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When isotope signals in tree rings contradict our concepts and interpretations

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The use of stable C and O isotopes in tree rings for retrospective climatic and environmental analyses and reconstructions is well established. The $^{13}C/^{12}C$ ratio in wood reflects largely the isotopic signal of the leaves, which is an expression of the balance between the CO_2 supply (stomatal conductance) and the Carbon sink strength (photosynthetic rate or demand function). When the stomatal conductance is reduced (usually under drought conditions) the leaf intercellular CO_2 concentration (c_i) is reduced relative to the ambient carbon dioxide concentration. Thus the conclusion was established the $^{13}C/^{12}C$ isotope ratio in the leaf is an indicator for water availability or air humidity. Under dry conditions the $^{13}C/^{12}C$ isotope ratio is higher than for conditions when soil water is abundant and the air humidity is high.

The oxygen isotope ratio is usually considered as a proxy for temperature, since the condensation temperature of the precipitation water determines the $^{18}O/^{16}O$ ratio, i.e. the warmer the condensation temperature of the precipitation water the higher the $^{18}O/^{16}O$ ratio. When plants absorb this water the signal is transferred via photosynthesis to the wood, as the source water from the soil is used during photosynthesis for the sugar synthesis. Transpiration via leaves either amplifies or reduces this $^{18}O/^{16}O$ signal. Thus the conclusion that the oxygen isotope ratio can serve as a paleoclimatic thermometer is plausible and justified.

Besides numerous successful applications often our concepts and assumptions do not match the data. E.g. when a tree ring oxygen isotope chronology shows a decrease within the last fifty years, even though other proxies confirm a continuously increasing temperature. Or a severe drought period is not reflected in the isotope signals as expected. The same paradox can be found in air pollution studies, when trees seemingly do not respond even the heavy pollution loads. At times the explanations for such phenomena are very plausible and at times we simply do not understand the results. In this presentation we show results where the expected climate signals are not present or even show opposite trends and we present various explanations for these findings.