Global Hydrology Resource Center

Data User Guide

TC4 AMPR Brightness Temperature (TB)

Introduction

The TC4 AMPR Brightness Temperature (TB) dataset was collected during the NASA Tropical Composition, Cloud, and Climate Coupling (TC4) mission, which investigated the atmospheric layer between properties and processes in the tropical Eastern Pacific near Costa Rica. The primary area of interest was the atmospheric layer between 14 - 18 km. These data were collected by the Advanced Microwave Precipitation Radiometer (AMPR) at four distinct microwave frequencies (10.7, 19.35, 37.1, and 85.5 GHz) for the time period of July 19, 2007 through August 8, 2007. These data are available in ASCII and netCDF-4/CF formats.

Citation

Petersen, Walt and Timothy Lang. 2008. TC4 AMPR Brightness Temperature (TB) [indicate subset used]. Dataset available online [insert URL if appropriate (does not have a DOI)] from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/TC4/AMPR/DATA101

Keywords:

GHRC, AMPR, Costa Rica, Eastern Pacific Ocean, Microwave, TC4, clouds, surface characteristics, brightness temperature

Campaign/Instrument Description

The Advanced Microwave Precipitation Radiometer (AMPR) has participated in more than 14 major research programs and numerous instrument integrations beginning in October 1990. A summary of AMPR research missions is given in Table 1.

Table 1: AMPR Research Mission Summary

Time Period	Campaign Name	Acronym	Region of Interest
October 1990	Validation flights from Jacksonville, Florida	JAX90	Gulf of Mexico
July 1991	Convection and Precipitation/Electrification Experiment	CaPE	Melbourne, Florida
February-March 1992	STormscale Operational and Research Meteorology Fronts Experiment Systems Test	STORMFEST	Central United States
January-February 1993	Tropical Ocean Global Atmosphere Coupled Ocean-Atmosphere Response Experiment	TOGA COARE	Southwest Pacific Ocean
September 1993	First Convection and Moisture Experiment	CAMEX-1	United States Atlantic
August 1995	Second Convection and Moisture Experiment	CAMEX-2	United States Atlantic
June-July 1996	Huntsville Soil Moisture Experiment	HSME-96	Huntsville, Alabama
March-April 1998	Texas-Florida Underflight Experiment-A	TEFLUN-A	Gulf Coast
July 1998	First International Satellite Cloud Climatology Project (ISCCP) Regional Experiment III (FIRE-III) Arctic Cloud Experiment (ACE)	FIRE-III/ACE	Arctic Ocean
August-September 1998	Third Convection and Moisture Experiment/Texas-Florida Underflight Experiment-B	CAMEX-3/ TEFLUN-B	Southeast United States/Atlantic/Gulf of Mexico
January-February 1999	Tropical Rainfall Mission - Large-scale Biosphere-Atmosphere (LBA) experiment	TRMM-LBA	Amazon Basin
July-September 1999	Kwajalein Experiment	KWAJEX	Central Pacific
August-September 2001	Fourth Convection and Moisture Experiment/Keys Area Microphysics Project	CAMEX-4	Atlantic Ocean, Florida Keys
July 2005	Tropical Cloud Systems Processes Experiment	TCSP	Eastern Pacific Ocean, Caribbean Sea
July-August 2007	Tropical Composition, Cloud and Climate Coupling	TC4	Tropical Eastern Pacific/San Jose, Costa Rica

The NASA Tropical Composition, Cloud, and Climate Coupling (TC4) mission investigated the atmospheric structure, properties, and processes in the tropical Eastern Pacific near

Costa Rica. The primary area of interest was the atmospheric layer between 14 - 18 km (approximately 46,000 - 59,000 ft). This is where the lower part of the atmosphere, or the troposphere, meets the upper part of the atmosphere, or the stratosphere. The TC4 mission was sponsored by the NASA Headquarters Atmospheric Composition Focus Area, including the Upper Atmospheric Research Program, the Radiation Science Program, and the Tropospheric Chemistry Program. The field experiment phase was completed during July and August 2007 based out of San Jose, Costa Rica. Table 2 shows flight date and times during the TC4 mission. More information about TC4 can be found at https://espo.nasa.gov/tc4/.

