Global Hydrology Resource Center

Data User Guide

GPM Ground Validation C-Band Radar LPVEx Datasets

Introduction

The GPM Ground Validation C-Band Radar LPVEx datasets consists of radar reflectivity data from the ground based dual-polarimetric C-Band Doppler radar network in Finland during the Global Precipitation Measurement (GPM) mission Light Precipitation Validation Experiment (LPVEx) field campaign. There are five separate datasets including data from the C-Band Ikaalinen (IKA) Radar, the C-Band Kerava (KER) Radar, the C-Band Korpo (KOR) Radar, the C-Band Kumpula (KUM) Radar, and the C-Band Vantaa (VAN) Radar. These radars provided reflectivity measurements for light precipitation systems during LPVEx. This field campaign took place around the Gulf of Finland, aiming to provide additional high-latitude, light rainfall measurements for the improvement of GPM satellite precipitation algorithms. The C-Band Radar data files are available in RAW and UF format, with browse imagery in PNG format, for a range of dates between September 01, 2010 and January 31, 2011 depending on the radar site.

Notice:
The Ikaalinen and Korpo radar sites were only used on October 19, 2010 to provide radar data during King Air flight observations over the Gulf of Bothnia, therefore, data for these two sites are only available for this date.

Citation

There are five citations, each for one of the LPVEx C-Band radar systems, including the Ikaalinen radar, Kerava radar, Korpo radar, Kumpula radar and Vantaa radar, respectively. Please select the appropriate citation for the data you are using:

GPM Ground Validation C-Band Ikaalinen (IKA) Radar LPVEx

Moisseev, Dmitri. 2020. GPM Ground Validation C-Band Ikaalinen (IKA) Radar 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/RADAR/DATA101

GPM Ground Validation C-Band Kerava (KER) Radar LPVEx

Moisseev, Dmitri. 2020. GPM Ground Validation C-Band Kerava (KER) Radar 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/RADAR/DATA201

GPM Ground Validation C-Band Korpo (KOR) Radar LPVEx

Moisseev, Dmitri. 2020. GPM Ground Validation C-Band Korpo (KOR) Radar 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/RADAR/DATA301

GPM Ground Validation C-Band Kumpula (KUM) Radar LPVEx

Moisseev, Dmitri. 2020. GPM Ground Validation C-Band Kumpula (KUM) Radar 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/RADAR/DATA401

GPM Ground Validation C-Band Vantaa (VAN) Radar LPVEx

Moisseev, Dmitri. 2020. GPM Ground Validation C-Band Vantaa (VAN) Radar 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/RADAR/DATA501

Keywords:

NASA, GHRC, University of Helsinki, FMI, Vaisala, LPVEx, C-Band radar, Gulf of Finland, Ikaalinen, Kerava, Korpo, Kumpula, Vantaa

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.

