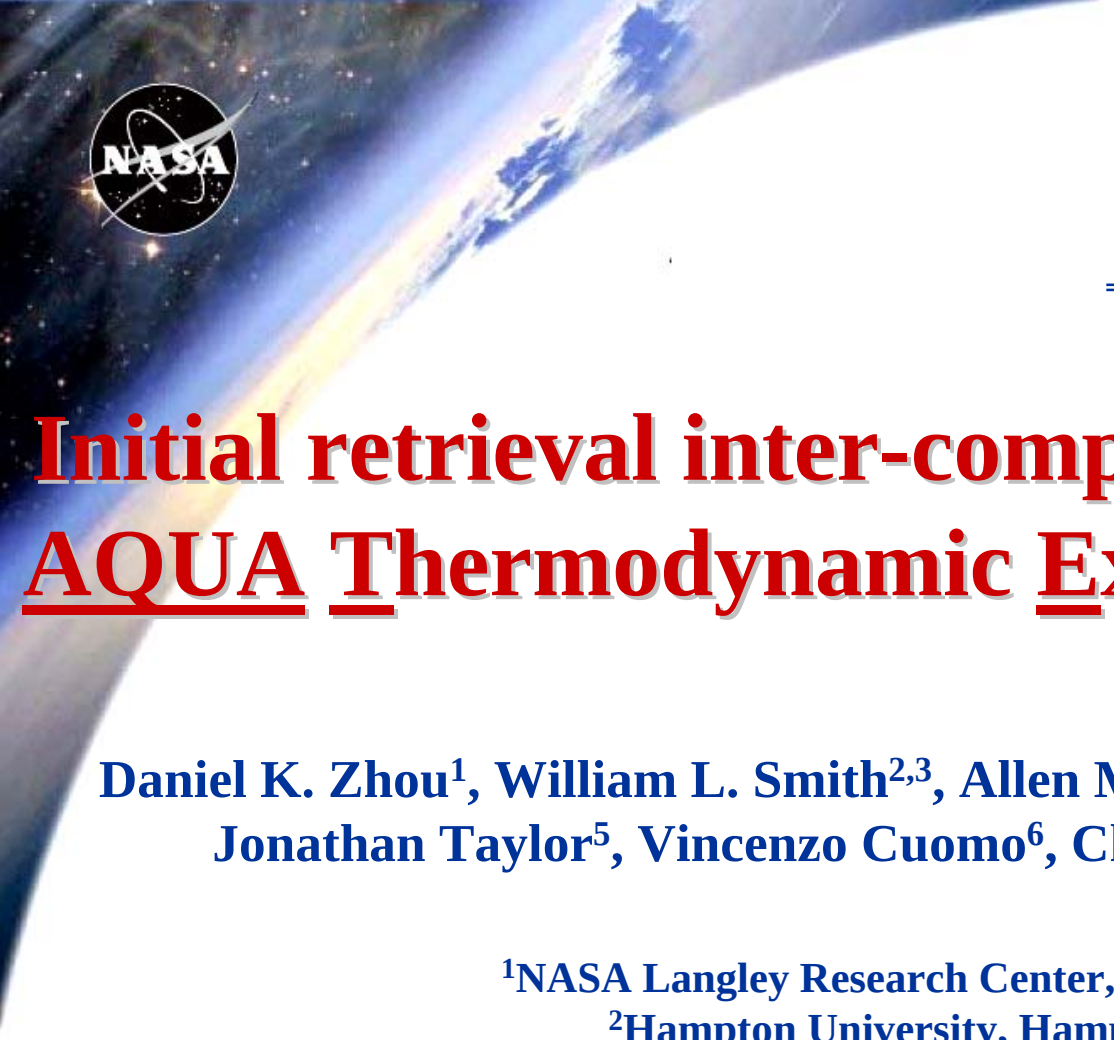


14th International
TOVS Study Conference

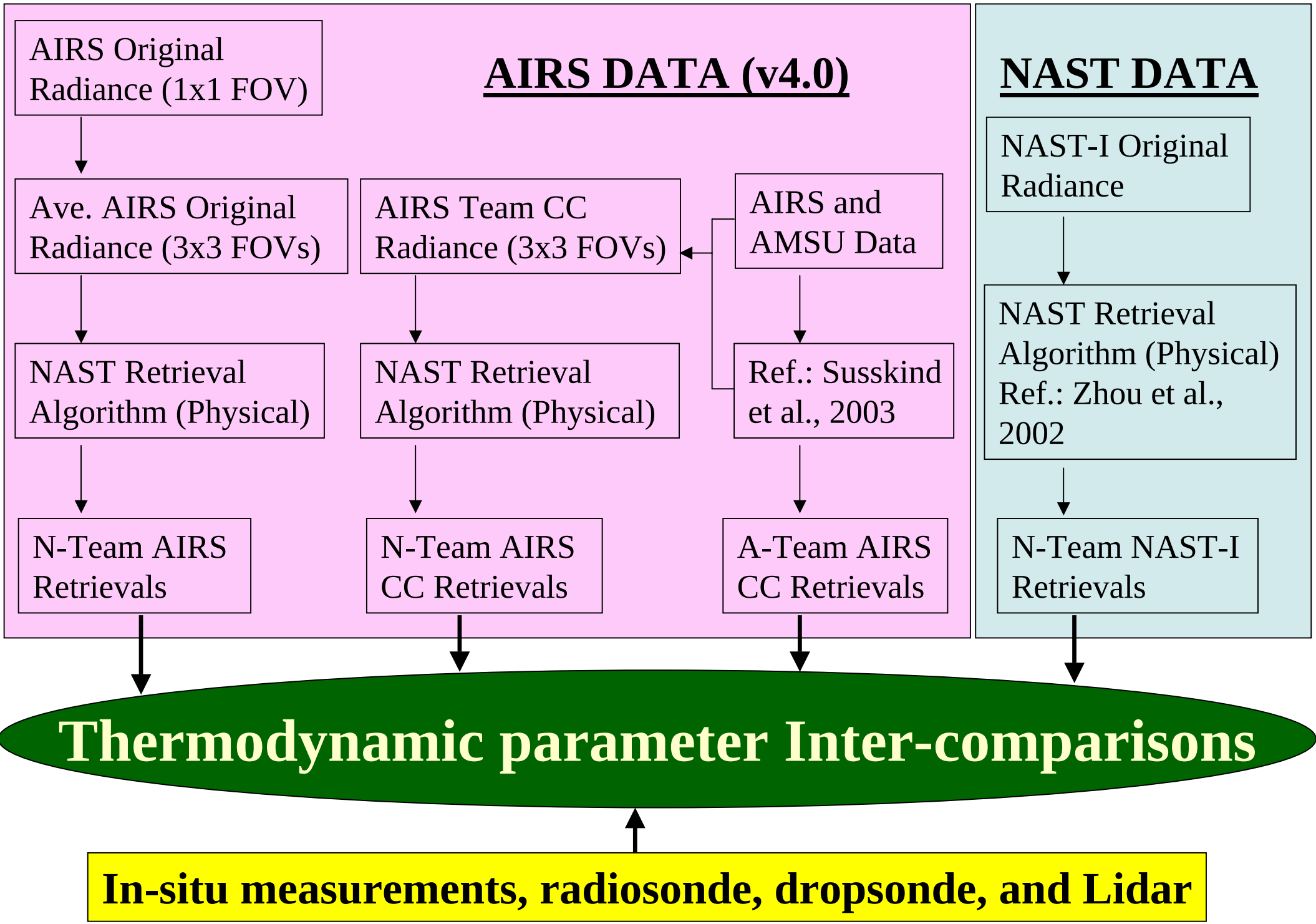
Initial retrieval inter-comparison of the European AQUA Thermodynamic Experiment (EAQUATE)

Daniel K. Zhou[1], William L. Smith[2,3], Allen M. Larar[1], Xu Liu[1], Stephen A. Mango[4], Jonathan Taylor[5], Vincenzo Cuomo[6], Chris Barnet[7], and Mitch Goldberg[7]

[1]NASA Langley Research Center, Hampton, VA 23681, USA
[2]Hampton University, Hampton, VA 23668, USA
[3]University of Wisconsin – Madison, Madison, WI 53706, USA
[4]NPOESS Integrated Program Office, Silver Spring, MD 20910, USA
[5]Met Office, Exeter Devon, UK
[6]Istituto di Metodologie l'Analisi Ambientale, Potenza, IT
[7]NOAA/NESDIS, Camp Springs, MD 20746, USA

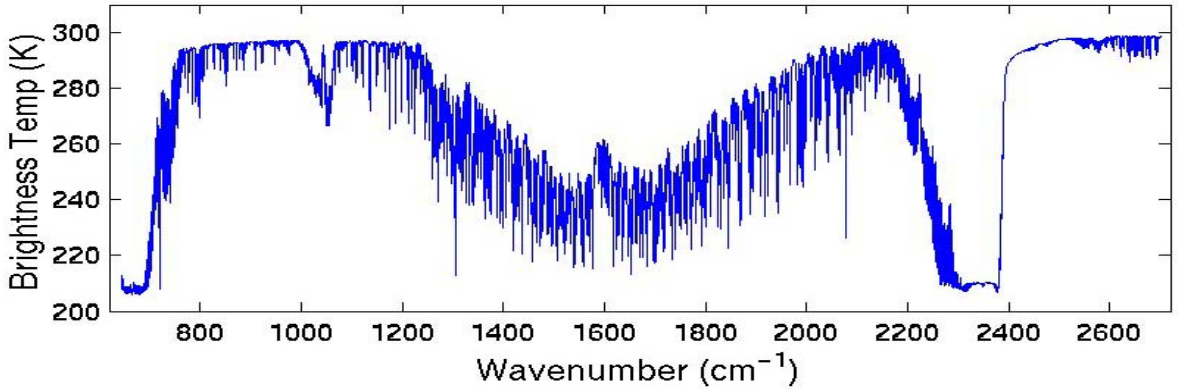
May 25 – 31, 2005
Beijing, China

Data and Algorithm Used for Inter-Comparisons

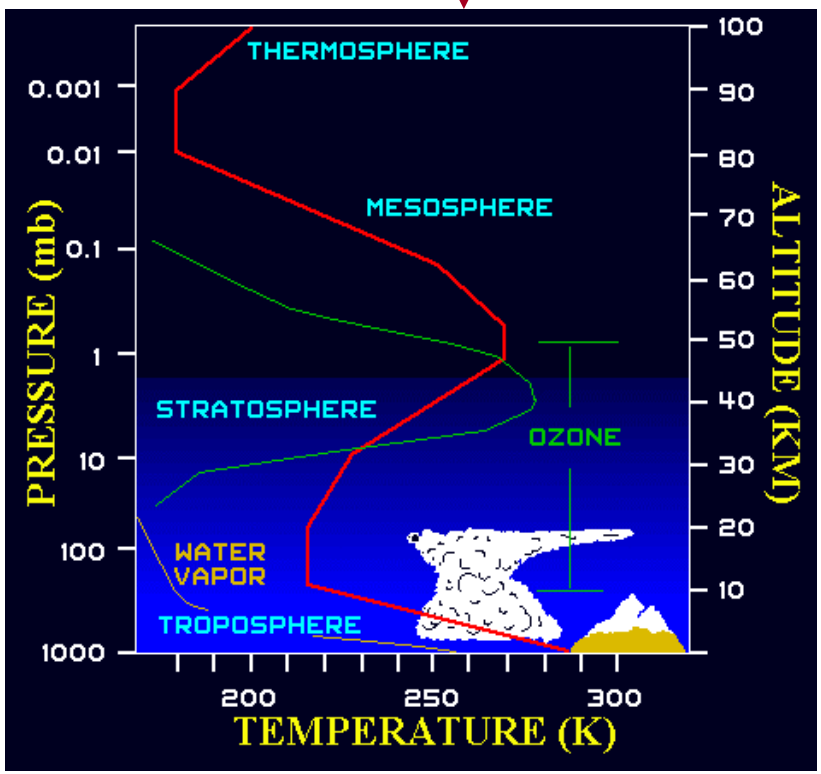


NAST-I Data Products

Calibrated Brightness Temperature or Radiance Spectrum



NUMERICAL INVERSION



Vertical Sounding and Surface Properties, Cloud Properties

Retrievals under clear conditions:

- Surface skin properties.
- Atmospheric temperature and moisture profiles.
- Atmospheric CO and O_3 abundances.

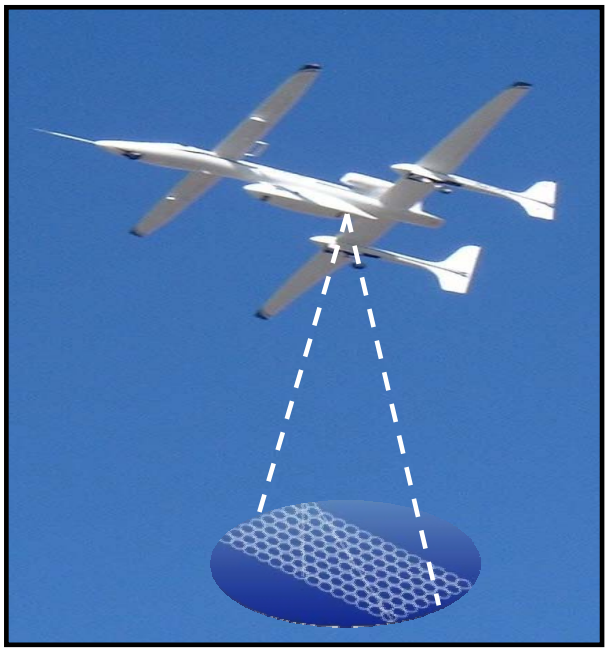
[Zhou et al. (2002), *Applied Optics*, **41**, 6957–6967]
[Zhou et al. (2005), *Applied Optics*, **44**, 3032–3044]

Retrievals under cloudy conditions:

- Atmospheric profile through optically thin cirrus clouds and above optically thick clouds.
- Effective cloud parameters (i.e., cloud top pressure, particle size, and optical depth).

[Zhou et al. (2005), submitted to *Geophys. Res. Lett.*]

Flow Diagram for NAST-I Data



Historical Training Data (Raob Temp and H_2O, manufactured CO and O_3) & Radiance Simulation

EOFs & Regression Coefficients

PCA and Optimal Regression Analyses; Statistical Optimal Regression Retrieval

Regression Retrievals (Stage #1)

NAST-I Measured Raw Data

Calibration

Simultaneous Matrix Inversion (multiple variable matrix inversion – MVMI)

SMI – Physical Retrievals (Stage #2)

Total Noise Level

Calibrated Spectral Radiances

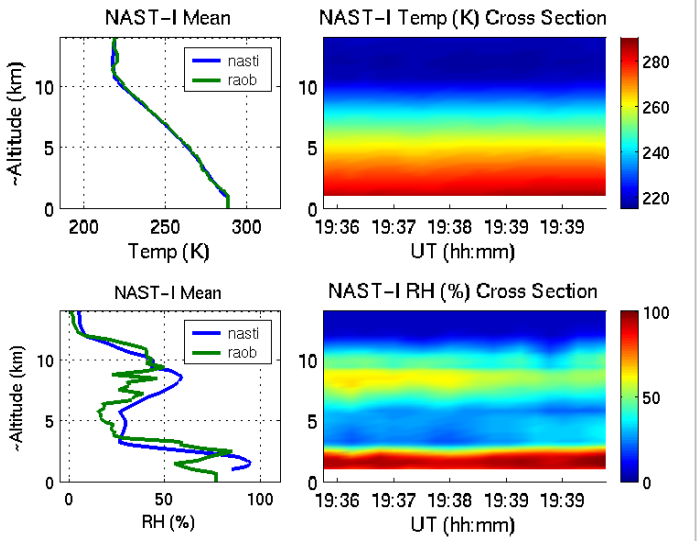
CO Physical Retrieval (single variable matrix inversion – SVMI)

CO Physical Enhancement Retrievals (Stage #3)

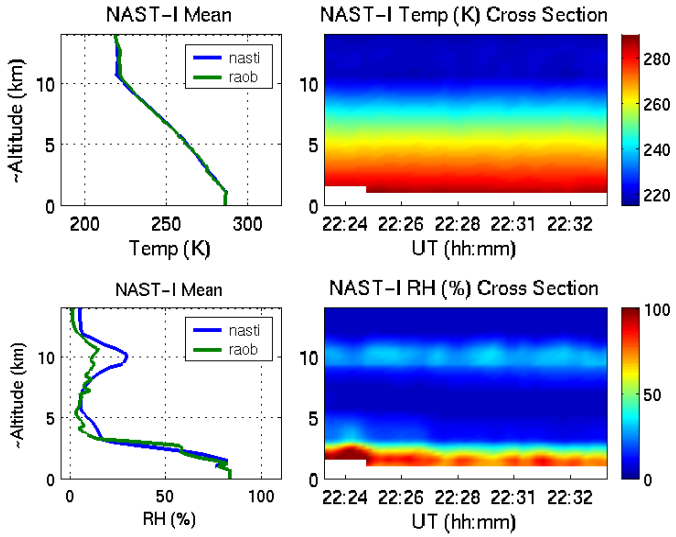
NAST-I Retrieval, Radiosonde, and Dropsonde

NAST-I Retrieval sounding validation from the EAQUATE Field Mission (Sept., 2004). A total of six flights: four from Italy and two from the UK.

