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Unraveling ecological and abiotic controls on seasonal runoff dynamics at lower mesoscale catchments

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To better understand how storage, catchment structure and vegetation controls stream flow release we explored the seasonal water balance of 22 mesoscale catchments (16-160 km^2) along a distinct geological and physiographic gradient in southern Germany. Specifically we compared normalized annual double mass curves of accumulated normalized rainfall and runoff fluxes and normalized triple mass curves of accumulated normalized rainfall, evaporation and runoff depths.

The double mass curves consistently revealed two different regimes of storage and release: steep slopes and thus large seasonal runoff coefficients during winter (CRw) and rather flat slopes and thus small seasonal runoff coefficients during summer (CRs). In fact summer runoff coefficients were rather constant and the double mass curves were simply parallel shifted during the vegetation period, depending on the length of the period when vegetation is dormant. Surprisingly we found that temperature data alone was able to accurately predict both, the onset and the strength of the regime shift (r^2=0.72).

To explore the controls on winter runoff coefficients and we compared it to a total number of 24 different topographic, pedological, ecological and physiographic predictors. The key finding was here, that the topographic gradient multiplied with the average saturated hydraulic conductivity significantly explained 22 % variance of the CRw, while the two variables alone were not significant. This corroborates, that gradients and resistances jointly control runoff behavior and thus, that they must be interpreted as parameter teams. It is particular interesting that their joint impact is even detectable at lower mesoscale catchments.