Overview GOES-R Aviation Algorithm Requirements

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Joint Interagency Weather Research Coordination Meeting 22-24 March 2010

GOES-R Aviation AWG

AWG Aviation Team Chairs : Ken Pryor, Wayne Feltz
Funded by GOES-R Program Office

- Convective Initiation
  - John Mecikalski (Lead)
  - Wayne MacKenzie
  - Kris Bedka
- Enhanced-V/Overshooting top detection
  - Kristopher Bedka (Lead)
  - Jason Brunner
  - Wayne Feltz
- Turbulence
  - Anthony Wimmers (Lead)
  - Wayne Feltz
- ***Volcanic ash - > Baseline***
  - ***Mike Pavolonis (Lead)***
  - ***Justin Sieglaff (Support)***
- SO_2
  - Mike Pavolonis (Lead)
  - Andrew Parker (Support)
- Visibility
  - Brad Pierce (Lead)
  - Wayne Feltz
- Aircraft Icing
  - Bill Smith, Jr. (Lead)
- Fog/Low Cloud
  - Mike Pavolonis (Lead)
  - Corey Calvert (Support)

GOES-R Convective Initiation

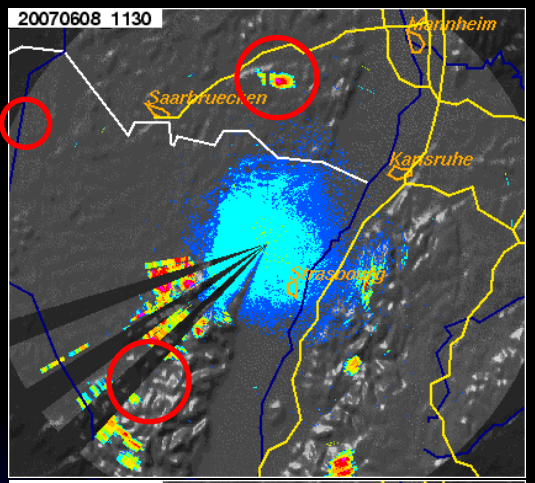
Lead: John Mecikalski/Wayne Mackenzie
University of Alabama - Huntsville

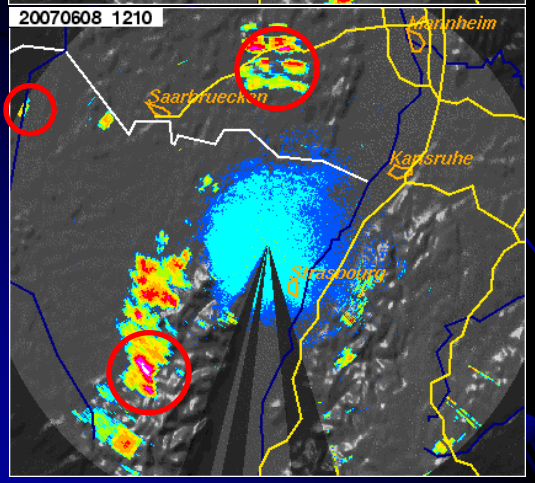
Requirements
Convective Initiation

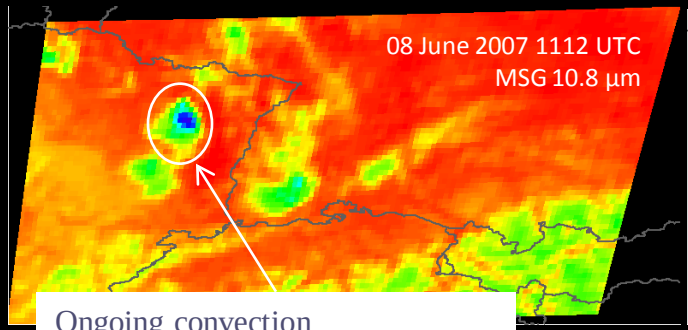
Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Product Refresh Rate/Coverage Time (Mode 3)	Product Refresh Rate/Coverage Time (Mode 4)	Vendor Allocated Ground Latency	Product Measurement Precision
Convective Initiation	GOES-R	C	N/A	2 km	km	Binary yes/no detection	70% correct detection	5 min	5 min	159 sec	N/A
Convective Initiation	GOES-R	M	N/A	2 km	1 km	Binary yes/no detection	70% correct detection	5 min		159 sec	N/A

