Pre-Depression Investigation of Cloud-systems in the Tropics (PREDICT) 2010 USAF C-130 Dropsonde Analysis Summary

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Document Version Control

Version	Date	Author	Change Description
1.0	05-02-2012	*S. Loehrer*	Initial Document Release
2.0	03-24-2017	*K. Young*	A dry bias in the RD94 and mini-dropsonde (NRD94) relative humidity measurements was discovered in data collected from 2010 to present. The dry bias is strongly temperature dependent. It is considered small at warm temperatures and it becomes stronger at cold temperatures. This RH dry bias has been corrected for. The dropsonde files that have

			received this correction contain an indicator in the header of the file, 'TDDryBiasCorrApplied'.

* The National Center for Atmospheric Research is managed by University Corporation for Atmospheric Research and sponsored by the National Science Foundation.

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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 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 plots from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NSF and NCAR/EOL and make reference to Loehrer et al. (2012, S. Loehrer, J. Wang, K. Young, T. Hock, D. Lauritsen and C. Martin: PREDICT 2010 USAF C-130 quality controlled dropsonde data set.)

I. Dataset Overview

Pre-Depression Investigation of Cloud-systems in the Tropics (PREDICT) was a field campaign aimed at examining and improving upon the prediction and understanding of tropical cyclogenesis. The project was conducted in the tropical Atlantic Ocean during August and September 2010 (Figure 1). From 15 August through 30 September 2010, thirteen flights were conducted and 86 dropsondes deployed. All 86 quality controlled soundings are contained in the final DYNAMO dropsonde data set. A detailed summary of the flights is shown in Table 1.

Table 1 - Summary of Flights

Name	Dates	System	Dropondes deployed	Dropsondes in final archive
0607A	31 Aug 2010	Earl	14	14
0807A	31 Aug 2010	Earl	14	14
0208A	01 Sep 2010	Fiona	6	6
0907A	01 Sep 2010	Earl	4	4
1007A	01 Sep 2010	Earl	5	5
0308A	01 Sep 2010	Fiona	10	10
0408A	03 Sep 2010	Fiona	4	4
1607A	03 Sep 2010	Earl	7	7
0508A	03 Sep 2010	Fiona	3	3
1707A	04 Sep 2010	Earl	3	3
01GGA	28 Sep 2010	Nicole	1	1
0216A	29 Sep 2010	Nicole	3	3
0316A	29 Sep 2010	Nicole	12	12
Total			86	86

