Comparative Results of AIRS/AMSU and CrIS/ATMS Retrievals Using a Scientifically Equivalent Retrieval Algorithm

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Objective

The AIRS Science Team Version 6 retrieval algorithm is currently producing high quality level-3 Climate Data Records (CDRs) from AIRS/AMSU which are critical for understanding climate processes. The AIRS Science Team is finalizing an improved Version-7 retrieval algorithm to reprocess all old and future AIRS data. AIRS CDRs should eventually cover the period September 2002 through at least 2020

CrIS/ATMS is the only scheduled follow on to AIRS/AMSU

The objective of this research is to prepare for generation of a long term CrIS/ATMS level-3 data using a finalized retrieval algorithm that is scientifically equivalent to AIRS/AMSU Version-7.

Success Metric

- Agreement of AIRS/AMSU and CrIS/ATMS monthly mean fields with each other, and even more importantly, agreement of interannual differences of monthly mean fields.

Background

Last year at this meeting, I presented results comparing AIRS/AMSU and CrIS/ATMS retrievals using Version-6.22. The CrIS/ATMS level-1b data used was generated by the IDPS. The ATMS level-1b data was brightness temperatures, T_B, resampled to the CrIS footprints. There is now a new source of CrIS/ATMS level-1 data generated by U. Wisc/JPL. The new ATMS level1-b data is antenna temperatures, T_A.

We continue to make improvements in our AIRS/AMSU retrieval methodology. The latest scientific version we use for both AIRS/AMSU and CrIS/ATMS is called Version-6.28, which now runs at JPL for both AIRS/AMSU and CrIS/ATMS. JPL plans to generate many months in common of AIRS Version-6.28 and CrIS Version-6.28 data products, or possibly products using further improved versions of each retrieval system, for comparison purposes. JPL CrIS/ATMS retrievals will use ATMS T_A's. The results we show today also use ATMS T_A's.

Major Improvements in Version-6.28 Over Version-6

Version-6.28 is very much like Version-6 with some modifications in details. The major improvements are listed below.

- AIRS Version-6.28 retrievals of $O_3(p)$ have improved considerably compared to AIRS Version-6, both with regard to accuracy and Quality Control (QC) methodology.
- AIRS Version-6.28 retrievals of *q(p)* have also improved considerably compared to Version-6, especially during the day.

Quality Control

Version-6.28 has QC flags for all parameters. Level-3 products include all cases passing climate QC (QC=0 or QC=1). All results presented today are for cases passing climate QC.

First guesses used in the retrieval

First guesses for *T(p)* and *q(p)* use Neural-Net methodology with coefficients trained once and for all early in the AIRS/AMSU and CrIS/ATMS missions. The $O_3(p)$ first guess is zonally averaged monthly mean climatology. All longitudinal $O_3(p)$ structure comes from the retrieval process.

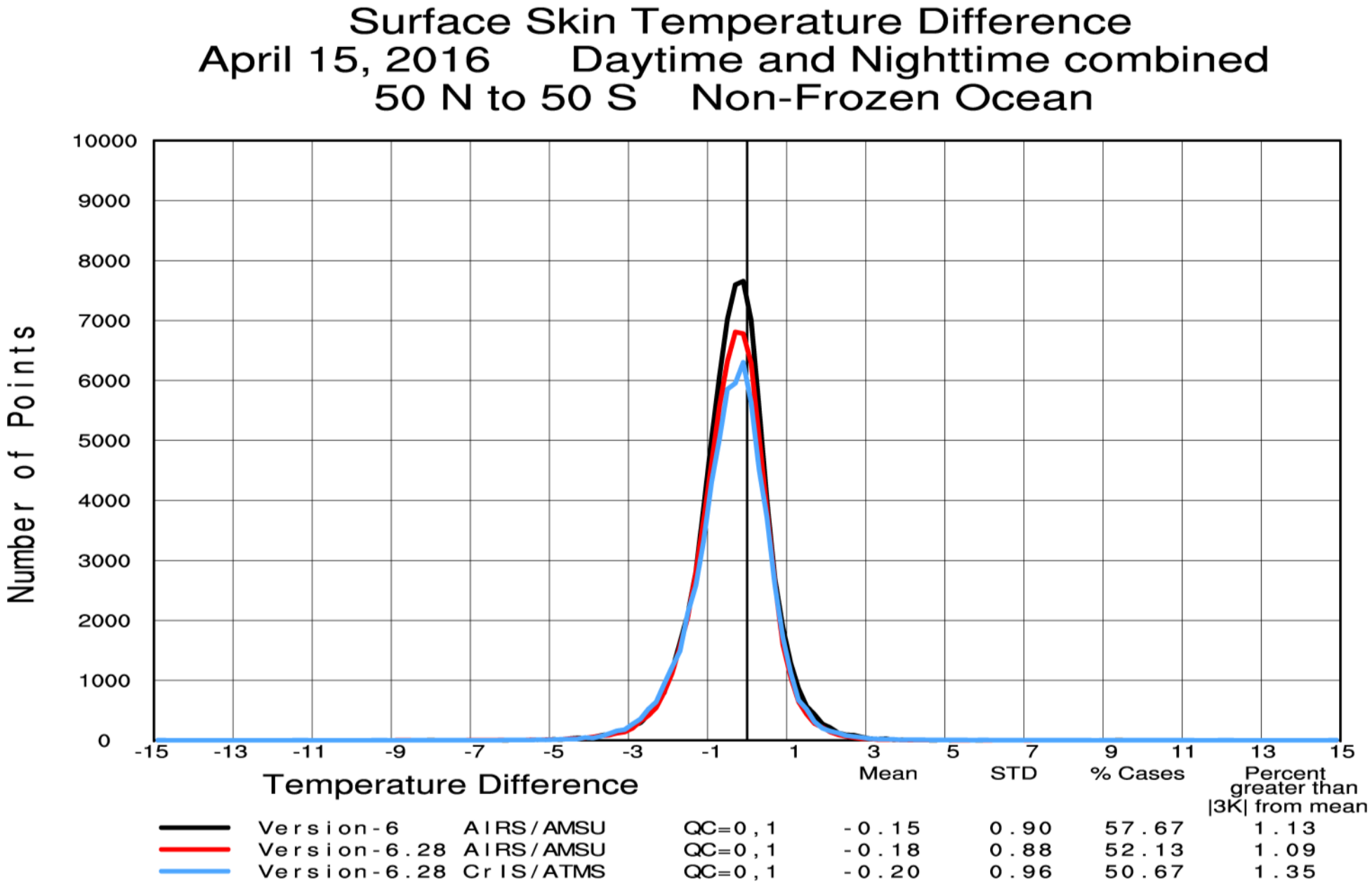
Comparison of AIRS Version-6, AIRS Verison-6.28, and CrIS Version-6.28 Results

