Geophysical Research Abstracts
Vol. 13, EGU2011-12753-3, 2011
EGU General Assembly 2011

Ensemble Forecasting and Uncertainty in Wind and Wind Power Prediction

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Weather forecasting has an initial-boundary value problem. In many cases a small error in initial conditions could grow to several times more after two days. For wind power forecasting, high resolution domains are crucial to describing local scale motions, and because of computer resources, the high-resolution domain is usually limited in extension. The question is how much we can rely on the short-range limited-area forecasts, how much uncertainty is in the wind and wind power predictions, and how it is distributed over complex terrain.
In this study, ten-member ensembles with randomly perturbed initial and lateral boundary conditions were conducted using the Weather Research and Forecasting Model (WRF) and its variational data assimilation module (WRF-Var). The model was set up with two nested domains covering the western U.S.A. The forecasts start at 12 UTC each day in December 2008, and the forecast time range is 36 hours. The simulation results were verified against the wind data collected at four meteorological towers, at 10 m, 20 m, 30 m, 40 m, and 50 m levels. The verification over the whole month shows that the ensemble mean gives better results of the error statistics than the control run, which was initialized with the NCEP North American Regional Reanalysis (NARR) data. Furthermore, the forecasting uncertainty is investigated, which includes a correlation of the ensemble spread and the forecast error of the ensemble mean over one month, and the distribution of forecast uncertainty over complex terrain. The uncertainty distribution exhibits different patterns during daytime and nighttime.