Global Hydrology Resource Center

Data User Guide

GPM Ground Validation UND Citation Cloud Microphysics OLYMPEX

Introduction

The GPM Ground Validation UND Citation Cloud Microphysics OLYMPEX dataset includes measurements of cloud microphysics, state of the atmosphere parameters, three-dimensional winds, and turbulence. These measurements were taken during the OLYMPEX campaign by the University of North Dakota's (UND) Cessna Citation II aircraft over a series of 20 flights totaling roughly 60 flight hours. The UND Citation Cloud Microphysics data are stored as separate files for each flight, with a primary (*.olympex) file containing both direct and derived parameters. Raw data files for each instrument are also archived for investigators who wish to use their own processing software. Data are available from flights that occurred from November 12, 2015 through December 19, 2015 in ASCII, ASCII-csv, and binary formats, while browse images are available in PNG format.

Citation

Poellot, Michael R., Andrew Heymsfield, and Aaron Bansemer. 2017. GPM Ground Validation UND Citation Cloud Microphysics 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/MULTIPLE/DATA201

Keywords:

NASA, GHRC, OLYMPEX, GPM, Washington, UND Citation, Cloud Microphysics, atmospheric water vapor, clouds, cloud liquid water/ice, cloud droplet concentration, cloud droplet size, particle size distribution

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)

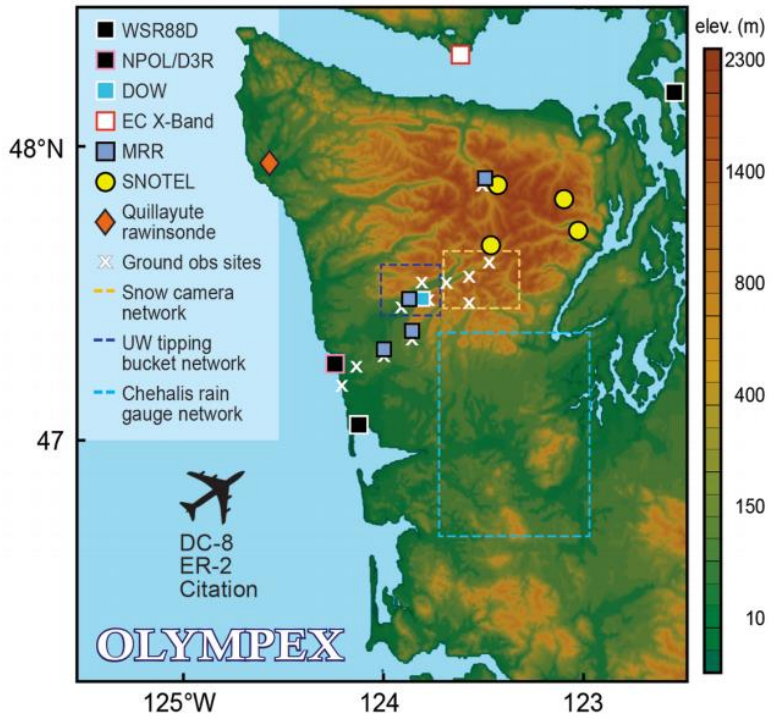

Figure 2: OLYMPEX Field Locations
(Image Source: https://pmm.nasa.gov/OLYMPEX)

Instrument Description

All instruments are on the UND Cessna Citation II Research Aircraft that is owned and operated by the University of North Dakota. The Citation II is a twin-engine fanjet with an operating ceiling altitude of 13km. The turbofan engines provide sufficient power to cruise at speeds of up to 175 m s^{-1} or climb at 16.8 m s^{-1}. These high performance capabilities are accompanied by relatively low fuel consumption at all altitudes, giving the UND Cessna Citation II Research Aircraft an on- station time of 3 to 5 hours, depending on the mission type. Long wings allow it to be operated out of relatively short airstrips and to be flown at the slower speeds (72 m s^{-1}) necessary for many types of measurements. More information on the UND Cessna Citation II is available at http://cumulus.atmos.und.edu/. The Citation II flew 20 missions during OLYMPEX.

