Identifying drivers of leaf water and cellulose stable isotope enrichment in Eucalyptus in northern Australia

JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

ID 3882721

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Year 2017
Title Identifying drivers of leaf water and cellulose stable isotope enrichment in Eucalyptus in northern Australia
Journal Oecologia
Volume 183
Number 1
Pages / Article-Number 31-43

Several previous studies have investigated the use of the stable hydrogen and oxygen isotope compositions in plant materials as indicators of palaeoclimate. However, accurate interpretation relies on a detailed understanding of both physiological and environmental drivers of the variations in isotopic enrichments that occur in leaf water and associated organic compounds. To progress this aim we measured δ(18)O and δ(2)H values in eucalypt leaf and stem water and δ(18)O values in leaf cellulose, along with the isotopic compositions of water vapour, across a north-eastern Australian aridity gradient. Here we compare observed leaf water enrichment, along with previously published enrichment data from a similar north Australian transect, to Craig-Gordon-modelled predictions of leaf water isotopic enrichment. Our investigation of model parameters shows that observed (18)O enrichment across the aridity gradients is dominated by the relationship between atmospheric and internal leaf water vapour pressure while (2)H enrichment is driven mainly by variation in the water vapour-source water isotopic disequilibrium. During exceptionally dry and hot conditions (RHă<ă21%, Tă>ă37ăřC) we observed strong deviations from Craig-Gordon predicted isotope enrichments caused by partial stomatal closure. The atmospheric-leaf vapour pressure relationship is also a strong predictor of the observed leaf cellulose δ(18)O values across one aridity gradient. Our finding supports a wider applicability of leaf cellulose δ(18)O composition as a climate proxy for atmospheric humidity conditions during the leaf growing season than previously documented.

Publisher Springer
ISSN/ISBN 0029-8549 ; 1432-1939
edoc-URL http://edoc.unibas.ch/55710/
Full Text on edoc No;
Digital Object Identifier DOI 10.1007/s00442-016-3761-8
PubMed ID http://www.ncbi.nlm.nih.gov/pubmed/27798741
ISI-Number WOS:000392391300004
Document type (ISI) Journal Article