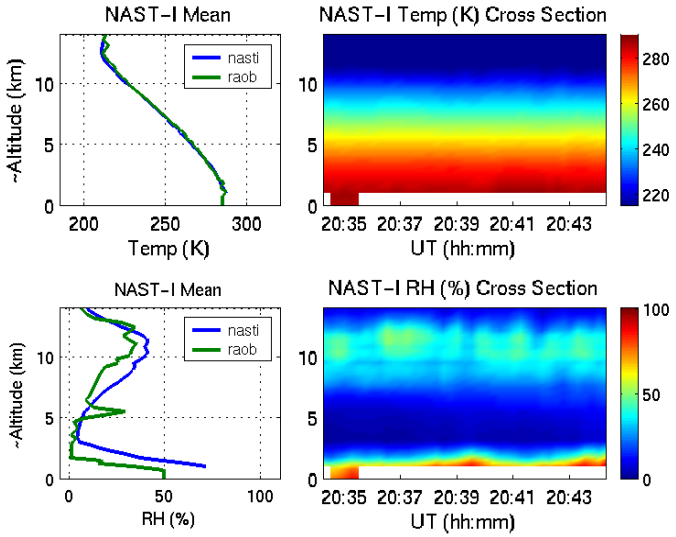
(1) Sept. 06 - Potenza, IT



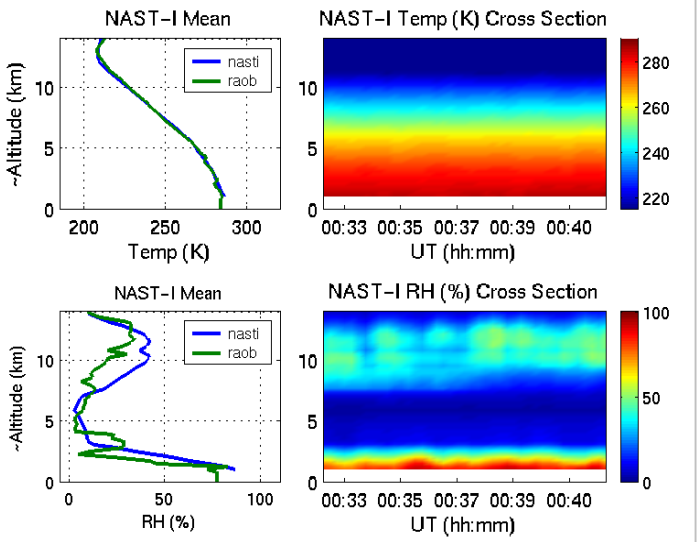
(2) Sept. 07 - Potenza, IT



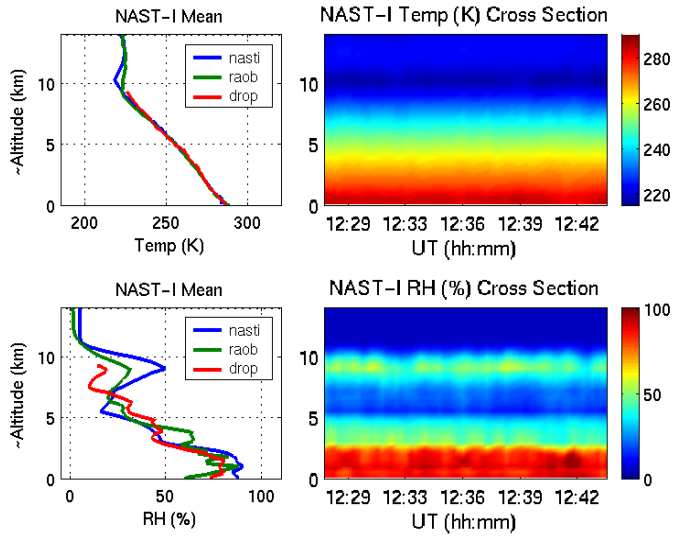
(3) Sept. 08 - Potenza, IT



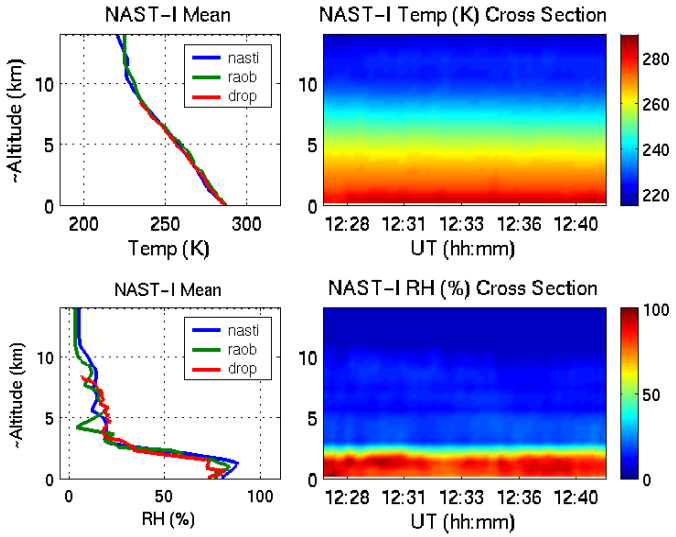
(4) Sept. 10 - Potenza, IT



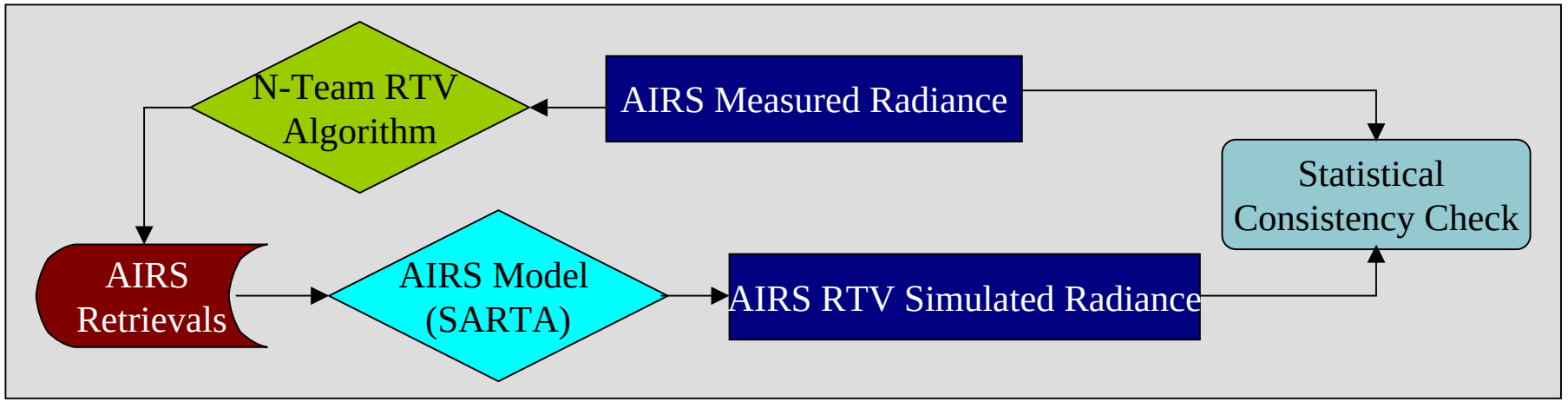
(5) Sept. 14 - SW Sea of Wales, UK

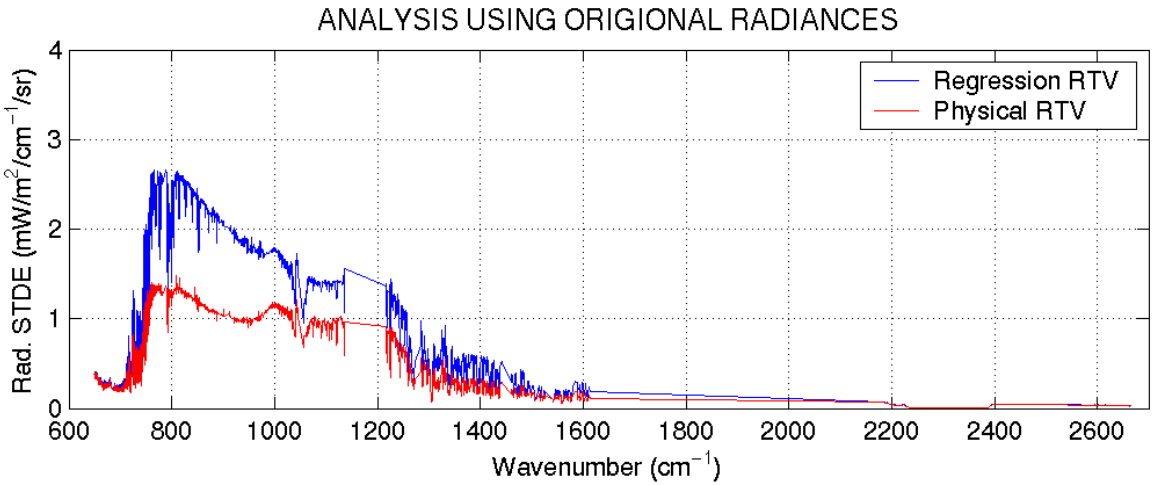


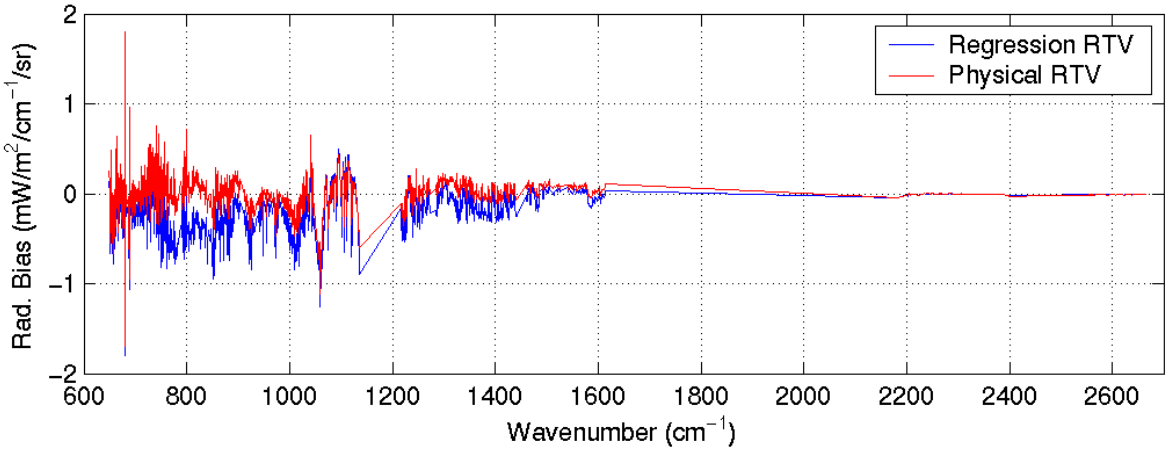
(6) Sept. 18 - SW Sea of Wales, UK



AIRS Retrieval Consistency Check







One AIRS granule (2004.09.08.011) data set shows retrieval quality using the NAST-team retrieval algorithm.

Retrieval-simulated radiance and measured radiance convergence from regression to physical process.

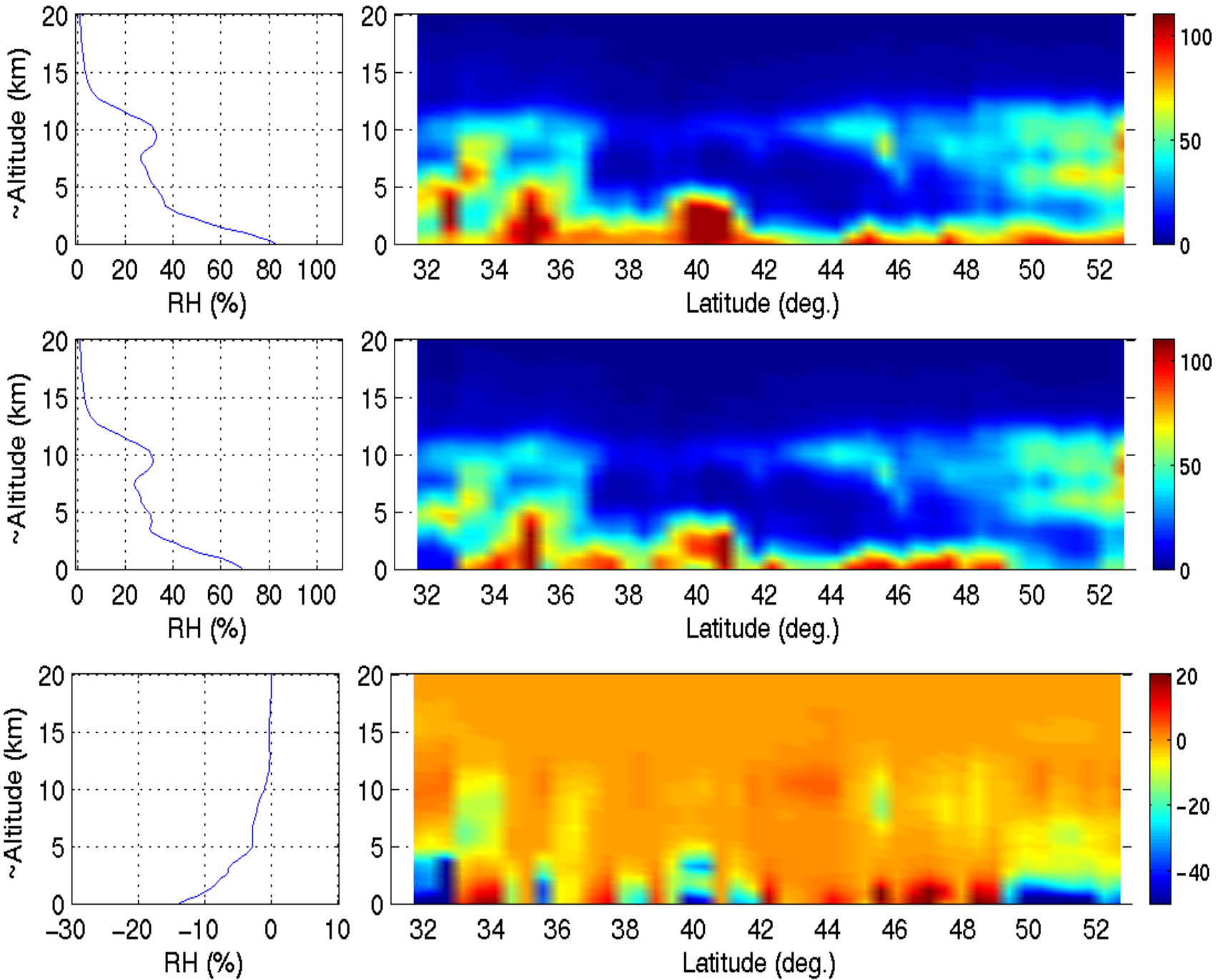
AIRS Moisture: from Reg. to Phys. Ret. (04.09.08)

NAST-Team Retrieval Algorithm:

Regression Retrieval

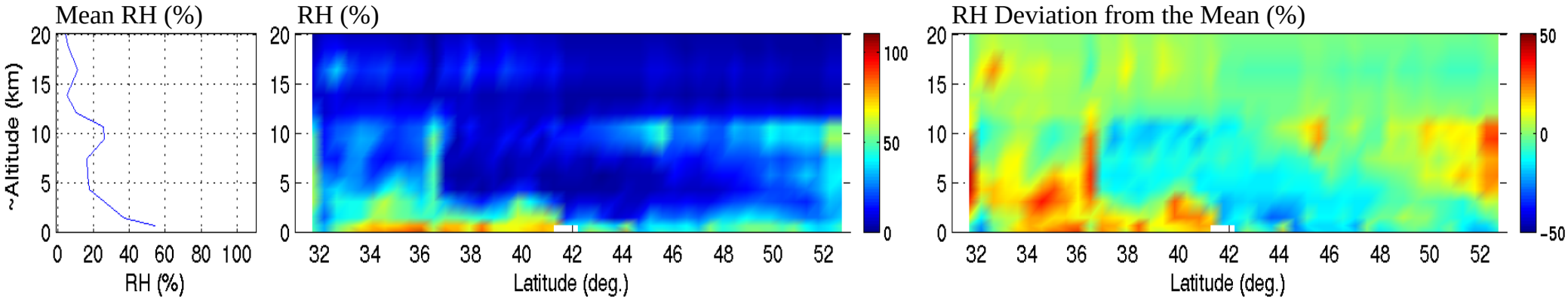
Physical Retrieval

Phys. Ret. – Reg. Ret.

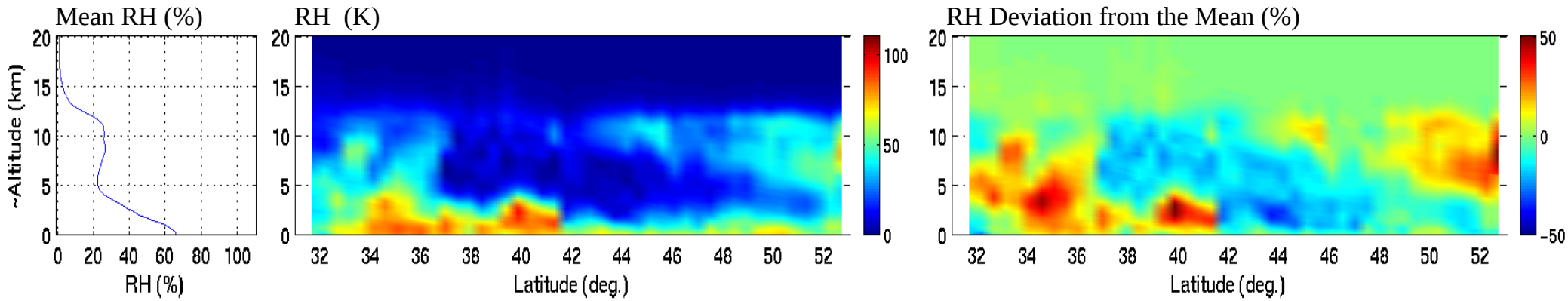


AIRS-Team Level 2 Version Progress: Moisture (04.09.08)

(1) AIRS-Team Retrieval from CC Radiance – V 3.0 (Current DAAC version)



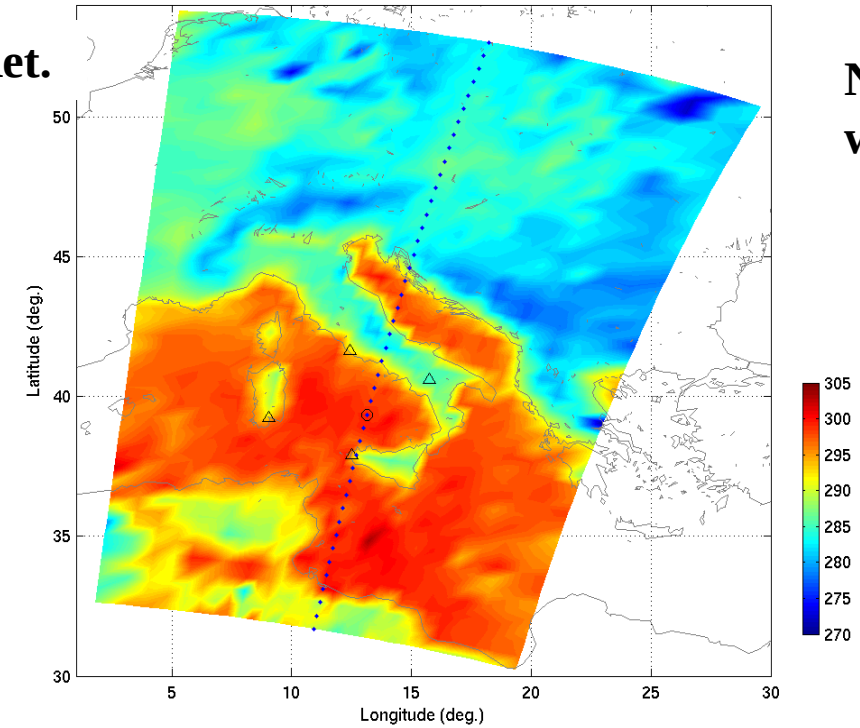
(2) AIRS-Team Retrieval from CC Radiance – V 4.0



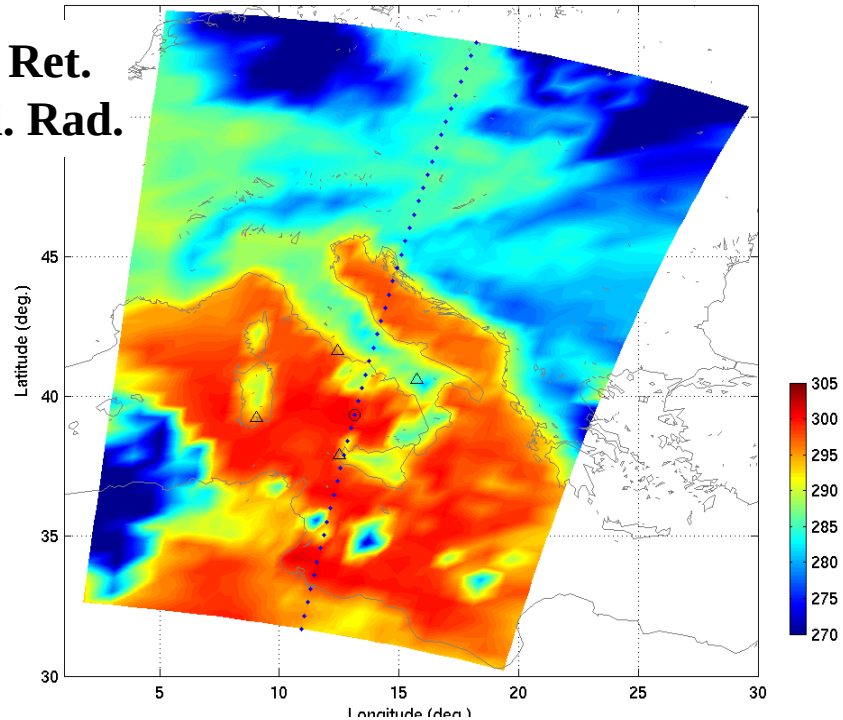
AIRS Team Retrieval Version 4.0 is used in this work.

Surface Skin Temp. Inter-Comparison (04.09.08)

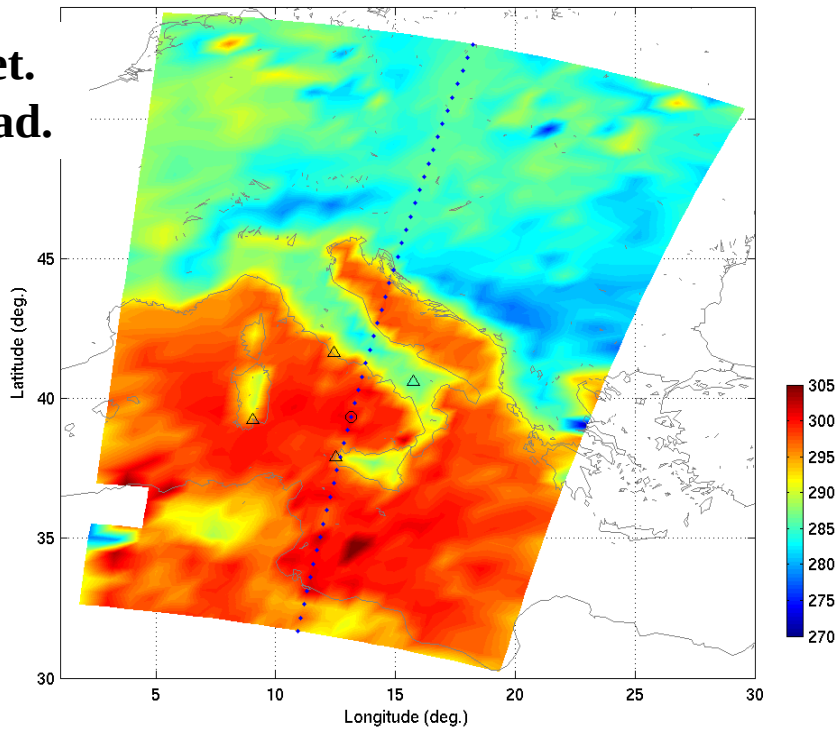
A-Team Ret.

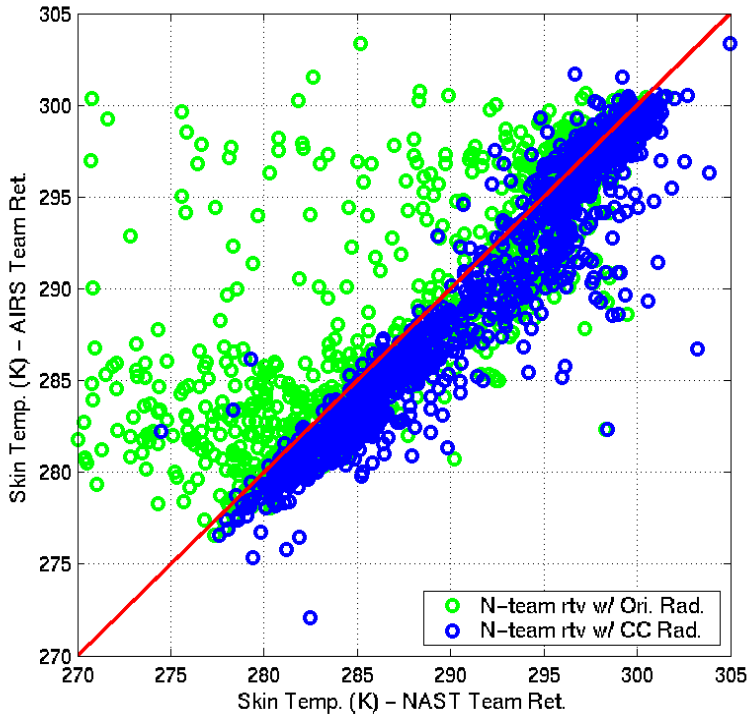


N-Team Ret. with Ori. Rad.



