



Data User Guide

GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEX

Introduction

The GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEX dataset was collected in support of the Global Precipitation Measurement (GPM) mission Ground Validation Integrated Precipitation and Hydrology Experiment (IPHEX) field campaign in North Carolina, with an intense study period occurring from May 1, 2014 through June 15, 2014. The goal of IPHEX was to evaluate the accuracy of satellite precipitation measurements and use the collected data for hydrology models in the region. EXRAD is a single-frequency X-band Doppler radar that measures reflectivity and Doppler velocity. The science instruments, including the EXRAD, onboard the NASA ER-2 aircraft acted as a proxy for GPM satellite instruments. This dataset is available in netCDF-3 file format.

Notice:

This dataset only contains data from the nadir beam of the EXRAD instrument due to nadir being the focus of the IPHEX campaign.

Citation

Heysfield, Gerald M and Lin Tian. 2016. GPM GROUND VALIDATION ER-2 X-BAND RADAR (EXRAD) IPHEX [indicate subset used]. Dataset available online from the NASA Global Hydrology Resource Center DAAC, Huntsville, Alabama, U.S.A.

DOI: <http://dx.doi.org/10.5067/GPMGV/IPHEX/EXRAD/DATA101>

Keywords

GHRC, GPM GV, NASA, PMM, IPHEX, ER-2, EXRAD, North Carolina, radar, x-band, nadir, radar reflectivity, Doppler velocity

Campaign

The Global Precipitation Measurement mission Ground Validation (GPM GV) 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). These field campaigns accounted for the majority of the effort and resources expended by GPM GV mission. More information about the GPM GV mission is available at the [PMM Ground Validation webpage](#).

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 goal of IPHEX was to characterize warm season orographic precipitation regimes and the relationship between precipitation regimes and hydrologic processes in regions of complex terrain. The IPHEX campaign was a part of the development, evaluation, and improvement of remote-sensing precipitation algorithms in support of the GPM mission through the NASA GPM Ground Validation field campaign (IPHEX_GVFC) and the evaluation of Quantitative Precipitation Estimation (QPE) products for hydrologic forecasting and water resource applications in the Upper Tennessee, Catawba-Santee, Yadkin-Pee Dee, and Savannah river basins (IPHEX-HAP, H4SE). NOAA Hydrometeorology Testbed (HTM) has synergy with this project. More information about IPHEX is available at the [IPHEX Field Campaign webpage](#).

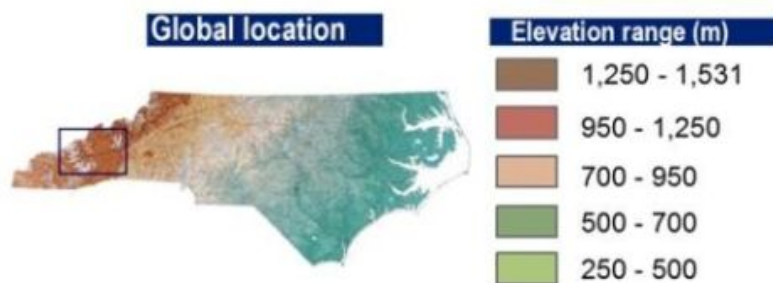


Figure 1: Region of North Carolina IPHEX campaign ground validation
(Image source: <http://gpm-gv.gsfc.nasa.gov/Gauge/>)

Instrument Description

The X-band Radar (EXRAD) is a single-frequency radar onboard NASA's ER-2 aircraft that measures radar backscatter at the X-band (9.6 GHz) frequency. This instrument was flown on the NASA ER-2 aircraft during the IPHEX field campaign. EXRAD is affected less by signal attenuation from storms than other radars. The instrument has both a conical/cross-track

scanning beam and a fixed nadir beam. This unique combination allows for the measurement of vertical hydrometeor velocity and air motions. More information about the EXRAD instrument is available on the [NASA Airborne Science EXRAD webpage](#).

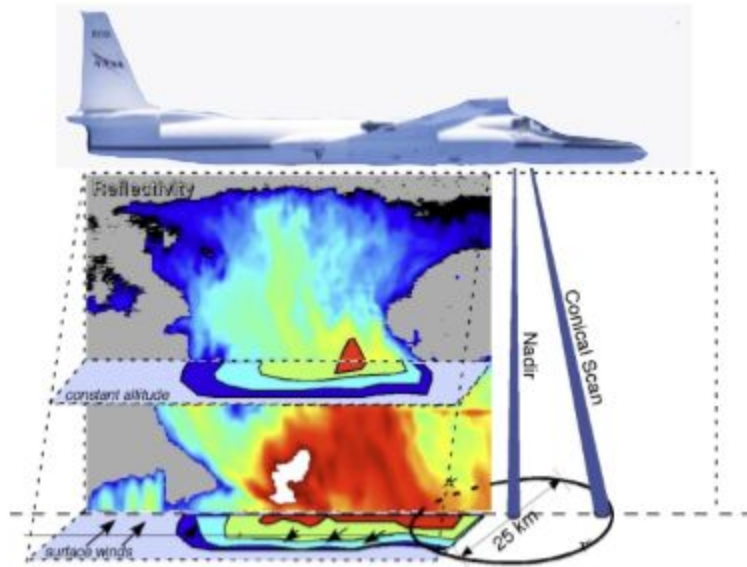


Figure 2: Image of the measurement concept of EXRAD.
(Image source: [First Flights of ER-2 X-band Radar](#))

