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# Wind speed reductions within and wake lengths behind wind parks, an analytical model

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In the interior of large wind parks the wind speed at hub height is reduced due to the momentum extraction by the turbines. Simultaneously, a wake region forms behind the wind park.

An analytical model is presented here which estimates the magnitude of the wind speed reduction and the extension of the wake region as a function of wind speed and thermal stratification in the atmospheric boundary layer, surface roughness, wind turbine drag, turbine density in the park and the turbulence production by the turbines. The model is based on equilibrium between momentum extraction by the turbines and momentum supply by vertical turbulent momentum fluxes from higher atmospheric layers above the wind park.

The model simulates a clear dependence of the wind speed reduction on atmospheric stability and surface roughness. The reduction increases with stable stratification and decreasing surface roughness. I.e., the reduction is considerably larger for offshore wind parks than for onshore parks. Similarly, the length of the wake depends on the same parameters. The length of offshore wind parks is longer than the wake of onshore wind parks.