

Generation and Analysis of CrIS/ATMS Proxy Data

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Proxy Data and Simulated Data

Simulated data computes expected channel radiances R_i on a “truth” ensemble

Advantages

“Truth” is known everywhere

Expected instrument noise can be added to R_i

Limitations

Simulated data does not completely reflect reality

Does not contain

- True physics
- Real clouds
- Real surfaces
- Sub-pixel variability
- Etc.

Proxy data represents what an instrument would see based on observations of another instrument

Addresses limitations of simulated data

“Truth” is not known perfectly, just as with real data

We use AIRS/AMSU observations to generate CrIS/ATMS proxy data

Assumes fields of view are identical with AIRS/AMSU

AIRS/AMSU observations can also be used to generate proxy AIRS/AMSU data

Objectives of the Research

- Evaluation of aspects of the NGST CrIMMS EDR algorithm
- Identification of areas (if any) where improvements are needed
- Comparison of performance of NGST CrIMMS EDR algorithm with government algorithm

Analogous to AIRS Science Team AIRS/AMSU EDR algorithm

The purpose of this research is not to compare AIRS/AMSU with CrIS/ATMS

Generation of Proxy CrIS Data $\tilde{R}_i^{\text{CrIS}}$

Approach uses simulated radiances based on a good representation of “truth”

“Truth” is taken as global ensemble of complete states determined using AIRS Version 5 for September 6, 2002

Includes clouds, liquid water, surface spectral emissivity and reflectivity, etc.

For each state k observed at (θ_k) compute noise free CrIS radiances $R_{i,k}^{\text{CrIS}}(\theta_k)$ and noisy AIRS radiances

$$R_{j,k}^{\text{AIRS}}(\theta_k)$$

Physics used to compute $R_{i,k}^{\text{CrIS}}$ and $R_{j,k}^{\text{AIRS}}$ identical

Only channels and spectral response functions differ between AIRS and CrIS

We express $\tilde{R}_{i,k}^{\text{CrIS}}$ as a linear combination of $R_{j,k}^{\text{AIRS}}$

$$\tilde{R}_{i,k}^{\text{CrIS}}(\theta) - \overline{\tilde{R}_i^{\text{CrIS}}(\theta)} = \sum_j M_{i,j} \left(R_{j,k}^{\text{AIRS}}(\theta) - \overline{R_j^{\text{AIRS}}(\theta)} \right) \quad (1)$$

$M_{i,j}$ is angle independent

$M_{i,j}$ is found by linear regression such that $\text{RMS}(\tilde{R}_{i,k}^{\text{CrIS}} - R_{i,k}^{\text{CrIS}})$ is minimized

$\text{RMS}(\tilde{R}_{i,k}^{\text{CrIS}} - R_{i,k}^{\text{CrIS}})$ is considerably lower than CrIS noise $NE\Delta N_i^{\text{CrIS}}$

The above methodology generates M , $\overline{R}_i^{\text{CrIS}}$, and $\overline{R}_j^{\text{AIRS}}$ for use with observed AIRS data

Proxy CrIS data is generated from AIRS observations R_j^{AIRS} by substitution in Equation 1

Generation of Proxy, AIRS, AMSU, and ATMS Data

All use an equation analogous to equation 1

Proxy AIRS

Generate AIRS noise free radiance $R_i^{\text{AIRS,NF}}$ and noisy radiances $R_i^{\text{AIRS,N}}$

Find M such that $R_i^{\text{AIRS,NF}}$ is best matched by $\sum M_{i,j} R_j^{\text{AIRS,N}}$

M is not the identity matrix

$\sum M_{i,j} R_j^{\text{AIRS,N}}$ matches $R_i^{\text{AIRS,NF}}$ to better than the AIRS noise $NE\Delta N_i^{\text{AIRS}}$

Can match essentially as well leaving out R_i from the sum (use only other channels)

Proxy AMSU

Analogous methodology is used with the following exception

Observed AMSU data Θ_i^{AMSU} is affected by an antenna pattern distortion $\delta\Theta_{i,l}$ for beam position l

AIRS Science Team EDR algorithm subtracts $\delta\Theta_{i,l}$ from AMSU observation $\Theta_{i,l}$

We subtract $\delta\Theta_{i,l}$ from Θ_i^{AMSU} before using Equation 1

Proxy ATMS

Done using analogous methodology as proxy AMSU

ATMS physics currently assumes polarization of ATMS is the same as AMSU – not the case

This affects proxy ATMS window channels over ocean, but not land

Experiments Run with AIRS Science Team – like EDR algorithms

All experiments use a form of the AIRS Science Team Version-5 algorithm

Version-5 computes error estimates and a pressure p_{best} down to which the profile is used for statistics

p_{best} is determined according to error estimate thresholds

Results show % accepted and RMS difference from ECMWF "Truth" using QC

Results referred to as government algorithm

Test of proxy AIRS/AMSU data

Government proxy AIRS/AMSU retrieval algorithm like Version-5, but uses its own coefficients

Tuning, regression, error estimates, QC thresholds

No tuning used ($\delta\Theta_i$ for θ) proxy AMSU

Test of proxy CrIS/ATMS data

CrIS/ATMS algorithm used is analogous to AIRS/AMSU Version-5 algorithm

Government CrIS/ATMS retrieval uses its own coefficients

Current CrIS RTA does not account for non-LTE

We do not use CrIS channels between 2358 cm^{-1} and 2395 cm^{-1} in T(p) retrieval

They are used with AIRS in Version-5 AIRS Science Team retrieval algorithm

Findings using Government CrIS/ATMS algorithm on Proxy Data

Results using real AIRS/AMSU and proxy AIRS/AMSU are similar

No antenna pattern correction needed to analyze proxy AMSU data
Final IR/MW retrievals as well as MIT MW Only retrievals agree well

