1. **Contacts:**

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**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 22 stations (Figure 1 and Section 3.5) located within the WINTER domain for the WINTER field phase (1 February 2015 to 15 March 2015). A total of 1934 quality controlled, high resolution (1-second) soundings are contained in the final WINTER data set.

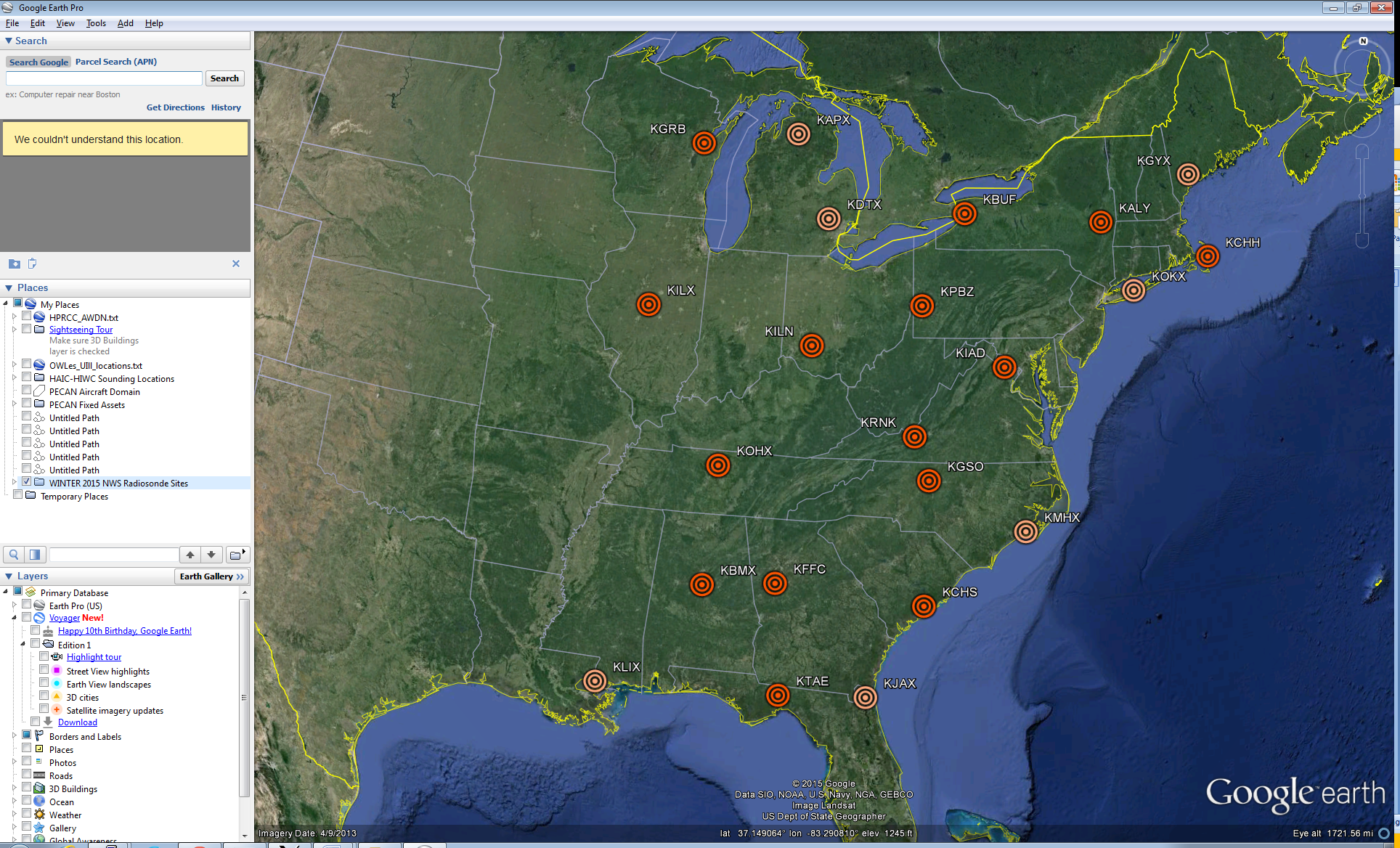


Figure 1. Locations of the 22 NWS release locations included in the WINTER data set. The orange (pink) stations used LMS-6 (VRS92) radiosondes.

