CLIVAR KESS 2006 Quality Controlled Radiosonde Data Set

Contents:

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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 Climate Variability and Predictability (CLIVAR) Project is an international, multi-agency campaign aimed at understanding the physical processes responsible for climate variability and predictability. The Kuroshio Extension Sytem Study (KESS) is a subset of the CLIVAR program and is a collaborative effort between the Woods Hole Oceanographic Institution, the University of Rhode Island, and the University of Hawaii. The purpose of KESS is to understand the processes that govern the variability of, and the interaction between the warm, northward-flowing waters that leave the Japanese coast to flow eastward into the North Pacific, also known as the Kuroshio Extension, and its recirculation gyre, the large oval current system to the south of the extension. For this study NCAR/EOL deployed a sounding system on a ship off of the coast of Japan, east of the Yokohama port. The soundings were made at various locations among the surface buoys marked by red diamonds on map below (Figure 1). One hundred and forty-eight radiosonde launches were made from the ships deck between May 29 and July 4, 2006. For more information in the CLIVAR project please visit: http://www.clivar.org/index.php or for additional information on KESS please visit: http://www.po.gso.uri.edu/dynamics/KESS/

The sounding system deployed 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.

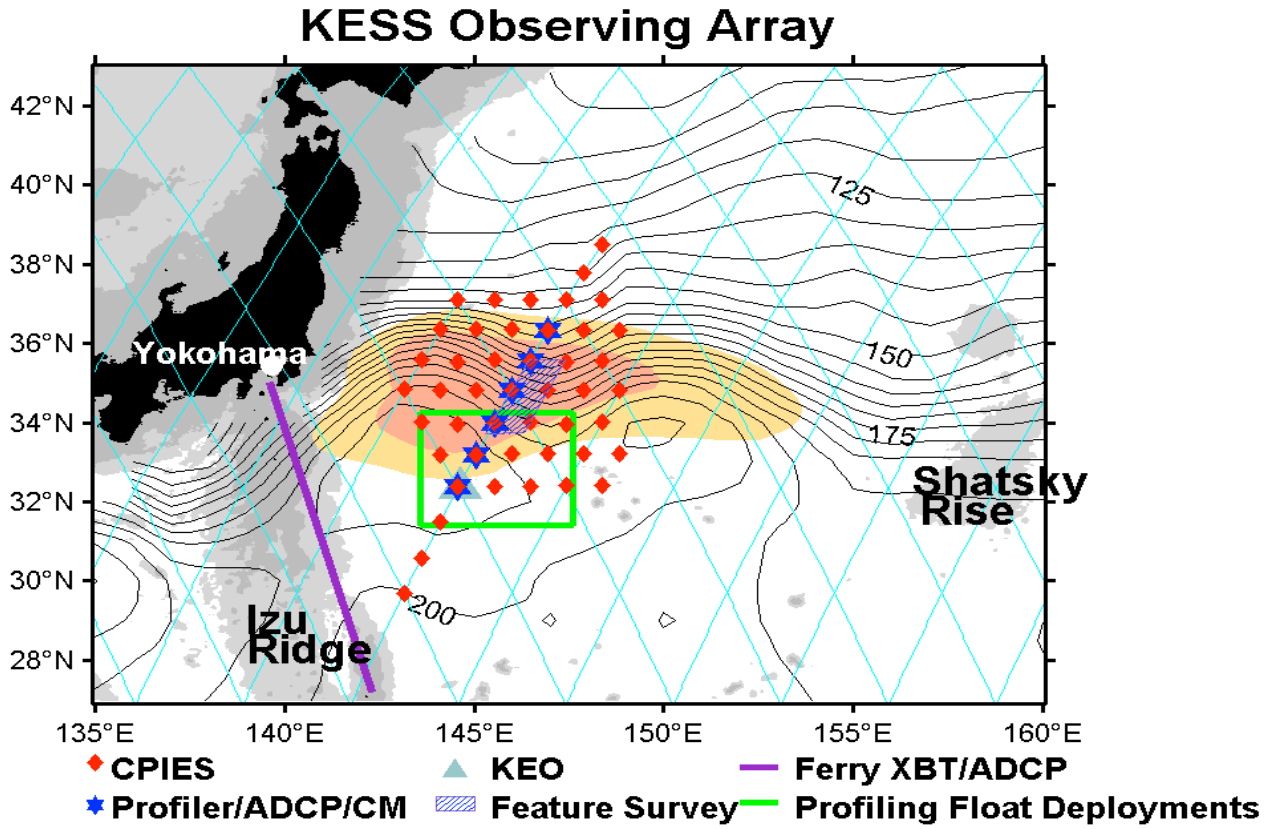

Figure 1 Map of area off Japanese coast where radiosondes were deployed among surface buoys (red diamonds) for the KESS experiment deployed by PMEL/NOAA

