Global Hydrology Resource Center

Data User Guide

GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx

Introduction

The GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx dataset includes, in addition to aircraft parameters, many scientific parameters, such as static pressure, dew point temperature, relative humidity, mixing ratio, liquid water content, and droplet concentration. These data were collected as part of the Light Precipitation Evaluation Experiment (LPVEx) from September 11, 2010 to October 20, 2010 in the Gulf of Finland. The dataset was collected to aid in achieving the overarching goals of LPVEx, to conduct a comprehensive evaluation of precipitation algorithms for current and future satellite platforms and to detect and understand the process of light rainfall formation at high latitudes. It should be noted that multiple instruments were carried aboard the University of Wyoming King Air (UWKA) including the Cloud Microphysics instrument and the Wyoming Cloud Radar (WCR) instrument. Data files are in netCDF-3 format.

Citation

Lecuyer, Tristan and J. French. 2013. GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx [indicate subset used]. Dataset available online, [http://ghrc.nssstc.nasa.gov] 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/LPVEX/MULTPLE/DATA202

Keywords:

NASA, GHRC, Global Precipitation Measurement, GPM, LPVEx, Gulf of Finland, King Air, airborne, cloud droplet concentration

Campaign

The Light Precipitation Evaluation Experiment (LPVEx) occurred in the Gulf of Finland in September and October 2010. The purpose of LPVEx was to characterize the ability of

CloudSat, the Global Precipitation Mission (GPM) Dual-frequency Precipitation Radar (DPR), and existing/planned passive microwave (PMW) sensors such as the GPM microwave imager (GMI) to detect light rain and evaluate their estimates of rainfall intensity in high latitude, shallow freezing level environments. A map of the LPVEx campaign region with the extent of radar coverage and other campaign related information marked is available through the LPVEx website, as well as through the GHRC LPVEx site. More detailed information about the Global Precipitation Measurement (GPM) mission is also available on the Precipitation Measuring Mission (PMM) webpage.

Aircraft and Instrument Description

The University of Wyoming King Air (UWKA) aircraft is a Raytheon King Air 200T twin turboprop designed to be used for atmospheric research by the University of Wyoming (Figure 1). It supports a wide range of research instrumentation and is frequently used for measuring cloud properties, air motion, turbulence/fluxes, atmospheric chemistry, and aerosols. Typically accommodating a crew of three or four, the UWKA can remain aloft for up to four hours at maximum payload capacity, roughly 1,650 pounds, and operate at a maximum flight altitude of 28,000 feet. It was used during the LPVEx field campaign to acquire data over the Gulf of Finland. More information about the UWKA aircraft is available on the University of Wyoming King Air Research webpage.

The Wyoming Cloud Radar (WCR) instrument was was one of many payload packages flown during the LPVEx field campaign onboard the UWKA. The Cloud Microphysics instruments consisted of the Particle Measuring System (PMS), which uses the Two-Dimensional Cloud (2-DC) and the Two-Dimensional Precipitation (2-DP) probes to measure distributed droplets of drizzle and precipitation over ranges of 25-6,500 micrometers and 100-9,000 micrometers, respectively. The Forward Scattering Spectrometer Probe (FSSP) and Cloud Droplet Probe (FSSP/CDP) measured cloud droplet concentrations over 1-31 micrometers and 2-50 micrometers, respectively. Additional measurements from the PMS include numerous observations, such as static pressure, dew point temperature, relative humidity, mixing ratio, liquid water content, and droplet concentration. Further information about the PMS and Cloud Microphysics payloads can be found in the LPVEx science plan document from 2010.

Figure 1: University of Wyoming King Air Research Aircraft
(Image Source: http://flights.uwyo.edu/uwka/)

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Data Characteristics

The GPM Ground validation Wyoming King Air Cloud Microphysics LPVEx data are available in netCDF-3 format at a level 2 processing level. For more information regarding NASA data processing levels, refer to this link. Table 1 outlines key characteristics about the Cloud Microphysics data files.

