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

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AIRS Sounder Science Team Meeting
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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
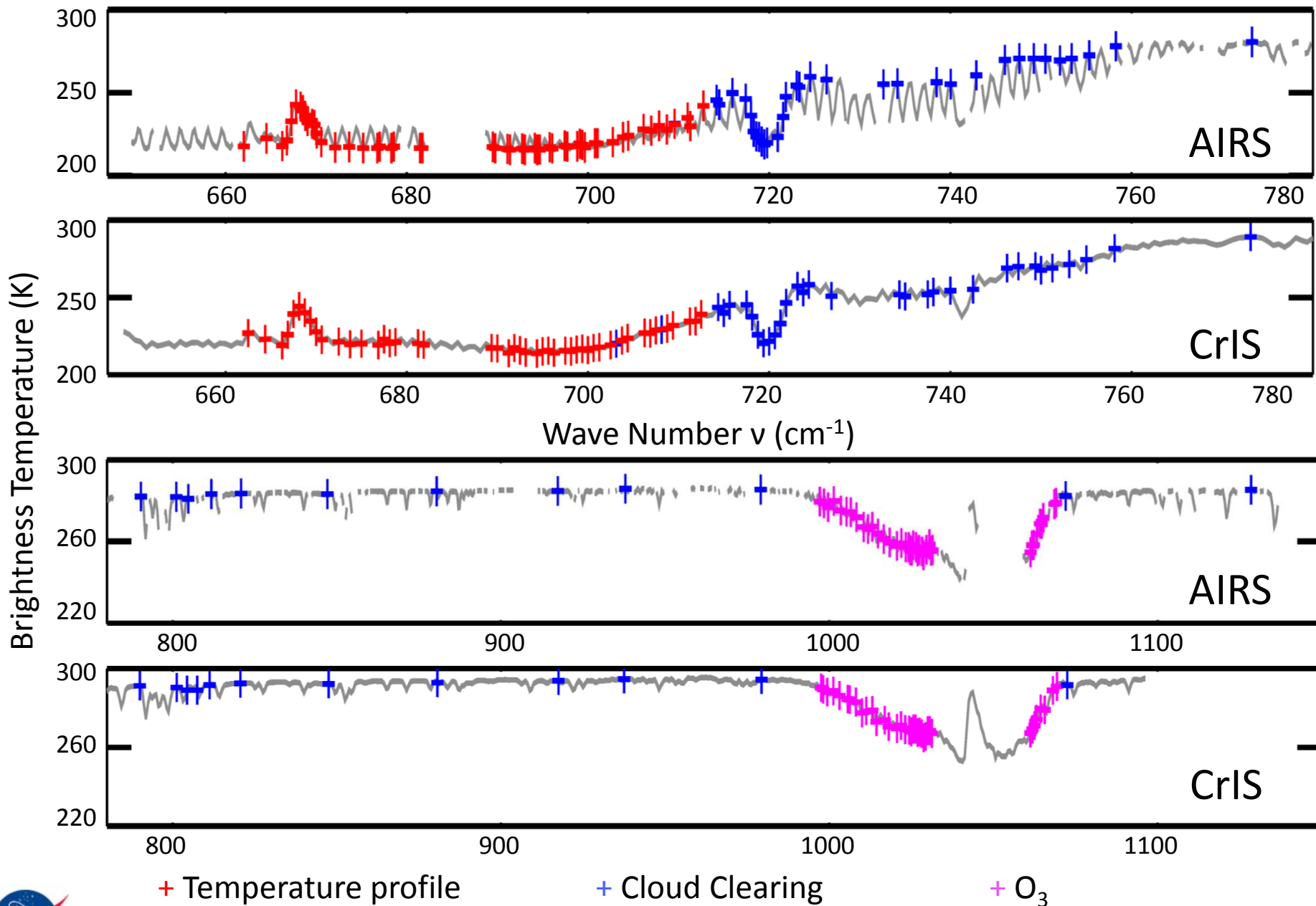
Current Limitations