The following results are shown for the single day, April 15, 2016. EOS Aqua and NPP orbits overlap closely on this day. This is important for comparison purposes to minimize time-of-day sampling differences.

We show Climate QC'd level-2 results for all experiments in terms of yields, RMS errors, and biases compared to ECMWF for *T(p)*, *q(p),* and ocean surface skin temperature T_s.

In addition, we show AIRS Version-6, AIRS Version-6.28, and CrIS/ATMS Version-6.28 level-3 gridded fields and compare them to measures of truth. AIRS and CrIS results using Version-6.28 are significantly improved compared to Version-6 for ozone products.

Finally, we compare level-3 fields of other select products of Version-6.28 AIRS and Version-6.28 CrIS which show good agreement with each other, especially over ocean.



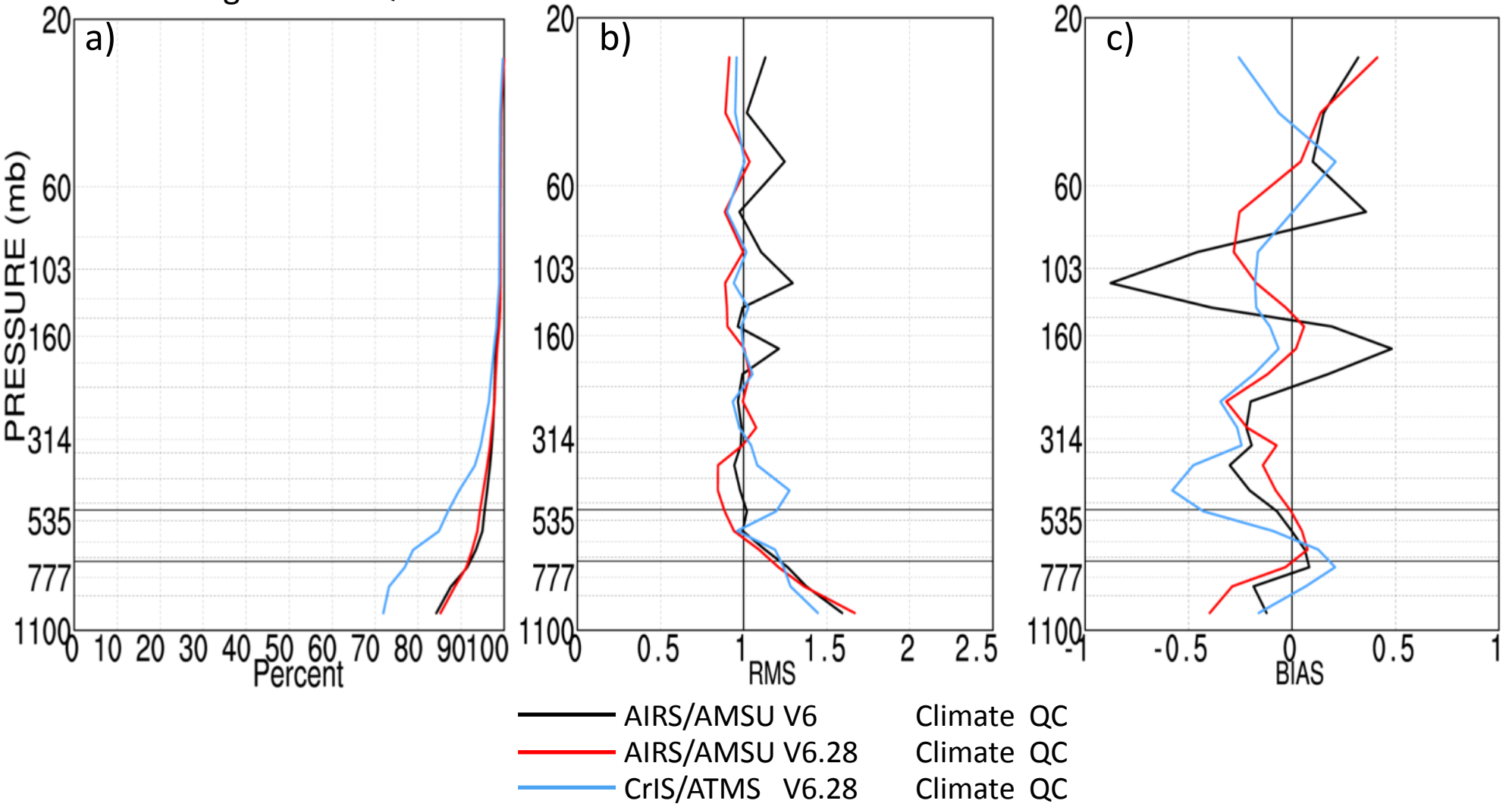
Counts of QC'd values as a function of errors of AIRS Version-6, AIRS Version-6.28 and CrIS Version-6.28 sea surface temperatures using Climate (QC=0,1) QC thresholds. All three sets of results are excellent and are of comparable quality with each other. CrIS SW spectral coverage truncated at 2550 cm^{-1} does not degrade ocean SST significantly.

