East Pacific Origins and Characteristics of Hurricanes (EPOCH) Project

EPOCH-2017 Dropsonde Data Quality Report

February 28

2018

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 Young K. and H. Vömel: EPOCH 2017 Dropsonde Data Quality Report.

In the event that these datasets are used for research resulting in a publication, please include the following citations in your paper:

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EPOCH 2017 Quality Controlled Dropsonde Dataset

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I. Dataset Overview

The East Pacific Origins and Characteristics of Hurricanes (EPOCH) was a NASA funded research campaign aimed at studying tropical storms in the Northern Hemisphere in order to learn more about conditions that drive changes in intensity, and to use the data to improve forecasting models that predict tropical storm impacts on coastal communities. The project planned six research flights of the NASA Global Hawk conducted between August 1 and August 30, 2017 with 50% of the flights supported through a partnership with the NOAA UAS Program Office, based from NASA Armstrong Flight Research Facility. Only three research flights were flown during the field campaign. A total of 216 dropsondes were deployed on the three flights (Figure 1). One hundred and ninety two of the dropsondes were the NRD94 dropsondes and twenty four dropsondes were a new design referred to as the NRD41 dropsonde (Table 1). The NRD41dropsondes can be identified in the header of each sounding file, where 'Sonde Type' is set to 'RSS421', this is the module number of the PTU sensor. For NRD94 dropsondes, 'Sonde Type' is set to 'RSS904'. The RD41 dropsondes use a next generation PTU module manufactured by Vaisala that has a faster temperature response sensor and improved RH sensor, all the dropsonde electronics were updated including a new 400 MHz transmitters and next generation GPS receiver for the computation of winds.

This document contains information on the field project, a link to information on the sounding file format and data parameters, and provides details regarding the quality control procedures performed and corrections applied.

