

Validation of Suomi-NPP CrIMSS retrievals of temperature and water vapor using ARM site best estimates of atmospheric state



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Abstract

CrIMSS is the Cross-track Infrared and Microwave Sounding Suite, which is comprised of the Cross-track Infrared Sounder (CrIS) and the Advanced Technology Microwave Sounder (ATMS) instruments. This suite of instruments is onboard the Suomi-NPP satellite which was launched in October 2011. In this effort, CrIMSS Environmental Data Records (EDRs), including atmospheric temperature and water vapor retrieved profiles, are validated against radiosondes launched coincident with the satellite overpasses of three Atmospheric Radiation Measurement (ARM) sites. These sites represent three different climatic regimes and include Lamont, Oklahoma in the US Southern Great Plains (SGP), Barrow, Alaska on the North Slope of Alaska (NSA), and Manus, Papua New Guinea in the Tropical Western Pacific (TWP). Combined with other ARM data, an assessment of the radiosonde data quality is performed and post-processing corrections are applied producing an 'ARM site best estimate' product. Comparisons of the resulting sonde profiles and the satellite retrievals are made to determine the accuracy of the satellite products. Retrieval products include those from the CrIMSS IDPS EDR Algorithm, GDAS, and CSPP Dual Regression Model (here noted as CSPP HSRTV).

Conclusions

- The Phase1 sonde launch effort is complete and Phase2 is ongoing
- The ARM site best estimates (BE) of the atmospheric state were produced for Phase1&2
- Comparisons were made between ARM BEs of temperature and water vapor and NPP derived retrievals (CrIMSS, GDAS, and CSPP HSRTV)
- For Phase1, the ARM BE agrees well with the GDAS retrievals and differs with the CrIMSS retrievals. Note that this analysis uses the CrIMSS EDRs with MX Version 5.3 - 6.5 and did not follow the official 1km/2km layering methodology for reporting statistics. The official analysis will require comparison with the CrIMSS EDR IPs, which are currently not available with the latest MX version.
- For Phase1 and Phase2 comparisons were made between the ARM BE and the CSPP HSRTV products. Analysis is ongoing.

Future Work

- Coordination of the remaining Phase2 sonde launch schedule
- Incorporation of additional datastreams into ARM BE product
- Repeating analysis when CrIMSS EDR products are reprocessed

References

Nalli, N. R., et al. (2013). Validation of satellite sounder environmental data records: Application to the Cross-track Infrared Microwave Sounder Suite, *J. Geophys. Res. Atmos.*, 118, doi:10.1002/2013JD020436.
 Tobin, D. C., H. E. Revercomb, R. O. Knuteson, B. M. Lesht, L. L. Strow, S. E. Hannon, W. F. Feltz, L. A. Moy, E. J. Fetzer, and T. S. Cress (2006a), Atmospheric Radiation Measurement site atmospheric state best estimates for atmospheric infrared sounder temperature and water vapor retrieval validation, *J. Geophys. Res.*, 111, D09S14, doi:10.1029/2005JD006103.

Acknowledgement

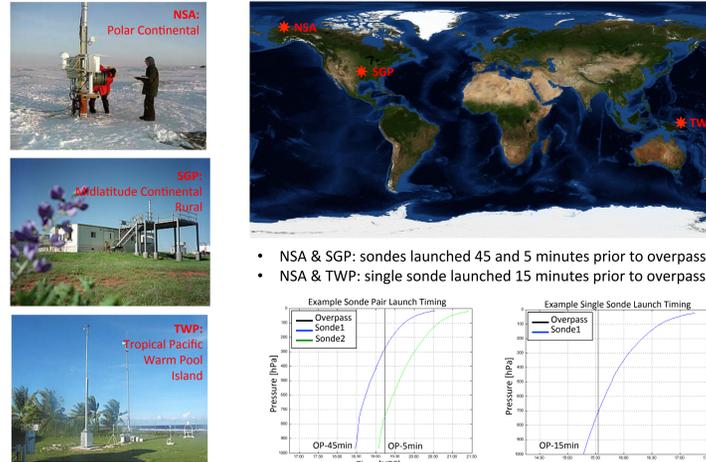
Data were obtained from the Atmospheric Radiation Measurement (ARM) Program sponsored by the U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research, Climate and Environmental Sciences Division.



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Best Estimate Data Access: ftp://ftp.ssec.wisc.edu/pub/crimss_edr_calval/
CSPP HSRTV Model: <http://cimss.ssec.wisc.edu/cspp>

Methodology

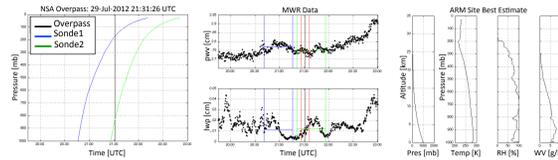
1. Coordinate radiosonde launches at NSA, SGP, & TWP coincident with NPP overpasses



