



Data User Guide

GRIP Hurricane Imaging Radiometer (HIRAD)

Introduction

The Hurricane Imaging Radiometer (HIRAD) utilizes NASA Instrument Incubator Technology which provides unique observations of sea surface wind, temperature and rain. HIRAD measures brightness temperature at 4, 5, 6 and 6.6 GHz. Ocean surface wind speed and rain rate are derived from the brightness temperature measurements. HIRAD data was collected for storms EARL and KARL during the GRIP field experiment.

Dataset updated. Two different versions of the data are available: V1 published in 2015, and a preliminary V0 published in 2011. V0 updated files for the Karl hurricane in 2013.

Version 1, 2015:

Observed brightness temperature (T_b) data at all four measurement frequencies (4, 5, 6 and 6.6 GHz) are available for the entire flight duration. This updated data has utilized calibration coefficients derived from some laboratory tests performed in the year of 2014. V1 data solely contains brightness temperature; wind speed and rain rate products must be obtained from [version 0 data](#). Matlab software is also provided in the file [read v2 grip HIRADnc.m](#).

Google Earth browse images are available for this data set along with a flight track that can be displayed in the Google Earth platform. For additional info on the Google Earth data files, please refer to the guide, [HIRAD GoogleEarth kmz-GUIDE.pdf](#)

Version 0, 2011:

Preliminary Version 0 of the data measures brightness temperatures at 5 GHz frequency. Four rain rate and wind speed files for EARL have been added to the collection. These files are available in ASCII text format and are available for the following days:

09-01-2010: Legs 1 and 3

09-02-2015: Legs 4 and 6

More specific information for V0 HIRAD data is provided in the Principal Investigator's documentation listed on [the GRIP HIRAD V0 Dataset Information Page](#)

Note: If you plan to use the V0 data in a publication and/or a presentation, please contact [GHRC User Services Office \(support-ghrc@earthdata.nasa.gov\)](mailto:support-ghrc@earthdata.nasa.gov).

Citation

Version 1, 2015.

Cecil, Daniel J., T. Miller, W. L. Jones, S. Farrar, S. Sahawneh. 2015. GRIP Hurricane Imaging Radiometer (HIRAD) V1 [indicate subset used]. Dataset available online. <https://fcportal.nsstc.nasa.gov/pub/grip/HIRAD/v1/> from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. DOI: <http://dx.doi.org/10.5067/GRIP/HIRAD/DATA202>.

Version 0, 2011.

Cecil, Daniel J. and Sayak K. Biswas. 2011. GRIP Hurricane Imaging Radiometer (HIRAD) V0 [indicate subset used]. Dataset available online. <https://fcportal.nsstc.nasa.gov/pub/grip/HIRAD/v0/> from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. DOI: <http://dx.doi.org/10.5067/GRIP/HIRAD/DATA201>.

Keywords:

NASA, GHRC; GRIP, HIRAD; Atlantic Ocean; aircraft observations, Global Hawks; radiometer, multi-frequency interferometric radiometer, passive microwave sensor; sea surface wind, temperature, rain; hurricane, hurricane study campaign;

Campaign

The Genesis and Rapid Intensification Processes (GRIP) experiment was a NASA Earth science field experiment conducted August 5 to September 30, 2010. The major goal was to better understand how tropical storms form and develop into major hurricanes. NASA used the DC-8 aircraft, the WB-57 aircraft and the Global Hawk Unmanned Airborne System (UAS), configured with a suite of in situ and remote sensing instruments that were used to observe and characterize the lifecycle of hurricanes. This campaign also capitalized on a number of ground networks and space-based assets, in addition to the instruments deployed on aircraft from Ft.

Lauderdale, Florida (DC-8), Houston, Texas (WB-57), and NASA Dryden Flight Research Center, California (Global Hawk). More information about this Campaign can be found on the GRIP web site: <http://airbornescience.nsstc.nasa.gov/grip>.

