GPM Ground Validation Southern Appalachian Rain Gauge IPHEx

Introduction

The GPM Ground Validation Southern Appalachian Rain Gauge IPHEx dataset was collected during the Integrated Precipitation and Hydrology Experiment (IPHEx) field campaign consisting of 45 observation sites. The main goal of IPHEx were to characterize warm season orographic precipitation regimes and hydrologic processes in regions of complex terrain, to contribute to the development, evaluation, and improvement of remote sensing precipitation algorithms in support of the GPM mission. These data are available in ASCII-csv format from January 3, 2008 thru December 31, 2014. Data collection began in 2008 due to the entire network being funded by the NASA Precipitation Measurement Missions (PMM) to make these observations of orographic precipitation in preparation for the IPHEx field campaign.

Notice:

This same dataset is also publicly available at the Duke Data Repository. If you obtained the Duke Data Repository dataset, please use the following citation:

Barros, A.P., Miller, D., Wilson, A.M., Cutrell, G., Arulraj, M., Super, P., Petersen, W.A. (2017). IPHEx-Southern Appalachian Mountains -- Rainfall Data 2008-2014. Duke Digital Repository. https://doi.org/10.7924/G8CJ8BJK

Citation

Barros, Ana P., Douglas Miller, Anna M. Wilson, Gregory Cutrell, Malarvizhi Arulraj, Paul Super, and Walt Petersen. 2017. GPM Ground Validation Southern Appalachian Rain Gauge 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/GAUGES/DATA301

Keywords:

GHRC, Duke, IPHEx, GPM GV, Rain Gauge, precipitation, cumulative rainfall amount, tipping bucket rain gauge

Campaign

The GPM Ground Validation campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch on 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. These field campaigns accounted for the majority of the effort and resources expended by the GPM Ground Validation mission. More information about the GPM Ground Validation mission is available at https://pmm.nasa.gov/index.php?q=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 goals of the IPHEx field campaign were to characterize warm season orographic precipitation regimes and hydrologic processes in regions of complex terrain to contribute to the development, evaluation, and improvement of remote sensing precipitation algorithms in support of the GPM mission, and to evaluate 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) in conjunction with the NOAA Hydrometeorology Testbed project. More information about IPHEx is available at http://gpm.nsstc.nasa.gov/iphex/.
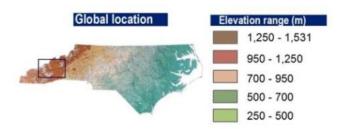

Figure 1: Region of North Carolina IPHEx campaign ground validation
(image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The tipping bucket rain gauge measures the amount of fallen precipitation entering the gauge orifice, where there is a central swinging shaft with two small buckets on top and a magnet on the bottom. These tipping bucket gauges hold 0.01 inches, or 0.234 mm, of rain; however, once the bucket reaches capacity, the bucket tips over, empties the contents, and records the bucket tip. The number of bucket tips are recorded by the magnet passing over two wires, causing them to touch, and completing an electrical circuit. The GPM Ground Validation Southern Appalachian Rain Gauge IPHEx dataset is comprised of 45 observation systems with one tipping bucket rain gauge per site. Table 1 provides the location of each observation system, while Figure 2 shows where these observations are located and what year they were installed. More information about the Duke University rain gauges can be found at https://iphex.pratt.duke.edu/long-termRGDuke.