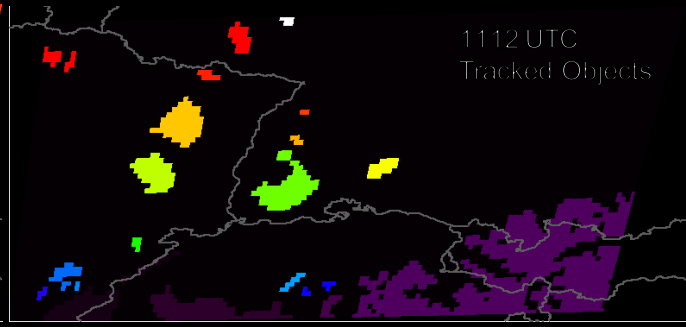
M – Mesoscale **C - CONUS**

CI Test Plan – Offline Validation Test Methods Example: MSG 08 June 2007

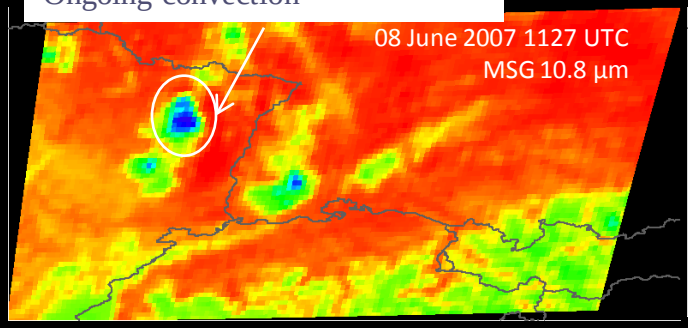


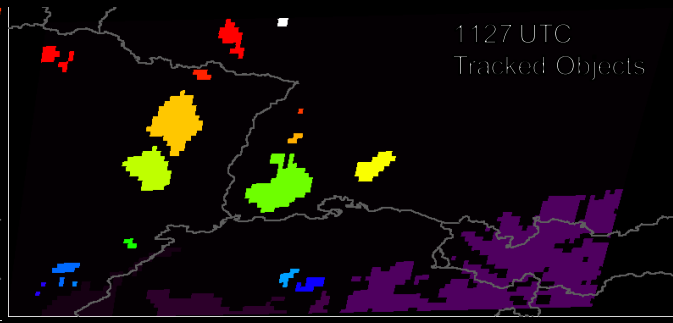




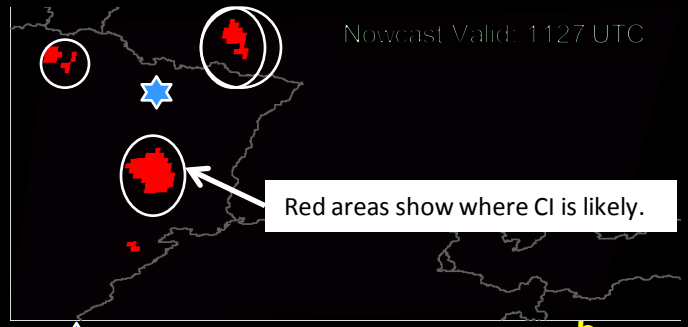


Ongoing convection





Circled areas show the nowcasted regions, and their locations on the radar. There was ongoing convection, and the CI algorithm picked up on regions where CI was going to occur with ~40 minute lead time.

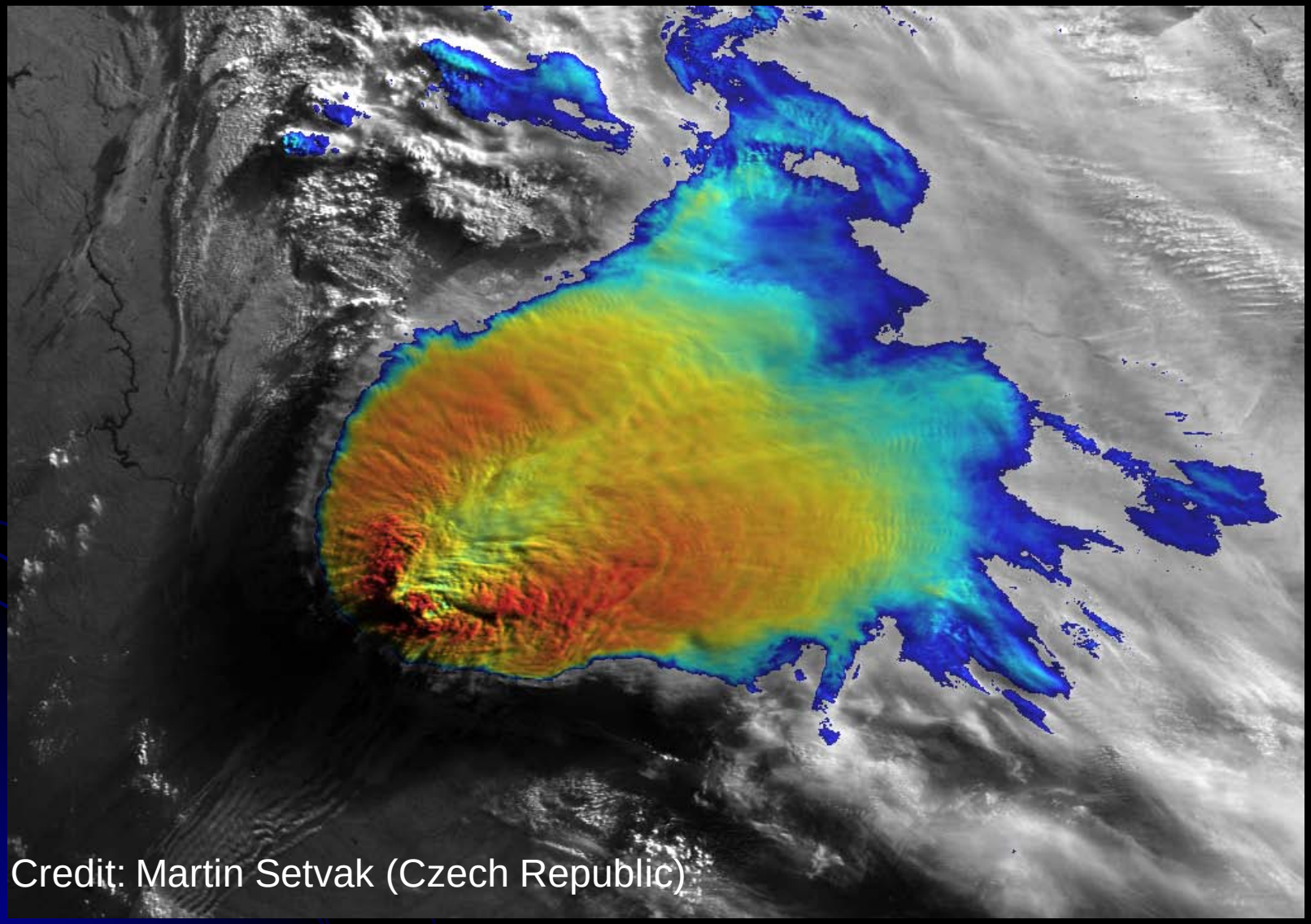


Red areas show where CI is likely.

Denotes radar location.

