



# GOES-R Proving Ground Update

Presented by Jim Gurka

NOAA/NESDIS GOES-R Program Office

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OCONUS Proving Ground Meeting

Juneau, Alaska

# Contributors

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Cooperative Institute for Meteorological Satellite Studies (CIMSS)

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NWS Alaska Region Scientific Services Division



# Outline

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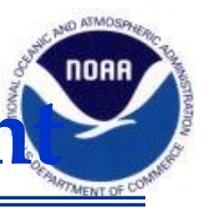
- What is the GOES-R Proving Ground?
- Examples of GOES-R Proxy Products tested at:
  - Cooperative Institutes
  - HWT Spring Experiment
  - NHC 2010 Hurricane Season
  - Aviation Testbed at AWC and Alaska
- Lessons Learned and User Input
- Plans for 2011
- Summary



# GOES-R Proving Ground

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- What is the GOES-R Proving Ground?
  - Collaborative effort between the GOES-R Program Office, selected NOAA/ NASA Cooperative Institutes, NWS forecast offices, NCEP National Centers, JCSDA, and NOAA Testbeds.
  - Where proxy and simulated GOES-R products are tested, evaluated and integrated into operations before the GOES-R launch
  - A key element of GOES-R User Readiness (Risk Mitigation)



# Proving Ground Mission Statement

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The GOES-R Proving Ground engages NWS in pre-operational demonstrations of selected capabilities of next generation GOES

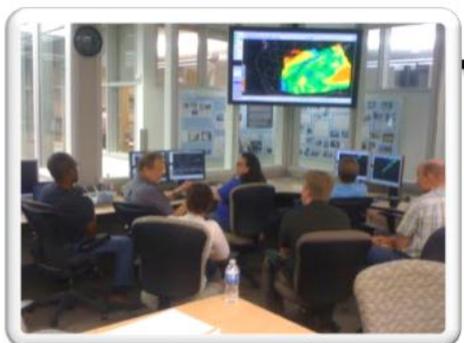
- **Objective is to bridge the gap between research and operations by:**
  - Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
  - Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
  - Engaging in a dialogue to provide feedback to developers from users
- **The Proving Ground accomplishes its mission through:**
  - Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
  - Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations

Intended outcomes are Day-1 readiness and maximum utilization for both the developers and users of GOES-R products, and an effective transition to operations

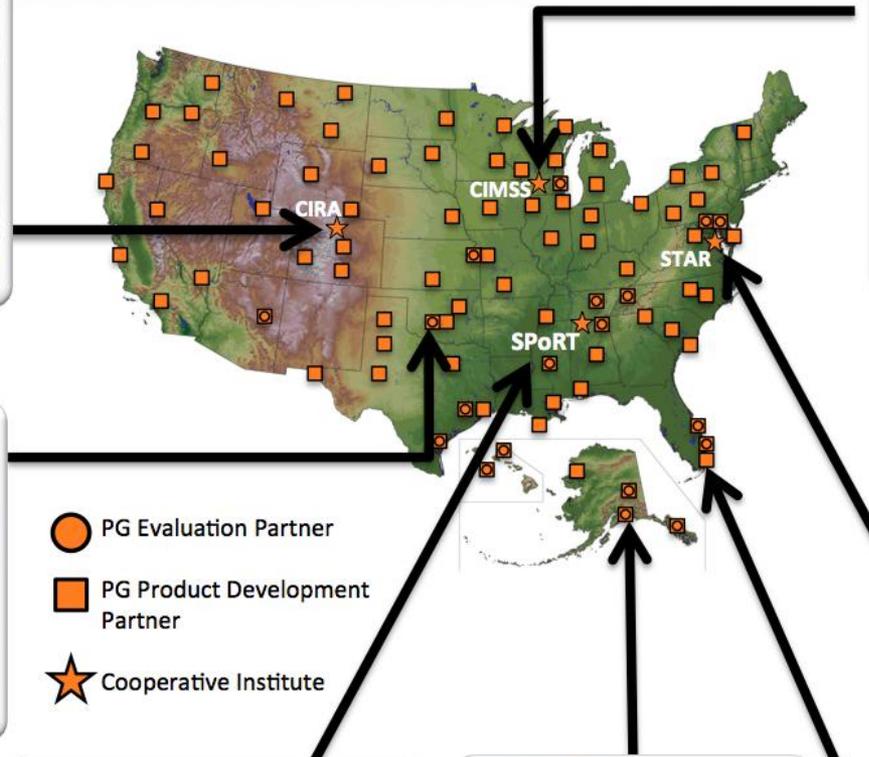
# GOES-R Proving Ground



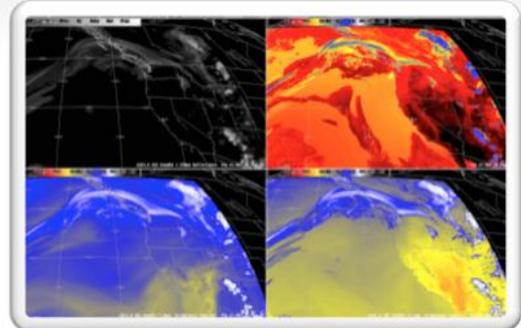
**CIRA - Ft. Collins, CO**  
ABI Simulated Natural Color



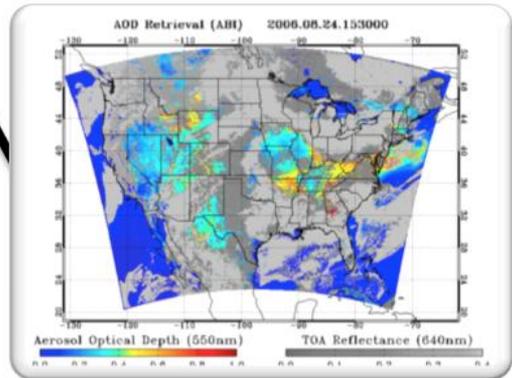
**SPC - Oklahoma City, OK**  
Nearcast Training at the Hazardous Weather Testbed



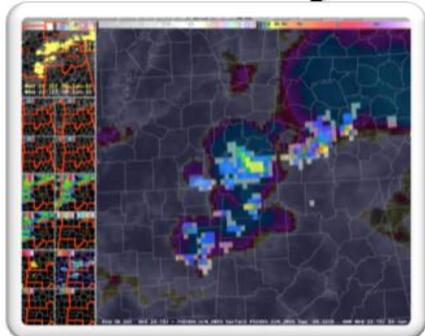
-  PG Evaluation Partner
-  PG Product Development Partner
-  Cooperative Institute



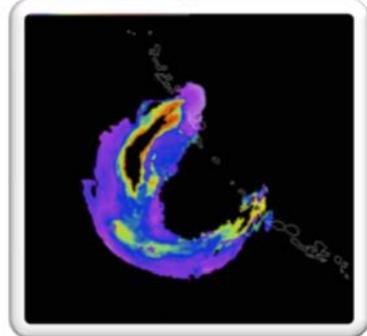
**CIMSS - Madison, WI**  
Simulated ABI Bands



**STAR - Camp Springs, MD**  
Aerosol Optical Depth Product



**SPoRT - Huntsville, AL**  
GLM Lightning Flash Density



**AFC - Anchorage, AK**  
Volcanic Ash Product



**NHC - Miami, FL** Rapid Intensification Index

# GOES-R Warning Product Set

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The following list of products offers opportunity for near-real time Warning Related utility.

## Baseline Products:

Volcanic Ash: detection & Height

Cloud and Moisture Imagery

Hurricane Intensity

Lightning Detection: Events, Groups & Flashes

Rainfall Rate / QPE

Total Precipitable Water

Fire/Hot Spot Characterization

## Future Capabilities:

Aircraft Icing Threat

Convective Initiation

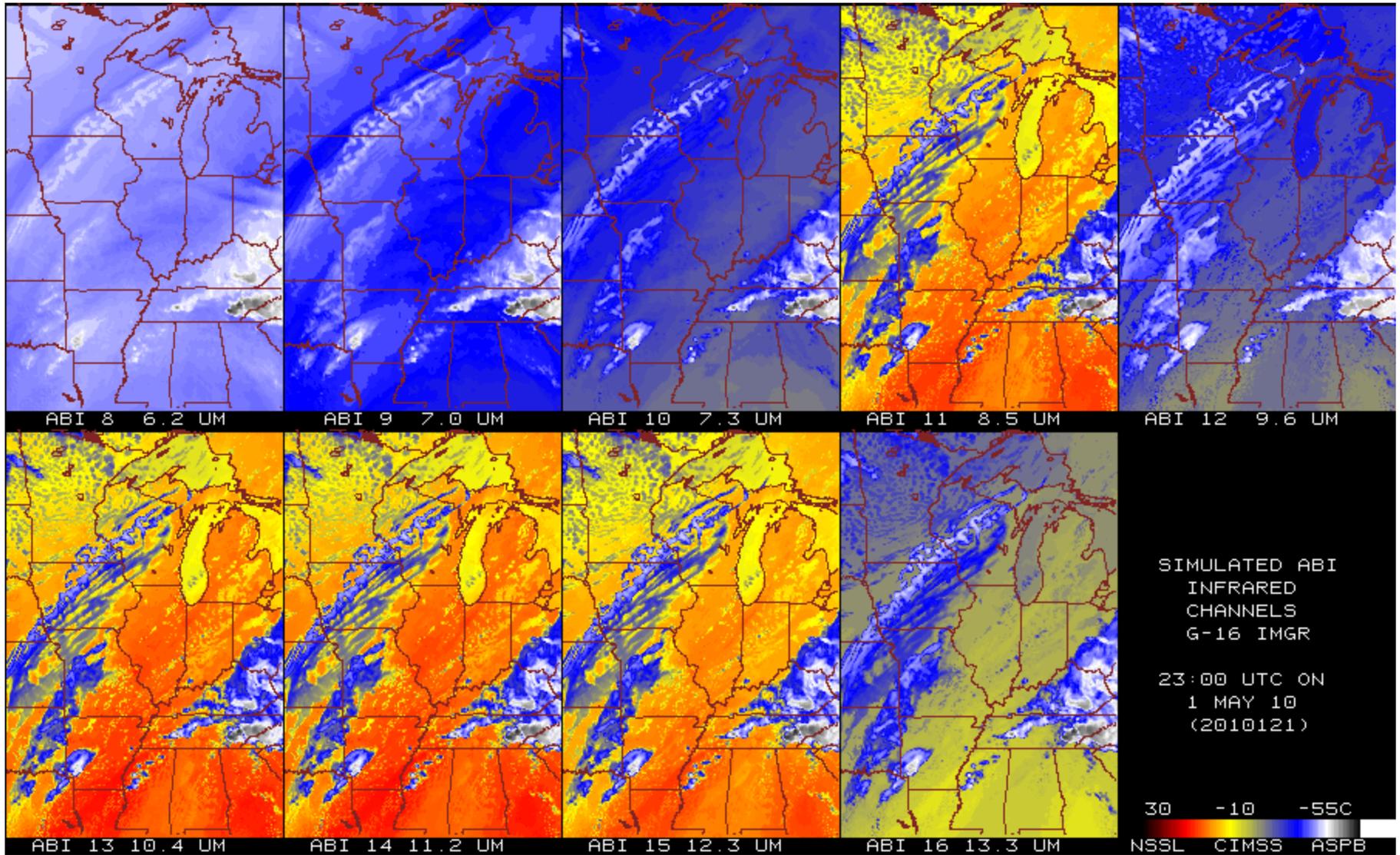
Enhanced "V" / Overshooting Top Detection

