NASA African Monsoon Multidisciplinary Analysis (NAMMA) 2006 Quality Controlled Dropsonde Data Set

Contents:

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For more information on the NCAR GPS Dropsonde System please visit the following site: http://www.atd.ucar.edu/rtf/facilities/dropsonde

I. Dataset Overview

The African Monsoon Multidisciplinary Analysis (AMMA) project is an international collaboration aimed at improving our knowledge and understanding of the West African Monsoon and its variability. NASA, along with NOAA and other universities and agencies, conducted the field campaign called NAMMA (NASA-AMMA), a subset of AMMA, in an effort to examine winds and dust conditions from Africa, that influence the genesis of hurricanes over the Atlantic. During this project, 197 dropsonde soundings were collected during 13 research flights, off of the West Coast of Africa, between August 6 and September 12, 2006 (Figure 1). For more information on the NAMMA project please visit: http://namma.msfc.nasa.gov/index.html

The NAMMA field campaign used two different versions of the dropsonde. The Rev. D dropsondes, also referred to as GPS121, are an older version. The new Rev F dropsondes use a GPS receiver based upon u-Blox GPS receiver technology. The new GPS receiver is a full up code correlating receiver providing a 12 channel receiver with significant improved tracking performance and reliability over the previous codeless GPS receiver used in Rev D dropsondes. This new GPS receiver module also provides superior latitude, longitude and altitude information.

