# Preliminary Assessment of the Accuracy of CrIS/ATMS Retrievals Generated at SRT Using an AIRS "Version-6-like" Retrieval Algorithm

Joel Susskind, Louis Kouvaris, and John Blaisdell
NASA GSFC Sounder Research Team (SRT)

AIRS Sounder Science Team Meeting
Greenbelt, MD

November 15, 2012

# Objective

Assessment of whether the CrIS/ATMS sounding system on NPP is adequate to allow for seamless continuation of AIRS/AMSU Version-6 Climate Data records

Approach

- Modify and optimize the AIRS/AMSU Version-6 retrieval algorithm for best use with CrIS/ATMS data

- Compare global CrIS/ATMS monthly mean level-3 products with those of AIRS/AMSU for a number of months

  Biases, inter-month differences

# Current Status

The AIRS Version-6 retrieval algorithm is currently not fully operational at SRT

- John Blaisdell has not yet successfully implemented the neural-net initial guess

SRT AIRS Version-5.59 is otherwise functionally identical to JPL AIRS Version-6 but uses a two-regression based initial guess

We are currently running CrIS/ATMS retrievals using an algorithm analogous to AIRS Version-5.59

We show results comparing V-5.59 CrIS/ATMS, V-5.59 AIRS/AMSU, and V-6 AIRS/AMSU

- The goal is to eventually run CrIS/ATMS Version-6 retrievals using neural-net at SRT and then at the Sounder PEATE

John Blaisdell expects to have AIRS/AMSU neural-net running at SRT by the end of November

Bill Blackwell has indicated he could get us CrIS/ATMS neural-net coefficients in December

# Cross Track Infrared Sounder CrIS

CrIS is the infrared high spectral resolution atmospheric sounder on Suomi-NPP: 1305 channels between 650 $cm^{-1}$ and 2550 $cm^{-1}$

CrIS/ATMS comprise the IR/MW Sounding Suite on NPP called CrIMSS

CrIS is functionally equivalent to AIRS, the high spectral resolution IR sounder on EOS Aqua and ATMS is functionally equivalent to AMSU on EOS Aqua

CrIS is an interferometer and AIRS is a grating spectrometer however:

- Spectral coverage, spectral resolution, and channel noise of CrIS are similar to AIRS

  CrIS spectral sampling is roughly twice as coarse as AIRS

  AIRS has 2378 channels extending to 2665 $cm^{-1}$

- Spatial resolution of CrIS is comparable to AIRS

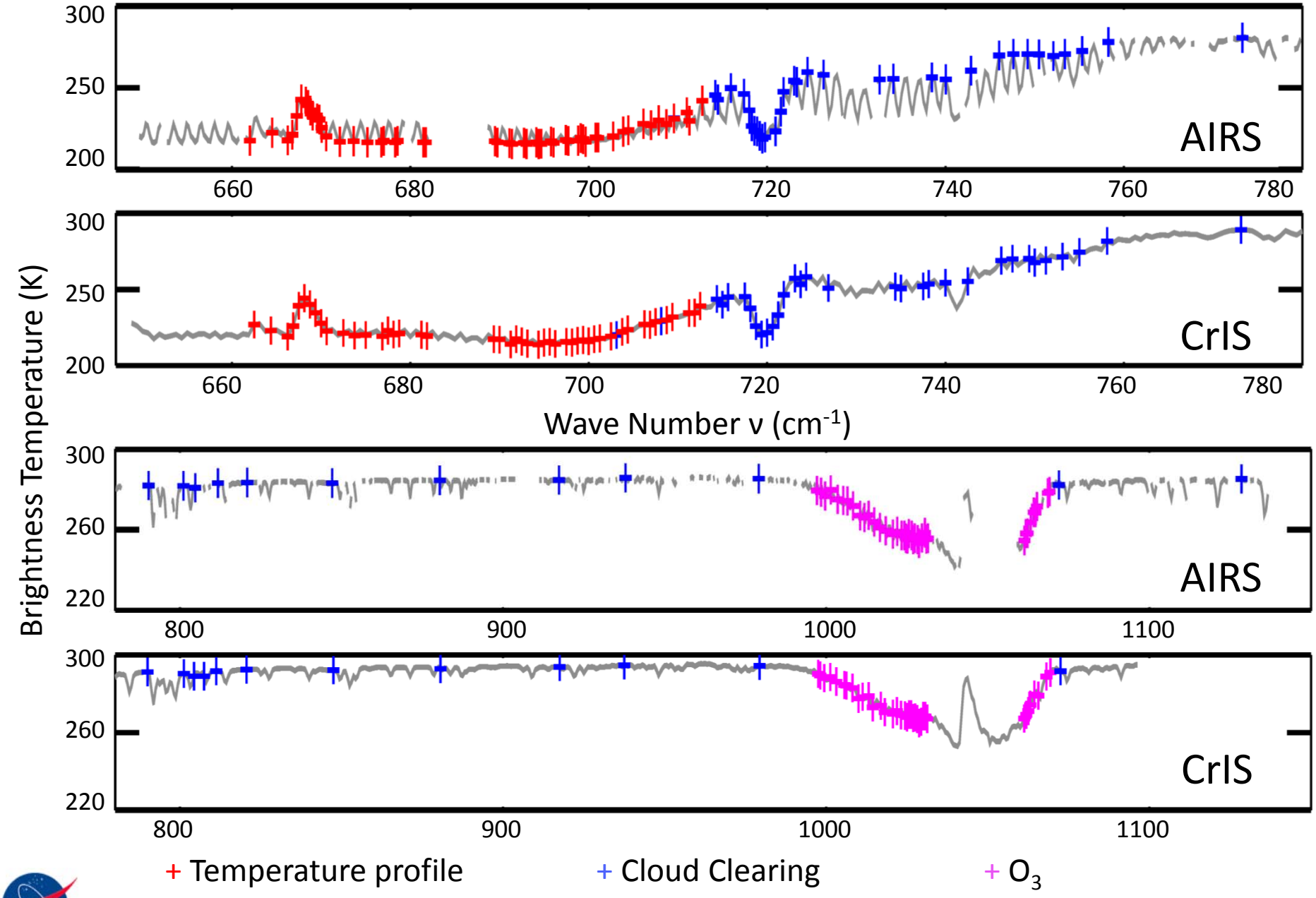
# Adaptation of AIRS 5.59 Retrieval Program to Run Using CrIS/ATMS Data

