Profiling of Winter Storms (PLOWS) 2009-2010
Quality Controlled Dropsonde Data Set

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I. Project/Dataset Overview

The Profiling of Winter Storms (PLOWS) project was a study focused on examining winter cyclones and associated fronts and precipitation bands, in Illinois and surrounding states. The project included two field phases. The first phase was conducted during February and March of 2009, and included only ground-based systems. The second phase of PLOWS took place between November 2009 and March 2010, and employed the use of the NCAR C-130 aircraft. The C-130 is equipped with a suite of instruments that includes an Airborne Vertical Atmospheric Profiling System (AVAPS), used for dropsonde deployment. Fifty-one dropsondes were deployed during six research flights (Figure 1). Forty-one of those soundings are included in the final quality controlled data archive. This document contains information on the sounding file format, data parameters included in the sounding files, and details regarding the quality control measures applied to the sounding data set, and our subsequent findings.

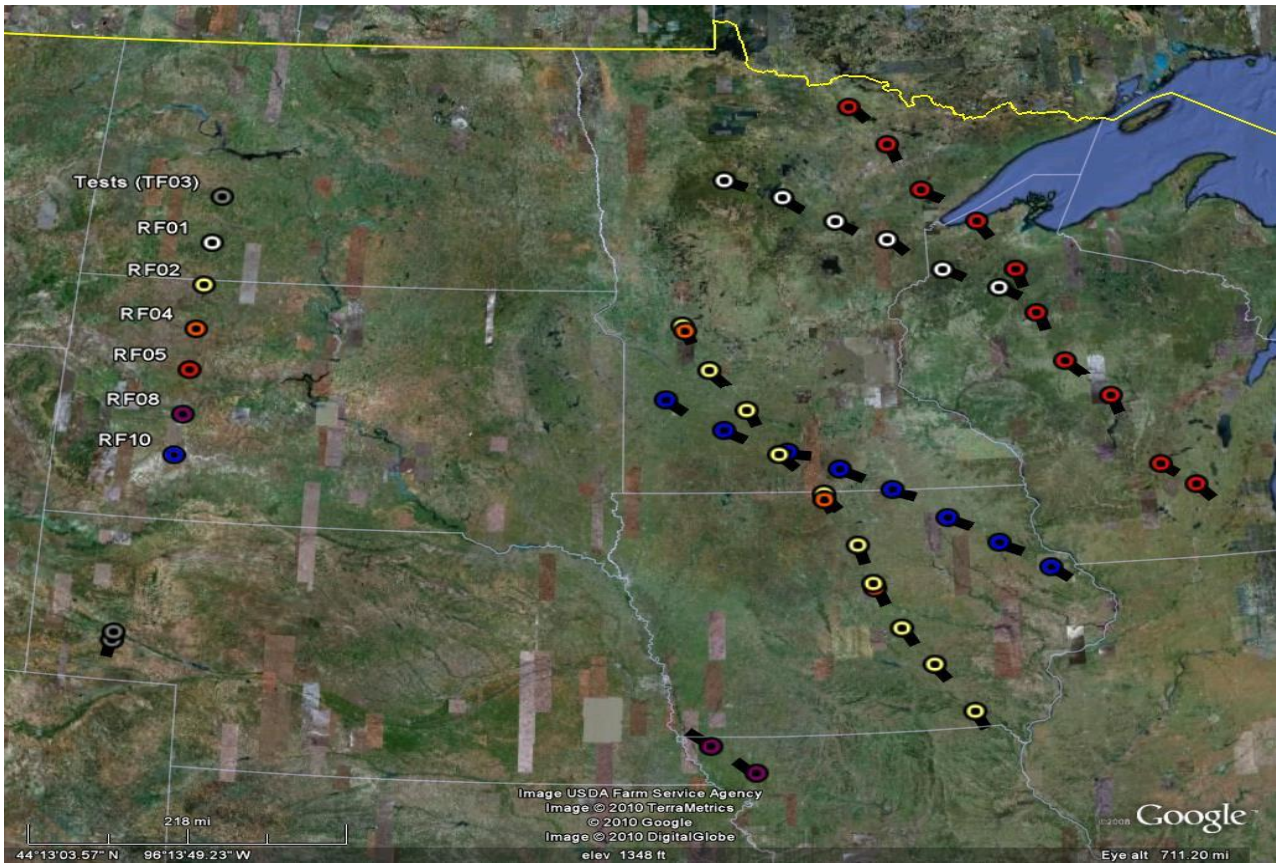

Figure 1 Map of the dropsonde launch locations from the NCAR C-130. Different flights are distinguished by different colors.