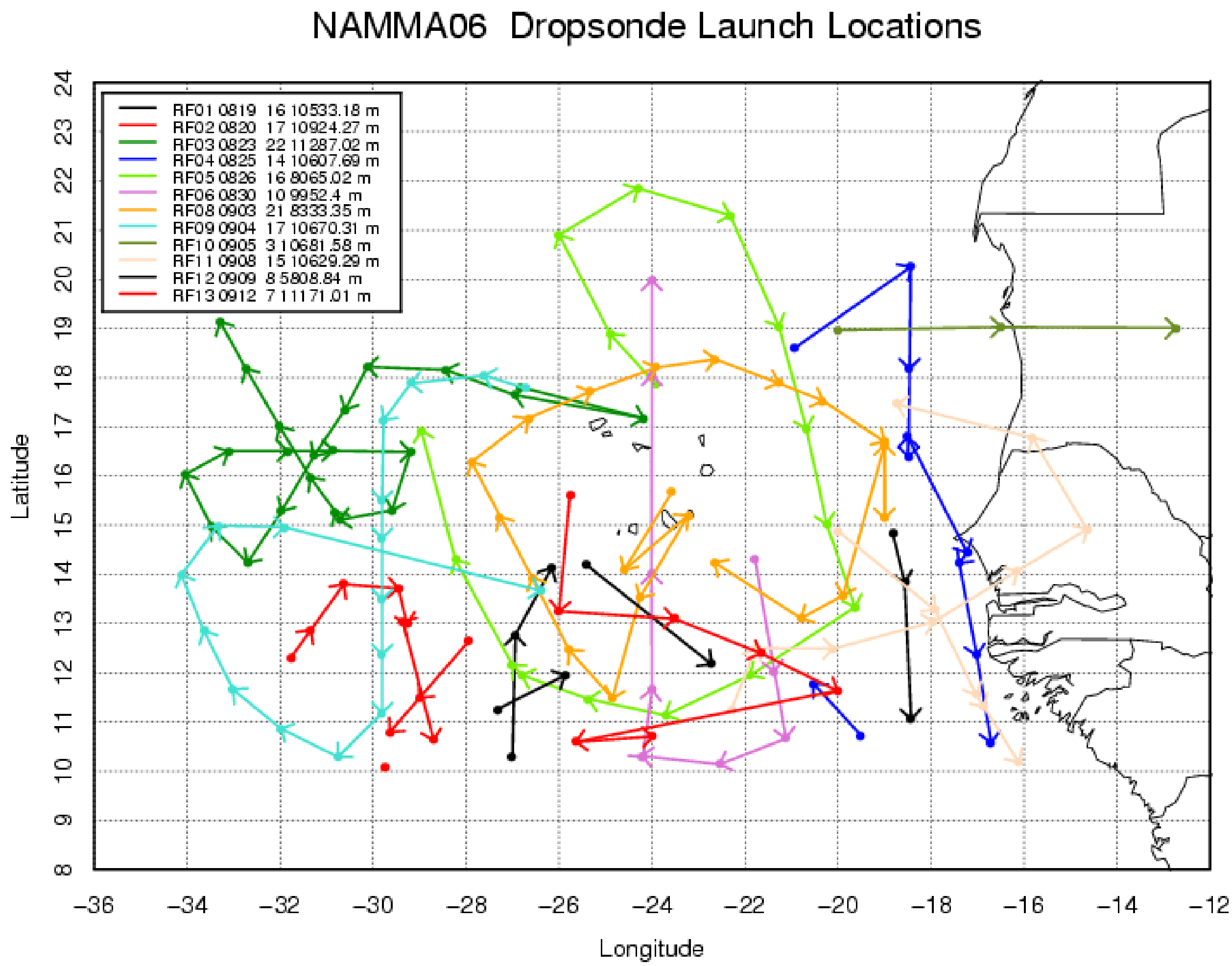

Figure 1 Map of NAMMA flight tracks. Different flights are distinguished by different colors, shown in the legend.

III. ***New EOL File Format***

EOL has introduced a new ascii "EOL file format" for all radiosonde and dropsonde sounding files. This new file format is similar to the CLASS format, used in the past, but has been improved to include a revised header with more detailed sounding information, addition of UTC time, an increase in precision of the longitude and latitude to six decimal places, and GPS altitude is now also provided in addition to geopotential altitude (Table 1). Additionally, all missing values are now set to -999.

The "D" files are half-second data files with appropriate corrections and quality control measures applied. The naming convention for these files is - "D", followed by "yyyymmdd_hhmmssQC.eol" where yyyy = year, mm = month, hh = hour of the day GMT, mm = minute of the hour, ss = second of the hour, QC refers to Quality Controlled, and ".eol" refers to the file format type.

The header records now consist of 14 lines which contain information such as 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 aircraft 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 2.

```
Data Type/Direction:                    AVAPS SOUNDING DATA, Channel 4/Descending
File Format/Version:                    EOL Sounding Format/1.0
Project Name/Platform:                  T-REX, RF1/Gulfstream V, N677F
Launch Site:
Launch Location (lon,lat,alt):          118 14.04'W -118.234000, 36 46.04'N 36.767400, 12439.20
UTC Launch Time (y,m,d,h,m,s):          2006, 03, 02, 18:00:30
Sonde Id/Sonde Type:                    053116003/Vaisala RSS903 & Ublox TIM-Lx
Reference Launch Data Source/Time:      NCAR G-V (ADS)/18:00/29
System Operator/Comments:               emk/none, Good Drop
Post Processing Comments:               Aspen Version
/
 Time  --UTC --   Press    Temp   Dewpt     RH   Uwind  Vwind   Wspd    Dir      dZ  GeoPoAlt      Lon        Lat       GPSAlt
  sec  hh mm  ss    mb       C       C       %     m/s    m/s    m/s    deg     m/s      m          deg        deg          m
------- -- -- ----- ------- ------- ------- ------- ------- ------- ------- ------- ------- -------- ----------- ---------- ---------
  -1.0 18  0 29.00  178.80  -61.10  -61.10  100.00   28.44   23.18   36.69  230.81 -999.00 12439.20 -118.234000 36.767400 12446.20
   0.4 18  0 30.40 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00 -999.00  -999.00 -999.000000 -999.000012416.27
   0.9 18  0 30.90 -999.00 -999.00 -999.00    0.72 -999.00 -999.00 -999.00 -999.00 -999.00  -999.00 -999.000000 -999.000000 12416.94
```

Table 1 Example of new EOL format used for both dropsonde and radiosonde sounding files.

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	Calculated
12	Wind Direction	Degrees	Calculated
13	Ascension Rate	Meters/Second	Calculated
14	Geopotential Altitude	Meters	Calculated
15	Longitude	Degrees	Measured
16	Latitude	Degrees	Measured
17	GPS Altitude	Meters	Measured

Table 2 Lists data fields provided in the EOL format ascii soundings.

