SRT Status and Plans for Version-7

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AIRS Sounder Science Team Meeting
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Outline

- Status of Version-6 at GSFC

  GSFC Version-6 must match JPL Version-6 before we can improve it

- Short-range plans – evolutionary improvements
- Mid-range plans – new thrusts

  Higher spatial resolution retrievals

  Cloud spectral emissivity

- Long-range plans – more challenging ideas

Accomplishments since November 2012 Meeting

- Delivered to Ed Olsen documentation for release of Version-6
- Delivered draft ATBD to JPL
- Version-6 development at JPL outpaced GSFC system – we are catching up
  - Neural Network first guess (Blackwell) installed
    - Neural-Net guess at SRT matches results at JPL
  - ECMWF based climatology (Manning) installed
  - MODIS climatological emissivity (Hulley, Manning) installed
  - Various limit checks (Manning) installed
- Some known code differences remain
  - Some previously unknown differences were found and corrected
    - More small differences probably still exist

Known Differences between GSFC and JPL V-6

- V-6 microwave RTA and microwave tuning*
- Use of dynamic noise in MW retrieval*
- Use of AMSU land fraction instead of AIRS to determine surface classification*
- Doppler shift in frequency adjustment
- Use of MODIS emissivity in polar regions

* Does not affect AIRS Only (AO) retrievals

One might expect differences in JPL and GSFC AO results to be smaller than AIRS/AMSU differences

Testing of GSFC Version-6

Approach

- Use same error estimate coefficients and QC thresholds we derived for JPL Version-6
- Compare JPL Version-6 and GSFC Version-6 yields and errors
  - The ability to match yields is a tight test of GSFC Version-6
- Compare spatial plots of JPL Version-6 and GSFC Version-6
  - Indicates spatial areas where results may differ
- Comparisons done in both AIRS/AMSU and AIRS Only modes
  - Shows importance of MW RTA and MW tuning differences
- These types of tests led John and Lena to identify and correct many small differences at JPL and SRT that led to differences in results
- The goal is to make JPL Version-6 and GSFC Version-6 essentially identical
- If the unchanged result at SRT is actually better, this change goes into Version-7 – we don't want to change Version-6

Surface Skin Temperature Difference from ECMWF
September 6, 2002 Version-6
Daytime and Nighttime Combined
50°N to 50°S Non-Frozen Ocean

AIRS/AMSU

	Mean	STD
JPL Climate	-0.33	0.96
GSFC Climate	-0.34	0.98
JPL DA	-0.32	0.86
GSFC DA	-0.31	0.88

