

Mesoscale Predictability Experiment (MPEX) 2013 5hPa Resolution Radiosonde Composite Data Set

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2.0 Dataset Overview

This data set contains a composite of the 5 hPa resolution upper air sounding data from all sources for the Mesoscale Predictability Experiment (MPEX). Sounding data is included from nine sources: the National Weather Service (23 sites and 1484 soundings), the dropsondes from the NSF/NCAR G-V aircraft (426 soundings), the Atmospheric Radiation Measurement (ARM) Central Facility site (123 soundings), Vandenberg Air Force Base (31 soundings), and soundings from MPEX mobile sounding systems operated by Colorado State University (55 soundings), the National Severe Storms Laboratory (111 soundings), Purdue University (93 soundings), and Texas A&M University (23 soundings). Included are 2346 soundings from 30 platforms from 10 May to 16 June 2013. Version 2 of this data set was released in December 2016, see Section 3.3 for information on the changes from Version 1.

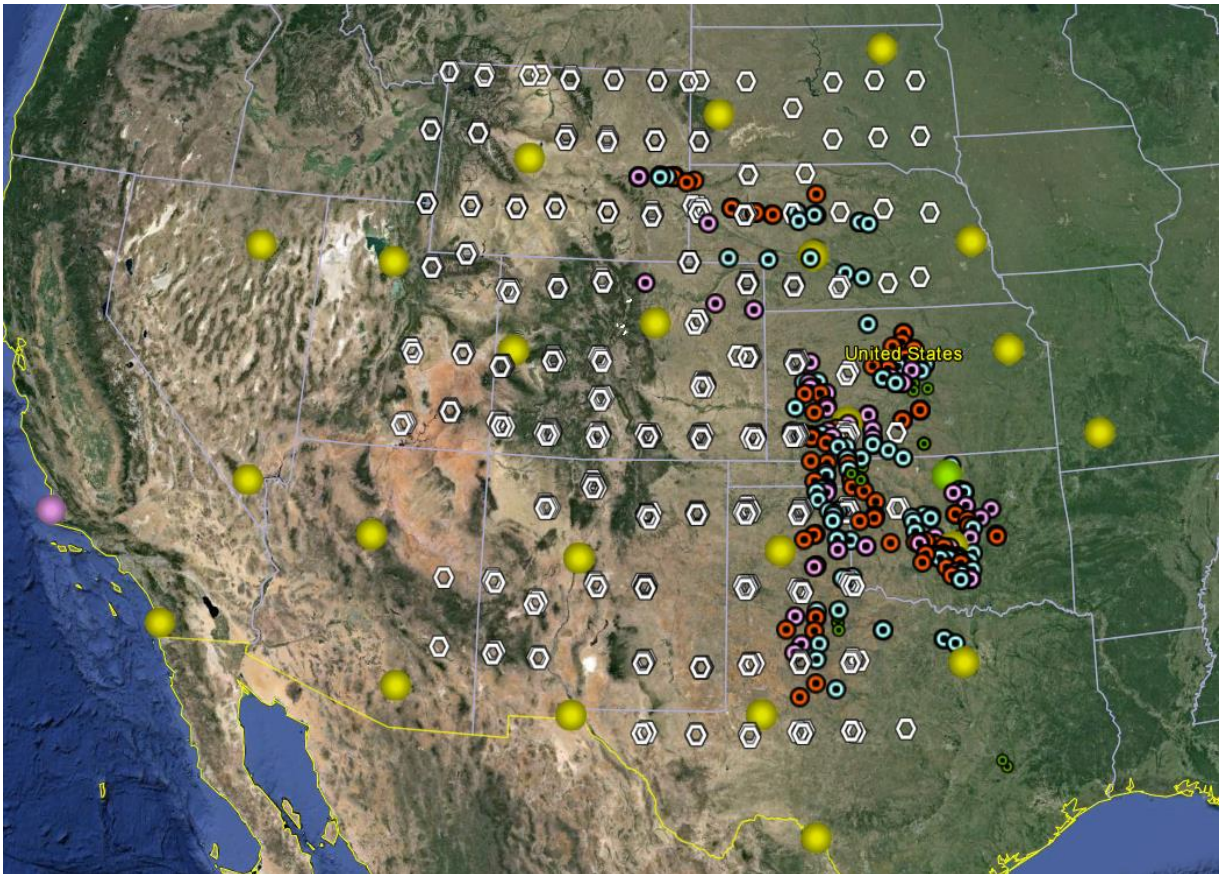


Figure 1. Locations of the MPEX release locations included in the 5 hPa resolution composite data set. NWS (large yellow dots), Vandenberg (large purple dot), ARM CF (large green dot), G-V dropsonde (white pentagon), TAMU mobile (small green

circles), NSSL mobile (small cyan circles), Purdue mobile (small red circles), and CSU mobile (small purple circles).

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 skill in regional numerical weather prediction over a 6-24 hour time span. The NSF/NCAR Gulfstream-V (GV) aircraft deploying dropsondes was the primary platform used in the experiment. 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 vary based on the source. See the original readme files for details.

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 data are in files by day, so all soundings from all platforms for a particular day are concatenated into a single file ordered by nominal time first and then latitude (south to north) and then longitude. The file naming convention is: MPEX_2013_5MB_yyyymmdd.cls where yyyy is the year, mm is the month, and dd is the day of the month.

