Data User Guide

Advanced Vertical Atmospheric Profiling System (AVAPS) IMPACTS

Introduction

The Advanced Vertical Atmospheric Profiling System (AVAPS) IMPACTS dataset consists of vertical atmospheric profile measurements collected by the Advanced Vertical Atmospheric Profiling System (AVAPS) dropsondes released from the NASA P-3 aircraft during the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) field campaign. IMPACTS was a three-year sequence of winter season deployments conducted to study snowstorms over the U.S Atlantic Coast (2020-2023). The campaign aimed to (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. AVAPS uses a Global Positioning System (GPS) dropsonde to measure atmospheric state parameters (temperature, humidity, wind speed/direction, pressure) and location in 3-dimensional space during the dropsonde's descent. The AVAPS dataset files are available from January 12, 2020, through February 28, 2023, in ASCII-ict format.

Citation

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Keywords:

NASA, GHRC, IMPACTS, NOAA, NCAR, AVAPS, dropsonde, GPS, temperature, humidity, pressure, wind speed, wind direction, vertical profiles

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2023) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020, and ended on March 1, 2020. The second deployment was from January through March 2022. IMPACTS samples U.S. East Coast winter storms using advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and other polar-orbiting satellite systems), and computer simulations. IMPACTS addressed three specific objectives: (1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution; (2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands; and (3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. More information is available from NASA's Earth Science Project Office's IMPACTS field campaign webpage.

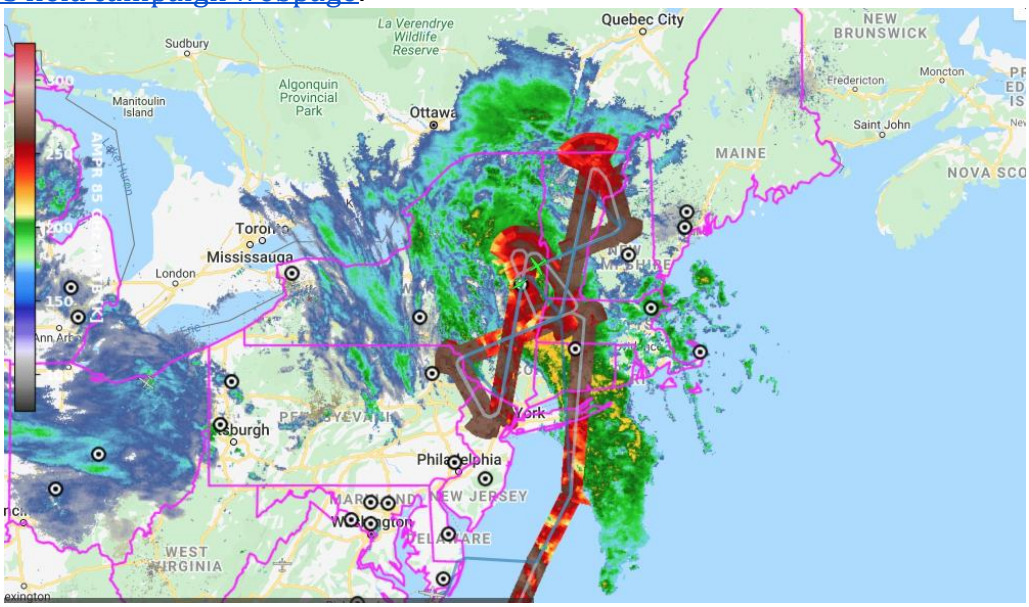

Figure 1: IMPACTS field campaign operations on January 25, 2020 with plots of ER-2 and P-3 flight tracks in addition to ground radar sites and radar reflectivity over the region (Image source: Dr. Timothy Lang, NASA MSFC)

Instrument Description

The Airborne Vertical Atmosphere Profiling System (AVAPS) uses dropsonde and Global Positioning System (GPS) receivers to measure vertical profiles of pressure, ambient temperature, humidity, wind speed, and wind direction during the sonde's descent through the atmosphere. The dropsonde measurements are transmitted to the aircraft from the

time of release until the sonde reaches the surface. During IMPACTS, AVAPS was released from the NASA P-3 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 GPS dropsonde using a new sensor module from Vaisala, Inc. The system provides 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). The nRD41 was the specific model used during IMPACTS. 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.

