Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX

Introduction

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX data were collected during the GPM Ground Validation Olympic Mountain Experiment (OLYMPEX) held on the Olympic Peninsula in the Pacific Northwest of the United States. Collected from four sites, the data contains daily ASCII-tsv files with information on individual hydrometeors including the number of hydrometeors, raindrop size distribution, and particle concentration. The data range from October 31, 2015 through January 17, 2016; exact dates may vary per site, and these data are available in ASCII-tsv format.

Notice:
The collection of the GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX dataset included mixed and frozen precipitation. It should also be noted that SN37 stopped operating on December 24, 2015, and had interruptions in the data collection due to power failure and other technical issues, so this site was not ideal and users should be cautious in using SN37 data.

Citation

Petersen, W. A., D. B. Wolff, M. Wingo, and A. Tokay. 2017. GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) 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/2DVD/DATA301.

Keywords:

NASA, GHRC, OLYMPEX, Washington, droplet size, hydrometeors, liquid precipitation, drizzle, rain, liquid water equivalent, precipitation amount, precipitation anomalies, precipitation rate, snow water equivalent, solid precipitation, total surface precipitation rate, virga, temperature, water vapor profiles, aerosol backscattering coefficients

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, several 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)

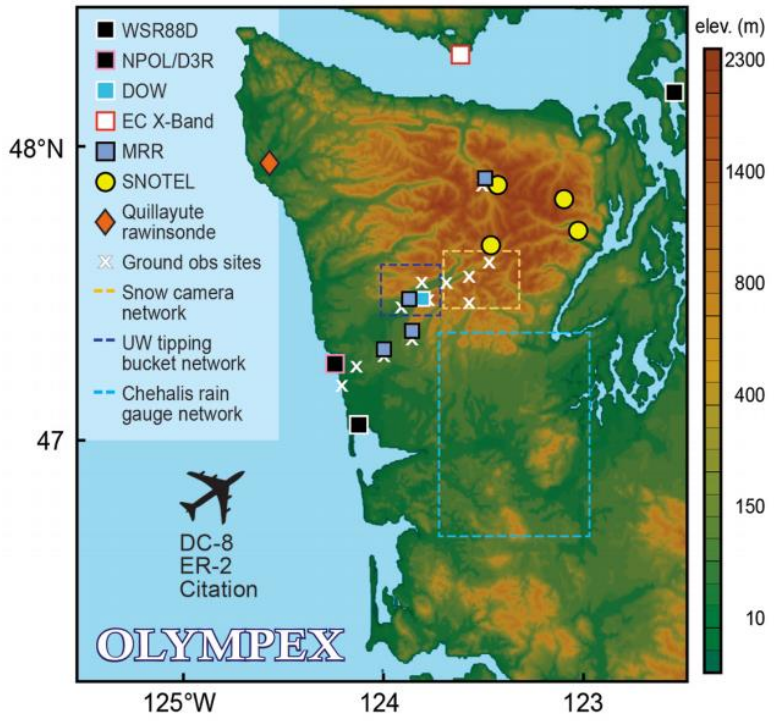

Figure 2: OLYMPEX Field Locations
(Image Source: https://pmm.nasa.gov/OLYMPEX)

Instrument Description

The Two-Dimensional Video Disdrometer (2DVD) instrument uses two high speed line scan cameras to provide continuous measurements of size distribution, shape, and fall velocities of all precipitation particles and types. Two orthogonal light planes, provided by two internal lamps, transect the approximate 10x10cm virtual measurement area and are projected onto two high speed line-scan cameras. Precipitation particles, also known as hydrometeors, that fall through the light planes cast a shadow that is recorded by the two cameras nested within the instrument. Detailed shape and size information for each individual hydrometeor is available through the two "side image shadows" that are recorded by the two cameras. The light planes are separated by a calibrated distance of 6mm from which the vertical fall velocity can be measured. The line scan cameras sample each plane every 18 microseconds at a horizontal resolution of 200 microns. Therefore, as a raindrop falls through the measurement area, several line scans of each image are recorded from two sides and two different heights. This allows for precise measurements to be made. More information about the 2DVD instrument can be found in Kruger et al., 2001 and https://wallops-prf.gsfc.nasa.gov/Field_Campaigns/Olympex/.

