Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Precipitation Occurrence Sensor System (POSS) LPVEx

Introduction

The GPM Ground Validation Precipitation Occurrence Sensor System (POSS) LPVEx dataset consists of precipitation and radar parameter estimates for both liquid and solid precipitation. Measurements were collected by the Precipitation Occurrence Sensor System (POSS) during the Global Precipitation Measurement (GPM) mission Light Precipitation Validation Experiment (LPVEx) field campaign. This 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-latitude, light rainfall measurements for the improvement of GPM satellite precipitation algorithms. The POSS dataset files are available from September 18, 2010 through April 20, 2011 for two POSS sites: Emasalo and Jarvenpaa. The data files are in CSV format with browse imagery in PNG format.

Notice:
The LPVEx field campaign officially took place in September and October 2010, but individual data sets, such as the POSS dataset discussed here, provided data beyond the campaign.

Citation

Peter Rodriguez. 2019. GPM Ground Validation Precipitation Occurrence Sensor System (POSS) 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/POSS/DATA101

Keywords:

NASA, GHRC, GPM GV, LPVEx, POSS, precipitation, DSD, Doppler velocity spectrum, radar reflectivity, hydrometeor

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 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 (Figure 1). 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-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 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](#).

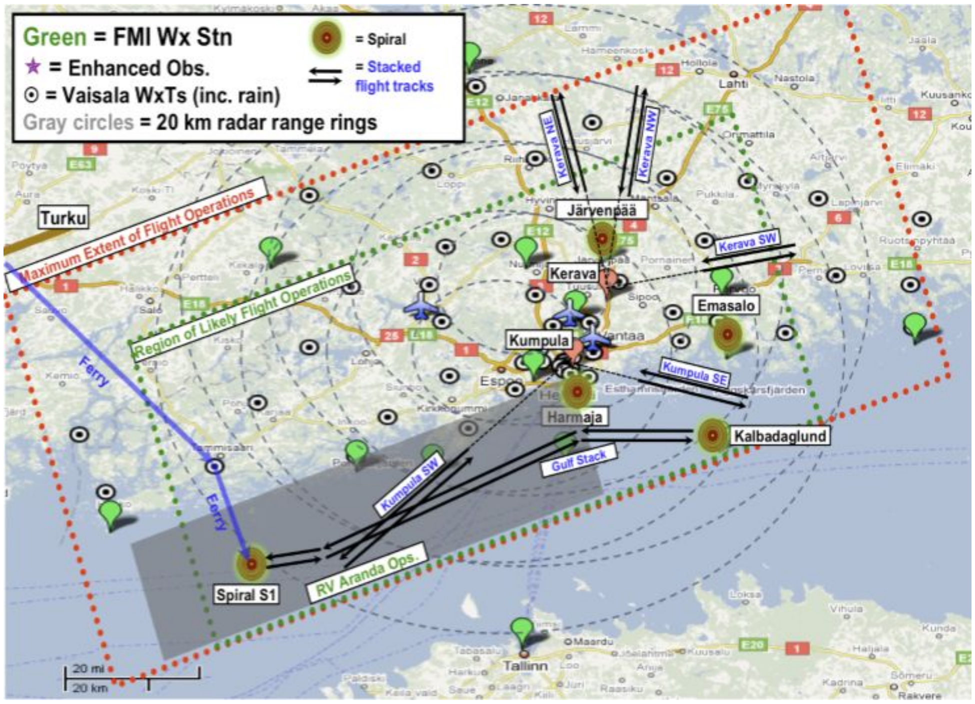

Figure 1: LPVEx field campaign study area along the Gulf of Finland
(Image source: [LPVEx Science Plan])

Instrument Description

The Precipitation Occurrence Sensor System (POSS) is a small bistatic, X-band Doppler radar (Figure 2) that measures the radar backscatter of hydrometeor targets to retrieve information such as velocity and size. The radar's transmitter and receiver antennas are mounted approximately 25 cm apart on a post about 3 m above the surface. The radomes that house the antennas are oriented at 20° from the vertical, allowing the antenna beams to intersect about 34 cm above and halfway in-between the radomes. POSS operates by measuring the characteristics of hydrometeors passing through the volume just above the instrument within a distance of about 3 m. From POSS measurements, additional parameters such as rain drop size distribution (DSD) and precipitation rate can be estimated. More information about the POSS instrument is available in Sheppard and Joe, 2008 and Sheppard, 2007.

