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Supporting Information for

Critical zone storage control on the water ages in ecohydrological outputs

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Introduction

This supporting information provides a description of the study site (Fig. S1) the datasets used to conduct the ensemble simulations used in this study (Text S1 and Table S1), an overview of the performance of the previously calibrated model (Fig. S2), and additional time series of water fluxes and ages (Figs. S3 to S5).

Text S1.

Datasets description

We used the wealth of diverse and often multi-year time series available at different locations in the BB catchment (Fig. S1). These measurements capture numerous ecohydrological processes and observables, used either for model inputs, or calibration/evaluation of simulations (Table S1). These datasets have been extensively described in previous calibration and evaluation efforts with EcH2O at the BB catchment (Kuppel at al, 2018a, 2018b).

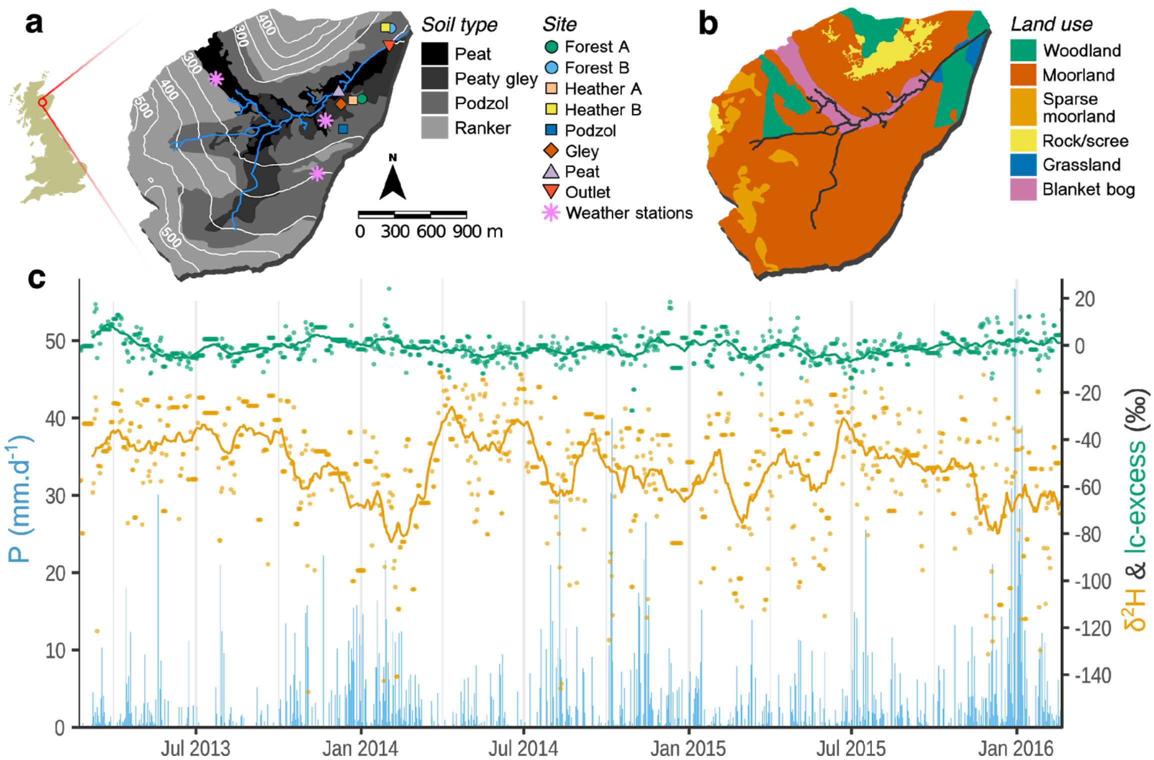

Figure S1. Bruntland Burn catchment characteristics, showing (**a**) topography, soil cover as derived from the Hydrology of Soil Types (HOST) classification types, stream network, and measurement site locations, and (**b**) land use type. (**c**) Time series (Feb 2013 – Feb 2016) of measured precipitation amount (blue bars, daily) and isotopic signatures - δ^2H (orange) and lc-excess (green), showing daily values (dots) and the 30-day running mean (solid lines).

Table S1. Datasets used for forcing, calibration and evaluation in this study. Annotations: * this weather station is located further up on the same podzolic hillslope (see Fig. S1a) and started operating in 2015, [1] (Met Office, 2017), [2] (Birkel et al., 2011), [3] (Dee et al., 2011).