- Uses CrIS/ATMS Level-1 radiances obtained from Sounder PEATE
- AIRS preprocessor was modified to be consistent with CrIS/ATMS scan pattern and channel $NE\Delta N_i$
  - We use the average $NE\Delta N_i$ of all 9 detectors as $NE\Delta N_i$
- Uses CrIS Hamming Apodized RTA obtained from Larrabee Strow
- Uses ATMS RTA obtained from Phil Rosenkranz
- Program has been modified by Chris Barnet to account for the fact that observed CrIS Hamming apodized radiances $R_i$ have channel correlated $NE\Delta N_i$
- CrIS channels have been selected for use in different retrieval steps analogous to those of AIRS Version-6

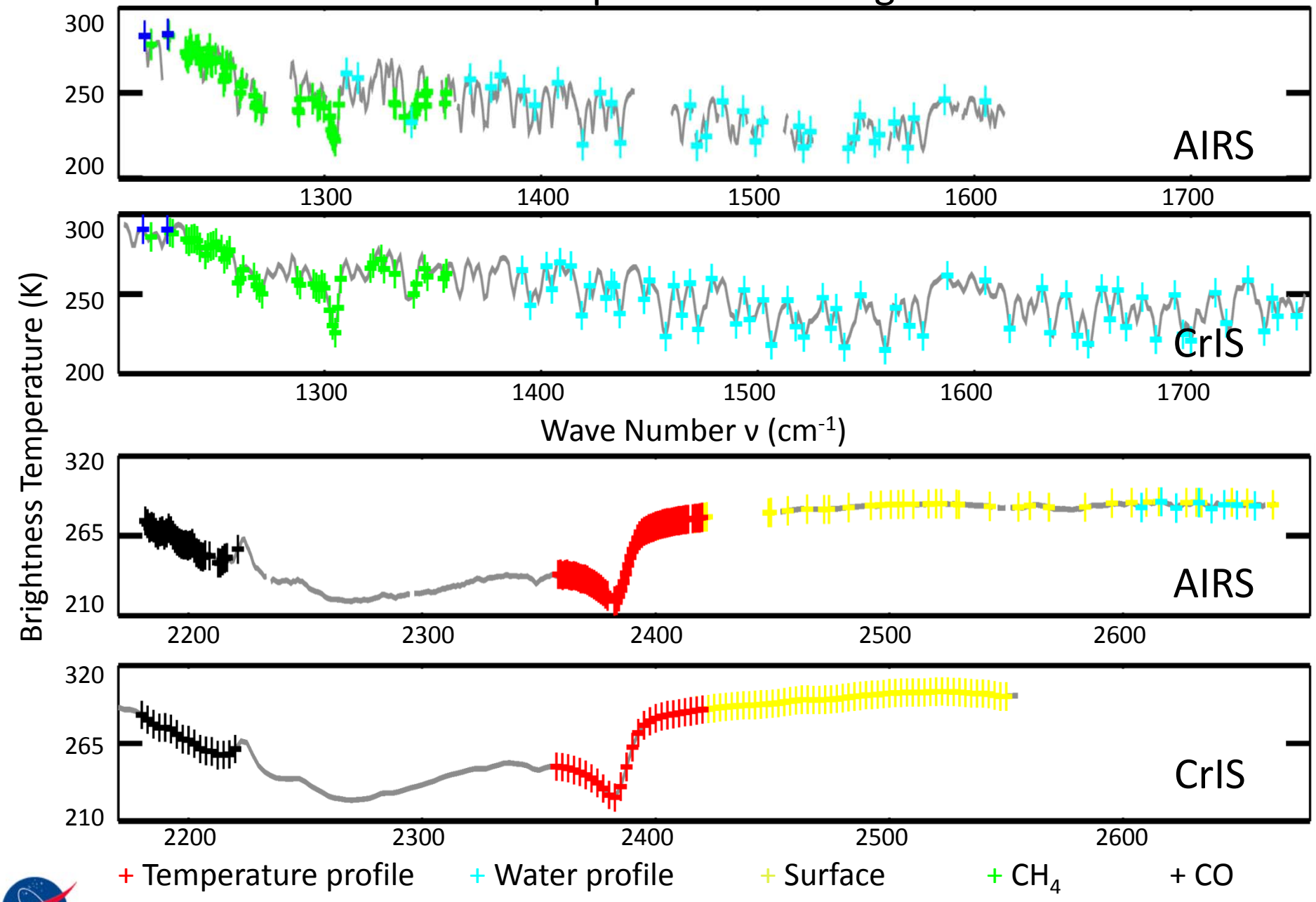
<u>Current Limitations</u>

- AIRS program has not yet been modified to account for CrIS $NE\Delta N_i$ being spot dependent (different detectors)
- AIRS 3x3 radiance angle correction to central 3x3 FOV zenith angle is not used for CrIS because CrIS scan pattern is more complicated than AIRS – Chris Barnet said he will generate appropriate code for CrIS

