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.

Version 1, 2015:

Observed brightness temperature (Tb) data at all four measurement frequencies are available for the entire flight duration. The data used calibration coefficients derived from some laboratory tests performed in the year of 2014. V1 data contains brightness temperature; wind speed and rain rate products must be obtained from version 0 data. Google earth browse images are available for this data set along with a flight track that can be displayed on Google Earth platform. For additional info refer to the guide HIRAD_GoogleEarth_kmz-GUIDE.pdf. Matlab software is also provided in the file read_v2_grip_HIRADnc.m.

Version 0, 2011:

Preliminary Version 0 of the data measures brightness temperatures at 5 GHz. Rain Rate and Wind speed files for EARL have been added to the collection. 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).

Notice:
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.

Citation

Version 1, 2015:
Cecil, Daniel J. and Sayak K. Biswas. 2015. GRIP Hurricane imaging Radiometer (HIRAD) V1 [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/GRIP/HIRAD/DATA202

Version 0, 2011:
Cecil, Daniel J., Timothy Miller, W. Linwood Jones, Spencer Farrar and Saleem Sahawneh. 2011. GRIP Hurricane Imaging Radiometer (HIRAD) [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/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: https://ghrc.nsstc.nasa.gov/home/field-campaigns/grip.

Instrument Description

The Hurricane Imaging Radiometer (HIRAD)is a hurricane imaging, single-pole 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:
yyyymmdd = 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"
5. single ACLAT(time), shape = [Ntime]
   :units = "deg. N."
   :valid_range = "-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"
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. single PEIA(time,azimuth), shape = [Ntime Naz]
    :units = "deg."
    :valid_range = "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"
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. single EXTB6(time,azimuth), shape = [Ntime Naz]
    :units = "Kelvin"
    :valid_range = "0.0 to 400.0"
    :missing_value = -999.9
    :long_name = "Excess Brightness Temperature@ 6.0 GHz"
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"
    :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:hhmmss>-<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:
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