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Signatures as proxies for hydrological functioning

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Fundamental characteristics of any hydrological system are its structure, states and dynamics. In our contribution we present signatures which shed light on selected system dynamics, namely the partitioning of precipitation into free (blue) and confined (green) water.

Our signatures are based on the concept of "system time" which assumes that every system exhibits certain periods wherein specific processes are either inactive or active. For instance, during winter time evapotranspiration (ET) can be approximated by zero, which allows simplifying the mass balance equation to precipitation (P), discharge (Q) and rate of storage change (dS). Accordingly, other system times exist where one or more processes can be isolated, i.e. night times, snow/ ice days, dry spells, period of vegetation, periods of high precipitation or energy input, etc.. Considering system times allows studying temporal storage dynamics and the partitioning and transfer of water under clearly defined conditions.

Focusing on the partitioning of water represents an excellent starting point for a meaningful and physically based catchment classification since it addresses the interplay of runoff and evapotranspiration. The blue water dynamics, which control runoff, are driven by gravity and are associated with comparably slow energy fluxes and large mass fluxes. The opposite is the case for green water which refers to capillary bound water which is stored against gravity. It feeds evapotranspiration where dynamics are driven by solar energy and high energy fluxes are associated with slow mass fluxes.

Our approach seeks to foster a data-driven description (and classification) of hydrological systems using signatures which describe selected system dynamics under clearly defined conditions. The approach is applied to a data set from southern Germany which comprises nearly 100 catchments (40 - 200 km^2) which are located on six different geologies and exhibit strong gradients in all hydrometeorological variables typically found in temperate environments.