Meteor Crater Experiment II

METCRAX II 2013 Radiosonde Data Quality Report

March 12

2014

The radiosonde data for this project were quality controlled and are maintained by the Earth Observing Laboratory at the National Center for Atmospheric Research (NCAR). NCAR is sponsored by the National Science Foundation (NSF). In the event that information or plots from this document are used for publication or presentation purposes, please provide appropriate acknowledgement to NSF and NCAR/EOL and make reference to Young, K., J. Wang, W. Brown and D. Lauritsen, 2014: METCRAX 2013 quality controlled radiosonde data set. Available at ??? (add the link once it is available)

Meteor Crater Experiment II (2013)
Quality Controlled Radiosonde Dataset

*National Center for Atmospheric Research**
Earth Observing Lab
Boulder, Colorado

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

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I. Dataset Overview

The Meteor Crater Experiment II (METCRAX II) is a 4-year meteorological research program conducted approximately 35 miles East of Flagstaff AZ (Figure 1). This campaign was designed to investigate short-lived high wind and turbulence events on the west sidewall of the crater. These features were unexpectedly observed by researchers during METCRAX I, which was aimed at investigating the structure and evolution of temperature inversions or cold-air pools that form in topographic basins and valleys. For this most recent phase of the project, NCAR/EOL deployed one Integrated Sounding System (ISS), one GPS Atmospheric Sounding System (GAUS) and four surface met towers. For more information on the towers please visit, https://www.eol.ucar.edu/field_projects/metcraxii.
The sounding system was located approximately .6 miles Southeast of the Crater (Figure 2). Fifty-two radiosonde launches were performed from between October 6 and October 27, 2013. This document contains information on the sounding file format, data parameters included in each of the files, and details regarding the quality control measures applied to the sounding data set.

For more information on the METCRAX II project please visit:
http://www.inscc.utah.edu/~whiteman/metcrax2/

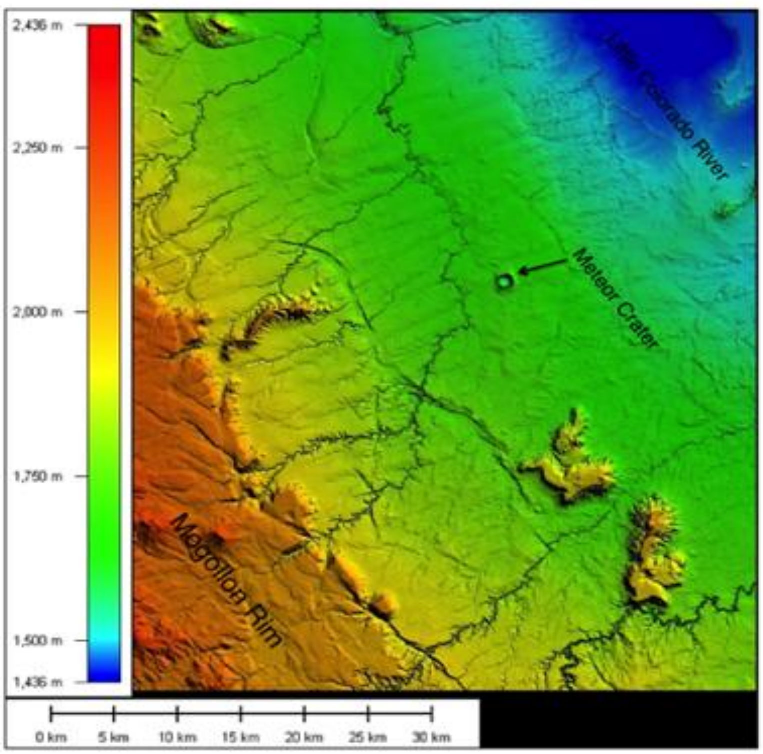

Figure 1. Topography of the Meteor Crater region. Southwest of the crater is the Mogollon Rim, a high altitude ridge of mesas (adopted from Univ of Utah METCRAX2 webpage).

