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Constraining effects of canopy interception on isotopic composition of recharge

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Modification of precipitation by canopy interception generally affects both mass and isotopic composition of soil water, recharge to groundwater, and streamflow, but magnitudes of the isotopic effects are poorly understood. Observations of isotopic differences between rainfall and throughfall are accumulating in the literature, but there is not yet a general theory to explain them despite importance of accurate isotopic input signals for tracing hydrological processes. We used numerical experiments based on empirical data and a simple one-dimensional soil model to constrain vegetation effects for use in hydrological models of rain-dominated, forested watersheds. The soil model partitions infiltration into bypass flow (including stemflow bypass to depth) and Darcy-Buckingham matrix flow to represent the isotopic separation of mobile and bound waters, respectively, and matrix water is ablated by transpiration. Stochastic simulations of rainfall isotopic composition and canopy isotopic fractionation, parameterized from the experimental literature, show that temporal variability of isotopic composition of groundwater recharge is attenuated by soil storage proportionally to soil depth, dominance of matrix flow, and rate of transpiration. Parameterizing the model for some typical forest soils reveals that temporal variability of the vegetation isotopic effect on groundwater recharge is likely larger than the mean.