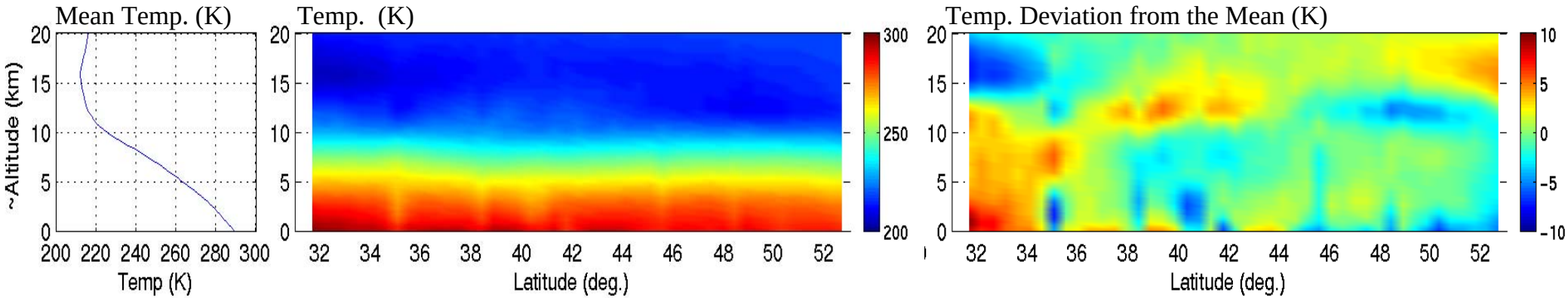
N-Team Ret. with CC Rad.



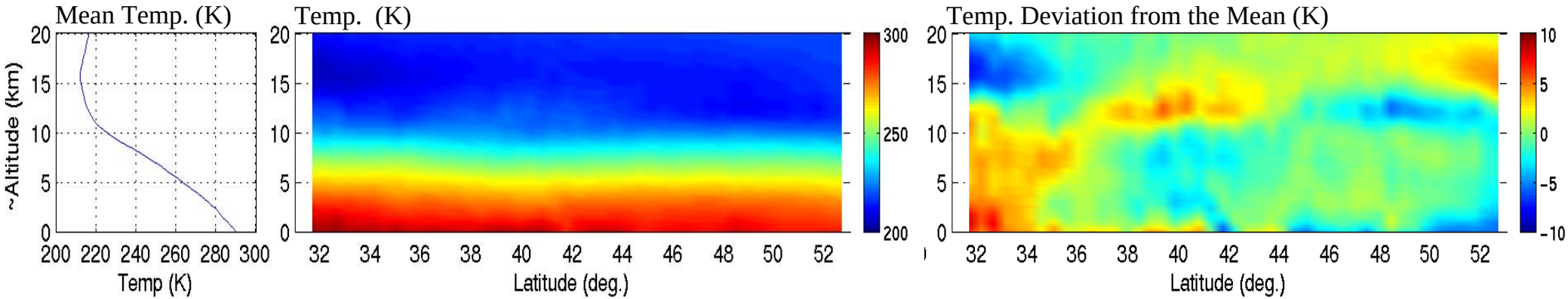


Temp. Cross Section Inter-Comparison (04.09.08)

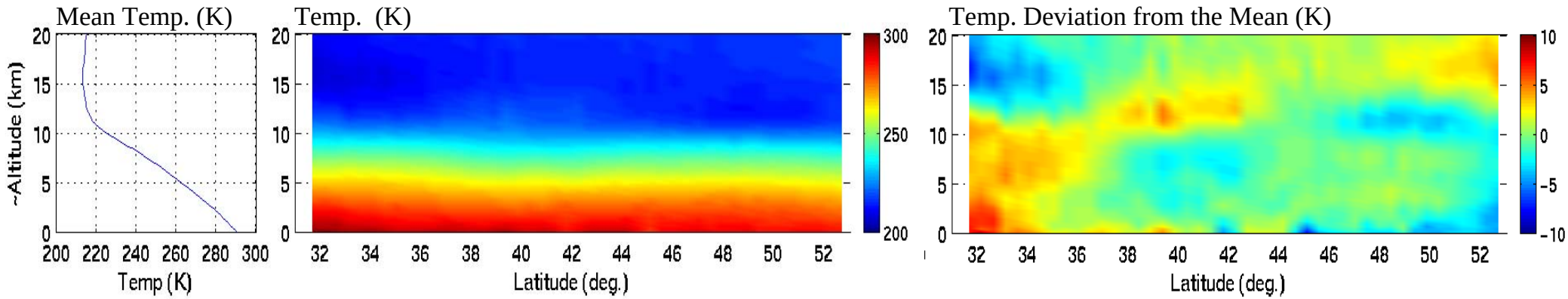
(1) NAST-Team Retrieval from Original Radiance



(2) NAST-Team Retrieval from Cloud Cleared Radiance

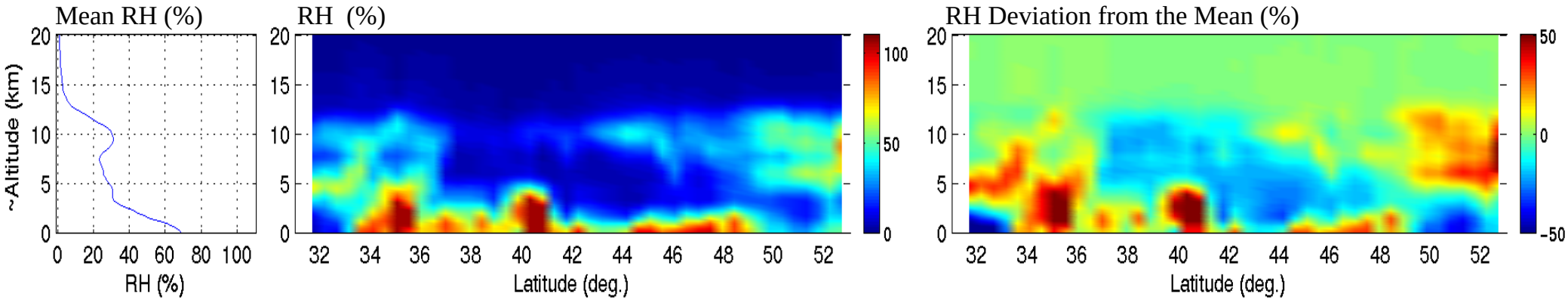


(3) AIRS-Team Retrieval from Cloud Cleared Radiance

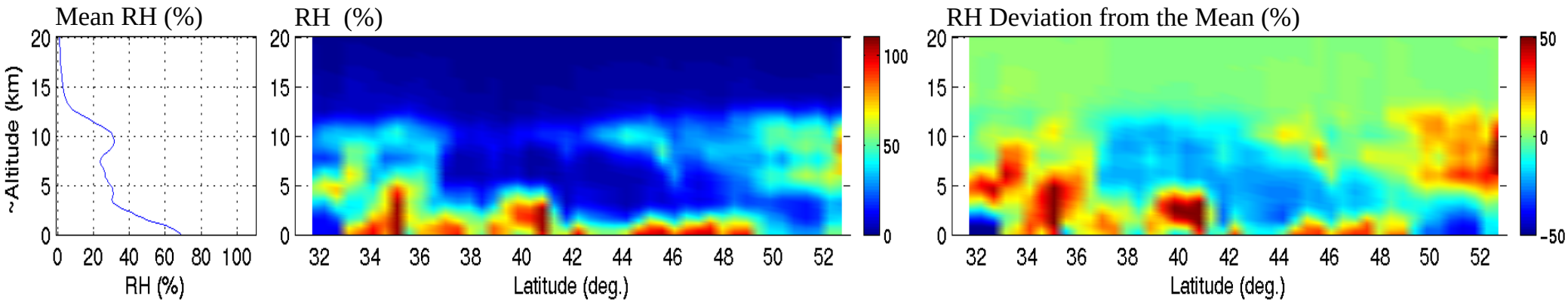


Moisture Cross Section Inter-Comparison (04.09.08)

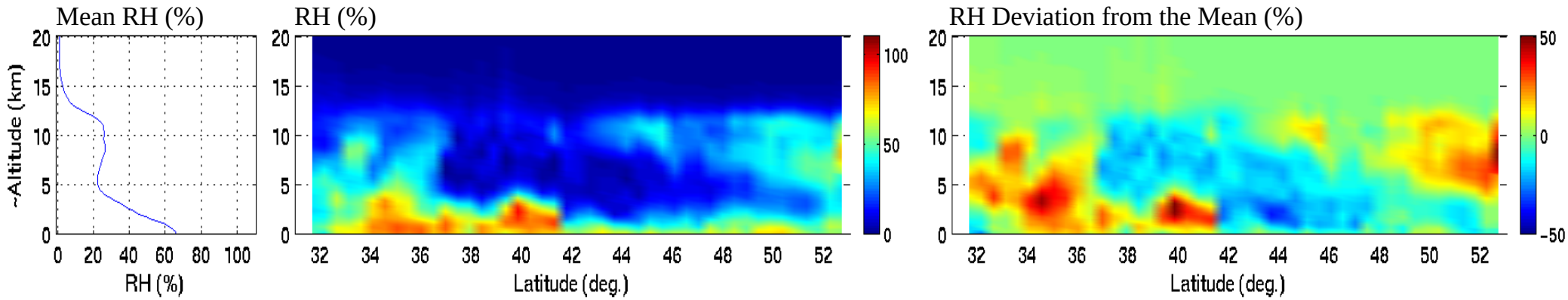
(1) NAST-Team Retrieval from Original Radiance



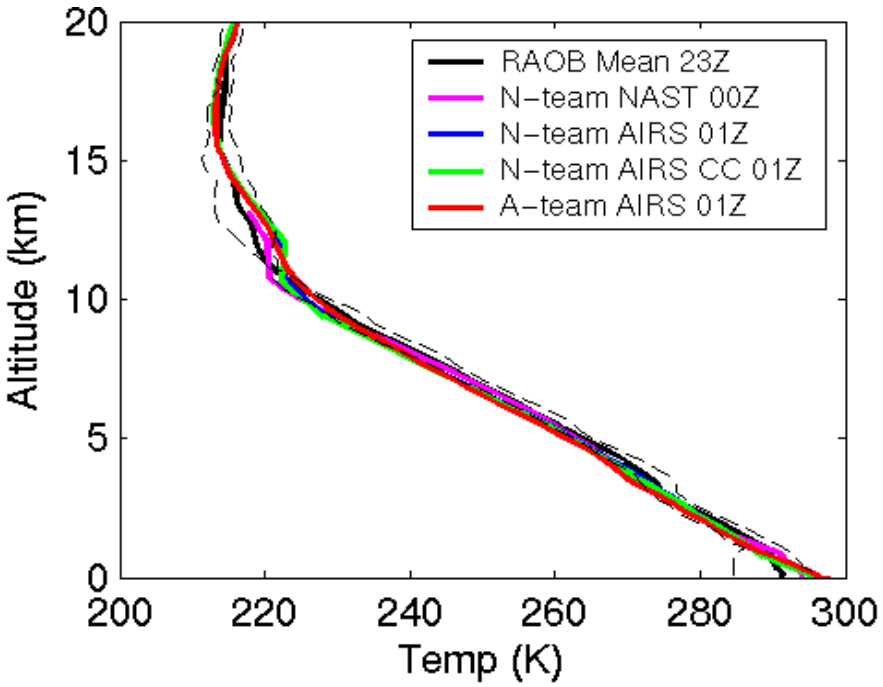
(2) NAST-Team Retrieval from Cloud Cleared Radiance

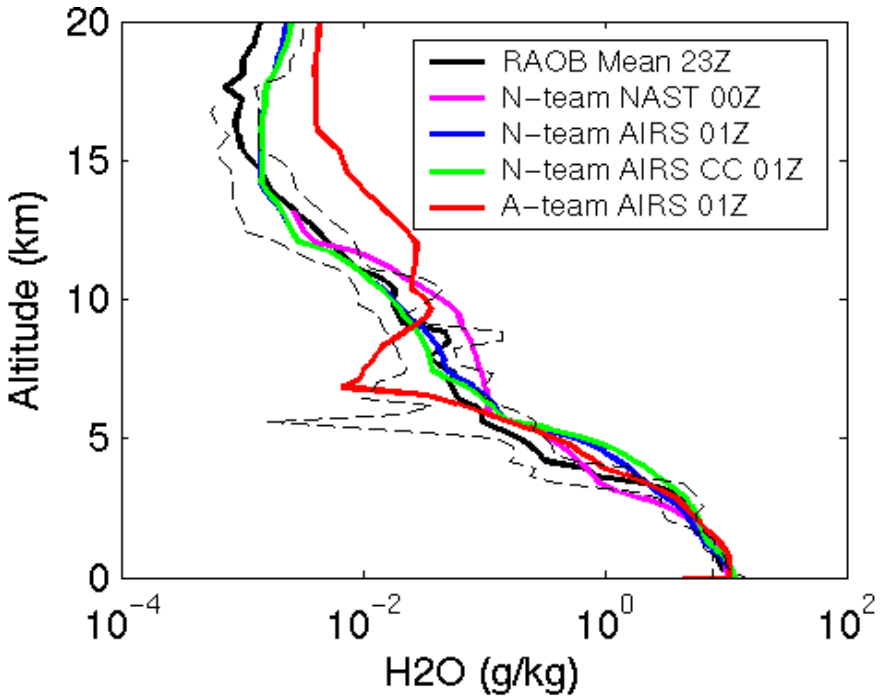


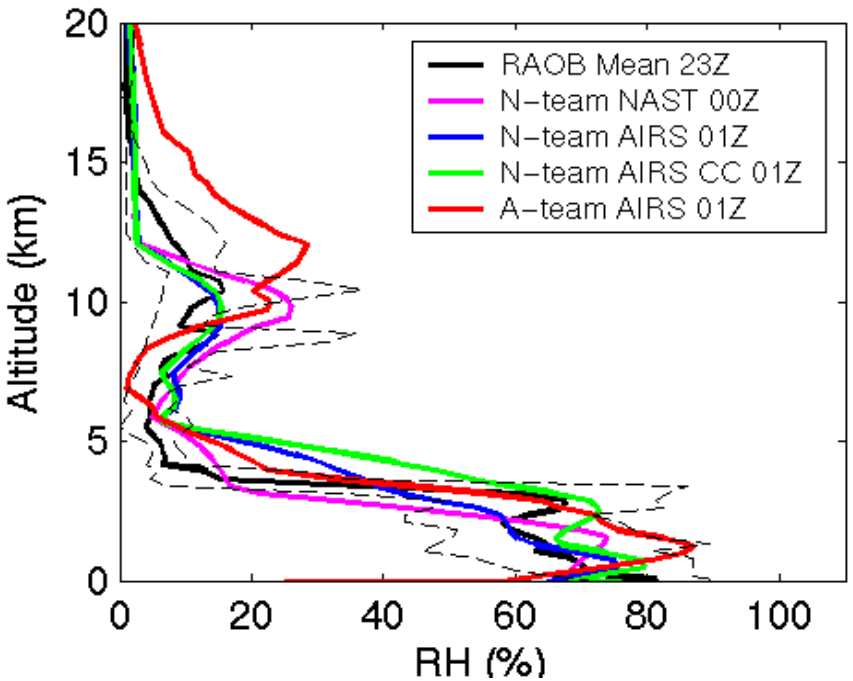
(3) AIRS-Team Retrieval from Cloud Cleared Radiance

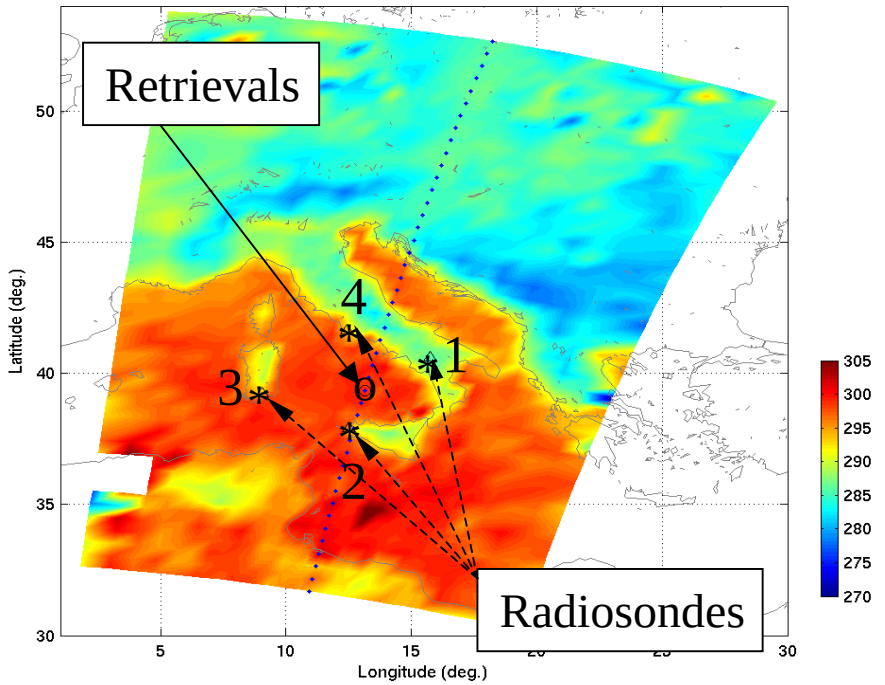


Inter-Comparison with Sounding Average (04.09.08)

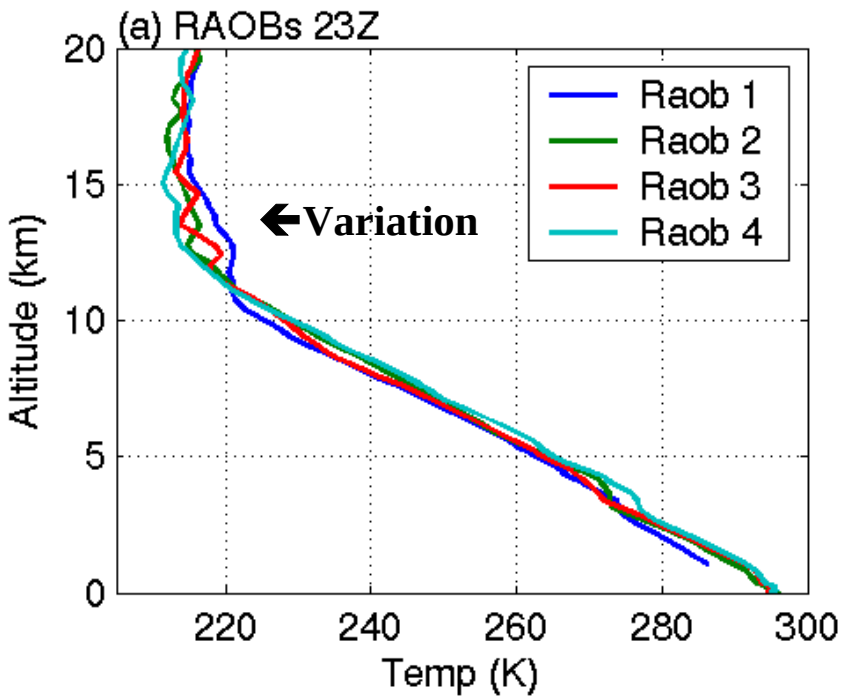


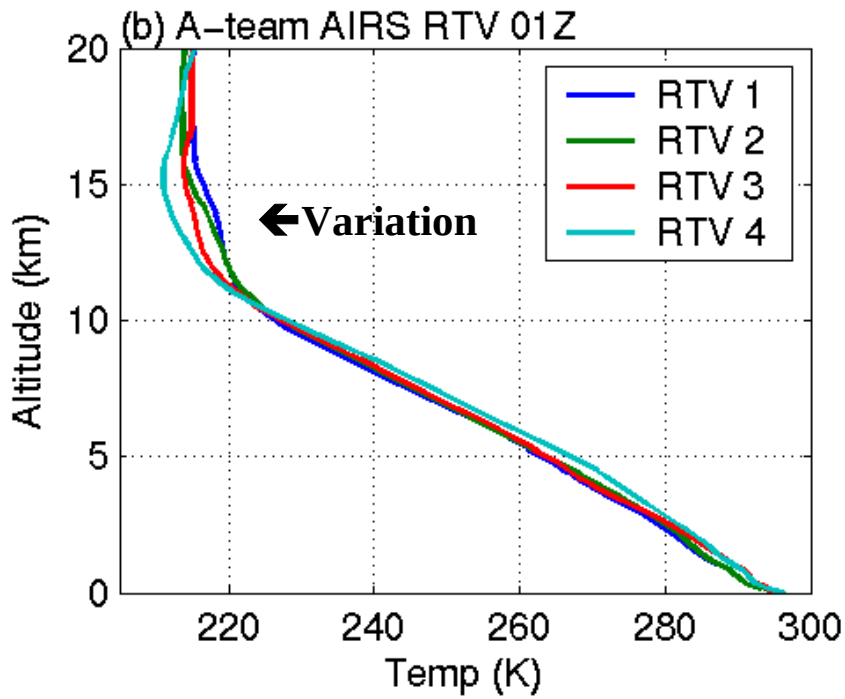


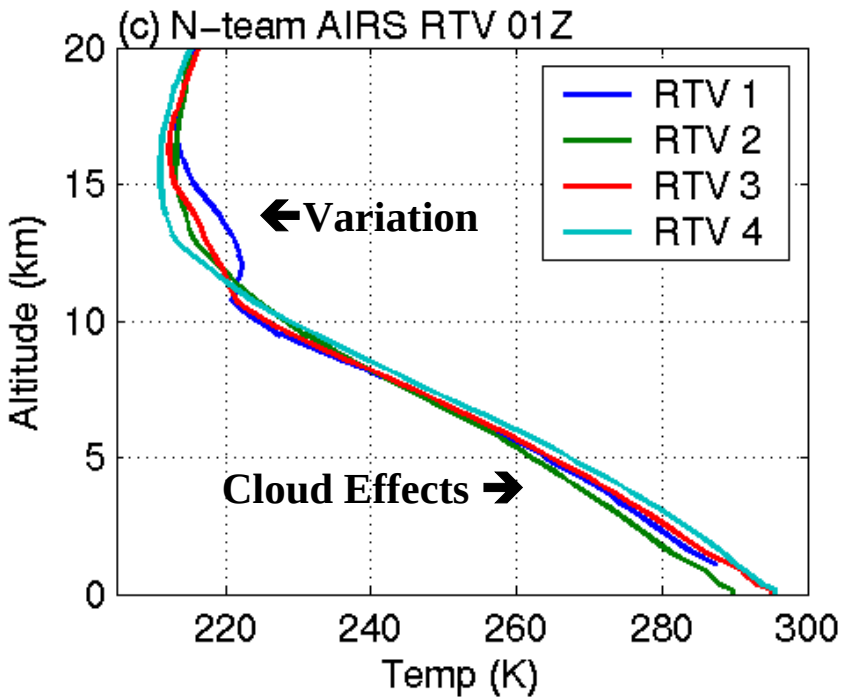


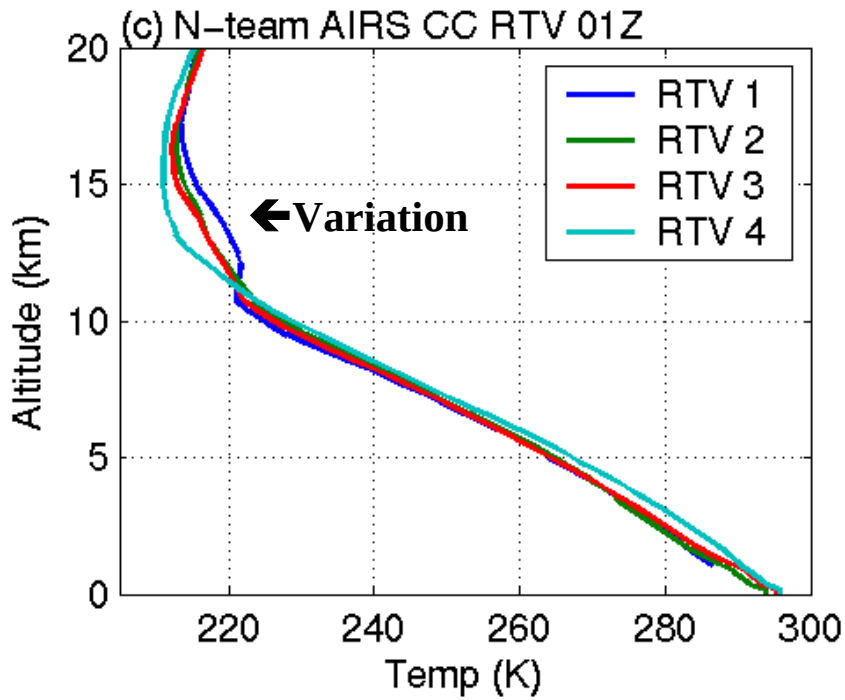


Sounding Variation and Retrieval Sensitivity (04.09.08)





