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# Reduction of Wake Modelling Uncertainty Using a 3D RANS Model

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## Site

In order to reduce uncertainty of wake modelling, it is important to validate wake models against as much operational data as possible. WakeBlaster has been validated against 12 onshore and offshore wind farms in Europe and North America. In this poster we cover the validation of a 3D RANS wake model, WakeBlaster, against ten years of operational data from an onshore wind farm in North-East Germany. The wind farm properties are:

| | |
|---|---|
| Location | Onshore, North-East Germany |
| Number of turbines | 17 |
| Turbine Rating | 1.5MW |
| Hub Height | 80m |
| Rotor Diameter | 77m |
| Terrain | Flat; forest and low-density urban areas nearby |
| Typical turbine spacing | 4 – 6 diameters |

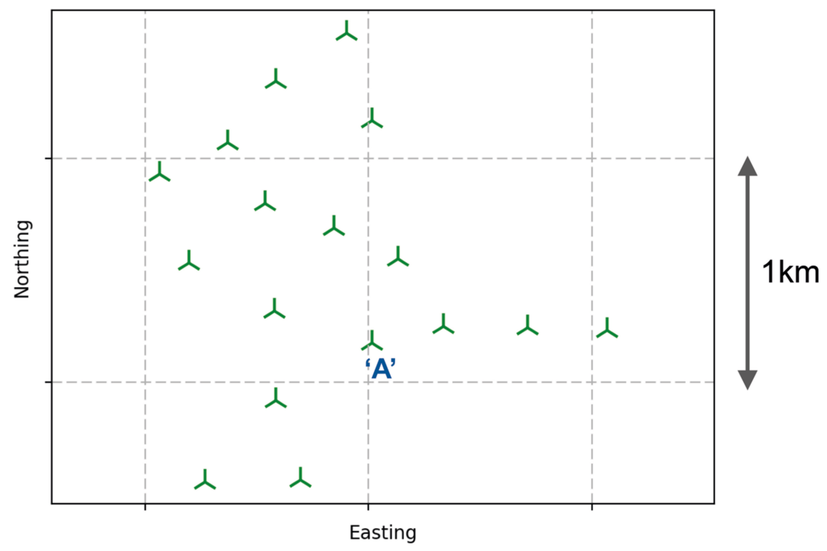



*Figure 1 – Layout of wind farm*

## Analysis

Ten years of 10-minute SCADA data were analysed from the farm in order to gather observational power matrices (power against wind speed and direction) for each turbine. For each 10-minute timestep, the ambient conditions were derived as follows:

| | |
|---|---|
| Mean wind speed | Median of nacelle anemometer measurements from all wake-free turbines, taking into account terrain model speed-ups. |
| Mean wind direction | Median of nacelle direction of all operating turbines. |
| Turbulence intensity | From mesoscale roughness from WAsP model for each direction sector. |

Results were binned into 5 degree direction sectors and 1m/s wind speed bins.

