Comparison of the near-wake between actuator-line simulations and a simplified vortex model of a horizontal-axis wind turbine

The flow around an isolated horizontal-axis wind turbine is estimated by means of a new vortex code based on the Biot–Savart law with constant circulation along the blades. The results have been compared with numerical simulations where the wind turbine blades are replaced with actuator lines. Two different wind turbines have been simulated: one with constant circulation along the blades, to replicate the vortex method approximations, and the other with a realistic circulation distribution, to compare the outcomes of the vortex model with real operative wind-turbine conditions (Tjæreborg wind turbine). The vortex model matched the numerical simulation of the turbine with constant blade circulation in terms of the near-wake structure and local forces along the blade. The results from the Tjæreborg turbine case showed some discrepancies between the two approaches, but overall, the agreement is qualitatively good, validating the analytical method for more general conditions. The present results show that a simple vortex code is able to provide an estimation of the flow around the wind turbine similar to the actuator-line approach but with a negligible computational effort. Copyright © 2015 John Wiley & Sons, Ltd.