

AIRS Real-Time Sounding Profile Retrieval for IMAPP (International MODIS/AIRS Processing Package) Users

Elisabeth Weisz, Hung-Lung Huang, Jun Li,
Suzanne Seemann, Eva Borbas, Liam Gumley

Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin-Madison

- Introduction
- IMAPP AIRS Retrieval (RTV) Algorithm
- Global, Granule and single Profile RTV Results
(Comparison with Operational AIRS RTV Product,
ECMWF Analysis, MODIS and GOES RTV)
- Conclusions



**SPACE SCIENCE AND
ENGINEERING CENTER**

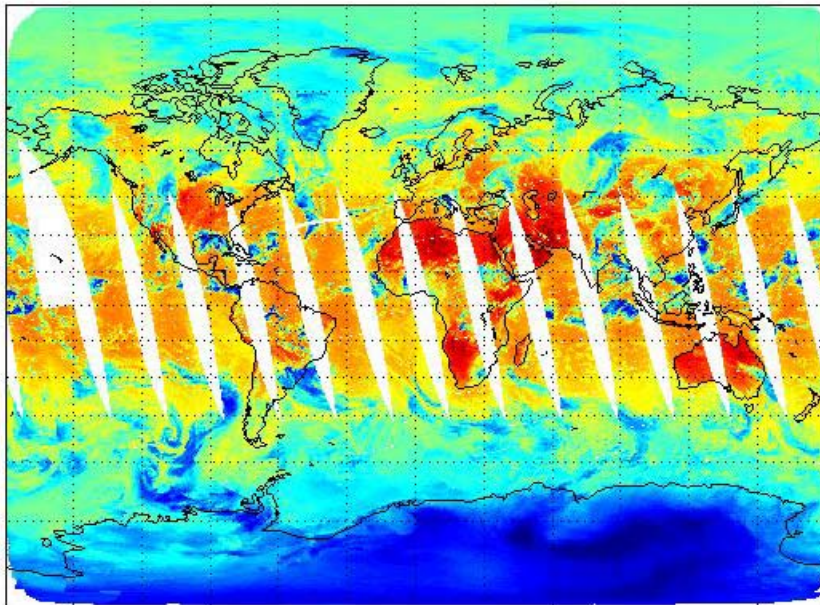


ITSC XIII Sainte Adele, Canada
29 Oct – 4 Nov 2003

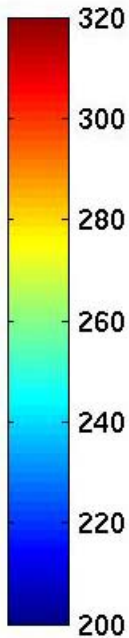
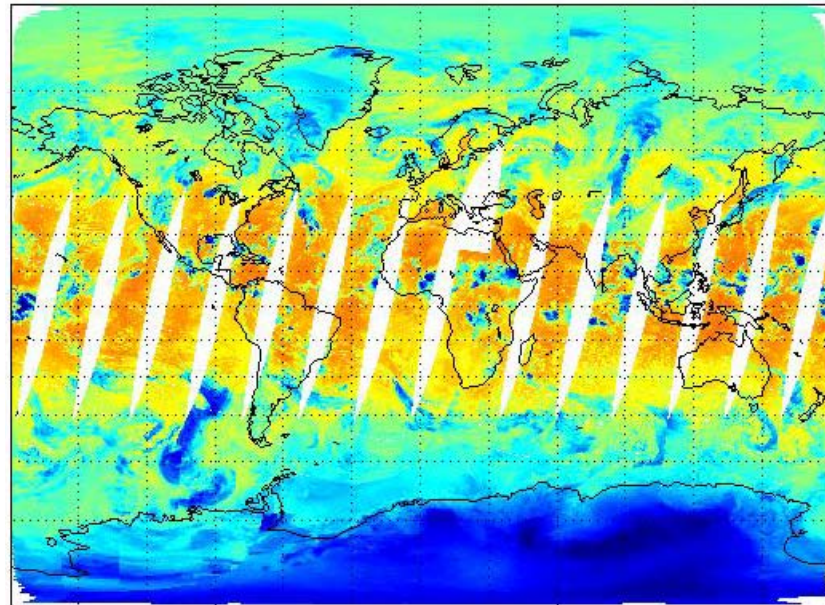
The Atmospheric Infrared Sounder on AQUA

- 2378 channels, spectral ranges: 3.7 - 4.61 μm , 6.2 - 8.22 μm , 8.8 - 15.4 μm ;
- Spectral resolution: $\lambda/d\lambda > 1200$
- Altitude: 705 km, Swath: 1650 km, 90 Ground Footprints, 1.1° IFOV
- 6 min and 125 MB per Granule (135x90 pixels), 240 granules per day

6-Sept-2002, Brightness Temperature [K] at 1000 cm^{-1}
Ascending Granules



Descending Granules



AIRS Clear-Sky Retrieval (RTV) at CIMSS

- Regression Retrieval of T, q, Ts, TPW, O3, and ϵ_s under clear conditions

Regression Model

$$X = C Y$$

Least squares regression solution

$$C = X Y^T (Y Y^T)^{-1}$$

X...Atmospheric State, C...Coefficients, Y...Measurements

- Preparation of multiple Trainingsets
- Forward Model Calculations using SARTA
- Application of BT/scanang-classification scheme
- Use of MODIS Cloudmask product for AIRS FOVs cloud detection
- Retrieval Validation/Comparison: ECMWF analysis, global RAOBs, MODIS and GOES Retrievals

→ SelChans RTV, nch=337
→ PC regression RTV, npc=30

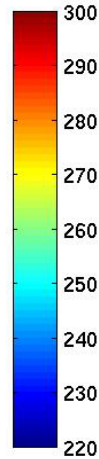
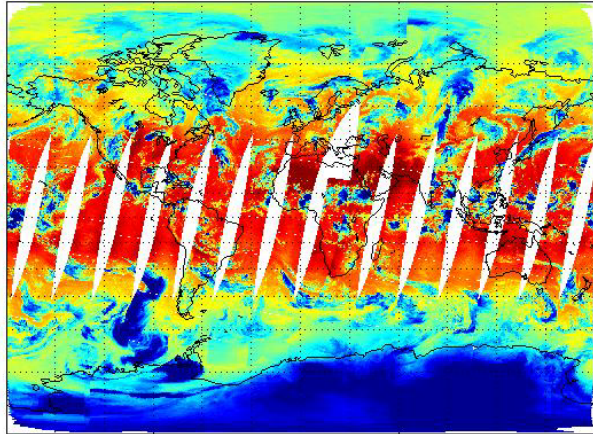
→ TIGR3 & Noaa88 & special desert and polar cases
→ Ecosystem assigned to each point to get realistic surface pressure, surface skin temperature and surface emissivity.

Class	BT@1000 cm ⁻¹ training	BT@1000 cm ⁻¹ observations
1	BT ≤ 260	BT ≤ 255
2	250 < BT ≤ 270	255 < BT ≤ 265
3	260 < BT ≤ 280	265 < BT ≤ 275
4	270 < BT ≤ 290	275 < BT ≤ 285
5	280 < BT ≤ 300	285 < BT ≤ 295
6	290 < BT	295 < BT

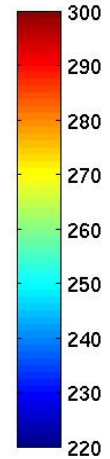
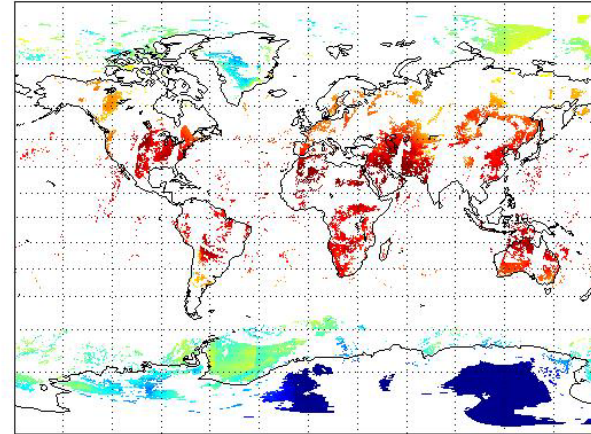
Global IMAPP AIRS Single FOV RTV Results: Temperature [K] at 850 mbar (09-06-2002)

Descending Grans

Temperature [K] at 852.788 mbar
Descending Granules (09-06-2002)

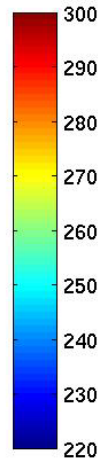
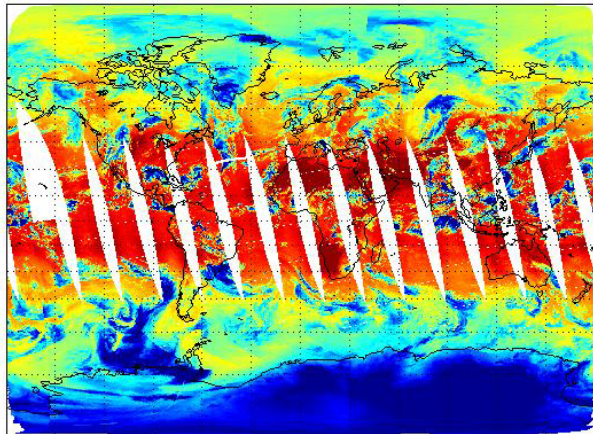


Temperature [K] at 852.788 mbar
Descending Granules (09-06-2002)

