Incorporating the TRMM Dataset into the GPM Mission Data Suite

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ABSTRACT

In June 2015 the TRMM satellite came to its end. The 17+ year of mission data that it provided has proven a valuable asset to a variety of science communities. This 17+ year data set does not, however, stagnate with the end of the mission itself. NASA/JAXA intend to integrate the TRMM data set into the data suite of the GPM mission. This will ensure the creation of a consistent, intercalibrated, accurate dataset within GPM that extends back to November of 1998. This paper describes the plans for incorporating the TRMM 17+ year data into the GPM data suite. These plans call for using GPM algorithms for both radiometer and radar to reprocess TRMM data as well as intercalibrating partner radiometers using GPM intercalibration techniques. This reprocessing will mean changes in content, logical format and physical format as well as improved geolocation, sensor corrections and retrieval techniques.

Index Terms— **TRMM, GPM, V7, V8, V05, Precipitation**

1. INTRODUCTION

In November 1997 the National Aeronautical and Space Administration (NASA) and the Japanese Aerospace Exploration Agency (JAXA) launched the Tropical Rainfall Measuring Mission (TRMM) [1] [2] satellite from Tanegashima Space Center Japan on a JAXA HIIA rocket. This satellite carried a Visible Infrared Scanner (VIRS), a TRMM microwave imager (TMI), and the first active precipitation radar (PR) in space. In addition TRMM also has a Lightening Imaging Sensor (LIS) and the Cloud and the Earth's Radiant Energy System (CERES). In June 2015 the TRMM mission ended with satellite reentry into the Earth's atmosphere. While the TRMM mission ended NASA/JAXA are committed to keeping the TRMM dataset current and updated using the best retrieval algorithms and intercalibration techniques [3]. To this end the TRMM data from the first data after launch in November 1997 to the end of the mission will be reprocessed as part of the GPM reprocessing cycles.

As part of the end of mission activities funded by NASA and JAXA, TRMM data will undergo a final reprocessing under the TRMM mission (TRMM V8). An important aspect of this last "TRMM" reprocessing is that TRMM data will be incorporated into the GPM data suite as part of the GPM V05 reprocessing. From this point onward the TRMM dataset is considered to be part of the GPM data suite. Anytime the Precipitation Measurement Mission (PMM) Joint Science Team (JPST) authorizes the reprocessing of GPM data, TRMM data will be part of that reprocessing.

This TRMM V8 data reprocessing is the key step in the integration of TRMM data into GPM. This integration will be timed with the GPM V05 reprocessing scheduled for 2017. During this reprocessing cycle TRMM data will be created using the latest GPM based intercalibration said [3] and the latest GPM retrieval algorithms. From the radiometer perspective an important change is that TRMM radiometer data will be intercalibrated using GPM GMI as the calibrator. The overlap of TRMM and GPM affords the opportunity to carry out such GMI based intercalibration.

2. TRMM V8/GPM V05 FORMATTING CHANGES

This section describes the more superficial, but nevertheless important for data use, changes that will take place as part of the TRMM V8/GPM V05 reprocessing of the 17+ year dataset.

The last TRMM reprocessing started in July of 2011. All TRMM data was reprocessed back to the beginning of the TRMM mission. This reprocessing maintained the use of the coded TRMM names (e.g. 2A12 radiometer retrievals, 2A25 PR retrievals, etc.) The reprocessing also maintained the use of Hierarchical Data Format 4 (HDF4). In addition the parameters within the HDF4 data products remained substantially like that in TRMM V6 with only minor additions or renaming.

A major formatting change during the TRMM V8/GPM V05 reprocessing is the switch to HDF5. All TRMM data will be stored in internally compressed HDF5 files. This is the same physical format in which GPM data are stored.

The logical format for the data products will also be changed. TRMM radiometer 1B and 1C data will have the

logical format of GMI 1B and 1C data products. The PR L1 and L2 data will have the logical format of GPM Ku data products. TRMM Level 3 data products will change to .25 deg x .25 degree grids. Each level 3 product will have a monthly and a daily gridded product. These also will have a logical format like the GPM GMI or Ku products. So user read routines will of necessity have to change to take advantage of improvements to TRMM data that will be undertaken as part of the TRMM V8/GPM V05 incorporation.

Another change as part of the reprocessing cycle will be to rename all the TRMM data products using the naming conventions adopted for GPM. This means that the V8 TRMM data will get the GPM version V05. It also means the coded data type identifiers used in TRMM (1B11, 2A12, 2A21, 2A23, 2A25, etc.) will no longer be used. In their place the GPM file naming will be adopted. For example the TRMM TMI level 2 retrieval currently named 2A12.20021010.27947.7.HDF will be renamed: 2A.TRMM.TMI.GPROF2016v1-0.20021010-S000001-E013001.027947.V05.HDF5. The algorithm name GPROF2016v1-0 is only an example of what this will be and the start time and end time are also just examples.

