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Identifying Key Processes for optimized modeling of Water and Solute Dynamics in the Lehstenbach Watershed

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Groundwater and stream water quality are affected by a multitude of hydrologic and biogeochemical processes that act at different scales and often interact in highly non-linear ways. As a consequence, effects of anthropogenic impacts (e.g. land use change, water management) and natural variability (e.g. interanual climatic variability and long-term climate change) are difficult to differentiate. Often, a few single events are much more decisive for a system's behavior than long-term mean conditions. That renders a sound assessment of the impacts of expected climate change, including changing frequencies and intensities of meteorological extreme events, on water quality difficult. Complex hydrologic process models are often plagued with large uncertainties stemming not only from uncertain input parameters but also from the inherent model structure, which attempts to capture the complex arrangement and interplay of processes. Rather than using the common bottom-up approach in hydrologic modeling we suggest to combine it with a top-down approach using nonlinear statistical techniques and long term monitoring data, which aims at optimizing model structure by an a priori identification of key processes and dynamics. The Lehstenbach watershed has been the focus of numerous biogeochemical process studies and extensive monitoring since 1986. The obtained data provide an ideal basis for studying the interplay between different processes, linking upslope soil and groundwater bodies with riparian wetlands and streams. Using nonlinear statistics, a methodology has been developed and applied to the data that allows an identification of prevailing processes at the watershed scale. This information shall be used to optimize model structure (processes

and data explicitly included in the model) of a physically based, numerical watershed model for water flow, solute transport and turnover that would allow an integration of the findings of single process studies at the watershed scale. The optimized model can be used to study the effect of recent climatic variability on watershed solute turnover, and thus provide a tool for scenario analyses. As such it can help to get closer to an integral description of total system's water flow and solute transport behavior.