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**Using flow visualization with natural snowfall to quantify the effects of atmospheric coherent structures on a utility-scale wind turbine**[1]
ALIZA ABRAHAM, JIARONG HONG, University of Minnesota — The presence of coherent structures in atmospheric turbulence can lead to substantial changes in the structural loading, power generation, and wake behaviors of utility-scale wind turbines. These structures are difficult to model in the laboratory or in simulations, and their effects on turbine operation have not been well understood due to limitations in field measurement techniques. In the current study, flow visualization and super-large-scale particle image velocimetry using natural snowfall were employed to quantify the impact of these coherent turbulent structures on turbine loading, operation, and wake. Three datasets with fields-of-view capturing the inflow and wake simultaneously were recorded, with significantly different levels of turbulence depending on the mean wind speed. In all datasets, structural loading increased with the presence of inflow coherent structures, though the correlation strength varied with turbine operational regime. Further, these structures were found to reduce power output at low wind speeds. Finally, the strong influence of these structures on tip vortex behavior in the near wake was also observed. These effects demonstrate the need to improve the accuracy of turbulence modelling in simulations of turbine-atmosphere interactions.

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