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Forecasting wind power production from a wind farm using the RAMS Model

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Wind farms power prediction is of great importance, since a good forecast allows better renewable energy grid integration. A suitable use of wind energy needs to setup methodologies able to reduce the uncertainty of the wind resource.
The prediction system is usually based on meteorological models e.g. Limited Area Models (LAM). These models predict the wind speed and direction in the target region and, by a turbine power curve, this output is converted in wind power produced by a wind farm. Hence, the quality of the power forecast at different forecasting ranges is strictly dependent on the quality of the prediction of the wind in the area of the wind power plant.
In Italy, wind farms are usually located in complex topographical regions, which mirror the complex orography of the country. In this situation, wind prediction is more difficult than in flat terrain and a high spatial LAM resolution is necessary to simulate the behavior of the wind.
In this context, we produced a wind power forecast in Central Italy using the LAM model RAMS "Regional Atmospheric Modeling System" at the horizontal resolution of 3 km, suitable to the complex orography of the site.
The procedure for the forecast of the power production by a wind farm was divided in two phases: a) finding a law representing the power curve of the production of the whole wind farm for the whole spectrum of wind speed in the area; b) forecasting the power produced by the power plant starting from the RAMS wind forecast using the retrieved power curve for the next 48 h.
In this work, we consider the European Centre for Medium Weather range Forecast (ECMWF) operational analysis of wind data spanning two years (2010-2011), to find the power curve of the wind farm. To fit the data, we have divided the sample data in bins 0.5 m/s wide. For each bin, we have computed a power output (fitting power) by minimizing the variance between the power values inside the bin and the fitting power. Considering those calculated points (one for each bin), we then obtained the power curve by linear interpolating the fitting power values.
The retrieved power curve was then used to produce the power forecast using RAMS for one year. Results are compared with power observations recorded at a wind farm in Central Italy.
Results show the method feasibility with errors ranging between 10 and 20% of the wind farm nominal power for most forecasts.
Finally, we evaluated the potential of a post-processing technique (MOS; Model Output Statistics) for improving the wind power forecast.

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