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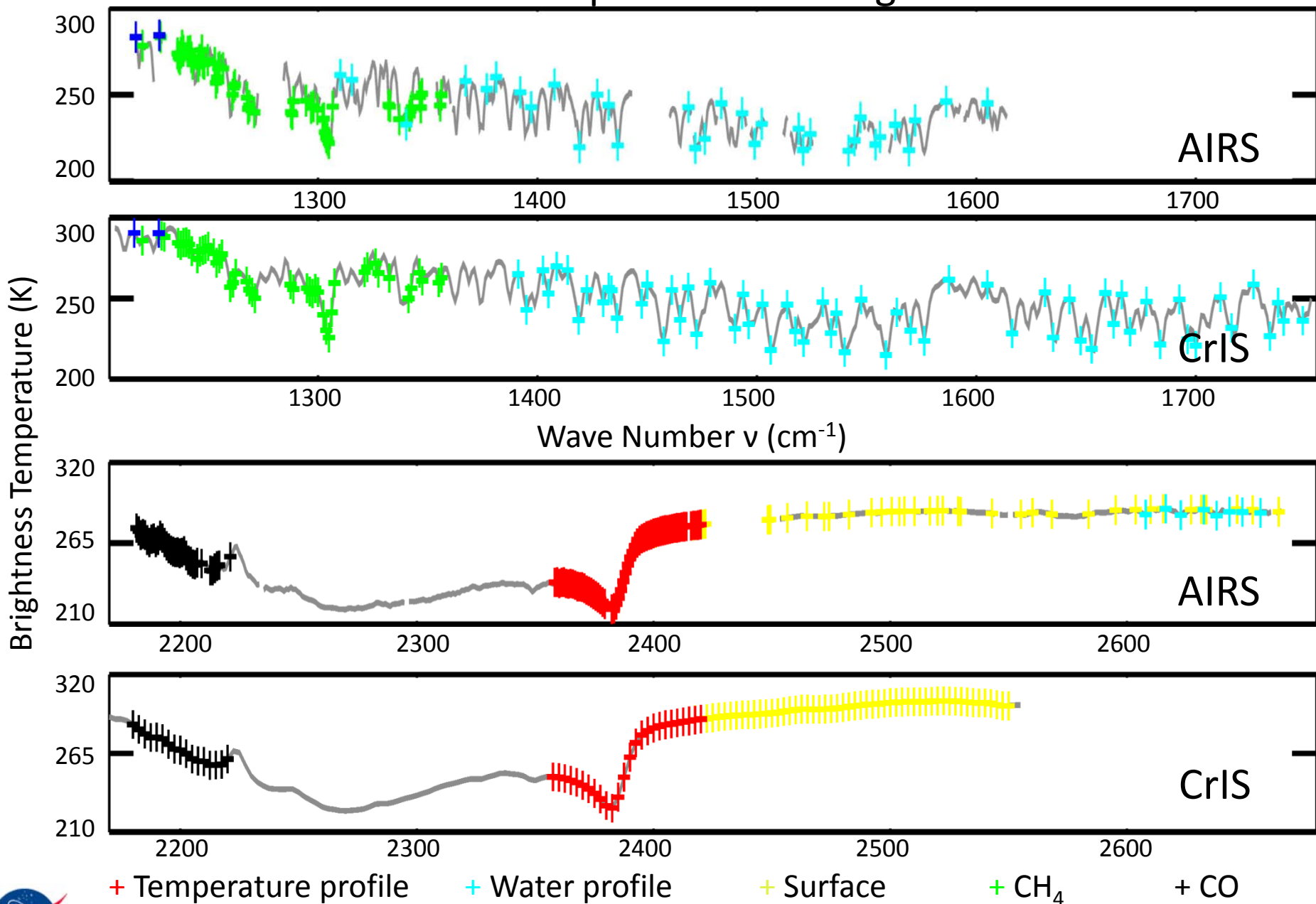
AIRS 3x3 radiance angle correction to central 3x3 FOV zenith angle is not used for CrIS because CrIS scan pattern is more complicated than AIRS – Chris Barnet said he will generate appropriate code for CrIS

Simulated Noise-free Spectra indicating Retrieval Channels

+ Temperature profile   + Cloud Clearing   + O$_3$

Simulated Noise-free Spectra indicating Retrieval Channels

Brightness Temperature (K)

Wave Number ν (cm⁻¹)

AIRS

CrIS

AIRS

CrIS

+ Temperature profile   + Water profile   + Surface   + CH₄   + CO

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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
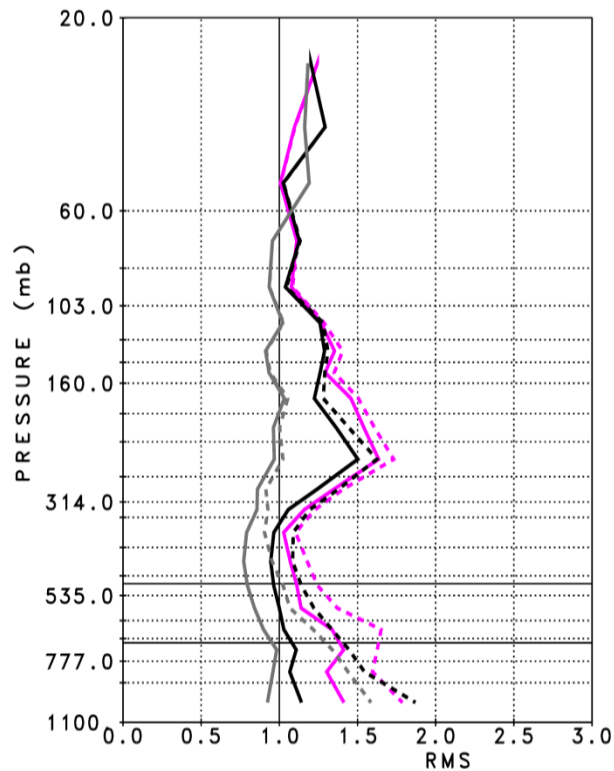   T(p) QC thresholds were set for yields comparable to CrIS/ATMS