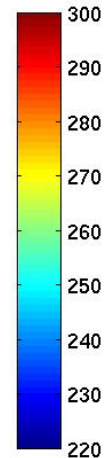
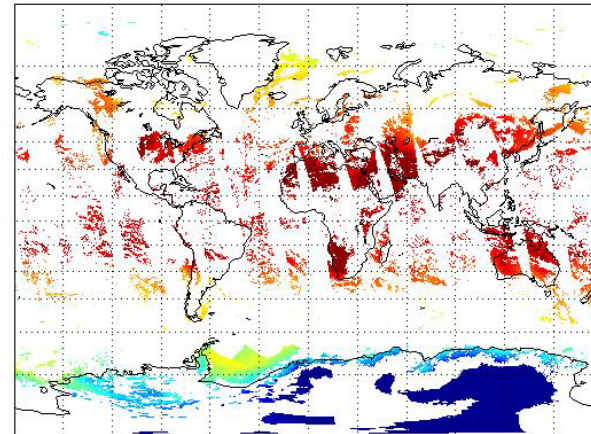


Ascending Grans

Temperature [K] at 852.788 mbar
Ascending Granules (09-06-2002)



Temperature [K] at 852.788 mbar
Ascending Granules (09-06-2002)



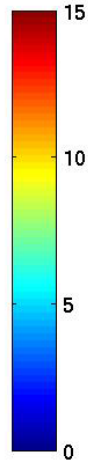
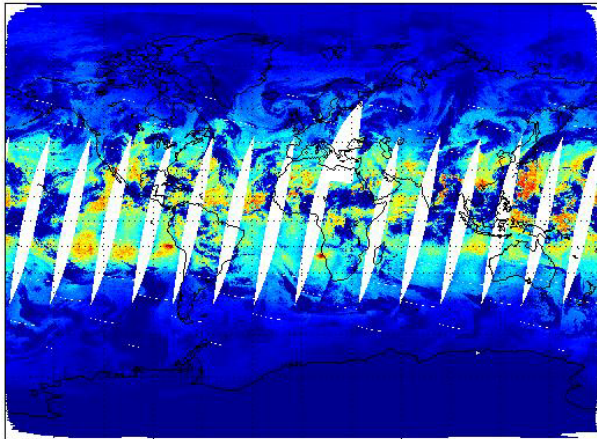
Without Cloudmask

With Cloudmask

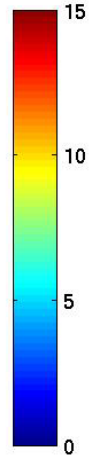
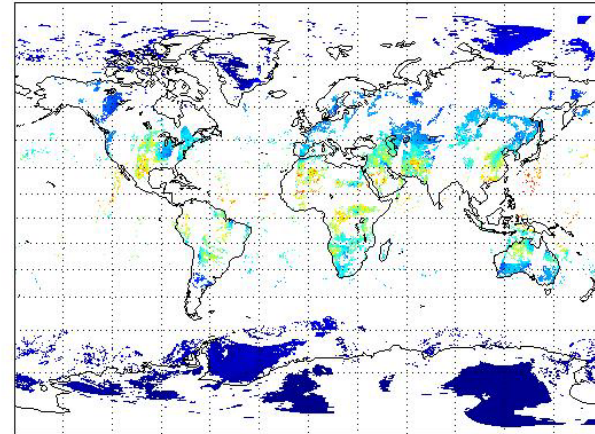
Global IMAPP AIRS Single FOV RTV Results: Humidity [g/kg] at 850 mbar (09-06-2002)

Descending Grans

Humidity [g/kg] at 852.788 mbar
Descending Granules (09-06-2002)

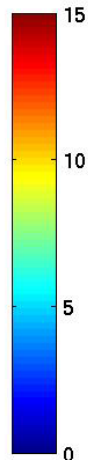
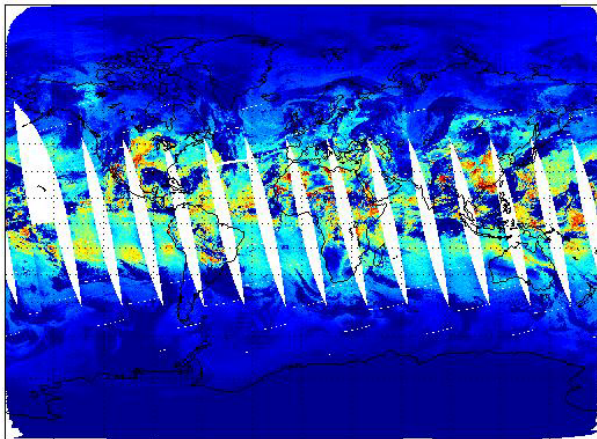


Humidity [g/kg] at 852.788 mbar
Descending Granules (09-06-2002)

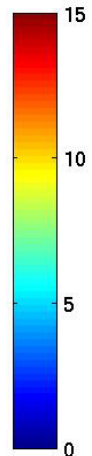
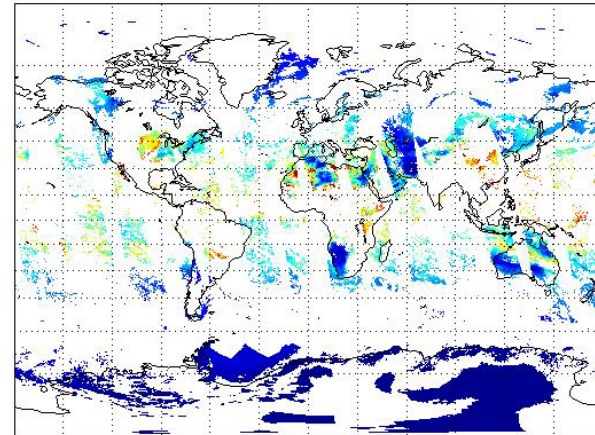


Ascending Grans

Humidity [g/kg] at 852.788 mbar
Ascending Granules (09-06-2002)



Humidity [g/kg] at 852.788 mbar
Ascending Granules (09-06-2002)



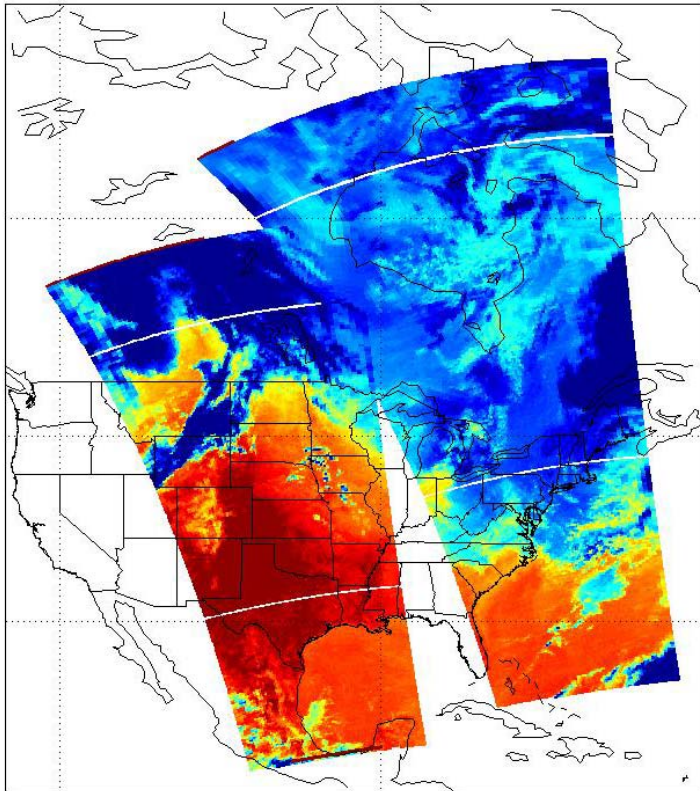
Without Cloudmask

With Cloudmask

IMAPP AIRS Single FOV RTV: CIMSS Direct Broadcast Area (10-23-2003,Day)

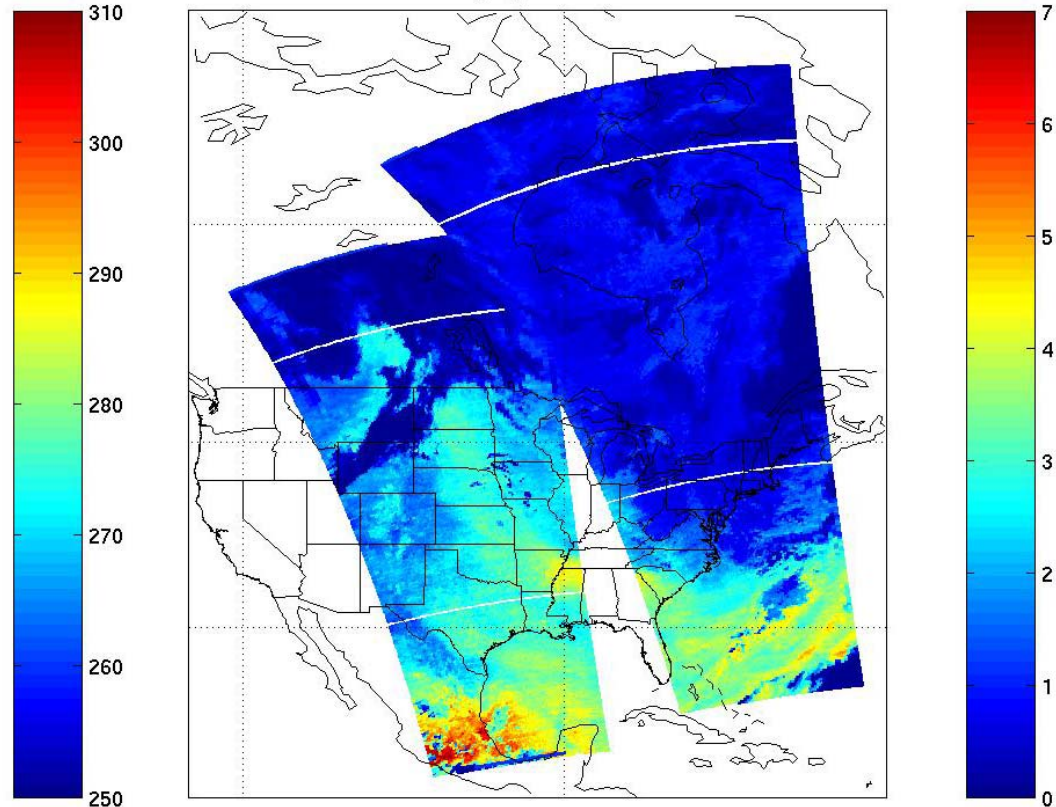
Surface Skin Temperature [K]
(no cloudmask)