A variety of instruments are onboard the UND Cessna Citation II Aircraft to measure both atmospheric conditions and cloud particles. These are listed in Table 1. More information about the instruments on the Citation II is available at http://olympex.atmos.washington.edu/index.html?x=Aircraft_Scorecards. More information about the conditions of the flights and Citation II track is available at http://olympex.atmos.washington.edu/index.html?x=Aircraft_Msns.

Table 1: Instruments on Citation aircraft

Instrument	Measurements
King Hot Wire Probe	Liquid water 0.05 - 5.0 g/m^3
Cloud Droplet Probe (CDP)	Cloud droplet size distribution 2-50 um range
2D Stereo Particle Probe (2D-S)	Particle images 10um - 1,280 um
High Volume Particle Sampler - 3 (HPVS-3) (2 units)	Particle images 150 um - 1.92 cm One horizontal and one vertically-orientated instrument
Cloud Particle Imager (CPI)	Cloud particle imager Particle imagery at 2.3 m resolution
Cloud Spectrometer and Impactor (CSI)	Cloud water content 0.02 - ~1.0 g/m^3
2D Cloud Probe (2D-C)	Particle images 30 - 960 um
Nevzorov	Total water content 0.02 - ~1.5 g/m^3

The 2D Stereo Particle Probe (2D-S) instrument on the UND Cessna Citation II Research Aircraft is a cloud particle imaging probe that consists of two 128-element diode arrays with 10 microns per pixel that record particles in both vertical (imaging the top view) and horizontal (imaging the side view) orientation. The vertical and horizontal orientation data are considered as two separate instruments in this dataset.

The 2D Cloud Probe (2D-C) is a cloud particle imaging probe that has a 32-element diode array with 30 microns per pixel. The 2D-C was oriented vertically for all flights for this dataset.

The High Volume Particle Sampler - 3 (HPVS-3) instrument is a newer version of the HPVS-2 particle probe used on previous field campaigns. The HPVS-3 probe consists of a 128-element array with 150 microns per pixel and can completely image particles up to 1.92 cm. Even larger particles can be sized in the direction of flight. Sample volume of the HVPS-3 is 400 L s-1 at 100 m s-1. The 2D-S and the HVPS-3 make an excellent pair of probes that completely image particles from 10 microns to 1.92 cm. There are two HPVS-3 instruments flown on the Citation II during OLYMPEX, one in horizontal orientation and the other in a vertical orientation.

The positioning of the 2D-S, 2D-C, and HVPS-3 particle probes on the Citation aircraft is shown at http://airborneresearch.atmos.und.edu/Instrumentation/external14F.aspx. More information about the instruments on the Citation aircraft can be found at http://olympex.atmos.washington.edu/docs/OLYMPEX_OpsPlan.pdf.

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Data Characteristics

The GPM Ground Validation UND Citation Cloud Microphysics OLYMPEX data are available in ASCII, ASCII-csv, and binary formats at a data processing level 2. More information about the NASA data processing levels are available here. The browse images are in PNG format and contain a collection of individual particle images.

Table 2: Data Characteristics

Characteristic	Description
Platform	UND Cessna Citation II Research Aircraft
Primary Instruments	2D Cloud Probe (2D-C) 2D Stereo Particle Probe (2D-S) High Volume Particle Sampler (HVPS-3)
Projection	n/a
Spatial Coverage	N: 48.35 , S: 46.22, E: -97.18, W: -126.13 (Washington)
Spatial Resolution	7.5 mm - 2.5 cm
Temporal Coverage	November 12, 2015 - December 19, 2015
Temporal Resolution	Daily (per flight which can extend past calendar day)
Sampling Frequency	1 second
Parameter	Cloud microphysics
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation UND Citation Cloud Microphysics OLYMPEX dataset consists of quality controlled/processed (.conc.cdp.1Hz and .olympex) and raw (.roi, .sea,.csv, and .HVPS) data files using the file naming conventions shown below. The browse images are available in PNG format. The two HVPS-3 instruments are labeled A (horizontal orientation) and B (vertical orientation)

Quality Controlled Data files: YY_MM_DD_hh_mm_ss.[conc.cdp.1Hz|olympex]

Raw Data files: MMDDYYhhmm.roi
YY_MM_DD_hh_mm_ss.sea
CSI_data_YYMMDDhhmmss.csv
[NAV|base]YYMMDDhhmmss.2DS
[NAV|base]YYMMSShhmmss_[A|B].HVPS
TDL_data_YYMMDDhhmmss.csv
Browse files: CPyyyyMMDD_hhmmss_***.png

