

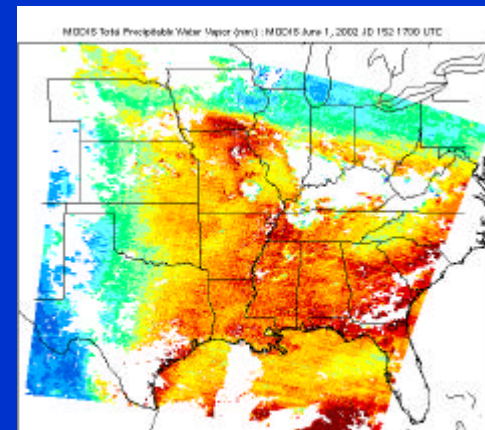
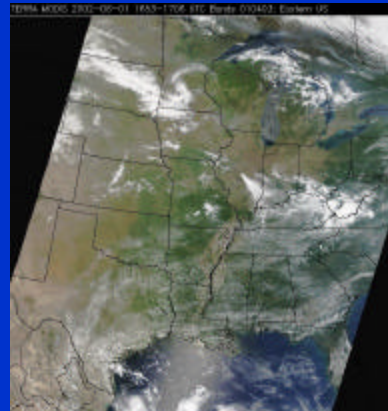
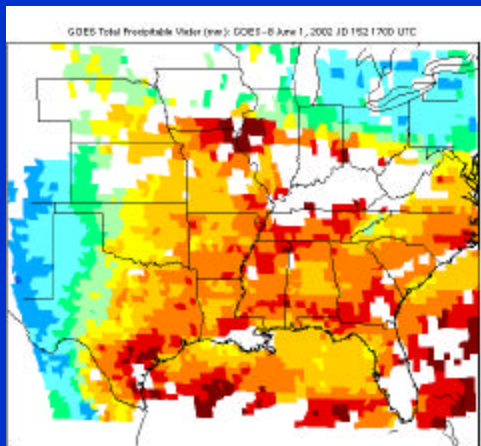
# INFRARED-DERIVED ATMOSPHERIC PROPERTY VALIDATION

W. Feltz, T. Schmit, J. Nelson, S. Wetzel-Seeman,

J. Mecikalski and J. Hawkinson

3<sup>rd</sup> Annual MURI Workshop

University of Wisconsin CIMSS/SSEC



# OUTLINE

- Satellite Derived Product Overview
- Validation Efforts
- Overview of Satellite/Aircraft/Ground-based Infrared Thermodynamic Retrieval Products
- Summary and Future Efforts

# GOAL

To evaluate quality of current satellite, aircraft and, groundbased infrared derived atmospheric properties such as stability and cloud products using **latest** in situ and remotely sensed meteorological validation data.

Then relate current IR-derived atmospheric products to future GIFTS retrieval products.

# Derived Products from IR Data

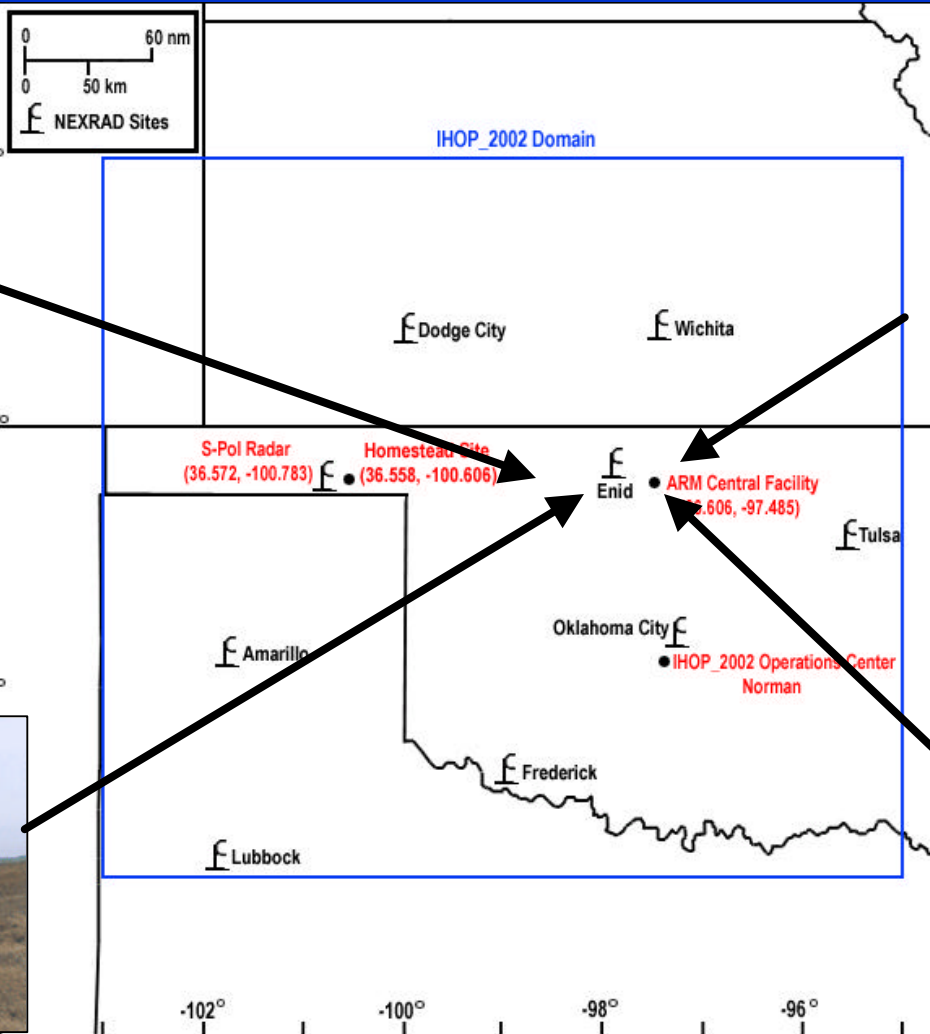
- **Total Precipitable Water Vapor (TPW)**
  - **Important for NWP assimilation and nowcasting**
- **Stability Indices**
  - **Lifted Index (LI) – measure of instability magnitude**
  - **Convective Available Potential Energy/ Convective Inhibition (CAPE/CIN) – amount of energy available**
  - **Functions of the average equivalent potential temperature within the PBL and temperature profile**
  - **Important for nowcasting convection**
- **Cloud Top Pressure**
  - **Important for NWP assimilation and short-term forecasting**

# Validation of GOES/MODIS/AIRS and GIFTS Atmospheric Products Using DOE ARM



Radiosondes

Microwave Radiometer



Raman Lidar

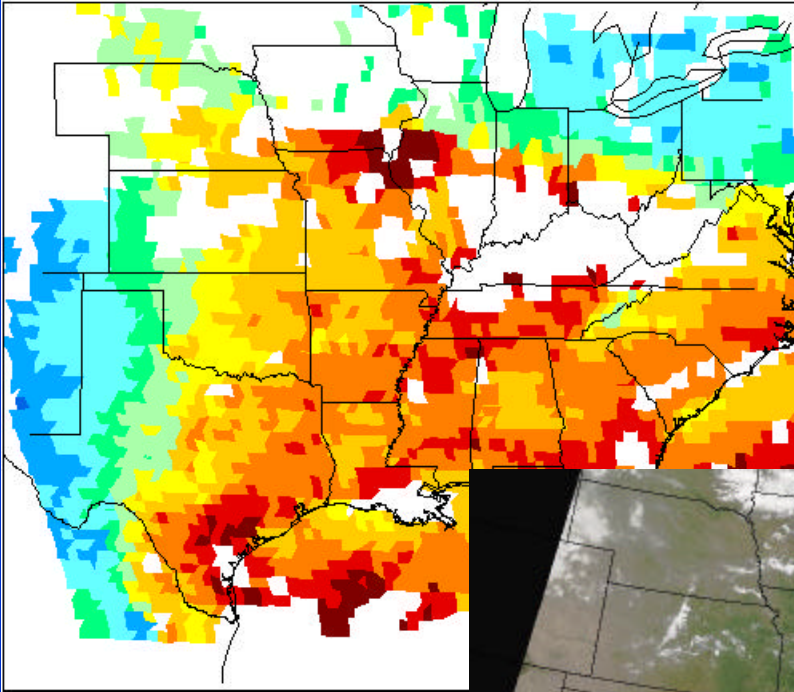
Millimeter Microwave Cloud Radar



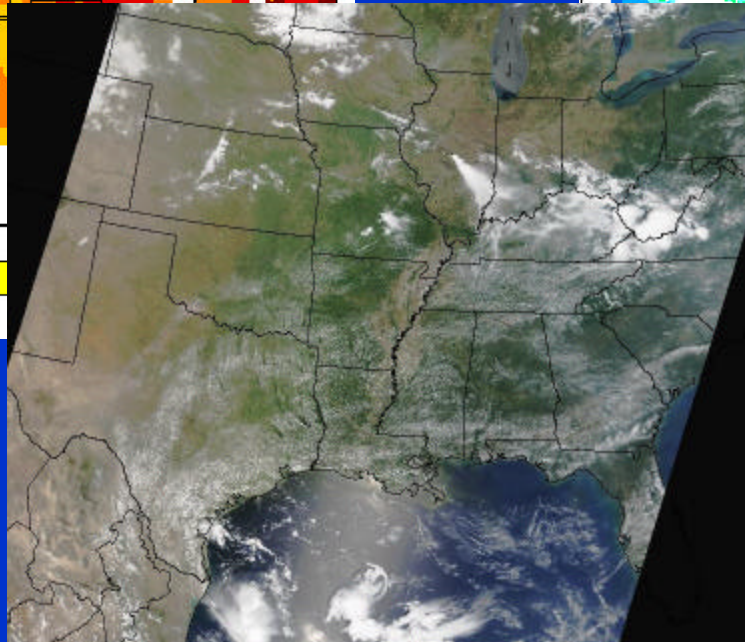
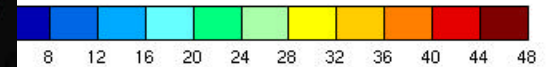
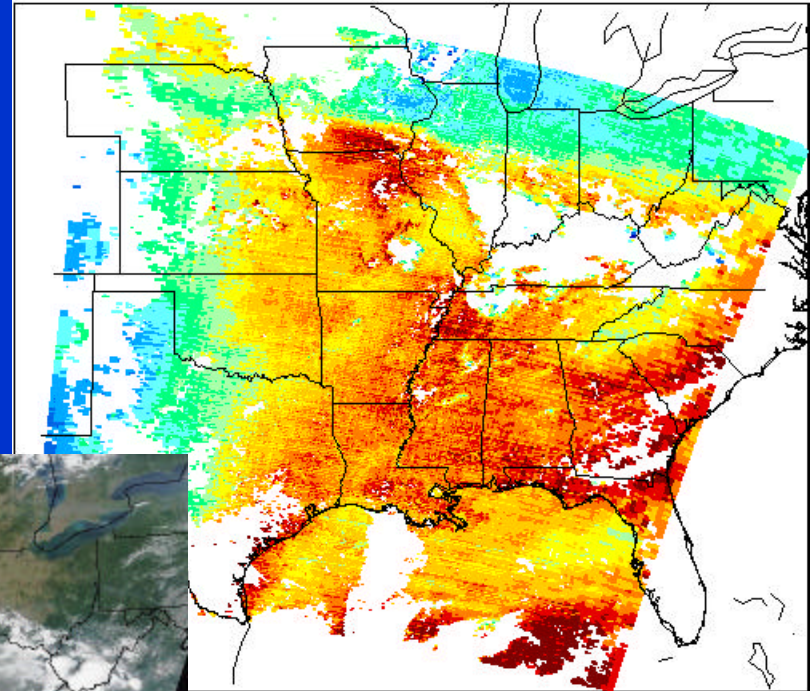


# Satellite Derived Product Validation

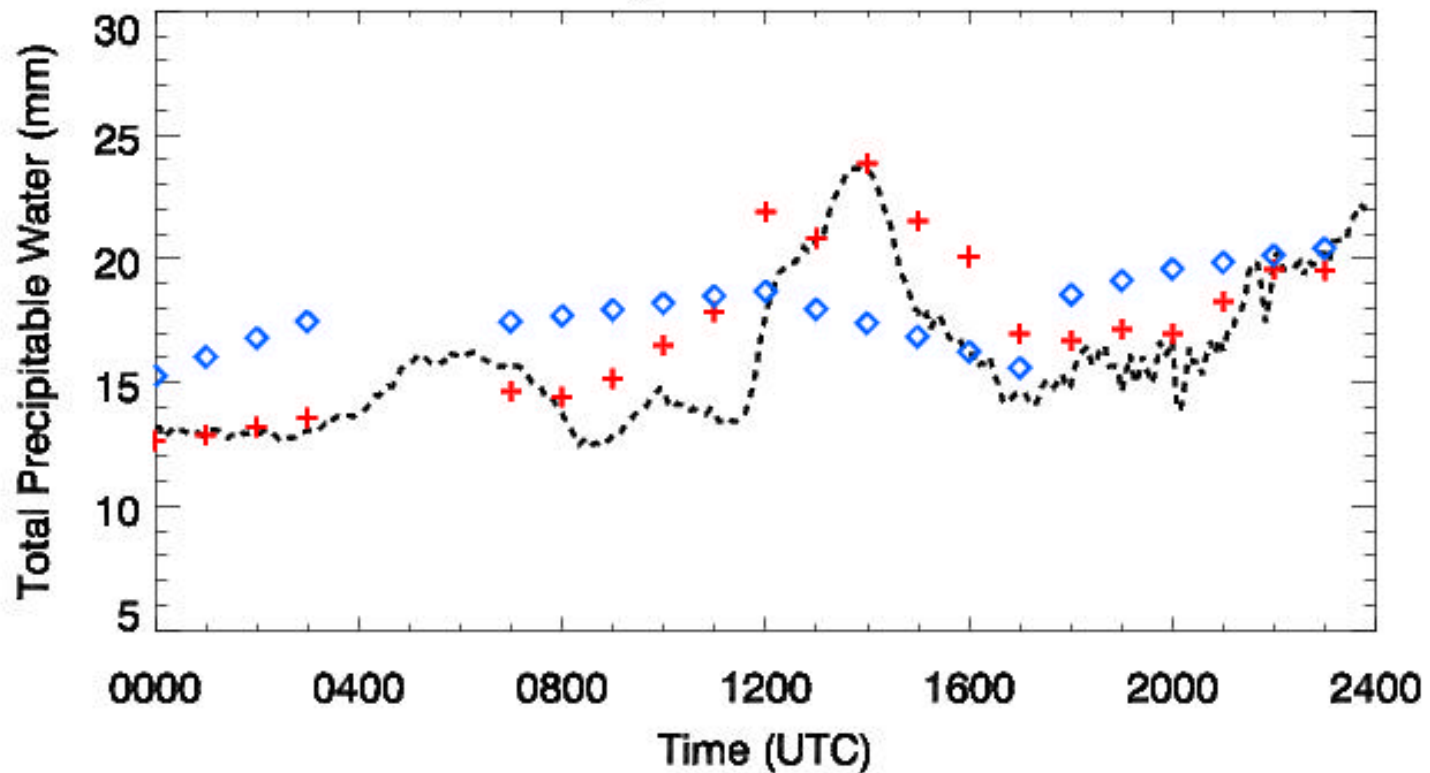
GOES Total Precipitable Water (mm): GOES-8 June 1, 2002 JD 152 1700 UTC



