Analysis of CrIS/ATMS using AIRS Version-7 Retrieval and QC Methodology

Joel Susskind[1],
Louis Kouvaris[2], John M. Blaisdell[2], and Lena Iredell[2]

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[1]NASA GSFC Laboratory for Atmospheres
[2]SAIC

Background

- AIRS is a high spectral resolution IR grating spectrometer which has been flying on EOS Aqua and producing data products since September 2002. AIRS monthly mean products have been generated operationally from September 2002 through October 2017 using the AIRS Version-6 retrieval algorithm. AIRS Version-7 is expected to become operational in early 2018, and be used to generate AIRS products for its entire data record extending into the future. AIRS is accompanied by AMSU, a microwave radiometer.
- CrIS is a high spectral resolution IR interferometer with spatial and spectral characteristics similar to those of AIRS. It is accompanied by ATMS, a microwave radiometer. CrIS/ATMS flew on SNPP and was recently launched on NOAA-20.

Objective

The objective of this research is to develop and implement an algorithm to analyze a long term data record of CrIS/ATMS observations so as to produce monthly mean gridded Level-3 products which are consistent with, and will serve as a seamless follow on to, those of AIRS Version-7.

We feel the best way to achieve this result is to analyze CrIS/ATMS data using retrieval and Quality Control (QC) methodologies which are scientifically equivalent to those used in AIRS Version-7.

We developed and implemented a single retrieval program that uses as input either AIRS/AMSU or CrIS/ATMS radiance observations, and has appropriate switches that take into account the spectral and radiometric differences between CrIS and AIRS. Our methodology is call CHART (Climate Heritage AIRS Retrieval Technique).

Success Criteria

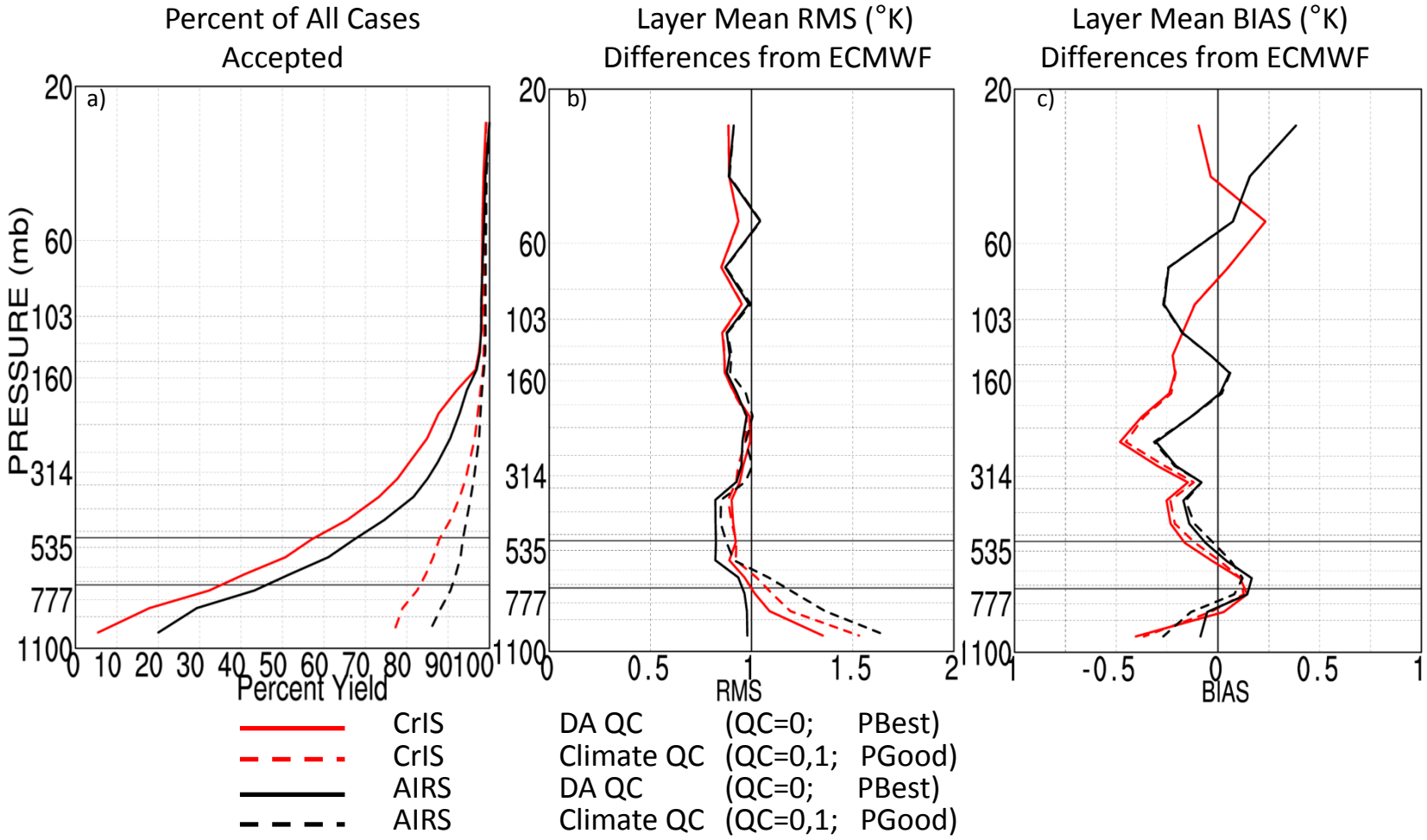
Our measure of success is the level of agreement of CrIS and AIRS monthly mean products with each other for months in common, and even more importantly, the level of agreement of interannual differences of CrIS and AIRS monthly mean products.