Low Cloud and Fog

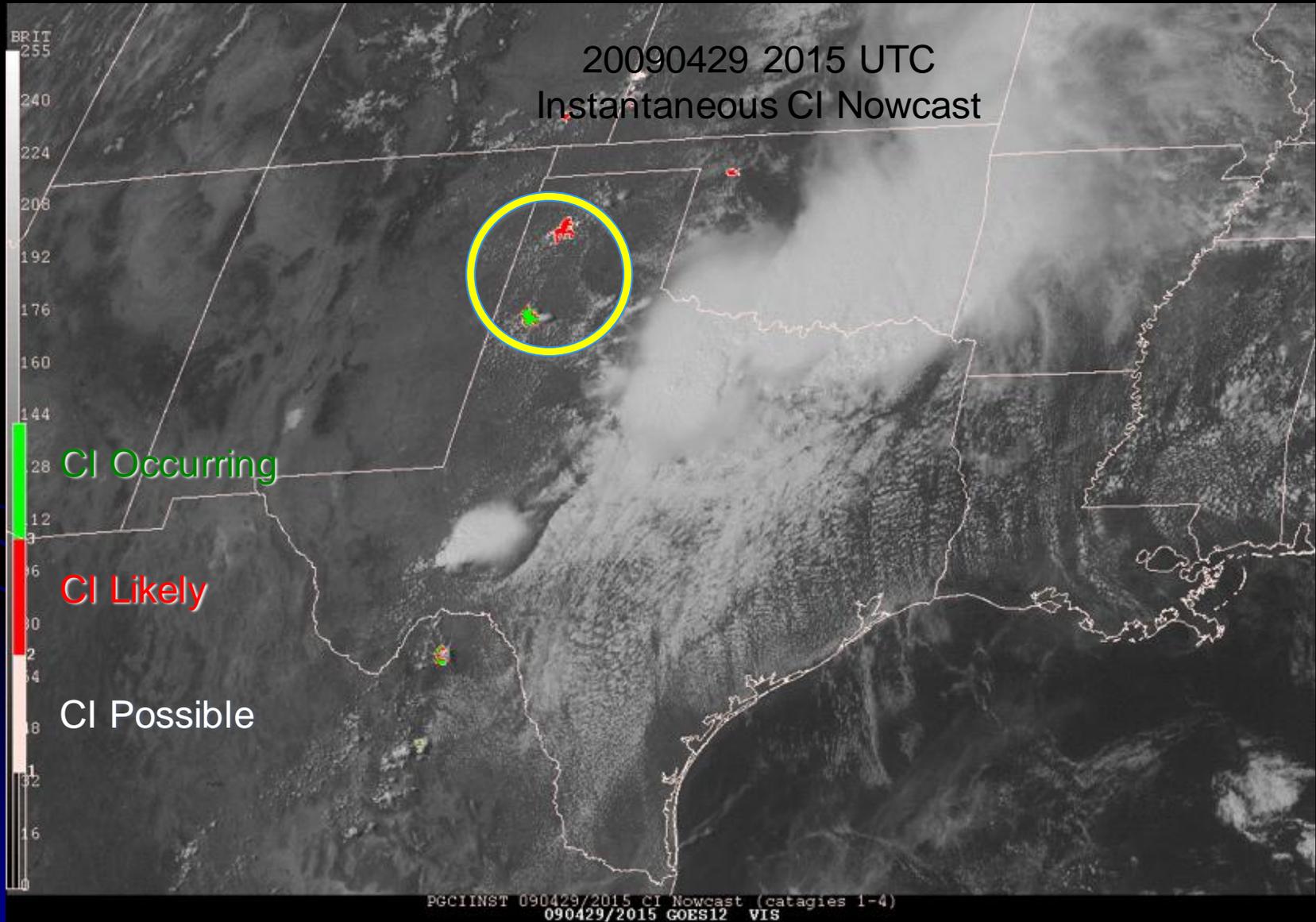
SO<sub>2</sub> Detection

# Estimated ABI Emitted-only bands

From NSSL WRF



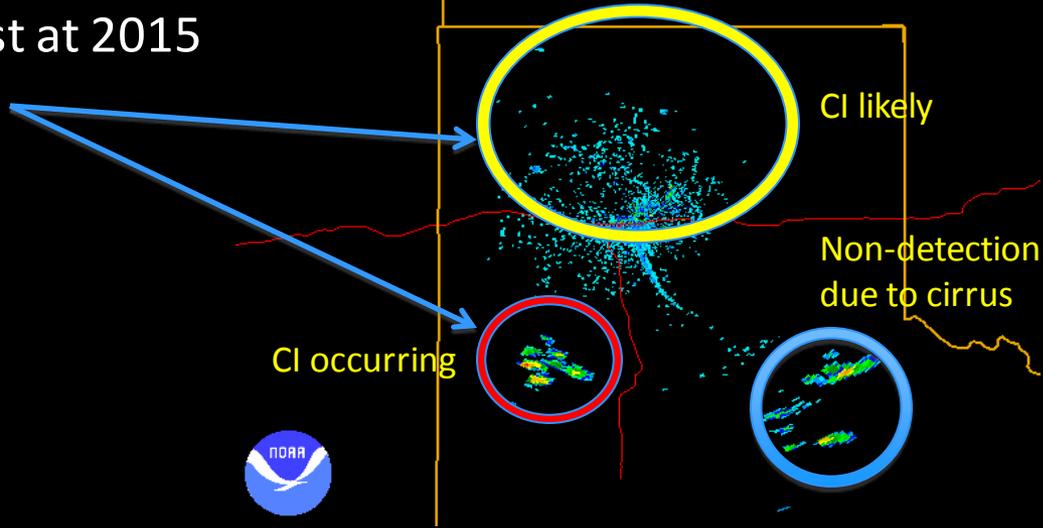
# 20090429 Dryline CI Case SPC HWT Proving Ground



CI nowcast at 2015 UTC

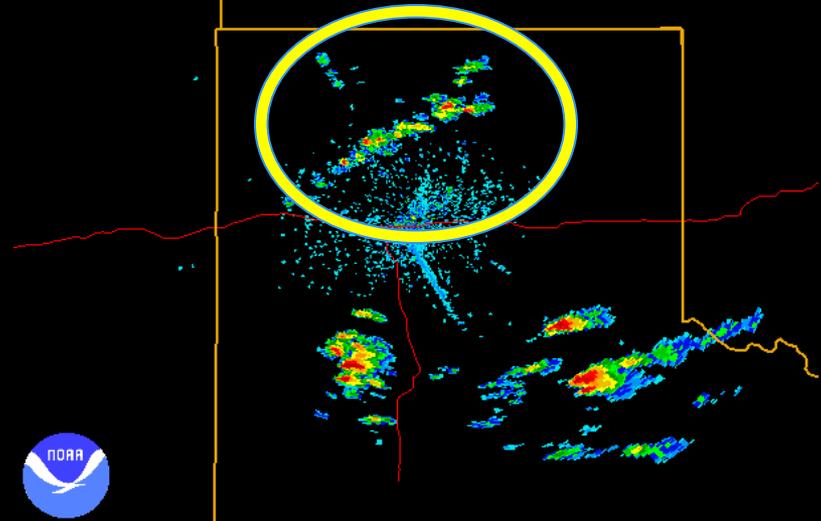
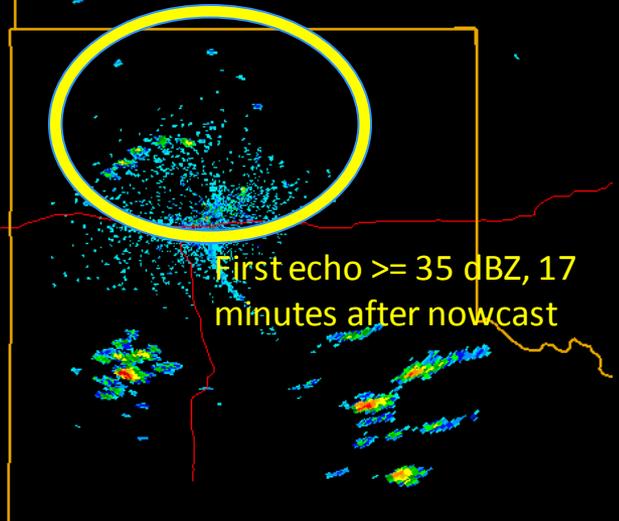
### KAMA 2018 UTC Base Reflectivity

