GOES-R Proving Ground Update

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GOES-R Program Science Office

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

GOES-R Science Week
Annual R3 Science Meeting
Huntsville, AL
September 21-23, 2011

Acknowledgments

With contributions from our many partners

Web Sites

GOES-R: http://www.facebook.com/GOESRsatellite
CIMSS blog: http://cimss.ssec.wisc.edu/goes/blog/
CIRA blog: http://rammb.cira.colostate.edu/research/goes-r/
SPoRT blog: http://weather.msfc.nasa.gov/sport/goesrpg/

What Is the GOES-R Proving Ground?

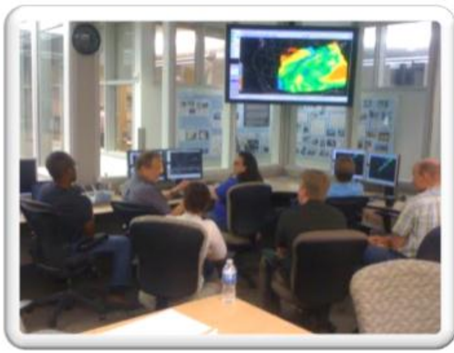
- Collaborative effort between the GOES-R Program Office, selected NOAA Cooperative Institutes, NWS forecast offices, NCEP National Centers, NASA SPoRT, JCSDA, and NOAA Testbeds
- Responsible for user readiness testing of GOES-R baseline products and future capabilities prior to launch
- Where proxy and simulated GOES-R products are tested, evaluated, and integrated into operations before launch to maximize user readiness for GOES-R capabilities
  - Satellite Champions at NWS National Centers
  - Develop training for users
  - Display within AWIPS/N-AWIPS and transition to AWIPS-II
  - Initial focus on High Impact Weather and warning related products requested by NWS
- A key element of GOES-R User Readiness (Risk Mitigation)

GOES-R Proving Ground
Accelerates Utility and User Readiness

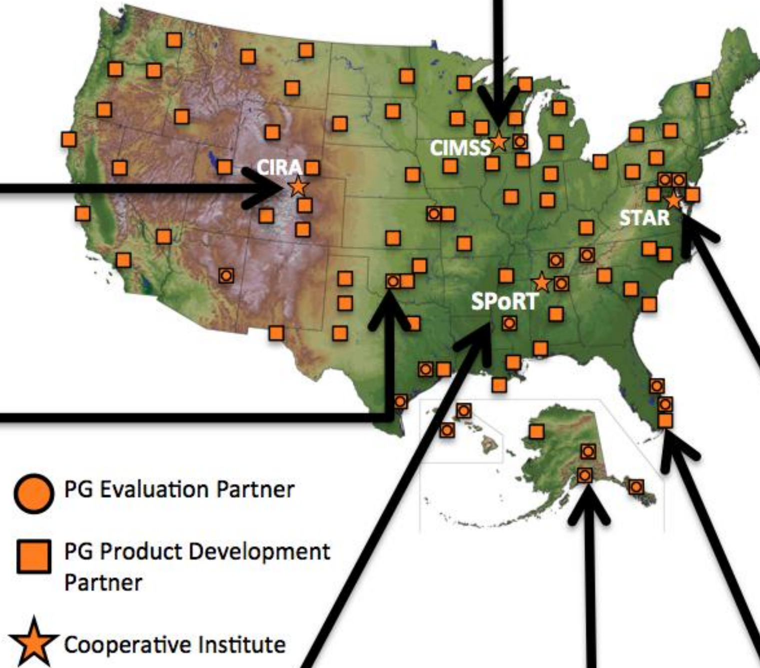
- Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
- Infusing GOES-R products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II.
- Engaging in a dialogue to provide feedback to product developers from users
- Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction programs as sources of demonstration products, promoting a smooth transition to operations
- Matching observations/capabilities to forecast problems
- Developing/Assessing solutions in “testbeds” and transition to decision support system
- Conducting training, product assessment, and impact

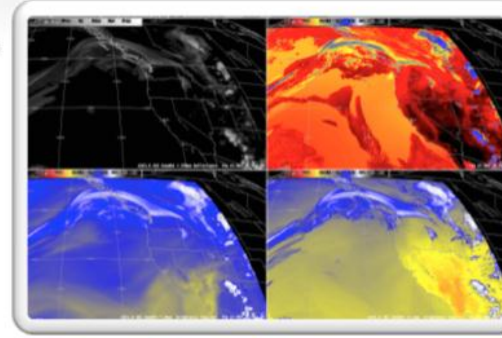
GOES-R Proving Ground

CIRA - Ft. Collins, CO
ABI Simulated Natural Color

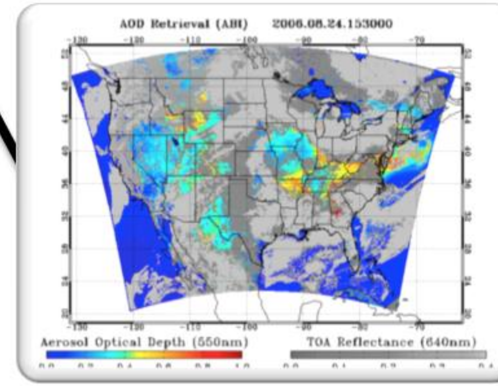


SPC – Oklahoma City, OK
Nearcast Training at the Hazardous Weather Testbed

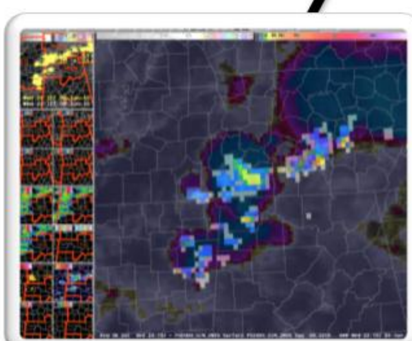




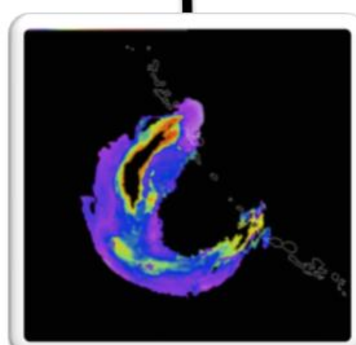
CIMSS – Madison, WI
Simulated ABI Bands



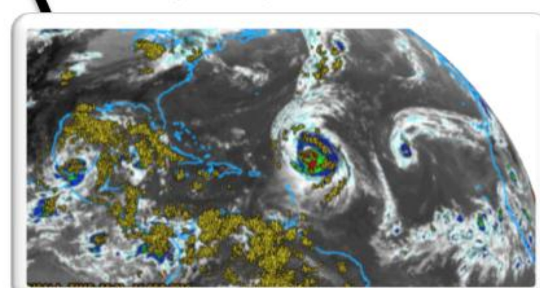
STAR – Camp Springs, MD
Aerosol Optical Depth Product



