



## Reconstructing last 2000 years of temperature variation from Pyrenean caves (N Spain)

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The Central Pyrenees, and particularly the protected area known as Ordesa and Monte Perdido National Park, is a high-altitude karstic region rich in cavities with active drips and present precipitation of carbonates. Although not generally very abundant, there are speleothems growths in several of those cavities. We present here (1) a three-year seasonal monitoring survey to isolate the environmental parameters influencing isotopic composition of farmed carbonate and (2) the last 2000 years isotopic record resulting from compiling seven stalagmites from three different caves. In temperate regions such as the NE Iberian Peninsula is difficult to discern the influences on  $\delta^{18}\text{O}$  variation in speleothems since temperature, amount of precipitation or even source effect are usually acting simultaneously. Main results after three years monitoring period indicate a strong dependence on air temperature through its influence on rainfall  $\delta^{18}\text{O}$ , although a small amount effect is not discarded. The good overlapping during the observational period of  $\delta^{18}\text{O}$  from actively growing modern stalagmites and air temperature in the area supports this dependence and provides a reliable proxy for the temperature evolution along last millennia.

The stalagmites belong to three different caves (Seso, Gloces and B-1 caves) but still present a very coherent isotopic signal allowing us to discard local effects (diagenetic imprint, non-equilibrium fractionation) and to produce a stacked record with decadal resolution. Interpreting this signal as regional temperature variation divides the temporal sequence in five main periods, in consonance with historical stages. Thus, a continuous decrease in temperature characterized the end of the Roman period (0-500 AD). Lower temperatures are dominant during “Dark Ages” (500-1000 AD) that increase during the Medieval Climate Anomaly (MCA, 1000-1400 AD). Following this warm period, the cold signal during the Little Ice Age is very well replicated in several speleothems, even for short events lasting less than a decade. The warming that identifies the Industrial Era (from 1850 AD to present day) is also well document.

This reconstruction is in striking similarity with other high-resolution records in Europe and, particularly, with global temperature reconstructions for last 2000 years. In addition, the fact that the  $\delta^{18}\text{O}$  signal presented here is so well replicated in speleothems from different caves gives strong support to our interpretation and opens the door to further research on Pyrenean speleothems as exceptional archives of thermal oscillations.