



# GOES IR Sounder – future perspective from current applications

**Jun Li<sup>@</sup>, Tim Schmit<sup>#</sup>, Jaime Daniels<sup>#</sup>, Gary S. Wade<sup>#</sup>,  
Jinlong Li<sup>@</sup>, Zhenglong Li<sup>@</sup>, Chian-Yi Liu<sup>@</sup>, W. Paul Menzel<sup>#</sup>  
(and many others)**

**ITSC-15, Maratea, Italy  
4 - 10 October 2006**

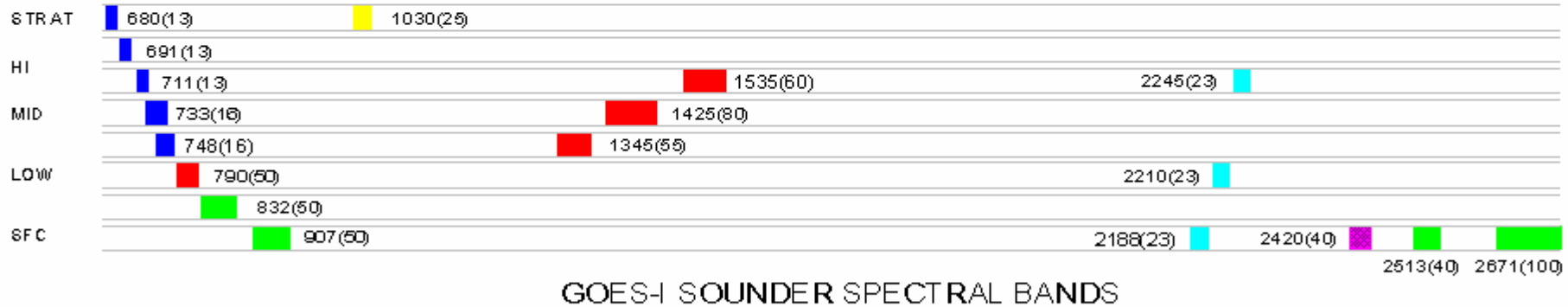
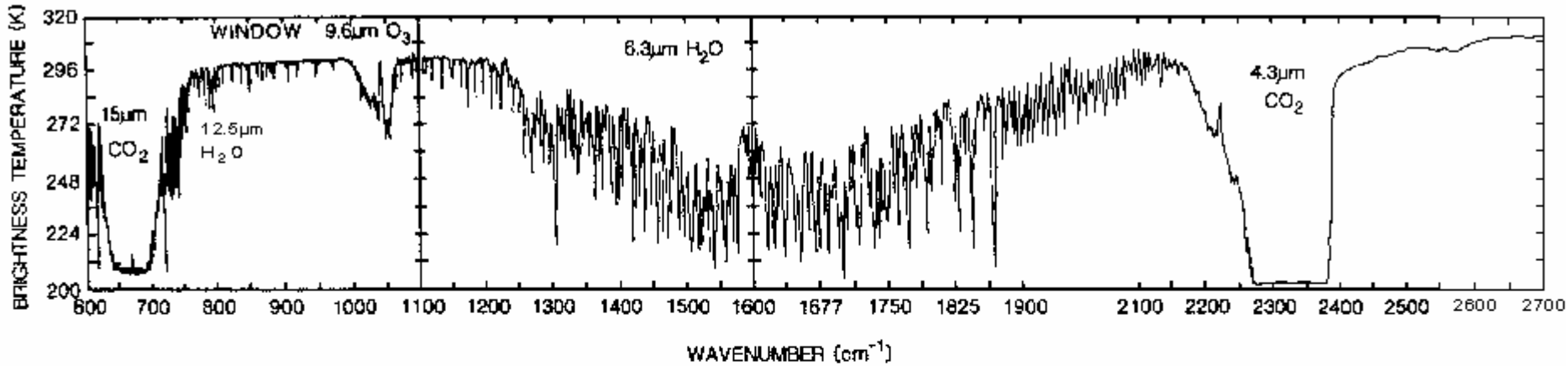
**@Cooperative Institute for Meteorological Satellite Studies  
University of Wisconsin-Madison  
#Center for Satellite Applications and Research  
NESDIS/NOAA**



# Outline

- GOES-I(8)/P Sounders
- Selected Applications of Current GOES Sounder Products
- Transition from Current GOES IR Sounder to Geo Hyperspectral IR Sounder
- Future Perspective of Geo IR Hyperspectral IR Sounder
- Summary

## EARTH EMITTED SPECTRA

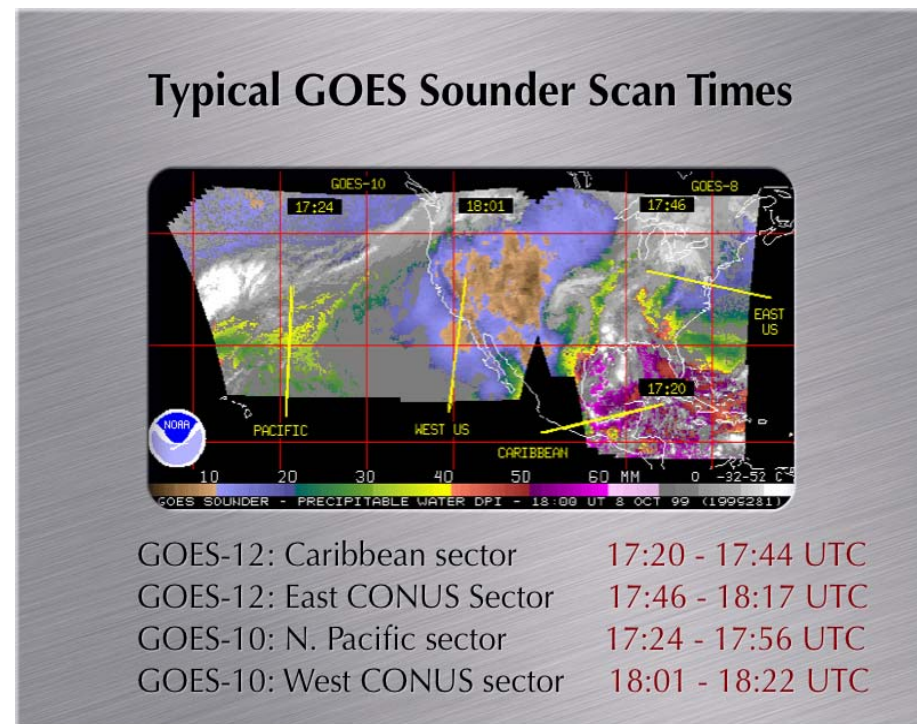
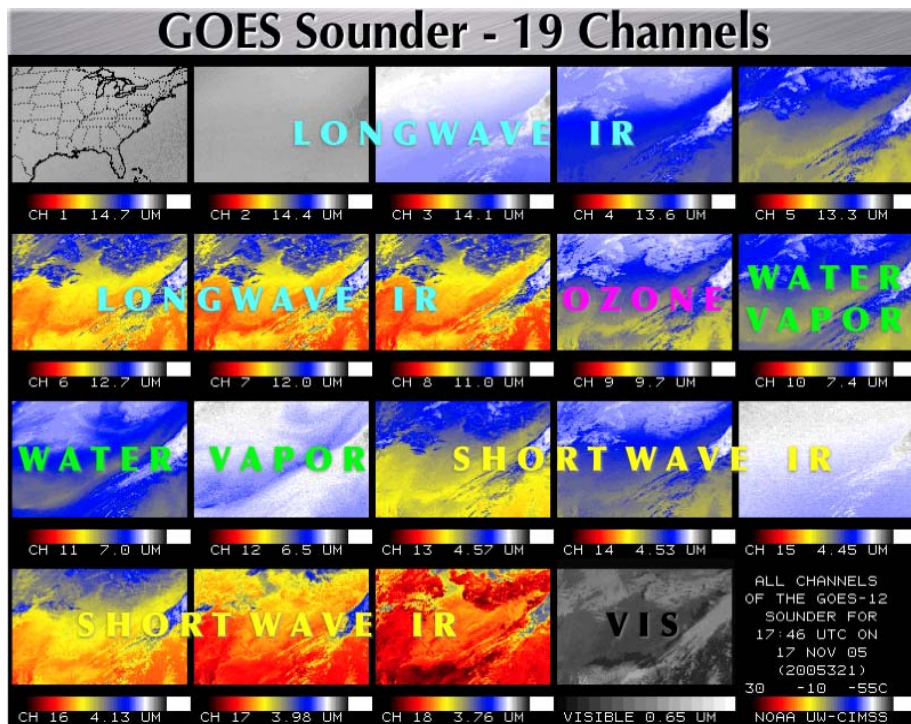


**COOPERATIVE INSTITUTE FOR METEOROLOGICAL SATELLITE STUDIES**

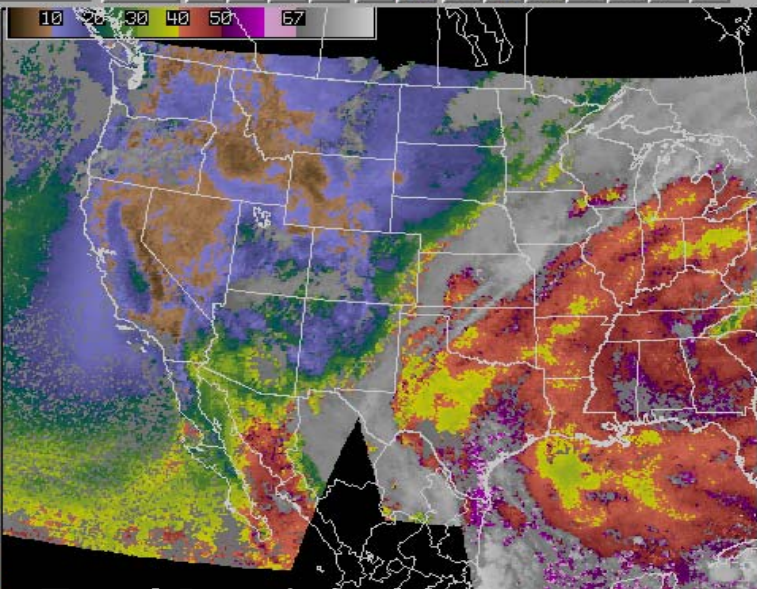
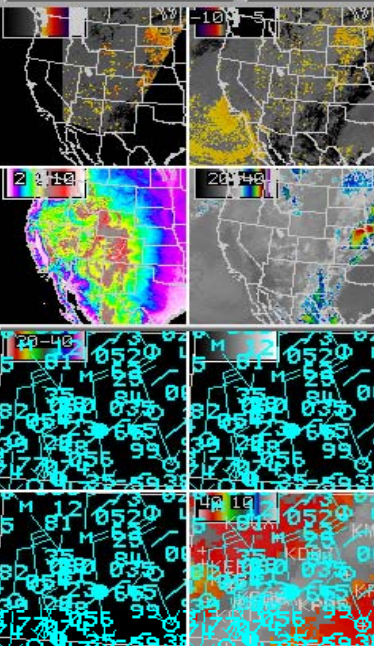
Current GOES sounder obtains 18 broad spectral IR bands

# Description: GOES-I(8)/P Sounders

- 19 channels (18 Infrared; 1 Visible)
- Spatial resolution: ~ 10km
- Hourly scanning over CONUS and adjacent waters
- Products include standard imagery and derived, Level-2 products

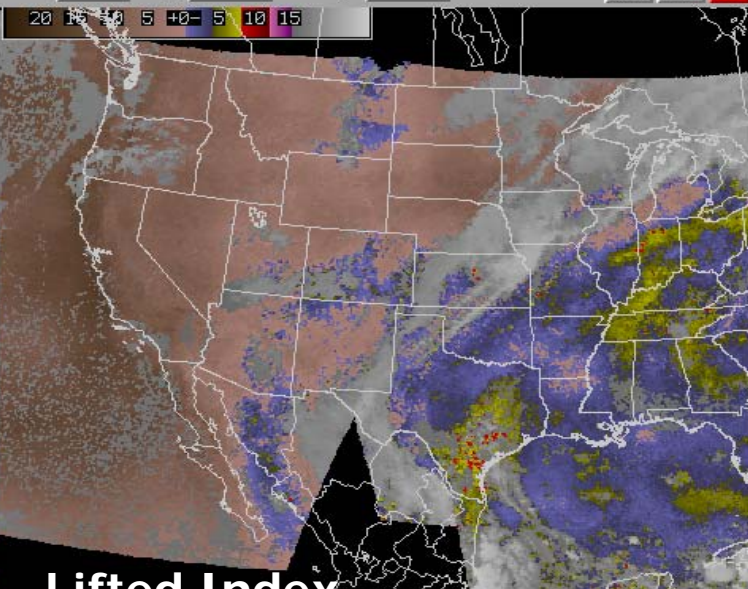


<b><i>GOES Sounder Product</i></b>	<b><i>Operational Use within the NWS</i></b>
<b>Clear-sky Radiances</b>	<b>Assimilation into</b> NCEP operational regional & global NWP models over water
<b>Layer &amp; Total Precipitable Water</b>	<b>Assimilation into</b> NCEP operational regional & global NWP models; <b>display and animation within</b> NWS AWIPS for use by forecasters at NWS WFOs & National Centers in forecasting precipitation and severe weather
<b>Cloud-top retrievals (pressure, temperature, cloud amount)</b>	<b>Assimilation into</b> NCEP operational regional NWP models; <b>display and animation within</b> NWS AWIPS for use by forecasters at NWS WFOs; <b>supplement to</b> NWS/ASOS cloud measurements for generation of total cloud cover product at NWS/ASOS sites
<b>Surface skin temperature</b>	<b>Image display and animation within</b> NWS AWIPS for use by forecasters at NWS WFOs
<b>Profiles of temp &amp; moisture</b>	<b>Display (SKEW-Ts) within</b> NWS AWIPS for use by forecasters at NWS WFOs in forecasting precipitation and severe weather
<b>Atmospheric stability indices</b>	<b>Image display and animation within</b> NWS AWIPS for use by forecasters at NWS WFOs in forecasting precipitation and severe weather
<b>Water Vapor Winds</b>	<b>Image display and animation within</b> NWS AWIPS for use by forecasters at NWS WFOs



