



# THE GLOBAL IMPACT OF MODIS DIRECT BROADCAST ATMOSPHERE PRODUCTS

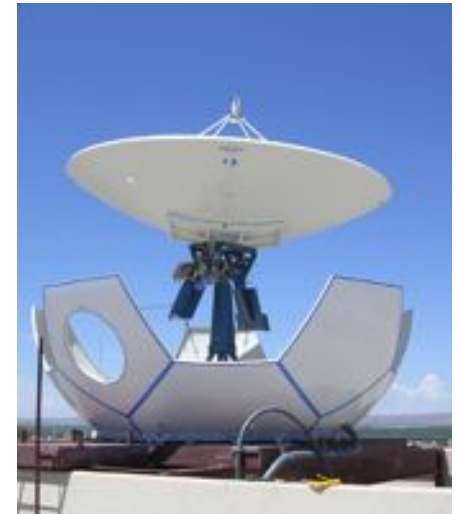
Kathleen Strabala, Liam Gumley, Hung-Lung Huang,  
W. Paul Menzel

Space Science and Engineering Center  
University of Wisconsin-Madison

MODIS/VIIRS Science Team Meeting, 28 January 2010

# What is Direct Broadcast?

- Direct Broadcast is the real-time transmission of earth observation data from the spacecraft to the ground (via X-band on Terra and Aqua)
- On Terra, only MODIS is broadcast
- On Aqua, all data is broadcast
- Data are free and clear with no encryption
- All you need is an antenna and receiver!
- “Terra and Aqua are a great gift to the world” (*Vladimir Gershenson, ScanEx*)



# Why is this important?

- ▶ X-band ground stations that we know of
  - No one knows for sure how many there are



# How can DB data be useful?

- ▶ **Freely distributed software packages**
  - Calibration, navigation
  - Ocean, atmosphere, land products (from NASA versions)
  - Visualization tools
- ▶ **These allow support of local:**
  - Environmental Monitoring and Forecasting
    - Timeliness of data is vital
  - Research
  - Teaching
    - Remote Sensing Schools – eg. Paul Menzel
    - Direct Broadcast Workshops
      - Such as IGARSS short course SC4: MODIS direct broadcast data for enhanced forecasting and real-time environmental decision making



# Free Direct Broadcast Software Packages

- ▶ **MODISL1DB – MODIS Calibration/geolocation**
  - Distributed by MODIS Ocean Biology Group
  - <http://oceancolor.gsfc.nasa.gov/seadas/modisl1db/>
- ▶ **SeaDAS**
  - MODIS Ocean Products
  - <http://oceancolor.gsfc.nasa.gov/seadas/>
- ▶ **International MODIS/AIRS Processing Package (IMAPP) – More to come**
- ▶ **Direct Readout Lab**
  - Surface Reflectance (MOD09), Corrected Reflectance, simple NDVI/EVI, Land Surface Temperature, Fire Product (MOD14)
  - <http://directreadout.sci.gsfc.nasa.gov/>
- ▶ **Visualization (examples)**
  - HDFLook: <http://www-loa.univ-lille1.fr/Hdflook/>
  - Hydra: <http://www.ssec.wisc.edu/hydra/>

# NASA funded International MODIS/AIRS Processing Package (IMAPP)

Freely distributed and builds upon our previous experience with

- ITPP (International TOVS Processing Package) since 1985
- IAPP (International ATOVS Processing Package) since 1998

*Purpose: To allow DB users capability of producing EOS products*

IMAPP is derived from the operational EOS processing software developed at NASA GSFC and JPL, and has been modified to be compatible with direct broadcast data. The main differences between IMAPP and the operational software are:

- portability,
- wherever possible, the reliance on toolkits has been eliminated,
- the IMAPP processing environment is greatly simplified,
- overpasses of arbitrary size may be processed.

*New IMAPP web page and download interface:*

<http://cimss.ssec.wisc.edu/imapp>



# Current IMAPP Status

## *MODIS products – Level 2 (Collection 5)*

- Cloud mask (MOD35),
- Cloud top properties (MOD06CT) – height, temperature, emissivity, phase
- Cloud optical properties (MOD06OD) – cloud effective radius, cloud optical thickness
- Atmospheric profiles (MOD07) T, q, tpw, total ozone, stability
- Aerosol optical depth (MOD04)
- Near-infrared water vapor

## *MODIS utilities*

- Destriping software – removes artificial striping in infrared bands
- Direct Broadcast Google Earth (DBGE)
  - Software to create jpgs and KML for true color MODIS 250 m data



# Current IMAPP Status

## *AIRS products – Atmospheric Infrared Sounder*

- AIRS/AMSU/HSB Level 1 and Level 2 v5.2 (with JPL – 3x3 pixels)
- AIRS Level 2 profiles (UW – single pixel clear sky only)
- MODIS/AIRS utilities package
  - MODIS/AIRS collocations
  - AIRS cloud mask based upon the collocated MODIS mask
  - AIRS all sky retrievals
- AIRS L1B HDFEOS to BUFR utility software
  - Written by Nigel Atkinson, packaged and distributed by UW

## *AMSR-E products – RSS L1B software*

- Rain rate, rain type
- Soil Moisture
- Snow Water Equivalence



# Current IMAPP Status

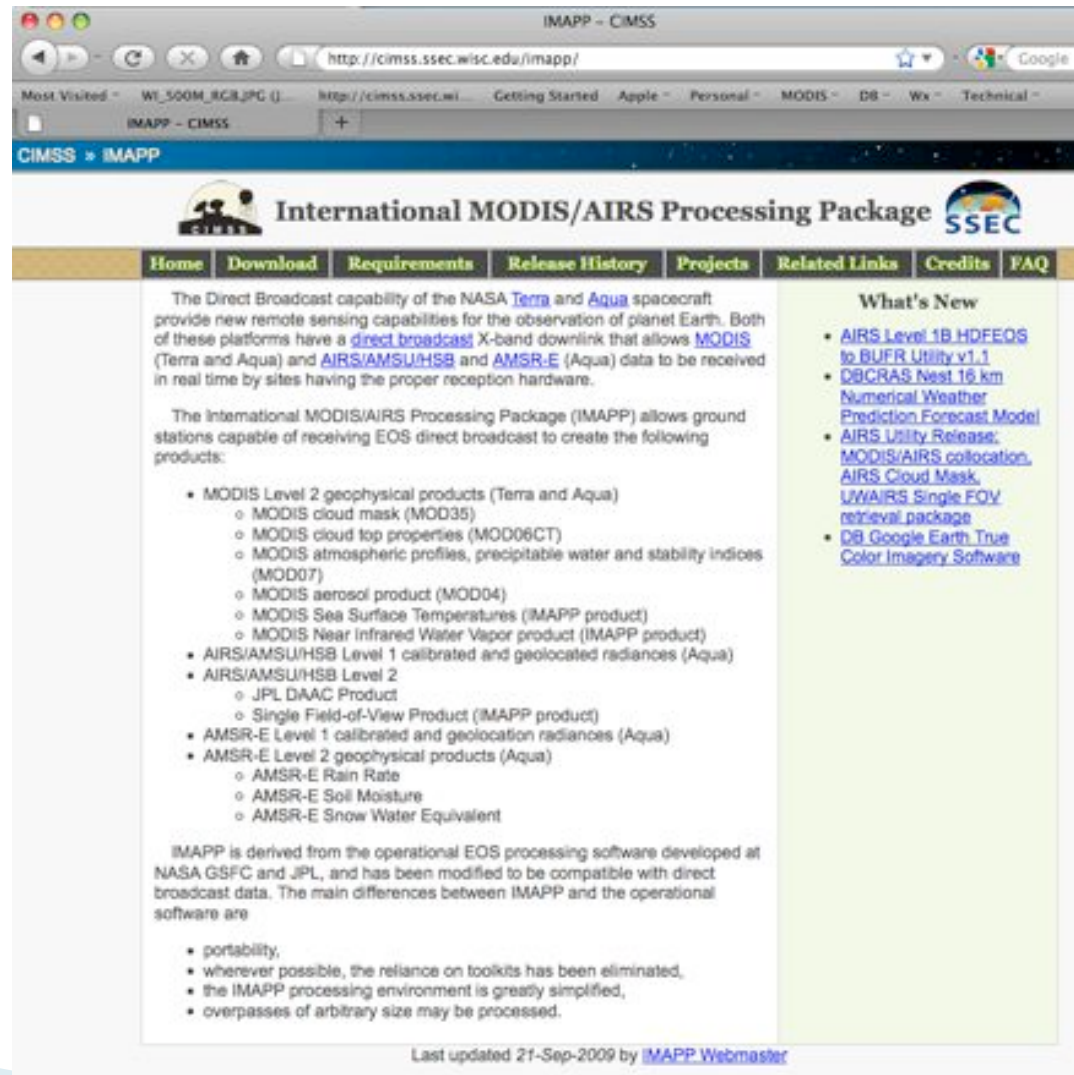
## *DB CRAS (Numerical Weather Assimilation and Forecast Model)*

- Domain centered on DB station – 48 km grid
- Assimilates IMAPP MOD07 and MOD06CT products
- Produces standard NWP gridded fields as well as forecast satellite IR and WV imagery
  - Used by some US NWS forecasters in AWIPS
- Nest centered within coarse model domain
  - 16 km resolution
  - 48 hour forecast



# IMAPP Web Site

- ▶ Over 600 people have registered since October 2007



The screenshot shows the IMAPP web site interface. At the top, there is a navigation bar with the following links: Home, Download, Requirements, Release History, Projects, Related Links, Credits, and FAQ. The main content area is divided into two columns. The left column contains text about the Direct Broadcast capability of NASA Terra and Aqua spacecraft and a list of products. The right column is titled 'What's New' and lists recent updates. At the bottom, there is a footer indicating the last update date and the webmaster's name.

**Home** | **Download** | **Requirements** | **Release History** | **Projects** | **Related Links** | **Credits** | **FAQ**

The Direct Broadcast capability of the NASA [Terra](#) and [Aqua](#) spacecraft provide new remote sensing capabilities for the observation of planet Earth. Both of these platforms have a [direct broadcast](#) X-band downlink that allows [MODIS](#) (Terra and Aqua) and [AIRS/AMSU/HSB](#) and [AMSR-E](#) (Aqua) data to be received in real time by sites having the proper reception hardware.

The International MODIS/AIRS Processing Package (IMAPP) allows ground stations capable of receiving EOS direct broadcast to create the following products:

- MODIS Level 2 geophysical products (Terra and Aqua)
  - MODIS cloud mask (MOD35)
  - MODIS cloud top properties (MOD06CT)
  - MODIS atmospheric profiles, precipitable water and stability indices (MOD07)
  - MODIS aerosol product (MOD04)
  - MODIS Sea Surface Temperatures (IMAPP product)
  - MODIS Near Infrared Water Vapor product (IMAPP product)
- AIRS/AMSU/HSB Level 1 calibrated and geolocated radiances (Aqua)
- AIRS/AMSU/HSB Level 2
  - JPL DAAC Product
  - Single Field-of-View Product (IMAPP product)
- AMSR-E Level 1 calibrated and geolocation radiances (Aqua)
- AMSR-E Level 2 geophysical products (Aqua)
  - AMSR-E Rain Rate
  - AMSR-E Soil Moisture
  - AMSR-E Snow Water Equivalent

IMAPP is derived from the operational EOS processing software developed at NASA GSFC and JPL, and has been modified to be compatible with direct broadcast data. The main differences between IMAPP and the operational software are

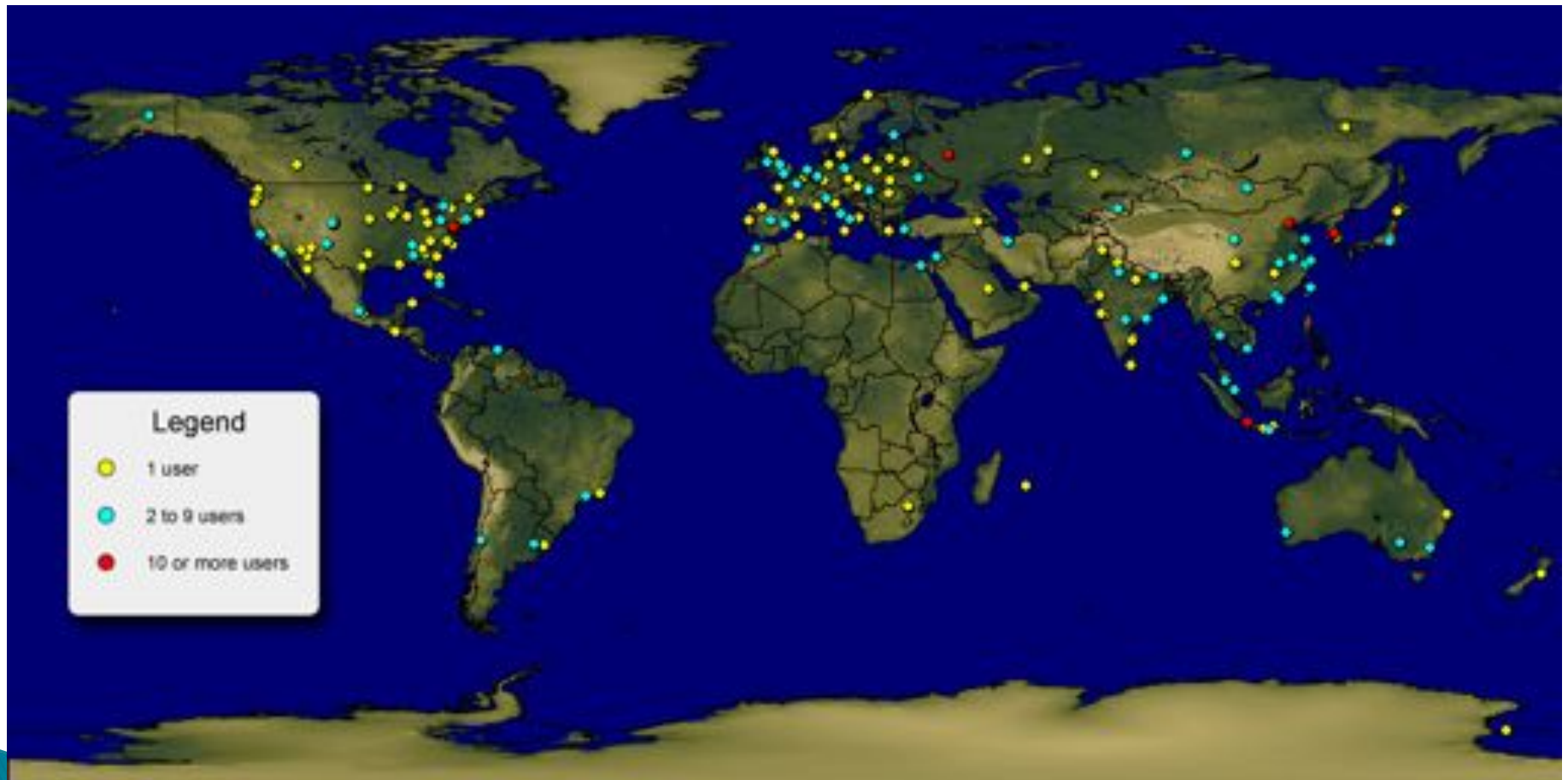
- portability,
- whenever possible, the reliance on toolkits has been eliminated,
- the IMAPP processing environment is greatly simplified,
- overpasses of arbitrary size may be processed.

**What's New**

- [AIRS Level 1B HDFEOS to BUFR Utility v1.1](#)
- [DBCRAS Nest 16 km Numerical Weather Prediction Forecast Model](#)
- [AIRS Utility Release: MODIS/AIRS collocation, AIRS Cloud Mask, LWA/RS Single FOV retrieval package](#)
- [DB Google Earth True Color Imagery Software](#)

Last updated 21-Sep-2009 by [IMAPP Webmaster](#)

# Location of IMAPP registrants Representing 55 countries



Since 2007

# DB Applications – MODIS

## Huge Variety

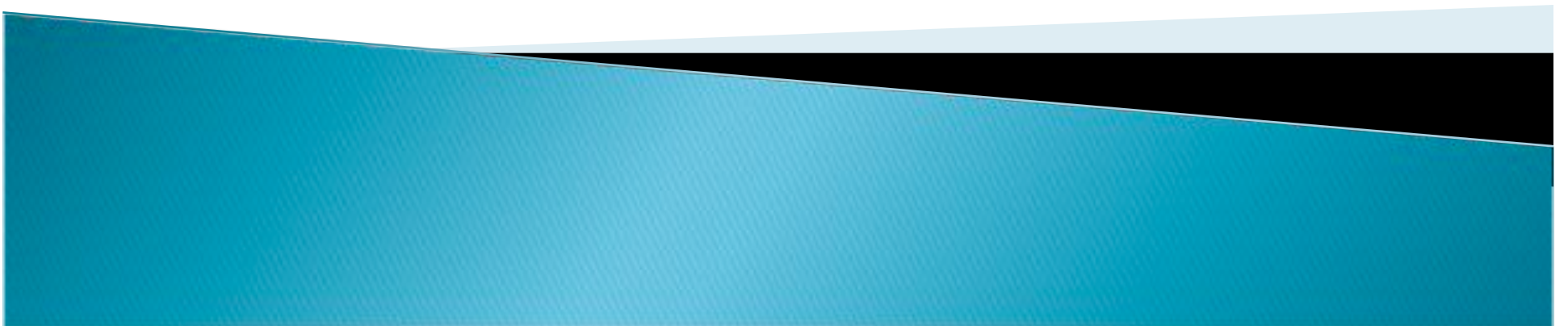
- Including Fires (detection and burned area), etc., etc., etc.

