General comments:

This manuscript validated several reanalysis data against measurement data and calculated/discussed wake effect due to turbine spacing at Scotian Shelf offshore site in Canada. In introduction part, there are many paper reviews and well summarized. Although there are some uncertainties of measurement data remain, general trend of each reanalysis data is well presented in validation part. Then, authors calculated wake effect in wind farm for both high dense layout, which could be maximize total power production in wind farm, and low dense layout, which minimize wake loss, and considered and modelled optimal spacing to maximize total power production of wind farm. Also, seasonal differences of these two topics are compared and well presented. Although the result of this manuscript itself may site specific, the methodology will be good reference in future project and there are some scientific interests.

In conclusion, a reviewer consider that this manuscript can be accepted with MINOR REVISION.

Specific Comments and Responses

Comment: ERA 5 is explained as mean percentage for all stations, while JRA-55 and MERRA-2 are explained as its ranges. Although it is not a part of your research, it should be explained by fair criteria.
Response: The authors intended to express that the mean percentage for other three datasets are in the range from -54.22% to 42%. This might be confusing. Now we have improved our expression as "*The authors found that ERA5 demonstrated the best overall performance among the five reanalysis wind dataset products, with ERA5 exhibiting a mean percent bias for all stations of -4.54 %, while the mean percent bias was -54.22% for JRA-55, -49.63% for CFSv2 and 42.03% for MERRA-2*".

Comment: It is suggested show station height above sea level and mounted height of measurement devices in the table.
Response: We modified the table as suggested.

Comment: Authors have to explain how Quality level flag (if exist) is handled. Also, explanations about measurement devices, and its consistency in validation period, definition of wind direction (i.e. true north or magnetic north) are missing. It is also suggested to add a table about monthly data availability.
Response: We added text about the quality level flags and the description of our quality control procedure. Information about wind measurement instruments was added. The definition of wind

direction is now stated in Section 2.1. The monthly data availability is shown in a new figure in the appendix.

Comment: Although authors assume neutral stratification and alpha = 1/7, which is international standard, it is not clear if this assumption is correct in Scotian Shelf, and if not how big impact is given on validation result.
Response: We added the reason for choosing the alpha value, following the IEC standard. The discussion about alpha's variability and dependence on atmospheric stability was also added.

Comment: Need explanations about symbols "U" and "z".
Response: We added the explanations for these symbols.

Comment: ERA5 has UV component 100m above ground and it reduces vertical extrapolation uncertainty. Authors need to explain the reasons why 10m height data is used, if there is.
Response: We now used both 10 m and 100 m wind speed data to calculate time-varying alpha values. These were then used for extrapolation to 150 m height.

Comment: Need explanation about symbol "$\bar{O}$".
Response: We explained it as: $\bar{O}$ denotes the average value of the observations.

Comment: "measured at 10m" should be "at 10m".
Response: We corrected this as suggested.

Comment: higher -> lower? The sentence is bit difficult to understand.
Response: We confirmed that ERA5 does show higher RMSE than HRDPS. We revised our sentence to make it clearer:
"Compared to HRDPS, ERA5 exhibited higher five-year averaged RMSE values of 1.76 ± 0.20 m/s and 2.08 ± 0.37 m/s at the two corresponding nearshore sites".

Comment: CFSv2 is better than ERA5 at Site 2. It is better to add the explanation.
Response: We revised the sentence to reflect that the performance of CFSv2 was mixed, and provided the relevant values.

Comment: “RMSE values tended to increase during winter months…”, This just may be because magnitude of wind speed is high. Use of normalized RMSE may help further understanding.
Response: We thank the reviewer for this insightful comment. After conducting additional analysis using normalized RMSE (calculated as RMSE divided by the mean observed wind speed), we confirmed that the reviewer’s thought is correct. The originally observed increase in RMSE during winter months was indeed influenced by the higher wind speeds in winter. When evaluated using the normalized RMSE, the results revealed the opposite seasonal pattern: normalized RMSE values were generally lower in winter and higher in summer.

We have added this clarification to the revised manuscript (Section 3.1), stating:
“*However, this pattern was primarily due to the higher wind speed magnitudes in winter compared to summer. When normalized RMSE (calculated as RMSE divided by the mean observed wind speed) was used, it was found that the normalized errors were actually smaller in winter and larger in summer.*”

Comment: The use of the word “overestimated” toward wind direction is weird. It is suggested to use “shifted (anti)clockwise”.
Response: We rephrased the expression as suggested.

