Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2

Introduction

The GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 dataset includes reflectivity and Doppler velocity measurements obtained by the Wyoming Cloud Radar (WCR) flown on board the University of Wyoming King Air (UWKA) aircraft, as well as aircraft navigation parameters. These data were collected as part of the Light Precipitation Validation Experiment (LPVEx) in September and October of 2010 around the Gulf of Finland. The dataset was collected to aid in achieving the overarching goals of LPVEx, to conduct a comprehensive evaluation of precipitation algorithms for current and future satellite platforms and to detect and understand the process of light rainfall formation at high latitudes. Data files are available in netCDF-3 format from September 16 through October 20, 2010 along with browse imagery in PDF and PNG format.

Notice: The UWKA aircraft did not operate each day of the campaign, therefore, data are only available on flight days.

Citation

Lecuyer, Tristan and J. French. 2013. GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx [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/GPMGV/LPVEX/WCR/DATA101

Keywords:

NASA, PMM, GPM GV, GHRC, LPVEx, University of Wyoming, Gulf of Finland, King Air, airborne, radar, cloud radar, reflectivity, Doppler velocity, polarimetric

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 the 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 observation infrastructure (polarimetric radars, profilers, rain gauges, and disdrometers). These field campaigns accounted for the majority of the effort and resources expended by the GPM GV mission. More information about the GPM mission is available on the PMM Ground Validation webpage.

The Light Precipitation Validation Experiment (LPVEx) sought to characterize high-latitude, 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's National Environment 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 (Figure 1). One of the objectives of the experiment was to evaluate the performance of satellite measurements when estimating rainfall intensity in high-latitude regions. This data collection had the purpose of improving high-latitude 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 identify 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.

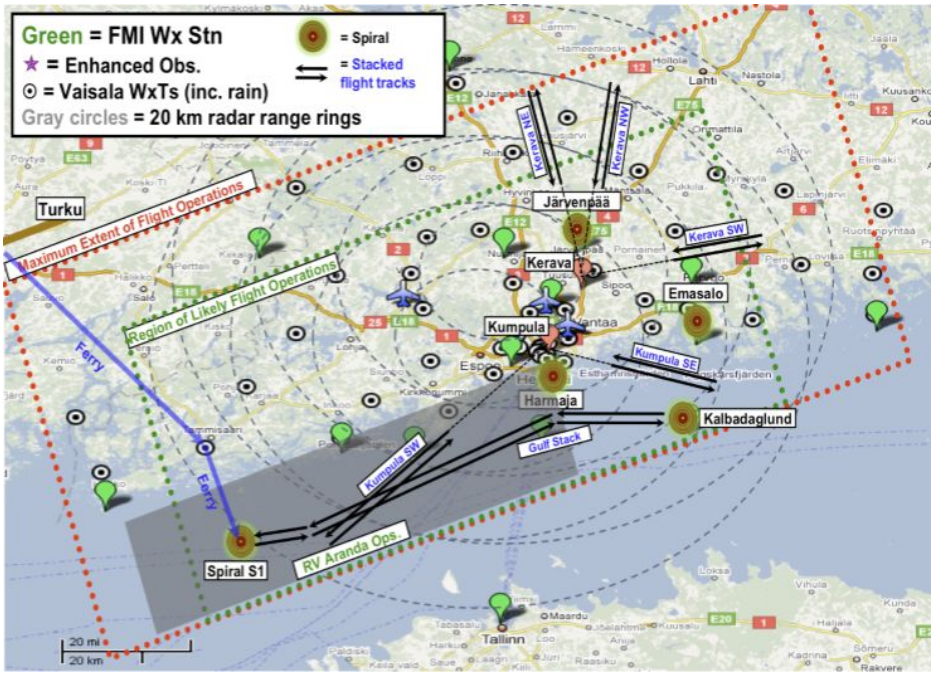

Figure 1: The LPVEx field campaign study area along the Gulf of Finland (Image source: LPVEx Science Plan)

Instrument Description

The Wyoming Cloud Radar (WCR) is a 95 GHz, W-band polarimetric Doppler radar that collects radar reflectivity, Doppler velocity, and polarization measurements from onboard the University of Wyoming King Air (UWKA) research aircraft. UWKA is a Raytheon King Air 200T twin-turboprop aircraft designed to be used for atmospheric research by the University of Wyoming (Figure 2). WCR can operate up to four antennas to obtain observations from above, below, and beside the aircraft. WCR's short wavelength and high-resolution cloud observations make it useful in a number of research areas including cloud and aerosol studies. More information about WCR is available on the University of Wyoming WCR webpage. More information about the UWKA aircraft is available on the University of Wyoming King Air Aircraft webpage.

