Deep Convective Clouds and Chemistry Experiment

DC3 2012 Radiosonde Data Quality Report

December 21

2012

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: DC3 2012 quality controlled radiosonde data set.)

Deep Convective Clouds & Chemistry Experiment 2012 Quality Controlled Radiosonde Dataset

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I. Dataset Overview

The Deep Convective Clouds and Chemistry Project (DC3) was a field campaign aimed at investigating the impact of deep, mid-latitude continental convective clouds, including their dynamical, physical, and lightning processes, on upper tropospheric (UT) composition and chemistry (Fig. 1). The NSF/NCAR Gulfstream-V (GV) aircraft was the primary platform to study the high altitude outflow of the storms. The project also employed the use of the DLR Falcon, the NASA DC-8, a network of ground-based radar, as well as lightning mapping arrays. Two NCAR sounding systems were also deployed to Northern Colorado from May to July 2012 (Fig 2). The Mobile Integrated Sounding System (MISS) was a stationary system located at the Fort Morgan Airport, and the Mobile GPS Advanced Upper Sounding System (MGAUS) launched radiosondes from various locations around Northern and Central Colorado (Fig. 2). A total of 58 quality controlled soundings are contained in the final DC3 data set, 31 from the MGAUS and 27 from MISS.

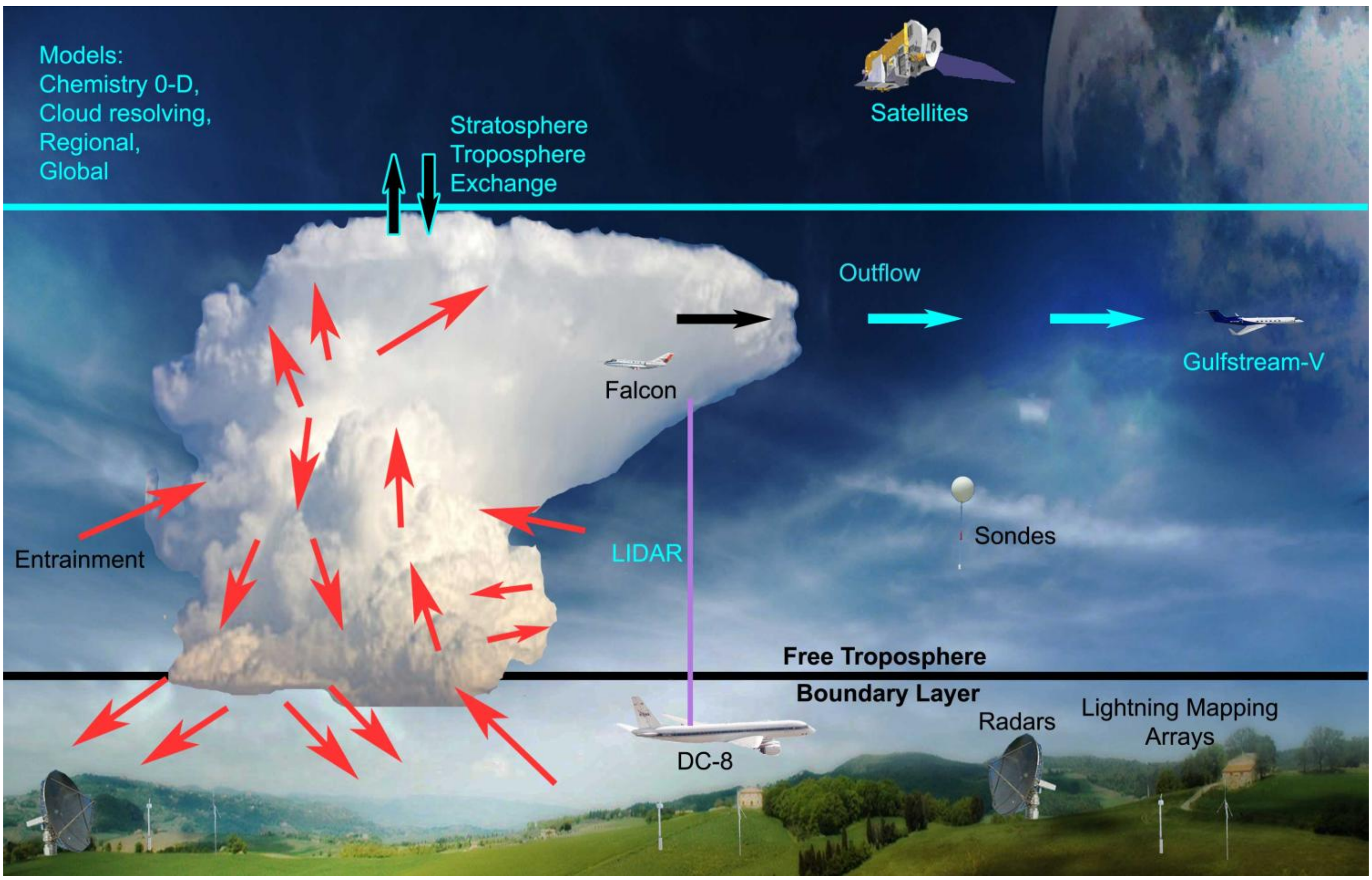

Figure. 1 Image of instrumentation used for the DC3 field campaign (adopted from DC3 project page: http://www.eol.ucar.edu/projects/dc3/)