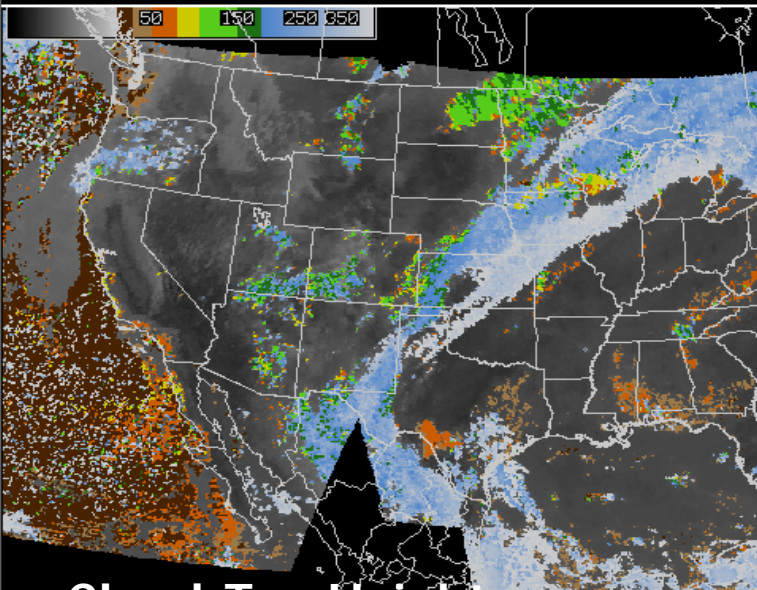
### Total Precipitable Water

GOES Sounder DPI Total Precip Water (mm) Wed 16:00Z 02-Aug-06



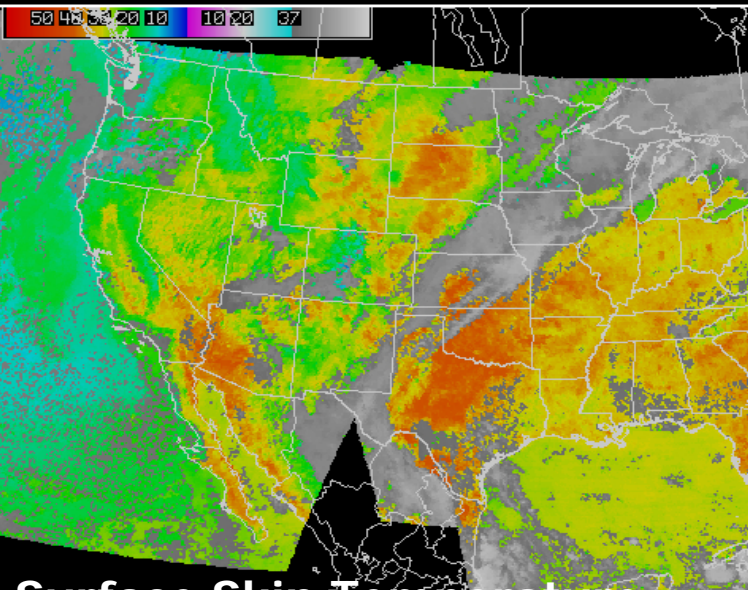
### Lifted Index

GOES Sounder DPI Lifted Index (C) Wed 16:00Z 02-Aug-06



### Cloud-Top Height

GOES Sounder DPI Cloud Top Height (ft/100 MSL) Wed 16:00Z 02-Aug-06

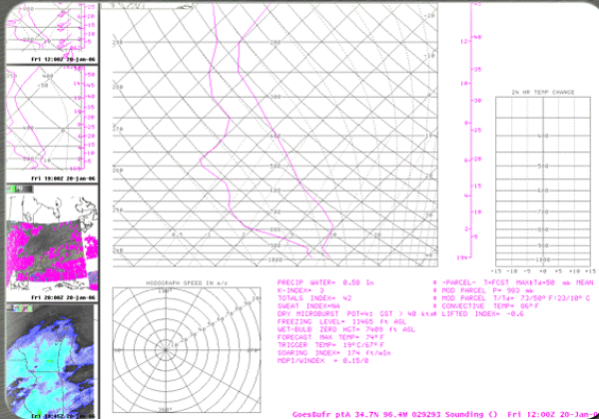


### Surface Skin Temperature

GOES Sounder DPI Skin Temperature (C) Wed 16:00Z 02-Aug-06

# Temperature & Moisture Profiles

## GOES Sounder Point Soundings



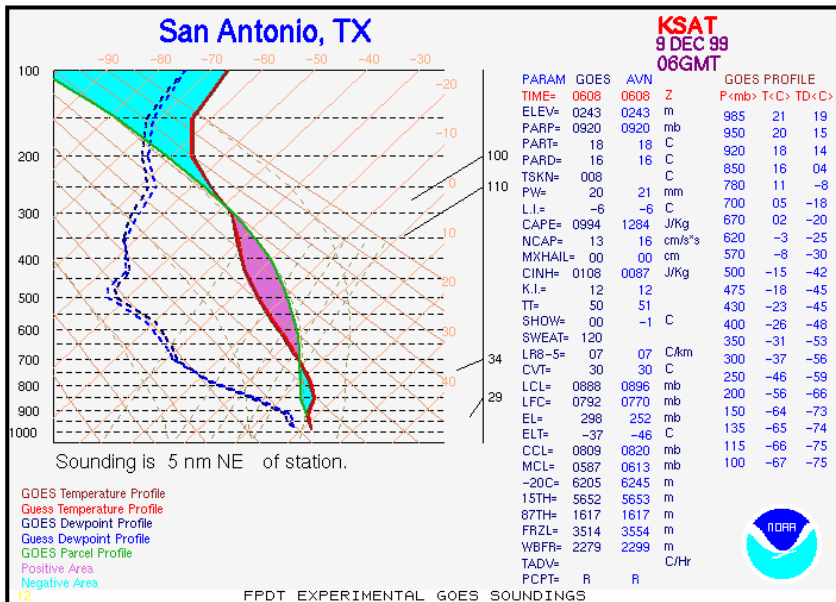
- **Physical Retrieval (Ma et al, 1999)**
  - Short-term (< 12 hrs) GFS model forecasts provide first guess
  - Hourly surface observations, NCEP SST analysis provide boundary conditions
  - Computed at 40 levels
  - Pixel level retrievals

- **Distributed to AWIPS, NCEP**

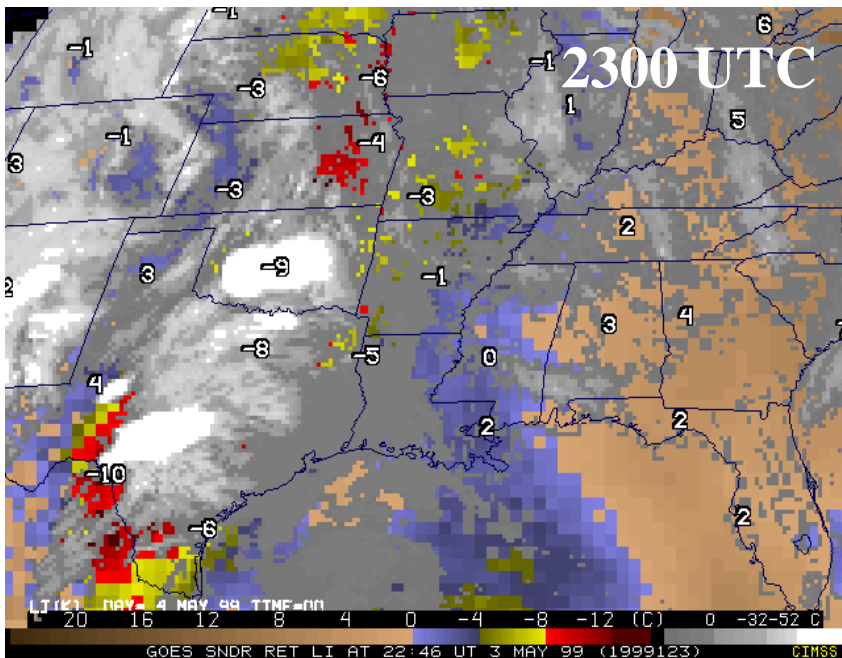
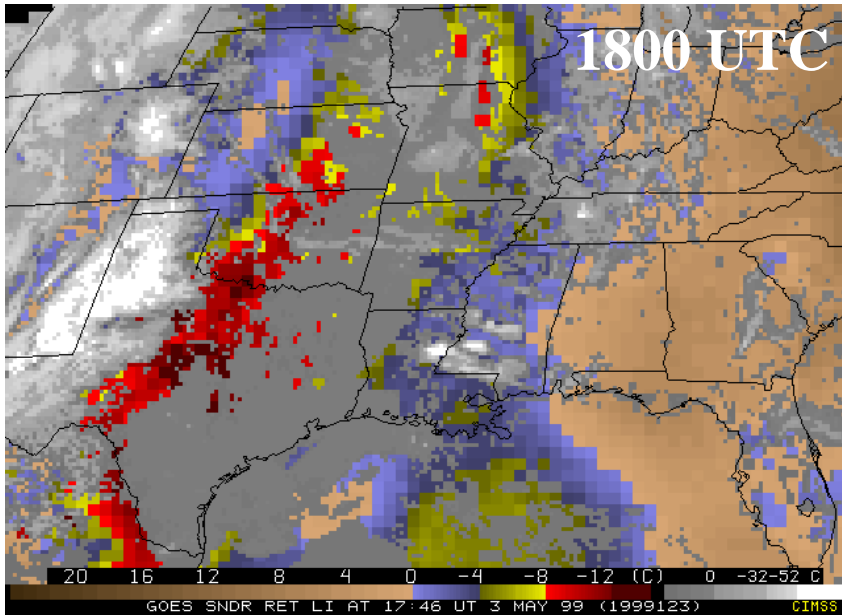
- **Operational Applications**

### *Nowcasting*

- Aids in monitoring of vertical structure of temperature and moisture of the atmosphere
- Fills in gaps between conventional observations
- Convective potential and morphology
- Situational awareness in pre-convective environments for potential watch/warning scenarios



## View from space



## Hourly LI indicates instability

5 hours before

OK tornado 3 May 99

## View from ground

530 CDT (2330 UTC)

This ground-level photograph shows a large, dark, and turbulent storm cloud structure, likely a supercell, with a visible funnel cloud extending downwards. The image is labeled '530 CDT (2330 UTC)'. A tree is visible in the foreground on the left.



April 13 – 14 hail storm case



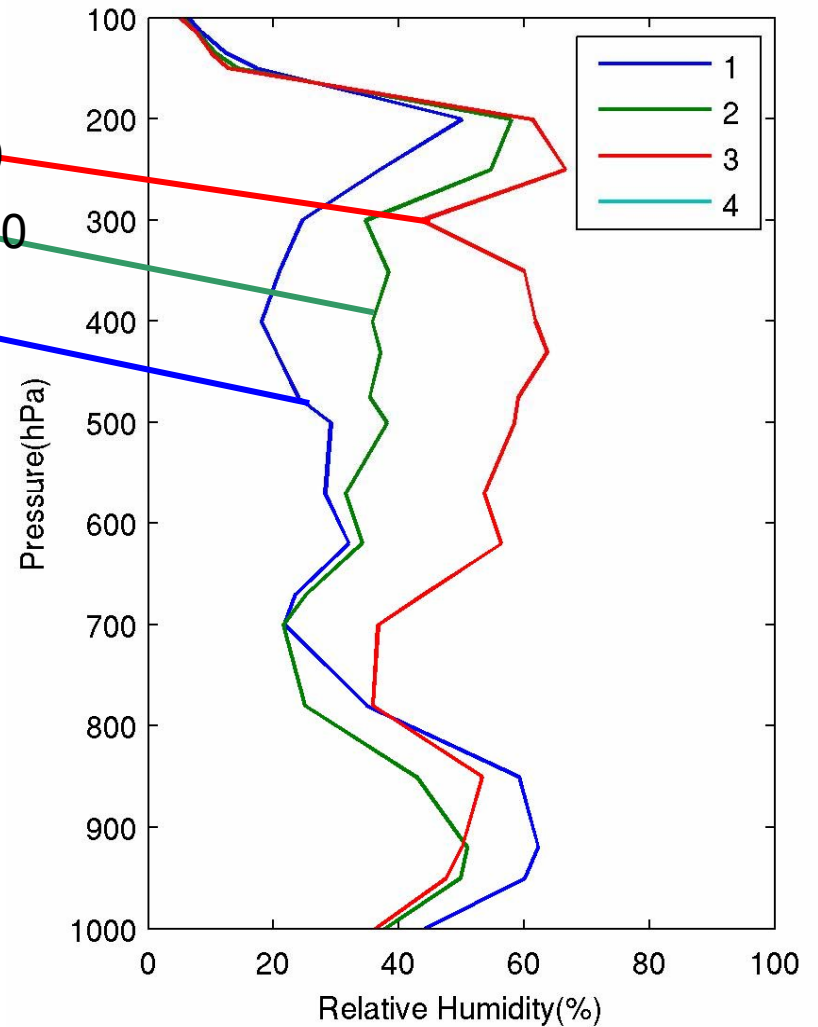
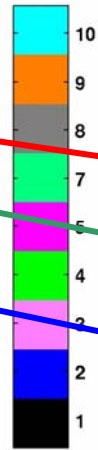
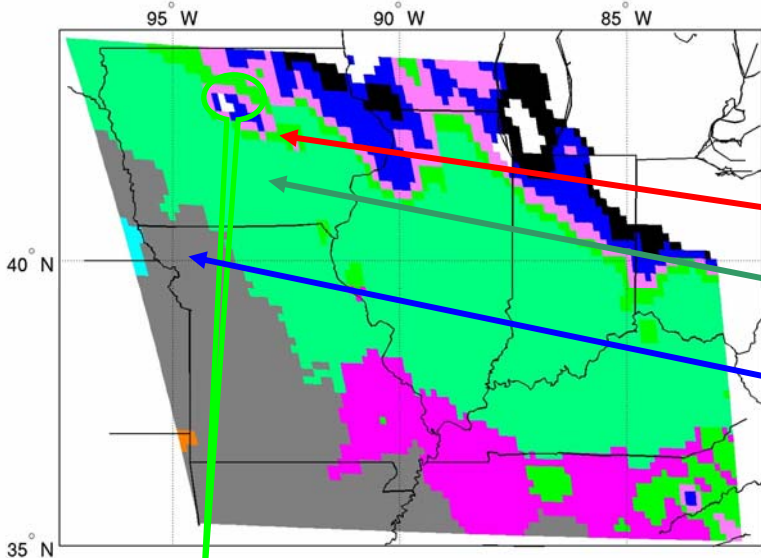
April 13 - 14, 2006



