

Winter Plant Nutrient Uptake Controls Arctic Tundra Vegetation Change Under 21st Century Climate

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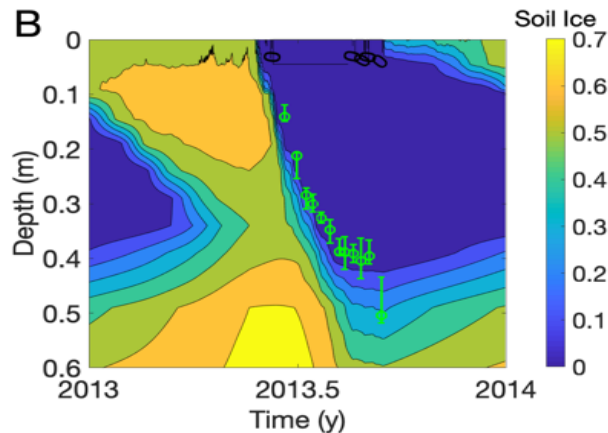
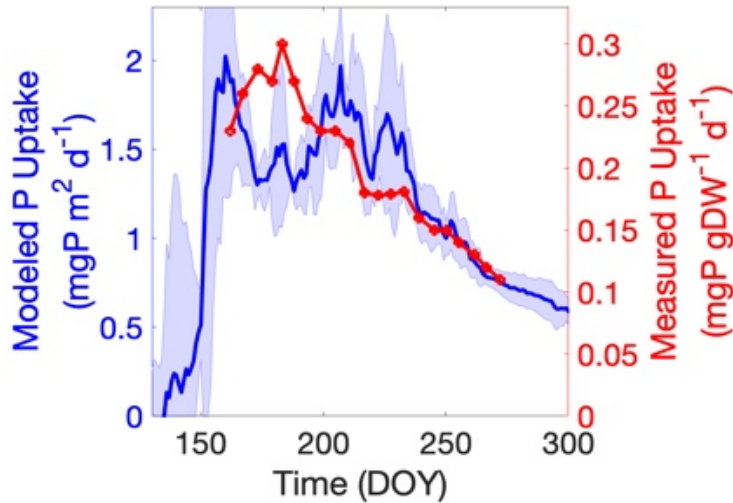
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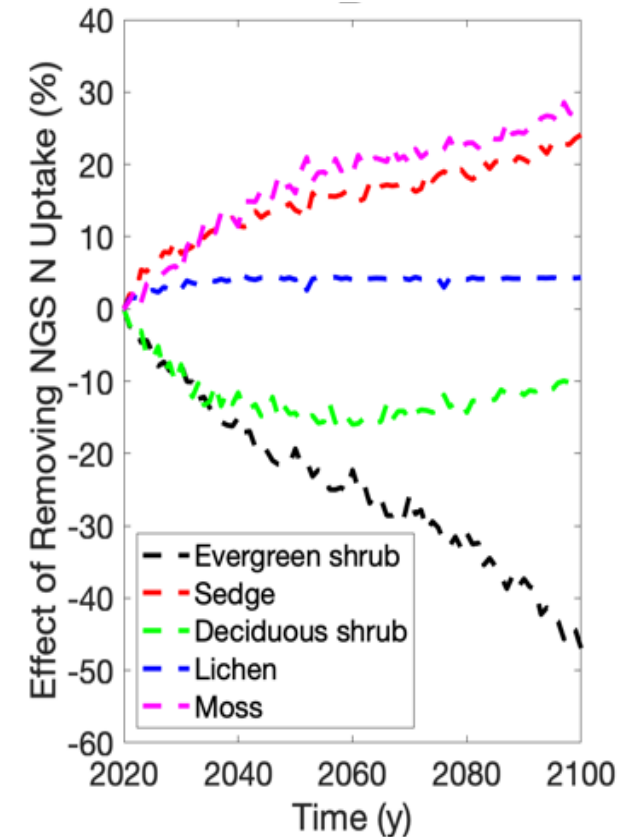
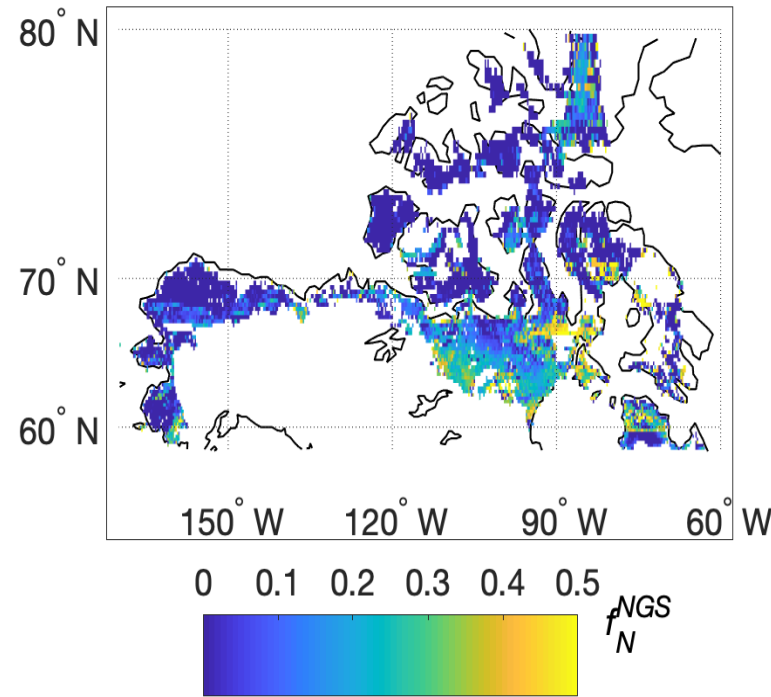
Winter Plant Nutrient Acquisition Enhances Shrubification

- Winter processes are important for high-latitude C cycle (e.g., Natali et al. 2019 *Nature Climate Change*)
- Winter nutrient uptake is widely observed and affects C cycle (Riley et al. 2018 *Nature Climate Change*)
- Almost all large-scale models ignore these processes, including ELMv2



Riley et al. in review

Model is consistent with observations that $f_N^{NGS} \sim 5-50\%$



Effects on deciduous shrubs are smaller because they better take advantage of warming



Future Research

- Biophysical responses to high-latitude vegetation cover change
 - Effects on hydrology, thaw depth, albedo, leaching, etc.
- Responses to atmospheric CO₂ and disturbance (e.g., wildfire)
- Winter soil decomposition and nutrient cycling interactions with vegetation and effects on net C balance
- Develop wintertime benchmarks for models

Relationship to White Paper

- High-latitude carbon, nutrient, hydrological, and energy balances all depend on vegetation processes
 - Shrub expansion will strongly affect these processes and the net C balance of high-latitude ecosystems
- Biophysical responses to vegetation cover change
- Plant physiological responses to atmospheric CO₂, surface energy budgets, nutrient availability, and regional environmental conditions.
- Soil dynamics
- Ecosystem vegetation dynamics and effects on C budgets