IV. Data File Specifics

The files contain data collected at half-second intervals. 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. The geopotential altitude value is calculated from the hydrostatic equation using first available pressure, temperature, and relative humidity. For the dropsondes specifically, if the sonde is launched over water and transmits data to the surface, the height is calculated by integrating from the surface (sea level) upward. However, if the sonde failed to transmit data to the surface or if the dropsonde is launched over land, because of unknown surface elevations, we integrate from the flight level down. The descent rate of the dropsonde is computed using the time-differentiated hydrostatic equation. The position (lat, lon) comes directly from the GPS sensor. All wind data are computed from GPS navigation signals received from the sonde. The raw wind values are calculated at a one half second data rate by a commercial processing card.

V. Data Quality Control

1. Temperature and relative humidity profiles from the raw soundings were first examined to determine if all of the files contained data, and to ensure that nothing looked suspicious. Doing this allows us to determine if there were any errors with the automatic launch detect, or if a sounding was started up, but not launched.
2. The raw soundings were then run through the Atmospheric Sounding Processing ENvironment (ASPEN) software, which analyzes the data, performs smoothing, and removes suspect data points.
3. Time series plots of temperature (Figure 2), RH (Figure 3) and wind speed (Figure 4), with regard to altitude, were 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 a dropsonde was launched over land. In these cases, the soundings are re-run through ASPEN with geopotential altitude calculated from flight level downward.
4. Profiles of temperature, RH, wind speed and vertical velocity from the quality controlled soundings are visually evaluated for outliers, and are used to determine if there was a "fast fall" caused by failure of the parachute to properly deploy.
5. Histograms of pressure, temperature, relative humidity, wind speed and wind direction were then created to examine the distribution, range, and characteristics of each parameter.
6. Plots of percentages of available data, and of time elapsed before availability of winds, were examined to get a general sense of dropsonde performance between the two dropsonde types (Figures 5 and 6).

In performing the QC procedures described above, we found that:

- Six test launches were performed and these are included in the final archive. These soundings were made on 08/07/2006 and 08/09/2006, and they are located under the test flight, TF1 and TF2, directories.

- We were able to clearly examine differences between the Rev D and Rev F dropsondes, and view further evidence of the superior performance of the Rev F dropsondes. The Rev F dropsondes have a higher reliability, and as seen in the bottom plots of Figures 5 and 6, they are able to acquire winds, after launch, substantially faster (~2 seconds) than the Rev D dropsondes (~31 seconds).

- Four soundings experienced problems with the launch detect (Table 3). As a result, **the filenames and launch times were changed to reflect the actual time of deployment of the dropsonde,** determined by a change in pressure. The aircraft data, denoted by -1.0 sec in the first data line of each quality controlled sounding file, should be measured just prior to launch. When launch detect is late, the aircraft reference data may not accurately represent atmospheric conditions at the time of launch. In cases where the launch detect fails completely, the sounding contains neither launch nor aircraft data lines. For these four soundings, launch time was determined by change in pressure and a launch line was manually added. The aircraft data lines were retrieved from a separate file and inserted into the sounding file. The files were then processed through ASPEN.

Flight Number	**New Launch Time**	**Original Launch Time**
RF03	D20060823_123715	D20060823_121426
RF07	D20060901_164403	D20060901_162223
RF08	D20060903_172601	D20060903_170208
RF09	D20060904_143239	D20060904_140910

Table 3 Lists soundings where the launch detect mechanism experienced problems. Column one lists the flight number, column 2 lists the new filename with corrected launch time (last six digits), column 3 lists the original filename of the sounding.

- One sounding (D20060819_165901_PQC.eol) was launched with the protective cap still on. The cap shields the sensors from contamination, and should be removed prior to launch. This error results in measurements of T and RH inside the cap instead of the ambient environment, and is indicated by the red arrows on the temperature time series plot (Figure 2). This sounding was removed from the final archive.

- Seven sounding files did not contain data because either the dropsondes were not launched, or the files contained no PTU data. These files were excluded from the final dataset.

- 15 sounding files contained little or no wind data, 8 of which were Rev D dropsondes and 7 were the Rev F dropsondes. These files are included in the final dataset.

