Global Hydrology Resource Center

Data User Guide

GPM Ground Validation CAX1 Radar CFradial format OLYMPEX

Introduction

The GPM Ground Validation CAX1 Radar CFradial format OLYMPEX dataset consists of radar parameters, such as Radar reflectivity, Doppler velocity, Doppler width, Differential reflectivity, and Signal quality index, provided on a 0.4 to 1.0 km spatial resolution within the OLYMPEX field campaign study region in the state of Washington. These data were obtained for the GPM Ground Validation OLYMPEX field campaign by the SELEX Meteor 60DX10 Compact Weather (CAX1) radar. The CAX1 radar was located at the southern tip of Vancouver Island on the Canadian Forces Base (CFB) Esquimalt Albert Head (AHD) military training area. The CAX1 radar was operated by Environment and Climate Change Canada to support the OLYMPEX field campaign. These data are available in Cfradial netCDF-4 format from November 14, 2015 through April 1, 2016.

Citation

Hudak, David, Peter Rodriguez, Vlado Stojanovic, Norman Donaldson, Robert Reed, and Stacy Brodzik. 2018. GPM Ground Validation CAX1 Radar CFradial format 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/XBAND/DATA301

Keywords:

NASA, GHRC, GPM, OLYMPEX, ECCC, Albert Head, radar reflectivity, CAX1, radar, CFradial

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 mid-latitude 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)

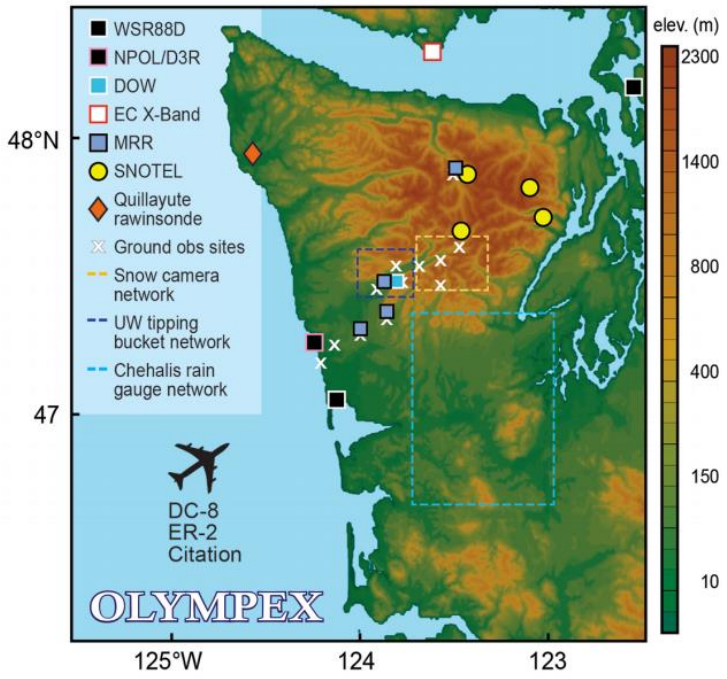

Figure 2: OLYMPEX Field Locations.
(Image Source: https://pmm.nasa.gov/OLYMPEX)

Instrument Description

This dataset contains measurements made by a compact dual-polarization X-band portable weather radar labeled "CAX1" that was located at the southern tip of Vancouver Island on the Canadian Forces Base (CFB) Esquimalt Albert Head (AHD) military training area (lat: 48.38711667, lon: -123.4780556) - labeled as EC X-band in Figure 2 above and DND - Albert Head in Figure 3 below which also shows the radar measurement extent. The CAX1 radar was placed in a location that would cover the northern lee-side of the Olympic Mountains and the inland waters. This location had a direct line-of-sight of Hurricane Ridge (HRR) on the Olympic Peninsula, an area of high elevation over which Pacific storms had to pass when moving from west to east.

The CAX1 radar is a SELEX Meteor 60DX10 Compact Weather radar with a 2.4m dish, a portable, low-cost, active radar that is capable of weather and target detection. This radar has a maximum range of 100 km. The radar operated continuously during of the field campaign from November 14, 2015 through April 1, 2016. The radar scanning pattern had a 5 minute repeat time. The series of scans in each cycle were 5 vertical cross sections (range height indicator scans) centered on Hurricane Ridge followed by 3 low level azimuthal scans (plan position indicator scans) on elevation angles of 1,5, 2.5 and 5.0 degrees out to a range of 100 km. The radar can perform Range Height Indicator (RHI) scans, as well as provide surveillance data. An RHI scan is where the radar holds the azimuth angle constant, but moves the elevation angle. Surveillance data is often used for high temporal resolution sampling of clear air and convection. More information about the

CAX1 dual polarization X-band radar is available in Hudak et al., 2016 and in the METEOR 60DX COMPACT WEATHER RADAR documentation.

