National Aeronautics and Space Administration

Progress Towards AIRS Science Team Version-7 at SRT

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NASA GSFC Sounder Research Team (SRT)

AIRS Science Team Meeting

Pasadena, CA

March 23, 2016

Background

The AIRS Science Team Version-6 retrieval algorithm is currently producing level-3 Climate Data Records (CDRs) from AIRS that have been proven useful to scientists in understanding climate processes. CDRs are gridded level-3 products which include all cases passing AIRS Climate QC. SRT has made significant further improvements to AIRS Version-6. At the last Science Team Meeting, we described results using SRT AIRS Version-6.22. SRT Version-6.22 is now an official build at JPL called 6.2.4. Version-6.22 results are significantly improved compared to Version-6, especially with regard to water vapor and ozone profiles. We have adapted AIRS Version-6.22 to run with CrIS/ATMS, at the Sounder SIPS which processed CrIS/ATMS data for August 2014. JPL AIRS Version-6.22 uses the Version-6 AIRS tuning coefficients.

Limitations of Version-6.22

AIRS Version-6.22 has at least two limitations which must be improved before finalization of Version-7: Version-6.22 total O_3 has spurious high values in the presence of Saharan dust over the ocean; and Version-6.22 retrieved upper stratospheric temperatures are very poor in polar winter. SRT Version-6.28 addresses the first concern. John Blaisdell ran the analog of AIRS Version-6.28 in his own sandbox at JPL for the 14th and 15th of every month in 2014 and all of July and October for 2014. AIRS Version-6.28a is hot off the presses and addresses the second concern.

This talk will compare AIRS and CrIS Version-6.22 results with AIRS Version-6, and also show some Version-6.28 and Version-6.28a AIRS results.

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CrIS/ATMS Neural-Net Coefficients

Like in AIRS Version-6, Version-6.22 uses Neural-Net methodology to generate the first guess for each AIRS/AMSU or CrIS/ATMS FOR. The CrIS/ATMS Neural-Net coefficients were trained by Bill Blackwell and co-workers at Lincoln Labs using CrIS/ATMS observations early in the NPP mission. CrIS and ATMS calibration procedures were modified in November 2013. The quality of CrIS/ATMS retrievals improved after this change, even though the Neural-Net coefficients began to produce a biased first guess. They will need retraining. Bill Blackwell has indicated that he will generate new CrIS/ATMS Neural-Net coefficients trained on radiances using the newest CrIS/ATMS calibration procedures when they are finalized. In the meantime, CrIS Version-6.22 uses current CrIS calibration and Neural-Net coefficients. Results should improve when we have new CrIS/ATMS calibration and Neural-Net coefficients.

Ozone (DU) August 2014
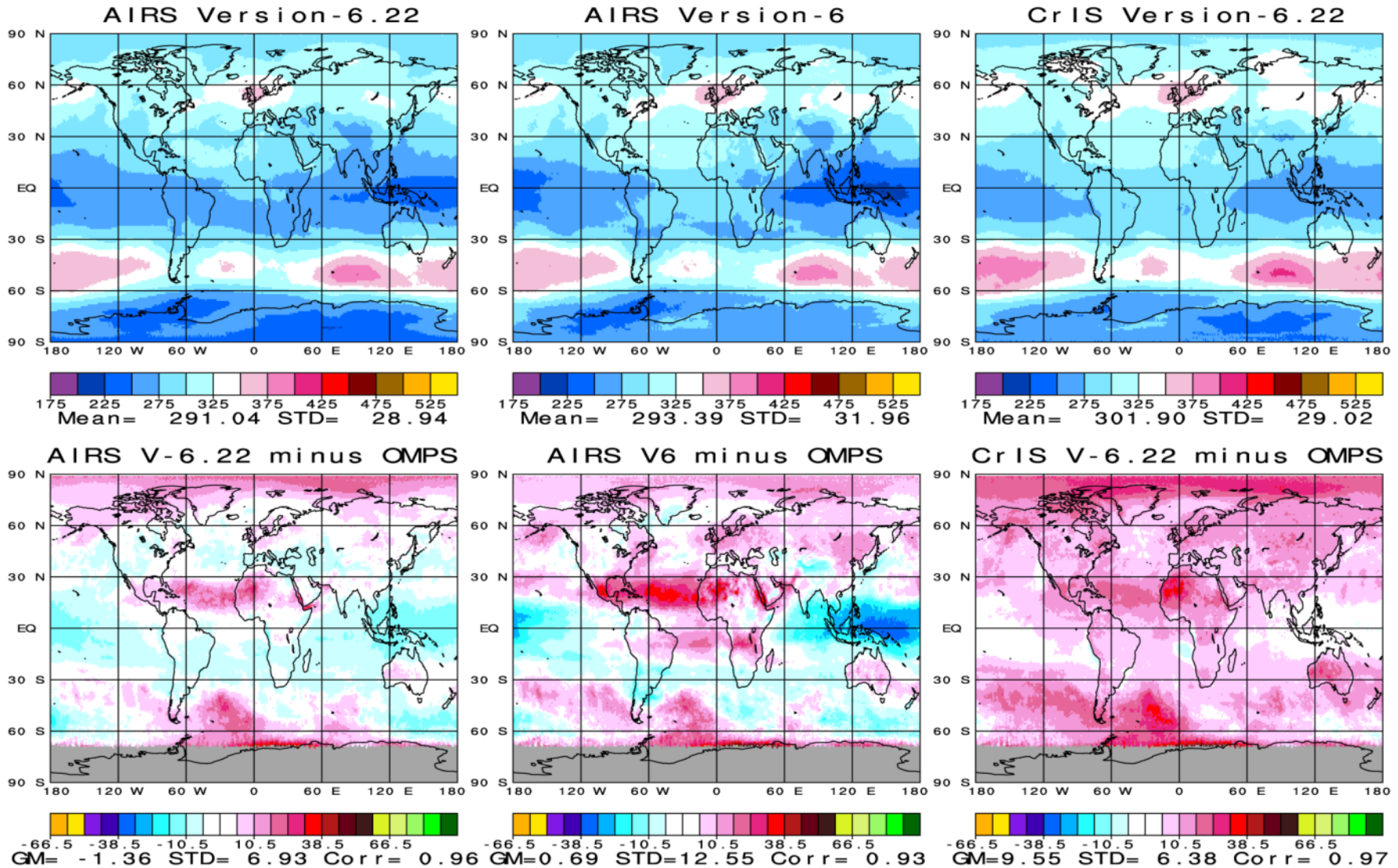
AIRS Version-6.22 monthly mean total O_3 agrees much better with OMPS than Version-6, especially in the tropics. CrIS Version-6.22 total O_3 has comparable spatial standard deviation and correlation with OMPS as AIRS Version-6.22, but is biased high.

