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A new way to estimate the uncertainty in wind power predictions

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For the grid management and trading of wind power generation, it is necessary to have on one hand the accurate deterministic forecast and on the other hand the knowledge about the uncertainty. In recent years much progress was achieved in the development of advanced deterministic forecast methods. To give uncertainty estimates, state of the art models are ensemble predictions or power curve mapping of the error distribution of the wind forecast.
In this work we develop a new method to estimate the probability distribution of the wind power forecast error. Only the characteristics of the predicted wind power time series itself determine the uncertainty prediction. We have defined five different measures for these characteristics to relate the forecast error to these quantities. Two of them are physically motivated (time series energy and gradients), two are probabilistic measures (entropy and jump-entropy). As a fifth measure the Lyapunov exponent of the time series is used. By combination of these five measures, we can estimate the time evolution of the standard deviation of the forecast error. The Fokker Planck equation with the appropriate boundary conditions is then solved to describe the time evolution of the error distribution in the following 72 hours.
The developed algorithms were applied in three case-studies: Firstly for an offshore site forecast at the FINO1-mast (located in the North Sea), secondly for a German onshore region with an installed wind power capacity of approx. 2GW and finally for whole Germany with an installed capacity of approx. 17GW. For these three cases the wind power prediction is based on the wind forecast of the European Centre of Medium range Weather Forecasts (ECMWF). Furthermore we compare the quality of the ECMWF prediction for whole Germany with forecasts based on the GFS model of the National Centre of Environmental Predictions (NCEP).
The validation of this new uncertainty estimation method has shown that for all test

cases the confidence intervals are estimated with an error of $\pm$ 2-5% of the empirical coverage.
It can be shown that the developed tools give good estimates of the trust levels of wind power predictions with only a small amount of input information, which is an important end-user requirement.