GMP X-CAL Activity

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OBJECTIVE

To make the GPM rain data set as clean and self-consistent as possible

CONTEXT: 3 Layer Process

Calibrate individual instruments as well as possible

Instrument Manufacturers

Cross Calibrate instruments

Intercalibration (X-CAL) Working Group

Statistical Comparisons at Rain Retrieval Level

Algorithm Teams

Develop techniques for comparing similar, but not identical, microwave radiometers

Develop implementation strategy for routine intercalibration of constellation radiometers

Develop Traps and corrections for recurring instrument errors.

APPROACH *(IMAGERS)*

Use low inclination satellite as a transfer standard (*e.g*. TMI or GMI)

Complements Polar orbiter matchups done by NOAA

Gives many coincidences over a range of latitudes

Instruments are not identical

Need to convert observations of one satellite to virtual observations of another for comparison

To develop conversions we put several teams to work on the same data

July 2005- June 2006

TMI, SSM/I (F23 , F14), Windsat

Use same models

Two classes of conversions

Matchup data/ compute Tbs

(CSU, UCF, JAXA, BESS)

Limiting value algorithms based on monthly histograms of TBs

(U. Mich. Yonsei U. (Korea))

RESULTS

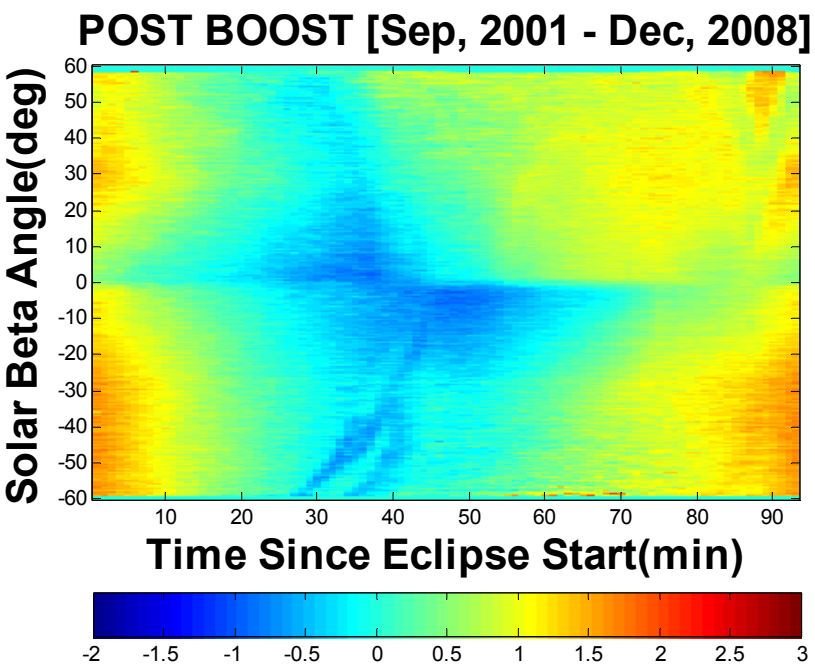
Agreement between similar methods of the order 0.3K

