



## Data User Guide

# High Altitude MMIC Sounding Radiometer (HAMSR) EPOCH

### Introduction

The High Altitude MMIC Sounding Radiometer (HAMSR) EPOCH dataset includes measurements gathered by the HAMSR instrument during the East Pacific Origins and Characteristics of Hurricanes (EPOCH) project. EPOCH was a NASA program manager training opportunity directed at training NASA young scientists in conceiving, planning, and executing a major airborne science field program. The goals of the EPOCH project were to sample tropical cyclogenesis or intensification of an Eastern Pacific hurricane and to train the next generation of NASA Airborne Science Program leadership. 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. HAMSR is mounted in payload zone 3 near the nose of the Global Hawk NASA aircraft. Data is available from August 9, 2017 through August 31, 2017 in netCDF-3 format.

**Notice:** The Global Hawk UAV aircraft did not operate each day of the campaign, therefore HAMSR data are only available for aircraft flight days.

### Citation

Schreier, Mathias. 2022. High Altitude MMIC Sounding Radiometer (HAMSR) EPOCH [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/EPOCH/HAMSR/DATA101>

### Keywords:

NASA, GHRC, EPOCH, Global Hawk, HAMSR, humidity, cloud liquid water, brightness temperature, reflectivity, precipitable water vapor

## Project

The East Pacific Origins and Characteristics of Hurricanes (EPOCH) project was a NASA program manager training opportunity directed at training NASA young scientists in conceiving, planning, and executing a major airborne science field program. Combined with this goal the EPOCH project was to sample tropical cyclogenesis or intensification of an Eastern Pacific hurricane. The EPOCH project consists of three payload instruments, ER-2 X-band Radar (EXRAD), High Altitude Monolithic Microwave Integrated Circuit Sounding Radiometer (HAMSr), and Advanced Vertical Atmospheric Profiling System (AVAPS), onboard the AV-6 Global Hawk Unmanned Aerial Vehicle research aircraft. The launch site was at the Armstrong Flight Research Center located on Edwards Air Force Base in California. The launch/flight window consisted of up to six 24-hour science flights from August 1, 2017 through August 30, 2017 over the Pacific Ocean. More information about the EPOCH project can be found at [NOAA UAS Program Participates in NASA's East Pacific Origins and Characteristics of Hurricanes \(EPOCH\) Project](#), [Emory et al., 2015](#), and [EPOCH: East Pacific Origins and Characteristics of Hurricanes | Earth](#).



Figure 1: EPOCH airborne instrument suite  
(Image source: [Emory et al., 2015](#))

## Instrument Description

The 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. HAMSr is mounted in payload zone 3 near the nose of the Global Hawk NASA aircraft. 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 1 shows, in gray, the location of the HAMSr instrument on the Global Hawk NASA aircraft. Data is processed through two processing levels. Level 1B data files contain calibrated brightness temperatures with geolocation and timestamp information. 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](#).

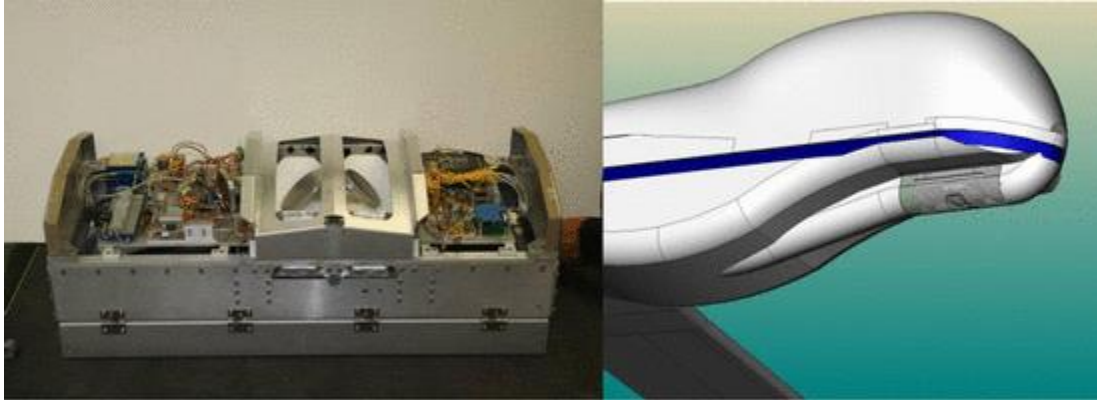


Figure 2: HAMSRS instrument (left) and location on the Global Hawk NASA aircraft (right).  
 Source: [Brown et al., 2011](#)

