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Large eddy simulation analysis of thermally stratified atmospheric boundary layer interacting with large wind farms[1] ADRIAN SESCU, CHARLES MENEVEAU, Johns Hopkins University — Based on a series of large eddy simulation (LES) studies of interactions between the atmospheric boundary layer (ABL) in neutral conditions and infinitely large arrays of wind turbines, new models for the effective roughness length have been developed (Calaf et al. 2010, PoF). Here we consider stratified ABL interacting with large wind turbine arrays. However, in the case of non-neutral conditions, achieving statistically stationary conditions is challenging since, for example, the heat flux at the ground causes vertical profiles of mean temperature to vary in time. To achieve statistical stationarity we use an artificial source of heat, in a region located above ABL, using a PI controller. Another controller is used to drive the flow within ABL, causing the mean velocity to achieve a prescribed direction at a specified height. A suite of simulations at various resolutions and levels of thermal stratification are presented, and the profiles of horizontally averaged velocity, temperature and turbulent fluxes, with and without wind turbines, are compared with each other. In stable conditions the turbulent heat flux increases when wind turbines are included, but in unstable conditions the turbulent heat flux decreases with increasing stratification.

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Charles Meneveau
Johns Hopkins University

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