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Controls on Ecosystem and Root Respiration in an Alaskan Peatland

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Boreal ecosystems cover 14% of the vegetated surface on earth and account for 25-30% of the world's soil carbon (C), mainly due to large carbon stocks in deep peat and frozen soil layers. While peatlands have served as historical sinks of carbon, global climate change may trigger re-release of C to the atmosphere and may turn these ecosystems into net C sources. Rates of C release from a peatland are determined by regional climate and local biotic and abiotic factors such as vegetation cover, thaw depth, and peat thickness. Soil CO2 fluxes are driven by both autotrophic (plant) respiration and heterotrophic (microbial) respiration. Thus, changes in plant and microbial activity in the soil will impact CO2 emissions from peatlands. In this study, we explored environmental and vegetation controls on ecosystem respiration and root respiration in a variety of wetland sites.

The study was conducted at the Alaskan Peatland Experiment (APEX; www.uoguelph.ca/APEX) sites in the Bonanza Creek Experimental Forest located 35 km southwest of Fairbanks Alaska. We measured ecosystem respiration, root respiration, and monitored a suite of environmental variables along a vegetation and soil moisture gradient which included 5 plots each dominated by a different vegetation type: black spruce shrub, tussock-grass, sedge, and brown moss and forb dominated. Within the rich fen, we have been conducting water table manipulations including a control, lowered, and raised water table treatment. In each of our sites, we measured total ecosystem respiration using static chambers and root respiration by harvesting roots from the uppermost 20 cm and placing them in a root cuvette to obtain a root flux.

Ecosystem respiration (ER) on a μmol/m2/sec basis varied across sites. At the rich fen, ER varied significantly by year and was partially governed by climate. ER varied significantly by plot along the gradient with higher ER fluxes at the grass and sedge dominated plots. Mean seasonal fluxes showed no significant relationships with temperature or precipitation suggesting vegetation could be an important factor driving ecosystem respiration.

Root respiration fluxes (mg CO2sec-1gC-1) were highest for forb and sedge species and were lower for shrub and tree species. It appears that the variation in root respiration could partially explain the variation in ER along the gradient plots. Therefore, an important next step will be to partition ER into autotrophic and heterotrophic components to determine how much root respiration controls the variability in ecosystem respiration. This in turn will provide a better assessment of peatland C responses to global climate change.