

Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations (RELAMPAGO) 5hPa Vertical Resolution Sounding Composite Data Set Version 1.3 (March 2020)

1.0 Contacts:

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2.0 Dataset Overview

This data set contains a composite of interpolated 5hPa resolution upper air sounding data from all sources for the Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations (RELAMPAGO) project in the EOL Sounding Composite (ESC) columnar ASCII format. The data set contains 2714 soundings the Colorado State University (CSU) mobile radiosondes (105 soundings), the Center for Severe Weather Research (CSWR) mobile radiosondes (266 soundings), the University of Illinois (UIUC) mobile radiosondes (206 soundings), the DOE/ARM CACTI soundings from their two sites (1255 soundings), the INPE radiosondes from Sao Borja, Brazil (58 soundings), as well as the radiosondes from six locations around central Argentina that were operated by Servicio Meteorológico Nacional (SMN; 824 radiosondes).

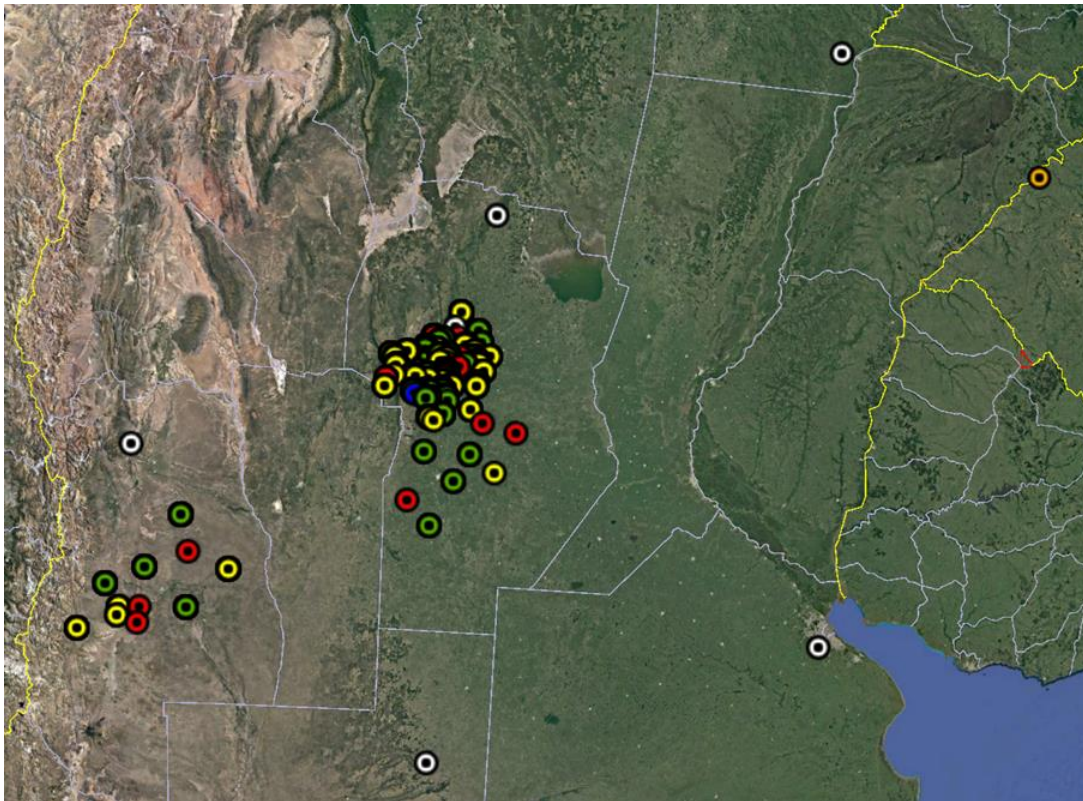


Figure 1. Locations of the soundings included in the RELAMPAGO high vertical resolution sounding composite data set. The CSU Mobile stations are red circles, CSWR yellow circles, UIUC green circles, SMN locations are white circles, DOE/ARM CACTI sites are blue circles, and the Sao Borja, Brazil site is orange.