Table 1: Data Characteristics

Characteristic	Description
Platform	University of Wyoming King Air (UWKA)
Instrument	Wyoming King Air Cloud Microphysics
Projection	N/A
Spatial Coverage	N: 61.540, S: 59.688, E: 26.513, W: 19.837 (Gulf of Finland)
Temporal Coverage	11 September 2010 - 20 October 2010
Temporal Resolution	Daily < Weekly
Sampling Frequency	1 second
Parameter	Cloud Droplet Concentration
Version	1
Processing Level	2

File Naming Convention

The GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx dataset consists of netCDF-3 files with the following convention:

Data files: UWKA_cloudmicro_YYYYMMDD.c#.nc

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
.c#	# = 1 Hz - 25 Hz (c# designates the observation frequency 1hz = 1 obs/ sec, 25 hz = 25 obs/second)
.nc	netCDF-3 file format extension

Data Format and Parameters

The GPM Ground Validation Wyoming King Air Cloud Microphysics LPVEx dataset files contain atmospheric and meteorological airborne data, such as static pressure, dew point temperature, relative humidity, mixing ratio, liquid water content, and droplet concentration. The PI has composed a User Notes document that explains the data processing procedures for several variables in the dataset as well as calibration notes. Table 3 outlines and describes the data fields found in the files:

Table 3: Data Fields

Field Name	Description	Data Type	Unit	Scale Factor
A2DP0_OBL	PMS 2D_P number per cell (missing unit -32767.0)	float	count	N/A
A2DP1_OBL	PMS 2D_P number per cell (all values in)	float	count	N/A
A2DP2_OBL	PMS 2D_P number per cell (max values)	float	count	N/A
A2DPsz2_OBL	PMS 2D_P number per cell (all values in svol correction)	float	count	N/A
ACDP_NRB	DMT CDP number (per cell)	float	count	N/A
ACIP0_IBR	DMT CIP number per cell	float	count	N/A
ACIP1_IBR	DMT CIP number per cell (all values in)	float	count	N/A
ACIP2_IBR	DMT CIP number per cell (max values)	float	count	N/A
ACIPsz2_IBR	DMT CIP number per cell (all values in svol correction)	float	count	N/A
AFSSP_IBL	FSSP-100 Raw Accumulation (per cell)	float	count	N/A
aias	Indicated airspeed (boom pitot)	float	knots	N/A
AIAS_RAW	Uncooked tape variable	float	hPa	N/A
alpha	Attack angle (corrected)	float	radians	N/A
beta	Sideslip angle (corrected)	float	radians	N/A
bias	Indicated airspeed (co-pilot pitot)	float	knots	N/A
BIAS_RAW	Co-pilot Indicated Airspeed	float	hPa	N/A
BOAMP_RAW	Nose Boom Oven	float	amp	N/A
boom_pcor	Static pressure correction from boom calculation	float	mb	N/A
BOTMP1_RAW	Boom Oven Temperature	float	celsius	N/A
BOTMP2_RAW	Desiccant Block Temperature	float	celsius	N/A
BOVOLT_RAW	Boom Oven Voltage	float	volt	N/A
C2DP0_OBL	PMS 2D_P number per cell (svol correction)	float	count per liter	N/A
C2DP1_OBL	PMS 2D_P number per cell (all values in svol correction)	float	count per liter	N/A
C2DP2_OBL	PMS 2D_P number per cell (max svol correction)	float	count per liter	N/A
C2DPsz0_OBL	PMS 2D_P number per cell (svol correction)	float	count per liter	N/A

