A monolithic and adaptive finite element method to simulate floating wind turbine dynamics

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ABSTRACT

The demand in renewable energy has significantly increased over a few years and, consequently, the industrial production of renewable energy has considerably expended. In the meantime, wind energy has matured, and many wind farms have been installed, both onshore and offshore. One way to reduce costs when using such technology is to use numerical simulation for optimizing the whole structure from the mooring lines to the blades. The numerical tools involved enable a fine prediction of the behavior the structures have under a large span of conditions, e.g. the loads applied on the structures when extreme events occur. These results can lead to an adjustment of the security coefficients of the wind turbines, which can reduce the CAPEX costs.

This work focuses on a methodology enabling the simulation of one or several floating wind turbines using full-CFD, with an accurate representation of their respective geometries. The software library used is ICI-Tech, developed at the High Performing Computing Institute of Centrale Nantes. A monolithic approach is used, with a single mesh in the simulation, where all the interfaces are defined using modified level-set functions. The Navier-Stokes equations are solved using stabilized finite elements and the Variational MultiScale formulation. In order to largely reduce the computational costs, an anisotropic and automatic mesh adaptation is done, which enables to capture physical phenomena having different orders of magnitude, and parallel implementation allow reaching reasonable computational times. The first results of mesh immersion and aerodynamic simulations are presented.