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Scaling properties of the mean wall-normal velocity in the zero pressure gradient boundary layer TIE WEI, New Mexico Institute of Mining and Technology, JOSEPH KLEWICKI, University of Melbourne — The scaling properties of the mean wall-normal velocity, $V(x, y)$, in zero-pressure-gradient laminar and turbulent boundary layer flows is investigated using numerical simulation data, physical experiment data, and integral analyses of governing equations. The maximum mean wall-normal velocity, V_∞, and the boundary layer thickness, δ, are evidenced to be the proper scaling for V over most if not the entire boundary layer. This is different from the behavior of the mean streamwise velocity (U) or the turbulent shear stress ($T = -\rho\langle uv\rangle$), which depend on different characteristic length scales in the regions near to and away from the surface. Insights pertaining to this are further surmised from an analytical relationship for the ratio of the displacement to momentum thickness, i.e., shape factor, H. Integral analyses using the continuity and mean momentum equation show that $(U_\infty V_\infty)/u_\tau^2 = H$, where u_τ is the friction velocity. Both the laminar similarity solution and DNS data in post-transitional flows convincingly support this relation. Over the transitional regime, sufficiently high quality data is still lacking to check if this relation remains valid.

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