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# An Overview of New and Unique GOES-R Products for Hazard Assessment


**Mike Pavolonis**

**(NOAA/NESDIS)**

Justin Sieglaff, Dan Hartung, and Corey Calvert

(UW-CIMSS)

# Outline

- **Impact of GOES-R on Hazard Assessment**

- **Hazards (covered in this talk)**
  - **Volcanic Clouds**
  - **Severe Weather**
  - **Fog/Low Cloud**
  - **Lake/Sea Ice**

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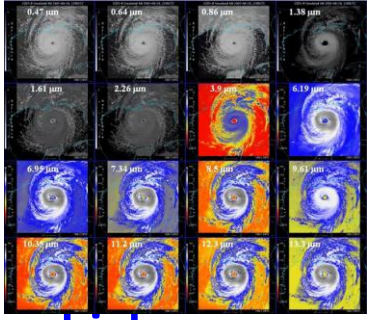
# Impact of GOES-R



- More capable instruments (more channels, higher spatial resolution, higher temporal resolution, lightning mapper, etc…)
- Better algorithms (spawned scientific creativity); More than imagery (advanced quantitative information)
- GOES-R algorithm development work and interactions with NWS led to an increased emphasis on “fused” products (GOES-R, JPSS, NEXRAD, NWP, etc…)
- Many lessons were learned from interactions with NWS forecasters via the GOES-R Proving Ground (e.g. present quantitative products to forecasters in familiar ways (overlay on imagery))
- GOES-R is very well suited for automatically detecting hazards and alerting forecasters (forecasters cannot constantly stare at imagery, no matter how pretty it is!)

# Volcanic Clouds: GOES-R Impact

# Economic Impacts of Volcanic Ash

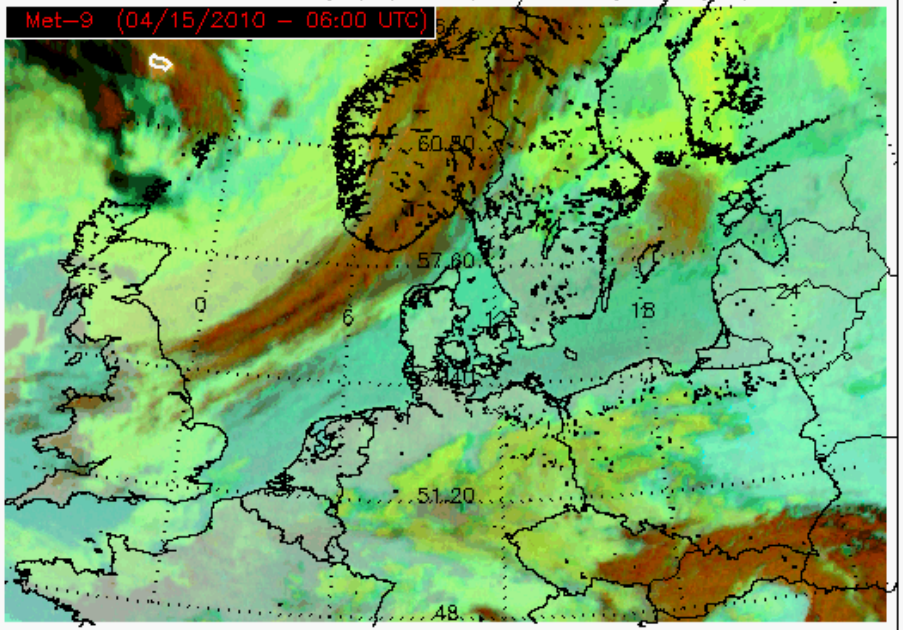
**The Eyjafjallajökull Eruption:**

- **Nearly 100,000 canceled flights**
- **Airlines were losing $200 million/day**
- **Total economic impact - $2 billion**

**Before Ash Event**

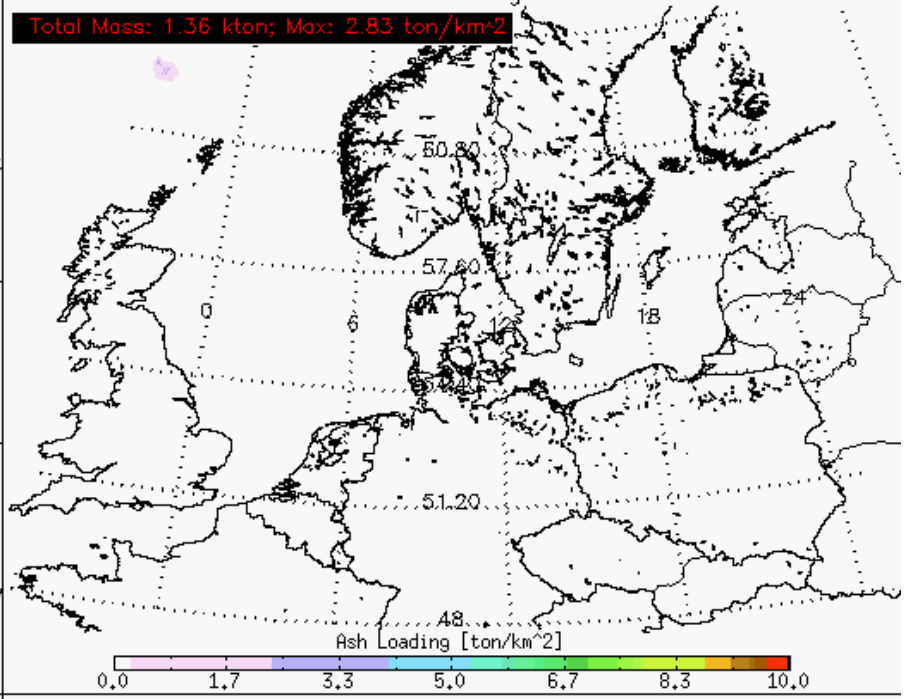

**During Ash Event**

False Color Imagery (12–11$\mu$m, 11–8.5$\mu$m, 11$\mu$m)

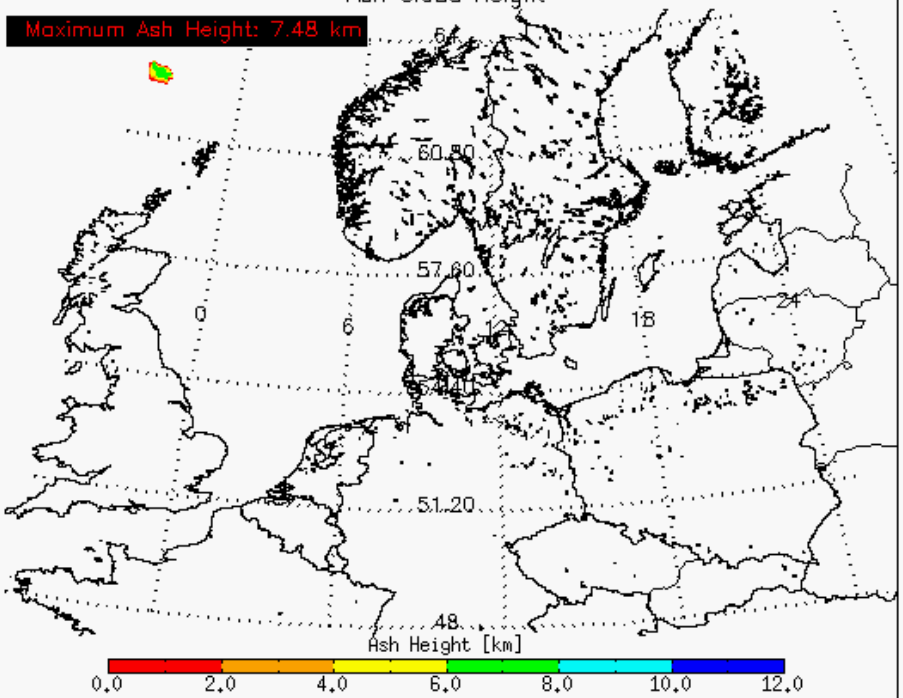



***EXPERIMENTAL PRODUCT***, Contact: Mike.Pavolonis@noaa.gov

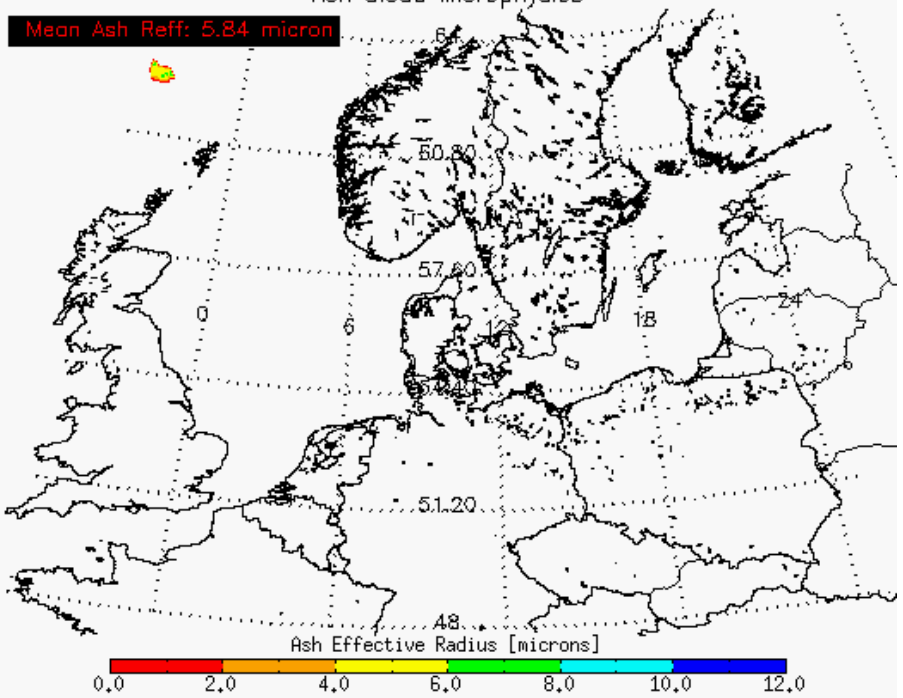
Ash Loading




Ash Cloud Height




Ash Cloud Microphysics



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

## Cordon Caulle

GOES-R -- CIMSS

http://cimss.ssec.wisc.edu/goes_r/proving-ground/geocat_ash/loops/floater.html

Apple (167) Yahoo! Amazon eBay News (1452)

GOES-R Activities at CIMSS / SSEC

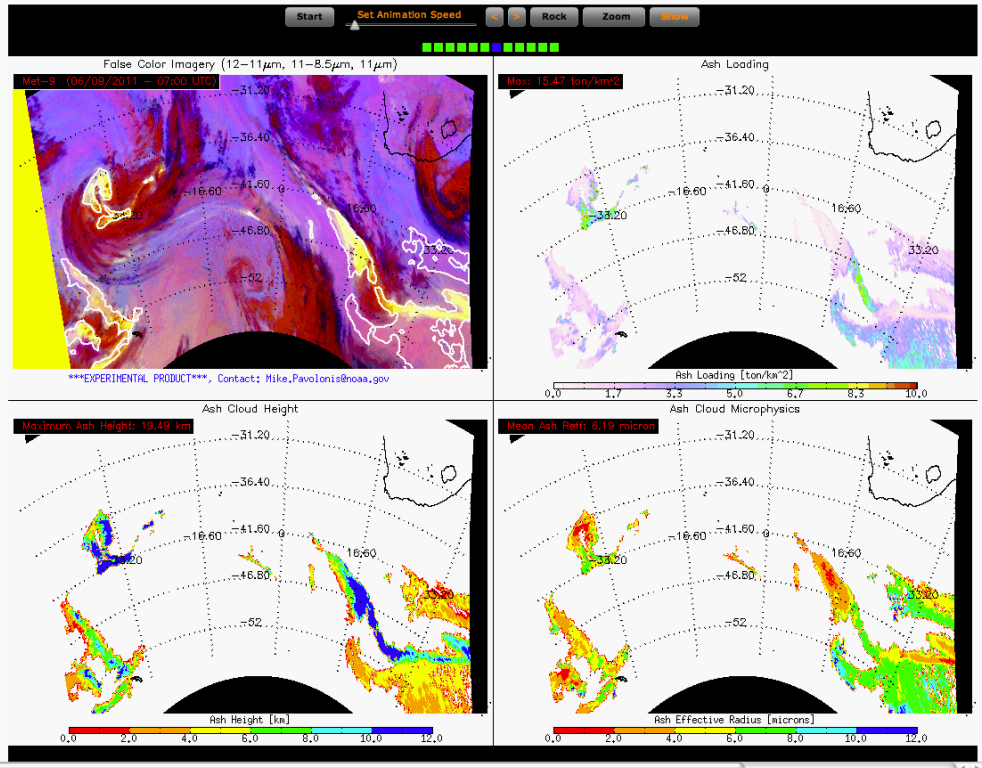
» Home » SEVIRI Volcanic Ash Retrievals

NOAA/NESDIS/STAR/CIMSS -- SEVIRI Volcanic Ash Retrievals

DISCLAIMER: THESE PRODUCTS ARE GENERATED ON AN EXPERIMENTAL BASIS.
ACCURACY AND TIMELINESS IS SOUGHT BUT NOT GUARANTEED.

Most recent 12 hours.

SEVIRI DATA TRANSFER PROBLEMS ARE OCCURING.
SPORADIC DATA OUTAGES AND DEGRADED DATA QUALITY MAY IMPACT PRODUCTS.




