

In-Cloud Icing and Large-Drop Experiment (ICICLE) National Weather Service Radiosonde Data Set

1.0 Contacts:

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Original Data Source:

NOAA/NWS

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 ICICLE NWS soundings released at 10 sites (Figure 1) throughout the western Great Lakes region during the ICICLE field phase (26 January to 9 March 2019). Two of the stations were only available at the mandatory and significant levels (KDVN and KTOP). A total of 703 1-second vertical resolution and 163 mandatory/significant level soundings are contained in the final ICICLE data set.

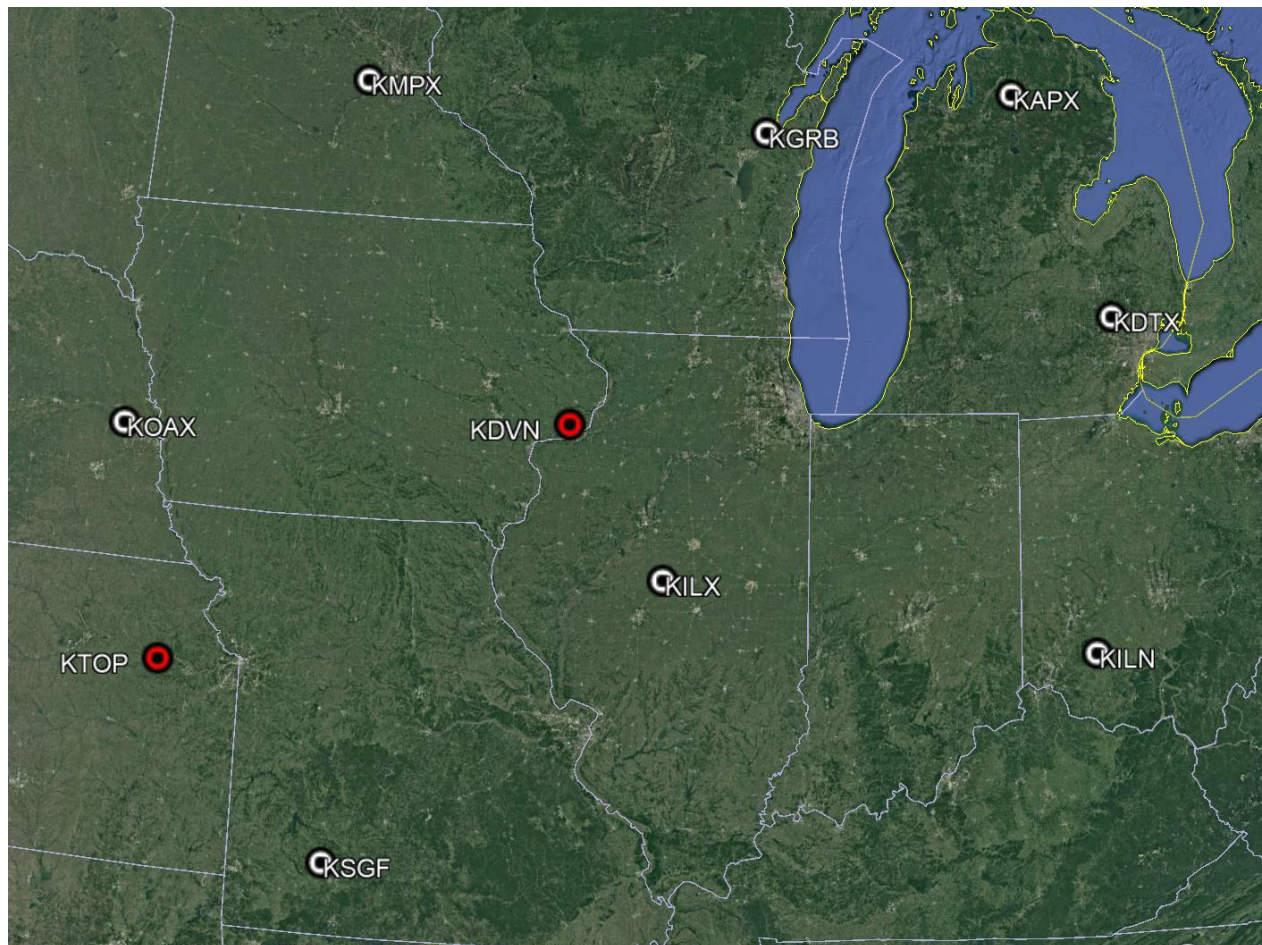


Figure 1. Location of ICICLE NWS radiosonde sites. Stations with white dot have one second vertical resolution data and those with red dots have mandatory/significant level data.