Figure 3: Two-Dimensional Video Disdrometer (2DVD)
(Image Source: https://wallops-prf.gsfc.nasa.gov/Disdrometer/index.html)

Table 1: OLYMPEX 2DVD sites and location information.

Site	Latitude (°)	Longitude (°)	Range (km) from NPOL	Azimuth (degrees) from NPOL
SN35 (Fishery)	47.360	-123.993	18.85	060.6
SN36 (Amanda Park)	47.460	-123.890	31.60	049.8
SN37 (Neilton Point)	47.389	-123.867	28.76	064.2
SN38 (Bishop CRN)	47.514	-123.812	39.96	048.6

Investigators

Walter A. Petersen
NASA Marshall Space Flight Center
Huntsville, Alabama

David B. Wolff
NASA Goddard Space Flight Center
Greenbelt, Maryland

Matthew Wingo
NASA Wallops Flight Facility
Wallops Island, Virginia

Ali Tokay
NASA Goddard Space Flight Center
Greenbelt, Maryland

File Naming Convention

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX dataset file names are in the following naming convention:

Data files: olympex_2dvd_disdrometer020.txt
olympex_2dvd_eachdrop_sn##_[50|100]pct.txt
olympex_2dvd_largedrop_sn##_50pct.txt
olympex_2dvd_sn##_[raindsd|rainparameter|raintotalhour]_[50pct|100pct].txt
olympex_2dvd_sn##_[raindsd|rainparameter]_[50pct|100pct]_ter.txt

Table 2: File naming convention variables

Variable	Description
sn##	Site number (35, 36, 37, or 38)
[50pct|100pct]	50pct: If the drop fall is outside the ±50% of its terminal fall speed, it is considered as a secondary drop and eliminated from the processing 100pct: all drops less than 10.0 mm in diameter are included in this file
.txt	ASCII-tsv text file

Data Format Description

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX data are available in ASCII-tsv format. The ASCII-tsv files are available in data processing level 3.

Table 3: Data Characteristics

Characteristic	Description
Platform	In Situ Land-based Platforms, Ground-Based Observations
Instrument	Two-Dimensional Video Disdrometer (2DVD)
Spatial Coverage	N: 47.514, S:47.360, E: -123.812, W: -123.993 (Olympic Mountains Washington)
Spatial Resolution	Point
Temporal Coverage	Start Date: October 31, 2015 Stop Date: January 17, 2016
Temporal Resolution	File per parameter, but each file contains the whole campaign of data
Sampling Frequency	Per rain event
Parameter	Precipitation, rain events, precipitation rate, drop size
Version	1
Processing Level	3

Data Parameters

For olympex_2dvd_eachdrop_sn##_100pct.txt files, all drops less than 10.0 mm in diameter are included in this file. There are 10 columns within these files. Table 4 describes each column within these olympex_2dvd_eachdrop_sn##_100pct.txt files.

For olympex_2dvd_eachdrop_sn##_50pct.txt files, all drops less than 10.0 mm in diameter are included in this file. The file screens the rain drops following ±50% of the terminal fall

speed limit. If the drop fall is outside the ±50% of its terminal fall speed, it is considered as a secondary drop and eliminated from the processing. There are 10 columns within these files. Table 4 describes each column within these olympex_2dvd_eachdrop_sn##_50pct.txt files.

Table 4: Description of each column within eolympex_2dvd_eachdrop_sn##_100pct.txt and olympex_2dvd_eachdrop_sn##_50pct.txt files

Column	Description	Unit
1	Year	-
2	Day of the year	-
3	Hour	hour
4	Minute	minute
5	Second	second
6	Drop equivalent diameter	mm
7	Measured drop fall velocity	m/s
8	Terminal fall speed	m/s
9	Measured drop oblateness	-
10	Sampling cross section	mm^2

The olympex_2dvd_diameter020.txt file presents midsize diameter, bin width size, and terminal fall speed velocity measurements following Beard et al., 1976 for 50 size bins from 0 to 10.0 mm. It should be noted that the terminal fall speeds are interpolated for the drops between 6.0 and 8.0 mm in diameter using measured fall speed increments just under 6.0 mm in diameters and assumed constant for the drops larger than 8.0 mm in diameter. There are 3 columns within the olympex_2dvd_disdrometer020.txt file. Table 5 describes each column within the olympex_2dvd_disdrometer020.txt file.

