Data User Guide

UAlbany Micro Rain Radar 2 (MRR-2) IMPACTS

Introduction

The UAlbany Micro Rain Radar 2 (MRR-2) IMPACTS dataset consists of reflectivity, Doppler velocity, signal-to-noise ratio, spectral width, droplet size, Liquid Water Content, melting layer, drop size distribution, rain attenuation, rain rate, and radial velocity data collected 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. The MRR-2 instrument was used to collect data for this dataset. The dataset files are available from January 30, 2020, through February 28, 2023, in netCDF-3 and netCDF-4 format.

Citation

Minder, Justin R., Erin Potter, and W. Massey Bartolini. 2022. UAlbany Micro Rain Radar 2 (MRR-2) 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/MRR2/DATA101

Keywords:

NASA, GHRC, IMPACTS, UALB, MRR, MRR2, UAlbany, precipitation, rain, reflectivity, Doppler velocity, signal-to-noise ratio, spectral width, droplet size, Liquid Water Content, melting layer, drop size distribution, rain attenuation, rain rate, radial velocity

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. The second deployment was from January 2022 through March 2022. 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](#).

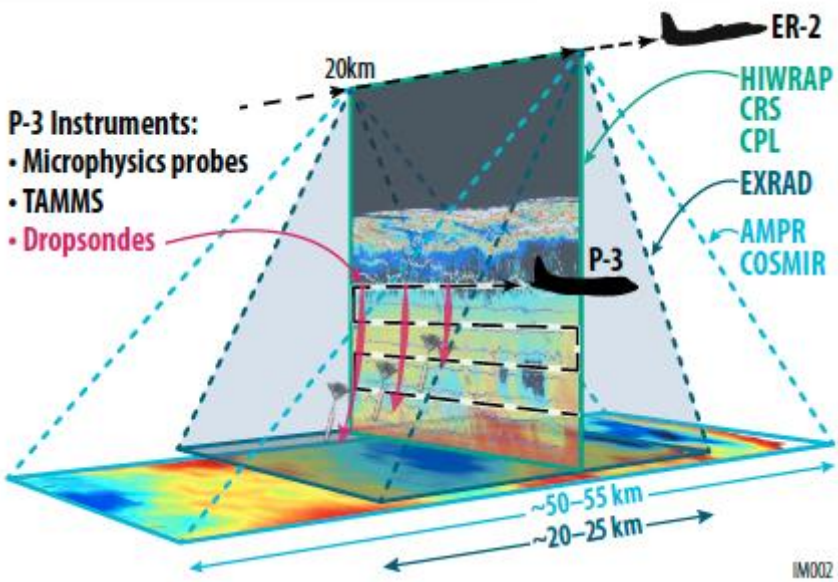

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Instrument Description

This dataset includes measurements from the METEK GmbH Micro Rain Radar (MRR-2). The MRR-2 is a unique meteorological radar profiler for comprehensive investigations of precipitation and cloud dynamics. The system is mounted on the surface and allows precise measurements of the Doppler spectra caused by hydrometeors. The liquid phase, the rain rate, and the liquid water content can be derived online. The transition zone

between the frozen and liquid phases is identified in the profile by a significant local maximum of the radar reflectivity. More information about the MRR-2 instrument is available in Table 1 and the below-listed references.

Table 1: Technical specifications for the MRR-2

Transmit power	50 mW
Frequency	24 GHz
Averaging interval	10 - 3,600 s
Height resolution	10 - 200 m
Number of range gates	Up to 30
Antenna heating	230 VAC / 24 VDC, 25 W
Interface	RS232 / RS422 / LAN
Power supply	24 VDC, 25 W
Weight (without power supply and cable)	6 kg

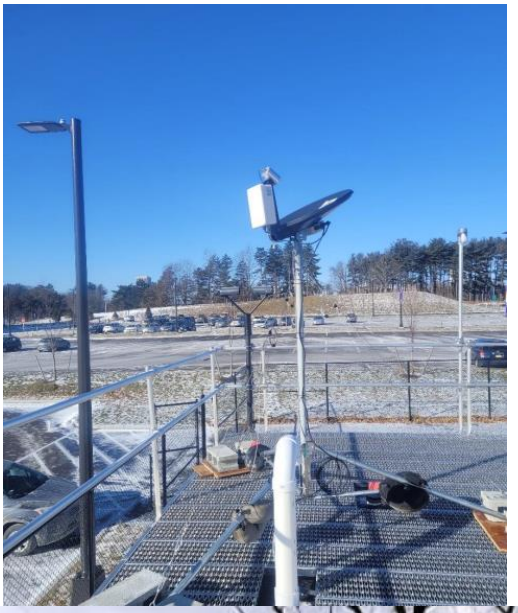

Figure 2: Images of the MRR2 instrument as deployed at UAlbany in 2022. The instrument was mounted on the roof of the ETEC weather yard trailer at the University at Albany campus
(Image source: Erin Potter)

