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Turbulent secondary flows in high Reynolds number boundary layers induced by streamwise-elongated complex roughness WILLIAM ANDERSON, University of Texas at Dallas, JULIO BARROS, United States Naval Academy, KENNETH CHRISTENSEN, University of Notre Dame — It has been reported that complex roughness with a predominant streamwise elongation induces secondary mean flow heterogeneities in the above turbulent boundary layer (Mejia-Alvarez and Christensen, 2013: *Phys. Fluids* **25**:115109, MAC; Nugroho et al., 2013: *Int. J. Heat Fluid Flow* **41**:90-102). These mean secondary flows exist as transverse variations of mean streamwise velocity (so-called low- and high-momentum pathways, MAC) and are flanked by mean counter-rotating, boundary layer-scale circulations (Christensen and Barros, 2014: *J. Fluid Mech.* **748**:R1). In related work, we have used large-eddy simulation to model turbulent boundary layer flow over a suite of topographies composed of "strips" of high and low roughness length (drag imposed with the equilibrium logarithmic law); in all cases, we observe the formation of high- and low-momentum pathways (Willingham et al., 2013: *Phys. Fluids* **26**:025111.). Here, we investigate turbulence statistics from large-eddy simulation such as magnitudes and spatial gradients of Reynolds stresses and turbulence kinetic energy, to discern underlying physical processes responsible for the secondary flows. We demonstrate that elevated production of turbulence above "high" roughness necessitates the mean circulations by virtue of turbulent kinetic energy production-dissipation non-equilibrium. We propose that the mean flow is Prandtl's secondary flow of the second kind.

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