## Grimsvotn

GOES-R -- CIMSS

http://cimss.ssec.wisc.edu/goes_r/proving-ground/geocat_ash/loops/iceland.html

Apple (298) Yahoo! Amazon eBay News (3489)

GOES-R Activities at CIMSS / SSEC

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NOAA/NESDIS/STAR/CIMSS -- SEVIRI Volcanic Ash Retrievals

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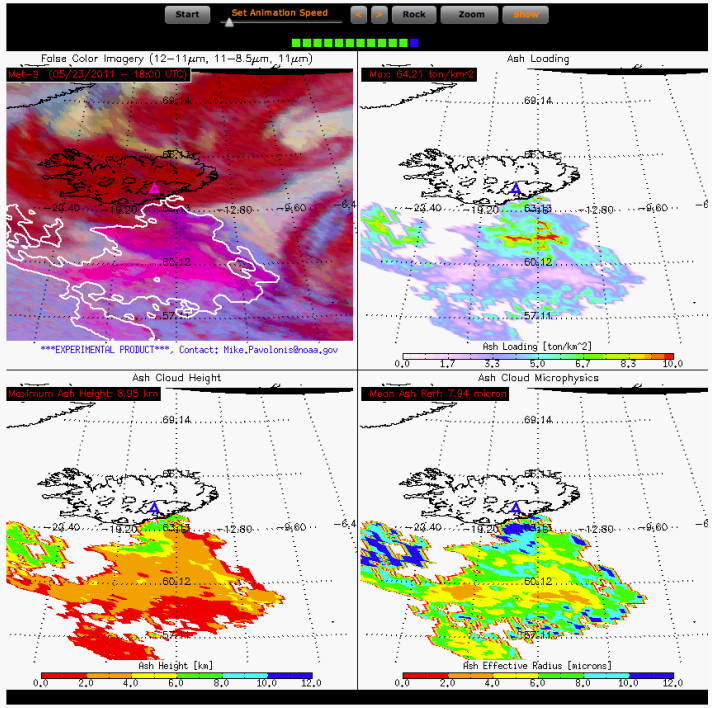
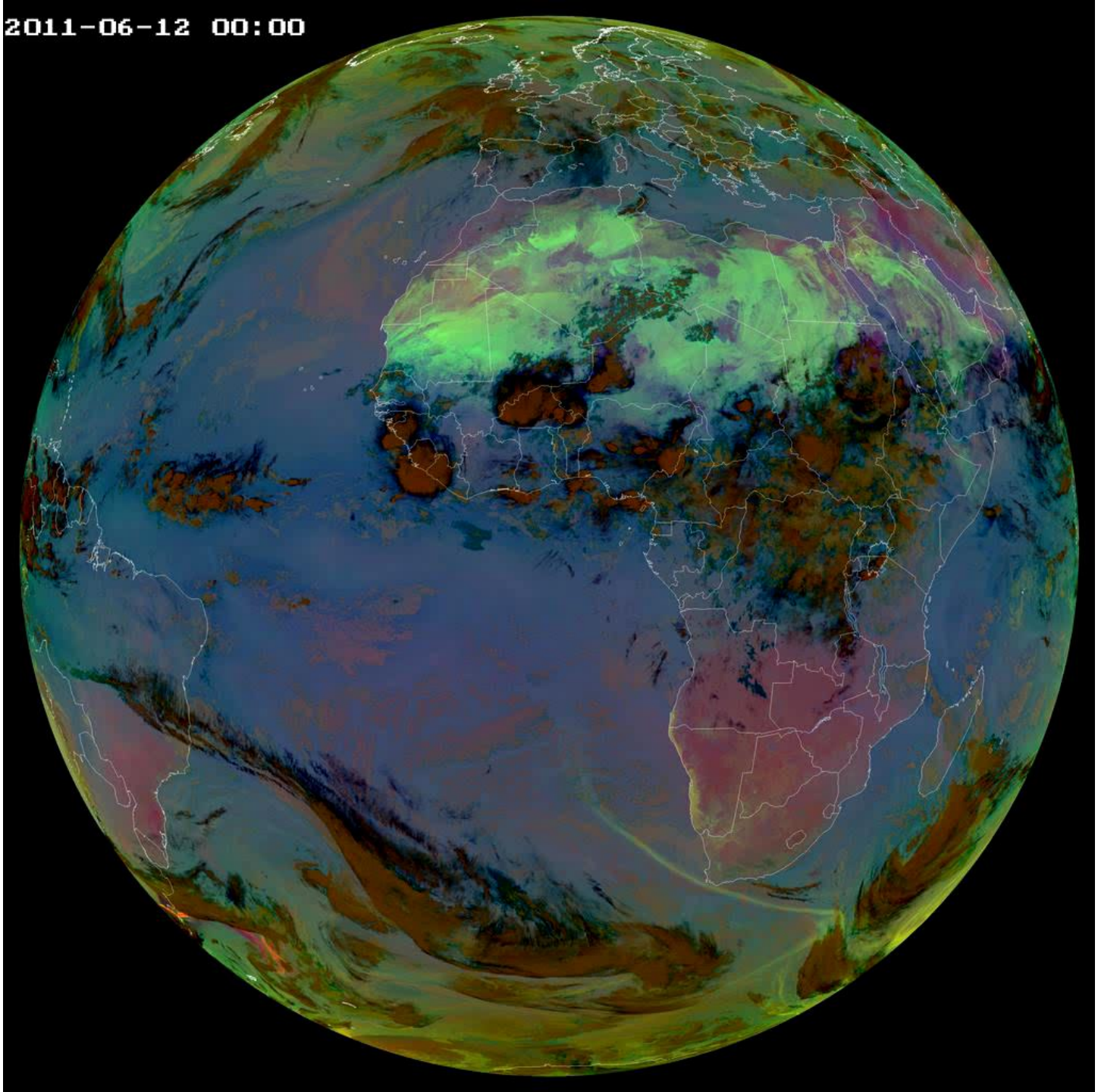
Most recent 12 hours.




Last updated 10-Nov-2010

Contact: Michael Pavolonis
Contact: Justin Sieglaff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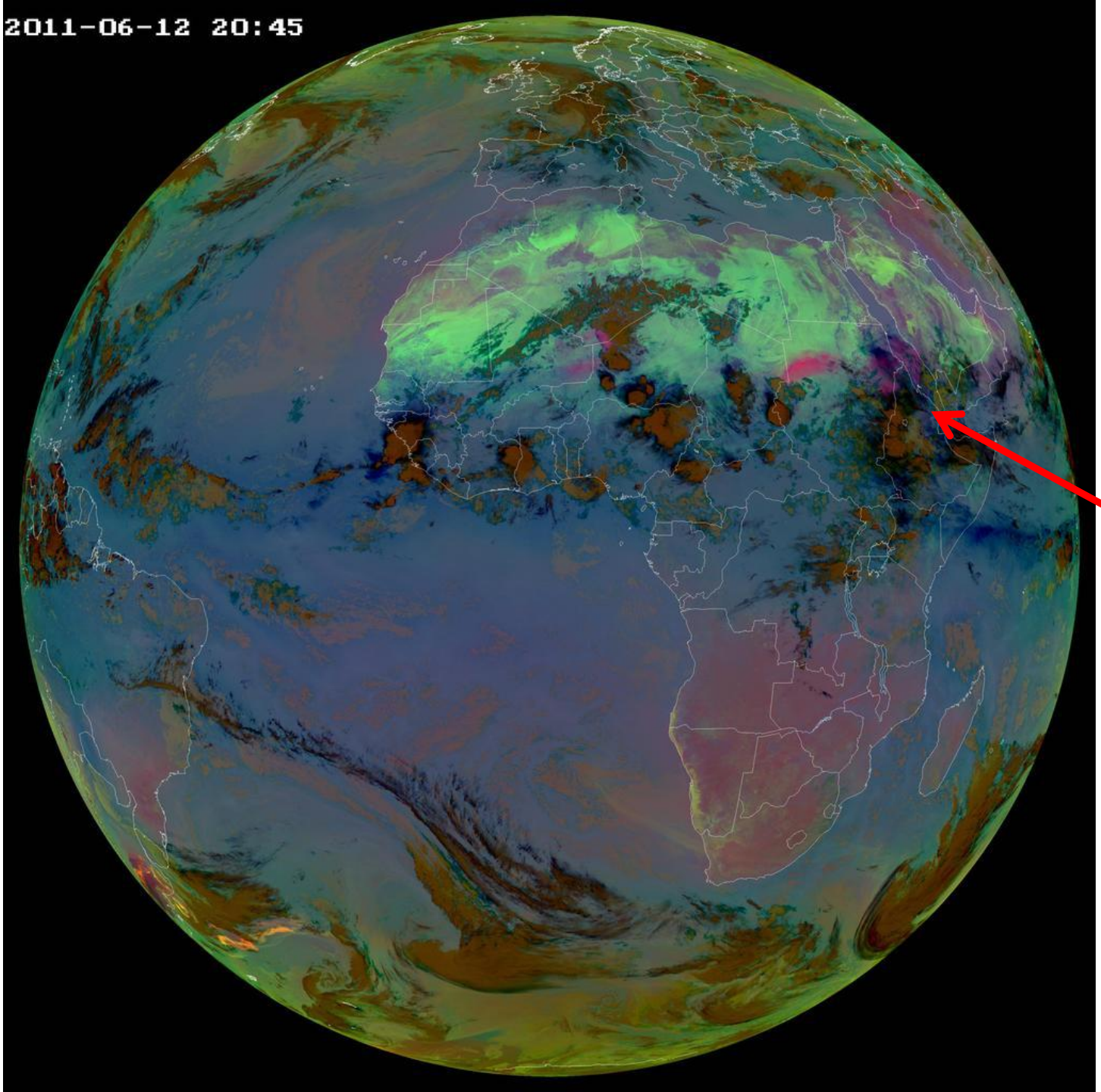
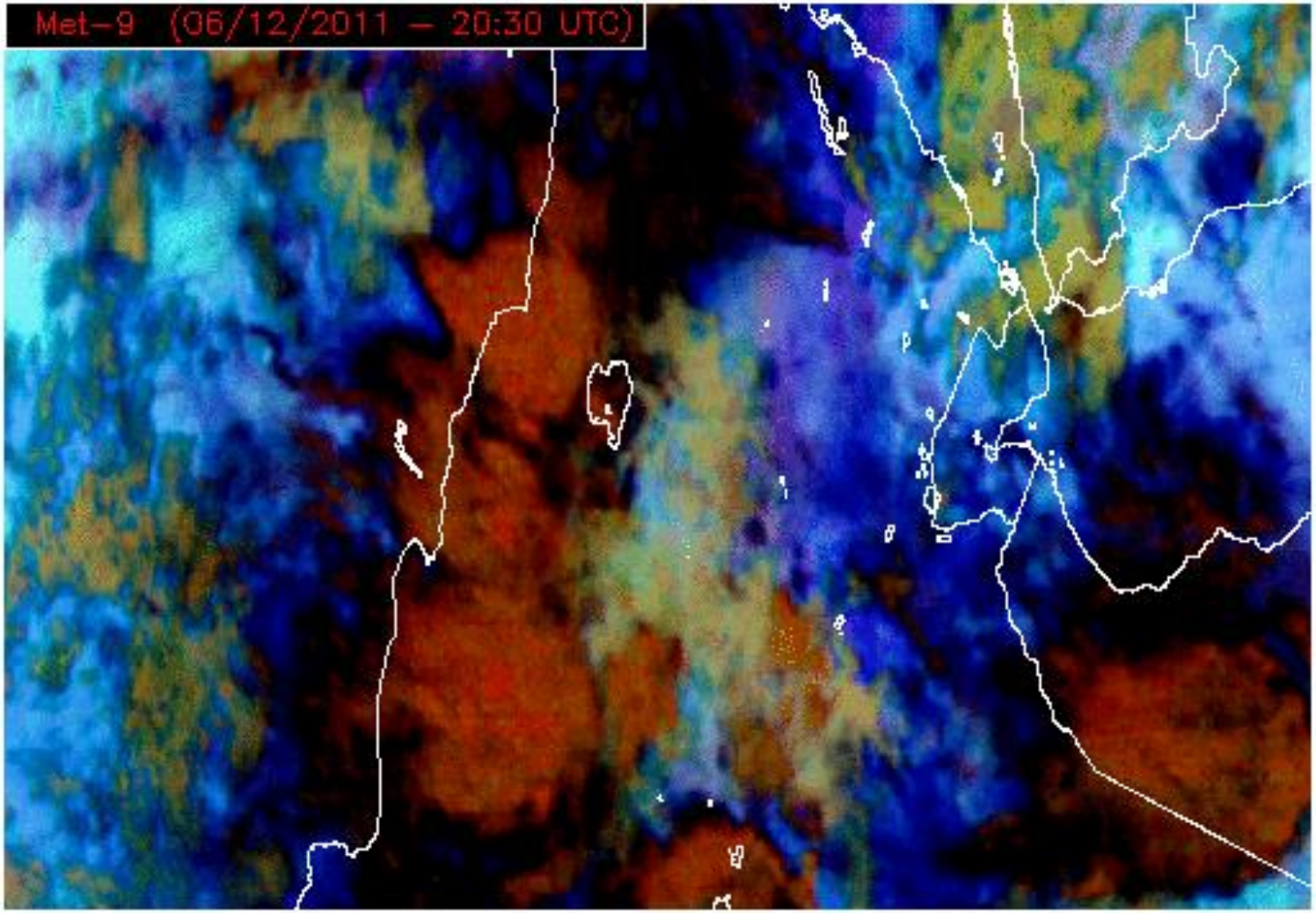
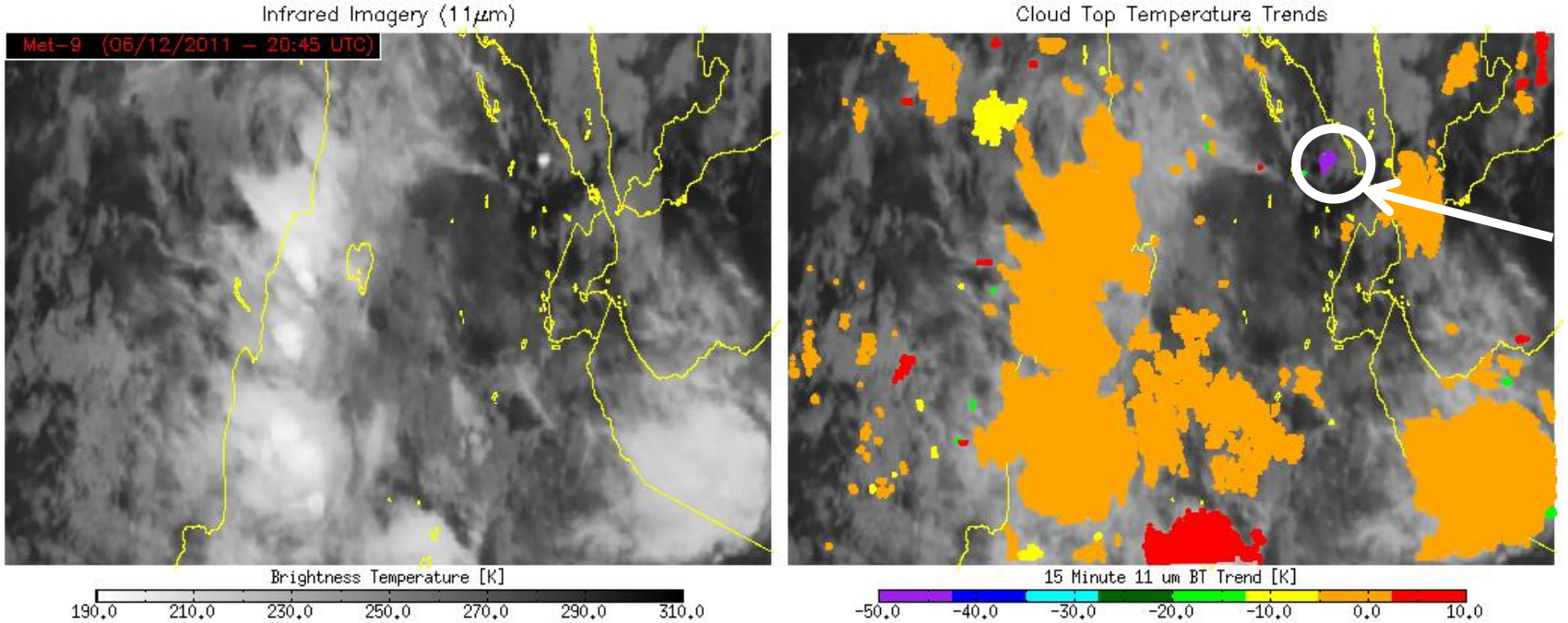
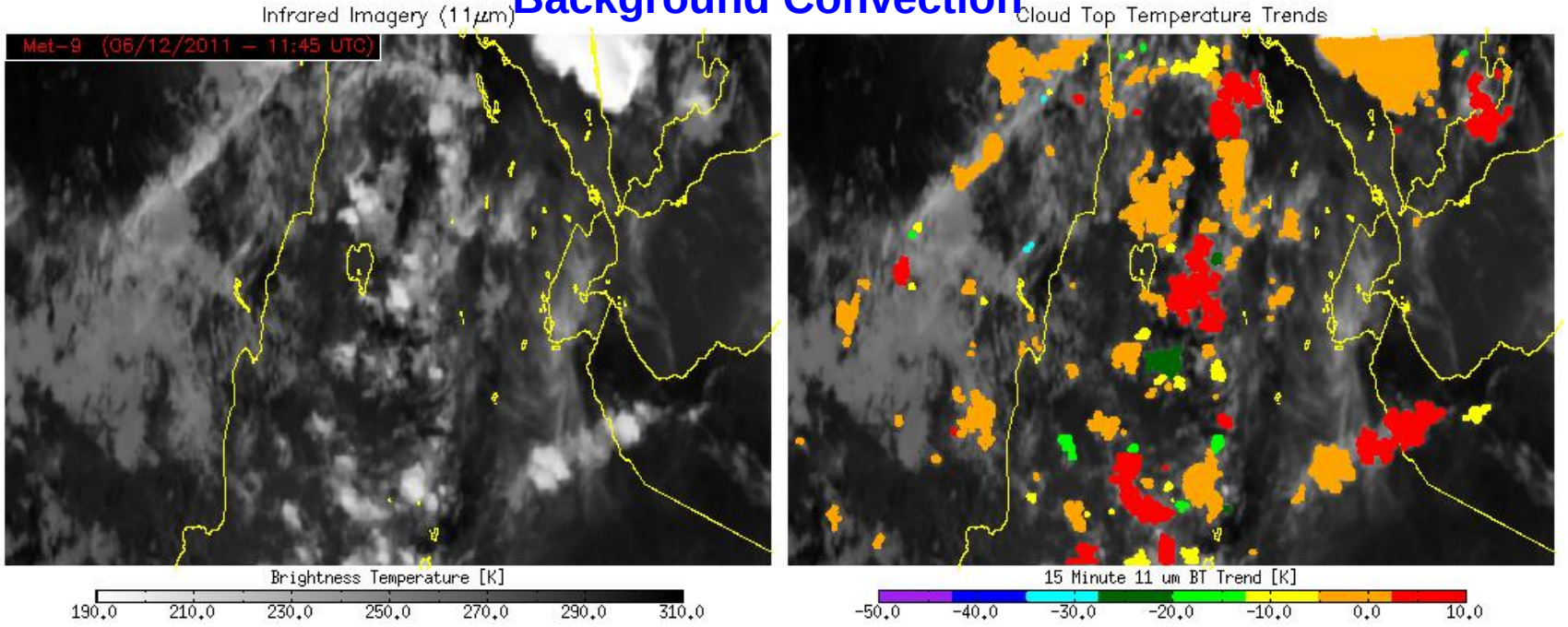