# Simulated Noise-free Spectra indicating Retrieval Channels



# Simulated Noise-free Spectra indicating Retrieval Channels



# Current Status

We ran CrIS/ATMS Version-5.59 retrievals for 2 days

**July 10, 2012 – preparation day**

These retrievals were used to

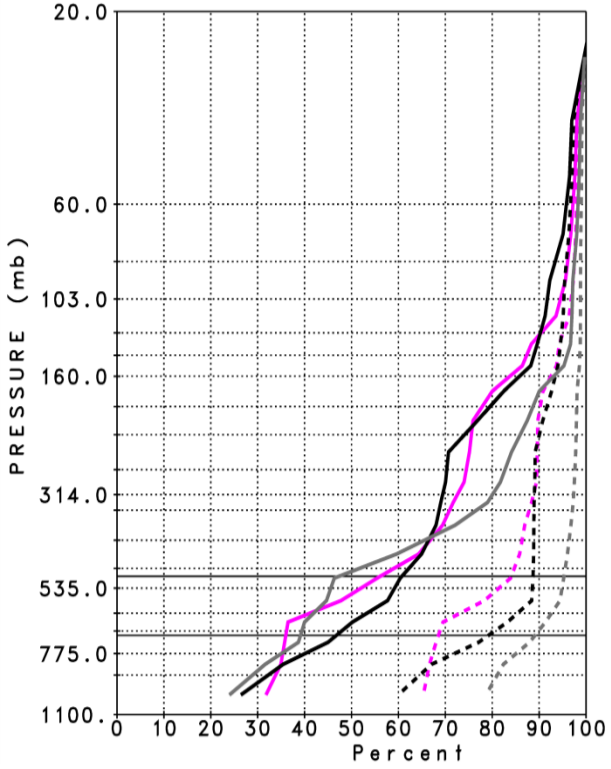
- Do preliminary optimization studies
  channels, functions, damping parameters
- Generate CrIS and ATMS tuning coefficients
- Generate CrIS/ATMS error estimate coefficients
- Generate CrIS/ATMS QC thresholds
  QC=0 thresholds were set to minimize RMS errors
  QC=1 thresholds were set to maximize yield with reasonable RMS errors

**September 14, 2012 – test day**

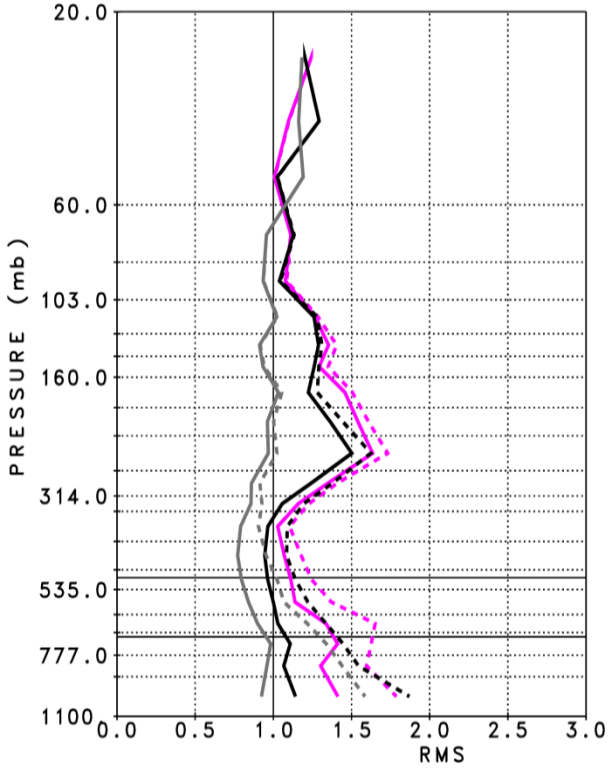
- CrIS/ATMS V-5.59 retrievals were run using coefficients and thresholds determined for July 10
- AIRS/AMSU Version-6 retrievals were run at JPL
- AIRS/AMSU Version-5.59 retrievals were run at SRT
  Uses AIRS Science Team tuning, regression coefficients, and error estimate coefficients
  T(p) QC thresholds were set for yields comparable to CrIS/ATMS

# Global Temperature Profile September 14, 2012

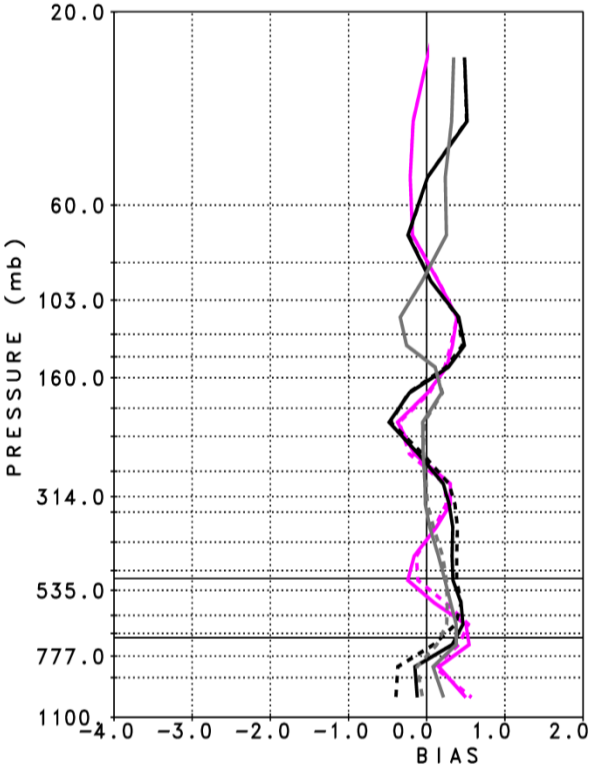
Percent of All Cases Accepted




1 km Layer Mean RMS (°K) Differences from ECMWF




1 km Layer Mean BIAS (°K) Differences from ECMWF

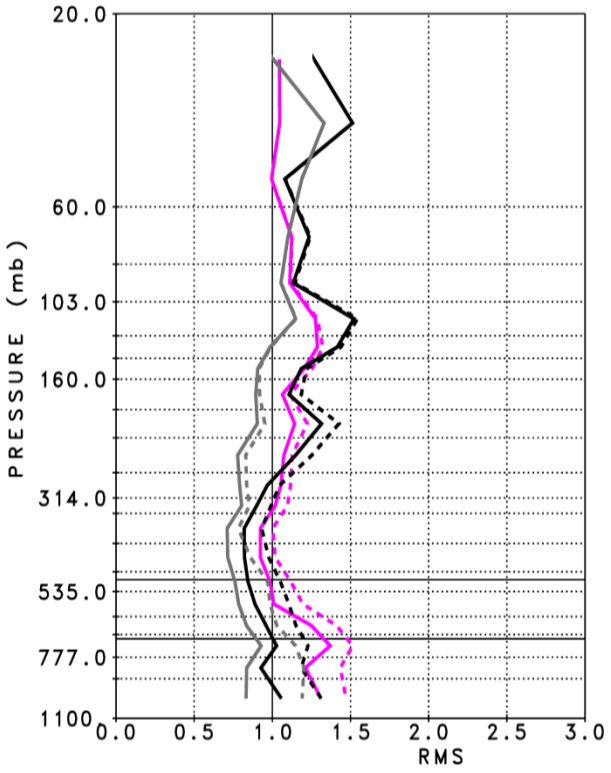



| | |
|---|---|
| CrIS Version-5.59 | DA QC |
| CrIS Version-5.59 | Climate QC |
| AIRS Version-5.59 | DA QC |
| AIRS Version-5.59 | Climate QC |
| AIRS Version-6 | DA QC |
| AIRS Version-6 | Climate QC |