Figure 2: The POSS instrument
(Image source: Shepard and Joe, 2008)

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Data Characteristics

The GPM Ground Validation Precipitation Occurrence Sensor System (POSS) LPVEx dataset includes precipitation and radar parameter estimates at 1-minute intervals. These files are in CSV format and have undergone post-processing from the raw Doppler velocity power spectrum products. The data files contain Doppler velocity spectrum, precipitation type, water content, radar reflectivity factor, precipitation rate, differential phase, attenuation, and other parameters derived from POSS measurements. This dataset is 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 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	Ground Stations (Emasalo and Jarvenpaa, Finland)
Instrument	Precipitation Occurrence Sensor System (POSS)

Instrument location	Emasalo: (Lat: 60.204, Lon: 25.625) Jarvenpaa: (Lat: 60.485, Lon: 25.082)
Spatial Coverage	N: 60.485, S: 60.204, E: 25.625, W: 25.082 (Finland)*
Spatial Resolution	Horizontal: 5cm Vertical: 1cm
Temporal Coverage	September 17, 2010 - April 20, 2011
Temporal Resolution	1 minute
Sampling Frequency	2.048 kHz
Parameter	Precipitation
Version	1
Processing Level	2

*Note: Because POSS observations are made in the area just above the instrument, they are essentially point observations.

File Naming Convention

The GPM Ground Validation Precipitation Occurrence Sensor System (POSS) LPVEx dataset files are named using the following convention:

Data files: lpvex_poss_PR_YYYYMMDD_[EMA|JAR].csv
Browse files: lpvex_poss_PR_YYYYMMDD_[EMA|JAR].png

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
[EMA|JAR]	Instrument location: EMA = Emasalo JAR = Jarvenpaa
.csv	Comma-Separated Values (CSV) file format
.png	Portable Network Graphics (PNG) image format

Data Format and Parameters

The GPM Ground Validation Precipitation Occurrence Sensor System (POSS) LPVEx dataset files are in CSV format. Each file begins with a header providing an overview of the data contained within the file. Following the header are the POSS data fields. Each column corresponds to the fields listed in Table 3 below. These fields describe the characteristics of the observed precipitation including various radar parameters and statistical calculations. Additional date-by-date weather observations for the Jarvenpaa location are included in the LPVEx POSS JAR document.

Table 3: Data Fields

Column	Field Name	Description	Unit
A	Date	*MM/DD/YY hh:mm:ss* where MM, DD, YY = Two-digit month, day, year hh, mm, ss = Two-digit hour, minute, second in UTC	-
B	Obs_Wx	Meteorological Observer Weather in standard "SA" format (see Table 4)	-
C	POSS_Wx	POSS Weather in standard "SA" format (see Table 4)	-
D	Obs_Temp(c)	Meteorological observer temperature (integer)	deg C
E	POSS_Temp(c)	POSS temperature (integer)	deg C
F	Obs_wind_speed(kts)	Meteorological observer wind speed(integer)	knots
G	1min_wind_speed(kts)	When available 1 min wind speed in knots	knots
H	Diagnostic	POSS diagnostic code not defined here (4 hex digits)	-
I	0th_moment	0th moment of POSS Doppler velocity spectrum	-
J	Mode_vel(m/s)	Velocity at the mode of the POSS Doppler velocity spectrum	m/s
K	Mean_vel(m/s)	1st moment of POSS Doppler velocity spectrum	m/s
L	SD_vel(m/s)	2nd moment of POSS Doppler velocity spectrum	m/s
M	LWC_or_IWC(g/m^3)	POSS estimate of liquid precip water content from 3rd moment of DSD or ice precip water content from first order log-log regression on 0th moment. (4 decimals)	g/m^3
N	RATE_dsd(mm/h)	POSS mass flux rate (mm/h) (3 decimals) for liquid precip and *#N/A* for solid. Note if a "T" is the last character then the DSD is wind corrected otherwise "F" indicates uncorrected.	mm/h
O	log_RATE_dsd(mm/h)	Log base 10 of POSS mass flux rate (mm/h) (3 decimals)	mm/h
P	RATE_regression(mm/h)	POSS rate (mm/h) from second order log-log regression on 0th moment (3 decimals). Eq. different for liquid and solid	mm/h
Q	log_RATE_regression(mm/h)	Log base 10 of POSS regression rate (mm/h) (3 decimals)	mm/h

