

On Empirical Bias Corrections of NPP CrIMSS OSS Forward Model

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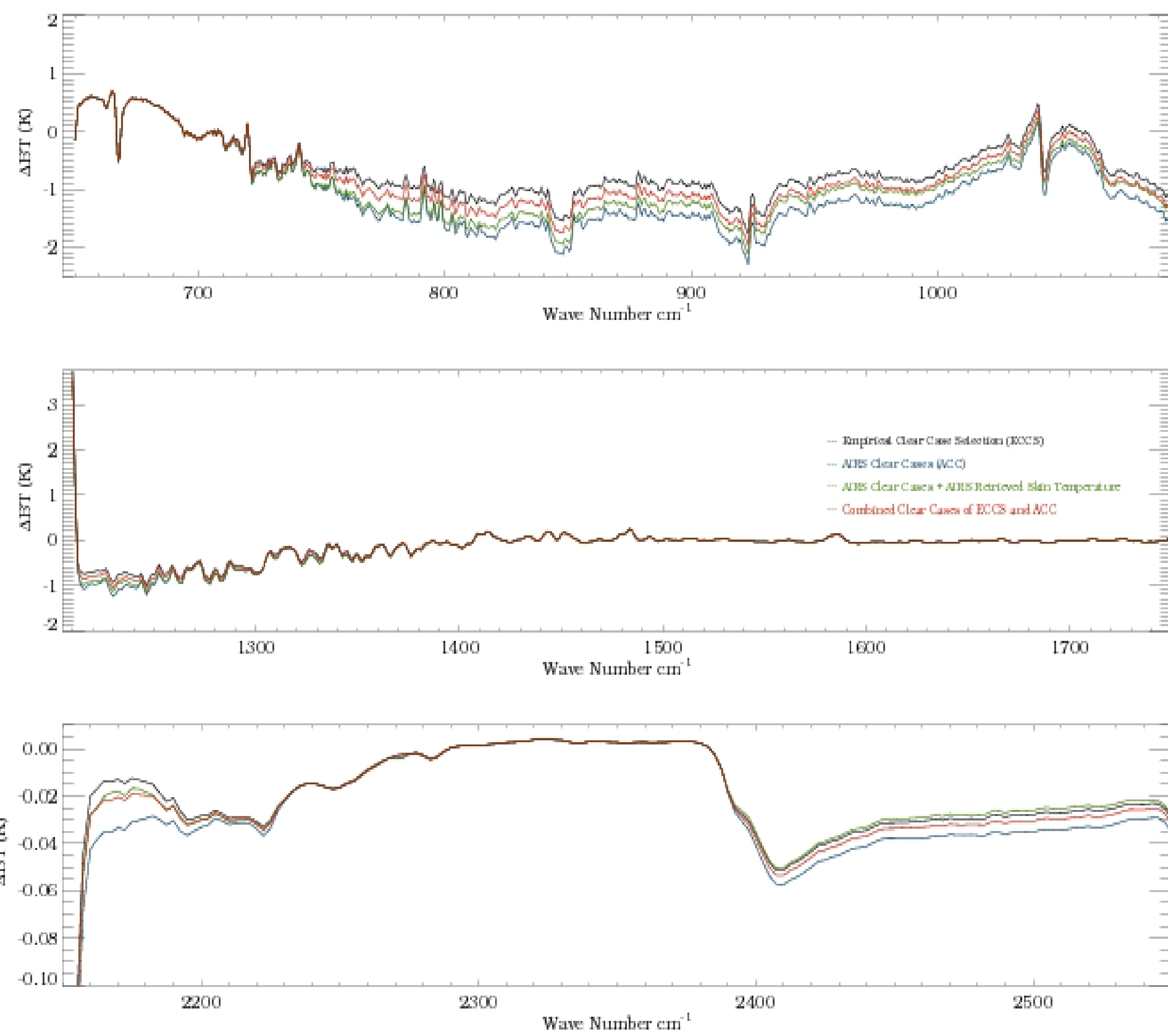
Abstract: The Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) are two critical sounding instruments onboard the Suomi National Polar-orbiting Partnership (NPP) satellite. CrIS and ATMS collect radiance, with excellent radiometric precision, in the upwelling infrared spectra and microwave spectra respectively. The Cross-track Infrared and Micrwoave Sounding Suite (CrIMSS) Enviromental Data Record (EDR) algorithm converts these radiances using a simultaneous retrieval technique to generate atmospheric vertical profiles of temperature, moisture, and other geophysical parameters. The CrIMSS EDR algorithm employs the forward model of Optimal Spectral Sampling (OSS), developed by AER. The OSS model is applied in calculations of both the IR and microwave (MW) radiances. However, because of errors in the forward model calculations due to the instrumental sensitivity to trace gases, uncertainties due to surface emissivity, etc., a bias always exists between the observed and computed radiances. Therefore, the CrIMSS algorithm requires a bias-correction component to account for the differences between the observed radiances and the forward model used in the retrieval algorithm. This work will demonstrate the empirical IR and MW bias corrections of the OSS forward model based on CrIS and ATMS data from the focus day on May 15, 2012. We use ECMWF profiles along with AIRS retrieval products and trace-gas climatologies to compute the empirical bias correction. We also confirmed the empirical bias corrections that were done by NASA/LaRC and compared the CrIMSS EDR profiles based on different empirical bias corrections from different clear case selections and current IDPS EDRs.