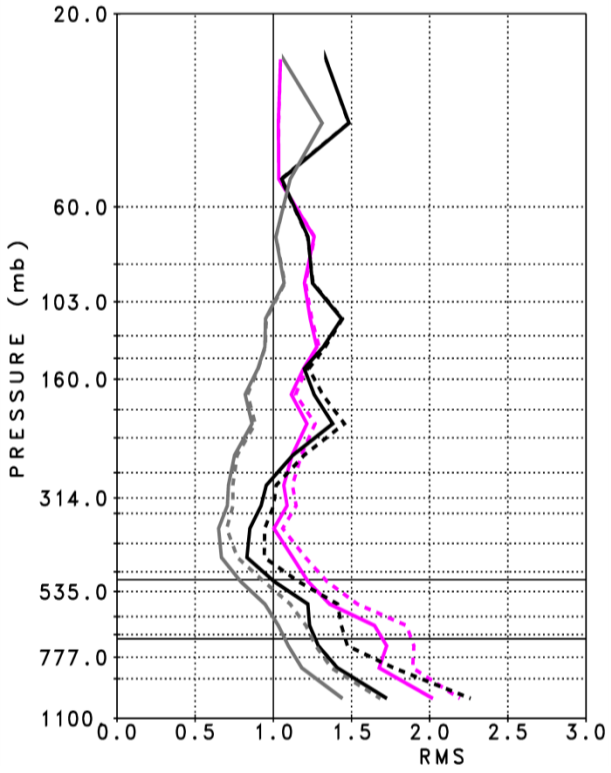
# Temperature Profile September 14, 2012

