First Year Results of Radiometric Inter-Calibration (XCAL) of GMI and TMI

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Abstract

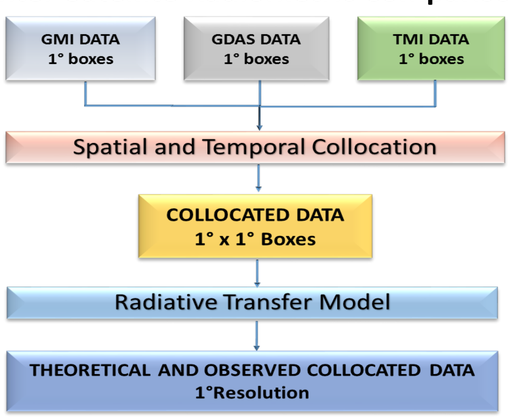
This poster presents inter-satellite radiometric calibration (XCAL) results between the GPM Microwave Imager (GMI) and the previous TRMM radiometric transfer standard, the TRMM Microwave Imager (TMI). The GMI, in non-sun-synchronous orbit, serves as the radiometric transfer standard for the constellation radiometers, which will reduce errors in global rainfall estimates associated with temporal/spatial sampling. Brightness temperature (Tb) biases for constellation radiometers have been characterized with respect to GMI and appropriate radiometric corrections have been applied in the Precipitation Processing System before performing rain retrievals. Our XCAL goal is that all radiometers will be cross-calibrated relative to GMI to a Tb accuracy of ± 0.1 K.

GMI & TMI Imagers Channels

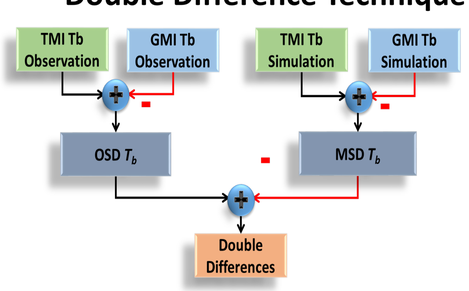
	TMI			GMI		
	Channels	Central Freq. (GHz)	BW (MHz)	Channels	Central Freq. (GHz)	BW (MHz)
	T1	10.65 V	100	G1	10.65 V	100
	T2	10.65 H	100	G2	10.65 H	100
*	T3	19.35 V	500	G3	18.70 V	200
	T4	19.35 H	500	G4	18.70 H	200
	T5	21.30V	200	G5	23.80 V	400
	T6	37.00V	2000	G6	36.64 V	1000
	T7	37.00 H	2000	G7	36.64 H	1000
	T8	85.50 V	3000	G8	89.00 V	6000
	T9	85.50 H	3000	G9	89.00 H	6000

* Significant radiometer channel differences

Inter-Satellite Radiometric Comparison



Double Difference Technique

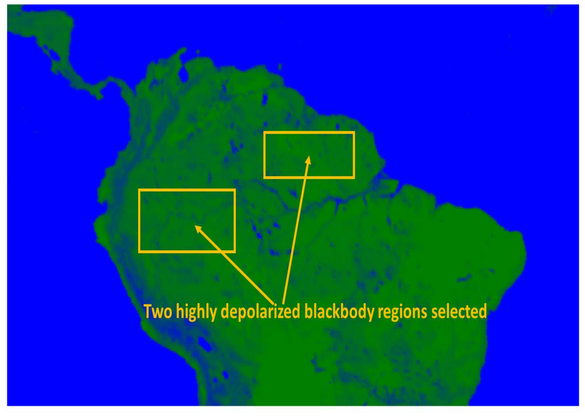


Modeled Single Difference: $MSDT_b = (T_{b_TMI\text{-}sim} - T_{b_GMI\text{-}sim})$

Observed Single Difference: $OSDT_b = (T_{b_TMI\text{-}obs} - T_{b_GMI\text{-}obs})$

Double Difference: $DD = OSDT_b - MSDT_b$

Warm-end XCAL on Amazon Rain Forest



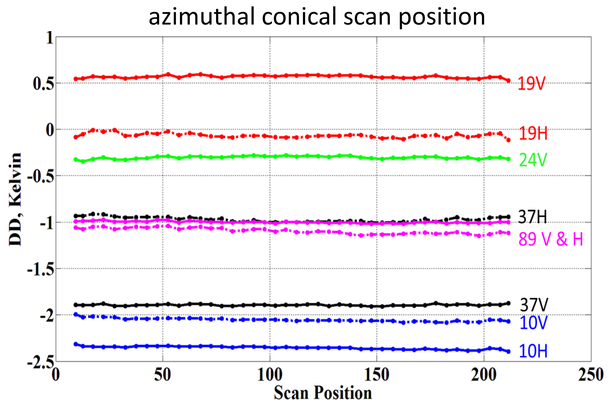
Warm-end GMI/TMI DD Bias

Tb Biases do NOT have to be zero; but they must remain stable (no systematic dependence on any parameter)

