Comparisons of Wind Measurements Across Observation Systems

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Introduction / Purpose

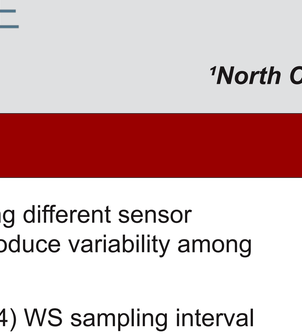
- Wind speed (WS) data is often collected using different sensor technology and sampling intervals which introduce variability among wind observations.
- The World Meteorological Organization (2024) WS sampling interval standard is 3 seconds. [1]
- The North Carolina Environment and Climate Observing Network (ECONet) provide 5-second sampled wind speed and direction observations at 2 m, 6 m, and 10 m using propeller and ultrasonic anemometers. [2]
- Wind speed measurements are critical for weather forecasting, aviation, fire weather prediction, and agriculture.

This study investigates the impacts of sensor type and 3 second versus 5 second sampling intervals on ECONet wind measurements.

Data and Methods

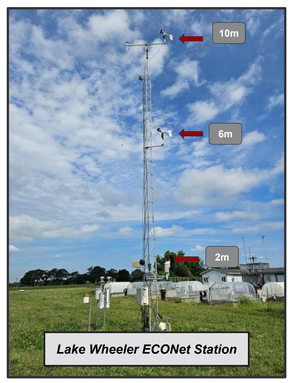
Field Campaign Data (April 24th - July 6th)

- 3 Co-located RM Young propeller anemometers were deployed at a preexisting ECONet station.
  - ➢ Positioned at **4 ft, 5 ft, and 6ft** (~1.83m)
  - ➢ Data were sampled at **3-second intervals** and averaged every minute.



ECONet Data (April 24th - July 6th)

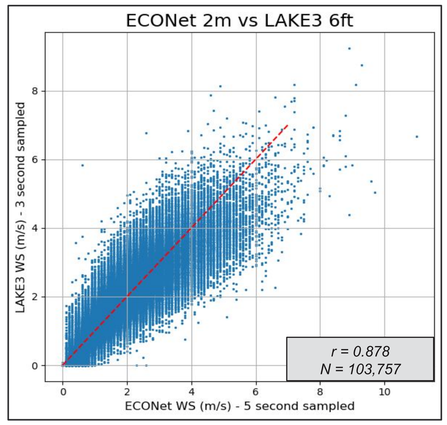
- Wind speed and direction data were obtained from a preexisting ECONet station (Lake Wheeler).
  - ➢ **6m and 10m** data were collected through RM Young propeller anemometers.
  - ➢ **2m** data were collected through the Vaisala Weather Transmitter (ultrasonic).
  - ➢ Data were sampled at **5-second intervals** and averaged every minute.



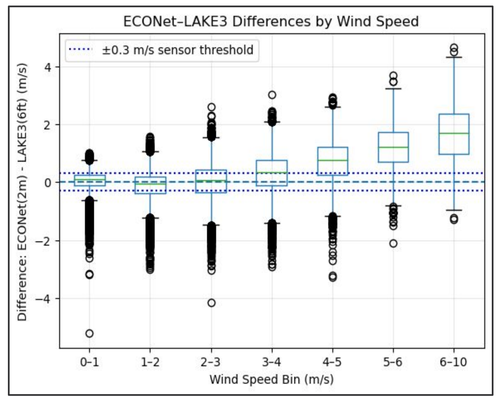
Quality Control (QC) and Analysis

- Time-series inspections and sensor correlations aided in validation of field campaign set up.
- The logarithmic wind-profile was used in observation systems comparisons.

