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Influence of inflow condition on wind turbine operation and wake unsteadiness KEVIN HOWARD, Saint Anthony Falls Laboratory, University of Minnesota, LEONARDO P. CHAMORRO, University of Illinois, MICHELE GUALA, Saint Anthony Falls Laboratory, University of Minnesota — A model wind turbine was tested in a closed-circuit wind tunnel under three different inflow conditions, (i) smooth wall turbulent boundary layer, (ii) preceding turbine wake and (iii) three dimensional sinusoidal hill wake, and three thermal stratifications. Two particle image velocimetry (PIV) fields were taken simultaneously upwind and downwind of the turbine along with the turbine voltage, which quantifies rotor fluctuations. Both wall-normal PIV fields were oriented on the centerline of the turbine and captured flow data in a window of approximately 1.1D by 1.1D, where D is the rotor diameter of the turbine. The upwind PIV measured the changing inflow conditions while both the voltage and downwind PIV field provided data that describes the response of the turbine and near wake to the inflow, respectively. Changes occurring in the inflow, whether upwind perturbation or thermal stability related, were statistically linked to the turbine voltage production and wake unsteadiness, as shown by turbulence intensity and swirling strength contours. A laboratory to field scale comparison is completed by inspecting light detection and ranging (Lidar) data taken upwind of the EOLOS utility scale, 2.5 MW wind turbine in conjunction with the turbine power production time signals.

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