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Quantifying the effects of urban green space on water partitioning and ages using an isotope-based ecohydrological model

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1. Figures

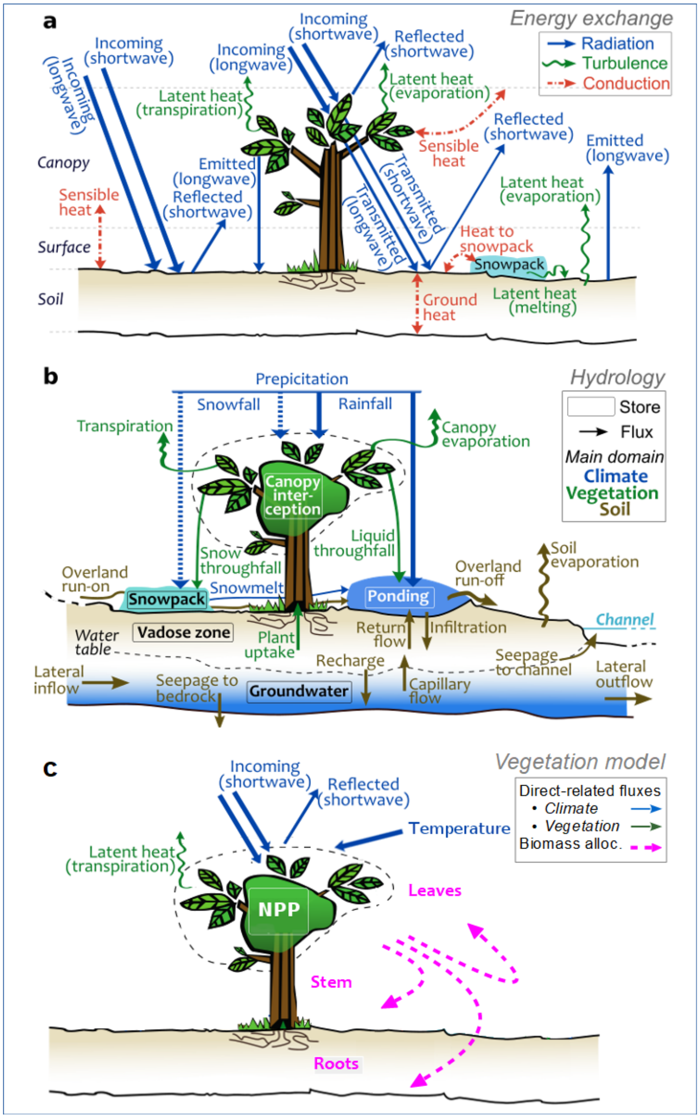

Figure S1: EcH$_2$O-iso schematic description of processes in a) energy balance b) water balance and c) vegetation calculations. Adapted from Douinot et al. (2019).

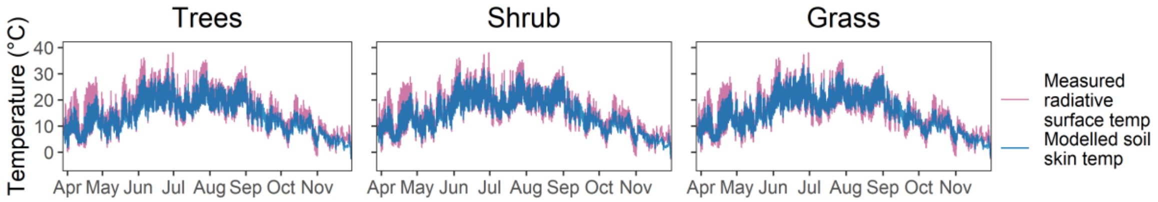

Figure S2: Modelled soil skin temperature (average of 20 best runs) for all vegetation types (trees, shrub and grass) and calculated radiative temperature from upward longwave radiation.

