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Are oxygen isotopes in Amazon tree rings a good proxy for Amazon rainfall?

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The Amazon is the world's largest drainage basin, transporting about one fifth of the annual global river runoff. Its hydrological cycle is tightly linked with the carbon cycle of the Amazon rainforest, one of the largest terrestrial carbon pools, and small changes in the hydrological cycle of the Amazon therefore affects climate globally. The increase in extreme droughts of the Amazon over the last decade, possibly due to anthropogenic forcing, emphasizes the need for understanding the magnitude of historical variability of hydrological circulation patterns within the Amazon. However, instrumental climate records of the Amazon are scarce and of limited length. In this study, we investigate oxygen isotopes in tree rings as a proxy for the hydrological cycle of the Amazon. To this end, we established a 100 yr long chronology of oxygen isotopes in tree ring cellulose (TR-δ^{18}O) of *Cedrela odorata* from northern Bolivia (11^{o}55'S, 65^{o}40'W).

In temperate regions oxygen isotopic measurements in tree rings have been extensively used as climate proxies reflecting significant influences of several external and internal factors, but only weakly the isotopic variations in source water. In the tropics such studies are very scarce. Our site record from individual trees show that TR-δ^{18}O is highly correlated with δ^{18}O in meteoric water over the Amazon (r=0.83) with depleted values of δ^{18}O during high rainfall years (i.e., so-called "amount-effect"). This suggests that *Cedrela odorata* relies on superficial soil water and that TR-δ^{18}O is a reliable measure of historical variation in δ^{18}O in meteoric water. The long-term inter-annual record of TR-δ^{18}O correlated well with inter-annual variation in (summer) rainfall over the entire basin (r=-0.46) and with (maximum) river run-off levels of the Rio Negro at Manaus (r=-0.62). Pronounced dry years over the last century are clearly visible in the oxygen isotope chronology as anomalously high values of TR-δ^{18}O. TR-δ^{18}O is also a good proxy for large-scale controls of Amazon precipitation, showing strong correlations with ENSO indices (SOI; r=- 0.52) and Tropical North Atlantic SSTa (r=0.45), two of the main drivers of Amazon precipitation. These correlation patterns are not stable over time and show decadal-scale variations, indicating that large-scale controls of Amazon basin hydrology may have varied over historical time periods.

Our study shows that δ^{18}O in tree rings of *Cedrela odorata* is a powerful proxy for historical variability in the Amazon hydrological cycle and will improve our knowledge of long-term precipitation changes, which is of great importance for future predictions of the hydrological cycle in the Amazon.