Global Hydrology Resource Center

Data User Guide

GPM Ground Validation UND Citation Cloud Microphysics IPHEx

Introduction

The GPM Ground Validation UND Citation Cloud Microphysics IPHEx dataset includes measurements of cloud microphysics, state of the atmosphere parameters, bulk aerosols, three-dimensional winds, and turbulence. These measurements were taken during the IPHEx campaign by the University of North Dakota's (UND) Cessna Citation aircraft, an in situ platform. The Citation flew 20 data missions for a total of 56.8 flight hours. The UND Citation Cloud Microphysics data are stored as a separate file for each flight, with a primary (*.IPHEX) file containing both direct and derived parameters. Raw data files for each cloud instrument are also archived for investigators who wish to use their own processing software. Data are available from March 6, 2014 to June 13, 2014 in ASCII and binary formats, while browse images are available in PNG format.

Citation

Poellot, Michael R. and Andrew J. Heymsfield. 2014. GPM Ground Validation UND Citation Cloud Microphysics IPHEx [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/IPHEX/MULTIPLE/DATA201

Keywords:

NASA, GHRC, North Carolina, cloud microphysics, UND Citation II, IPHEx, aerosols, atmospheric water vapor, clouds, droplet concentration, probes

Campaign

The GPM Ground Validation campaign used a variety of methods for validation of GPM satellite constellation measurements prior to and after launch on 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. These field campaigns accounted for

the majority of the effort and resources expended by the GPM Ground Validation mission. More information about the GPM Ground Validation mission is available at https://pmm.nasa.gov/index.php?q=science/ground-validation.

One of the GPM Ground Validation field campaigns was the Integrated Precipitation and Hydrology Experiment (IPHEx), which was held in North Carolina during 2014 with an intense study period from May 1 to June 15, 2014. The goals of the IPHEx field campaign were to characterize warm season orographic precipitation regimes and hydrologic processes in regions of complex terrain, to contribute to the development, evaluation, and improvement of remote sensing precipitation algorithms in support of the GPM mission, and to evaluate Quantitative Precipitation Estimation (QPE) products for hydrological forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE) in conjunction with the NOAA Hydrometeorology Testbed project. More information about IPHEx is available at http://gpm.nsstc.nasa.gov/iphex/.

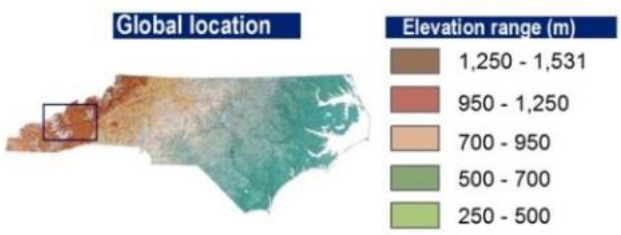

Figure 1: Region of North Carolina IPHEx campaign ground validation (image source: http://gpm-gv.gsfc.nasa.gov/Gauge/)

Instrument Description

The UND Cessna Citation II Research Aircraft flown in the IPHEx experiment is owned and operated by the University of North Dakota. The Citation II is a twin-engine fanjet aircraft with an operating ceiling of 43,000 feet (13.1 km). The turbo fan engines provide sufficient power to cruise at speeds of up to 340 knots (175 m s-1) or climb at 3300 feet per minute (16.8 m s- 1). The Citation II has relatively low fuel consumption at all altitudes which allows for operation of 3-5 hours, depending on mission type. Long wings allow it to be operated out of relatively short airstrips and to be flown at the slower speeds (140 kts/72 m s-1) necessary for many types of measurements. The Citation is certified for flight into known icing conditions. Further details on the UND Cessna Citation II are available at http://cumulus.atmos.und.edu/. The Citation carried a variety of instruments used to assess the microphysics of clouds. The instruments and associated measured parameters are provided in Table 1, below.

