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Synthetic daily weather time-series for future climate in Switzerland

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Given the expected changes in the climate system over the 21st century, the need for future climate data with high resolution in space and time is continuously growing. This is especially true for impact modelers that require daily input data of several variables. Regional climate models (RCMs) typically provide information on possible future climatic changes at a spatial resolution of 10-50 km, which is often too coarse for direct use in climate impact models requiring realistic spatio-temporal structures. Hence, further statistical downscaling is necessary. In this regard, stochastic multi-site weather generators (WGs) are an appealing technique that allow the simulation of synthetic weather series consistent with the locally observed weather statistics across several stations and its future changes.

Here, we present results of stochastically simulated future daily weather time-series (precipitation, minimum and maximum temperature) with a spatio-temporal correlation structure similar to present-day in-situ observations. For this purpose, a multi-site WG recently developed by the authors has been perturbed with WG parameter changes from RCM projections of ENSEMBLES. The multi-site WG is calibrated over a network of Swiss measurement stations from MeteoSwiss over the time-period 1980-2009 and run under future climate conditions for the time-period 2070-2099.

The RCM analysis reveals that largest deviations from present-day precipitation time-series are expected in summer with a substantial decrease in mean precipitation all over Switzerland. This is pre-dominantly an effect of a reduction in the number of wet days, which also leaves an imprint on simulated transition probabilities and multi-day dry spells. In fact, at low-elevated stations, mean dry spell lengths increase by around 18% - 40%. In winter, Switzerland will experience a general shortening of the frost period (of roughly 1-2 months) and a general decrease of snow days (-20% to -100%). Owing to climate model uncertainty and stochastic variability, the downscaled future timeseries do not preclude the possibility of individual years with snow days that fall within the range of present-day interannual variability. A comparison to a delta change approach generally reveals differences for indices sensitive to changes in the temporal structure, but also for aspects, which the WG is not trained for, such as extreme records. The latter are implicitly retained in future time-series from a delta-change approach.