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Relevant length scales in wall-bounded turbulence SUBHAS VENAYAGAMOORTHY, LAKSHMI DASI, Colorado State University — The structure of wall-bounded turbulence is different from the case of isotropic/homogeneous turbulence due to the presence of local mean shear rate S. S produces kinetic energy that have been classically assumed to occur at length scales of the order of the integral length scale. We show that there are three independent length scales that are regulated by S interacting with kinetic energy k, viscosity ν and dissipation rate ϵ. The first two length scales: $L_{S,k}$ based on S and k; and $L_{S,\nu}$ based on S and ν; signify the upper and lower bounds of the scales that represent turbulence production respectively. The third length scale, $L_{S,\epsilon}$ which is based on S and ϵ, is an intermediate scale that signifies the beginning of overlap between the energy cascade process and the production range set by the first two scales. We also illustrate the fundamental and independent nature of these three length scales in that they set two important classical length scales of motion in wall-bounded turbulence, namely the large eddy length scale $L_{k,\epsilon}$ based on k and ϵ; the Kolmogorov length scale η; and a third new smallest length scale $L_{k,\nu}$ based on k and ν. Analysis of the variation of all six length scales using a large high-resolution DNS database of turbulent channel flow is provided with fresh insights into the dynamic characteristics that define the viscous sublayer, buffer layer, and the inertial regime.

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