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On the sensitivity of convective system structure and propagation in convection-allowing runs to horizontal grid spacings

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Mesoscale convective systems (MCSs), particularly those with bowing lines of convection that often are associated with damaging wind, are often poorly simulated in numerical weather prediction models. Although the use of convection-allowing grid spacings results in simulated structures, propagation, and evolution that usually resemble those observed much better than what happens when convection is parameterized, numerous problems remain that typically keep skill scores low for precipitation verification. Among these problems are the failure of models to produce bowing structures within convective systems, and displacement errors in positioning of the simulated convection.

We will show results that suggest that both the amount of bowing in severe bow echo convective systems and the propagation speed of convective systems in general is very sensitive to changes in horizontal grid spacing when the typically used 3 or 4 km is refined down to around 1 km. Results will focus on both an 11 member Weather Research and Forecasting model ensemble making use of the Stochastic Kinetic Energy Backscatter scheme that was run using both a single 3 km horizontal grid, and with a 1 km refined nest embedded within it for two bow echo events, and on a much larger set of general MCS cases simulated with single deterministic runs of the NMMB (Nonhydrostatic Mesoscale Model on the B-grid) using both 4 and 1.33 km grid spacing. In the bow echo events, the use of a two-way nested 1 km grid significantly increases the propagation speed of the system and results in much more organized bow structures that better resemble observations. However, the increased speed results in too rapid propagation of the system compared to observations, making the 1 km ensemble less skillful than the 3 km ensemble. In addition, ensemble spread was generally less in the 1 km ensemble than in the 3 km ensemble. The increased organization and propagation of the bow echoes appears to be due to a much stronger rear-inflow jet with a stronger cold pool in the 1 km members. A similar trend for increased propagation speed and worse position errors was observed in the deterministic NMMB simulations for most of the 27 MCSs simulated when horizontal grid spacing was refined from 4 km to 1.33 km.