README for Accessing Experimental Real-Time TRMM Multi-Satellite Precipitation Analysis (TMPA-RT) Data Sets

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News Archive

20 October 2015 Corrected the statement in "data file layout" under 3B42RT to read "The leading precipitation field has a climatological bias correction to the 3B42 Version 7 estimates (step 2 in the 3B42RT process, above)".

7 July 2015 MTSat-2 was replaced by Himawari 8 effective 02 UTC on 7 July 2015.

28 April 2015 NOAA reprocessed the global IR data for 10 UTC 26 April through 14 UTC 27 April due to dropped images, and all 3B41RT and 3B42RT files for this time period were reprocessed by PPS:

3B41RT.2015042610.7.bin.gz through 3B41RT.2015042714.7.bin.gz
3B42RT.2015042612.7.bin.gz through 3B42RT.2015042715.7.bin.gz

17 April 2015 IR fill-ins ceased when CPC Global 4 km Merged IR data dropped out starting 16 UTC 14 April due to processing issues at NOAA, and gradually returned through 11 UTC 17 April. The 3B41RT and 3B42RT files for that time period were batch-processed:

3B41RT.2015041416.7.bin.gz - 3B41RT.2015041710.7.bin.gz
3B42RT.2015041418.7.bin.gz - 3B42RT.2015041709.7.bin.gz

8 April 2015 TMI data are no longer input to the products because they were terminated on 8 April 2015 as part of the TRMM satellite end-of-mission activities.

28 October 2014 Starting about 22 UTC on 20 October 2014, PPS discovered missing input data files originating at NOAA. This networking issue prevented the reception of sounder data, and the IR fields only contained GOES-E and -W. MHS data started flowing around 02 UTC on 23 October 2014, with full geo-IR returning around 16 UTC 23 October 2014. Specifically, 3B42RT missed both MHS and Eastern Hemisphere IR for 00 UTC 21 October through 00 UTC 23 October, and then missed Eastern Hemisphere IR through 15 UTC 23 October. Subsequently, PPS reprocessed 3B41RT and 3B42RT after NOAA forwarded revised, fully populated IR datasets. The reprocessed files produced on 28 October are:

3B41RT.2014102022.7.bin.gz – 3B41RT.2014102306.7.bin.gz
3B42RT.2014102021.7.bin.gz – 3B42RT.2014102306.7.bin.gz

However, it is not practical to recover the missing sounder data in the RT system, so the microwave content is about half the usual amount in 3B40RT and 3B42RT for the outage period:

00 UTC 21 October through 00 UTC 23 October.

25 May 2014 Metop-A was restored to functionality; after verification, the date were again included in the TMPA-RT starting 03 UTC on 25 May 2014.

28 March 2014 Metop-A had an apparent hardware failure at 14 UTC on 27 March 2014 and the instrument is off.

15 February 2014 Snow accumulation on the receiving antenna prevented reception of MTSAT-2 data from 1832 UTC on 14 February 2014 to 1232 UTC on 15 February 2014. The data are lost.

12 November 2013 A TRMM spacecraft anomaly resulted in the loss of most TRMM sensor data for the period 02-14 UTC on 12 November 2013, and additional issues resulted in data gaps during the period 20-23:30 UTC. This reduces the data content in 3B40RT and 3B42RT somewhat, but is not a serious issue overall.

16 August 2013 Metop-B was added as an input data source on 15 August 2013; the first time in 3B40RT was 09 UTC, and for 3B41RT (in the calibration) and 3B42RT the first time was 15 UTC.

28 January 2013 Processing issues were discovered with both the Version 7 TMPA production (3B42/43) and Version 7 TMPA-RT (3B40/41/42RT) data series and it was decided to re-do the retrospective processings to correct the issues. In general the original Version 7 data sets are considered an improvement over Version 6, but this additional processing is considered important to meet the goals of the project. Users are urged to switch to the newest Version 7 data sets as soon as practical. See "additional retrospective processing for Version 7" for more details.

