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Interpreting δ^{18}O and δ^{13}C of two co-eval calcite and aragonite speleothems supported by cave monitoring from Grotte de Piste, Morocco

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Interpreting speleothem δ^{18}O and δ^{13}C records can be challenging. Although these proxies can be affected by various processes taking place within the cave environment, δ^{18}O values commonly reflect local and regional atmospheric and hydrological processes, whereas δ^{13}C values are rather controlled by local processes only, such as type of vegetation (C3 versus C4), soil CO_2 production, cave air circulation, and drip rate. In order to relate speleothem stable isotope data to the exterior climate, monitoring of the local meteoric rainfall and drip water isotope composition, and temperature is necessary. In the case of δ^{18}O values, it is important to assess whether the speleothem reflects the δ^{18}O value of meteoric precipitation or whether there are significant isotope effects due to evapo-transpiration and/or other processes occurring within the karst environment. In addition, net infiltration is commonly restricted to a particular season, and speleothem growth may be seasonal. Hence speleothem δ^{18}O values may be biased to a specific season.

Here we present the results of two years (2011-2012) of monitoring of the δ^{18}O values of spring water, meteoric rainfall and cave drip water in Grotte de Piste, NW Middle Atlas, Morocco. Watch glass experiments were performed at the monitored drip sites that correspond to an actively growing calcite stalagmite (GP7) and an actively growing aragonite stalagmite (GP5). This enabled us to assess the link between the δ^{18}O values of the rainfall, the drip water, the associated $CaCO_3$ precipitates and the stalagmite δ^{18}O values of both polymorphs. In addition, δ^{18}O and δ^{13}C values of both stalagmites were analyzed at 5-year or higher resolution for the last 600 years. As expected, a systematic isotopic offset between the calcite and the aragonite stalagmite can be observed. This is approximately 0.86 ‰ for δ^{18}O and 0.88 ‰ for δ^{13}C. However, both stalagmites show similar trends in their δ^{18}O and δ^{13}C records, even though speleothem growth rates differ considerably. This replication test increases the confidence that these stalagmites recorded an environment signal.