Experiments at SRT Using the NOAA CrIS/ATMS Proxy Data Set

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Sounder Operational Algorithm Team Meeting

CrIS/ATMS Cal/Val Team

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Objectives of the Talk

- Assess the performance of NGAS Version-1.5.03.00 CrIS/ATMS retrieval algorithm as delivered by LaRC, modified to include the MW and IR tuning coefficients and new CrIS noise model delivered by Degui Gu

  Percent acceptance

  RMS and mean differences of T(p) vs. ECMWF truth as a function of % yield

- Compare performance of NGAS retrieval algorithm with an AIRS Science Team Version-6 like retrieval algorithm modified at SRT for CrIS/ATMS

All experiments use NOAA CrIS/ATMS proxy data based on IASI/AMSU observations

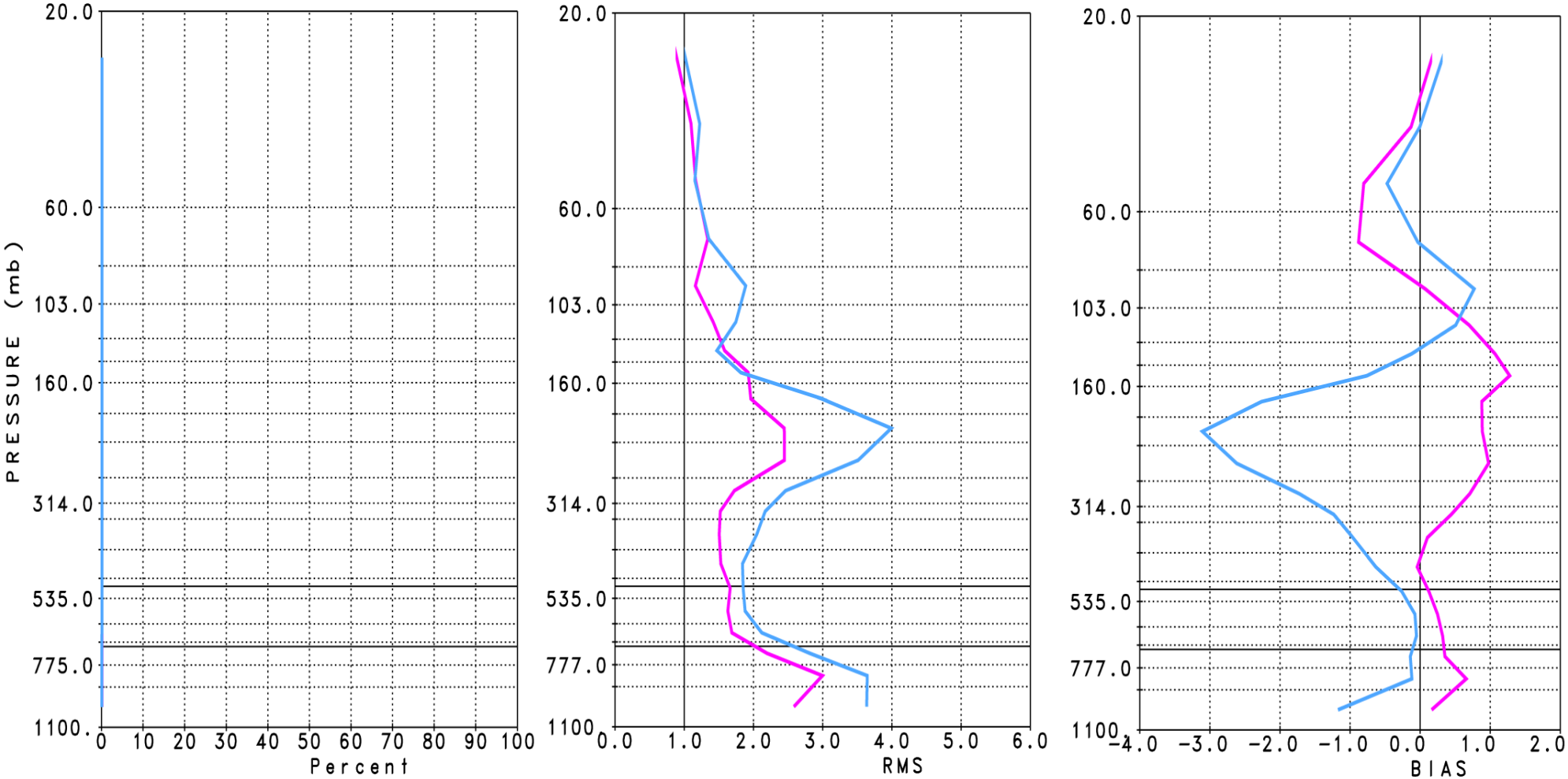
The next chart shows results we obtained using the NGAS retrieval system using the new CrIS noise level done both with and without NGAS IR and MW tuning coefficients

