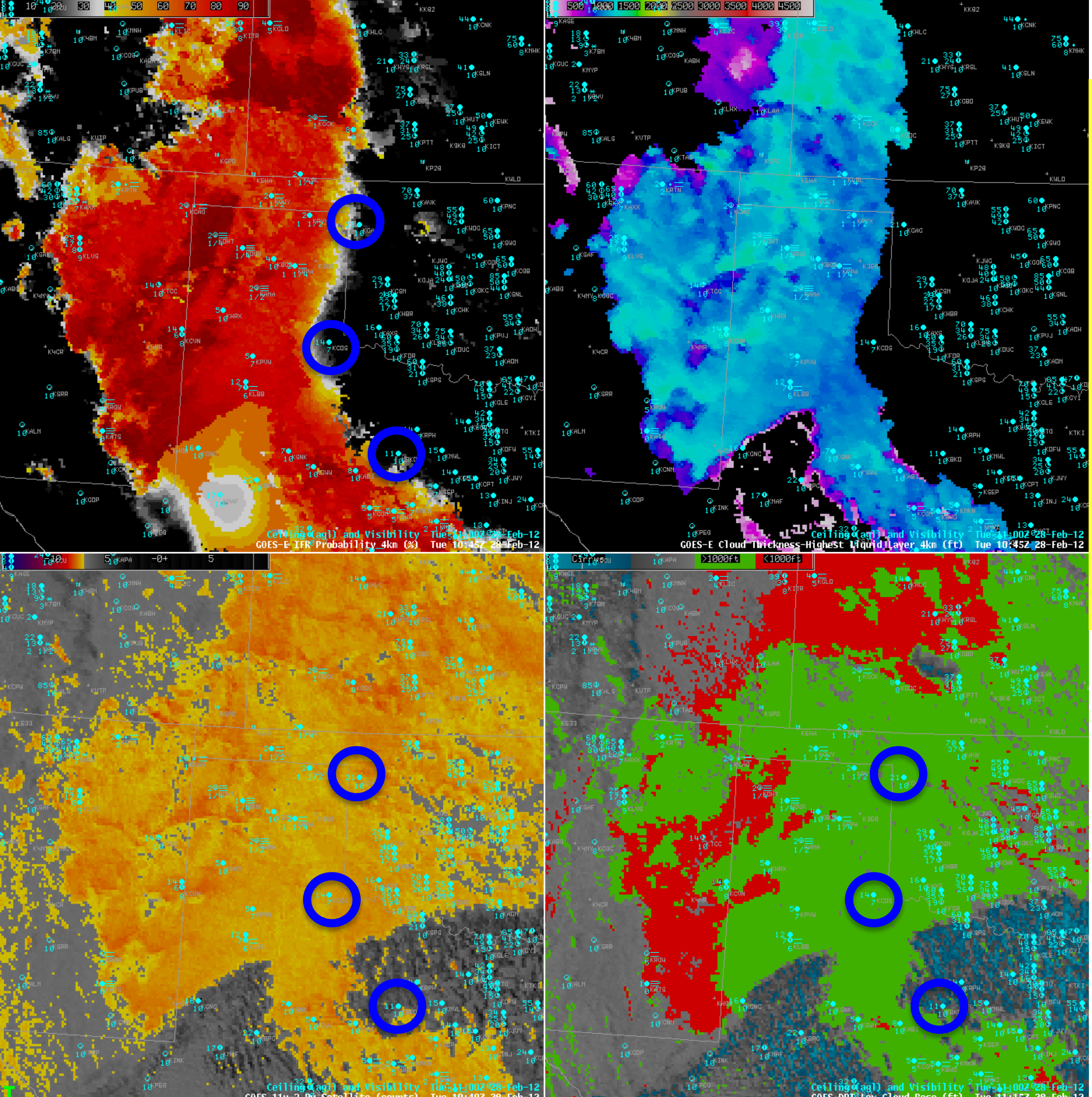
2/28/2012
09:45 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

2/28/2012
10:15 UTC



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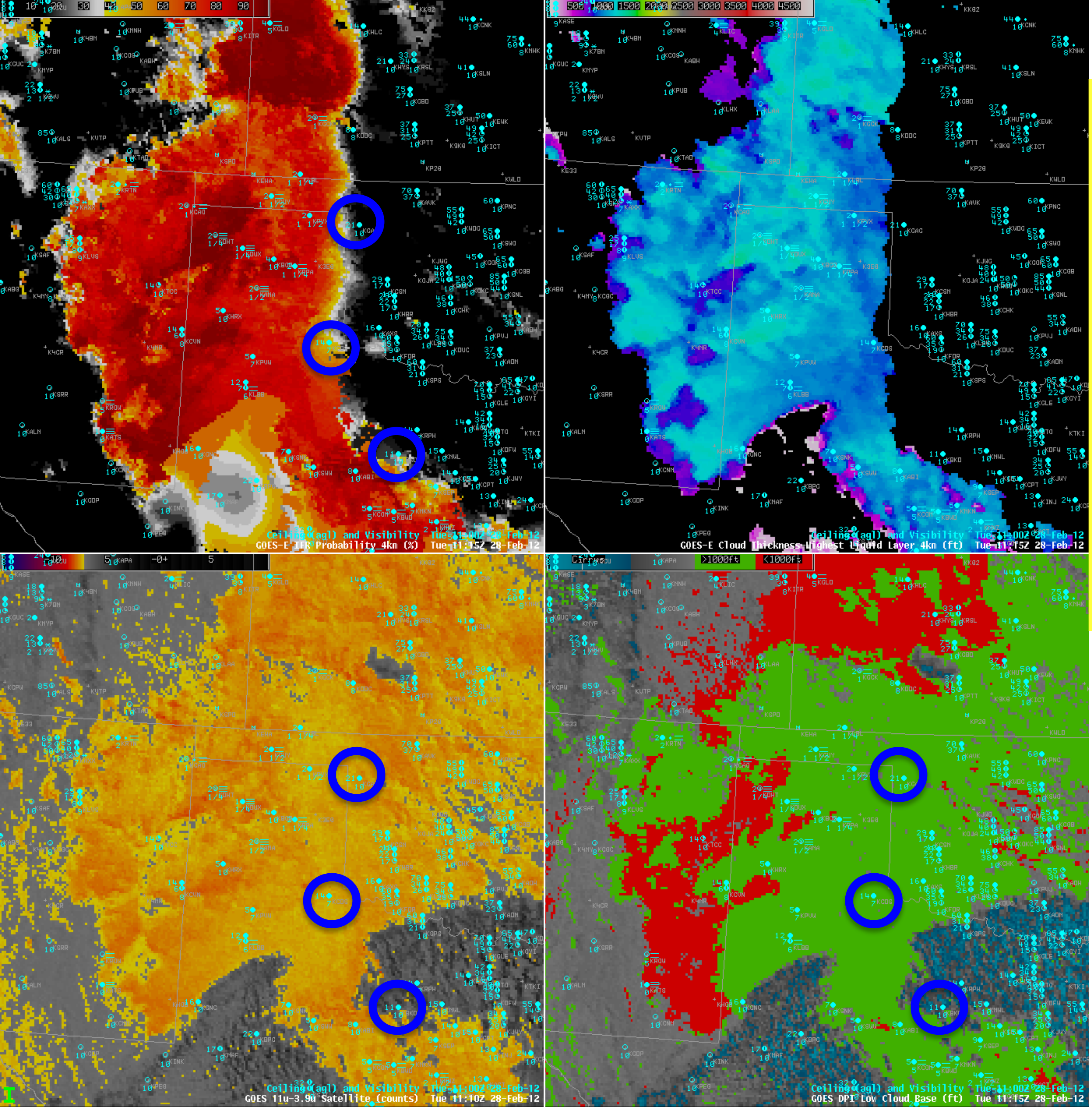
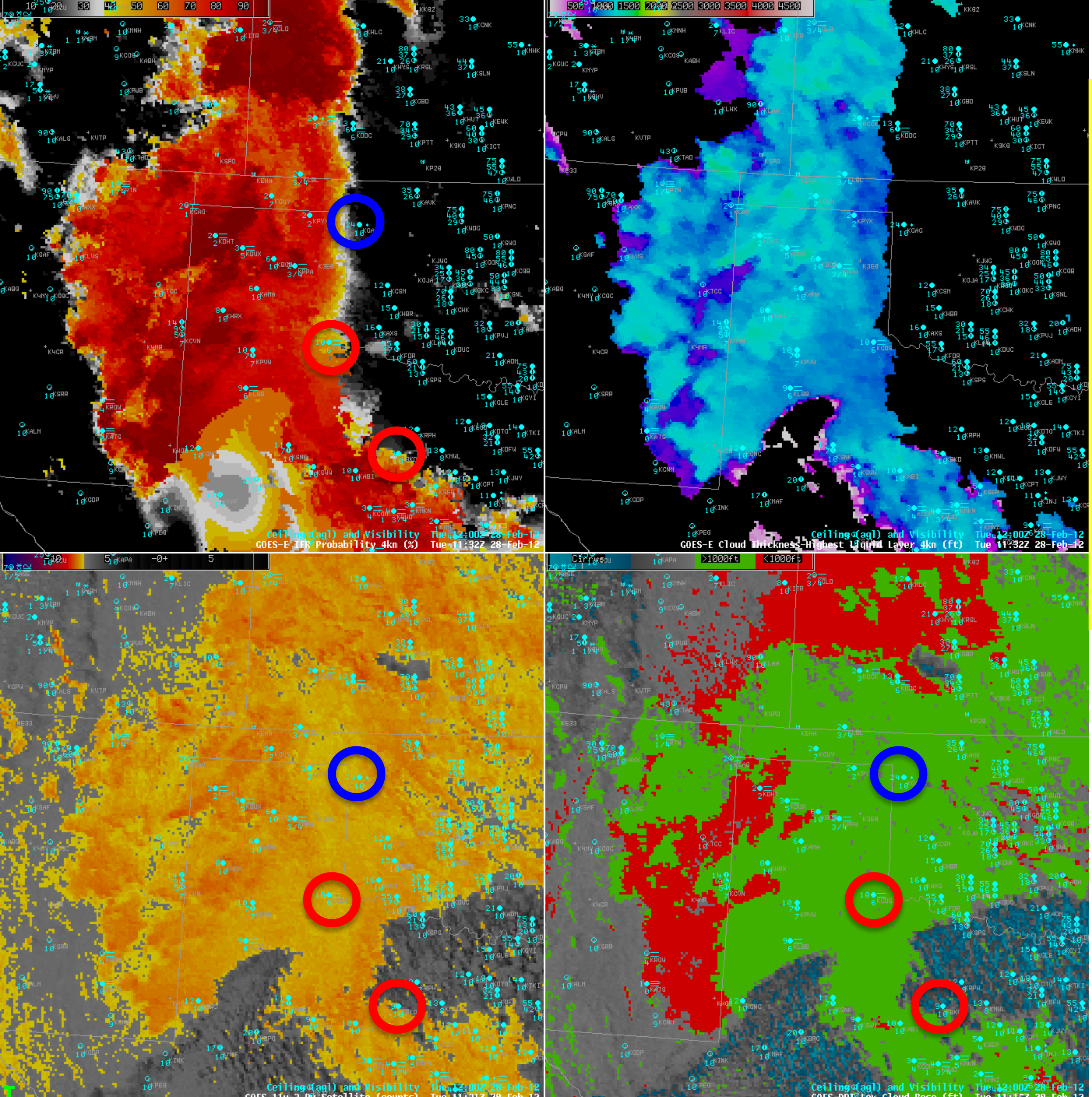
2/28/2012
10:45 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

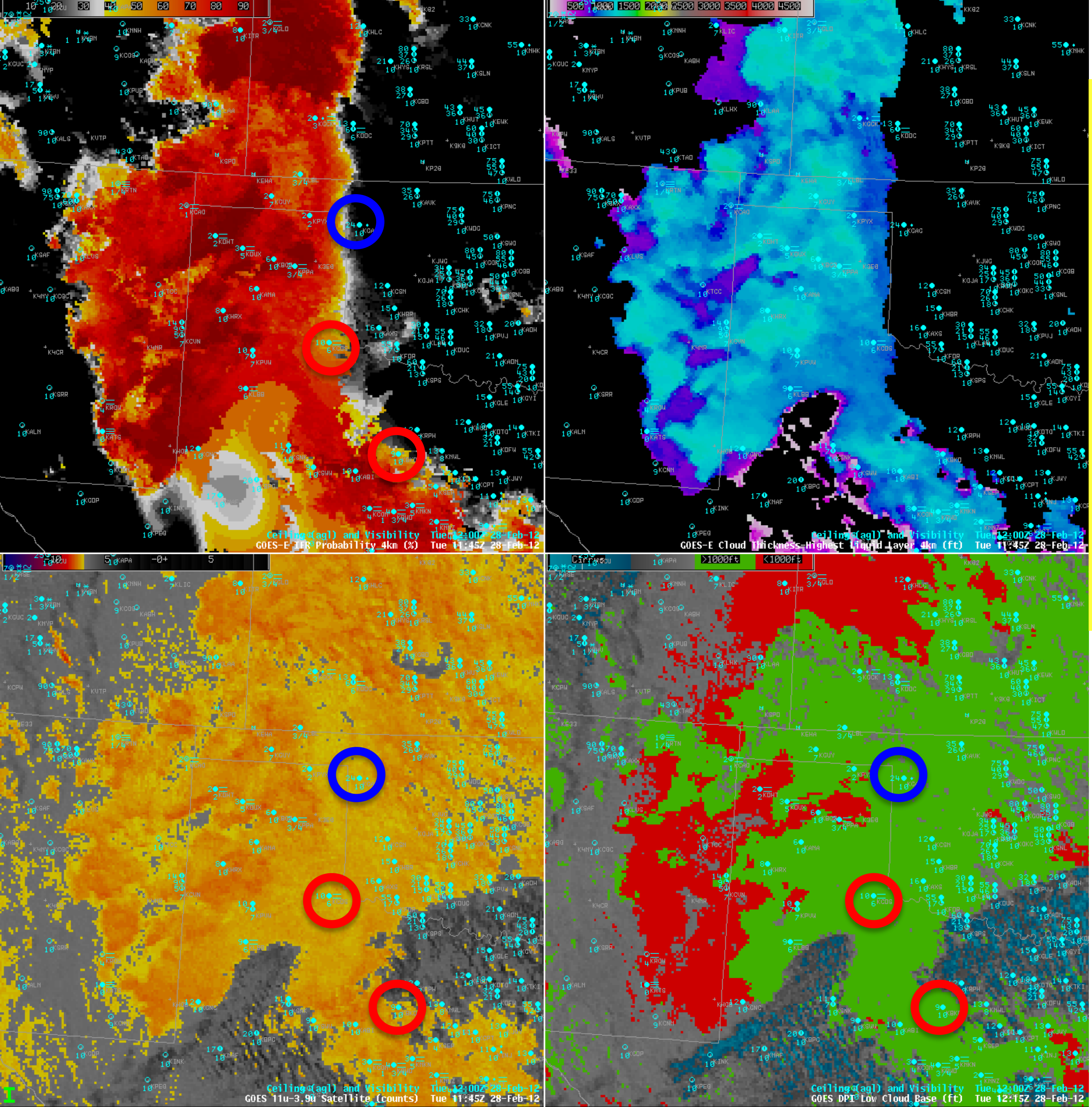
2/28/2012
11:15 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

