CuPIDO 2006 Quality Controlled Radiosonde Data Set

Contents:

Contacts:

Data Quality
Kate Young
kbeierle@ucar.edu

Junhong (June) Wang
junhong@ucar.edu

System/Software
Dean Lauritsen
lauritsn@ucar.edu

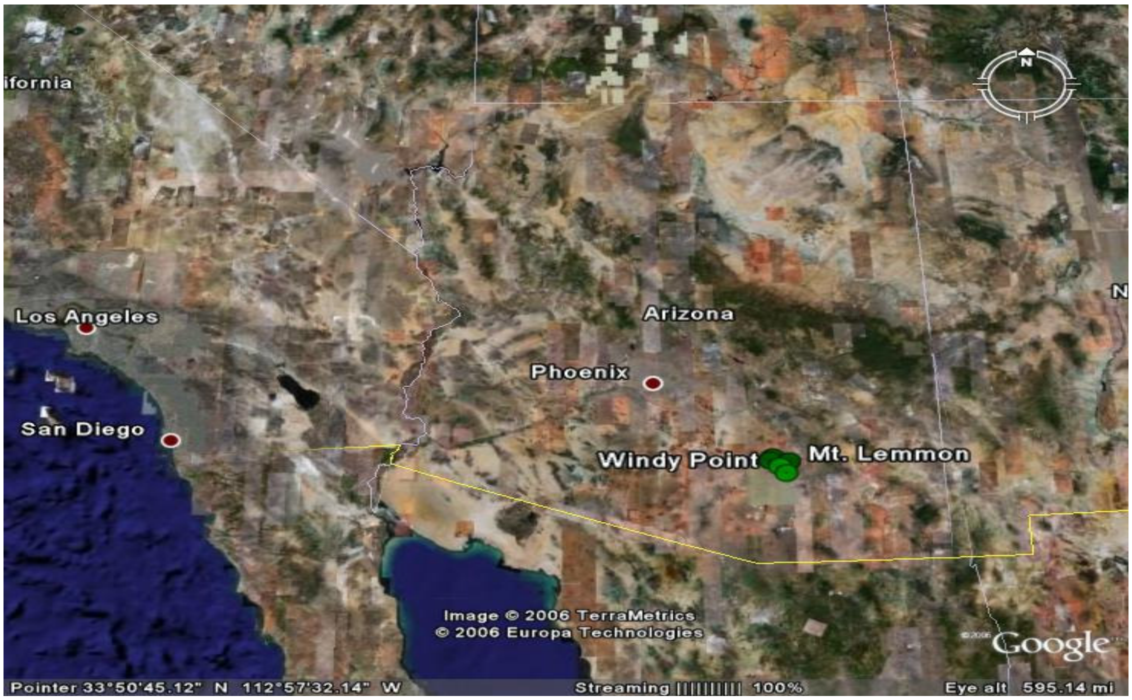
Mailing Address: NCAR/Earth Observing Laboratory
P.O. Box 3000
1850 Table Mesa Drive
Boulder, CO 80307; USA

For more information on the NCAR Earth Observing Laboratory GAUS System (formally GLASS) please visit the following site:
http://www.eol.ucar.edu/facilities/gaus.html

I. GAUS Project/Dataset Overview

The goal of the Cumulus Photogrammetric, In-Situ and Doppler Observations (CuPIDO) project was to examine the onset and development of orographic thunderstorms associated with the North America Monsoon using surface stations, digital visible spectrum cameras, soundings and aircraft data. For this study NCAR/EOL deployed two mobile sounding systems to the mountainous region of Southern Arizona just north of Tucson (Figure 1). Soundings were made from various locations. Ninety-six radiosonde launches were performed between July 17 and Aug 17, 2006. For more information on the CuPIDO project please visit: http://geography.asu.edu/zehnder/cupido/

The sounding system used was the NCAR/EOL GPS Advanced Upper-air Sounding system (GAUS). It was developed to replace the GPS LORAN Atmospheric Sounding System (GLASS). GAUS incorporates Vaisala RS92 next generation 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 will reduce missing data due to noise and increase overall reliability of the system. The Vaisala RS92 provides much better humidity measurements with a heated twin-sensor design and incorporates a new reconditioning procedure before launch.