C2DPsz1_OBL	PMS 2D_P number per cell (all values in, svol correction)	float	count per liter	N/A
C2DPsz2_OBL	PMS 2D_P number per cell (max svol correction)	float	count per liter	N/A
CABINP_RAW	Cabin Pressure	float	hPa	N/A
CCDP_NRB	DMT CDP concentration (per cell)	float	cm-3	N/A
CCIP0_IBR	DMT CIP number per cell (svol correction)	float	count per liter	N/A
CCIP1_IBR	DMT CIP number per cell (all values in, svol correction)	float	count per liter	N/A
CCIP2_IBR	DMT CIP number per cell (max, svol correction)	float	count per liter	N/A
CCIPsz0_IBR	DMT CIP number per cell (svol correction)	float	count per liter	N/A
CCIPsz1_IBR	DMT CIP number per cell (all values in, svol)	float	count per liter	N/A
CCIPsz2_IBR	DMT CIP number per cell (max values in, svol correction)	float	count per liter	N/A
cdpacc_NRB	DMT CDP Total number	float	count	N/A
cdpconc_NRB	DMT CDP Total Concentration	float	cm-3	N/A
cdpdbar_NRB	DMT CDP Mean Diameter	float	um	N/A
cdplwc_NRB	DMT CDP Liquid Water Content	float	g m-3	N/A
cdpreff_NRB	DMT CDP Effective Radius	float	um	N/A
CFSSP_IBL	FSSP-100 Accumulation (per cell)	float	cm-3	N/A
CIParrt_IBR	DMT CIP arrival times	float	log10(seconds)	N/A
co21s	Licor CO2 concentration	float	volt	N/A
CO21S_RAW	Licor carbon dioxide signal	float	volt	N/A
co2ml	CO2 mole fraction LICOR	float	umol/mole	N/A
co2mx	CO2 mixing ratio LICOR	float	ugram/gram	N/A
co2pbmld	CO2 mole fraction (dry) LICOR (corrected for press boarding)	float	umol/mole	N/A
co2pbmx	CO2 mixing ratio LICOR (corrected for press boarding)	float	ugram/gram	N/A
CONC0_2dp_OBL	PMS 2D-P concentration	float	count per liter	N/A
CONC0_cip_IBR	DMT CIP concentration	float	count per liter	N/A
CONC1_2dp_OBL	PMS 2D-P concentration (all values in, svol correction)	float	count per liter	N/A
CONC1_cip_IBR	DMT CIP concentration (all values in, svol correction)	float	count per liter	N/A
CONCF_IBL	FSSP-100 Concentration (all cells)	float	cm-3	N/A
CPC_RAW	Condensation Particle Counter	float	cm-3	N/A
DATE	Date yymmdd (GMT)	float	yymmdd	N/A
DBARF_IBL	FSSP-100 Mean Particle Diameter	float	um	N/A
dpa	Rosemount 1332B1	float	mb	N/A
DPA_RAW	Attack angle	float	hPa	N/A
dpb	Rosemount 1332B1	float	mb	N/A
DPB_RAW	Sideslip angle	float	hPa	N/A
dpr	Rosemount 1332B1	float	mb	N/A