Hail in my yard

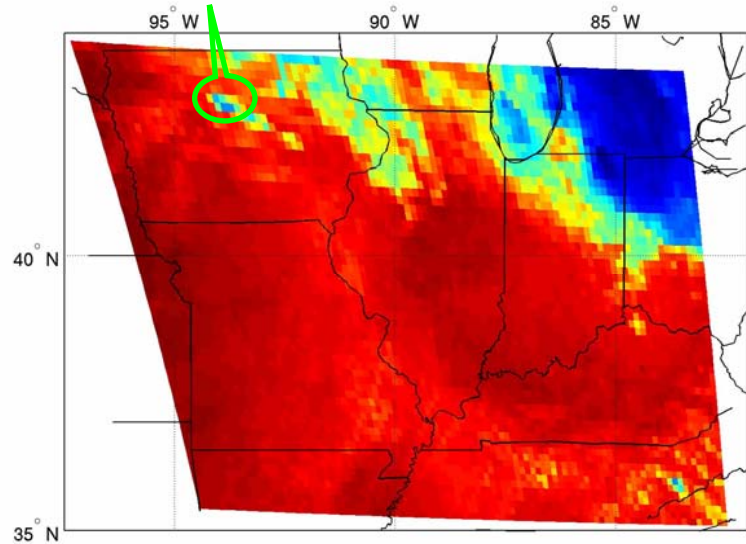
# 21 UTC April 13, 2006

## Classification



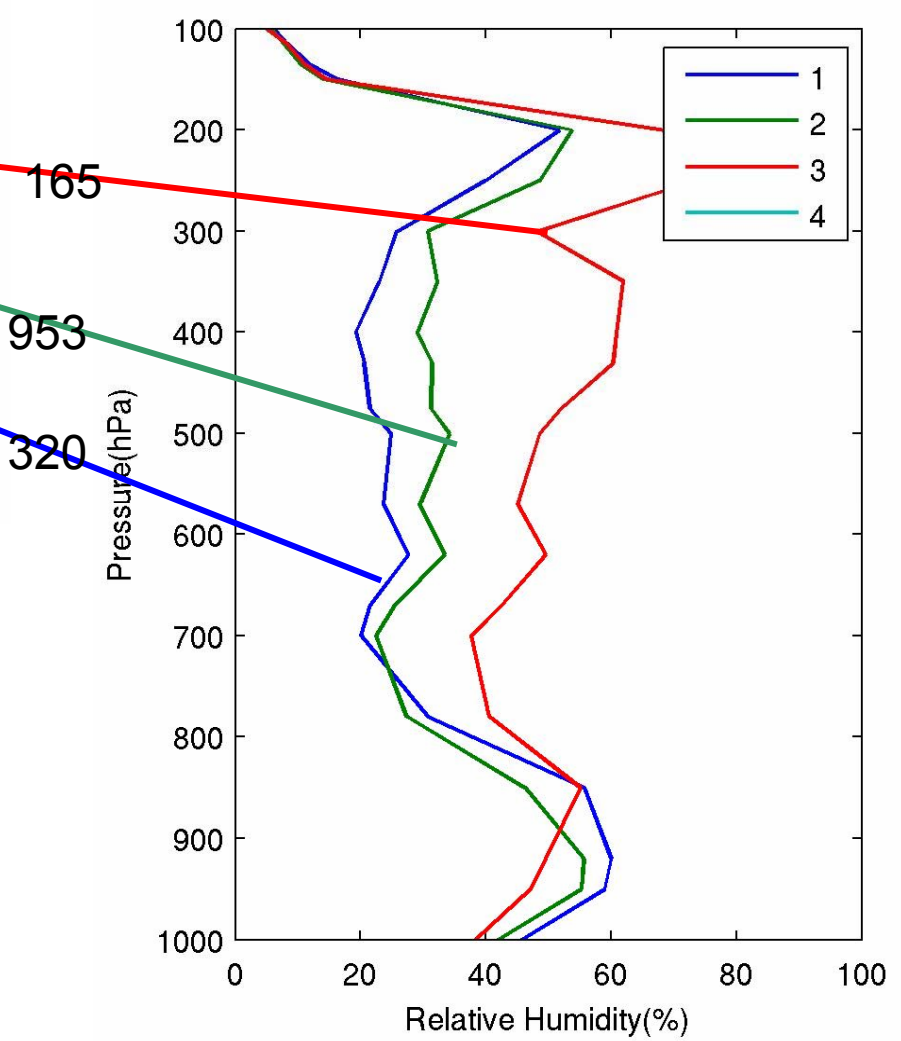
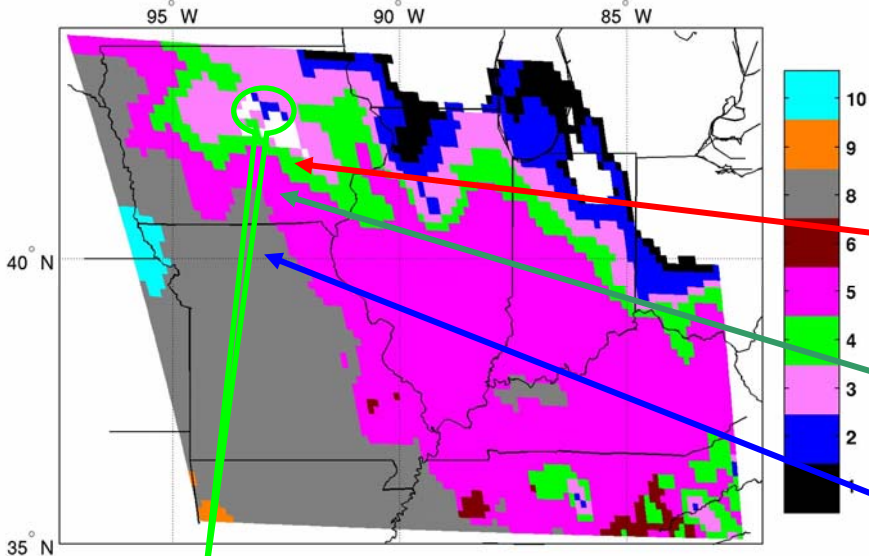
Super Cell

11um BT

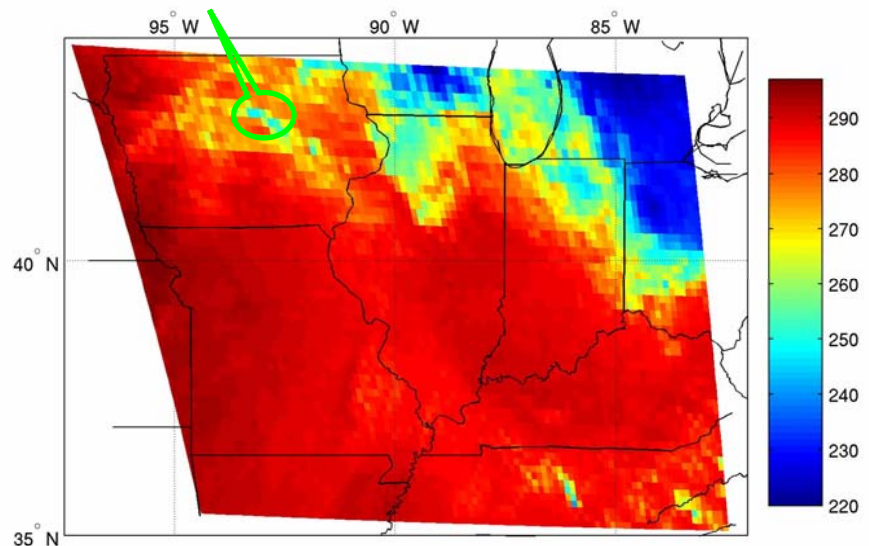


# 22 UTC April 13, 2006

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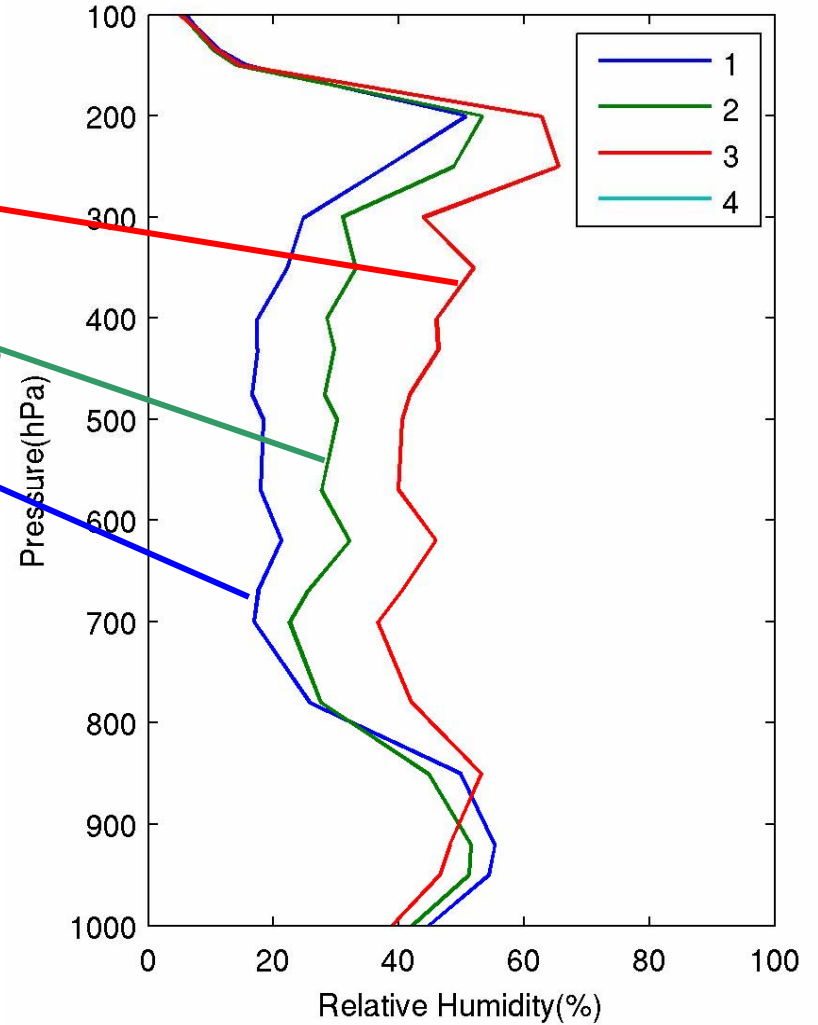
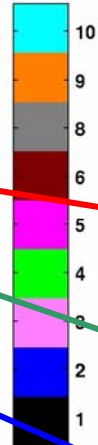
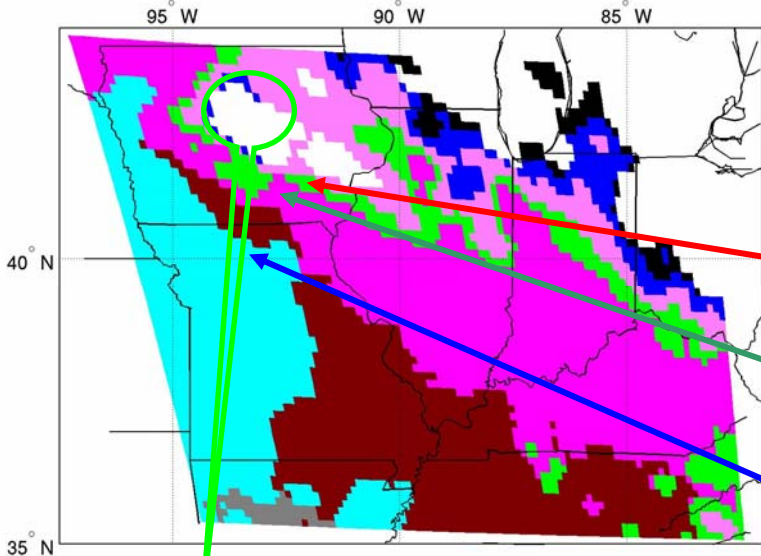


**Super Cell**  
11um BT



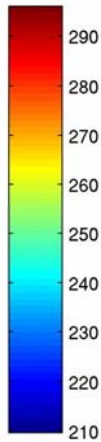
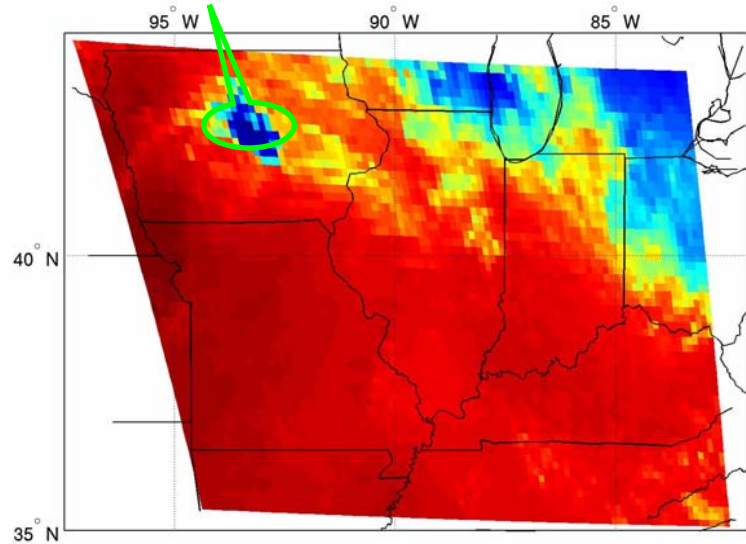
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## Classification



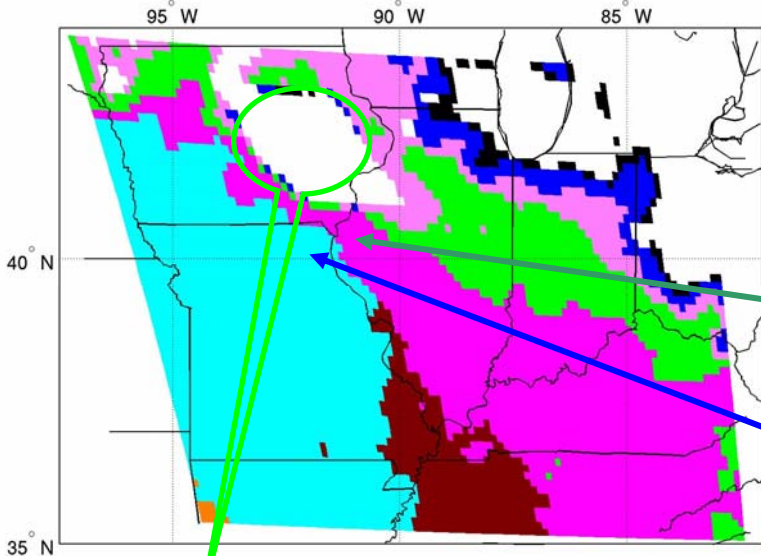
Super Cell

11um BT



# 00 UTC April 14, 2006

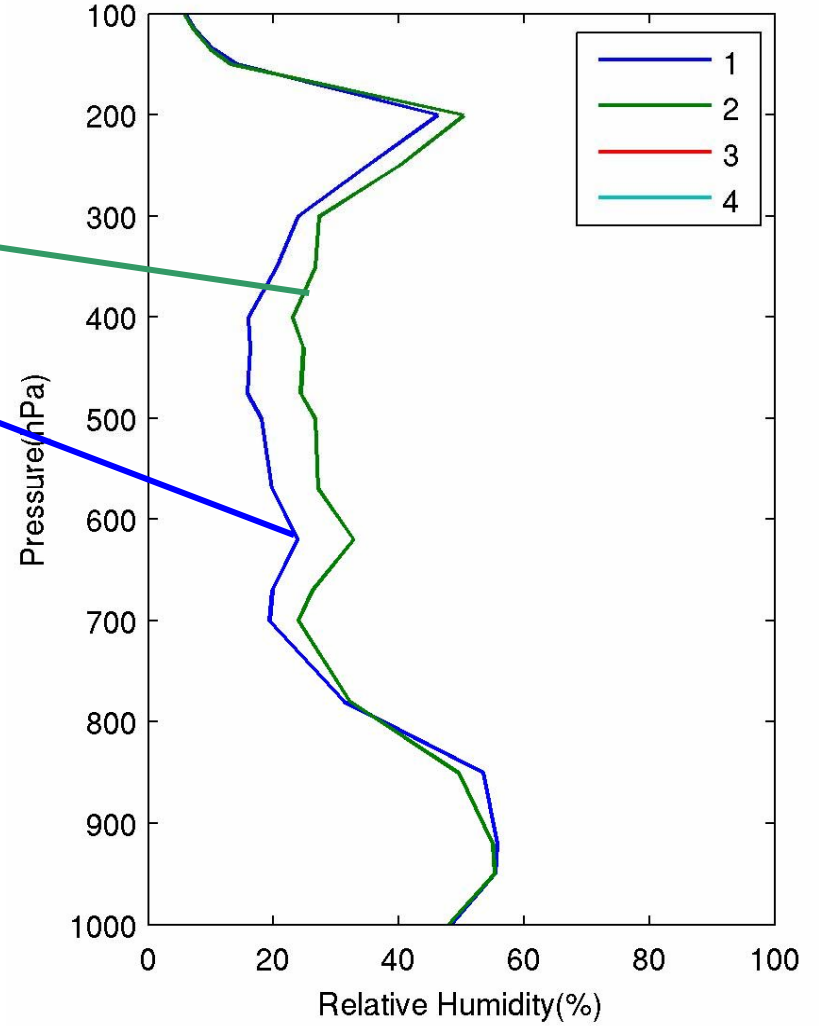
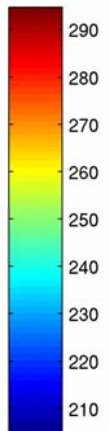
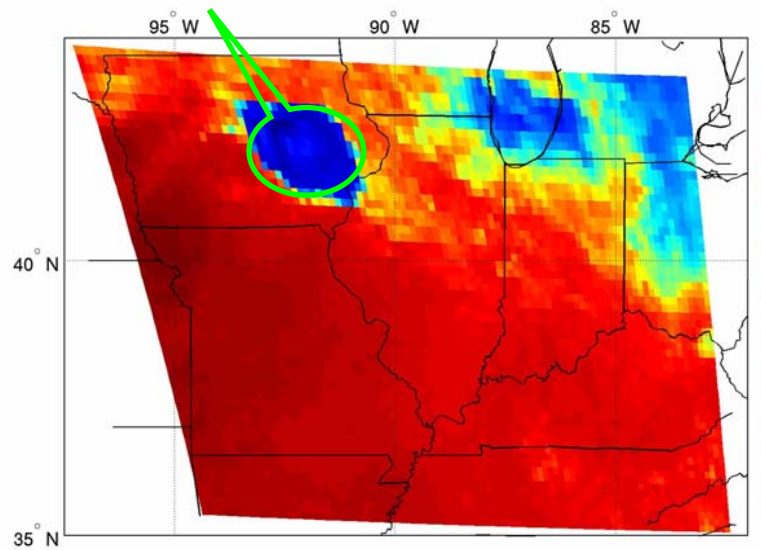
## Classification



