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A High-Resolution Modeling Study of the 19 June 2002 Convective Initiation Case during IHOP_2002: Localized Forcing by Horizontal Convective Rolls

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The initiation processes of one of the initial convective cells near and on the east side of a dryline on 19 June 2002 during the IHOP_2002 field experiment in the central United States is analyzed in detail based on a high-resolution numerical simulation. Prominent horizontal convective rolls and associated near-surface moisture convergence bands [called roll convergence bands (RCBs) here] develop within the convective boundary layer (CBL) due to surface heating, in the hours leading to convective initiation (CI). The RCBs east of the dryline are advected toward the primary dryline convergence boundary (PDCB) by the southerly moist flow as the CBL deepens with time. Backward trajectories of air parcels forming the initial precipitating updraft of the convective cell are found to primarily originate at about 1–1.5 km above ground, within the upper portion of the shallower CBL earlier on. The representative air parcel is found to follow and stay on top of a surface RCB as the RCB moves toward the PDCB, but the RCB forcing alone is not enough to initiate convection. As this RCB gets close to the PDCB, it moves into a zone of mesoscale convergence and a deeper CBL that exhibits an upward moisture bulge associated with the PDCB. The combined upward forcing of the RCB and the mesoscale PDCB convergence quickly lifts the representative air parcel above its level of free convection to initiate convection. Furthermore, the CI occurs at a particular point on the RCB followed by the representative parcel, where a localized convergence maximum at the surface on the RCB is created due to the development of a local vortex or misocyclone at an RCB ahead and the enhancement of surface divergence between the RCB and the PDCB. A conceptual model summarizing the CI processes is proposed.