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Reconstruction of Drought Periods in South-Western France Based on the Isotopic Composition of Tree Rings and Speleothems

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The aim of this project is to reconstruct drought periods in south-western France based on the analysis of two complementary continental archives: tree rings and speleothems. The use of multiple proxies with different resolution and seasonality can exploit the strengths of each for a better climate reconstruction. The oxygen isotopic composition of tree ring cellulose depends on the source water delta-18O and the hydric state of the tree, and has been shown to provide a good proxy for summer maximum temperatures in temperate climate. Oxygen isotopes of water in speleothem fluid inclusions reflect the mean annual delta-18O of local rainfall, while the delta-18O of calcite is a function of the delta-18O of drip water and fractionation processes between water and calcite, controlled by temperature during calcite precipitation.
Cores have been collected from up to 400 year old oak trees at Braconne forest (Charente, FR), as well as from from timbers of historic buildings in the nearby town of Angouleme, which extends the chronology back to the 14th century. The provenance of the wood is most likely the same forest. Two stalagmites have been sampled from Bois du Clos cave, located also at Braconne. Furthermore, a stable isotope monitoring of delta-18O in precipitation and cave drip water over 15 years is available from Villars cave, 50 km away.
As a preliminary step, the oxygen isotopic composition of two groups of "young" (150 years) and "old" (400 years) living trees, 1 km away from each other, was analyzed and compared. show that the delta-18O of young trees displays a slight upward trend in delta-18O over their first 20 years. It is on average 0.5 per mill higher than that of the older trees over their common period, although the interannual variations are similar. There is a strong common signal between the young trees (r=0.91) and a strong correlation between cellulose delta-18O and maximum summer temperatures for both tree groups (r=0.70).
These results demonstrate the suitability of the site for reconstructing summer temperatures based on tree ring isotopes and encourage a continuation of the cellulose delta-18O series using the timbers. However, an interpretation with regard to an age effect on the tree ring oxygen isotopes is complicated by the fact that on the karstic terrain, there might be small-scale differences in soil and hydrology. An implication for further analysis strategy is to avoid pooling of different cores for the timber, since the exact site of the tree is unknown and there is a risk of mixing trees with different signals. This further underlines the importance of a multiproxy approach in combination with stalagmites.