Instrument Description

The Hurricane Imaging Radiometer (HIRAD) is a hurricane imaging, single-pol passive C-band radiometer with both cross-track and along-track resolution that measures strong ocean surface winds through heavy rain from an aircraft or space-based platform. Its swath width is approximately 60 degrees in either direction. It provides unique observations of sea surface wind, temperature, and rain.

Investigators

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File Naming Convention

2015 version: data:

TB Data: HIRAD_TBdata_yyyymmdd_<start>-<stop>_leg##.nc Browse:

Flight Track : grip_flighttrack_YYYYMMDD_YYYYMMDD_earl_extrude.kmz

TB Image: TB#.kmz

Excess TB Image: TB#ex.kmz

= 4, 5, 6 and 7 corresponds to 4GHz , 5GHz, 6GHz and 6.6GHz measurement frequencies

2011 version:

The data and browse files are of the form:

data:

grip_hirad_yyyymmdd_[EARL|KARL16]_leg#[WSRR|].[mat|nc|txt]
grip_hirad_yyyymmdd_[EARL|KARL16]-leg#delTB5fltrd.[mat|nc]

browse: grip_hirad_yyyymmdd_[EARL|KARL16]-
leg#[After|Before|Mean_4thOrderFit].jpg
grip_hirad_yyyymmdd_[EARL|KARL16]_leg#.jpg

where:

yyymmdd = year, month and day hirad
= Hurricane Imaging Radiometer
EARL = Hurricane EARL
KARL16 = Hurricane KARL
= number of the flight leg (1,2,3,..10)
WSRR = wind speed and rain rate
delTB5 = Excess TB at 5 Ghz channel
<start>, <stop> = time in hhmmss for
start and stop times of data collection
<dd> = day of flight mat
= Matlab
nc = netCDF txt
= ASCII text jpg
= JPEG

Data Format Description

2015 version:

This data is available in NetCDF format only. A MATLAB script is provided (read_HIRADnc.m) to import the data into MATLAB environment. The format of the NetCDF files is given below:

variables:

1. single PAZ(azimuth), shape = [Naz]
 :units = "deg."

:valid_range = "-80.0 deg. to +80.0 deg."
:long_name = "Pixel Azimuth (+ve is starboard side)"

2. int32 DATE(time), shape = [Ntime]
:units = "YYYYMMDD"
:valid_range = "0 to 99999999"
:long_name = "Date"

3. int32 TIME(time), shape = [Ntime]
:units = "HHMMSS UTC"
:valid_range = "0 to 235959"
:long_name = "Time"

4. single ACLON(time), shape = [Ntime]
:units = "deg. E."
:valid_range = "-180.0 to +180.0"
:long_name = "Aircraft Longitude"

```
single
:units =
:valid_range
5.          ACLAT(time), shape = [Ntime]
           "deg. N."
           = "-90.0 to +90.0"
:long_name = "Aircraft Latitude"

6.          single ACALT(time), shape = [Ntime]
:units = "meters"
:valid_range = "0 to 20000"
:long_name = "Aircraft Altitude"

7.          single RANG(time), shape = [Ntime]
:units = "deg."
:valid_range = "-30.0 to +30.0"
:long_name = "Aircraft Roll Angle"

8.          single PANG(time), shape = [Ntime]
:units = "deg."
:valid_range = "-30.0 to +30.0"
:long_name = "Aircraft Pitch Angle"

9.          single THDG(time), shape = [Ntime]
:units = "deg."
:valid_range = "0.0 to 360.0"
:long_name = "Aircraft True Heading (Clockwise from
North)"

10.         single ACGS(time), shape = [Ntime]
:units = "meters per second"
:valid_range = "0.0 to 999.0"
:long_name = "Aircraft Ground Speed"
```

single
:units =
:valid_range

11. single PLON(time,azimuth), shape = [Ntime Naz]
:units = "deg. E."
:valid_range = "-180.0 to +180.0"
:missing_value = -999.9
:long_name = "Pixel Longitude"

