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CFD Settings and Verification and Validation for the Performance Prediction of a Generic Standalone Flettner Rotor and Rigid Wing.

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ABSTRACT

In the past few years, the International Maritime Organization (IMO) is focusing on decreasing the greenhouse emissions caused by the shipping industry. A viable solution to cut emissions from ships, is to harvest wind as an auxiliary and/or primary source of propulsion energy. Several technologies are present nowadays on the market, such as: kites, Flettner rotors, suction wings, soft and rigid sails to mention few.

Computational Fluid Dynamics (CFD) is one of the methodologies used to study the performance of such devices. Due to the novelty of the field, there is not yet a best practice in CFD for such numerical simulations, and many different settings can be found in the relatively limited literature available. Additionally, due to the lack of experimental results in the past, a comprehensive verification and validation of these applications is also missing.

The scope of this paper is to simulate two different generic wind propulsion technologies (WPT), nominally a Flettner rotor and a rigid wing, in an open field scenario. Within these simulations, sensitivities studies on domain size, boundary conditions, meshing techniques, as well as turbulence quantities will be carried out.

Additionally, a verification and validation study, using the methodology proposed by Eça and Hoekstra (2014), will be performed. This study will be based on the same WPT geometries as the sensitivity study, and will be compared to the two wind tunnel campaigns presented in Marimon Giovannetti et al. (2022), for the case of the rigid wing, and in Deybach et al. (2024), for the case of the Flettner rotor. Verification and validation studies are necessary to have a deeper understanding of the numerical uncertainties and to build confidence in the numerical models chosen to describe the physics of the specific test cases.

References

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