- 14 dropsondes were classified as "fast fall" (Table 4). This occurs when the parachute fails to deploy, resulting in the dropsonde falling at approximately twice the normal speed (Figure 7). Fast fall soundings have a much lower vertical resolution and wind data may not be as clean because of tumbling of the dropsondes as they fall.

Flight #	**Fast Fall Drops**
RF02	D200600820_153600
RF03	D200060823_123500
RF03	D200060823_123715
RF03	D200060823_132041
RF05	D20060826_131300
RF05	D20060826_170159
RF07	D20060901_155411
RF07	D20060901_164403
RF09	D20060904_151400
RF11	D20060908_142830

RF11	D20060908_143101
RF12	D20060909_142330
RF12	D20060909_150257
RF13	D20060912_154407

Table 4 Lists dropsondes classified as “fast fall”.

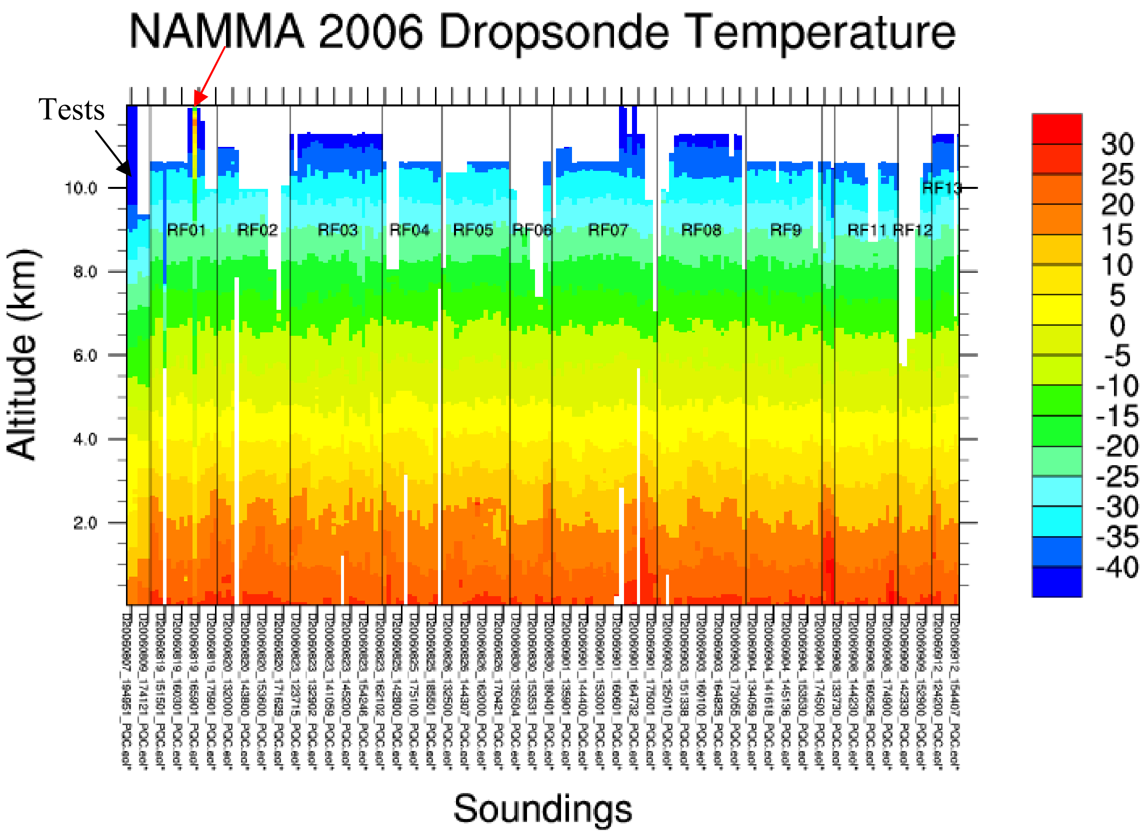

Figure 2 – Time series of dropsonde temperature (deg C) profiles. Sounding files are labeled along x-axis and RF# indicates the flight number. Red arrow indicates sounding made with protective cap still on. This sounding was removed from the final dataset.

