

Wind Energ. Sci. Discuss., referee comment RC2  
<https://doi.org/10.5194/wes-2021-130-RC2>, 2022  
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## **Comment on wes-2021-130**

Vasilis A. Riziotis (Referee)

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Referee comment on "Comparison of free vortex wake and blade element momentum results against large-eddy simulation results for highly flexible turbines under challenging inflow conditions" by Kelsey Shaler et al., Wind Energ. Sci. Discuss., <https://doi.org/10.5194/wes-2021-130-RC2>, 2022

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The paper compares aeroelastic simulation results of a newly developed lifting line model against a standard BEM model and an actuator line model, all coupled to the same structural module. The paper is relevant for the wind community and it is of great interest to a broad audience that employs the open source tools of NREL. Despite the fact that the level of innovation and originality of the reported work is relatively low, still the paper provides some useful information about the level of agreement of the predictions of various aerodynamic options of different fidelity.

Therefore, in my opinion the paper deserves publication, however after major revision is performed in the first submission.

Several, less or more important, specific comments can be found in the accompanying pdf file (performed directly on the body of the paper). The most important changes are though collected and listed below:

1) In the reviewer opinion the main shortcoming of the reported work is the way that results are presented. More specifically,

- starting from the simplest zero yaw case, the difference between the BEMT and the other two models is substantial. I would not expect such a high difference between the three methods given that they all share the same set of polars. In the reviewer opinion some further investigation is needed before proceeding to comparisons of more complex conditions. The first thing that should be highlighted and explained is the very big difference in the induction of Figure 8c which of course drives differences in the mean values of loads. Why the BEMT model over-predicts induction by more than 10% compared to OLAF (most probably also compared to the CFD – btw velocity predictions by SOWFA are missing).

- when dealing with the yawed cases mean value (OP) is not so important (besides some explanation of the mean value differences will be provided by the analysis of the 0 deg yaw case). What is more important is the 1P harmonic (in terms of magnitude and phase). I don't see a reason why one would compare sdv in a periodic response case. Therefore

my strong recommendation for the yawed cases is to compare 1P amplitude and phase. I would mainly focus on flapwise moment as differences in blade loads drive differences in the loads of all other components. Note that the information provided in the plots is vast and sometimes becomes confusing while the key differences are not really highlighted.

- From all the results presented in 4.1.1 the most important information is provided in Figure 8c, which explains the mean value differences of BEMT against the other two models and in Figure 9b which shows the azimuthal variation of the flapwise moment and explains again the difference of the various models in terms of the azimuthal variation of the induction (of course a plot with the 1P amplitude and phase variation vs. yaw angle would be much more instructive). Then all the rest would be probably expected and linked to the deviations in the rotor loads, as all simulations are based on the same structural code. In this case the authors are limited to a superficial discussion of the percentage change of the different loads and they do not go deeper to the discussion of how the difference in the azimuthal variation of the flapwise moment affects and justifies differences in the loads of the components that are not rotating. For example, the higher amplitude of the flapwise moment predicted by BEMT justifies the increased mean tower yaw moment and the lower mean justifies the lower tower bottom bending moment. Looking in figure 9b, nobody would expect tower moments predicted by the different models to be the same. Furthermore, the information of how much they differ is not so useful either. What is more useful again is to explain the differences in figure 9b in terms of the predicted induction by the different models (varied azimuthally this time).

- Time averaged loads and induction distributions of Figure 8 are completely pointless (apart from the 0 deg yaw plots). What is more relevant in this case (for the yawed cases) is to compare distributions at different azimuthal positions (of course after periodicity has been reached). For example with a step of 90deg.

- When it comes to turbulent flow predictions  $\sigma_{dv}$  is more relevant but what would be also interesting for the reader is to see how the energy is distributed to the various frequencies. Azimuthal averaged plots don't offer much more than those presented in 4.1.1. However, comparison of FFTs would be definitely preferable.

2) The introduction section needs to be improved. First, the context of existing engineering models is much different than that presented by the authors. There are several engineering hybrid models that account for the effects that standard BEM models omit and these seem to be neglected by the authors. Some references on improved BEM models are missing. Furthermore, the type of CFD analysis performed should be detailed in the introduction section (actuator line modelling).

3) With regard to the theoretical model no explanation is given on how the authors deal with the violation of Kelvin's theorem when truncating the near wake. Is this maybe the reason why the "far wake extent" results don't seem to converge in figure 2?

4) The total number of simulated revolutions is not provided (if I'm not wrong). This will probably explain why computational time differs so much between the different wind velocities (I suppose they correspond to different number of revolutions but the same distance travelled by the wake).

5) I would be nice to provide the equations for all the filter functions you apply in the treatment of the wake (since a sensitivity analysis is performed on the tuning parameters of these filters).

Please also note the supplement to this comment:

<https://wes.copernicus.org/preprints/wes-2021-130/wes-2021-130-RC2-supplement.pdf>