Global Hydrology Resource Center

Data User Guide

GPM GROUND VALIDATION NASA S-BAND DUAL POLARIMETRIC (NPOL) DOPPLER RADAR IFLOODS V2

Introduction

The GPM Ground Validation NASA S-Band Dual Polarimetric (NPOL) Doppler Radar IFloodS dataset was collected from April 30 to June 16, 2013 near Traer, Iowa as part of the Global Precipitation Measurement (GPM) mission Iowa Flood Studies (IFloodS) campaign. Officially the IFloodS campaign ran from May 1 to June 15 but the NPOL Doppler radar was installed and calibrated prior to the start, allowing for the wider period of record. The NPOL radar, developed by a research team from Wallops Flight Facility, is a fully transportable and self-contained S-band (10 cm), scanning dual-polarimetric, doppler research radar that collected and operated nearly continuously during the IFloodS field campaign. It takes accurate volumetric measurements of precipitation including rainfall rate, particle size distributions, water content and precipitation type. The NPOL Doppler Radar IFloodS data is available in Universal Format (UF) with browse images available in PNG file format.

Notice:
The NPOL Doppler radar did not operate on May 12, 2013, therefore there is no data available for this date.

Citation

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Keywords:

NASA, GHRC, PMM, GPM GV, IFloodS, NPOL, Iowa, reflectivity, rainfall rate, particle size distribution, precipitation type, Doppler velocity, PPI, RHI, PPS

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 mission. More information about the GPM mission is available at the PMM Ground Validation webpage.

The Iowa Flood Studies (IFloodS) field campaign was a ground measurement campaign that took place in central-northeastern Iowa from May 1 to June 15, 2013. The main goal of IFloodS was to evaluate how well the GPM satellite rainfall data can be used for flood forecasting. Specifically, this meant collecting detailed measurements of precipitation at the Earth's surface using ground instruments and advanced weather radars while simultaneously collecting data from satellites passing overhead. The ground instruments were used to thoroughly characterize precipitation and contribute to improved satellite rainfall estimates; in particular, the improvement of algorithms that interpret raw data for the GPM mission's Core Observatory satellite. More information about IFloodS is available at the IFloodS Field Campaign webpage and more information about GPM's partner organization for this project, the Iowa Flood Center, is available on the Iowa Flood Center website.

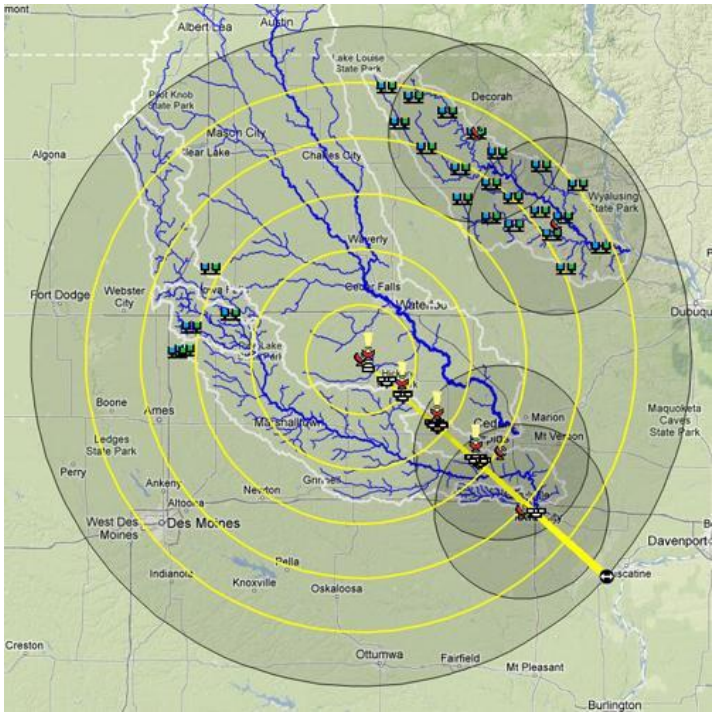

Figure 1: Areas of focus during the IFloodS campaign were the Cedar and Iowa River Basins, the South Fork Iowa River, and the Turkey River Basin in Northeast Iowa. The NPOL

radar is denoted by the red icon in the center of the image, with the radar coverage area denoted by the large circle encompassing most of the image.
(image source: PMM IFloodS webpage)

