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Event water fractions in overland flow and shallow subsurface flow in a pre-Alpine headwater catchment in Switzerland

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In steep humid catchments with a low permeability soil layer close to the surface, lateral flow at or near the soil surface is an important runoff mechanism. In these catchments overland flow and shallow (i.e., near-surface) subsurface flow also play a crucial role in nutrient and sediment mobilization and transport, and thus affect stream water chemistry. However, due to the lack of data on the spatial and temporal variability in the occurrence of overland flow and shallow subsurface flow and their isotopic signature, it is still poorly understood how rainfall event- and site characteristics affect the onset and mixing of these near-surface flow pathways.

We installed 14 small (1 m wide) runoff plots in a 20-ha headwater catchment in the Swiss pre-Alpine area that is underlain by Gleysols and Flysch bedrock. We coupled hydrometric measurements and stable water isotope data to infer the source (groundwater, soil water, and rainfall) of overland flow and shallow subsurface flow during rainfall events during the snow-free seasons of 2021 and 2022. Rainfall was sampled sequentially at two locations. The isotopic composition of pre-event water was determined based on the soil and groundwater samples taken at each plot prior to the event. Preliminary isotope hydrograph separation results for five rainfall events indicate a median event water fraction over all plots and events of 87% for overland flow and 58% for shallow subsurface flow and a very large variation in the event water contributions (30–100% for overland flow and 9–100% for shallow subsurface).

In this presentation, we will provide an overview of these new data on the temporal and spatial variability of isotopic composition in overland flow and shallow subsurface flow and describe how the event water fractions depend on rainfall event- and site characteristics (topographic position, vegetation cover, and antecedent moisture conditions).