AHATS 2008 Quality Controlled Radiosonde Data Set

Contents:

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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/rtf/facilities/iss/
GAUS: http://www.eol.ucar.edu/instrumentation/sounding/gaus

I. ISS Project/Dataset Overview

The Advection Horizontal Array Turbulence Study (AHATS) was the fourth in a series of field campaigns aimed at improving large-eddy simulations (LES) of turbulence close to the Earths surface. The first three Horizontal Array Turbulence Studies (HATS) were, HATS (2002), OHATS (2004) and CHATS (2007). This most recent field campaign, AHATS, took place from May to August 2008 in Kettleman City, CA, the location of the original HATS project. Instrumentation at AHATS included one Integrated Surface Flux System (ISFS) and one Integrated Sounding System (ISS). The ISS was equipped with a UHF boundary layer wind profiler, Radio Acoustic Sounding System (RASS), radiosonde sounding system, and a surface meteorology tower. ISS also deployed a sodar-RASS at the ISFS array three miles downwind of the ISS site. A total of 86 radiosonde soundings were collected during the project, launched from the ISS site.

The NCAR/EOL GPS Advanced Upper-air Sounding system (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 Radiosonde launches were made from the ISS site northeast of Kettleman City, CA.

II. ***New EOL File Format***

EOL has introduced a new ascii “EOL file format” for all radiosonde and dropsonde sounding files. This 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.1QC.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
----   -- -- --  -----  ----  -----  ---  -----  -----  ----- ---- ----- -------  ------ ----- -------
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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. The accuracy of the GPS altitude is approximately 20-30 m and due to the nature of the sensor, the measurement may be quite variable from one point to the next. It is recommended that geopotential altitude be used over the GPS altitude. The 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 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, which could result in a loss of data near the surface 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 (Figure 4) of the raw data are created to check differences in pressure, temperature and RH between independent surface met sensors and the last available surface radiosonde measurement before launch.

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

5. Examination of skew-t diagrams is performed.

6. 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. One sounding (D20080703_051910_P.1QC.eol) experienced failure of one of its two hygrometers. This resulted in gaps of missing data throughout the profile (Figure 2).

2. One sounding (D200816_045658_P.1QC.eol) contains erratic GPS altitude measurements at the beginning of sounding, near the surface (first six points). (Figure 3)

3. Based on the results from the scatter plots (Figure 4), there appears to be either a moist bias of the sondes or a dry bias of the surface met ranging between 2-6 %. While these plots are of raw pre-launch sounding data, to some degree, differences do carry over to the final quality controlled product. The red circle highlights temperature differences during the day time hours between the radiosonde and surface met measurements consistent with sensor arm heating (SAH). In light of the fact that no dry bias in the sondes, usually associated with SAH, is seen in the relative humidity difference plot and because the sondes are consistently more moist during the night time launches, when only very small temperature differences occur, it is apparent that there is either a moist bias of the radiosondes or a dry bias of the surface met sensor. Pressure differences, seen in the lower left, are yet to be explained however, evaluation of the sensors is on-going.

