Mapping Arctic Tundra Landscapes Using Multiscale Hyperspectral Data

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High latitude ecosystems are experiencing among the fastest rates of climate-driven ecological change on Earth. Arctic tundra landscapes are not only vast and difficult to access but are heterogeneous and dynamic, due to the interplay between changing vegetation, surface hydrology and geomorphology. The spatial and temporal scale of these interactions and consequent changes makes it challenging to monitor and describe the nature of their responses to ongoing climate change. Consequently, over the last decade, *in situ*, near-surface and remote sensing data have been collected over high latitude ecosystems at locations across Alaska and Canada, as part of NSF's International Tundra Experiment (ITEX) - Arctic Observing Network (AON) and NASA's The Arctic-Boreal Vulnerability Experiment (ABoVE). These efforts provide unique opportunities to examine the rich structural and spectral information present in multiscale hyperspectral data to study an array of characteristics of tundra ecosystems and landscapes. Here we present algorithms that help extend localized ground measurements to the region by applying them to the Airborne Visible/Infrared Imaging Spectrometer Next Generation (AVIRIS NG) imagery. Descriptions of a variety of landscape and ecosystem characteristics are derived from reflectance spectra, including estimates of tundra plant cover, chlorophyll content, normalized difference vegetation index (NDVI), and gross primary productivity (GPP), which help describe regional patterns and relationships among surface hydrology, plant functional type diversity, vegetation biochemistry, and ecosystem productivity. This study demonstrates how (i) the partial least squares regression (PLSR) approach can be used to extract important spectral information from both *in situ* and airborne hyperspectral data and (ii) high-spatial and spectral resolution ecosystem level data products can be developed using hyperspectral data collected across scales and using different sensors. While this study focuses on high arctic tundra plant communities, these approaches can be applied across other landscapes and to data from a variety of sensors, including future hyperspectral imaging satellites (e.g. SBG, DESIS, CHIME, EnMAP, PRISMA).