Plains Elevated Convection at Night (PECAN) MP2 MIPS Radiosonde Data Set

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2.0   Dataset Overview

The PECAN Mobile PISA (PECAN Integrated Sounding Array) 2 was the Mobile Integrated Profiling System (MIPS) facility run by the University of Alabama-Huntsville. MIPS released radiosondes at locations around the Central United States (Figure 1) during some of the PECAN Intensive Operation Periods (IOPs) and Unofficial Field Operations (UFOs). This data set includes the 84 high vertical resolution (1-second), quality controlled PECAN Mobile PISA 2 MIPS soundings released for the PECAN field phase (3 June to 16 July 2015).
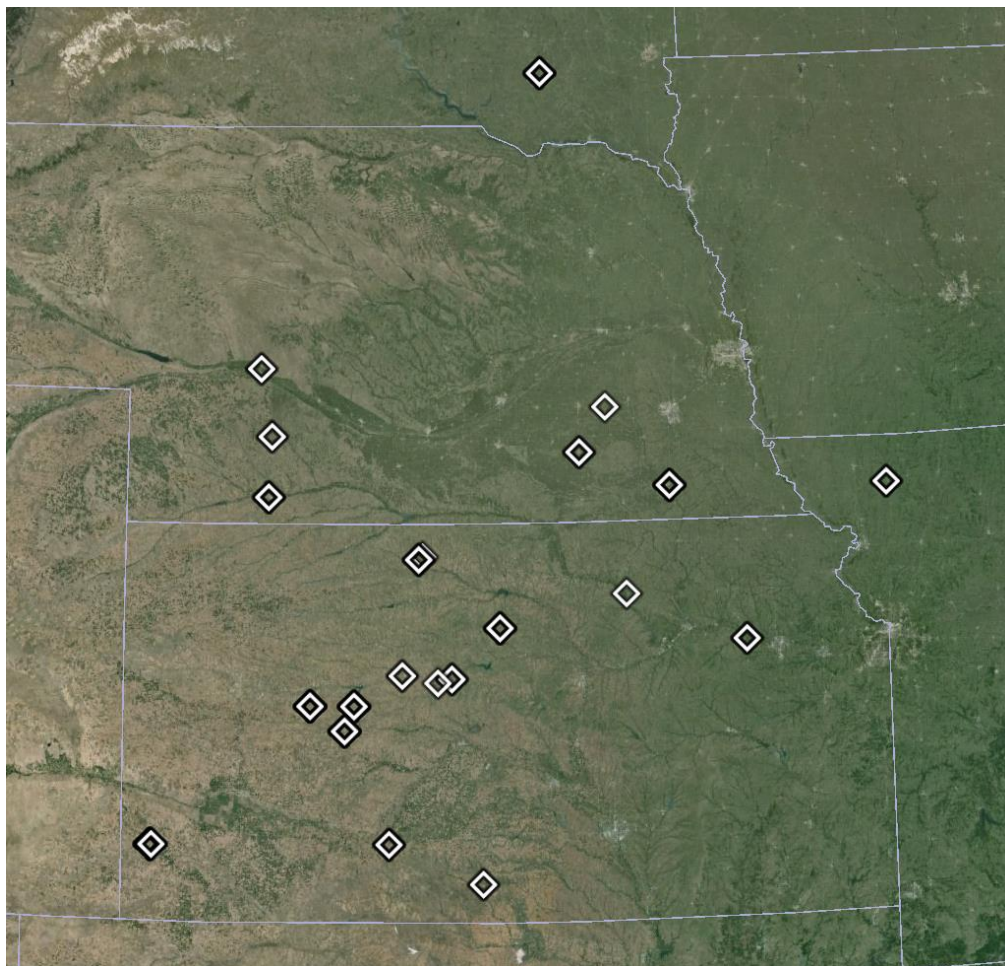

Figure 1. Location of the MP2 MIPS radiosonde site.

3.0   Project Overview

Plains Elevated Convection At Night (PECAN) was a multi-agency project designed to advance the understanding of continental, nocturnal, warm season precipitation. It focused on nocturnal convection in conditions over the central United States plains states with a stable boundary layer (SBL), a nocturnal low-level jet and the largest convective available potential energy located above the SBL. Three aircraft (University of Wyoming King Air, NOAA P-3, and NASA DC-8) as well as a large array of fixed and mobile ground instrumentation were deployed out of Kansas from 1 June to 15 July 2015. Further information on PECAN is available at the PECAN web site: https://www.eol.ucar.edu/field_projects/pecan and information on PECAN operations is available at the PECAN Field Catalog: http://catalog.eol.ucar.edu/pecan.

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.

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	Radiosonde Type	
7	Radiosonde Serial Number	
8	Ground Station Equipment	

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 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:

UAH_MIPS_yyyymmdd.cls where yyyy is the year, mm is the month, and dd is the day of the month.

The MP2 MIPS utilized InterMet IMET1 AB radiosondes using GPS for windfinding during PECAN.

