Topographic and hydrogeologic controls of groundwater dynamics in generalized hydrologic landscapes with a humid climate

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The study investigates how topographic and hydrogeological properties influence groundwater dynamics. Using the concept of the fundamental hydrologic landscape (FHL; Winter, 2001), the impact of slope angle, wavelength and amplitude, as well as boundary conditions and hydraulic conductivity on groundwater dynamics is systematically assessed. This type of global sensitivity study has been done for stream flow (e.g. Carlier et al., 2019) or within groundwater focusing solely on groundwater flow and fractions of regional versus local recharge at steady state (e.g. Gleeson and Manning, 2008). In contrast, we study the influence of controls on groundwater level dynamics by using transient models. The coupled, physically based Groundwater and Surface-Water Flow simulator GSFLOW (Markstrom et al., 2008) is employed, to run a set of simulations for a FHL, where topographic and hydrogeological properties are varied across a range of possible value. The model is run at a daily time-step with climate data obtained from a measuring station in Southern Germany. Subsequently, groundwater level time series are read from the model domain across the set of simulations. These time series are decomposed into amplitude, magnitude, timing, flashiness and inter-annual variability by using dynamics indices (Heudorfer et al., 2019). Sensitivity of groundwater dynamics to the different topographic and hydrogeological controls is discussed and contrasted with the results from a prior empirical study (Haaf et al., under review). This type of global sensitivity study may aid understanding hypothesis testing of climate change impacts on groundwater level dynamics.
