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Sensitivity of WRF forecasts of nocturnal convective system morphology evolution in weakly-forced environments to microphysical schemes and horizontal resolution.

William Gallus, Jonathan Thielen, and Brian Squitieri
Iowa State University, Geological and Atmospheric Sciences, Ames, IA, United States (wgallus@iastate.edu)

The use of convection-allowing models has allowed reproduction of detailed convective morphologies in model forecasts with some degree of success, however, some recent studies have found major shortcomings in forecasts of some modes, especially bow echos and squall lines. For both a sample of 14 nocturnal convective system events from 2010 to 2013 where the low-level jet (LLJ) was present with weak synoptic forcing, and five additional cases from the 2015 Plains Elevated Convection At Night (PECAN) field experiment, the present study uses Advanced Research - Weather Research and Forecasting model (WRF-ARW) simulations to examine the predictability of convective morphology through a 10-category classification scheme. For the 14 cases, a six-member ensemble was run at 3 km horizontal grid spacing utilizing two different microphysical schemes (Thompson and WSM6) and three different planetary boundary layer schemes (YSU, MYJ, MYNN). Additionally, a subset of these runs was conducted at 1 km horizontal grid spacing to allow for investigation into the effects of increased resolution.

Results for the full sample of cases show an overall underprediction of linear convective modes with both microphysical schemes in the 3 km runs, which agrees with the results of previous studies at similar resolutions. However, the 1 km runs simulate more linear modes although still not enough, albeit without significant improvement in the mean morphology verification score originally used in Snively and Gallus (Wea. Forecasting, 2014). This score, which uses a weighted scale based on either exact classification match or cellular/linear/non-linear group matches, also showed no significant difference in mean score between the two microphysics schemes. This result implies that perhaps better resolution of strong upward motion along the cold pool boundaries in the 1 km runs allowed for more continuous regions of intense convection, but timing errors, errors in depiction of stratiform rain regions, or inability to distinguish between cases where linear systems occurred or did not occur remained problems. Scores for the runs utilizing Thompson microphysics varied much more among cases than those utilizing WSM6 microphysics. In addition, the Thompson scheme resulted in more extensive stratiform regions. Additionally, the ensemble was used to generate probabilistic forecasts of convective morphology. Analysis of the Divergence Skill Score (which is based on the Kullback-Leibler Divergence) of these forecasts showed decreasing skill over time compared to the study climatology, with less skill overall compared to that in a different set of cases that were not restricted to the nocturnal period.