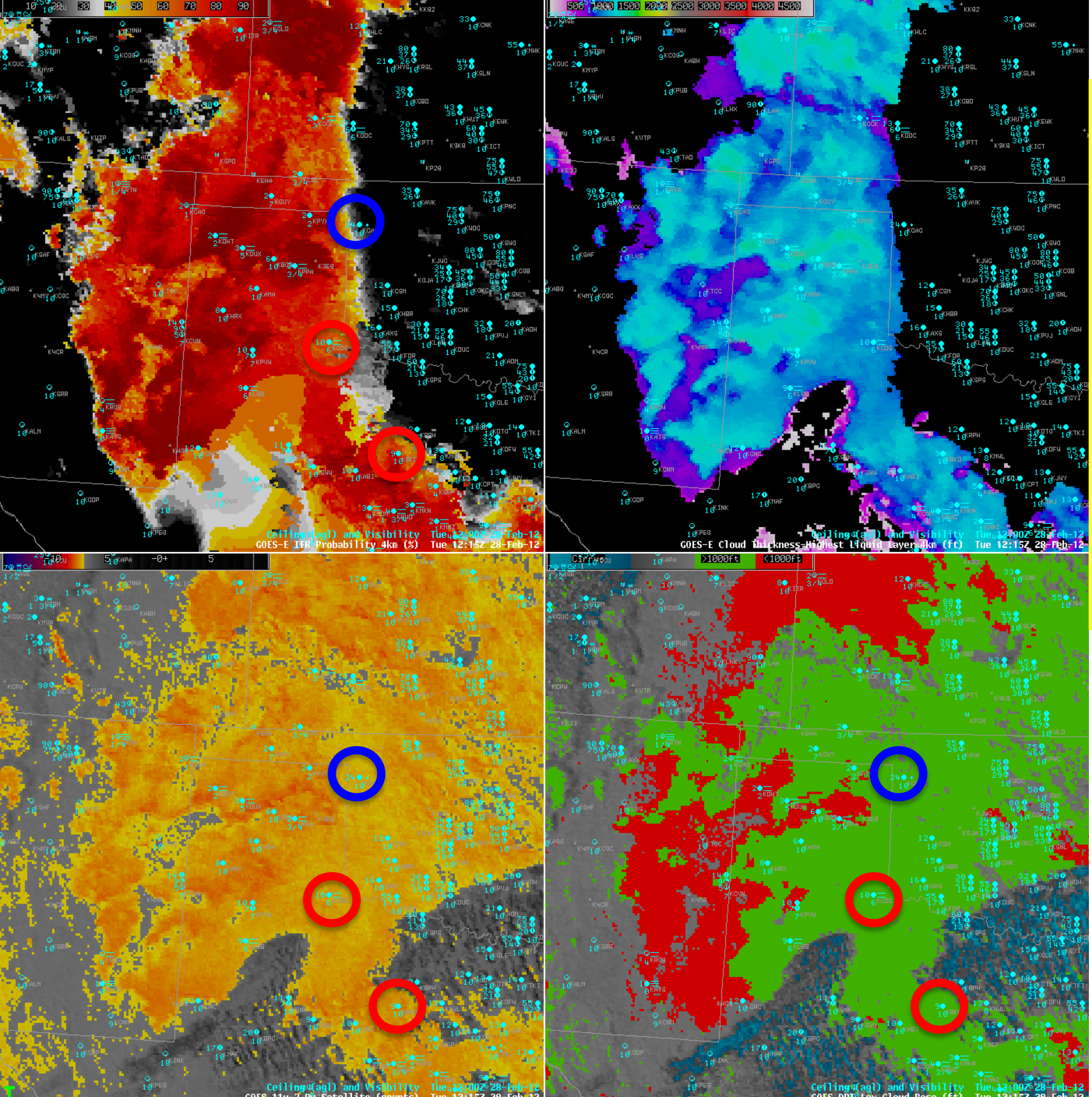
2/28/2012
11:32 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

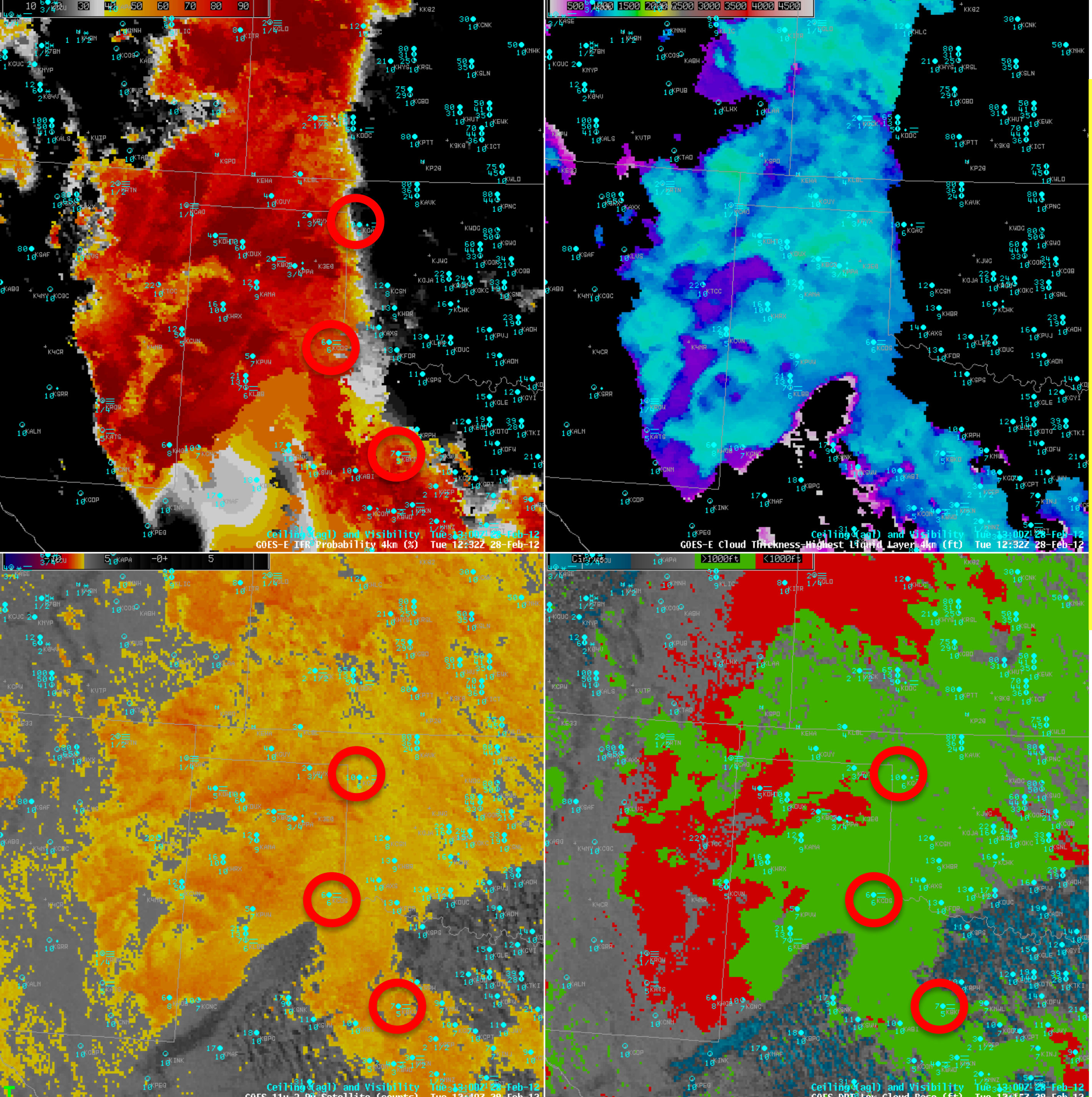
2/28/2012
11:45 UTC



The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

2/28/2012
12:15 UTC

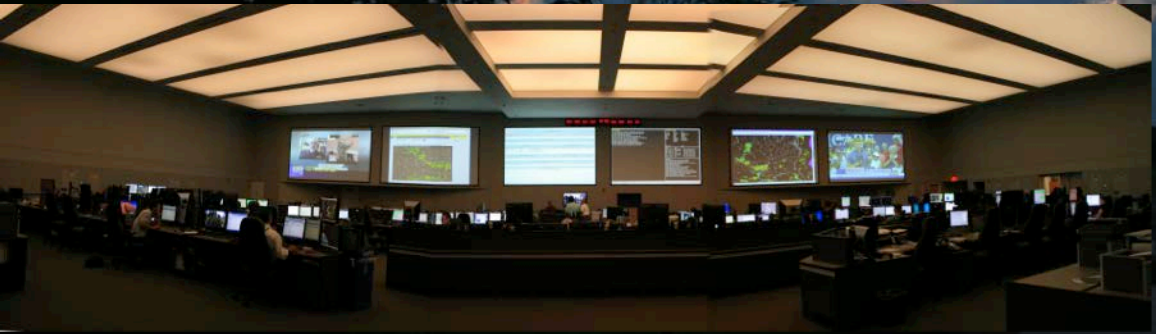


The surface observations circled in blue are NOT reporting IFR conditions

As the high GOES-R IFR probabilities push east over time those stations begin reporting IFR conditions (when circles turn red)

2/28/2012
12:32 UTC

Using GOES-R Probabilities of IFR Visibility and Ceiling for Decision Support at the FAA - Air Traffic Control System Command Center (ATCSCC)

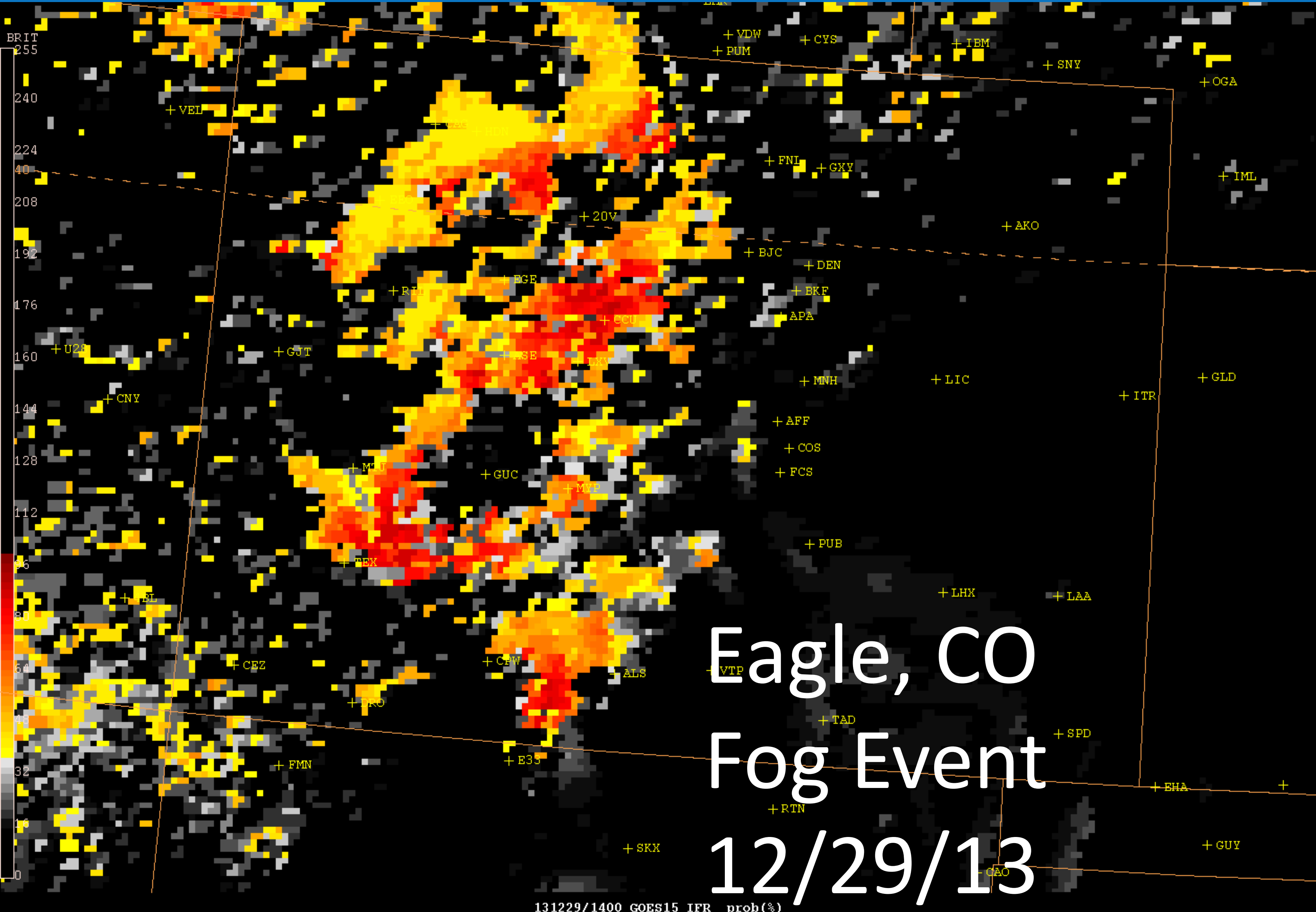


NWS National Aviation Meteorologist (NAM)

Michael Eckert

AOMSUC-6, Tokyo, Japan, Nov 9-13, 2015

Eagle, CO Fog Event 12/29/13



EGE Fog Event 12/29/13

30 minutes after GOES-R indicated clearing

EGE Fog Event 12/29/13

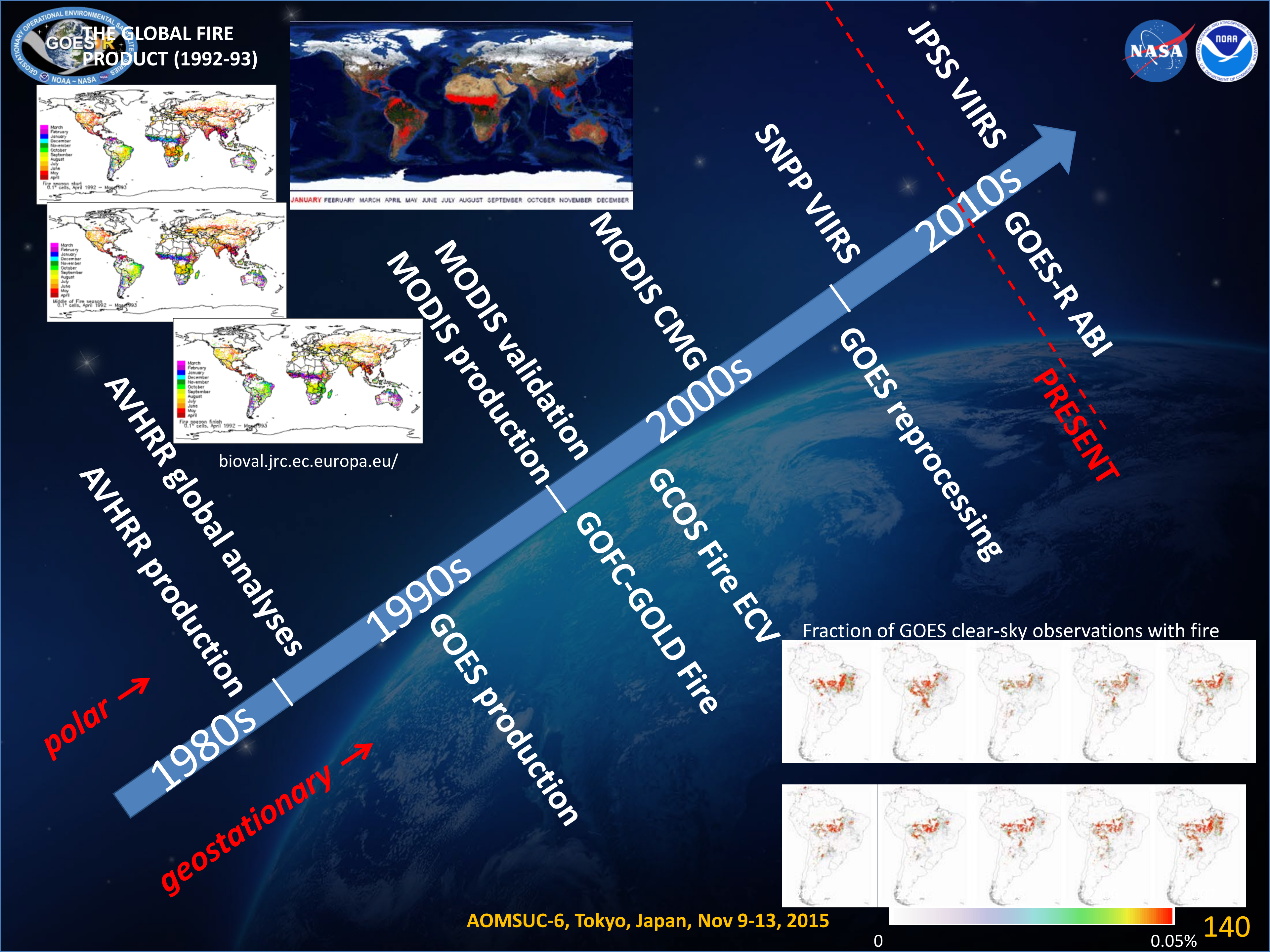
KEGE 291450Z 00000KT **1/4SM FZFG OVC002** M11/M11 A3022
KEGE 291550Z 00000KT **1/2SM FZFG OVC002** M09/M10 A3024
KEGE 291650Z 00000KT **1/2SM FZFG OVC003** M07/M08 A3025
KEGE 291750Z 00000KT **1/4SM FZFG OVC002** M04/M05 A3025
KEGE 291859Z 00000KT 10SM FEW030 M01/M03 A3021 RMK VIS E 3/4 FG BANK E

