Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

The Role of Free Stream Turbulence on the Aerodynamic Performance of a Wind Turbine Blade VICTOR MALDONADO, University of Texas at San Antonio, ADRIEN THORMANN, CHARLES MENEVEAU, Johns Hopkins University, LUCIANO CASTILLO, Texas Tech University — Effects of free stream turbulence with large integral scale on the aerodynamic performance of an S809 airfoil-based wind turbine blade at low Reynolds number are studied using wind tunnel experiments. A constant chord (2-D) S809 airfoil wind turbine blade model with an operating Reynolds number of 208,000 based on chord length was tested for a range of angles of attack representative of fully attached and stalled flow as encountered in typical wind turbine operation. The smooth-surface blade was subjected to a quasi-laminar free stream with very low free-stream turbulence as well as to elevated free-stream turbulence generated by an active grid. This turbulence contained large-scale eddies with levels of free-stream turbulence intensity of up to 6.14% and an integral length scale of about 60% of chord-length. The pressure distribution was acquired using static pressure taps and the lift was subsequently computed by numerical integration. The wake velocity deficit was measured utilizing hot-wire anemometry to compute the drag coefficient also via integration. In addition, the mean flow was quantified using 2-D particle image velocimetry (PIV) over the suction surface of the blade. Results indicate that turbulence, even with very large-scale eddies comparable in size to the chord-length, significantly improves the aerodynamic performance of the blade by increasing the lift coefficient and overall lift-to-drag ratio, L/D for all angles tested except zero degrees.

Victor Maldonado
University of Texas at San Antonio

Date submitted: 01 Aug 2014 Electronic form version 1.4