2011-06-12 20:45
Nabro
Erupts!

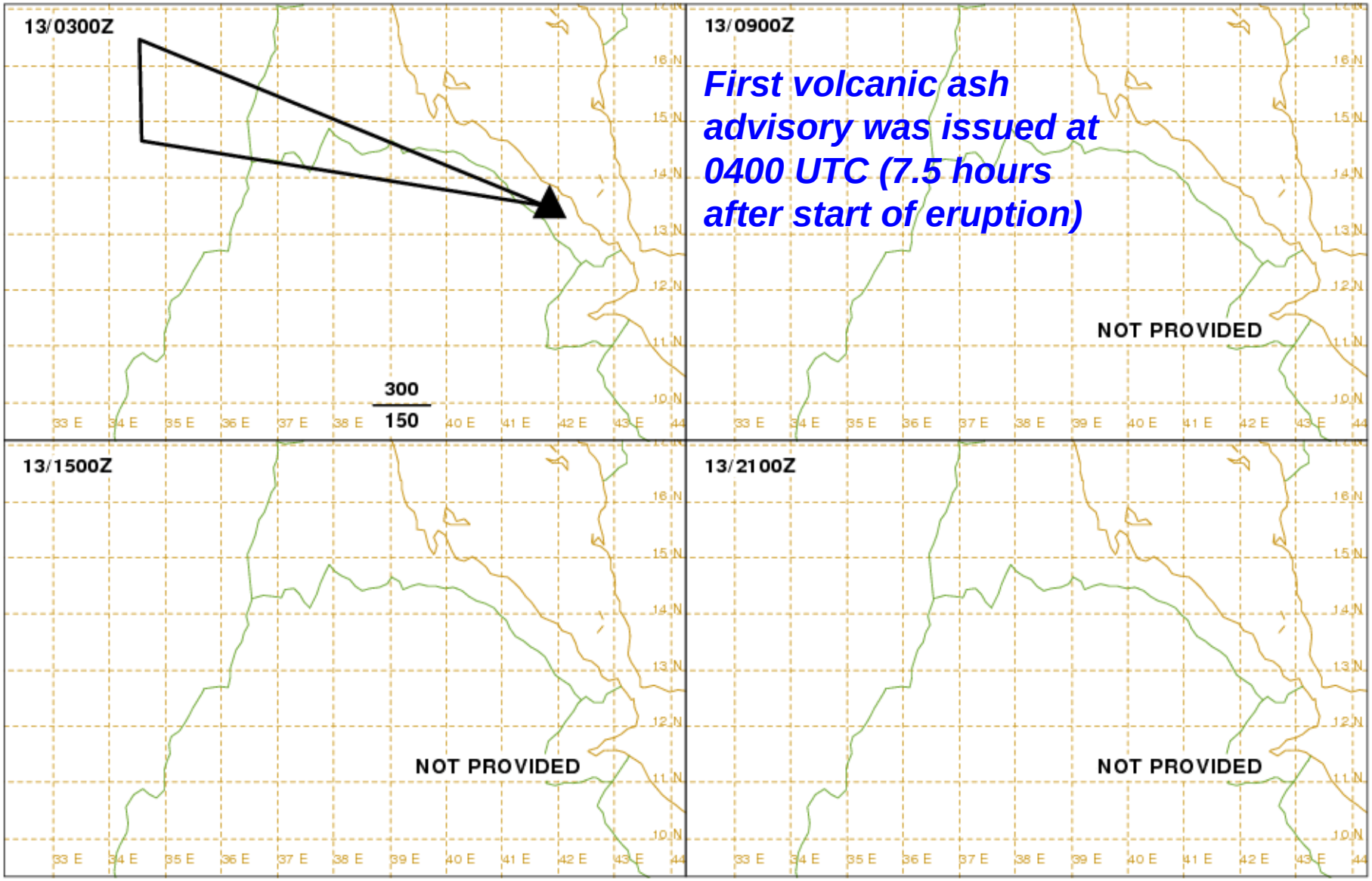
False Color Imagery (12−11 $\mu$m, 11−8.5 $\mu$m, 11$\mu$m)






**Background Convection**






VOLCANIC ASH ADVISORY

DTG: 20110613/0400Z

VAAC: TOULOUSE

VOLCANO: DUBBI 0201-10

AREA: ETHIOPIA

SUMMIT ELEV: 1625M

METEO FRANCE

ADVISORY NR: 2011/01

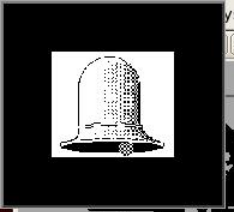
INFO SOURCE: METEOSAT IMAGERY

AVIATION COLOUR CODE: UNKNOWN

ERUPTION DETAILS: ERUPTION STARTED AROUND 23UTC

RMK: SEEMS NOW DECREASING

NXT ADVISORY: 20110613/1000Z



Thu 16 Sep 2010 20:20 UTC
Thu 16 Sep 2010 20:20 GMT

Alarm/Alert
Text 1: MKEWRKASH
Text 2
Text 3
Text 4

Text 1: MKEWRKASH

File Edit Options Version Tools Scripts Products Help

AFOS Browser | Load History | WMO Search | Enter Editor | Accum | Update Obs | Clear

