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Capturing Plant Trait Variation in the Arctic with Remote Sensing

Shawn Serbin[1], Wil Lieberman-Cribbin[1], Kim Ely[1], Alistair Rogers[1] and Stan Wullschleger[2]

[1] Brookhaven National Laboratory
[2] Oak Ridge National Laboratory

Contact: Shawn Serbin [sserbin@bnl.gov]

The inadequate representation of plant traits and trait variation in terrestrial biosphere models (TBMs), including many that underlie the land-surface component of Earth System Models (ESMs), is a key driver of uncertainty in model hindcasts and forecasts of terrestrial carbon, water, and energy cycling and storage. This is particularly relevant for biomes with only sparse observational data availability such as the Arctic and tropics. In the Arctic, uncertainty in the modeling of carbon fluxes has been tied to the lack of key data on plant properties that regulate these processes. What is needed is an approach to bridge the scales between detailed observations of Arctic vegetation in remote locations and the larger, landscape context needed to inform models on parameter variation in relation to climate, soils, topography, perturbations and other edaphic conditions. Remote sensing approaches, particularly spectroscopy, imaging spectroscopy and thermal infrared (TIR), represent powerful observational datasets capable of scaling plant properties and capturing broad-scale spatial and temporal dynamics in many important vegetation properties. In temperate ecosystems we have shown how leaf and imaging spectroscopy (IS) can be used to map a broad range of plant traits across large areas of the continental U.S. and through time. Here we extend these approaches to the high Arctic to evaluate the capacity to scale and map vegetation properties, including biochemical, morphological and physiological leaf traits from the leaf to landscape scales. Our initial focus is on the development of linkages between a range of plant species and remote sensing data within the Barrow Environmental Observatory (BEO), Barrow, Alaska study site. We coupled measurements of leaf chemistry and physiology, including leaf-level gas exchange, with measurements of full range (i.e. 0.3 to 2.5 microns) leaf optical properties (reflectance and transmittance). Our resulting leaf-level spectra-trait models for Arctic vegetation, developed using data collected in the BEO during the 2014-2016 growing seasons, are comparable with existing models from other biomes. Importantly, despite strong variation in leaf morphology and physiology, we are finding a good potential for spectral models to capture trait variation and highlights the possibility to map traits in the high Arctic. Our next steps include the use of Unmanned Aerial Systems (UASs) for very high resolution near surface scaling as well as leveraging the upcoming 2017 NASA ABoVE airborne campaign, which will including flights over Barrow and the Seward Peninsula, to develop algorithms for mapping key traits across broad regions in the Arctic.