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Plant Traits Across an Arctic Landscape: Above Versus Belowground

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The complex response of ecosystems to climate change is predicted using Earth System Models, many of which utilize the concepts of plant functional types and plant traits to simulate potential fluxes of energy, carbon (C), and nutrients through a given plant community. High-latitude ecosystems are made up of a mosaic of different plant communities, all of which are exposed to warming at a rate double that observed in ecosystems at lower latitudes. Arctic regions are an important component of global Earth System Models due to the large amounts of soil carbon currently stored in permafrost as well their potential for increased plant C sequestration under warmer conditions. Losses of C from thawing and decomposing permafrost may be offset by increased plant productivity, but plant allocation to belowground structures and nutrient acquisition by roots remain a key source of uncertainty in Earth System Models. The relationship between belowground plant traits and environmental conditions is not well understood in high latitude ecosystems, nor are tradeoffs between above- and belowground plant traits. To address these knowledge gaps, the NGEE Arctic project sampled plant species across a variety of different microsites along the Kougarok Hillslope on the Seward Peninsula, Alaska. The vegetation communities sampled included Alder shrubland, willow birch tundra, tussock tundra, dwarf shrub lichen tundra, and non-acidic mountain complex. Within each plant community, aboveground biomass and canopy height were characterized. For each plant species present, specific leaf area, leaf chemistry (%C, %N, %P and δ15N), and wood density were measured. Belowground fine-root biomass and rooting depth distribution were also determined at the community level. Fine roots from shrubs and graminoids were separated so that specific root area, average diameter, and root chemistry (%C, %N, %P and δ15N) could assessed for these contrasting plant functional types. The environmental conditions present across these vegetation types varied greatly and linear mixed effect models were used to determine their relative influence on above- and belowground plant traits. Tradeoffs between above- and belowground plant traits were also examined for both graminoid and shrub plant functional types. The results of this analysis will inform the inclusion of belowground plant traits in Earth System Models and represent a novel contribution of the NGEE Arctic to arctic ecosystem ecology.