Data Sets and Methods

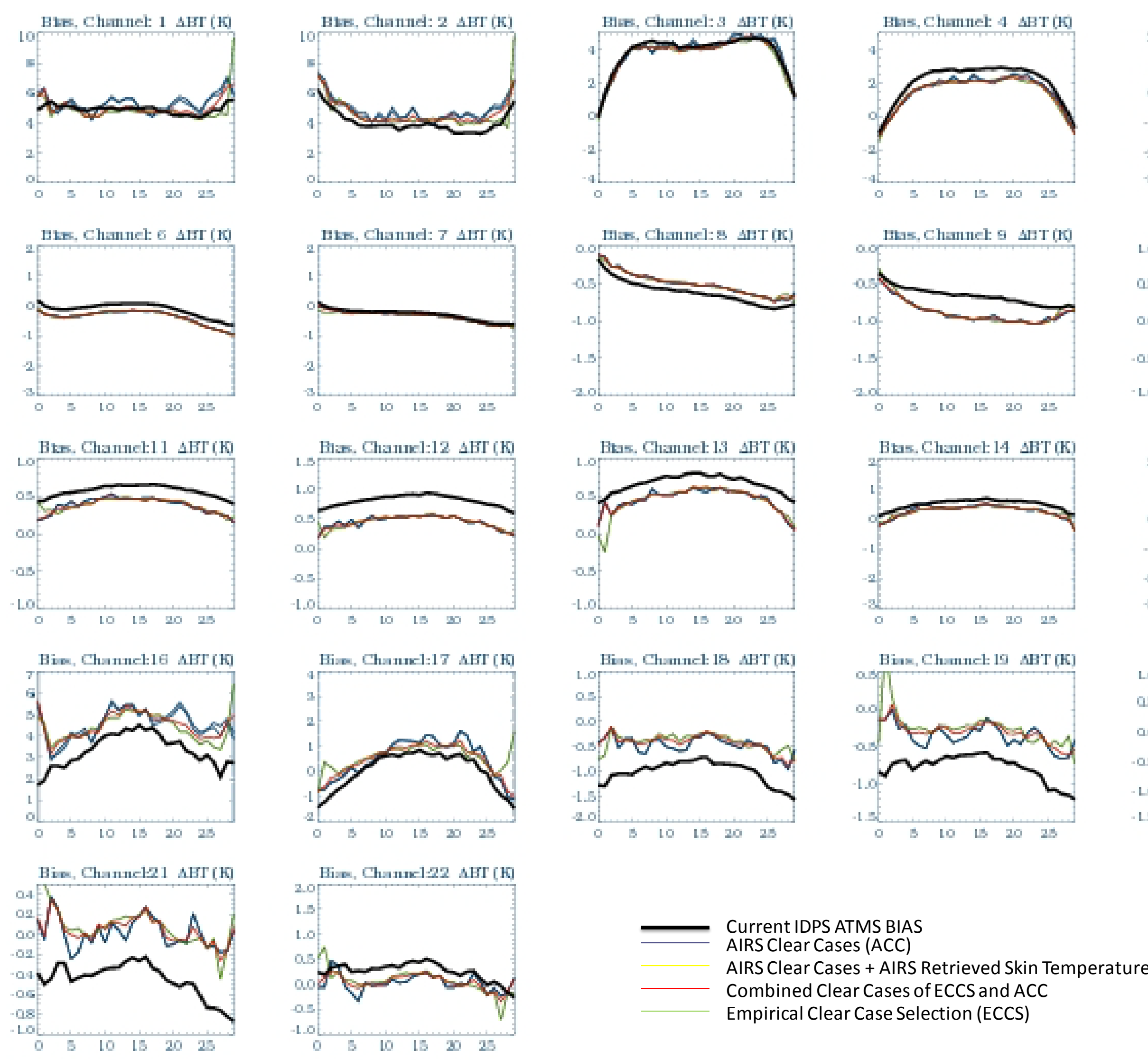
We performed brightness temperature bias corrections of the CrIMSS OSS forward model. The bias between observed brightness temperatures and brightness temperatures computed by the OSS forward model was analyzed for clear profiles from May 15, 2012. Therefore, the clear case selection methods will impact the bias correction significantly. In this work, the clear case selection methods include (1) empirical clear case selection (ECCS) with criteria of (a) oceanic areas, (b) latitudes between 60°N and 60°S, and (c) night time or descending orbits; (2) The Aqua Atmospheric Infrared Sounder (AIRS) retrieval clear cases; and (3) The combination of empirical selection and AIRS retrieved clear cases. From the difference between observations and computations, we obtained the bias records for each channel of both CrISS and ATMS from the May 15 data, and applied the bias correction additively on CrIMSS offline runs on the data of September 20, 2012. Note that the sanity check by applying the bias correction to September 20, 2012 data is to assure that the bias correction is independent and robust.

