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Decoupled evolution of temperature and precipitation in western Germany during the Last Interglacial reconstructed from a precisely dated speleothem

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We present high-resolution stable oxygen and carbon isotope (δ^{18}O and δ^{13}C) as well as trace element profiles for stalagmite HBSH-1 from Hüttenbläserschachthöhle, western Germany. The chronology was established by MC-ICPMS ^{230}Th/U-dating, and the high U-content of the stalagmite allowed determination of very precise ^{230}Th/U-ages although using very small sample sizes. The beginning and end of individual growth phases of the stalagmite could, thus, be determined very accurately.

Stalagmite HBSH-1 grew during the penultimate interglacial (MIS 7), the Last Interglacial (MIS 5) and the Holocene. The major part of the sample (40 cm) grew between 130 and 80 ka providing a climate record with decadal to centennial resolution for this period. The record shows three growth interruptions during MIS 5 coinciding with Greenland Stadials 25, 24 and 22, as recorded in the NGRIP ice core (North Greenland Ice Core Project members, 2004). The end of the MIS 5 growth phase coincides with GS 21. This shows that stalagmite growth in this area is a very sensitive proxy for northern hemisphere cooling. Correlation of the absolutely dated stalagmite record with Greenland ice cores may provide a tool to improve the chronology of the Greenland Stadials.

The δ^{18}O profile of stalagmite HBSH-1 shows a distinct similarity during MIS 5 with the NGRIP ice core and a sea surface temperature record from the Iberian Margin (Martrat et al., 2007). This suggests that stalagmite δ^{18}O mainly reflects past temperature variability.

Stalagmite HBSH-1 consists of aragonite rather than calcite, which is probably a result of pronounced prior calcite precipitation in the epikarst above the cave (Fairchild and Treble, 2009). In this case, the δ^{13}C signal rather reflects changes in past precipitation than temperature. The δ^{13}C record of HBSH-1 shows three pronounced negative peaks during MIS 5, in agreement with the three MIS 5 warm phases, MIS 5e, 5c and 5a. During the Last Interglacial, however, the evolution of δ^{18}O and δ^{13}C, and thus temperature and precipitation, is opposite. Whereas the δ^{18}O signal suggests the warmest temperatures around 125 ka followed by a gradual decrease, the δ^{13}C signal indicates wetter conditions towards the end of the Last Interglacial.

The decoupling of temperature and precipitation during this time period is also seen in a series of snapshot simulations performed using a fast coupled ocean-atmosphere general circulation model. This behaviour can be explained by the influence of varying solar insolation patterns (in response to changing orbital configuration) on atmospheric dynamics and the resulting influence on storm activity in the region.

References

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