



# DB Product Applications

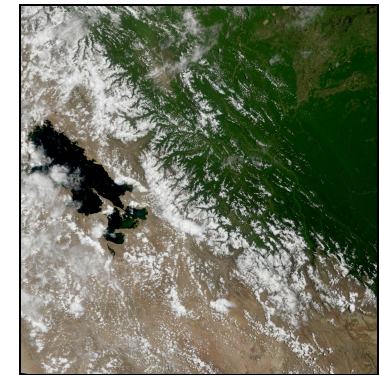
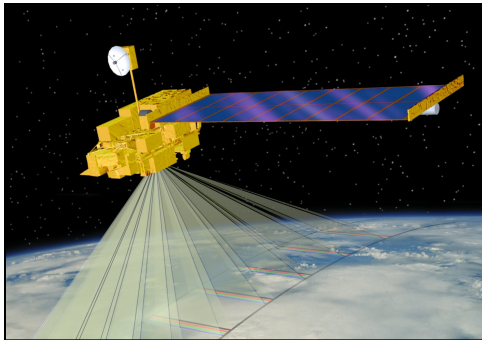
**2011 IMAPP Training Workshop: Satellite  
Direct Broadcast for Real-Time Environmental**

**Applications**

**ECNU, China**

**4 June 2011**

**Part 2**



Kathleen Strabala

Cooperative Institute for Meteorological Satellite Studies

Space Science and Engineering Center

University of Wisconsin-Madison

# Aviation Applications Continued

- Clouds
  - Composition
  - Cloud Top Properties
  - Cloud Phase

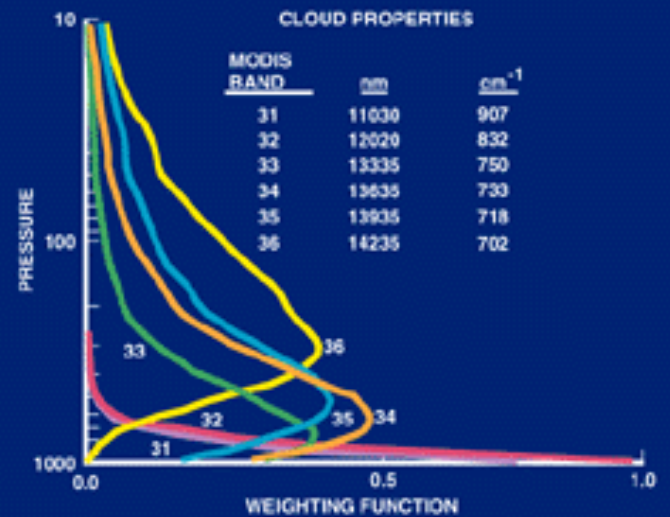
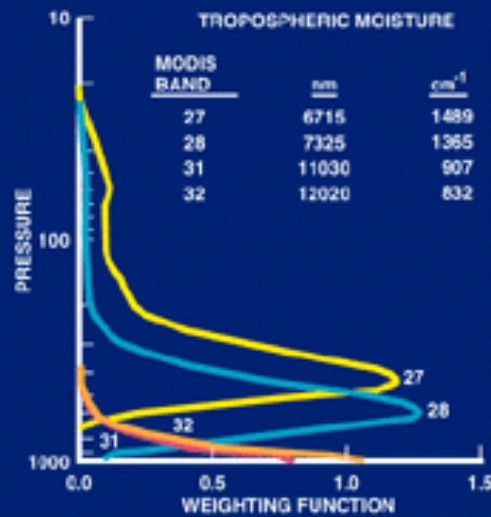
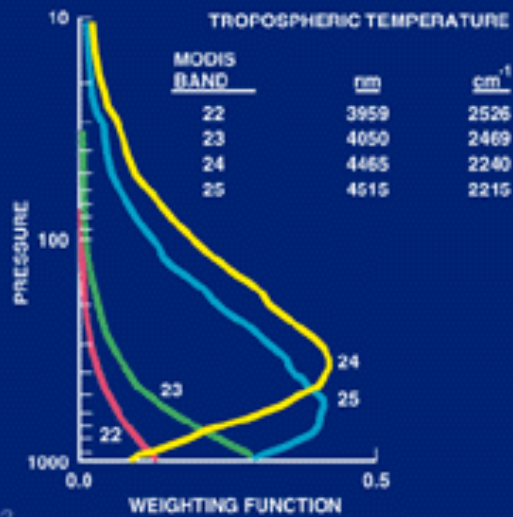
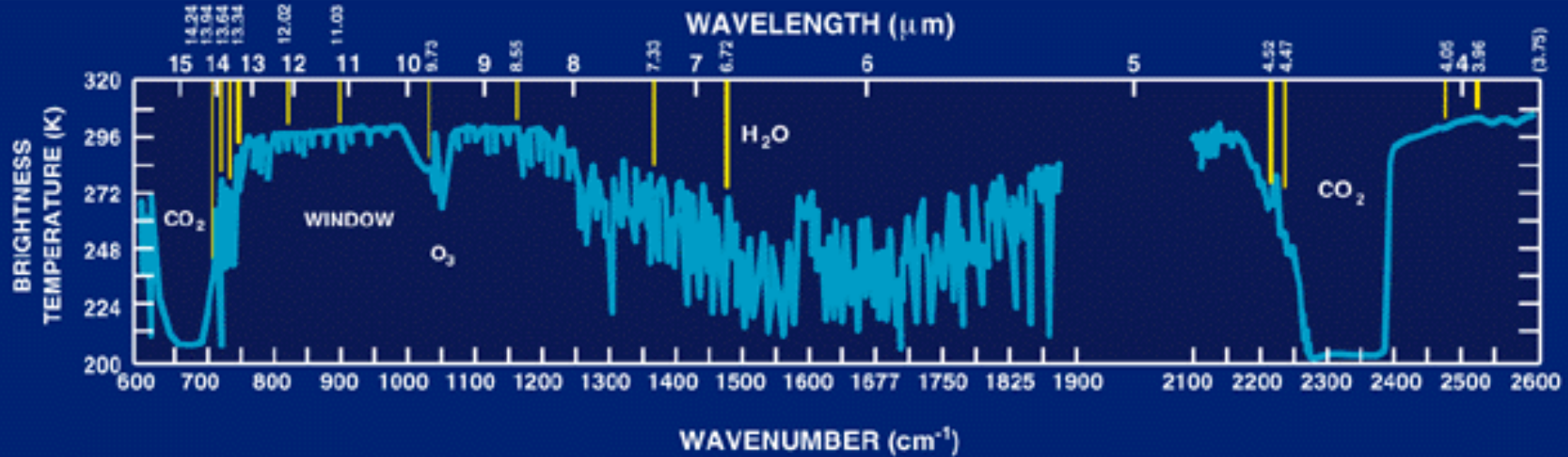
# Clouds

- MOD06 Cloud Product contains
  - Cloud Top Properties at 5km
    - Cloud Top Pressure, Cloud Top Temperature, Cloud Fraction, Cloud Emissivity
  - Cloud Phase at 5 km
  - Cloud Optical Properties at 1 km (Daytime only)
    - Cloud Effective Radius
    - Cloud Optical Thickness

# Cloud Top Property Algorithm

- Cloud Top Pressure, Temperature, Emissivity derived using CO<sub>2</sub> “slicing”
- MODIS product utilizes 4 spectral channels in the 13 – 14 μm region.
- 5x5 1 km pixel retrievals where at least 5 of the 1 km pixels are cloudy as determined by the cloud mask
- Cloud properties retrieved both day and night

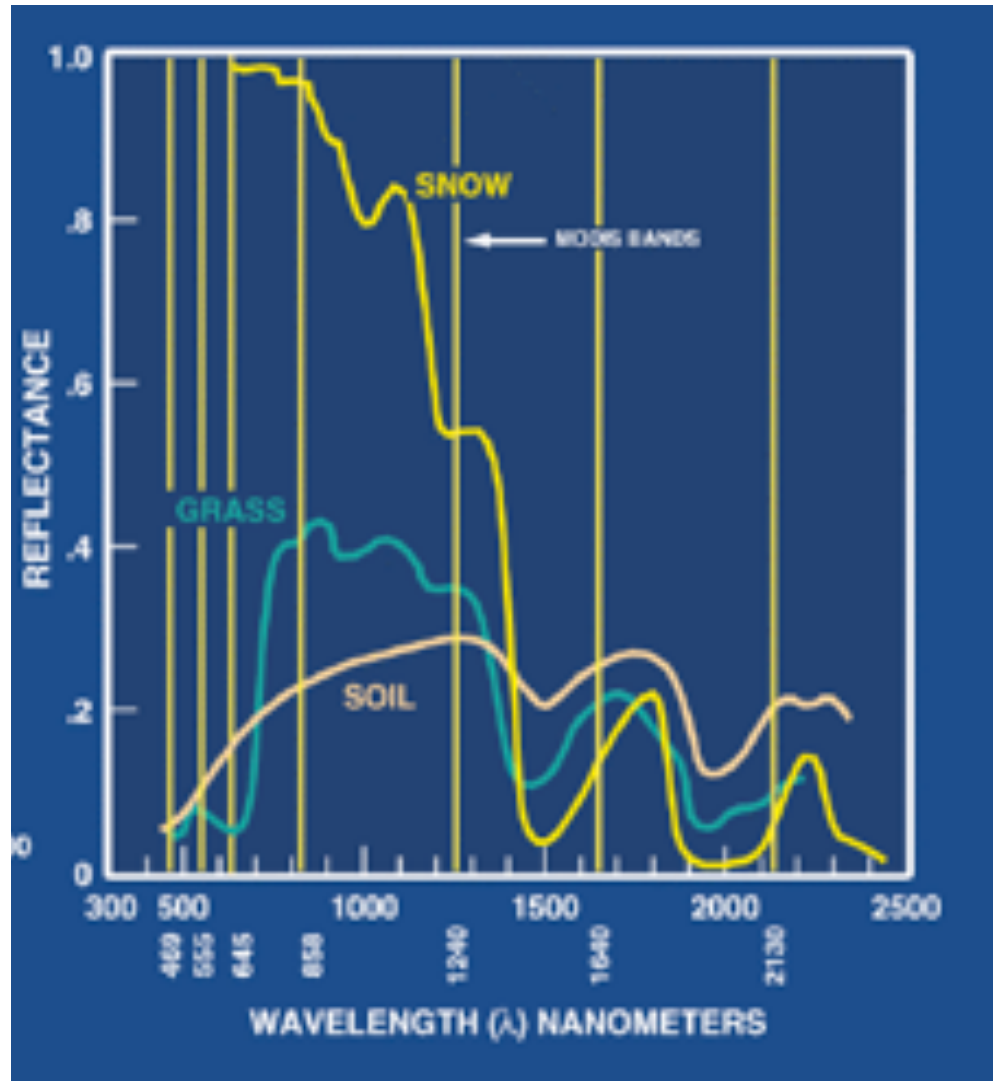
# ATMOSPHERE - THERMAL RADIATION



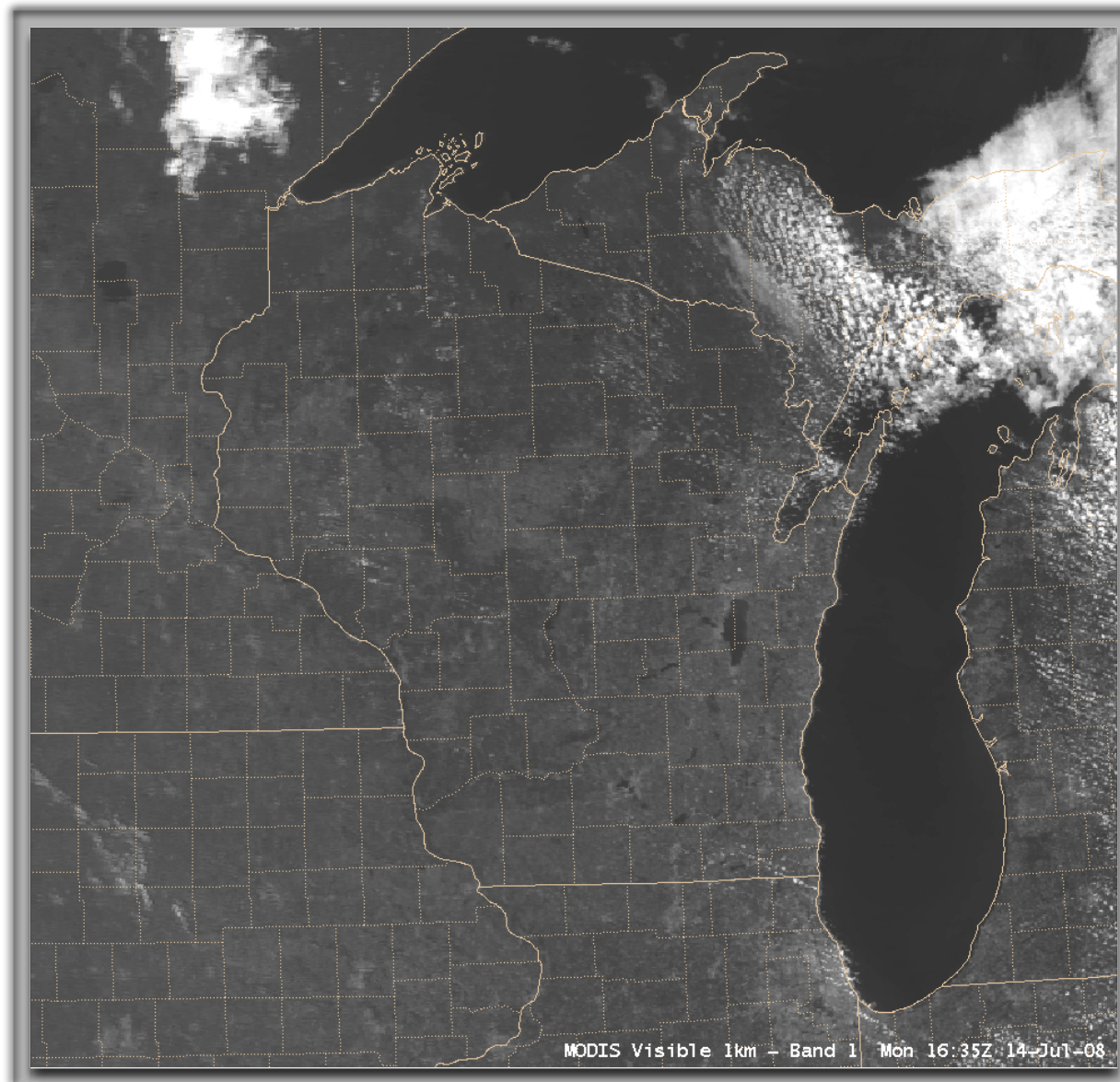
# Cloud Phase

- IR Brightness Temperature Difference Product
  - Band 29 (8.6  $\mu\text{m}$ ) – Band 31 (11  $\mu\text{m}$ )
  - Takes advantage of difference in water/ice cloud absorption in this spectral region
- Near Infrared Bands (1.6 and 2.1  $\mu\text{m}$ )
- Short Wave Infrared Bands (4  $\mu\text{m}$  region)

