Global Hydrology Resource Center

Data User Guide

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

Introduction

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) WFF data were collected during the Global Precipitation Mission (GPM) Ground Validation campaign at the NASA Wallops Flight Facility (WFF) in Wallops Island, Virginia from June 7, 2012 to March 5, 2014. This two-dimensional video disdrometer measured the size, equivalent diameter, volume, fall speed, oblateness, and cross-sectional area of raindrops, as well as particle concentration, total number of drops, total drop concentration, liquid water content, rain rate, reflectivity, and rain event characteristics. Two side view optical images of each raindrop were also recorded. The data files are in ASCII format.

Notice:

There are temporal gaps in the dataset due to the 2DVD instruments participation in other GPM Ground Validation field experiments during the campaign. If there is no data on a given day, then the instrument was not functioning or rain was not recorded that day. There are 29 files with no data and not included in the dataset.

Citation

Petersen, W. A., P. N. Gatlin, A. Toaky, and M. T. Wingo . 2016. GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) WFF [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: https://dx.doi.org/10.5067/GPMGV/WFF/2DVD/DATA201

Keywords:

NASA, GHRC, GPM GV, 2DVD, WFF, Virginia, drop distribution, drop size distribution, drop fall speed, drop volume, drop equivalent diameter, drop oblateness, drop cross-sectional area, total drop concentration, rain events, reflectivity, Rayleigh, rain rate, liquid water content;

Campaign

The Global Precipitation Measurement (GPM) mission Ground Validation (GV) campaign used a variety of methods for validating GPM satellite constellation measurements prior to and after launch of the GPM Core Satellite, which occurred on February 27, 2014. The GPM 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/.

Instrument Description

The 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.

Investigators

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File Naming Convention

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) WFF dataset consists of ASCII files. The data file names have the following naming convention.

Data tar file: wff_2dvd_YYYYMMDD_NLLLLLL_Wllllll.tar
Containing individual files named: wff_2dvd_snXX_NLLLLLL_Wllllll_type.txt

Table 1: File naming convention variables

Variable	Description

<table>
<tr><td>YYYY</td><td>Four-digit year</td></tr>
<tr><td>MM</td><td>Two-digit month</td></tr>
<tr><td>DD</td><td>Two-digit day</td></tr>
<tr><td>NLLLLLL</td><td>latitude</td></tr>
<tr><td>Wlllllll</td><td>longitude</td></tr>
<tr><td>.tar</td><td>Tape ARchive</td></tr>
<tr><td>snXX</td><td>Serial number of the instrument</td></tr>
<tr><td>type</td><td>
<table>
<tr><th>type</th><th>Description</th></tr>
<tr><td>“drops”</td><td>File containing information on individual hydrometeors</td></tr>
<tr><td>“rainDSD”</td><td>Quality-controlled raindrop size distribution based on measured fall velocities for each diameter bin each minute rain was detected</td></tr>
<tr><td>“rainDSD_vT”</td><td>Quality-controlled raindrop size distribution based on terminal fall velocities for each diameter bin each minute rain was detected</td></tr>
<tr><td>“rainParams”</td><td>Quality-controlled integral parameters based on measured fall velocities for each minute hydrometeors were detected</td></tr>
<tr><td>“rainParams_vT”</td><td>Quality-controlled integrated parameters for rain based on terminal fall velocities for each minute hydrometeors were detected</td></tr>
<tr><td>“rainEvents”</td><td>Quality-controlled total rainfall measured for a continuous period of precipitation</td></tr>
</table>
</td></tr>
<tr><td>.txt</td><td>Text file</td></tr>
</table>

Data Format Description

This data product contains daily .tar files with text files within the .tar files. The format for each .tar file may not contain all the files listed in Table 1. If an instrument did not collect any data or observe any precipitation on a given day, then no .tar file was created for that day.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground stations
Instrument	Two-Dimensional Video Disdrometer
Projection	N/A
Spatial Coverage	N: 37.94 , S: 37.93, E: -75.46 , W: -75.48
Spatial Resolution	Point source

Temporal Coverage	Start date: June 7, 2012 Stop date: March 5, 2014
Temporal Resolution	daily
Sampling Frequency	2DVD instrument takes a measurement of each hydrometeor that falls in the bin
Parameter	Equivalent diameter, drop fall speed, drop volume, precipitation distribution, particle concentration, liquid water content, rain rate, reflectivity, mean mass-weighted diameter, and precipitation
Version	1
Processing Level	2

Data Parameters

The GPM Ground Validation Two-Dimensional Video Disdrometer (2DVD) WFF data are in .tar files with ASCII text files within the .tar files. Oblateness measurements may not be precise during strong winds.

