WINTRE-MIX: High Resolution Radiosonde Composite

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1.0   Data Set Description

High vertical resolution radiosonde data from research and operational sources during the Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX) campaign converted into a common format (EOL Sounding Composite format which is a columnar ASCII format). The composite includes data from radiosondes from locations around Quebec, Canada and the northeastern United States. The radiosondes were released by the University at Albany (three sites), University of Colorado Boulder (four sites), Université du Québec à Montréal (three sites), McGill University (three sites), and the National Weather Service (four sites).

Data Version: 1.0
Data Status: Final
Time Period: 30 January to 16 March 2022
Physical Location: 40.865 to 46.349N and 70.257 to 78.725W
Data Frequency: Varies by location
Vertical Resolution: 1 second (~5m)
Data Source: University at Albany, University of Colorado Boulder, Université du Québec à Montréal. McGill University, and NOAA/National Weather Service
Data Restrictions: Limited to WINTRE-MIX investigators through 17 March 2023. Open access thereafter.

1.1 WINTRE-MIX Description

The WINTRE-MIX campaign had the overarching goal of gaining a better understanding of how multi-scale processes influence the variability and predictability of precipitation type and amount under near-freezing surface condition. The WINTRE-MIX field campaign was conducted in the region around Montreal, Canada during February and March 2022. The study region had a strong backbone of existing state-of-the-art mesoscale observation networks, and experiences

plentiful near-freezing precipitation with interesting terrain influences. WINTRE-MIX supplemented existing networks with additional observations from aircraft, mobile radars, and other surface-based instruments. Information on WINTRE-MIX operations and Intensive Observation Periods (IOPs) can be found in the WINTRE-MIX Field Catalog (http://catalog.eol.ucar.edu/wintre-mix) and additional background information can be found at the WINTRE-MIX website (https://www.eol.ucar.edu/field_projects/wintre-mix).

2.0   Instrument Description

2.1 Instrumentation

University at Albany (UA) used iMet-4 radiosondes performed with the iMet-3050A sounding system for IOP1-4 and the iMet-3150 sounding system for IOP6-11 (no soundings were released for IOP5). Soundings were processed using the iMetOS-II Meteorological Operating Software version 3.133.0C.

University of Colorado Boulder (UCB) used Vaisala RS41-SG radiosondes processed with the Vaisala Sounding System MW41 version 2.11.

Université du Québec à Montréal (UQAM) used iMet-4 radiosondes performed with the iMet-3050A sounding system. Soundings were processed using the iMetOS-II Meteorological Operating Software version 3.133.0C.

McGill University (MU) used iMet-4 radiosondes performed with the iMet-3050A sounding system. Soundings were processed using the iMetOS-II Meteorological Operating Software version 3.133.0C.

NWS KALY (Albany, New York) used Lockheed Martin Sippican LMS-6 GPS radiosondes with a capacitance humidity sensor.

NWS KBUF (Buffalo, New York) used Vaisala RS41 radiosondes (DigiCORA MW41) with a Humicap capacitance humidity sensor with active de-icing method.

NWS KGYX (Gray, Maine) and KOKX (Upton, New York) used Vaisala RS92-NGP/Intermet IMS-2000 radiosondes with a twin alternatively-heated humicap capacitance humidity sensor

