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Influence of long-term variation in storage on hydrological drought characteristics

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Characteristics of drought events in streamflow, like drought duration and deficit, are largely determined by catchment processes. Understanding and identification of these processes that affect drought development is important to ensure water availability in the future, especially because drought severity is projected to increase in many regions of the world. In this study, we analysed the influence of storage processes on drought characteristics to quantify the relationship between long-term variation in storage and drought characteristics. For this analysis, a large dataset with discharge observations from 1737 catchments (made available by GRDC and MOPEX) was used. The catchments are situated in Europe and the United States. The discharge time series were divided in three components with a Seasonal-Trend decomposition procedure based on Loess (STL). The long-term trend component derived with the STL method was used as a proxy for the long-term variation in storage. Hydrological drought events were identified from the observations with the variable threshold level method. The contribution of the trend component to the total discharge indicates the importance of the long-term storage variation for drought development in the catchment. A high contribution of the trend component was found in slowly-responding catchments compared to fast-responding catchments. Features of drought propagation (pooling, lag, lengthening and attenuation) were identified in slowly-responding catchments. The contribution of the trend component was linked to the mean drought duration. As expected the catchments with a high contribution experienced relatively long drought events as compared to catchments with a low contribution of the trend component. This relation was less clear for the mean standardized deficit volume. A high contribution of the trend component was only found in smaller catchments, which reflects the importance of storage processes in these catchments. With the STL-method a large dataset of discharge observations could be analysed in a consistent matter and the method provides insight in the importance of storage processes for drought development in specific catchments and regions. The potential for storage change in a catchment has large influence on the duration of the hydrological drought events. This has implications for the adequate inclusion of storage processes in (hyper-resolution large-scale) hydrological models, and their capability to simulate drought impact.