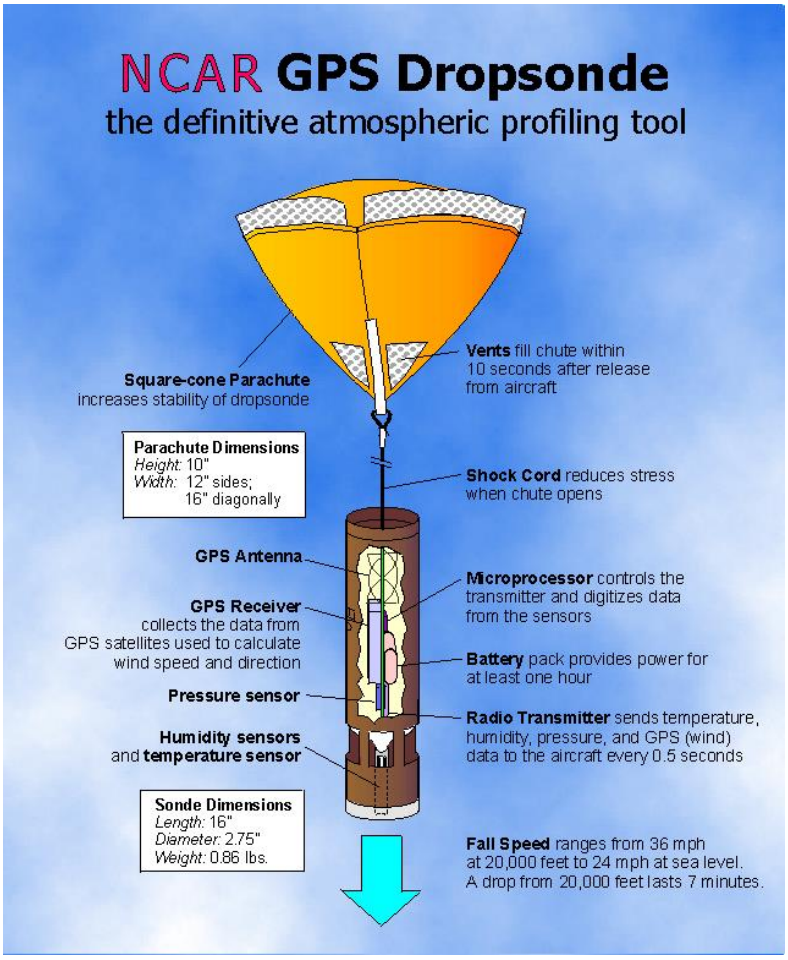

Figure 2: Advanced Vertical Atmospheric Profile (AVAPS) Dropsonde System (Image Source: UCAR NCAR EOL Dropsonde webpage)

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Data Characteristics

The Advanced Vertical Atmospheric Profiling System (AVAPS) IMPACTS dataset consists of vertical measurements of atmospheric state variables. These data are stored in ASCII-ict format and 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.

Table 1: Data Characteristics

Characteristic	Description
Platform	NASA P-3 Orion Research Aircraft
Instrument	Advanced Vertical Atmospheric Profiling System (AVAPS)
Spatial Coverage	N: 44.10, S: 33.540, E: -65.440, W: -77.815 (United States)
Spatial Resolution	< 10 meters in the vertical
Resolution	Pressure: 0.01 hPa Temperature: 0.01 °C Humidity: 0.01% Horizontal Wind: 0.01 m/s
Temporal Coverage	January 12, 2020 - February 28, 2023
Temporal Resolution	One file per sonde release
Sampling Frequency	0.5 second (temperature, pressure, relative humidity) 0.25 second (wind speed, wind direction)
Parameter	Vertical Atmospheric Profiling (pressure, temperature, humidity, wind, dewpoint)
Version	1
Processing Level	2

File Naming Convention

The Advanced Vertical Atmospheric Profiling System (AVAPS) IMPACTS dataset files are stored in ASCII-ict format and named using the following convention:

Data files: IMPACTS_AVAPS_P3B_YYYYMMDDhhmmss_R0.ict

Table 2: File naming convention variables

Variable	Description
YYYY	Four-digit year
MM	Two-digit month

DD	Two-digit day
hh	Two-digit hour in UTC
mm	Two-digit minute in UTC
ss	Two-digit second in UTC **Note:** All files do not include this variable
.ict	ASCII-ict format

Data Format and Parameters

The Advanced Vertical Atmospheric Profiling System (AVAPS) IMPACTS dataset files are stored in ASCII-ict format. Each file contains dropsonde data collected by AVAPS during descent. Each file begins with a header that includes the project, flight, platform, research organization, AVAPS data field descriptions, launch latitude/longitude, and other related information. The header is followed by the AVAPS data fields at 0.25-second time intervals. Some AVAPS parameters are only sampled at a 0.5 second frequency and therefore shown as missing data with a value of *-9999* for the intervals when these data are not available. The AVAPS parameters and their sampling frequencies are listed in Table 1. Tables 3 through 5 list descriptions for the smoothing parameters, quality control filter parameters, and the AVAPS data fields. More information about the AVAPS ASCII-ict data file format is available in the NCAR EOL dropsonde data file document.