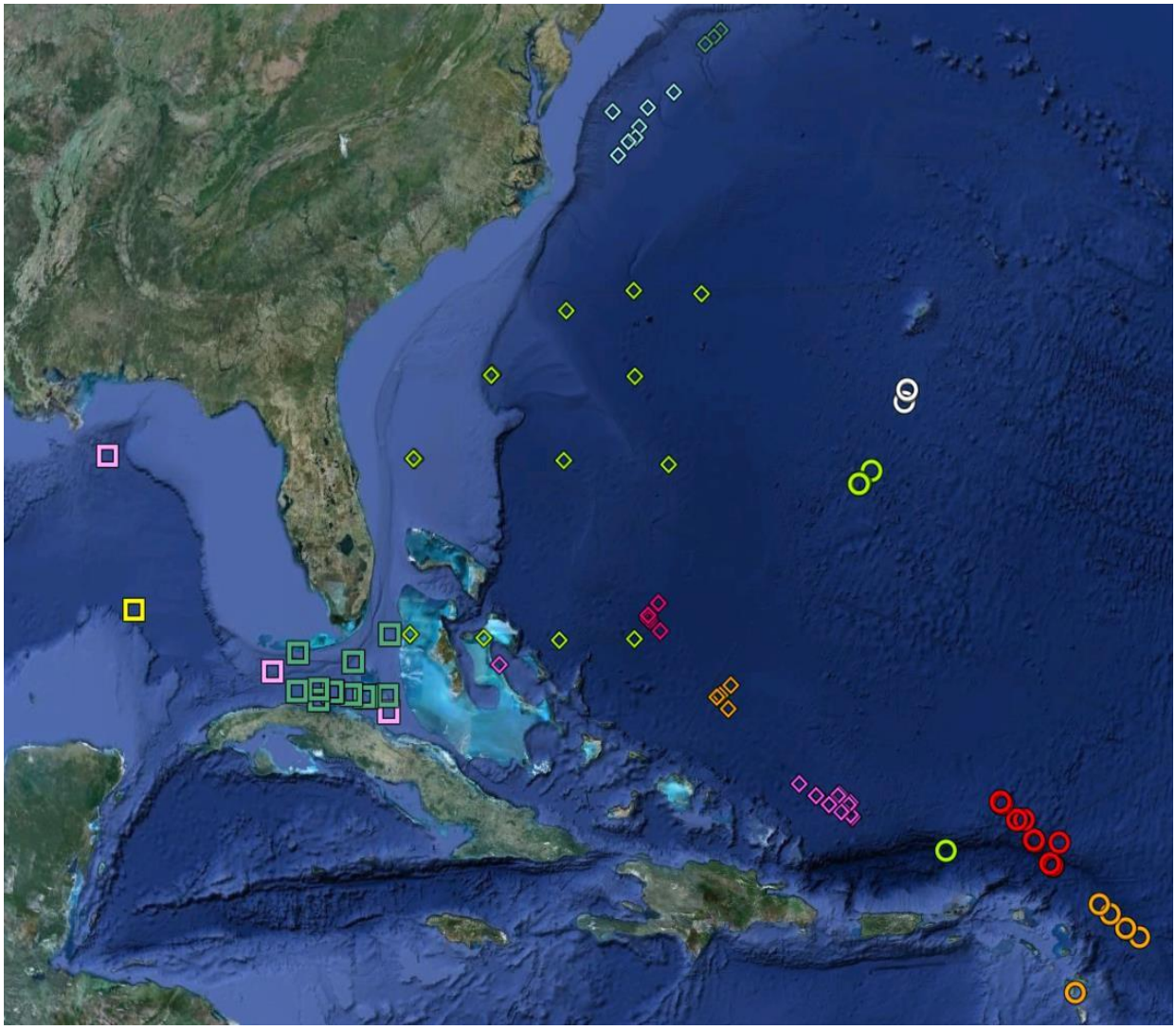

Figure 1- Map of Flights over the Atlantic Ocean and Gulf of Mexico. Each symbol represents one dropsonde location. Different symbols with different colors represent different flights shown in the legend and Table 1.

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 "QC.eol" files are half-second resolution data files with appropriate corrections and quality control measures applied, except for D20100903_235514, D20100904_000016, D20100904_000404, D20100929_035435, D20100929_052011, and D20100929_062122 which used a later version of dropsonde that provided GPS parameters at 0.25 sec intervals. The naming convention for these files is "D", followed by "yyyymmdd_hhmmss_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.

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 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.

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

```
Data Type/Direction:                        AVAPS SOUNDING DATA, Channel 1/Descending
File Format/Version:                        EOL Sounding Format/1.1
Project Name/Platform:                      10083107309 0607A EARL, 10083107309 0607A EARL/Lockheed C-130J, ---
Launch Site:
Launch Location (lon,lat,alt):              76 32.30'W -76.538300, 24 24.39'N 24.406500,  8072.30
UTC Launch Time (y,m,d,h,m,s):              2010, 08, 31, 09:47:10
Sonde Id/Sonde Type:                        093259101/Vaisala RSS903 & Ublox TIM-Lx
Reference Launch Data Source/Time:          AFRC WC-130J (ARWO)/09:47:10.00
System Operator/Comments:                   DANIEL/none, Good Drop
Post Processing Comments:                   Aspen Version 3.0; Created on 12 Feb 2012 17:18 UTC; Configuration ModEditsonde
/
  Time    -- UTC  --    Press     Temp    Dewpt     RH      Uwind    Vwind    Wspd      Dir      dZ     GeoPoAlt      Lon          Lat       GPSAlt   Wwind   Wwind_f
   sec    hh mm   ss      mb       C        C        %       m/s      m/s      m/s      deg      m/s        m          deg          deg          m      m/s     m/s
-------- -- -- ----- ------- ------- ------- ------- ------- ------- ------- ------- ------- -------- ----------- ----------- -------- ------ --------
```

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

III. Data Quality Control Process

1. Profiles of pressure, temperature, RH, wind speed and descent rate from the raw D-files are first 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.

2. The raw soundings files are then processed through the Atmospheric Sounding Processing ENvironment (ASPEN) software, which analyzes the data, performs data quality control and smoothing, sensor time response corrections, and removes suspect data points.

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 are created to examine the distribution, range, and characteristics of each parameter.

6. A dry bias in the relative humidity measurements was discovered, in the Spring of 2016, in all RD94 dropsondes from 2010 to present and all mini-dropsondes (NRD94) collected. This dry bias is strongly temperature dependent and most significant at cold temperatures. It is considered small at warm temperatures. All sounding files undergoing post-processing have been corrected for this error and contain the flag, 'TDDryBiasCorrApplied', in the last line of the header to confirm that this correction has been applied. For more information on the dry bias, please access the technical note, linked below, which contains information on the origin, magnitude and impact of the dry bias.

   NCAR/EOL Technical Note: Dropsonde Dry Bias
   https://www.eol.ucar.edu/system/files/software/Aspen/Windows/W7/documents/Tech%20Note%20Dropsonde_Dry_Bias_20160527_v1.3.pdf

IV. Special Problems to Note (Important Information for Users)

Performing the quality control procedures outlined above allows us to identify and, in many cases, resolve issues that could potentially impact research performed using these data sets.

