Global Hydrology Resource Center

Data User Guide

GPM Ground Validation TRMM 2A25 NRT Precipitation Radar IPHEx

Introduction

The GPM Ground Validation TRMM 2A25 NRT Precipitation Radar IPHEx data are estimates of instantaneous three-dimensional distribution of rain from the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR). The TRMM 2A25 (NRT) orbital precipitation radar data from NASA GES DISC have been extracted for the southeast US region for May 1 to June 16, 2014 during the GPM Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEx) field campaign. This data product contains the average rainfall rate between two predefined altitudes derived from each radar beam position. Other output data include parameters of Z-R relationships ($R=aZ^b$), integrated rain rate of each beam, range bin numbers of rain layer boundaries, and many intermediate parameters. Data files are available in HDF-4 format, while corresponding browse images are also available in PNG format.

Notice:
This dataset is constructed from the NASA GES DISC Please refer to section 2-3. 8. in the Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar Algorithm Instruction Manual For Version 7 document (http://www.eorc.jaxa.jp/TRMM/documents/PR_algorithm_product_information/pr_manual/PR_Instruction_Manual_V7_L1.pdf) regarding caveats about the 2A25 algorithm.

Citation

Stocker, Erich. 2018. GPM Ground Validation TRMM 2A25 NRT Radar IPHEx [indicate subset used]. Dataset available online [insert URL if appropriate (does not have a DOI)] 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/TRMM/DATA101

Keywords:

NASA, GHRC, IPHEx, GPM GV, TRMM 2A25, NRT Precipitation Radar, precipitation

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/. More information about the GPM Ground Validation mission is available at https://pmm.nasa.gov/science/ground-validation.

One of the GPM Ground Validation field campaigns was the Integrated Precipitation and Hydrology Experiment (IPHEx), which was held in North Carolina during 2014 with an intense study period from May 1 to June 15, 2014. The goal of the IPHEx campaign was to contribute to 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 hydrological 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://dx.doi.org/10.5067/GPMGV/IPHEX/DATA101 and https://pmm.nasa.gov/IPHEx.

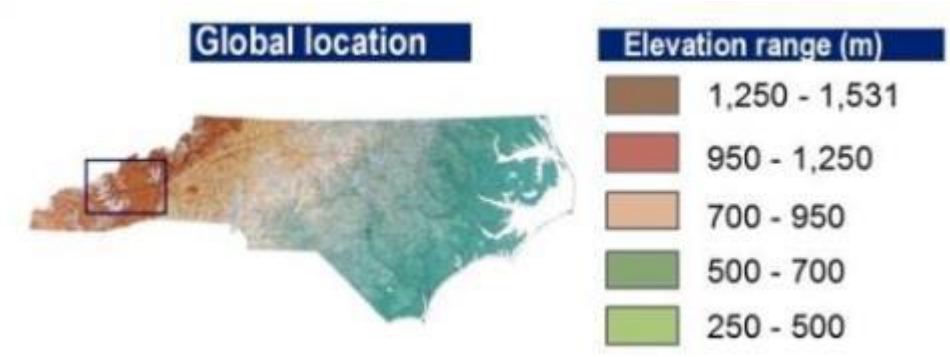

Figure 1: Region of North Carolina IPHEx campaign ground validation (image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The Tropical Rainfall Measuring Mission (TRMM) was a joint mission between NASA and the Japan Aerospace Exploration Agency (JAXA) designed to monitor and study tropical rainfall. The TRMM satellite was launched on November 27, 1997 and decommissioned on April 15, 2015.

The Precipitation Radar (PR) on the TRMM satellite was the first spaceborne instrument designed to provide three-dimensional maps of storm structure. The PR measurements yielded valuable information on the intensity and distribution of rain, rain type, storm structure, and snow melt height. The TRMM PR can achieve quantitative rainfall estimations over both land and ocean. The TRMM PR provided vertical profiles of the rain and snow from the surface up to a height of about 20 km at a frequency of 13.8 GHz and a horizontal ground resolution of 5 km and a swath width of 247 km. The TRMM PR has a minimum detectable rain rate of 0.5 mm/h with range resolution of 250 m which is equal to the vertical resolution at nadir. More information about TRMM PR can be found in Kozu et al., 2001.

