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A new class of actuator surface models incorporating wind turbine blade and nacelle geometry effects[1] XIAOLEI YANG, FOTIS SOTIROPOULOS, University of Minnesota — It was shown by Kang, Yang and Sotiropoulos (Journal of Fluid Mechanics 744 (2014): 376-403.) that the nacelle has significant effects on the turbine wake even in the far wake region, which the standard actuator line model is not able to predict. We develop a new class of actuator surface models for the blades and nacelle, which is able to resolve the effects of both tip vortices and nacelle vortex. The new nacelle model, which is based on distributing forces from the actual nacelle geometry as in the diffused interface immersed boundary methods, is first tested by carrying out LES of the flow past a sphere and demonstrating good agreement with available in the literature DNS results. The proposed model is subsequently validated by simulating the flow past the hydrokinetic turbine used in the simulations of Kang et al. and good agreement with the measurements is demonstrated. Finally, the proposed model is applied to utility scale wind turbines to elucidate the role of nacelle vortex dynamics on turbine wake meandering.

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