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Influence of transition on steady and unsteady wind-turbine airfoil aerodynamics[1] ERIC PATERSON, ADAM LAVELY, GANESH VIJAYAKUMAR, JAMES BRASSEUR, The Pennsylvania State University — Laminar–flow airfoils for large stall–regulated horizontal–axis wind turbines are designed to achieve a restrained maximum lift coefficient and a broad laminar low- drag bucket under steady flow conditions and at specific Reynolds numbers. Blind- comparisons of the 2000 NREL Unsteady Aerodynamics Experiment showed large discrepancies and illustrated the need for improved physics modeling. We have studied the S809 airfoil under static and dynamic (ramp-up, ramp-down, and oscillatory) conditions, using the four-equation transition model of Langtry and Menter (2009), which has been implemented as a library accessible by an OpenFOAM RANS solver. Model validation is performed using surface–pressure and lift/drag data from U. Glasgow (2009) and OSU (1995) wind tunnel experiments. Performance of the transition model is assessed by analyzing integrated performance metrics, as well as detailed surface pressure and pressure gradient, wall–shear stress, and boundary–layer profiles and separation points. Demonstration of model performance in the light– and deep–stall regimes of dynamic stall is an important step in reducing uncertainties in full 3D simulations of turbines operating in the atmospheric boundary layer.

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Eric Paterson
The Pennsylvania State University

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