FATES Capabilities and Calibration at NEON Sites
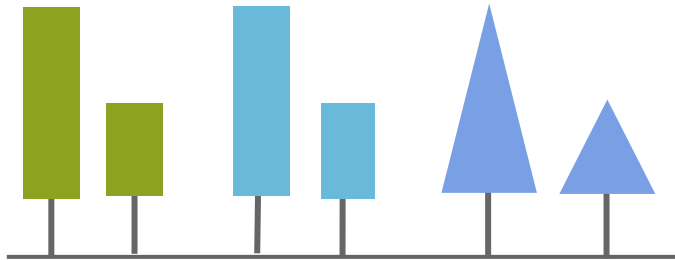
How do we calibrate a complex model with noisy data?

Adrianna Foster
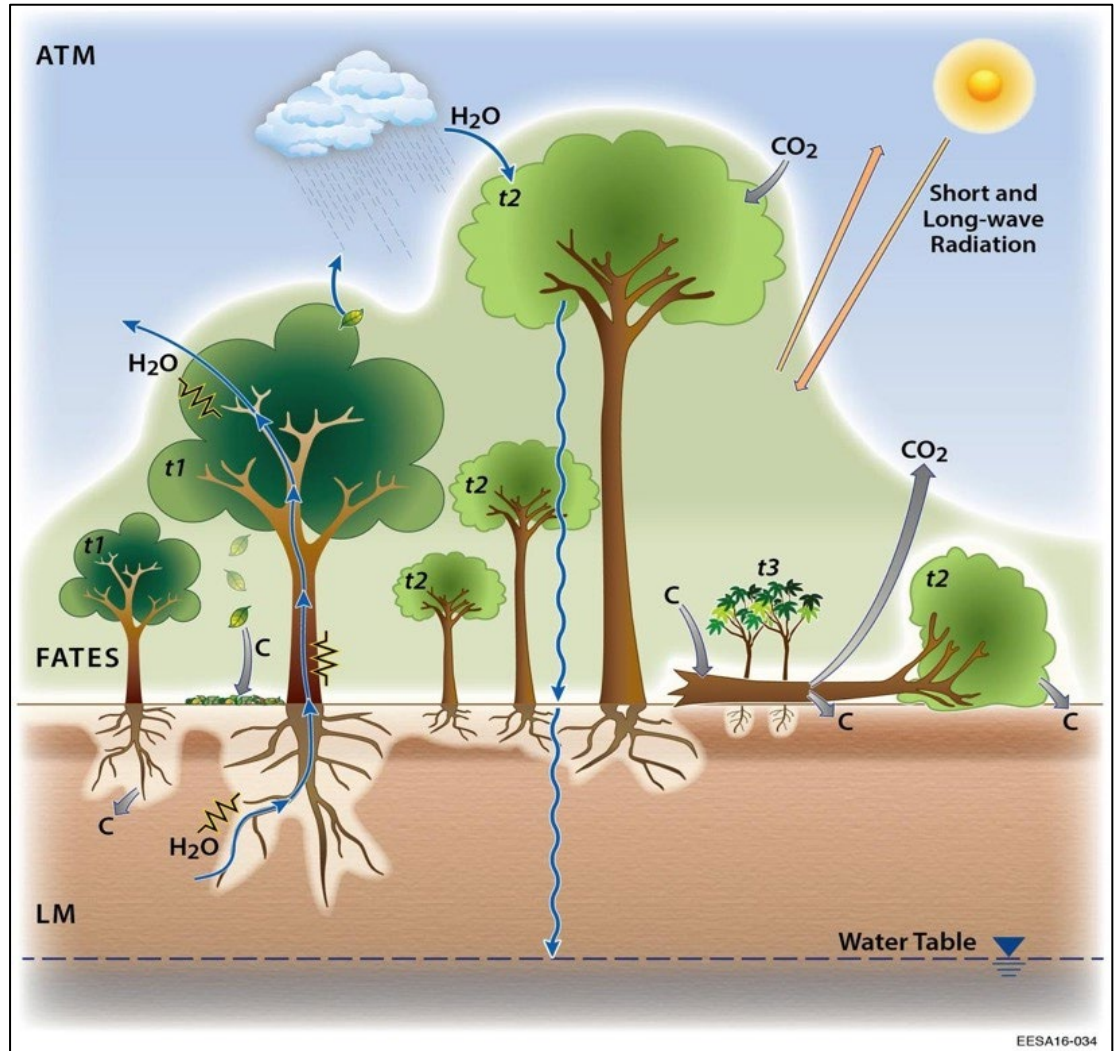
Project Scientist I, NCAR CGD Terrestrial Sciences Section

