Discussion of:

Predicting and reducing wind energy field experiment uncertainties with low-fidelity simulations

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The paper presents a virtual experiment-based methodology for estimating the amount of uncertainty in wind turbine load and power performance measurements, subsequently providing possibilities to estimate how long a measurement campaign will need to be in order to achieve a certain level of confidence in the results.

While I definitely encourage the general idea of the authors to consider "how long measurements are long enough" and I find this to be a very relevant question, I believe they make several assumptions that may not be valid in some circumstances. This may question the robustness and generality of their methodologies, and I therefore recommend that these assumptions are discussed in much more detail and corrected wherever necessary. Below, additional explanations are given in the General Comments section, as well as some additional recommendations for further improvement.

General comments

1) The authors assume that the random errors are aleatoric, and completely independent. I am not certain this is the case, for example one could assume that the random error in two anemometers of the same type and on the same site may have correlation with external factors like the wind speed and turbulence. Then the random errors will be correlated to each other through the correlation to external factors. Such correlation may reduce the total variance of the difference between the errors. This issue can however be partially taken into account if the uncertainty is evaluated bin-wise as the authors are doing.
2) It is not a given that a numerical model will be able to simulate all the random variability present in real experiments. As the actual wind field in an experiment is never fully observable, we are not necessarily able to represent the entire variability in the wind conditions in the simulations, because the simulations will only vary a limited number of parameters, and the simulated wind fields will match the target statistics of the entire wind field, while the measurements are taken at a single point or a few points only. As a result, it is very often that one-to-one numerical load simulations will have smaller variance (after subtracting the bias and conditional means) than the actual measurements.
3) Power performance and load validation are addressed in the IEC 61400-12 and -13 standards respectively. Uncertainty is discussed in both standards. Any real load or power performance validation campaign would be expected to comply with the provisions of these standards. It is therefore important to align the discussions of this paper with the standards and outline any differences.

Specific comments

4) Page 2, line 26: I am not certain about the strict classification of bias as epistemic and the random errors as aleatoric. There may be epistemic errors that have non-zero variance (aliasing and other numerical artefacts being an example), while aleatory effects may also be autocorrelated or related to an external factor which will introduce bias for a finite experiment.
5) Equation (2): I believe this equation is true for the case when delta_P1 and delta_P2 are completely uncorrelated. This however may not be the case, for example if the error is dependent on an external parameter (say, wind speed), then delta_P1 and delta_P2 will be positively correlated and the total variance will be less than the root mean square sum that the authors suggest.
6) Page 10: the authors say “day-to-day variations should be much smaller than hour-to-hour variations”. It depends – the weather systems passing over a location typically have duration in the range of 1-3 days, so there could be significant day-to-day variations. On the other hand, this may not be very important as we should not expect that “calendar days” should have influence on the external conditions, it will more likely be dependent on season and time of day.
7) As mentioned earlier, I expect that the variability produced in simulations may be smaller than what we see in real measurements, mainly because of the incomplete characterization of the true wind field passing through the rotor. I think this expectation is confirmed by the results shown in Figure 5, where there is only limited dispersion in the data.