Geophysical Research Abstracts
Vol. 14, EGU2012-8374, 2012
EGU General Assembly 2012

The impact of bryophytes on the carbon stocks of northern boreal forest soils

U. Hagemann (1), M. T. Moroni (2), C. H. Shaw (3), and W. A. Kurz (4)

(1) Leibniz Centre of Agricultural Landscape Research (ZALF) e.V., Institute of Landscape Biogeochemistry, Müncheberg, Germany (ulrike.hagemann@zalf.de), (2) Forestry Tasmania, Hobart, Australia, (3) Natural Resources Canada, Canadian Forest Service - Northern Forestry Centre, Edmonton, AB, Canada, (4) Natural Resources Canada, Canadian Forest Service - Pacific Forestry Centre, Victoria, BC, Canada

Dead organic matter (DOM), organic layer, and mineral soil carbon (C) dynamics in cool and humid northern boreal forests are expected to differ from those of drier or warmer boreal forests, because processes such as paludification and woody debris (WD) burial within the organic layer by overgrowing moss are more pronounced in regions with low average temperatures, vigorous moss layers, and long fire-return intervals. However, very few studies have provided field-measured data for these mostly remote regions. Hence, C cycling models such as the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3) have rarely been validated with field data from northern boreal forest soils, resulting in large uncertainties for estimated C stocks in a large proportion of the boreal forest ecozone. We present (i) measured data on organic layer and mineral soil (0–45 cm) C stocks in 18 old-growth and disturbed high-boreal black spruce stands in Labrador, Canada; (ii) a comparison of field-measured soil C stocks with those predicted using the CBM-CFS3; and (iii) special characteristics of the DOM and soil C dynamics of northern boreal forest soils that require modifications of model parameters and structure.

Measured organic layer C stocks (30.4–47.4 Mg C ha-1) were within the range reported for other boreal forests. However, mineral soil C stocks (121.5–208.1 Mg C ha-1) contributed 58–76% to total ecosystem C stocks. Mineral soil C stocks were thus considerably higher than observed in other upland boreal forests in drier or warmer regions, but similar to values reported for black spruce on poorly drained sites and peat soils. In addition, large amounts of deadwood C (4.7–18.2 Mg C ha-1) were found to be buried within the organic layer, contributing up to 31% to total organic layer C stocks.

The comparison of field-measured and CBM-CFS3 modeled C stocks showed that organic layer and mineral soil DOM in Labrador black spruce stands likely decays at lower rates than assumed by CBM-CFS3 default parameters. Modeled estimates of mainly wood- and bryophyte-derived organic layer C stocks were improved by reducing the respective base decay rate to 50% of default (0.0075 yr^{-1}), thus reflecting the impact of bryophytes on organic layer decay rates. Mineral soil C stocks modeled using a preliminary soil type-specific decay rate (0.00207 yr^{-1}) optimised for Humo-Ferric Podzols were in better agreement with field-measured values than default estimates. However, the incorporation of WD burial, which results in an increased transfer of C from the WD to the organic layer C pool, would require structural changes of the model. The model evaluation process highlighted the importance of accounting for bryophyte C dynamics, the physical burial of WD by bryophytes, and associated changes in organic layer and mineral soil decay rates in northern boreal forests.