# MODIS – Snow/Ice and Ice Clouds

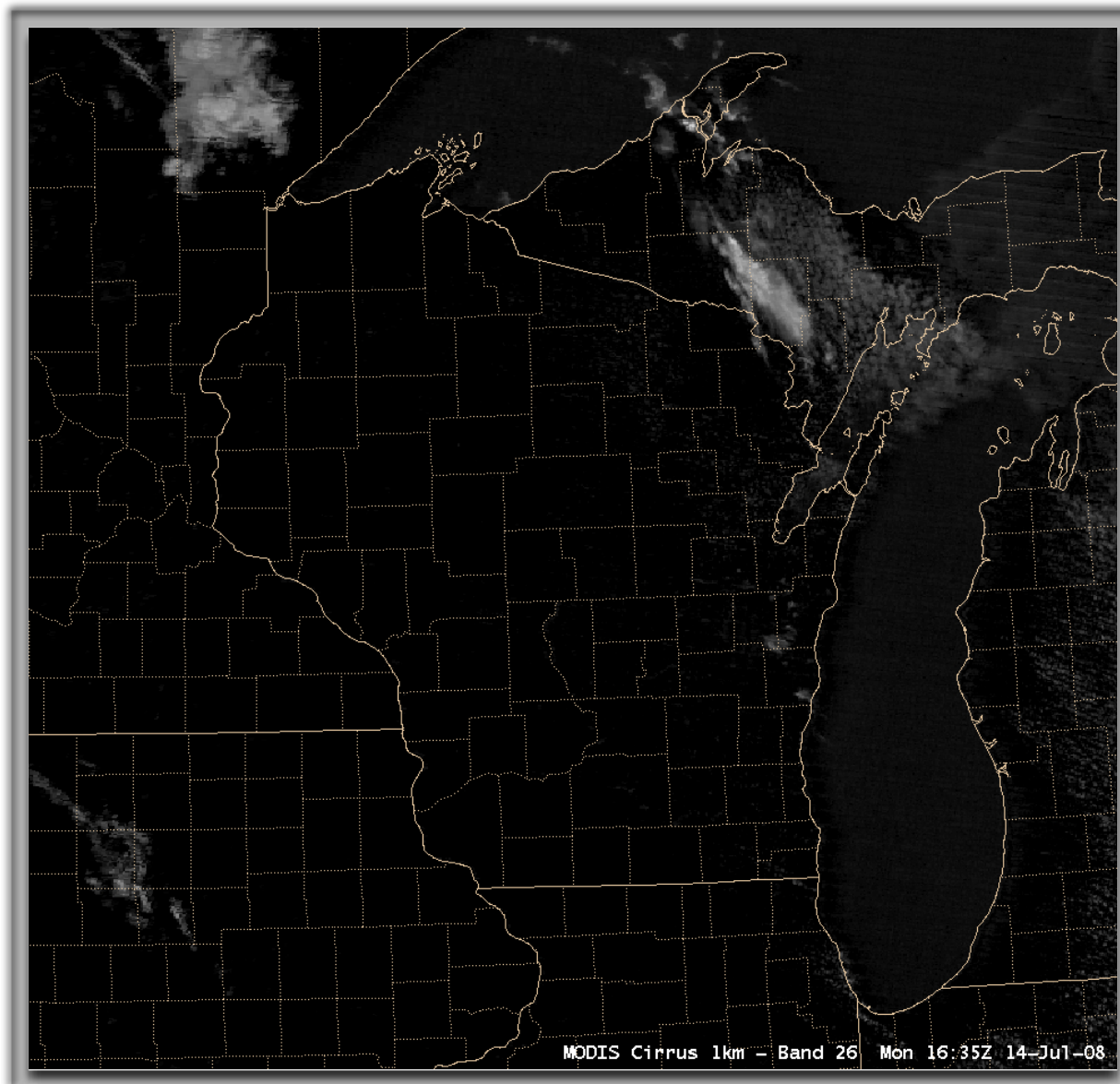


# MODIS Products in AWIPS

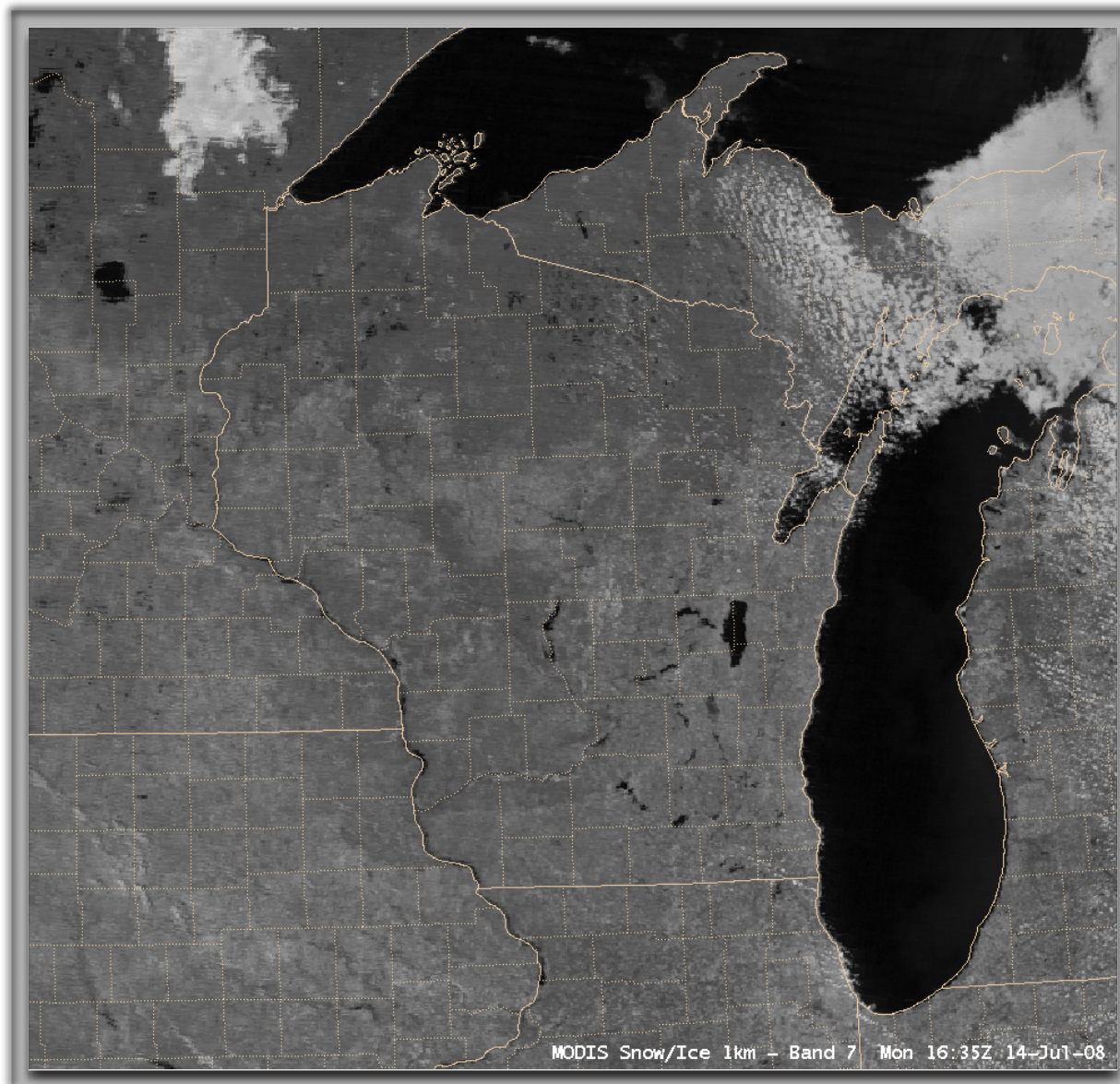


Visible (0.65  $\mu\text{m}$ ): 1-km resolution

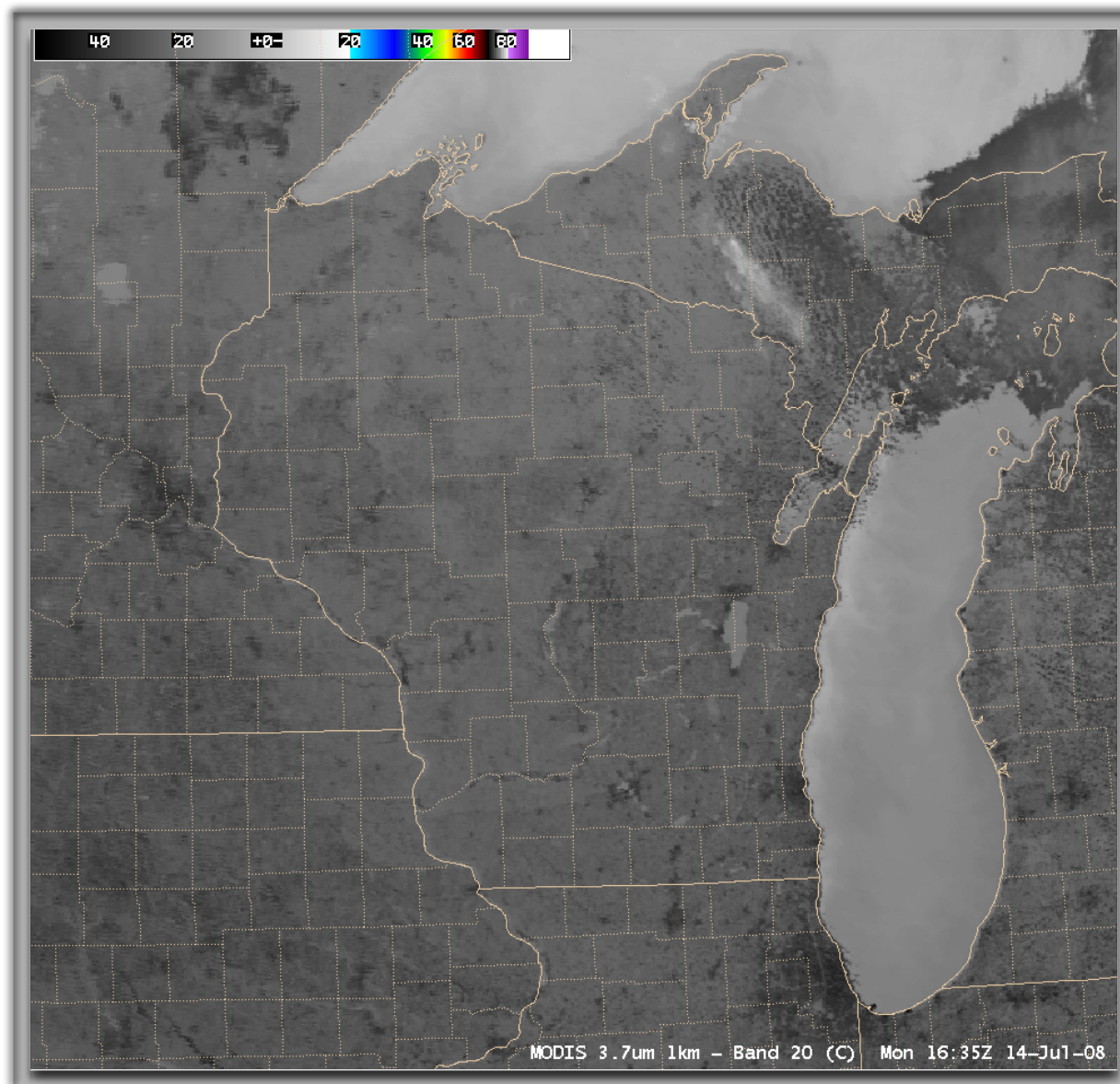




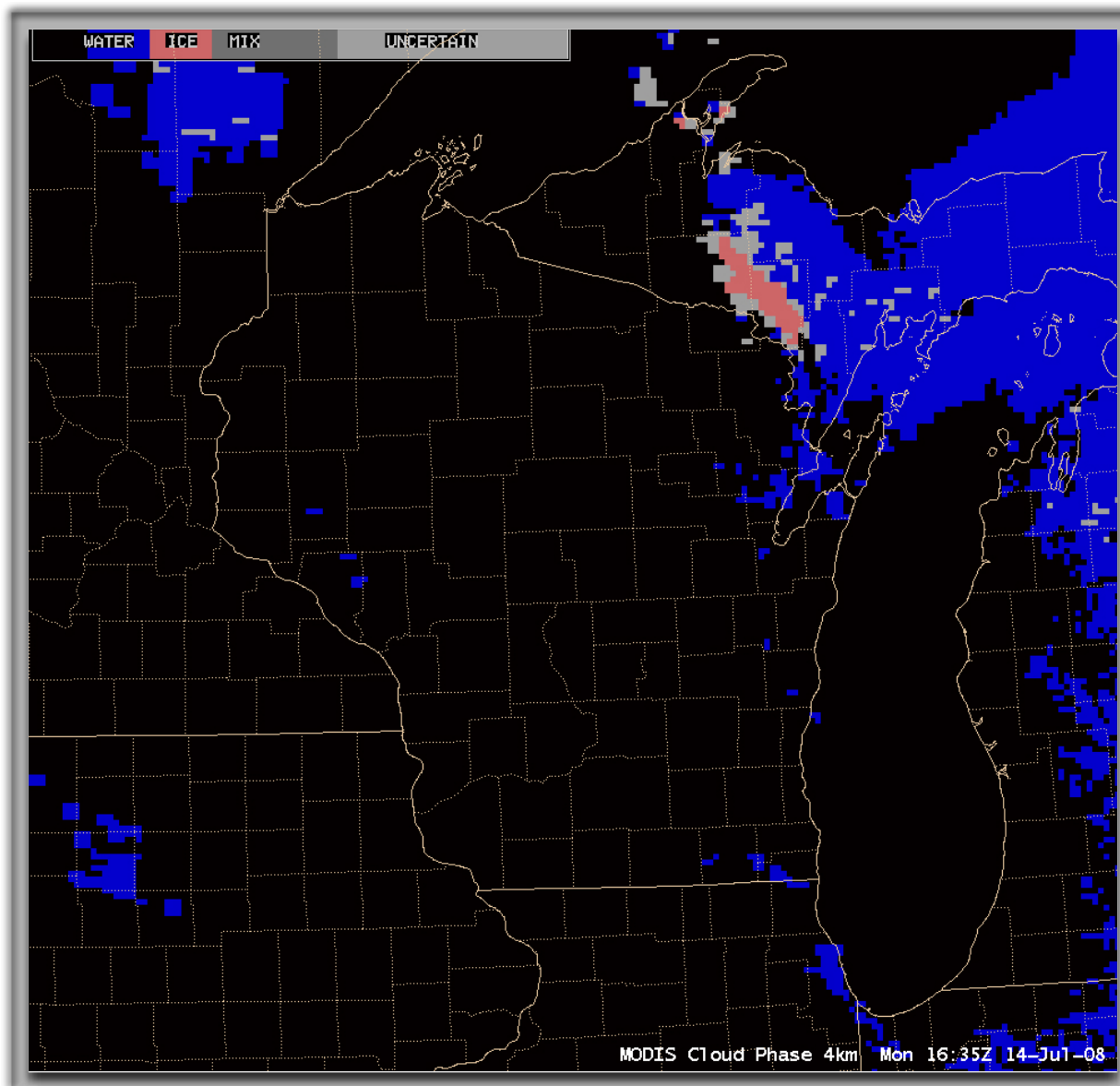
Cirrus detection ( $1.3 \mu\text{m}$ ): 1-km resolution



Snow/ice discrimination ( $2.1 \mu\text{m}$ ): 1-km resolution

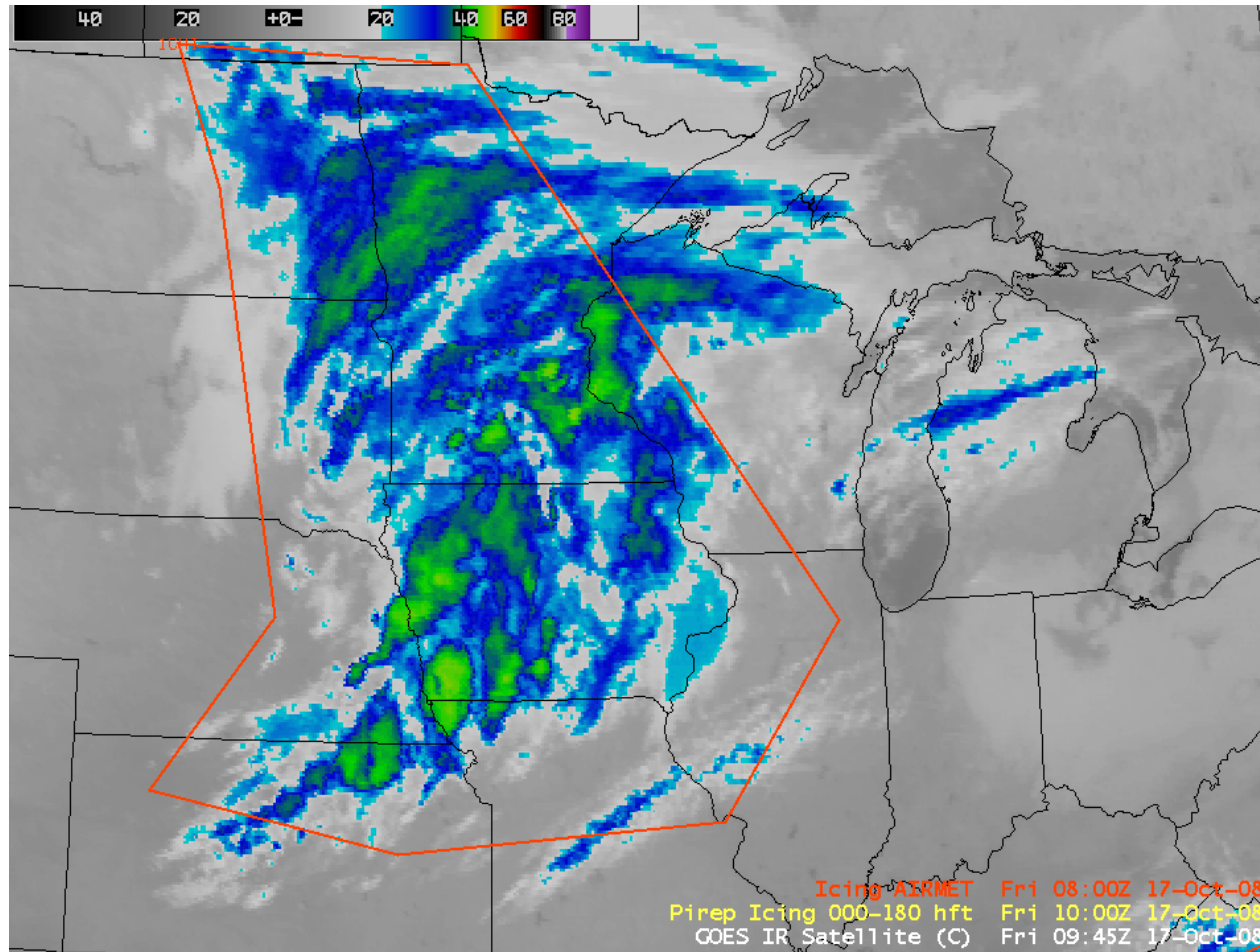


Shortwave IR (3.7  $\mu\text{m}$ ): 1-km resolution



Cloud Phase: 4-km resolution

# Using Satellite Imagery to Help Diagnose Areas of Aircraft Icing Potential



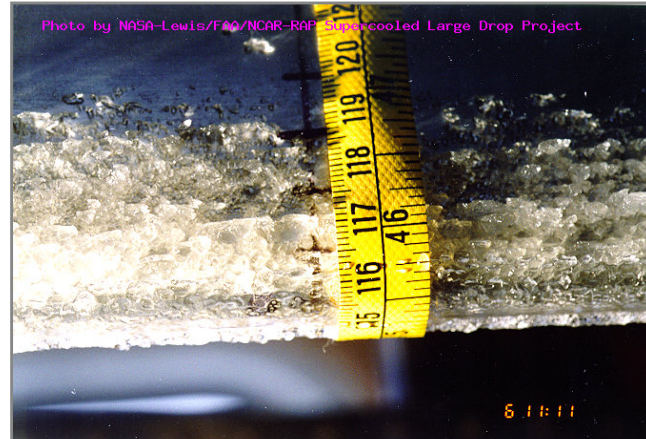
GOES IR window animation 17 October 2008

# Icing

- Freezing Level
  - Altitude at which the temperature is 0 degrees C
  - Above this level the temperature is  $< 0$  C
- Water Can Exist at Temperatures Well Below Freezing
  - Supercooled Water
- An airplane whose temperature is  $<$  freezing in this environment can accrue ice

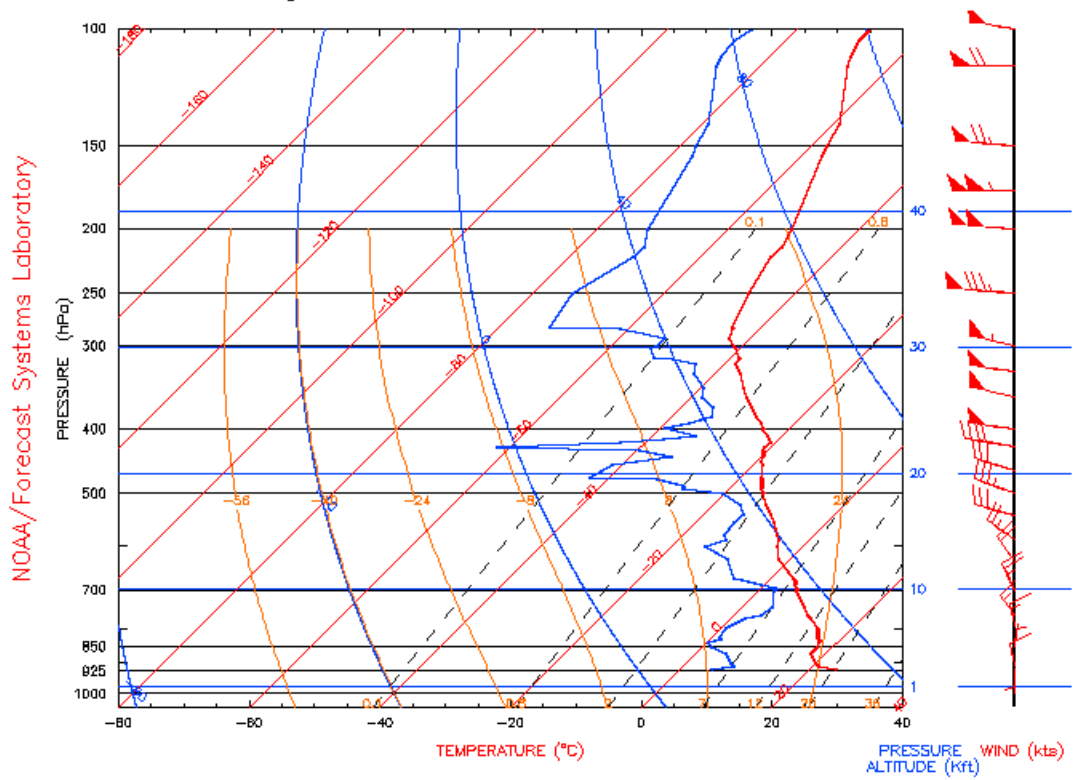
# Why is This Important?

- We worry about icing because it can adversely affect the flight characteristics of an aircraft. Icing can increase drag, decrease lift, and cause control problems. The added weight of the accreted ice is generally only a factor in light aircraft.



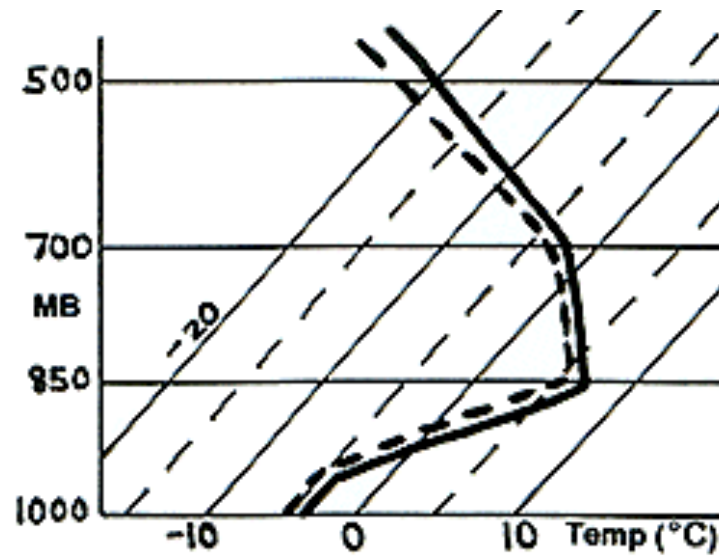
Ice Accumulation On  
The Wing of a Small Aircraft  
NASA

# Sounding for AUP, 10 UTC, 5-MAY-2009

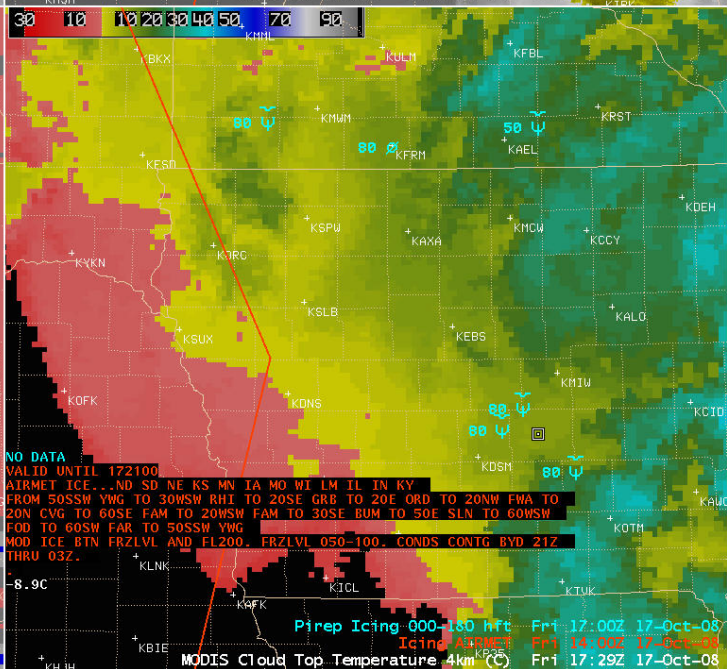
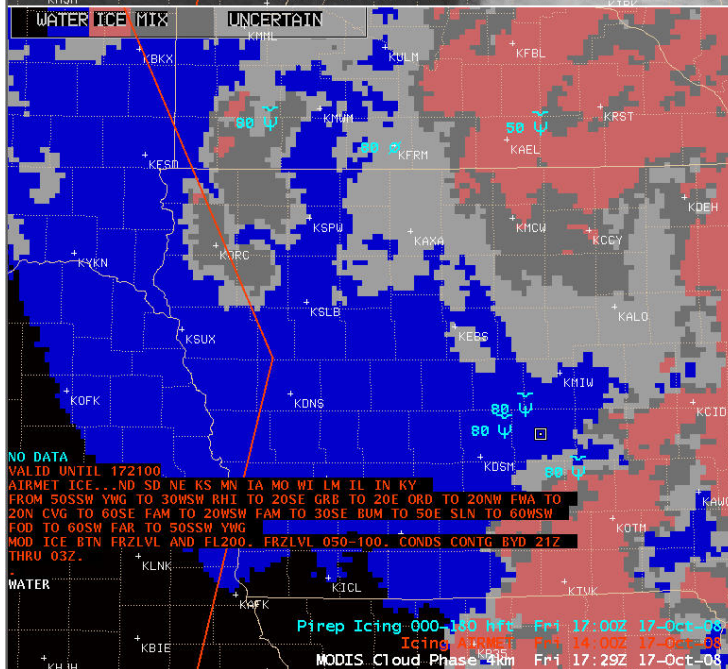
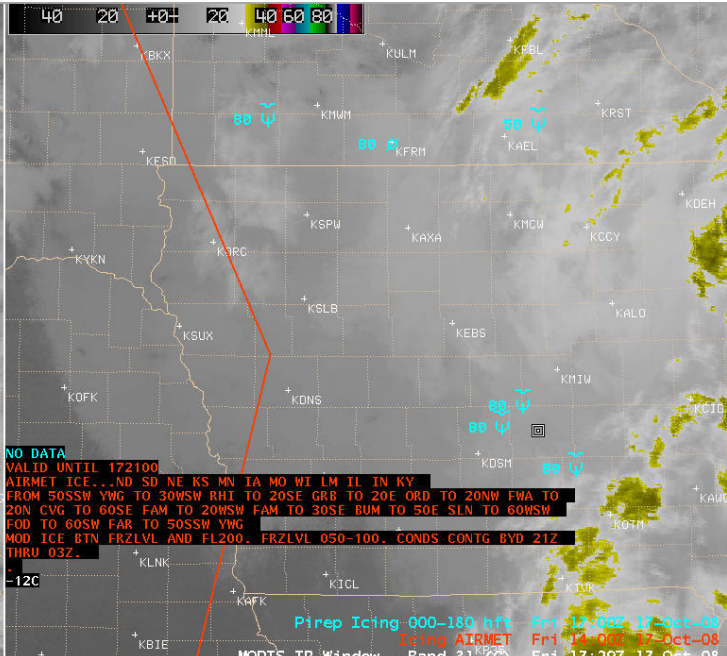
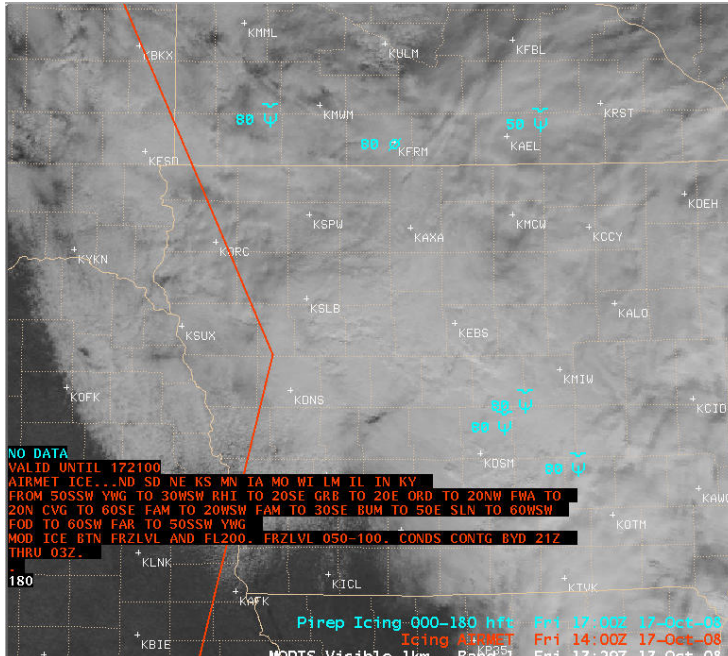




# Freezing Rain Sounding



- A closer view using AWIPS images of the MODIS visible channel, 11.0  $\mu\text{m}$  “IR window” channel, Cloud Top Temperature (CTT) product, and Cloud Phase product at 17:29 UTC (below) indicated that much of the cloud shield along the trailing (western) edge of the shortwave over Minnesota and Iowa exhibited cloud top temperatures that were below freezing (generally in the  $-5$  to  $-12^\circ\text{C}$  range), but the MODIS Cloud Phase product designated those trailing edge clouds as “Water droplet” clouds (blue enhancement). Within this area of supercooled water droplet clouds were several pilot reports of icing at the 8000-foot altitude across southern Minnesota and western/central Iowa.