12. single PLAT(time,azimuth), shape = [Ntime Naz]
:units = "deg. N."
:valid_range = "-90.0 to +90.0"
:missing_value = -999.9
:long_name = "Pixel Latitude"

13. PEIA(time,azimuth), shape = [Ntime Naz]
"deg."
= "0.0 to +90.0"
:missing_value = -999.9
:long_name = "Pixel Earth Incidence Angle"

14. single TB4(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Brightness Temperature @ 4.0 GHz"

15. single TB5(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Brightness Temperature @ 5.0 GHz"

single
:units =
:valid_range

16. single TB6(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Brightness Temperature @ 6.0 GHz"

17. single TB7(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Brightness Temperature @ 6.6 GHz"

18. single EXTB4(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Excess Brightness Temperature @ 4.0 GHz"

19. single EXTB5(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Excess Brightness Temperature @ 5.0 GHz"
20. EXTB6(time,azimuth), shape = [Ntime Naz]
 "Kelvin"
 = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Excess Brightness Temperature @ 6.0 GHz"

- single
:units =
:valid_range

- 21. single EXTB7(time,azimuth), shape = [Ntime Naz]
:units = "Kelvin"
:valid_range = "0.0 to 400.0"
:missing_value = -999.9
:long_name = "Excess Brightness Temperature @ 6.6 GHz"

- 22. single JSST(time,azimuth), shape = [Ntime Naz]
:units = "Centigrade"
:valid_range = "0.0 to 100.0"
:missing_value = -999.9
:long_name = "JPL MUR Sea Surface Temperature"

- 23. single MWS(time,azimuth), shape = [Ntime Naz]
:units = "meters per second"
:valid_range = "0.0 to 100.0"
:missing_value = -999.9
:long_name = "MERRA 2m Wind Speed"

- 24. int32 flag4(time,azimuth), shape = [Ntime Naz]
:units = "unitless"
:valid_range = "0, 1 and 2"
:valid_data = 0
:questionable_data = 1
:invalid_data = 2
:long_name = "Validity Flag for 4.0 GHz Observations"

- 25. int32 flag5(time,azimuth), shape = [Ntime Naz]
:units = "unitless"

```
    single
:units =
:valid_range
```

```
:valid_range = "0, 1 and 2"
:valid_data = 0
:questionable_data = 1
:invalid_data = 2
:long_name = "Validity Flag for 5.0 GHz Observations"
```

```
26.      int32 flag6(time,azimuth), shape = [Ntime Naz]
        :units = "unitless"
```

```
:valid_range = "0, 1 and 2"  
:valid_data = 0  
:questionable_data = 1  
:invalid_data = 2  
:long_name = "Validity Flag for 6.0 GHz Observations"
```

27. int32 flag7(time,azimuth), shape = [Ntime Naz]

```
:units = "unitless"  
:valid_range = "0, 1 and 2"  
:valid_data = 0  
:questionable_data = 1  
:invalid_data = 2  
:long_name = "Validity Flag for 6.6 GHz Observations"
```

//global Attributes:

```
:FileName = "HIRAD_TBdata_YYYYMMDD_<start:hmmss>-<stop>_leg##.nc"  
:FlightDate = "YYYY/MM/DD"  
:Leg = #  
:TimeInterval = "hh:mm:ss-hh:mm:ss"  
:Source = "NASA/MSFC/ZP11"  
:Project = "Hurricane Imaging Radiometer"  
:Campaign = "GRIP"  
:Aircraft = "NASA WB57"  
:StormName = "<name of storm>"
```

2011 version:

The data is available in both Matlab and NetCDF format. The wind speed and rain rate files are available in ASCII text format. Information on the variable order in the netCDF files may be found in [grip_hirad_netcdf_variables_v0.txt](#). An example script for reading and plotting the Matlab data is available in [grip_hirad_plotting_v0.m](#), and a cross-track filter script is available in [grip_hirad_read_plot_filterTB_HIRAD_v0.m](#). The browse is available in JPEG format.

Contact Information

To order these data or for further information, please contact:
Global Hydrology Resource Center

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