

# FATES Capabilities and Calibration at NEON Sites

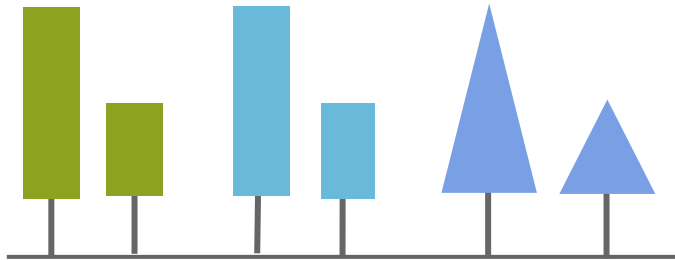
How do we calibrate a complex model with noisy data?

*Adrianna Foster*

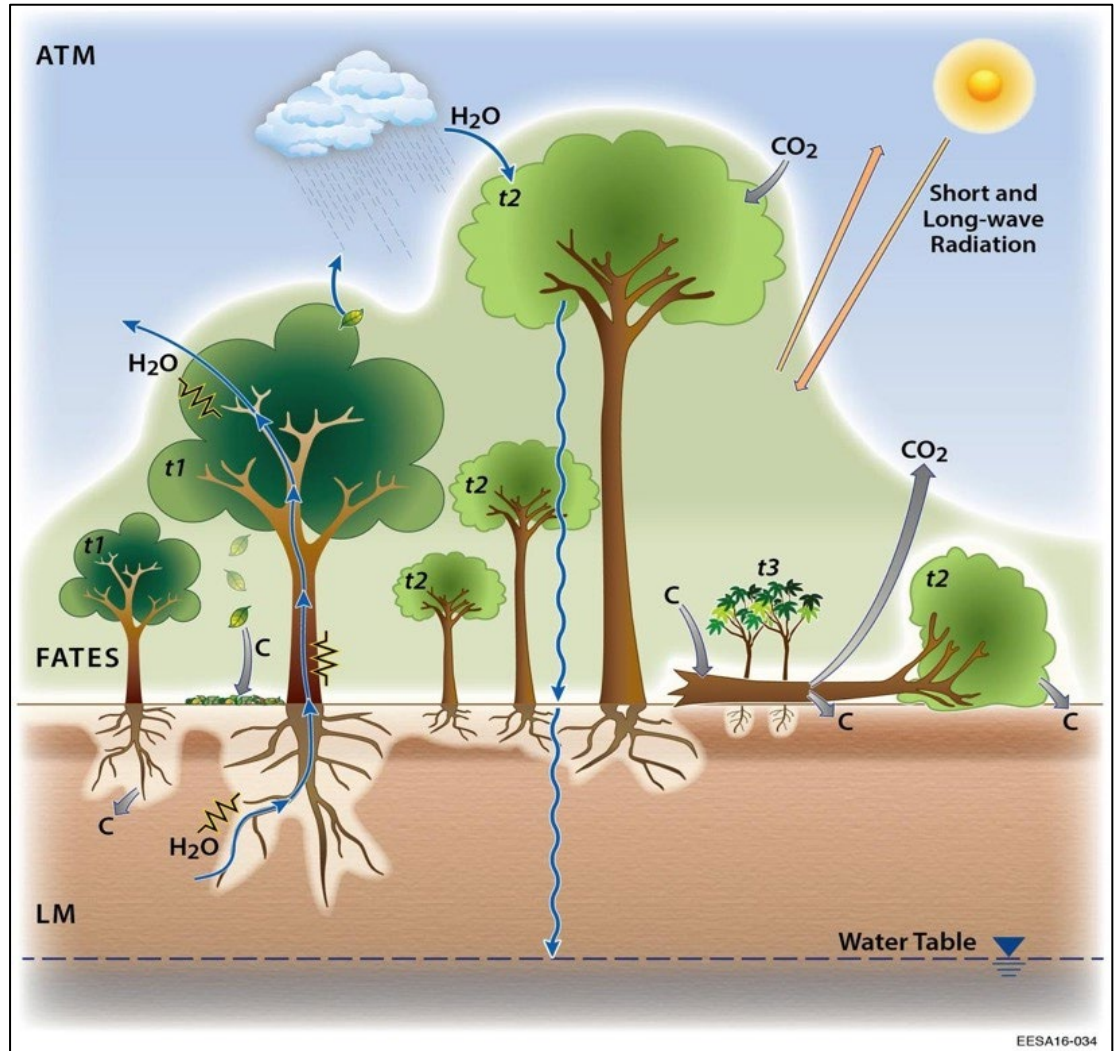
*Project Scientist I, NCAR CGD Terrestrial Sciences Section*



2024 CESM Workshop Land Model Working Group  
June 10, 2024



cohort-specific model  
 30-minute photosynthesis and fluxes  
 daily growth and allocation



Adrianna Foster – [afoster@ucar.edu](mailto:afoster@ucar.edu)

# FATES complexity modes

## Satellite Phenology

One cohort and patch  
Observed LAI for each PFT  
No disturbance, growth, or mortality

## No Competition

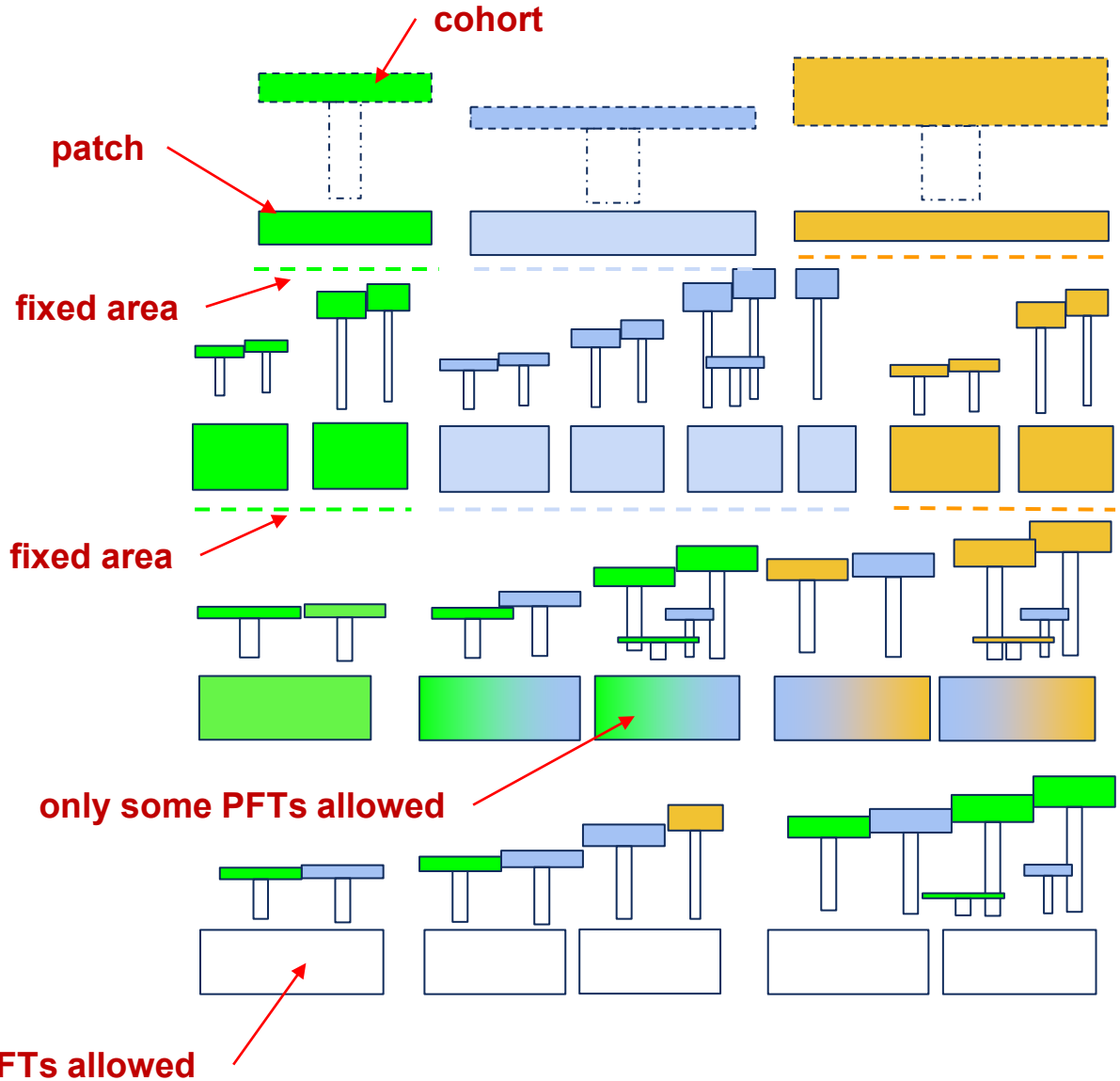
All PFTs given a fixed area to grow  
Growth & disturbance  
Fixed biogeography

## Prescribed Biogeography

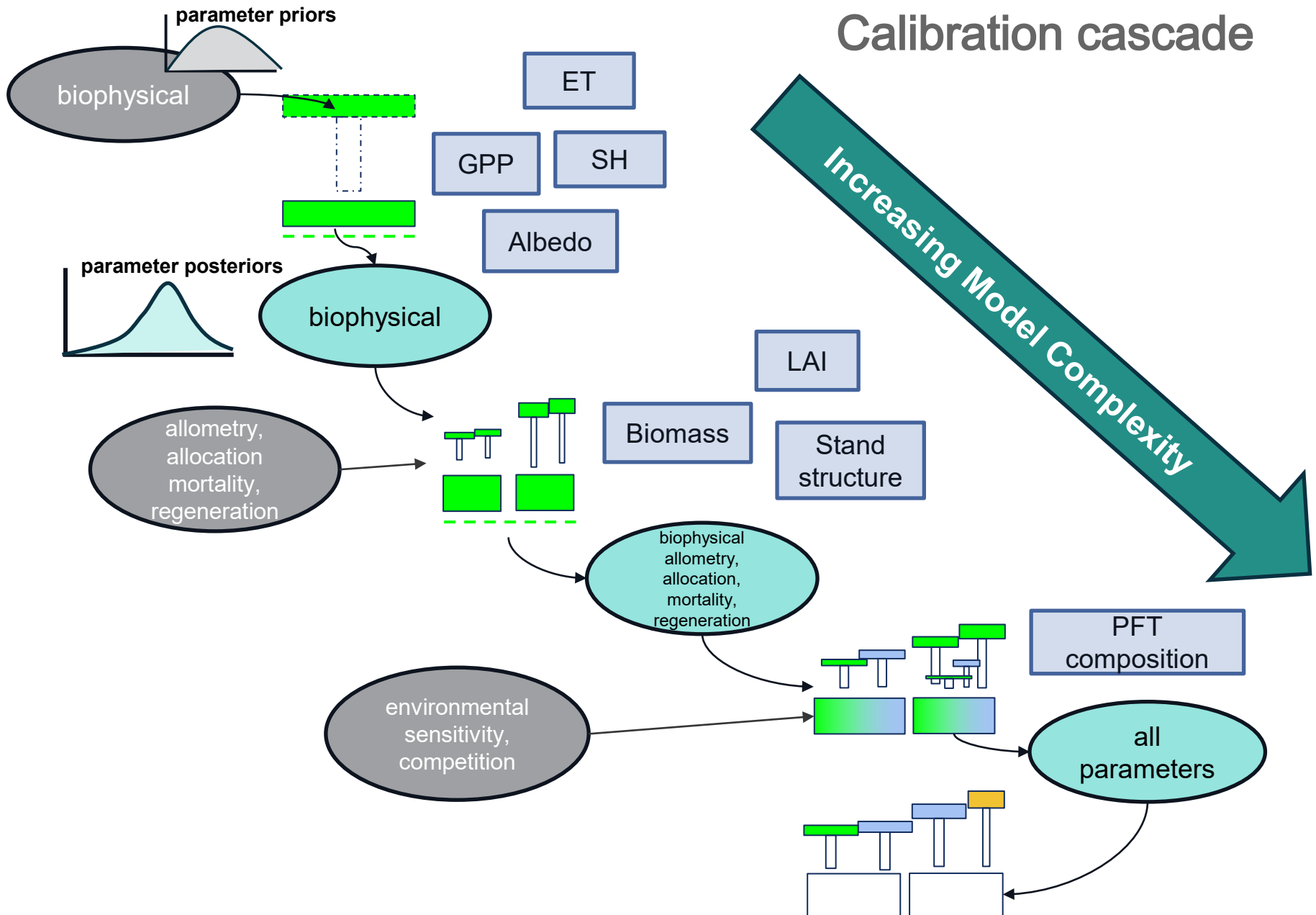
Growth, disturbance, and competition,  
but only where each PFT actually grows

