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Understanding the impact of climate change on areal reduction factors using convection-permitting models

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Areal reduction factors (ARFs) are essential in hydrological modeling as they enable the conversion of point design precipitation into the average design precipitation for a catchment area. This study aims to assess the projected variations in ARFs during precipitation events for different return levels, focusing on the upper Adige River, Italy (Eastern Italian Alps). The study utilizes simulations from the ensemble of convection-permitting climate models (CPMs), which are well-suited for this purpose due to their ability to explicitly represent deep convection and to resolve the mountainous topography. The CPM data, provided by the CORDEX-FPS Convection project at 1-hour temporal resolution and remapped to a common 3 km spatial resolution, cover historical and far-future (2090-2099) time periods under the extreme climate change scenario (RCP8.5). The method applied for estimating the ARFs utilizes gridded precipitation data from CPMs and is based on precipitation quantiles derived from frequency curves. The extreme quantiles are estimated by the Simplified Metastatistical Extreme Value approach, known for its reduced uncertainty compared to conventional approaches. The ARFs are then calculated as the ratio of extreme quantiles for a selection of events with different duration and return period, which allows the ARF to vary where necessary. Our preliminary results indicate that ARFs for short-duration events are likely to increase in the future, suggesting a potentially larger spatial structure for storms. Additionally, for longer duration storms, ARFs are expected to remain relatively same, although a slight negative trend is observed for higher return period events. These results highlight the importance of considering advanced statistical methods and high-resolution climate models to address emerging challenges in hydrology and climate science.