These TRMM 2A25 Preicpitation Radar data have been extracted in the vicinity and time of the IPHEx field campaign from the published TRMM 2A25 dataset at the NASA GES DISC (https://disc.gsfc.nasa.gov/datasets/TRMM_2A25_V7/summary). Users wanting more information and access to the entire TRMM 2A25 data are encouraged to visit GES DISC, https://disc.gsfc.nasa.gov.

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Data Characteristics

The GPM Ground Validation TRMM 2A25 NRT Precipitation Radar IPHEx dataset consists of data files in HDF-4 format with corresponding browse imagery available in PNG format at a Level 2 processing level. These files are available between May 1, 2014 and June 16, 2014. More information about the NASA data processing levels are available on the NASA Data Processing Levels website. Table 1 provides the characteristics of this dataset. Though new versions of the GES DISC TRMM 2A25 data may be released in the future, we do not expect to update this subset as it is particular to the data available at the time of the IPHEx field campaign.

Table 1: Data Characteristics

Characteristic	Description
Platform	Tropical Rainfall Measuring Mission (TRMM)
Instrument	Precipitation Radar (PR)
Projection	n/a

Spatial Coverage	N: 36.227089, S: 25.8391, W: -92.739044, E: -70.814842 (North Carolina)
Spatial Resolution	Horizontal: 5 km* see below Vertical: 250 m
Temporal Coverage	Start date: May 1, 2014 Stop date: June 16, 2014
Temporal Resolution	Hourly -< Daily
Sampling Frequency	< 1 second
Parameter	Precipitation
Version	7
Processing Level	2

* The TRMM satellite orbit was changed in 2001 to extend the operational lifetime of the satellite and instruments onboard. The parameters below summarize the changes to the datasets due to the orbit boost.
Pre-Boost (before 7 August 2001): Temporal Resolution: 91.5 min/orbit; Swath Width: 215 km; Horizontal Resolution: 4.3 km
Post-Boost (after 24 August 2001): Temporal Resolution: 92.5 min/orbit; Swath Width: 247 km; Horizontal Resolution: 5.0 km

File Naming Convention

The GPM Ground Validation TRMM 2A25 NRT Precipitation Radar IPHEx dataset includes both data files and browse images named with the following convention:

Data files: iphex_2A25_YYYYMMDDThh-mm-ssZ.7.HDF
Browse files: iphex_2A25_YYYYMMDDThh-mm-ssZ.7.PNG

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
mm	Two-digit minute in UTC
ss	Two-digit second in UTC
.HDF	HDF-4 format
.PNG	Portable Network Graphics format

Data Format and Parameters

The GPM Ground Validation TRMM 2A25 NRT Precipitation Radar IPHEx dataset consists of data files in HDF-4 format. Each HDF-4 data file consists of two Vgroups named “Clutter” and “Swath”. There are three Vgroups under the “Swath” Vgroup: navigation, scanStatus, and ScanTime. Data fields in the “Swath” Vgroup include estimates of instantaneous three-dimensional distribution of rain, parameters of Z-R relationships ($R=aZ^b$), integrated rain

rate of each beam, range bin numbers of rain layer boundaries, and many intermediate parameters. Most of these variables have dimensions of 'nscan' x 'nray', where 'nscan' refers to the number of scans in each granule, which varies by file. The second dimension, 'nray' refers to the number of angle bins in each scan, which is always 49. Table 3 outlines all data fields (variables, parameters) in each HDF4 data file. We suggest users wanting more information access the GES DISC File Specification documentation or the GES DISC Readme for the TRMM 2A25 data for more details.

