Title: NSSL Mobile Sounding Quality Controlled (QC) Meteorological Data (PERiLS)

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1.0 Data Set Overview:

This document describes data characteristics from National Severe Storms Laboratory (NSSL) mobile sounding systems provided in support of the Propagation, Evolution, and Rotation in Linear Storms (PERiLS) during the late spring of 2022.

The files contained in this archive and described in this document represent a processed file after the completion of the soundings and the project itself. The raw collected data and various file formats, including those readily useable by programs such as SHARPpy are available upon request. To get these files, or more information about the type of raw data available, please contact the author of this document.

2.0 Instrument Description:

The NSSL mobile sounding vehicle were collected from a 2022 Ford F-350 (Lidar). The vehicle contained not only the sounding system and associated VHF and GPS antennas, but also a surface observation station collecting state observations at the ground for input into the surface conditions for each sounding. These instrument racks were mounted above the roof line, over the hood of the vehicle to provide clean observations even while moving. For more information on the mobile mesonet observing systems contact Dr. Sean Waugh or explore the mobile mesonet data archive for this project. Sounding information is described further in sections 3.0, 4.0 and 5.0 below.

The sounding system in use is an MW41 system from Vaisala, utilizing the RS41-SGP radiosonde. The RS41 utilizes the PTU sensor technology from Vaisala but also includes a sensor specifically for pressure rather than computing pressure from geopotential height as is standard with the RS41-D and –SG models. Data from the radiosonde is transmitted at 1 Hz to the ground receiving station using the 400-406 MHz radio band and has a maximum transmitting range of 350 km. For detailed information on the RS41 or MW41 sounding systems please see Vaisala (www.vaisala.com), but below are the general sensor specifications for the RS41

Temperature

Measurement Range:	+60….-95 °C
Resolution:	0.01 °C
Response Time:	0.5 s
Combined Uncertainty <16 km:	0.3 °C
Combined Uncertainty >16 km:	0.4 °C

Humidity

Measurement Range:	0…..100 %
Resolution:	0.1%
Response Time:	<0.3 s @ +20°C, <10 s at -40°C
Combined Uncertainty:	4%

Pressure

Measurement Range:	sfc pressure to 3 hPa
Resolution:	0.01 hPa
Combined Uncertainty:	0.4 hPa

Wind Speed

Velocity Uncertainty:	0.15 m/s
Resolution:	0.1 m/s
Max Wind Speed:	160 m/s

Wind Direction

Directional uncertainty:	2 deg
Resolution:	0.1 deg

*While various instruments specify a particular accuracy, it takes a finite amount of time for these sensors to respond to a given change, known as the response time or time constant. This response time is a combination of every factor influencing the measurement being made and thus represents an unknown quantity as it is impossible to completely describe every scenario in which the sensors are being used.

For questions, comments, concerns, or more information, contact the NSSL/Field Observation Facilities Support (FOFS) Mobile Mesonet Lead: Sean Waugh (sean.waugh@noaa.gov)

3.0 Data Collection and Processing:

The QC'd sounding files for each individual launch combine information from all of the available sounding files to provide a single record of all relevant information for the entire sounding. The first record of each file contains the input surface conditions at the time the sounding was launched, and the file ends at the top of the ascent portion of the sounding (when the balloon burst is detected or when the sounding it terminated).

Each file contains a complete record of the entire sounding, with outputs including Vaisala specific variables and several in-house derived variables (to be described in section 4.0). The file names are structured to contain the vehicle identifier from which the sounding was launched, as well as the UTC date/time of launch.

Users of this data, as is the case with all data, are encouraged to be cognizant of the limitations of the instrumentation and think critically of the calculated variables. Typical sounding parameters such as convective available potential energy (CAPE) and shear from various levels are computed and provided, however these values can be very sensitive to integration depth and surface parameters, so each should be evaluated critically. Additionally, partial soundings often occur in the research realm and such profiles have unintended consequences on computed parameters.