## Layer Mean RMS (°K) Differences from ECMWF

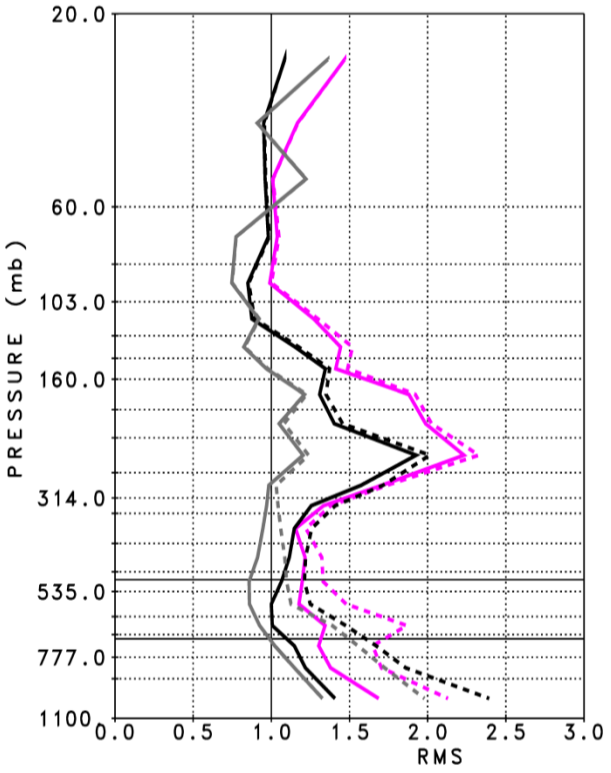
Ocean 50°N to 50°S




Non-Ocean 50°N to 50°S

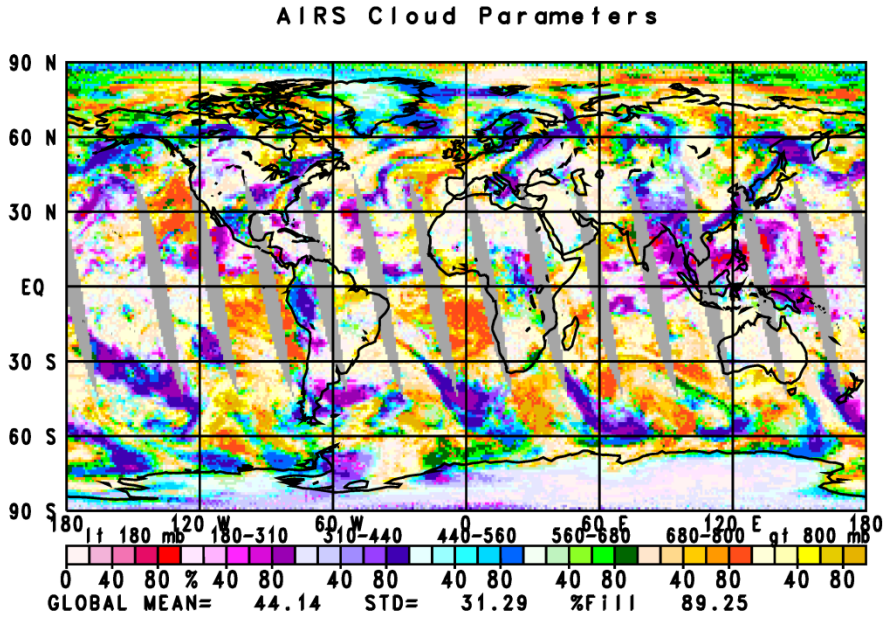


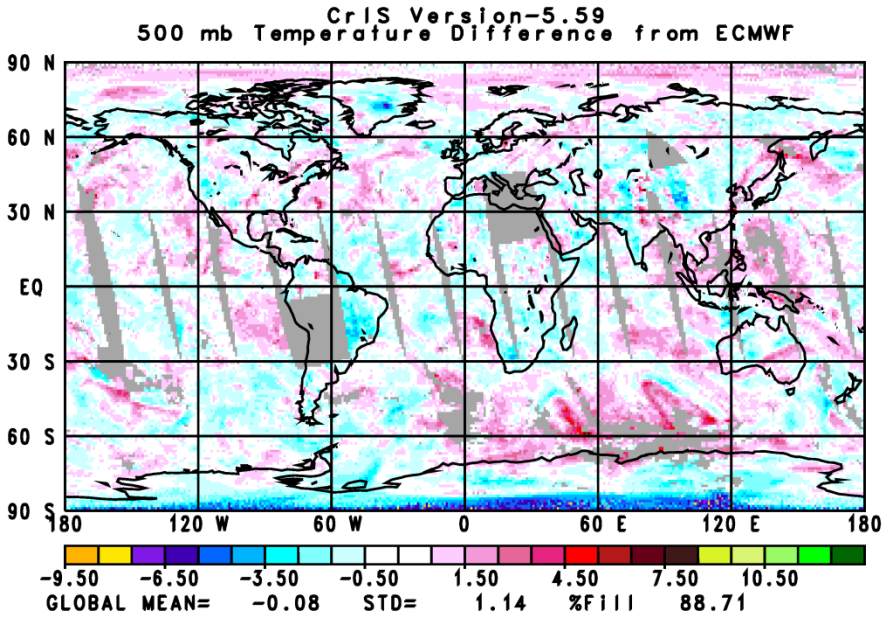

Poleward of 50°

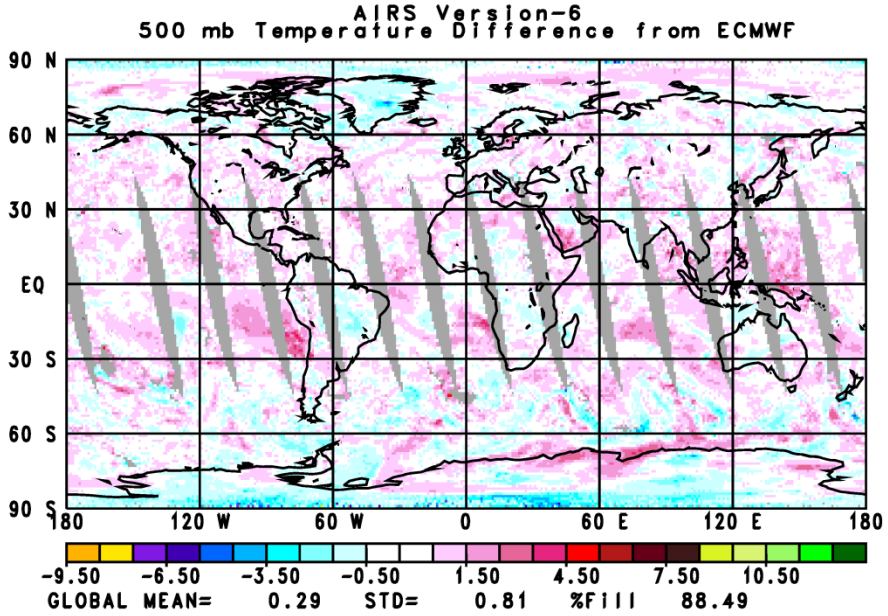


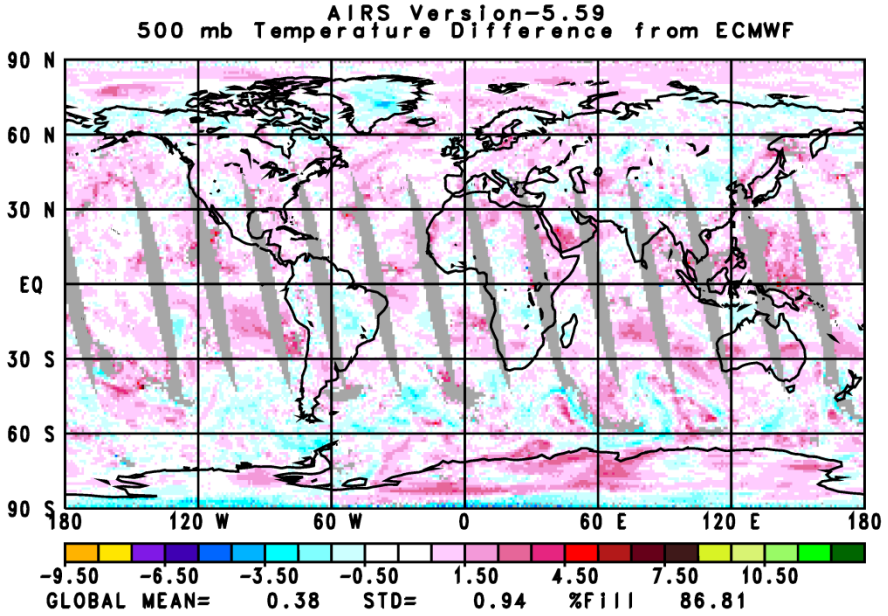

| | |
|---|---|
| CrIS Version-5.59 | DA QC |
| CrIS Version-5.59 | Climate QC |
| AIRS Version-5.59 | DA QC |
| AIRS Version-5.59 | Climate QC |
| AIRS Version-6 | DA QC |
| AIRS Version-6 | Climate QC |

