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The role of turbulent mixing in wind turbine wake recovery and wind array performance

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The effect of wind turbine wakes in large offshore wind energy arrays can be a substantial factor in affecting the performance of turbines inside the array. Turbulent mixing plays a key role in the wake recovery, having a significant effect on the length over which the wake is strong enough to affect the performance other turbines significantly.

We aim to highlight how turbulence affects wind turbine wakes, first by examining a high resolution CFD model of a single turbine wake validated by LIDAR measurements [1], and secondly with a much larger CFD simulation of Lillgrund offshore wind farm, validated with SCADA data [2].

By comparing the decay rates behind single turbines in environments of different surrounding surface features, ranging from ideal free-slip wind tunnels to mixed-vegetation hills, we suggest that the decay rate of turbine wakes are enhanced by free-stream turbulence, created by topography and ground features.

In the context of Lillgrund wind farm, observations and computational results suggest that the wakes created by the turbines in the leading row facing the wind decay much slower than those in second row, or further into the turbine array. This observation can be explained by the diffusive action of upwind turbulence breaking up the wake generated by a turbine rotor.

1. Angus CW Creech, Wolf-Gerrit Früh, Peter Clive (2012). Actuator volumes and hradaptive methods for threedimensional simulation of wind turbine wakes and performance. *Wind Energy* Vol.15, 847 – 863.

2. Angus C.W. Creech, Wolf-Gerrit Früh, A. Eoghan Maguire (2013). High-resolution CFD modelling of Lillgrund Wind farm. *Renewable Energies and Power Quality Journal*, Vol. 11