Cloud and Precipitation Study (CPS) 2008 Quality Controlled Radiosonde Data Set

Contents:

Contacts:

Data Quality
Kate Young
kbeierle@ucar.edu

Junhong (June) Wang
junhong@ucar.edu

ISS Group Leader
Bill Brown
wbrown@ucar.edu

System/Software
Dean Lauritsen
lauritsn@ucar.edu

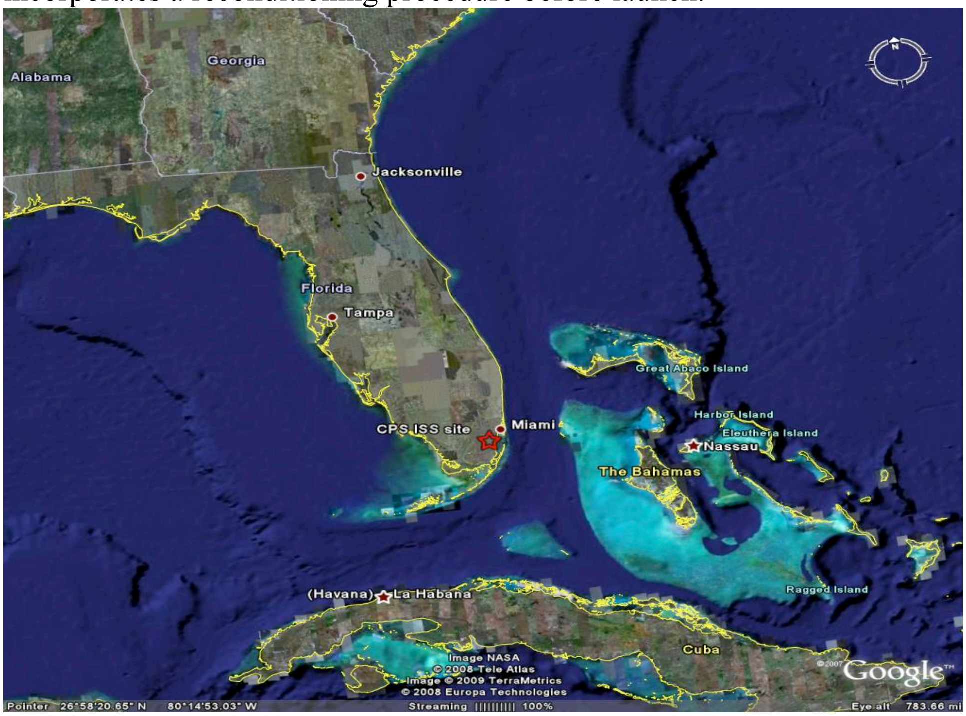
Mailing Address: NCAR/Earth Observing Laboratory
P.O. Box 3000
1850 Table Mesa Drive
Boulder, CO 80307; USA

For more information on the NCAR Earth Observing Laboratory Integrated Sounding System (ISS), or on the GPS Advanced Upper-Air Sounding System (GAUS), please visit:
ISS: http://www.eol.ucar.edu/instrumentation/sounding/iss
GAUS: http://www.eol.ucar.edu/instrumentation/sounding/iss/gaus

I. ISS Project/Dataset Overview

The Cloud and Precipitation Study (CPS) is a project aimed at examining shallow and deep convection, as well as stratiform precipitation, in a tropical/subtropical environment in an attempt to better understand cloud and precipitation processes. The CPS site was located in Miami, Florida and was equipped with an EOL Integrated Sounding System (ISS). The ISS included a 915 MHz Multiple Antenna Profiling Radar (MAPR), a radiosonde sounding system, a surface meteorology tower, and a ceilometer for measuring cloud base heights. Seventy-eight radiosonde launches were made from the ISS site; seventy-three sounding files are included in the final archive. The average horizontal distance traveled by the radiosondes during this project was 31.5 km (19.6 miles) from surface to 20.3 km.

The NCAR/EOL GPS Advanced Upper-air Sounding system (GAUS) incorporates Vaisala RS92 radiosondes, has portability, built-in test capability and flexibility for multiple channel operations, and delivers users high precision GPS measurements of radiosonde positions. The Vaisala RS92 radiosonde delivers high quality wind measurements from the ground with code-correlating GPS technology, as well as pressure, temperature and humidity measurements all transmitted digitally to the receiving station. Digital technology reduces missing data due to noise and increases overall reliability of the system. The Vaisala RS92 provides much better humidity measurements with a heated twin-sensor design and incorporates a reconditioning procedure before launch.