13 October 2012 Due to internal processing errors, some radiometer data were not included in data files for 08 UTC 12 October 2012 through 03 UTC 13 October 2012. PPS has rerun all the affected TMPA 3B40RT, 3B41RT, and 3B42RT. The original files are probably adequate for most purposes, but the rerun data should be more accurate.

11 October 2012 the NOAA server providing access to sounder data went out of service from 15:51 UTC 10 October to 02 UTC 11 October. Data continued to be recorded, so at the first opportunity after the NOAA server came up, PPS retrieved the backlogged products. All the TMPA-RT products were re-run for 18 UTC 10 October through 03 UTC 11 October.

25 September 2012 Retrospective processing is complete, providing a consistently processed data record for March 2000 – present.

25 June 2012 The new Version 7 of the TMPA-RT (not to be confused with the on-going Version 7 of the official TRMM products) was released effective 10 UTC, Monday, 25 June 2012. This is the upgrade that many of you have heard discussed for over a year, during which time we waited for the Version 7 TRMM products, the TMPA in particular, and developed an interim solution for SSMIS calibration. The new version includes the following:

1. SSMIS data are introduced based on interim calibration developed in conjunction with D. Vila (ESSIC).
2. It is planned to retrospectively process the RT system back to 1 March 2000 during July 2012 to satisfy numerous user requests for a long archive of RT data to enable calibration of real-time applications that cannot take advantage of the Version 7 TMPA archive. In this innovative approach the RT code was run on the production computer system, since the RT computer system is not equipped to do such processing. As a result, Version 7 RT data sets will be made available starting 1 March 2000. The main difference from true RT processing is that the full input satellite data sets available in the Version 7 production system are used. These production data archives are somewhat more complete than what would have been received in real time. The start date is driven by the start date of the CPC Merged 4 Km IR data record and the need to spin up the microwave-IR calibration. It continues to be the case that, despite the long RT record, it is strongly recommended that the production dataset (3B42) be used or all research not specifically focused on RT applications.
3. Upon this release RT data that pre-date Version 6 continue to be provided in subdirectory *V5*, while Version 6 RT data are moved to subdirectory *V6*.

Introduction

The system to produce the "TRMM and Other Data" estimates in real time was developed to apply new concepts in merging quasi-global precipitation estimates and to take advantage of the increasing availability of input data sets in near real time. The overall system is referred to as the real-time TRMM Multi-Satellite Precipitation Analysis (TMPA-RT), and is currently in Version 7. The TMPA-RT is run quasi-operationally on a best-effort basis at the Precipitation Processing System (PPS; formerly the TRMM Science Data and Information System, TSDIS), with on-going scientific development by the research team led by Dr. George Huffman in the GSFC Mesoscale Atmospheric Processes Laboratory. Estimates are posted to the web about 6 hours after observation time, although processing issues may delay or prevent this schedule. Due to the experimental nature of these estimates, users are encouraged to report their experiences with the data, and they should expect episodic upgrades or outages as the system develops.

Product Definitions

There are three “TRMM and Other Data” products:

<u>3B40RT (High Quality, or HQ)</u>

The 3B40RT combined microwave precipitation estimate provides an 0.25ºx0.25º-averaged 3-hourly combination of all available TMI, AMSR-E, SSMI, SSMIS, AMSU-B, and MHS estimates:

1. Offline, the GPROF-AMSR, GPROF-SSMI, GPROF-SSMIS, AMSU-B, and MHS have been probability-matched to 2A12RT. The calibrations of AMSU-B, MHS, SSMI, SSMIS, and AMSR-E to TMI each have one set of coefficients for each sensor type for land and 14 sets for ocean, while SSMIS is calibrated separately for each satellite, again having one set for land and 14 for ocean. The ocean latitude bands are 15° overlapping latitude bands centered on the 5° bands 35-30°S, 30-25°S, 25-20°S, …, 20-25°N, 25-30°N, and 30-35°N. The outermost bands are used in their respective hemispheres for all higher-latitude calibrations due to the lack of TMI data beyond about 38°. The SSMIS are calibrated individually due to particular calibration issues for each satellite. AMSR-E uses a 2-month set of match-ups to ensure sufficient sampling, while all of the others work with single-month accumulations. The coefficients are computed separately for each season. Finally, a volume adjustment factor is computed for each set to ensure that total TMI precipitation is preserved in these transformations.
2. The GPROF-AMSR, GPROF-SSMI, GPROF-SSMIS, AMSU-B, MHS, and 2A12RT estimates are gridded to a 0.25°x0.25° grid for a 3-hour period centered on the major synoptic times (00, 03, ..., 21 UTC).
3. The GPROF-AMSR, GPROF-SSMI, GPROF-SSMIS, AMSU-B, and MHS estimates are calibrated to 2A12RT.
4. The precipitation rate in each grid box is the pixel-weighted average of the calibrated conical-scan microwave radiometer estimates (2A12RT, GPROF-AMSR, GPROF-SSMI, and GPROF-SSMIS) contributing during the 3 hours, or the pixel-weighted average of AMSU-B and MHS if no other HQ estimates are available.
5. Additional fields in the data file include the number of pixels, the number of pixels with non-zero precipitation, the number of pixels for which the estimate is "ambiguous," or highly uncertain, and the sensor type providing the estimate.
6. All of the HQ algorithms are unable to provide estimates in regions with frozen or icy surfaces.
7. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

<u>3B41RT (Variable Rainrate, or VAR)</u>

The 3B41RT IR precipitation estimate converts 0.25°x0.25° -averaged geo-IR Tb to rainrates that are HQ-calibrated locally in time and space:

1. Both geo-IR Tb and HQ are averaged to 0.25°x0.25° to ensure consistent spatial scale, and time-space matched data are accumulated over calendar months.
2. In each calibration, the Tb-rainrate curve is set locally by probability matching the month's histograms of coincident IR Tb and HQ rain rate.

The local VAR Tb-rainrate curve is applied to each Merged 4-Km IR Tb data set in the month:

1. Over most of the globe the on-hour data field is taken as the input data, with fill-in by the previous half-hour image. The exception is the GMS sector, where the previous half-hour is primary, since GMS does not schedule images on the hour. [In that case, much of the GMS sector is filled with data from METEOSAT5 and GOES-W at very high zenith angles.]

2. The Tb-to-rainrate conversion is a simple look-up, using whatever set of VAR calibration coefficients is current.
3. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

<u>3B42RT (Combination of HQ and VAR)</u>

The 3B42RT combination is computed on the latitude band 50°N-S every 3 hours from that hour's HQ and VAR fields:

1. The present combination scheme is to take the HQ field wherever it is non-missing, and fill in with VAR elsewhere.
2. Offline, 14 years of matched instantaneous TCI and TMI have been used to compute climatological monthly calibration histograms, working with 0.25° grid values accumulated on a 1°x1° grid smoothed with a 3x3 moving boxcar template. As well, 14 years of monthly TCI and 3B43 Version 7 estimates have been used to compute climatological monthly calibration ratios, starting with 0.5° averages, smoothing the TCI with a 5x5 moving boxcar template, and averaging both to 1°. For both steps, the statistics are smooth-filled over 36-40° N and S (just outside the TCI zone), and then the 40° N and S values are extended to all higher latitudes using a smooth-fill scheme. In use, the TMI-TCI and TCI-3B43 calibrations are applied sequentially to the initial 3-hourly HQ+VAR fields.
3. The additional fields in the file are the source of the estimate and the uncalibrated HQ+VAR estimate.
4. The VAR estimates are only trusted for the latitude band 50ºN-S, so both the calibrated and uncalibrated HQ+VAR fields are clipped to 50ºN-S, with estimates outside that encoded to negative values. Accordingly, users generally should not employ these values.
5. It is planned to do a more sophisticated combination in a future release.
6. In a future upgrade the random error will be estimated. Currently the random error field is set to missing.

File Contents and Format

Table 1. File layout for 3B40RT, 3B41RT, 3B42RT.

