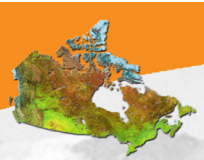

Reducing Canada's vulnerability to climate change

Assessing the use of dendroisotope geochemistry to evaluate the impact of urban pollution on CO_2 uptake by forests

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Abstract

We had previously reported that emissions of SO_2 diminish by 35 and 6% the C uptake by trees located 9 and 116 km from a copper smelter, respectively. In this activity, we combine dendrochronology (basal area increment -BAI) with stable isotope geochemistry ($\delta^{13}C$) to investigate forest stands undergoing different levels of urban diffuse pollution and assess their relative C uptake. Trees were selected 25 km west of downtown Montréal (Arboretum Morgan) where the summer ozone concentrations average 25 ppb, and 100 km northwest of Montréal (Mont-Tremblant) where the concentrations average 30 ppb.

Our preliminary results indicate that diffuse pollution (O_3, SO_2) from Montréal also diminishes the C uptake by trees but in a spatial fashion opposite to that found in smelter regions. In fact, increasing $\delta^{13}C$ coupled with decreasing BAI indicate a relative lowering of C uptake starting in the 50's, but the reduction is more important in the distant countryside than in the immediate peri-urban setting. These preliminary results confirm the pertinence of using the dendroisotopic tool to understand the impact of urban pollution on forest C uptake. The relative rates of C uptake will serve to quantify the C budget over the Canadian landmass. The dendroisotopic monitoring tool we are developing here and its application to the quantification of the Canadian C budget constitutes a precedent on the international scene.

Objectives

Long Term
To Address the issue of relative capacity of CO_2 uptake by polluted (diffuse pollution) and unpolluted forests

To Contribute to the Quantification of C storage of the Canadian forest through time

2003-2004

To Evaluate the impact of urban diffuse pollution on the CO_2 uptake by trees into exposed sites.

Approach and Methodology - (2003-2004)

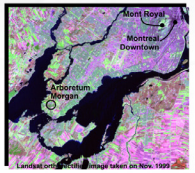
(a) Develop numerical model to include air pollution component (O_3, SO_2) in plant physiology and ecosystem carbon regime as approximated using stable isotope data and calculations (EALCO model)

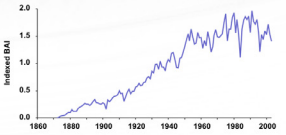
(b) Determine the forest surface affected by high SO_2 and O_3 exposure, and the surface of Canadian forest that is not polluted (in collaboration with EC and CFS experts)

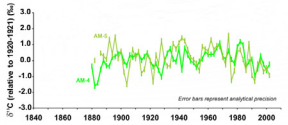
→ **(c) Initiate collection of ecosystem and environmental database for numerical model calibration and validation**

→ **(d) Determine the H (or O) and C isotopic ratios of selected trees undergoing pollution stress in selected exposed sectors and measure the tissue increments of the stems for the polluted sites**

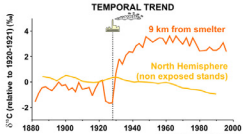
Initial results - Arboretum Morgan American Beech

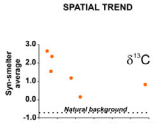


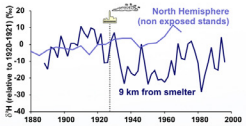


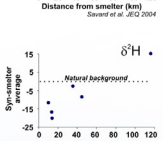


Rationale



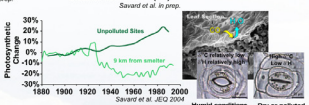


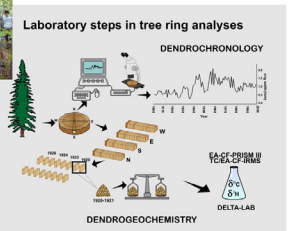




It has been reported that smelter SO_2 emissions modify the C uptake of exposed trees, what should we expect for trees growing in regions submitted to urban diffuse pollution?

If the polluted Canadian forest decrease its CO_2 uptake, what is the impact on the annual Canadian CO_2 budget?

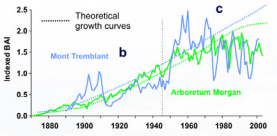


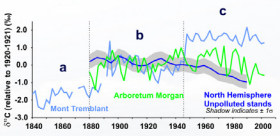


Studied sites

Sampling Site	Tree species	No trees	Time period	Trees for geochemistry	Analyses/ Isotopes
Arboretum Morgan	American Beech (*Fagus grandifolia*)	12	1840 - 2003	2	250
Parc du Mont-Tremblant	Red Spruce (*Picea rubens*)	19	1835 - 2003	2	250

Preliminary interpretations



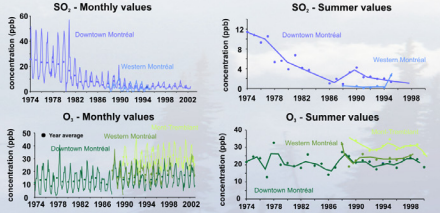


a) Canopy effect

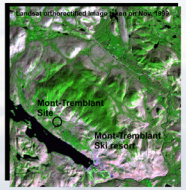
b) Regular behavior

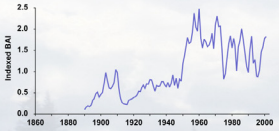
c) Urban diffuse pollution effect: higher $\delta^{13}C$ and lower basal area increment (BAI) reflect lower CO_2 uptake, as expected if urban diffuse pollution such as O_3 was responsible for the changes

Atmospheric pollutants Montréal region & countryside



Initial results - Mont-Tremblant Red Spruce





Future activities

- **Increase number of analyses for BAI and $\delta^{13}C$ statistics (before March 2004)**
- **To better understand the impact of pollutants on tree growth, investigate the response of O isotopes in cellulose of the same trees (ongoing lab work)**
- **Assess the use of dendroisotopic geochemistry to evaluate the impact of pollution on CO_2 uptake by trees (2004-2005)**
- **Integrate the pollution parameter into the modeling (EALCO model) of the Canadian biological carbon budget**

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