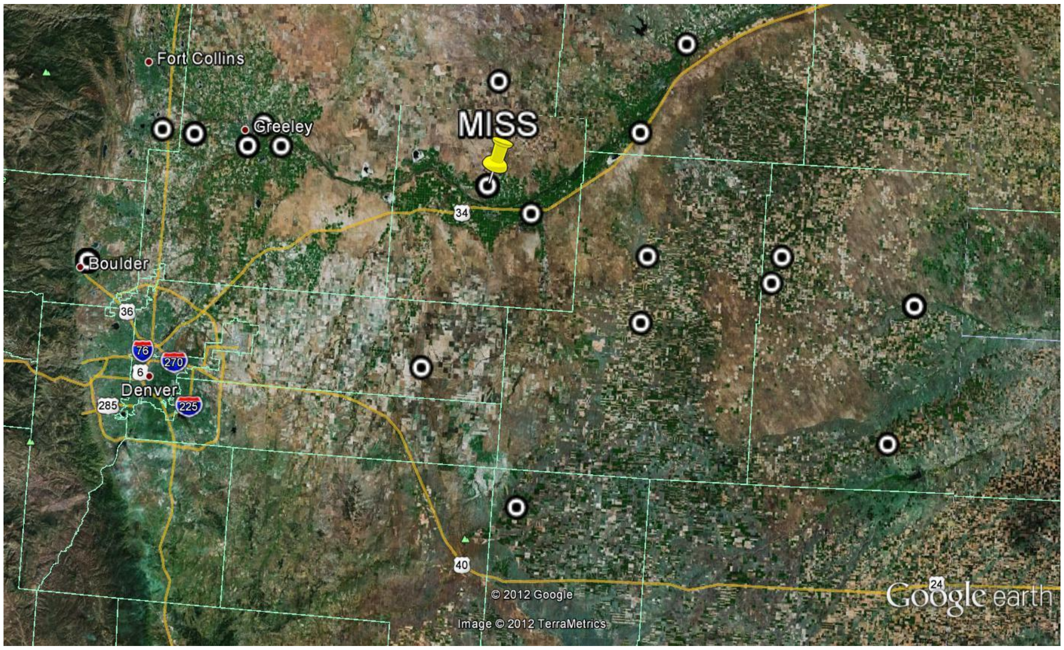

Figure. 2 Map of Mobile ISS site located at the Fort Morgan CO Airport (yellow pin) and Mobile GAUS radiosonde launch locations (white circles).

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:                  DC3 ops MGAUS/NCAR GAUS
Launch Site:                            dc3
Launch Location (lon,lat,alt):          104 41.37'W -104.689577, 40 23.15'N 40.385752,  1422.64
UTC Launch Time (y,m,d,h,m,s):          2012, 06, 05, 21:58:54
Sonde Id/Sonde Type:                    001831258/Vaisala RS92-SGP (ccGPS)
Reference Launch Data Source/Time:      Vaisala WXT510/21:58:54.00
System Operator/Comments:               tim/none, none
Post Processing Comments:               Aspen Version 3.1; Created on 19 Dec 2012 21:07 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 (can result in RH errors). Corrections are made where possible to address these specific problems.

2. All of the mobile soundings were adjusted to correct surface heights. When set to mobile mode, the sounding system depends on the GPS sensor to capture accurate surface heights, for stationary sites a geometric surface altitude is manually entered into the system before the start of the project. During post-processing, the GPS heights from the mobile system are converted to geometric height, by taking into account the geoid altitude at each launch location. Then geometric altitude and latitude are used to compute accurate surface geopotential heights.

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. 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.

5. 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 systematic biases in the radiosonde data (Fig. 3).

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

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. Three files, D20120503_170527, D20120627_191724, D20120627_233924, contained no surface met data and therefore could not receive the ground check pressure correction.

2. Five 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 if the sonde signal was not reacquired, anything measured by the radiosonde during the ascent, and 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	**Pressure at Time of Lock-up**
D20120602_193710	Locked up during descent – no data lost
D20120605_232719	Signal lost at 445 mb and recaptured at 246 mb.
D20120615_204308	Signal lost at 590 mb and recaptured at 152 mb.
D20120629_000123	Balloon popped at 327 mb. Lock up occurred on descent – no data lost
D20120606_223149	Signal lost at 400

3. One, D20120622_215311, sounding was characterized with excessive noise in the pressure, temperature and RH data (Figure 4). We suspect this radiosonde may have been struck by or affected by a nearby lightning strike.