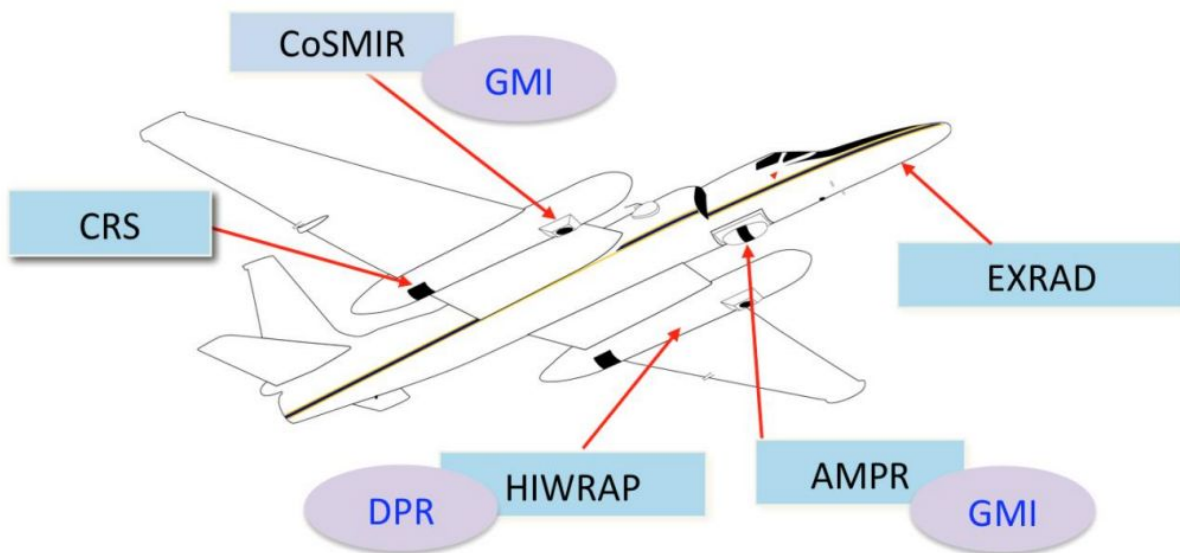


Figure 3: Location of IPHEX remote sensing instruments on the NASA ER-2 aircraft. The blue boxes label the instruments onboard, and the purple circles indicate which GPM Satellite instrument they can simulate.
(Image source: [IPHEX Science Plan](#))

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Data Characteristics

The GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEX dataset consists of netCDF-3 data format files at a Level 1B processing level. More information about the NASA data processing levels is available on the [EOSDIS Data Processing Levels](#) webpage. Each file contains data measured only by the nadir beam during some portion of an ER-2 flight. Flight portions vary in duration. ER-2 flights during IPHEX started on May 1, 2014 and ended on June 14, 2014, with CRS data only available from May 3, 2014 to June 12, 2014. No conical beam information is available.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Earth Resources-2 (ER-2)
Instrument	ER-2 X-band Doppler Radar (EXRAD)
Spatial Coverage	N: 36.55 , S: 26.8 , E: -71.94 , W: -86.56 (North Carolina)
Spatial Resolution	1.2 km
Temporal Coverage	May 3, 2014 - June 12, 2014
Temporal Resolution	Hourly - < Daily
Sampling Frequency	0.25 seconds
Parameter	Doppler velocity and radar reflectivity
Version	1
Processing Level	1B

File Naming Convention

The GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEX data files have the following naming convention:

Data: IPHEX_EXRAD_L1B_<start time>-<stop time>_nadir_dist_v01.nc

Table 2: File naming convention variables

Variable	Description
<start time>	Start time in YYYYMMDD-hhmmss

	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
<stop time>	Stop time in YYYYMMDD-hhmmss 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
.nc	netCDF-3 file format

Data Format and Parameters

The GPM Ground Validation ER-2 X-band Radar (EXRAD) IPHEX dataset consists of measured parameters from the nadir beam including doppler velocity and radar reflectivity as well as aircraft flight information such as altitude and ground speed. Table 3 below describes the data fields contained in each netCDF-3 file.

