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MULTILEVEL UNCERTAINTY QUANTIFICATION OF A WIND TURBINE LARGE EDDY SIMULATION MODEL

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Abstract. Wind energy is stochastic in nature; the prediction of aerodynamic quantities and loads relevant to wind energy applications involves modeling the interaction of a range of physics over many scales for many different cases. These predictions require a range of model fidelity, as predictive models that include the interaction of atmospheric and wind turbine wake physics can take weeks to solve on institutional high performance computing systems. In order to quantify the uncertainty in predictions of wind energy quantities with multiple models, researchers at Sandia National Laboratories have applied Multilevel-Multifidelity methods. A demonstration study was completed using simulations of a NREL 5MW rotor in an atmospheric boundary layer with wake interaction. The flow was simulated with two models of disparate fidelity; an actuator line wind plant large-eddy scale model, Nalu, using several mesh resolutions in combination with a lower fidelity model, OpenFAST. Uncertainties in the flow conditions and actuator forces were propagated through the model using Monte Carlo sampling to estimate the velocity defect in the wake and forces on the rotor. Coarse-mesh simulations were leveraged along with the lower-fidelity flow model to reduce the variance of the estimator, and the resulting Multilevel-Multifidelity strategy demonstrated a substantial improvement in estimator efficiency compared to the standard Monte Carlo method.