

Table S1. Multiple regression coefficients and fit statistics for models describing the spatial variations in sine parameters that capture seasonal precipitation isotope cycles (amount-weighted fitted $\delta^{18}\text{O}$, robust-fitted $\delta^2\text{H}$, and amount-weighted fitted $\delta^2\text{H}$; see Table 2 for robust-fitted $\delta^{18}\text{O}$). Dashes mark predictors that were excluded by the stepwise-regression model selection.

	Latitude (° from equator)	Elevation (m asl)	Dist. from coast (km)	Temp. range (°C)	Mean Annual Temp. (°C)	Mean Annual Precip. (mm yr ⁻¹)	Intercept	RMSE	R ²
Amplitude (‰ $\delta^{18}\text{O}$)*	-0.07	0.0002	0.0013	0.07	-0.1	—	5.2	1.2	0.56
Phase (days)* ^a	0.39	0.0091	—	—	—	—	-1.2	13.5	0.24
Phase (days)* ^b	-1.15	—	—	—	—	—	-92.2	35.1	0.23
Offset (‰ $\delta^{18}\text{O}$)*	0.10	—	—	-0.11	0.5	-0.0006	-15.5	1.9	0.79
Amplitude (‰ $\delta^2\text{H}$)	-0.48	0.0024	0.0105	0.55	-1.1	—	39.1	9.5	0.61
Phase (days) ^a	0.31	0.0089	-0.0044	—	—	—	9.3	13.9	0.19
Phase (days) ^b	-1.07	—	—	0.74	—	—	-105.6	24.7	0.19
Offset (‰ $\delta^2\text{H}$)	0.87	0.0027	—	-0.90	4.7	-0.0054	-123.5	17.6	0.81
Amplitude (‰ $\delta^2\text{H}$)*	-0.56	0.0013	0.0099	0.49	-1.1	—	43.2	9.8	0.53
Phase (days)* ^a	—	0.0072	—	—	-0.4	—	-21.1	15.5	0.23
Phase (days)* ^b	—	—	—	—	—	0.0454	-130.8	151.9	0.06
Offset (‰ $\delta^2\text{H}$)*	0.68	—	—	-0.80	4.0	-0.0052	-110.8	17.0	0.78

* referring to amount-weighted sine curve fits
^a referring to sites in latitudes > 30° (N or S)
^b referring to sites in latitudes < 30° (N or S)

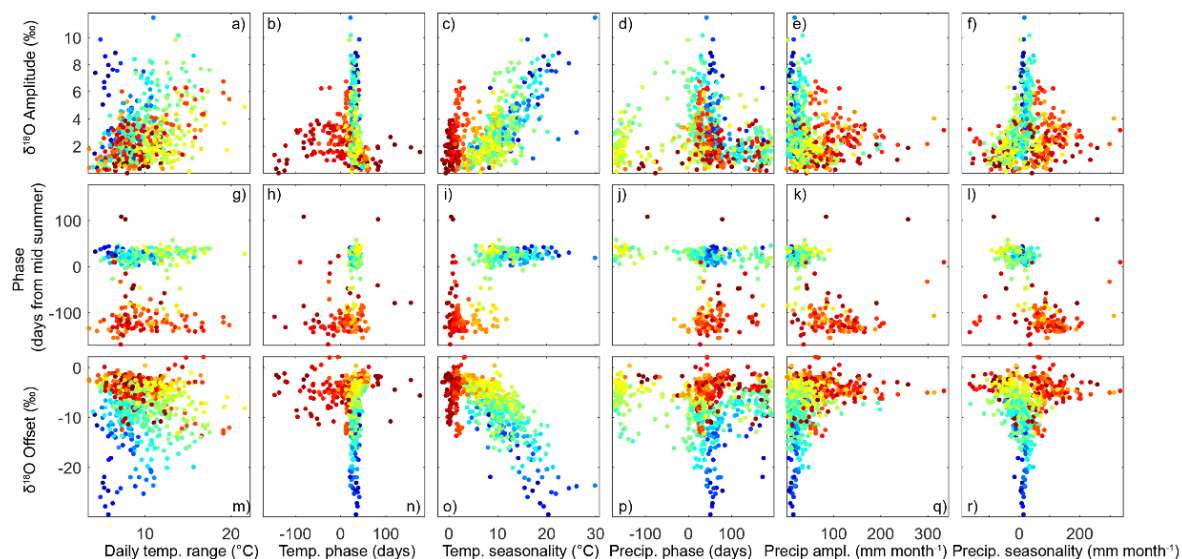


Figure S1. Scatter plots of fitted sine parameters describing precipitation $\delta^{18}\text{O}$ seasonal cycles – a-f) amplitude, g-l) phase, m-r) offset – versus site characteristics. Phase refers to day of peak temperature or precipitation amount, relative to the summer solstice. Precip ampl. refers to seasonal amplitude of precipitation amount. Seasonality metrics are calculated as the temperature or precipitation amplitude multiplied by 1.0 if they peak in the summer, and -1.0 if they peak in winter. Colours indicate absolute latitude (high latitudes in blue, low latitudes in red) as shown in Figure 2.

