Constraining source water and biosynthetic hydrogen isotope effects in leaf waxes on a continental scale

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Hydrogen isotope values of sedimentary waxes from vascular plants are valuable hydroclimate proxies. However, considerable uncertainty still surrounds the paleoclimate interpretation of these data due to factors such as differences in species-specific biosynthetic fractionation and variability in leaf water isotopic enrichment over space and time. Although leaf wax hydrogen isotope values generally reflect those of local precipitation, leaf water is the direct hydrogen source for plant lipids. Due to transpiration, leaf water isotopes are typically enriched relative to source water taken up at the roots. The magnitude of transpirative enrichment is also controlled by hydroclimate conditions, so improved understanding of this component of hydrogen transfer from precipitation water to vascular plant lipid will facilitate better understanding of the climatic significance of the sedimentary leaf wax signal.

Here we present monthly time series records of hydrogen isotope values from the 2014-growing season of precipitation, leaf water, xylem water, and leaf waxes in a collaborative network of 20 sites throughout Europe. For each site we used precipitation and xylem water measurements, along with contemporaneous weather station data, to calculate expected leaf water isotope values with a generalized model. Measured leaf water isotope values were then used to validate the model predicted values. This well-constrained plant water isotope data set was also used to evaluate the extent to which vascular plant lipids differ in how they reflect the hydrogen isotope value of biosynthetic source water among species and over large spatial scales. Improved understanding of the hydroclimate signal imparted to waters up to the point directly preceding photosynthetic uptake, and isolated assessment of the net biosynthetic isotope effects that follow, advances the robust application of sedimentary leaf wax hydrogen isotope values as proxies for leaf water or precipitation isotope values.