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Comment on wes-2021-85

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Referee comment on "Optimal closed-loop wake steering – Part 2: Diurnal cycle atmospheric boundary layer conditions" by Michael F. Howland et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-85-RC1, 2021

Dear authors,

I sincerely thank you for your invaluable contributions to the research field. Your manuscript contains notable and novel contributions that further the state of the art in wind farm control. I find the scientific relevance and level of detail both excellent. I very much enjoyed the thorough literature review in the introduction, and how this article combines both a high-quality large-eddy simulation study with an advanced wind farm control solution. Important findings regarding wind direction forecasting, real-time model parameter estimation and yaw optimization is likely to shape the next step in wake steering after open-loop control. Generally, the paper is dense in information but does not go too far in that matter. I only have a handful of minor remarks.

- Can you say more about the inherent assumptions in Equation (1)? Are you assuming wakes to propagate instantly? Is there anything you can do to include time dependency in this optimization?
- Equation (2), near line 150, you state that the wind direction is assumed to be uniformly distributed. In other work, the wind direction is often assumed to have a Gaussian distribution (Rott et al., Simley et al.) or a Laplace distribution (Quick et al.). Could you explain your choice?
- Line 177: "The standard approach … direction filter used." You mention a "low-pass moving averaged filtered wind direction". A moving average filter also falls within the class of lowpass filters, as far as I understand it. The way you specify it; do you mean that you used two filters, one to lowpass filter the signal and one to additionally calculate a moving average from those filtered values? Similarly, you cite Simley et al. (2020) to use a "first order filter", but this is also a lowpass filter. You state that the results do not really change much based on which filter is used, and I assume you are already aware of the things I stated here, but this paragraph was not completely clear for me.
- Line 185, top of page 7: I really appreciate the simplicity of assuming a linear trend for

the wind direction, if a certain threshold is met. Is there a theoretical motion that would support the decision to model this as a linear process?

- Line 195, Section 3: To de-condense the text somewhat, please consider putting important details of the LES simulation in a table.
- Line 214: Perhaps remove footnote 1 and instead add an entry to the reference list.
- Page 8, Figure 1, and lines 219 until 227: I was wondering if this information is essential in the main text. I do see the value of explaining why and how the wind direction changes, but perhaps it is not essential to the story you are trying to tell in this article. Showing figure 3 should provide the reader with sufficient information in how the ambient conditions will change and under what conditions the turbines and the wind farm controllers are subjected. Perhaps some of this information can be moved to an appendix.
- Figure 4: I think this figure is really interesting. You may consider it moving to an appendix, as stated in the previous remark. Also, could you please add a legend defining the time window for each vertical line.
- Figure 5: this is a very informative figure. It is a little difficult to see at the current resolution. Could you perhaps update the xlims/ylims, zooming in to the region of interest? Also, if can consider removing the yticks and ylabels from subplots (b) and (d), and similarly for the x-axis for plots (a) and (b).
- Line 225, Section 4: After reading "Case A" (and "Case D" later on), I was expecting to also see a "Case B" and "Case C". I later realized what they were actually supposed to mean. To clarify this and also to de-condense the text somewhat, please add a table defining the various cases. I think with that table, you can keep the case naming convention you have now. A table would really make it easier for the reader to see what cases were tested and what combinations of controllers, prediction vs. past-time-window-averaged wind direction estimates, with and without uncertainty.
- Line 307: The default cases are presented with a control update period of T=30 minutes. This seems very high to me, especially if you are anticipating a change in the mean wind direction. It there a reason you picked such a high value to start with?
- Page 14: explanations are very clear, really excellent.
- Figure 9: plots are somewhat small, while the xlabel and ylabel are large. Could you enlarge the actual plots? Also, could you export these plots in vectorized format (.pdf, .eps) so that I can zoom in at a high resolution?
- Figure 10: Can the EnKF estimate the model parameters if there is no wake interaction? Will your estimates drift off if you are without wake interaction for an extended period of time?
- Line 356: "The wake model… exhibit low error." If you use power production measurements in your EnKF, is the model-predicted power production a fair value to use in validation? Had you calibrated your EnKF to have a much lower measurement noise covariance matrix than the process noise cov. matrix, then would you not only further improve this quantity?
- How large is the sample pool in the EnKF, and what did you base this on?
- Figure 12 says "Case SF", but no such case was introduced in the text. Did you mean OOU-F?
- I would very much like to see you separate the update/averaging sampling time for the model estimation part from the control setpoint update rate. Naturally, I can see that you may not need to update the model parameters very frequently, notably since perhaps the wake expansion parameter need not change very fast. However, the optimal yaw setpoint may need to change much at a much higher frequency. I think there still may be a lot to gain here. You rightfully mention it in your text, but I wanted to emphasize that I am very curious to see how your results would change. Again, this is not something I expect you to address in this manuscript.
- Line 448-465: I wonder if these two paragraphs could be omitted. They seem to be a general summary of the methodology and background information. I think you can assume that the reader has read at the very least the introduction of your manuscript. This would make the manuscript's results and conclusions stand out more.

Thank you for considering my comments.