Role of forest fire on carbon accumulation in boreal peatlands

Peat bogs are terrestrial ecosystems that store large amounts of carbon through production and accumulation plant material. Despite peatlands cover of only 3% of the global land area, these ecosystems store about 30% of the global soil carbon (Blodau, 2002; Gorham, 1991). The net accumulation of carbon is the result of a positive balance of input (plant growth or production) and loss (decomposition of peat) of carbon. The high potential for carbon storage results primarily from the low decomposition rates of dead plant material due to high water table depth, resistant plant material, acidic conditions (a pH of 3-4) and generally low annual temperatures. Climate variations are generally accepted as important factors influencing peat accumulation and decomposition. In addition, disturbance by human action such as drainage, grazing or natural fire activity can disturb the general positive balance of carbon accumulation. Forest fires are the most important factor in the boreal region of North America (Kasischke et al., 1995). However, to which extent boreal bogs in eastern Canada can be affected or have been affected by fire during their existence is poorly known. Western Canadian peat bogs, often covered by trees, can be burned relatively easily (Turetsky et al., 2002), probably due to a dry climate compared to eastern Canada. Bogs in Québec are suspected to be much less susceptible to burning because of a high surface humidity and open nature often lacking a tree cover (Figure 1). As part of the Eastmain-1 project, this research aims at linking historical peat burning patterns to variations in carbon accumulation rates. These results will allow a better evaluation of future peatland carbon loss through fire activity, and therefore better estimate the net greenhouse gas budget of the Eastmain-1 project.

Figure 1: *Lac Le Caron peatland located in the Eastmain-1 region. Note the lack of tree cover on the peatland compared to the surrounding area.*

Peat accumulation in the Eastmain-1 region started shortly after the disappearance of the ice sheet around 8000 years before present. Since, approximately 20% of the Eastmain-1 project terrestrial area has been covered by peatlands, with peat accumulation ranging form 50 to 550 cm in thickness. For this study, three bogs were selected to evaluate the role of forest fire on their carbon accumulation. Five peat cores (Figure 2) were extracted from each of the three peatlands and analysed at Université du Québec à Montréal. Peat cores were first described and their content was later analysed. Results obtained are typically around 90-95% moisture, 5-10% organic material and 0.1% mineral material. With these data, the total amount of carbon in a peat column can be calculated, taking into account that carbon typically constitutes 50% of the organic matter. The history of the local vegetation was reconstructed by plant macrofossil analysis. This technique involves counting and estimating the presence of fossil plant tissue, leaves, seeds, etc. using a binocular microscope. In addition, the assemblages of fossil testate amoebae were reconstructed. Testate amoebae are shell-forming amoebae that are very sensitive to local peat humidity. Using a transfer function, past water table position can be obtained from testate amoebae assemblages. Finally, peat cores were analyzed on the presence of macrocharcoal particles (>355 µm). Charcoal particles of this size or greater found in peat cores are good indicators of local fire events (Figure 2) (Ohlson and Tryterud, 2000).

By comparing these records of past local variations in peat growth and the use of radiocarbon dating techniques, we can infer a regional record of past carbon accumulation. Carbon dynamic will also be linked to changes in dominant peat vegetation and water table depth in relation to various past regional climatic episodes and fire events. These data maybe useful to validate models of future peat carbon accumulation patterns related to existing scenarios of century-scale climate change.

Figure 2: *Peat core extracted from the Lac Le Caron peatland. Charcoal layer can be observed around 50cm.*

References

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