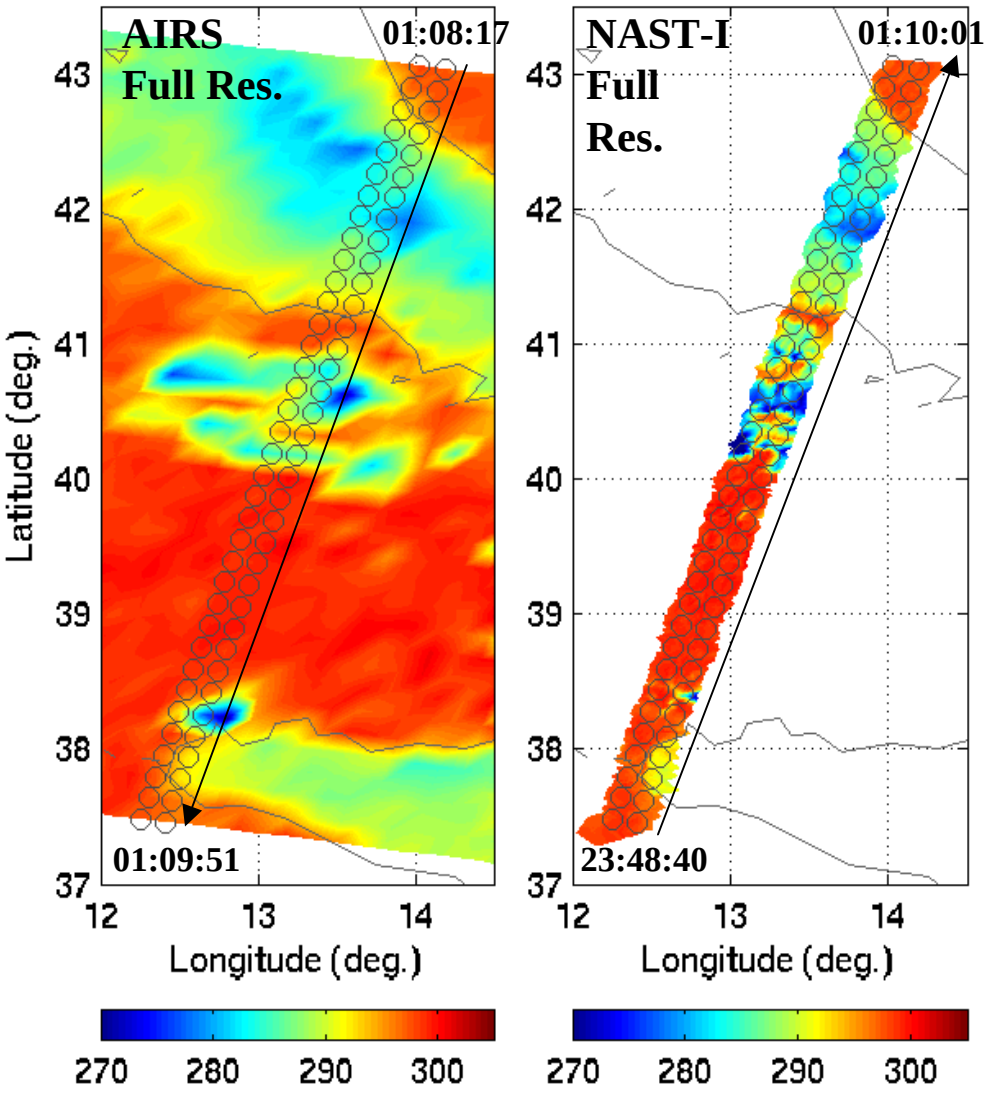




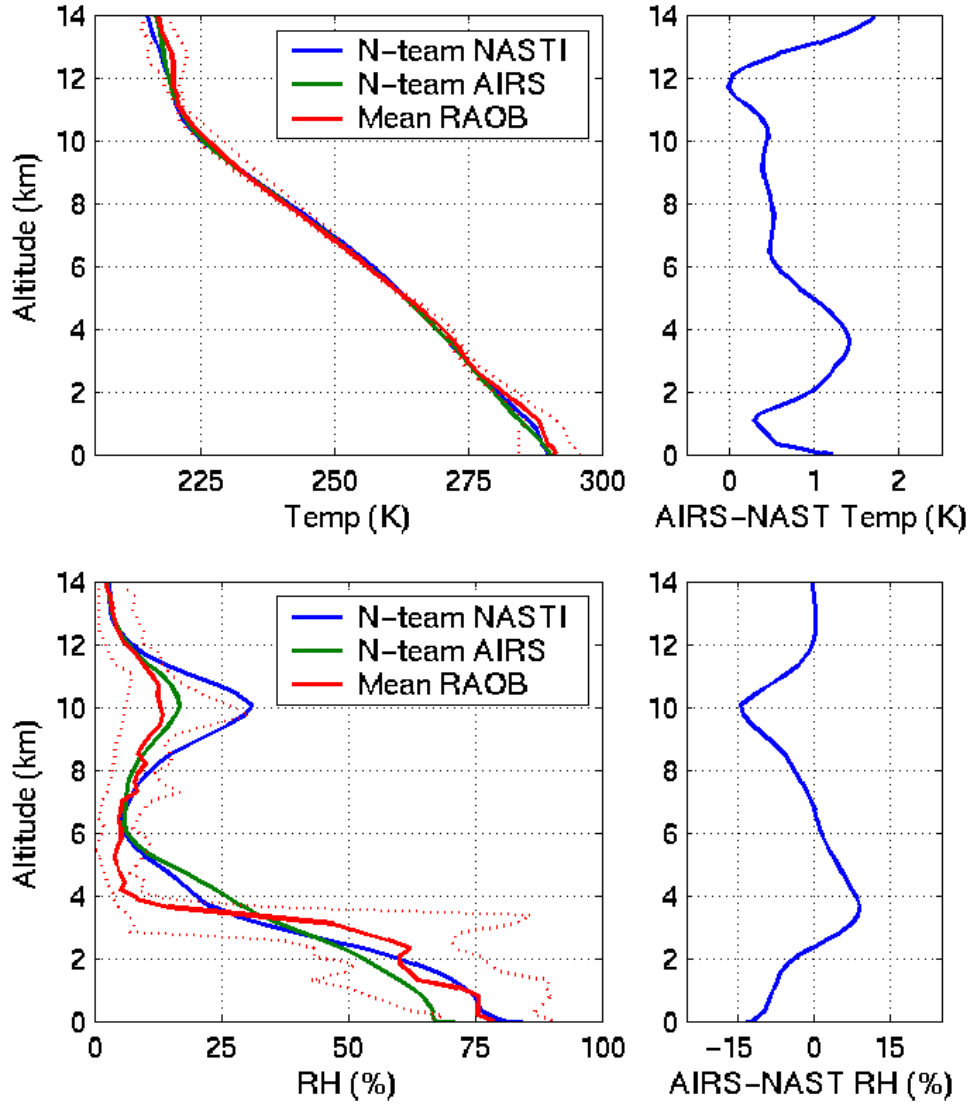
Spatial Variation Inter-Comparison (04.09.08)

- Same retrieval algorithm (NAST Team) used to minimize the algorithm difference, but forward models are different (SARTA for AIRS and OSS for NAST-I).
- AIRS Original 1x1 FOV radiance data and NAST-I are used.
- NAST-I retrievals are degraded to AIRS spatial resolution.

Retrieved Eff. Surf. Skin Temperature

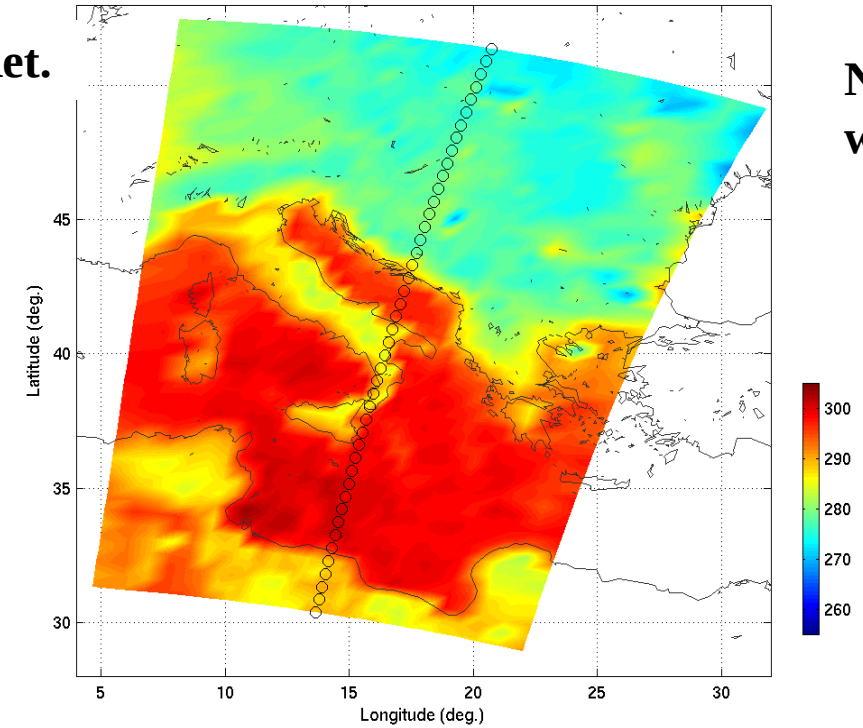


Mean Temperature Comparison

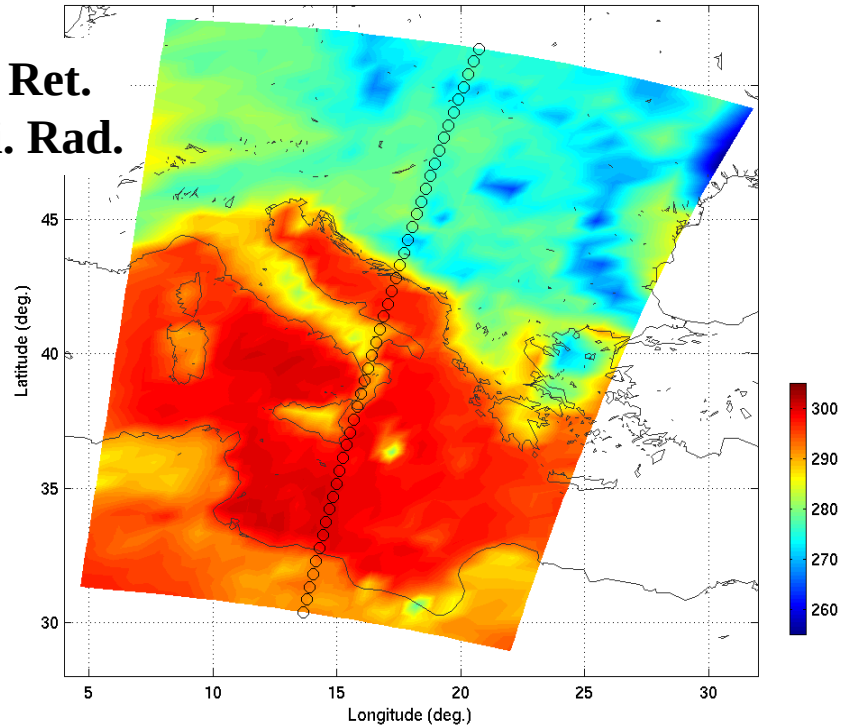


Surface Skin Temp. Inter-Comparison (04.09.10)

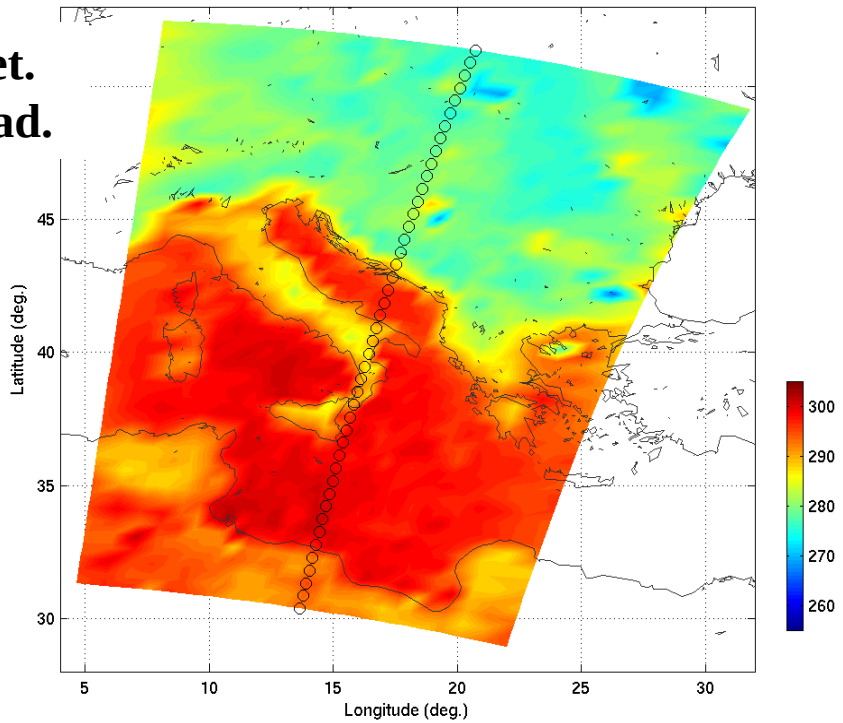
A-Team Ret.

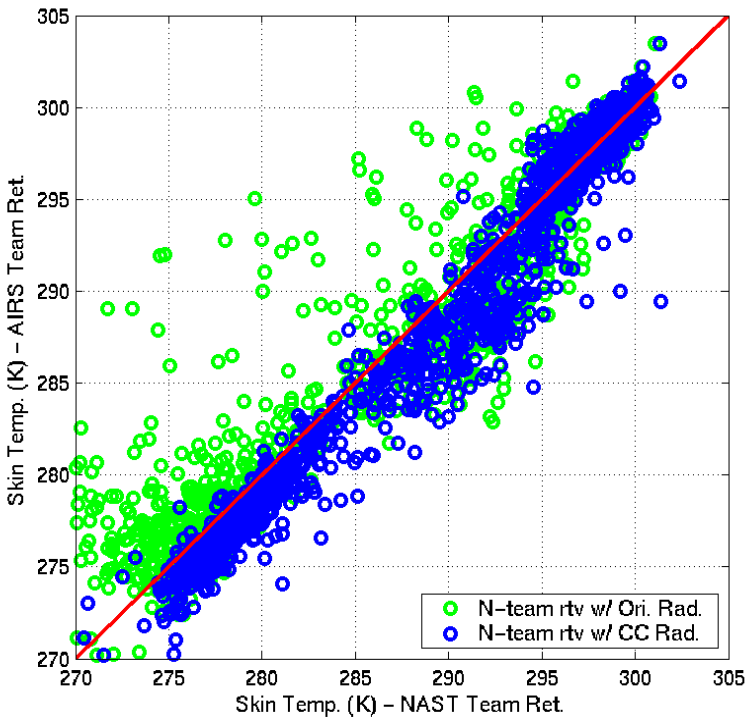


N-Team Ret. with Ori. Rad.



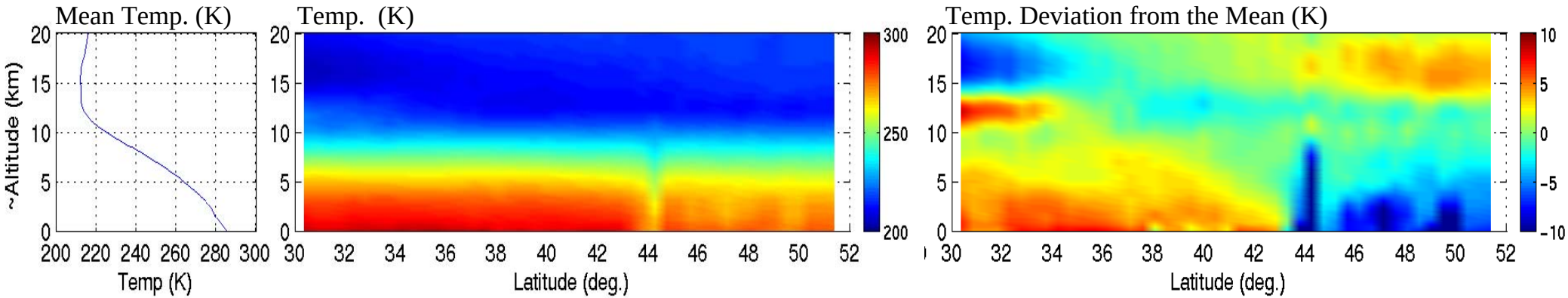
N-Team Ret. with CC Rad.



