Cascaded numerical models for offshore floating wind turbines - DTU Orbit (02/10/2019)

Cascaded numerical models for offshore floating wind turbines
The aim of this doctoral thesis is to develop, investigate and validate numerical models for the dynamic analysis of floating offshore wind turbines.

The presented models address some of the challenges currently encountered in the design of floating substructures for offshore wind application. First, a state-of-the-art numerical model is set up and demonstrated in a wide range of environmental conditions with wind and waves. Second, this model is used to develop a simplified, efficient frequency-domain tool for the assessment of loads and response to wind and waves in the preliminary design phase. Third, a time-domain model is established and used to investigate the response of floating wind turbines to waves by comparing to experimental results.

The research focuses on aerodynamic and hydrodynamic loads, and how these can be efficiently combined with appropriate representations of the damping to yield a reasonable prediction of the response at low computational cost. The frequency domain model includes aerodynamic and hydrodynamic loads and captures the main planar degrees of freedom of the floater, as well as tower deflection. The hydrodynamic damping is approximated analytically and the state-of-the-art model is used to extract the aerodynamic damping. The model is able to capture the dominant physics, while the reasons behind the most important deviations are identified. In the time-domain model only hydrodynamic loads are considered, including second-order in viscid slow-drift forces and viscous forces. The damping is identified from the experimental data using Operational Modal Analysis (OMA). The model generally reproduces well the response after proper damping calibration. The damping levels are observed to depend on the sea state and are found to be acceptably predicted by OMA for mild environmental conditions. For the larger sea states, the OMA-detected damping levels are found to deviate from the calibrated values.

The results show that good predictions can be obtained with both models. They also highlight the important role of damping in the dynamics of floating offshore wind turbines, and help to identify further research needs in this area.

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