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

FATES complexity modes

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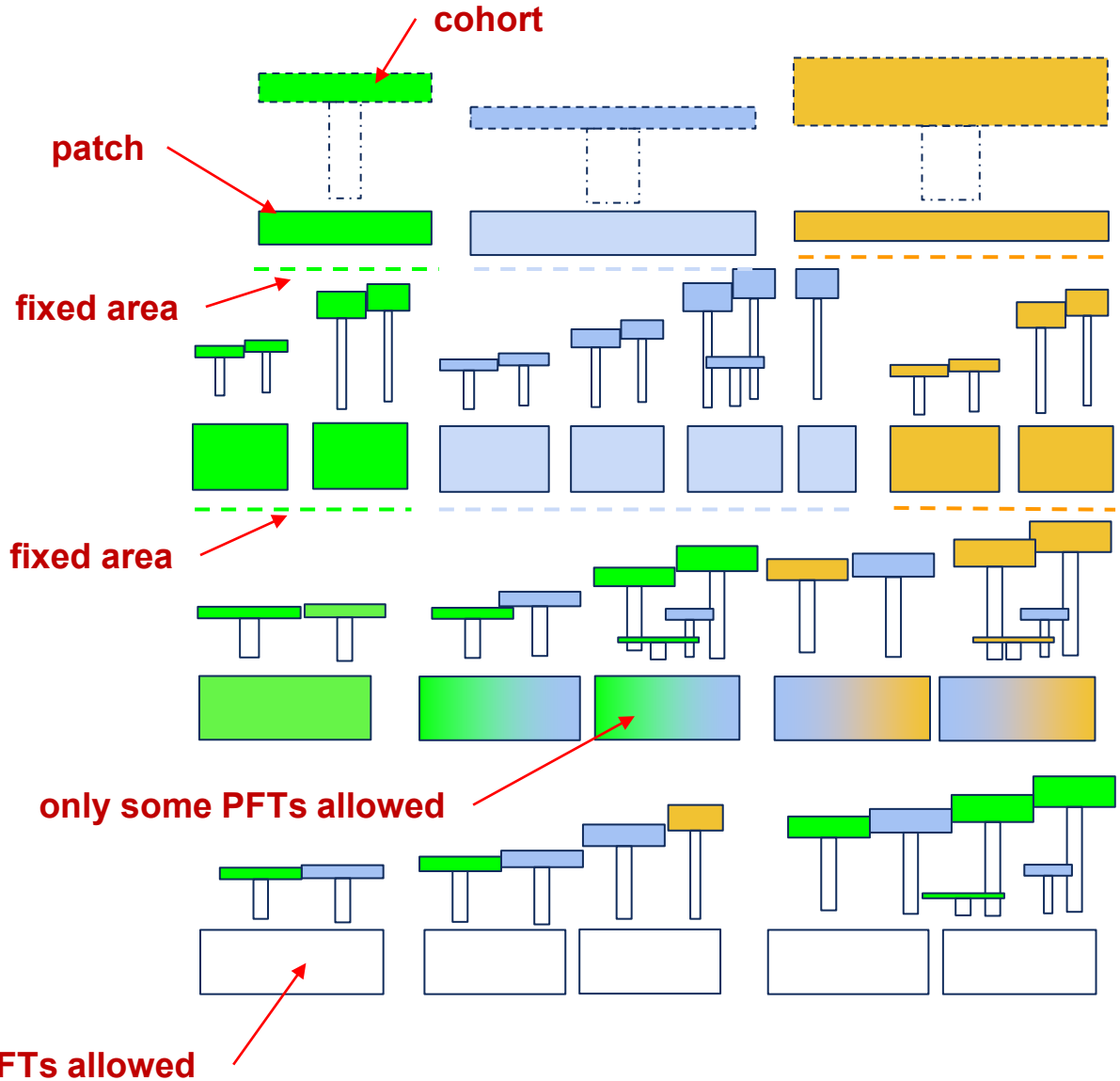*No disturbance, growth, or mortality*