537  
378

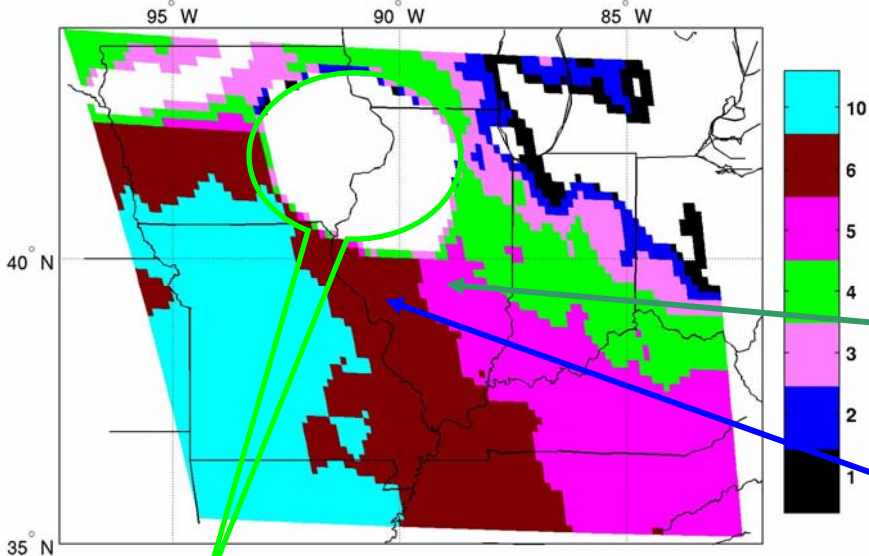
Super Cell

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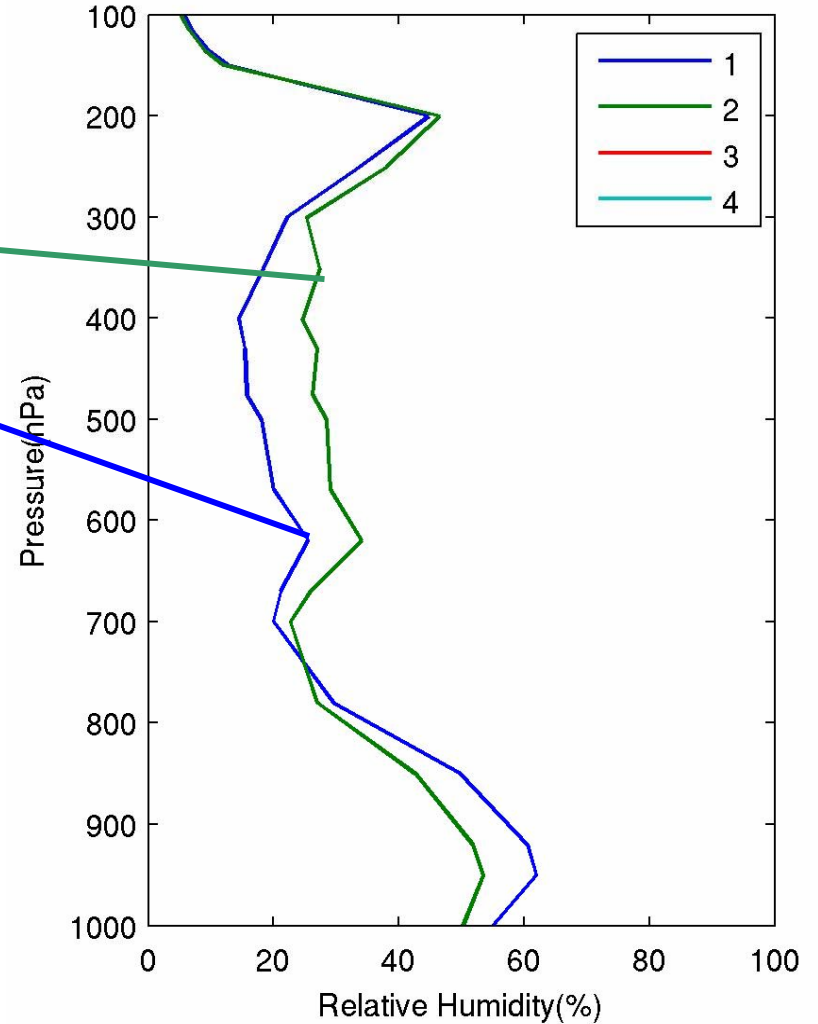
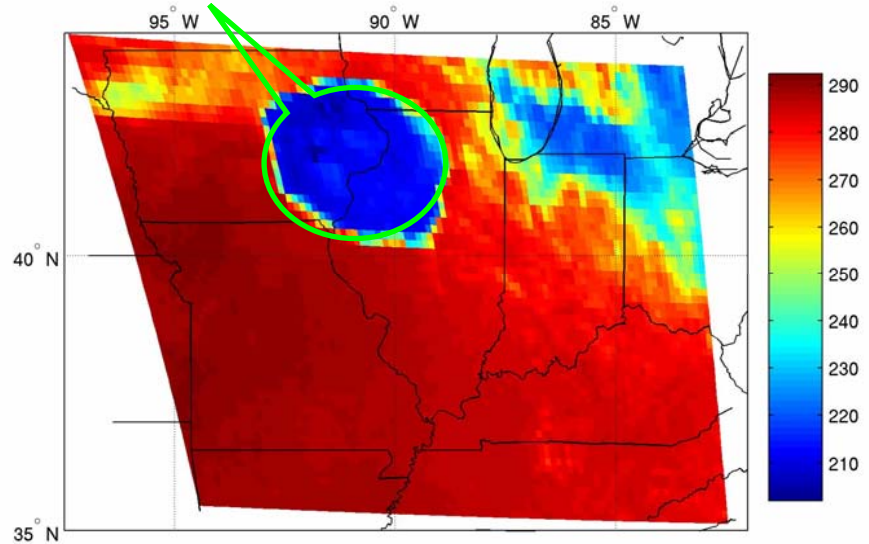
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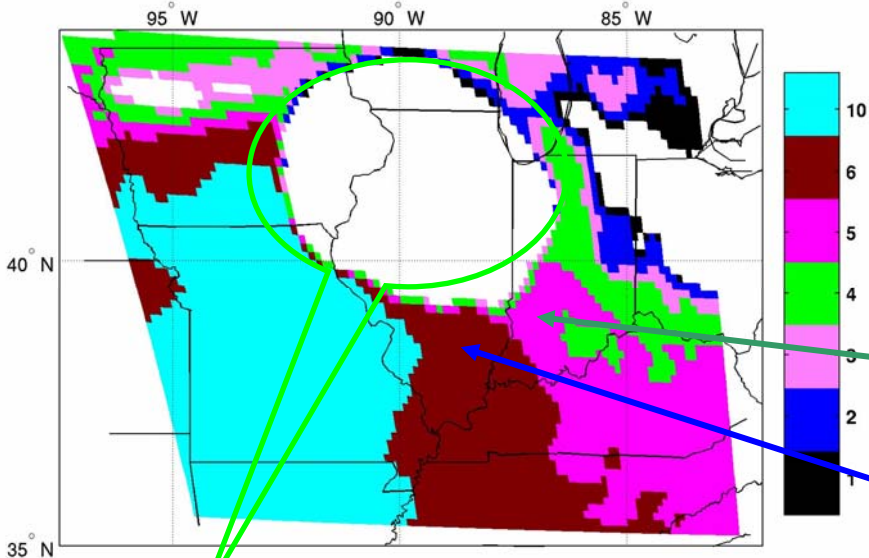
Super Cell

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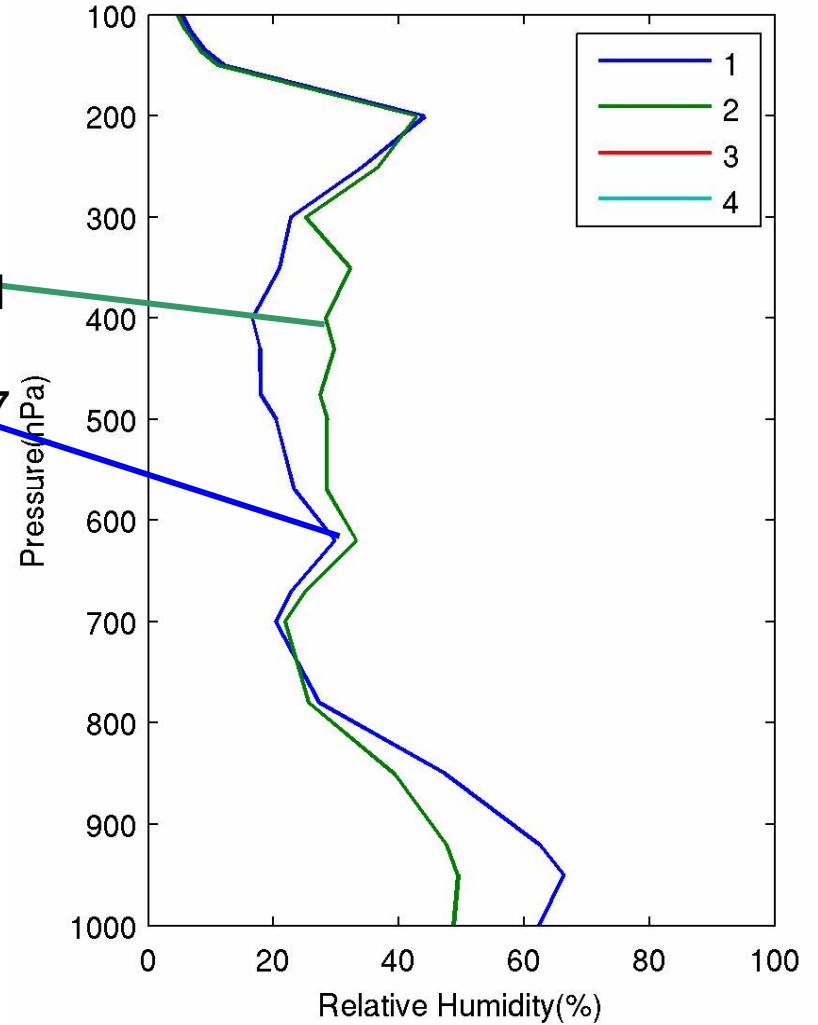
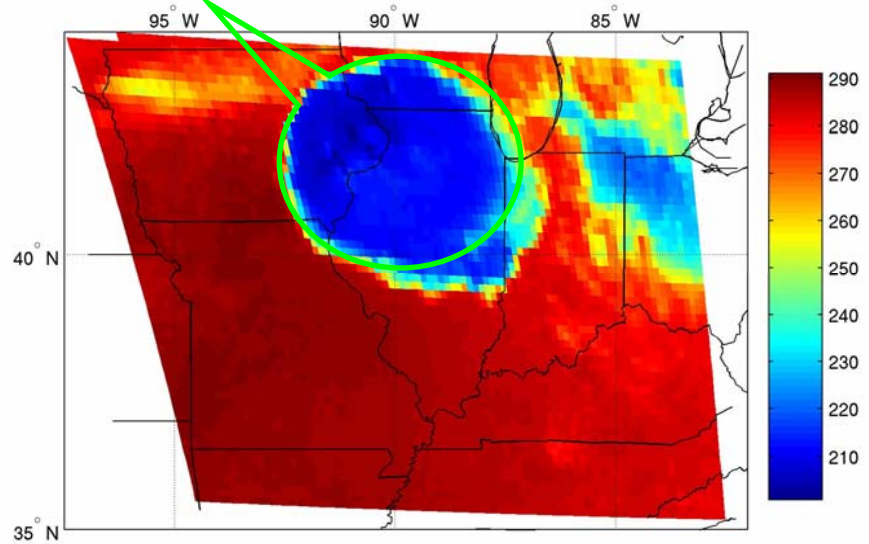
# 02 UTC April 14, 2006

