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Self-similarity in the atmospheric boundary layer revisited

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The paper discusses drawbacks of the similarity approach in the atmospheric boundary layer, and proposes several remedies. In the convective case, convective scaling w*, ČÁ*, q*, zi, is found valid only in quasi-steady (mid-day) conditions, and partially ineffective during daily transitions, particularly for velocity moments. Temperature and humidity variances near the underlying surface are not similar, due to effects of entrainment. In the upper portion of the mixed layer, there exists a substantial scatter of dimensionless quantities, scaled in terms of convective scales, especially for statistics of scalars (temperature, humidity, concentration of passive scalars). The scatter can be related to a strong sensitivity of statistical moments at the top of the mixed layer to values of scalar gradients. This implies a necessity for an additional "gradient-based" interfacial scaling Sw, SČá, Sq, Sh. In the stable case, a "flux-based" (Monin-Obukhov) scaling is valid only in cases with strong, continuous turbulence, when the gradient Richardson number Ri is constant and sub-critical. Such a scaling introduces self-correlation effects, i.e., a significant correlation between considered variables. The flaws can be fixed in terms of an alternative, "gradient-based" local scaling, un, Tn, qn, Ln.