

# On Empirical Bias Corrections of NPP CrIMSS OSS Forward Model

Changyi Tan<sup>2</sup>, A. Gambacorta<sup>2</sup>, M. G. Divakarla<sup>2</sup>, S. Kizer<sup>3</sup>, E. Maddy<sup>4</sup>, G. Guo<sup>2</sup>, M. Wilson<sup>2</sup>, X. Xiong<sup>2</sup>, X. Liu<sup>5</sup>, and C. D. Barnet<sup>1</sup>

<sup>1</sup>NOAA/NESDIS/STAR, <sup>2</sup>I.M. Systems Group, Inc., <sup>3</sup>Science Systems and Applications, Inc., <sup>4</sup>Science and Technology Corporation, and <sup>5</sup>LaRC/NASA

**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 CrIS 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.

## 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%	88.36%	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