No Competition
All PFTs given a fixed area to grow
Growth & disturbance
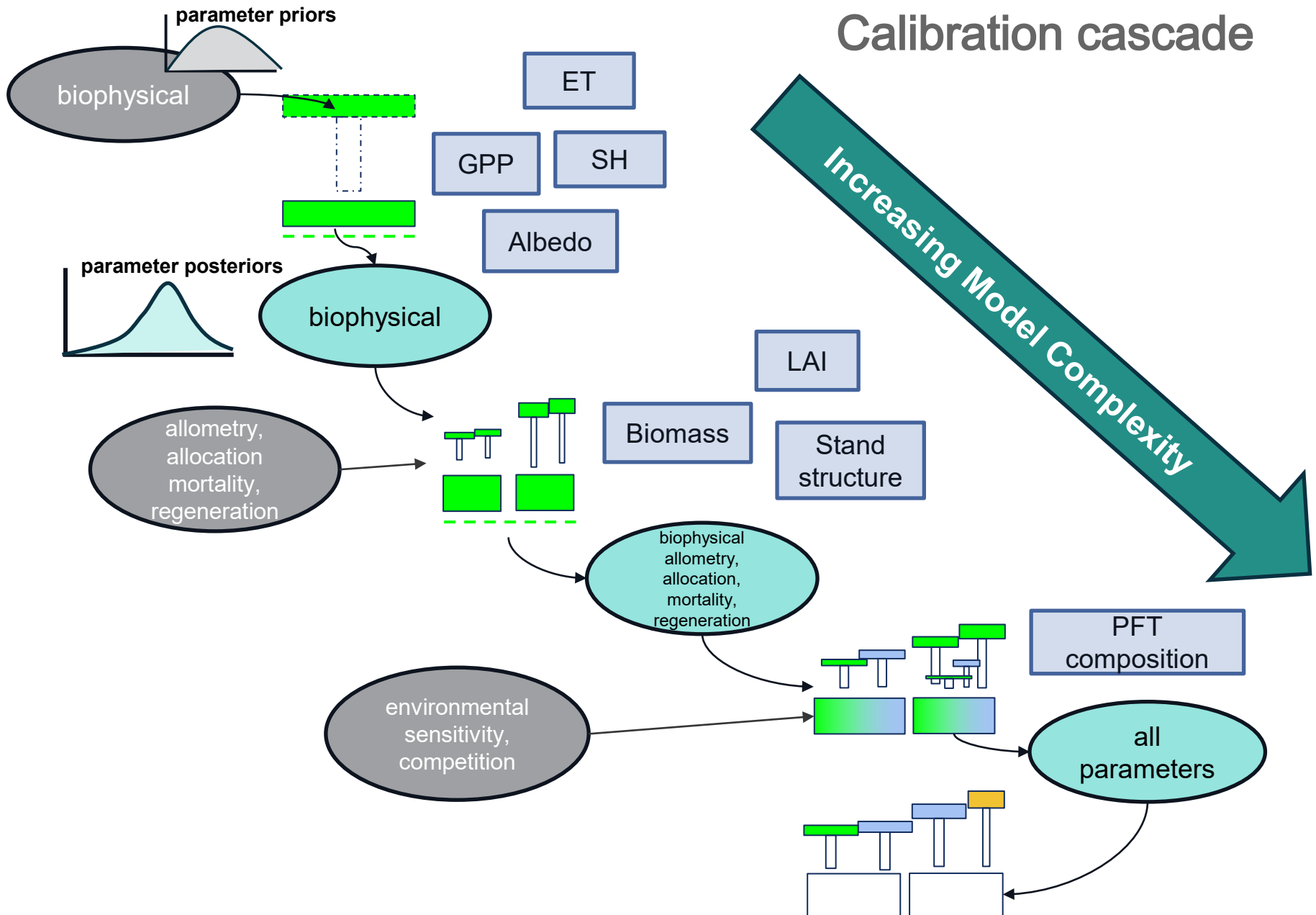*Fixed biogeography*

