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Modeling Shrub Expansion Under Changing Climate Across Arctic Tundra of North America

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Recent changes in species composition and increased shrub abundance in particular has been reported as a result of amplified warming in Arctic tundra. Despite these changes, the driving factors that control recent Arctic shrubification and its future trajectory remain uncertain. Here, we used an ecosystem model, *ecosys*, to mechanistically represent and explain the underlying processes of how plant functional types (PFTs) have changed under climate change in recent decades and will change over the 21st century across the Arctic tundra of North America (NA). Modeled changes in average productivity of shrubs (~35%) over recent decades were corroborated by observed changes (20 – 40%) across different sites of the NA Arctic tundra. Recent and projected warming was modeled to increase thawing of the permafrost, deepen the active layer (~3 cm decade-1), increase nutrient availability, and enhance shrub growth in Arctic tundra. Although spatial heterogeneity and contrasting modeled responses of co-existing Arctic PFTs occur in the predictions, overall increases in shrub productivity was modeled across the tundra, particularly in Alaska and the tundra-boreal ecotone. Increases in graminoids were modeled in the lower central Arctic, while non-vascular plants increased across much of the high-Arctic and declined in the low-Arctic from increased canopy cover of shrubs that limited incoming shortwave radiation for low-lying plants. A particular increase in productivity of fast-growing deciduous vs. slow-growing evergreen shrubs in the warmer low-Arctic was modeled through differences in investment and retention of carbon and nutrients in their leaves under enhanced N mineralization.