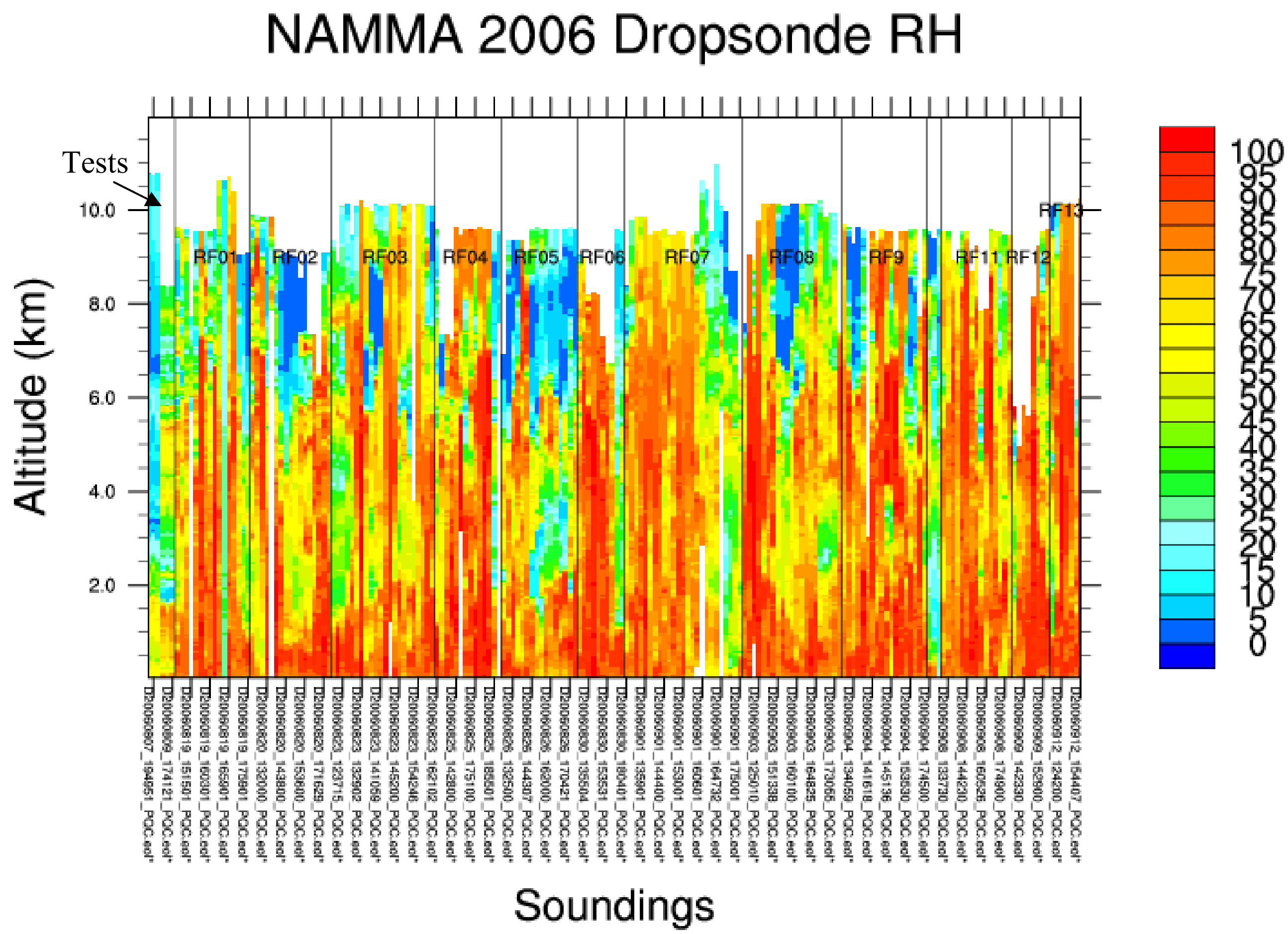

Figure 3 –Time series of dropsonde relative humidity (%) profiles. Sounding files are labeled along x-axis and RF# indicates the flight number.

