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Buoyancy effects on the mean velocity profile in atmospheric surface layer flows SCOTT SALESKY, The Pennsylvania State University, GABRIEL KATUL, Duke University, MARCELO CHAMECKI, The Pennsylvania State University — Within the diabatic atmospheric surface layer (ASL), the mean velocity profile deviates from its conventional logarithmic shape by a stability correction function $\phi_m(\zeta)$ that varies with the stability parameter ζ. The ζ parameter measures the relative importance of mechanical to buoyant production or destruction of turbulent kinetic energy within the ASL. A theoretical framework is developed to link the coefficients in empirical curves for $\phi_m(\zeta)$ to stability-dependent properties of turbulence in the ASL including the variation with ζ of the integral lengthscales and anisotropy of momentum transporting eddies. Approximate asymptotic solutions for $\phi_m(\zeta)$ are derived for the slightly unstable and free convective limits in order to make an explicit link between $\phi_m(\zeta)$ and the stability variation of the integral lengthscale and eddy anisotropy. Analysis of data from the Advection Horizontal Array Turbulence Study indicates the theory is able to explain the behavior of $\phi_m(\zeta)$ accurately for slightly unstable and free convective conditions, but an explanation for the observed behavior of ϕ_m for stable conditions remains elusive.

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