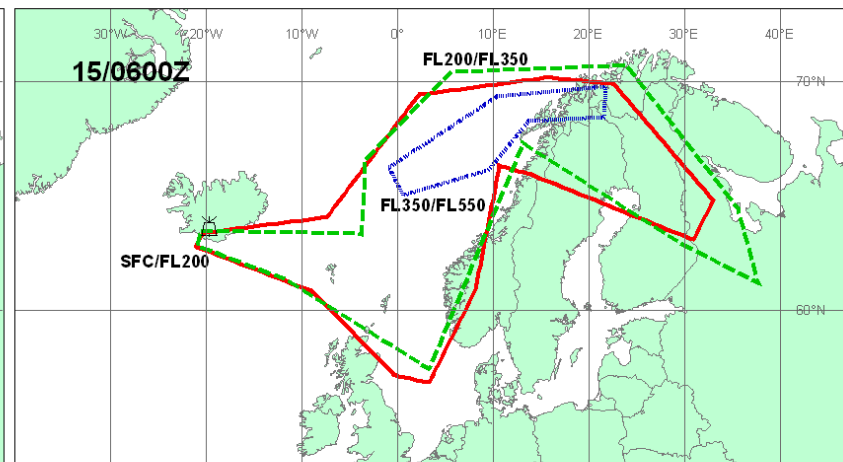
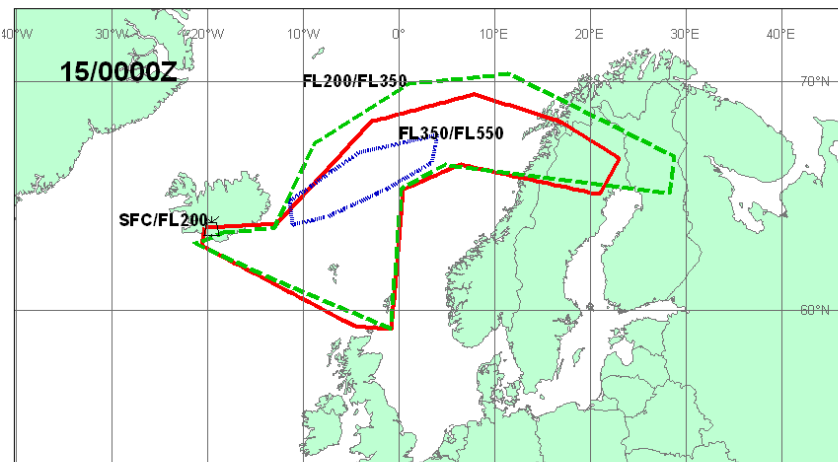
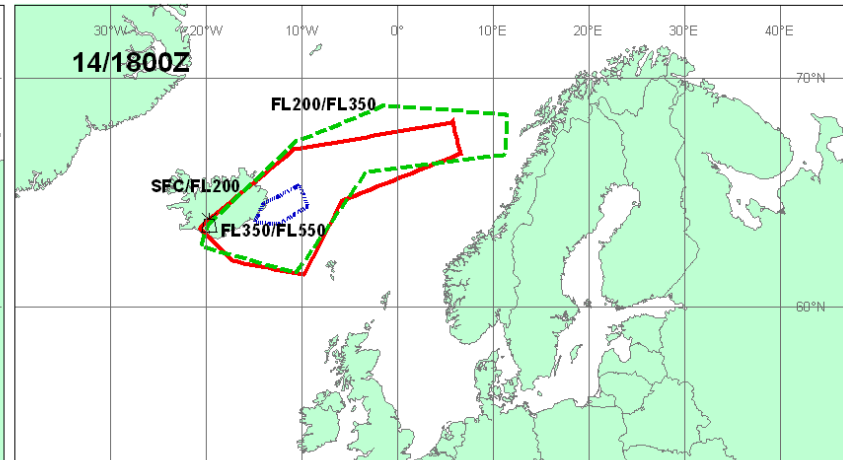
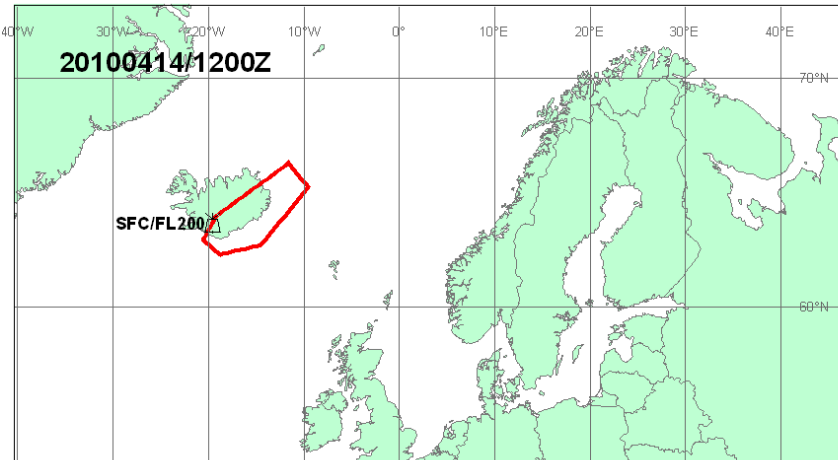


# Other Cloud Applications Too

- Identification of mature T-storms
  - Must glaciate, meaning tops of cell must be ice
- Accurate height of “thin” high clouds
  - Energy transmitted from below the cloud in the IR window. Can't get accurate level from window BT.
  - Important for pilots. Clouds mean more moisture, dry entrainment and potential for turbulence.

# Ash Detection

# Why is this important?



VA ADVISORY  
DTG: 20100414/1200Z  
VAAC: LONDON  
VOLCANO:  
EYJAFJALLAJOKULL  
PSN: N6338 W01937  
AREA: ICELAND

SUMMIT ELEV: 1666M  
ADVISORY NR: 2010/001  
INFO SOURCE: ICELAND MET OFFICE  
AVIATION COLOUR CODE: UNKNOWN  
ERUPTION DETAILS: PLUME FROM VOLCANO  
REPORTED TO BE UP TO 6000M

RMK: NIL  
NXT ADVISORY: 20100414/1800Z

## Grimsvotn



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LATEST UPDATE: 25/05/2011 - AVIATION - ICELAND - VOLCANO

# Volcanic ash causes flight disruption in Germany



Germany's Hamburg and Bremen airports were forced to cancel flights on Wednesday as ash from Iceland's Grimsvotn volcano drifted across northern Europe. Authorities have warned that southwest Scandinavia could also be affected.

By News Wires (text)

REUTERS - Two German airports halted flights on Wednesday as ash from an Icelandic volcano drifted across northern Europe, with parts of Scandinavia also facing a risk of disruption.

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# Ash Detection

## Why is this important?

- Ash particles can clog airline engines
- One such event caused a commercial airliner to make an emergency landing