R	RATE_regression_for_P(mm/h)_assuming_liquid	If POSS reports “P” then rate (mm/h) assuming liquid second order log-log regression on 0th moment (3 decimals). If POSS reports “R” “L” or “S” then *#N/A* is reported	mm/h
S	log_RATE_regression(mm/h)	Log base 10 of POSS regression rate (mm/h)(3 decimals) in column 18	mm/h
T	RATE_regression_for_P(mm/h)_assuming_solid	If POSS reports “P” then rate (mm/h) assuming solid second order log-log regression on 0th moment (3 decimals). If POSS reports “R” “L” or “S” then *#N/A* is reported	mm/h
U	log_RATE_regression(mm/h)	Log base 10 of POSS regression rate (mm/h)(3 decimals) in Column T	mm/h
V	Z_Rayleigh(dBZ)	Radar reflectivity factor calculated assuming Rayleigh scattering by spherical water drops, i.e. 6th moment of DSD (1 decimal). For snow, this is *#N/A*	dBZ
W	Zh_C(dBZ)=Ze	Equivalent radar reflectivity factor for horizontal polarization for C-band wavelengths (1 decimal). If POSS reports liquid or “P” then it is calculated from the DSD using the refractive index factor for liquid $\lvert K_w \rvert^2$. If POSS reports solid it is calculated from a second order log-log regression on the 0th moment using refractive index factor for liquid $\lvert K_w \rvert^2$.	dBZ
X	Zh_C(dBZ)=Ze_for_P_assuming_solid	Equivalent radar reflectivity factor of solid precipitation for horizontal polarization for C-band wavelengths (1 decimal) reported only if POSS reports “P”. The calculation is identical to Column W for solid precipitation. If POSS reports “R” “L” or “S” then *#N/A* is reported.	dBZ
Y	Zv_C(dBZ)	Radar reflectivity factor for vertical polarization for C-band wavelengths (1 decimal) for liquid and *#N/A* for solid	dBZ
Z	Zdr_C(dBZ)	Differential radar reflectivity factor for C-band wavelengths for liquid precip only (2 decimal)	dBZ
AA	Kdp_C(deg/km)	Specific differential phase for C-band wavelengths for liquid precip only (2 decimal)	deg/km

AB	Ah_C(dB/km)	Specific horizontal attenuation (dB/km) for liquid precip only (scientific notation)	dB/km
AC	Ah_C(dB/km)	Specific vertical attenuation (dB/km) for liquid precip only (scientific notation)	dB/km
AD	Ad_C(dB/km)	Specific differential attenuation (dB/km) for liquid precip only (scientific notation)	dB/km
AE	D0(mm)	Median volume diameter (2 decimal)	mm
AF	N0_Waldvogel(m^-3 mm^-1)	Intercept of DSD calculated using Waldvogel (1974) JAS vol.31 p.1072 (2 decimal)	m^{-3} mm^{-1}
AG	N0_mod_gamma(m^-3 mm^-(1+mu))	N0 modified gamma function fit to DSD (2 decimal)	m^{-3} $mm^{-(1+mu)}$
AH	SD_N0_mod_gamma	Uncertainty in estimate of N0 modified gamma function fit to DSD (2 decimal)	-
AI	Mu_gamma	Mu modified gamma function fit to DSD (2 decimal)	-
AJ	SD_Mu_gamma	Uncertainty in estimate of mu modified gamma function fit to DSD (2 decimal)	-
AK	Lambda_gamma(mm^-1)	Lambda modified gamma function fit to DSD (2 decimal)	mm^{-1}
AL	SD_Lambda_gamma	Uncertainty in estimate of lambda modified gamma function fit to DSD (2 decimal)	-
AM	chi2	Chi-squared for modified gamma function fit to DSD (2 decimal)	-
AN	NVALID	Number of DSD points in modified gamma function fit to DSD (integer)	-
AO	NTOTAL(m^-3)	Total number of raindrops per m^3 rounded to nearest integer	m^{-3}
AP	log N(D)(m^-3 mm^-1)	Start of raindrop size distribution (DSD); filled with value "N(D)="	-
AQ-BX	*See note	34 channels of DSD at diameter (mm) given in header (4 decimal)	m^{-3} mm^{-1}

