Global Hydrology Resource Center

Data User Guide

NEXRAD Mosaic IMPACTS Datasets

Introduction

The NEXRAD Mosaic IMPACTS datasets consist of Next Generation Weather Radar (NEXRAD) 3D mosaic files created from Level II surveillance data gathered during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign. IMPACTS was a three-year sequence of winter season deployments conducted to study snowstorms over the U.S. Atlantic Coast (2020-2022). The campaign aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. The Mosaic East dataset is composed of Level II data from 19 NEXRAD sites in the eastern U.S. and the Mosaic Midwest dataset is composed of Level II data from 11 NEXRAD sites in the midwestern U.S. (see Table 1). These data files are available in netCDF-4 format and contain meteorological and dual-polarization base data quantities including radar reflectivity, radial velocity, spectrum width, differential reflectivity, differential phase, and cross correlation ratio from January 1 through February 29, 2020. It should be noted that this dataset will be updated in subsequent years of the IMPACTS campaign.

Citation

Listed below are the citations for the NEXRAD Mosaic IMPACTS datasets:

NEXRAD Mosaic East IMPACTS

Brodzik, Stacy. 2020. NEXRAD Mosaic East IMPACTS [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/IMPACTS/NEXRAD/DATA201

NEXRAD Mosaic Midwest IMPACTS

Brodzik, Stacy. 2020. NEXRAD Mosaic Midwest IMPACTS [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/IMPACTS/NEXRAD/DATA202

Keywords:

NASA, GHRC, IMPACTS, NOAA, NWS, NEXRAD, KCLE, KDTX, KDVN, KGRB, KILN, KILX, KIND, KIWX, KLOT, KMKX, KVWX, KAKQ, KBGM, KBOX, KBUF, KCCX, KCXX, KDIX, KDOX, KENX, KFCX, KGYX, KJKL, KLWX, KMHX, KOKX, KPBZ, KRAX, KRLX, KTYX, NCAR

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2022) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020 and ended on March 1, 2020. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from NASA's Earth Science Project Office's IMPACTS field campaign webpage.

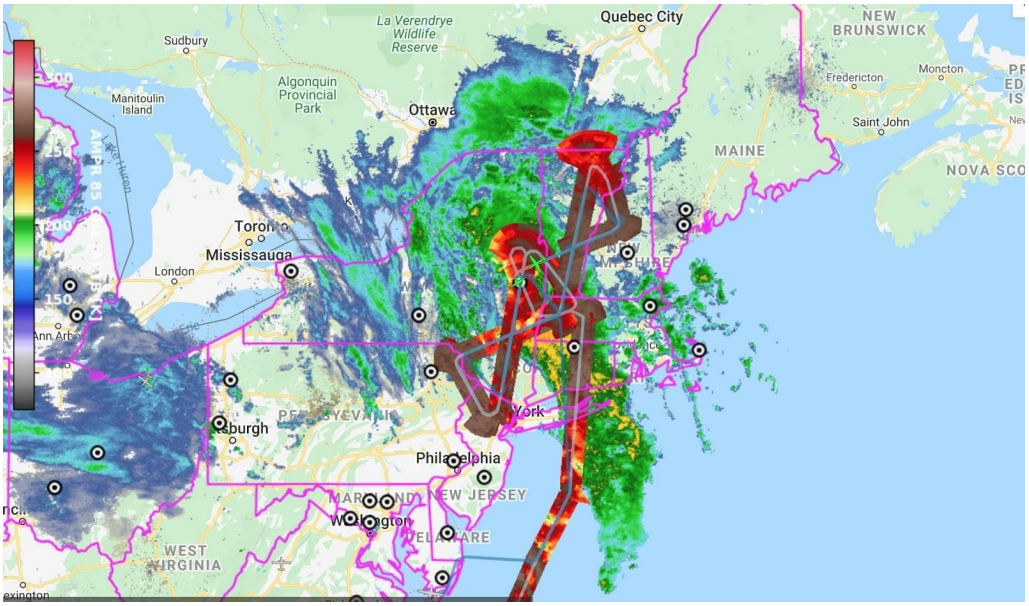

Figure 1: IMPACTS field campaign operations on January 25, 2020 with plots of ER-2 and P-3 flight tracks in addition to ground radar sites and radar reflectivity over the region (Image source: Dr. Timothy Lang, NASA MSFC)

Instrument Description

The Next-Generation Radar system (NEXRAD) consists of 160 Weather Surveillance Radar - 1988 Doppler (WSR-88) sites located throughout the United States and at select locations around the world (Figure 2). 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 responsible for general operations. The main purpose of NEXRAD is to provide real-time measurements of winds and precipitation, which improves weather forecasting; specifically the prediction of severe weather events.

