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Towards Modelling the Downstream Development of a Turbulent Boundary Layer Following a Rough-to-Smooth Step Change in Surface Condition[1] MOGENG LI, University of Melbourne, CHARITHA M. DE SILVA, University of New South Wales, DANIEL CHUNG, University of Melbourne, DALE I. PULLIN, California Institute of Technology, IVAN MARUSIC, NICHOLAS HUTCHINS, University of Melbourne — In this study we examine the effect of both the friction Reynolds number Re_τ and the roughness Reynolds number k_s^+ on a turbulent boundary layer following a rough-to-smooth step change in surface condition along the flow direction. To investigate the effect of Re_τ, a set of wind-tunnel experiments is conducted at $k_s^+ = 160$ while Re_τ is varied from 7100 to 21000. Similarly, to examine the dependence on k_s^+, a set of measurements is conducted at $Re_\tau = 14000$ with k_s^+ ranging from 110 to 230. Hot-wire profiles are obtained on a logarithmically spaced grid up to 120 boundary-layer thicknesses downstream of the step change, and the local wall-shear stress is measured directly using oil-film interferometry. Using these data, we propose a new model of the recovering mean velocity profile which accounts for the well-known non-equilibrium behaviour of the internal layer. This mean velocity distribution is then evolved downstream of the step change using the integrated streamwise momentum equation to achieve a full prediction of the mean flow recovery.

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