Verification of the Origins of Rotation in Thunderstorms Experiment-Southeast 2016 (VORTEX-SE_2016) National Weather Service Radiosonde Data Set

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2.0 Dataset Overview

The National Weather Service (NWS) routinely releases radiosondes at 00 and 12 UTC with occasional special releases at sites throughout the United States. This data set includes the quality controlled VORTEX-SE_2016 NWS soundings released at 10 sites (Figure 1) throughout the southeastern United States during the VORTEX-SE_2016 field phase (1 March to 2 May 2016). A total of 1280 quality-controlled, high vertical resolution (1-second) soundings are contained in the final VORTEX-SE_2016 data set.

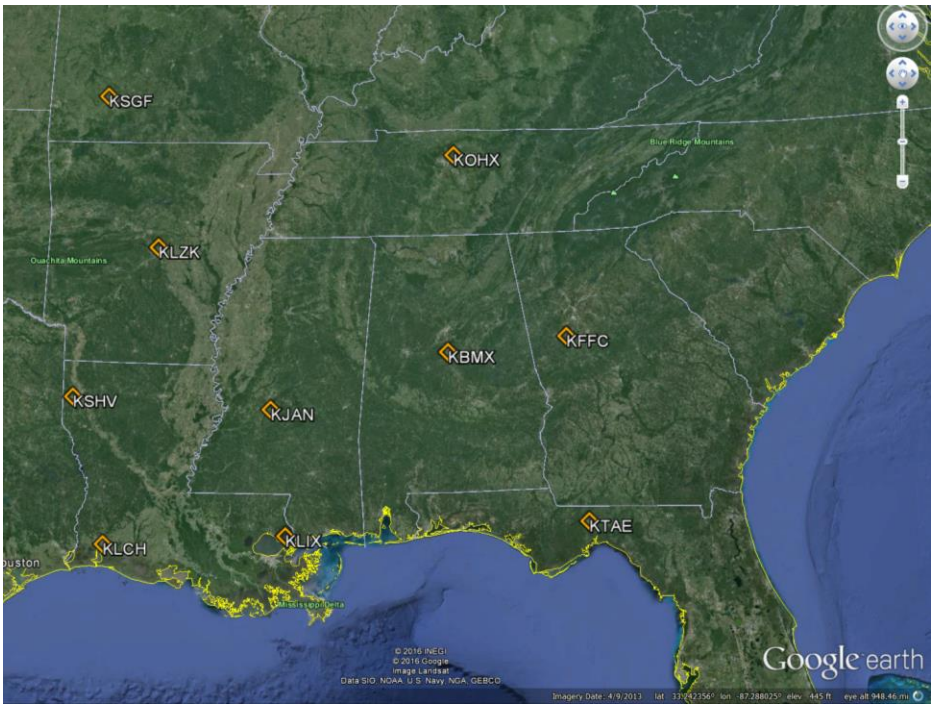

Figure 1. Location of VORTEX-SE_2016 NWS radiosonde sites.

3.0 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 2016 field season a large array of fixed and mobile ground instrumentation were deployed around Huntsville, AL from 1 March to 1 May 2016. 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_2016 deployments is available at the VORTEX-SE_2016 Field Catalog: http://catalog.eol.ucar.edu/vortex-se_2016.

4.0 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	Ascension Number	Number sounding this year
7	Radiosonde Serial Number	
8	Balloon Manufacturer/Type	
9	Balloon Lot Number/Weight	
10	Radiosonde Type/RH Sensor Type	
11	Surface Observations	

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	Azimuth Angle	Degrees	999.0
15	7	F7.1	Altitude	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 files contain data at one-second intervals.

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:

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

The KBMX, KFFC, KJAN, KLZK, KOHX, KSHV, and KTAE stations utilized the Lockheed Martin Sippican LMS-6 Radiosonde with the capacitance RH sensor and GPS windfinding during PECAN.

The KLCH, KLIX, and KSGF stations utilized the Vaisala RS92-NGP radiosonde with twin alternatively heated Humicap capacitance RH sensors and GPS windfinding during PECAN.