Surface Skin Temperature [K], 10-23-2003



Total Precipitable Water [cm]
(no cloudmask)

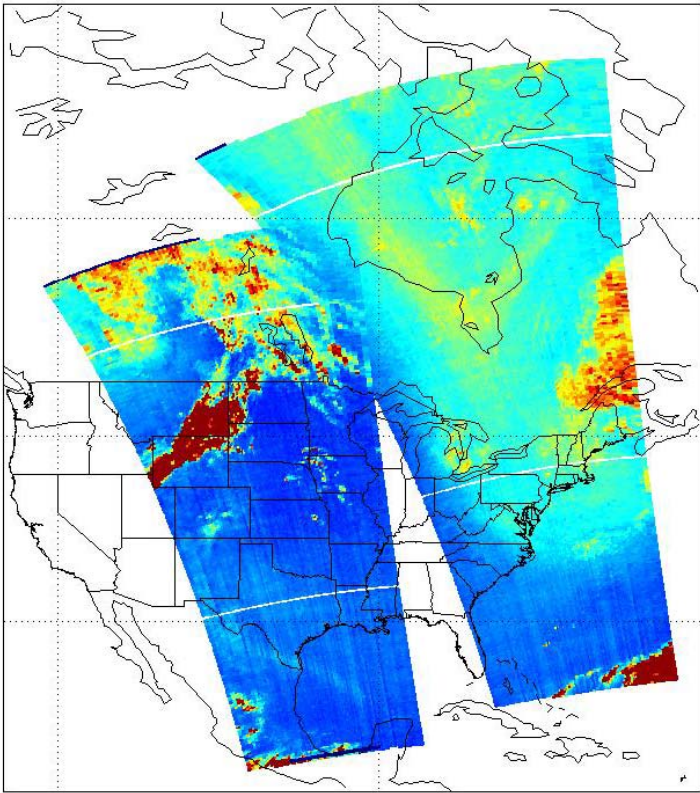
TPW [cm], 10-23-2003



IMAPP AIRS Single FOV RTV: CIMSS Direct Broadcast Area (10-23-2003,Day)

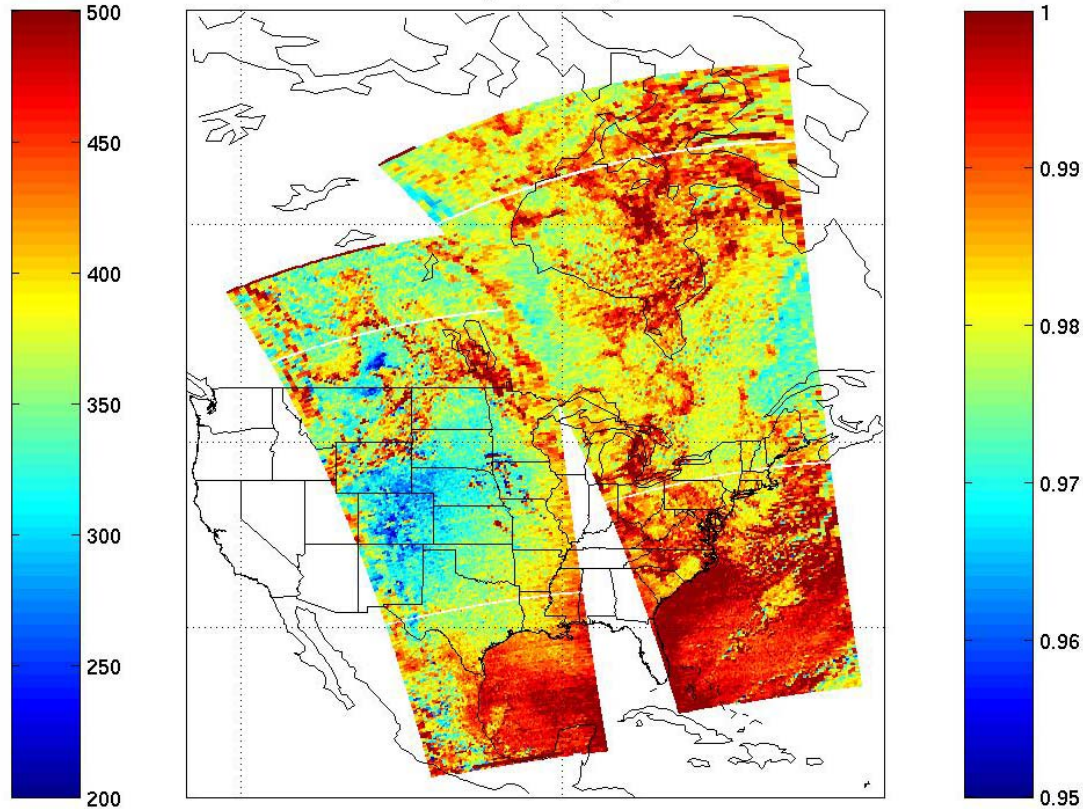
Total Ozone [DU]
(no cloudmask)

Total Ozone [DU], 10-23-2003



Surface Emissivity @926 cm⁻¹
(no cloudmask)

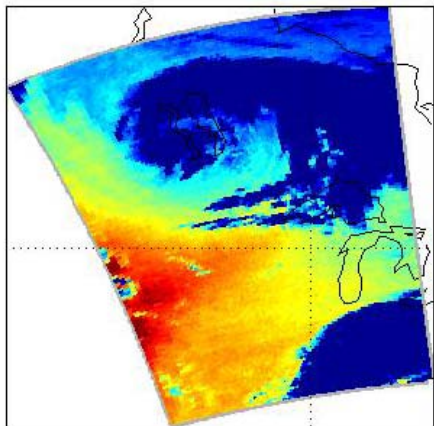
Surface Emissivity at 926 cm⁻¹, 10-23-2003



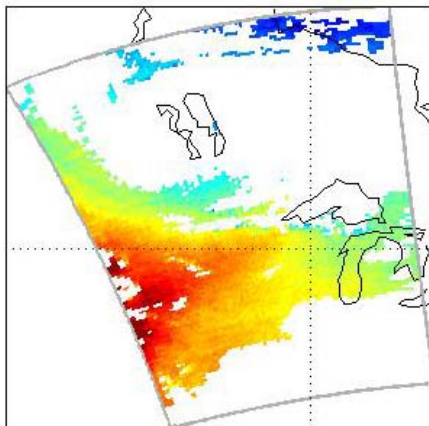
IMAPP AIRS Single FOV RTV vs. ECMWF Analysis : Temperature at 850 mbar (09-02-2003,192,Day)

AIRS FOV RTV

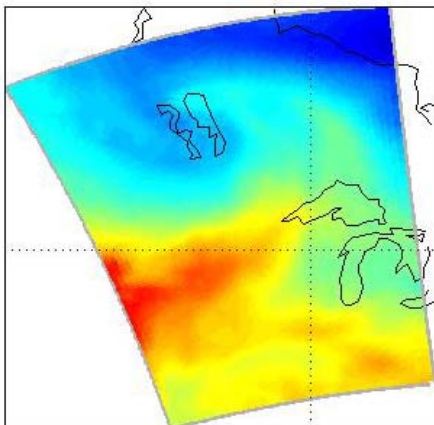
Temperature [K] at 852.788 mbar
AIRS RTV



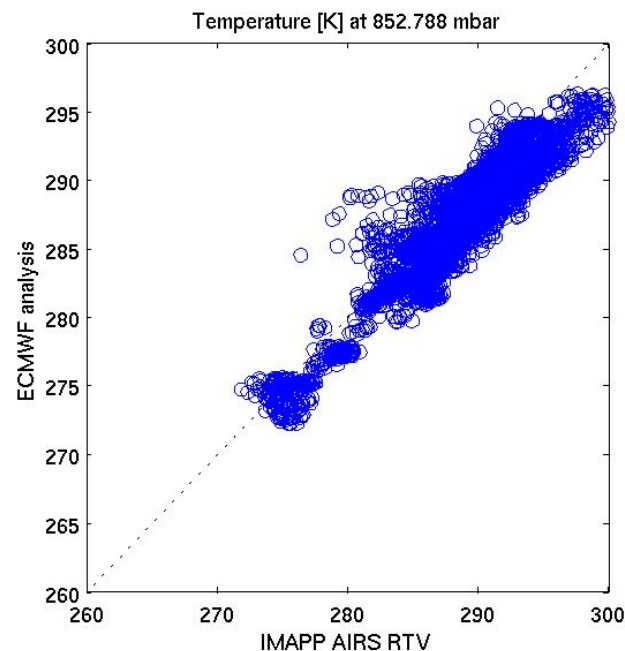
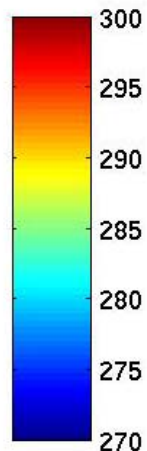
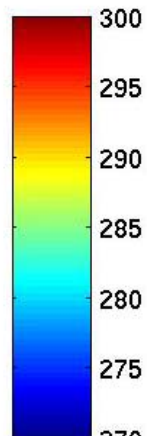
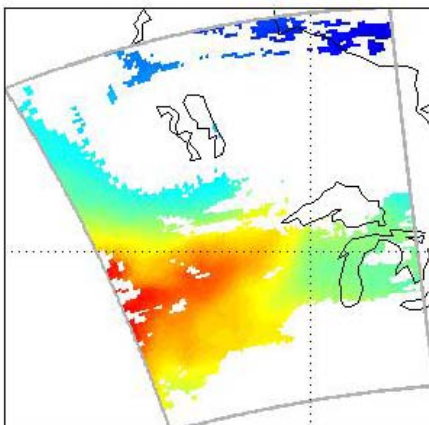
Temperature [K] at 852.788 mbar
AIRS RTV