29 April 2009



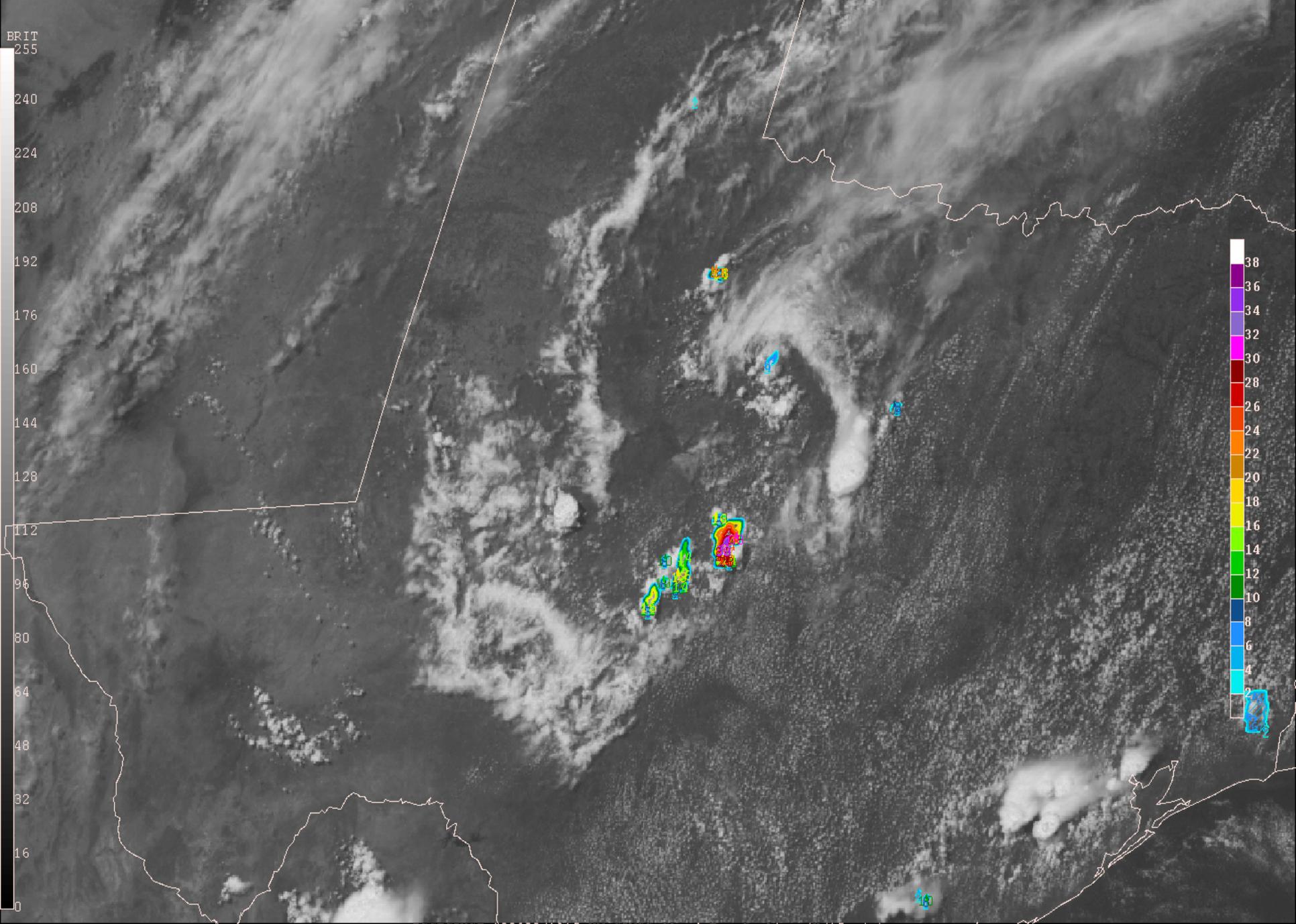
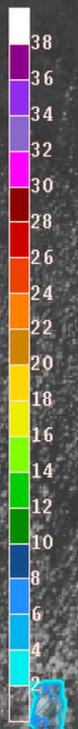
### KAMA 2035 UTC Base Reflectivity

### KAMA 2103 UTC Base Reflectivity



BRIT  
255

240  
224  
208  
192  
176  
160  
144  
128  
112  
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64  
48  
32  
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NO DATA  
0.00195C/15min  
159

-10 -20

TOP

EAX

ICT

SGF

Local EWW Warnings Tue 21:31Z 08-Jun-10  
Local TOR Warnings Tue 21:31Z 08-Jun-10  
Local SVR Warnings Tue 21:31Z 08-Jun-10  
Local CWA Warnings Tue 21:31Z 08-Jun-10

Reg Vis Sat Tue 21:31Z + CONVECT CIMSS Auto Overshooting Tops Magnitude Img 08.21 32MIN Tue 21:32Z 08-Jun-10

Radar: 16:18:55: ktk: MRU Unavail (Task Not Ld) RPS 1619 0.00 4.50

Frames: 12 Time: 22:16 Z 08-Jun-10

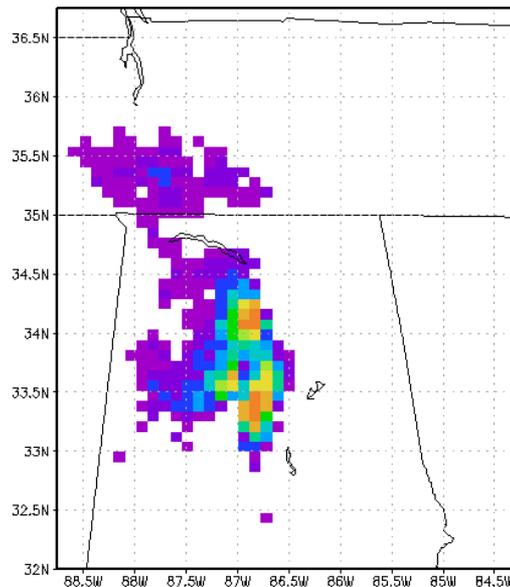
# SPoRT Pseudo GLM Product

Provide forecaster exposure to GLM data, differences from LMA, applicability to severe weather forecasting – benefits transition of full AWG proxy when available

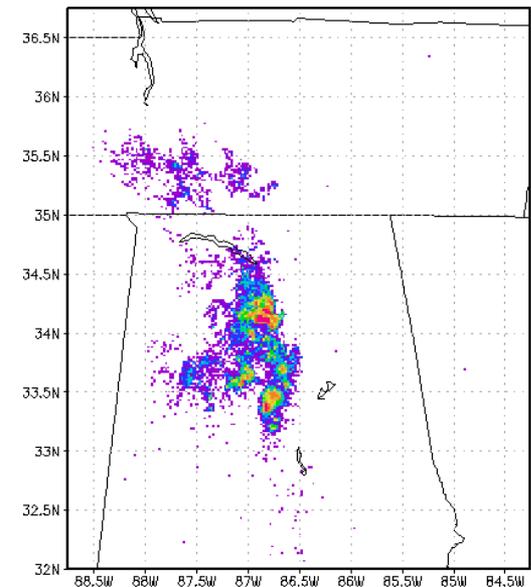
Flash Extent Density derived from LMA data at GLM resolution

- different from AWG proxy - no optical data
- forecaster demonstration and education
- applicable to other total lightning networks
- focus on AWIPS II development with user feedback

Pseudo GLM Flash Extent



LMA Source Densities



# Using the GOES-12 Sounder to Nearcast Severe Weather

<http://cimss.ssec.wisc.edu/model/nrc/>

Robert Aune (NESDIS) and Ralph Petersen (CIMSS)



The CIMSS Near-casting Model uses hourly GOES Sounder retrievals of layered precipitable water (PW) and equivalent potential temperature (Theta-E) to predict severe weather outbreaks up to **6 hours in advance!**

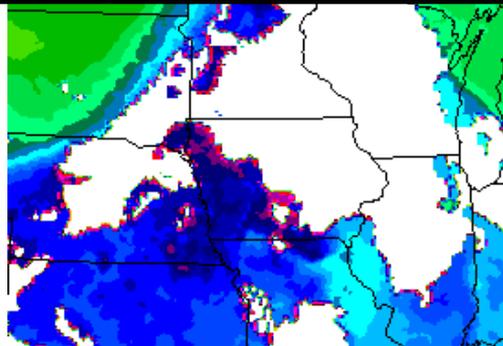
Hourly, multi-layered observations from the GOES Sounder are projected forward in time along Lagrangian trajectories forced by gradient winds. "Trajectory observations" from the previous six hours are retained in the analysis. Destabilization is indicated when theta-E decreases with height.

## Limitations:

- Sounder channels support only two layers for near-casting
- Only useful for elevated convection – Sounder can't detect low-level moisture
- Frequent false alarms – Sounder can't detect inversions

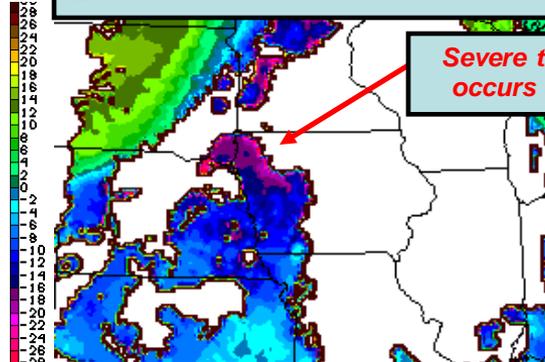
## One Example of a Successful Near-cast

Low-level Theta-E NearCasts shows warm moist air band moving into far NW Iowa by 2100 UTC.



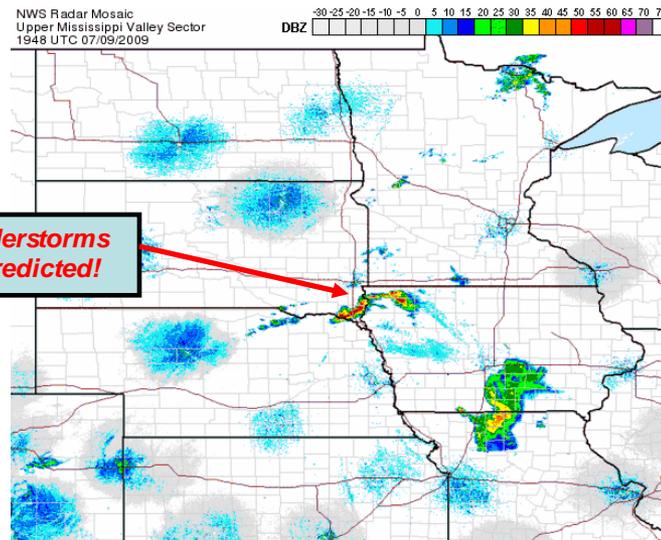
6-hour NearCast for 2100 UTC  
Low level Theta-E

Vertical Theta-E Differences predict complete convective instability by 2100 UTC.