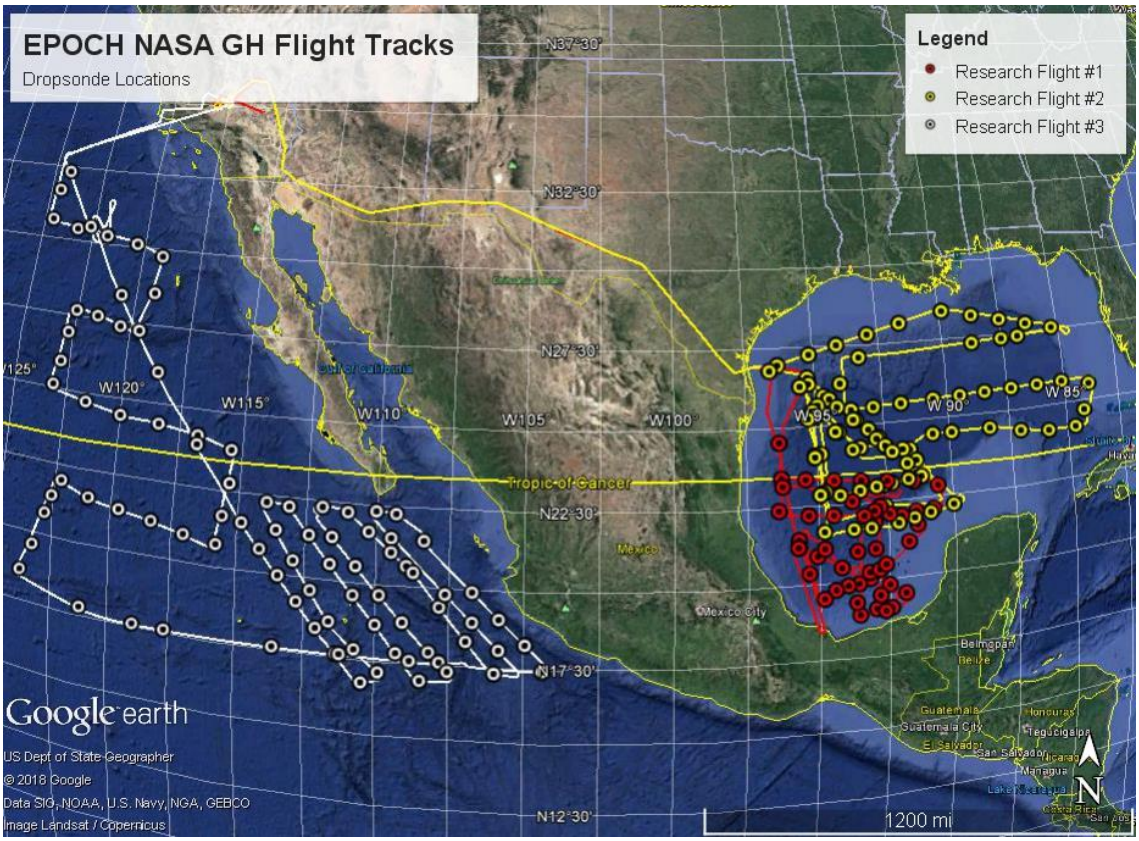

Figure 1 Map of Global Hawk flight tracks and dropsonde launch locations from research flights 1, 2 and 3.

Table 1 - Number of NRD94 and NRD41 Dropsondes Deployed and Total Dropsonde Counts for each Global Hawk Research Flight

Research Flight	Dates	NRD94	NRD41	Sondes deployed
RF01	08/09/2017	48		48
RF02	08/23/2017 - 08/24/2017	65	13	78
RF03	08/30/2017 - 08/31/2017	79	11	90
Total				**216**

II. EOL Sounding File Format and Data Specifics

https://www.eol.ucar.edu/system/files/files/observing_facility/AVAPS%20Dropsonde%20System/v4.EOL%20Sounding%20Data%20File%20Format.docx

III. Data Quality Control Process

1) The AVAPS software applies a dry bias correction in the relative humidity measurements of the NRD94 dropsondes. This bias was discovered, in the spring of 2016. All sounding files 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 see Vömel et al. (2016). The NRD41 dropsondes do not contain this dry bias and have not been corrected.

2) A pressure calibration correction is applied to the entire profile for each sounding during the QC process. The pressure correction value is unique for each dropsonde and is determined in the final testing of the dropsonde, during production, at which time an independent reference pressure sensor is used to determine a constant pressure offset correction. The corrected pressure $P = P_{DS} + (P0_{REF} - P0_{DS})$, where P_{DS} is the pressure measured by the dropsonde, $P0_{REF}$ is the pressure as indicated by the reference sensor and $P0_{DS}$ is the dropsonde pressure during calibration testing. This pressure correction is on average -0.98 for the NRD41 dropsondes and -1.1 hPa for the NRD94 (Figure 2). This correction is not implemented in real-time data in the field.

