Global Hydrology Resource Center

Data User Guide

GPM Ground Validation NEXRAD Level III IFloodS

Introduction

The NEXt Generation Weather RADar system (NEXRAD) Level III IFloodS datasets contain precipitation products derived from selected NEXRAD radars in operation during the Iowa Flood Studies (IFloodS) field campaign to help support the ground validation of the Global Precipitation Measurement (GPM). NEXRAD is a network of 160 stationary S-Band radars dispersed throughout the United States and select locations abroad. Data were gathered from four NEXRAD stations in the vicinity of the IFloodS campaign during March 29, 2013 through June 18, 2013. The NEXRAD Level III IFloodS dataset contains data files of digital instantaneous precipitation rate (DPR) and storm total accumulation estimates (DTA) in NIDS binary format.

Notice: These data were downloaded from the NOAA website during the IFloodS field campaign, which can result in missing data. For a complete archive of data from each station, please utilize the NOAA archives at Amazon Web Services and Open Common Consortium. See the NOAA website for more information.

Citations:

This user guide covers 4 datasets. Each dataset contains DTR and DPR data files from a specific NEXRAD instrument location. Use the appropriate citation listed below. There is a DOI for each individual station. More information about the instrument is available in this guide.

GPM Ground Validation NEXRAD Level III KARX IFloodS

Unidata and NWS Radar Operations Center. 2018. GPM Ground Validation NEXRAD Level III KARX IFloodS [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/IFLOODS/NEXRAD/DATA201

GPM Ground Validation NEXRAD Level III KDMX IFloodS

Unidata and NWS Radar Operations Center. 2018. GPM Ground Validation NEXRAD Level III KDMX IFloodS [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/IFLOODS/NEXRAD/DATA401

GPM Ground Validation NEXRAD Level III KDVN IFloodS

Unidata and NWS Radar Operations Center. 2018. GPM Ground Validation NEXRAD Level III KDVN IFloodS [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/IFLOODS/NEXRAD/DATA301

GPM Ground Validation NEXRAD Level III KMPX IFloodS

Unidata and NWS Radar Operations Center. 2018. GPM Ground Validation NEXRAD Level III KMPX IFloodS [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/IFLOODS/NEXRAD/DATA501

Keywords:

NASA, GHRC, GPM, NWS, IFloodS, Iowa, radar reflectivity, precipitation rate, NEXt generation RADar, NEXRAD Level III, storm total accumulation, DTR, DPR

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. More information about the GPM mission is at https://pmm.nasa.gov/GPM/.

The Iowa Flood Studies (IFloodS) was a ground measurement campaign that took place throughout 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 and simultaneously collecting data from satellites passing overhead. The ground instruments characterize precipitation – the size and shape of raindrops, the physics of ice and liquid particles throughout the cloud and below as it falls, temperature, air moisture, and distribution of different size droplets – to

improve rainfall estimates from the satellites, and in particular the algorithms that interpret raw data for the GPM mission's Core Observatory satellite, which launched in 2014. More information about IFloodS is available at https://ghrc.nsstc.nasa.gov/home/field-campaigns/ifloods.
Additional information about the Iowa Flood Center is available at http://iowafloodcenter.org/.

Instrument Description

The NEXt generation RADar(NEXRAD) system consists of 160 Weather Surveillance Radar-1988 Doppler (WSR-88D) sites located throughout the United States, as well as some select oversea locations (Figure 1). The system is jointly operated and maintained by the Department of Commerce, Department of Defense, and the Department of Transportation; however, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) is the civilian agency responsible for general operations (OFCM, 2016).