## Full FATES

Growth, disturbance, and  
competition everywhere

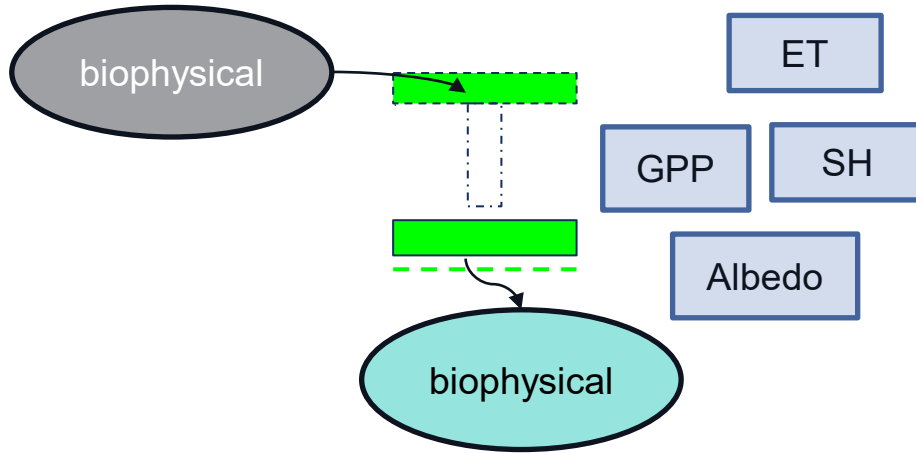


# Calibration cascade

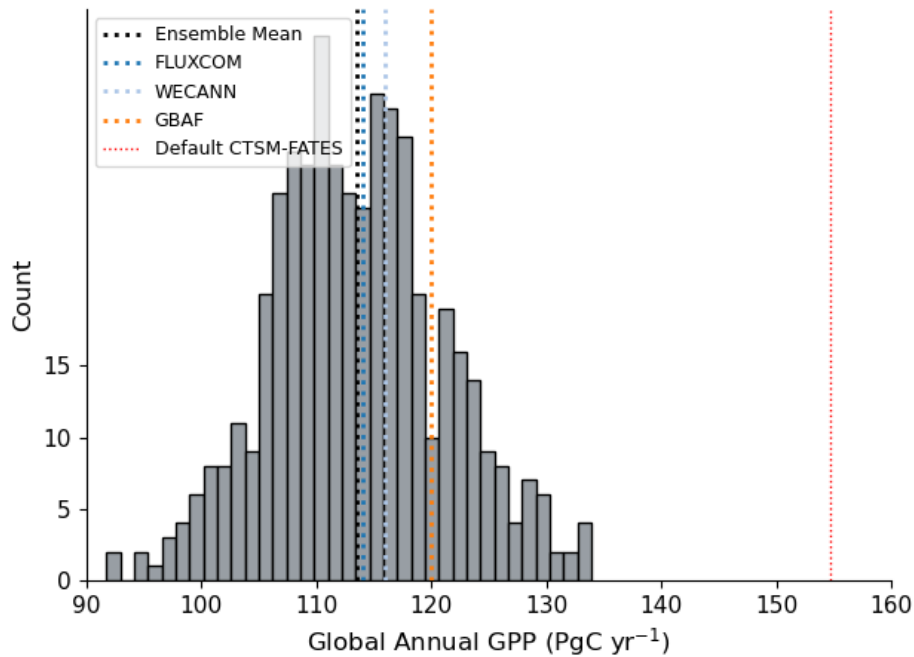




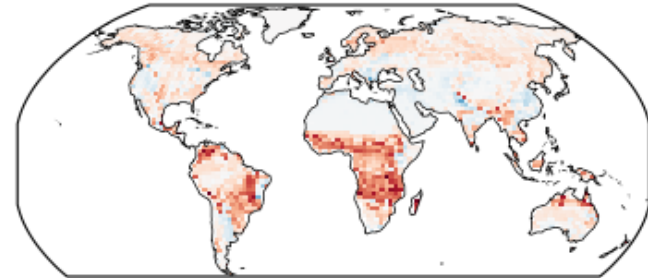
# Calibration cascade



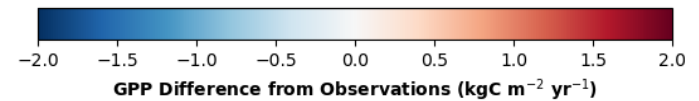
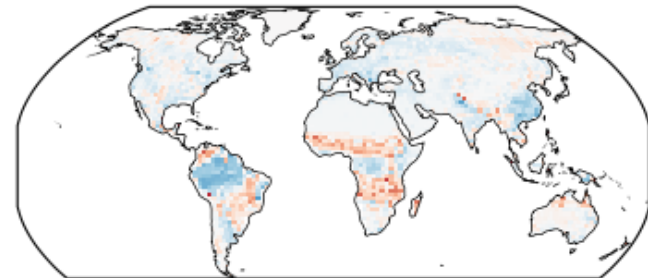
# Global SP Calibration at sparse grid



**Default CTSM-FATES**



**Updated CTSM-FATES**



# NEON sampling design provides ample data sources for benchmarking and model assimilation

<https://data.neonscience.org/data-products/explore>

[Data & Samples](#) / [Data Portal](#) / Explore Data Products

## Explore Data Products

### All Products

☰ 182 products from 81 sites 📅 Data available Jan 2012 – May 2023

#### Sort

by Product Name ▾



"Available" data products will always show above "Coming Soon" data products, except when sorting by search relevance.

Showing first 10 of 182 total products

#### 2D wind speed and direction

DPI.00001.001

DOWNLOAD DATA ↓

PRODUCT DETAILS ⓘ

Two-dimensional wind speed and direction, available as two- and thirty-minute aggregations of 1 Hz observations. Observations are made by 2-D sonic anemometer sensors located at multiple heights on the tower infrastructure and by 2-D sonic anemometer sensors located on the aquatic meteorological station.

#### Available Dates

2013-12 through 2023-04

#### Data Themes



#### Visualize Data

TIME SERIES VIEWER ✓

Key: ■ Available ■ No data

View By: SUMMARY SITE STATE DOMAIN



#### 3D wind attitude and motion reference

DOWNLOAD DATA ↓

#### Filter

✕ RESET ALL FILTERS

#### Search

Utah, "snow depth", 2022, etc...

Use several terms to match products having any term (*term OR term*). Quote terms to match phrases (e.g. "wind speed"). [Browse keywords](#) for ideas.

#### Release ⓘ

Latest and Provisional ▾

Data in the latest release in addition to provisional data (not yet in any release)

182 data products

RELEASE DETAILS ⓘ

#### Available Dates

Show products that have any data available between two dates.

FILTER ON AVAILABLE DATES...

#### Data Status

Available 163

Coming Soon 19

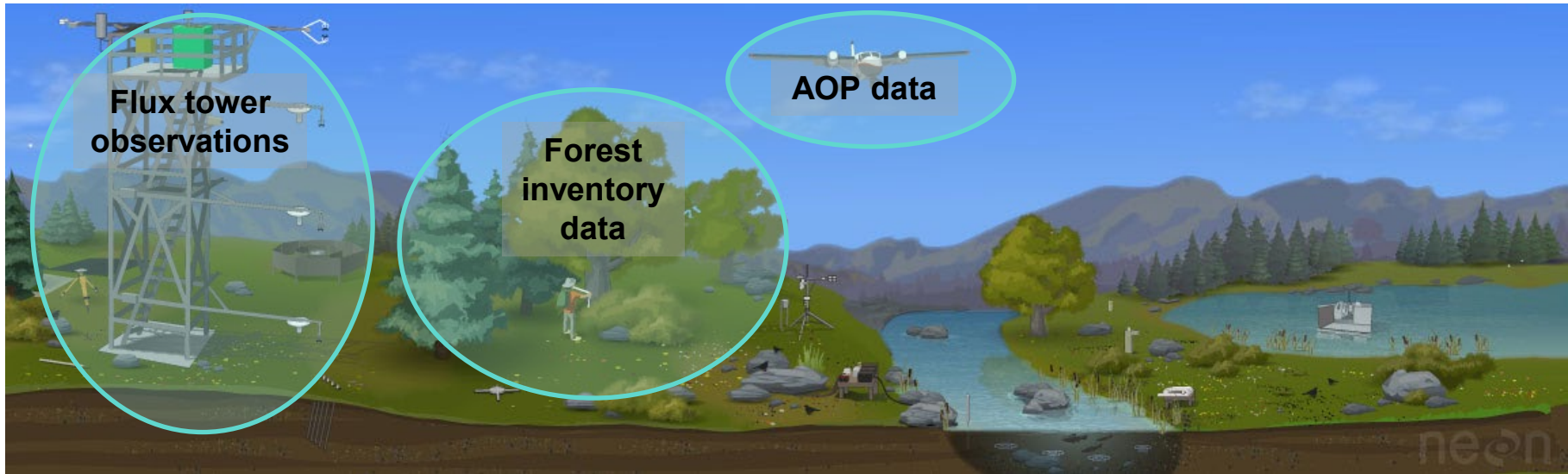
#### Visualizations

Time Series Viewer 34

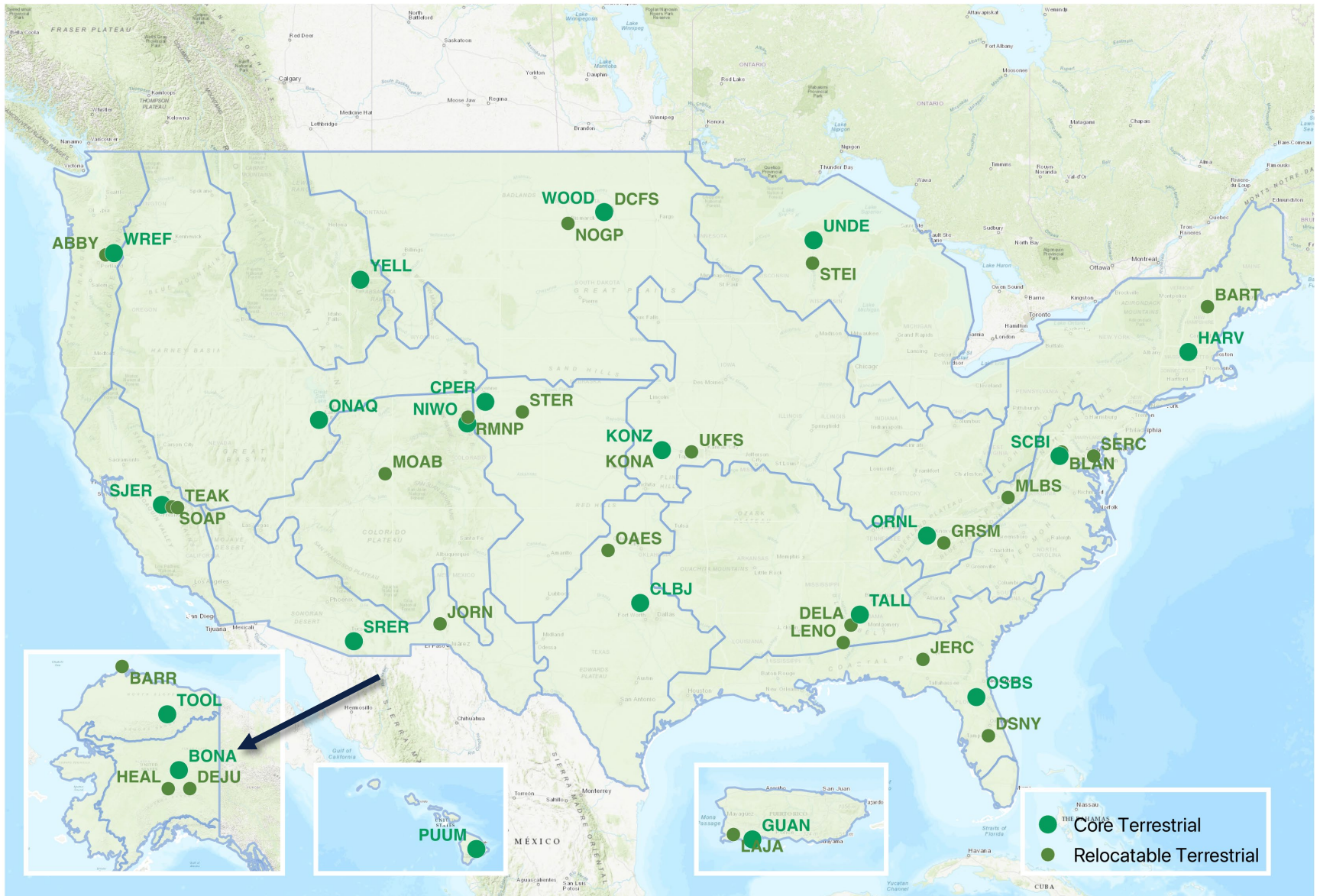


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# NEON sampling design provides ample data sources for benchmarking and model assimilation