Table 3: Final smoothing parameters

Field Name	Description
PresSmoothWL	Period over which final pressure data have been smoothed. If this field is set to 0, then no final smoothing has been performed
RHSmoothWL	Period over which final relative humidity data have been smoothed. If this field is set to 0, then no final smoothing has been performed
TdrySmoothWL	Period over which final temperature data have been smoothed. If this field is set to 0, then no final smoothing has been performed
WindSmoothWL	Period over which final wind components data have been smoothed. If this field is set to 0, then no final smoothing has been performed

Table 4: Quality control filter parameters

Field Name	Description
QCDisclaimer	Disclaimer information about the quality control procedures
DoQC	Flag indicating, whether ASPEN performed its regular quality control, or whether the data were just reformatted

DiscardBadCrcData	If true, then telemetry frames with CRC errors were discarded
PresDisableOutlierCheck	Flag indicating, whether pressure outliers were not removed
RHDisableOutlierCheck	Flag indicating, whether relative humidity outliers were not removed
TdryDisableOutlierCheck	Flag indicating, whether temperature outliers were not removed
WindDisableOutlierCheck	Flag indicating, whether wind components outliers were not removed
PresMonoCheck	Flag indicating that the sondes must have a monotonic pressure increase, i.e. data during upward motion were removed
RHchoice	For older xRD93 and xRD94 dropsondes, this field indicates, which of the two humidity sensors was used to generate the final relative humidity data (0=AVAPS selected, 1=RH1, 2=RH2)
SfcAltitude	Altitude of the surface for soundings over land
SfcAltUnknown	Flag indicating that the surface altitude is not known. If this flag is set, then the upward calculation of the geopotential height is skipped
UseTheoryVentRate	Use the theoretical fall rate in calculations rather than the measured fall rate, in particular in the dynamic wind correction and ventilation correction
WindDisableQCFilter	Flag indicating, whether winds have not been quality controlled
PresEquilTime	Equilibration time used in processing to remove contributions from the aircraft cabin pressure to the measured air pressure
RHEquilTime	Equilibration time used in processing to remove contributions from the relative humidity prior to launch to the measured air relative humidity
TDryEquilTime	Equilibration time used in processing to remove contributions from the prelaunch temperature to the measured air temperature
WindEquilTime	Equilibration time used in processing to remove contributions from the aircraft speed to the measured wind
WindErrorHigh	Threshold for reported wind speed accuracies above 10 km
WindErrorLow	Threshold for reported wind speed accuracies below 10 km
WindSats	Minimum number of GPS satellites required in wind calculations

TdryDynCorWL	Time used in the correction of slower temperature sensor response
WindDynCorWL	Time used in the correction of the sonde inertia in response to changing winds
RHOffset	Constant offset correction for relative humidity sensor (Obsolete feature)
TdryOffset	Constant offset correction for the temperature sensor (Obsolete feature)
PresOffset	Constant offset for the pressure sensor based on comparison measurements inside the aircraft prior to launch
RHThreshold	Flag indicating, whether the final data have been limited to a range of 0% < RH <= 100%. Without thresholding, relative humidity values in the range 100% < RH <120% will be reported. Values outside this range will be flagged as bad values
BlendLength	The blending interval for the last points of dropsonde pressure and winds. A second bspline filter is calculated with a higher frequency wavelength, and the results from this are blended back into the primary filter results, over this time. The width of this filter is also set to BlendLength
AltInterpSpan	Maximum time gaps over which geopotential altitude calculations are interpolated
GPSAltBuddySlope	Maximum rate of change between neighboring GPS altitude data points. Data points changing faster are flagged as outliers and removed
GPSAltQCDev	Maximum allowed number of GPS altitude standard deviations within a period
GPSAltQCWL	Period for GPS altitude outlier filter
GPSPosBuddySlope	Maximum rate of change between neighboring GPS position data points. Data points changing faster are flagged as outliers
GPSPosQCDev	Maximum allowed number of GPS position standard deviations within a period
GPSPosQCWL	Period for GPS position outlier filter
PosInterpSpan	Maximum time span, in seconds, over which the position integration from winds data will be interpolated. (Obsolete feature)
PresBuddySlope	Maximum rate of change between neighboring pressure data points. Data points changing faster are flagged as outliers
PresOutlier	Threshold for number of deviations from the linear fit, over which a point will be flagged and discarded

