

Wind Energ. Sci. Discuss., referee comment RC1  
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## **Comment on wes-2021-133**

Anonymous Referee #1

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Referee comment on "Sensitivity Analysis of Turbine Fatigue and Ultimate Loads to Wind and Wake Characteristics in a Small Wind Farm" by Kelsey Shaler et al., Wind Energ. Sci. Discuss., <https://doi.org/10.5194/wes-2021-133-RC1>, 2021

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Investigation into how different environmental conditions effect turbine loads is very important for a number of perspectives within Wind Energy. So, the aim of this work is very compelling. However, it was difficult for me to judge the significance of this work for a number of reasons. First, the literature review is totally inadequate so it fails to adequately place itself in the wider body of literature. The focus of the paper is on wake effects, however, the wake model is not well described. Furthermore, due to the lack of review it's also difficult to assess what assumptions were used in the modelling. Furthermore, there is no validation of the chosen model. So it's also difficult to determine how well this analysis reflects reality. In the presentation of the results, the authors tend to show too much data in the plots, which makes the plots difficult to read and understand. I would encourage the authors to focus on the important parameters and group the rest ins "misc." or "other". Furthermore, in the discussion, the authors merely highlight the results given in the tables. I think that the discussion can be greatly enhanced if they could give more insights and explanation on how or why these ressults came about. To what extent are these conclusions a reflection of reality or maybe effected by different choices in the modelling and analysis? Otherwise, the article reads too much like a technical report. Detailed comments are given below.

The abstract is too long and verbose. It is written more as an introduction. Please make it more concise.

The abstract also fails to mention the model that was used to calculate the loads, I assume FAST.

Additionally, the author uses highly technical language to describe other models (e.g. IEC

Kaimal turbulence spectrum with IEC exponential coherence model), it would make the work more readable to a larger audience if they used more colloquial terms like Turbsim.

In the abstract and introduction, the author only mentions their own previous work on the subject and claims that their work is unique. However, they fail to mention any other work for example "<https://wes.copernicus.org/articles/3/767/2018/>". On the subject of loads in general, the impact of wakes on turbines, the sensitivity of turbulence and inflow on loads etc. there are multiple research groups that are looking into these things (DTU, University of Oldenburg, TUM, etc.). There is a huge body of work already and failing to give a proper review of the relevant literature makes it difficult to judge where this work fits within the larger body of literature. The authors need to give a more comprehensive review of the state of the art on this subject.

Further to the review of literature, there are actually multiple approaches for evaluating sensitivity. Sobol indices for example. Each of these methods look at different aspects (local sensitivity, variance based, etc.). It would be helpful if the author could place their choice amongst these competing methods and explain why they chose their method and how that choice may alter the conclusions.

The author uses the term "waked" and "unwaked", these are proper English words. However, they are misused by the author when they are used to differentiate between operating within a wake or not. According to the dictionary, waked refers to either the state of being awake or to an event that occurs after a funeral. To avoid confusion, it's important that the author uses the correct terminology.

Line 58 when you define QoI, capitalize Quantities of Interest.

In the methods section the author mentions the use of established tools. Regardless it would still help to give citations where people can learn about the details of those models, (Elastodyn, ServoDyn, etc.).

The title "Case Study" for section 2.2 is too vague and implies that some results will be given.

I am not sure that section 3 needs its own section. Section 3 is a method and I think would fit better as a sub section in section 2.

Overall it is unclear how wake effects were modelled. There are little details on the model, other than a description of various parameters. Since this is the main focus of the paper, it is very important that a better description of this model is given.

The other thing that I am concerned with, is that it's not clear how well the chosen wake model fits with reality. It would be nice to see some validation of the wake model with either high fidelity tools or with experimental data. Maybe previous work can be leaned on. A parameter study on a model is rather useless if one does not know how well the model itself describes reality.

Again, a literature review on different wake modelling would also be helpful here too. What fidelity level is this work based on? What assumptions are made in the modelling?

I am also curious whether this model is based on partial wake coverage or not.

Also, another interesting parameter that I think would be important for a study like this is the distance between turbines.

There are a lot of parameters discussed in the paper, in tables and figures they are represented as symbols that have been defined in the text. Given the large number of parameters and the fact that the parameters are the focus of the study, it would be helpful if a nomenclature was given to list the definitions of all the symbols.

The text in figure 2 is too small and difficult to read. Also, the colored text for inflow parameters is difficult to see with the hazy background.

Figure 4 shows a lot of information... It's a funny way to show things, but I can understand that they are trying to focus in on the significant results. However, because there is so much data, it's difficult to comprehend the plots. I would recommend only populating the figures with results that exceed the threshold and try to give better labels. It's really confusing, because the yellow curves almost completely obscure the other colors. The legend is only for the blue data. It's clear that they run out of symbols to differentiate the different data. So, because they are trying to show all data, it's actually becomes too confusing to understand these plots.

Could figure 6 and 7 be plotted in log scale for the y axis? Again, it appears that a lot of data is given ... the clarity could be improved by focusing on the important stuff. I really think that you need to have a category "misc." or "other" to group together the data that is not important.

Table 6 is not described well enough for me to understand the data. Why is WT1 all blue, while 2 and 3 are a mix of red and blue? I suppose 2 and 3 are relative to 1, but that is

not mentioned in the caption. Also, instead of giving raw counts, it would be more helpful to normalize the data in percentages. Otherwise, it's difficult to judge the significance of these counts.

Most of the analysis focused on the number of significant events... however, I think it would be helpful to describe how a QoI varies with a given parameter. Does it go up or down with respect to a parameter?

It appears that the authors consider the effect of the wakes by looking at the differences between the first turbine and the down stream turbines.

I like that the author broke down the data by the different loads and showed that these different loads had different sensitivities.

I found the discussion to be weak. The authors merely highlight the different results that the reader could easily see for themselves. It would really strengthen the work if the authors could give some insights and explanations on why the various parameters were significant. Why different changes in the loads were seen in the down stream turbines, etc.

I think more can be said in the conclusions. First, the fact that the sensitivity only changed by 3% when a turbine was within a wake is an important result in itself. Furthermore, the difference in sensitivities between the loads is also interesting to mention. It's not clear to me how the authors classify primary, secondary and tertiary. Given the nature of the study, (i.e. high degree of aleatory uncertainty), it would be difficult to accurately identify low-order effects.

I think a very important result that is missing is an uncertainty quantification. Upon identifying the most important parameters, what would be my uncertainty in the loads if I was incorrect in my parameter value by a given value?