Geophysical Research Abstracts
Vol. 13, EGU2011-2564, 2011
EGU General Assembly 2011

The long way down – How tightly are carbon and oxygen isotope signals in the tree ring coupled to canopy physiological processes?

Arthur Gessler (1), Brandes Elke (2), Offermann Christine (3), Ferrio Juan Pedro (3,4)

(1) Institute for Landscape Biogeochemistry, Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V., Eberswalderstr. 84, 15374 Müncheberg, Germany (gessler@zalf.de), (2) Institute of Forest Botany and Tree Physiology, Albert-Ludwigs-University Freiburg, Georges-Köhler-Allee 53/54, 79110 Freiburg, Germany, (3) Centre for Systems Biology (ZBSA), Albert-Ludwigs-University Freiburg, Habsburgerstr. 49, 79104 Freiburg, Germany, (4) Dep. Crop and Forest Science, ETSEA-University of Lleida Avda. Rovira Roure 191 E-25198 Lleida, Spain

The carbon (δ^{13}C) and oxygen (δ^{18}O) stable isotope composition is widely used to obtain information on the inter-link between environmental drivers and tree physiology over various time scales. Especially the tree ring archive can be exploited to reconstruct inter- and intra-annual variation of both climate and physiology. There is, however, a lack of information on the processes potentially affecting δ^{13}C and δ^{18}O on their way from recent assimilates to the tree ring. While photosynthetic carbon isotope discrimination and evaporative oxygen isotope enrichment on the leaf level are well understood, we lack information on how the isotope signal is altered by downstream metabolic processes. As a consequence, we traced the isotopic signals from their origin in the leaf water (δ^{18}O) or the newly assimilated carbon (δ^{13}C, δ^{18}O), via phloem sugars to the tree-ring over a time-scale that ranges from hours to a growing season. We compared the seasonal isotope patterns between a deciduous (European Beech) and a coniferous species (Scots Pine) in order to account for differences in the physiology of photosynthesis and carbon storage and remobilisation. δ^{18}O in the tree ring tissue was much stronger influenced by source water δ^{18}O in beech compared to pine. In the coniferous species, the oxygen isotope signal was transferred from the leaf water to the tree-ring with an expected enrichment of 27‰ with time lags of approximately 2 weeks and with a 40% exchange between organic oxygen and xylem water oxygen during cellulose synthesis. Post-photosynthetic carbon isotope fractionation either associated with phloem transport or related to seasonal starch storage and remobilisation partially decoupled the tree ring δ^{13}C from canopy photosynthetic physiology. A deeper understanding of post-photosynthetic isotope fractionation processes and the temporal and species dependent variability of oxygen atom exchange between organic matter and water is necessary to mechanistically interpret the tree ring isotope signal not only intra- but also inter-annually.