ECMWF Analysis



ECMWF Analysis



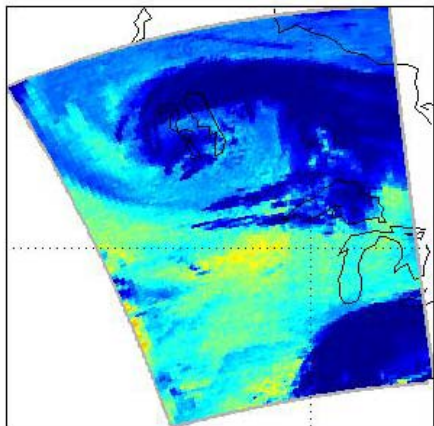
Without Cloudmask

With Cloudmask

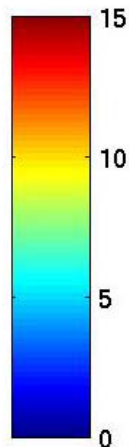
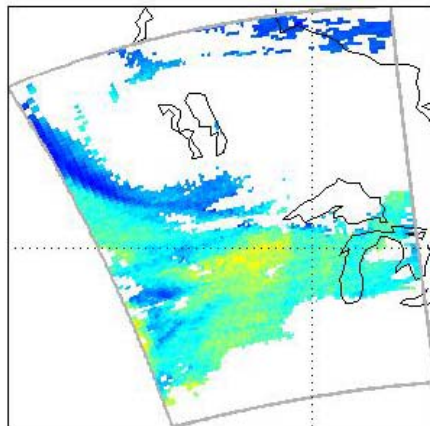
IMAPP AIRS Single FOV RTV vs. ECMWF Analysis : Humidity at 850 mbar (09-02-2003,192,Day)

AIRS FOV RTV

Total Precipitable Water [cm]
AIRS RTV

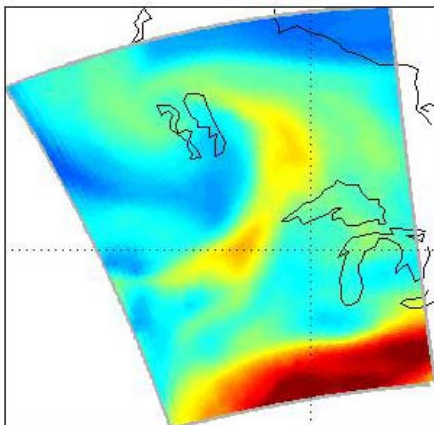


Humidity [g/kg] at 852.788 mbar
AIRS RTV

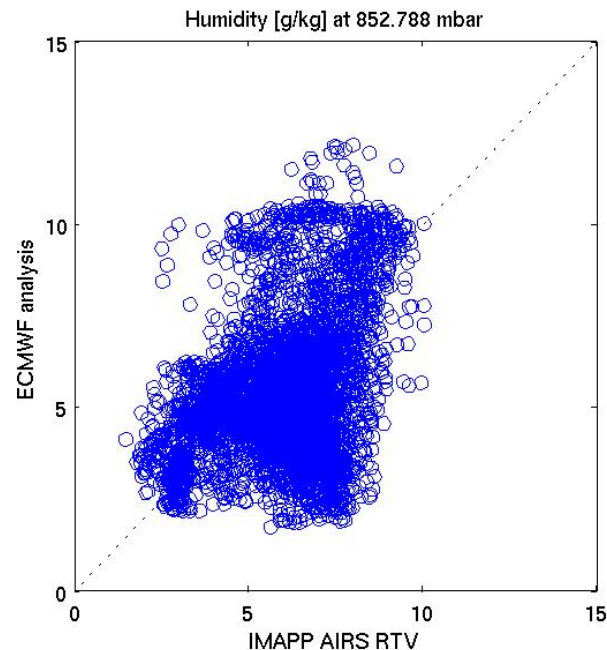
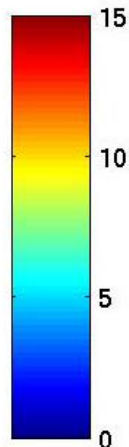
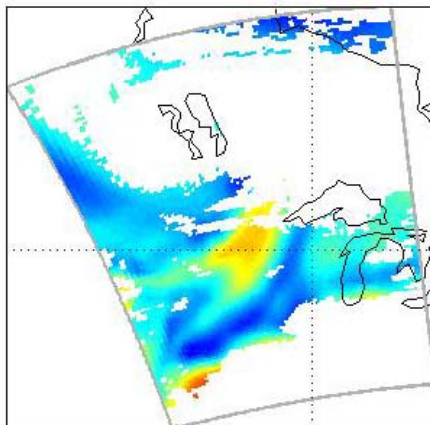


ECMWF ANL

ECMWF Analysis



ECMWF Analysis



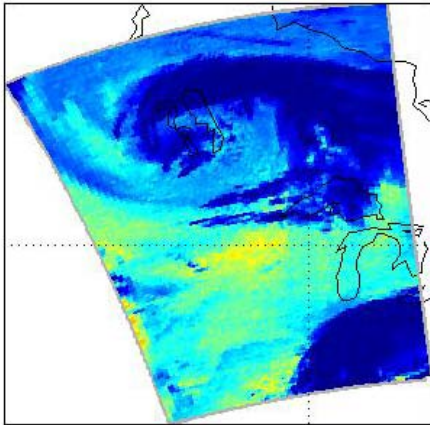
Without Cloudmask

With Cloudmask

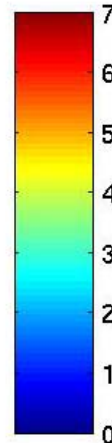
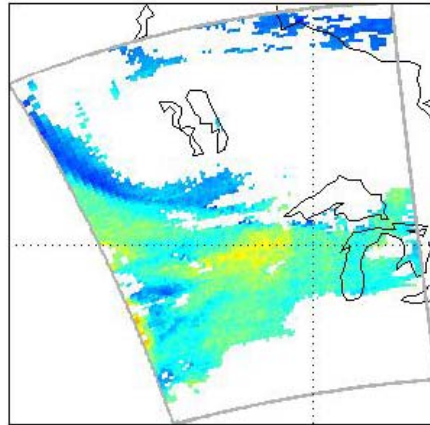
IMAPP AIRS Single FOV RTV vs. ECMWF Analysis : TPW (09-02-2003,192,Day)

AIRS FOV RTV

Total Precipitable Water [cm]
AIRS RTV

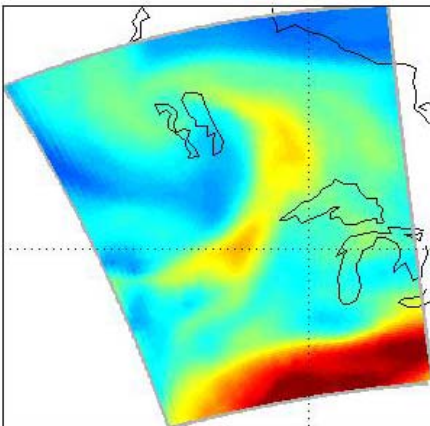


Total Precipitable Water [cm]
AIRS RTV

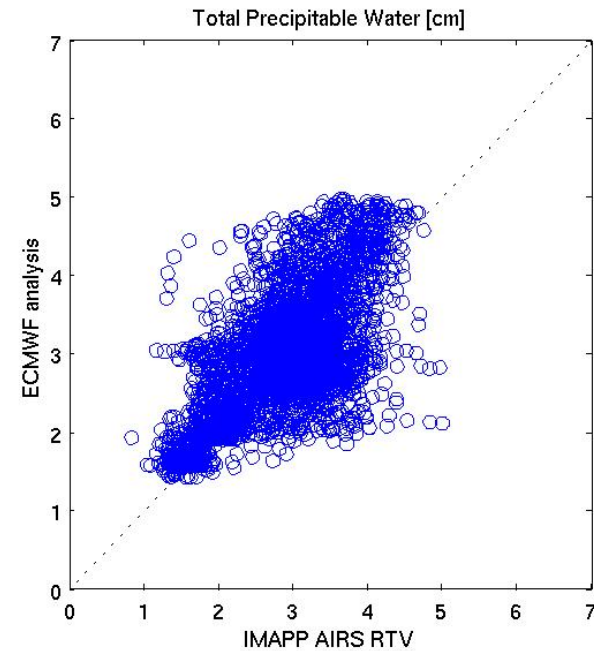
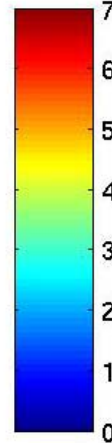
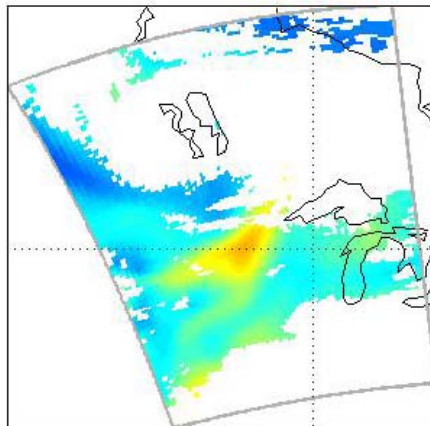


ECMWF ANL

ECMWF Analysis



ECMWF Analysis

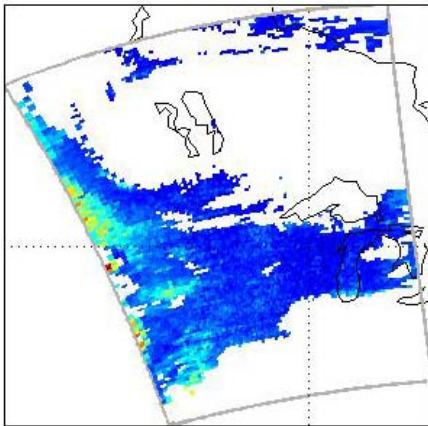


Without Cloudmask

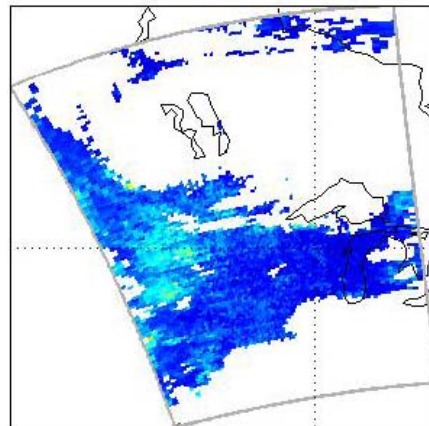
With Cloudmask

IMAPP AIRS Single FOV BT Residual vs. ECMWF : Spectral Mean (09-02-3003,192,Day)