2.2 Station Locations

| Site ID	Source	Site Name	State	Latitude	Longitude	Elev (m)
DOW-US-N	UA	Champlain	NY	44.955	-73.387	46
DOW-US-P	UA	Plattsburgh	NY	44.684	-73.526	109
ESSX	UA	Essex Farm	NY	44.308	-73.374	67
DOW-CAN-N	UCB	Acton Vale	QC	45.704	-72.644	69
DOW-CAN-SE	UCB	St. Blaise-sur-Richelieu	QC	45.212	-73.285	47
DOW-CAN-S	UCB	Noyan	QC	45.085	-73.271	37
JEAN	UCB	St. Jean-sur-Richelieu	QC	45.324	-73.266	37
Sorel	UQAM	Sorel	QC	46.030	-73.110	13
TR	UQAM	Trois-Rivières	QC	46.349	-72.581	52
JEAN	UQAM	St. Jean-sur-Richelieu	QC	45.324	-73.266	37
Gault	MU	Mont St. Hilaire	QC	45.535	-73.149	132
KALY	NWS	Albany	NY	42.692	-73.833	95
KBUF	NWS	Buffalo	NY	42.940	-78.725	218
KGYX	NWS	Gray	ME	43.893	-70.257	124
KOKX	NWS	Upton	NY	40.865	-72.863	20
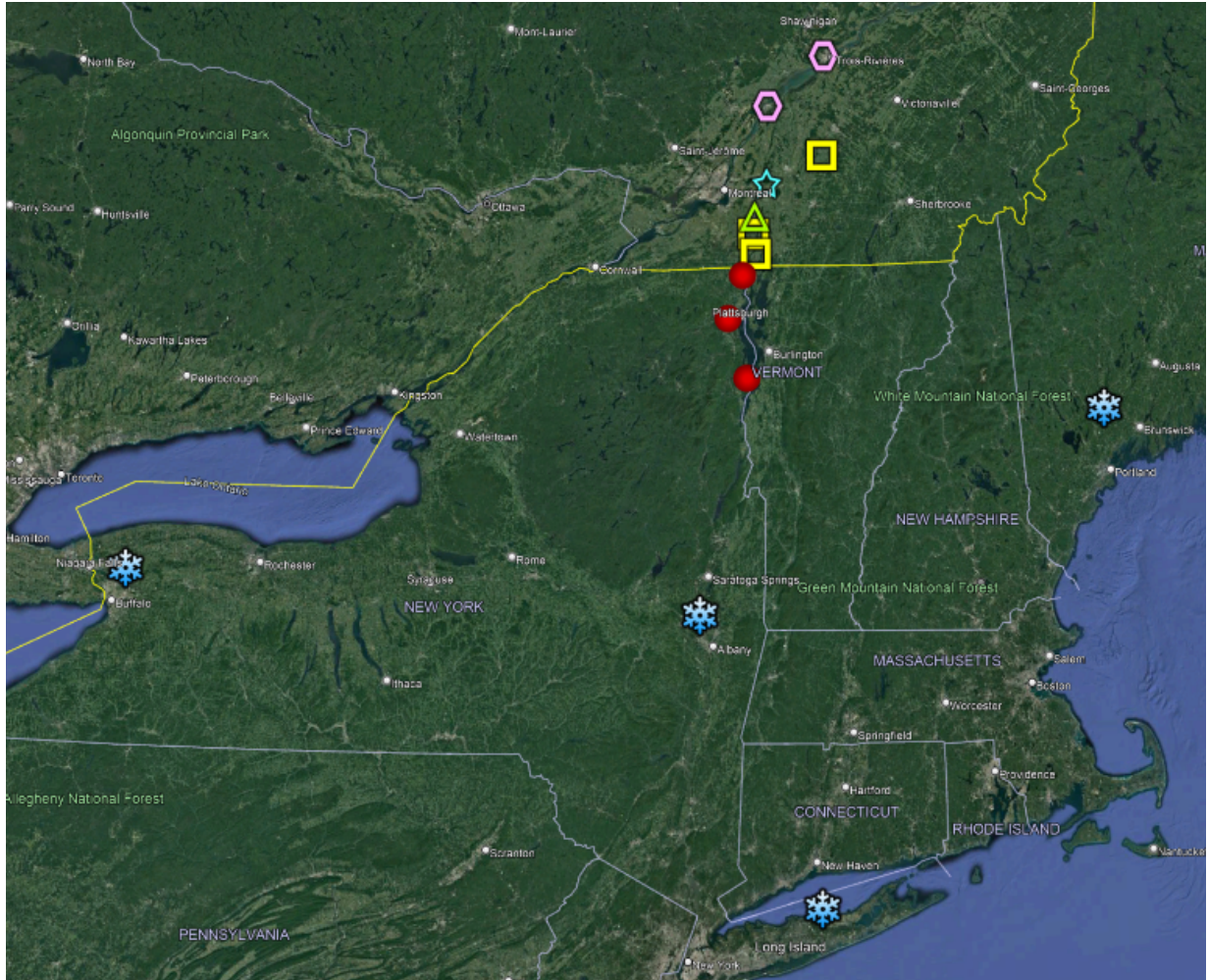
Figure 1. Map of WINTRE-MIX radiosonde composite locations. Red circles are UA sites, yellow squares are UCB sites, the green triangle is a combined UCB/UQAM site, the pink hexagons are UQAM sites, the green star is the MU site, and the blue snowflakes are the NWS sites.