	3B40RT		*3B41RT*		*3B42RT*	
Block	*Byte Count*	*Field*	*Byte Count*	*Field*	*Byte Count*	*Field*
1	2880	header	2880	header	2880	header
2	2073600*	precip	1382400&	precip	1382400&	precip
3	2073600*	error	1382400&	error	1382400&	error
4	1036800+	# pixels	691200@	# pixels	691200@	source
5	1036800+	# ambig. pixels	-	-	1382400&	uncal precip
6	1036800+	# rain pixels	-	-	-	-
7	1036800+	source				

* INTEGER*2, 90ºN-S & INTEGER*2, 60ºN-S
+ INTEGER*1, 90ºN-S @ INTEGER*1, 60ºN-S

Header:

Each file starts with a header that is one 2-byte-integer row in length, or 2880 bytes. The header is ASCII in a "PARAMETER=VALUE" format that makes the file self-documenting (e.g., "algorithm_id=3B40RT"). As such, the header can be read with standard text editors, output as text with simple application programs, or parsed for input into applications. Successive "PARAMETER=VALUE" sets are separated by spaces, and no spaces or "=" are permitted in either PARAMETER or VALUE. The current PARAMETER entries and definitions are:

PARAMETER	Definition
algorithm_ID	TRMM algorithm identifier (e.g., "3B40RT")
algorithm_version	Version of the science algorithm
granule_ID	PPS granule identifier (e.g., "3B40RT.2001121809.7R.bin")
header_byte_length	Number of bytes in the header
file_byte_length	Number of bytes in the file, expressed as a formula describing the file structure
nominal_YYYYMMDD	Nominal UTC year, month, and day of the month
nominal_HHMMSS	Nominal UTC hour, minute, and second
begin_YYYYMMDD	Start UTC year, month, and day of the month
begin_HHMMSS	Start UTC hour, minute, and second
end_YYYYMMDD	End UTC year, month, and day of the month
end_HHMMSS	End UTC hour, minute, and second
creation_YYYYMMDD	Date the file was created as year, month, and day of the month
west_boundary	Longitude of the western edge of the data domain
east_boundary	Longitude of the eastern edge of the data domain
north_boundary	Latitude of the northern edge of the data domain
south_boundary	Latitude of the southern edge of the data domain
origin	Geographical direction of the first grid box from the grid center
number_of_latitude_bins	Number of grid boxes in the meridional direction
number_of_longitude_bins	Number of grid boxes in the zonal direction
grid	Size of one grid box
first_box_center	Geolocation of the first grid box center
second_box_center	Geolocation of the second grid box center
last_box_center	Geolocation of the last grid box center
number_of_variables	Number of data fields
variable_name	List of the data field names, separated by commas
variable_units	List of data field units, separated by commas, in the same order as the variable_name list
variable_scale	List of data field scaling factors, separated by commas, in the same order as the variable_name list
variable_type	List of data field word types, separated by commas, in the same order as the variable_name list
byte_order	Order of bytes in a data word ("big_endian" or "little_endian")
flag_value	List of special values, separated by commas

flag_name	List of special value names, separated by commas, in the same order as the flag_value list
contact_name	Name of the person to contact with questions
contact_address	Postal address of the contact_name
contact_telephone	Telephone number of the contact_name
contact_facsimile	Facsimile number of the contact_name
contact_email	Email address of the contact_name

Thereafter the data fields follow. All the fields are on a 0.25º lat./lon. grid that increments most rapidly to the east (from the Prime Meridian) and then to the south (from the northern edge). Grid box edges are on multiples of 0.25º. The data fields are written as flat binary data in big-endian byte order.

<u>3B40RT</u>:

Following the header, 6 data fields appear:

precipitation	(2-byte integer)
precipitation_error	(2-byte integer)
total_pixels	(1-byte integer)
ambiguous_pixels	(1-byte integer; highly uncertain values)
rain_pixels	(1-byte integer)
source	(1-byte integer; the values are: 0 = no observation 1 = AMSU 2 = TMI 3 = AMSR 4 = SSMI 5 = SSMIS 6 = MHS 30 = AMSU&MHS avg. 31 = conical avg.)