April 15, 2016 Global Statistics

Percent of all Cases Accepted Using Climate QC

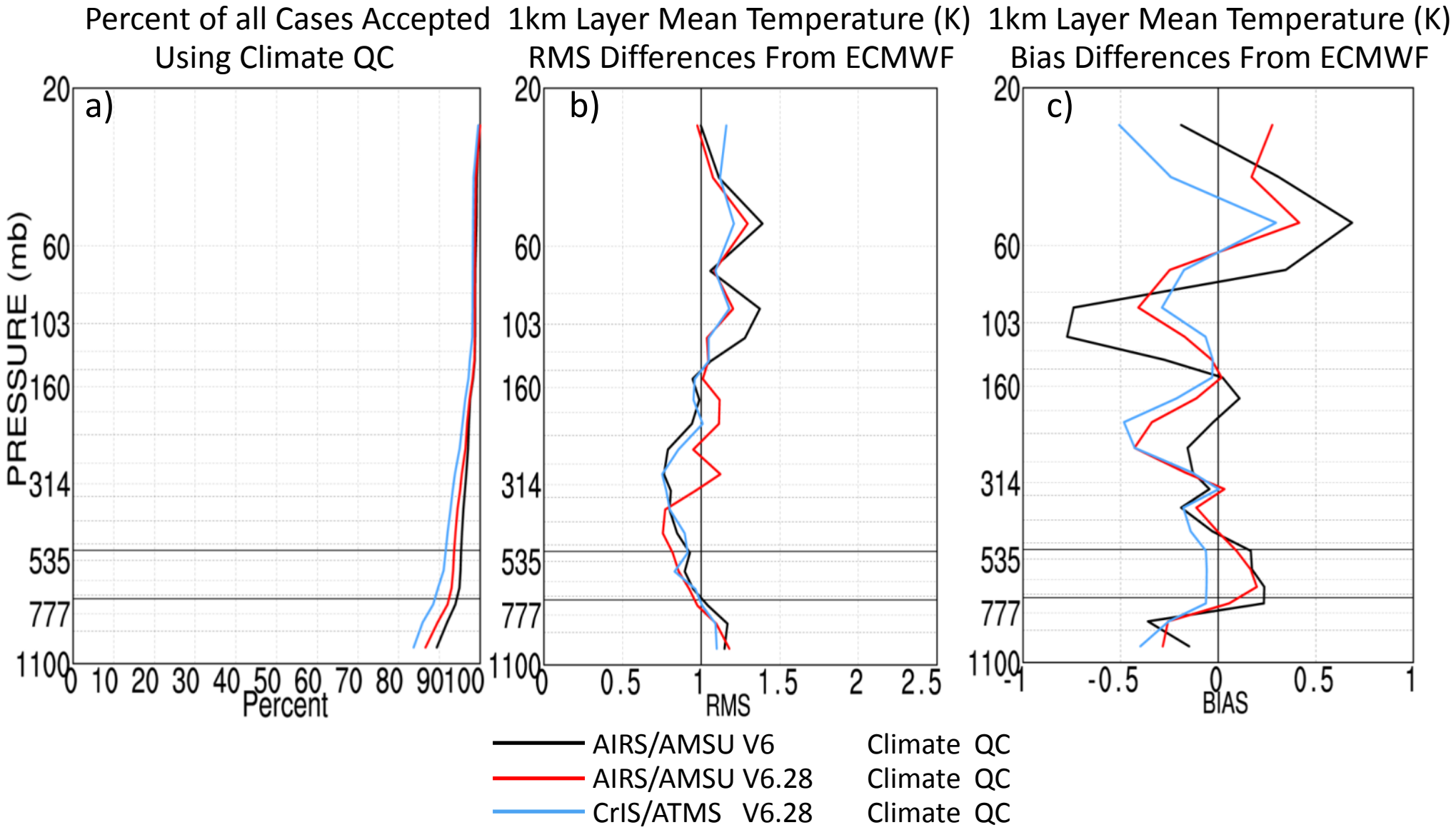
1km Layer Mean Temperature (K) RMS Differences From ECMWF

1km Layer Mean Temperature (K) Bias Differences From ECMWF



AIRS V6.28 and CrIS V6.28 1 km layer mean temperatures are both more accurate than AIRS V6 overall. CrIS V6.28 results with Climate QC has a lower yield, and somewhat larger errors, than AIRS V6.28, with a spurious positive bias at 700 mb and a negative bias at 500 mb.