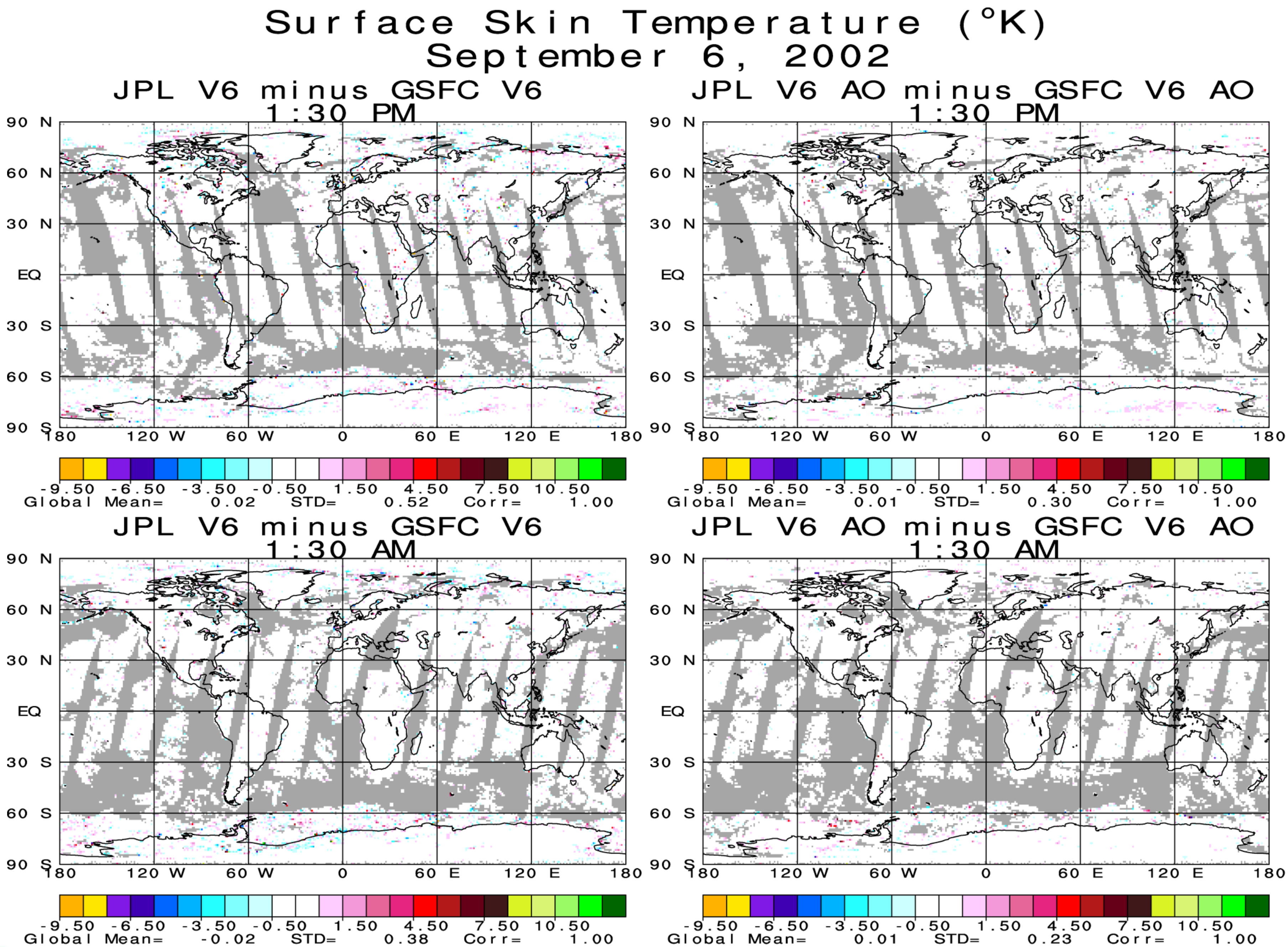
	% Cases	% Greater than |3| from Mean
JPL Climate	52.66	1.22
GSFC Climate	52.69	1.28
JPL DA	40.17	0.59
GSFC DA	40.14	0.68

AIRS Only

	Mean	STD
JPL Climate	-0.37	0.97
GSFC Climate	-0.37	0.97
JPL DA	-0.33	0.90
GSFC DA	-0.34	0.90

