Comments to the manuscript “Performance of wind assessment datasets in United States coastal areas”

General comments

This manuscript compares the existing wind speed datasets in the coastal regions of the United States by using measurement data at 23 points. The discussion is clear and the reviewer could not find any fundamental mistakes in their analysis. However, at the same time, the reviewer could not find any scientific or engineering value which is worth for this manuscript to be published as a research paper in Wind Energy Science journal. In other words, what are the findings in this work and what is the contribution of this work for wind energy community? The authors do not answer this most important question. As seen in the table 1, which is the summary of the datasets used in this work, the characteristics of the data are very different by datasets. For example, the method of downscaling is different, the temporal resolution is different and the spatial resolution is different, making it very difficult to investigate the cause of the error for each site. It seems that the discussion in this manuscript is very specific to the datasets and measurement sites, and it is hard to generalize the conclusion. Thus, the reviewer does not agree this manuscript to be published even with major revisions, unless substantial change are made with the introduction of the new viewpoints which brings more general conclusions.

Thank you so much for your time and effort in reading our manuscript. We apologize that we did not do a sufficient job of relating our results to how they will help the wind energy community. Our work provides quantification and analysis of the errors associated with multiple recently released wind resource datasets made available to wind analysts, which we feel aligns with Thematic Area 1 of the Wind Energy Science journal: Wind and the Atmosphere.

We are often asked by users of wind resource assessment tools and datasets, including manufacturers and installers of small and midsize wind turbines and potential distributed wind customers, about the accuracy of the products they use. The small and midsize distributed wind market typically does not have the time or monetary investment available to support gathering onsite observations and are thus dependent on wind resource datasets, such as those considered in this work, for pre-construction analysis.

Given this background, we completely agree with you that the characteristics of the datasets in this work are very different from each other, making it difficult to investigate the cause of the error for each dataset at each site. While we endeavor to investigate some of the discrepancies in dataset performance, such as the sensitivity of resultant annual average wind speed estimates based on which output heights a user selects, the main goal of this work is to share the dataset biases and relative errors, along with the accuracy of representing temporal trends in the wind resource. The datasets are recently released and easily accessible, therefore it is important to empower users with the level of confidence they should expect when working with them.

The following excerpts from the first and current drafts outline the goals of this work, the intended wind energy audiences we wish to support, and the usefulness of the findings:

Lines 14-24: “New models and tools are continually being developed in support of wind resource assessment, and three recent products are explored in this work for their performance in representing characteristics of the wind resource at coastal locations: the Global Wind Atlas 3 (GWA3), the 2023

National Offshore Wind data set (NOW-23), and the wind climate simulations that are a component of the Wind Integration National Dataset (WIND) Toolkit Long-term Ensemble Dataset (WTK-LED Climate). These relatively new products are freely available and user-friendly so that anyone from a utility-scale developer to a resident or business owner can evaluate the potential for wind energy generation at their location of interest.

The validations in this work provide guidance on the accuracy of wind resource assessments for coastal customers interested in installing small or midsize wind turbines (≤ 1 MW in capacity) to support energy needs at the residential, business, or community scale, such as the island and remotely located participants of the U.S. Department of Energy's Energy Transitions Initiative Partnership Project."

Lines 51-53: "The sparsity of publicly-available observation data to support comprehensive wind resource assessment has driven the development of a variety of models, datasets, and tools over the last decade. Three datasets that were specifically developed to support the wind energy industry are evaluated in this work."

Lines 72-74: "The following analysis evaluates the performance of three recent wind assessment datasets in previously unvalidated locations along United States coastlines. The validation heights (20 m – 60 m) in this work support coastal communities interested in adopting small or midsize wind energy."

Lines 442-448: "Given that the significant time and economic investments involved with collecting pre-installation onsite wind resource measurements are often at odds with the timelines and available funds of communities, business owners, and residents interested in small or midsize wind turbine deployment, the free and user-friendly datasets evaluated in this article provide crucial value in the wind speed estimates they provide. Additionally, the wind speed estimates for coastal communities can be adjusted using the validation results of this study. For example, because NOW-23 and WTK-LED Climate overestimate the observed annual average wind speeds at 96% of the study sites in this work, coastal users of these products might consider lowering their wind speed and energy production expectations."