Investigators

Justin R. Minder
University of Albany, DAES
Albany, New York

W. Massey Bartolini
University of Albany, DAES
Albany, New York

Erin Potter
University of Albany, DAES
Albany, New York

Data Characteristics

The UAlbany Micro Rain Radar 2 (MRR2) IMPACTS dataset consists of reflectivity, Doppler velocity, signal-to-noise ratio, spectral width, droplet size, Liquid Water Content, melting layer, drop size distribution, rain attenuation, rain rate, and radial velocity data. The dataset files are available in netCDF-3 format for the 2020 data and netCDF-4 for the 2022 data. These data are available at a Level 1A 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. The instrument was mounted on the roof of the ETEC weather yard trailer at the University at Albany campus (Figure 2). The archived data have been processed using the IMProToo post-processing tool (Maahn, 2019). The post-processing is described in Maahn and Kollias (2012). This processing reduces noise, improves the effective sensitivity of the radar, and provides velocity dealiasing. The derived variables are listed in Table 4.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	Micro Rain Radar 2 (MRR-2)
Spatial Coverage	N: 42.686 , S: 42.680, E:-73.814, W: -73.832 (New York)
Elevation	112 m ASL
Spatial Resolution	60 m horizontal 200 m vertical
Temporal Coverage	January 30, 2020 - February 28, 2023
Temporal Resolution	Daily
Sampling Frequency	Raw: 10 s Post processing averaging interval: 60 s
Parameter	Reflectivity, Doppler velocity, signal-to-noise ratio, spectral width, droplet size, Liquid Water Content, melting layer, drop size distribution, rain attenuation, rain rate, radial velocity
Version	2

Processing Level	1A

File Naming Convention

The UAlbany Micro Rain Radar 2 (MRR2) IMPACTS dataset files are stored in netCDF-3 and netCDF-4 formats and named using the following convention:

Data files: IMPACTS_UALB_mrr2_YYYYMMDD.nc

Table 3: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
.nc	netCDF-3 (2020) and netCDF-4 (2022) format

Data Format and Parameters

The UAlbany Micro Rain Radar 2 (MRR2) IMPACTS dataset files are stored in netCDF-3 format for the 2020 files and netCDF-4 format for the 2022 files. Each file contains one day of data, and the variables are listed in Table 4.

Table 4: MRR2 netCDF-3 data fields

Field Name	Description	Unit
eta	Spectral reflectivity*	mm^6/m^3
eta_noDA	Spectral reflectivity NOT dealised	mm^6/m^3
etaMask	Noise mask of eta: 0: signal 1: noise	-
etaMask_noDA	Noise mask of eta NOT dealised: 0: signal 1: noise	-
etaNoiseAve	Mean noise of one Doppler spectrum in the same units as eta, never dealised	mm^6/m^3
etaNoiseStd	Standard deviation of noise of one Doppler spectrum in the same units as eta, never dealised	mm^6/m^3
height	Height above instrument	m
kurtosis	Kurtosis of the most significant peak	m/s
kurtosis_noDA	Kurtosis of the most significant peak, not dealised	m/s
leftSlope	Slope at the left side of the peak	dB/ (m/s)
leftSlope_noDA	Slope at the left side of the peak, not dealised	dB/ (m/s)

peakVelLeftBorder	Doppler velocity of the left border of the peak	m/s
peakVelLeftBorder_noDA	Doppler velocity of the left border of the peak, not dealised	m/s
peakVelRightBorder	Doppler velocity of the right border of the peak	m/s
peakVelRightBorder_noDA	Doppler velocity of the right border of the peak, not dealised	m/s
quality	This information can be found in the Quality Assessment section below*	-
range	Range bins	-
rightSlope	Slope at the right side of the peak	dB/ (m/s)
rightSlope_noDA	Slope at the right side of the peak, not dealised	dB/ (m/s)
skewness	Skewness of the most significant peak	m/s
skewness_noDA	Skewness of the most significant peak, not dealised	m/s
SNR	Signal-to-noise ratio of the most significant peak, never dealised	dB
spectralWidth	Spectral width of the most significant peak	m/s
spectralWidth_noDA	Spectral width of the most significant peak, not dealised	m/s
TF	Transfer function	-
time	Measurement time	Seconds since 1970-01-01
velocity	Doppler velocity bins. If dealiasing is applied, the spectra are triplicated	m/s
velocity_noDA	Original, non-dealised, Doppler velocity bins	m/s
W	Mean Doppler velocity of the most significant peak	m/s
W_noDA	Mean Doppler velocity of the most significant peak, not dealised	m/s
Ze	Reflectivity of the most significant peak	dBz
Ze_noDA	Reflectivity of the most significant peak, not dealised	dBz

*Additional information in the Quality Assessment section below

Algorithm

The archived data have been processed using the IMProToo post-processing tool (Maahn, 2019). The post-processing is described in Maahn and Kollias (2012). This processing reduces noise, improves the effective sensitivity of the radar, and provides velocity dealiasing.

