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Pollen-based reconstruction of Holocene climate variability in the Eifel region evaluated with stable isotopes

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Pollen as well as stable isotopes have great potential as climate proxy data. While variability in these proxy data is frequently assumed to reflect climate variability, other factors than climate, including human impact and statistical noise, can often not be excluded as primary cause for the observed variability. Multiproxy studies offer the opportunity to test different drivers by providing different lines of evidence for environmental change such as climate variability and human impact. In this multiproxy study we use pollen and peat humification to evaluate to which extent stable oxygen and carbon isotope series from the peat bog "Dürres Maar" reflect human impact rather than climate variability. For times before strong anthropogenic vegetation change, isotope series from Dürres Maar were used to validate quantitative reconstructions based on pollen.

Our study site is the kettle hole peat bog "Dürres Maar" in the Eifel low mountain range, Germany (450m asl), which grew 12m during the last 10,000 years. Pollen was analysed with a sum of at least 1000 terrestrial pollen grains throughout the profile to minimize statistical effects on the reconstructions. A recently developed probabilistic indicator taxa method ("pdf-method") was used for the quantitative climate estimates (January and July temperature) based on pollen. For isotope analysis, attention was given to use monospecific Sphagnum leaves whenever possible, reducing the potential of a species effect and any potential artefact that can originate from selective degradation of different morphological parts of Sphagnum plants (Moschen et al., 2009).

Pollen at "Dürres Maar" reflect the variable and partly strong human impact on vegetation during the last 4000 years. Stable isotope time series were apparently not influenced by human impact at this site. This highlights the potential of stable isotope investigations from peat for climatic interpretation, because stable isotope series from lacustrine sediments might strongly react to anthropogenic deforestation, as carbon isotope time series from the adjacent Lake Holzmaar suggest. Reconstructions based on pollen with the pdf-method are robust to the human impact during the last 4000 years, but do not reproduce the fine scale climate variability that can be derived from the stable isotope series (Kühl et al., in press). In contrast, reconstructions on the basis of pollen data show relatively pronounced climate variability (here: January temperature) during the Mid-Holocene, which is known from many other European records. The oxygen isotope time series as available now indicate that at least some of the observed variability indeed reflects climate variability. However, stable carbon isotopes show little concordance.

At this stage our results point in the direction that 1) the isotopic composition might reflect a shift in influencing factors during the Holocene, 2) climate trends can robustly be reconstructed with the pdf method and 3) fine scale climate variability can potentially be reconstructed using the pdf-method, given that climate sensitive taxa at their distribution limit are present. The latter two conclusions are of particular importance for the reconstruction of climatic trends and variability of interglacials older than the Holocene, when sites are rare and pollen is often the only suitable proxy in terrestrial records.

Kühl, N., Moschen, R., Wagner, S., Brewer, S., Peyron, O., in press. A multiproxy record of Late Holocene natural and anthropogenic environmental change from the Sphagnum peat bog Dürres Maar, Germany: implications for quantitative climate reconstructions based on pollen. J. Quat. Sci., DOI: 10.1002/jqs.1342. Available online.

Moschen, R., Kühl, N., Rehberger, I., Lücke, A., 2009. Stable carbon and oxygen isotopes in sub-fossil Sphagnum: Assessment of their applicability for palaeoclimatology. Chemical Geology 259, 262–272.