GOES-R Overshooting-Top

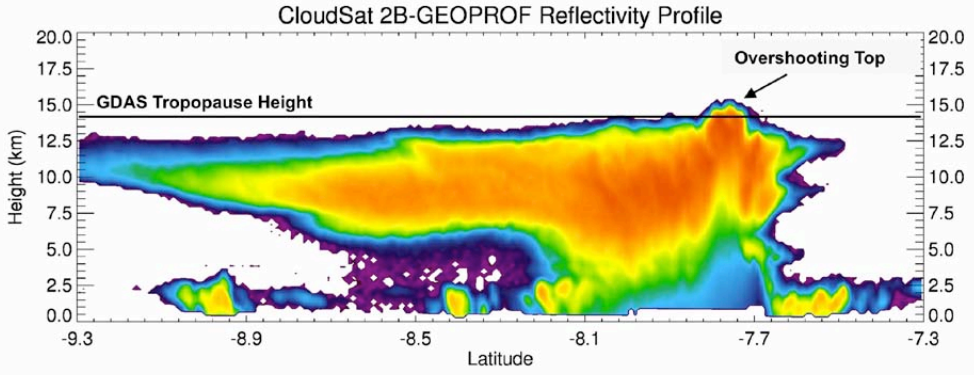
Lead: Kristopher Bedka NASA LaRC SSAI

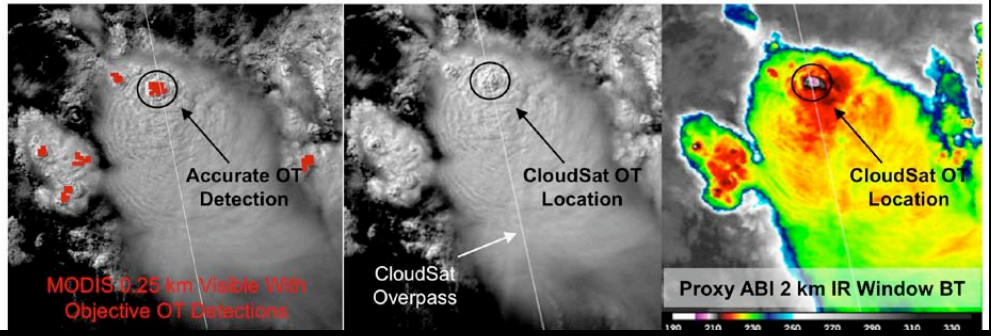


Requirements
Enhanced "V"/ Overshooting Top Detection

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Product Refresh Rate/Coverage Time (Mode 3)	Product Refresh Rate/Coverage Time (Mode 4)	Vendor Allocated Ground Latency	Product Measurement Precision
Enhanced "V"/Overshooting Top Detection	GOES-R	C	N/A	2 km	1 km	Binary yes/no detection (160 – 270K)	75% correct detection (in terms of 1 – False Alarm Rate)	min	5 min	159 sec	N/A
Enhanced "V"/Overshooting Top Detection	GOES-R	M	N/A	2 km	1 km	Binary yes/no detection (160 – 270K)	75% correct detection (in terms of 1 – False Alarm Rate)	5 min		159 sec	N/A

M – Mesoscale **C - CONUS**





- **Overshooting tops (OTs) are the product of deep convective storm updrafts with sufficient strength to rise above the storms' equilibrium level and penetrate into the lower stratosphere**

- **OTs appear as small clusters of very cold pixels relative to the surrounding thunderstorm anvil**
  - Infrared (IR) temperature gradients (i.e. texture) are combined with NWP information to accurately detect OTs during day/night using current and future satellite sensors (Bedka et al. 2010)

- **Detection product being evaluated within the 2010 SPC Spring Experiment via the GOES-R Proving Ground and the NCAR Global Atmospheric Turbulence Decision Support System for Aviation**

OT Detection Method	OT Pixel FAR	ABI OT Detection Product Maximum Acceptable FAR Requirement	OT Top Region POD	Number of OT Detection Pixels Along CloudSat Track
IR-Texture (Applied to Synthetic ABI)	16.1%	25%	74.6%	940 *(114 Global OT Events)*
IR-Texture (Applied to Current GOES and SEVIRI)	18.3%	N/A	57.6%	252 *(59 OT Events)*
WV-IR BT Diff > 0 K (Currently Operational At Aviation Weather Center)	81.2%	25%	99.1%	15079 *(114 Global OT Events)*

GOES-R Turbulence

Lead: Anthony Wimmers UW-CIMSS

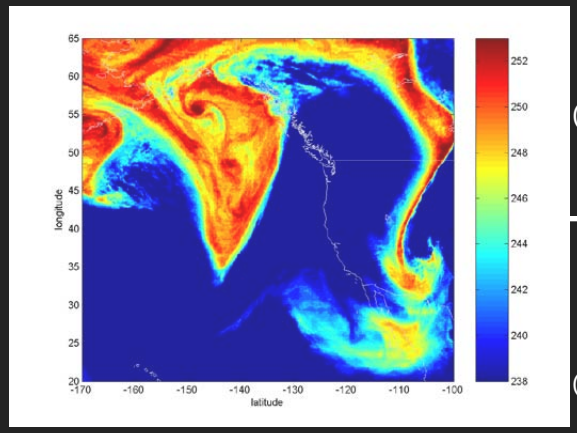
Requirements
Tropopause Folding Turbulence Prediction

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Product Refresh Rate/Coverage Time (Mode 3)	Product Refresh Rate/Coverage Time (Mode 4)	Vendor Allocated Ground Latency	Product Measurement Precision
Tropopause Folding Turbulence Prediction	GOES-R	FD	SFC – 100 mb	2 km	1 km	Binary yes/no detection above boundary layer for moderate or greater condition	50% correct detection of Moderate or Greater turbulence	15 min	5 min	159 sec	N/A
Tropopause Folding Turbulence Prediction	GOES-R	M	SFC – 100 mb	2 km	1 km	Binary yes/no detection above boundary layer for moderate or greater condition	50% correct detection of Moderate or Greater turbulence	5 min		159 sec	N/A

M – Mesoscale **FD – Full Disk**

Tropopause Folding Turbulence Prediction (TFTP)

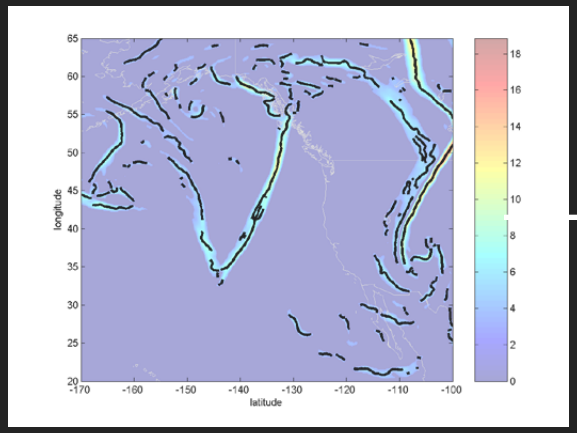
"Tropopause folding" is the entrainment of high-vorticity stratospheric air underneath a warm air mass, along a front. It creates eddy circulations and unstable flow around the jet stream, causing CAT.