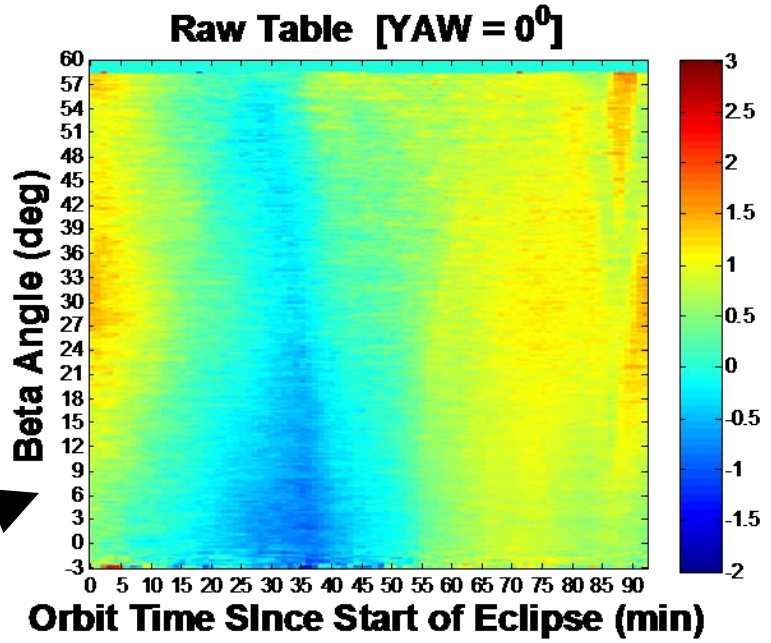
Target 0.1K

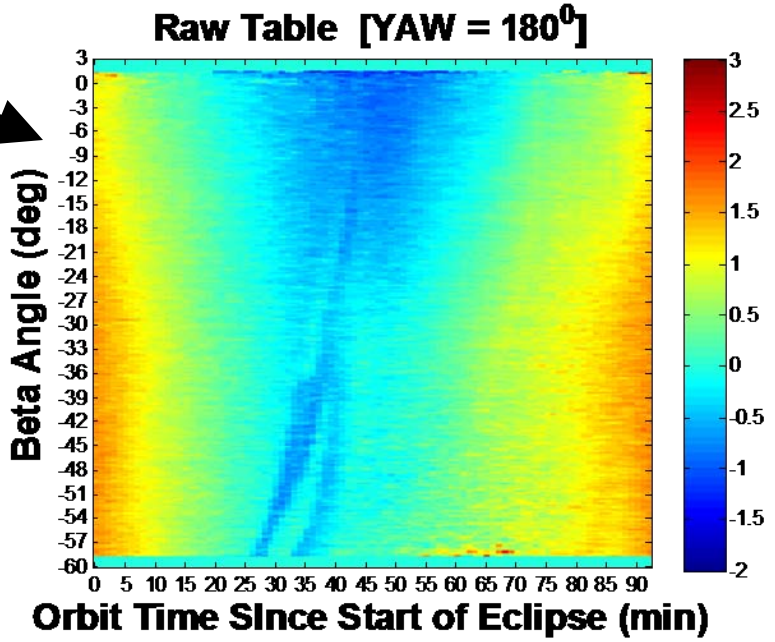
Discovered (*and largely fixed*)TMI Calibration problem

- Different calibration errors for Ascending and Descending passes of Sun-Sync instruments
- Computed TMI TB errors using GDAS data set
- Characterized by phase in TMI orbit and solar beta angle
- Antenna is emissive but temperature isn't monitored
- Compute correction for 10V channel
- Move to other channels using emissivity values from deep space calibration
- Will be included in TMI V-7 (but reversible)

Correction table split into two tables because Solar Beta Angle is not an exact discriminator of yaw orientation. Yaw turns occur within about +/- 3 degrees of $\beta = 0$.