DPR_RAW	Noseboom reference pressure	float	hPa	N/A
FACT_IBL	FSSP-100 Activity Fraction	float	none	N/A
FDOFFR_IBL	FSSP-100 DOF Fraction	float	fraction	N/A
FLOWI_RAW	Licor Sample Flow	float	slpm	N/A
FLOWR_RAW	Licor reference flow	float	sccm	N/A
FRNG_IBL	FSSP-100 Size Range Category	float	none	N/A
FRST_IBL	FSSP-100 Fast Resets	float	count	N/A
FSTB_IBL	FSSP-100 Total Strobes	float	count	N/A
GALT	Altitude GPS (derived variable)	float	count	N/A
galt	Altitude GPS (GPS processing enabled)	float	m	N/A
GLAT	Latitude GPS (derived variable)	float	degrees North	N/A
glat	Latitude GPS (GPS processing enabled)	float	degrees North	N/A
GLON	Longitude GPS (derived variable)	float	degrees East	N/A
glon	Longitude GPS(GPS processing enabled)	float	degrees East	N/A
GPS0B_RAW	GPS PPS signal (at 1 PPS)	float	volt	N/A
GPS0C_RAW	GPS PPS signal (at 100 PPS)	float	volt	N/A
gvew	Ground velocity component East GPS	float	m/s	N/A
gvns	Ground velocity component North GPS	float	m/s	N/A
gvs	Ground velocity component Vertical GPS	float	m/s	N/A
h2o1s	Licor H2O concentration	float	volt	N/A
H2O1S_RAW	Licor Water Vapor Signal (raw)	float	volt	N/A
h2oml	H2O mole fraction LICOR	float	mmol/mole	N/A
h2omx	H2O mixing ratio LICOR	float	gram/kgram	N/A
hacz3	Vertical acceleration (inertial-baro)	float	m/s^2	N/A
HADSA_VR_RAW	HADS channel A temperature reference	float	volt	N/A
HADSA_VT_RAW	HADS channel A temperature correction	float	volt	N/A
HADSB_VR_RAW	HADS channel B temperature reference	float	volt	N/A
HADSB_VT_RAW	HADS channel B temperature correction	float	volt	N/A
hewvel	Inertial ground speed (E-W component, uncorrected)	float	m/s	N/A
hgs	Ground Speed (IRS, uncorrected)	float	m/s	N/A
hi3	Height (inertial-baro)	float	meters	N/A
hia	Inertial altitude (IRS)	float	meters	N/A
hivs	Inertial vertical speed (IRS)	float	m/s	N/A
hlat	Latitude (uncorrected, IRS)	float	Degrees North	N/A
hlata	Lateral acceleration, body axis (IRS)	float	g (gravity)	N/A

hlon	Longitude (uncorrected, IRS)	float	Degrees East	N/A
hlonga	Longitudinal acceleration, body axis (IRS)	float	g (gravity)	N/A
hnorma	Normal acceleration, body axis(IRS)	float	g (gravity)	N/A
hnsvel	Inertial ground speed (N-S component, uncorrected)	float	m/s	N/A
HOUR	Hour from midnight (GMT)	float	hours	N/A
hpitch	Pitch angle	float	degree	N/A
hpitchr	Pitch angle rate	float	radian/sec	N/A
hroll	Roll angle	float	degree	N/A
hrollr	Roll Angle Rate	float	radian/sec	N/A
hthead	Heading Angle (true)	float	Degree (true)	N/A
htrk	Track angle (IRS uncorrected)	float	Degree (true)	N/A
hu	Wind component (East)	float	m/s	N/A
hv	Wind component (North)	float	m/s	N/A
hw	Wind component (Vertical)	float	m/s	N/A
hwdir	Wind direction (from)	float	m/s	N/A
hwf	Wind component (Vertical, high pass filtered)	float	m/s	N/A
hwind_qflag	Horizontal Wind Correction Quality flag (0=accept, -1=reject)	float	number	N/A
hwmag	Wind Magnitude	float	m/s	N/A
hwp3	Vertical speed (inertial-baro)	float	m/s	N/A
hyawr	Yaw angle rate	float	radian/sec	N/A
ilwcool	Nevzorov LWC collector current	float	amp	N/A
ILWCCOL_RAW	Nevzorov LWC collector current (raw)	float	amp	N/A
ilwcref	Nevzorov LWC reference current	float	amp	N/A
ILWCRED_RAW	Nevzorov LWC reference current	float	amp	N/A
itwcool	Nevzorov TWC collector current	float	amp	N/A
ITWCCOL_RAW	Nevzorov TWC collector current	float	amp	N/A
itwcref	Nevzorov TWC collector current	float	amp	N/A
ITWCREF_RAW	Nevzorov TWC collector current	float	amp	N/A
jib_conc2_IBL	FSSP droplet concentration (JLB) method 2	float	cm^-3	N/A
jlb_conc3_IBL	FSSP droplet concentration (JLB) method 3	float	cm^-3	N/A
jlb_conc4_IBL	FSSP droplet concentration (JLB) method 4	float	cm^-3	N/A
jlb_lwc2_IBL	FSSP liquid water content (JLB) method 2	float	gram/m^3	N/A
jlb_lwc3_IBL	FSSP liquid water content (JLB) method 3	float	gram/m^3	N/A
jlb_lwc4_IBL	FSSP liquid water content	float	gram/m^3	N/A

