ISPA 2007 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

Bill Brown
wbrown@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/rtf/facilities/iss/
GAUS: http://www.eol.ucar.edu/facilities/gaus.html

I. ISS Project/Dataset Overview

The Inhibition of Snowfall by Pollution Aerosols (ISPA) was the second phase of a field campaign with the primary objective to better quantify the amount of water in snow pack lost due to pollution aerosols. The first phase of ISPA took place in 2002. The second phase was conducted during January and February 2007. Both phases took place near Steamboat Springs, Colorado. ISPA was organized by the Desert Research Institute (DRI), and the primary site was located on Mount Werner at the Storm Peaks Laboratory (SPL), with an EOL Integrated Sounding System located in town (Figure 1), near the base of the Steamboat Ski Resort. The ISS was equipped with a UHF boundary layer wind profiler, Radio Acoustic Sounding System (RASS), radiosonde sounding system, a surface meteorology tower, and a ceilometer for measuring cloud base heights. A total of 71 radiosonde launches were made from the ISS site, 70 of which are included in the final archive.

The NCAR/EOL GPS Advanced Upper-air Sounding system (GAUS) 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.

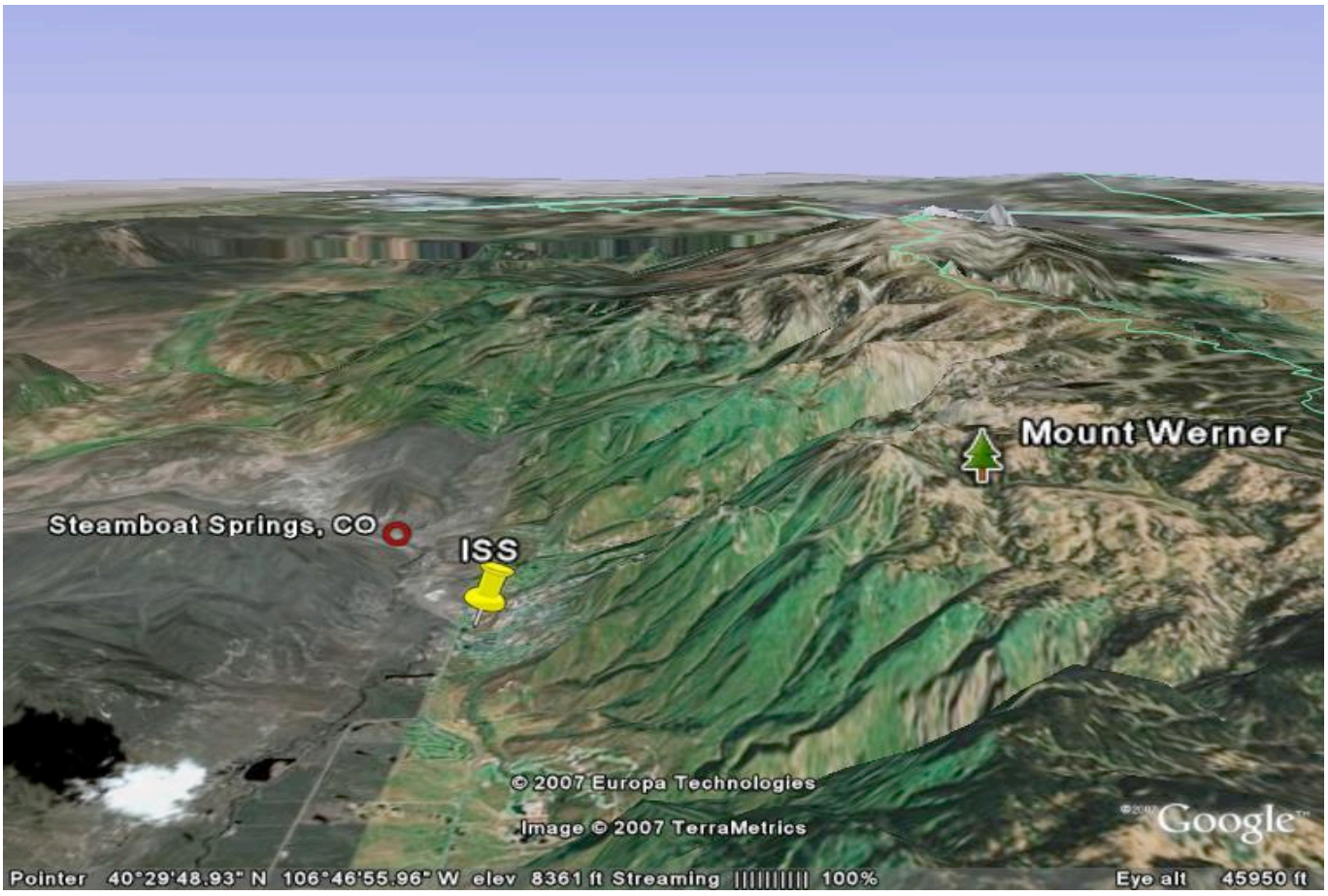

Figure 1 Radiosonde launches were made from the ISS site in Steamboat Springs, CO. This map shows the proximity of the ISS location to DRI's Storm Peak Lab located on Mount Werner.

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.1.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 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 2) 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:

1. One sounding (D20070212_040535_P1.QC.eol) was removed from the final archive because it contained no temperature or relative humidity measurements.

2. Two soundings (D20070107_020024_P.1QC.eol and D2007211_205751_P.1QC.eol) needed repair because the system locked up during flight when the radiosonde traveled behind a mountain, causing a loss of the signal. 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 file; all things necessary in order for ASPEN to run properly. Data before the lock-up 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 a pressure change.