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OLR (Watts/m²) August 2014
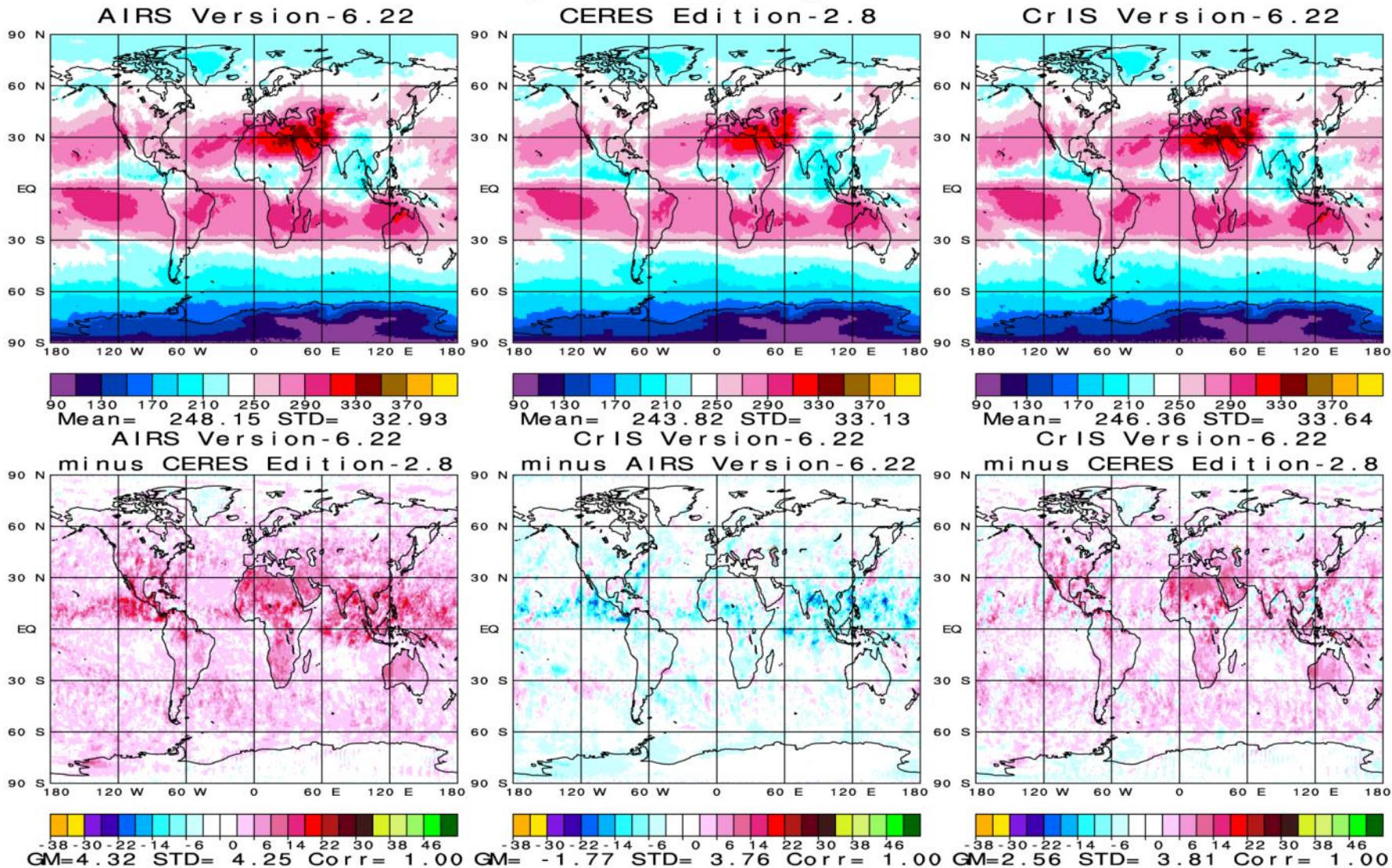
Version-6.22 AIRS and CrIS monthly mean OLR agree well with each other and with CERES Edition-2.8. CrIS OLR actually agrees better with CERES in areas containing high clouds.