Supplement to Global sinusoidal seasonality in precipitation isotopes (in HESS)

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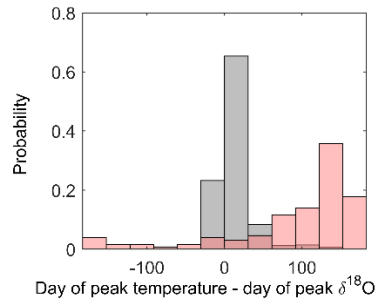


Figure S2. Histograms of phase differences between seasonal isotope cycles and seasonal temperature cycles, with height of bars showing probability. At 49% of all precipitation measurement stations, peak isotope values preceded peak temperatures by less than one month; peak isotope values lagged peak temperatures by less than one month at another 18% of the sites. However, these patterns differed substantially between sites in absolute latitudes below 30° (shaded in pink) versus above 30° (shaded in grey).

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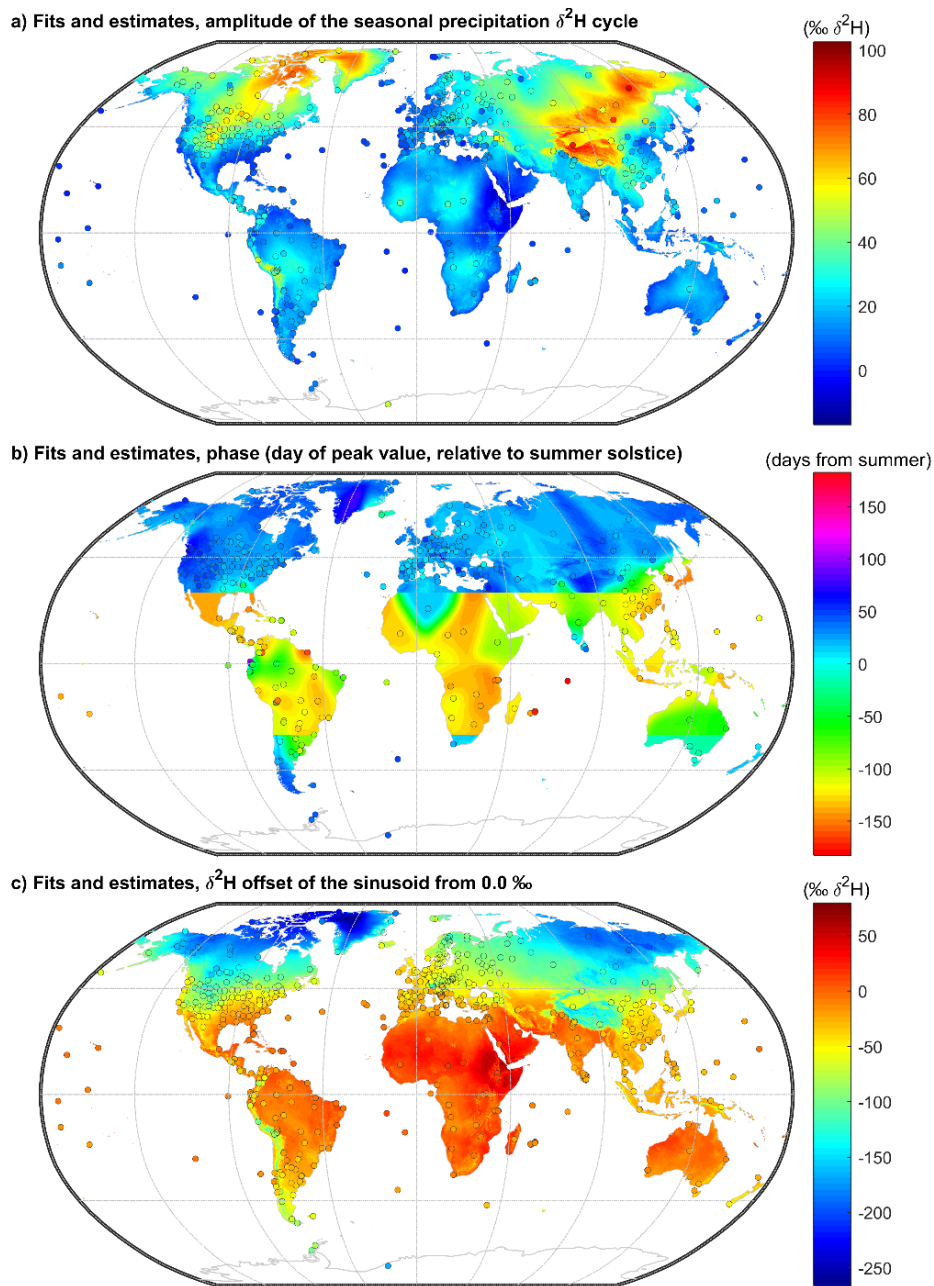


Figure S3. Maps of fitted station values (markers) and the residual-adjusted maps of sine-curve parameters (shaded) that describe the seasonal cycles in precipitation $\delta^2\text{H}$ a) amplitude, b) phase, and c) offset. The interpolated surface is the sum of the infilled surfaces in Figures 3 and 4 (see methods).