SPoRT – Huntsville, AL
GLM Lightning Flash Density



AFC – Anchorage, AK
Volcanic Ash Product



NHC – Miami, FL Rapid Intensification Index

July 2011

Visiting Scientists: Satellite Champions

NWS Centers	Visiting Scientist/PI	CI	NOAA Host
SPC/HWT	C. Siewert, K. Kuhlman	OU-CIMMS	Russ Schneider
OPC, HPC, SAB	M. Follmer, S. Rudlosky	CICS	J. Sienkiewicz, E. Danaher, J. Kibler
AWC	new hire	UW-CIMSS	David Bright
NWS Training Center	new hire	UW-CIMSS	John Ogren
Pac Region	S. Businger /new hire	UH-JIMAR	Bill Ward
AK Region	T. Heinrichs	UAF-CIFAR	Gary Hufford
Multiple	R. Brummer	STAR/CSU-CIRA	Various
Multiple	W. Feltz	STAR/UW-CIMSS	Various
Multiple	G. Jedlovec	NASA-SPoRT	Various
SwPC	W. Denig	NGDC/CIRES	Rodney Viereck
NWS HQS	A. Huff/ S. Kondragunta/R. Hoff	STAR/UMBC	Ivanka Stajner

Proving Ground Product Evaluations

Baseline Products

- Cloud and Moisture Imagery
- Volcanic Ash: Detection and Height
- Hurricane Intensity
- Lightning Detection: Events, Groups & Flashes
- Rainfall Rate/QPE
- Total Precipitable Water
- Fire/Hot Spot Characterization
- Cloud Top Phase
- Cloud Top Height
- Cloud Top Temperature
- Derived Motion Winds
- Aerosol Detection
- Aerosol Optical Depth

Future Capabilities

- Aircraft Icing Threat
- Convective Initiation
- Enhanced “V”/Overshooting Top Detection
- Low Cloud and Fog
- SO_2 Detection

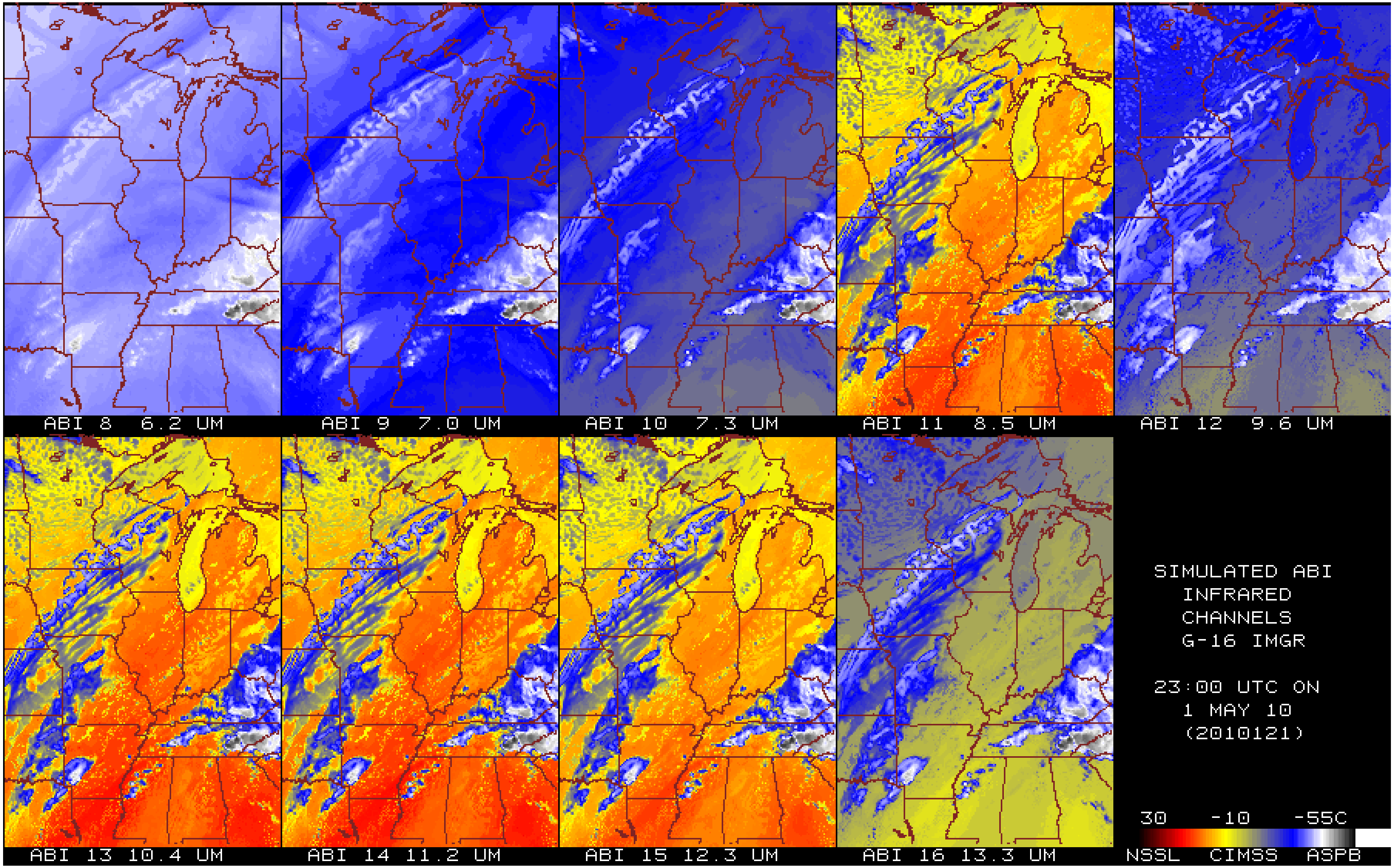
HWT Spring Experiment

Evaluating 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 CIMSS Visiting Scientists to introduce the products to forecasters
- Lightning Detection
  - Ground-based VHF Lightning Mapping Array provides pseudo GLM products
  - Routinely used in the EWP
  - Numerous examples of operational value in generating forecasts of lightning threat and severe weather warnings
  - Provides early indication of when 1st cloud to ground flash will occur
- Simulated Cloud and Moisture Imagery from NSSL WRF
  - Part of daily routine at the CI desk for model performance evaluation
  - Used for tracking model forecasts vs observations