Table 1: Instrument and measurements included

Parameter	Instrument	Instrument Description

Measured		
State Parameters	Total Temperature Probe	Flight Level Temperature
	Pressure Transducer	Flight Level Pressure
	Cooled Mirror Hygrometer	Dew/Frost Point
	Laser Hygrometer	Dew/Frost Point Temperature
Winds and Turbulence	Gust Probe	Airspeed, Angles of Attack and Sideslip
	Pitot Tube	Airspeed, Turbulence
Cloud Imaging and Sizing	CDP	Cloud Droplet Concentration and Size
	PMS 2DC	Cloud Particle Imaging Probe
	Cloud Imaging Probe (CIP)	Cloud Particle Imaging Probe
	CPI	Small Cloud Particle Imaging Probe
	HVPS-3	Precipitation Particle Imaging Probe
Water	King Probe	Liquid Water Content
	Nevzorov Probe	Liquid Water and Total Water Content
	Rosemount Icing Detector	Supercooled Liquid Water Presence and Content
	CSI	Total Water Content
Aerosols	CPC	Condensation Particle Counter
Aircraft	Applanix	Inertial Platform with Integrated GPS

The complete list of measurements and associated instruments is available in the header block of the QC processed data files. More information about Citation flight days can be found in the IPHEx Citation Mission Summary document.

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Data Characteristics

The GPM Ground Validation UND Citation Cloud Microphysics IPHEx data are available in ASCII and binary formats, while browse images are available in PNG format.

Table 2: Data Characteristics

Characteristic	Description

Platform	UND Citation II
Instruments	CDP, CPC, CPI probe, HVPS, INS, King probe, Laser Hygrometer, Nevzorov Probe, PMS 2D-C probe, Rosemount icing detector
Projection	n/a
Spatial Coverage	N: 35.59 , S: -83.1, E: -82.06, W: 35.23 (North Carolina)
Spatial Resolution	n/a
Temporal Coverage	March 6, 2014 - June 13, 2014
Temporal Resolution	File per flight
Sampling Frequency	1 second
Parameter	Aerosols, atmospheric water vapor, clouds
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation UND Citation Cloud Microphysics IPHEx data are in the following naming convention.

QC processed files: YYYY_MM_DD_hh_mm_ss.conc.cdp.1Hz
YYYY_MM_DD_hh_mm_ss.iphex

Raw files: YYYY_MM_DD_hh_mm_ss.sea
YYYYMMSShhmm.roi
[CSI|TDL]_YYYYMMDDhhmmss.csv
baseYYYYMMDDhhmmss.[HVPS|2DS]
NAVYYYYMMDDhhmmss.csv

Browse files: CPYYYYMMDD_hhmmss_###.png

Table 3: File naming convention variables

Variable	Description
YYYY	Four-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
.1Hz	ASCII format
.iphex	ASCII format
.roi	Binary format
[CSI|TDL]	CSI: Cloud Spectrometer and Impactor TDL: Tunable Diode Laser hygrometer in CSI
.csv	ASCII-csv format
.[HVPS|2DS]	.HVPS: signifies a High Volume Precipitation Spectrometer - binary

	format file .2DS: signifies a 2D Stereo probe binary format file
###	Three-digit millisecond in UTC
.png	Portable Network Graphics format

Data Format and Parameters

The GPM Ground Validation UND Citation Cloud Microphysics IPHEx dataset consists of Quality Controlled (QC) processed files in ASCII format. Processed data files are in the UND-NASA-AMES format. The dataset also contains raw files (.roi, .sea, .HVPS, .2DS, and .csv). The Science Engineering and Associates (SEA) model M300 data system manual contains file format information for the .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 .roi files. File format information for the .HVPS and .2DS files are available in the SPEC Inc. HVPS3 and 2DS manual.

More information on the GPM Ground Validation UND Citation Cloud Microphysics IPHEx dataset can be found in the UND Citation Data Summary document. More information on missing data can be found in the IPHEx Citation Data Edit Overview document.