IFR conditions

- NWS Met monitored GOES-R probability of IFR conditions. Coordination with ZDV throughout the event due to high volume of Holiday Travel to Ski Resorts.
- Once Satellite lost the “one” pixel of 70% probability, we notified Terminal Specialist/Supervisor/ZDV that clearing was imminent.
- Normal flight operations commenced ahead of schedule (~60 min), thereby saving time and $$ to the customers and airlines.
- Delay cost → $76.00/min × 60 min × 50 aircraft

Savings ~ $228,000.00

FIRE Applications



THE GLOBAL FIRE PRODUCT (1992-93)
bioval.jrc.ec.europa.eu/
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1980s
1990s
2000s
2010s
polar
geostationary
AVHRR production
AVHRR global analyses
MODIS production
MODIS validation
MODIS CMG
SNPP VIIRS
JPSS VIIRS
GOES production
GOFC-GOLD Fire
GCOS Fire ECV
GOES reprocessing
GOES-R ABI
PRESENT
Fraction of GOES clear-sky observations with fire
0
0.05%

Fire: Critical relevant capability gaps

- "Sharing of information through multiple communication systems represents both a capability accomplishment and a continuing challenge for integration and management of information" **(USDA FS)**

- "Major uncertainties and data gaps are associated with fire activity data, plume injection height, and observational data/protocols for evaluating predictions from emissions and air quality models" **(EPA)**

- "Research to Operations (R2O) transformation challenges include fire weather and smoke modeling, research with and access to observation data, operational fire weather capabilities and services" **(NWS)**

- "Emerging needs of the land management agencies include improved fire weather forecasts (…)" **(DOI, USDA FS)**

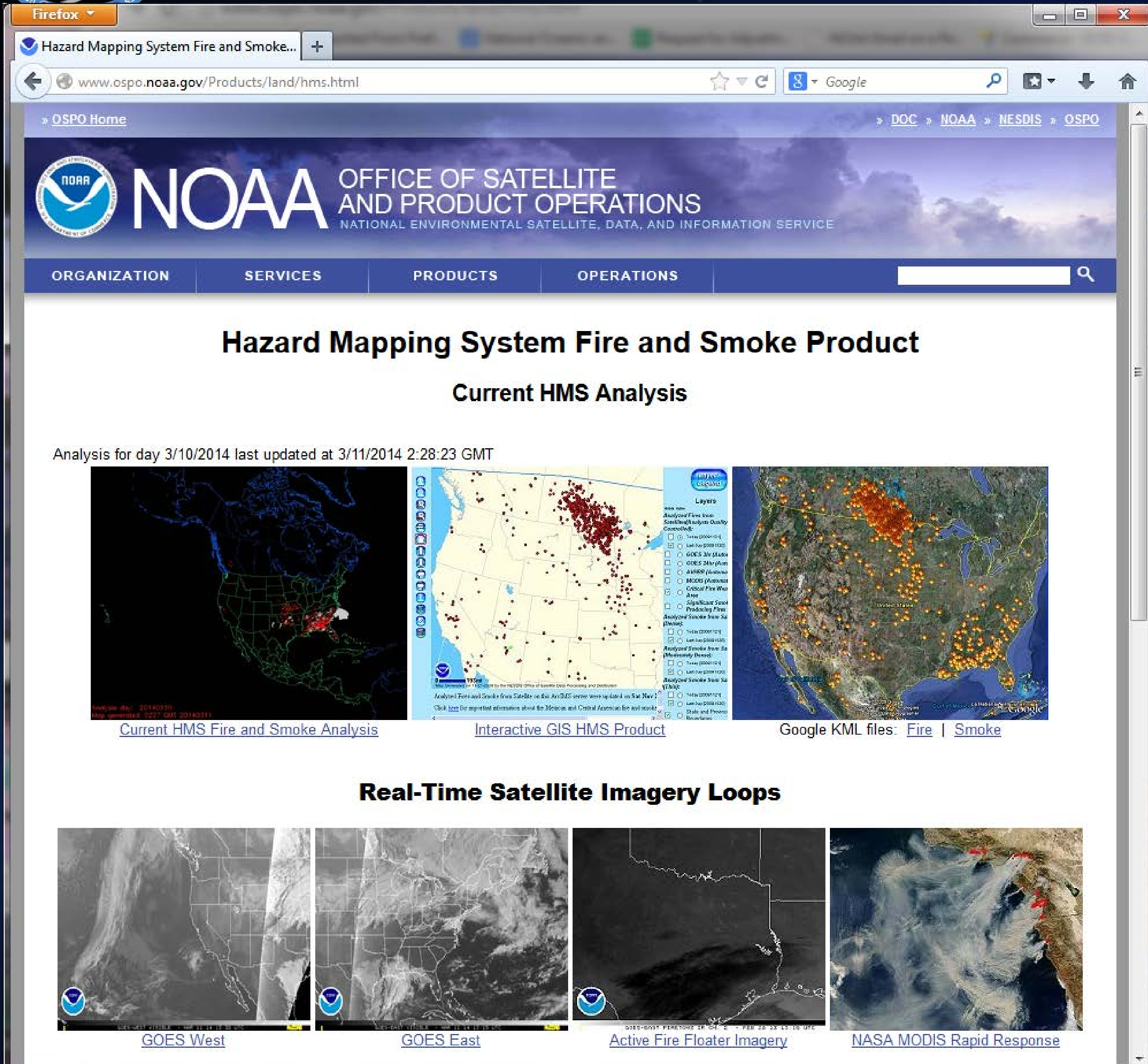
COMMITTEE FOR ENVIRONMENTAL SERVICES, OPERATIONS, AND RESEARCH NEEDS (CESORN)
WORKING GROUP FOR WILDLAND FIRE WEATHER (WG/WFW), March 13, 2014 ROA
http://www.ofcm.gov/wg-wfw/index.htm

National Weather Service: Information Gaps

- Limited observations and measurements near fires
- Real-time detection of fires
- Improved high-res model forecast guidance
- Fine-scale coupled model (sub 1-km, hourly)
- Improved Red Flag ID, lead time, indexing
- No coupled smoke behavior prediction less than 4 km res
- Intra-seasonal prediction of fires
- Incident Meteorologist (IMET) capability improvements (training, customer interface)
- Tool for debris flow prediction
- Social science evaluation

Eli Jacks, Supervisory Meteorologist, Fire and Public Weather Services
Peter Roohr, Meteorologist, Science Plans Branch
Heath Hockenberry, Meteorologist, Fire and Public Weather Services

http://www.ospo.noaa.gov/Products/land/hms.html



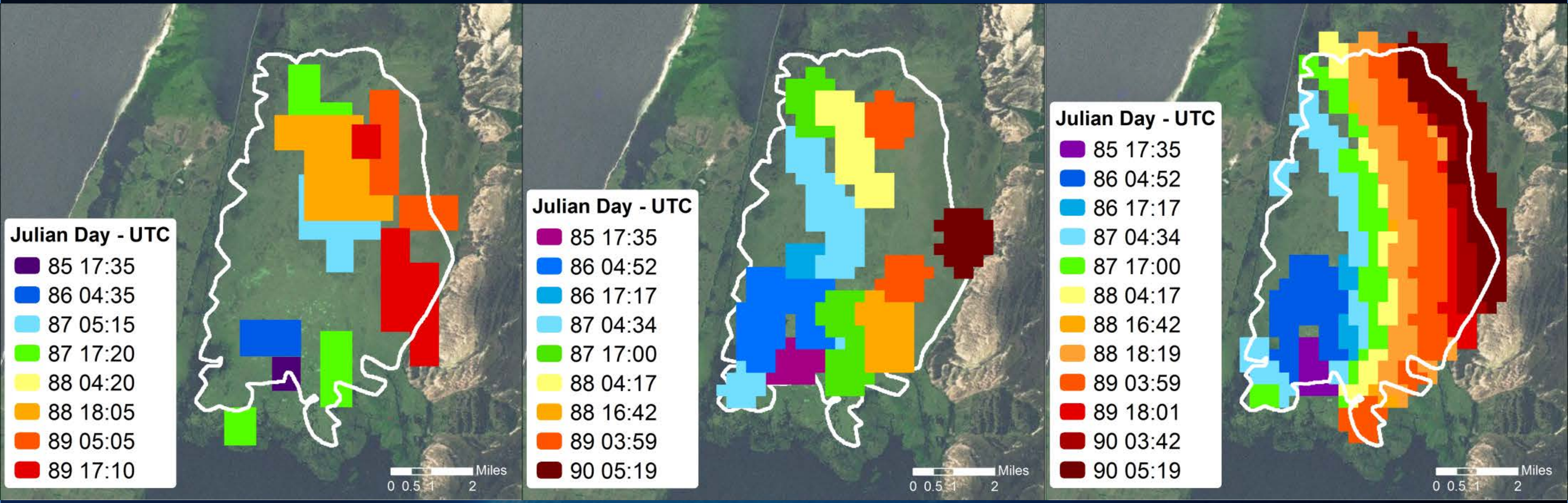
NOAA Hazard Mapping System

The Fire and Smoke Analysis is performed daily for the Continental US, Hawaii, Puerto Rico and Central America year round

Seasonal analysis performed for Alaska and Canada from May through November

Development of Spatially Refined Satellite Fire Products Enabling Improved Fire Mapping

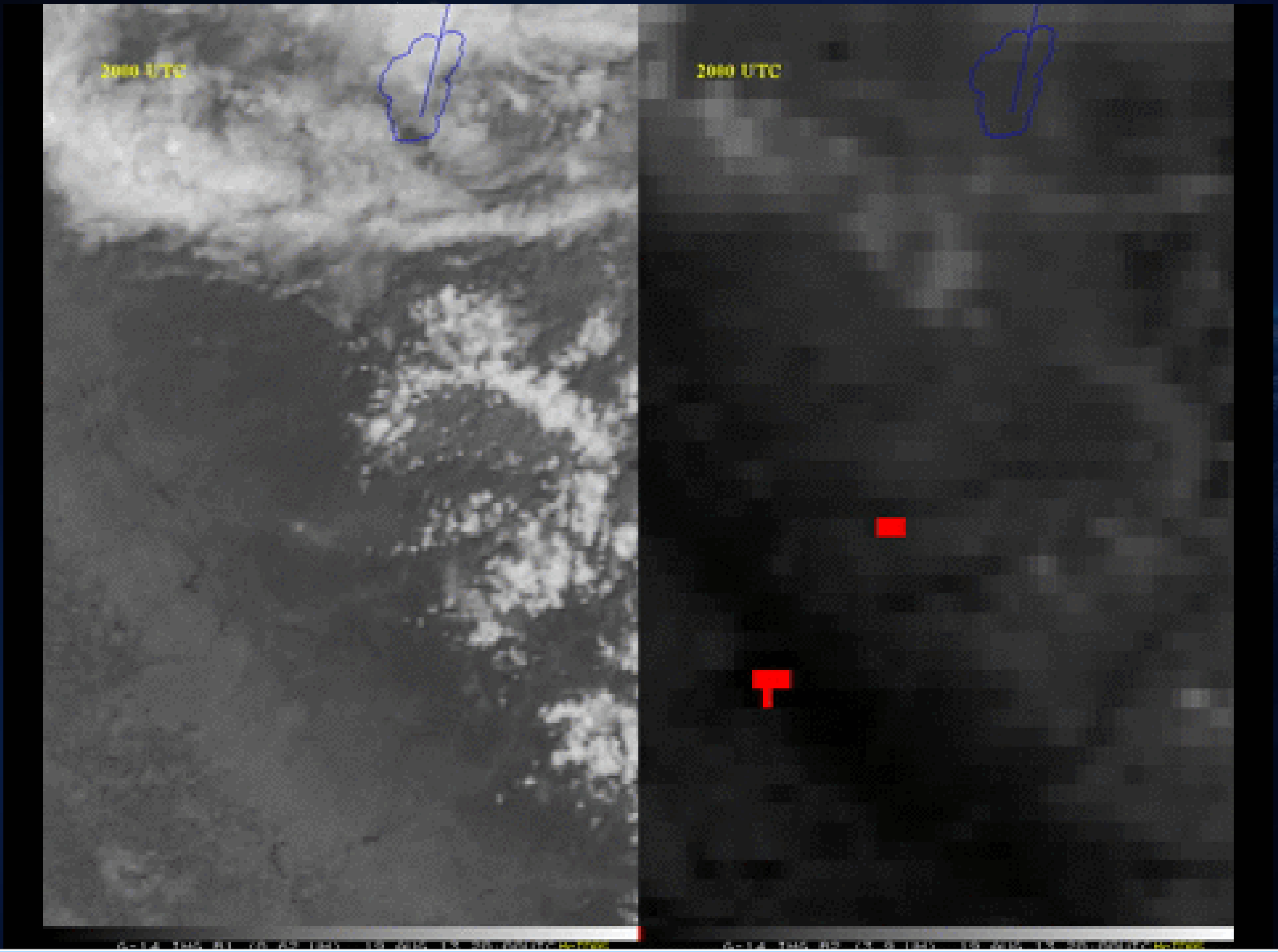
Grass fire in Southern Brazil, 26-31 March 2013



Aqua/MODIS 1 km Spotty detection pixels and coverage gap at low latitudes	S-NPP/VIIRS 750 m Spotty detection pixels	S-NPP/VIIRS 375 m Improved fire line mapping

Credit: Wilfrid Schroeder (UMD)
See for example: Schroeder et al., 2014 [doi:10.1016/j.rse.2013.12.008]

California Rim Fire



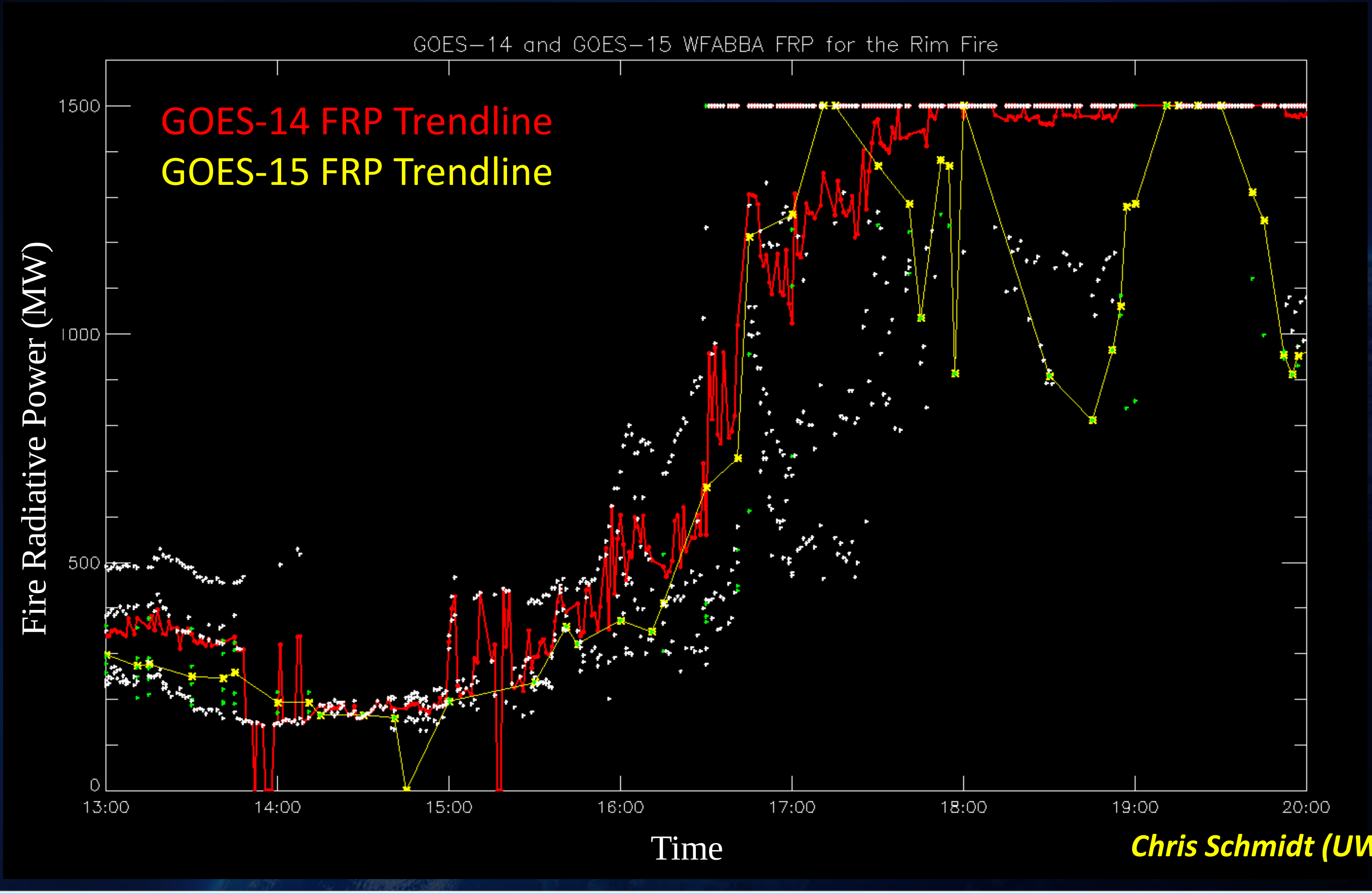
ABI's finer spectral, spatial, and temporal resolution will enable improvements in fire detection, characterization, monitoring, and forecasting.