August 2014
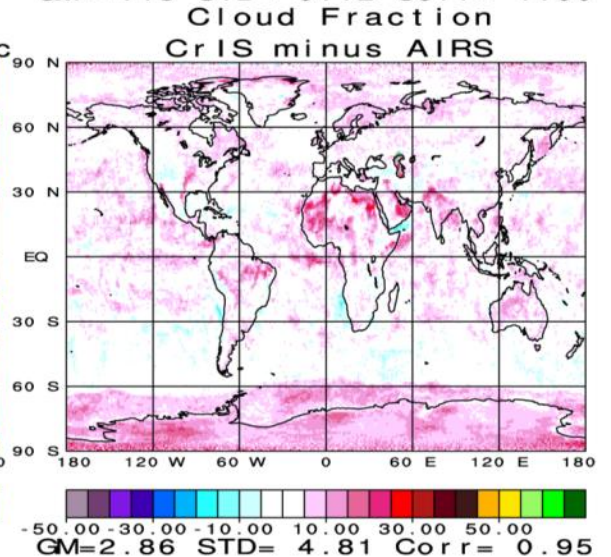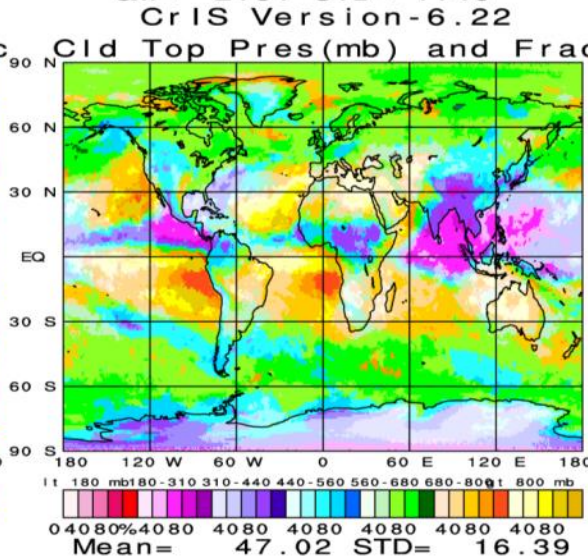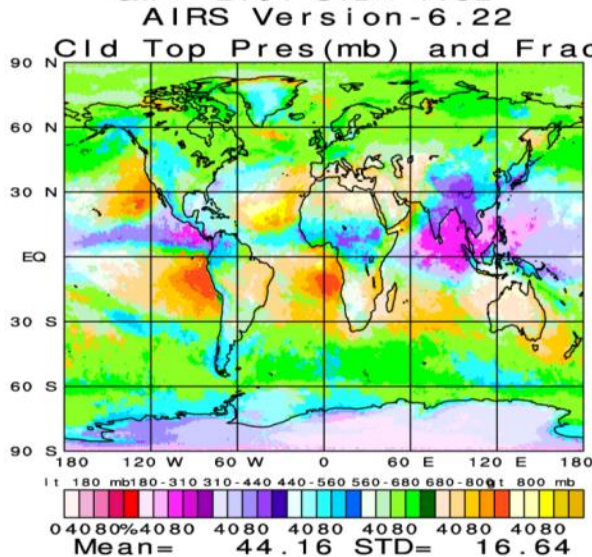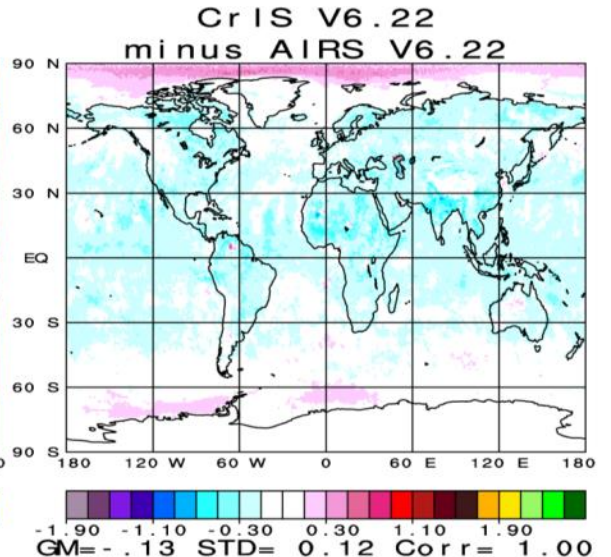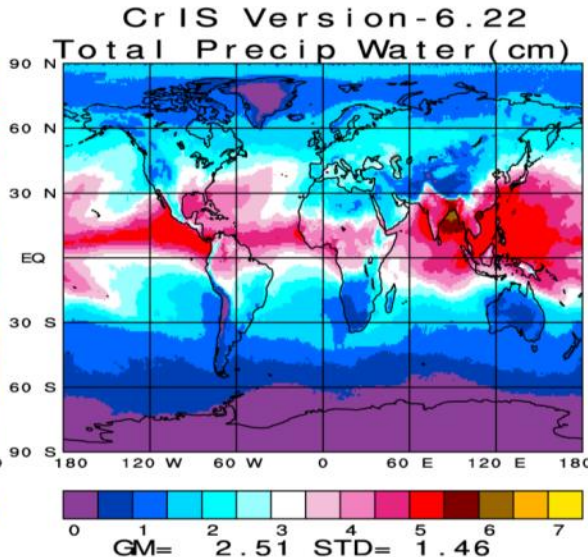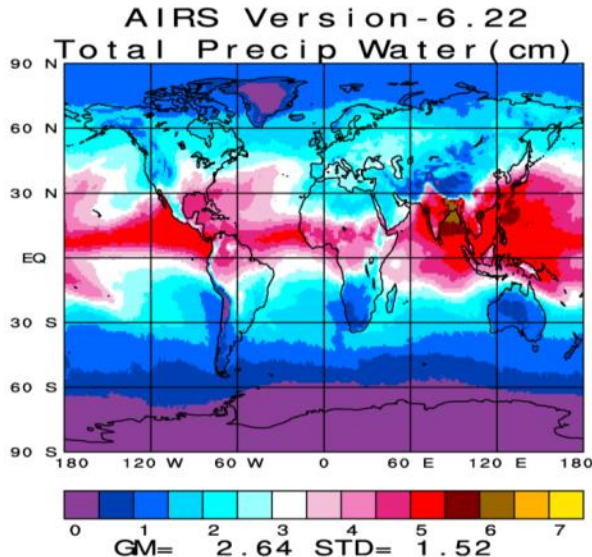
Version-6.22 AIRS and CrIS monthly mean cloud parameters agree well with each other. CrIS total precipitable water is lower than AIRS in the tropics. This is consistent with CrIS generating more tropical cloud cover, resulting in better agreement of OLR with CERES.