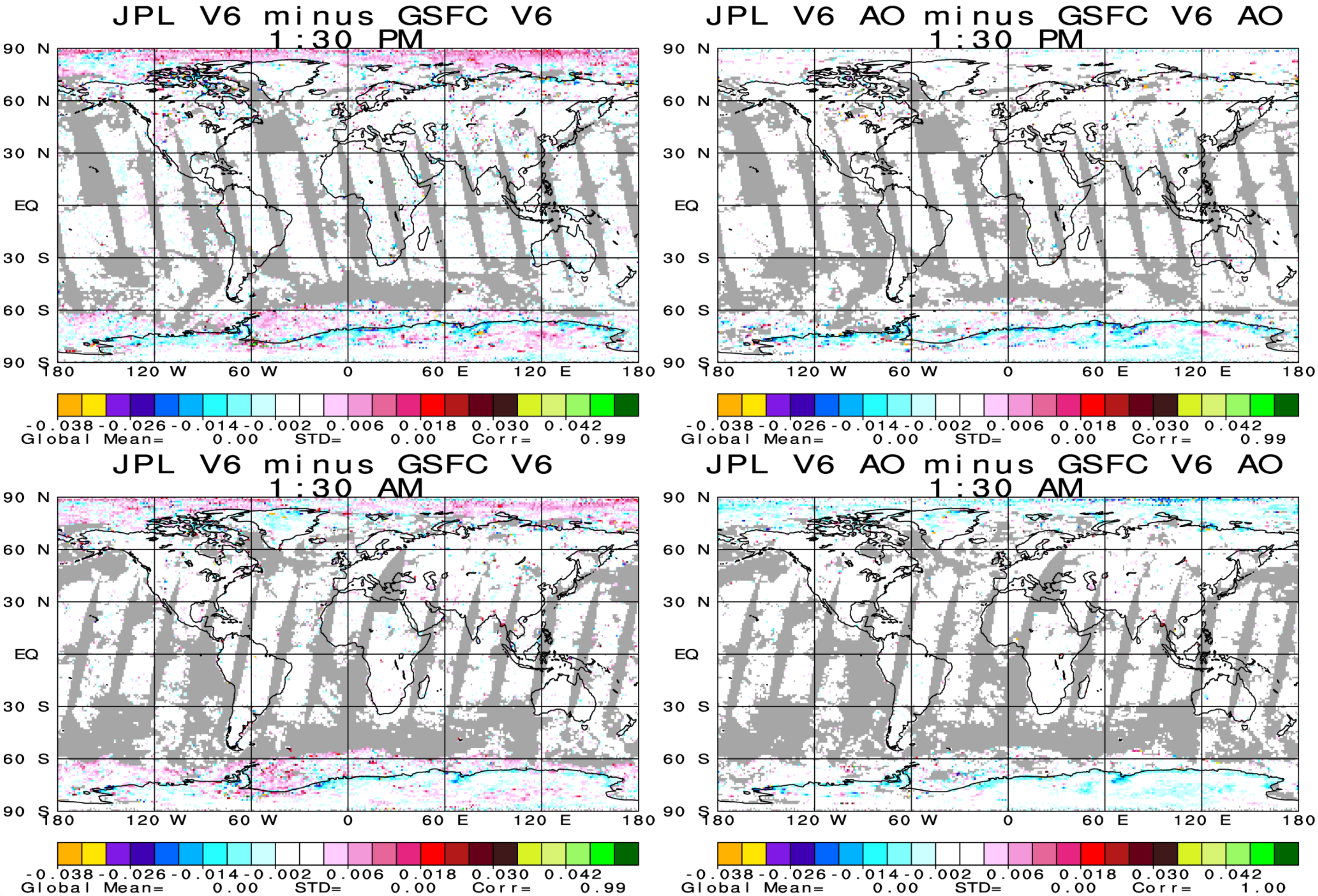
	% Cases	% Greater than |3| from Mean
JPL Climate	48.43	1.28
GSFC Climate	48.28	1.28
JPL DA	39.02	0.70
GSFC DA	38.89	0.70

AIRS/AMSU agreement is very good. AIRS Only agreement is even better.



Agreement of QC'd T_{skin} is excellent. Differences in AO are even smaller than in AIRS/AMSU.

AIRS Surface Emissivity at 2400 cm^{-1}
September 6, 2002



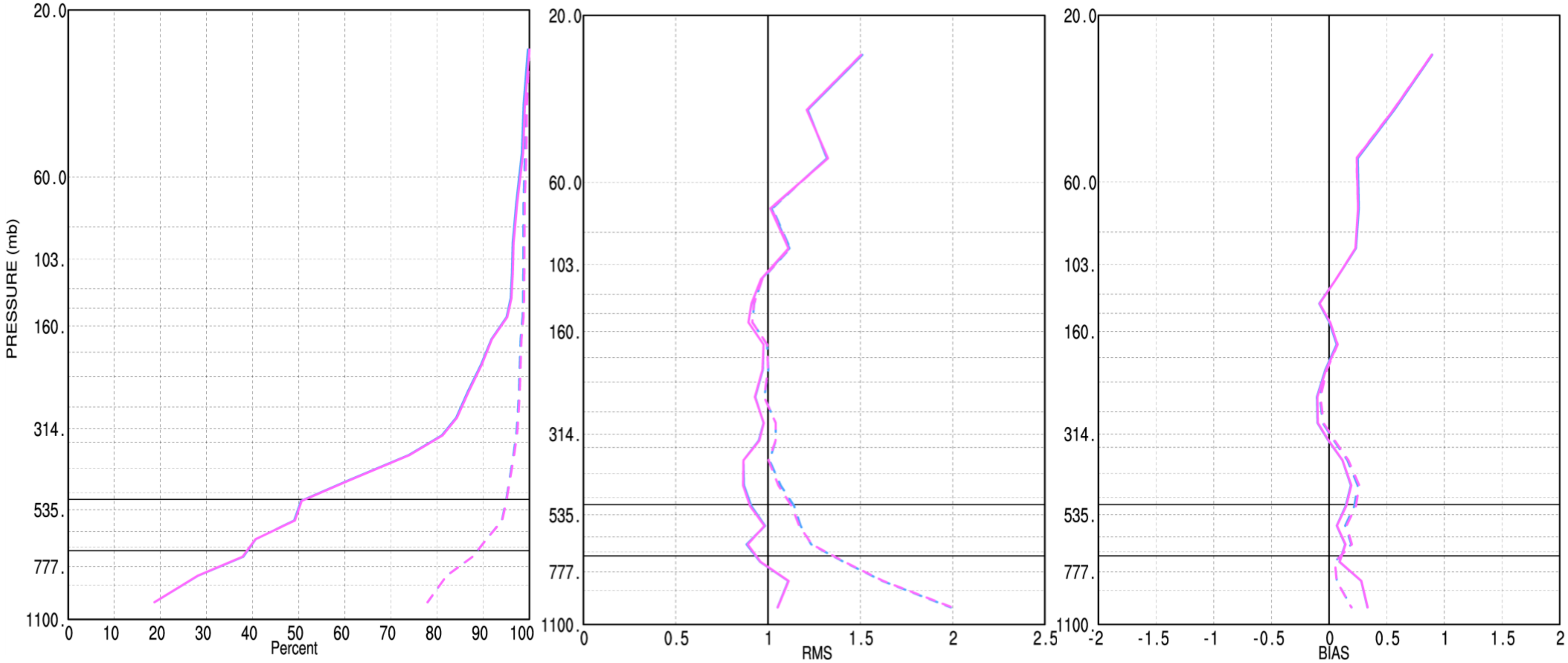
Agreement is very good - biggest differences near poles. AIRS Only agreement is better.