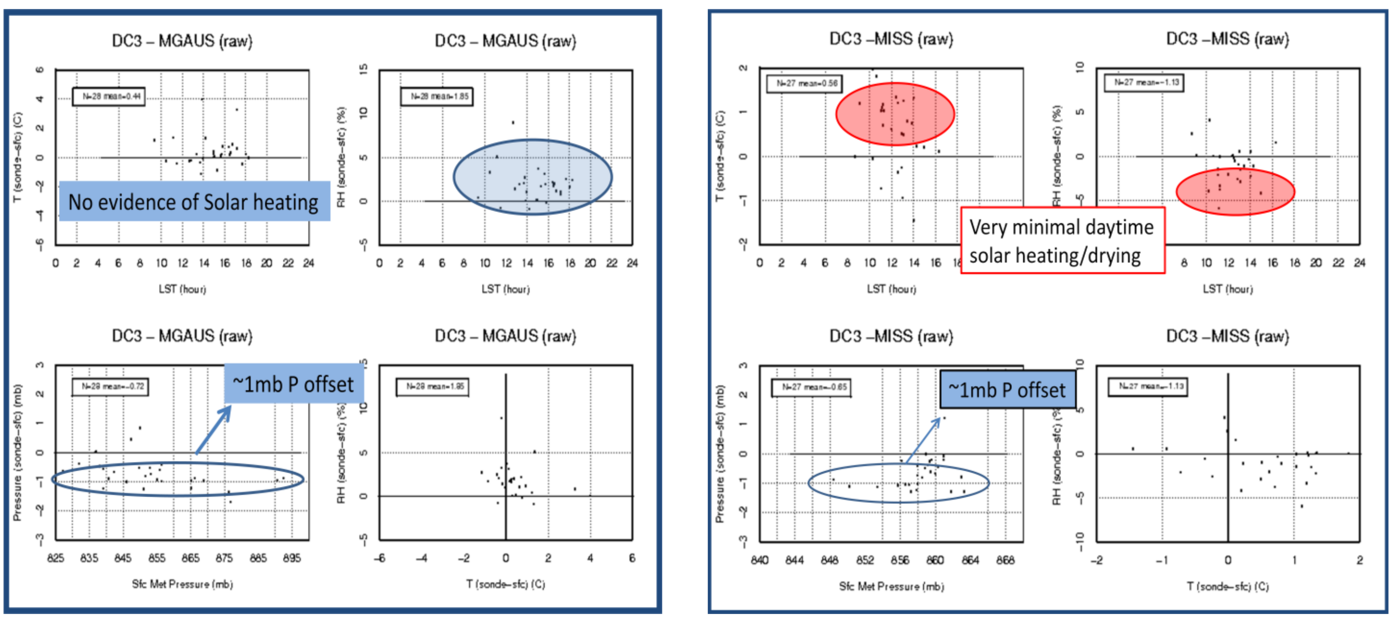

Figure 3. Plots above show differences between prelaunch surface radiosonde and an independent surface met station measurements. Data from the mobile GAUS are shown in four plots on the left and data from MISS are shown on the right. The upper left-hand shows differences in temperature, upper right shows RH differences, lower left show systematic pressure offsets in the of ~1 mb, and lower right show correlation between Tdiff and RHdiff.

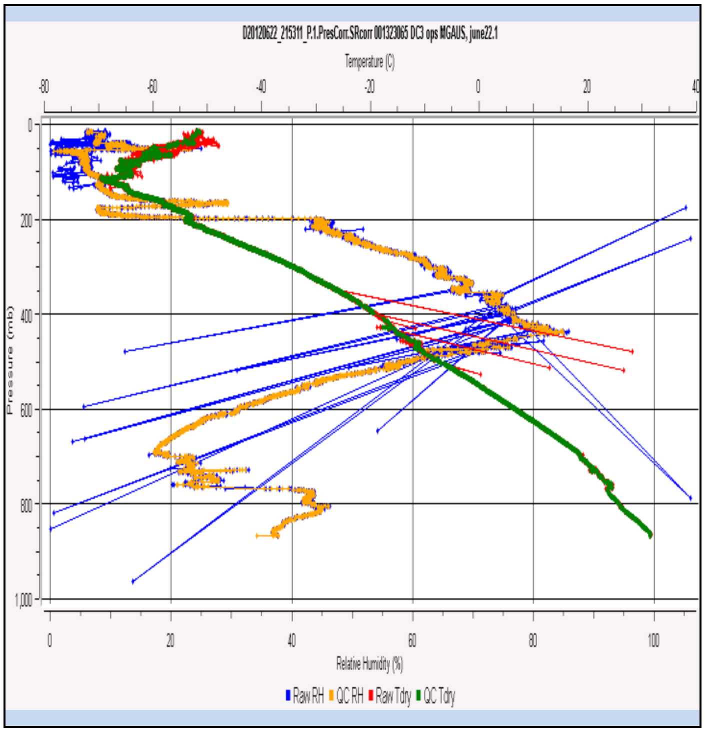

Figure 4 Raw and QC data profiles, for sounding D20120622_215311, show temperature and relative humidity (%) versus pressure. This sounding file contains excessive noise, at approximately 400 mb, in the raw data believed to be cause by lightning.