Abstract Submitted
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Field Sensitivity Analysis for Wind Energy Modeling[1] JULIAN QUICK, CU Boulder, RYAN KING, MARC HENRY DE FRAHAN, SHREYAS ANANTHAN, MICHAEL SPRAGUE, National Renewable Energy Laboratory, PETER HAMLINGTON, CU Boulder — Wind energy systems are complex, necessitating turbulence models to approximate the true flow dynamics. However, designs based on inaccurate turbulence model parameters may yield unexpected turbine aerodynamics, extreme structural loads, or suboptimal energy production. A field sensitivity analysis can reveal crucial model parameters that introduce simulation errors leading to these undesirable outcomes. This study demonstrates field sensitivity analysis for a turbulent flow simulation relevant to wind energy — flow over a NACA 0015 wing at 12 degrees angle of attack and Reynolds number of 1.5 million — with respect to ten parameters in the 2003 Menter shear-stress transport turbulence model. Sensitivity is quantified using Sobol indices and the mean-squared gradient, which are estimated through polynomial chaos expansion and active subspace models, respectively. Two different sets of most sensitive turbulence model parameters are identified, corresponding to regions near and far from the wing. Simultaneous dimension reduction across several quantities of interest is also explored. This sensitivity analysis and dimension reduction will enable efficient model calibration for future wind energy studies.

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