Stony Brook Univ. Windsond Data for PERiLS-2023

Michael M. French
Stony Brook University
michael.m.french@stonybrook.edu
(631) 632-8659
111 Endeavour Hall
Stony Brook, NY 11794-5000
ORCiD: 0000-0003-4601-8233

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1.0 Dataset Description

The accompanying dataset consists of Windsond data obtained by Stony Brook Univ. (SBU) researchers during the PERiLS-2023 field campaign. SBU participated in two intensive observing periods (IOPs) during the 2023 field campaign, IOPs 3 and 5, but collected data only in IOP-5. Our goal was to launch Windsonds rapidly in advance of approaching QLCSs to sample the environment in the lowest 2-3 km above the ground, ideally at locations favorable for imminent mesovortex and/or tornado development.

Version: 1.0
Date: 1 August 2024
Status: Final
Time period: April 2023
Location: Variable (see section 3.0)
Frequency: Variable (see section 3.0)

2.0 Instrument Description

The Windsond data we collected used Windsonds developed by Sparv Embedded (http://windsond.com/windsond_catalog_Feb2019.pdf). The Windsond system consists of temperature and moisture sensors housed within a Styrofoam cup that is powered by a lithium rechargeable battery. The cup can be tied to a latex weather balloon via a string, and once launched, is tracked via GPS using a receiver and Sparv Embedded's proprietary software. We used sonde type S1H3-R Reusable and RR2 radio receiver that allows for multiple sondes to be launched and tracked simultaneously. Data frequency are 1 Hz ideally but may sometimes be reduced owing to poor receiver connectivity. Sondes can be programmed to detach from the balloon and descend to the ground at a specified height level, details of which are given in section 3.0. Sparv Embedded provides the following accuracy information for atmospheric variables:

Variable	Specification
GPS	Rated to altitude of 40 km ASL
Pressure/Altitude	Range: 1100-300 hPa Pressure accuracy/resolution: 1 hPa / 0.02 hPa Altitude accuracy/resolution: 7 m / 0.4 m (at sea level)
Temperature	Accuracy/resolution: 0.2° C / 0.01° C at 25°C Response time: 6 s
Moisture	Accuracy/resolution: 1.8% / 0.05% Response time: 6 s
Wind speed	Accuracy/resolution: ~5% / 0.1 m s^{-1}
Wind direction	Resolution: 0.1°

3.0 Data Collection and Processing

Windsond data were obtained in one IOP, IOP-5 for PERiLS-2023. Windsonds were launched from the same location but at different times (i.e., not all sondes were launched simultaneously). Also, the time between sondes launched varied depending on motion of the QLCS, QLCS evolution, and the number of sondes and helium remaining. The table below summarizes the locations, times, and number of sondes successfully launched in IOP-5:

IOP	Date	Location	Times	Sondes
5	5 April 2023	35.410981° N, 90.954563° W; ~4 km E of Hickory Ridge, AR	15:41 – 17:08 UTC	9

More details of the IOP is provided in the table below:

IOP	Description/Notes
5	Our team set up in the southern part of the PERiLS sub-domain at a location that was chosen to optimize potential dual-Doppler radar collection with the SBU SKYLER-2 radar truck collocated with the SBU Windsond team. Therefore, unlike in 2022, our location was not chosen to optimize Windsond data collection. Nonetheless, we launched ~10 Windsonds out ahead of the target weak QLCS beginning at ~1540 UTC. After that, a line segment out ahead of the main QLCS developed and moved towards us with a tornado warning. Sampling continued until ~1630 UTC at which point the pre-line cells overtook our location. After that rain stopped, we had time for two additional Windsond launches at 16:49 and 16:54 UTC before the main convective line overtook our location, after which data collection ceased. Windsonds were programed to sample up to 2.5 km AGL before descending to the ground.

Data checks and QC was complicated by our proximity to the QLCS. We sampled the "near-field" environment rather than the "far-field" environment of the QLCS. As a result, Windsonds often encountered precipitation, which can be difficult to distinguish from bad data. Comparison with the large number of contemporary radiosondes and Windsonds launched in any individual IOP is likely to be the best indicator of bad data.

However, there were several instances of obviously bad data that were deleted. These bad data all shared the same characteristics:

- unrealistically large and sudden ascent rate, typically > 15 m s^{-1}; there was no time continuity to the ascent rate (e.g., ascent rates progressing from 2 m s^{-1} to ~+/–20 m s^{-1} back to 2 m s^{-1} in less than 10-15 seconds)
- bearing / wind direction that was often inconsistent with those immediately preceding and following the observation in question
- height that was different from those before and after the observation in question, often times a height at or near 0 m
- time that often was identical or within 1 second of another measurement from the same Windsond; in all cases the other measurement recorded values that was consistent with those before and after it, and was not deleted

Our best guess is that these bad data are the result of multisonde interference. The bad data were deleted from the two raw .csv files in every instance that they were found in. In a few cases, the only data that were inconsistent were the ascent rates; in those cases, the data were not deleted. As a result, there are some observations with unrealistically large ascent rates included in this dataset.

