Remote Sensing Systems

Updates to TMI Ocean Products

March 2015

In January of 2015, TMI data were reprocessed using the consistently applied RSS Version-7 radiometer data processing algorithm. This change (V4 to V7.1) is a significant change in product quality and file format. This document briefly summarizes the most important changes that were made. Greater details are available from a publication by Wentz (submitted to Journal of Climate, 2015).

All TMI from December 7, 1997 to December 31, 2014 have been reprocessed using this updated and improved Version-7 algorithm. Data from the previous TMI version (V4) is no longer available for those dates. Daily ongoing data processing will continue in V4 until TMI is turned off later in 2015, at that point V7 will be updated to the end of the mission. We advise all users to make use of other radiometers instead of TMI during 2015. We recommend using V7 data instead of any V4 data you may have previously downloaded.

Summary of Changes:

- The TMI data file format has significantly changed. The TMI file format is now identical to that of all other RSS microwave instrument bytemap data files. Each file contains an array sized (1440x720x7x2) corresponding to (longitude, latitude, parameter, maps of ascending or descending orbit segments).
- An offset is now applied to the cloud liquid water that allows for small negative cloud values. This is consistent with cloud in other RSS V7 data (SSMIS, WindSat, AMSR2, etc.)
- The TMI data have been fully recalibrated using the same procedures applied to all other RSS radiometers. Also, the Amazon Forest is used to calibrate TMI in addition to the ocean.
- A diurnal signal present in the emissive antenna has been removed.
- Radio Frequency Interference (RFI) has been removed from the cold mirror.
- Some large geolocation errors were identified and removed.
- The roll of the satellite was recalculated.

The result of all these changes is a very clean and temporally consistent data product suitable for climate study.

The TMI instrument remains in operation during the orbital descent which began in August 2014. We expect the instrument to be shut off sometime in 2015. Until this time, we continue routine processing using the old V4 algorithm and produce files with V4 format (1440,320,7,2). We highly recommend Users not include these last few months of data in their analysis as the data quality has diminished (see http://www.remss.com/node/5129).

More Detailed Description of Changes:

Format Changes: TMI bytemap files contain longitude/latitude arrays of 1440 by 720 (0.25 degree grid) for each geophysical parameter provided as two maps of ascending and descending orbit segments. Since the file consists of a single byte of data for each parameter, the resulting data array is 1440x720x7x2. The order of the 7 ocean parameters is Time, SST, Wind Speed-LF, Wind Speed-MF, Vapor, Cloud, and Rain Rate. Since TRMM travels in a semi-equatorial orbit, no measurements are made at latitudes greater than +40/-40 deg. TMI V4 files had an array size of 1440x320x7x2. All other RSS V7 products were on the full grid sized 1440x720. We decided to put TMI on the same 1440 by 720 grid for ease of comparison and multiple instrument use. However, beware that there are no data below latitude grid cell 200 or above latitude grid cell 520 despite the size of the file.

Negative Cloud Values: The cloud retrievals have an offset of 0.05 applied to them that can result in slightly negative cloud values. These negative values exist as a means to compensate for the clear sky bias (Horvath and Gentemann, 2007). We suggest Users treat negative cloud values as zero. However, when calculating a mean, include the negative values in the average. Should your mean result in a negative value, treat it as zero.

Re-calibration of TMI: In the many years since TMI first started, we have improved and unified our data processing for all microwave radiometers processed by RSS. The current calibration standard is the most recent version of our radiative transfer model (RTM) which we call Version-7 (Meissner and Wentz, 2012). We have now fully recalibrated TMI to the RTM and adjusted all processing so that it matches the approach used for the other V7 processed radiometers. This has resulted in highly consistent values between all microwave radiometer environmental parameter values.

Diurnal Signal in Emissive Antenna Removed: TMI has an emissive antenna in which some of the radiation measured by the instrument comes from the antenna itself. Using far more data than initially used originally in 2001, we redeveloped the model of the emissive antenna and recalculated the physical temperature of the TMI antenna.

Radio Frequency Interference in Cold Mirror Removed: RFI contamination of cold counts was not removed in the previous V4 TMI data. RFI is an ever-growing problem which greatly affects the 10.7 GHz data in specific geographical regions. We have implemented a methodology for RFI-affected data removal. RFI from geostationary satellites produces cold count anomalies.

We remove these cold count anomalies from each channel in V7 processing and perform a linear interpolation of cold counts and time using the good cold counts on either side of the gap.

Geolocation Recalculated: We found some geolocation errors in the V4 data that have been fixed in V7. The changes include fixing pointing errors and using optimum interpolation to co-register the 10.7 GHz observations with the higher-frequency channels.

Satellite Roll Adjusted: We have applied a correction to the spacecraft roll that is determined by regressing the difference between the TMI SST retrieval and the Reynolds OI SST data over one day. The method finds very similar results to an independent analysis using the Precipitation Radar (Bilanow and Slojkowski, 2006). The correction is a first-order harmonic of the spacecraft orbital angle.

References

Bilanow, S., and S. Slojkowski, 2006: TRMM on-orbit performance reassessed after control change. *25th International Symposium on Space Technology and Science*, Kanazawa City, Japan, JAXA, ISTS 2006-d-35

Horváth, Á, CL Gentemann, 2007, Cloud-fraction-dependent bias in satellite liquid water path retrievals of shallow, non-precipitating marine clouds, Geophysical Research Letters, 34, L22806, doi:10.1029/2007GL030625

Meissner, T., and F. J. Wentz, 2012: The emissivity of the ocean surface between 6 - 90 GHz over a large range of wind speeds and Earth incidence angles. *IEEE Transactions on Geoscience and Remote Sensing*, 50(8), 3004-3026, doi:10.1109/TGRS.2011.2179662.