Reviewer comment for the WES paper

"Surrogate models for the blade element momentum aerodynamic model using non-intrusive Polynomial Chaos Expansions"

by Rad Haghi and Curran Crawford

Specific comments that remain after the revision

Referee comment #1

There are issues with two of those three key aspects that would need to be addressed by the authors before releasing this work. First, the curse of dimensionality is not adequately alleviated for the future purposes of this work. Selecting a simpler wind velocity model with a reduced number of inputs does not tackle the problem, just avoids it. When a more complex model is needed, the same technique presented here is not enough to tackle the challenge of dimensionality in PCEs and the work should be revisited entirely. The literature is very rich with mathematical ways of dealing with this issue (low-rank approximations, sparse PCEs etc) and these have not been explored which would be more important for the impact of this work in the field of wind engineering. Furthermore, there are no account of errors for each PCE approximation, for instance for Figure 4, computations of the L2 error norm, not just a qualitative indication.

Authors' response

The authors agree with the comment about the reduced Veers model. We are aware of the challenge and will tackle this in future work. This comment is thoroughly addressed in the new revision. The reduced model showed enough accuracy in Fluck's (2016b) work in covering the variation in the unsteady wind. This reduced Veers model is not a substitute to the high fidelity Turbsim model but a necessity to study the surrogate model at this stage. The sparse PCEs were tested, and the result was not promising in terms of the required data for the Quadrature method. The full gaussian quadrature methods for 10 random variables and polynomial order 4 require 9765625 data points, which means 9765625 simulations. For the sparse setup, 10626 simulations are required. The L2 error for the point-to-point comparison is added to the revised version.

Referee comment to authors' response

It's still not clear how building a surrogate for a simpler model helps with a more complex model. Surrogate modeling is highly dependent on the problem at hand (e.g. behavior of the function to approximate, discontinuities, non-linearities, correlation, etc). If the problem at hand completely changes (more complex model) then the whole methodology here described will have to be re-assessed entirely. The authors should detail what exactly is the usefulness of approximating this simpler model, what is this "necessity" you mention? If the purpose is to guide future research for

more complex models, as repeatedly mentioned throughout the manuscript, then a wider exploration of options and discussion on how well they adapt to your problem should be priority.

You only mention the number of evaluations required but for what level of fidelity/error? Generally, an L2 error norm vs points used for surrogate building plot is used for the rigorous comparison. How many points you need for what level of error, etc. Rigorous discussion is missing for proper justification of the approach and not just comparison based on number of evaluations. You may be happy with the error you get with the point-collocation method but the error with the sparse quadrature approximation might be smaller (even if you don't want to pay the price of the extra simulations), in which case the comparison is not fair, and again, all of this is with the foresight of going to more complex models in the future for which this aspect might be important. In this regard, the L2 error norm of Figure 7 seems rather large. A good surrogate model should not exceed 1% error. The argument made by the authors who claim to care about the statistics should be revised by computing the same metric on the statistics instead. Error on the standard deviations and means, for instance. Is that error acceptable and why?

Referee comment #4

Another concern to be raised is the structure of the paper. It is not well-organized and some sections are a paragraph long. Maybe a better way would be to devote section 2 entirely to the models the authors aim at approximating, with more in-depth discussion. Section 3 could be devoted to the methodology and all the different aspects. Section 4 could then discuss the results.

Authors' response

Thanks for bringing this to our attention. The model in this study is treated as a black box, therefore we do not see any need to go further into the details of the model. We did revise the manuscript to better organize the section and subsections and address your comment.

Referee comment to authors' response

Fine with referencing the model and treating it in black box fashion but I don't see changes in the paper structure. The same concerns remain. For instance, Section 2. mixes the physical model, surrogate model, statistical convergence, etc. It is confusing. Section 2.5 is one paragraph long.