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Progress and Challenges for Computational Naval Hydrodynamics[1]

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Flows around surface and underwater marine vehicles present challenges that are unique to computational naval hydrodynamics. Hydrodynamics phenomena of interest where considerable challenges remain to model and simulate include some problems that have been under study for decades due to their importance also in other fields. Boundary layer transition is important for small autonomous underwater vehicles, tests of model surface ships and submarines, and immersed sensors. A wide range of spatial and temporal scales that not always can be decoupled results in the need of models to make problems tractable. Bubbles are relevant in cavitation and wakes, and can affect propeller performance, coupling the large scale flow and dynamics of a maneuvering ship in waves with the small scale of sheet and cloud cavitation. For single-phase flow problems governed by the ship scale, including the classic naval architecture areas of resistance, propulsion, seakeeping and maneuvering, great progress has been made over the past 20 years, but considerable challenges related to turbulence modeling, separation, free surface modeling and waves, dynamic stability, and others. Two-phase flows of interest include bubble entrainment and transport, cavitation and bubble dynamics, air layer drag reduction, sprays and drops, and bubbly wake dynamics, among others. Larger and faster computers and progress on numerical techniques have enabled ever larger computations resolving more and modeling less, allowing researchers to reveal important physics that are then incorporated in models operating at larger space and time scales. However, even in the most optimistic scenarios computers are still decades away from resolving all the scales of interest for naval flows, making modeling still necessary. After an introduction to computational naval hydrodynamics problems, the presentation will focus on the progress and challenges involved in simulation of cavitating and bubbly flows on marine vehicles.

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[2]39.5 State of the Art in Naval Hydrodynamics