# September 14, 2012 1:30 PM Climate QC



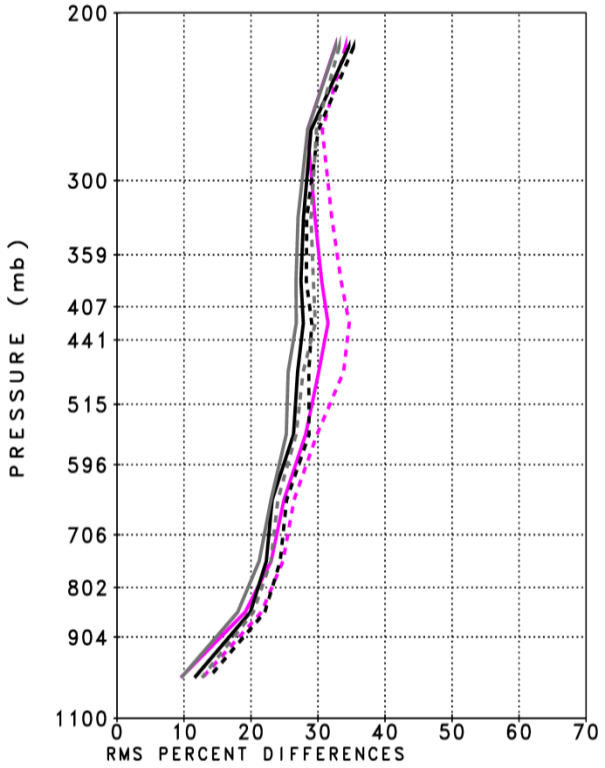



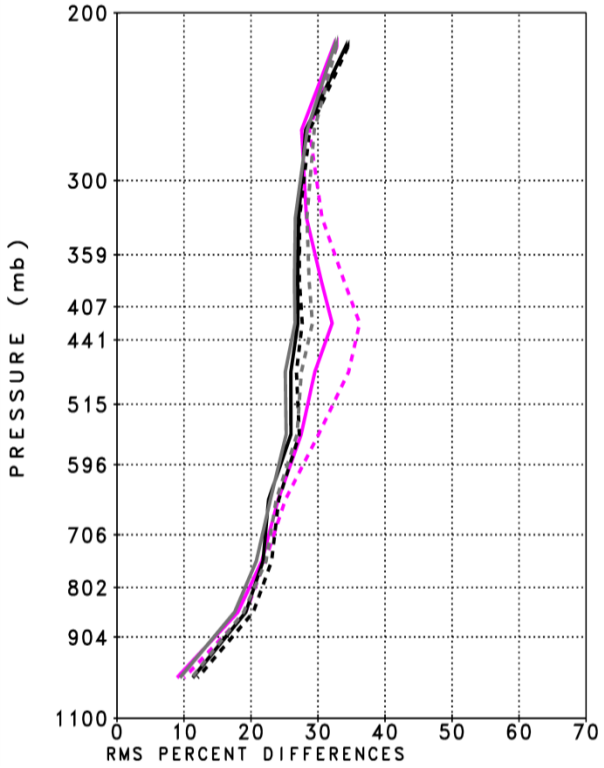
# Water Vapor Profile September 14, 2012