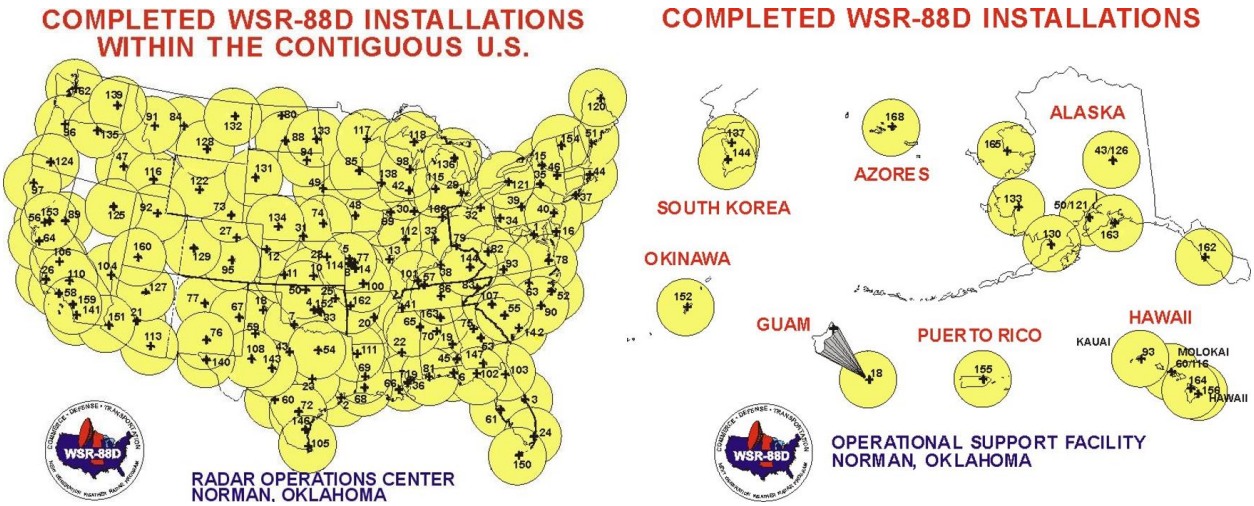

Figure 1: Location of WSR-88D NEXRAD radar stations.
Image source: (https://www.roc.noaa.gov/WSR88D/Maps.aspx)

NEXRAD is a 10 cm wavelength (S-Band) Doppler ground station radar with systems that operate within a range of 2,700 - 3,000 MHz (Figure 2). There are two scan modes for each station. Mode A is a fast tracking scan that is designed to detect different types of precipitation during active weather events. Mode B is a slow-scanning mode for clearer weather used for observing air movements when there is little to no precipitation (NOAA National Center for Environmental Information, 2017). The NEXRAD radar stations collect data in a 360 degree swath, with the radar location at the center, at several predetermined elevation angles at specific periods of time. Most data products are generated from radar scan times of 4.5, 5, 6, and 10 minute periods. There are several products generated from NEXRAD, both from base data moments and dual polarization variables. These include base reflectivity, mean radial velocity, and spectrum width. Dual polarization variables include differential reflectivity, correlation coefficient, and differential phase (OFCM, 2016).

Data coverage can vary by station but overall NEXRAD data are available from the mid-1990s to the present with nearly continuous archived data.

Figure 2: Image of NEXRAD radar site with antenna tower and radome.
Image Source: (https://www.ll.mit.edu/mission/aviation/faawxsystems/nexrad.html)

More information about the WRS-88D NEXRAD system can be found in the Federal Meteorological Handbooks at the Office of the Federal Coordinator for Meteorological Services and Supporting Research (http://www.ofcm.gov/publications/fmh/allfmh2.htm) as well as from NOAA's Nationa Center for Environmental Information (NCEI) site located at NOAA (https://www.ncdc.noaa.gov/data-access/radar-data/nexrad).

This user guide describes NEXRAD Level III data collected from the NEXRAD website for use in the IFloodS field campaign. There were four NEXRAD radar stations in operation during the campaign and within the IFloodS study area. Table 1 contains the names and locations of the four stations. More information about the NEXRAD Level III data is available on the NOAA website.