## Classification



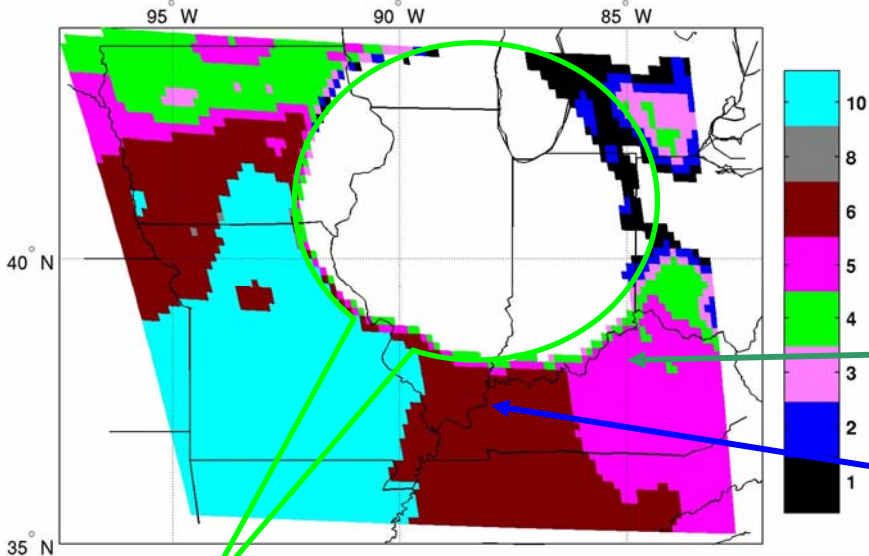
Super Cell

11um BT



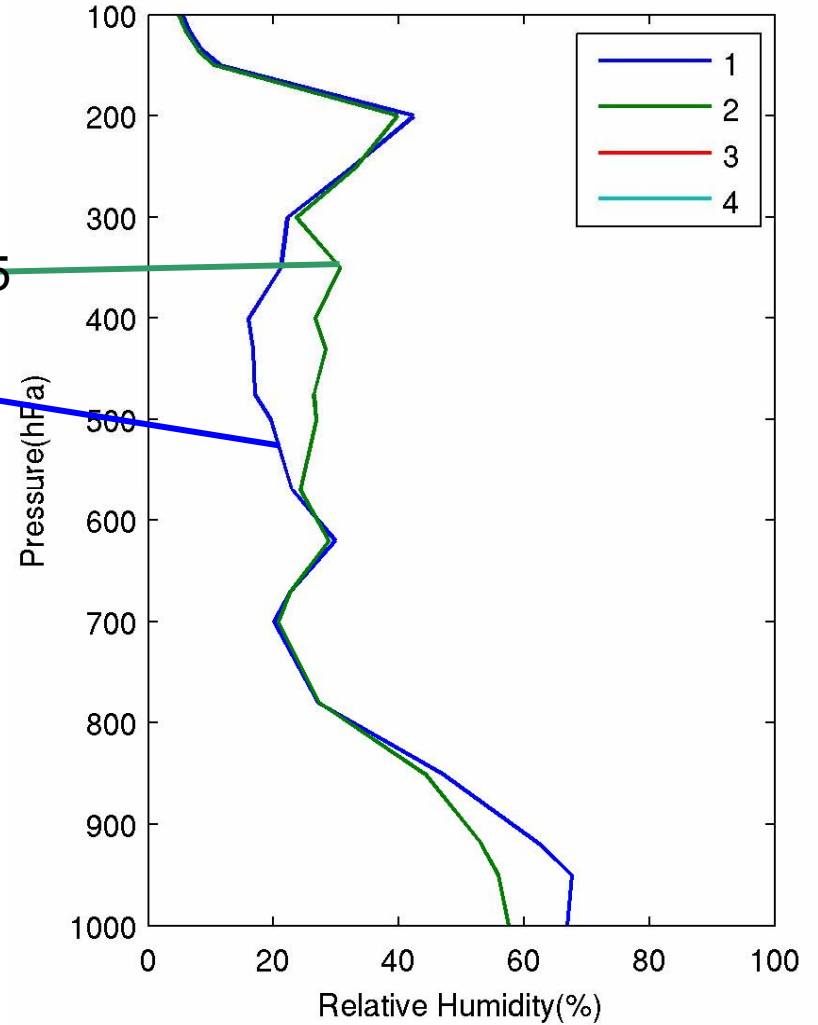
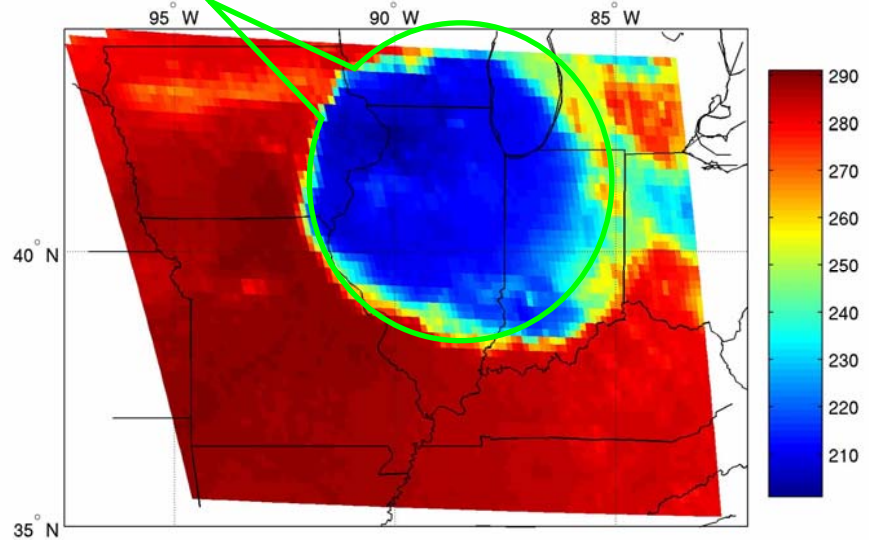
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## Classification



Super Cell

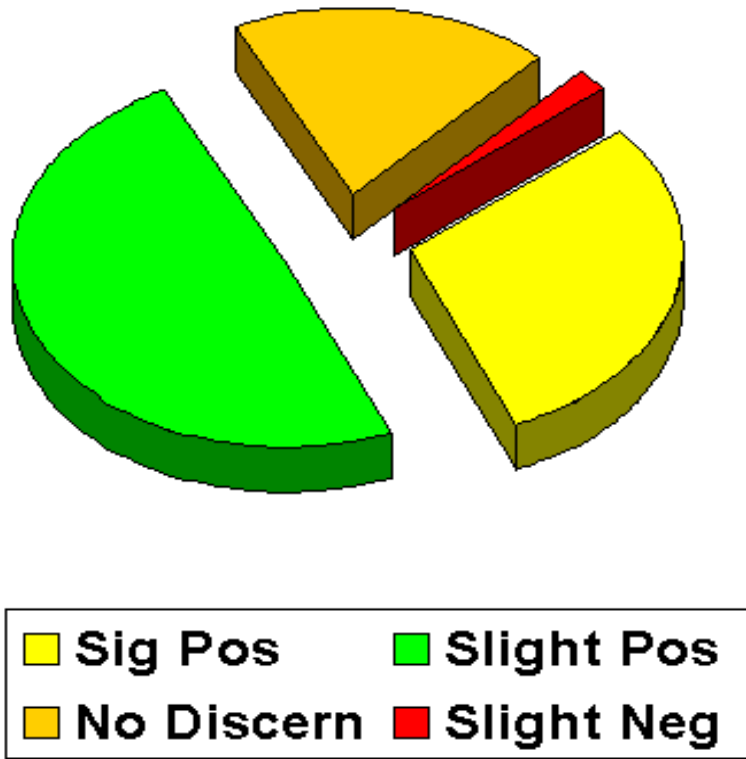
11um BT





# NWS Forecast Office Assessment of GOES Sounder Atmospheric Instability

Summer 99 Forecaster assessment of usefulness of changes in hourly LI, CAPE, & CINH product for predicting location/timing of thunderstorms



Out of 248 valid weather cases:

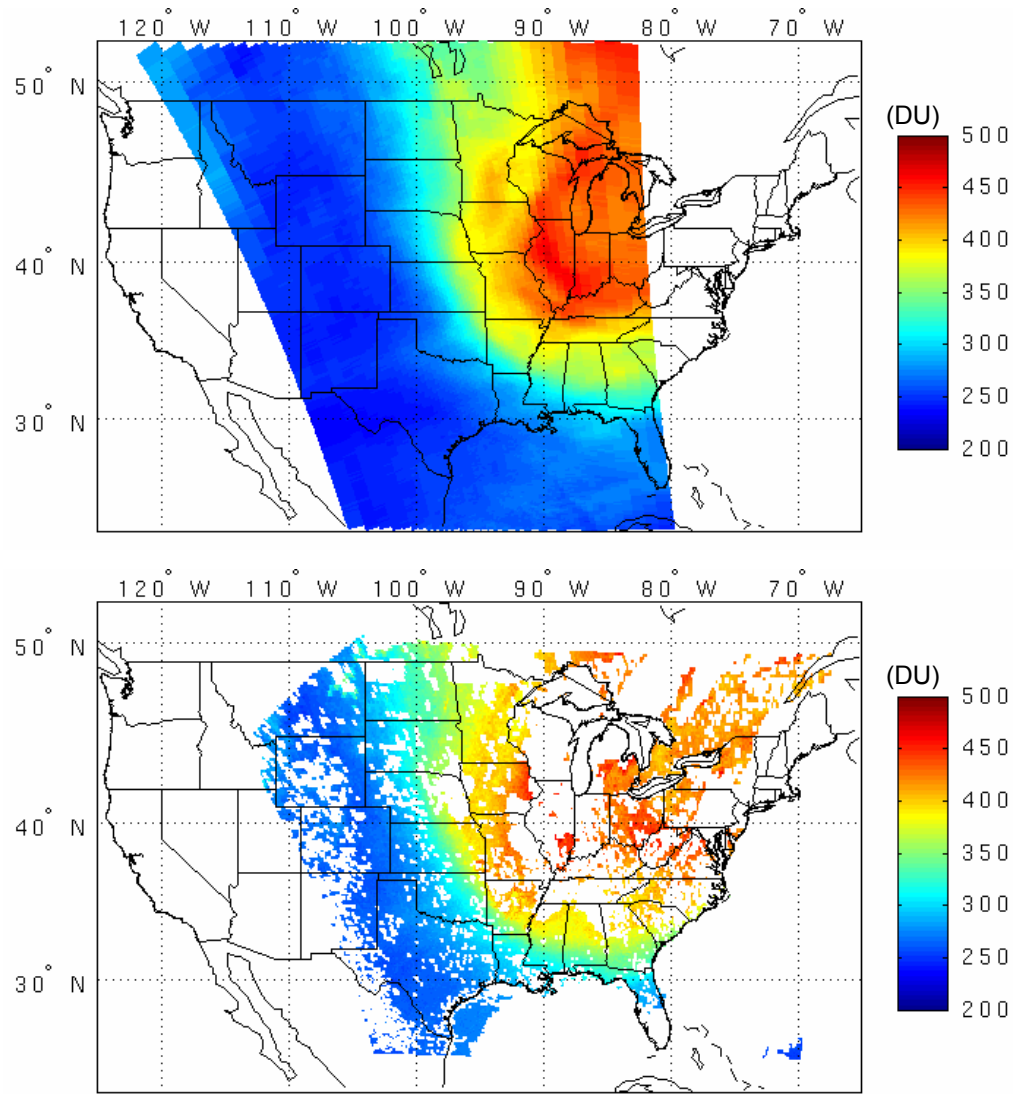
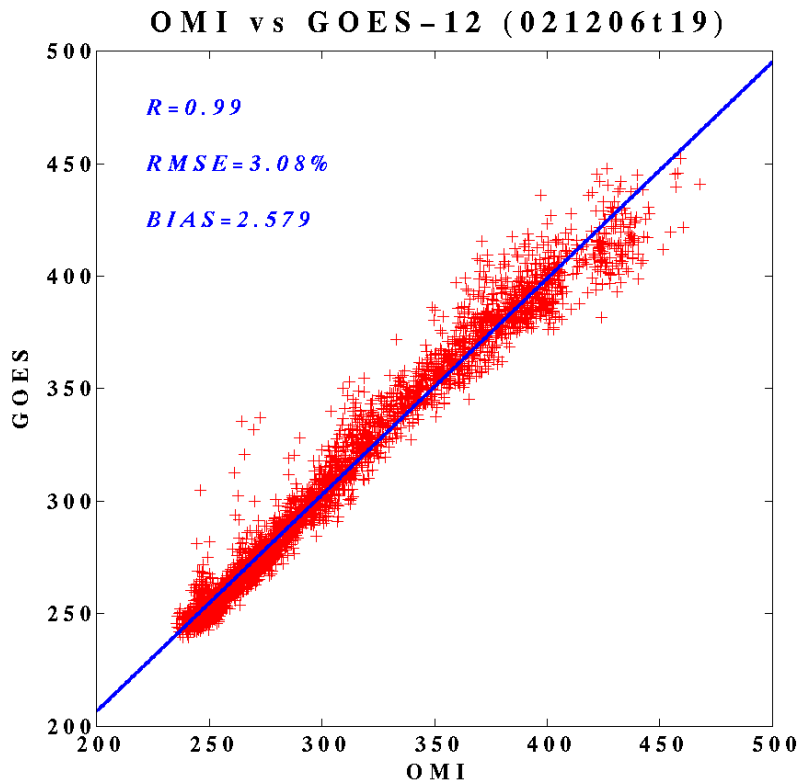
- Significant Positive Impact (30%)
- Slight Positive Impact (49%)
- No Discernible Impact (19%)
- Slight Negative Impact (2%)
- Significant Negative Impact (0)

# GOES Sounder Data and Products

## Some Non-Operational Products

- **DPI Products (Not available on AWIPS, but via web pages,etc)**
  - **Downburst potential product**
    - Aids in monitoring and situational awareness in pre-convective environments
    - Assessment and short term forecasting of severe convective storm and downburst wind gust potential
  - **Convective Available Potential Energy (CAPE) DPI**
    - Aids in monitoring and situational awareness in pre-convective environments
  - **Convective Inhibition (CINH) DPI**
    - Aids in monitoring and situational awareness in pre-convective environments
  - **Layer Precipitable Water (PW) DPI**
    - Useful in tracking SW monsoon moisture
  - **700-500 MB Temperature Lapse Rate DPI**
    - Used to identify areas of elevated instability
- **Other Products**
  - **Ozone**
  - **Outgoing Longwave Radiation (OLR)**

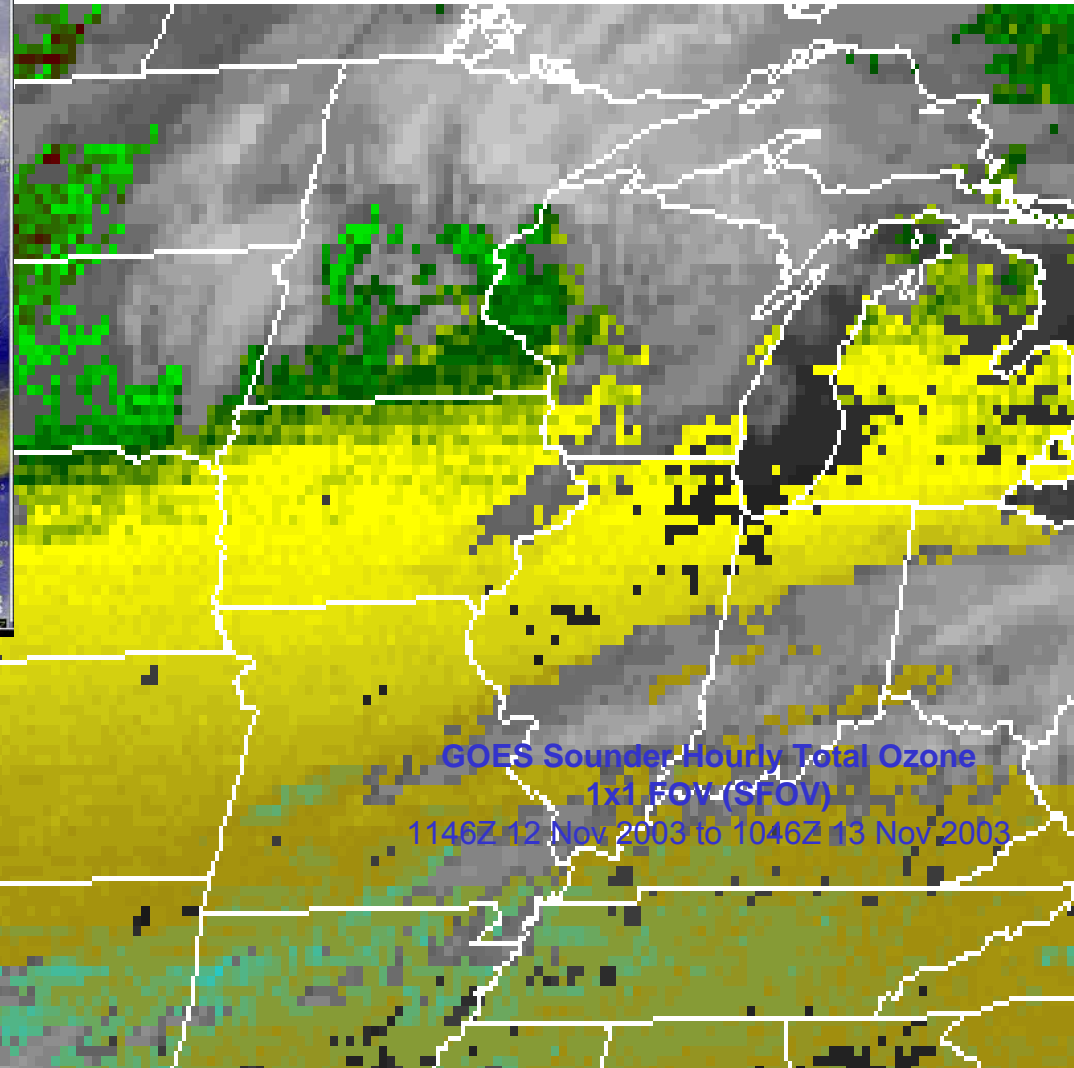
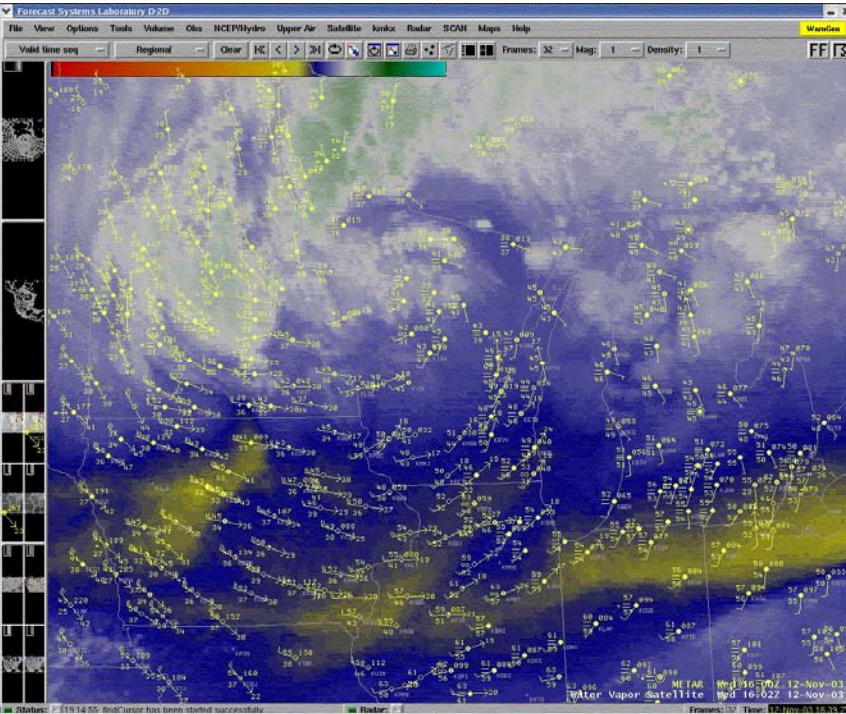
# OMI and GOES 12 (12 Feb 2006)



