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Investigating coherent vortex structures in the near wake of a utility-scale wind turbine using flow visualization with natural snowfalls[1]
TEJA DASARI , JIARONG HONG, University of Minnesota — Flow visualization techniques using natural snowfall have been shown as an effective tool to probe coherent flow structures around utility-scale wind turbines (Hong et al. *Nature Comm.* 2014). Here we present a follow-up study using the data collected during multiple deployments from 2014 to 2016 around the 2.5 MW turbine at EOLOS wind energy research station. The data include flow visualization from different perspectives in the near wake of the turbine. Coherent wake structures, including blade tip vortex, trailing vortex sheet, nacelle-generated structures, and tower vortex characterized by the snow voids, are correlated with atmospheric conditions (e.g. turbulence intensity), turbine operational conditions (e.g. power and tip-speed ratio) as well as turbine response (e.g. tower and blade strain). Physical factors and processes that affect the features and the behaviors of tip vortices including their void size and shape, their stability (e.g. meandering and intermittent appearance) and vortex interaction (e.g. vortex merging and leapfrogging) are analyzed. In particular, a strong influence of the tower on tip-vortex structures is demonstrated through simultaneous comparison of vortex voids at elevations below and above the height of nacelle and the plan view visualization.

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