Table 3: File naming convention variables

Variable	Description
YY	Two-digit year
MM	Two-digit month
DD	Two-digit day
hh	Two-digit hour in UTC
mm	Two-digit minute in UTC
ss	Two-digit second in UTC
[conc.cdp.1Hz|olympex]	conc.cdp.1Hz = concentration cloud droplet probe files olympex = OLYMPEX campaign Both files are in the UND-NASA-AMES ASCII format
.roi	Report Object Instance binary file format
.sea	Science Engineering Associate Model 300 data buffer format file in binary format
.csv	Comma-separated ASCII file format
[NAV|base]	NAV = navigation file base = base file
CSI/TDL	CSI = Cloud Spectrometer and Impactor data TDL = Tunable Diode Laser hygrometer data
.2DS	Binary data from the 2D-S instrument
[A|B]	A = horizontally orientated HVPS-3 data B = vertically oriented HVPS-3 data
.HVPS	Binary data from the HVPS-3 instrument
yyyy	Four-digit year
***	Three-digit milliseconds in UTC
.png	Portable Network Graphic format

Data Format and Parameters

The GPM Ground Validation UND Citation Cloud Microphysics OLYMPEX dataset consists of quality controlled processed files in NASA Ames ASCII format, as well as raw files in ASCII, ASCII-csv, and binary formats. The Science Engineering and Associates (SEA) model M300 data system manual contains file format information for the raw .sea files. In order to process the raw .sea binary data files, the M300 instrument tag numbers need to be used. The SPEC Inc. CPI manual contains file format information for the raw .roi files. File format information for the raw .HVPS and .2DS files are available in the SPEC Inc. HVPS-3 and 2D-S manuals.

There are about 71 header lines within the quality control processed YY_MM_DD_hh_mm_ss.conc.cdp.1Hz files with data measurements following. Table 4 describes the data fields within the YY_MM_DD_hh_mm_ss.conc.cdp.1Hz files.

There are about 78 header lines within the quality control processed YY_MM_DD_hh_mm_ss.olympex files with data measurements following. Table 5 describes the data fields within the YY_MM_DD_hh_mm_ss.olympex files.

Table 4: Data fields for the YY_MM_DD_hh_mm_ss.conc.cdp.1Hz files

Column	Field Name	Description	Unit
1	Time	UT seconds from midnight on day aircraft flight started based on data system clock	s
2	CDP_CH1	CDP Channel 1 concentration Channel size range 2.000 um to 3.000 um diameter	#/cm^3
3	CDP_CH2	CDP Channel 2 concentration Channel size range 3.000 um to 4.000 um diameter	#/cm^3
4	CDP_CH3	CDP Channel 3 concentration Channel size range 4.000 um to 5.000 um diameter	#/cm^3
5	CDP_CH4	CDP Channel 4 concentration Channel size range 5.000 um to 6.000 um diameter	#/cm^3
6	CDP_CH5	CDP Channel 5 concentration Channel size range 6.000 um to 7.000 um diameter	#/cm^3
7	CDP_CH6	CDP Channel 6 concentration Channel size range 7.000 um to 8.000 um diameter	#/cm^3
8	CDP_CH7	CDP Channel 7 concentration Channel size range 8.000 um to 9.000 um diameter	#/cm^3
9	CDP_CH8	CDP Channel 8 concentration Channel size range 9.000 um to 10.000 um diameter	#/cm^3
10	CDP_CH9	CDP Channel 9 concentration Channel size range 10.000 um to 11.000 um diameter	#/cm^3
11	CDP_CH10	CDP Channel 10 concentration Channel size range 11.000 um to 12.000 um diameter	#/cm^3
12	CDP_CH11	CDP Channel 11 concentration Channel size range 12.000 um to 13.000 um diameter	#/cm^3
13	CDP_CH12	CDP Channel 12 concentration Channel size range 13.000 um to 14.000 um diameter	#/cm^3
14	CDP_CH13	CDP Channel 13 concentration Channel size range 14.000 um to 16.000 um diameter	#/cm^3
15	CDP_CH14	CDP Channel 14 concentration Channel size range 16.000 um to 18.000 um diameter	#/cm^3
16	CDP_CH15	CDP Channel 15 concentration Channel size range 18.000 um to 20.000 um diameter	#/cm^3
17	CDP_CH16	CDP Channel 16 concentration Channel size range 20.000 um to 22.000 um diameter	#/cm^3