In addition, we simply substituted the skin temperature of ECMWF profiles which were matched up by the AIRS clear cases with the AIRS retrieved skin temperature as input into forward model for bias correction. By this additional work, we tested the influence from the skin temperature which impacts the CrIMSS retrievals near the surface.

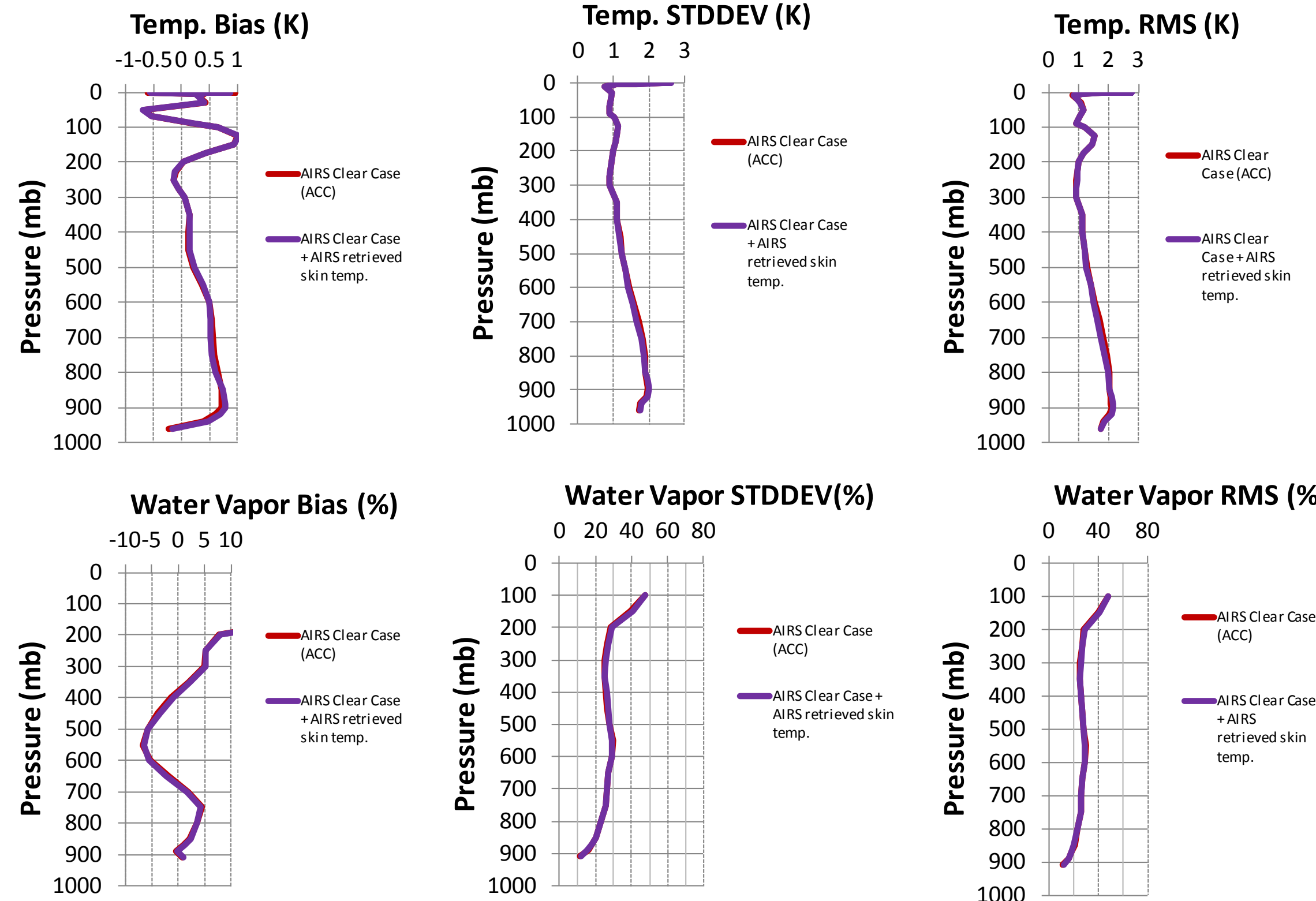
CrIS Bias Comparison



ATMS Bias Comparison



Performance Evaluation (AIRS CLR Cases vs. AIRS CLR Cases + AIRS Tskin)



Summary and Discussion

We performed empirical brightness temperature bias corrections for both CrIS and ATMS and found (1) the yield rates are comparable with the proposed IDPS MX7.1; (2) The vertical temperature and water vapor profiles near the surface are slightly improved, however the upper troposphere (from 500 to 900 mb) profiles are worse than the proposed IDPS MX7.1 due to the clear case selection algorithm differences, hence the CrIS/ATMS bias correction differences; (3) The near surface temperature improvement is very tiny by applying AIRS retrieved skin temperature. In future work, we may improve the clear case selection methodology and the bias corrections in channels with higher weighting functions.

QC Chart (or Yield Rate) of the CrIMSS Offline Runs

	Percentage of Profiles in Category	% of Profiles Passing the Infrared QC Test in the Combined Retrieval					% of Profiles Passing the Microwave QC Test in the Combined Retrieval					% of Profiles Passing the Microwave QC Test in the Microwave-Only Retrieval					% of Profiles Passing both the Infrared and Microwave QC Tests in the Combined Retrieval				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
