

Hydroclimate variations in southwestern Japan over the past 1500 years inferred from oxygen isotope ratios in tree rings

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Oxygen isotope ratios ($\delta^{18}\text{O}$) in tree-ring cellulose have been widely used to reconstruct hydroclimate variations and atmospheric circulations over monsoon Asia. However, most of previous reconstructions based on tree-ring $\delta^{18}\text{O}$ cover only the past several hundred years, and therefore millennium-scale reconstructions are yet to be developed. Here we present a well-replicated 1500-year tree-ring $\delta^{18}\text{O}$ chronology that was constructed using living and fallen dead trees (*Cryptomeria japonica*) in Yakushima Island, southwestern Japan. First of all, core or disk samples were absolutely dated by matching ring-width patterns among different trees. Then a total of 14 trees were selected for isotopic analysis. We employed the 'plate method' to isolate cellulose component directly from a 1.0-mm wood plate. Each annual ring of cellulose was separated using a razor blade. Finally $\delta^{18}\text{O}$ of individual ring was determined using a continuous flow isotope ratio mass spectrometer coupled to an elemental analyzer. The $\delta^{18}\text{O}$ time series were highly correlated with one another, suggesting that common climatic signals are preserved in all the sampled trees. Because the $\delta^{18}\text{O}$ series did not show prominent age-related trends, all the series were simply normalized to have the same mean during the overlapping segments. The normalized series were then averaged to construct the final chronology. Response analysis using ambient climate records for the last 50 years indicates that tree-ring $\delta^{18}\text{O}$ is mainly governed by summer relative humidity. We therefore interpret this record as a proxy of hydroclimate related to East Asian summer monsoon. Low-frequency variations in our chronology are similar to those of a Northern Hemisphere temperature reconstruction. More specifically our reconstruction shows a relatively dry (wet) condition during the Medieval Warm Period (the Little Ice Age). Centennial-scale fluctuations of sea surface temperatures in the equatorial Pacific may play a role in modulating long-term hydroclimate changes in southwestern Japan.

Keywords: Tree rings, Oxygen isotope, Yakushima Island, Monsoon