Table 1: NEXRAD Level III IFloodS stations

Station Name	Location
KARX	La Crosse, Wisconsin 43.823, -91.191
KDMX	Des Moines, Iowa 41.731, -93.723
KDVN	Davenport, Iowa 41.612, -90.581
KMPX	Minneapolis, Minnesota 44.849, -93.566

Data Providers

Unidata - Data Services and Tools for the Geosciences

https://www.unidata.ucar.edu/data/index.html#levelIII

NWS Radar Operations Center
https://www.roc.noaa.gov/wsr88d/Level_III/Level3Info.aspx

Data Characteristics

These GPM Ground Validation NEXRAD Level III IFloodS datasets consist of precipitation rate estimates in NIDS binary format. Each dataset contains data files from one NEXRAD radar station located within the IFloodS study area. Temporal resolution may vary from file to file, but in general show the precipitation rate estimates for 10 minutes or less. These data files are considered Level 3 products. More information about the NASA data processing levels are available on the NASA Data Processing Levels website.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground Stations
Instrument	NEXt generation RADar (NEXRAD)
Projection	n/a
Spatial Coverage	**KARX:** N: 44.272, S: 43.374, E: -90.742, W: -91.640 **KDMX:** N: 42.180, S: 41.282, E: -93.274, W: -94.172 **KDVN:** N: 42.063, S: 41.164, E: -90.146, W: -91.044 **KMPX:** N: 45.298, S: 44.400, E: -93.116, W: -94.014 with a 50 km spatial range from NEXRAD radar station
Spatial Resolution	1 km
Temporal Coverage	March 29, 2013 - June 18, 2013
Temporal Resolution	<10 minutes
Sampling Frequency	<1 second
Parameter	Radar reflectivity, precipitation rate, total precipitation
Version	1
Processing Level	3

File Naming Convention

The GPM Ground Validation NEXRAD Level III IFloodS datasets contain two sets of NIDS binary format data files, each representing a specific Level-3 product: digital instantaneous precipitation rate estimates (DPR) and storm total accumulation estimates (DTA).

Data files: ifloods_Level3_<station>_<type>_YYYYMMDD_hhmm.nids

Table 3: File naming convention variables

Variable	Description
<station>	**KARX** - La Crosse, Wisconsin

	Latitude:43.823, Longitude: -91.191 **KDMX -** Des Moines, Iowa Latitude: 41.731, Longitude: -93.723 **KDVN-** Davenport, Iowa Latitude: 41.612, Longitude: -90.581 **KMPX -** Minneapolis, Minnesota Latitude: 44.849, Longitude: -93.566
<type>	**DPR**: digital precipitation rate estimates **DTA**: storm total accumulation estimates
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
hh	Two-digit hour in UTC
mm	Two-digit minute in UTC
.nids	NIDS binary NEXRAD radar format. More information about this data format is available at http://weather.unisys.com/wxp/Appendices/Formats/NIDS.html.

Data Format and Parameters

There are two NEXRAD Level-III data products for each station: digital precipitation rate estimates (DPR) and storm total precipitation accumulation estimates (DTA).

Digital Precipitation Rate (DPR/176) (Dual-Pol. only)
This product displays the instantaneous precipitation rate using the dual-polarization Quantitative Precipitation Estimation (QPE) algorithm. Table 4 describes the data fields in DPR files.

Storm Total Precipitation (DTA/172) (Dual-Pol. only) The Storm Total precipitation accumulation is provided on a .13 nm x 1 degree grid. The dual-polarization QPE algorithm is used and 256 possible data levels are available.