6-hour NearCast for 2100 UTC  
Low to Mid level Theta-E Differences

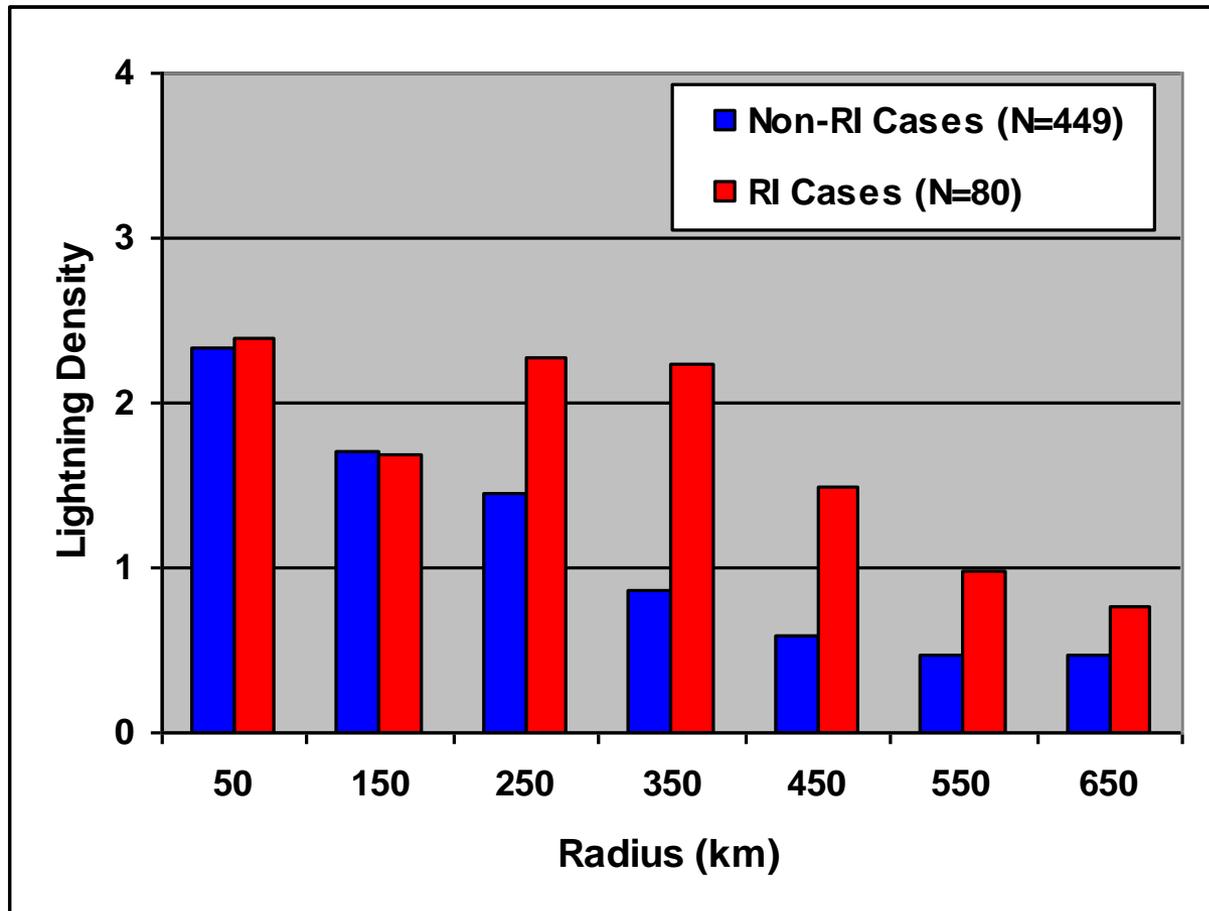
Severe thunderstorms occurs as predicted!



Rapid Development of Convection over NW Iowa between 2000 and 2100 UTC 9 July 2009



# Comparison of Lightning Density Intensifying and non-Rapidly intensifying cases



Based on 5-year sample (2005-2009) of Atlantic cases

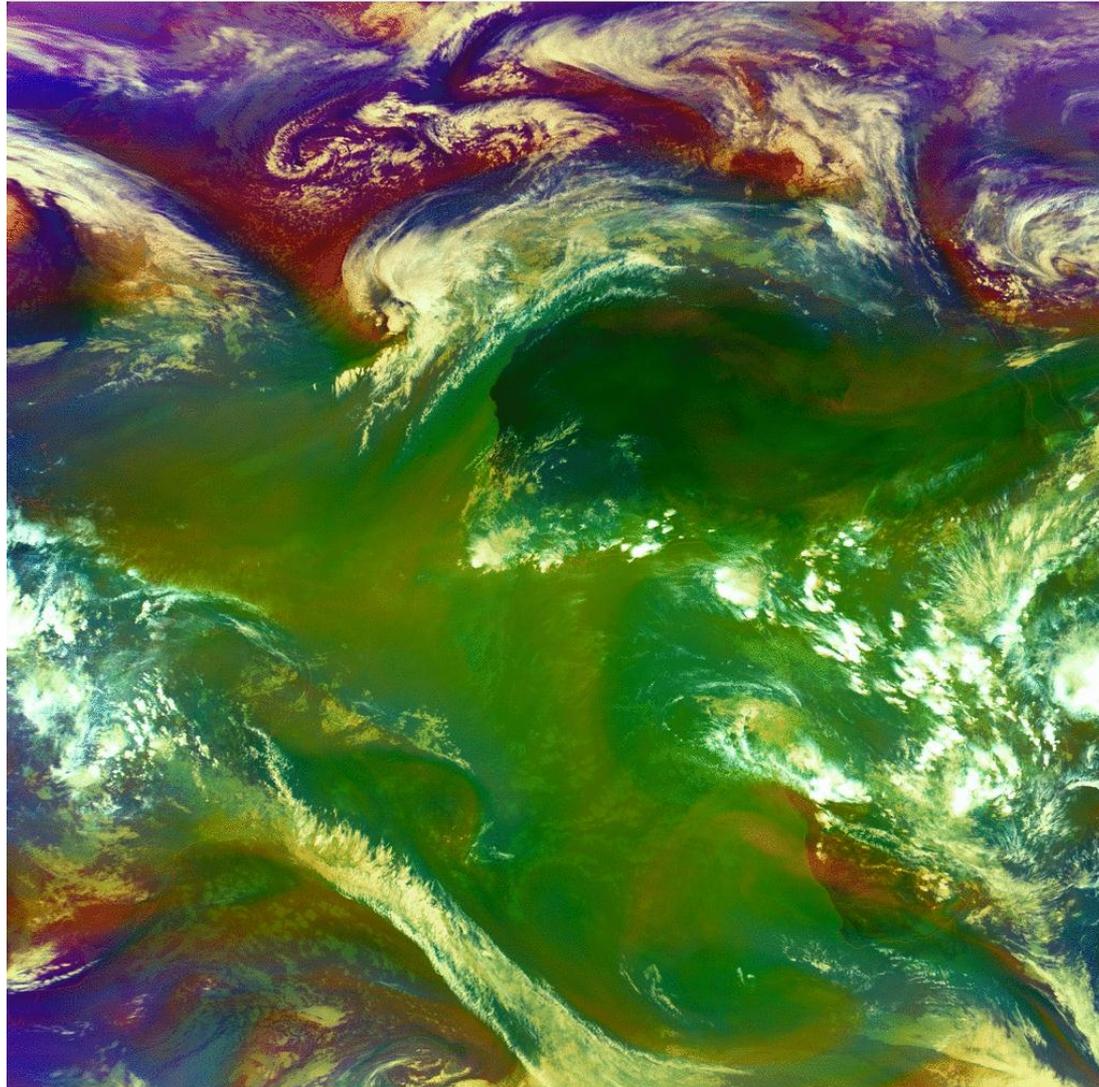


# RGB Air Mass Product

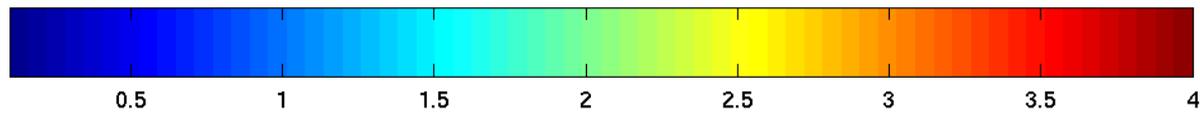
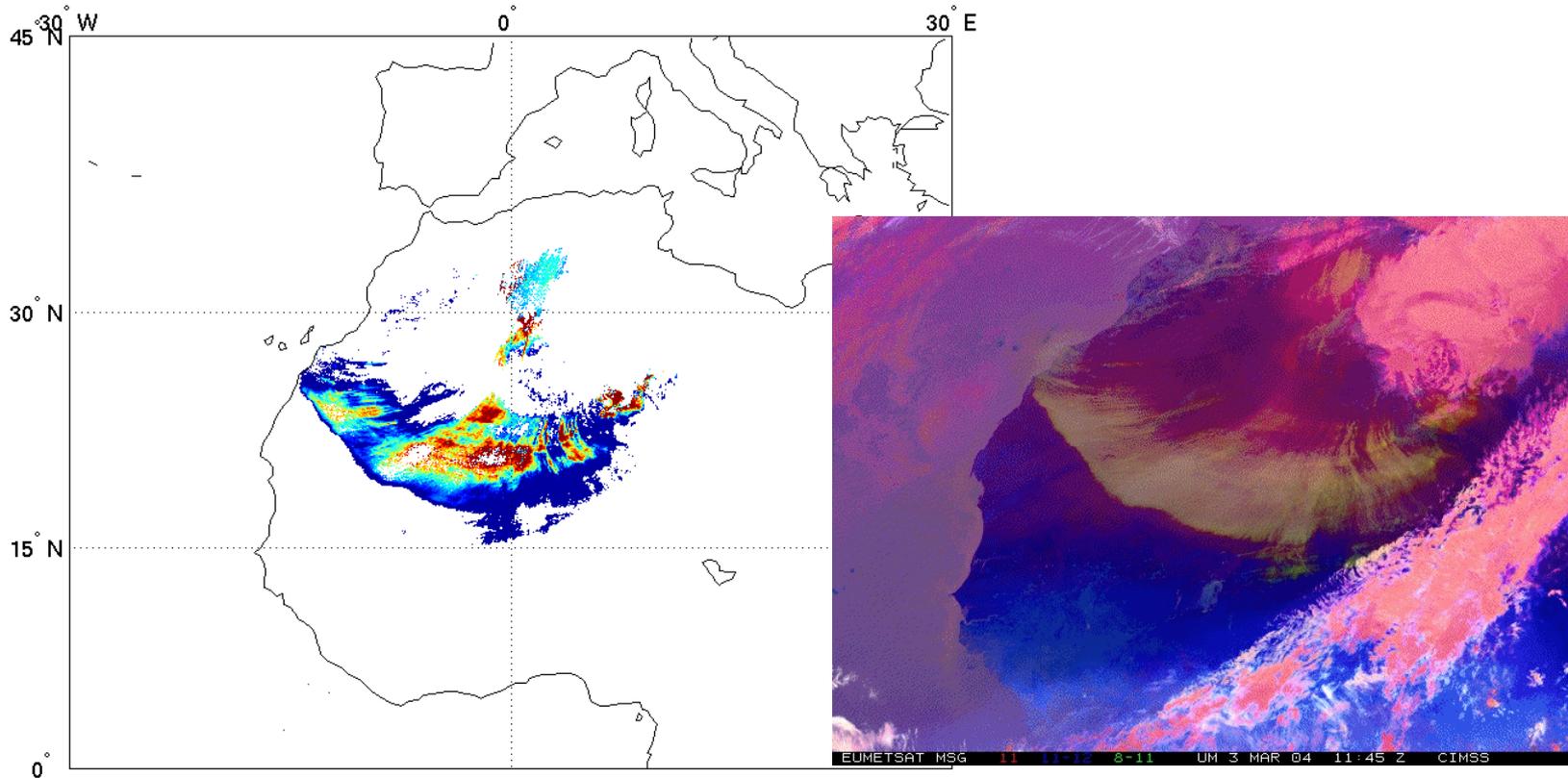
CIRA  
Cooperative Institute for  
Research in Atmospheres