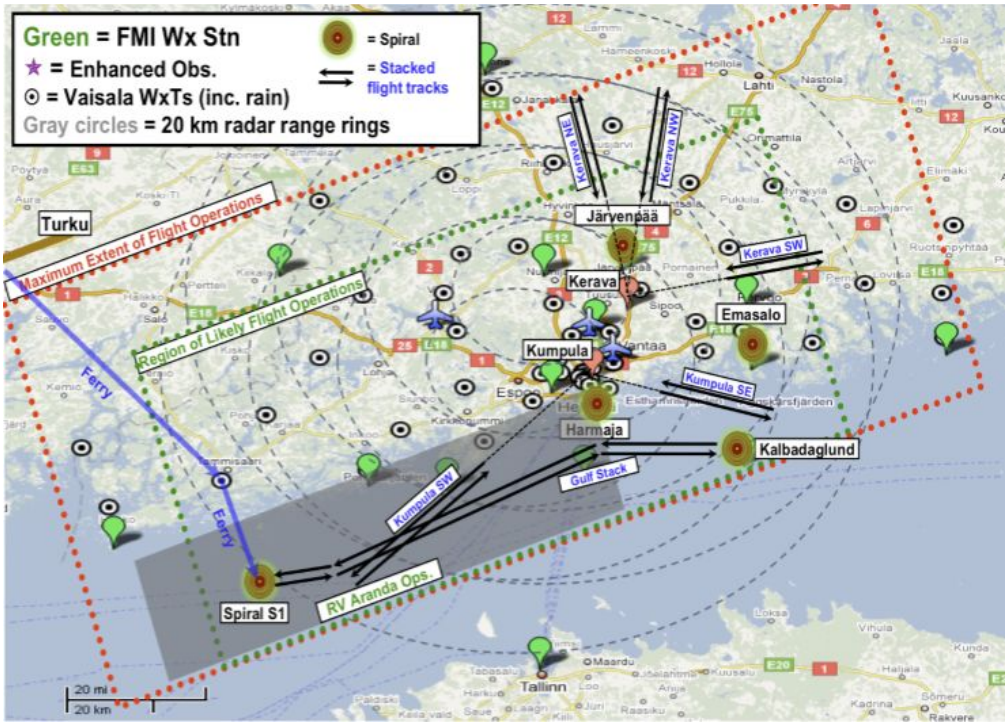

Figure 1: The LPVEx field campaign study area along the Gulf of Finland (Image source: LPVEx Science Plan)

Instrument Description

The C-Band radars used during the LPVEx field campaign included systems operated by the Finnish Meteorological Institute (FMI) and the University of Helsinki. The Ikaalinen, Korpo,

and Vantaa C-Band radars are a part of the FMI C-Band radar network that now includes 10 radar sites at various locations across Finland. These radars make up Finland's National Radar Network that provide operational weather observations. The radars of this network are dual-polarization C-Band Doppler radars. C-Band radars were chosen because they are cost effective while still providing quality precipitation measurements. The Kumpula and Kerava C-radars were operated by the University of Helsinki (Figure 2). These radar systems are also dual-polarization C-Band Doppler radars and function as research radar systems. There were three primary C-Band radars used throughout the field campaign including the Vantaa, Kumpula, and Kerava sites. The two other FMI radar sites were used for a specific operations day on October 19, 2010 to provide radar data during King Air flight observations over the Gulf of Bothnia.

During the LPVEx campaign, the researchers were allowed full control of the University of Helsinki research radars. This allowed for more research operations such as RHI scans along flight and satellite tracts. The other radar system completed operational volume scans. Radars can be maneuvered to complete different types of scans. During the campaign, they utilized the Plan Position Indicator (PPI) scan where a 360 degree sweep of the antenna is made and the Range Height Indicator (RHI) scan in which scans point at a specific azimuth and the antenna tilts upward to get vertical profile information. The characteristics of each C-Band radar used during LPVEx is listed in Table 1 below.

Table 1: LPVEx C-Band Radar Sites

Field Name					
Radar name	Vantaa	Kumpula	Kerava	Ikaalinen	Korpo
Frequency	5649 MHz	5610 MHz	5625 MHz	5600-5650 MHz	5600-5650 MHz
Antenna gain	45.8 dBi	45 dBi	45 dBi	44.2 - 45.1 dBi	44.2 - 45.1 dBi
Transmitter	magnetron	klystron	magnetron	magnetron	magnetron
Beam width	0.98°	0.95°	0.95°	0.94° - 0.98°	0.94° - 0.98°
Peak power	250 kW	250 kW	250 kW	250 kW	250 kW
Pulse length	0.5 - 2 μs	0.5 - 5 μs	0.5 - 2 μs	0.84μs, 2μs	0.84μs, 2μs
Location	60.2706°N, 24.8725°E	60.2043°N, 24.9630°E	60.3883°N, 25.1133°E	61.7671°N, 23.0799°E	60.1284°N, 21.6465°E
Scanning strategy	operational	research	research	operational	operational

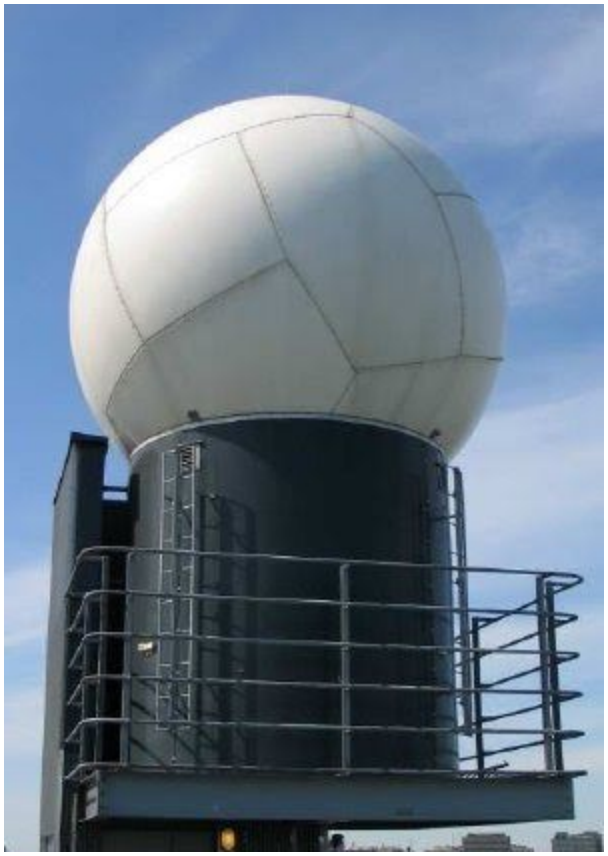

Figure 2: The University of Helsinki Kumpula C-Band Weather Radar
(Image source: UH Radar Meteorology Group)