Instrument Description

The NASA S-Band Dual Polarimetric (NPOL) Doppler radar is a research grade S-band, scanning dual-polarimetric radar (Figure 2) which was located near Traer, Iowa (Lat: 42.268056, Lon: -92.509444) during the IFloodS campaign. The "dual-polarimetric" description means that the radar has the ability to transmit pulses at two orientations, horizontal and vertical. The "Doppler" means that the radar can produce velocity data from the return signal. These capabilities allow the NPOL Doppler radar to discern size, shape, and distribution of raindrops in clouds and their velocities. The NPOL is one of two completely transportable research-grade S-band systems in the world. It takes accurate volumetric measurements of precipitation including rainfall rate, particle size distributions, water contents and precipitation type. Three different radar scan types were used: Plan Position Indicator (PPI) where a 360 degree sweep of the antenna is made; PPI Sector (PPS) where the sweep of the antenna is limited to a specific azimuth range; and Range Height Indicator (RHI) in which scans point at a specific azimuth and the antenna tilts upward to get vertical profile information. More information about the NPOL instrument is available on the PMM NPOL webpage.

Figure 2: Image of the NPOL Doppler Radar
(Image source: PMM NPOL webpage)

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Data Characteristics

The GPM Ground Validation NPOL Doppler Radar IFloodS V2 data are available in UF format at level 1B processing level with browse images available in PNG file format. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. Information on programs available to read the UF files will be discussed later, in the "Software" section.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	NASA S-Band Dual Polarimetric (NPOL) Doppler Radar
Projection	n/a
Spatial Coverage	N: 43.17 , S: 41.33 , E: -91.23 , W: -93.85 (Iowa)
Spatial Resolution	125m - 300m
Temporal Coverage	April 30, 2013 - June 16, 2013
Temporal Resolution	Daily -< Weekly
Sampling Frequency	3-10 minutes
Parameter	Reflectivity, rainfall rate, particle size distribution, precipitation type, Doppler velocity
Version	2
Processing Level	1B

File Naming Convention

The GPM Ground Validation NPOL Doppler radar IFloodS V2 dataset includes data and browse image files. The data files are named with the following convention:

Tarred data files: ifloods_npol_YYYY_MMDD_[scan type].tar

Each unzipped .tar file contains a folder with the same filename as the .tar file. Within this folder is a folder with the name format "MMDD". Within this folder, there is a folder with

the name format "[scan type]". Within this folder are gzipped files with the following naming convention:

ifloods_npol1_YYYYMMDD_HHMMSS_uf.gz

Within these files is a folder with the same filename as the .gz file containing a Universal Radar Format (UF) file with the name format:

npol1_YYYYMMDD_HHMMSS.uf

This UF file requires special software to read it. More information is included in the "Software" section near the end of this document. Table 2 below describes the variables included in the data file names.

Table 2: File naming convention variables for data files

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
HHMMSS	Time of the data in HHMMSS where: HH = two-digit hour in UTC MM = two-digit minute in UTC SS = two-digit second in UTC
[scan type]	Type of radar scan used: ppi = Plan Position Indicator pps = Plan Position Indicator Sector rhi = Range Height Indicator
uf	Universal format (binary)
.tar	Archive file type; will need to be extracted
.gz	Gzipped file; will need to be extracted

The GPM Ground Validation NPOL Doppler radar IFloodS V2 dataset browse image files are named with the following convention:

Browse files: ifloods_npol_images_YYYY_MMDD.gz

Note: The file name download link will display having the extension .tgz (a TAR archive file compressed using GNU zip software) in the GHRC directory but once downloaded will have a .gz extension.

Each unzipped .gz file contains a folder with the same name as the .gz file. This folder contains a file without an extension and is therefore labelled as a "File" file type . This file is compressed and will need to be unzipped. The unzipped file contains a folder with the following name format:

ifloods_npol_images_YYYY_MMDD~

Within this folder will be another folder with the name format “MMDD”. Inside this folder will be a set of folders with names indicating various image types. The coded folder names may include:

CZ: Quality-controlled reflectivity
DR: Differential reflectivity
KD: Specific differential phase
PH: Total differential phase
RH: Correlation coefficient
SD: Standard deviation of PH
SQ: Signal Quality Index
VR: Doppler velocity
ZZ: Uncorrected reflectivity (no quality control)

Within each coded folder type will be the respective images captured on that particular date. These browse images are named with the following convention:

ifloods_npol1_YYYYMMDD_HHMMSS_[image type]_###.#AZ_[scan type].png
ifloods_npol1_YYYYMMDD_HHMMSS_[image type]_sw##_[scan type].png

Table 3 below describes the variables included in the browse image file names.

