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Turbulence-driven power fluctuations on a wind turbine: characterization in the spectral domain LEONARDO CHAMORRO, NICOLAS TOBIN, HYUN J. KIM, JIN T. KIM, University of Illinois at Urbana-Champaign — Power and loading fluctuations experienced by wind turbines are mostly driven by the turbulent characteristics of the incoming flow, which limit their life span. Understanding the complex relation between wind turbine(s) and flow unsteadiness is key for the development of advanced controls and also in structural design. In this field study, we investigate the response of a 1kW wind turbine under various inflow conditions. The research is performed in the RE-TE Wind Energy Field Station of the University of Illinois. Synchronous measurements of the three velocity components of the incoming flow, turbine power and rotational speed of the rotor are acquired at a temporal resolution that includes the majority of the scales relevant for the problem. An array of sonic anemometers is used to characterize the incoming flow in the vicinity of the wind turbine. Insights on the scale-to-scale interaction between flow and the turbine are obtained as well as the linkage between their spectral structures. A comparison with a wind-tunnel experiment and full-scale setup suggest an apparent universal behavior of the spectral structure of the wind turbine power.

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