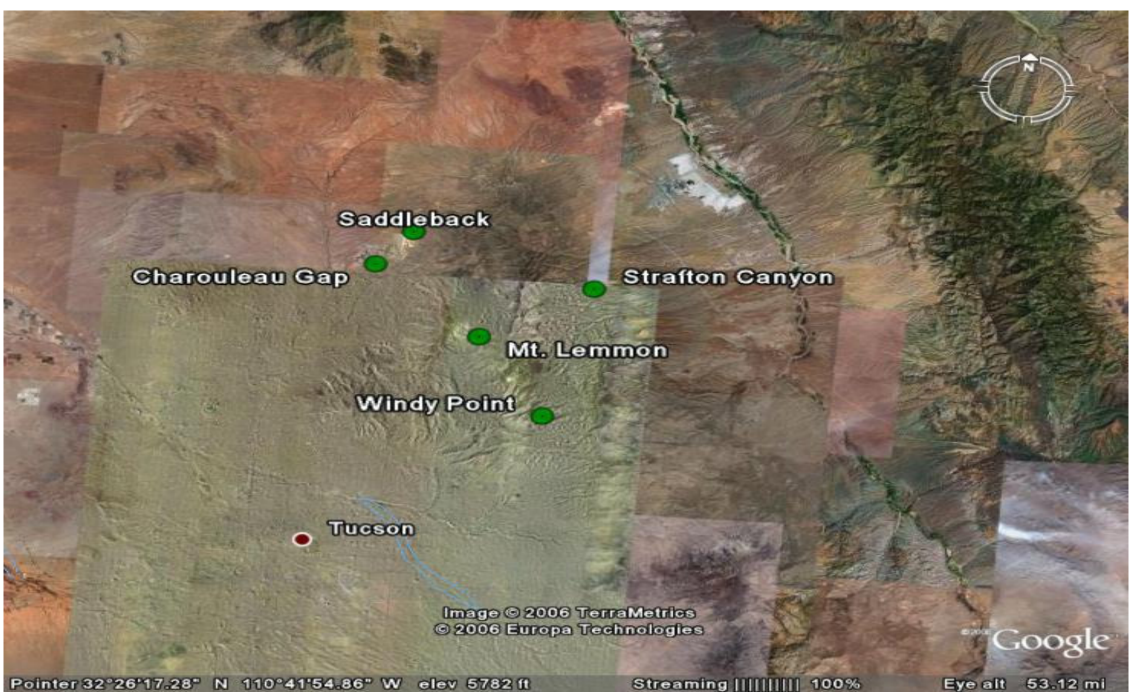


Figure 1 Mobile GAUS launch locations during CuPIDO are shown by green circles. Figures show proximity of project sites to major cities (top) and proximity to each other (bottom).

II. ***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 accuracy 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 one second, ascii format data files with appropriate corrections and quality control measures applied. The naming convention for these files is - "D", followed by "yyyymmdd_hhmmss_P.QC.eol" where yyyy = year, mm = month, hh = hour of the day GMT, mm = minute of the hour, ss = second of the hour 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:                  GAUS/Ascending
File Format/Version:                  EOL Sounding Format/1.0
Project Name/Platform:                T-REX/NCAR GAUS
Launch Site:                          IOP01 08z
Launch Location (lon,lat,alt):        119 20.88'W -119.347997, 36 19.74'N 36.328918,    90.98
UTC Launch Time (y,m,d,h,m,s):        2006, 03, 02, 08:33:34
Sonde Id/Sonde Type:                    043937408/Vaisala RS92-SGP (ccGPS)
Reference Launch Data Source/Time:    Vaisala WXT510/08:33:32.80
System Operator/Comments:               Vic/Tim, 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 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	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 ASPEN.

IV. Data Quality Control and Important Information for Users

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

2. Profiles of the raw soundings are examined to determine if there are any errors with the launch detect or if system lock-up occurred which could result in a loss of data near the surface and an incorrect launch time.

