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Stable isotope compositions of carbonate and inclusion-hosted water of speleothems from the last interglacial – spatial patterns of climate fluctuations in Europe

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Studies on the last interglacial (LIG) can provide information on how our environment behaved in a period of slightly higher global temperatures at about 120 ka compared to the current climate conditions. This paper presents complex stable H-C-O isotope records obtained for carbonate and fluid inclusion hosted water of U-Th dated stalagmites from the Baradla Cave system in Central Europe. Comparing C and O isotope data with records reported for other speleothem (cave-hosted carbonate) deposits from Europe revealed the complex behavior of these climate proxies, with a concerted relative increase in 18O of carbonates from 128 to 120 ka and synchronized shifts in the opposite direction after 119 ka. The hydrogen isotope analyses of inclusion-hosted water extracted from the BAR-II stalagmite also correspond to the regional climate proxy records, with meaningful deviations from global temperature trends. Beside the well known 120 ka climate optimum and the subsequent cooling starting at about 118 ka, the δD values show a negative peak at about 124-125 ka that does not appear in the C-O isotope data. This negative peak fits well to temperature and humidity changes inferred from proxy records from the northern Atlantic to the eastern Mediterranean. Spatial distributions of these variables show, that while the northern Atlantic ocean experienced a cold phase (possibly also dry in NW Europe), the Mediterranean region was characterized by warm, humid conditions and enhanced seasonality, most probably related to a freshwater flux to the North Atlantic and consequent large-scale heat and moisture transport changes affecting the Mediterranean. The combined interpretation of H-C-O isotope data revealed that the Alpine and Mediterranean regions behaved differently again during Greenland Stadial 26 (GS26, $\sim$119 to 115.5 ka). While the Alpine records fluctuated in close agreement with the Central Greenland ice core δ18O data, the BAR-II stalagmite and southern European records show a positive δ18O anomaly. The Baradla data indicate enhanced aridity and seasonality, with the relative dominance of summer precipitation and Mediterranean moisture contribution. Following the GS26 event, the effect of long-term global cooling becomes dominant in the Baradla isotope records and leads to glacial inception at about 110 ka.

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