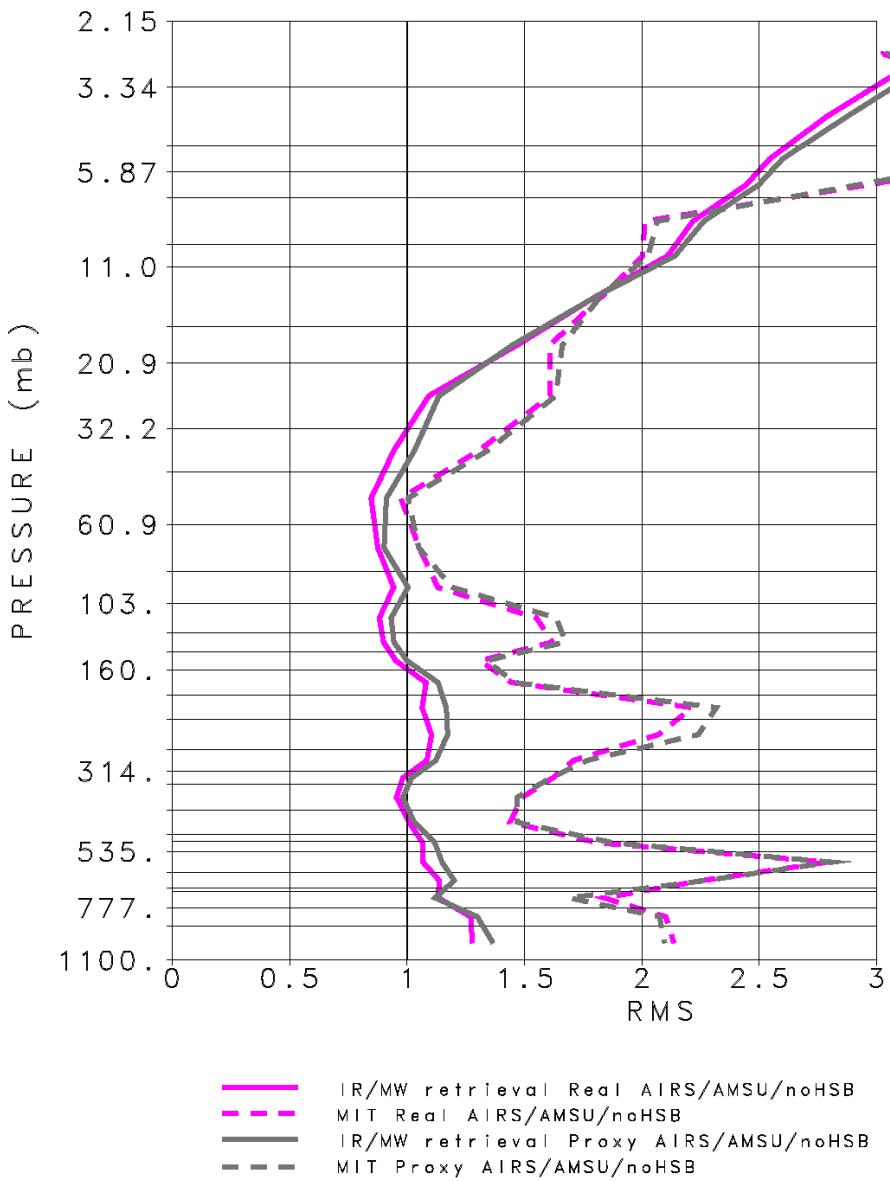
Results using CrIS/ATMS proxy data

Similar to results using proxy and real AIRS/AMSU

These results show that the proxy CrIS/ATMS data is reasonable

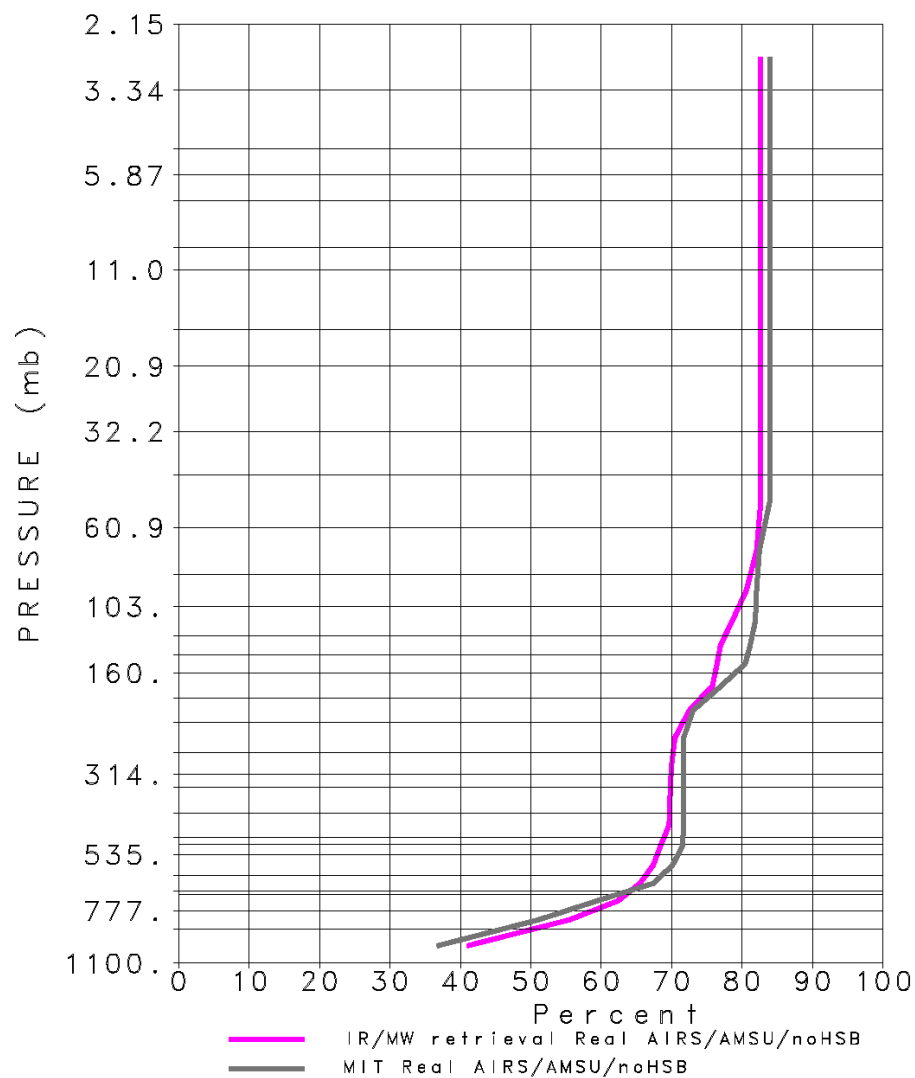
Reflects real physics, clouds, surfaces, etc.

LAYER MEAN RMS TEMPERATURE ($^{\circ}\text{C}$)
DIFFERENCES FROM ECMWF "TRUTH"
September 6, 2002

