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A numerical framework for the simulation of flows with soluble surfactant: application to superhydrophobic drag reduction FERNANDO TEMPRANO-COLETO, CHARLES CLERET DE LANGAVANT, ARTHUR GUITTET, University of California Santa Barbara, MAXIME THEILLARD, University of California San Diego, FRANCOIS PEAUDECERF, University of Cambridge, JULIEN LANDEL, University of Manchester, PAOLO LUZZATTO-FEGIZ, FREDERIC GIBOU, University of California Santa Barbara — The study of flow over superhydrophobic surfaces (SHS) is an area in which the role of surfactants has recently been proven as potentially critical (Peaudecerf et al., PNAS 2017). Traces of surfactants adsorb onto the plastron and are redistributed by the flow, triggering adverse Marangoni stresses that can negate drag reduction. This effect is crucially dependent on seven dimensionless groups describing momentum and surfactant transport, as well as on texture geometry, and is governed by six strongly coupled PDEs in a complex domain. To investigate this problem, as well as other flows with surfactants, we describe a new computational approach for the transport of soluble surfactant in an incompressible fluid (de Langavant et al., JCP 2017 and Guittet et al., JCP 2015). The interface is represented with a level-set approach, and the governing equations are discretized combining finite-difference and finite-volume techniques in Cartesian non-uniform Quad/Octree grids, which allow for an efficient treatment of the multiple scales involved. This research is intended to be the first building block towards direct numerical simulations of realistic turbulent flows over SHS inclusive of surfactants, which are unavoidable in large-scale applications.

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