Table 3: File naming convention variables for browse image files

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
HHMMSS	Time of the image in HHMMSS where: HH = two-digit hour in UTC MM = two-digit minute in UTC SS = two-digit second in UTC
[image type]	Type of image: CZ, DR, KD, PH, RH, SD, SQ, VR, ZZ
###.#AZ	Azimuth (only for RHI images; see note below)
sw##	Elevation angle (only for PPI and PPS; see note below)
[scan type]	Type of radar scan used: ppi = Plan Position Indicator pps = Plan Position Indicator Sector rhi = Range Height Indicator
.gz	Gzipped file; will need to be extracted
.png	Portable Network Graphics image file type

Note: For a PPI scan, "sw00" is the base sweep at 0.70 degrees elevation angle; "sw01" is the next elevation angle at 1.40 degrees. For PPS sweeps, there are different elevation

angles depending upon which sector was being scanned; the specific elevation angles are noted on each image. RHI images are defined by the specific azimuth.

Data Format and Parameters

The GPM Ground Validation NASA S-Band Dual Polarimetric (NPOL) Doppler Radar IFloodS data are available in UF file format; browse images are also available in PNG image format. The NPOL instrument takes accurate volumetric measurements of precipitation including rainfall rate, particle size distributions, water contents and precipitation type. The data fields cover various parameters including radar reflectivity, Doppler velocity, rain rate, and co-polar correlation.

Table 4: Data Fields for NPOL data files

Parameter	Acronym	Unit
Radar Reflectivity	ZZ	dBz
Corrected Radar Reflectivity	CZ	dBz
Co-polar Correlation	RH	-
Differential Reflectivity	DR	dB
Differential Phase	PH	degrees
Specific Differential Phase	KD	degrees/km
Spectrum Width	SW	m/s
Signal Quality Index	SQ	-
Doppler Velocity	VR	m/s
Hydrometeor Identification (see Table 5)	FH	-
Normalized Intercept Parameter (DM)	NW	-
Median Volume Diameter	D0	mm
Normalized Intercept Parameter (D0)	N2	-
DROPS2 Rain Rate	RR	mm/h
Pol ZR Rain Rate	RP	mm/h
Cifelli 2002 Rain Rate	RC	mm/h

Table 5: Hydrometeor Identification Classifications

Classification	Acronym
Unclassified	UC
Drizzle	DZ
Rain	RN
Ice Crystals	CR
Dry Snow	DS
Wet Snow	WS
Vertically-aligned Ice	VI
Low-density Graupel	LDG
High-density Graupel	HDG
Hail	HA
Big Drops	BD

Algorithm and Quality Assessment

The dual-polarization quality control (DPQC) algorithm is used for quality control of the NPOL Doppler radar data. The DPQC algorithm outputs quality controlled radar structure, radar fields, and a parameter file. More information on the DPQC algorithm is available in Pippitt, Marks, and Wolff (2013). The NASA NPOL Doppler Radar calibrates as it is collecting data. More information about the calibration process and data quality can be found in Chandrasekar et al., 2008.

Software

The UF format is the common Doppler radar data exchange format, described at UCAR (document based on a 1980 BAMS publication). Special software is required to read the UF files. There are free decoder programs available to read UF data on the NOAA Radar Decoding Utilities webpage. Some of these options are listed in Table 6 below. Code for reading UF files with IDL is available at GHRC.

Table 6: Software/Tool Information Table

Name	Type	Access	Software	License
Department of Energy (DOE) Py-ART	Plotting, conversion, analysis	Download	Python 2.6 or 2.7	Open source
UCAR Radx C++ Library	Conversion, analysis	Download	C++	Open source
NASA Radar Software Library	Visualization, conversion, analysis	Download	C	Open source
SSEC McIDAS-V	Visualization, analysis	Download	Java or Java-3D	Open source

Known Issues or Missing Data

The NPOL Doppler radar did not operate on May 12, 2013, therefore there is no data available for this date.

References

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Related Data

The full list of IFloodS campaign data can be located using Hydro2.0 and searching 'IFLOODS'. The complete IFloodS data collection is available here. The following datasets are from other GPM GV field campaigns and sites that used the NPOL Doppler Radar.

GPM Ground Validation NASA S-Band Dual Polarimetric (NPOL) Doppler Radar OLYMPEX V2
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/NPOL/DATA301)

GPM Ground Validation NASA S-Band Dual Polarimetric (NPOL) Doppler Radar IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/NPOL/DATA101)

GPM Ground Validation NASA S-band Dual Polarimetric (NPOL) Doppler Radar MC3E
(http://dx.doi.org/10.5067/GPMGV/MC3E/NPOL/DATA101)

GPM Ground Validation NASA S-Band Dual-Polarimetric (NPOL) Doppler Radar Wallops Flight Facility (WFF)
(http://dx.doi.org/10.5067/GPMGV/WFF/NPOL/DATA101)

Contact Information

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

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