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Statistical coupling of mesoscale and microscale simulations: combining WRF and WAsP for wind resource assessments

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To meet renewable energy targets in a cost-effective way, accurate modelling of the wind resource for planned wind farms is crucial. The Wind Atlas Analysis and Application Program (WAsP) is frequently employed for performing wind resource assessments. The WAsP method uses wind observations measured near a site of interest to provide modelled wind distributions at potential wind turbine locations using a combination of microscale models for the effects of roughness, orography, stability and obstacles. Here we use this method to transform wind distributions simulated by the Weather Research and Forecasting (WRF) model, i.e. downscaling the coarse ($\sim$ 3 km) WRF outputs to higher resolution ($\sim$ 50 m) using the WAsP method.

For vertical and horizontal modelling of the wind, WAsP mainly uses the logarithmic wind profile and the geostrophic drag law. Previously, this has been done by directly using the wind distributions of the WRF model, ‘cleaning’ them from mesoscale flow effects and correcting with appropriate microscale speed-up effects at the site of interest. Here we study the impact of using, in addition, WRF modelled distributions of stability, boundary layer height and geostrophic wind shear in the WAsP model for vertical and horizontal extrapolation. The results are evaluated with measurements from meteorological masts using as a metric the relative errors in wind speed and power density. The methodologies are implemented in a new python module called ‘PyWAsP’, which can be used for high-resolution wind resource assessments using a high-performance computing cluster. This provides the possibility to compute large areas more accurately and efficiently.