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Dynamics and coupling of inertial particles on the wake recovery and flow entrainment of a wind turbine SARAH SMITH, KRISTIN TRAVIS, Department of Mechanical and Materials Engineering, Portland State University, HENDA DJERIDI, MARTIN OBLIGADO, LEGI - Laboratoire des coulements Gophysiques et Industriels, RAL BAYON CAL, Department of Mechanical and Materials Engineering, Portland State University — Impacting particles such as rain, dust, and other debris can have devastating structural effects on wind turbines, but little is known about the interaction of such debris within turbine wakes. This study aims to characterize behavior of inertial particles within the axisymmetric turbulent wake of a wind turbine and the resulting effects on wake recovery. Here a model wind turbine is subjected to varied two-phase inflow conditions with wind as the carrier fluid ($Re_D = 17.7*10^3 - 39.3*10^3$) and polydisperse water droplets (averaging 60 micrometers in diameter) at varied concentrations ($\phi_v = 9.7*10^{-6} - 2.6*10^{-5}$). Phase doppler interferometry (PDI) and particle image velocimetry (PIV) were employed at multiple downstream locations, centered with respect to turbine hub height. Analysis considers energy and particle size distribution within the wake focusing on particle entrainment, settling velocity, and preferential concentration. Near wake statistics show similarities to those of turbines in single-phase flows, and show persisting velocity deficits at least as far as 9.5 rotor diameters downstream. Complex particle behavior is evident in the near wake region where small particles are captured within tip vortices and central wake regions.

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