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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Sensitivity of Uncertainty in Wind Characteristics and Wind Turbine Properties on Wind Turbine Extreme and Fatigue Loads" *by* Amy N. Robertson et al.

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//————————————-// General comments //————————————-//

The date of Reference number 2 ("Assessment of extreme design loads for modern wind turbines using the probabilistic approach," DTU Wind Energy (DTU Wind Energy PhD; No. 0048(EN)) should be 2015 and not 2018.

Early in the paper, the authors should consider explaining their logic for choosing to use the Elementary Effects sensitivity approach instead of other approaches. As far as I am concerned EE sensitivity type of analysis is mainly used for initial assessments of input parameters, when you have large number of input parameters and it only provides information in the qualitative sense: indicates influential vs non-influential input, and hints to higher order effects caused by nonlinear or interactive relationship between parameters. You briefly explain this in section 3.1, but maybe you should consider summarizing the logic in your intro.

//——————————-// Specific comments //——————————-//

Page 2, Lines 4-6: I don't fully agree. Say we have a long and slender blade. You use ElastoDyn for the to define the blade dynamics via 1-2 assumed flap and 1-edge modes. This means that all your structural dynamics are effectively filtered through those three modes. A complex combination of wind speed, turbulence, shear, veer and yaw error might -in reality- result in a bend-twist coupling that will increase the loads or, unintuitively, reduce the loads (because the twist results in lower angles of attack). You will never be able to capture such a phenomena with a simpler model resulting in erroneous conclusions on your sensitivity analysis.

Page 2, Lines 13-14: What do you see the downfall of your sensitivity analysis if correlations and joint distributions of input parameters are not taken into account? See for instance slides 22 and 23 in http://www.gdr-mascotnum.fr/media/mascot12caniou.pdf On the same topic, since you use ranges, you might easily fall into an erroneous case where high wind speeds and large shear exponents (alfa>1) combine. . .but I could see from Table 3 that you chose your ranges and combinations carefully (you also make this clear on lines 4.8, page 10).

Page 3, Lines 23-24: could you please explain the reason for choosing the vector sum of the components of the bending moments? Imagine bending moment Mx is an order of magnitude larger than bending moment My. Under some combination of the input, we observe that My exhibit large variations (x2 or x3) where as Mx doesn't. However, given that Mx is an order of magnitude larger than My, the large fluctuations of My will not be really reflected in the vector sum. Consequently, the sensitivity analysis will not reflect the real effects of the input any longer.

Page 10, lines 4-6: I actually propose you compare the sensitivity analysis performed on the same set of input assuming they are independent and then assuming joint distributions (where possible).

Despite my previous comment, your results in Figures 3 & 4 and your summary on page 18, conform to results found by investigators/researchers. So, I don't think you have introduced flagrant errors using the approach proposed in this article.

Section 4.2.2.4 Steady Airfoil Aerodynamics - Abdallah et al. proposed the initial probabilistic model. You made some nice modifications and contributions. I propose we make both models available to the public (open source, open access), in order for further future improvements be made by others. - Figure 13 shows samples of perturbed Cl and Cd curves. I notice that the Cl perturbations for positive angles of attack are shown but not for the negative angles of attack. Does this mean that the model does not handle Cl perturbations for negative angles of attack? If not it should, especially that you consider ultimate loads and large yaw errors. - It is not clear if you maintain the correlations of Cl and Cd curves along the span of the blade?

Control properties, Table 10 - -20 to 20 degrees is a fairly large range for standard yaw error for a turbine in normal operation and connected to the grid, which might explain why this parameter ends up being so significant as shown in Figure 13, 14, and Table 11. Unless the underlying assumption is that this range implicitly includes the effect of rapid directional change of the wind. In principle a controller should be able to detect such large yaw errors (say over a 30-60 second averaging windows) and perform the necessary safety procedure (whatever that might be).

Figure 13 has the grid on, Figure 14 has the grid off.

Page 25, Line 13: "Ultimate turbine loads are most sensitive to yaw error (theta) and lift (Cl) distribution" I would say "Both Ultimate and fatigue loads are…"

Page 27, Lines 3-17: very good discussion. Useful information here that needs to be carried out to future investigations!

Page 35, Line 8-10: very good discussion. Useful information here that needs to be carried out to future investigations!

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