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Local free convection in the atmospheric boundary layer using matched asymptotic expensions[1] MENGJIE DING, CHENNING TONG, Clemson University — The local free convection (LFC) scaling in the convective atmospheric boundary layer (ABL) was previously obtained using dimensional analysis, assuming the limits $-z/L \to \infty$ and $z/z_i \to 0$, where z, z_i, and L are the distance from the ground, the boundary layer height, and the Monin-Obukhov length respectively. However, when the conditions are not satisfied, there is a departure from the LFC scaling, which cannot be obtained using dimensional analysis. In this study we derive the LFC limit from the equations for the velocity variances using matched asymptotic expansions. In the outer layer ($-z/L > 1$) buoyancy dominates whereas in the inner layer ($-z/L < 1$) shear production is important, resulting in a singular perturbation problem. Matching between the inner and outer solutions results in the LFC scaling. We also obtain the corrections to the LFC scaling of the vertical velocity variance near the two ends of the LFC region ($-z/L \to 1$ and $z/z_i \to 1$). The analysis reveals the influence of z_i/L on the correction for reduced $-z/L$ values, which is absent from previous empirical formulae. The composite expansion provides a unified expression for the vertical velocity variance in the convective layer of the convective ABL.

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