Data User Guide

High Altitude MMIC Sounding Radiometer (HAMSR) CPEX

Introduction

The High Altitude MMIC Sounding Radiometer (HAMSR) CPEX dataset includes measurements gathered by the HAMSR instrument during the Convective Processes Experiment (CPEX) field campaign. The CPEX field campaign took place in the North Atlantic-Gulf of Mexico-Caribbean Sea region from 25 May-25 June 2017. CPEX conducted a total of sixteen DC-8 missions from 27 May-24 June. The CPEX campaign collected data to help explain convective storm initiation, organization, growth, and dissipation in the North Atlantic-Gulf of Mexico-Caribbean Oceanic region during the early summer of 2017. HAMSR has 25 spectral channels which are split into 3 bands to provide measurements that can be used to infer the 3-dimensional distribution of temperature, water vapor, and cloud liquid water profiles in the atmosphere, even in the presence of clouds. Data are available from May 24, 2017 through July 16, 2017 in netCDF-3 format.

Notice:
The NASA DC-8 aircraft did not operate each day of the campaign, therefore HAMSR data are only available for aircraft flight days.

Citation

Lambrigtsen, Bjorn. 2023. High Altitude MMIC Sounding Radiometer (HAMSR) CPEX [indicate subset used]. Dataset available online from the NASA Global Hydrometeorology Resource Center DAAC, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/CPEX/HAMSR/DATA101

Keywords:

NASA, GHRC, CPEX, HAMSR, DC-8, humidity, cloud liquid water, brightness temperature, reflectivity, precipitable water vapor

Campaign

The NASA Convective Processes Experiment (CPEX) aircraft field campaign took place in the North Atlantic-Gulf of Mexico-Caribbean Sea region from 25 May-25 June 2017. CPEX conducted a total of sixteen DC-8 missions from 27 May-24 June. The 16 missions covered a wide range of weather conditions from clear and calm wind, isolated convective cloud systems, to Tropical Storm Cindy (2017). It is the first field campaign that collected airborne observations continually from pre-tropical disturbance in the Caribbean Sea, to tropical depression, and formation of Tropical Storm Cindy in the Gulf of Mexico prior to landfall. The three main science objectives of CPEX were: 1) Improve understanding of convective processes including cloud dynamics, downdrafts, cold pools and thermodynamics during initiation, growth, and dissipation. 2) Obtain a comprehensive set of simultaneous wind, temperature, and moisture profiles, using Doppler wind lidar (DAWN), microwave radiometer and sounder (HAMSR/MASC), and GPS dropsondes, conduct a quantitative evaluation of those profiles in the vicinity of scattered and organized deep convection measured by airborne precipitation radar (APR2), in all phases of convective life cycle. 3) Improve model representation of convective and boundary layer processes over the tropical oceans using a cloud-resolving, fully coupled atmosphere-ocean model, and assimilate the wind, temperature and humidity profiles into the model. More information is available from NASA's Jet Propulsion Laboratory's CPEX field campaign webpage.

Figure 1: CPEX field campaign logo
(Image source: CPEX)

Instrument Description

TThe High Altitude Monolithic Microwave Integrated Circuit (MMIC) Sounding Radiometer (HAMSR) is a microwave atmospheric sounder developed by the NASA Jet Propulsion Laboratory (JPL) in Pasadena, California under the NASA Instrument Incubator Program.

Operating with 25 spectral channels in 3 bands (50-60 Ghz, 118 Ghz, and 183 Ghz), it provides measurements that can be used to infer the 3-dimensional distribution of temperature, water vapor, and cloud liquid water profiles in the atmosphere, even in the presence of clouds. The HAMSR instrument is compact enough to fit into a package that is 90 cm long, 38 cm wide, and 33 cm tall and weighs 45 kg. Its scan axis is oriented along the flight path, and its antenna system includes two back-to-back reflectors. Figure 2 shows, in gray, the location of the HAMSR instrument on the Global Hawk NASA aircraft. Level 2 data files include temperature, water vapor, cloud liquid water profiles, and derived products, such as potential temperature and relative humidity. More information about the HAMSR instrument can be found in Brown et al., 2011.