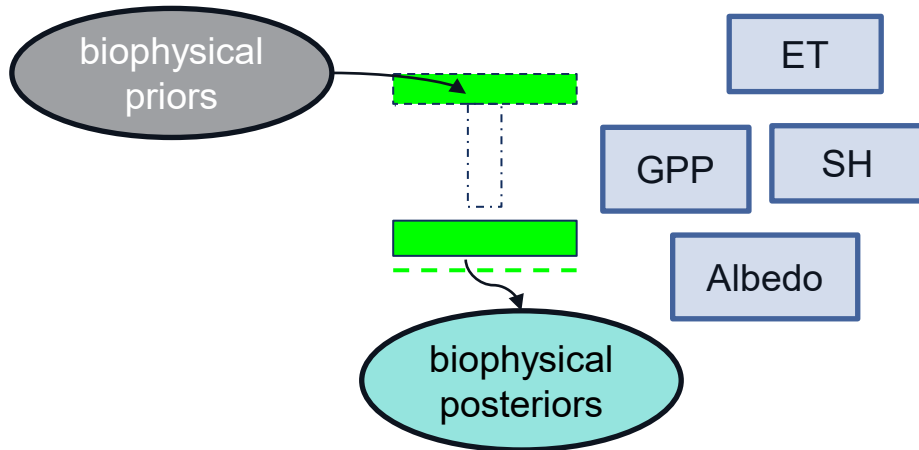






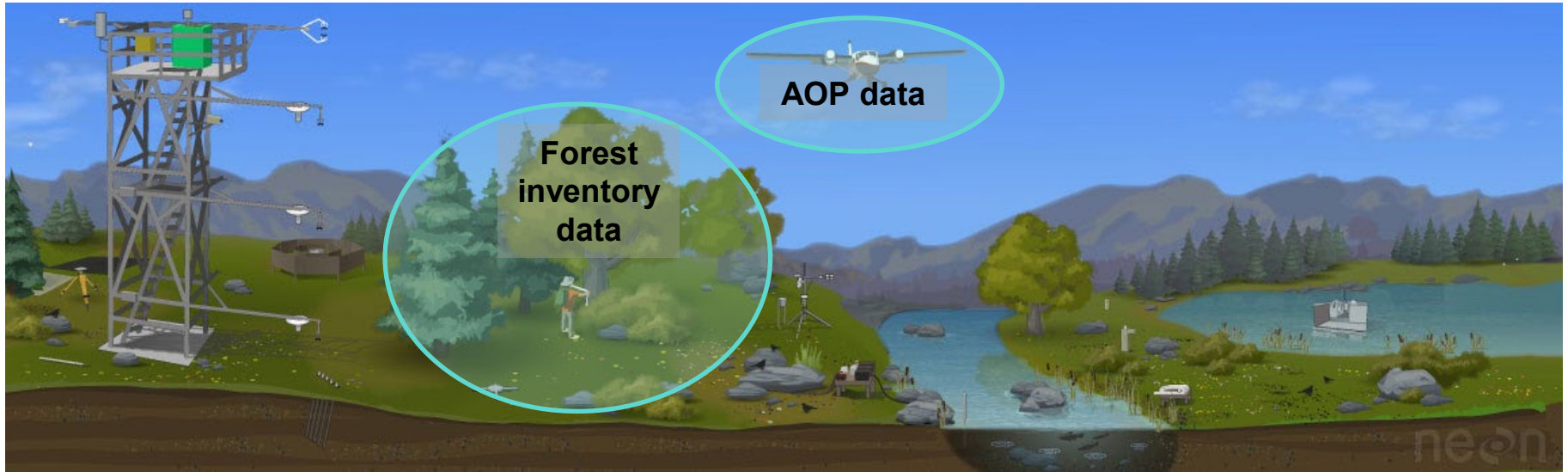
Adrianna Foster – [afoster@ucar.edu](mailto:afoster@ucar.edu)

