Scaling ground-based hyperspectral scans to AVIRIS next gen using UAV-based VNIR imaging spectroscopy for mapping arctic and boreal plants in Alaska.

Peter Nelson[1], David Paradis[2], and Wouter Hantson[3]

[1]University of Maine at Fort Kent
[2]Student
[3]University of Maine

November 21, 2022

Abstract

Arctic plants are small in stature and spectrally diverse, which presents challenges to current NASA missions to visualize effects of disturbance or directional vegetation change via mapping. Remotely sensed data having fine spatial (ca. 10 cm pixels) and spectral grain (eg. "hyperspectral") will therefore help resolve patches of many arctic plant groups, such as dwarf shrubs, bryophytes and lichens and separate them from litter, wood or rock/soil. To address these challenges, in summer 2018 we sampled vegetation at 15 different sites around Fairbanks, Alaska using ground-based and airborne hyperspectral sensors under eight different AVIRIS ng flight lines next gen flight lines (circa 2017-2018). At each AVIRIS flight line, we estimated percent cover of plant functional types in eleven 1m2 quadrats every 10 m along a 100m transect. We then flew our UAV and imaging spectrometer (Headwall Micro A-series VNIR, 400-1000 nm, 330 bands, 10 cm pixels). Spectral signatures of any surfaces were sampled using a field spectroradiometer (PSR+ Spectral Evolution, 400-2500 nm, 1nm bands). We collected 600+ georeferenced scans from 70+ species/plant functional types at 25+ different sites around Alaska. Spectral profiles showed many different plant species have similar to indistinguishable signatures (eg. Paper birch and Alder) while many plant functional types that have been grouped together (eg. Moss) were very spectrally heterogenous. UAV-based hyperspectral imagery (ca. 4-10 cm pixels) resolved pure pixels of many artic plants. Our approach resolves fine grained ecological features, such as networks of circular patches (mostly lichens, brophytes and mineral soil) over very large areas (ca. 10,000 m2), created by small cryoturbation features (frost boils). We explore spectral unmixing and other statistical approaches to compare mapping results using our spectral library with AVIRIS ng (4 m pixels) and our UAV-based VNIR hyperspectral imagery.

POSTER: B31F-2532

Scaling ground-based hyperspectral scans to AVIRIS next gen using UAV-based VNIR imaging spectroscopy for mapping arctic and boreal plants in Alaska.

Peter R. Nelson and David P. Paradis, Natural and Behavioral Sciences Division, University of Maine at Fort Kent, Fort Kent, ME, USA; Wouter Hanston, School of Forest Resources, University of Maine, Orono, ME

Introduction: Arctic plants are small in stature, spectrally diverse or highly intermixed, which presents challenges to current NASA missions to visualize effects of disturbance or directional vegetation change via mapping. Remotely sensed data having fine spatial (ca. 10 cm pixels) and spectral grain (eg. "hyperspectral") could help resolve patches of many arctic plant groups, such as shrubs, dwarf shrubs, bryophytes and lichens and separate them from litter, wood or rock/soil.

Fig. 1: Field sites (dots) within Alaska, USA.

Fig. 2: Median reflectance spectral signatures collected in the field with a spectroradiometer. Scans are grouped by plant type.

