Mesoscale Predictability Experiment (MPEX) 2013
NWS Radiosonde Data Set

1.0 Contacts:

NCAR/EOL Processing and Quality Control:
Scot Loehrer (NCAR/EOL)
loehrer@ucar.edu

Original Data Source:
NOAA/NWS

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 23 stations (Figure 1 and Section 3.5) located within the MPEX domain for the MPEX field phase (15 May to 15 June 2013). A total of 1484 quality controlled, high resolution (1-second) soundings are contained in the final MPEX data set.

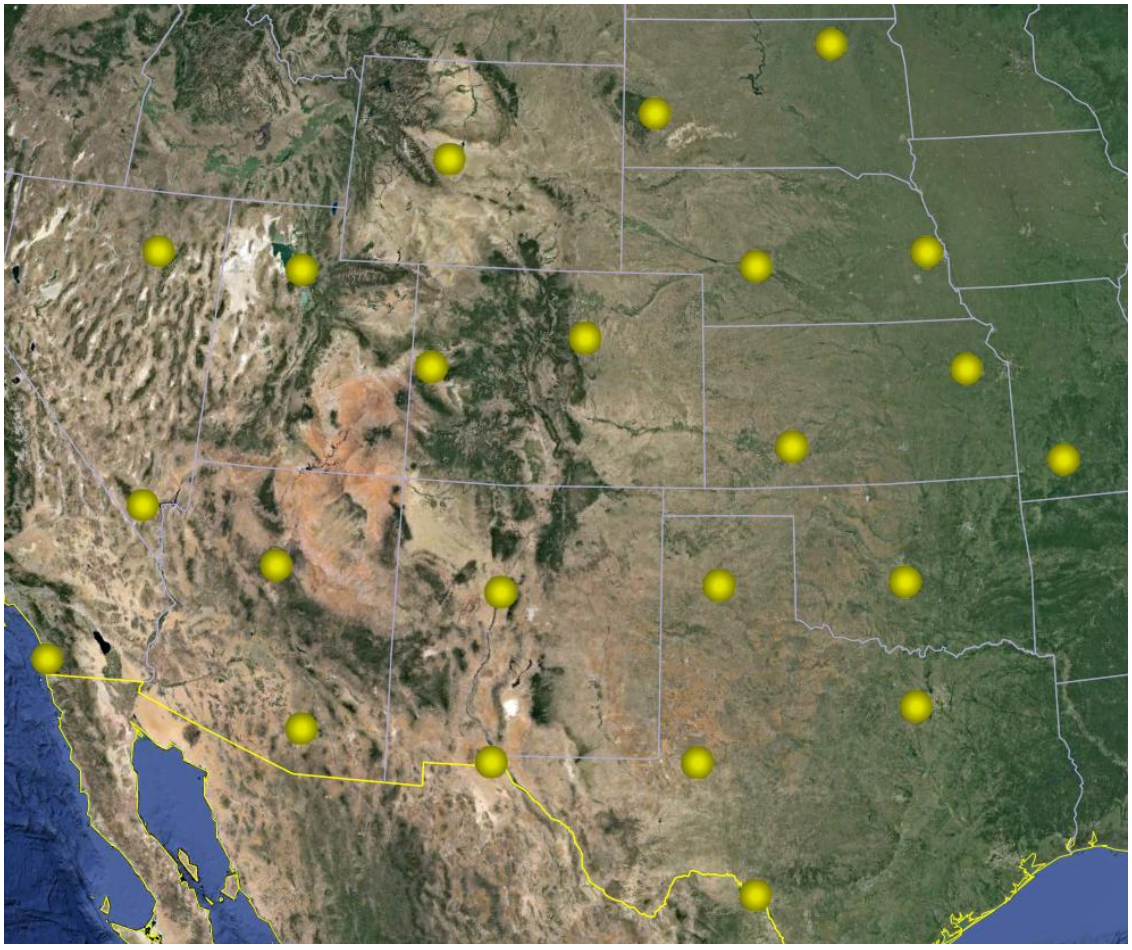

Figure 1. Locations of the 23 NWS release locations included in the MPEX data set.

The Mesoscale Predictability Experiment (MPEX) was a field campaign aimed at investigating if experimental sub-synoptic observations can extend convective-scale predictability and otherwise enhance sill in regional numerical weather prediction over a 6-24 hour time span. The NSF/NCAR Gulfstream-V (GV) HAIPER aircraft deploying dropsondes was the primary platform used in the experiment. There were also four groups on the ground releasing radiosondes from mobile platforms. Further information on MPEX is available at the MPEX web site: https://www.eol.ucar.edu/field_projects/mpex and information on MPEX operations are available at the MPEX Field Catalog: http://catalog.eol.ucar.edu/mpex/.

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.

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

KABQ, KABR, KAMA, KDNR, KDRT, KGJT, KLBF, KLKN, KMAF, KOAX, KOUN, KRIW, KTOP, KUNR, and KVEF used the Sippican Mark IIA Radiosonde with chip thermistor, pressure with the Sippican Mark IIA Carbon Hygristor RH sensor.

