Penn State Windsond Observations: PERiLS 2023

Lead Author: Paul Markowski
Penn State University
pmarkowski@psu.edu
(814) 865-0478
502 Walker Building
University Park, PA 16802

Author: Luke LeBel
Penn State University
ljl5305@psu.edu

1. **Dataset description:** Data Version 1.0, updated 14 November 2023

This dataset contains Windsond observations collected by Penn State University (PSU) researchers during the 2023 PERiLS field campaign. Our goal was to launch sondes rapidly in advance of and within QLCS cold pools. A summary of our observation locations and times for each IOP is summarized below:

IOP	Launch Location	Launch Time Window	# of Launches
2	34.091153N 91.381427W, 54 m (~3 km S Gillett, AR)	0728–0922 UTC 3 March 2023 (data collection ended at 0942 UTC)	38
3	33.378983N 91.263404W, 39 m (~6 km NNE Lake Village, AR)	Period 1: 2232–0009 UTC 24–25 March 2023 (data collection ended at 0030 UTC) Period 2: 0106–0112 UTC 25 March 2023 (data collection ended at 0131 UTC)	25 5
4	34.830251N 87.861038W, 150 m (~17 km WNW Florence, AL)	Period 1: 0211–0316 UTC 1 April 2023 (data collection ended at 0348 UTC) Period 2: 0552–0606 UTC 1 April 2023 (data collection ended at 0635 UTC) Other: Test launch at 0403 UTC 1 April 2023	34 7 1

A very brief summary of the features we observed during each IOP is presented in the following table:

IOP	Description of observations
2	Rapid (every ~3 minutes) balloon launches were conducted throughout the passage of a weakening, nocturnal QLCS that was embedded within stratiform rainfall.
3	Period 1: Rapid (every ~1-3 minutes) balloon launches were conducted in the near-inflow region of a nontornadic (but tornado-warned) supercell with a few balloons sampling the supercell forward flank, rear flank, and cold pool. Period 2: A few sondes were launched before and within a developing sub-severe QLCS.
4	Period 1: Rapid (every ~1-3 minutes) balloon launches were conducted in the far-inflow region of a weakening supercell thunderstorm. Period 2: A few sondes were rapidly (every ~1–3 minutes) launched in advance of a tornado-warned supercell/developing QLCS.

2. Instrument description:

We used the Windsond system from Sparv Embedded. For information regarding sensor accuracy and response time, we refer the reader to Markowski et al. (2018) and Bartos et al. (2022). Please feel free to reach out with additional questions.

3. Data Collection and Processing

Sondes were launched at approximately 1–3-minute intervals in ahead of, within, and behind the convective systems documented in 2023 PERiLS IOPs 2, 3, and 4.

<u>Quality assurance and control:</u> Only very minimal work has been done to quality control the data by removing egregious files. All the files produced during our data collection periods are included in the dataset, divided into directories corresponding to each IOP. Any data files associated with sondes that were flagged in the quality control process are still included but reside in subdirectories within the IOP directory. The *unlaunched_sondes* subdirectory includes all sondes that our launch system never detected as having been launched (this may be because the sondes never left the van, or because we immediately lost connection with the sondes after launch, or because the sondes did not rise sufficiently high for a launch to be detected). If present, the *early_test_launches* subdirectory includes any sondes launched before the official data collection period. Finally, the *sonde_errors* subdirectory, if present, includes sondes that we have identified as having consistent issues after launch.

Because of the minimal quality control applied to this dataset, we recommend users manually inspect our data (and compare against other sources such as upper-air soundings, if applicable) before using it in research applications.

4. Data format:

We have included all the files produced by our data collection system in this dataset. Most users will only need to use a few of the file types, which are summarized below. The files for each sonde have a consistent prefix, of the form “YYYY-MM-DD-N”, where YYYY is the four-digit year, MM is the two-digit month, DD is the two-digit day, and N is a sonde ID that is the based on the time that the sonde was turned on. For example, all files beginning with “2023-03-03_0726.” correspond to a sonde turned on at 0726 UTC 3 March 2023. If two soundings are turned on at the same time, a “_1” will be appended to the prefix.

The most useful data files for each sonde include:

- <u>YYYY-MM-DD-N.kml:</u> Useful to visualize sonde trajectories in Google Earth.
- <u>YYYY-MM-DD-N.psu_format.csv:</u> *This is the file format that we recommend using.* It includes every data point received from the sonde from the time the sonde is turned on, and reports time, pressure (mb), GPS altitude (m MSL), latitude, longitude, uncorrected temperature (°C), uncorrected humidity (%), time from launch (s), unfiltered wind speed (m/s), and unfiltered wind direction (deg).
- <u>YYYY-MM-DD-N.raw_history.csv:</u> *This file format may also be useful.* As with the psu_format files, it includes every data point collected from the time the sonde is turned on. One difference is that this file includes heights above the ground obtained from integrating the hydrostatic equation (as opposed to from the GPS system). This can be useful because the GPS altitude is reported relatively infrequently.
- <u>YYYY-MM-DD-N.raw_flight_history.csv:</u> The same as the raw_history files, although it only includes every data point collected after the launch of the sonde is detected.
- <u>YYYY-MM-DD-N.sounding.csv:</u> This file includes observtions interpolated to 20 m intervals (above ground level). Note that this only includes observations as a sonde ascends, and therefore may not include all observations (if sondes descend while in precipitation, for example).

5. Data remarks:

There is one noteworthy issue with the sondes launched for IOPs 2 and 3. The sondes launched in these IOPs experienced connection issues, and often were only trackable for 10–20 km (with data becoming intermittent before then). In IOP 2, 75% of data observations are within 11.8 km of the launch site, and in IOP 3, 75% of data observations are within 12.2 km of the launch location. These values contrast with the data collection for IOP 4, where 75% of the data observations are within 33.09 km of the launch location (i.e., the sondes were trackable for a much longer time/distance in IOP 4). A different batch of sondes was used in IOP 4 than was used in IOPs 2 and 3, and therefore we believe that this issue is a result of a "bad" batch of sondes.

Additionally, we have noticed that there appear to be some occasional issues with the relative humidity data in heavy rainfall. These issues are associated with a seemingly unphysical discontinuity/downward step change in relative humidity values. The origin of these issues is unknown. Based on conversations with the manufacturer, these data probably should not be used in analyses.

We encourage people interested in using this dataset to reach out to us with any questions regarding the observations.

6. References:

Bartos, E. A., P. M. Markowski, and Y. P. Richardson, 2022: Three-Dimensional Thermodynamic Observations in Supercell Thunderstorms from Swarms of Balloon-Borne Sondes. *Mon. Wea. Rev.*, **150**, 1689–1723, https://doi.org/10.1175/MWR-D-21-0122.1.

Markowski, P. M., Y. P. Richardson, S. J. Richardson, and A. Petersson, 2018: Aboveground thermodynamic observations in convective storms from balloonborne probes acting as pseudo-Lagrangian drifters. *Bull. Amer. Meteor. Soc.*, **99**, 711-724, https://doi.org/10.1175/BAMS-D-17-0204.1.