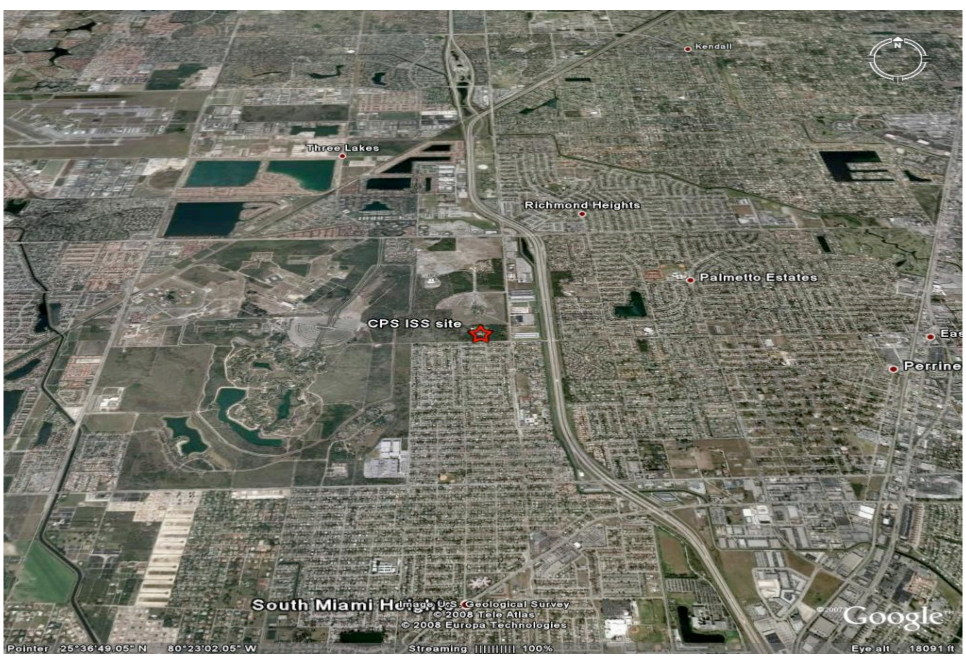


Figure 1 Radiosonde launches were made from the ISS site in Miami, FL. The bottom figure shows the location of the site in proximity to other locations in the city.

II. EOL File Format

The EOL format is an ascii text format that includes a header, with detailed project and sounding information, and seventeen columns of high resolution data (Table 1). The "D" files are one second resolution data files with appropriate corrections and quality control measures applied. The naming convention for these files is - "D", followed by "yyyymmdd_hhmmss_P.1.QC.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 ".eol" refers to the file format type

