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Young and new water fractions in soil and hillslope waters

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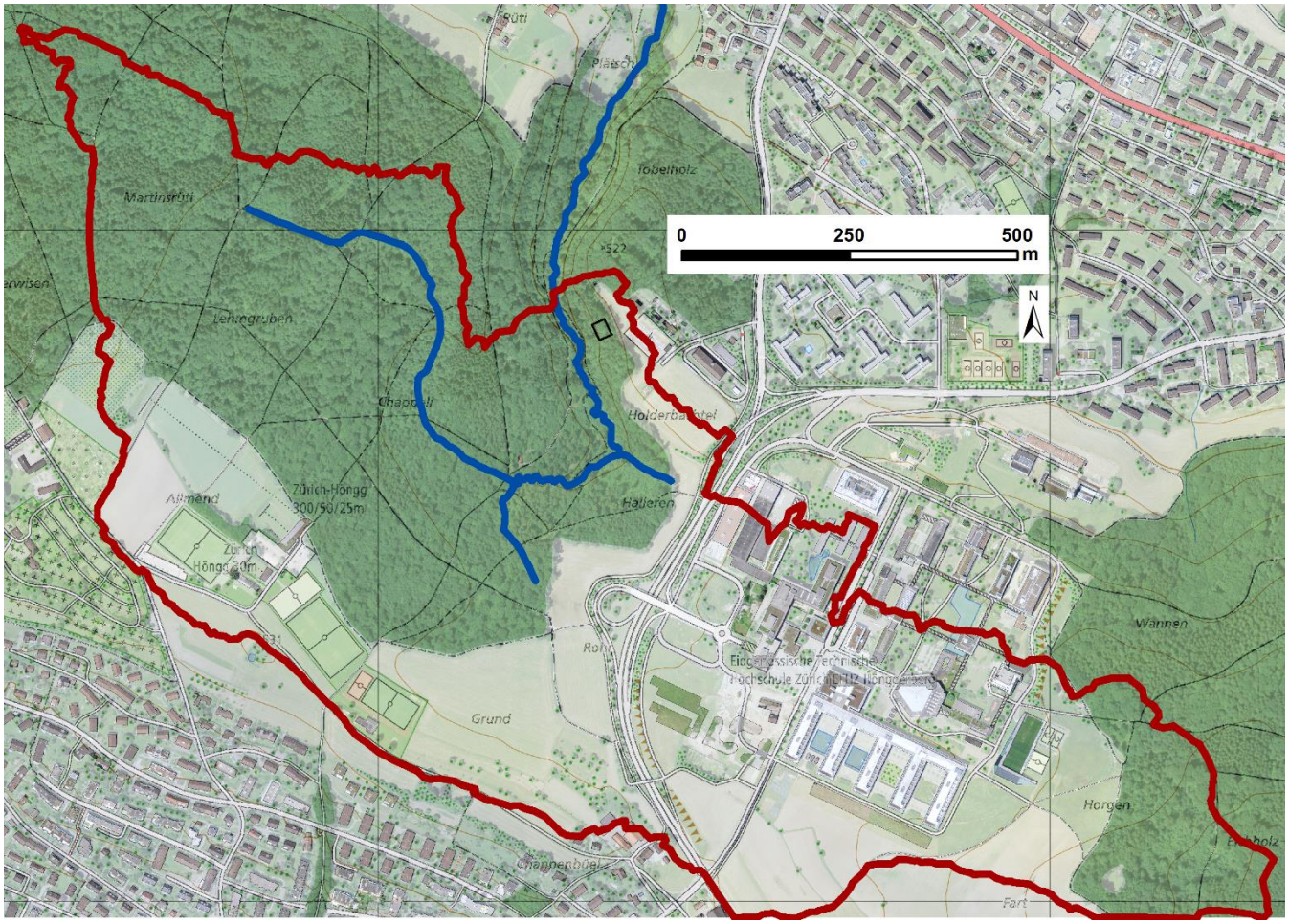

Figure S1: Catchment map of the 'WaldLab Forest Experimental Site' study site in Zurich, Switzerland. The location of the soil sampling plot is shown by the black box. The catchment outlet is shown by the red line. The DEM and aerial photographs used in the map are provided by the Swiss Federal Office of Topography (SwissTopo)

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Table S1: Elevation (in m asl) and depth of the screened parts of the boreholes (in m below the surface). Readers should
30 note that only boreholes 13 & 14 are located in the saturated zone.

