Answers to RC2 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.

As the hydrodynamics of platform is considered in OpenFOAM, and the motions of platform is transmitted to OpenFAST. Why the OpenFAST calculate the hydrodynamics again based on potential-flow and Morison equation? I think the coupling between OpenFOAM and OpenFAST should be explained in detail.

Thank you for your comment. At the manuscript two different simulation approaches are employed: OpenFAST and OF^2. The OpenFAST approach, or OpenFAST-only model, is detailed between lines 215 and 230. The hydrodynamic model of this approach is based in a combination of potential-flow and Morison equation, using HydroDyn. On the other hand, the new approach described is OF^2. Under this approach, as explained in section 2, the aero-servo-elastic response of the wind turbine is simulated with OpenFAST, while the floating platform dynamics, hydrodynamics and fluid flow are simulated with OpenFOAM. Therefore, nor potential-flow nor Morison terms are included in OF^2, as the hydrodynamic response is resolved with this CFD model.

In the OF^2 approach, at the beginning of a time step, the hydrodynamic forces acting on the platform are computed with OpenFOAM and the influence of the wind turbine (loads at tower base) is also taken into account on the platform through the OpenFOAM restraint that we have developed contained in the libOF2.so dynamic library. To compute the wind turbine forces at the tower base, the displacement, velocity and acceleration of the floating platform reference point is imposed to the OpenFAST simulation. Once this forces are taken into account, the dynamics of the platform is solved and fluid flow is solved finishing the current iteration.

1. Listing 1 can be given as an appendix.

Thank you very much for your suggestion. We agree with you and we have modified the manuscript accordingly.

2. I think it needs some words to introduce how the mesh around the platform's surface is refined, instead *only show some figure. In addition, I think the edge of column of platform above the free surface does not need refinement.*

As you suggest we have completed the mesh description including the mesh refinements employed and this will be added to the next version of the manuscript.

3. Please give the reason why the laminar simulation is carried out in OpenFOAM. In my opinion, the turbulence model should be used to capture the nonlinear wave loads.

According to [Wang et al.(2022)Wang, Robertson, Jonkman, Kim, Shen, Koop, Borràs Nadal, Shi, Zeng, Ransley, Brown, H where uncertainties from different turbulence modelling were studied, the uncertainty associated with the turbulence model is secondary to the discretization uncertainty. We assume, therefore, that analyzing the impact of the choice of turbulence model without performing a discretization analysis study is beyond the scope of the present study. Indeed, the main objective of the manuscript is to demonstrate the feasibility of the new approach. Therefore, these turbulence sensitivity analysis were not carried out.

4. Please specify the wave theory which is used to generate the wave. And the figure 6 should present the more results to make sure the wave is simulate accurately. Form the presented results, it is hard to estimate whether the wave amplitude decreases with time or not

The wave model employed to generate the wave is STOKES II according to the relationship between wave height, wave period and water depth. Figure 6 was included to demonstrate why there is not a oscillatory response of the FOWT at the start of the simulation. As you suggest, the complete wave elevation time series will be updated. Below you can see the complete wave elevation series.

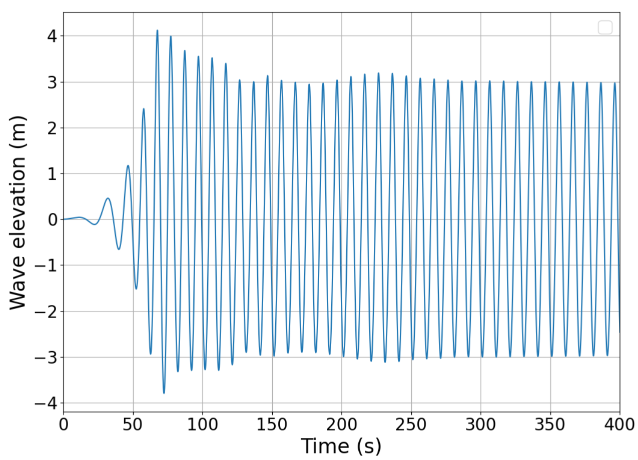

Figure 1: Wave elevation evolution.

5. Why the platform move towards opposite directions at the beginning of simulations in Fig7(b). The difference of mean heave position can be removed in Fig7(c). Even though the difference of mean heave position is removed, the mean value of heave motion between OpenFAST and OF 2 is also very large. Under this condition, there is no wave, I think the mean value of heave should be very close. And the difference of heave force is quite small in Fig.8. Please check the results of heave motion again.

With regard to the surge displacement, we believe that OpenFAST usually struggles with initialization and that this could be the cause of this miss behaviour at the beginning of the simulation. We have also checked that the mooring system is configured equally in both approaches.

Regarding to heave behaviour, we appreciate your suggestion, we have checked again the heave displacement. Firstly, the OpenFAST model that has been used is the one defined by NREL at the DeepCWind definition document [Robertson et al.(2017)Robertson, Wendt, Jonkman, Popko, Dagher, Gueydon, Qvist, Vittori, Azcona, Uzunoglu, Soares, Secondly,for OF^2 simulations, we have employed the mass defined at the aforementioned document while the submerged volume is not user-defined but a result of the surface mesh employed. As collected in table 2, the mean heave displacement at the OpenFAST simulation is -0.03 m while at the OF^2 is -0,08m. It is true that a more refined surface mesh would lead to a smaller mean heave offset. Nevertheless, as the total draft of the platform is 30m, we have assumed that this deviation was negligible, as it represents a 0.3% of the platform draft.

6. The legend of figure should be OF^2 , not OF2.

Thank you very much for your correction. The manuscript has been corrected accordingly.

References

[Robertson et al.(2017)Robertson, Wendt, Jonkman, Popko, Dagher, Gueydon, Qvist, Vittori, Azcona, Uzunoglu, Soares, Harri
Robertson, A. N., Wendt, F., Jonkman, J. M., Popko, W., Dagher, H., Gueydon, S., Qvist, J., Vittori, F., Azcona, J., Uzunoglu, E., Soares, C. G., Harries, R., Yde, A., Galinos, C., Hermans, K., De Vaal, J. B., Bozonnet, P., Bouy, L., Bayati, I., Bergua, R., Galvan, J., Mendikoa, I., Sanchez, C. B., Shin, H., Oh, S., Molins, C., and Debruyne, Y.: OC5 Project Phase II: Validation of Global Loads of the DeepCwind Floating Semisubmersible Wind Turbine, Energy Procedia, 137, 38–57, https://doi.org/10.1016/j.egypro.2017.10.333, 2017.

[Wang et al.(2022)Wang, Robertson, Jonkman, Kim, Shen, Koop, Borràs Nadal, Shi, Zeng, Ransley, Brown, Hann, Chandramo
Wang, L., Robertson, A., Jonkman, J., Kim, J., Shen, Z.-R., Koop, A., Borràs Nadal, A., Shi, W., Zeng, X., Ransley, E., Brown, S., Hann, M., Chandramouli, P., Viré, A., Ramesh Reddy, L., Li, X., Xiao, Q., Méndez López, B., Campaña Alonso, G., Oh, S., Sarlak, H., Netzband, S., Jang, H., and Yu, K.: OC6 Phase Ia: CFD Simulations of the Free-Decay Motion of the DeepCwind Semisubmersible, Energies, 15, https://doi.org/10.3390/en15010389, 2022.