Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX

Introduction

The GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX dataset was gathered during the Global Precipitation Measurement (GPM) Ground Validation OLYMPEX field campaign held at Washington's Olympic Peninsula from November 2015 through May 2016. The dataset contains measured and derived data from four MRR instruments placed in separate locations within the study region. 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. Data files are available in ASCII data format.

Note: This dataset contains MRR data both during the OLYMPEX field campaign and from test runs prior to the start of the project, beginning as early as October 2014. To obtain data during the intense operation period (IOP) of the OLYMPEX field campaign, select data for the months of November 2015 to January 2016. A few of the site continued operation later in 2016.

Citation

Petersen, Walt and Patrick Gatlin. 2017. GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX [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/OLYMPEX/MRR/DATA201

Keywords:

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

Campaign

The Global Precipitation Measurement (GPM) mission Ground Validation 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). Surface rainfall was measured by very dense rain gauge and disdrometer networks at various field campaign sites. These field campaigns accounted for the majority of the effort and resources expended by GPM GV. More information about the GPM mission is available at https://pmm.nasa.gov/GPM/.

One of the GPM Ground Validation field campaigns was the Olympic Mountains Experiment (OLYMPEX) which was held in the Pacific Northwest. The goal of OLYMPEX was to validate rain and snow measurements in midlatitude frontal systems as they move from ocean to coast to mountains and to determine how remotely sensed measurements of precipitation by GPM can be applied to a range of hydrologic, weather forecasting, and climate data. The campaign consisted of a wide variety of ground instrumentation, radars, and airborne instrumentation monitoring oceanic storm systems as they approached and traversed the Peninsula and the Olympic Mountains. The OLYMPEX campaign was part of the development, evaluation, and improvement of GPM remote sensing precipitation algorithms. More information is available from the NASA GPM Ground Validation web site https://pmm.nasa.gov/olympex, and the University of Washington OLYMPEX web site http://olympex.atmos.washington.edu/.

Figure 1: OLYMPEX Domain
(Image Source: https://pmm.nasa.gov/OLYMPEX)

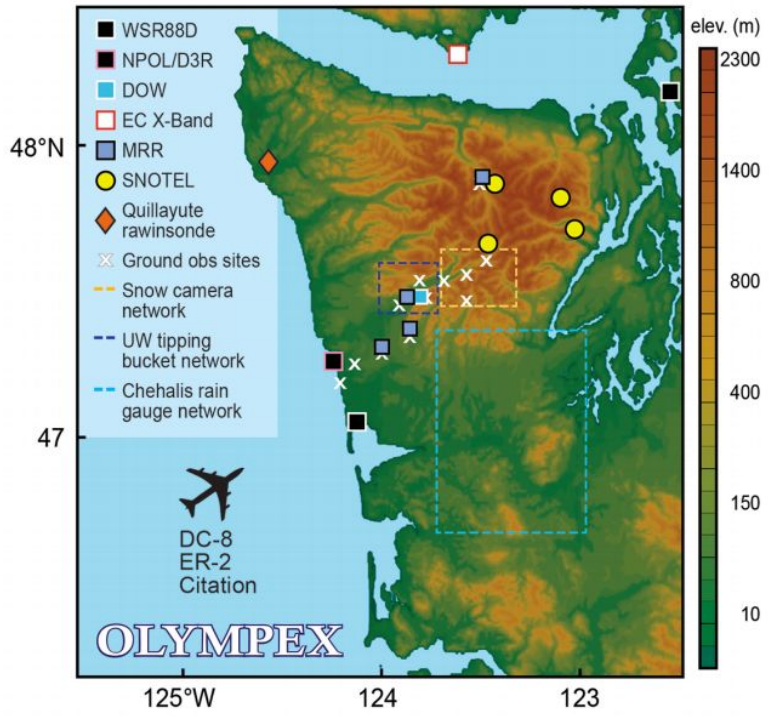

Figure 2: OLYMPEX Field Locations.
(Image Source: https://pmm.nasa.gov/OLYMPEX)

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/.

Figure 3: MRR used for GPM Ground Validation
(Image source: http://wallops-prf.gsfc.nasa.gov/Radar/MRR/index.html)

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Data Characteristics

The GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX data are available in ASCII format. Both raw data and averaged data files are available for each day. Data exist for all MRR operation, including test operation before the field campaign started in Fall 2015.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Micro Rain Radar (MRR)
Operation Frequency	24.23 GHz
Beam Width	1.5 degrees
Projection	n/a

Spatial Coverage	N: 47.970 , S: 47.360, E: -123.499, W: -123.993 (Washington) MRRs located at 4 sites: 01-Hurricane = 47.970, -123.499 02-Fishery = 47.360, -123.993 03-Neilton = 47.390, -123.867 04-CRN = 47.514, -123.812
Spatial Resolution	Point with 200 m range
Temporal Coverage	Start date: October 30, 2014 Stop date: May 22, 2016
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

File Naming Convention

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

Data files: olympex_mrr##_YYYYMMDD_[ave|pro|raw].txt

Table 2: File naming convention variables

Variable	Description
mrr##	MRR station number
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
[ave|pro|raw]	ave: time-averaged data pro: processed instantaneous data raw: raw spectra data
.txt	ASCII text data file extension

Data Format and Parameters

The GPM Ground Validation Micro Rain Radar (MRR) OLYMPEX 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://www.ncas.ac.uk/en/documents/amf/manuals/1030-mrr-user-manual/file.

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
MRR Raw Spectra data files for mrr2-02_Fishery for months 2015-10 and 2015-12 were lost due to disk failure.

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, http://journals.ametsoc.org/doi/pdf/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. http://dx.doi.org/10.1029/2010GL046018

Related Data
All other data collected during the OLYMPEx field campaign is considered related data. OLYMPEx data can be located using the HyDRO 2.0 search tool. 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)

Contact Information

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

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