GOES ozone and OMI  
agree very well (Li et al.  
2006, GRL)

Collaborative work from this project is also presented by John A. Knox of University of Georgia, the title of oral presentation is "GOES single FOV total column ozone: development and initial results" at the AMS2006 meeting held in Atlanta, GA

## Use GOES Sounder ozone to study non-convective wind storm



GOES 15-Minute Water Vapor and Hourly METARs  
1600Z 12 Nov 2003 to 2300Z 12 Nov 2003

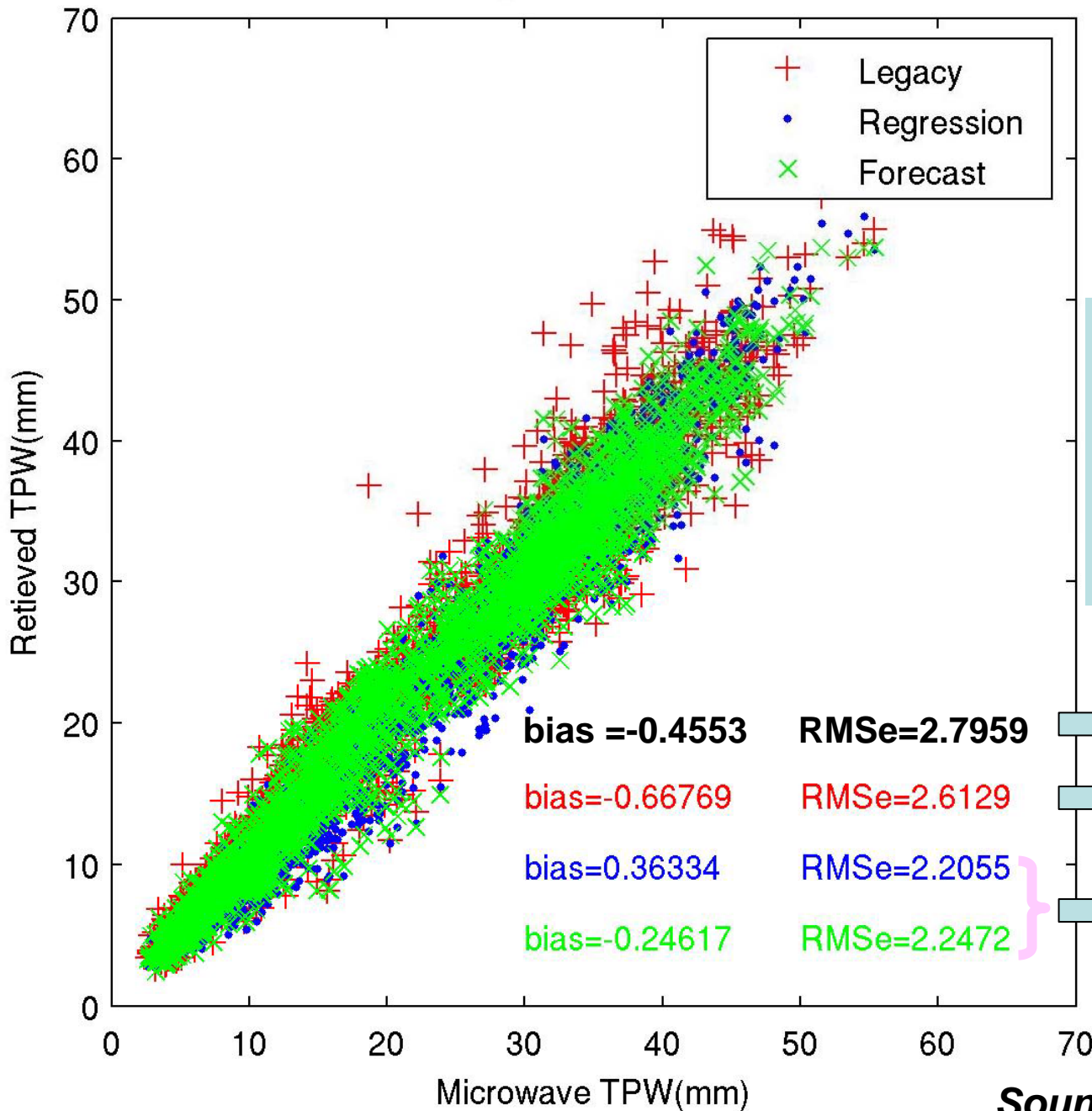
# Challenges: Current & Future

- **GOES sounder data and products are well established in operational environments**
  - Contribute to meeting NOAA mission goals
  - Demonstrated to have positive impact in nowcasting and NWP applications

## Many challenges remain.....

- **Need for new instruments**
  - Faster scanning; adaptable scanning strategies
  - Improved vertical resolving power
    - Improved depiction of vertical distribution of moisture
  - Surface emissivity determination
- **Need to reduce product latency**
  - Streamlined product processing
- **Improved product quality control & monitoring to assure the reliability of high quality products**
- **Getting experimental satellite products into the hands of NWS forecasters & NWP Centers**
  - Especially those that have the potential to positively impact weather forecasts and services

# Physical Retrieval

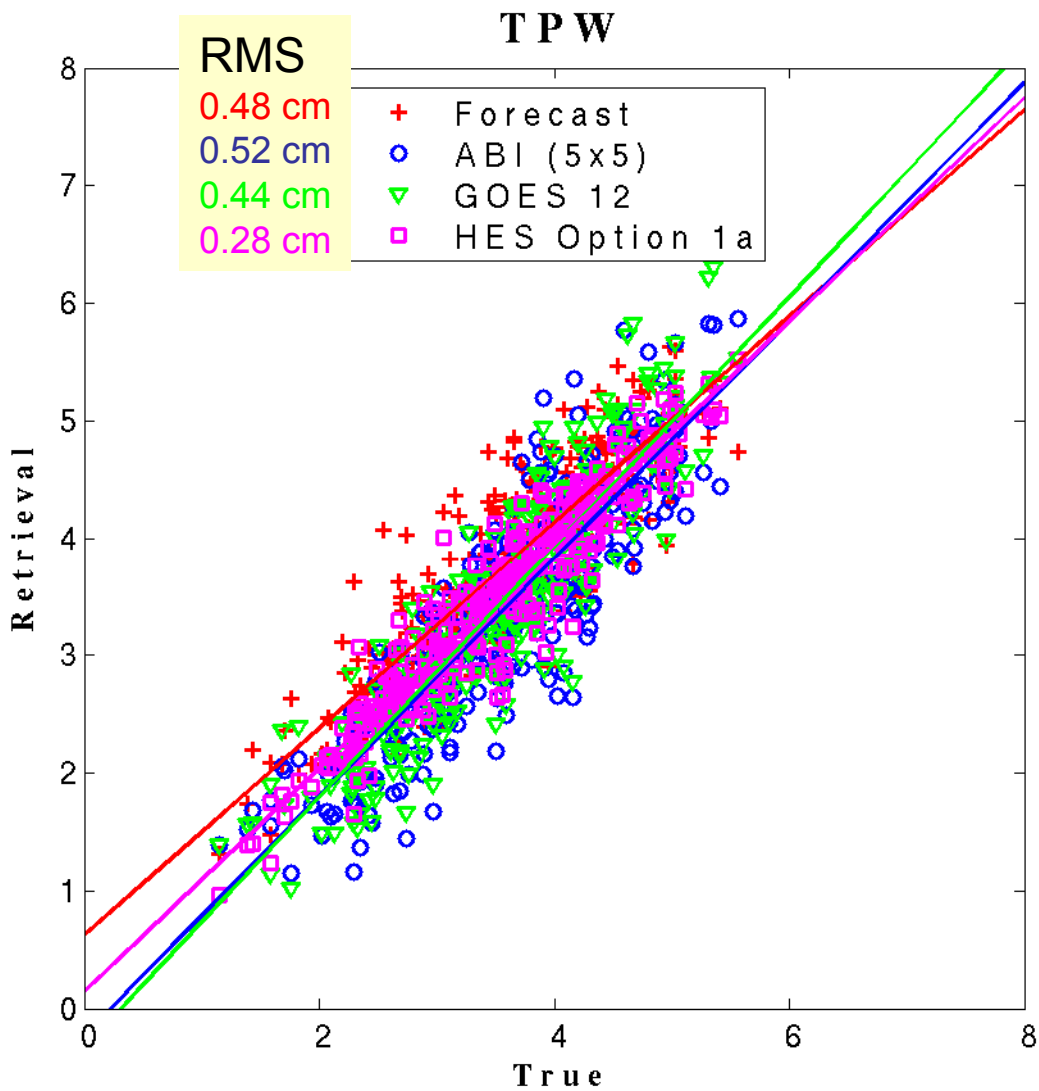


Validation with ARM site measurements

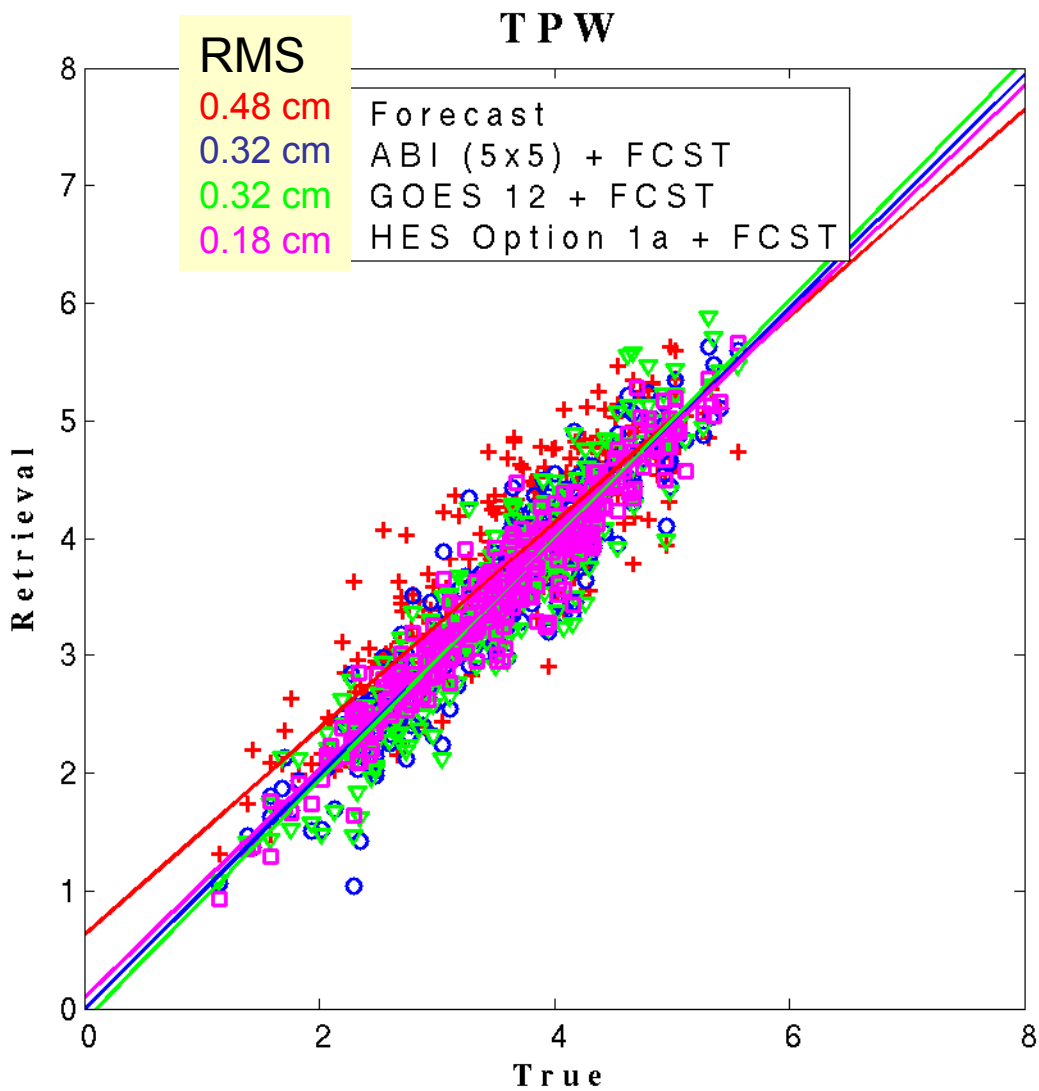
Improved sounding retrievals give reasonable accuracy when compare with microwave radiometer TPW measurements.