October 19, 2007 Global
NGAS CrIS/ATMS Retrievals

Percent of All Cases
Accepted as a Function of Height
Using NGAS Quality Control

Layer Mean RMS Temperature (°C)
Differences from ECMWF "Truth"

Layer Mean BIAS Temperature (°C)
Differences from ECMWF "Truth"



NGAS Without Tuning — Yield = 0.12%

NGAS Tuned — Yield = 0.14%

Results Using NGAS Retrieval System

- **With No tuning**

  Results using no IR or MW tuning were very poor

  - Less than 1% of the retrievals were accepted using NGAS QC procedure
  - There were very large biases from ECMWF in retrieved quantities for the few accepted cases
  - There were also very large RMS differences from ECMWF for these cases

  This is not a surprise – tuning coefficients developed after launch are always needed

- **With IR and MW tuning**

  Results using IR and MW tuning are better but still unacceptable for operational use

  - Less than 1% of the retrievals are still accepted using NGAS QC
  - Biases against ECMWF are much lower but still unacceptably large

    NGAS tuning coefficients appear to be sub-optimal
  - RMS differences from ECMWF are unacceptably large, especially near the surface

These results do not mean much given that the % yield is so low

We conducted a further evaluation of NGAS retrievals using cases in common with those accepted using the AIRS Version-6-like CrIS/ATMS retrieval algorithm

AIRS Science Team Version-6 T(p) QC Methodology

All retrieved profiles T(p) have their own empirical error estimates $\delta T(p)$

Each profile has two pressures assigned to it, p_{best} and p_{good}, down to which the profile is considered of best quality and good quality where $p_{best} \leq p_{good} \leq p_{surf}$

There are two sets of thresholds $\Delta_{DA}(p)$ and $\Delta_{CLIM}(p)$ used to determine p_{best} and p_{good} respectively

p_{best} is the pressure down to which $\delta T(p) \leq \Delta_{DA}(p)$

$\Delta_{DA}T(p)$ is a tight set of thresholds designed to give RMS errors of T(p) down to p_{best} on the order of 1K – these are called Data Assimilation thresholds

p_{good} is the pressure down to which $\delta T(p) \leq \Delta_{CLIM}(p)$ where $\Delta_{CLIM}(p)$ are larger than $\Delta_{DA}(p)$

$\Delta_{CLIM}(p)$ is designed to maximize percent yield down to p_{good} while providing RMS errors $\leq$ 2K – these are called Climate thresholds

AIRS Version-6 results for October 19, 2007 are shown on the next viewgraph

- Demonstrates the concept of having 2 types of pressure dependent QC thresholds
- Demonstrates the quality of results we should get using CrIS/ATMS data
- Statistics include all cases down to p_{best} and p_{good} respectively