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

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. Lastly, 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.

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 we found that:

1. Two soundings needed repair because the system locked up during the flight of the sonde when the signal weakened, as a result of the distance of the sonde from the surface. The affected sounding files were not saved in the correct file format. They contained no LAU (launch) or A00 (surface met) data lines, and were missing the standard 20 line tail at the end of the files. These things are all necessary in order for ASPEN to run properly. Data before the lockup was preserved, however anything measured after the lock-up has been lost. Filenames for these soundings were changed to reflect the actual launch time determined by the pressure change.

2. There were three test launches performed. One from the mobile1 system, D20060807_173329 and two from the mobile2 system, D20060717_204023 and D20060718_183909. **All test soundings are included in the final archive.**

3. Two soundings contained no GPS data; D20060813_172950 (mobile1) and D20060719_171000 (mobile2)

4. The RS-92 radiosondes are equipped with two hygrometers that measure alternately during the ascent of the radiosonde. These measurements are then merged into one profile. Upon examining the relative humidity profiles, it was determined that 5 humidity sensor malfunctioned or completely failed during the flight (Figure 2). The plots on the right show RH sensors that were not measuring correctly (shown in black circles). These RH profiles have been corrected with the erroneous points changed to missing values. For the remaining three soundings, one of the humidity sensor failed completely resulting in gaps of missing data though out the profiles.