Figure 2: University of Wyoming King Air Research Aircraft (Top), NSF/NCAR C-130 Research Aircraft (Bottom Left), and WCR antenna (Bottom Right)
(Image source: University of Wyoming WCR webpage)

Investigators

Tristan Lecuyer
University of Wisconsin - Madison
Madison, WI

Jeffrey French
University of Wyoming
Laramie, WY

Data Characteristics

The GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 dataset files are available in netCDF-3 format at a level 1B 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 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	University of Wyoming King Air (UWKA)
Instrument	Wyoming Cloud Radar (WCR)
Spatial Coverage	N: 61.540, S: 59.631 , E: 26.513, W: 19.837 (Gulf of Finland)
Spatial Resolution	Volume Resolution at 1km, 250ns: 37 (range) x 12 x 15 m at 3km, 250ns: 37 (range) x 36 x 39 m
Temporal Coverage	September 16, 2010 - October 20, 2010
Temporal Resolution	1 minute -< 1 hour
Sampling Frequency	0.1 second
Parameter	Reflectivity and Doppler Velocity
Version	2
Processing Level	1B

File Naming Convention

The GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 dataset consists of netCDF-3 data files along with PDF and PNG browse imagery. These files are named using the following convention:

Data files:
WCR.LPVEX10.YYYYMMDD.<start_time>_<stop_time>.CPP-<antenna>.nc
Browse files:
WCR.LPVEX10.YYYYMMDD.<start_time>_<stop_time>.CPP. <parameter> . <direction>.pdf

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
start_time	File UTC start time in *hhmmss* where: hh = two-digit hour mm = two-digit minute ss = two-digit second
stop_time	File UTC stop time in *hhmmss* where: hh = two-digit hour mm = two-digit minute ss = two-digit second
antenna	H1, H2, V2 (All represent different antennas/pointing directions for the radar; H1: vertically up, H2: Down-slant, V2: vertically down. So if a file has all three, the radar was transmitting/receiving to all three antennas; if a file only contains H1V2, then only those two antennas were being used for that particular file.)

parameter	Radar parameter type DV1: Doppler velocity dBZhh1: reflectivity
direction	Antenna pointing direction Down-fore: pointing ~30° forward from nadir Updown: Upward/downward pointing
.nc	netCDF-3 file format
.pdf	PDF file format
.png	PNG file format

Data Format and Parameters

The GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 dataset files contain airborne radar data, including Doppler velocity and radar reflectivity. The WCR User Notes document explains the data processing procedures for each variable in the dataset, as well as calibration notes. Multiple data variables are available for users to select, however, the variables listed below are those that were chosen to be provided for the LPVEx field campaign. Table 3 below outlines and describes the data fields found in each netCDF-3 file.

Table 3: netCDF-3 Data Fields

Field Name	Description	Data Type	Unit
acvcbeam	Platform velocity component along WCR beam (Positive is away from the radar)	float	$m\ s^{-1}$
acwcbeam	Platform measured wind component along WCR beam (Positive is away from the radar)	float	$m\ s^{-1}$
ALT	Radar platform altitude from MSL	float	meters
irigstatus	WCR TFP card IRIG-B status 8-bit word	int	-
LAT	Radar platform latitude	double	degrees North
LON	Radar platform longitude	double	degrees East
noise	Estimated receiver noise power in mm^6m^{-3} at 1 km	float	mm^6m^{-3}
noisestd	Standard deviation of noise power in mm^6m^{-3} at 1 km	float	mm^6m^{-3}
ppmag	Pulse Pair magnitude	float	mW
ppnm	Pulse Pair Noise magnitude	float	mW
range	Range to (geometric) center of radar range gates	float	meters
range_cor	Received power range(in km) correction ($1/r^2$)	float	dB
reflectivity	Equivalent reflectivity factor	float	mm^6m^{-3}

