Verification of the Origins of Rotation in Thunderstorms Experiment-Southeast 2017 (VORTEX-SE_2017) Purdue University Mobile Radiosonde Data Set

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2.0 Dataset Overview

Purdue University (MSU) utilized a mobile radiosonde system to release radiosondes at locations around northern Alabama (Figure 1) during VORTEX-SE_2017 Intensive Observation Periods (IOPs). The choices for the locations and times of the releases were made in collaboration with other VORTEX-SE PIs. This data set includes a total of 18 high vertical resolution radiosondes from the MSU system during the VORTEX-SE_2017 field season (25 March to 1 May 2017).

This document describes the EOL Sounding Composite (ESC) format version of the files. The data are unchanged (except for derived parameters as noted) from the original data, they are simply in a consistent format also available for the other VORTEX-SE radiosonde data sets.

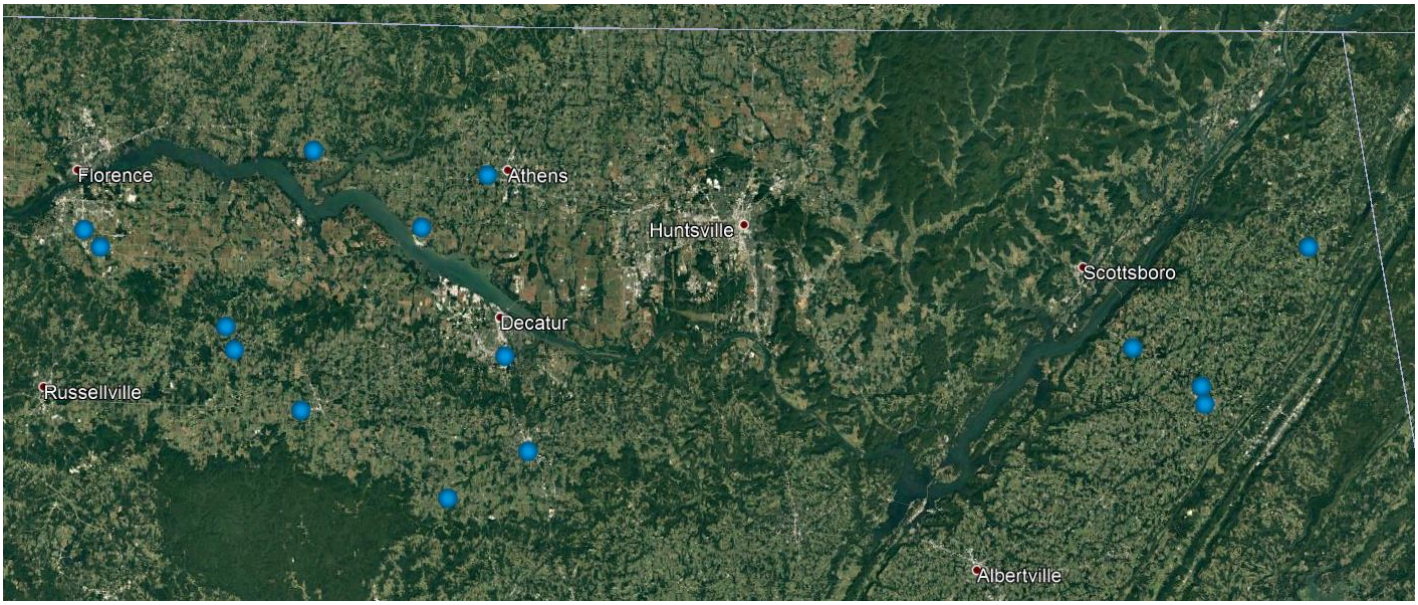

Figure 1. Location of the Purdue University mobile radiosonde sites during VORTEX-SE_2017.