## Weather Observation and Forecasting

- Compliment to Geostationary
  - Higher Spatial Resolution (data at 250 m – 1 km, products at 250 m – 5 km)
  - Unique spectral bands (such as 1.38  $\mu\text{m}$ )
  - New products (such as cloud phase)
  - Preparation for next generation of geo instruments
- Key for forecasts is timeliness of data
  - DB can supply this



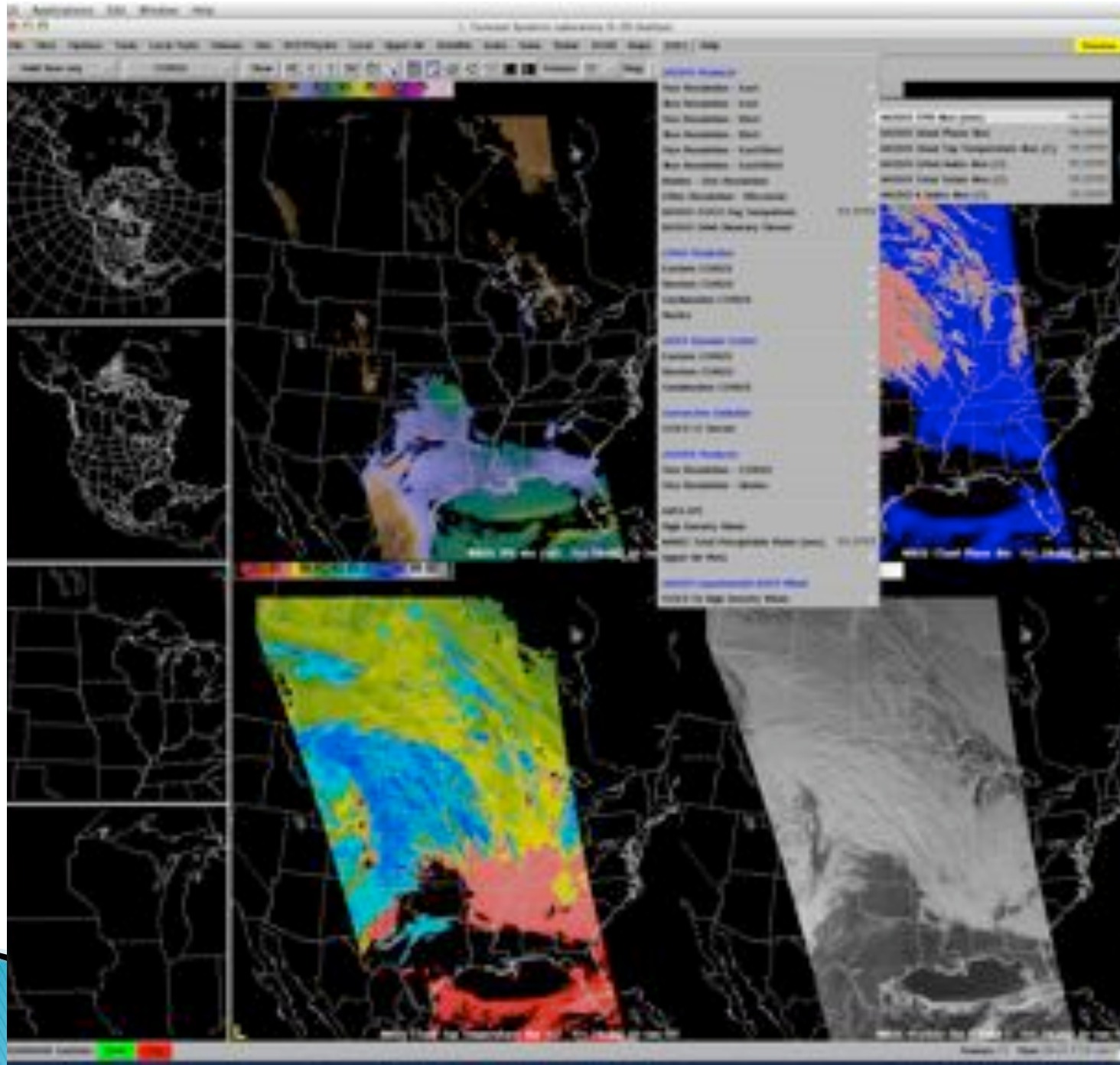
Can Polar Orbiter Data  
Really Be That Useful to  
Forecasters?



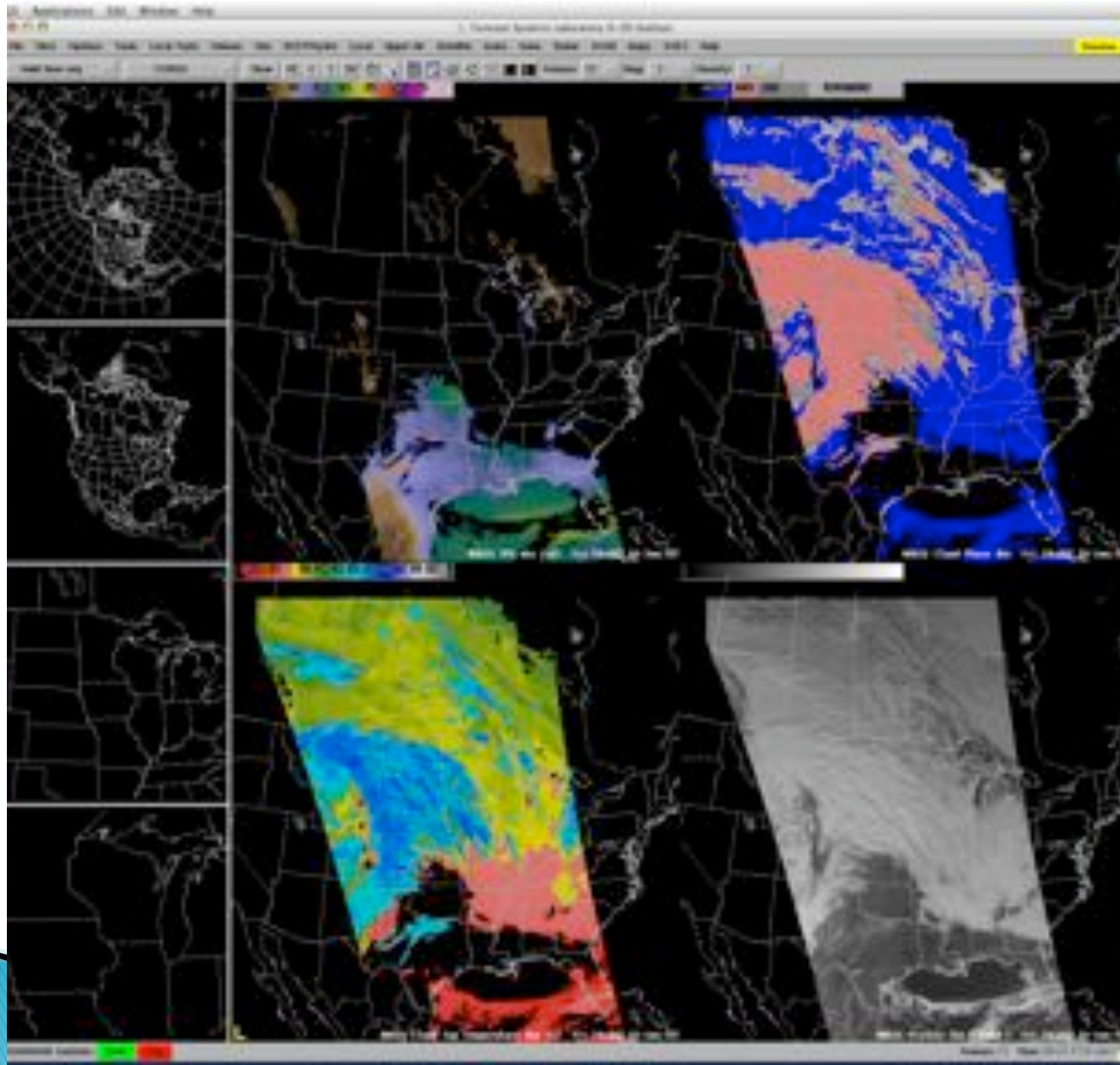
# Support of US National Weather Service Forecasters

- ▶ University of Wisconsin began providing Direct Broadcast MODIS products NWS in June 2006
- ▶ Reflectances and Brightness Temperatures
  - Bands 1 (.68  $\mu\text{m}$ ), Band 26 (1.38  $\mu\text{m}$ ), Band 7 (2.1  $\mu\text{m}$ )
  - Band 20 (3.7  $\mu\text{m}$ ), Band 27 (6.7  $\mu\text{m}$ ), Band 31 (11  $\mu\text{m}$ )
- ▶ Products
  - 1 km
    - Sea Surface Temperature, NDVI (DB version), Land Surface Temperature, Fog Product
  - 5 km
    - Cloud Top Pressure, Total Precipitable Water, Cloud Phase, Stability Indices
- ▶ True Color 250 m Imagery

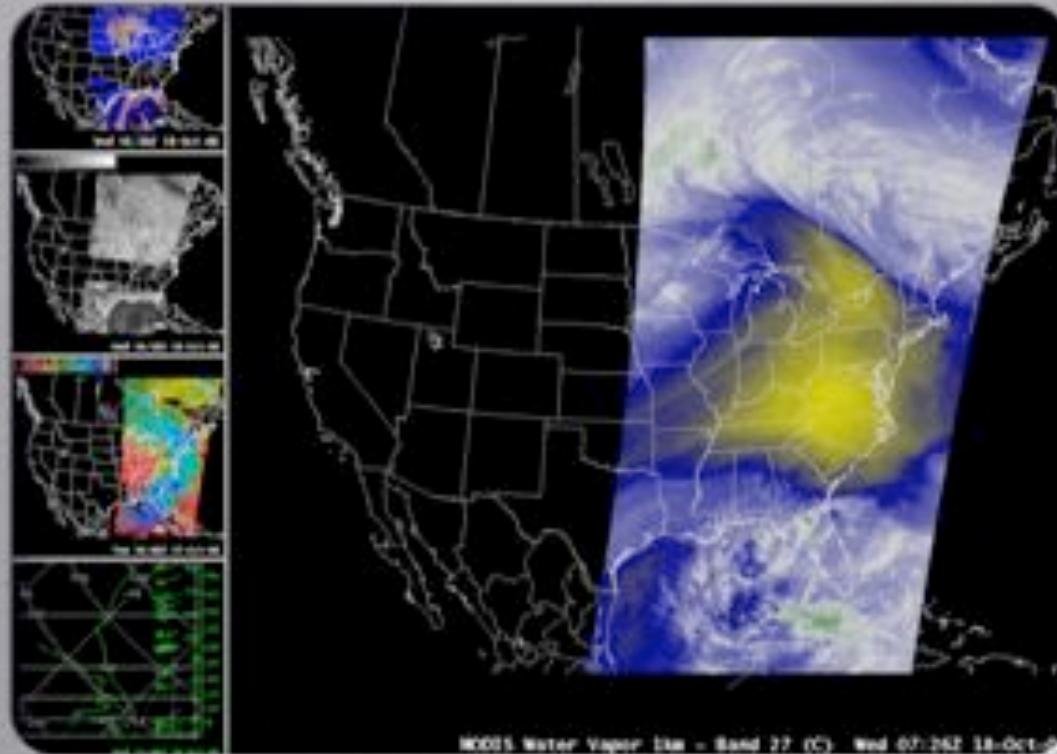








# MODIS Products in AWIPS

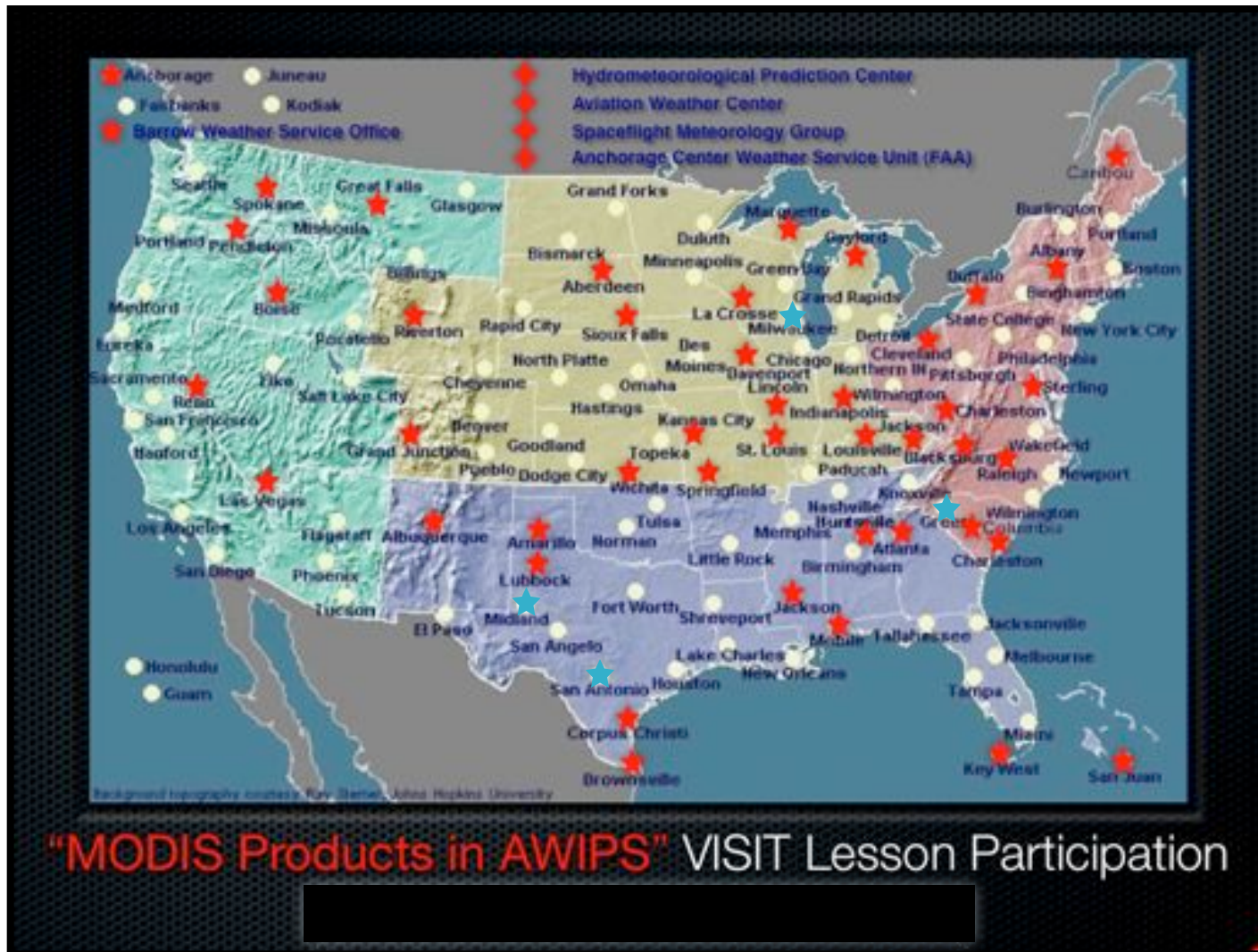


National Weather Service • Integrated Sensor Training Professional Development Series  
Virtual Institute for Satellite Integration Training

Virtual Institute for Satellite Integration Training  
(VISIT) lesson – offered since October 2006

