Global Hydrology Resource Center

Data User Guide

SBU Micro Rain Radar 2 (MRR-2) IMPACTS

Introduction

The SBU 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 (2020-2022). 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. Both the MRR-2 and the MRR-PRO instruments were used to collect data for this dataset. The dataset files are available from January 1 through February 28, 2020 in netCDF-3 and netCDF-4/CF formats.

Citation

Kollias, Pavlos and Mariko Oue. 2020. SBU Micro Rain Radar 2 (MRR-2) 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/MRR/DATA101

Keywords:

NASA, GHRC, IMPACTS, SBU, MRR, MRR2, 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 flew 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.

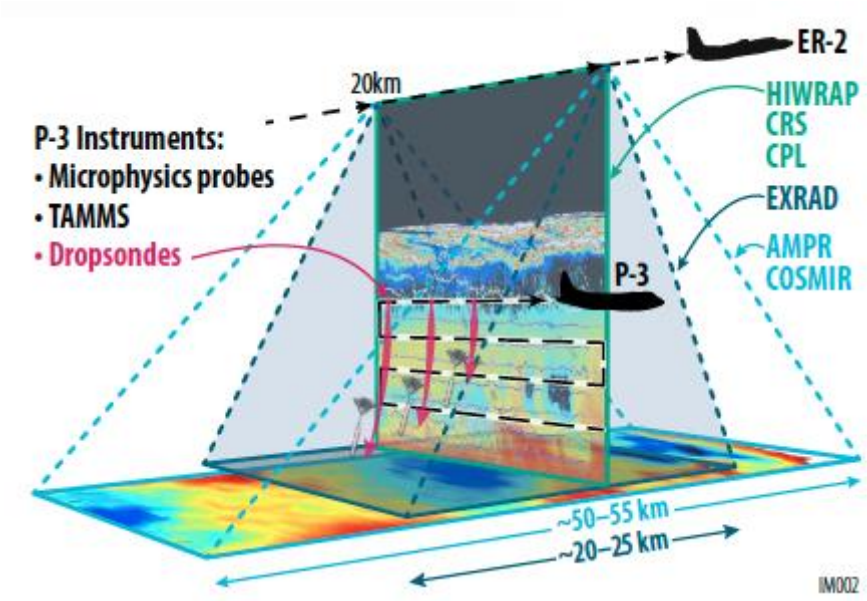

Figure 1: IMPACTS airborne instrument suite
(Image source: NASA IMPACTS ESPO)

Instrument Description

This dataset includes measurements from both the METEK GmbH Micro Rain Radar (MRR-2) and the METEK GmbH Micro Rain Radar PRO (MRR-PRO). 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 frozen and liquid phase is identified in the profile by a significant local maximum of the radar reflectivity. More information about the MRR-2 instrument is available at MRR-2 Instrument Data Sheet and METEK GmbH Germany MRR-2.

Table 1: Specs of 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: Image of the MRR-2 instrument
(Image source: Metek)

The MRR-PRO combines the unique MRR technique of the MRR-2 and a high performance processing unit which significantly improves all operating parameters. The system allows precise measurements of the Doppler spectra caused by hydrometeors and yields the rain rate, liquid water content, and drop size distribution for the liquid phase. All computations including automatic melting zone detection are integrated in the outdoor electronics. More information about the MRR-PRO can be found at MRR-PRO Instrument Data Sheet and METEK GmbH Germany MRR-PRO.

Table 2: Specs of the MRR-PRO

Range resolution	> 10 m
Operating frequency	24,23 GHz (K-band)
Sampling frequency	500 kHz
Number of range gates	30 - 254
Acquisition time for one set of spectra	>= 1.6 ms
Time interval for averaged spectra	>= 1 s
Velocity resolution	0.05 - 6.00 m/s
Nyquist velocity range	12.3 - 96.3 m/s
Duty cycle (net-sampling time in one averaging interval)	> 99 %
Minimum detectable radar reflectivity (z = 1000 m, Δz = 100 m, Δt = 60 s)	-8 dBZ

Figure 3: Image of the MRR-PRO instruments
(Image source: METEK GmbH Germany MRR-PRO)

Investigators

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Data Characteristics

The SBU 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-4/CF and netCDF-3 formats. These data are available at a Level 1A processing level. More information about the NASA data processing levels are available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 3 below.