In a larger sense these changes represent the fact that within the GPM mission the TRMM satellite will be just like other partner constellation satellite.

3. TRMM MICROWAVE IMAGER (TMI) CHANGES

TMI data products will have the most extensive changes and improvements of all the TRMM product as a result of the TRMM V8/GPM V05 reprocessing cycle.

Major changes will occur in geolocation and at the top level these will apply to all the TRMM instruments. The first step is the use of the GPM geolocation toolkit rather then the older TRMM one. This will ensure a consistent geolocation approach across all the GPM mission satellites. The use of the GPM geolocation toolkit will also correct some small bugs in the original toolkit that impacted the accuracy of some of the geolocation over the 17+ years of the mission. Geolocation improvements will also include the use of TRMM gyro data to improve the roll, pitch and yaw information. PR derived roll information will also be applied to all the data from 2011 to end of mission. This will greatly improve the positional accuracy of the TRMM data.

As a major part of both geolocation and emissive reflector correction, TMI level 1 data will change to reflect a GPM approach. The L1A data will no longer be packed binary data but unpacked HDF5 data. In addition, from having only 2 swaths resolution, 4 swaths will be contained in Level 1A, 1B, 1 Base and 1C. Additionally L1A will have the counts geolocated for each of the pixels in the 4 swaths. This is a major change for TRMM but it is also an important step in improving geolocation and applying more focused emissive antenna corrections.

The most important improvement in TMI level 1 data will be a more accurate, channel based improvement of the emissive reflector issues with TMI. The initial correction was made in TRMM V7 [4] and was based on 10GHz channel analysis and then extended to the other changes.

The most important change for TRMM V8/GPM V05 for TMI will be improved emissive antenna corrections. For the TRMM V8/GPM V05 reprocessing the corrections will be more tailored around the 4 different channel groups. As good as the V7 corrections were, this new approach will ensure a more accurate correction for each of the channels.

The other major change in the TMI level 1 data products will be the use of GPM GMI as the calibrator for the TMI level 1C products. In TRMM V7, and indeed for the at launch GPM, the TMI was used as the intercalibrator for the other radiometers in the constellation. For TRMM V8 the intercalibration working group will use the overlap period of TRMM/GPM to develop intercalibration adjustments [3] which will then be extended back in time to TMI. The adjusted TMI will then be used to intercalibrate other radiometers in the constellation. This intercalibration will ensure GPM mission consistent brightness temperatures.

TRMM TMI level 2 swath based precipitation retrieval will be made using the GMI intercalibrated TMI 1C products. The V05 GPM GPROF retrieval algorithm will then be used to produce the TRMM V8/GPM V05 swath based retrievals. This will ensure that the TMI precipitation retrievals are consistent with all other GPM radiometer retrievals.

4. PRECIPITATION RADAR (PR) CHANGES

A first step in the improvement of the PR level 1 will be the use of the improved geolocation toolkit that was described in the previous section.

JAXA proposes to make calibration changes to the 1B radar powers product to make the PR 1B more like the GPM DPR level 1 products. In addition, JAXA will be modifying calibration of PR L1B to ensure appropriate calibration consistency between TRMM PR and GPM Ku sensors. The L1B format for TRMM PR L1B will be almost identical with that of the GPM Ku 1B product.

Effective with the TRMM V8/GPM V05 reprocessing there will be no L1C product for TRMM 1C. Just as in GPM Ku, the reflectivities are part of the TRMM L2 PR product.

As a final step in the improvement of the TRMM PR V8 products, the GPM Ku level 2 retrieval algorithm will be used to produce the TRMM PR retrievals. These will have the same logical format as the GPM V05 Ku products.

Additionally TRMM V8/GPM V05 reprocessing will also use the GPM level 2 combined algorithm to produced combined TMI/PR retrievals.

5. VISIBLE INFRARED SENSOR (VIRS) CHANGES

At this time no extensive algorithm changes are anticipated for the VIRS dataset. It obviously will have its geolocation improved as part of the geolocation changes being implemented as part of the TRMM V8 reprocessing.

No calibration changes are anticipated in the VIRS level 1B product.   Also the logical format/content of the VIRS product will remain the same as V7 version. VIRS will be stored in internally compressed HDF5 format.

6. CONCLUSIONS

The TRMM V8 reprocessing will greatly improve the geolocation and retrieval accuracy of TRMM data products. It will also apply all the improvements in retrieval algorithms that have been developed since the TRMM V7 data reprocessing.

Most importantly it will integrate TRMM data into the GPM data suite and ensure that as part of the GPM mission it will have an accurate, internal consistent and long term climate quality data suite back to the beginning of the TRMM mission. This mission consistent long term dataset will be a major contribution of the GPM mission.

7. REFERENCES

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