Location	**ID**	**Elevation**	**Screen between**	
		[m asl]	**[m below surface]**	
upslope	**1**	**519.7**	1.58	5.58
	2	**519.2**	1.40	5.40
	3	**516.9**	1.00	2.00
	4	**516.9**	3.00	4.00
	5	**517.0**	1.32	4.32
midslope	**8**	**499.0**	1.23	2.23
	9	**499.0**	1.77	2.77
	11	**498.7**	1.38	3.38
	12	**498.4**	1.10	2.10
downslope	**13**	**486.7**	1.35	5.35
(saturated)	**14**	**483.7**	1.27	2.27

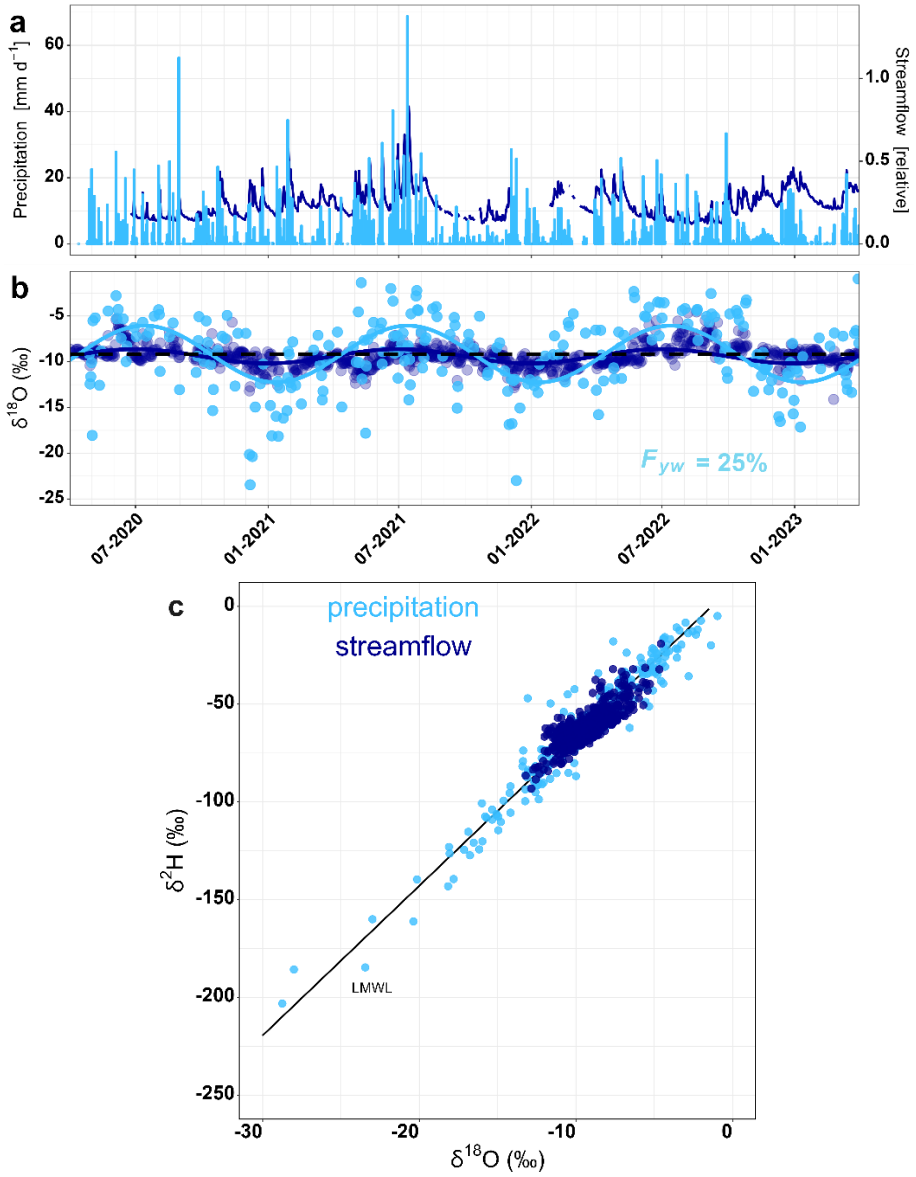

Figure S2: Timeseries of precipitation (light blue) and streamflow (dark blue) (a) and their $\delta^{18}O$ isotopic compositions as timeseries (b) and in dual isotope space (c) from April 2020 until March 2023. Sinusoidal cycles were fitted to the isotope data using iteratively re-weighted least squares regression (in light blue for precipitation isotopes and in dark blue for streamflow isotopes). The dashed black line indicates the volume weighed mean isotopic composition of precipitation; streamflow samples lying above and below this line indicate dominance by summer and winter precipitation, respectively. The seasonal cycles of the streamwater isotopes are damped relative to the precipitation isotopic cycles due to storage and mixing in the subsurface.