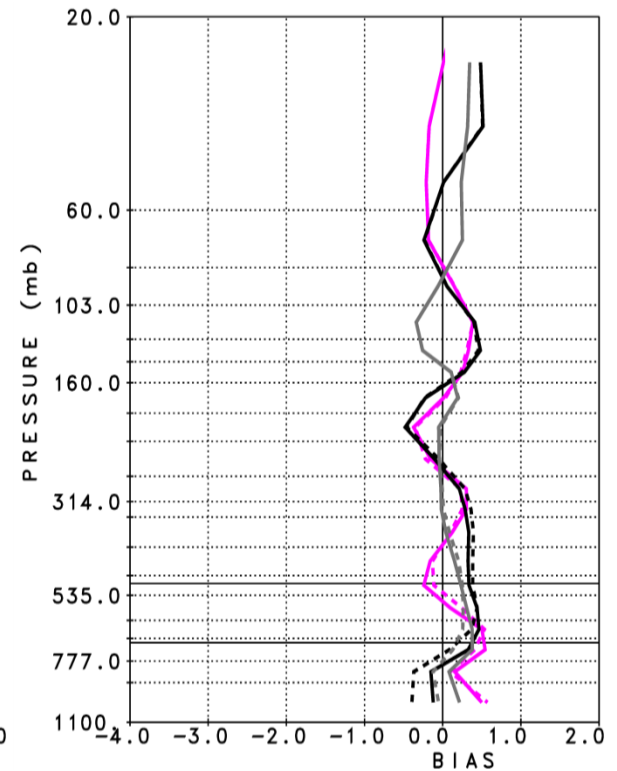# Global   Temperature Profile   September 14, 2012

Percent of All Cases Accepted
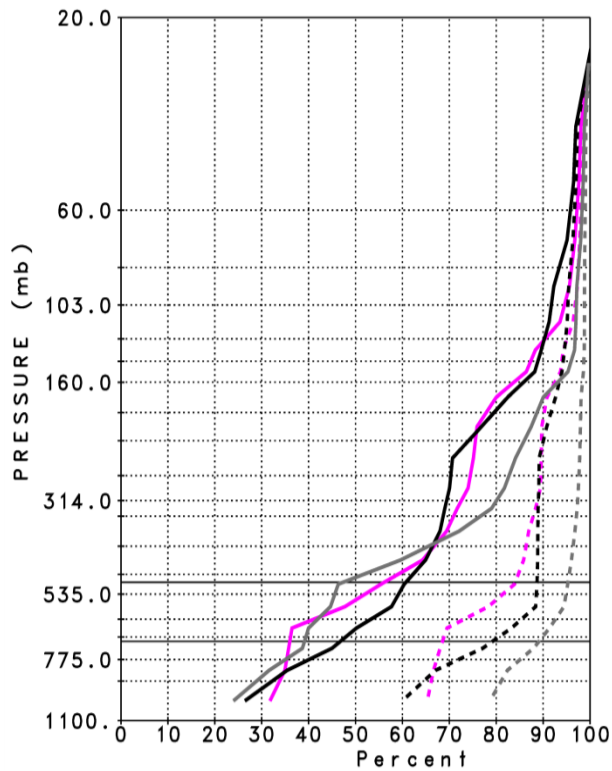
1 km Layer Mean RMS (°K) Differences from ECMWF

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	

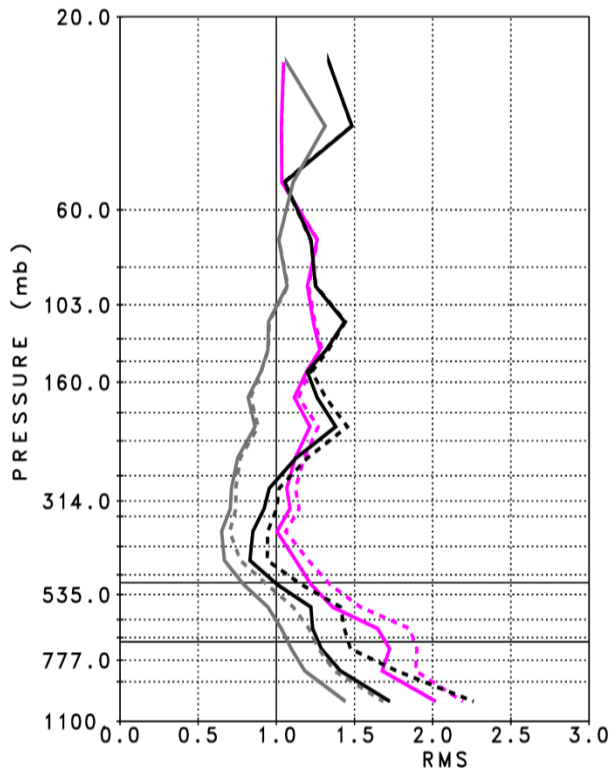Joel Susskind, Louis Kouvaris, John Blaisdell

