Multi-scale modeling of forest growth in interior Alaska

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Background

- This project is a new ABoVE-affiliated project supported by NASA's Postdoctoral Program
- The boreal zone of Alaska is highly influenced by climate and climate-driven disturbances (e.g. fire, insect outbreaks, etc.)[1, 2]
- Climate change within Alaska is likely to bring about increased drought, longer fire seasons, and increases in the severity and frequency of disturbances[3, 4, 2, 5]
- These changes may lead to widespread tree mortality, species shifts, and changes in ecosystem C stocks[6, 7]
- It is difficult to parse out the vegetative response to the interactive effects of climate and disturbances

Project Objective

Ecological modeling, and especially individual-based modeling (IBM), allows for the detailed simulation of tree response to shifting climate and disturbance regimes. Such an IBM will be used across interior Alaska to project and predict current and future forest conditions.

UVA Forest Model Enhanced

- UVAFME is an extension of the individual-based gap model FAREAST[8] with updated fire, windthrow, and bark beetle submodules
- Simulates the annual growth, death, and regeneration of individual trees on 500 m^2 independent patches of a landscape; several hundred patches represent average forest structure and composition over time (Fig. 1)
- Has been successfully validated and tested within boreal Russia[9, 10]

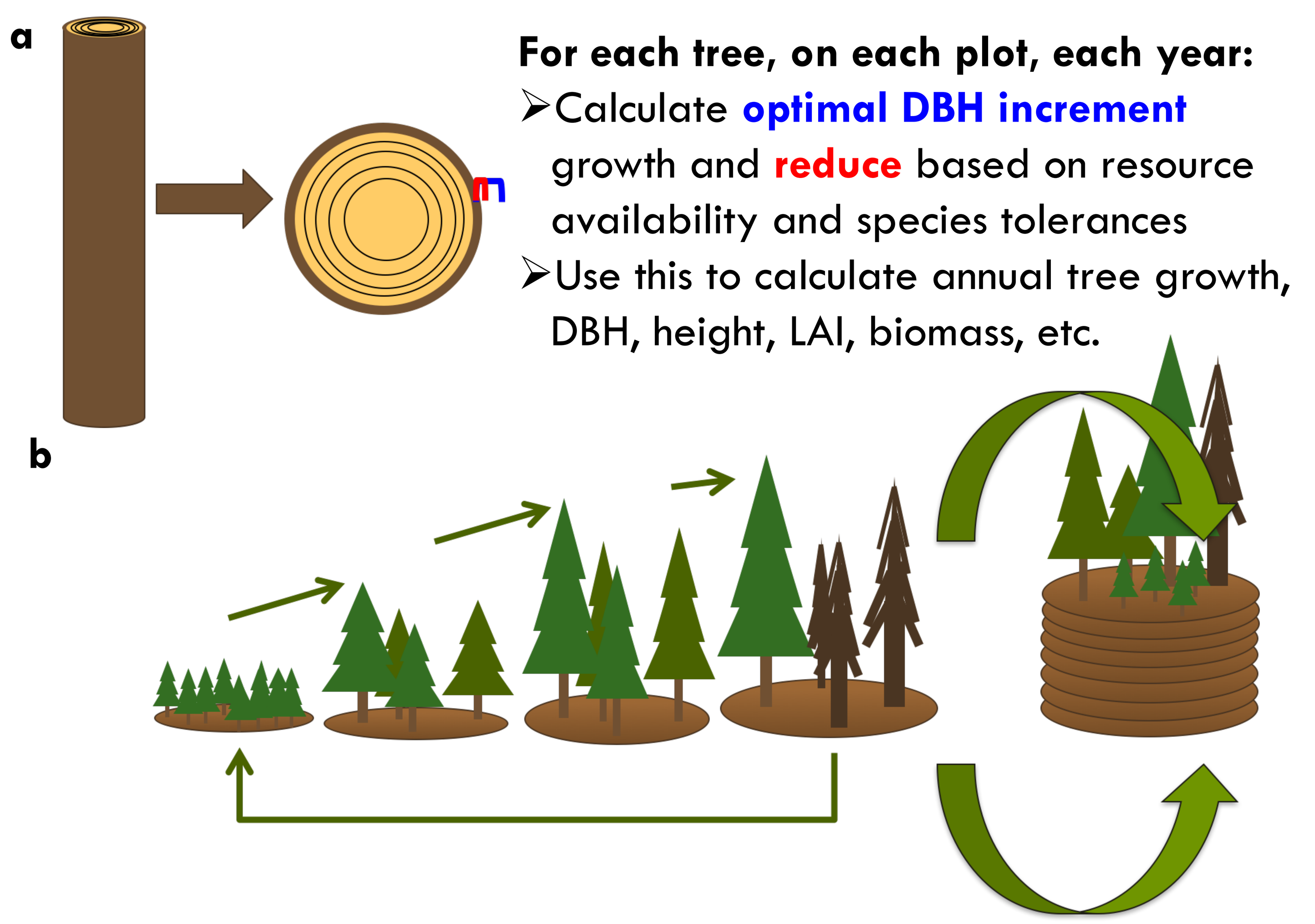

Figure 1. **(a)** Allometric equations used to calculate individual tree diameter increment growth each year. **(b)** Tree growth and forest dynamics simulated at the plot-scale are aggregated over several hundred plots to represent forest dynamics at the landscape scale