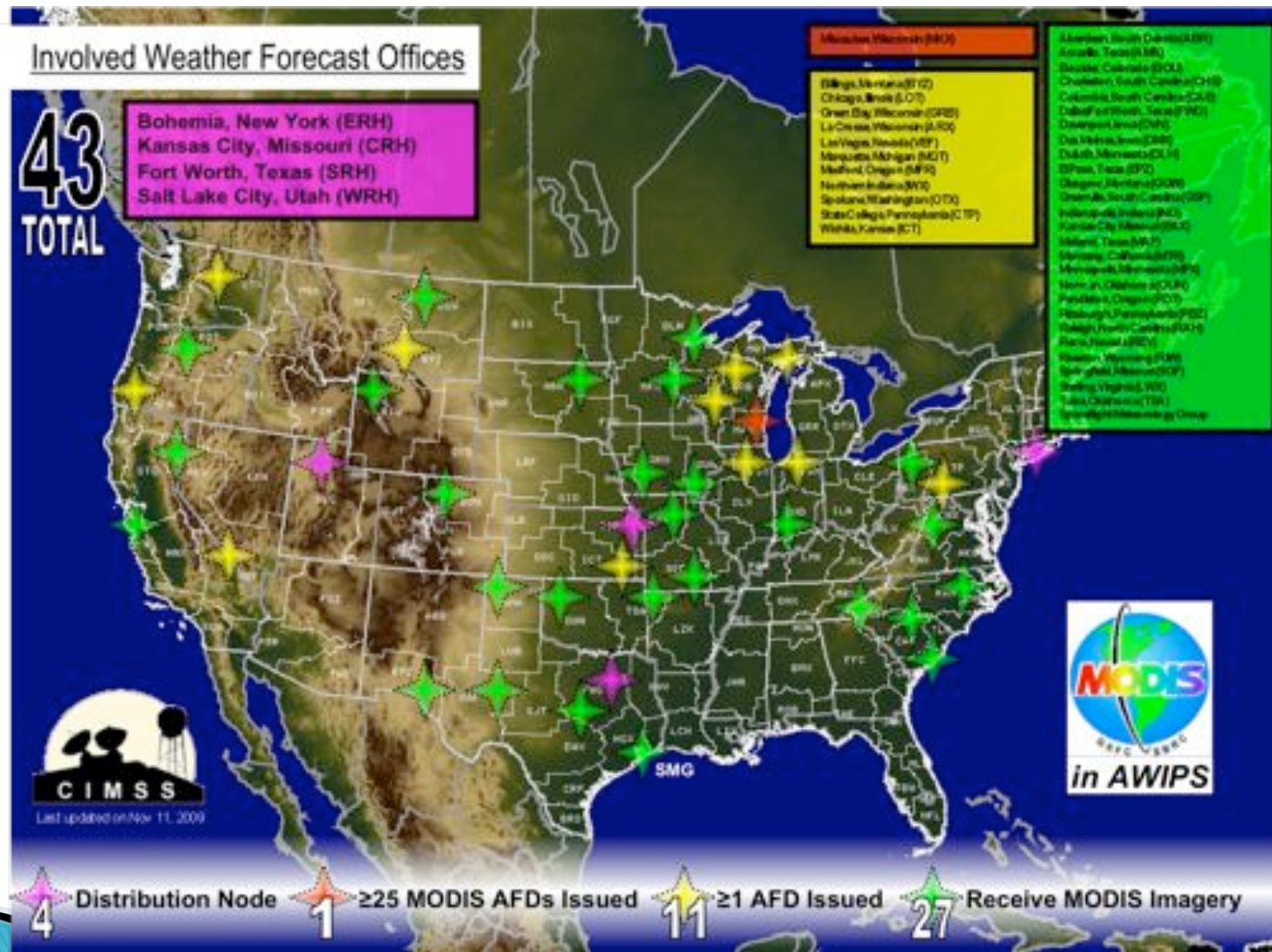


# MODIS Products in AWIPS



53 NWS forecast offices participating so far

# University of Wisconsin Direct Broadcast MODIS Data used by the National Weather Service



MODIS products have been mentioned in Area Forecast Discussions 151 times



# MODIS Products in AWIPS

AREA FORECAST DISCUSSION NATIONAL WEATHER SERVICE  
MILWAUKEE/SULLIVAN WI  
422 AM CDT FRI AUG 3 2007

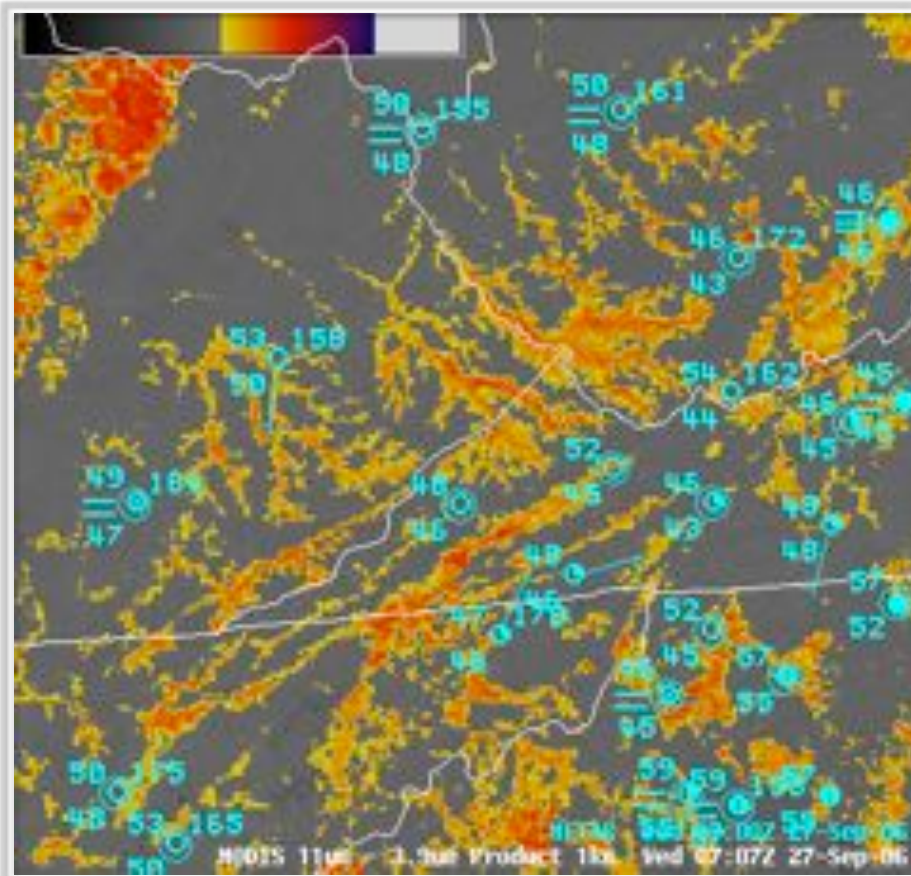
DISCUSSION...FORECAST FOCUS ON COOLER AND MUCH DRIER CONDITIONS TODAY...THEN PRECIPITATION CHANCES THIS WEEKEND THROUGH NEXT WEEK. 00Z 500/300MB ANALYSIS INDICATED A CLOSED UPPER LOW INVOF OF HUDSON BAY WITH A BROAD UPPER HIGH CENTERED NEAR THE 4-CORNERS AREA...VERY TYPICAL LOCATION FOR THIS TIME OF YEAR. PLACEMENT OF THESE FEATURES PRODUCING A DEEP...DRY NWLY FLOW OVER THE NRN PLAINS/GREAT LAKES REGION. AT THE SFC...WEAK TROF/COLD FRONT CONTINUES TO PUSH SOUTHEAST OF WI...ALLOWING SOME MUCH DRIER AIR TO FILTER INTO THE AREA. **IN FACT...04Z 4KM MODIS PW SOUNDER SHOWING PWS FALLING AOB 0.40" OVER MN/NRN WI CORRESPONDING WITH A BROAD AREA OF UPPER 40S-LOW 50S SFC DWPTS.** 1KM MODIS LAKE SFC TEMP PRODUCT INDICATING NARROW RIBBON OF UPWELLING ALONG WRN SHORE OF LK MICHIGAN DUE TO OFFSHORE WINDS. IR IMAGERY EARLY THIS MORNING INDICATING CRYSTAL CLEAR SKIES OVER THE ENTIRE STATE OF WI.



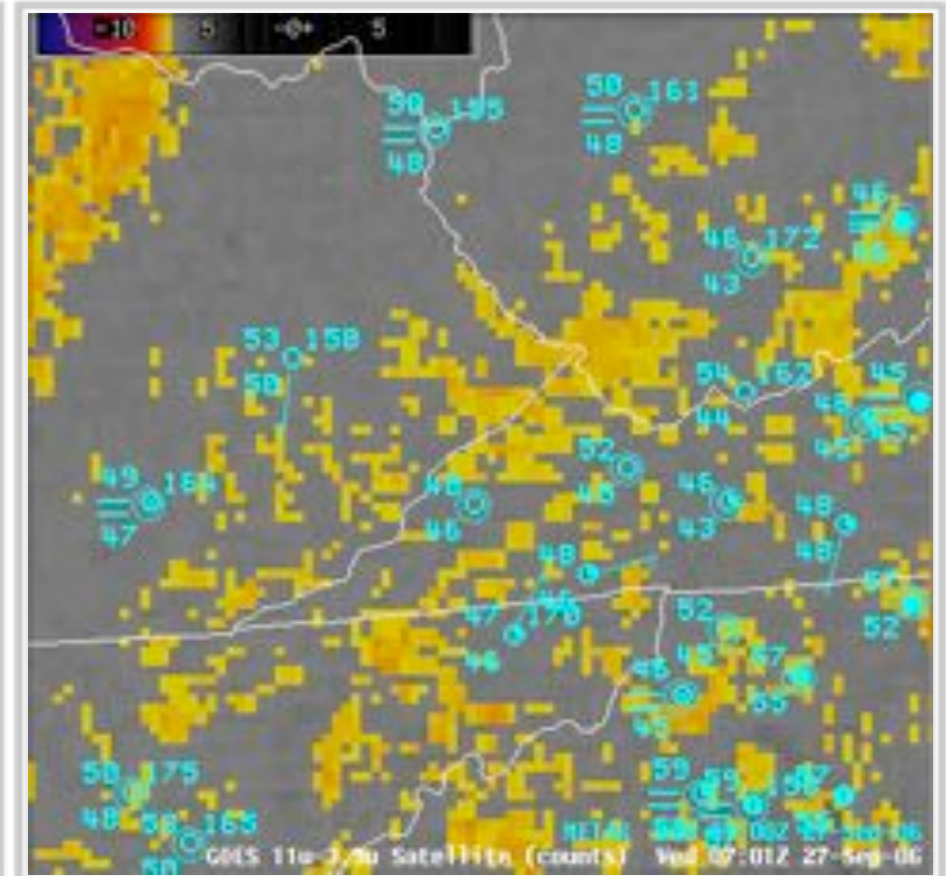
**MODIS has been mentioned in 151 NWS  
Area Forecast Discussions to date**

# MODIS Imagery in AWIPS

## Fog/stratus product (11.0 $\mu$ m – 3.7 $\mu$ m)



1-km MODIS



4-km GOES

Improved fog/stratus detection capability

**AREA FORECAST DISCUSSION  
NATIONAL WEATHER SERVICE STATE COLLEGE PA  
1 58 AM EDT WED SEP 2 2009**

.NEAR TERM /UNTIL 11 AM THIS MORNING/...

IDEAL RADIATIONAL COOLING UNDER LARGE SFC ANTICYCLONE WILL PROVIDE ANOTHER CHILLY MORNING ACROSS THE REGION. OBSERVED DEWPTS SUGGEST MINS WILL BE A FEW DEGS WARMER THAN LAST NIGHT...WITH THE COLDEST READINGS /UPPER 30S/ FOUND ACROSS THE USUAL COLD SPOTS IN THE NORTH-CENTRAL MTNS.

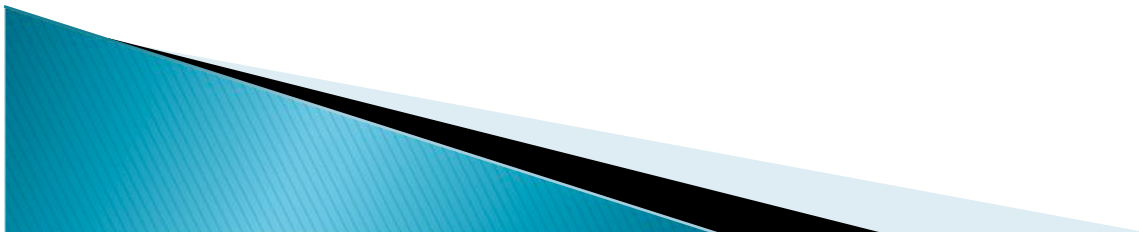
**11-3.9U AND 1KM MODIS SATL IMAGERY DEPICTING DENDRITIC PATTERN OF SHALLOW...LOCALLY DENSE RIVER VALLEY FOG AND STRATUS BEGINNING TO DEVELOP OVR CENTRAL PENN EARLY THIS MORNING. XPC** THE DENSE FOG TO INC IN CVRG THROUGH SUNRISE WITHIN THE RIVER/STREAM VLYS AS THE BLYR CONTS TO COOL. A LOOK BACK AT YESTERDAYS VIS LOOP SUGGESTS FOG AND STRATUS WILL DISSIPATE BTWN 14-15Z...GIVING WAY TO AM/SUNNY SKY.





# How do we know MODIS data has an impact?

- ▶ Forecaster surveys
  - >70 percent responded that MODIS data is useful
- ▶ MODIS data used as a forecast decision making tool in AFD's
- ▶ MODIS data has been designated as “critical” for inclusion in AWIPS II
  - UW responsible for writing AWIPS II MODIS plug-in

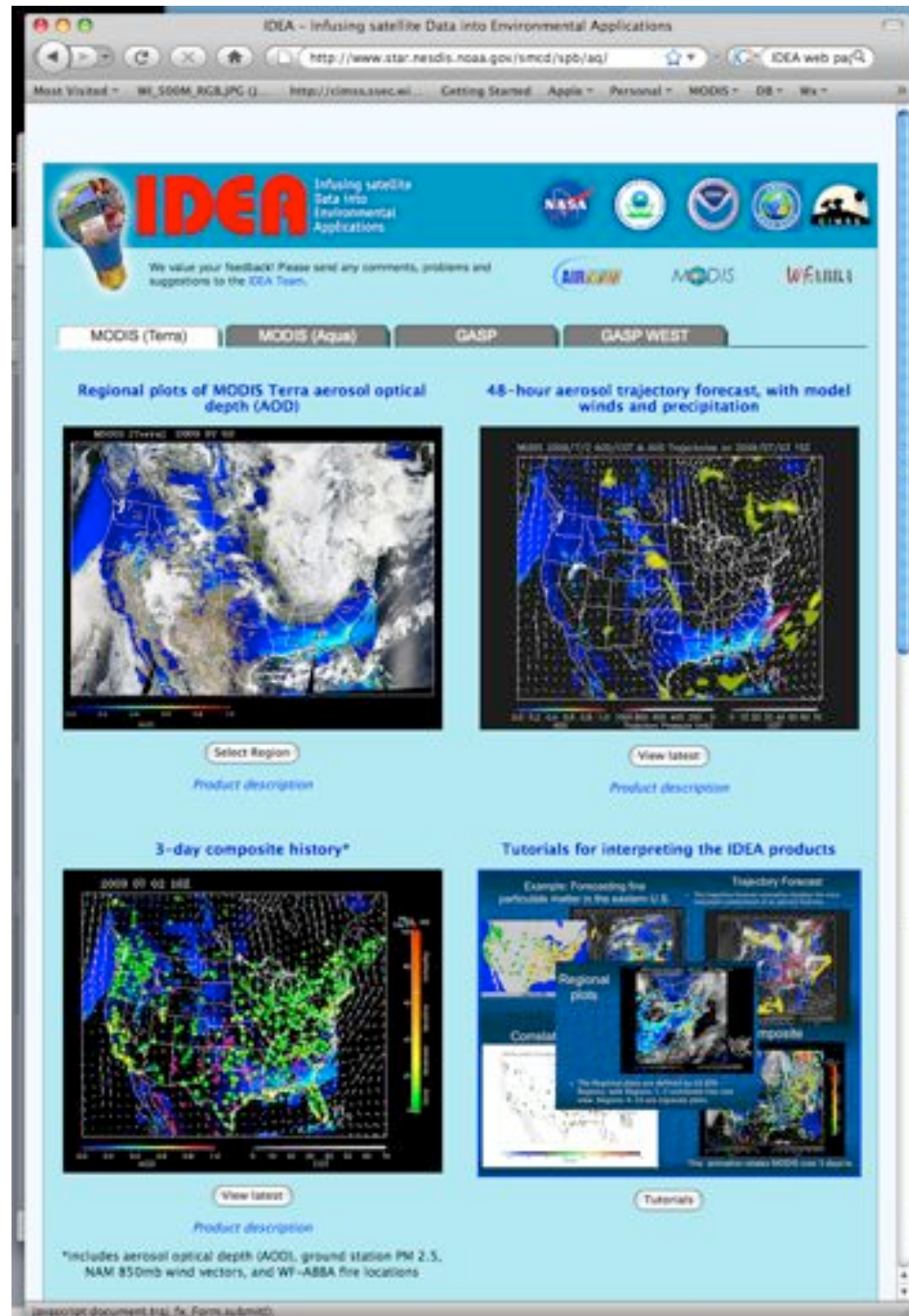


# Infusing Satellite Data into Environmental Applications

NASA-EPA-NOAA

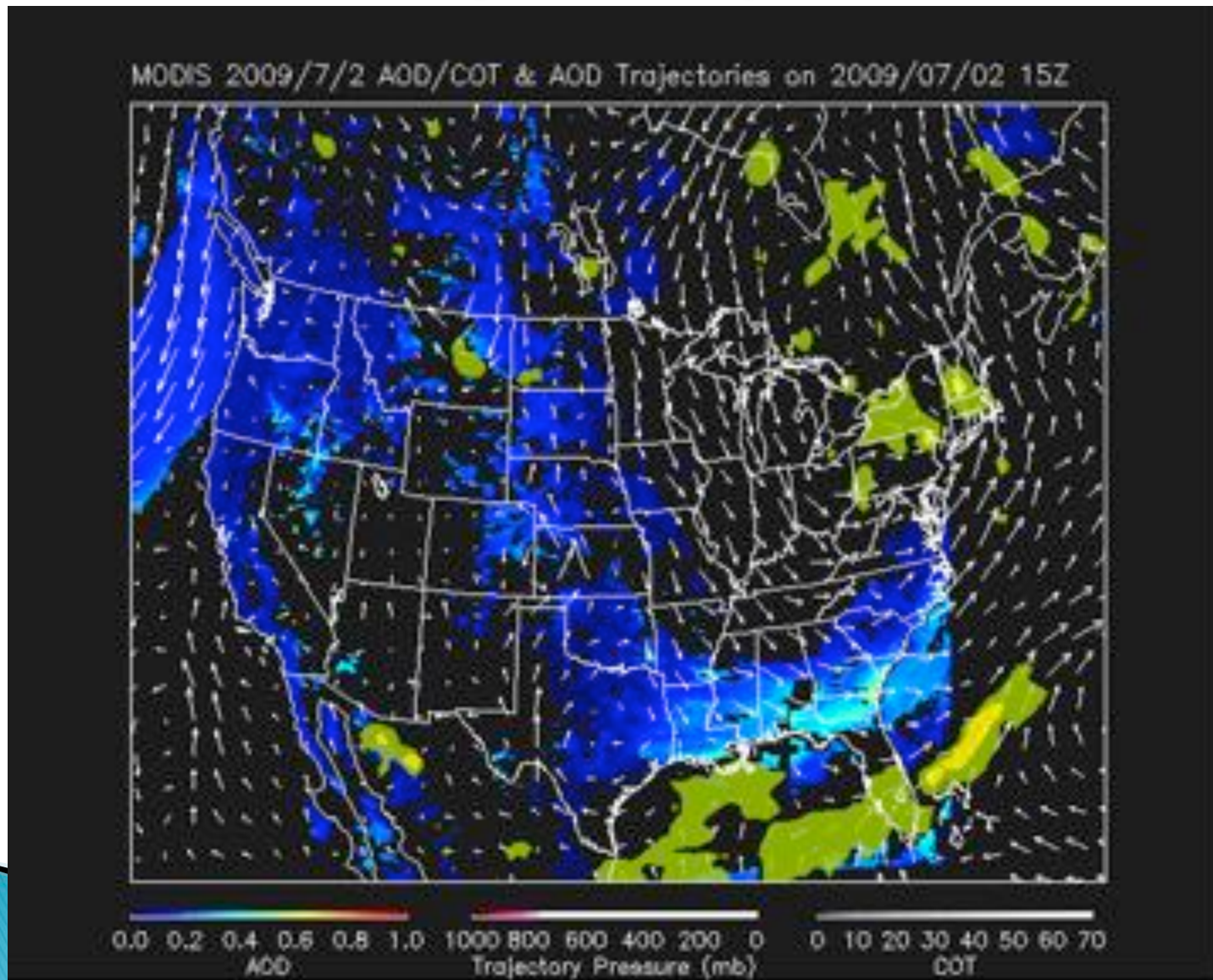
partnership to improve air quality assessment, management, and prediction by infusing (NASA) satellite measurements into (EPA, NOAA) analyses for public benefit.

