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On the importance of cloud—cloud interaction to invigorate convective extremes

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Observational studies have shown that convective extremes are invigorated with increasing temperatures beyond thermodynamic constraints through the Clausius-Clapeyron relationship (e.g. Lenderink and van Meijgaard, Nature Geosci., 2008; Berg et al., Nature Geosci., 2013). This implies that there are changes in the dynamics of the convective showers that are dependent on the environmental conditions. Observations of convective cells lack sufficient resolution to investigate the dynamics in detail. We have therefore applied a large eddy simulator (LES) at a 200 m horizontal resolution to study the dynamical interaction between convective cells in a set of idealized simulations of a full diurnal cycle with a vertical profile of a typical day with convective showers (Moseley et al., Nature Geosci., 2016). The simulations show that the convective cells are subjected to a gradual self-organization over the day, forming larger cell clusters and more intense precipitation. Further, by tracking rain cells, we find that cells that collide with other cells during their lifetime have a different response to changes in the environmental conditions, such as an increase in temperature, than cells that do not interact. Whereas the non-interacting cells remain almost unaffected by the boundary conditions, the colliding cells show a strong invigoration. Interestingly, granting more time for the self-organization to occur has a similar effect as increasing the temperature. We therefore speculate that self-organization is a key element to explain the strong response of convective extremes to increasing temperature. Our results suggest that proper modeling and predicting of convective extremes requires the description of the interaction between convective clouds.