# SP mode calibration at NEON sites



## SP Mode driven by:

1. PFT composition (percent cover)
2. canopy height (top and bottom)
3. LAI & SAI

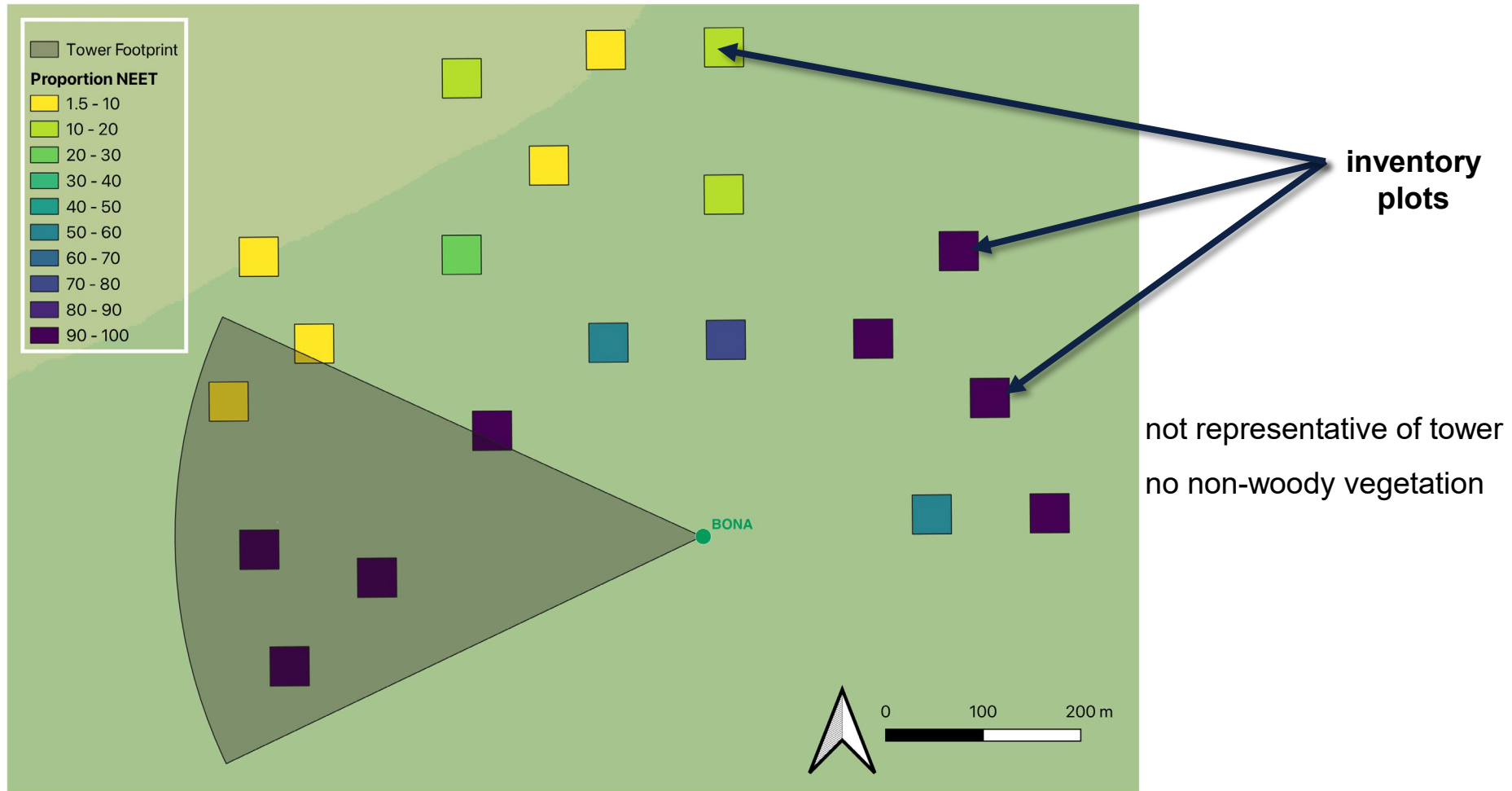




# PFT composition



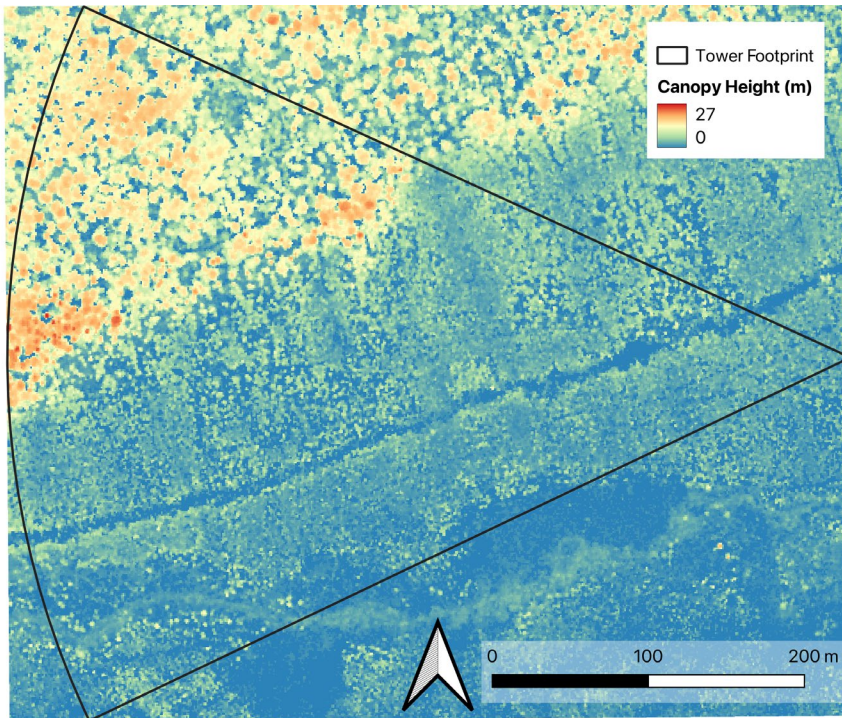
# PFT composition



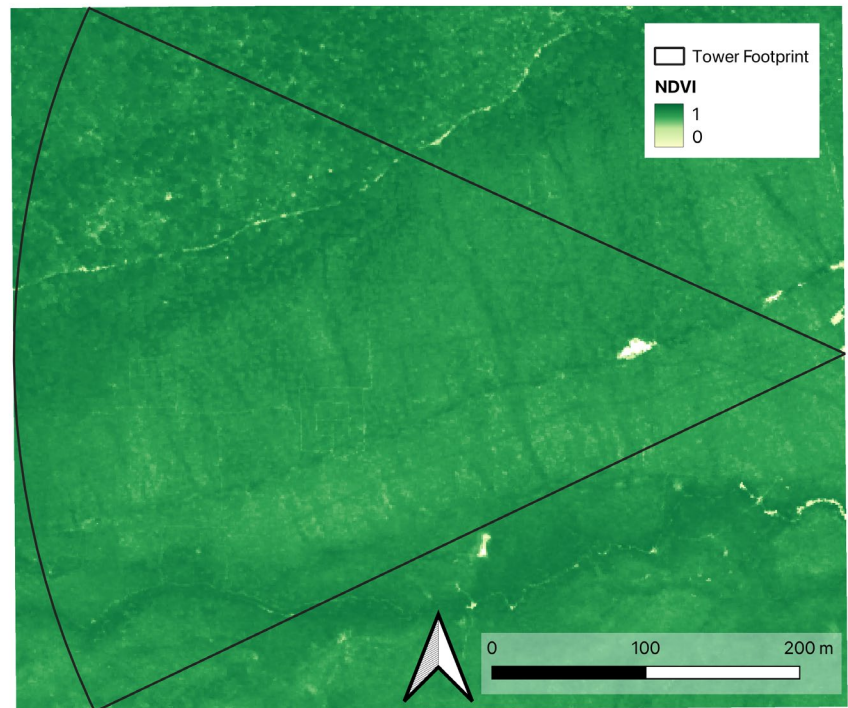


# PFT composition

## canopy height

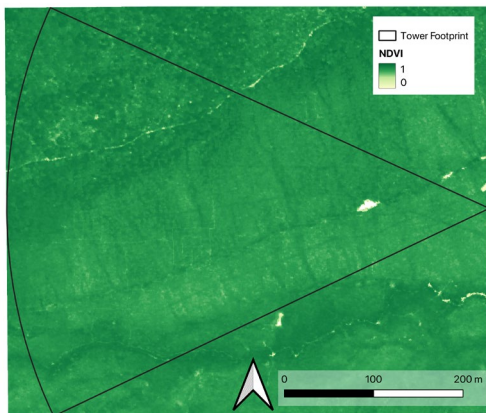


## NDVI



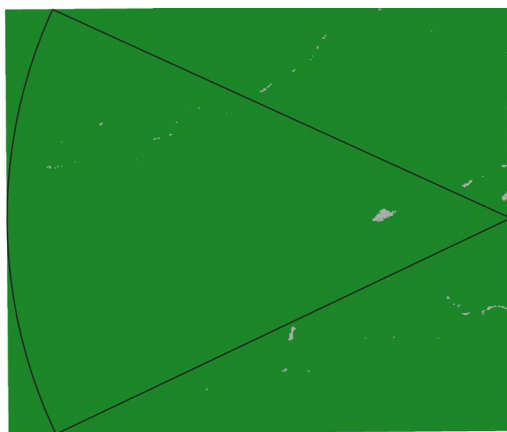
# PFT composition

NDVI

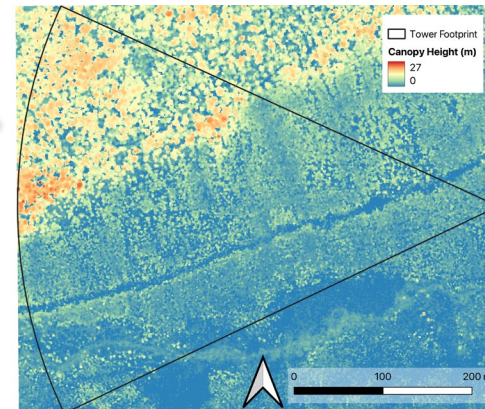


NDVI > 0.5

vegetated

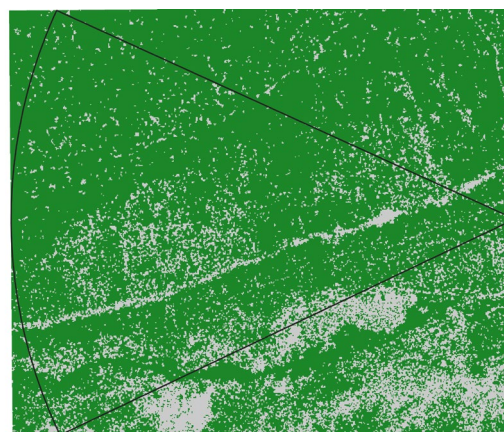


Canopy height



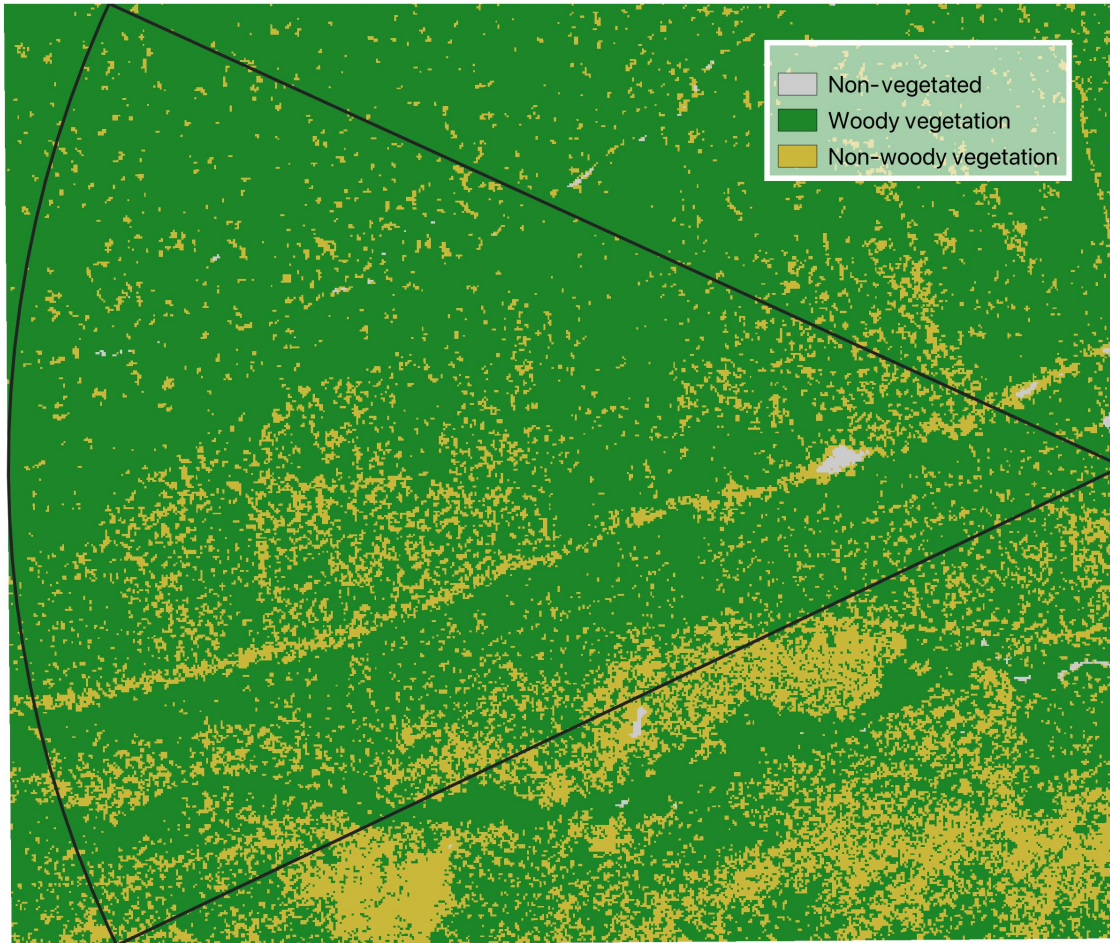
height > 0.5 m

woody vegetation





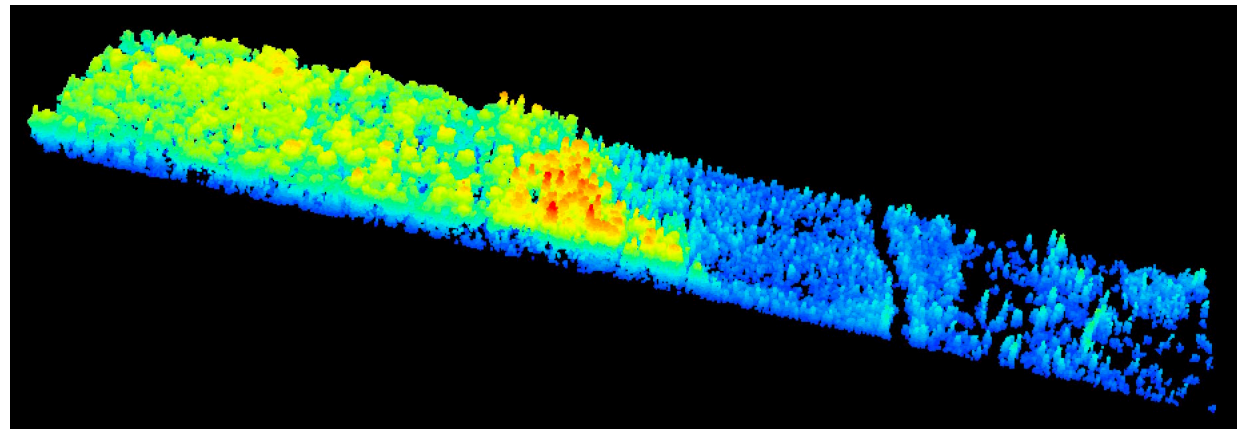
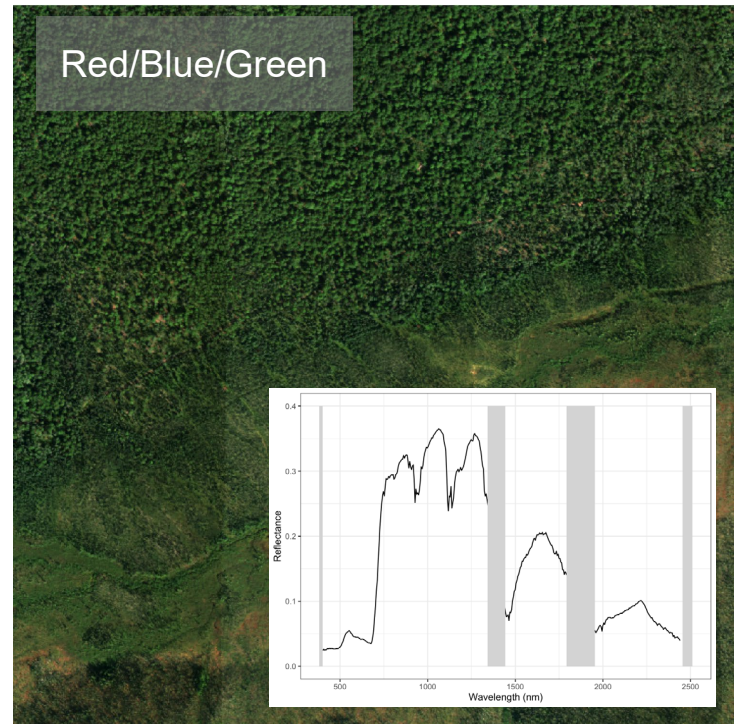
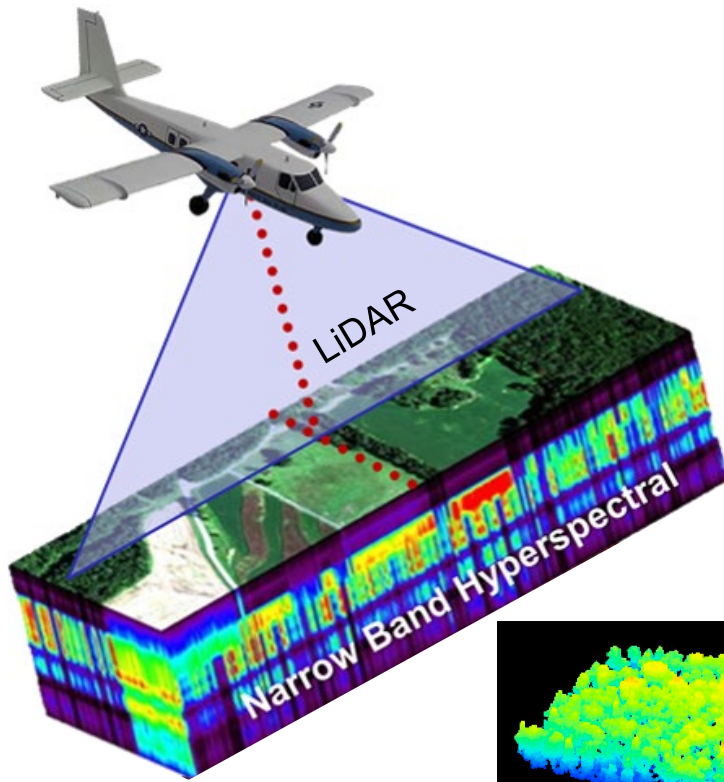
# PFT composition



**Non-woody vegetation:**  
assume relative proportion of  
C3/C4 grass on surface  
dataset is correct (??)

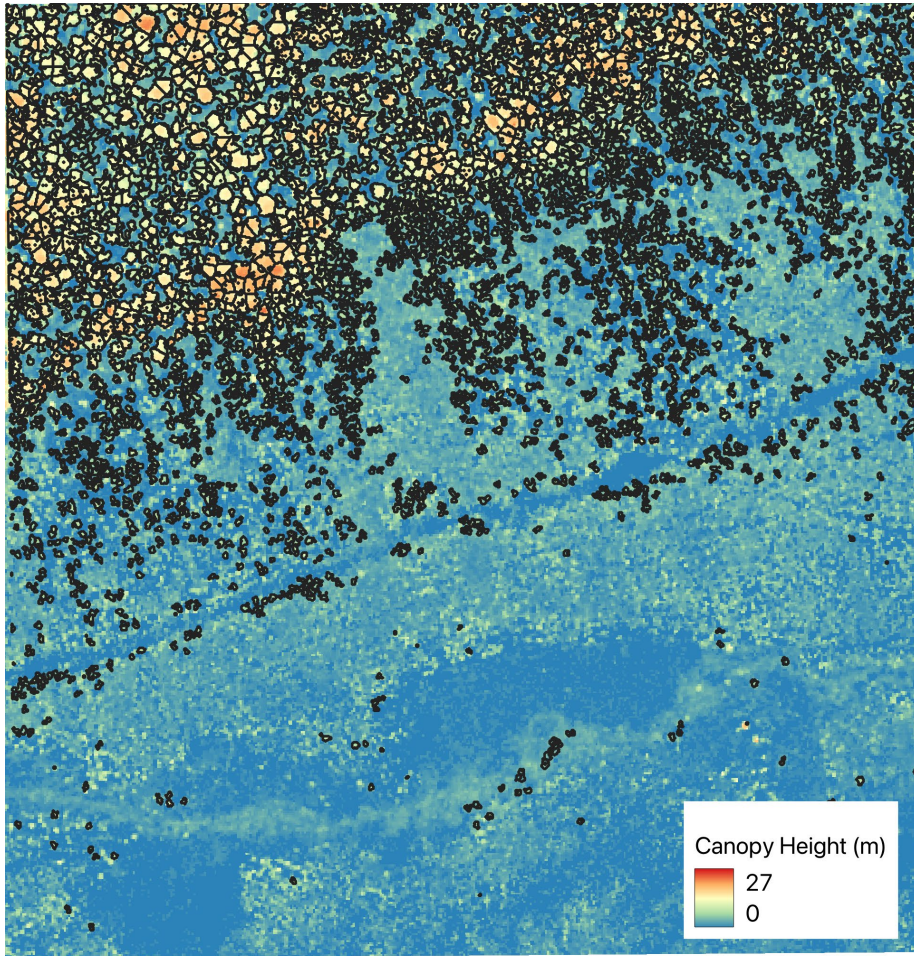
**Woody vegetation:**  
Use other AOP data to  
classify trees inside tower  
footprint

