Multiproxy isotope dendroclimatology for mature white pine (Pinus strobus L.) in southern Ontario, Canada

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Abstract
In this study tree-ring width, trace element composition, and stable carbon isotope chronologies constructed from measured specimens from a mature white pine plantation (Pinus strobus L.) in southern Ontario are presented. In 2015, tree samples were collected from the 80-year-old plantation near Lake Erie, Ontario. A tree-ring chronology of ring width was constructed from 15 series. Trace element concentration per ring year was constructed from two series scanned at 500µm resolution. Two carbon isotope chronologies δ13C were constructed using two individual trees at sub-anual resolution.

As forests cover approximately 30% of the Earth’s land area and serve as its largest terrestrial carbon sink, it is important to identify relationships between environmental variables and forest growth. In light of climate change where the volume of water resources may change over regions across the globe, how have forests adapted to climate change over the past and what seasonal climate variables are most important to their sustainability at all time scales.

Objectives
The aim of the present study is to investigate the environmental control on carbon uptake of a mature afforested white pine forest in southern Ontario using a multi-proxy approach centered on carbon isotopes. Specifically, the aim is to identify the environmental effects on the δ13C of tree wood, and 2: identify if there is a relationship between ecosystem-scale measurements and δ13C of tree wood.

Study Site
The study took place in an afforeseted area of southern Ontario near Lake Erie. The site was a cleared oak savanna prior to its afforestation in 1939. The site currently is a mature stand of white pine interspersed with deciduous hardwoods.

Material and Methods
This is a multi-proxy study that used several methods to construct each data set. Data points were assigned a calendar date based on position within the tree ring and simple (Pearson) correlations between proxies to climate and ecosystem flux data were made aligned with calendar dates.

Results

![Graph of δ13C Plant vs Ring Year](image1)

Simple Correlations of Proxies:
- ET (evapotranspiration) δ13C 0.45
- GEP (gross ecosystem productivity) δ13C 0.64
- PE (potential evaporation) δ13C -0.69
- P-PE (water availability) δ13C 0.48
- Mean summer temperature δ13C -0.61

Discussion

Growing season carbon isotope / water relationships:
- δ13C

Uncorrected tree-ring δ13C is a record of instantaneous water use efficiency by the tree (molar ratio of water loss to CO2 fixation). This data, corrected for atmospheric effects, yields δ13C which has a greater correlation with other proxies and measurement data due to detrending of data for atmospheric effects. When the plant is stressed (because of low water, temperature, or other factors) the tree responds by closing its stomata, forcing carbon fixation (less CO2 fixation). This data, corrected for atmospheric effects, yields δ13C which has a greater correlation with other proxies and measurement data due to detrending of data for atmospheric effects.

Acknowledgements
This study is being funded by the Natural Sciences and Engineering Research Council of Canada (NSERC). Special thanks to Michelle Williams-Marucco for assistance with sampling and isotope analysis. We also acknowledge Dr. Sang Tae Kim and Martin Knyn of the McMaster Research Group for Stable Isotopologues for technical assistance, collaboration, and use of their facility. The first author is a PhD student at McMaster.

References:
IPCC. Intergovernmental Panel on Climate Change 2012.