This is a status report of where we are today. We will show the level of agreement of CrIS and AIRS results for a single day in common, April 15, 2016. We also show agreement for the only single month in common we currently have, July 2015.

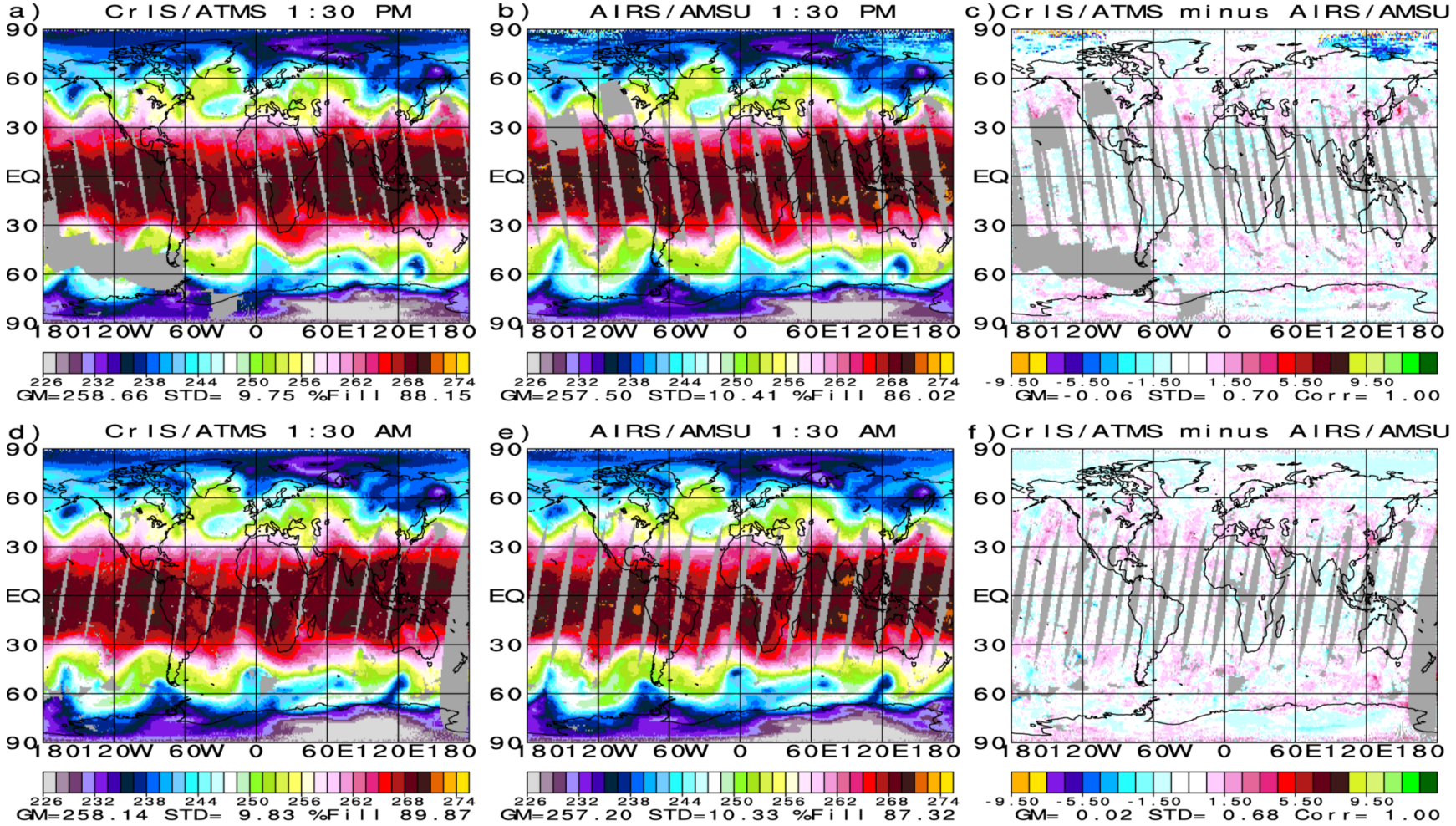
Results for July 2015 look very encouraging. We still need to compare CrIS and AIRS results for other months as well as interannual differences.

We are still working on further improving details of our CrIS retrieval system, especially with regard to surface skin temperature.