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Temperature Profile   September 14, 2012
Layer Mean RMS (°K) Differences from ECMWF
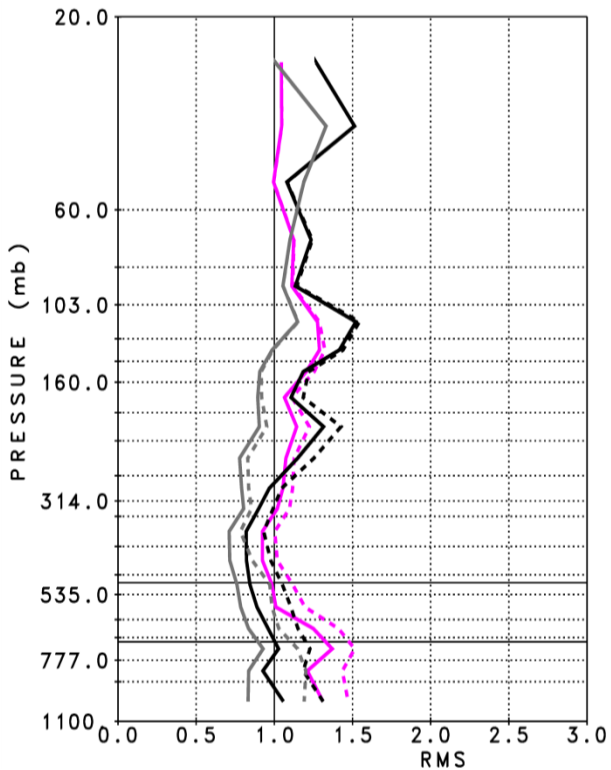
Ocean 50°N to 50°S	Non-Ocean 50°N to 50°S	Poleward of 50°
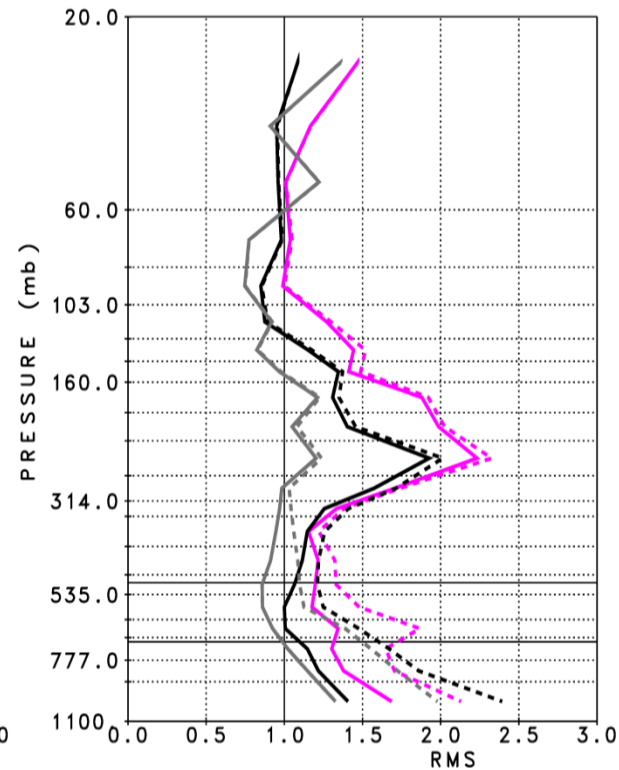
CrIS Version-5.59   DA QC
CrIS Version-5.59   Climate QC
AIRS Version-5.59   DA QC
AIRS Version-5.59   Climate QC
AIRS Version-6   DA QC
AIRS Version-6   Climate QC

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September 14, 2012 1:30 PM   Climate QC

AIRS Cloud Parameters

lt 180 mb   180-310   310-440   440-560   560-680   680-800   gt 800 mb
0   40 80 % 40 80   40 80   40 80   40 80   40 80   40 80
GLOBAL MEAN=   44.14   STD=   31.29   %Fill   89.25

CrIS Version-5.59
500 mb Temperature Difference from ECMWF

-9.50   -6.50   -3.50   -0.50   1.50   4.50   7.50   10.50
GLOBAL MEAN=   -0.08   STD=   1.14   %Fill   88.71
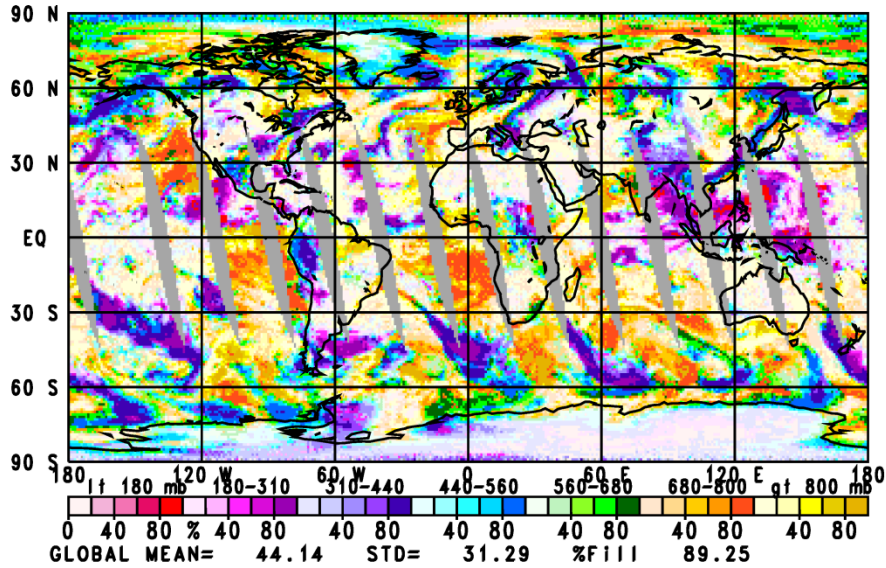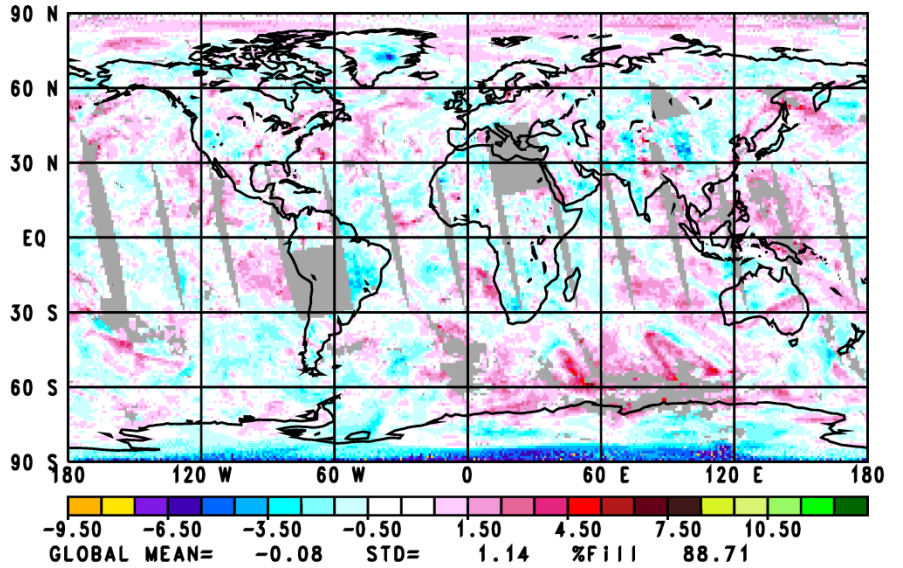
AIRS Version-6
500 mb Temperature Difference from ECMWF