- Forecast
- Legacy retrieval
- New retrieval

***Sounder product improvement***



Simulated TPW retrievals over CONUS with lifted index <0 (~300 independent cases)



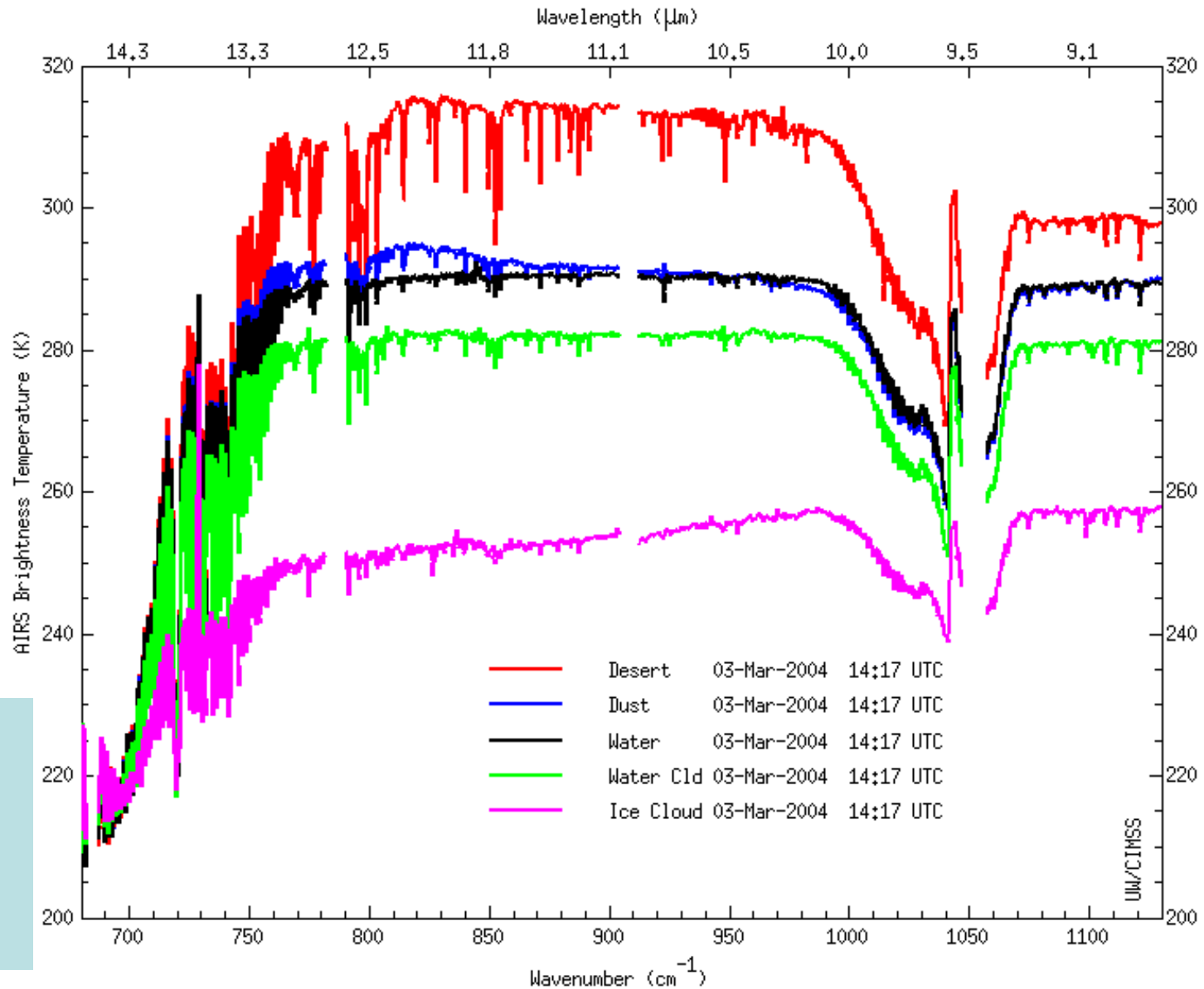
Simulated TPW retrievals over CONUS with lifted index <0 (~300 independent cases)



# Sounder Comparison (GOES-Current to Future-Req)

	<u>Current</u>	<u>Future req.</u>
Coverage Rate	CONUS/hr	Sounding Disk/hr
Horizontal Resolution		
Sampling Distance	10 km	5 - 10 km
Sounding FOR	30-50 km	10 km
Vertical Resolution	~3 km	1 km
Accuracy		
Temperature	2 deg. K	1 deg. K
Relative Humidity	20%	10%

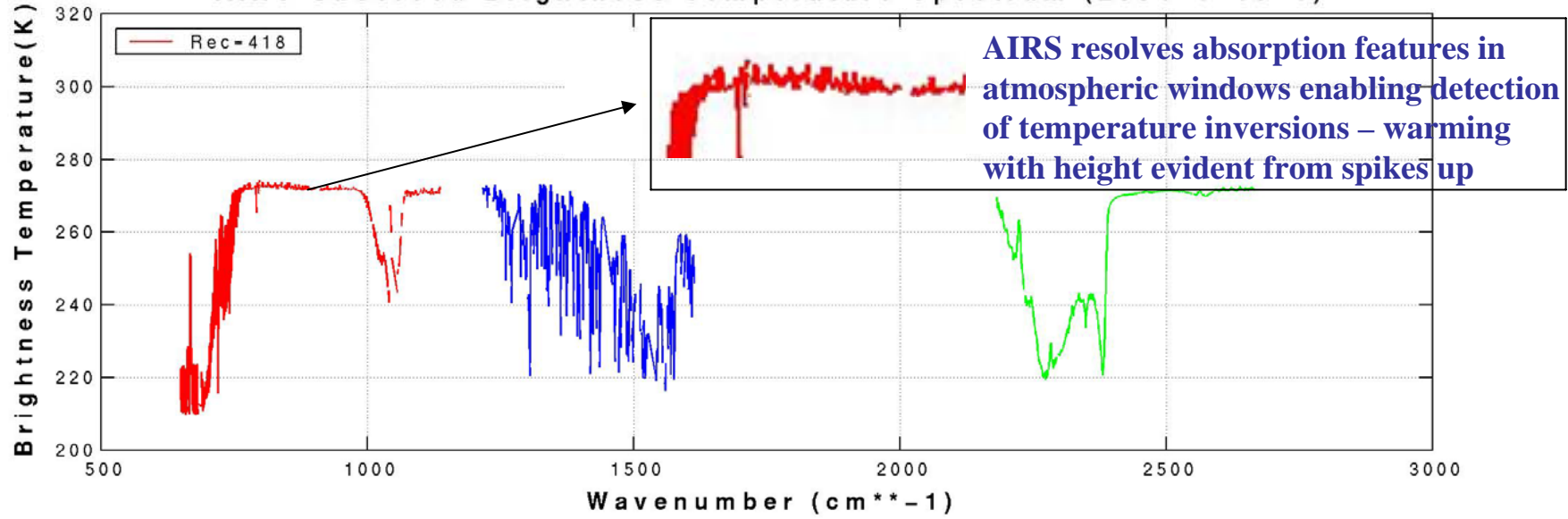
# Different AIRS spectrum from one AIRS granule



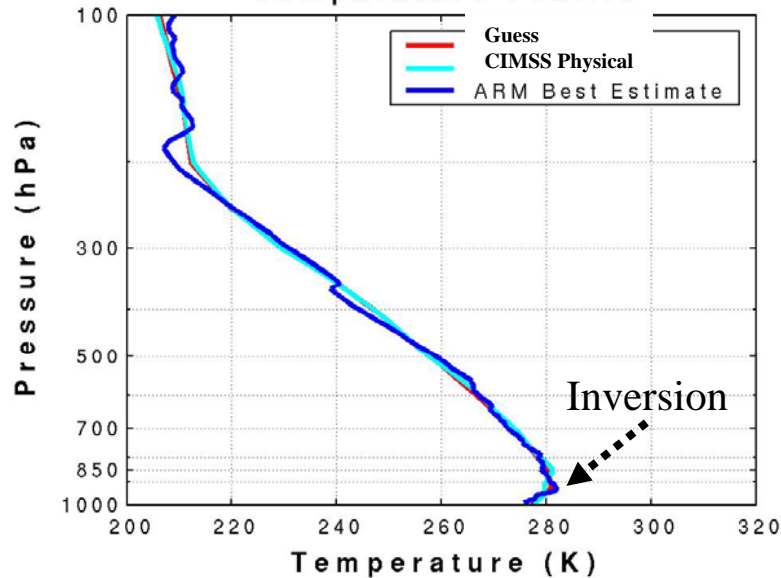
Hyperspectral IR measurements provide detailed features on surface, atmosphere, clouds, dust, etc.

# Hyperspectral IR measurements provide profile with high vertical resolution

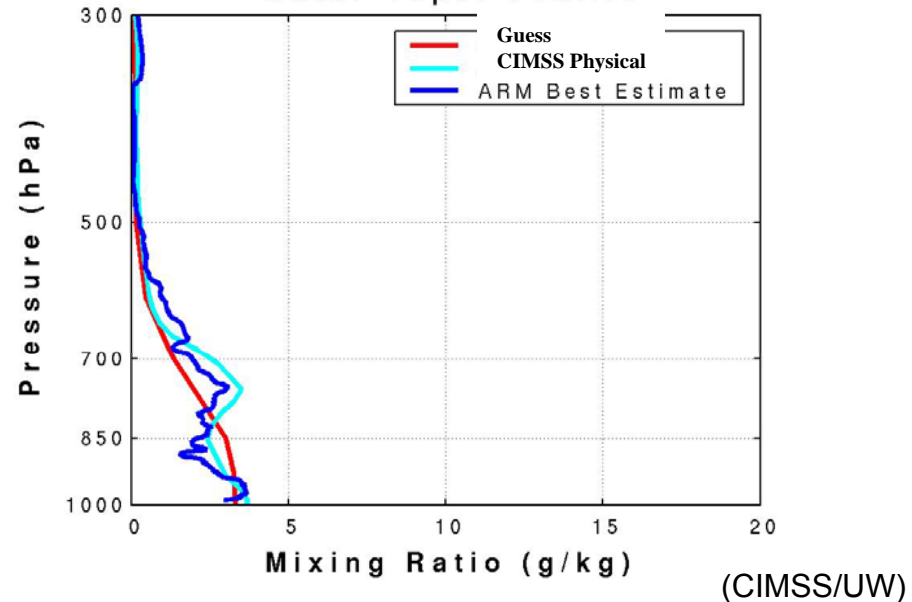
AIRS Observed Brightness Temperature Spectrum (2004-1-15-1)



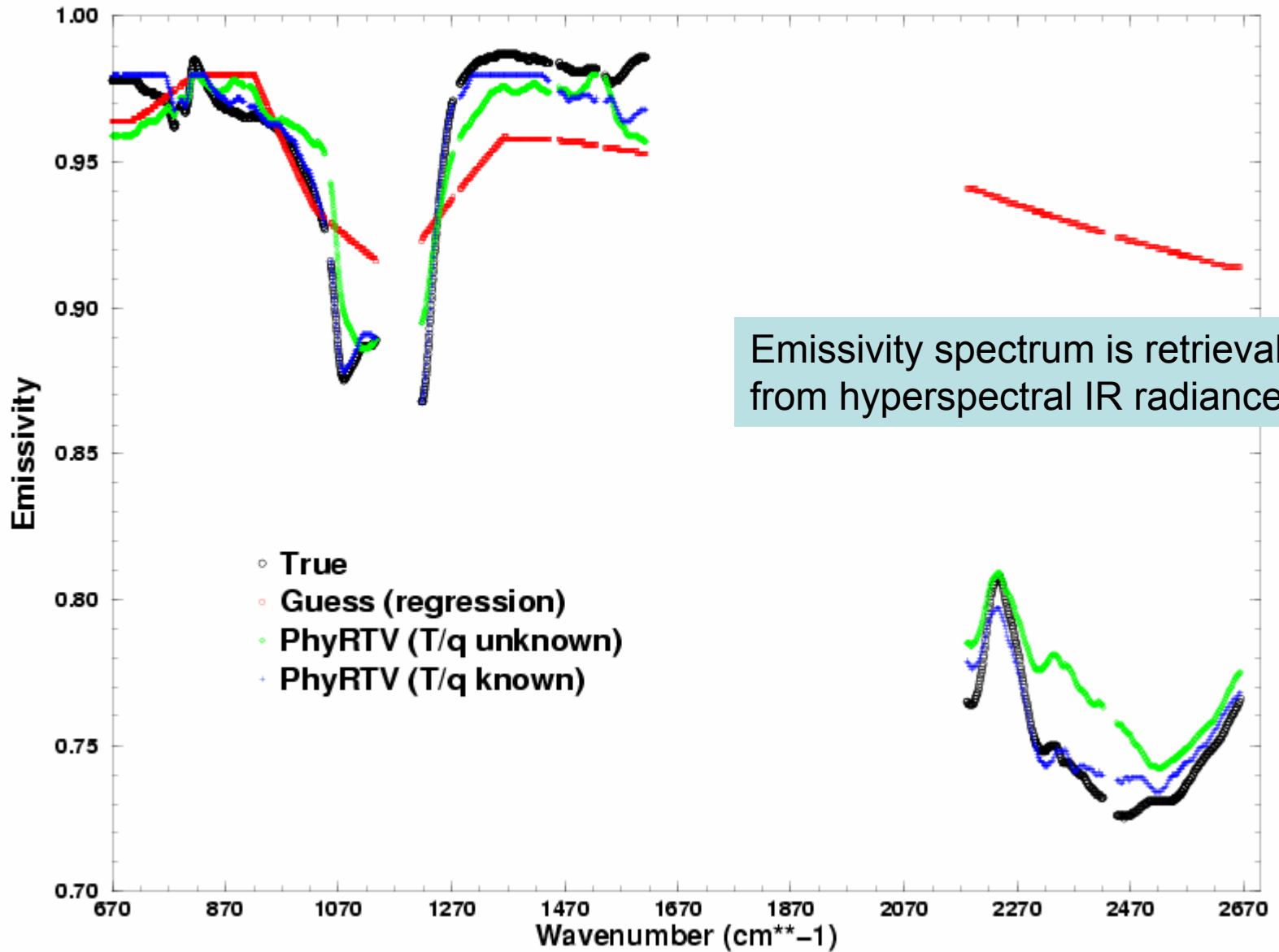
Temperature Profile

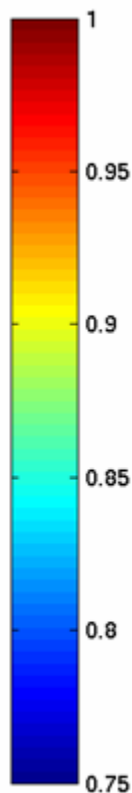
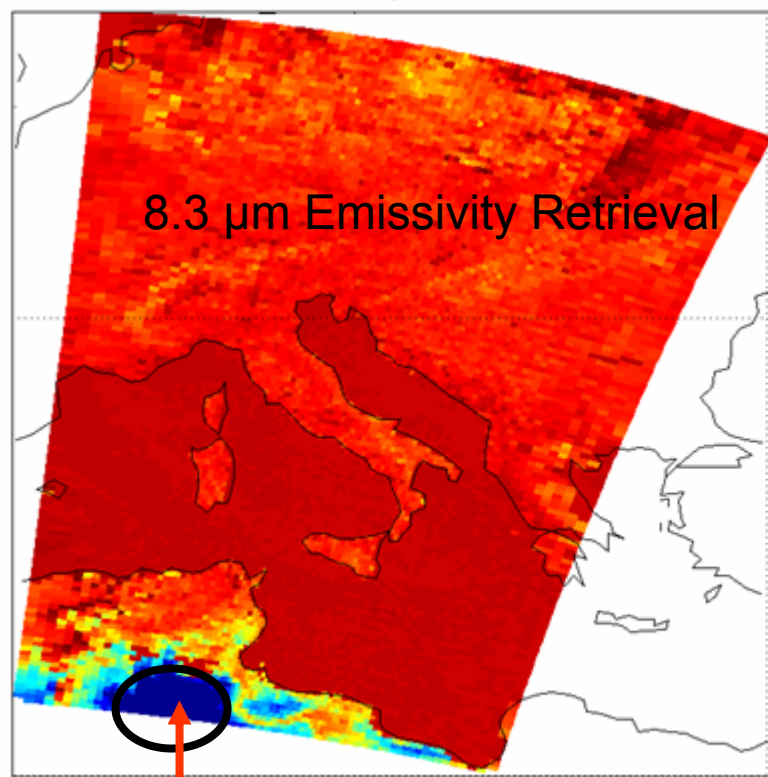
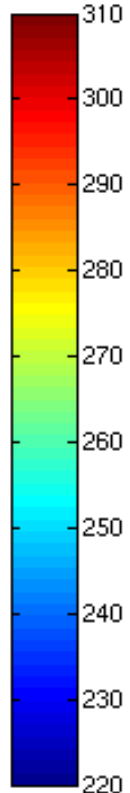
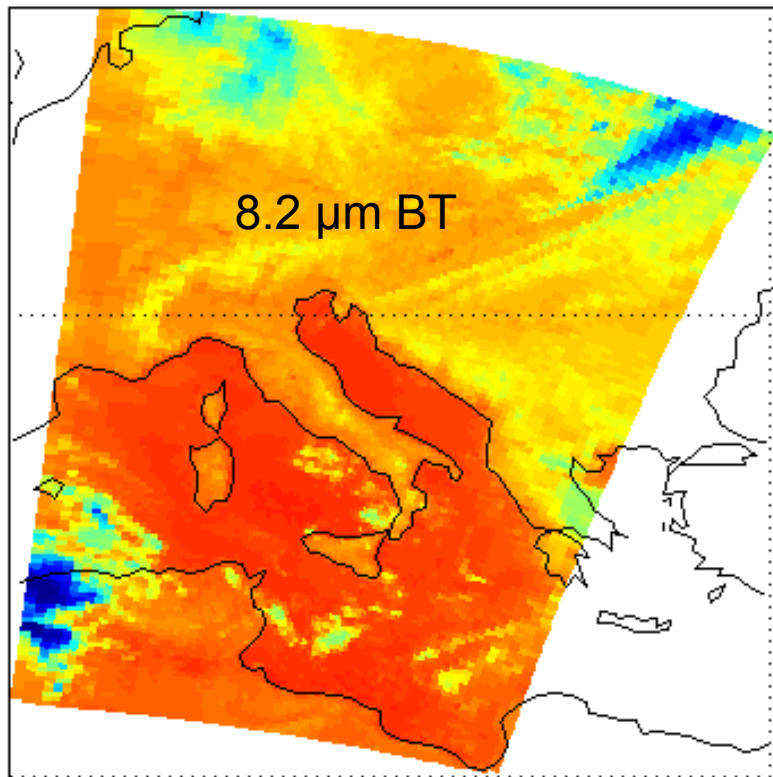


