AgI Seeding of Clouds Impact Investigation

ASCII 2012 Radiosonde Data Quality Report

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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 et al. (2012, J. Wang, W. Brown and D. Lauritsen: ASCII 2012 quality controlled radiosonde data set.)

AgI Seeding of Clouds Impact Investigation (ASCII) 2012 Quality Controlled Radiosonde dataset

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Contents

List of Tables

List of Figures

I. Dataset Overview

AgI Seeding of Clouds Impact Investigation (ASCII) was one project in a series of multi-season field campaigns, all part of the Wyoming Weather Modification Pilot Program, aimed at studying randomized cloud seeding. ASCII was conducted over the Sierra Madre mountain range, in Southern Wyoming, and employed the use of the Wyoming King Air Aircraft, equipped with both a cloud radar and a cloud lidar, a dual-polarization Doppler on Wheels (DOW) scanning radar, a profiling Micro-Rain Radar (MRR), and a NCAR GPS Advanced Upper-Air Sounding (GAUS) radiosonde system. A total of 50 Vaisala RS92 radiosondes were launched between January 7 and March 3, 2012 (Fig. 1). All 50 sounding are contained in the final quality controlled data archive.

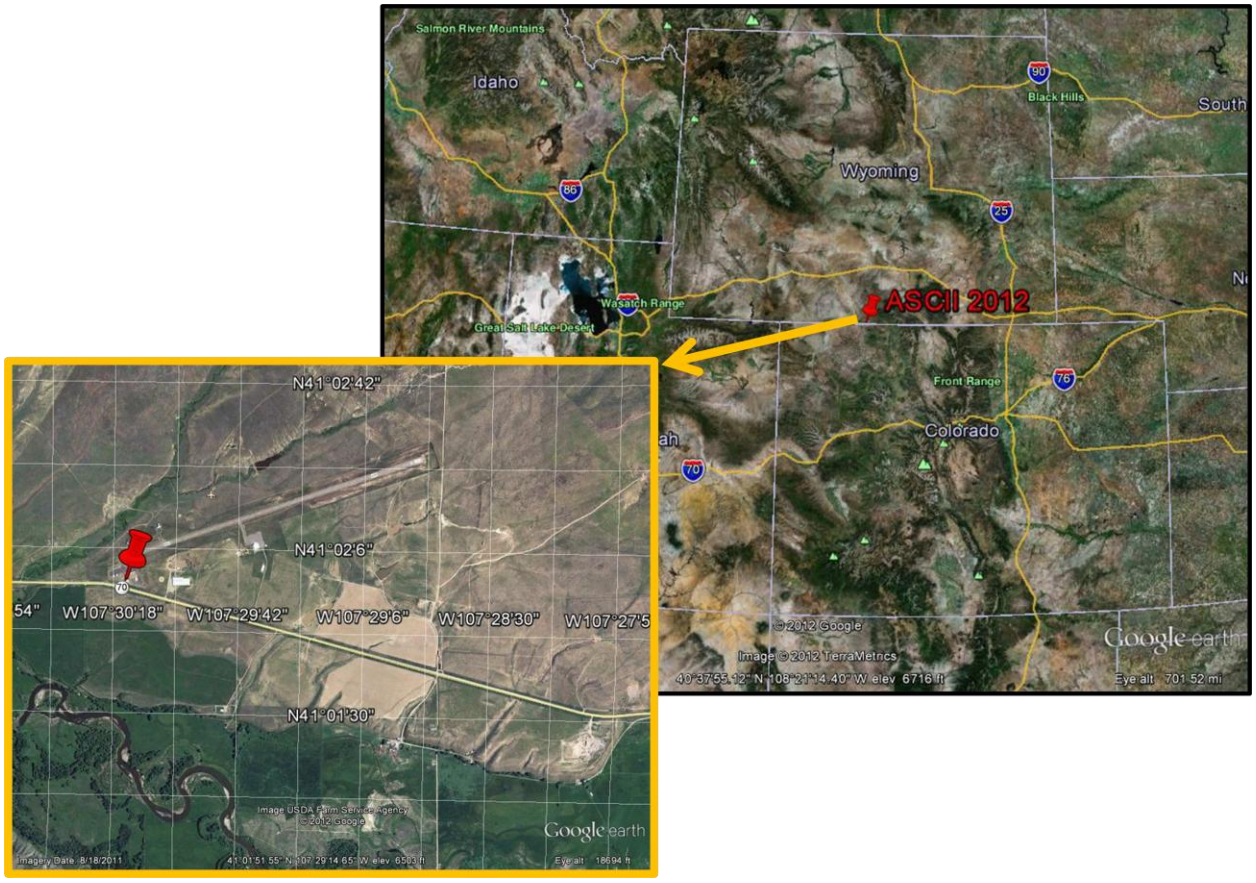

Fig. 1 Aerial map of ASCII radiosonde GAUS site west of Sierra Madre Mountain Range in Southern Wyoming.