-9.50   -6.50   -3.50   -0.50   1.50   4.50   7.50   10.50
GLOBAL MEAN=   0.29   STD=   0.81   %Fill   88.49

AIRS Version-5.59
500 mb Temperature Difference from ECMWF

-9.50   -6.50   -3.50   -0.50   1.50   4.50   7.50   10.50
GLOBAL MEAN=   0.38   STD=   0.94   %Fill   86.81

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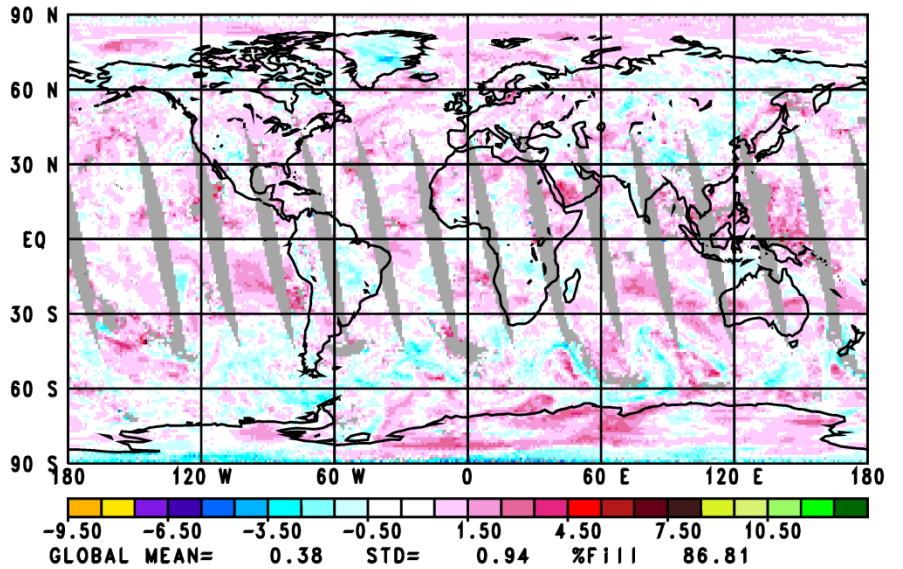
Water Vapor Profile   September 14, 2012
1 Km Layer Mean Precipitable Water RMS % Differences from ECMWF