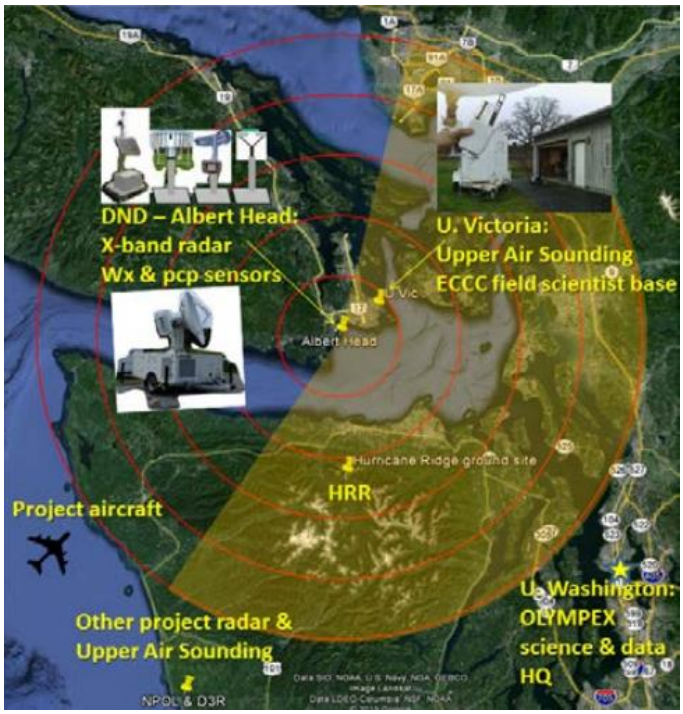

Figure 3: CAX1 radar location and view with respect to other ECCC and University of Washington OLYMPEX instruments
(Image Source: Hudak et al., 2016)

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Data Characteristics

The GPM Ground Validation CAX1 Radar CFradial format OLYMPEX dataset files are in netCDF-4 format at Level 2 processing level. More information about the NASA data processing levels are available on the NASA Data Processing Levels website. Table 1 shows the characteristics of the data file.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground Station
Instrument	Dual-pol X-band radar
Projection	Azimuthal equidistant
Spatial Coverage	N: 49.285, S: 47.4888, E: -122.580, W: -124.376 (Washington)
Spatial Resolution	0.4 - 1.0 km
Temporal Coverage	November 14, 2015 - April 1, 2016
Temporal Resolution	5 minutes
Sampling Frequency	<1 second
Parameter	Radar reflectivity, Doppler velocity, Doppler width, Differential reflectivity, Differential phase, Differential phase shift, Correlation coefficient, Signal quality index
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation CAX1 Radar CFradial format OLYMPEX dataset consists of netCDF-4 formatted data. These data has the file naming convention shown below.

Data files: olympex_cax1_cfrad_<start>_to_<end>_v#_[RHI|SUR].nc

Table 2: File naming convention variables

Variable	Description
<start>	Start time of data collection in YYYYMMDD_hhmmss.*** 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 ***: three-digit milliseconds in UTC
<end>	End time of data collection in YYYYMMDD_hhmmss.*** YYYY: Four-digit year MM: Two-digit month DD: Two-digit day hh: Two-digit hour in UTC
v#	Scan number of day indicated in the file name
[RHI|SUR]	RHI: Range Height Indicator, which is where the radar holds the elevation angle constant, but changes the azimuth angle SUR: Surveillance data, which is often used for high temporal resolution sampling of clear air and convection.
.nc	netCDF-4 format

Data Format and Parameters

The GPM Ground Validation CAX1 Radar CFradial format OLYMPEX dataset consists of Cfradial netCDF-4 data files constructed from CAX1 RB5 data files, a raw format derived directly from the radar instrumentation. The code for translating the data from RB5 format into CFRadial format was implemented by Stacy Brodzik. The CFradial data files contain observations from 5-minute radar scans and provide radar parameters that include reflectivity, Doppler velocity, and differential phase, and Doppler width, for the time period from November 14, 2015 through April 1, 2016. Table 3 lists and describes the primary parameters in the data file. Instrument parameters that are in the data files are not listed in Table 3; however, each parameter is documented in the file metadata.

