



Data User Guide

GPM Ground Validation Duke Rain Gauges IPHEX

Introduction

The GPM Ground Validation Duke Rain Gauge data were collected during the GPM Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEX) field campaign which was held in the Southern Appalachian region, including the Piedmont and Coastal Plain regions of North Carolina. TB3 Model Tipping Bucket rain gauges collected precipitation data from May 1, 2014 through June 15, 2014. The IPHEX campaign was designed to characterize warm season orographic precipitation regimes and determine the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The rain gauge data are available in ASCII-csv (comma separated) format for each of the rain gauge locations.

Citation

Barros, Ana P. 2017. GPM Ground Validation Duke Rain Gauges IPHEX [indicate subset used]. Dataset available online from the NASA Global Hydrometeorology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi:

<http://dx.doi.org/10.5067/GPMGV/IPHEX/GAUGES/DATA202>

Keywords:

NASA, GHRC, GPM GV, IPHEX, North Carolina, Rain Gauge, Precipitation, Tipping Bucket, cumulative rainfall amount

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 [The Global Precipitation Measurement Mission \(GPM\) | NASA Global Precipitation Measurement Mission](#).

One of the GPM-GV field campaigns was the GPM 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-GV 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 [IPHEX: Integrated Precipitation and Hydrology Experiment](#).

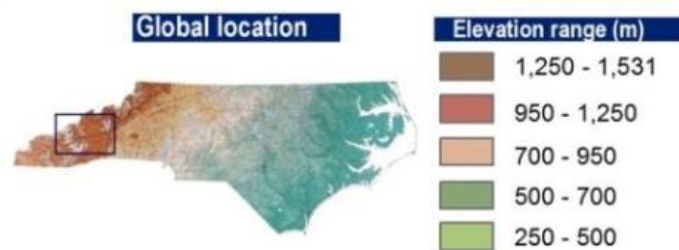


Figure 1: Region of North Carolina IPHEX campaign ground validation (image source: [GPM Ground Validation Data Archive](#))

Instrument Description

The TB3 Model Tipping Bucket rain gauge, manufactured by HyQuest Solutions, measures the amount of fallen precipitation entering the gauge orifice in increments of 0.1mm, 0.2mm, and 1.0mm. The gauge has a 20cm diameter receiver that is a powder coated, heavy duty cast aluminum. When 0.2mm of precipitation is collected, the tipping bucket assembly tips, draining the collection and recording the data. Figure 2 shows the locations of the Duke rain gauges in pink circles. More information about the TB3 Model Tipping Bucket rain gauge can be found at [INSTRUCTION MANUAL TIPPING BUCKET RAINGAUGE MODEL TB3](#).