The wind speed and direction data can be quite noisy, which is normal for Windsonds. We encourage use of smoothing but allow the user to apply the smoothing procedure that best works for their own work (e.g., interpolation, 1-2-1 filters, etc.). As a result, the datasets consist of the raw data as they were obtained with one exception. Raw data included the heading of the Windsond instead of the meteorological wind direction; the wind direction was obtained by simply subtracting 180˚ if the heading was ≥ 180˚ or adding 180˚ if the heading was < 180˚.

4.0 Data Format

The data are provided as .csv files (comma separated values format) with a common file structure that is the same as other Windsond teams used in PERiLS. The file name is given as follows:

YYYY-MM-DD_TTTT.ttt.csv

where YYYY is the year, MM is the month, DD is the day, TTTT is the UTC time, and ttt further describes the type of file, detailed more below. Importantly, the date and time in the filename indicate when the Windsond first began to collect data, not necessarily the time it was launched. Given that we often ensured Windsonds were working properly long before they were launched, it should be expected that the times in the filename will often be several minutes prior to when data first were obtained above the surface.

For each IOP Windsond, three .csv files are included (ttt):

raw_history: This file includes all of the data obtained by the Windsond, which is as follows:
UTC time: time of the observation in UTC

Altitude (m MSL): approximate height of the observation above mean sea level in m
Altitude (m AGL): height of the observation above the ground in m
Pressure (Pascal): atmospheric pressure in Pa
Speed (m/s): wind speed in m s^{-1}
Heading (degreees): The direction the Windsond traveled in degrees
Direction (degrees): wind direction in degrees according to meteorological convention (i.e., 90˚ indicates an east/easterly wind)
Temperature (C): temperature in degrees C
Relative humidity (%): relative humidity in percent
Internal temperature (C): the temperature within the Windsond in degrees C
Latitude: latitude of the observation in degrees
Longitude: longitude of the observation in degrees
Rise speed(m/s): the ascent rate of the Windsond in m s^{-1}

Note that data from prolonged periods on the surface before launch are also included. We often prepared Windsonds several minutes prior to launch, including turning them on, at which point they would start logging measurements. This file includes all of those data, which we do not recommend using as Windsonds were often kept near or inside a vehicle during this time. As a result, they do not necessarily represent the character of the air in the free atmosphere near the ground. To avoid these data, please use the raw flight history csv file (see below).

raw_flight_history: This file includes all of the data obtained by the Windsond once it was launched and does not include the data obtained by Windsonds prior to their launch. Otherwise, the data are the same as those in the raw_history file above.

sounding: The sounding file contains data that are interpolated every 20 m above the ground starting at 20 m AGL. No data are included after the Windsonds are cut from the ballon and descend towards the ground.

There are two additional files included for each Windsond/IOP:

YYYY-MM-DD_TTTT.kml: A file that tracks the Windsond in Google Earth. Note again that this file will contain sometimes long periods of time from before the Windsond was launched.

SBU_IOPn_d.jpeg: A picture of the deployment site for each IOP, n is the IOP number and d is the approximate cardinal direction the photo is directed in (i.e., “E” indicates the photo looks towards the east).

5.0 Data Remarks

- As discussed above, a sometimes-significant amount of data are included from before Windsonds were launched. These data should be used carefully, if at all, owing to their location within or immediately adjacent to the vehicle used to store them.
- Occasionally, data are missing during times of poor receiver connectivity.

- As discussed in section 3.0, bad data were deleted from the raw_history and raw_flight_history csv files; the removed data indicated height and pressure values that were extremely unlikely to be physical. Given the data frequency of Windsonds, we believe the impact of the removed data on the quality of the sounding is negligible.
- Ascent rates were sometimes very low owing to improperly filled balloons and/or precipitation. In such cases, there may be several consecutive observations from almost identical heights.
- If there are no descent data in the raw_history or raw_flight_history file, then the Windsond could no longer be tracked by the receiver following the last recorded observation
- Biased sensors and other data quality issues are difficult to identify, however practice launches of Windsonds in Stony Brook, NY displayed temperature and humidity data near the ground that were qualitatively similar to those from the nearby Stony Brook, NY Mesonet station.

6.0 References

http://windsond.com/windsond_catalog_Feb2019.pdf