Variable	Location	Resolution	Time period
Micro-meteorological forcing data			
Precipitation (m s^{-1})	SEPA network [1] Podzol*, Gley, Peat	Daily Daily	2013 – 2014 2014 – 2016
Air temperature (mean, ˚C) Relative humidity (-) Horizontal wind speed (m s^{-1})	Balmoral (CEDA) [2] Podzol*, Gley, Peat	Daily Daily	2013 – 2014 2014 – 2016
Air temperature (max. & min.,˚C)	ERA-Interim [3] Podzol*, Gley, Peat	Daily Daily	2013 – 2014 2014 – 2016
Incoming longwave radiation (W m^{-2}) Incoming shortwave radiation (W m^{-2})	ERA-Interim [3]	Daily	2013 – 2016
Precipitation isotopes (‰)	Outlet	Event-based	2013 – 2016
Calibration and evaluation data			
Stream discharge (m s^{-3})	Outlet	Daily	2013 – 2016
Stream isotopes (‰)	Outlet	Daily	2013 – 2016
Soil water content (m^3 m^{-3})	Forest B Heather A Podzol Gley Peat	Daily	2015 – 2016 2015 – 2016 2015 – 2016 2014 – 2016 2013 – 2016
Soil isotopes (bulk water, ‰)	Forest A Forest B Heather A Heather B	Weekly	2015 – 2016
Pine transpiration (mm d^{-1})	Forest A Forest B	Daily	Summer 2015 Summer 2016
Net radiation (W m^{-2})	Podzol* Gley Bog	Daily	2015 – 2016 2014 – 2016 2014 – 2016
Evaluation-only data			
Groundwater isotopes (‰)	Podzol (1 well) Gley (1 well) Peat (2 wells)	Monthly	2015 – 2016

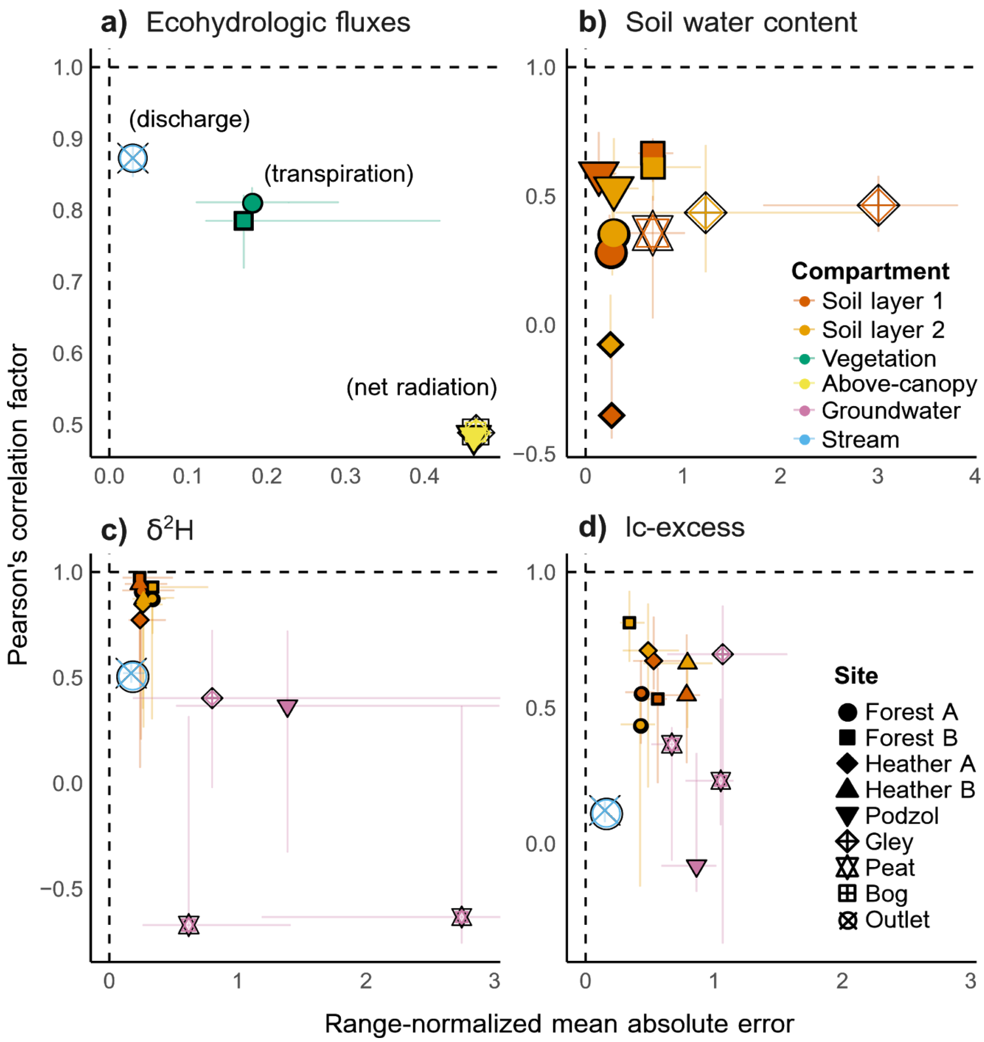

Figure S2. Performance of the calibrated model across the different measured observables, quantified using Pearson's correlation factor and range-normalized mean absolute error. The symbols show the median scores and the error bars the 90% range across the 30 ensemble simulations. Detailed analysis of the model performance can be found in Kuppel et al. (2018a,b).