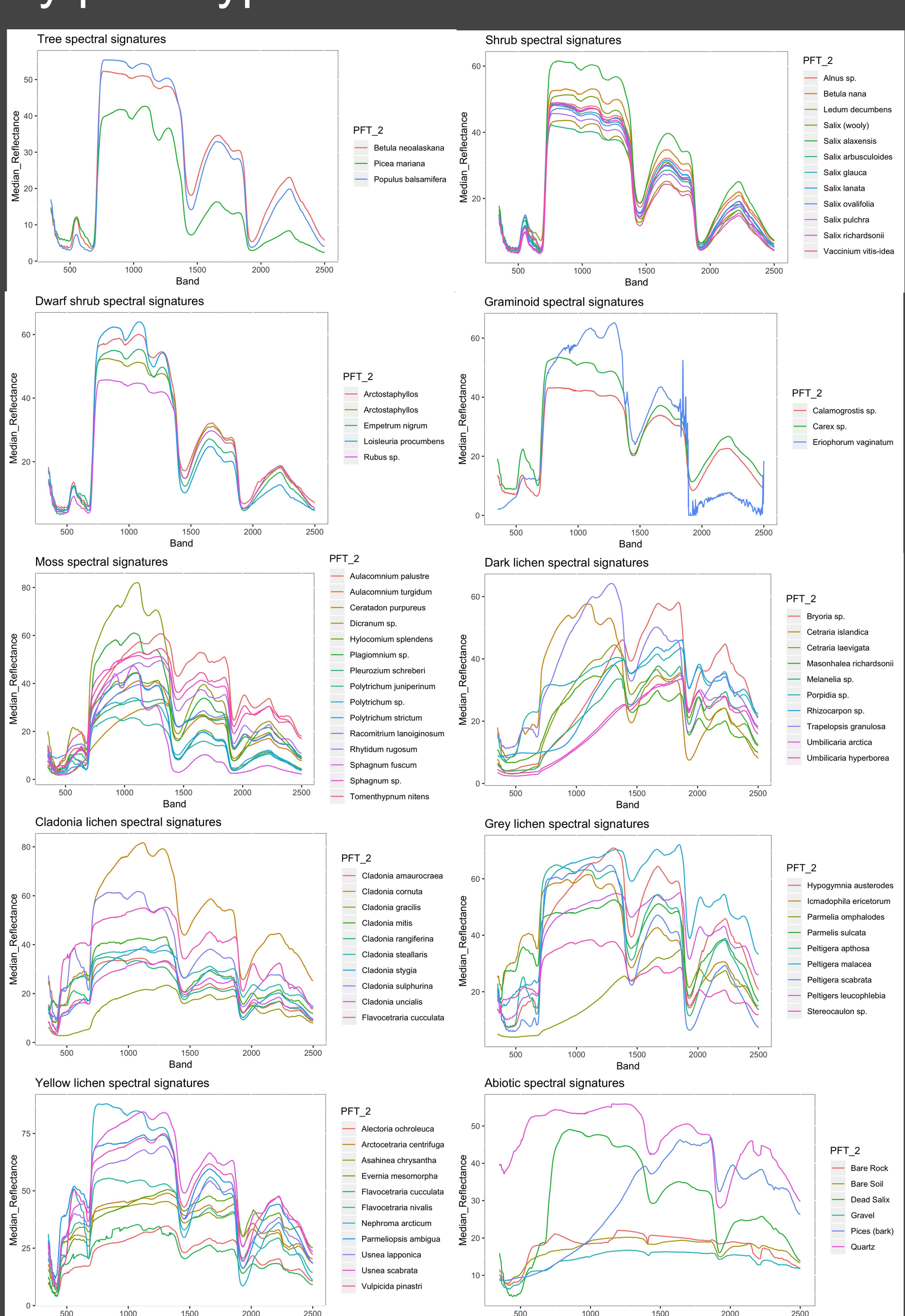
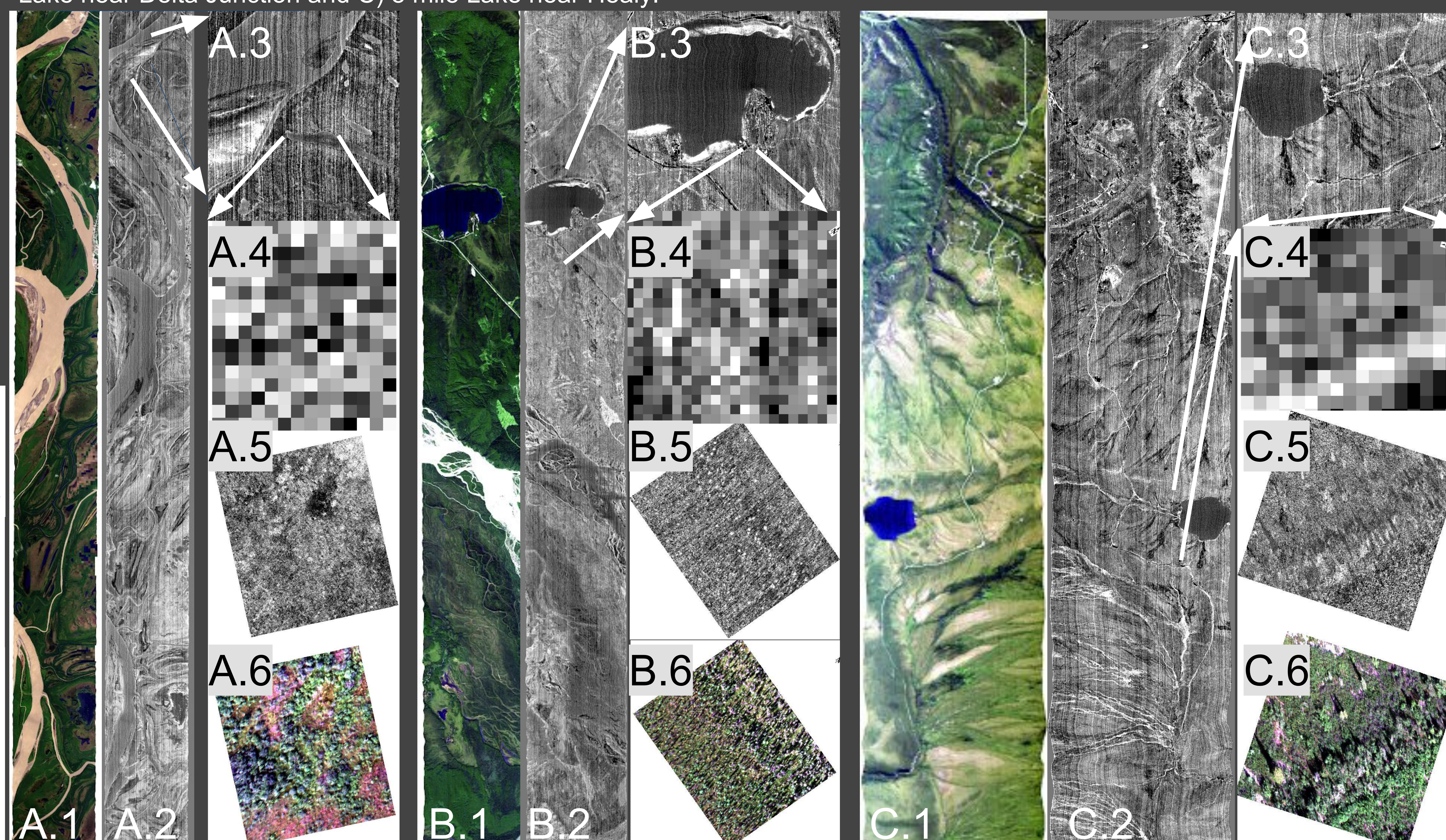