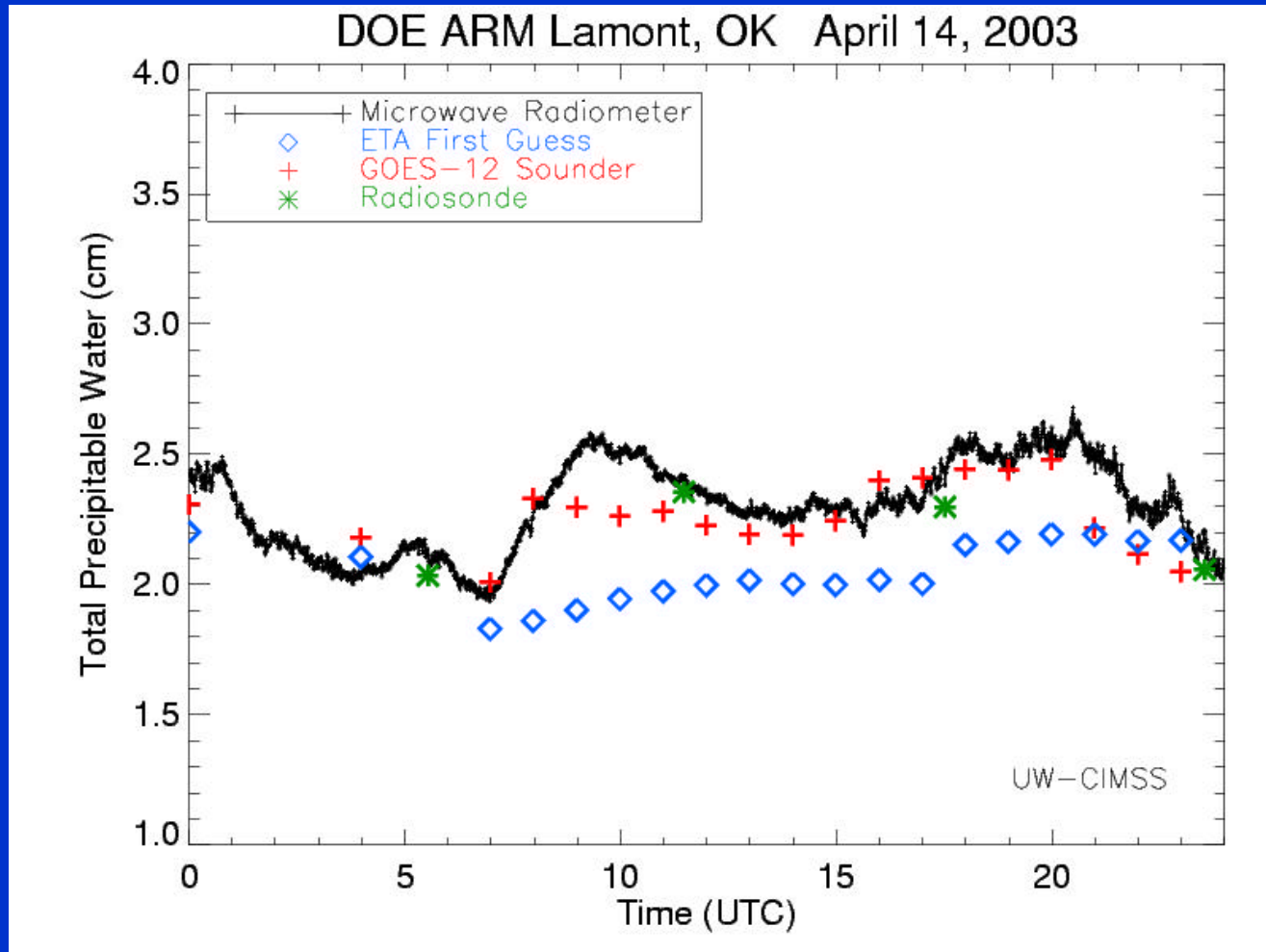
MODIS Total Precipitable Water Vapor (mm): MODIS June 1, 2002 JD 152 1700 UTC



# Example of Validation of GOES-8 Sounder Hourly 3x3 TPW Validation Using ARM Microwave Radiometer (Black - MWR; Red - GOES TPW; Blue - ETA First Guess)

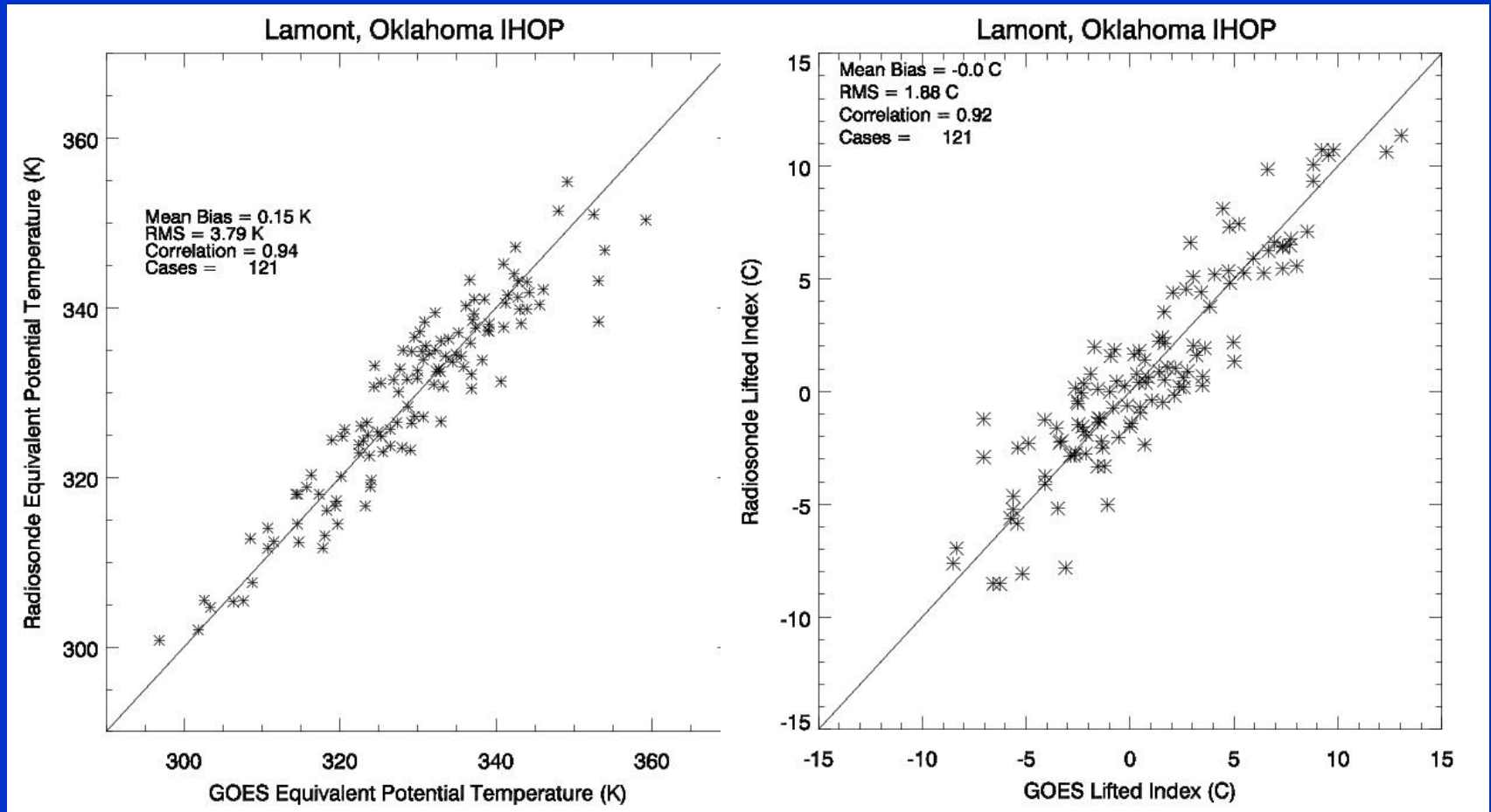


# Example of Near Realtime Validation of GOES-12 Sounder Hourly 3x3 TPW Validation Using ARM Microwave Radiometer





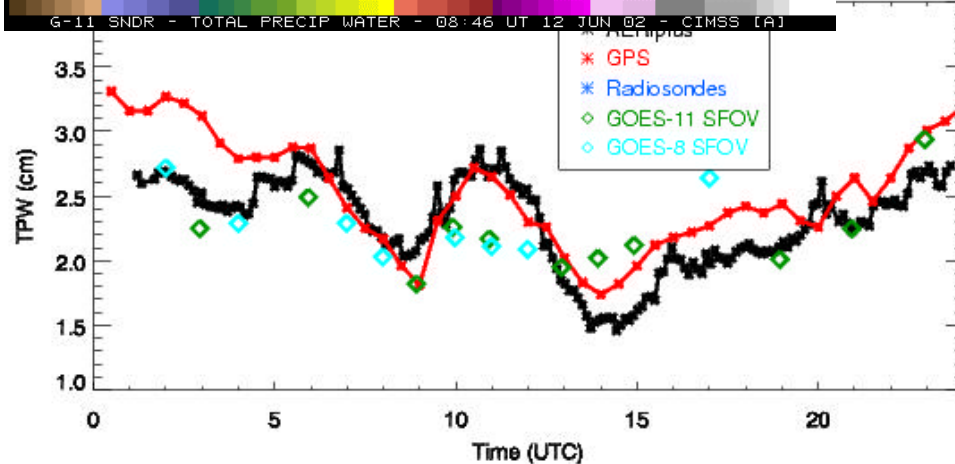
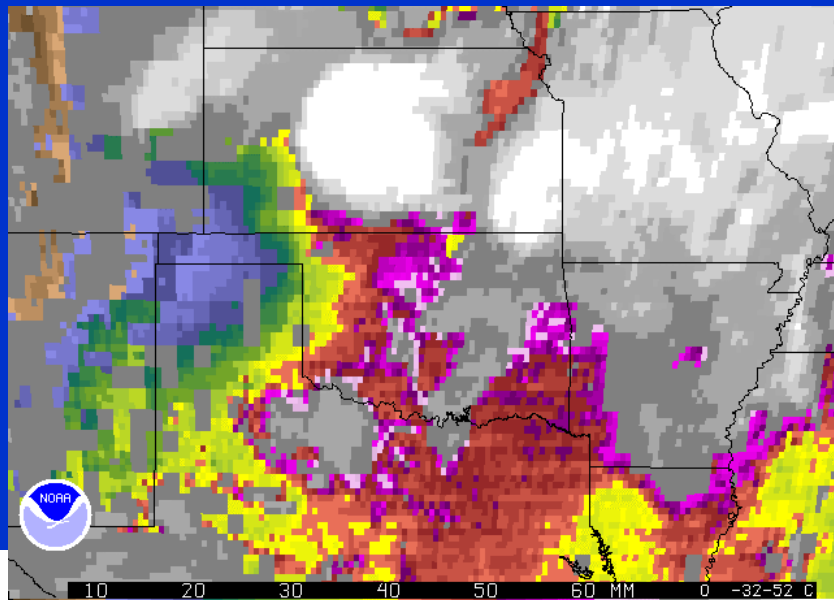
# VALIDATION OF GOES SOUNDER DERIVED PBL EQUIVALENT POTENTIAL ENERGY AND LI



