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Influences of Atmospheric Stability State on Wind Turbine Aerodynamic Loadings GANESH VIJAYAKUMAR, ADAM LAVELY, JAMES BRASSEUR, ERIC PATERSON, MICHAEL KINZEL, Penn State University — Wind turbine power and loadings are influenced by the structure of atmospheric turbulence and thus on the stability state of the atmosphere. Statistical differences in loadings with atmospheric stability could impact controls, blade design, etc. Large-eddy simulation (LES) of the neutral and moderately convective atmospheric boundary layer (NBL, MCBL) are used as inflow to the NREL FAST advanced blade-element momentum theory code to predict wind turbine rotor power, sectional lift and drag, blade bending moments and shaft torque. Using horizontal homogeneity, we combine time and ensemble averages to obtain converged statistics equivalent to "infinite" time averages over a single turbine. The MCBL required longer effective time periods to obtain converged statistics than the NBL. Variances and correlation coefficients among wind velocities, turbine power and blade loadings were higher in the MCBL than the NBL. We conclude that the stability state of the ABL strongly influences wind turbine performance. Supported by NSF and DOE.

Ganesh Vijayakumar
Penn State University

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