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	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 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. The geopotential altitude is calculated from the hydrostatic equation using pressure, temperature, and relative humidity. The rate of ascent calculated, but the position (lat, lon, GPSAlt) come directly from the GPS sensor. All wind data are computed from GPS navigation signals received from the radiosonde. The raw wind values are calculated at a one second data rate by a commercial processing card. These raw values are subjected to a digital filter to remove low frequency oscillations due to the sonde pendulum motion beneath the balloon.

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 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 then 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 CLIVAR KESS data we found that:

1. Twenty 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 (typically above 100 mb) has been lost. Filenames for these soundings were changed to reflect the actual launch time determined by the pressure change.

2. There were five test launches performed before the project officially began. Only one of these, D20060529_102849_P.1QC.eol, contained any data. **This sounding is included in the final archive.**

3. There were three soundings, D20060607_053000, D200609_233035 and D20060611_112959, with no pressure, temperature or humidity above 850 mb. The first radiosondes balloon popped early. The reason for the other two failures is unknown.

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 one humidity sensor malfunctioned during sounding D20060613_112749 (Figure 3). One RH sensor measured at or close to 100% while the other measured around 70%. We were unable to determine which sensor to trust so **we recommend that the relative humidity measurements from this sounding not be used.**

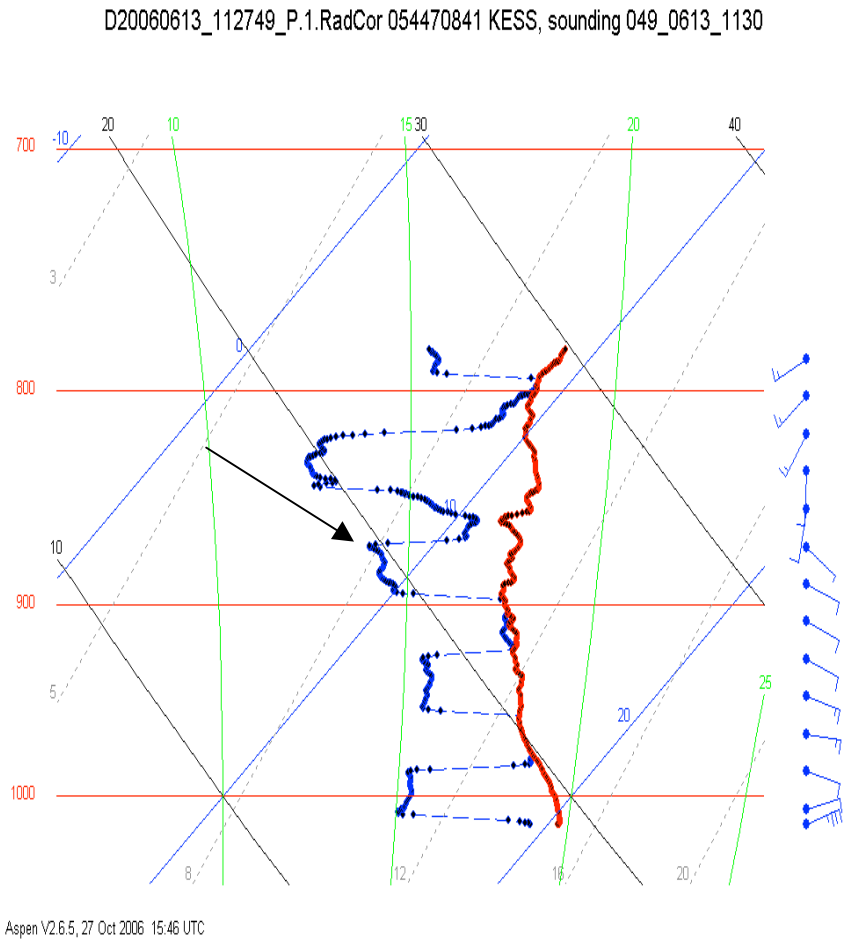

Figure 3 – One of two radiosondes hygrometers malfunctioned during flight.

