Abstract Submitted
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A 2-dimensional–3-component model of turbulent flow over riblets DAVIDE MODESTI, SEBASTIAN ENDRIKAT, Department of Mechanical Engineering, University of Melbourne, Victoria 3010, Australia, RICARDO GARCIA-MAYORAL, Department of Engineering, University of Cambridge, Cambridge CB2 1PZ, UK, NICHOLAS HUTCHINS, DANIEL CHUNG, Department of Mechanical Engineering, University of Melbourne, Victoria 3010, Australia — Riblets are streamwise-aligned grooves that are designed to reduce drag by modifying the near-wall flow with respect to that of the smooth wall. Nevertheless, drag reduction breaks down when the viscous-scaled square root of the groove area $\ell_g^+ > 11$, and this breakdown has been attributed to the formation of time-averaged secondary flows over riblets, among other mechanisms. Here we propose to predict these secondary flows by adapting the 2-dimensional–3-component (2D–3C) model of Gayme *et al.* (*J. Fluid Mech.*, vol. 665, 2010, pp. 99–119), in which a sustained turbulent flow is obtained by modelling the incoherent turbulent fluctuations as random forcing. We conduct 2D–3C simulations of flow over several riblet geometries and sizes and compare the results with minimal direct numerical simulations. The 2D–3C model captures the onset and the topology of the secondary flows, suggesting that they are generated by a preferential distribution of near-wall turbulence pinned by the riblet grooves. The model can be used to predict the slip velocity at the riblet crest, providing a better estimate than Stokes (purely viscous) calculations for riblets of moderate sizes, $\ell_g^+ < 20$.

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