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Comparing bottom-up and top-down parameterisations of a process-based runoff generation model tailored on floods

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Information about the spatial distribution of dominant runoff processes (DRPs) can improve flood predictions on ungauged basins, where conceptual rainfall-runoff models usually appear to be limited due to the need for calibration. For example, hydrological classifications based on DRPs can be used as regionalisation tools assuming that, once a model structure and its parameters have been identified for each DRP, they can be transferred to other areas where the same DRP occurs.
Here we present a process-based runoff generation model as an event-based spin-off of the conceptual hydrological model PREVAH. The model is grid-based and consists of a specific storage system for each DRP. To unbind the parameter values from catchment-related characteristics, the runoff concentration and the flood routing are uncoupled from the runoff generation routine and simulated separately. For the model parameterisation, two contrasting approaches are applied. First, in a bottom-up approach, the parameters of the runoff generation routine are determined a priori based on the results of sprinkling experiments on 60-100 m^2 hillslope plots at several grassland locations in Switzerland. The model is, then, applied on a small catchment (0.5 km^2) on the Swiss Plateau, and the parameters linked to the runoff concentration are calibrated on a single heavy rainfall-runoff event. The whole system is finally verified on several nearby catchments of larger sizes (up to 430 km^2) affected by different heavy rainfall events. In a second attempt, following a top-down approach, all the parameters are calibrated on the largest catchment under investigation and successively verified on three sub-catchments. Simulation results from both parameterisation techniques are finally compared with results obtained with the traditional PREVAH.