We expect immediate and positive impacts on NWS Fire Operations

GOES-14/-15 Fire Radiative Power

22 August 2013

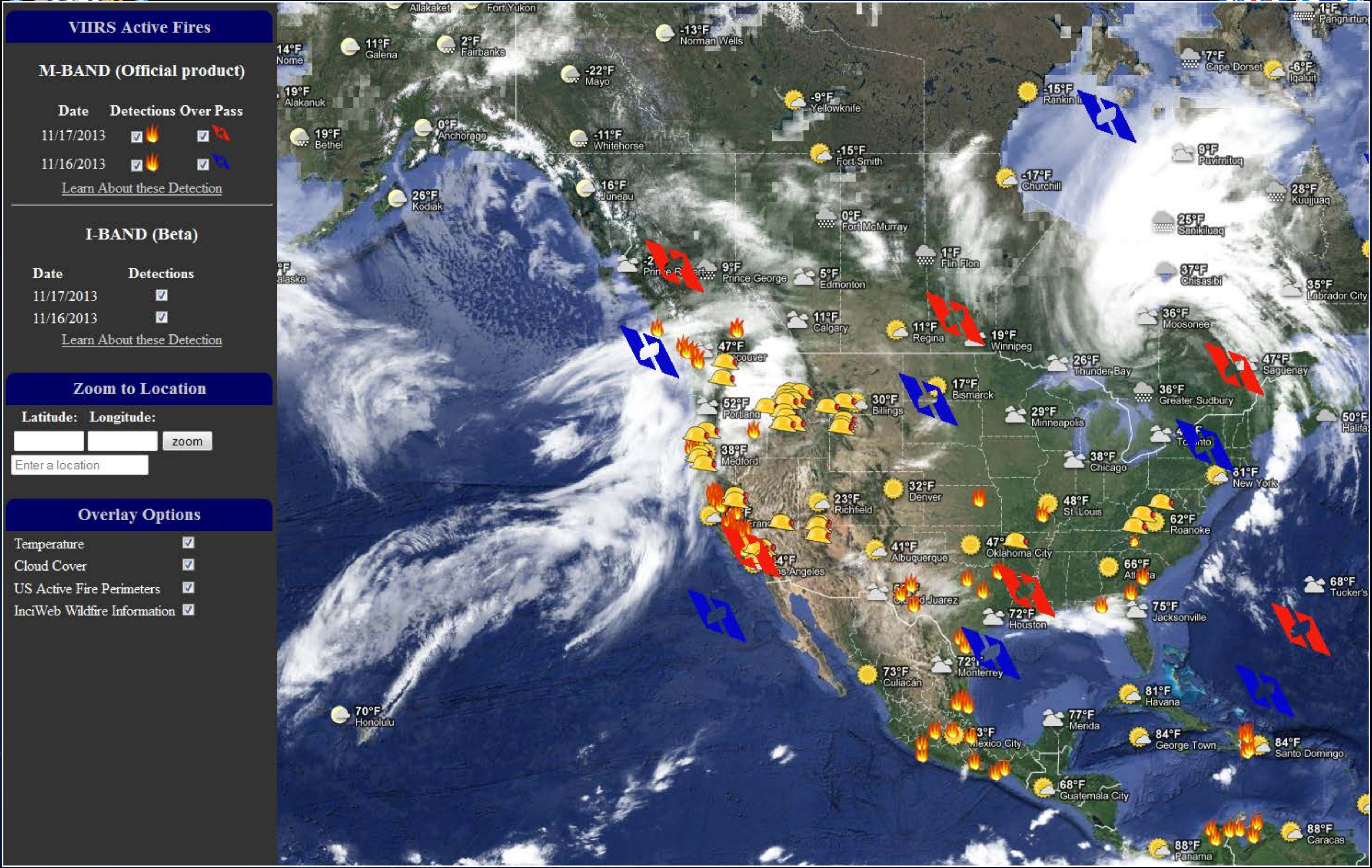
California Rimfire

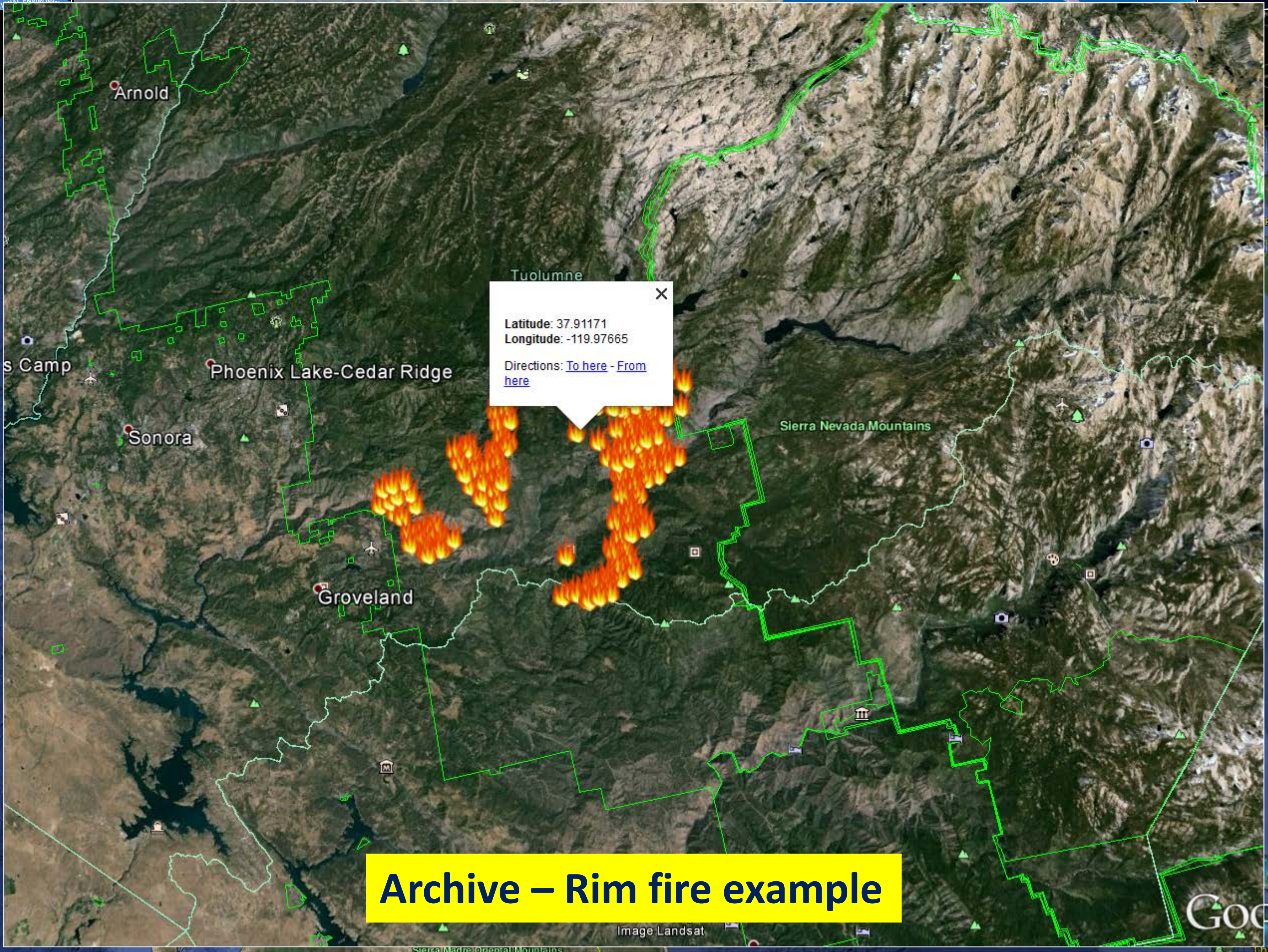


Chris Schmidt (UW/CIMSS)

GOES-14 SRSOR allowed capture of the intensification of the fire before it was observed with GOES-15 data (which was on the normal operational schedule).

We expect immediate and positive impacts on NWS Fire Operations


VIIRS Active Fires
M-BAND (Official product)
Date Detections Over Pass
11/17/2013
11/16/2013
Learn About these Detection
I-BAND (Beta)
Date Detections
11/17/2013
11/16/2013
Learn About these Detection
Zoom to Location
Latitude: Longitude:
zoom
Enter a location
Overlay Options
Temperature
Cloud Cover
US Active Fire Perimeters
InciWeb Wildfire Information



Archive – Rim fire example

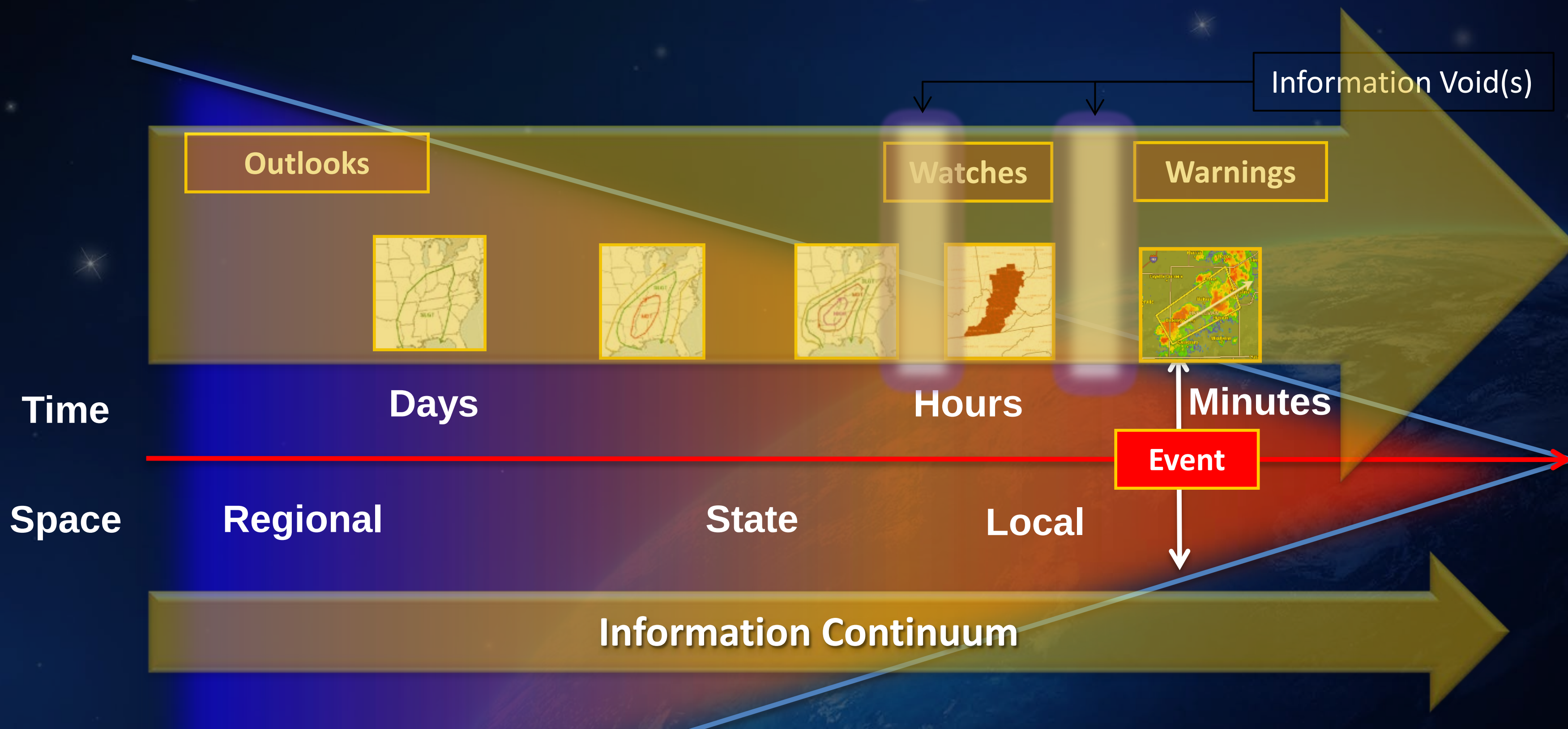
Fire Products: Take Home Messages

- **Latency is critical.**
- **Data format.**
  - User friendly (e.g. KML/KMZ).
  - Time is limited and they need "simple-stupid" products/data that can be opened and viewed quickly (i.e. Google Earth).
- **Users need one-stop shopping** (e.g. COP)
  - Need to obtain and use polar orbiting and geostationary data effectively.
  - Example – using the sequence of Aqua/VIIRS (0100), Terra (1000), Aqua/VIIRS (1300), Terra (2200) to build a picture of fire progression and location.
- For many, fire intensity (FRP) was not even a metric they were aware of.
- The thermal channels (e.g. MODIS channel 31/32) often used at night to see cloud/smoke location to estimate when and where it will impact fire behavior, inversions, and track movement.
  - We could be promoting other VIIRS products (cloud micro physics, AOD) along with the AVAFO. This would also assist the Smoke/Air Quality Analyst on the fire, who was also unaware of these types of products and their potential use (he was from the US Fish & Wildlife).
- **Fire Behavior Analysts (FBANs) and Long Term Analysts (LTANs)** – we are missing an audience here who was keenly interested in fire location, intensity, and vegetation products (e.g. EVI, NDVI, dNBR, etc.)

Applications for Severe Thunderstorms

- Pre-storm environment:
  - Mesoanalysis
    - Identification of air masses and boundaries.
- Monitor the changing environment during the nowcast to WDM time period.
  - Continue to identify boundaries and air masses.
  - Monitor interactions between boundaries / storms.
  - Consider storm-motion relative to boundary orientation.
  - Effects of outflow on the near-storm environment.
  - Identify potential satellite severe storm signatures.

Current Warning System "Challenges" Moving Towards Impact-based Decision Support System (DSS)



- **Product-centric and binary.**
- **More information needed.**
- **More information available.**

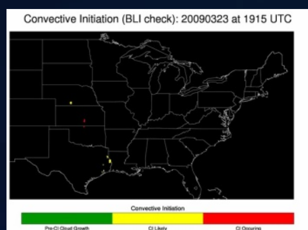
Adapted from Dr. Heather Lazrus (SSWIM)

NWS Vision to Integrate ABI and GLM Products with Other Data and Models

A Potential Operational Example: Convective Initiation/Severe Wx

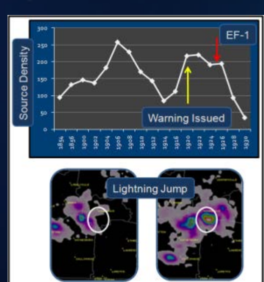
How can we integrate the information in future tools?