Version 2.0 of this data set was released in December 2016. In this version a dry bias in the RD94 relative humidity measurements was corrected. The dry bias was strongly temperature dependent, being considered quite small at warm temperature and more substantial at cold temperatures. More complete information on the origin, magnitude, and impact of the bias is available in an NCAR Technical Note (Voemel, et al 2016): <http://dx.doi.org/10.5065/D6XS5SGX>.

For additional specifics please see the original readme files associated with each data source:

NWS <http://data.eol.ucar.edu/datafile/nph-get/371.014/readme> MPEX NWS radiosonde.pdf

ARM - <http://data.eol.ucar.edu/datafile/nph-get/371.004/readme> MPEX ARM radiosonde.pdf

Vandenberg –
<http://data.eol.ucar.edu/datafile/nph-get/371.007/readme> MPEX Vandenberg radiosonde.pdf

GV Dropsondes –
<http://data.eol.ucar.edu/datafile/nph-get/371.021/readme> MPEX NSF-NCAR G-V Dropsonde V2.pdf

CSU Mobile –
<http://data.eol.ucar.edu/datafile/nph-get/371.018/readme> CSU Mobile radiosonde.pdf

NSSL Mobile –
<http://data.eol.ucar.edu/datafile/nph-get/371.020/readme> NSSL Mobile radiosonde.pdf

Purdue Mobile –
<http://data.eol.ucar.edu/datafile/nph-get/371.019/readme> Purdue Mobile radiosonde.pdf

TAMU Mobile –
<http://data.eol.ucar.edu/datafile/nph-get/371.022/readme> TAMU Mobile radiosonde.pdf

3.4 Sample Data

The following is a sample of the MPEX high resolution radiosonde data in ESC format.

```
Data Type: National Weather Service Sounding/Ascending
Project ID: MPEX
Release Site Type/Site ID: KDRT Del Rio, TX / 72261
Release Location (lon,lat,alt): 100 55.10'W, 29 22.47'N, -100.918, 29.375, 314.0
UTC Release Time (y,m,d,h,m,s): 2013, 05, 27, 23:07:11
Ascension Number: 295
Radiosonde Serial Number: 85305236
Balloon Manufacturer/Type: Totex / GP26
Balloon Lot Number/Weight: 2013 / 0.600
Radiosonde Type/RH Sensor Type: Sippican Mark IIA with chip thermistor, pressure / Sippican Mark IIA Carbon Hygristor
Surface Observations: P: 971.4, T: 24.1, RH: 43.0, WS: 8.2, WD: 130.0
Nominal Release Time (y,m,d,h,m,s):2013, 05, 28, 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 deg m code code code code code code
```

