RELEASE NOTES OF GPM VERSION 05 GMI CALIBRATION

The PPS V05 GMI calibration updates include adjustments of spillover coefficients for all GMI channels (these have a major impact on T_b) and a number of other minor adjustment described below. The magnitudes of T_b changes can be seen in Figure 12.1. The T_bs are reduced around 1 K at T_b around 280 K for channels 1-5. These changes are dominated by antenna pattern correction (APC) revisions. T_b changes for other channels are minor.

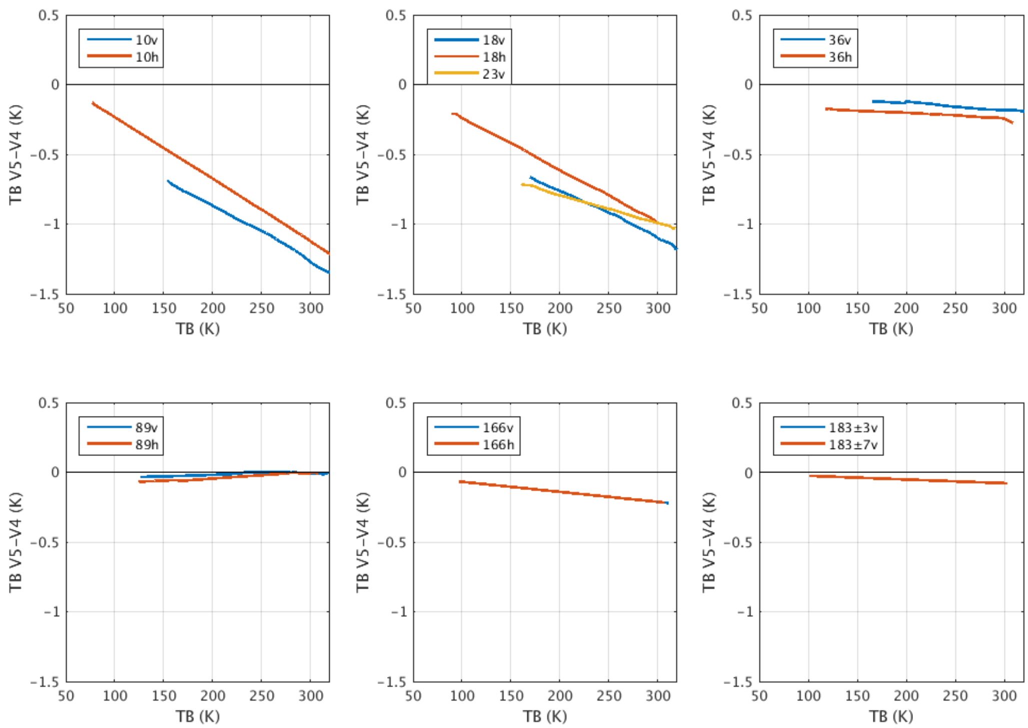

Figure 1. GMI T_b changes from V04 to V05.

1. Adjusted spillover coefficients of all GMI channels. This adjustment is the major improvement from V04 to V05 in GMI antenna pattern correction. The adjustment of spillover is based on the data from GMI deep space maneuver, inertial hold, and refinements of the analysis performed by the GMI manufacturer and the GPM Inter-calibration Working Group (X-CAL). T_b changes vary from channel to channel and are functions of brightness temperatures. For channels 1-5, the maximum change is around -1.0 K. for other channels, Tb changes are minor.

2. Adjusted cold load temperature for 10 GHz channels (from 2.74 K to 2.94 K). This is a minor adjustment and may result in T_b changes of less than 0.2 K for 10 GHz channels.

3. Added a count (earth and cold) adjustment in the magnetism correction equation. This is a minor adjustment and may result in T_b changes of less than 0.2 K.

4. Adjusted magnetic correction coefficients. This is also a minor adjustment and may result in T_b changes of less than 0.2 K.

5. Added Earth-view antenna-induced along-scan corrections (Table see ATBD Table 12.6). The correction is < 0.1 K for most pixels along a scan but can be as large as 0.5 near the edge of scans.

All of these corrections are implemented in V05 GMI L1B/Base and in ITE101.

Level 1C Version 05 (V05) Release Notes

This Level 1C V05 release involves the following changes from the previous release in the calibration of the GPM radiometer constellation.