3.0   Data Collection and Processing

3.1 Data Collection

Complete information on the collection procedures at each site can be found in the documentation at their respective dataset pages in the NCAR/EOL Field Data Archive:

NWS: https://doi.org/10.26023/C20Y-VK2S-YG11

UA/UCB/UQAM/MU: https://doi.org/10.26023/DN6Q-VKKE-V002

3.2 Data Processing

Complete information on the collection procedures at each site can be found in the documentation at their respective dataset pages in the NCAR/EOL Field Data Archive:

NWS: https://doi.org/10.26023/C20Y-VK2S-YG11

UA/UCB/UQAM/MU: https://doi.org/10.26023/DN6Q-VKKE-V002

3.3 Quality Control Processing

Each sounding underwent initial quality control processing by their respective radiosonde systems described above.

In addition to the quality control procedures conducted by the data source, each sounding was passed through a two-step quality control process. First a series of automated data quality checks were conducted including basic gross limit checks as well as rate of change checks as described in section 3.3.1. Second, each sounding was visually examined utilizing the NCAR/EOL XQC sounding QC software as described in section 3.3.2.

3.3.1 Automated Data Quality Checks

Each sounding in this dataset was passed through a set of automated data quality checks. This procedure includes both gross limit checks (section 3.3.1.1) on all parameters as well as rate-of-change checks (section 3.3.1.2) on temperature, pressure, and ascent rate. A version of these checks is described in Loehrer et al. (1996) and Loehrer et al. (1998).

3.3.1.1 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	RH T, RH	Q Q

	> T		
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

3.3.1.2 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, RH	Q
	> 1mb/s or < -1mb/s > 2mb/s or < -2mb/s	P, T, RH	Q

		P, T, RH	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

3.3.2 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.

4.0 Data Format

The data are in files by day and include radiosonde data from all sites for the day concatenated into a single file. The file naming convention is: WINTRE-MIX_2022_HighRes_yyyymmdd.cls where yyyymmdd is the UTC year, month, and day of month.

 The final dataset is in the EOL Sounding Composite (ESC) format. ESC is a columnar ASCII format that consists of 15 header records for each sounding with the remaining records containing the radiosonde data and their 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	Contents
1	Data Type:	Description of the type and resolution of data
2	Project ID:	Short name for the field campaign
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. They typically include things such as radiosonde type, radiosonde serial number, sensor information, balloon information, and/or ground station software.

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	6.1	Time since release	Seconds	9999.0
2	6	6.1	Pressure	hPa	9999.0
3	5	5.1	Temperature	°C	999.0
4	5	5.1	Dew Point Temperature	°C	999.0
5	5	5.1	Relative Humidity	Percent	999.0
6	6	6.1	U Wind Component	m/s	9999.0
7	6	6.1	V Wind Component	m/s	9999.0
8	5	5.1	Wind Speed	m/s	999.0
9	5	5.1	Wind Direction	Degrees	999.0
10	5	5.1	Ascent Rate	m/s	999.0
11	8	8.3	Longitude	Degrees	9999.0
12	7	7.3	Latitude	Degrees	999.0
13	5	5.1	Elevation Angle	Degrees	999.0
14	5	5.1	Azimuth Angle	Degrees	999.0
15	7	7.1	Geopotential Altitude	Meters	99999.0
16	4	4.1	QC code for Pressure	Code	99.0
17	4	4.1	QC Code for Temperature	Code	99.0
18	4	4.1	QC Code for Humidity	Code	99.0
19	4	4.1	QC Code for U Wind	Code	99.0
20	4	4.1	QC Code for V Wind	Code	99.0
21	4	4.1	QC Code 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. ("QUESTIONABLE")
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")

5.0 Data Remarks

See the respective FDA dataset pages linked in Section 3.1 for any details on data quality issues.

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.

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