Ontario Winter Lake-effect Systems (OWLeS) 2013-2014 University of Illinois Mobile Radiosonde Data Set

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2.0 Dataset Overview

The University of Illinois operated a mobile radiosonde system during lake-effect systems on Lake Ontario. University of Illinois operations were on the northern side of Lake Ontario (Figure 1). This data set includes the quality controlled University of Illinois soundings released for the OWLeS field phase (7 December 2013 to 29 January 2014). A total of 61 quality controlled, high resolution (1-second) soundings are contained in the final OWLeS data set.
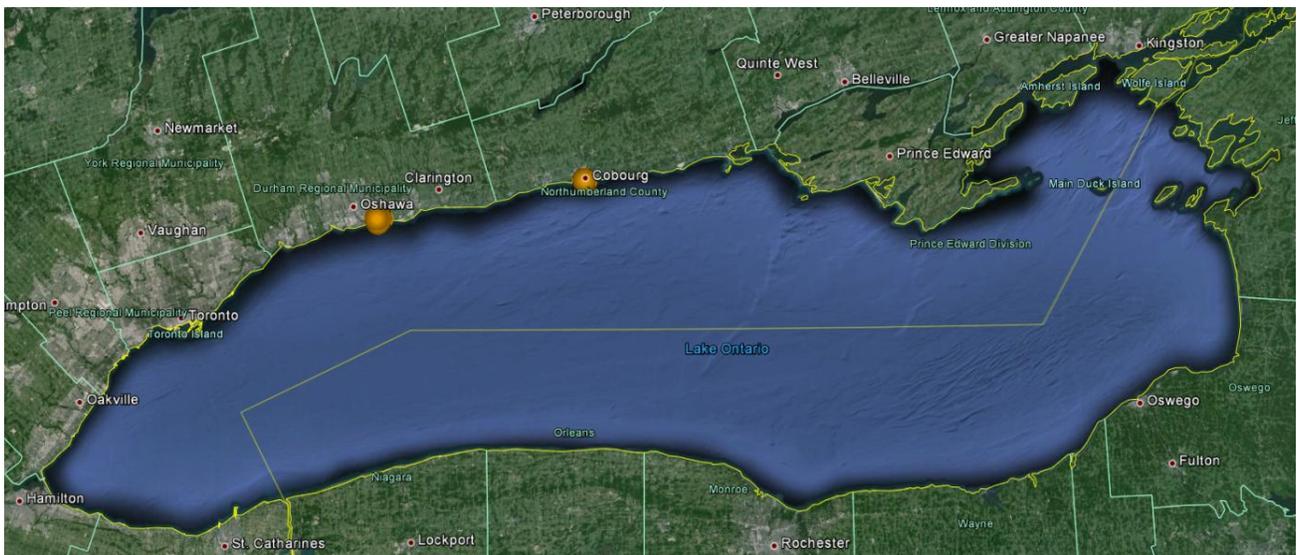

Figure 1. Locations of the University of Illinois mobile radiosonde release locations included in the OWLeS data set.

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	Radiosonde Type	
7	Ground Station Software	

	8	Surface Data Source	

The nominal release time for these soundings is the same as the actual time.

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:

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

The University of Illinois utilized GRAW DFM-09 radiosondes with GPS windfinding during OWLeS. GRAWmet 5 version 5.9.2.4 ground station software was used.

3.4 University of Illinois Data Notes

201312071742 -   Rise rate – 400-600 m/min; Georgian Bay band overhead; One sonde failed before launch
201312072333 - One sonde failed after launch
201312110253 - Initial sonde hit tree. A new launch was accomplished
201312110522 - Relocated inland because winds were too strong near the lake, and more sondes would be blown into trees.
201312111124 - Data losses above 350 mb. Data for periods with no winds removed.
201312111433 - Bad sonde replaced before launch.
201312112020 - Some missing data above about 410mb.
201312112317- Missing humidity observation at 148.1mb.
201312122024 - Launch was not detected and was started manually.
201312122357 - Time corrected on project computer.
201312130233 - Launch was not detected and was started manually.
201312152343 - Some data skips due to soundcard settings. Once corrected, data was more consistently recorded.
201312181716 - Launch was not detected and was started manually.
201312182041 - Initial launch terminated due to questionable temperature data. Launch was repeated with new sonde.
201401070517 - Sounding operator questioned surface temperature obs.
201401081430 - Data were removed for 150.6 mb observation due to missing values.
201401152317 - Light snow at launch
201401192318 - Missing data created rh errors. Removed data at and above 118.4mb
201401201916 - Condensation likely on sensor before launching
201401202125 - One failed launch, gps data not received prior to launch. Second sonde launched.
201401210215 - Condensation likely on sensor before launching
201401211129 - Lost signal with sonde immediately prior to launch. Sonde used successfully later. Second sonde launched.
201401211714 - Sonde that failed at 1129 launch worked successfully this time.
201401232315 - Receiver batteries died and lost data between 757 to 672 mb. Resulted in a >20°C anomalous spike in temperature and dew point; removed data to 600 mb to remove erroneous recovery from very high temperatures.

