Data User Guide

Multi-Radar/Multi-Sensor (MRMS) Precipitation Reanalysis for Satellite Validation Product IMPACTS

Introduction

The Multi-Radar/Multi-Sensor (MRMS) Precipitation Reanalysis for Satellite Validation Product IMPACTS dataset contains reflectivity products using the MRMS system 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 (2020-2023). 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. Data are available from January 1, 2022, through March 2, 2023, in netCDF-4 format.

Citation

Brodzik, Stacy. 2022. Multi-Radar/Multi-Sensor (MRMS) Precipitation Reanalysis for Satellite Validation Product IMPACTS [indicate subset used]. Dataset available online from the NASA Global Hydrometeorology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/IMPACTS/MRMS/DATA101

Keywords:

NASA, GHRC, CPEX-AW, St. Croix, precipitation rate, rainfall, precipitation rate estimates, precipitation type, radar quality index

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 (2020-2023) 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.

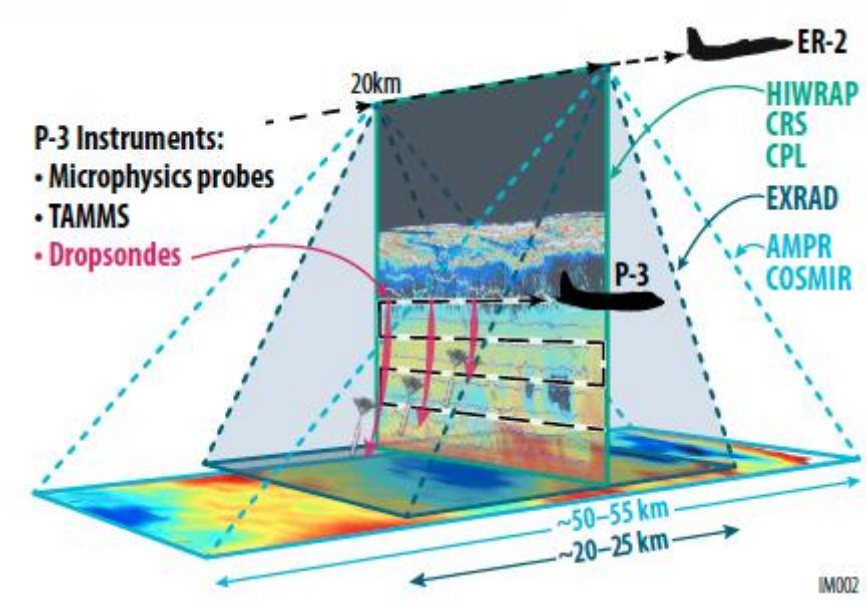

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Product Description

The Multi-Radar Multi-Sensor (MRMS) system, developed at the National Severe Storms Laboratory and the University of Oklahoma consists of the Warning Decision Support System–Integrated Information (WDSS-II; Lakshmanan et al. 2007) suite of severe weather and aviation products and the quantitative precipitation estimation (QPE). These products were created by the National Mosaic and Multi-Sensor QPE (NMQ; Zhang et al. 2011)

system. This MRMS system provides operational guidance for severe convective weather, QPE, and aviation hazards on a seamless three-dimensional grid. This grid is created every two minutes at a spatial resolution of 0.01° latitude × 0.01° longitude, with 33 vertical levels.

The WDSS-II system, also called MRMS-Severe/Aviation, is a multi-radar, multisensor distributed system. This system enables the integration of large datasets into a single seamless, three-dimensional spatial database for analysis by forecasters. Inputs into the operational MRMS-Severe/Aviation system include the following: radar data from the U.S. Weather Surveillance Radar-1988 Doppler (WSR-88D) network, the Geostationary Operational Environmental Satellite (GOES) series, surface terrain elevation information, the National Lightning Detection Network (NLDN; Orville 2008), and hourly surface and upper-air analyses from the Rapid Refresh model (Benjamin et al. 2016).

More information about the MRMS system can be found on NSSL's MRMS webpage, the MRMS Fact Sheet, and Kirstetter et al., 2012.

Investigators

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Data Characteristics

The MRMS IMPACTS data files are available in netCDF-4 format. These data consist of reflectivity, precipitation rate estimates, and quality control product estimates during the IMPACTS field campaign. Data files are in netCDF-4 format at a Level 3 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 below.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	WSR-88D, Canadian C-band radars, gauges
Spatial Coverage	N: 54.995, S: 20.005 E: -60.005, W: -129.995 (Northeast United States)
Spatial Resolution	0.01 degrees
Temporal Coverage	January 1, 2022 - March 2, 2023
Temporal Resolution	1 minute -< 1 hour
Parameter	Reflectivity, radar parameters
Version	1
Processing Level	3

File Naming Convention

The MRMS IMPACTS data are within netCDF-4 files and are named using the following convention:

Data files: IMPACTS_mrms_YYYYMMDD_hhmmss_<param>.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
<param>	BaseDBZ: Mosaic Base Reflectivity (optimal method) CompDBZ: Composite Reflectivity Mosaic (optimal method) DBZ: WSR-88D 3D Reflectivity Mosaic KDP: specific differential phase RhoHV: correlation coefficient SW: spectrum width ZDR: differential reflectivity
.nc	netCDF-4 format

Data Format and Parameters

There are seven data products within this dataset including Mosaic Base Reflectivity, Composite Reflectivity Mosaic, WSR-88D 3D Reflectivity Mosaic, specific differential phase, correlation coefficient, spectrum width, and differential reflectivity. The data files are in netCDF-4 format. Tables 4-10 describe how these measurements are organized in each file, as well as their units.