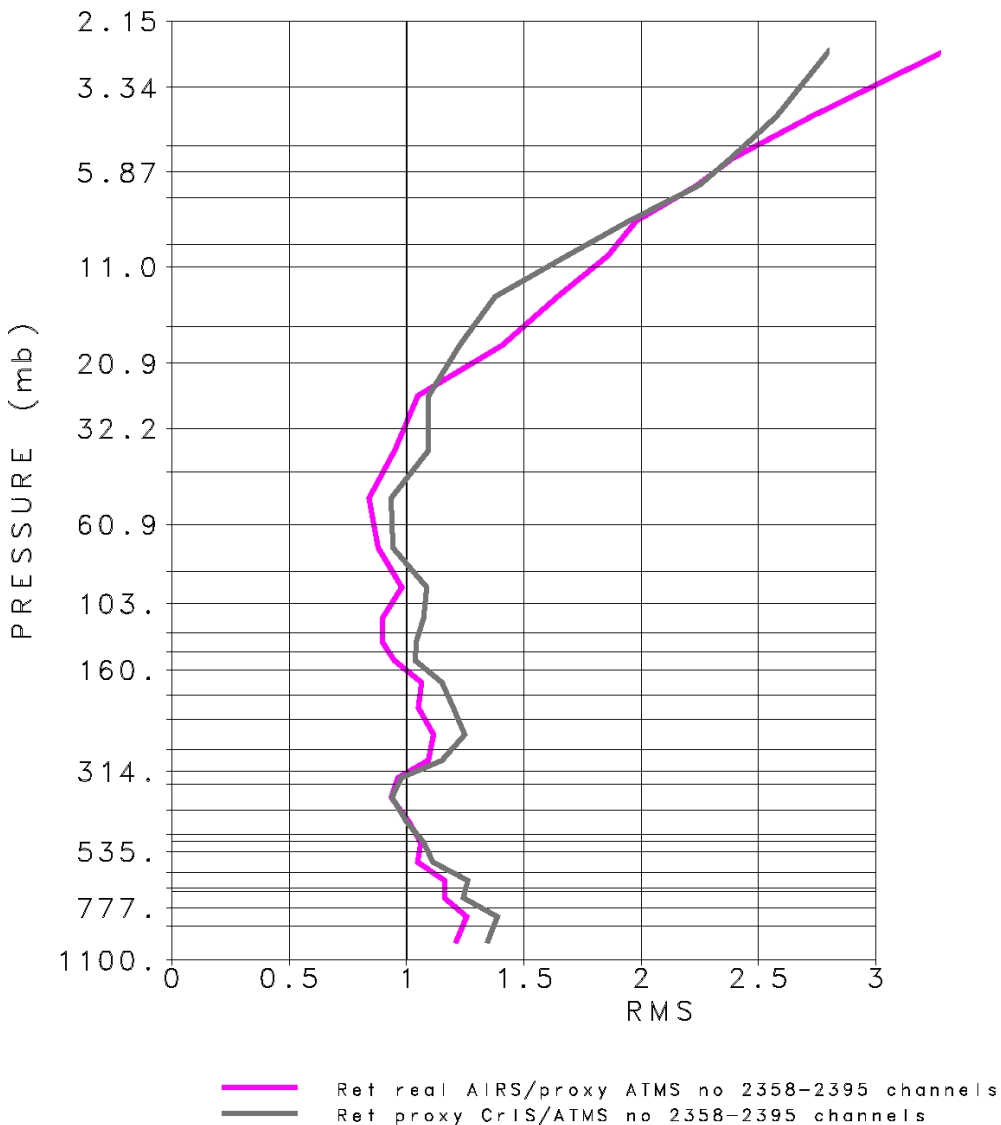


Percent of Global IR/MW Cases Included

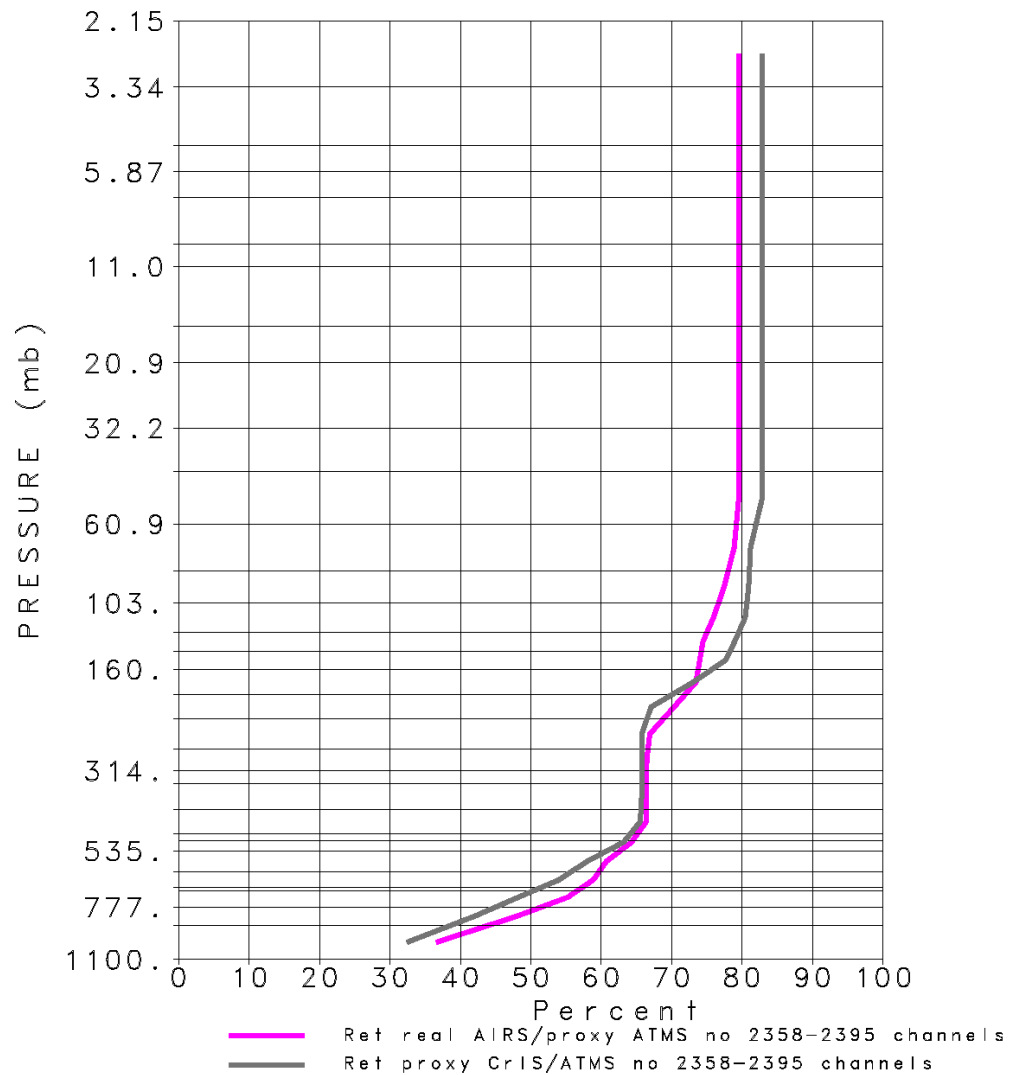
September 6, 2002



LAYER MEAN RMS TEMPERATURE ($^{\circ}\text{C}$)
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Percent of Global IR/MW Cases Included
September 6, 2002



Preliminary Findings Using NGST CrIMMS EDR algorithm with Proxy CrIS/ATMS data

NGST QC rejected all retrievals

Results are very poor if no QC is used (as with government algorithm)

Results shown selects p_{best} for NGST to match government algorithm p_{best}

Only land cases shown because NGST EDR algorithm assumes correct ATMS polarization