Lines 454-456: "GWA3 exhibits the greatest challenges at representing diurnal patterns (median correlation = 0.62), which could lead to challenges for a customer planning for energy coverage or offset around the clock using multiple distributed energy technologies."

Lines 457-460: "WTK-LED Climate produces the highest annual average relative errors (median = 17.4%) and the lowest inter-annual correlations (median = 0.58). Providing accurate representations of the year-to-year variability in the wind resource is important for setting customer expectations for the wind energy that high, average, and low wind resource years will produce at their site."

Per your concern that we did not adequately share our findings and the impact to the wind energy community, we have provided additional context to the discussion of the findings as follows:

Lines 267-273: "The recent datasets tend to overestimate the wind resource (GWA3 at 78% of the observation sites and NOW-23 and WTK-LED Climate at 96% of the observation sites). Disagreement between actual and predicted wind energy generation can lead to customer dissatisfaction and damage to the reputation of distributed wind as a viable energy resource, particularly in circumstances of overestimation. The findings of this work encourage users of GWA3, NOW-23, and WTK-LED Climate for coastal analyses to adjust their annual average wind speed and wind energy production expectations.

Additionally, the findings encourage the use of bias correction where possible, which can provide significant improvement to wind resource estimates (Wilczak et al., 2024)."

Lines 200-202: "The following sections compare recent wind assessment dataset performance at coastal sites versus the more established ERA5 in order to enable dataset users with the level of accuracy they can expect in representation of important pre-construction wind metrics, such as annual average wind speed and temporal trends in the wind resource."

Lines 471-473: "Finally, it is hoped that the validations provided in this work identify areas of future research for dataset developers, such as accuracy improvements for locations dominated by land-based flow and understanding of the NOW-23 discrepancies between 10 m and the rest of the wind profile."

Wilczak, J. M., Akish, E., Capotondi, A., and Compo, G.: Evaluation and Bias Correction of the ERA5 Reanalysis over the United States for Wind and Solar Energy Applications, Energies, 17, 7, 1667, https://doi.org/10.3390/en17071667, 2024.

Technical comments

Table 1.: What is the meaning of "Annual, seasonal, diurnal" in the temporal resolution rowof GWA3 and WTK-LED Climate? Does it mean annual average value per each year, seasonal average per season and diurnal average per a day are provided? But if so, the "temporal" resolutions is "once a day", isn't it?? (I mean annual or seasonal average value can be calculated from diurnal average data….) And the averaging time is different from the resolution and has to be specified separately. Anyway, more clarification needed

Thank you for your valuable suggestion to add clarity to the temporal resolution descriptions. We agree and have altered the description for GWA3 in Table 1 to read "Annual average wind speeds and normalized wind speed indices for establishing wind speed trends according to hour of day, month of year, and specific year in the 10-year coverage period."

Similarly, we have updated the description for WTK-LED Climate in Table 1 to read "Average wind speed by month and hour of day (12 x 24) for each year in the 20-year coverage period."

Equation 4.: The numerator of the right side of the equation looks like a ceiling function. But it does not make sense. Is it a simple bracket or absolute value?? From the following discussion, the relative error is always positive and the reviewer assumes this is an absolute value. But in that case, equation 4 has to be modified to the absolute value.

We are very grateful that you pointed this out! It is indeed intended to be an absolute value in the equation and we mistakenly used the ceiling brackets. We have corrected this in Equation 4:

$$relative\ error = 100\% * \frac{|\overline{u_{mod}} - \overline{u_{obs}}|}{\overline{u_{obs}}} \quad (4)$$

Figure 3: The difference of the different method to calculate the shear exponent is a little unclear. It's better to explicitly show by equation.

We appreciate this suggestion to add clarity to the different methods we used for calculating shear. While the basic equation for the shear exponent, defined in Equation 1, remains unchanged through this analysis, the averaging periods and wind speed output heights for the equation do change and we agree that the different scenarios can be challenging to keep track of. We've added the following table to the text to add clarity, per your helpful recommendation.