KDDC, KFWD, and KSLC used the Lockheed Martin Sippican LMS-6 GPS Radiosonde with the Capacitance RH sensor.

KEPZ, KFGZ, KNKX, KSGF, and KTWC 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 MPEX NWS high resolution radiosonde data in ESC format.

```
Data Type:                          National Weather Service Sounding/Ascending
Project ID:                         MPEX
Release Site Type/Site ID:          KABQ Albuquerque, NM / 72365
Release Location (lon,lat,alt):     106 37.37'W, 35 02.29'N, -106.623, 35.038, 1619.0
UTC Release Time (y,m,d,h,m,s):     2013, 05, 14, 23:03:46
Ascension Number:                   269
Radiosonde Serial Number:           85304061
Balloon Manufacturer/Type:          Totex / GP26
Balloon Lot Number/Weight:          12 / 0.600
Radiosonde Type/RH Sensor Type:     Sippican Mark IIA with chip thermistor, pressure / Sippican Mark IIA Carbon Hygristor
Surface Observations:               P: 835.0, T: 15.4, RH: 12.0, WS: 3.6, WD: 248.0
Nominal Release Time (y,m,d,h,m,s):2013, 05, 15, 00:00:00Nominal Release Time (y,m,d,h,m,s):2013, 06, 14, 06:00:00
 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  977.4  24.6  19.7  74.0   -1.1    2.9   3.1 159.0   0.0  -97.490  36.610 999.0 999.0    315.0  1.0  1.0  1.0  1.0  1.0 99.0
   2.0  976.7  24.3  20.6  79.8   -2.4    2.3   3.3 134.0   3.4  -97.490  36.610 999.0 999.0    321.8  1.0  1.0  1.0  1.0  1.0 99.0
   4.0  975.7  24.4  20.7  79.9   -2.9    2.6   3.9 132.0   3.9  -97.490  36.610 999.0 999.0    330.7  1.0  1.0  1.0  1.0  1.0 99.0
   6.0  974.6  24.5  20.7  79.1   -3.4    3.2   4.7 133.0   4.2  -97.490  36.610 999.0 999.0    340.5  1.0  1.0  1.0  1.0  1.0 99.0
```

3.5 Station List

Site ID	WMO ID	Site Name	State	Latitude	Longitude	Elev (m)
KABQ	72365	Albuquerque	NM	35.03809	-106.62280	1619
KABR	72659	Aberdeen	SD	45.45450	-98.41416	398
KAMA	72363	Amarillo	TX	35.23253	-101.70874	1095
KDDC	72451	Dodge City	KS	37.76164	-99.96936	790
KDNR	72469	Denver	CO	39.76749	-104.86945	1611
KDRT	72261	Del Rio	TX	29.37448	-100.91828	314
KEPZ	72364	Santa Teresa	NM	31.87268	-106.69709	1254
KFGZ	72376	Flagstaff	AZ	35.23057	-111.82019	2179
KFWD	72249	Fort Worth	TX	32.83508	-97.29794	195
KGJT	72476	Grand Junction	CO	39.11974	-108.52431	1474
KLBF	72562	North Platte	NE	41.13395	-100.69991	849
KLKN	72582	Elko	NV	40.86018	-115.74146	1593
KMAF	72265	Midland	TX	31.94267	-102.18986	874
KNKX	72293	San Diego	CA	32.84536	-117.12350	137
KOAX	72558	Valley	NE	41.31950	-96.36633	351
KOUN	72357	Norman	OK	35.18095	-97.43787	345
KRIW	72672	Riverton	WY	43.06485	-108.47667	1699
KSGF	72440	Springfield	MO	37.23583	-93.40216	391
KSLC	72572	Salt Lake City	UT	40.77244	-111.95470	1289
KTOP	72456	Topeka	KS	39.07297	-95.62983	268
KTWC	72274	Tucson	AZ	32.22794	-110.95601	741
KUNR	72662	Rapid City	SD	44.07301	-103.21027	1029
KVEF	72388	Las Vegas	NV	36.04714	-115.18464	697

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 > 1mb/s or < -1mb/s > 2mb/s or < -2mb/s	P, T, TH P, T, TH P, T, TH	Q Q B
Temperature	< -15°C/km < -30°C/km > 50°C/km > 100°C/km	P, T, RH P, T, RH P, T, RH P, T, RH	Q B Q B
Ascent Rate	> 3m/s or < -3m/s > 5m/s or < -5m/s	P P	Q 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. One file (KTWC 6 June at 1103 UTC) contained only surface data records and was not included in the final data set. There was no second release so no sounding data are available at the 1200 UTC nominal time on 6 June at KTWC.
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:
   KTOP 27 May at 2317 UTC
   KUNR 11 June at 2300 UTC
3. The temperature data above 294 mb was mostly bad in the following sounding:
   KUNR 25 May at 2309 UTC

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.