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

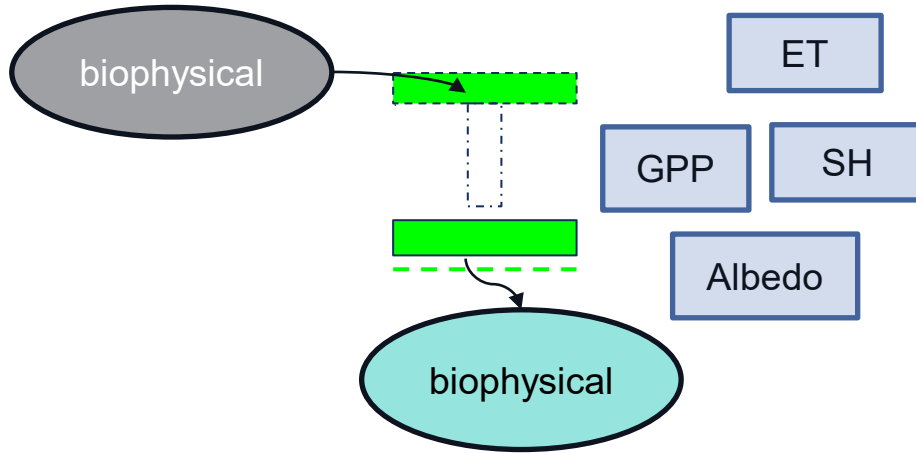**Full FATES**
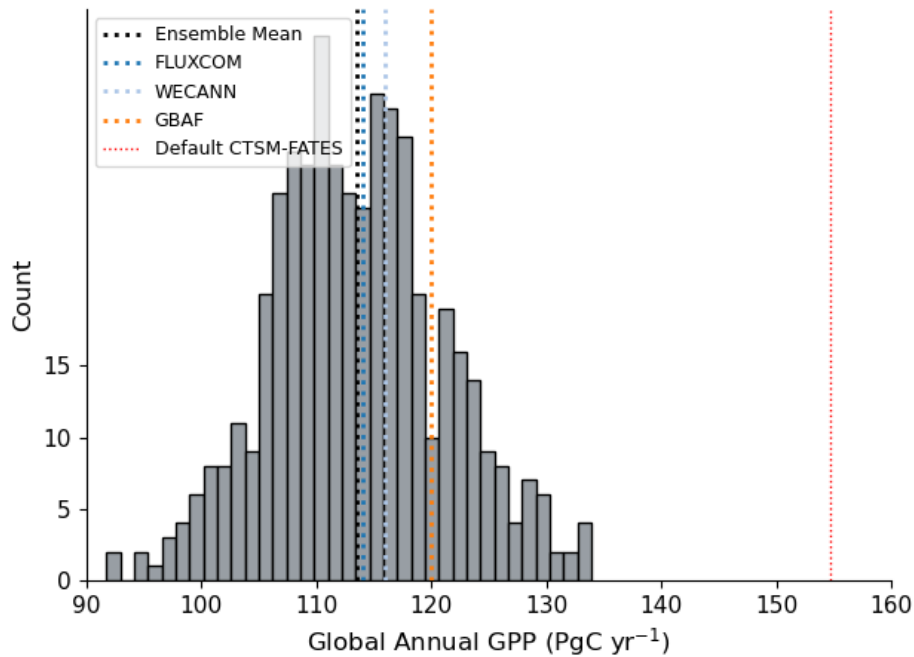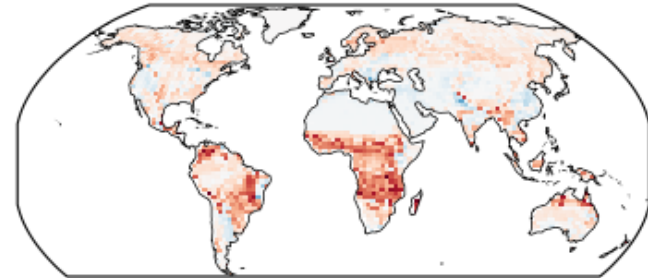*Growth, disturbance, and competition everywhere*

cohort

patch

fixed area

fixed area

only some PFTs allowed

all PFTs allowed

Adrianna Foster – afoster@ucar.edu

Calibration cascade

biophysical

ET

GPP   SH

Albedo

biophysical

Global SP Calibration at sparse grid

GPP Difference from Observations (kgC m^{-2} yr^{-1})

