

Authors' Note to the Associate Editor and Reviewers

Title: Sensitivity of Uncertainty in Wind Characteristics and Wind Turbine Properties on Wind Turbine Extreme and Fatigue Loads

Ref. No: wes-2019-2

The authors thank the reviewers for their thorough assessment, comments, and insights. Revised text in the manuscript is highlighted in red.

Reviewer's comments are shown in blue. Authors' responses are shown in black.

Very interesting paper with very interesting and useful results. The baseline methodology should be described in more detail in order to stand out as reference. For other wind systems. In particular sections 3.3.1 and 3.3.2 should be revised to clarify to the reader in which way the initial function was adjusted. This is done good on a detailed level, but it would help to get a higher-level summary of the idea behind the applied procedure.

A. Yb was necessary to properly compare ultimate load consistently across the bins because it is only the maximum ultimate load that matters. The scaling by the probability was necessary to properly compare fatigue loads consistently across the bins because it is the cumulative effect of all bins that matters for fatigue.

Also, it should be highlighted throughout the paper that the approach is a tailored approach for the problem at hand. The alteration of the baseline formulas as well as the threshold evaluation of EE indicates that classical SA is not applied. There are good reasons presented for it, and i expect the results to be valid nonetheless, but the variation of standard approaches is significant.

A. Some language was added to the paper to address this comment.

The plots are quite comprehensive. It could be sufficient to just show exemplary plots to describe the applied methodology, and provide the full set of plots inside the appendix. The summarizing tables are very helpful.

A. Some plots have been moved to the appendix.

EE is generally used as screening method, in order to identify relevant input parameters. In this sense, the values of the resulting EE should be handled with care. They only provide an indicator of relevance, not of the sensitivity (or even the comparative relevance). This should be taken into account when evaluating the resulting EEs.

A. Elementary Effects at its fundamental level can only be considered a screening method. However, the introduction of the use of Sobol numbers and radial trajectories increases its efficacy as a method for estimating sensitivity, not just as a screening method. Campolongo empirically demonstrated that the results obtained by EE can converge to a variance-based sensitivity index with increased number of Sobol points. In this work, the authors increased the number of Sobol starting points until the EE-based sensitivity metrics had shown convergence.

Page 1: "sensitive" to "influential":

A. The authors believe that “sensitive” is the proper term in this case.

Page 1: are you sure? to my knowledge, EE is not suitable for the quantification of uncertainty..

A. See explanation above.

Page 2: towards

A. Due to the placement of this comment in the document, the authors are unsure what it is referring to.

Page 2: not 100% sure since no native english speaker myself, but shouldnt it be the "sensitivity of an output towards an input" rather than the other way around? in the same way i would write here "impact of input on response,..."

A. I have changed it to “sensitivity due to each input”

Page 2: so different number of seeds for each design point? what was the employed convergence threshold?

A. The same number of seeds was used for each design point. To establish a convergence threshold, the authors visually examined the convergence to ensure that differences between the EE values across the design points were larger than differences between seeds.

Page 3: somewhat out of touch with the motivation of EE, which is screening.

A. This comment is in relation to the fact that we had to first choose a set of parameters for the study, which involved down-selecting from a large list of possible ones. If all parameters would be considered, the total number could reach into the thousands. The approach used here was to choose those that spanned the characteristics being considered, and in a succinct manner. For instance, the TurbSim model parameters were chosen as an effective representation of the parameters for wind-inflow characterization.

Page 3: this figure is very high level and does not contain a lot of information, but does take a lot of space. consider leaving out?

A. The authors believe that this figure aids in the explanation on the setup and considered parameters.

Page 3: i think in sensitivity terminology this would be the dependent or output parameters. it might be valuable to stick to the same nomenclature in order to avoid confusion?

A. The authors have changed the text to consistently use “QoI” throughout the text.

Page 3: vector sum based on the time series or on the ULS results of the time series?

A. The vector sum was taken at each time step.

Page 4: in table 1

A. This sentence is referring to the processes of used to assess the sensitivity of the input parameters, which is separate from the QoIs described in Table 1. This has been clarified in the text.

Page 4: not sure if this is correct ("common")

A. The authors believe this is correct.

Page 4: including meta modeling

A. We are unsure of the meaning of this comment. The sentence is about meta modeling.

Page 4: dont understand this comparison. the choice of sensitivity analysis is more or less independent from the choice of sampling procedure..

A. The discussion here is on how to improve the time efficiency of a sensitivity analysis. This can be done either through the mathematical approach for calculating the sensitivity, or through a down-selection of simulations based on the important ones, or through a reduced-order model.

Page 4: elementary effect

A. I'm assuming that the reviewer would like us to spell out EE here? The name has been introduced before, as well as the acronym, but we will go ahead and spell it out again here.

Page 5: R is 10 in this work => 10%?

how is this value selected?

A. R is 30 in this work and was selected based on a convergence study that considered all QoIs.

Page 5: in line with proposed method from campolongo, no? should be sufficient to only highlight the differences from there

A. Campolongo has looked at multiple approaches, so the authors thought it would be useful to provide a high-level summary of the approach being taken.

Page 5: reference?

A. A reference has been added.

Page 6: clarify again that i is for the input variables

A. The authors do not believe this is necessary, as the parameter is defined multiple times before this point.

Page 6: r is iterating from 1 to 10?

A. 30 starting points are used in this work. r is not necessarily iterating from 1 to 30, but is instead being calculated separately at each starting point.

Page 7: difficult statement. EE already describes the sensitivity. Do you have an "exact" sensitivity in mind that is modeled with the EE?

A. There is a sensitivity formula suggested by Campolongo, and introduced by Janson. In the end, the formula is very similar to the μ^* metric associated with Elementary Effects, and is therefore used directly as a sensitivity metric.

Page 7: can you explain your motivation of deviating from from the classical procedure? is this resulting from introducing new measures of EE which deviates from general methodology?

A. The classical method has a pictorial representation of mean vs standard deviation of the EE values. There is no definitive procedure for identifying or selecting the most significant parameters. The metric devised here is focused only on μ^* (mean) as this is the sensitivity indicator, whereas the standard deviation is an indicator of the influence of other parameters.

Page 7: is there a general procedure on how to assess these thresholds?

A. The authors chose a value that was reasonable given the data.

Page 7: also an interesting paper from Kelly and Dimitrov using pce to establish Sobol indices

A. Thank you for the additional reference. However, since this was not used when establishing the method we did not add it as a reference in the paper.

Page 8: should be highlighted in the abstract that a kaimal spectrum was used

A. A statement has been added to the abstract.

Page 11: you show results across all QoI, right?

A. Correct. These results are presented in Figures 5-8 and Figures 15-18.

Page 24: this seems very large

A. The level of yaw error was based on a reference by Quick, and the author's agreed that this level was feasible by consulting experts.

Page 27: should be mentioned in section on methodology or outlook as well

A. The general methodology is summarized above. There were issues encountered for this second case study, and we felt it was best to discuss the issues encountered within the individual study, since they did not occur for the other case study.

Page 27: this paragraph should be revised to increase readability.

A. The paper will go through a formal review process with an editor. This will be addressed at that time.

Page 36: the purpose of EE is more the determination of relevant input parameters, not the sensitivity assessment. This should not be the motivation of this study.

A. Please see discussion above.

Page 36: is there any improvement possible on the applied procedure in this work for other systems or do you propose that it can be used as a baseline method?

A. Though minor adjustments may need to be made, the overall process is quite applicable to the related analyses.