Polarization affects results over ocean but not land

NGST MW retrieval on proxy ATMS data produces very poor water vapor retrievals

NGST CrIMMS retrieval algorithm does not (properly?) account for non-LTE

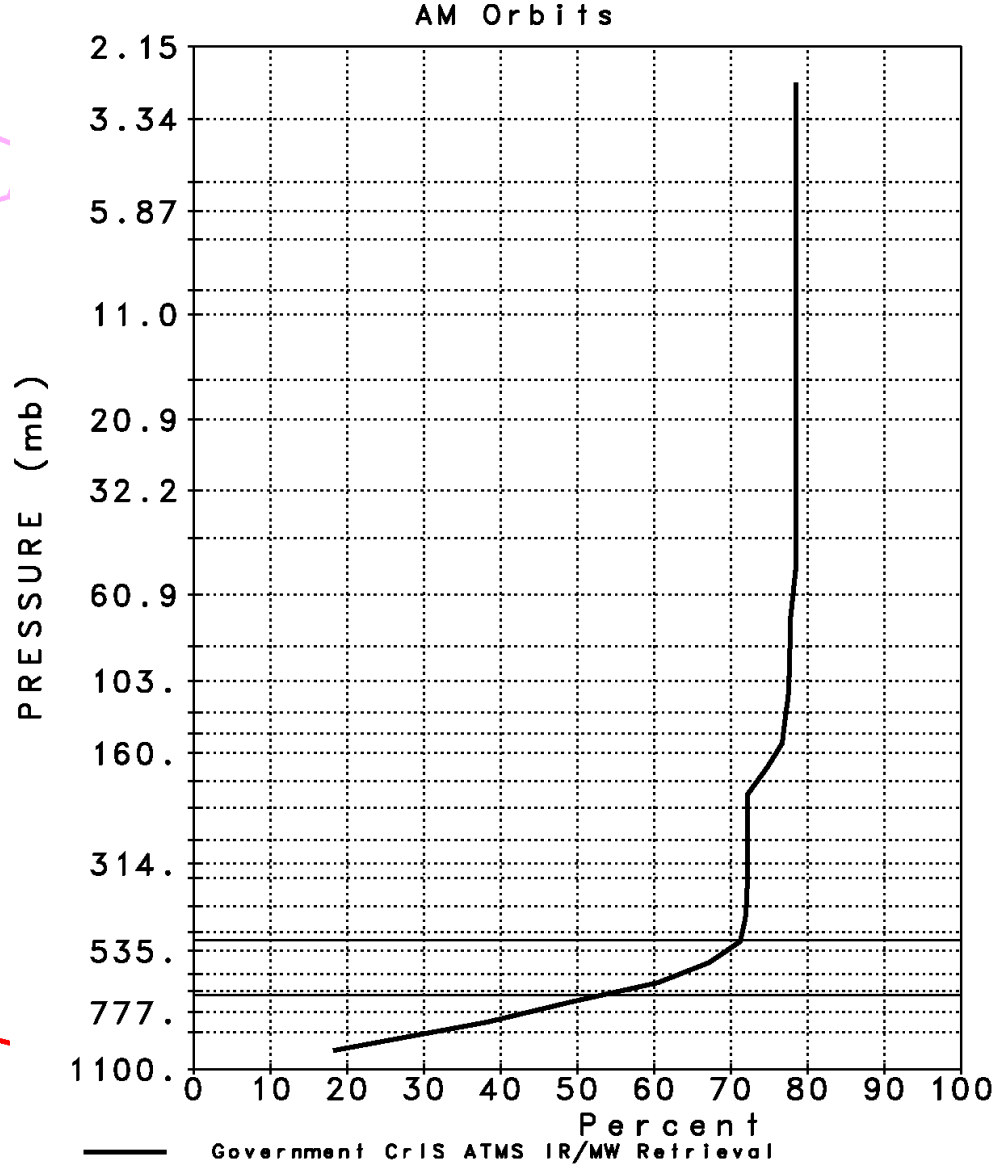
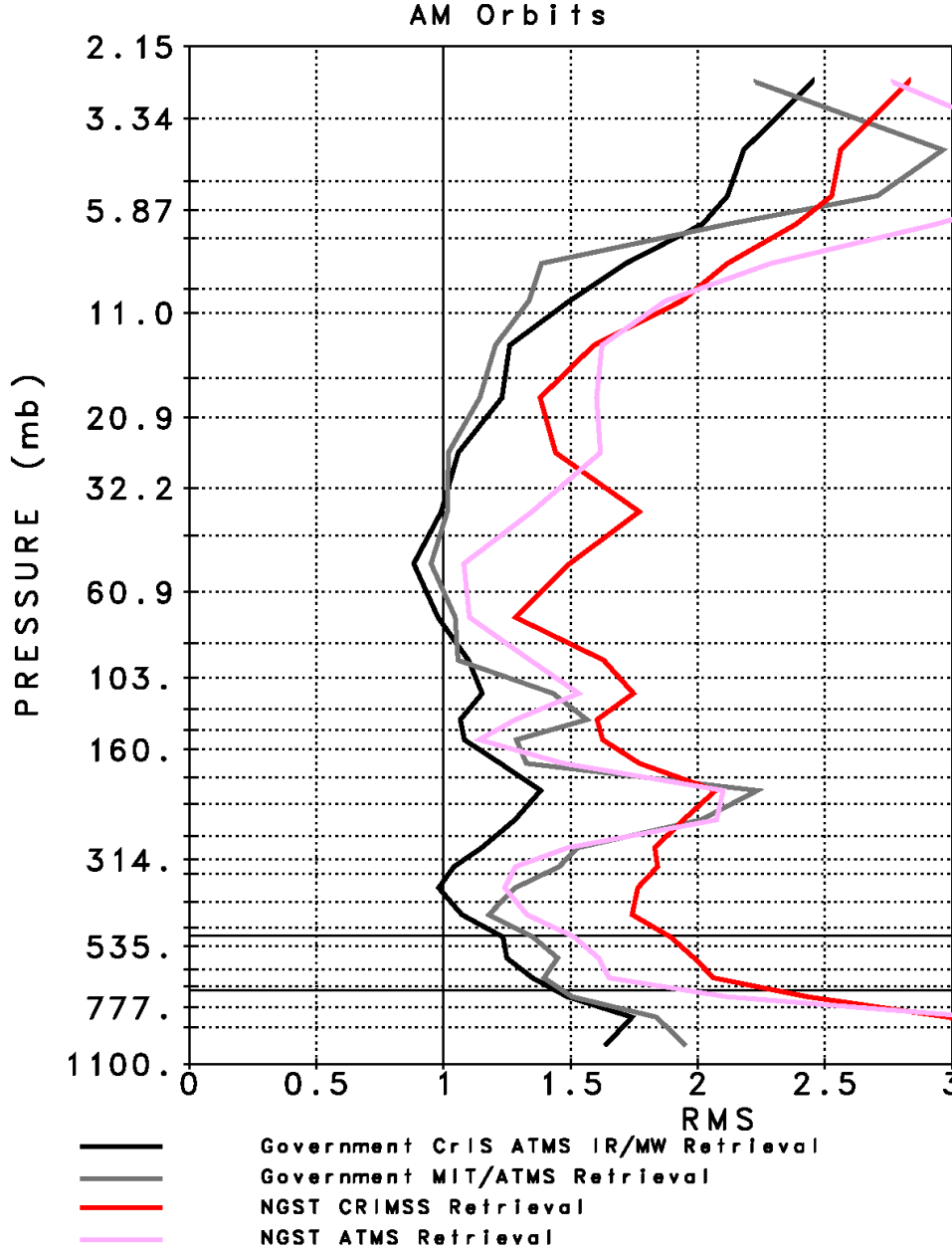
We will continue to study the NGST CrIMMS algorithm

NGST algorithm was optimized on simulated data

Test NGST algorithm on simulated data to see if use of real physics, scenes is the problem