1. Level 1C GMI V05 brightness temperature (Tc) differs from V04 by as much as -1.4 K for some channels (Figure 1) due to the following calibration adjustments implemented in V05 GMI L1B/Base:

- Adjusted spillover coefficients. This adjustment is based on the data from GMI deep space maneuver, inertial hold, and refinements of the analysis performed by the GMI manufacturer and the GPM Inter-calibration Working Group (X-CAL). Tc changes vary from channel to channel and are functions of brightness temperatures. For channels 1-5, the maximum change is around -1.0 K. for other channels, Tc changes are minor.
- Adjusted cold load temperature for 10 GHz channels. This is a minor adjustment and the maximum impact is less than 0.2 K for 10 GHz channels.
- Added a count (earth and cold) adjustment in the magnetism correction equation. This is a minor adjustment and the maximum impact is less than 0.2 K.
- Adjusted magnetic correction coefficients. This is also a minor adjustment and the maximum impact is less than 0.2 K.
- Added Earth-view antenna-induced along-scan corrections. The correction is less than 0.1 K for most pixels along a scan but can be as large as 0.5 K near the edge of scans.

2. For the constellation radiometers, the Level 1C brightness temperature (Tc) data has been intercalibrated to be consistent with the V05 GMI brightness temperature. As a result, V05 AMSR2 Tc decreased 0 to 1.2 K depending on the channel and brightness temperature, ATMS decreased 0 to 0.77 K, MHS decreased 0 to 0.2 K, SSMI/S decreased 0 to 1.05 K, and SAPHIR decreased 0.07 to 0.08 K.

3. Due to sensor issues, SSMI/S F17 37V channel Tc data has been flagged and set to missing during 2016-04-05 to 2016-05-18 (orbits 48595 to 49202) and 2016-08-03 to present (orbits 50286 onward) periods. During these 37V data missing periods, 37H channel Tc was affected and daily means reduced by 2 – 4 K due to lack of cross-pol correction. This issue has been corrected in V05.

4. Noise in the SSMIS F16 91 GHz channels begins to increase significantly in early July of 2015. The noise in the 91V channel starts to get worse in early July and then recovers at the end of August. The 91H channel starts to show issues in July as well, but it doesn’t appear to recover until December of 2016. Users should be cautious when using the SSMIS F16 Level 1C data during this period.