Comment: “April to December in 2022” Need to explain that this explanation is about Site 5. It also seems that July 2020 to July 2021 at Site 6 shows different trend, compared to other years on the site. Need a comment that how authors think this about this period. Also, explanation that how authors handle these measurement errors when calculate aggregate metrics mentioned in text, Figure 8, Table 4 etc. in this sub section is needed.
Response: We thank the reviewer for this careful observation. In the revised manuscript, we have clarified that the period from April to December 2022 refers specifically to Site 5 and have explicitly specified the corresponding period for Site 6. The revised text now reads: “*At the three offshore sites observed using buoys, notable biases were present during specific periods, i.e., from April to December 2022 at Site 5, and from June 2020 to July 2022 at Site 6, which were likely caused by systematic observational errors.*"

The selection criterion for wind direction data was the same as that used for wind speed: all data from months with at least 120 valid hourly records were included in the calculation of both monthly and aggregated metrics. Although the periods of large errors at Sites 5 and 6 are suspected to have resulted from systematic observational issues, the metrics presented in Figure 8 and Table 4 include these periods. We acknowledge that such anomalies may

influence the results; however, we chose not to exclude them in order to maintain a consistent and objective screening criterion across all sites. This decision is reflected in the box plots in Figure 8, where outliers indicate the presence of anomalous data during specific periods at Sites 5 and 6. Notably, offshore sites exhibit more outliers than nearshore sites, which suggests the influence of the suspected observational errors at Sites 5 and 6.

We have added a clarification in Section 3.2 stating:
"*It is noted that for the offshore group, periods with suspected systematic observational errors at Sites 5 and 6 were not excluded from the analysis. All data from months with at least 120 valid hourly records were retained to maintain a consistent screening criterion across all sites. As a result, the box plots in Figure 8 reflect the influence of these anomalies, as indicated by a greater number of outliers at offshore sites compared to nearshore sites.*"

Comment: It is better to add text that "x_t" and "x_m" will be explained later in section 4.2, like as Figure 9.
Response: We added such text in the table caption to remind readers that x_t and x_m are explained in Section 4.2.

Comment: Need to explain data period for 'spatial and seasonal mean'.
Response: We revised the sentence to specify that values were averaged across ERA5 grid points within each PFDA and over the 2019–2023 period.

Comment: "These values were determined as the spatial and seasonal mean for each PFDA." I understand wind speeds and wind directions shown in Table 5 are used in this section to reduce computational cost. Is my understanding correct? If so, why Punit in Figure 9 reaches 15MW? All wind speeds in Table 5 are lower than 10.6m/s, which is rated wind speed of IEA 15MW turbine.
Response: We clarified that the wind speeds in Table 5 are at 10 m, and when extrapolated to 150 m they exceed the rated speed of 10.6 m/s.

Comment: "Punit revealed the average turbine efficiency" I understand Punit is average of "all wind turbine" in a PFDA. If so, the authors need to explain that (i.e. what consist of average). Also, it is not "efficiency" but "power output", isn't it?
Response: We clarified that Punit represents the average power output per turbine, calculated by dividing Ptotal by the number of turbines.

Comment: It is suggested to write brief explanation (e.g. Summer, 9.6D) in each figure.
Response: We added such labels to each panel in Figure 11(a).

Comment: “10 additional time series”
It is difficult to understand why 10? It is suggested to add brief explanation (e.g. 5 yeas data and ±).
Response: We thank the reviewer for requesting clarification. We have now expanded the explanation in the revised manuscript to clarify why 10 additional time series were used. Unlike wind speed, where power production is a monotonic function, the effect of wind direction on power output is non-monotonic due to wake interactions. Within the ±RMSE bounds, we generated a range of perturbed wind direction time series at small directional intervals to capture this variability. Through sensitivity testing, we found that 10 evenly spaced perturbations were sufficient to capture the range of power variation while keeping computational demands reasonable. This clarification has been added to Section 4.3 of the revised manuscript.

The revised text reads:
“*To address this, multiple simulations were performed across a range of possible wind directions to capture the potential variation in power output. For each month, the range of possible wind directions was defined by adding and subtracting the monthly RMSE from the original wind direction time series. Within this range, additional wind direction time series were generated, with values evenly distributed between the upper and lower bounds. Based on sensitivity testing, it was found that using 10 perturbations provided sufficient resolution to capture variability in power production without incurring excessive computational cost.*”

Comment: Discussion regarding uncertainty of measurement data is needed.
Response: We thank the reviewer for this suggestion. In the revised manuscript, we have added a discussion in Section 5 acknowledging the uncertainties associated with the observational data used for validation. These include potential errors due to sensor calibration, platform motion (in the case of buoys), and long-term drift or bias in measurements. We also mention that certain persistent anomalies in wind direction (e.g., at Sites 5 and 6) may be attributed to observational errors.

Comment: Wind frame -> wind farm?
Response: This typo has been corrected.