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Scaling properties and turbulence modulation of flows with variable density and viscosity[1] RENE PECNIK, ASHISH PATEL, JURRIAAN PEETERS, BENDIKS JAN BOERSMA, Delft University of Technology — In order to identify the effect of variable density and viscosity on turbulence, we have performed DNS of canonical channel flows. The channel walls are isothermal and the flow is heated volumetrically to obtain gradients in temperature and thus in density and viscosity. Several constitutive relations for density ρ and viscosity μ as a function of temperature are used to create a database. We parametrize the influence of density and viscosity in terms of gradients in semi-local Reynolds number $Re_\tau^* = \frac{\sqrt{\overline{\rho}/\overline{\rho}_w}}{\overline{\mu}/\overline{\mu}_w} Re_\tau$ (bar denotes Reynolds averaging, subscript w denotes wall value and Re_τ is the friction Reynolds number). The dominant factors that influence the turbulence are then attributed first to changes in viscous length scales and second to structural changes in turbulence. While the change in viscous length scales is accounted for by the semi-local scaling, structural changes remain for cases with gradients in Re_τ^*. Additionally, budgets of streamwise and spanwise vorticity equations are studied and the role of terms that are not accounted for by the semi-local framework, e.g. baroclinic torque, are also discussed.

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