Research Flight Numbers – Dates of Flight (mm/dd/yy)
TF03 – 10/13/09 (Test Flight)
RF01 – 11/13/09
RF02 – 11/24/09
RF04 – 12/09/09
RF05 – 12/14/09
RF08 - 01/14/10 (Ferry Flight)
RF10 – 02/08/10

II. EOL File Format

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

The header records contain 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 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:                AVAPS SOUNDING DATA, Channel 4/Descending
File Format/Version:                EOL Sounding Format/1.0
Project Name/Platform:              PLOWS, RF01/NCAR C-130
Launch Site:
Launch Location (lon,lat,alt):      94 14.12'W -94.235300,47 06.13'N 47.102100,  6717.42
UTC Launch Time (y,m,d,h,m,s):      2009, 11, 13,  17:51:53
Sonde Id/Sonde Type:                064916107/
Reference Launch Data Source/Time:  IWADTS/17:51:54
System Operator/Comments:           Tudor
Post Processing Comments:           Aspen Version 2.8.1.8
/
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 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	Measured
10	V Wind Component	Meters/Second	Measured
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
18 Vertical Wind	Meters/Second	Calculated
19 Filtered Vertical Wind	Meters/Second	Calculated

Table 2 Lists data fields provided in the EOL format ascii soundings.

III. Data File Specifics

The files contain data collected at half-second intervals. The variables pressure, temperature, and relative humidity are calibrated values from measurements made by the dropsonde. The dew point is calculated from the temperature and relative humidity. The geopotential altitude value is calculated from the hydrostatic equation using first available pressure, temperature, and relative humidity. For the dropsondes specifically, if the sonde is launched over water and transmits data to the surface, the height is calculated by integrating from the surface (sea level) upward. However, if the sonde failed to transmit data to the surface or if the dropsonde is launched over land (as was the case for all dropsondes deployed for PLOWS), because of unknown surface elevations, we integrate from the flight level down. The descent rate of the dropsonde is computed using the time-differentiated hydrostatic equation. All wind and position (lat, lon and alt) data are computed from GPS navigation signals received from the sonde.

IV. Data Quality Control and Results

1. Profiles of the raw data are first examined to determine if all of the files contain data, and to ensure that nothing looked suspicious. Doing this allows us to determine if there were any errors with the automatic launch detect, or if a sounding was started up, but not launched.

2. The raw soundings files are then run through the Atmospheric Sounding Processing ENvironment (ASPEN) software, which analyzes the data, performs smoothing, and removes suspect data points. All soundings from PLOWS were launched over land so, when run through ASPEN, geopotential altitudes were calculated from flight level downward.

3. Time series plots of temperature (Figure 1), RH, wind speed, and fall rate with respect to altitude, are used to examine the consistency of soundings launched during each flight, and to show the variability of soundings from different missions. These plots are also used to determine if the sounding did not transmit data to the surface, or if there was a “fast fall” caused by failure of the parachute to properly deploy.

4. Profiles of temperature, RH, wind speed and vertical velocity from the quality controlled soundings are visually evaluated for outliers, or any other obvious issues.

5. Histograms of pressure, temperature, relative humidity, wind speed and wind direction are then created to examine the distribution, range, and characteristics of each parameter.

6. Lastly, we examine skew-t diagrams from each sounding.

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 the following issues were found, and where possible, corrections were applied:

1. Ten sounding files were removed from the final archive because they contained very little data (of poor quality). The problems with these files were results of a malfunctioning of the new launch detect mechanism during research flight 4.

2. Three dropsondes experienced a loss of signal and failed to transmit data to the ground.

Filename
D20091113_172801
D20091113_174410
D20081113_175153

3. Seven soundings were classified as “fast fall drops”, or partial “fast fall”, meaning the parachute failed to deploy or deployed late. Fast fall dropsondes have a descent rate of almost twice the normal speed. With fast fall drops, the wind measurements are unreliable so wind speed, wind direction and vertical velocity are set to missing.

