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A New Similarity theory for Strongly Unstable Atmospheric Surface Layer YONG JI, ZHEN-SU SHE, State Key Lab for Turb. Complex Sys., College of Engg., Peking Univ., Beijing 100871, China — We apply the structural ensemble dynamics (SED) theory to analyze mean velocity and streamwise turbulence intensity distribution in unstable atmospheric surface layer (ASL). The turbulent kinetic energy balance equation in ASL asserts that above a critical height z_L, the buoyancy production cannot be neglected. The SED theory predicts that a stress length function displays a generalized scaling law from z to $z^{4/3}$. The z_L derived from observational data show a two-regime form with Obukhov length L , including a linear dependence for moderate heat flux and a constant regime for large heat flux, extending the Monin-Obukhov similarity theory which is only valid for large $|L|$. This two-regime description is further extended to model turbulent intensity, with a new similarity coordinate L_z such that the observational data collapse for all L. Finally, we propose a phase diagram for characterizing different ASL flow regimes, and the corresponding flow structures are discussed. In summary, a new similarity theory for unstable atmosphere is constructed, and validated by observational data of the mean velocity and streamwise turbulence intensity distribution for all heat flux regimes.

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