Geophysical Research Abstracts
Vol. 18, EGU2016-152, 2016
EGU General Assembly 2016

Sub-annual variability in historical water source use by Mediterranean riparian trees.

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The seasonal availability of water within a tree's rooting zone may be an important determinant for individual tree growth and overall forest health, particularly in riparian corridors of Mediterranean climate zones that are vulnerable to water stress. Here, we present a new method that combines dendro-isotopes and isotope-modelling for determining how water source use varies over 10 consecutive growing seasons (2000-2010) for co-occurring species P. nigra and F. excelsior, along the Rhône River, south-eastern France. We conducted highly resolved cellulose δ18O analysis of micro-slices within tree rings and back-calculated the δ18O signature of source water available at the time of growth using a biochemical fractionation model. We related these patterns to inferred seasonal hydrological partitioning through comparison with δ18O of waters from the vadose and phreatic zones, precipitation, and streamflow. The shallowly rooted Fraxinus displayed greater sub-annual source water variability, as well as greater isotopic enrichment, reflecting use of precipitation-derived vadose moisture. Its earlywood component was formed mainly from winter rainfall (depleted) whilst the latewood relied on growing season precipitation (enriched). In Populus, the sub-annual source water use was relatively depleted, suggesting use of hyporheic water and regional groundwater. From 2007, both species converged in their pattern of water source uptake which was attributed to a decline in phreatic water access for Populus. These results demonstrate that the seasonal variability in source water use can be identified retrospectively, a method which may prove important for anticipating the future consequences of climatic driven changes to the hydrological cycle.