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A multiple hypotheses uncertainty analysis in hydrological modelling: about model structure, landscape parameterization, and numerical integration

Tobias Pilz, Till Francke, and Axel Bronstert
University of Potsdam, Institute of Earth and Environmental Science, Potsdam, Germany (tpilz@uni-potsdam.de)

Until today a large number of competing computer models has been developed to understand hydrological processes and to simulate and predict streamflow dynamics of rivers. This is primarily the result of a lack of a unified theory in catchment hydrology due to insufficient process understanding and uncertainties related to model development and application. Therefore, the goal of this study is to analyze the uncertainty structure of a process-based hydrological catchment model employing a multiple hypotheses approach.
The study focuses on three major problems that have received only little attention in previous investigations. First, to estimate the impact of model structural uncertainty by employing several alternative representations for each simulated process. Second, explore the influence of landscape discretization and parameterization from multiple datasets and user decisions. Third, employ several numerical solvers for the integration of the governing ordinary differential equations to study the effect on simulation results. The generated ensemble of model hypotheses is then analyzed and the three sources of uncertainty compared against each other. To ensure consistency and comparability all model structures and numerical solvers are implemented within a single simulation environment.
First results suggest that the selection of a sophisticated numerical solver for the differential equations positively affects simulation outcomes. However, already some simple and easy to implement explicit methods perform surprisingly well and need less computational efforts than more advanced but time consuming implicit techniques. There is general evidence that ambiguous and subjective user decisions form a major source of uncertainty and can greatly influence model development and application at all stages.