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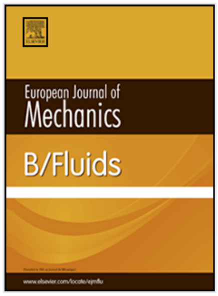

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Vorticity transport in low Reynolds number turbulent channel flows

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Abstract

The vorticity transport mechanism is analyzed in fully developed turbulent channel flows by means of direct numerical simulations data. The later are obtained in large computational domains as in Hoyas and Jiménez (Phys. Fluids, 18, 011702, 2006) to take into account the effect of large scale outer eddies. The Karman number is varied from 180 to 1100 in the simulations. The turbulent intensities of the streamwise and spanwise vorticity components scaled in inner variables are Reynolds number dependent and this is related to the modulation effect of the outer structures in the inner layer in the same way as Mathis et al. (J. Fluid Mech., 715, 163, 2013). The wall normal vorticity intensity scales perfectly with the wall variables. In order to understand the physical mechanism that leads to this Reynolds number independence, the wall normal vorticity is first related to the streamwise velocity u and wall normal velocity flux in the Fourier domain by using incompressibility. A detailed analysis of the related spectral densities shows that the wall normal vorticity is connected to the low pass filtered streamwise velocity domain concentrated within the inner spectral core. Therefore it is spared from the spectral ridge caused by the outer-layer passive effects and is consequently insensitive to the Reynolds number, when scaled with wall variables. Subsequently, the transport process of the vorticity intensities is carried out in detail. The production of the spanwise component of the enstrophy peaks in the viscous sublayer, while