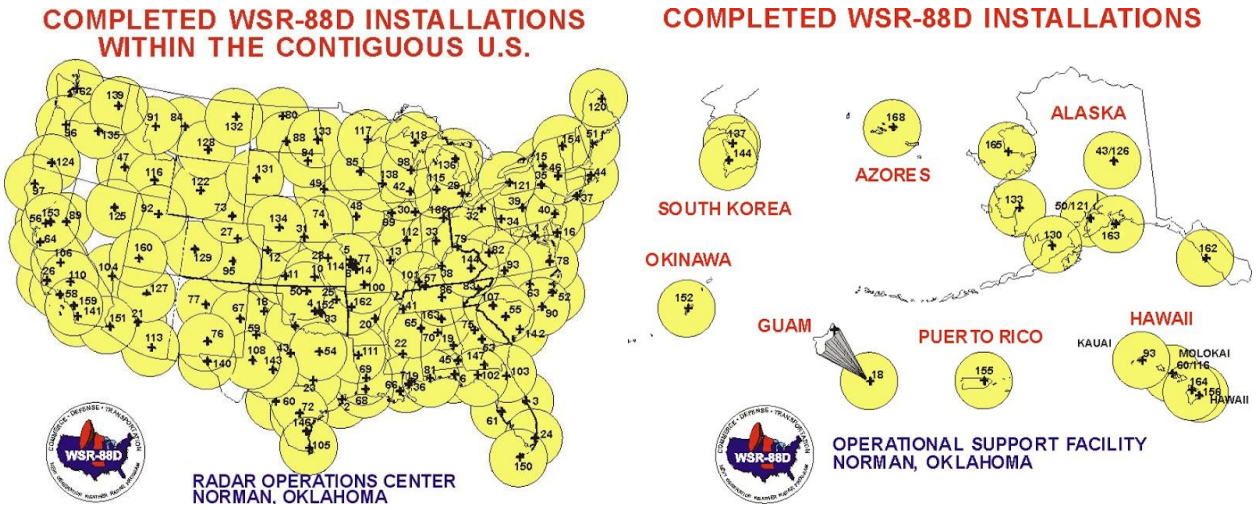

Figure 2: Location of WSR-88D NEXRAD radar stations.
(Image source: NWS Radar Operations Center)

NEXRAD is a 10 cm wavelength (S-Band) Dual-polarization Doppler ground station radar (Figure 3) with systems that operate within a range of 2,700 - 3,000 MHz. There are two scan modes for each station. Precipitation Mode is a fast tracking scan that is designed to detect different types of precipitation during active weather events. Clear Air Mode is a slow-scanning mode used for observing air movements when there is little to no precipitation. 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. The radars are continually scanning around each site to a radius of a few hundred kilometers. Most data products are generated from radar scan times of 4.5, 5, 6 and 10 minute periods. The radar's transmitter, receiver, and antenna are contained within the radar data acquisition (RDA) component of the system. The RDA samples the following parameters: reflectivity, radial velocity, spectrum width, differential reflectivity, differential phase, and correlation coefficient. NEXRAD has 250 m range resolution for reflectivity with a maximum range of 460 km, and 250 m range resolution for Doppler velocity and spectrum width with a maximum range of 300 km. The azimuthal resolution is 0.5 degree for reflectivity, velocity and spectrum width. Data coverage can vary by station but generally NEXRAD data are available from the mid-1990s to the present with nearly continuous archived data. These data can be accessed through the National Centers for Environmental Information.

Figure 3: Image of NEXRAD radar site with an antenna tower and radome.
(Image source: NOAA Photo Library)

The NEXRAD Mosaic IMPACTS datasets include data from 30 NEXRAD locations separated into the East and Midwest Mosaic groups listed in Table 1 below:

Table 1: IMPACTS NEXRAD Sites

Site Name	Location	Latitude	Longitude
3D Mosaic East			
KAKQ	Wakefield, VA	36.979	-77.004
KBGM	Binghamton, NY	42.196	-75.980
KBOX	Boston, MA	41.951	-71.133
KBUF	Buffalo, NY	42.944	-78.732
KCCX	State College, PA	40.918	-77.999
KCXX	Burlington, VT	44.506	-73.161
KDIX	Mt. Holly, NJ	39.942	-74.406
KDOX	Dover AFB, DE	38.821	-75.435
KENX	Albany, NY	42.581	-74.059
KFCX	Blacksburg, VA	37.019	-80.269
KGYX	Portland, ME	43.886	-70.252
KJKL	Jackson, KY	37.586	-83.308
KLWX	Sterling, VA	38.970	-77.473
KMHX	Newport/Morehead, NC	34.772	-76.872
KOKX	Upton, NY	40.861	-72.859
KPBZ	Pittsburgh, PA	40.526	-80.213
KRAX	Raleigh/Durham, NC	35.661	-78.486
KRLX	Charleston, WV	38.306	-81.718
KTYX	Montague, NY	43.751	-75.675
3D Mosaic Midwest			
KCLE	Cleveland, OH	41.408	-81.855
KDTX	Detroit, MI	42.695	-83.467
KDVN	Quad Cities, IA	41.607	-90.576
KGRB	Green Bay, WI	44.493	-88.106
KILN	Cincinnati/Wilmington, OH	39.415	-83.817
KILX	Lincoln, IL	40.146	-89.332
KIND	Indianapolis, IN	39.703	-86.275
KIWX	Northern Indiana, IN	41.354	-85.695
KLOT	Chicago, IL	41.599	-88.080
KMKX	Milwaukee, WI	42.963	-88.546
KVWX	Evansville, IN	38.255	-87.719

More information about the WSR-88D NEXRAD system and Level II data can be found at the following links:

NWS Radar Operations Center NEXRAD webpage
Office of the Federal Coordinator for Meteorological (OFCM)
NOAA's National Center for Environmental Information (NCEI) website
Huber and Trapp (2009)

Investigators

Stacy Brodzik
University of Washington
Seattle, WA

Data Characteristics

The NEXRAD Mosaic IMPACTS datasets consist of 3D mosaic data files created from NEXRAD Level II surveillance data. The National Center for Atmospheric Research (NCAR) MdvMerge2 software was used to create the mosaic files with 0.025 degree horizontal and 0.5 km vertical resolution. These data are available at a Level 3 processing level. More information about the NASA data processing levels are available on the EOSDIS Data Processing Levels webpage. The characteristics of these datasets are listed in Table 2 below.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Next Generation Weather Radar (NEXRAD)
Spatial Coverage	N: 46.475 , S: 32.5 , E: -67.525, W: -85.0 (U.S. East Coast) N: 45.975, S: 36.0, E: -79.025, W: -93.0 (U.S. Midwest)
Spatial Resolution	Horizontal: 0.025 degree Vertical: 0.5 km
Temporal Coverage	January 1, 2020 - February 29, 2020
Temporal Resolution	1 minute -< 1 hour
Sampling Frequency	< 1 second
Parameter	Radar reflectivity, radial velocity, spectrum width, differential reflectivity, cross correlation
Version	1
Processing Level	3

File Naming Convention

The NEXRAD Mosaic IMPACTS datasets are available in netCDF-4 format. Each file is named using the following convention:

Data files: IMPACTS_nexrad_YYYYMMDD_hhmmss_mosaic_<region>.nc

Table 3: File naming convention variables

Variable	Description
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
region	Region of NEXRAD radar sites: ‘east’ or ‘midwest’
.nc	netCDF-4 format

Data Format and Parameters

The NEXRAD Mosaic IMPACTS gridded mosaic dataset files were created every five minutes from NEXRAD Level II surveillance data. The Level II data from each site was converted to cfradial format (netcdf/cf compliant) and interpolated to a grid with 1 km horizontal resolution and 0.5 km vertical resolution. NCAR’s MdvMerge2 software was used to merge individual grids to form a mosaic with 0.025 degree horizontal resolution and 0.5 km vertical resolution. The data were collected from a total of 30 NEXRAD sites. The 3D Mosaic Midwest includes data from 11 NEXRAD sites: KCLE, KDTX, KDVN, KGRB, KILN, KILX, KIND, KIWX, KLOT, KMKX, KVWX; and the 3D Mosaic East includes data from 19 NEXRAD sites: KAKQ, KBGM, KBOX, KBUF, KCCX, KCXX, KDIX, KDOX, KENX, KFCX, KGYX, KJKL, KLWX, KMHX, KOKX, KPBZ, KRAX, KRLX, KTYX. The data fields included in each netCDF-4 mosaic file are listed in Table 4 below.