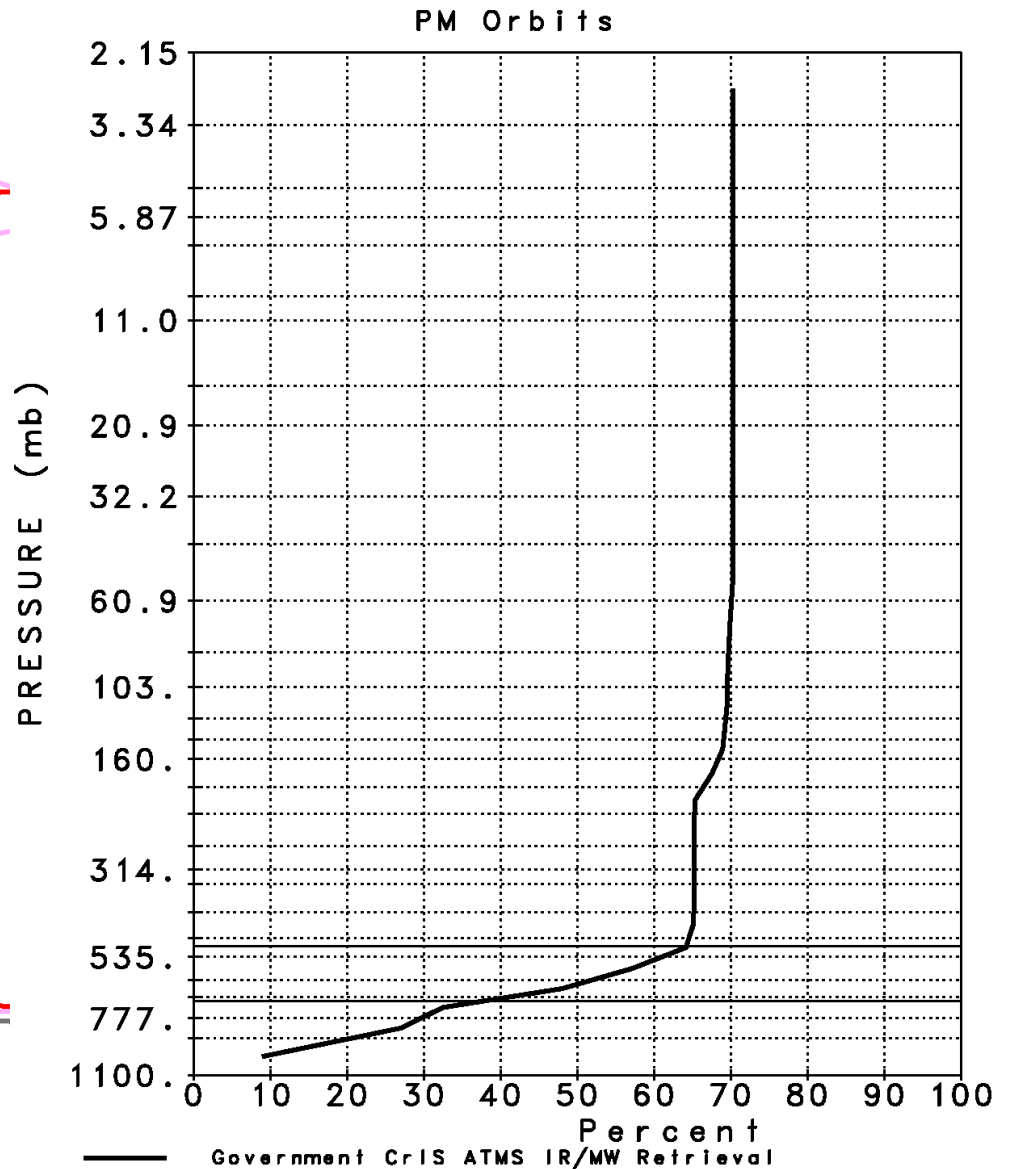
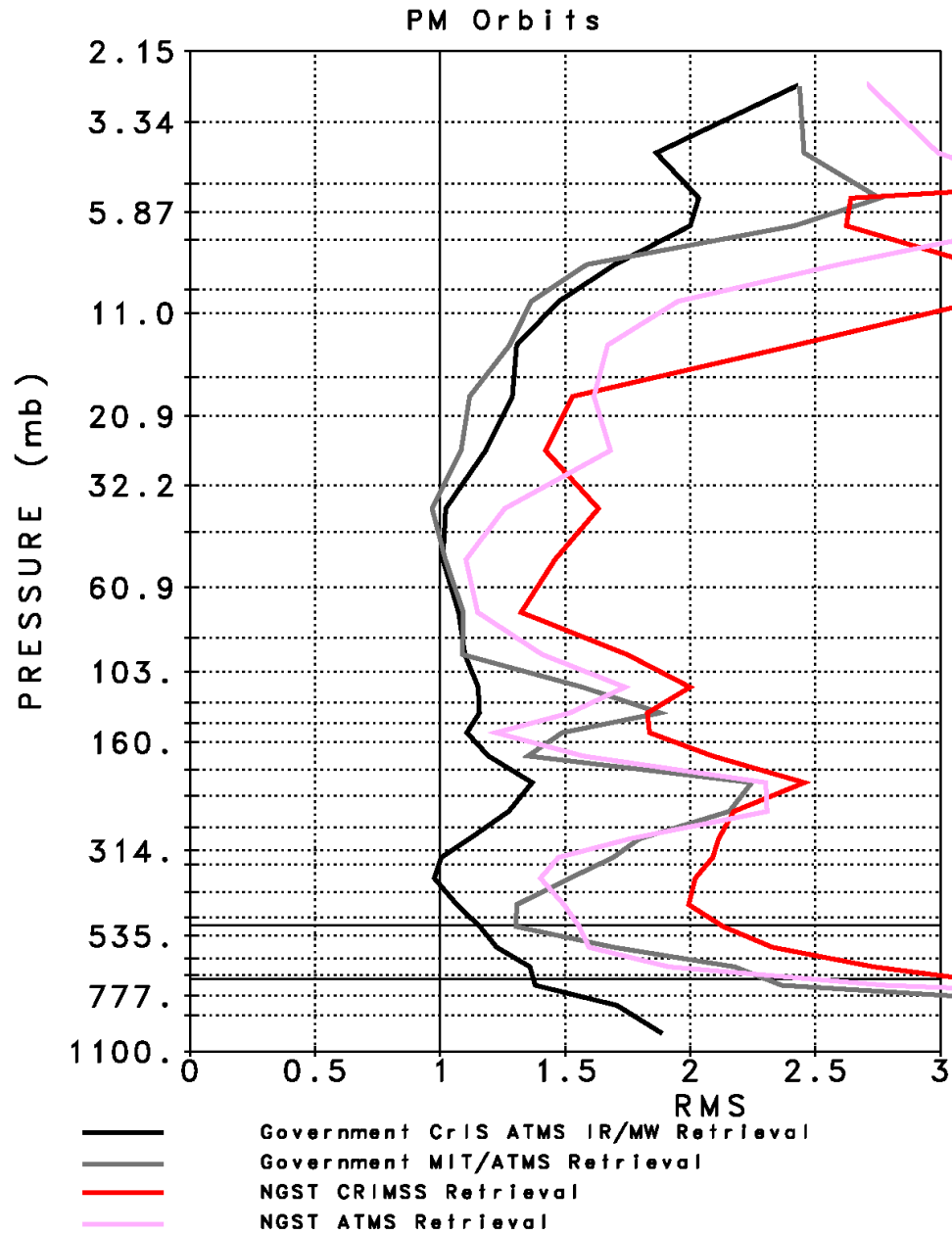
LAYER MEAN RMS TEMPERATURE (°C)
 Differences from ECMWF
 September 6, 2002
 50N to 50S Non-Ocean

Percent of All Cases Included
 Differences from ECMWF
 September 6, 2002
 50N to 50S Non-Ocean