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August 2014
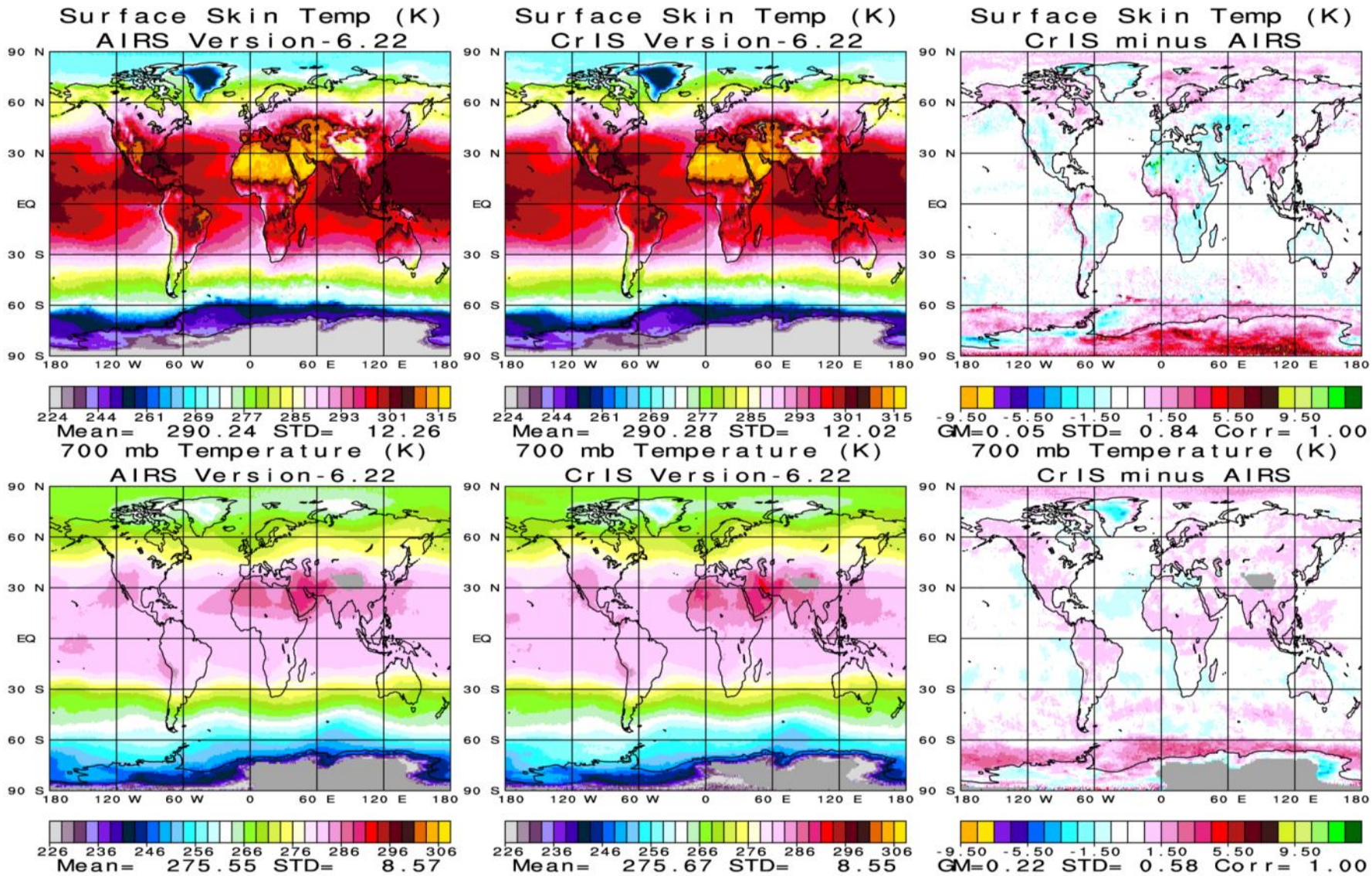
Monthly mean Version-6.22 AIRS and CrIS surface skin and atmospheric temperatures also agree well with each other, with the exception of Antarctic surface skin temperature.
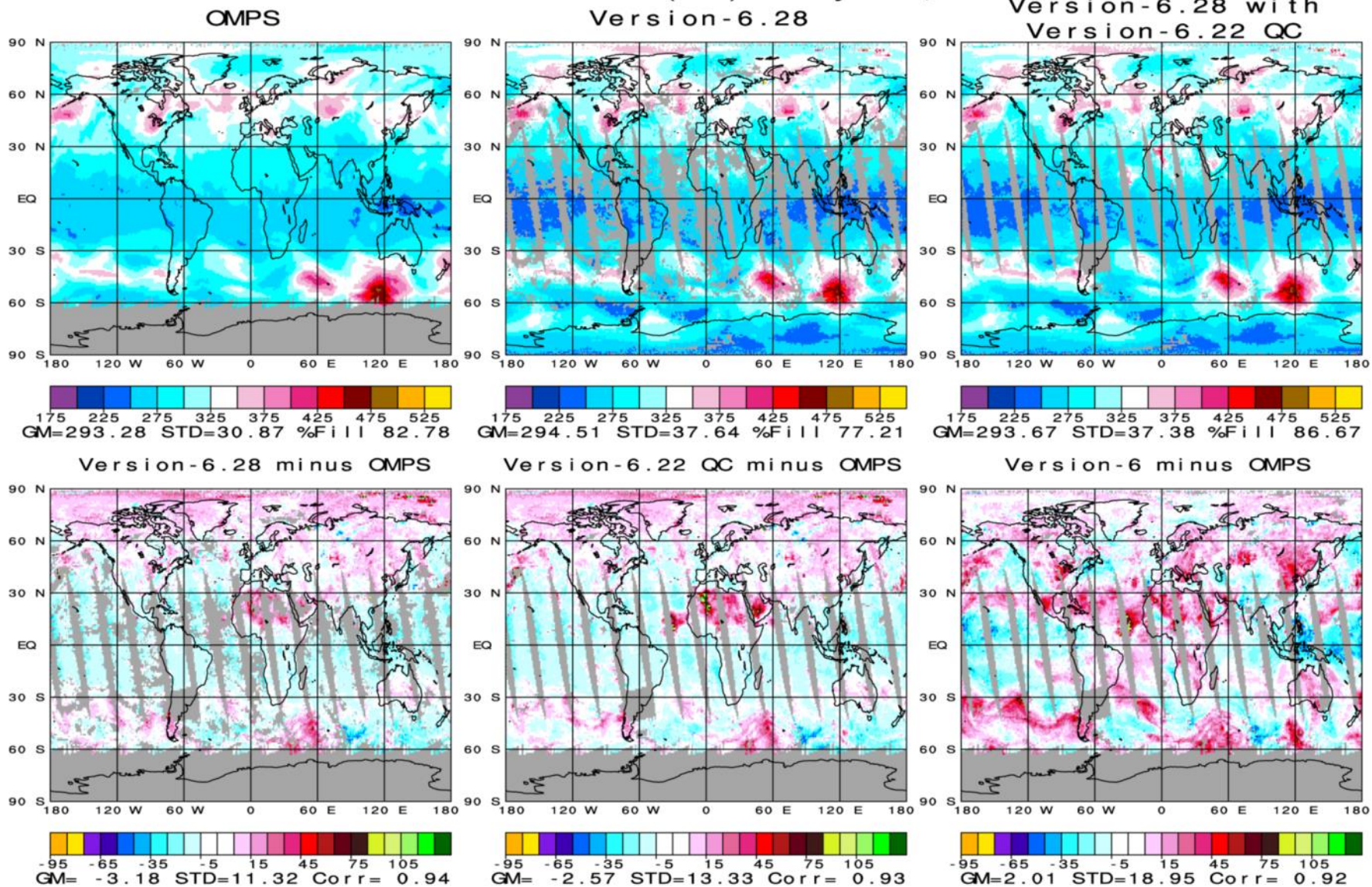
AIRS Version-6.28

AIRS Version-6.28 differs from AIRS Version-6.22 in two important ways.