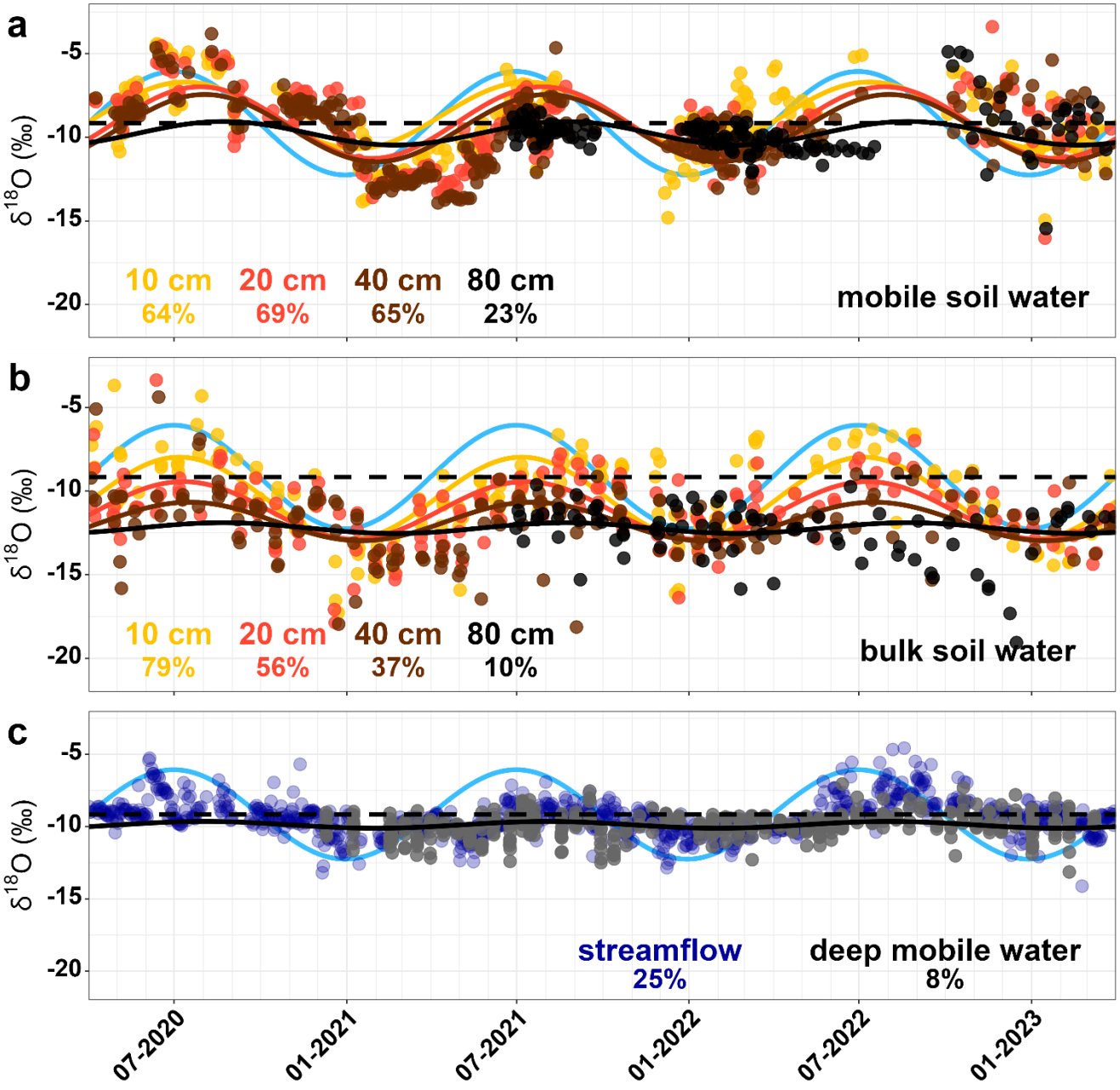

Figure S3: Timeseries of the $\delta^{18}O$ isotopic composition from April 2020 until March 2023 in mobile (a) and bulk soil waters (b) of 10, 20, 40 and 80 cm depth and in deep mobile waters collected in boreholes of 2 to 6 m depth (c). Sinusoidal cycles were fitted to the isotope data using iteratively re-weighted least squares regression. The light blue graph shows the sinusoidal cycle of precipitation. The dashed black line indicates the mean isotopic composition of precipitation, all samples above are dominated by summer precipitation, all samples below a dominated by winter precipitation. The seasonal cycles of soil waters exhibit increasing damping with depth.

Table S2: Fitting parameters of the sinusoids for the different water pools.

	δ^2H						$\delta^{18}O$					
	k [‰]	**a**	**b**	**amp.**	**φ**	**F_{yw}**	**k [‰]**	**a**	**b**	**amp.**	**φ**	**F_{yw}**