April 15, 2016 50°N to 50°S Ocean



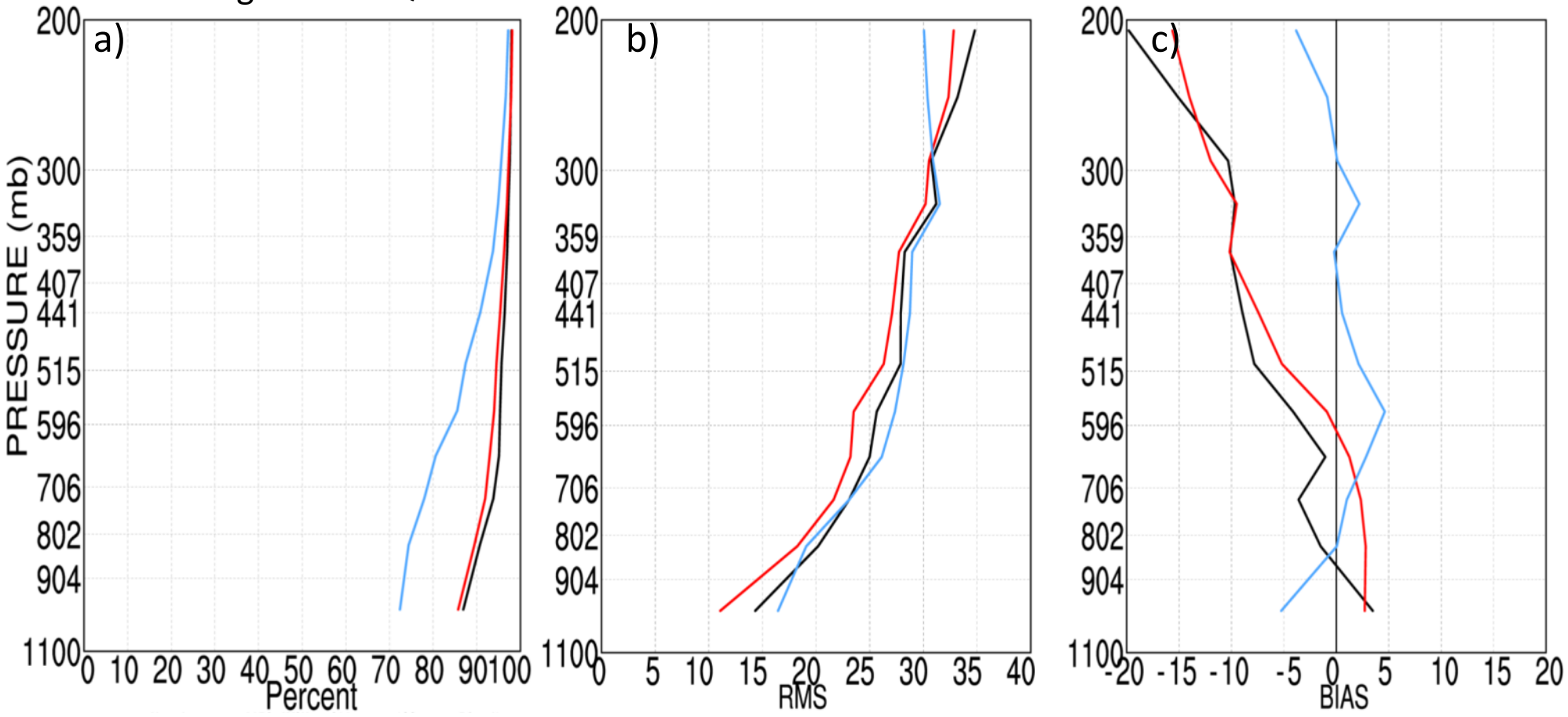
CrIS/ATMS statistics for *T(p)* are similar to those of AIRS/AMSU over mid-latitude ocean using Climate QC thresholds. Degradation of CrIS/ATMS retrievals compared to AIRS/AMSU occurs primarily over land.

