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Fast responses of root dynamics to increased snow deposition and summer air warming in an arctic wetland

Ludovica D'Imperio (1,2), Cecilie Skov Nielsen (1,3), Marie Arndal (2), Bo Elberling (1), and Inger Kappel Schmidt (2)

(1) University of Copenhagen, Center for Permafrost (CENPERM), Department of Geosciences and Natural Resource Management , Denmark , (2) University of Copenhagen, Section for Forest, Nature and Biomass, Department of Geosciences and Natural Resource Management, Denmark, (3) Department of Forest Ecology and Management, Swedish University of Agricultural, Umeå, Sweden

In wet tundra ecosystems, covering vast areas of the Arctic, the below-ground plant biomass exceeds the above-ground, making root dynamics a crucial component of the nutrient cycling and the carbon (C) budget of the Arctic. In response to the projected climatic scenarios for the Arctic, namely increased temperature and changes in precipitation patterns, root dynamics may be altered leading to significant changes in the net ecosystem C budget. Here, we quantify the single and combined effects of one year of increased winter snow deposition by snow fences and summer warming by open-top chambers (OTCs) on root dynamics in a wetland at Disko Island (West Greenland). Based on ingrowth bags, snow accumulation decreased root productivity by 42 % in the 0-15 cm soil depth compared to ambient conditions. Over the growing season 2014, minirhizotron observations showed that root growth continued until mid-September in all treatments, and it peaked between the end of July and mid-August. During the season, plots exposed to experimental warming showed a significant increase in root number between the end of July and mid-September (between 9 % and 32 %) and a 94 % increase in root length by the beginning of September. Also, it was observed a significant reduction of root diameter (14 %) in plots with increased snow accumulation. Along the soil profile (0-40 cm) summer warming by OTCs significantly increased the total root length (54 %), root number (41 %) and the root growth in the 20-30 cm soil depth (71 %). These results indicate a fast response of this ecosystem to changes in air temperature and precipitation. Hence, on a short-term, summer warming may lead to increased root depth and below-ground C allocation, while increased winter snow precipitation may reduce root production by means of reduced growing season length or increased nutrient cycling. Knowledge on below-ground root dynamics is therefore critical to improve the estimation of the C balance of the Arctic.