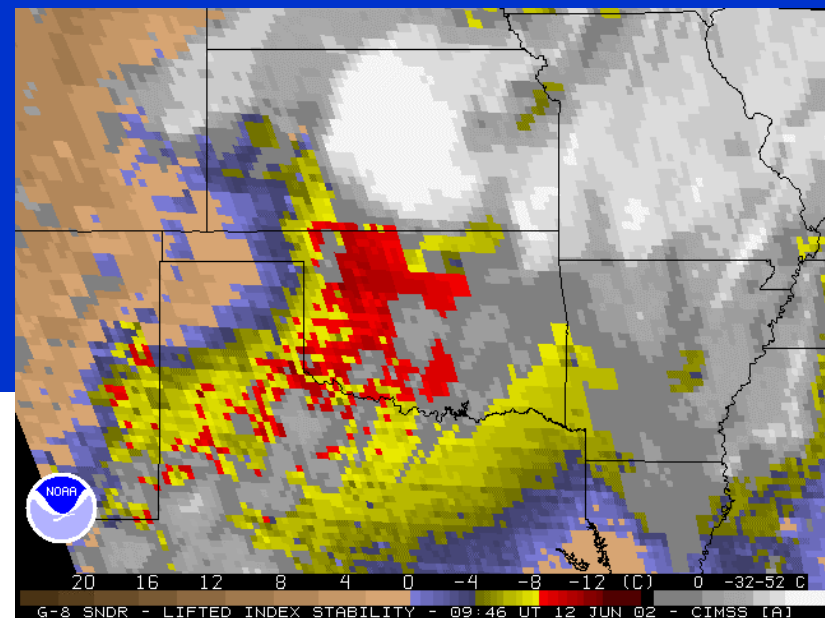
# GOES-11 1x1 IHOP DERIVED PRODUCTS

## 30 - minute SFOV Sounder and 5 - minute Imager

### Total Precipitable Water

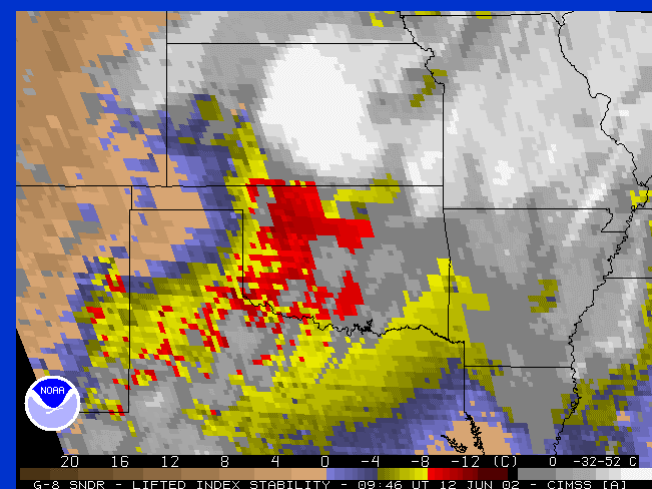


### Lifted Index

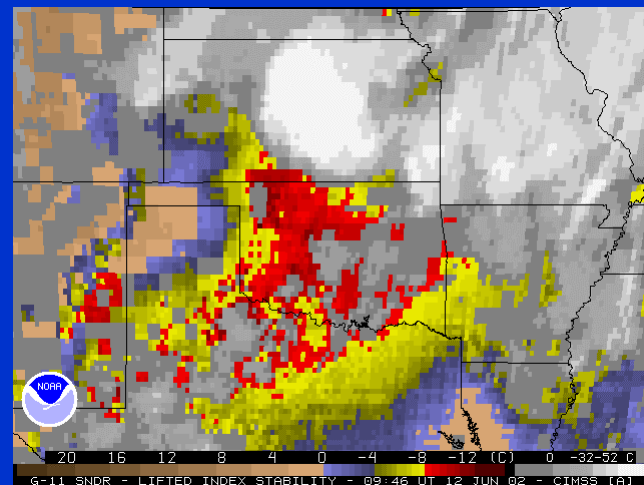


# GOES-11 International H2O Program Validation

- GOES-11 reactivated for IHOP at 5-min imager and 30-min sounder resolution
- Evaluation of GOES-11/GOES-8 total precipitable water (TPW) versus DOE ARM microwave radiometers and radiosondes from all five SGP ARM sites
- Determine the improvement of 1x1 GOES derived imagery products (LI, TPW, ..) compared to 3x3 GOES DPI using DOE ARM high frequency radiosonde launches and microwave radiometer



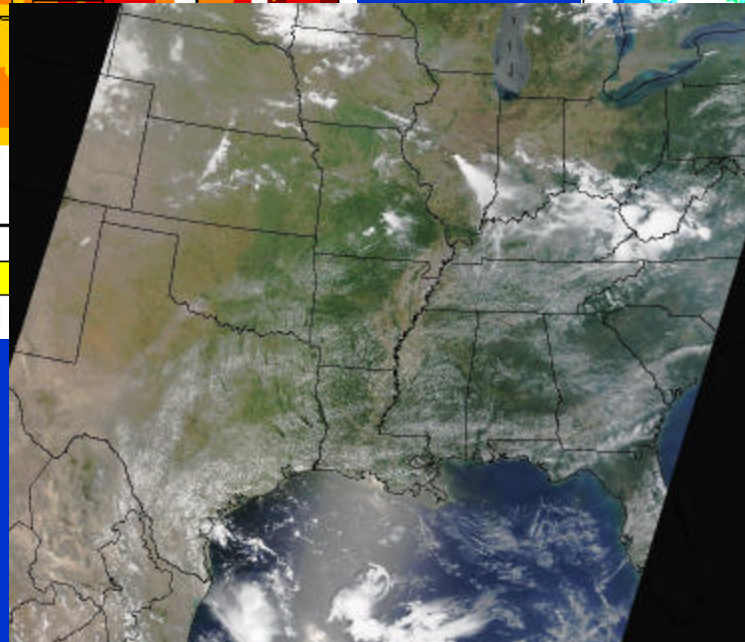
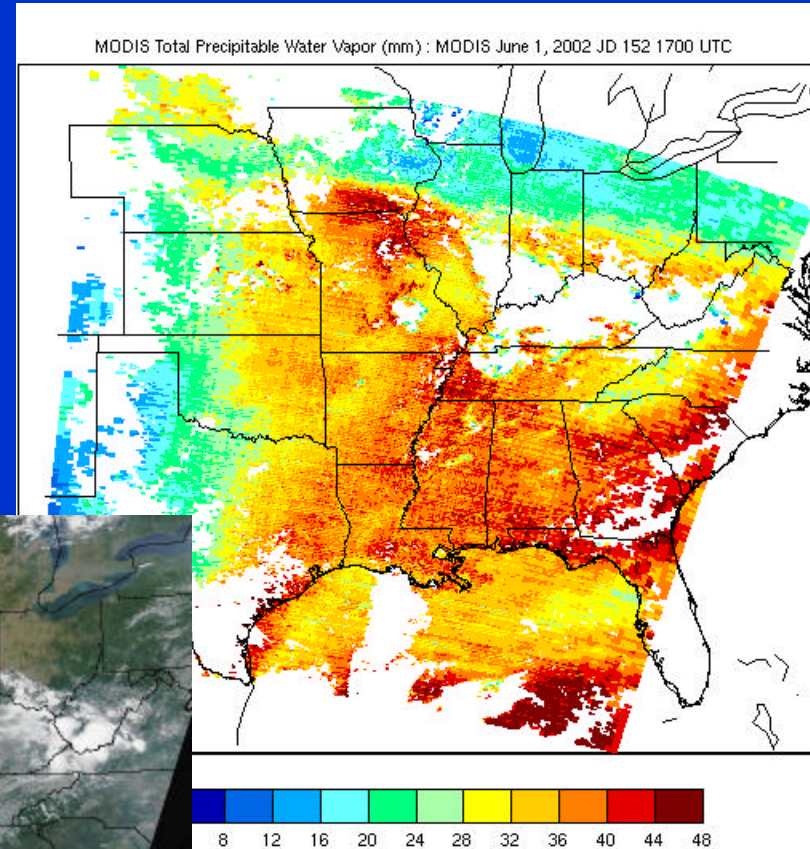
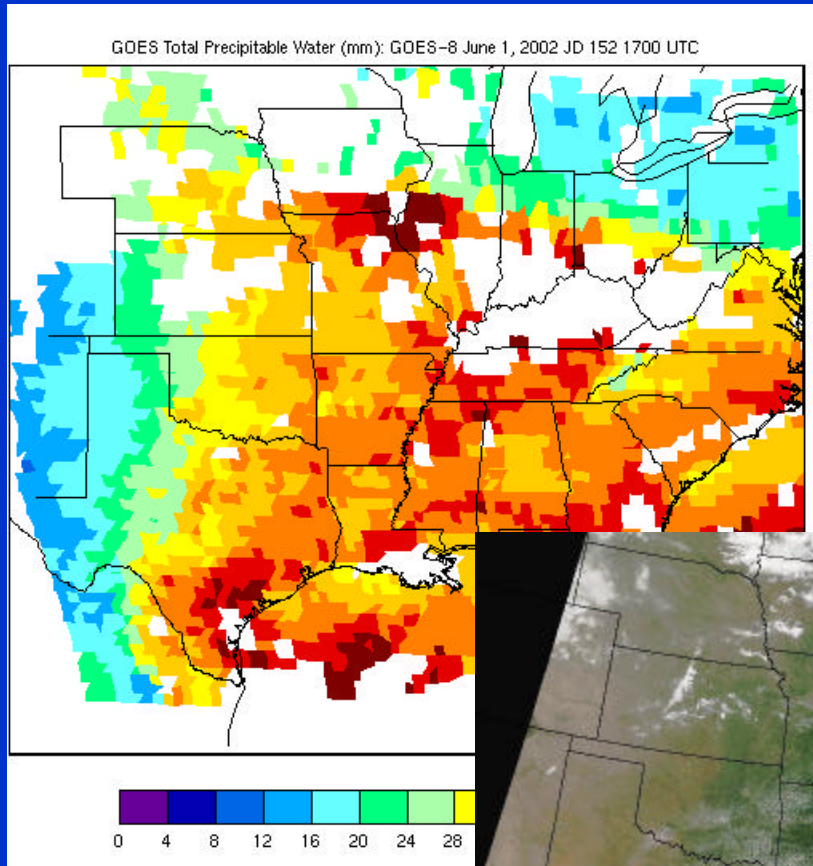
**GOES-08  
SFOV LI**