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.QCeol" 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:                  ASCII/NCAR GAUS
Launch Site:                            Dixon Airport
Launch Location (lon,lat,alt):          107 30.2375'W -102.503958, 41 01.9894'N 41.033157, 1987.3m
UTC Launch Time (y,m,d,h,m,s):          2012, 02, 28, 22:29:42
Sonde Id/Sonde Type:                    001813998/Vaisala RS92-SGP (ccGPS)
Reference Launch Data Source/Time:      PAM station/22:29:42
System Operator/Comments:               Binod and Joe/Windy, cloudy and no snow
Post Processing Comments:               Aspen Version 3.1; Created on 08 Aug 2012 15:11 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. 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. Corrections are made where possible to address these specific problems.

2. All of the 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.

3. A pressure ground check (GC) correction is applied to the entire profile for each sounding. 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.

4. 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.

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

6. 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. The soundings listed below experienced errors with the automatic launch detect. The launch detect mechanism relies on change in pressure to determine when the balloon release occurs. In some instances the launch detect can be incorrectly triggered early, as was the case with fourteen soundings listed below (in black), or it can trigger late if an insufficient amount of pre-launch surface data is collected prior to launched (files listed in red). These sounding files have all been corrected to reflect the accurate time of launch.

Original Filename	New Filename
D20120116_141442_P.1	D20120116_141407_P.1
D20120120_151603_P.1	D20120120_151615_P.1
D20120211_023057_P.1	D20120211_023023_P.1
D20120211_043100_P.1	D20120211_043117_P.1
D20120213_022943_P.1	D20120213_023006_P.1
D20120213_045539_P.1	D20120213_045553_P1
D20120213_070013_P.1	D20120213_070034_P.1
D20120213_220051_P.1	D20120213_220100_P.1
D20120215_013036_P.1	D20120215_013050_P.1
D20120215_191707_P.1	D20120215_191720_P.1
D20120221_212017_P.1	D20120221_212033_P.1
D20120221_223024_P.1*	D20120221_224623_P.1

D20120222_141741_P.1*	D20120222_135550_P.1
D20120222_153033_P.1*	D20120222_151541_P.1
D20120222_163510_P.1	D20120222_163522_P.1
D20120228_211127_P.1	D20120228_211146_P.1
D20120229_153107_P.1	D20120229_153129_P.1

*Red indicates late launch detect
*Black indicates early launch detect

2. For the following soundings the surface met pressure, temperature and RH data was replaced with surface radiosonde data collected prior to launch. On Feb 13, 14 and 15 the surface met station failed to report temperature and RH. Pressure and temperature are both needed for the geopotential altitude calculation, so this information was obtained from the radiosonde.

Pre-launch Sonde Data Replaced Missing Surface Met Data		
D20120213_001510_P.1	D20120213_193007_P.1	D20120215_000007_P.1
D20120213_022943_P.1	D20120213_204509_P.1	D20120215_013036_P.1
D20120213_045539_P.1	D20120213_220051_P.1	D20120215_191707_P.1
D20120213_070013_P.1	D20120214_223009_P.1	

3. The following sounding files needed repair because they experienced sounding system lock-up caused by weakening or loss of the radiosonde signal. The original sounding files were not saved in the correct format or to the correct file names. They contained no LAU (launch) or A00 (surface met) data lines, and were missing the standard 19 line tail at the end of the raw data file; all things necessary in order for ASPEN to run properly. Data before the lock-up was preserved, however anything measured by the radiosonde after the lock-up was lost. Filenames for these soundings were changed to reflect the actual launch time, determined by pressure change and GPS dz/dt, and surface met data collected just prior to launch was retrieved and entered into the sounding files.

New Filenames with Corrected Launch Times	
D20120213_001510_P.1	D20120119_030454_P.1