A simple gust estimation algorithm and machine learning based nowcasting for wind turbines

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Wind gusts and high wind speeds need to be considered in wind power industry and power grid management as they affect construction, material, siting and maintenance of turbines and power lines. Furthermore, gusts are an important information source on turbulence conditions in the atmosphere at the respective sites.

Often, the wind farm operators only provide basic data of the turbines such as average wind speed, direction, power and temperature. However, they require forecasts of gusts, too. Thus, a simple gust estimation algorithm based on the average wind speed was developed. The algorithm is tested at different mast measurement sites and WFIP2 data and applied to selected wind turbines. Results show that the algorithm is skillful enough to be used as a first guess gust estimation for single turbines and is, thus, used for nowcasting.

For nowcasting for the first two hours with a temporal frequency of ten minutes solely observations are used. A high-frequency wind speed and gust nowcasting ensemble based on different machine learning methodologies, including an ensemble for every method, was developed. Used are boosting, random forest, linear regression, a simple monte carlo method and a feed forward neural network. Results show that perturbing the observations provides a good forecasting spread for at least some of the methods. However, for other methods the spread is reduced significantly. Most of the used methods are able to provide good forecasts. However, hyperparameter tuning for the lightGBM boosting algorithm and the neural network is still needed.