CI

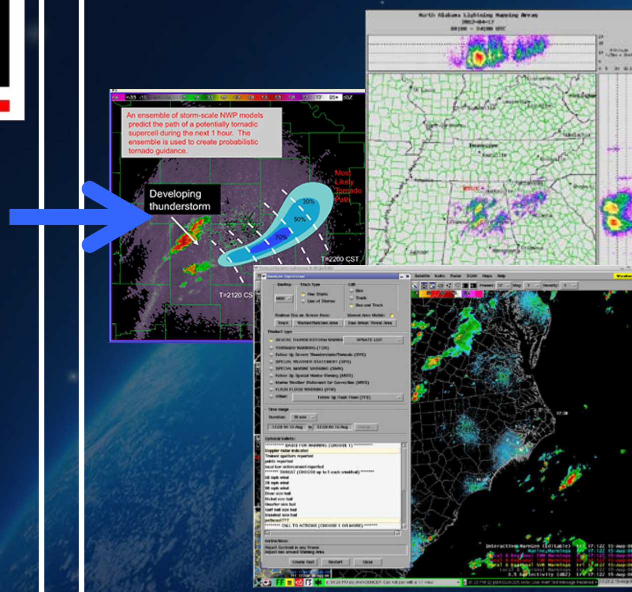


Over-shooting tops

Lightning Jumps



Next Generation Warning System



Why NWS needs this?

Situational Awareness
Warning confidence
Decision Support (venues)

<u>Situational Awareness:</u>

User comment: ‘Cloud Top Cooling product is an excellent source of enhancing the situational awareness for future convective initiation, particularly in rapid scan mode’.

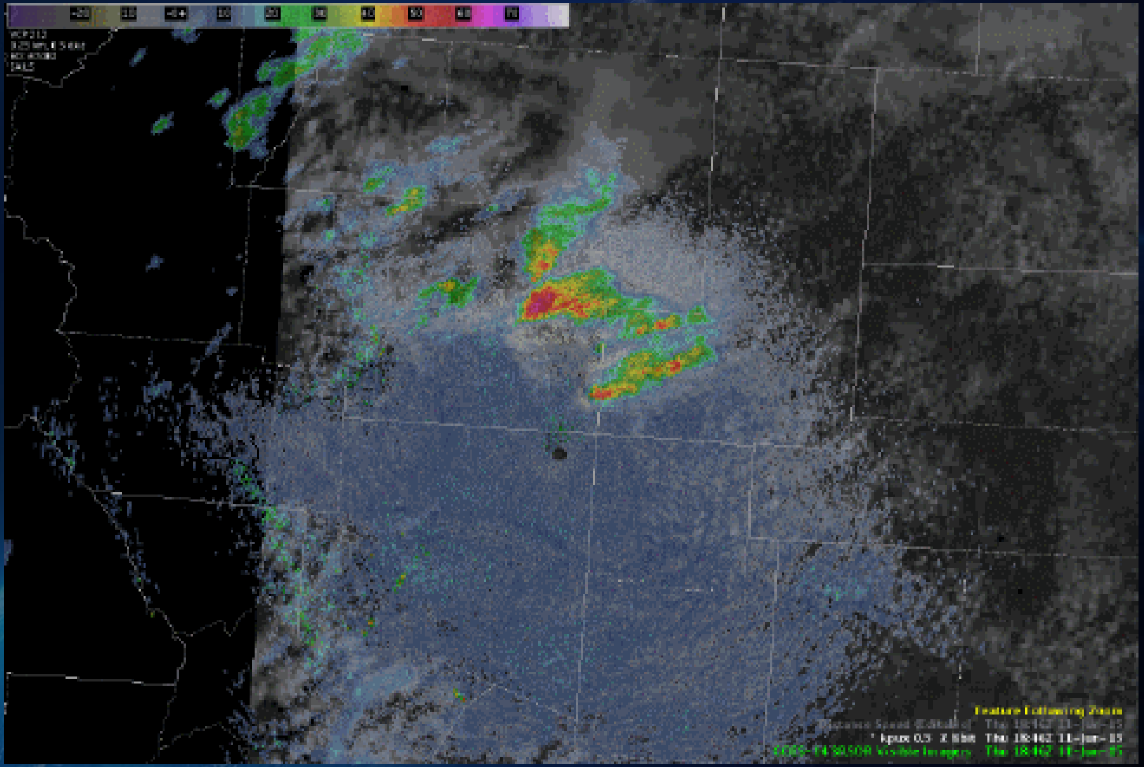
AWC Testbed forecaster

(June 2012)

HWT 1-Min Imagery Evaluation

- "I would love to have an Super Rapid Scan Satellite loop with reflectivity, and lightning somewhere on my D2D as a way to stay grounded with what is happening in real time during severe weather operations."

- "The 1 min satellite data was vital to my knowledge of the environment and subsequent warnings."

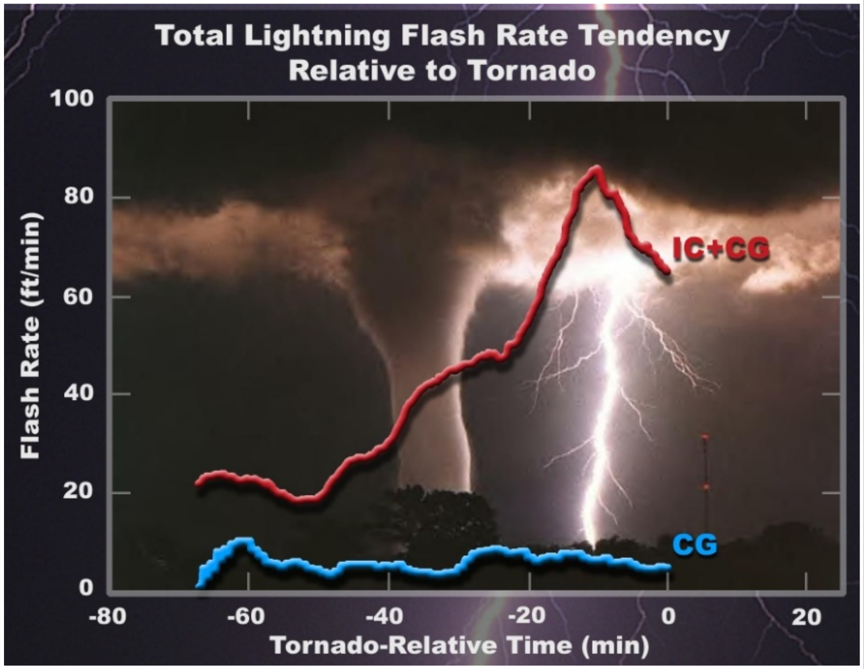


93% of days in 2015, forecasters found that the 1-min data provided them with significant information not captured in the routine satellite imagery.

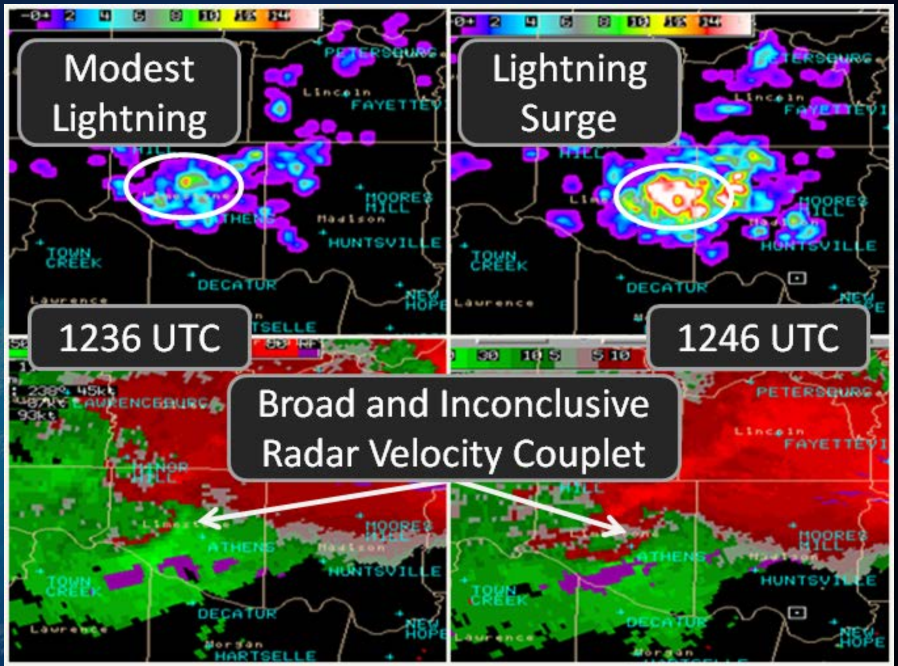
Lightning Jumps and Severe Storms

Improved forecaster situational awareness and confidence results in more accurate severe storm warnings (i.e., improved lead times and reduced false alarms)

Current national average for tornado warning lead-time is ~13 minutes



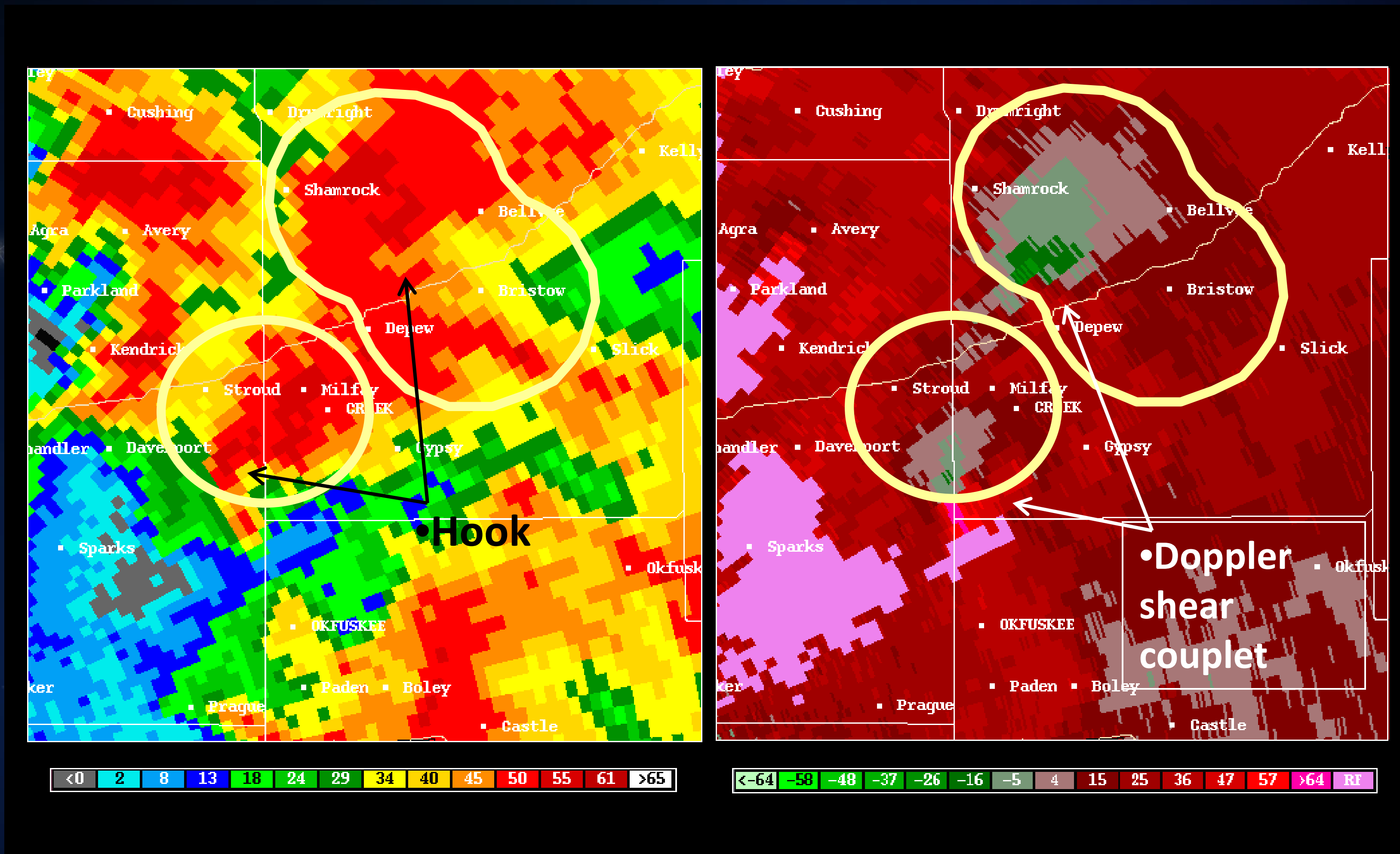
Lightning flash rate increase can be a predictor of tornado formation



Total lightning (Upper) from the North Alabama Lightning Mapping Array (LMA) coincident with NEXRAD radar-derived storm relative velocity (Lower) at 1236 (Left) and 1246 (Right) UTC on 6 May 2003. Image courtesy of Geoffrey Stano and SPoRT.

OK Tornado Outbreak 3 May 1999

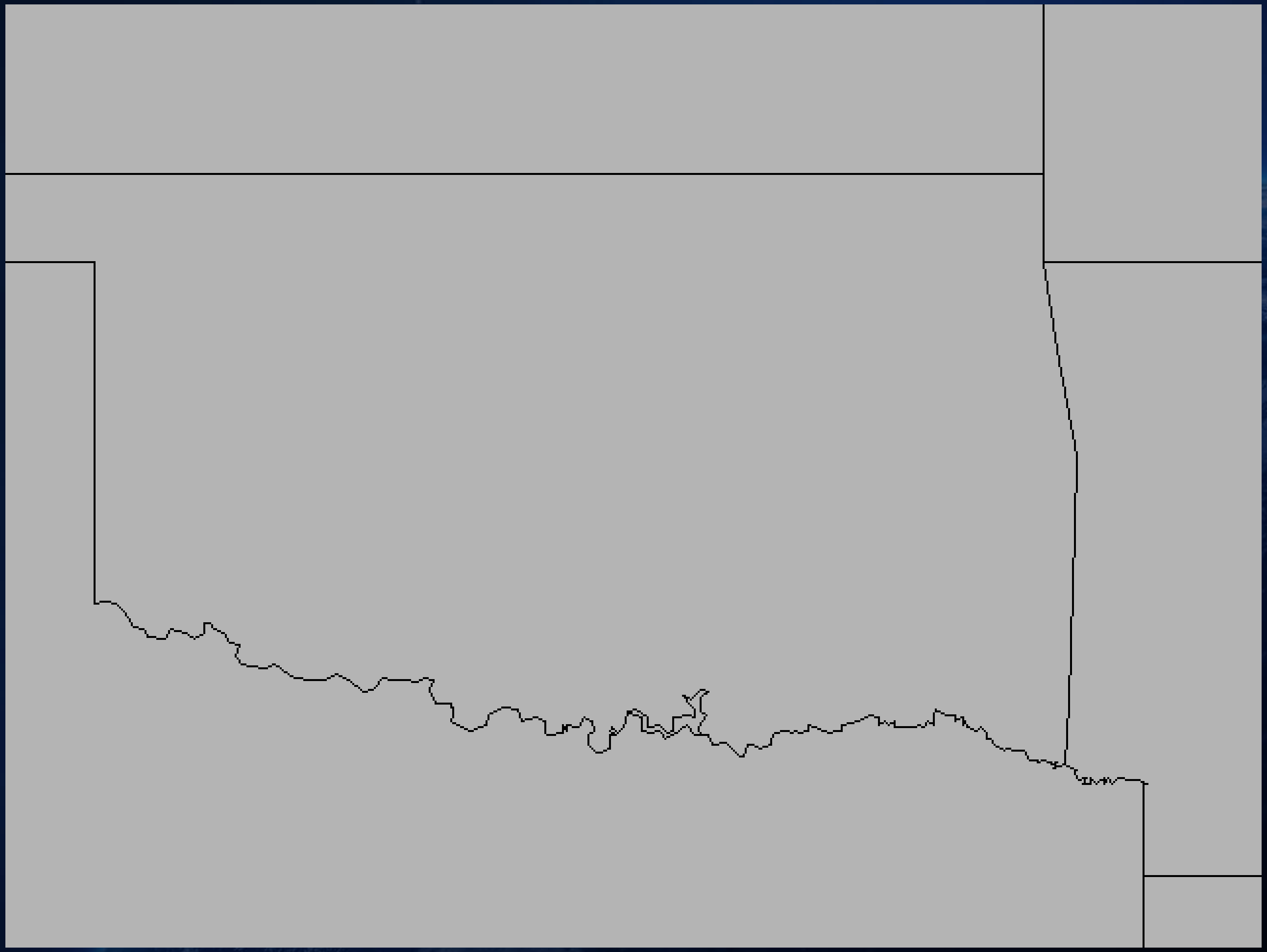
NEXRAD Reflectivity | NEXRAD Velocity



Active lightning region in tornadic supercell … correlates with radar hook echo and velocity couplet