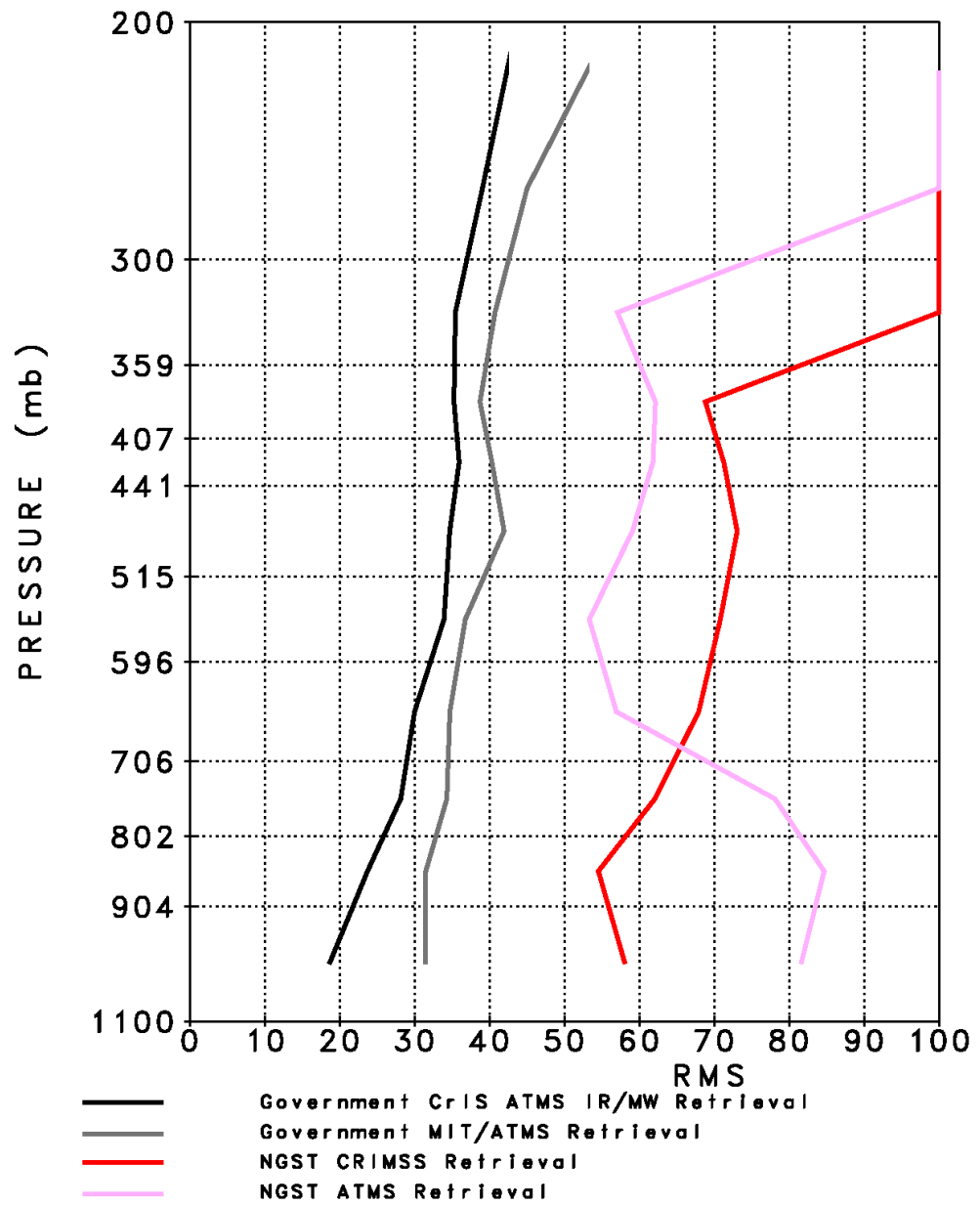


LAYER MEAN RMS TEMPERATURE (°C)
 Differences from ECMWF
 September 6, 2002
 50N to 50S Non-Ocean

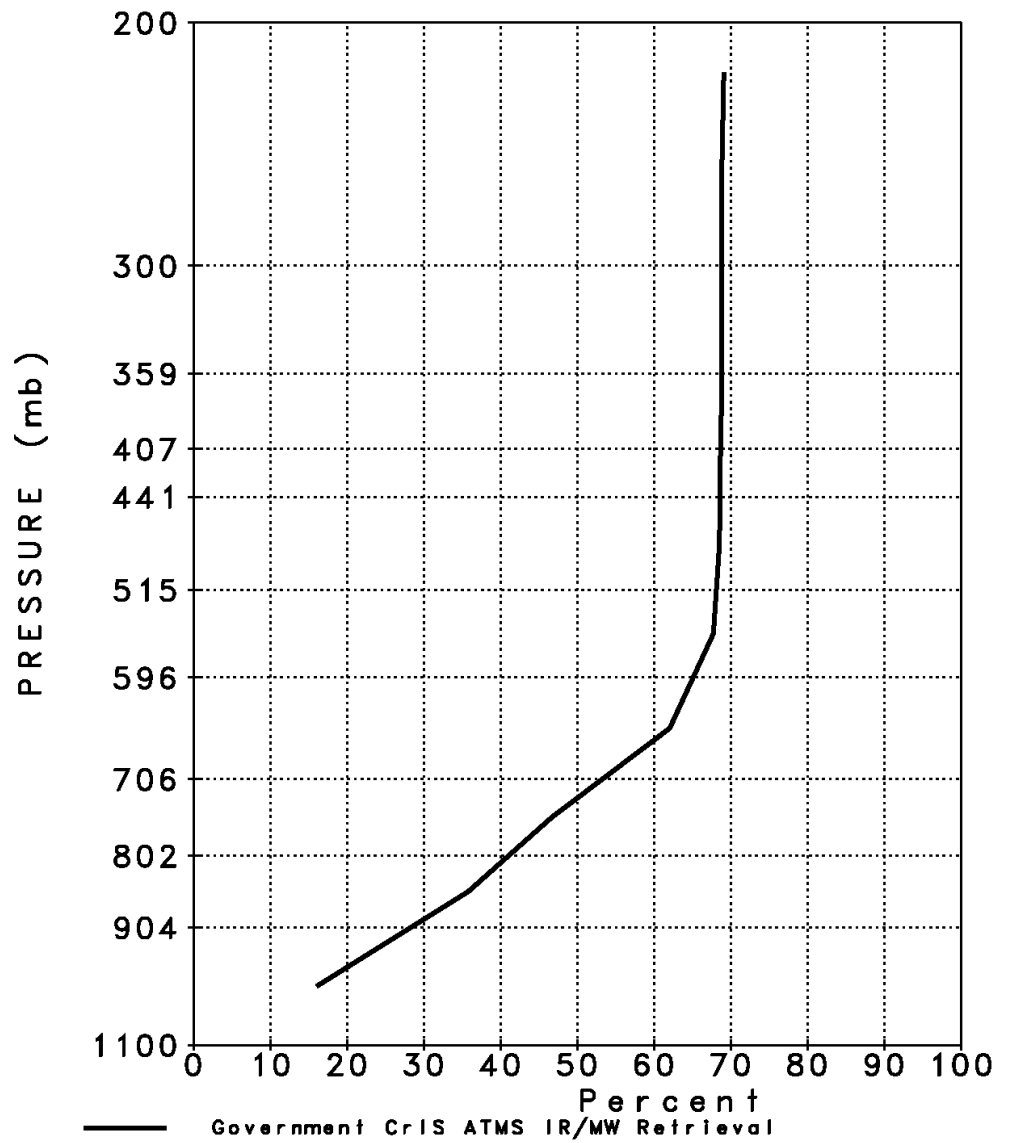
Percent of All Cases Included
 Differences from ECMWF
 September 6, 2002
 50N to 50S Non-Ocean



1 Km LAYER PRECIPITABLE WATER
 % DIFFERENCES FROM ECMWF
 September 6, 2002
 50N to 50S Non-Ocean

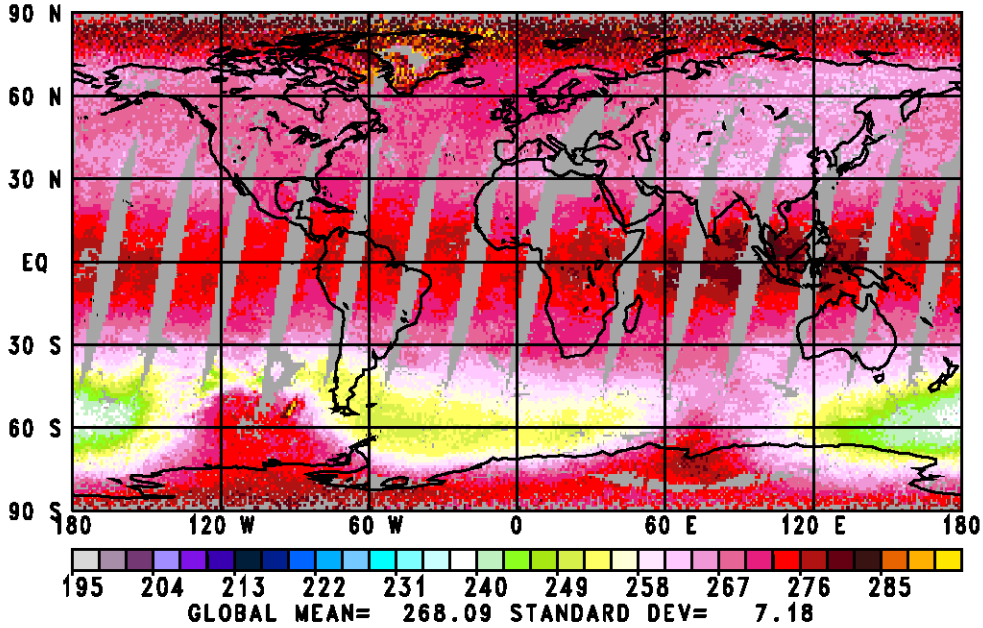


Percent of All Cases Included
 Differences from ECMWF
 September 6, 2002
 50N to 50S Non-Ocean