Table 3: Data Fields

Structure	Field Name	Data Type	Unit
./Clutter	mainlobeEdge	byte	-
	sidelobeRange	byte	-
./	Parameters_Convective	char	-
	Parameters_General	char	-
	Parameters_Other	char	-
	Parameters_Stratiform	char	-
./Swath	attenParmAlpha	float	-
	attenParmBeta	float	-
	correctZFactor	short	dBZ
	e_SurfRain	float	mm/hr
	epsilon	float	-
	epsilon_0	float	-
	epsilon_alpha	float	-
	epsilon_nubf	float	-
	errorRain	float	dB
	errorZ	float	dBZ
	freezH	float	-
	Latitude	float	degrees
	Longitude	float	degrees
	method	short	-
	nearSurfRain	float	mm/hr
	nearSurfZ	float	dBZ
	nubfCorrectFactor	float	-
	parmNode	short	-
	pia	float	dB
	pia_srt	float	dB
	precipWaterParmA	float	-
	precipWaterParmB	float	-
	precipWaterSum	float	g km/m^3
	qualityFlag	short	-
	rain	short	mm/hr
	rainAve	float	mm/hr
	rainFlag	short	-

	rainType	short	-
	rangeBinNum	short	-
	reliab	byte	-
	scanTime_sec	double	s
	scLocalZenith	float	-
	sigmaZero	float	-
	spare	float	-
	stddev_alpha	float	-
	stddev_PIAsrt	float	dB
	stddev_srt	float	dB
	stddev_zeta	float	-
	stddev_Zm	flaot	dBZ
	zeta	float	-
	zeta_mn	float	-
	zeta_sd	float	-
	zmmax	float	dBZ
	ZRParmA	float	-
	ZRParmB	float	-
./Swath/navigation	greenHourAng	float	degrees
	scAlt	float	m
	scAttPitch	float	degrees
	scAttRoll	float	degrees
	scAttYaw	float	degrees
	scLat	float	degrees
	scLon	float	degrees
	scPosX	float	m
	scPosY	float	m
	scPosZ	float	m
	scVelX	float	m/s
	scVelY	float	m/s
	scVelZ	float	m/s
	SensorOrientationMatrix	float	-
./Swath/scanStatus	missing	byte	-
	validity	byte	-
	qac	byte	-
	geoQuality	byte	-
	dataQuality	byte	-
	SCorientation	short	degrees
	acsMode	byte	-
	yawUpdateS	byte	-
	prMode	byte	-
	prStatus1	byte	-
	prStatus2	byte	-
	FractionalGranuleNumber	double	-

./Swath/ScanTime	Year	short	years
	Month	byte	months
	DayOfMonth	byte	days
	Hour	byte	hours
	Minute	byte	minutes
	Second	byte	s
	MilliSecond	short	ms
	DayOfYear	short	days

Algorithm

The 2A25 algorithm estimates the instantaneous three-dimensional distribution of rain from the TRMM Precipitation Radar (PR) data. First, TRMM PR-measured radar reflectivity (Z_m) is corrected for the rain attenuation. A hybrid of the Hitschfeld-Bordan method and the surface reference method is used to estimate the vertical profile of attenuation-corrected effective radar reflectivity factor Z_e. The vertical rain profile is calculated from the estimated Z_e profile by using an appropriate Z_e-R relationship. The rainfall estimates are calculated from the attenuation-corrected Z_e-profiles by using a power law: $R=aZ_e^b$ in which the parameters a and b are both functions of the rain type, existence of bright-band, freezing height, storm height and absolute height. Effects of the difference in the raindrop size distribution by rain type, the phase state, the temperature, and the difference in terminal velocity due to changes in the air density with height are taken into account. Since radar rain echoes from near the surface are hidden by the strong surface echo, the rain estimate at the lowest point in the clutter-free region is given as the near-surface rainfall rate for each angle bin.

Iguchi and Meneghini (1994) describe this algorithm. More information about the algorithm including its attenuation correction methods can be found in the TRMM Precipitation Radar Algorithm Manual. .

Software

These data files are in HDF-4 format, and may be read using Python, IDL, or other common HDF reader. Users are advised to check the GES DISC user guide for further information. Panoply or HDFView can be used to easily view these data.

Known Issues or Missing Data

There are no known issues with these data. Known gaps for TRMM data can be found at ftp://gpmweb2.pps.eosdis.nasa.gov/tsdis/AB/docs/anomalous.html.

References

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Related Data

All datasets from IPHEx can be considered related to this dataset. IPHEx campaign data can be located using the GHRC HyDRO 2.0 search tool, by entering the term 'IPHEx'.

Contact Information

To order these data or for further information, please contact:

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