NOAA Satellites and Information  
National Environmental Satellite, Data, and Information Service

RAMMB  
Regional and Mesoscale  
Modeling Branch



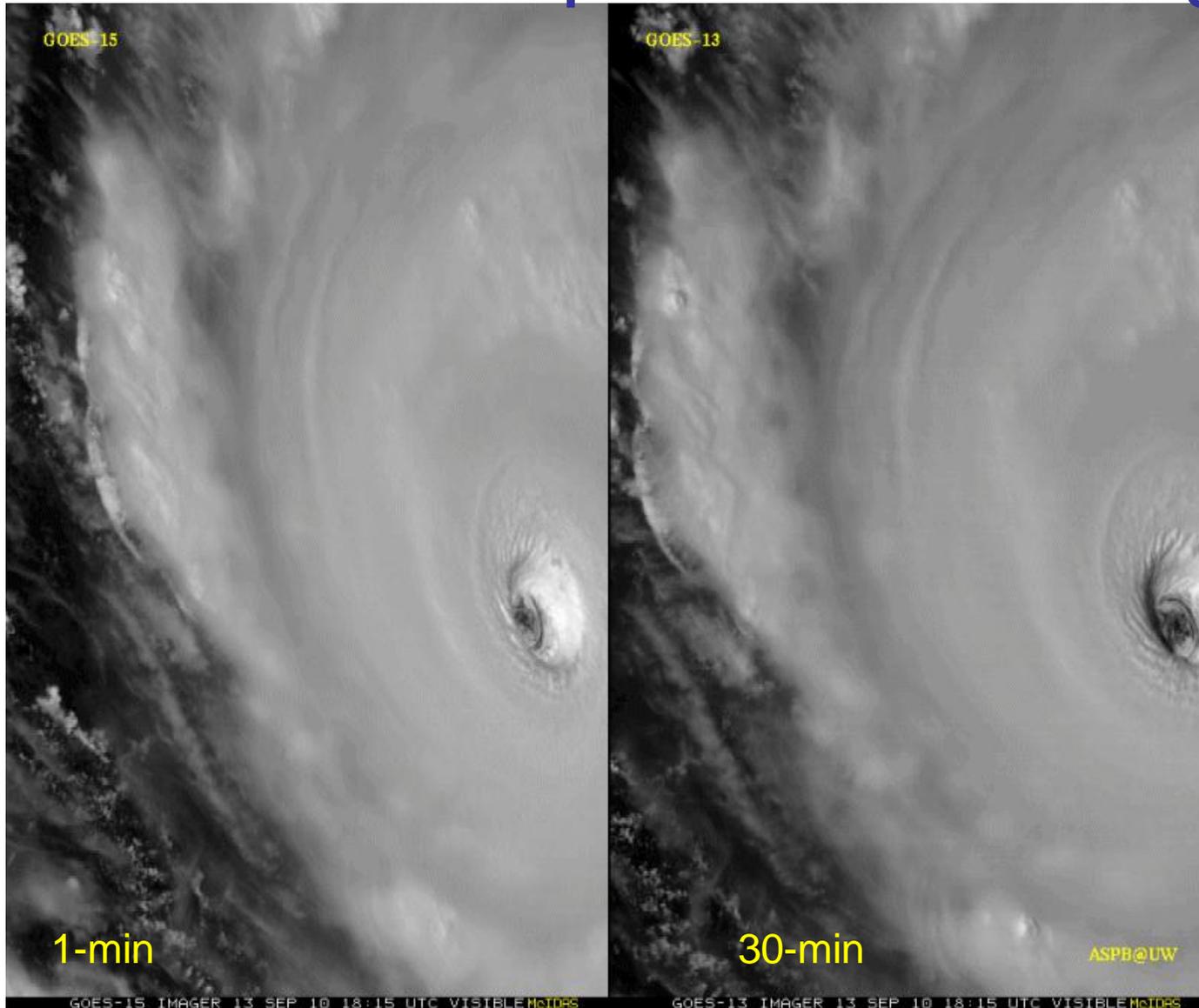
# Aerosol/Dust Optical Thickness Retrieval Results from SEVIRI@EUMETSAT