**GOES-11  
SFOV LI**

# GOES

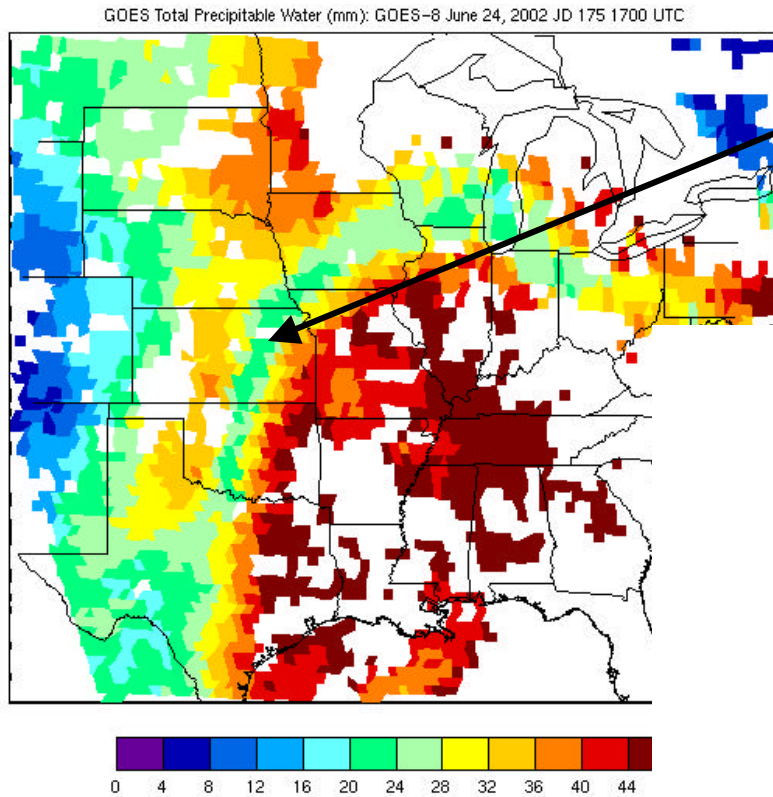
# MODIS



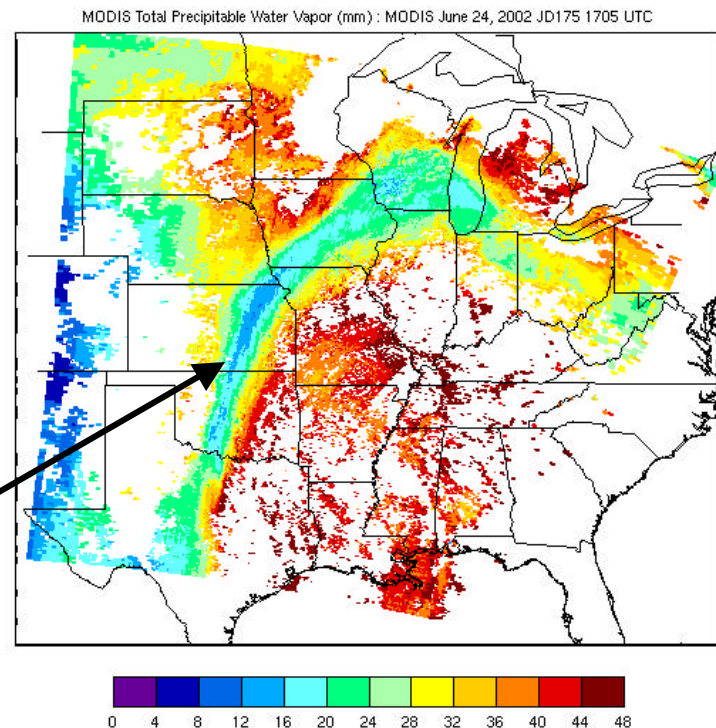


# GOES vs MODIS Derived Products

24 June 2002 TPW



**GOES Sounder**  
Temporal resolution - Hourly  
Spatial resolution – 10 km



**MODIS**

Temporal – twice daily

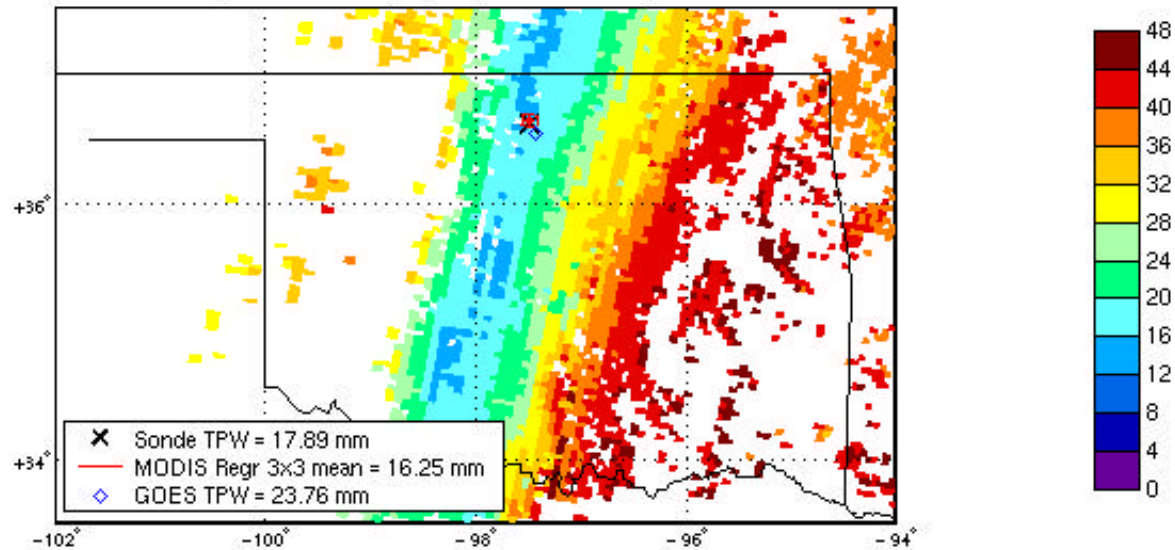
Spatial resolution – 1 km



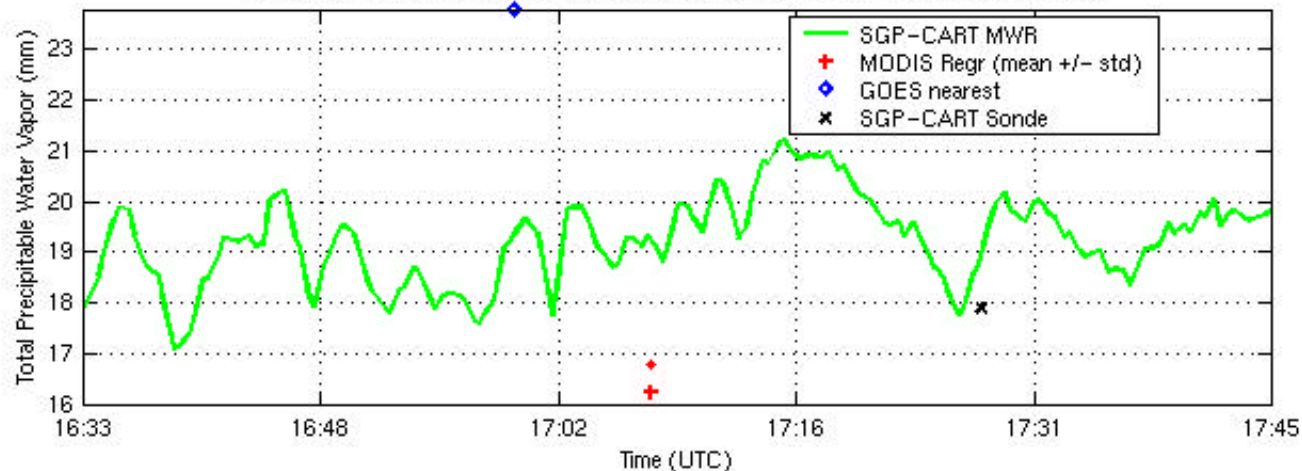
# MODIS Derived Product Validation

## 24 June 2002 TPW

MODIS Total Precipitable Water Vapor (mm): MODIS June 24, 2002 JD175 1705 UTC



Time Series of Total Precipitable Water Vapor over the SGP-CART site for 06-24-2002



# Aircraft Derived Product Validation



NASA DC-8



NASA PROTEUS

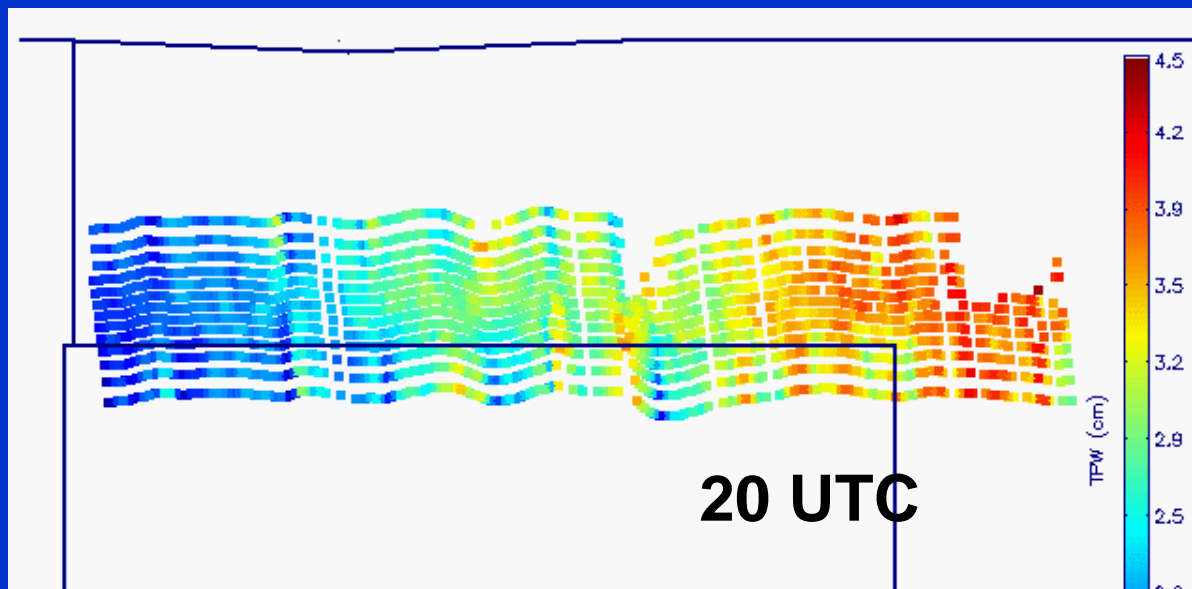
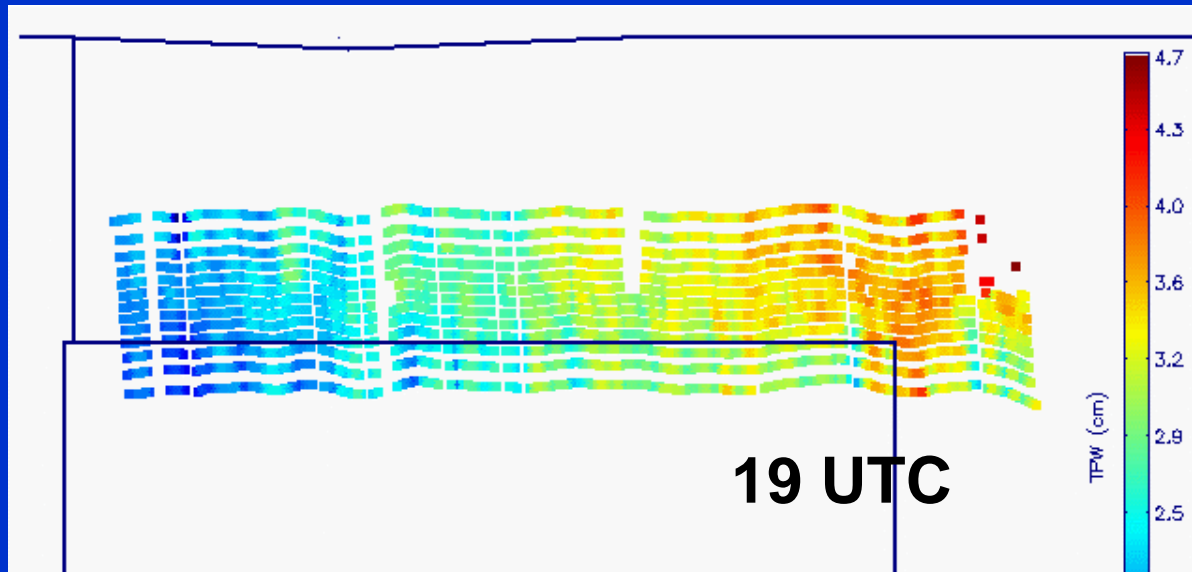


S-HIS

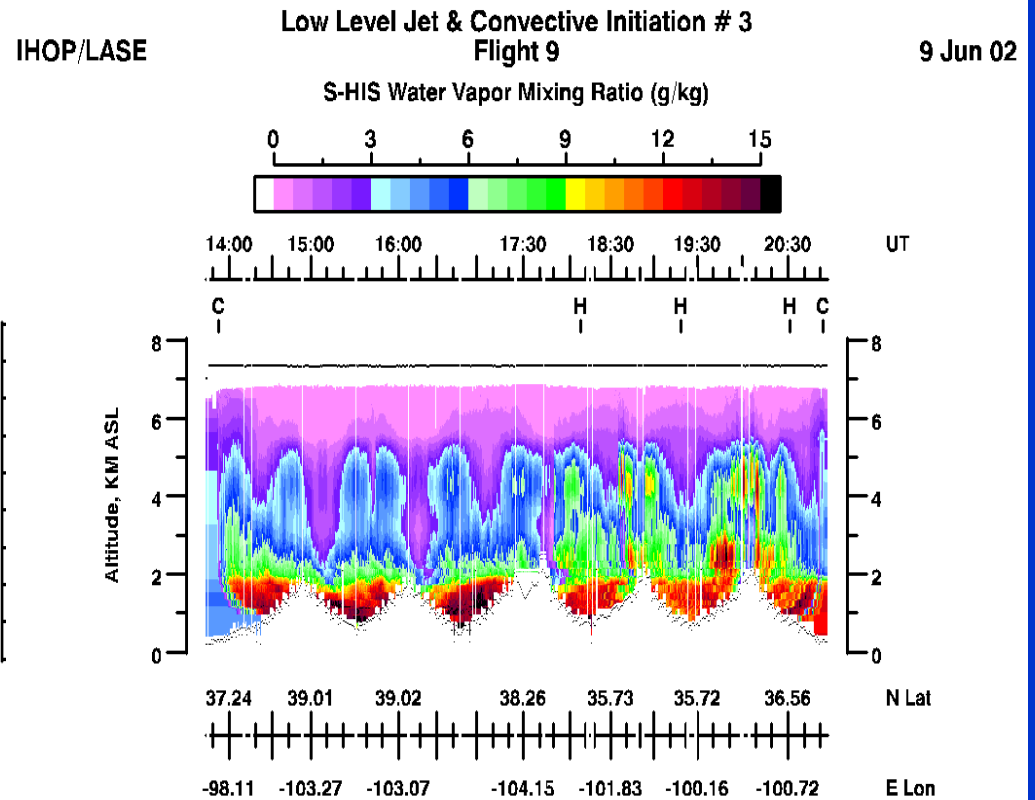
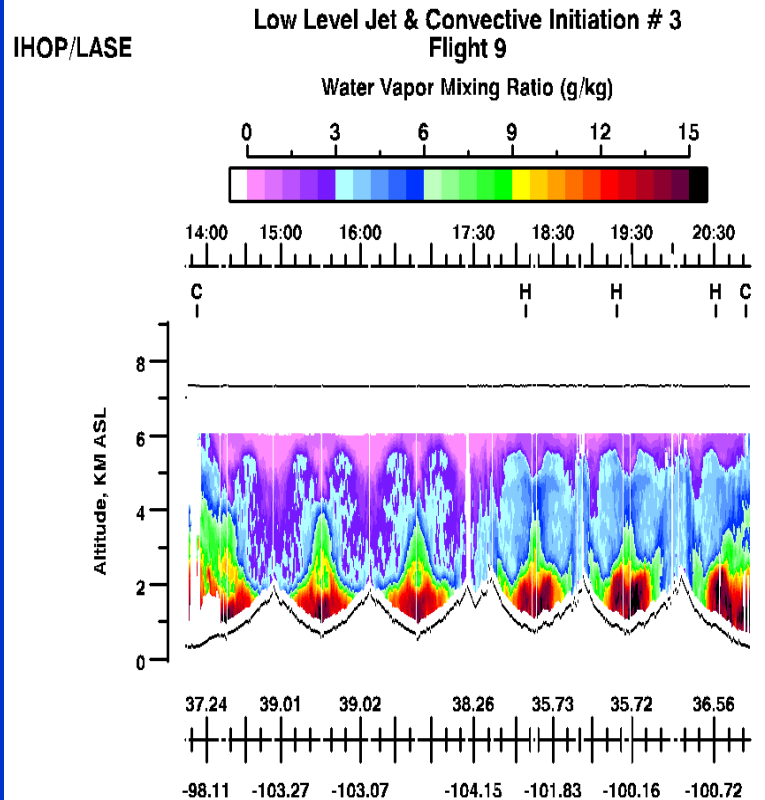


