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Oak tree ring stable isotope records of late-summer and autumn temperature changes in the Eastern European lowlands

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Stable isotopes in tree rings are arguably the best proxies of past climate variability on annual time scales. They can be calibrated against instrumental data and used to extend climate reconstructions for centuries and even millennia. Although records with similar resolution and longer time spans have been recovered in different parts of the world – ice cores in Greenland and varved sediments in lakes in Northern and Western Europe - no such archives exist in Eastern Europe. Therefore, the isotopic composition of tree rings may be the only long-term and high resolution proxy available from this region.

Here we present the first results of oxygen and carbon stable isotopes analyses of Quercus robur tree rings, covering the 1900-2016 period. The samples were collected at a low altitude (200m), site in NW Romania (Nușfalău, 47.198277 N, 22.668441 E). We have studied these data in connection with the oxygen isotopic composition of precipitation and the main climatic parameters to evaluate their potential for paleoclimatic reconstructions.

Oxygen and carbon stable isotopes composition from earlywood and latewood were analysed separately, from nine pooled Quercus robur trees, using a high-temperature pyrolysis system (Flash HT) coupled to an isotope ratio mass spectrometer (Thermo Delta V), after whole-ring samples were prepared to alpha-cellulose by the modified Jayme-Wise method, and measured tree ring width for the same cores, using LINTAB equipment and TSAP software, with a precision of 0.01mm. Also, we analysed oxygen isotopic composition at Baia Mare station (BM), located at 85km distance from Nușfalău. Climate-measurement parameters relationships were analysed using daily (0.5°x0.5° ROCADA) and monthly (0.5°x0.5° CRU) climatic gridded database.

The oxygen isotopic composition of precipitation at BM (average for the 2012-2015 period) has a seasonal variation, with maximum in July (-5.6‰ and minimum in December (-12.8‰. The mean stable isotope composition in earlywood during the last 115 years is 27.2 ‰ for δ18O and -23.4 ‰ for δ13C‰ and 28.9 ‰ for δ18O and -23.8‰ for δ13C for late wood, respectively.

We observed a good correlation between the δ18OLW with δ18Oprec at BM and mean temperature during the summer season (June-July-August, JJA) and between δ18OEW with δ18Oprec and precipitation amount at BM during the previous year's autumn (September-October-November, SON). Based on the 115 years long chronology of isotopic composition and tree ring width, we found a high coefficient of correlation between δ18OEW, δ18OLW, δ13CEW δ13CLW and temp, pp amount, sunshine and cloud cover (coefficient of correlation varies between 0.42 and 0.63). Mean coefficient of correlation between TRW and t is -0.2 and 0.3 for precipitation. δ18OEW and δ13CEW are correlated with previous year's late autumn temp, and inversely correlated with previous year's autumn cloud cover (r = -0.54) and precipitation amount (r= -0.47). Also, we have found a good correlation of 0.4 with the winter, North Atlantic Oscillation index. δ18OLW and δ13CLW have a good correlation with late summer temperature and sunshine duration (r=0.63), and inverse correlation with late summer cloud cover (r=-0.56) and pp (r=-0.54).

Stable isotopes in the earlywood of low altitude oak tree rings oak represent a good proxy indicator for cloud cover and precipitation amount from previous year's autumn and, stable isotopes in latewood represent a good proxy indicator for summer temperature and sunshine duration. We conclude that the stable isotopic composition of tree rings have considerable potential for paleoclimatic reconstruction even in areas such as lowland Romania, where climate does not strongly constrain tree growth and TRW has very limited potential for paleoclimatic reconstruction.

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