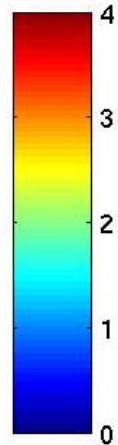
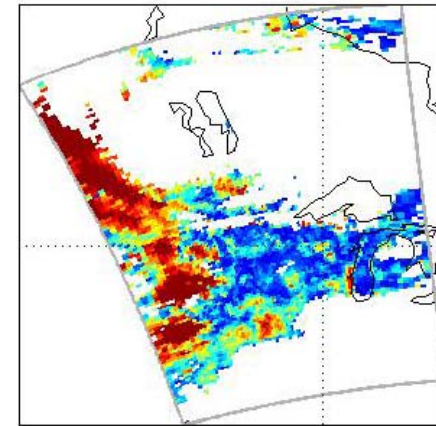
AIRS RTV/npc=30/trset=10118
Mean LW |Obs-Calc| [K]



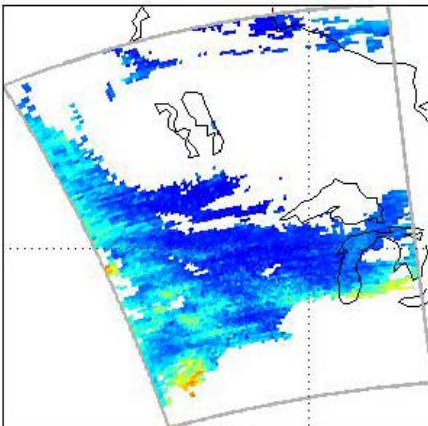
AIRS RTV/npc=30/trset=10118/class
Mean LW |Obs-Calc| [K]



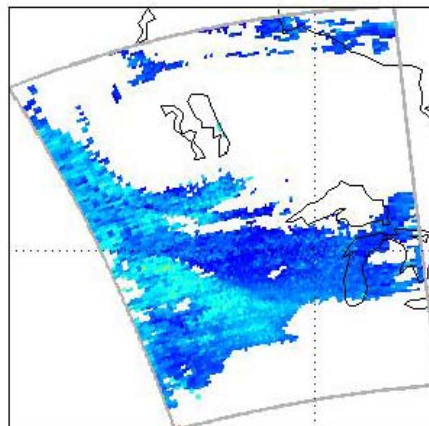
ECMWF Analysis/inch=2047
Mean LW |Obs-Calc| [K]



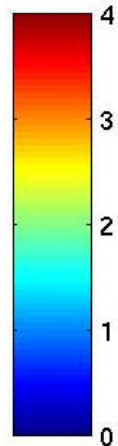
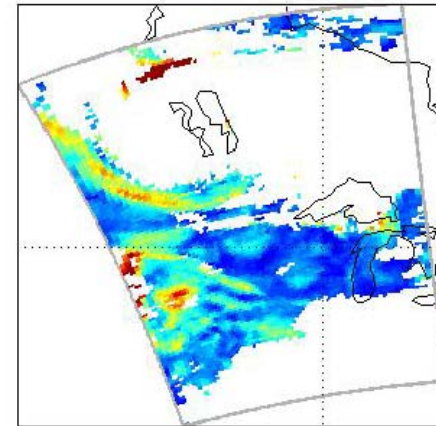
Mean MW |Obs-Calc| [K]



Mean MW |Obs-Calc| [K]



Mean MW |Obs-Calc| [K]



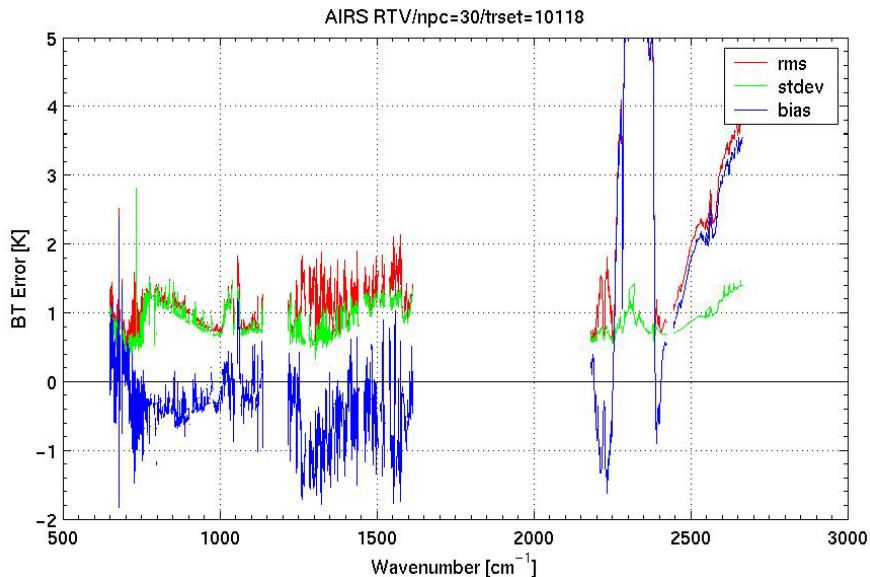
RTV (no BT-class)

RTV (with BT-class)

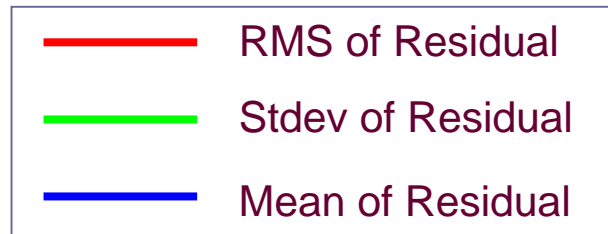
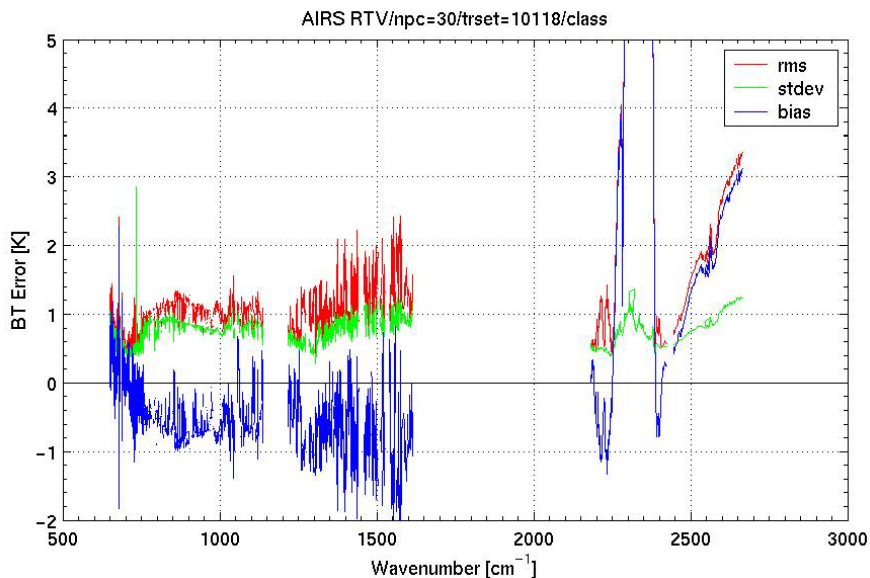
ECMWF ANL

IMAPP AIRS Single FOV BT Residual vs. ECMWF : Spatial Mean (09-02-3003,192,Day)

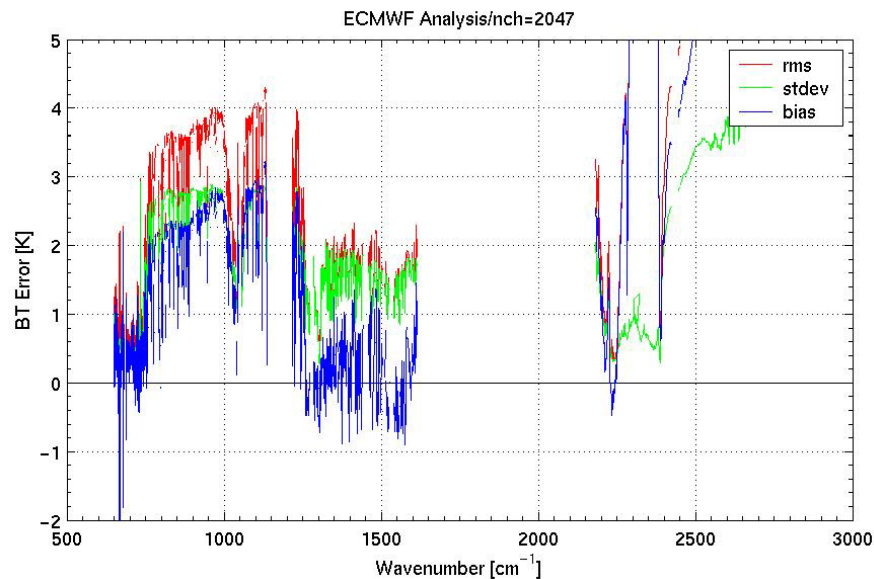
RTV (no BT-class)



RTV (with BT-class)