Quality Assessment

For the 'eta' variable in the MRR2 data files, if dealiasing is applied, the spectra are triplicated, thus up to three peaks can occur from -12 to +24 m/s. However, only one peak is not masked in etaMask.

Software

The UAlbany MRR2 IMPACTS dataset files are stored in netCDF-3 (2020) and netCDF-4 (2022) formats, so no software is needed to view these data; however, Panoply can be used to easily plot variables within these data files.

Known Issues or Missing Data

Any missing data values are filled with the values '-9999'.

February 10, 2020:
Data outage between approximately 0725 and 1010 UTC, cause unknown but MRRService restarted data collection automatically. Data records are either non-existent or very infrequent in raw MRR data files during this time period, with reports of "Checksum error in MRR Raw Spectra line!". Similar errors have happened very infrequently for a few minutes at a time on previous days, but not for a long period like today.

February 28, 2020:
The computer was forced to restart to install software updates at 1700 UTC. Lost data between 1700 and 1900 UTC before MRR restarted data collection automatically. The corresponding Parsivel outage lasted until 2230 UTC since Parsivel data collection had to be resumed manually.

January 10. 2022:
Instrument down from 1636-1640 UTC due to moving the computer.

January 21. 2022:
The instrument was down due to a communication error between the instrument and the computer, research at 1930 UTC.

February 17. 2022:
Rebooted PC, and manually restarted MRR at 1905-1920 UTC.

A persistent artifact is apparent in the upper-most 5–6 range gates. It is most apparent during non-precipitating periods and exhibits enhanced reflectivity and spectrum width with negative radial velocities. After testing and correspondence with the manufacturer (METEK) and Pavlos Kollias (SBU) we concluded that the artifact is most likely caused by a local source of microwave interference. Pavlos noted that one could "add a subroutine in the post-processing software to identify and address RHI in the spectra domain. In this particular case, the altitude and the Doppler velocity of the RHI makes this possible." No

correction has been applied to the current dataset. However, we are willing to reprocess the raw data if the code can be supplied by the SBU research group.

Version 2 of the dataset was created due to missing post-processed data, script rerun to retain full daily data. Global attributes are updated in version 2.

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 GHRC Search Portal. The MRR instrument was used in other projects like the GPM Ground Validation project. These datasets are listed below:

GPM Ground Validation Micro Rain Radar (MRR) NASA ACHIEVE IPHEx (http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA201)

GPM Ground Validation Duke Micro Rain Radar (MRR) IPHEx (http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA202)

GPM Ground Validation NASA Micro Rain Radar (MRR) IPHEx (http://dx.doi.org/10.5067/GPMGV/IPHEX/MRR/DATA203)

GPM Ground Validation Micro Rain Radar (MRR) NASA IFloodS
(http://dx.doi.org/10.5067/GPMGV/IFLOODS/MRR/DATA201)

GPM Ground Validation NASA Micro Rain Radar (MRR)

HyMeX (http://dx.doi.org/10.5067/GPMGV/HYMEX/MRR/DATA201)

GPM Ground Validation Environment Canada (EC) Micro Rain Radar (MRR) GCPEx V2
(http://dx.doi.org/10.5067/GPMGV/GCPEX/MRR/DATA203)

GPM Ground Validation NASA Micro Rain Radar (MRR) GCPEx V2
(http://dx.doi.org/10.5067/GPMGV/GCPEX/MRR/DATA204)

GPM Ground Validation NASA Micro Rain Radar (MRR) MC3E
(http://dx.doi.org/10.5067/GPMGV/MC3E/MRR/DATA201)

GPM Ground Validation Micro Rain Radar (MRR) LPVEx
(http://dx.doi.org/10.5067/GPMGV/LPVEX/MRR/DATA101)

GPM Ground Validation Micro Rain Radar (MRR) ICE POP
(http://dx.doi.org/10.5067/GPMGV/ICEPOP/MRR/DATA101)

GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/MRR/DATA201)

Contact Information

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

NASA Global Hydrometeorology 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: 8/6/2021
Updated: 11/29/2022