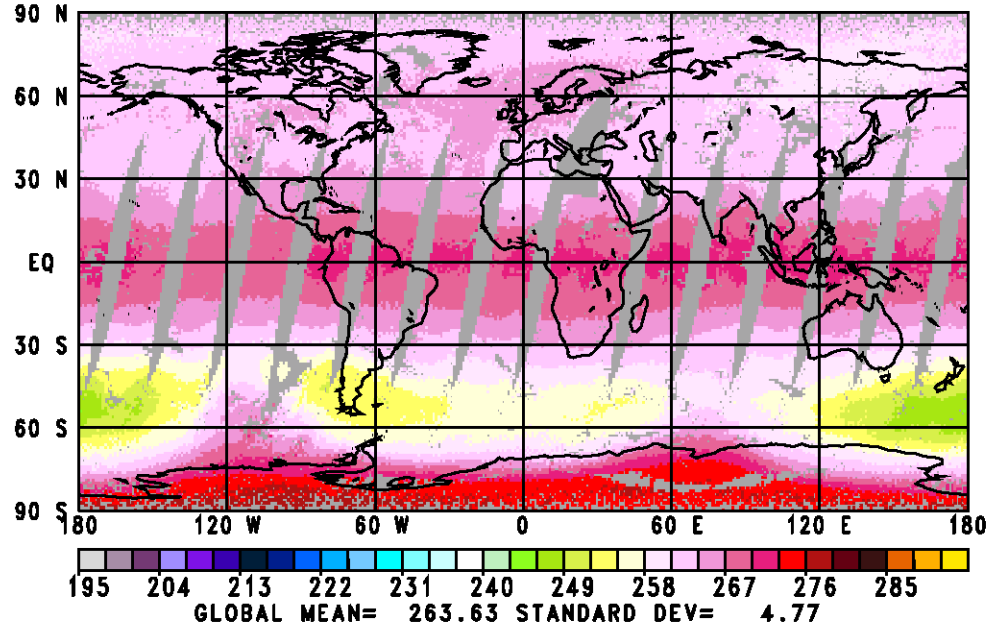


1 mb Temperature (K)
 Government CrIS/ATMS vs. NGST CrIMMS
 September 6, 2002 1:30 AM