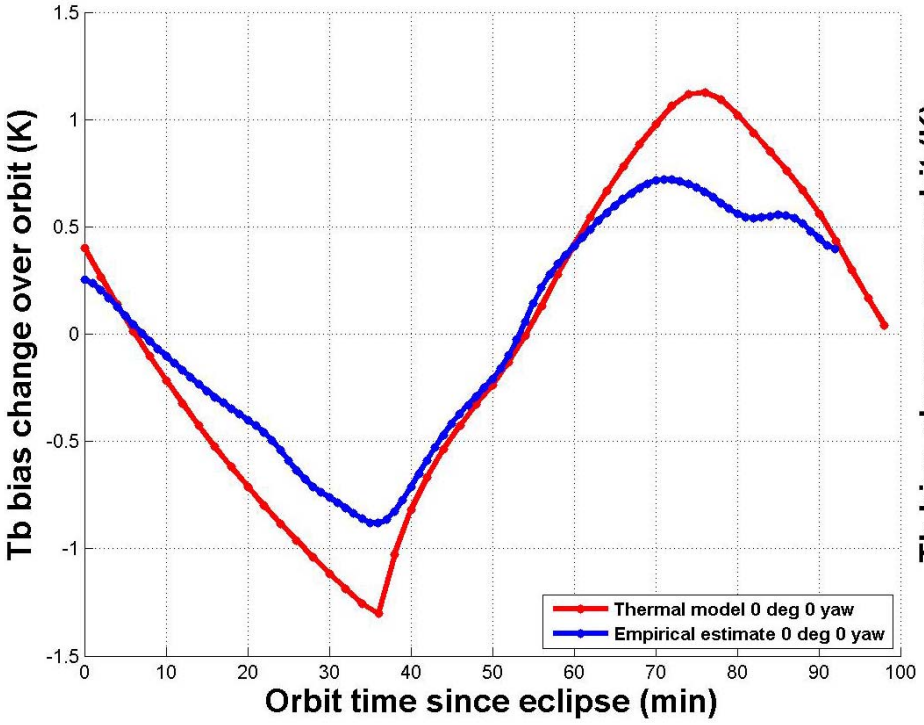




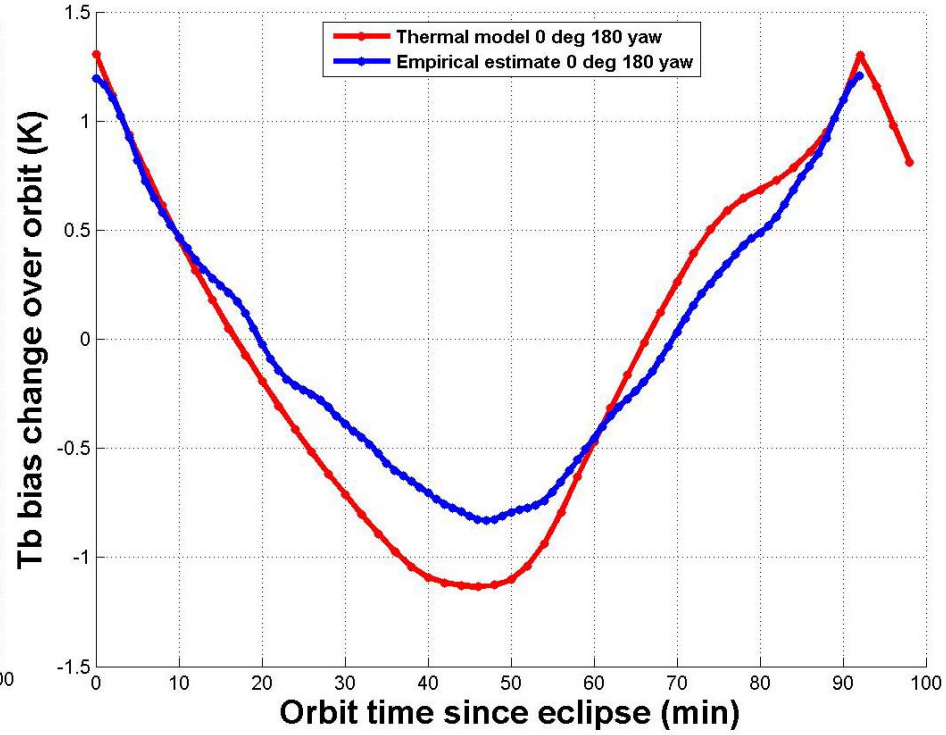
Correction table used is selected based on actual yaw orientation: 1st table if yaw <90, 2nd if yaw > 90