The header records contain 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 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:                        GAUS SOUNDING DATA/Ascending
File Format/Version:                        EOL Sounding Format/1.0
Project Name/Platform:                      CPS/NCAR GAUS
Launch Site:                                20080730
Launch Location (lon,lat,alt):              80 23.05'W -80.384153, 25 36.81'N 25.613458, 4.00
UTC Launch Time (y,m,d,h,m,s):              2008, 07, 30, 18:03:02
Sonde Id/Sonde Type:                        082033941/Vaisala RS92-SGP (ccGPS)
Reference Launch Data Source/Time:          Campbell Scientific CR10/18:03:03.25
System Operator/Comments:                   Brad & Lou/test flight, Good Sounding
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
```

Table 1. Example of the 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	Measured
12	Wind Direction	Degrees	Measured
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 all parameters provided in the sounding files, their unit of measurement, and if the values are measured or calculated.

III. Data File Specifics

The files contain data calculated at one-second intervals. The variables pressure, temperature, and relative humidity are calibrated values from measurements made by the radiosonde. The dew point is calculated from the relative humidity and temperature. The geopotential altitude is calculated from the hydrostatic equation using pressure, temperature, and relative humidity. The rate of ascent is calculated from pressure. The radiosonde position (lat, lon, GPSAlt) and winds are measured by use of a GPS receiver in the sonde. These raw wind values are subjected to a digital filter to remove low frequency oscillations due to the sonde pendulum motion beneath the balloon when run through NCAR's Atmospheric Sounding Processing ENironment (ASPEN) software.

IV. Data Quality Control and Results

1. Profiles of the raw soundings are first examined to determine if there are any errors with the launch detect, or if system lock-up occurred, as a result of weaken of the sonde signal, which could result in a loss of data and an incorrect launch time.

2. All of the soundings are then subjected to a radiation correction that takes into account the solar angle at time of launch, and removes solar heating that could skew the temperature measurements.

3. Scatter plots (Figures 3, 4 and 5) of the raw data are created to check differences in pressure, temperature and RH between the surface met and the last available surface radiosonde measurement before launch.