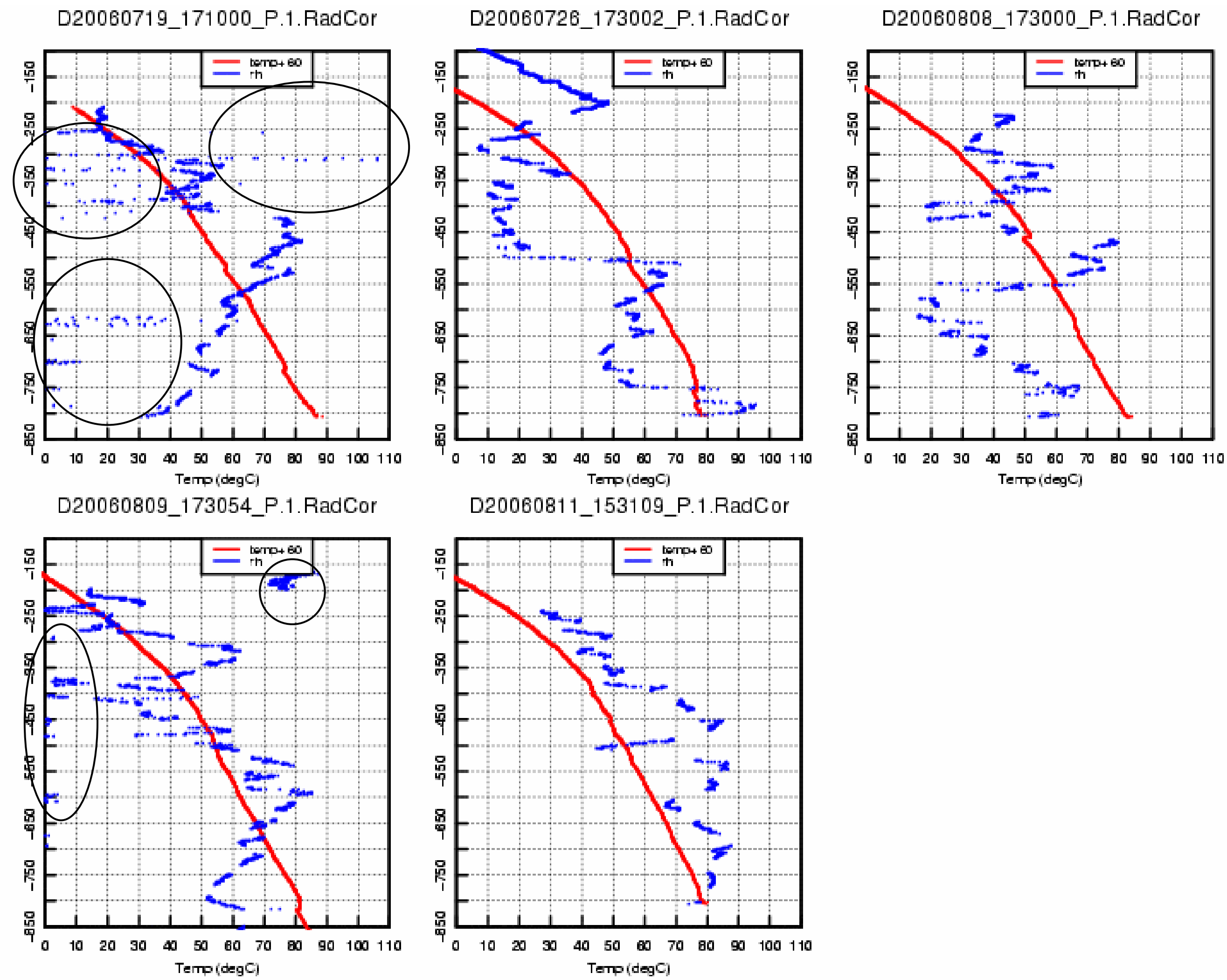


Figure 2 One of two radiosondes hygrometers malfunctioned during each of the five radiosonde flights shown. A 60^{o} offset has been added to the temperature data.

5. The temperature profile from the sounding D20060808_183004, shown below, shows evidence of the wet-bulb effect. The profile between 700 and 650 mb shows the RH sensor reaching saturation. When the radiosonde exits the moist layer and begins to dry, you see a drop in temperature of approximately 5-7^{o} C (Figure 3). This results from water evaporating off of the sensor, and these temperatures are not representative of the actual environment.

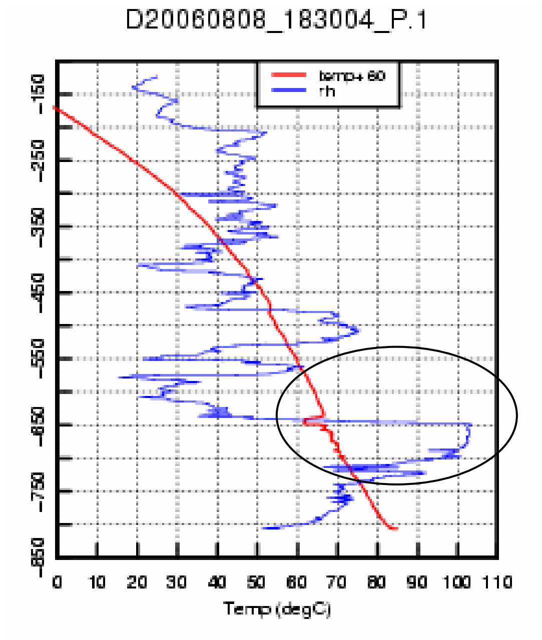


Figure 3 Wet-bulb effect, caused by moisture evaporating from the temperature sensor, is shown in the profile above between 650-700 mb. A 60° offset has been added to the temperature data.

6. Differences between the last radiosonde surface measurement before launch and the surface met sensor measurement (from raw sounding files) can be seen in Figures 4 and 5 below. While these plots are of raw sounding data, to some degree, differences do carry over to the final product. Based upon these plots, close inspection of individual profiles near the surface, and given that the project took place in Arizona in the summer time, large differences in temperature and relative humidity can most likely be attributed to sensor heating of either the radiosonde or the surface met. Consistent differences in pressure can also be seen in the bottom left-hand plots from both mobile 1 and mobile2. The cause of these differences is unknown however, there is suspicion that the surface met pressure sensors may have been slightly off, and this is being investigated.