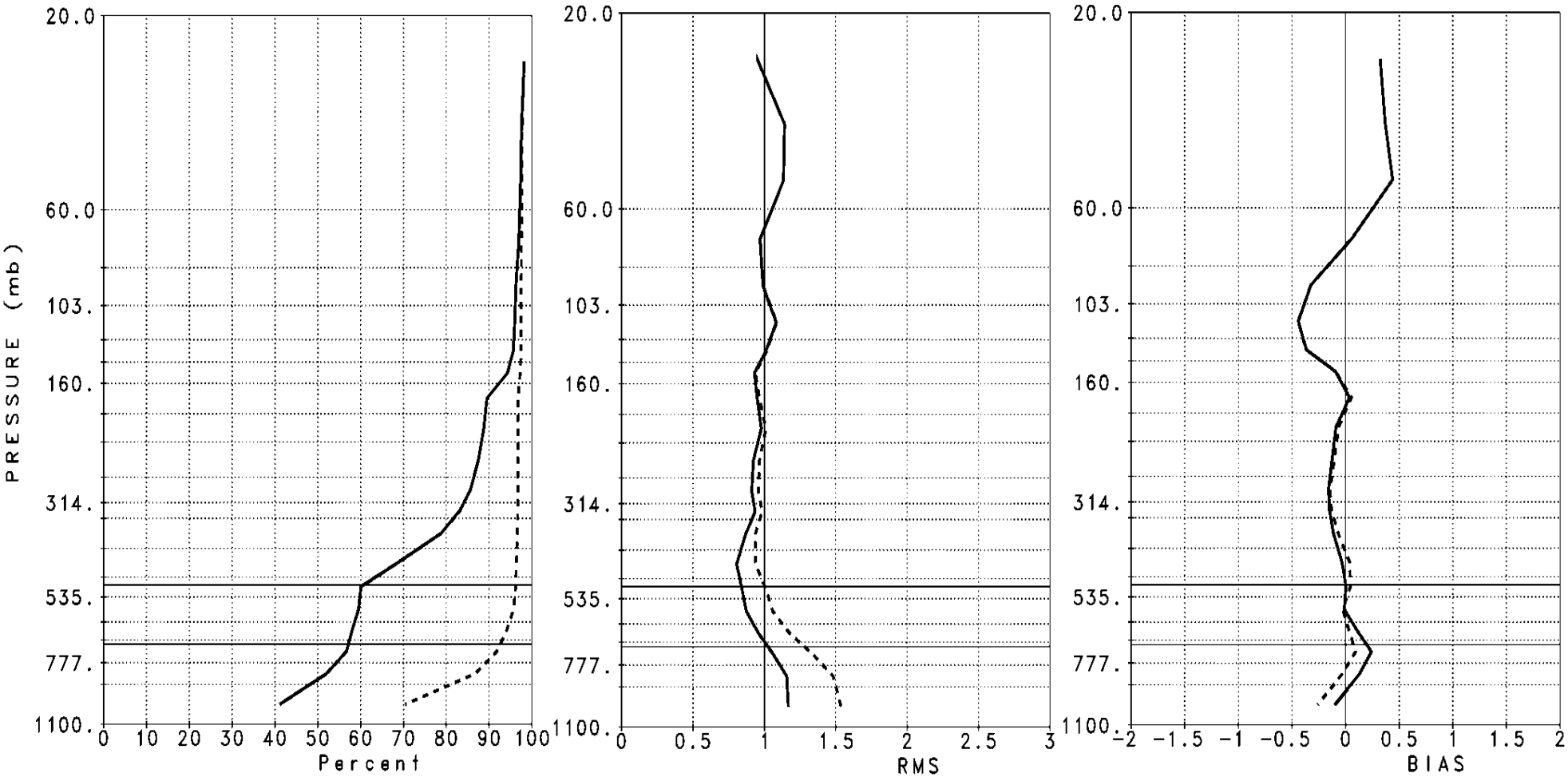
Global percent yields at 500 mb are 60% and 96% using DA and CLIM thresholds

October 19, 2007 Global
AIRS Science Team Version-6 Retrievals

Percent of All Cases Accepted
Accepted as a Function of Height
Using AIRS Version-6 Quality Control

Layer Mean RMS Temperature (°K)
Differences from ECMWF

Layer Mean BIAS Temperature (°K)
Differences from ECMWF



AIRS Version-6 Data Assimilation Quality Control
AIRS Version-6 Climate Quality Control

