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Numerical simulation of hot smoke plumes from funnels

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The flow around ship over-structures is characterized by both separation phenomena with recirculation regions at high Reynolds number, and the fast ejection of hot smokes from funnels. These two features are of the utmost importance for two linked goals in the ship design, namely the aerodynamic drag reduction and the preservations of passengers' comfort. In particular, the latter depends on different flow aspects, among the others: the turbulent fluctuations intensity, the smoke temperature and pollutant dispersion and the flow induced noise.
In this work, we present an open-source solver developed in OpenFOAM® that is especially suited for the analysis of ship over-structures. It adopts Large-eddy simulation approach and implements an in-house version of the dynamic Lagrangian Sub-grid Scale LES model along with an equilibrium stress wall function in order to deal with high Reynolds number simulations. Furthermore, a synthetic turbulent inflow generation has been developed to provide a more realistic condition. The hot smoke plumes are reproduced considering the buoyancy effect through the Boussinesque approximations. The model has been validated on different benchmark cases and an analysis of a real ship over-structure is presented.

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