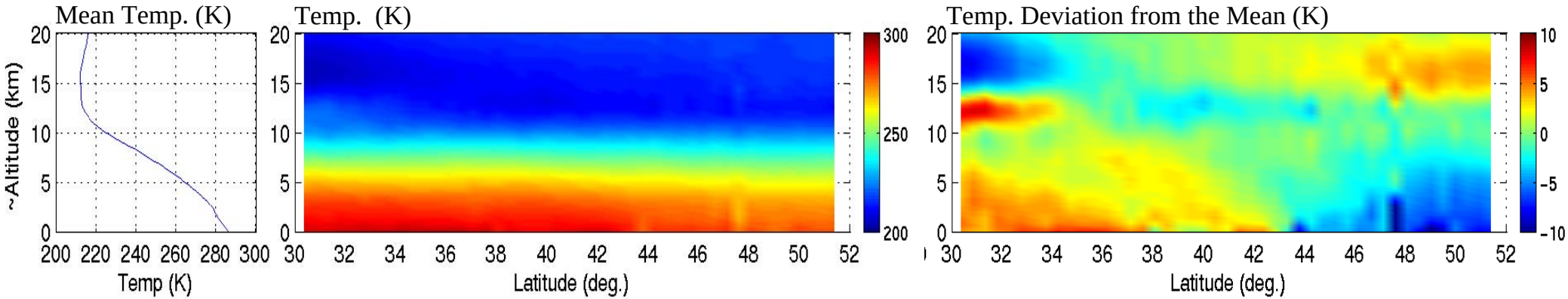


Temp. Cross Section Inter-Comparison (04.09.10)

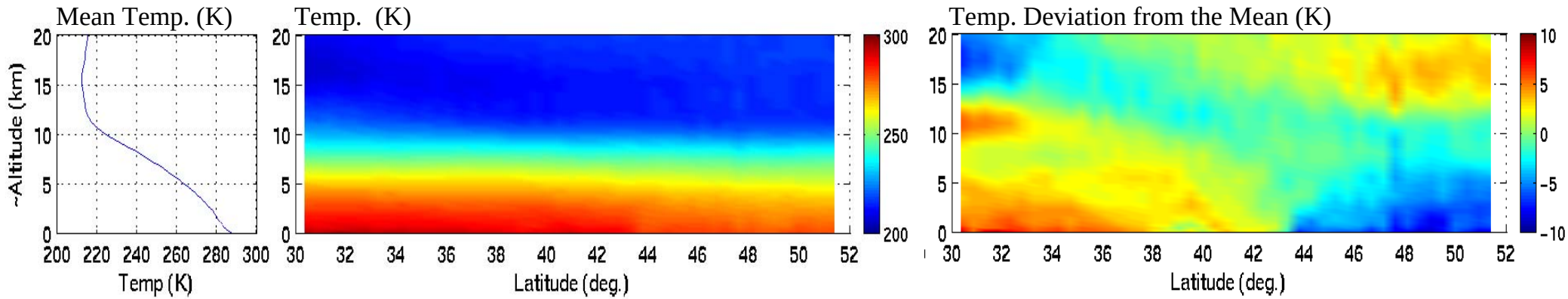
(1) NAST-Team Retrieval from Original Radiance



(2) NAST-Team Retrieval from Cloud Cleared Radiance

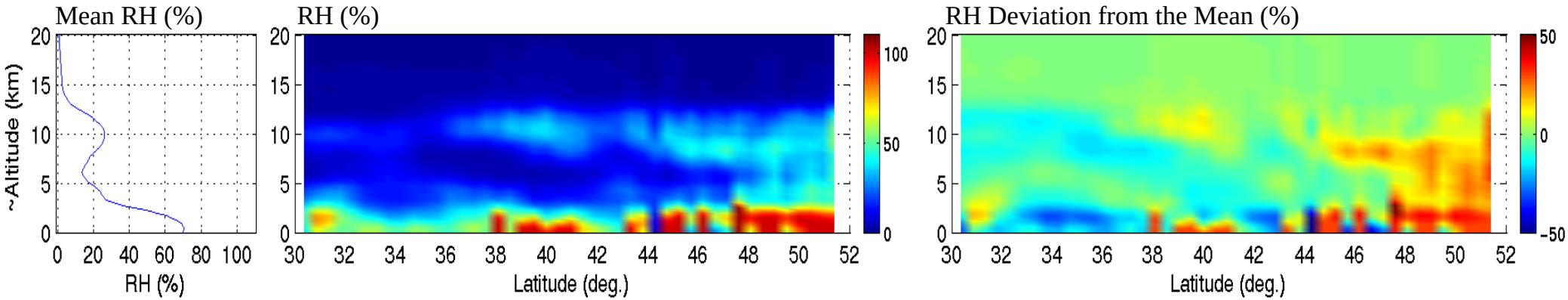


(3) AIRS-Team Retrieval from Cloud Cleared Radiance

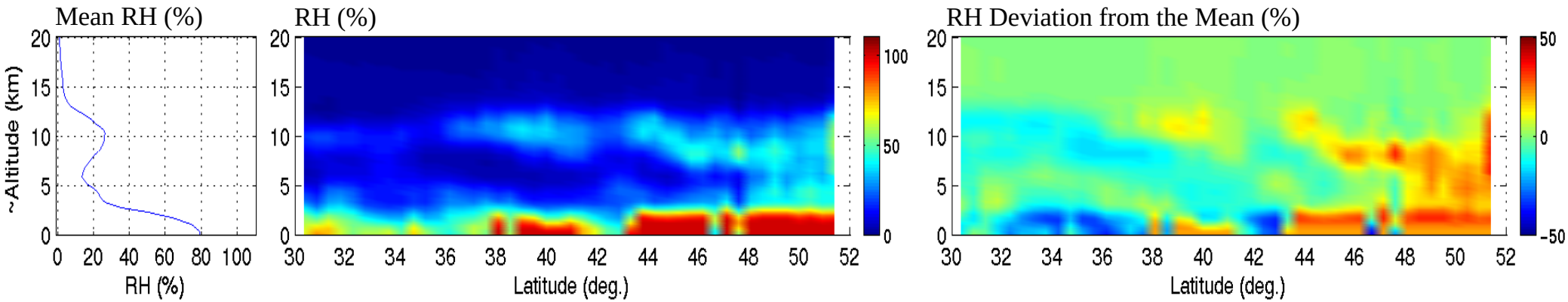


Moisture Cross Section Inter-Comparison (04.09.10)

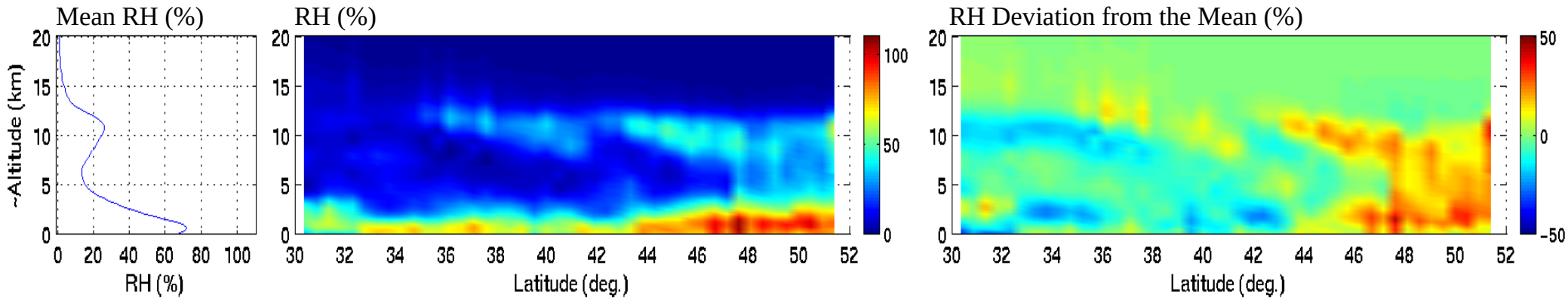
(1) NAST-Team Retrieval from Original Radiance



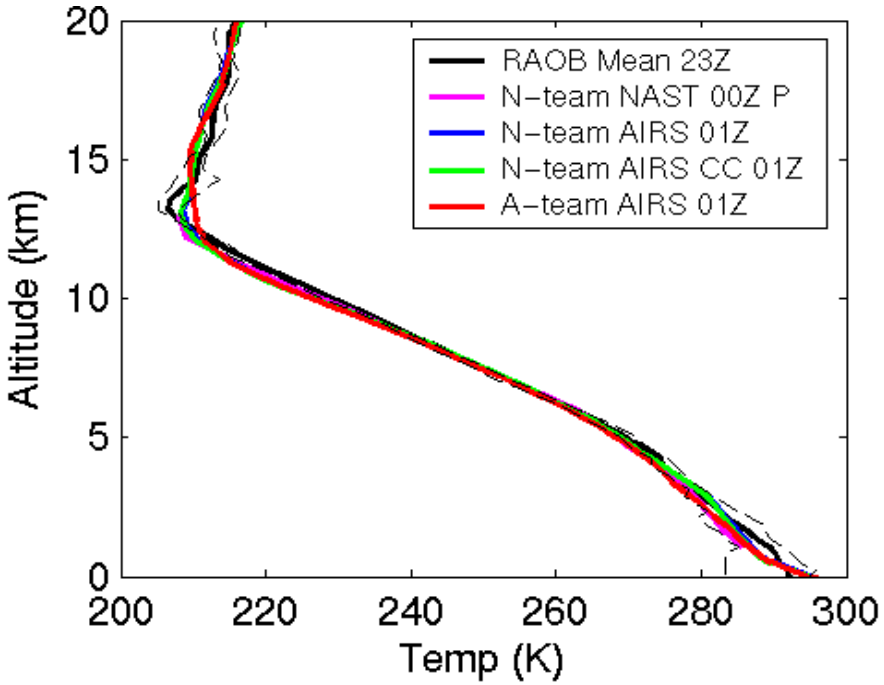
(2) NAST-Team Retrieval from Cloud Cleared Radiance

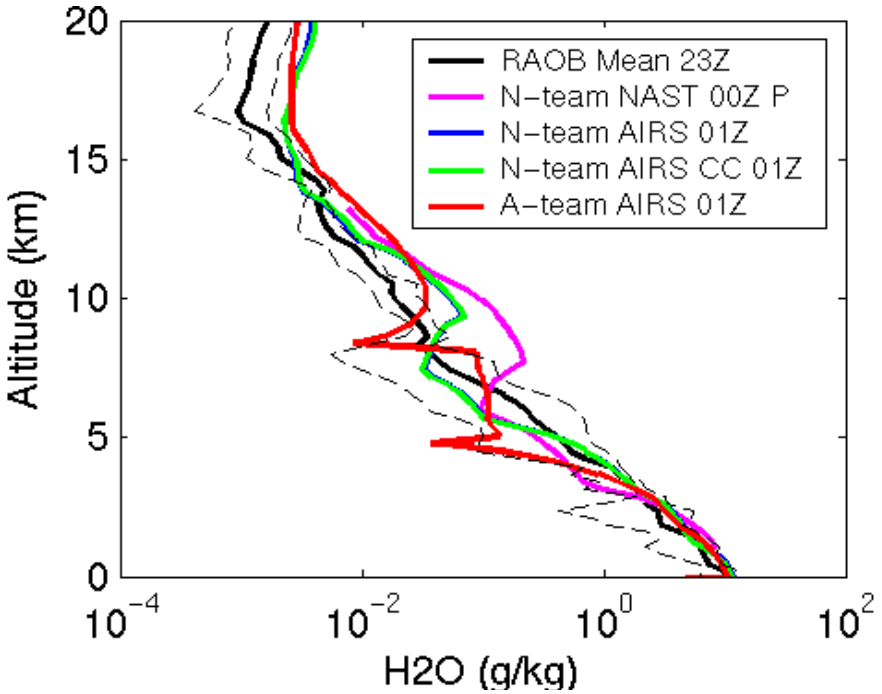


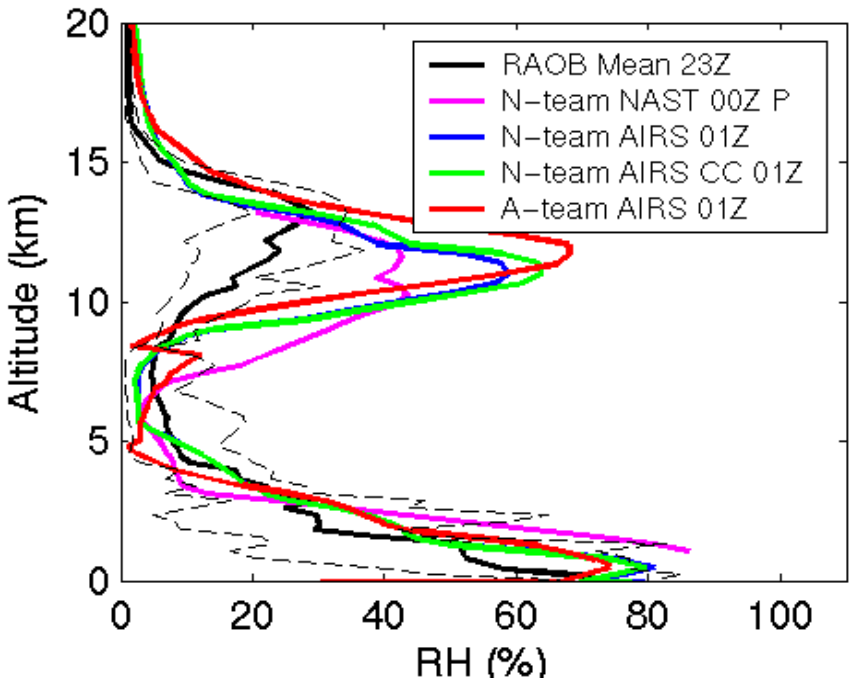
(3) AIRS-Team Retrieval from Cloud Cleared Radiance

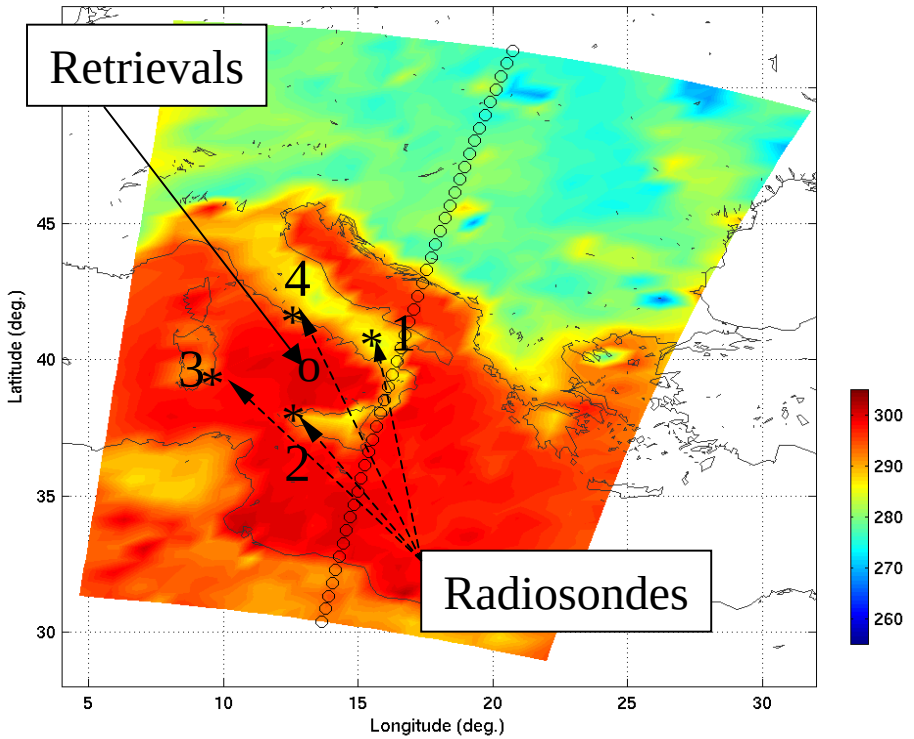


Inter-Comparison with Sounding Average (04.09.10)





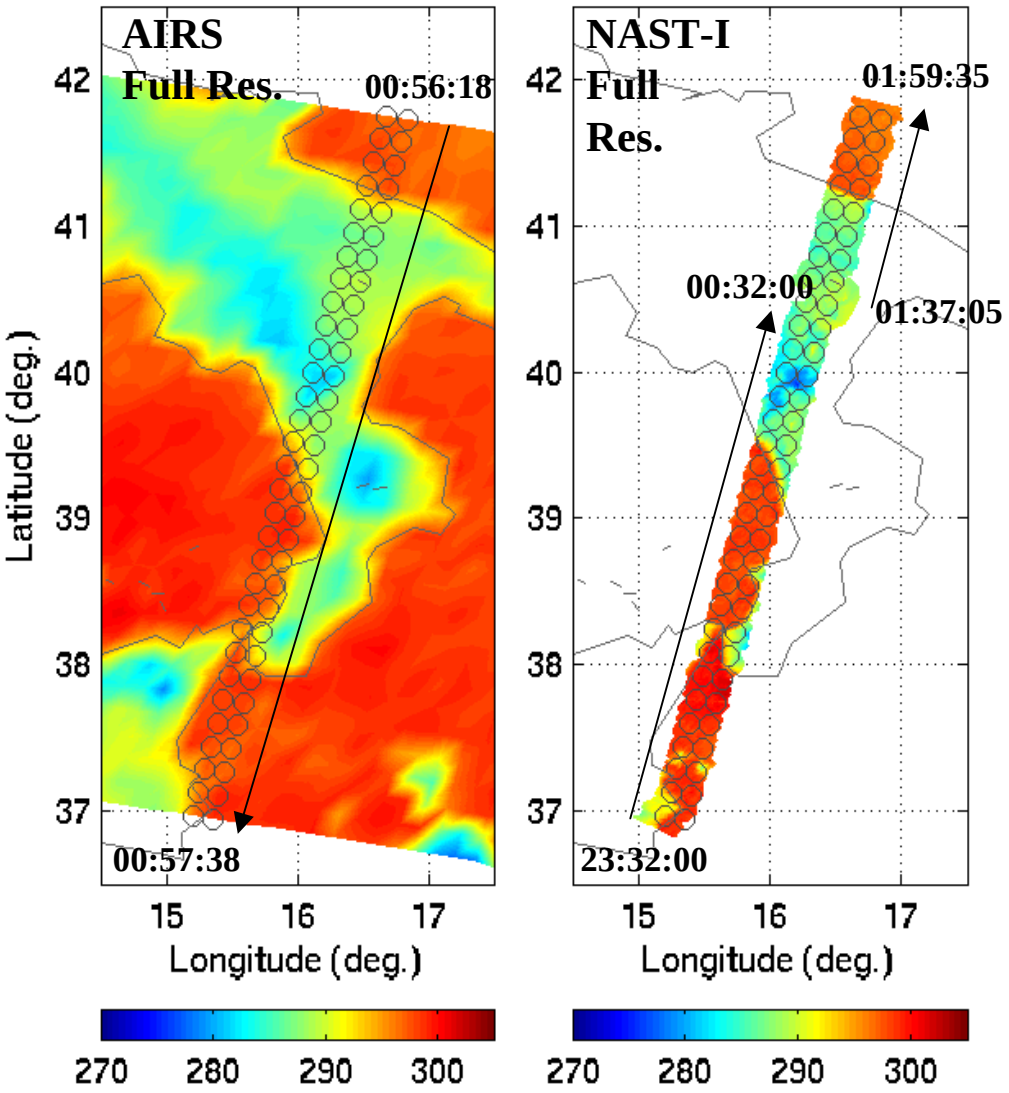




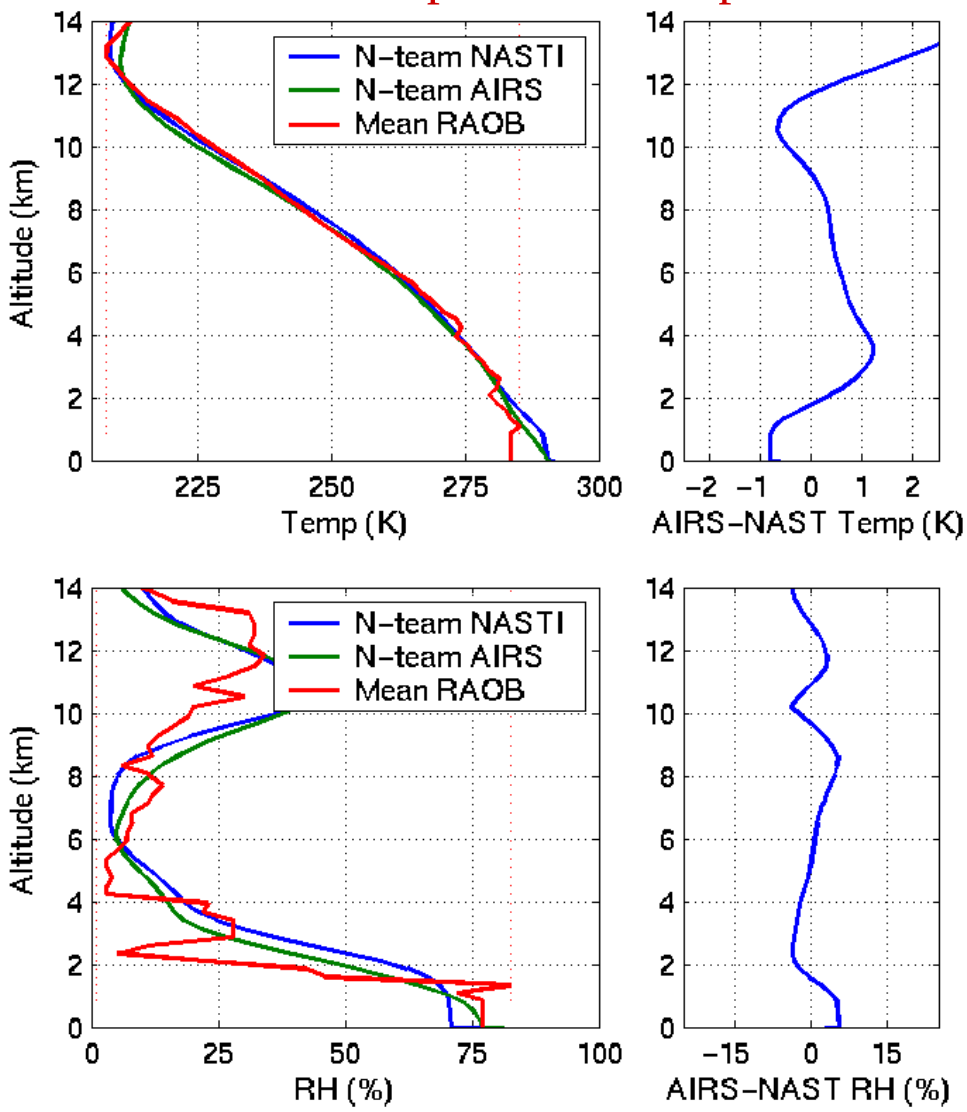
Spatial Variation Inter-Comparison (04.09.10)

- Same retrieval algorithm (NAST Team) used to minimize the algorithm difference, but forward models are different (SARTA for AIRS and OSS for NAST-I).
- AIRS Original 1x1 FOV radiance data and NAST-I are used.
- NAST-I retrievals are degraded to AIRS spatial resolution.