Water Vapor Profile



### (Emissivity Retrieval Simulation)

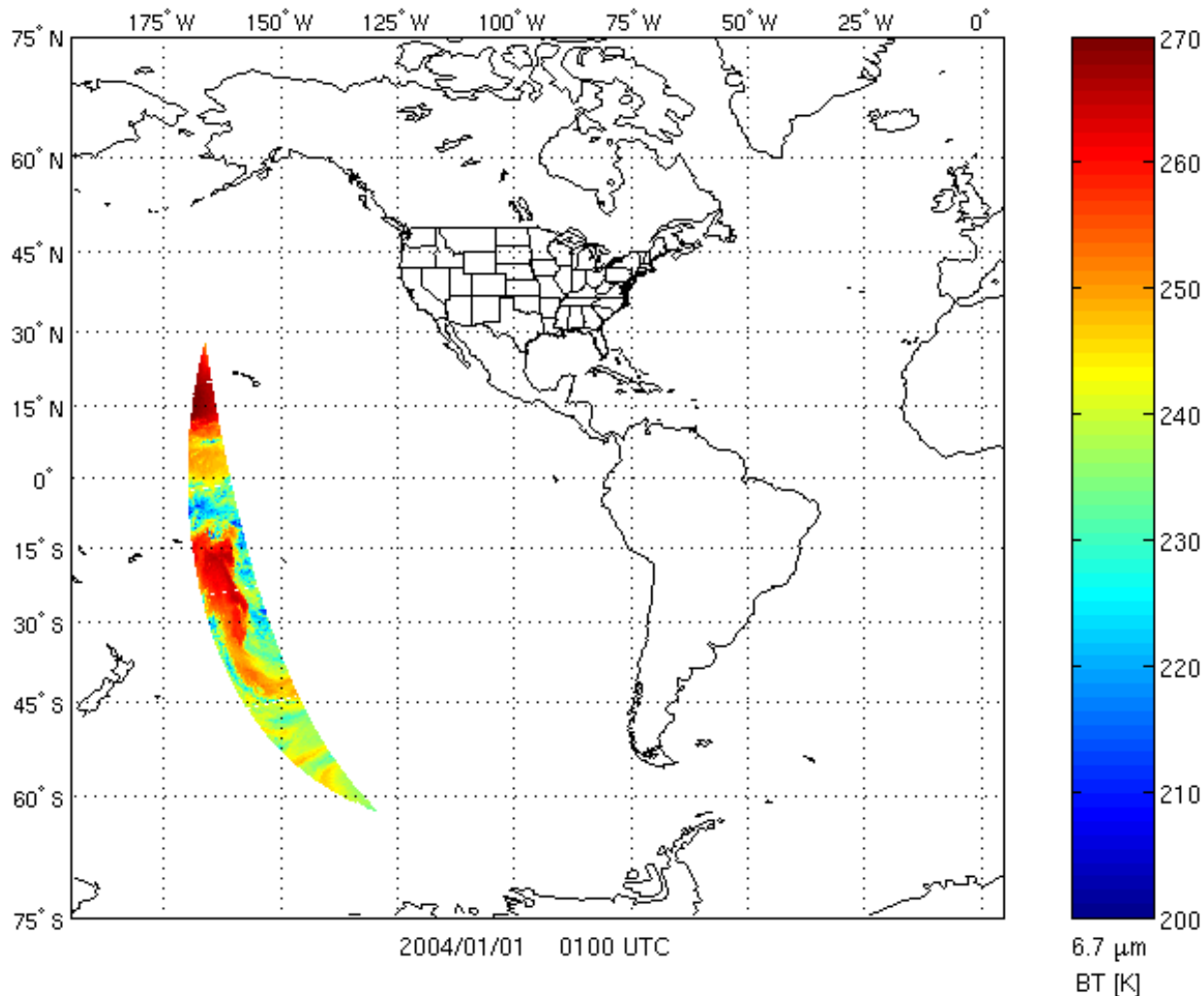




Desert Area

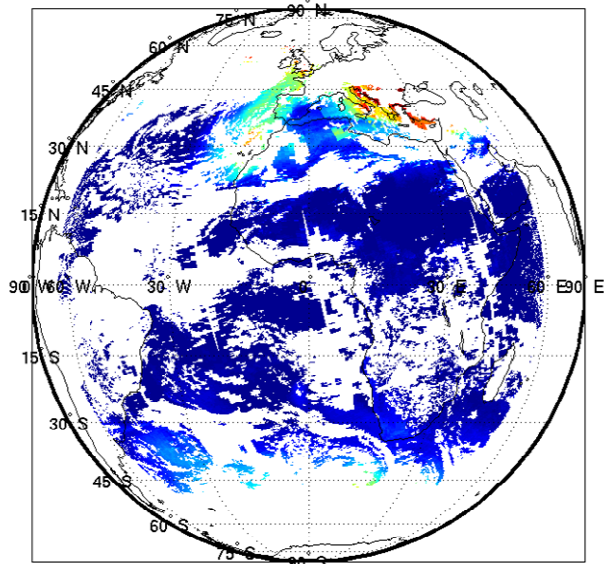
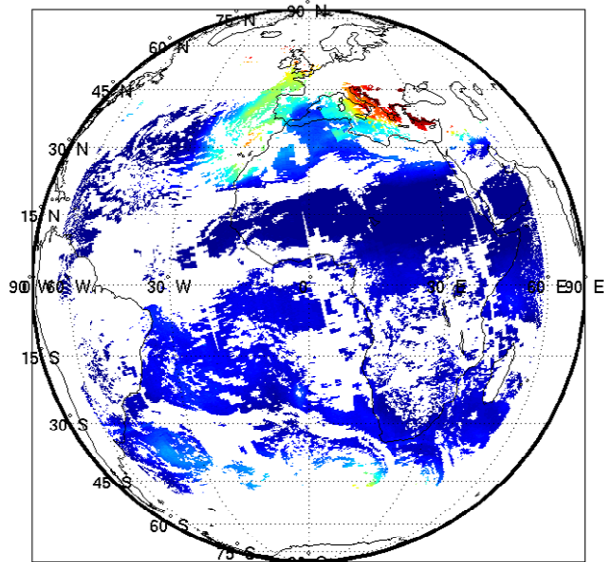
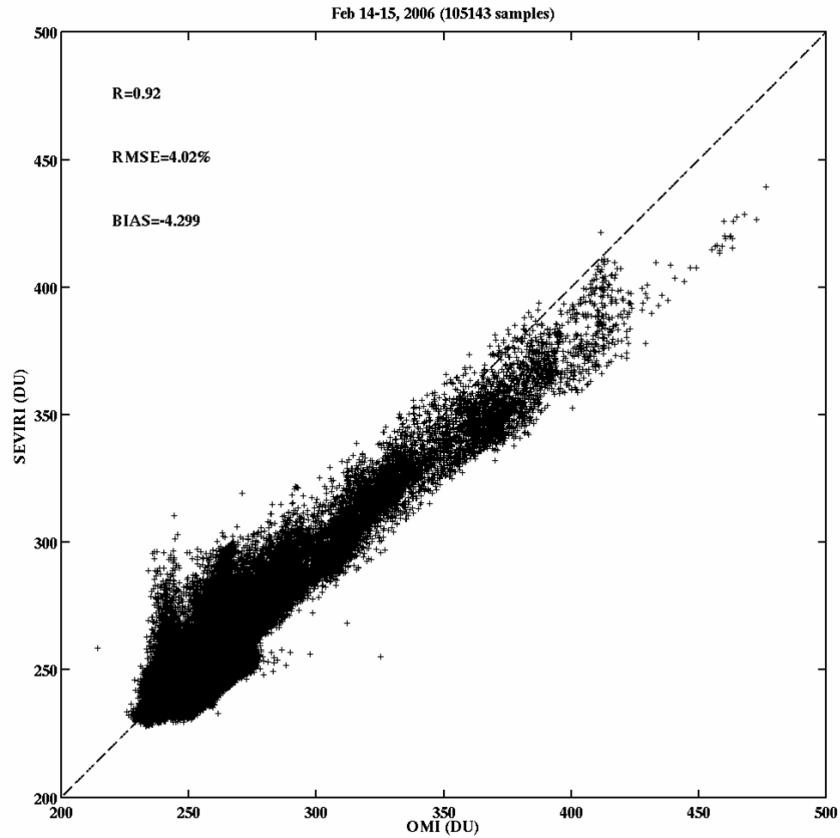
# Hourly AIRS measurements within an approximate geostationary disk coverage area

Temporal resolution is unique aspect of Geostationary IR measurements

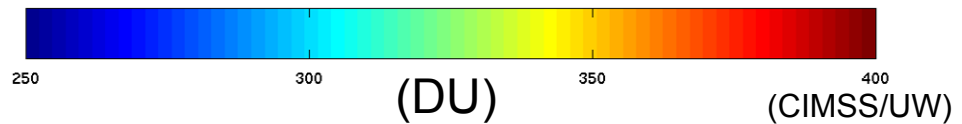


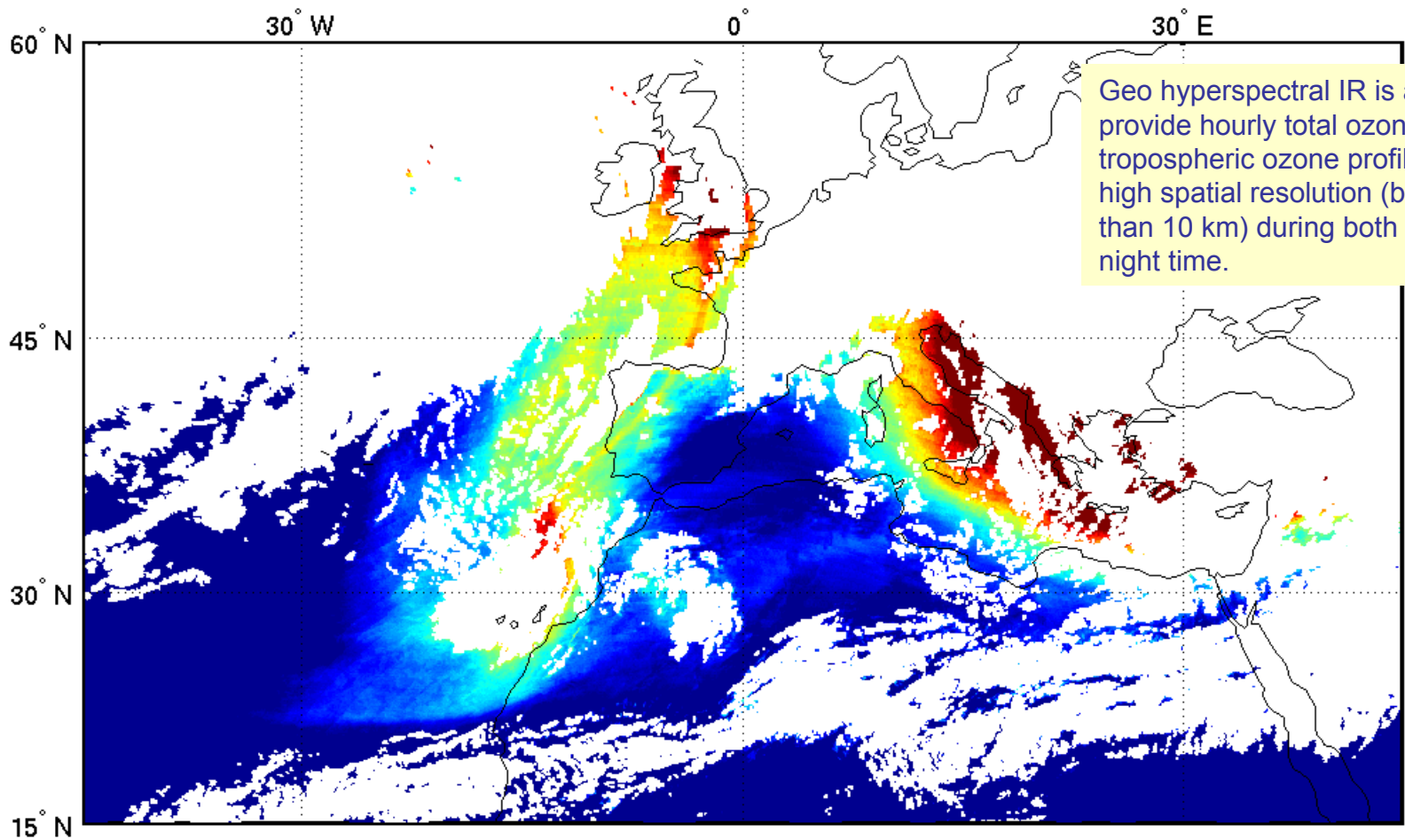
A geostationary hyperspectral sounder will provide full hourly disk coverage rather than the partial coverage available with polar orbiting sounders.

# SEVIRI data from EUMETSAT

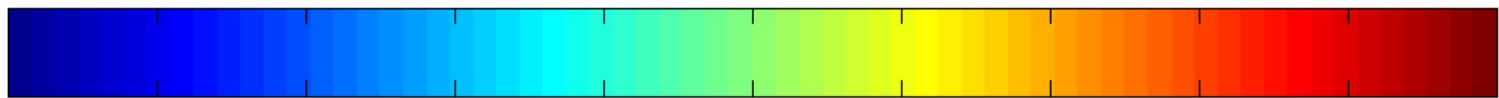


SEVIRI ozone agrees with OMI





SEVIRI total ozone retrieval



270

280

290

300

310

320

330

340

350

360

370

Total Ozone content (DU) at ---2006045:12:00



# Summary

- Current GOES Sounder provides important products that have been used in NWP and short range forecasts and nowcasts
- ABI can be used together with forecast to continue the current GOES Sounder
- Geo hyperspectral IR sounder is needed to meet future NWP requirement
  - Depict large water vapor variations spatially and temporally
  - Improve thunderstorm over land
  - Emissivity determination over land
  - Low level inversion and cape inversion detection and retrieval

International TOVS Study Conference, 15<sup>th</sup>, ITSC-15, Maratea, Italy, 4-10 October 2006  
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,  
Cooperative Institute for Meteorological Satellite Studies, 2006.