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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Hurricane eyewall winds and structural response of wind turbines" *by* Amber Kapoor et al.

Anonymous Referee #1

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General Comments This paper presents the use of a high-fidelity wind data from an LES simulation of a Cat 5 hurricane as wind input to drive the aero-elastic loading of the DTU 10-MW turbine to show the impact of hurricane winds on structural loading. The paper is very well written and the topic of relevance to the offshore wind turbine industry, but there are some issues that need to be addressed before final publication.

Specific Comments - Page / Line / Comment 4 / 115 / Why was the analysis of the LES data for use in TurbSim limited to shear, veer, and TI? The TurbSim tool can generate synthetic wind from more information than is used here. It appears possible to derive the turbulence spectra in u,v,w, the spatial coherence in u,v,w, and the Reynold's stresses (vector component correlations) from the LES data. 10 / 211 / The previous section focused a lot on gust factors and direction changes. How do these compare

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between the LES data and the resulting TurbSim simulations? 10 / 217 / The wind data extracted from the LES was only 10-minutes long. Is it OK to assume that the same 10-minutes of wind conditions would apply for a full 1-hour? Wouldn't increasing the length of the averaging period result in a reduction of storm severity e.g. a reduction in mean wind speed? 11 / 233 / This section does not mention how the transverse turbulence is considered. How do the v and w components of the turbulence compare? 11 / 239 / From the understanding of the reviewer, Figure 4 shows the maximum instantaneous veer over the 10-minute LES data. Why is this veer used as the 1-hour average veer in TurbSim / FAST? Shouldn't the 10-minute average veer be used? It appears that the veer applied here is far stronger than what is physical. 12 / 249 / Can't the turbulence spectra be derived directly from the LES? Why not simply use that directly in TurbSim? Why introduce an error by using a Kaimal spectrum with only the TI matching LES? Also, what about the velocity spectra for the v and w components? 14 / 260 / What values of "a" and "b" where used? Wouldn't it be better to fit "a", "b", and "CohExp" collectively based on the LES data? And why not do this separately for each case? 15 / 281 / What features in FAST are enabled? Has induction been disabled for the hurricane / idling cases? Are aerodynamic loads on the tower considered? Is BeamDyn enabled to permit the modeling of large blade deflections? 15 / 283 / Why compare the hurricane loads to loads while the turbine is operating at rated? Wouldn't it be better to compare the hurricane loads directly against what a standard IEC-based design would consider e.g., load cases 6.1 and 6.2 based on class I winds and category "A" turbulence? 15 / 289 / It is unclear to the reviewer how the yaw misaligments were derived. Are you assuming that the yaw controller is always active? Are you assuming the time it takes for the yaw controller to measure the yaw misalignment before inducing yaw motion? 16 / 298 / Modeling high wind events with yaw errors in the range of 20-30 degrees typically result in aero-elastic instability (negative damping) of the blade-edgewise mode, which results in unrealistically large blade deflections and tower side-to-side loads. Do you see any signs of this instability here? The wind industry typically neglects yaw errors that result in this instability because they don't believe the numerical models accurate predict deflections and loads under these conditions. 17 / 311 / A tower has a cylindrical cross section, so, the maximum loads should be assessed in terms of the vector magnitude / resultant, rather than specific fore-aft and side-to-side components. The reviewer suggests eliminating the rows associated with FA and SS. Also, why are the blade-root loads not shown? These too should be shown in terms of the vector magnitude, not the vector component. 17 / 316 / The text here and later refers to "blade loads", but only "blade deflections are shown. The reviewer suggests adding blade loads to these tables. 17 / 330 / It is unclear where the 5.4 10ˆ5 kNm load and 18-m deflection limit come from. Please clarify. 19 / 375 / Such large deflections cannot reasonably be modeled with FAST's ElastoDyn module. Was BeamDyn applied here? 19 / 380 / Is this blade root moment the vector magnitude / resultant, or something else? (It should be the resultant because the blade root is an axisymmetric structure.)

Technical Corrections - Page / Line / Comment 1 / 36 / The reviewer hasn't checked all of the references, but this publication by Tarp-Johansen et al does not appear in the Reference section. 3 / 86 / The word "fully" has no technical meaning. Suggest eliminating the word "fully". 3 / 94 / This paper does not discuss the probability of occurrence of the events simulated. It may be that it is not wise to design the structure to withstand the loads under the events simulated if the probability is very low. It may be better to accept this risk and insure for it. Some mention of this is likely worth it in the paper introduction. 7 / 159 / If important, a battery back-up system could be installed to ensure that yaw control is not lost even if the grid is lost. It may be worth mentioning this here, but it doesn't appear that grid loss was assumed in the further FAST analysis. 10 / 222 / You reiterate that the nonGaussian wind is not simulated in TurbSim. It may be worth referencing here work from others that has shown that assuming Gaussian wind tends to be a reasonable assumption without being nonconservative in regards to loads prediction. 11 / 233 / It appears that TurbSim always simulated a lower TI than prescribed by LES. This underprediction can be eliminated by using the ScaleIEC option in TurbSim. 18 / 336 / Change "wind speed profile veer" to "wind speed profile". 20 / 405 / Earlier in the paper you say that the Cat 5 simulation is not a severe Cat 5 hurricane, but now you call this "a worst-case scenario"? Choose your wording carefully.

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