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Does the increased air humidity affect soil respiration and carbon stocks?

Mai Kukumägi (1), Luisella Celi (2), Daniel Said-Pullicino (2), Priit Kupper (1), Jaak Sõber (1), Krista Lõhmus (1), Sander Kutti (3), and Ivika Ostonen (1)

(1) Institute of Ecology and Earth Sciences, University of Tartu, Estonia (mai.kukumagi@ut.ee), (2) Department of Agricultural, Forest and Food Sciences, University of Turin, Italy, (3) Tartu College of Tallinn University of Technology, Estonia

Climate manipulation experiments at ecosystem-scale enable us to simulate, investigate and predict changes in carbon balance of forest ecosystems. Considering the predicted increase in air humidity and precipitation for northern latitudes, this work aimed at investigating the effect of increased air humidity on soil respiration, distribution of soil organic matter (SOM) among pools having different turnover times, and microbial, fine root and rhizome biomass. The study was carried out in silver birch (Betula pendula Roth.) and hybrid aspen (Populus tremula L. × P. tremuloides Michx.) stands in a Free Air Humidity Manipulation (FAHM) experimental facility containing three humidified (H; on average 7% above current ambient levels since 2008) and three control (C) plots. Soil respiration rates were measured monthly during the growing season using a closed dynamic chamber method. Density fractionation was adopted to separate SOM into two light fractions (free and aggregate-occluded particulate organic matter, fPOM and oPOM respectively), and one heavy fraction (mineral-associated organic matter, MOM). The fine root and rhizome biomass and microbial data are presented for silver birch stands only.

In 2011, after 4 growing seasons of humidity manipulation soil organic carbon contents were significantly higher in C plots than H plot (13.5 and 12.5 g C kg-1, respectively), while soil respiration tended to be higher in the latter. Microbial biomass and basal respiration were 13 and 14% higher in H plots than in the C plots, respectively. Twice more fine roots of trees were estimated in H plots, while the total fine root and rhizome biomass (tree + understory) was similar in C and H plots. Fine root turnover was higher for both silver birch and understory roots in H plots. Labile SOM light fractions (fPOM and oPOM) were significantly smaller in H plots with respect to C plots (silver birch and hybrid aspen stands together), whereas no differences were observed in the contents of the more stable MOM. These results strongly suggest that, apart from the predicted increase in temperature and atmospheric carbon and nitrogen concentrations, an increase in free air humidity as a result of climate change may significantly influence the complex belowground carbon cycling by affecting biomass production, soil respiration and organic matter turnover.