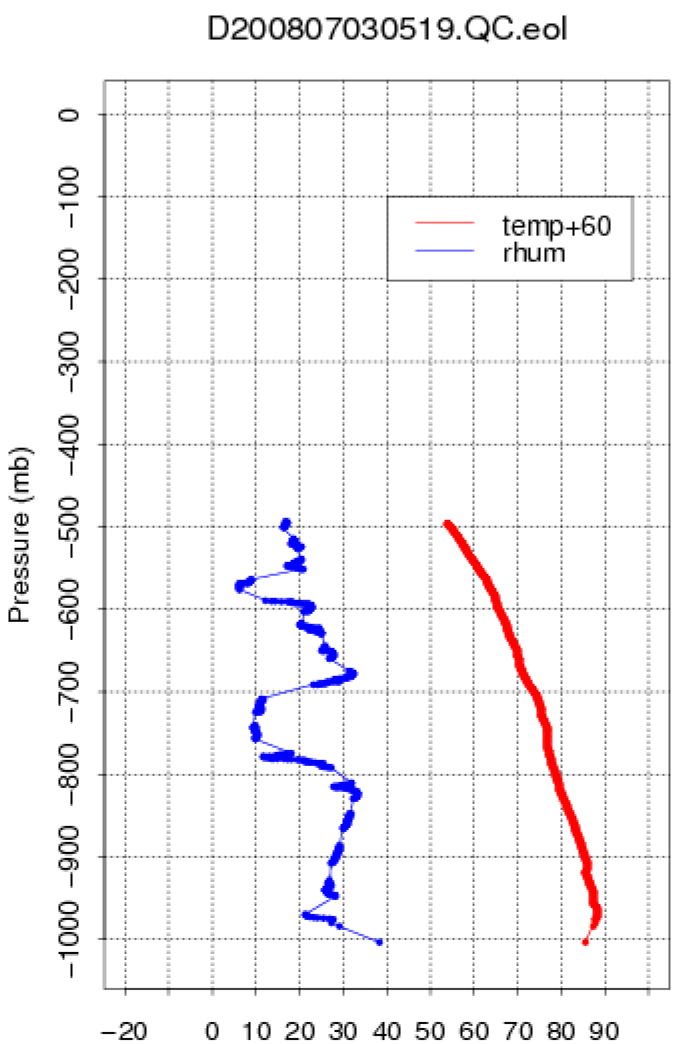

Figure 2. Vertical profiles of relative humidity (%) (blue) and temperature (degC + 60) (red) versus pressure. Radiosondes are equipped with two hydrometers that measure alternately during the radiosondes flight. This figure shows failure of one of the two hygrometers.

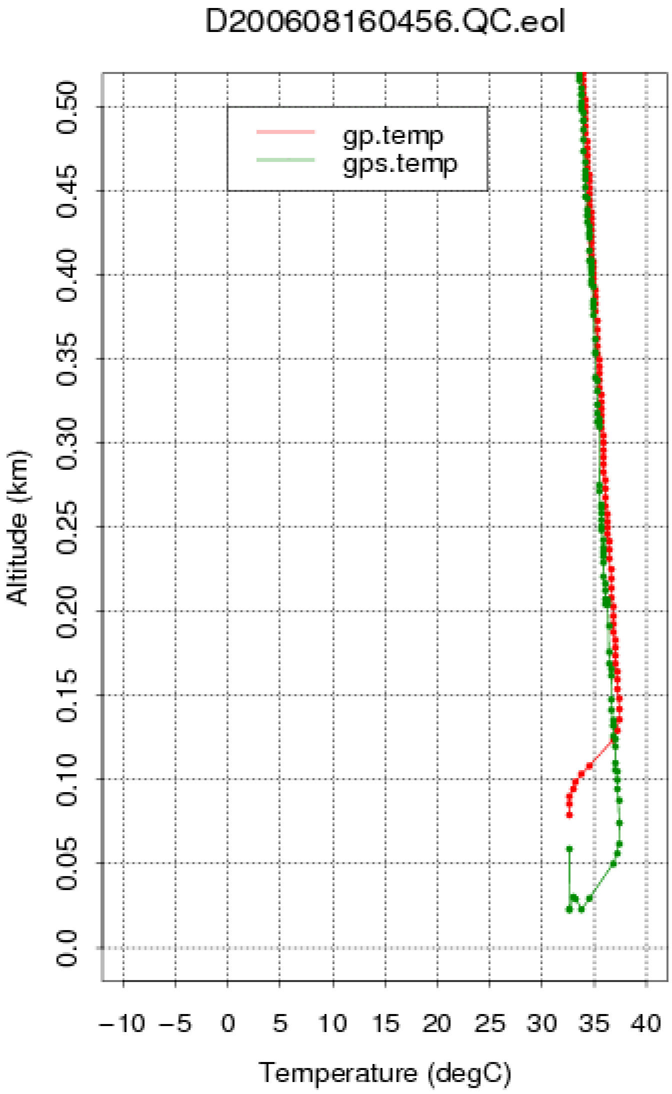

Figure 3. Vertical profiles of temperature, versus both geopotential altitude (red) and GPS altitude (green), show erratic measurements from the GPS sensor near the surface.

