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A state-based conceptual model for convective cloud interaction

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Although convective precipitation events are often local and short-term, extreme convective precipitation can directly affect society, e.g. through flash floods. Additionally, the larger-scale organisation of convective clouds may affect cloud cover and thereby the radiation budget of the atmosphere. In general circulation models (GCMs), grid box averages of instability parameters like convective available potential energy (CAPE) and convective inhibition (CIN) are traditionally used as a proxy for the formation of clouds and resulting precipitation. Individual convective clouds are however much smaller than current GCM resolutions. It has been proposed that the sub-grid scale interactions between single clouds through cold pools can trigger new and stronger convective events and influence the timing of precipitation, drastically affecting the grid-box state. In order to understand these cloud interactions better, we create a dynamical model where CAPE and CIN are defined locally at the scale of individual convective cells. The model domain is divided into a grid, where each grid cell can be in different states: some defining local processes, e.g. thermally activated convective cells, and others non-local, which involve cold pool currents originating from several cells undergoing local processes. The latter is hence an interaction process, benefiting from a set of “firing” and decaying convective cells in the near or distant surroundings. The aim of this simple model is to capture effects of cold pool interactions such as organization and scale increases and to show how such interactions can lead to a structuring of the cloud field – with possible implications for the emergence of extreme convective events.