The following issues were found, and where necessary, corrections were applied (Tables 4 & 5):

1. **Fast Fall/Partial fast fall:** There were eleven dropsondes where the parachute did not deploy, did not deploy properly, or deployed late, three sondes were fast falls and eight sonde were partial fast fall (Figure 2). Failure of the parachute to properly deploy results in dropsondes falling at an accelerated rate (and often tumbling) causing winds to be unreliable. For these soundings, wind speed, wind direction, U/V winds, and vertical winds are set to missing where the fall rate is accelerated.

2. **Errors with Accurate Launch Detection:** Thirty-six dropsondes experienced problems with the launch detect mechanism. In these cases the launch detect was either triggered late (35 dropsondes) or it failed completed (one dropsonde). When this occurs, raw data is incorrectly recorded as "pre-launch" for failed and late launch detect. Additionally, the filenames and launch times and flight level data recorded are incorrect. For these sounding files the records incorrectly labeled as "pre-launch" were corrected and correct/revised launch times were assigned. However, the flight level data remains unchanged. Also, due to the lack of raw, unprocessed D-files, for those that have late launch detects of more than 10 seconds varying amounts of data were unrecoverable and the actual launch time was not able to be determined. In some cases this was minor and still during the period of acclimatization of the dropsonde, however some cases had significant data loss (e.g. D20100929_150749 where about 74mb of data were lost). Table 5 lists the no launch detect file as well as the late launch detects of 10 seconds or longer where some data were lost.

Table 4 - Summary Statistics

Description	# of Files	Filenames	Comments/Corrections
Total	86 dropsondes deployed 86 in final archive (**100% success rate**)		All files from these flights are in the final archive.
Complete Profiles	76 (87.2%)		Ten soundings excluded from total 86 are the following ones listed below.
Fast Fall	2	D20100929_052011 D20100929_183543	All wind data are set to missing.
Partial Fast Fall	8	D20100831_115615 D20100901_080343 D20100901_172141 D20100901_172925 D20100903_133041 D20100903_223959 D20100929_150749 D20100929_163111	Parachute opened late. Wind data where fast fall occurred are set to missing.

Table 5 - The files with late or no launch detects.

Description	# of Files	New Filename (UTC lau time hhmmss)	Original Filename (UTC lau time hhmmss)	Comments/Corrections
Late Launch Detect	12	D20100831_**115605** D20100831_**151918** D20100831_**170507** D20100901_**080343** D20100901_**172141** D20100901_**172925** D20100903_**123724** D20100903_**133041** D20100903_**151518** D20100903_**223959** D20100929_**150749** D20100929_**163111**	D20100831_**115615** D20100831_**151928** D20100831_**170517** D20100901_**080353** D20100901_**172150** D20100901_**172935** D20100903_**123734** D20100903_**133051** D20100903_**151527** D20100903_**224009** D20100929_**150759** D20100929_**163121**	Only the late launch detects of longer than 10 seconds are listed. Due to the lack of unprocessed D-files, varying amounts of data were lost in these files. There were 23 other late launch detect files but they were less than 10 seconds and no data were lost.
No Launch Detect	1	D20100929_**183543**	D20100929_**183536**	All data was recovered and correct launch times were assigned to each file

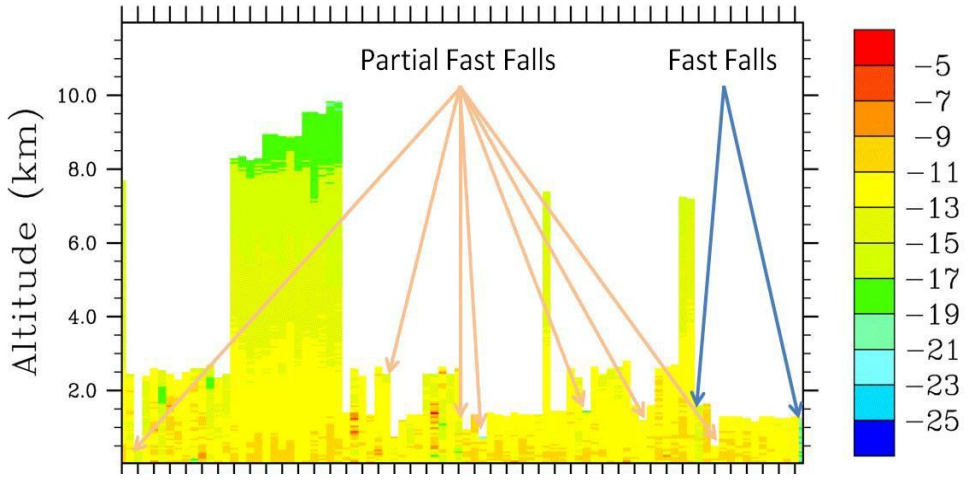

Figure 2 - Pressure-calculated fall rate (m/s) profiles of final QCed data. The two fast fall soundings and four of the partial fast fall soundings are indicated by the arrows.