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Beyond single biomarker-isotope studies in paleolimnology - towards a coupled $\delta^2H_{leaf-wax}$-$\delta^{18}O_{hemicellulose}$ based paleohygrometer approach

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Lacustrine sedimentary leaf wax-derived biomarkers, e.g. long chain n-alkanes, and their hydrogen isotopic composition are proved to be of a value in paleohydrology research. The alteration of the isotopic signal as a result of the often unknown amount of leaf water enrichment, however, can challenges a direct reconstruction of the isotopic composition of paleoprecipitation. The interpreation of single biomarker-based isotope proxies therefore remain often not quantitive. The coupling of $^2H/^1H$ results of leaf wax-derived n-alkanes with $^{18}O/^{16}O$ results of hemicellulose-derived sugars has the potential to overcome this limitation and additionally allows reconstructing relative air humidity.

First, we investigated leaf material from a climate chamber experiment for their $^2H/^1H$ (leaf wax-derived n-alkanes) and $^{18}O/^{16}O$ (hemicellulose-derived sugars) isotopic composition. Three species were grown under controlled conditions, enabling the validation of the proposed $\delta^2H_{leaf-wax}$-$\delta^{18}O_{hemicellulose}$ based paleohygrometer approach. The results show that ^2H and ^{18}O enrichment of leaf water is predominantly controlled by relative humidity of the climate chambers. Calculated biosynthetic fractionation factors between the leaf biomarkers and leaf water are furthermore well in agreement with values reported in literature. Finally, the biomarker-based calculated relative humidity values correlate significantly with the actual relative humidity of the climate chambers.

Second, we present $\delta^2H_{leaf-wax}$ and $\delta^{18}O_{hemicellulose}$ results obtained from lacustrine sediment of Lake Gemündener Maar, Germany, located in the Western Volcanic Eifel region. The investigated core section covers the time between 13.2 ka and 9.7 ka BP. The relative humidity history, derived from the proposed $\delta^2H_{leaf-wax}$-$\delta^{18}O_{hemicellulose}$ based paleohygrometer approach, document particularly dry conditions at the end of the Younger Dryas as well as during the earliest Holocene and the Preboreal. By contrast, a pronounced wet phase is documented during the Preboreal. Our results suggest that solar activity might play an important role in controlling relative humidity changes in Central Europe during the Late Glacial - Early Holocene transition.