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Water partitioning and flux ages in temperate forest and grassland plots: assessment using the EcH$_2$O-iso ecohydrological model

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We used the process-based and tracer-aided ecohydrological model EcH$_2$O-iso to assess the effects of vegetation cover on water balance partitioning and associated flux ages under temperate beech forest (F) and grassland (G) in Northern Germany. The model was tuned on the basis of a multi-criteria calibration against an unusually rich measured data set from a long-term monitoring site.. The calibration incorporates metrics of the energy balance, hydrological function and biomass accumulation. It resulted in good efficiency statistics for simulations of surface energy exchange, soil water content, transpiration and biomass production. The model simulations showed that the forest "used" more water than the grassland; from 620mm of average annual precipitation, losses were higher through interception (29% under F, 16% for G) and combined soil evaporation and transpiration (59% F, 47% G). As a result, groundwater recharge was greatly enhanced under grassland at 37% of precipitation compared with 12% for forest. The model allowed us to track the ages of water in the different storage compartments and fluxes. In the shallow soil horizons, the average ages of soil water fluxes and evaporation were similar in both plots ($\sim$1.5 month), though transpiration and groundwater recharge were older under forest ($\sim$6 months compared with $\sim$ 3 months for transpiration and $\sim$ 12 months compared with $\sim$10 months for GW). Flux tracking with Cl tracers provided independent support for the modelling results, though also highlighted effects of uncertainties in forest partitioning of evaporation and transpiration. This underlines the potential for tracer aided ecohydrological models in land use change studies. By tracking storage – flux – age interactions under different land covers, the effects on water partitioning and age distributions can be quantified and the implications for climate change assessed. Better conceptualisation of soil water mixing processes, and improved calibration data on leaf area index and root distribution appear obvious respective modelling and data needs for improved model results.