Data User Guide

GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS

Introduction

The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS dataset is a subset of the TMPA 3B42RT gridded precipitation real-time product selected for the time period of the GPM Ground Validation Iowa Flood Studies (IFloodS) held in Iowa during April 1, 2013 to June 30, 2013. The goals of IFloodS were to collect detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars and to simultaneously collect data from satellites passing overhead. TMPA is a calibration-based sequential scheme for combining microwave (MW) and infrared (IR) precipitation estimates from multiple satellites, as well as surface precipitation gauge analyses where feasible, to produce precipitation estimates at fine scales: 3-hourly, 0.25 degree maps. The TMPA IFloodS product is available in netCDF-4 and binary formats, as well as 3-hour rainfall browse images in JPG format.

Notice: The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS dataset is a temporal subset of the TMPA 3B42RT Version-7 gridded precipitation product available at https://pmm.nasa.gov/data-access/downloads/trmm. The version number of this dataset matches the original TMPA product at NASA Goddard.

Citation

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Keywords:

GHRC, NASA, IFloodS, TRMM, TMPA, Iowa, precipitation, uncalibrated precipitation, precipitation estimate error

Campaign

The Global Precipitation Measurement mission Ground Validation (GPM GV) campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch of the GPM Core Satellite, which launched on February 27, 2014. The instrument validation effort included numerous GPM-specific and joint agency/international external field campaigns, using state of the art cloud and precipitation observational infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). These field campaigns accounted for the majority of the effort and resources expended by GPM GV. More information about the GPM mission is at https://pmm.nasa.gov/GPM/.

The Iowa Flood Studies (IFloodS) was a ground measurement campaign that took place throughout Iowa from May 1 to June 15, 2013. The main goal of IFloodS was to evaluate how well the GPM satellite rainfall data can be used for flood forecasting. Specifically, this meant collecting detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars and simultaneously collecting data from satellites passing overhead. The ground instruments characterize precipitation – the size and shape of raindrops, the physics of ice and liquid particles throughout the cloud and below as it falls, temperature, air moisture, and distribution of different size droplets – to improve rainfall estimates from the satellites, and in particular the algorithms that interpret raw data for the GPM mission's Core Observatory satellite, which launched in 2014. More information about IFloodS is available at http://dx.doi.org/10.5067/GPMGV/IFLOODS/DATA101.
Additional information about the Iowa Flood Center is available at http://iowafloodcenter.org/.

Instrument Description

The Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) 3B42 data product contains calibrated precipitation estimates on a 0.25° by 0.25° latitude/longitude grid at 3-hourly intervals (centered on 0, 3, 6, 9Z, etc) derived by combining precipitation values from microwave and infrared satellite instruments and surface precipitation gauges, if possible. This IFloodS TMPA precipitation dataset is the real-time (RT, ~9 hours post measurement) TMPA 3B42RT product. To derive precipitation values, TMPA processing combines rainfall estimates from Passive Microwave Sensors (MW) on Low Earth Orbit (LEO) satellites, such as the TRMM Microwave Imager (TMI), the Advanced Microwave Scanning Radiometer-EOS (AMSR-E), SSM/I and SSMIS sensors onboard the Defense Meteorological Satellite Program (DMSP) satellites, and Advanced Microwave Sounding Unit (AMSU-B) on NOAA satellites. In addition, infrared (IR) measurements from geostationary satellites are calibrated with the MW data and incorporated into the precipitation estimate. Details of the product algorithm and processing steps are presented in Huffman et al., 2007.

The full set of TMPA 3B42 data are located at the NASA GES DISC. The web pages containing

more detailed information are located at https://trmm.gsfc.nasa.gov/3b42.html (description of 3B42 product) and the GES DISC landing page for the 3B42 product https://disc.gsfc.nasa.gov/datasets?keywords=tmpa&page=1.

Investigators

Dr. George Huffman
NASA Goddard Space Flight Center
Greenbelt, Maryland

Dr. Erich Stocker
NASA Goddard Space Flight Center
Greenbelt, Maryland

David T. Bolvin
NASA Goddard Space Flight Center
Greenbelt, Maryland

Eric J. Nelkin
NASA Goddard Space Flight Center
Greenbelt, Maryland

Data Characteristics

The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IPHEx dataset consists of netCDF-4 and binary file formats with precipitation estimates, as well as 3-hour rainfall browse imagery available in JPG format. These data are available at Level 3 processing level. More information about the NASA data processing levels are available on the NASA Data Processing Levels website. Table 1 lists the data characteristics of these data.

Table 1: Data Characteristics

Characteristic	Description
Platforms	Data collected by instruments on the following satellites are incorporated into making the 3B42RT product: Tropical Rainfall Measuring Mission (TRMM); Defense Meteorological Satellite Program (DMSP F-13, F-14, F-15, F-16, F-17); Aqua; NOAA; geostationary satellites
Instruments	Data from the following instruments are incorporated into making the 3B42RT product:TMI(TRMM); SSM/I and SSMIS (DMSP); AMSR-E (Aqua); AMSU-B (NOAA); IR sensors (geostationary satellites)
Projection	Equirectangular
Spatial Coverage	N: 59.875, S: -59.875, E: 179.875, W: -179.875 (Global)
Spatial Resolution	0.25 degrees

Temporal Coverage	April 1, 2013 - June 30, 2013
Temporal Resolution	3 hours
Sampling Frequency	Varies by sensor used in the product
Parameter	Precipitation, uncalibrated precipitation
Version	7
Processing Level	3

File Naming Convention

The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS dataset is available in netCDF-4 and binary data formats, as well as 3-hour rainfall browse imagery available in JPG format. The netCDF-4 and binary data are the same data, but in two different formats. These data files are in the following naming conventions.