Wintertime Investigation of Transport, Emission, and Reactivity (WINTER) was an atmospheric chemistry field campaign that was focused on wintertime emissions and chemical processes in the northeastern United States. The goals of WINTER included 1) characterize the chemical transformations of wintertime emissions; 2) assess the dominant mechanism of secondary aerosol formation and quantify the distribution of inorganic and organic aerosol types in winter; and 3) provide constraints on wintertime emission inventories for urban areas, power plants, and agricultural areas and characterize the export pathways of primary pollutants to the North Atlantic. WINTER was based out of NASA Langley in Hampton, VA and utilized the NSF/NCAR C-130 aircraft. Further information on WINTER is available at the WINTER web site: <https://www.eol.ucar.edu/field_projects/winter> and information on WINTER flights and operations is available in the NCAR/EOL WINTER Field Catalog: <http://catalog.eol.ucar.edu/winter>.

**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.

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

The Lockheed Martin Sippican LMS-6 GPS Radiosonde with the Capacitance RH sensor.

The Vaisala RS92-NGP Radiosonde /Intermet IMS-2000 with the Twin alternatively heated Humicap capacitance RH sensor.

See Section 3.5 for details on radiosonde type by station.

All stations utilized GPS windfinding.

**3.4 Sample Data**

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

Data Type: National Weather Service Sounding/Ascending

Project ID: WINTER

Release Site Type/Site ID: KALY Albany, NY / 72518

Release Location (lon,lat,alt): 073 49.96'W, 42 41.53'N, -73.833, 42.692, 95.0

UTC Release Time (y,m,d,h,m,s): 2015, 01, 31, 23:03:13

Ascension Number: 63

Radiosonde Serial Number: 88060626

Balloon Manufacturer/Type: Totex / GP26

Balloon Weight: 0.600

Radiosonde Type/RH Sensor Type: Lockheed Martin Sippican LMS-6 GPS Radiosonde / Capacitance sensor

Surface Observations: P: 1010.6, T: -17.0, RH: 50.0, WS: 3.6, WD: 318.0

Nominal Release Time (y,m,d,h,m,s):2015, 02, 01, 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 1010.7 -9.6 -17.6 52.0 1.5 -0.5 1.6 288.4 999.0 -73.833 42.692 999.0 999.0 95.0 1.0 1.0 1.0 1.0 1.0 9.0

1.0 1010.0 -9.6 -17.7 51.8 1.7 -0.7 1.8 292.4 5.0 -73.833 42.692 999.0 999.0 100.0 1.0 3.0 3.0 1.0 1.0 99.0

2.0 1009.4 -9.6 -17.7 51.5 2.0 -0.9 2.2 294.2 5.0 -73.832 42.692 999.0 999.0 105.0 1.0 3.0 3.0 1.0 1.0 99.0