# Okmok Volcano



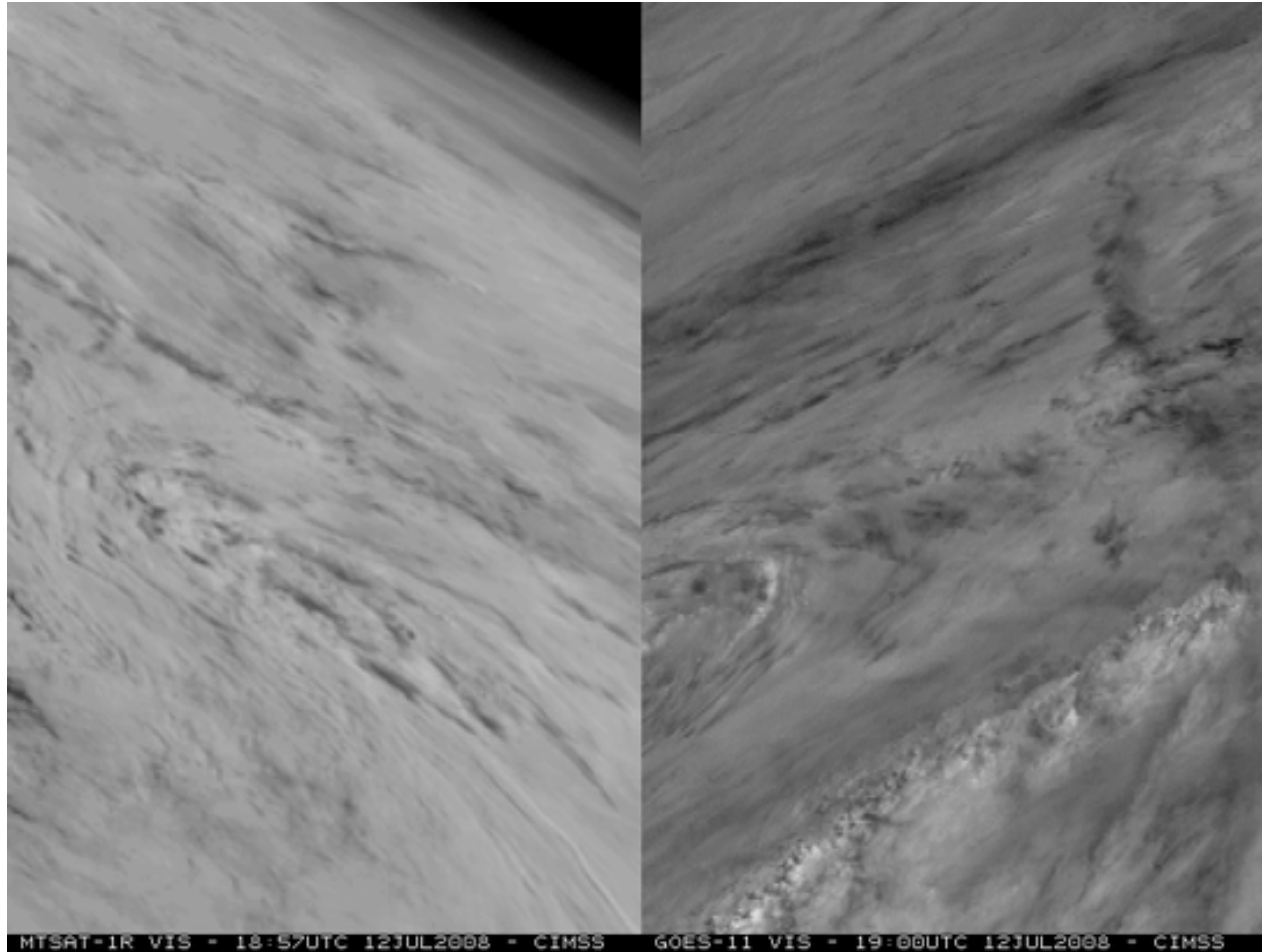
# Okmok Volcano Eruption

13 July 2008

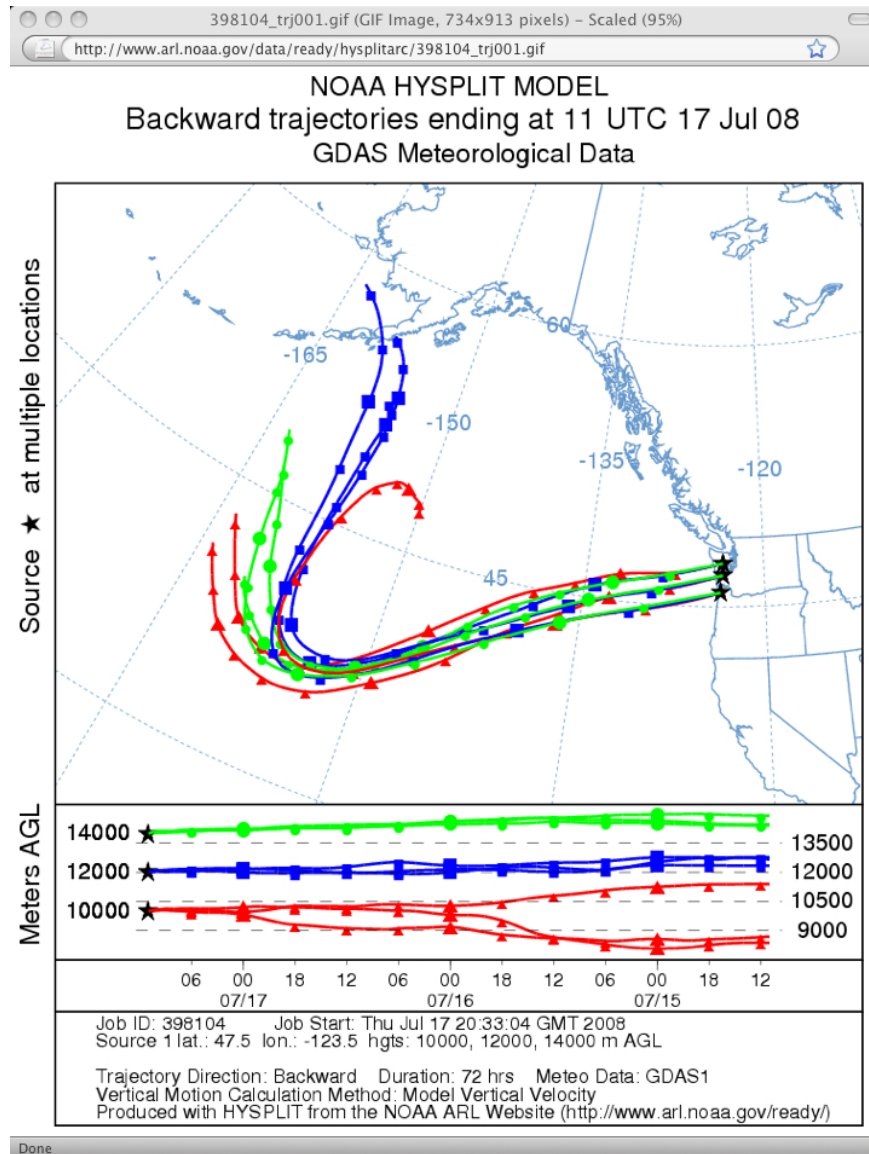


# Okmok Eruption

12 July 2008

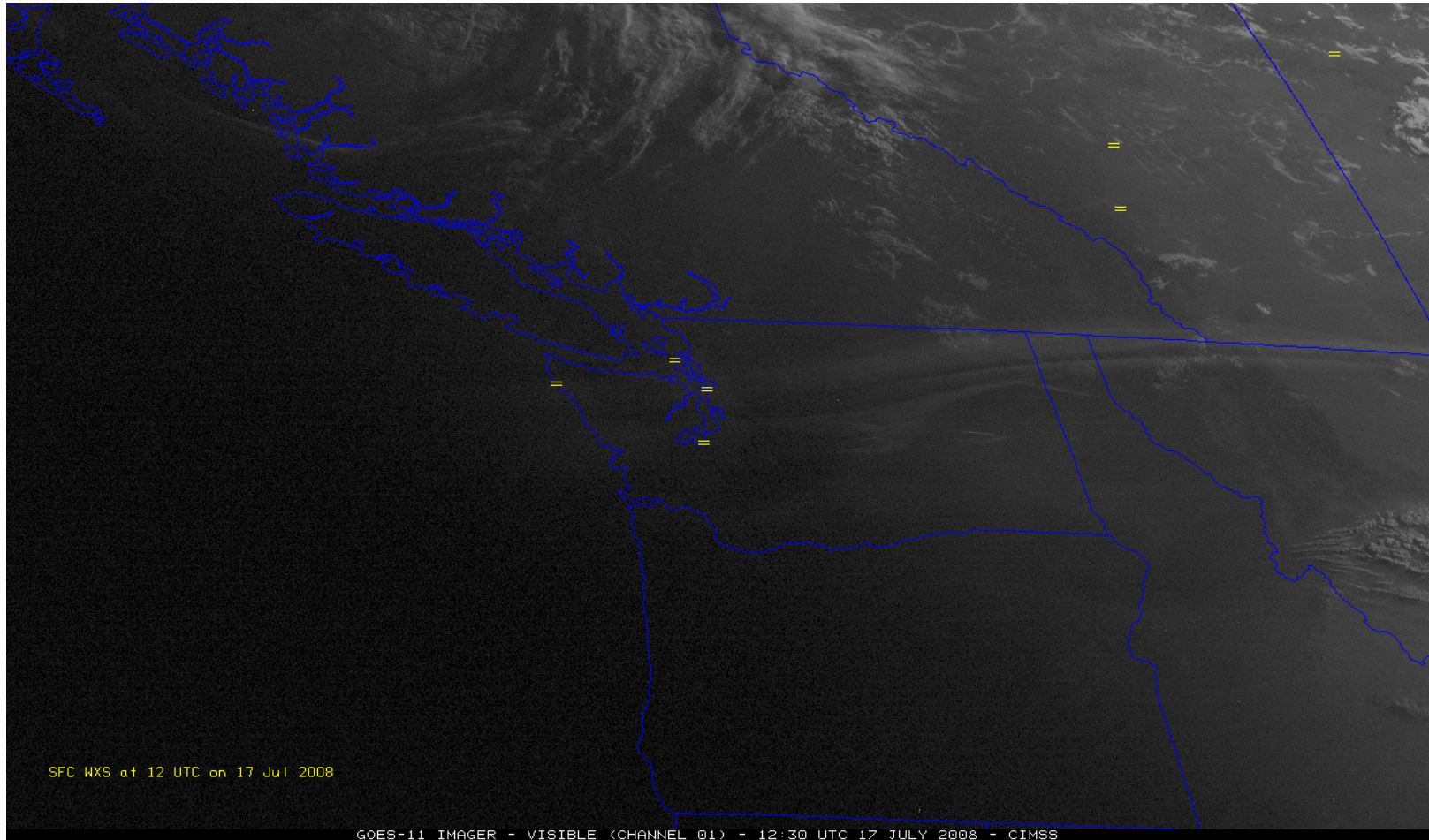


# NOAA Aerosol Trajectory Model



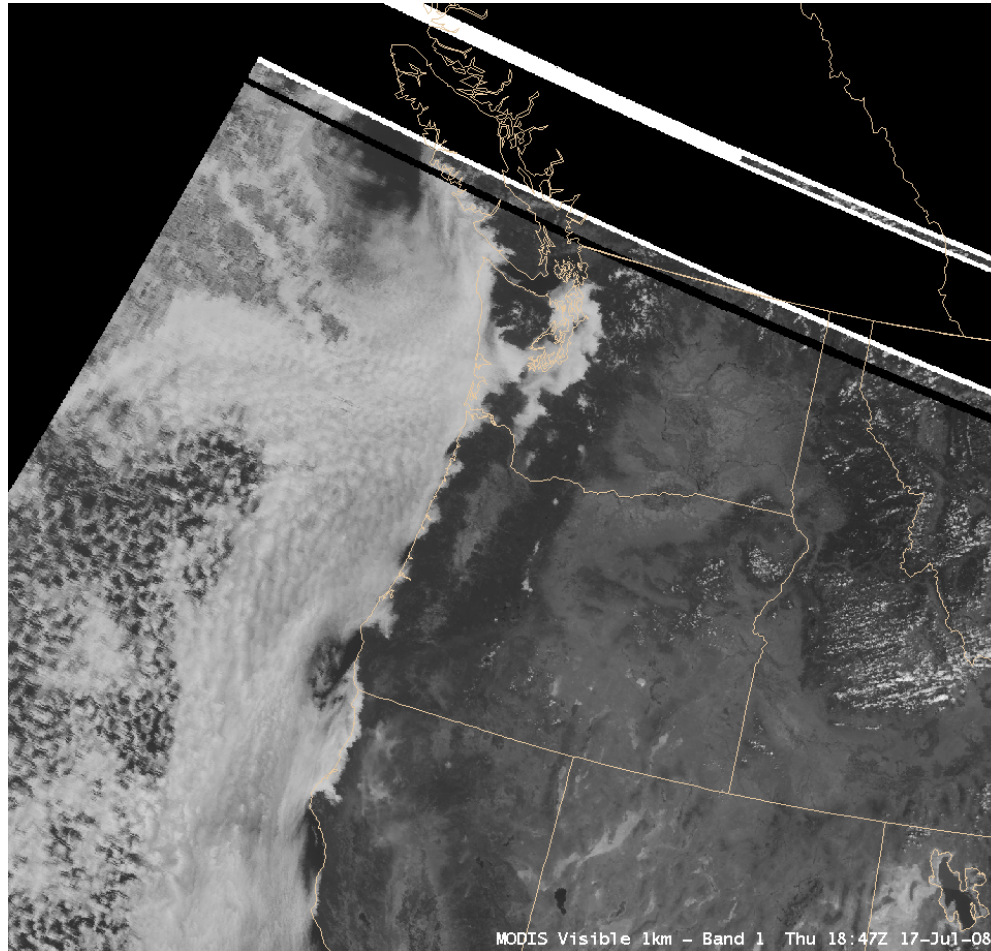
# GOES Visible Image Loop

17 July 2008



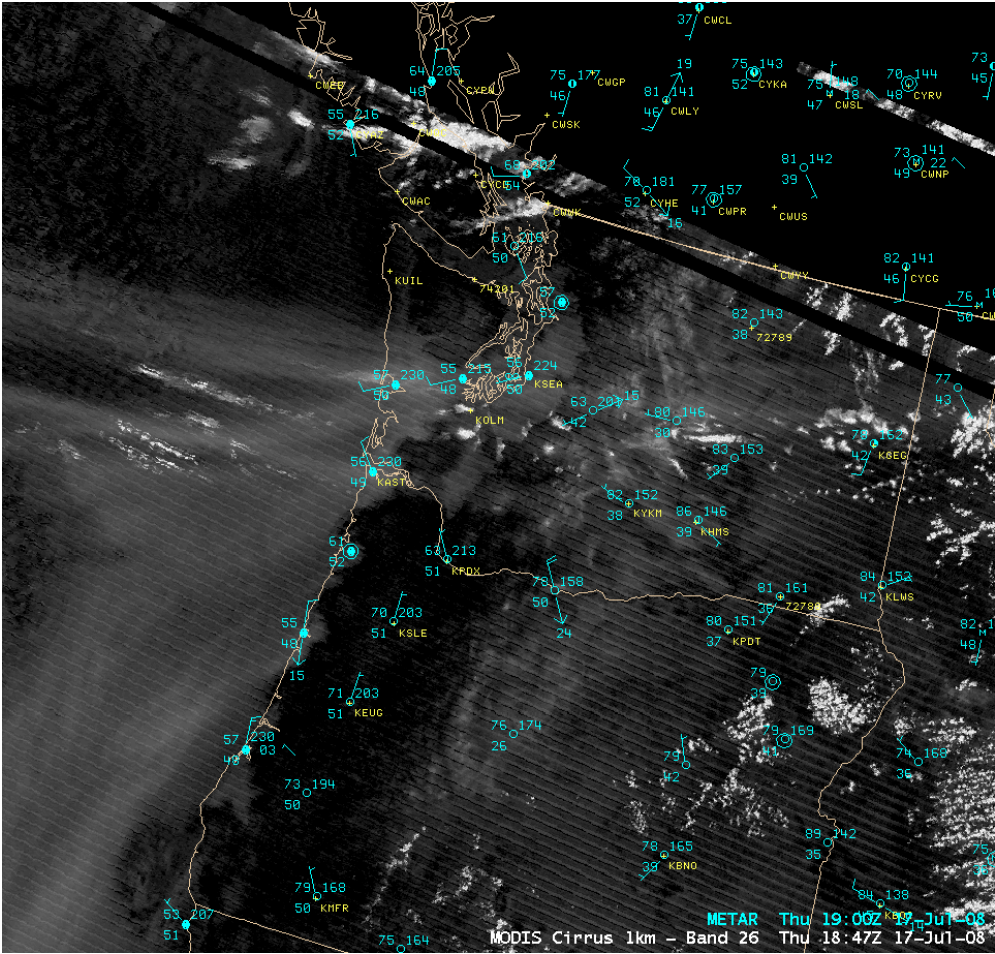
# Terra MODIS Band Comparison

17 July 2008

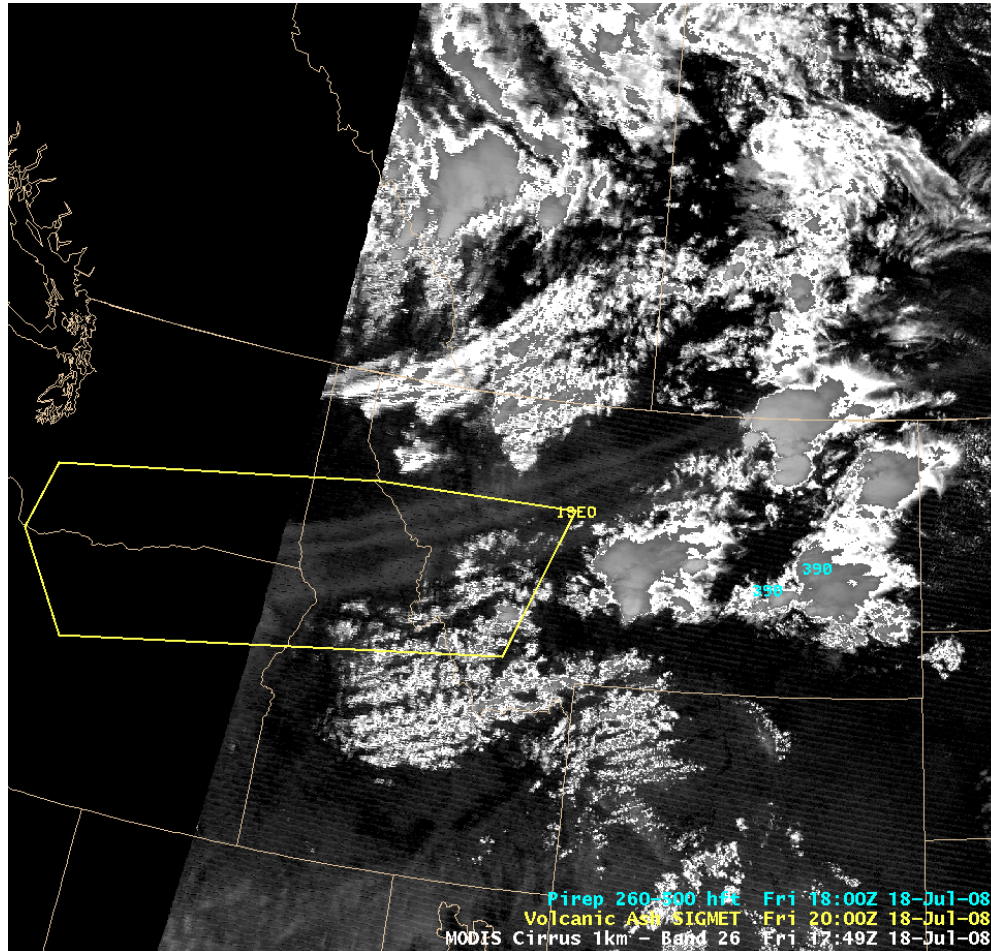


# MODIS 1.38 $\mu\text{m}$ Reflectances

17 July 2008



# MODIS 1.38 $\mu\text{m}$ Reflectances



18 July 2008



# Pilot Reports

## 18-19 July 2008

Pilot reports (PIREPS) from aircraft encountering the Okmok volcanic plume over the northwestern and northcentral continental US on 18-19 July 2008:

DLN UA /OV DLN 270080/TM 1900/FL320/TP MD80/RM ORANGE CLOUD ASSOCIATED WITH VOLCANIC ACTIVITY. NO SMELL, CLR ABV/BLW FL320/ZLC

RDM UUA /OV DSD280030/TM 1909/FL310/TP B737/RM LGT ASH CLOUD FL320 -ZSE

PDX UUA /OV BTG180060/TM 1912/FL330/TP B738/RM FL330-310 ASH CLOUD CLR AT FL300 -ZSE

SLE UA /OV BTG180060/TM 1921/FL300/TP B733/RM BAND OF SULFUR DIOXIDE WEST TO EAST FL300-340 AWC-WEBSWA

PDT UA /OV PDT/TM 1937/FL380/TP NUMEROUS/SK ORANGE HAZE/RM VOG 320-380 SMELLS THROAT IRRITATION -ZSE

PDX UUA /OV KPDX/TM 2018/FL320/TP B739/RM VERY THIN PROB ASH CLOUD VISIBLE E-W OVER PDX AND MT HOOD AT APPROX FL320 AWC-WEBASA

LWS UUA /OV MQG130050/TM 2051/FL350/TP B737/RM VOLCANIC ASH CLOUD 320-380 -ZSE

LWS UUA /OV MQG 135060/TM 2053/FL320/TP SVRL ACFT/RM VOLCANIC ASH CLOUD 320-386 CLIMBING/ DESCENDING TO AVOID ZLC

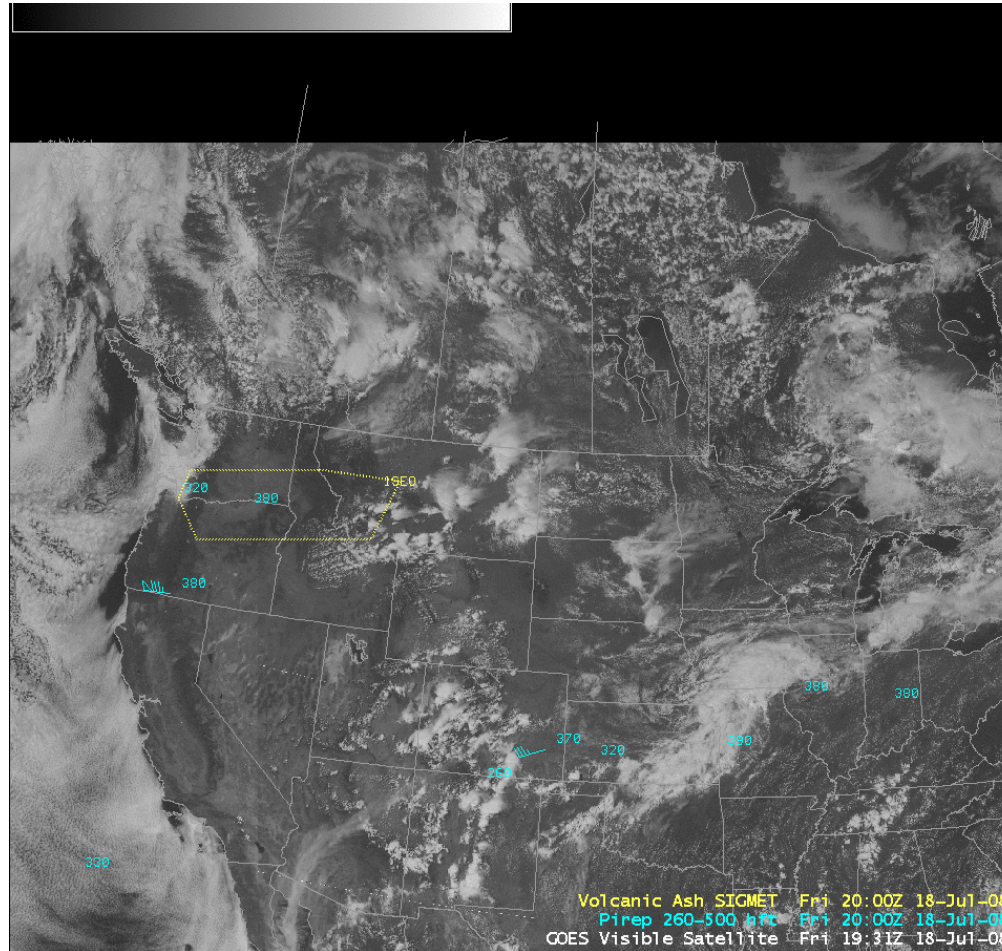
MSO UA /OV MLP143070/TM 2053/FLUNKN/TP B737/RM BAND OF CLOUDS W/ ORANGE TINT FL300-FL350 AWC-WEBSWA

PDT UA /OV PDT200020/TM 2100/FL290/TP B737/WV 275039KT/TB SMOOTH/RM ASH CLOUD APPEARS TO BE DISPERSED IN SEVERAL AREAS.MAIN CLOUD LOCATED FURTHER NORTH RUNS W-E AWC-WEBSWA

MSO UUA /OV MSO 120030/TM 2115/FL320/TP CL60/RM ASH CLOUD FL320-395 ZLC

# SIGMET eventually extended

## 18 July 2008



# Numerical Weather Prediction

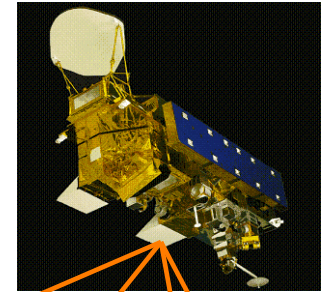
Good Grief, what is this doing here?



The Cooperative Institute for Meteorological Satellite Studies  
University of Wisconsin, Madison

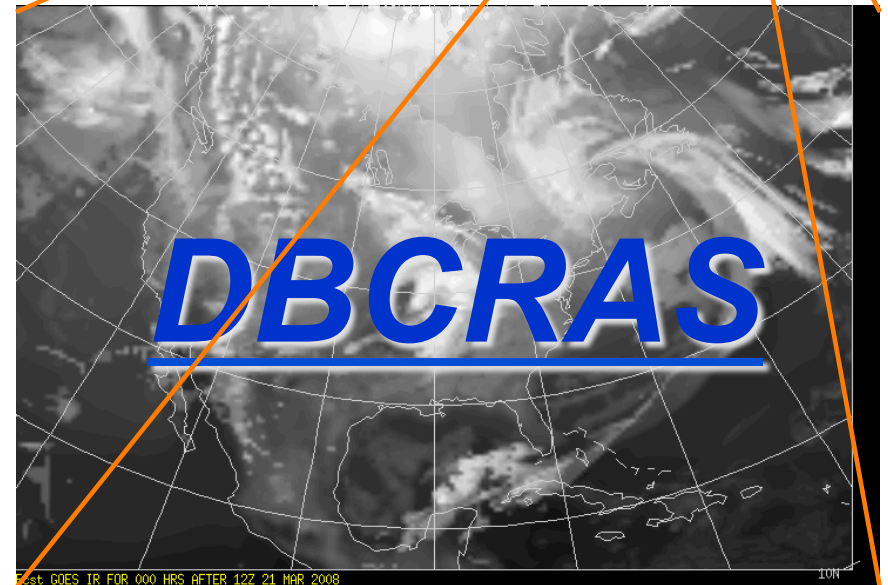


# The Direct Broadcast Version of the CIMSS Regional Assimilation System for Global Users



**Bob Aune**

Advanced Satellite Products Branch,  
Cooperative Research Program  
Center for Satellite Applications and Research  
DOC/NOAA/NESDIS



# What is Numerical Weather Prediction?

- Describing the Atmosphere mathematically
  - Equations of motion
- Taking the Derivative with respect to time
  - Delta T is time step
- Need good representation of the atmosphere in 3 dimensions to start with
  - Assimilation
    - Gathering all surface observations (METARS)
    - Radiosondes – Balloon launches that provide vertical profiles of the temperature, moisture and winds
  - Satellite observations

# Why should I care about DBCRAS?

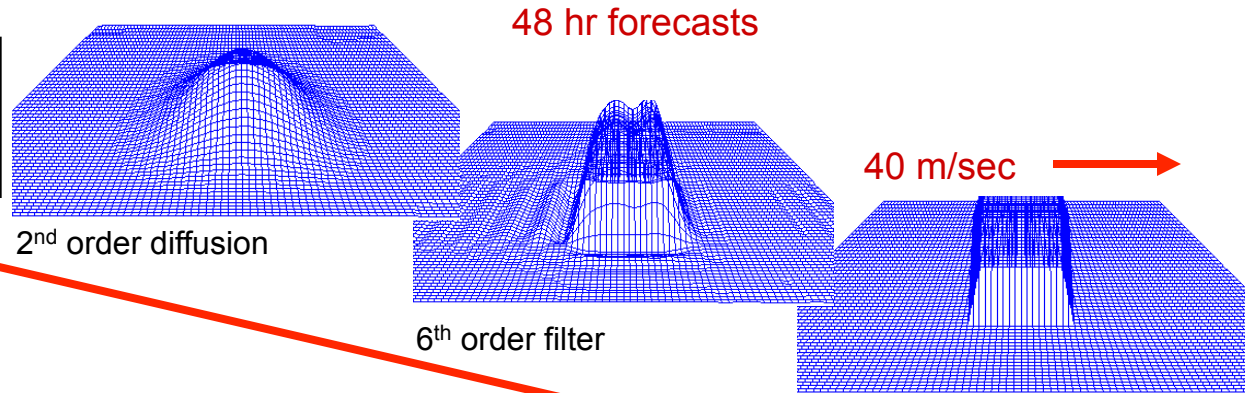
- Uses MODIS Products to improve the depiction of clouds and moisture in the initial model conditions
  - MOD07 Total Precipitable Water Vapor
  - MOD06 Cloud Top Pressure, Cloud Emissivity
- Others only assimilate satellite clear radiances
- Requires efficient and reliable internet connection
  - $\approx$  500MB of ancillary data required per model run

# Why should I care about DBCRAS?

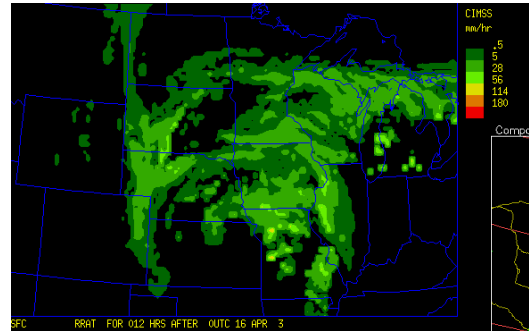
- Products created at 48 km resolution out to 72 hours
- Automatically creates forecast imagery

# Improvements to CRAS Validated by GOES

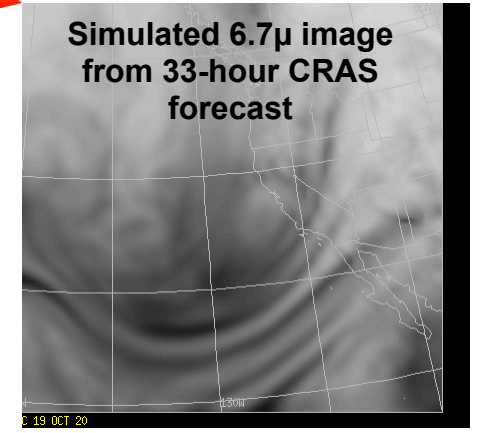
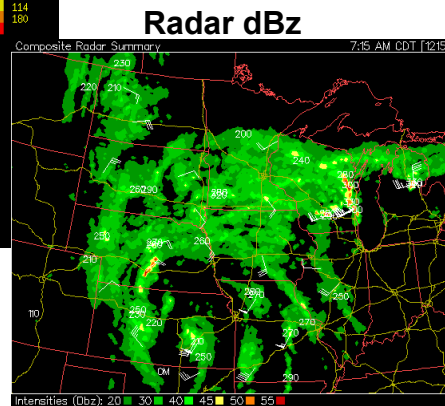
**Preservation of information:**  
 Mass conservation in advection  
 Reduced gradient dissipation



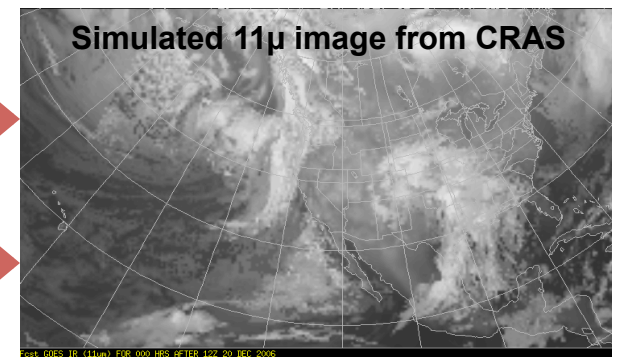
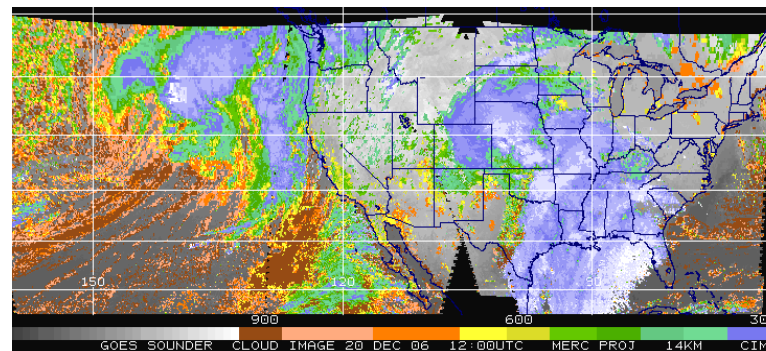
**Improved physics:**  
 Radiative fluxes  
 Moist physics



12-hour forecast rain-rate from 20 km CRAS



**Improved Initial Fields:**  
 Water vapor  
 3D cloud water  
 Upper-level winds  
 Temperature fields







# Summary of improvements made to the CRAS forecast model that were validated using observations from GOES.



<b>Year</b>	<b>Description of Improvement</b>	<b>GOES Product</b>
1996	Initialize water vapor mixing ratio fields	Sounder 3-layer precipitable water
1998	Initialize 3D cloud fields	Sounder cloud products
1998	Precipitation parameterization	Sounder cloud products
1998	Shortwave and longwave radiative flux	Sounder skin temperature
1999	6 <sup>th</sup> order filter to preserve gradients	Imager water vapor
1999	Precipitation drag on vertical motion	Sounder cloud temperatures
2001	Hydrometeor advection (horizontal)	Sounder cloud products
2002	Hybrid convective parameterization	Sounder cloud products
2002	Turbulent mixing to Improve low clouds	Sounder cloud product
2004	Sub-surface soil model	Sounder skin temperature
2006	Cloud particle sedimentation	Sounder cloud products

# CIMSS Regional Assimilation System - Details

## Specifications

Grid: Limited area, re-locatable, Arakawa C grid  
Map: Lambert conformal or polar stereographic  
Resolution: Horizontal: 127km to 10km  
Vertical: ~40 sigma levels, floating top  
Platforms: Linux, Intel compiler  
Performance: 150 minutes on a single 3.6 GHz Intel Xeon  
(72hr fcst, 275x150x38 grid, dx=48 km, dt=200 sec)