Global Temperature September 6, 2002 Statistics use their own QC

Percent of All Cases Accepted

Layer Mean RMS (°K) Differences from ECMWF

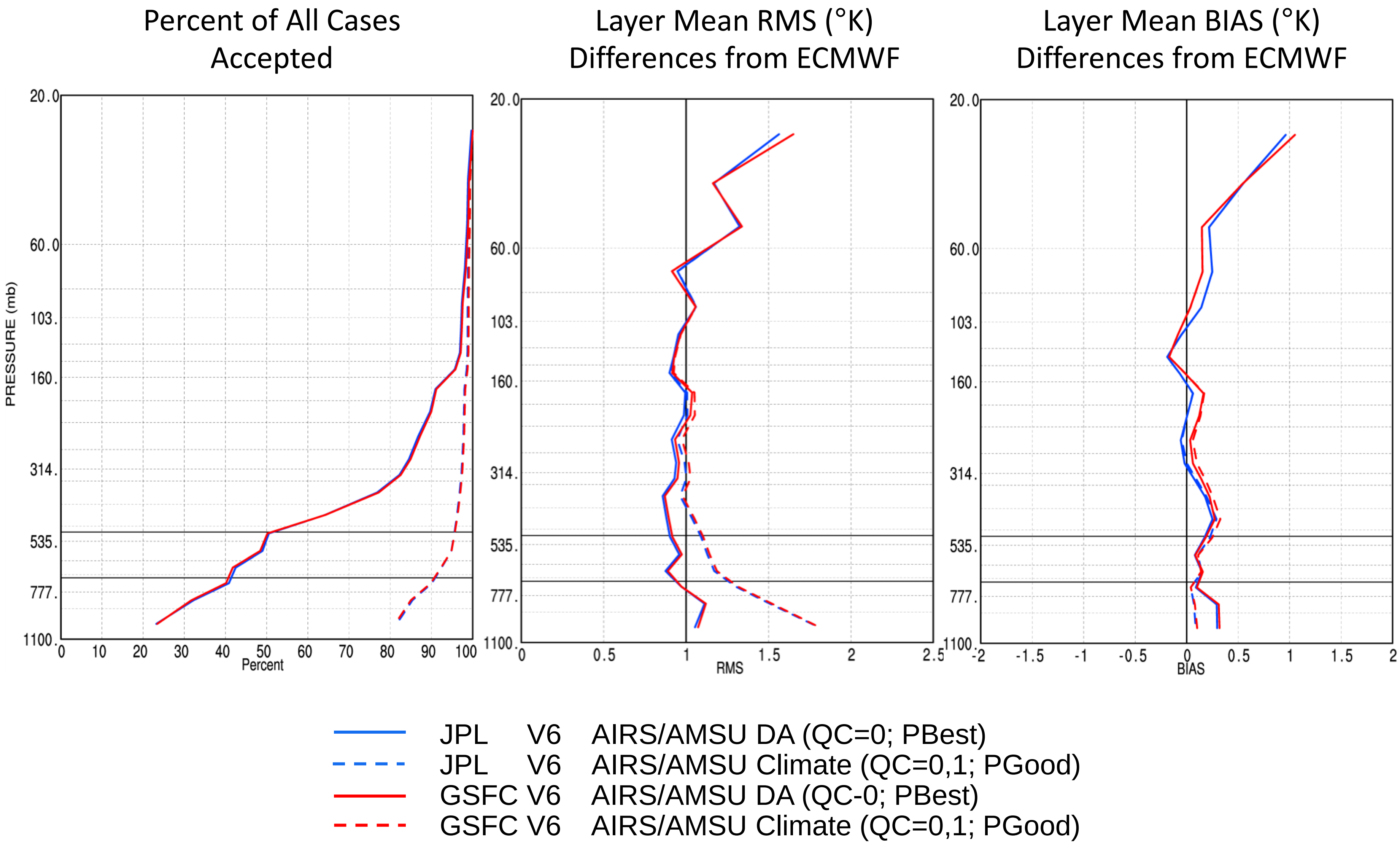
Layer Mean BIAS (°K) Differences from ECMWF