April 15, 2016 Global Statistics

Percent of all Cases Accepted Using Climate QC

1km Layer Precipitable Water RMS % Differences From ECMWF

1km Layer Precipitable Water Bias % Differences From ECMWF

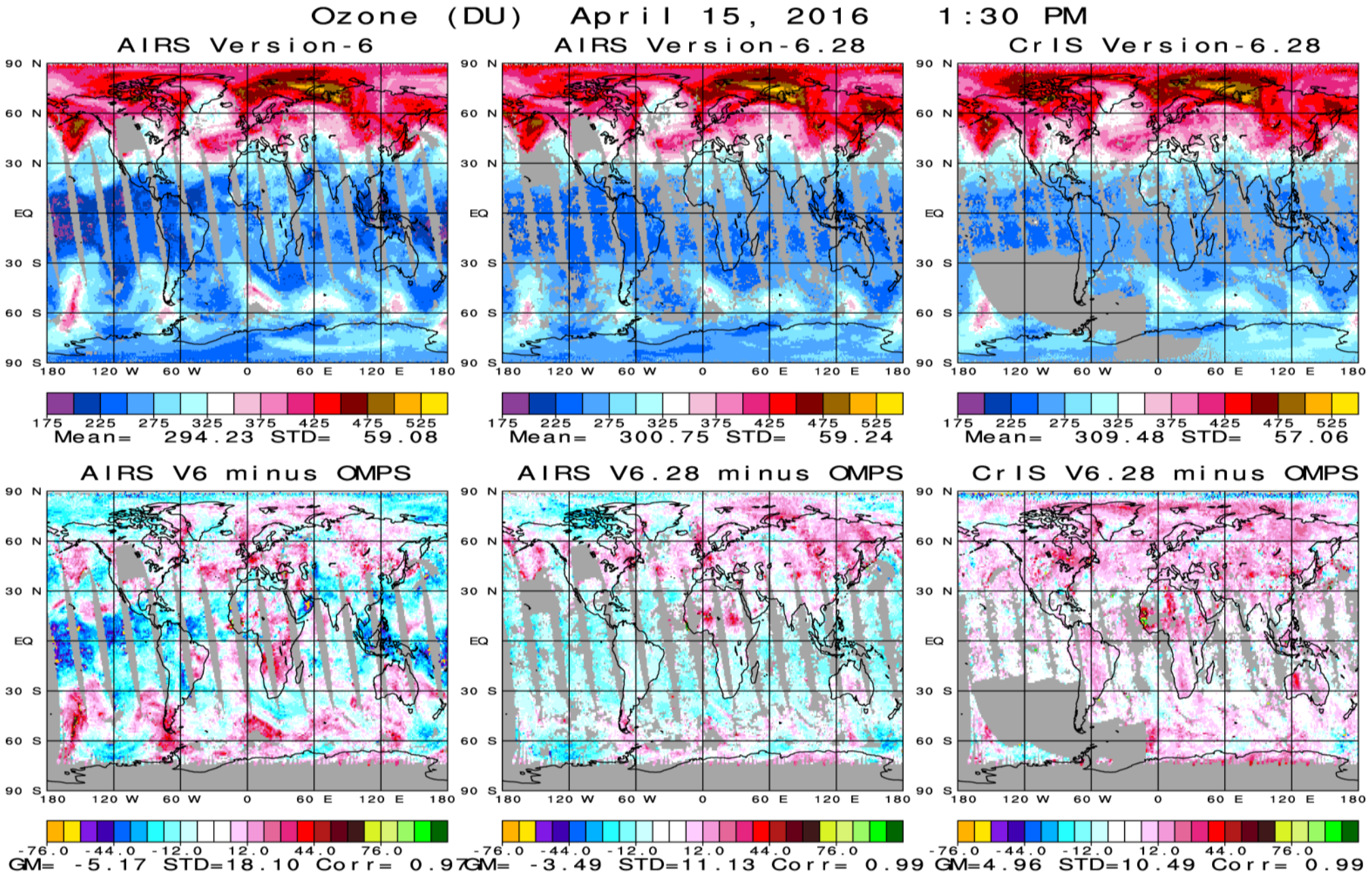


AIRS/AMSU V6 Climate QC

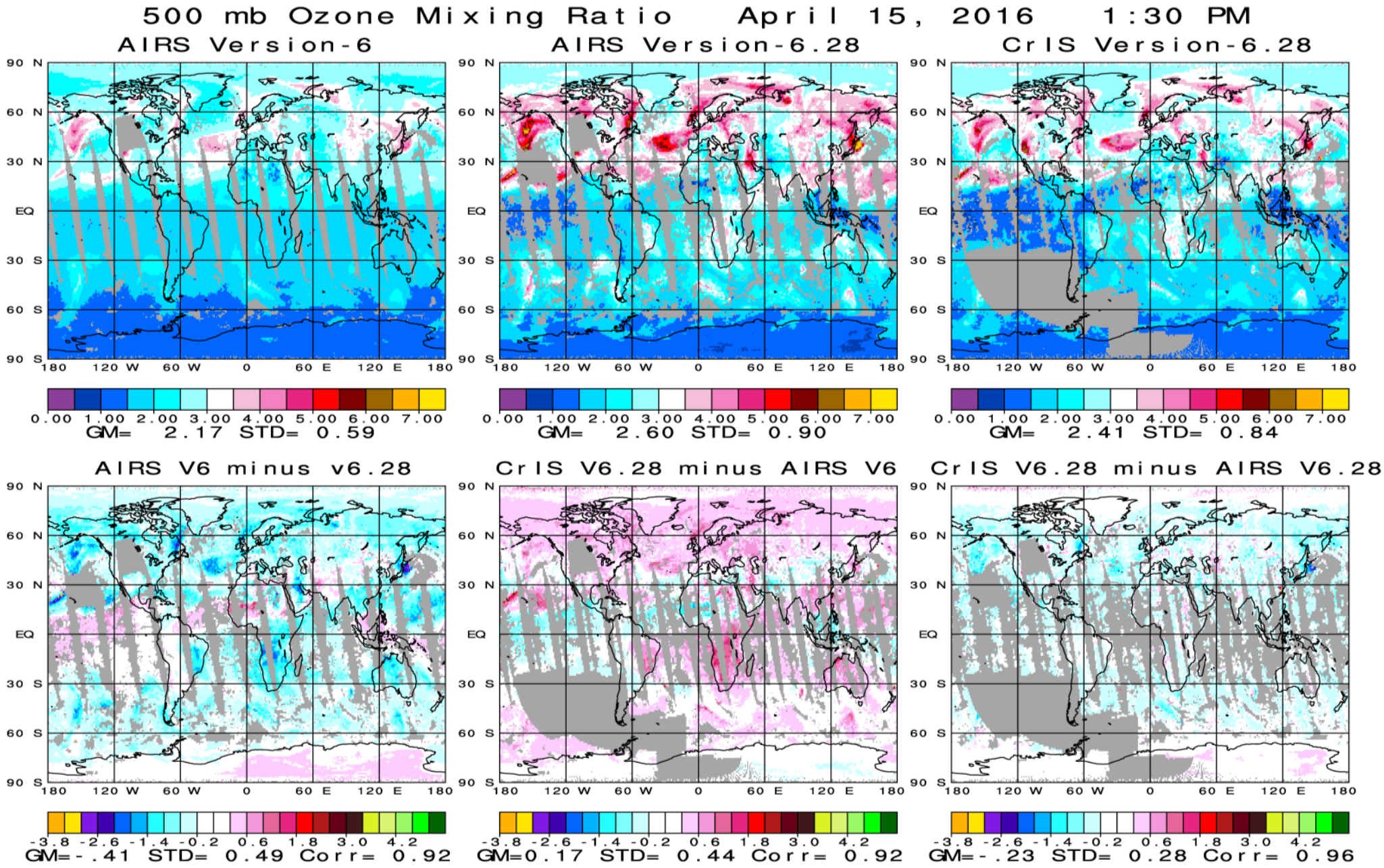
AIRS/AMSU V6.28 Climate QC

CrIS/ATMS V6.28 Climate QC

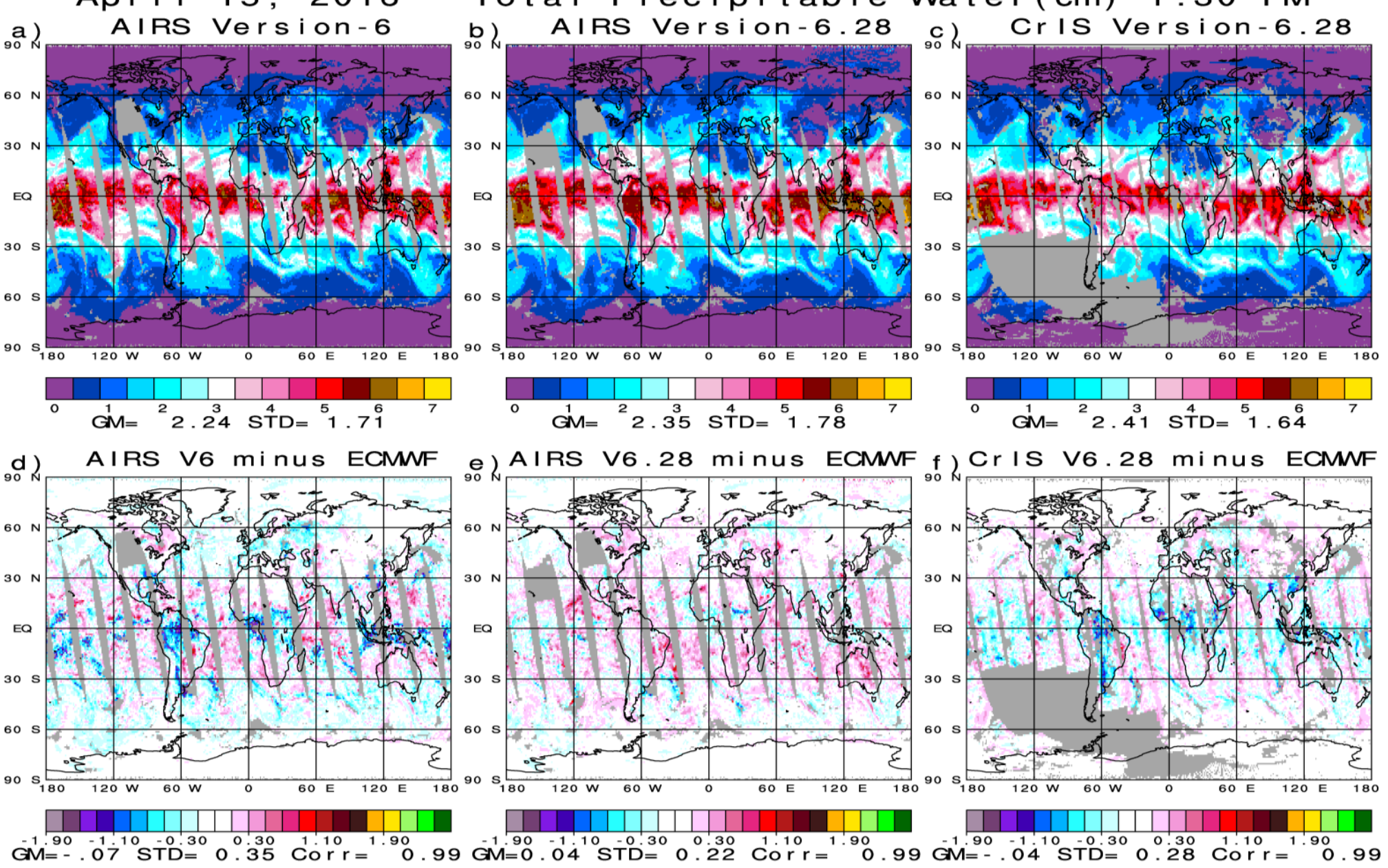
AIRS V6.28 1 km layer precipitable water results are superior to those of AIRS V6 with regard to both RMS errors and biases. The AIRS V6.28 dry bias