**3.5 Station List**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Site ID** | **WMO ID** | **Site Name** | **State** | **Latitude** | **Longitude** | **Elev (m)** | **Sonde Type** | **#** |
| KALY | 72518 | Albany | NY | 42.692 | -73.833 | 95 | LMS6 | 87 |
| KAPX | 72634 | Gaylord | MI | 44.908 | -84.719 | 448 | VRS92 | 87 |
| KBMX | 72230 | Birmingham | AL | 33.180 | -86.783 | 174 | LMS6 | 93 |
| KBUF | 72528 | Buffalo | NY | 42.940 | -78.725 | 218 | LMS6 | 87 |
| KCHH | 74494 | Chatham | MA | 41.657 | -69.959 | 15 | LMS6 | 87 |
| KCHS | 72208 | Charleston | SC | 32.895 | -80.028 | 13 | LMS6 | 87 |
| KDTX | 72632 | White Lake | MI | 42.699 | -83.472 | 330 | VRS92 | 87 |
| KFFC | 72215 | Peachtree City | GA | 33.356 | -84.567 | 245 | LMS6 | 90 |
| KGRB | 72645 | Green Bay | WI | 44.498 | -88.112 | 209 | LMS6 | 83 |
| KGSO | 72317 | Greensboro | NC | 36.098 | -79.943 | 276 | LMS6 | 93 |
| KGYX | 74389 | Gray | ME | 43.893 | -70.257 | 124 | VRS92 | 89 |
| KIAD | 72403 | Sterling | VA | 38.977 | -77.486 | 88 | LMS6 | 88 |
| KILN | 72426 | Wilmington | OH | 39.421 | -83.821 | 323 | LMS6 | 86 |
| KILX | 74560 | Lincoln | IL | 40.151 | -89.338 | 179 | LMS6 | 87 |
| KJAX | 72206 | Jacksonville | FL | 30.483 | -81.701 | 10 | VRS92 | 87 |
| KLIX | 72233 | Slidell | LA | 30.338 | -89.825 | 10 | VRS92 | 89 |
| LMHX | 72305 | Newport | NC | 34.776 | -76.878 | 11 | VRS92 | 88 |
| KOHX | 72327 | Nashville | TN | 36.247 | -86.562 | 180 | LMS6 | 87 |
| KOKX | 72501 | Upton | NY | 40.865 | -72.863 | 20 | VRS92 | 87 |
| KPBZ | 72520 | Pittsburgh | PA | 40.532 | -80.218 | 360 | LMS6 | 88 |
| KRNK | 72318 | Blacksburg | VA | 37.206 | -80.414 | 639 | LMS6 | 89 |
| KTAE | 72214 | Tallahassee | FL | 30.446 | -84.300 | 53 | LMS6 | 88 |

**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 | < -15oC/km  < -30oC/km  > 50oC/km  > 100oC/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. No high resolution data are available for the following 00/12 UTC sounding times:

KGRB 12 Feb at 12 UTC, 19 Feb at 00/12 UTC, and 9 Mar at 00 UTC

KFFC 24/25 Feb at 00/12 UTC.

KILN 7 Mar at 00 UTC

KMHX 13 Feb at 00 UTC

1. 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:

KALY 20150209 at 2302 UTC (560-520mb)

KBMX 20150222 at 2309 UTC (640-475mb)

KFFC 20150302 at 2311 UTC (570-555mb)

KFFC 20150303 at 1114 UTC (680-630mb)

KGYX 20150208 at 2300 UTC (570-530mb)

KRNK 20150304 at 1104 UTC (535-460mb)

KRNK 20150305 at 2334 UTC (660-600mb)

1. Significant GPS/wind data gaps in the following soundings:

KAPX 20150226 at 1120 UTC (no GPS sfc-240mb)

KJAX 20150208 at 2305 UTC (little GPS data)

KJAX 20150220 at 2313 UTC (little GPS below 620mb, none above 300mb)

KJAX 20150224 at 1111 UTC (little GPS data)

KMHX 20150215 at 1101 UTC (little GPS above 340mb)

KMHX 20150226 at 1151 UTC (little GPS below 260mb)

KOHX 20150302 at 2309 UTC (no GPS)

KTAE 20150206 at 1101 UTC (no GPS above 630mb)

KTAE 20150211 at 1101 UTC (little GPS data)

1. Significant RH data gaps in the following soundings:

KILX 20150218 at 1104 UTC (no RH data)

KOHX 20150304 at 2301 UTC (880-540mb)

KTAE 20150313 at 1102 UTC (985-820mb)

1. Two soundings stopped data transmission below 500 mb:

KFFC 20150222 at 2309 UTC (810mb)

KGRB 20150223 at 1121 UTC (790mb)

1. Periods of falling radiosonde:

KLIX 20150305 at 1431 UTC (several periods below 705mb, interspersed with periods of high ascent rates of 15-20m/s)

1. Bad low level temperature data:

KTAE 20150219 at 2301 UTC (first few sonde temperatures are very high)

KTAE 20150220 at 2312 UTC (first few sonde temperatures are very high)

KTAE 20150314 at 2303 UTC (first few sonde temperatures/RH are cold/dry)

**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.