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Accuracy of current actuator-line modeling methods in predicting blade loads and wakes of wind turbines PANKAJ JHA, Pennsylvania State University, MATTHEW CHURCHFIELD, PATRICK MORIARTY, National Renewable Energy Laboratory, SVEN SCHMITZ, Pennsylvania State University —
Actuator-line modeling has become a prominent method for computing individual wind turbine wakes and their interaction within large wind turbine arrays. The advantage of actuator-line modeling is rooted in discretizing wind turbine blades as compact lines of body forces within an outer RANS- or LES-type solver. This eliminates the need for prohibitively expensive fully-resolved and detailed blade flow simulations. However, the close linkage between sectional blade forces and their reactive momentum deficit distribution just behind the rotor and its evolution and recovery further downstream in the wake has not been addressed in much detail in the literature. We have observed that current actuator-line modeling overpredicts blade tip loads by as much as twenty percent in comparison to blade-element momentum analyses and available data. The effect of the observed discrepancies in blade loading on the wake recovery and blade loading of a downstream wind turbine is unknown. This work addresses current efforts in quantifying the uncertainty and improving the predictive capability of actuator-line modeling. A detailed study of the combined effects of local grid refinement, body force projection width, and actuator element distribution is presented.

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