Quantification of relative humidity and isotopic composition of precipitation using combined δ^2H and δ^{18}O analyses on lipid and sugar biomarkers

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The δ^2H isotopic composition of leaf waxes is used increasingly for paleohydrological and –climate reconstructions. However, it is challenging to disentangle past changes in the isotopic composition of precipitation and changes in evapotranspirative enrichment of leaf water.

We analyzed δ^2H on *n*-alkanes and fatty acids in topsoils along a climate transect in Argentina, in adition to our previously established $\delta^{18}O_{sugars}$ record. Our results corroborate that leaf wax biomarkers primarily reflect the $\delta^2H_{source\ water}$ (precipitation), but are modulated by evapotranspirative enrichment. A mechanistic model is able to produce the main trends in δ^2H_{lipids} along the transect, but seems to slightly underestimate evapotranspirative enrichment in arid regions and overestimate it in grass-dominated ecosystems.

Assuming constant biosynthetic fractionation and combining $\delta^2H_{n\text{-alkanes}}$ and $\delta^{18}O_{sugars}$ biomarkers, the isotopic composition of leaf water can be calculated, which also yields the deuterium excess (d-excess), mainly reflecting the evapotranspirative enrichment. The d-excess can be converted to relative air humidity (RH). The high correlation with actual modern RH, as well as the good agreement between reconstructed and actual δ^2H and δ^{18}O of precipitation along the transect generally validates our approach and highlights the great potential of combining δ^2H and δ^{18}O of lipid and sugar biomarkers for paleoclimate research.