Poster #24

ANL Terrestrial Ecosystem Science SFA: Estimating Arctic Coastal Plain Soil Carbon Stocks Vulnerable to Active Layer Thickening Under Future Climate

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Estimates of the amount and distribution of organic carbon (C) stored in permafrost-region soils are improving but uncertainties remain high, affecting the ability to reliably predict regional C-climate feedbacks. In lowland permafrost soils, much of the organic matter exists in a poorly degraded state and is often weakly associated with soil minerals due to the cold, wet environment and cryoturbation. Thus, climate warming and permafrost thaw are likely to increase active layer thickness and expose relatively labile soil C stocks to enhanced microbial activity and decomposition. Ice wedge polygons are ubiquitous, patterned ground features throughout Arctic coastal plain regions and are large enough (5-30 m across) that a better three-dimensional understanding of the potential vulnerability of their C stocks to regional warming could improve geospatial upscaling of observational data. We investigated the distribution of soil organic C to a depth of 2 meters across three polygon types developed on glaciomarine sediments of the Arctic Coastal Plain of Alaska: flat-centered (FCP), low-centered (LCP), and high-centered (HCP) polygons, with each type replicated 3 times. We found that soil organic C stocks varied across polygon features (troughs versus centers) and differed among polygon types, with HCPs generally having the largest C stocks despite greater ice volumes. Organic horizon and permafrost C stocks increased from FCPs to LCPs to HCPs, in large part due to greater presence of organic horizons in the upper permafrost of LCPs and HCPs. Our detailed polygon profiles also enable estimation of the amount permafrost-stabilized C that could become vulnerable to enhanced decomposition as a result of increases in active layer thickness under future climate as projected by Earth system models. Thus, accounting for polygon-scale (trough to center to trough) and landscape-scale (polygon type) variations could help reduce the uncertainties in observational estimates of potentially vulnerable soil C stocks for areas dominated by ice wedge polygons and contribute benchmarks for constraining model parameters.