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Using Bayes Model Averaging for Wind Power Forecasts

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For operational purposes predictions of the forecasts of the lumped output of groups of wind farms spread over larger geographic areas will often be of interest. A naive approach is to make forecasts for each individual site and sum them up to get the group forecast. It is however well documented that a better choice is to use a model that also takes advantage of spatial smoothing effects. It might however be the case that some sites tends to more accurately reflect the total output of the region, either in general or for certain wind directions. It will then be of interest giving these a greater influence over the group forecast.

Bayesian model averaging (BMA) is a statistical post-processing method for producing probabilistic forecasts from ensembles. Raftery et al. [1] show how BMA can be used for statistical post processing of forecast ensembles, producing PDFs of future weather quantities. The BMA predictive PDF of a future weather quantity is a weighted average of the ensemble members' PDFs, where the weights can be interpreted as posterior probabilities and reflect the ensemble members' contribution to overall forecasting skill over a training period.

In Revheim and Beyer [2] the BMA procedure used in Sloughter, Gneiting and Raftery [3] were found to produce fairly accurate PDFs for the future mean wind speed of a group of sites from the single sites wind speeds. However, when the procedure was attempted applied to wind power it resulted in either problems with the estimation of the parameters (mainly caused by longer consecutive periods of no power production) or severe underestimation (mainly caused by problems with reflecting the power curve).

In this paper the problems that arose when applying BMA to wind power forecasting is met through two strategies. First, the BMA procedure is run with a combination of single site wind speeds and single site wind power production as input. This solves the problem with longer consecutive periods where the input data does not contain information, but it has the disadvantage of nearly doubling the number of model parameters to be estimated. Second, the BMA procedure is run with group mean wind power as the response variable instead of group mean wind speed. This also solves the problem with longer consecutive periods without information in the input data, but it leaves the power curve to also be estimated from the data.

[1] Raftery, A. E., et al. (2005). Using Bayesian Model Averaging to Calibrate Forecast Ensembles. Monthly Weather Review, 133, 1155-1174.
[2]Revheim, P. P. and H. G. Beyer (2013). Using Bayesian Model Averaging for wind farm group forecasts. EWEA Wind Power Forecasting Technology Workshop,Rotterdam, 4-5 December 2013.
[3]Sloughter, J. M., T. Gneiting and A. E. Raftery (2010). Probabilistic Wind Speed Forecasting Using Ensembles and Bayesian Model Averaging. Journal of the American Statistical Association, Vol. 105, No. 489, 25-35