Global Temperature April 15, 2016
Statistics use their own QC

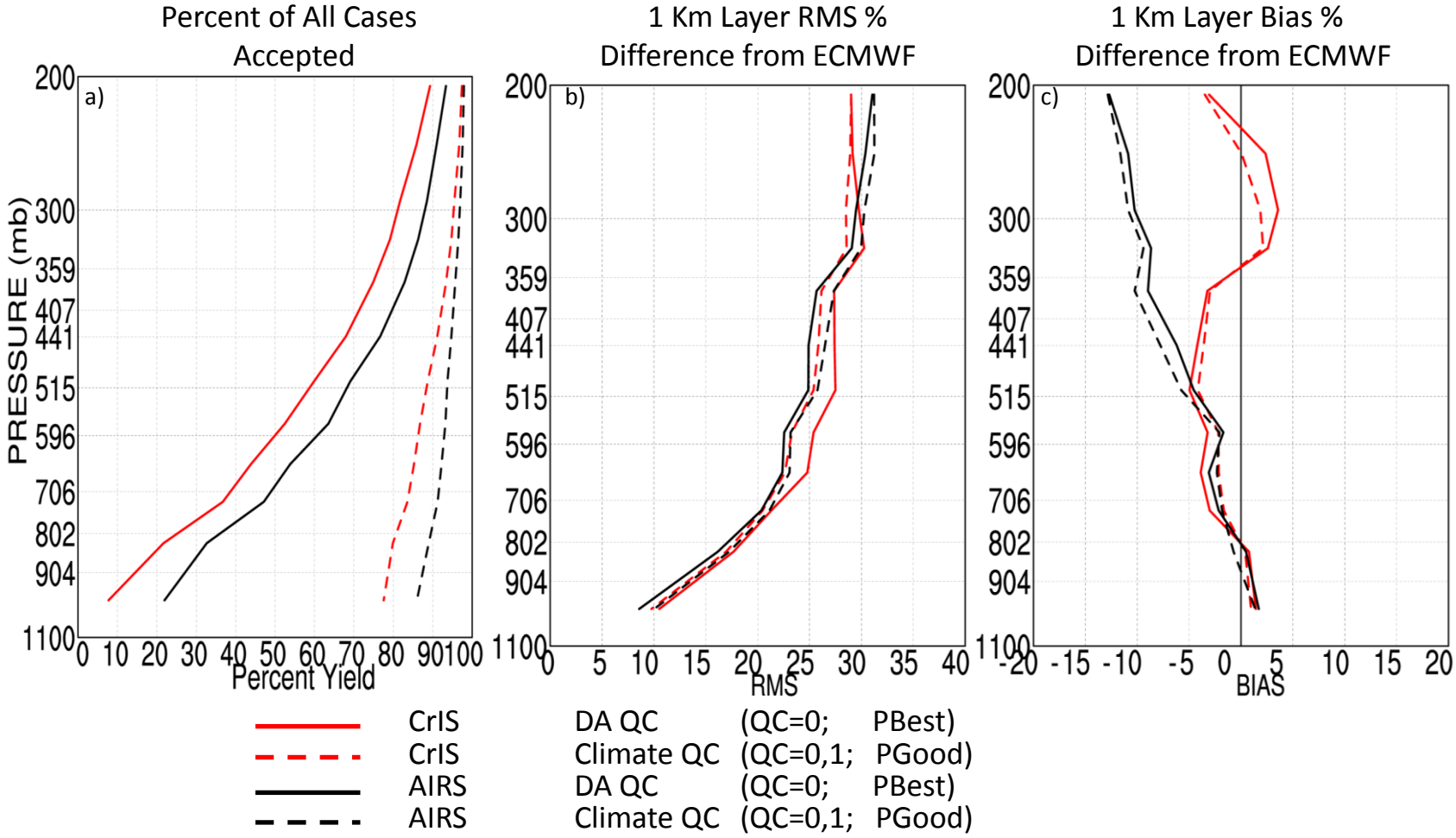


QC thresholds are pressure dependent. Statistics are shown for two sets of QC thresholds, those passing the highest standard and are accepted down to PBest, which we suggest for use for Data Assimilation purposes, and those accepted down to PGood, which are used for the creation of Level-3 products used for climate research. Somewhat less CrIS retrievals are accepted than AIRS, and CrIS RMS errors are slightly poorer.