1) AIRS Version-6.28 has 6 more $T(p)$ and $q(p)$ expansion functions than Version-6.22. This modification was made to allow for more boundary layer structure in retrieved values of $T(p)$ and $q(p)$, which was suggested by JPL.

2) Version-6.28 has improved total O_3 QC methodology which accounts for effects of dust on the O_3 retrievals. In addition to Version-6.22 O_3 QC, Version-6.28 also rejects the O_3 profile if either of these tests are flagged:

   - The difference of the retrieved emissivity at 1020 cm^{-1} from its first guess is greater than the average of the analogous differences at 877 cm^{-1} and 1205 cm^{-1} by an area dependent value.
   - Sergio's dust flag is greater than 290 over ocean, or greater than 200 over land if the 1170 cm^{-1} surface emissivity is less than 0.85 (this indicates desert). We have constructed an analogous CrIS dust flag.

The following figures compare the effect of using Version-6.28 O_3 QC and Version-6.22 QC applied to Version-6.28 retrievals.

Total Ozone (DU) July 15, 2014

Version-6.28 O_3 QC removes many cases with spuriously high total O_3 values. Version-6.28 total O_3 agrees much better with OMI than does AIRS Version-6. Unlike AIRS Version-6, AIRS Version-6.28 total O_3 is biased slightly high compared to OMPS poleward of 80°N.

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Total Ozone (DU) July 2014
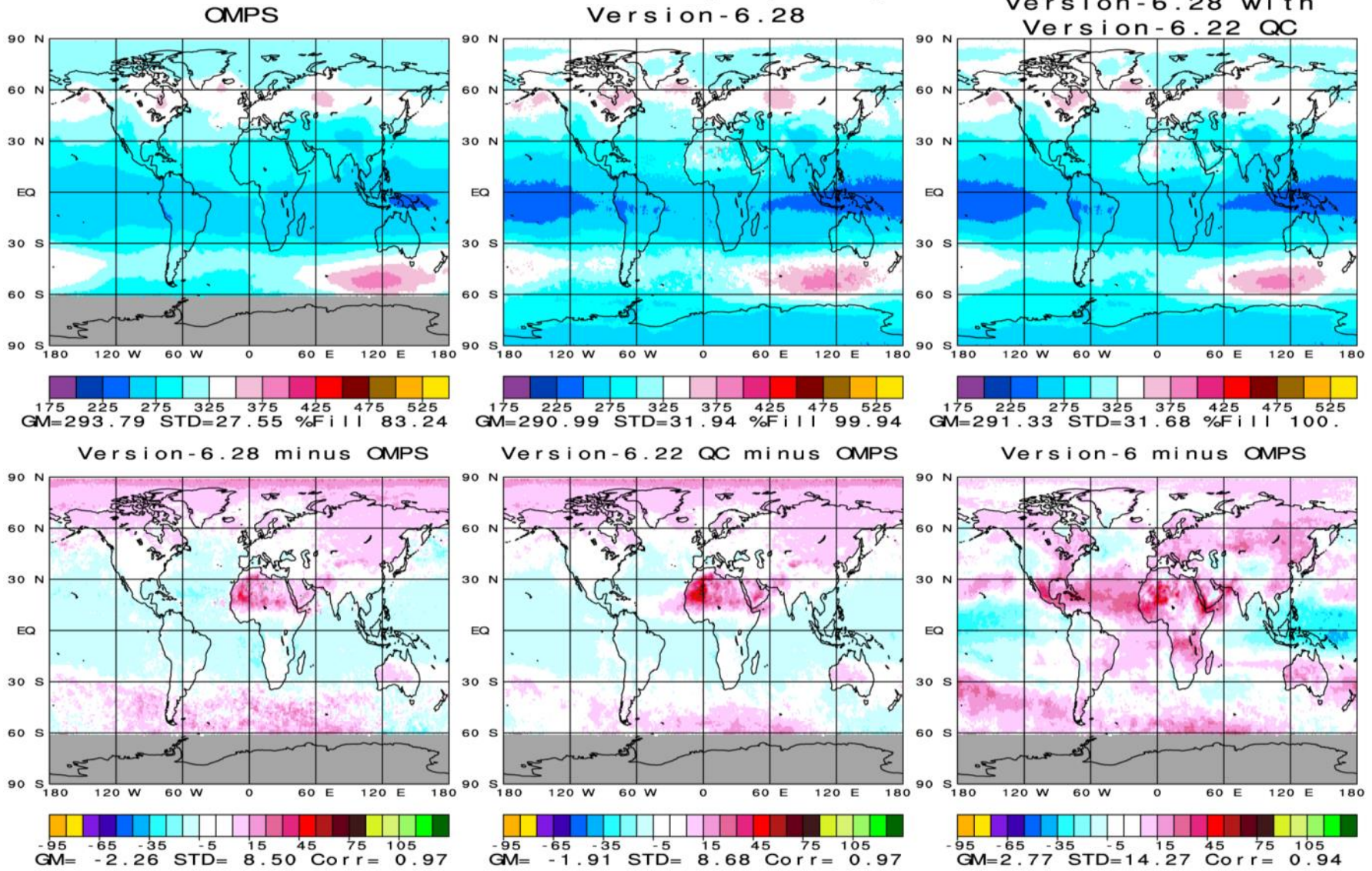
Relative monthly mean findings for July 2014 are similar to those for July 15, 2014.

