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Nonequilibrium Behavior of the Daytime Atmospheric Boundary Layer, from LES[1] BALAJI JAYARAMAN, JAMES BRASSEUR, Penn State U, TYLER MCCANDLESS, SUE HAUPT, NCAR — LES of the daytime atmospheric boundary layer (ABL) over flat topography is universally developed as an equilibrium ABL with steady surface heat flux Q_0 and steady unidirectional "geostrophic" wind vector $\mathbf{V}_g$ above a capping inversion, where $\mathbf{V}_g$ also defines a spatially uniform transverse mean pressure gradient. The LES approaches a quasiequilibrium state characterized statistically by the ratio of boundary layer depth to Obukhov length scale. In contrast, the true daytime ABL is driven by surface heat flux increases to peak mid-day and drops in the afternoon, and by mesoscale wind vectors $\mathbf{U}_g$ that change in magnitude and direction during the day. We study the consequences of mesoscale weather on ABL dynamics by forcing ABL LES with a WRF simulation of the Midwest during 3 days of frontal passage over Kansas. Assuming horizontal homogeneity, we derive the relationship between $\mathbf{U}_g$ and $\mathbf{V}_g$ and study ABL response with systematic variation in Q_0 and the magnitude and direction of $\mathbf{U}_g$. Interesting results include: (1) asymmetry nonequilibrium diurnal response of the ABL; (2) directional changes in surface layer winds relevant to wind turbine function; and (3) changes in ABL stability state arising solely from changes in the direction of $\mathbf{U}_g$.

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