precipitation	-59.53	-20.44	-6.45	21.43	-	-	-9.16	-3.01	-0.73	3.09	-	-
streamflow	-63.36	-2.41	-3.03	3.88	0.59	0.18	-9.41	-0.61	-0.49	0.78	0.45	0.25
mobile soil water												
10 cm	-58.60	-9.21	-9.86	13.50	0.51	0.63	-8.69	-1.56	-1.24	1.99	0.43	0.64
20 cm	-60.67	-3.61	-14.19	14.64	1.02	0.68	-9.12	-0.81	-1.98	2.14	0.95	0.69
40 cm	-63.04	-1.46	-13.48	13.56	1.16	0.63	-9.45	-0.40	-1.97	2.01	1.13	0.65
80 cm	-64.82	4.15	-3.78	5.61	2.10	0.26	-9.76	0.33	-0.62	0.71	1.82	0.23
bulk soil water												
10 cm	-72.60	-10.73	-9.15	14.11	0.40	0.66	-10.42	-2.22	-1.04	2.45	0.20	0.79
20 cm	-77.01	-5.67	-8.96	10.60	0.70	0.49	-11.16	-1.44	-0.95	1.72	0.34	0.56
40 cm	-80.39	-0.94	-7.73	7.79	1.14	0.36	-11.82	-0.78	-0.85	1.15	0.59	0.37
80 cm	-79.85	3.82	-0.01	3.82	2.83	0.18	-12.22	-0.10	0.31	0.32	4.79	0.10
deep mobile water	-64.41	1.19	-0.49	1.29	2.45	0.06	-9.88	-0.43	-0.23	0.23	1.15	0.08