NAST-I

# NAST-I IHOP 9 June 2002 Total Precipitable Water



# IHOP S-HIS Retrieval Validation



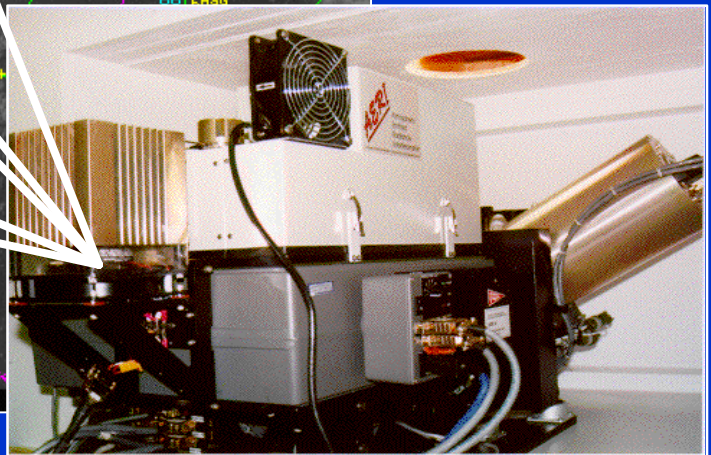
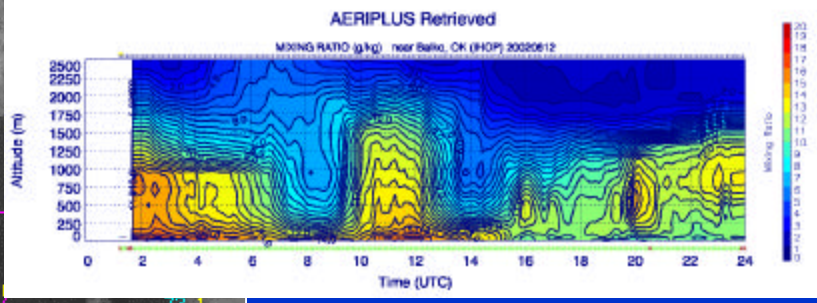
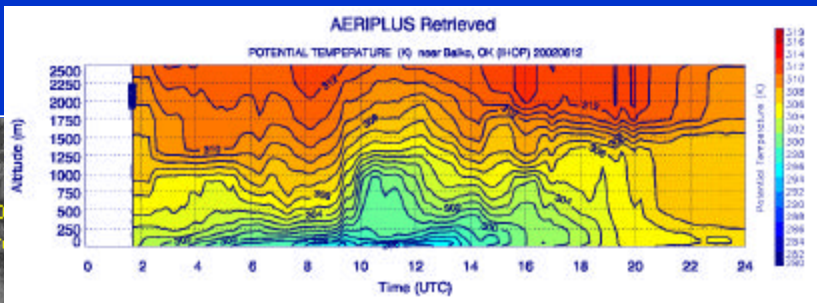
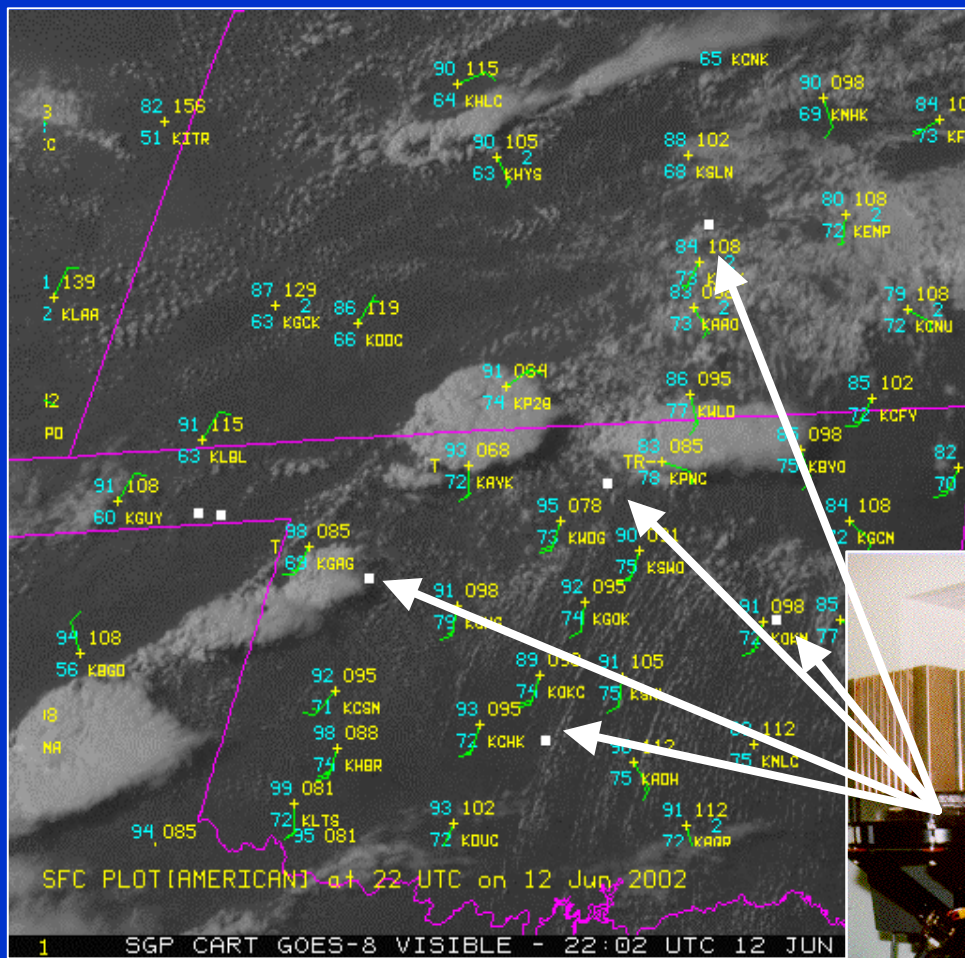
**NASA LaRC LASE DIAL  
Water Vapor\***

**S-HIS Water Vapor\***

\* Courtesy of Rich Ferrare NASA LaRC and Paolo Antonelli CIMSS/SSEC



# Groundbased Derived Product Validation

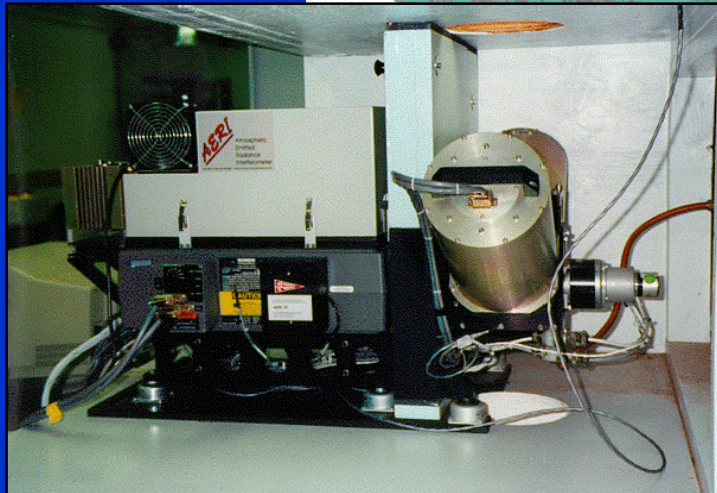
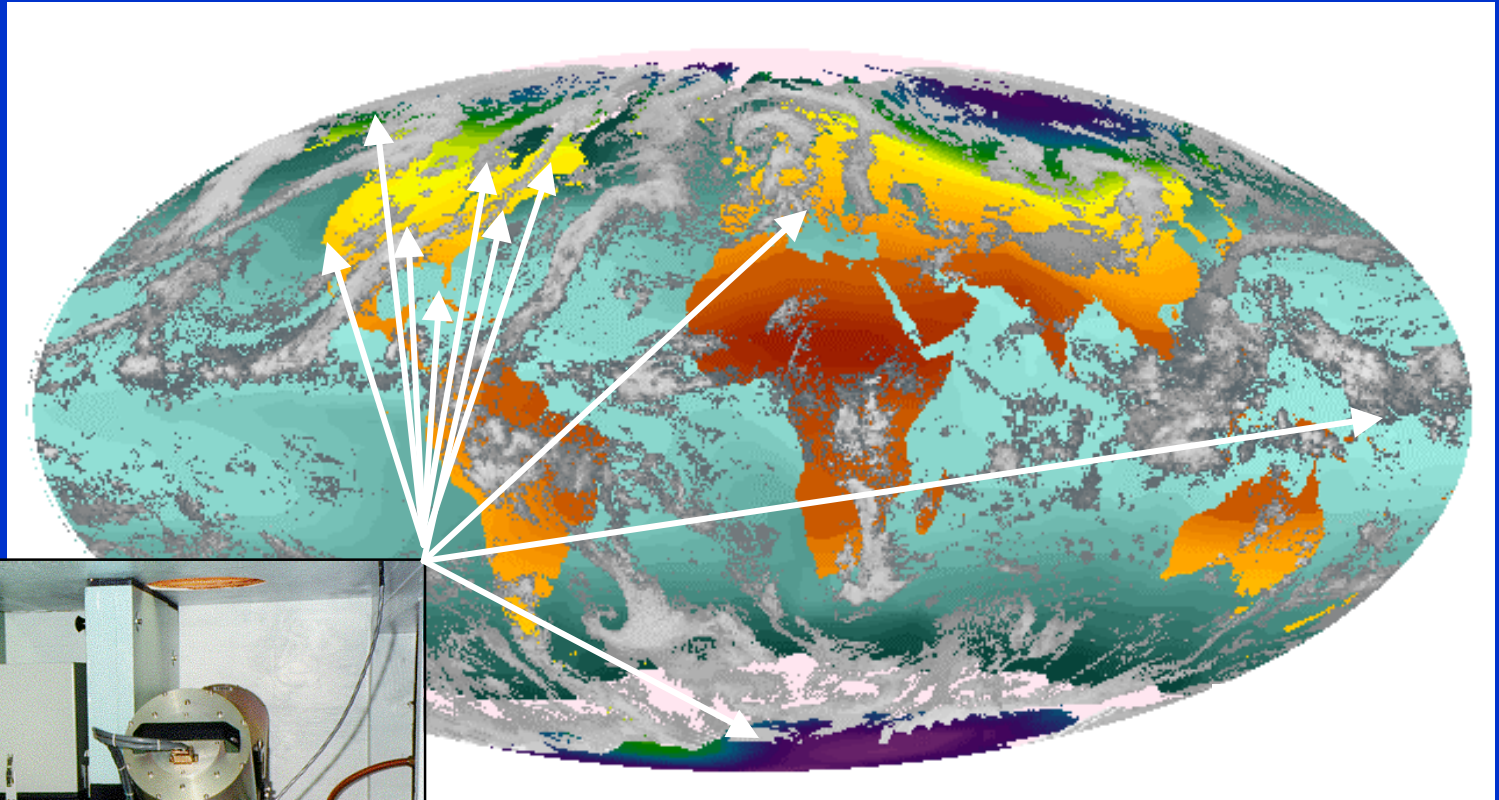




# AERI SPECIFICATIONS

- Spectral Resolution better than  $1 \text{ cm}^{-1}$  wavenumber from  $520\text{-}3000 \text{ cm}^{-1}$  (3 - 20  $\mu\text{m}$ )
- Calibrated to 1% ambient radiance (better than 1 K ambient temperature)
- Automated and environmentally hardened
- Time resolution: 6 - 10 minutes (adjustable)
- Ground-based and portable

# AERI SYSTEMS AROUND THE WORLD



UW AERI - 2 (AERIBAGO, SSEC)

DOE AERI - 8 (Kansas/Oklahoma, Alaska, S. Pacific)

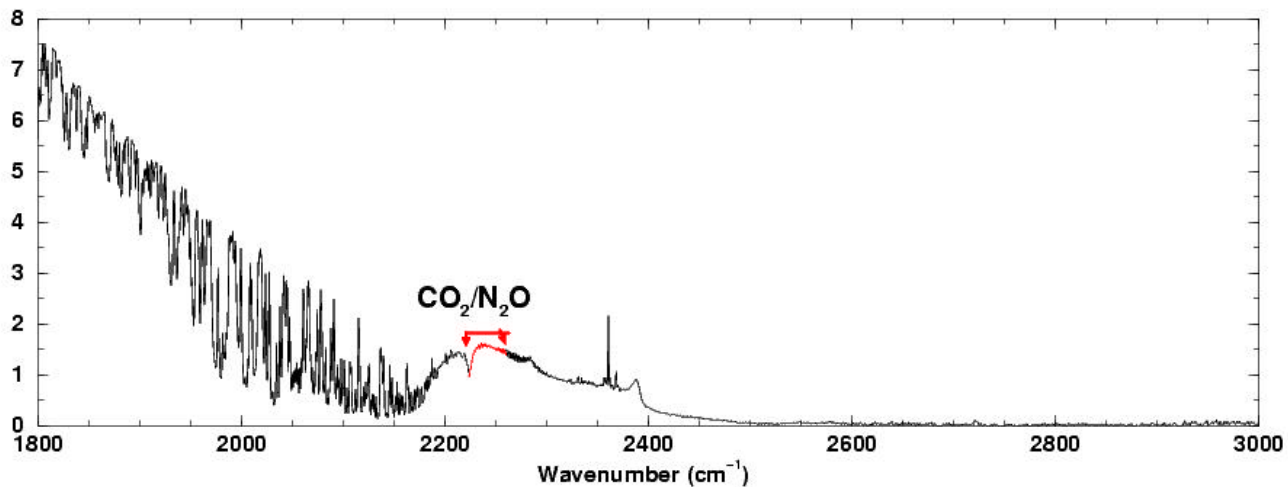
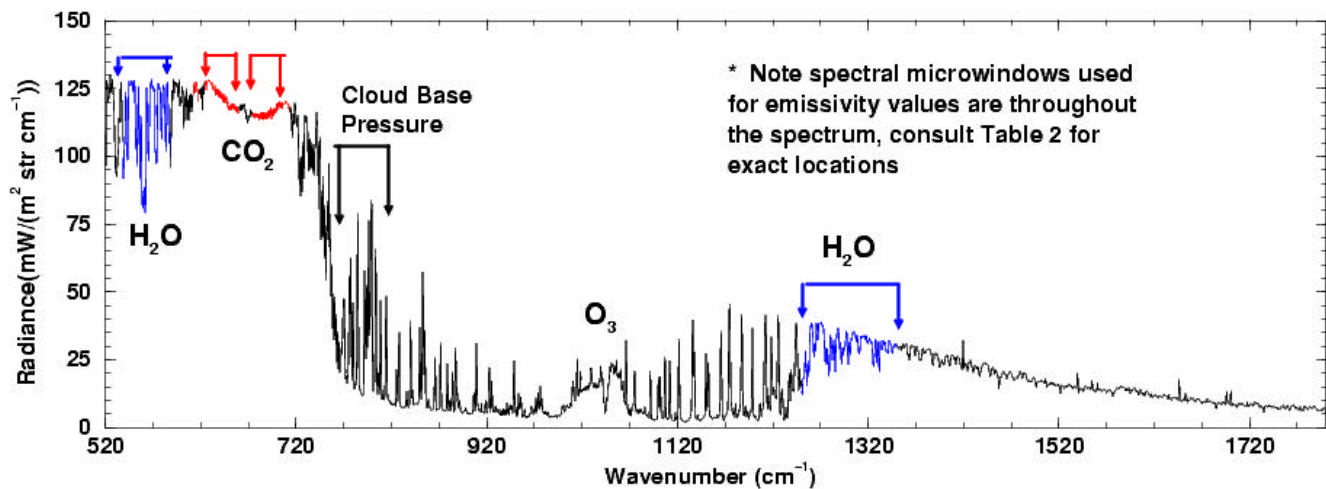
U-Miami M-AERI - 3 (Florida)

