

CFACT National Weather Service High Resolution Radiosonde Data

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1.0 Data Set Description

High vertical resolution radiosonde data from National Weather Service radiosonde stations within and near the CFACT domain. Three stations are included in this dataset: Salt Lake City UT (KSLC), Boise ID (KBOI), and Elko, NV (KLKN).

Data Version: 1.0

Data Status: Final

Time Period: 5 January to 24 February 2022

Physical Location: three point locations within 40.772 to 43.568N and 111.955 to 116.211W

Data Frequency: Soundings were typically every 12 hours at 00 and 12 UTC

Vertical Resolution: 1 second (~5m)

Data Source: NOAA/National Weather Service and NOAA/National Centers for Environmental Information (NCEI)

Data Restrictions: None

2.0 Instrument Description

2.1 Instrumentation

KBOI used Vaisala RS41 radiosondes (DigiCORA MW41) with a humicap capacitance RH sensor with an active de-icing method.

KLKN switched radiosonde systems during CFACT as part of the NWS transitioning from the Radiosonde Replacement System (RRS) to the Manual Radiosonde Observation System (MROS).

5 January and 00 UTC 6 January used the Lockheed Martin Sippican LMS-6 GPS radiosondes with a capacitance RH sensor

After 00 UTC 6 January used the Graw DFM-17 radiosondes with a capacitance RH sensor

KSLC switched radiosonde systems during CFACT also as part of the RRS to MROS transition.

5 January to 12 UTC 11 January and 00 and 12 UTC 12 January used the Lockheed Martin Sippican LMS-6 GPS radiosondes with a capacitance RH sensor

16 and 20 UTC 11 January and after 12 UTC on 12 January used the Graw DFM-17 radiosondes with a capacitance RH sensor

2.2 Station Locations

Site ID	WMO ID	WBAN	Site Name	State	Latitude	Longitude	Elevation (m)
KBOI	72681	24131	Boise	ID	43.568	-116.211	873
KLKN	72582	04105	Elko	NV	40.860	-115.742	1593
KSLC	72572	24127	Salt Lake City	UT	40.773	-111.955	1289

3.0 Data Collection and Processing

3.1 Data Collection

Data were collected via two methods. All data except for that on 11 February 2022 were collected via the Global Telecommunications System. These data were in the WMO GTS BUFR radiosonde standard format. Due to a GTS ingest outage on 11 February 2022 the data for this period are from the NOAA/NCEI RRS BUFR system. The dataset includes 102 soundings from KBOI, 106 from KLKN, and 106 from KSLC.

3.2 Data Processing

The WMO GTS BUFR data were decoded using the ECMWF ECCODES software package. The NCEI BUFR data were decoded using the NWS RRS decoder software.

The decoded data were converted to the EOL Sounding Composite (ESC) format using EOL software. 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. ESC is further described in section 4.0.

3.3 Quality Control Processing

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	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

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

Data are of generally good quality. A few issues of note:

KBOI 7 January at 2303 UTC – RH cycling from 405-217 hPa

KLKN 21 February at 1117 UTC – temperature bad below 700 hPa

KSLC 20 January at 1105 UTC – the radiosonde sat at the surface for an extended period and these data should be ignored

KSLC 20 January at 1110 UTC – the surface RH is bad

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.