All fields are 1440x720 grid boxes (0-360ºE,90ºN-S). The first grid box center is at (0.125ºE,89.875ºN). Files are produced every 3 hours on synoptic observation hours (00 UTC, 03 UTC, ..., 21 UTC) as an accumulation of all HQ swath data observed within +/-90 minutes of the nominal file time. Estimates are only computed for the band 70ºN-S.

<u>3B41RT</u>:

Following the header, 3 data fields appear:

precipitation	(2-byte integer)
precipitation_error	(2-byte integer)
total_pixels	(1-byte integer)

All fields are 1440x480 grid boxes (0-360ºE,60ºN-S). The first grid box center is at (0.125ºE,59.875ºN). Files are produced every hour from the on-hour IR image (except for the previous half-hour image for GMS), with fill-in by the previous half-hour image (except for GMS, where the on-hour image is used for fill-in). Valid estimates are only provided in the band 50ºN-S.

<u>3B42RT</u>:

Following the header, 4 data fields appear:

precipitation	(2-byte integer)
precipitation_error	(2-byte integer)
source	(1-byte integer; the values are:

0 = no observation	1 = AMSU	2 = TMI	3 = AMSR
4 = SSMI	5 = SSMIS	6 = MHS	30 = AMSU&MHS avg.
31 = conical avg.	50 = IR	1,2,3,4,5,6 + 100 = sparse-sample HQ)	

uncal. precip	(2-byte integer)

All fields are 1440x480 grid boxes (0-360ºE,60ºN-S). The first grid box center is at (0.125ºE,59.875ºN). Files are produced every 3 hours on synoptic observation hours (00 UTC, 03 UTC, ..., 21 UTC) using that hour's 3B40RT and 3B41RT data sets. Valid estimates are only provided in the band 50ºN-S. See "decode high-latitude VAR and HQ+VAR precipitation values" for discussion of retrieving values outside 50ºN-S. The leading precipitation field has a climatological bias correction to the 3B42 Version 7 estimates (step 2 in the 3B42RT process, above), while the last field is the multi-satellite precipitation before this calibration.

Note that we use the term "gridbox" to denote the values on Level 3 data (i.e., gridded data), while we use the term "pixel" to denote individual values of Level 2 data (i.e., instrument footprints). Thus, there can be many pixels contributing to a gridbox.

Both precipitation and random error are scaled by 100 before conversion to 2-byte integer. Thus, units are 0.01 mm/h. To recover the original floating-point values in mm/h, divide by 100. Missings are given the 2-byte-integer missing value, -31999. The remaining fields are in numbers of pixels, except the source variable, which is dimensionless.

Currently the random error fields are all set to the 2-byte-integer missing value, -31999. This placeholder will be replaced with actual estimates as development proceeds.

The variable ambiguous_pixels is the count of pixels for which the algorithm cannot determine whether the scene has valid or invalid data. It is a subset of the total_pixel and many, but not all, are included in raining_pixels. In general, a "high" fraction of ambiguous_pixels indicates that the grid box value is invalid.

The originating machine on which the data files are written is a Silicon Graphics, Inc. Unix workstation, which uses the "big-endian" IEEE 754-1985 representation of 4-byte floating-point unformatted binary numbers. Some CPUs, including PCs and DEC machines, might require a change of representation (i.e., byte swapping) before using the data. In some cases, the gunzip routine, used to uncompress the data, will change representations automatically.

Special Values

All of the scaled 2-byte-integer precipitation and random error fields have one value with special meaning. Any grid box with insufficient valid data to make an estimate is assigned the 2-byte-integer value -31999. As well, the scaled 2-byte-integer precipitation and random error fields are clipped to [-31998,31998]to prevent duplication of the missing value (at the negative end) or overflows (at both the positive and negative ends). Note that any examples of clipping should be immediately reported to the dataset developers.

In addition, 3B40RT precipitation values that are highly likely to be artifacts (ambiguous fraction of pixels at least 40% or 5x5-gridbox averaged ambiguous fraction at least 5%) are encoded as (-p - 0.01), where "p" is the original precipitation value, before conversion to scaled 2-byte-integer. Thus, users can recover the estimated value of such gridboxes if desired, but the usual scheme of requiring precipitation to be non-negative will filter out these suspect values.