Table 3: Data Characteristics

Characteristic	Description
Platform	Ground Station
Instrument	MRR-2 and MRR-PRO
Spatial Coverage	N: 40.975, S: 40.718, E: -72.864, W: -74.017 (New York Coast)
Spatial Resolution	60 m in vertical
Temporal Coverage	January 1, 2020 - February 28, 2020
Temporal Resolution	MRR-2: Daily MRR-PRO: Hourly
Sampling Frequency	4 seconds - 1 minute
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	1
Processing Level	1A

File Naming Convention

The SBU Micro Rain Radar 2 (MRR2) IMPACTS dataset files are named using the following convention:

MRR-2 Data files: IMPACTS_SBU_mrr2_YYYYMMDD_BNL.nc
MRR-PRO Data files: IMPACTS_SBU_mrrpro2_YYYYMMDD_hhmmss_MAN.nc
IMPACTS_SBU_mrrpro_YYYYMMDD_hhmmss_RT.nc

Table 4: 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

.nc	MRR-2 data files: netCDF-3 MRR-PRO data files: netCDF-4/CF

Data Format and Parameters

The SBU Micro Rain Radar 2 (MRR2) IMPACTS dataset files are available in netCDF-3 for the MRR-2 data files and in netCDF-4/CF for the MRR-PRO data files. The MRR-2 data files contain one day data, while the MRR-PRO data files contain one hour of data. The data variables included in the MRR-2 data files are listed in Table 5, and the variables included in the MRR-PRO data files are listed in Table 6.

Table 5: MRR-2 netCDF-3 Data Fields

Field Name	Description	Unit
eta	Spectral reflectivities*	mm^6/m^3
eta_noDA	Spectral reflectivities 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 deliased	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-dealiased, 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 dealiased	m/s
Ze	Reflectivity of the most significant peak	dBz
Ze_noDA	Reflectivity of the most significant peak, not dealiased	dBz

*Additional information in the Quality Assessment section below

Table 6: MRR-PRO netCDF-4/CF Data Fields

Field Name	Description	Unit
altitude	Altitude of instrument	m
azimuth	Azimuth angle from true North	degrees
calibration_constant	Calibration constant	-
D	Drop sizes	-
doppler_shift_spectrum	Doppler shift spectrum	-
elevation	Elevation angle from horizontal plane	degrees
fixed_angle	Fixed angle	degrees
index_spectra	Index variable spectra	-
instrument_type	Instrument type	-
latitude	latitude	Degrees North
longitude	longitude	Degrees East
LWC	Mass concentration of liquid water in air	g/m^3
ML	Melting layer	-
N	Drop size distribution	-
PIA	Path integrated rain attenuation	dB
range	Range to measurement volume	m
RR	Rainfall rate	mm/h
SNR	Signal-to-Noise Ratio	dB
spectrum_raw	Log attenuated power	dB
sweep_end_ray_index	Sweet end ray index	-

sweep _mode	Sweep mode	-
sweep_number	Sweep number	-
sweep_start_ray_index	Sweep start ray index	-
time	Time in seconds since volume start	s
time_coverage_end	Time coverage end in YYYY-MM-DDThh:mm:ss	UTC
time_coverage_start	Time coverage end in YYYY-MM-DDThh:mm:ss	UTC
time_reference	Time reference in YYYY-MM-DDThh:mm:ss	UTC
transfer_function	Transfer function	-
VEL	Radial velocity of scatterers towards instrument	m/s
volume_number	Volume number	-
WIDTH	Doppler spectra width	m/s
Z	Log reflectivity	dBZ
Za	Log attenuated reflectivity	dBZ
Ze	Equivalent reflectivity factor	dBZ
Zea	Attenuated equivalent reflectivity factor	dBZ

Quality Assessment

For the 'eta' variable in the MRR-2 netCDF-3 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

These data files are stored in netCDF-4/CF and netCDF-3 formats. No special software is required to read these files however Panoply can be used to easily open and view these data files.

Known Issues or Missing Data

There are no known issues with these data or any known gaps in the dataset; however, missing data values are filled with the value '-9999.0'.

References

Metex. Micro Rain Radar MRR-2 Data Sheet. https://metek.de/wp-content/uploads/2014/05/Datasheet_MRR-2.pdf

Metex. Micro Rain Radar MRR | MRR-2. https://metek.de/product/mrr-2/

Metex. Micro Rain Radar MRR | MRR-PRO. https://metek.de/product/mrr-pro/

Metex. Micro Rain Radar MRR-PRO Data Sheet. https://metek.de/wp-content/uploads/2016/12/20180206_Datenblatt_MRR-PRO.pdf

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

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 HyDRO2.0 search tool. 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:

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