Wind Energ. Sci. Discuss., referee comment RC1
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Comment on wes-2022-38

Anonymous Referee #1

Referee comment on "Extreme coherent gusts with direction change – probabilistic model, yaw control, and wind turbine loads" by Ásta Hannesdóttir et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2022-38-RC1, 2022

Overall comments:

- The manuscript presents results from a probabilistic model of a dataset consisting of 92 measurements of wind conditions meeting the authors' definition of a coherent gust. The probabilistic model uses the Nataf model to create a trivariate distribution of the data in terms of rise time, direction change, and amplitude change of the gust and ISORM is used to calculate environmental surfaces (i.e., combinations of these three variables with a common mean return period). The coherent wind gusts associated with the 50-yr environmental surface are then analyzed using a model of the DTU 10MW wind turbine in HAWC2 and the results are presented in terms of several cross-sectional demands on the tower and blades of the turbine. Simulations are implemented with and without a yaw controller. Results are compared with demands calculated following the definition of a coherent gust in IEC 61400-1.
- The authors present a clear and interesting analysis of an influential load case in the design of wind turbines. Their interpretation of the analysis provides useful insight and I enjoyed reading the manuscript. I have a few recommendations to increase clarity and accuracy, but otherwise recommend this paper for publication.

Specific comments:

- Line 6, the 460 year return period is written as if this is a general finding. Please revise to clarify that this return period is specific to a particular dataset at a particular location following a particular methodology.
- Line 16, DLCs not DLC's
- Line 18, pls replace the wording "which is the target reliability level in wind turbine design." with something like "which is the intended recurrence period of the environmental conditions prescribed by the IEC Standard." The target reliability level depends on load and resistance factors in addition to the intended recurrence period of

the environmental conditions of the DLC.

- Lines 61-68, while the authors refer to a previous study for the detection and characterization of the coherent gusts within their dataset, it would be helpful to provide a sentence or two here describing the criteria for an event to be categorized as a gust and the way in which the three variables are calculated for each event. In particular, please provide brief information on the spatial criteria for classification as a gust and the time average used to calculate the wind speed.
- Lines 68-69, how are the wind speeds Ua and Ub averaged in time and in space? I imagine this is described comprehensively in the authors' previous work, but it would help to provide some brief information here.
- Section 3.1, the discussion on IFORM and ISORM needs revision. On Line 88, the statement that IFORM has been shown to underestimate the exceedance probability by an order of magnitude needs conditioning, as this is not a statement that is generally true. Can the authors elaborate what they are talking about? When multiple variables are being modeled probabilistically, there are many, equally legitimate, ways to determine exceedance probabilities and recurrence periods for combinations of these variables, so I am having trouble understanding what the authors mean when they say the exceedance probability is underestimated – underestimated compared to what?
- On Line 90, the authors refer to Equation (7) to distinguish between IFORM and ISORM, however this equation, which defines a sphere with radius beta in standard normal space, is used for both IFORM and for ISORM. The difference between the methods is in how the sphere is used to define the space of variables for which probability is calculated. In IFORM, the space is defined by a plane tangent to the sphere. In ISORM, which is a new method to me, I believe the space is defined as all points outside of the sphere. Can the authors explain more clearly the differences between IFORM and ISORM given that both require use of Equation (7)?
- On Line 91, the authors refer to an exact solution for the return period using ISORM. Perhaps I am not understanding the authors' intent here, but I don't understand the idea of an exact solution for calculating a return period for combinations of three variables. Since multiple variables cannot be ranked unambiguously, there are many ways to calculate exceedance probability/return periods for combinations of these variables. IFORM is one way. ISORM is another way. I don't think it's appropriate to call either one exact. They are just different. Are the authors saying that environmental surfaces using ISORM lead to more accurate calculations of probability of structural failure? If so, this should be clarified. And, even still, calling the result generally exact is too strong of a statement since this could only be true for a specific and simple idealization of the loading given the environmental variables.
- Section 3.1.2, suggest editing the section title to emphasize IEC, e.g. "the IEC ECD" instead of "the ECD"
- The result on Line 160 should be emphasized as being calculated for one specific site using one specific methodology.
- Line 232, bending not binding.
- Line 251, at this point the meaning of "load channels" was not clear to me. I eventually figured it out after seeing Table 2. It could be helpful to define this term earlier.
- Line 257, pitch not pith.
- Line 271, as I was thinking about the results for TT_yaw, I was curious how much of the loading is inertial as the yaw controller accelerates the rotor. On a related note, does the yawing of the spinning rotor during an ECD cause a significant gyrotorque? This may be outside of scope, but, it my opinion, it would be interesting to provide some discussion on the influence of inertial loading compared to aerodynamic loading for this condition
- Table 2, suggest dropping a couple of significant figures from the reported moments.