Local and Regional Drivers of Shrub Traits in Northern Alaska

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BER Program: TES
Project: University-Led Research

Project Abstract:
Rapid warming in the Arctic is driving changes in the structure and composition of tundra ecosystems, resulting in dramatic increases in the cover of deciduous shrubs. Deciduous shrub expansion is expected to shift the distribution of aboveground and belowground plant traits, which in turn may feedback to climate by altering carbon and nutrient dynamics. However, the magnitude of this feedback is highly uncertain given limited understanding of spatial variation in plant functional traits and the over-simplification of shrub traits and their ecological effects in current ecosystem and Earth system models. To facilitate improved representation of aboveground and belowground shrub traits in models, we sampled leaf, size and root traits of common deciduous shrub species in three genera (*Betula, Alnus, and Salix*) and tussock sedge vegetation (dominantly *Eriophorum spp.*) across five moist acidic tundra sites along a latitudinal gradient in Northern Alaska (67.0 °N – 69.3 °N) and used Bayesian multilevel modeling to determine inter- and intra-specific trait relationships with local and regional environmental conditions.

We found strong interactions between site and species for most traits, indicating that interspecific trait responses covaried with regional environmental conditions. Average summer temperature and average annual climatic water deficit were the primary drivers of interspecific variation in leaf and size traits. Both shrub specific leaf area (SLA) and height increased strongly with summer temperature, while SLA, height and leaf nitrogen concentration ([N]) decreased with climatic water deficit. Root traits also covaried with climate. Specific root length (SRL) decreased with summer temperature and increased with climatic water deficit, whereas fine root density showed the opposite pattern, suggesting shrubs increase belowground carbon allocation under warmer and drier conditions. There was substantial intraspecific trait variation driven by local edaphic conditions. Shrub SLA, leaf [N], and SRL all decreased with local soil temperature and increased with thaw depth. *Eriophorum* leaf [N] also decreased with local soil temperature. These results demonstrate that there are predictable spatial environment-trait relationships at both regional and local scales that can be leveraged to model the functional consequences of climate change in tundra ecosystems.