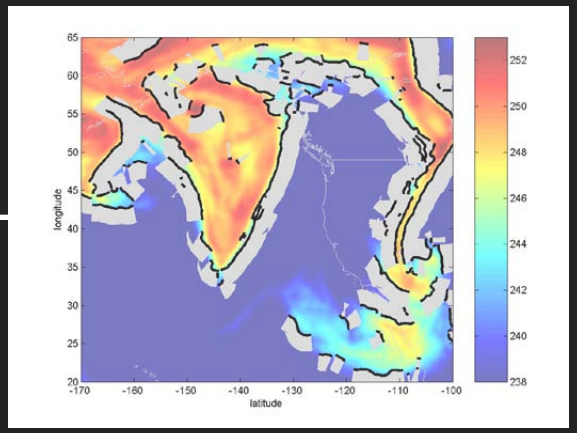
(low WV)

(high WV)

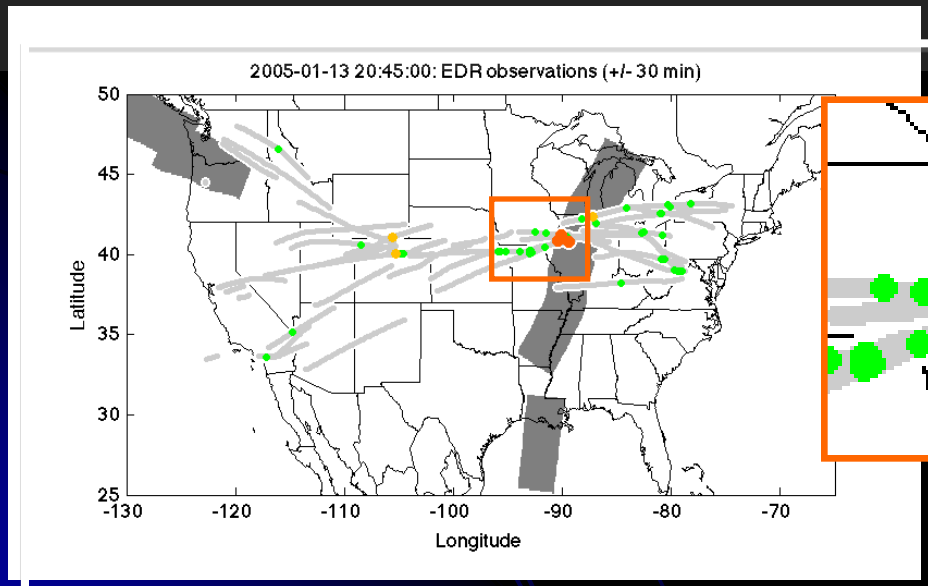
GOES Water Vapor



Edge Detection



Tropopause fold layer



Moderate turbulence
Light turbulence
None

Trop folding product with EDR observations

Key attributes, status

- Can be produced from any satellite water vapor channel.
- Performing at 40% accurate detection of Moderate turbulence (50% by October 2010)
- TFTP is being integrated into the GTG project with global geostationary coverage.
- TFTP will be available as a GOES-R product in 2014

GOES-R Volcanic Ash

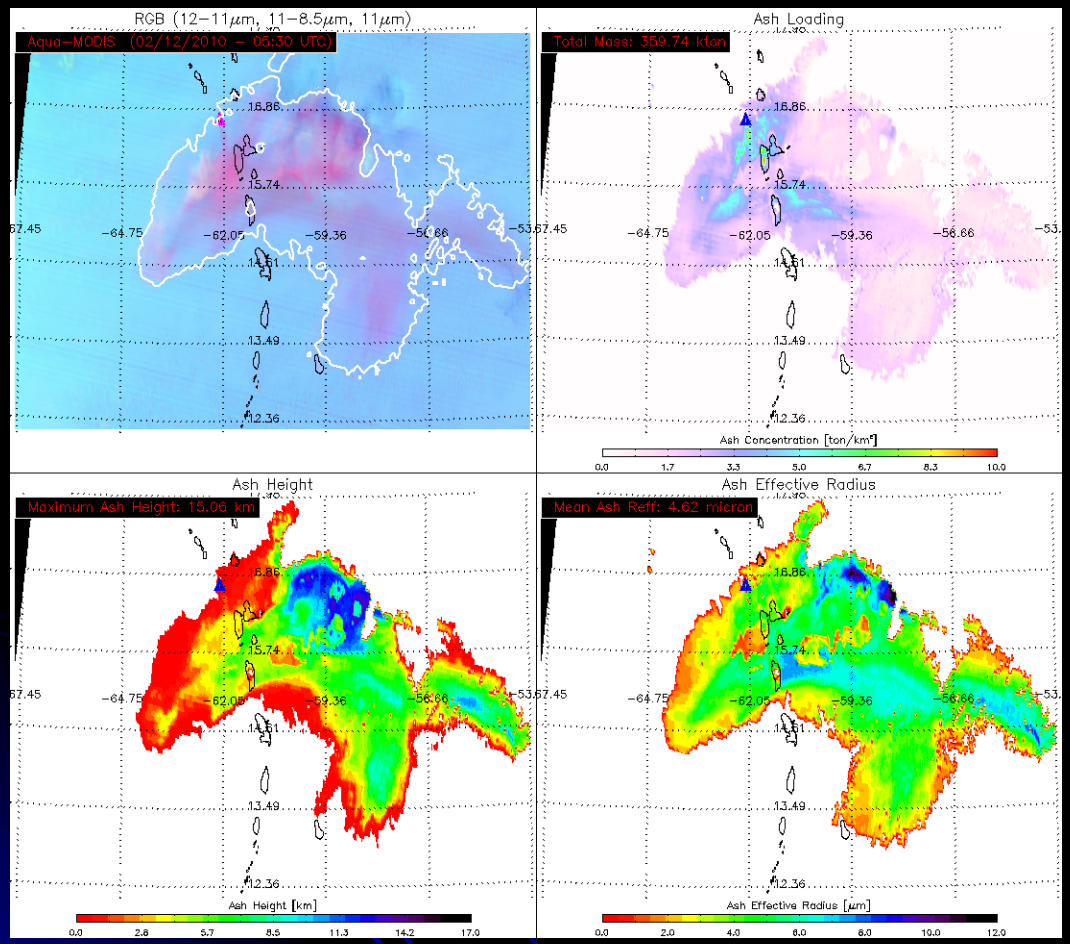
Lead: Michael Pavolonis NOAA

Requirements GOES-R Volcanic Ash: Detection and Height

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Volcanic Ash: detection and Height	GOES-R	FD	3 km (top height)	2 km	1 km	0 – 50 tons/km2	2 tons/km2	15 min	430 sec	10%	Day and night	Quantitative out to at least 60 degrees LZA (threshold) and qualitative beyond	Clear conditions down to feature of interest associated with threshold accuracy	Over volcanic ash cases

FD – Full Disk

Soufriere Hills (2/12/2010)



Project Status:

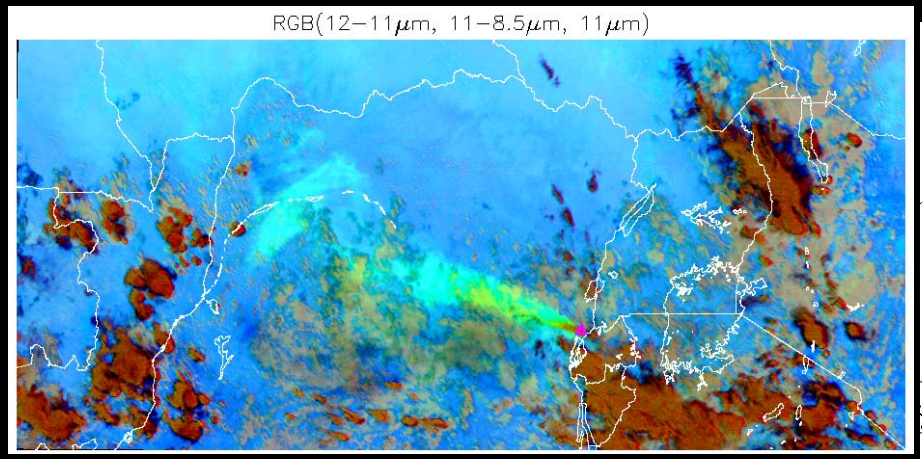
- **The products are meeting the height and mass loading accuracy specifications.**
- **The 100% Algorithm Theoretical Basis Document will be delivered in July.**
- **We plan on developing an automated alert capability, although the alert is not a GOES-R requirement.**

GOES-R SO2

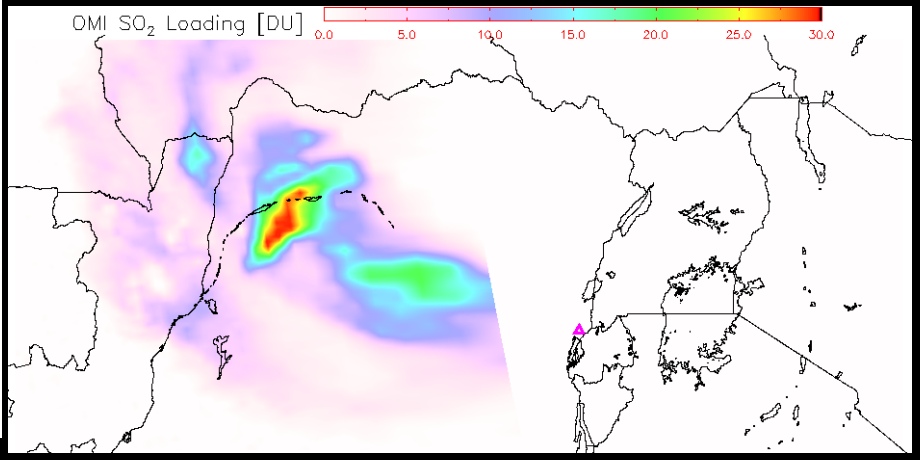
Lead: Michael Pavolonis NOAA

Validation of Nyamuragira (11/29/2006, 1245 UTC)

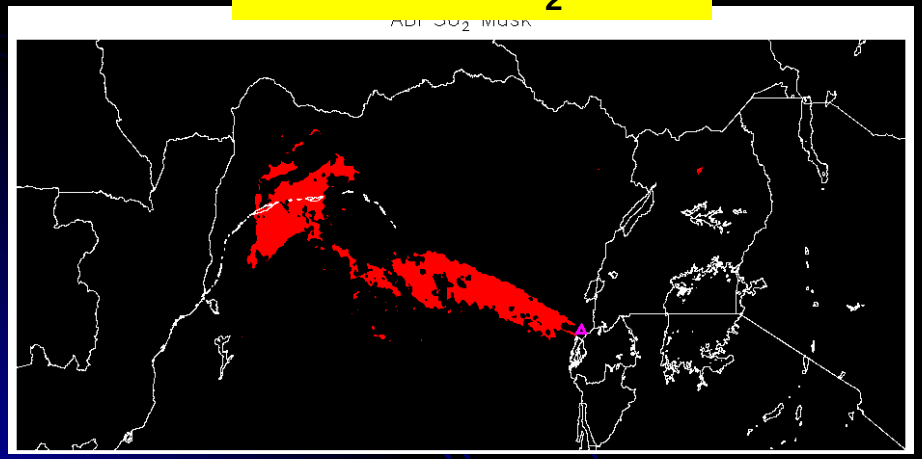
False Color



OMI (UV) SO_2



ABI SO_2



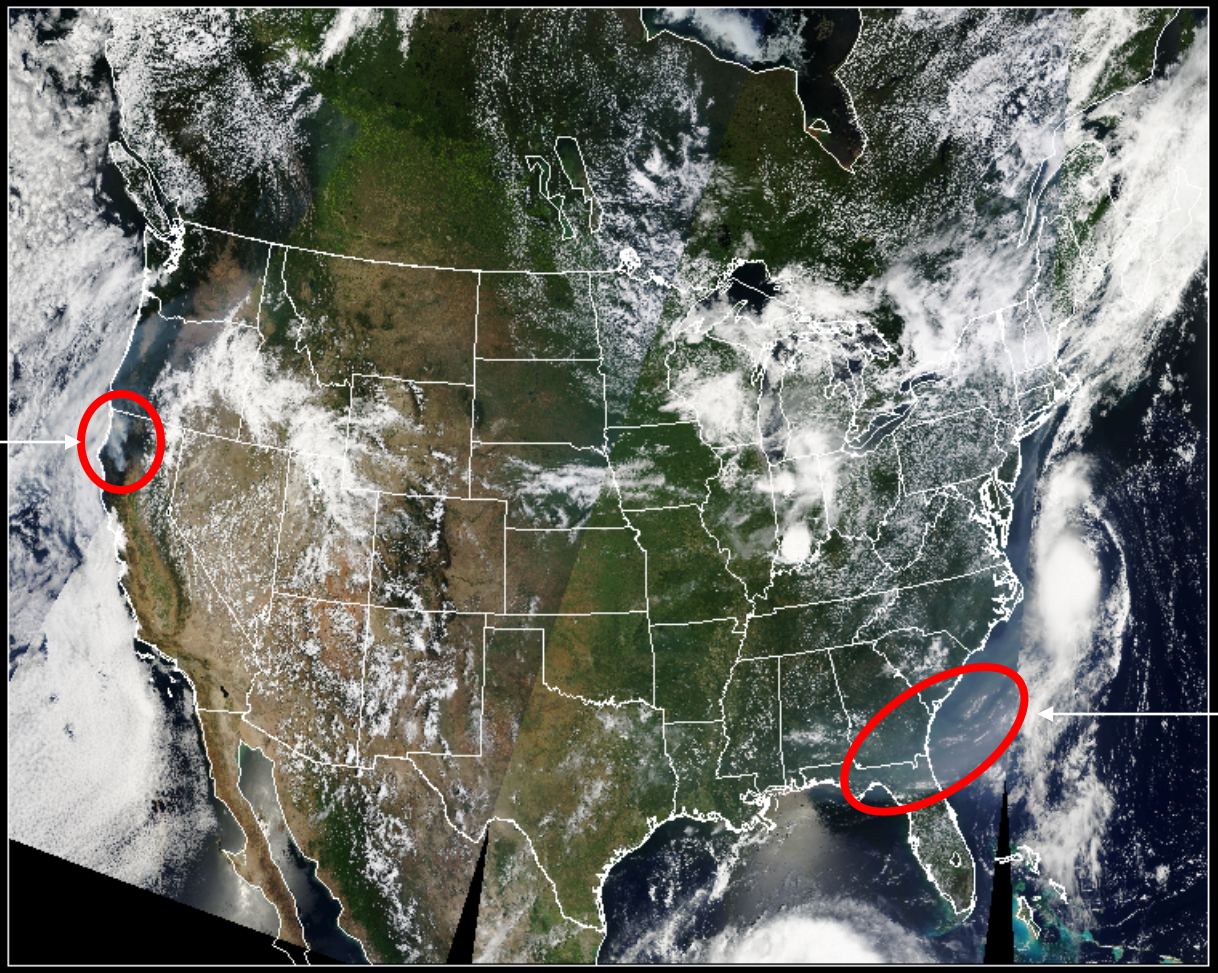
Project Status:

- **The GOES-R SO_2 detection algorithm is close to meeting the 70% detection requirement (for loadings of 10 DU or greater).**
- **The 80% version of the Algorithm Theoretical Basis Document will be delivered in July.**

GOES-R Visibility

Lead: Bradley Pierce NOAA

MODIS (Terra) Visible Image: August 21st, 2008

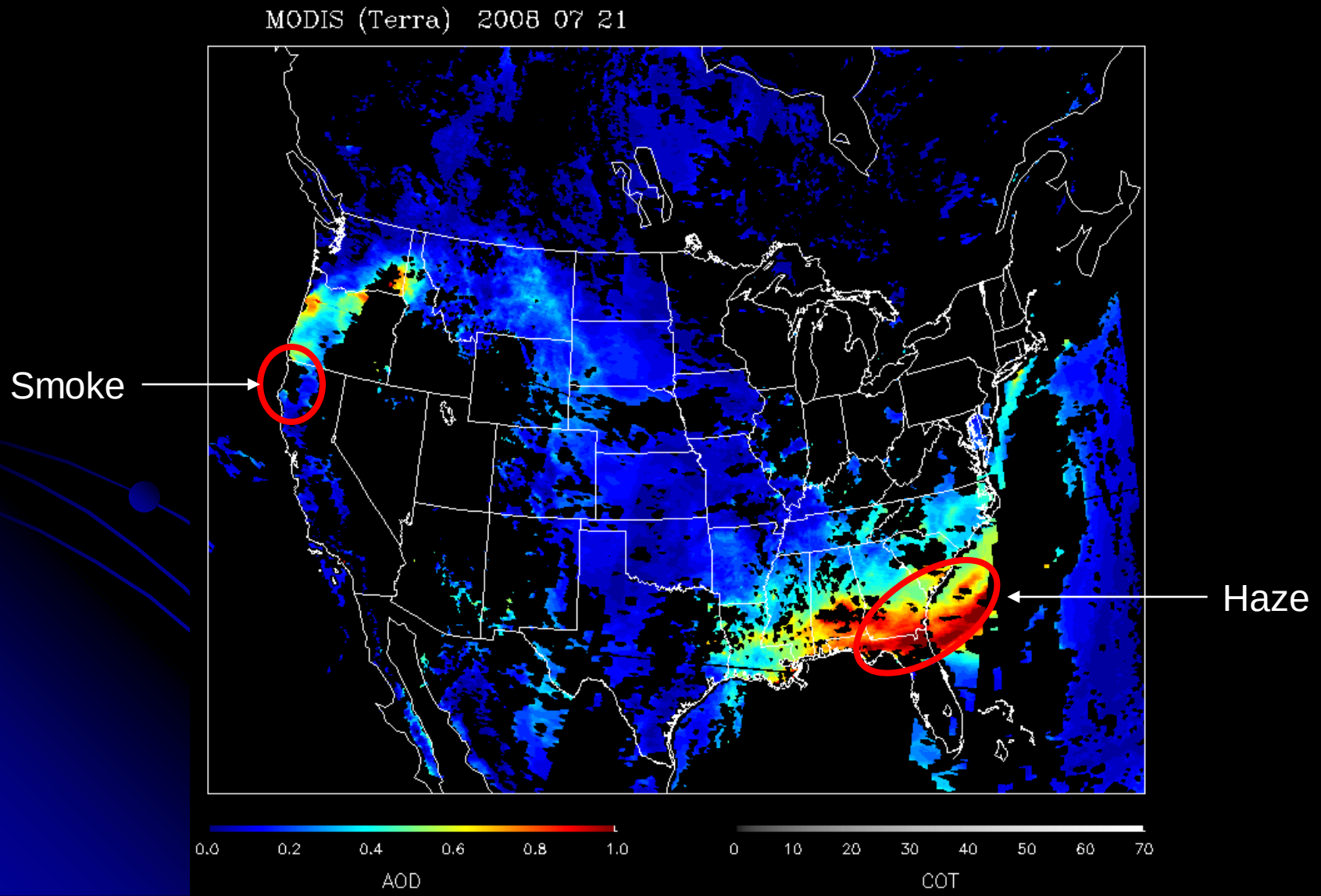


Visibility Product Requirements

Name	Product Set Number	Product Baseline or Product Option	Output Format	Number of End Products	RBU Product	Product Level	Product Geographic Coverage	Product Vertical Reolution	Product Horizontal Resolution	Product Mapping Accuracy	Product Measurement Accuracy	Product Measurement Range	Product Refresh Rate	VAGL Mode 3	VAGL Mode 4	Product Measurement Precision	Product Type	Product Subtype
Visibility	4	O2	NetCDF and/or McIDAS	2	No	2+	Fulldisk		Fulldisk: 10 km	Fulldisk: 5 km	Correct Classification: 83%	Clear (vis ≥ 30 km) Moderate (10 km ≤ Vis < 30 km) Low (2 km ≤ vis < 10 km); Poor (vis < 2 km) (under the conditions of clear up through clouds of only layer)	Fulldisk: 60 min	266 Sec	266 Sec	12 %	Atmosphere	Clouds