Table 3: Primary CFradial Format Data Fields

Field Name	Description	Data Type	Unit
altitude	Altitude	double	m
altitude_agl	Altitude above ground level	double	m
antenna_transition	Antenna is in transition in between sweeps. 1 if antenna is in transition 0 otherwise	byte	-
azimuth	Ray azimuth angle	float	degrees
DBZ	Equivalent reflectivity factor. Logged horizontally-polarized reflectivity factor.	byte	dBZ
DBZC	Equivalent reflectivity factor. Logged horizontally-polarized reflectivity factor	byte	dBZ

	(corrected).		
elevation	Ray elevation angle	float	degrees
fixed_angle	Ray target fixed angle	float	degrees
frequency	Transmission frequency	float	s^{-1}
grid_mapping	Azimuthal equidistant projection	int	-
latitude	Latitude	double	degrees N
longitude	Longitude	double	degrees E
nyquist_velocity	Unambiguous doppler velocity	float	m/s
PHIDP	Differential phase	short	degrees
RHOHV	Correlation between horizontal and vertical radar reflectivity	byte	-
SQI	Signal quality index	byte	-
sweep_mode	Scan mode for sweep: Sector, coplane, rhi, vertical_pointing, idle, azimuth_surveillance, elevation_surveillance, sunscan, pointing, calibration, manual_ppi, manual_rhi, sunscan_rhi	char	-
time_coverage_end	Data volume end time UTC	char	UTC
time_coverage_start	Data volume start time UTC	char	UTC
UDBZ	Logged horizontally-polarized total reflectivity factor (uncorrected)	byte	dBZ
UPHIDP	Differential phase (uncorrected)	short	degrees
VEL	Radial velocity of scatterers away from instrument	byte	m/s
WIDTH	Doppler spectrum width	byte	m/s
ZDR	Corrected logged differential reflectivity	byte	dB

Algorithm

Due to precipitation, the radar radiation and differential reflectivity are attenuated. The Dual-Pol based Attenuation Correction (DPATC) algorithm is used to correct the reflectivity values for rain attenuation. The algorithm is applied to both the SUR and RHI data files. More information about the DPATC algorithm is provided in the DPATC – Dual-Pol based Attenuation Correction documentation.

Quality Assessment

The CAX1 radar had an absolute up-time of about 96.7% without any significant technical difficulties (less than 0.2%). When there was an outage, it was related to shutdowns for safety during on-site activities. In theory, the radar reflectivity value of a horizontal view of light raindrops should be 0.0, as well as appear spherical. To remove the possible effect of radome wetting, times where the precipitation rate was >0.01 mm/h were not included in the calculation of a daily mean radar reflectivity bias. This radar reflectivity bias was determined to be 0.75 dB for the entire dataset, where there was no significant day-to-day variation of the overall radar reflectivity bias. Also, no radar reflectivity bias correction was applied to this dataset. More information about the quality of these data are available in the CAX1 ZDR bias PI documentation.

Software

These data are available in Cfradial netCDF-4 format and can be read using the Python ART Radar Toolkit (Py-ART) or the C++ Radar Decoder. More information about these decoders is available on the NOAA Decoding Utilities and Examples webpage. These data can also be viewed in Panoply.

Known Issues or Missing Data

It was a significant challenge to mitigate clutter in the radar data, including severe orography of the Olympic Peninsula and sea clutter and ship traffic in the Juan de Fuca Strait. Because of the orographic conditions of the area, the CAX1 radar could only take measurements on the lee side of the Olympic Mountains; however, there were still a number of precipitation events on the lee side of these mountains. More information about the known issues of these data can be found in Hudak et al., 2016.

References

METEOR 60DX COMPACT WEATHER RADAR. http://www.de.selex-es.com/documents/16243296/30914446/Kopie+von+Selex-ES-METEOR-60DX.pdf

Hudak, David, Peter Rodriguez, Norman Donaldson, and Daniel Kirshbaum (2016). OLYMPEX Canada. https://ams.confex.com/ams/17Mountain/webprogram/Paper296448.html

Related Data

All data from other instruments collected during the OLYMPEX field campaign are related to this dataset. Other OLYMPEX campaign data can be located using the GHRC HyDRO 2.0 search tool.

In particular, the following datasets are directly related to this CAX1 radar during the OLYMPEX field campaign:

GPM Ground Validation CAX1 Radar ODIM format OLYMPEX
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/XPOL/DATA101)

GPM Ground Validation CAX1 Radar RB5 format OLYMPEX (not yet published)

Contact Information

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

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