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A Wind Forecasting System for Energy Application

Jennifer Courtney, Peter Lynch, and Conor Sweeney
UCD Meteorology and Climate Centre, School of Mathematical Sciences (jennifer.courtney2@gmail.com)

Accurate forecasting of available energy is crucial for the efficient management and use of wind power in the national power grid. With energy output critically dependent upon wind strength there is a need to reduce the errors associated wind forecasting. The objective of this research is to get the best possible wind forecasts for the wind energy industry. To achieve this goal, three methods are being applied.

First, a mesoscale numerical weather prediction (NWP) model called WRF (Weather Research and Forecasting) is being used to predict wind values over Ireland. Currently, a gird resolution of 10km is used and higher model resolutions are being evaluated to establish whether they are economically viable given the forecast skill improvement they produce.

Second, the WRF model is being used in conjunction with ECMWF (European Centre for Medium-Range Weather Forecasts) ensemble forecasts to produce a probabilistic weather forecasting product. Due to the chaotic nature of the atmosphere, a single, deterministic weather forecast can only have limited skill. The ECMWF ensemble methods produce an ensemble of 51 global forecasts, twice a day, by perturbing initial conditions of a 'control' forecast which is the best estimate of the initial state of the atmosphere. This method provides an indication of the reliability of the forecast and a quantitative basis for probabilistic forecasting.

The limitation of ensemble forecasting lies in the fact that the perturbed model runs behave differently under different weather patterns and each model run is equally likely to be closest to the observed weather situation. Models have biases, and involve assumptions about physical processes and forcing factors such as underlying topography.

Third, Bayesian Model Averaging (BMA) is being applied to the output from the ensemble forecasts in order to statistically post-process the results and achieve a better wind forecasting system. BMA is a promising technique that will offer calibrated probabilistic wind forecasts which will be invaluable in wind energy management. In brief, this method turns the ensemble forecasts into a calibrated predictive probability distribution. Each ensemble member is provided with a 'weight' determined by its relative predictive skill over a training period of around 30 days.

Verification of data is carried out using observed wind data from operational wind farms. These are then compared to existing forecasts produced by ECMWF and Met Eireann in relation to skill scores.
We are developing decision-making models to show the benefits achieved using the data produced by our wind energy forecasting system. An energy trading model will be developed, based on the rules currently used by the Single Electricity Market Operator for energy trading in Ireland. This trading model will illustrate the potential for financial savings by using the forecast data generated by this research.