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Methodological challenges to bridge the gap between regional climate and hydrology models

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The frequency and severity of floods worldwide, together with their impacts, are expected to increase under climate change scenarios. It is therefore very important to gain insight into the physical mechanisms responsible for such events in order to constrain the associated uncertainties. Model simulations of the climate and hydrological processes are important tools that can provide insight in the underlying physical processes and thus enable an accurate assessment of the risks. Coupled together, they can provide a physically consistent picture that allows to assess the phenomenon in a comprehensive way. However, climate and hydrological models work at different temporal and spatial scales, so there are a number of methodological challenges that need to be carefully addressed.

An important issue pertains the presence of biases in the simulation of precipitation. Climate models in general, and Regional Climate models (RCMs) in particular, are affected by a number of systematic biases that limit their reliability. In many studies, prominently the assessment of changes due to climate change, such biases are minimised by applying the so-called delta approach, which focuses on changes disregarding absolute values that are more affected by biases. However, this approach is not suitable in this scenario, as the absolute value of precipitation, rather than the change, is fed into the hydrological model. Therefore, bias has to be previously removed, being this a complex matter where various methodologies have been proposed. In this study, we apply and discuss the advantages and caveats of two different methodologies that correct the simulated precipitation to minimise differences with respect an observational dataset: a linear fit (FIT) of the accumulated distributions and Quantile Mapping (QM). The target region is Switzerland, and therefore the observational dataset is provided by MeteoSwiss. The RCM is the Weather Research and Forecasting model (WRF), driven at the boundaries by the Community Earth System Model (CESM).

The raw simulation driven by CESM exhibit prominent biases that stand out in the evolution of the annual cycle and demonstrate that the correction of biases is mandatory in this type of studies, rather than a minor correction that might be neglected. The simulation spans the period 1976 – 2005, although the application of the correction is carried out on a daily basis. Both methods lead to a corrected field of precipitation that respects the temporal evolution of the simulated precipitation, at the same time that mimics the distribution of precipitation according to the one in the observations. Due to the nature of the two methodologies, there are important differences between the products of both corrections, that lead to dataset with different properties. FIT is generally more accurate regarding the reproduction of the tails of the distribution, i.e. extreme events, whereas the nature of QM renders it a general-purpose correction whose skill is equally distributed across the full distribution of precipitation, including central values.