Table 4: Data Fields for QC processed YYYY_MM_DD_hh_mm_ss.conc.cdp.1Hz files

Field Name	Description	Unit
Time	UT seconds from midnight on day aircraft flight started based on data system clock	s
CDP_CH1	CDP Channel 1 concentration Channel size range 2.000 um to 3.000 um diameter	#/cm^3
CDP_CH2	CDP Channel 2 concentration Channel size range 3.000 um to 4.000 um diameter	#/cm^3
CDP_CH3	CDP Channel 3 concentration Channel size range 4.000 um to 5.000 um diameter	#/cm^3
CDP_CH4	CDP Channel 4 concentration Channel size range 5.000 um to 6.000 um diameter	#/cm^3
CDP_CH5	CDP Channel 5 concentration Channel size range 6.000 um to 7.000 um diameter	#/cm^3
CDP_CH6	CDP Channel 6 concentration Channel size range 7.000 um to 8.000 um diameter	#/cm^3
CDP_CH7	CDP Channel 7 concentration Channel size range 8.000 um to 9.000 um diameter	#/cm^3
CDP_CH8	CDP Channel 8 concentration Channel size range 9.000 um to 10.000 um diameter	#/cm^3
CDP_CH9	CDP Channel 9 concentration Channel size range 10.000 um to 11.000 um diameter	#/cm^3
CDP_CH10	CDP Channel 10 concentration Channel size range 11.000 um to 12.000 um diameter	#/cm^3
CDP_CH11	CDP Channel 11 concentration	#/cm^3

	Channel size range 12.000 um to 13.000 um diameter	
CDP_CH12	CDP Channel 12 concentration Channel size range 13.000 um to 14.000 um diameter	#/cm^3
CDP_CH13	CDP Channel 13 concentration Channel size range 14.000 um to 16.000 um diameter	#/cm^3
CDP_CH14	CDP Channel 14 concentration Channel size range 16.000 um to 18.000 um diameter	#/cm^3
CDP_CH15	CDP Channel 15 concentration Channel size range 18.000 um to 20.000 um diameter	#/cm^3
CDP_CH16	CDP Channel 16 concentration Channel size range 20.000 um to 22.000 um diameter	#/cm^3
CDP_CH17	CDP Channel 17 concentration Channel size range 22.000 um to 24.000 um diameter	#/cm^3
CDP_CH18	CDP Channel 18 concentration Channel size range 24.000 um to 26.000 um diameter	#/cm^3
CDP_CH19	CDP Channel 19 concentration Channel size range 26.000 um to 28.000 um diameter	#/cm^3
CDP_CH20	CDP Channel 20 concentration Channel size range 28.000 um to 30.000 um diameter	#/cm^3
CDP_CH21	CDP Channel 21 concentration Channel size range 30.000 um to 32.000 um diameter	#/cm^3
CDP_CH22	CDP Channel 22 concentration Channel size range 32.000 um to 34.000 um diameter	#/cm^3
CDP_CH23	CDP Channel 23 concentration Channel size range 34.000 um to 36.000 um diameter	#/cm^3
CDP_CH24	CDP Channel 24 concentration Channel size range 36.000 um to 38.000 um diameter	#/cm^3
CDP_CH25	CDP Channel 25 concentration Channel size range 38.000 um to 40.000 um diameter	#/cm^3
CDP_CH26	CDP Channel 26 concentration Channel size range 40.000 um to 42.000 um diameter	#/cm^3
CDP_CH27	CDP Channel 27 concentration Channel size range 42.000 um to 44.000 um diameter	#/cm^3
CDP_CH28	CDP Channel 28 concentration Channel size range 44.000 um to 46.000 um diameter	#/cm^3
CDP_CH29	CDP Channel 29 concentration Channel size range 46.000 um to 48.000 um diameter	#/cm^3
CDP_CH30	CDP Channel 30 concentration Channel size range 48.000 um to 50.000 um diameter	#/cm^3
CDP_Conc	Number of concentration droplets based on the Cloud Droplet Probe	#/cc
CDP_LWC	Liquid Water Content based on the Cloud Droplet Probe	g/m^3
CDP_MenD	Cloud Droplet Probe's mean droplet diameter	um
CDP_VolDia	Cloud Droplet Probe's mean droplet volume diameter	um
CDP_EffRad	Cloud Droplet Probe's effective droplet radius	um

