Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Vertical Mean Kinetic Energy Entrainment in a Scaled Wind Turbine Array ANDREW NEWMAN, Texas Tech University, DON DREW, Rensselaer Polytechnic Institute, LUCIANO CASTILLO, Texas Tech University — A 2D model of the Mean Kinetic Energy (MKE) of a scaled wind turbine array was analyzed to understand how turbulent transport brings MKE into arrays from the Turbulent Boundary Layer above. This was done by applying a Proper Orthogonal Decomposition to particle image velocimetry data and constructing modal expansions for the Reynolds stress terms which appear in the transport equation along a horizontal surface above the array. These terms have been shown to be of the same order of magnitude as the power extracted from the turbines. It was also found that 75% of the total Reynolds shear stress was carried by the first 13 modes. A strong correlation between a mode's Reynolds shear stress and its contribution to the MKE entrainment was demonstrated. Thus, a small number of modes are responsible for a large quantity of the MKE entrainment for the array. Modal streamwise length scales were determined; it was found that modal length decreases with increasing mode number. By considering sums of modes the largest scales observable in the experiment (13 rotor diameters) were shown to contribute over 50% of the MKE entrainment.

Andrew Newman
Texas Tech University

Date submitted: 15 Oct 2012 Electronic form version 1.4