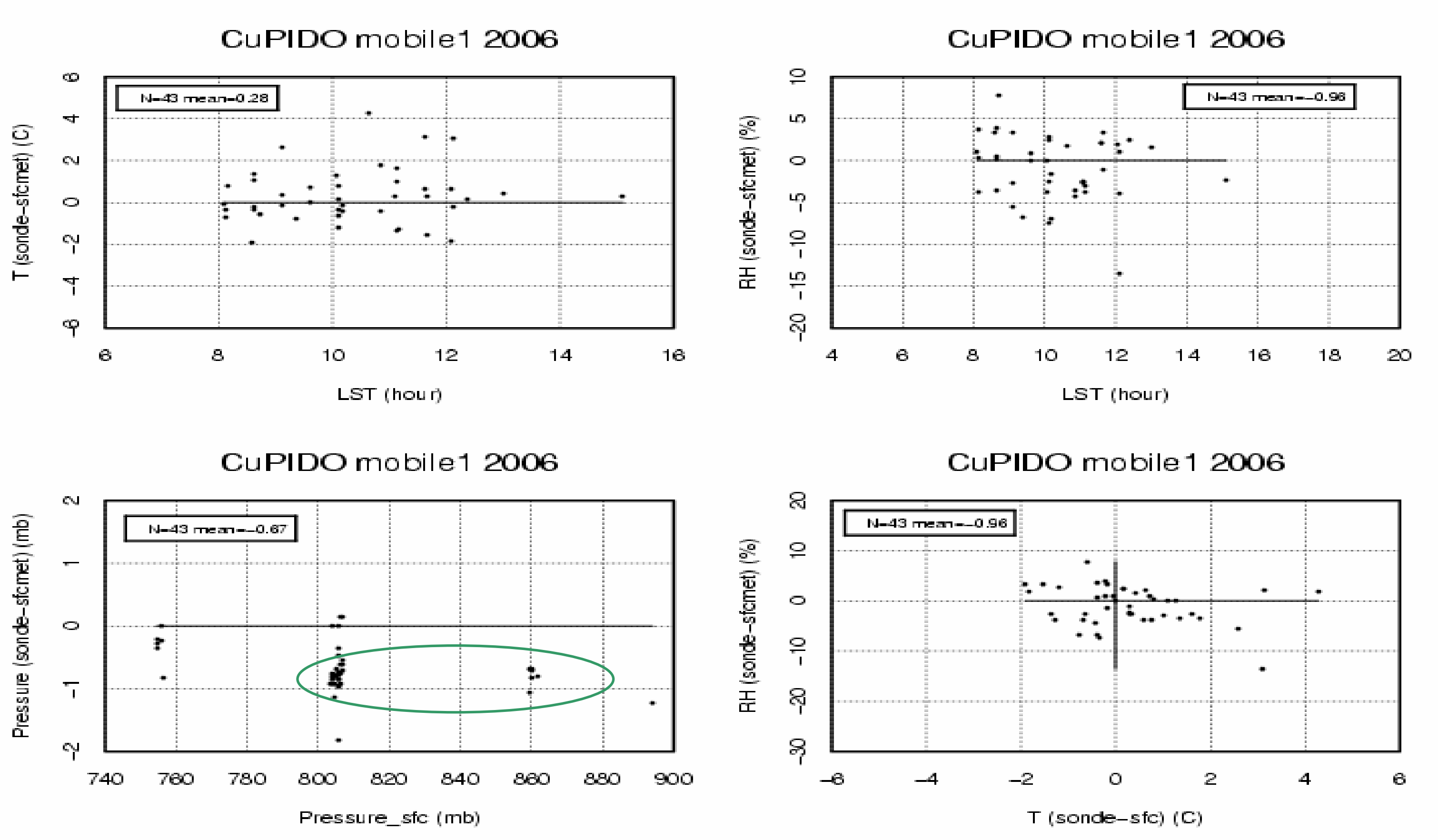


Figure 4 Scatter plots from mobile1 of difference calculated between the last sonde data measurement taken at the surface and the measurements taken by the surface met station. Red circles possibly show small degree of heating and drying of the radiosondes. Green circle shows consistent pressure difference between surface met and sonde.