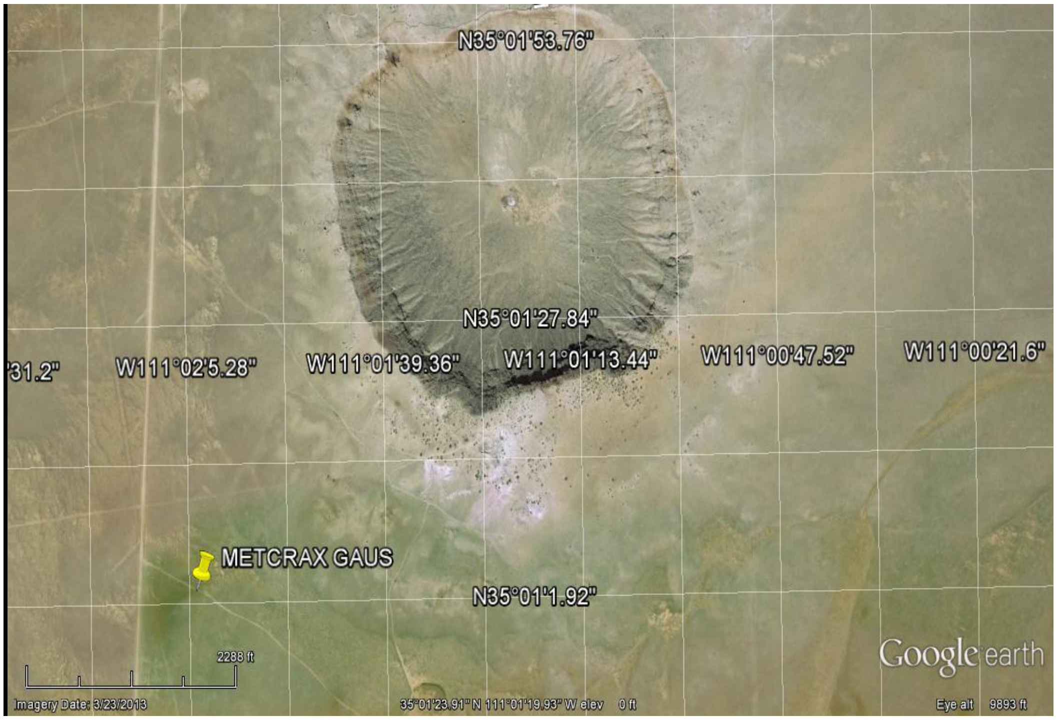

Figure 2 Map of GAUS radiosonde site located Southwest of Meteor Crater

II. EOL Sounding File Format and Data Specifics

The EOL format is an ASCII text format that includes a header (Table 1), with detailed project and sounding information, and seventeen columns of high resolution data (Table 2). The "QC.eol" 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.PreCorr.SRcorr.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 "QC.eol" refers to the EOL file format type.

The header contains 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 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.

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 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 ENvironment (ASPEN) software. The quality of the GPS altitude is somewhat questionable. The accuracy of the sensor is typically +/-20 m, and may show large variability. For this reason, investigators are encouraged to use geopotential altitude over GPS altitude.

Table 1 - EOL Sounding File Format (dropsonde and radiosonde)

```
Data Type/Direction:                    GAUS SOUNDING DATA/Ascending
File Format/Version:                    EOL Sounding Format/1.1
Project Name/Platform:                  METCRAX2/NCAR GAUS
Launch Site:                            IOP 01
Launch Location (lon,lat,alt):          111 02.07'W -111.034537, 35 01.05'N 35.017525,  1694.08
UTC Launch Time (y,m,d,h,m,s):          2013, 10, 06, 23:06:45
Sonde Id/Sonde Type:                    001533514/Vaisala RS92-SGP (ccGPS)
Reference Launch Data Source/Time:      Campbell Scientific CR10/23:06:44.00
System Operator/Comments:               Tim and Kate/iop #1 sounding #1, Good Sounding
Post Processing Comments:               Aspen Version 3.1; Created on 20 Feb 2014 18:20 UTC; Configuration upsonde-1s
/
  Time  -- UTC  --   Press    Temp   Dewpt     RH    Uwind   Vwind    Wspd     Dir      dZ  GeoPoAlt      Lon         Lat      GPSAlt  Wwind  Wwind_f
   sec  hh mm   ss     mb       C       C       %     m/s     m/s     m/s     deg     m/s       m        deg         deg          m     m/s     m/s
-------- -- -- ----- ------- ------- ------- ------- ------- ------- ------- ------- ------- -------- ----------- ----------- -------- ------ --------
```

Table 2 - Lists data fields provided in the EOL format ASCII soundings

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	Descent Rate	Meters/Second	Calculated
14	Geopotential Altitude	Meters	Calculated
15	Longitude	Degrees	Measured
16	Latitude	Degrees	Measured
17	GPS Altitude	Meters	Measured

III. Data Quality Control Process

1. **1.** Profiles of raw temperature, relative humidity, wind speed and ascent rate versus pressure are first examined to determine if there are problematic sounding files which could be a result of malfunctioning of the launch detect, sounding system lock-up (a result of weakening of the sonde signal in flight), sensor failure, sensor offsets or biases, and slow radiosonde ascent rates (can result in RH errors). Corrections are made where possible to address these specific problems.

2. **2.** Scatter plots 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 to find biases in the radiosonde data (Figure 3). These plots allow us to determine if the ground check pressure correction (see #4 below) is needed, and they allow us to investigate large differences in temperature and relative humidity.

3. **3.** All of the data files were adjusted to correct initial geopotential surface heights. A geometric surface height, from the site, was obtained from Google Earth. This height was then converted to geopotential height, by taking into account latitude at the site location. This ensures an accurate starting point for the geopotential altitude calculation.

4. **4.** A pressure ground check (GC) correction is applied to the entire profile for most soundings (see exceptions in table below). The surface pressure measured by an independent surface sensor is used as a reference for the correction. The corrected pressure $P = P^{RS} * P_0^{REF} / P_0^{RS}$, where P^{RS} is the pressure measured by radiosonde, P_0^{REF} is the ground check pressure as indicated by the reference sensor, and P_0^{RS} is the ground check pressure as indicated by the radiosonde on the ground.