Estimated ABI Emitted-only bands

From NSSL WRF



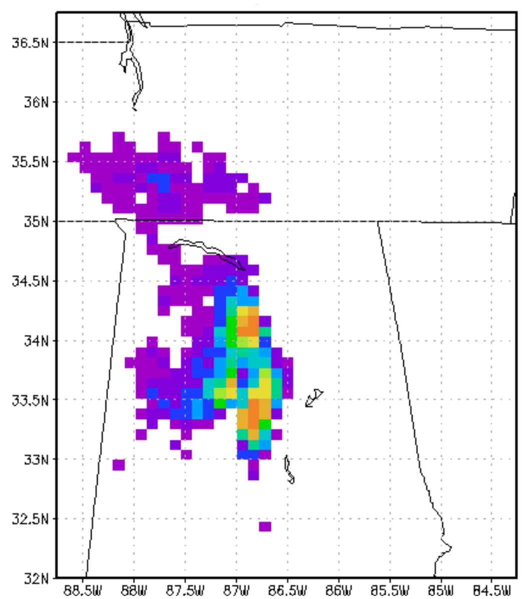
SPoRT Pseudo GLM Product

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

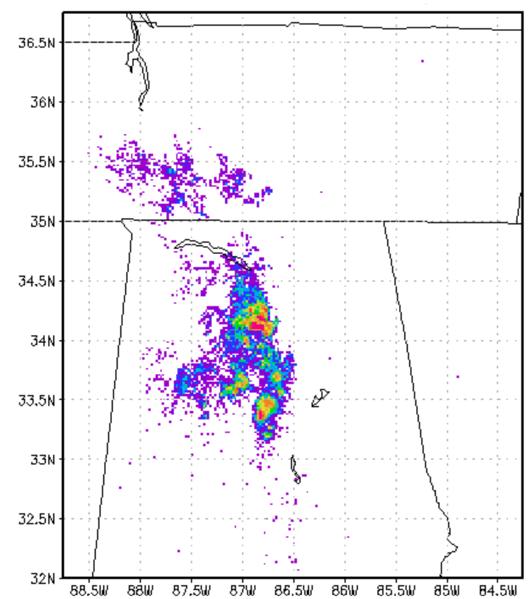
Flash Extent Density derived from LMA data at GLM resolution

- 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



Nearcasting

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!*

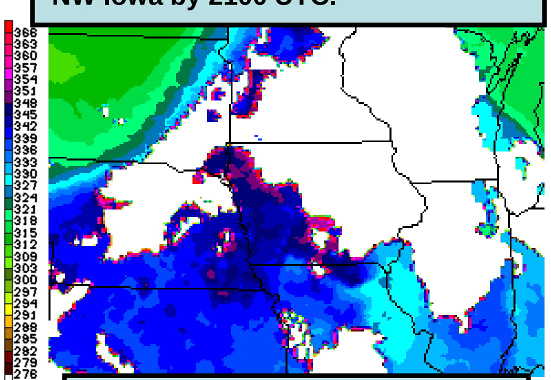
Hourly, multi-layered observations from the GOES Sounder are projected forward in time along Lagrangian trajectories forced by gradient winds. "Trajectory observations" from the previous six hours are retained in the analysis. Destabilization is indicated when theta-E decreases with height.

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**

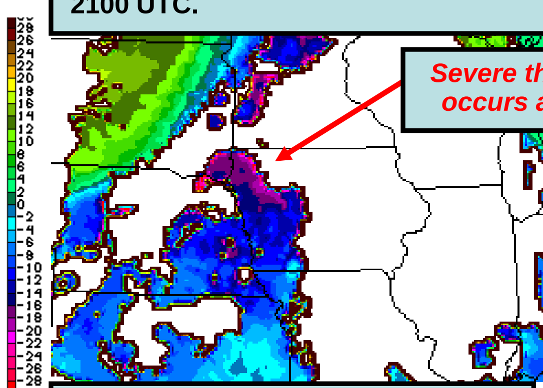
One Example of a Successful Near-cast

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



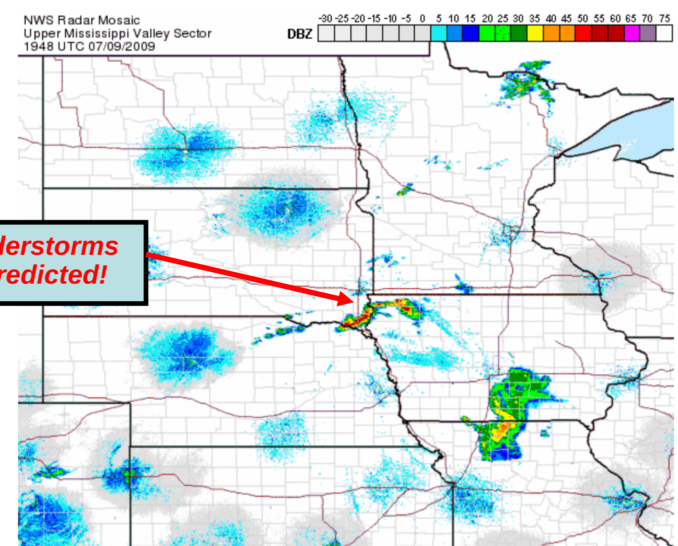
6-hour NearCast for 2100 UTC
Low level Theta-E

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!