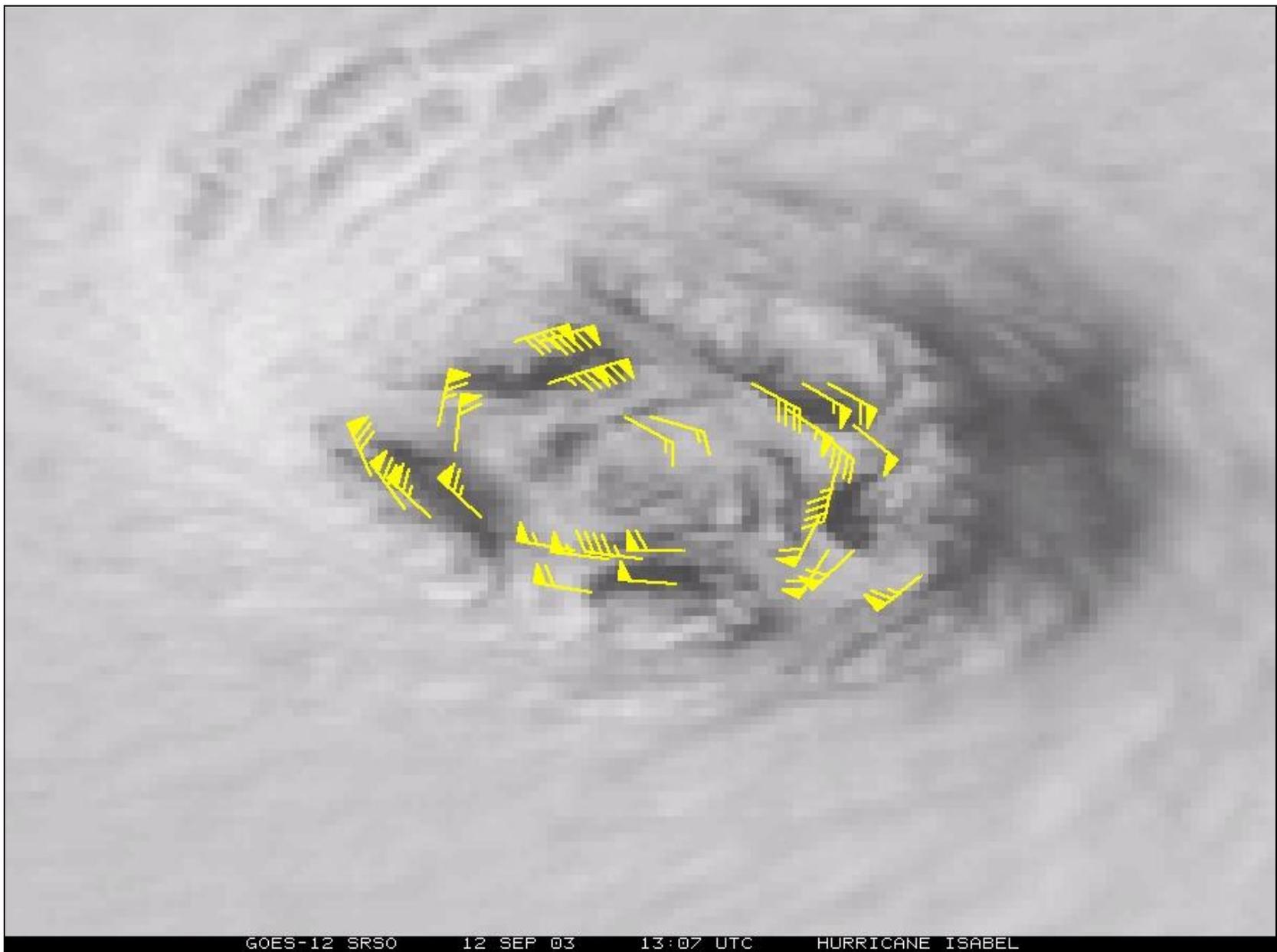


Optical Thickness at ---104063 :114500



# GOES-15: Sample “1-min” imagery

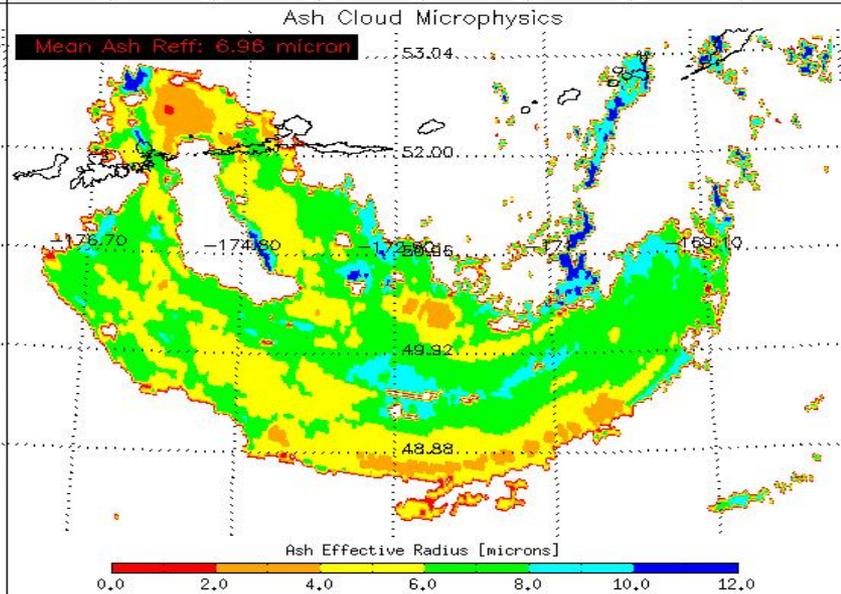
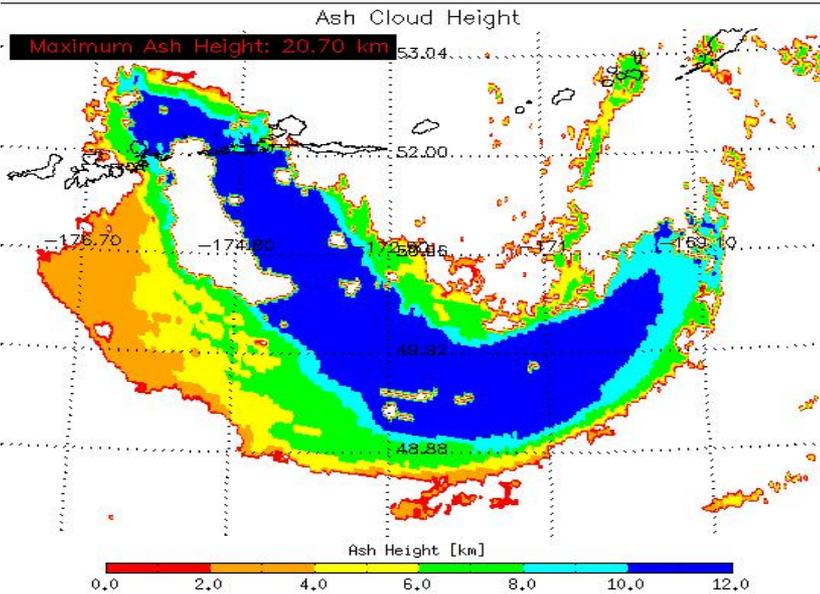
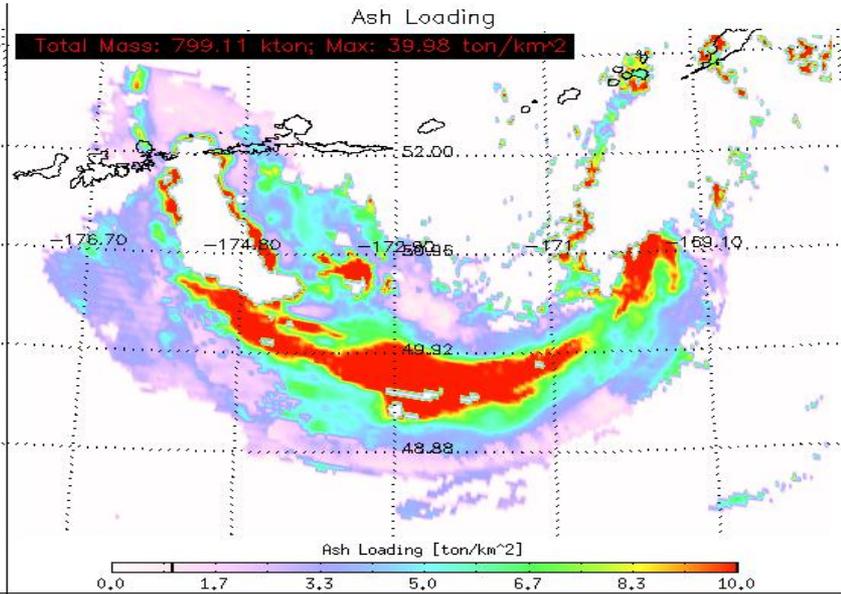
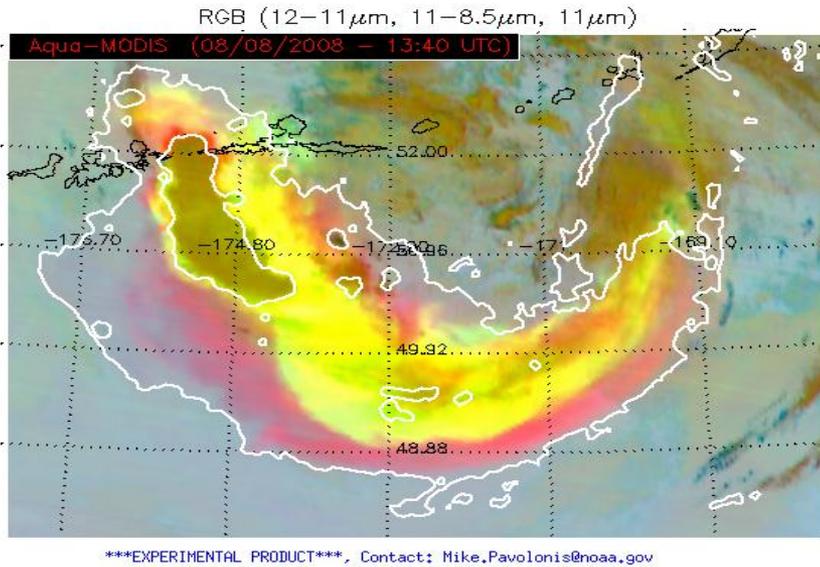


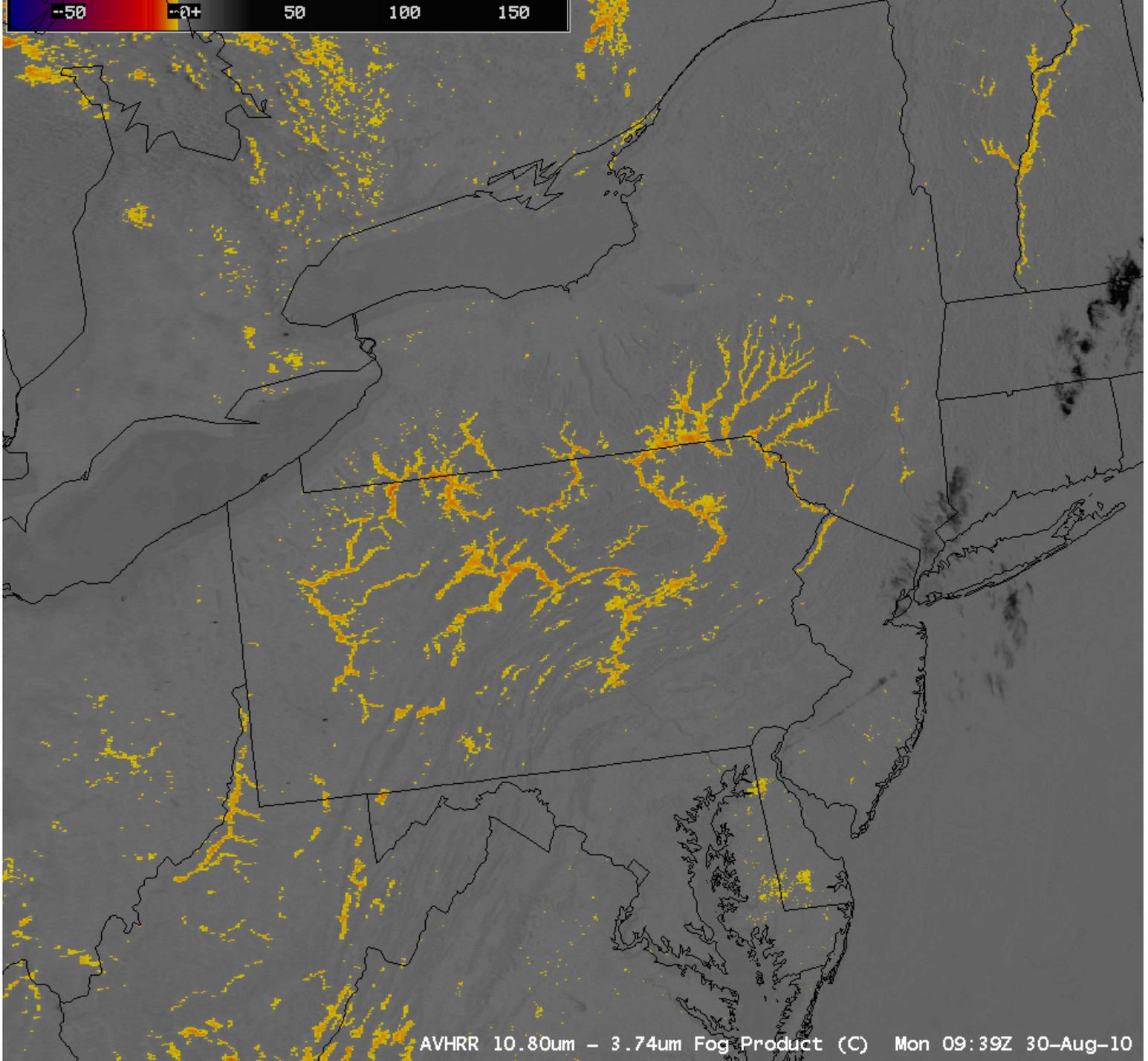


From C. Velden, UW/CIMSS

Rapid scan (3-min) low-level winds in the hurricane eye

# Aviation PG Products: Volcanic Ash





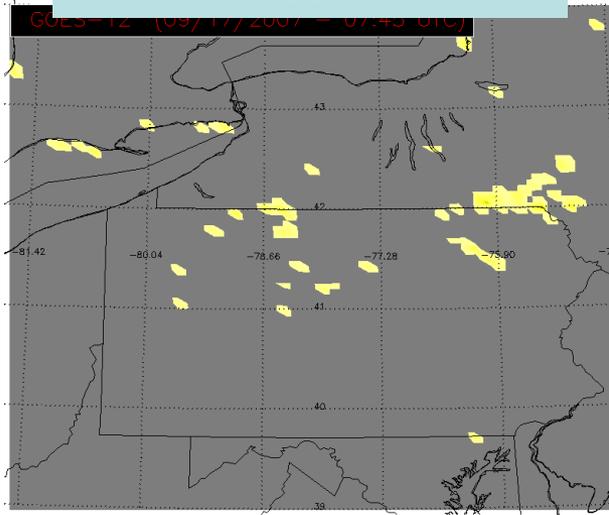
AVHRR 10.80um - 3.74um Fog Product (C) Mon 09:39Z 30-Aug-10

