Abstract Submitted
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Quantifying large-scale flow structures in the wake of a 2.5 MW wind turbine using natural snowfall[1] JIARONG HONG, MOSTAFA TOLOUI, SEAN RILEY, MICHELE GUALA, KEVIN HOWARD, LEONARDO CHAMORRO, JAMES TUCKER, FOTIS SOTIROPOULOS, University of Minnesota — The atmospheric inflow conditions around utility-scale turbines and multi-turbine arrayed wind farms remain poorly known, despite ongoing research, resulting in considerable wind plant power loss and increased annual operating costs. Gaining detailed full-scale flow information is constrained by low resolution spatial characterization of the flow field around turbines due to a lack of utility-scale research facilities and a number of technical challenges associated with obtaining measurements. Taking advantage of natural snowfall, we now achieve velocity field measurements in the wake of a 2.5 MW wind turbine at a scale of 36x36 m^2. The spatial and temporal resolutions of the measurements are sufficiently high to quantify the evolution of blade-generated coherent motions, such as the tip and trailing sheet vortices, identify their instability mechanisms, and correlate them with turbine operations, control, and performance. This technique has been further validated by comparing the obtained mean velocity and Reynolds stress profiles, up to 60 m above the ground with sonic anemometer measurements at specific elevations, where less than a 3% and 10% difference were observed, respectively.

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