Project Overview

The **Verification of the Origins of Rotation in Tornadoes Experiment-Southeast (VORTEX-SE)** is a research program to understand how environmental factors characteristic of the southeastern United States affect the formation, intensity, structure, and path of tornadoes in this region. VORTEX-SE will also determine the best methods for communicating forecast uncertainty related to these events to the public, and evaluate public response. For the 2017 field season a large array of fixed and mobile ground instrumentation were deployed around northern Alabama from 1 March to 1 May 2017. Further information on VORTEX-SE is available at the VORTEX-SE web site at NCAR/EOL: https://www.eol.ucar.edu/field_projects/vortex-se and information on the VORTEX-SE_2017 deployments is available at the VORTEX-SE_2017 Field Catalog: http://catalog.eol.ucar.edu/vortex-se_2017.

3.0 EOL Sounding Composite (ESC) File Format Description

The ESC is a columnar ASCII format consisting of 15 header records for each sounding followed by the data records with associated data quality flags.

3.1 Header Records

The header records (15 total records) contain a variety of metadata about the sounding (i.e. location, time, radiosonde type, etc). The first five header lines contain information identifying the sounding, and have a rigidly defined form. The following 7 header lines are used for auxiliary information and comments about the sounding, and may vary from dataset to dataset. The last 3 header records contain header information for the data columns. Line 13 holds the field names, line 14 the field units, and line 15 contains dashes ('-' characters) delineating the extent of the field.

The file standard header lines are as follows:

Line	Label (padded to 35 char)	Contents
1	Data Type:	Description of the type and resolution of data
2	Project ID:	Short name for the field project
3	Release Site Type/Site ID:	Description of the release site.
4	Release Location (lon,lat,alt):	Location of the release site.
5	UTC Release Time (y,m,d,h,m,s):	Time of release.

The release location is given as:
lon (deg min), lat (deg min), lon (dec. deg), lat (dec. deg), alt (m)

Longitude in deg min is in the format: ddd mm.mm'W where ddd is the number of degrees (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 time of release is given as: yyyy, mm, dd, hh:nn:ss.
Where yyyy is the year, mm is the month, dd is the day of month, and hh:nn:ss are the UTC hour, minute, and second respectively.

The seven non-standard header lines may contain any label and contents. The labels are padded to 35 characters to match the standard header lines. Records for this data set include the following non-standard header lines:

Line	Label (padded to 35 char)	Contents
6	Radiosonde Type	
7	Ground Station Software	
8		
9		
10		

3.2 Data Records

The data records each contain time from release, pressure, temperature, dew point, relative humidity, U and V wind components, wind speed and direction, ascent rate, balloon position data, altitude, and quality control flags (see the QC code description). Each data line contains 21 fields, separated by spaces, with a total width of 130 characters. The data are right-justified within the fields. All fields have one decimal place of precision, with the exception of latitude and longitude, which have three decimal places of precision. The contents and sizes of the 21 fields that appear in each data record are as follows:

Field	Width	Format	Parameter	Units	Missing Value
1	6	F6.1	Time since release	Seconds	9999.0
2	6	F6.1	Pressure	Millibars	9999.0
3	5	F5.1	Dry-bulb Temperature	Degrees C	999.0
4	5	F5.1	Dew Point Temperature	Degrees C	999.0
5	5	F5.1	Relative Humidity	Percent	999.0
6	6	F6.1	U Wind Comp	m/s	9999.0
7	6	F6.1	V Wind Comp	m/s	9999.0
8	5	F5.1	Wind speed	m/s	999.0
9	5	F5.1	Wind direction	Degrees	999.0
10	5	F5.1	Ascent Rate	m/s	999.0
11	8	F8.3	Longitude	Degrees	9999.0
12	7	F7.3	Latitude	Degrees	999.0
13	5	F5.1	Elevation Angle	Degrees	999.0
14	5	F5.1	Mixing Ratio	g/kg	999.0
15	7	F7.1	Geopotential Height	Meters	99999.0
16	4	F4.1	QC for Pressure	Code	99.0
17	4	F4.1	QC for Temperature	Code	99.0
18	4	F4.1	QC for Humidity	Code	99.0
19	4	F4.1	QC for U Wind	Code	99.0
20	4	F4.1	QC for V Wind	Code	99.0
21	4	F4.1	QC for Ascent Rate	Code	99.0