Data files: ifloods_tmpa_3B42RT_YYYYMMDDhh_v7.[nc|bin.gz]
Browse files: ifloods_tmpa_3hrly_rain_YYYYMMDDhh.jpg

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
hh	Two-digit hour in UTC
v7	Algorithm version of 3B42RT product at GES DISC
[nc|bin.gz]	nc: netCDF-4 format bin.gz: gzipped binary data format
jpg	Joint Photographic Experts Group format

Data Format and Parameters

The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS dataset is available in netCDF-4 and binary data formats, as well as 3-hour rainfall browse imagery available in JPG format. These data are available from April 1, 2013 through June 30, 2013. The netCDF-4 and binary data consists of precipitation and uncalibrated precipitation estimates, as well as precipitation error estimates. The GPM TMPA IFloodS data files are a temporal subset of the TMPA 3B42RT version-7 gridded precipitation product available at the NASA GES DISC data archive (https://pmm.nasa.gov/data-access/downloads/trmm). Table 3 lists and describes these data parameters. More information about this data product is available in the Precipitation Processing System Tropical Rainfall Measuring Mission File Specification for TRMM Products document.

Detailed description of the binary file contents are provided on page 15 of the 3B4* descriptive document:
(https://docserver.gesdisc.eosdis.nasa.gov/public/project/GPM/3B4XRT_doc_V7.pdf)
Note that binary data are stored as big-endian and must be byte swapped for proper use.

Read routines for the binary data are available from GES DISC.

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, 03, ..., 21 UTC) using that hour's 3B40RT and 3B41RT data sets. Note that valid estimates are only provided in the band between 50ºN-S.

Table 3: Data Fields

Field Name	Description	Data Type	Unit
error	Error in precipitation estimate	float	mm
latitude	Latitude	float	Degrees North
longitude	Longitude	float	Degrees East
precip	Precipitation amount estimate	float	mm
source	Satellite source	short	-
time	Time of measurement	int	Seconds since time in file name
uncal_precip	Uncalibrated precipitation amount estimates	float	mm

Algorithm

The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IFloodS precipitation estimates are produced using the following steps:
1. Microwave precipitation estimates are calibrated and combined
2. Infrared precipitation estimates are created using calibrated microwave precipitation
3. Microwave and infrared estimates are combined
4. Surface precipitation gauge data are incorporated

More detailed information about the algorithm of TMPA is available in [Huffman et. al., 2007](#) and [Huffman et al., 2010](#).

Quality Assessment

As part of the routine processing, the TMPA is computed twice: first, as a real-time, best-effort product, and second, as a research quality, post-real-time product. This dataset consists of the real-time product. TMPA depends on Low Earth Orbit (LEO) satellites carrying passive microwave sensors and includes data from Geosynchronous Earth Orbit (GEO) IR sensors. Despite the large number of sensors, there remain significant gaps in coverage. A 3-hourly gridded map may only have 80% microwave (MW) coverage in later years, with as low as 40% coverage in earlier years. These data gaps in coverage can affect product quality. IR-based precipitation estimates have reduced brightness temperature measurement quality that results in limited precipitation quality. In October 2014, with the

degradation of TMI (the calibration standard) prior to the final shutdown, the calibration standard had to change for the TMPA 3B42 product. This created a slight inhomogeneity in the data product time series, primarily over ocean regions. Comparisons of TMPA to various precipitation measurements, such as radar, ocean buoy gauges, atoll gauges, and other precipitation products, have been completed and are reported in Huffman et al., 2007. The paper by Liu, 2015 provides a comparison of the real-time product to the science research quality product, 3B42.

Software

No software is required to read netCDF-4. Panoply can be used to read these files easily. Software in various programming languages are available for the binary files at ftp://trmmopen.nascom.nasa.gov/pub/merged/software/.

Known Issues or Missing Data

Missing satellite scans were filled with standard values denoting missing data. Values less than or equal to '-99', '-9999', or '-9999.9' denote missing or invalid data. If an entire granule was missing, an empty granule was created. If an entire orbit of Level 1B or 2 satellite data used as input to the product was missing, scan data was omitted and the 'Orbit Size' had a value of 0. More information about known issues and missing data within this data product is available in the Precipitation Processing System Tropical Rainfall Measuring Mission File Specification for TRMM Products document.

References

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Related Data

All data collected during the IFloodS field campaign should be considered related datasets. To locate other IFloodS data, use the GHRC search tool, HyDRO 2.0, with the search term 'IFloodS'.

In addition, a subset of the TMPA product was created for other GPM GV field campaigns.:

GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IPHEx (http://dx.doi.org/10.5067/GPMGV/IPHEX/MULTIPLE/DATA301)

GPM Ground Validation Global Flood Monitoring System (GFMS) Flood Maps IFloodS (http://dx.doi.org/10.5067/GPMGV/IFLOODS/TMI/DATA101)

Contact Information

To order these data or for further information, please contact:
        NASA Global Hydrology Resource Center DAAC
        User Services
        320 Sparkman Drive
        Huntsville, AL 35805
        Phone: 256-961-7932
        E-mail: support-ghrc@earthdata.nasa.gov
        Web: https://ghrc.nsstc.nasa.gov/

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