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Forecasting the weather
- ensemble techniques
in probabilistic weather prediction

Integration of high-resolution mesoscale-ensemble and very high–resolution deterministic NWP models for wind power prediction

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Accurate wind power forecasts are crucial for wind energy integration into electric grids because wind is highly intermittent and large changes in wind within minutes to hours are common for wind farms around the globe. These wind characteristics are a result of complex multi-scale weather forcing of and interaction between scales of planetary waves to intra-fame microscale circulations. Specializing and optimizing physics-based numerical weather prediction (NWP) models to simulate complex details of multiscale dynamical and physical forcing and effective assimilation of wind farm observations are crucial and a viable way toward accurate wind power forecasting. On the other hand, it is known that the atmospheric motion is chaotic, and thus under certain regimes even small errors in the model system can lead to dramatically erroneous forecasts. Effective algorithms to deal with these inevitable prediction uncertainties should be developed for wind power forecasting applications. This paper reports the research work and tools developed at the National Center for Atmospheric Research (NCAR) to address these issues. In particular, we will focus on the research and development of the technologies of a collaborative project between NCAR and Xcel Energy Services, Inc. that aims to improve Xcel Energy's ability to increase the amount of wind energy in their portfolio. First, we introduce two advanced numerical weather prediction (NWP) systems: a very high-resolution deterministic prediction model (DPM) and a high-resolution mesoscale ensemble prediction model (EPM) system, developed at NCAR for wind power forecasts. Both NWP systems are formulated with multiscale nested-grid domains, four-dimensional data assimilation (FDDA) and rapidly-cycling forecasting capabilities. Then we focus on the algorithms developed to post-process the model output to create bias-removed and uncertainty-calibrated final probability forecasts. The ability of the modeling system for wind ramp forecasting will also be discussed.