Table 3: Data Fields

Field Name	Description	Data Type	Unit
altitude	Aircraft Altitude	float	m
dopcorr	Doppler velocity after correction for aircraft motion and folding	float	m/s
evel	East aircraft ground speed	float	m/s
gatesp	Radar range gate	float	m
gspeed	Aircraft ground speed	float	m/s
head	Aircraft heading	float	degree
lat	GPS aircraft latitude, minus sign = South	float	degree
lon	GPS aircraft longitude, minus sign = West	float	degree
missing	Missing value	float	-
noise_thresh	Noise threshold	float	-
nvel	North aircraft ground speed	float	m/s
pitch	Aircraft pitch angle	float	degree

range	Range from radar	float	m
roll	Aircraft roll angle	float	degree
sigm0	Surface sigma0 (reflected signal)	float	dB
tilt	Incidence angle	float	degree
timed	UTC time	float	hour
track	Aircraft track angle	float	degree
vacft	Estimate of aircraft Doppler component	float	m/s
wlku	Wavelength length of radar	float	m
wvel	Aircraft vertical speed	float	m/s
year	Year the data were collected	short	-
zku	x Radar Reflectivity	float	dBz

Algorithm

High-resolution cross-sections of vertical air motions within precipitation regions of a storm are calculated by factoring out hydrometeor fallspeeds and aircraft motions from the EXRAD nadir beam measurements. The instrument's dual-beam technology can also provide measurements of horizontal air motions and assist with attenuation estimates. More information about EXRAD measurement capabilities is described in [Heymsfield et al. \(1996\)](#).

Quality Assessment

Meteorological targets are usually distorted by the radar antenna main- and sidelobes, often near the edges of deep convective areas. There is also some deviation in measurements from airborne nadir pointing weather radars due to errors in surface cross-sectional estimates. Correction filters are applied and sampling rates adjusted to account for these inaccuracies. More information about errors in radar measurements is available in [Heymsfield et al. \(2000\)](#) and [Caylor et al. \(1997\)](#).

Software

No special software is needed to read the netCDF-3 data files; however, [Panoply](#) is an easy-to-use free tool for reading and visualizing the data within the netCDF-3 file.

Known Issues or Missing Data

Within each data file, there is a variable named 'missing', which indicates missing data values. The ER-2 aircraft did not operate during the entire campaign, so EXRAD data are only available for aircraft flight days. Additionally, only the nadir data from EXRAD are available as nadir was the focus of the IPHEX campaign.

References

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Caylor, I. J., Heymsfield, G. M., Meneghini, R., Miller, L. S., Caylor, I. J., Heymsfield, G. M., ... Miller, L. S. (1997). Correction of Sampling Errors in Ocean Surface Cross-Sectional Estimates from Nadir-Looking Weather Radar. *Journal of Atmospheric and Oceanic Technology*, 14(1), 203–210.

[https://doi.org/10.1175/1520-0426\(1997\)014<0203:COSEIO>2.0.CO;2](https://doi.org/10.1175/1520-0426(1997)014<0203:COSEIO>2.0.CO;2)

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[https://doi.org/10.1175/1520-0426\(1996\)013<0795:TERSOT>2.0.CO;2](https://doi.org/10.1175/1520-0426(1996)013<0795:TERSOT>2.0.CO;2)

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[https://doi.org/10.1175/1520-0450\(2001\)040<2080:TPRRPA>2.0.CO;2](https://doi.org/10.1175/1520-0450(2001)040<2080:TPRRPA>2.0.CO;2)

Related Data

The following datasets are from other instruments onboard the ER-2 aircraft during the IPHEX campaign. The full list of IPHEX campaign data can be located using [Hydro 2.0](#) and searching 'IPHEX'. The complete IPHEX field campaign data collection can be found [here](#).

GPM Ground Validation Conical Scanning Millimeter-wave Imaging Radiometer (CoSMIR)
IPHEX

(<http://dx.doi.org/10.5067/GPMGV/IPHEX/CoSMIR/DATA101>)

GPM Ground Validation High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)
IPHEX

(<http://dx.doi.org/10.5067/GPMGV/IPHEX/HIWRAP/DATA101>)

GPM Ground Validation Cloud Radar System (CRS) IPHEX

(<http://dx.doi.org/10.5067/GPMGV/IPHEX/CRS/DATA101>)

GPM Ground Validation Advanced Microwave Precipitation Radiometer (AMPR) IPHEX
(<http://dx.doi.org/10.5067/GPMGV/IPHEX/AMPR/DATA202>)

GPM Ground Validation NASA ER-2 Navigation Data IPHEX
(<http://dx.doi.org/10.5067/GPMGV/IPHEX/NAV/DATA002>)

Contact Information

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

NASA Global Hydrology Resource Center DAAC

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