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Testing a Weather Generator for Downscaling Climate Change Projections over Switzerland

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Climate information provided by global or regional climate models (RCMs) are often too coarse and prone to substantial biases, making it impossible to directly use daily time-series of the RCMs for local assessments and in climate impact models. Hence, statistical downscaling becomes necessary. For the Swiss National Climate Change Initiative (CH2011), a delta-change approach was used to provide daily climate projections at the local scale. This data have the main limitations that changes in variability, extremes and in the temporal structure, such as changes in the wet day frequency, are not reproduced. The latter is a considerable downside of the delta-change approach for many impact applications. In this regard, stochastic weather generators (WGs) are an appealing technique that allow the simulation of multiple realizations of synthetic weather sequences consistent with the locally observed weather statistics and its future changes.

Here, we analyse a Richardson-type weather generator (WG) as an alternative method to downscale daily precipitation, minimum and maximum temperature. The WG is calibrated for 26 Swiss stations and the reference period 1980-2009. It is perturbed with change factors derived from 12 RCMs (ENSEMBLES) to represent the climate of 2070-2099 assuming the SRES A1B emission scenario. The WG can be run in multi-site mode, making it especially attractive for impact-modelers that rely on a realistic spatial structure in downscaled time-series. The results from the WG are benchmarked against the original delta-change approach that applies mean additive or multiplicative adjustments to the observations.

According to both downscaling methods, the results reveal area-wide mean temperature increases and a precipitation decrease in summer, consistent with earlier studies. For the summer drying, the WG indicates primarily a decrease in wet-day frequency and correspondingly an increase in mean dry spell length by around 18% - 40% at low-elevation stations. By construction, these potential changes cannot be represented by a delta-change approach. In winter, both methods project a shortening of the frost period (-30 to -60 days) and a decrease of snow days (-20% to -100%). The WG demonstrates though, that almost present-day conditions in snow-days could still occur in the future. As expected, both methods have difficulties in representing extremes. If users focus on changes in temporal sequences and need a large number of future realizations that are spatially consistent, it is recommended to use data from a WG instead of a delta-change approach.