All Profiles	100%	81.10%	76.11%	75.87%	76.59%	77.63%	53.05%	59.20%	59.25%	60.17%	60.94%	89.82%	89.95%	90.12%	90.57%	90.17%	51.15%	55.90%	55.82%	56.85%	57.87%
Day Profiles	49.31%	80.37%	75.13%	75.16%	75.65%	76.68%	54.18%	61.74%	61.96%	62.69%	63.13%	90.93%	90.71%	91.00%	91.34%	90.99%	51.74%	57.16%	57.14%	58.03%	58.79%
Night Profiles	50.69%	81.82%	77.17%	76.57%	77.48%	78.54%	51.95%	56.70%	56.56%	57.78%	58.81%	88.74%	89.21%	89.24%	89.85%	89.38%	50.58%	54.75%	54.51%	55.73%	56.98%
Clear Profiles	8.31%	85.23%	73.43%	74.51%	76.10%	78.39%	60.99%	68.48%	68.81%	71.38%	72.61%	93.62%	96.68%	96.37%	96.79%	96.51%	58.14%	64.13%	64.80%	67.33%	68.80%
Partly Cloudy Profiles	80.58%	79.70%	74.99%	74.63%	75.27%	76.20%	51.77%	56.57%	56.65%	57.26%	58.05%	89.05%	88.85%	89.16%	89.54%	89.16%	50.01%	53.43%	53.30%	54.05%	55.10%
Cloudy Profiles	11.11%	88.21%	86.15%	85.76%	86.20%	87.25%	56.43%	72.13%	71.53%	72.75%	73.12%	92.58%	93.47%	92.69%	93.45%	92.85%	54.19%	68.44%	67.86%	69.15%	69.78%
Ocean Profiles	62.52%	82.08%	78.23%	78.29%	78.77%	79.97%	50.89%	60.69%	60.81%	61.63%	62.98%	91.97%	92.05%	92.62%	92.82%	92.62%	50.21%	59.25%	59.24%	60.14%	61.62%
Land Profiles	29.33%	80.47%	73.09%	72.24%	73.49%	74.07%	60.26%	58.41%	58.22%	59.44%	58.92%	88.88%	87.83%	87.17%	88.17%	87.36%	55.55%	51.06%	50.69%	52.15%	52.00%
Coast Profiles	8.15%	75.91%	70.49%	69.88%	70.89%	72.23%	43.65%	50.55%	50.79%	51.64%	52.42%	76.68%	81.36%	81.46%	81.90%	81.31%	42.52%	47.27%	47.41%	48.32%	49.78%

Here letters “A” through “E” are representing different runs with different CrIS/ATMS bias corrections.