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Data Characteristics

The GPM Ground Validation C-Band Radar LPVEx dataset consists of radar reflectivity data in RAW and UF formats with browse imagery available in PNG format. These data are available at a Level 2 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 2 below.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground Based
Instrument	Ikaalinen (IKA) C-Band Radar Kerava (KER) C-Band Radar

	Korpo (KOR) C-Band Radar Kumpula (KUM) C-Band Radar Vantaa (VAN) C-Band Radar
Spatial Coverage	IKA: N: 64.012 , S: 9.522 , E: 27.830 , W: 18.330 KER: N: 62.634 , S: 58.142 , E: 29.663 , W: 20.565 KOR: N: 62.373 , S: 57.884 , E: 26.157 , W: 17.136 KUM: N: 64.687 , S: 55.722 , E: 34.012 , W: 15.914 VAN: N: 60.342 , S: 60.322 , E: 24.916 , W: 24.896
Spatial Resolution	120 - 250 km range
Temporal Coverage	IKA: October 19, 2010 - October 19, 2010 KER: September 21, 2010 - October 20, 2010 KOR: October 19, 2010 - October 19, 2010 KUM: September 01, 2010 - January 31, 2011 VAN: September 16, 2010 - January 31, 2011
Temporal Resolution	Gzipped TAR files: Daily Unzipped Raw and UF files: 5 minute Unzipped Browse files: 6 minute
Sampling Frequency	< 1 second
Parameter	Reflectivity
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation C-Band Radar LPVEx data files are available in compressed Gzip TAR files. Once unzipped, the data files are available in RAW and UF format with browse files available in PNG format. The files are named using the following convention:

Gzipped Data files:
lpvex_RADAR_<site name>_<data type>_YYYYMMDD.tar.gz
Gzipped Browse files:
lpvex_RADAR_<site name>_IMAGES_YYYYMMDD.tar.gz

Unzipped Raw Data files:
YYYYMMDDhhmm_<abbrev>.<scan>.raw
Unzipped UF Data files:
YYYYMMDDhhmm_<abbrev>.<scan>.raw.uf
Unzipped Browse files:
<abbrev>YYMMDDhhmm<##>.PPI<serial number>.png

Table 3: File naming convention variables

Variable	Description
<site name>	Radar site name: IKAALINEN, KERAVA, KORPO, KUMPULA, or VANTAA

<data type>	RAW or UF
YYYY	Four-digit year
YY	Two-digit year
MM	Two-digit month
DD	Two-digit day
<##>	15 or 16
<serial number>	Three-digit serial number for each image with each digit increasing from 1-9, then A-Z (not including O & Q); e.g. VX4, W3Y, etc. (this number is not included for Vantaa browse files)
<abbrev>	Radar site abbreviation: IKA, KER, KOR, KUM, or VAN
hh	Two digit hour in UTC
mm	Two digit minute in UTC
<scan>	Scan sequence: PPI[1|2|3]_[A|B|C|D|E|F] (e.g. PPI1_A, PPI3_F, etc.) RHI_HV (cycle repeats every 15 minutes)
.tar	TAR archive file
.gz	GNU zipped (gzipped) archive file
.raw	Unprocessed data file
.uf	Universal File format (UF)
.png	Portable Network Graphic (PNG) format

Data Format and Parameters

The GPM Ground Validation C-Band Radars LPVEx dataset files are stored in Gzipped TAR files. Once unzipped they contain RAW and UF data files. The RAW files contain the unprocessed radar data. The UF files contain radar data in Universal File format (UF) which is common for Doppler radar data. These files can be viewed using specific software listed in the *Software* section. The radar products included in each data file are listed in Table 4 below.

