Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Micro Rain Radar (MRR) LPVEx

Introduction

The GPM Ground Validation Micro Rain Radar (MRR) LPVEx dataset was collected during the Global Precipitation Measurement (GPM) mission Ground Validation Light Precipitation Validation Experiment (LPVEx) field campaign. The LPVEx field campaign took place around the Gulf of Finland in September and October of 2010. The goal of the campaign was to provide additional high altitude, light rainfall measurements for the improvement of GPM satellite precipitation algorithms. The MRR is a Biral/Metek 24 GHz (K-band) vertically oriented Frequency Modulated Continuous Wave (FM-CW) radar that measures signal backscatter from which Doppler spectra, radar reflectivity, Doppler velocity, drop size distribution, rain rate, liquid water content, and path integrated attenuation are derived. The dataset contains measured and derived data from MRR instruments placed at four remote sites (Jarvenpaa, Emasalo, Harmaja, and the research vessel Aranda). Data files are available in ASCII data format.

Notice:
This dataset contains MRR data during the LPVEx field campaign. A few of the sites have MRR operation before and after the field campaign: May 2010 (Aranda and Jarvenpaa), and November 2010 through March 2011 (Jarvenpaa). These data are also included in the dataset.

In the beginning of September 2010, the feed of the MRR at Jarvenpaa was oriented towards the C-band weather radar of the site, and that caused some extra interference, particularly during PPI scans once every hour. Before the active measurements of LPVEx campaign the feed was oriented away from the weather radar, and no significant interference from that source appeared anymore.

On 9 November, 2010, components from the MRR deployed at Emasalo were relocated to Jarvenpaa and used to deploy a second MRR ("MRR2") at that site. When the radar was redeployed as the Jarvenpaa MRR2, the vertical resolution was changed from 100 m to 15 m.

Citation

Gatlin, Patrick. 2019. GPM Ground Validation Micro Rain Radar (MRR) LPVEx [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/LPVEX/MRR/DATA101

Keywords:

NASA, GHRC, GPM GV, LPVEX, Micro Rain Radar, MRR, Doppler radar, vertical velocity, drop size distribution, rainfall rate, attenuation, liquid water content

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 (Ground Validation) mission. More information about the GPM mission is available at the PMM Ground Validation webpage.

The Light Precipitation Validation Experiment (LPVEx) sought to characterize high-altitude, light precipitation systems by evaluating their microphysical properties and utilizing remote sensing observations and models. This campaign was a collaborative effort between the CloudSat mission, GPM GV mission, the Finnish Meteorological Institute, Environment Canada, the United Kingdom National Environmental Research Council, Vaisala Inc., and the University of Helsinki. The campaign took place in September and October of 2010 in Northern Europe in the areas surrounding the Gulf of Finland. One of the objectives of the experiment was to evaluate the performance of satellite measurements when estimating rainfall intensity in high altitude regions. This data collection had the purpose of improving high-altitude rainfall estimation algorithms and understanding of light rainfall processes. The campaign utilized coordinated aircraft flights, atmospheric profile soundings, ground precipitation gauges, radar measurements, and coordinated satellite observations to obtain light precipitation properties and the spatial distribution of those properties. More information about the GPM LPVEx campaign can be found on the LPVEx Field Campaign webpage.

