

Validation of ATMS Radiance Using GPS RO and Radiosonde Data

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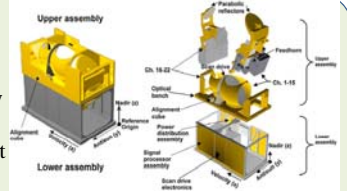
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Introduction

The Suomi National Polar-Orbiting Partnership (NPP) satellite was launched on October 28, 2011 and carries the Advanced Technology Microwave Sounder (ATMS) on board. Since December 2012, accuracy of the antenna brightness temperatures (TDR) from the ATMS upper level temperature sounding channels is assessed by comparing with the simulated TDR, which is computed by using the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) Radio Occultation (RO) data as input to the U.S. Joint Center of Satellite Data Assimilation (JCSDA) Community Radiative Transfer Model (CRTM). It is found that the mean differences (i.e., biases) between the observed TDR and the GPS RO simulations are positive for channels 6, 10-13 with values less than 1K while it is negative for channels 7-9 with values greater than -0.7K. Moreover, the biases and standard deviations of channels 6-11 are stable and consistent with each other; while for channels 12 and 13 the biases increase since July 2012. This may be caused by the change made in the COSMIC retrieval algorithm at about the same time. The Southern Great Plain (SGP) Lamont station radiosonde data from July 24 to December 26, 2012 provided by U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) research campaign is utilized to validate the ATMS water vapor channels 18 to 22. It's found that ATMS observation appears to be colder (in a level within 2.3K) than the radiosonde simulation using CRTM. The correlation coefficients between observation and simulation for the water vapor channels are all around 0.98. Particularly, for channels 18 and 20 their biases are always smaller at night time than that at day time while their standard deviations are always larger at night time than that at day time. Moreover, the correlation coefficients of these two channels are smaller at night time than that at day time.

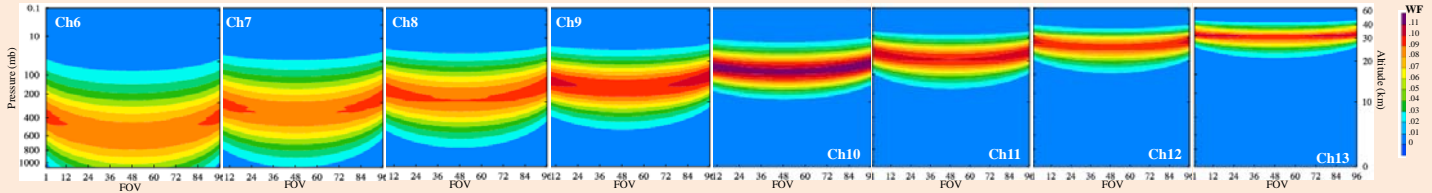


Characterization of the ATMS Upper-Level Temperature Sounding Channels Bias Using Collocated COSMIC RO Data

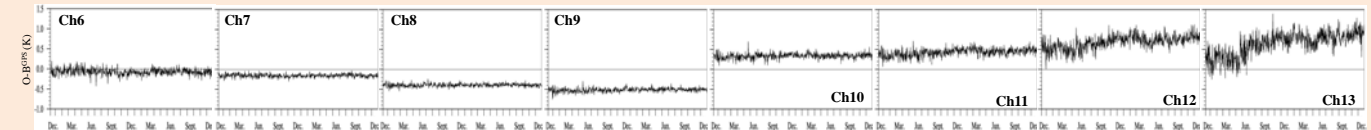
Considering the geolocation change of the perigee point of a GPS RO profile with altitude, the geolocation of a GPS RO at the altitude where the weighting function (WF) for each collocated ATMS FOV of a specified sounding channel reaches the maximum, is used for implementing the spatial collocation criteria (listed below). The altitude of the maximum WF is determined by applying the U.S. standard atmosphere into CRTM.

The collocation Criteria: Time difference < 3 hours and spatial distance < 50 km.