## Investigators

Mathias Schreier  
 Jet Propulsion Laboratory  
 Pasadena, California

## Data Characteristics

The HAMSRS EPOCH dataset consists of measurements gathered by the HAMSRS instrument during the EPOCH project. These data are stored in netCDF-3 format at a Level 2 processing level. More information about the NASA data processing levels are 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	Global Hawk UAV
Instrument	High Altitude MMIC Sounding Radiometer (HAMSRS)
Spatial Coverage	N: 36.473, S: 16.116, E: -83.077, W: -125.321 (Pacific Ocean)
Spatial Resolution	2 km
Temporal Coverage	August 9, 2017 - August 31, 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 EPOCH dataset files are available in netCDF-3 format and named using the following convention:

**Data:** EPOCH\_HAMSR\_L2\_realtime\_<start\_time>\_<end\_time>.nc

Table 2: File naming convention variables

Variable	Description
<start_time>	YYYYMMDDThhmm YYYY = four-digit year MM = two-digit month DD = two-digit day hh = two-digit hour mm = two-digit minute
<end_time>	YYYYMMDDThhmm YYYY = four-digit year MM = two-digit month DD = two-digit day hh = two-digit hour mm = two-digit minute
.nc	netCDF-3 format

## Data Format and Parameters

The HAMSR EPOCH 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 [https://microwavescience.jpl.nasa.gov/files/mws/HAMSR\\_L2\\_description.pdf](https://microwavescience.jpl.nasa.gov/files/mws/HAMSR_L2_description.pdf).

Table 3: HAMSR EPOCH netCDF-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 <sup>-3</sup>
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  $\pm 45^\circ$  is less than 0.8 K, and the bias of 118/183 GHz channels is less than 0.5 K within this  $\pm 45^\circ$  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 Global Hawk UAV aircraft did not operate each day of the campaign, therefore HAMSR data are only available for aircraft flight days. Also, there are bad latitude and longitude values in the EPOCH\_HAMSR\_L2\_realtime\_20170809T0500\_20170809T0600.nc data file.

## 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>.

Amber, Emory E., M. McLinden, M. Schreier and G. A. Wick (2015). An Introduction to the Nasa East Pacific Origins and Characteristics of Hurricanes (Epoch) Field Campaign, *Tropical Cyclone Research and Review*, 4, 3-4. doi:

<https://doi.org/10.6057/2015TCRRh3.03>

NASA Earth Sciences: EPOCH: East Pacific Origins and Characteristics of Hurricanes.

<https://earth.gsfc.nasa.gov/meso/campaigns/epoch>

NOAA UAS, 2017: Program Participates in NASA's East Pacific Origins and Characteristics of Hurricanes (EPOCH) Project.

<https://uxsrto.research.noaa.gov/News/Articles/ArtMID/6699/ArticleID/401/NOAA-UAS-Program-Participates-in-NASAs-East-Pacific-Origins-and-Characteristics-of-Hurricanes-EPOCH-Project>

## Related Data

All data collected during the EPOCH field campaign are considered to be related. These data can be located by searching the term 'EPOCH' using the GHRC [HyDRO 2.0](#) data search tool. Other HAMSR datasets can be located by searching the term "HAMSR" in [HyDRO2.0](#) and are listed below.

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:

NASA Global Hydrology Resource Center DAAC

User Services

320 Sparkman Drive

Huntsville, AL 35805

Phone: 256-961-7932

E-mail: [support-ghrc@earthdata.nasa.gov](mailto:support-ghrc@earthdata.nasa.gov)

Web: <https://ghrc.nsstc.nasa.gov/>

Created:1/13/2022