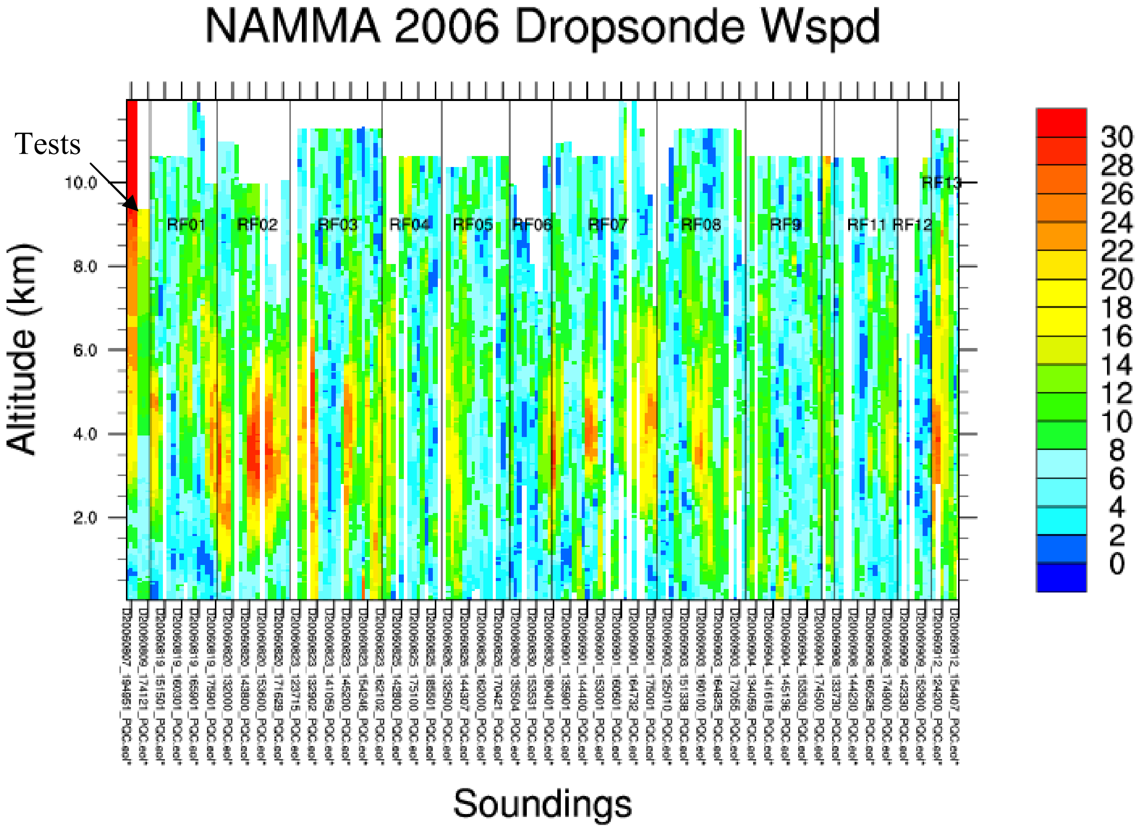

Figure 4 –Time series of dropsonde wind speed profiles (m/s). Sounding files are labeled along x-axis and RF# indicates the flight number.