AFOS Cmd: WMO and AWIPS queries are not supported in practice mode

```
ZCZC MKEWRKASH ALL
TTAA00 KMKE 162004

...THIS IS A TEST...

@**********GENERATING VOLCANIC CLOUD WARNINGS********** DATE:
08/08/2008
TIME: 14:35 UTC
SATELLITE: NOAA-18 AVHRR
L1B FILENAME: NSS.HRPT.NN.D08221.S1435.E1448.B1658686.GC
ORBIT NUMBER: 1658686
NUMBER OF ASH CLOUD WARNINGS: 1
NUMBER OF VOLCANIC CB WARNINGS: 0
NUMBER OF VOLCANIC HOT SPOT WARNINGS: 0


**************************************************
VOLCANIC ASH CLOUD FOUND
RADIATIVE CENTER (LAT, LON): 51.855, -175.294
MEAN VIEWING ANGLE (DEGREES): 53.47
MEAN SOLAR ZENITH ANGLE (DEGREES): 100.96
NEARBY VOLCANOES:
                SERGIEF(32.06 KM)
             KASATOCHI(38.71 KM)
               KONIUJI(42.13 KM)
         GREAT SITKIN(62.37 KM)
                ATKA(95.31 KM)
FALSE ALARM POTENTIAL: 0 OUT OF 276994
MAXIMUM HEIGHT: 10.9 KM (35890.07 FT)
MEAN TROPOPAUSE HEIGHT: 10.9 KM (35917.70 FT)
MEDIAN EFFECTIVE RADIUS: 5.05 MICRON
TOTAL MASS: 486.67 KTONS
TOTAL MASS OF FINE ASH: 9.45 KTONS
TOTAL AREA: 58982.00 KM^2
**************************************************

$$
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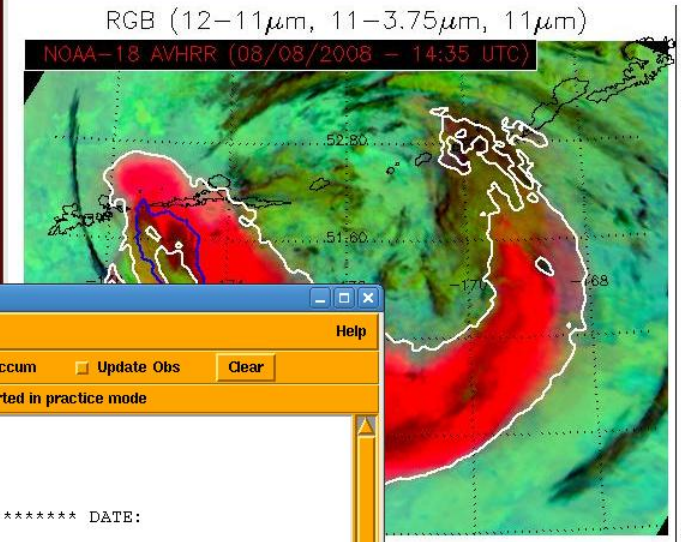
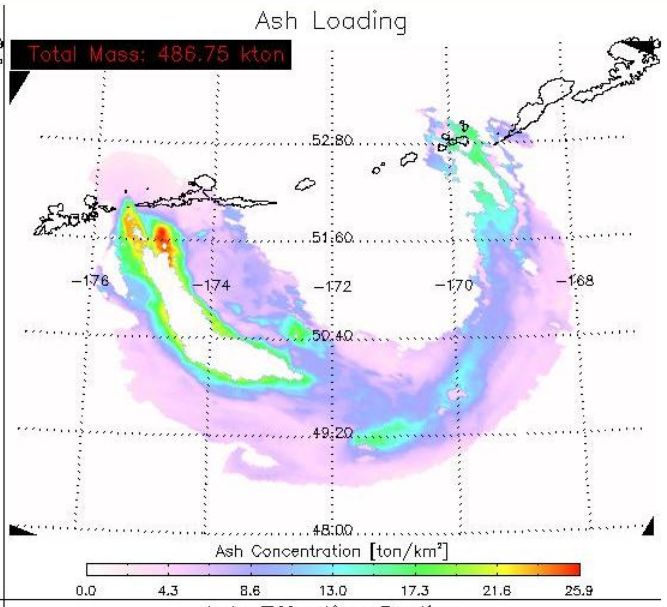
test.jpg (JPEG Image, 1096x992 pixels) - Mozilla Firefox

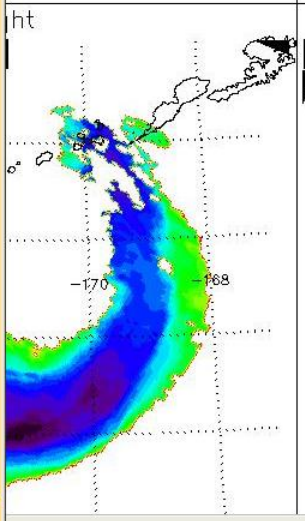
File Edit View History Bookmarks Tools Help

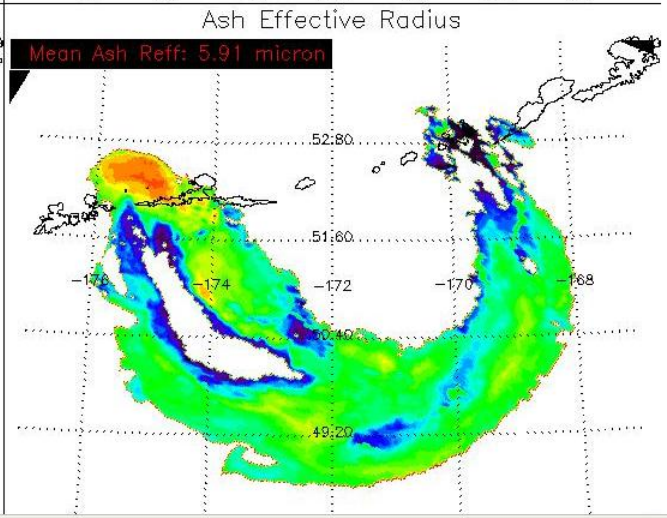
http://www.ssec.wisc.edu/~mpav/test.jpg

Most Visited | Red Hat | Red Hat Magazine | Red Hat Network | Red Hat Support



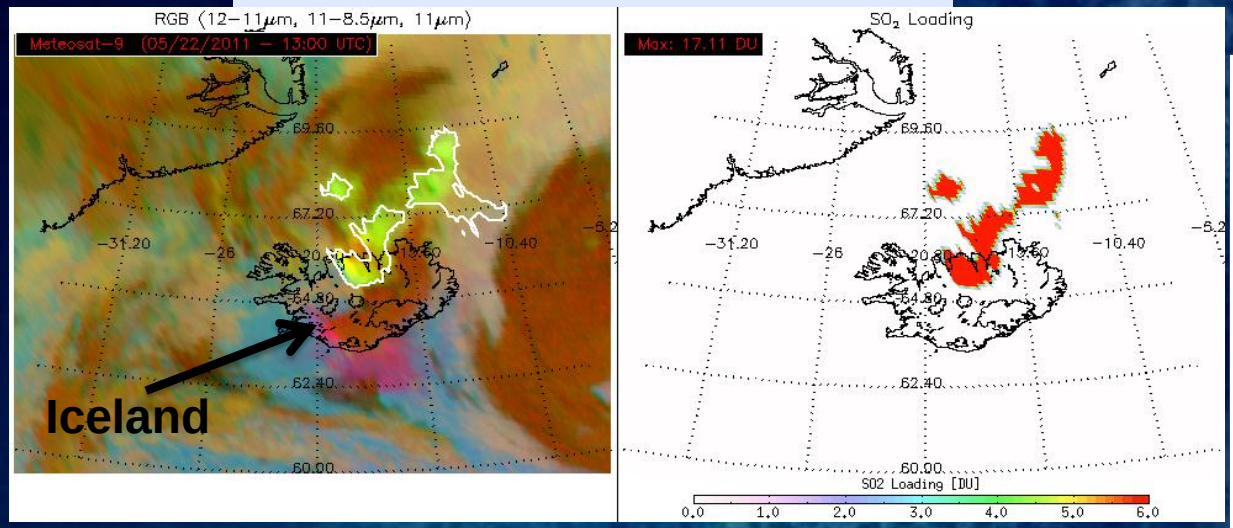