*Note: For fields "AQ-BX", the field names are the following particle diameters (in mm): 0.34, 0.38, 0.44, 0.49, 0.54, 0.60, 0.66, 0.72, 0.78, 0.84, 0.91, 0.97, 1.05, 1.12, 1.20, 1.28, 1.37, 1.46, 1.55, 1.65, 1.76, 1.87, 2.00, 2.12, 2.26, 2.40, 2.56, 2.73, 2.92, 3.14, 3.40, 3.70, 4.15, and 5.34.

Table 4: Weather (Wx) code descriptions

Wx Code	Description
C	Clear
R	Rain
S	Snow
P	Snow-pellet
L	Drizzle
Intensity	**Description**

++	Very heavy
+	Heavy
no sign	Moderate
-	Light
--	Very light

E.g. *R++* means 'very heavy rain'

Note: The value *#N/A* means that the data were not available or the field was not calculated from the raw data. "P" in the *POSS_Wx* field indicates precipitation was detected but the type could not be identified. If very light precipitation was detected with the "0th moment" field equal to 0, no precipitation or radar parameters were calculated. The radar parameters dependent on polarization are calculated for liquid precipitation only.

Browse Imagery

The dataset browse images consist of six time-series plots, in UTC time, of POSS measured parameters for each date.

Algorithm

The algorithm that is applied to estimate the precipitation rate depends on the precipitation type. If reports from meteorological observations are available, the precipitation type reported is used to determine which algorithm is applied. If observation reports are not available, the POSS determined precipitation type is used.

The "mass flux (MF) method" is used to estimate precipitation rates for liquid precipitation. In this method, the DSD is estimated from the measured Doppler velocity spectrum. The product of the number concentration of drops, their volume, and fall velocity is summed over 34 diameter channels to give the mass flux rate. This method, however, cannot be used for solid precipitation. The "regression method"can be used to estimate rates for both liquid and solid precipitation. It is similar to the "Z-R" method used by large scale precipitation radars, using a regression between radar reflectivity (Z) and rate (R). In addition, the liquid water content (LWC) is calculated by integrating the DSD for liquid precipitation while the ice water content (IWC) is calculated using the regression equation for solid precipitation. More information about POSS precipitation algorithms is available in Sheppard and Joe, 2008, Sheppard, 2007, and the POSS Post-Processed Data Description document.

Quality Assessment

The regression method is more accurate at higher wind speeds compared to the MF method, which overestimates the liquid precipitation rate as speeds > 12 knots (~14 mph). Because of this, high winds can cause overestimation of LWC for liquid precipitation. In wet snow conditions near 0°C, overestimation in snowfall rates can occur due to the "bright band effect", when a radar detects a layer of higher reflectivity at the melting level where falling frozen hydrometeors begin to melt. Also, because POSS defines the precipitation type for mixed precipitation based on the dominant type in the volume, if POSS reports rain for mixed precipitation, all the parameters derived from the DSD can be overestimated. Additional information about POSS calibration and measurement validation is available in Sheppard and Joe, 2008 and Sheppard, 2007. More information about POSS data accuracy is described in the POSS Post-Processed Data Description document.

Software

No special software is required to view the POSS dataset files. The CSV files can be viewed in a spreadsheet software such as Microsoft Excel.

Known Issues or Missing Data

The value *#N/A* indicates data that were not available or the data field was not calculated from the raw data. A value of *-99* also indicates missing data. The LPVEx POSS JAR document outlines dates during the campaign with missing or incomplete data for the Jarvenpaa POSS location.

References

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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.

Additionally, the POSS instrument has been used in the GPM Ground Validation Environment Canada POSS Experiment (GCPEX).
(http://dx.doi.org/10.5067/GPMGV/GCPEX/POSS/DATA201)

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