Remote Sensing of Plant Functional Traits for Modeling Arctic Tundra Carbon Dynamics

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Project Abstract:

Rapid warming in the Arctic is driving changes in the structure and composition of tundra vegetation communities. These changes are expected to alter key biogeochemical and physical processes that feedback to climate. However, the magnitude of this feedback is highly uncertain due to limited understanding of the spatial distribution of plant functional traits and the over-simplification of traits in current Earth system models. To facilitate improved representation of aboveground and belowground traits in models, we aim to characterize directly observable plant functional traits from remotely sensed data, and predict non-observable (e.g., belowground) traits by leveraging trait-environment relationships and trait covariation. Additionally, we will integrate trait information into the Terrestrial Ecosystem Model (TEM) to quantify and predict regional C balance in the Alaskan tundra.

In July and August 2021, we established four sites representing dominant plant community types in northern Alaska. Two sites were located south of the Brooks Range in the boreal-tundra ecotone, and the other two sites were in the Arctic Coastal Plain. In each site, we measured species percent cover, canopy height, and edaphic parameters, and collected leaf samples and root cores to characterize traits at the species, functional type, and community levels. Each site was also imaged with a drone to collect hyperspectral and LiDAR data. A minimum of six additional study sites will be sampled and imaged over the next two years. Using these data, we will test a range of hypotheses about the processes that control plant trait distributions in northern Alaska. We will also integrate ground-based measurements with information derived from multi-scale remote sensing platforms from drone, hypertemporal, LiDAR, and hyperspectral imagery to produce maps of leaf, size and root traits, greatly expanding the trait information available for modelers. Finally, we will use Bayesian data-model fusion methods to improve the parameterization and formulation of TEM, which is widely used in Arctic carbon studies, and perform simulation experiments to evaluate how differences in plant functional traits affect C dynamics.