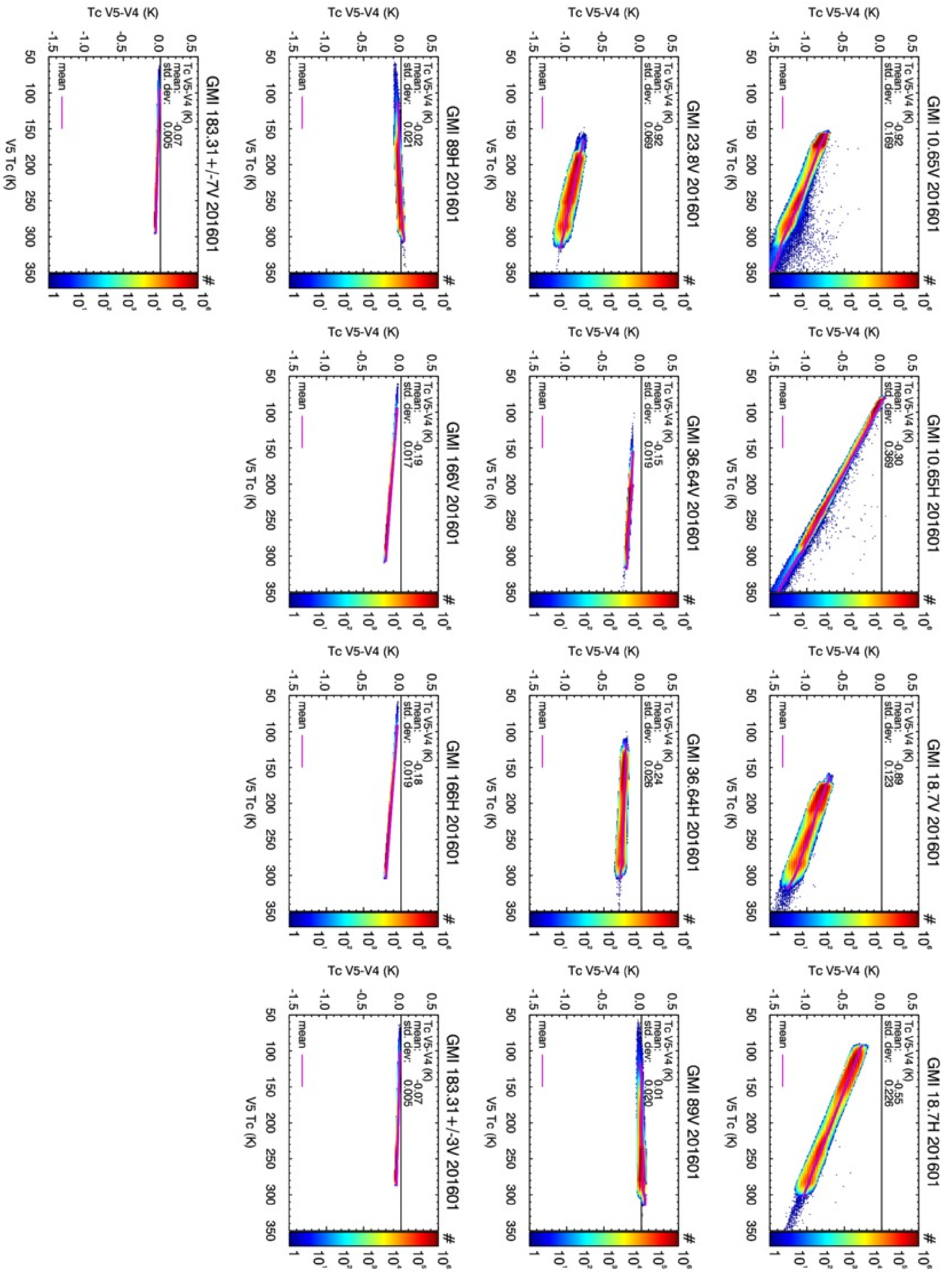

Figure 1: Monthly density plot of L1C GMI Tc difference between V05 and V04.

May 1, 2017

Release Notes for GPROF V05 Public Release

The Goddard Profiling Algorithm is a Bayesian approach that nominally uses the GPM Combined algorithm to create it's a-priori databases. Given the importance of these databases to the final product, they are worth reviewing before discussing particular changes to the algorithm. GPROF V03 was implemented at the launch of the GPM mission and thus had no databases from the GPM satellite itself. Instead, databases were made from a combination of TRMM, Cloudsat, ground based radars and models. V04 used the GPM generated databases but had a very short lead time as the radar and combined algorithm were in flux until nearly the date of the public release. Because the V04 of the Combined algorithm appeared to significantly overestimate precipitation over land, the a-priori databases were constructed from the Combined Algorithm (V04) over ocean, but the DPR Ku (V04) over land and coastal regions. The very short lead time to produce the a-priori databases led to insufficient testing of GPROFV04 that resulted in some less-than ideal retrievals.

GPROF V05 retains the previous version (i.e. V04) of the Combined and DPR-Ku products for its databases. Future versions of GPROF, because of its need for existing GPM products to construct it's a-priori database, will always be one version behind the Combined algorithm. In GPROF V05, we nonetheless improved some of the ice hydrometeor simulations in order to get better agreement between computed and simulated brightness temperatures [ref Sarah]. This leads to smaller bias adjustments in the radiometer simulations and to an overall better fit between the radiometer retrievals and both the Combined products as well as ground validation data.

GPROF V05 made additional changes to retrievals of high latitude oceanic drizzle and snowfall over land. Both of these changes were made because the DPR sensitivity of 12 dBZ was shown to miss substantial amounts of drizzle and light to moderate snowfall events. Because the GPM radars do not have signal in these cases, they are not addressed in the newer versions of the Combined and Radar products either.

Drizzle was addressed in the a-priori database by setting a threshold in the cloud liquid water retrieval from GMI (done before the DPR or Combined rainfall is inserted into the scene), to match the CloudSat based probability of rainfall. This is done for each temperature and Total Precipitable Water (TPW) bin used to subset the a-priori database. While this assumes that higher cloud liquid water amounts correspond to precipitation, the assumption is generally thought to be reasonable. Additional cloud water beyond the CloudSat determined threshold was partitioned between Cloud- and rain water similar to the procedure used by Hilburn and Wentz (2008). This increases rain water at high altitudes to agree better with CloudSat and ERA and MERRA re-analyses but continues to be low relative to these estimates. More work in ongoing to assess high latitude drizzle from different sources.