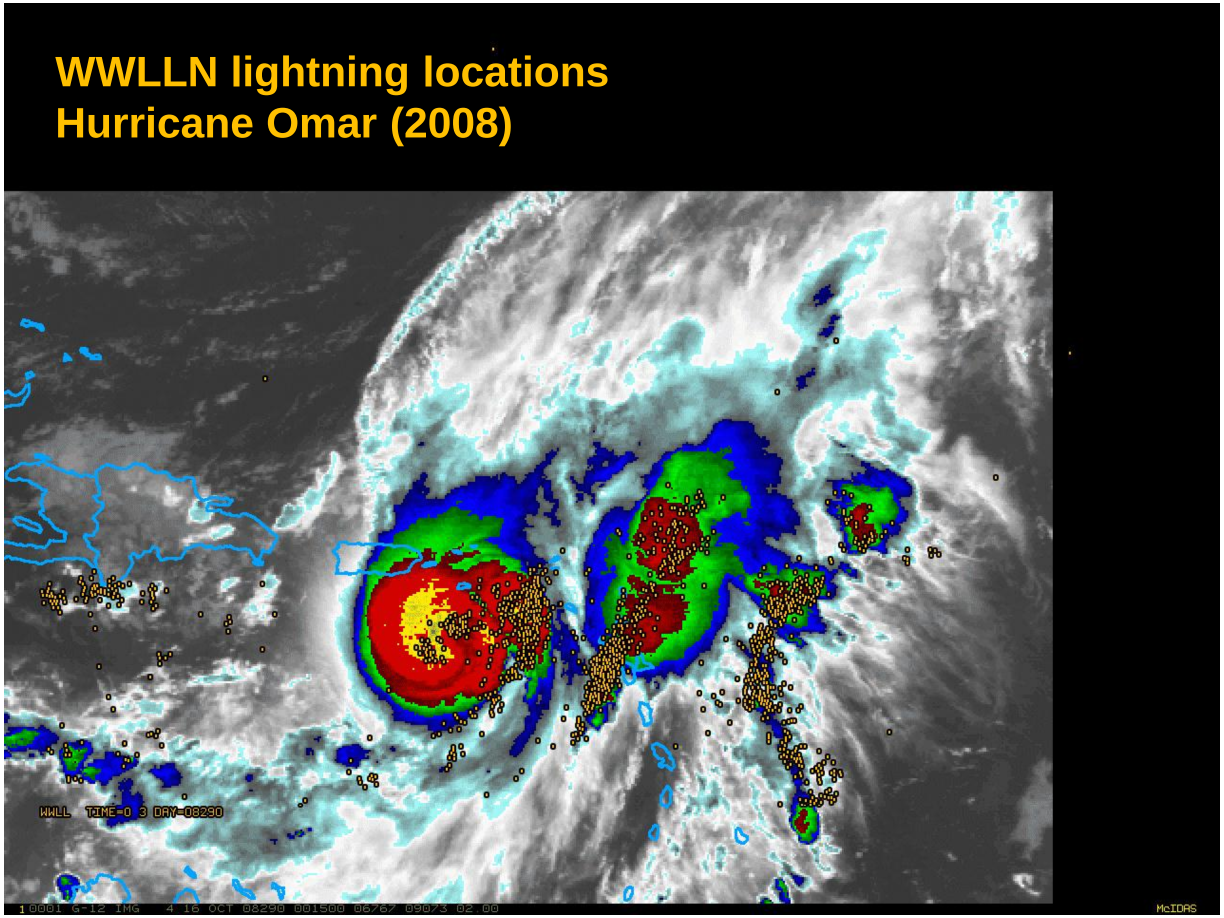


Rapid Development of Convection over NW Iowa between 2000 and 2100 UTC 9 July 2009

NHC PG Project Overview

- **Super Rapid Scan**
  - Get forecasters used to routine 5 min imagery from GOES-R and special 1 min imagery
  - Many good cases from 2010, emphasis on landfall cases in 2011
- **Red-Green-Blue (RGB) products**
  - Prepare forecasters for use of image combination products due to large number of ABI channels
  - Air Mass, Dust and Saharan Air Layer products
- **Natural Color**
  - Prepare for natural color available from GOES-R
  - GOES-R simulated green algorithm on MODIS
  - Qualitative true color from SEVIRI
- **Lightning-based Rapid Intensification Index**
  - Quantitative use of GLM for intensity forecasting
  - Ground based WWLLN data from U. Washington used as proxy

The Rapid Intensification Index



- Inner core and rainband lightning provide predictive information
- Added to other predictors such as SST and vertical shear
- Used to forecast rapid intensification and rapid weakening
- Impact of lightning can be determined quantitatively from product verification

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                    *   ATLC RAPID INTENSITY INDEX TESTS        *
                    *      GOES DATA AVAILABLE                  *
                    *      OHC  DATA AVAILABLE                  *
                    *  AL01        AL012010  06/30/10  00 UTC   *

++++++++ SECTION 1, COPY OF OPERATIONAL RII ++++++++

   ** 2010 ATLANTIC RI INDEX AL012010 AL01       06/30/10  00 UTC **
           ( 30 KT OR MORE MAX WIND INCREASE IN NEXT 24 HR)

 12 HR PERSISTENCE (KT):    5.0 Range:-45.0 to  30.0 Scaled/Wgted Val:  0.7/  1.4
 850-200 MB SHEAR (KT) :    6.5 Range: 26.2 to   3.2 Scaled/Wgted Val:  0.9/  1.0
 D200 (10**7s-1)       :   61.0 Range:-21.0 to 140.0 Scaled/Wgted Val:  0.5/  0.7
 POT = MPI-VMAX (KT)   :   69.0 Range: 33.5 to 126.5 Scaled/Wgted Val:  0.4/  0.3
 850-700 MB REL HUM (%):   81.8 Range: 56.0 to  85.0 Scaled/Wgted Val:  0.9/  0.5
 % area w/pixels <-30 C:   92.0 Range: 17.0 to 100.0 Scaled/Wgted Val:  0.9/  0.1
 STD DEV OF IR BR TEMP :   10.9 Range: 30.6 to   3.2 Scaled/Wgted Val:  0.7/  1.2
 Heat content (KJ/cm2) :   44.6 Range:  0.0 to 130.0 Scaled/Wgted Val:  0.3/  0.0

 Prob of RI for 25 kt RI threshold=    44% is   3.5 times the sample mean(12.6%)
 Prob of RI for 30 kt RI threshold=    33% is   4.1 times the sample mean( 8.1%)
 Prob of RI for 35 kt RI threshold=    21% is   4.1 times the sample mean( 4.8%)
 Prob of RI for 40 kt RI threshold=    20% is   6.4 times the sample mean( 3.4%)

++++++++ SECTION 2, RII WITH LIGHTNING DATA ++++++++
                    FOR GOES-R PROVING GROUND

AL01       Initial vmax, lat, lon:    65.   23.0   -94.4

 Prob of RI for 30 kt RI threshold=    28%,   no lightning input, exper. algorithm
 Prob of RI for 30 kt RI threshold=    33%, with lightning input, exper. algorithm

