Last interglacial speleothem records from the western and southeastern side of the Alps

Charlotte Honiat¹, Christoph Spötl¹, Stéphane Jaillet², Paul Wilcox¹, Tanguy Racine¹, R.Larry Edwards³, and Hai Cheng⁴

¹Institute of Geology, University of Innsbruck, 6020 Innsbruck, Austria
²Laboratoire EDYTEM, Univ. Savoie Mont Blanc, CNRS, 73376 Le Bourget-du-Lac, France
³Department of Earth Sciences, University of Minnesota, Minneapolis, MN, USA
⁴Institute of Global Environmental Change, Xi'an Jiaotong University, Xi'an 710054, China

The Last Interglacial (LIG, ~130–116 ka) was one of the warmest interglacials of the past 800,000 years. Although the orbital configuration was different, the LIG is a useful test bed for the future of the Holocene, because LIG archives have a higher preservation potential and can be dated at much higher precision than older interglacials, e.g. Marine Isotope Stage 11. Speleothems are among the most important terrestrial archives to study the climate of the LIG. Only few well-dated such studies, however, have been published for Europe and there are significant uncertainties regarding the timing of the onset and the magnitude of the peak warmth between some of these reconstructions.

The European Alps have shown to be a climatically highly sensitive region with a warming trend twice the average of the Northern Hemisphere. We therefore examined Alpine caves and studied stalagmite records of the LIG to gain insights into how this mountain range was affected by a warmer climate than today. We present a new, replicated and precisely dated speleothem stable isotope stack from two caves in the Western Alps and two caves in the southeastern Alps. Modern and paleodata show that the O isotopic composition of meteoric precipitation is a function of the mean air temperature in most parts of the Alps. Western stalagmites record an initial warming at 129.6 ± 0.4 ka and reach a first O isotope plateau at 129.0 ± 0.4 ka. An early optimum is identified after the first warming until 127.4 ± 0.5 ka, followed by a cooling until 126.6 ± 0.5 ka. The warming continued but the growth rate slowed down from 126.2 ±0.4 ka to 123.7 ±0.8 ka. Toward the end of the record (123.7 ±0.8 ka) the carbon isotopes slightly rise toward less negative values, possibly indicating climate cooling. The southeastern Alpine stalagmites started growing after Termination II (between 129.1±1.1 ka and 128.5±0.5 ka) and the oxygen isotope values slightly increase from 129 to 120 ka. At the onset of the LIG the carbon isotope values show a stepwise decrease as the oxygen isotope values become less negative, documenting the expansion of vegetation and the gradual soil development during the early part of the LIG. Vegetation and soil bioproductivity peaked around 126 ka in the west and at 125 ka in the southeast. Growth in the west was interrupted soon after 125 ka while in the southeast the carbon isotope signal stayed stable until 123 ka. The final decrease in vegetation density towards the end of the LIG was less synchronous.
among the southeastern speleothems and was characterized by abrupt shifts. Most stalagmites stopped growing after 119 ka when the carbon isotope values reached their highest values indicating a decrease in soil activity and/or vegetation density, possibly associated with deforestation.