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A conceptual model for interpreting δ18O and δD biomarker records from terrestrial archives

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The natural abundances of stable oxygen (18O/16O) and hydrogen isotopes (D/H) are valuable proxies for reconstructing paleoclimate history on global as well as on regional scale. While stable isotope analyses of sedimentary leaf wax-derived n-alkanes enables establishing δD biomarker records, we recently developed a method based on compound-specific δ18O analyses of hemicellulose sugars (Zech and Glaser, 2009), which now additionally allows establishing δ18O biomarker records from soil/sedimentary organic matter of terrestrial archives.
Here we present a conceptual model for interpreting combined δ18O and δD biomarker records (Zech et al., submitted). Based on this model, we suggest that both δ18O and δD biomarker records primarily reflect the isotopic composition of paleoprecipitation modified by evaporative isotope enrichment of leaf water during transpiration. Considering biosynthetic fractionation factors allows reconstructing from combined δ18O and δD biomarker records the leaf water isotopic composition and the deuterium excess of the leaf water. The deuterium excess may serve as proxy for evaporative enrichment and allows reconstructing relative humidity using a Craig-Gordon model. Furthermore, the model allows calculating δ18O of the plant source water (δ18Osource water), which can be assumed to primarily reflect δ18O of paleoprecipitation. Hence, paleoclimatic conclusions in terms of temperature can be drawn in high latitude study areas and precipitation amount can be reconstructed in monsoon regions.

Zech, M., Glaser, B., 2009. Compound-specific δ18O analyses of neutral sugars in soils using GC-Py-IRMS: problems, possible solutions and a first application. Rapid Commun. Mass Spectrom. 23, 3522-3532.
Zech et al., 2013. A 220 ka terrestrial δ18O and deuterium excess biomarker record from an eolian permafrost paleosol sequence, NE-Siberia. Submitted to Chemical Geology.