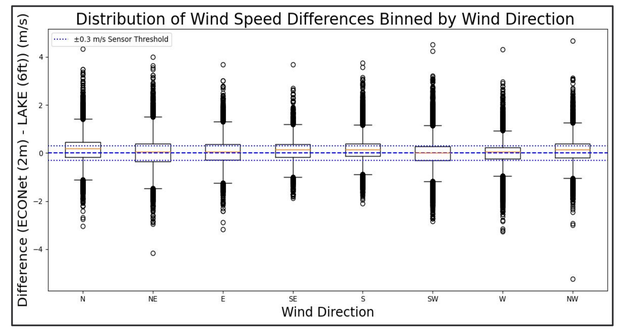
Results



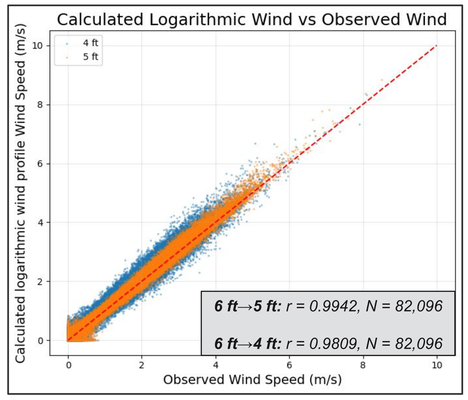
- Linear agreement between ECONet 2m Vaisala and 6ft RM Young.



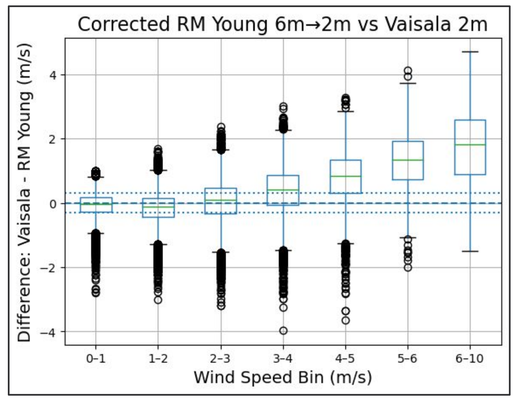
- Median WS differences remained within the sensor threshold below ~3 ms^{-1}.
- **WS differences increased above ~3 ms^{-1}.**



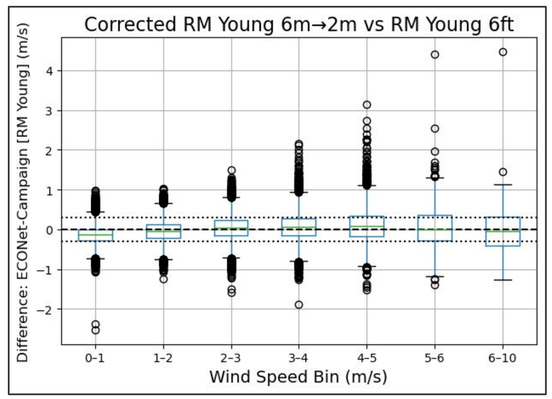
- Median WS differences remained near zero across wind directions.
- **No observed directional dependence.**



- **The logarithmic wind profile** (*calculated from 6ft data*) **accurately reproduced the observed 4ft and 5ft wind.**



- **WS differences remained between the Vaisala and RM Young sensors after height correction.**
- *5 vs 5 second sampled*



- **Differences disappeared when comparison was between RM Young anemometers.**
- *5 vs 3 second sampled*

Discussion

- Wind-speed differences increased above approximately 3 m s^{-1}.
- **Wind direction** and **sensor height did not seem to be primary contributors to the observed differences.**
- Comparisons between RM Young anemometers using **3 s and 5 s sampling intervals showed little bias**.
- **Sensor technology** (Vaisala ultrasonic vs. RM Young propeller), rather than the 3 s versus 5 s sampling interval, **is most likely the primary contributor to the observed wind-speed differences.** These sensor differences have been documented in previous studies. [3]

Future work:

- Evaluate additional ECONet stations to determine whether the observed sensor differences are consistent across locations.
- Quantify the relationship between Vaisala ultrasonic and RM Young wind speed measurements.
- Replicate this experiment across seasons to encompass varying atmospheric conditions.

Additional Information

[1] World Meteorological Organization, 2024: Guide to Instruments and Methods of Observation. WMO-No. 8, Vol. I, Chap. 5, "Measurement of Surface Wind," World Meteorological Organization, Geneva, Switzerland, https://library.wmo.int/viewer/68695
[2] Saia, S. M., S. P. Heuser, M. D. Neill, W. A. LaForce IV, J. A. McGuire, and K. D. Dello, 2023: A Technical Overview of the North Carolina ECONet. J. Atmos. Oceanic Technol., 40, 701–717, https://doi.org/10.1175/JTECH-D-22-0079.1.
[3] Meindl, E. A., and G. D. Hamilton, 2008: Intercomparison of new generation marine wind sensors. J. Atmos. Oceanic Technol., 25, 368–376, https://doi.org/10.1175/2007JTECHO518.1