# GOES-R Fog Detection

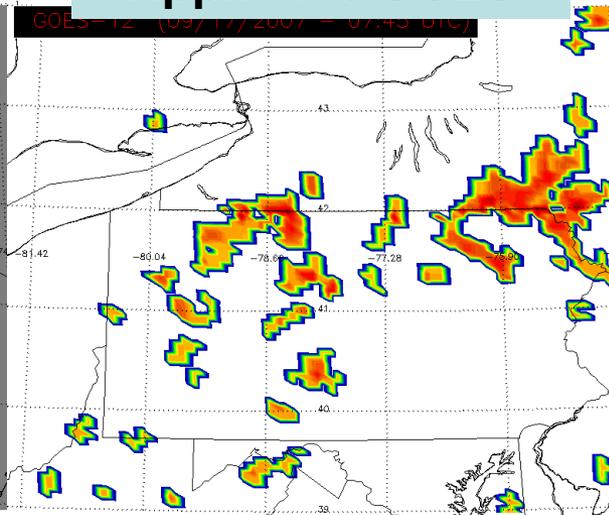
The GOES-R fog detection product will significantly improve geostationary satellite fog monitoring capabilities because:

- **Improved algorithm technology** - the GOES-R algorithm provides quantitative information on fog probability, while heritage GOES fog detection products are more qualitative in nature
- **Improved sensor technology** - the ABI has greatly improved spectral information, spatial resolution, and temporal resolution

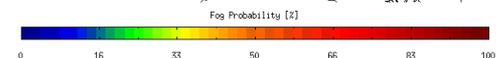
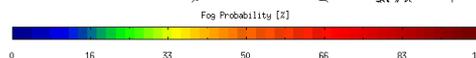
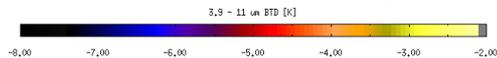
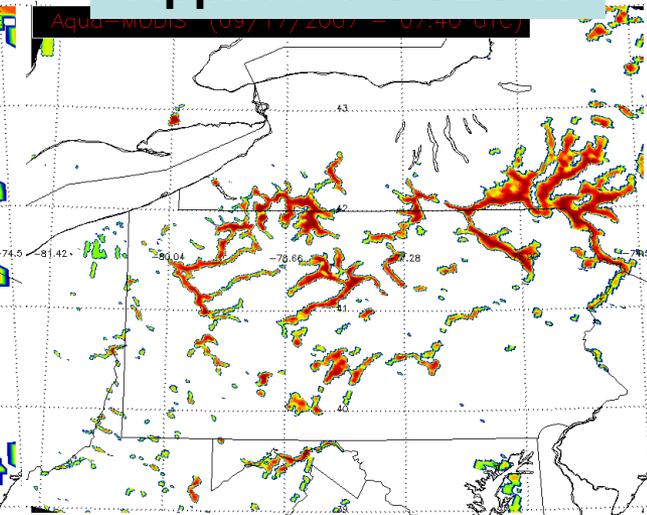
Heritage GOES Fog Detection



GOES-R Algorithm Applied to GOES



GOES-R Algorithm Applied to GOES-R





# HWT Spring Experiment

- In 2010 experiment...Products evaluated include:
  - Convective Initiation (CI)
  - Lightning Detection
  - Enhanced V/ Overshooting Top Detection
  - Cloud and Moisture Imagery
  - Simulated lightning threat
  - Hail Probability (risk reduction)
- In 2010.... Creation of a pseudo-GLM product
  - Total flash extent density product at 8 km resolution
  - More accurate simulation of future GLM products
  - Data from additional sites provided to support SPC
- In 2011... Added the “Nearcasting” products

# Capturing User Feedback

- **Real-time blogging**  
<http://goesrhwt.blogspot.com/>
  - During forecast/warning exercises
  - Participants were also encouraged to blog following forecast/warning exercises
- **Web-based surveys**
  - Immediately following forecast/warning operations
- **Daily post-mortem discussions**
  - Between visiting scientists and forecasters



# HWT: Forecaster Feedback from 2010



“We saw several instances where the total lightning was picking up on storms before the AWIPS lightning [NLDN] program picked up on them. One could see the utility of this in the future, bringing with it a potential for lightning statements and potentially lightning based warnings.”

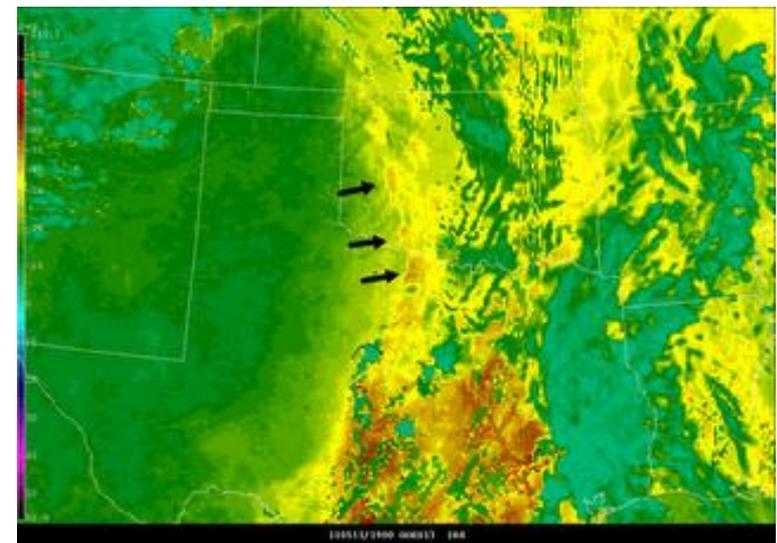
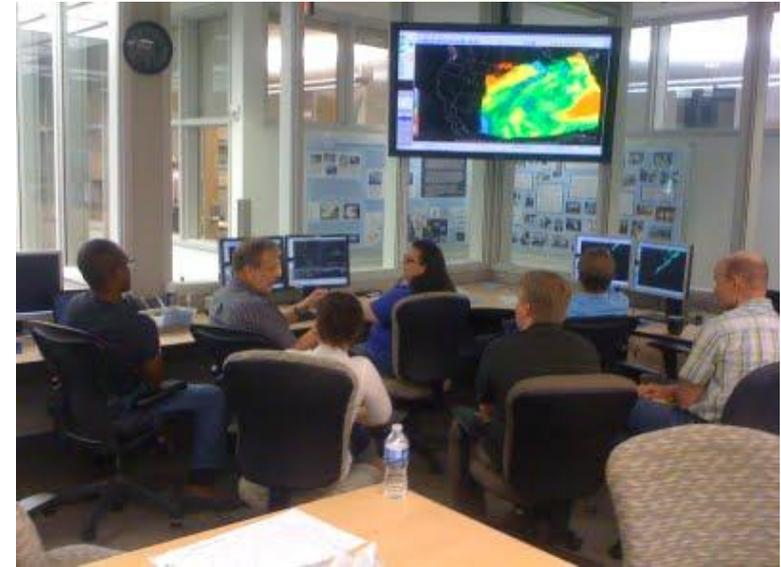
-Pat Spoden (SOO, NWSFO  
Paducah, KY)

\* <http://ewp.nssl.noaa.gov/>

\* <http://goesrhwt.blogspot.com/>

# HWT: Forecaster Feedback from 2011

- WRF Band Difference (KPPs)
  - “The band difference has a lot of potential... you can get a head start by looking at the trends in the data that help you anticipate what’s going to happen.”
- Nearcast (Legacy Atmospheric Profiles)
  - “A lot of the time to increase my lead time in the morning, I like to take a look at PW and WV... so I found that this was a nice utility because it was indicative of finding areas of greatly deep instability, or moisture source regions.”
- Convective Initiation
  - “CI did much better during rapid scan.”
  - “For non-severe faster moving systems it may be useful in detecting regions of heavy rain.”



# HWT: Forecaster Feedback from 2011 Lightning Detection

- “The total lightning data is an excellent tool for monitoring convection, I see much promise for such data in the future, especially since CG strikes may be only a small fraction of the total lightning strikes within a given storm.”
  - “I utilized it as a situational awareness product and then kept a watch on my tried and true radar practices to issue the warning. The PGLM data gave me more confidence in my warning. Which is always something that is positive.”



# 2011 Spring Experiment

## **Products with greatest operational value**

- Nearcasting products
  - Routinely used at all the desks in both the EFP and EWP
  - Did a good job showing where convection is likely and just as important... where it can be ruled out in the next 1-6 hours
  - SPC deputy director plans to make products available to operational forecasters this summer for evaluation
  - HPC representative requested a one week visit by Ralph Petersen or Bob Aune to introduce the products to forecasters
- LMA: pseudo GLM products
  - Routinely used in the EWP
  - Numerous examples operational value in generating forecasts and warnings and in identifying when 1<sup>st</sup> cloud to ground flash will occur
- Simulated CMI from NSSL WRF
  - Part of daily routine at the CI desk for model performance evaluation



# NHC Proving Ground

- Hurricane products for 2010 PG:
  - Hurricane intensity estimate (baseline)
  - Super rapid scan imagery (baseline)
  - RGB aerosol/ dust product
  - Saharan air layer (SAL)
  - Rapid intensification index
    - Based on global ground-based lightning detection network

# 2011 Proving Ground Activities & Plans

- Spring Experiment: NWS SPC and Hazardous Weather Testbed
  - Used Improved version of 2010 products
  - Nearcasting model
- NHC Proving Ground
  - Gain more experience with RGB products
  - Continue evaluation of lightning input
  - Potential new products: Overshooting tops, and product to discriminate thin from thick cirrus over tropical cyclones, true color products
  - Provide RGB products in N-AWIPS format
- Aviation: Alaska Aviation Weather Unit and AWC (Kansas City)
  - Cloud top height and phase (Alaska only)
  - Fog/low cloud probability
  - Volcanic ash mass loading, height, and particle size
  - SO<sub>2</sub> detection and loading
  - Convective initiation
  - Nearcasting (AWC only)