201401261415 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page

201401271849 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401272015 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401272147 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page. Balloon popped at about 600 mb.

201401272316 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401280218 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401280515 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401281715 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page. Odd observations between 130 and 160 mb, interestingly as the sonde passed over military base

201401282015 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

201401291715 - Kestrel wind direction not working. Initialized sonde using estimated direction from NCAR RAP weather page.

3.5 Sample Data

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

```
Data Type:                          University of Illinois Mobile Radiosonde/Ascending
Project ID:                         OWLeS
Release Site Type/Site ID:          Cobourg, Ontario
Release Location (lon,lat,alt):     078 10.07'W, 43 57.32'N, -78.168, 43.955, 75.0
UTC Release Time (y,m,d,h,m,s):     2013, 12, 07, 17:42:00
Radiosonde Type:                    GRAW DFM-09
Ground Station Software:            GRAWmet 5 version 5.9.2.4
Surface Data Source:                Kestrel 4500 Pocket Weather Tracker
/
/
/
Nominal Release Time (y,m,d,h,m,s):2013, 12, 07, 17:42:00
 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 1019.0  0.3  -4.5 70.0    3.1    0.0   3.1 270.0 999.0  -78.168  43.955 999.0 999.0    75.0 99.0 99.0 99.0 99.0 99.0  9.0
  1.0 1019.0  0.2  -4.6 70.0    2.8    0.0   2.8 270.0   0.0  -78.168  43.955 999.0 999.0    75.0  2.0  2.0  2.0 99.0 99.0 99.0
  2.0 1019.0  0.2  -4.6 70.0    2.5    0.0   2.5 270.0  -0.1  -78.168  43.955 999.0 999.0    74.9  2.0  2.0  2.0 99.0 99.0 99.0
```

3.6 Station List

Site ID	WMO ID	Site Name	State	Latitude	Longitude	Elev (m)
UIllinois	N/A	Cobourg	ON	-78.168	43.955	75
UIllinois	N/A	Darlington Provincial Park Coastal Site	ON	-78.795	43.873	78
UIllinois	N/A	Darlington Provincial Park Inland Site	ON	-78.783	43.873	90

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	RH	Q
	> T	T, RH	Q
Wind Speed	< 0 or > 100	U, V	Q
	> 150	U, V	B
U Wind	< 0 or > 100	U	Q
	> 150	U	B
V Wind	< 0 or > 100	V	Q
	> 150	V	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. All files had a surface elevation of 0m and thus incorrect geopotential height data. The surface elevation data were corrected using values from Google Earth at the release location and the geopotential height data were derived using the proper start value for these soundings.
2. Several files had wind spikes that have been flagged bad or questionable:
   201312071742 – winds above 158mb questionable and occasionally bad.
   201312110253 – wind bad 169-159mb.
   201312110522 – wind bad 107-103mb.
   201312111433 – wind bad 240-232mb. Several other periods questionable
   201312122024 – several areas of bad winds above 100mb.
   201401261415 – winds above 168mb noisy, mostly questionable.
3. Two soundings have a period of data at the surface prior to release:

201312071742 (first 36 seconds)
4. Five soundings have issues with the pressure, altitude, or temperature data:
    201312110253 – temperatures cold
    201312112317 – temperature questionable below 682mb
    201312122024 – pressure and altitude data bad
    201312130233 – pressure and altitude data bad
    201401272316 – low level temperature data bad.

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.