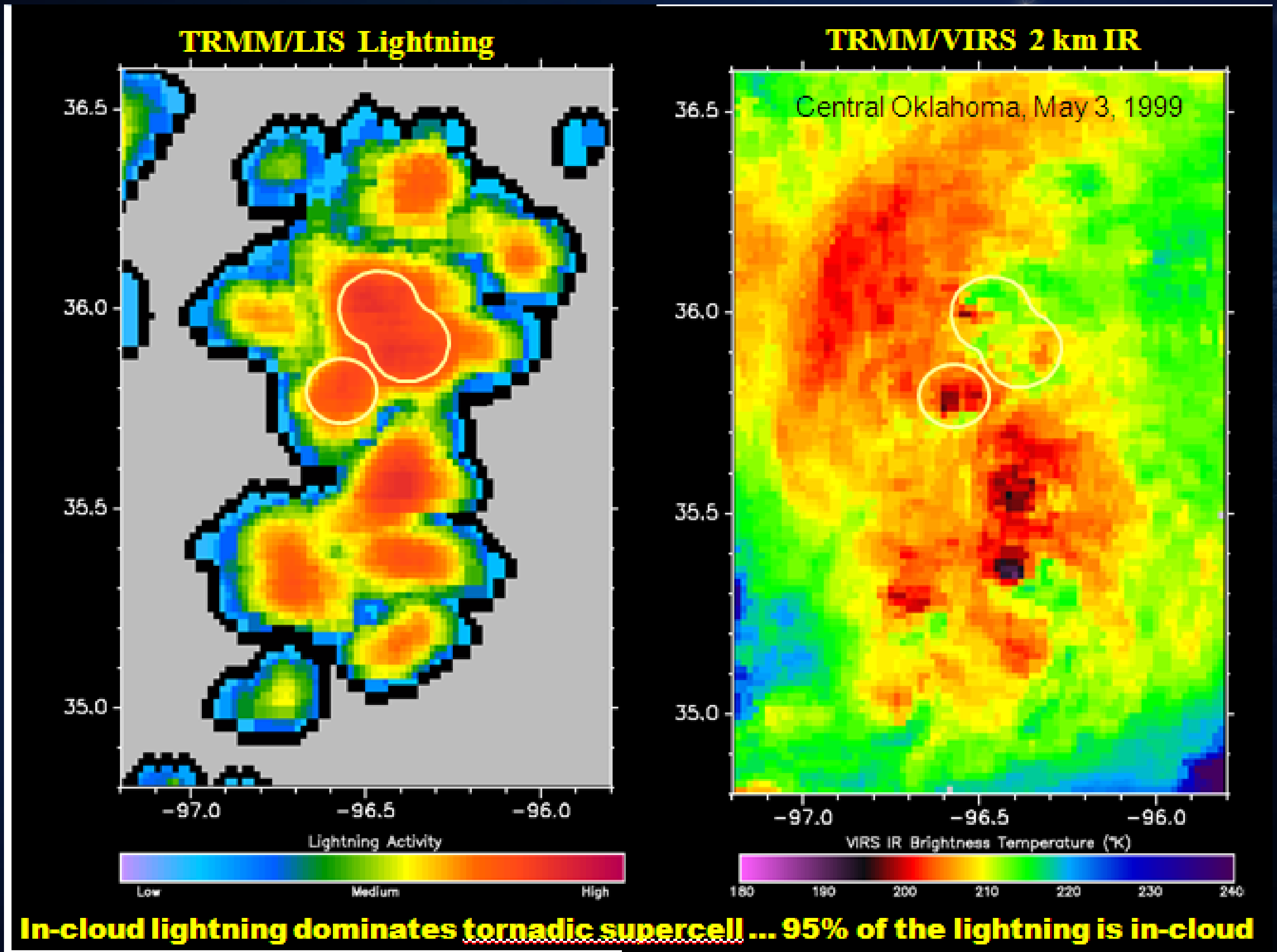
Total Lightning Detection

1-min TRMM/LIS overpass, May 3, 1999 tornado outbreak

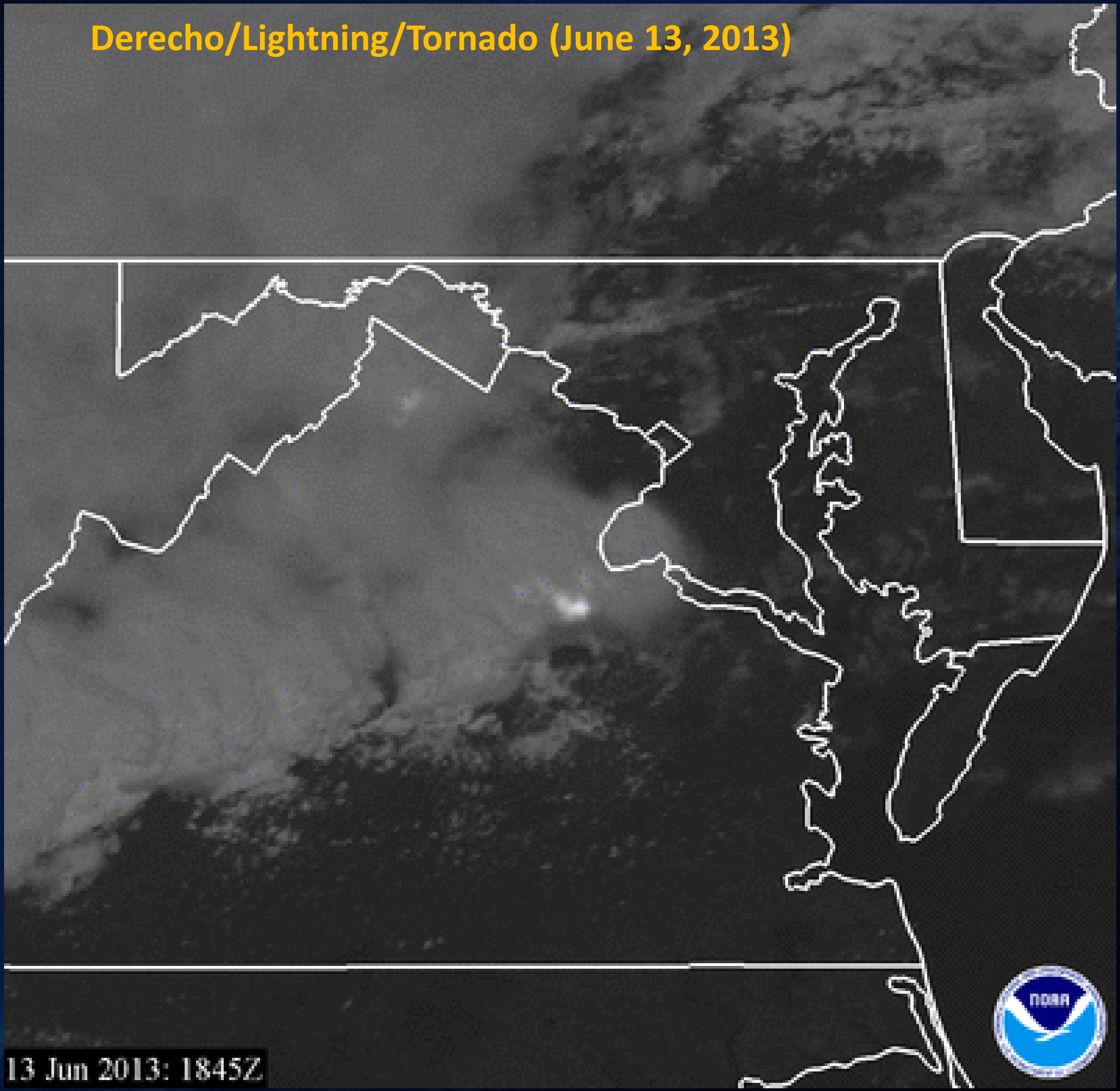


Total Lightning Dominates During OK Tornado: 3 May 1999

GLM and ABI Combined (with radar) characterizes storm intensification and decay)



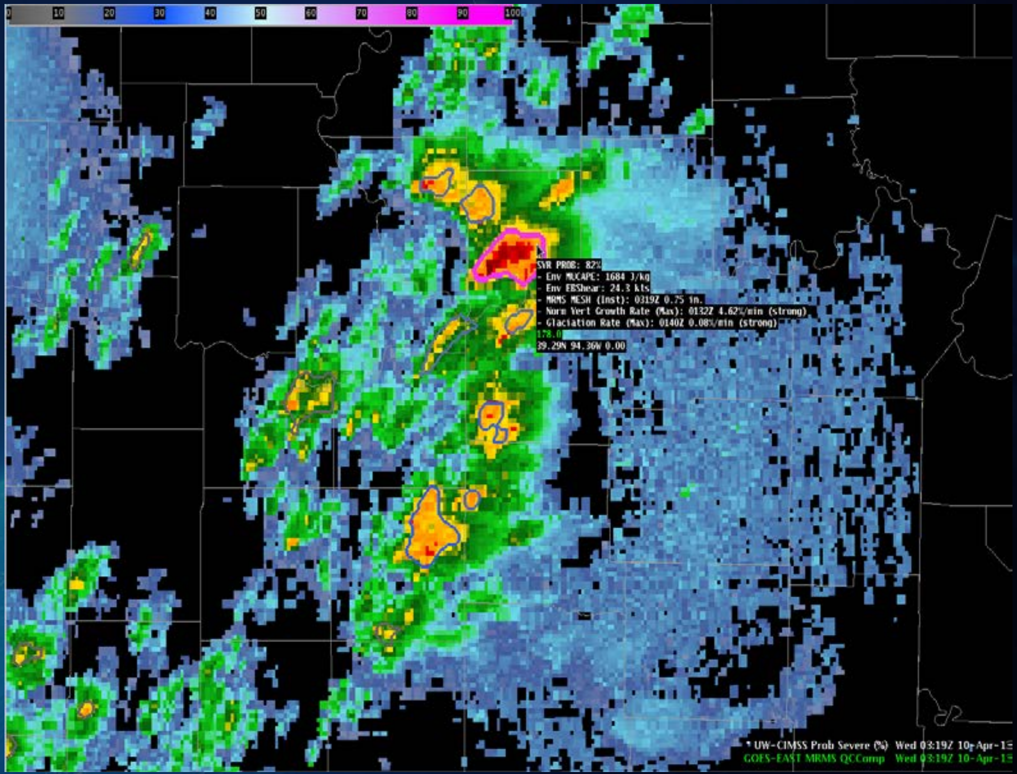
GOES-R Rapid Refresh- 1-min Imagery and Lightning



Courtesy of Scott Rudlosky, CICS-MD

Probabilistic Forecasting of Severe Convection through Data Fusion

- GOES-derived cloud growth rates, NEXRAD-derived products, and NWP-derived fields are used as input into a statistical model to compute the probability that a storm will first produce severe weather in the near-term
- Satellite and radar object-tracking are used to keep a history of storm development
- FY15-16 R3 project will investigate total lightning data and additional NWP sources, as well as advantages to be gained using super-rapid scan data
- The product display will complement NWS warning operations
- The product will be evaluated in testbeds and proving ground experiments

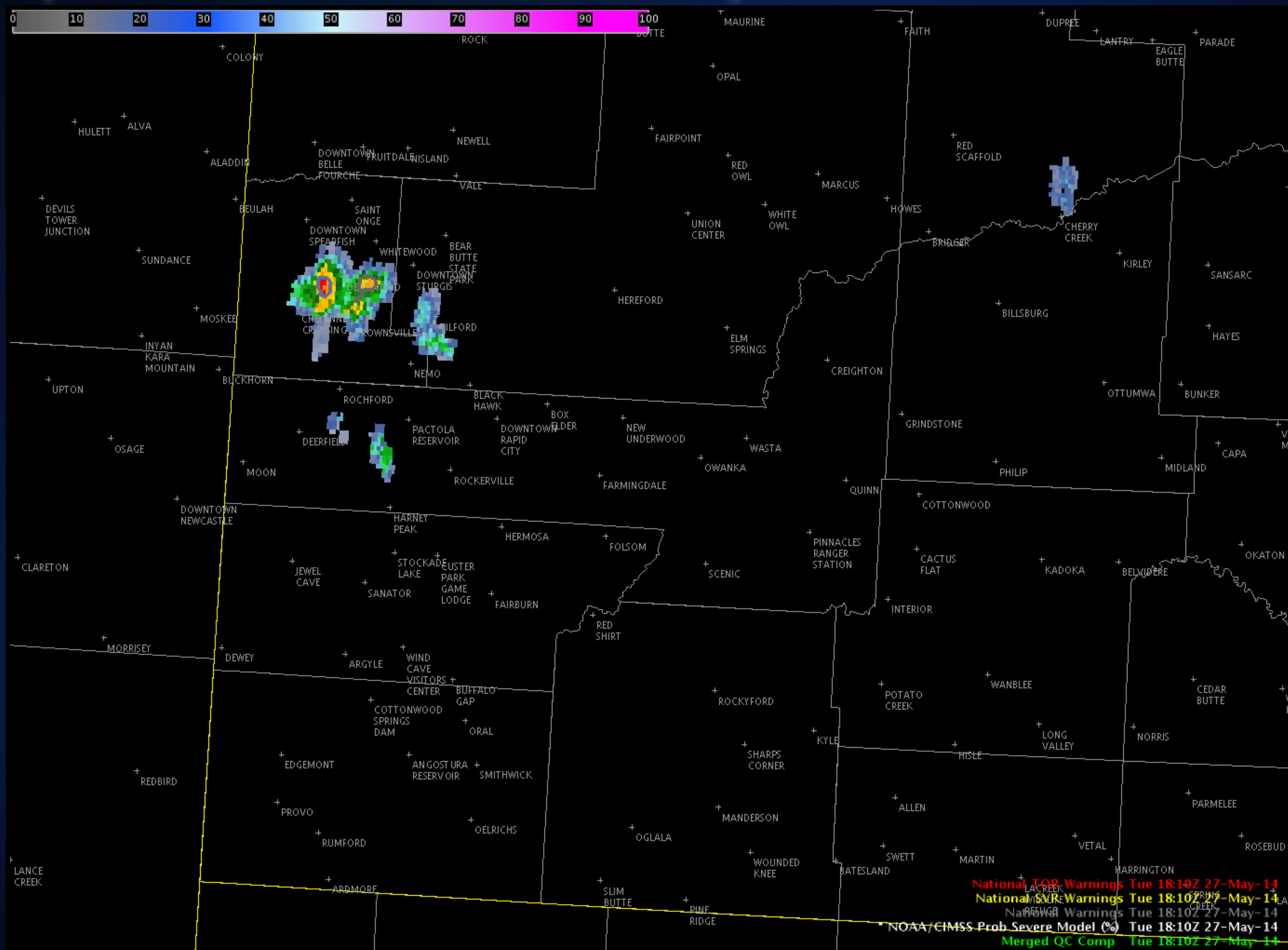


Merged radar reflectivity with model probability of severe contours. The highlighted storm had strong satellite growth rates, contributing to a high probability prior to severe hail occurrence. No warning was issued.