Parachute Failure “Fast Fall”	**Late Parachute “Partial Fast Fall”**
D20100114_191121	D20100208_173312
D20100208_180247	D20091124_175838
D20100208_181900	D20091214_141050
	D20100114_190441
	D20100208_183617

4. One dropsonde (D20100208_174337) was launched with the protective temperature and relative humidity cap left on. The cap is meant to protect the sensors before flight, but when left on, it prevents the thermometer and hygrometers from accurately measuring the atmosphere. For this file, temperature and relative humidity, and geopotential altitude were removed, but pressure and GPS data remain.

5. One sounding experienced a delay in the launch detect mechanism. No data is lost when this occurs, but raw data recorded prior to launch detect is recorded as “pre-launch” rather than “in-flight”, and the filenames and launch times are incorrect. This sounding file was corrected and the original and new filenames are listed below.

Original Filename	**Corrected Filename**
D20091214_141127	D20091214_141050

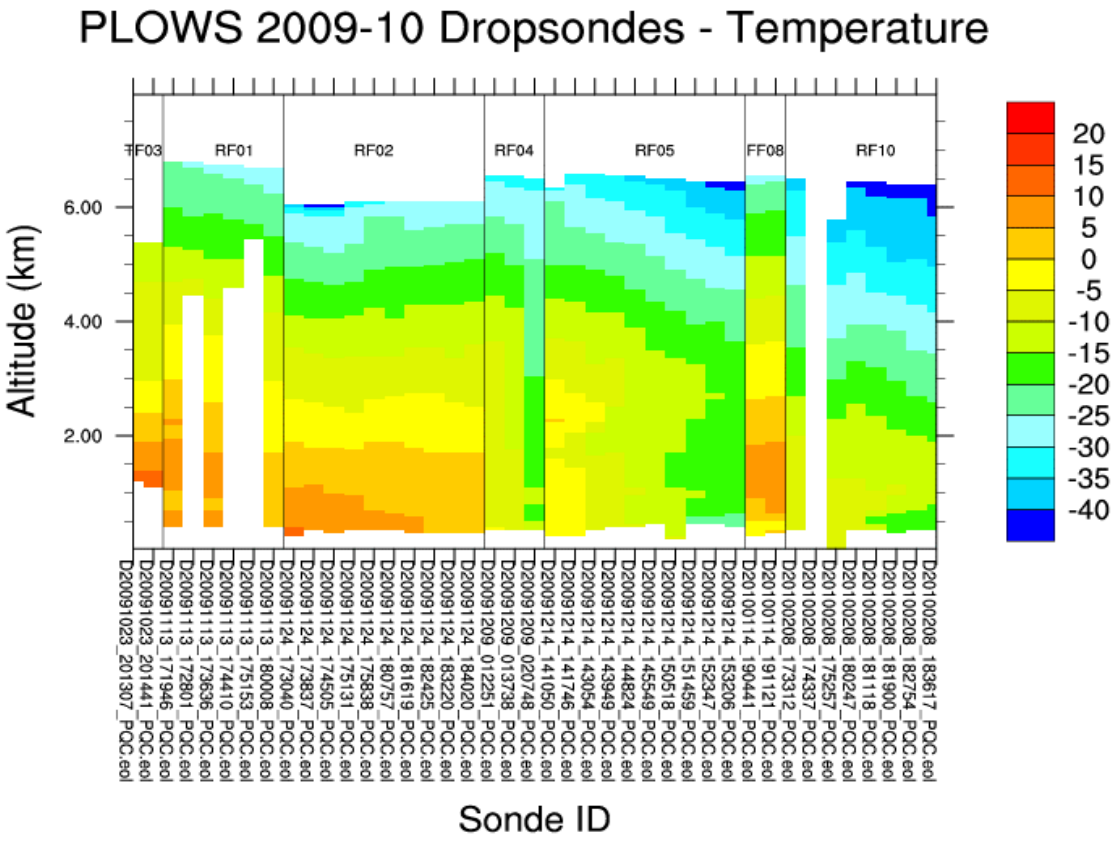

Figure 1. Temperature time series of all dropsondes made during PLOWS. Plot shows consistency of soundings during the same flight and some variability between flights. Labels on the plot represent the Test Flight (TF), Research Flight (RF), and Ferry Flight (FF) numbers.