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Maximizing power to constrain simple conceptual models

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Traditionally, hydrological models are calibrated to observables such as discharge or groundwater levels. However, in recent years more and more researchers recognize that catchments organize themselves, and there have been strong arguments for behavioral models (i.e. models that constrain their parameters by an organizing principle). The principle of Maximum Entropy Production (MEP) is an often mentioned candidate. But until now, only limited studies explore the use of this principle.
In this study we explore the principle of maximum power (which is equivalent to MEP) to constrain the water partitioning in the unsaturated zone and link that to widely applied bucket models such as HBV. Maximum power (or MEP) only applies to systems that are in steady state. By only considering the yearly water balance, the system can be assumed to be in steady state. Therefore we limit ourselves to the unsaturated zone in which the partitioning between transpiration and runoff takes place.
For each time step the matrix potential in the unsaturated zone has been determined. The matrix potential influences the driving gradients of both evapotranspiration and runoff to the stream. Power was then determined by multiplying the water flux with the gradient driving that flux. By varying the unsaturated hydraulic conductivity, soil depth and a shape factor accounting for the spatial variability in soil depth, power has been maximized. Since a catchment is never in steady state due to e.g. tectonic movement, only those parameter sets were considered that mimic the yearly water balance correctly.
This study is one of the first studies that explore the principle of maximum Power (or MEP) to model real world catchments. It sheds light on its usefulness in hydrology and its limitation and it may bring the hydrological sciences a step further in understanding catchment behavior.