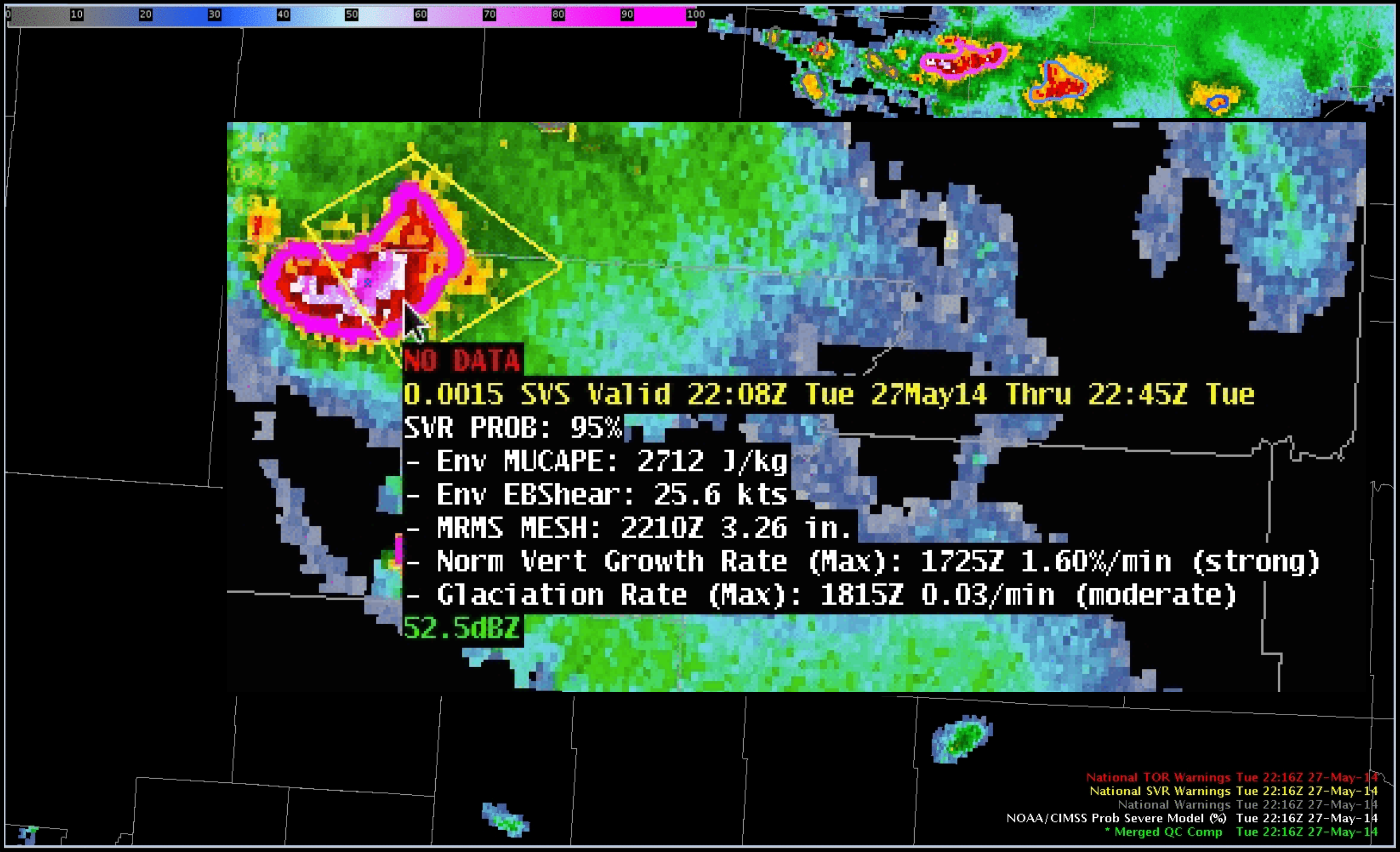
Help NWS forecasters skillfully increase warning lead time to severe hazards

M. Pavolonis (STAR/ASPB) and J. Cintineo (UW-CIMSS), J. Sieglaff (UW-CIMSS), D. Lindsey (STAR/RAMMB), D. Bikos (CSU-CIRA)

Probability of Severe Convection



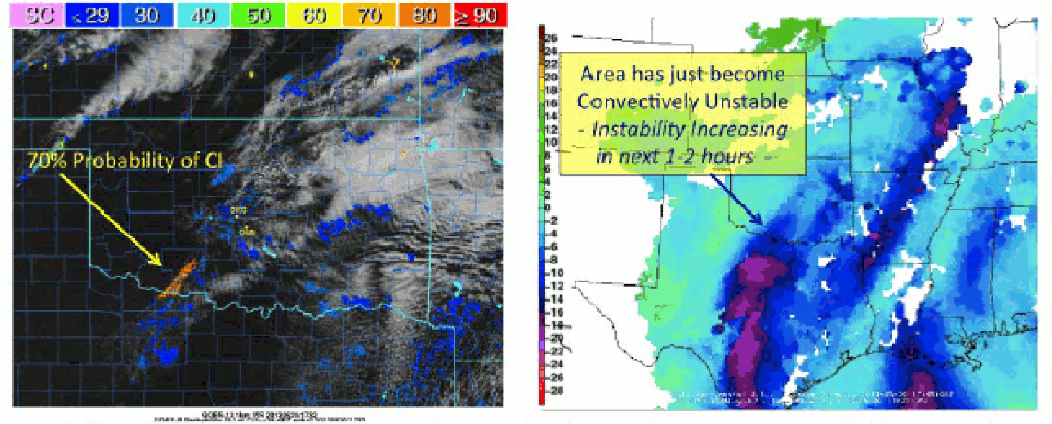
Probability of Severe Convection



Development and Demonstration of the Fusion of GOES-R Legacy Sounding NearCasts with Convective Initiation Products to Improve Convective Weather Nowcasts

- GOES-R convective initiation (CI) algorithm is only product that provides CI information for convective storms
- CI algorithm currently over-forecasts due to little knowledge of convective environment parameters
- FY15-16 R3 project will improve CI algorithm nowcasts by incorporating GOES-R NearCast algorithm forecasts into the CI algorithm framework, effectively gaining the missing convective environmental information
- Methodology will maximize use of all GOES-R ABI capabilities
- Improved convective weather nowcasts will be available in formats compatible with AWIPS (II)/NAWIPS systems

GOES-R CI (% Probability Cloud Object Reaching 35 dBZ) and NearCast Convective Instability from 1500 UTC, both valid 1730 20 May 2013.



GOES-R CI (%) and GOES-13 Visible valid 20 May 2013 at 1732 UTC

GOES-R 2.5 hr NearCast of Convective Instability (Δθe) from 1500 UTC 20 May 2013

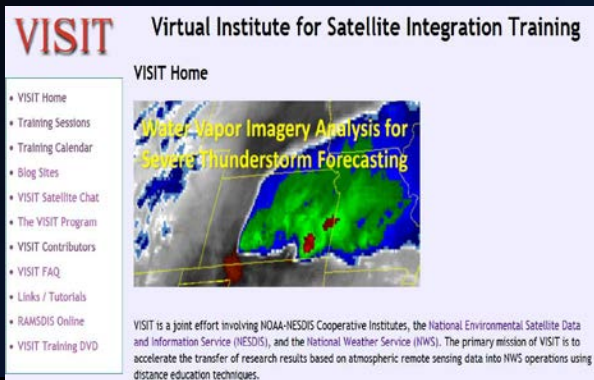
GOES-R CI analysis (left) and NearCast Convective Instability forecast (right) valid 1730 UTC 20 May 2013 illustrating the complimentary nature of the two algorithm datasets

Improve convective initiation nowcasts via fusion of two established GOES-R algorithms

L. Cronce (UW-CIMSS), J. Mecikalski (UAH), and R. Petersen (UW-CIMSS)

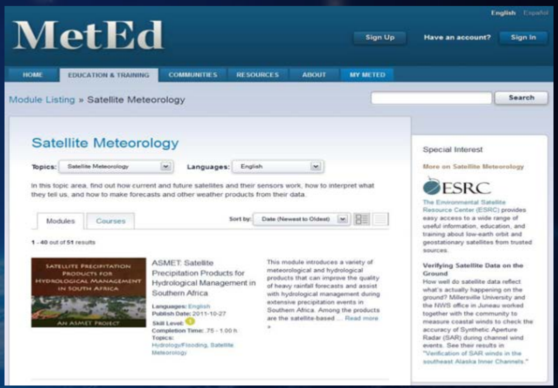
TRAINING

Working Together for Satellite Training



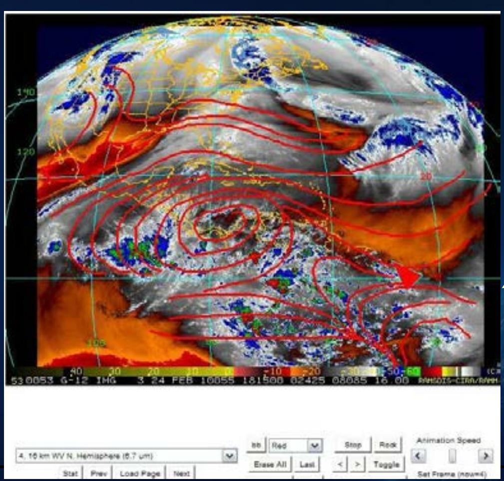
VISIT (CIRA/CIMSS)

NASA/SPoRT, DOD, …



UCAR/COMET®

Satellite Proving Ground



WMO, EUMETSAT, Canada, …

Users & Developers

Training Division + SOOs & DOHs

Training and User Education Update

New!

Updated!

Online Training Modules

- GOES-R ABI: Next Generation Satellite Imaging (COMET)
- GOES-R: Benefits of Next-Generation Environmental Monitoring (COMET)
- The Geostationary Lightning Mapper (COMET)
- GOES-R 101
- Satellite Hydrology and Meteorology for Forecasters (SHyMet)
- SPoRT product training modules
- VISIT Training Resources
- Commerce Learning Center

Printed Materials

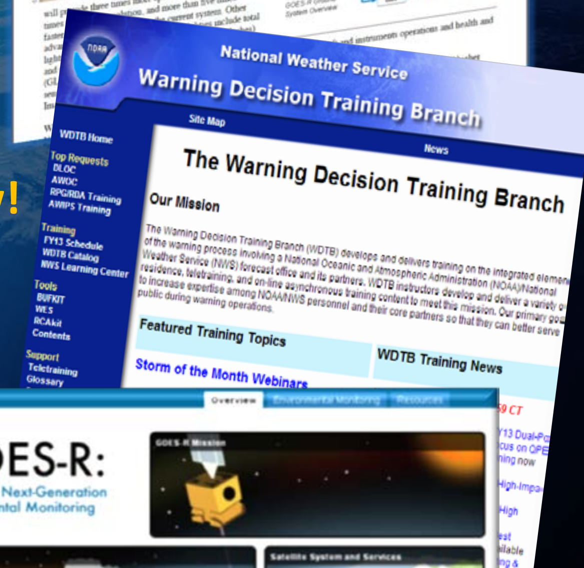
- GOES-R Fact Sheets (18)
- GOES-R Tri-fold
- User Readiness Plan
- GRB Downlink Specifications and Product Users Guide

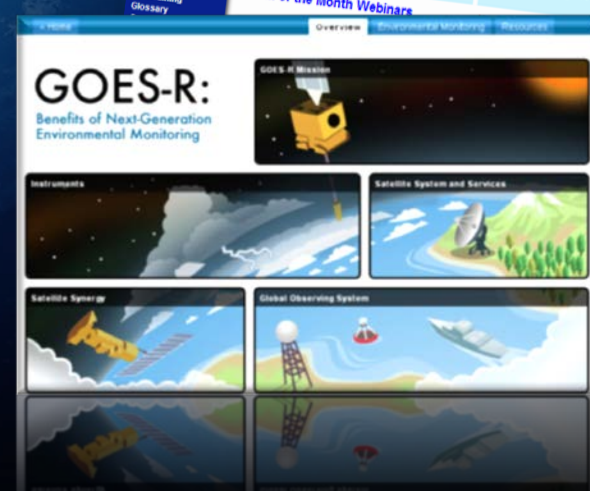
GRB Simulators

- Available to vendors 2013
- Industry Day October 25, 2013

New!

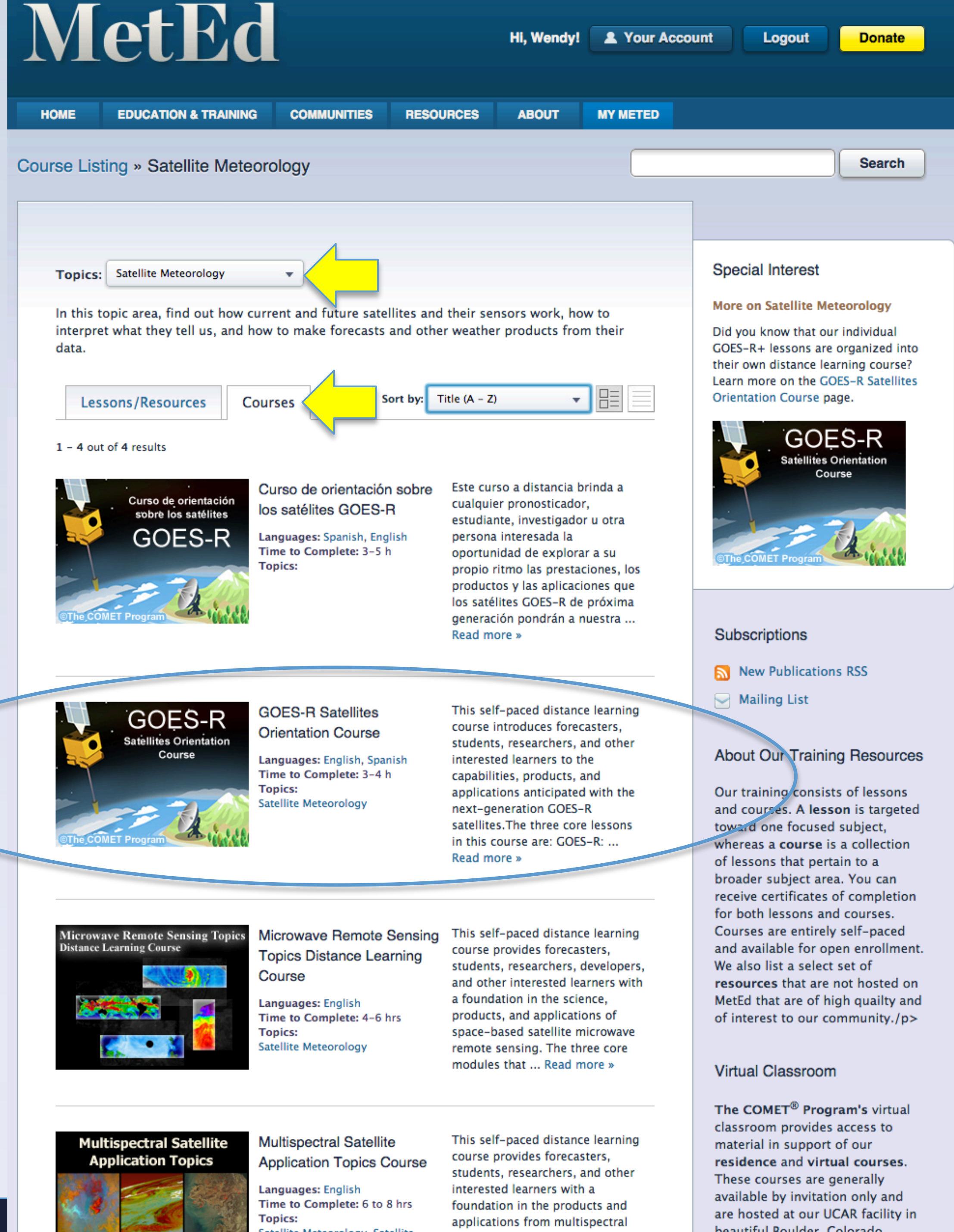
New!





http://www.goes-r.gov/users/training.html

COMET MetEd



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In this topic area, find out how current and future satellites and their sensors work, how to interpret what they tell us, and how to make forecasts and other weather products from their data.
Lessons/Resources
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Sort by: Title (A - Z)
1 - 4 out of 4 results
Curso de orientación sobre los satélites GOES-R
Languages: Spanish, English
Time to Complete: 3-5 h
Topics:
Este curso a distancia brinda a cualquier pronosticador, estudiante, investigador u otra persona interesada la oportunidad de explorar a su propio ritmo las prestaciones, los productos y las aplicaciones que los satélites GOES-R de próxima generación pondrán a nuestra ... Read more »
GOES-R Satellites Orientation Course
Languages: English, Spanish
Time to Complete: 3-4 h
Topics: Satellite Meteorology
This self-paced distance learning course introduces forecasters, students, researchers, and other interested learners to the capabilities, products, and applications anticipated with the next-generation GOES-R satellites.The three core lessons in this course are: GOES-R: ... Read more »
Microwave Remote Sensing Topics Distance Learning Course
Languages: English
Time to Complete: 4-6 hrs
Topics: Satellite Meteorology
This self-paced distance learning course provides forecasters, students, developers, and other interested learners with a foundation in the science, products, and applications of space-based satellite microwave remote sensing. The three core modules that ... Read more »
Multispectral Satellite Application Topics Course
Languages: English
Time to Complete: 6 to 8 hrs
Topics: Satellite Meteorology, Satellite
This self-paced distance learning course provides forecasters, students, researchers, and other interested learners with a foundation in the products and applications from multispectral satellite observations and various
Special Interest
More on Satellite Meteorology
Did you know that our individual GOES-R+ lessons are organized into their own distance learning course? Learn more on the GOES-R Satellites Orientation Course page.
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About Our Training Resources
Our training consists of lessons and courses. A lesson is targeted toward one focused subject, whereas a course is a collection of lessons that pertain to a broader subject area. You can receive certificates of completion for both lessons and courses. Courses are entirely self-paced and available for open enrollment. We also list a select set of resources that are not hosted on MetEd that are of high quailty and of interest to our community./p>
Virtual Classroom
The COMET® Program's virtual classroom provides access to material in support of our residence and virtual courses. These courses are generally available by invitation only and are hosted at our UCAR facility in beautiful Boulder, Colorado.