Table 5: Description of each column within olympex_2dvd_disdrometer020.txt file

Column	Description	Unit
1	Midsize diameter	mm
2	Size bin width	mm
3	Terminal fall velocity	m/s

The olympex_2dvd_sn##_raindsd_100pct.txt files uses the olympex_2dvd_eachdrop_sn##_100pct.txt files as inputs and outputs 50 size bin drop counts for 0.2 mm size width from 0 to 10.0 mm in diameter. The output file is generated for each minute where at least 10 drops were observed and a minimum rain rate of 0.01 mm/hr are considered as an event. Table 6 describes each column within each olympex_2dvd_sn##_raindsd_100pct.txt file.

The olympex_2dvd_sn##_raindsd_100pct_ter.txt files uses olympex_2dvd_eachdrop_sn##_100pct.txt files as inputs and outputs 50 size bin raindrop size distribution measurements. The output file is generated for each minute where at least 10 drops were observed and a minimum rain rate of 0.01 mm/hr are considered as an event. The size distribution calculation is based on the terminal fall speed. There are 54

columns within each olympex_2dvd_sn##_raindsd_100pct_ter.txt file. Table 6 describes each column within each olympex_2dvd_sn##_raindsd_100pct_ter.txt file.

The olympex_2dvd_sn##_raindsd_50pct.txt files uses the olympex_2dvd_eachdrop_sn##_50pct.txt files as inputs and outputs 50 size bin drop counts for 0.2 mm size width from 0 to 10.0 mm in diameter. The output file is generated for each minute where at least 10 drops were observed and a minimum rain rate of 0.01 mm/hr are considered as an event. Table 6 describes each column within each olympex_2dvd_sn##_raindsd_50pct.txt file.

The olympex_2dvd_sn##_raindsd_50pct_ter.txt files uses olympex_2dvd_eachdrop_sn##_50pct.txt files as inputs and outputs 50 size bin raindrop size distribution measurements. The output file is generated for each minute where at least 10 drops were observed and a minimum rain rate of 0.01 mm/hr are considered as an event. The size distribution calculation is based on the terminal fall speed. There are 54 columns within each olympex_2dvd_sn##_raindsd_50pct_ter.txt file. Table 6 describes each column within each olympex_2dvd_sn##_raindsd_50pct_ter.txt file.

Table 6: Description of each column within olympex_2dvd_sn##_raindsd_50pct_ter.txt, olympex_2dvd_sn##_raindsd_100pct_ter.txt, olympex_2dvd_sn##_raindsd_50pct.txt, and olympex_2dvd_sn##_raindsd_100pct.txt files

Column	Description	Unit
1	Year	-
2	Day of the year	-
3	Hour	hour
4	Minute	minute
5	0.2 mm in diameter drop counts	-
6	0.4 mm in diameter drop counts	-
7	0.6 mm in diameter drop counts	-
8	0.8 mm in diameter drop counts	-
9	1.0 mm in diameter drop counts	-
10	1.2 mm in diameter drop counts	-
11	1.4 mm in diameter drop counts	-
12	1.6 mm in diameter drop counts	-
13	1.8 mm in diameter drop counts	-
14	2.0 mm in diameter drop counts	-
15	2.2 mm in diameter drop counts	-
16	2.4 mm in diameter drop counts	-
17	2.6 mm in diameter drop counts	-
18	2.8 mm in diameter drop counts	-
19	3.0 mm in diameter drop counts	-
20	3.2 mm in diameter drop counts	-
21	3.4 mm in diameter drop counts	-
22	3.6 mm in diameter drop counts	-
23	3.8 mm in diameter drop counts	-

