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Climatic signals in tree-ring stable isotope records from the U.S. Great Lakes subfossil wood network: Successes and limitations

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Hydroclimatic proxy studies and general circulation models suggest diverse spatial-temporal patterns of North American environmental variability during the last deglaciation. The U.S. Great Lakes network of subfossil tree rings comprises tree-ring proxy records ranging in length from 100 to 320 years originating along the margin of the Laurentide ice sheet. We explore application of stable isotope measurements from the floating tree-ring chronologies to assess climatic variance and ultimately vegetation response to abrupt environmental changes in the Great Lakes region associated with the Older Dryas, Younger Dryas and Preboreal cooling events. Comparison of tree-ring widths and δ13C and δ18O records from black and white spruce from four sites (Two Creeks-WI, Shelton-MI, Liverpool-IN and Gribben Basin-WI) dating back to ca. 13.7ka,13.5ka, 12ka and 11.2ka BP capture diverse climatic signals although there seems to be some instability in the relationships with the isotopic signatures of tree rings. Intercomparison of tree-ring isotopic signatures of the ancient chronologies and modern analog sites from Manitoba, Canada, suggests positive relationships between summer temperature and dew point with δ13C and tree-ring widths of white spruce. The δ18O signal of the subfossil tree rings is commonly different from δ13C, suggesting greater δ18O correspondence to moisture variance. Nevertheless, the last few decades of 100-to-300-year tree-ring records demonstrate unusual behavior and their stable isotopic ratios vary greatly in response to rapid changes in local hydrology. It is possible that an influx of glacial meltwater or rapidly rising water table are forcing the discordance of coupling temperature –moisture climatic signals in the studied tree-ring records prior to tree dieback or mortality. We discuss the merit and limitations in interpretation of tree-ring proxies from stable isotope measurements during the last deglaciation. The floating chronology tree-ring proxies are important to understanding past regional hydroclimate and associated abrupt climate changes, yet the reconciliation of climatic signals in tree-ring stable isotope proxies should be modeled systematically and cautiously.