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Propagation of hydrological modeling uncertainties on bed load transport simulations in steep mountain streams

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As mountain streams are sources of both, water and sediment, they are strongly influencing the whole downstream river network. Besides large flood flow events, the continuous transport of sediments during the year is in the focus of this work. Since small mountain streams are usually not measured, spatial distributed hydrological models are used to assess the internal discharges triggering the sediment transport. In general model calibration will never be perfect and is focused on specific criteria such as mass balance or peak flow, etc. The remaining uncertainties influence the subsequent applications, where the simulation results are used.
The presented work focuses on the question, how modelling uncertainties in hydrological modelling impact the subsequent simulation of sediment transport. The applied auto calibration by means of MonteCarlo Simulation optimizes the model parameters for different aspects (efficiency criteria) of the runoff time series.
In this case, we investigated the impacts of different hydrological criteria on a subsequent bed load transport simulation in catchment of the Längentaler Bach, a small catchment in the Stubai Alps. The used hydrologic model HQSim is a physically based semi-distributed water balance model. Different hydrologic response units (HRU), which are characterized by elevation, orientation, vegetation, soil type and depth, drain with various delay into specified river reaches. The runoff results of the Monte-Carlo simulation are evaluated in comparison to runoff gauge, where water is collected by the Tiroler Wasserkraft AG (TIWAG). Using the Nash-Sutcliffe efficiency (NSE) on events and main runoff period (summer), the weighted root mean squared error (RMSE) on duration curve and a combination of different criteria, a set of best fit parametrization with varying runoff series was received as input for the bed load transport simulation.
These simulations are performed with sedFlow, a tool especially developed for bed load transport in steep mountain streams, concentrating on the lower part of the main channel. Calibration of the sediment transport model was based on measured sediment data. This is obtained from settling basin connected to Tyrolean Weir type water intake, in which almost all sediments are deposited. Typical morphologic structures of this steep mountain stream, like step pool sequences, sudden changes of cross sections and armoring of the surface layer, and its characteristic flow regime lead to highly fluctuating transport rates. These are additionally strongly depending on preconditions of the river bed. Consequently, the different hydrographs of the hydrological model are causing significantly deviating results, which are induced by varying water volumes as well as temporal variations of the hydrographs.