# 2011 Proving Ground Plans

- Marine Weather and Oceanic Testbed: NWS OPC, NHC, NESDIS SAB
  - Cloud and moisture imagery
  - Derived stability Indices
  - Lightning detection
  - Convective initiation
  - Enhanced V / Overshooting top detection
  - Cloud top phase, height, temperature
  - RGB air mass product
- Space Weather PG: U.C. CIRES
  - Solar thematic maps (SUVI)
  - Products from NASA SDO to approximate GOES-R SUVI
  - Create means to ingest and display GOES-R like Level 2+ products

# 2011 Proving Ground Plans

- NESDIS SAB: Hazardous Weather and Rainfall Potential
  - Cloud and moisture imagery
  - Derived stability Indices
  - Lightning detection
  - Convective initiation
  - Enhanced V / Overshooting top detection
  - Cloud top phase, height, temperature
  - RGB air mass product
- QPF: NWS HPC and NESDIS SAB
  - Cloud and moisture imagery
  - Derived motion winds
  - RGB air mass
  - Rainfall Rate QPE

# Summary

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- GOES-R Proving Ground provides mechanism to:
  - Involve CIs, AWG, National Centers, NOAA Testbeds and WFOs in user readiness
  - Get prototype GOES-R products in hands of forecasters
  - Keep lines of communication open between developers and forecasters
  - Allow end user to have have say in final product, how it is displayed and integrated into operations
- Proving Ground continues to grow and plans in place for 2011
- For a GOES-R Success...Forecasters must be able to use GOES-R products on Day 1

# 7TH GOES USERS' CONFERENCE

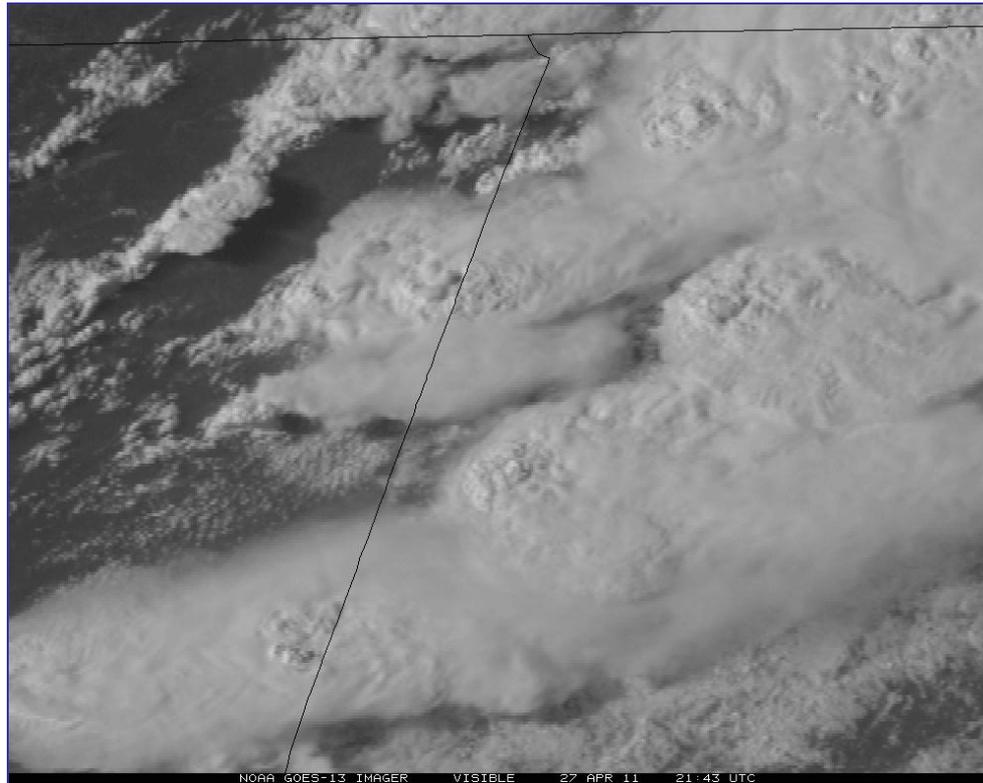
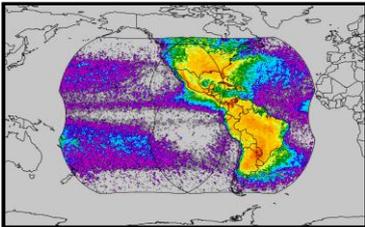
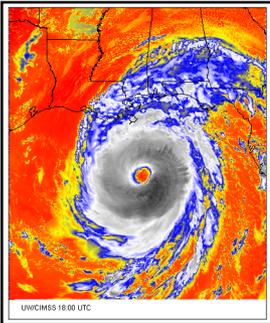
[http://directreadout.noaa.gov/GUC\\_VII/index.htm](http://directreadout.noaa.gov/GUC_VII/index.htm)

20-21 October 2011 The Wynfrey Hotel Birmingham, AL



To be held in conjunction with the 15-20 October 2011  
36<sup>th</sup> National Weather Association Annual Meeting:

<http://www.nwas.org/meetings/nwa2011>



The Wynfrey Hotel



Geostationary Operational Environmental Satellites: <http://www.goes-r.gov>

# Backup Slides

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# Proving Ground Organization

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## **Executive Board:**

Steve Goodman (Chair)- NESDIS/GOES-R Senior Program Scientist

Jaime Daniels-NESDIS/STAR/GOES-R AWG

Mark DeMaria-NESDIS/STAR/ GOES-R Risk Reduction

Jim Gurka- NESDIS/GOES-R Ground Segment Project Scientist

Mike W. Johnson, NWS/OST/Programs & Planning

Tim Schmit-NESDIS/STAR/ASPB

Kevin Schrab- NWS

Gary Jedlovec-NASA SPoRT

## **Advisory Team:**

Tony Mostek-NWS/COMET

Russ Schneider- NWS/NCEP/SPC

Gary Hufford- NWS Alaska Region

Shanna Pitter- PPI, NWS WW Goal Team

Cecilia Miner- NWS, C&T Goal Team

Steve Miller- CIRA

Wayne Feltz-CIMSS

Shobha Kondragunta-NESDIS/STAR AQ IPT



# HWT Spring Experiment

- In 2009 experiment...primary focus was on Convective Initiation Product.
- In 2009 experiment...LMA data used to generate 10-km source density product from three sites:
  - Norman OK
  - Huntsville AL
  - Washington D.C.

# Lessons Learned at SPC (2009)

- **Convective Initiation (CI)/Cloud Top Cooling (CTC)**
  - CTC is valuable product in itself
  - Diagnostic tool rather than prognostic over SE warm sector environments
  - Masked where thick cirrus present
  - Thin cirrus over land/water/water clouds and expanding edge false alarms
  - Avg. lead time ~15 minutes over radar (for successful nowcasts)
  - Full disk 30 min. scan limitations (false alarms/missed nowcasts)
  - Cloud detection limitations due to poor spatial/spectral resolution
  - Instantaneous fields more useful to forecasters than accumulated fields
  - Overlay on visible/IR essential to forecasters
  - Continue CTC after CI occurs (storm severity) interest from forecasters
  - Effective for terrain/dryline convection
  - CI misses some CTC signals
  - Works well in rapid scan operations

# 2010 Spring Experiment

Products evaluated and user feedback:

## – Simulated Satellite Imagery

- Much enthusiasm for simulated satellite imagery along side traditional model fields
- Strong push for simulating additional GOES-R channel differences and products as decision aids
- The simulated imagery can provide more realistic view of GOES-R capabilities in a weather event simulator (WES) case.

## – Simulated Lightning Threat

- Due to time constraints and sub-par performance of the NSSL-WRF...only limited demonstration
- Expected to provide valuable tool within operations and future experiments including the 2011 Spring severe weather and summer fire weather experiments.

## – 0-3 Hour Severe Hail Probability

- Product performed well in forecasting severe hail 1-2 hours in advance
- 3 hour forecast only limited value due to reliance on observations
- May be most useful in combination with other datasets...such as stability indices

# 2010 Spring Experiment

Products evaluated and user feedback:

- University of Wisconsin Convective Initiation (USCI)
  - Useful tool for situational awareness prior to warning operations
  - Lead time generally 5-30 min. over radar
  - Forecaster frustration with temporal refresh rate of GOES-13
- Satellite-based convective analysis and tracking (SATCAST)
  - Proxy for the AWG version of the CI algorithm
  - Day-only cloud typing but will be expanded to day and night
  - Data latency an issue (arrived 12-13 post image stamp time)
- Overshooting-top and Thermal Couplet Detection (OTTC)
  - Forecasters liked concept of product but spatial resolution and temporal refresh on GOES-13 provided limited value
- Pseudo Geostationary Lightning Mapper (PGLM)
  - Utilizes total lightning data from 3 LMA networks and KSC LDAR
  - Provided strong support tool for warn/ no-warn decision
  - Most viewed future GLM as a “great tool” for situational awareness
  - PGLM particularly useful when blended with other products

# 2010 NHC Experiment

Products evaluated and user feedback:

- Hurricane Intensity Estimate (HIE)
  - Generally comparable to ADT, but min SLP can be unrealistically low at times
  - Adjusted applied to HIE pressure estimate
- RGB Air Mass Product
  - Useful complement to the dust product
  - In some ways better separates the dry from moist air masses
  - At times product indicates polar air at very low latitudes
  - There are limb effects that could be corrected as a f(zenith angle)
- SAL Product
  - Animated version: improvement over static images
  - May be contamination near stratocumulus fields
- SRSO data
  - Large number of excellent cases obtained due to GOES-15 science test coinciding with the peak of the hurricane season
- Lightning based RII
  - Post season preliminary results show lightning reduces false alarms of rapid intensity forecasts
  - Additional testing needed to increase sample size



# 2010 NHC Proving Ground

- Ground-based WWLLN data used as a proxy for GLM in tropical cyclone studies
  - Adjustment to account for the low detection rate of WWLLN and conversion of C-G to total lightning using OTD/LIS climatology
- Storm-centered lightning density calculated and related to changes in tropical cyclone intensity
  - Lightning density in the rain bands is related to subsequent intensity changes (if vertical shear accounted for)
- Algorithm used lightning data in combination with global model fields to predict rapid intensity change
- Tested in real time in 2010 using Vaisala GLD-360 data