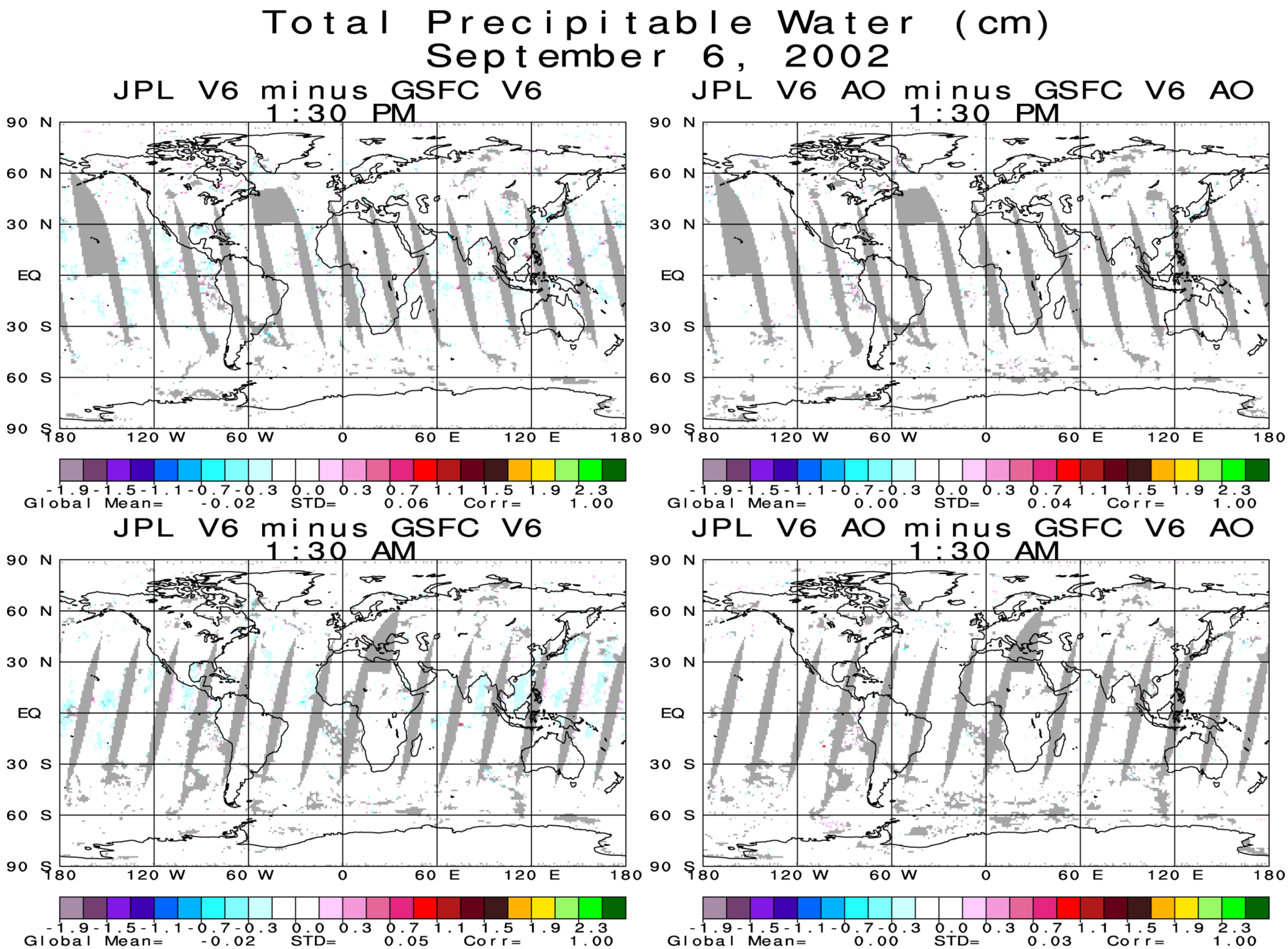
JPL V6 AIRS Only DA (QC=0; PBest)
JPL V6 AIRS Only Climate (QC=0,1; PGood)
GSFC V6 AIRS Only DA (QC-0; PBest)
GSFC V6 AIRS Only Climate (QC=0,1; PGood)