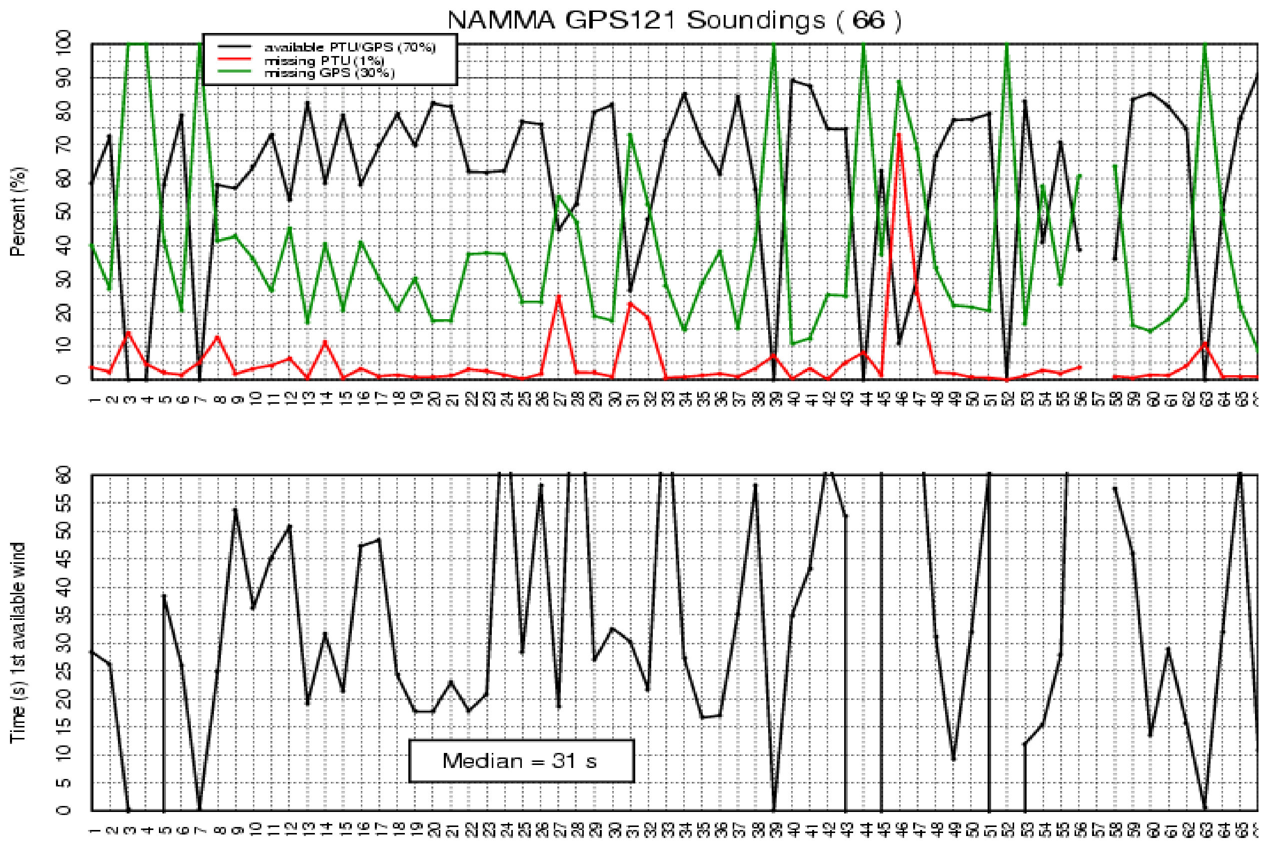

Figure 5. Top plot shows percentages of available PTU/GPS data (black), missing PTU (red), and missing GPS (green) from the Rev D (GPS121) dropsondes. Bottom plots show amount of time elapsed between launch and the time of first available winds.