3.4 Sample Data

The following is a sample of the FP6 Hesston, Kansas high resolution radiosonde data in ESC format.

```
Data Type:                      UAH MIPS Mobile/Ascending
Project ID:                     PECAN
Release Site Type/Site ID:      UAH MIPS Mobile
Release Location (lon,lat,alt): 099 48.48'W, 38 38.40'N, -99.808, 38.640, 694.5
UTC Release Time (y,m,d,h,m,s): 2015, 06, 03, 00:11:00
Radiosonde Type:                IMET1 AB
Radiosonde Serial Number:       20517
Ground Station Equipment:       iMET-3150
/
/
/
Nominal Release Time (y,m,d,h,m,s):2015, 06, 03, 00:11:00
 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
------ ----- ---- ----- ---- ----- ----- ----- ----- ----- -------- ----- ----- ----- ------- ---- ---- ---- ---- ---- ----
   0.0 939.4 29.5 14.5 40.0  -1.6   4.4   4.6 160.0 999.0 -99.808 38.640 999.0 999.0   694.5 99.0 99.0 99.0 99.0 99.0  9.0
   1.0 938.9 29.4 19.9 56.5  -5.3  12.3  13.4 156.8   5.0 -99.808 38.641 999.0 999.0   699.5 99.0 99.0 99.0 99.0 99.0 99.0
   2.0 938.4 29.4 19.8 56.5  -5.3  12.2  13.3 156.6   4.5 -99.808 38.641 999.0 999.0   704.1 99.0 99.0 99.0 99.0 99.0 99.0
```

3.5 Station List

Site ID	WMO ID	Site Name	Latitude	Longitude	Elev (m)
MP2	N/A	MIPS	Mobile	Mobile	Mobile

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.

4.1 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	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 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, 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

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.

Wind Issues – These soundings had periods with poor winds. These have mostly been flagged as bad.
  201506030011 – 643-602, 414-392, 308-207, and above 192mb
  201506030254 – 880-862mb
  201506170125 – 397-302mb
  201507060200 – 837-810, 497-468mb
  201507100555 – 866-828mb
  201507110212 – from surface to 800mb the winds look to be interpolated, flagged questionable

RH Issues – These soundings contain periods were there are issues with the RH.
  201506030011 – RH cycling 639-625 and 300-229mb
  201506100553 – RH sensor broken (constant 1%)
  201506170234 – RH sensor broken (constant 1%)

Data gaps – These soundings have substantial periods of parameter(s) missing below 500mb.

      201506030254 – no winds from surface to 866mb
      201506080556 – no data above 898mb
      201506110316 – no data above 602mb
      201507060200 – No winds below 837mb
      201507060527 – no data above 787mb
      201507060641 – no data above 590mb
      201507090207 – no data above 603mb
      201507090453 – no data above 555mb
      201507100457 – no data above 601mb
      201507100555 – no wind data below 849mb
      201507120550 – no data above 518mb
      201507140355 – no data above 503mb

Ascent Issues – These soundings contain periods there seem to be issues with the ascent of the radiosonde.

      201506030254 – Sonde initially reported to ascend at 10-18m/s for first 15 seconds after release (to 896mb), then stays near 894mb for ~350 seconds. The sonde is several degrees warmer than the 0103 and 0434 UTC soundings.
      201506030434 – Slow rising (1.5-2.5m/s) entire release
      201506050253 – Very rapid descent from 413mb to 481mb followed by very rapid ascent from 481mb to 382mb, temperature very cold during this whole period.
      201506170125 – Very rapid ascent from 365mb to 291mb followed by very rapid descent from 291mb to 338mb
      201506170234 – few periods of steady/falling sonde above 456mb
      201506260535 – Updraft starting ~880mb, steady/falling sonde ~501mb
      201507060402 – Several periods of rapid ascent and descent above 665mb. Biggest descent period from 435mb to 631mb.
      201507060527 – slow ascent sounding, period of descent from 787mb to 817mb.
      201507090453 – period of descent from 555mb to 737mb.
      201507100457 – slow ascent sounding above 850mb and periods of descent from 758mb to 760mb and 601mb to 703mb.
      201507140459 – very rapid descent (with bad temperature data) from 421mb to 475mb followed by very rapid ascent from 475mb to 404mb. Pressure, altitude, and temperature data all bad during this period. Another period of very rapid descent (with bad temperature data) from 277mb to 432mb followed by very rapid ascent from 432mb to 175mb
      201507140601 – period of descent from 576mb to 812mb
      201507160511 – period of very rapid descent from 382mb to 478mb followed by very rapid ascent from 478mb to 352mb, continued period of rapid ascent/descent above 352mb. Temperature data is bad during this entire period.

Incorrect release locations –

      All of the soundings released on 14 July had their release location in the raw data files as 38.271N 99.535W when the actual release location was 38.454N and 99.898W. The surface latitude and longitude values were corrected to use the proper values. The reported surface elevations were correct for the proper location and are unchanged from those in the raw data. In the first sounding of the day at 0001 UTC it took 104 seconds for the latitude and longitude values to adjust to the proper

values, so the latitude and longitude values up to the 104 second record are incorrect.

There are a few other soundings where the surface lat/long values differ in smaller amounts from the radiosonde GPS locations. These differences are <5km and are kept as is (201506110316, 201506170234, and 201507150307)

Other issues
201506040342 – Above 510mb the temperature goes to 0C and the RH to 1%. Flagged bad.
201506050253 – several short period cold temperature spikes between 307 and 213mb, flagged bad.
201506120131 – wetbulbing temperature 671mb
201506120429 – all data looks to be interpolated above 467mb flagged questionable.
201506120606 – Above 527mb the temperature goes to 0C and the RH to 1%. Flagged bad.
201506170234 – Cold biased.
201507010310 – all data looks to be interpolated above 222mb, flagged bad.
201507040501 – all data looks to be interpolated above 176mb, flagged bad.
201507090315 – cold biased.
201507110810 – wetbulbing temperature 591mb
201507140001 – all data bad above 350mb
201507160603 – temperature too cold from surface to 922mb, wetbulbing temperature 540mb

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.