Likewise, 3B41RT and 3B42RT precipitation values outside the 50ºN-S latitude band are considered experimental and are encoded as (-p - 0.01), where "p" is the original precipitation value, before conversion to scaled 2-byte-integer. Thus, users can recover the estimated value of such gridboxes if desired, but the usual scheme of requiring precipitation to be non-negative will filter out these suspect values.

The 3B42RT "source of estimate" field only has three discrete values, -1, 0, 100, which correspond to "no estimate", "HQ", and "VAR".

Note that any negative values in the various "number of" fields is a processing error that should be immediately reported to the dataset developers.

Dataset Validation

The TMPA-RT **intercomparison results** continue to be developed. The time series of the global images shows good continuity in time and space across the geo-IR data boundaries. Overall, the analysis approach appears to work as expected. See Huffman et al. (2007, 2010) for more information. Numerous studies by the community are listed in the summary of citations:

ftp://meso-a.gsfc.nasa.gov/pub/trmmdocs/rt/TMPA_citations.pdf .

Validation studies are being conducted under the auspices of the International Precipitation Working Group (IPWG) in Australia, the continental U.S., western Europe, parts of South America, and Japan. Respectively, the web sites for these activities are:

http://cawcr.gov.au/projects/SatRainVal/validation-intercomparison.html
http://cics.umd.edu/~johnj/us_web.html
http://meso-a.gsfc.nasa.gov/ipwg/ipwgeu_home.html
http://cics.umd.edu/~dvila/web/SatRainVal/dailyval.html
http://www-ipwg.kugi.kyoto-u.ac.jp/IPWG/sat_val_Japan.html

The primary limitations on the HQ (3B40RT) are the sparse sampling by the collection of passive-microwave satellites and algorithm drop-outs in regions with icy or frozen surface. The infrared results (3B41RT) are designed to emulate the microwave results as closely as possible, so known deficiencies in the microwave will likely be reflected in the infrared as well. In addition, it is well-known that infrared algorithms of the kind used here have large random errors at the fine time and space scales provided. However, we expect the infrared estimates to match the histogram of microwave estimates, so that user-specified averaging should yield approximately unbiased results. Finally, the combined microwave-IR fields (3B42RT) contain data boundaries between the regions of microwave and IR coverage. Instantaneously the boundaries are usually subtle, but are more noticeable in movie loops, since the regions of coverage change with each image. We encourage users to report successes and problems in applying these datasets to their particular applications.

Dataset Status

An **additional retrospective processing for Version* 7* was carried out when processing issues were discovered with both the Version 7 TMPA production (3B42/43) and Version 7 TMPA-RT (3B40/41/42RT) data series. In general, the original Version 7 data sets are considered an improvement over Version 6, but this additional processing is considered important to meet the goals of the project. Users are urged to switch to the newest Version 7 data sets as soon as practical.

In November 2012 it was discovered that AMSU data were omitted in the first retrospective processing of both the Version 7 TMPA (3B42/43) and TMPA-RT (3B40/41/42RT) data series, which created an important shortcoming in the inventory of microwave precipitation estimates used during 2000-2010. In addition, a coding error in the TMPA-RT replaced the occasional missing-filled areas in product 3B42RT with zero-fills. Accordingly, both product series were retrospectively processed again. The main impact in both series was to improve the fine-scale patterns of precipitation during the periods noted below, roughly 2000-2010 (3B42/43) and 2000-2012 (3B4xRT). Averages over progressively larger time/space scales should be progressively less affected. [This is the reason the lack of AMSU went undiscovered; the merger system copes very reasonably with missing data.] Nonetheless, users are urged to switch to the newest Version 7 data sets as soon as practical.

It should be noted that these retrospective processings were done with archived "production" input data. For the RT, this resulted in some instances in which files that originally had not been received in a timely fashion, and hence did not make it into the original RT product, were ultimately archived when they showed up later, and then were included in the new retrospective processing. As such, the retrospectively processed RT is built from a superset of the data that had actually been available in true real time. The main implication is that the current “Initial Processing” RT being run only on real-time input could have somewhat worse errors than the equivalent reprocessed data.