Study Area

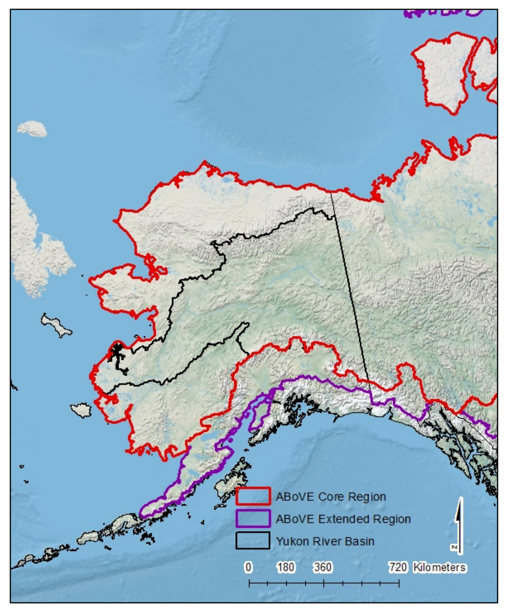

Figure 2. Study area within ABoVE domain

Yukon River Basin

- Within boreal Alaska
- UVAFME will be run in wall-to-wall fashion across Yukon River Basin at 2 km resolution (~ 130, 000 sites; Fig. 3)

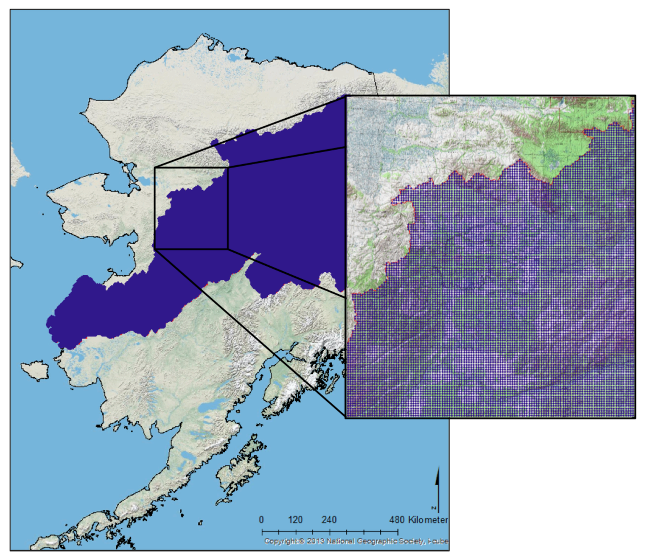

Figure 3. Setup of gridded sites (2 x 2 km resolution)

- Portions of these sites overlap with airborne G-LiHT and inventory data (Fig. 5), which will be used to calibrate and validate model performance within the region

UVAFME Parameterization

- Individual-tree growth at a single plot responds to environmental and climate factors (Fig. 4)
- Climate, site, and soil input parameters will be obtained from relevant databases (CRU, SNAP, SSURGO, NCSCD, FRAMES, etc.) and mapped to each gridcell/site