18	CDP_CH17	CDP Channel 17 concentration Channel size range 22.000 um to 24.000 um diameter	#/cm^3
19	CDP_CH18	CDP Channel 18 concentration Channel size range 24.000 um to 26.000 um diameter	#/cm^3
20	CDP_CH19	CDP Channel 19 concentration Channel size range 26.000 um to 28.000 um diameter	#/cm^3
21	CDP_CH20	CDP Channel 20 concentration Channel size range 28.000 um to 30.000 um diameter	#/cm^3
22	CDP_CH21	CDP Channel 21 concentration Channel size range 30.000 um to 32.000 um diameter	#/cm^3
23	CDP_CH22	CDP Channel 22 concentration Channel size range 32.000 um to 34.000 um diameter	#/cm^3
24	CDP_CH23	CDP Channel 23 concentration Channel size range 34.000 um to 36.000 um diameter	#/cm^3
25	CDP_CH24	CDP Channel 24 concentration Channel size range 36.000 um to 38.000 um diameter	#/cm^3
26	CDP_CH25	CDP Channel 25 concentration Channel size range 38.000 um to 40.000 um diameter	#/cm^3
27	CDP_CH26	CDP Channel 26 concentration Channel size range 40.000 um to 42.000 um diameter	#/cm^3
28	CDP_CH27	CDP Channel 27 concentration Channel size range 42.000 um to 44.000 um diameter	#/cm^3
29	CDP_CH28	CDP Channel 28 concentration Channel size range 44.000 um to 46.000 um diameter	#/cm^3
30	CDP_CH29	CDP Channel 29 concentration Channel size range 46.000 um to 48.000 um diameter	#/cm^3
31	CDP_CH30	CDP Channel 30 concentration Channel size range 48.000 um to 50.000 um diameter	#/cm^3
32	CDP_Conc	Number of concentration droplets based on the Cloud Droplet Probe	#/cc
33	CDP_LWC	Liquid Water Content based on the Cloud Droplet Probe	g/m^3
34	CDP_MenD	Cloud Droplet Probe's mean droplet diameter	um
35	CDP_VolDia	Cloud Droplet Probe's mean droplet volume diameter	um
36	CDP_EffRad	Cloud Droplet Probe's effective droplet radius	um
37	CDP_MedD	Cloud Droplet Probe's median droplet diameter	um
38	CDP_MedVD	Cloud Droplet Probe's median droplet volume diameter	um
39	CDP_LasCur	The electrical current flowing through the Cloud Droplet Probe laser diode	mAmps
40	CDP_DSMoni	The amount of focused, unobstructed laser light collected in the dump spot monitor of the Cloud Droplet Probe	volts
41	CDP_WingT	The temperature at the Cloud Droplet Probe's signal and power distribution board	degC
42	CDP_LaserT	The temperature of the laser heat sink on the Cloud Droplet Probe	degC

43	CDP_SizBas	The voltage from the Cloud Droplet Probe's sizer detector	volts
44	CDP_QuaBas	The voltage from the Cloud Droplet Probe's qualifier detector	volts
45	CDP_5VMoni	The power 5-volt reference for the Cloud Droplet Probe's control system	volts
46	CDP_ConBoa	The temperature at the digital board of the Cloud Droplet Probe	degC
47	CDP_BeamF	Beam Fraction (ratio of total count to total strobes)	-
48	CDP_Strobe	Total Strobes (all particles within the laser beam)	-
49	CDP_Stdev	Cloud Droplet Probe's standard deviation of the mean radius	um
50	CDP_RDisp	Cloud Droplet Probe's relative dispersion	-
51	CDP_EffRRa	Cloud Droplet Probe's effective radius ratio based on the effective radius, concentration, and Liquid Water Content	-
52	CDP_EffRRT	Cloud Droplet Probe's effective radius ratio based on Theoretical System Theory Equation	-
53	CDP_SamVol	Cloud Droplet Probe's sample volume	cm^3
54	CDP_SamArea	Cloud Droplet Probe's sample area	mm^2
55	CDP_Shape	Cloud Droplet Probe's shape parameter	-

