Tree-ring δ^2H chronology of lignin methoxyl groups from Germany reflects Western European temperature changes

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Stable hydrogen isotope ratios of lignin methoxyl groups (δ^2H_{LM}) of wood have been shown to reflect the climate-sensitive δ^2H values of precipitation (δ^2H_{precip}) modulated by a largely uniform negative isotope fractionation. However, a detailed high-resolutional calibration study evaluating the temporal relationship between tree-ring δ^2H_{LM} and site-specific δ^2H_{precip} data is missing. Here, we compared annually measured δ^2H_{LM} values from nine tree-ring series (derived from four *Fagus sylvatica* L. trees) with nearby instrumental δ^2H_{precip} data at Hohenpeißenberg (Germany; ~48°N, 11°E). The nine δ^2H_{LM} tree-ring series (common period of overlap 1916-2015) show highly significant inter-series correlations (Rbar = 0.52; $p<0.001$) indicating strong coherency. We produced therefore a mean δ^2H_{LM} chronology which shows highest correlations with annually averaged δ^2H_{precip} values ($r=0.73$; $p<0.001$) suggesting that δ^2H_{LM} reflects primarily an annual integral of δ^2H values of the tree's source water. The δ^2H_{LM} chronology correlates further highly significant with local annual temperature anomalies at Hohenpeißenberg ($r=0.56$) whereby correlations increase in magnitude for numerous areas west of our study site ($r>0.6$) covering most of Western Europe. We established a linear regression model between averaged Western European surface air temperatures (range: 30°W–20°E, 35–60°N) and the δ^2H_{LM} chronology yielding $r=0.71$ ($p<0.001$). When comparing instrumental and reconstructed large-scale temperature anomalies from 1916-2015, an average absolute deviation in annual reconstructions of as low as 0.3 °C was found. Overall, this study improves not only the understanding of the δ^2H_{precip}-δ^2H_{LM} relationship but indicates also that mid-latitudinal δ^2H_{LM} values may serve as a valuable proxy for large-scale temperature reconstructions when applied in dendroclimatology.