Languages: English
Completion Time: 3-4 h
Topics:
Satellite Meteorology

Enrollment Information:

Enroll

Description | Objectives | Overview | Additional Resources

Description

This self-paced distance learning course introduces forecasters, students, researchers, and other interested learners to the capabilities, products, and applications anticipated with the next-generation GOES-R satellites.

The three core lessons in this course are:

- GOES-R: Benefits of Next-Generation Environmental Monitoring
- GOES-R ABI: Next Generation Satellite Imaging
- GOES-R GLM: Introduction to the Geostationary Lightning Mapper

Course Outline

Core Topics/Modules

GOES-R: Benefits of Next-Generation Environmental Monitoring
Languages: English, Spanish
Publish Date: 2008-12-19
Last Updated On: 2013-04-18
Skill Level: 1
Topics: Emergency Management, Satellite Meteorology
(2 reviews)

GOES-R ABI: Next Generation Satellite Imaging
Languages: English, Spanish
Publish Date: 2013-02-19
Skill Level: 1
Topics: Satellite Meteorology
(0 reviews)

GOES-R GLM: Introduction to the Geostationary Lightning Mapper
Languages: English, Spanish
Publish Date: 2014-09-05
Skill Level: 1
Topics: Mesoscale Meteorology, Satellite Meteorology
(1 review)

Optional Topics/Modules

Multispectral Satellite Applications: RGB Products Explained Optional
Languages: English, Spanish
Publish Date: 2013-07-08
Last Updated On: 2013-07-22
Skill Level: 2
Topics: Satellite Meteor

Multispectral Satellite Applications: Monitoring the Wildland Fire Cycle, 2nd Edition Optional
Languages: English
Publish Date: 2013-06-11
Skill Level: 2
Topics: Fire Weather, S

How Satellite Observations Impact NWP Optional
Languages: English
Publish Date: 2014-03-12
Last Updated On: 2013-06-14
Skill Level: 2
Topics: Numerical Modeling (NWP), Satellite Meteorology
(2 reviews)

Satellite Meteorology: GOES Channel Selection V2 Optional
Languages: English, Spanish
Publish Date: 2011-05-04
Skill Level: 2
Topics: Satellite Meteorology
(0 reviews)

Advanced Himawari Imager (AHI): What's Different from the GOES-R Advanced Baseline Imager (ABI) Optional
Languages: English
Publish Date: 2015-01-27
Last Updated On: 2015-02-09
Skill Level: 1
Topics: Satellite Meteorology
(0 reviews)

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COMET MetEd RGB Lesson

Multispectral Applications: RGB Products Explained

(updated July 2013)

- **http://meted.ucar.edu**
- **http://meted.ucar.edu/topics/satellite**
- **https://www.meted.ucar.edu/training_module.php?id=568**

or search by keywords for either Lessons, Courses, or Images & Media

Slide courtesy of Patrick Dills

dills@ucar.edu

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http://meted.ucar.edu/goes_r/glm

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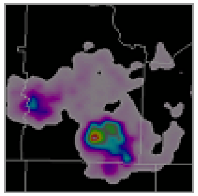
Training Modules for the GOES-R Proving Ground: Total Lightning

TRAINING

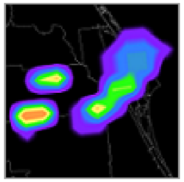


Total Lightning Training: Part 1

Download *(for NWS users; 8.3 MB)*
Launch in browser
(user guide)

This is Part 1 of 2 Lightning Mapping Array training modules. This module introduces the user to total lightning and the source density product provided by NASA SPoRT. While the North Alabama Array is the focus of this module, the concepts can be applied to any total lightning network. Users will learn the difference between total lightning and National Lightning Detection Network (NLDN) data. Also, the concept of a lightning jump will be introduced, which has great use in enhancing the warning decision making process. This module is 16 minutes long and requires the flash plug-in. (March 2009)

TRAINING

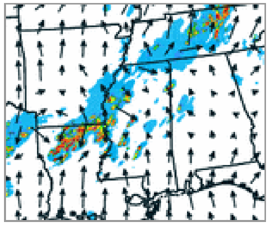


Pseudo Geostationary Lightning Mapper

Download *(for NWS users; 14 MB)*
Launch in browser
(user guide)

This module is an update to the original 2010 training module with new information, graphics, and content. This module introduces SPoRT's Pseudo Geostationary Lightning Mapper Flash Extent Density product and variants for use in the GOES-R Proving Ground. The Pseudo GLM is intended as a training product for forecasters ahead of the GOES-R era and to prepare forecasters for the more robust GLM Proxy product under development by the Algorithm Working Group. Experts with total lightning and the GLM have contributed to this module that provides brief overviews of total lightning and the actual GLM instrument. Additionally, the Pseudo GLM is described and examples of its use are provided. As this module is intended for preparation for GOES-R Proving Ground activities, particularly the Hazardous Weather Testbed's Spring Program the length is a little longer than most SPoRT modules. This module is 37 minutes long and requires the flash plug-in. (Updated March 2012)

TRAINING



WRF Model Lightning Forecast Algorithm (LFA)

Download PDF *(1.2 MB)*
Authors: Eugene McCaul, Kevin Fuell, Geoffrey Stano, and Jonathan Case

This tutorial provides background information on the development, calibration, and application of the Lightning Forecast Algorithm (LFA), as implemented into the Weather Research and Forecasting (WRF) numerical weather prediction model. The LFA is a demonstration product for use in the GOES-R Proving Ground to develop model proxy fields of total lightning that could be used in future data assimilation applications of the Geostationary Lightning Mapper. Since the initial journal publication in 2009, the LFA has been implemented into the NSSL WRF 4-km daily model runs beginning in Spring 2010, and was incorporated into the Storm Scale Ensemble Forecast runs for the 2011 Experimental Forecast Program in Norman, Oklahoma. The LFA is also being run within the High Resolution Rapid Refresh at the Global Systems Division in Boulder, CO. (November 2011)

http://weather.msfc.nasa.gov/sport/training/

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FY11-12 Live Training Sessions

Synthetic Imagery in Forecasting Orographic Cirrus (January 2011)

Synthetic Imagery in Forecasting Severe Weather (February 2011)

Objective Satellite-Based Overshooting Top and Enhanced-V Anvil Thermal Couplet Signature Detection (February 2011)

Volcanoes and Volcanic Ash Part 2 (March 2011)

GOES-15 Becomes GOES-West (December 2011)

VISIT Satellite Chats (short, interactive discussions, Q&A, monthly since February 2012)

Topics:

- Fog and Low-Cloud Detection from Satellite (2-22-2012)
- Water Vapor Imagery (3-21-2012)
- Satellite Related Severe Weather Products (4-25-2012)
- Fire Weather Imagery and Products (5-23-2012)
- Mesoscale Convective Vortices (6-27-2012)

Synthetic Imagery in Forecasting Low Clouds and Fog (April 2012)

Pseudo GOES Lightning Mapper (May 2012)

Tropical Cyclone Intensity Model Guidance Used by NHC (June 2012, updated)

Tropical Cyclone Track Model Guidance Used by NHC (June 2012, updated)

Convective Cloud Top Cooling, UW Convective Initiation Algorithm (July 2012)

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Training Sessions

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Title	Topic	Developed	Level	Instructor(s)	Recorded	Talking points	Live Training	Length (Min)
A Brief Introduction to Social Science: A course for physical scientists	Social Science	2015	Basic	Weaver	N	Y	Y	30
NOAA/CIMSS ProbSevere Product	Severe / Sat	2014	Basic	Lindstrom	Y	Y	Y	30
Use of VIIRS imagery for Tropical Cyclone Forecasting	Tropical / Sat	2015	Basic	Knaff ; Chirokova	Y	N	N	12
NUCAPS Soundings in AWIPS	Satellite	2015	Basic	Lindstrom	Y	Y	Y	20
Can total lightning help with warnings for non-supercell tornadoes?	Severe	2015	Basic	Szoke ; Bikos	Y	N	Y	30
Tracking the Elevated Mixed Layer with a new GOES-R Water Vapor Band	Severe / Sat	2015	Basic	Bikos; Szoke	Y	N	Y	20
1-minute Visible Satellite Imagery Applications for Severe Thunderstorms	Severe / Sat	2014	Basic	Bikos; Szoke	Y	N	N	22
VIIRS Imagery Interpretation of Super Typhoon Vongfong	Tropical / Sat	2014	Basic	Knaff	Y	N	N	10
GPM Mission Overview	Satellite	2014	Basic	King	Y	N	N	8
Identifying Snow with Daytime RGB Satellite Products	Satellite Proving Ground	2013	Basic	Connell	Y	Y	Y	30
VIIRS Satellite Imagery in AWIPS	Satellite	2013	Basic	Bachmeier; Lindstrom	Y	N	Y	45
AWIPS Blended Rain Rate Product	Satellite	2012	Basic	Van Til	Y	N	N	10
Forecaster Training for the GOES-R Fog/low stratus (FLS) Products	Satellite Proving Ground	2012	Basic	Pavolonis; Calvert	Y	Y	Y	60
Synthetic Imagery in Forecasting Cyclogenesis	Satellite Proving Ground	2012	Basic	Bikos	Y	Y	Y	30
Synthetic Imagery in Forecasting Low Clouds and Fog	Satellite Proving Ground	2012	Basic	Bikos	Y	Y	Y	30
GOES-15 Becomes GOES-West	Satellite	2011	Basic	Van Til; Motta	Y	N	N	30
Volcanoes and Volcanic Ash Part 2	Aviation / Satellite	2011	Basic	Braun	Y	Y	N	90
Objective Satellite-Based Overshooting Top and Enhanced-V Anvil Thermal Couplet Signature Detection	Satellite Proving Ground	2011	Basic	Lindstrom	Y	Y	Y	60
Synthetic Imagery in Forecasting Severe								

4:50 PM 10/5/2015

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http://dx.doi.org/10.1016/j.atmosres.2015.06.005

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GOES- R Additional Information

GOES-R web site

http://www.goes-r.gov

NOAA Satellite Services

http://www.ospo.noaa.gov/Services/

GOES-R FAQs

http://www.goes-r.gov/resources/faqs.html

GOES-R Rebroadcast (GRB), Product Users Guide, Downlink Specifications

http://www.goes-r.gov/users/grb.html

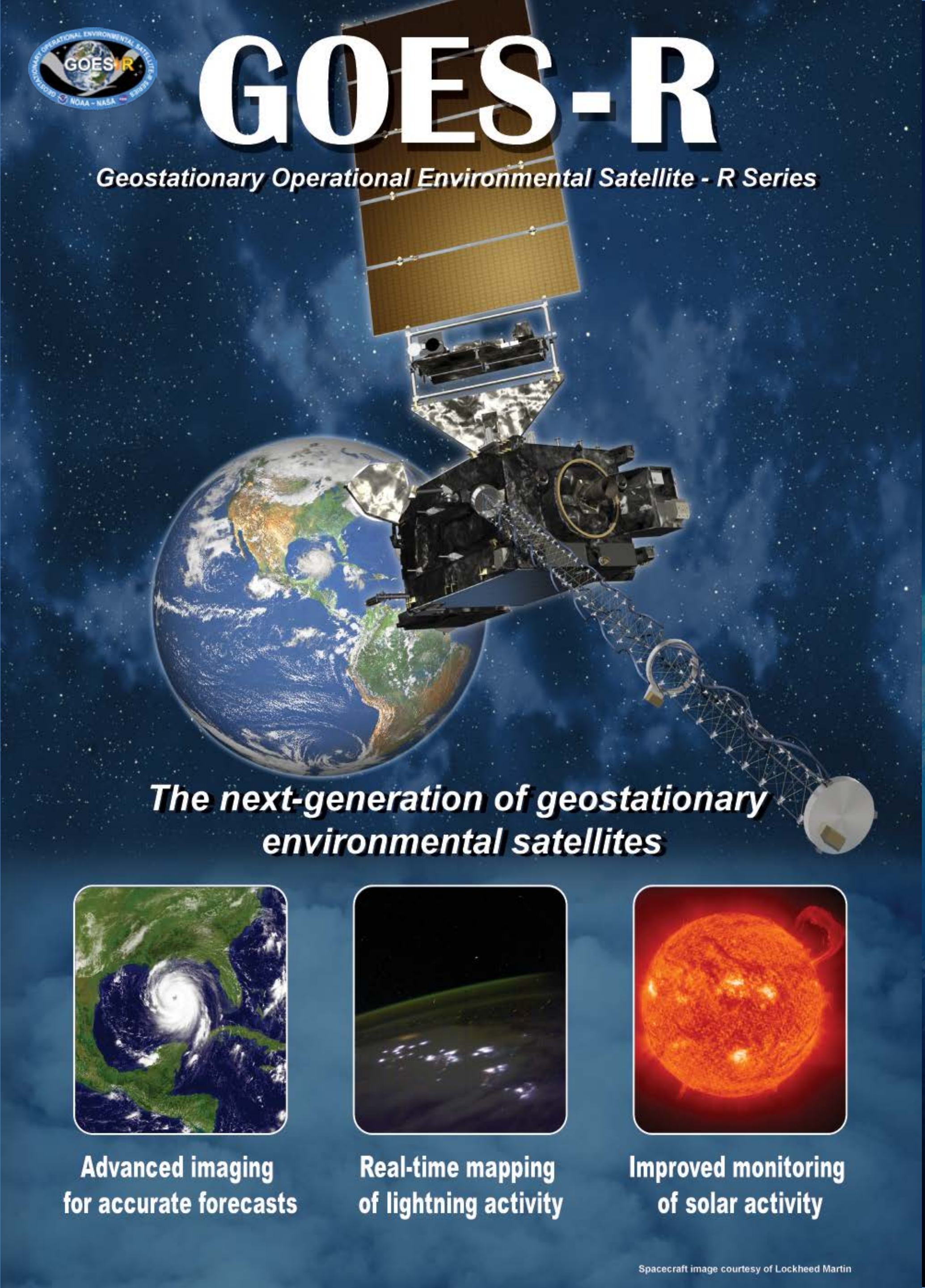
GOES-R Super Rapid Scan Experiment with GOES-14

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

http://rammb.cira.colostate.edu/training/visit/blog/index.php/category/goes-r-proving-ground/

Summary

- GOES-R is coming - Launch October 2016
- New sensors, products, and services will help improve forecasts and increase lead times for warnings and decision makers
- Presents Challenges and Opportunities for model assimilation, data fusion and tools
- Product testing as soon as 2 months post-launch, also available to users for science assessment
- User preparation is essential to take advantage of the advanced capabilities to support a Weather Ready Nation - Hemisphere – World
- NWS Satellite User Readiness Training in development
- Training coordination with WMO VLAB



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