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Turbulent boundary layer over a small, 2-D, k-type roughness[1]
M.P. SCHULTZ, R.J. VOLINO, K.A. FLACK, U.S. Naval Academy — Previous results (Volino, Schultz & Flack JFM to appear) indicate that 2-D, k-type roughness gives rise to significant changes in the turbulence structure well into the outer layer. This stands in contrast to the similarity that has been observed between flows over smooth walls and 3-D roughness outside the roughness sublayer and seems to indicate that there is a fundamental difference in the response of boundary layers to 2-D and 3-D roughness. In the previous study, however, the relative roughness height was fairly large ($k/\delta = 0.03$; $k_s/\delta = 0.42$) leaving open the possibility that the observed effect was simply due to the strength of the wall perturbation. In the present paper, experimental results are presented for a zero pressure gradient boundary layer over a surface with 2-D, k-type roughness. The roughness consisted of transverse bars of square cross section with a pitch of $8k$ like the previous 2-D rough wall but with k reduced by a factor of 7. The relative roughness height was significantly reduced ($k/\delta = 0.007$; $k_s/\delta = 0.055$) in the present case. The results were qualitatively similar to those over the larger roughness. Specifically, the Reynolds stresses were significantly larger over the 2-D roughness than over a smooth wall, and length scales based on two-point spatial correlations were longer for the 2-D roughness.

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