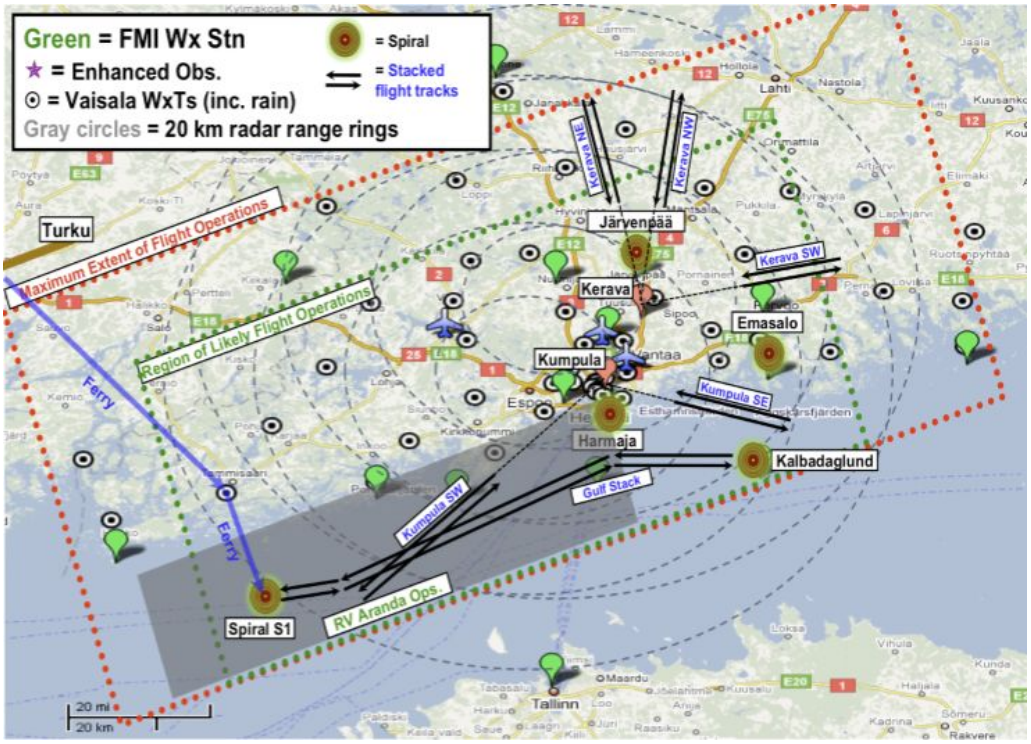

Figure 1: LPVEx field campaign study area along the Gulf of Finland
(Image source: LPVEx Science Plan)

Instrument Description

The Micro Rain Radar (MRR) instrument is a Biral/Metek 24 GHz (K-band) continuous wave radar that derives profiles of drop size distributions and rain parameters from measured spectral power backscatter intensity. The MRR signal is transmitted vertically into the atmosphere where a small portion is scattered back to the antenna from rain drops or other forms of precipitation. Due to the falling velocity of the rain drops there is a frequency deviation between the transmitted and the received signal (Doppler frequency). This frequency is a measure of the falling velocity of the rain drops. Since drops with different diameters have different falling velocities the backscattered signal consists of a distribution of different Doppler frequencies. The spectral analysis of the received signal yields a power spectrum which is spread over a range of frequency lines corresponding to the Doppler frequencies of the signal. Drop size distributions are derived in the range of 0.25 mm to 4.53 mm which covers the size of atmospheric precipitation drops. Larger drops in the atmosphere are affected by the air resistance as they fall and will split into smaller drops. Derived rain parameters include rain rates, liquid water content, Doppler velocity of falling drops, and path integrated attenuation. Data are provided as raw observations and time averaged values.

More information about the MRR instrument is available at http://www.biral.com/product/micro-rain-radar/ and https://metek.de/wp-content/uploads/2016/12/2018-0206-MRR_tutorial.pdf.

Figure 2: MRR used for GPM Ground Validation
(Image source: http://wallops-prf.gsfc.nasa.gov/Radar/MRR/index.html)

Investigators

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Data Characteristics

The GPM Ground Validation Micro Rain Radar (MRR) LPVEx data are available in ASCII format at a Level 2 processing level. More information about the NASA data processing levels are available on the EOSDIS Data Processing Levels webpage. Table 1 shows the characteristics of this dataset.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground stations, research vessel Aranda
Instrument	Micro Rain Radar (MRR)
Projection	n/a
Spatial Coverage	N: 60.4864 , S: 59.3778, E: 21.3281, W: 25.6294 (Gulf of Finland) MRRs located at 4 sites: Emasalo: 60.2036N, 25.6247E Jarvenpaa: 60.4846N, 25.0826E Harmaja: 60.1050N, 24.9749E

	Aranda*
Spatial Resolution	Point with 200 m range
Temporal Coverage	May 19, 2010 to March 30, 2011
Temporal Resolution	Daily
Sampling Frequency	10 sec - raw; 1 minute - averaged
Parameter	Radar reflectivity, Doppler velocity, precipitation rate, drop size distribution
Version	1
Processing Level	2

*Coordinates for research vessel Aranda can be found at https://ghrc.nsstc.nasa.gov/pub/fieldCampaigns/gpmValidation/lpvex/parsivel/data/Aranda/ in 'aranda_coordinates_*.txt' files

File Naming Convention

The GPM Ground Validation Micro Rain Radar (MRR) LPVEx dataset files are named with the following convention:

Data files: lpvex_mrr_<site>_YYYYMMDD_[Data|Instdata|Rawdata].txt

Table 2: File naming convention variables

Variable	Description
<site>	MRR sites: Aranda, Emasalo, Harmaja, Jarvenpaa1, Jarvenpaa2*
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
[Data|Instdata|Rawdata]	Data: time-averaged data Instdata: processed instantaneous data Rawdata: raw spectra data
.txt	ASCII text data file extension

*On 9 November, 2010, components from the MRR deployed at Emasalo were relocated to Jarvenpaa and used to deploy a second MRR ("MRR2") at that site. When the radar was redeployed as the Jarvenpaa MRR2, the vertical resolution was changed from 100 m to 15 m.

Data Format and Parameters

The GPM Ground Validation Micro Rain Radar (MRR) LPVEx data are available in ASCII format. There are three files for each day of operation. One contains raw data, another the time-averaged data, and the third the instantaneous processed data. Each file contains three header lines followed by the data.

The first header line contains the instrument name, date/time stamp, time zone information, device version number, device serial number, bandwidth, calibration constant, MRR data quality (percentage of valid spectra), and identifier data type. The second header line contains the height above the ground the measurement was taken in meters. The third header line contains the transfer function for each height step.

Data lines follow the third header line and start with the letter F and a 2-digit number representing the spectra line. The data following the F, D or N represent the spectra signal power for each height step in the engineering units received. The order of the data are given in Table 3. More information about MRR data parameters is available at https://ghrc.nsstc.nasa.gov/pub/fieldCampaigns/gpmValidation/lpvex/mrr/doc/mrr_dataFormat_v6_20120301.pdf

Table 3: Data Fields

Identifier	Description	Unit
MRR	Header line	-
H	Height header line	m
TF	Transfer Function header line	-
F*nn*	Spectral reflectivities	dB
D*nn*	Drop size	mm
N*nn*	Spectral drop densities	$m^{-3}mm^{-1}$
PIA	Path Integrated Attenuation	dB
z	Attenuated radar reflectivity	dBZ
Z	Radar reflectivity	dBZ
RR	Rain rate	$mm\ h^{-1}$
LWC	Liquid Water Content	$g\ m^{-3}$
W	Fall velocity	$m\ s^{-1}$

Where *nn* represents the levels of atmosphere from minimum height to maximum height
The drop size given is for the center of the size class

Quality Assessment

A description of the physical principles behind the operation of the MRR is provided in https://www.ncas.ac.uk/en/documents/amf/manuals/1029-mrr-operational-pronciples/file. This measurement capability has been in operation for decades and the MRR is known to derive very small rain rates accurately. Errors are presented in Gerhard et al., 2005. The droplet number concentration in each drop-diameter bin is derived from velocity and drop size is exploited to remotely measure to droplet size. At higher measurement frequencies of the radar there can be signal attenuation effects, but these are generally weak enough that they can be corrected.

Strong vertical winds can affect the data due to distortion of the measured reflectivity spectra. When strong vertical winds are present, the MRR instrument overestimates the amount of attenuation present causing inaccurate measurements. More information about data quality if available in Tridone et al., 2011.

Software

No software is required to read these data since they are in ASCII format.

Known Issues or Missing Data

In the beginning of September 2010, the feed of the MRR at Jarvenpaa was oriented towards the C-band weather radar of the site, and that caused some extra interference, particularly during PPI scans once every hour. Before the active measurements of LPVEx campaign the feed was oriented away from the weather radar, and no significant interference from that source appeared anymore.

References

Gerhard, P. B. Fischer, et al., 2005: Profiles of Raindrop Size Distributions as Retrieved by Microrain Radars, Journal of Applied Meteorology, 44, 1930-1949. doi: https://doi.org/10.1175/JAM2316.1.

Tridon, F., J. Van Baelen, and Y. Pointin, 2011: Aliasing in Micro Rain Radar data due to strong vertical winds, Geophysical Research Letters, 38, L02804. Doi: https://doi.org/10.1029/2010GL046018.

Related Data

All other data collected during the LPVEx field campaign is considered related data. LPVEx data can be located using the GHRC HyDRO 2.0 search tool, by entering the term 'LPVEx'. In addition, the MRR was used in other GPM Ground Validation field campaigns. These other datasets are listed below and may be of interest:

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

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

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

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

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

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

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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