Over land, the US based MRMS data was used to build a-priori databases for snow covered surfaces of each of the constellations radiometers. Two years of MRMS data were matched up with individual satellite overpasses. This removed much of the low bias that GPROF V04 had over snow covered surfaces.

A final modification made to GPROF V04 is the determination of a precipitation threshold. Whereas GPROF V04 reported an unconditional rain rate and a probability of precipitation, it was up to the user to set a threshold (either in probability or rain rate) if rain/no rain information was needed. While GPROF V05 reports the same information, the algorithm has internally decided if the pixel is precipitating or not, and non-precipitating pixels have been set to zero rainfall. While the original probability of precipitation is still reported, its purpose is only as a diagnostic tool. The user can treat positive rainfall rates as definitively raining. Setting thresholds for precipitation is sometimes difficult in the snowfall where the radiometric information is very limited – particularly for sensors such as AMSR2 that lack high frequency channels. A new quality flag = 2 in therefore introduced.
Quality Flag = 0 still implies that the pixel is good. Quality flag = 1 means there are issues with the retrieval that require caution on the part of the user – particularly for applications such as constructing climate data records. Quality flag = 2 implies the rain/no rain threshold may not be working properly. When the quality flag is set to 3, the retrieved pixel should be used with extreme caution. A complete description of the GPROF quality flag is described below.

Limited validation done by the GPM Validation team shows significantly better correlations and smaller biases with GPROF V05 than GPROF V04. Statistics were run over the Continental United States, Middleton, AK, and over a dense set of rain gauges in the Mountains of Austria. Even more limited validation have been done on snow due to the difficulty in getting reliable ground based measurements. Over the Olympic peninsula (GPM Field Experiment), the total precipitation over the mountains appears correct, but the phase is not. The phase of precipitation in GPROF cannot be determined from the Tb signal itself. Instead, it is determined from the 2 meter temperature and dew point depression (provided by the ancillary data) according to Sims and Liu (2015). Because grid boxes of GANAL or ECMWF are relatively large, they do not capture small-scale terrain variability. Users needing to account for high resolution terrain variability will have to do so as post-processing step in GPROF V05. We hope to correct this in V06.

Almost no validation has been done on the constellation radiometer beyond comparisons of limited coincident overpasses with GMI, and comparisons of monthly means to ensure that the retrieval is performing as expected. AMSR2 comparisons against limited GV observations has similar statistics as GMI for liquid precipitation.

The GPROF output file has a parameter labeled 'CAPE'. This parameter is set to missing in GPROF V05. It will be use and implemented in subsequent versions.

GPROF 2017 V1 (GPM V5) Quality Flag Description

The GPROF Quality Flag variable for GPM V5 has added one additional index. The old indices in V3 and V4 included values: 0,1,2. The new index can be 0,1,2,3

The description is as follows:

Value 0: pixel is "good" and has the highest confidence of the best retrieval.

Value 1: "use with caution" . Pixels can be set to value 1 for the following reasons:

1) Sunglint is present, RFI, geolocate, warm load or other L1C 'positive value" quality warning flags
2) All sea-ice covered surfaces
3) All snow covered surfaces
4) Sensor channels are missing, but not critical ones.

Value 2: "use pixel with extreme care over snow covered surface" This is a special value for snow covered surfaces only. The pixel is set to 2 if the probability of precipitation is of poor quality or indeterminate. Use these pixels for climatological averaging of precipitation, but not for individual storm scale daily cases.

Value 3: "Use with extreme caution". Pixels are set to value 3 if they have channels missing critical to the retrieval, but the choice has been made to continue the retrieval for these pixels.

Hilburn, K.A. and F.J. Wentz, 2008: Intercalibrated Passive Microwave Rain Products from the Unified Microwave Ocean Retrieval Algorithm (UMORA). *J. Appl. Meteor. Climatol.,* **47**, 778–794, doi: 10.1175/2007JAMC1635.1.

Sims, E.M. and G. Liu, 2015: A Parameterization of the Probability of Snow–Rain Transition. *J. Hydrometeor.,* **16**, 1466–1477, doi: 10.1175/JHM-D-14-0211.1.