4. **4.** The raw soundings are run through EOL's Atmospheric Sounding Processing ENvironment (ASPEN), which analyzes the data, performs smoothing, and removes suspect data points.

5. **5.** We create profiles of temperature, RH, wind speed and wind direction of the quality controlled soundings which enable us to visually evaluate the soundings for outliers, or any other obvious problems.

6. **6.** Lastly, we examine skew-t diagrams from each sounding.

Performing the QC steps above allows us to identify and, in some cases, correct errors that could potentially impact research performed using these data sets. During processing of the sounding data the following issues were found, and where possible, corrections were applied:

1. **1.** The following five soundings were removed from the final archive. They either contained little or no data because the signal was lost shortly after launch.
   D20080730_171339_P.1
   D20080819_155030_P.1
   D20080822_204750_P.1
   D20080822_205529_P.1
   D20080928_150045_P.1

2. **2.** One sounding reported incorrect measurements from both of its hygrometers (Figure 2). This sounding is included in the final archive and was corrected by applying a -6% offset to RH1 and an 8% offset to RH2.

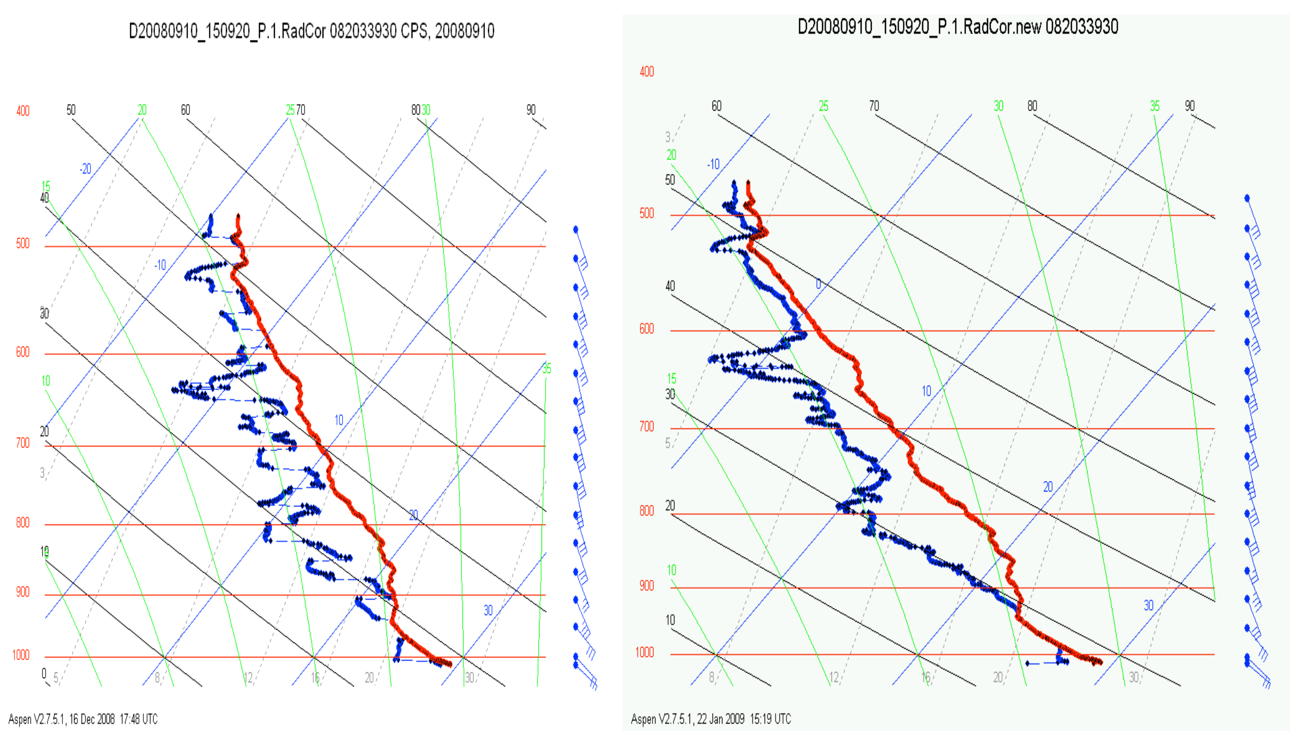


Figure 2 – Left panel shows skew-t of data with incorrect RH measurements. Right panel shows skew diagram after correction is applied

3. Four soundings, all of which are included in the final archive, appear to have entered very deep moist cloud layers. This likely caused freezing of the sensors, and a loss of the signal for three of the radiosondes, resulting in early termination of the soundings.
   D20080810_190115_P1.QC.eol – loss of signal above 600 mb.
   D20080812_145555_P1.QC.eol – signal maintained through cloud layer
   D20080928_195934_P1.QC.eol – loss of signal at 500 mb
   D20080929_173318_P1.QC.eol – loss of signal just above 600 mb

4. One sounding (D20080804_135946_P.1.QC.eol) did not contain GPS (latitude, longitude or altitude) below 600 mb.

5. Differences between the last radiosonde surface measurement before launch and the surface met measurement can be seen below. Temperature differences are shown in Figure 3, RH differences in Figure 4, and pressure differences in Figure 5. While these plots are of raw sounding data, to some degree, differences do carry over to the final product. Large differences between the radiosonde and surface met temperature measurements can be seen below on the left, in red (Figure 3). The Campbell surface met sensor, typically used in the ISS, began experiencing problems towards the end of