GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx

Introduction

The GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx dataset consists of cloud and light precipitation radar observations gathered during the Global Precipitation Measurement (GPM) mission Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEx) Intensive Observing Period (IOP) in North Carolina from May 1 through June 15, 2014. The goal of IPHEx was to evaluate the accuracy of satellite precipitation measurements and use the collected data for hydrology models in the region. The dataset includes data from the ProSensing 95 GHz W-band cloud radar, which is part of the NASA Goddard Space Flight Center (GSFC) Aerosol, Cloud, Humidity, Interactions Exploring and Validating Enterprise (ACHIEVE) ground-based mobile laboratory. The W-band cloud radar is a scanning 95 GHz dual-polarization (horizontal transmission and co- and cross-polar receiving) Doppler radar used for observing liquid and ice clouds and light precipitation. The instrument measures co- and cross-polar reflectivity, radial velocity, Doppler spectrum width, and signal-to-noise ratio. Linear depolarization ratio was derived from the measured parameters. During the IPHEx campaign, the W-Band radar was used exclusively in vertical-pointing mode. The dataset files are available from May 9 through June 14, 2014 in netCDF-3 data format.

Notice:
Use of this data for publication is prohibited without proper reference and/or offer of co-authorship, or with expressed permission. Data with 50 m spatial resolution have not yet had post-mission calibration factors applied and will be uploaded at a later date.

Citation

Tsay Si-Chee, Adrian Loftus and Peter Pantina. 2016. GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx [indicate subset used]. Dataset available online from the NASA

Keywords:

GHRC, NASA, GPM GV, IPHEx, ACHIEVE, North Carolina, Doppler radar, polarimetric radar, W-band, co-polar reflectivity, cross-polar reflectivity, radial velocity, Doppler spectrum width, signal-to-noise ratio, linear depolarization ratio, liquid cloud, ice cloud, precipitation

Campaign

The NASA Global Precipitation Measurement (GPM) mission Ground Validation (GV) 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 GV mission. More information about the GPM GV mission is available at the PMM Ground Validation webpage.

One of the GPM GV 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 on the GPM IPHEx Field Campaign webpage, the GHRC IPHEx Field Campaign project homepage, and in the GHRC IPHEx Field Campaign micro article.
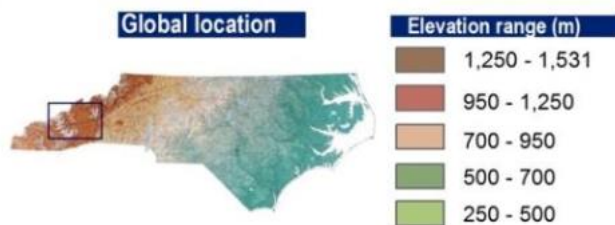

Figure 1: Region of North Carolina IPHEx campaign ground validation
(Image source: IPHEx Science Plan)

Instrument Description

The ProSensing 95 GHz W-band cloud radar (Figure 2) is a dual-polarization Doppler radar. This instrument scans horizontally and receives co- and cross-polarized signals. The instrument observes liquid and ice clouds and light precipitation, and was exclusively used in the vertical-pointing mode for IPHEx intensive observation period. Details on the ProSensing 95 GHz W-band cloud radar are available on the Prosensing Zenith Pointing W-band Cloud Radars webpage. Descriptions for a similar 95 GHz dual-polarization radar system are given in Pazmany et al. (1994).

Figure 2: A ProSensing zenith pointing transportable W-band cloud radar
(Image source: ProSensing W-band cloud radar webpage)

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Data Characteristics

The GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx dataset consists of co- and cross-polar reflectivity, radial velocity, Doppler spectrum width, signal-to-noise ratio, and linear depolarization ratio data from clouds and light precipitation observed by the ProSensing 95 GHz W-band cloud radar. The data are available in netCDF-3 format with a data processing level of 1B. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	ProSensing 95 GHz W-band cloud radar
Spatial Coverage	N: 35.56 , S: 35.48, E: -83.04, W: -83.18 (North Carolina)
Spatial Resolution	Primarily at 25 m resolution, although depending on sky conditions, resolution is switched to 50 m
Temporal Coverage	May 9, 2014 - June 14, 2014
Temporal Resolution	Hourly -< Daily
Sampling Frequency	1.15 seconds
Parameters	co-polar reflectivity (ZH), cross-polar reflectivity (ZX), radial velocity (VEL), Doppler spectrum width (SW), signal-to-noise ratio (SNR), linear depolarization ratio (LDR)
Version	Intermediate version - post-mission calibration applied to reflectivity values
Processing Level	1B

File Naming Convention

The GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx dataset files are named with the following convention:

Data: IPHEx_ACHIEVE_WBAND_<start time>Z_to_<end time>Z_dR25m.nc

Table 2: File naming convention variables

Variable	Description
<start time>	Start time in *YYYYMMDD_hhmmss* where: YYYY: Four-digit year MM: Two-digit month DD: Two-digit day hh: Two-digit hour in UTC (Z) mm: Two- digit minute in UTC (Z) ss: Two-digit second in UTC (Z)

	End time in *YYYYMMDD_hhmmss* where: YYYY: Four-digit year MM: Two-digit month DD: Two-digit day hh: Two-digit hour in UTC (Z) mm: Two- digit minute in UTC (Z) ss: Two-digit second in UTC (Z)
<end time>	
.nc	netCDF-3 data file format

Data Format and Parameters

The GPM Ground Validation ACHIEVE W-band Cloud Radar IPHEx dataset consists of co- and cross-polar reflectivity, radial velocity, Doppler spectrum width, signal-to-noise ratio, and linear depolarization ratio data stored in netCDF-3 format. Table 3 lists and describes the data fields contained in each file.

