Ontario Winter Lake-effect Systems (OWLeS) 2013-2014 NWS Radiosonde Data Set

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2.0 Dataset Overview

The National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) routinely releases radiosondes two times per day (00 and 12 UTC) and does occasional special releases at other times of day (usually 18 UTC) from sites across the United States. This data set includes the quality controlled NWS soundings released from 8 stations (Figure 1 and Section 3.5) located within the OWLeS domain for the OWLeS field phase (1 December 2013 to 31 January 2014). A total of 991 quality controlled, high resolution (1-second) soundings are contained in the final OWLeS data set.

Figure 1. Locations of the 8 NWS release locations included in the OWLeS data set.

The Ontario Winter Lake-effect Systems (OWLeS) was a field campaign aimed at investigating the formation mechanisms, cloud microphysics, boundary layer processes, and dynamics of lake-effect systems (LeS) using new observational tools

capable of detailing LeS characteristics not observed in previous LeS field experiments. Observations were focused around Lake Ontario because of its geometry and size, the influence of upstream lakes, the frequency of LeS, nearby orography, and its proximity to several participating universities. The University of Wyoming King Air aircraft took part in the experiment as well as several mobile radars and five mobile radiosonde sites. Further information on OWLeS is available at the OWLeS web site: https://www.eol.ucar.edu/field_projects/owles and information on OWLeS operations is available at the OWLeS Field Catalog: http://catalog.eol.ucar.edu/owles/.

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	Ascension Number:	Radiosonde ascension number
7	Radiosonde Serial Number:	Radiosonde serial number
8	Balloon Manufacturer/Type:	
9	Balloon Lot Number/Weight:	
10	Radiosonde Type/RH Sensor Type:	
11	Surface Observations:	
12	Nominal Release Time (y,m,d,h,m,s):	Nominal release time

The nominal release time is 00, 06, 12, or 18 UTC.

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 calculated at one-second intervals.

We have utilized the processed PTU and GPS data from the Radiosonde Replacement System (RRS) sounding systems to generate these files. The raw position, temperature and RH data are normalized by linear interpolation into 1 second processed data. The raw pressure data are normalized by least square interpolation into 1 second processed data. The pressure data are smoothed over 11 seconds of corrected pressure and the result is applied to the 6th corrected pressure within the 11 second spread. The temperature data are smoothed over 9 seconds of uncorrected temperature and the result is applied to the 5th uncorrected temperature within the 9 second spread. There must be at least 2 good raw temperature elements with the 9 second spread.

The following corrections were applied by the RRS sounding system.

Pressure correction - pressure correction is used to compensate for offsets of the radiosonde pressure sensor as compared to the station's pressure sensor.
The pressure offset is determined during the radiosonde baseline operations.
The correction is applied to the uncorrected pressure prior to pressure smoothing.

This correction is defined as:

Pc = Pu * (Pstn/Psonde)
where Pc is the corrected pressure
Pu is the uncorrected pressure
Pstn is the station pressure
Psonde is the radiosonde surface pressure

Temperature correction - temperature correction is used to compensate for solar radiation. The correction is applied to the smoothed temperature.
These corrections are proprietary to the radiosonde manufacturer.

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.

Two radiosonde and RH sensor types are used by the NWS stations included in this data set.

KALY, KBUF, KGRB, KMPX, and KPBZ used the Lockheed Martin Sippican LMS-6 GPS Radiosonde with the Capacitance RH sensor.

KAPX, KDTX, and KINL used the Vaisala RS92-NGP Radiosonde /Intermet IMS-2000 with the Twin alternatively heated Humicap capacitance RH sensor.

All stations utilized GPS windfinding.

3.4 Sample Data

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

```
Data Type:                          National Weather Service Sounding/Ascending
Project ID:                         OWLES
Release Site Type/Site ID:          KALY Albany, NY / 72518
Release Location (lon,lat,alt):     073 49.96'W, 42 41.53'N, -73.833, 42.692, 95.0
UTC Release Time (y,m,d,h,m,s):     2013, 12, 05, 11:02:58
Ascension Number:                   681
Radiosonde Serial Number:           88010162
Balloon Manufacturer/Type:          Totex / GP26
Balloon Weight:                     0.600
Radiosonde Type/RH Sensor Type:     Lockheed Martin Sippican LMS-6 GPS Radiosonde / Capacitance sensor
Surface Observations:               P: 1006.9, T: 2.0, RH: 81.0, WS: 2.6, WD: 168.0
Nominal Release Time (y,m,d,h,m,s):2013, 12, 05, 12:00:00
 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 1006.9   3.5   0.9  83.0   -0.7    4.1   4.2 170.3 999.0  -73.833  42.692 999.0 999.0    95.0  3.0  3.0  3.0  1.0  1.0  9.0
   1.0 1006.3   5.2   2.6  83.4   -0.7    4.4   4.5 171.0   5.0  -73.833  42.692 999.0 999.0   100.0  3.0  3.0  3.0  1.0  1.0 99.0
   2.0 1005.7   5.1   2.6  83.9   -0.7    4.8   4.9 171.7   5.0  -73.833  42.692 999.0 999.0   105.0  1.0  1.0  3.0  1.0  1.0 99.0
```

3.5 Station List

Site ID	WMO ID	Site Name	State	Latitude	Longitude	Elev (m)
KALY	72518	Albany	NY	42.692	-73.833	95
KAPX	72634	Gaylord	MI	44.908	-84.719	448
KBUF	72528	Buffalo	NY	42.940	-78.725	218
KDTX	72632	Detroit/White Lake	MI	42.699	-83.472	330
KGRB	72645	Green Bay	WI	44.498	-88.112	209
KINL	72747	International Falls	MN	48.565	-93.397	357
KMPX	72649	Chanhassen	NM	44.849	-93.564	290
KPBZ	72520	Pittsburgh	PA	40.532	-80.218	360

4.0 Data Quality Control Procedures

1. Each sounding was converted from its original format (BUFR) 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	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.

1. Five files contained no (or little) GPS data and thus no winds above the surface.
   KALY 18 Dec at 2308
   KAPX 4 Dec at 2321
   KGRB 8 Dec at 2307
   KGRB 11 Dec at 2328
   KINL 7 Dec at 2309
2. Significant wet-bulbing (superadiabatic layers near cloud top) was evident for short periods and the temperature data were flagged as questionable in the following soundings:
   KALY 22 Dec 2305 (795-762mb)
   KALY 23 Dec 2306 (610-595mb)
   KGRB 4 Dec 2313 (685-670mb)
3. One file had no RH data:
   KGRB 9 Dec 2313
4. Two files stopped data transmission below 500 mb:
   KALY 1 Jan 1145 (stopped at 500mb)
   KMPX 5 Dec 2323 (stopped at 765mb)
5. Two files had bad temperature data for short periods:

KAPX 9 Dec 2326 (810-752mb)
KPBZ 5 Dec 2308 (541-531mb)

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.