3. Two soundings, listed below, experienced problems with the automatic launch detect. The first sounding needed repair because launch occurred before all steps of the sounding software had been completed. This caused an error in the automatic launch detect, which uses pressure change to determine time of release and requires at least one minute of surface data to accurately detect launch. Some of the data near the surface was lost. For the second file listed, the launch-detect triggered early resulting in an incorrect launch time. The times found in the filenames, and in the headers, were changed to reflect a more accurate launch time.
   D20070210_190619_P1.QC.eol – was previously D20070210_194010_P1.QC.eol
   D20070212_032120_P1.QC.eol – was previously D20070212_031420_P1.QC.eol

4. One sounding (D20070225_000123_P.1.QC.eol) did not contain GPS (latitude, longitude or altitude) data. This sounding is included in the final data archive.

5. Ten soundings were test launches. These files are listed below and all are included in the final dataset.
   D20061128_181240_P.1QC.eol
   D20061218_170023_P.1QC.eol
   D20070110_195812_P.1QC.eol
   D20070127_005231_P.1QC.eol
   D20070127_145116_P.1QC.eol
   D20070127_225833_P.1QC.eol
   D20070128_015746_P.1QC.eol
   D20070203_180936_P.1QC.eol
   D20070209_000115_P.1QC.eol
   D20070213_163423_P.1QC.eol

6. Differences between the last radiosonde surface measurement before launch and the surface met sensor measurement can be seen in Figure 2 below. While these plots are of raw sounding data, to some degree, differences do carry over to the final product. The green circles highlight relatively consistent differences between the radiosonde and surface met measurements. The temperature and relative humidity differences, seen in the top two plots, are likely a result of the radiosonde being prepared inside a heated trailer and then brought outside into snowy conditions before release. The operators took care to allow some time for the radiosonde sensors to adjust to the environment, prior to launch, however significant differences can still be seen. Pressure differences seen in the lower left may be attributed to the barometer on the surface met tower being mounted at an elevation slightly higher then where the radiosondes were placed prior to launch. There appears to be no directcorrelation between pressure and temperature differences (Figure 3). The surface met pressure measurement of 824 mb, circled in red, came from a test flight performed in Boulder before the project began.

