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Transit time distributions of evapotranspiration and the impact of evapotranspiration on catchment transit time distributions

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Evapotranspiration plays a key role in hydrologic catchment dynamics. In order to quantify its influence on the hydrologic system we chose to investigate its impact on the ages of water flowing through and residing in a model catchment. How old is water that evaporates from a catchment and how old is water that plants take up and transpire? Furthermore, which factors control whether this evaporated and transpired water is younger or older when it leaves the catchment? We employed a physically-based spatially explicit 3D model to investigate how, amongst other factors, rooting depth and LAI influence water age distributions in different physical environments. This gives indications on how specialized vegetation alters the dynamics of the water cycle. Our results show that evapotranspiration can be both younger and older than streamflow depending on the specific vegetation and physical catchment properties. For example the tails of transit time distributions (TTDs) of evapotranspiration become heavier and the means become longer in environments with decreasing runoff coefficients and deeper roots. Evapotranspiration also significantly alters the TTDs of the water flowing through the catchment discharging at the outlet: Adding evapotranspiration as a process and an additional pathway for exiting water makes catchment discharge younger – an effect that becomes stronger with decreasing runoff coefficients.