SRT Version-6 Like CrIS/ATMS Retrievals

Uses AIRS Version-6 retrieval code modified for use with CrIS/ATMS observations

Uses ATMS RTA provided by Phil Rosenkranz in 2007

Uses CrIS RTA Version-10A developed by Larrabee Strow and augmented by Eric Maddy for compatibility with SRT AIRS-like retrieval program

Uses CrIS and ATMS channels analogous to those used with AIRS/AMSU

No optimization has been done yet with regard to channels or other retrieval details

SRT did update the following for CrIS/ATMS

- Regression coefficients
- IR and MW tuning coefficients
- Error estimate coefficients
- $\Delta_{DA}(p)$ and $\Delta_{CLIM}(p)$ thresholds

Next figures compare performance of SRT and NGAS CrIS/ATMS retrievals on two common sets of ensembles

SRT cases accepted down to p_{best} using DA thresholds

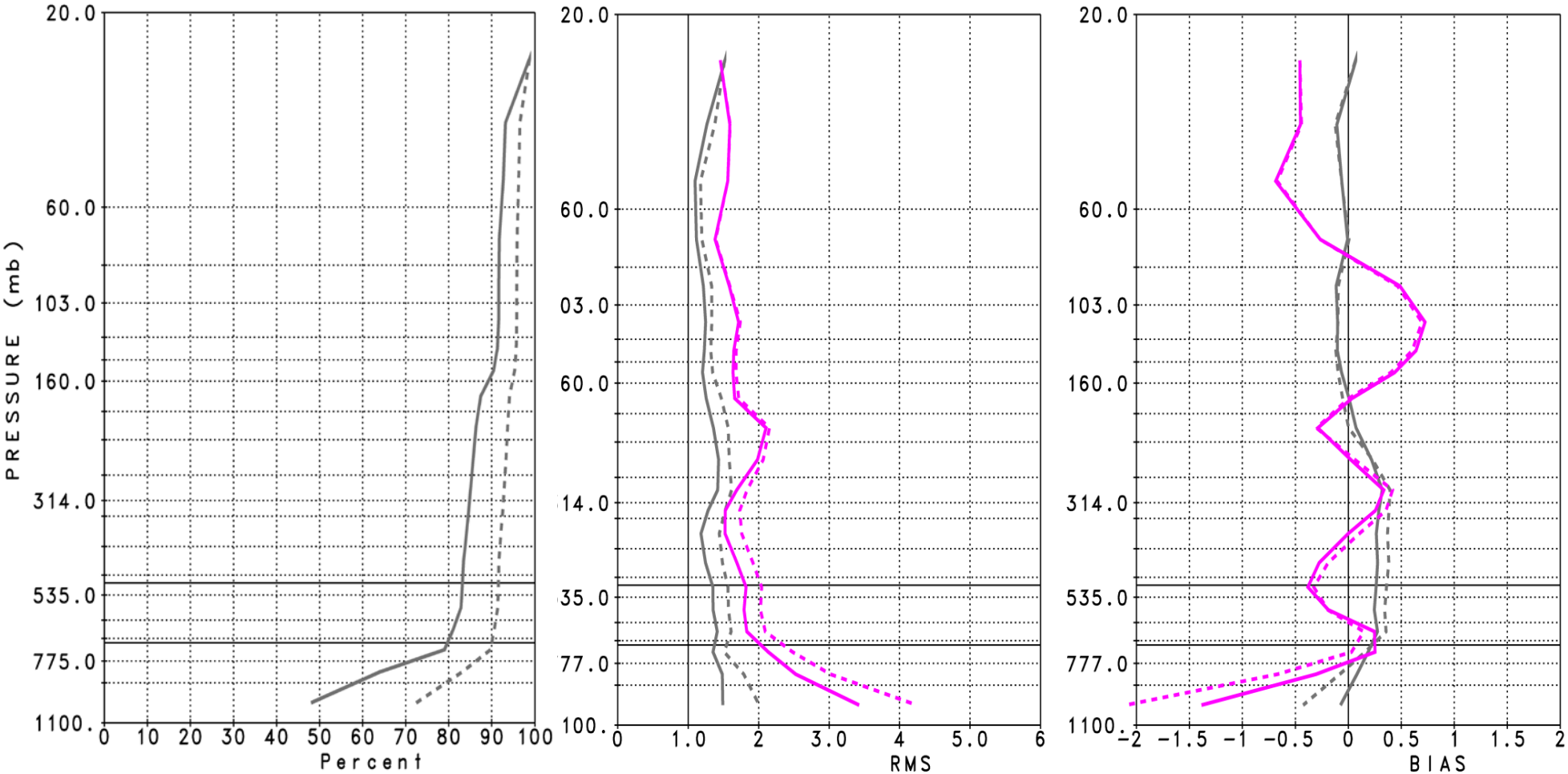
SRT cases accepted down to p_{good} using CLIM thresholds