A -- Proposed IDPS MX7.1 System with the current IDPS bias tuning files

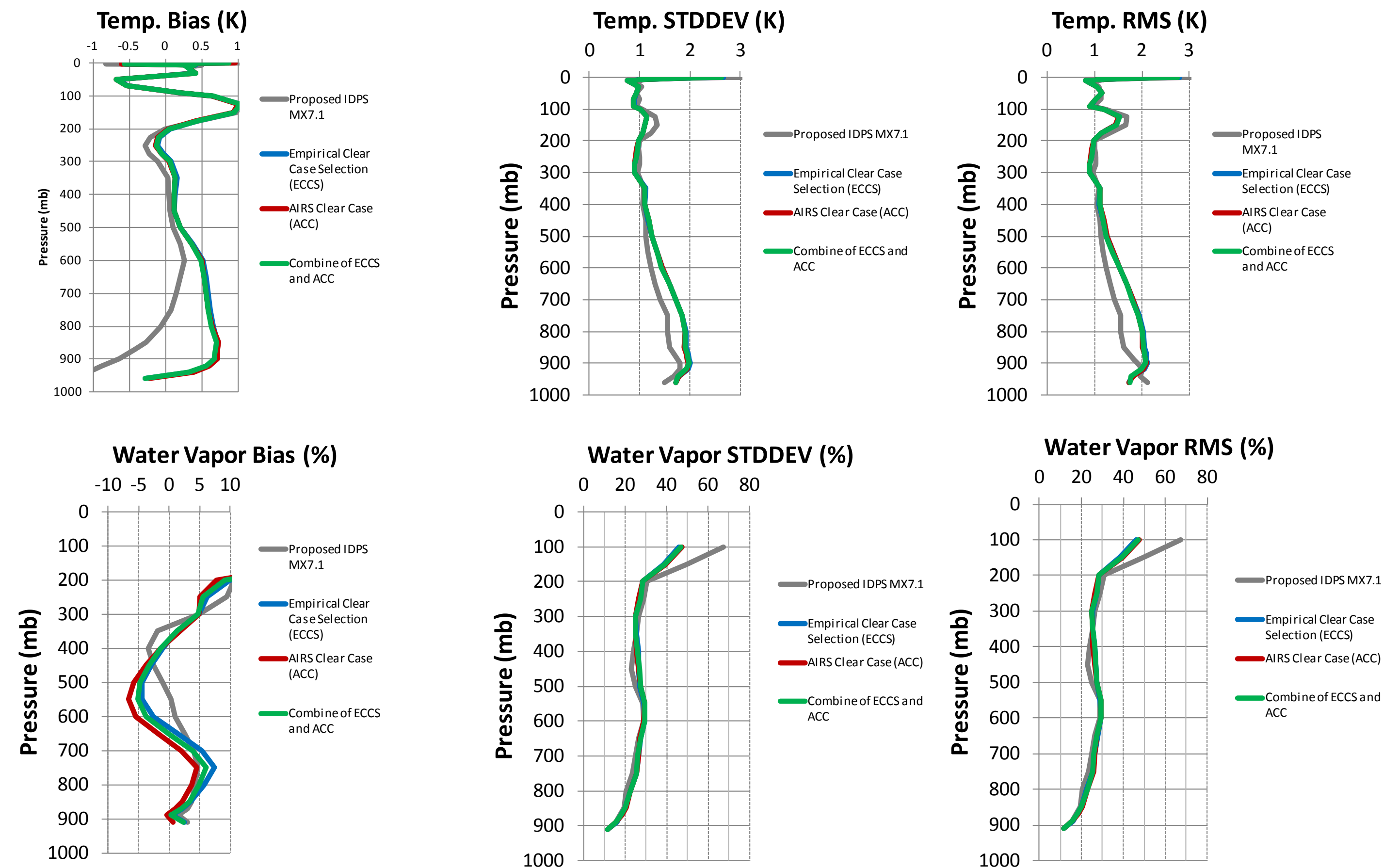
B -- Proposed IDPS MX7.1 System with the bias tuning files from the empirical clear case selection

C -- Proposed IDPS MX7.1 System with the bias tuning files from the AIRS retrieved clear cases

D -- Proposed IDPS MX7.1 System with the bias tuning files from the clear cases of the combination of B and C

E -- Proposed IDPS MX7.1 System with the bias tuning files from the AIRS retrieved clear cases, plus the AIRS retrieved skin temperature

Performance Evaluation (New bias corrections vs. IDPS)



Note that the truth is the ECMWF data.

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