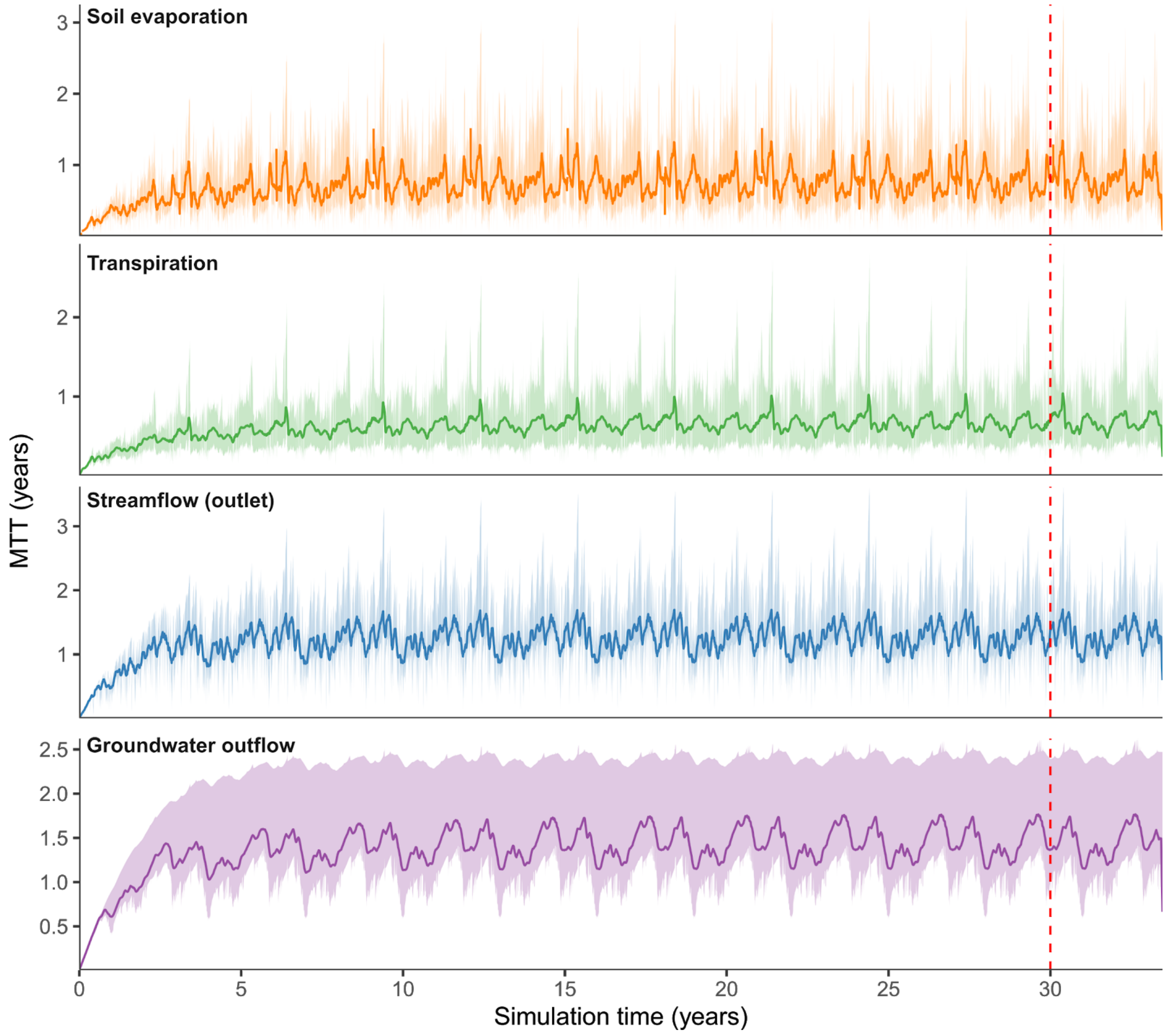

Figure S3. Time series of the full simulation ensemble of mean transit times for catchment-scale outputs (80%-quantile range and 30-day smoothed median), showing the 30-year spin-up (vertical dashed line).