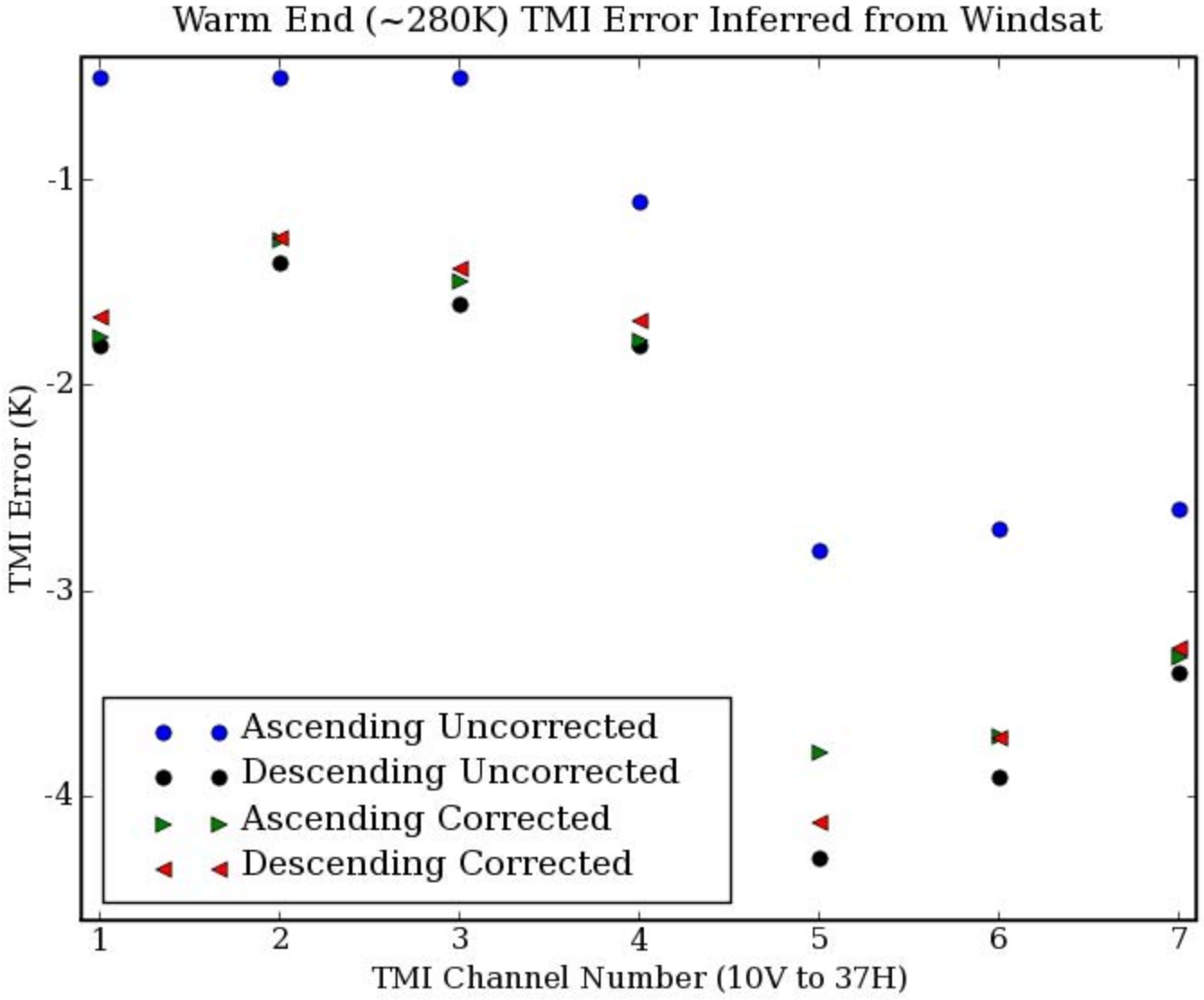
10V empirical bias compared to TRMM thermal model assuming microwave emissivity = 0.038 (Wentz model) for solar beta angle, β=0

Yaw = 0



Yaw = 180




Warm End (~280K) TMI Error Inferred from Windsat
TMI Error (K)
-1
-2
-3
-4
1
2
3
4
5
6
7
TMI Channel Number (10V to 37H)
Ascending Uncorrected
Descending Uncorrected
Ascending Corrected
Descending Corrected

PLANS

For X-CAL purposes GPM exists now

Begin ingesting/calibrating sensors

- Prescreening (individual instrument checkout)
  - Scan dependent biases (statistical)
  - Orbit dependent biases (model calculations)
- Pair-wise matchup and histogram comparisons

Start with operational flow for TMI and Windsat

- Use these two to generate a consensus calibration
- TMI can transfer consensus calibration to other instruments

Continue adding sensors to the mix

- AMSR-E, SSM/Is….. .

Total Transparency

- Recalibrations will be publicly available on website
- Logic/ Models/ Results/ Numbers

Step 1

Check individual instrument for errors

Along Scan Variability

- Bin by latitude and scan position
- Average enough data to get the uncertainty very low
- Do low and high TBs separately
- Average TBs, Incidence Angle and Latitude
- Nominal Incidence Angle and Latitude for small corrections.

Large Scale Errors

- Bias in nominal attitude
- Blockage of main beam by spacecraft structure

Small Scale Errors

- Interaction of sidelobes with spacecraft structure

Step 1 Continued

TB calculations based on GDAS (*e.g.*)

Sun/Moon in sky cal view

Sun in warm load

Sun glint

Abrupt gain jumps

Other instrument specific problems (some yet to be discovered)