October 19, 2007 Global
CrIS/ATMS Retrievals

Percent of SRT Cases
Accepted as a Function of Height
Using AIRS Version-6-like Quality Control

Layer Mean RMS Temperature (°C)
Differences from ECMWF "Truth"

Layer Mean BIAS Temperature (°C)
Differences from ECMWF "Truth"



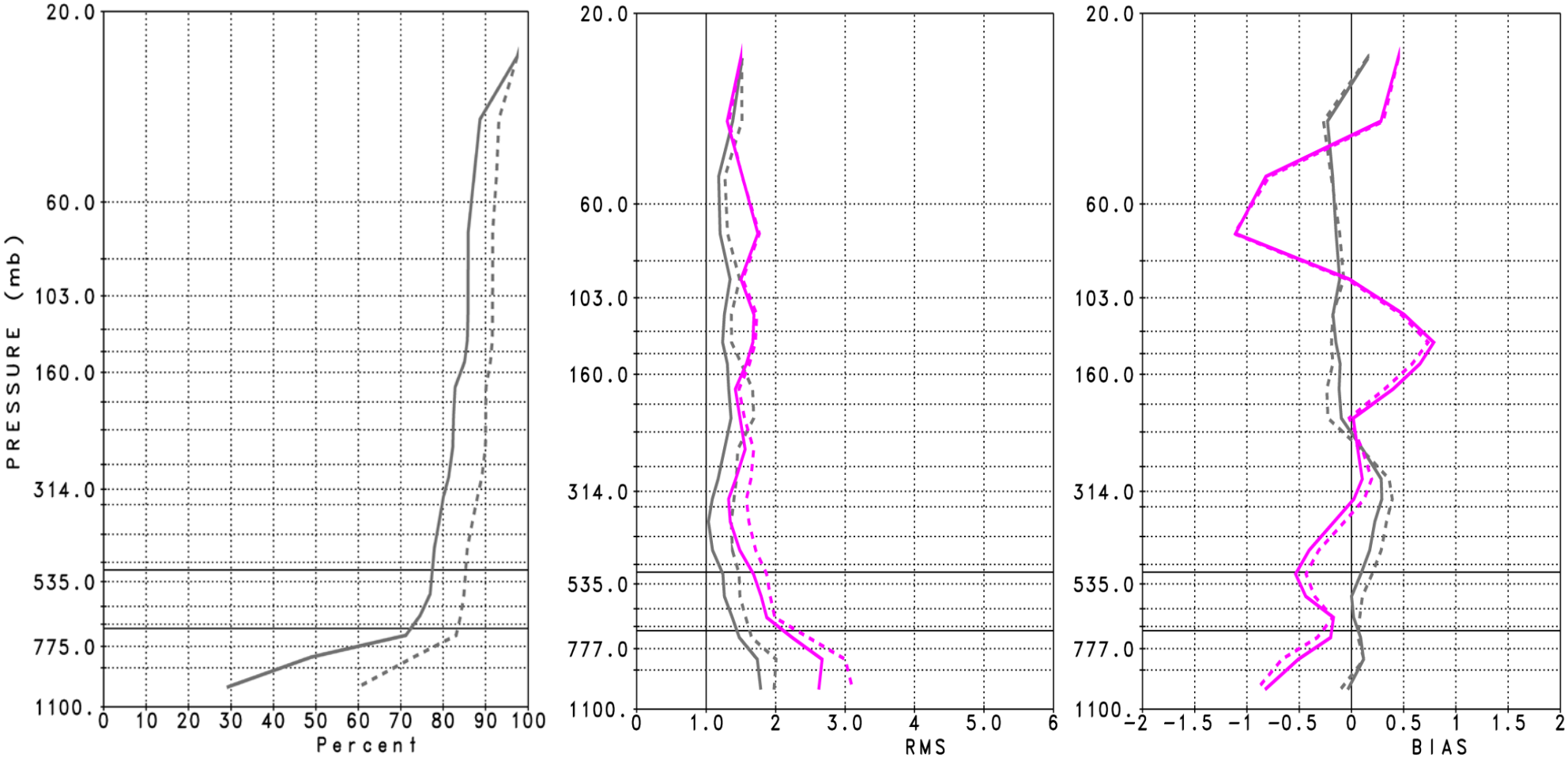
SRT Retrievals for Data Assimilation QC Ensemble
SRT Retrievals for Climate QC Ensemble
NGAS Retrievals for Data Assimilation QC Ensemble
NGAS Retrievals for Climate QC Ensemble