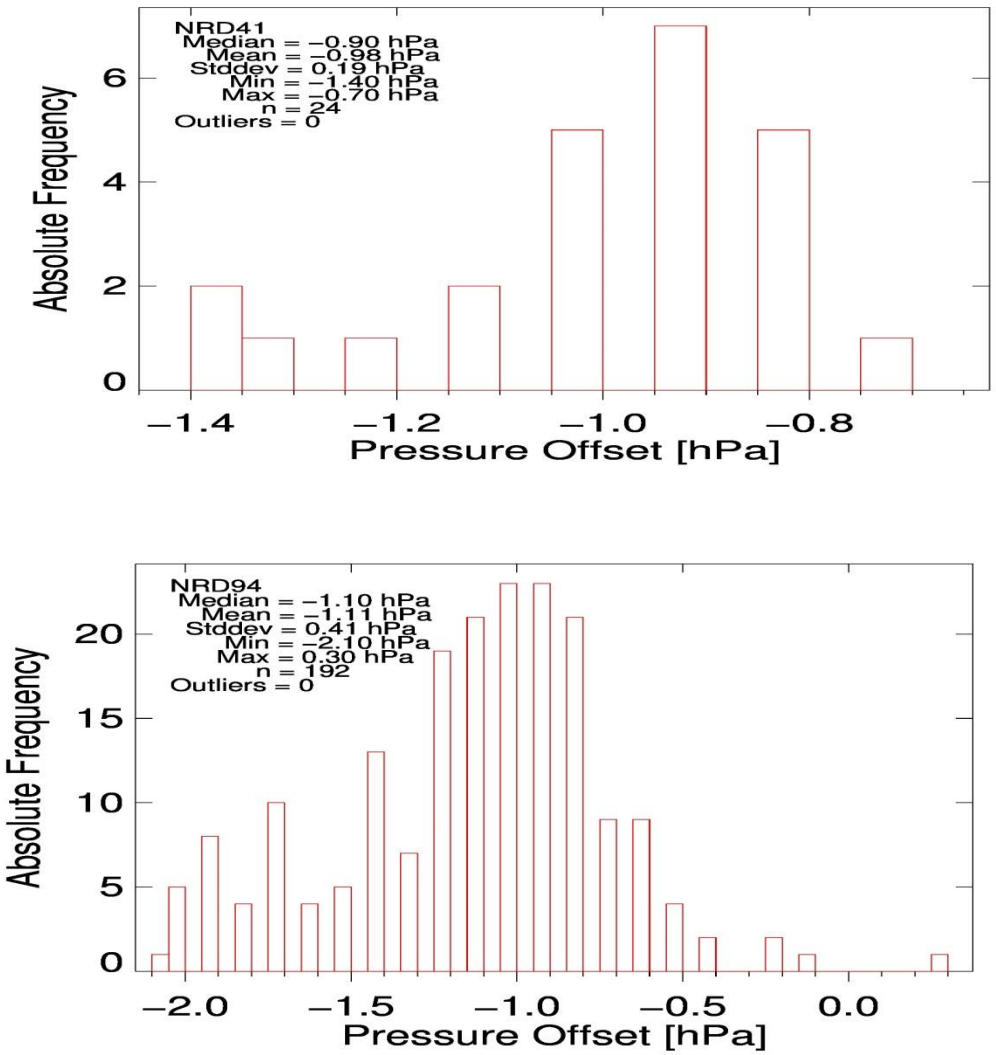

Figure 2 Frequency histograms of pressure corrections applied to NRD41 dropsonde profiles (top) and NRD94 dropsonde profiles (bottom). The NRD41 have a mean correction of -.98 hPa, which is comparable to the NRD94 sondes which have a mean correction of -1.1 hPa.

3) For the NRD94 dropsondes, the GPS altitude measurements have been improved by removing an existing real-time geoid correction and replacing it with a more accurate geoid height from the Earth Gravitational Model 1996 (EGM96). On average the difference between the two is approximately 1.6 m, but the scatter is quite significant, making this correction necessary. No correction is needed for the NRD41, as they report altitude above mean sea level.

4) Filtering of the GPS latitude, longitude and altitude is performed to remove spikes introduced by telemetry errors.

5) The sounding files with the corrected pressure offset and filtered GPS data are then processed through the Batch Atmospheric Sounding Processing ENvironment (ASPEN) software which:

   i) Applies a dynamic correction for temperature and wind

   ii) Separates wind speed and direction into *u* and *v* components and individually applies QC. If one of the two components fails a test, then the components as well as speed and direction are removed from the QC data.

   iii) Performs smoothing

   iv) Removes suspect data points.

   The ASPEN software version and configuration file used for this program are included in the header of each "QC.eol" sounding file. For more information on ASPEN or to download the software please visit: http://www.eol.ucar.edu/software/aspen

IV. Results

The following issues were found in Table 2. Corrections applied are detailed below.

Table 2 – Summary of Data Quality Issues

Data Quality Issue	# of soundings
Data Not to Surface	3
Broken RH Sensor	2
Early Launch Detect	1
Bad T/ RH	1
Missing RH through Saturated Layers	3

1. **Data Not to Surface -** Three soundings, noted in Table 3 and shown in Figure 3, were classified as dropsondes that did not transmit useful data to the surface.

Table 3 – Dropsondes that Experienced Premature Data Loss

Filename	Lowest Computed Geopotential Alt (m)	Lowest Measured GPS Alt (m)
D20170824_045752	944.53	1042.79
D20170824_063706	12659.18	13122.39
D20170830_223402	1086.72	1177.28

2. **Broken RH sensors –** Two of the dropsondes had broken RH sensors that produced only missing values, D20170823_193906 and D20170823_222131.

3. **Early Launch Detect** – One dropsonde experienced launch detect which triggered prematurely, before the dropsondes left the aircraft. When this occurs, data collected in the launch tube is incorrectly flagged as "in-flight". The launch time contained in the data file was changed to reflect the accurate launch time, and the flight level aircraft data were updated to reflect pressure, temperature, wind and location at time of launch, as well. Table 4 provides the filename, the original launch time recorded by the sounding system and the corrected launch time.