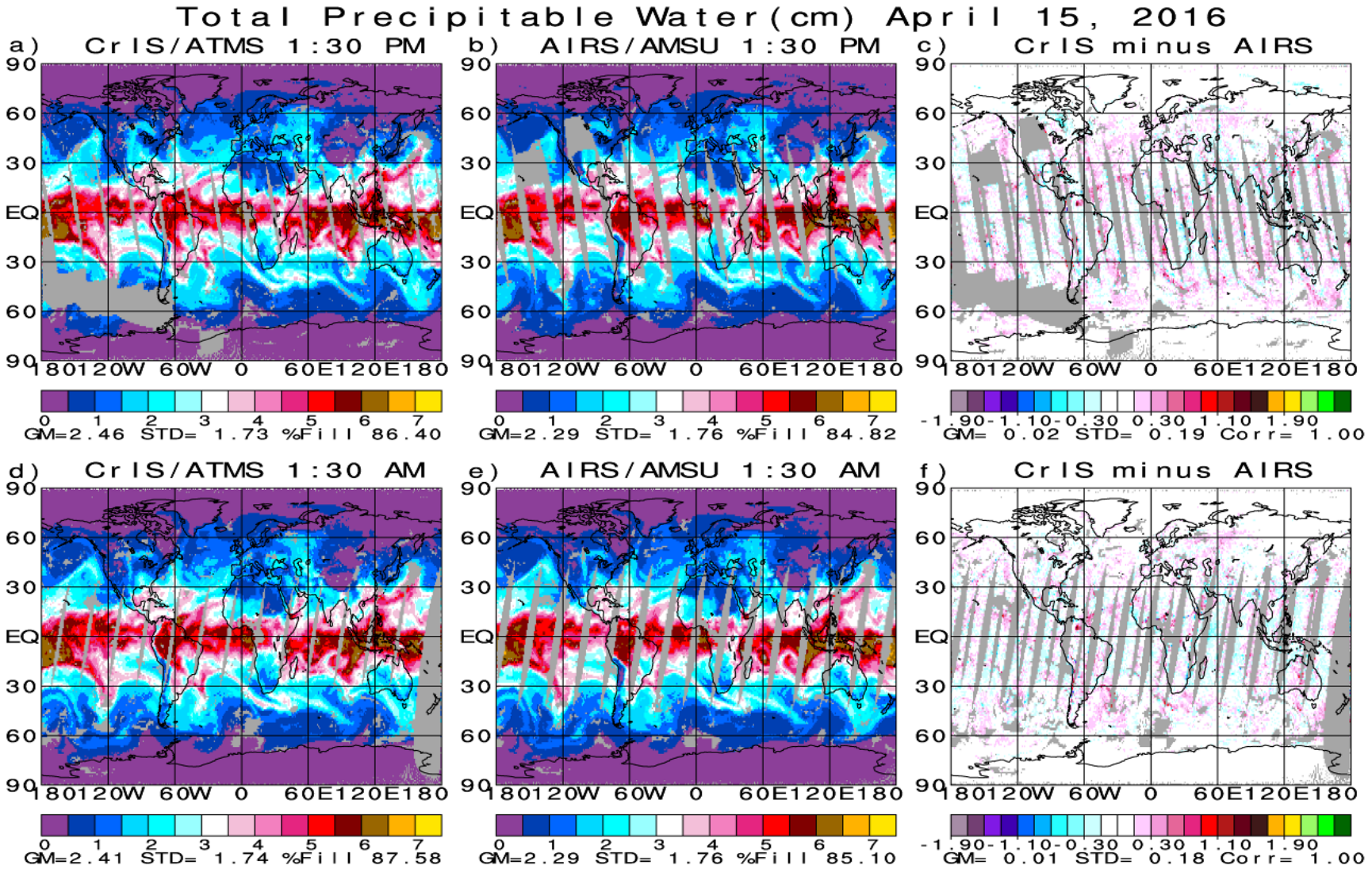


Grid boxes containing no data are shown in gray. This situation occurs between orbit gaps and in other places where observations are missing. It also occurs in grid boxes where all retrievals are rejected. CrIS observations have a wider swath than do AIRS, and therefore the CrIS orbit gaps are narrower than those of AIRS. CrIS and AIRS Level-3 500 mb temperatures agree extremely well with each other for both the 1:30 PM and 1:30 AM local time orbits on April 15, 2016. There is a slight mismatch in time at high latitudes between 1:30 PM CrIS and AIRS observations.

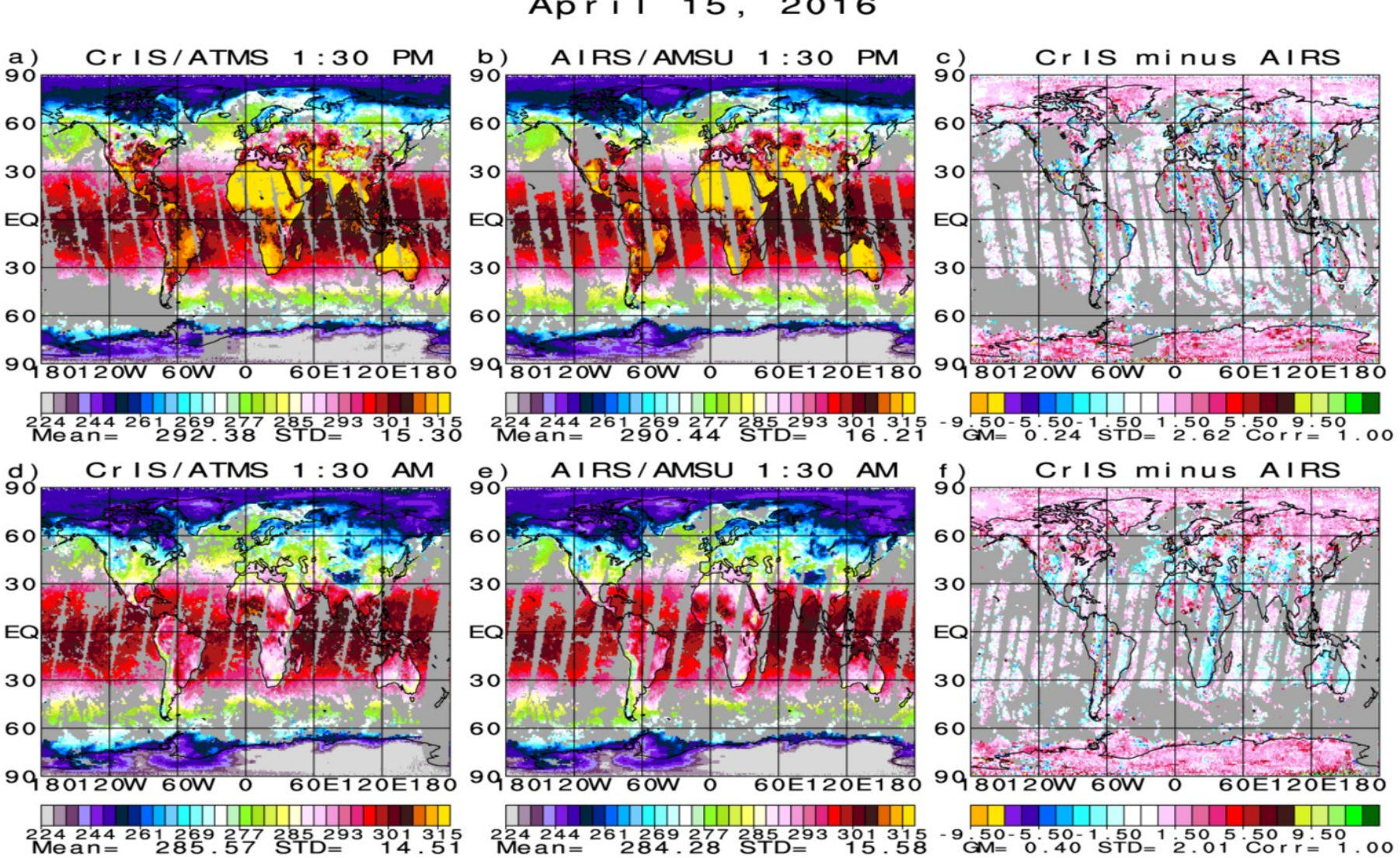
Global 1 Km Layer Precipitable Water (%) April 15, 2016
Statistics use their own QC