AIRS Only T(p) statistics are in perfect agreement.

Global Temperature September 6, 2002 Statistics use their own QC

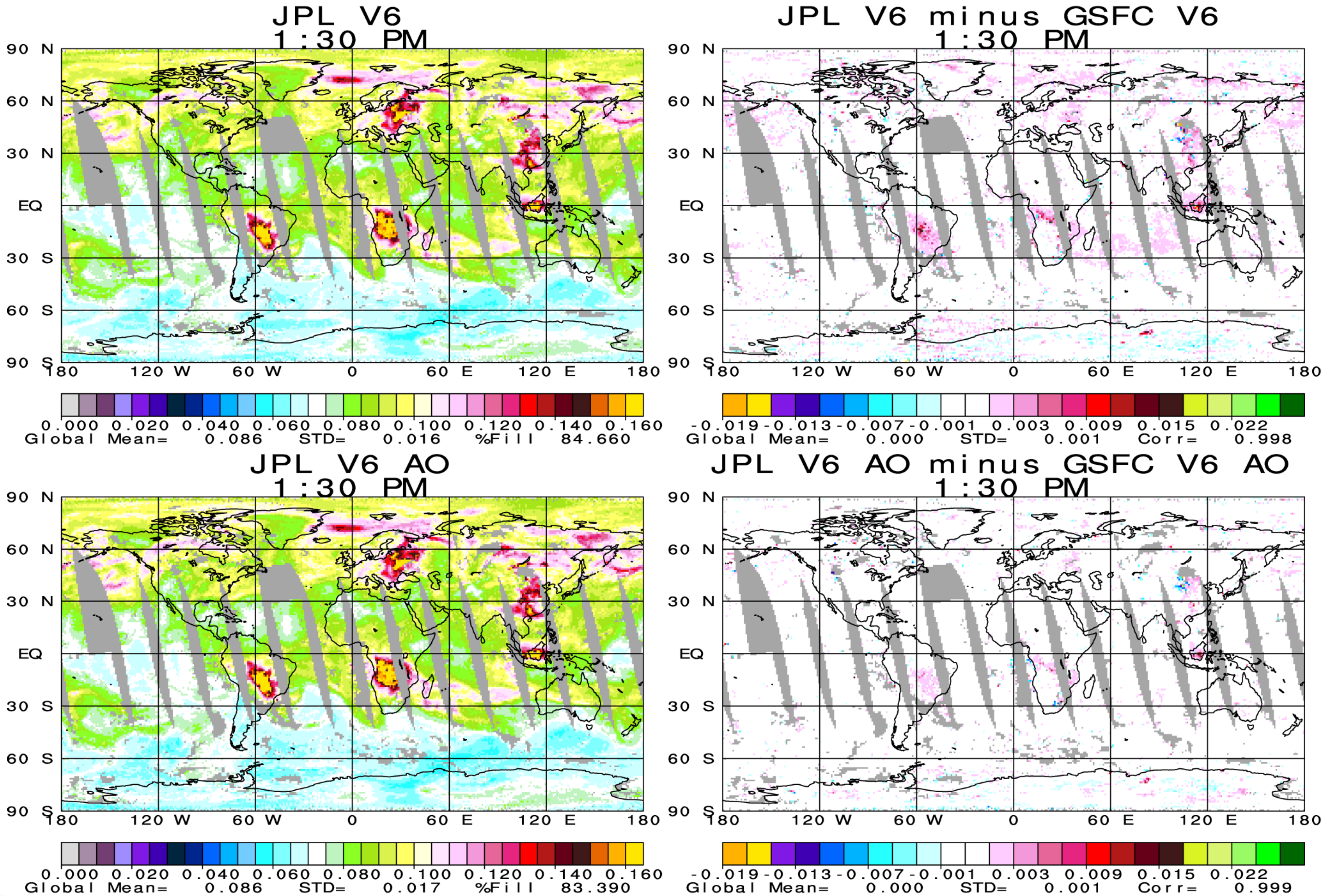


AIRS/AMSU T(p) statistics are in close agreement. Differences are the result of different MW RTA and tuning.