CDP_MedD	Cloud Droplet Probe's median droplet diameter	um
CDP_MedVD	Cloud Droplet Probe's median droplet volume diameter	um
CDP_LasCur	The electrical current flowing through the Cloud Droplet Probe laser diode	mAmps
CDP_DSMoni	The amount of focused, unobstructed laser light collected in the dump spot monitor of the Cloud Droplet Probe	volts
CDP_WingT	The temperature at the Cloud Droplet Probe's signal and power distribution board	degC
CDP_LaserT	The temperature of the laser heat sink on the Cloud Droplet Probe	degC
CDP_SizBas	The voltage from the Cloud Droplet Probe's sizer detector	volts
CDP_QuaBas	The voltage from the Cloud Droplet Probe's qualifier detector	volts
CDP_5VMoni	The power 5-volt reference for the Cloud Droplet Probe's control system	volts
CDP_ConBoa	The temperature at the digital board of the Cloud Droplet Probe	degC
CDP_BeamF	Beam Fraction (ratio of total count to total strobes)	-
CDP_Strobe	Total Strobes (all particles within the laser beam)	-
CDP_Stdev	Cloud Droplet Probe's Standard Deviation of the mean radius	um
CDP_RDisp	Cloud Droplet Probe's relative dispersion	-
CDP_EffRRa	Cloud Droplet Probe's Effective Radius Ratio based on the effective radius, concentration, and Liquid Water Content	-
CDP_EffRRT	Cloud Droplet Probe's Effective Radius Ratio based on Theoretical System Theory Equation	-
CDP_SamVol	Cloud Droplet Probe's sample volume	cm^3
CDP_SamArea	Cloud Droplet Probe's Sample Area	mm^2
CDP_Shape	Cloud Droplet Probe's Shape Parameter	-

Table 5: Data Fields for QC processed YYYY_MM_DD_hh_mm_ss.iphex files

Field Name	Description	Unit
Time	UT seconds from midnight on day aircraft flight started	s
Air_Temp	Air temperature corrected for Dynamic Heating (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	degC
MachNo_N	Mach number (based first on the main pitot instrument and secondarily based on the backup	-

	temperature/pitot instrument)	
IAS	Indicated air speed (based first on the main pitot instrument and secondarily based on the backup pitot instrument)	m/s
TAS	True air speed (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	m/s
Press_Alt	Pressure altitude	m
Pot_Temp_T1	Potential temperature (based first on the main temperature/pitot instrument and secondarily based on the backup temperature/pitot instrument)	degK
Pitot_Wing	Pitot pressure from Wing Probe (Calibration: slope = 207.08000 offset = -147.45550)	hPa
CABIN_PRES	Aircraft cabin pressure	mb
STATIC_PR	Static pressure (Calibration: slope = 207.08000 offset = -0.71000000)	hPa
DEWPT	Dew point temperature from EG&G Probe (Calibration: slope = 20.000000 offset = -70.000000)	degC
MixingRatio	Mixing ratio by weight from the Laser Hygrometer	ppmw
DewPoint	Dew point temperature from the Laser Hygrometer	degC
FrostPoint	Frost point temperature from the Laser Hygrometer	degC
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
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
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
POSZ_Acc	Aircraft z-direction (vertical) acceleration for the Applanix Position and Orientation System (POS)	m/s^2
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
POS_Lon	Aircraft longitude from the Applanix Position and	degrees