above 500 mb has been alleviated by subsequent research. Global CrIS V-6.28 water vapor retrievals have comparable RMS errors to those of AIRS V6.



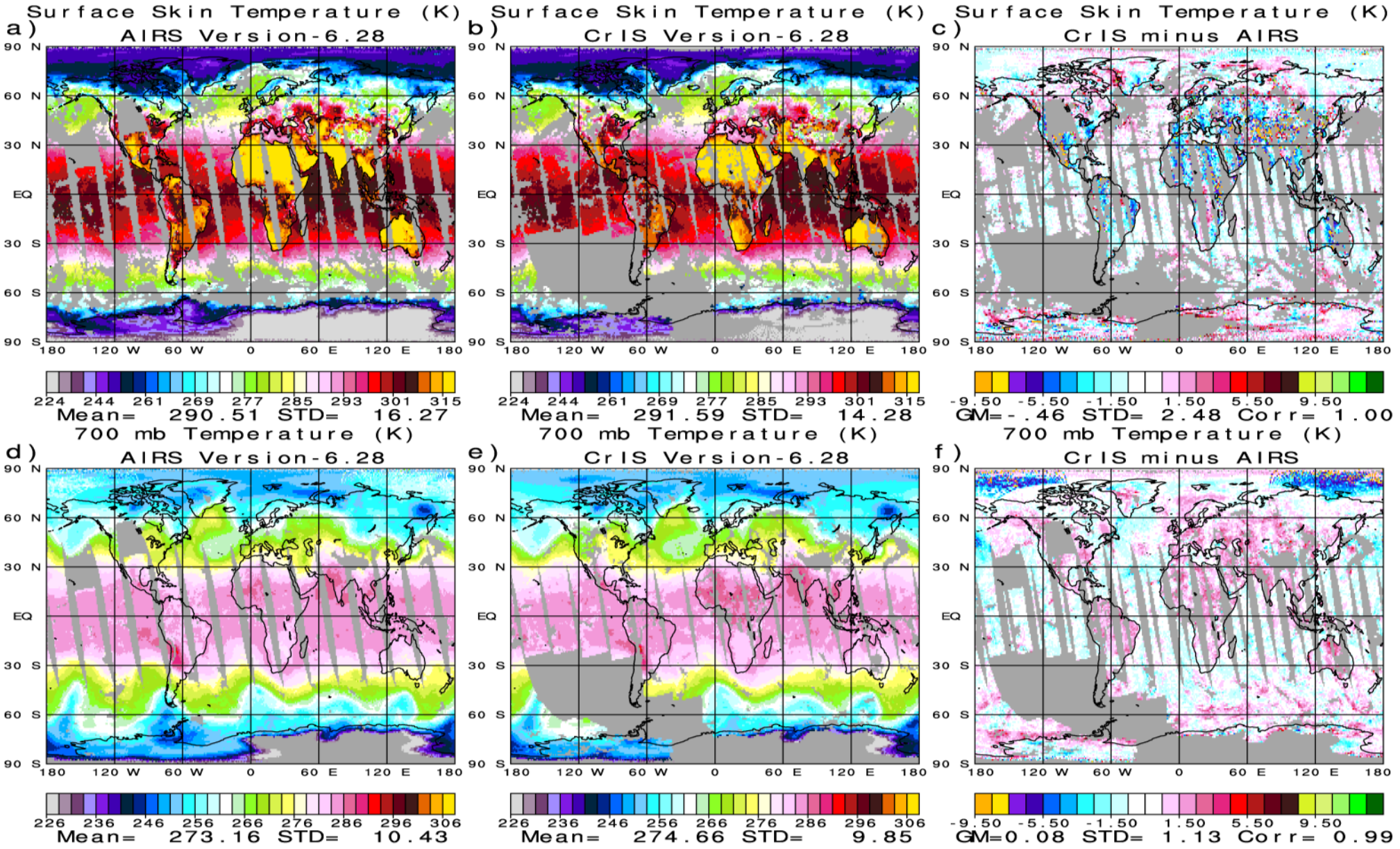
AIRS Version-6, AIRS Version-6.28, and CrIS Version-6.28 QC'd fields of total O_3 for ascending orbits on April 15, 2016, and their differences from OMPS. CrIS is missing parts of some orbits. AIRS V6.28 and CrIS V6.28 agree much better with OMPS than AIRS V6 with regard to both STD and spatial correlation. CrIS V6.28 statistics are comparable to AIRS V6.28.