Global   Ocean 50°N to 50°S   Non-Ocean 50°N to 50°S

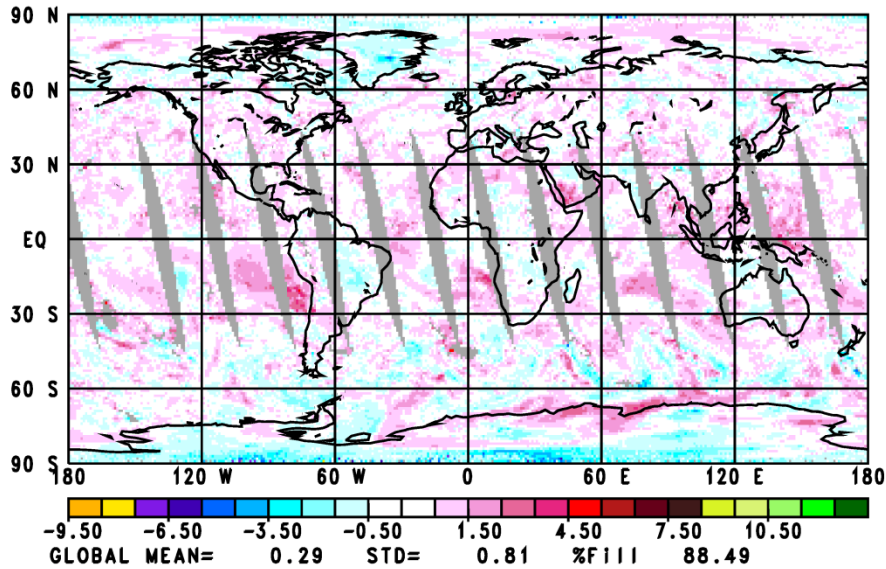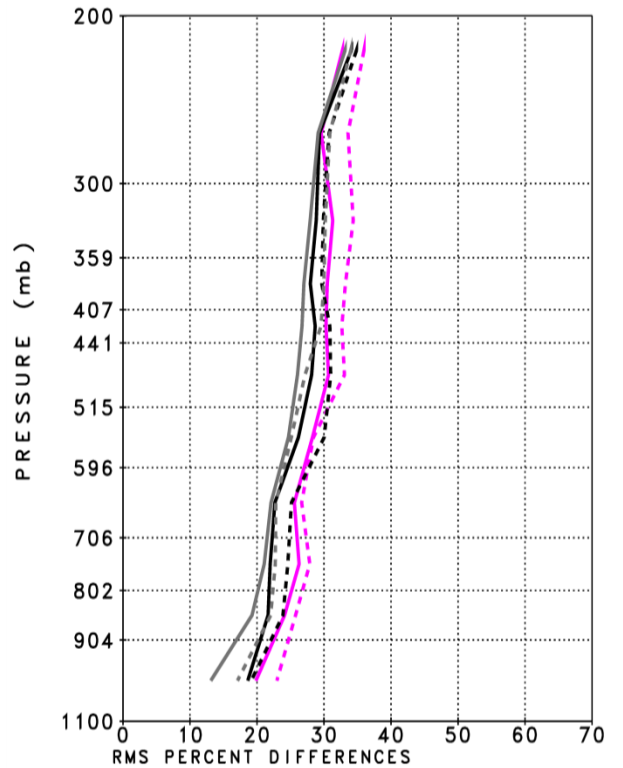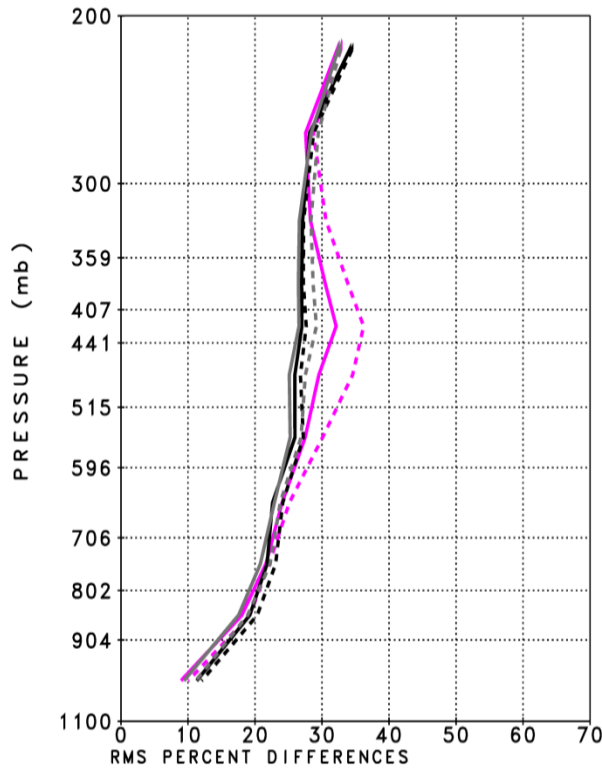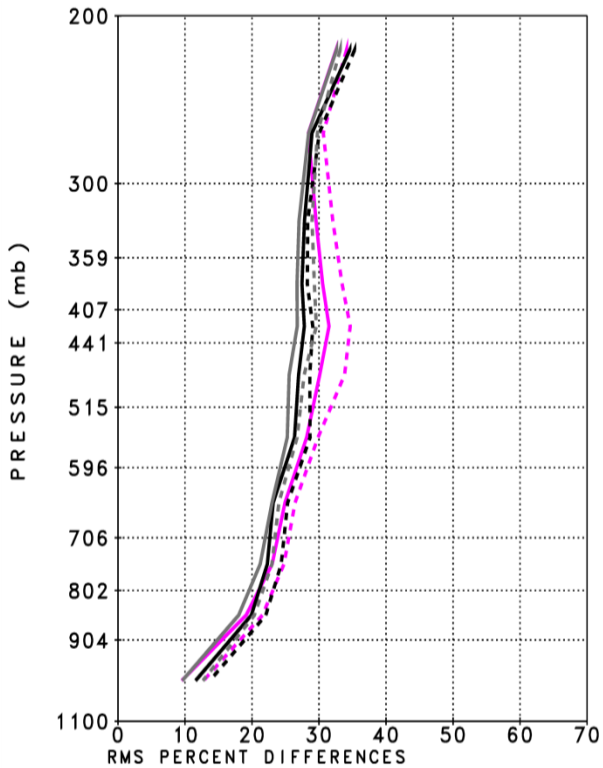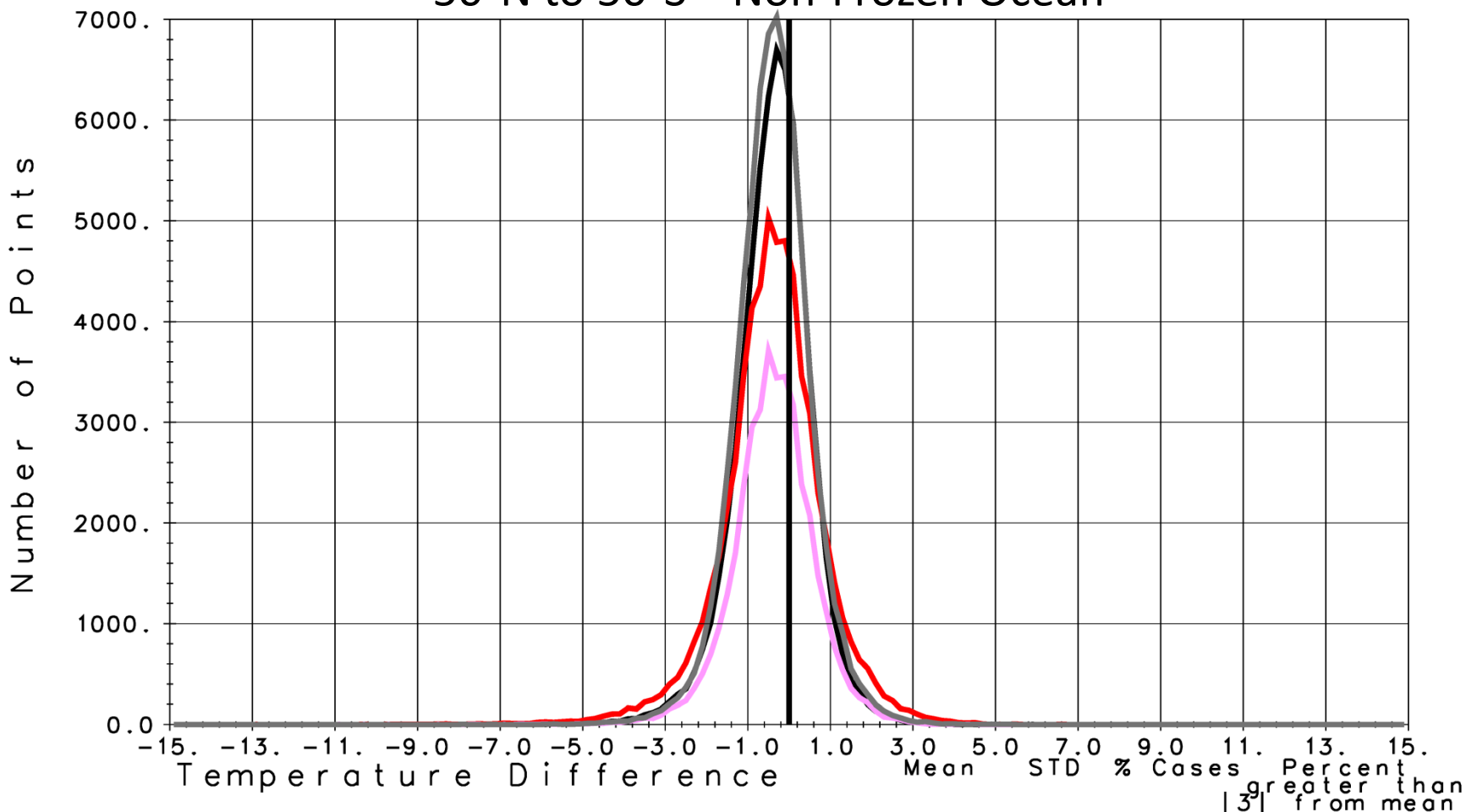|		
CrIS Version-5.59	DA QC	
CrIS Version-5.59	Climate QC	
AIRS Version-5.59	DA QC	
AIRS Version-5.59	Climate QC	
AIRS Version-6	DA QC	
AIRS Version-6	Climate QC	

