Moist convection and mesoscale predictability

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Soon after the beginning of numerical weather prediction, the following question presented itself: “What degree of improvement in the prediction can be expected from a given improvement of the initial condition?” If only small improvements were to be obtained for a much more accurate initial condition, then there would be an effective limit on the ability to predict the weather (i.e. a limit on predictability). A consensus has formed behind the idea of Lorenz that predictability is limited for flows with many scales of motion in which errors in small scales grow faster than and spread to errors in larger scales. This idea is supported by numerical experiments using turbulence models under varying degrees of idealization and approximation. However, as complicated as the latter models are, they are considerably simpler than numerical weather prediction models as they do not take into account moist convection, cloud microphysics, complex orography and physiography, etc.

In this talk, results will be presented from recent studies examining error growth in relatively high-resolution numerical weather prediction models initialized with idealized (but meteorologically relevant) initial conditions. These studies indicate the critical importance of moist convection in the initial rapid error growth at small scales which, consistent with the Lorenz idea, eventually transition to more slowly growing larger-scale errors in the forecast. Although the latter supports the idea of a predictability limit, there remains the very practical question of whether error transfers slowly enough from convective scales to the mesoscale for the latter to retain useable information in short-term ($\sim$1 day) forecasts. Results will be presented from real-time high-resolution numerical weather forecasts in convective-weather situations showing that skill in predicting the mesoscale can translate into skill of forecasting aspects of convective weather such as its structure (e.g. squall lines, supercells, etc.), and areal coverage (if not the exact placement and timing of convective cells).