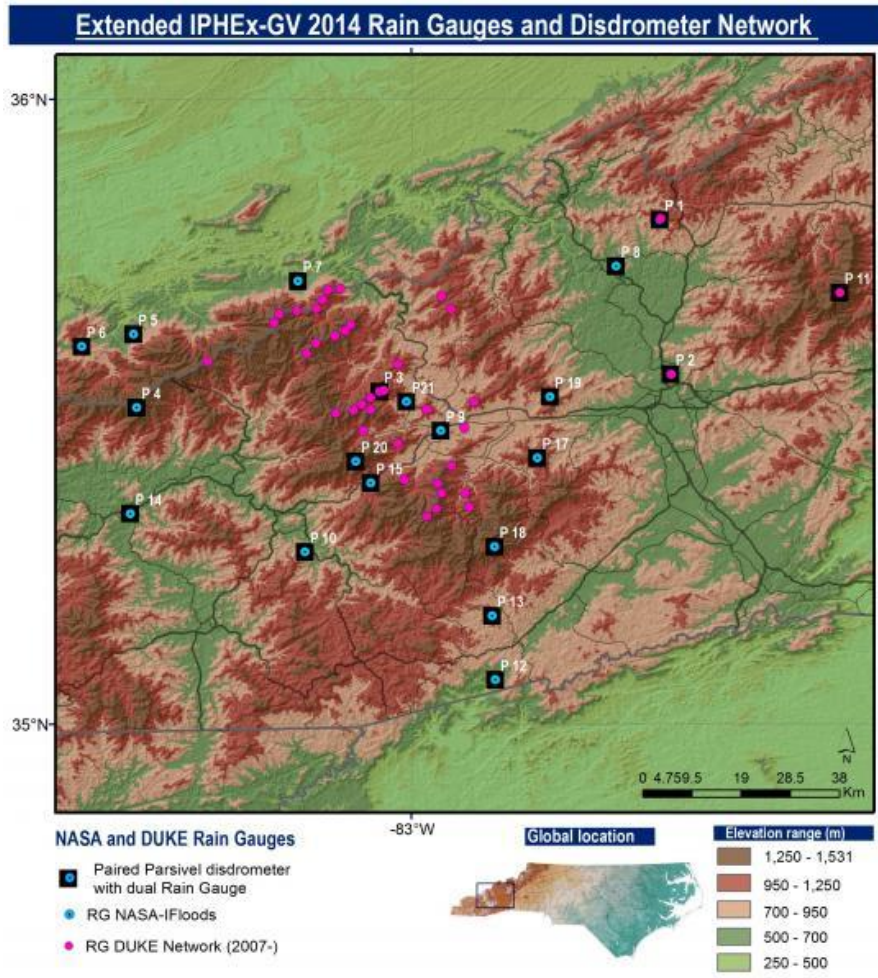


Figure 2: Locations of Duke rain gauges in pink circles during IPHEX (image source: [Instrumentation and sensors | IPHEX: Integrated Precipitation & Hydrology Experiment](#))

Investigators

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File Naming Convention

The GPM Ground Validation Duke Rain Gauges IPHEX dataset consists of ASCII-csv files. The files are in the following naming convention:

Data: iphex_Duke_rain_gauge_PMM-###-PROCESSED-<start date>-<end date>-L1.csv

Table 1: File naming convention variables

Variable	Description
###	Gauge number
<start date>	YYYYMMDD YYYY: Four-digit year MM: Two-digit month DD: Two-digit day
<end date>	YYYYMMDD YYYY: Four-digit year MM: Two-digit month DD: Two-digit day
.csv	ASCII comma separated file format

Data Format Description

The GPM Ground Validation Duke Rain Gauges IPHEX data consists of ASCII files. Each file contains no header lines, but only contains approximately 46 days of cumulative rainfall data for each station.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	TB3 Model Tipping Bucket rain gauge (TB03/0.2)
Spatial Coverage	Each station is at a specific geographic location, collectively the data set covers a region throughout North Carolina defined by N: 35.888 S: 35.368 E: -82.271 W: -83.371
Spatial Resolution	Point
Temporal Coverage	Start date: May 1, 2014 Stop date: June 15, 2014
Temporal Resolution	Cumulative rain total for each day (46 days total per file) - divided up by rain gauge/location
Sampling Frequency	varies
Parameter	Cumulative rainfall amount
Version	1
Processing Level	1

Table 3: Format within the file

Column	Description
1	Cumulative rainfall amount in mm
2	Date DD-MMM-YY DD: Two-digit day MMM: Three-letter month YY: Two-digit year
3	Time hh:mm:ss hh: two-digit hour in EDT mm: two-digit minute in EDT ss: two-digit second in EDT
4	Quality Flag (more information below in 'Quality Assessment')

Data Parameters

GPM Ground Validation Duke Rain Gauges IPHEX dataset consists of cumulative rainfall amounts in mm which are located in the first column within the .csv file.

Quality Assessment

The rain gauges have a reported accuracy of $\pm 2\%$ at 0-250 mm hr⁻¹ and $\pm 3\%$ 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](#).

Table 4: Quality Flag Detail

Quality Flag	Description
C	Clogged gauge (i.e., standing water was found in the gauge top). This flag will be placed on all data between the last visit and the date it was found in this state.
K	Gauge was found knocked over. This flag will be 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 since there is no way to tell on which date the gauge was knocked over.
T	Time shift has been detected or described here and fixed.
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 the cumulative rainfall column within the file will stay the same.
0	Data have not failed any of the quality checks described above.

References

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Ciach, 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<752:LREITB>2.0.CO;2](https://doi.org/10.1175/1520-0426(2003)20<752:LREITB>2.0.CO;2)

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Related Data

All other data collected during the IPHEX field campaign is considered related data. IPHEX data can be located using the GHRC HyDRO search tool with the search term "IPHEX". In addition, the rain gauges were used in other GPM Ground Validation field campaigns. Datasets from other campaigns can be located by using the search term "rain gauge".

Contact Information

To order these data or for further information, please contact:
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 User Services
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 Huntsville, AL 35805
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 Web: <https://ghrc.nsstc.nasa.gov/>