Recent Lightning Density History  (Strikes/km2-year)
Date/Time     Inner core (0-100 km)  Rainband (300-400 km)
10 0630 00      0.5                    40.7
10 0629 18      2.0                     4.5
10 0629 12      0.0                    15.4
10 0629 06      0.0                    53.7
10 0629 00      0.0                    80.0
10 0628 18      0.0                     2.0
10 0628 12      2.5                     0.5
10 0628 06      5.3                     0.6
10 0628 00      0.0                     2.3
10 0627 18      0.0                     9.9
10 0627 12      0.0                    12.3
10 0627 06      0.0                    15.7
10 0627 00     47.2                    82.1

Sample mean:   21.5                    14.7

 Note: Inner core lightning <  sample mean favors RI
       Rainband lightning   >  sample mean favors RI
```

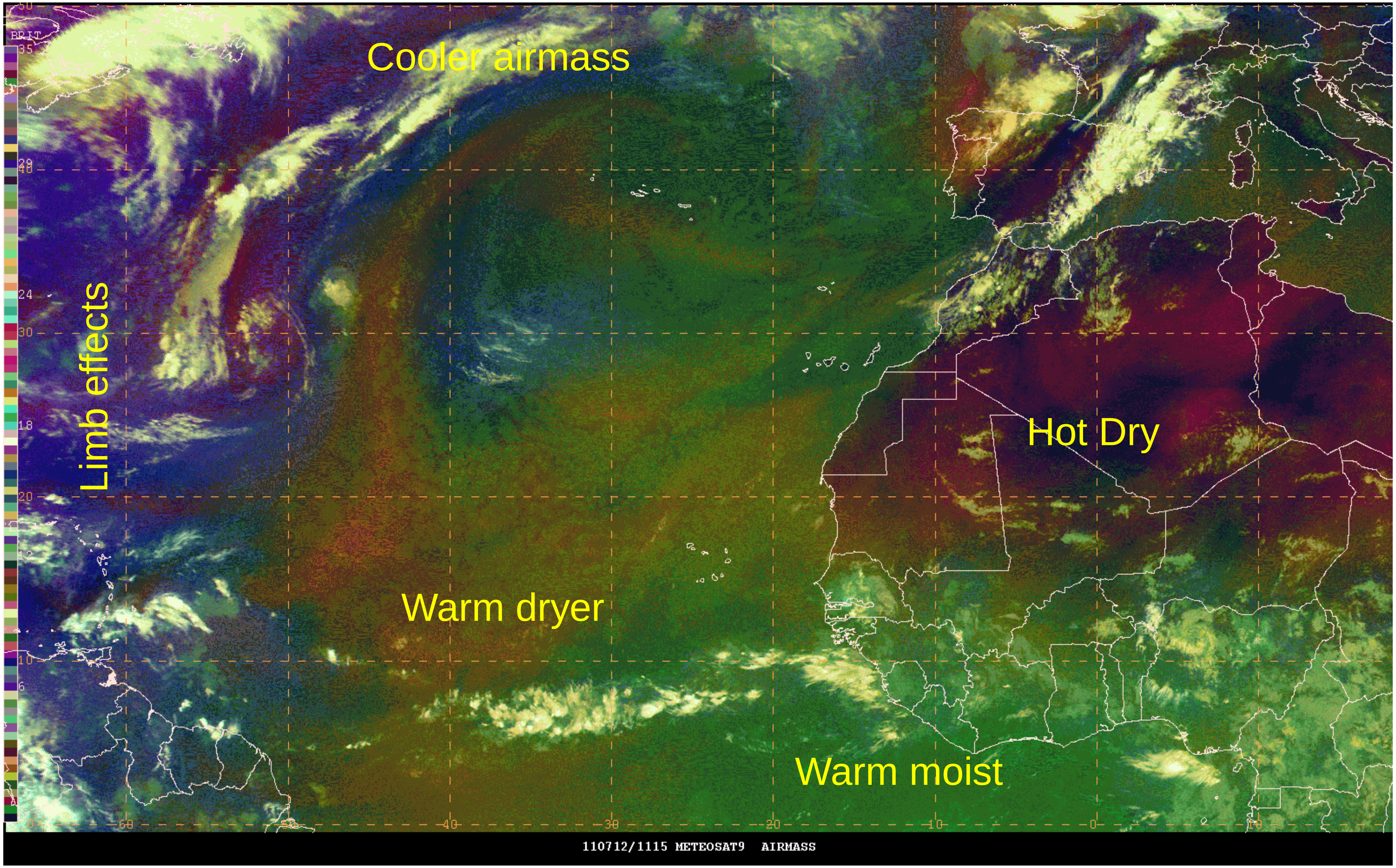
Sample Text Output

Lightning-Based Rapid Intensification Forecast Algorithm

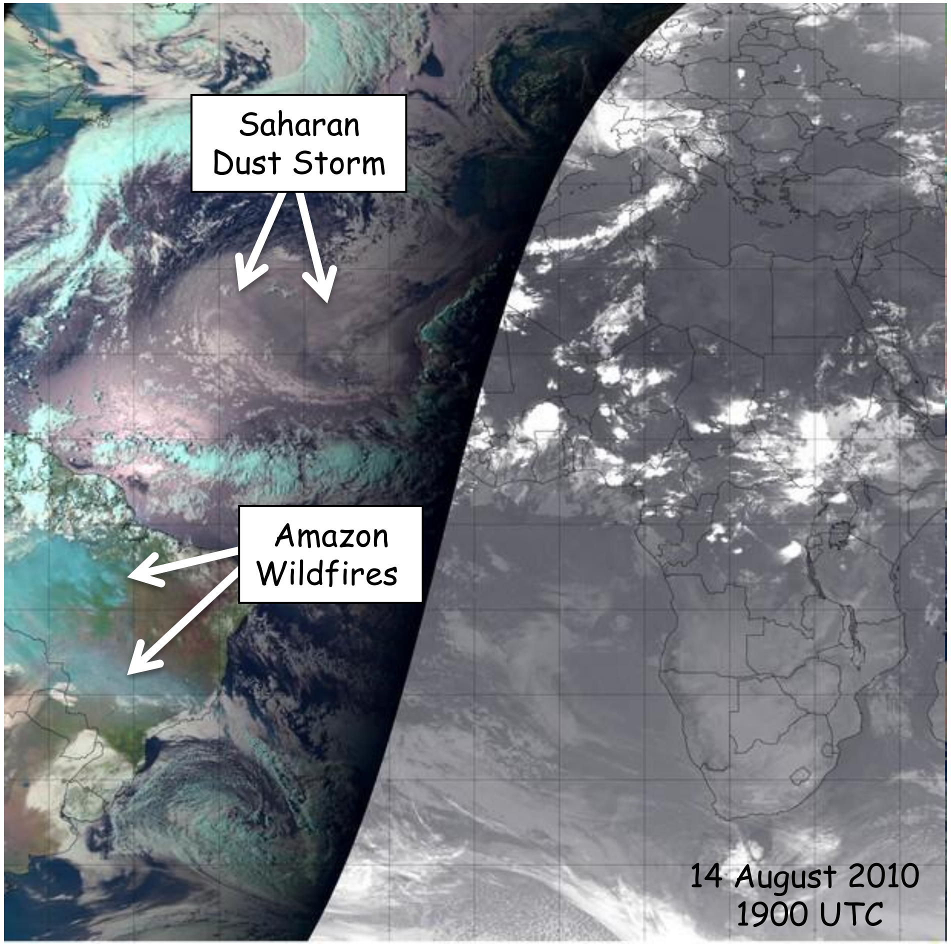
Hurricane Alex
30 June 2010 00 UTC

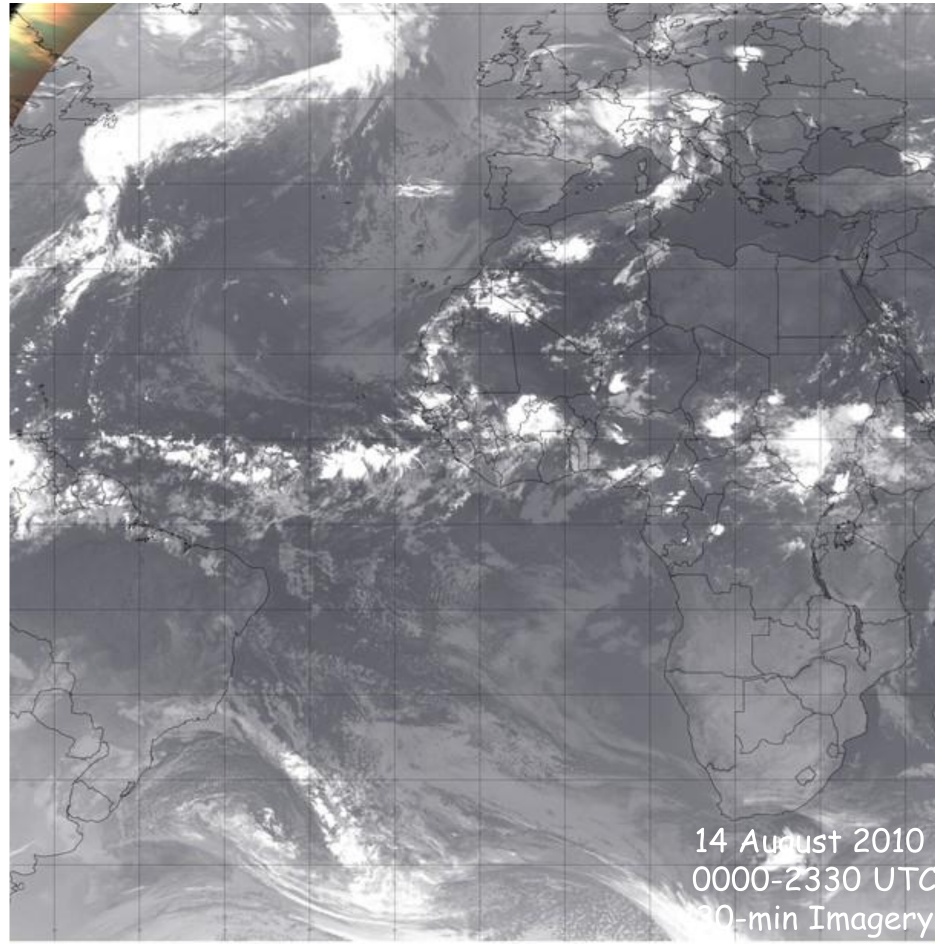
Available at: ftp://rammftp.cira.colostate.edu/demaria/NHCPG

RGB Air Mass Product from SEVIRI

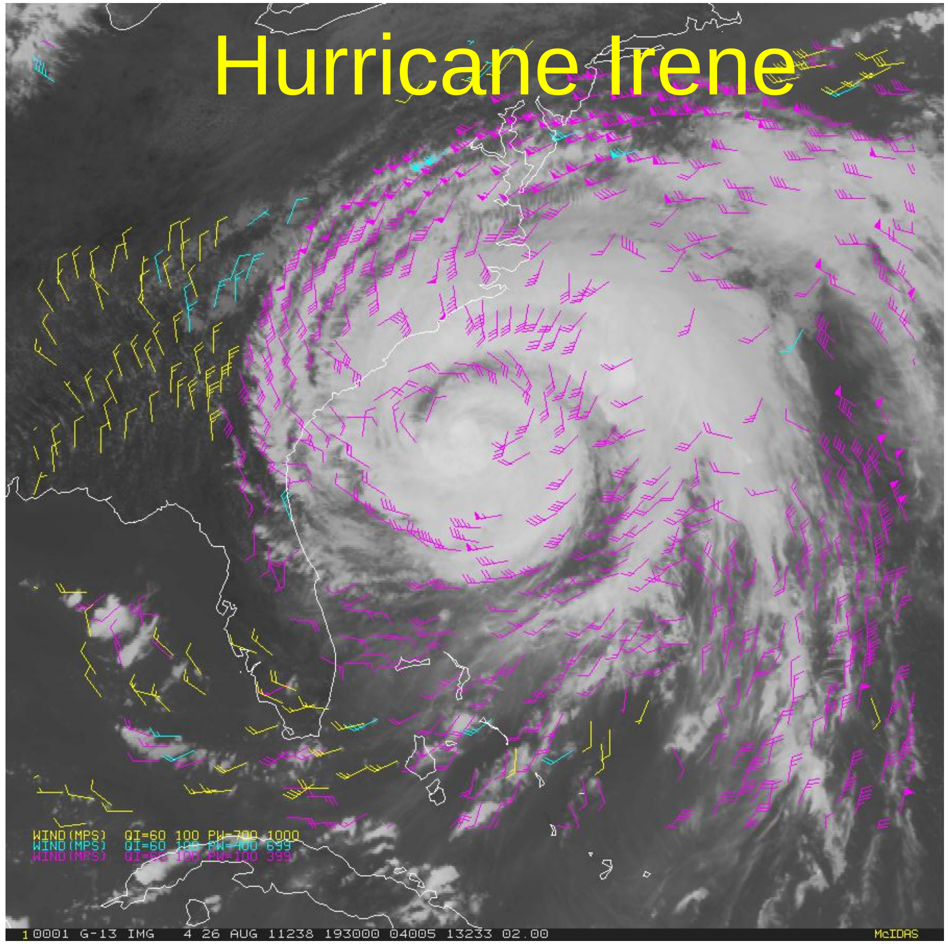


Pseudo Natural Color Satellite Imagery (Meteosat)





GOES-R AMVs Applied to GOES-13



Jamie Daniels/NESDIS STAR

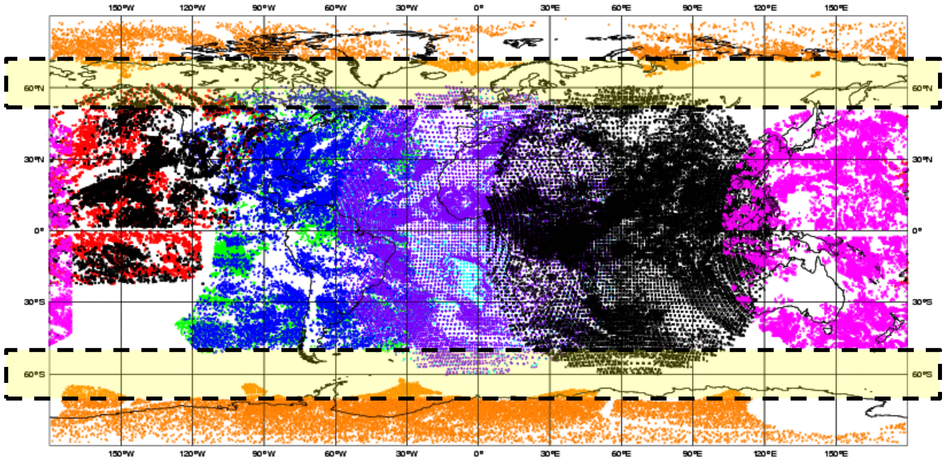
Example of the cloud-drift winds derived from 15-minute GOES-13 imagery over Hurricane Irene at 1930 UTC on 26 August 2011 using the GOES-R cloud and derived motion wind algorithms. These winds are derived from tracking cloud features using the 11.2um channel. High level (100-400 hPa) winds are shown in violet; mid-level (400-700 hPa) winds are shown in cyan; and low level winds (below 700 hPa) are shown in yellow.

2011 Aviation Products

– 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_2 detection and loading
  - Convective initiation
  - Nearcasting (AWC only)