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

6. **6.** The raw soundings are processed through Batch ASPEN, which analyzes the data, performs smoothing, and removes suspect data points.

7. **7.** Profiles of quality controlled temperature, RH, wind speed and wind direction versus geopotential altitude are examined. These enable us to visually evaluate the final data product for outliers, or any other obvious problems that may have previously gone undetected.

IV. Special Problems to Note (Important Information for Users)

Performing the quality control procedures outlined above allows us to identify and, in many cases, resolve issues that could potentially impact research performed using these data sets.

The following issues were found, and where necessary, corrections were applied:

1. One file, D20131027_114331, experienced brief data loss near the surface as a result of the launch taking place before all steps of the sounding computer software had been completed. As a result, the time indicated in the filename is the time at which the first sonde data point was collected and not the time of the

actual launch. Due to the fact that there is no surface met data (because actual time of launch is unknown) and no prelaunch radiosonde data, no ground check pressure correction could be applied.

2. One sounding, D20131024_050033, was found to have bad RH measurements, with a significant offset between the two hygrometers. All RH measurements were removed and replaced with missing values.

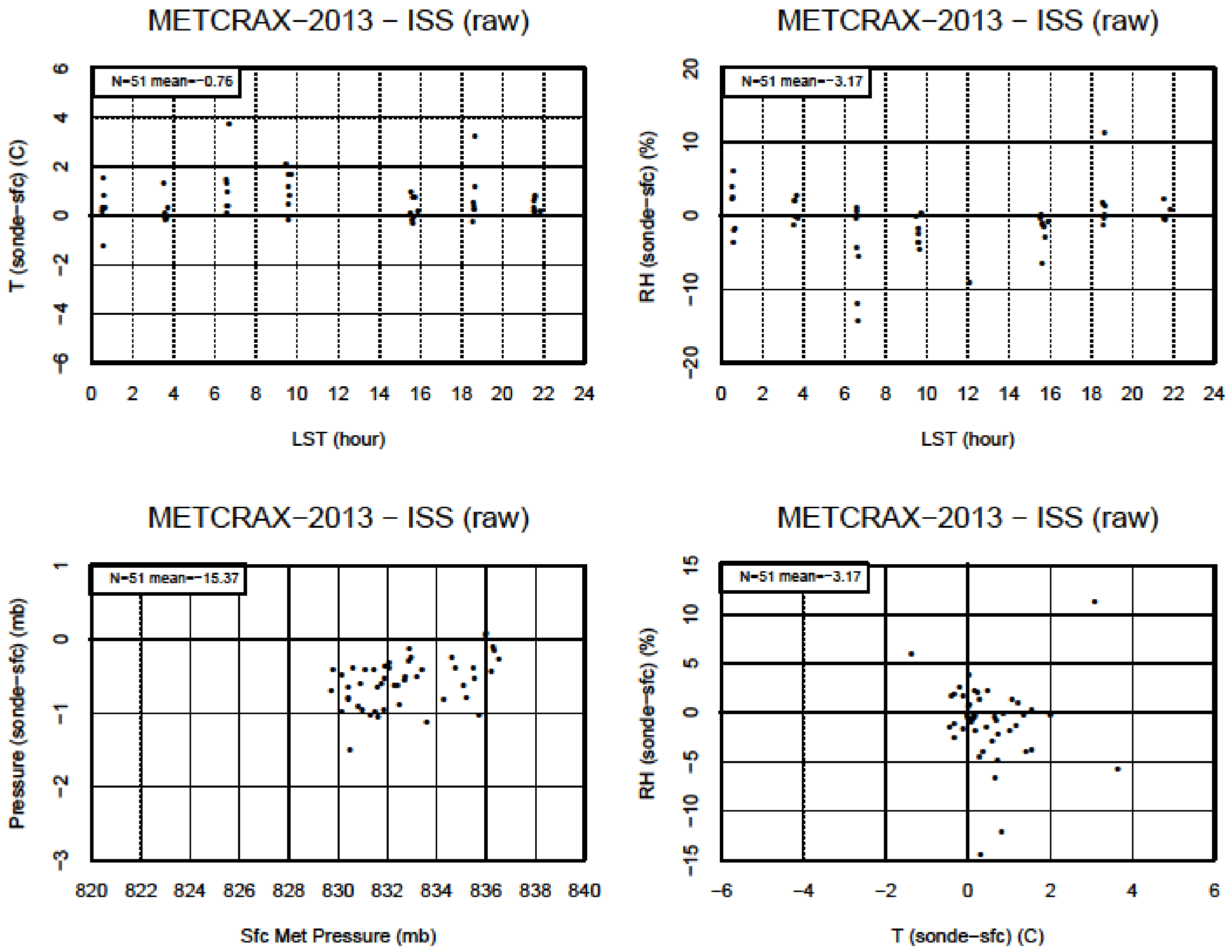

Figure 3 Plots above show measurement differences between prelaunch surface radiosonde and an independent surface met station. The upper left-hand shows differences in temperature, upper right shows RH differences, and lower left shows systematic pressure offsets in the of ~.5 mb (before correction), and lower right shows no correlation between Tdiff and RHdiff.