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Proper Orthogonal Decomposition analysis of kinetic energy entrainment in large wind farms[1] CLAIRE VERHULST, CHARLES MENEVEAU, Johns Hopkins University — Vertical entrainment of kinetic energy is thought to play an important role in the dynamics of very large wind farms (Calaf et al., Phys Fluids 2010; and Cal et al. J. Ren. Sust. Energy 2010). To elucidate dominant mechanisms and flow physics of this vertical transfer of kinetic energy, we use Proper Orthogonal Decomposition (POD) to extract dominant flow structures from snapshots of velocity fields generated using Large Eddy Simulation of flow in an infinite turbine array in the atmospheric boundary layer. The POD analysis shows that the dominant modes are large streamwise counter-rotating vortices located above the turbines. The contribution of each POD mode to kinetic energy entrainment at the turbine level is then quantified and the modes are ordered by this contribution. Interestingly, the number of POD modes needed to represent dominant portions of the kinetic energy entrainment is less that the number needed to represent similar portions of the kinetic energy in the turbulent field. This suggests that understanding and controlling only a small number of flow structures may be relevant to the design of very large wind farms. In addition, to understand how the array layout affects the POD modes, several turbine orientations (aligned, staggered, etc) will be discussed.

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