



Climatic evolution of Marine Isotope Stage 5 and particularly the Eemian reconstructed from precisely dated speleothems from western Germany

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We present high-resolution $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and trace element profiles for three stalagmites from western Germany, which grew during Marine Isotope Stage (MIS) 5. All stalagmites were precisely dated by MC-ICPMS $^{230}\text{Th}/\text{U}$ -dating. Stalagmite HBSH-1 from Hüttenbläuserschachthöhle grew between 130 and 80 ka and provides a climate record with decadal to centennial resolution. The other two stalagmites grew faster than HBSH 1, but their growth phases are shorter. Stalagmite HBSH 5 grew between 129 and 122 ka, whereas stalagmite BR 5 grew between 126 and 122 ka.

The record of HBSH 1 shows four growth interruptions coinciding with Greenland Stadials (GS) 21, 22, 24, 25, and 26. This shows that stalagmite growth is a very sensitive proxy for cool and dry conditions in the northern hemisphere and enables us to precisely determine the timing and duration of the GS.

We interpret stalagmite $\delta^{18}\text{O}$ values as a proxy for supra-regional temperature changes in the North Atlantic realm, which is particularly evident from their close resemblance with the $\delta^{18}\text{O}$ values of the NGRIP and NEEM ice core records. Stalagmite $\delta^{13}\text{C}$ values primarily reflect changes in hydrological balance and (local) vegetation and are, thus, a proxy for terrestrial climate change in central Europe. The $\delta^{13}\text{C}$ record shows three pronounced negative peaks during MIS 5, and their timing is in agreement with MIS 5e, 5c and 5a. This suggests generally warm and humid climate in central Europe during these phases.

The evolution of the $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values during the Eemian is not parallel. The $\delta^{18}\text{O}$ values progressively increase from 130 ka, peak at 125 ka and subsequently show a gradual decrease. The $\delta^{13}\text{C}$ values, in contrast, start to decrease at 123 ka, show a negative peak at 120 ka and an abrupt increase at 114 ka. This suggests that the Eemian *sensu strictu* lasted from 124 to 114 ka, in agreement with a marine record from the Norwegian Sea and indicates a strong influence on central European climate from high northern latitudes. We also compare our records with other MIS 5 climate records and climate modelling simulations performed with the general circulation model FAMOUS.