Fields 16 through 21 contain the data quality flags from the NCAR/Earth Observing Laboratory (EOL) sounding quality control procedures. The data quality flags are defined as follows:

Code	Description
1.0	Checked, datum seems physically reasonable. (“GOOD”)
2.0	Checked, datum seems questionable on a physical basis. (“MAYBE”)
3.0	Checked, datum seems to be in error. (“BAD”)
4.0	Checked, datum is interpolated. (“ESTIMATED”)
9.0	Checked, datum is missing. (“MISSING”)
99.0	Unchecked (QC information is “missing”.) (“UNCHECKED”)

3.3 Data Specifics

The data are in files by day, so all soundings for a particular day are concatenated into a single file ordered by time. The file naming convention is:

Purdue_yyyymmdd.cls where yyyy is the year, mm is the month, and dd is the day of the month.

Purde utilized WindSond S1H3-S radiosondes with GPS windfinding and the RR1 radio receiver with software version 2.80.

The data are at 100ft (~30m) vertical intervals.

3.4 Sample Data

The following is a sample of the Purdue mobile high resolution radiosonde data in ESC format.

```
Data Type:                          Purdue Mobile Sounding Data/Ascending
Project ID:                         VORTEX-SE_2017
Release Site Type/Site ID:          Moulton, AL
Release Location (lon,lat,alt):     087 18.36'W, 34 28.81'N, -87.306, 34.480, 192.0
UTC Release Time (y,m,d,h,m,s):     2017, 03, 25, 16:05:48
Radiosonde Type:                    Windsond S1H3-S
Ground Station Software:            RR1 Radio Receiver Software Version 2.80
/
/
/
/
Nominal Release Time (y,m,d,h,m,s):2017, 03, 25, 16:05:48
 Time  Press  Temp  Dewpt  RH    Ucmp   Vcmp   spd   dir   Wcmp     Lon      Lat   Ele   MixR   Alt    Qp   Qt   Qrh  Qu   Qv   QdZ
  sec    mb     C     C     %     m/s    m/s   m/s   deg   m/s      deg      deg   deg   g/kg    m    code code code code code code
------ ------ ----- ----- ----- ------ ------ ----- ----- ----- -------- -------- ----- ----- ------- ---- ---- ---- ---- ---- ----
   0.0  994.8  23.0  11.6  48.5 9999.0 9999.0 999.0 999.0 999.0  -87.306  34.480 999.0 999.0   229.0 99.0 99.0 99.0  9.0  9.0  9.0
 107.0  993.7  22.9  12.0  50.5    2.6    5.9   6.4 203.7   0.1  -87.306  34.481 999.0   8.9   238.0 99.0 99.0 99.0 99.0 99.0 99.0
 118.0  990.1  21.5  11.8  53.9    0.1    7.4   7.4 181.1   2.9  -87.306  34.481 999.0   8.8   269.4 99.0 99.0 99.0 99.0 99.0 99.0
```

3.5 Station List

This was a mobile system.

4.0 Data Quality Control Procedures

1. Purdue’s primary data quality control and assurance was automatically performed by the WindSond software.

2. NCAR/EOL converted each sounding from its original format into the ESC format described above. The station elevation was derived from Google Earth

using the release location. The geopotential height, dew point, and wind components were derived using common methods. The surface altitudes were derived from the release latitude and longitude using Google Earth.

3. NCAR/EOL passed each sounding through a set of automated data quality checks which included basic gross limit checks as well as rate of change checks. This is further described in Section 4.1.

4. NCAR/EOL visually examined each sounding utilizing the NCAR/EOL XQC sounding quality control software. This is further described in Section 4.2.

4.1 Automated Data Quality Checks

This data set was passed through a set of automated data quality checks. This procedure includes both gross limit checks on all parameters as well as rate-of-change checks on temperature, pressure, and ascent rate. A version of these checks is described in Loehrer et al. (1996) and Loehrer et al. (1998).

