Answers to RC1 Comments

March 31, 2023

Dear sir or madam,

Thank you very much for your kind comments on the manuscript. We have carefully considered all your appreciations and have revised the manuscript accordingly.

Please, find below our answers to each one of your comments. We hope that you agree with all our responses. We are looking forward to hearing from you.

Best regards,

Guillén Campaña-Alonso, Raquel Martín-San-Román, Beatriz Méndez-López, Pablo Benito-Cia, José Azcona-Armendáriz.

1. In Table 1, what does "deterministic" mean in the load case description?

We use the term "deterministic" to describe those load cases where the wind is both steady and uniform as those two presented in the paper, as it follows the nomenclature previously used in OC4 project [Robertson et al.(2014b)Robertson, Jonl
Would you suggest a more suitable description for this type of load cases?

2. On page 7 line 190, please add a comma before "and two flexible modes . . . "

Thank you very much for your appreciation and careful review. The manuscript has been corrected accordingly.

3. Were wave forcing/damping zones included in the OpenFOAM/OF2 simulations?

No, they were not included because the boundary conditions implemented in OpenFOAM do not need them. We assure that the boundary conditions are far enough from the platform ensuring it is not influenced by them.

At the outlet, the *shallowWaterAbsortion* boundary condition has been used for wave absorption. This boundary condition applies a zero gradient condition to the alpha field and to the velocity z-component (as it can be seen in OpenFOAM's documentation: https://www.openfoam.com/documentation/guides/latest/doc/guide-wave-modelling.html) while it sets to zero the other two velocity components.

4. Please provide the total number of cells used in the OpenFOAM/OF2 simulations.

As you suggest, the total number of elements will be added to the manuscript. The mesh is approximately composed by 2.3 million elements. As the floating platform is geometrically not too complex it can be meshed with a relatively small quantity of elements while preserving the geometry integrity. Furthermore, the refinement strategy employed allowed us to reduce the total number of elements.

5. In figure 5, it looks like the CFD mesh does not have a boundary-layer region next to the floater surface. What is the boundary condition on the platform surface? Free slip?

Due to the fact that we are using morphing meshes, it is needed that the boundary condition applied on the platform surface accounts for its velocity. This is achieved by applying the *movingWallVelocity* boundary condition. This boundary condition would be equivalent to a no-slip one if the platform could not move.

In addition, the main objective of the manuscript is to demonstrate the feasibility of this new approach and how it could be used as an alternative tool to analyze and design floating offshore wind turbines. This exhaustive verification regarding the boundary layer influence will be performed in future studies. We appreciate your suggestion.

6. In Figures 7 and 8, the agreement between the two approaches for LC 3.1 appears acceptable. However, the results for LC 3.1 with waves show important differences. Apart from the opposite initial transient motion in surge, which the authors already pointed out and should be investigated further, there is also a large phase shift in the periodic steady-state motion. This is somewhat concerning because the same wave time series was used in both simulations. The authors are encouraged to investigate what is causing the phase shift.*

As you kindly pointed out, there was an issue with the wave time series initialization used in the OpenFAST simulation that induced a greater phase shift than the truly existing one. This has been rectified and the manuscript will be updated. Furthermore, it will also been added an analysis of the existing phase shift between the wave elevation and the heave force and the pitch moment. For OpenFAST, the phase shifts are consistent with the reference [Robertson et al.(2014a)Robertson, Jonkman, Masciola, Song, Goupee, Coulling, and Luan]. Nevertheless, comparing this results against OF^2 there exists a difference between these values collected in the following table.

Phase shift	OF^2	OpenFAST
Heave force	173.56 deg	181.84 deg
Pitch moment	-118.73 deg	-88.24 deg

It is likely that these differences is due to the fact that OpenFAST computes the wave forces at the initial position of the platform whereas OpenFOAM/OF^2 computes them at the displaced position. In the OF^2 case, the displacement in surge is more than 5 meters causing this differences.

7. Between lines 245 and 250 on page 11, the authors state that the mean displacements of the platform are similar between the two approaches; therefore, the mean drift load is consistently captured. In my opinion, the mean displacement observed in this case is primarily driven by the wind. In fact, Figure 8b shows the two methods giving rather different mean hydrodynamic force in surge. It's also surprising that OpenFAST appears to show a negative mean surge force, opposite of what's expected.

As you suggested, we have analyzed the force in surge direction together with the surge displacement. We believe that the stationary states has not been fully reached and there are still some low frequency oscillations that difficult the analysis. Furthermore, considering that the mean force at this wave period should be possitive but very small. In consequence we have decided to run the analysis for 20 wave periods more in order to being capable of analysing the response in surge direction adequatelly. We are also considering to decrease the regular wave period so as to obtain higher mean drift forces. Due to lack of resources, we are not able to update the results in this submission, and we hope to do it in a few weeks.

8. The OF2 results for pitch motion and moment appear to be slowly decaying, whereas the pure OpenFAST results do not. I'm curious if there is any potential explanation for this.

As you pointed out, both the pitch displacement and moment are slowly decaying and the stationary state seems not to be reached. As we are going to run the simulation for 20 wave periods more, we will come back to this analysis in order to answer why this decay is happening. At the OF^2 simulation the free surface elevation has not been monitored in order to avoid a computation problem that sometimes occur when trying to sample a position within the platform geometry.

9. Is the larger fluctuation of rotor speed and generator power observed in the pure OpenFAST results simply a consequence of the larger tower-top motion?

Yes we agree with you that this is the main reason.

10. While the hybrid approach presented in this paper is definitely more computationally efficient compared to full CFD simulations, the comparison of computing time needs to be treated with care because it heavily depends on the targeted level of numerical resolution and convergence. For example, Tran and Kim (2016) reported the use of a prism-layer mesh on the platform surface to help resolve the boundary layer. It can therefore be argued that the CFD simulations of Tran and Kim have a higher level of fidelity compared to the present study. The authors are encouraged to include discussions on these caveats in the comparison of CFD computing time.

Yes, you are completely right and a more fair description of the compared simulations will be added to the manuscript. As you suggest, this is an interesting issue that should have been covered in the initial version of the mansucript.

References

[Robertson et al.(2014a)Robertson, Jonkman, Masciola, Song, Goupee, Coulling, and Luan] Robertson, A., Jonkman, J., Masciola, M., Song, H., Goupee, A., Coulling, A., and Luan, C.: Definition of the Semisubmersible Floating System for Phase II of OC4, Technical Report TP-5000-60601, NREL, 2014a.

[Robertson et al.(2014b)Robertson, Jonkman, Vorpahl, Wojciech, Frøyd, Chen, Azcona, Uzunoglu, Guedes Soares, Luan, Yuto Robertson, A., Jonkman, J., Vorpahl, F., Wojciech, P.and Qvist, J., Frøyd, L., Chen, X., Azcona, J., Uzunoglu, E., Guedes Soares, C., Luan, C., Yutong, H., Pengcheng, F., Yde, A., Larsen, T., Nichols, J., Buils, R., Lei, L., Nygaard, T., Manolas, D., and He: Offshore Code Comparison Collaboration Continuation Within IEA Wind Task 30: Phase II Results Regarding a Floating Semisumersible Wind System, in: International Conference on Ocean, Offshore and Arctic Engineering, OMAE, 2014b.