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Applied tracers for the observation of subsurface stormflow at the hillslope scale

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Abstract. Rainfall-runoff response in temperate humid headwater catchments is mainly controlled by hydrological processes at the hillslope scale. Applied tracer experiments with fluorescent dye and salt tracers are well known tools in groundwater studies at the large scale and vadose zone studies at the plot scale, where they provide a means to characterise subsurface flow. We extend this approach to the hillslope scale to investigate saturated and unsaturated flow paths concertedly at a forested hillslope in the Austrian Alps. Dye staining experiments at the plot scale revealed that cracks and soil pipes function as preferential flow paths in the fine-textured soils of the study area, and these preferential flow structures were active in fast subsurface transport of tracers at the hillslope scale. Breakthrough curves obtained under steady flow conditions could be fitted well to a one-dimensional convection-dispersion model. Under natural rainfall a positive correlation of tracer concentrations to the transient flows was observed. The results of this study demonstrate qualitative and quantitative effects of preferential flow features on subsurface stormflow in a temperate humid headwater catchment. It turns out that, at the hillslope scale, the interactions of structures and processes are intrinsically complex, which implies that attempts to model such a hillslope satisfactorily require detailed investigations of effective structures and parameters at the scale of interest.

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