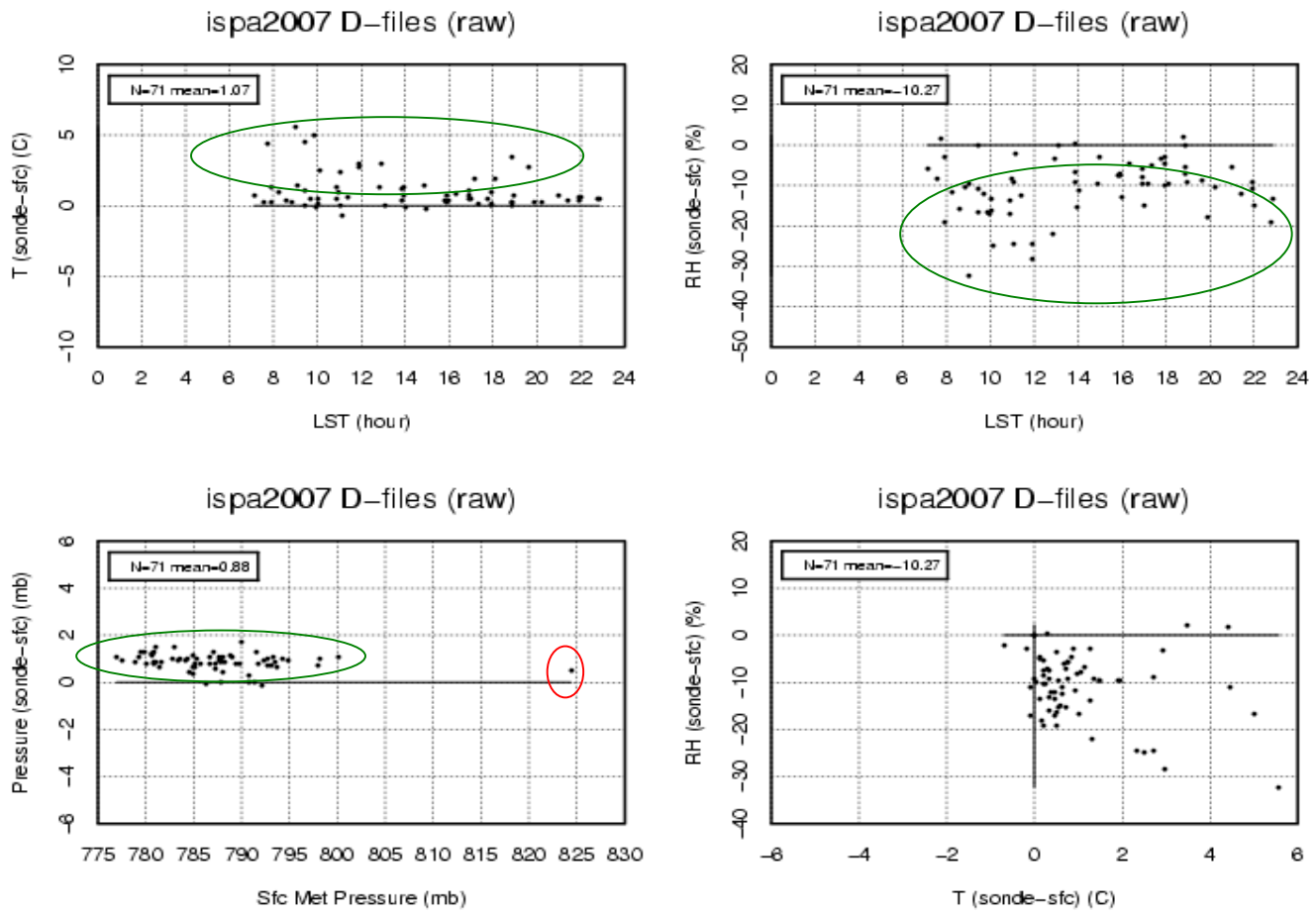

Figure 2 Scatter plots of differences calculated between the last sonde data measurement taken at the surface and the measurements taken by the surface met station. Green circles show difference between temperature and pressure measurements. The red circle shows measurements from a test flight likely released in Boulder, CO before the project began.