3.0 Project Overview

The **In-Cloud ICing and Large-drop Experiment (ICICLE)** is a field program where the FAA and other agencies worked with the National Research Council of Canada (NRC) to fly the NWC Convair-580 research aircraft into a broad spectrum of icing conditions (freezing drizzle, freezing rain, "small drop" icing, high liquid water contents, and mixed phase) with the goal of developing the methods for diagnosis and forecasting of aircraft icing at the surface and aloft to reduce the rate of aircraft icing related accidents and fatalities. to understand how environmental factors characteristic of the southeastern United States affect the formation, intensity, structure, and path of tornadoes in this region. Operations occurred from 18 January to 8 March 2019 based out of Rockford, Illinois. Further information on ICICLE is available at the VORTEX-SE web site at NCAR/EOL: https://www.eol.ucar.edu/field_projects/icicle and information on the ICICLE deployments is available at the ICICLE Field Catalog: <http://catalog.eol.ucar.edu/icicle>.

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.

4.1 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	

4.2 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	Geopotential 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")

4.3 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 KGRB, KILN, KILX, KMPX, KOAX stations utilized the Lockheed Martin Sippican LMS-6 Radiosonde with the capacitance RH sensor and GPS windfinding during ICICLE.

KDVN and KTOP utilized the Lockheed Martin Sippican LMS6 with the chip thermistor, external boom mounted capacitance relative humidity sensor, and derived pressure from GPS height during ICICLE.

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

4.4 Sample Data

The following is a sample of the ICICLE NWS radiosonde data in ESC format.

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Data Type: National Weather Service Sounding/Ascending
Project ID: ICICLE_2019
Release Site Type/Site ID: KAPX Gaylord, MI / 72634
Release Location (lon,lat,alt): 084 43.16'W, 44 54.50'N, -84.719, 44.908, 448.0
UTC Release Time (y,m,d,h,m,s): 2019, 01, 25, 23:18:52
Ascension Number: 51
Radiosonde Serial Number: P2613327
Balloon Manufacturer/Type: Totex / GP26
Balloon Lot Number/Weight: 2018 / 0.600
Radiosonde Type/RH Sensor Type: Vaisala RS92-NGP/Intermet IMS-2000 / Twin alternatively heated Humicap capacitance sensor
Surface Observations: P: 960.6, T: -13.1, RH: 80.0, WS: 2.6, WD: 264.0
Nominal Release Time (y,m,d,h,m,s): 2019, 01, 26, 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 m code code code code code code
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0.0 960.9 -16.5 -19.0 81.0 2.5 0.5 2.5 258.7 999.0 -84.719 44.908 999.0 999.0 448.0 1.0 1.0 1.0 1.0 1.0 9.0
1.0 961.1 -16.5 -19.0 80.9 2.7 0.5 2.7 259.5 -2.0 -84.719 44.908 999.0 999.0 446.0 3.0 3.0 3.0 1.0 1.0 99.0
2.0 960.7 -16.6 -19.1 80.8 2.9 0.6 3.0 258.3 3.0 -84.719 44.908 999.0 999.0 449.0 3.0 3.0 3.0 1.0 1.0 99.0

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4.5 Station List

Site ID	WMO ID	Site Name	State	Latitude	Longitude	Elev (m)
KAPX	72634	Gaylord	MI	44.908	-84.719	448
KDTX	72632	Detroit	MI	42.699	-83.472	330
KDVN	74455	Davenport	IA	41.612	-90.582	230
KGRB	72645	Green Bay	WI	44.498	-88.112	209
KILN	72426	Wilmington	OH	39.421	-83.821	323
KILX	74560	Lincoln	IL	40.151	-89.338	179
KMPX	72649	Chanhassen	MN	44.849	-93.564	290
KOAX	72558	Omaha	NE	41.320	-96.366	351
KSGF	72440	Springfield	MO	37.236	-93.402	391
KTOP	72456	Topeka	KS	39.073	-95.630	268

5.0 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.

5.1 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).

5.1.1 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 were 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

5.1.2 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 were 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

5.2 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.

5.3 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.

KAPX 201901272327 – moisture cycling
KAPX 201903071109 – limited GPS/wind data
KGRB 201902121121 – no GPS/wind data
KGRB 201902221115 – no GPS/wind data below 407mb
KGRB 201903061101 – no RH data
KILN 201902021105 – no GPS/wind data below 192mb
KILN 201902121826 – wetbulbing 690mb
KMPX 201902012313 – no GPS/wind data below 433mb
KOAX 201902082322 – no GPS/wind data above 557mb
KOAX 201902122308 – no data above 653mb, no wind data above 800mb
KSGF 201902191108 – very little RH data
KSGF 201903091100 – no GPS/wind data

6.0 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.