3.0 Project Overview

The Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations (RELAMPAGO) field program was set up to elucidate the connections between the land surface, complex terrain, convective development, and the production of severe weather, the role of terrain processes in initiating and developing organized convective systems and altering flows within and above the convective boundary layer, and the roles of environmental moisture, aerosols, and instability on the resultant intensity, organization, precipitation, and high impact weather production of deep convective systems. It provided a unique configuration of atmospheric profiling and remote sensing capabilities including fixed and mobile radars, radiosonde systems, and surface meteorological instrumentation. There were additional projects occurring at the same time that were cooperating with RELAMPAGO, these included the DOE/ARM CACTI (Cloud, Aerosol, and Complex Terrain Interactions) project which included the DOE/ARM G1 aircraft and a suite of in-situ and remote sensing instrumentation in the Sierras de Córdoba mountain range of north-central Argentina, and the Instituto Nacional de Pesquisas Espaciais (INPE) operations that occurred in the area around Sao Borja, Brazil. Further information on RELAMPAGO is available at the RELAMPAGO web site at NCAR/EOL: https://www.eol.ucar.edu/field_projects/relampago and information on the RELAMPAGO deployments is available at the RELAMPAGO Field Catalog: <http://catalog.eol.ucar.edu/relampago>.

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.

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 (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. For this composite data set these non-standard header lines vary depending on the data source. See the individual data set readmes for details.

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	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	Geopotential 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")

4.3 Data Specifics

Details on the radiosonde systems included in this data set are included in this section. Links are included to the documentation for the individual sounding data sets for details on processing and quality control.

Colorado State University Radiosondes

105 total radiosondes with 1 second vertical resolution
 Vaisala RS41-SG radiosondes
 MW41 2.2.1DigiCORA radiosonde system
<https://doi.org/10.26023/3QGG-JQKS-AFOG>

CSWR Mobile Radiosondes

266 total radiosondes with 5 m vertical resolution
 GRAW DFM-09 radiosondes
 GRAWMET 5.14 radiosonde system
 These soundings came with data quality flags provided by CSWR, these were translated to those used by NCAR/EOL and included in the converted files. In the CSWR documentation one of these flags was mislabeled (QD was labeled as a wind direction quality flag, but it was a dew point quality flag. Version 1.2 (released Dec 2019) of the composite corrects this translation. The impacted flags are qrh, qu and qv. No data values were changed. Version 1.3 (released March 2020) includes CSWR updated surface wind speed and direction and they also added additional objective/subjective flags.

University of Illinois Mobile Radiosondes

206 total radiosondes with 5 m vertical resolution
 GRAW DFM-09 radiosondes
 GRAWMET 5.14 radiosonde system
 These soundings came with data quality flags provided by CSWR, these were translated to those used by NCAR/EOL and included in the converted files. In the CSWR documentation one of these flags was mislabeled (QD was labeled as a wind direction quality flag, but it was a dew point quality flag. Version 1.2 (released Dec 2019) of the composite corrects this translation. The impacted flags are qrh, qu and qv. No data values were changed. Version 1.3 (released March 2020) includes CSWR updated surface wind speed and direction and they also added additional objective/subjective flags.

Brazil Sao Borja RS41 Radiosondes

30 total radiosondes at 2 second vertical resolution
Vaisala RS41-SGP radiosondes
MW41 2.2.14 DigiCORA radiosonde system
<https://doi.org/10.26023/416N-161D-BC09>

Brazil Sao Borja RS92 Radiosondes

28 total radiosondes at 2 second vertical resolution
Vaisala RS92 radiosondes
<https://doi.org/10.26023/416N-161D-BC09>
The sounding at 1200 UTC on 2 November has mandatory and significant level data below 330 mb and 2 second data above.
The sounding at 1200 UTC on 5 November has mandatory and significant level data below 311 mb and 2 second data above.