Table 4: Data Fields in DPR files

Field Name	Description	Data Type	Unit
altitude	Altitude above mean sea level	float	m
azimuth	Azimuth angle: 0 = true north 90 = east	float	degrees
DigitalInstantaneousPrecipitationRate	Digital Instantaneous Precipitation Rate	float	in/hr

DigitalInstantaneousPrecipitationRate_RAW	Raw Digital Instantaneous Precipitation Rate	short	in/hr
elevation	Elevation angle: 0 = parallel to pedestal base 90 = perpendicular to base	float	degrees
gate	Radial distance to the start of gate	float	m
latitude	Latitude of instrument	float	degrees
longitude	Longitude of instrument	float	degrees
rays_time	Rays time	double	Milliseconds since 1970-01-01 00:00 UTC

Algorithm

These data products were derived from NEXRAD Level-II measurements using the NEXRAD Dual-Polarization (DP) Quantitative Precipitation Estimation (QPE) algorithm, which was developed and tested based on data collected during the Joint Polarization Experiment (JPOLE) that took place in central Oklahoma. The DP QPE algorithm identifies the most likely hydrometeor type sampled by the NEXRAD radar based on the top and bottom melting-layer boundaries. These hydrometeor classifications and the melting-layer positions are then used to specify the most appropriate relationship to convert DP variables into rainfall. For example, for light-moderate rain and heavy rain, rainfall rate is a function of reflectivity and differential reflectivity. The estimated rain rates are used to calculate the storm total accumulation. More information about the NEXRAD DP QPE algorithm is described in Cunha et al., 2015 and Giangrande and Ryzhkov, 2008.

Quality Assessment

The DP QPE algorithm uses the hydrometeor type and the melting-layer positions to specify the most appropriate relationship to convert NEXRAD measurements into rainfall. For example, for light-moderate rain and heavy rain, rainfall rate is a function of reflectivity and differential reflectivity. The quality of the base reflectivity products have undergone data quality assurance by NOAA prior to use in the QPE algorithm. Further data processing and product generation are performed as part of the DP QPE algorithm. More information about the methodology used to quality control the NEXRAD data are available in Cunha et al., 2015 and OFCM, 2017.

Software

These data are NIDS binary format data; therefore software is required to visualize these data. A list of software that can be used to visualize radar data can be found at NOAA's Display and Conversion Tools webpage.

Known Issues or Missing Data

In general for the NEXRAD system, occasional data gaps and missing data are common. Typical causes of missing data include scheduled maintenance of an individual radar, severe weather, communication problems, and data archiving issues.

References

Cunha, Luciana K., James A. Smith, Witold F. Krajewski, Mary Lynn Baeck, and Bong-Chul Seo (2015): NEXRAD NWS Polarimetric Precipitation Product Evaluation for IFloodS. *Journal of Hydrometeorology*, 16, 1676-1699. doi: https://doi.org/10.1175/JHM-D-14-0148.1

Giangrande, Scott E. and Alexander V. Ryzhkov, 2008: Estimation of Rainfall Based on the Results of Polarimetric Echo Classification. *Journal of Applied Meteorology and Climatology*, 47, 2445-2462. doi: https://doi.org/10.1175/2008JAMC1753.1

OFCM (2017): WSR-88D Meteorological Observations: Part C WSR-88D Products and Algorithms. https://www.ofcm.gov/publications/fmh/FMH11/fmh11partC.pdf

Related Data

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

Also, NEXRAD Level II IFloodS data are available from GHRC for IFloodS stations and can be found below:

GPM Ground Validation NEXRAD Level II KDVN IFloodS (http://dx.doi.org/10.5067/IFLOODS/NEXRAD/DATA203)

GPM Ground Validation NEXRAD Level II KDMX IFloodS (http://dx.doi.org/10.5067/IFLOODS/NEXRAD/DATA202)

GPM Ground Validation NEXRAD Level II KMPX IFloodS (http://dx.doi.org/10.5067/IFLOODS/NEXRAD/DATA204)

GPM Ground Validation NEXRAD Level II KARX IFloodS (http://dx.doi.org/10.5067/IFLOODS/NEXRAD/DATA201)

Contact Information

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

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Web: https://ghrc.nsstc.nasa.gov/

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