Long-Term NOAA Dropsonde Hurricane Archive Quality Assurance Summary

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1.0	10-21-2013	*K. Young*	Initial NOAA Release
2.0	12-30-2013	*J. Wang*	Add radius, azimuth and vertical velocity
3.0	08-20-2014	*J. Wang*	Add Table 4

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For more information on the NCAR Dropsonde System please visit the following site: http://www.eol.ucar.edu/instrumentation/sounding/dropsonde

Disclaimer: The dropsonde data for this project were obtained by NOAA. The data were then quality controlled and are maintained by the Earth Observing Laboratory at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF). In the event that information or images from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NOAA, NSF and NCAR/EOL and make reference to Young et al. (2013, K. Young, J. Wang, D. Behringer, Long Term NOAA Dropsonde Hurricane Archive Quality Assurance Summary).

I. Dataset Overview

Dropsonde data is primarily used in studying and helping predict the path and intensity of hurricanes. The data in this archive are a compilation of 17 years (1996-2012) of high resolution dropsonde data collected by NOAA's National Hurricane Center and Hurricane Research Division. In the future, subject to the availability of support, this data archive will be expanded to include quality controlled dropsonde data from NCAR's Earth Observing Laboratory, the United States Air Force, NASA and other agencies. The raw data were reformatted to the same format and have undergone consistent quality-control in order to produce a high-quality, long-term dropsonde climatology that may be used by researchers for various scientific applications. The number of storms and soundings in each year is summarized in Table 1.

Table 1 – Storm/Data Summary

Year	# of Storms	Soundings in final archive
1996	7	68
1997	7	388
1998	7	1124
1999	11	1105
2000	8	311
2001	8	709
2002	7	948
2003	5	769
2004	5	1332
2005	13	2306
2006	5	470
2007	6	361
2008	8	1302
2009	5	540
2010	9	954
2011	9	278
2012	3	716
Total		**13681**

II. EOL Sounding File Format and Data Specifics

The EOL format is an ASCII text format that includes a header (Table 2), with detailed project and sounding information, and seventeen columns of high resolution data (Table 3). The files are broken out into directories by year, storm, GPS sensor type, and aircraft. Two types of GPS sensor have been used since 1996, they are the GPS121 and u-blox sensors. The GPS121 "QC.eol" data files are half-second resolution data files with appropriate corrections and quality control measures applied. For u-blox dropsondes the thermodynamic data (pressure, temperature and humidity (PTU)) are available at half-second resolution and wind data is available at quarter-second resolution. The naming convention for these files is "D", followed by "yyyymmdd_hhmmss.sondeID.PQC.eol" where yyyy = year, mm = month, hh = hour of the day

GMT, mm = minute of the hour, ss = second of the hour (which refer to the launch time of the sonde), and "QC.eol" refers to the EOL file format type. For version 2, ".radazm.Wwind" is added to the end of the filename to denote that the radius, azimuth angle and vertical velocity profiles are added to the data.

The header contains information including data type, project name, site location, actual release time, and other specialized information. The first seven header lines contain information identifying the sounding. The release location is given as: lon (deg min), lon (dec. deg), lat (deg min), lat (dec. deg), altitude (meters). Longitude in deg min is in the format: ddd mm.mm'W where ddd is the number of degrees from True North (with leading zeros if necessary), mm.mm is the decimal number of minutes, and W represents W or E for west or east longitude, respectively. Latitude has the same format as longitude, except there are only two digits for degrees and N or S for north/south latitude. The following three header lines contain information about the data system and auxiliary information and comments about the sounding. The last 3 header lines contain header information for the data columns. Line 11 includes the sonde weight and parachute size used to calculate the vertical velocity, and medium VV value. Line 12 holds the field names, line 13 the field units, and line 14 contains dashes (--- characters) signifying the end of the header. Data fields are listed below in Table 3.

The variables pressure, temperature, and relative humidity are calibrated values from measurements made by the dropsonde. The dew point is calculated from the relative humidity and temperature. The geopotential altitude is calculated from the hydrostatic equation, typically from the ocean's surface upward. For dropsondes that failed to transmit useful data to the surface, we integrate geopotential altitude from flight level down. The descent rate of the sonde is computed using the time-differentiated hydrostatic equation. The position (lat, lon) and wind data come directly from the GPS sensor.

The NHC Best Track, linearly interpolated to 1-minute time resolution, was used to determine the radius and azimuth of the dropsonde. The azimuth represents the position of the dropsonde relative to the center of the tropical cyclone following the meteorological wind direction convention. For example, dropsondes located in the northwest quadrant have azimuths ranging from 270-360 degrees, southwest quadrant 180-270 degrees, southeast quadrant 90-180 degrees, and northeast quadrant 0-90 degrees.