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Total Ozone (DU) January 15, 2014
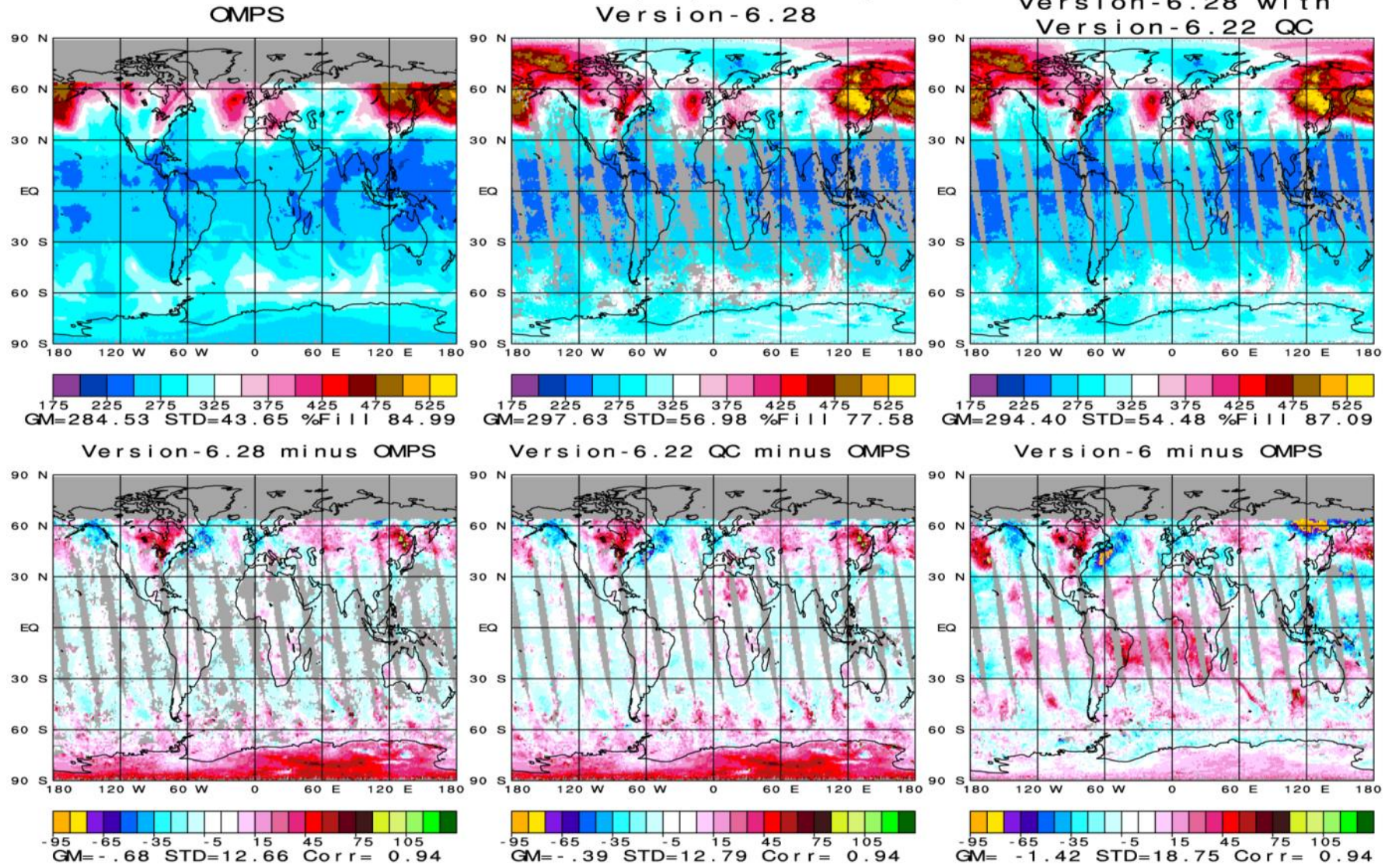
As in July, Version-6.28 O_3 QC rejects some spuriously high total O_3 values over the Sahara and in Saudi Arabia, and Version-6.28 total O_3 agrees with OMI much better than Version-6 almost everywhere. Version-6.28 total ozone is spuriously high over Antarctica however, while Version-6 was not. We need to correct this problem.

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AIRS Version-6.28a

Version-6.28a is otherwise identical to Version-6.28 but uses new AIRS/AMSU Neural-Net coefficients recently generated by Adam Milstein at Lincoln Labs. John and Adam are still checking that everything is implemented 100% correctly at GSFC. The following charts show sample SRT results of AIRS Version-6.28a run for August 15, 2013. Version 6.28a performs much better than Version 6.28 with regard to retrieved $T(p)$ and $q(p)$ profiles, both of which have improved initial guesses.

August 15, 2013   Global

RMS Differences From ECMWF   Bias Differences From ECMWF

- - -	AIRS Version-6.28	Neural-Net	(QC=0,1; Pgood)
——	AIRS Version-6.28	Final Retrieval	(QC=0,1; Pgood)
- - -	AIRS Version-6.28a	Neural-Net	(QC=0,1; Pgood)
——	AIRS Version-6.28a	Final Retrieval	(QC=0,1; Pgood)

AIRS Version-6.28a *T(p)* profiles have higher yield than those of Version-6.28 with smaller RMS errors and biases, especially in the upper stratosphere, in which the Version-6.28 Neural-Net behaved poorly.

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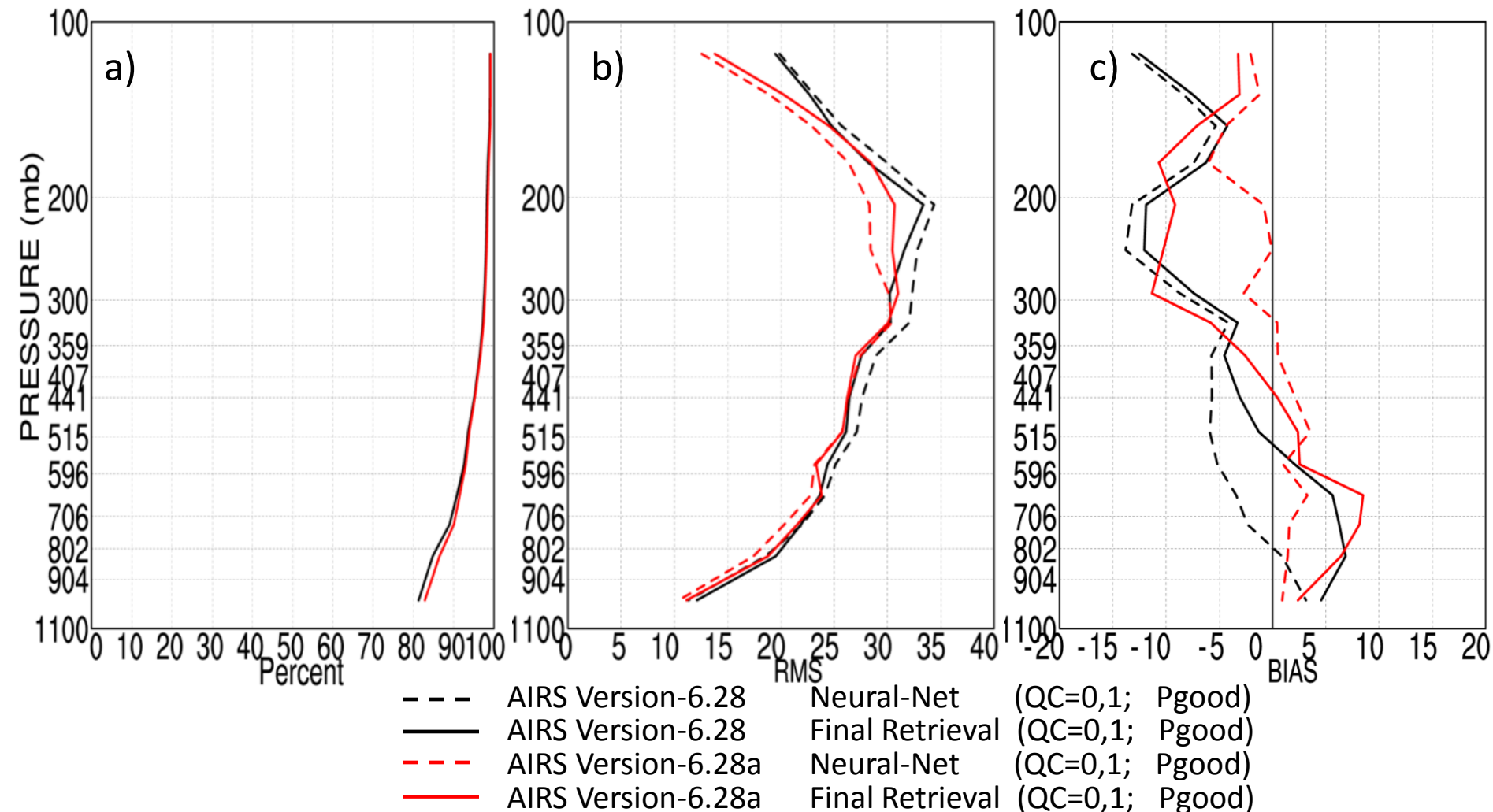
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August 15, 2013   Global