reflectivity_mask	Target mask (1=target, 0=no signal,9=receiver saturation)	byte	-
TAS	Radar platform true airspeed	float	m s^{-1}
time	Profile acquisition time in "seconds since 1970-01-01 00:00:00 +0000 "	double	seconds
velocity	Doppler radial velocity (Positive is toward the radar)	float	m s^{-1}
wcraspect	WCRrangesampling/(WCRtimeint*tas)	float	-
wcrbeamacvec	Radar beam unit vector in platform coordinates	float	-
wcrbeamvector	(East, North, Up) radar beam unit vectors	float	-

Browse Imagery

The browse image files consist of radar reflectivity and Doppler velocity time-series plots for each antenna pointing direction. There are 4 image files for each time range: up/down reflectivity, up/down velocity, down-fore reflectivity, and down-fore velocity. The data values are plotted against time, altitude, and distance. The majority of the browse image files are in PDF format, however, there are some duplicate images in PNG format.

Algorithm

Reflectivity and Doppler velocity variables are the two primary measurements stored in the GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 dataset. No correction for scattering or absorption is applied to the reflectivity; however, mean noise is subtracted to remove negative values that are outliers, e.g. lower than the mean. The Doppler velocity values have been corrected for aircraft motion and orientation using navigation and GPS data from the aircraft flight system. More information about the data processing algorithms used to produce this dataset is available in the WCR User Notes document provided by the PI.

Quality Assessment

The GPM Ground Validation Wyoming Cloud Radar (WCR) LPVEx V2 reflectivity products have undergone noise removal and range correction. The Doppler velocity measurements have been corrected for platform (i.e., aircraft) motion and the beam orientation is provided in the Earth-relative coordinates for each beam. Further information about the filtering and correction algorithms are available in the LPVEx Science Plan document.

Software

This dataset is in netCDF-3 format and does not require any specific software to read; however, the data files can easily be opened and viewed in Panoply.

Known Issues or Missing Data

The UWKA aircraft did not operate each day of the campaign, therefore, data are only available on flight days. There are also several gaps in the data caused by a variety of flight or sensor issues. The PI Release Notes provide detailed remarks for missing data issues and sensor errors.

References

Haimov, S. & Rodi, A. (2013). Fixed-Antenna Pointing-Angle Calibration of Airborne Doppler Cloud Radar. *Journal of Atmospheric and Oceanic Technology*, *30*, 2320–2335. https://doi.org/10.1175/JTECH-D-12-00262.1

NASA (2014). Light Precipitation Evaluation Experiment (LPVEx). https://ghrc.nsstc.nasa.gov/home/sites/default/files/lpvex_science_plan_June2010.pdf

University of Wyoming - Flight Center. (1977). University of Wyoming King Air Aircraft. https://doi.org/doi:10.15786/M29M1V

University of Wyoming - Flight Center. (1995). Wyoming Cloud Radar (WCR). https://doi.org/doi:10.15786/M2237S

Wang, J. & Geerts, B. (2003). Identifying drizzle within marine stratus with W-band radar reflectivity. *Atmospheric Research*, *69*, 1-27. https://doi.org/10.1016/j.atmosres.2003.08.001

Related Data

All data collected by other instruments during the LPVEx field campaign are considered related datasets. These data can be located by searching the term 'LPVEX' using the GHRC HyDRO2.0 search tool. For example, other datasets collected from onboard the UWKA aircraft such as the LPVEx Cloud Microphysics and Cloud Spectrometer and Impactor (CIP) datasets are linked below:

GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx dataset (http://dx.doi.org/10.5067/GPMGV/LPVEX/MULTPLE/DATA202)

GPM Ground Validation Cloud Spectrometer and Impactor (CIP) LPVEx (http://dx.doi.org/10.5067/GPMGV/LPVEX/PROBES/DATA201)

Contact Information

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

NASA Global Hydrology 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: 01/30/18
Updated: 09/18/19