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Computational study on the statistics of turbulent pipe flow XIAOHUA WU, Royal Military College of Canada, PARVIZ MOIN, Stanford University — Fully developed turbulent pipe flow at Re_D 44000 was simulated with finite difference method on 630 million grid points. The corresponding pipe radius R based Karman number R^+ is 1142 and the domain length is 15R. Simulation results agree well with the experimental data of Lawn (1971), Zagarola et al (1997) and McKeon et al (2004). Near the wall the gradient of lnU^+ with respect to $\ln(1-r)^+$ is approximately constant for the narrow region of $70 < (1-r)^+ < 120$. Thus the DNS is consistent with the limited power-law of Zagarola et al for $R^+ < 5000$. Similarly, the near-wall gradient of U^+ with respect to $\ln(1-r)^+$ can only be considered constant for $50 < (1-r)^+ < 90$ thereby indicating limited log-law. The gradient of U with respect to $1-r$ at Re_D 44000 is found to nearly collapse with that at Re_D 5300 for the central region of $1-r > 0.4$. An explanation for the existence of logarithmic mean pipe flow velocity profile even at very low Reynolds numbers is given. Budgets of the mean axial velocity balance show that at Re_D 44000 only within a very narrow range of approximately 10 wall units $(0.003 < 1-r < 0.015)$ do the effects of viscous shear stress gradient and turbulent shear stress gradient overwhelm other contributions. Away from the pipe surface for $1-r > 0.2$ all terms in the mean axial momentum transport equation remain nearly unchanged. Flow visualizations at both Reynolds numbers will also be presented.

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