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Oxygen Isotope Speleothem record of Decadal and Multidecadal Atlantic Oscillations over the last millennium in Southwestern Morocco

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In this work, we present a stable oxygen isotope (δ18O) speleothem record from Ifoulki cave located South-West of Morocco (N 30°42'29", W 09°19'39" and 1267 meters above sea level). The age model, based on eighteen U-Th dates, reveals that the record covers the AD 790-1953 period with a data resolution of $\sim$1.7 years. Stable oxygen isotope variations show substantial decadal to multi-decadal swings between dry and humid periods. The Medieval Climate Anomaly (MCA) is characterized by the longest period with δ18O values above the average, suggestive of pronounced drying possibly as a response to positive North Atlantic Oscillation (NAO) phases and increased volcanic activity during this period. However, at least two short wet phases are recognized during the MCA in Morocco, with peaks centered on the years AD 1040 and AD 1190 and seem to overlap with negative NAO phases as recorded in a recently published NAO reconstruction for the last millennium. During the next centuries, the NAO again depicts predominantly negative values and the δ18O drops below the average during the Little Ice Age (LIA). Furthermore, a striking resemblance is observed between our record and another recently published stalagmite record from the Piste cave in Northeastern Morocco, which is quite remarkable given the different type of tracers (δ18O vs. Mg and Sr) obtained from different environments (Western High Atlas vs. Northeastern Middle Atlas and $\sim$634 km away). Comparison with regional paleorecords from other studies also reveals the replication of many characteristic climate features from the last millennium, first detected in Northern Morocco and the Iberian Peninsula. In particular, the evidence of generally dry conditions during the MCA and wetter conditions in the LIA, which is confirmed by all the paleorecords. These similarities indicate coherent climate variability in Northwest Africa and the Iberian Peninsula and suggest a strong regional control of the NAO during the last millennium.

Keywords: δ18O, Morocco, MCA, NAO, LIA, Stalagmite.