Foliar functional trait variation in ABoVE Arctic and Boreal regions of North America

Kyle Kovach[1,*], Ryan Pavlick[2], Zhiwei Ye[1], Charles Miller[2], Eric Kruger[1], Else Radeloff[1], Adam Redmer[1], Morgan Dean[2], Samuel Jaeger[1], Philip Townsend[1]

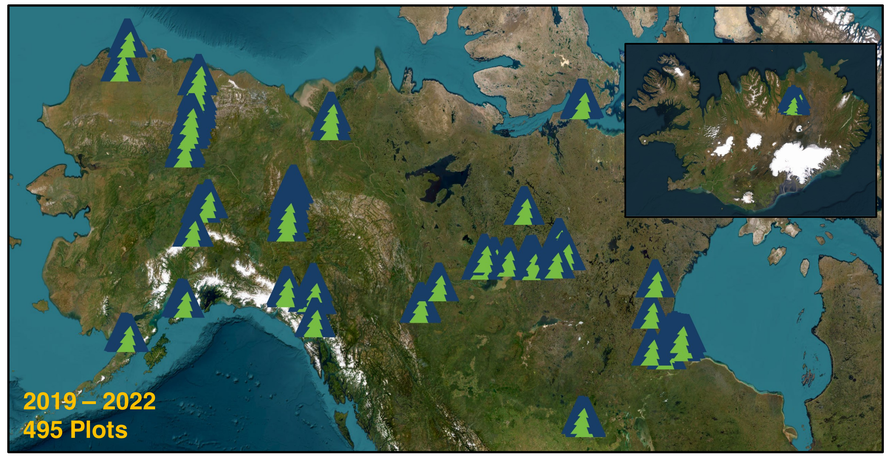
[*]Contact Information: kyle.kovach@wisc.edu

[1]University of Wisconsin [2]Jet Propulsion Laboratory, California Institute of Technology

Background

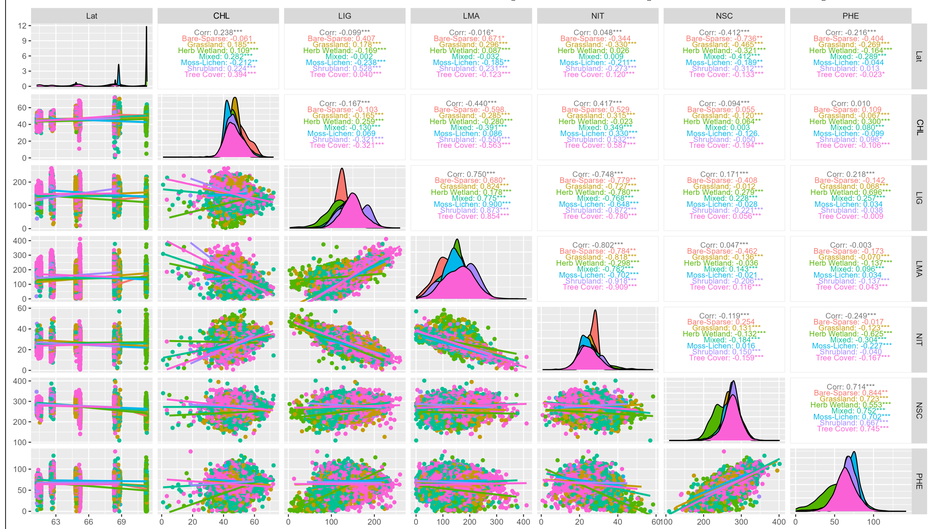
Foliar functional traits are measurable plant properties strongly tied to plant growth, defense, and reproduction. As the effects of climate change influence plant health and species ranges in Arctic and Boreal ecosystems, we seek to quantify these effects by assessing as many variables associated with the variation and change as possible. We have leveraged NASA AVIRIS – Next Generation imagery collected in Arctic and Boreal regions within the ABoVE domain in Alaska and northwest Canada to produce large scale trait maps across the landscape. Initial analysis includes seven traits (Chlorophylls, d13C, Lignin, Leaf Mass per Unit Area, Nitrogen, Non-structural Carbohydrates, and Phenolics). These maps have been combined with environmental and climatological data to understand what is driving potential trait change, as well as differences between and within traits across these ecosystems. These results show strong regional differences by climate, with more homogeneous trait profiles within local regions. They also show the value of imaging spectroscopy to assess change and variation in remote locations. Additionally, a robust field campaign was carried out by two teams in Alaska and upper Canada in 2022 to contribute 205 additional plots to an existing dataset used to build and update trait models. The locations of these campaigns were based on environmental datasets linked to existing plot sites to create representativeness maps highlighting areas which could benefit from increased sampling.

Field Sites

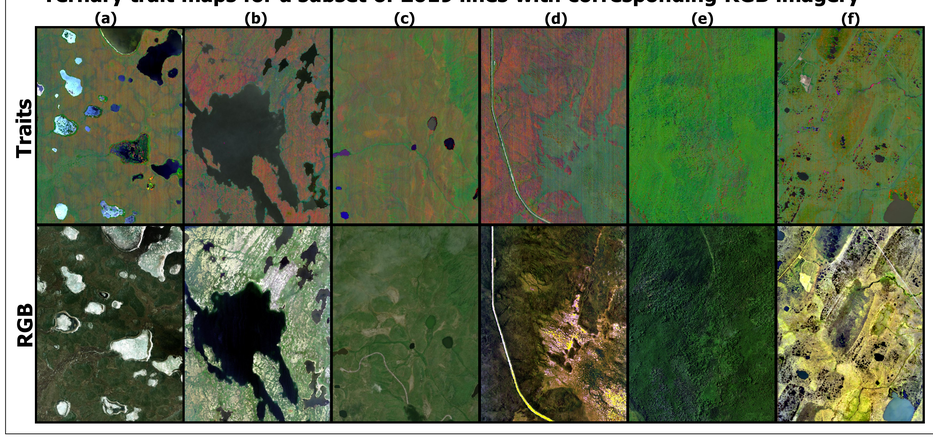


Results

Trait correlations for a subset of 2019 lines by land cover (ESA WorldCover)