Retrieved Eff. Surf. Skin Temperature

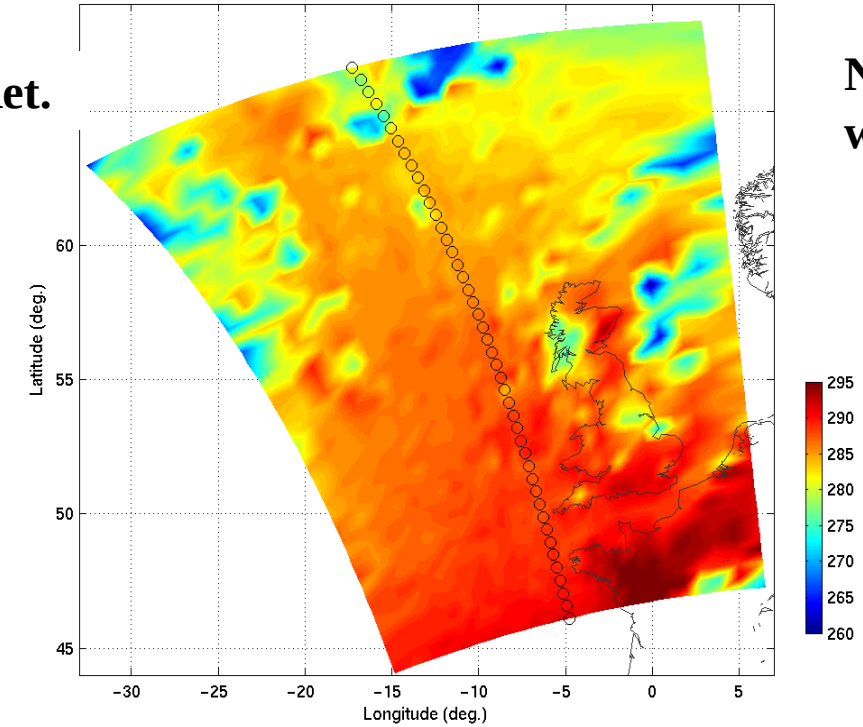


Mean Temperature Comparison

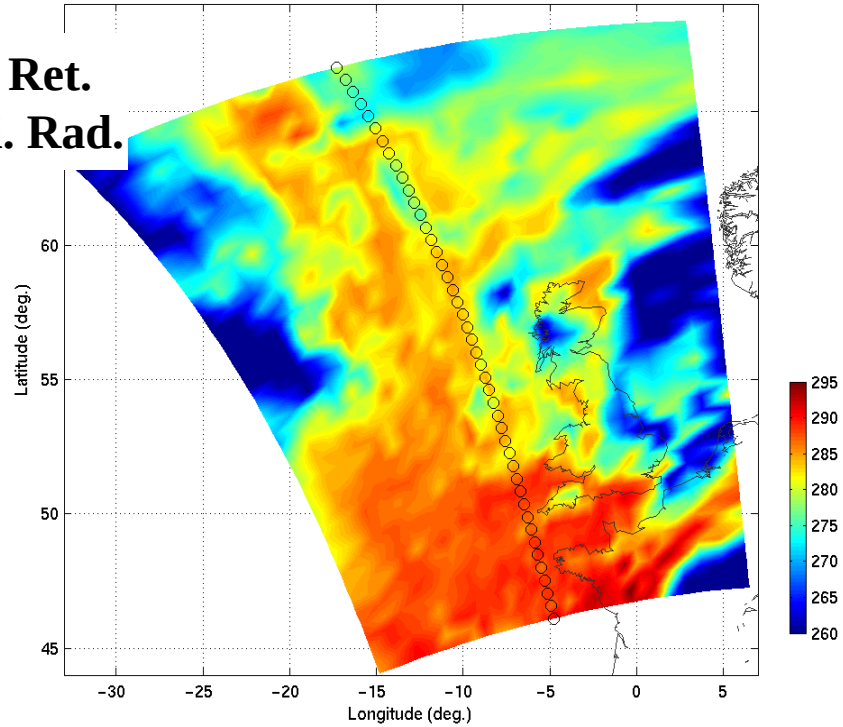


Surface Skin Temp. Inter-Comparison (04.09.14)

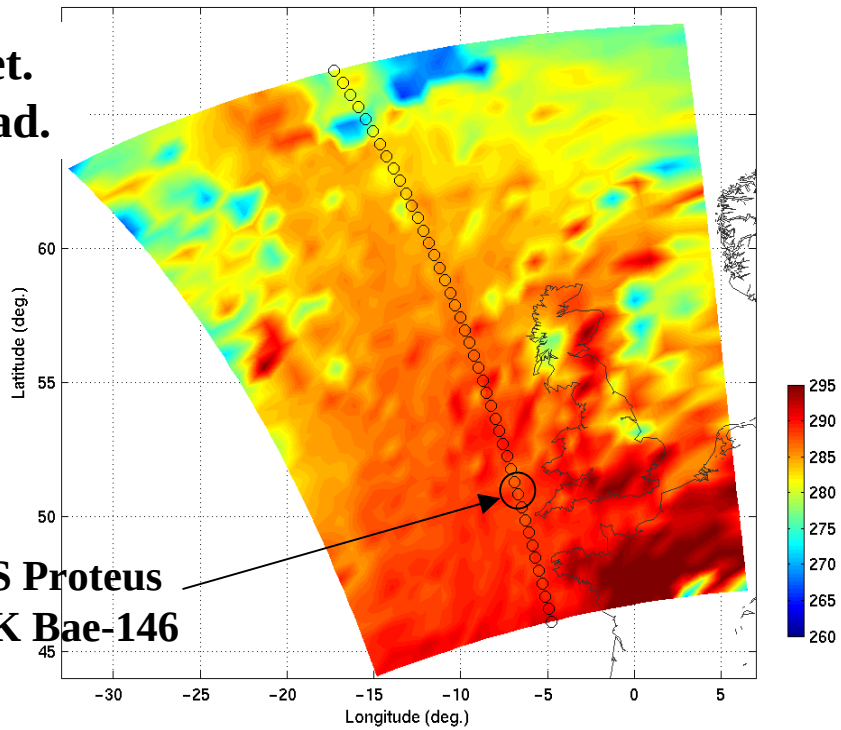
A-Team Ret.



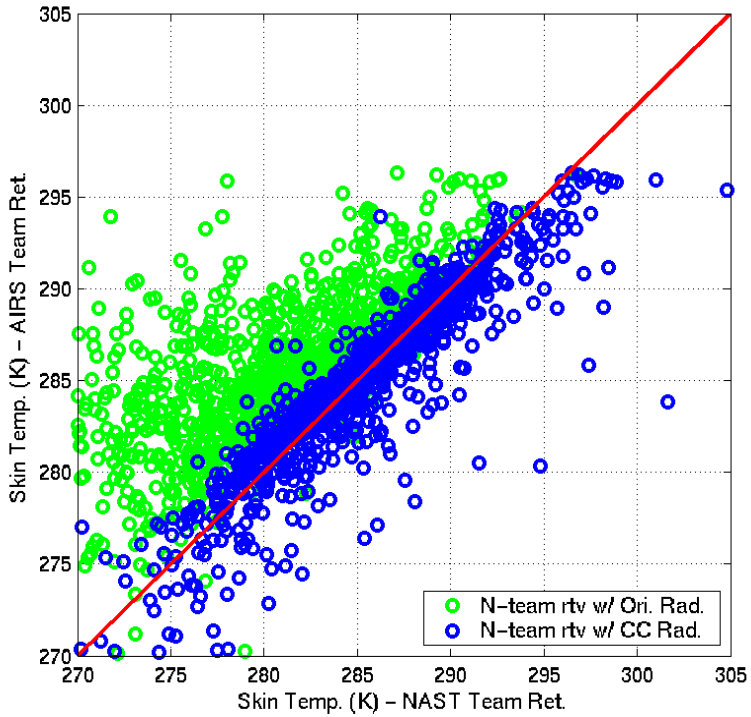
N-Team Ret. with Ori. Rad.



N-Team Ret. with CC Rad.

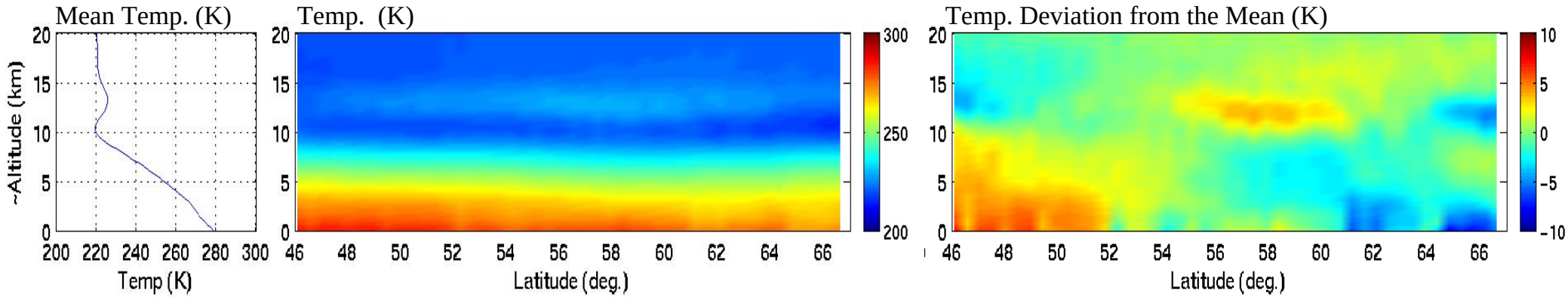


US Proteus
UK Bae-146

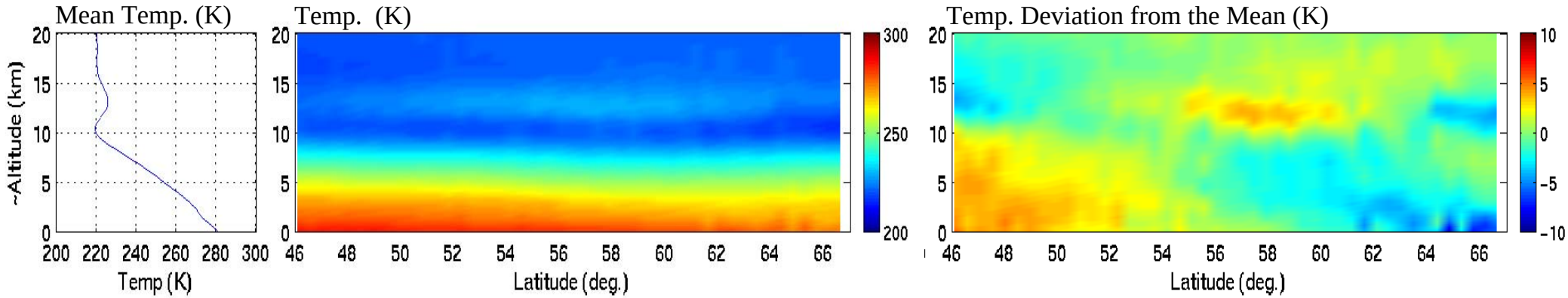


Temp. Cross Section Inter-Comparison (04.09.14)

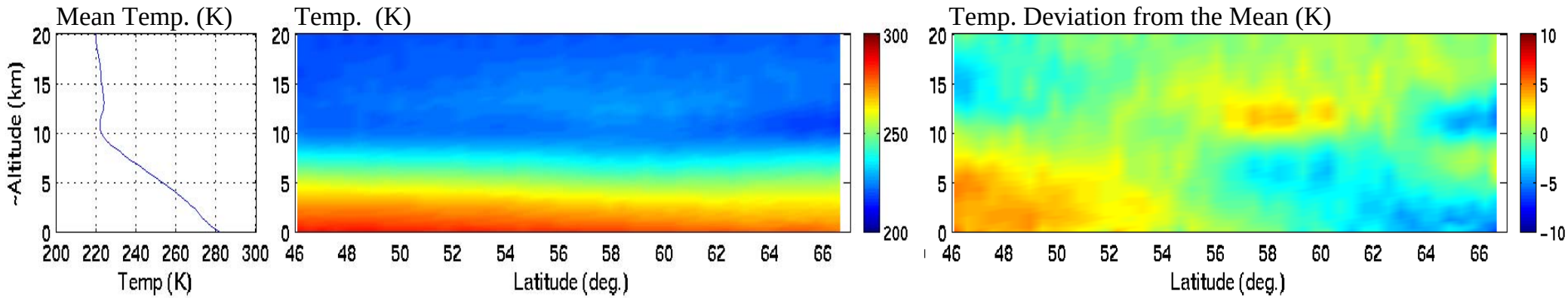
(1) NAST-Team Retrieval from Original Radiance



(2) NAST-Team Retrieval from Cloud Cleared Radiance

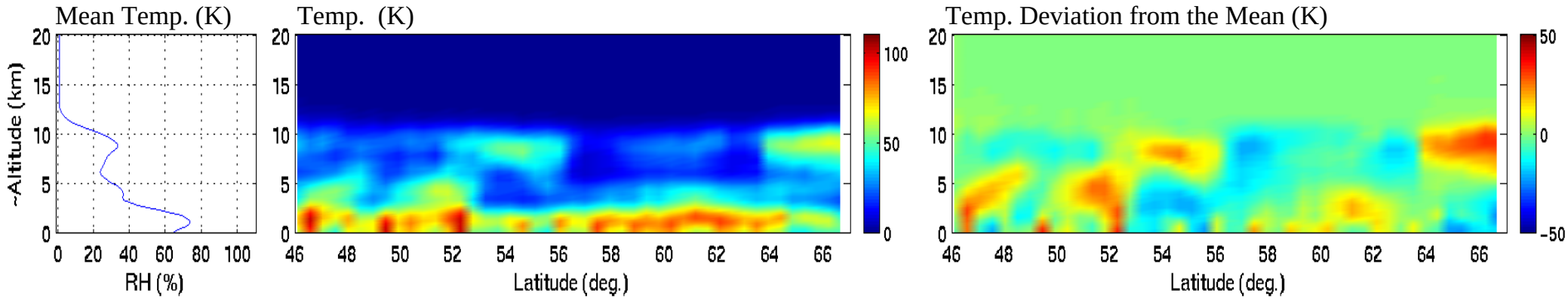


(3) AIRS-Team Retrieval from Cloud Cleared Radiance

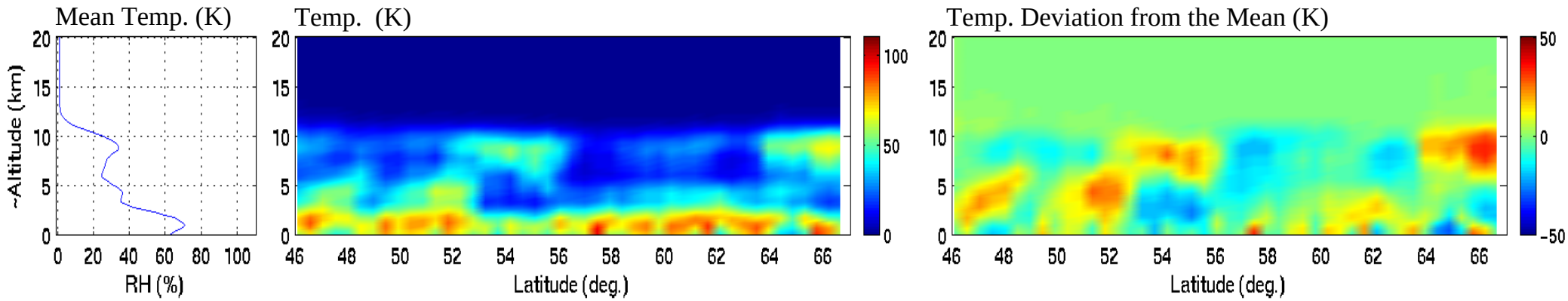


Moisture Cross Section Inter-Comparison (04.09.14)

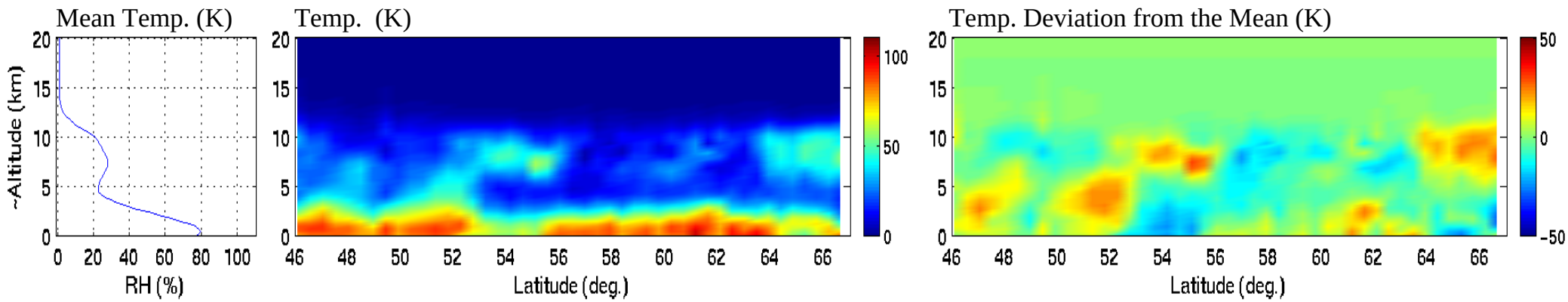
(1) NAST-Team Retrieval from Original Radiance



(2) NAST-Team Retrieval from Cloud Cleared Radiance

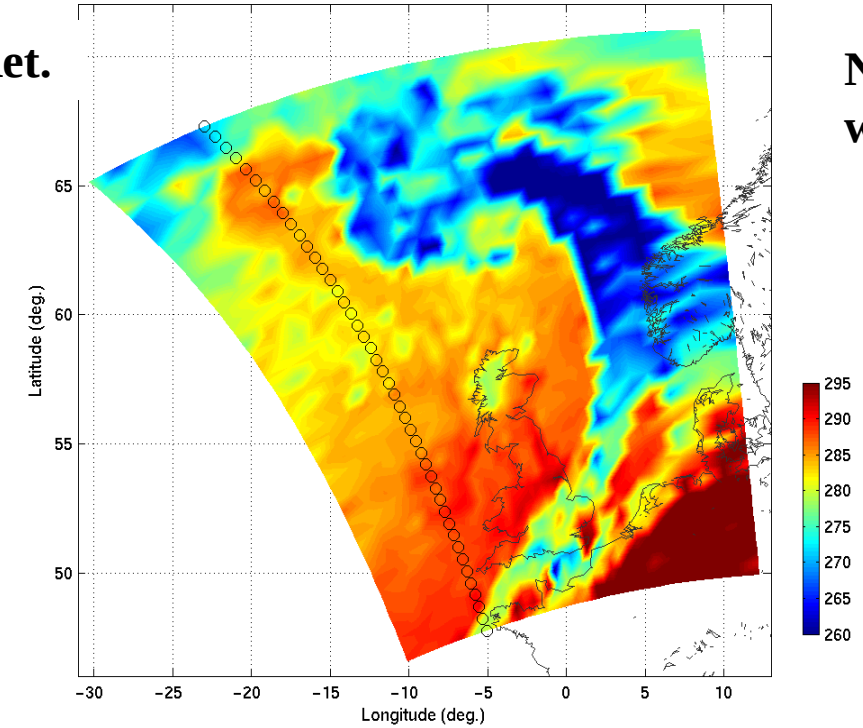


(3) AIRS-Team Retrieval from Cloud Cleared Radiance

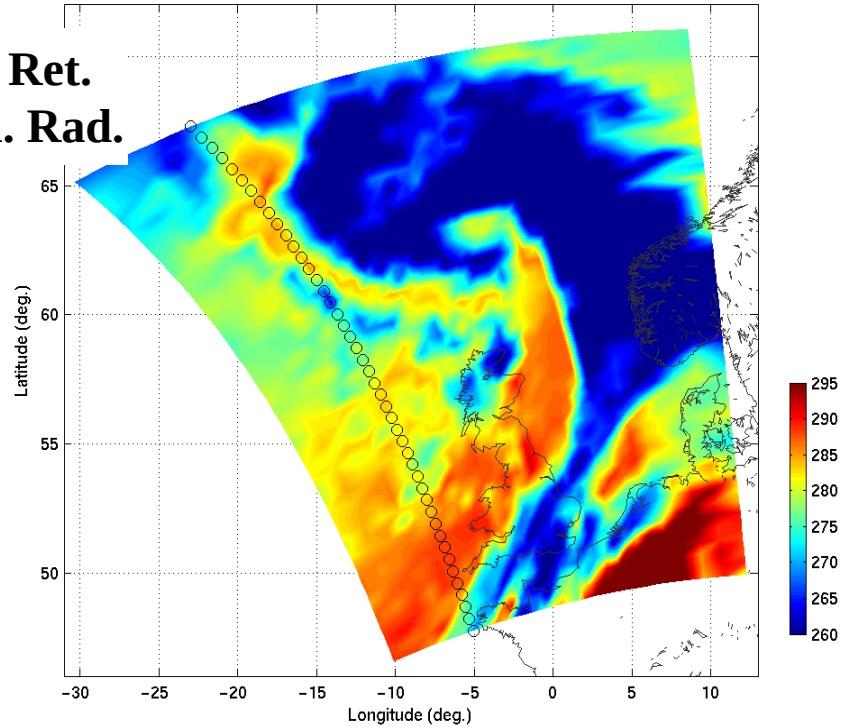


Surface Skin Temp. Inter-Comparison (04.09.18)

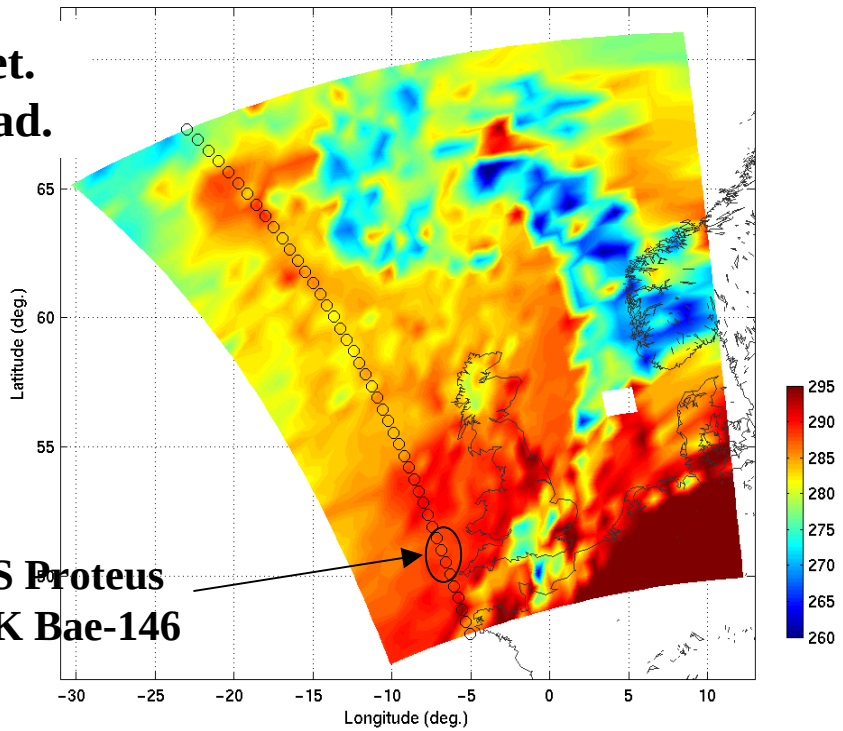
A-Team Ret.



