



Data User Guide

GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX

Introduction

The GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX data set contains radar reflectivity and doppler velocity measurements. The D3R was developed by a government-industry-academic consortium with funding from NASA's Global Precipitation Measurement (GPM) Project. It operates at the ku (13.91 GHz \pm 25 MHz) and ku (35.56 GHz \pm 25 MHz) frequencies covering a fixed range from 450 m to 39.75 km. The instrument's data are available in netCDF-4 format with browse imagery available in PNG format.

Citation

Chandrasekar, V. 2016. GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX [indicate subset used]. Dataset available online from the NASA Global Hydrometeorology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: <https://dx.doi.org/10.5067/GPMGV/IPHEX/D3R/DATA101>

Keywords:

NASA, GHRC, IPHEX, D3R, reflectivity, velocity, frequency, doppler velocity

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 validation effort entailed 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, 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 mission. More information about the GPM GV mission is available at the [PMM Ground Validation webpage](#).

The GPM Integrated Precipitation and Hydrology Experiment (IPHEX) was held in North Carolina during the months of April-June 2014. IPHEX seeks to characterize warm season orographic precipitation regimes, and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The IPHEX focus includes the development, evaluation and improvement of remote-sensing precipitation algorithms in support of the GPM mission through the 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 the [IPHEX Field Campaign webpage](#).

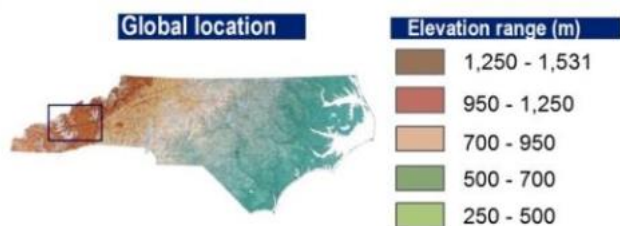


Figure 1: Region of North Carolina IPHEX campaign ground validation
(image source: <http://gpm-gv.gsfc.nasa.gov/Gauge/>)

Instrument Description

The Dual-frequency Dual-polarized Doppler Radar (D3R), developed with funding from NASA's Global Precipitation Measurement (GPM) Project, is a fully polarimetric, scanning weather radar system which provides estimations of hydrometeor classification and drop size distribution retrievals. The first generation D3R design comprises two separate co-aligned single-frequency antenna units mounted on a common pedestal with a dual-frequency dual-polarized solid-state transmitter. The D3R operates at the ku ($13.91 \text{ GHz} \pm 25 \text{ MHz}$) and ka ($35.56 \text{ GHz} \pm 25 \text{ MHz}$) frequencies covering a fixed range from 450 m to 39.75 km. These frequencies were selected for close compatibility with the GPM Dual-frequency Precipitation Radar (DPR) instrument onboard the GPM Core Observatory satellite.

More detailed information on the Dual-frequency Dual-polarized Doppler Radar is available at [Dual-frequency Dual-polarized Doppler Radar \(D3R\) D3R Documents](#), [SCIENTIFIC AND ENGINEERING OVERVIEW OF THE NASA DUAL-FREQUENCY DUAL-POLARIZED DOPPLER RADAR \(D3R\) SYSTEM FOR GPM GROUND VALIDAT](#), and [REALIZATION OF THE NASA DUAL-FREQUENCY DUAL-POLARIZED DOPPLER RADAR](#)

(D3R) Manuel Vega 1,3, James Carswell 2, V. Chandrasekar 1. The requirements document for Mobile Ka-/Ku-band Radar is available at [GVS KaKu Radar Description](#).



Figure 2: Image of D3R instrument

(image source: [D3R Radar at IPHEX | NASA Global Precipitation Measurement Mission](#))

Investigators

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Data Characteristics

The GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX dataset consists of reflectivity, Doppler velocity, signal-to-noise ratio, and spectral width data. These data are stored in netCDF-4 format and are available at a Level 1B processing level. 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 2.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	Dual-frequency Dual-polarized Doppler Radar (D3R)
Spatial Coverage	N: 35.19590, S: 35.19591, E: -81.9631, W: -81.9632 (North Carolina)
Spatial Resolution	450m-39.75km
Temporal Coverage	May 1, 2014 - June 15, 2014
Temporal Resolution	1 minute < 1 hour
Sampling Frequency	1 s
Parameter	Reflectivity, Doppler velocity, signal-to-noise ratio, spectral width, radial velocity
Version	1
Processing Level	1B

File Naming Convention

The GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX dataset files are stored in netCDF-4 format, while the browse imagery are available in PNG format, and named using the following convention:

Data files: iphex_d3r_[ka|ku]_YYYYMMDD_hhmmss_##.nc

Browse files: iphex_d3r_[ka|ku]_YYYYMMDD_hhmmss_##_[ppi|rhi]**_zbd.png

Table 2: File naming convention variables

Variable	Description
[ka ku]	Frequencies, ka or ku (13.91 GHz \pm 25 MHz and 35.56 GHz \pm 25 MHz, respectively)
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
##	Number of scan
.nc	netCDF-4 format
[ppi rhi]	ppi: plan position indicator rhi: range height indicator
**	Elevation angle
.png	Portable Graphics Format

Data Format and Parameters

The GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX dataset files are stored in netCDF-4 format. Each file contains one day of data, and the variables are listed in Table 4.

