1 Supplement 1

Figure S1 shows the monthly sampled isotopes in precipitation (raw and kriged $\delta^{18}O_P$) and streamflow ($\delta^{18}O_Q$) in the Upper Selke catchment during the study period. The difference between the raw and kriged $\delta^{18}O_P$ values is explained in section 3.2 in the main text. Briefly, raw $\delta^{18}O_P$ data, taken from (Lutz et al., 2018), correspond to the values collected at the catchment outlet (i.e., Meisdorf station). Then, Lutz et al., (2018) interpolated the raw $\delta^{18}O_P$ by kriging with altitude as external drift and weighted them with the spatially distributed cumulative monthly precipitation, thus obtaining the kriged $\delta^{18}O_P$ employed in this study.

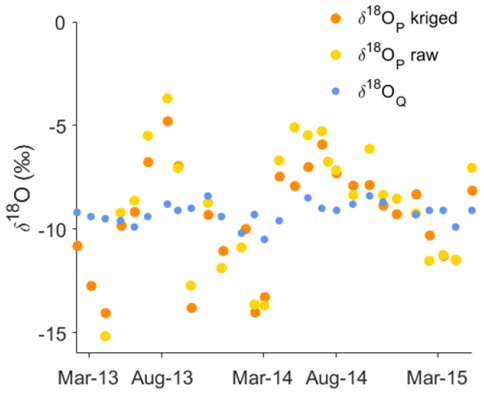

Figure S1. Time series of $\delta^{18}O$ data in precipitation ($\delta^{18}O_P$; kriged values as orange dots and raw values as yellow dots) and streamflow ($\delta^{18}O_Q$; blue dots).

Figure S2 displays the input reconstruction of $\delta^{18}O$ record in precipitation via step function and sine interpolation for raw and kriged isotopes in order to obtain daily precipitation isotope data as input for the SAS model. The interpolation techniques are explained in section 3.2 in the main text. Shortly, when using the step function interpolation, the values between two observations were simply assumed as the value of the second observation. When using the sine function interpolation, the missing data were gap-filled by fitting the observed isotopes with regression with sinusoidal cycles.

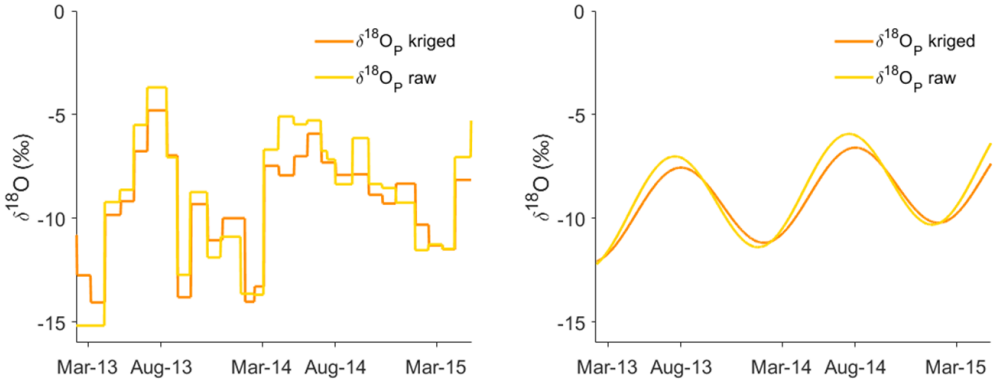

Figure S2. Time series of the predicted $\delta^{18}O$ values in precipitation ($\delta^{18}O_P$; kriged values as orange dots and raw values as yellow dots). Reconstruction via step function interpolation approach (left) and sine interpolation method (right).

2 Supplement 2

Table S1 summarizes the SAS parameter ranges for each tested setup. The values of the behavioral parameters have been identified considering the SAS parameters set providing the best 5% higher model performances in terms of the Kling-Gupta efficiency.

Table S1. Behavioral range of model parameters identified by 5% best KGE.

interpolation technique	SAS parameterization	k_Q [-]	k_{Q1} or α [-]	k_{Q2} or β [-]	k_{ET} [-]	S_0 [mm]
step function kriged $\delta^{18}O_P$	PLTI	0.4 - 1.09	-	-	0.23 - 2.0	517 - 2986
	PLTV	-	0.28 - 1.0	0.48 - 1.99	0.25 - 1.99	475 - 2973
	BETA	-	0.26 - 1.12	0.87 - 2.0	0.18 - 2.0	462 - 2989
step function raw $\delta^{18}O_P$	PLTI	0.48 - 1.13	-	-	0.12 - 1.99	475 - 2973
	PLTV	-	0.38 - 1.14	0.48 - 1.99	0.12 - 2.0	473 2987
	BETA	-	0.35 - 1.33	0.52 - 1.99	0.13 - 2.0	474 - 2352
sine function kriged $\delta^{18}O_P$	PLTI	0.32 - 1.93	-	-	0.1 - 2.0	305 - 2409
	PLTV	-	0.21 - 1.55	0.4 1.99	0.1 - 1.99	309 - 2135
	BETA	-	0.18 - 1.97	0.11 - 1.99	0.11 - 2.0	302 - 2160
sine function raw $\delta^{18}O_P$	PLTI	0.42 - 1.98	-	-	0.11 - 2.0	305 - 1982
	PLTV	-	0.28 - 1.7	0.54 - 1.9	0.14 - 2.0	314 - 1862
	BETA	-	0.24 - 1.97	0.2 - 2.0	0.12 - 1.99	322 - 1964