[Terminal] | test.jpg (JPEG Image, 1096x992 pixels) - Mozilla ... | Control | WRKASH

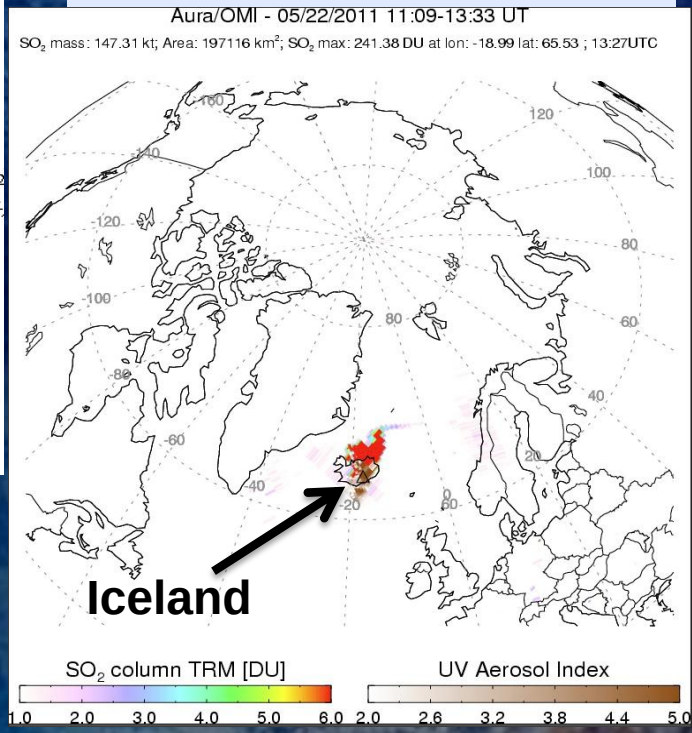
# Quantifying $SO_2$ Loading

## Grimsvotn, May 22, 2010 - 13:00 UTC

### GOES-R $SO_2$ Product

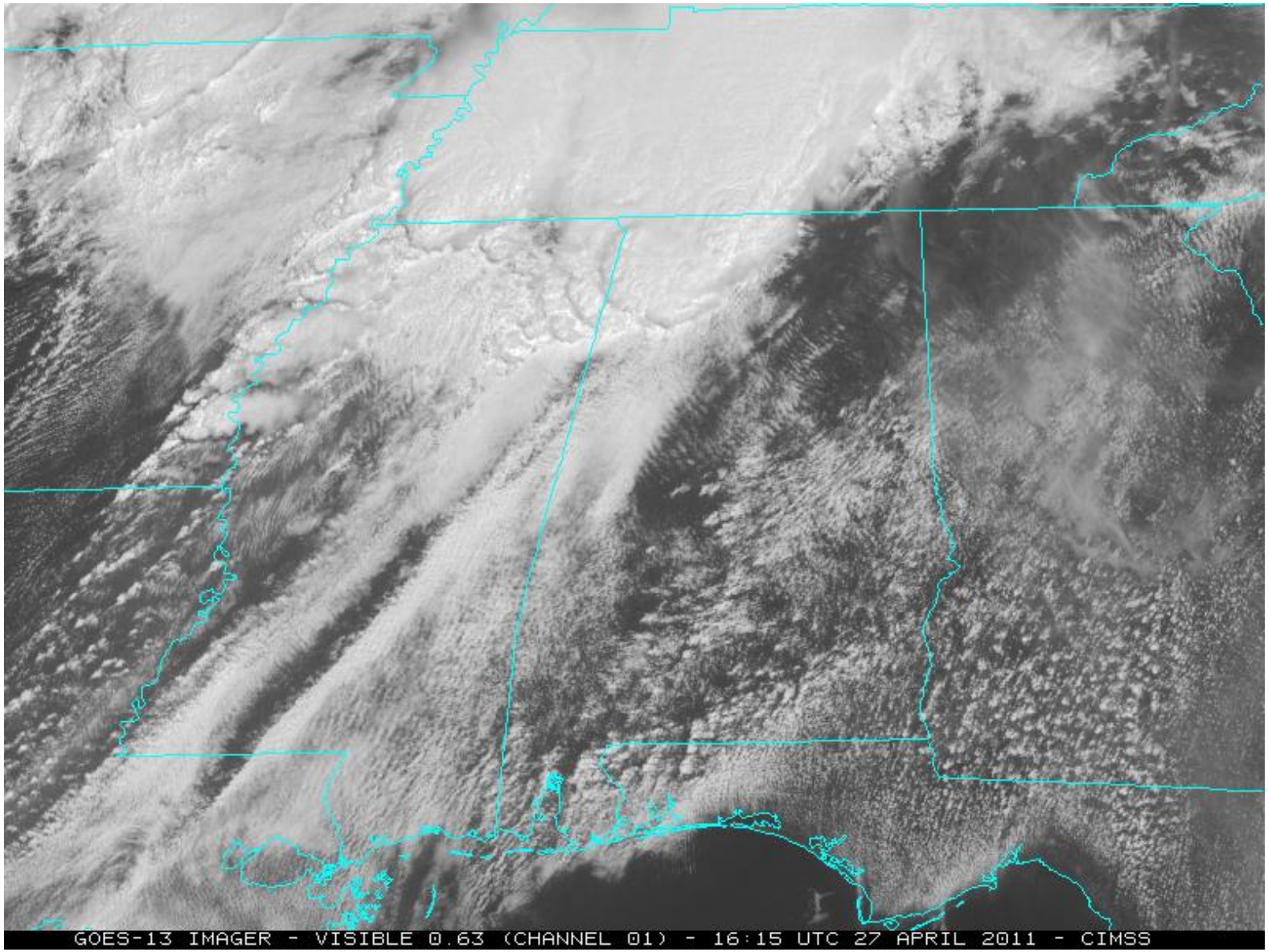



### OMI $SO_2$ Product




**The 7.3 μm channel on the GOES-R ABI was specifically designed to be sensitive to $SO_2$**

# Severe Convection: GOES-R Impact

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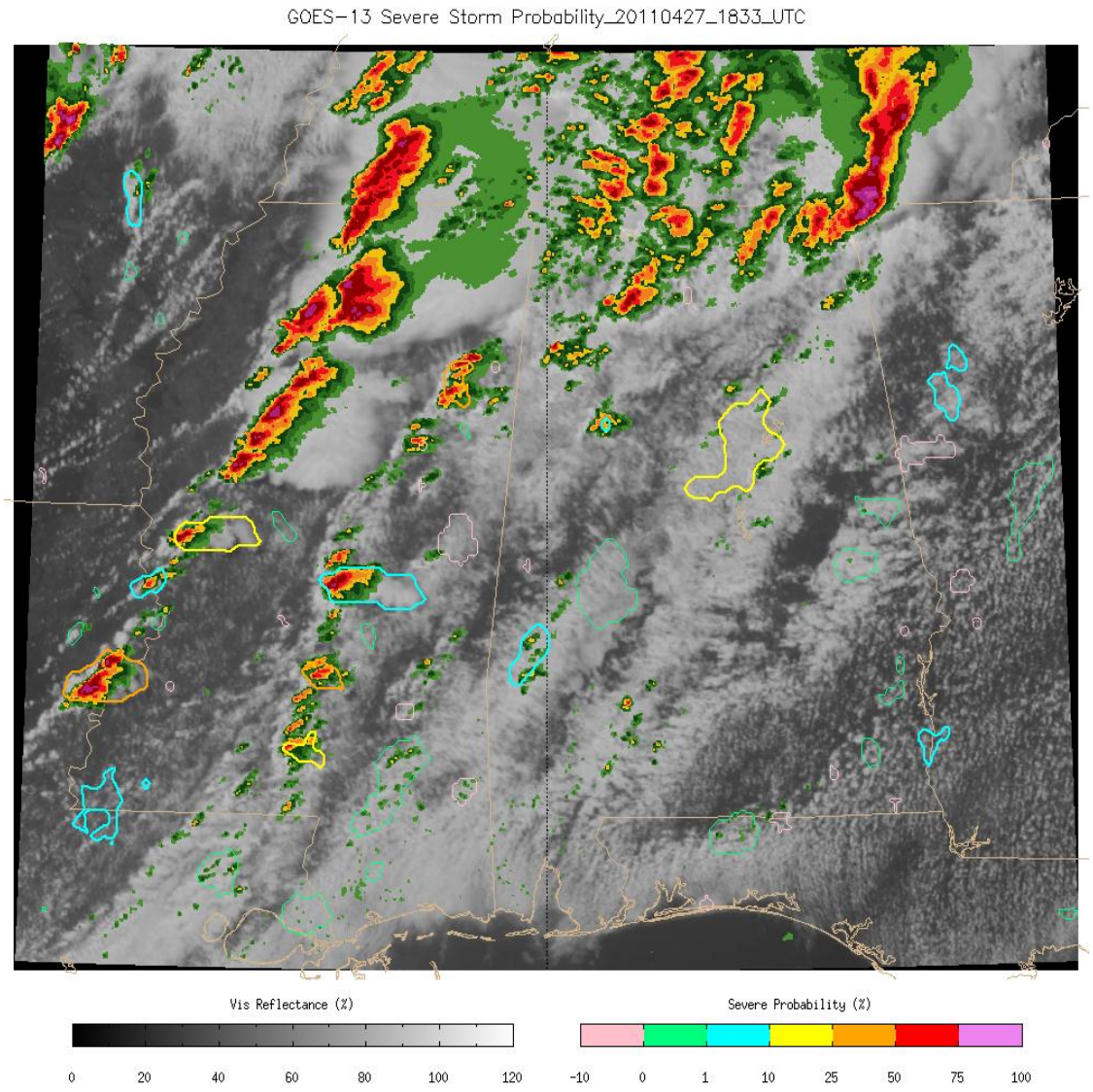
***The improved capabilities offered by GOES-R will make this approach even more effective***




- **Research is ongoing to incorporate meso-scale model (Rapid Refresh) and NEXRAD into the Naïve Bayes Model.**

- **Efforts are also focused on improving automated cloud object/storm tracking procedure (GOES-R will help a lot).**

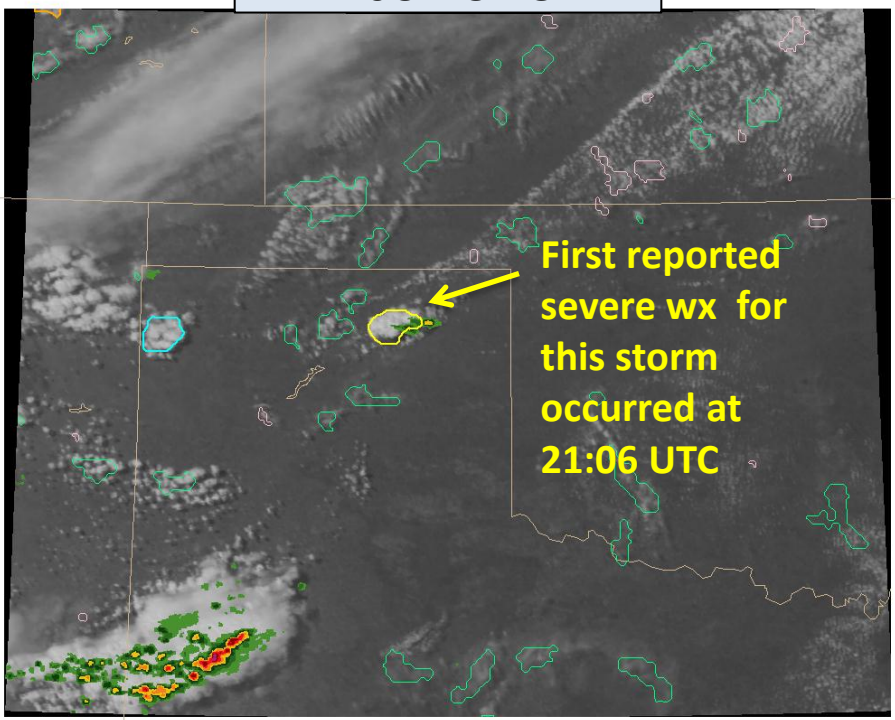
- **Efforts will also focus on developing an effective visualization method.**

# Bayes Probabilistic Model Output: 15 May 2009 Case Study

A severe thunderstorm warning was issued at 20:07 UTC based on NEXRAD indicated signatures received at 20:06 UTC. The GOES severe weather probability indicated an enhanced probability as early as 19:45 UTC (21 minutes prior to NEXRAD signatures).

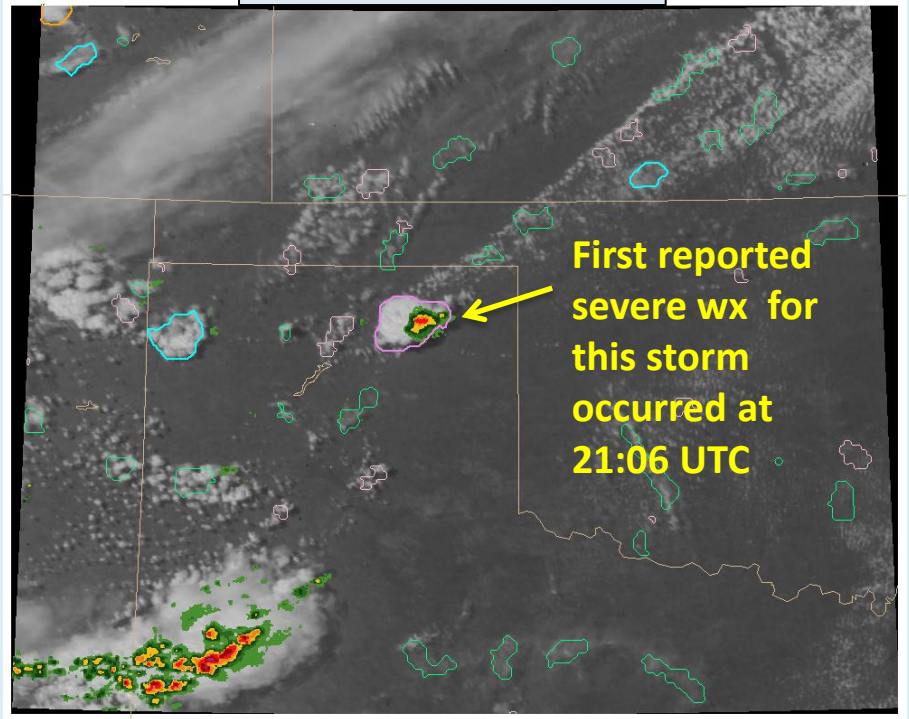
GOES-12 1-km Vis, NEXRAD Composite Reflectivity, and Probability of Severe Development

1932 UTC

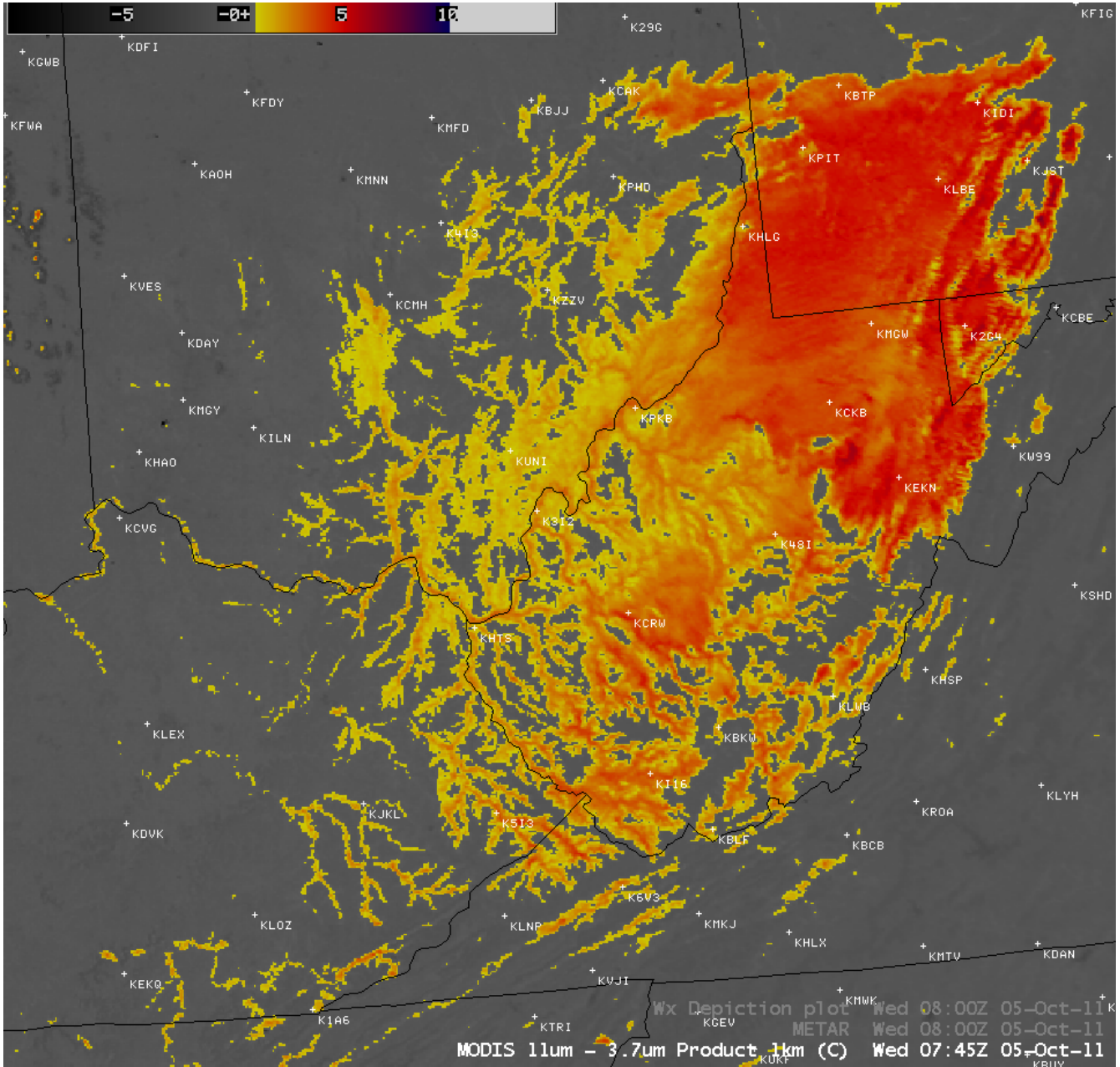



GOES-12 1-km Vis, NEXRAD Composite Reflectivity, and Probability of Severe Development

1945 UTC