	(JLB) method 4			
LAT	Latitude (not corrected with GPS)	float	Degree North	N/A
LATC	Latitude (IRS, gps corrected)	doube	Degree North	N/A
licorp	Licor Pressure	float	kPa	N/A
LICORP_RAW	Licor Pressure	float	kPa	N/A
LON	Longitude (not corrected with GPS)	float	Degree East	N/A
LONC	Longitude (IRS gps corrected)	float	Degree East	N/A
lwc100	Liquid water content (DMT100)	float	gram/m^3	N/A
LWC100_RAW	LWC 100 Liquid Water	float	watt	N/A
mass0_2dp_OBL	PMS 2D-P mass concentration	float	gram/m^3	N/A
mass0_cip_IBR	DMT CIP mass concentration	float	gram/m3	N/A
mass1_2dp_OBL	PMS 2D-P mass concentration	float	gram/m^3	N/A
mass1_cip_IBR	DMT CIP mass concentration	float	gram/m^3	N/A
mass2_2dp_OBL	PMS 2D-P mass concentration	float	gram/m^3	N/A
mass2_cip_IBR	DMT CIP mass concentration	float	gram/m^3	N/A
MINUTE	Minute from Beginning of HOUR	float	minutes	N/A
mr	Mixing Ratio	float	gram/kgram	N/A
npart_2dp_OBL	PMS 2D-P # of particles	float	number	N/A
npart_cip_IBR	DMT CIP # of particles	float	number	N/A
PALT	Pressure altitude (Std Atm)	float	meters	N/A
PLWCF_IBL	FSSP-100 Water Content	float	gram/m^3	N/A
PMB_RAW	Analog Static Pressure	float	hPa	N/A
ps_hads_a	Static Pressure (Rosemount 1501 High Accuracy Digital Sensing Module A)	float	millibar	N/A
ps_hads_b	Static Pressure (Rosemount 1501 High Accuracy Digital Sensing Module B)	float	millibar	N/A
ps_weston	Static Pressure (Weston Digital)	float	millibar	N/A
PUMPPRES_RAW	Gast pump pressure	float	N/A	N/A
pvmlwc	PVM-100A (Gerber) liquid water content	float	gram/m^3	N/A
PVMLWC_RAW	PVM-100A liquid water content	float	gram/m^3	N/A
pvmpsa	PVM-100A (Gerber) particle surface area	float	cm^2/m^3	N/A
PVMPSA_RAW	PVM-100A (Gerber) particle surface area (RAW)	float	cm^2/m^3	N/A
pvmre_c	PVM-100A (Gerber) effective radius (computed from lwc and psa)	float	micrometer	N/A
ralt1	Radar altitude (King)	float	meter	N/A
RBarVol_IBL	FSSP-100 Mean volume radius	float	micrometer	N/A
REffective_IBL	FSSP-100 Effective Radius	float	micrometer	N/A
rh	Relative Humidity	float	percent	N/A
rid_cycles	Icing cycles from Rosemount 871 icing detector	float	count	N/A
RIPEV_RAW	Rosemount Icing Event	float	volt	N/A

