



Data User Guide

CAMEX-3 DC-8 Airborne Vertical Atmosphere Profiling System (AVAPS)

Introduction

The CAMEX-3 DC-8 Airborne Vertical Atmosphere Profiling System (AVAPS) dataset consists of measurements from AVAPS, which uses dropsonde and Global Positioning System (GPS) receivers to measure the atmospheric state parameters (temperature, humidity, wind speed/direction, pressure) and location in 3-dimensional space during the dropsonde's descent once each half second. These measurements were collected in support of the third field campaign in the Convection And Moisture EXperiment (CAMEX) series, CAMEX-3. This field campaign took place from August to September 1998 based out of Patrick Air Force Base in Florida, with the purpose of studying various aspects of tropical cyclones in the region. AVAPS provided vertical profiles of temperature, humidity, pressure, and winds. The dataset files are available in netCDF-3 and ASCII format with browse imagery available in GIF image format.

Notice:

These data are airborne and flights did not occur each day of the campaign; therefore, data are only available for flight days.

Citation

Rothermel, Jeffry. 1999. CAMEX-3 AIRBORNE VERTICAL ATMOSPHERE PROFILING SYSTEM (AVAPS) [indicate subset used]. Dataset available online from the NASA Global Hydrology Center DAAC, Huntsville, Alabama, U.S.A.

DOI: <http://dx.doi.org/10.5067/CAMEX-3/DROPSONDE/DATA101>.

Keywords:

NASA, GHRC, DC-8, AVAPS, NCAR, dropsonde, temperature, relative humidity, wind speed, wind direction, pressure

Campaign

The Convection And Moisture EXperiment (CAMEX) is a series of field research investigations sponsored by the Earth Science Enterprise of NASA. The third field campaign in the CAMEX series, CAMEX-3, ran from August to September 1998, and was based out of Patrick Air Force Base, Florida. CAMEX-3 focused on the study of tropical cyclone development, tracking, and intensification impacts using NASA-funded aircraft and surface remote sensing instrumentation. The ultimate goal of the campaign was to improve the efficiency of hurricane evacuations and warnings. The campaign successfully studied hurricanes Bonnie, Danielle, Earl, and Georges (Figure 1). CAMEX-3 yielded high-resolution spatial and temporal data on hurricane structure, dynamics, and motion. These data, when analyzed within the context of more traditional aircraft, satellite, and ground-based radar observations, provided additional insight to hurricane modelers and forecasters who continually strive to improve hurricane predictions. More information about CAMEX-3 can be found on the [CAMEX-3 Field Campaign](#) webpage and in [Kakar, Goodman, Hood, and Guillory \(2006\)](#).

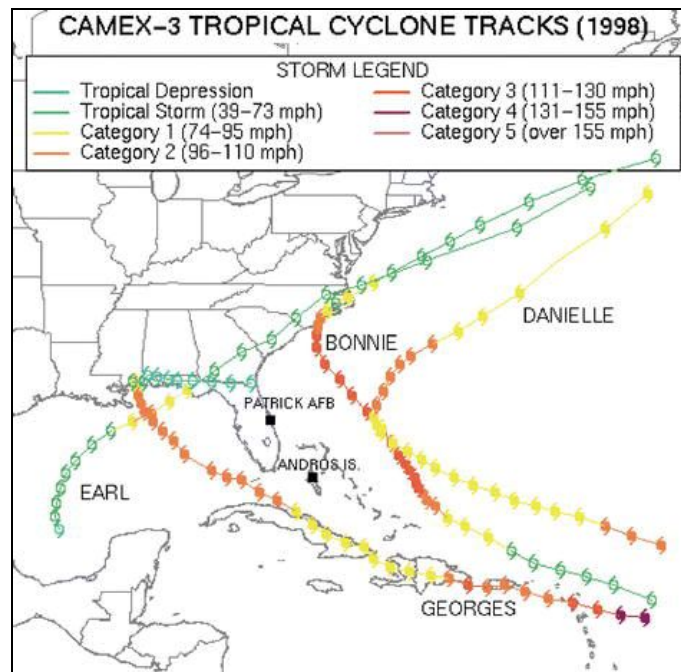


Figure 1: Tropical Cyclone Tracks during CAMEX-3
(Image source: [Kakar et al. 2006](#))

Instrument Description

The Airborne Vertical Atmosphere Profiling System (AVAPS) uses dropsonde and Global Positioning System (GPS) receivers to measure vertical profiles of pressure, temperature, humidity, and wind during their descent through the atmosphere. The dropsonde

measurements are transmitted to the aircraft from the time of release until impact with the ocean's surface. During CAMEX-3, AVAPS was deployed on the NASA DC-8 research aircraft.