24	4.0 mm in diameter drop counts	-
25	4.2 mm in diameter drop counts	-
26	4.4 mm in diameter drop counts	-
27	4.6 mm in diameter drop counts	-
28	4.8 mm in diameter drop counts	-
29	5.0 mm in diameter drop counts	-
30	5.2 mm in diameter drop counts	-
31	5.4 mm in diameter drop counts	-
32	5.6 mm in diameter drop counts	-
33	5.8 mm in diameter drop counts	-
34	6.0 mm in diameter drop counts	-
35	6.2 mm in diameter drop counts	-
36	6.4 mm in diameter drop counts	-
37	6.6 mm in diameter drop counts	-
38	6.8 mm in diameter drop counts	-
39	7.0 mm in diameter drop counts	-
40	7.2 mm in diameter drop counts	-
41	7.4 mm in diameter drop counts	-
42	7.6 mm in diameter drop counts	-
43	7.8 mm in diameter drop counts	-
44	8.0 mm in diameter drop counts	-
45	8.2 mm in diameter drop counts	-
46	8.4 mm in diameter drop counts	-
47	8.6 mm in diameter drop counts	-
48	8.8 mm in diameter drop counts	-
49	9.0 mm in diameter drop counts	-
50	9.2 mm in diameter drop counts	-
51	9.4 mm in diameter drop counts	-
52	9.6 mm in diameter drop counts	-
53	9.8 mm in diameter drop counts	-
54	10.0 mm in diameter drop counts	-

The olympex_2dvd_sn##_rainparameter_100pct.txt files uses the olympex_2dvd_eachdrop_sn##_100pct.txt files as inputs, and the output is the integral rain parameters based on measured fall velocities at 1-minute integrations. The file consists of 13 columns, and it should be noted that total concentration, liquid water content, reflectivity in Rayleigh regime, and mass-weighted drop diameter requires fall speed information in their formulations. More information on the disdrometer-based calculation of integral rain parameters can be found in Tokay et al., 2001. Table 7 describes each column within these data files.

The olympex_2dvd_sn##_rainparameter_100pct_ter.txt files uses olympex_2dvd_eachdrop_sn##_100pct.txt files as inputs, and the output is the integral rain

parameters based on terminal fall velocities at 1-minute integrations. Table 7 describes each column within these data files.

The olympex_2dvd_sn##_rainparameter_50pct.txt files uses the olympex_2dvd_eachdrop_sn##_50pct.txt files as inputs, and the output is the integral rain parameters based on measured fall velocities at 1-minute integrations. The file consists of 13 columns, and it should be noted that total concentration, liquid water content, reflectivity in Rayleigh regime, and mass-weighted drop diameter requires fall speed information in their formulations. More information on the disdrometer-based calculation of integral rain parameters can be found in Tokay et al., 2001. Table 7 describes each column within these data files.

The olympex_2dvd_sn##_rainparameter_50pct_ter.txt files uses olympex_2dvd_eachdrop_sn##_50pct.txt files as inputs, and the output is the integral rain parameters based on terminal fall velocities at 1-minute integrations. Table 7 describes each column within these data files.

Table 7: Description of each column within olympex_2dvd_sn##_rainparameter_100pct.txt, olympex_2dvd_sn##_rainparameter_100pct_ter.txt, olympex_2dvd_sn##_rainparameter_50pct.txt, and olympex_2dvd_sn##_rainparameter_50pct_ter.txt files

Column	Description	Unit
1	Year	-
2	Day of the year	-
3	Hour	hour
4	Minute	minute
5	Total number of drops	-
6	Total concentration	Drops m^{-3} of air
7	Liquid water content	g/m^3
8	Rain rate	mm/h
9	Reflectivity in Rayleigh regime	dBZ
10	Mass-weighted drop diameter	mm
11	Maximum drop diameter	mm
12	Minimum drop diameter	mm
13	Standard deviation of the mass-weighted drop diameter following Ubrich and Atlas. 1998	-

The olympex_2dvd_sn##_raintotalhour_100pct.txt files uses olympex_2dvd_sn##_rainparameter_100pct.txt files as inputs, and provides the rain event summaries. The events are separated by 1 hour or more rain-free periods in rain rate time series. Events that are less than 3 minutes in duration or with rain totals less than 0.1 mm are not included. The files consists of 10 columns, which are described in Table 8.

The olympex_2dvd_sn##_raintotalhour_50pct.txt files uses olympex_2dvd_sn##_rainparameter_50pct.txt files as inputs, and provides the rain event summaries. The events are separated by 1 hour or more rain-free periods in rain rate time series. Events that are less than 3 minutes in duration or with rain totals less than 0.1 mm are not included. The files consists of 10 columns, which are described in Table 8.

Table 8: Description of each column within olympex_2dvd_sn##_raintotalhour_100pct.txt and olympex_2dvd_sn##_raintotalhour_50pct.txt files.

