Intra-annual relationships between $\delta^{13}C$ ratios and xylogenesis for Black Spruce (Eastern North America)

Sepideh Namvar[1], Etienne Boucher[2], Hubert Morin[3], Annie Deslauriers[3]
[1]Department of Biological Sciences, Université du Québec à Montréal, Canada
[2]Department of Geography, Geotop, Université du Québec à Montréal, Canada
[3]Department of Fundamental Sciences, Université du Québec à Chicoutimi, Canada

AmeriDendro2022 Montréal, Canada

UQÀM UQAC geotop

INTRODUCTION

The use of stable isotope proxies in combination with tree-ring parameters has become a well-established tool to unravel plants' responses to a changing environment. However, while there have been many studies on intra-annual wood formation processes, the specific patterns and processes of stable isotopes fractionation in high-resolution time scales -knowing the exact date of fractionation- remain unknown.

Such a time scale mismatch, represents an obstacle to investigate the timing, sensitivity and interactions among important ecophysiological processes that drive responses over shorter time scales. Consequently, process-based modeling remains poorly constrained, casting important uncertainties on the prediction of forest responses to meteorological variability.

OBJECTIVES

The objective of this project is to unravel the links between anatomical stages and underlying physiological mechanisms evidenced by $\delta^{13}C$ in tree rings (Fig .1).

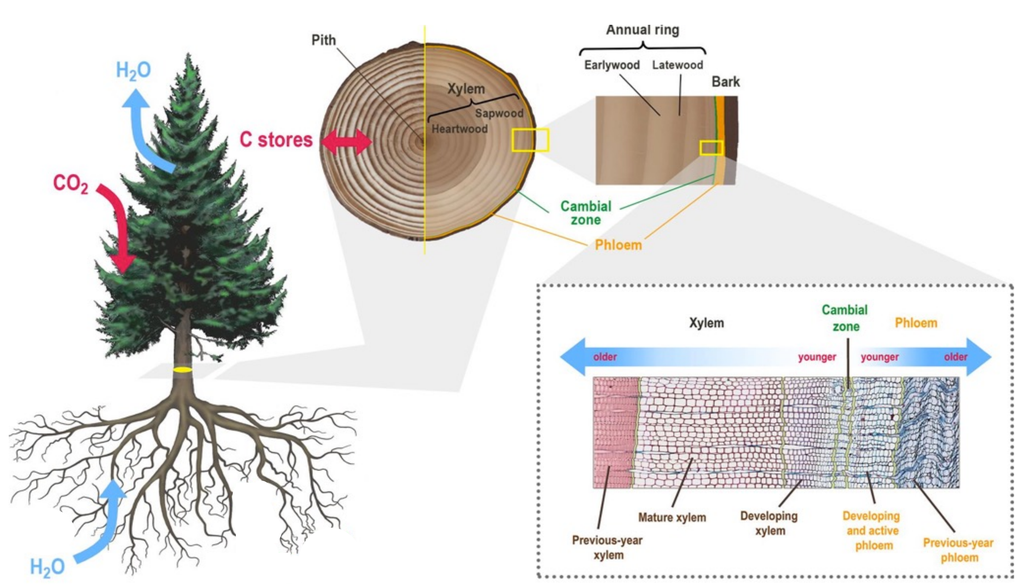

Fig. 1: Fractionation of carbon stable isotopes in tree rings and wood formation dynamics.[1]

METHOD

Five trees of black spruce species (*Picea mariana*) were selected in two sites in eastern Canada. The number of cells in different phases of growth was counted and carbon stable isotope ratios ($\delta^{13}C$) were measured on a weekly basis, in two consecutive growing seasons (2020-21) (Fig .2).

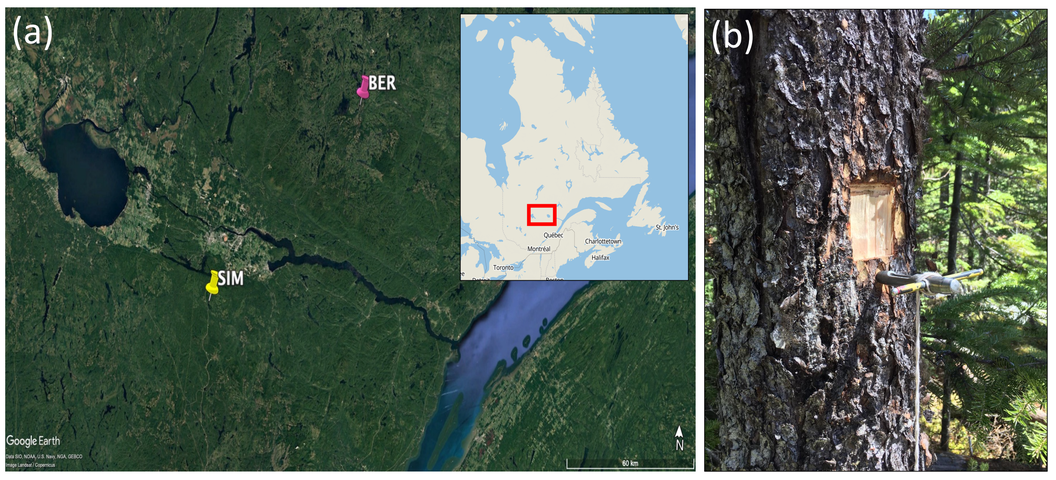

Fig. 2: (a) Maps of Quebec province and the sampling sites' locations: Simoncouche (SIM) and Bernatchez (BER), (b) Method of sampling.