In collaboration with the National Oceanic and Atmospheric Administration/ Atlantic Oceanographic and Meteorological Laboratory (NOAA/AOML) and the German Aerospace Research Establishment (DLR), the National Center for Atmospheric Research/ Atmosphere Technology Division (NCAR/ATD) developed the RD93 dropsonde, a third-generation dropsonde using a new sensor module and GPS receiver from Vaisala, Inc. This new system provided more accurate wind profiles because of the NCAR/ATD-developed square-cone parachute that reduces the initial shock load and stabilizes the dropsonde as it falls (Figure 2). More information about AVAPS can be found on the [NCAR AVAPS webpage](#). More information on AVAPS dropsondes can be found in [Hock and Franklin \(1999\)](#) and on the [NCAR AVAPS Dropsondes](#) webpage.

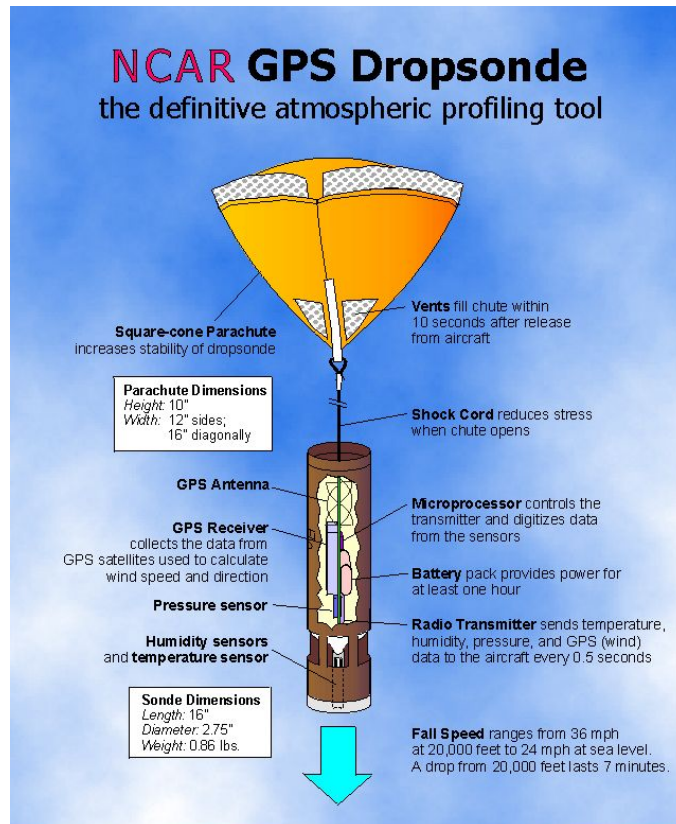


Figure 2: Advanced Vertical Atmosphere Profiling System (AVAPS) Dropsonde (Image Source: [NCAR/UCAR Dropsonde webpage](#))

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Data Characteristics

The CAMEX-3 Advanced Vertical Atmosphere Profiling System (AVAPS) dataset provides vertical measurements of atmospheric state variables. These data are available at Level 1B processing level in ASCII and netCDF-3 format; with browse imagery of corresponding skew-T diagrams provided in GIF file format. 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.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA Douglas DC-8 (DC-8) aircraft
Instrument	Airborne Vertical Atmosphere Profiling System (AVAPS)
Spatial Coverage	N: 50, S: 10, E: -50, W: -105 (Caribbean)
Spatial Resolution	10 m (vertical)
Temporal Coverage	August 3, 1998 - September 23, 1998
Temporal Resolution	one file per sonde release
Sampling Frequency	0.5 second (temperature, pressure, relative humidity) 0.25 second (wind speed, wind direction)
Parameter	Atmospheric temperature, pressure, humidity, and winds
Version	1
Processing Level	1B

File Naming Convention

There are four files associated with each dropsonde released during the experiment: a GIF image (.gif) of the sounding, a raw ASCII (.txt) data file, a QCed ASCII (.txt) data file, and finally a netCDF-3 (.cdf) file. The naming conventions for these files are listed below:

Raw Data files: yyddd.hhmm_avaps_raw.txt

Quality Control Data files: yyddd.hhmm_avaps_QC.cls.txt

NetCDF-3 Data files: yyddd.hhmm_avaps_QC.cdf

Browse files: yyddd.hhmm_avaps_plot.gif

Table 2: File naming convention variables

Variable	Description
yy	Two-digit year (e.g. 1998 = 98)
ddd	Three-digit day of the year
hh	Two-digit hour in UTC
mm	Two-digit minute in UTC
_raw.txt	ASCII file for raw data
_QC.cls.txt	ASCII file for quality controlled data
_QC.cdf	netCDF-3 file for quality controlled data

_plot.gif	GIF (Graphics Interchange Format) image file of skew-T plot
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Data Format and Parameters

The CAMEX-3 Airborne Vertical Atmosphere Profiling System (AVAPS) dataset includes four files per dropsonde drop that contain vertical profiles of atmospheric and dropsonde location variables. These four file types are described in detail below.

Browse Image Files (.gif):

The skew-T diagram shows the temperature, dewpoint, and vertical wind profiles measured during the descent of the dropsonde. Date, time of release, and mission ID are given in the title of the image.

Raw Data Files (_raw.txt):

This file contains the raw data as relayed from the dropsonde to the aircraft. Data is in ASCII format, has not been quality controlled, and usually contains many extraneous points. A sample file is shown below in Figure 3. The file reads forward in time from the top of the file to the bottom and pressures increase from top to bottom because the sonde is traveling toward earth’s surface. The raw file data fields listed in Table 3.

Figure 3: Example of “_raw.txt” file

```

AVAPS-T01 STA 981830027 980815 221646.8
AVAPS-T01 COM          GMT      GMT      Air   Air   Rel   Wind   Wind   Vert   GPS   GPS   Geopoten GPS   Sonde   Sonde
AVAPS-T01 COM          Date    Time    Press Temp Humid Dir   Spd   Veloc Longitude Latitude Altitude Sats  RH #1  RH #2
AVAPS-T01 COM          ID      yymmdd hhmss.s (mb) (degC) (%) (deg) (m/s) (m/s) (deg) (deg) (m) (Wd) (%) (%)
AVAPS-T01 COM -----
AVAPS-D01 P00 981830027 980815 222047.3 858.09 23.95 22.81 999.00 999.00 999.00 999.000000 99.000000 1403.12 99 22.81 22.38
AVAPS-D01 P00 981830027 980815 222047.8 858.10 23.95 22.82 999.00 999.00 999.00 999.000000 99.000000 1402.98 99 22.82 22.24
AVAPS-D01 P10 981830027 980815 222048.3 9999.00 99.00 999.00 999.00 999.00 999.000000 99.000000 99999.00 99 999.00 999.00
AVAPS-D01 P10 981830027 980815 222048.8 951.43 37.22 13.34 999.00 999.00 999.00 999.000000 99.000000 99999.00 99 13.34 12.25

```

Table 3: Raw file data fields (raw.txt)

Variable	Description	Units
Sonde ID	9-digit dropsonde ID number	-
GMT Date	UTC Date (yymmdd) where: yy: two-digit year mm: two-digit month dd: two-digit day	-
GMT Time	Time in UTC (hhmss.s) where: hh: two-digit hour in UTC mm: two-digit minute in UTC ss.s: two-digit second in UTC (with accuracy to a tenth of a second)	-
Air Press	Air pressure	mb
Air Temp	Air temperature	deg C
Rel Humid	Relative Humidity	%
Wind Dir	Wind direction	degrees
Wind Spd	Wind speed	m/s

Vert Veloc	Vertical velocity	m/s
GPS Longitude	GPS Longitude	degrees
GPS Latitude	GPS Latitude	degrees
Geopoten Altitude	Geopotential Altitude	m
GPS Sats	GPS Stats	Wd
Sonde RH #1	Sonde measured relative humidity #1	%
Sonde RH #2	Sonde measured relative humidity #2	%

Quality controlled ASCII Data Files (_QC.cls.txt):

This is the data file as it appears following quality control by NCAR. An example is shown below in Figure 4. The files include a header followed by the data fields. The header contains information such as data type, project name, launch site location, and other specialized information. The data are very similar to that in the raw data files, however, the data here is “inverted”, meaning the data has been re-formatted so that the surface data (the last sensed by the dropsonde) appears first while the data collected at the aircraft flight level appear last. Because of this inversion of the data, the timestamps run backwards as you read the dataset from the top to bottom. This puts the data into a form very similar to that used by radiosonde (i.e. surface-launched) instruments for ease in reading by existing radiosonde software packages. The last six data fields are empty (denoted by the fill value ‘99.0’), as these data are the parameters reported from the surface during the surface launched radiosonde flight. The quality controlled file data fields are listed in Table 4.