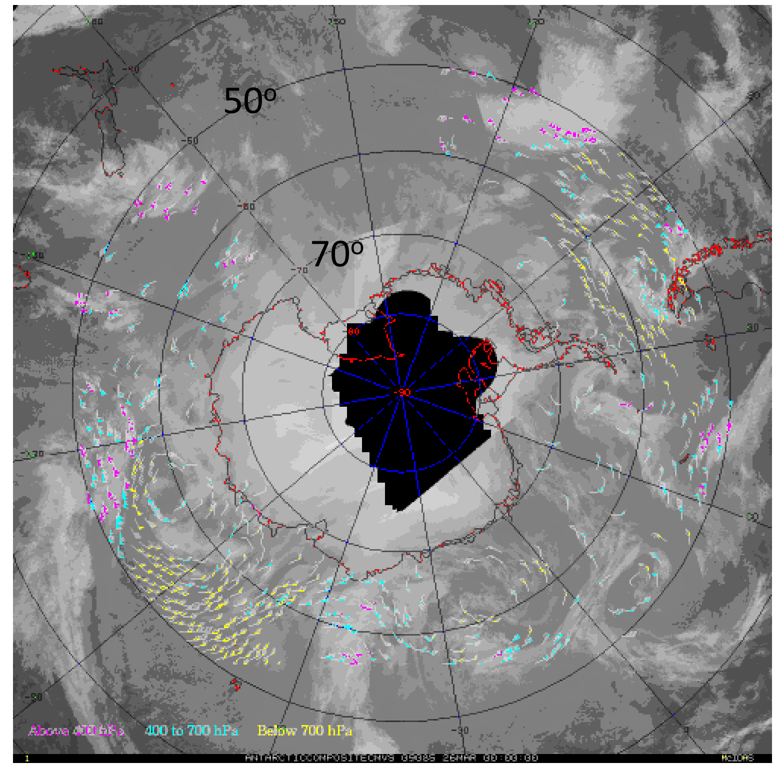
Example of Geo-LEO blended Product
High Latitude Atmospheric Motion Vectors

Geostationary satellites provide Atmospheric Motion Vectors (AMV) equatorward of ~60° latitude; polar satellites provide AMVs poleward of ~70° latitude.



Developing novel ways to fill this gap is the next step in providing complete wind coverage for NWP applications.

Multiple satellite data are blended and used for AMV generation. The images are composites of the Geo (GOES, Meteosat-7 and -9, FY-2C, MTSAT-1R, Kalpana-1) and Leo satellites (NOAA-15 through NOAA-19, Metop-A, NASA's Terra and Aqua).



Animation: Example of winds from composite GEO/LEO satellite data over Antarctica.

Slide courtesy of Matthew Lazzara/SSEC

GOES-R Fog Detection

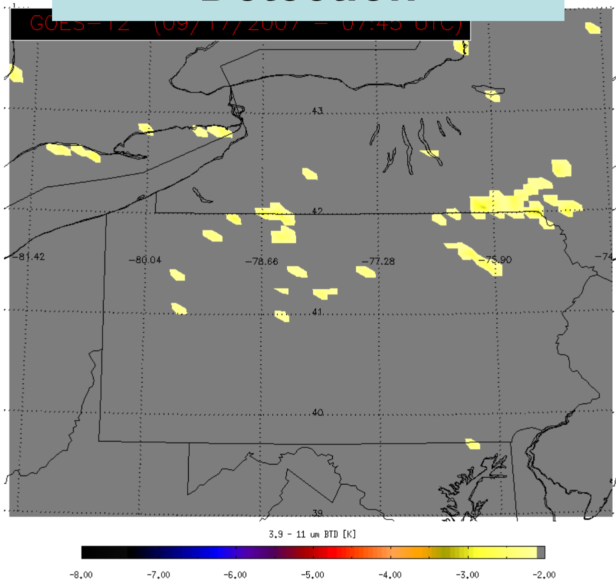
M. Pavolonis

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

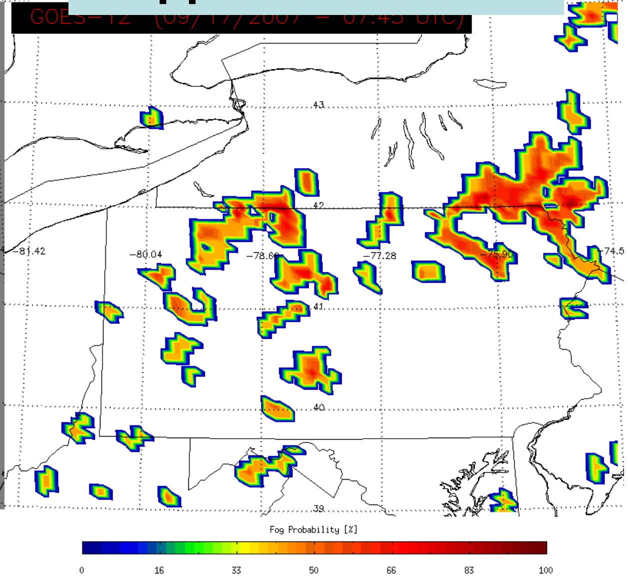
•***Improved algorithm technology*** - the GOES-R algorithm provides quantitative information on fog probability, while heritage GOES fog detection products are more qualitative in nature

•***Improved sensor technology*** - the ABI has greatly improved spectral information, spatial resolution, and temporal resolution

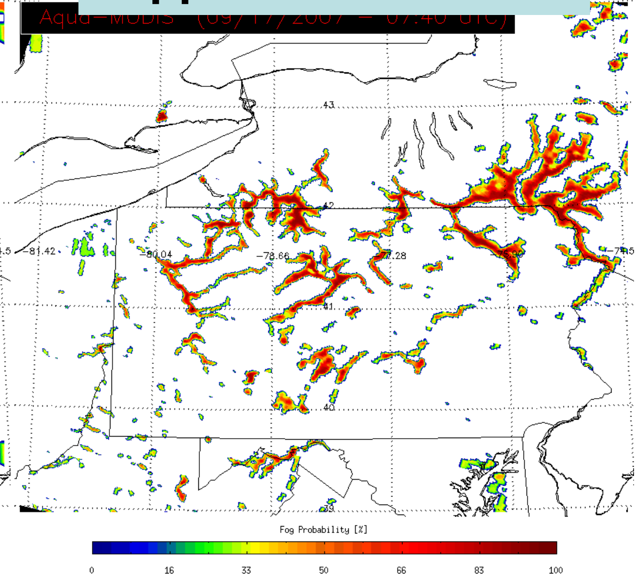
Heritage GOES Fog Detection



GOES-R Algorithm Applied to GOES



GOES-R Algorithm Applied to GOES-R



2011 Product Demonstrations

- Oceanic Weather and Precipitation: NWS OPC, HPC, NESDIS SAB Testbed
  - 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

- Quantitative Precipitation Forecasts: NWS HPC and NESDIS SAB
  - Cloud and moisture imagery
  - Derived motion winds
  - RGB air mass
  - Rainfall Rate QPE

2011 Product Demonstrations

- Hazardous Weather and Rainfall Potential: 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: NWS SwPC and NESDIS NGDC
  - Planning phase-implementation plan in development
