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Restricted nonlinear (RNL) study of the mechanisms underlying drag reduction via riblets[1] XIAOWEI ZHU, BENJAMIN MINNICK, DENNICE GAYME[2], Johns Hopkins University — Riblets in the form of spanwise-varying micro-grooves are known to change skin-friction drag in wall-bounded shear flows as a function of their size and shape. However, the drag reduction and degradation mechanisms associated with these flows are not fully understood. In this work, we seek to gain insight into this question through simulations of restricted nonlinear (RNL) flow over a range of riblet geometries. This reduced order model is first shown to reliably predict drag-reduction trends and the secondary flow motions attributed with the underlying mechanisms for different riblet shapes in low to moderate Reynolds number channel flow. The ability of the RNL model to reproduce quantities such as slip velocity, roughness function, and swirling strength, over this wide range of parameters suggests that its greatly reduced computational complexity can be exploited to perform parametric studies aimed at characterizing the underlying mechanisms. We use this model to isolate the contributions to the added stresses thought to contribute to increasing drag in certain parameter ranges. The reduced setting, which does not fully capture features such as the spanwise Kevin Helmholtz-like rollers, allows us to investigate how the absence of such mechanisms change the underlying behavior.

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