Figure 4: Example of “_QC.cls.txt” file

```

Data Type:                SUDS EDITED SOUNDING
Project ID:                UNKNOWN
Launch Site Type/Site ID:  class
Launch Location (lon,lat,alt): 9999 0.00°W, 9999 0.00°S, -9999.0000, -9999.0000, -9999
GMT Launch Time (y,m,d,h,m,s): 1998, 08, 20, 17:23:30
Sonde Type/ID/Sensor ID/Tx Freq:
Met Processor/Met Smoothing:
Winds Type/Processor/Smoothing:
Pre-launch Surface Obs Source:
System Operator/Comments:   SUDS edited file, created by kbeierle Wed Jun 23 16:04:08 1999
/
/
Time  Press  Temp  Dewpt  RH    Uwind  Vwind  Wspd  Dir  dZ    Lon   Lat   Rng  Ang  Alt  Qp  Qt  Qh  Qu  Qv  Quv
sec   mb      C      C      %    m/s    m/s    m/s  deg  m/s   deg  deg  km  deg  m   mb  C  %   m/s  m/s  m/s
-----
494.1 9999.0 999.0 999.0 999.0 999.0 999.0 999.0 999.0 99.0 999.00000 999.00000 999.0 999.0 99999.0 99.0 99.0 99.0 99.0 99.0 99.0
493.6 9999.0 999.0 999.0 999.0 999.0 999.0 999.0 999.0 99.0 999.00000 999.00000 999.0 999.0 99999.0 99.0 99.0 99.0 99.0 99.0 99.0
493.1 9999.0 999.0 999.0 999.0 999.0 999.0 999.0 999.0 99.0 999.00000 999.00000 999.0 999.0 99999.0 99.0 99.0 99.0 99.0 99.0 99.0
492.6 9999.0 999.0 999.0 999.0 999.0 999.0 999.0 999.0 99.0 999.00000 999.00000 999.0 999.0 99999.0 99.0 99.0 99.0 99.0 99.0 99.0
492.1 9999.0 999.0 999.0 999.0 999.0 999.0 999.0 999.0 99.0 999.00000 999.00000 999.0 999.0 99999.0 99.0 99.0 99.0 99.0 99.0 99.0

```

Table 4: Quality controlled file data fields (_QC.cls.txt)

Variable	Description	Units
Time	Elapsed time from launch*	sec
Press	Atmospheric pressure	mb
Temp	Dry-bulb temperature	deg C
Dewpt	Dew point temperature	deg C

RH	Relative humidity over liquid water	%
Uwind	Zonal wind component	m/s
Vwind	Meridional wind component	m/s
Wspd	Wind speed from GPS receiver	m/s
Dir	Wind direction measured by GPS receiver	degrees
dZ	Descent rate of the dropsonde	m/s
Lon	Longitude position	degrees
Lat	Latitude position	degrees
Rng	Range	km
Ang	Angle from launch station	degrees
Alt	GPS altitude over the WGS84 geoid	m
Qp	Quality-controlled atmospheric pressure	mb
Qt	Quality-controlled dry-bulb temperature	deg C
Qh	Quality-controlled relative humidity	%
Qu	Quality-controlled zonal wind component	m/s
Qv	Quality-controlled meridional wind component	m/s
Quv	Quality-controlled combined u and v wind component	m/s

*the -1.0 second time stamp indicates reference flight-level aircraft collected from independent sensors. All subsequent time stamps represent data directly from the dropsonde.

More details on the quality controlled file format can be found in the [EOL Dropsonde Sounding Data File Format](#) document.

Quality controlled netCDF-3 Data Files (_QC.cdf):

For these quality controlled data files, values for measured parameters (e.g. temperature, relative humidity) as well as derived/calculated parameters (e.g. vertical distance between data reports, theta, theta-e) are given in a netCDF file format. Depending upon the utility used to view the netCDF-3 data, output can be either tabular or graphical. The netCDF-3 file data fields are listed in Table 5 below.