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

https://data.neonscience.org/data-products/explore
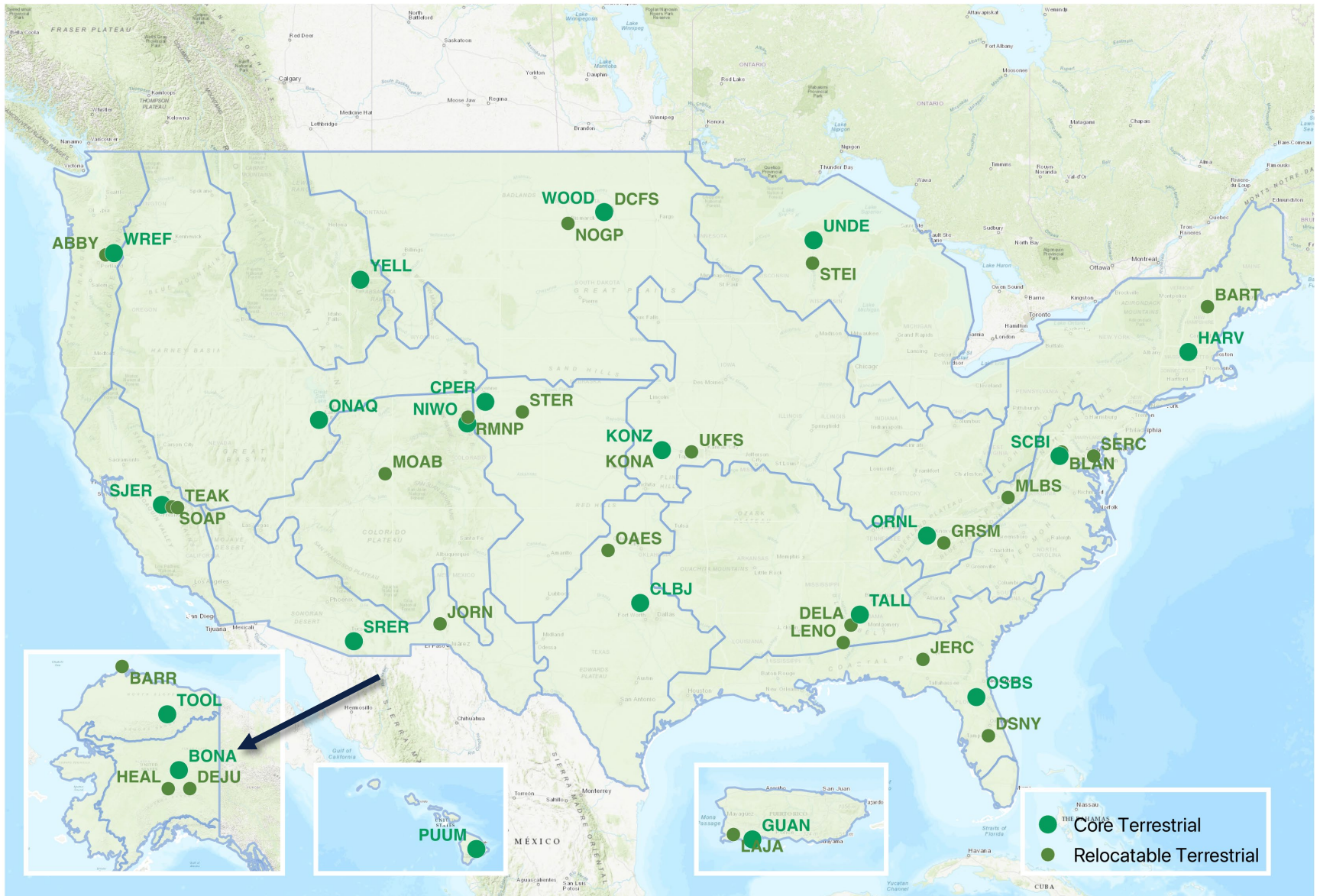