Percent of all Cases Accepted   1km Layer Precipitable Water   1km Layer Precipitable Water
RMS % Differences From ECMWF   Bias % Differences From ECMWF

	AIRS Version-6.28	Neural-Net	(QC=0,1; Pgood)
– – –	AIRS Version-6.28	Neural-Net	(QC=0,1; Pgood)
———	AIRS Version-6.28	Final Retrieval	(QC=0,1; Pgood)
– – –	AIRS Version-6.28a	Neural-Net	(QC=0,1; Pgood)
———	AIRS Version-6.28a	Final Retrieval	(QC=0,1; Pgood)

AIRS Version-6.28a *q(p)* profiles have lower RMS errors than Version-6.28 beneath 500 mb and above 300 mb. Mid-lower tropospheric *q(p)* is still biased high and upper troposphere *q(p)* is still biased low. We have to look into why this is the case.

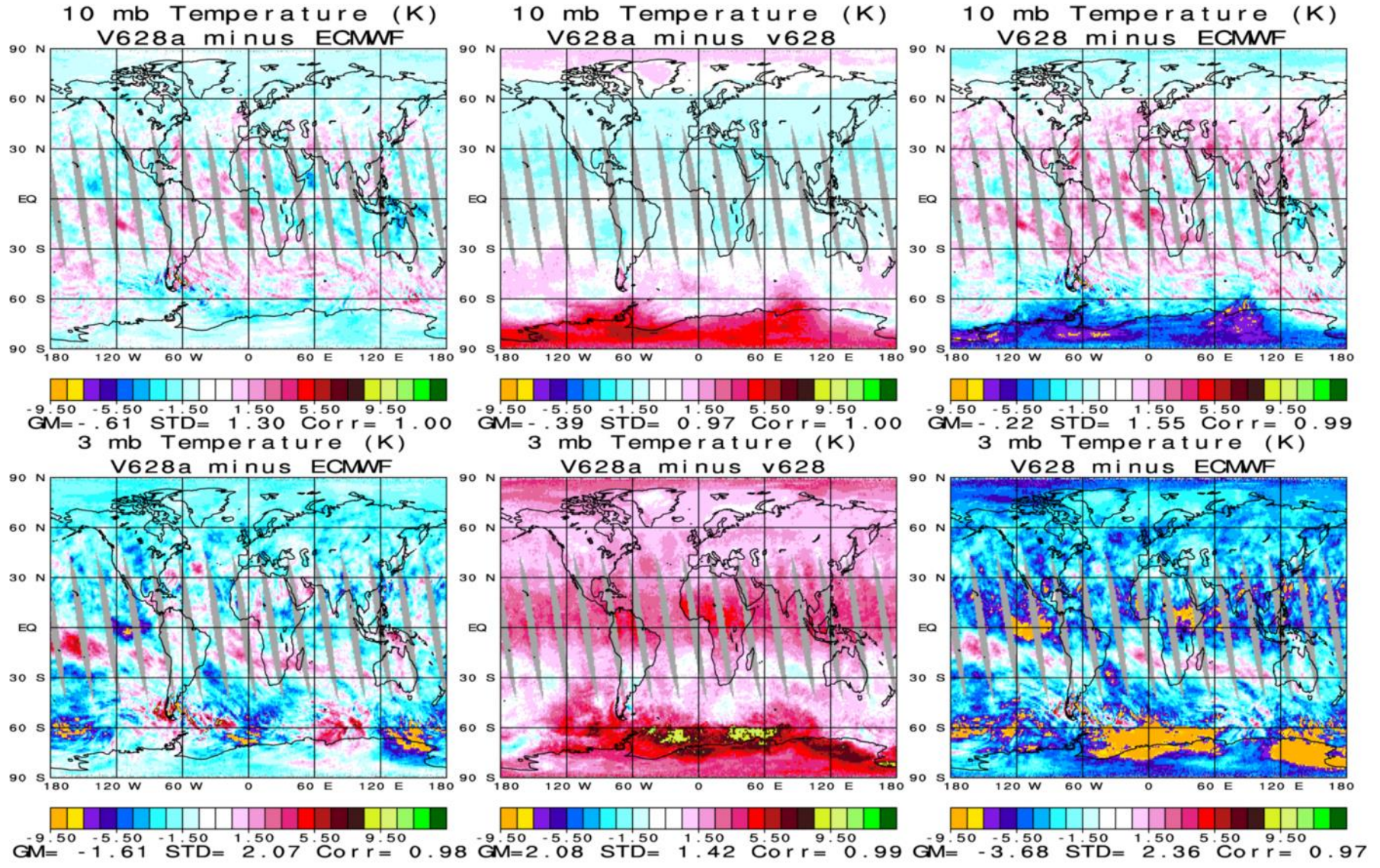Joel Susskind, John Blaisdell, Lena Iredell, and Louis Kouvaris
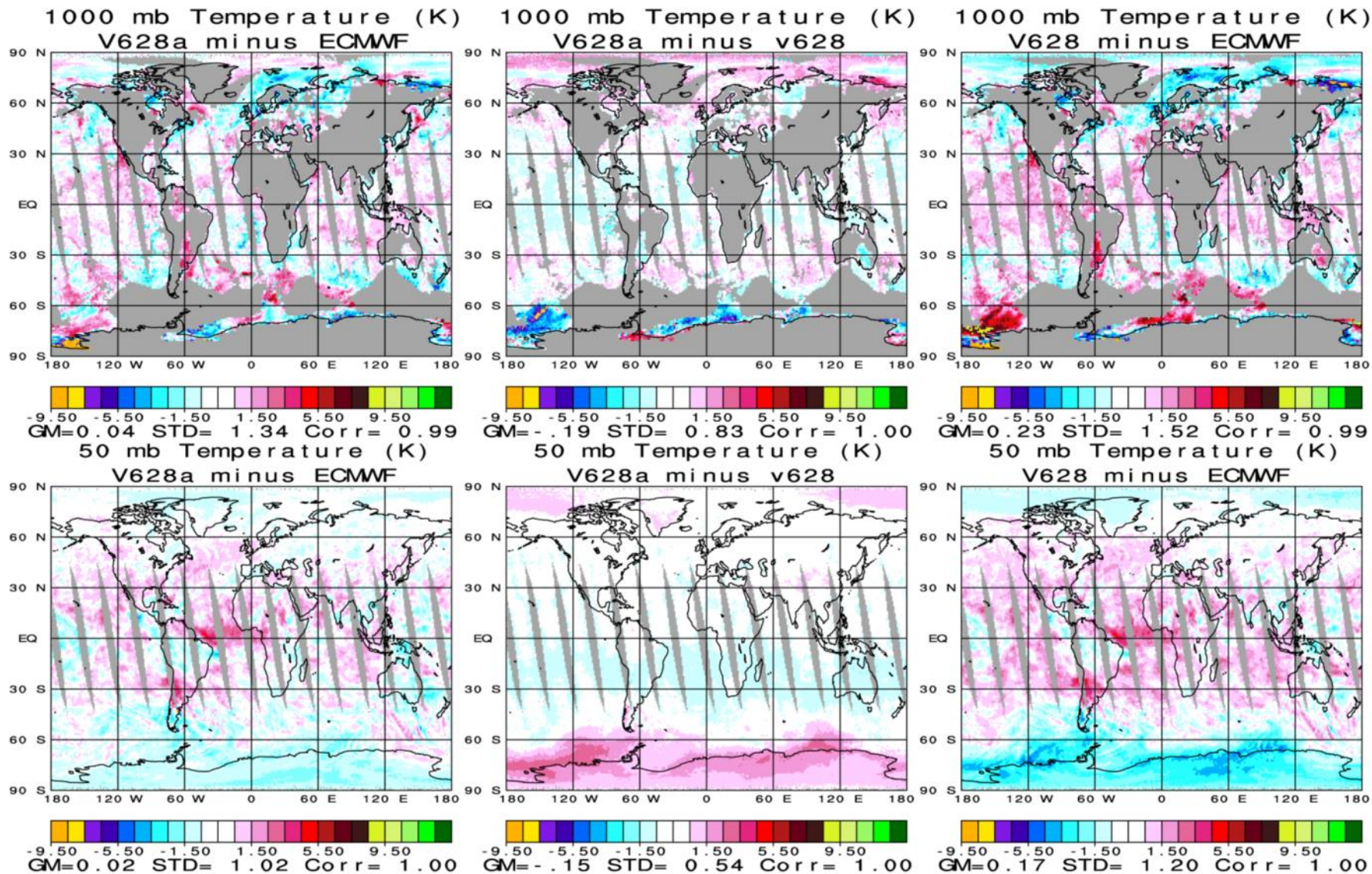
August 15, 2013

AIRS Version-6.28a 1000 mb and 50 mb retrieval temperatures are both significantly better than those of AIRS Version-6.28, especially at high latitudes, as a result of using the new Neural-Net coefficients.

August 15, 2013

The same finding holds for 10 mb and 3 mb temperatures, and for other pressure levels as well low and high in the atmosphere.

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Summary

Version-6.22 AIRS and CrIS monthly mean fields for August 2014 agree very well with each other except for a roughly 10 DU high bias of CrIS Total O_3 compared to AIRS. We do not understand the origin of this. This agreement is a good sign that CrIS Version-7 and AIRS Version-7 products should agree well when the algorithms are finalized. *CrIS Version-7 cannot be finalized until after we get newly calibrated CrIS/ATMS radiances as well as new CrIS/ATMS Neural-Net coefficients.*

AIRS Version-6.28a has addressed the two main concerns we had about AIRS Version-6.22:
- Improving O_3 QC flags to remove dusty cases.
- Improving polar winter upper stratospheric temperatures.

Summary (cont.)

AIRS Version-6.28a has at least 2 additional liens that we would like to correct in Version-7:

- Version-6 total O_3 agreed better with OMI at very high latitudes in polar summer than does Version-6.28a, especially over Antarctica. We should find out why and correct this result.

- The Version-6.28a water vapor profile is biased high against ECMWF in the mid-lower troposphere. We want to see if we can correct this artifact. This high water vapor bias may be contributing to the small low bias in total O_3 compared to OMI that exists over the oceanic warm pool.

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SRT Contributions to Finalization of AIRS Version-7

Before the finalization of AIRS Version-7, the following must be done:

- Test the new Neural-Net coefficients at SRT in all 4 seasons
- Install the new Neural-Net coefficients at JPL
- Remove use of the AMSU Channel-6 brightness temperature as an error estimate predictor. Channel-6 is degrading

The following should be done:

- Revisit details of all retrieval steps, error estimate methodology, and QC procedures. In particular, see if we can fix the cause of spuriously high total O_3 values over Antarctica and reduce the spurious high bias in mid-tropospheric water vapor.
- Fix the problem that causes a very small percentage of cloud parameter retrievals to blow up. This terminates the retrieval process and results in loss of all retrieval parameters for that FOR.
- Address any issues found in JPL testing of Version-6.22.

Our goal is to install our contributions to candidate Version-7 at JPL in June.

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