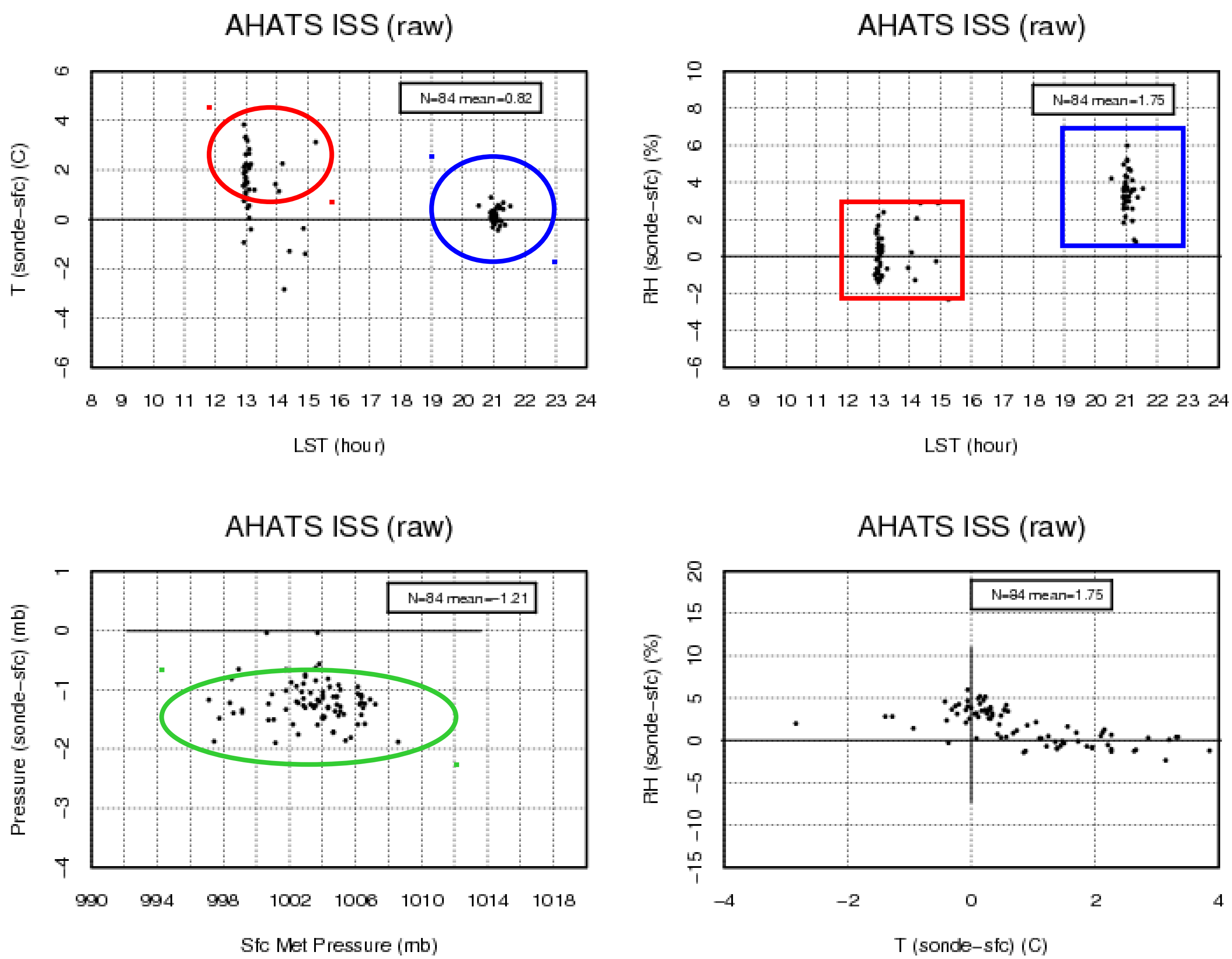

Figure 4. Scatter plots of differences calculated between the last sonde measurement taken at the surface and the measurement taken by the surface met station. The red circle shows evidence of sensor arm heating during the day however, the corresponding daytime RH measurements (red box) show no indication of a dry bias usually associated with sensor arm heating. On the contrary, the night time launches show no indication of any temperature variation (blue circle), but they are consistently more moist then the surface met (blue square). Based on these results, there appears to be a moist bias between 2-6 % in the radisondes. The green circle shows the difference between temperature and pressure measurements, which is currently under investigation.