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Effect of roughness texture on transient, accelerating channel flows[1] SAI CHAITANYA MANGAVELLI, JUNLIN YUAN, GILES BRERETON, Michigan State University — The effect of surface roughness texture on non-equilibrium, accelerating wall turbulence is studied using direct numerical simulation of transient periodic channels. The smooth-wall base case is compared with two irregular rough surfaces: i) a small-wavelength sand-grain roughness and ii) a multiscale turbine-blade roughness. The flow is accelerated from a bulk Reynolds number of 3000 to 12000 in a short time interval, rendering the rough-wall flows transitionally-rough to fully-rough. The smooth wall undergoes reverse transition towards a laminar-like state with quasi-1D turbulence, before re-transition into a new equilibrium state. In contrast, near a rough wall a more isotropic Reynolds stress tensor and a higher friction coefficient are observed. This is mainly due to the fast responses of the form-induced Reynolds-stress production and pressure work to the increased shear, both contributing significantly to higher Reynolds-stress isotropy. As the characteristics of the form-induced fluctuations are important for these mechanisms, the roughness texture determines the initial rate of turbulence response. Results show that the roughness geometry is important in a non-equilibrium turbulence over a rough wall.

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