Table 5: Data fields for the YY_MM_DD_hh_mm_ss.olympex files

Column	Field Name	Description	Unit
1	Time	UT seconds from midnight on day aircraft flight started based on data system clock	s
2	Air_Temp	Air temperature corrected for Dynamic Heating (based first on the main temperature/pitot instrument)	degC
3	MachNo_N	Mach number (based first on the main pitot instrument and secondarily based on the backup temperature/pitot instrument)	-
4	IAS	Indicated air speed (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	m/s
5	TAS	True air speed (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	m/s
6	Press_Alt	Pressure altitude	m
7	Pot_Temp_T1	Potential temperature (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	degK
8	STATIC_PR	Static pressure (Calibration: slope = 207.08000 offset = -0.71000000)	hPa
9	DEWPT	Dew point temperature from EG&G Probe	degC

		(Calibration: slope = 20.000000 offset = -70.000000)	
10	REL_HUM	Relative humidity from the EG&G probe	%
11	MixingRatio	Mixing ratio by weight from the Laser Hygrometer	ppmw
12	DewPoint	Dew point temperature from the Laser Hygrometer	degC
13	FrostPoint	Frost point temperature from the Laser Hygrometer	degC
14	RH	Relative humidity from the Laser Hygrometer with respect to: water T>=0 Ice T<0	%
15	IceMSOFreq	The current sensor (MSO) frequency from the Icing Detector	Hz
16	TSG_Date	Date stamp based on the data file name Example: 94119 is 19 November 1994	stamp
17	POS_Roll	Aircraft roll angle from the Applanix Position and Orientation System (POS) -180 to 180 range with 0 being level and positive angles in the clockwise (right) direction	degrees
18	POS_Pitch	Aircraft pitch angle from the Applanix Position and Orientation System (POS) -180 to 180 range with 0 being level and positive angles in the clockwise (upward) direction away from center of the Earth	degrees
19	POS_Head	Aircraft heading angle from the Applanix Position and Orientation System (POS) 0 to 360 range with 0 being North and angles increasing in a clockwise (right) direction	degrees
20	POSZ_Acc	Aircraft z-direction (vertical) acceleration for the Applanix Position and Orientation System (POS)	m/s^2
21	POS_Lat	Aircraft latitude from the Applanix Position and Orientation System (POS) -90 to 90 range with positive values in Northern Hemisphere and negative values in Southern Hemisphere	degrees
22	POS_Lon	Aircraft longitude from the Applanix Position and Orientation System (POS) -180 to 180 range with positive values in Eastern Hemisphere and negative values in Western Hemisphere	degrees
23	POS_Alt	Aircraft altitude from the Applanix Position and Orientation System (POS)	m
24	POS_Spd	Aircraft ground speed from the Applanix Position and Orientation System (POS)	m/s
25	POS_Trk	Aircraft track angle from the Applanix Position and Orientation System (POS) 0 to 360 range with 0 being North and angles	degrees

