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A unified interpretation of carbon and oxygen isotope records from tree rings: A quantitative reflection of seasonality

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Multiple working models exist for the interpretation of carbon and oxygen isotopes in tree rings from both modern and fossil wood. A quantitative mechanistic relationship for interpreting these records has proven difficult because multiple environmental parameters, such as temperature and precipitation, are thought to affect the $\delta^{13}C$ and $\delta^{18}O$ values of tree ring tissues. Here we present a unified set of independent proxy relationships developed for high-resolution, intra-ring isotope records. These relationships result from our comparison of a total of 1067 tree rings from 42 sites across the globe in order to relate $\delta^{13}C$ and $\delta^{18}O$ values to local seasonal climate parameters. We show that the intra-ring change in $\delta^{13}C$ value reflects seasonal changes in precipitation amount, while the intra-ring change in $\delta^{18}O$ value reflects seasonal changes in both precipitation amount and temperature. Therefore, by using a combined isotope approach, one can use the carbon isotope record to quantify changes in seasonal precipitation and then use this data to solve for changes in seasonal temperature using the intra-ring $\delta^{18}O$ record.