Table 2: TC4 Flight Date and Times

Flight Date	Start-Stop Time (UTC)
July 19, 2007	1227 - 1830
July 22, 2007	1201 - 1750
July 24, 2007	1147 - 1849
July 25, 2007	1356 - 1858
July 29, 2007	1141 - 1821
July 31, 2007	1250 - 1801
August 3, 2007	1323 - 1833
August 5, 2007	1254 - 1735
August 6, 2007	1212 - 1852
August 8, 2007	2110 - 1817

The AMPR remotely senses passive microwave signatures of geophysical parameters from an airborne platform. The instrument is a low-noise system which can provide multi-frequency microwave imagery with high spatial and temporal resolutions. AMPR data are collected at a combination of four microwave frequencies (10.7, 19.35, 37.1, and 85.5 GHz), which are complementary to current aircraft and satellite instrumentation. These frequencies are best suited to the study of rain systems, but are also useful to studies of other atmospheric, oceanic, and land surface processes.

The AMPR is a cross-track scanning total power microwave radiometer. It has a dual-lens antenna to accommodate two separate feed horns. The horn that feeds the three higher frequency channels is a copy of the Special Sensor Microwave/Imager (SSM/I) space borne multi-frequency feed horn on the Defense Meteorological Satellite Program (DMSP) satellites. A separate AMPR feed horn, which was built by the Georgia Technology Research Institute (GTRI), accommodates the 10.7 GHz frequency. Table 3 lists several of the AMPR performance characteristics.

Table 3: AMPR Performance Characteristics

Characteristic	85.5 GHz	37.1 GHz	19.35 GHz	10.7 GHz
Bandwidth (MHz)	1,400	900	240	100

Integration Time (ms)	50	50	50	50
Horn Type	SSM/I	SSM/I	SSM/I	GTRI
Lens Diameter (in)	5.3	5.3	5.3	9.7
Beamwidth (degrees)	1.8	4.2	8.0	8.0
Footprint (km) At 20 km ER-2 altitude 500 kts	0.64	1.48	2.78	2.78
Beam Efficiency (%)	-	98.8	98.7	97.8
Cross Polarization (%)	-	0.4	1.6	0.2

The AMPR radiometer has flown on the NASA ER-2 and the NASA DC-8 aircrafts. The instrument has a 90 degree total scan centered at nadir. The data footprints are designed to be contiguous at 85.5 GHz and coincident at all four channels leading to over-sampling at the lower frequencies. The polarization varies from vertical at 45 degrees to the left of nadir, an equal mixture of vertical and horizontal polarization at nadir, and horizontal 45 degrees to the right at nadir.

Investigators

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Data Characteristics

The TC4 AMPR Brightness Temperature (TB) data are available in both ASCII and netCDF-4/CF formats for the processing level 1B data. The browse images are available in GIF format and contain AMPR Brightness Temperature plots over a specific flight time.

Table 4: Data Characteristics

Characteristic	Description
Platform	NASA ER-2
Instrument	Advanced Microwave Precipitation Radiometer (AMPR)
Spatial Coverage	N: 17.22 , S: -6.57, E: -47.58, W: -93.60 (Costa Rica)
Spatial Resolution	85.5 GHz channel: 0.6 km 37.1 GHz channel: 1.5 km 19.35 GHz channel: 2.8 km 10.7 GHz channel: 2.8 km
Temporal Coverage	July 19, 2007 - August 8, 2007
Temporal Resolution	File per flight

Sampling Frequency	1.8 seconds
Parameter	Brightness temperature
Version	1
Processing Level	1B

File Naming Convention

The TC4 AMPR Brightness Temperature (TB) dataset has the following naming conventions shown below. The data files are available in ASCII and netCDF-4/CF formats, and the browse images are available in GIF format.

Data files: tc4_ampr_YYYYMMDD_ghrc_ver2.[txt.gz|nc]
Browse files: tc4_ampr_YYYYMMDD_<start time>-<stop time>.gif

Table 5: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month
DD	Two-digit day
[txt.gz|nc]	txt.gz: zipped ASCII file nc: netCDF-4/CF file
<start time>	Start time of flight in hhmmss format hh: Two-digit hour in UTC mm: Two-digit minute in UTC ss: Two-digit second in UTC
<stop time>	Stop time of flight in hhmmss format hh: Two-digit hour in UTC mm: Two-digit minute in UTC ss: Two-digit second in UTC
.gif	Graphics Interchange Format

Data Format and Parameters

The TC4 AMPR Brightness Temperature (TB) data consists of brightness temperature measurements, as well as other flight characteristics, in ASCII and netCDF-4/CF formats. There are also browse images available in GIF format. The variables in the TC4 AMPR Brightness Temperature (TB) netCDF-4/CF files are shown in Table 6, while variables within the ASCII files are shown in Table 7.