Table 4: Data Fields

Field Name	Description	Units
Ah/v	Integral attenuation for horiz. and vert. channels	dB
Azdr	Integral attenuation of ZDR (dB) format	dB
CCOR	Cross-correlation	-
CSP	Doppler channel clutter power	dB
CSR	Clutter-to-signal ratio	dB
dBT	Total power	dBT
dBZ	Clutter corrected reflectivity	dBZ
dBZt	Uncorrected reflectivity	dBZ
KDP	Specific differential phase	degrees/km

LDR	Linear depolarization ratio	dB
LOG	Log receiver signal-to-noise ratio	dB
PHIH/V	Horizontal/vertical differential phase	degrees
PHIDP	Differential phase	degrees
PMI	Polarimetric meteo index	-
R	Rate of accumulation of precipitation	mm/hr
RHOHV	Correlation coefficient between HH and VV	-
SNR	Signal-to-noise ratio	dB
SQI	Signal quality index	-
T	Total reflectivity	dBZ
V	Velocity	m/s
VC	Corrected velocity	m/s
W	Spectral width	m/s
Z	Reflectivity	dBZ
ZC	Corrected reflectivity	dBZ
ZDR	Differential reflectivity	dB
ZDRC	Corrected differential reflectivity	dB
Zh	Horizontal Reflectivity	dBZ
Zv	Vertical Reflectivity	dBZ
Zhv	Horizontal/vertical Reflectivity	dBZ

Browse Imagery
The browse files are also stored in Gzipped TAR file format. Once unzipped, they contain PNG image files of radar reflectivity. Browse files are only available for the Kumpula and Vantaa radar sites.

Algorithm
Different methods are used to determine the relationship between radar reflectivity measurements and the accompanying rainfall intensity. The relationship depends largely on precipitation type. For FMI radars, an empirical equation is used to determine the water phase of precipitation for each radar measurement bin. In addition, the air temperature and humidity at 2 m are used to select the relation that is used along with an empirical equation for the probability of water. More information about FMI radar data processing is available in Saltikoff et al. (2010).

Quality Assessment
For the FMI radars, Doppler data is used to eliminate ground clutter as ground targets typically have zero velocity and SNR is used for thresholding reflectivity values to eliminate noise. FMI radars are calibrated twice a year for antenna pointing and power. The pointing angle is calibrated using masts and the position of the Sun. In addition, a fuzzy logic based procedure is used in post-processing to remove interference, sea clutter and echoes from

birds. More information about the quality of data from the FMI C-Band Doppler radar network is available in Saltikoff et al. (2010).

Software

The UF format is the common Doppler radar data exchange format, described at UCAR (document based on a 1980 BAMS publication). Special software is required to read the UF files. There are free decoder programs available to read UF data on the NOAA Radar Decoding Utilities webpage. Some of these options are listed in Table 6 below. Code for reading UF files with IDL is available at GHRC.

Table 5: Software/Tool Information Table

Name	Type	Access	Software	License
Department of Energy (DOE) Py-ART	Plotting, conversion, analysis	Download	Python 2.6 or 2.7	Open source
UCAR Radx C++ Library	Conversion, analysis	Download	C++	Open source
NASA Radar Software Library	Visualization, conversion, analysis	Download	C	Open source
SSEC McIDAS-V	Visualization, analysis	Download	Java or Java-3D	Open source

Known Issues or Missing Data

The Ikaalinen and Korpo radar sites were only used on October 19, 2010 to provide radar data during King Air flight observations over the Gulf of Bothnia, therefore, data for these two sites are only available for this date. Also, browse files are only available for the Kumpula and Vantaa radar sites.

References

L'Ecuyer, T., Petersen, W., & Moiseev, D. (2010). Light Precipitation Validation Experiment (LPVEx) Science Plan. https://ghrc.nsstc.nasa.gov/home/sites/default/files/lpvex_science_plan_June2010.pdf

Petersen, W., L'Ecuyer, T., & Moiseev, D. (2011). The NASA CloudSat/GPM Light Precipitation Validation Experiment (LPVEx). https://ntrs.nasa.gov/search.jsp?R=20110015768

Saltikoff, E., Huuskonen, A., Hohti, H., Koistinen, J. & Järvinen, H. (2010). Quality Assurance in the FMI Doppler Weather Radar Network. *Boreal Environment Research*, *15*, 579-594. https://www.researchgate.net/publication/280623315_Quality_Assurance_in_the_FMI_Doppler_Weather_Radar_Network

University of Helsinki Radar Meteorology Group. (n.d.). Instruments. https://www.atm.helsinki.fi/UH_RADAR/sites.html

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.

Contact Information

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

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