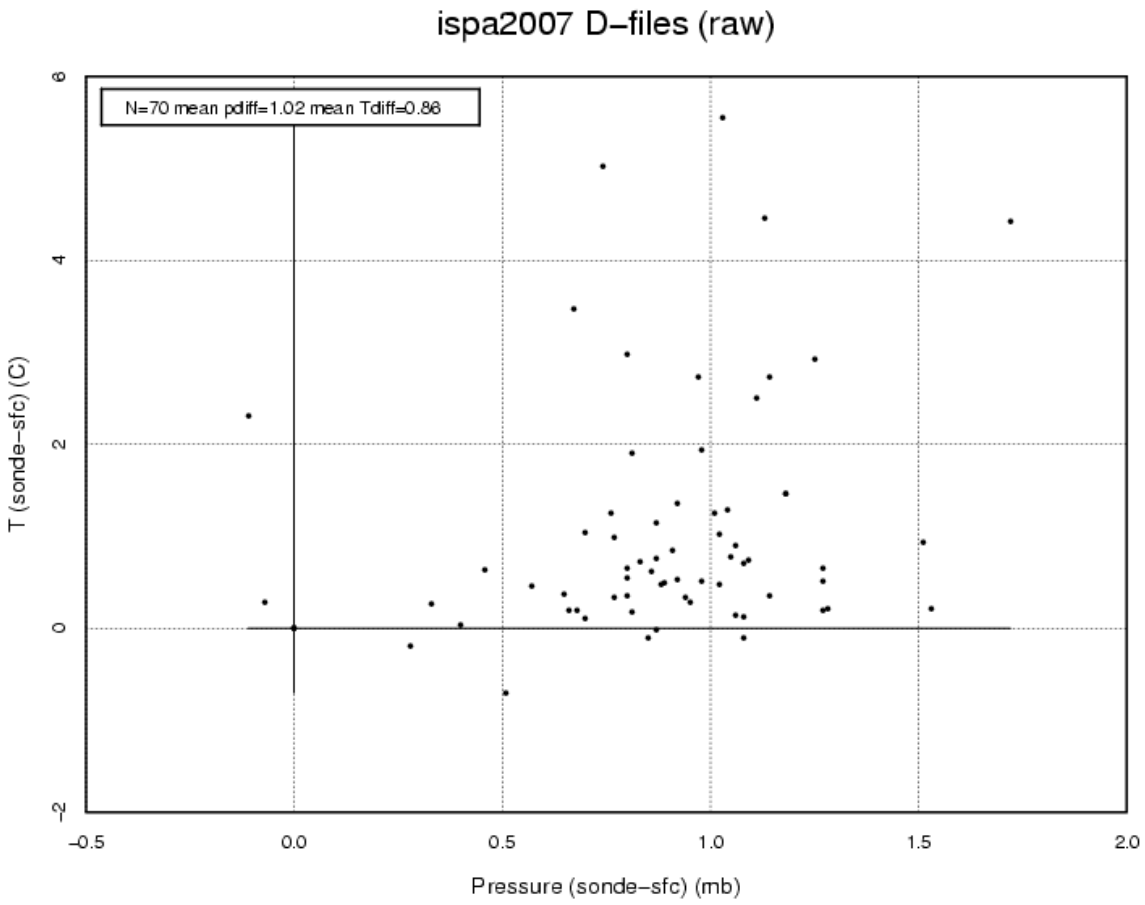

Figure 3 Pressure differences (radiosonde-surface), in millibars, versus temperature differences (radiosonde-surface), in degrees Celsius, show no correlation indicating that the colder temperatures measured at the surface met station were a result of lower pressure measurements.