



HAL
open science

Investigating high-resolution stable isotope signals of annual tree rings across a moisture gradient with the MuSICA model

Lisa Wingate, Didier Bert, Emmi Hiltavuori, Raphaël Dulhoste, James Rolfe, Michel Stievenard, Pasi Kolari, Pertti Hari, Tuomas Aakala, Barbara Köstner, et al.

► To cite this version:

Lisa Wingate, Didier Bert, Emmi Hiltavuori, Raphaël Dulhoste, James Rolfe, et al.. Investigating high-resolution stable isotope signals of annual tree rings across a moisture gradient with the MuSICA model. COST Action ES0806 ('Stable Isotopes Biosphere-Atmosphere Exchange') Final Conference, May 2013, Wroclaw, Poland. hal-02806909

HAL Id: hal-02806909

<https://hal.inrae.fr/hal-02806909>

Submitted on 6 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

INVESTIGATING HIGH-RESOLUTION STABLE ISOTOPE SIGNALS OF ANNUAL TREE RINGS ACROSS A MOISTURE GRADIENT WITH THE MUSICA MODEL

Lisa Wingate^{1,2}, Didier Bert³, Emmi Hiltavuori⁴, Raphaël Dulhoste¹, James Rolfe⁵, Michel Stievenard⁶, Pasi Kolari⁴, Pepi Hari⁴, Tuomas Aakala⁴, Barbara Köstner⁷, Thomas Grünwald⁷, Kadmiel Maseyk⁸, Eyal Rotenberg⁹, Valerie Daux⁶, Valerie Masson-Delmotte⁶, Cathy Lambrot¹, John Grace¹⁰, Dan Yakir⁸, and Jérôme Ogée¹

INRA EPHYSE UR1263, Bordeaux, France¹ University of Cambridge, Department of Plant Sciences, Cambridge, UK² INRA BIOGECO UMR1202, Bordeaux, France³ University of Helsinki, Helsinki, Finland⁴ The University of Cambridge, Department of Earth Sciences, Cambridge⁵ LSCE, CEA/CNRS, 91191, Paris, France⁶ Chair of Meteorology, Technische Universität Dresden, Tharandt, Germany⁷ BIOEMCO- Université Pierre et Marie Curie, Thiverval-Grignon, France⁸ Weizmann Institute of Science, Rehovot, Israel⁹ University of Edinburgh, School of GeoSciences, Edinburgh, UK¹⁰

Abstract

Seasonal variations in annual precipitation have recently been shown to dominate the mean intra-annual variation in the carbon isotope composition of evergreen wood ($\delta^{13}\text{C}_{\text{cellulose}}$) across a range of biomes (Schubert & Jahren, 2011). When such strong relationships are preserved in plant cellulose it may also be possible to spatially reconstruct rainfall patterns in detail over large areas and back in time using empirical relationships (del Castillo *et al.*, 2013). Using a new high-resolution carbon and oxygen isotope dataset of cellulose, we investigated this relationship further. At five FLUXNET sites spanning a significant gradient of moisture (MAP range of 280 to 930mm) and temperature (MAT range of -1 to 18°C), we collected tree core samples and extracted cellulose at high resolution. For each site, we explored whether the inter-annual variability of seasonal precipitation over the past 15 years dominated the inter-annual variations in the amplitude of $\delta^{13}\text{C}_{\text{cellulose}}$. Using the process-based model MuSICA (Ogée *et al.*, 2009), that links $\delta^{13}\text{C}_{\text{cellulose}}$ and $\delta^{18}\text{O}_{\text{cellulose}}$ signals in tree rings to environmental conditions, we explored the sensitivity of cellulose isotope signals to light, temperature and growing season length as these drivers may gain importance when trees grow without moisture limitations across large temperate regions.

References

Ogée, J., Barbour, M.M., Wingate, L., Bert, D., Bosc, A., Stievenard, M., Lambrot, C., Pierre, M., Berbigier, P., Bariac, T., Loustau, D. and Dewar, R. (2009). A single-substrate model to interpret intra-annual stable isotope signals in tree ring cellulose. *Plant, Cell and Environment*, Vol. 32, 8, 1071-1090, doi:10.1111/j.1365-3040.2009.01989.x

Schubert, B.A. & Jahren, A.H., 2011. Quantifying seasonal precipitation using high-resolution carbon isotope analyses in evergreen wood. *Geochimica et Cosmochimica Acta* 75, 7291-7303.

Del Castillo J, Aguilera M, Voltas J, Ferrio JP (2013) Isoscapes of tree-ring carbon-13 perform like meteorological networks in predicting regional precipitation patterns. *Journal of Geophysical Research - Biogeosciences*, doi: 10.1002/jgrg.20036.