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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "An efficient frequency-domain model for quick load analysis of floating offshore wind turbines" *by* Antonio Pegalajar-Jurado et al.

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The authors thank the reviewer for the feedback provided. Please find below the reviewer's comments (RC) and corresponding author's comments (AC). PXLY refers to page X and line Y in the manuscript.

RC: This paper presents a simplified modeling approach, called QuLAF, to calculate towerbase loads in a floating wind turbine. The approach is an interesting one and is well thought out and presented.

RC: Some items that I think would make the paper better include a larger discussion on

what makes this modeling approach unique from others that have done simplified modeling in the past. Other work is presented, but the differences are not well described.

AC: To the authors knowledge, this work is the first simplified tool for floating wind turbines to include both stochastic wind and waves (see P2L24), and to compare not only motion PSDs but also extreme values and fatigue loads. This has been made more clear in the end of Section 1.

RC: A second point would be to better describe how the authors see this approach benefiting the design process for a floating wind turbine.

AC: The model is meant to complement existing state-of-the-art tools, giving a preliminary quick overview of the response and loads for a wide range of environmental conditions. After this preliminary screening, the time-domain model should be used to analyze in more detail specific load cases - e.g. cases with extreme loads or transient events (see P3L16-17 and P27L30-P28L2).

RC: There appears to be several steps in developing the simplified model which could make it time consuming, such as the extraction of damping coefficients. How much of this work can be automated, versus how much needs to be done manually? What would the total time to develop this approximated model from the original? With super computers now, 50,000 simulation could be run in a couple of days.

AC: For this study, the focus has been on assessing the simplified approach and identifying potential improvements, therefore many things have been done manually (e.g. linearization of mooring system and extraction of aerodynamic damping). However, the authors believe that most of this work can be automated if needed. In addition, aerodynamic loads and damping coefficients have to be extracted only once for a given wind turbine. We cannot give an exact figure on the time spent developing the model because it has been an incremental process, through which we have tried many ideas that finally were not included in the final version. It is true that supercomputers make state-of-the-art models more attractive, but not all concept developers have access to such resources and the simplified model will always run a few order of magnitude faster (e.g. the 50,000 simulations with QuLAF would take a couple of minutes in a supercomputer). This discussion has been added to the end of Section 7.

RC: In addition, the authors are still using WAMIT in the pre-computation stage, which will be time consuming. The time savings seems to come from being able to do multiple simulations for the same design. However, it does not seem like this approach would allow designers to quickly examine different design approaches due to the time components for creating the model. Why not consider using a Morison model for the hydrodynamic loading? While it may not be completely accurate for larger structures, it seems the represent the system fairly well, especially considering the level of accuracy in this simplified approach. Was a comparison to this approach done?

AC: The choice of a radiation-diffraction solver for the hydrodynamic modelling was motivated by the study case, given the shape and size of the chosen floating substructure. In an optimization process where many design variations are to be evaluated, the WAMIT panel geometry can still be parameterized and the WAMIT analysis can be done automatically. On the other hand, for slender simpler geometries (such as spars) it would be natural to employ a Morison approach, thus simplifying the whole process. No comparison to the Morison approach has been done in this study. This discussion has been added to the end of Section 7.

RC: While I can see such a model could predict steady-state loading, and thus be able to estimate the fatigue loading of the system, it would not capture the discrete events that tend to cause extreme loading in the system, which can be a design driver. I therefore think a more thorough discussion of where this tool fits within the design process would be beneficial.

AC: As stated in P27L30-P28L2, the model presented here is not meant to replace state-of-the-art tools, but rather to complement them by allowing a faster exploration of the design space. In addition, the QuLAF and FAST models presented in this

study have been recently used in the LIFES50+ project for a broader analysis of different design-driving load cases, including normal operation, extreme and transient events (report available at http://lifes50plus.eu/wp-content/uploads/2018/07/D78-GA_640741.pdf). Generally, the results were quite satisfactory and the main limitations found in the simplified model were: a) underprediction of wave-induced response for large waves; and b) underprediction of wind-induced response around rated wind speed. These findings are in line with the ones discussed in the paper. In the extended study the effect of aerodynamic damping on tower vibrations was found to also play a role in b). This discussion was not originally in the paper, but it has been included now.

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