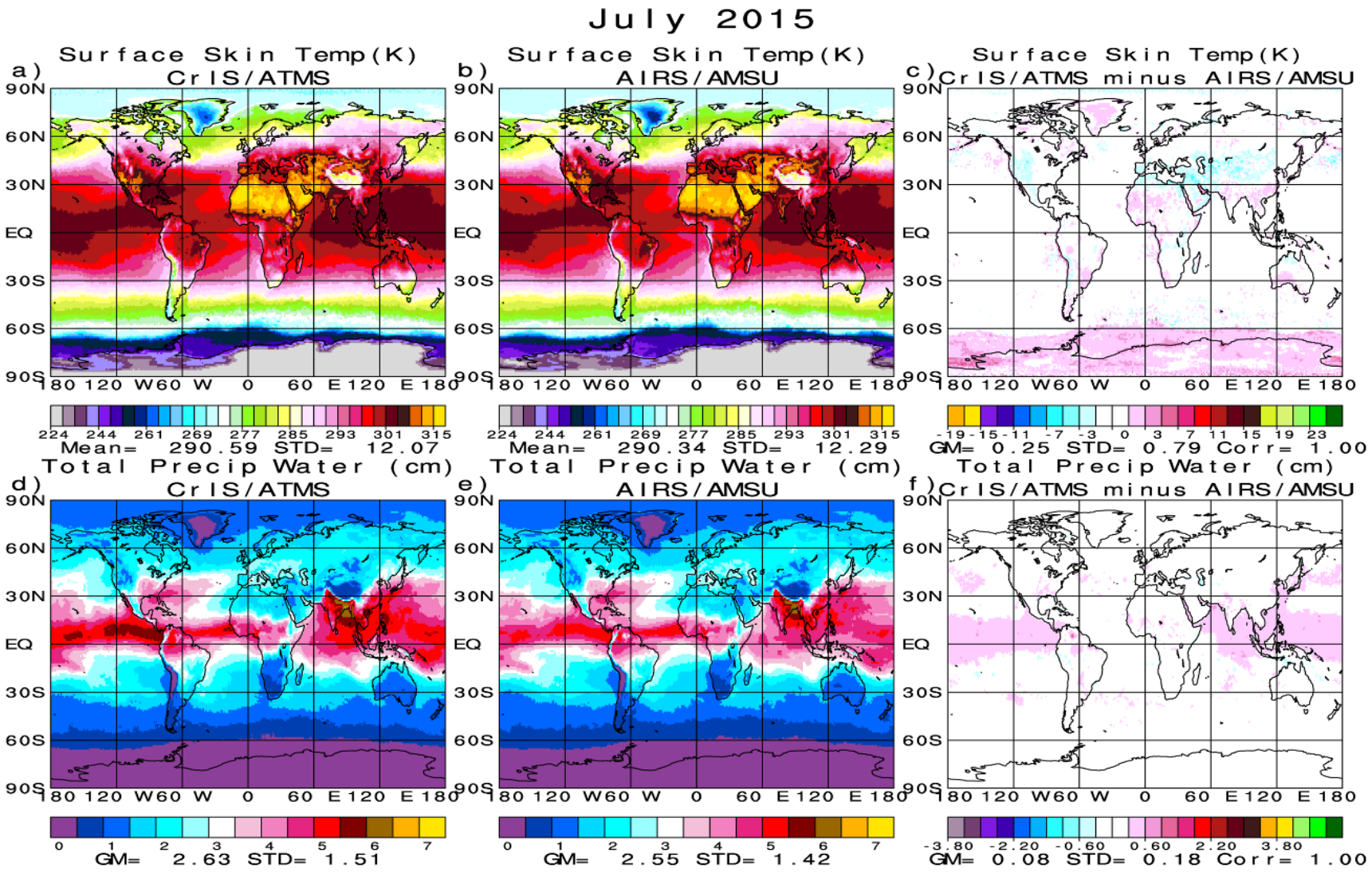
As with regard to T(p), the yield for accepted CrIS q(p) retrievals with either set of QC thresholds is somewhat lower than that of AIRS. Like AIRS, CrIS q(p) retrievals have high accuracy. Unlike AIRS, CrIS q(p) upper tropospheric retrievals are unbiased compared to ECMWF while AIRS is biased dry.



AIRS and CrIS single day Level-3 total precipitable water fields agree extremely well with each other, both in terms of biases as well as spatial standard deviations and correlations.