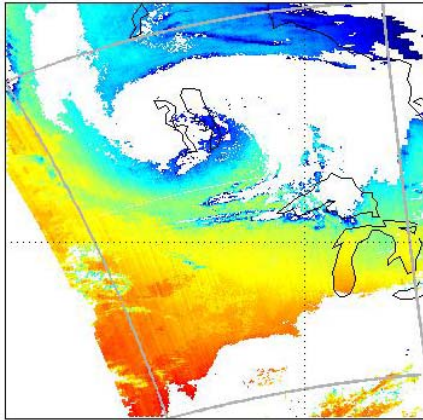
ECMWF ANL



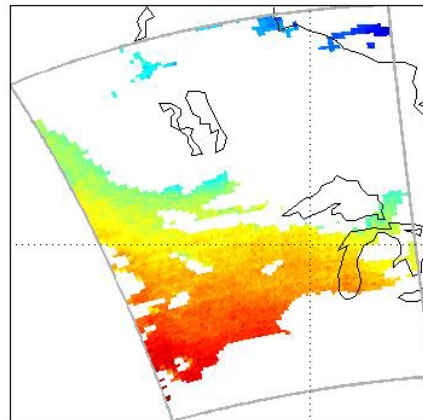
IMAPP AIRS Single FOV RTV vs MODIS and GOES RTV: T and q at 620 mbar (09-02-2003,192,Day)

Temperature @620

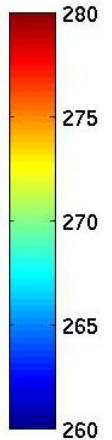
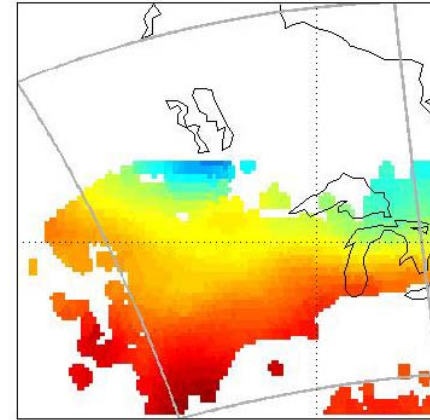
Temperature [K] at 620 mbar
MODIS RTV



Temperature [K] at 617.511 mbar
AIRS RTV

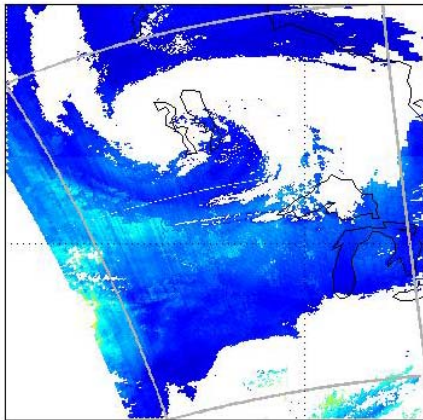


Temperature [K] at 620 mbar
GOES RTV

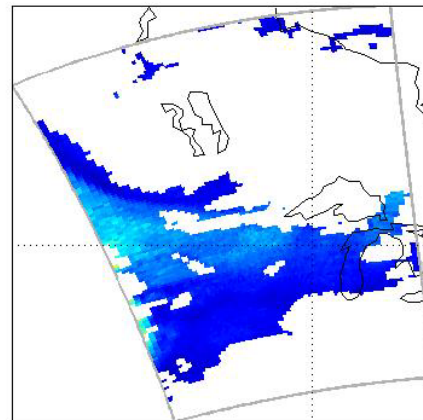


Humidity @620

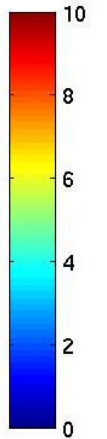
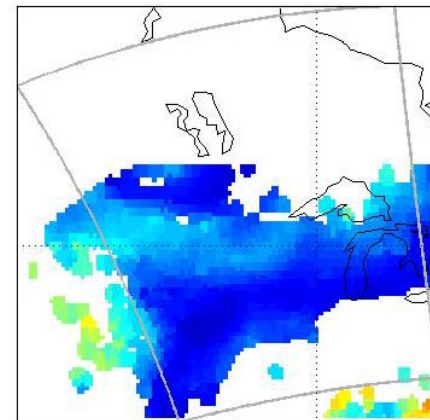
Humidity [g/kg] at 620 mbar
MODIS RTV



Humidity [g/kg] at 617.511 mbar
AIRS RTV



Humidity [g/kg] at 620 mbar
GOES RTV



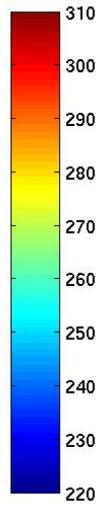
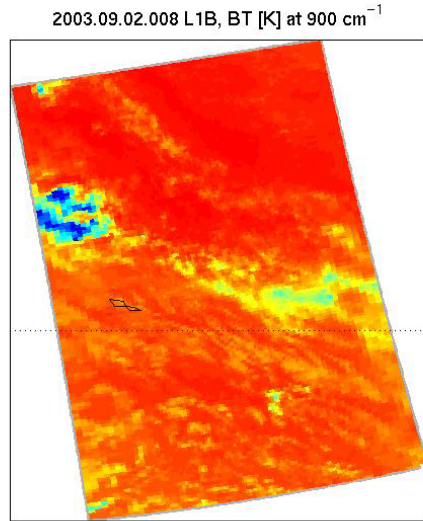
MODIS RTV

AIRS FOV RTV

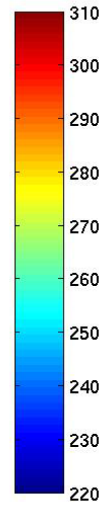
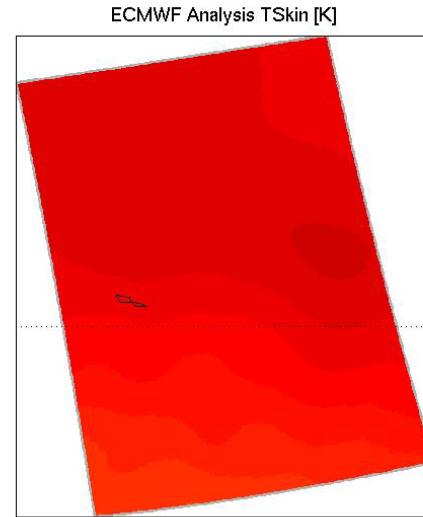
GOES RTV

Operational L2 Cloud-Cleared Std Product (Ocean): Case 1 (09-02-2003,8,Day)

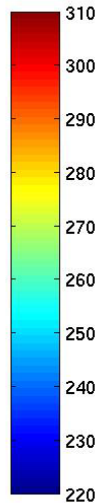
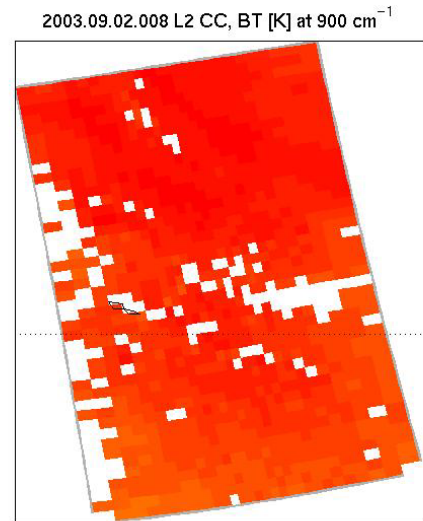
L1B BT @900



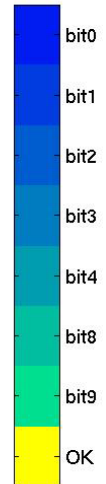
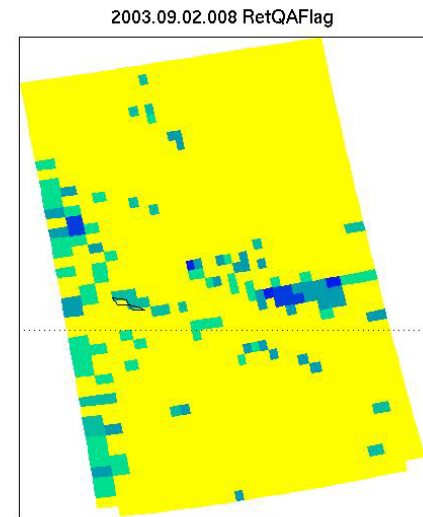
ECMWF TSkin



Op L2 CC @900

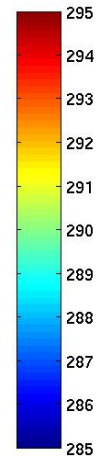
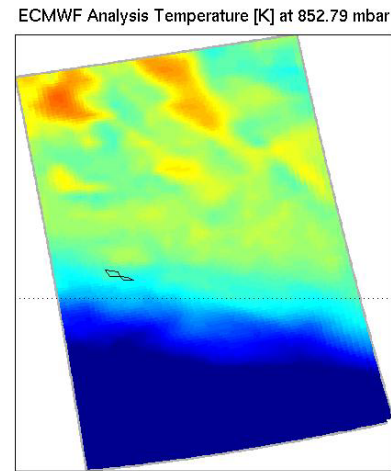
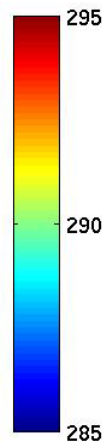
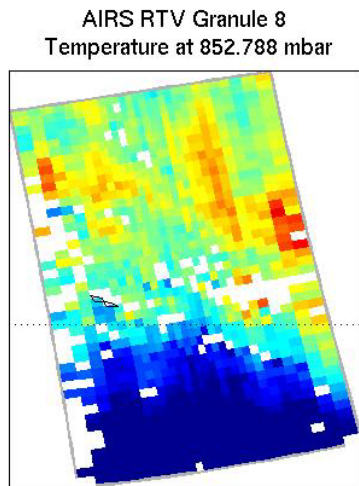
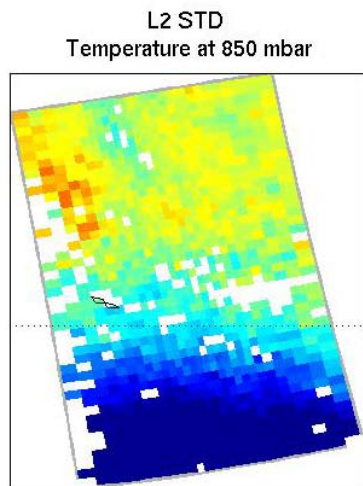