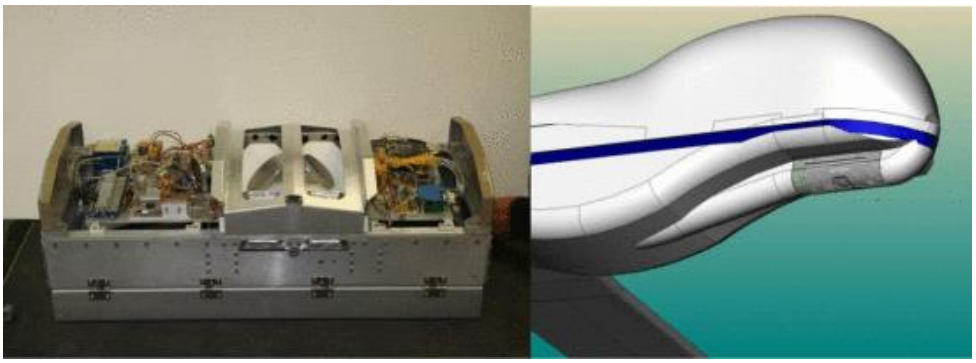

Figure 2: HAMSR instrument (left) and location on the Global Hawk NASA aircraft (right). Source: Brown et al., 2011

Investigators

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Data Characteristics

The HAMSR CPEX dataset consists of measurements gathered by the HAMSR instrument during the CPEX field campaign. These data are available at a Level 2 processing level. More information about the NASA data processing levels is available on the EOSDIS Data Processing Levels webpage. The characteristics of this dataset are listed in Table 1 below.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA DC-8 aircraft
Instrument	High Altitude MMIC Sounding Radiometer (HAMSR)
Spatial Coverage	N: 39.950, S: 5.050, E: -45.050, W: -99.950 (North Atlantic, Gulf of Mexico, caribbean)
Spatial Resolution	2km
Temporal Coverage	May 24, 2017 - July 16, 2017

Temporal Resolution	Hourly -< Daily
Sampling Frequency	5 seconds
Parameter	Cloud liquid water, absolute humidity, relative humidity, air temperature, derived reflectivity, precipitable water vapor, calibrated brightness temperature
Version	1
Processing Level	2

File Naming Convention

The HAMSR CPEX data are within netCDF-3 files and are named using the following convention:

Data files: CPEX_HAMSR_L2_realtime_<start date>_<end date>.nc

Table 2: File naming convention variables

Variable	Description
<start date>	Date when data collection began in YYYYMMDD format, where: YYYY = Four-digit year MM = Two-digit month DD = Two-digit day
<end date>	Date when data collection ended in YYYYMMDD format, where: YYYY = Four-digit year MM = Two-digit month DD = Two-digit day
.nc	netCDF-3 format

Data Format and Parameters

The HAMSR CPEX data are available in netCDF-3 format. The data contains time ordered and geo-located calibrated brightness temperatures for the Earth scan for each of the 25 HAMSR channels along with retrieved products, including cloud liquid water, absolute humidity, relative humidity, air temperature, derived reflectivity, and precipitable water vapor (Table 3). More information about HAMSR Level 2 data format is available at Description of the High Altitude MMIC Sounding Radiometer (HAMSR) Level 2 data format.

