Mapping Plant Functional Types (PFT) Cover across the ABoVE Domain

Matthew J. Macander, P.R. Nelson, K. Orndahl & S.J. Goetz
mmacander@abrinc.com

Goetz (TE 2021)

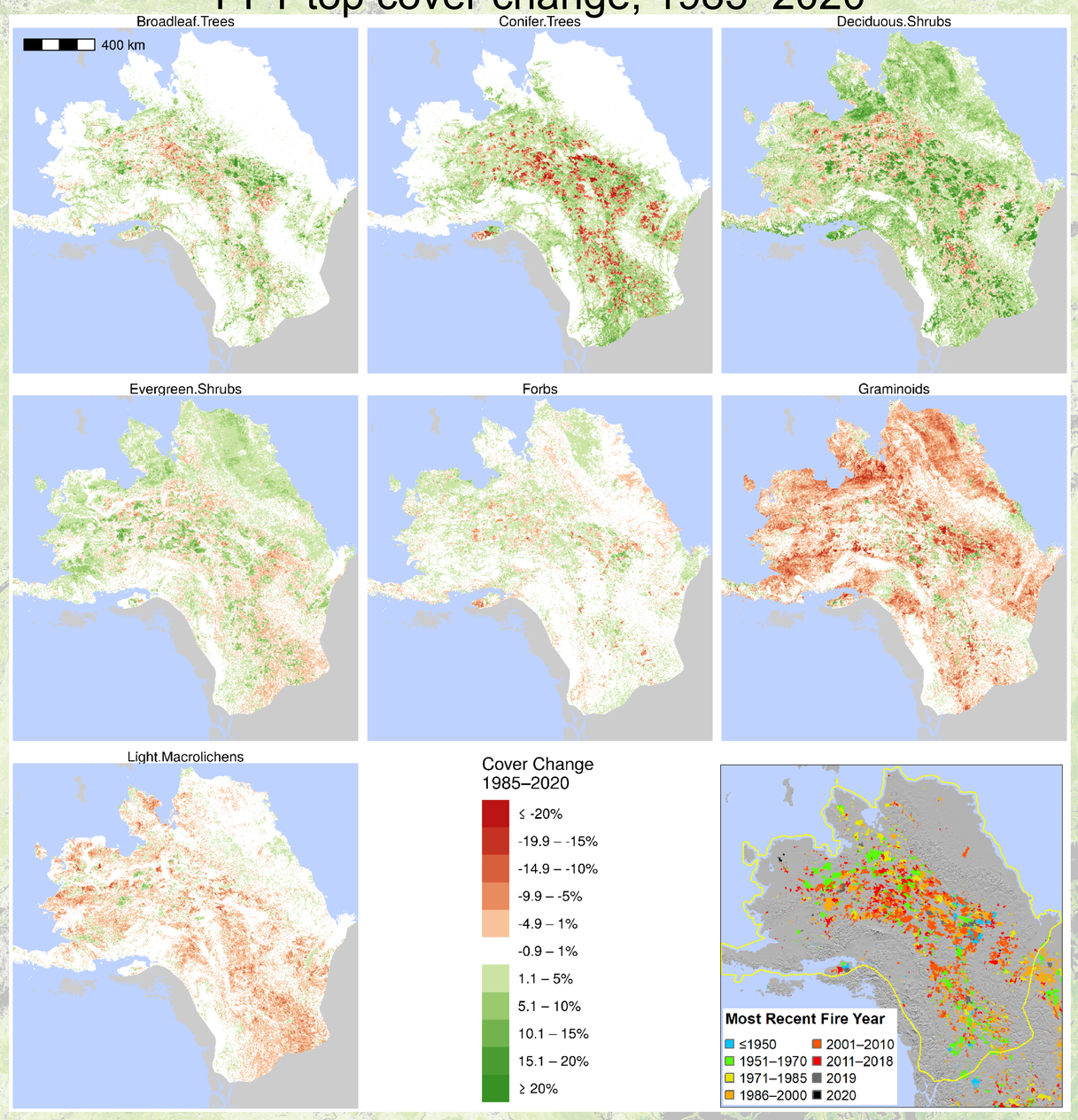
Background

Widespread changes in the distribution and abundance of plant functional types (PFTs) are occurring in Arctic and boreal ecosystems due to the intensification of disturbances, such as fire, and climate-driven vegetation dynamics, such as tundra shrub expansion. To quantify these changes we mapped a 35-year time-series (1985–2020) of top cover (TC) for seven PFTs across a 1.77 x 10^6 km² study area in northern and central Alaska and northwestern Canada. In Phase 3 of ABoVE, we are extending the spatial and temporal extent of the maps and improving the vertical resolution of shrub PFTs.

Version 1 (Macander et al. 2022)

PFT	Height (cm)	Description
Conifer Trees	150–3500	Spruce trees are dominant in boreal forest and forest-tundra ecotones, with pines also common in Canada. Deciduous Tamarack also occurs.
Broadleaf Trees	150–3000	Birch, Aspen, and Cottonwood trees.
Deciduous Shrubs	0–500	Primarily Willow, Alder, and Birch shrubs; other shrubs, including blueberry and arctic rose.
Evergreen Shrubs	0–100	Widespread low and dwarf shrubs with persistent leaves. Common species include entire leaf mountain-avens, mountain heather, lingonberry, and Labrador tea.
Graminoids	10–100	Sedges, grasses, and rushes. Can be abundant across a range of habitats from permanently inundated wet meadows to dry uplands. They often have abundant dead litter.
Forbs	0–50	Diverse group of non-graminoid herbaceous flowering plants found throughout the Arctic and boreal. Cover is typically low but may be high in the years following fire.
Light Macrolichens	0–5	Diverse nonvascular plants consisting of fungal and algal symbionts. Reindeer lichens and other mostly light-colored taxa can form extensive mats on undisturbed, well drained sites and are important winter forage for caribou.