Bomem AERI - 6 (Italy, California, Maryland, Canada)

U Idaho P-AERI - 1 (Antarctica)

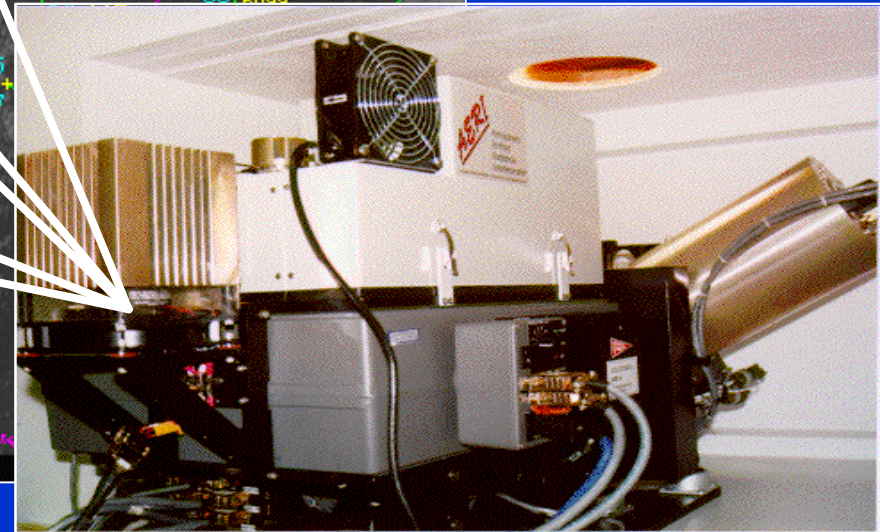
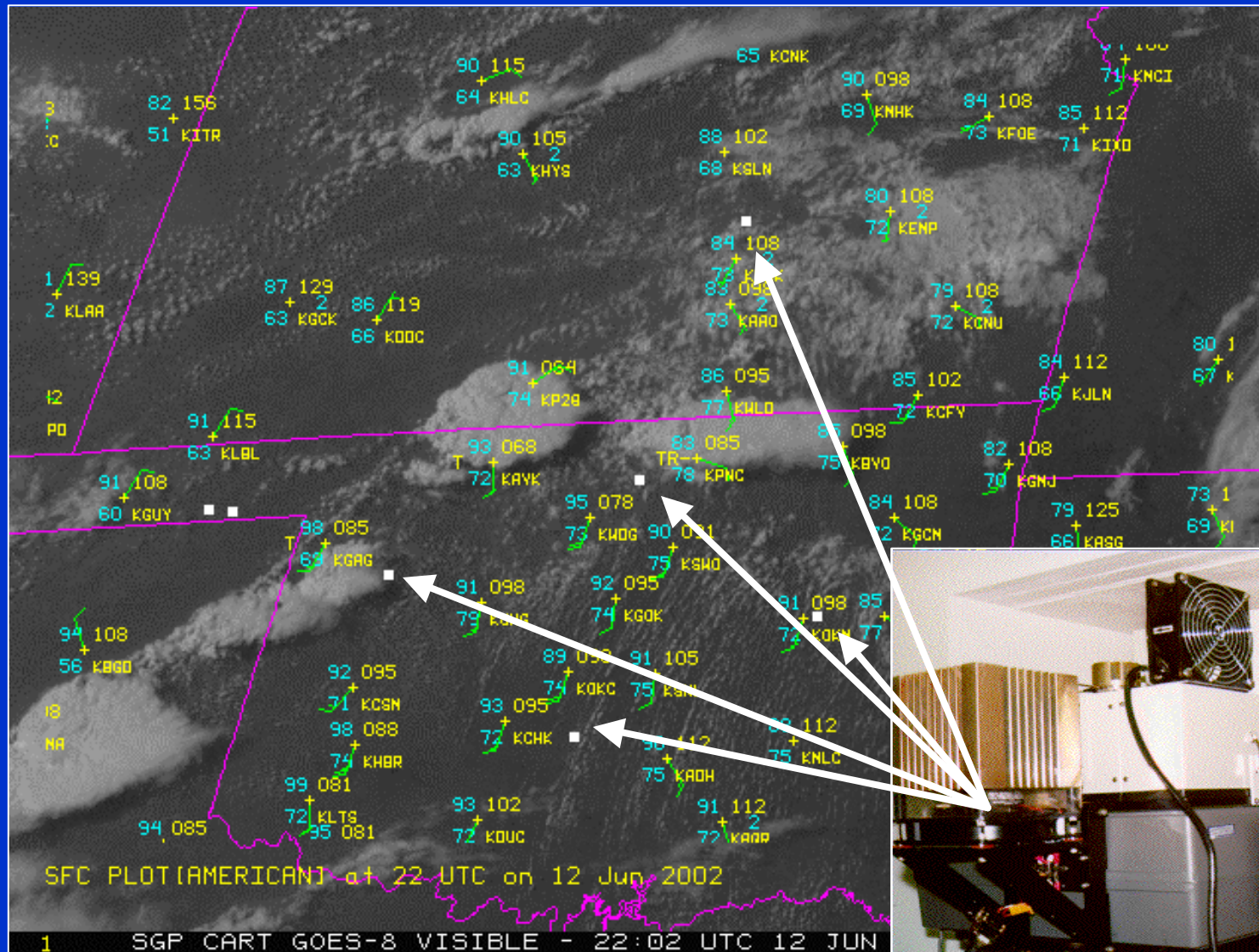
# AERI CHANNEL RETRIEVAL SPECTRAL REGIONS

AERI Radiance Channel 1 and 2

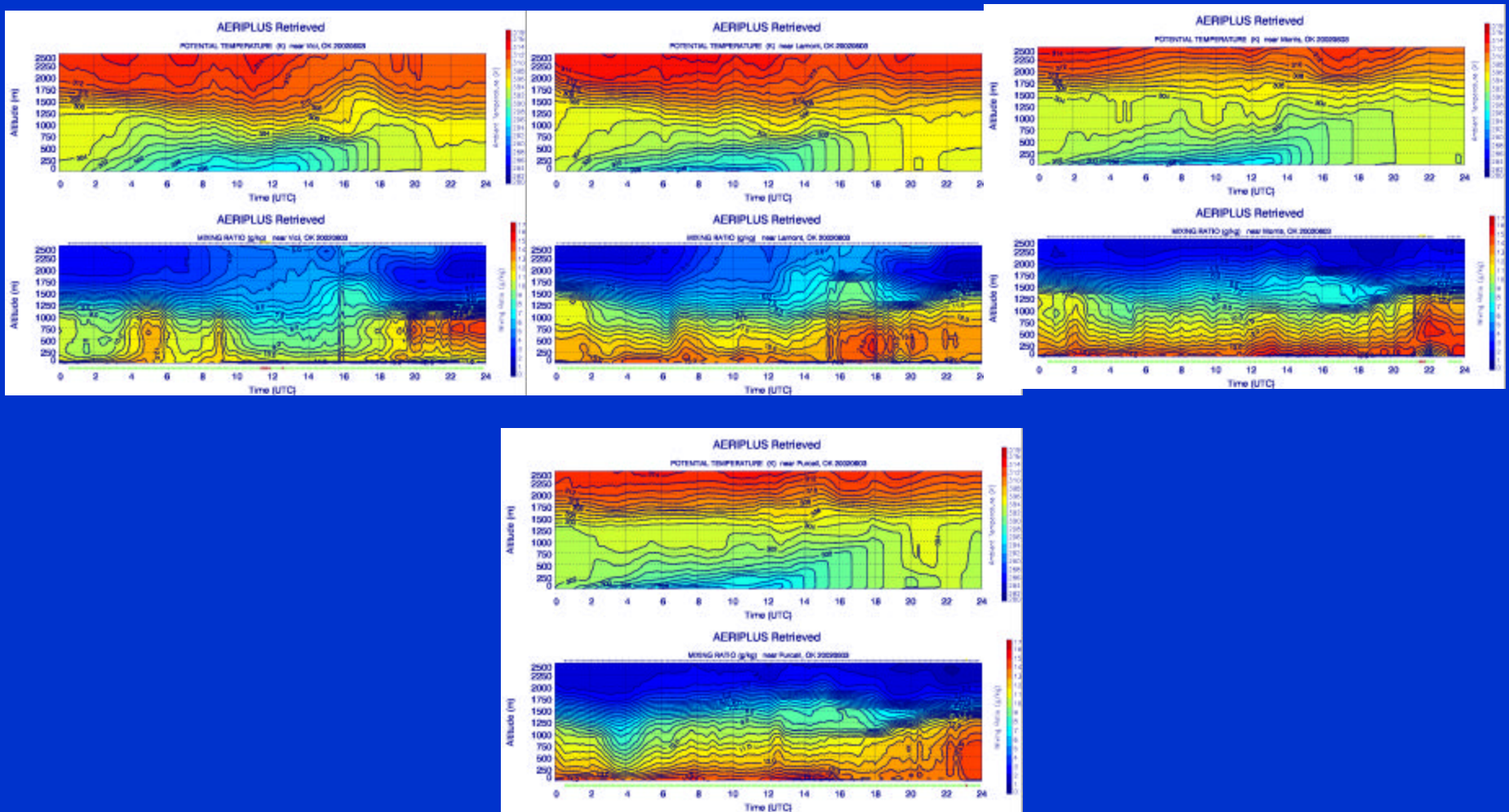




# DOE ARM SGP AERI LOCATIONS



# AERIplus Cross Section Examples

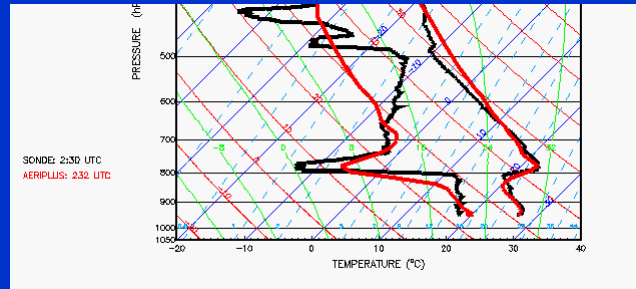




# AERIplus and Radiosonde Comparisons

## Hillsboro

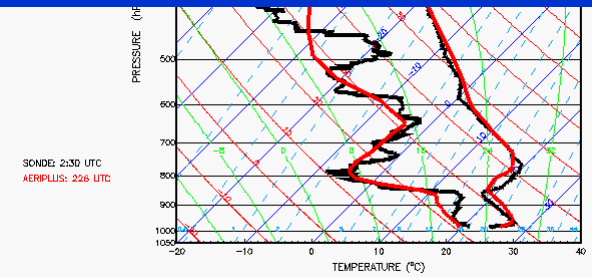
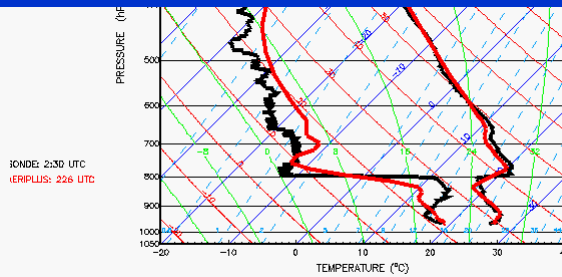
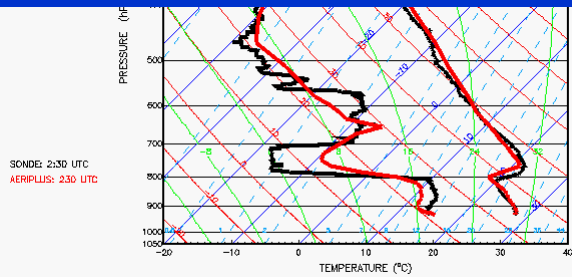
3 June 0230 UTC