  - 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

User Community Proving Ground

Post to your blogs

initiated to facilitate research-to-operations with the principal focus being on the forecaster/AWIPS-II environment; to prepare for the GOES-R information, to get real-world experience by leveraging existing resources, and to evaluate product tailoring. The GOES-R Proving Ground engages NWS, EPA, DoD, and other operational environments in pre-operational demonstrations of selected capabilities of next generation GOES with the objective 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-like products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II*
- *Engaging in a dialogue to provide feedback between developers and users*

The GOES-R project engages the National Weather Service (NWS) forecast and warning community in preoperational demonstrations of selected capabilities anticipated from the next generation of NOAA geostationary earth observing systems.

The Proving Ground was established to realize the benefits of the GOES-R system as soon as the satellites are launched and operational. GOES-R will mark the first major technological advances in geostationary observations since 1994. The advances include improvements upon existing data such as increased spatial, temporal, and spectral resolutions for Earth monitoring and improved space weather observations and initiation of new operational observations such as lightning mapping.

Many of the GOES-R products will be aimed at monitoring severe weather and helping forecasters issue earlier, more accurate severe weather warnings. In order to create the most useful severe weather tools possible, the GOES-R Proving

The GOES-R Overshooting Top Detection (OTD) algorithm identified an overshooting top at NOAA's Hazardous Weather Testbed with the severe thunderstorm and tornado that struck in Springfield, MA on June 1, 2011. The OTD singled out the most intense thunderstorm cell out of a very large storm complex over Southern and Central New England. National Weather Service forecasters at the HWT Experimental Warning Program and Convective Initiation desk were alerted to the developing severe storm with 28 minute lead time before the first tornado report.

For More Information

- CIMSS GOES-R Proving Ground Website
- Proving Ground Partners Page
- Proving Ground Products Website
- GOES-R Proving Ground Facebook Page

Blogs

- CIMSS Satellite Blog
- RAMMB GOES-R Proving Ground Blog
- GOES-R Proving Ground at NOAA's Hazardous Weather Testbed
- The Wide World of SPoRT Blog

Fact Sheets

- Proving Ground Severe Weather Fact Sheet
- National Hurricane Center 2010 Experiment

Documents

- GOES-R Proving Ground Update - *September 2011*
- GOES-R Proving Ground Program Plan (PGPP)
- GOES-R Proving Ground Hazardous Weather Testbed 2011 Spring Experiment Operations Plan
- Proving Ground Status Spreadsheet
- Proving Ground Annual Meeting presentations

Future Plans: 2012 And Beyond

- Demonstrate products and decision aids in NOAA Testbeds, NCEP Centers, WFOs, and the NWS Proving Ground Training Center
- Transition from demonstrating Warning Related Products to demonstrating the remaining GOES-R Baseline Products, Day 2 Future Capability Products, Decision Aids, and Fused Decision Support
- Continue to develop, demonstrate, and test fused decision support services
- Enhanced JPSS collaboration (integrated products, VIIRS as a proxy for ABI)

Summary

- Risk Reduction Science Program- more emphasis on NWS integrated observations and NWP for Future Capabilities- “fused capabilities and services”
- Proving Ground continues to grow and plans are in place for continued demonstrations with forecasters
  - National demo of lightning jump algorithm
  - BAMS article in review
- GOES-R Science Week II (AWG, Cal/Val, R3, PG, Training), NWS Training Center, Kansas City, April 30-May 4