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Application of the Sensitivity Equation Method to Examine Low-Reynolds Number Effects in Turbulent Channel Flow[1] RICHARD KIRKMAN, MEREDITH METZGER, University of Utah — The sensitivity equation method (SEM) has been implemented in the context of direct numerical simulations of fully-developed turbulent channel flow to explore low Reynolds number effects on the profiles of the mean velocity and Reynolds stresses. Simulations were performed at Reynolds numbers of 100, 150, and 180, based on the friction velocity and channel half-width. In SEM, the governing equations are differentiated with respect to the parameter of interest, in this case the Reynolds number, yielding a set of sensitivity equations, which are subsequently discretized and numerically solved concurrently with the discretized equations for the primitive variables (i.e., velocity and pressure). The present study utilizes a finite-volume, fractional step computational scheme to solve both the governing equations and the sensitivity equations. Turbulent velocity statistics compare very well to others in the literature (Kim et al., 1987; Kuroda et al., 1989). The results from SEM correctly predict the Reynolds number trend in the wall shear stress. The SEM method also provides quantitative information about the rate of change of the mean streamwise velocity profile with respect to Reynolds number. Finally, wall-normal profiles of the higher order moments of the sensitivity of all velocity components were calculated, along with the sensitivity profiles of the Reynolds stresses.

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