October 19, 2007 Land 50°N to 50°S
CrIS/ATMS Retrievals

Percent of SRT Cases
Accepted as a Function of Height
Using AIRS Version-6-like Quality Control

Layer Mean RMS Temperature (°C)
Differences from ECMWF "Truth"

Layer Mean BIAS Temperature (°C)
Differences from ECMWF "Truth"



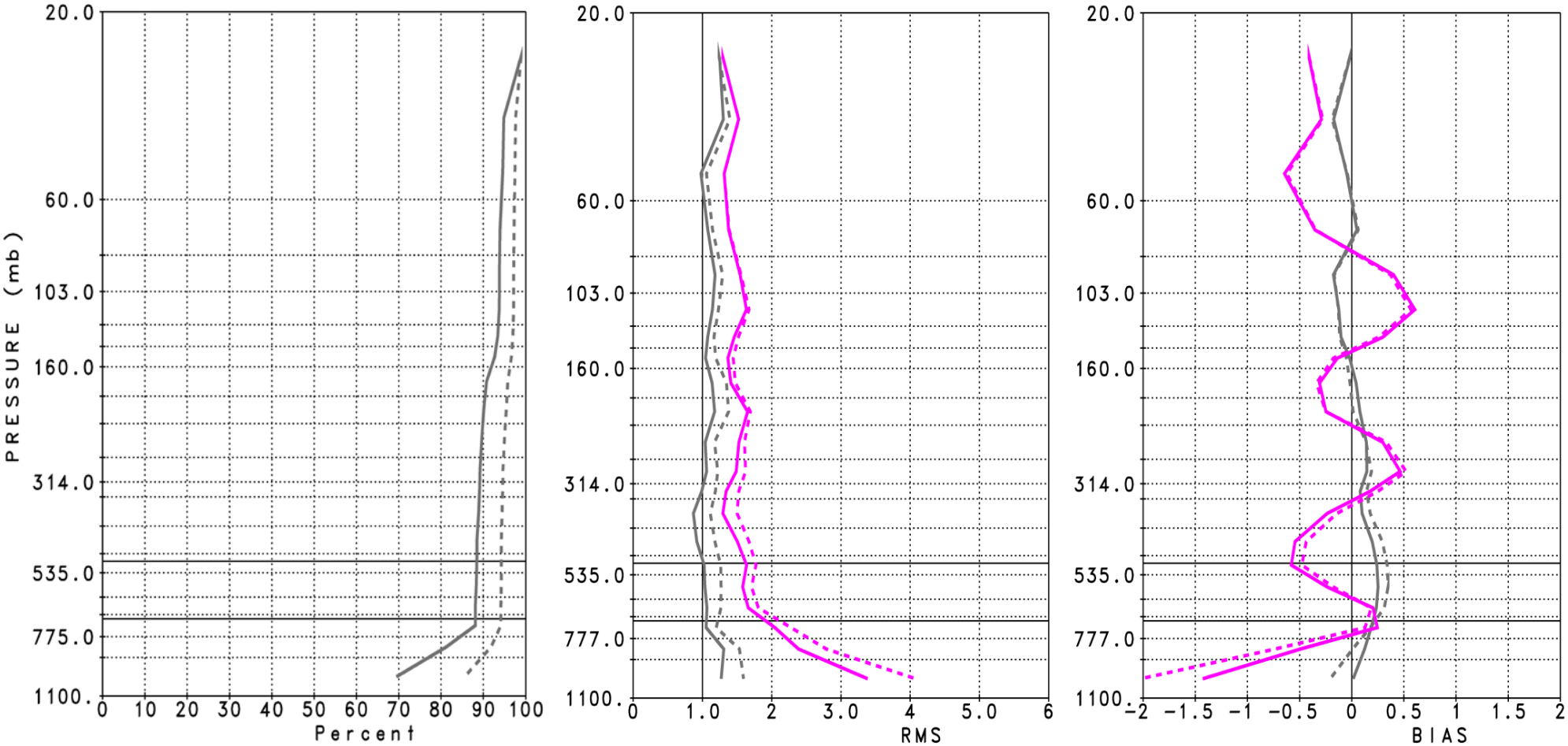
SRT Retrievals for Data Assimilation QC Ensemble
SRT Retrievals for Climate QC Ensemble
NGAS Retrievals for Data Assimilation QC Ensemble
NGAS Retrievals for Climate QC Ensemble