In the original archive sites the newest runs may be identified by the file name suffixes. Specifically:

- V.7 3B42/43: "7A.HDF" for January 2000 - September 2010 on *http://mirador.gsfc.nasa.gov/cgi/bin/mirador/presentNavigation.pl?tree=project&project=TRMM&dataGroup=Gridded* ;

- V.7 3B4xRT: suffix of "7R2.bin" for 00 UTC 1 March 2000 – 05 UTC 7 November 2012 on *ftp://trmmopen.gsfc.nasa.gov/pub/merged/mergeIRMicro/* .

However, the secondary archive at *ftp://disc2.nascom.nasa.gov/data/TRMM/Gridded/* associated with TOVAS currently requires a uniform naming convention for each data series. Thus, users must inspect the file date/times to determine that the data are the latest:

- V.7 3B42/43: original retrospectively processed data were posted in late May 2012, the newly reprocessed data (for January 2000 – September 2010) were posted in December 2012, and Initial Processing data were posted as produced.
- V.7 3B4xRT: newly reprocessed data (for 00 UTC 1 March 2000 – 05 UTC 7 November 2012) were posted in January 2013, then Initial Processing data were posted as produced.

In the second retrospective processing it continues to be the case that the Version 7 3B42/43 is some 5-8% higher than the calibrating data set (2B31) over oceans, which is believed to be erroneous. However, the first several attempts at diagnosing this issue have not been fruitful. At the large scales this offset seems to be nearly a proportional constant. Another known issue is that RT over land seems to have an increasing trend that is strongest in south-central Asia and northwestern South America, again for reasons we do not yet understand. The RT trend over land is somewhat weaker in the second retrospective processing.

Example Programs

The data fields are all written with C-language code as blocks of bytes, so there are no extraneous bytes in the files. Because the first two fields are 2-byte integers and the rest are 1-byte integers in each file (to save space), users must exercise care in using FORTRAN direct access to read the data. The FORTRAN example programs read all fields with a single OPEN. Alternatively, the files can be opened with different logical record sizes depending on whether one is reading 2-byte-integer or 1-byte-integer fields. Note well that the units of the logical record size is not part of the FORTRAN 77 standard. On SGI machines it is in 4-byte words, but some other systems expect it in bytes. Also, to repeat an earlier comment, the originating machine on which the data files are written is a Silicon Graphics, Inc. Unix workstation. It uses the "big-endian" IEEE 754-1985 representation of 4-byte floating-point unformatted binary numbers, and some CPUs, such as PCs and DEC machines, might require a change of representation (i.e., byte swapping) before using the data.

The FTP site *ftp://trmmopen.gsfc.nasa.gov/pub/merged/software* provides several example programs:

idlsave.pro	IDL journal file showing output of a particular 3B40RT header
read3B4XRT.c	C example
read_header.f	FORTRAN header-read example
read_rt_file.f	FORTRAN single-read example
read_rt_file.pro	IDL example
read_rt_lines.f	FORTRAN line-by-line example

These are also available at *ftp://meso.gsfc.nasa.gov/pub/agnes/huffman/rt_examples/rt_docs* .

Sample R code for reading the data files is located remotely at *https://github.com/barryrowlingson/trmm*

Please contact Barry Rowlingson (b.rowlingson@lancaster.ac.uk) for any questions regarding the R code distribution.

Example Images and Movies

Users may obtain example GIF images and QuickTime movies at *http://trmm.gsfc.nasa.gov* . In addition, users may create their own subsets, averages, and time series, downloadable as plots or ASCII data from the TRMM Online Visualization System (TOVAS), at *http://disc2.nascom.nasa.gov/Giovanni/tovas/* . TOVAS is provided by the Goddard Earth Science Data and Information Services Center (GES DISC).

Additional Documentation

Users should refer to the detailed documentation (3B4XRT_doc.pdf) and programming examples at the anonymous FTP site *ftp://trmmopen.gsfc.nasa.gov/pub/merged/software* for additional details.

Primary References

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