Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Conditional flow structures in a Large Eddy Simulation of the fully developed wind-turbine array boundary layer[1] CLAIRE VERHULST, CHARLES MENEVEAU, Johns Hopkins University, Baltimore, MD — Wind-turbines deployed in a large array experience a decrease in individual efficiency due to interactions among themselves and the atmospheric boundary layer (ABL). A fully developed flow regime can be established when this wind-turbine array is an order of magnitude longer than the height of the ABL. Under this condition, vertical entrainment of kinetic energy is essential for power extraction. In order to characterize this entrainment process, a Large Eddy Simulation of the fully developed wind-turbine atmospheric boundary layer (WTABL) is performed using a pseudo-spectral method with periodic boundary conditions in the horizontal directions. The wind-turbines are modeled as drag disks with a force proportional to the local disk-averaged velocity (Calaf et al. 2010, Phys. Fluids 22, 015110). Conditional averaging of the WTABL velocity field based on thresholds set on the instantaneous power extraction is performed to determine conditional coherent flow structures associated with large values of power extraction. Properties of the conditional structures are examined and their dependencies on WT loading factors are studied.

[1]Supported by NSF (Project CBET 0730922 and CMMI-0941530)

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Date submitted: 06 Aug 2010 Electronic form version 1.4