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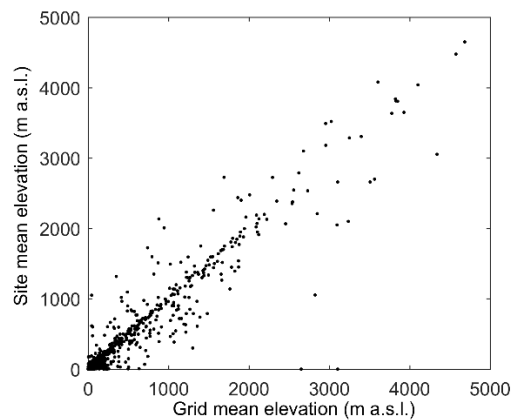


Figure S4. Elevations reported for sites regressed against gridded predictions of elevations of pixels containing those sites. Mismatches likely occur because grid-averaged values poorly capture small-scale variations in elevation.

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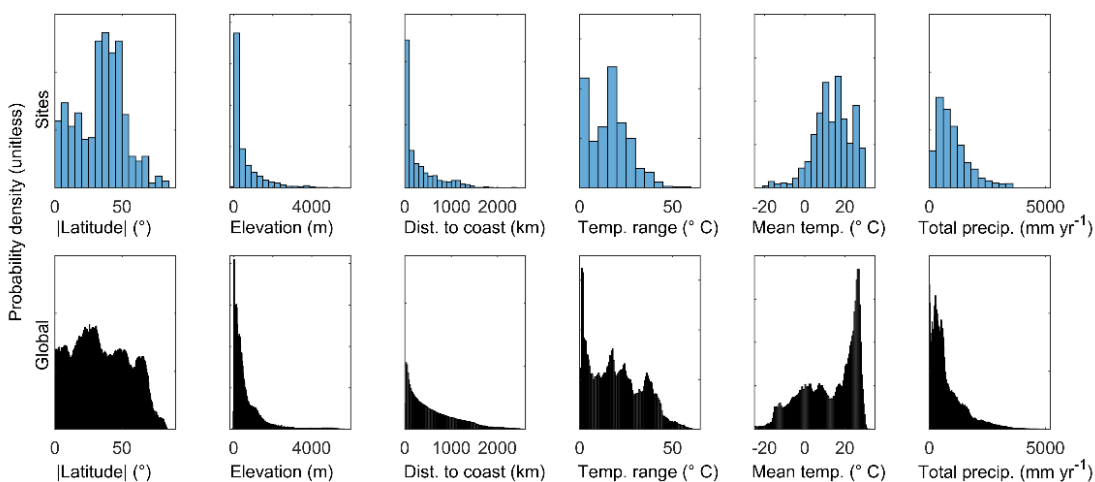


Figure S5. Probability density functions of the site characteristics used to predict seasonal precipitation isotope cycles, where the top row shows the distribution of values at precipitation isotope monitoring stations, and the bottom row shows the global distribution of values on land.

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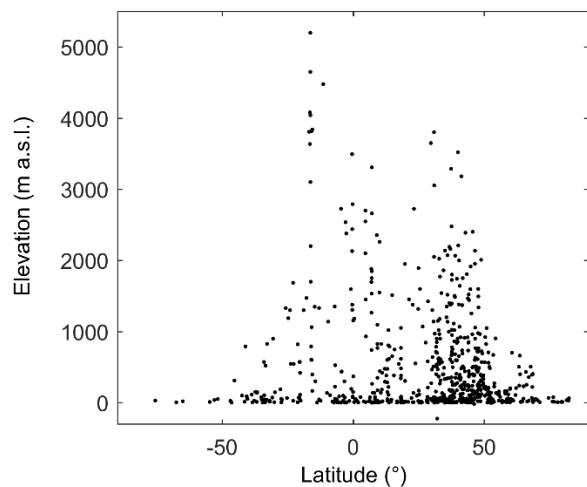


Figure S6. Elevation versus latitude of precipitation isotope monitoring sites. Very high elevation precipitation isotope monitoring sites are almost exclusively located in the intra-tropical zone (specifically, in the Andes mountains). High latitude sites are mostly in low elevation regions.

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