Table 3: Data Fields

Variable	Description	Scale Factor	Units
ACheading	Airplane Heading [-180:180]	0.01	degrees
AClat	Airplane Latitude [-90:90]	0.001	degrees_north
AClon	Airplane Longitude [-180:180]	0.001	degrees_east
ACpitch	Airplane Pitch [-180:180]	0.01	degrees
ACroll	Airplane Roll [-180:180]	0.01	degrees

altitude	Aircraft altitude from GPS in meters	0.1	m
TB	Calibrated Brightness Temperature	0.001	K
CLW	HAMSR Integrated Cloud Liquid Water - Regression Algorithm	0.0001	mm
ham_airQ	HAMSR Vertical Absolute Humidity	0.001	g m^{-3}
ham_airRH	HAMSR Vertical Relative Humidity	0.01	%
ham_airT	HAMSR Vertical Air Temperature	0.1	K
ham_dBz	HAMSR Derived Reflectivity Profile	0.01	dBz
ham_dBz_heights	HAMSR Height of Reflectivity Profile	1.0	m
ham_pres_levels	HAMSR Profile Pressure Levels	0.1	mb
PWV	HAMSR Precipitable Water Vapor - Regression Algorithm	0.001	cm
rain_flag	Rain flag (0-no rain, >0 rain)	1.0	-
inc	Pixel Incidence Angle [-180:180]	0.01	degrees
lat	Pixel Latitude [-90:90]	0.001	degrees_north
lon	Pixel Longitude [-180:180]	0.001	degrees_east
time	Measurement time (seconds since 2000-01-01 00:00:00.0)	1.0	seconds

Quality Assessment

The HAMSR instrument is fully calibrated ensuring high quality measurements. The calibration tests include characterization of receiver linearity, stability, along scan biases, and end-to-end pass band. The bias of scan angles between ±45° is less than 0.8 K, and the bias of 118/183 GHz channels is less than 0.5 K within this ±45° scan range. The bias for brightness temperature is much larger with a bias of almost 70 K; however, brightness temperature measurements during flights at about 20 km altitude have a bias no greater than 0.5 K. These errors may be because the metal frame of the aircraft is mainly in the field of view of the scan. More information about these biases can be found in Brown et al., 2011.

Software

No special software is needed to read these netCDF data files; however, Panoply is an easy-to-use free tool for reading and visualizing the data within these netCDF files.

Known Issues or Missing Data

The aircraft did not operate each day of the campaign, therefore HAMSR data are only available for aircraft flight days.

References

Brown, S. T., B. Lambrigtsen, R. F. Senning, T. Gaier, P. Kangaslahti, B. H. Lim, J. M. Tanabe, A. B. Tanner (2011). The High-Altitude MMIC Sounding Radiometer for the Global Hawk Unmanned Aerial Vehicle: Instrument Description and Performance, *IEEE Transactions of Geoscience and Remote Sensing*, 49, 3291-3301. doi: https://doi.org/10.1109/TGRS.2011.2125973.

Related Data

All other datasets collected as part of the CPEX campaign are considered related and can be located by searching the term "CPEX" in the Earthdata Search. Other HAMSR datasets can be located by searching the term "HAMSR" in the Earthdata Search and are listed below.

High Altitude MMIC Sounding Radiometer (HAMSR) CPEX-AW
(http://dx.doi.org/10.5067/CPEXAW/HAMSR/DATA101)

High Altitude MMIC Sounding Radiometer (HAMSR) EPOCH
(http://dx.doi.org/10.5067/EPOCH/HAMSR/DATA101)

Hurricane and Severe Storm Sentinel (HS3) Global Hawk High Altitude MMIC Sounding Radiometer (HAMSR)
(http://dx.doi.org/10.5067/HS3/HAMSR/DATA201)

GRIP High-Altitude MMIC Sounding Radiometer (HAMSR)
(http://dx.doi.org/10.5067/GRIP/HAMSR/DATA201)

NAMMA High Altitude MMIC Sounding Radiometer (HAMSR)
(http://dx.doi.org/10.5067/NAMMA/HAMSR/DATA201)

TCSP High Altitude MMIC Sounding Radiometer (HAMSR)
(http://dx.doi.org/10.5067/TCSP/HAMSR/DATA101)

CAMEX-4 High Altitude MMIC Sounding Radiometer (HAMSR)
(http://dx.doi.org/10.5067/CAMEX-4/HAMSR/DATA101)

Contact Information

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

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Created: 2/28/2023