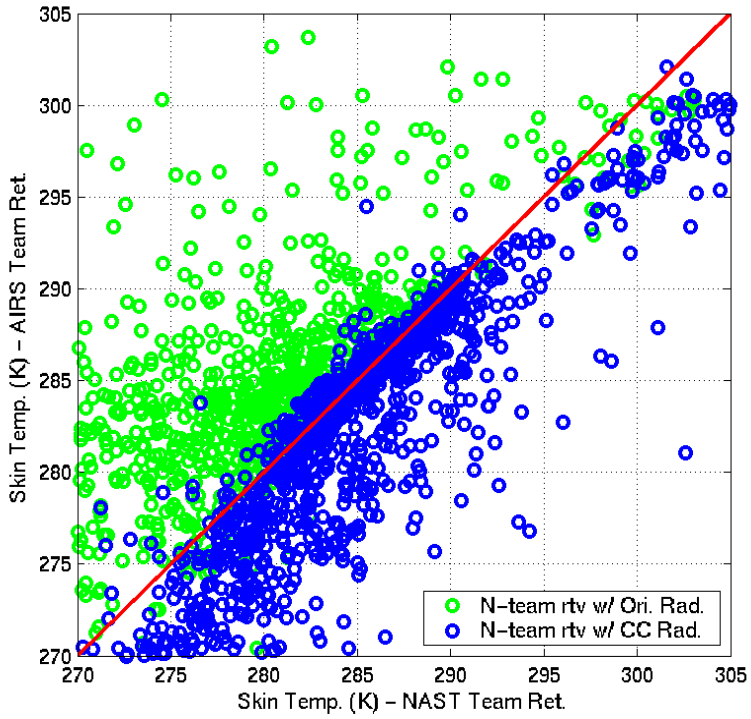
N-Team Ret. with Ori. Rad.



N-Team Ret. with CC Rad.

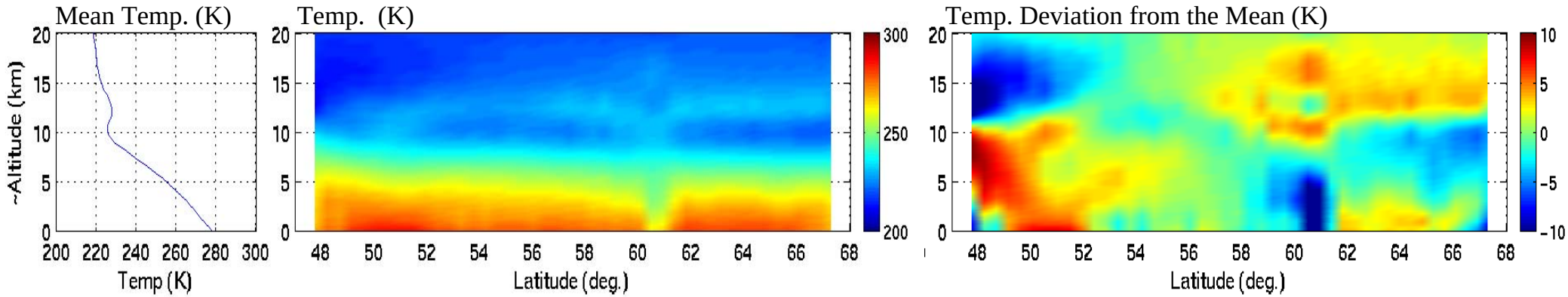


US Proteus
UK Bae-146

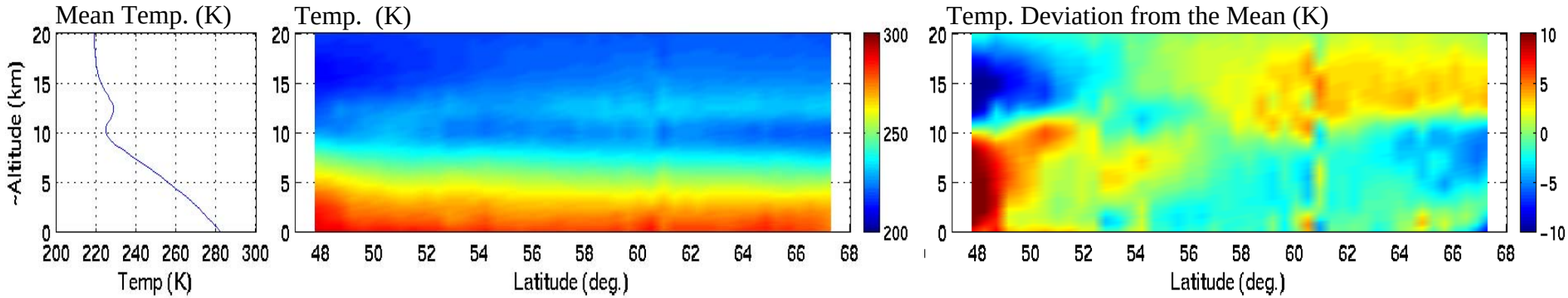


Temp. Cross Section Inter-Comparison (04.09.18)

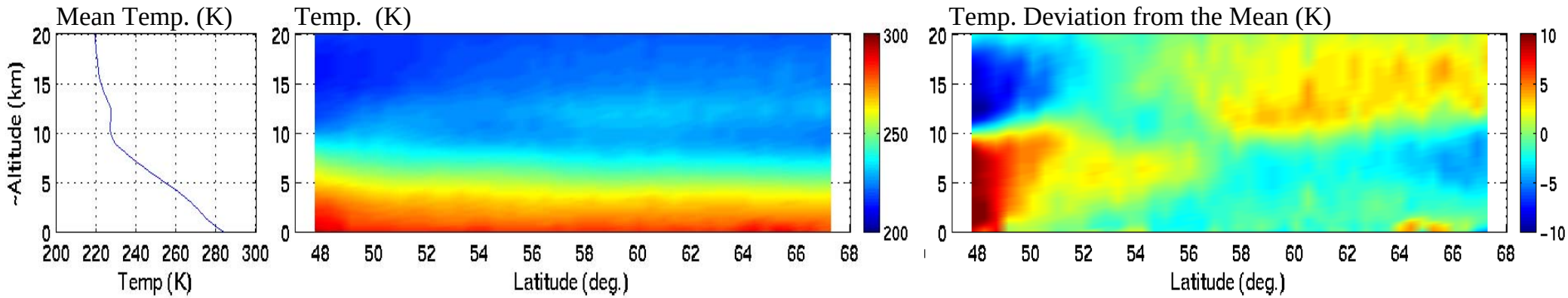
(1) NAST-Team Retrieval from Original Radiance



(2) NAST-Team Retrieval from Cloud Cleared Radiance

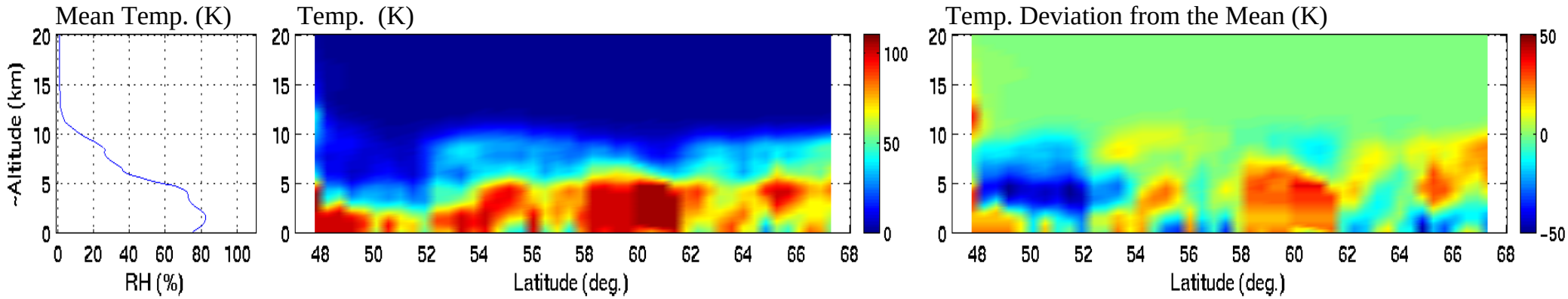


(3) AIRS-Team Retrieval from Cloud Cleared Radiance

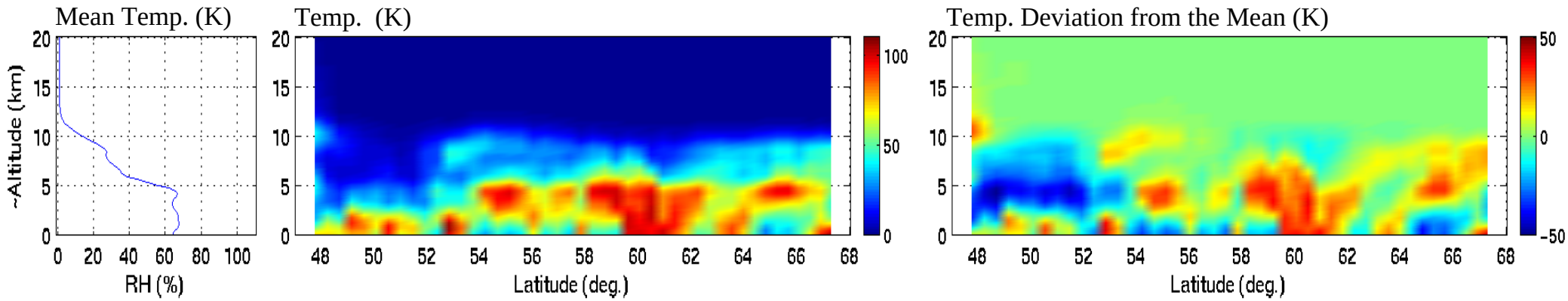


Moisture Cross Section Inter-Comparison (04.09.18)

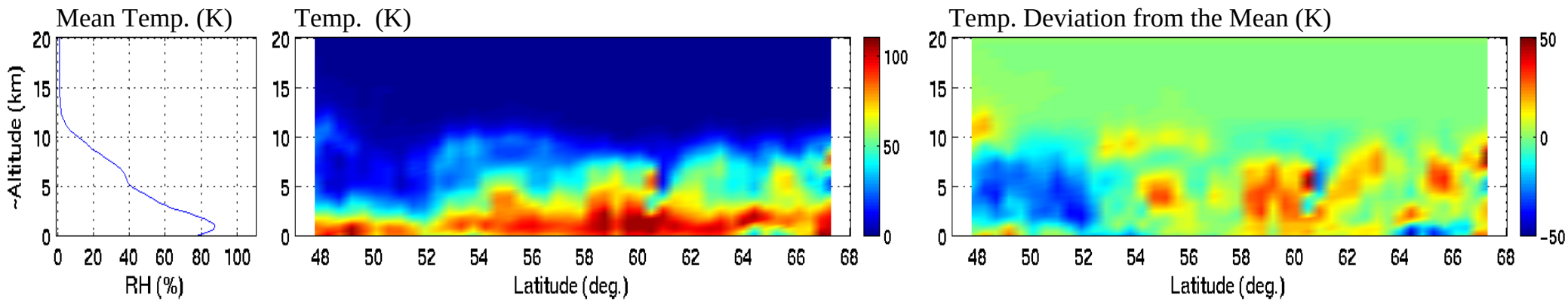
(1) NAST-Team Retrieval from Original Radiance



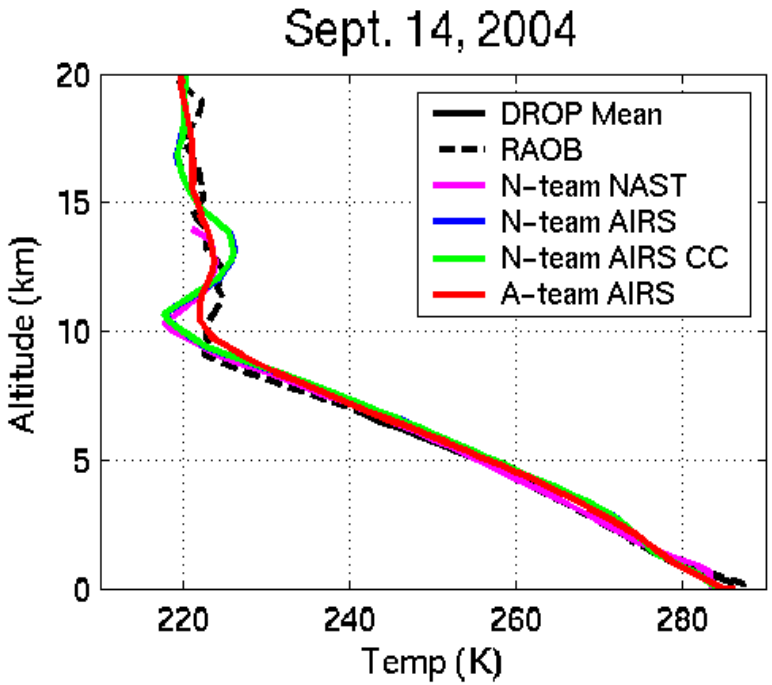
(2) NAST-Team Retrieval from Cloud Cleared Radiance

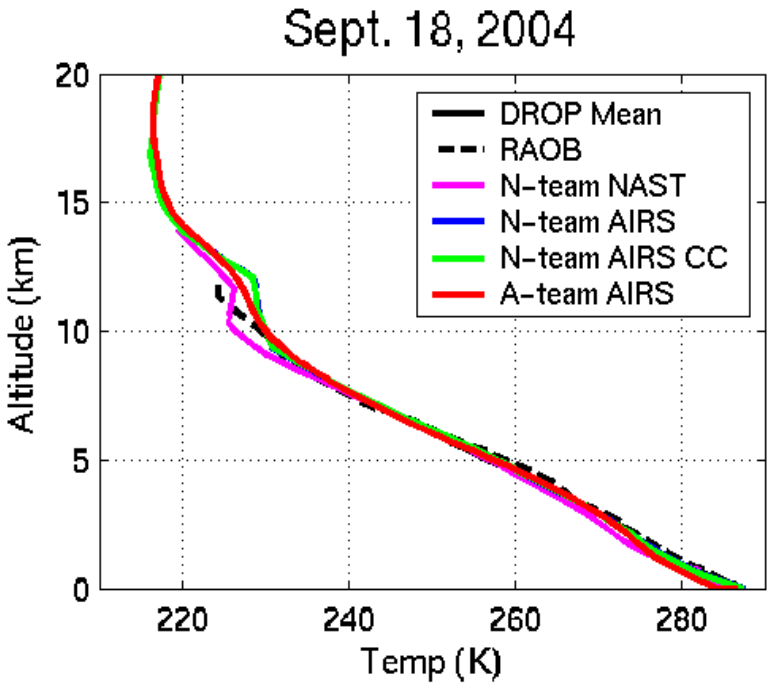


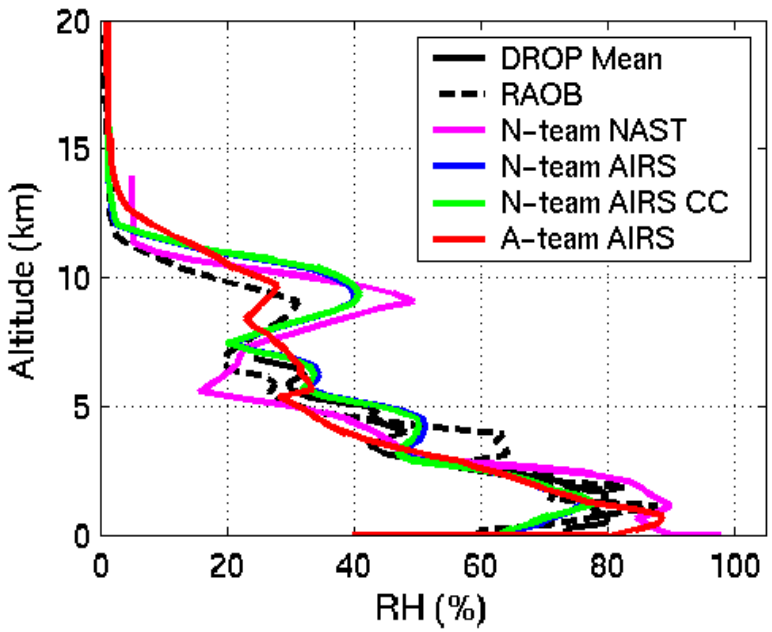
(3) AIRS-Team Retrieval from Cloud Cleared Radiance

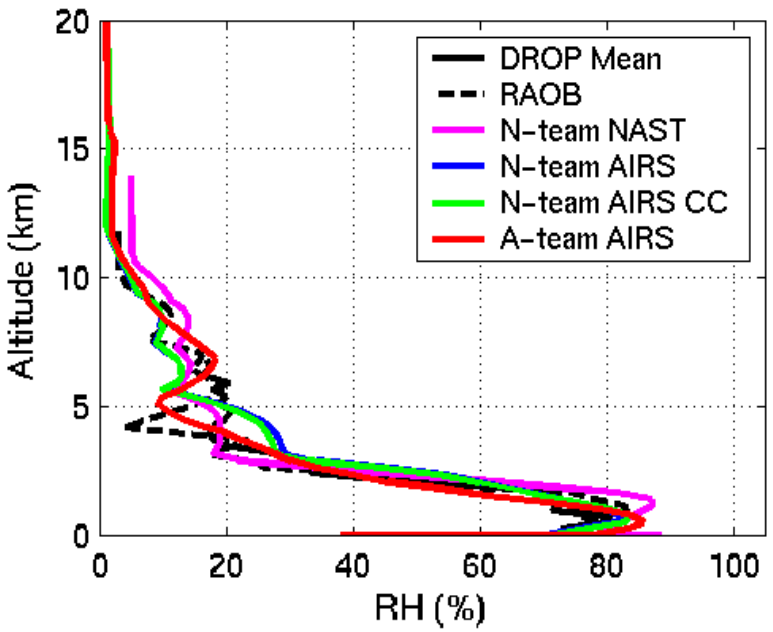


Sounding Inter-Comparison (04.09.14 vs. 04.09.18)









Retrieval Statistical Analysis between 2 Algorithms (1)

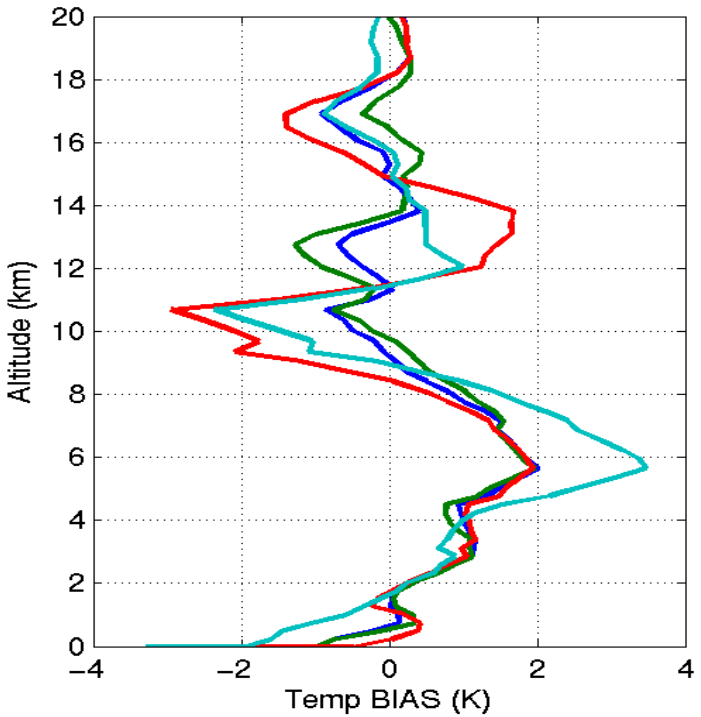
Using all the data in the granule; the results are affected by the cloud clearing error and surface emissivity error.