UW DB testbed for NOAA operations



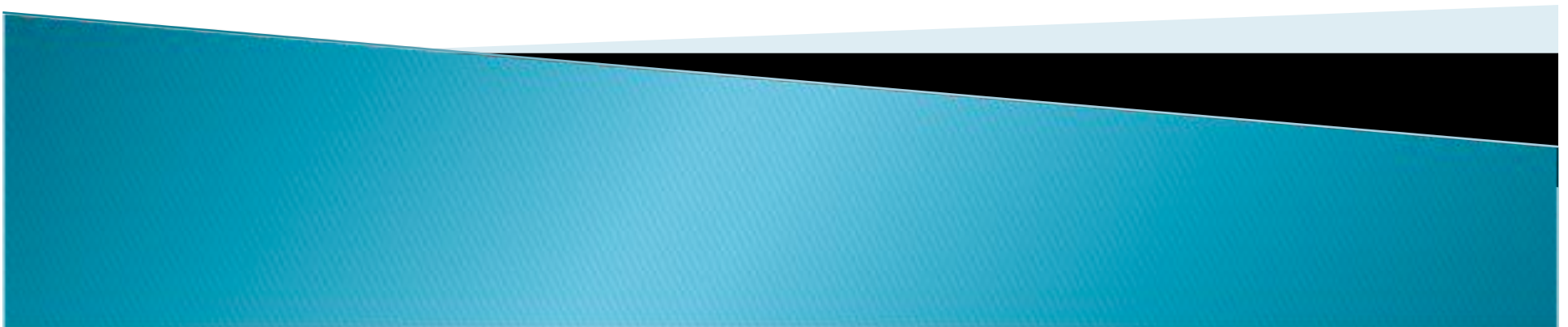
<http://www.star.nesdis.noaa.gov/smcd/spb/aq/>

# 48 Hour Trajectory Forecast





# Other Global Users


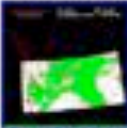













# IMAPP Products Used for Forecasting at the Poles

## Real-Time MODIS Products from McMurdo

A number of MODIS products are generated on-site at McMurdo, Antarctica, using data from the National Science Foundation's direct broadcast system. Here are the most recent images for each product. **Click on the product links at left for more images of a specific product.** The purpose of this direct broadcast real-time system is two-fold: (1) to generate polar wind and other information more quickly than is done with our current system, so that numerical weather prediction centers can assimilate more polar data in their model runs, and (2) to provide an additional source of information, primarily winds, for weather forecasters in Antarctica.




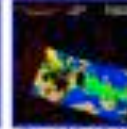



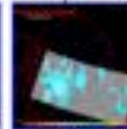

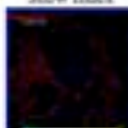




**TERRA:**

Winds	Cloud Mask	Cloud Pressure	Cloud Phase
			
Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC
Inversion Strength	Inversion Depth	Precipitable Water	Surface Temperature
			
Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC
Surface Albedo	Snow Index	Vegetation Index	RGB Day
			
Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC	Day 120, 16:46 UTC
RGB Night	True Color		
			
Day 120, 16:46 UTC	Day 120, 16:46 UTC		

## Real-Time MODIS Products from Tromsø, Norway

A number of MODIS products are generated on-site at Tromsø, Norway, using data from the Integrated Program Office's direct broadcast system. That system is operated by Knut. Here are the most recent images for each product. **Click on the product links at left for more images of a specific product.** The purpose of this direct broadcast real-time system is two-fold: (1) to generate polar wind and other information more quickly than is done with our current system, so that numerical weather prediction centers can assimilate more polar data in their model runs, and (2) to provide an additional source of information, primarily winds, for local weather forecasters. NOTE: Because of Aqua playback scheduling, only Terra data are used for these products.

**TERRA:**

Winds	Cloud Mask	Cloud Pressure	Cloud Phase
			
Day 120, 17:33 UTC	Day 120, 17:33 UTC	Day 120, 17:33 UTC	Day 120, 17:33 UTC
Inversion Strength	Inversion Depth	Precipitable Water	Surface Temperature
			
Day 120, 17:33 UTC	Day 120, 17:33 UTC	Day 120, 17:33 UTC	Day 120, 17:33 UTC
Surface Albedo	Snow Index	Vegetation Index	RGB Day
			
Day 120, 17:33 UTC	Day 112, 16:45 UTC	Day 112, 16:45 UTC	Day 120, 17:33 UTC
RGB Night	True Color		
			
Day 120, 17:33 UTC	Day 112, 16:45 UTC		

# Vendor Distributions

- SeaSpace Corporation
- Kongsburg Satellite Services

## Description:

MODIS Cloud Top Temperature Product (1KM)

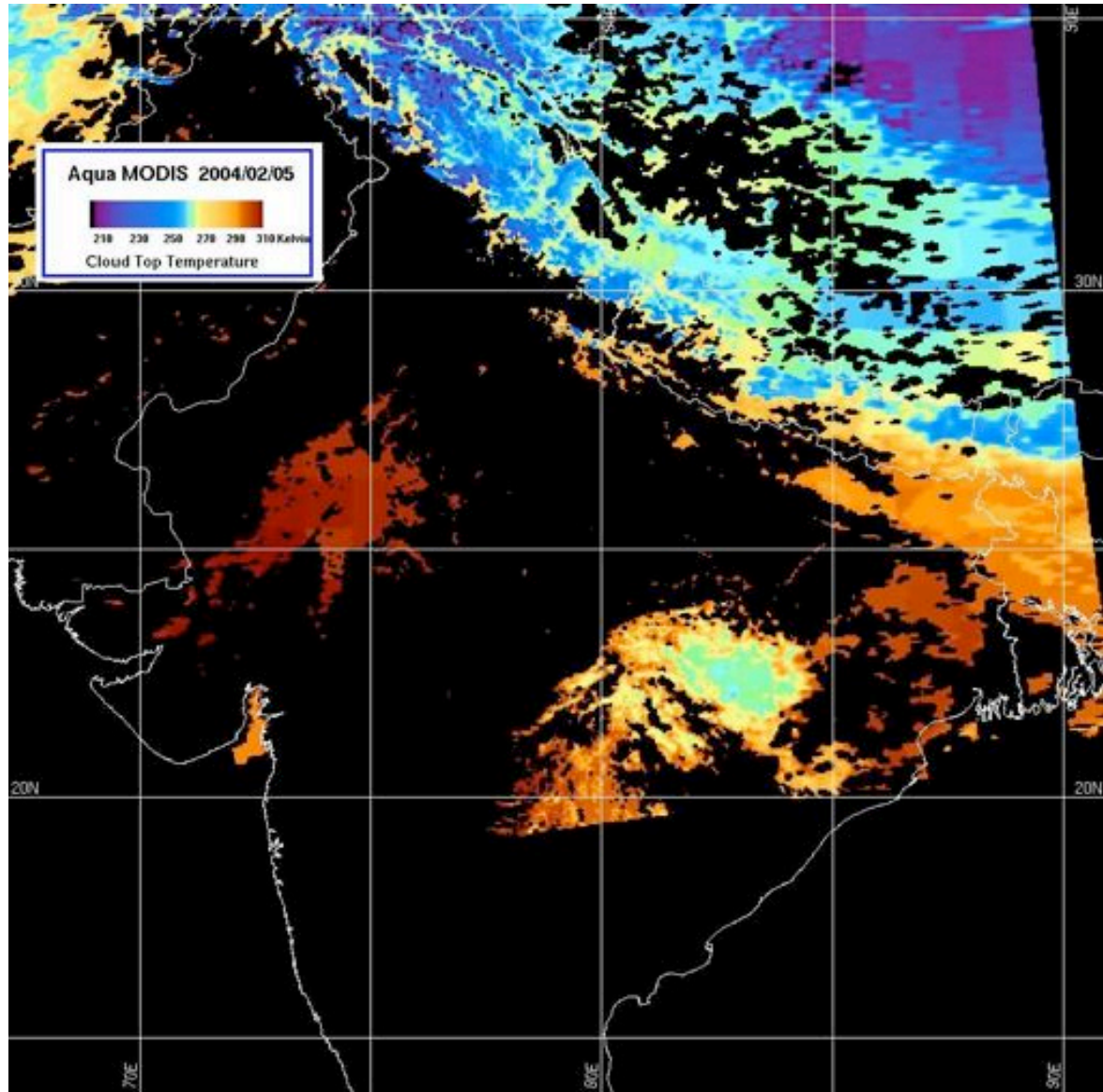
MOD06 Cloud Top product

Cloud Top Temperature

Aqua/MODIS 1000m calibrated data as inputs to the MOD06 algorithm – Automated supervised classification scheme

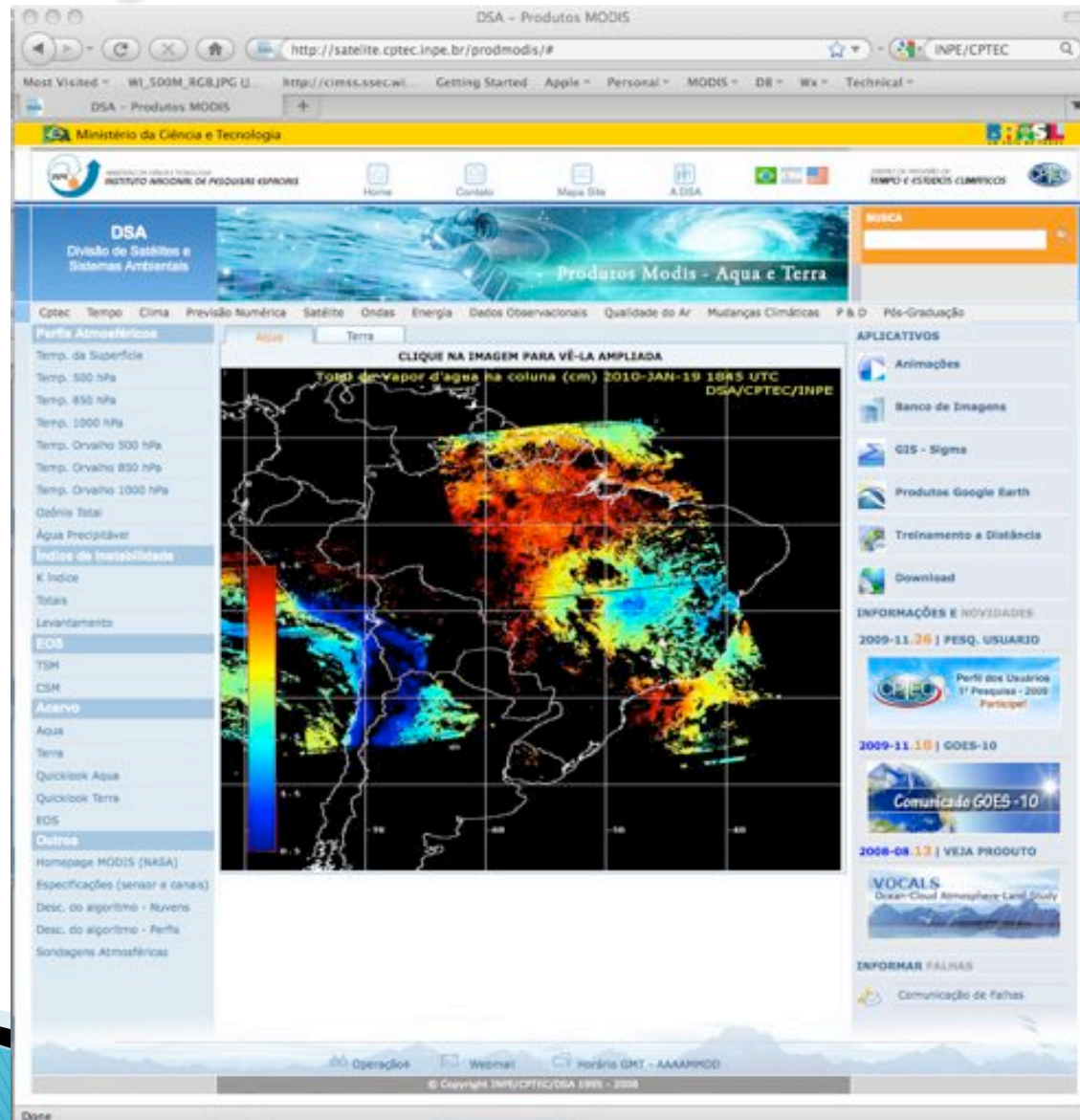
**Estimates cloud top temperatures**

**SeaSpace Example:  
5 February 2005**





# INPE/CPTEC Real Time Page Supporting Forecasting, Assimilation and Climate Research



AQUA MODIS  
TPW  
19 Jan 2010



# Using MODIS cloud mask to interactively choose DB scenes

EOStation.ScanEx.ru

MODIS data >> Search&Browse interactive tool

Using this interactive search tool you may find required MODIS granules in our archive. To specify region of interest select one or more cells clicking with left mouse button on the map below. Hold "Alt" key with the mouse click to deselect cells. Then set additional criteria (date interval, minimum % of valid data in cell, maximum cloudiness per cell and operation mode) and press the "Do search" button to obtain a list of suitable passes.

From date: 2003-10-10 To date: 2009-11-16 Valid data: 100 % Cloudiness: <= 40 %

Day passes  Night passes

Do search

Pass ID	V.%	Cl.%
<input type="checkbox"/> PM0503212348	100	7
<input type="checkbox"/> PM0503202305	100	24
<input type="checkbox"/> PM0503200000	100	38
<input type="checkbox"/> PM0503192223	100	39
<input type="checkbox"/> PM0503162330	100	20
<input type="checkbox"/> PM0503152247	100	6
<input type="checkbox"/> PM0503122354	100	5
<input type="checkbox"/> PM0503052348	100	39
<input type="checkbox"/> PM0503040000	100	6
<input type="checkbox"/> PM0503032223	100	26
<input type="checkbox"/> PM0503022317	100	3
<input type="checkbox"/> PM0503012235	100	6
<input type="checkbox"/> PM0502282342	100	36
<input type="checkbox"/> PM0502232311	100	20
<input type="checkbox"/> PM0502230007	100	2
<input type="checkbox"/> PM0502222229	100	1
<input type="checkbox"/> PM0502212324	100	17
<input type="checkbox"/> PM0502202241	100	32
<input type="checkbox"/> PM0502182253	100	32
<input type="checkbox"/> PM0502132235	100	29
<input type="checkbox"/> PM0502122330	100	19
<input type="checkbox"/> PM0502072312	100	32
<input type="checkbox"/> PM0502052324	100	0
<input type="checkbox"/> PM0502042241	100	9
<input type="checkbox"/> PM0502032336	100	12

Map Layers:  Coastlines  Boundaries  Graticule 5x5°  Rivers  Russian regions  Coverage zone

©2003, R&D center ScanEx

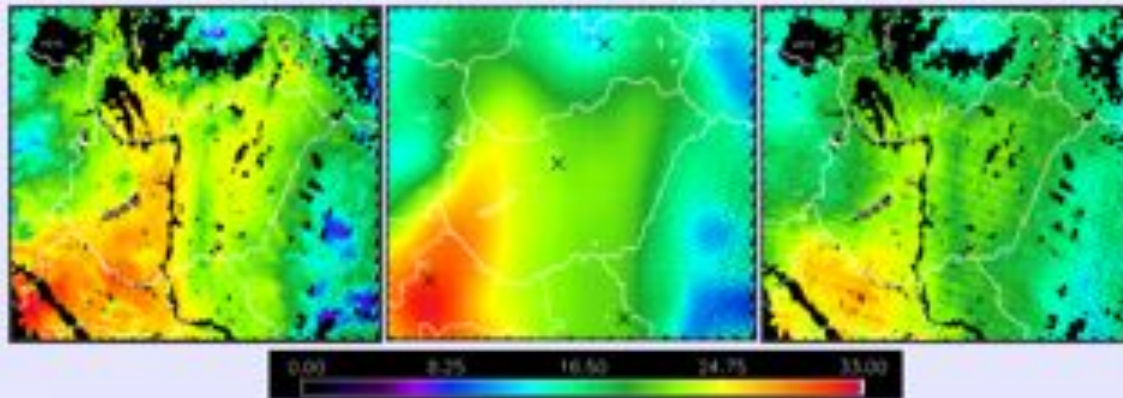
ScanEx  
Russia

<http://eostation.scanex.ru/data/cellquery.html>

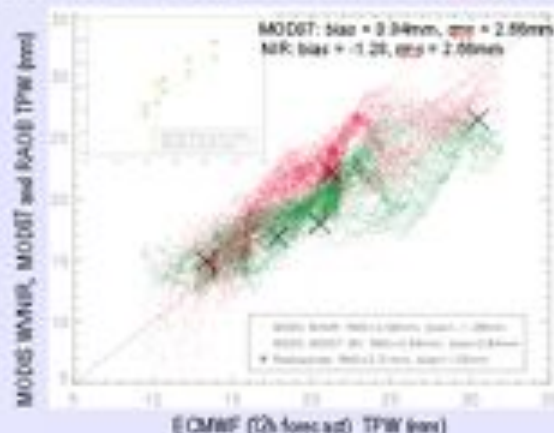
# Estimation of vertically integrated water vapor in Hungary using MODIS imagery

Aniko Kern, Judit Bartholy, Eva E. Borbas, Zoltan Barcza, Rita Pongracz, Csaba Ferencz, 2008: *Advances in Space Research*, 41, 1933–1945.