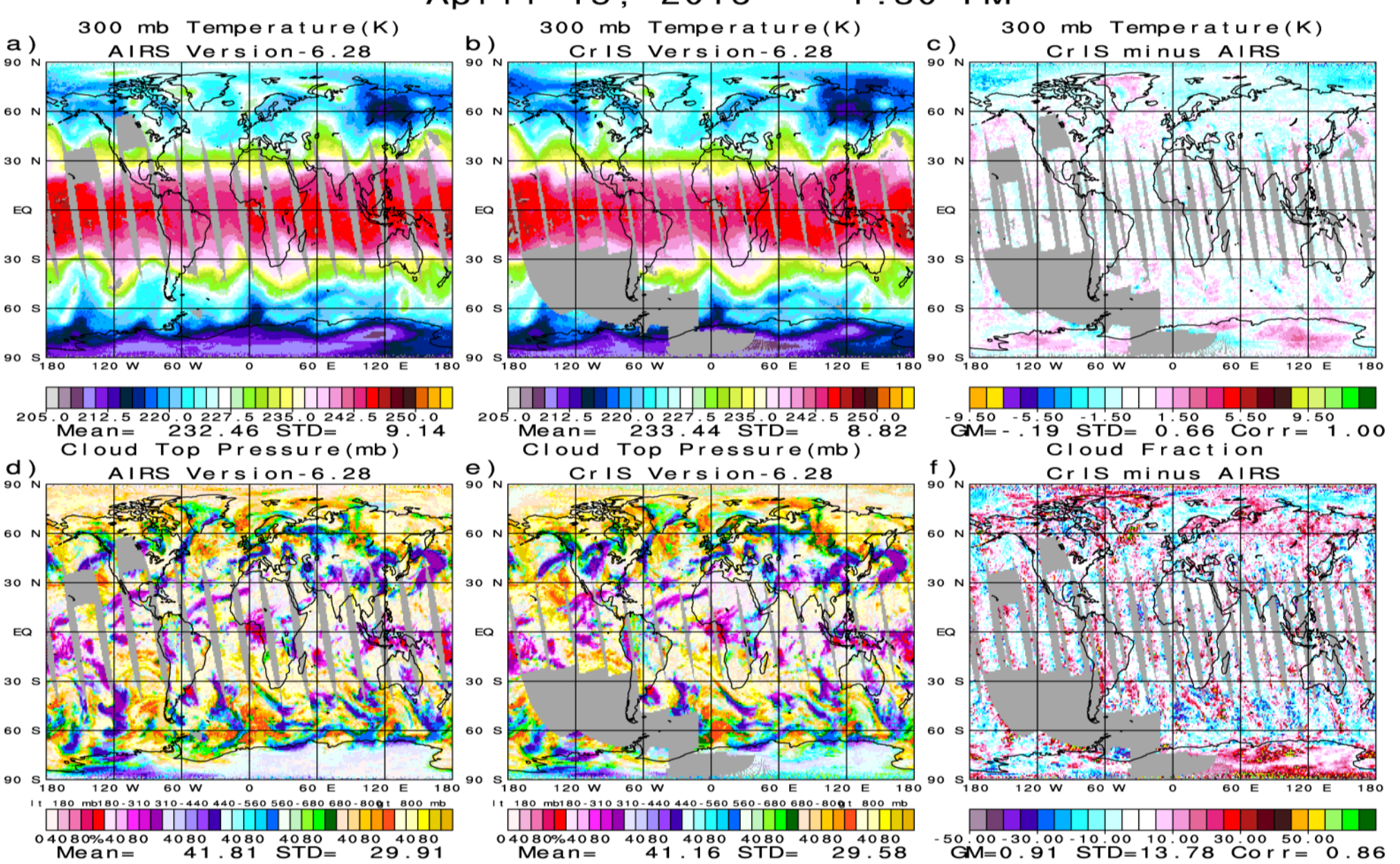
AIRS Version-6.28 and CrIS Version-6.28 QC'd fields of O_3 500 mb mixing ratio agree reasonably well with each other, and both show more pronounced spatial structure than what was found in AIRS Version-6.



