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Evolution of turbulence characteristics from straight to curved pipes GEORGE K. EL KHOURY, AZAD NOORANI, PHILIPP SCHLATTER, Linne FLOW Centre, KTH Mechanics, PAUL F. FISCHER, MCS, Argonne National Laboratory — Large-scale direct numerical simulations are performed to study turbulent flow in straight and bent pipes at four different Reynolds numbers: $Re_b = 5300$, 11700 (bent and straight) and 19000 and 37700 (only straight). We consider a pipe of radius R and axial length $25R$ with curvature parameter κ taken to be $0, 0.01$ and 0.1 for zero, mild and strong curvatures, respectively. The code used is Nek5000 based on the spectral element method. In the straight configuration, the obtained DNS data is carefully checked against other recent simulations, highlighting minute differences between the available data. Owing to a centrifugal instability mechanism, the flow in bent pipe ($\kappa \neq 0$) develops counter-rotating vortices, so-called Dean vortices. The presence of the secondary motion thus induces substantial asymmetries both in the mean flow and turbulence characteristics for the bent pipe. These asymmetries tend to damp turbulence along the inner side and correspondingly enhance it along the upper side. The results are validated with recent experiments, and we could confirm the peculiar behaviour of the friction factor for specific curvatures and Re, leading to a lower friction in curved pipes than in straight pipes for the same mass flux.

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