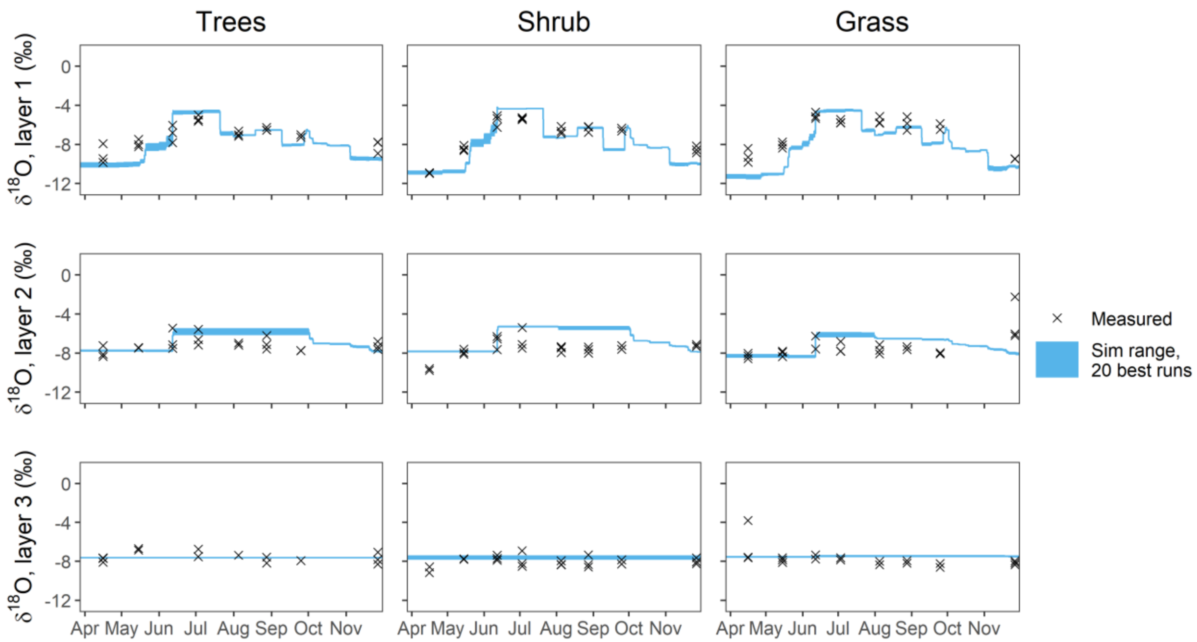

Figure S3: Measured and modelled stable water isotope $\delta^{18}O$ in bulk soil water.

2. Tables

Table S1: Final ranges for calibrated vegetation and soil parameters.

Parameter	Abbreviation	Final parameter range/value		
Vegetation parameters		Trees	Grass	Shrub
Vegetation albedo [-]	α_{veg}	0.12–0.20	0.13–0.20	0.13–0.20
Leaf area index (LAI) [-]	LAI	4.0–5.0	2.1–2.9	3.0–3.5
Maximum stomatal conductance [ms^{-1}]	g_{Smax}	0.008–0.011	0.031–0.049	0.010–0.020
Stomatal sensitivity to vapor pressure deficit	g_{Svpd}	1.5e-4–3.9e-4	3.2e-4–9.0e-4	4.2e-4–1.00e-3
Stomatal sensitivity to soil moisture content	LWP_C	1.8e-4–9.2e-3	2.0e-4–6.6e-4	1.1e-4–1.9e-2
Light extinction coefficient for the canopy [-]	K_{beer}	0.20–0.78	0.52–0.78	0.41–0.79
Optimal growth temperature (° C)	T_{opt}	14.2–24.6	16.0–24.0	11.2–19.6
Soil parameters				
Total soil depth [m]	D_{soil}	4.65	2.35	1.2
Thickness of 1st hydrological layer [m]	D_{L1}	0.25	0.15	0.25

Thickness of 2nd hydrological layer [m]	D_{L2}	0.4	0.4	0.6
Porosity [-]	H	0.41–0.50	0.40–0.48	0.40–0.50
Air-entry pressure head [m]	ψ_{AE}	0.26–0.52	0.16–0.53	0.15–0.29
Saturated horizontal hydraulic conductivity [ms^{-1}]	K_{EFF}	0.011–0.020	0.002–0.030	0.007–0.028
Exponential root profile [-]	k_{root}	1.1–9.7	7.3–17.5	2.6–9.6
Brooks-Corey exponent [-]	λ_{BC}	2.0–2.2	2.4–3.7	2.0–2.6

Table S2. Parameters not part of calibration process.