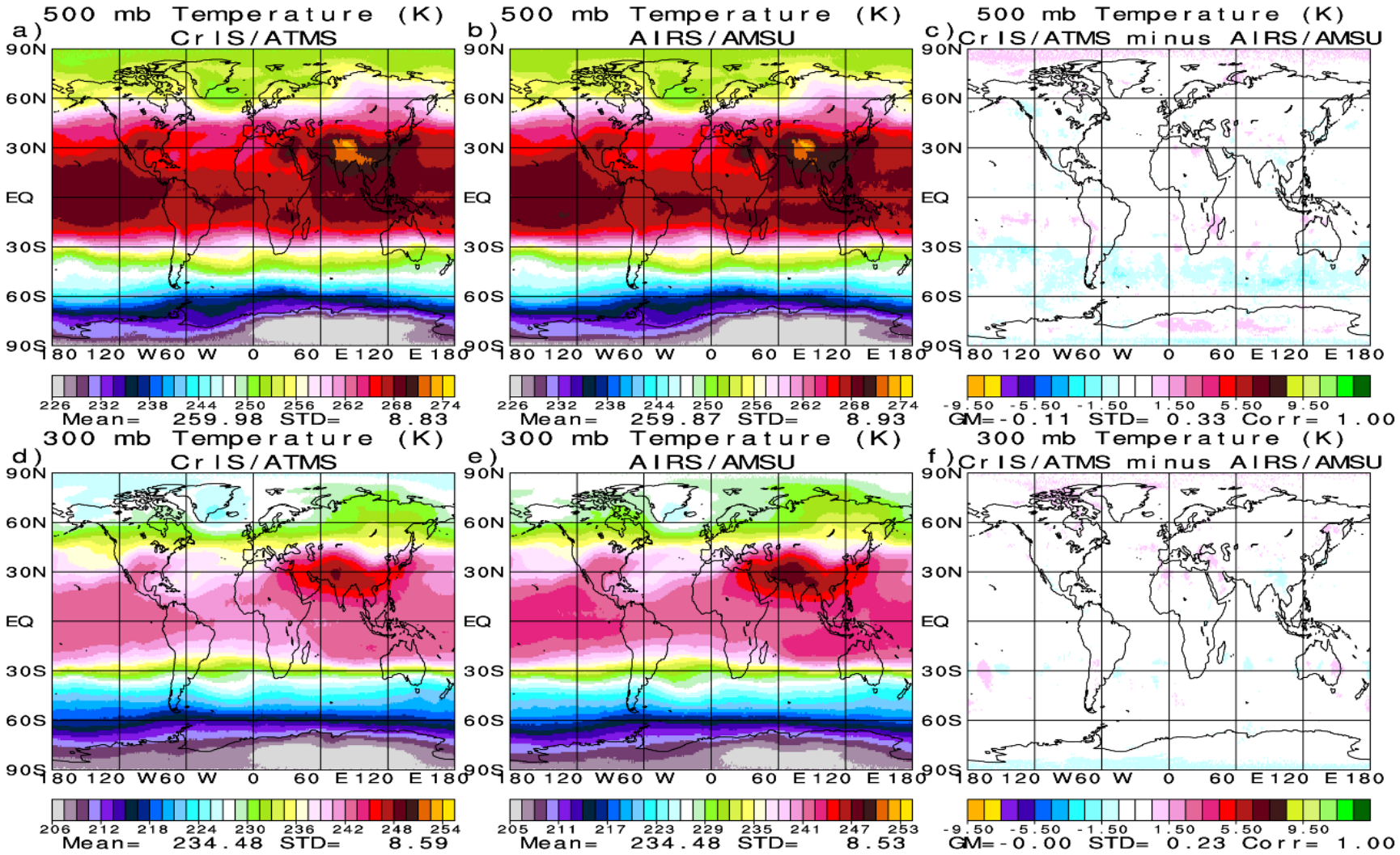


Agreement between CrIS and AIRS ocean skin temperature values (SST) is extremely good. CrIS Land Skin Temperature (LST) values agree somewhat poorer with AIRS, especially in polar areas in both Hemispheres, where LST is very cold. In these areas, CrIS LST is warmer than that of AIRS and may not be cold enough.