Total precipitable water agreement is very good. Differences are smaller in AIRS Only mode.

AIRS CO Average Mixing Ratio PPM
September 6, 2002



Agreement is total CO is very good. AO agreement is even better.

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Short Range SRT Plans for Version-7

- Differences between GSFC and JPL are very small
  - Congratulations to John and Lena!
- Resolve remaining discrepancies between GSFC and JPL Version-6
  - John expects to complete this by the end of June
  - This is critical for optimal development and testing of further improvements

Re-optimize details of retrieval steps

Most optimization was done using 2 regression start up state

q(p) retrieval has not been modified since Version-4

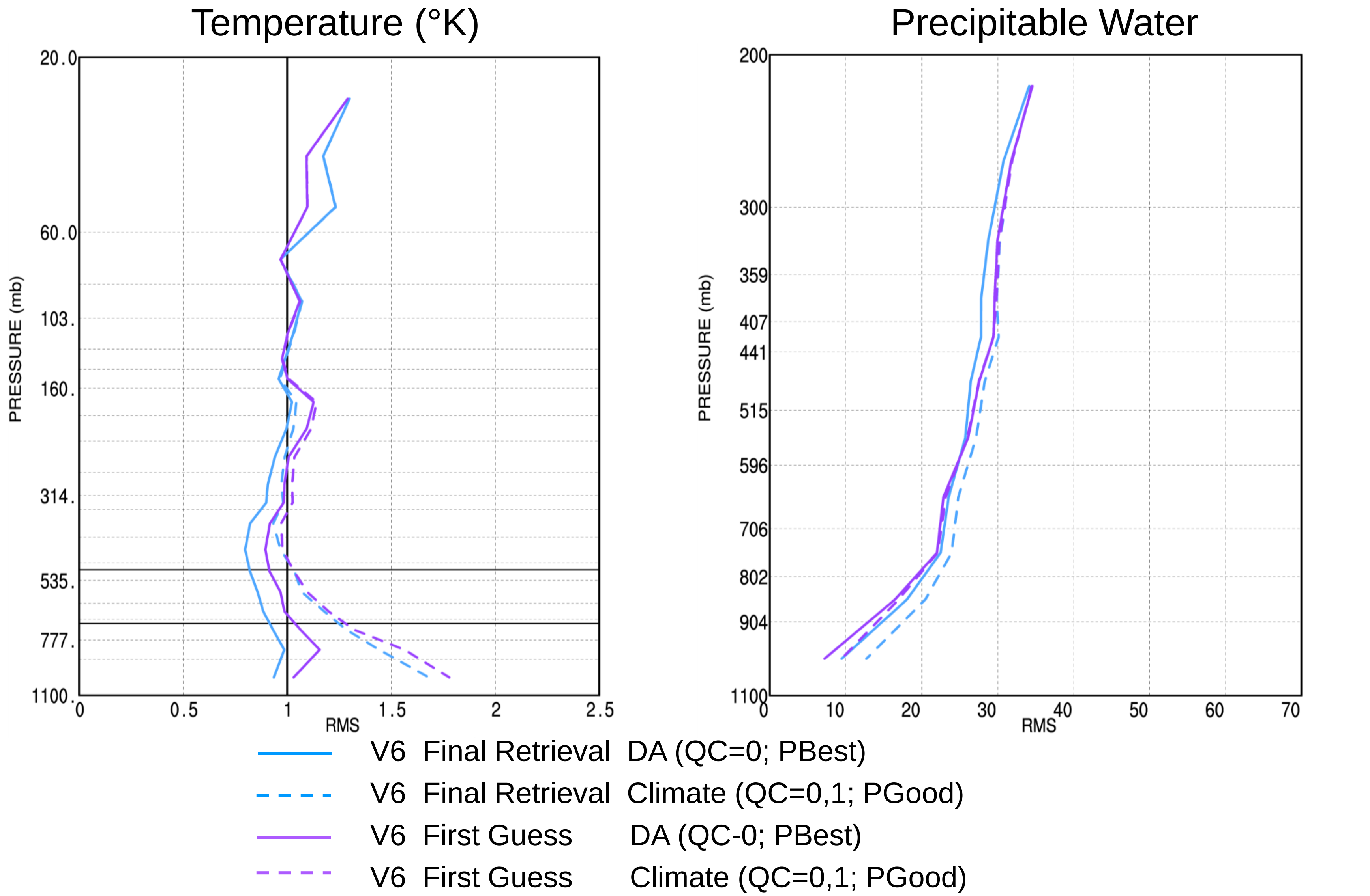
Current q(p) retrieval degrades Neural-Net guess

