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Simulated discharge trends indicate robustness of hydrological models in a changing climate

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Assessing the robustness of hydrological models under contrasted climatic conditions should be part any hydrological model evaluation. Robust models are particularly important for climate impact studies, as models performing well under current conditions are not necessarily capable of correctly simulating hydrological perturbations caused by climate change. A pressing issue is the usually assumed stationarity of parameter values over time. Modeling experiments using conceptual hydrological models revealed that assuming transposability of parameters values in changing climatic conditions can lead to significant biases in discharge simulations. This raises the question whether parameter values should to be modified over time to reflect changes in hydrological processes induced by climate change. Such a question denotes a focus on the contribution of internal processes (i.e. catchment processes) to discharge generation. Here we adopt a different perspective and explore the contribution of external forcing (i.e. changes in precipitation and temperature) to changes in discharge. We argue that in a robust hydrological model, discharge variability should be induced by changes in the boundary conditions, and not by changes in parameter values.

In this study, we explore how well the conceptual hydrological model HBV captures transient changes in hydrological signatures over the period 1970-2009. Our analysis focuses on research catchments in Switzerland undisturbed by human activities. The precipitation and temperature forcing are extracted from recently released 2km gridded data sets. We use a genetic algorithm to calibrate HBV for the whole 40-year period and for the eight successive 5-year periods to assess eventual trends in parameter values. Model calibration is run multiple times to account for parameter uncertainty. We find that in alpine catchments showing a significant increase of winter discharge, this trend can be captured reasonably well with constant parameter values over the whole reference period. Further, preliminary results suggest that some trends in parameter values do not reflect changes in hydrological processes, as reported by others previously, but instead might stem from a modeling artifact related to the parameterization of evapotranspiration, which is overly sensitive to temperature increase. We adopt a trading-space-for-time approach to better understand whether robust relationships between parameter values and forcing can be established, and to critically explore the rationale behind time-dependent parameter values in conceptual hydrological models.