Column	Description	Unit
1	Year	-
2	Event start day of the year	-
3	Event start hour and minute in HH:MM where HH=hour and MM=minute	Hour and minute
4	Event end day of the year	-
5	Event end hour and minute in HH:MM where HH=hour and MM=minute	Hour and minute
6	Event rainy minutes	minute
7	Event maximum rain rate	mm/h
8	Event rain total	mm
9	Event maximum drop diameter	mm
10	Precipitation type R = rain S = snow	-

Algorithm

The fall velocity for each drop was calculated by using the time it takes for the drop to enter into the measurement plane of Camera A, the time proceeding from the upper Camera A to the lower Camera B, and the time the drop enters into the measurement plane of Camera B of the instrument, as well as the distance between the two cameras. More information about these calculations is available in Schönhuber et al., 2008.

The size distribution calculation within 2dvd_sn##_raindsd_ter.olympex files is based on the terminal fall speed.

Quality Assessment

In this dataset, raindrops exceeding 50% of their terminal fall speed are removed to eliminate spurious measurements, such as insects or splash drops. Also, minutes during a rain event with fewer than 10 drops and a rainfall rates less than 0.01 mm hr^{-1} are removed to eliminate noise. The rain events in the "rainEvent" data files are separated by one or more hours of precipitation-free periods based on the rain rates calculated from the

rain rate time series, and the rain events must persist for more than 3 minutes or have at least 0.1mm of rain accumulation.

Within the eachdrop_sn##_100%.txt files, note that the precise measurement of oblateness and fall speed was not achieved due to severe wind conditions and the change of instrument calibration during the field campaign, as compared with the 80 m fall experiment described in Thurai et al., 2007.

For eachdrop_sn##_50%.txt files, the file screens the rain drops following ±50% of the terminal fall speed limit. If the drop fall is outside the ±50% of its terminal fall speed, it is considered as a secondary drop and eliminated from the processing.

For largedrop_sn##_50%.txt files, the drops following ±50% the terminal fall speed limit are screened. If the drop fall is outside the ±50% of its terminal fall speed, it is regarded as a secondary drop and eliminated from the processing.

It should be noted that total concentration, liquid water content, reflectivity in Rayleigh regime, and mass-weighted drop diameter requires fall speed information in their formulations within the olympex_2dvd_sn##_rainparameter_100pct.txt and olympex_2dvd_sn##_rainparameter_50pct.txt files.

Events that are less than 3 minutes in duration or with rain totals less than 0.1 mm are not included in the olympex_2dvd_sn##_raintotalhour_100pct.txt and olympex_2dvd_sn##_raintotalhour_50pct.txt files.

Software

No software is required to read the GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX ASCII-tsv data files.

Known Issues or Missing Data

The collection of the GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) OLYMPEX dataset included mixed and frozen precipitation. SN35 had no snow days. SN36 had some mixed precipitation between December 23-27, 2015, while SN38 had mixed precipitation between December 23-28, 2015. SN37 was located at a relatively higher elevation and had snow measurements on November 15-16, November 19, November 24, November 30, December 12, December 17, and December 19-23 of 2015. Site SN37 stopped operating on December 24, 2015, and had interruptions in the data collection due to power failure and other technical issues.

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Related Data

All data collected during the OLYMPEX field campaign should be considered related datasets. Those data can be located using HyDRO 2.0 with the search term OLYMPEX. In addition, the 2DVD instrument was used in other GPM Ground Validation field campaigns. These other 2DVD datasets are listed below as these other datasets may be of interest.

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **IPHEx** (http://dx.doi.org/10.5067/IPHEX/2DVD/DATA301)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **IFloodS** (http://dx.doi.org/10.5067/GPMGV/IFLOODS/2DVD/DATA301)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **GCPEx** (http://dx.doi.org/10.5067/GPMGV/GCPEX/2DVD/DATA101)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **LPVEx** (http://dx.doi.org/10.5067/GPMGV/LPVEX/2DVD/DATA301)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **MC3E** (http://dx.doi.org/10.5067/GPMGV/MC3E/2DVD/DATA301)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **HyMeX** (http://dx.doi.org/10.5067/GPMGV/HYMEX/2DVD/DATA301)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **NSSTC** (http://dx.doi.org/10.5067/GPMGV/NSSTC/2DVD/DATA201)

GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) **WFF** (http://dx.doi.org/10.5067/GPMGV/WFF/2DVD/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/

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