American Geophysical Union Fall Meeting, San Francisco, CA, December 9-13, 2013.

# High-resolution oxygen isotope profiles in tree-rings and how to interpret them

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Workers have long sought to gain environmental information from oxygen isotope measurements in both modern and ancient wood cellulose ($\delta^{18}O_{cellulose}$). A quantitative mechanistic relationship for interpreting seasonal changes has proven difficult because multiple environmental parameters, such as temperature and precipitation, affect the $\delta^{18}O$ value of meteoric water ($\delta^{18}O_{MW}$), which forms the primary source of oxygen for plant tissue construction. Here we present new high-resolution $\delta^{18}O_{cellulose}$ profiles across tree rings from five widely distributed sites, and combine these new data with 26 other similar records from the literature to form a global dataset of intra-annual changes in $\delta^{18}O_{cellulose}$ from 781 tree rings measured at 31 sites. Using the International Atomic Energy Agency Global Network of Isotopes in Precipitation month-by-month database we first develop relationships between the seasonal changes in temperature and precipitation amount to seasonal changes in $\delta^{18}O_{MW}$. We then use these relationships based on modern precipitation to relate the seasonal change in $\delta^{18}O_{cellulose}$ measured across tree rings to these seasonal climate parameters. Our analysis results in a unifying relationship explaining the intra-annual $\delta^{18}O_{cellulose}$ patterns observed in tree rings worldwide that can be used to reconstruct seasonal temperature and precipitation amount from modern and fossil wood.