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Impact of the horizontal resolution on the simulation of extremes

O. Gutjahr (1), L. Schefczyk (1), P. Reiter (2,3), and G. Heinemann (1)

(1) Environmental Meteorology, University of Trier, Germany, (2) Rhineland-Palatinate Centre of Excellence for Climate Change Impacts, Trippstadt, Germany, (3) Physical Geography, University of Trier, Germany

The simulation of extremes using climate models is still a challenging task. Currently, the horizontal resolution of state-of-the art regional climate models (RCMs) is about 12.5-25 km, which may still be too coarse to represent local extremes realistically. In this study we use dynamically downscaled ERA-40 reanalysis data of the RCM COSMO-CLM at 18 km resolution, downscale it further to 4.5 km and 1.3 km and investigate the impact of the horizontal resolution on extremes. Extremes are estimated as return levels for the 2, 5 and 10-year return periods using 'peaks-over-threshold' (POT) models. Daily return levels are calculated for precipitation and maximum 2 m temperature in summer as well as precipitation and 2 m minimum temperature in winter. The results show that the spatial variability of the return levels increases with resolution. This effect is more distinct in case of temperature extremes due to a higher dependency on the better resolved orography. In comparison to observations, the spatial variability of temperature extremes is better simulated at a resolution of 1.3 km, but the return levels are cold biased in summer and warm biased in winter. Regarding precipitation, the spatial variability improves as well, but return levels were strongly overestimated in summer by all CCLM simulations. In summary, the results indicate that an increase in resolution improves the simulation of extremes in an RCM, and impact models and assessment studies may benefit from such high-resolution model output.