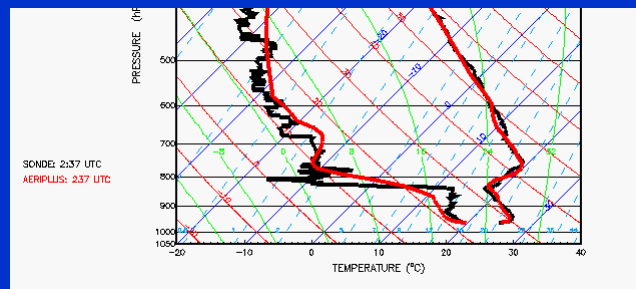
## Vici

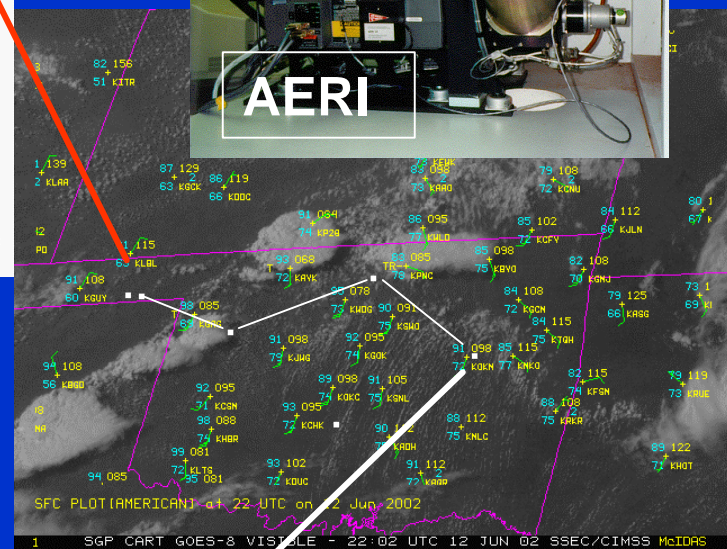
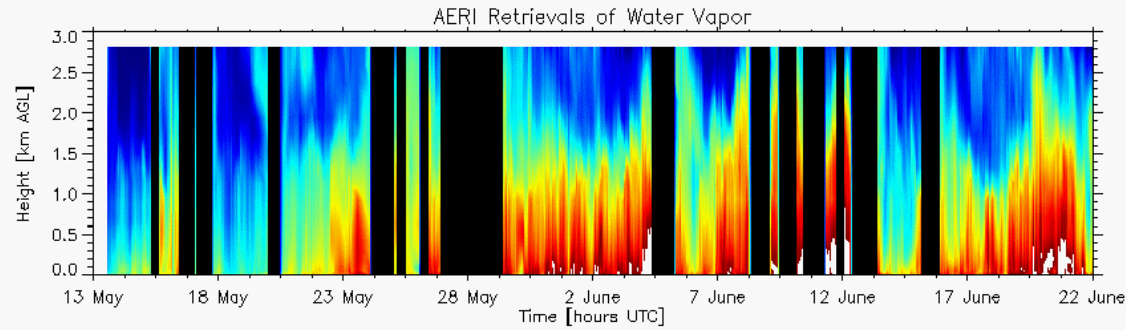
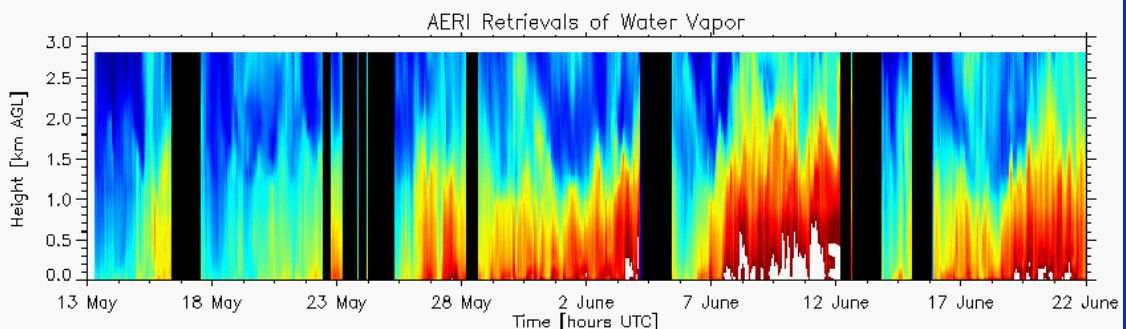
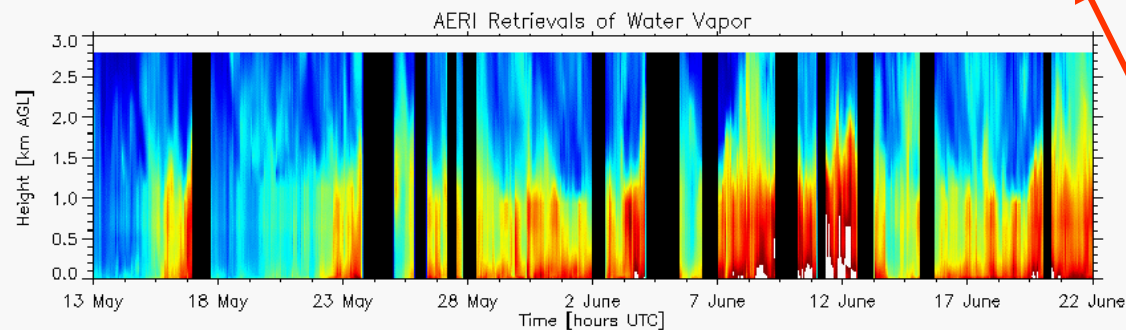
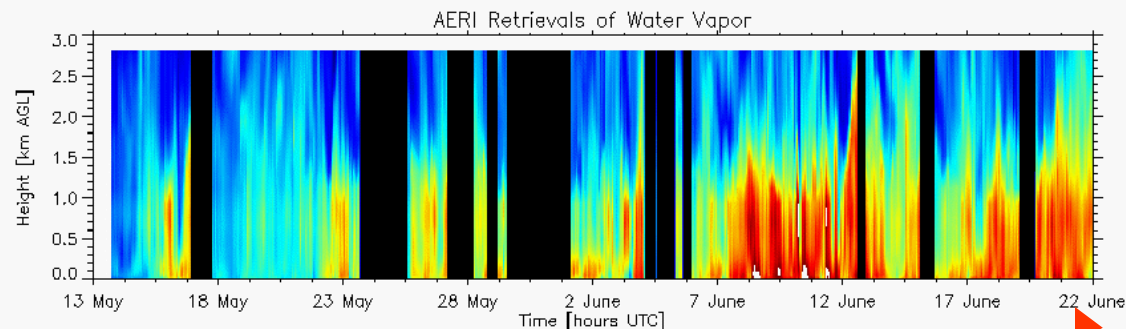
## Lamont

## Morris



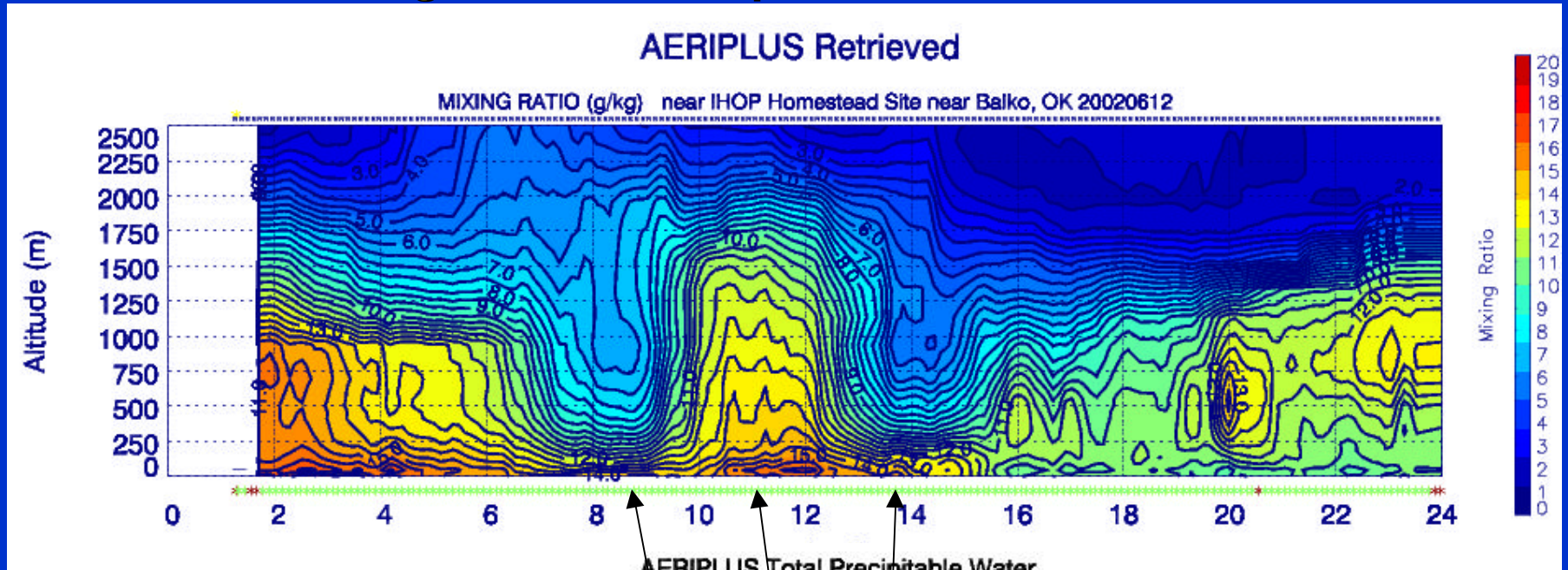
## Purcell



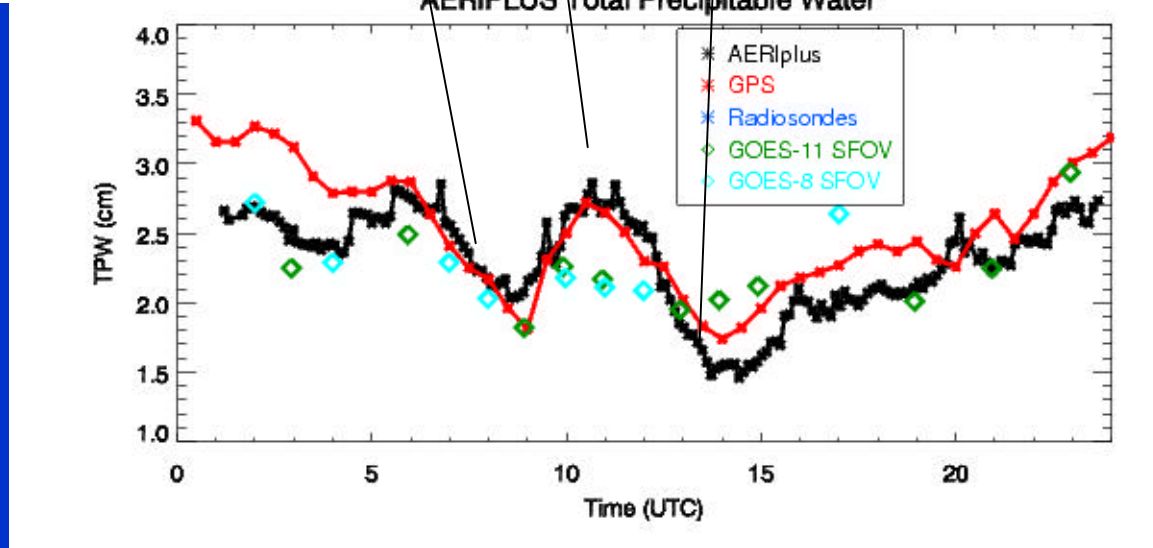


West – East AERI water vapor cross sections for IHOP

# AERI Retrieved IHOP water vapor time height cross sections from 12 June 2002 indicating rapid water vapor oscillations also indicated by GPS retrieved integrated water vapor