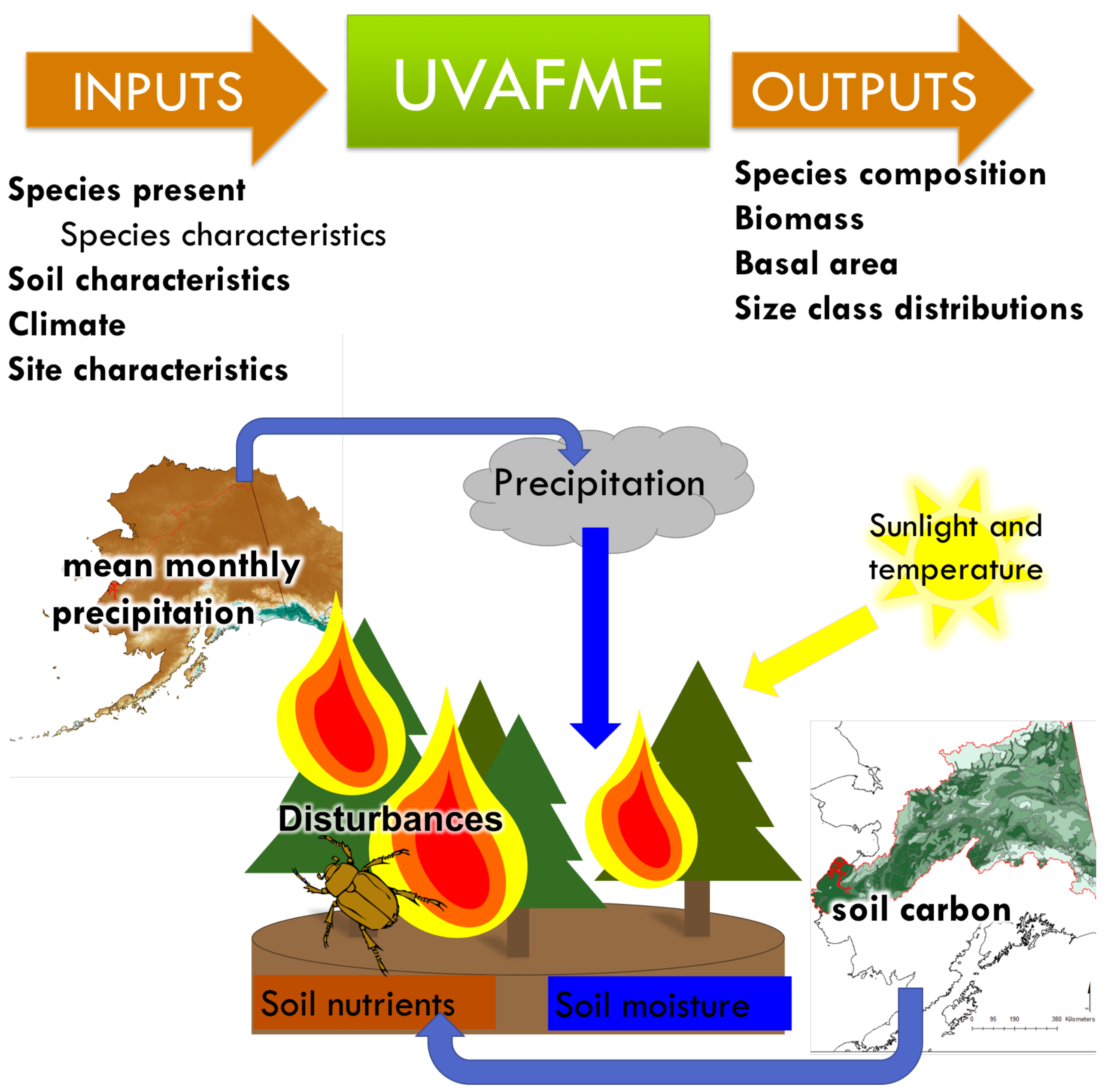

Figure 4. Environmental variables such as climate (e.g. precipitation), site and soil characteristics (e.g. soil carbon), and disturbances affect individual-tree processes on each plot.

Validation & Initialization

- Initial testing and calibration to be conducted in the Tanana Valley
  - Airborne GLiHT and inventory (CAFI) data (Fig. 5)
- UVAFME will also be initialized with structure data derived from GLiHT and CAFI data
  - Conditional distributions (mean ± sd) of height/biomass/DBH and species composition from inventory and GLiHT data
  - Size and species of individual simulated trees sampled from these distributions

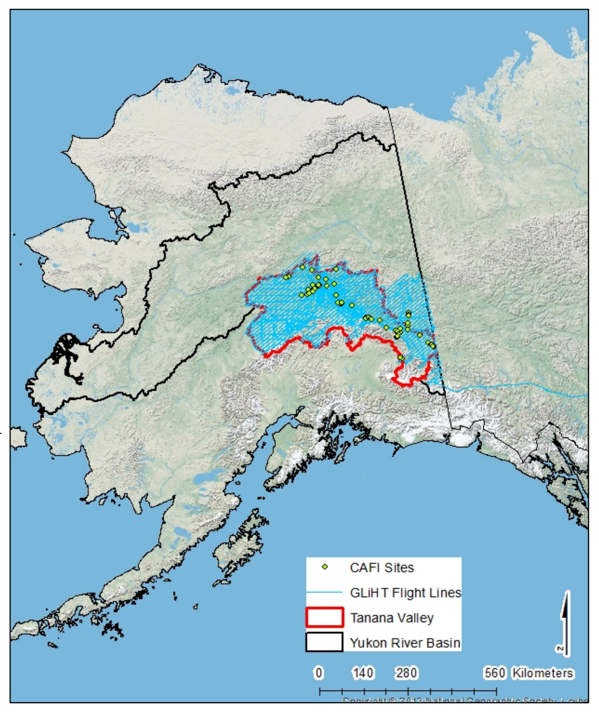

Figure 5. GLiHT flight lines and CAFI site locations in interior Alaska

Large-scale Simulations

- UVAFME will be run across 130,000 gridded sites for several combinations of climate change, fire, and insect disturbance scenarios

This project will thus produce regional-scale maps of species-level biomass, basal area, and stand structure for roughly a 500,000 km^2 study region (Fig. 2) for current conditions as well as for several scenarios of interacting climate, fire, and insect outbreaks.

Project Progress

- ✓ Site, climate, and species range list parameterization complete for 130,000 gridded sites and CAFI site locations
- ✓ UVAFME successfully transitioned from the UVA Computing Cluster to NASA's ABoVE Science Cloud
  - Testing in process for determining how many nodes will be needed for wall-to-wall simulation
- Species parameterization complete by February 2017
- Calibration/validation complete by May 2017

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