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Predicting cold pool strength as a function of rain duration and intensity

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Idealised large-eddy simulations (LES) of isolated or colliding CPs have proven to be a useful tool to investigate the life cycle of CPs, their mutual interaction and the derivation of simple theories about CP properties such as the propagation speed. On the contrary, the formation of CPs by rain evaporation and specifically their relation to the parent rain event has so far gained little attention in idealized studies. This is surprising, as the 'rain –CP –rain'cycle lies at the core of the CPs'effect on the spatio-temporal distribution of convective fields. From an application perspective, understanding such relations is important in the development of cold pool parameterisations, that aim at adjusting for the enhanced convective triggering at the presence of CPs, where the triggering scales with the CP strength.
In this project we thus study the relation between rain intensity, duration and CP strength in an idealized setting. To this end, we include the temporal extent of the rain event that forms the CP through evaporative cooling by varying the duration, intensity and area of the volume that is cooled and moistened to simulate the generation of a CP. This has been neglected by most studies, who initialize the CP by an instantaneous forcing alone. These results will help to relate precipitation intensity and CP strength in observational studies, where testing the relation between rain cells and CP strength is complicated by the finite duration of rain events, and a missing understanding whether instantaneous or time-integrated precipitation statistics should be related to the CP.
Our simulations serve as a confirmation of many intuitive scaling behaviour, such as that CPs become larger and stronger the larger and more intense its parent rain cell is. However, our simulations also indicate a maximum cooling duration of approximately 20mins to be affecting the CP. Continuous cooling occurring after this does not visibly affect the CP radius and propagation speed. Consequently, the CP's effect on the environment, measured in terms of the updraft strength ahead of the CP, shows the same convergence. However, the CP interior shows enhanced radial airflow near the surface which affects the moisture uptake from the surface and thus may lead to more enhanced moisture rings. Furthermore, it acts as cold air supply, preventing the CP from early dissipation and prolonging its life-time.

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