We will revisit channels, functions, and damping parameter

We will consider a second pass q(p) retrieval step

Not found useful in Version-5 and never tested in Version-6

Layer Mean Differences from ECMWF
9-Day Global Average



Physical retrieval improves T(p) Neural-Net guess. Physical retrieval degrades q(p) Neural-Net guess.

More Short Range SRT Plans for Version-7

We will evaluate the use of the difference in brightness temperature between 2 channels on and off weak CO_2 and H_2O lines as single pieces of information

- This decreases the contribution of uncertainties in cloud-clearing as well in the contribution of surface leaving radiance to the channel noise covariance matrix – may enhance sensitivity in boundary layer

- Improve temperature profile retrieval by using tropospheric 15 μm CO_2 channels that do not see clouds.

  Theory says that 15 μm CO_2 channels that see clouds should not be used in T(p) retrieval. Version-6 assures this by using only stratospheric sounding CO_2 channels in T(p) retrieval

  Many tropospheric 15 μm do not see clouds depending on the scene and can (should) be used in T(p) retrieval for that case

- Further stabilize cloud parameter retrievals

Mid Range Plans for Version-7- Higher Resolution (HR) Retrievals

- Implement 1 (cross track) x 3 (along track) FOV retrieval system

  This triples the spatial resolution and density of the AIRS soundings

Cloud clearing allows for up to two cloud formations in FOR

	Nadir FOR	Largest Zenith Angle FOR
Version-6	40.6 km x 40.6 km	115.0 km x 63.3 km
HR	13.5 km x 40.6 km	38.3 km x 65.3 km

Cloud clearing should improve, especially over land, because spatial variability of T_{skin}, ε_{ν}, q(p) is less in FOR

Retrievals should also improve, especially over land, because quantities to be retrieved vary less in FOR

Boundary layer temperature and boundary layer water vapor should improve as well

SRT will investigate generation of 0.5 degree x 0.5 degree level-3 products using HR system

Mid Range SRT Plans for Version-7 Cloud Spectral Longwave Cloud Spectral Emissivity

Version-6 uses 57 channels to retrieve cloud parameters for each of two cloud layers k=1,2 for each AIRS Field of View (FOV)

$\alpha\varepsilon_1$, pc_1, $\alpha\varepsilon_2$, pc_2

where $\alpha\varepsilon_k$ is the product of a spectrally independent cloud emissivity and the geometric fractional cloud cover for a cloud at pressure pc_k as seen from above

We plan to determine a cloud spectral emissivity ratio $\alpha\varepsilon_\nu/\alpha\varepsilon^\circ$ for the upper level cloud in a form analogous to longwave surface spectral emissivity – surface retrieval uses 77 channels

This can be done either

- Sequentially after current cloud retrieval step, using the current 77 surface longwave emissivity channels or
- Concurrently with cloud retrieval using 57 channels + 77 channels (134) channels

Cloud spectral emissivity will be used in spectral OLR calculation

Longer Term Plans

1) Including CO_2 retrieval as part of retrieval process

   CO_2 retrieval is currently a post processing step

   Does not interact with anything else

   We plan to work with Ed Olsen to examine feasibility of:

   - doing CO_2 retrieval after pass 1 and using retrieved CO_2 in recomputation of T(p), OLR, everything else
   - This is a big if: attempting coupled CO_2, T(p) retrieval

     Mous said this cannot be done – I am not so sure

2) Incorporating dust retrieval as part of retrieval process

   - Including dust score as part of error estimate procedure

     Could help flag poor dusty retrievals

   - Including dust into the RTA used in second pass

     Could potentially improve retrievals in dusty cases