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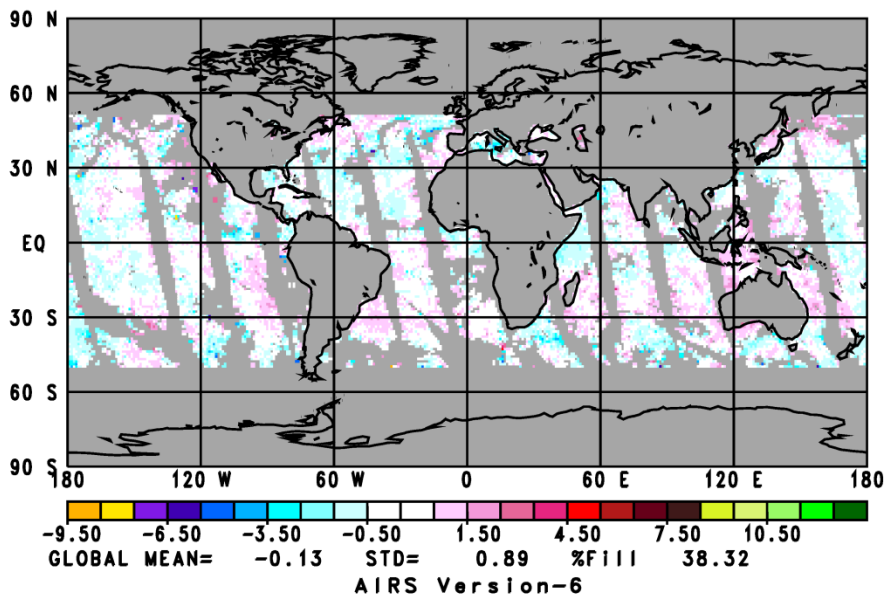## 50°N to 50°S   Non-Frozen Ocean