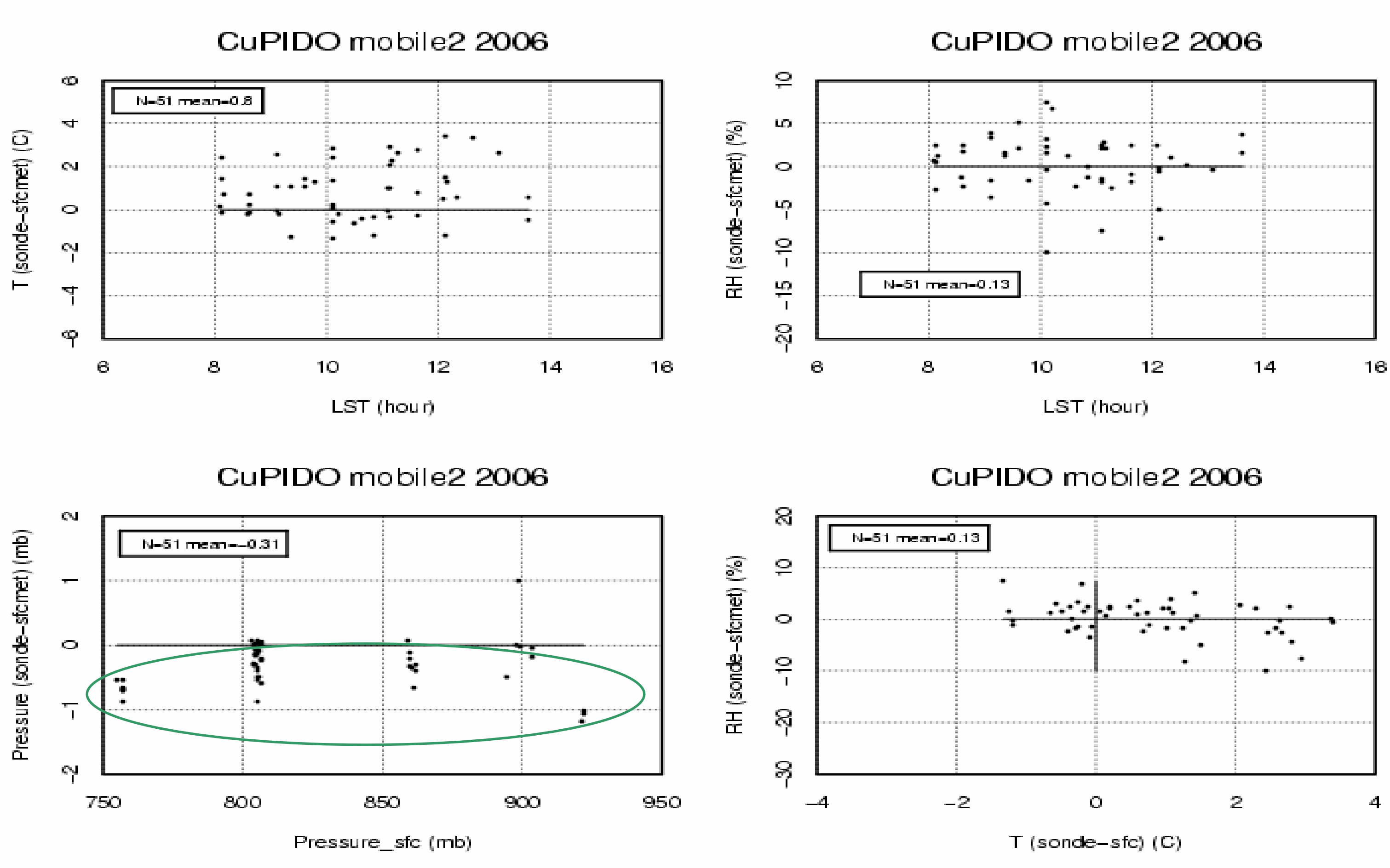


Figure 5 Scatter plots from mobile2 of difference calculated between the last sonde data measurement taken at the surface and the measurements taken by the surface met station. Red circles possibly show small degree of heating and drying of the radiosondes.