		increasing in a clockwise (right) direction	
26	Alpha	Alpha (attack) angle Calibration: Slope = 0.066317100 Offset = 0.40082229	degrees
27	Beta	Beta (sideslip) angle Calibration: Slope = 0.085875130 Offset = 0.16014451	degrees
28	VERT_VEL	Vertical velocity of the aircraft based on the change in position over a 2 second interval	m/s
29	Wind_Z	Z (vertical) component of the wind speed Positive value is upward, away from the Earth's surface	m/s
30	Wind_M	Horizontal wind speed	m/s
31	Wind_D	Horizontal wind direction True direction from which it blows	degrees
32	TURB	Turbulence parameter (Eddy Dissipation Rate) based on Wing Pitot pressure	$cm^2/3*s^{-1}$
33	King_LWC_ad	Liquid water content based on King Probe measurement adjusted for the baseline offset Cloud threshold = 5.1 ($\#/cm^3$) Cloud interval = 30.0 (s) Adjustment slope = 0.500	g/m^3
34	Nev_TWC	Total water content based on the Nevzorov Probe measurement	-
35	Nev_LWCcor	Liquid water content based on the Nevzorov Probe measurement with correction for residual ice Beta = 0.110000	g/m^3
36	Nev_IWC	Ice water content based on the Nevzorov Probe measurement Beta = 0.110000	g/m^3
37	CSI_M_Ratio	CSI mixing ratio	g/m^3
38	CSI_CWC	Cloud water content from the CSI probe with correction Calibration: TDL Slope = 1.5070000 TDL Offset = 0.025000000 Out-of-Cloud Slope = 1.00000 Out-of-Cloud Offset = 0.00000	g/m^3
39	CDP_Conc	Number concentration of droplets based on the cloud droplet probe	#/cc
40	CDP_LWC	Liquid water content based on the Cloud Droplet Probe	g/m^3
41	CDP_MenD	Cloud Droplet Probe's mean droplet diameter	um
42	CDP_VolDia	Cloud Droplet Probe's mean droplet volume diameter	um
43	CDP_EffRad	Cloud Droplet Probe's effective droplet radius	um
44	2-DC_Conc	Number concentration of droplets based on the 2-DC Probe measurements	$\#/cm^3$
45	2-DC_MenD	Mean droplet diameter based on the 2-DC Probe measurements	um

46	2-DC_VolDia	Mean droplet volume diameter based on the 2-DC Probe measurements	um
47	2-DC_EffRad	Effective droplet radius based on the 2-DC Probe measurements	um
48	Nt2DSHGT105	TwoDS (SN: 012) horizontal total normalize particle concentration of particles greater than 105 microns	$\#/m^3$
49	Nt2DSH_all	TwoDS (SN:012) horizontal total normalize particle concentration for all bin sizes	$\#/m^3$
50	Nt2DSVGT105	TwoDS (SN: 012) vertical total normalize particle concentration of particles greater than 105 microns	$\#/m^3$
51	Nt2DSV_all	TwoDS (SN: 012) vertical total normalize particle concentration for all bin sizes	$\#/m^3$
52	Nt_HVPS3H	HVPS3 (SN: 04) horizontal total normalize particle concentration for all bin sizes	$\#/m^3$
53	Nt_HVPS3BV	HVPS 3 (SN: 07) vertical total normalize particle concentration for all bin sizes	$\#/m^3$

Quality Assessment

Concentrations from particles smaller than 100 microns may contain large errors due to uncertainties in the probe's sample area; therefore, particles smaller than 100 microns are not included in measurements. Also, images that touch a side of the array are allowed. The technique described in Field et al., 2006 has been applied to mitigate shattering artifacts on the 2D-C and 2D-S instruments. These instruments also had modified probe tips to minimize the amount of shattering.

The condensed water content algorithm has been indiscriminately applied, and will not be valid in cases of rain, graupel, or ice habits that are not well represented by this mass-size parameterization.

Software

Software is not required to view the ASCII and ASCII-csv files. The Science Engineering and Associates (SEA) model M300 data system manual contains file format information for the raw .sea files. In order to process the raw .sea data files, the M300 instrument tag numbers need to be used. The SPEC Inc. CPI manual contains file format information for the raw .roi files. File format information for the raw .HVPS and .2DS files are available in the SPEC Inc. HVPS-3 and 2D-S manuals.

Known Issues or Missing Data

Bad or missing data are flagged with 9.99e+30.

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Related Data

All data from other instruments collected during the OLYMPEX field campaign are related to this dataset. Other OLYMPEX campaign data can be located using the GHRC HyDRO 2.0 search tool.

In addition, other data related to UND Citation Cloud Microphysics are in previous GPM Ground Validation campaigns. The following datasets are UND Citation Cloud Microphysics data from other field campaigns:

GPM Ground Validation UND Citation Cloud Microphysics **IPHEx** (http://dx.doi.org/10.5067/GPMGV/IPHEX/MULTIPLE/DATA201)

GPM Ground Validation UND Citation Cloud Microphysics **GCPEx** V2 (http://dx.doi.org/10.5067/GPMGV/GCPEX/MULTIPLE/DATA203)

GPM Ground Validation UND Citation Cloud Microphysics **MC3E** (http://dx.doi.org/10.5067/GPMGV/MC3E/MULTIPLE/DATA201)

Contact Information

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

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