Op L2 QAFlag

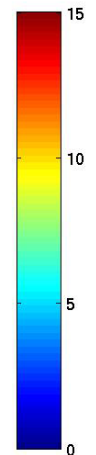
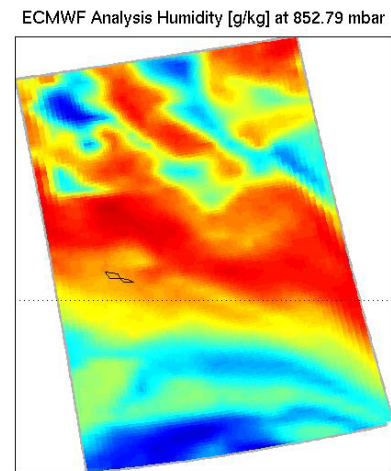
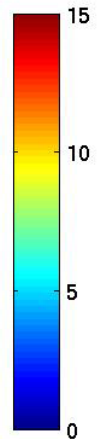
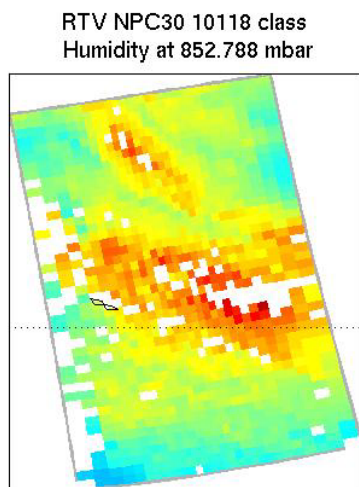
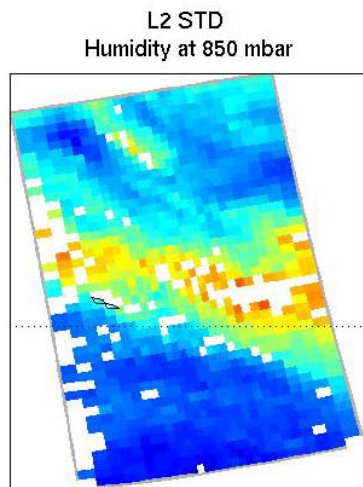


IMAPP AIRS FOR 3x3 Retrieval vs Op AIRS RTV and ECMWF ANL: Case 1 (09-02-2003,8,Day)

Temperature @850



Humidity @850



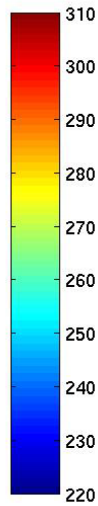
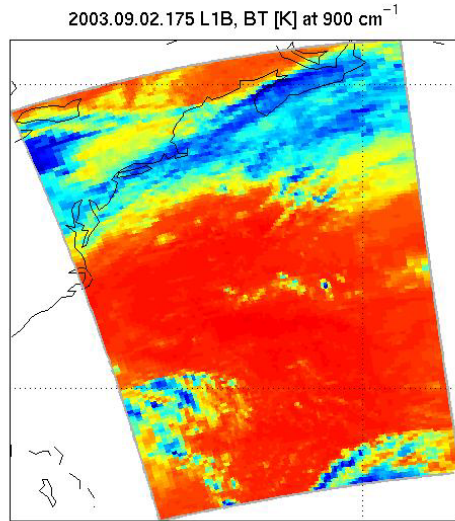
Op AIRS RTV

AIRS FOR RTV

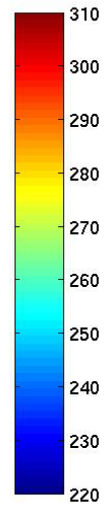
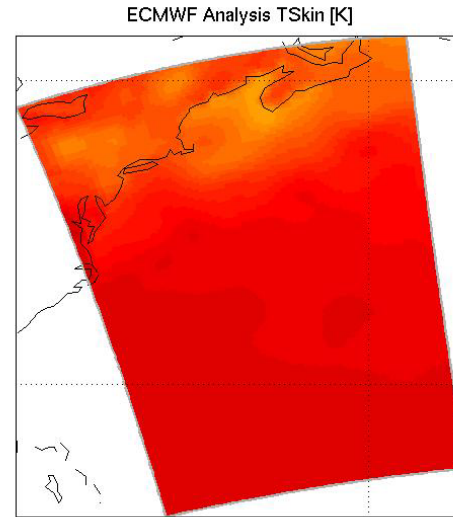
ECMWF ANL

Operational L2 Cloud-Cleared (CC) Std Product (Ocean): Case 2 (09-02-2003, 175, Day)

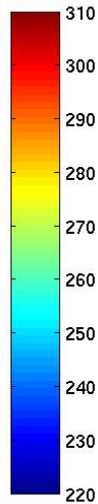
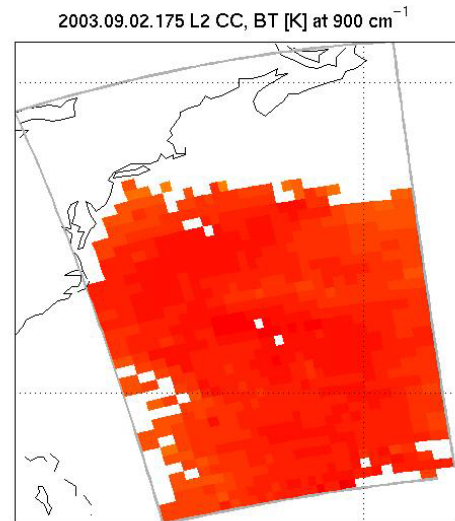
L1B BT @900



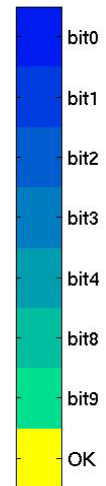
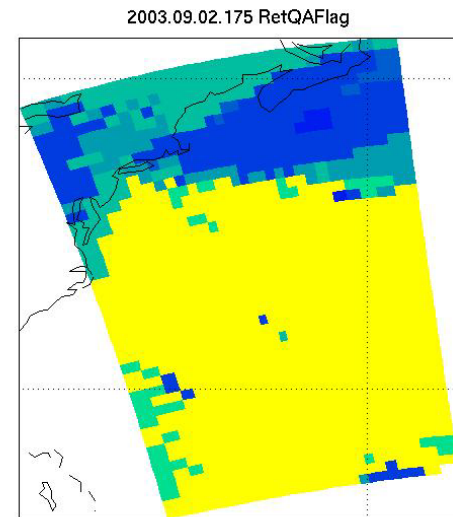
ECMWF TSkin



Op L2 CC @900



Op L2 QAFlag

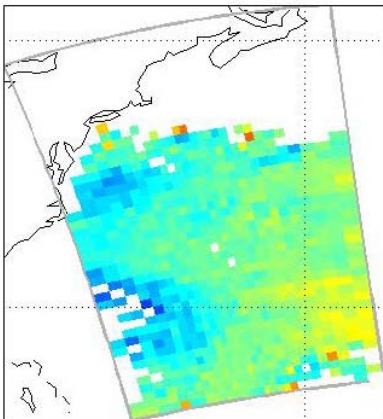


IMAPP AIRS FOR 3x3 Retrieval vs Op AIRS RTV and ECMWF ANL: Case 2 (09-02-2003,175,Day)

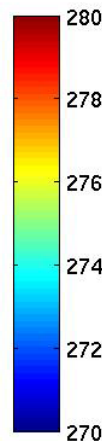
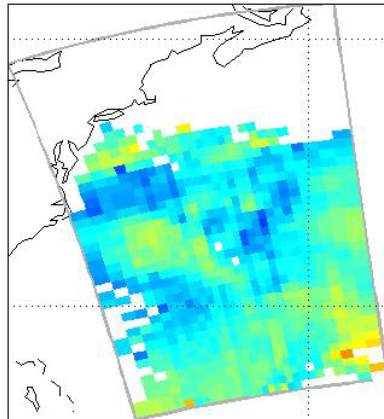
Temperature @600

Humidity @850

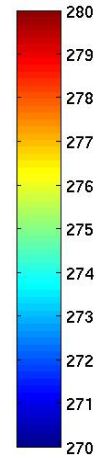
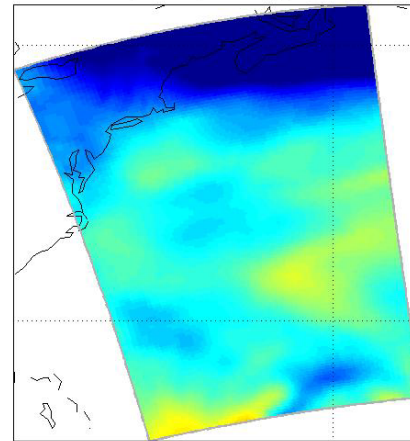
L2 STD
Temperature at 600 mbar



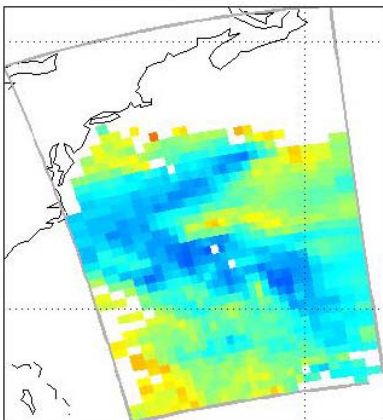
AIRS RTV Granule 175
Temperature at 596.306 mbar