Table 2: Observation locations

Site number	Site name	Latitude	Longitude
RG001	CDB1	35.409	-82.923
RG002	WaynesvilleWatershed1	35.425	-82.971
RG003	CDB2	35.385	-82.916
RG004	RichlandBalsam	35.368	-82.990
RG005	WaynesvilleWatershed2	35.409	-82.965
RG008	WaynesvilleWatershed3	35.382	-82.974
RG010	BeatySpring	35.456	-82.947
RG100	PurchaseKnob	35.586	-83.073
RG100T	PurchaseKnobTower	35.588	-83.065
RG101	TheSwag	35.575	-83.088
RG102	HemphillBald	35.564	-83.104
RG103	JLRich	35.553	-83.118
RG104	SkiCataloochee	35.555	-83.087
RG105	HultquistMeadow	35.634	-83.041
RG106	PinnacleRidge	35.432	-83.029
RG107	LookoutPoint	35.568	-82.907
RG108	UtahMountain	35.555	-82.990
RG109	EaglesnestRidge	35.496	-83.040
RG110	Hawkins-SWCataloochee	35.548	-83.148
RG111	HurricaneRidge	35.730	-82.948
RG112	OreKnob	35.752	-82.964
RG113	MarshallRidge	35.888	-82.583
RG114	LynnLowry	35.464	-83.113
RG115	UNCA	35.616	-82.565
RG300	CamelHump	35.727	-83.217
RG301	MtGuyot	35.706	-83.256
RG302	SnakeDenRidge	35.721	-83.247
RG303	MtCammerer	35.763	-83.162
RG303S	MtCammerer	35.763	-83.162
RG303PK	PurchaseKnob	35.586	-83.073
RG304	BigCataloochee	35.670	-83.183
RG305	MtSterling1	35.692	-83.132
RG306	SunupKnob	35.746	-83.171
RG307	BalsamMountain	35.652	-83.200
RG308	CosbyKnob	35.730	-83.182
RG309	MtSterling2	35.683	-83.150
RG310	MtSterlingFireTower	35.703	-83.123
RG311	BigCreek	35.765	-83.140
RG400	MtSterlingFireTower	35.703	-83.123
RG401	BalsamMountain	35.652	-83.200
RG402	SnakeDenRidge	35.721	-83.247

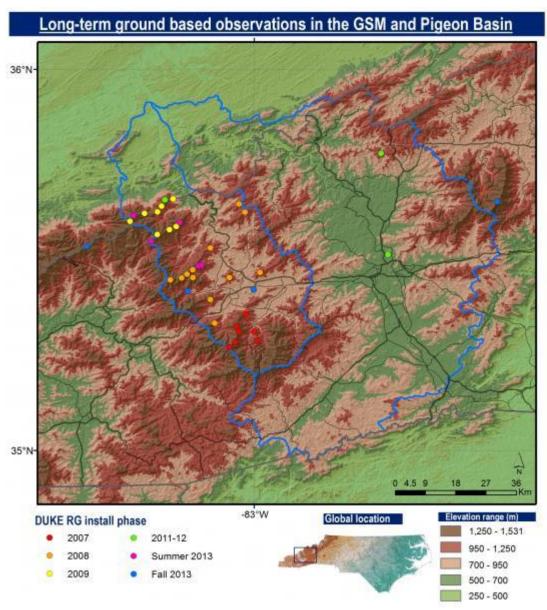| RG403 | MaggieValleyWater | 35.518 | -83.101 |
RG404	MtMitchell	35.759	-82.271
RG405	Hickory	35.663	-81.232
RG406	CharlesBunion	35.638	-83.371

Figure 2: Rain gauge locations for the IPHEx field campaign
(Image source: https://iphex.pratt.duke.edu/long-termRGDuke)

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Data Characteristics

The GPM Ground Validation Southern Appalachian Rain Gauge IPHEx data are available in ASCII-csv file format at a data processing level of 2. More details regarding NASA's data processing levels can be found at this link. Table 2 outlines the key dataset characteristics about the dataset.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	Tipping bucket rain gauge
Projection	n/a
Spatial Coverage	N: 35.888 , S:35.368 , E:-81.232 , W: -83.371 (North Carolina)
Spatial Resolution	point
Temporal Coverage	January 3, 2008* - December 31, 2014
Temporal Resolution	File per site containing about 6 years of data
Sampling Frequency	Varies: <2 minutes
Parameter	Cumulative rainfall amount
Version	1
Processing Level	2

*Data collection started before the IPHEx field campaign. This is due to the entire network being funded by the NASA Precipitation Measurement Missions (PMM) to make these observations of orographic precipitation in preparation for the IPHEx field campaign.

File Naming Convention

The GPM Ground Validation Southern Appalachian Rain Gauge IPHEx dataset uses the file naming convention shown below. The data files are available in ASCII-csv format.