PresQCDev	Threshold for maximum deviation from the smoothed series, above which values will be flagged and removed
PresQCWL	Period for pressure outlier filter
RHOutlier	Flag indicating, whether a relative humidity outlier check was performed
RHBuddySlope	Maximum rate of change between neighboring relative humidity data points. Data points changing faster are flagged as outliers
RHQCDev	Maximum allowed number of relative humidity standard deviations within a period
RHQCWL	Period for relative humidity outlier filter
TdryBuddySlope	Maximum rate of change between neighboring temperature data points. Data points changing faster are flagged as outliers
TdryOutlier	Flag indicating, whether a temperature outlier check was performed
TdryQCDev	Maximum allowed number of temperature standard deviations within a period
TdryQCWL	Period for temperature outlier filter
WindBuddySlope	Maximum rate of change between neighboring wind components data points. Data points changing faster are flagged as outliers
WindOutlier	Flag indicating, whether a wind outlier check was performed
WindQCDev	Maximum allowed number of wind components standard deviations within a period
WindQCWL	Period for wind components outlier filter
WindVVdelta	Maximum difference between GPS measured vertical fall speed and that calculated from pressure, temperature, and humidity
WindVVPresWL	Period for GPS altitude outlier filter

Table 5: AVAPS IMPACTS Data Fields

Field Name	Description	Unit
Time_Start	Starting time of the sampling period in UTC seconds from midnight	seconds
TimeFLStart	None, Starting time of the sampling period from the launch	seconds
Pressure	Met_StaticPressure_InSitu_None, Static air temperature	mb
Temperature	Met_StaticAirTemperature_InSitu_None, Static air temperature	Deg C
RH	Met_RelativeHumidityWater_InSitu_None, Relative humidity over water	%
Speed	Met_WindSpeed_InSitu_None, Wind Speed	m/s

Direction	Met_WindDirection_InSitu_None, Wind Direction	deg
Latitude	Platform_Latitude_InSitu_None, Sonde latitude	deg
Longitude	Platform_longitude_InSitu_None, Sonde longitude	deg
Altitude	Platform_AltitudePressure_InSitu_None, Sonde pressure altitude	m
GPS Altitude	Platform_AltitudeMSL_InSitu_None, Sonde altitude over mean sea level	m
Dewpoint	Met_DewPoint_InSitu_None, Dew Point Temperature	Deg C
Uwnd	Met_UWindSpeed_InSitu_None, East-West wind speed	m/s
Vwnd	Met_VWindSpeed_InSitu_None, North-South wind speed	m/s
Ascent	Met_WWindSpeed_InSitu_None, Vertical wind speed	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 Atmospheric Sounding Processing Environment (ASPEN) software. This software implements the quality control procedures to produce the quality control parameters listed in the dataset. The user can also modify which quality control parameters are produced. More information about the ASPEN software is available on the NCAR AVAPS Software webpage.

Software

The AVAPS IMPACTS dataset files are stored in ASCII-ict format and can be viewed in a text editor or spreadsheet software such as Notepad++ or Microsoft Excel.

Known Issues or Missing Data

There are no known issues with these data or any known gaps in the dataset. Missing data are indicated by a value of *-9999*.

References

Hardy, B. (1998). ITS-90 Formulations for Vapor Pressure, Frostpoint Temperature, Dewpoint Temperature, and Enhancement Factors in the Range -100 to +100 C.

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UCAR NCAR E.O.L. Laboratory. (n.d.). What is a Dropsonde? https://www.eol.ucar.edu/content/what-dropsonde

Related Data

All other datasets collected as part of the IMPACTS campaign are considered related and can be located by searching the term "IMPACTS" in the GHRC Search Portal. Listed below are datasets from other field campaigns and studies that used the AVAPS instrument:

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
(http://dx.doi.org/10.5067/HS3/AVAPS/DROPSONDE/DATA202)

CAMEX-3 DC-8 Airborne Vertical Atmospheric Profiling System (AVAPS)
(http://dx.doi.org/10.5067/CAMEX-3/DROPSONDE/DATA101)

Contact Information

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

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