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Inherent Variability in Short-time Wind Turbine Statistics from Turbulence Structure in the Atmospheric Surface Layer ADAM LAVELY, GANESH VIJAYAKUMAR, JAMES BRASSEUR, ERIC PATERSON, MICHAEL KINZEL, Penn State University — Using large-eddy simulation (LES) of the neutral and moderately convective atmospheric boundary layers (NBL, MCBL), we analyze the impact of coherent turbulence structure of the atmospheric surface layer on the short-time statistics that are commonly collected from wind turbines. The incoming winds are conditionally sampled with a filtering and thresholding algorithm into high/low horizontal and vertical velocity fluctuation coherent events. The time scales of these events are $\sim$5 - 20 blade rotations and are roughly twice as long in the MCBL as the NBL. Horizontal velocity events are associated with greater variability in rotor power, lift and blade-bending moment than vertical velocity events. The variability in the industry standard 10 minute average for rotor power, sectional lift and wind velocity had a standard deviation of $\sim 5\%$ relative to the "infinite time" statistics for the NBL and $\sim$10% for the MCBL. We conclude that turbulence structure associated with atmospheric stability state contributes considerable, quantifiable, variability to wind turbine statistics. Supported by NSF and DOE.

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