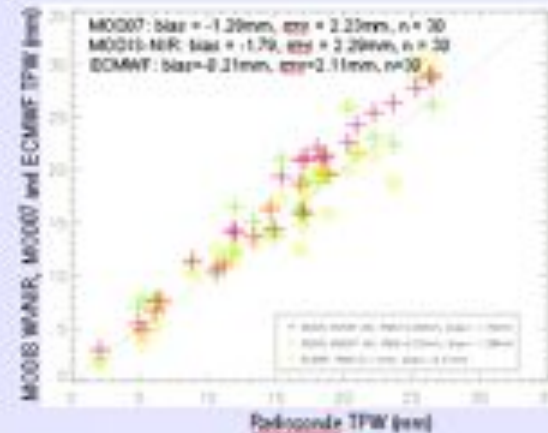
## Comparison of IR and NIR TPW over the Carpathian Basin



Comparison of the MODIS Near-IR (left), ECMWF forecast (middle) and MOD07 (right) derived TPW for Terra satellite on Sept 8 2005 at 9:55 UTC. (Radiosonde stations are indicated by X on the middle image). The MODIS data were received at the MODIS DB station in Budapest, Hungary.

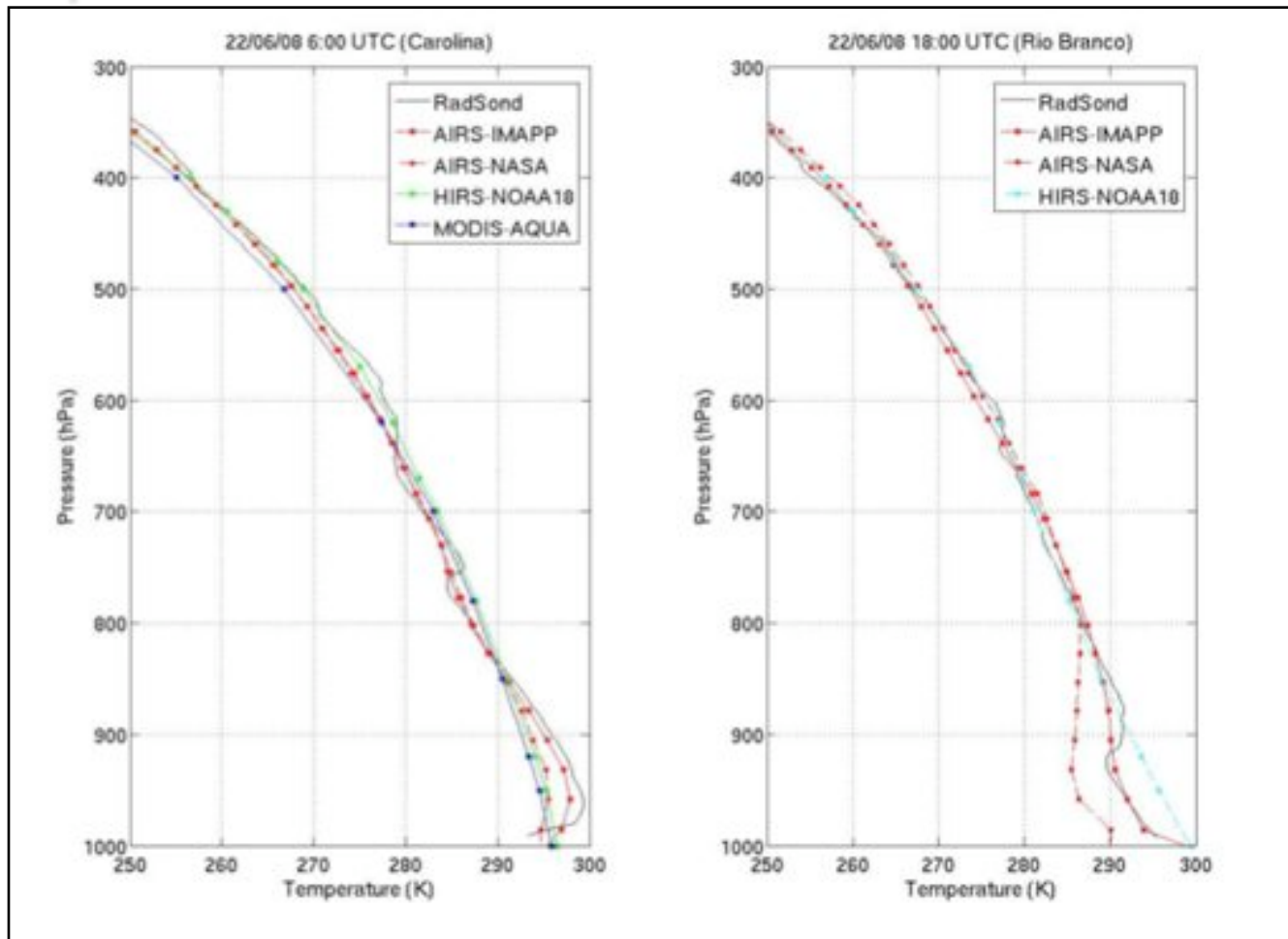


Comparison of TPW from MOD07 (red+), Near-IR WV (green+), and radiosonde (black crosses) with the ECMWF 00+12 h forecast for September 8, 2005, 9:55 UTC



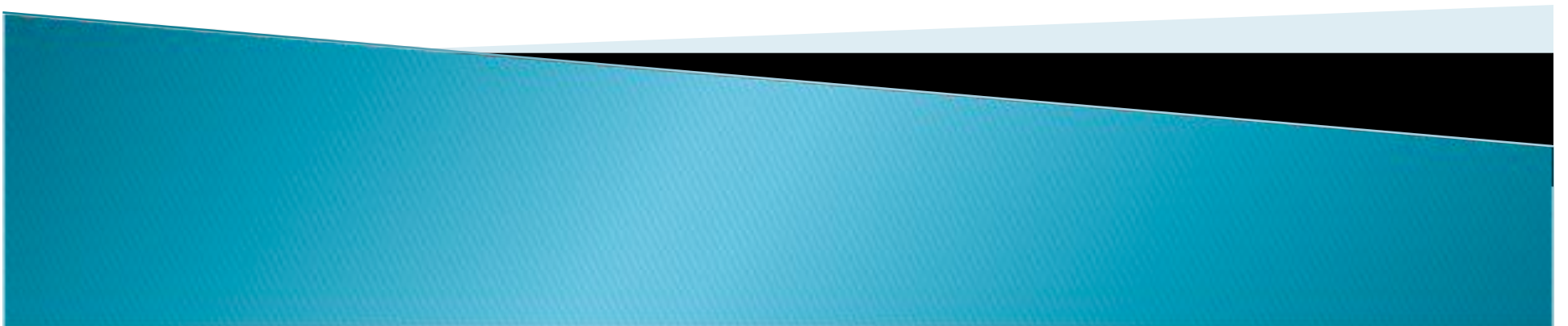
Comparison of TPW from MOD07 (green+), Near-IR WV (red+), and ECMWF (yellow) with the radiosondes for 20 Terra clear sky overpasses between March 2005 and Jun 2006.

# Comparison of Real Time Retrievals in Brazil



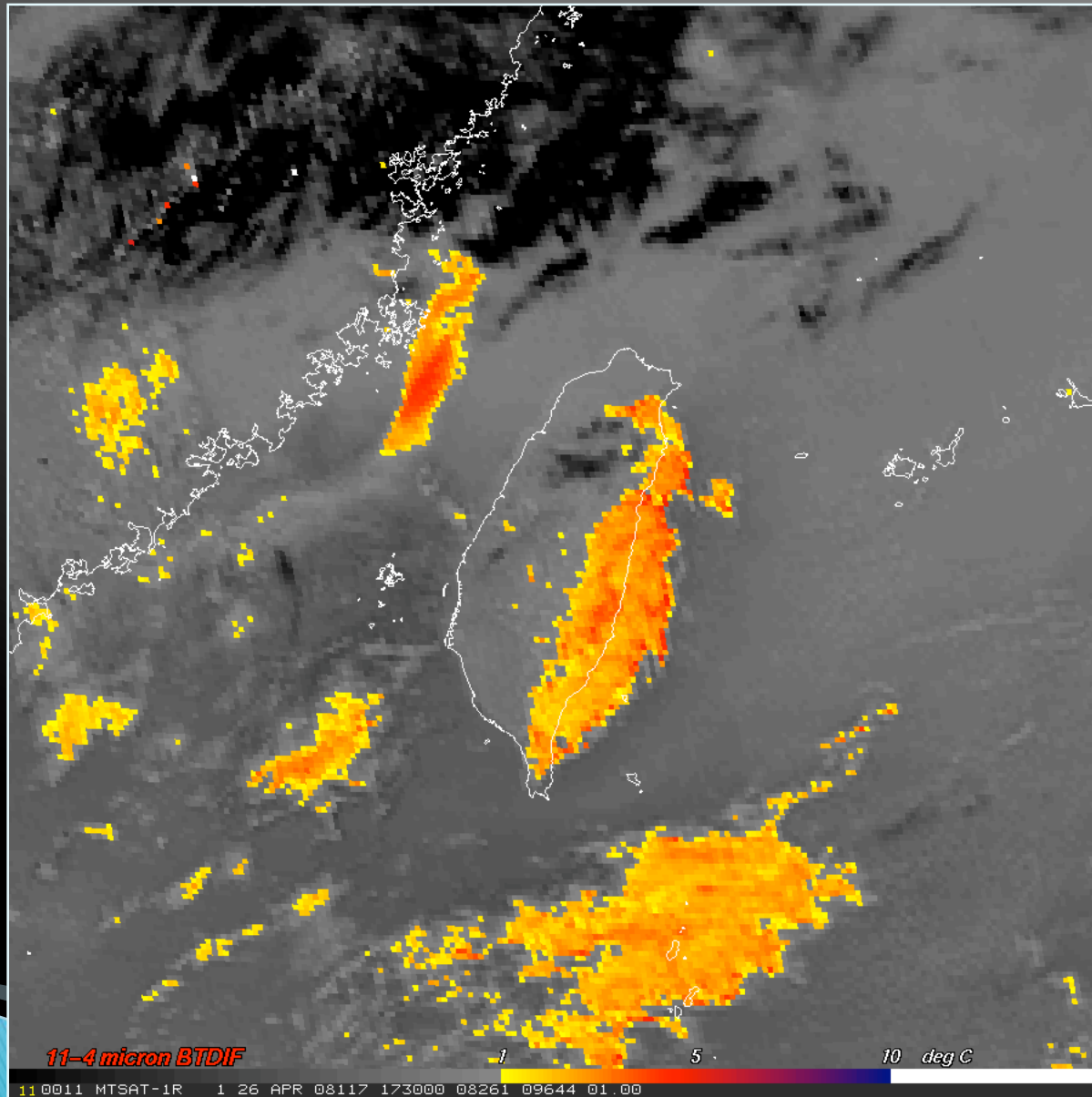
Vertical profiles of temperature retrieved for different sensors and algorithms compared with two radiosondes from the MiniBarca campaign, performed by CPTEC/INPE personnel from June 2008.