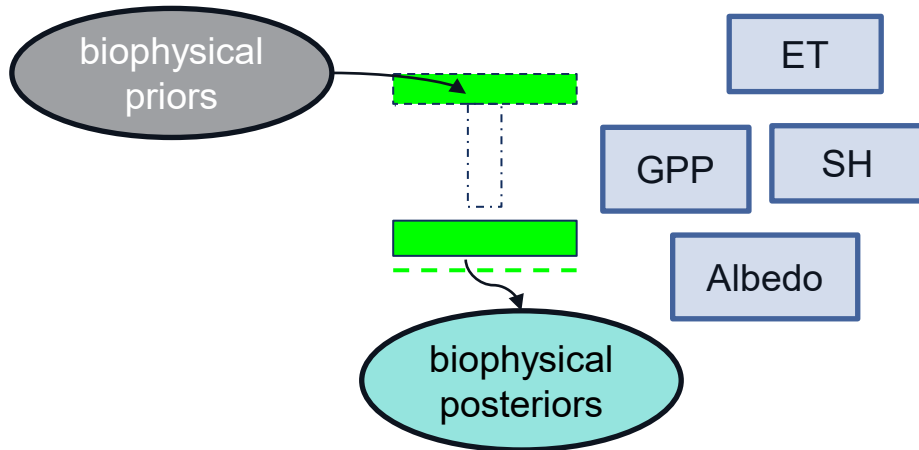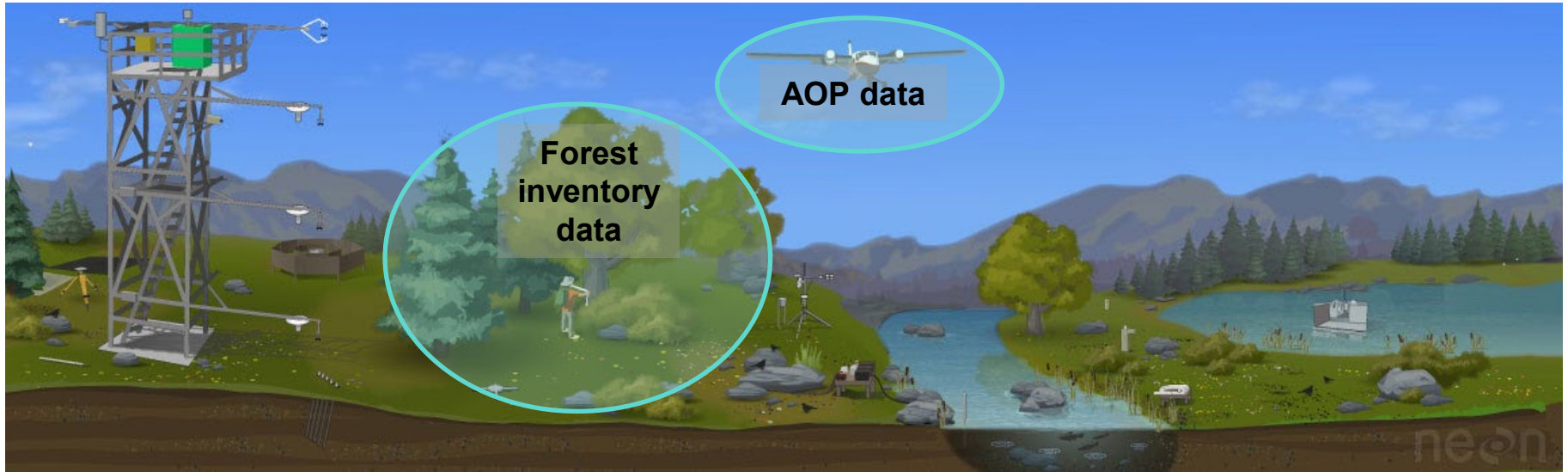
NEON sampling design provides ample data sources for benchmarking and model assimilation