Table 3: "drops" file parameters

Column	Parameter	Unit
1	hour	hour
2	minute	minute
3	second	second
4	millisecond	millisecond
5	equivalent diameter	mm
6	volume	mm^3
7	fall speed	$m\ s^{-1}$
8	oblateness	N/A
9	cross-sectional area	mm^2
10	height in Camera A	mm
11	height in Camera B	mm
12	width in Camera A	mm
13	width in Camera B	mm
14	minimum pixel shadowed in Camera A (pixel location)	N/A
15	maximum pixel shadowed in Camera A (pixel location)	N/A
16	minimum pixel shadowed in Camera B (pixel location)	N/A
17	maximum pixel shadowed in Camera B (pixel location)	N/A

Table 4: "DSD" and "DSD_vT" file parameters

Column	Parameter	Unit
1	year	year
2	day of year	day
3	hour	hour

4	minute	minute
5	particle concentration in each of the 50 diameter bins (see Table 7)	m^{-3} mm^{-1}

Table 5: "rainParams" and "rainParams_vT" file parameters

Column	Parameter	Unit
1	year	year
2	day of year	day
3	hour	hour
4	minute	minute
5	total number of drops	N/A
6	total drop concentration	m^{-3}
7	liquid water content	g m^{-3}
8	rain rate	mm h^{-1}
9	reflectivity in Rayleigh regime	dBZ
10	mean mass-weighted diameter	mm
11	maximum drop diameter	mm
12	minimum drop diameter	mm
13	standard deviation of mean mass-weighted diameter	N/A

Table 6: "rainEvent" file parameters

Column	Parameter	Unit
1	year	year
2	day of year precipitation begins	day
3	beginning of precipitation	hour:minute
4	day of year precipitation ends	day
5	ending of precipitation	hour:minute
6	number of precipitation observations	minutes
7	event maximum rainfall rate	mm hr^{-1}
8	event total rain accumulation	mm
9	event maximum drop diameter	mm
10	precipitation type	R-rain S-snow

Algorithm

The "rainEvent" files were derived from the "rainParam" integral rain parameters files. The standard deviation of mean mass-weighted diameter was calculated following the method used in Ulbrich et al., 1997.

The terminal velocity for the bins diameter follows the method used in Beard, 1976 for bin diameters less than 6.0mm, and a linear interpolation is performed for bin diameters that are between 6.0mm to 8.0mm. Bin diameters greater than 8.0 mm are considered to have a constant terminal velocity. More information is available at Beard, 1976.

Table 7: Level 3 Diameter Bins and Terminal Velocity

Bin Number	Bin Average (mm)	Bin Spread (mm)	Terminal Velocity
1	0.1	0.2	0.248
2	0.3	0.2	1.144
3	0.5	0.2	2.018
4	0.7	0.2	2.858
5	0.9	0.2	3.649
6	1.1	0.2	4.349
7	1.3	0.2	4.916
8	1.5	0.2	5.424
9	1.7	0.2	5.892
10	1.9	0.2	6.324
11	2.1	0.2	6.721
12	2.3	0.2	7.084
13	2.5	0.2	7.411
14	2.7	0.2	7.703
15	2.9	0.2	7.961
16	3.1	0.2	8.187
17	3.3	0.2	8.382
18	3.5	0.2	8.548
19	3.7	0.2	8.688
20	3.9	0.2	8.805
21	4.1	0.2	8.900
22	4.3	0.2	8.977
23	4.5	0.2	9.038
24	4.7	0.2	9.084
25	4.9	0.2	9.118
26	5.1	0.2	9.143
27	5.3	0.2	9.159
28	5.5	0.2	9.169
29	5.7	0.2	9.174
30	5.9	0.2	9.175
31	6.1	0.2	9.385
32	6.3	0.2	9.415
33	6.5	0.2	9.442
34	6.7	0.2	9.465
35	6.9	0.2	9.486
36	7.1	0.2	9.505
37	7.3	0.2	9.521

38	7.5	0.2	9.536
39	7.7	0.2	9.549
40	7.9	0.2	9.560
41	8.1	0.2	9.570
42	8.3	0.2	9.570
43	8.5	0.2	9.570
44	8.7	0.2	9.570
45	8.9	0.2	9.570
46	9.1	0.2	9.570
47	9.3	0.2	9.570
48	9.5	0.2	9.570
49	9.7	0.2	9.570
50	9.9	0.2	9.570

Quality Assessment

Raindrops exceeding 50% of their terminal fall speed are removed to eliminate spurious measurements, such as insects or splash drops. More information is available in Gunn et al., 1949. Also, minutes during a rain event with fewer than 10 drops and a rainfall rate less than 0.01 mm hr^{-1} are removed to eliminate noise. These rain events in the "rainEvent" 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.

References

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