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Stable hydrogen isotope ratios of methoxyl groups in Eifel (Germany) maar deposits: a potential palaeotemperature proxy

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Stable hydrogen isotope ratios (δD values) of methoxyl groups in a variety of plant types from different locations have been shown to record δD values of precipitation, with a mean uniform isotopic fractionation. Since δD in precipitation is mainly influenced by climatic conditions, including temperature, evaporation and precipitation amount, methoxyl groups of organic matter have been proposed as a potential palaeoclimate proxy. We measured the δD values of the methoxyl groups in bulk sediment and oospores (algal spores from charophytes) from Eifel maar sediment core samples. The sediment cores cover the entire Holocene and part of the Late Glacial (9640 BC to ∼12,000 BC). The methodology employed was precise with mean standard deviations of δD values of 3.3‰ (n = 12) and 1.3‰ (n = 3) for methoxyl groups of bulk sediment and oospore samples, respectively. Based on our measurements palaeoclimatic interpretations were made. Along a North-South transect of Europe δD values of precipitation and lake water are both strikingly correlated with the mean annual air temperature (R^2 = 0.99 and R^2 = 0.93, respectively), leading to a temperature gradient of 4–6‰ per 1° C. We used this gradient to calculate changes in temperature over the past ∼14,000 years as indicated by changes in the δD values of the bulk sediment and oospores. Whereas the mean temperature variation within the Holocene was found to be consistently less than 2° C, the covered Late Glacial period indicates colder temperatures, by as much as 5° C, both with respect to the average Holocene temperature. The observed long term temperature trend is broadly in line with that reported from the NGRIP ice core for the same time period. δD values of methoxyl groups of bulk sediment are also consistent with those obtained from oospores. We suggest that the δD values of methoxyl groups from well-characterized organic material, especially in the case of oospores, have great potential to assist palaeoclimate reconstructions.