October 19, 2007 Ocean 50°N to 50°S
CrIS/ATMS Retrievals

Percent of SRT Cases
Accepted as a Function of Height
Using AIRS Version-6-like Quality Control

Layer Mean RMS Temperature (°C)
Differences from ECMWF "Truth"

Layer Mean BIAS Temperature (°C)
Differences from ECMWF "Truth"



SRT Retrievals for Data Assimilation QC Ensemble
SRT Retrievals for Climate QC Ensemble
NGAS Retrievals for Data Assimilation QC Ensemble
NGAS Retrievals for Climate QC Ensemble

Comparison of NGAS and SRT Retrieval Performance on Common Ensembles

- By definition, % yields as a function of pressure increase going from Data Assimilation thresholds to Climate thresholds
  - Data Assimilation thresholds includes an easier, but still very large, set of cases
    - 84% accepted globally at 500 mb
  - Climate thresholds include a very extensive set of cases
    - 91% accepted globally at 500 mb
- Both SRT and NGAS results degrade as more difficult cases are included in the ensemble
- SRT CrIS/ATMS retrievals are considerably more accurate than NGAS retrievals for each common ensemble
  - SRT RMS errors are much lower
  - SRT retrievals are essentially unbiased
    - This shows SRT derived tuning coefficients are performing well
  - NGAS retrievals have large negative biases near the surface especially for climate ensemble
    - This shows that NGAS cloud clearing methodology is not performing optimally for hard cloud cases
  - Degradation in NGAS retrievals compared to SRT is greater over ocean than over land
- **NGAS retrieval system needs significant improvement before it is ready for operational use**

Improved SRT Methodology to Generate IR Tuning Coefficients $\Delta\Theta_i$

Tuning coefficients $\Delta\Theta_i$ represent a term which is added to $\left(\hat{\Theta}_i - \Theta_i^{comp}\right)$ in the retrieval

where $\hat{\Theta}_i$ is the clear column brightness temperature for channel i and Θ_i^{comp} is a computed brightness temperature

$\Delta\Theta_i$ is derived as the mean value of $\hat{\Theta}_i - \Theta_i^{truth}$ over an ensemble where Θ_i^{truth} is Θ_i^{comp} using ECMWF as "truth"

Previous methodology used an ensemble comprised of clear ocean cases

There are very few clear ocean cases, and some might not actually be clear

New methodology used $\hat{\Theta}_i$ for the 70% of the ocean cases in which $p_{best} = p_{surf}$

See chart 10

Charts 10 (ocean) and 9 (land) show SRT tuning coefficients perform well over ocean and land

$\Delta\Theta_i$ is compatible with CrIS RTA Version-10A and available for everyone to use

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