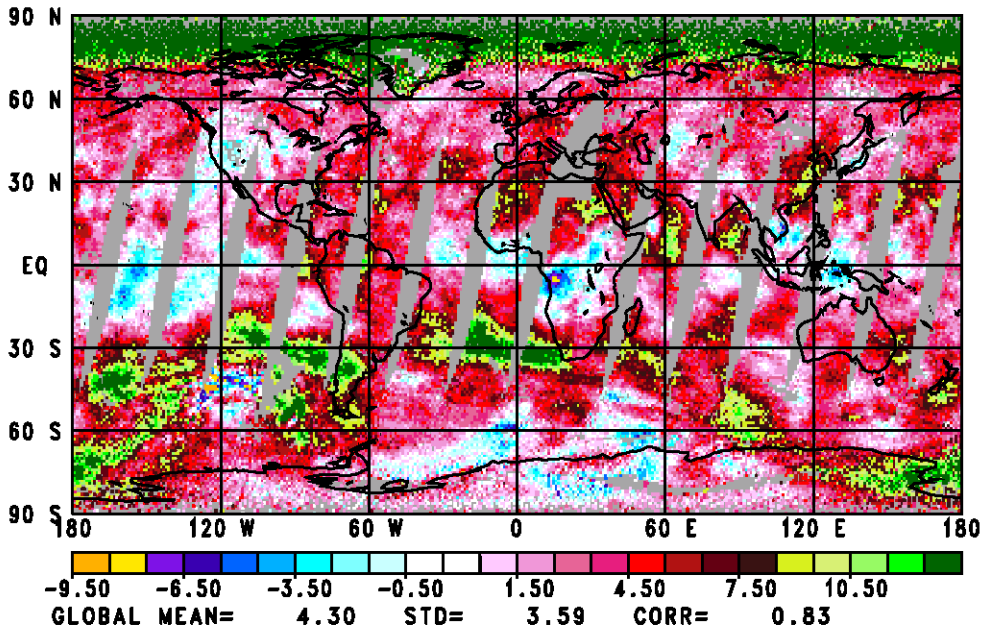
NGST CrIMMS



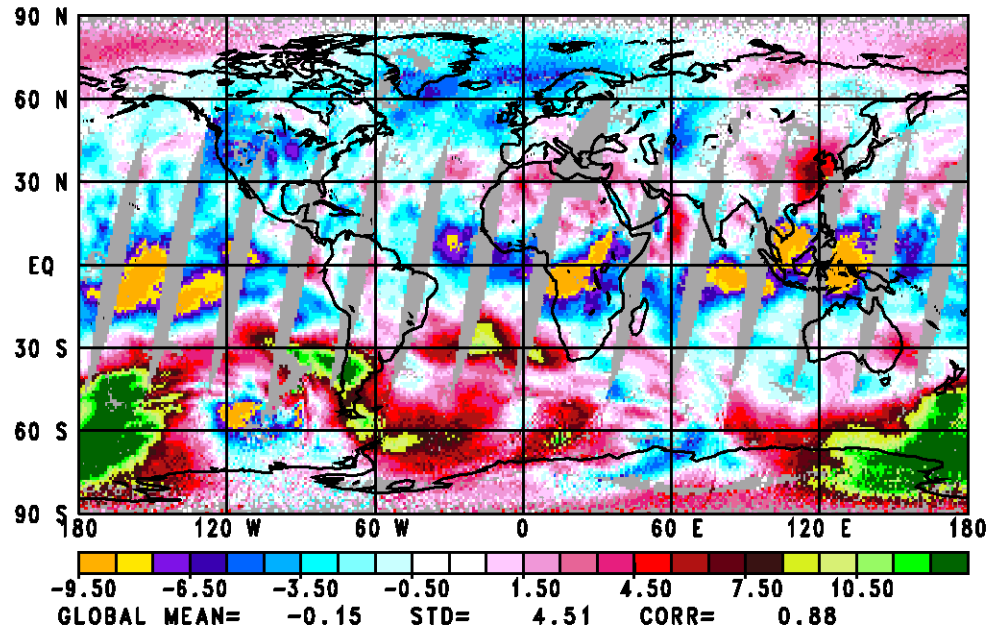
Government CrIS/ATMS



CrIMMS minus ECMWF

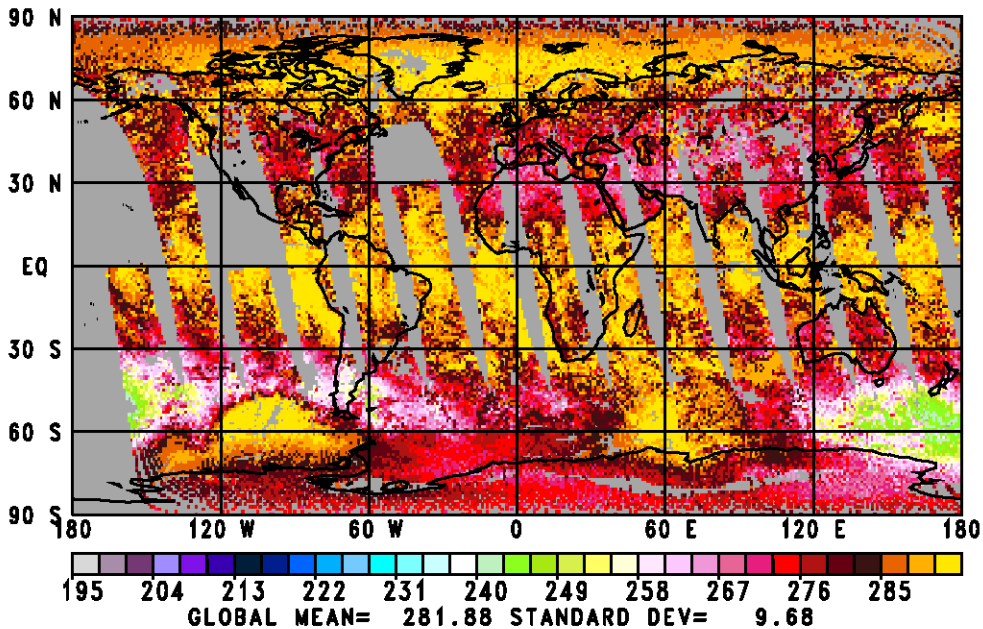


Government CrIS/ATMS minus ECMWF

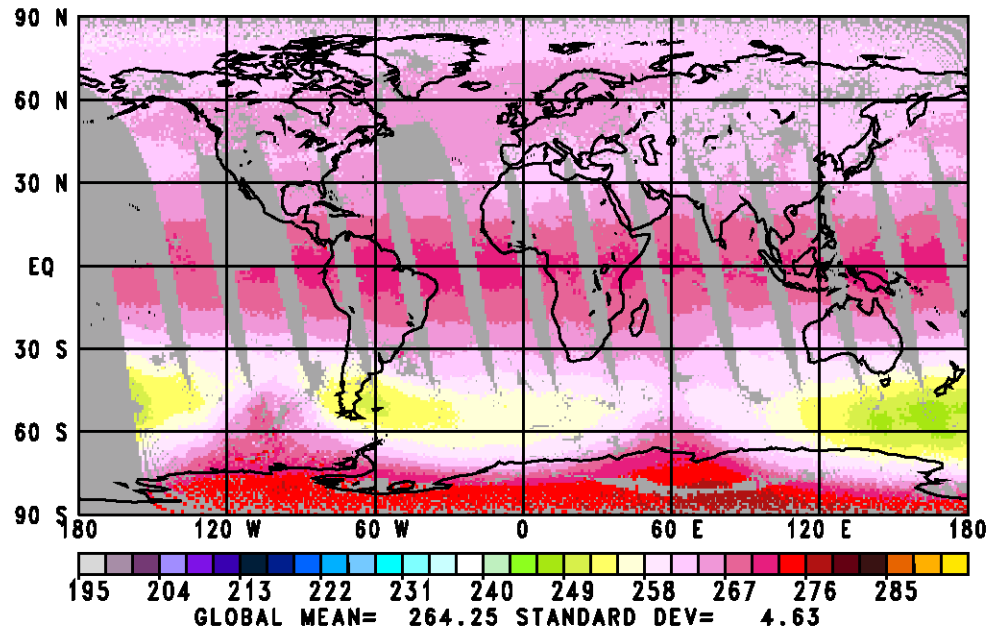


1 mb Temperature (K)
 Government CrIS/ATMS vs. NGST CrIMMS
 September 6, 2002 1:30 PM

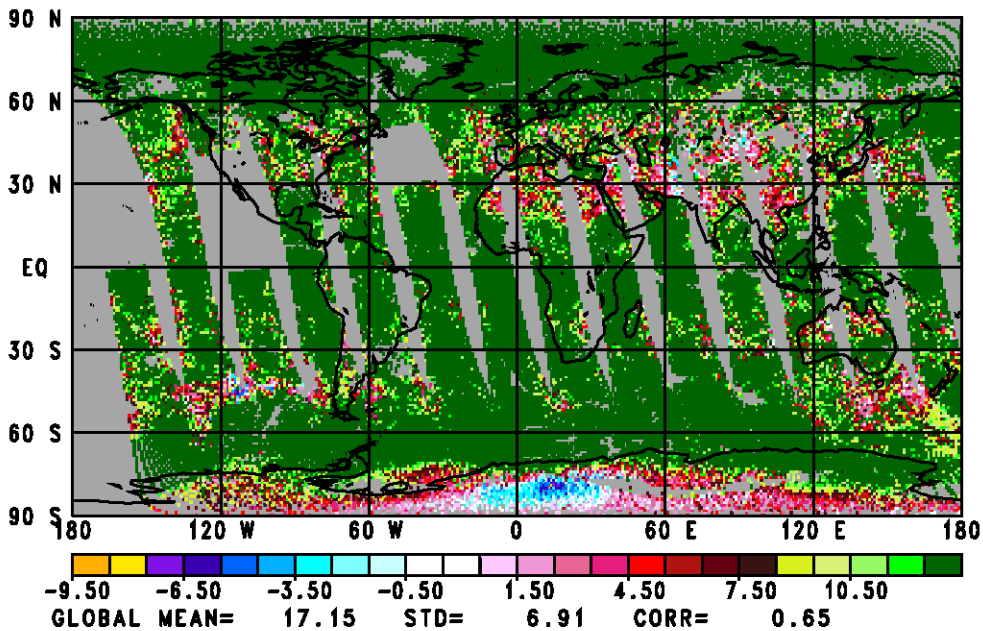
NGST CrIMMS



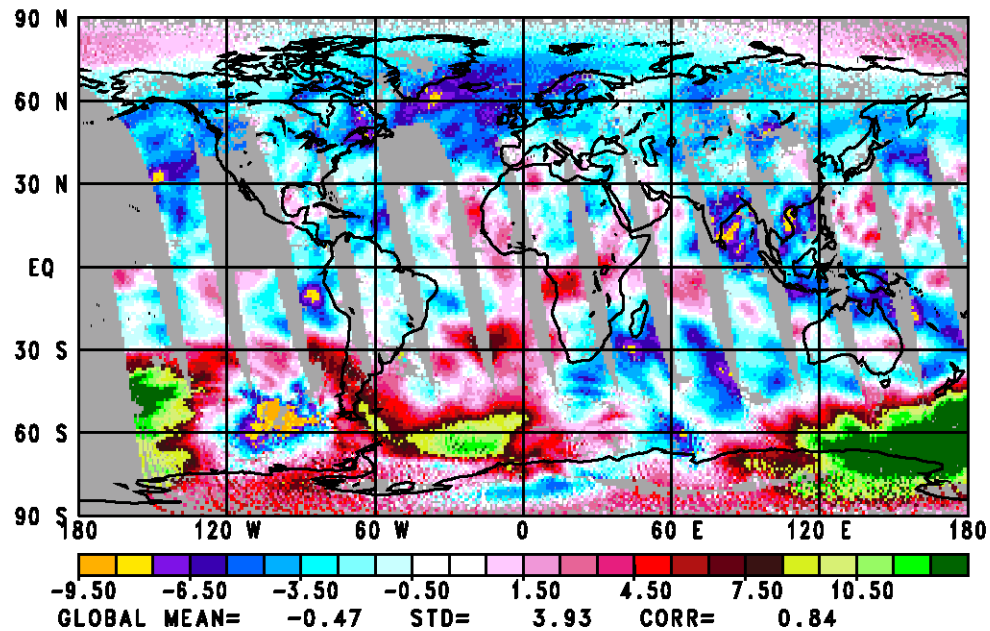
Government CrIS/ATMS



CrIMMS minus ECMWF



Government CrIS/ATMS minus ECMWF



Generation of proxy CrIS/ATMS data using IASI/AMSU

Generation of proxy ATMS data from METOP-AMSU

Use identical methodology to Aqua AMSU

Need METOP-AMSU antenna pattern correction

Generation of proxy CrIS data from IASI

Will be done two ways

- Use analogous methodology to that used with AIRS
- Truncate IASI OPD to CrIS values – generate directly

Compare EDR results using both methodologies

