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Effects of increased entrainment in turbulent boundary layers[1]
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It has been reported that certain rough surfaces modify the outer region of turbulent boundary layers. One of the effects of surface roughness is additional friction that causes an accelerated entrainment rate, which is also known to modify the outer intermittent layers of external turbulent flows. One and two-points statistics are presented from a direct numerical simulation of a zero-pressure-gradient turbulent boundary layer in the range $Re_\theta = 1400 - 4500$, in which the spreading rate is increased by 70% by a smooth volumetric force restricted to the layer below $y^+ = 25$, and equivalent to a sand roughness of $k_s \sim 60$. The goal of this simulation is to separate the effects of surface geometry from those of entrainment. The velocity fluctuations, Reynolds stresses and spatial correlations $C_{\xi\xi}(x; x', y; y', k_z)$, that are consistently different from those in smooth-wall boundary layers at similar Reynolds numbers, will be compared with experimental and numerical data sets available in the literature.

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