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Scaling lowland hydrology: a stochastic model for the spatial distribution of groundwater depths.

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In densely drained lowland catchments surface water discharge is fed by groundwater flow toward streams and ditches, tile drain flow, and overland flow. These flow routes locally switch between active or passive depending on the ambient groundwater level. Describing the discharges of each of these flow routes, therefore, involves characterizing the spatial patterns of groundwater levels.
We propose a stochastic model that describes the spatial variation of groundwater depths. Under dry conditions many flow routes are passive (no discharge) and therefore do not affect the groundwater table. Furthermore, evapotranspiration lowers the groundwater levels mainly at relatively wet locations. Consequently, under dry conditions the groundwater level runs relatively parallel to the soil surface and the spatial variation in groundwater depths is low. When the catchment becomes wetter, i.e. storage increases, more flow routes start to discharge and the variation in groundwater depths increases. Under even wetter conditions surface storage in streams and ponds start to hamper flow route discharge and the spatial variation in groundwater depths starts de decrease again. This behavior is observed at field-scale as well as catchment-scale. Scaling lowland hydrology, with our stochastic model approach, has become characterizing the spatial distribution of groundwater depths under different storage conditions at that scale.
However at catchment-scale many groundwater depth time series are needed to quantify the spatial distribution of groundwater depths. Therefore, we installed a nested-scale observation setup in a 6.6 km2 lowland catchment where we measured the groundwater depth distribution and the discharges of the individual flow route at the field-scale. At catchment-scale we continuously measured discharge and nitrate concentrations. We will show that we can now use the field-scale storage-discharge relationships for each of the flow routes to largely constrain the storage–discharge relationships at catchment-scale. Also we will explore the relations between spatial scales and the distribution of groundwater depths and how this affects the storage-discharge relations across scales.