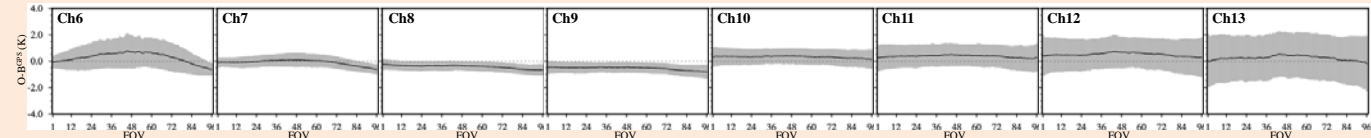
ATMS Weighting Function (U.S. Standard Atmosphere)



Daily Mean of GPS RO Derived Bias (Dec. 2011 to Dec. 2013)



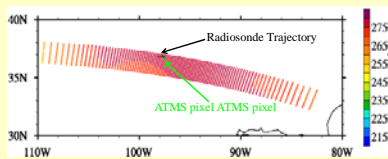
GPS RO Derived Scan Bias



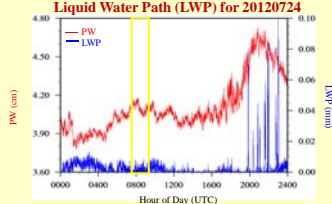
ATMS Water Vapor Channels Calibration using Collocated DOE ARM/CART Radiosonde at SGP Site

The U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Calibration and Radiation Test Bed (CART) at Southern Great Plain (SGP) provides well-calibrated radiosonde data. Early study has assessed the AMSU-B opaque channels (183.31±7, 183.31±3, and 183.31±1GHz) using the radiosonde data at SGP site. Besides these AMSU-B channels, ATMS adds two new water vapor channels (183.31±4.5 and 183.3±1.8GHz). The near-concurrent ATMS pixels are collocated with radiosonde data from the campaign of ARM Radiosondes for NPOESS/NPP validation and the brightness temperatures from CRTM simulation are compared with ATMS measurements for channels 17 to 22. The collocation criteria are: Time difference < 1.5 hours & spatial distance < 50 km, the averaged liquid water path (LWP) within 3 hours < 0.02mm and the averaged precipitable water (PW) within 3 hours > 1.5 cm.

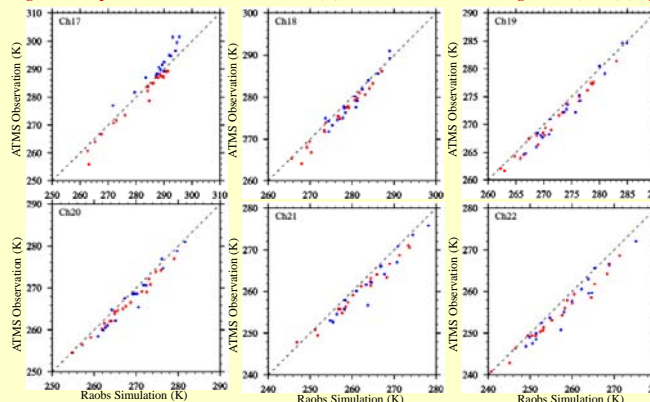
Example of Spatial Matchup



Time series of Precipitable Water (PW) and Liquid Water Path (LWP) for 20120724



Brightness temperature from ATMS observations (O) and Raobs Simulations using CRTM (B^{raobs}) (Day 23/Night 17)



Statistics of Brightness Temperature Bias

Channel Number	Mean			Std. Dev.			Corr. Coef.		
	day	night	total	day	Night	total	day	night	total
17	-1.888	2.816	0.878	1.614	2.208	3.319	0.988	0.937	0.898
18	-1.517	-0.945	-0.929	0.915	1.433	1.302	0.988	0.970	0.982
19	-1.316	-1.354	-1.130	0.671	1.113	1.067	0.993	0.985	0.987
20	-1.484	-1.476	-1.427	0.756	1.376	1.188	0.993	0.980	0.986
21	-1.845	-2.126	-2.004	1.113	1.606	1.505	0.990	0.974	0.981
22	-2.115	-2.375	-2.558	1.335	1.706	1.583	0.989	0.973	0.983

Summary

With the high quality of COSMIC RO observations in the middle troposphere to lower stratosphere, the reliable radiosonde profiles in the lower troposphere and radiative transfer model, ATMS upper level temperature sounding and water vapor channels can be accurately validated. Since the launch in 2011, ATMS shows consistent O-B for temperature sounding channels except for channels 12 and 13. The O-B of water vapor channels is all less than 2.1K.