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Sub-daily precipitation disaggregation for a simulation of annual runoff maxima

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Measurement of precipitation has been often restricted to daily totals only. This applies especially to observations from the previous century which constitutes a valuable source of long-term precipitation records needed for statistical analysis such as for annual runoff maxima. In this respect, the knowledge about the exact temporal distribution of these precipitation totals at sub-daily time steps can play an important role on the magnitude of simulated runoff maxima using these data. But it is difficult to estimate the sub-daily temporal distribution of precipitation if it was not measured. Instead, the effect of the precipitation in the form of runoff measured at the catchment outlet, which is usually available at sub-daily time steps for longer periods, provides an alternative to evaluate the potential effect of the need to disaggregate precipitation data.

In this study we assess how the choice of the temporal distribution of daily precipitation totals might affect the simulation of the catchment runoff annual maxima when using a hydrological model. To examine this issue, we tested six different settings of precipitation total distribution within the day. These are: 1) uniform distribution (daily totals uniquely divided over 24 hours); all daily totals fall within a respective time window, i.e., 2) one hour, 3) two successive hours, 4) three successive hours, 5) six successive hours, and 6) twelve successive hours, each time randomly selected for each observation day independently. To assess the effect on simulated runoff maxima, such generated hourly precipitation datasets were next used as input into a pre-calibrated HBV model. As a reference, we used model simulations with observed hourly precipitation data.

This study was conducted using thirty years of precipitation and runoff observations in three Swiss catchments. Our results showed that the annual maxima were best simulated when distributing daily totals over twelve successive hours randomly selected for each observation day, as compared to original hourly data. Next best simulations were obtained for the uniform distribution and then for a six hour distribution. Interestingly, accumulating all precipitation totals over the period between 1 hour and 6 hours led to highly overestimated maxima. Our findings suggest therefore that regardless the true temporal distribution the effective distribution resulting in the observed streamflow maxima was closer to a uniform distribution than to a concentration during a few hours. These results support the use of simple disaggregation schemes such as the uniform distribution when daily precipitation data are used to simulate runoff maxima.