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Supercell predictability studies in support of NOAA Warn-on-Forecast

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The goal of the NOAA Warn-on-Forecast (WoF) project is to develop and implement convection-allowing NWP ensembles that provide 0-3-h probabilistic guidance for severe weather operations. Due to computational limitations, real-time capability requires tradeoffs between forecast accuracy and critical ensemble configuration parameters, including model grid spacing and ensemble size. Better understanding of the relative importance of various forecast error sources is therefore vital for optimizing WoF system design. Supercell predictability studies have been conducted over the last several years in support of this goal. These studies have used a variety of theoretical frameworks involving both idealized and full-physics models, and both deterministic and ensemble forecasts, to carefully isolate and explore a range of forecast error sources.

Significant conclusions from the supercell predictability studies will be presented, including: 1) supercells are much better resolved with 3-km than 4-km grids, with additional significant improvements requiring $\sim$1-km grid spacing; 2) limited initial condition resolution has qualitatively small impacts on forecasts due to rapid generation of initially missing scales, favoring further development of hybrid-resolution NWP systems; 3) lack of low-level radar observations for data assimilation does not preclude accurate ensemble forecasts; 4) the intrinsic predictability limit for particular storm attributes may be $<$ 2 h in many cases; 5) dramatic reductions in intra-storm initial condition uncertainty may not improve forecasts beyond $\sim$1 h without simultaneous reductions in environmental uncertainty; 6) physics parameterization deficiencies appear to be the leading source of forecast error in contemporary NWP systems. Important experiment design choices will also be discussed to provide guidance for future convective-scale predictability studies.