Dynamics: Semi-implicit time scheme, 3<sup>rd</sup> order  
Advective form - Leslie, et.al.,1985  
Pseudo-non-hydrostatic, Raymond and Aune, 1998  
3<sup>rd</sup> order Time filter - Raymond, 1991  
6<sup>th</sup> order tangent - Raymond, 1988

Physics: Radiation – Ackerman and Stephens, 1987  
Turbulence – Raymond, 1999  
Precip/Clouds – modified Kessler, 1974 and Tiedke, 1993  
Precip Fall rate – Kreitzberg and Perkey, 1976  
Convection – Raymond and Aune, 2002

Initialization: Vertical normal mode - Bourke and McGregor, 1983

Analysis: Recursive filter - Control variables  
3D variational - heights and winds, Seaman et al.,1977  
1D variational - satellite radiances/retrievals

Input grids: Currently using CRAS moisture analysis merged with winds and temperatures from the NCEP GFS  
Topography: USGS 2-minute surface elevation, land-water flag

Climatology: Monthly albedo, deep-soil temperature, sub-soil moisture, sea ice, roughness, vegetative roughness, leaf-area index, greenness

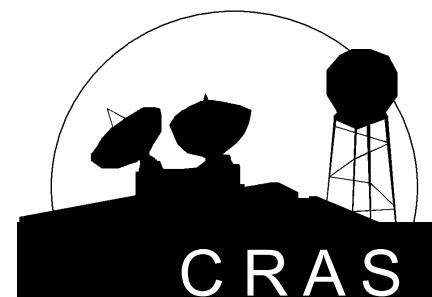
## Observations:

In situ: RAOBs, surface data, ACARS

GOES: 3-layer precipitable water  
Cloud-top pressure and effective cloud amount, 4-layer thickness

Cloud-track and water vapor winds

Other: Gridded hourly precip, Stage II, from NCEP  
SST and sea ice coverage from NESDIS



*CRAS TEMPESTUS HODIE  
Tomorrow's Weather Today*

# ECNU DBCRAS Set up

- User: imcras
- PW: XXXXXX
- DBCRAS 48 km software package is installed at:
  - **/home/imcras/dbCRAS**
- NdbCRAS 16 km software package is installed at:
  - **/home/imcras/NdbCRAS**

# dbCRAS Archive

- Output grib2 file archive directories:

**`/archive/data/dbcras/<YYYY_MM_DD_ddd>/<HH>UTC/`**

YYYY is the year

MM is the month

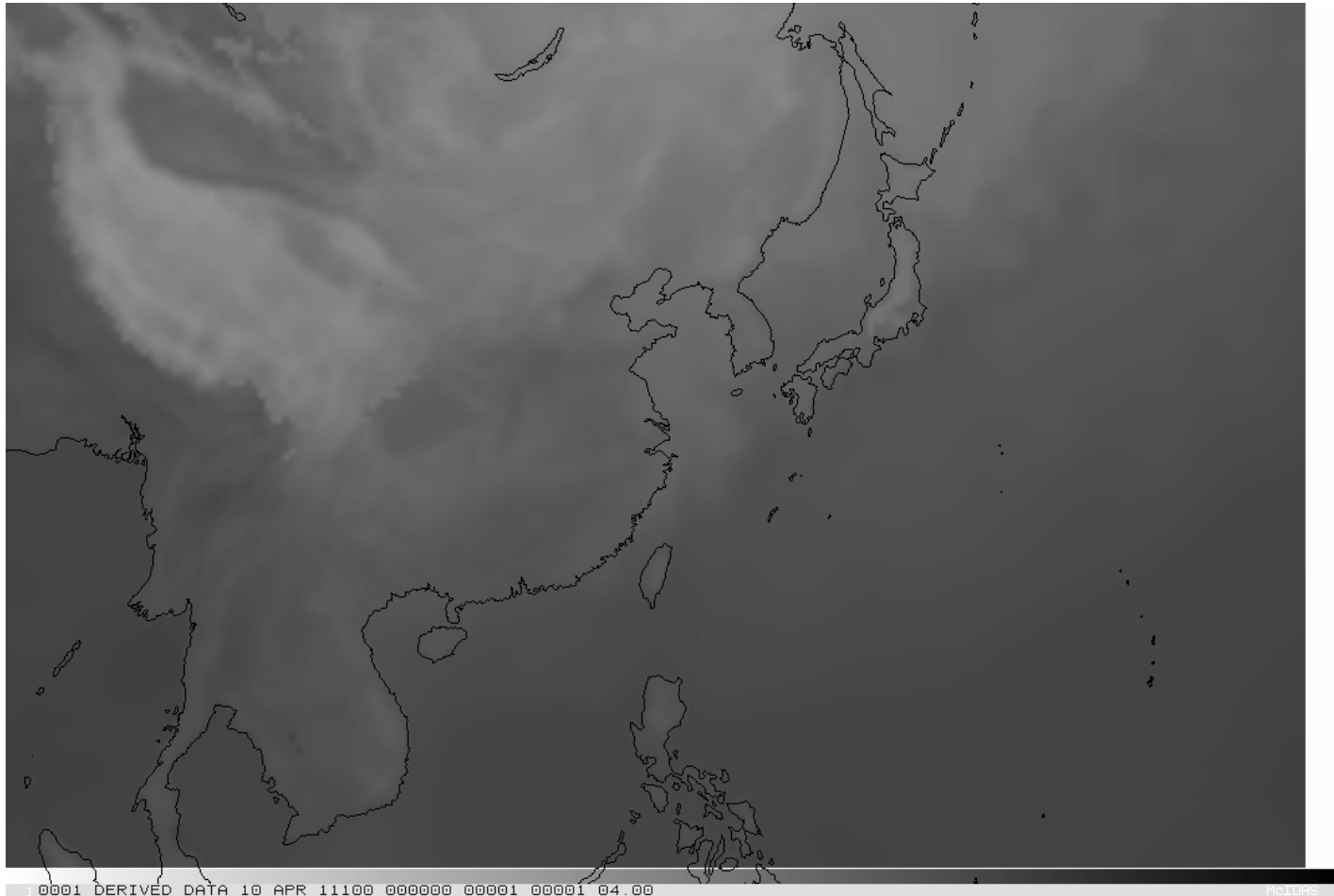
DD is the day of the month

ddd is the day of the year

HH is the dbcras run time, either 00 or 12 UTC

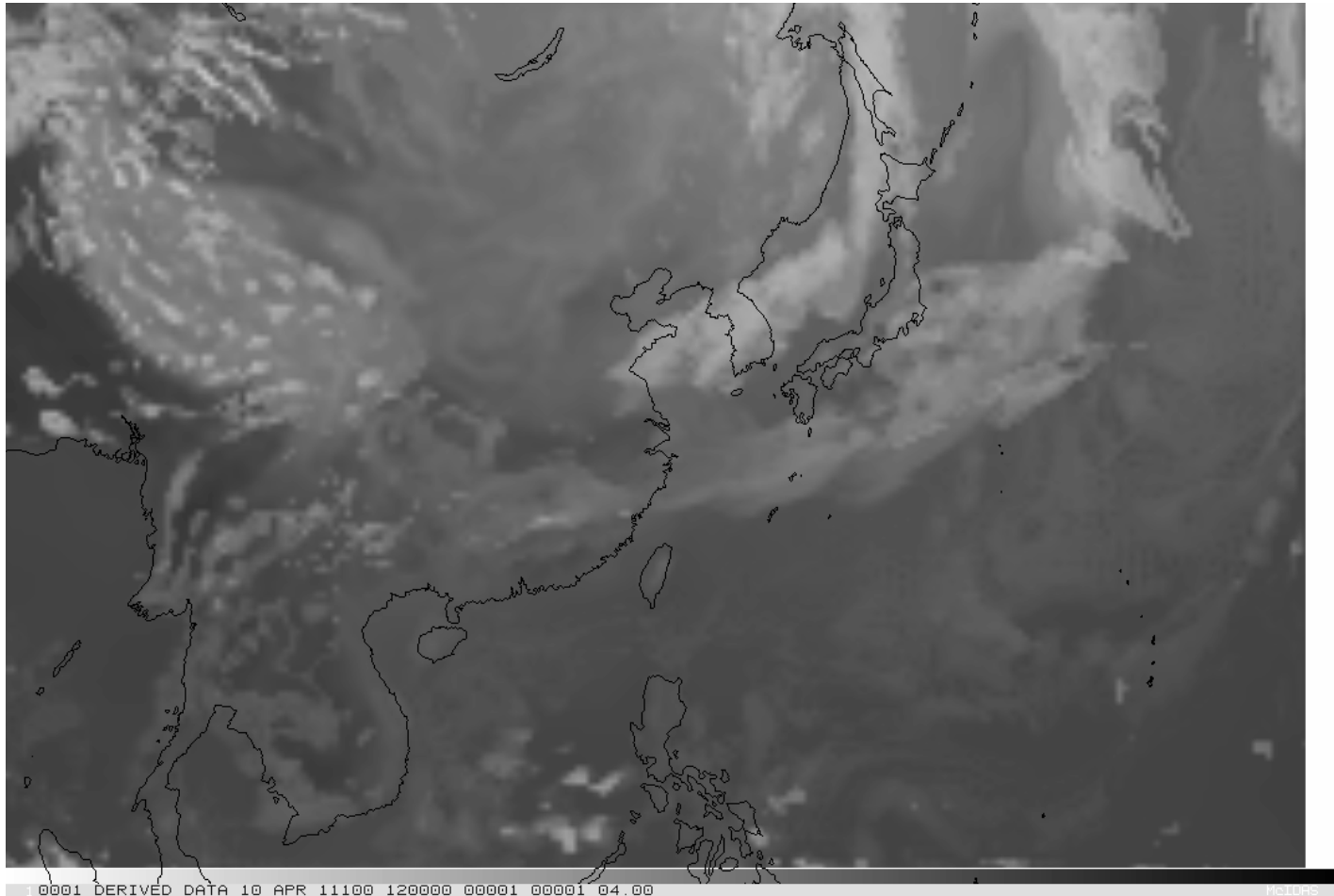
Ex: `/archive/data/dbcras/ 2010_05_11_131/12UTC`

# DBCRRAS IR window



DBCRRAS 12 hour Pre-forecast 11  $\mu\text{m}$  Brightness Temperatures 00 UTC 10 April 2011

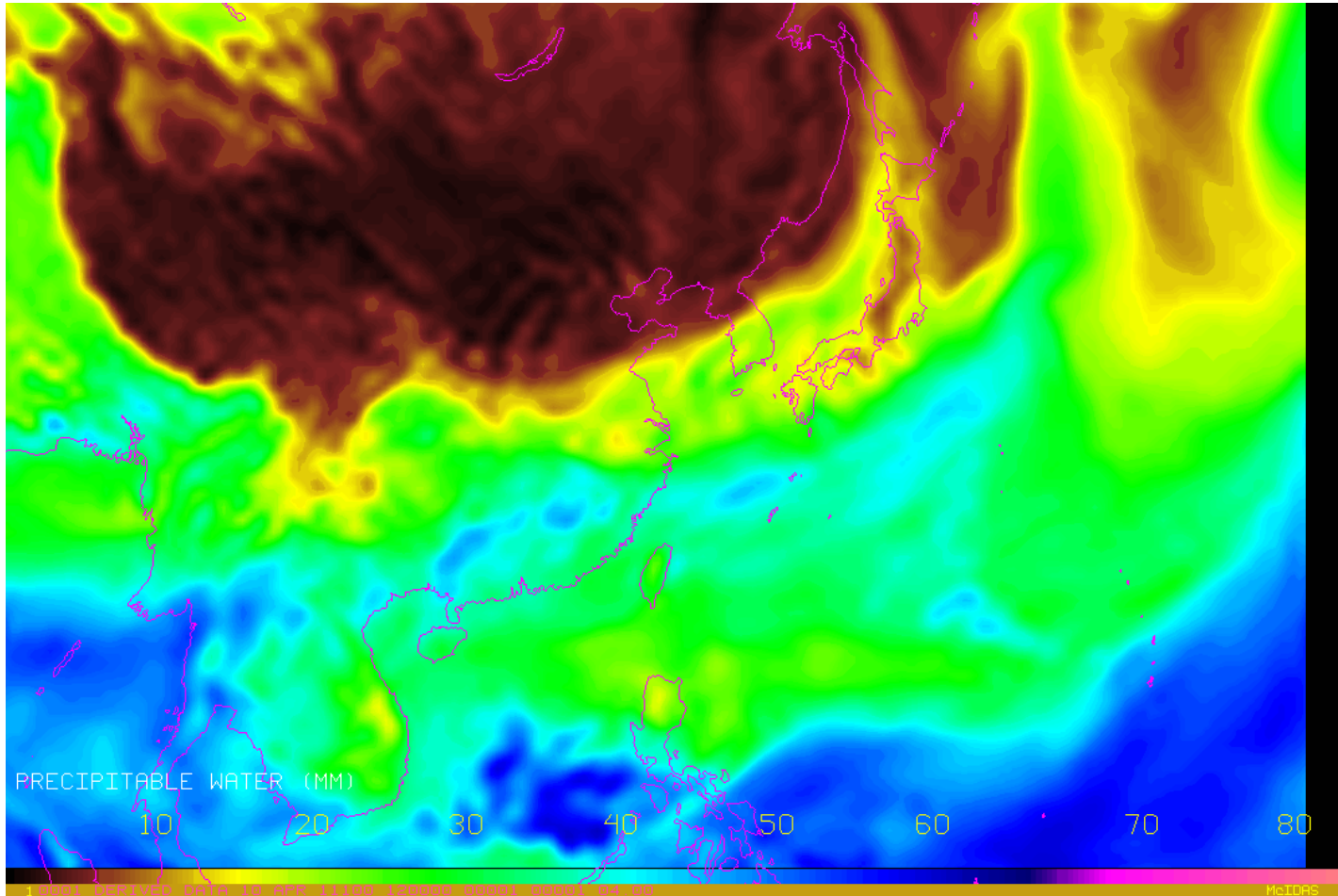
# DBCRRAS IR Window



DBCRRAS 72 hour Forecast 11  $\mu\text{m}$  Brightness Temperatures 12 UTC 10 April 2011



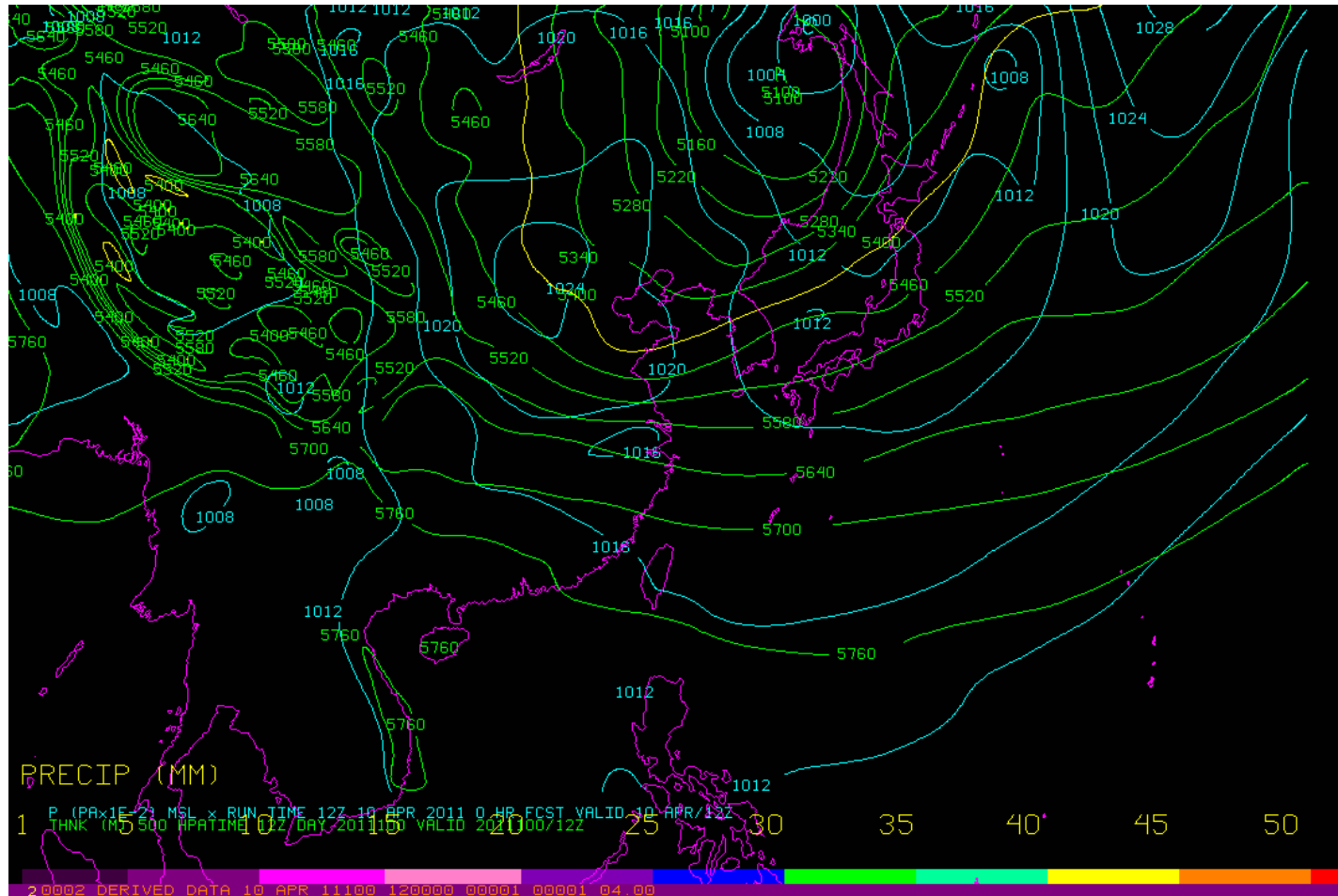
# DBCRRAS Moisture (TPW)



DBCRRAS 72 hour Forecast Total Precipitable Water Vapor 12 UTC 10 April 2011



# DBCRRAS Sea Level Pressure, Precipitation



DBCRRAS 72 hour Forecast SLP, Precipitation 12 UTC 10 April 2011

# Applications

- Weather Forecasting
  - CRAS is used by some US Forecasters in the US
  - DBCRAS was installed at Taiwan Central Weather Bureau in November 2008
- Aerosol transport – Dust storm case study
- Fire hazard
- Others?

# References

- Bayler, G., R. M. Aune and W. H. Raymond, 2000: NWP cloud initialization using GOES sounder data and improved modeling of nonprecipitating clouds. *Mon. Wea. Rev.* 128, 3911-3920.
- Raymond, W. H., and R. M. Aune, 1998: Improved precipitation forecasts using parameterized feedbacks in a hydrostatic forecast model. *Mon. Wea. Rev.*, 126, 693-710.
- Raymond, W. H., 1999: Non-local turbulent mixing based on convective adjustment concepts (NTAC). *Bound-layer Meteor.* 92, 263-291.

# How accurate is the CRAS model?

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE TWIN CITIES/CHANHASSEN MN

224 PM CDT WED OCT 29 2008

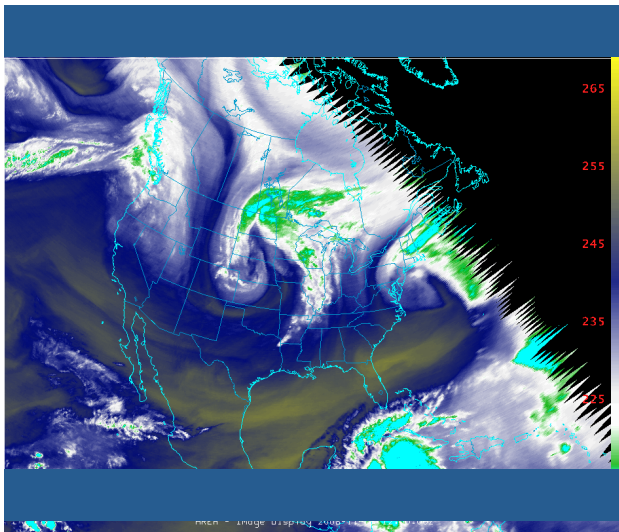
.DISCUSSION...

NEXT COLD FRONT EXPECTED TO COME THROUGH DRY...WITH LIMITED MOISTURE...LITTLE CLOUD WILL BE ASSOCIATED...AS INDICATED BY MODEL BUFKIT TIME/HGT OVERVIEWS AND CRAS IR SATELLITE FCST. SOME CONCERN HOW FAR SOUTH CURRENT STRONG LOOKING SHORT WAVE MOVING THROUGH MT/ID/WY REGION. MODELS DIVE THIS FEATURE FAR ENOUGH SOUTH TO LIMIT THREAT OF SIGNIFICANT CLOUDS OVER THE CWA. FRONT SHOULD EXIT TO THE SOUTHEAST OF THE AREA BY FRIDAY MORNING. SHOULD SEE SOME MARGINAL COOLING BEHIND THIS FRONT. AGREE WITH MAV GUIDANCE NUMBERS FOR THE MOST PART.