5. The temperature and RH sensors on one radiosonde froze in mid-flight (D20060622_2334). At 544 mb the temperature suddenly dropped from -7° C to -60° C and RH increased to well above 100%. For this sounding, temperatures and relative humidities above this height were changed to missing values (Figure 4).

Humidity
profile

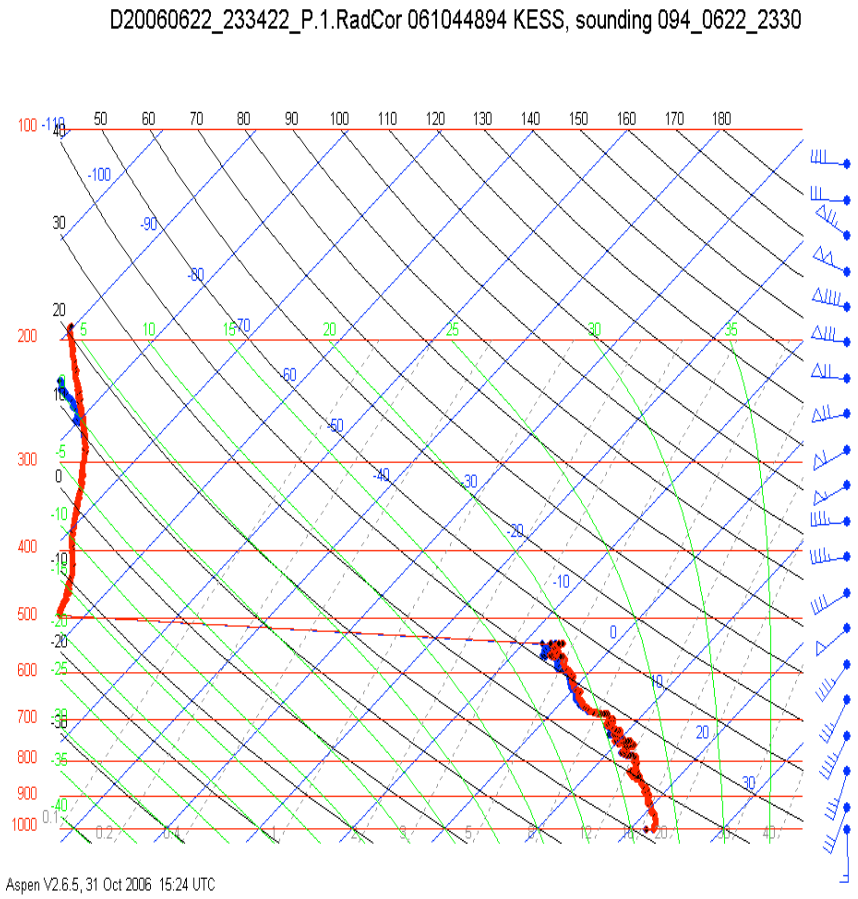

Figure 4. Freezing of temperature and RH sensors are shown in profile above 600 mb.

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 5 below. Red circles indicate extreme differences and possible explanations are provided below. While these plots are of raw sounding data, to some degree, differences do carry over to the final product. In the upper most plots, temperature and RH from the radiosonde are slightly warmer (~1-2 deg) and drier than the surface instruments. We suspect the difference in temperature and relative humidity is a result of the radiosondes being launched from the rear deck of the ship over a metal plated platform where heating may have taken place. Large differences may also reflect that the surface met sensors were located in the bow of the ship some distance from the radiosonde, and may have been moistened by sea spray, while launches of the sondes were done on the rear of the ship.

1. The small red circles in the temperature, RH and pressure plots were a result of a late launch detect where data near the surface for one sounding was lost. Pressure difference for this sounding was -575.88 mb and that values is not shown on the bottom left hand plot.
2. The large red circle on the RH plot (upper right) **may** have been caused by wetting of the radiosondes RH sensors. These sondes were all launched at the beginning of the project between May 29 and June 3. After that date the problem disappeared. This leads us to believe that the initial launch location may have put the sondes in contact with moisture,

possibly sea spray, and that when the cause of the bias was discovered the launch location was moved.