	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

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

AIRS Version-5.59

GLOBAL MEAN=   -0.13   STD=   0.89   %Fill   38.32

CrIS Version-5.59 Comparable Accuracy

GLOBAL MEAN=   -0.38   STD=   0.98   %Fill   29.64

AIRS Version-6

GLOBAL MEAN=   -0.17   STD=   0.87   %Fill   39.97

CrIS Version-5.59 Comparable Yield

GLOBAL MEAN=   -0.48   STD=   1.32   %Fill   43.90

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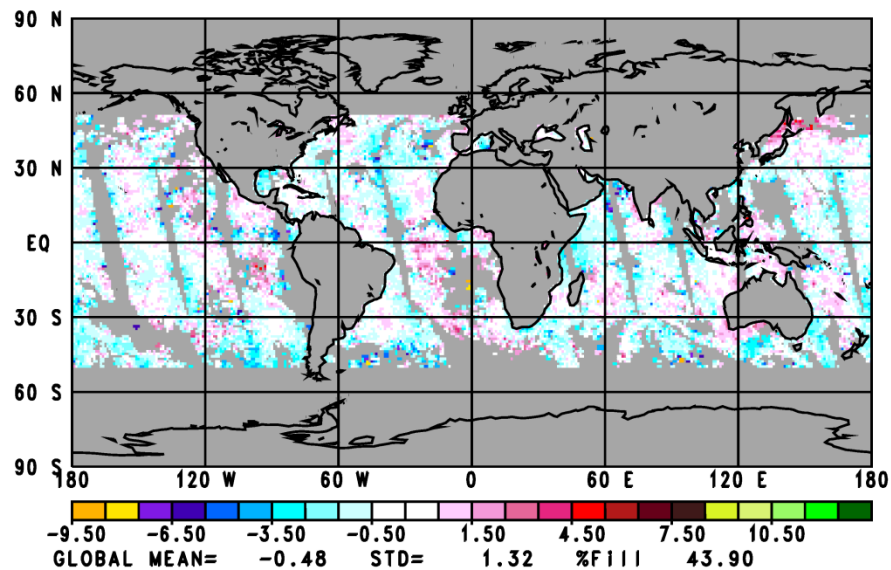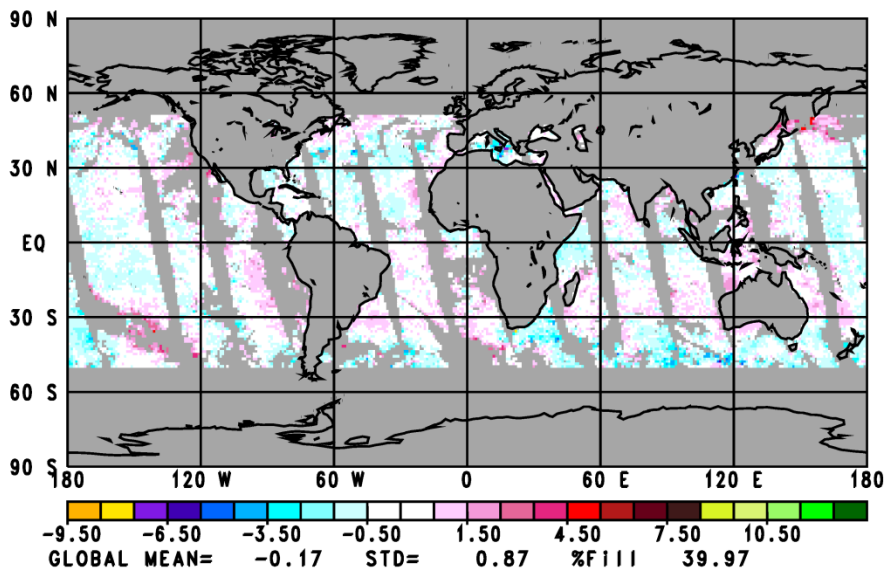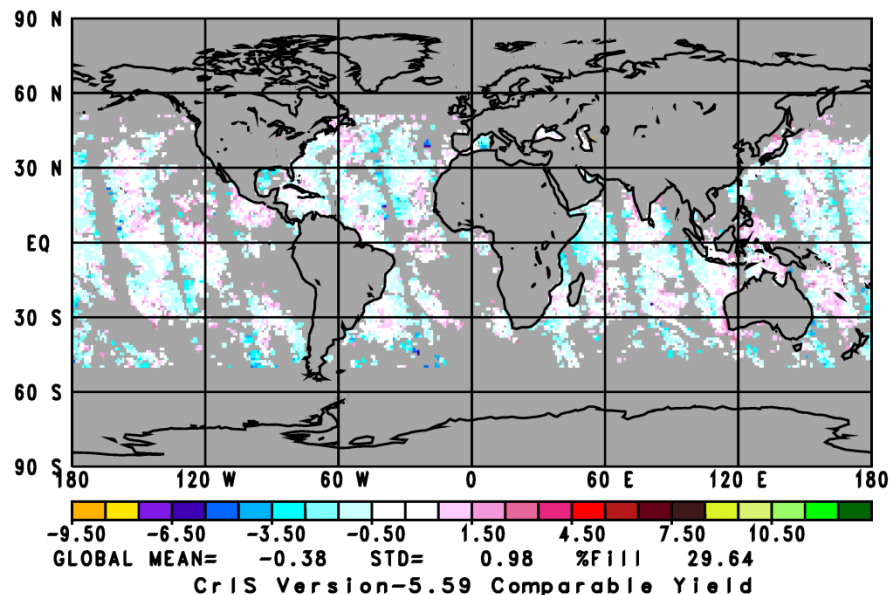
Findings with Current CrIS/ATMS Retrieval System

<u>Temperature Profile T(p)</u>

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

<u>Water Vapor Profile q(p)</u>

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

<u>Ocean Skin Temperature T_s</u>

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