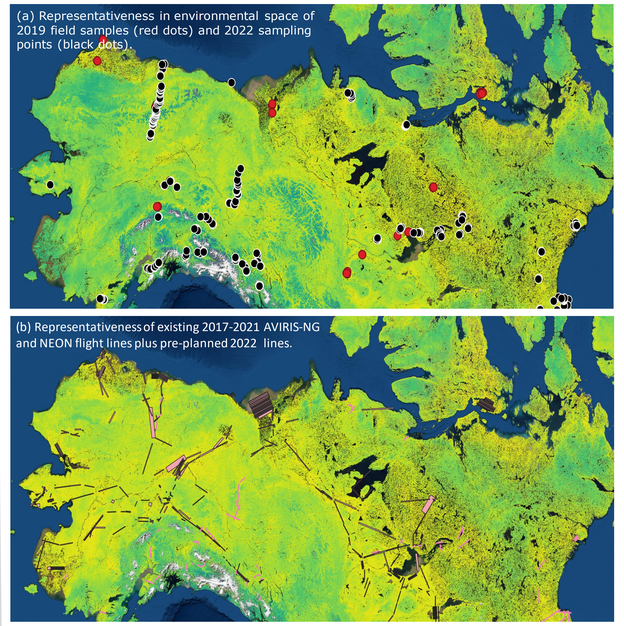


Ternary trait maps for a subset of 2019 lines with corresponding RGB imagery

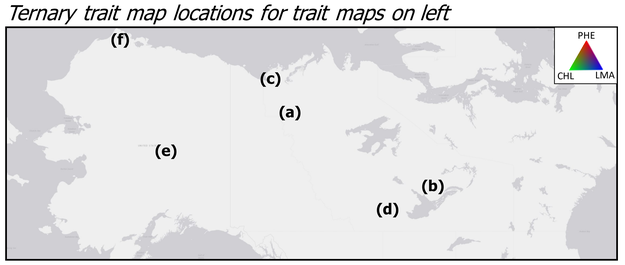


Representativeness of field sampling and AVIRIS imagery

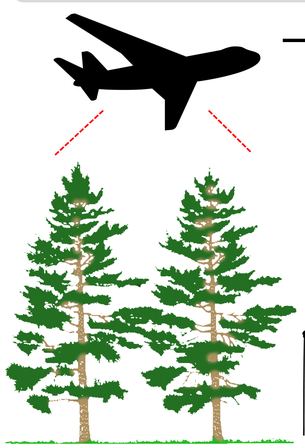
We conducted a PCA-based representativeness analysis using environmental data (climate, soils, geology, etc.) to assess the representativeness of the existing data to hypothesized drivers of foliar traits across the ABoVE domain. We used this to identify sampling and imaging locations for 2022.



Ternary trait map locations for trait maps on left



Data Collection



Airborne Spectral Imagery

- Bidirectional Reflectance Distribution Function Correction
- Topographic Feature Correction
- Partial Least Squares Regression Models

Traits

- Aluminum
- Boron
- Calcium
- Carbon
- Carotenoids
- Cellulose
- Chlorophylls
- Copper
- d13C
- d15N
- EWT
- Fiber
- Flavonoids
- Iron
- Lignin
- LMA
- Magnesium
- Manganese
- Nitrogen
- NSC
- Phenolics
- Phosphorus
- Potassium
- SLA
- Starch
- Sugar
- Sulfur
- Water %
- Zinc

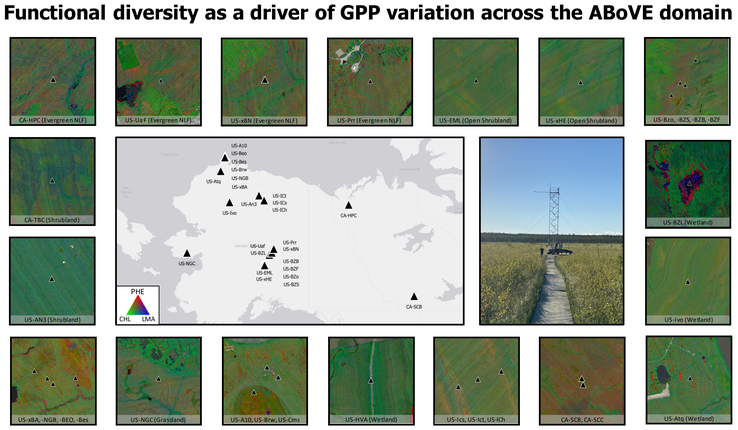
Ground-Based Spectroscopy

- Partial Least Squares Regression Models
- Lab Chemistry and Field Measurements

Future Work

Townsend (TE 2021) – Functional diversity as a driver of GPP variation across the ABoVE domain

In addition to 2022 sampling and completing trait and uncertainty maps for the entire ABoVE record, we see potential to use trait and trait diversity maps to predict variation in flux tower GPP based on flux footprints. See initially extracted 1km trait-tower windows from 2019 imagery on right.



Acknowledgements

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