Step 2

Establish a consensus calibration standard

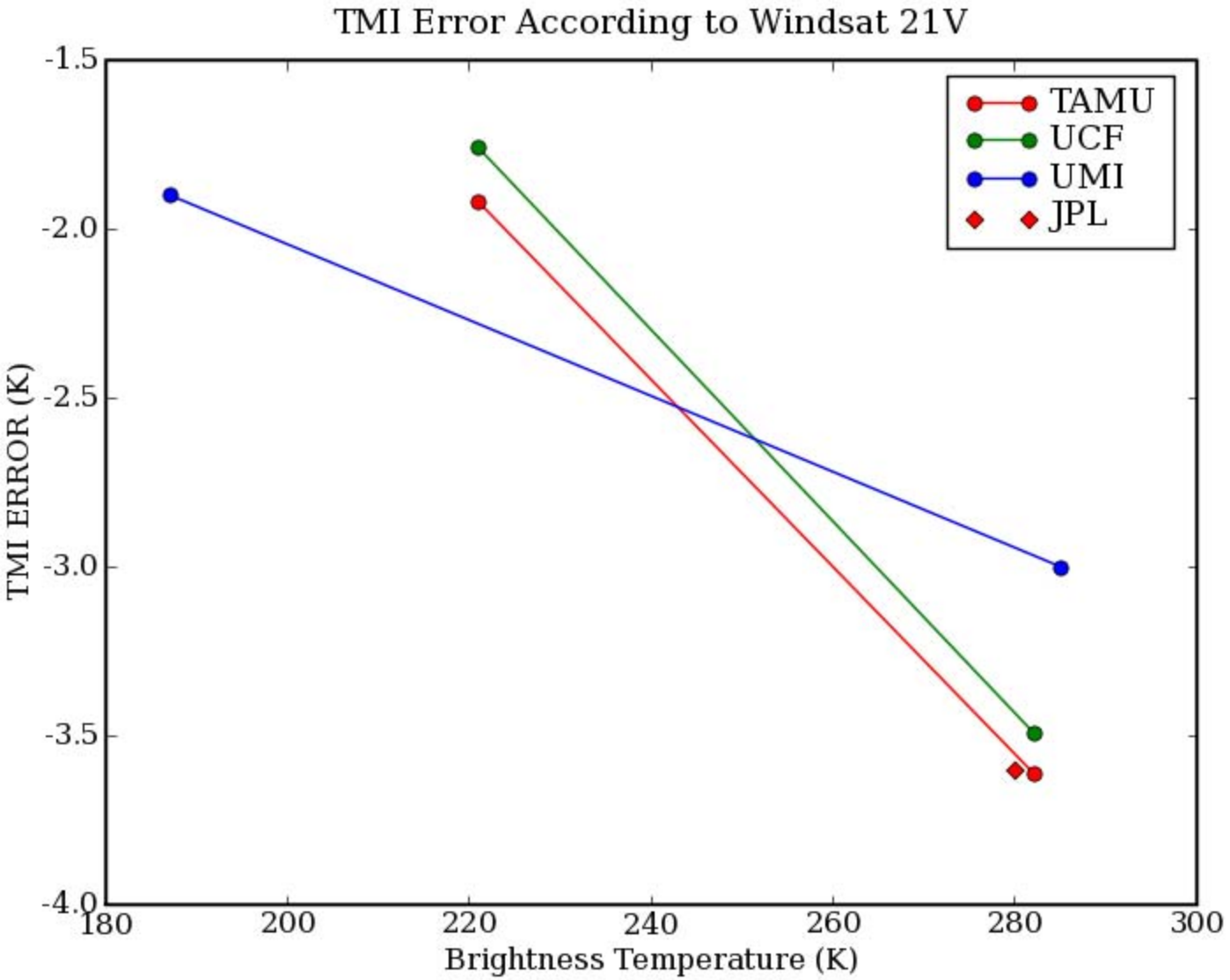
March 5-6 Meeting

Use various formalisms to predict transfer standard (TMI or GMI) TBs from other sensors.

Establish weight of each sensor used

- Size of corrections in step 1
- Residuals from Optimal Estimation predictions
- Reasonable engineering judgment

Generate correction to transfer standard.


TMI Error According to Windsat 21V
TMI ERROR (K)
Brightness Temperature (K)
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
180
200
220
240
260
280
300
TAMU
UCF
UMI
JPL

Step 3

Predict TBs of constellation radiometers from transfer standard.

Use oceanic and rain forest cases to get two point correction

Compute differences and apply corrections to Level 1C data.

SOUNDERS

Plans are less well developed for sounders

GMI will have water vapor sounding channels

Some GPM precipitation algorithms will use μλ temperature sounders

Residuals from direct assimilation of radiances can be used to compare sensors

Likely the best way for sounders

We will also develop sensor-to-sensor algorithms for wv channels

Cross check with computations from DOE/ARM site data

Precipitation less sensitive than sounding to TB errors.

Concluding Remarks

The X-CAL Working Group is implementing the GPM Intercalibration now as a rolling wave.

TMI serves the role of GMI for now.

Forecast Models will serve as a transfer standard for 60 and 183 GHz channels