SMN Argentina Radiosondes

824 total radiosondes: Cordoba (270 soundings), Ezeiza (90 soundings), Mendoza (146 soundings), Resistencia (87 soundings), Santa Rosa (95 soundings), Villa de Maria del Rio Seco (136 soundings)

All radiosondes used were Modem GPSonde M10 (2 second vertical resolution) except for Ezeiza which used Vaisala RS41 with pressure derived from GPS height/DigiCORA MW41(1 second vertical resolution) until 22 December 2018 when it changed to the Modem radiosondes. One sounding (29 December 2018) was provided at mandatory and significant levels only.
<https://doi.org/10.26023/E8MP-0GD3-4903>

All sondes had the solar and infrared corrections applied by the radiosonde system and GPS winds.

Highest Resolution Radiosonde Composite

Contains all of the above soundings at their native resolution.
<https://doi.org/10.26023/GKFF-YNBJ-BV14>

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:

RELAMPAGO_5mb_yyyymmdd.cls where yyyy is the year, mm is the month, and dd is the day of the month.

4.4 Sample Data

The following is a sample of the 5hPa vertical resolution radiosonde data in ESC format.

```
Data Type: CSU Mobile Radiosonde/Ascending
Project ID: RELAMPAGO
Release Site Type/Site ID: Mobile/CSU_Mobile
Release Location (lon,lat,alt): 064 10.46°W, 31 25.16°S, -64.174, -31.419, 385.0
UTC Release Time (y,m,d,h,m,s): 2018, 10, 31, 15:13:00
Radiosonde Type: RS41-SG
Radiosonde Serial Number: P3311138
Ground Station Software: MW41 2.2.1
/
/
Nominal Release Time (y,m,d,h,m,s):2018, 10, 31, 15:13:00
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	970.9	24.8	7.9	34.0	-2.0	1.1	2.3	120.0	0.0	-64.174	-31.419	999.0	999.0	385.0	3.0	3.0	3.0	1.0	1.0	99.0
2.0	970.6	23.9	6.9	33.3	-2.5	0.6	2.6	104.3	1.7	-64.174	-31.419	999.0	999.0	388.1	3.0	3.0	3.0	1.0	1.0	99.0
3.0	970.1	23.6	6.8	34.0	-2.7	0.7	2.8	104.0	5.6	-64.174	-31.419	999.0	999.0	393.7	2.0	1.0	1.0	1.0	1.0	99.0

4.5 Station List

Site ID	WMO ID	Site Name	Country	Latitude	Longitude	Elev (m)
CSU_Mobile	N/A	CSU Mobile		Mobile	Mobile	Mobile
CSWR_Mobile	N/A	CSWR Mobile		Mobile	Mobile	Mobile
UIUC_Mobile	N/A	UIUC Mobile		Mobile	Mobile	Mobile
N/A	N/A	Sao Borja	BR	-28.643	-55.989	92
N/A	87344	Cordoba	AR	-31.298	-64.212	490
N/A	87576	Ezeiza	AR	-34.819	-58.542	21
N/A	87418	Mendoza	AR	-32.844	-68.797	704
N/A	87155	Resistencia	AR	-27.439	-59.046	52
N/A	87623	Santa Rosa	AR	-36.593	-64.279	191
N/A	87244	Villa de Maria del Rio Seco	AR	-29.906	-63.726	341
M1		Cordoba	AR	-32.130	-64.730	1139
S1		San Luis	AR	-31.950	-65.150	565

5.0 Data Quality Control Procedures

The quality control procedures were conducted on the native resolution data files. No additional quality control has been performed on these 5hPa vertical resolution data files.

The 5hPa data were interpolated from the native resolution data using a weighted average of the values used on either side based on the distance from the interpolation height. If a record was at exactly the 5hPa height interval, it was used as is unless the data were flagged "Bad".

Data of the highest possible quality in the native resolution data files was used in the development of the interpolated 5hPa vertical resolution data. The data quality flags in these 5hPa data are the worst quality flag of the data used to interpolate the value.

5.1 Data Quality Issues of Note

See the readme files linked above for details on the data quality issues in each individual sounding data set.

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.