Parameter	Abbreviation	Fixed value		
Vegetation parameters		**Trees**	**Grass**	**Shrub**
Maximum interception storage [$mmLAI^{-1}$]	CWS_{max}	0.0006	0.0004	0.0006
Stomatal sensitivity to light	g_{Slight}	150	150	150
Emissivity of vegetation [-]	$Emiss_{Veg}$	0.99	0.99	0.99
Soil moisture suction potential at which stomatal function is reduced by 50%.	LWP_D	10	10	10
Maximum temperature for the comfort of the species (° C)	T_{max}	35	35	35
Minimum temperature for the comfort of the species (° C)	T_{min}	-2	-2	-2
Wilting point [-]	Wilt	0.001	0.001	0.001
Cold stress [° C]	T_{cold}	-2	-2	-2
Vegetation height [m]	hgt	20	0.2	5
Soil parameters				
Soil albedo [-]	α_{soil}	0.18	0.18	0.18
Soil heat capacity [$Jm^{-3}K^{-1}$]	S_{HP}	2.5e6	2.5e6	2.5e6
Soil thermal conductivity [$Wm^{-1}K^{-1}$]	$K_{Sthermal}$	0.15	0.15	0.15
Ratio of vertical t horizontal K_{EFF} [-]	KvKh	0.4	0.4	0.4
Leakance to groundwater [-]	L_G	0.01	0.01	0.01
Dampening depth [m]	D_{damp}	2	2	2
Temperature at dampening depth [° C]	T_{damp}	10	10	10

3. Further details on precipitation and soil sampling with subsequent laboratory analysis

Measurement of soil water content (using Time Domain Reflectometry; TDR, CS650 reflectometers (Campbell Scientific, Inc., Logan, USA)) is ongoing below trees, shrub and grass at three depths (two sensors at each depth: 10–15 cm, 40–50 cm and 90–100 cm) since 24 March 2019. Measurement of sap flow by sap velocity sensors (FLGS-TDP XM1000 sap velocity logger system (Dynamax Inc, Houston, USA)) measuring temperature differences between heated sensors is ongoing on six representative urban trees (maple, elm, plane and oak) since end of March 2019. Soil sampling and consequent stable water isotope analysis of the bulk soil water was performed monthly from April to September and in November of 2019. Precipitation for subsequent analysis of stable isotopes was sampled at the Leibniz Institute of Freshwater Ecology and Inland Fisheries location in Berlin-Friedrichshagen (daily from August 2018 until March 2019) and from the SUEO in Berlin-Steglitz (daily from March 2019 onwards). Precipitation was sampled on a daily basis using a 3700 sampler (Teledyne Isco, Lincoln, USA). In each bottle, 1.5 cm of paraffin oil was added to prevent evaporation and samples smaller than 1.5 cm were rejected to exclude any potential outliers due to extreme and unrealistic fractionation effects. To hindcast an extended timeseries of stable isotopes in precipitation for the model spin up, data from Zittau, 200 km southeast of Berlin (monthly from March 2017 until

August 2018) were used (IAEA/WMO, 2020). Soil samples for subsequent analysis of stable isotopes in soil water were taken on a monthly basis from April to November 2019. At three points under each vegetation type, duplicated samples were performed using a soil auger at depths 0-10, 10-20, 40-50 and 80-90 cm. The soil samples (~250 cm^3) were put into bags (WEBAbag, Silver Range, Weber Packaging, Germany) and were stored in an isolated box.

The laboratory analysis was performed at the Leibniz Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany. Using a L2130-i isotopic water analyser (Picarro, Inc., USA) the filtered precipitation was analysed by cavity ring-down spectroscopy. Linear correction was performed using four lab standards and calibration using standards from the International Atomic Energy Agency. Mean analytical precision was 0.16 ‰ standard deviation (SD) for δ^2H and 0.05 ‰ SD for $\delta^{18}O$. Following Waasenar et al. (2008), the direct equilibrium method was used to analyse the soil samples. Mean analytical precision was 0.34 ‰ SD for δ^2H and 0.14 ‰ SD for $\delta^{18}O$. For a full description of field and laboratory measurements, see Kuhlemann et al., 2021.

References:

Kuhlemann, L.-M., Tetzlaff, D., Smith, A., Kleinschmit, B., and Soulsby, C.: Using soil water isotopes to infer the influence of contrasting urban green space on ecohydrological partitioning, Hydrol. Earth Syst. Sci., 25, 927–943, https://doi.org/10.5194/hess-25-927-2021, 2021.

Wassenaar, L. I., Hendry, M. J., Chostner, V. L., and Lis, G. P.: High Resolution Pore Water δ2H and δ18O Measurements by H2O(liquid)-H2O(vapor) Equilibration Laser Spectroscopy, Environ. Sci. Technol., 42, 9262–9267, 2008.