# How accurate is the CRAS model??

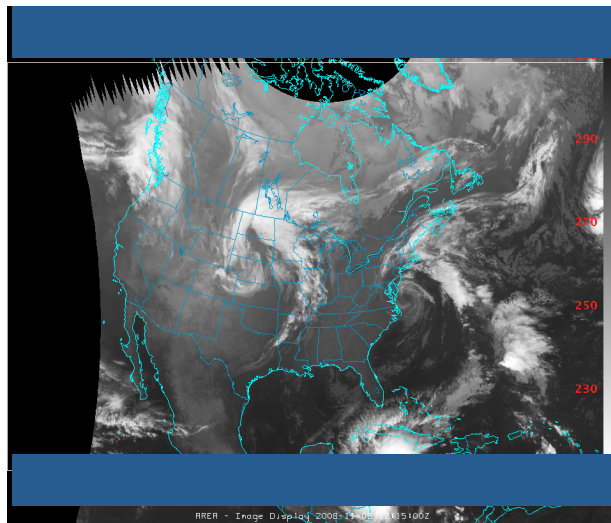
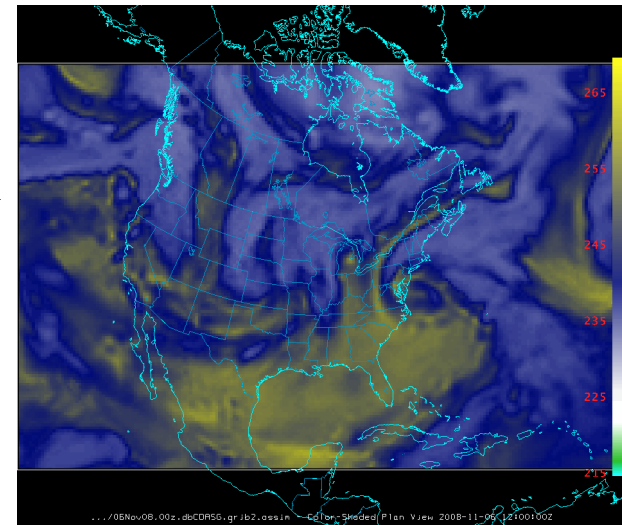
Comparison from 5 November 2008

GOES Observations

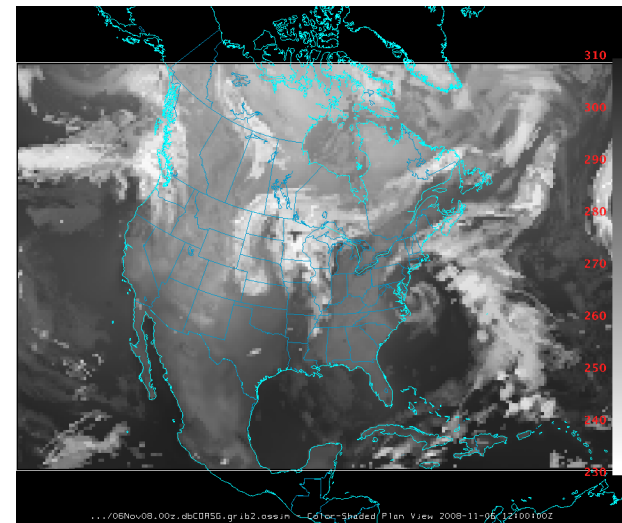


6.7 micron  
(CRAS no  
Clouds)

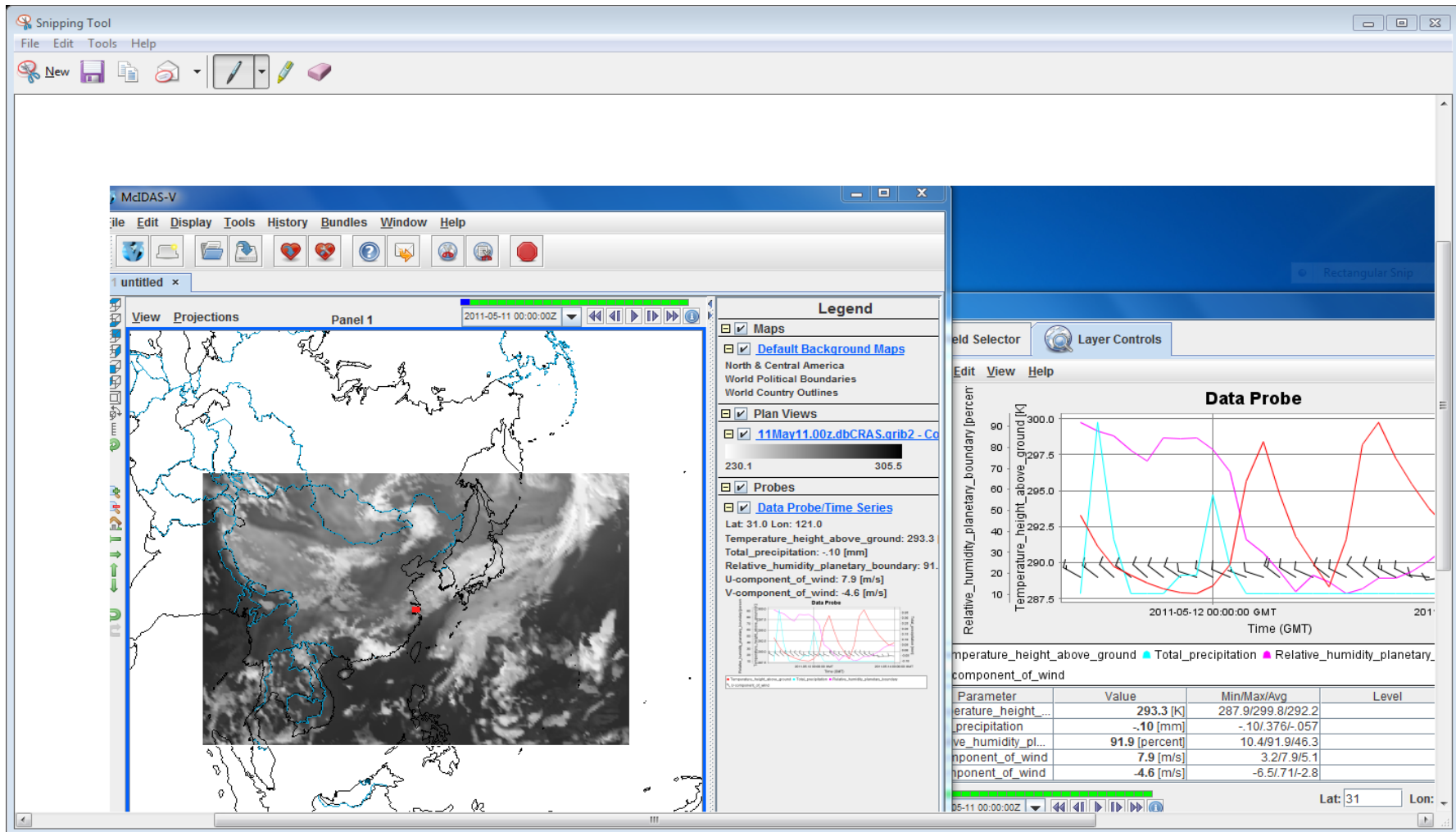
CRAS 12 Hour forecast



11 micron



# Examining DBCRAS Output



# Air Quality Applications

Aerosol Detection

# Infusing Satellite Data into Environmental Applications

Used by the US Environmental Protection Agency to Monitor and Forecast Air Quality in the United States

The screenshot shows the IDEA web application interface. At the top, there is a navigation bar with the IDEA logo and the text "Infusing satellite Data into Environmental Applications". Below the navigation bar, there are four tabs: "MODIS (Terra)", "MODIS (Aqua)", "GASP", and "GASP WEST". The main content area is divided into four sections:

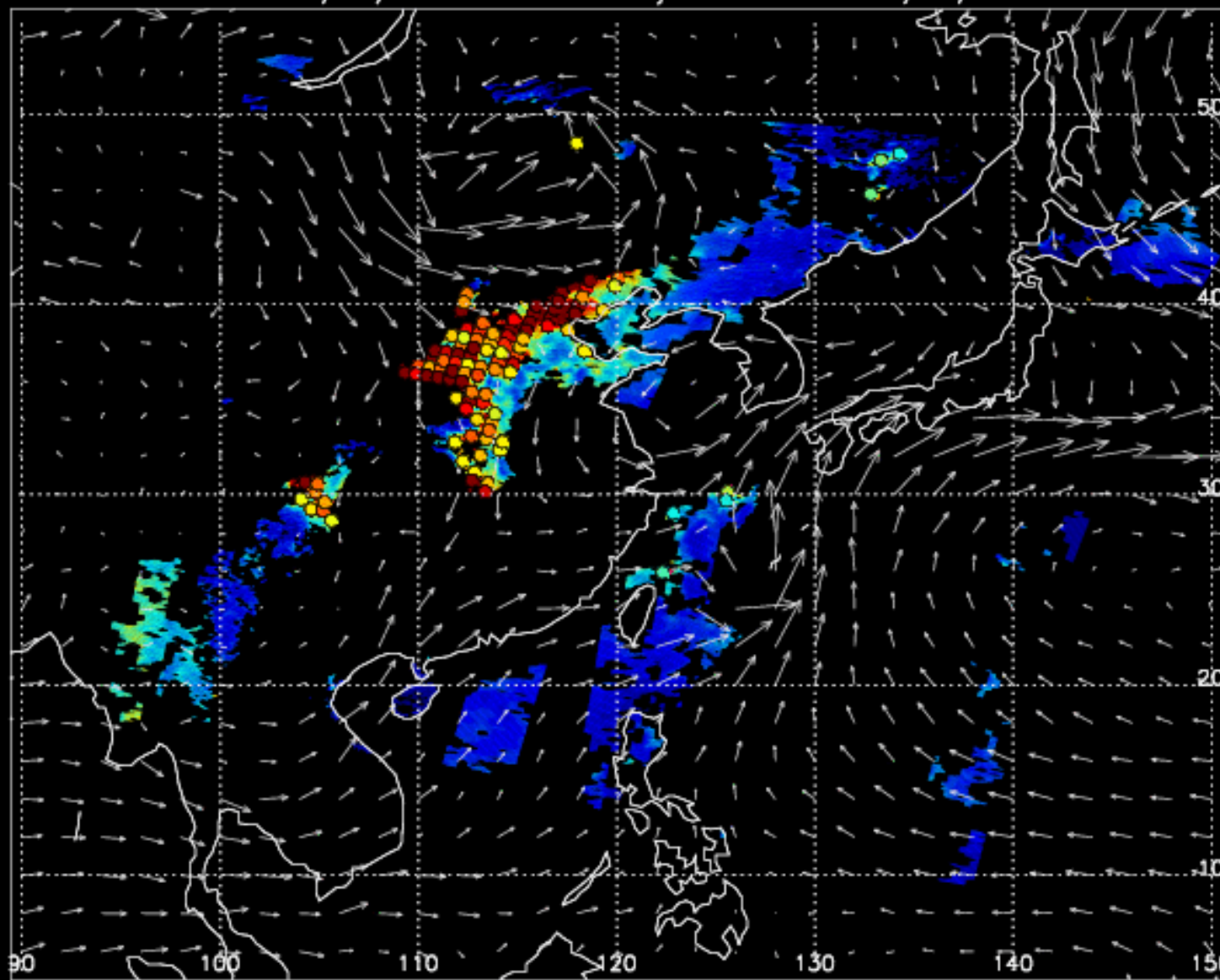
- Regional plots of MODIS Terra aerosol optical depth (AOD)**: A map of the United States showing AOD data. Below the map is a "Select Region" button and a "Product description" link.
- 48-hour aerosol trajectory forecast, with model winds and precipitation**: A map showing trajectory forecasts. Below the map is a "View latest" button and a "Product description" link.
- 3-day composite history\***: A map showing a 3-day composite history of AOD. Below the map is a "View latest" button and a "Product description" link.
- Tutorials for interpreting the IDEA products**: A section with a "Tutorials" button and a "Product description" link.

At the bottom of the page, there is a footnote: "\*includes aerosol optical depth (AOD), ground station PM 2.5, NAM 850mb wind vectors, and WF-ABBA fire locations".

<http://www.star.nesdis.noaa.gov/smcd/spb/aq/>



MODIS 2011/05/11 AOD & AOD Trajectories on 2011/05/11 02Z



# Dust Storm Case Study

Heavy sand storm sweeps Tarim Basin of Xinjiang - China News - SINA English

http://english.sina.com/china/p/2011/0429/371173.html


China Duststorm

Most Visited WI\_500M\_RGB.JPG (U... http://cimss.ssec.wi... Getting Started Apple Personal MODIS DB Wx Technical

Heavy sand storm sweeps Tarim ...


## Heavy sand storm sweeps Tarim Basin of Xinjiang

2011-04-29 14:06:48 GMT 2011-04-29 22:06:48(Beijing Time) Xinhua English




WWW.NEWS.CN

An elderly man walks in sand storm in Yecheng County, northwest China's Xinjiang Uygur Autonomous Region, April 29, 2011.(Xinhua/Jiang Wenya)




蘇州創業周吉祥物：智智

### SPECIAL COVERAGE



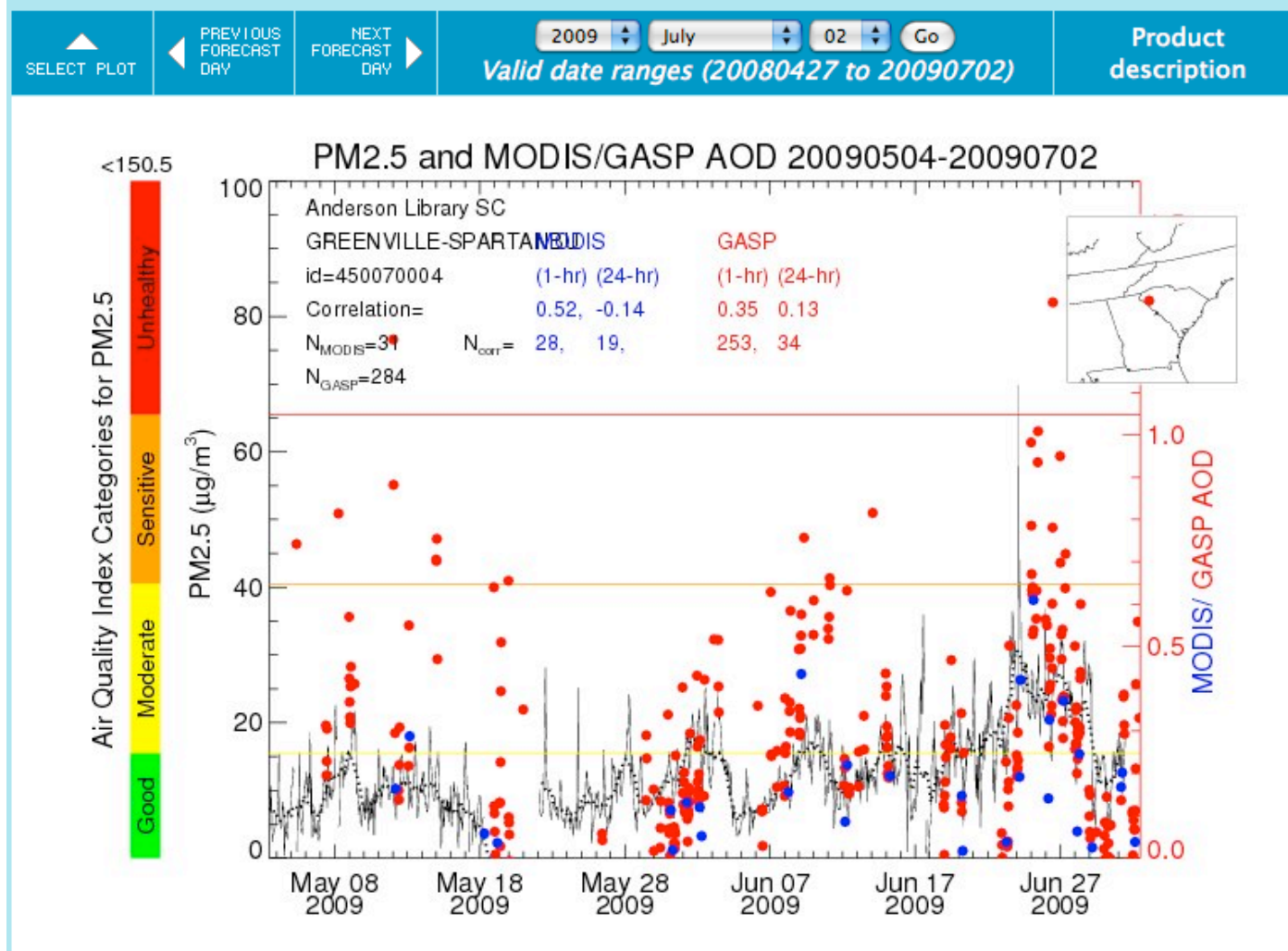
**The sixth national census data**



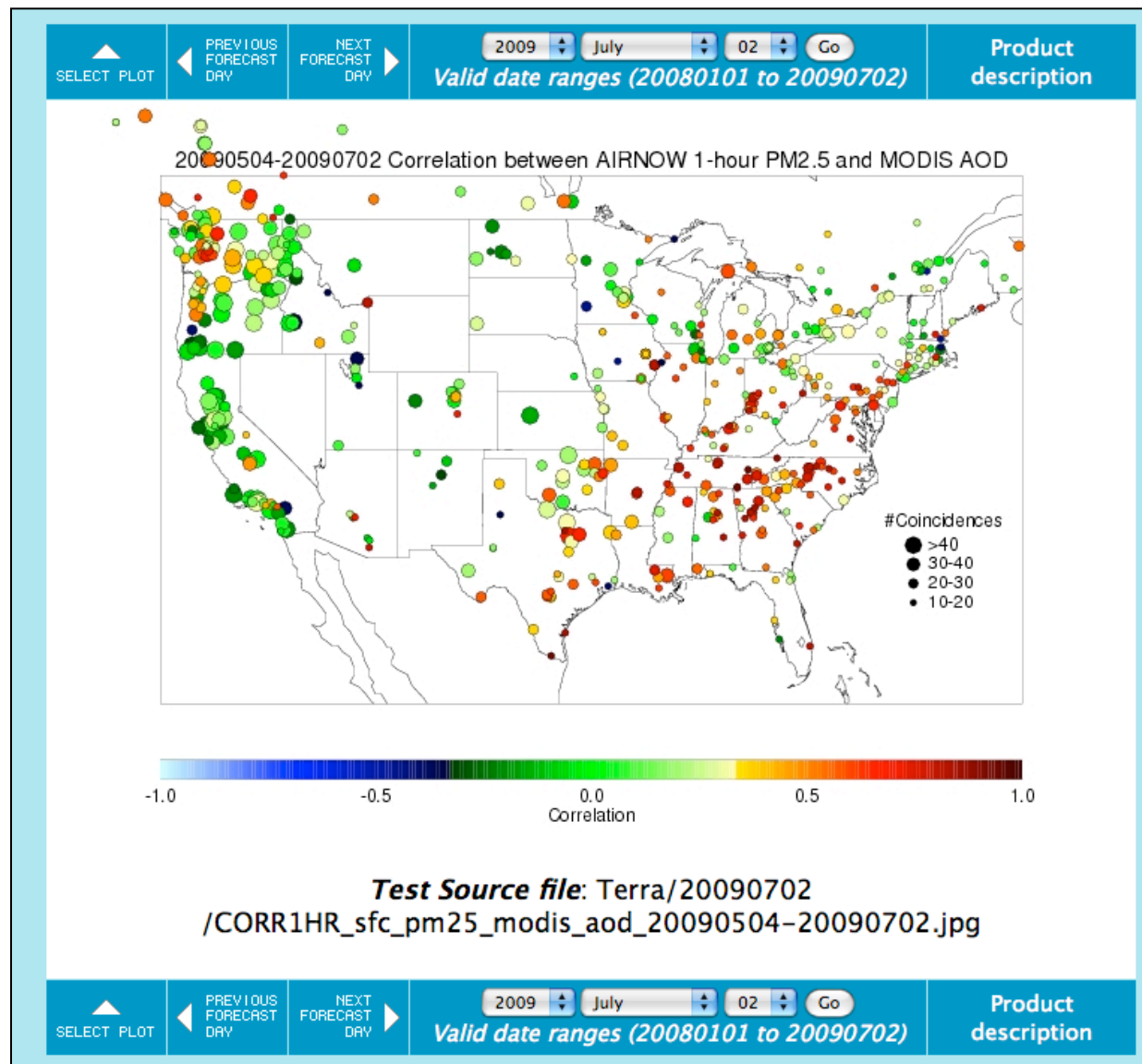
**Vegetable price slump hurts farmers**

- 100th anniversary of Tsinghua University
- 2011 Shanghai International Auto Show
- UK Royal Wedding
- Boao Forum for Asia 2011

# PM Observations, MODIS AOD and GOES AOD retrieval Time Series



# Correlation Between MODIS AOD and PM Observations



Fires

# MODIS Fire Detection Applications



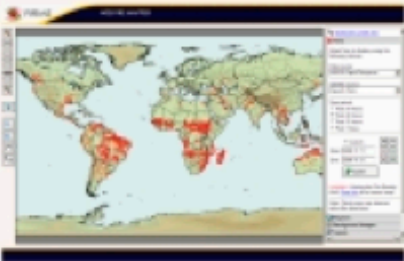
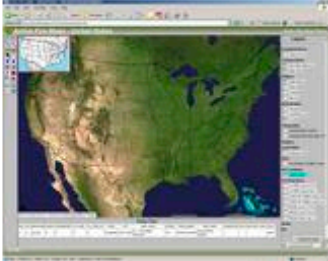
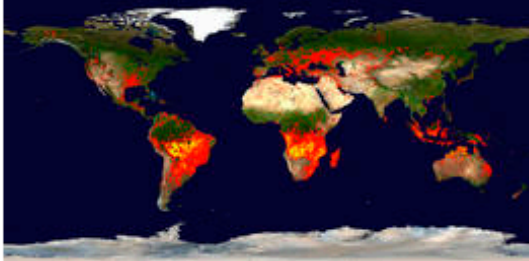
The screenshot shows the MODIS Rapid Response System website. The browser address bar displays <http://rapidfire.sci.gsfc.nasa.gov/>. The page features a navigation menu with links for Home, Gallery, Real-Time, FAQ, and Status. Below the navigation is a 'Mission' section and a 'MODIS Image of the Day' section. The 'Mission' section describes the system's purpose and lists various users. The 'MODIS Image of the Day' section shows a satellite image of a dust storm in Iraq and provides information about near-real-time MODIS data.

