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Experimental Study of Aligned and Staggered Wind Farms in a Convective Boundary Layer COREY MARKFORT, WEI ZHANG, Univ of Minnesota, FERNANDO PORTE-AGEL, WIRE-ENAC, EPFL — Wind farm-atmosphere interaction is complicated by turbine configuration and thermal effects on momentum and kinetic energy fluxes. Wind farms of finite length have been modeled as increased surface roughness or as a sparse canopy; however it is not clear which approach is more appropriate. Experiments were conducted in a thermally controlled boundary layer wind tunnel, using a custom x-wire/cold wire and surface heat flux sensors, to understand the effect of aligned versus staggered turbine configurations on momentum absorption and flow adjustment in a convective boundary layer (CBL). Results for experiments of a large farm show the span-wise averaged flow statistics exhibit similar turbulent transport properties to that of canopy flows. The wake adjusts within and grows over the farm more quickly for a staggered compared to an aligned farm. Using canopy flow scaling, we show that the flow equilibrates faster and the overall momentum absorption is higher in a staggered compared to an aligned farm. Wake recovery behind a single turbine is facilitated by buoyancy in a CBL (Zhang et al. under review). We find a similar effect in wind farms resulting in reduced effective roughness and momentum absorption. We also find a reduction of surface heat flux for both wind farms, but greater for the staggered farm.

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