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Impact of surfactant on the drag-reduction potential of superhydrophobic surfaces in turbulent flows[1] JULIEN R. LANDEL, University of Manchester, SCOTT SMITH, FERNANDO TEMPRANO-COLETO, University of California Santa Barbara, FRANCOIS PEAUDECERF, ETH Zurich, FREDERIC GIBOU, PAOLO LUZZATTO-FEGIZ, University of California Santa Barbara — Recent studies, Peaudecerf et al. (PNAS 2017) and Song et al. (PRF, 2018), have shown the negative effect of surfactant on the drag-reduction performance of superhydrophobic surfaces (SHS) in laminar flow conditions. As SHS could have a large impact in reducing energy utilisation for many internal and external flow applications, particularly under turbulent flow regimes (e.g. ships, pipelines), it is important to understand and predict how surfactant-Marangoni stresses affect turbulent flows over SHS. This is crucially important, since surfactants are present in normal environmental conditions for most applications. Our existing model for SHS inclusive of surfactant (Landel et al. arXiv:1904.01194, 2019) captures the effect of surfactant for two-dimensional laminar flow. Using a technique inspired by Belyaev & Vinogradova (J. Fluid Mech. 652, 2010), we adapt our two-dimensional model to flows above three-dimensional SHS with longitudinal gratings. Then, we use the results of Fukagata et al. (Phys. Fluids 18, 2006) to relate the effect of the surfactant-affected slip length on the drag reduction of SHS in turbulent flows. We discuss the impact of the main parameters: the gas fraction, the surfactant concentration, and the Reynolds number on the drag reduction. Finally, we compare the results of our model with experimental results from the literature.

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