## 1 Km Layer Mean Precipitable Water RMS % Differences from ECMWF

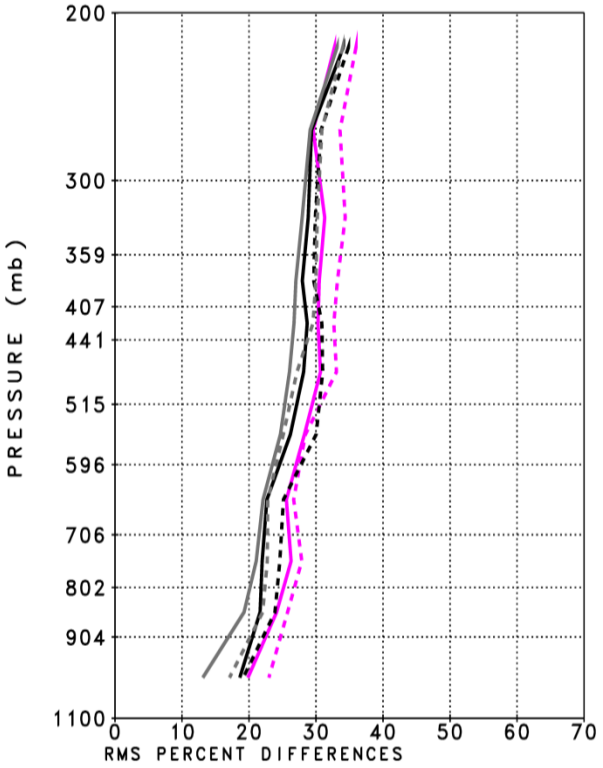
Global




Ocean 50°N to 50°S

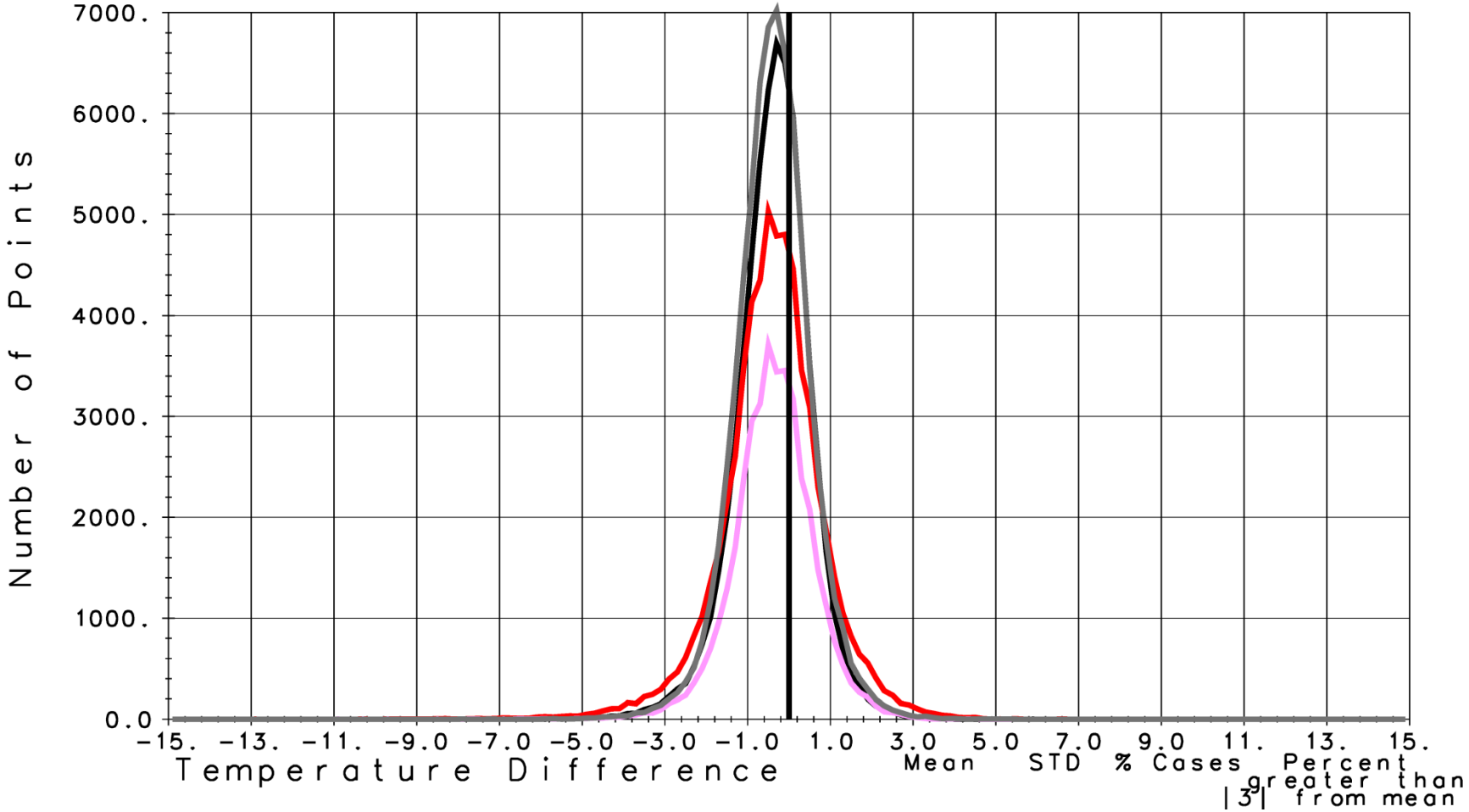



Non-Ocean 50°N to 50°S



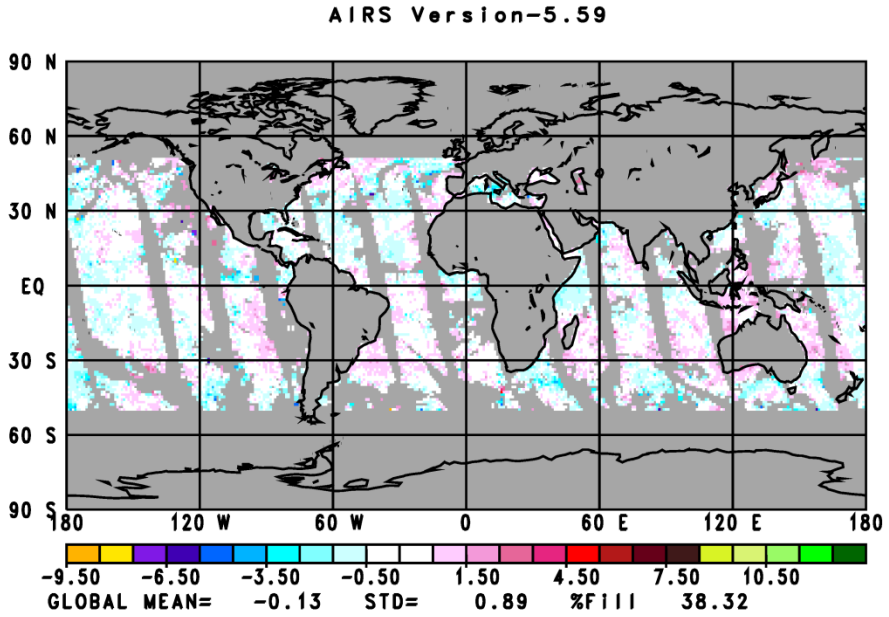

| | |
|---|---|
| CrIS Version-5.59 | DA QC |
| CrIS Version-5.59 | Climate QC |
| AIRS Version-5.59 | DA QC |
| AIRS Version-5.59 | Climate QC |
| AIRS Version-6 | DA QC |
| AIRS Version-6 | Climate QC |

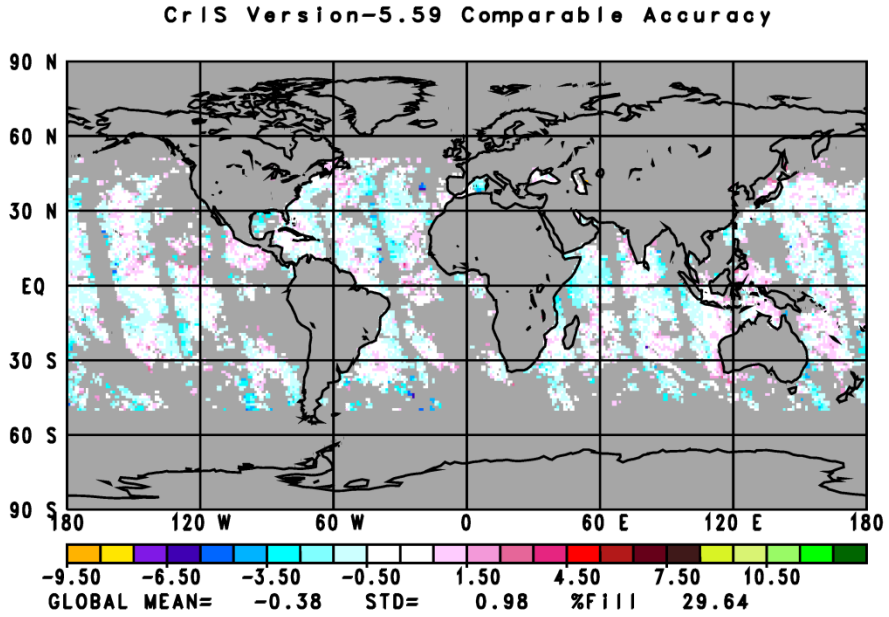
# Surface Skin Temperature Difference from ECMWF
## September 14, 2012 Daytime and Nighttime Combined
## 50°N to 50°S Non-Frozen Ocean