Table 4 – Dropsondes that Experienced Early Launch Detect

Filename	Original Launch time Recorded (UTC)	Corrected Launch Time (UTC)
D20170824_063706	06:37:06	06:43:23

4. **Bad T/RH –** One sounding, D20170824_041950, contained no salvageable pressure, temperature or RH data so it was removed from the final archive.

5. **Missing RH through Saturated Layers -** Three dropsondes (D20170823_230717, D20170830_211731, and D20170831_004814) were missing RH values through saturated cloud layers. The RH sensors in three of the NRD41 sondes produced measurements that exceeded saturation which were inadvertently set to missing by the AVAPS software. Those data were corrected by replacing the missing values with 100%.

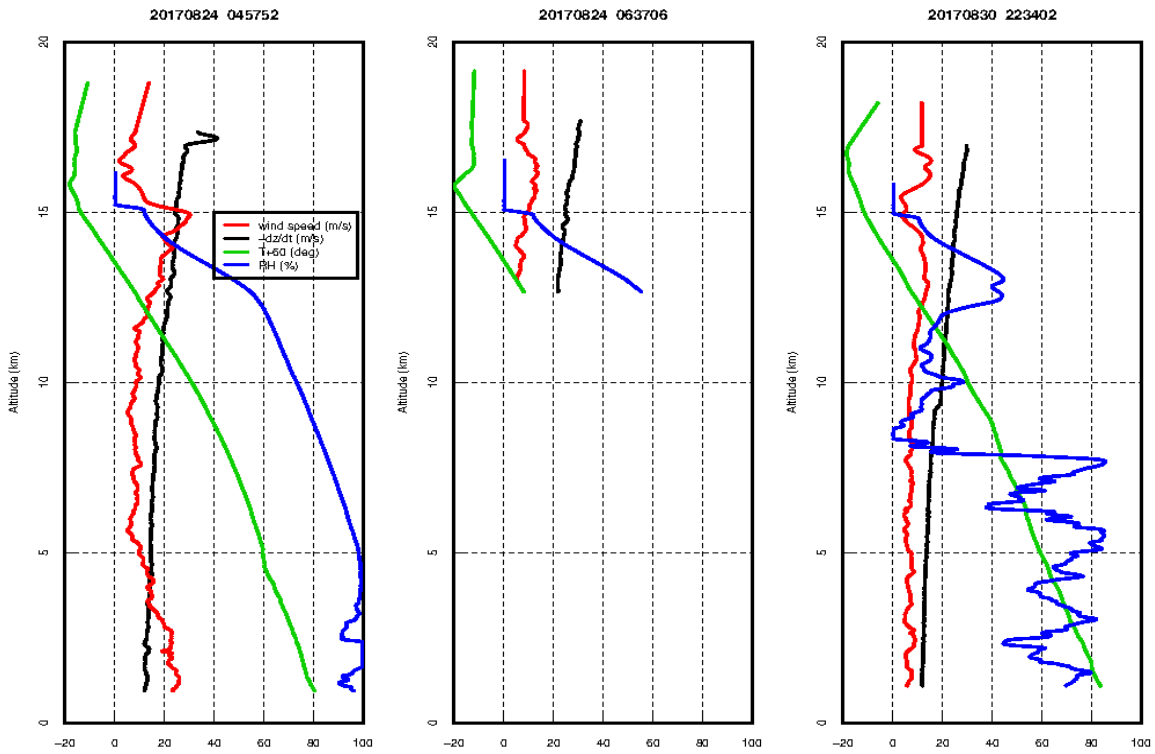

Figure 3 Three sounding profiles of temperature+60 (green), RH (blue), wind speed (red), and positive DZ/DT (black), versus calculated geopotential altitude, failed to transmit data to the surface. Temperature and descent rates were modified to fit the scale.

References

Young, K., Vömel, H. (2016, Dec. 09). *EOL Sounding File Format.* Retrieved from https://www.eol.ucar.edu/system/files/files/observing_facility/AVAPS%20Dropsonde%20System/EOLSoundingDataFileFormat.v2_0.pdf

Vömel, H., K. Young, and T. F. Hock, 2016: *NCAR GPS Dropsonde Humidity Dry Bias*. NCAR Technical Note NCAR/TN-531+STR, 8 pp, doi:10.5065/D6XS5SGX. (http://opensky.ucar.edu/islandora/object/technotes:542)