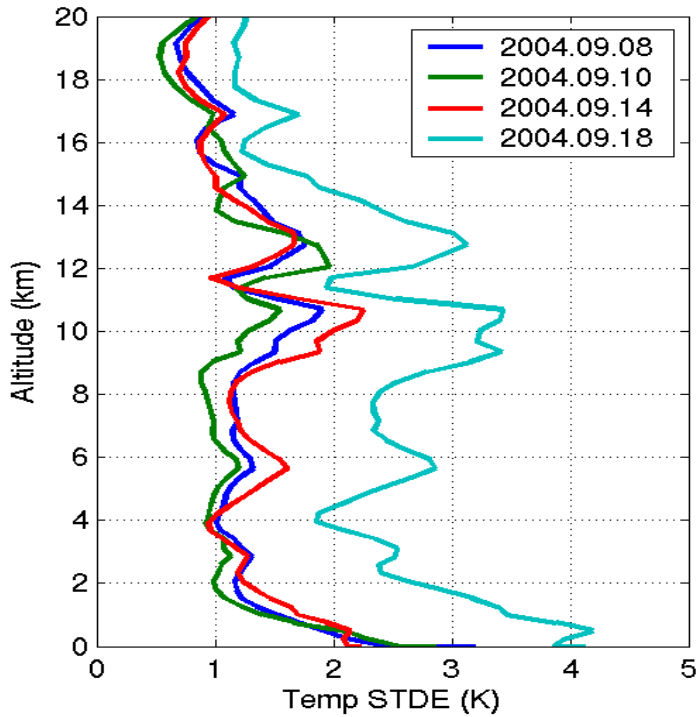
Temperature

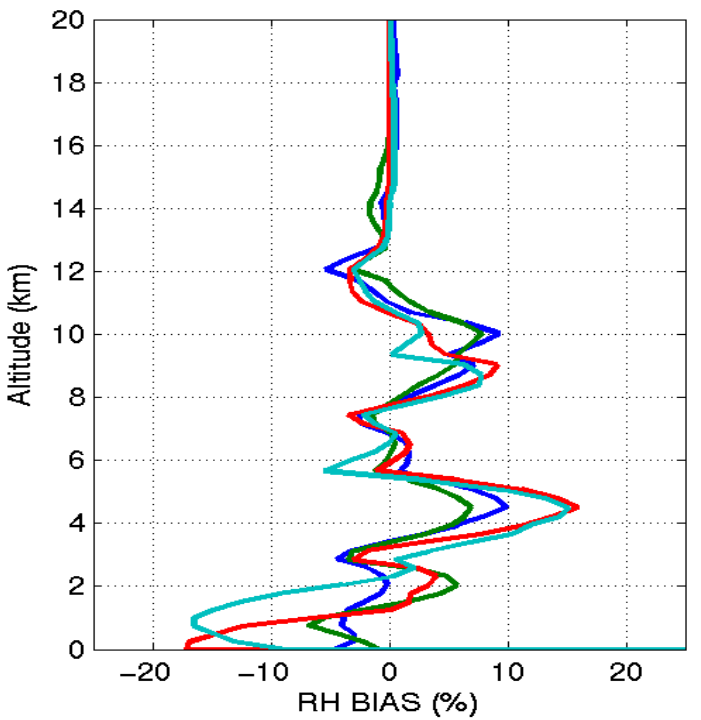
Moisture

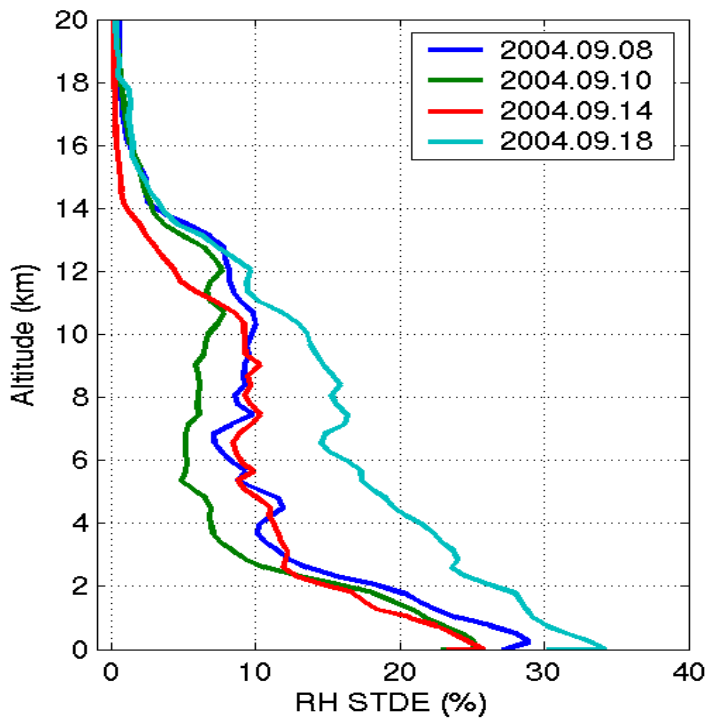
Surf. Skin Temp.

Date	BIAS(K)	STDE(K)
09.08	1.31	2.08
09.10	0.86	1.81
09.14	0.31	2.02
09.18	2.90	4.34

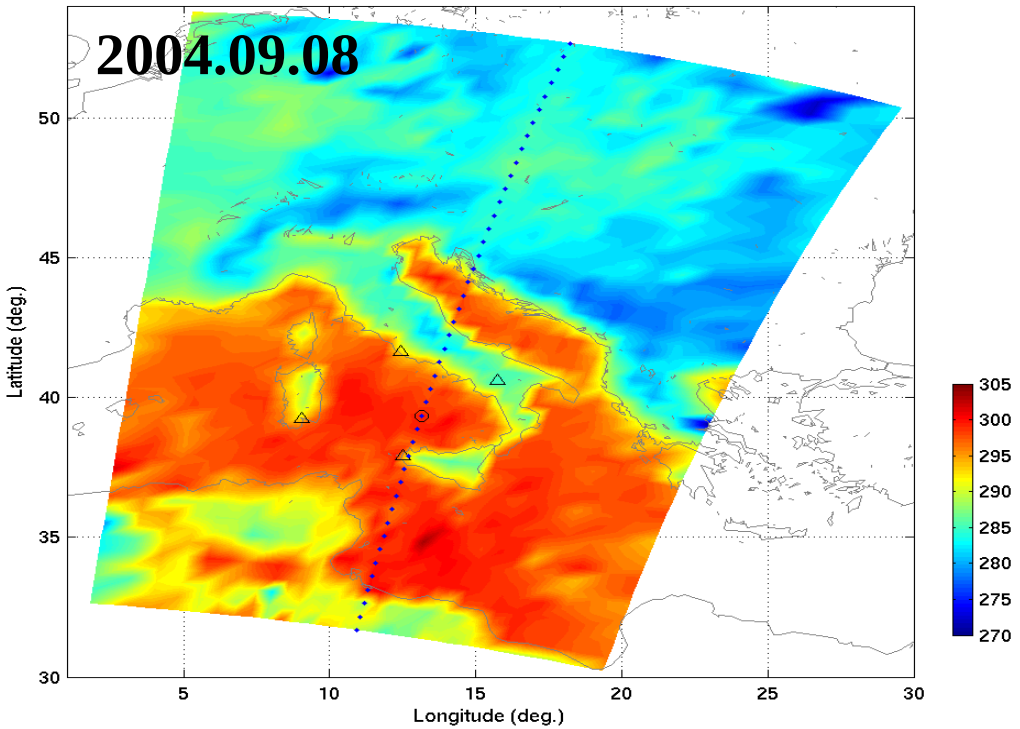


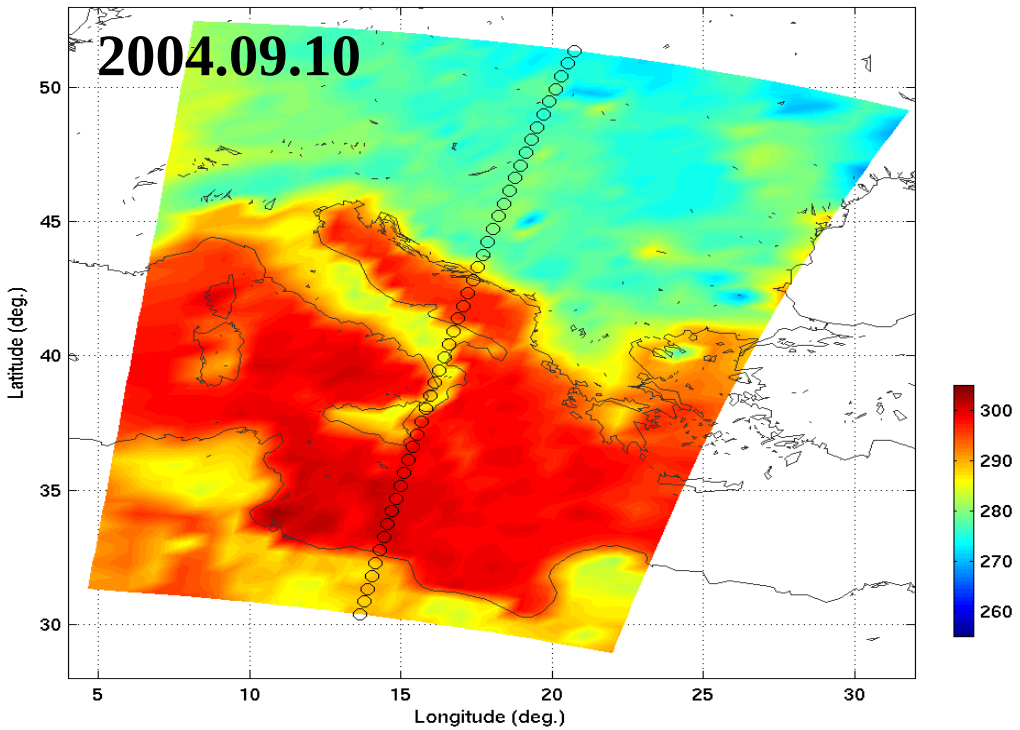


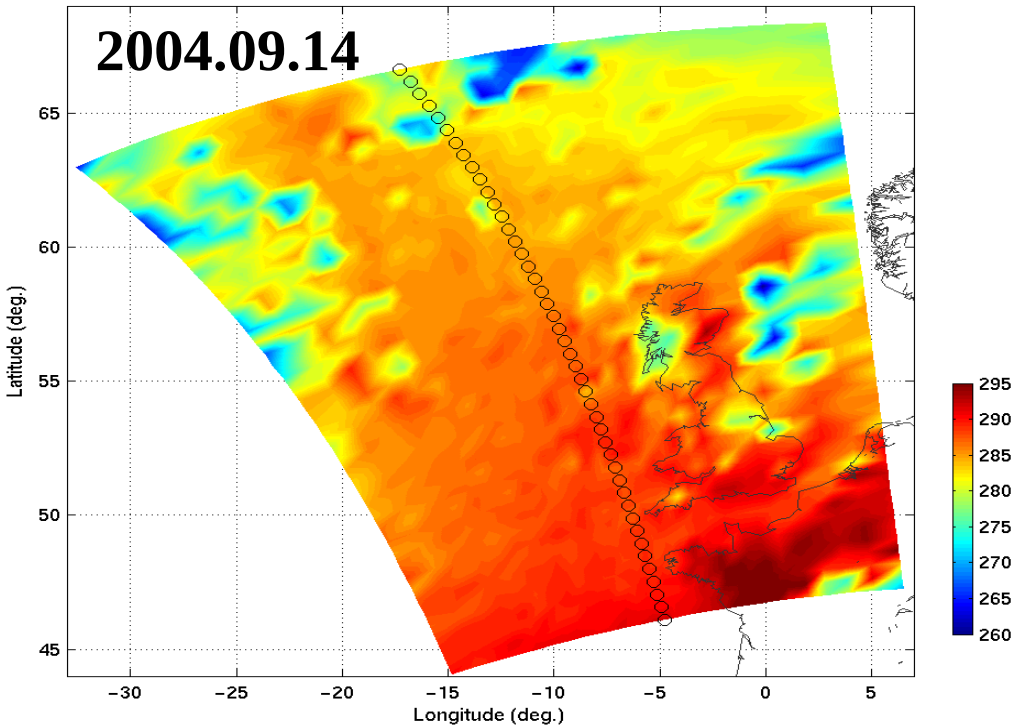


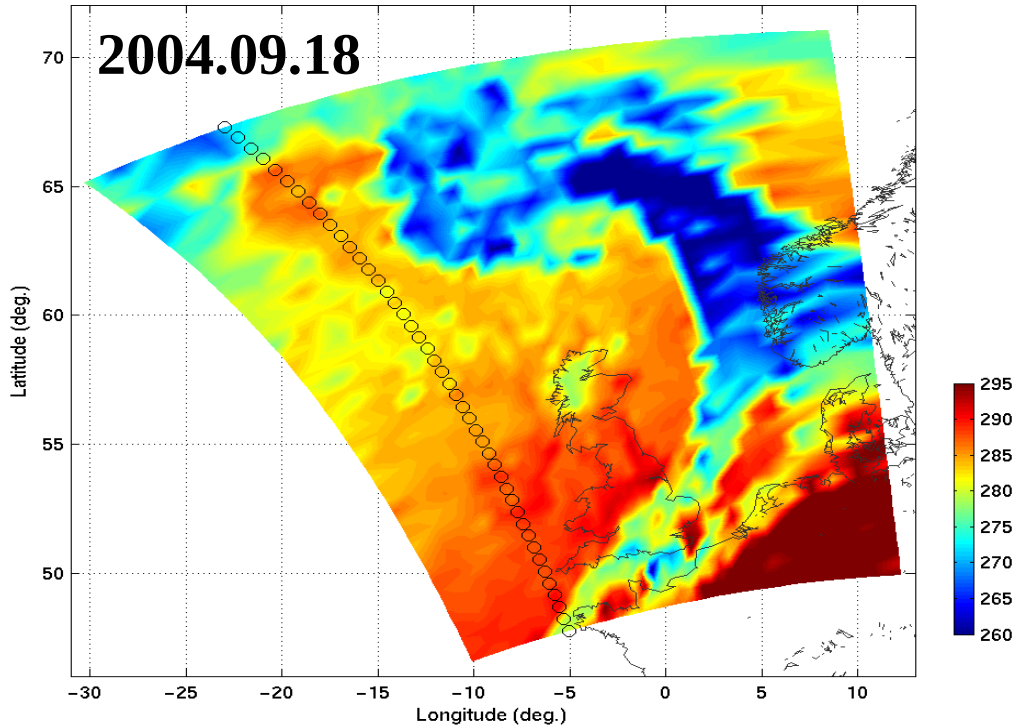


Surface Skin Temp. Retrieved from CC Radiance









Retrieval Statistical Analysis between 2 Algorithms (2)

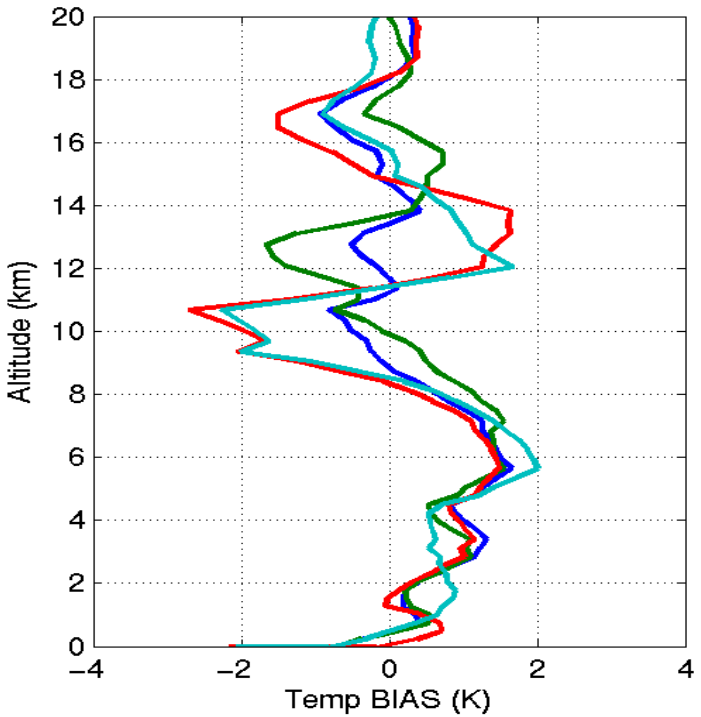
To avoid cloud clearing error: Ts>250K
To avoid emissivity error: ΔTs<1.0K;

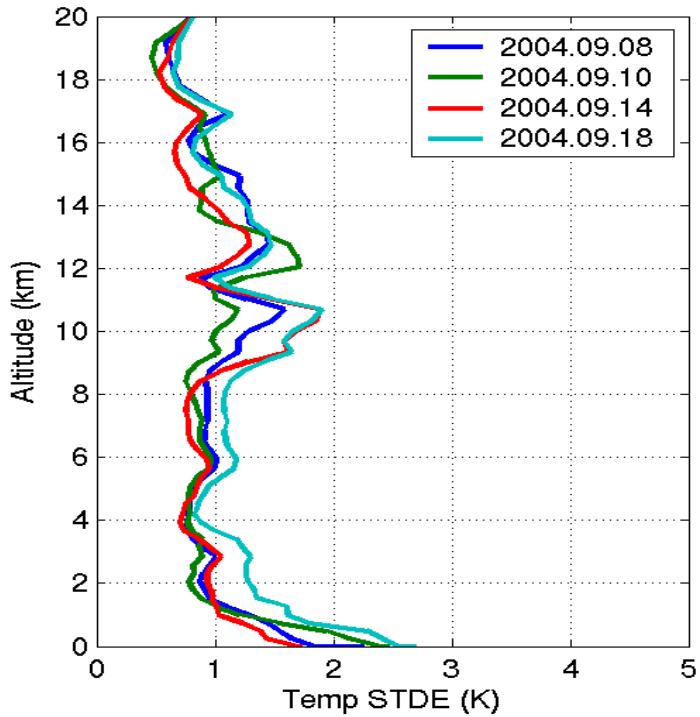
Temperature

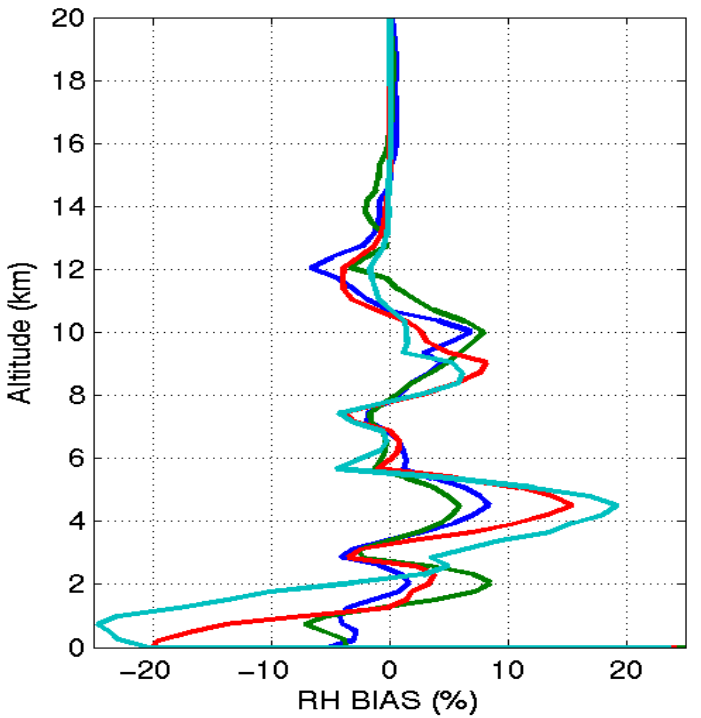
Moisture

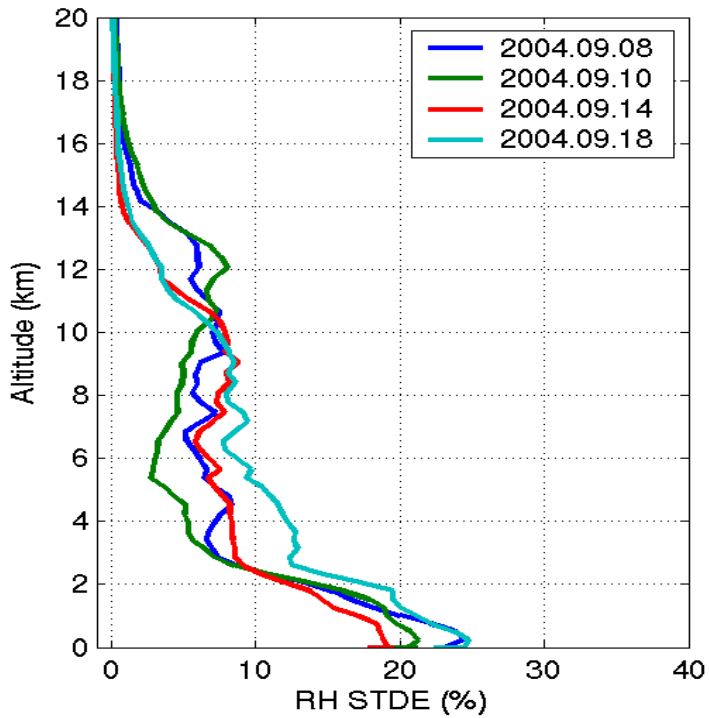
Surf. Skin Temp.

Date	BIAS(K)	STDE(K)
09.08	0.25	0.52
09.10	0.11	0.55
09.14	-0.07	0.51
09.18	0.11	0.52









Summary

- AIRS retrievals obtained from 2 inversion algorithms (AIRS-Team and NAST-Team) are used for retrieval algorithm inter-comparison.
- Retrievals of 2 instruments (AIRS and NAST-I) obtained by the NAST-Team retrieval algorithm are used for instrument performance inter-comparison.
- AIRS and NAST-I retrievals are compared with the radiosondes, dropsondes, aircraft in-situ measurements, and ground-based measurements (e.g., Lidar – on going efforts).
- Results show a general agreement between retrieval algorithms of AIRS team and NAST-I team (1K for temp. above the TBL and 2K in the TBL; 10% for RH above the TBL and 20% in the TBL).
- Results also show a good agreement between the retrieval products (AIRS and NAST-I) and radiosondes (and/or dropsondes).
- A similar atmosphere spatial variation was observed by both AIRS and NAST-I.
- AIRS surface skin temperature offset between two retrieval algorithms is more pronounced over the land – under investigation.

International TOVS Study Conference, 14th, ITSC-14, Beijing, China, 25-31 May 2005.
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,
Cooperative Institute for Meteorological Satellite Studies, 2005.