WES-2023-107 Response to Reviewers

Dear Reviewers, dear Editor,

thank you for your time managing and reviewing our work and for your feedback. Based on the Reviewers' suggestions, we have done our best to improve the paper. Before answering your observations in detail we would like to point out that we decided to change the title of this study, from the original *"A Code-to-Code Comparison for Floating Offshore Wind Turbine Simulation in Realistic Environmental Conditions: Quantifying the Impact of Modeling Fidelity on Different Substructure Concepts"* to *"Quantifying the Impact of Modeling Fidelity on Different Substructure Concepts for Floating Offshore Wind Turbines - Part II: Code-to-Code Comparison in Realistic Environmental Conditions"*. We believe this change better links this paper with WES-2023-117, also under review in the WES Journal. WES-2023-117 is in fact "Part I" of this two-part study and lays the groundwork for the considerations done in this study. We hope this change also helps address some of Reviewer's #1 concerns regarding our citation of WES-2023-107 to explain some of the differences we observed in this paper. We believe we should have presented the two papers as a two-part study from the start, as they are deeply linked and part of the same project.

We have provided detailed answers to your comments below, in blue colored text for your convenience.

Best regards,

F. Papi, G. Troise, R. Behrens de Luna, J. Saverin, S. Perez-Becker, D. Marten, M.L. Ducasse, A. Bianchini

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Reviewer #2 comments:

The manuscript discusses the performance of floating offshore wind turbines. For that, the differences in modelling these facilities are studied using three different simulation codes and three substructure designs and considering realistic environmental conditions. Furthermore, the study is made within the EU project floatech. The authors find that while all codes provide similar results for the system dynamics, differences are observed in the estimation of fatigue loads. I find the paper well written and the analysis sound for the offshore wind turbine community. I therefore consider it is suitable for publication in Wind Energy Science journal, provided the authors address the following minor comments:

Thank you for your time and valuable feedback. We are glad that the Reviewer generally appreciated our work. We provide detailed answers to the points raised below.

- The environmental conditions used for the present work correspond to the Scottish island of Barra. The authors argument this choice because, among other arguments, this location presents harsh conditions. The question arises therefore about how representative is this study of more standard offshore environmental conditions. I would appreciate if the authors can address this point in the manuscript.

The Reviewer raises an interesting point. It is hard to give a general and definitive answer to this without any additional research. As stated in the manuscript, we have selected these environmental conditions partly because they are believed to be particularly severe, and thus to better highlight the potential differences

between the codes. In other words, we were looking for environmental conditions that would give us strong wind and wave excitement on the turbines. Wind and wave actions are coupled in a FOWT, in the sense that one excitation influences the other and vice-versa. We were looking to maximize this interaction to comprehensively test QBlade-Ocean and highlight any differences in the multi-fidelity models. In more "standard" environmental conditions we would expect less wind-wave coupling in the FOWT dynamics and thus less differences between the codes. This reasoning is now reflected in the paper in section 2.1 (L104-106 of revised manuscript). Again, it is hard to state this with absolute certainty without performing additional research on the topic.

- Table 1 caption should describe the variables in more detail. Overall, while in another work from the authors this dataset is discussed, more detail about it would help the reader of the present manuscript.

Table 1 is indeed very dense and can be hard to understand for researchers out of the field of load simulation. We then improved the caption of the table as suggested, but also added additional details and references to section 2.2, where the interested reader can find more information (L118-120 of revised manuscript).

- Why DLC 1.4 simulations are only 10 minutes long? What is different with respect to the other ones?

The Reviewer's comment is on point. We did not explain this in detail in the first draft to keep the discussion short, but the choice indeed needs justification. In DLC 1.4 ad extreme wind gust with direction change occurs around 100 second into the simulation, which causes the turbine to shut down. Because this is an extreme load DLC, we are interested in the extreme loads that arise as a consequence of this event. These extreme loads occur in correspondence of the event itself or right after. If the Reviewer is interested, the timeseries in Fig. 42 in [1] show this nicely. As such, we don't need to simulate a full hour of operation in this DLC. We added an explanation to clarify this point in section 2.2 (L122-128 of revised manuscript).

- In figure 2, the turbine models from left to right do not agree with the order in their description in the sections below. This is a very minor issue but the authors may want to correct the inconsistency.

Thank you for pointing this out. We agree that this suggestion helps to keep the paper consistent and schematic. We changed the order of the models in Fig. 2 and the description of the figure to boot.

- I agree with the other Reviewer that the lack of convergence in some simulations in OpenFAST and DeepLine deserves a deeper discussion.

This should have been explained better in the first draft as requested by both Reviewers. Indeed, disclosing more information in this regard may help others facing similar issues in their simulations. One simulation in OpenFAST did not converge. Upon detailed inspection of this specific result, the issue seems to be related to numerical instabilities in the structural solver. In DeepLines-Wind the issue can be traced back to instabilities in the numerical integration scheme. Despite an initial attempt to solve these issues in both codes, we ultimately did not have the resources to attempt to fine-tune the numerical parameters in the two codes and solve the issues. The beginning of section 4 has been edited to reflect these changes (L310-314 of revised manuscript).

- While the manuscript reads well, it presents several typos that should be corrected.

Thank you again for pointing this out. We have proofread the manuscript once over and hopefully have rectified all the issues.

[1] Papi, F., Bianchini, A., Troise, G., Mirra, G., Marten, D., Saverin, J., Behrens de Luna, R., Ducasse, M.-L., and Honnet, J.: Deliverable 2.4 Full report on the estimated reduction of uncertainty in comparison to the state-of-the-art codes OpenFAST and DeepLines Wind, 2023.

[2] Abbas, N. J., Zalkind, D. S., Pao, L., and Wright, A.: A reference open-source controller for fixed and floating offshore wind turbines, Wind Energy Science, 7, 53–73, https://doi.org/10.5194/wes-7-53-2022, 2022.

[3] Behrens De Luna, R., Perez-Becker, S., Saverin, J., Marten, D., Papi, F., Ducasse, M.-L., Bonnefoy, F., Bianchini, A., Nayeri, C. N., and Paschereit, C. O.: Verifying QBlade-Ocean: A Hydrodynamic Extension to the Wind Turbine Simulation Tool QBlade, Wind Energy Science Discussions, 1–36, https://doi.org/10.5194/wes-2023-117, 2023.