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A Combined Bias Correction and Stochastic Downscaling Method

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Precipitation is highly variable in space and time, especially its extremes. Much of our knowledge about future changes in precipitation relies on global (GCM) and/or regional climate models (RCM) that have resolutions which are much coarser than typical spatial scales of extreme precipitation. The major problems with these projections are both GCM/RCM-biases in simulated precipitation and the scale gap between grid box and point scale. In particular, traditional bias correction methods (e.g., quantile mapping) cannot bridge this scale gap, and empirical statistical downscaling methods have a very limited ability to correct biases. Wong et al. presented a first attempt to jointly bias correct and downscale precipitation at daily scales. However, this approach relies on spectrally nudged RCM simulations, which are rarely available.

Here we present a combined statistical bias correction and stochastic downscaling method, with the aim of combining their respective advantages, that in principle also works for free running RCMs, such as those available from ENSEMBLES or CORDEX. Thereby, we separate bias correction from downscaling. In a first step, we bias correct the RCMs (EURO-CORDEX) against gridded observational datasets (e.g., E-OBS) at the same scale using a quantile mapping approach that relies on distribution transformation. To correct the whole precipitation distribution including extreme tails we apply a mixture distribution of a gamma distribution for the precipitation mass and a generalized Pareto distribution for the extreme tail. In a second step, we bridge the scale gap: we add small scale variability to the bias corrected precipitation time series using a vector generalized linear gamma model (VGLM gamma). To calibrate the VGLM gamma model we determine the statistical relationship between precipitation observations on different scales, i.e. between gridded (e.g., E-OBS) and station (ECA&D) observations. We apply this combined bias correction and downscaling method to example stations and present an initial validation against, e.g., discrete quantile mapping and the raw RCM output. Furthermore, we present an example application of our method to future projections with CORDEX-RCMs.