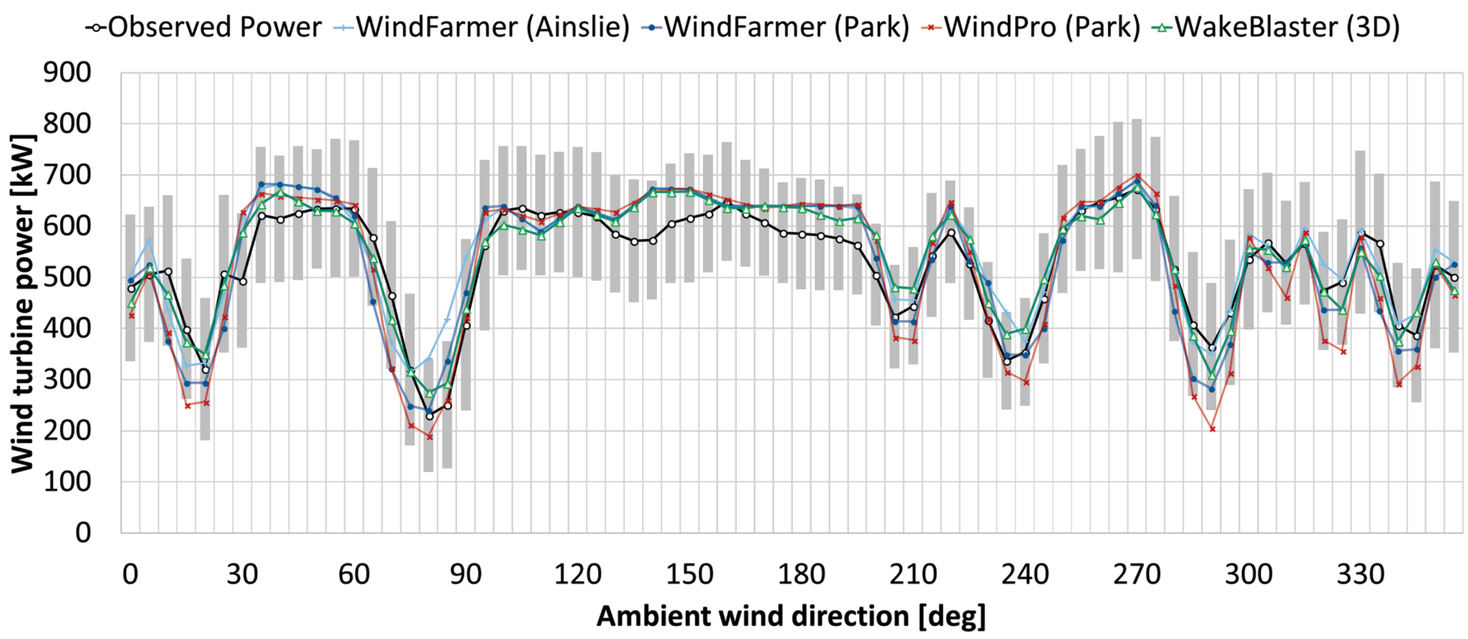



*Figure 2 – Observed power and standard deviation for a turbine 'A' (fig. 1) in one wind speed bin (8m/s) against wind direction, compared with WakeBlaster simulation and other wake models.*

## Results

*Terrain & flow uncertainty* + *Power curve uncertainty* + *Observational uncertainty* + *Wake model uncertainty* = ***Total uncertainty***

***Wake-free uncertainty***

In the comparison of wake model results against observational data, there are many uncertainties to consider other than the wake model uncertainty. In order to determine the uncertainty in the WakeBlaster model compared to other wake models, the **residual sum of squares** (RSS) was calculated by **aggregating the error in every direction and wind speed bin and for every turbine**. The RSS for wake-free and waked sector was then compared for each wake model:

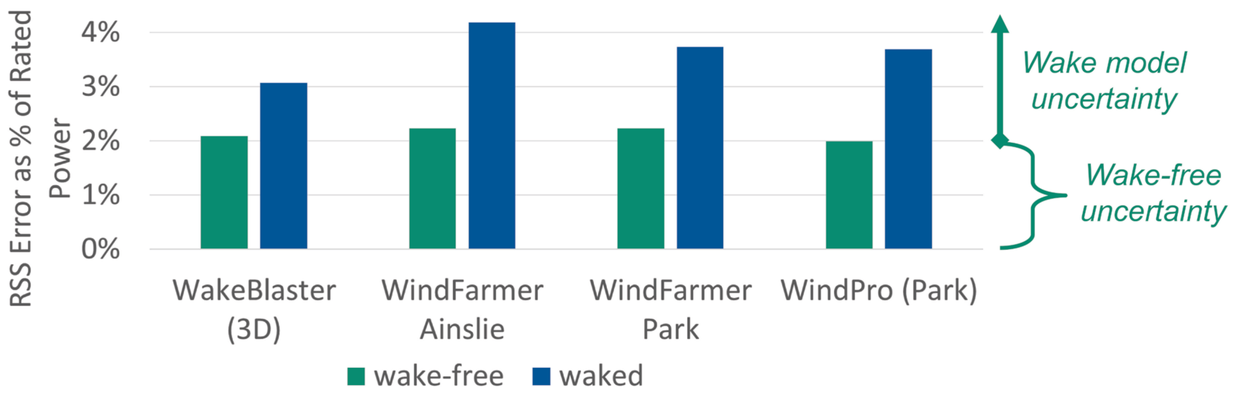
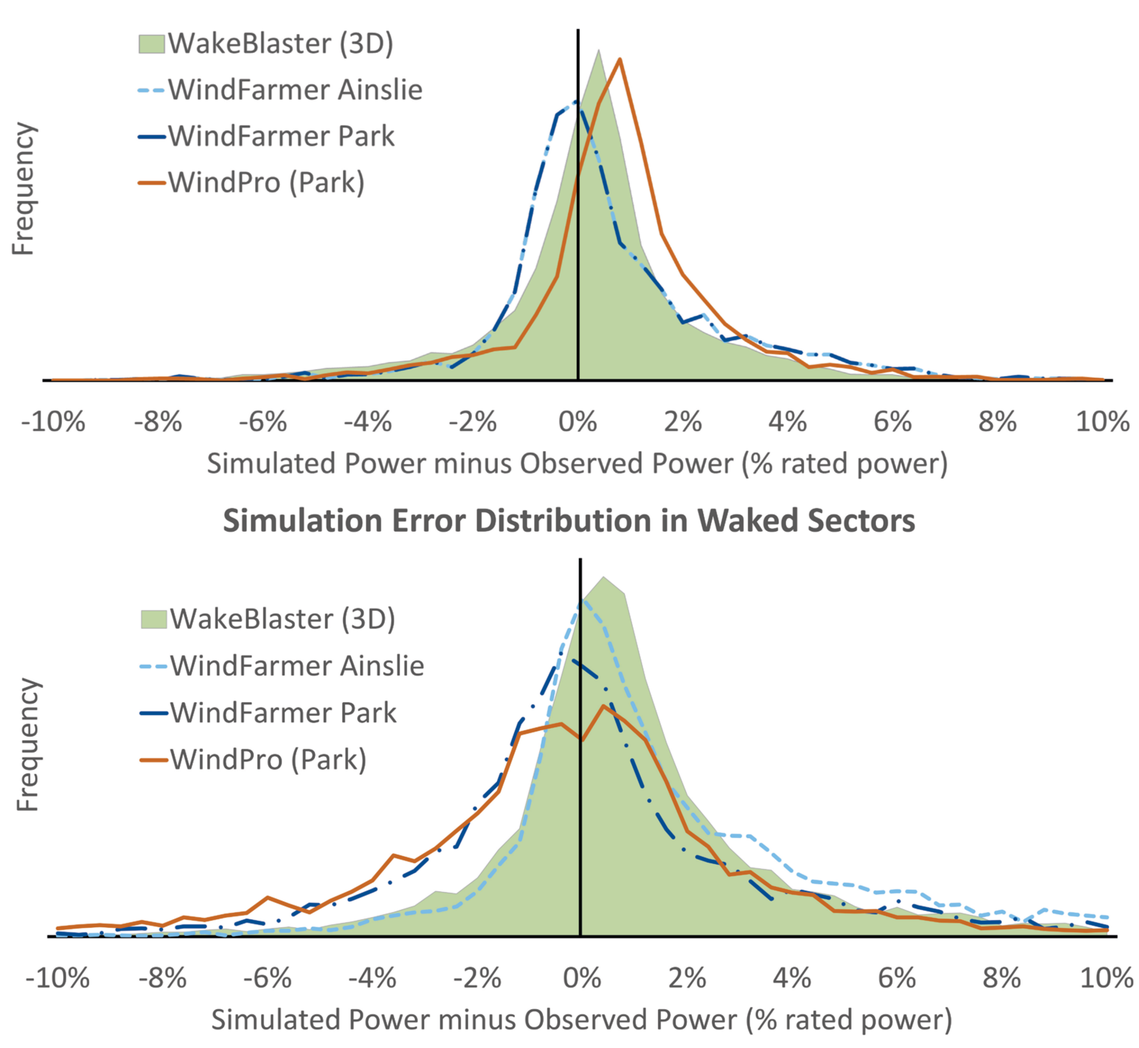



*Figure 3 – Comparison of summed mean absolute error for several wake models for this wind farm in wake-free and waked conditions. The difference between the two bars is considered to be the wake model uncertainty.*

It can be seen that all models have a similar RSS and uncertainty in wake-free sectors. However, the 3D RANS model, WakeBlaster has about half the additional wake model uncertainty compared to single turbine wake models.

Total error distributions for wake-free and waked sectors respectively:

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