Illustration of Visibility Algorithm Theoretical Approach

MODIS (Terra) Aerosol Optical Depth (AOD) retrieval: August 21st, 2008



Low Cloud and Fog

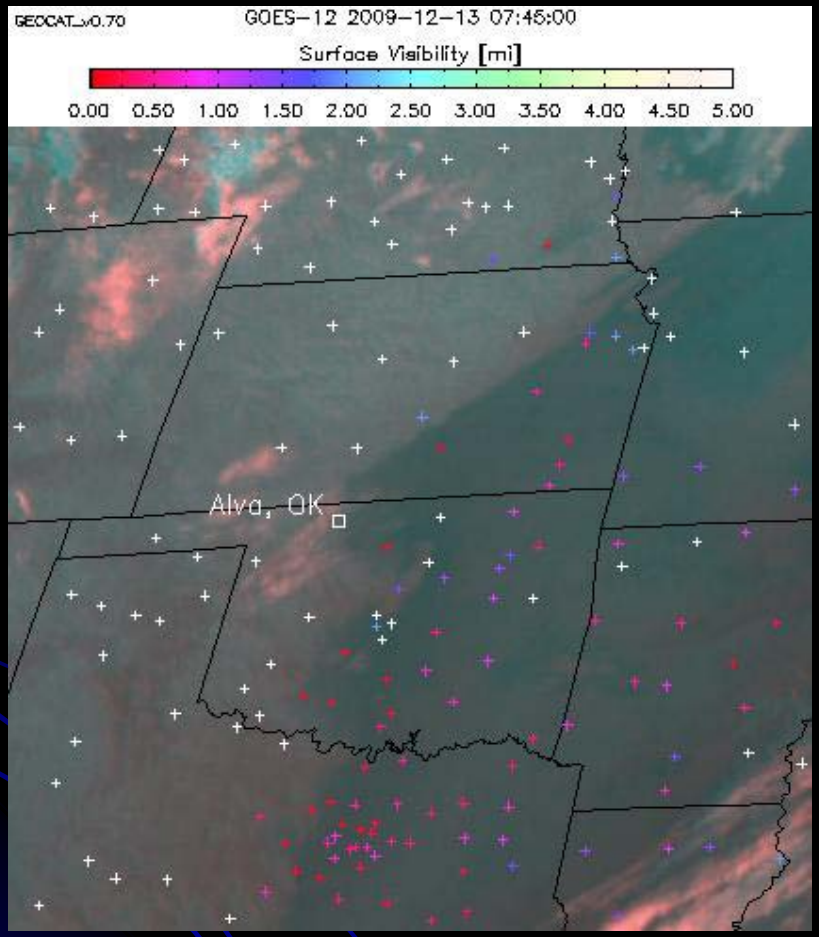
Lead: Michael Pavolonis NOAA

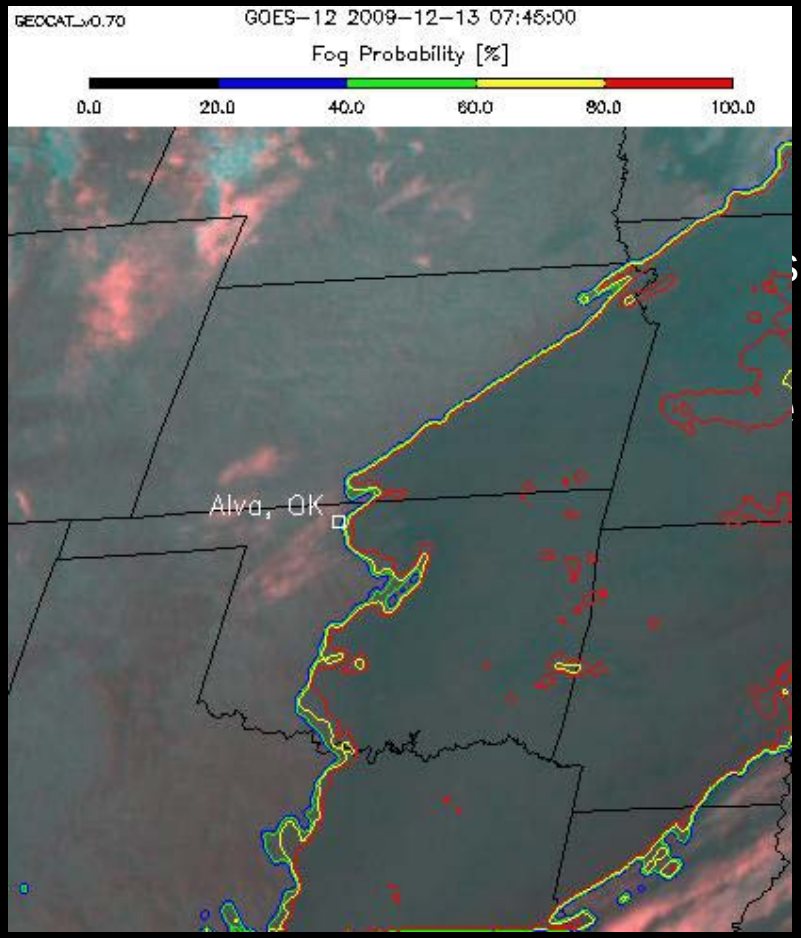
Requirements Low Cloud and Fog

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Low Cloud and Fog	GOES -R	FD	0.5 km (depth)	2 km	1 km	Fog/No Fog	70% correct detection	15 min	159 sec 806 sec	5% (TBR)	Day and night	Quantitative out to at least 70 degrees LZA and qualitative beyond	Clear conditions down to feature of interest associated with threshold accuracy	Over low cloud and fog cases with at least 42% occurrence in the region

- Changes since ADR FD – Full Disk

GOES-R Fog Detection Algorithm





- RGB image (R = 3.9 µm emissivity, G = 11 µm BT, B = 11 µm BT) of the US on December 13, 2009 at 7:45 UTC (1:45 am CST) with surface observations showing visibility in miles.
- RGB image (R = 3.9 µm emissivity, G = 11 µm BT, B = 11 µm BT) of the US on December 13, 2009 at 7:45 UTC (1:45 am CST) with fog probability from the GOES-R fog algorithm contoured on top.