# Tree Classification

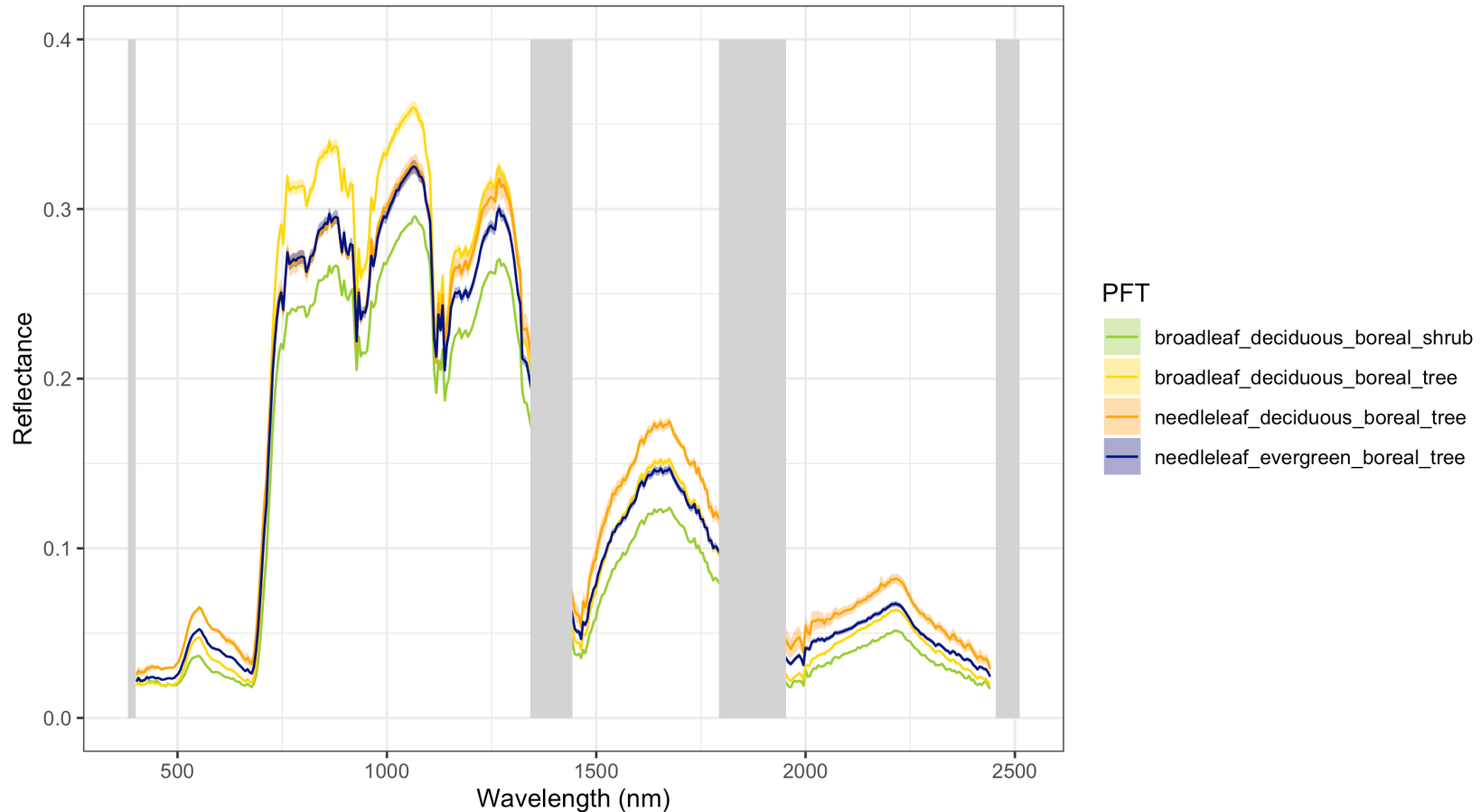




# Tree delineation using LiDAR point cloud



# Train classification models with hyperspectral data and inventory data

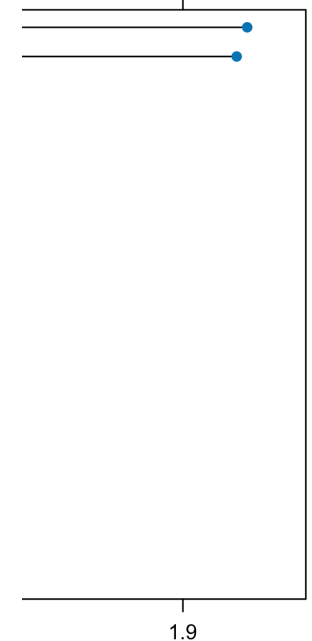
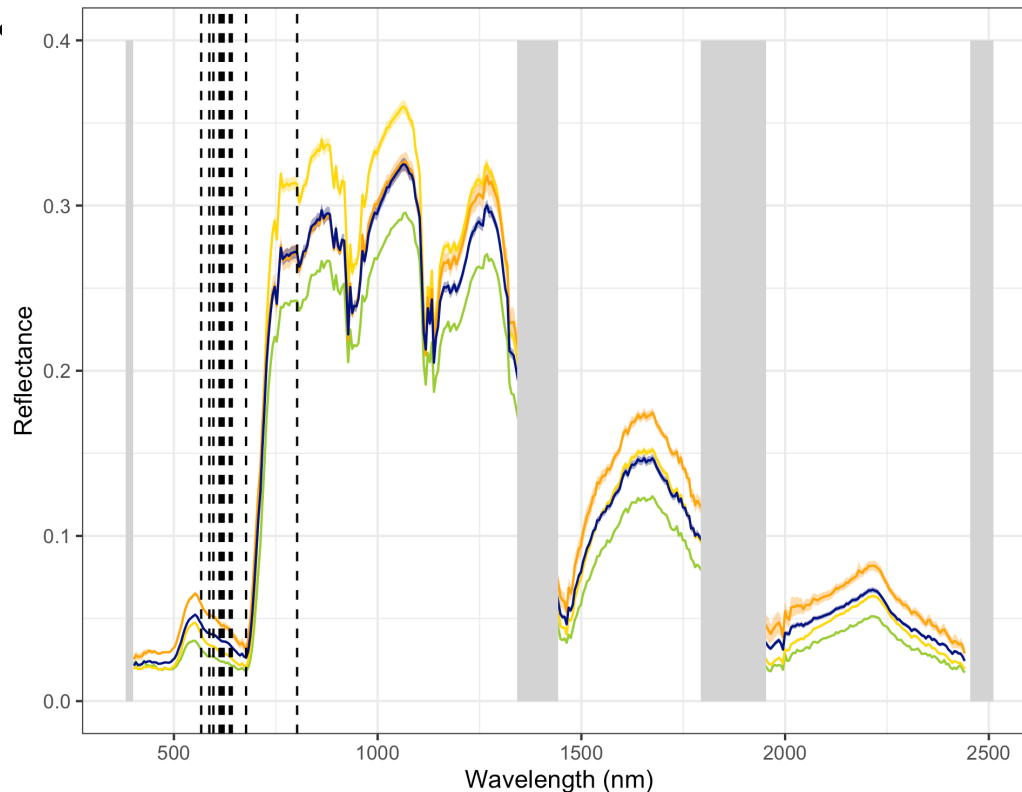


# Train classification models with hyperspectral data and inventory data

92% accuracy against testing data

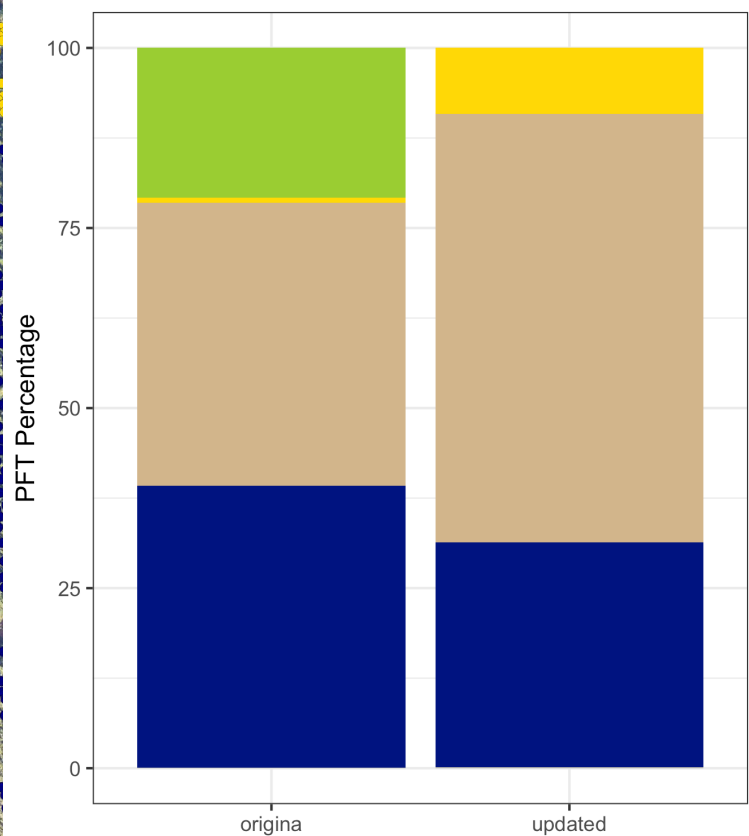
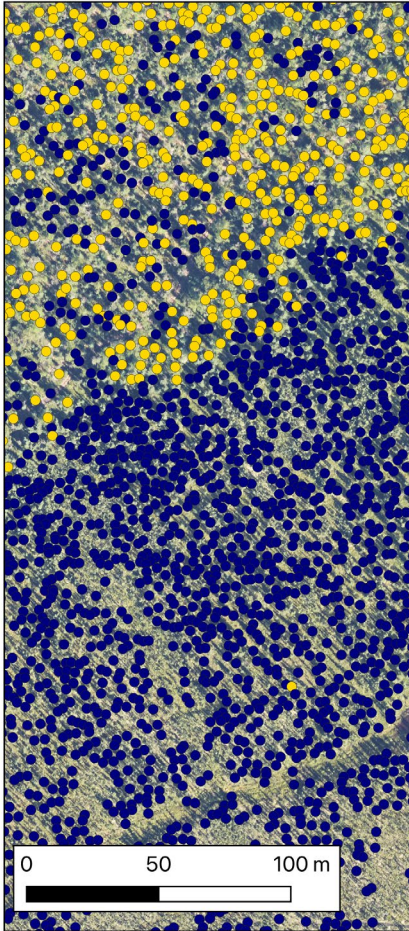
## PFT classification: random forest model

- 75/25 Training/Testing split

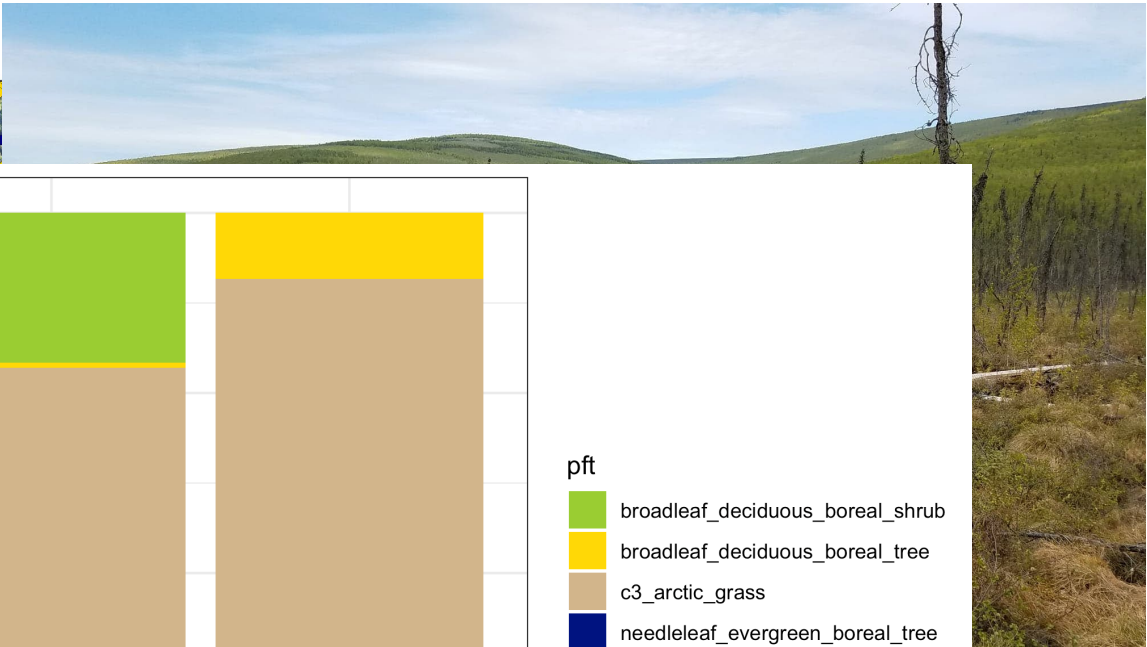




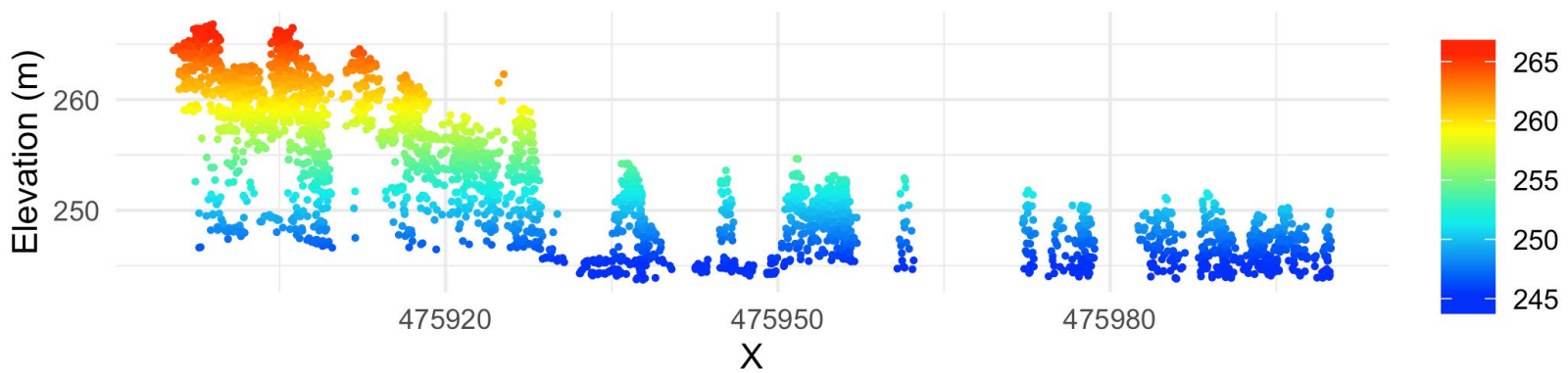
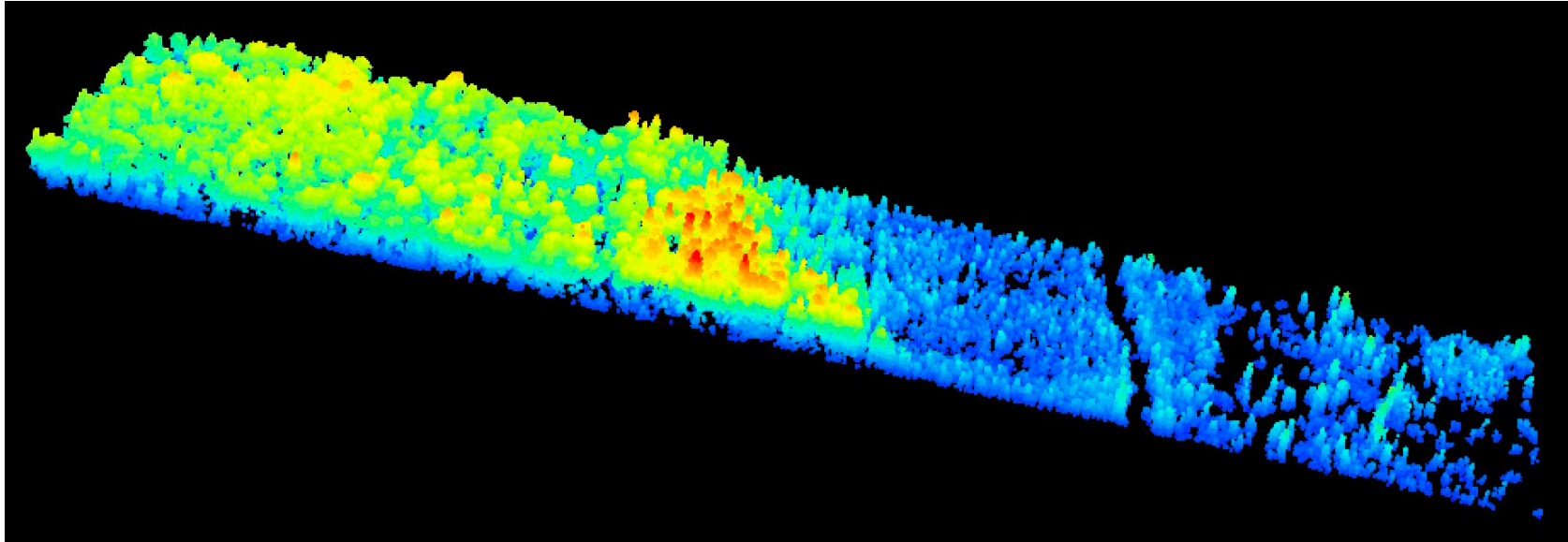
# Apply classification model to tree crowns



