Assessing Alaskan Boreal Forest Landcover Affected by Climate-wildfire Interactions from Ground Truth Surveys and NASA Airborne Remote Sensing

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November 22, 2022

Abstract

Alaska's boreal forest is facing unprecedented challenges under rapid climate warming (increasingly severe fires, droughts, pest/disease outbreaks) that may destabilize its function as a global carbon sink. Forests near Fairbanks may be especially vulnerable, impacting air quality and ecosystem services. We combined GT (ground truthing) with Airborne Visible InfraRed Imaging Spectrometer (AVIRIS-NG) images collected by the NASA Arctic-Boreal Vulnerability Experiment (ABoVE) program (2017-2019) to assess landcover change at five recently burned sites (2001-2019) of different fire severities and moisture regimes within 30 miles of Fairbanks. GT included tree seedling counts, understory % cover and >50% leaf canopy color assessment. 36 circular plots (1/30 ha radius) including 6 moderate to severely burned plots were selected across sites. 31 additional sites including 12 burned sites were geotagged in photos. AVIRIS images were processed from 29 spectral bands selected to identify changes in chlorophyll and water content. Images were segmented into natural boundaries (polygons) using ENVI 5.5 software. A spectral library of 8 AVIRIS bands with high between-class/low within-class variation was used in two random forest models to predict vegetation classes (model 1: 12 classes, model 2: 14 classes) in each AVIRIS scene, using 20% of the data as training data. Model 2 classified 20% more polygons overall, but only 42% of GT/geotagged polygons were correctly classified by both models. More forest sites were correctly classified (63%) than open vegetation (32%) or post-fire sites (46%). 50% of aspen forest and post-fire polygons were misclassified as shrubland. GT revealed that post-fire plots supported 134,000 (± 48,000) tree seedlings and saplings ha^{-1} (0.2 - 4 m height, 64% deciduous) versus 2500 (± 2100) shrubs ha^{-1} (1-6 m height). > 50% canopy browning was observed in conifer forest (8 plots) with no signs of insect infestation. Canopy herbivory > 50% (leaf miner, leaf beetle) and moose herbivory of tree bark was seen across aspen sites. Our study suggests: 1) low canopy vegetation presents challenges for improved landcover classification, and 2) aspen forest should be differentiated in vegetation maps which would aid in tracking herbivory.

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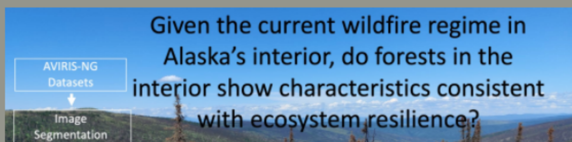
Motivation for the work



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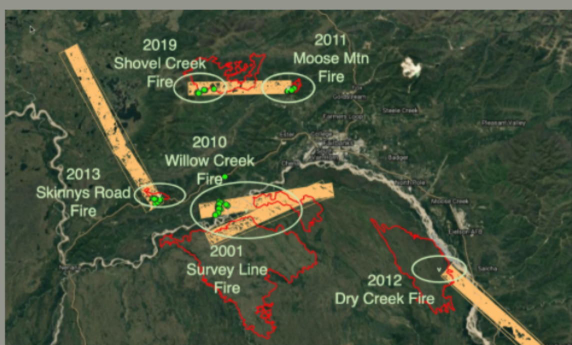
Methodology



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Main Findings

- **Spectral analysis of LUE, LWC, and NPV showed tree stress in 2017 at a site that burned in 2019.**

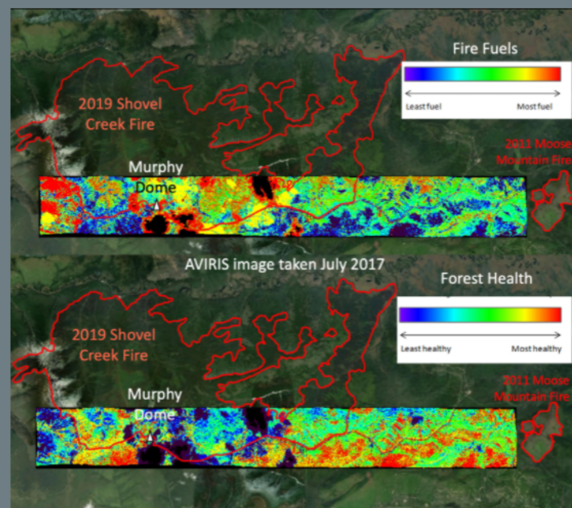

Figure 5. Spectral analysis of narrowband greenness, LUE, LWC and NPV of 2017 AVIRIS-NG image of Moose Mountain (Fairbanks, Alaska) shows ranges of fire fuels and forest health associated with tree stress. Red outlines show the boundary of the 2019 Shovel Creek fire. The peak of Murphy Dome (elevation 893 m) is shown for reference.

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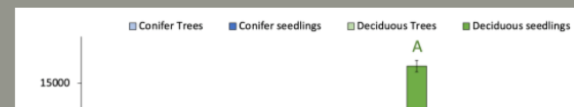
Other Results & Implications

- **Tree seedling densities were 4 to 80 times larger in post-burned sites** than in unburned forest (Figure 7)



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Future Work, Acknowledgements, & References

Future Work:

- Reclassification of AVIRIS scenes directly based on post-GT confirmation of endmembers
- Analysis of radial growth from tree cores
- Further spectral analysis of tree stress in AVIRIS scenes
- A higher resolution vegetation map (including differentiation of aspen and birch forest) to track areas vulnerable to fire and insect attack.

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