Sonde Validation Effort							
	Phase1			Phase2			
	NSA	SGP	TWP	NSA	SGP	TWP	
Planned N	180 (90 pairs)	180 (90 pairs)	90	135 (45 pairs + 45)	180 (90 pairs)	90	
Launched n1	95	95	94	56	57	45	
Launched n2	91	93	---	32	53	---	
Pairs Completed N	90	89	---	32	52	---	
Time Frame	Jul12 – Dec12	Jul12 – Jan13	Jul12 – Jun13	Jun13 - present	Jun13 - present	Jun13 – Nov13	

2. Produce best estimate (BE) of atmospheric state

- Sondes are interpolated onto common pressure grid
- MWR PWV scaling applied to sonde RHs & WV mixing ratios
- Sondes interpolated to overpass time

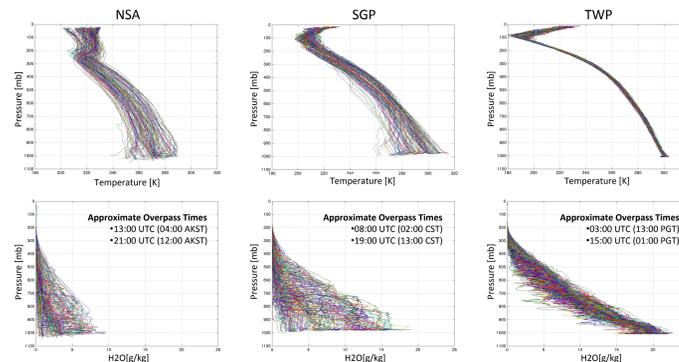


Primary ARM data products used:

- sondewnpn: RS-92 balloon-borne sounding system: Vaisala-processed, <http://dx.doi.org/10.5439/1021460>
- mwrlos: microwave radiometer: water liquid, & vapor along los path, <http://dx.doi.org/10.5439/1046211>
- vceil25k: Vaisala Ceilometer, cloud base heights, 25000 feet max range, <http://dx.doi.org/10.5439/1025313>

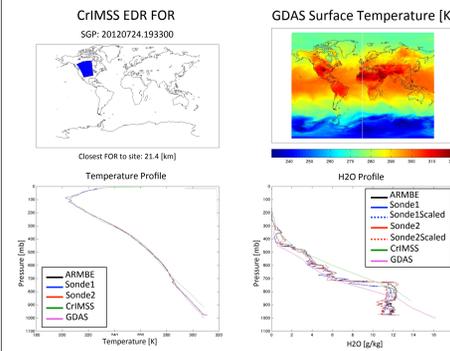
ARM Site Best Estimate Profiles

While the collection sites are limited in number, the BE profiles consist of highly accurate measurements of wide range of climatic conditions. This is ideal for assessing the CrIMSS EDRs.

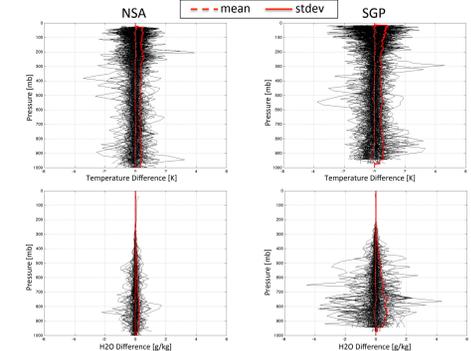


Comparisons of atmospheric state best estimate and NPP derived products

Sample Matchup: BE, CrIMSS, & GDAS



Difference Between Sonde Pairs (100 layers)

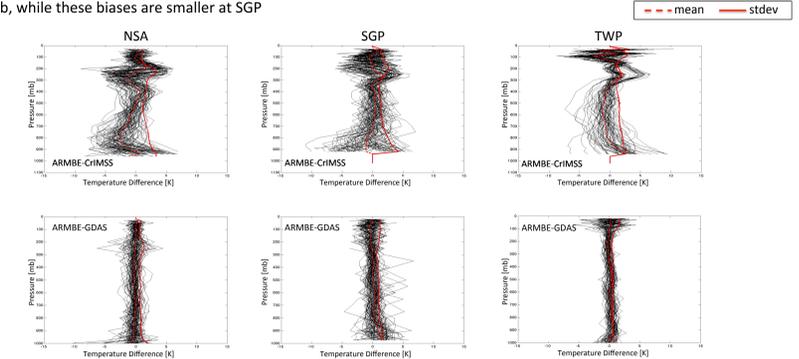


- ARM Best Estimate agrees well with GDAS, but differs significantly with CrIMSS product especially near the surface.

- Mean variability in temperature (water vapor) that occurs within ~40 minutes:
 NSA: 0.4°K (0.1 g/kg)
 SGP: 0.5°K (0.3 g/kg)

Phase1 Best Estimate Temperature Comparisons with CrIMSS & GDAS

- The ARM Best Estimate differs greatly from the CrIMSS product and compares well with the GDAS product
- At NSA there is a large temperature bias, on the order of 3K, between the ARMBE and CrIMSS products near 800mb, while these biases are smaller at SGP



Phase1 & 2 Best Estimate Comparisons with CSPP (100 layer)

- The ARMBE product differs with the CSPP product
- At NSA the large temperature bias that was present at 800mb with the CrIMSS comparison is gone
- At TWP there are large temperature biases, on the order of 3-4K, near 250mb and 50mb
- Also at TWP are large water vapor biases near the surface

