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Influence of convection-permitting modeling on future projections of extreme precipitation for a mid-latitude region with mixed topography

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One particular area where convection-permitting scale (CPS) could be of added value is in future projections of extreme precipitation, particularly for short timescales (e.g. hourly). However, recent studies that compare the sensitivity of extreme hourly precipitation at CPS and non-convection-permitting scale (non-CPS) have produced mixed results, with some reporting a significantly higher future increase of extremes at CPS, while others do not. However, the domains used in these studies differ significantly in orographic complexity, and include both mountain ranges as well as lowlands with minimal topographical features.

The goal of this study is to investigate if and how the added value of CPS for future extreme precipitation projections depends on topographic complexity and timescale. To that end, we perform and analyze 30 year climate simulations (hindcast, control and end-of-century RCP 8.5) at both non-CPS (12 km resolution) and CPS (2.5 km resolution), using the regional climate model COSMO-CLM. The study area is Belgium and surroundings, and is comprised of lowland in the north and a low mountain range in the south (Ardennes-Eifel range).

Results from the COSMO-CLM simulations show that the added value of CPS in simulating future extreme precipitation depends on both timescale and topography. Despite a background of general summer drying in our region caused by changes in large-scale circulation, CPS simulations predict a significant increase in the frequency of daily and hourly extreme precipitation events, for both the lowland and mountain areas. Non-CPS simulations are able to reproduce this increase for hourly extremes in mountain areas, but significantly underestimate a) the increase in hourly extremes in lowlands and b) the increase in the most extreme daily precipitation events (60-100 mm/day) everywhere. Thus, these results suggest that non-CPS models adequately simulate the future increase of extreme precipitation linked to orographic convection, but underestimate the increase in extremes linked to all other types of convective triggering.