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Temperature scaling of convective cells in present and future conditions

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Convection permitting climate models (CPMs) agree on an increase in short-term, extreme precipitation in the future. However, different studies using CPM simulations found regionally varying temperature scaling rates of hourly extreme precipitation either close to or above the Clausius-Clapeyron-rate (CC-rate) of 7%/K. These variations suggest that the dynamics of convective events strongly regulate the local scaling rates. In order to understand how the characteristics of convective events change in the future, we apply a tracking algorithm to precipitation data with 5-min temporal resolution from a regional climate model (COSMO-CLM) simulation. The model is run over central Europe at a grid size of 0.025° for an evaluation period (1981-2015) driven by ERA-Interim reanalysis data, as well as a present-day (1976-2005) and a future (2071-2100) period driven by the EC-Earth global model. We investigate the temperature scaling of convective cell characteristics like total precipitation per cell, mean area, lifetime and maximum intensity, as well as changes in the diurnal cycle of convective cells which might explain the overall scaling rates. The cell characteristics precipitation sum, mean area and maximum intensity show an exponential increase with temperature across most of the temperature range with a drop-off at high temperatures very similar to fixed location scaling curves. While the maximum intensity and area scale at rates close to the CC-rate, the precipitation sum scales at a rate close to twice the CC-rate. In contrast to this, the lifetime of convective cells does not increase with temperature but stays constant with a drop-off at high temperatures. The future simulation shows a shift of the scaling curves towards higher peak values at higher temperatures. Convective activity is projected to decrease during daytime and increase during nighttime. While the mean intensity of convective cells increases throughout the whole day, the number of cells is reduced during the afternoon peak and increased during nighttime. This leads to a slight reduction of convective precipitation during daytime and almost a doubling of convective precipitation during nighttime.