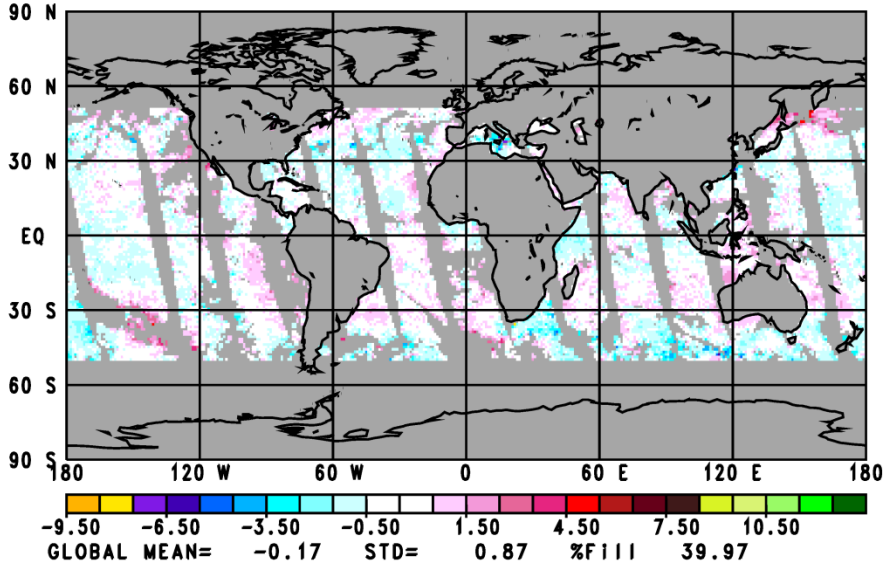


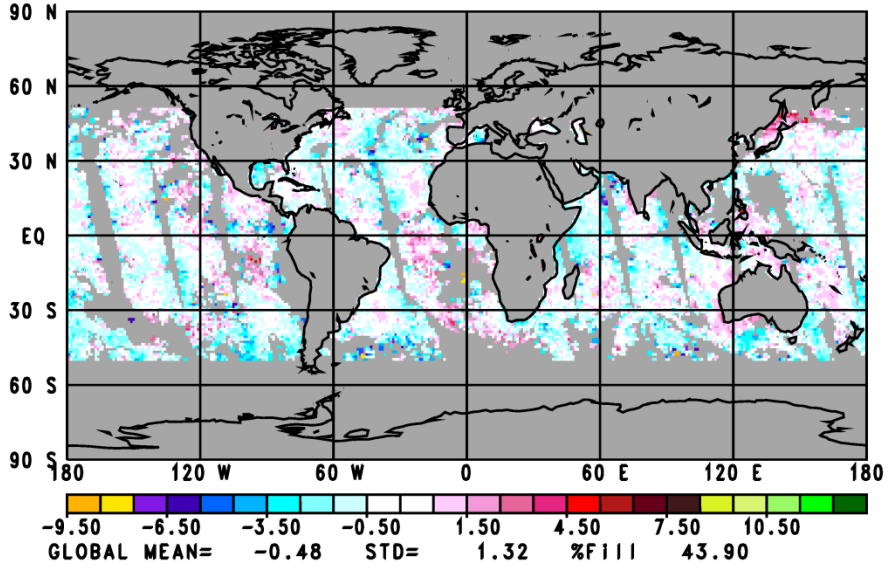

| | Mean | STD | % Cases | Percent greater than \|3\| from mean |
|---|---|---|---|---|
| AIRS Version-6 | -0.18 | 0.89 | 55.13 | 0.92 |
| AIRS Version-5.59 | -0.18 | 0.90 | 49.33 | 1.11 |
| CrIS Version-5.59 Comparable Yield | -0.20 | 1.23 | 46.20 | 3.50 |
| CrIS Version-5.59 Comparable Accuracy | -0.18 | 0.97 | 30.09 | 1.20 |

# Ocean Surface Skin Temperature (K) Difference from ECMWF
## September 14, 2012 1:30 PM



# Findings with Current CrIS/ATMS Retrieval System

Temperature Profile T(p)

- V-5.59 CrIS/ATMS T(p) retrievals with similar yields perform poorer than Version-5.59 AIRS/AMSU retrievals in the troposphere, especially over land
- V-6 AIRS/ATMS T(p) retrievals are significantly better than either V-5.59 AIRS/AMSU or V-5.59 CrIS/ATMS

Water Vapor Profile q(p)

- CrIS/ATMS q(p) retrievals perform well beneath 850 mb over ocean, but poorly over land
  - This may be a result of benefits of ATMS over ocean
- Both sets of AIRS/AMSU q(p) retrievals are better than CrIS/ATMS above 800 mb

Ocean Skin Temperature $T_s$

- Ocean CrIS/ATMS $T_s$ retrievals are currently poor compared to AIRS/AMSU – lower yield with comparable errors or comparable yield with higher errors
- This might be a consequence of CrIS extending only to 2550 $cm^{-1}$ rather than 2665 $cm^{-1}$ for AIRS

# Future Plans

- Test CrIS/ATMS retrievals on more days
- Continue optimization of CrIS/ATMS retrievals including cloud parameters and trace gases
- Bring up CrIS/ATMS "Version-6" retrieval system at SRT when practical

  Hopefully in early 2013
- Optimize the "Version-6" CrIS/ATMS retrieval system
- Work with Sounder PEATE to implement Version-6 CrIS/ATMS retrievals at JPL

  Must be suitable for the processing of extended time periods
- Validate results with CrIS/ATMS retrievals obtained at SRT
- Go "operational" with Version-6 CrIS/ATMS at Sounder PEATE in mid-late 2013
- Run retrievals for a number of months and compare global monthly mean CrIS/ATMS Version-6 Level-3 products with those of AIRS/AMSU

  Biases, inter-month differences, spatial coverage