**MODIS Rapid Response System**

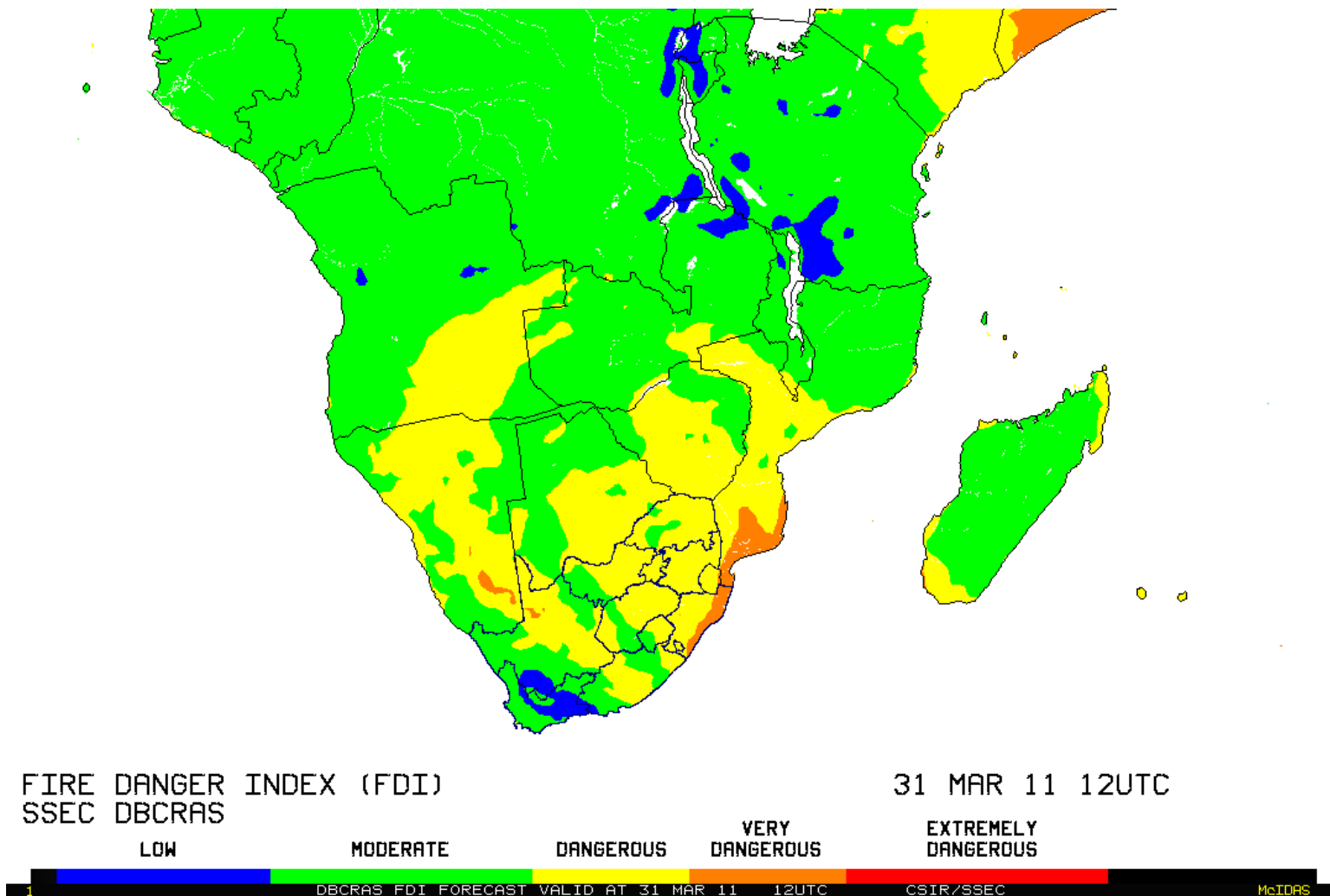
[Home](#) [Gallery](#) [Real-Time](#) [FAQ](#) [Status](#)

Mission	MODIS Image of the Day
<p>The MODIS Rapid Response System was developed to provide daily satellite images of the Earth's landmasses in near real time. True-color, photo-like imagery and false-color imagery are available within a few hours of being collected, making the system a valuable resource for organizations like the U.S. Forest Service and the international fire monitoring community, who use the images to track fires; the United States Department of Agriculture Foreign Agricultural Service, who monitors crops and growing conditions; and the United States Environmental Protection Agency and the United States Air Force Weather Agency, who track dust and ash in the atmosphere. The science community also uses the system in projects like the Aerosol Robotic Network (AERONET), which studies particles like smoke, pollution, or dust in the atmosphere. More information about science and application partners, including links, is provided on our <a href="#">applications</a> page. Captioned interpreted images for educators, the media, and the public are available through the <a href="#">Earth Observatory</a>. The system is freely available to everyone—scientists, operational users, educators, and the general public. Please see our <a href="#">Usage Guidelines</a>.</p> <p>The Moderate Resolution Imaging Spectroradiometer (MODIS) flies onboard NASA's Aqua and Terra satellites as part of the</p>	<p>: Dust storm in Iraq</p>  <p><b>Near-Real-Time MODIS Data</b></p> <p>MODIS level 2 clouds, aerosols, snow, sea ice, fire, land surface temperature, and land surface reflectance products are available within 2.5 hours of observation at <a href="#">LANCE-MODIS</a>, an element of the <a href="#">LANCE</a> near real-time system.</p> <p>NASA's <a href="#">Direct Readout Laboratory</a></p>

# MODIS Fire Detection Applications

FIRMS Web Fire Mapper	Active Fire Maps	Global Fire Maps
 <p>The Fire Information for Resource Management System (FIRMS) at the University of Maryland integrates remote sensing and GIS technologies to deliver global MODIS hotspot/fire locations to natural resource managers and other stakeholders around the World.</p> <p><a href="#">+ Read more and access data</a></p>	 <p>The USFS's Remote Sensing Applications Center generates regional maps for the US fire managers using the active fire locations provided by the MODIS Rapid Response System, and also makes them available through an interactive ArcIMS interface over the conterminous United States, Alaska, and Canada.</p> <p><a href="#">+ Read more and access data</a></p>	 <p>Global 10-day fire maps are generated using the MODIS Rapid Response fire locations to represent the current fire activity across the world.</p> <p><a href="#">+ Read more</a> <a href="#">+ Fire location data</a></p>
Natural Hazards	Applications	

# Forecasting Fire Potential over South Africa using DBCRAS CSIR Meraka Institute

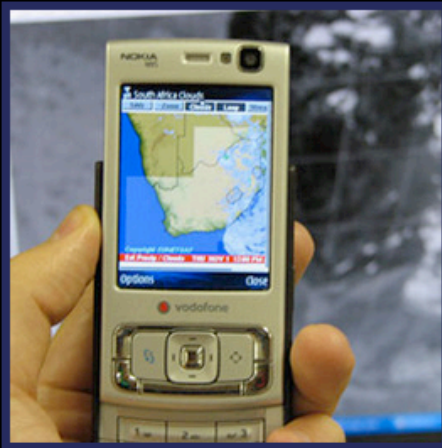




# Global Applications

<http://www.wamis.co.za/>

## WAMIS PORTAL



The Wide Area Monitoring Information System (WAMIS) portal consists of a collection of satellite-based information services providing near real-time monitoring and mapping capabilities of natural events such as Fires, Floods, and Droughts occurring within Southern Africa. The Terra and Aqua MODIS polar orbiting satellites as well as the Geostationary Meteosat Second Generation (MSG) satellite provide continuous data streams captured and processed by the CSIR, Satellite Application Centre (SAC) at Hartbeeshoek, as well as by the CSIR, Meraka Institute, in Pretoria.

Advanced processing systems convert raw data to higher level products that are fed through the WAMIS information systems. All information systems are available at no cost to the public.

This web portal is developed and maintained by the Meraka Institute. [Remote Sensing](#)

LINKS



GROUP ON  
EARTH OBSERVATIONS

SOUTH AFRICAN  
SPACE PORTAL



SAEON

# Other Applications

# MODIS LST and buggers

1064

JOURNAL OF MEDICAL ENTOMOLOGY

Vol. 43, no. 5

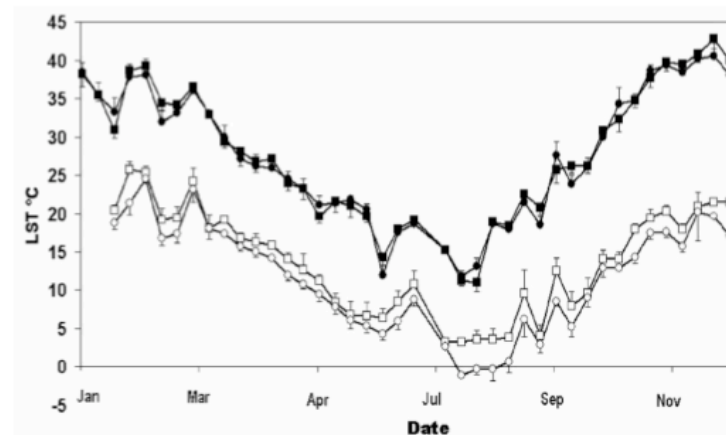


Fig. 4. Annual variation (2003) of diurnal land surface temperature (LST day) produced by the MODIS sensor (closed symbols) and LST night (open symbols) in locality groups of high (squares) and low (circles) house infestation rate. LST values are 8-d composites.

Reference: X. Porcasi, , S. S. Catala, H. Hrellac, M. C. Scavuzzo, D. E. Gorla, 2006: Infestation of Rural Houses by *Triatoma Infestans* (Hemiptera: Reduviidae) in Southern Area of Gran Chaco in Argentina, J. Med. Entomol. 43(5): 1060-1067.

# Using MODIS Sun Glint Patterns

- What is sun glint?
- Application
  - Identifying regions of calm waters
  - Relationship of calm waters and sea surface temperatures



“Mirror” reflection of sunlight off calm water.

Sun Glint Ellipse Defined by:  $\theta_r < 36$

$$\cos \theta_r = \sin \theta_v \cos \theta_s \cos \Delta\Phi + \sin \theta_v \cos \theta_s$$

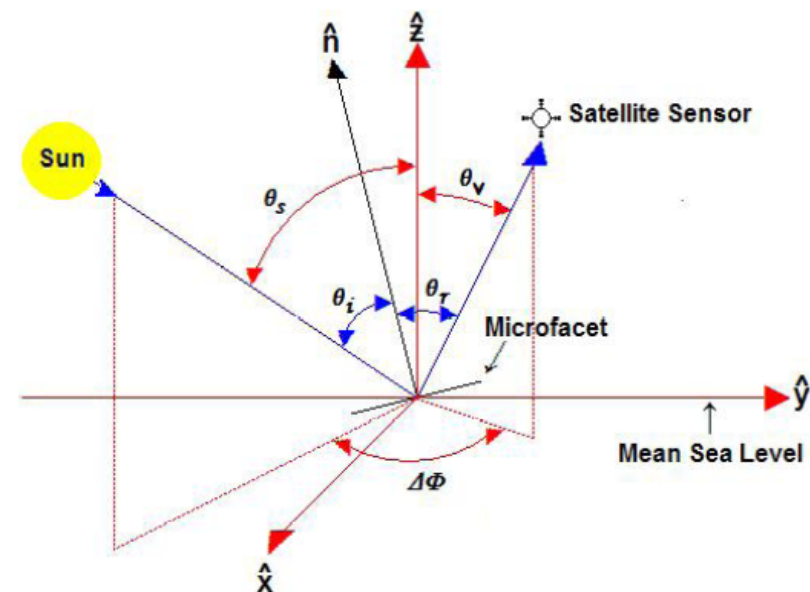
Where  $\theta_v$  = Viewing Zenith Angle

$\theta_s$  = Solar Zenith Angle

$\Delta\Phi$  = Relative Angle –  
difference between the Solar and  
Viewing azimuth angles.

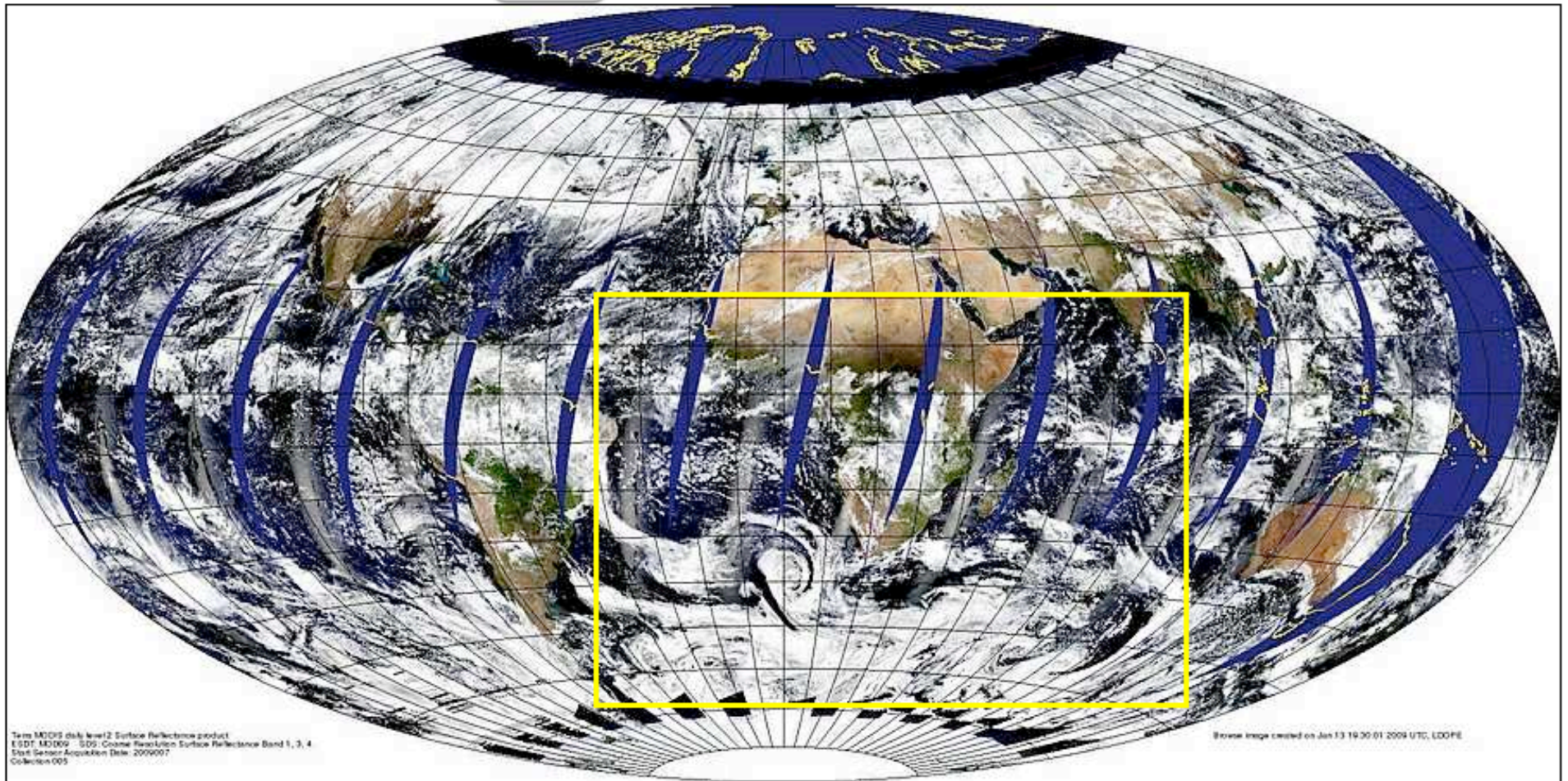
## Sun Glint

Simple example where your eye is the sensor

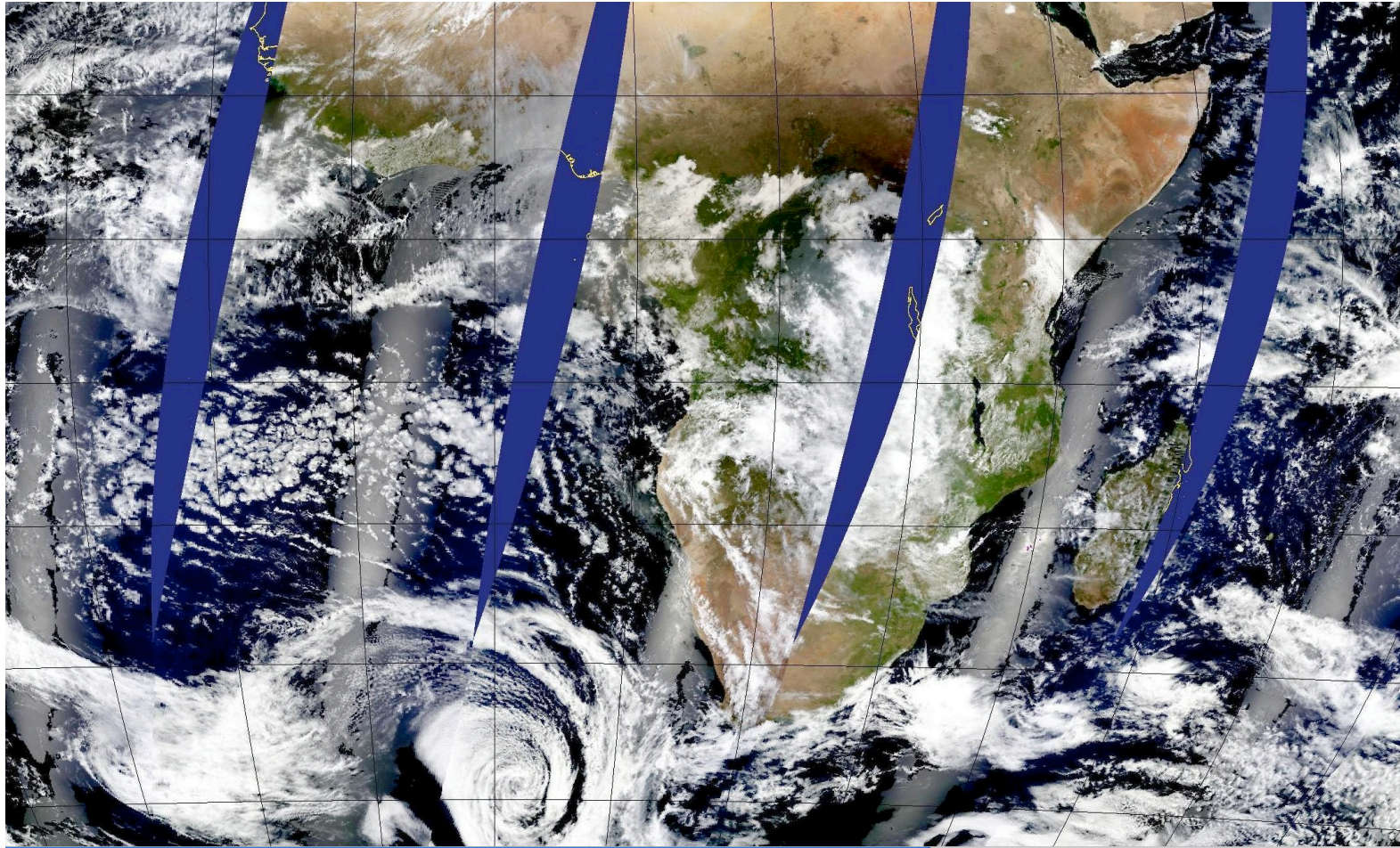


# Aqua MODIS Sun Glint Example

7 January 2009



# Sun Glint Patterns



# NASA Feature Article



NASA - NASA Satellite Imagery Keeping Eye on the Gulf Oil Spill

http://www.nasa.gov/topics/earth/features/oil-creep.html

Apple (160) Personal Direct Broadcast MODIS Technical Wx

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News


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NASA Satellite Imagery Keeping Eye on the Gulf Oil Spill 04.30.10



New Orleans

100 km



25 km

On April 29, the MODIS image on the Terra satellite captured a wide-view natural-color image of the oil slick (outlined in white) just off the Louisiana coast. The oil slick appears as dull gray interlocking comma shapes, one opaque and the other nearly transparent. Sun glint – the mirror-like reflection of the sun off the water – enhances the oil slick's visibility. The northwestern tip of the oil slick almost touches the Mississippi Delta. Credit: NASA/Earth Observatory/Jesse Allen, using data provided courtesy of the University of Wisconsin's Space Science and Engineering Center MODIS Direct Broadcast system.

