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Towards probabilistic Wind Power Forecasting based on Ensemble Prediction Techniques

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The role of wind power in the future worldwide energy supply is sharply increasing. The political will to fight climate change and to become less dependent from importing fossil fuels will boost wind power even more in the coming years. However, increasing wind power capacities require very good forecasts of wind power production to enable the integration into the grid keeping the commonly high level of reliability. Continuous improvement is indispensable and is requested by all stakeholder of the electricity market (Transmission System Operators (TSOs), energy traders, wind farm operators). The day-ahead (24-48h) predictions of wind power are nowadays established products. The root mean square error of the best forecast for Germany is between 5 and 6 % (normalized with the rated capacity) using the deterministic forecast model of the European Centre for Medium-Range Weather Forecasts (ECMWF).

However, the aims of longer lead-times (>2 days) and significant reduction of large forecast errors can not be solved with the state-of-the art wind power forecasting techniques that are based on deterministic models. The impact of less predictable states of the atmosphere and the impact of analysis errors require the development of probabilistic wind power forecasts for decision making.

In this paper we study the skill of ECMWF's Ensemble Prediction System (EPS) regarding wind power forecasts for Germany with lead-times up to the medium-range (5 days). A very effective wind power forecast model has been developed to cope with the 50 ensemble members. The wind power prediction model is based on principle component regression techniques of the wind speed (80m height) to reduce the degrees of freedom. Usually 6 to 8 eigenvectors are enough to explain 90% to 95% of

the wind field's variance (over Germany).

The evaluation includes a range of probabilistic skill scores like Brier Skill Score, ROC Area, Reliability Diagram, and Ignorance Score. Each of the scores is used to diagnose specific aspects of the quality of the wind power forecast system. For example, being a logarithmic score, the Ignorance Scores is very sensitive to extreme forecast errors, and thus can give valuable information to be confident (or not) in extreme situations. TSOs are predominantly concerned about extreme situations (either in forecast error or strong winds) as they are very costly with respect to save grid operation management decisions (high reserves of regulative power are needed).