Fig. 3: Sequence of Red/Green/Blue (RGB, eg. A.1, A6) and Mixture-Tuned Matched Filtering (MTMF, all other images) class maps for different AVIRIS ng flight lines and UAV-based VNIR imagery showing Salix alaxensis where white pixels indicate a better match (greater amount) to the imagery spectra. Imagery from Alaska at the A) Yukon delta near Emmonak B) BIrch Lake near Delta Junction and C) 8 mile Lake near Healy.



Methods: In the summer of 2018, sites were selected to be coincident with AVIRIS ng and other ABoVE science team projects (Fig. 1). At each site, we flew a DJI Matrice600 with a Headwall Micro A-series VNIR imaging spectrometer (400-1000 nm, 326 bands) at either 50 or 100m AGL (4-10 cm GSD). At the same time, we collected field spectra of plants, mosses and lichens with a Spectral Evolution PSR+ spectroradiometer (350-2500nm). We compiled a spectral library of all scans and calculated the median reflectance by plant functional type (PFT). UAV imagery was radiometrically calibrated using a white reference calibration tarp in each scene and orthromosaicked in Headwall's SpectralView software. AVIRIS ng reflectance products were downloaded from the online data portal and both UAV and AVIRIS imagery were analyzed using Mixture Tuned Matched Filtering (MTMF) in ENVI 5.5. The spectral library was resampled and rescaled to match each type of imagery.

Results:

UAV imagery: We flew 20 missions at 5 different general area from central to western Alaska, all under AVIRIS ng acquisitions.

Data Collection: Over 600 scans from >70 plant, moss or lichen species were collected (Fig. 2).

Mixture Tuned Matched Filtering: MTMF recovered general patterns of vegetation occurrence (eg. river bars of willows) in both AVIRIS ng and UAV VNIR imagery (Fig. 3). The pixel size difference between these two types of imagery showed spatial patterns in the UAV imagery not visible in AVIRIS ng.

Conclusion: This work reports on the progress to catalog the spectral signatures of plants in Alaska and apply them to different hyperspectral imagery. Attempts to use MTMF with AVIRIS ng were more successful compared to the UAV VNIR imagery based on subjective evaluation of what plant groups were detected compared to RGB imagery. Noise in the higher wavelengths, narrower spectral range and shadows all made using MTMF more difficult for the UAV imagery. Pure-pixel approaches (not shown) provided better results in terms of qualitative assessment of accuracy but poorer matches to spectral library endmembers. Future work will focus on accuracy assessment based on in-situ measurements and workflow automation.

Acknowledgements: Thanks to Matt Macander and J.J. Frost (ABR, Inc) for discussion about sampling methods and Headwall for tech support. **This work was was funded by NASA's Arctic Boreal Vulnerability Experiment (ABoVE) Grant NNX15AU05A,** and the Maine Economic Improvement Fund (MEIF-SCI).