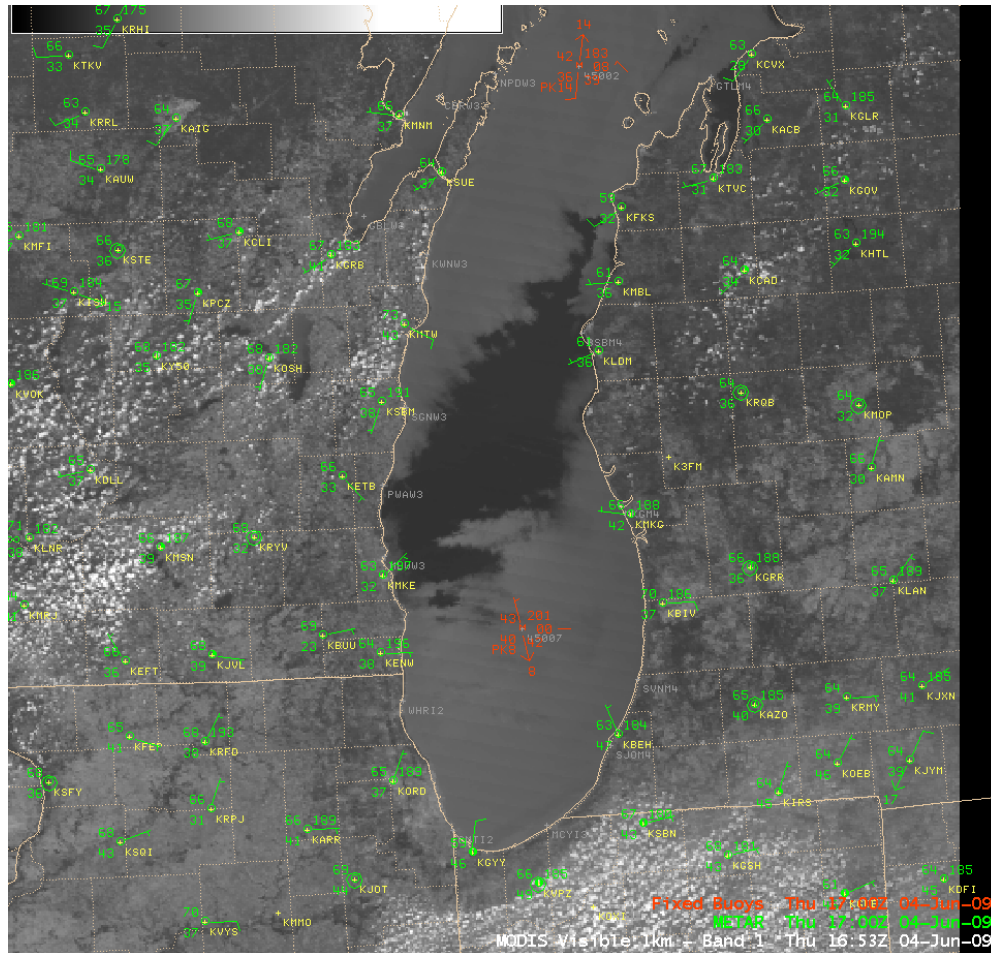
[Larger Image](#)

<http://www.nasa.gov/topics/earth/features/oil-creep.html>



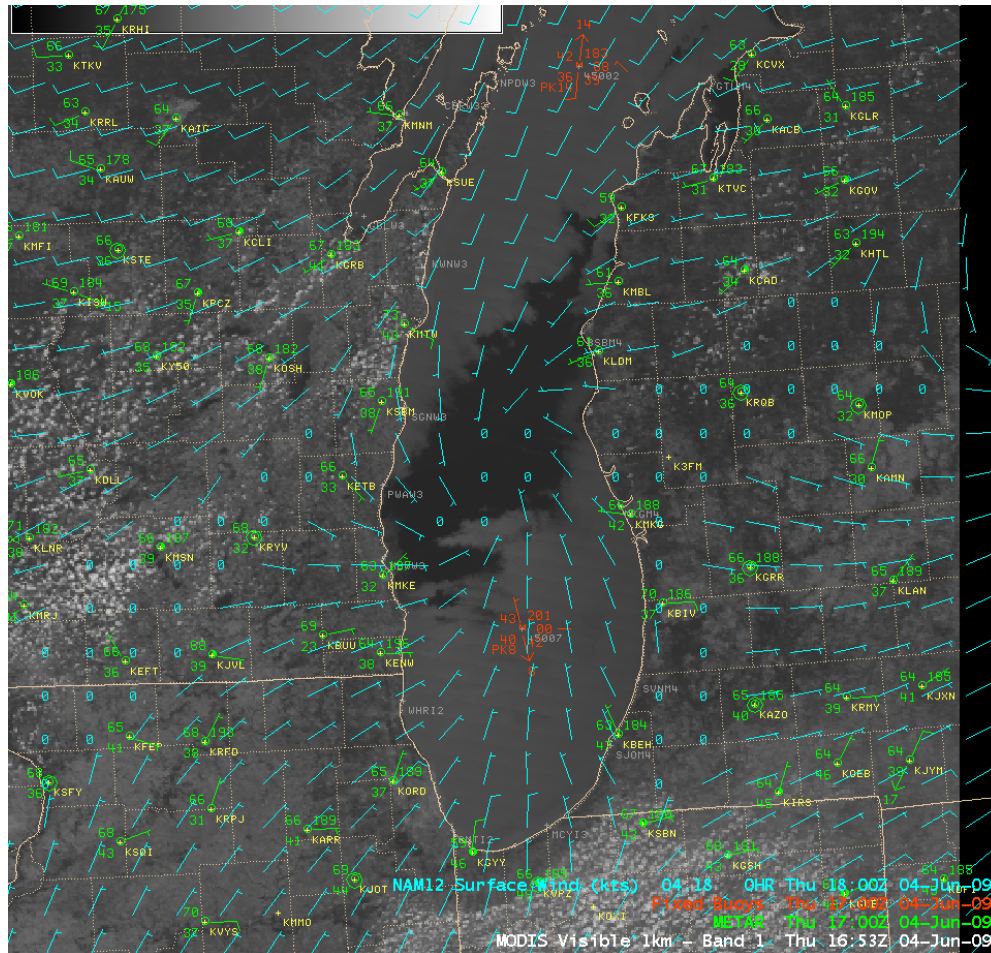
# Example From Lake Michigan

4 June 2009



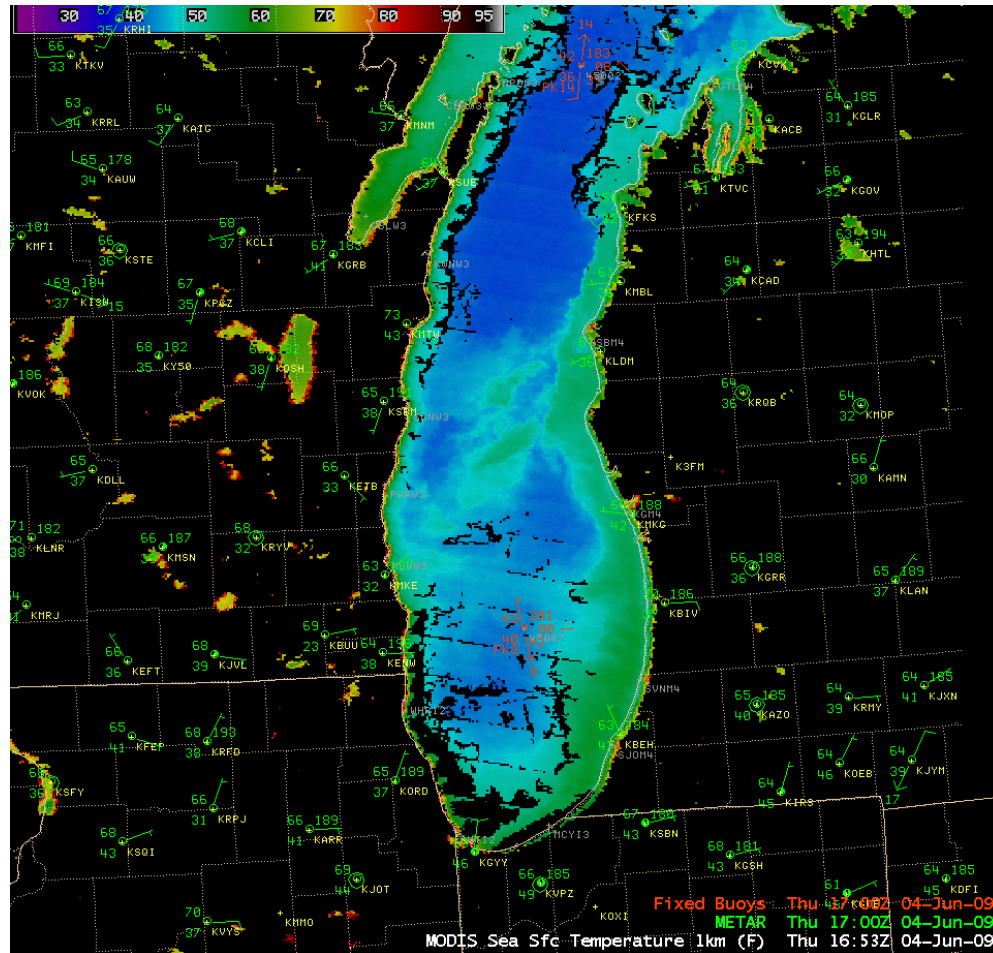
# Numerical Weather Prediction

Wind analysis 18 UTC 4 June 2009

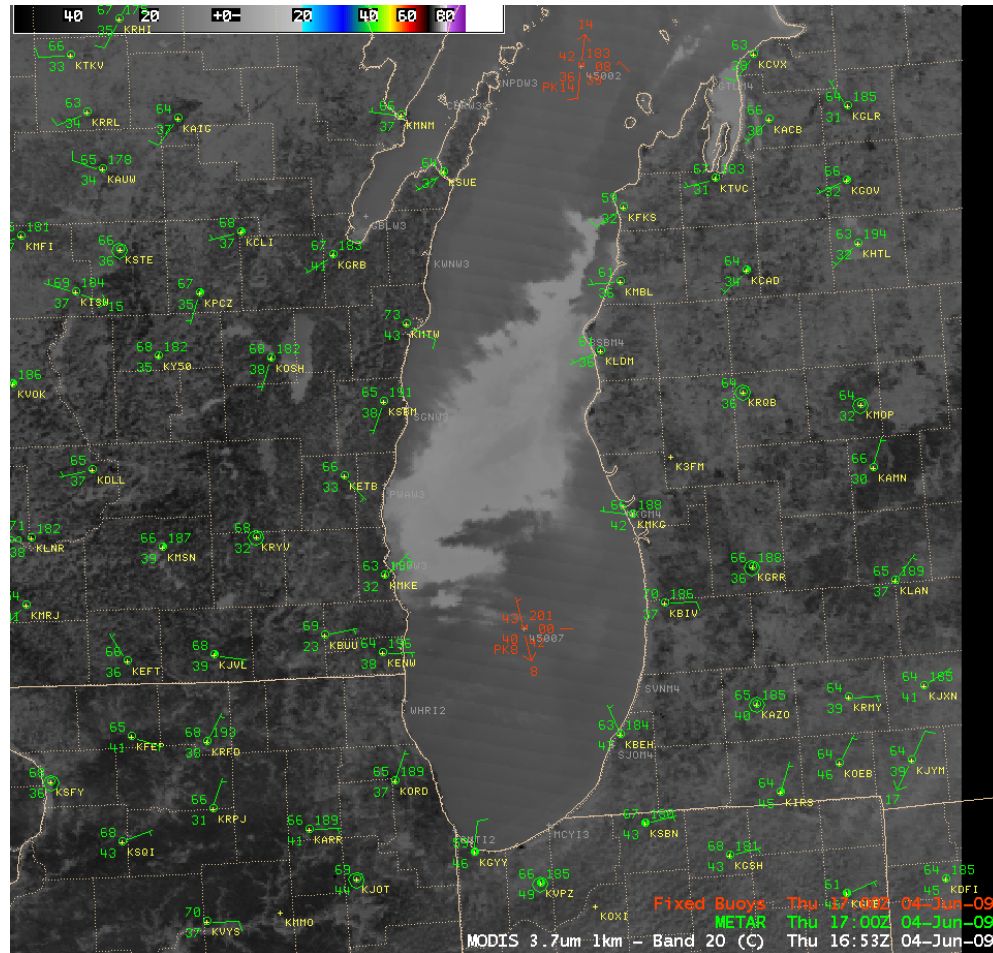


# MODIS Sea Surface Temperatures

4 June 2009

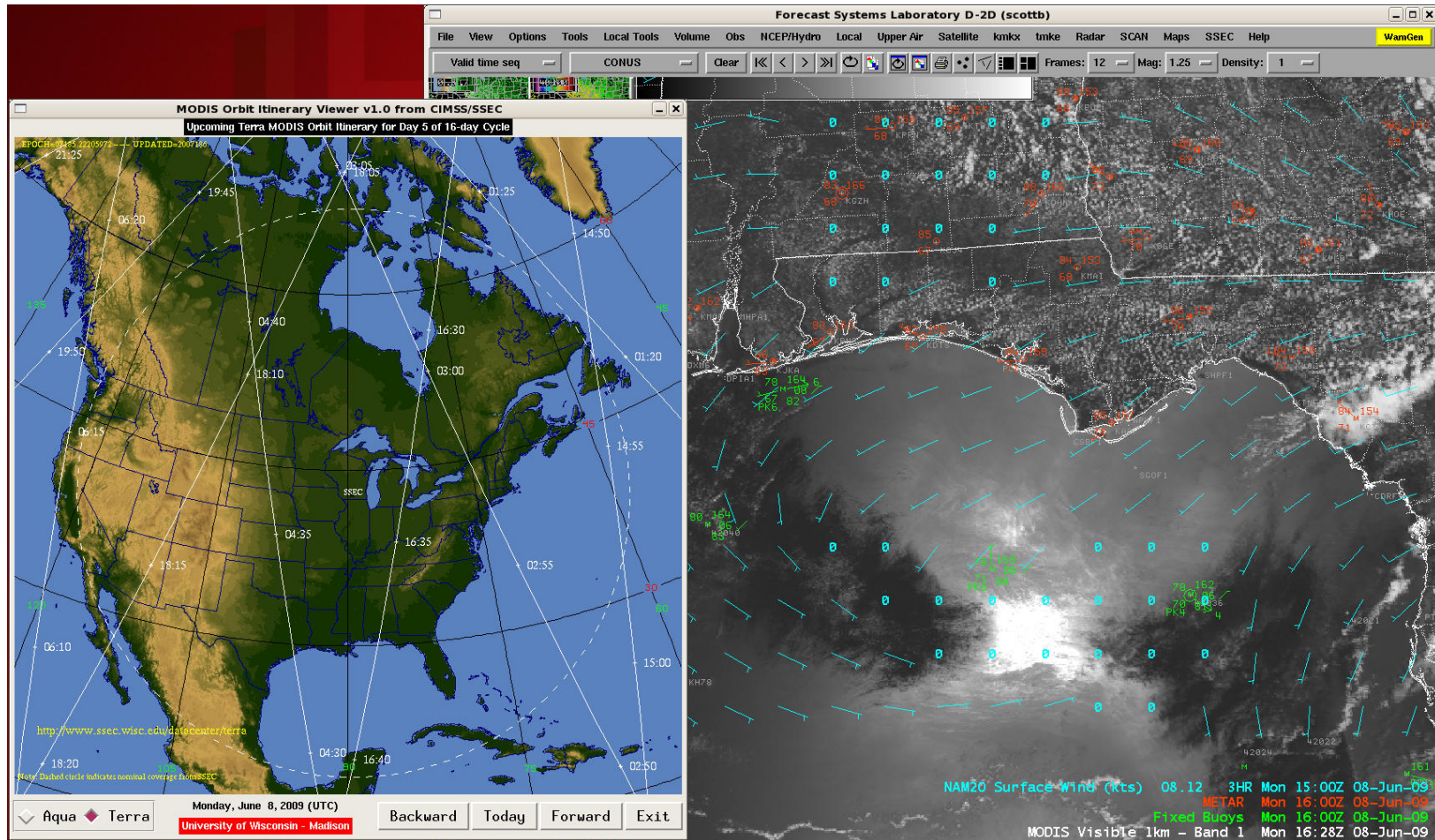


# MODIS 4 $\mu\text{m}$ Brightness Temperatures



# MODIS Sunglint Pattern

8 June 2009



# MODIS Polar Wind Vectors can be derived automatically

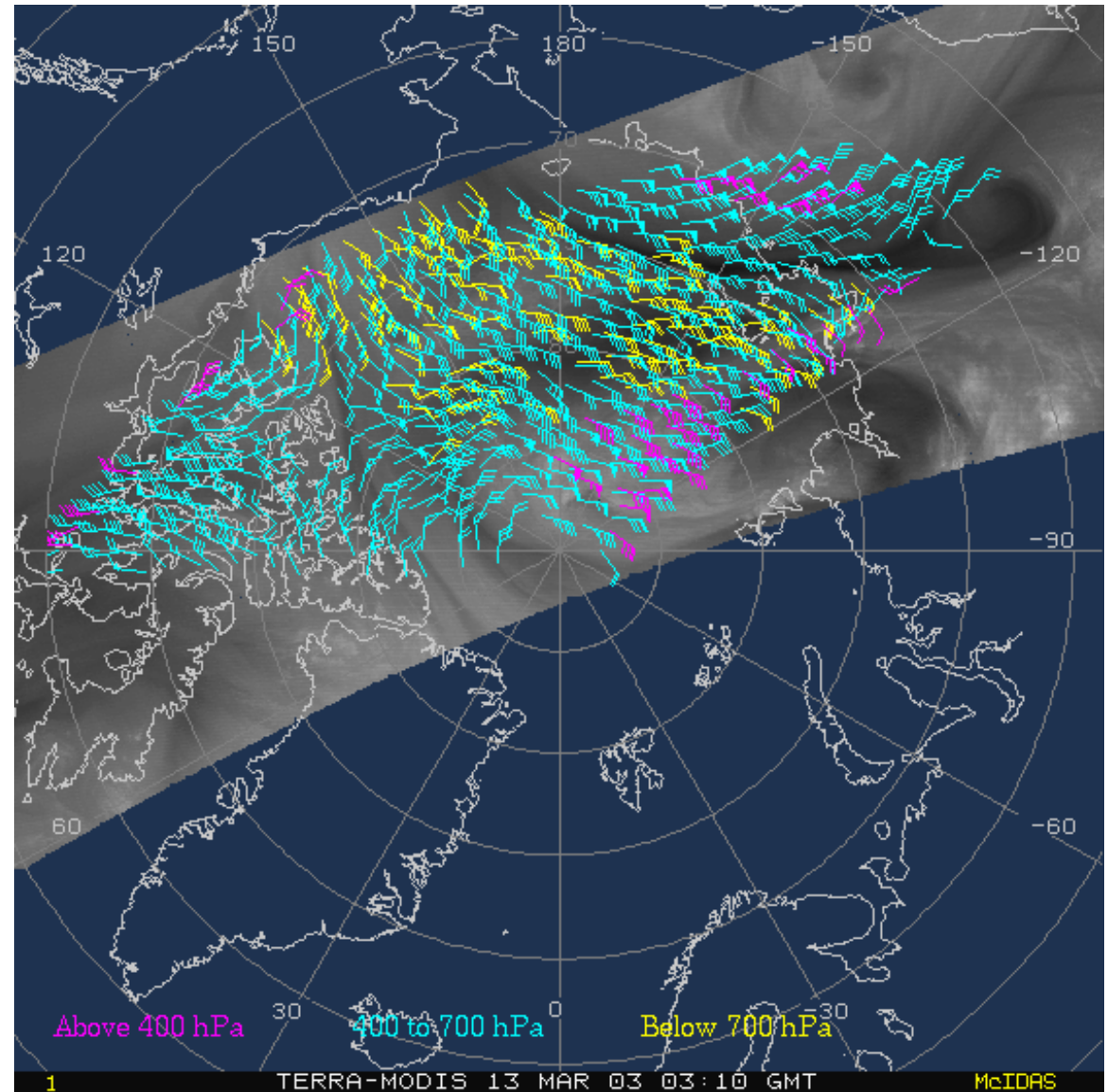
Jeff Key, Chris Velden, Dave Santek

Wind vectors are generated using automatic feature tracking software developed for GOES.

6.7  $\mu\text{m}$  heights are assigned based on forecast atmospheric profile.

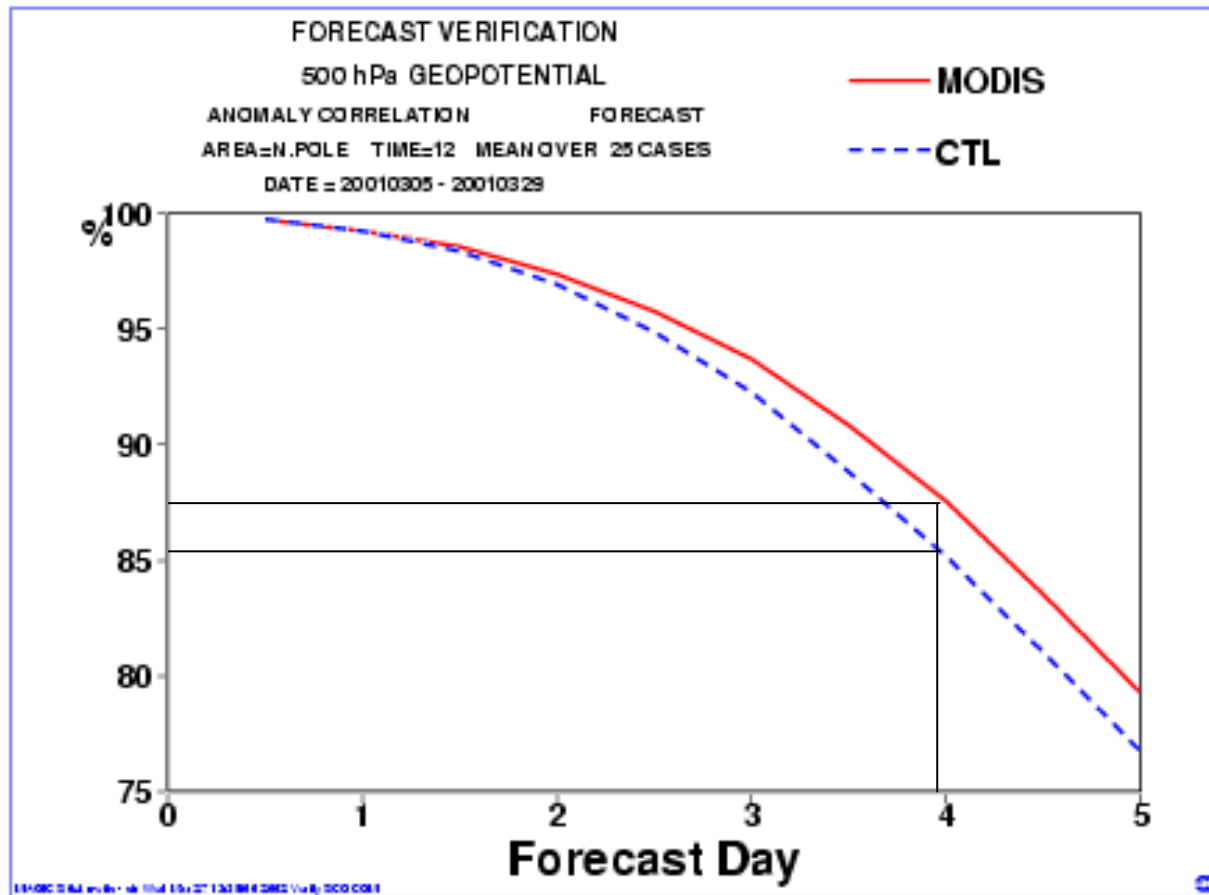
11.0  $\mu\text{m}$  heights are assigned based on window brightness temperature or CO<sub>2</sub> cloud height.

Winds are automatically quality controlled.



Terra MODIS 6.7  $\mu\text{m}$  (band 27) 2003/03/13

# Positive impact on forecast demonstrated by ECMWF



NWP Centers using MODIS Polar Winds Operationally:

ECMWF, GMAO, JMA, CMC, FNMOC, UKMO, DWD, NCEP/EMC  
Key, J. R., D. Santek, C. S. Velden, N. Bormann, J.-N. Thépaut, L. P. Riishojgaard, Y. Zhu, and W. P. Menzel, 2003. Cloud-Drift and Water Vapor Winds in the Polar Regions from MODIS. *IEEE Transactions on Geoscience and Remote Sensing*, 41, 482-492.