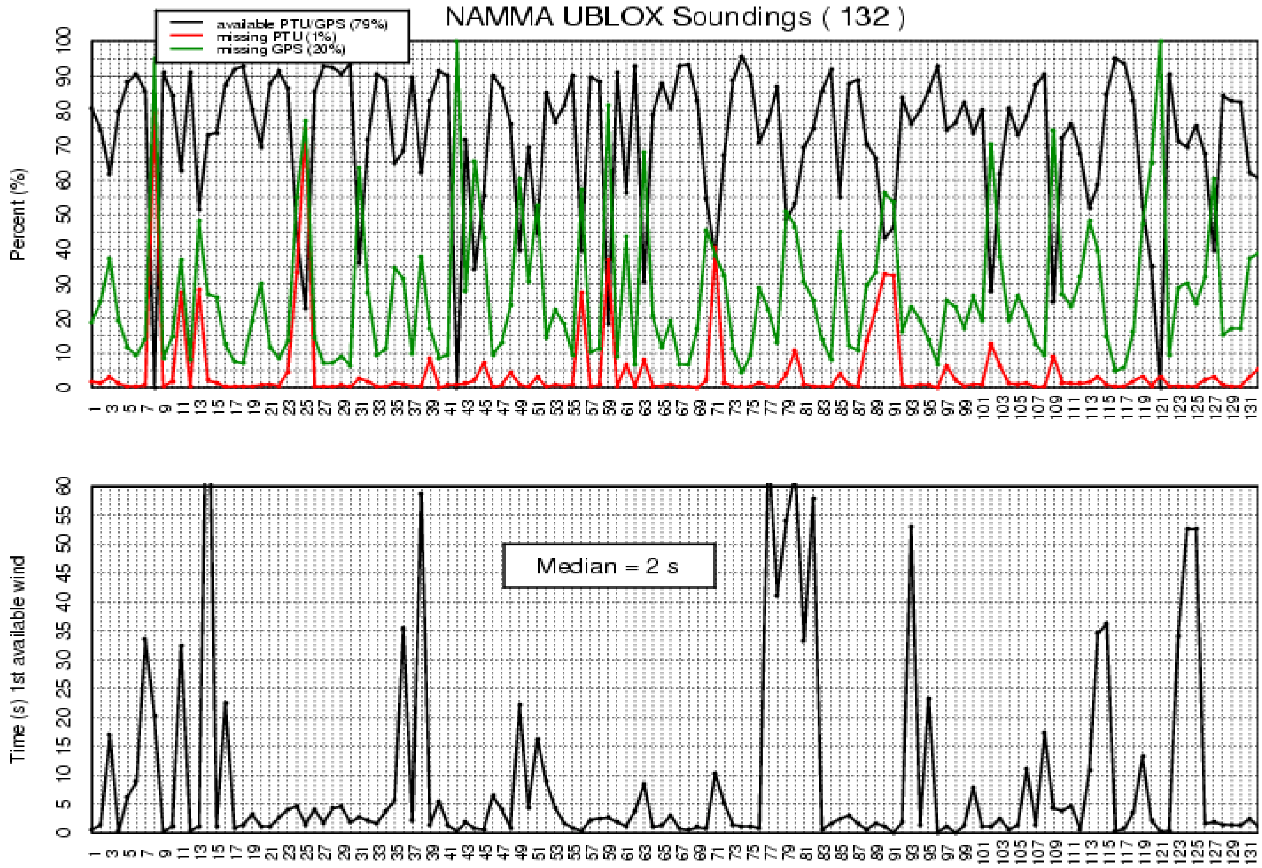

Figure 6. Top plot shows percentages of available PTU/GPS data (black), missing PTU (red), and missing GPS (green) from the Rev F (UBLOX) dropsondes. Bottom plots show amount of time elapsed between launch and the time of first available winds.

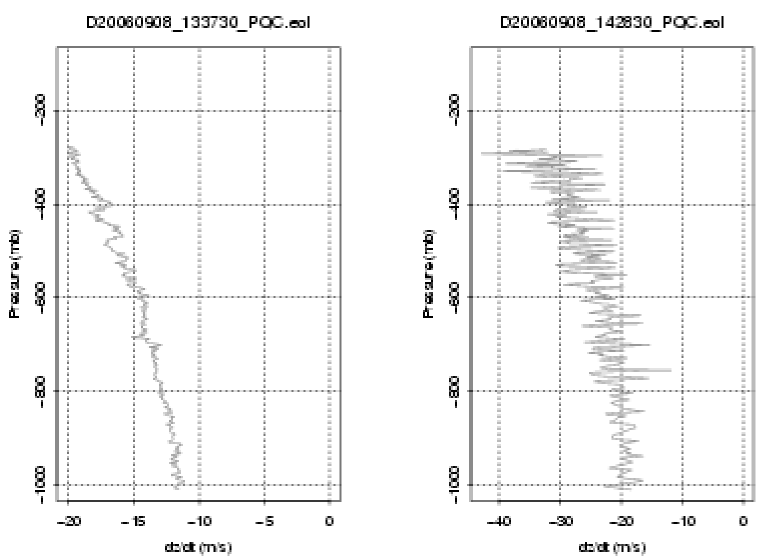

Figure 7. Plots above show normal descent speed of dropsonde with a parachute (left), and the descent speed of a “fast fall” dropsonde (right) where the parachute failed to deploy.