# Fog/Low Cloud: GOES-R Impact

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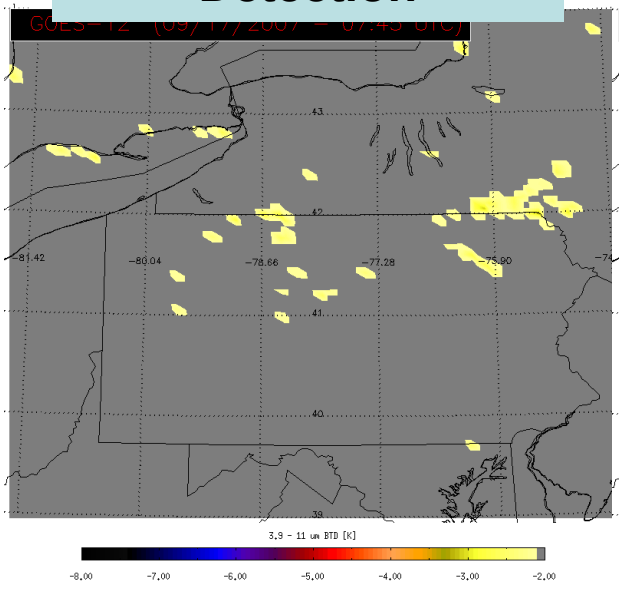
# GOES-R Fog Detection

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

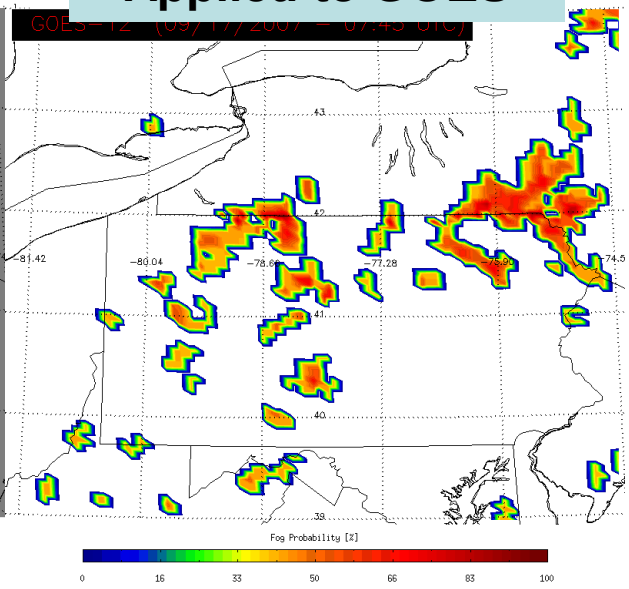
- ***Improved algorithm technology*** - the GOES-R algorithm provides quantitative information on fog probability, while heritage GOES fog detection products are more qualitative in nature

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

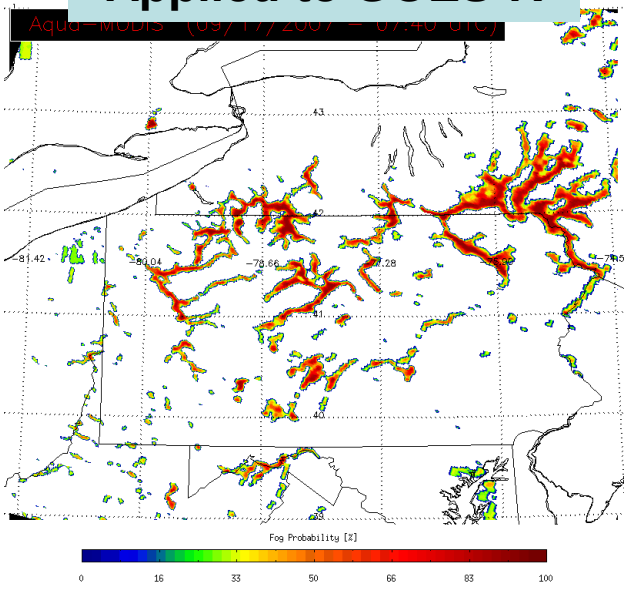
**Heritage GOES Fog Detection**



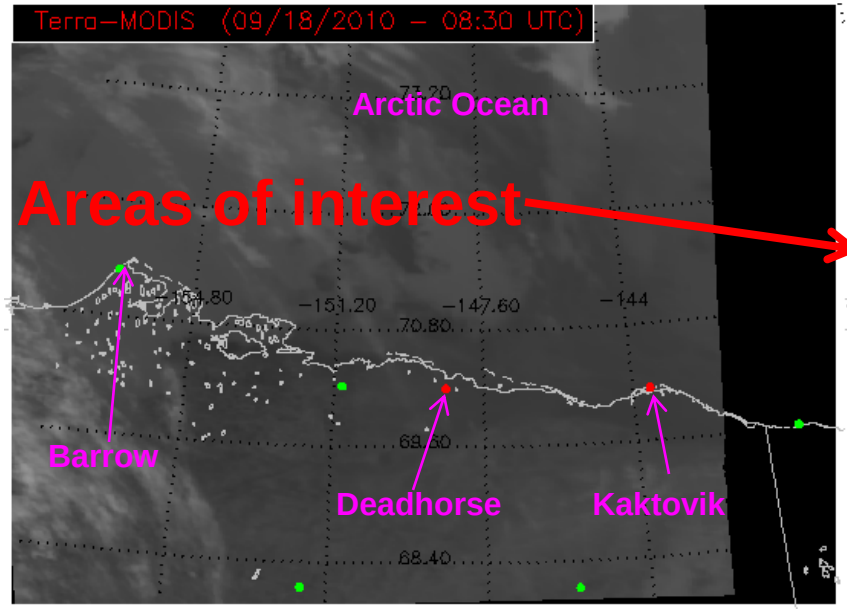

**GOES-R Algorithm Applied to GOES**

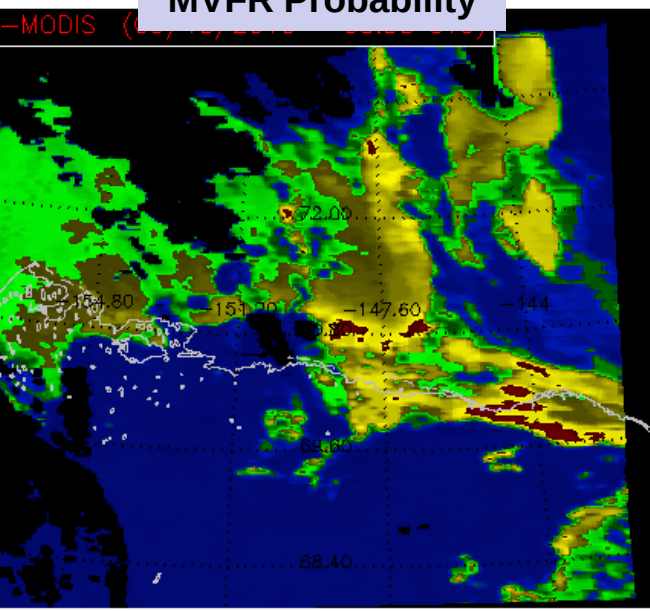



**GOES-R Algorithm Applied to GOES-R**

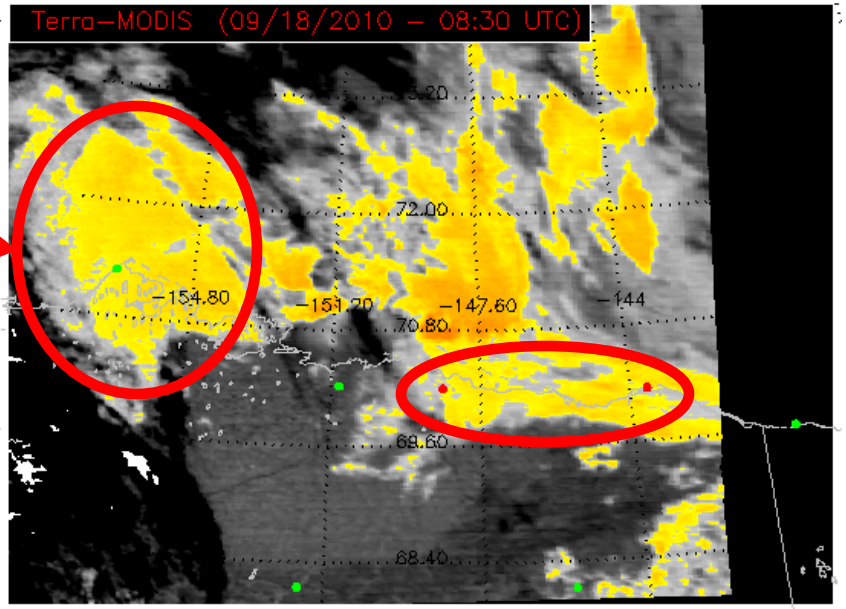


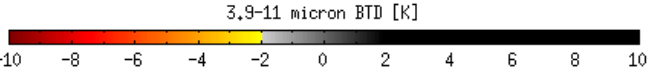
11$\mu$m Brightness Temperature



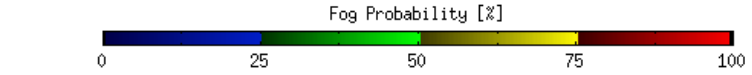

3.9–11 micron BTD



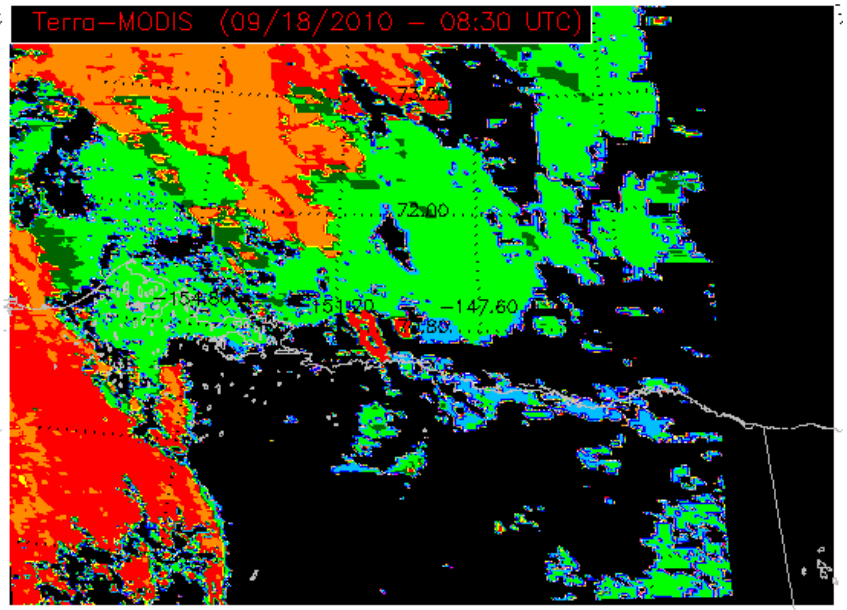



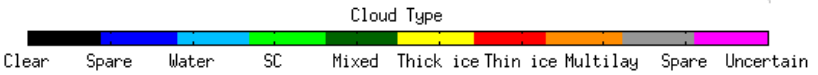

**MVFR Probability**



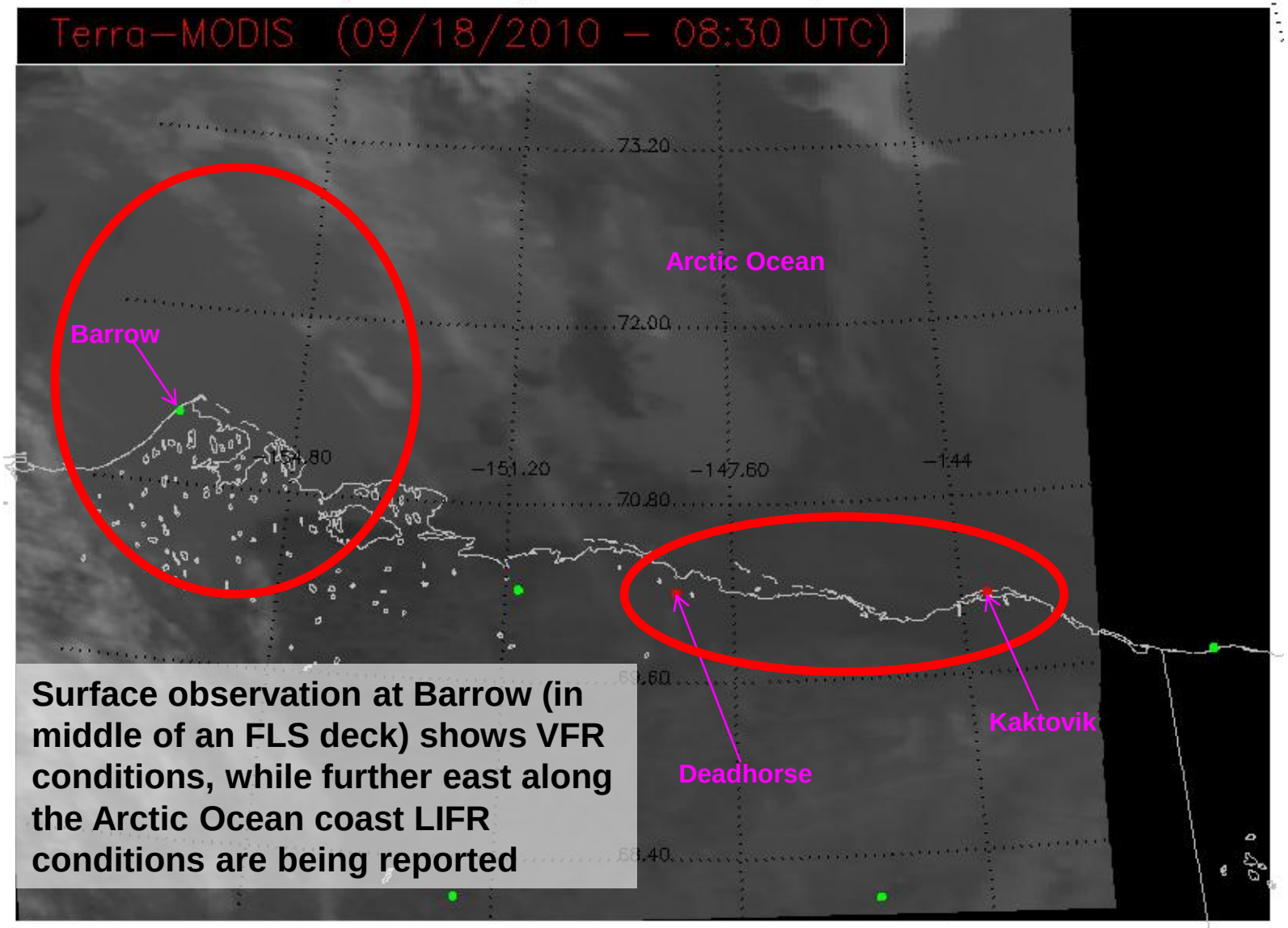




Cloud Type

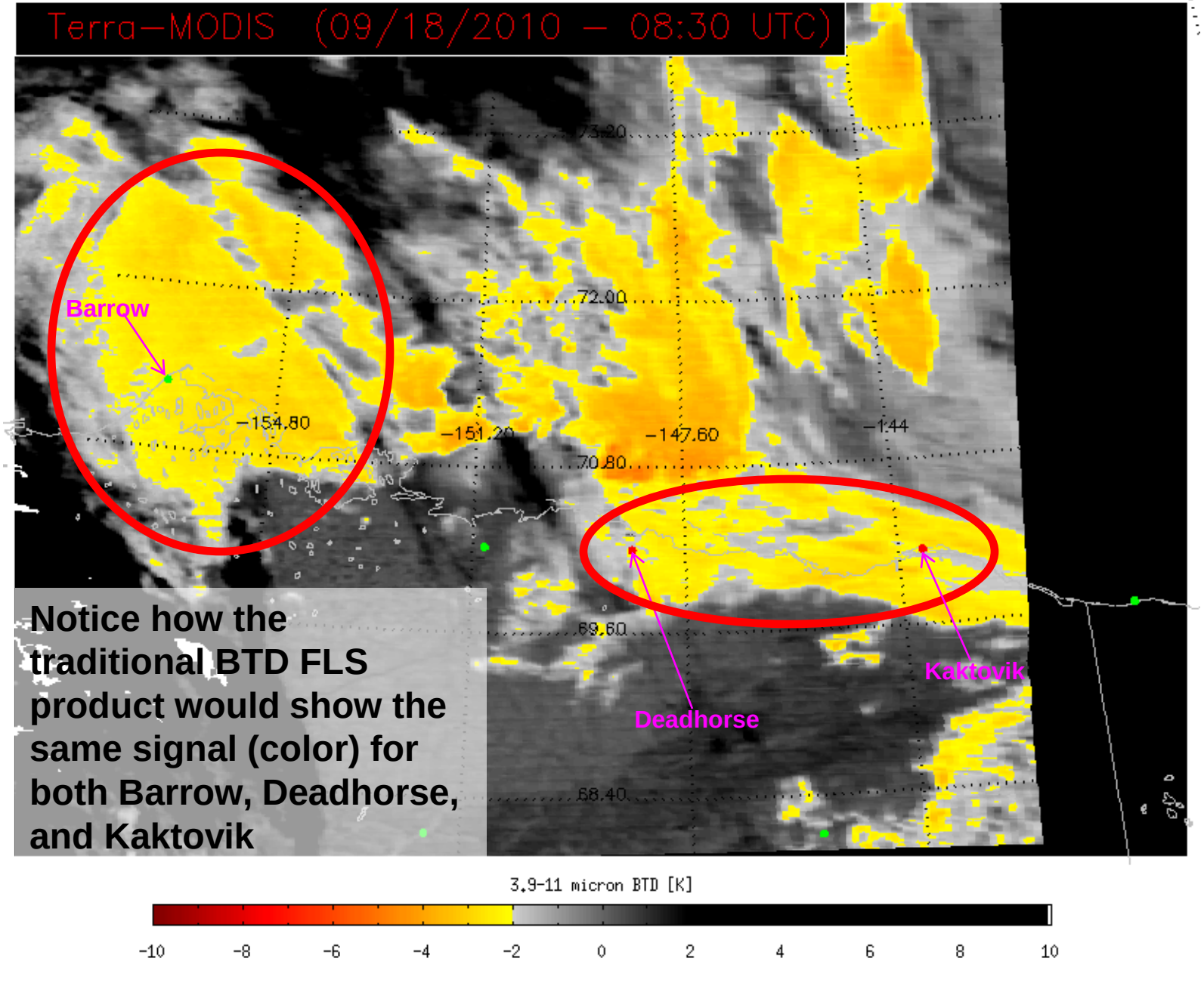


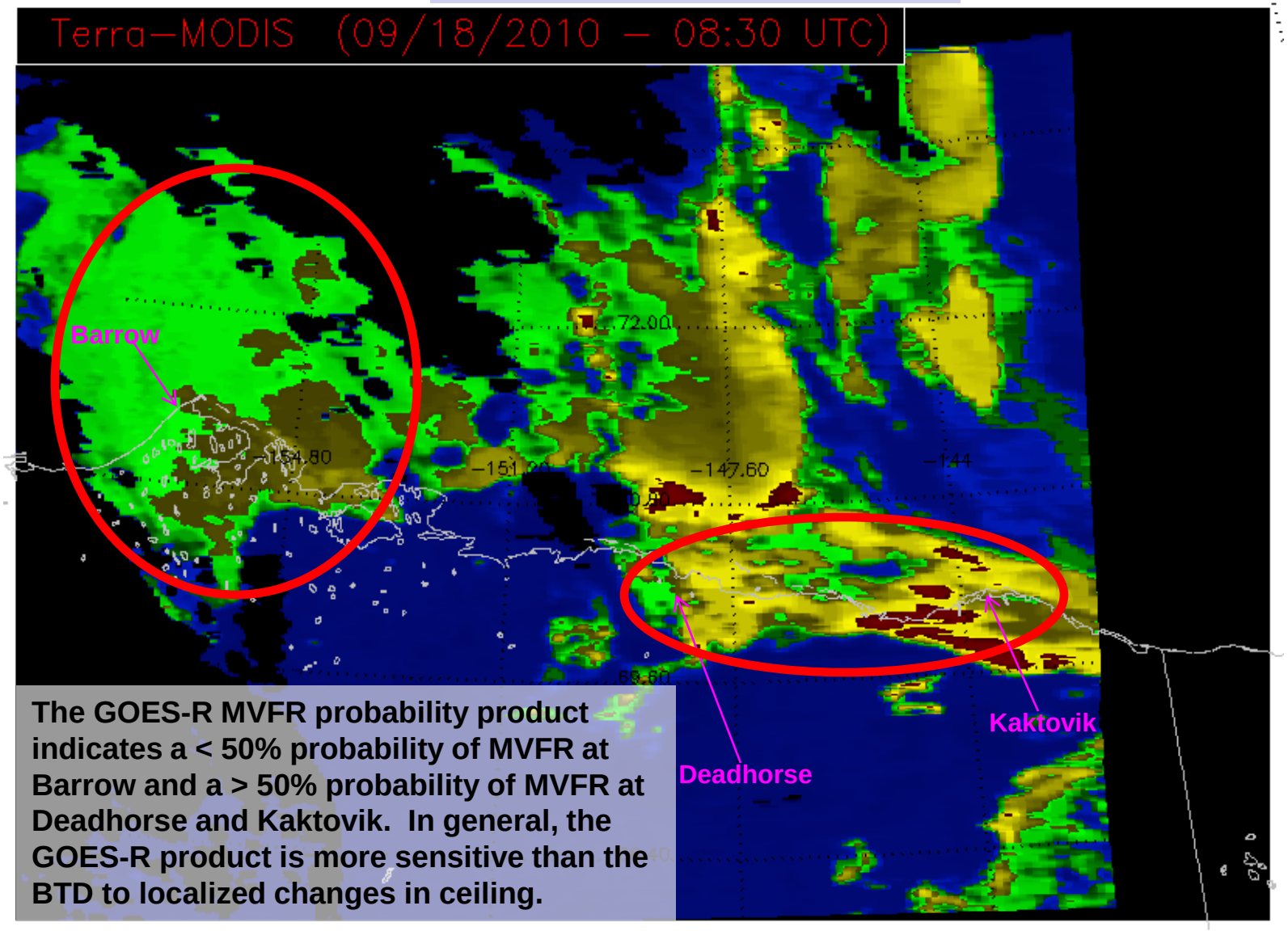
# 11$\mu$m Brightness Temperature



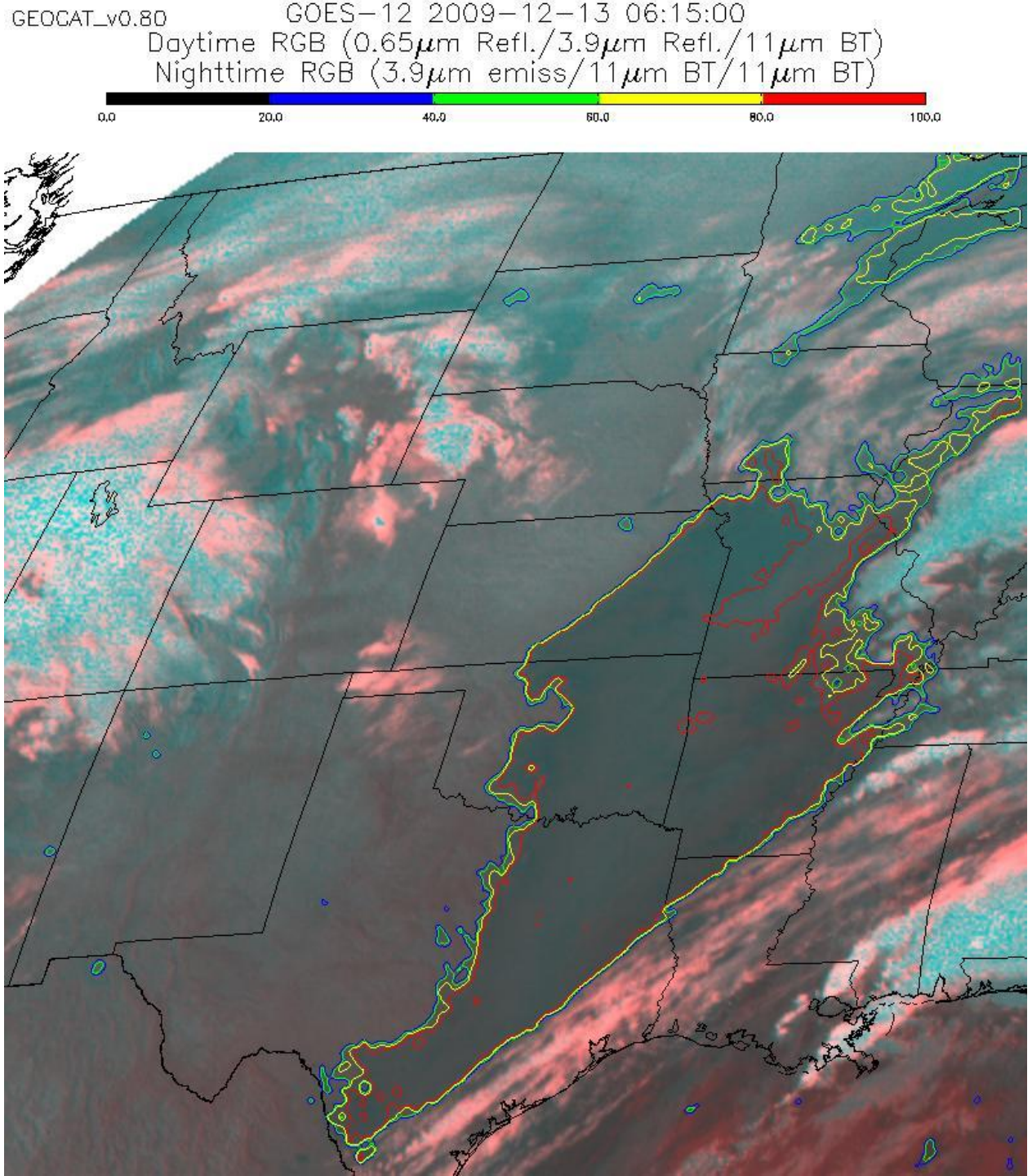
# 3.9–11 micron BTD



# MVFR Probability




**The GOES-R MVFR probability product indicates a < 50% probability of MVFR at Barrow and a > 50% probability of MVFR at Deadhorse and Kaktovik. In general, the GOES-R product is more sensitive than the BTD to localized changes in ceiling.**




- **The quantitative assessment of cloud ceiling can be overlaid on top of imagery to make the product more appealing to forecasters.**