Table 6: Data Fields within netCDF-4/CF data file

Field Name	Description	Data Type	Unit
AirSpeed	Air speed	double	m/s
Alt	Mean sea level elevation	short	m
DayofYear	Day of the year	short	day
Frequency	Central frequency of AMPR sensor	float	GHz

	channel. AMPR operates at 10.7, 19.35, 37.1, and 85.5 GHz		
GPSAltitude	GPS estimated aircraft altitude above mean sea level	double	m
GPSLatitude	GPS estimated aircraft latitude	double	Degrees North
GPSLongitude	GPS estimated aircraft longitude	double	Degrees East
GroundSpeed	INS estimated ground speed	double	m/s
Head	Aircraft true heading, clockwise from North	double	degrees
Hour	Hour in UTC	short	hour
LandFraction	The IFOV is estimated based on oversampling rate, and inverse-distance weighting is used to estimate the approximate contribution of land-containing scenes within the IFOV. Fraction of land in 2.5 km radius (approximate) at 10.7 GHz resolution	double	-
Lat	Latitude of georeferenced pixel	double	Degrees North
Lon	Longitude of georeferenced pixel	double	Degrees East
Minute	Minute in UTC	short	minute
Noise	RMS noise in four channels (10, 19, 37 and 85). Negative values indicate missing or bad data	double	K
Pitch	aircraft pitch (+ up)	double	degrees
QC	Quality Control field	double	-
Roll	aircraft roll (+ right)	double	degrees
Second	Second in UTC	short	seconds
TB	Brightness Temperature in four frequencies (10, 19, 37 and 85) and up to four channels (A, B, H, and V). Negative values indicate missing or bad data.	double	K
Time	Time of scene scan	double	Seconds since 1970-01-01 00:00:00.000
Yaw	INS estimated true track angle, clockwise from north	double	degrees

Table 7: Data Fields within ASCII data file

Column	Description	Unit

1	First row shows year of data collection, with the following rows showing the row number	Year
2	Julian Date of data collection	Date
3	Hour in UTC	Hour
4	Minute in UTC	Minute
5	Second in UTC	Second
6	Quality Control field	-
7	GPS estimated Latitude	Degrees North
8	GPS estimated Longitude	Degrees East
9	GPS estimated aircraft altitude above mean sea level	m
10	aircraft pitch (+ up)	degrees
11	aircraft roll (+ right)	degrees
12	INS estimated true track angle, clockwise from north	degrees
13	Aircraft true heading, clockwise from North	degrees
14	Derived air speed	m/s
15	INS estimated ground speed	m/s
16	RMS noise in channel 10. Negative values indicate missing or bad data	K
17	RMS noise in four channel 19. Negative values indicate missing or bad data	K
18	RMS noise in four channel 37. Negative values indicate missing or bad data	K
19	RMS noise in four channel 85. Negative values indicate missing or bad data	K
20-70	Brightness Temperature at frequency 10 GHz with 50 cross-track scanning measurements. Negative values indicate missing or bad data.	K
71-121	Brightness Temperature at frequency 19 GHz with 50 cross-track scanning measurements. Negative values indicate missing or bad data.	K
122 - 172	Brightness Temperature at frequency 37 GHz with 50 cross-track scanning measurements. Negative values indicate missing or bad data.	K
173 - 223	Brightness Temperature at frequency 85 GHz with 50 cross-track scanning	K

	measurements. Negative values indicate missing or bad data.	
224-274	Latitude of georeferenced pixel at each 50 cross-track scan.	Degrees North
275-325	Longitude of georeferenced pixel at each 50 cross-track scan.	Degrees East
326-376	Mean Sea Level elevation at each 50 cross-track scan. Value of -9999.0 indicates over water	m
377-427	The IFOV at each 50 cross-track scan is estimated based on oversampling rate, and inverse-distance weighting is used to estimate the approximate contribution of land-containing scenes within the IFOV. Fraction of land in 2.5 km radius (approximate) at 10.7 GHz resolution	-

Quality Assessment

Each data file has a quality control field variable. Also, the efficiency of the mainbeam on AMPR is 93.2% oversampling 1.0x for 85.5 GHz, 98.8% oversampling 2.3x for 37.1 GHz, 98.7% oversampling 4.4x for 19.35 GHz, and 97.8% oversampling 4.4x for 10.7 GHz. More information about the instrument characteristics are shown in Table 1 above, as well as in Hood et al., 1994.

Software

No software is required to view the ASCII data; however, Panoply can be used to view the netCDF-4/CF data files.

Known Issues or Missing Data

Within the 'Alt', or the Mean Sea Level elevation, variable, values of -9999.0 indicates areas over water. Also, negative values indicate missing or bad data within the 'Noise' and the 'TB' variables.

References

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Related Data

All data collected during the AMPR field campaign should be considered related datasets. Other AMPR campaign and instrument data can be located using the GHRC HyDRO 2.0 search tool.

Contact Information

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

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Updated: September 11, 2017