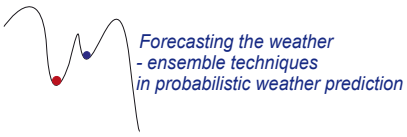
EMS Annual Meeting Abstracts
Vol. 8, EMS2011-697-1, 2011
11th EMS / 10th ECAM



A Probabilistic Approach to Forecast Ramps of Wind Power Production using Ensembles

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Nowadays, European countries like Germany, Spain and Denmark already have a significant share of wind generation in their electricity generation mix. In parallel, the large-scale integration of wind power is also taking place at a rapid pace in other European countries. Due to the variable nature of the wind resource, this large-scale integration of wind power causes several difficulties in the operation and management of a power system.

Forecasts of wind conditions and related power generation from a few hours to a few days ahead are paramount for various management tasks related to the integration of wind generation in power systems (e.g. quantification of reserves, economic dispatch of wind generation within a broader generation portfolio, or the design of optimal trading strategies).

Measuring errors of deterministic forecast is done operationally through measuring the mean distance between observations and prediction. However, in some cases, the operator is more interested in other type of error measurement related to the timing of the forecast. Indeed, large variation of wind power production in a small amount of time, often called ramp, are difficult to handle operationally and these difficulties are increased by the fact that forecast power may well predict the corresponding ramp of power in amplitude but not in time. This type of error is called phase error.

In our work, we propose a procedure to forecast the distribution of these phase errors using ensemble wind forecast. To this aim we first transform wind ensemble into calibrated wind power ensembles. This is done for each given wind power production site. These wind power ensembles are calibrated for each look ahead time but are not calibrated temporally. Indeed, for a given future temporal interval, the probability that a ramp is observed is not forecast in a reliable way by the proportion of ensemble member that forecast a ramp in it. We propose a procedure to forecast these probabilities in a reliable way using wind power ensembles, this can be considered as a temporal calibration procedure for wind power ensembles or as a procedure to forecast ramp timing and the uncertainty on this timing.

Our study is based on wind power production data in Ireland, Denmark and France for a large number of wind farms and a period ranging from 2 to 3 years depending on the site. The corresponding period is separated into a learning set (for calibration and wind power forecast) and a testing set. We used 3 different wind ensemble forecasts as input: poor man ensembles, classical ECMWF wind ensembles and a version of ECMWF ensembles optimized for wind forecast in the framework of the EU FP7 project SafeWind. Each of the corresponding wind power ensemble forecast is evaluated through a standard evaluation protocol. In addition, an evaluation of the reliability and sharpness of the forecast ramp timing and the associated forecast distribution is performed. At equal reliability, the sharpness evaluation permits to compare the different used wind ensemble with respect to their ability to inform about timing uncertainty. This work is perfomed in the framework of EU FP7 project SafeWind.