Total and pyrogenic carbon stocks in black spruce forest floors from eastern Canada

Laure Soucemarianadin (1,2), Sylvie Quideau (2), M. Derek MacKenzie (2), Alison Munson (3), Juliette Boiffin (3), Guy Bernard (4), and Roderick Wasylishen (4)

(1) Ecole Normale Supérieure (UMR 8538), Géologie, Paris, France (souce@geologie.ens.fr), (2) Department of Renewable Resources, University of Alberta, Edmonton, Canada, (3) Département des sciences du bois et de la forêt, Université Laval, Québec, Canada, (4) Department of Chemistry, University of Alberta, Edmonton, Canada

In boreal forests, pyrogenic carbon (PyC), a by-product of recurrent wildfires, is an important component of the global soil C pool, although precise assessment of boreal PyC stock is scarce. In this study including 14 fire sites spreading over 600 km in the Quebec province, our aim was to better estimate total C stock and PyC stock in forest floors of Eastern Canada boreal forests. We also investigated the environmental conditions controlling the stocks and characterized the composition of the various forest floor layers. We analyzed the forest floor samples that were collected from mesic black spruce sites recently affected by fire (3–5 years) using elemental analysis and solid state 13C nuclear magnetic resonance (NMR) spectroscopy. PyC content was further estimated using a molecular mixing model on the 13C NMR data.

Total C stock in forest floors averaged 5.7 ± 2.9 kg C/m2 and PyC stock 0.6 ± 0.3 kg C/m2. Total C stock was under control of the position in the landscape, with a greater accumulation of organic material on northern aspects and lower slope positions. In addition, total stock was significantly higher in spruce-dominated forest floors than in stands where jack pine was dominant. The PyC stock was significantly related to the atomic H/C ratio ($R^2 = 0.84$) of the different organic layers. 13C NMR spectroscopy revealed a large increase in aromatic carbon in the deepest forest floor layer (humified H horizon) at the organic-mineral soil interface. The majority of the PyC stock was located in this horizon and had been formed during past high severity fires rather than during the most recent fire event. Conversely, the superficial "fresh" PyC layer, produced by early-season wildfires in 2005–2007, had NMR spectra fairly similar to unburned forest floors and comparatively low PyC stocks.