Table 4: NEXRAD Mosaic IMPACTS netCDF-4 Data Fields

Field Name	Description	Data Type	Unit
time*	Data time	datetime64[ns]	ns
start_time	Start time	datetime64[ns]	ns
stop_time	Stop time	datetime64[ns]	ns
x0*	Longitude (x-axis)	float32	Degrees East
y0*	Latitude (y-axis)	float32	Degrees North
z0*	Constant altitude levels (z-axis)	float32	km
grid_mapping_0	Grid mapping name (latitude, longitude)	int32	-
DBZ	Radar reflectivity	float32	dBZ
VEL	Radial velocity	float32	m s^{-1}
WIDTH	Spectrum width	float32	m s^{-1}
ZDR	Differential reflectivity	float32	dB
RHOHV	Cross correlation	float32	-
range	Range from radar	float32	km
Coverage	Radar coverage flag	float32	-

*Note: the “time”, “x0”, “y0”, and “z0” field are coordinate variables

Algorithm

Several steps are taken to calculate the reflectivity, velocity, and spectrum width from NEXRAD's measurements. The volume reflectivity is calculated using the average power of the radar signal that is returned from the precipitation particles in the sample volume, along with the characteristics of the radar system. The mean radial velocity is estimated by using the Doppler shift to determine motions toward or away from the radar. The spectrum width uses the same estimate from the mean radial velocity calculation along with some assumptions to estimate the velocity spectrum standard deviation. More information on the data calculation methods can be found in Heiss et al. 1990.

The NCAR MdvMerge2 software used to create these datasets merges grids from individual radars into one collective grid containing the desired fields from the radar data. This software also supports 3D grids. The vertical levels of the final merged 3D grid are created using the closest plane if they do not match the vertical levels of the original input grids. More information about the NCAR MdvMerge2 software can be found in the NCAR TITAN Users Guide.

Quality Assessment

The transmitter and receiver design, pulse characteristics, and calibration techniques used all contribute to improved radar data quality. For example, ground clutter, erroneous return signal received from ground interference, is reduced due to the design of the NEXRAD transmitter and receiver, and calibration methods. More information on quality control methods can be found in Heiss et al. 1990. In addition, the NWS quality control procedures were concluded to be sufficient for this dataset.

Software

No special software is required to open the NEXRAD Mosaic dataset files. These netCDF-4 files can be read using the NASA Panoply Data Viewer. The py-ART module can be used to plot the NEXRAD Mosaic data in Python.

Known Issues or Missing Data

There are no known issues with these data or any known gaps in the dataset.

References

Dixon, Mike. (2005). TITAN USERS GUIDE.
https://ral.ucar.edu/projects/titan/docs/TitanDataFlow.pdf

Heiss, W. H., McGrew, D. L., & Sirmans, D. (1990). Nexrad: next generation weather radar (WSR-88D). *Microwave Journal*, *33(1)*, 79+.

https://go.gale.com/ps/anonymous?id=GALE%7CA9215749&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=01926225&p=AONE&sw=w

Huber, M., & Trapp, J. (2009). A Review of NEXRAD Level II: Data, Distribution, and Applications. *Journal of Terrestrial Observation*, *1*, 5 - 15. https://docs.lib.purdue.edu/jto/vol1/iss2/art4

NASA ESPO. (2020). IMPACTS. https://espo.nasa.gov/impacts

NOAA National Centers for Environmental Information (n.d.). NEXRAD. https://www.ncdc.noaa.gov/data-access/radar-data/nexrad.

NOAA (2019). NOAA NEXt-Generation RADar (NEXRAD) Products. https://catalog.data.gov/dataset/noaa-next-generation-radar-nexrad-products

OFCM (2005): Federal Meteorological Handbook No. 11 Part B: Doppler Radar Theory and Meteorology. Washington, D.C. http://www.ofcm.gov/publications/fmh/FMH11/fmh-11B-2005.pdf

OFCM (2006): Federal Meteorological Handbook No. 11 Part D: WSR-88D Unit Description and Operational Applications. Washington, D.C. http://www.ofcm.gov/publications/fmh/FMH11/FMH11D-2006.pdf

OFCM (2016): Federal Meteorological Handbook No. 11 Part A: System Concepts, Responsibilities, and Procedures. Washington, D.C. http://www.ofcm.gov/publications/fmh/FMH11/2016FMH11PTA.pdf

OFCM (2017): Federal Meteorological Handbook No. 11 Part C: WSR-88D Products and Algorithms. Silver City, MD. http://www.ofcm.gov/publications/fmh/FMH11/fmh11partC.pdf

Related Data

The full list of IMPACTS campaign data can be located using the GHRC Hydro2.0 search tool and searching the term 'IMPACTS'. The following datasets are from other field campaigns that used NEXRAD:

GPM Ground Validation NEXRAD OLYMPEX (3 radars)
GPM Ground Validation NEXRAD IPHEx (7 radars)
GPM Ground Validation NEXRAD IFloodS (4 radars)
GPM Ground Validation NEXRAD GCPEx (7 radars)
GPM Ground Validation NEXRAD MC3E (6 radars)

Contact Information

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

NASA Global Hydrology Resource Center DAAC
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/

Created: 06/23/20