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A robust framework for probabilistic precipitations downscaling from an ensemble of climate predictions applied to Switzerland

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Rainfall is poorly modeled by general circulation models (GCMs) and has to be downscaled to drive local hydrological impact studies. Such downscaling methods should be robust and accurate (to handle e.g. extreme events), but the non-continuous and highly non-linear nature of rainfall makes this task particularly challenging. Building upon state-of-the-art methods, we propose a robust probabilistic framework to downscale local daily rainfall series from an ensemble of climate simulations. The downscaling is based on Generalized Linear Models (GLMs) that relate monthly GCM-scale atmospheric variables to local daily rainfall series. The other key elements of the framework are i) a cross-validation step to ensure that the fitted models are correctly conditioned by the climate variables, and ii) a statistical procedure to test the stationarity assumption that the statistical relationships identified for the reference period also hold in a future perturbed climate. Additionally, we propose a strategy to downweight poor-performing GCMs-GLMs couples.

The methodology is assessed at 27 locations covering Switzerland and is shown to perform well in reproducing historical rainfall statistics, including extremes and inter-annual variability, and their projections are consistent with the simulations of physically-based dynamical models. Although the downscaling models were fitted for each of the 27 sites independently, their projections follow a spatially coherent pattern, exhibiting regions with different climate change impacts, which we identified using an original visualization method based on heatmaps.