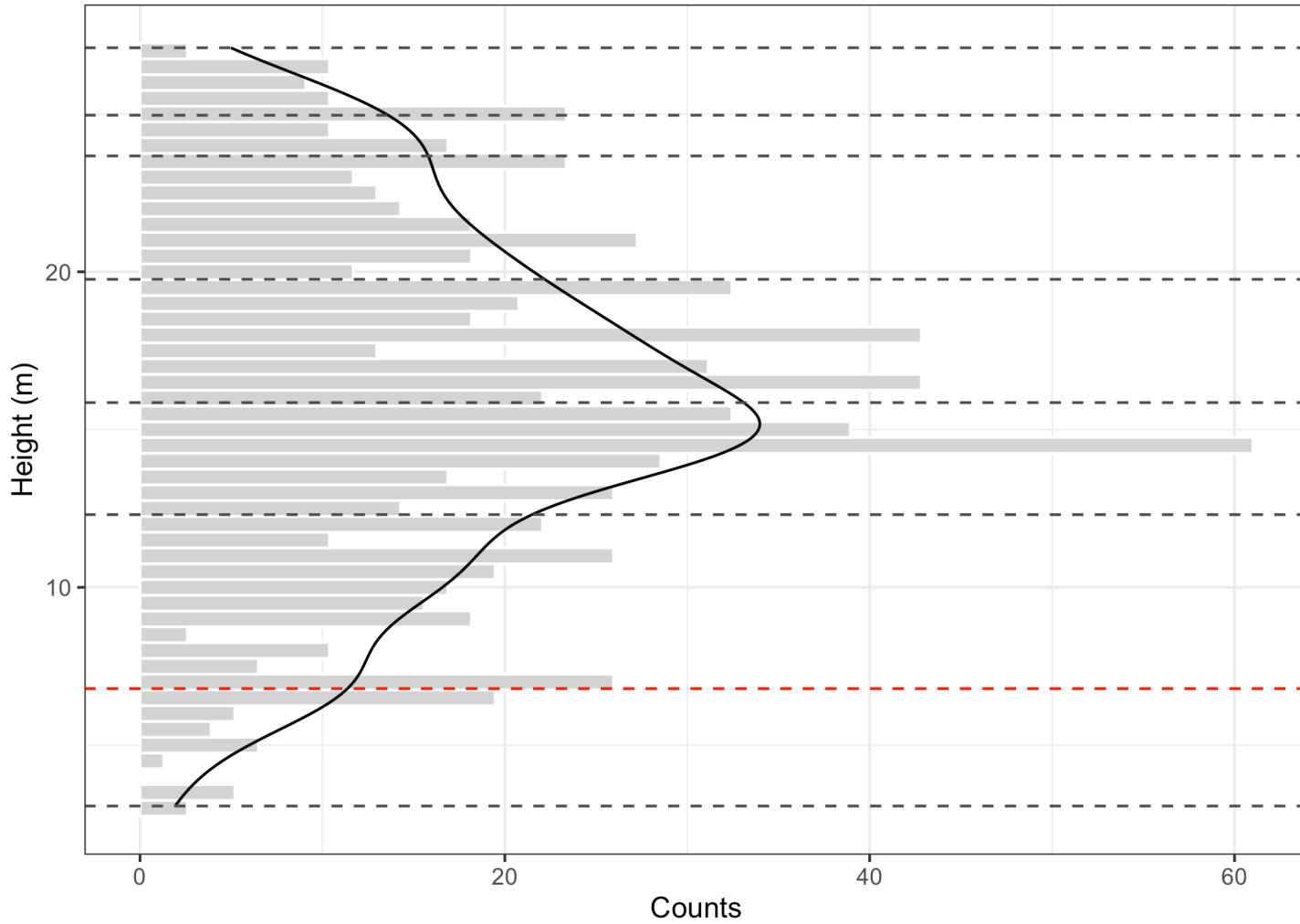
- pft
- broadleaf\_deciduous\_boreal\_shrub
  - broadleaf\_deciduous\_boreal\_tree
  - c3\_arctic\_grass
  - needleleaf\_evergreen\_boreal\_tree
  - not\_vegetated



# Canopy height top and bottom

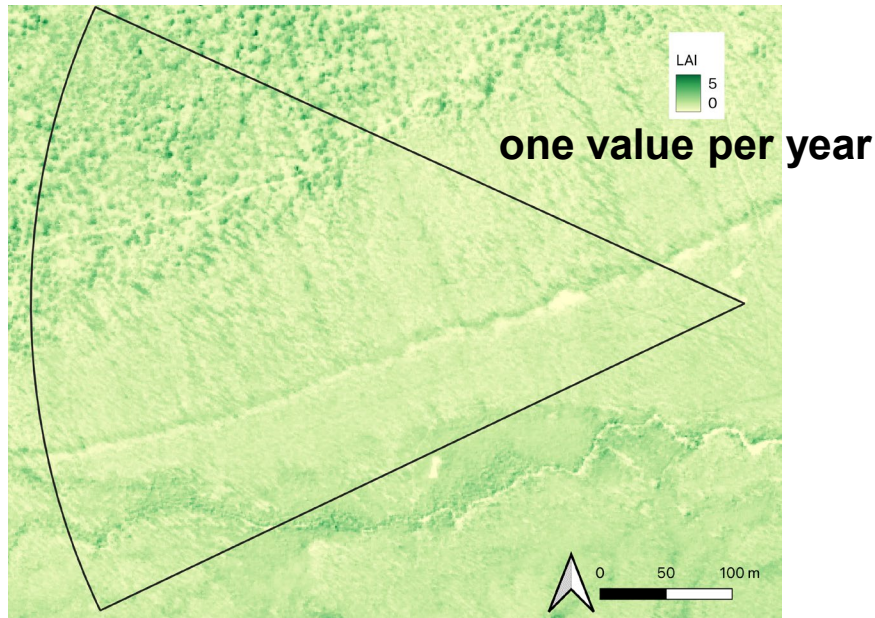
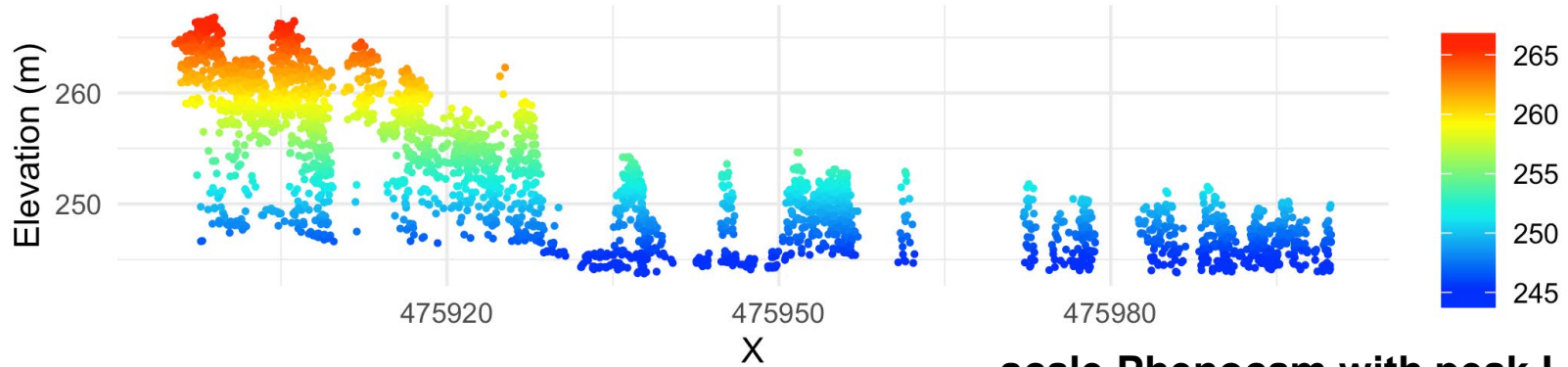