Channel	GMI TbObs (K)	GMI SD (K)	TMI SD (K)	DD (K)
10 V-Pol	284.3	3.16	0.76	-2.41
10 H-Pol	282.6	1.98	-0.34	-2.32
19 V-Pol	285.1	1.05	0.88	-0.17
19 H-Pol	283.9	0.24	0.10	-0.14
23 V-Pol	286.4	0.18	-1.17	-1.34
37 V-Pol	283.3	1.26	-0.55	-1.81
37 H-Pol	282.6	0.66	-0.96	-1.62
89 V-Pol	286.1	1.51	0.35	-1.17
89 H-Pol	285.7	1.19	-0.71	-1.89

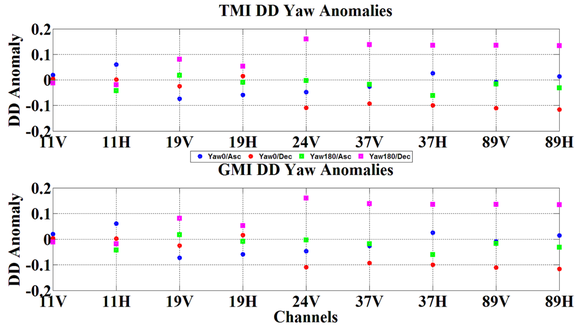
Cold-end (Ocean) GMI/TMI DD Biases

As desired, Tb biases are independent of azimuthal conical scan position



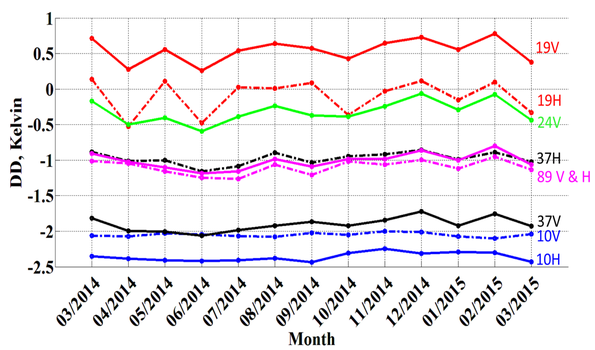
DD Bias Dependence on GMI Flight Direction (Asc/Desc and Yaw = 0° or 180°)

As desired, Tb biases are nearly independent of GMI/TMI flight direction



GMI/TMI DD Biases Monthly Analysis

As desired, there is no significant seasonal trend in the radiometric biases

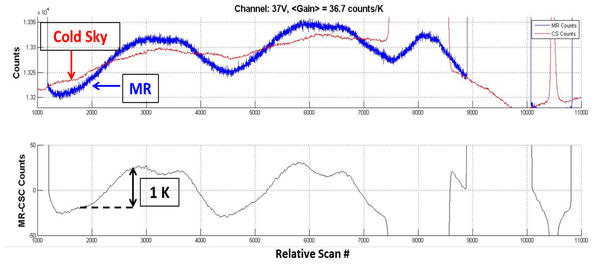


Cold-end GMI/TMI DD Biases

Tb Biases do NOT have to be zero; but they must remain stable (no systematic dependence on any parameter)

Channel	GMI TbObs (K)	GMI SD (K)	TMI SD (K)	DD (K)
10 V-Pol	170.6	1.22	0.76	-2.35
10 H-Pol	91.90	1.47	-0.34	-2.05
19 V-Pol	195.7	1.57	0.88	0.57
19 H-Pol	129.3	2.67	0.10	-0.07
23 V-Pol	227.8	1.72	-1.17	-0.30
37 V-Pol	216.5	0.38	-0.55	-1.89
37 H-Pol	155.9	2.40	-0.96	-0.97
89 V-Pol	266.4	-0.68	0.35	-1.00
89 H-Pol	238.5	1.85	-0.71	-1.10

GMI Tb Anomaly during Cold Sky Calibration



The upper panel depicts the time series for the cold sky mirror (red) and main reflector (blue) radiometric Counts for 36.64 GHz V-pol. There is an unexpected disagreement between the two time series which oscillates up to 1 Kelvin (lower panel). This Tb anomaly was later identified to be a magnetic susceptibility of the GMI receivers and was empirically corrected by Ball Aerospace.

Conclusions

First year GMI/TMI XCAL successfully performed over a full seasonal cycle of data

- Overall, GMI is very well calibrated compared to TMI with stable DD biases between the two
- There are no uncorrected DD Tb biases, which exhibit significant systematic trends
  - e.g., the magnetic anomaly is understood and empirically corrected

GMI is fully capable of serving as the GPM radiometric transfer standard for calibration of the GPM constellation

- Further, it is now possible to reprocess entire TRMM precipitation time series (17 years) using a stable GMI derived radiometric calibration

Future work includes 3-way XCAL with GMI/TMI/WindSat