PFT top cover change, 1985–2020



Version 2

We are refining the target PFTs to incorporate vegetation structure. The goal is to jointly map the type, cover and canopy height of the dominant PFTs and the cover of other PFTs. With input from stakeholders, we are also targeting mapping of key species groups, such as forage willows and wetland sedges.

For the updated maps, we can incorporate any suitable training data that is currently available or that is shared with us in 2023. We are particularly interested in utilizing vegetation cover data from analyses of airborne data.

Macander, M.J., and P.R. Nelson. 2022. ABoVE: Modeled Top Cover by Plant Functional Type over Alaska and Yukon, 1985-2020. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/2032
Macander, M. J., et al. 2022. Time-series maps reveal widespread change in plant functional type coveracross arctic and boreal Alaska and Yukon. Environmental Research Letters. IOP Publishing. https://doi.org/10.1088/1748-9326/ac6965

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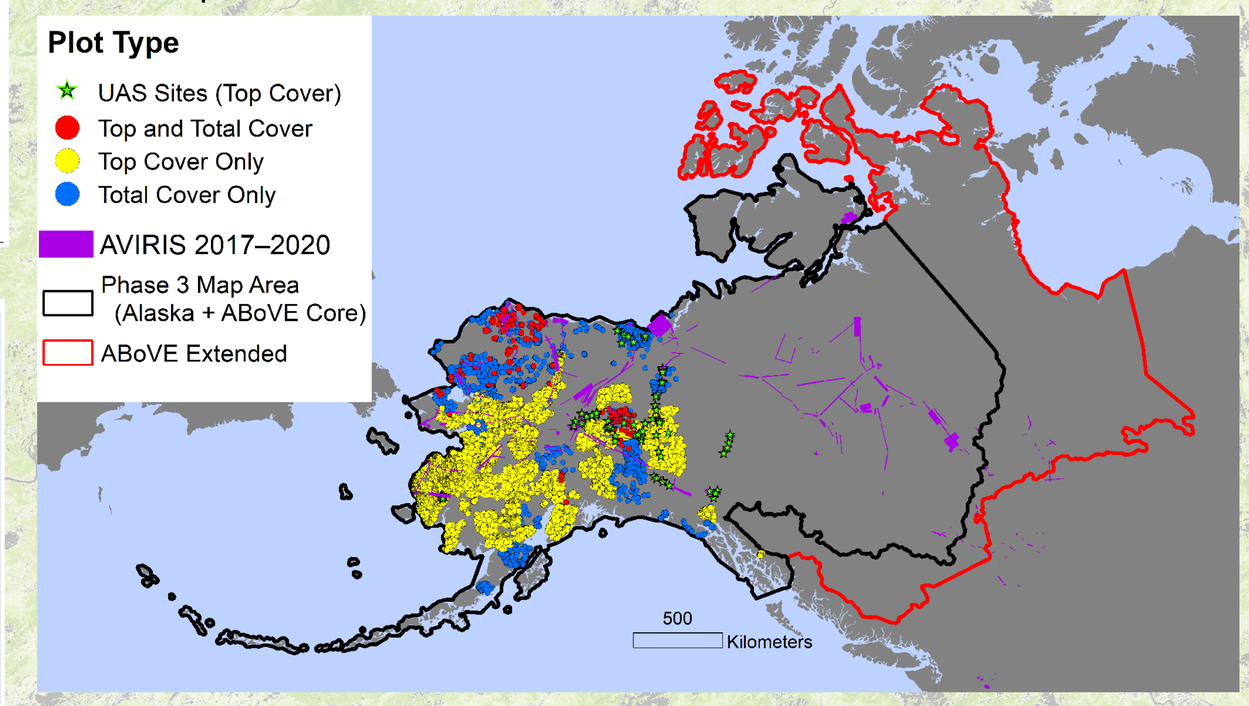
Modeling Methods

We are updating a suite of environmental and spectral covariates for the training and prediction of the time-series PFT models. The environmental covariates represent topographic, climatic, permafrost, hydrographic, and phenological gradients across the study area; and are constant for all models. The updated spectral covariates are based on Landsat TM, ETM+, and OLI data collected over 1984–2022, and Sentinel 2 Surface Reflectance collected over 2017–2022.

For the initial maps, we compiled and normalized field-based vegetation cover data collected during 1994–2019 from a variety of sources in Alaska and Yukon, including resource management agencies, academic researchers, industry, and consultants. For cross-validation purposes, we assign each observation to a spatial block at a scale larger than the autocorrelation sill.

We apply two stochastic gradient-boosting models to map PFT distributions based on the training data and spatial predictors. A binary probability model is applied to map PFT distribution and a regression model is applied to map PFT abundance. The two models are combined for a final prediction of PFT cover.



Ideas on Training Data Sources (Blue) and Fine-scale PFTs (Yellow)