# Canopy height top and bottom





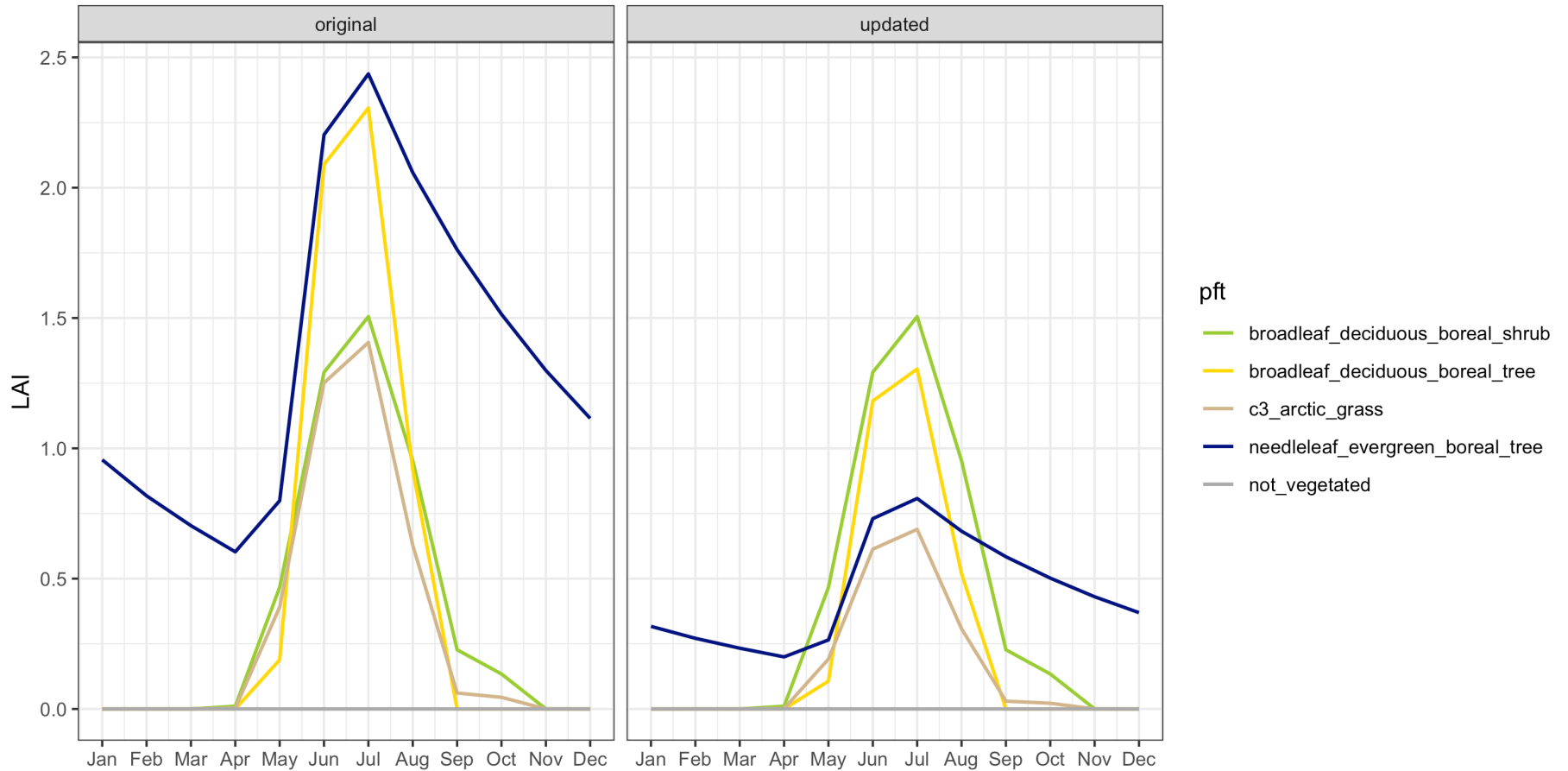
# LAI and SAI



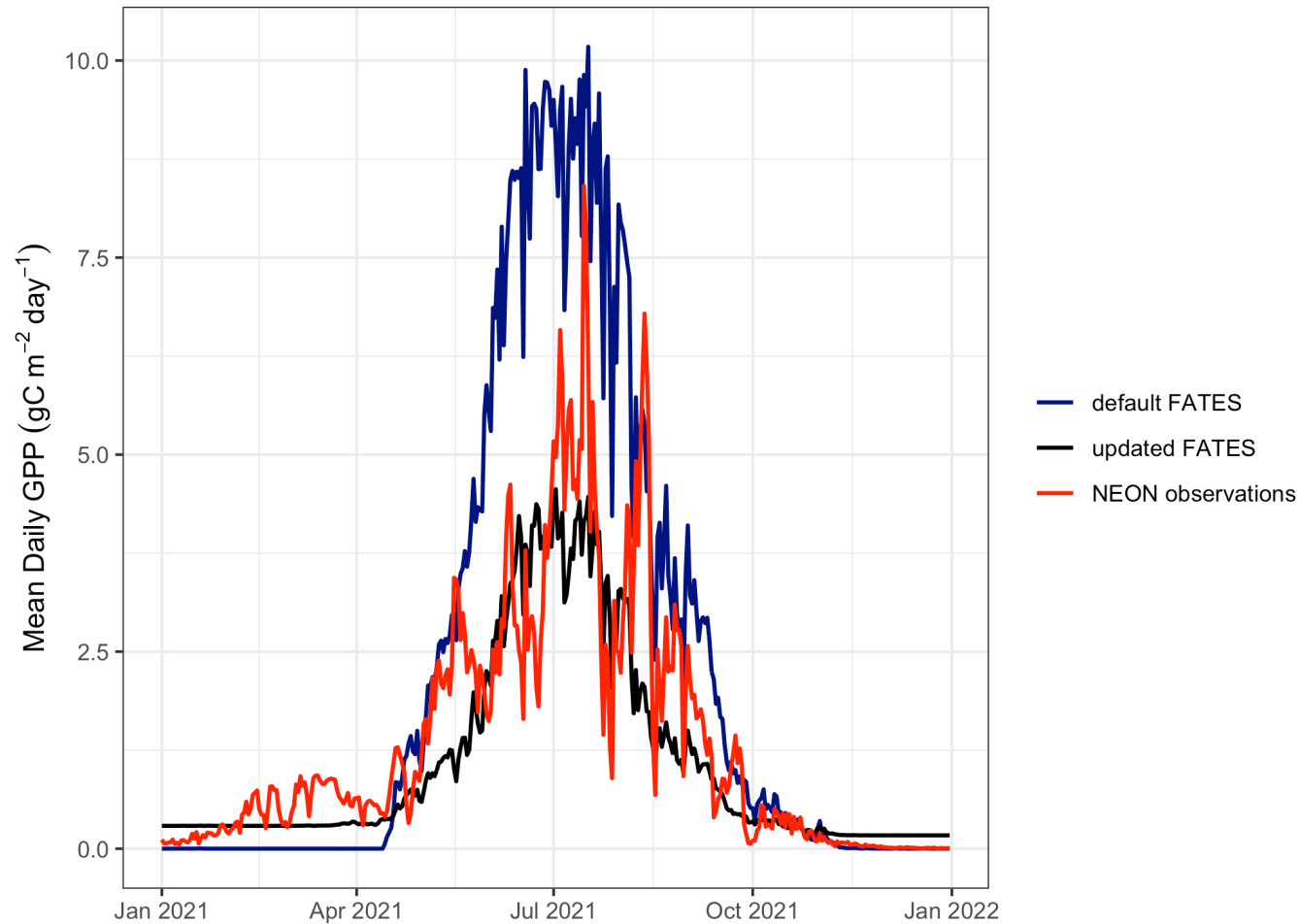
## scale Phenocam with peak LAI



# LAI updates to surface dataset



# Surface data updates improve simulation

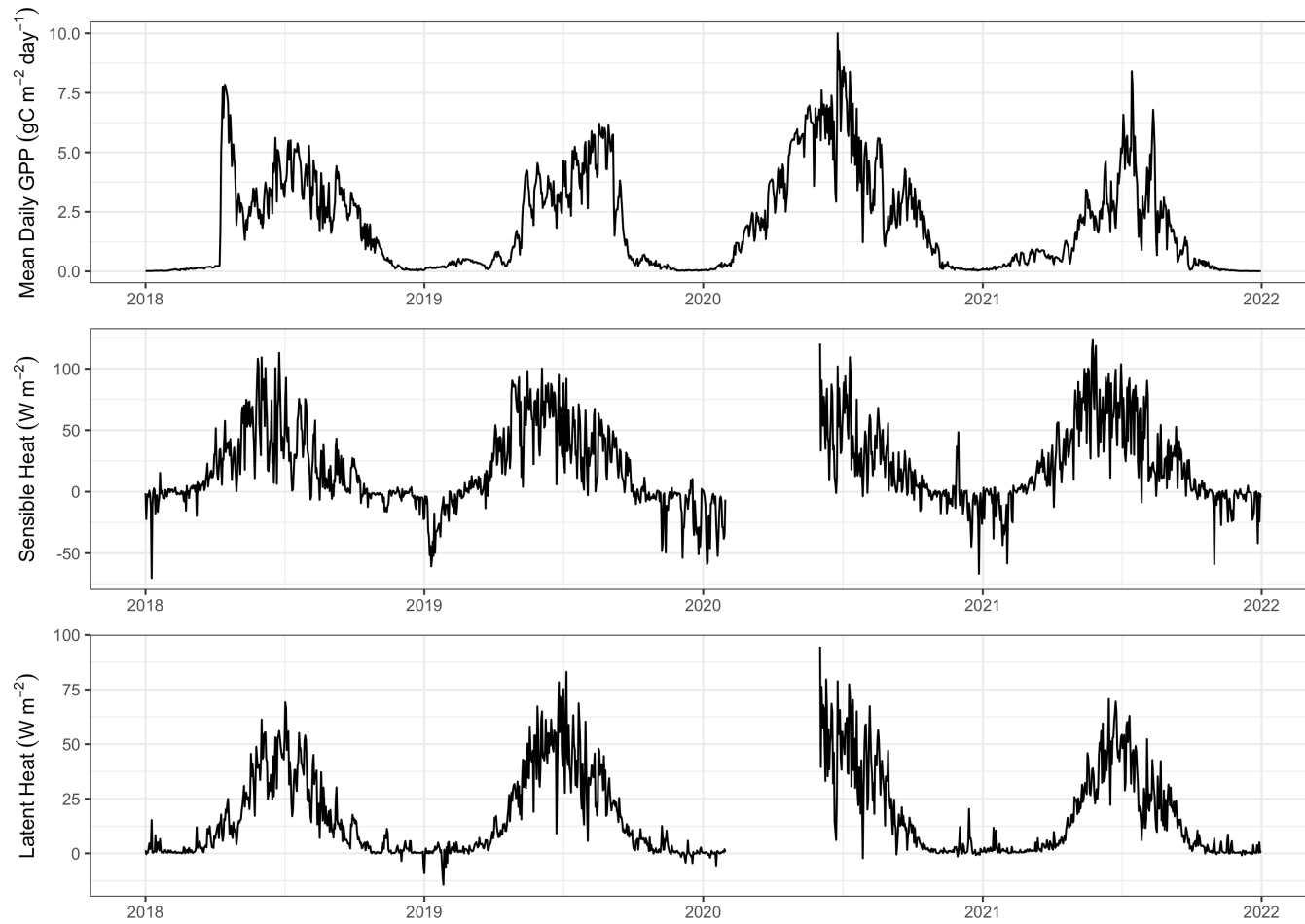


# NEON flux observations



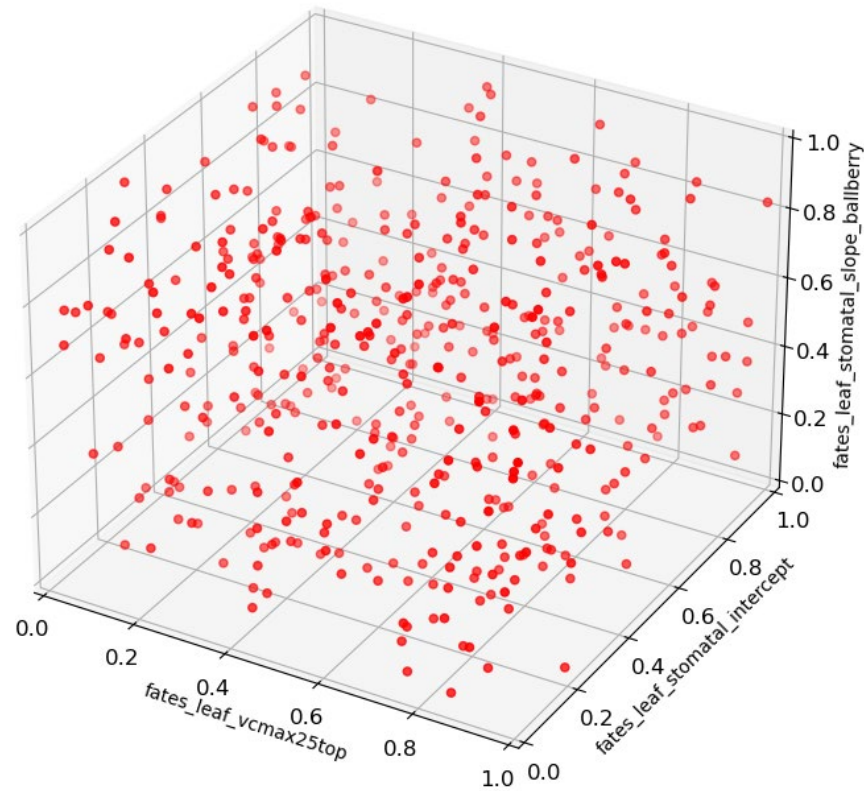
Adrianna Foster – [afoster@ucar.edu](mailto:afoster@ucar.edu)