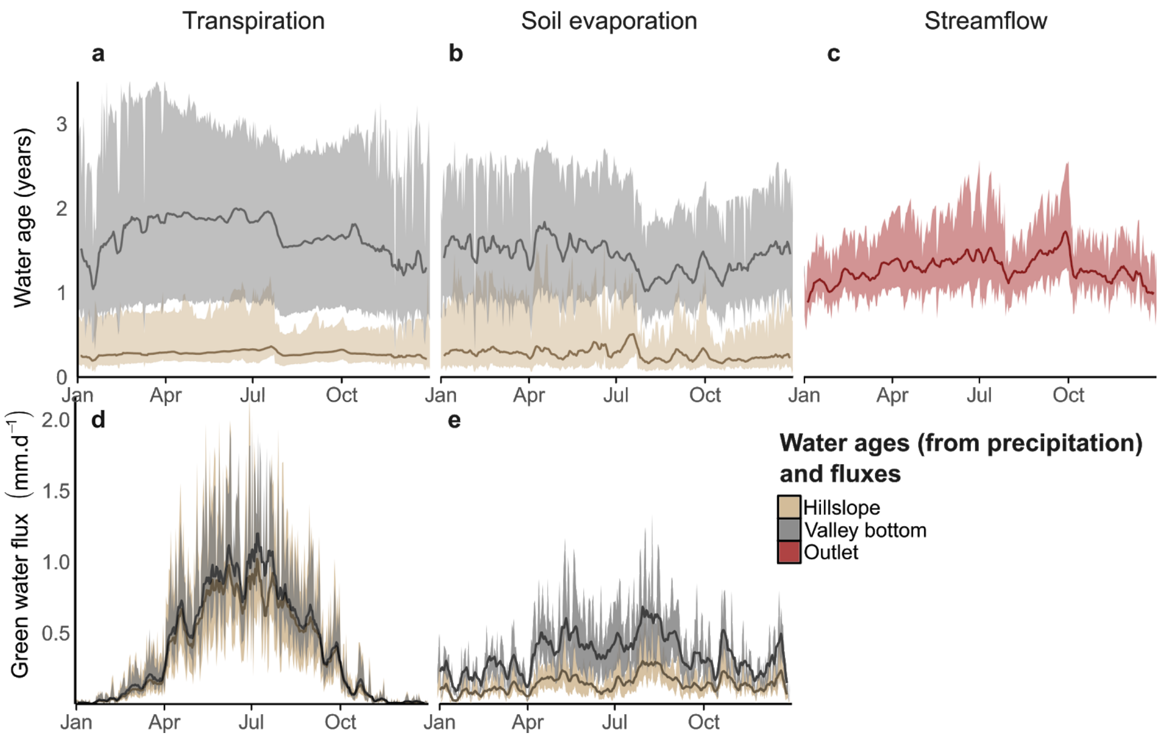

Figure S4. Mean seasonal cycles (ensemble median and 50% interval) of the ages of water (**a**) evaporated from the soil, (**b**) transpired by plants on the hillslopes (light brown) and in the valley bottom (grey), with the associated flux rates (**d-e**), and (**c**) of stream water at the outlet (red).

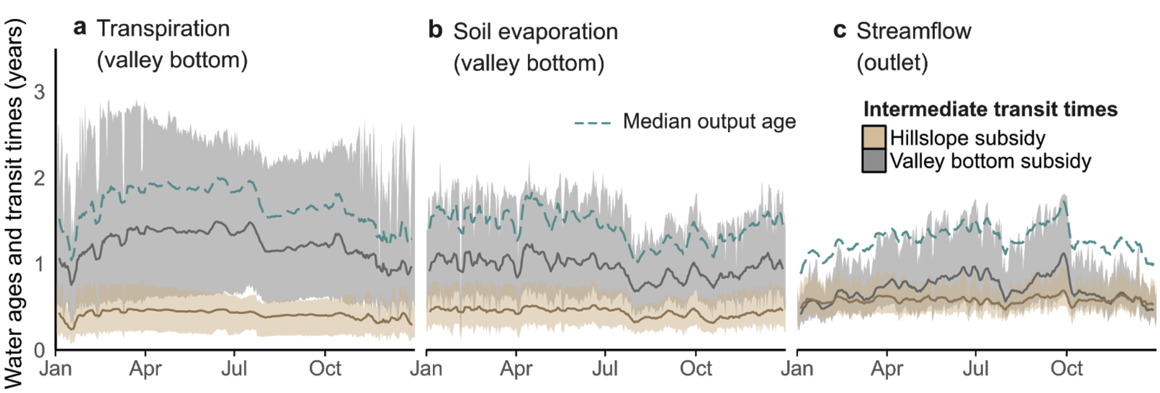

Figure S5. Contribution of transit times of water in the hillslopes (light brown) and in the valley bottom (grey) to the output ages (slate blue) in (**a**) transpiration (**b**) soil evaporation in the valley bottom, and (**c**) stream water at the outlet (ensemble medians and 50% intervals, unless otherwise specified).

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