4.0 Data Format

Each file contains a comma delimited string of values, with 3 header lines at the top of the file. The filename itself has the following format:

NSSL_{platform name}_MW41_output_{date of IOP in YYYYMMDD}_{UTC time of launch in HHMMSS}.csv

The first line of the header contains labels for the second line of values, which are in this order:

Radiosonde ID:	The type of radiosonde used
Frequency:	The radio frequency used to communicate with the radiosonde
Serial Number:	Serial number of the radiosonde
SFC to 500 m lapse rate:	The rate of temperature change between the surface and 500 m AGL (°C/km)
0-1 km lapse rate:	The rate of temperature change between the surface and 1 km AGL (°C/km)
0-3km lapse rate:	The rate of temperature change between the surface and 3 km AGL (°C/km)
700-500 mb lapse rate:	The rate of temperature change between the 700 mb and 500 mb pressure surfaces
Sfc to 500 m wind shear:	The change in wind direction/speed between the surface and 500 m AGL
0-1 km wind shear:	The change in wind direction/speed between the surface and 1 km AGL
Bunkers motion U:	The east/west component of right moving supercell motion following Bunkers et al. 2000
Bunkers motion V:	The north/south component of right moving supercell motion following Bunkers et al. 2000
Critical Angle:	The angle between the storm-relative wind at the surface and the 0-500 m AGL shear vector

Sfc to 500 m SRH:	Storm Relative Helicity (SRH). An estimate of a thunderstorms potential to acquire rotation given an environmental vertical wind shear profile, between the surface and 500 m AGL (m^2s^{-2})
0-1 km SRH:	The same as sfc to 500 m SRH, except for the surface to 1 km layer (m^2s^{-2})
0-3 km SRH:	The same as sfc to 500 m SRH, except for the surface to 1 km layer (m^2s^{-2})

The following values are computer for sfc based, most unstable, and the lowest 100 mb mixed layer parcels each

Convective Available Potential Energy (CAPE):
Assuming basic parcel theory, CAPE represents the amount of buoyant energy available to accelerate a parcel vertically due to differences in the parcel temperature vs the environmental temperature.

Convective Inhibition (CIN):
CIN is similar to CAPE, except it represents the negative buoyancy available to inhibit or suppress vertical motion

Lifting Condensation Level:	The height at which a parcel becomes saturated (m)
Level of Free Convection:	The level at which a parcel of air lifted dry-adiabatically until saturated, and moist adiabatically thereafter, first becomes warmer than the environment (m)
Equilibrium Level:	Above the LFC, the level at which a parcel again becomes equal to the environmental temperature (m)

End section on parcel specific values

Downdraft CAPE:	The mount of positive and negative cape in the lowest 400 mb of a sounding following a moist adiabat down to the surface from the minimum theta-e value
0-3 km CAPE:	Integrated ML CAPE in the lowest 3 km AGL
0-3 km CIN:	Integrated ML CIN in the lowest 3 km AGL
Supercell Composite Parameter:	A combination parameter that includes 0-3 km SRH, CAPE, and BRN shear
Significant Tornado Parameter:	A combination parameter that includes 0-6 km bulk wind difference, 0-1 SRH, SFC CAPE, and LCL height
Effective SRH:	The SRH computed from a layer where lifted parcels are buoyant (m^2s^{-2})
Complete sounding:	An indicator to readily mark whether the sounding reached 300 mb

Following the computed parameters provided in the second row of the file, the third header line contains the column information for the body of the file. Each column header is largely self-explanatory, however a brief description of general sections of data are presented here.

Following the date and radio transmission time in columns 1 and 2, columns 3 through 11 contain filtered data. This data utilizes the filtering algorithms put in place from Vaisala and as such are proprietary. The temperature field for example contains a smoothing parameter and an offset that is applied to account for incoming solar radiation. The derived winds in this section are the result of a significant filter that reduces sway of the radiosonde GPS coordinates due to the pendulum motion of the balloon, among other things .

The next section in columns 12 through 19 contain the raw GPS data, including latitude and longitude. This second comes straight from the GPS itself without any filtering or smoothing applied. The final two columns in this section (18 and 19) contain the GPS derived wind direction and speed respectively. This derivation was done using differences between successive lat/lon points with no smoothing applied.

Columns 20 through 27 contain the raw PTU data, without filtering applied.

Columns 28 through 31 contain the Vaisala wind components (some filtering applied).

The final column contains the calculated Mixing Ratio

5.0 Data Remarks

As was mentioned before, many of the parameters calculated here are sensitive to integration layers and surface variable inputs. As such, they should be examined carefully before use. Comparisons between these soundings and more traditional operational soundings are difficult due to the time resolution differences between them. Additionally, while the filtered data from Vaisala does provide a smoother more consistent output, it is not without its faults. For example, the solar radiation correct that Vaisala applies is done so universally, whether the radiosonde is in sun or not. Hence as is the case with all observations, care must be taken to adequately understand the environment that is being sampled.

6.0 References

Bunkers, M. J., B. A. Klimowski, J. W. Zeitler, R. L. Thompson, and M. L. Weisman, 2000: Predicting Supercell Motion Using a New Hodograph Technique. Weather and Forecasting, **15**, 61-79.