# Fog Detection

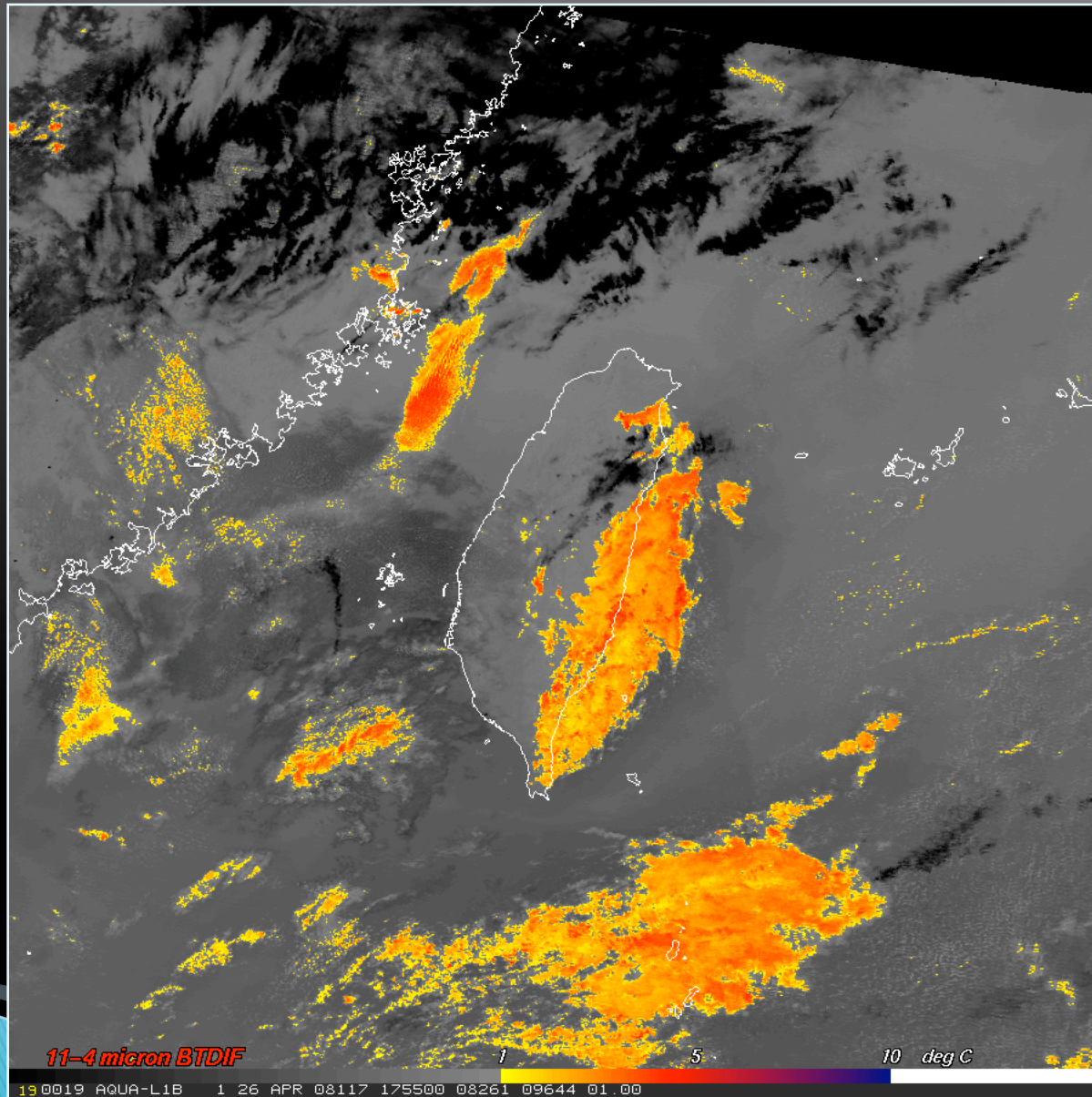




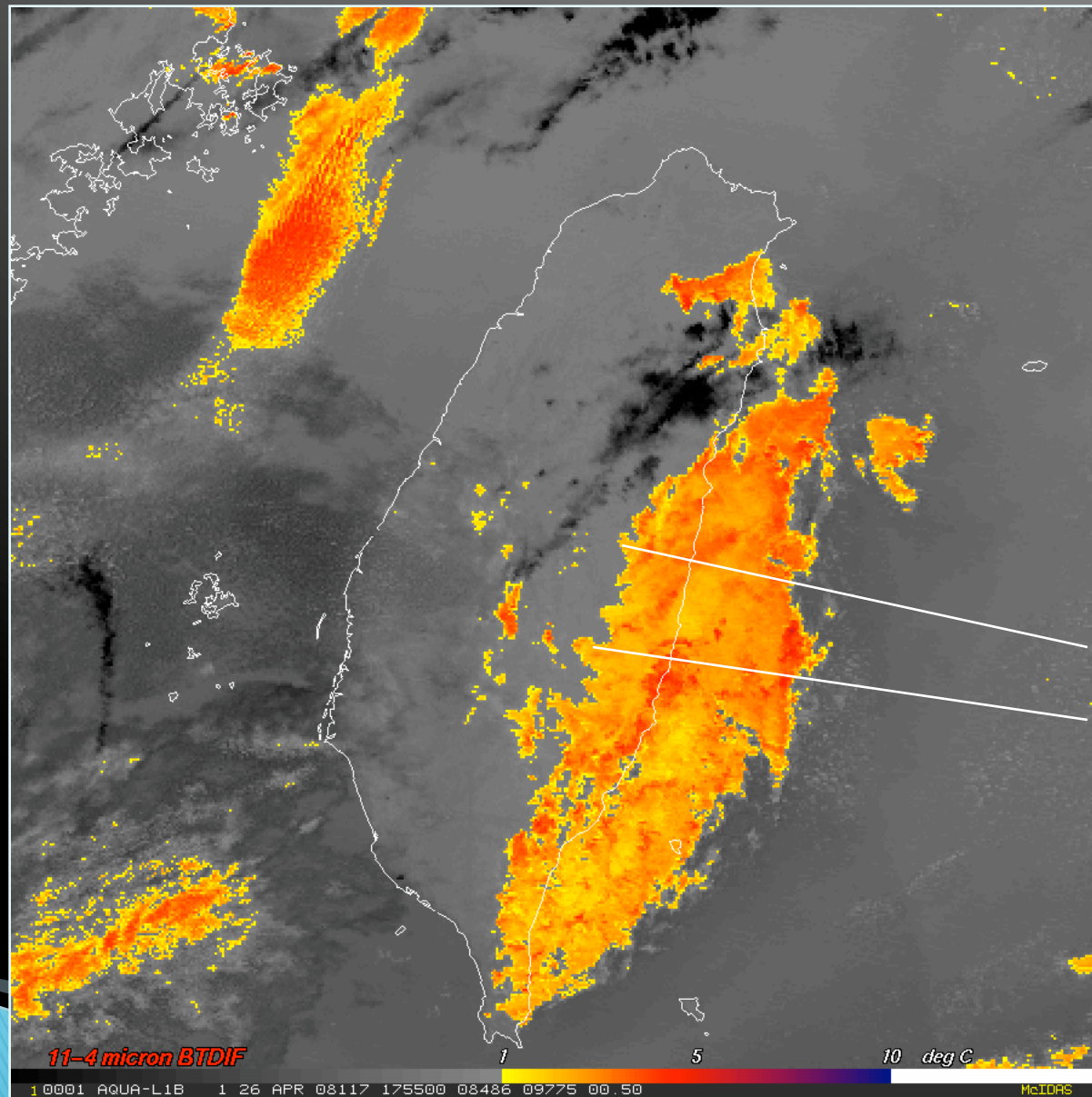
# Example MTSAT Low Cloud Fog Product



# Example MODIS Low Cloud Fog Product



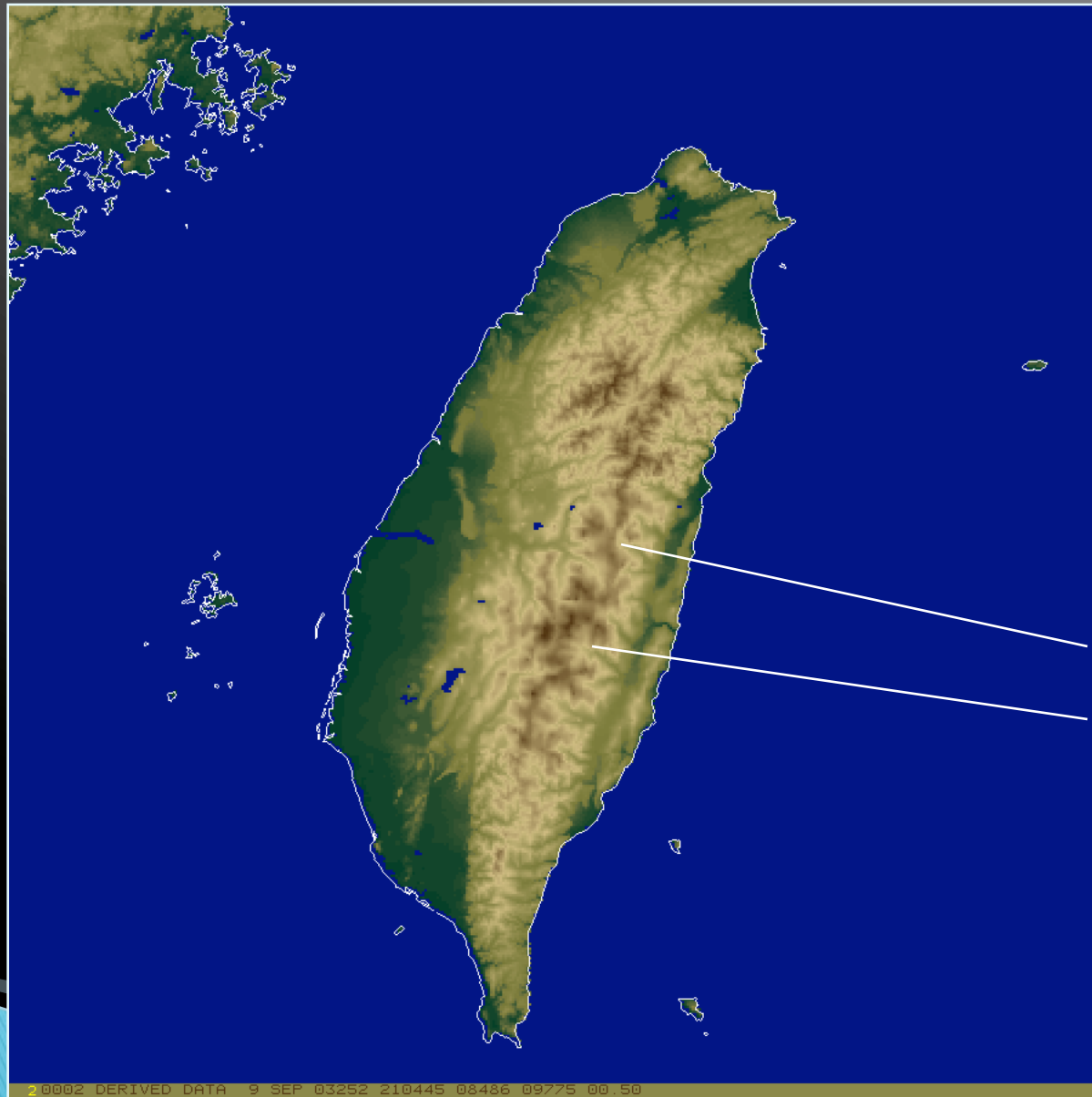
# MODIS Fog and Topography



Fog entering  
into valleys



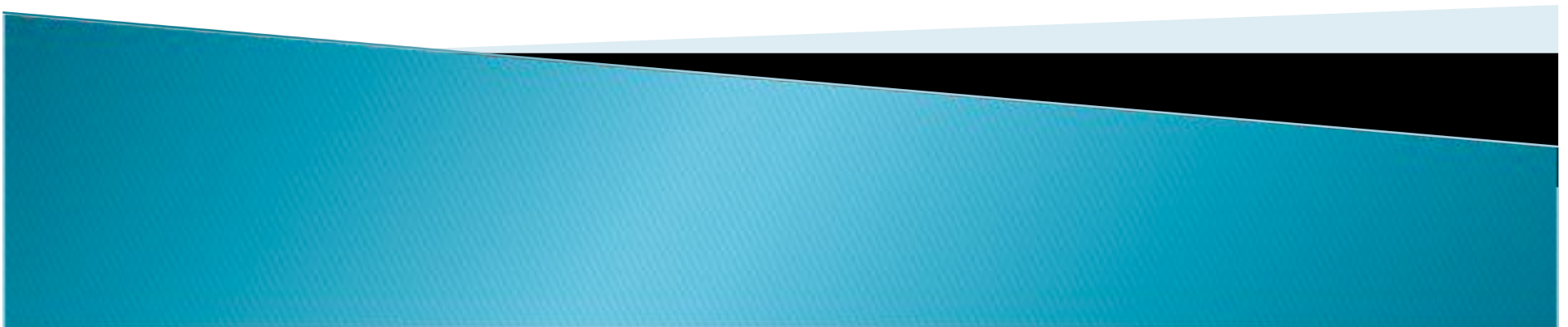
# MODIS Fog and Topography



Fog entering  
into valleys

# Numerical Weather Prediction

Good Grief, what is this doing here?

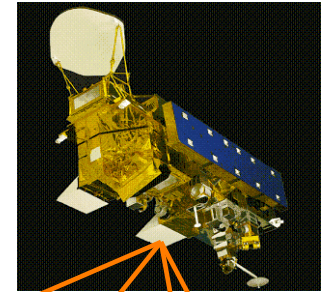




The Cooperative Institute for Meteorological Satellite Studies  
University of Wisconsin, Madison

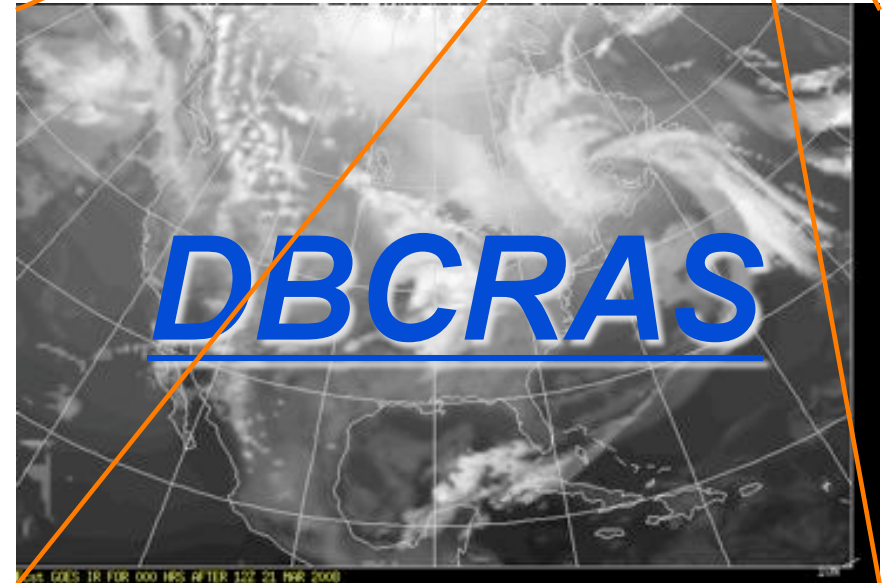


# The Direct Broadcast Version of the CIMSS Regional Assimilation System for Global Users



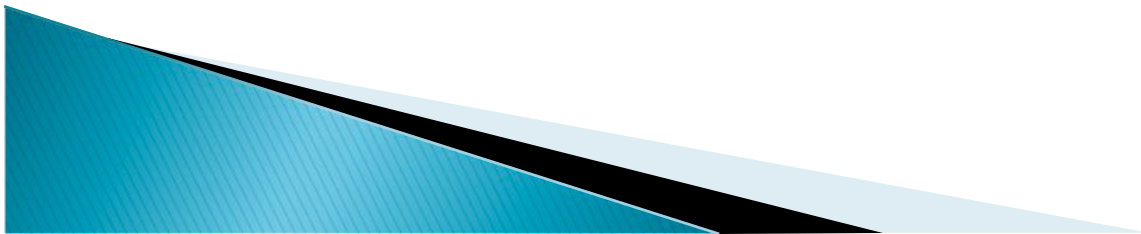
**Bob Aune**

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



# Why should I care about DBCRAS?

- ▶ Configurable anywhere in the world
  - One time initial domain set-up. You provide central latitude/longitude
- ▶ Can run on any modest linux platform
- ▶ Produces standard meteorological products
  - Temperature, Moisture, Precipitation, Winds
- ▶ Provides unique products
  - Forecast water vapor and IR window satellite imagery



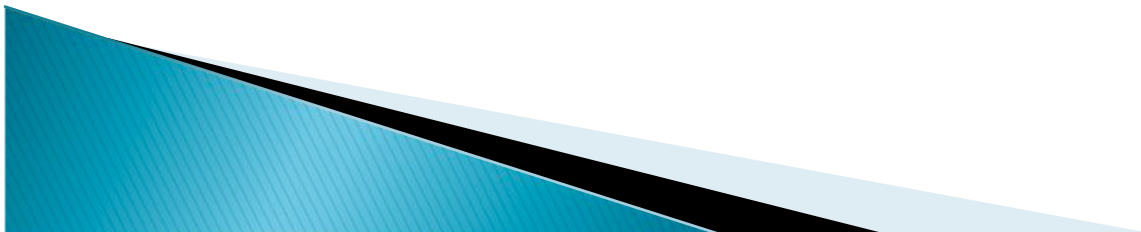
# Why should I care about DBCRAS?

- ▶ 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



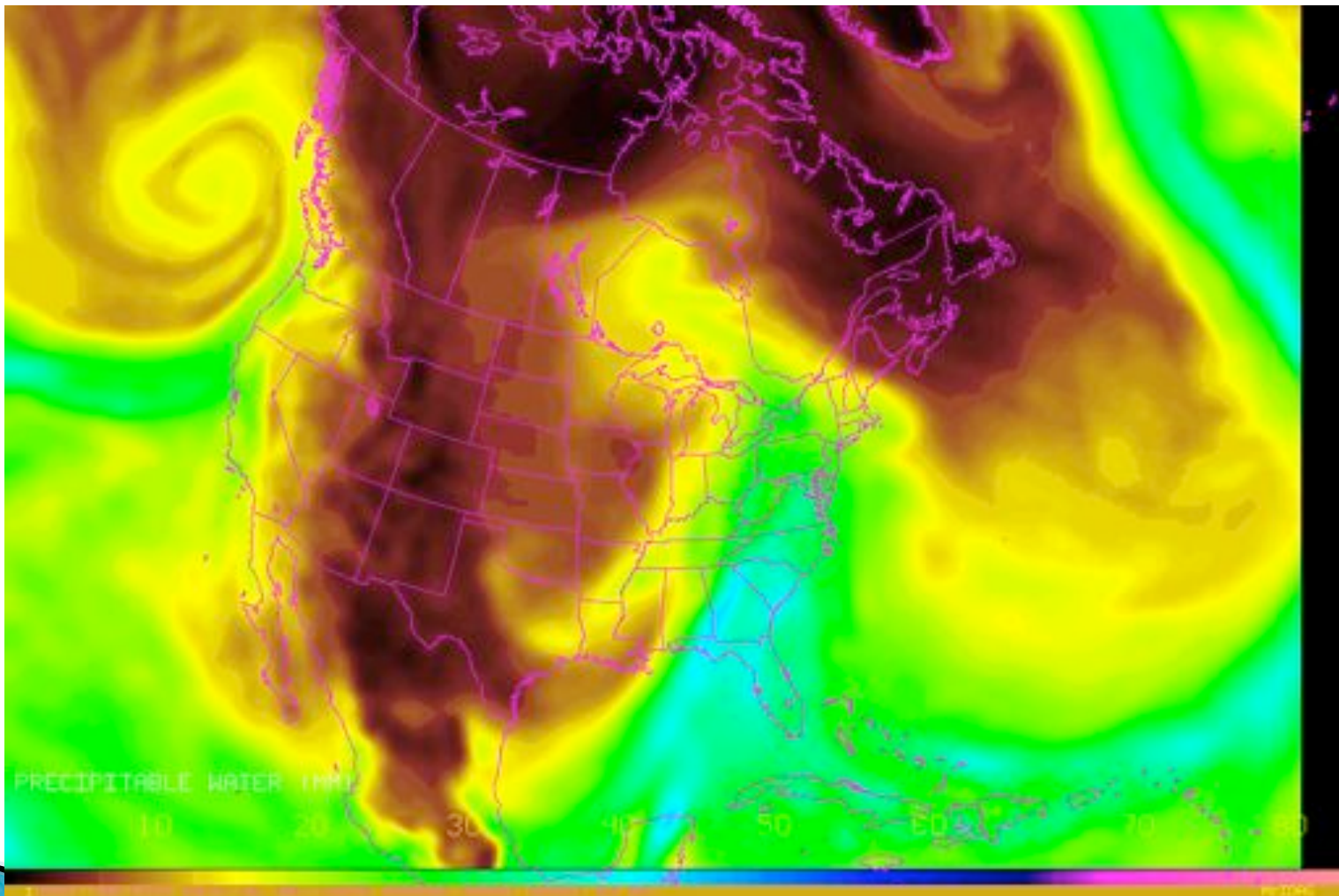
# Why should I care about DBCRAS?

- ▶ Products created at 48 km resolution out to 72 hours
- ▶ Automatically creates forecast imagery
- ▶ Nest at 16 km out to 48 hours