3.4 Sample Data

The following is a sample of the VORTEX-SE_2016 NWS high resolution radiosonde data in ESC format.

```
Data Type:                          National Weather Service Sounding/Ascending
Project ID:                         VORTEX-SE_2016
Release Site Type/Site ID:          KBMX Birmingham, AL / 72230
Release Location (lon,lat,alt):     086 46.96'W, 33 10.81'N, -86.783, 33.180, 174.0
UTC Release Time (y,m,d,h,m,s):     2016, 02, 29, 23:05:43
Ascension Number:                   127
Radiosonde Serial Number:           88110918
Balloon Manufacturer/Type:          Totex / GP26
Balloon Lot Number/Weight:          2015 / 0.600
Radiosonde Type/RH Sensor Type:     Lockheed Martin Sippican LMS-6 GPS Radiosonde / Capacitance sensor
Surface Observations:               P: 997.1, T: 10.6, RH: 43.9, WS: 2.1, WD: 210.0
Nominal Release Time (y,m,d,h,m,s):2016, 03, 01, 00:00:00
 Time  Press  Temp  Dewpt  RH    Ucmp   Vcmp   spd   dir   Wcmp     Lon     Lat   Ele   Azi    Alt    Qp   Qt   Qrh  Qu   Qv   QdZ
  sec    mb     C     C     %     m/s    m/s   m/s   deg   m/s      deg     deg   deg   deg     m    code code code code code code
------ ------ ----- ----- ----- ------ ------ ----- ----- ----- -------- ------- ----- ----- ------- ---- ---- ---- ---- ---- ----
   0.0  997.2  21.1   8.3  43.7    2.0   -0.4   2.0 281.3 999.0  -86.783  33.180 999.0 999.0   174.0  1.0  1.0  1.0  1.0  1.0  9.0
   1.0  996.7  21.1   8.1  43.3    2.2   -0.3   2.2 277.8   4.0  -86.783  33.180 999.0 999.0   178.0  1.0  1.0  1.0  1.0  1.0 99.0
   2.0  996.2  21.1   8.1  43.1    2.3   -0.2   2.3 275.0   4.0  -86.783  33.180 999.0 999.0   182.0  1.0  1.0  1.0  1.0  1.0 99.0
```

3.5 Station List

Site ID	WMO ID	Site Name	State	Latitude	Longitude	Elev (m)

KBMX	72230	Birmingham	AL	33.180	-86.783	174
KFFC	72215	Peachtree City	GA	33.356	-84.567	245
KJAN	72235	Jackson	MS	32.320	-90.080	91
KLCH	72240	Lake Charles	LA	30.126	-93.217	5
KLIX	72233	Slidell	LA	30.338	-89.825	10
KLZK	72340	Little Rock	AR	34.836	-92.260	173
KOHX	72327	Nashville	TN	36.247	-86.562	180
KSGF	72440	Springfield	MO	37.236	-93.402	391
KSHV	72248	Shreveport	LA	32.452	-93.842	85
KTAE	72214	Tallahassee	FL	30.446	-84.300	53

4.0 Data Quality Control Procedures

1. Each sounding was converted from its original format into the ESC format described above.

2. Each sounding was passed 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.

3. Each sounding was visually examined 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 > 1mb/s or < -1mb/s > 2mb/s or < -2mb/s	P, T, TH P, T, TH P, T, TH	Q Q B
Temperature	< -15°C/km < -30°C/km > 50°C/km > 100°C/km	P, T, RH P, T, RH P, T, RH P, T, RH	Q B Q B
Ascent Rate	> 3m/s or < -3m/s > 5m/s or < -5m/s	P P	Q 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.

KBMX 201603102305 – wetbulbing~766mb
KBMX 201603111115 – wetbulbing ~606mb

KBMX 201603241104 – no GPS/wind data above 898mb
KBMX 201603251105 – wetbulbing ~825mb
KBMX 201604261101 – no GPS/wind data below 294mb
KFFC 201603271107 – wetbulbing ~683mb
KFFC 201604011103 – wetbulbing ~534mb
KJAN 201602292307 – wetbulbing ~709mb
KJAN 201603102328 – no data above 710mb
KJAN 201603111155 – temp data questionable 735-604mb
KJAN 201603172303 – no RH above 878mb
KJAN 201603191140 – winds bad below 980mb
KJAN 201603272320 – wetbulbing ~727mb
KJAN 201603312303 – no data above 666mb
KLCH 201604121106 – no GPS/wind data
KLCH 201604131141 – RH cycling ~650-225mb
KLIX 201603101134 – wetbulbing ~660mb
KLZK 201603011116 – no data above 638mb
KLZK 201603090021 – no data above 700mb.
KLZK 201603091118 – little RH data 730-515mb
KLZK 201603111119 – wetbulbing ~716mb
KLZK 201603301715 – no data above 805mb
KLZK 201603302056 – temperature data above 508mb bad
KLZK 201604122305 – temperature data above 360mb bad, RH data above 144mb bad
KOHX 201604181114 – temperature data above 226mb bad
KSGF 201603302013 – no data above 525mb
KSHV 201603101147 – temperature data bad and RH questionable 670-301mb
KSHV 201603311107 – temperature data bad above 146mb
KSHV 201604212302 – wetbulbing ~771mb
KTAE 201603242301 – wetbulbing ~663mb
KTAE 201603312302 – wetbulbing ~877mb
KTAE 201604011106 – wetbulbing ~914mb
KTAE 201604012301 – no data above 669mb

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.

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