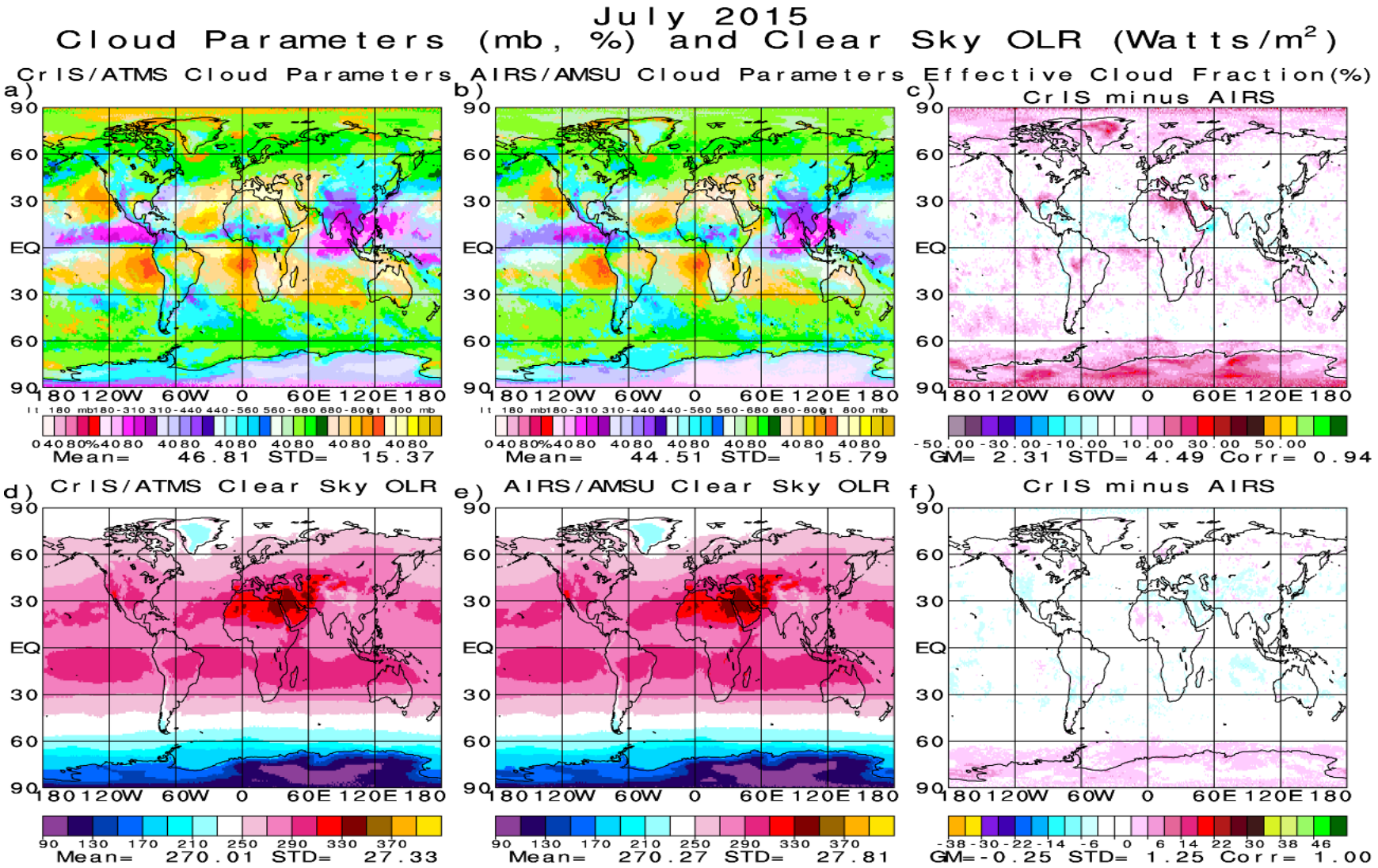


AIRS and CrIS monthly mean values of surface skin temperature and total precipitable water agree very well with each other. Monthly mean CrIS surface skin temperatures are slightly warmer than those of AIRS over Antarctica, where the earth's surface is extremely cold, and CrIS might not be cold enough. CrIS total precipitable water is slightly higher than AIRS over tropical ocean, and is more accurate than that of AIRS because CrIS has the benefit of ATMS.

