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Soil carbon dynamics along a climatic gradient in eastern boreal forests

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Introduction: An increase of 4°C in mean annual temperature over the next century is a likely scenario for the eastern Canadian boreal forest as predicted by GCM models (IPCC scenario A2). Gradient studies can be helpful in understanding the long-term effect of ecosystem acclimation to a given climate. Pools and fluxes of soil carbon were studied along a climatic gradient of 4°C in mean annual temperature (MAT) for two important coniferous stand types: balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). This gradient was related to latitude and altitude (Fig. 1).

Results: Soil respiration potential at a given temperature (soil respiration at 10°C (*Rs10*) as well as the change in soil respiration rate with a change in temperature (*Q10*)) did not vary along the gradient (Fig. 2). However, carbon fluxes in litterfall (Fig. 3) and soil respiration (both Rs and soil heterotrophic respiration Rh; Fig. 4) increased with increased MAT. Stand density also appeared to be related to C fluxes as one black spruce site (FLUXNET old eastern black spruce) bearing a low density of trees (classes C and D) showed low fluxes compared with other sites that had a higher stem density (density B). There was no relationship between climate regime and soil C stocks (Fig. 5).

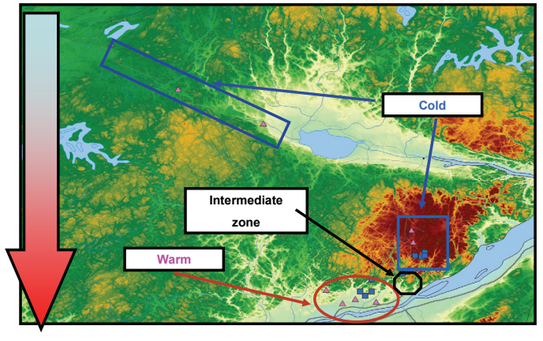

Fig. 1. Location of the 25 study sites, with 13 mature balsam fir sites (squares) and 12 mature black spruce sites (triangles). Altitudes create a climatic gradient. Mean annual temperature varies from -1.0 to 3.8°C, encompassing a 4.8°C gradient that represents a difference of 764 degree-days >5°C (856-1620).

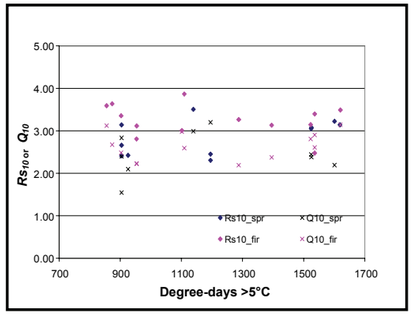

Fig. 2. Variation of soil respiration at 10°C (*Rs10*; µmol m^{-2} s^{-1}) and *Q10* with degree days >5°C.

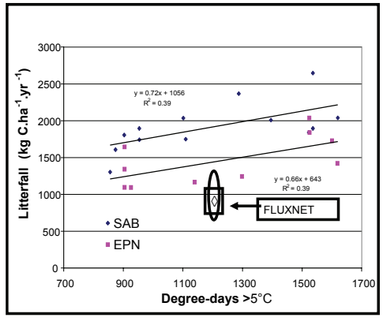

Fig. 3. Relationships between annual litterfall fluxes and degree-days >5°C.

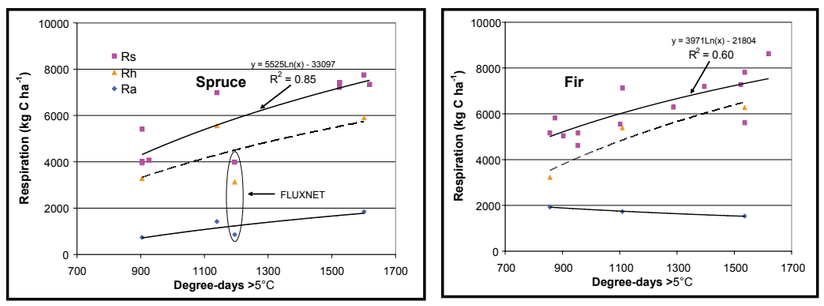

Fig. 4. Seasonal average (01/05 to 31/10) of total soil respiration (*Rs*), microbial respiration (*Rh*) and autotrophic respiration (*Ra=Rs-Rh*) with degree-days >5°C. Data from 2002 to 2005, except for the FLUXNET site (2004-2005).

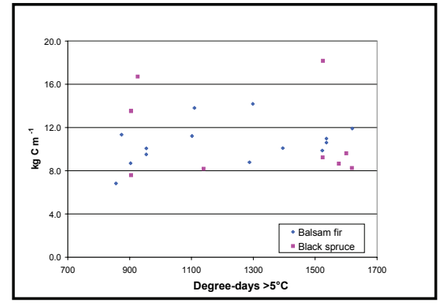

Fig. 5. Soil C content in LFH + 0-20 cm layers and degree-days >5°C.

Conclusions:

- Soil C pools were unrelated to climate along this gradient
- Soil C fluxes were related to soil T regime
- Potential to emit more CO_2 upon warming: no trend across the climatic gradient
- More research needed on the balance between C input to the soil and C output with climate, and the mechanisms of OM stabilization