Table 3: D3R netCDF-4 data fields

Field Name	Unit
Azimuth	degrees
ClutterPowerH	dBu
ClutterPowerV	dBu
CopolarCorrelation	-
DifferentialPhase	degrees
DifferentialReflectivity	dB
Elevation	degrees
GateWidth	mm
GcfState	m/s
NoiseSourcePowerH_Short	dBu
NoiseSourcePowerH_Short	dBu
NormalizedCoherentPower	-
PolarizationMode	-
PRTMode	-
RawPower_H	dBu
RawPower_HV	dBu
RawPower_V	dBu
Reflectivity	dBZ
ReflectivityHV	dBZ
ReflectivityV	dBZ
RxGainH_Medium	dB
RxGainH_Short	dB
RxGainV_Medium	dB
RxGainV_Short	dB
Signal+Clutter_toNoise_H	dB
SignalPower_H	dBu
SignalPower_HV	dBu
SignalPower_V	dBu
SpectralWidth	m/s
StartGate	-
StartGate_Medium	-
StartGate_Short	-
StartRange	mm
Time	s
TxFrequency_Medium	Hz
TxFrequency_Short	Hz
TxLength_Medium	s

TxLength_Short	s
TxPhaseH_Medium	degrees
TxPhaseH_Short	degrees
TxPhaseV_Medium	degrees
TxPhaseV_Short	degrees
TxPowerH_Medium	dBm
TxPowerH_Short	dBm
TxPowerV_Medium	dBm
TxPowerV_Short	dBm
Velocity	m/s
ZDRBiasApplied_Medium	dB
ZDRBiasApplied_Short	dB

The PolarizationMode”, “PRTMode”, and “GcfState” variables give the flag values for the radar polarization, pulse repetition time (PRT), and ground clutter filter (Gcf). Tables 4-6 below describe each field’s flag values.

Table 4: “PolarizationMode” states

Flag Value	Description
0	Passive (no transmitter fired)
1	H only
2	V only
3	Alternate
4	Simultaneous
99	Error

Table 5: “PRTMode” states

Flag Value	Description
0	Uniform PRT
1	Staggered $\frac{2}{3}$ PRT

Table 6: “GcfState” states

Flag Value	Description
0	Off - No ground clutter filtered used
1	On - GMPTD ground clutter filtering enabled

Algorithm

One of the purposes of D3R in the GPM GV program was to provide validation for spaceborne radar precipitation measurements. Due to hardware limitations on space-based platforms, spaceborne radars have to operate at higher transmission frequencies. Therefore, the ka- and ku-band frequencies used by D3R provide valuable validation measurements for satellite retrieval algorithms. The use of these high frequencies requires additional modifications to standard retrieval methods. For example, D3R provides

ground-based statistics for raindrop size distribution (DSD) to help improve satellite DSD retrievals. However, the DSD retrieval algorithms using differential phase shift had to be adjusted for D3R because the instrument's ka- and ku- bands observe different precipitation signatures and are more affected by attenuation than the more common S- and C- band radars. More information about these algorithm adjustments can be found in [Chandrasekar et al. \(2010\)](#).

Quality Assessment

The GPM GV radars routinely undergo various calibration procedures to maintain system accuracy and performance including receiver and sphere calibration. More information on these calibration procedures can be found in [Chandrasekar et al. \(2015\)](#). For the D3R data, differential reflectivity bias and initial differential phase shift offset have been corrected and the corrected values can be found under the global attribute "Modified" in the netCDF-4 data files. The ground clutter filter was not enabled for this dataset and therefore ground clutter will be present in the results.

Software

No software is required to view these data; however, [Panoply](#) can be used to easily open and examine the data files

Known Issues or Missing Data

There are no known issues or missing data.

References

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Related Data

All other datasets collected as part of the IPHEX campaign are considered related and can be located by searching the term "IPHEX" in the GHRC [HyDRO2.0](#) search tool. The D3R instrument was used in other projects like the GPM Ground Validation project. These datasets are listed below:

GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) OLYMPEX (<http://dx.doi.org/10.5067/GPMGV/OLYMPEX/D3R/DATA101>)

GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IPHEX (<http://dx.doi.org/10.5067/GPMGV/IPHEX/D3R/DATA101>)

GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) IFloodS (<http://dx.doi.org/10.5067/GPMGV/IFLOODS/D3R/DATA101>)

GPM Ground Validation Dual-frequency Dual-polarized Doppler Radar (D3R) GCPEX (<http://dx.doi.org/10.5067/GPMGV/GCPEX/D3R/DATA101>)

Contact Information

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

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