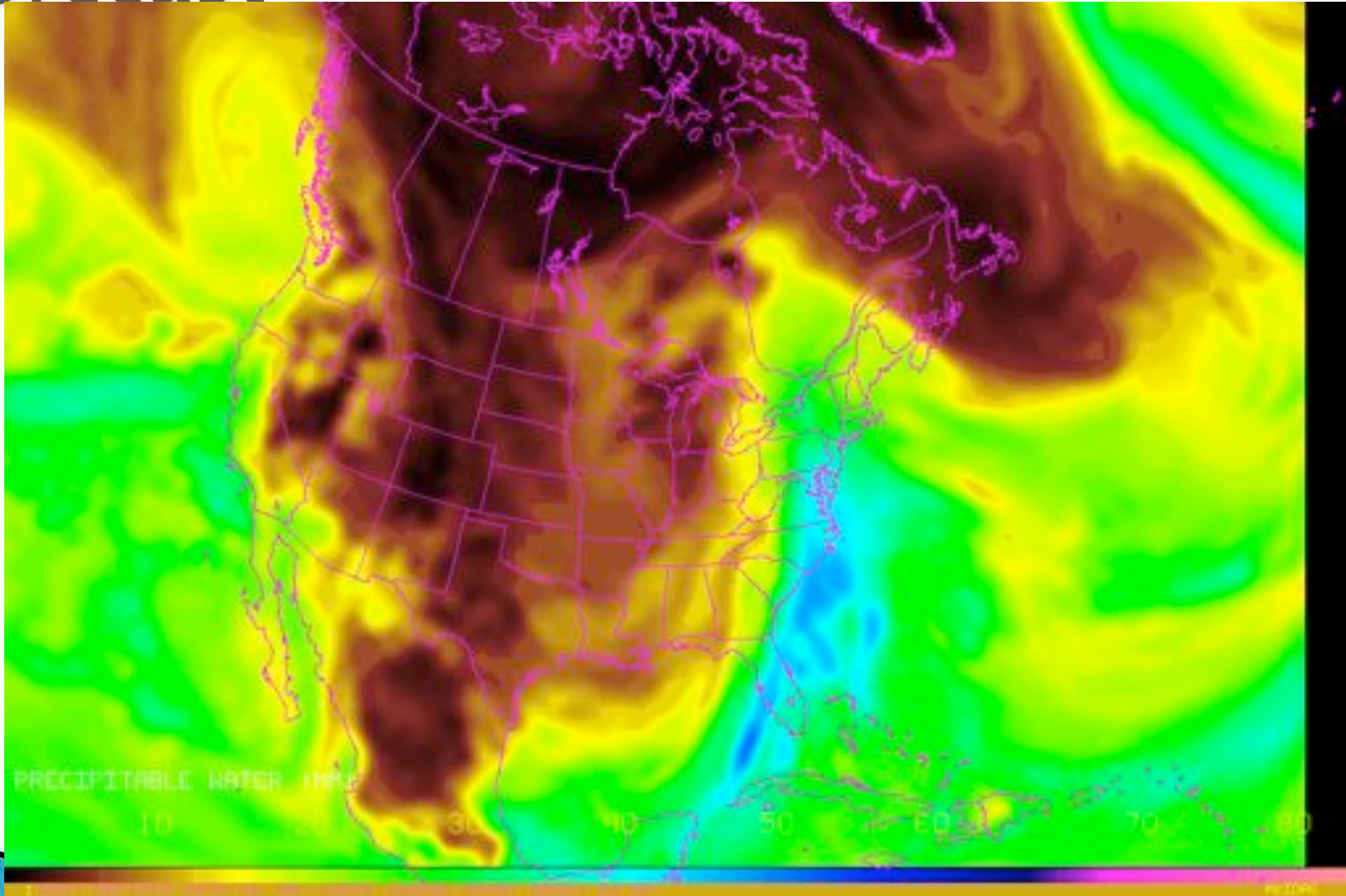


# DBCRRAS 12 Hour Spin-up Showing MODIS Product Assimilation Effect



DBCRRAS 12 hour Pre-forecast 48 km resolution 00 UTC 25 January 2010

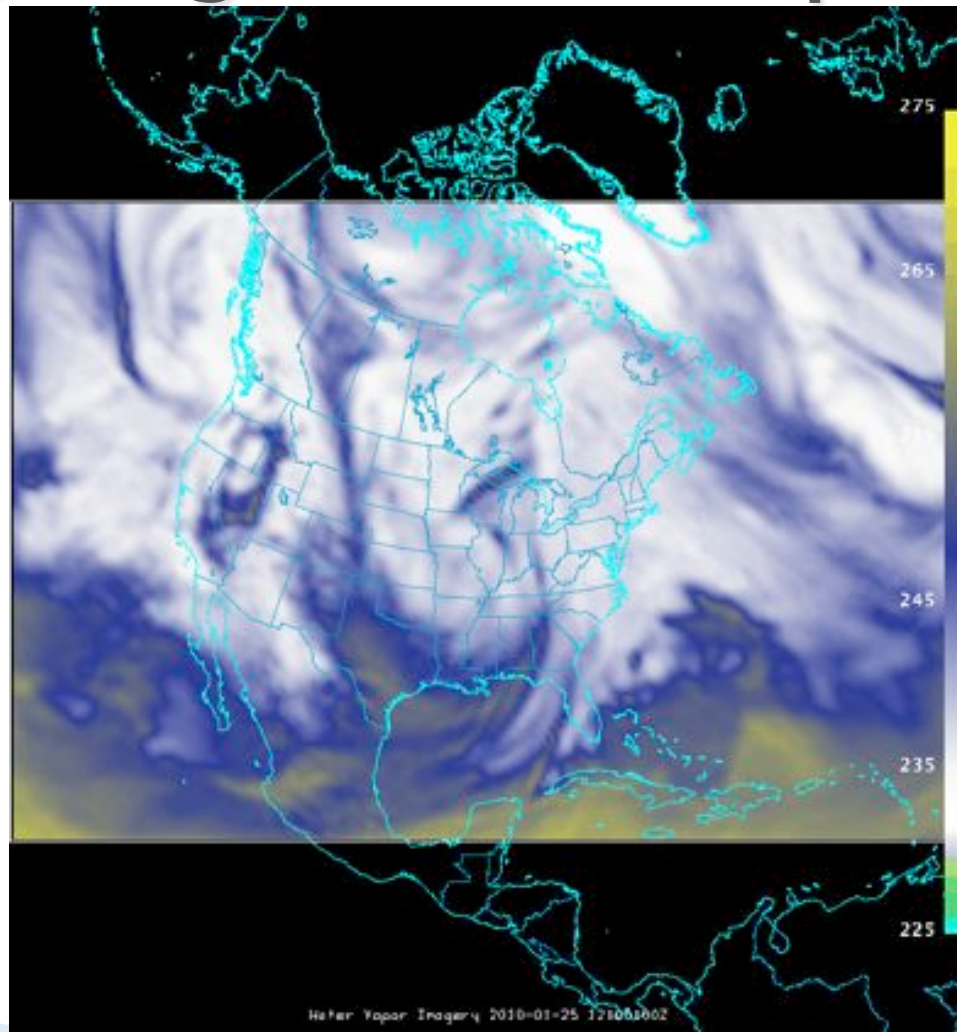
# DBCRRAS Precipitable Water Forecast



DBCRRAS 72 hour Forecast 48 km resolution 12 UTC 25 January 2010

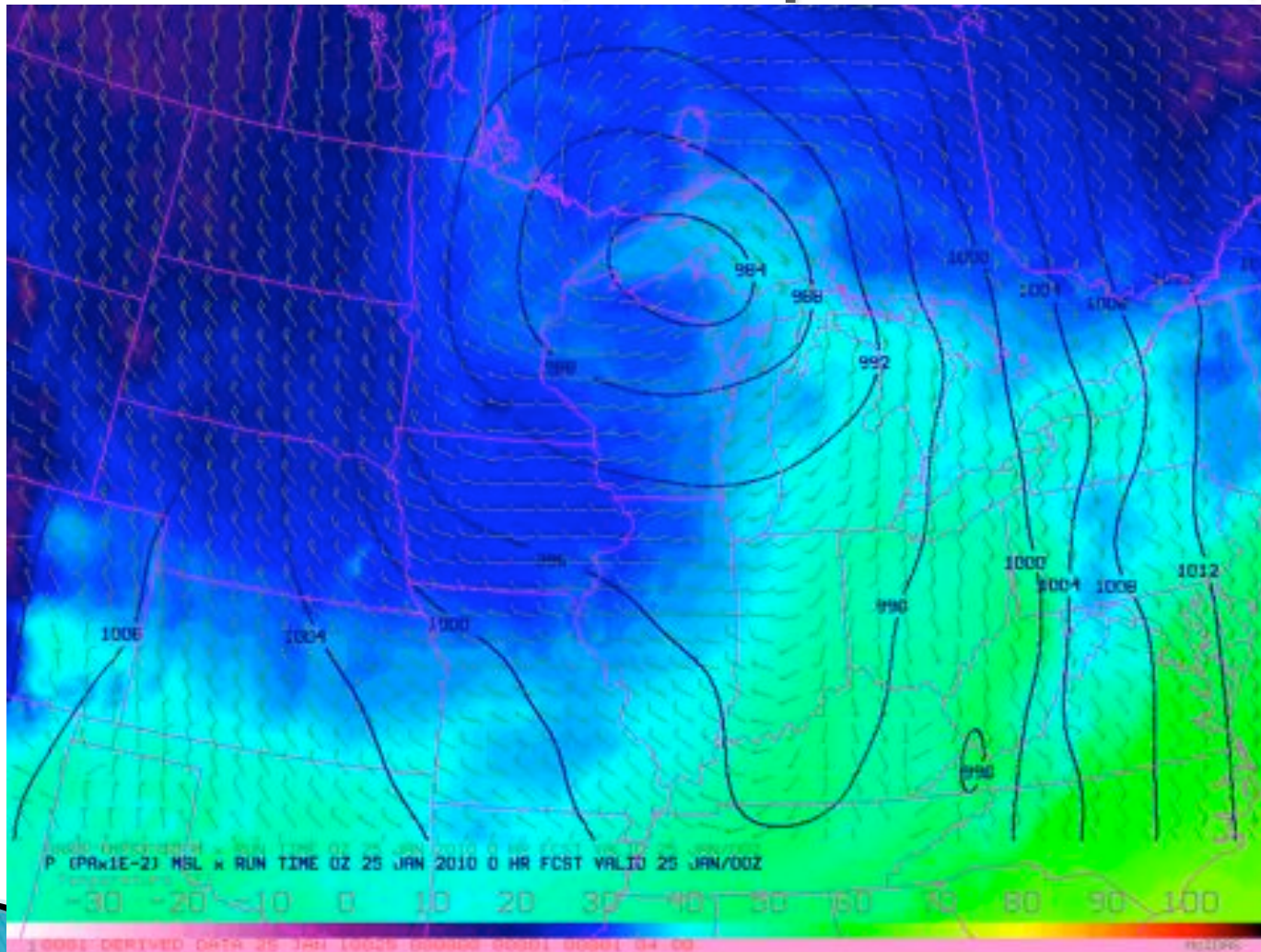


# DBCRRAS Forecast Water Vapor (6.7 micron) Brightness Temperatures



DBCRRAS 72 hour Forecast 48 km resolution 12 UTC 25 January 2010

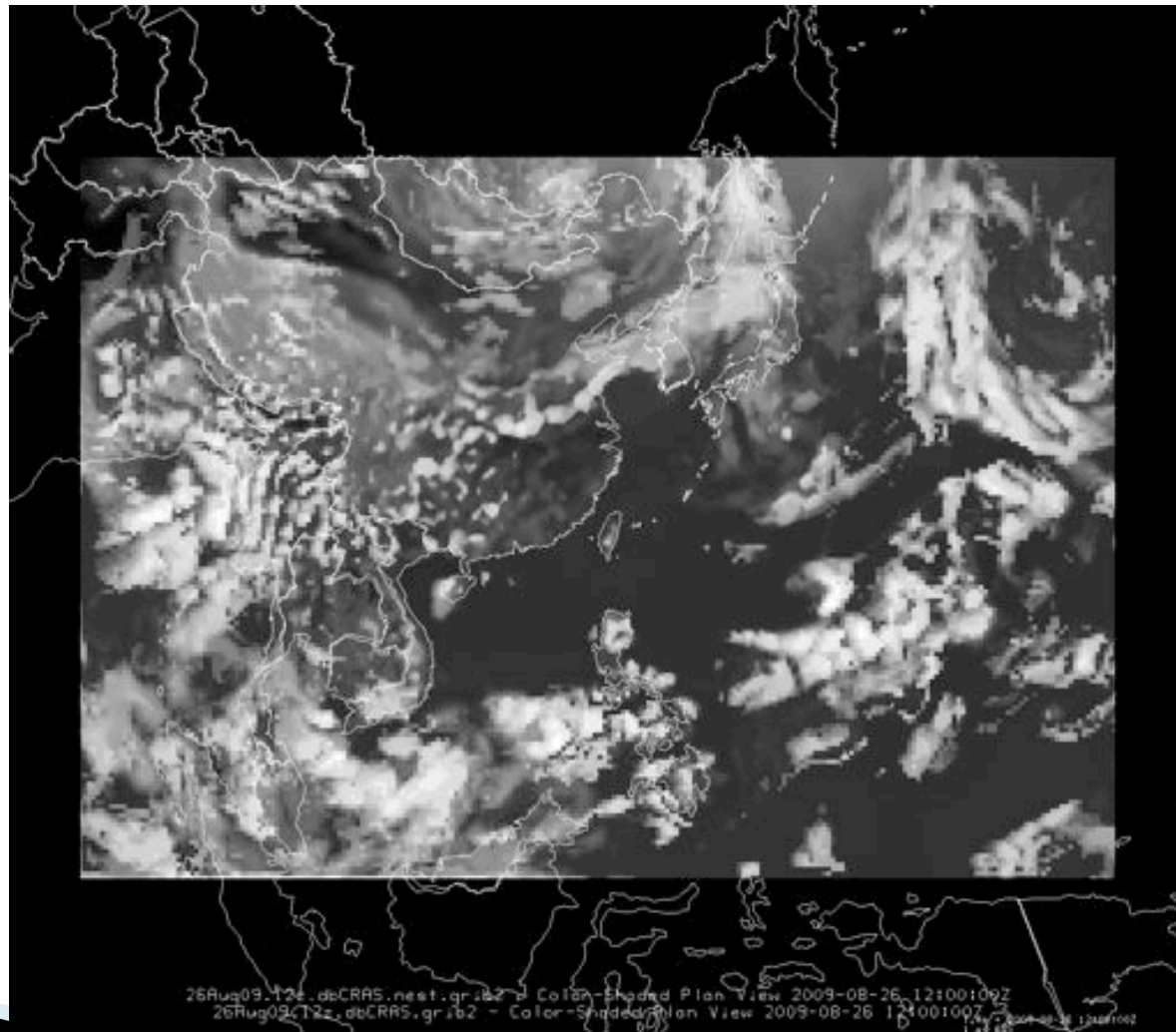
# DBCRRAS NEST Forecast SLP, 850 mb winds, temperatures (F)



DBCRRAS 48 hour Forecast 16 km resolution 00 UTC 25 January 2010



# DBCRRAS 48 km + 16 km Nest used by Taiwan CWB



DBCRRAS 72 hour Forecast IR Brightness Temperatures 12 UTC 26 Aug 2009

# Applications

## ▶ Why is this important?

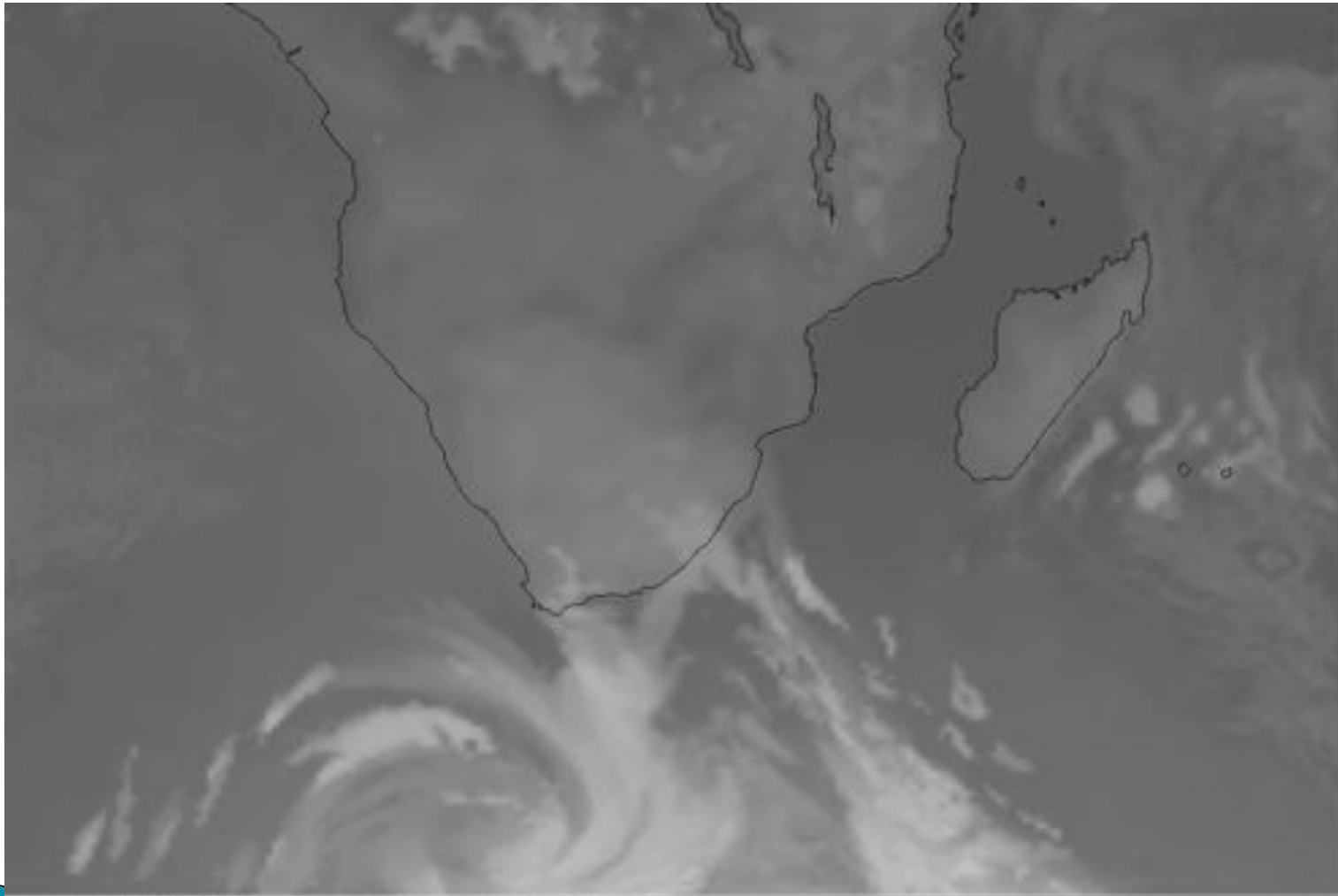
- Information provided that cannot be obtained from anywhere else – especially small/poor countries

- 2009-08-21\_11:02:08", "Ricardo", "Alcafuz", "ricardo@meteochile.cl", "Chilean Weather Service", "To implement DBCRAS over Chile"

## ▶ Weather Forecasting

- We know it has been installed and run at:
  - Italy
  - Hungary
  - Brazil
  - South Africa \*
  - Taiwan

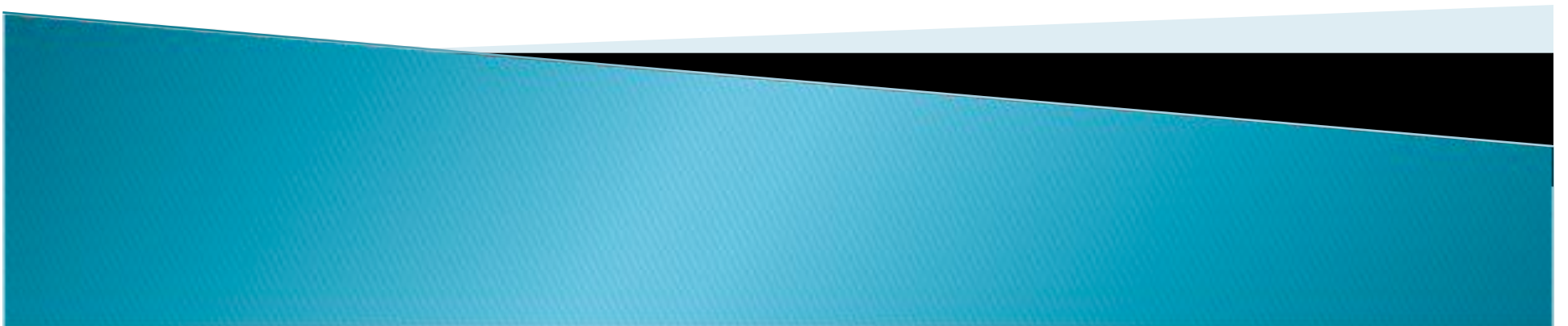
# DBCRCAS IR Window



0001 DERIVED DATA 26 Jul 07207 000000 00001 00001 04.00

DBCRCAS 72 hour Forecast 11  $\mu\text{m}$  Brightness Temperatures 00 UTC 26 July 2007