	Orientation System (POS) -180 to 180 range with positive values in Eastern Hemisphere and negative values in Western Hemisphere	
POS_Alt	Aircraft altitude from the Applanix Position and Orientation system (POS)	m
POS_Spd	Aircraft ground speed from the Applanix Position and Orientation System (POS)	m
POS_Trk	Aircraft track 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
Alpha	Alpha (attack) angle (Calibration: slope = 0.066317100 Offset = 0.40082229)	degrees
Beta	Beta (sideslip) angle (Calibration: slope = -0.085875130 Offset = 0.16014451)	degrees
VERT_VEL	Vertical velocity of the aircraft based on the change in position over a 2-second interval	m/s
Wind_Z	Z (vertical) component of the wind speed (positive value is upward, away from the Earth's surface)	m/s
Wind_M	Horizontal wind speed	m/s
Wind_D	Horizontal wind direction True direction from which it blows	degrees
TURB	Turbulence parameter (Eddy Dissipation Rate) based on Wing Pitot pressure	$cm^2/3*s^{-1}$
King_LWC_ad	Liquid Water Content based on King Probe measurement adjusted (cloud threshold = 5.1 $\#/cm^3$, cloud interval = 30.0 s, and adjustment slope = 0.500) for the baseline offset	g/m^3
Nev_TWC	Total Water Content based on the Nevzorov Probe measurement	-
Nev_LWC	Liquid Water Content based on the Nevzorov Probe measurement without correction for residual ice	-
CDP_Conc	Number concentration of droplets based on the Cloud Droplet Probe	#/cc
CDP_LWC	Liquid Water Content based on the Cloud Droplet Probe	g/m^3
CDP_MenD	Cloud Droplet Probe's mean droplet diameter	um
CDP_VolDia	Cloud Droplet Probe's mean droplet volume diameter	um
CDP_EffRad	Cloud Droplet Probe's effective droplet radius	um
2-DC_Conch	Number concentration of droplets based on the 2-DC Probe measurements for hydrometeors greater than 105 um	$\#/cm^3$

2-DC_MenDh	Mean droplet diameter based on the 2-DC Probe measurements for hydrometeors greater than 105 um	um
2-DCVolDiah	Mean droplet volume diameter based on the 2-DC Probe measurements for hydrometeors greater than 105 um	um
2-DCEffRadh	Effective droplet radius based on the 2-DC Probe measurements for hydrometeors greater than 105 um	um
IceMDOFreq	The current sensor (MSO) frequency from the Icing Detector	um
CPCConc	Total concentration from CPC	$\#/cm^3$
TSG_Date	Date stamp based on data file name (Example: 941119 is 19 November 1994)	stamp
CSI_M_Ratio	Mixing ratio by volume from the CSI Laser Hygrometer without external calibration applied	g/m^3
CSI_CWC	Cloud Water Content with correction from the CSI probe	g/m^3
Nt2DSHGT105	TwoDS H total normalize particle concentration of particles greater than 105 microns	$\#/m^3$
Nt2DSH_all	TwoDS H total normalize particle concentration for all bin sizes	$\#/m^3$
Nt2DSVGT105	TwoDS V total normalize particle concentration of particles greater than 105 microns	$\#/m^3$
Nt2DSV_all	TwoDS V total normalize particle concentration for all bin sizes	$\#/m^3$
Nt_HVPS3V	HVPS3 V total normalize particle concentration for all bin sizes	$\#/m^3$

Software

The Science Engineering and Associates (SEA) model M300 data system manual contains file format information for the .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 .roi files. File format information for the .HVPS and .2DS files are available in the SPEC Inc. HVPS3 and 2DS manual.

References

Delene, D. J. (2011). Airborne Data Processing and Analysis Software Package, Earth Science Informatics, 4(1), 29-44. doi: http://dx.doi.org/10.1007/s12145-010-0061-4

Related Data

All data from other instruments collected during the IPHEx field campaign are related. Other IPHEx campaign data can be located using HyDRO 2.0 with the search term IPHEx.

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

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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Updated: July 19, 2017