Data files: iphex_sarg_pmm_###-PROCESSED-<start date>-<end date>.csv

Table 3: File naming convention variables

Variable	Description
###	Tipping rain gauge site number
<start date>	Start date of data collection for that site in YYYYMMDD YYYY: Four-digit year MM: Two-digit month DD: Two-digit day
<end date>	End date of data collection for that site in YYYYMMDD YYYY: Four-digit year MM: Two-digit month DD: Two-digit day
csv	ASCII-csv format

Data Format and Parameters

The GPM Ground Validation Southern Appalachian Rain Gauge IPHEx dataset consists of ASCII-csv data files containing cumulative rainfall measurements and data quality flags. Table 4 describes these data fields within the ASCII-csv data files.

Table 4: Data Fields

Column	Description	Unit
1	Cumulative rainfall amount	mm
2	Date in DD-MMM-YY DD: Two-digit day MM: Three-letter month YY: Two-digit year	-
3	Time in hh:mm:ss hh: Two-digit hour mm: Two-digit minute ss: Two-digit second	EDT
4	Quality Flag More information about this in the 'Quality Assessment' section below	-

Quality Assessment

Each data file provides data quality flags for each measurement described in Table 4.

Table 4: Quality Control Flags

Value	Description
L	Corrected data based on collocated rain gauge. The problem is either C or K, which are defined below.
D	Temporary debris likely in gauge. During this period, gauge is likely underreporting.
C	Clogged gauge or standing water was found in the gauge top. This flag is placed on all data between the last visit and the date it was found in this state.
K	The gauge was found knocked over. This flag is placed on all data between the last visit and the date it was found. Data with this flag has been judged to be valid, but there is not 100% certainty given there is no way to tell on which date the gauge was knocked over.
T	Time shift has been detected and fixed.
A	Date stamp unreliable, thought to be corrected.
M	Missing period. There will always be two of these flags in a row, one to indicate the start date/time of the missing period, and the second to indicate the end. The amount in column 1 will stay the same.
O	Data are reliable.

The rain gauges have a reported accuracy of ±2% at 0-250 mm hr^{-1} precipitation rate and ±3% at 250-500 mm hr^{-1}. Errors in tipping bucket rain gauge measurements have been reported in Ciach, 2003, Tokay et al., 2010, and Wang et al., 2010.

Software

These data are in ASCII-csv format, so no software is required to view these data.

References

Ciach, Grzegorz (2003): Local random errors in tipping-bucket rain gauge measurements. *J. Atmos. Oceanic Technol.*, 20, 752-759. doi:https://doi.org/10.1175/1520-0426(2003)20%3C752:LREITB%3E2.0.CO;2

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Wang, J., and D. B. Wolff (2010): Evaluation of TRMM ground-validation radar-rain errors using rain gauge measurements. *J. Appl. Meteor. Climatol.*, 49, 310-24. doi: https://doi.org/10.1175/2009JAMC2264.1

Related Data

All data from other instruments collected during the IPHEx field campaigns are related to this dataset. Other IPHEx campaign data can be located using the GHRC HyDRO 2.0 search tool.

In addition, tipping bucket rain gauge instruments were used in previous GPM Ground Validation campaigns. The following datasets are tipping bucket rain gauge data from other field campaigns:

GPM Ground Validation Duke Rain Gauges **IPHEx**
(http://dx.doi.org/10.5067/GPMGV/IPHEX/GAUGES/DATA202)

GPM Ground Validation Iowa Flood Center (IFC) Rain Gauges **IFloodS**
(http://dx.doi.org/10.5067/GPMGV/IFLOODS/GAUGES/DATA/101)

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Barros, A.P., Miller, D., Wilson, A.M., Cutrell, G., Arulraj, M., Super, P., Petersen, W.A. (2017). IPHEx-Southern Appalachian Mountains -- Rainfall Data 2008-2014. Duke Digital Repository. https://doi.org/10.7924/G8CJ8BJK

Contact Information

To order these data or for further information, please contact:
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>   Web: https://ghrc.nsstc.nasa.gov/

Created: November 27, 2017