Table 4: MRMS IMPACTS BaseDBZ netCDF-4 data fields

Variable	Description	Units
altitude	Altitude	km
DBZ_base	Mosaic base reflectivity (optimal method) 500 m above mean sea level	dBZ
latitude	Latitude	Degrees North
longitude	Longitude	Degrees East
time	Verification time generated by wgrib2 function verftime(). Reference data is fixed.	Seconds since 1970-01-01 00:00:00.0 0:00

Table 5: MRMS IMPACTS CompDBZ netCDF-4 data fields

Variable	Description	Units
altitude	Altitude	km

DBZ_comp	Composite reflectivity mosaic (optimal method) 500 m above mean sea level	dBZ
latitude	Latitude	Degrees North
longitude	Longitude	Degrees East
time	Verification time generated by wgrib2 function verftime(). Reference data is fixed.	Seconds since 1970-01-01 00:00:00.0 0:00

Table 6: MRMS IMPACTS DBZ netCDF-4 data fields

Variable	Description	Units
DBZ	WSR-88D 3D reflectivity mosaic	dBZ
forecast_period	Forecast period	s
forecast_reference_time	Data generation time	Seconds since 1970-01-01T00:00:00Z
grid_mapping_0	Grid mapping	-
time	Date time	Seconds since 1970-01-01T00:00:00Z
x0	Longitude	Degrees East
y0	Latitude	Degrees North
z0	Constant altitude levels	km

Table 7: MRMS IMPACTS KDP netCDF-4 data fields

Variable	Description	Units
forecast_period	Forecast period	s
forecast_reference_time	Data generation time	Seconds since 1970-01-01T00:00:00Z
grid_mapping_0	Grid mapping	-
KDP	Specific differential phase	degrees/km
time	Date time	Seconds since 1970-01-01T00:00:00Z
x0	Longitude	Degrees East
y0	Latitude	Degrees North
z0	Constant altitude levels	km

Table 8: MRMS IMPACTS RhoHV netCDF-4 data fields

Variable	Description	Units
forecast_period	Forecast period	s

forecast_reference_time	Data generation time	Seconds since 1970-01-01T00:00:00Z
grid_mapping_0	Grid mapping	-
RHOHV	Correlation coefficient	-
time	Date time	Seconds since 1970-01-01T00:00:00Z
x0	Longitude	Degrees East
y0	Latitude	Degrees North
z0	Constant altitude levels	km

Table 9: MRMS IMPACTS SW netCDF-4 data fields

Variable	Description	Units
forecast_period	Forecast period	s
forecast_reference_time	Data generation time	Seconds since 1970-01-01T00:00:00Z
grid_mapping_0	Grid mapping	-
SW	Spectrum width	m/s
time	Date time	Seconds since 1970-01-01T00:00:00Z
x0	Longitude	Degrees East
y0	Latitude	Degrees North
z0	Constant altitude levels	km

Table 10: MRMS IMPACTS ZDR netCDF-4 data fields

Variable	Description	Units
forecast_period	Forecast period	s
forecast_reference_time	Data generation time	Seconds since 1970-01-01T00:00:00Z
grid_mapping_0	Grid mapping	-
time	Date time	Seconds since 1970-01-01T00:00:00Z
x0	Longitude	Degrees East
y0	Latitude	Degrees North
z0	Constant altitude levels	km
ZDR	Differential reflectivity	dB

Algorithm

The MRMS system generates several radar reflectivity products from the 3D reflectivity field. This allows the data to be combined with other 3D data sources to create multi-sensor/radar-only derived fields. Composite reflectivity is the maximum value of reflectivity above each grid point in the vertical column. Reflectivities at isotherm levels are based on the vertical profile of environment temperatures. More information about the reflectivities can be found in Smith et al., 2016.

Quality Assessment

The MRMS system includes quality-controlled multi-radar fields of 3D reflectivity, near-storm environment, and radial velocity derivatives. To eliminate non-meteorological radar echoes, reflectivity data pass through a quality control neural network that uses polarimetric variables. Data from multiple WSR-88Ds radars are blended and mosaicked using techniques described in Lakshmanan et al., 2006. More information about the quality assessment of this data product can be found in Smith et al., 2016.

Software

These data are in netCDF-4 format. No software is required; however, Panoply can be used to easily plot to view these data.

Known Issues or Missing Data

There are no known issues or missing data with this dataset.

References

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Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term “IMPACTS” in the Earthdata Search. Other MRMS data can be located by searing the term “MRMS” in the Earthdata Search.

GPM Ground Validation Multi-Radar/Multi-Sensor (MRMS) Precipitation Reanalysis for Satellite Validation Product (http://dx.doi.org/10.5067/GPMGV/MRMS/DATA101)

Contact Information

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

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