Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Similarity considerations for a turbulent axisymmetric wake with rotation subjected to a boundary layer flow[1] MARTIN WOSNIK, University of New Hampshire — Recently an analytical and experimental investigation of the turbulent axisymmetric wake with rotation found a new asymptotic scaling function for the mean swirl, $W_{max} \propto U_o^{3/2} \propto x^{-1}$ (Dufresne and Wosnik, *Mar Technol Soc J*, **47**, no.4, 193-205, 2013). An equilibrium similarity theory derived scaling functions from the conditions for the existence of similarity directly from the equations of motion. Axial and azimuthal (swirl) velocities were measured in the wake of a single 3-bladed wind turbine in a free stream up to 20 diameters downstream, and the data were found to support the theoretical results. The scaling implies that the mean swirl decays faster, with x^{-1}, than the mean velocity deficit, with $x^{-2/3}$. Real wind turbines, however, operate in the atmospheric boundary layer. They are subjected to mean shear and turbulence, both have been observed to improve wake recovery. Similarity considerations are extended to place a turbulent axisymmetric wake with rotation in a boundary layer flow, and the scaling implications are examined. Corresponding experiments were carried out in the UNH Flow Physics Facility, using model wind turbines of various sizes as swirling wake generators.

[1]Supported by NSF CBET grant 1150797

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Date submitted: 01 Aug 2015

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