Table 3: W-band Cloud Radar netCDF-3 File Data Field Descriptions

Field Name	Description	Data Type	Unit
altitude	Altitude	double	m
azimuth	Azimuth angle from true north	float	deg
dBZ	Horizontal co-polar equivalent reflectivity factor (ZH)	float	dBZ
dBZvx	Vertical cross-polar equivalent reflectivity factor (ZX)	float	dBz
elevation	Elevation angle from the horizontal plane	float	deg
fixed_angle	Fixed angle	float	deg
latitude	Latitude	double	deg
LDR	Linear depolarization ratio v over h (LDR)	float	dB
longitude	Longitude	double	deg
platform_type	Platform type	char	-
range	Range to measurement volume	float	m
SNRHC	Signal-to-noise ratio (SNR) co-polar h	float	dB
sweep_end_ray_index	Sweep end ray index	int	-
sweep_mode	Sweep mode	char	-
sweep_number	Sweep number	int	-
sweep_start_ray_index	Sweep start ray index	int	-
time	Time since volume start	float	seconds
time_coverage_end	Time coverage end	char	-
time_coverage_start	Time coverage start	char	-

VEL	Radial velocity of scatterers away from instrument (VEL)	float	m/s
volume_number	Volume number	int	-
WIDTH	Doppler spectrum width (SW)	float	m/s

Algorithm

The linear depolarization ratio (LDR) is derived from horizontally polarized and vertically polarized radar returns. More information about the LDR derivation algorithm for a W-band polarimetric radar can be found in Galloway et al. (1997).

Quality Assessment

To continually obtain accurate measurements, instrument calibration is maintained. The W-band cloud radar undergoes relative and absolute calibration procedures that are described in the W-band ARM Cloud Radar - Specs and Design documentation.

Software

The W-band cloud radar netCDF-3 data files do not require special software to open and view. The NASA Panoply Data Viewer can be used to easily open and view the data.

Known Issues or Missing Data

Use of this data for publication is prohibited without proper reference and/or offer of co-authorship, or with expressed permission. Data with 50 m spatial resolution have not yet had post-mission calibration factors applied and will be uploaded at a later date.

References

Barros, A. P., Petersen, W. A., Schwaller, M., Cifelli, R., Mahoney, K., Peters-Liddard, C., Shepherd, M., Nesbitt, S., Wolff, D., & Heymsfield, G. (2014). *NASA GPM-Ground Validation Integrated Precipitation and Hydrology Experiment 2014 Science Plan*. https://gpm.nasa.gov/sites/default/files/imce/IPHEX-Field%20Experiment%20Plan_Current.pdf

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Slant Linear Depolarization Ratio Mode. *Journal of Atmospheric and Oceanic Technology*, *29*, 989-1008. https://doi.org/10.1175/JTECH-D-11-00131.1

Pazmany, A. L., McIntosh, R. E., Kelly, R. D., & Vali, G. (1994). An airborne 95 GHz dual-polarized radar for cloud studies. *IEEE Transactions on Geoscience and Remote Sensing*, *32*, 731-739. https://doi.org/10.1109/36.298002

Related Data

All data from other instruments collected during the IPHEx field campaign are related to this dataset. Other IPHEx campaign data can be located by searching the term "IPHEx" in the GHRC HyDRO 2.0 search tool. Data from other W-band cloud radars can be found by searching the term "W-band cloud radar" or "W-band" in HyDRO 2.0 and are listed below.

GPM Ground Validation McGill W-Band Radar GCPEx
(http://dx.doi.org/10.5067/GPMGV/GCPEX/WBAND/DATA301)

GPM Ground Validation NASA W-band Airborne Cloud Radar (WACR) C3VP
(http://dx.doi.org/10.5067/GPMGV/C3VP/WACR/DATA101)

GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2
(http://dx.doi.org/10.5067/GPMGV/LPVEX/WCR/DATA101)

GPM Ground Validation Airborne Precipitation Radar 3rd Generation (APR-3) OLYMPEX V2
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/APR3/DATA201)

Cloud Radar System (CRS) IMPACTS
(http://dx.doi.org/10.5067/IMPACTS/CRS/DATA101)

GOES-R PLT Cloud Radar System (CRS)
(http://dx.doi.org/10.5067/GOESRPLT/CRS/DATA101)

GPM Ground Validation Cloud Radar System (CRS) OLYMPEX
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/CRS/DATA101)

GPM Ground Validation Cloud Radar System (CRS) IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/CRS/DATA101)

TCSP Cloud Radar System (CRS)
(http://dx.doi.org/10.5067/TCSP/CRS/DATA101)

Contact Information

To order these data or for further information, please contact:
        Global Hydrometeorology Resource Center
        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: 08/11/21