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A comparison of precipitation forecast skill between small convection-allowing and large convection-parameterizing ensembles

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An experiment was designed to evaluate and compare precipitation forecasts from a 5-member, 4-km grid-spacing (ENS4) and a 15-member, 20-km grid-spacing (ENS20) Weather Research and Forecasting (WRF) model ensemble, both covering a similar domain over the central United States. The ensemble forecasts were initialized at 2100 UTC on 23 different dates and integrated for 33 hours. Previous work has demonstrated that simulations using convection-allowing resolution (CAR; dx roughly 4-km) have a better representation of the spatial and temporal statistical properties of convective precipitation than coarser models using convective parameterizations. In addition, higher resolution should lead to greater ensemble spread as smaller scales of motion are resolved. Thus, CAR ensembles should provide more accurate and reliable probabilistic forecasts than parameterized-convection resolution (PCR) ensembles.

Computation of various precipitation skill metrics for probabilistic and deterministic forecasts revealed that ENS4 generally provides more accurate precipitation forecasts than ENS20, with the differences tending to be statistically significant for precipitation thresholds above 0.25 inches at forecast lead times of 9 to 21 hours (0600 – 1800 UTC) for all accumulation intervals analyzed (1-, 3-, and 6-hr). In addition, an analysis of rank histograms and statistical consistency revealed that faster error growth in ENS4 eventually leads to more reliable precipitation forecasts in ENS4 than in ENS20. For the cases examined, these results imply that the skill gained by increasing to CAR outweighs the skill lost by decreasing the ensemble size. Thus, when computational capabilities become available, it will be highly desirable to increase the ensemble resolution from PCR to CAR, even if the size of the ensemble has to be reduced.