Title: Soil Carbon Cycling Changes at Depth Due to Woody Encroachment of Tallgrass Prairie

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Project Abstract:

The earth's land surface is covered ~40% by grass-dominated ecosystems. Shrub encroachment into grasslands is also a widespread phenomenon across the U.S. Great Plains. Woody encroachment affects ecosystem carbon (C) dynamics; however, C-cycling responses in deeper soil horizons are unknown. Understanding subsoil C responses is critical, because C stocks at depth in grassland soils are large, and encroaching shrubs have deep rooting systems. Fresh C input to subsoils could either promote C accumulation, or C loss if microbial priming of soil C mineralization occurs. We asked how shrub encroachment affects soil C cycling at depth in (a) a transitional grassland, where shrub patches exist within a grass matrix, and (b) watersheds that are shrub-invaded or remain in full grass cover. We expected higher C input and microbial activity, particularly deeper in the soil profile, under woody plants in comparison to grasses at both scales. We collected 6 replicate 1-m soil cores under dogwood islands and open grass areas at both scales, and measured soil C pools and cycling rates at 10-cm increments. Isotopic C measurements were used to differentiate C3-woody-plant-derived from C4-grass-derived pools and fluxes. Results partially support our predictions, in that the δ13C‰ of soil microbial respiration was lower under woody plants than grasses (-19.9 (1.0) < -17.1 (1.1), mean (SE), $p=10^{-16}$) over the whole soil profile, and this difference was greater at both 0-10cm and 50-100cm depths (p=0.0002). This shows that soil microbes use more C3-plant derived C, particularly at depth, under encroaching dogwood plants. In contrast, both total microbial respiration and the labile (30-day mineralizeable) C pool was larger and had higher δ13C‰ in grassland than woody invaded watersheds (P<0.001), and there was a strong positive priming response to sugar addition in grassland soils only (40-110%); but these responses did not vary significantly by depth. Total soil C had higher δ13C‰ in grassy watersheds, but total C pools had not changed even after 30 years of woody encroachment. In sum this suggests that woody encroachment of grassland changes soil C cycling, with turnover in all pools, and a net decrease in labile soil C that may be related to priming of microbial consumption of labile C. Ultimately, these data will be used in combination with linked drought experiments to better parameterize Earth System Models for forecasting the large-scale impacts of woody encroachment and drought on the grassland terrestrial C balance.