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Mean annual temperatures of mid-latitude regions derived from stable hydrogen isotopes of wood lignin

Tobias Anhäuser (1), Markus Greule (1), Gabriel J Bowen (2), Frank Keppler (1,3)

(1) Institute of Earth Sciences, Ruprecht Karls University Heidelberg, Im Neuenheimer Feld 234-236, D-69120 Heidelberg, Germany, (2) Department of Geology and Geophysics and Global Change and Sustainability Center, University of Utah, Salt Lake City, Utah 84112, USA, (3) Heidelberg Center for the Environment (HCE), Ruprecht Karls University Heidelberg, D-69120 Heidelberg, Germany

Tree rings are widely used climate archives providing annual resolutions on centennial to millennial timescales. Besides plant physiological parameters such as tree-ring width or maximum latewood density, stable isotope compositions (expressed as δ values) complement or even broaden the potential of the climate archive tree rings. A considerable wood constituent are ether-bonded methoxyl groups as part of lignin which can be used for stable hydrogen isotope studies. The δ^2H value of the lignin methoxyl groups reflects the δ^2H value of the tree source water as a result of a large uniform fractionation. Hence, this relation can be used to infer δ^2H values of precipitation which are in temperate regions primarily controlled by temperature. Here, we measured δ^2H values of lignin methoxyl groups (n = 111) of tree rings from various species collected along a $\sim$3500 km north-south transect across Europe with mean annual temperatures (MAT) ranging from -4 to +17 °C. We found a significant linear correlation between δ^2H values of the lignin methoxyl groups and MAT (R^2 = 0.81, $p < 0.01$). We used this relationship to predict MATs from randomly collected wood samples and found general agreement between predicted and observed MATs for the mid-latitudes on a global scale. Thus our results indicate that δ^2H values of lignin methoxyl groups are a promising tool for mid-latitude temperature reconstruction of the Holocene.