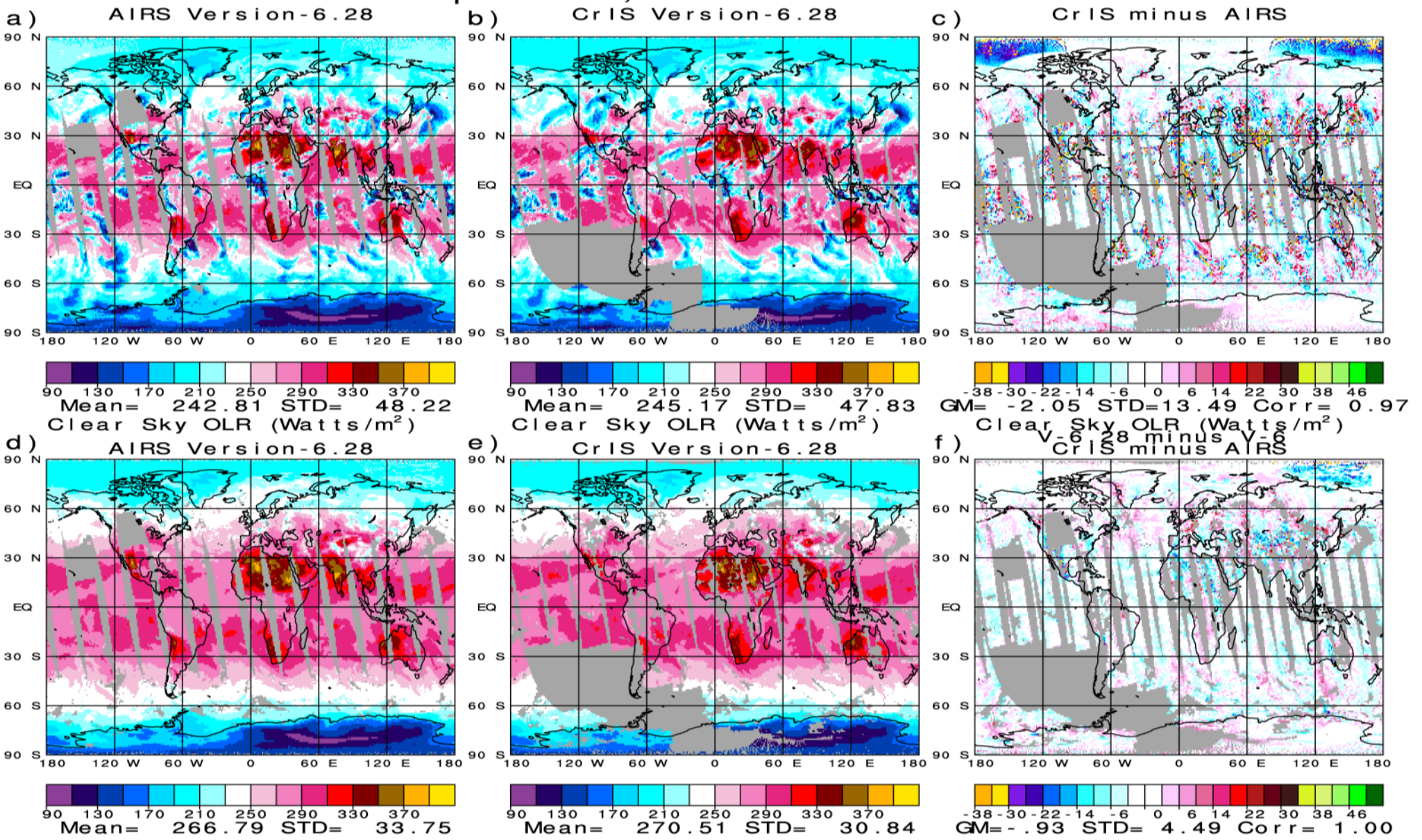
AIRS V6.28 W_{tot} is much more accurate than AIRS V6, especially in areas of high cloud cover. CrIS V6.28 W_{tot} has intermediate accuracy.



AIRS and CrIS retrieved values of surface skin temperature and 700 mb temperature for ascending orbits on April 15, 2016 agree very well over the tropical oceans. There are some differences over land, especially at high latitudes. Cooler CrIS land skin temperatures result in spuriously warmer 700 mb temperatures.



AIRS and CrIS retrieved values of 300 mb temperatures agree very well with each other. Cloud fields show both cloud top pressure (color) and cloud fraction (intensity). Cloud parameter agreement over tropical ocean is excellent, but some differences occur at high latitudes.



Agreement of AIRS and CrIS OLR and OLR_{CLR} fields is excellent with regard to both global means and spatial correlations. Some of the differences in OLR are a result of imperfect alignment of EOS Aqua and NPP orbits.

Summary

We evaluated Version-6.28 AIRS and Version-6.28 CrIS products on a single day, April 15, 2016, and compared results to those derived using AIRS Version-6.

- AIRS and CrIS Version-6.28 $O_3(p)$ products are both superior to those of AIRS Version-6.
- All AIRS and CrIS products agree reasonably well with each other.
- CrIS Version-6.28 *T(p)* and *q(p)* results are poorer than AIRS over land, especially under very cloudy conditions.

Both AIRS and CrIS Version-6.28 now run at JPL. Our short term plans are to analyze many common months at JPL in the near future using Version-6.28 or a further improved algorithm to assess the compatibility of AIRS and CrIS monthly mean products and their interannual differences.

Updates to the calibration of both CrIS and ATMS are still being finalized. JPL plans, in collaboration with the Goddard DISC, to reprocess all AIRS/AMSU data using a still to be finalized Version-7 retrieval algorithm. Our goal is to have all recalibrated CrIS/ATMS data eventually reprocessed using Version-7 as well.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