Validation of a coupling methodology for numerical modelling of near and far field effects of Wave Energy Converter arrays using the MILDwave and NEMOH models, based on the WECwakes experimental database

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Wave energy is a promising resource for the renewable energy sector. However, in order to be able to produce large amounts of electricity at a reasonable cost, large farms of Wave Energy Converters (WECs) will have to be deployed in the ocean. Due to the hydrodynamic interactions between the WECs, the surrounding wave field will be affected, both close to the WECs (near field effects) and at large distances from their location (far field effects). However, the accurate simulation of both near and far field effects at a reasonable computational cost using a single numerical model is still a challenge.

In the past years, a one way coupling methodology has been developed to combine the advantages of a wave structure interaction solver (e.g. NEMOH [1], used for the near field effects) and a wave propagation model (e.g. MILDwave [2,3], used for the far field effects). NEMOH is a Boundary Element Method (BEM) that can accurately model the hydrodynamic interactions of the WECs by solving the body motions. MILDwave is a mild-slope wave propagation model than can solve wave transformations in large domains. The coupling methodology consists of the superposition of two different wave field simulations: an incident wave field and a radiated/diffracted wave field. The incident wave field is calculated intrinsically in MILDwave. The diffracted/radiated wave field is calculated around the array in NEMOH and then propagated in MILDwave by imposing it on a wave generation boundary along a circle.

One of the key factors when developing a new numerical methodology or tool is to validate it against available experimental data. For this purpose, the model has been validated using experimental data available from the WECwakes project [4]. In this project, arrays of up to 25 heaving point absorber WECs have been tested in the DHI wave basin using different geometric WEC array configurations. By testing the different WEC array configurations under a wide range of sea states a large experimental dataset has been generated and is publically available for numerical validation purposes.

In the present research, numerical results are presented for different WEC array configurations from WECwakes (e.g. starting from 1 WEC and up to 5 and 9 under a set of regular wave conditions). Firstly, the experimental wave field around the WECs has been compared to numerical results from NEMOH, in order to assess the accuracy of modelling the wave field around the WEC. Then, the coupled numerical model has been run for the different cases and compared to the experimental data in order to validate the model. A good agreement has been found between the experiments and the numerical results from the coupling methodology.

References

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