rlwc	Liquid water content from Rosemount 871 icing probe	float	gram/m^3	N/A
SECOND	SECOND from Beginning of SECOND	float	seconds	N/A
SurfArea_IBL	FSSP-100 Particle Surface Area	float	cm^2/m^3	N/A
T2DParrt_OBL	PMS 2DP arrival times	float	log10(seconds)	N/A
tas	True Airspeed	float	m/s	N/A
TASX	True Airspeed (same as tas)	float	m/s	N/A
tdp	Dew Point Temperature	float	Celsius	N/A
TDPEDGE_RAW	Edgetech dewpoint (from Edgetech Vigilant 137 instrument)	float	Celsius	N/A
tdplicor	Dew point temperature from LICOR H2O mixing ratio	float	Celsius	N/A
thetad	Potential temperature (dry)	float	Kelvin	N/A
thetae	Equivalent potential temperature	float	Kelvin	N/A
TIME	Time HHMMSS GMT (hour, minute, second)	float	HHMMSS	N/A
time	seconds since 2010-01-01 00:00:00 +0000	double	seconds	N/A
TIME14D	TIME yyyymmddhhmmss GMT (year, month, day, hour, minute, second)	double	yymmddhhmmss	N/A
topo	Topography from Database	float	meter	NA
trf	Static Temperature (In-house Reverse Flow)	float	Celsius	N/A
TRF_RAW	Reverse Flow Temperature	float	Celsius	N/A
trose	Static Temperature (Rosemount 102)	float	Celsius	N/A
TROSE_RAW	Rosemount 102 Temperature	float	Celsius	N/A
TURB_RAW	MRI Turbulence	float	N/A	N/A
twodcip_IBR	DMT CIP *shadow OR	float	number/liter	N/A
twodp	2DP shadow or concentration	float	liter^-1	N/A
uerr	Velocity error (x-component)	float	m/s	N/A
ux	Wind component (horizontal longitudinal)	float	m/s	N/A
verr	Velocity error (y-component)	float	m/s	N/A
vlwccol	Nevzorov LWC collector voltage	float	volt	N/A
VLWCCOL_RAW	Nevzorov LWC collector voltage	float	volt	N/A
vlwcref	Nevzorov LWC reference voltage	float	volt	N/A
VLWCREF_RAW	Nevzorov LWC reference voltage	float	volt	N/A
VRIP_RAW	Rosemount Icing Probe Voltage	float	volt	N/A
vtwccol	Nevzorov TWC collector voltage	float	volt	N/A
VTWCCOL_RAW	Nevzorov TWC collector voltage	float	volt	N/A

vtwcref	Nevzorov TWC reference voltage	float	volt	N/A
vy	Wind component (horizontal lateral)	float	m/s	N/A
xdist	Position East	float	kilometer	N/A
xerr	Position Error (x-component)	float	kilometer	N/A
ydist	Position North	float	kilometer	N/A
yerr	Position Error (y-component)	float	kilometer	N/A
z	Pressure Altitude (Std Atm)	float	kilometer	N/A
ZRAD_RAW	Pilot Radar Altimeter	float	feet	N/A
ztrue	Altitude Hypsometric	float	meters	N/A

Algorithm

The dataset variables are values derived from the the Cloud Microphysics suite and are separate from the aircraft orientation/heading information, in regards to location, altitude, and azimuth. Further information about the calculations and filters applied to the variables in the dataset is available in the PI User Notes.

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. These instruments had modified probe tips to minimize the amount of particle 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

This dataset is in netCDF-3 format and does not require any specific software to read. However, the data is easily read and viewed in Panoply.

Known Issues or Missing Data

There are several gaps in the data caused by a variety of flight or sensor issues. A two-minute gap is the extent of nearly all breaks in data continuity during collection as per the PI Release Notes.

References

NASA. (2011). Global Precipitation Measurement. Retrieved from https://pmm.nasa.gov/GPM

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University of Wyoming - Flight Center. (1977). University of Wyoming King Air Aircraft. https://doi.org/doi:10.15786/M29M1V

Related Data

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

Additionally, the Wyoming Cloud Radar (WCR) dataset was collected with a suite of instruments carried onboard the Wyoming King Air science aircraft. Other datasets associated with these tandum flights could be relatable to the LPVEx campaign overall and the WCR dataset, for example the Cloud Microphysics dataset (http://dx.doi.org/10.5067/GPMGV/LPVEX/MULTPLE/DATA202).

Contact Information

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

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