Table 5: Quality controlled netCDF-3 file data fields (_QC.cdf)

Variable	Description	Data Type	Units
alt	Altitude	float	km
base_time	Base time in Epoch (seconds since 1/1/1970 0:00:0)	int	seconds
dp	Dewpoint	float	deg C
dz	Descent rate of the dropsonde	float	m/s
lat	North latitude	float	degrees
lon	East longitude	float	degrees
mr	Mixing ratio	float	g/kg
pres	Pressure	float	mb
qp	Quality-controlled pressure	float	mb
qrh	Quality-controlled relative humidity	float	%
qt	Quality-controlled temperature	float	deg C

qu	Quality-controlled u component of the instantaneous wind	float	m/s
qv	Quality-controlled v component of the instantaneous wind	float	m/s
qwind	Quality-controlled wind speed	float	m/s
range	Range from ground station to sonde	float	km
rh	Relative humidity	float	%
tdry	Dry bulb temperature	float	deg C
theta	Potential temperature	float	deg K
theta_e	Equivalent potential temperature	float	deg K
theta_v	Virtual potential temperature	float	deg K
time	Elapsed time from launch	float	seconds
time_offset	Time offset from base_time	double	seconds
u_wind	u component of instantaneous wind	float	m/s
v_wind	v component of instantaneous wind	float	m/s
vt	Virtual temperature	float	deg C
wdir	Wind direction (from which it comes)	float	degrees
wspd	Windspeed	float	m/s

Algorithm

Several of the additional parameters included in the dataset were derived from a combination of the standard dropsonde measurements (temperature, humidity, pressure, wind speed, wind direction) and applicable equations. The zonal and meridional wind components were calculated from the wind speed and direction. Dew point temperature was calculated from the relative humidity and temperature using the vapor pressure equation by Hardy (1998) while the hydrostatic equation was used to compute the descent rate of the dropsonde and the Geopotential altitude. More information on AVAPS measurement methods is available in the [EOL Dropsonde Sounding Data File Format](#) document.

Quality Assessment

Post-processing quality control of the raw data was completed by NCAR using ASPEN (Atmospheric Sounding Processing Environment) software. This process produced the quality controlled ASCII and netCDF-3 data files available within the dataset. More information about the ASPEN software is available on the [NCAR AVAPS Software](#) webpage.

Software

The AVAPS netCDF data files can be read and viewed using [Panoply](#). No software is required to view the ASCII data files. These files can be viewed in a text editor or in spreadsheet software, such as Microsoft Excel or Notepad++.

Known Issues or Missing Data

The CAMEX-3 AVAPS data are airborne and flights did not occur each day of the campaign, therefore, data are only available on flight days. The surface measurement fields for the dataset files are empty. Missing values in each field are denoted by consecutive 9's with the number of digits varying based on the data field parameter.

References

Hardy, B. (Ed.). (1998). ITS-90 formulations for vapor pressure, frost point, temperature dewpoint temperature, and enhancement factors in the range 100 to +100C. Proceedings from *the Third International Symposium on Humidity and Moisture*. London, England: National Physics Laboratory.

Hock, T. F. & Franklin, J. L. (1999). The NCAR GPS Dropwindsonde. *Bulletin of the American Meteorological Society*, 80(3), 407–420.
[http://doi.org/10.1175/1520-0477\(1999\)080<0407:TNGD>2.0.CO;2](http://doi.org/10.1175/1520-0477(1999)080<0407:TNGD>2.0.CO;2)

Kakar, R., Goodman, M., Hood, R., & Guillory, A. (2006). Overview of the Convection and Moisture Experiment (CAMEX). *Journal of the Atmospheric Sciences*, 63, 5–18.
<https://doi.org/10.1175/JAS3607.1>

Rizvi, S., Bensman, E., Vijaya Kumar, T., Chakraborty, A., & Krishnamurti, T.N. (2002). Impact of CAMEX-3 data on the analysis and forecasts of Atlantic hurricanes. *Meteorology and Atmospheric Physics* (pp. 13-32). Vienna, Austria: Springer-Verlag.
<https://doi.org/10.1007/s703-002-8226-9>

Related Data

All datasets from the CAMEX-3 field campaign are considered related to the CAMEX-3 AVAPS dataset. These datasets can be located using the GHRC [HyDRO2.0](#) search tool and entering the term “CAMEX-3” into the search box. AVAPS datasets from other field campaigns can be located by searching “AVAPS” in [HyDRO2.0](#) and are listed below.

GPM Ground Validation Advanced Vertical Atmospheric Profiling System (AVAPS)
OLYMPEX
(<http://dx.doi.org/10.5067/GPMGV/OLYMPEX/AVAPS/DATA101>)

Hurricane and Severe Storm Sentinel (HS3) Global Hawk Advanced Vertical Atmospheric Profiling System (AVAPS) Dropsonde System V2
(<http://dx.doi.org/10.5067/HS3/AVAPS/DROPSONDE/DATA202>)

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

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

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