Geophysical Research Abstracts
Vol. 20, EGU2018-7059, 2018
EGU General Assembly 2018

StorAge Selection functions in a catchment influenced by storage thresholds

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StorAge Selection functions (SAS) have received growing attention in recent years. The proposed SAS functions target a better understanding of fundamental hydrological catchment functions (i.e. water and solutes storage, mixing, and release). These new conceptualizations relate catchment travel times to residence times and describe with an unprecedented efficiency how different water ages are mobilized in catchments to generate streamflow and evapotranspiration fluxes. Recent work has shown that under oceanic climates, the variability of SAS functions is mostly governed by catchment wetness according to the 'Inverse Storage Effect' (ISE). The underlying assumption of the ISE is that younger water is preferentially mobilized to generate streamflow under wetter catchment states. Other recent research has shown that the relationship between SAS functions and catchment wetness can be time varying and more complex in catchments with pronounced seasonality and nonlinearity in the rainfall-runoff transformation. Therefore, more studies using SAS functions are needed in catchments presenting such characteristics. In our work, we study the dependence of SAS functions on wetness in the Weierbach catchment. This forested headwater catchment is located in Luxembourg and exhibits a strong discharge seasonality, as well as a highly nonlinear storage-discharge relationship. We use a conceptual model of the catchment that represents its major streamflow generation processes, reproducing notably the strong streamflow seasonality and its characteristic double peak hydrographs. The model is calibrated against discharge and stable isotope data over a 6-year period, including a 1-year sub-daily isotope measurement period. Preliminary results suggest that the SAS functions in the Weierbach catchment are governed by catchment wetness according to the 'Direct Storage Effect' (DSE). As opposed to the ISE, the DSE leads to a preference of discharge for older water at higher wetness states. This behavior seems to be linked to the generation of double peak hydrographs of the Weierbach catchment, through the influence of several storage thresholds in the storage-discharge relationship. These results stress again the need to test the ISE hypothesis across a wide range of heterogeneous catchments, notably exhibiting strong discharge seasonality and non-linear storage-discharge characteristics.