# Global Outreach





# Direct Broadcast Workshops

Web site: <http://cimss.ssec.wisc.edu/dbs/>

2004 – Nanjing, China

2004 – Perth, Australia

2005 – Taipei, Taiwan

2005 – Beijing, China

2006 – Andenes, Norway

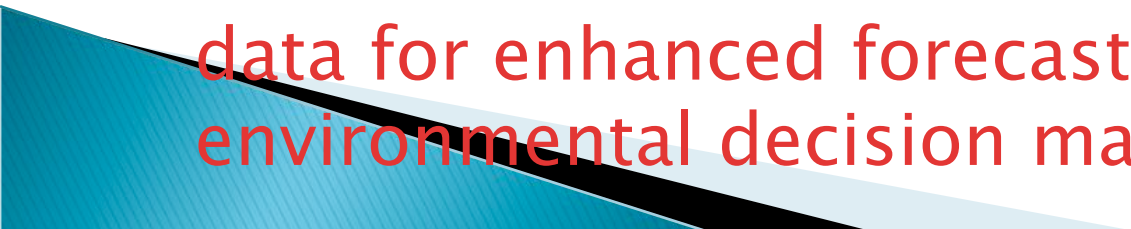
2006 – Pretoria, South Africa

2007 – Cachoeira Paulista, Brazil

As part of GEOSS

2009 – Stellenbosch University, South Africa

**IGARSS Short Course 4: MODIS direct broadcast data for enhanced forecasting and real-time environmental decision making**



# Why is this important?

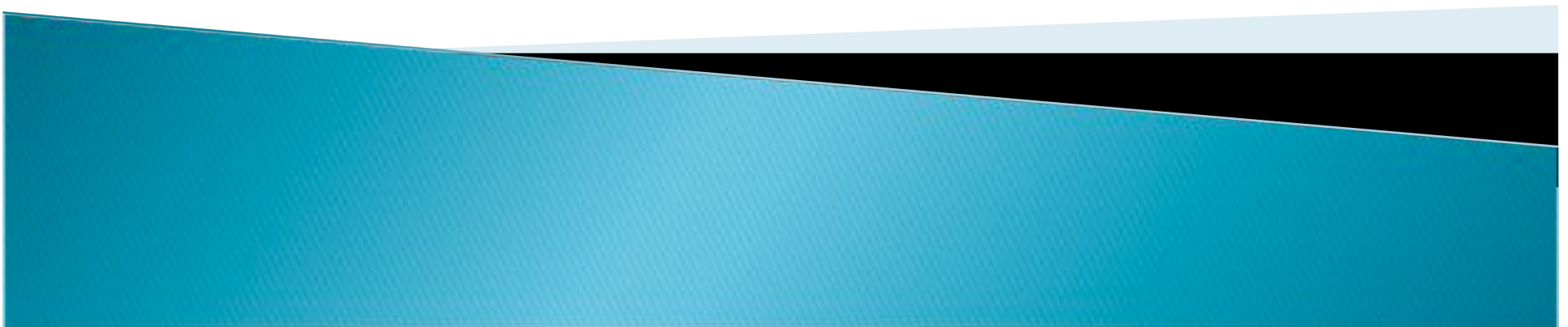
- ▶ Teach the principles of remote sensing to foster the next generation of scientists
  - Building on the work of Paul Menzel
  - 3 students from schools/workshops at UW now
- ▶ Promote the use of Satellite data
  - Lectures and hands-on labs determined by student interest – atmospheric products stressed
  - Lectures, labs, data and software freely distributed
  - How can the data better lives?
- ▶ Encourages international collaborations
- ▶ Web site contains all materials used in courses: <http://cimss.ssec.wisc.edu/dbs/>

# Radiative Transfer and Cloud Products

- ▶ Cloud mask tests provide good overview of MODIS bands
  - Individual and bi-spectral tests take advantage of absorption/scattering of clouds/land/atmosphere
  - Labs include hands on exploration of bands and student evaluation of cloud mask algorithm for their (usually DB) scene
- ▶ Others
  - Cloud phase – bi-spectral test and temperature sensitivity
  - Fog detection – bi-spectral test and IR emissivity



# Case Study





FleetWatch Online - 70-Fog-N12Crash

http://www.fleetwatch.co.za/magazines/Aug2005/70-Fog-N12Crash.htm

atch 2005 Beware the Fog

Most Visited - WJ\_500M\_RCR\_PC\_U - http://www.uscc.ac.za - Getting Started - Apple - Personal - MOODS - DS - Wx - Technical -

# FleetWatch

THE DEFINITIVE TRUCKING SITE 2005

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**Past Issues** **August 2005**

## BEWARE THE FOG

Summertime in South Africa is a dangerous season for road users. The rain pelts down, the roads get slippery, the December holidays bring greater volumes of traffic on our national roads and the festive season pours hordes of drinkers behind their steering wheels. When one considers winter time on our roads, one imagines the odd bit of ice or snow here and there with not much else to pose an 'out-of-the-ordinary' threat to road safety. How wrong this is! A recent report of an accident on the N12 suggests that winter may be even 'sillier' than summer' and highlights the need for drivers to exhibit extreme caution and slow down their speed when they come into foggy or misty conditions writes *Paul Collings*.

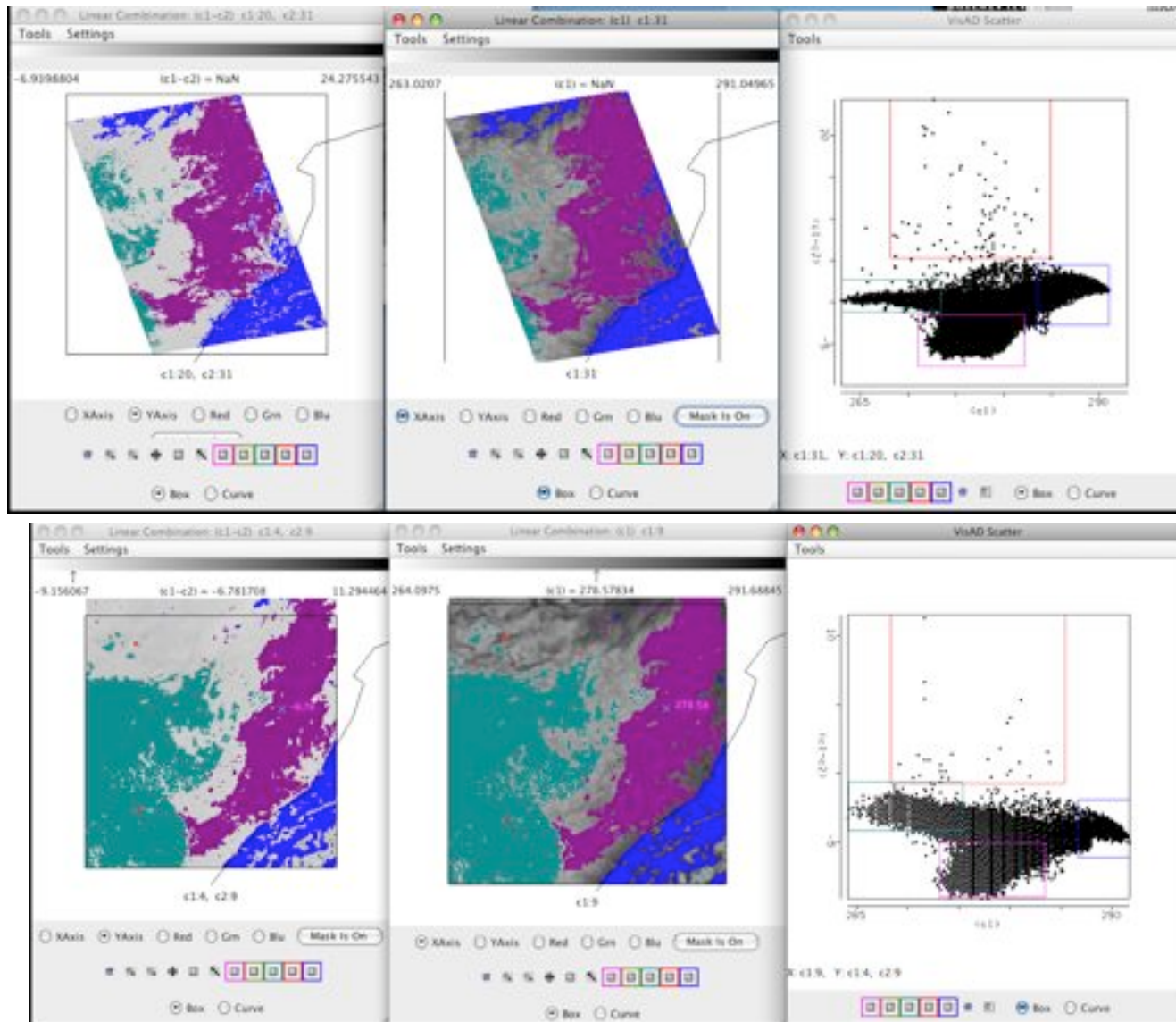
The N12 between Mpumalanga and Gauteng is a well traversed heavy truck route. Witbank is a mining town on this route and famous for its coal and other raw materials. For some reason, it hasn't been famous for its fog - until now that is.

On Thursday July 28th, in a fog bank where visibility was down to 2m on certain stretches of the N12, 12 trucks and two light vehicles were involved in a pile-up. Thankfully, no one was killed but there were several seriously injured drivers and passengers. The cost to the vehicle owners is still being tallied but you can bet your bogey, accidents like these don't come cheap. **(pictures at the bottom of this page)**

According to SAPS Inspector Benny Kotze, "there's a 20km stretch of the N12 as it passes through Witbank where the fog gets very dense. Visibility is always limited and on that particular day, it was reduced to between 50m and 2m."

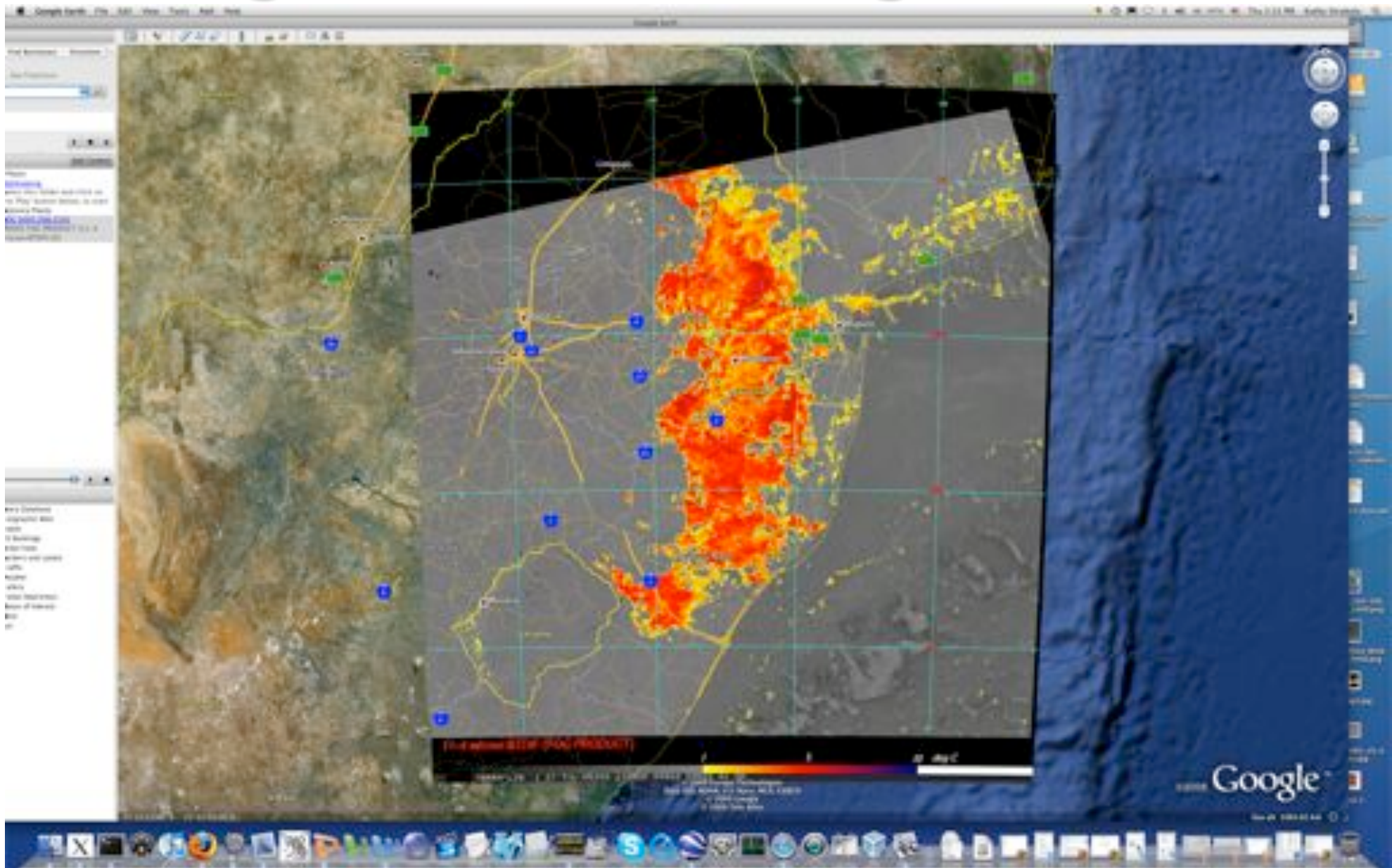
Done

# MODIS and SEVIRI Fog Detection





# Fog Product in Google Earth



# Student Presentations





- 

# Nanjing, China 2004



Nanjing 2004



# Andenes, Norway 2006

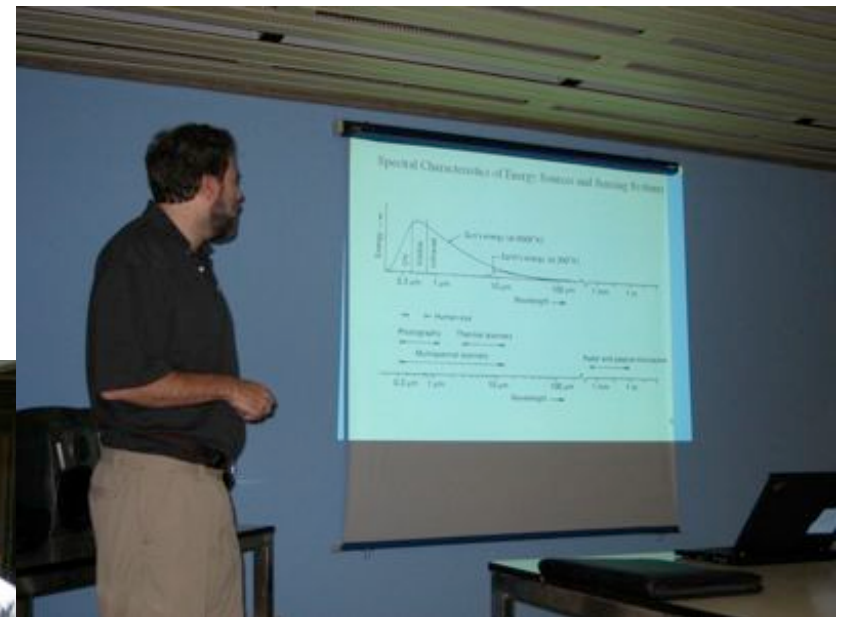




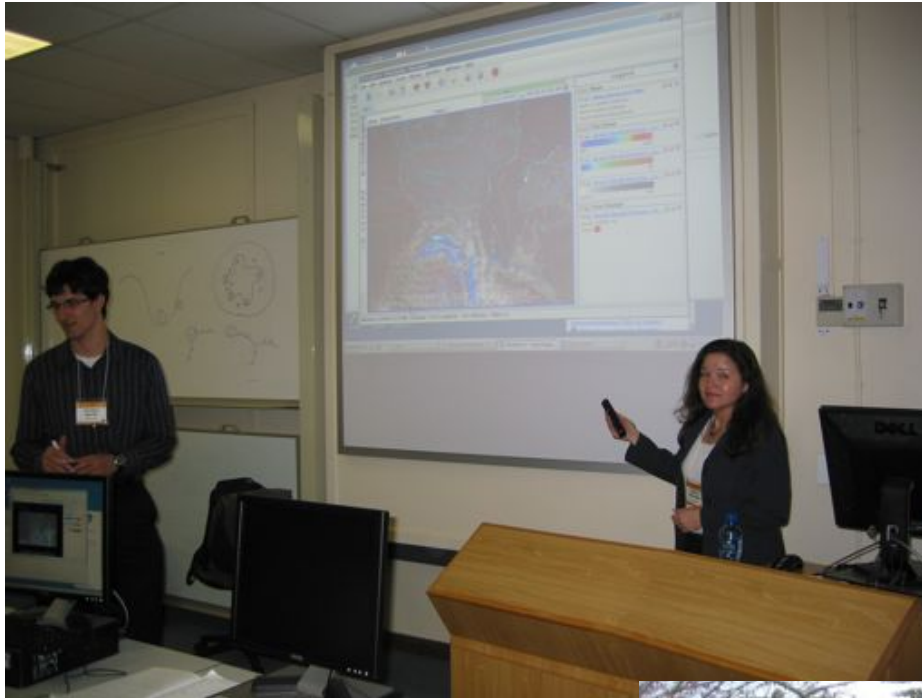
# Pretoria, South Africa 2006



# Sao Paulo, Brazil 2008







# Stellenbosch, South Africa 2009



# Conclusions

- ▶ Aqua and Terra direct broadcast products are being used by many countries for a wide variety of environmental applications
- ▶ The free distribution of data, products, software and visualization tools has promoted the creative use of the data
- ▶ We hope that future DB packages will do the same for future missions

