Does climate or tree roots control C and nutrient sequestration in temperate forests? A soil translocation approach

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Climate is an important master variable for temperate forests and is set to alter their hydrology, biogeochemical cycling, and add ecological pressures from the changing climate. In particular, increases in mean annual temperature are set to enhance the rate of abiotic and biotic processes from fewer days below freezing, greater day time temperatures, and longer growing seasons with implications for faster C and nutrient cycling in soils. Trees can alter nutrient dynamics through rhizosphere processes but capturing these effects at scale is difficult due to parent material controls through varying mineralogy and clay content. Here, we have conducted a study using translocated homogenized parent material within soil columns at six upland secondary growth forest sites following a climate gradient (MAT 6°C to 14 °C) along the Appalachian mountain range from Virginia to New Hampshire. The soil columns were filled with the sterile, sandy loam mixture and half were deployed with lateral root access windows while the other half did not. After four years of deployment, litter traps collection, and throughfall monitoring, we examined the biogeochemical fluxes and pools for C, N, K, and P. The six sites received comparable throughfall inputs and litterfall C and N inputs were comparable among the six sites. However, there were some significant differences in litterfall P inputs. Mean annual temperature was a significant factor in C, N, K, and P storage within the organic horizons, with greater pools in the northern sites. However, C and N mineral soil storage was increased by mean annual temperature but not K and P. Root biomass was significantly greater between the root exlusion and root inclusion soil columns but there was no significant difference in the storage of C, N, K, or P by rhizosphere processes. Our results show that after 4 years, temperature was a strong driver in organic horizon and mineral soil C and N sequestration but inorganic nutrients were not affected. We hypothesize the inorganic nutrients are either operating on much longer time scales and soil processes were unaffected.