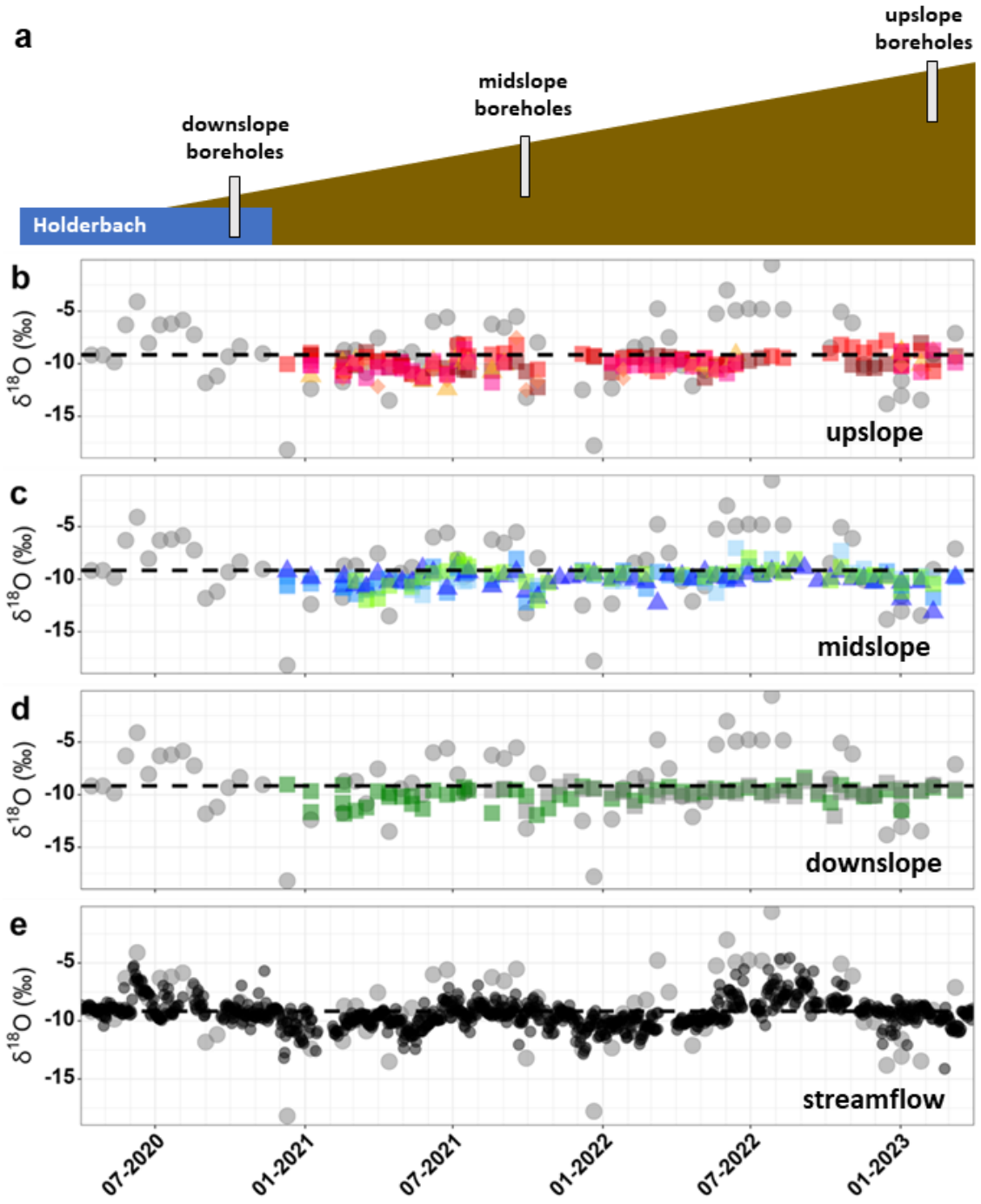

Figure S4: Schematic diagram of the hillslope and borehole locations (a). Differences in the isotopic $\delta^{18}O$ signatures of upslope and midslope deep mobile waters (b, c), downslope saturated groundwater (d), streamflow in the "Holderbach" creek (e) and precipitation (in grey in the background of the panels). The different colours indicate samples from different boreholes (five boreholes up-slope, four boreholes mid-slope and two boreholes down-slope).

