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400 years of summer climatic conditions in the N Carpathian Mts. (eastern Europe) based on O and C stable isotopes in Pinus Cembra L tree rings

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For a better understanding of how the climate is changing and how the environment responds to these changes, it is necessary to understand how the climate has varied in the past.
Romania's virgin forests have a great potential to obtain long tree-ring chronologies with annual resolution; but so far, only a few studies resulted in quantitative paleoclimatic reconstructions.
In this context, the aim of this study is 1) to calibrate the relationship between the stable isotopes of oxygen and carbon in tree rings and the main climatic parameters and determine the potential of Pinus cembra (Călimani Mts., N Romania, Eastern Europe) for paleoclimatic reconstructions; 2) to provide the first palaeoclimatic reconstitution in Romania based on the isotopic composition of oxygen and carbon in tree ring cellulose, and 3) to test the hypothesis that nearby sulphur mines have not altered the climatic signal recorded by the stable isotopic composition of tree rings, contrary to the similar signal recorded by TRW.
For this study, we have analysed wood samples of Swiss stone pine (Pinus cembra L.) from living and dead trees from Călimani Mts., NE Romania, aged between 1600 and 2012 AD. The isotopic composition of oxygen and carbon from the cellulose was analysed at the Institute for Geological and Geochemical Research, Budapest, Hungary, using a high-temperature pyrolysis system (Thermo Quest TC-EA) coupled to an isotope ratio mass spectrometer (Thermo Finningan Delta V) following a ring by ring (i.e. non-pooled) approach.
The average level of δ18O and δ13C in cellulose for the period 1600-2012 was 28.83‰ and -22.63 ‰.
The tree ring cellulose δ18O and δ13C values showed a strong positive correlation with maximum air temperature (r = 0.6 for δ18O and r = 0.5 for δ13C), mean temperature (r = 0.6 for δ18O and r = 0.45 for δ13C), and sunshine duration (r = 0.69 for δ18O) and negatively correlated with precipitation amount (r = -0.5 for δ18O and r = 0.3 for δ13C) and nebulosity (r = 0.6 for δ18O) during the summer months (June, July and August), while correlations with tree ring widths were always less than 0.3, thus showing the superior potential of the stable isotopes. Since temporal stability of the proxy-climate correlation is maintained also over the period of sulphur exploitation (1972 – 1992) when growth-climate relation was found to break down (based on TRW measurements) we conclude that this exploitation did not influenced the climate signal archived in the stable isotopic composition of cellulose. Based on these data, we suggest that δ18O and δ13C is a better indicator proxy for paleoclimatic reconstruction, and sulphur mining had less impact on this correlation than for tree ring widths.
We have used these correlations to reconstruct past climatic variability during the 400 years. The coldest periods occurred between 1650-1690, 1710-1880 and 1950-1980, while the warmest between 1690-1710, 1850-1900, and since 1980 until present, with the maximum values in the 21st century.
By Romania's position in East - Central Europe, where Atlantic, Mediterranean and Scandinavian climate influences converge, and strongly correlation between isotopic composition of tree-rings and climate, stable isotopes in tree ring could be an important tool for paleoclimatic reconstruction, what could shed light on our understanding of climate variability of the entire continent.

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