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Hydrogen isotopes from source water to leaf lipid in a continental-scale sample network

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Sedimentary plant waxes are useful paleoclimate proxies because they are preserved in depositional settings on geologic timescales and the isotopic composition of the hydrogen in these molecules reflects that of the source water available during biosynthesis. This application is based largely on empirical calibrations that have demonstrated continental-scale correlations between source water and lipid hydrogen isotope values. However, the importance of variable net isotopic fractionation between source water and lipid for different species and environmental conditions is increasingly recognized. Isotopic enrichment of leaf water during transpiration is key among these secondary factors, and is itself sensitive to changes in hydroclimate. Leaf water enrichment also occurs prior to photosynthetic water uptake, and is therefore independent from cellular-level biomarker synthesis. Mechanistic models can predict the mean leaf water hydrogen isotope composition from readily available meteorological variables. This permits global-scale isoscape maps of leaf water isotopic composition and enrichment above source water to be generated, but these models have not been widely validated at continental spatial scales.

We have established a network of twenty-one sites across Europe where we are sampling for leaf-, xylem-, and soil-water isotopes (H and O) at approximately 5-week intervals over the summer growing season. We augment the sample set with weekly to monthly precipitation samples and early- and late-season plant wax lipid samples. Collaborators at each site are conducting the sampling, and most sites are members of the FLUXNET tower network that also record high-resolution meteorological data. We present information on the implementation of the network and preliminary results from the 2014 summer season. The complete dataset will be used to track the evolution of water isotopes from source to leaf water and from leaf water to lipid hydrogen across diverse environments. This will provide a more focused framework for understanding the environmental signal captured in leaf waxes, and will be used to refine models of isotopic processes within plants as well as the impact of these processes on surface and atmospheric water.