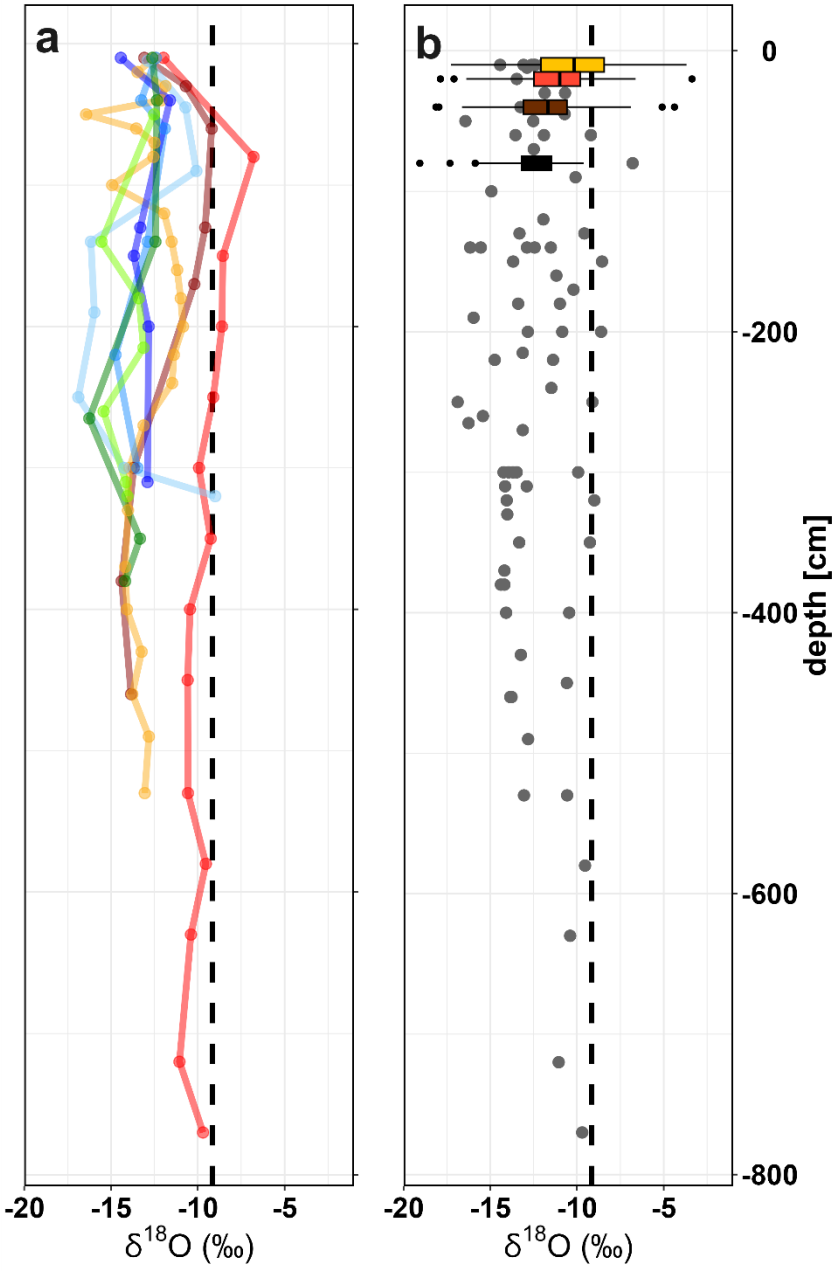

Figure S5: Isotopic $\delta^{18}O$ signals in bulk soil waters during borehole drilling on November 22nd 2020 down to ~7 m depth (a), plotted also in grey with boxplots of bulk soil water $\delta^{18}O$ isotopic signatures for all regular bulk soil water samples across the three-year observation period for 10 cm in yellow, 20 cm in red, 40 cm in brown and 80 cm in black (b). The dashed line indicates the mean precipitation $\delta^{18}O$ isotopic signature. Isotopic signatures in bulk soil water samples are typically lighter than the mean precipitation isotopic signatures, indicating a dominance of winter precipitation in bulk soil waters.