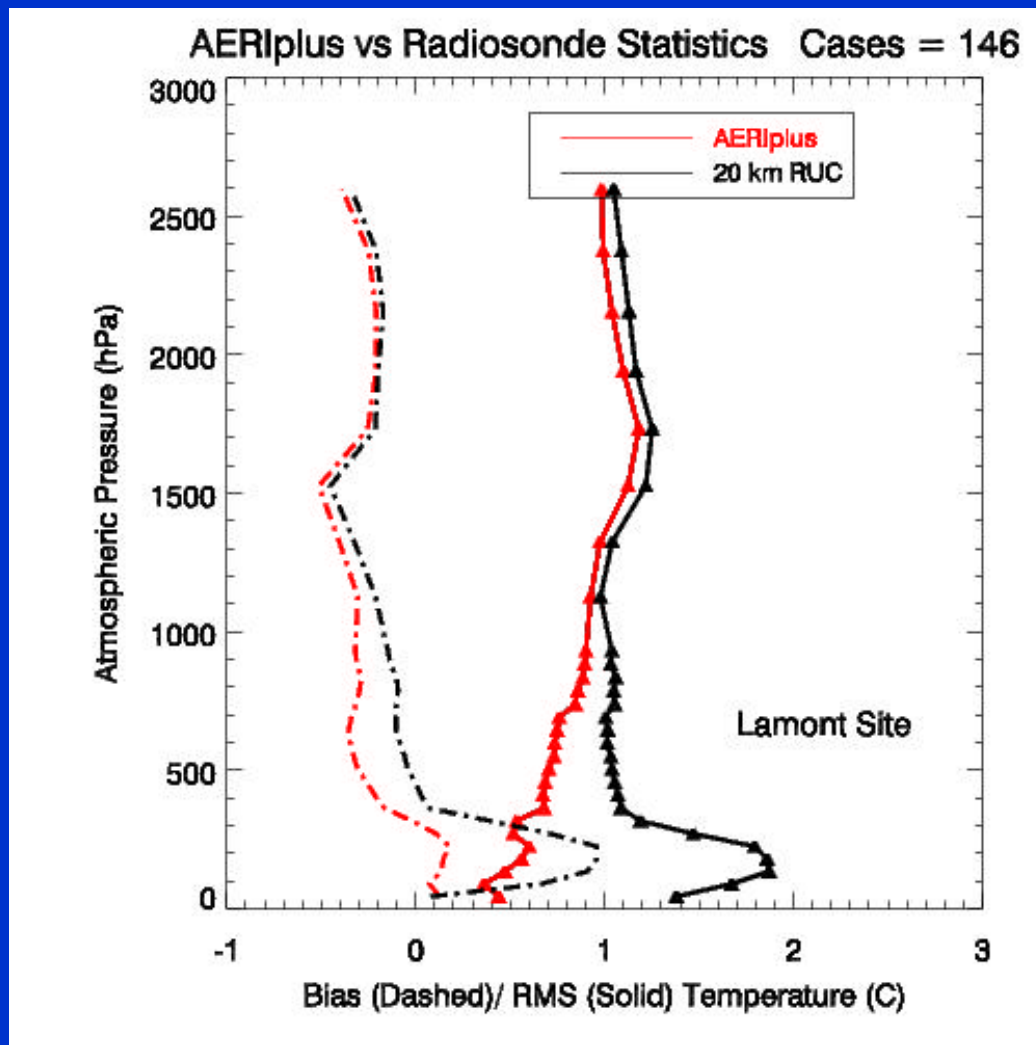


Total  
Precipitable  
Water



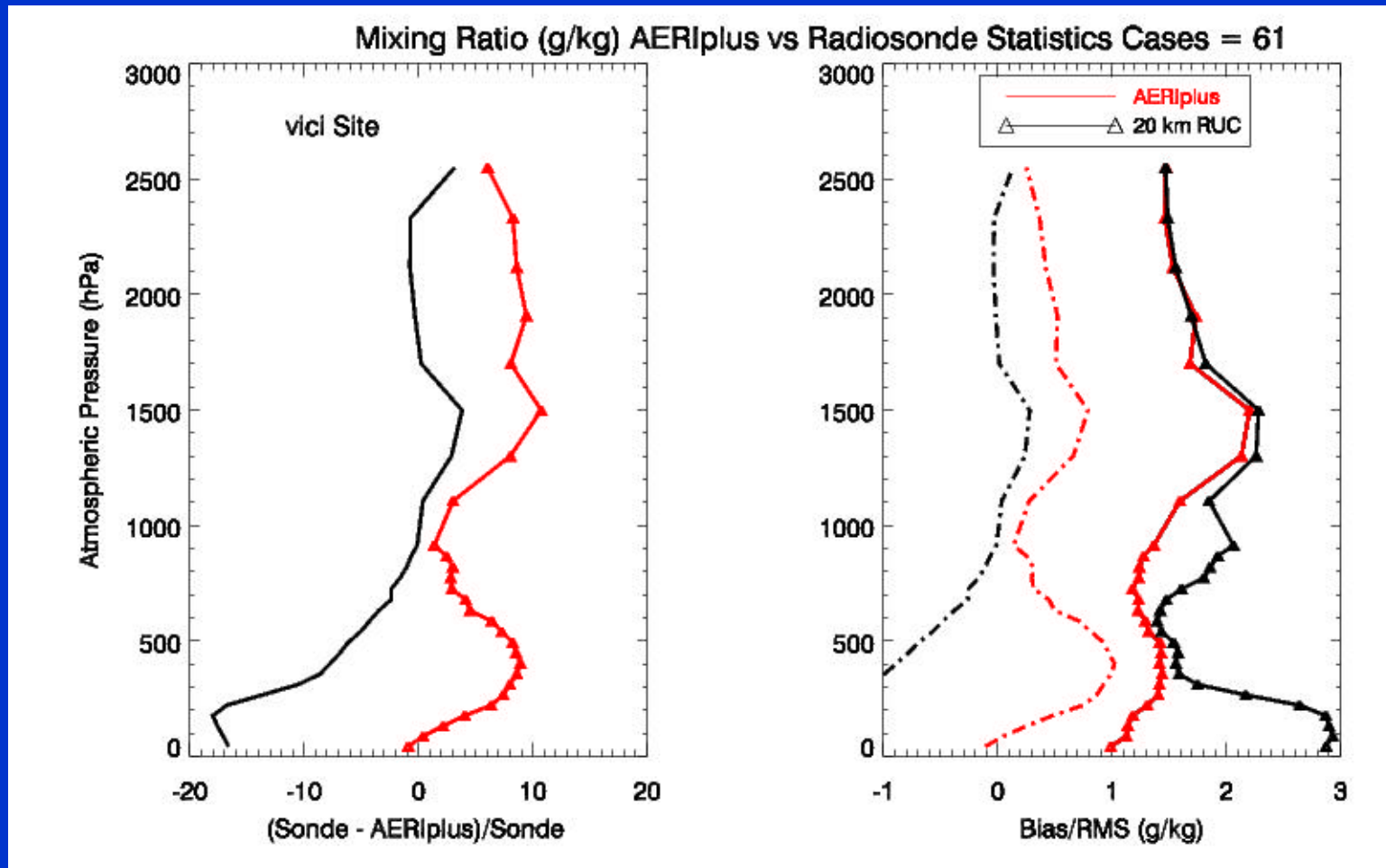


# IHOP AERIplus Retrieval RMS Statistics



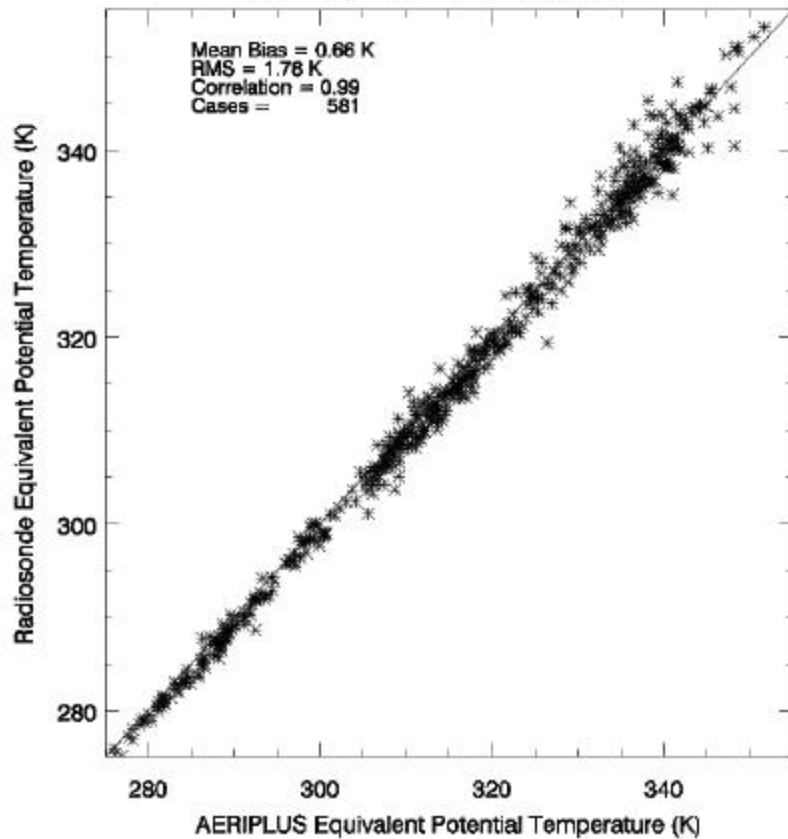


# IHOP AERIplus Retrieval RMS Statistics

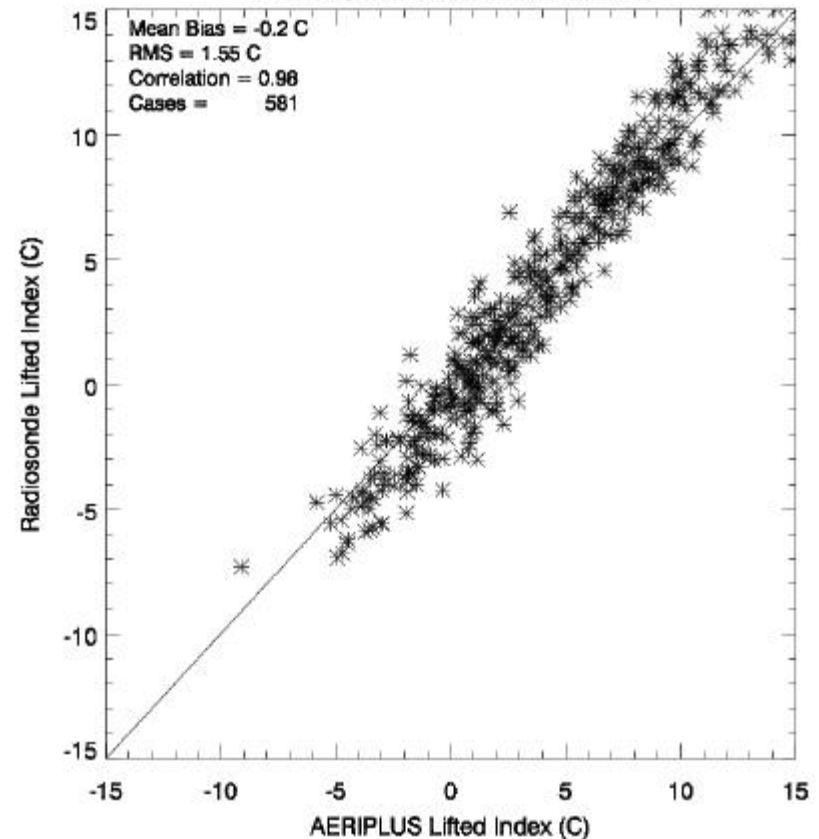


# AERI VS RADIOSONDE 100 MB SURFACE PARCEL ENERGY AND LIFTED INDEX

Lamont, Oklahoma 1999/2000

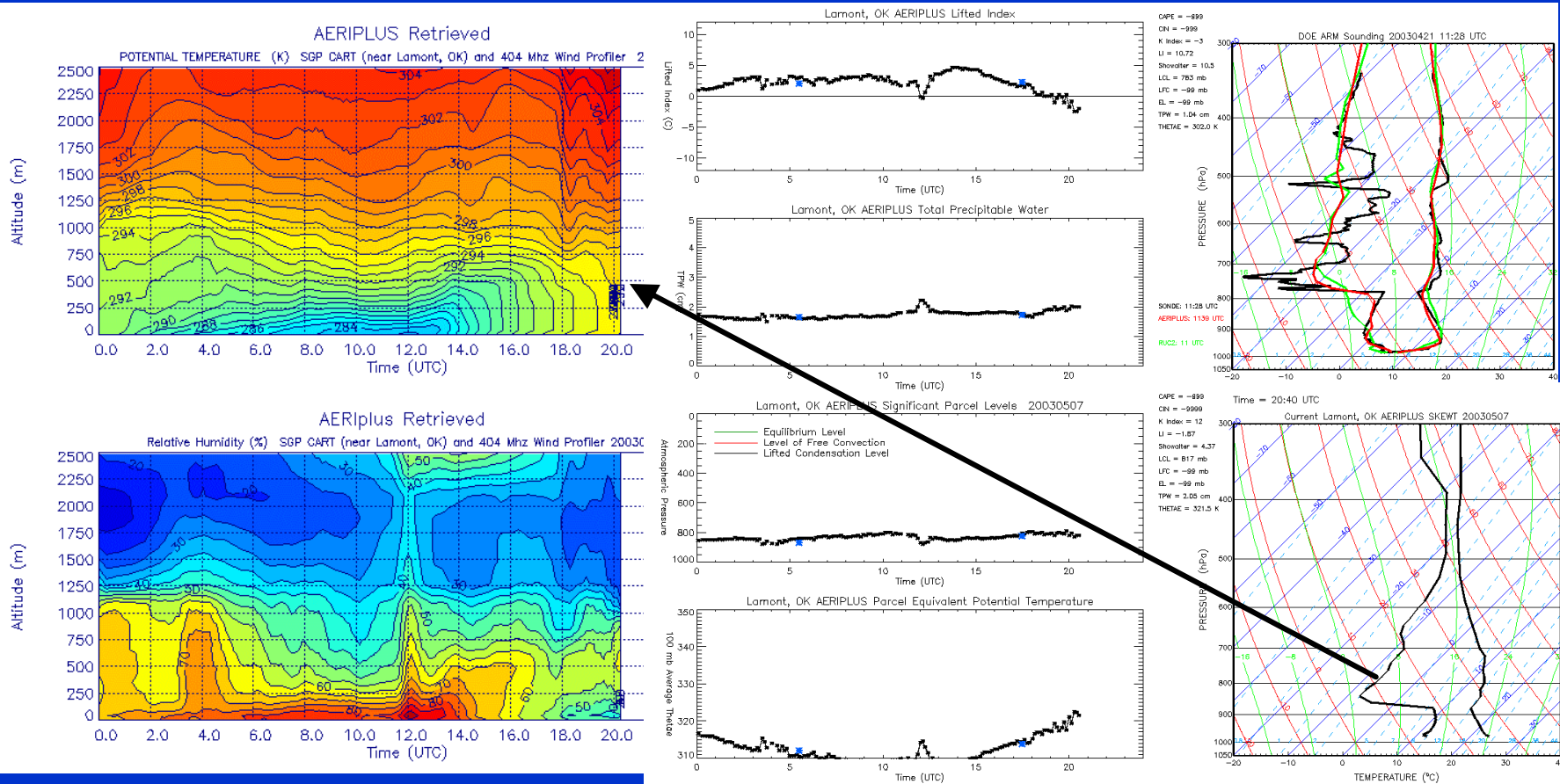


Lamont, Oklahoma 1999/2000



# Real-time Retrievals

Six AERI systems (including MSN) are currently processing PBL retrievals in near real-time, allowing “on the fly” validation:



# Future Research Plans

- Continue to assess GOES and MODIS meteorological derived products with DOE ARM data in near realtime
- Study precursors of convective initiation from AERI/NAOST-I/S-HIS retrievals during IHOP and THORPEX
- Evaluate AIRS derived stability products once available
- Use DOE ARM Tropical Western Pacific site at Nauru and Manus Islands in South Pacific to evaluate GOES-9, MODIS, and AIRS retrieved products



# AERIplus, RUC-2, GOES Statistics