August. Due to these errors, the temperature and RH surface measurements in all of the sounding data files were replaced with surface measurements from a co-located WXT surface met sensor. The pressure and wind data are still that from the Campbell. There were two exceptions to this. The sounding D20080730_180302, still contains surface data from the Campbell sensor because there was no WXT data available on that day. Also, D20080831_150025 has temperature and RH prelaunch sonde data entered in as surface met because the Campbell was not working properly at that time, and a CSTARS surface sensor that had been temporarily used (for this day only) was incorrect as well. The right hand panels of Figure 3 and Figure 4 show the scatter plots after the corrections were made. Pressure differences seen in Figure 5 are still under investigation.

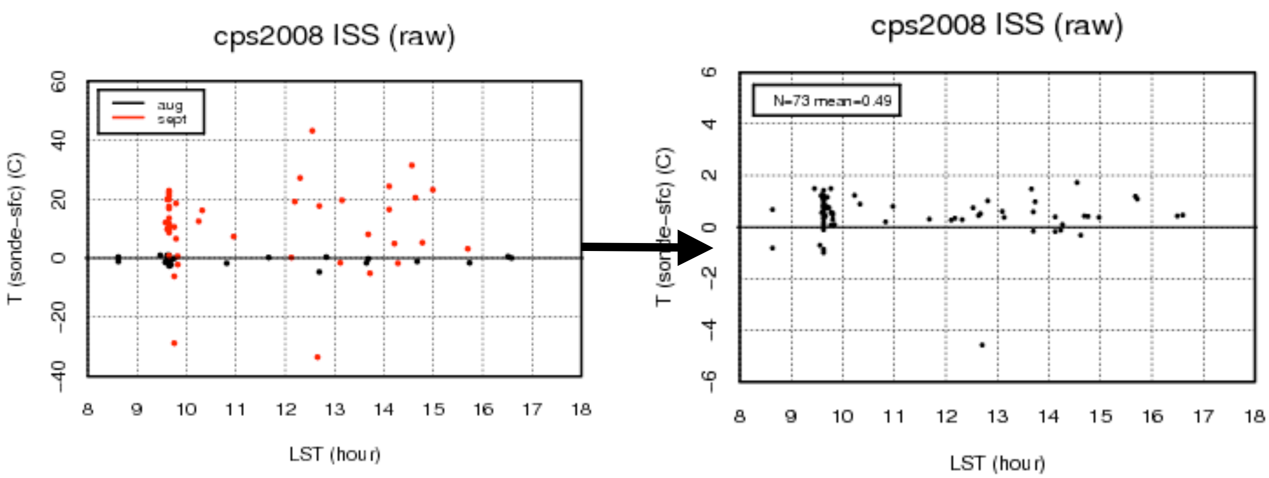


Figure 3 The left panel shows surface temperature differences between prelaunch radiosonde and Campbell surface met from August (black) and prelaunch radiosonde and Campbell surface measurements from September (red). The right panel shows improvement after WXT surface met data is used in place of the Campbell data. Note that the different scales are used for two plots.

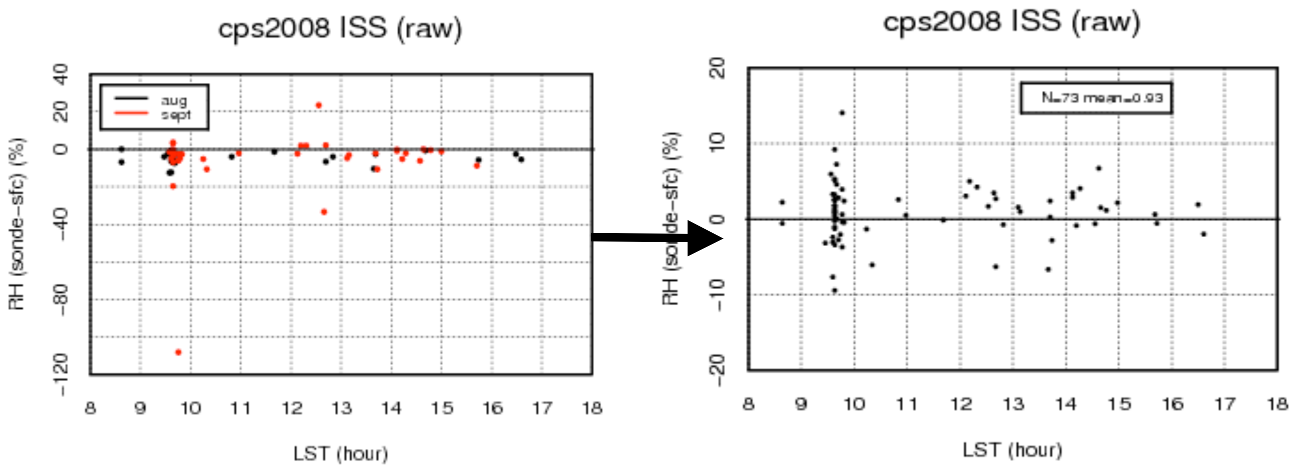


Figure 4 The left panel shows surface RH differences between prelaunch radiosonde and Campbell surface met from August (black) and prelaunch radiosonde and Campbell surface met from September (red). The right figure shows improvement after WXT surface met data is used in place of the Campbell data. Note that different scales are used for two plots.

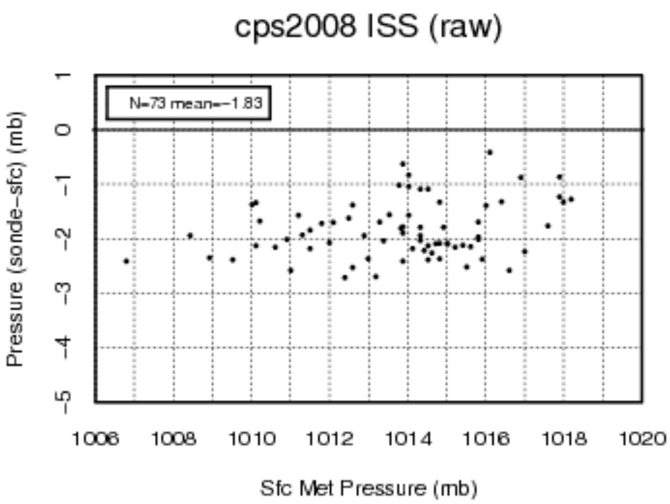


Figure 5 shows consistent surface pressure differences between the prelaunch radiosonde and Campbell surface met data. These differences are still under investigation.

6. Surface GPS and geopotential altitudes were set to zero while the Campbell surface met sensors were in use during the month of August. When a switch was attempted at using the WXT surface sensors in place of the Campbell, the surface geopotential altitudes somehow were set to missing in the raw data. This resulted in no geopotential altitudes being calculated by ASPEN in the QC dataset. In order to correct this, the surface altitude was retrieved from the GLOBE 1-km surface elevation dataset. This value (4 m) was entered in as the GPS surface altitude for all soundings, and the geopotential altitude was calculated from that. Once there was surface point, ASPEN was able to calculate the geopotential altitudes, in the QC data, using the hydrostatic equation.