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Aquifer type-specific conceptual groundwater models improve baseflow simulation

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Streamflow response during baseflow conditions is a function of storage and outflow, but it is also known that this functional relationship varies among catchments and seasons. Traditionally, hydrological models incorporate conceptual groundwater reservoirs consisting of linear or non-linear storage-outflow functions. Identification of the right model structure and model parameterization however is challenging particularly for models with a high degree of complexity. The aim of this contribution was to systematically test different parsimonious model structures in a set of catchments where different aquifer types govern streamflow response during baseflow conditions. Nine different conceptual groundwater models were applied with multi-objective calibration to transform two different groundwater recharge series derived from a SVAT model into baseflow separated from streamflow data. The relative performance differences of the model structures allow to systematically classify catchments' baseflow generation processes and to identify most appropriate model structures for different aquifer types. We found more aquifer-specific and more versatile optimal model structures and elucidate the role of recharge regimes, partially contributing storages and interflow. Aquifer-specific recommendations of storage models were found for fractured and karstic aquifers, whereas large storage capacities blur the identification of superior model structures for complex and porous aquifers. A model framework performance matrix highlights the joint effects of different recharge inputs, calibration criteria, model structures and aquifer types. This matrix is a guidance to improve groundwater model structures towards their representation of the dominant baseflow generation processes of specific aquifer types.