4.1.1 Gross Limit Checks

These checks were conducted on each sounding and the data quality flags in the ESC files were adjusted as appropriate. Only the data point under examination was flagged. All checks also produced warning messages that specified the location of the problem and the severity of the issue. These warning messages where then summarized statistically and examined to determine any consistent issues.

For this data set NCAR/EOL conducted the following gross limit checks. In the table P = pressure, T = temperature, RH = relative humidity, U = U wind component, V = V wind component, B= bad, and Q = questionable.

Parameter	Check	Parameter(s) Flagged	Flag Applied
Pressure	<0 or > 1050	P	B
Altitude	< 0 or >40000	P, T, RH	Q
Temperature	< -90 or > 45	T	B
Dew Point	< -99.9 or > 33 > T	RH T, RH	Q Q
Wind Speed	< 0 or > 100 > 150	U, V U, V	Q B
U Wind	< 0 or > 100 > 150	U U	Q B
V Wind	< 0 or > 100 > 150	V V	Q B
Wind Direction	< 0 or > 360	U, V	B
Ascent Rate	< -10 or > 10	P, T, RH	Q

4.1.2 Vertical Consistency Checks

These checks were conducted on each sounding and the data quality flags in the ESC files were adjusted as appropriate. These checks were started at the surface and compared each neighboring data record. In the case of checks that ensured that the

values increased/decreased as expected, only the data point under examination was flagged. However, for the other checks, all of the data points used in the examination were flagged. All items within the table are as previously defined. All checks also produced warning messages that specified the location of the problem and the severity of the issue. These warning messages where then summarized statistically and examined to determine any consistent issues.

Parameter	Check	Parameter(s) Flagged	Flag Applied
Time	Decreasing/equal	None	None.
Altitude	Decreasing/equal	P, T, RH	Q
Pressure	Increasing/equal	P, T, TH	Q
	> 1mb/s or < -1mb/s	P, T, TH	Q
	> 2mb/s or < -2mb/s	P, T, TH	B
Temperature	< -15°C/km	P, T, RH	Q
	< -30°C/km	P, T, RH	B
	> 50°C/km	P, T, RH	Q
	> 100°C/km	P, T, RH	B
Ascent Rate	> 3m/s or < -3m/s	P	Q
	> 5m/s or < -5m/s	P	B

4.2 Visual Data Quality Checks

Each sounding was visually examined using the NCAR/EOL XQC sounding data quality control software. This software allows the user to view a skew-t/log-p diagram of each sounding and apply data quality flags as appropriate. The user can zoom in on sections of soundings for detailed examination and can adjust the data quality flags for an individual point, sections of soundings, or entire soundings for each parameter individually. The software also allows the user to override the quality flags applied by the automated procedure.

4.3 Data Quality Issues of Note

The data quality control procedures outlined above allows us to identify and, in some cases, resolve issues that could potentially impact research performed using these data sets. The following issues were noted in these soundings.

The zero second records in these soundings are not surface values.

201703251605 – T/RH flagged Questionable below 888mb as Purdue stated that there may have been signal interference with another Windsond and T/RH uncertain.

201703280135 – No data above 835mb
201704301851 – updraft sounding.
201703272130 - Several periods of falling data around 780mb.
201703272131 – Period of falling data 713 to 824mb
201704031701 – Wind data noisy
201704031900 – Wind data noisy
201704051451 – Wind data noisy
201704052015 – Updaft sounding and wetbulbing 518mb
201704270127 – Period of falling data from 694 to 702mb and 636 to 743mb
201705010015 – RH questionable 796-629mb

5.0 References

Loehrer, S. M., T. A. Edmands, and J. A. Moore, 1996: TOGA COARE upper-air sounding data archive: development and quality control procedures. Bull. Amer. Meteor. Soc., 77, 2651-2671.

Loehrer, S. M., S. F. Williams, and J. A. Moore, 1998: Results from UCAR/JOSS quality control of atmospheric soundings from field projects. Preprints, Tenth Symposium on Meteorological Observations and Instrumentation, Phoenix, AZ, Amer. Meteor. Soc., 1-6.