Vertical wind was computed from the pressure-calculated and theoretical dropsonde fall rates. The filtered vertical winds are the smoothed values. Please note that the vertical wind is first interpolated and then filtered, so the filtered data at lines where the vertical wind is not available should be ignored. The algorithm for calculating the vertical wind is described in details in Wang et al. (2009, Wang, J., J. Bian, W. O. Brown, H. Cole, V. Grubišić, K. Young, 2009: Vertical Air Motion from T-REX Radiosonde and Dropsonde Data. J. Atmos. Oceanic Technol., 26, 928–942.). Note that the vertical wind is calculated and kept in the data for the fast fall soundings. You can use the median VV value on line 11 in the header to determine whether it is a fast fall (assuming some threshold) or look at the vertical wind profiles.

Table 2 – EOL Sounding File Format (dropsonde and radiosonde)

```
Data Type/Direction:                  /Descending
File Format/Version:                  EOL Sounding Format/1.1
Project Name/Platform:                /Lockheed WP-3B, N42RF
Launch Site:
Launch Location (lon,lat,alt):        75 43.99'W -75.733100, 23 50.60'N 23.843400,  6195.80
UTC Launch Time (y,m,d,h,m,s):        1996, 08, 14, 18:39:43
Sonde Id/Sonde Type:                  601330903/
Reference Launch Data Source/Time:    unknown/unknown
System Operator/Comments:             /
Post Processing Comments:             Aspen Version 3.1; Created on 25 Sep 2013 15:35 UTC; Configuration research-dropsonde
Weight(g)/Parachute_size(m)/med.VV(m/s): 389 0.26 1
```

Time	-- UTC	--	Press	Temp	Dewpt	RH	Uwind	Vwind	Wspd	Dir	dZ	GeoPoAlt	Lon	Lat	GPSAlt	Radius	Azimuth	Wwind	Wwind_f
sec	hh mm	ss	mb	C	C	%	m/s	m/s	m/s	deg	m/s	m	deg	deg	m	km	Deg	m/s	m/s
-1.00	18 39	42.00	483.60	-8.00	-26.15	22.29	-1.28	2.93	3.20	156.50	-999.00	6173.41	-75.733100	23.843400	-999.00	-999.00	-999.00	-999.00	-999.00
0.30	18 39	43.30	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.000000	-999.000000	-999.00	-999.00	-999.00	-999.00	-999.00
0.80	18 39	43.80	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.00	-999.000000	-999.000000	-999.00	-999.00	-999.00	-999.00	-999.00

Table 3 - Lists data fields provided in the EOL format ASCII soundings

Field No.	Parameter	Units	Measured/Calculated
1	Time	Seconds	----------
2	UTC Hour	Hours	----------
3	UTC Minute	Minutes	----------
4	UTC Second	Seconds	----------
5	Pressure	millibars	Measured
6	Dry-bulb Temp	Degrees C	Measured
7	Dewpoint Temp	Degrees C	Calculated
8	Relative Humidity	Percent	Measured
9	U Wind Component	Meters/Second	Calculated
10	V Wind Component	Meters/Second	Calculated
11	Wind Speed	Meters/Second	Measured
12	Wind Direction	Degrees	Measured
13	Descent Rate	Meters/Second	Calculated
14	Geopotential Altitude	Meters	Calculated
15	Longitude	Degrees	Measured
16	Latitude	Degrees	Measured
17	GPS Altitude	Meters	Measured
18	Radius	Kilometers	Calculated
19	Azimuth angle	Deg (from north)	Cacluated
20	Vertical Wind	Meters/Second	Calculated
21	Filtered Vertical Wind	Meters/Second	Calculated

III.Data Quality Control Process

1. Profiles of pressure, temperature, RH, wind speed and descent rate from the raw D-files are examined to determine if all of the files contain data, and to ensure that nothing looks

suspicious. Doing this allows us to determine if a sounding was started up, but not launched, or if the data contains any features that warrant further investigation. Corrections are applied where appropriate.

2. The raw soundings D-files are then processed through the Atmospheric Sounding Processing ENvironment (ASPEN) software, which analyzes the data, performs smoothing, sensor time response corrections, and removes suspect data points. The ASPEN configuration used to process this dataset is given in Table 4.

3. Time series plots of quality controlled temperature, RH, wind speed, and fall rate, are used to examine the consistency of soundings launched during each flight, and to show the variability of soundings from different missions. These plots are also used to determine if the sounding did not transmit data to the surface, or if there was a "fast fall" caused by failure of the parachute to properly deploy.

4. Profiles of temperature, RH and winds from the quality controlled soundings are visually evaluated for outliers, or any other obvious issues.

5. Finally, histograms of pressure, temperature, relative humidity, wind speed and wind direction at generated to examine the range and distribution of each parameter.

Table 4. ASPEN configuration parameters used to process this dataset

Dropsonde Data QC Configuration Set				
	Pressure	**Temperature**	**RH**	**Winds**
Wind Equilibration Time				10
Dynamic Correction		Yes	Yes	
Outlier Check (number of standard deviations)	10	10	10	5
Buddy Check Slope	2 hPa/s	3 °C/s	20 %/s	1.5 m/s^2
QC Filter wave length (WL)	10 s	10 s	10 s	30 s
QC Filter Deviation Limit	3 hPa	3 °C	3 %	3 m/s
Final Smoothing WL	5 s	5 s	5 s	10 s
Number of Satellites				5
Vertical Velocity Diff Limit				2.5 m/s