Referee 1 Comments and Response

Yihan Liu[1, 2] and Michael Chertkov[1]

[1]Program in Applied Mathematics & Department of Mathematics, University of Arizona, Tucson, AZ 85721, USA
[2]Virginia Tech, Blacksburg, VA 24061, USA

This paper demonstrates some analysis of the anomalous response of FOWT based on a linear model developed by an earlier work by Betti et al. (2014). The novelty of the paper could be strengthened. From my understanding, the linear FOWT model was adapted from Betti et al. (2014). The authors conducted some investigation of detuning the blade pitch controller. Subsequently, 10000 Monte Carlo simulation was carried out in the linear models and the analysis was mainly based on these simulation results. The novelty of this work could be better emphasised, and I recommend a major revision to clearly articulate its uniqueness and establish a stronger link with existing literature.

1. Section 1. The motivation can be improved. Why is the anomalous response of FOWT important? Why can't other models perform such a task? The link between the first and second paragraphs is weak.

   We appreciate your suggestion on strengthening the motivation. We have enriched the introduction to underscore the significance of investigating rare events in FOWT systems, emphasizing the unique contributions our study makes in this area.

2. The format of citations can be improved. The current format is quite disturbing when reading.

   Thank you for pointing out the issue with citation formatting. We have carefully adhered to the WES citation guidelines. However, to enhance readability, we will re-evaluate and adjust the citation format where possible, ensuring adherence to WES standards.

3. "Each controller operates independently, and within each region, only one variable is altered." This sentence is not true. Most of the controllers do not operate independently, and more than one variable is altered. For example, in the above-rated wind region, the generator torque can follow the Constant Power strategy, instead of Constant Torque.

   We acknowledge the misstatement regarding controller operations and appreciate your correction. The manuscript has been updated to reflect a more accurate description of the control strategies employed, particularly emphasizing the shift from 'constant torque' to 'constant power' for clarity and precision.

4. Page 5, lines 80, 81 and 82. $Q - Q_\alpha$?

   We recognize the need for clarity regarding Eq. (6) and have included a detailed explanation of its dependency on various factors, ensuring a comprehensive understanding.

5. Equation 8. Why is there a minus sign?

We understand the confusion regarding the minus sign in Eq.(8) and have now elaborated on the choice of frame reference in the manuscript, directly referencing the original model by Betti for coherence.

6. Equation 13. There is an assumption of 100% efficiency in the generator.

   We concur with the need to clarify assumptions about generator efficiency. The revised manuscript now explicitly states these assumptions, ensuring the analysis remains transparent and grounded in realistic operational parameters.

7. Page 9 "This observation appears counter-intuitive as it implies that the net wind thrust acting on the structure is lower in higher wind speed conditions." This is not counter-intuitive if one knows the basics of wind turbine operations. The thrust curve against the wind speed has a negative slope in the above-rated wind region due to the blade pitch, as the authors pointed out later. Please remove the word "counter-intuitive".

   Upon reflection, we agree that the term 'counter-intuitive' might mislead the readers about the complexity of wind turbine operations. This term has been removed to present a more nuanced understanding of wind thrust dynamics.

8. Page 11. Please define a_p and a_i as detuning parameters. It is confusing to see Equation (17) and wondering what a_p and a_i are.

   To address the confusion regarding detuning parameters, a_p and a_i , we have introduced a clear definition and discussion at the start of the relevant subsection, aiming for greater clarity and reader comprehension.

9. Page 11. Line 202. "We start with ai = 1, and calculate the average rotor speed where the averaging is over time (25 min)." Wouldn't using standard deviation be better in this case? Or is it because the convergency for the rotor speed took a long time and that's why the averaged rotor speed was used?

   We appreciate your suggestion regarding the analysis method. Upon review, we maintain that using integrated gain for averaging rotor speed over time is appropriate for this context, providing a stable convergence to the rated value. However, we have elaborated on this choice in the manuscript to clarify our rationale.

10. Page 11. Line 204. "tuned"$\longrightarrow$" fine-tuned"

    We agree with the recommendation to use 'fine-tuned' for greater precision in describing the tuning process. This modification has been made throughout the document. .

11. Page 13. I wonder why a duration of 1500 seconds was chosen. Why not a 10-minute time-series? Also, was the transient at the beginning discarded?

    The duration of 1500 seconds was chosen based on observed event lengths in our simulations, providing a comprehensive view of correlated events. We have now included a detailed rationale for this selection, ensuring the methodology is transparent and justifiable.

12. “FIG. 13 presents the probability density function (PDF), which depicts the overall distribution of individual states (grey)” Is the grey area representing the mean of each time series? Or is it a distribution of all data points? If latter, at what time step?

    To clarify, the grey area in Fig. 13 represents the distribution of all data points across time steps. We have now provided a more detailed description in the figure caption to eliminate any ambiguity.

13. Fig 14-40. The figures are generally too small to read. I encouraged the authors to use bigger figures or zoom in to highlight the meaningful part. Or maybe think about how to present them in an innovative way.

    Acknowledging the importance of figure clarity, we are committed to enhancing the legibility of all figures. This includes resizing and, where feasible, simplifying the figures to emphasize key findings. We will ensure that the figures are accessible and informative in both print and online formats.