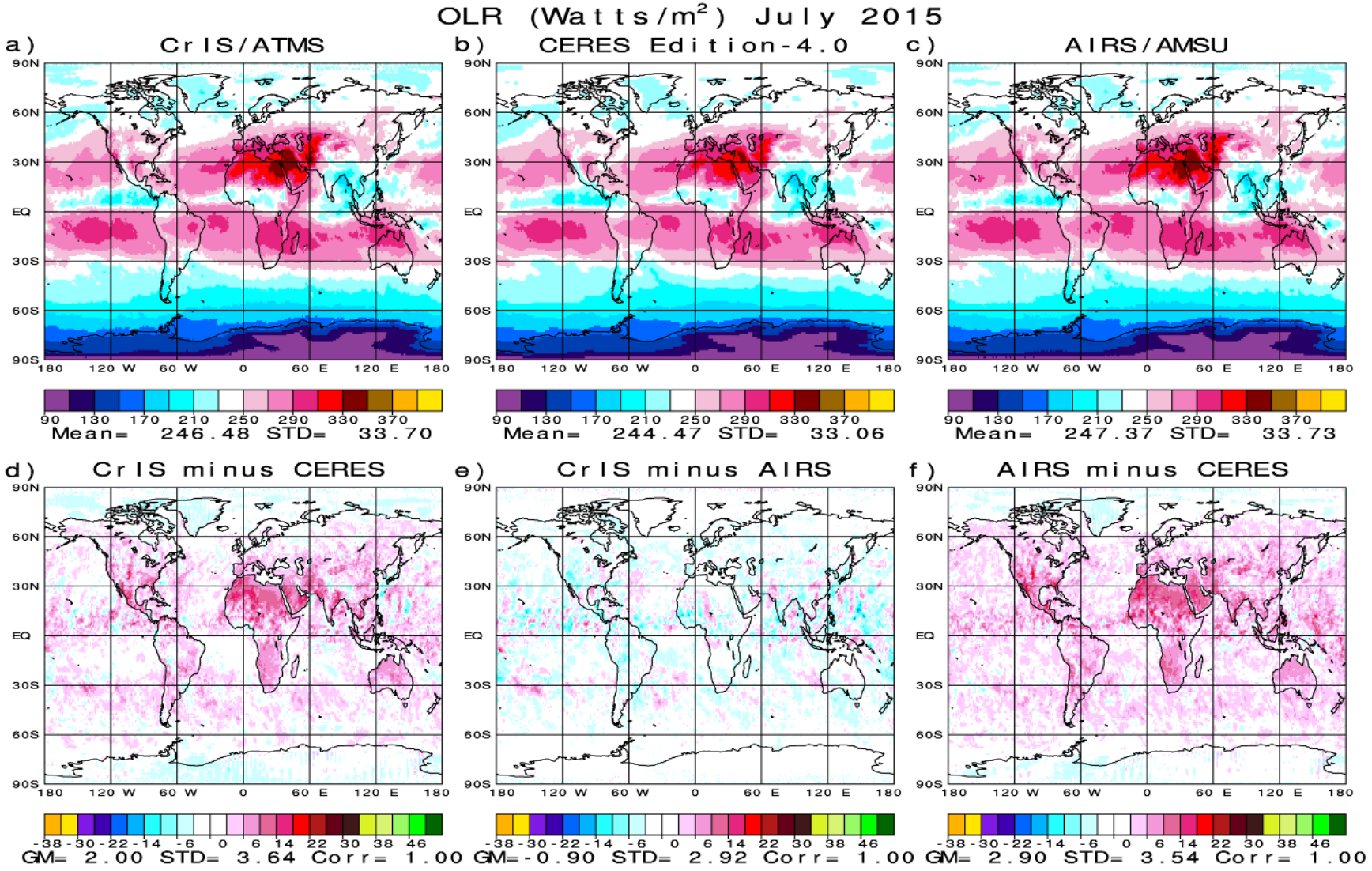
July 2015



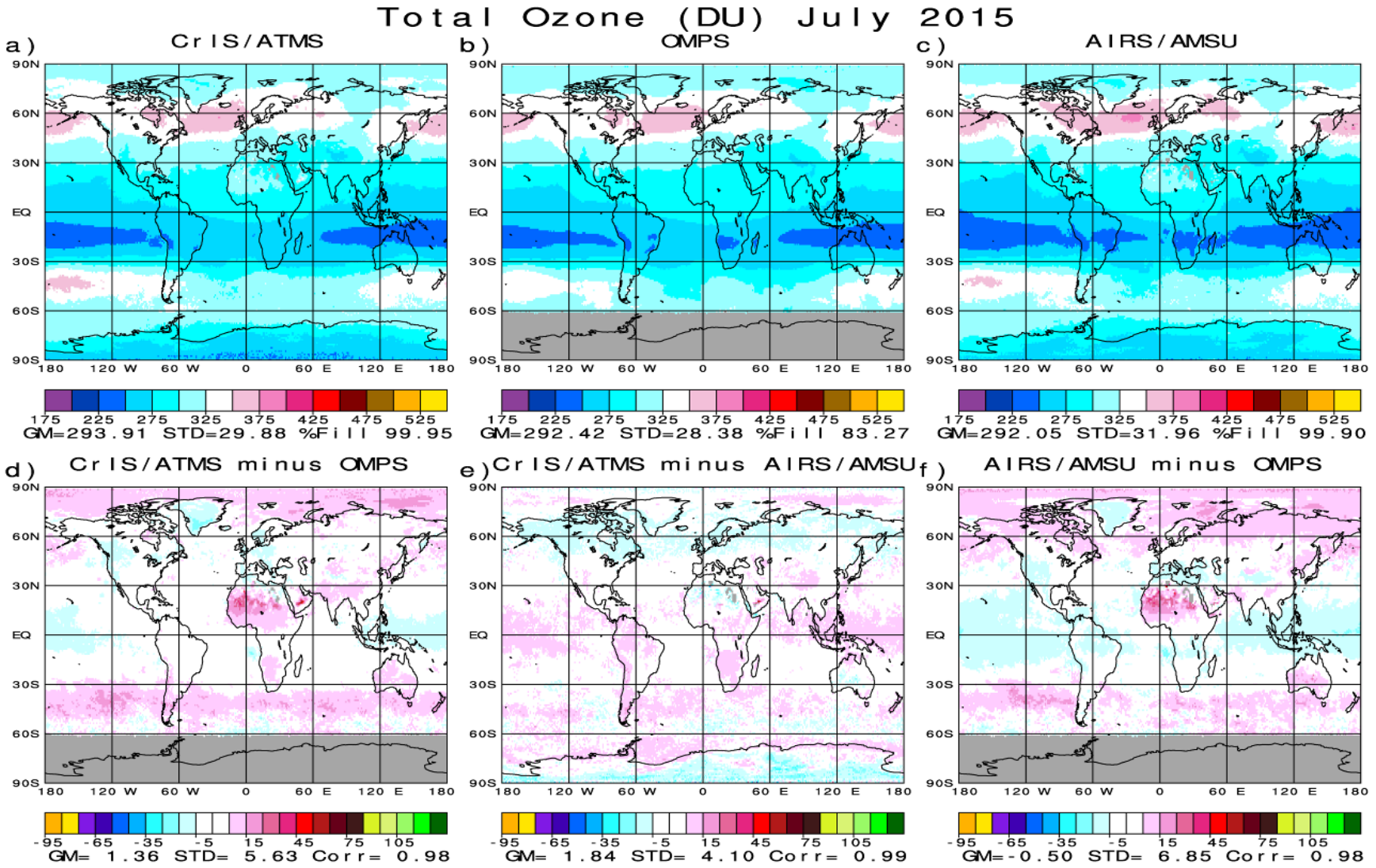
CrIS and AIRS monthly mean 500 mb temperatures and 300 mb temperatures are in almost perfect agreement with each other with regard to both global means as well as spatial standard deviations.



The agreement between CrIS and AIRS cloud products, and also between CrIS and AIRS clear sky OLR, is extremely good. The largest differences occur over Antarctica, where CrIS surface skin temperatures are warmer, and probably less accurate, than those of AIRS.



CrIS and AIRS July 2015 monthly mean values of OLR agree extremely well with each other, as well as with CERES Edition-4.0. CERES Edition-4.0 is considered the gold standard of OLR. CrIS OLR agrees even better with CERES than does AIRS.



CrIS and AIRS total ozone fields agree extremely well with each other, and also with that of Ozone Mapping and Profiling Suite (OMPS). OMPS is considered the gold standard of total ozone. OMPS has no data poleward of 60°S in July, because it is a UV instrument that requires sunlight. CrIS total ozone agrees even better with OMPS than does AIRS in terms of spatial standard deviation.

Status and Future Plans

- Current CrIS/ATMS results using CHART are encouraging. Select monthly mean CrIS/ATMS products for July 2015 match AIRS Version-7 very closely for almost all fields. CrIS/ATMS LST over very cold land surfaces appears to be not cold enough compared to AIRS. We are working on improving this result.
- CHART must be evaluated by comparison with AIRS for months in common for all seasons, as well as for interannual differences.
- We will generate and evaluate CHART NOAA-20 CrIS/ATMS products when the satellite radiances become available.