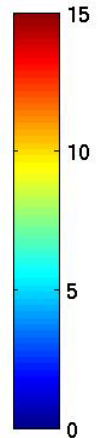
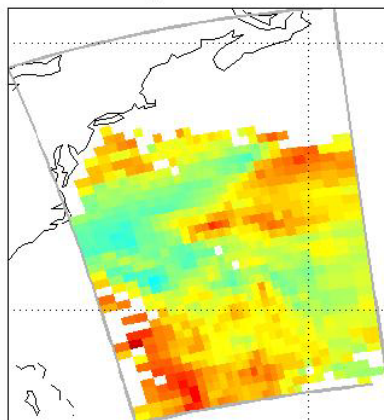
ECMWF Analysis Temperature [K] at 596.31 mbar



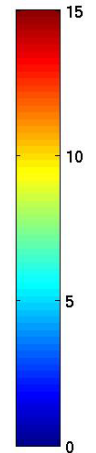
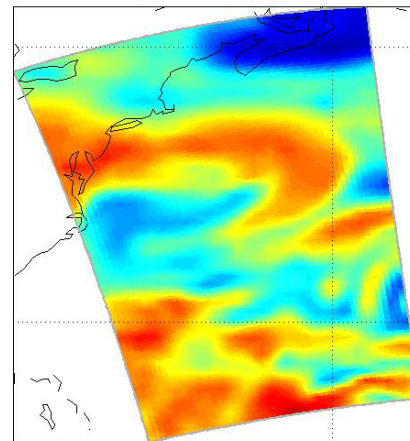
L2 STD
Humidity at 850 mbar



RTV NPC30 10118 class
Humidity at 852.788 mbar



ECMWF Analysis Humidity [g/kg] at 852.79 mbar



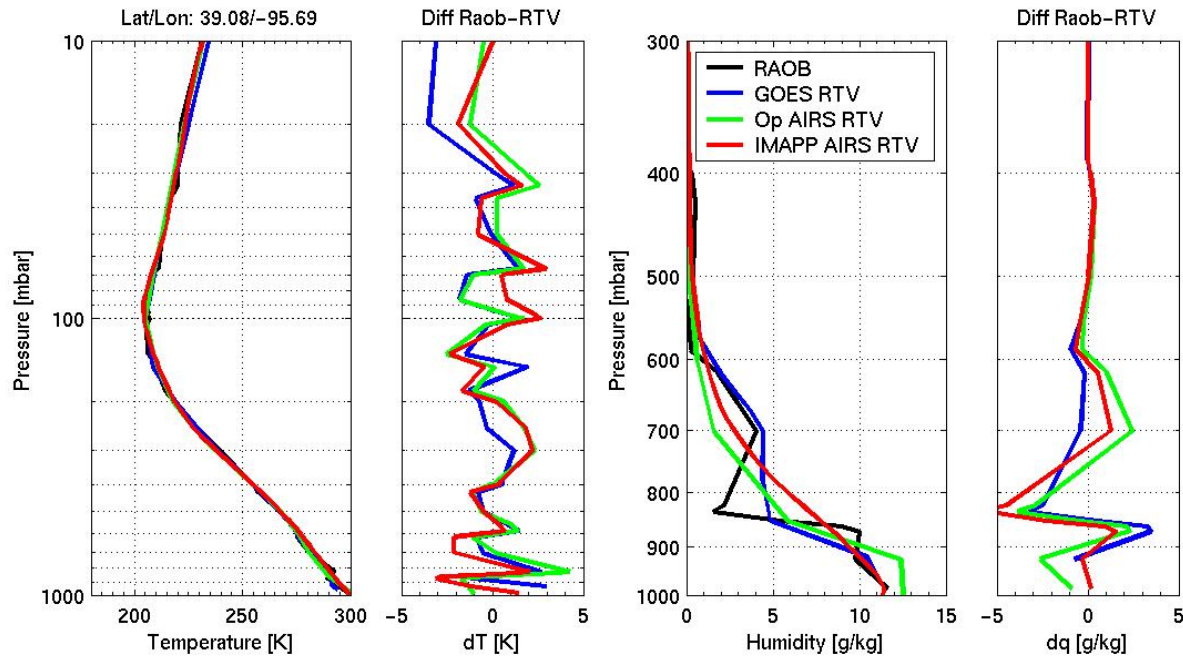
Op AIRS RTV

AIRS FOR RTV

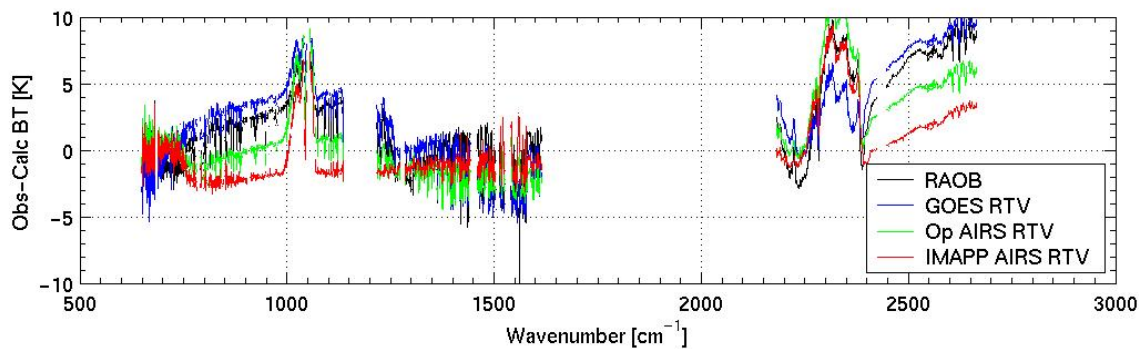
ECMWF ANL

Single FOV Retrieval 1: (09-02-2003,192)

Profile RTV

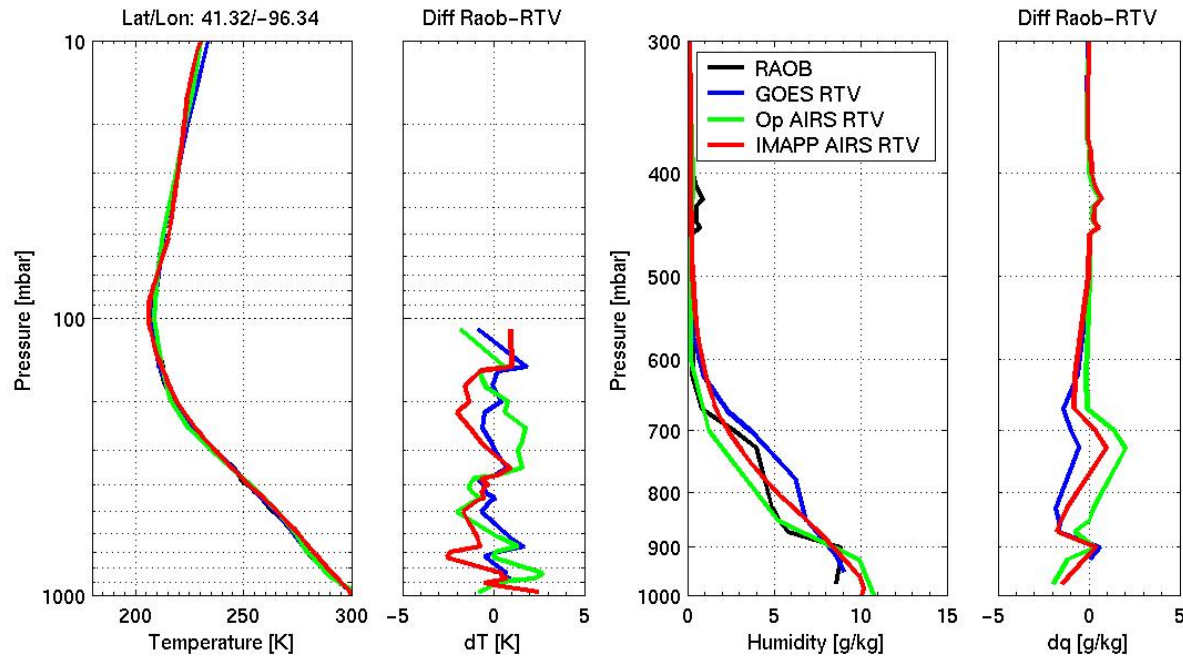


BT Residual [K]

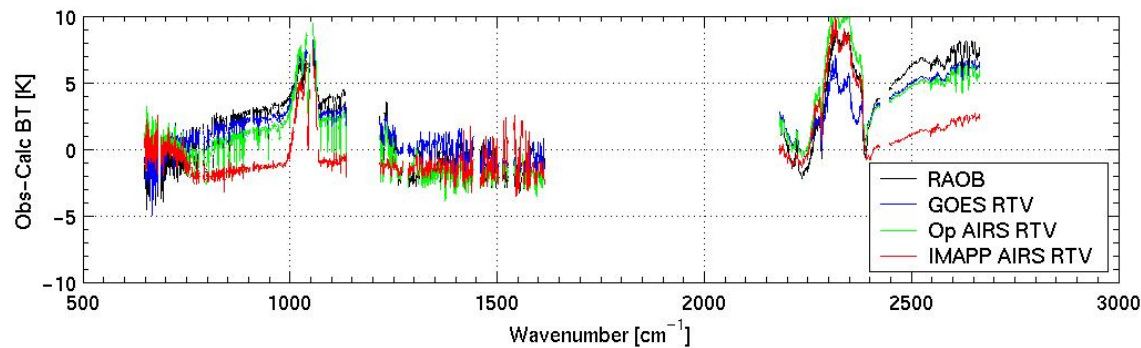


Single FOV Retrieval 2: (09-02-2003,192)

Profile RTV



BT Residual [K]



Conclusions

- Clear-Sky Regression Retrieval Algorithm (pre-release version 0) has been tested using AIRS measurements under various conditions and considered stable.
- Validation/Comparison with various data sets: results are convincing and encouraging.
- Version 1 Real-Time DB global retrieval algorithm available in near-future (as part of IMAPP) .
- Further Investigation and preparation of training and validation data is ongoing.
- Current statistical retrieval approach to be complemented by a non-linear iterative physical approach (version 2).

International TOVS Study Conference, 13th, TOVS-13, Sainte Adele, Quebec, Canada, 29
October-4 November 2003. Madison, WI, University of Wisconsin-Madison, Space Science and
Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2003.