Table 2. Scenarios for determining the shear exponent for adjusting simulated wind speeds at dataset output heights to observational heights.

Scenario	Description	GWA3	NOW-23	WTK-LED Climate	ERA5
1	Analogous calculation using annual average wind speeds at output heights shared by all datasets (10 m and 100 m)	For each year, α = $\frac{\ln(\overline{u_{100m}}/\overline{u_{10m}})}{\ln(100/10)}$	For each year, α = $\frac{\ln(\overline{u_{100m}}/\overline{u_{10m}})}{\ln(100/10)}$	For each year, α = $\frac{\ln(\overline{u_{100m}}/\overline{u_{10m}})}{\ln(100/10)}$	For each year, α = $\frac{\ln(\overline{u_{100m}}/\overline{u_{10m}})}{\ln(100/10)}$
2	Calculation using annual average wind speeds at the nearest surrounding heights to each observation	For each year, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10 or 50 m z_{hi} = 50 or 100 m according to z_{obs}	For each year, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10, 20, or 40 m z_{hi} = 20, 40, or 60 m according to z_{obs}	For each year, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10, 30, or 40 m z_{hi} = 30, 40, or 60 m according to z_{obs}	For each year, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10 m, z_{hi} = 100 m for all observations
3	Calculation at each dataset's highest temporal resolution using the nearest surrounding heights to each observation	For each year, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10 or 50 m z_{hi} = 50 or 100 m according to z_{obs}	At each hour, α = $\frac{\ln(u_{hi}/u_{lo})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10, 20, or 40 m z_{hi} = 20, 40, or 60 m according to z_{obs}	At each month/hour combination, α = $\frac{\ln(\overline{u_{hi}}/\overline{u_{lo}})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10, 30, or 40 m z_{hi} = 30, 40, or 60 m according to z_{obs}	At each hour, α = $\frac{\ln(u_{hi}/u_{lo})}{\ln(z_{hi}/z_{lo})}$ z_{lo} = 10 m, z_{hi} = 100 m for all observations

Line 296-302: NOW-23 is based on different PBL scheme by different locations, right? However it does not justify to discuss the results as the difference of the PBL scheme as figure 8. They are based on different sites. This discussion is misleading and unacceptable.

Thank you for pointing out this concern. We have removed Figure 8 and the associated discussion.

Line 347-: What is the meaning to discuss the relative diurnal cycle?? The meaning of discussing the diurnal cycle for wind power application is not clear. The authors needs to clarify the justification of this discussion.

Thank you for the suggestion to add a discussion of why the wind resource diurnal cycle is important for wind energy customers. We have added the following discussion to Lines 371-382 to provide this important context:

"Understanding how the available wind resource changes throughout the day and night is important for distributed wind energy customers looking to reduce energy costs, particularly when time-of-use electricity pricing schedules are applied by local utilities. From a supply-and-demand standpoint, since diurnal peaks and troughs in electricity demand vary according to customer location and application (e.g., residential versus industrial facility demand), a potential wind energy adopter will want to assess whether the times and degrees of wind generation will align with their energy needs. Finally, McCabe et al. (2022) highlight the importance of understanding diurnal (and seasonal) wind resource trends in the context of distributed wind complementarity with other energy technologies, such as solar energy. Distributed wind turbines and other energy technologies can be connected at the lower-voltage distribution level of an electricity grid to serve specific or local loads. In some instances, wind and other energy technologies may compete with each other to provide electricity for a distributed load. In other instances, wind and other energy technologies may provide complementary solutions for the supply of clean electricity for distributed applications if they are generating on differing temporal schedules (McCabe et al., 2022)."

McCabe, K., Prasanna, A., Lockshin, J., Bhaskar, P., Bowen, T., Baranowski, R., Sigrin, B., and Lantz, E.: Distributed Wind Energy Futures Study, National Renewable Energy Laboratory, Golden, CO (United States), NREL/TP-7A40-82519, https://doi.org/10.2172/1868329, 2022.