



A 1,000 year annually resolved record of speleothem $\delta^{18}\text{O}$ from Northern Spain; a potential new proxy for North Atlantic Oscillation (NAO) index reconstruction

L. Comas-Bru (1), F. McDermott (1), D. Fleitmann (2,3)

(1) School of Geological Sciences. University College Dublin. Belfield. Dublin 4. Dublin. Ireland, (2) Institute of Geological Sciences. University of Bern. Baltzerstrasse 1-3. 3012. Bern, Switzerland., (3) Oeschger Centre for Climate Change Research, Zähringerstrasse 25, 3012 Bern, Switzerland.

The North Atlantic Oscillation (NAO) is defined as the normalized pressure difference between the Azores and Iceland, and is the most prominent mode of climate variability during boreal winter (December to March) over a large region of the Northern Hemisphere from eastern North America to Siberia, and from the Arctic to the subtropical Atlantic. The NAO is responsible for much of the inter-annual variability in mean wind speed and direction, heat and moisture transport between the Atlantic and the surrounding areas, as well as the intensity, number and trajectory of storm tracks (Hurrell et al., 1995). An instrumental NAO index has been compiled by the Climate Research Unit at the University of East Anglia, extending back to 1821.

In this study, a lamina counted record of $\delta^{18}\text{O}$ from stalagmite GAR-02 from La Garma cave (in northern Spain) is presented as a new proxy to extend the instrumental NAO index back through the last 1,000 years.

The stalagmite measures 1140 mm in length and was collected during 2005. Before collection, the stalagmite was fed by a 150 mm long stalactite, which provided a relatively constant drip rate. The stalagmite preserves clear annual laminations due seasonal ventilation and a fast growth rate (418 $\mu\text{m}/\text{year}$; Jackson, 2009). These laminations have been sampled at a c.400 μm resolution along the central growth axis.

Winter rainfall amount in the region surrounding La Garma cave has been shown to be sensitive to the state of the NAO – with a Spearman rank correlation coefficient of $\rho = 0.28$ (54 years; $p < 0.05$) – consistent with the isotope results for GAR-02: maxima in speleothem GAR-02 $\delta^{18}\text{O}$ coincide with positive phases of the NAO.

Several studies have now reconstructed the NAO index using different proxies (e.g. speleothem lamina thickness, tree-ring widths, Sr/Ca ratio from corals). These proxies are correlated to the instrumental NAO coefficients that range between -0.25 (Proctor et al., 2000) and 0.15 (Goodkin et al., 2008). After applying a running mean of 3/5 years, $\delta^{18}\text{O}$ in the new GAR-02 speleothem record is significantly correlated with the instrumental NAO ($\rho = 0.16/0.28$) indicating the potential for speleothem $\delta^{18}\text{O}$ as an indicator of past NAO states during the last millennium.

REFERENCES:

Goodkin N.F., Hughen K.A., Doney, S.C. and Curry, W.B., *Increased multidecadal variability of the North Atlantic Oscillation since 1781*. Nature Geoscience, 2008. 1: p. 844-848.

Hurrell, J.W., *Decadal trends in the North Atlantic Oscillation: Regional temperatures and precipitation*. Science, 1995. 269: p. 676-679.

Jackson A.S., *Variable sensitivity of European Holocene speleothems to climate change: case studies from selected caves*. UCD School of Geological Sciences, 2009. University College Dublin, Dublin. p. 298.

Proctor C.J., Baker A., and Barnes W.L., *A three thousand year record of North Atlantic climate*. Climate Dynamics, 2002. 19: p. 449-454.