3. The reason for the pressure difference of 10.22 mb seen in the bottom left hand plot is unknown.

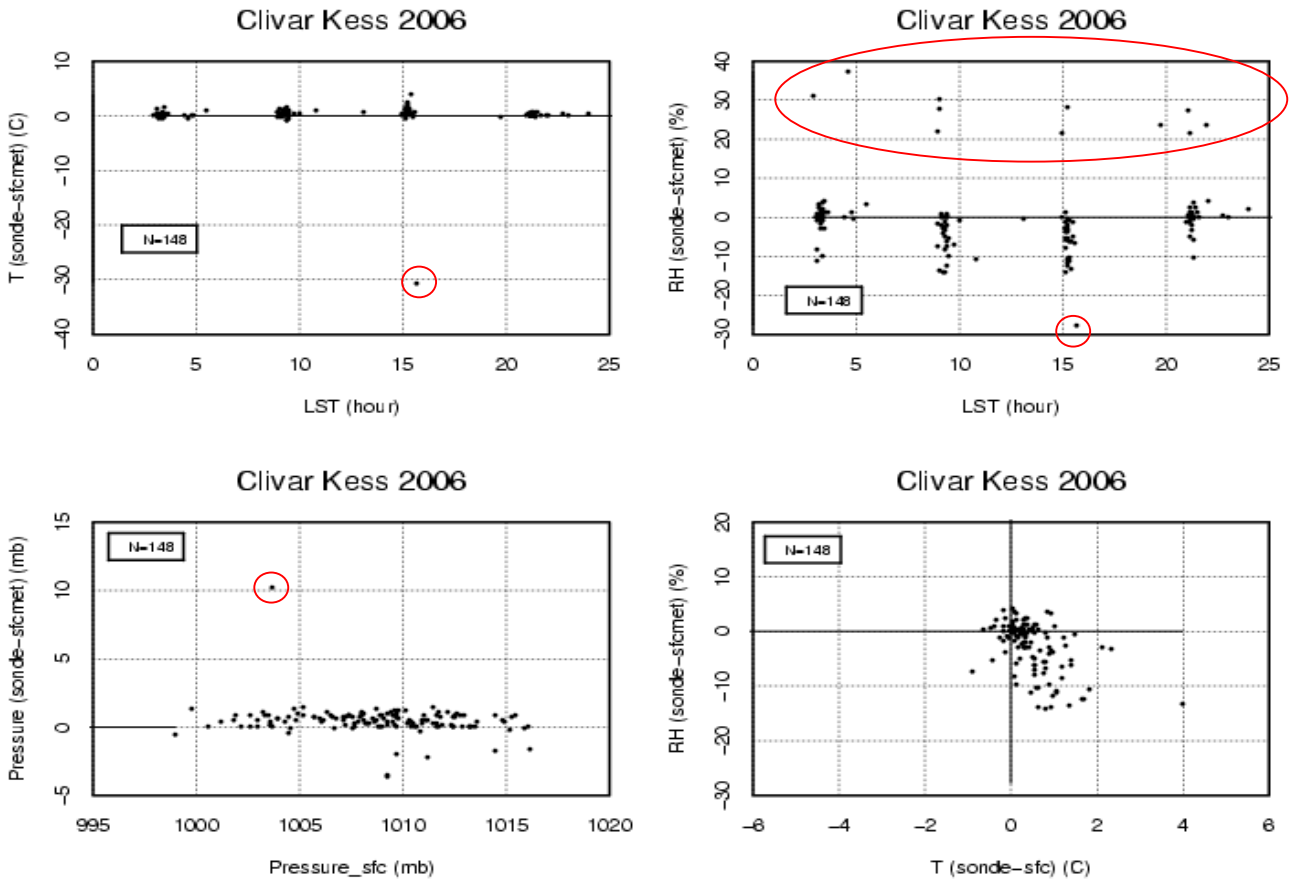

Figure 5. Scatter plots of difference calculated between the last sonde data measurement taken at the surface and the measurements taken by the surface met station.