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Scaling of mean inertia and theoretical basis for a log law in turbulent boundary layers[1] JIMMY PHILIP, CALEB MORRILL-WINTER, University of Melbourne, JOSEPH KLEWICKI, University of Melbourne; University of New Hampshire — Log law in the mean streamwise velocity (U) for pipes/channels is well accepted based on the derivation from the mean momentum balance (MMB) equation and support from experimental data. For flat plate turbulent boundary layers (TBLs), however, there is only empirical evidence and a theoretical underpinning of the kind available for pipes/channels in lacking. The main difficultly is the mean inertia (MI) term in the MMB equation, which, unlike in pipes/channels, is not a constant in TBLs. We present results from our paper (JFM 2017, Vol 813, pp 594-617), where the MI term for TBL is transformed so as to render it invariant in the outer region, corroborated with high Re (δ^+) data from Melbourne Wind Tunnel and New Hampshire Flow Physics Facility. The transformation is possible because the MI term in the TBL has a shape which becomes invariant with increasing δ^+ and a magnitude which is proportional to $1/\delta^+$. The transformed equation is then employed to derive a log law for U with κ an order one (von-Karman) constant. We also show that the log law begins at $y^+ = C_1\sqrt{\delta^+}$, and the peak location of the Reynolds shear stress, $y_m^+ = C_2\sqrt{\delta^+}$, where, $C_1 \approx 3.6$ and $C_2 \approx 2.17$ are from high Re data.

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