GOES-R Icing

Lead: Bill Smith Jr. NASA LaRC

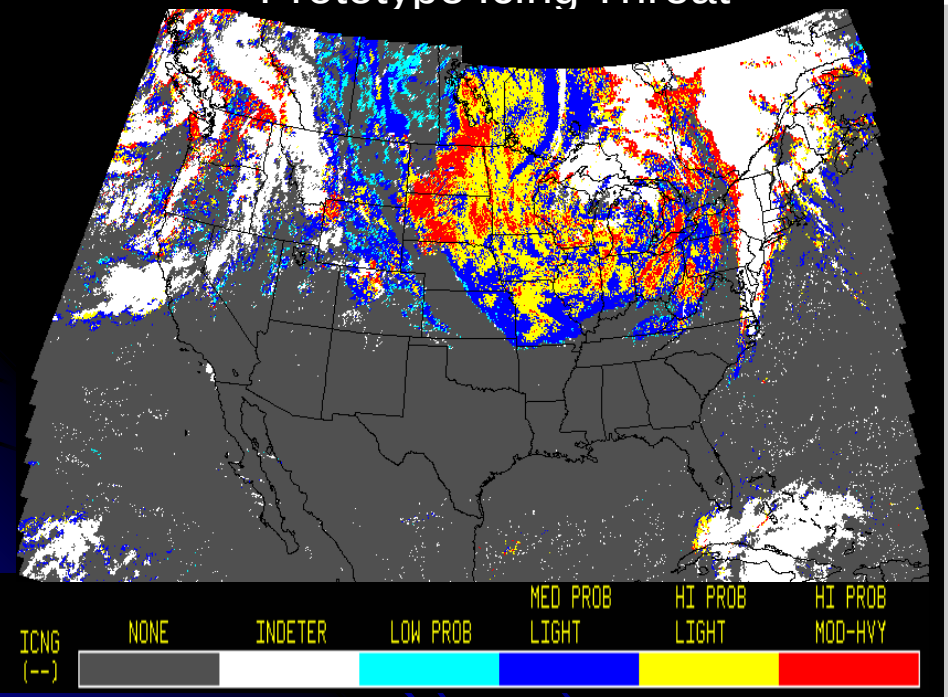
Requirements GOES-R Icing Detection

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Res.	Horiz. Res.	Mapping Accuracy	Msmnt. Range	Msmnt. Accuracy	Product Refresh Rate/Coverage Time	Vendor Allocated Ground Latency	Product Measurement Precision	Temporal Coverage Qualifiers	Product Extent Qualifier	Cloud Cover Conditions Qualifier	Product Statistics Qualifier
Aircraft Icing Threat	GOES -R	FD	1 km (top height) Cloud Top	10 km	5 km	None, Trace, light, Moderate, or Severe	2 categories	60 min	15 min 806 sec	50% classification error (TBR)	Day	Quantitative out to at least 60 degrees LZA and qualitative beyond	Clear conditions down to feature of interest associated with threshold accuracy	Over specified geographic area

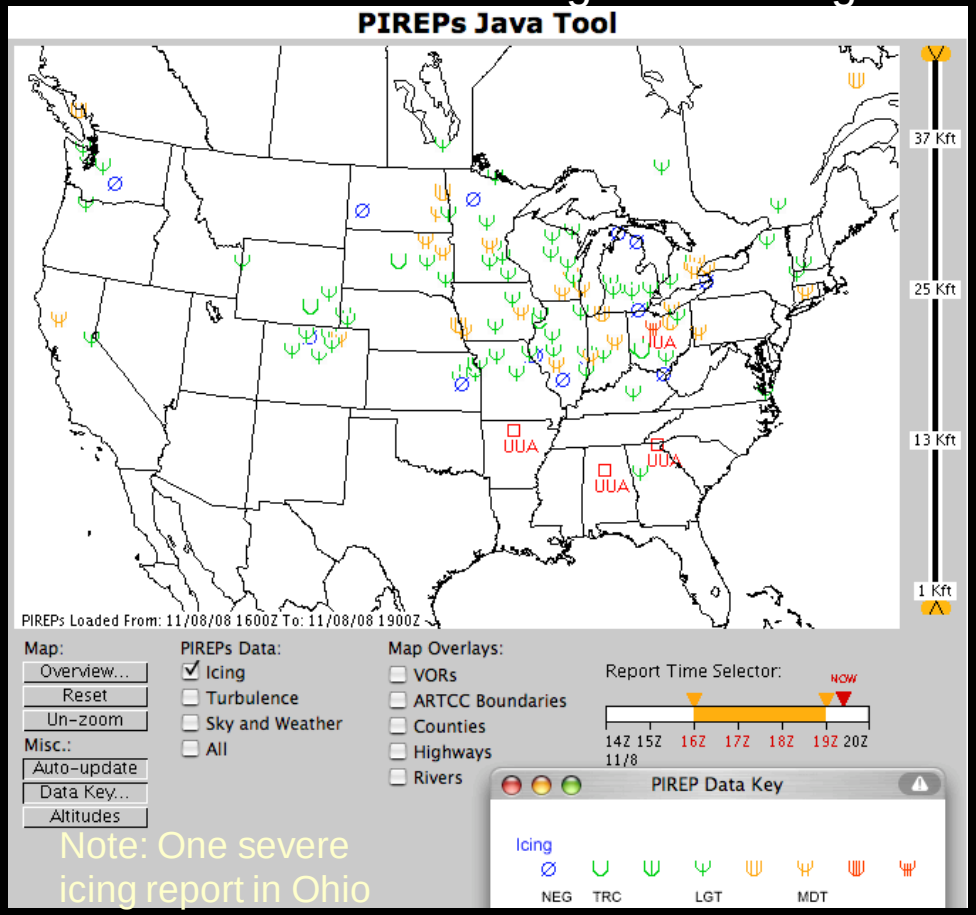
GOES-R FIT Algorithm Demonstration
Icing Severity from Current GOES

Nov. 8, 2008 (1745 UTC)

Prototype Icing Threat



PIREPS confirm significant icing



Note: One severe icing report in Ohio

Summary

- 100% ATBD to be delivered to GOES-R Program Office in 2011

- Strenuous validation is required to meet specification within GOES-R Mission Requirements Document

- Most of these science product requirements are being dovetailed into operational venue (examples below), other avenues to operations are becoming apparent (DOD AFWA)
    - Turbulence – GTG-N
    - Convective initiation - CoSPA
    - Icing - CIP
    - Volcanic Ash – VAACs

- Vested interest in providing GOES-R like products in hands of forecasters through Proving Grounds (example: Aviation Weather Center and SPC Testbed) -> Steve Goodman