# Numerical comparative study of viscous flows around JBC ship by DDES and RANS methods

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## ABSTRACT

Towing ship in calm water is one of the most fundamental studies in the research of ship hydrodynamics. Despite of the high accuracy of the resistance prediction, it is still challenging to resolve the detailed flow field around ship hull, especially for the wake region. In the present work, an unsteady VOF based CFD method is used to resolve and investigate flow field around the ship model towed in calm water. High resolution VOF method with artificial compression technique in OpenFOAM is used to accurately capture free surface. Firstly, RANS computations with SST k-w turbulence model are carried out to predict flow field around ship hull. Then, Delayed Detached Eddy Simulation (DDES) with the same turbulence model is conducted to resolve the transient flows and the results are compared with those in previous RANS approach. The benchmark ship model of Japan Bulk Carrier (JBC) in Tokyo 2015 CFD workshop in ship hydrodynamics is used for all the simulations and extensive experimental flow data (provided by NMRI) are available to validate the present CFD results.

The JBC ship model is towed at Froude Number 0.142 in calm water and free to trim and sink. All the computations are carried out by our in-house CFD solver naoe-FOAM-SJTU. The RANS and DDES predicted results, i.e. ship resistance, ship motions, wave elevations and flow velocities around ship hull are presented and compared with the experimental measurement. Ship resistance and ship motions are well predicted by both RANS and DDES method, while the flow field around ship hull are highly different. DDES show unsteady turbulent flow structures compared with RANS. Vortices separated from ship hull in the stern flow are also presented to further explain the difference of the flow region. Comparisons of velocity components at cross planes show that the DDES method can better describe the actual wake region for the towing ship.

**Keywords:** JBC ship; DDES; RANS; ship hydrodynamics; naoe-FOAM-SJTU solver