Flux tower observations

Forest inventory data

AOP data

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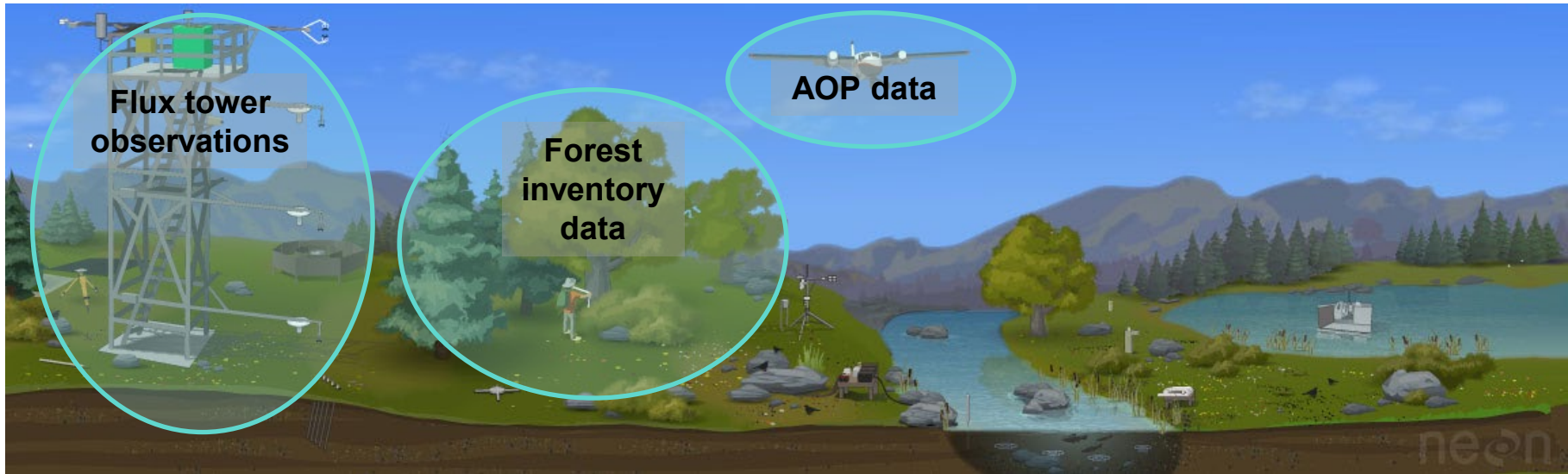
Adrianna Foster – afoster@ucar.edu

SP mode calibration at NEON sites

biophysical priors

ET

GPP   SH

Albedo

biophysical posteriors

SP Mode driven by:
1. PFT composition (percent cover)
2. canopy height (top and bottom)
3. LAI & SAI

AOP data

Forest inventory data

Adrianna Foster – afoster@ucar.edu

PFT composition

PFT composition

Legend:
- Tower Footprint
- **Proportion NEET**
  - 1.5 - 10
  - 10 - 20
  - 20 - 30
  - 30 - 40
  - 40 - 50
  - 50 - 60
  - 60 - 70
  - 70 - 80
  - 80 - 90
  - 90 - 100

