Experimental Study of the Effects of Blade Treatments on the Tip Vortex Characteristics. VERA KLIMCHENKO, University of Maryland —

The current study investigates the effects of blade tip treatments on the characteristics of a wind turbine blade tip vortex. Three blade tip shapes including a blunt edge, leading edge comb, and a winglet were designed and tested in a low speed wind tunnel. The rotor with a blunt edge was considered to be a baseline case corresponding to an untreated blade tip. The leading-edge comb rotor was designed with leading edge tubercles extending from the tip of the blade inward, 6 percent of rotor diameter. The winglet located at the tip of the winglet rotor had a cant angle of 45 degrees. The wind turbine operated at a tip speed ratio of 5 and a tip Reynolds number of 14,000. The tip treatments were intended to weaken the tip vortices by encouraging dissipation (leading edge comb) or promoting the formation of weaker vortices (winglet). Time-resolved and phase-averaged PIV was used to measure the velocity field behind the rotor. The time-averaged velocity field was subtracted from the phase-averaged velocity field to isolate the time-varying components of the flow. The vorticity of the phase-averaged time-varying field was calculated, and the tip vortices were identified using a vortex identification method. Vortex characteristics such as core radius and vortex strength were calculated and compared for the three rotors. The analysis of the vorticity showed that the winglet rotor had weaker tip vortices with a larger core radius, while the serrated tip rotor had strong tip vortices with the same core radius as the baseline case.