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Session:

Simulation of Aerodynamic Flows around Superstructures of Ships with Hybrid RANS/LES Methods

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Reducing the resistance and the emission of carbon dioxides in shipping is an actual challenge. Usually the focus is only set to the enhancement of the underwater hull flow properties, although the aerodynamic resistance of commercial vessels can amount up to 10 percent of the total resistance. In the design of modern ships, the aerodynamic of the hull and superstructures is not considered, instead the focus lies on a cost-effective production. The target of this study is to reduce the wind resistance of ships by installing aerodynamic plates and other aerodynamic add-on components.
The overwater topology of a ship consists of bluff bodies and the flow around them is characterized by massive separation. Therefore, using classical RANS approaches for the simulation result in inaccurate prediction of the drag forces. Thus, it is necessary to use scale resolving turbulence models to get reliable results and represent the turbulent interaction of the superstructure and the aerodynamic add-on components.

To investigate the aerodynamic flow, the in-house code FreSCo+, a cell centred finite volume method, is used. For scale resolving simulations the DES and the improved extensions DDES and IDDES [1] based on the k-omega SST model are implemented. For the wall modelling a high Reynolds function is used, blending to a low Reynolds wall treatment [2].

In the actual investigation the flow around a container feeder vessel with a length of approximately 140 meters and a partly loaded container arrangement is analysed. The considered air inflow angles are in the range of 0 to 90 degree. For the validation of the drag forces wind tunnel experiments are carried out. The model scale for these experiments is 1:100. For a good comparability the numerical simulations are also performed at the same scale. The geometry of the ship is divided into five parts, so the spatial distribution of the drag forces is accessible.

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Additionally, the temporal fluctuations of the measured forces are recorded. Evaluating the numerical and experimental results, the focus lies on statistical analysis of the fluctuating forces.

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References

[1] Gritskevich, N. et al. (2011). Development of DDES and IDDES Formulations for the k-ω Shear Stress Transport Model

[2] Gritskevich, N. et al. (2016). A Comprehensive Study of Improved Delayed Detached Eddy Simulation with Wall Functions