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The Influence of Shear on Deep Convection Initiation

Abstract

Vertical wind shear presents a physically paradoxical role in Deep Convection Initiation (DCI). This study evaluates the Progressive Rooting Hypothesis (PRH) through 1D theoretical modeling and 3D cloud-resolving simulations to reconcile these effects. The analysis identifies a distinct bifurcation in convective outcomes governed by a critical initial updraft radius threshold R0. Nascent updrafts below this threshold rapidly decay due to environmental dilution and dynamic resistance. Conversely, updrafts exceeding R0 dynamically expand and intercept stronger shear aloft, generating a robust cloud-relative inflow V_{CR}. This horizontal momentum is kinematically required to advect boundary-layer air into the updraft core to sustain the necessary mass flux. Vertically, detailed pressure diagnostics reveal that the non-linear dynamic pressure gradient acceleration, induced by storm-scale rotation, provides the critical upward forcing required to lift this air parcel through the Convective Inhibition (CIN) layer.

Keyword

vertical wind shear, entrainment

Reference

Peters, J. M., H. Morrison, T. C. Nelson, J. N. Marquis, J. P. Mulholland, and C. J. Nowotarski, 2022a: The influence of shear on deep convection initiation. Part I: Theory. J. Atmos. Sci., **79**, 1669–1690, https://doi.org/10.1175/JAS-D-21-0145.1.

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