PRELIMINARY RESULTS

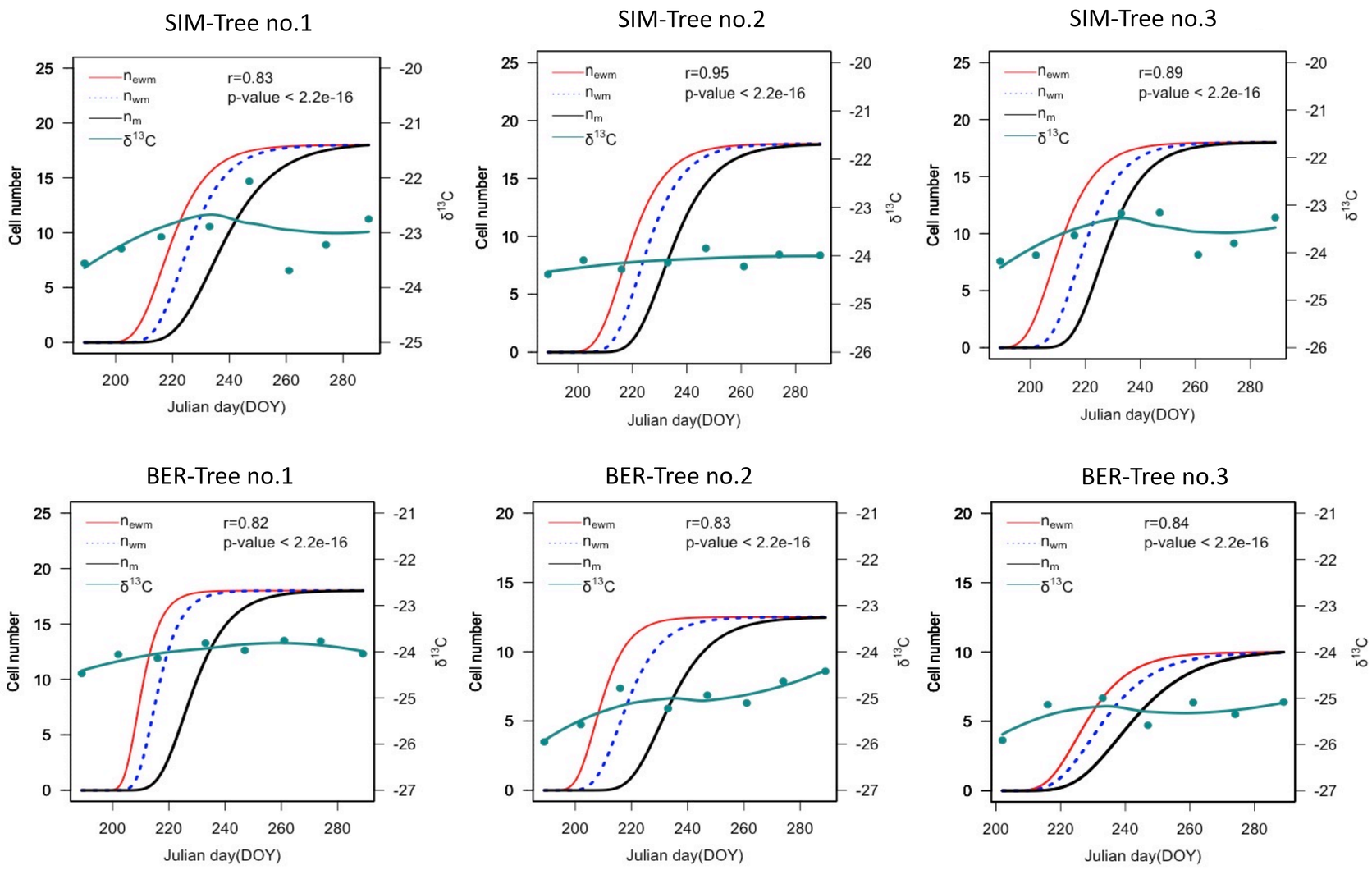

Fig. 3: Intra-annual relationships between $\delta^{13}C$ ratios and xylem development for black spruce in two sites (SIM and BER) for the growing season of 2020.

- The S-shaped curves: modelling of the cell number increase of n_{ewm}, n_{wm} and n_m, where:

$$n_{ewm} = n_e + n_w + n_m$$

$$n_{wm} = n_w + n_m$$

n_e: number of xylem cells in radial enlargement phase.

n_w: number of xylem cells in cell wall thickening phase.

n_m: number of xylem cells in mature cell phase.

- The green curve: The rate of intra-annual fractionation of carbon isotopes ($\delta^{13}C$).
- the green dots: the measured values of $\delta^{13}C$ for the specific dates of sampling during the growing season.
- The r and p-values illustrate the Pearson correlation between n_{ewm} and $\delta^{13}C$.

The results illustrate a positive correlation between weekly fractionation of $\delta^{13}C$ and cell production (number of cells per week) (Fig .3). The correlation indicate that fractionation of $\delta^{13}C$ may be a good proxy for intra-annual, photosynthesis-driven variations in tree productivity during the growing season.

SCAN ME
References