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Isoscapes of tree-ring carbon-13 perform like meteorological networks in predicting regional precipitation patterns

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Stable isotopes in tree rings provide climatic information with annual resolution dating back for centuries or even millennia. However, deriving spatially explicit climate models from isotope networks remains challenging. Here we propose a methodology to model regional precipitation from carbon isotope discrimination (Δ^{13}C) in tree rings by (1) building regional spatial models of Δ^{13}C (*isoscapes*), and (2) deriving precipitation maps from ^{13}C-isoscapes, taking advantage of the response of Δ^{13}C to precipitation in seasonally-dry climates. As a case study, we modeled the spatial distribution of mean annual precipitation (MAP) in the northeastern Iberian Peninsula, a region with complex orography and climate (MAP=303-1086 mm). We compiled wood Δ^{13}C data for two Mediterranean species that exhibit complementary responses to seasonal precipitation (*Pinus halepensis* Mill., N=38; *Quercus ilex* L.; N=44; pooling period: 1975-2008). By combining multiple regression and geostatistical interpolation, we generated one ^{13}C-isoscape for each species. A spatial model of MAP was then built as the sum of two complementary maps of seasonal precipitation, each one derived from the corresponding ^{13}C-isoscape (September–November from *Q. ilex*; December–August from *P. halepensis*). Our approach showed a predictive power for MAP (RMSE=84 mm) nearly identical to that obtained by interpolating data directly from a similarly dense network of meteorological stations (RMSE=80-83 mm, N=65), being only outperformed when using a much denser meteorological network (RMSE=56-57 mm, N=340). This method offers new avenues for modeling spatial variability of past precipitation, exploiting the large amount of information currently available from tree-ring networks.

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