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The Effects of Surface Roughness on Turbulent Channel Flow[1]
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— Direct numerical simulation of flow in a turbulent channel with a random rough bottom wall is performed at friction Reynolds number 400 and 600. The rough surface corresponds to the experiments of Flack et al. (2019). The skin-friction coefficients are in agreement with the experimental results. DNS results are used to investigate roughness effects on dispersive flux, pressure fluctuations and formation of vortices in the roughness layer. The mean-square pressure fluctuations show an increase in the inner layer. The mechanism of the increased pressure fluctuations for rough-wall flows is investigated by examining the pressure Poisson equation source terms. The results show that the attached shear layer formed upstream of the protrusions is a primary source while the streamwise vortices in the troughs and in front of the protrusions also make a contribution. A computational capability is developed for global linear stability analysis of three-dimensional base flows. A time-stepper method is used in conjunction with the implicitly restarted Arnoldi iteration method. Validation and application to surface roughness will be discussed.

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