Comparison of far-wake models for wind turbines in yaw

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A literature survey is carried out on the far-wake aerodynamics of wind turbines in yaw, and an inter-comparison is made of related engineering models. These engineering models are commonly applied to support the yaw controller for the prediction of the deflected wake path during wake steering strategies. Wake steering is a promising concept for the power optimization in a wind farm by guiding wakes around turbines standing downstream. Nevertheless, the related aerodynamics are complex and it has never been properly discussed whether these engineering models capture the relevant flow physics. Therefore, an inventory is set up of the characteristic aerodynamic phenomena in the deflected wake, and key parameters are identified for the quantification of these phenomena. The comparison involves four analytical (kinematic) models and one two-dimensional numerical (field) model. Implicit results of the velocity and energy deficit are provided in horizontal and cross-plane slices of the wake. The cross-plane results are important as all models assume axi-symmetric flow, whereas the deflected wake physics involve strong three-dimensional asymmetries. In addition, explicit results regarding the wake skew, centerline, expansion, and shape are given. The results of this study are a directive for the future development of far-wake engineering models regarding wind turbines in yaw.

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