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Mathematical models and numerical simulations for the America's Cup

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Abstract

This paper presents a review of the mathematical models which can be adopted to describe the different physical phenomena characterizing the flow around a sailing yacht. The complete model accounting for laminar-turbulent transition regime, free-surface dynamics and fluid-sails interaction is introduced as long as some simplified models that have been used to reduce the computational complexity. Drawing on the experience of the Ecole Polytechnique Fédérale de Lausanne (EPFL) as Official Scientific Advisor to the Alinghi Team, winner of the 2003 America's Cup, we discuss the role of Computational Fluid Dynamics simulations based on Reynolds Averages Navier-Stokes (RANS) equations and their integration in standard yacht design process. Numerical results in different areas (appendages design, free-surface flows, aerodynamics of sails) are presented and discussed.

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Keywords: Mathematical modeling; Numerical fluid dynamics; Fluid-structure interaction; Free-surface flows; Yacht design; America's Cup

1. Introduction

The America's Cup is a yachting race first run in 1851 and whose prize represents the world's oldest sporting trophy. America's Cup yacht races are fiercely competitive. Even after a race of several hours, just seconds can separate two teams at the finish line. Unlike aerospace or automotive applications, for which vast safety margins must be guaranteed, America's Cup competition demands the utmost performance.

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