- **The ability to contour the IFR and MVFR probabilities will soon be available in AWIPS.**

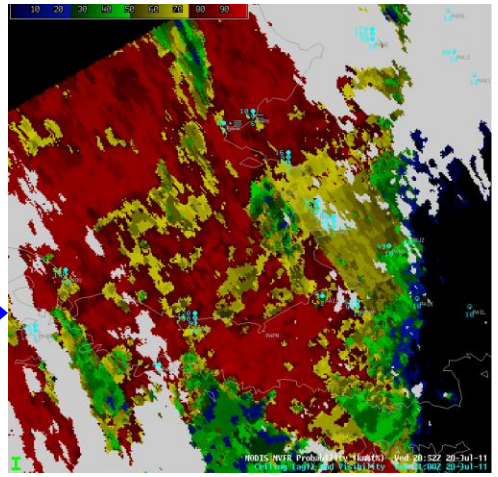
# Fused Fog/Low Cloud Detection Approach (development plan)

**ABI**

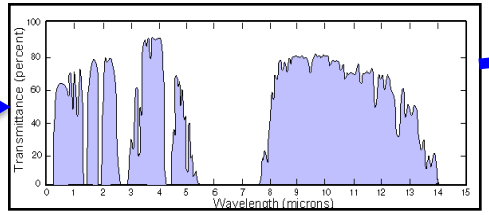
**ABI channels 2, 7,14**
**Cloud Mask**
**Cloud Phase**
**Solar zenith angle**

**VIIRS**

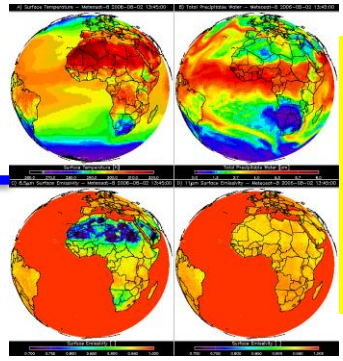
**MVFR and IFR Probability**



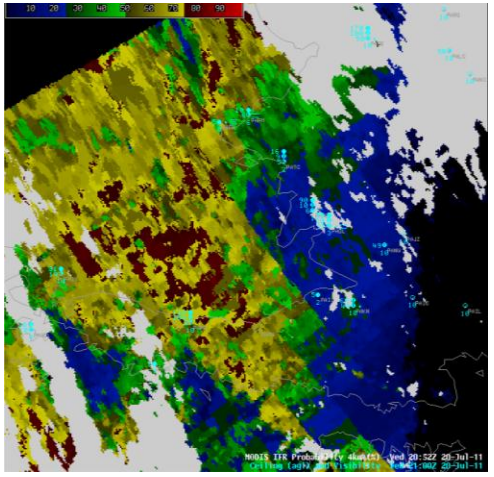
**Clear Sky RTM Output**




**Data Fusion Using Naïve Bayesian Model**



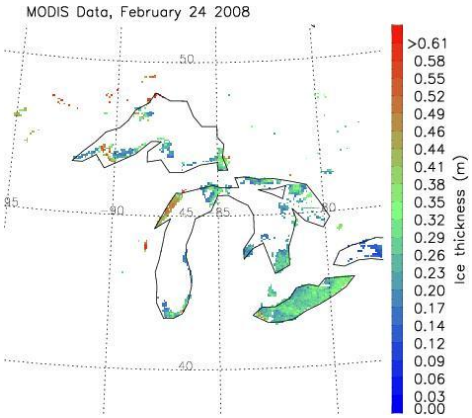
**-NWP Data (add additional fields**
**-DEM**
**-SST Data**
**-Surface Emissivity Data**



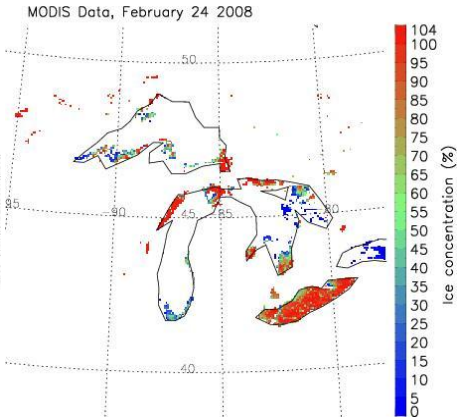
# Cryosphere Work

MODIS True Color Image

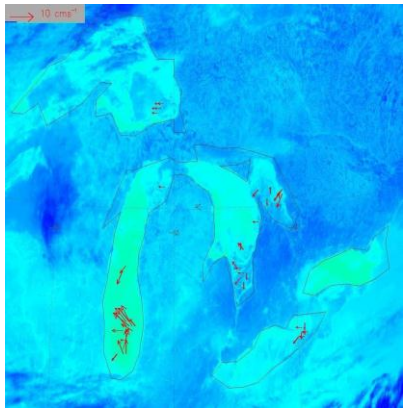
Ice Thickness (m)



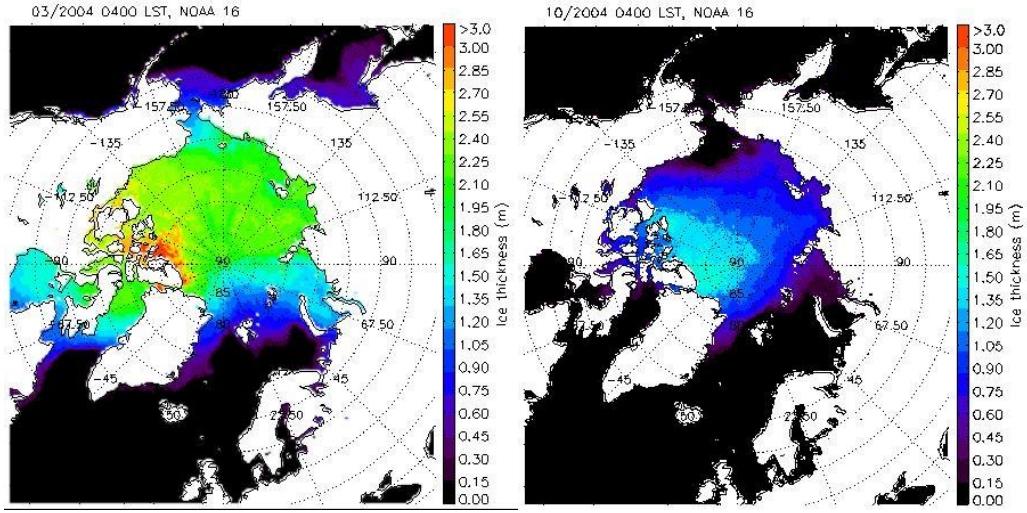

Ice Concentration (%)




Ice Motion (cm/s)



MODIS Aqua Data on February 24, 2008 except for ice motion that is from February 27,2003.



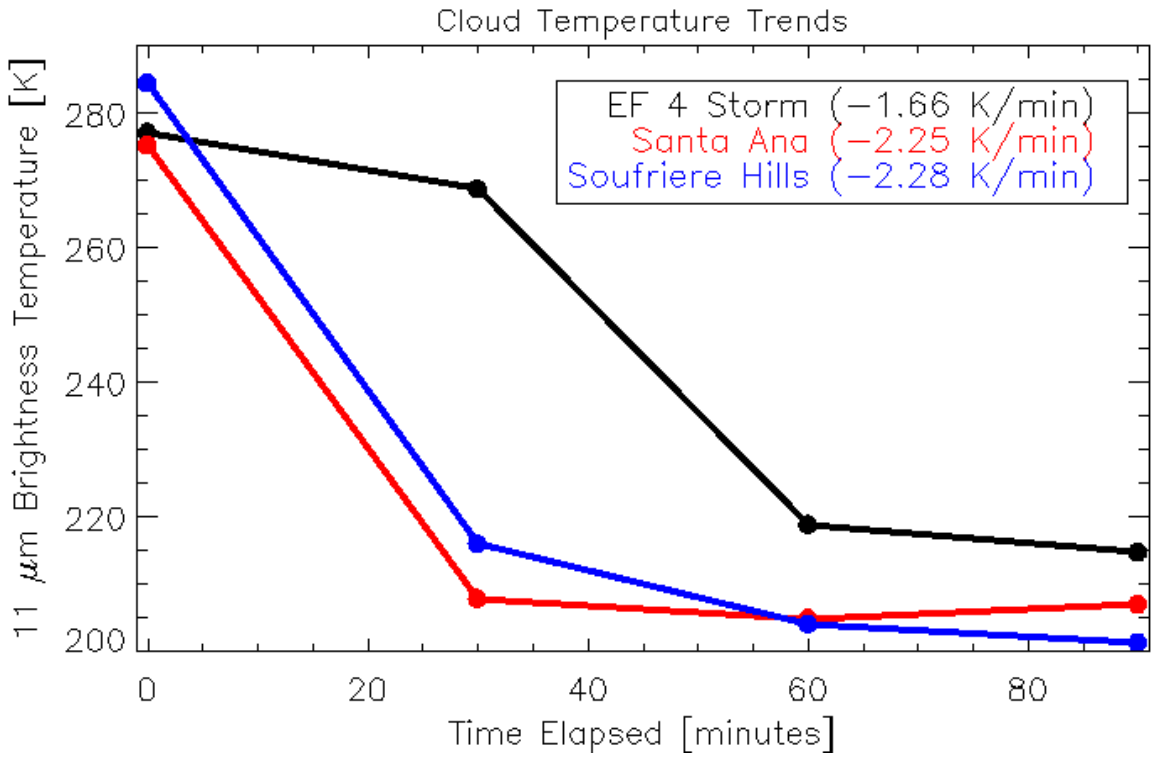

Arctic Sea Ice Thickness (m) for March (left) and October (right), 2004.

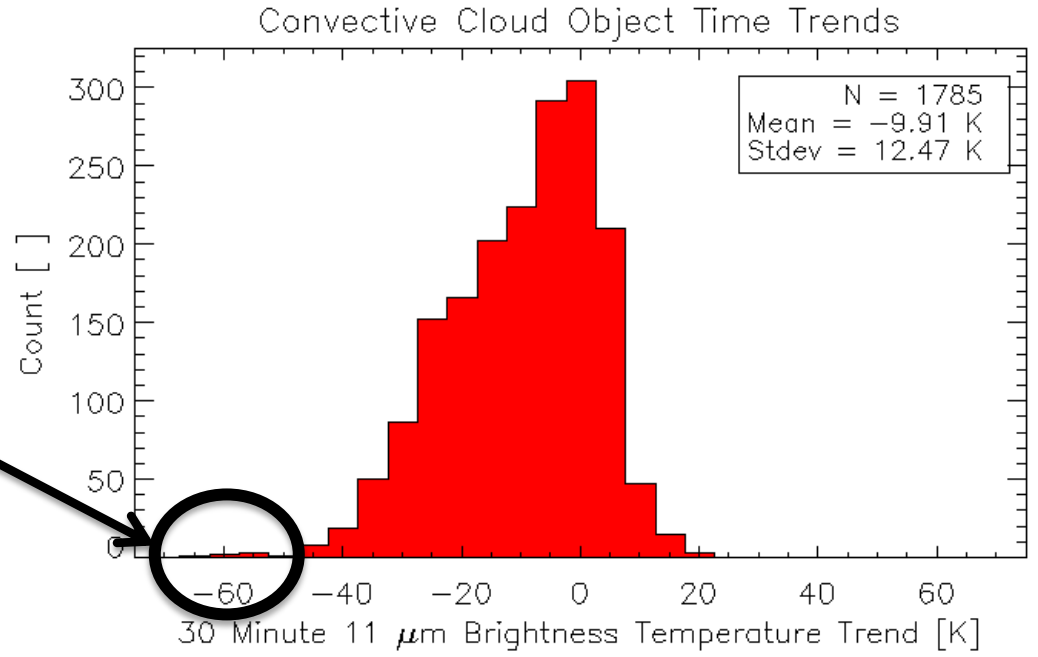
- **The algorithms of estimating sea and lake ice concentration, thickness, and motion have been developed for GOES-R ABI.** (*Wang, X., J. Key, and Y, Liu, 2009, A thermodynamic model for estimating sea and lake ice thickness with optical satellite data,* ***JGR-Ocean****, submitted, 2009*)
- **The algorithms have been tested and verified with proxy data from AVHRR, MODIS, and SEVIRI.**
