



Data User Guide

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

Introduction

This GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IPHEX dataset is a subset of the TMPA 3B42RT gridded precipitation product selected for the time period of the GPM Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEX) held in North Carolina during May 1, 2014 to June 15, 2014. The goal of IPHEX was to characterize warm season orographic precipitation regimes and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. This dataset contains 3-hourly, 0.25 degree maps of precipitation derived using microwave (MW), infra-red (IR), surface precipitation gauge measurements, and other rain products that include the TRMM Precipitation Radar (PR) data. The IPHEX TMPA product is available in netCDF-4 and binary formats.

Notice: The GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IPHEX 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

Huffman, George J, Erich Stocker, David T Bolvin and Eric J Nelkin. 2017. GPM Ground Validation TRMM Multi-satellite Precipitation Analysis (TMPA) IPHEX [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: <http://dx.doi.org/10.5067/GPMGV/IPHEX/MULTIPLE/DATA301>

Keywords:

GHRC, NASA, IPHEX, TRMM, TMPA, North Carolina, precipitation, uncalibrated precipitation, precipitation estimate error

Campaign

The Global Precipitation Measurement (GPM) mission Ground Validation 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). Surface rainfall was measured by very dense rain gauge and disdrometer networks at various field campaign sites. These field campaigns accounted for the majority of the effort and resources expended by GPM GV. More information about the GPM mission is available at <https://pmm.nasa.gov/GPM/>.

One of the GPM Ground Validation field campaigns was the Integrated Precipitation and Hydrology Experiment (IPHEX) which was held in North Carolina during 2013 and 2014 with an intense study period from May 1 to June 15, 2014. The goal of IPHEX was to characterize warm season orographic precipitation regimes and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The IPHEX campaign was part of the development, evaluation, and improvement of remote-sensing precipitation algorithms in support of the GPM mission through NASA GPM Ground Validation field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrologic forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEX is available at <http://gpm.nsstc.nasa.gov/iphex/>.

Data Product Description

The Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) 3B42 data product contains calibrated precipitation estimates on a 25° by 25° lat/lon grid at 3-hourly intervals (centered on 0, 3, 6, 9Z, etc) derived by combining precipitation values from microwave and IR satellites and surface precipitation gauges, if possible. This IPHEX TMPA precip dataset is the real-time (RT, ~9 hours post measurement) TMPA 3B42 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, 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 page containing more details is located at <https://trmm.gsfc.nasa.gov/3b42.html> and http://disc.sci.gsfc.nasa.gov/precipitation/documentation/TRMM_README/TRMM_3B42_readme.shtml

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

File Naming Convention

IPHEX TMPA data are in netCDF-4 and binary file formats and the files have the following naming convention.

netCDF Data Files: iphex_3B42RT_YYYYMMDDhh.7.nc

Raw Data Files: 3B42RT.YYYYYMMDDss.7.bin

Table 1: File naming convention variables

Variable	Description
3B42RT	Original product number (3B42) and delivery designation (RT=real-time)
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
hh	Hours in Z
.nc	netCDF-4 format
.bin	Binary format

Data Format Description

IPHEX TMPA data are available in two formats, as netCDF-4 and binary files. The data files contain both calibrated precipitation and uncalibrated precipitation data. Table 2 lists the details.

Table 2: Data Characteristics

Characteristic	Description
Platforms	Data from the following satellites are incorporated into the 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	TMI(TRMM); SSM/I and SSMIS (DMSP); AMSR-E (Aqua); AMSU-B (NOAA); IR sensors (geostationary satellites)
Projection	latitude/longitude
Spatial Coverage	N: 60.0 , S:-60.0, E: 180.0, W: -180.0
Spatial Resolution	0.25 degree lat/lon grid
Temporal Coverage	Start date: May 1, 2014 Stop date: June 16, 2014
Temporal Resolution	3 hours
Sampling Frequency	Varies by sensor used in product
Parameter	Precipitation, uncalibrated precipitation
Version	7
Processing Level	3

Data Parameters

IPHEX TMPA data consists of precipitation and uncalibrated precipitation data in mm with a precipitation error estimate in mm. Each parameter is mapped to a 1440 by 480 grid, containing 0.25 deg lat/lon pixels. More information is available at <https://pps.gsfc.nasa.gov/Documents/filespec.TRMM.V7.pdf>.

Algorithm

IPHEX TMPA 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. 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% MW

coverage in later years, with as low as 40% coverage in earlier years. 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 final shutdown, the calibration standard had to change for the TMPA 3B42 product. This created at least a slight inhomogeneity in the data product timeseries, 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). Liu (2015) provides a comparison of the RT 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/>.

References

Huffman, George J., Robert F. Adler, David T. Bolvin, Guojun Gu, Eric J. Nelkin, Kenneth P. Bowman, Yang Hong, Erich F. Stocker, and David B. Wolff, 2007: The TRMM Multi-satellite Precipitation Analysis (TMPA): Quasi-global, multiyear, combined-sensor precipitation estimates at fine scales. *Journal of Hydrometeorology*, 8, 38-55.

<http://dx.doi.org/10.1175/JHM560.1>

Huffman, G.J., R.F. Adler, D.T. Bolvin, E.J. Nelkin, 2010: The TRMM Multi-satellite Precipitation Analysis (TMPA). Chapter 1 in *Satellite Rainfall Applications for Surface Hydrology*, F. Hossain and M. Gebremichael, Eds. Springer Verlag, ISBN: 978-90-481-2914-0, pp 3-22, <http://dx.doi.org/10.1007/978-90-481-2915-7>

Liu, Zhong, 2015: Comparison of precipitation estimates between Version 7 3-hourly TRMM Multi-Satellite Precipitation Analysis (TMPA) near-real-time and research products. *Atmospheric Research* 153, 119–133. <http://dx.doi.org/10.1016/j.atmosres.2014.07.032>

Mantas, V. M., Z. Liu, C. Caro, and A. J. S. C. Pereira, 2015: Validation of TRMM multi-satellite precipitation analysis (TMPA) products in the Peruvian Andes, *Atmospheric Research*, 163, 132-145. doi: <http://dx.doi.org/10.1016/j.atmosres.2014.11.012>

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/>

Updated: January 17, 2017