0.0 971.4 32.8 18.6 43.0 -4.4 6.3 7.7 145.1 999.0 -100.918 29.374 999.0 999.0 314.0 1.0 1.0 1.0 1.0 1.0 9.0
 3.6 970.0 32.5 19.4 46.0 -4.4 6.5 7.8 145.9 5.0 -100.918 29.375 999.0 999.0 327.0 1.0 3.0 1.0 1.0 1.0 99.0
 12.2 965.0 31.8 19.3 47.7 -4.4 7.0 8.3 147.8 6.0 -100.919 29.375 999.0 999.0 374.0 1.0 3.0 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
N677F	N/A	NSF/NCAR G-V	Mobile	Mobile	Mobile	Mobile
N/A	74646	Central Facility	OK	36.610	-97.490	315
N/A	N/A	CSU Mobile	Mobile	Mobile	Mobile	Mobile
N/A	N/A	Purdue Mobile	Mobile	Mobile	Mobile	Mobile
N/A	N/A	NSSL Mobile	Mobile	Mobile	Mobile	Mobile
N/A	N/A	TAMU Mobile	Mobile	Mobile	Mobile	Mobile
N/A	72393	Vandenberg AFB	CA	34.737	-120.584	99.9

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. These checks were performed on the high resolution data files and the flags carried through to this 5 hPa version.

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 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

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 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

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

For the data quality issues please see the readme files mentioned in Section 3.3 as well as the readme for the original format NSF/NCAR G-V dropsonde data set at: <http://data.eol.ucar.edu/datafile/nph-get/371.005/readme.MPEX-2013.GVdropsonde.pdf>

5.0 Procedures for Generation of 5 hPa Data

The 'native' resolution data for every sounding were interpolated to 5 hPa vertical resolution files. The surface data point was kept as the initial level in each sounding. The first interpolated data point was at the next lowest pressure evenly divisible by 5 and then every 5 hPa pressure level beyond that point to either 50 hPa or the lowest pressure level reached by the radiosonde, whichever came first. The first 15 lines of each file (the header information) were kept without change.

For the interpolation, the software searched for two data points around the desired pressure level. The search was conducted by looking for two valid (i.e. non-missing) data points around the desired pressure level, while also paying attention to the time difference between the two data points as well as their quality control flags. There was a search for the two best possible data points to use in the interpolation. If the desired pressure level was within the original dataset, that data point was used without interpolation.

There was first a search for values flagged as good within some time range (50 sec for temperature, humidity, and wind and 100 sec for pressure; hereafter termed the ARANGE) and the interpolated data point was flagged as good. Failing that, it searched for values flagged as estimated within the same time range and the interpolated data point was flagged as estimated. Then the search went for good values within a wider time range (100 sec for temperature, humidity, and wind and

200 sec for pressure; hereafter termed the BRANGE) the flag for the interpolated data point here was then degraded (even though two 'good' data points were used there was a significant time difference between them) to questionable. Then, in turn, estimated values within the BRANGE were used (flag set to questionable), questionable values within the BRANGE (flag set to bad), good values greater than the BRANGE apart (flag set to bad), estimated values greater than BRANGE apart (flag set to bad), questionable values greater than BRANGE apart (flag set to bad), finally any bad values (flag set to bad). This search was conducted separately for each interpolated variable (pressure, temperature, relative humidity, and the u and v wind components).

Thus for each interpolated data point, the quality control flag was set to the worst case among the data points used in the interpolation, except, for each time range apart, the quality control flag was degraded one level (i.e. good to questionable, etc).

The quality control flags should be carefully heeded in these files. While some of the data may look good, it may have been interpolated over large pressure intervals, and thus be suspect.

For each interpolated data point the dew point was calculated from the temperature and relative humidity (Bolton 1980) and the total wind speed and direction were calculated from the interpolated u and v component values. Also, the altitude and time were interpolated using the same data points used for the pressure interpolation. The ascension rate was recalculated based on the time and altitude values from the two data points used to interpolate the 5 hPa data point. Thus the ascension rate values do not reflect the values based on the interpolated data. The latitude and longitude values were interpolated using the same data points used in the wind component interpolation.

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.