- **Snow and ice products have been validated for NPOESS VIIRS with in-situ measurements from submarine and stations.**
- **A 23-year long dataset of ice products including ice extent, concentration, thickness/age, and volume has been generated for the Arctic ocean over 1982-2004.**

# Summary

- Scientific creativity spawned while preparing for GOES-R is responsible for the development (and continued development) of new and exciting “fused” products for hazard assessment
- Quantitative products are needed to take full advantage of the GOES-R system (and the weather satellite constellation in general)
- Thanks to the Proving Ground, scientific developers and users are working more closely than ever


# Back-up Slides

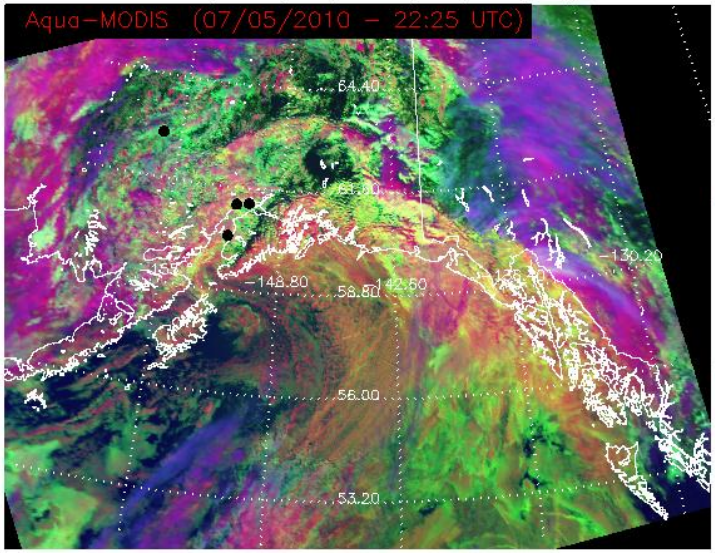


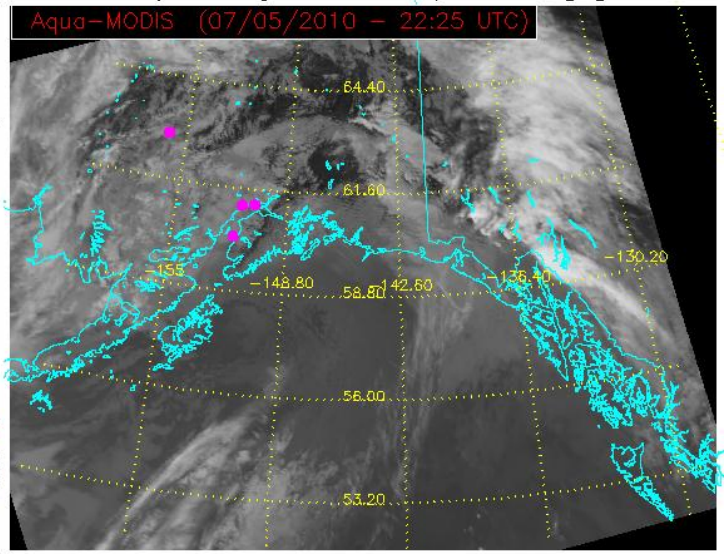

***Extreme 30 minute decreases are associated with volcanic convection events.***

# Aqua-MODIS (July 05, 2010, 22:25 UTC)

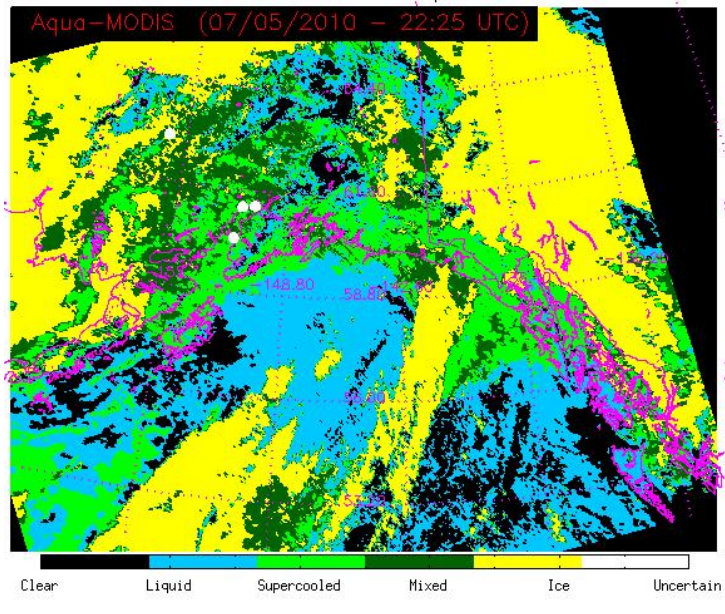
RGB (0.65$\mu$m, 3.75$\mu$m, 11$\mu$m)



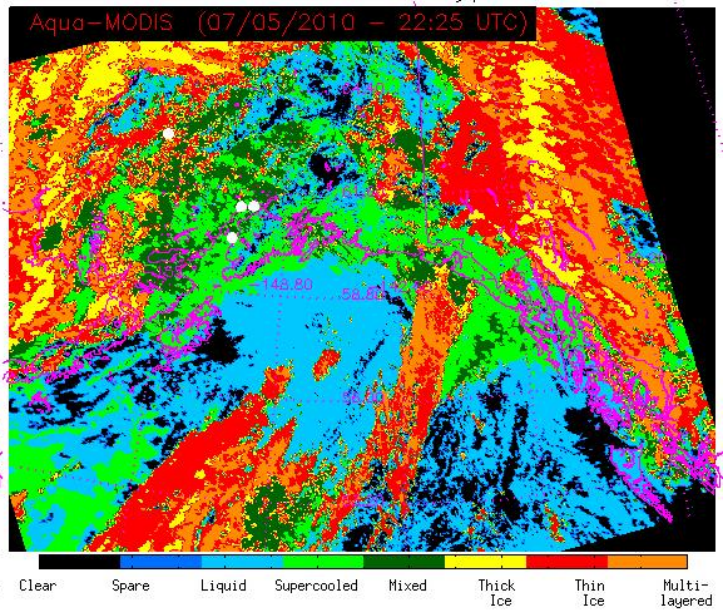

11$\mu$m Brightness Temperature [K]




GOES-R Cloud Top Phase

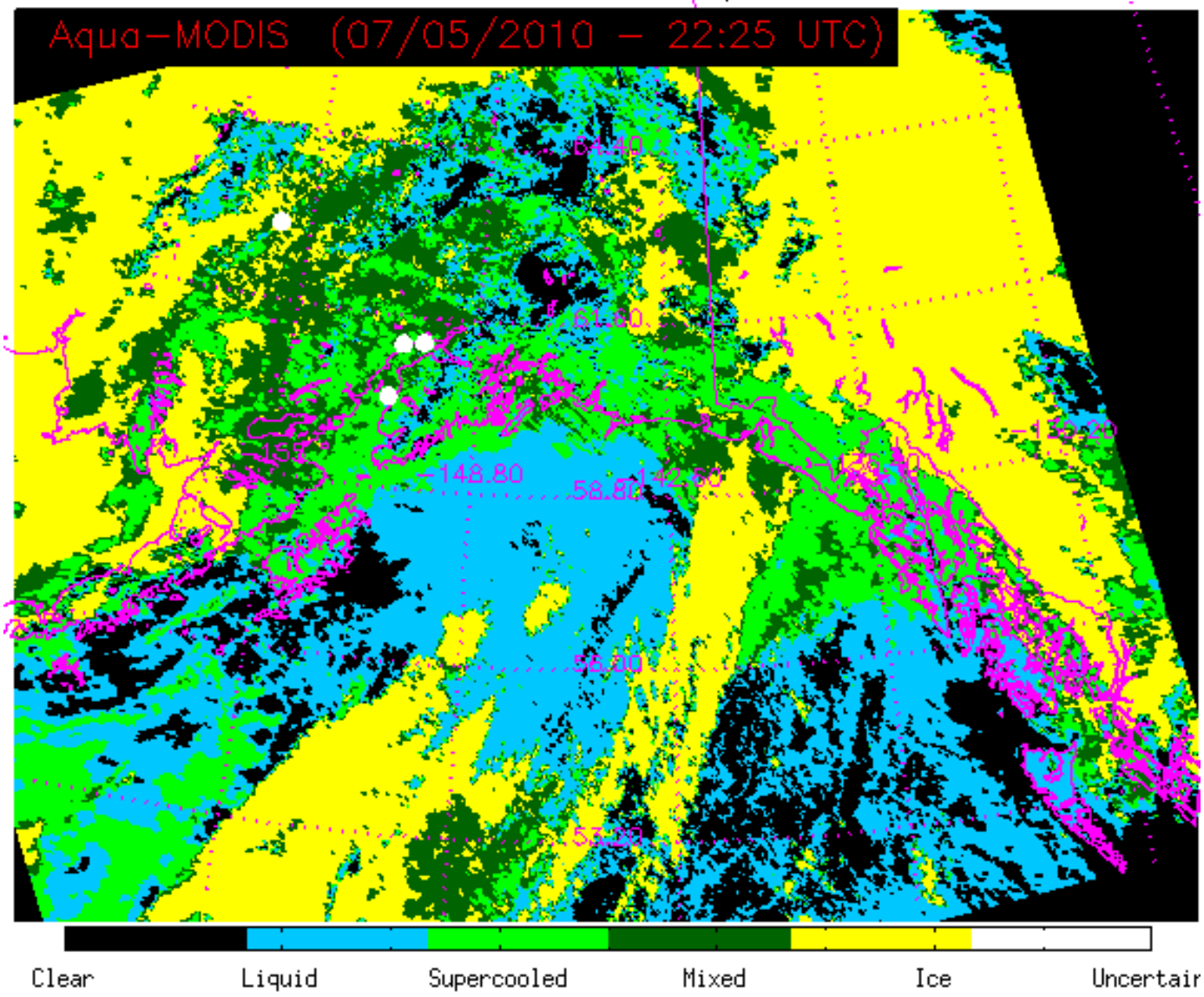



GOES-R Cloud Type




- **Icing reports are denoted by the filled circles.**
- **All pilot reported occurrences of aircraft icing are coincident with supercooled liquid water or mixed phase clouds.**

# GOES-R Cloud Top Phase




- **Icing reports are denoted by the filled circles.**
- **All pilot reported occurrences of aircraft icing are coincident with supercooled liquid water or mixed phase clouds.**