# NEON flux observations



# Latin Hypercube Ensemble

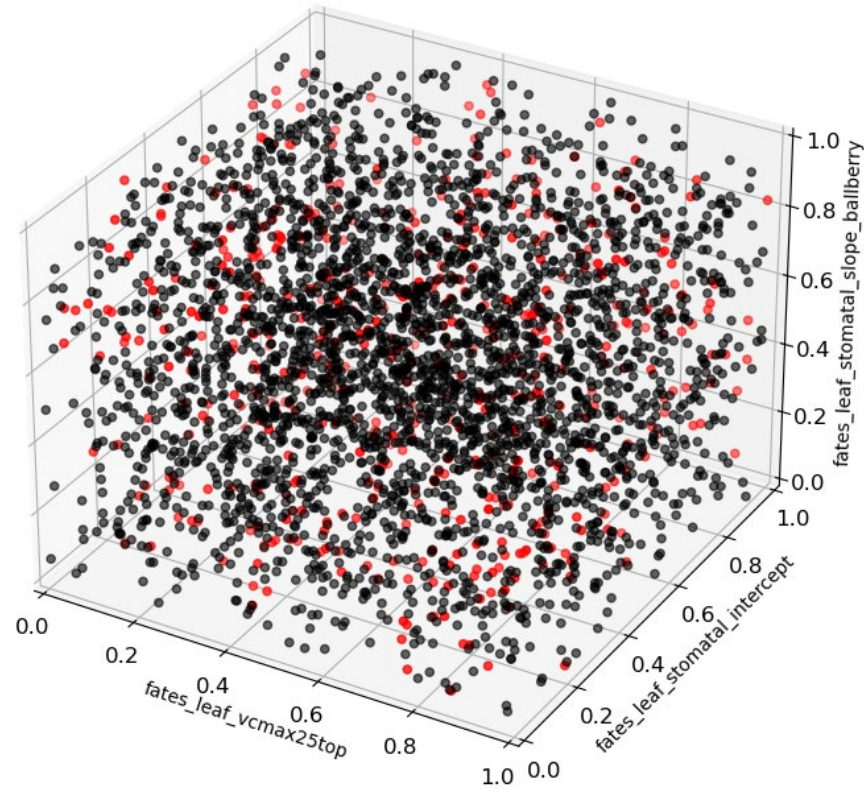
16 parameters  
500-member ensemble



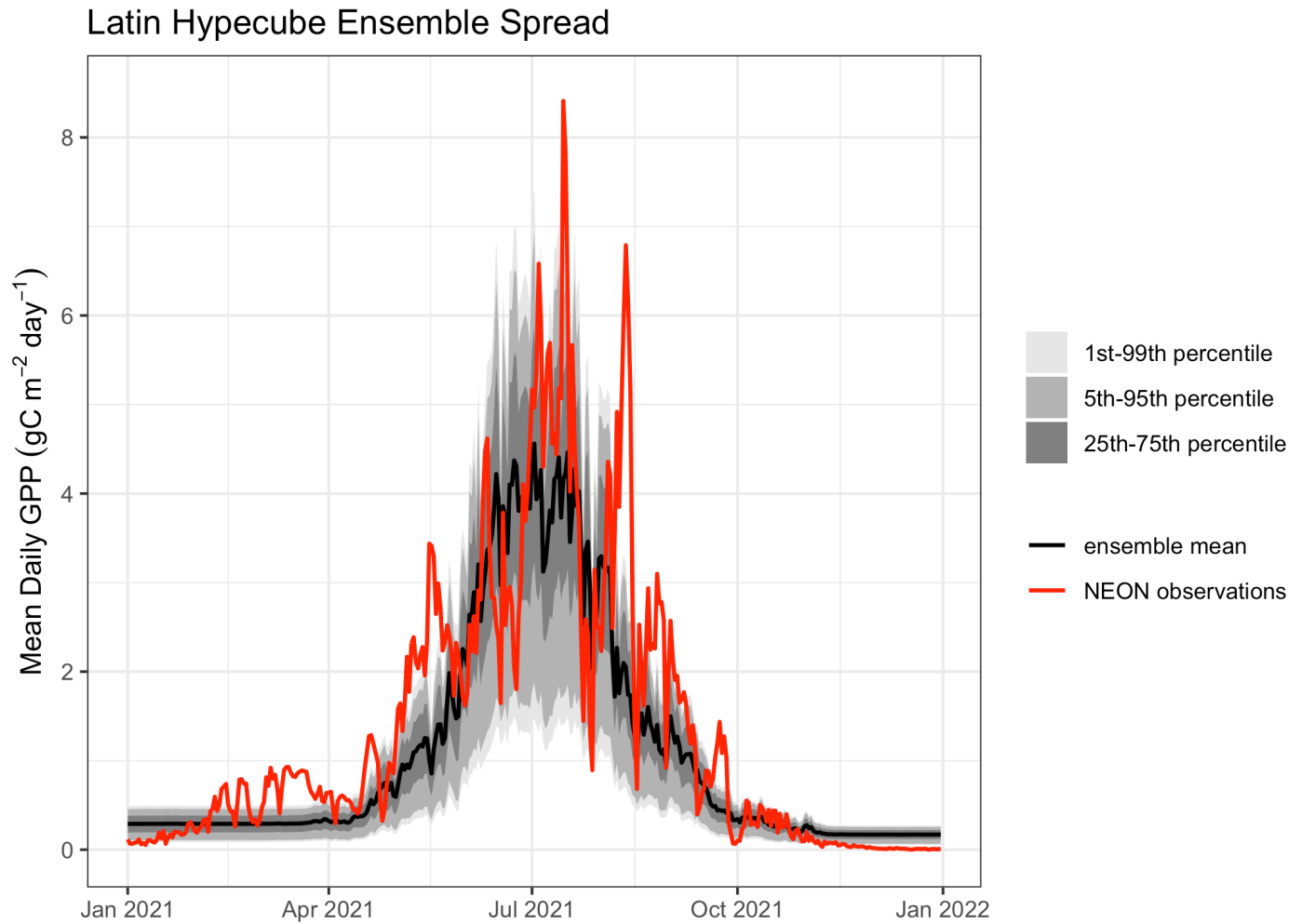


# Latin Hypercube Ensemble

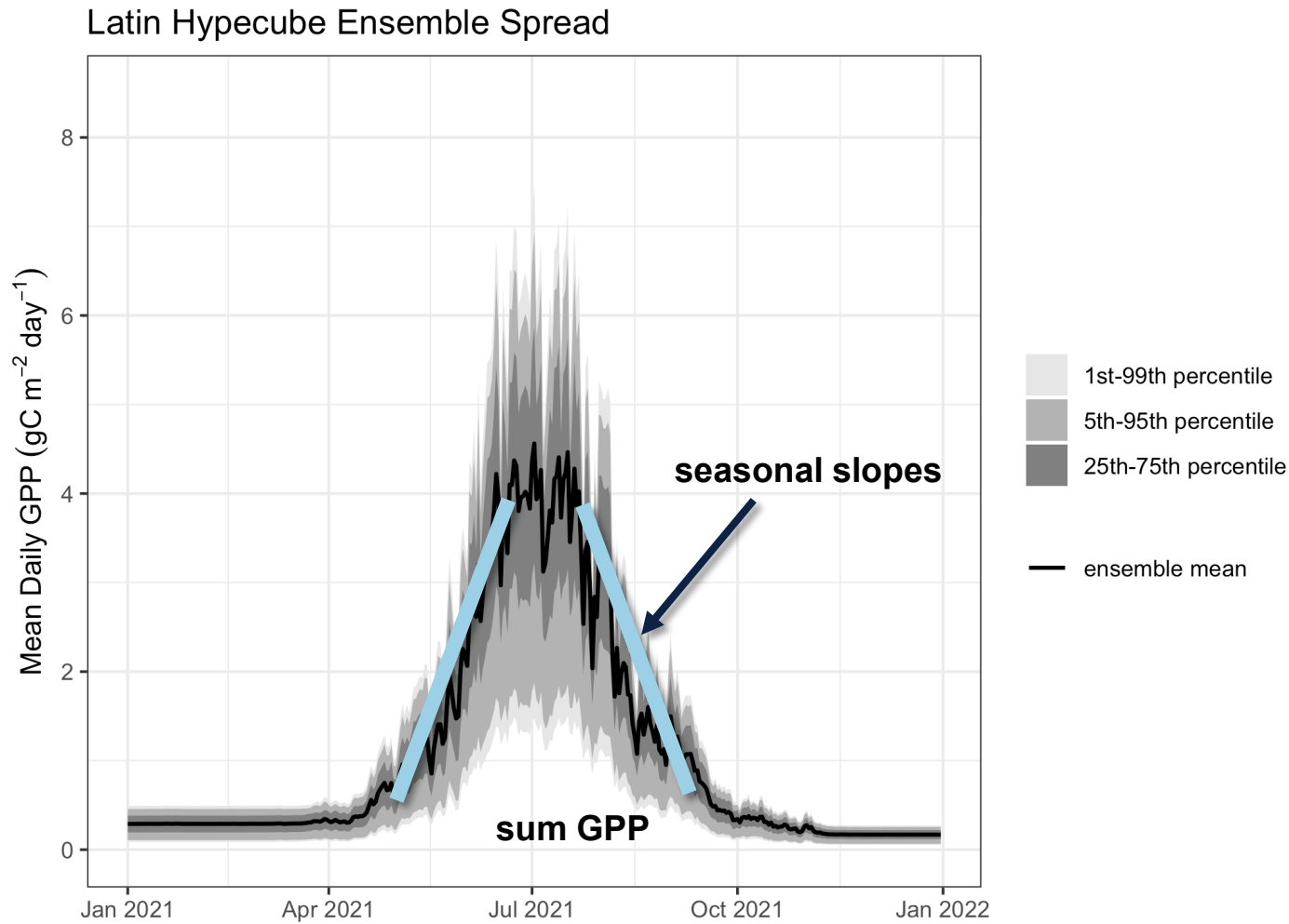
16 parameters  
500-member ensemble



# Latin Hypercube Ensemble

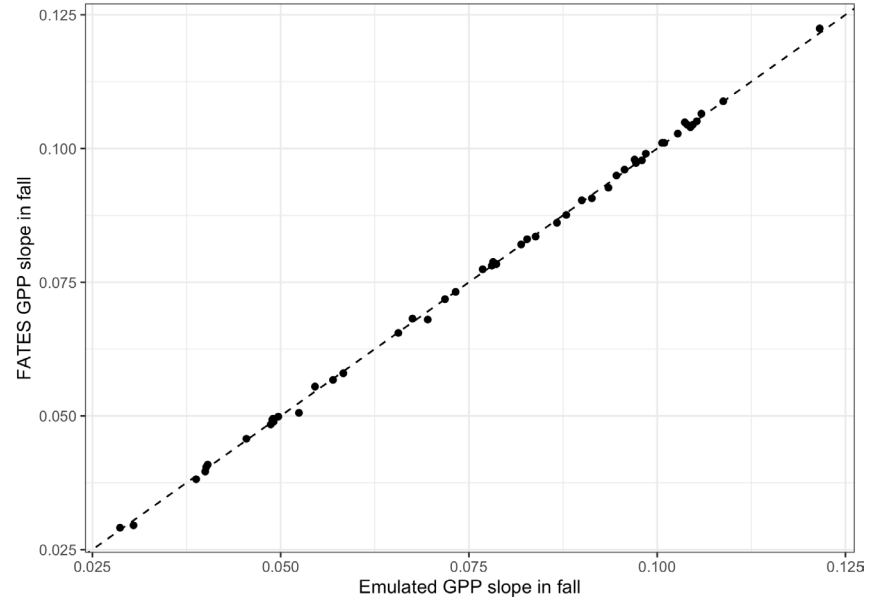
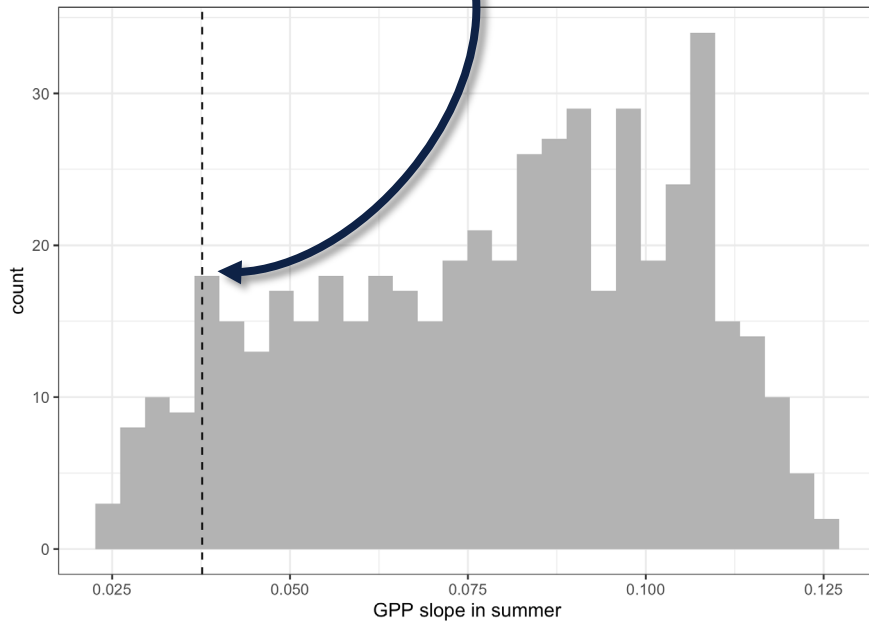


# Latin Hypercube Ensemble



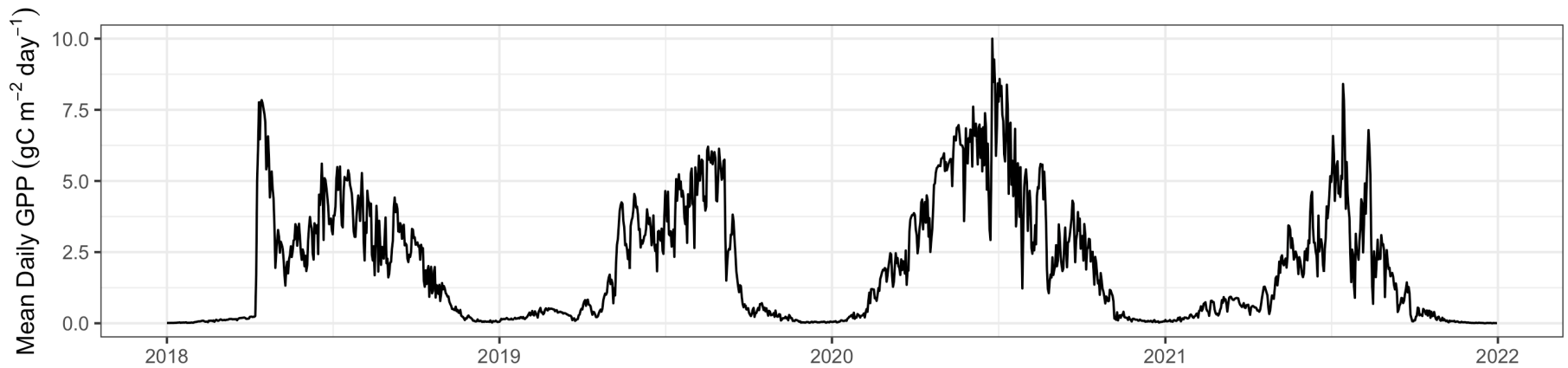
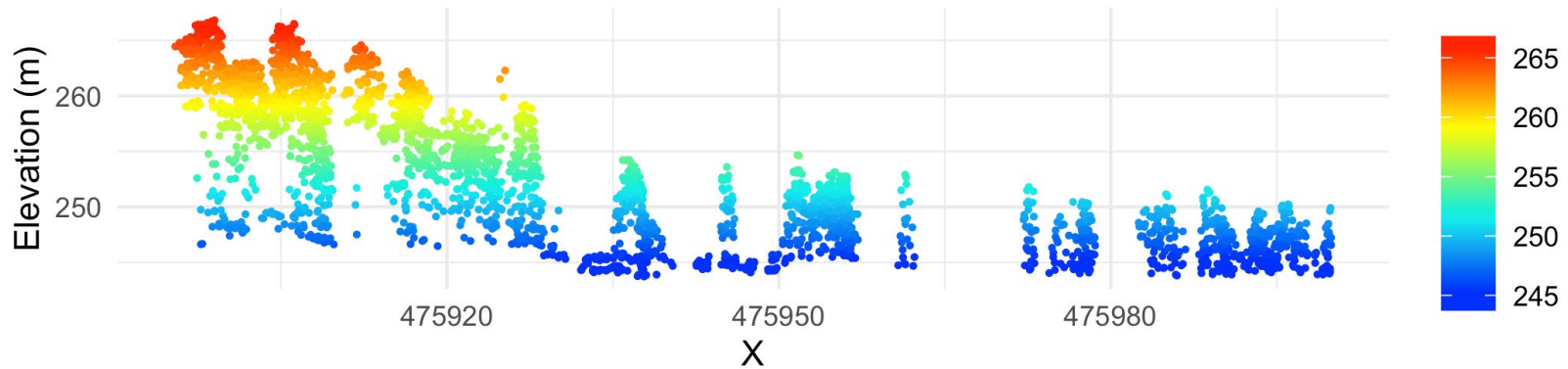
# Emulator testing

NEON observations





# How to get around noisy, sparse observational data?





Thank you!

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