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Spatio-temporal variability of Δ^{13}C in tree-rings of Aleppo pine

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Aim: To study the spatiotemporal variability of Δ^{13}C using a tree-ring network of Aleppo pine (*Pinus halepensis* Mill.) in the eastern part of the Iberian Peninsula. In this study, we tried to understand some of the environmental drivers behind changes in Δ^{13}C as well as to decide the most optimal sites to infer paleoclimatic information using such variables. We also try to understand key physiological aspects of *P. halepensis*.

Methods: In order to do that, we have collected biannual Δ^{13}C time series (1950-1998) together with mean annual precipitation (MAP), tree-ring width (TRW) and remote sensing (NDVI) data, for 7 different locations along a precipitation gradient. We assessed how correlations between variables changed along that gradient. In addition to that, we have also looked at how that precipitation gradient changed along the years and thus its relationships with the Δ^{13}C at the spatial level, giving us an idea whether changes in MAP at each site could affect the relationship between these two variables.

Results: We found that a log model better explains the relationship between Δ^{13}C and MAP and that it reaches a saturation point at values above 800 mm of MAP. Similarly, we found that, in the drier sites, correlations between Δ^{13}C and precipitation were higher than in wetter ones. In addition, the coefficient of variation (CV) of Δ^{13}C was a good indicator of the correlation between Δ^{13}C and MAP. Similarly, the mean and the CV of TRW and summer NDVI were good indicators of the level of such correlation between Δ^{13}C and MAP. On the other hand, the inter-site analysis of the data suggested that during dry years exists a stronger relationship between Δ^{13}C and precipitation than in wet years.

Discussion: Our results pointed out that the threshold for water limitation for Aleppo pine was around MAP=800 mm, an amount that might be sufficient for the tree to grow during most of the growing season without altering its water use efficiency (WUE) by closing stomata, which normally determines the Δ^{13}C signal in the tree-ring. In addition, the results show that we can infer key physiological aspects of *P.halepensis* through the combination of different types of ecological information. Finally, we managed to link remote sensing indices to individual functional patterns. From this point of view, one of the most appealing results is that we might be able to choose an optimal tree-ring sampling site for paleo-climate research based on high resolution NDVI layers.

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