inventory plots

not representative of tower

no non-woody vegetation

BONA

0   100   200 m

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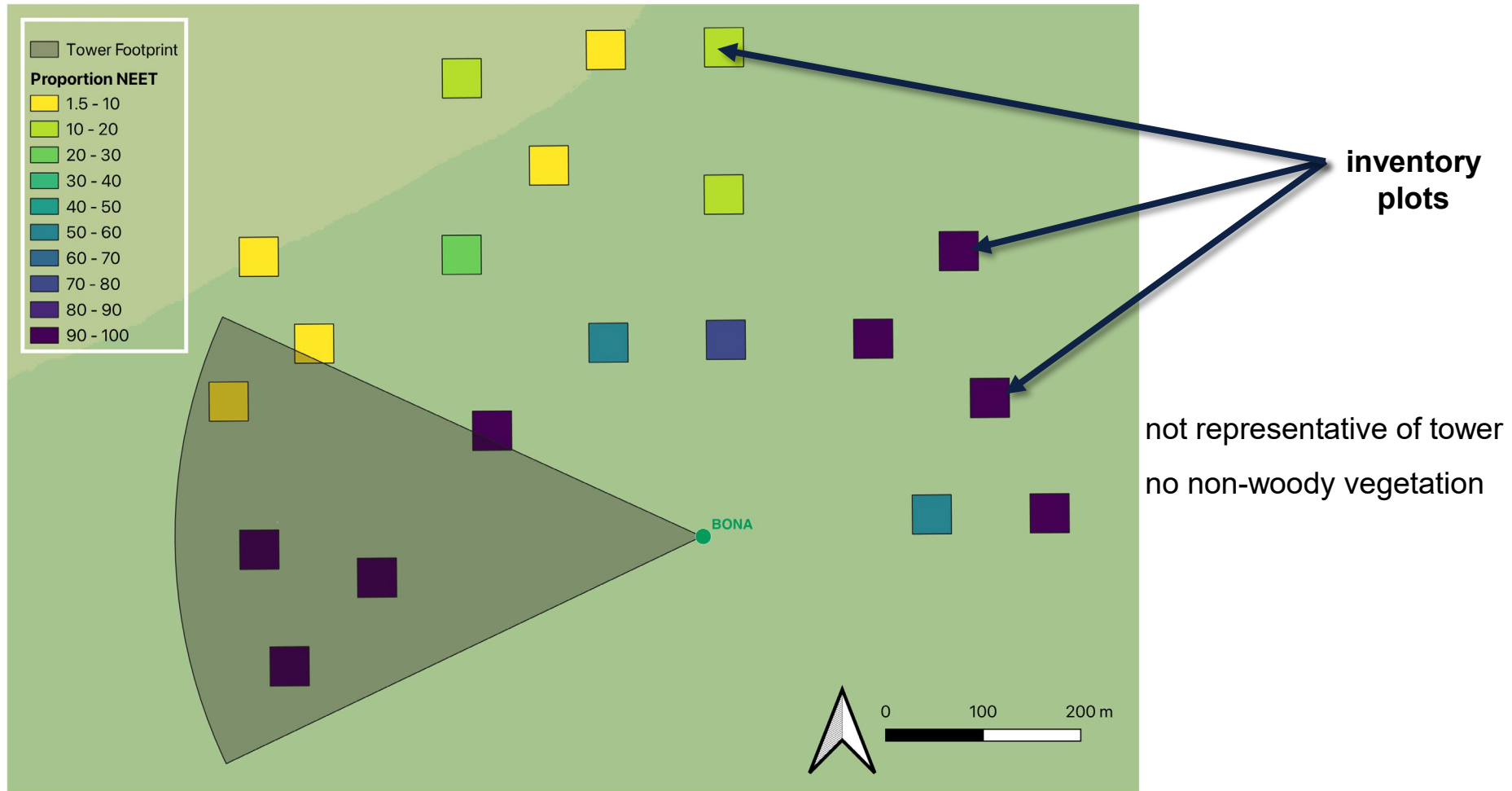
PFT composition

canopy height

NDVI

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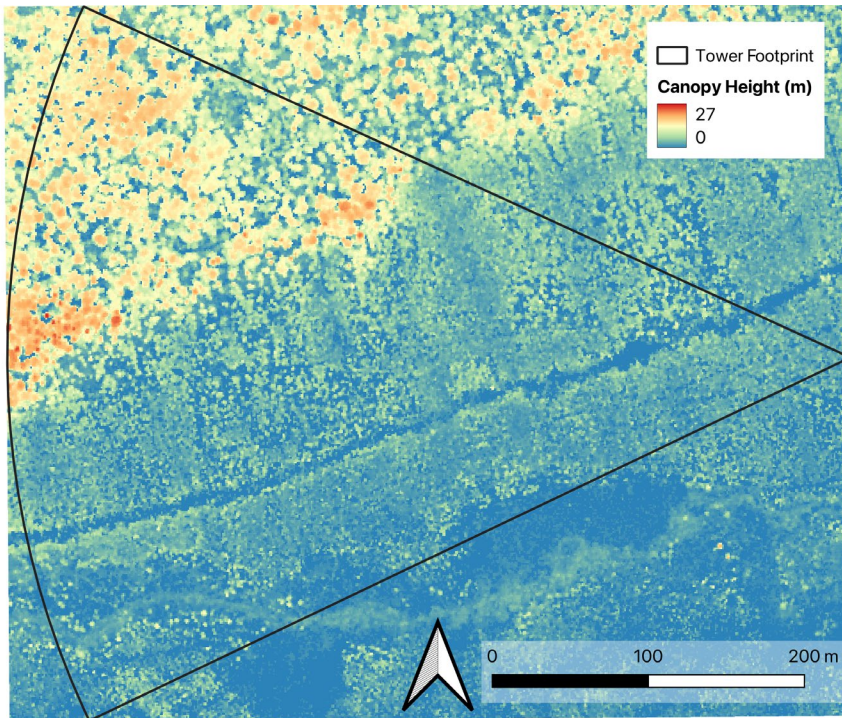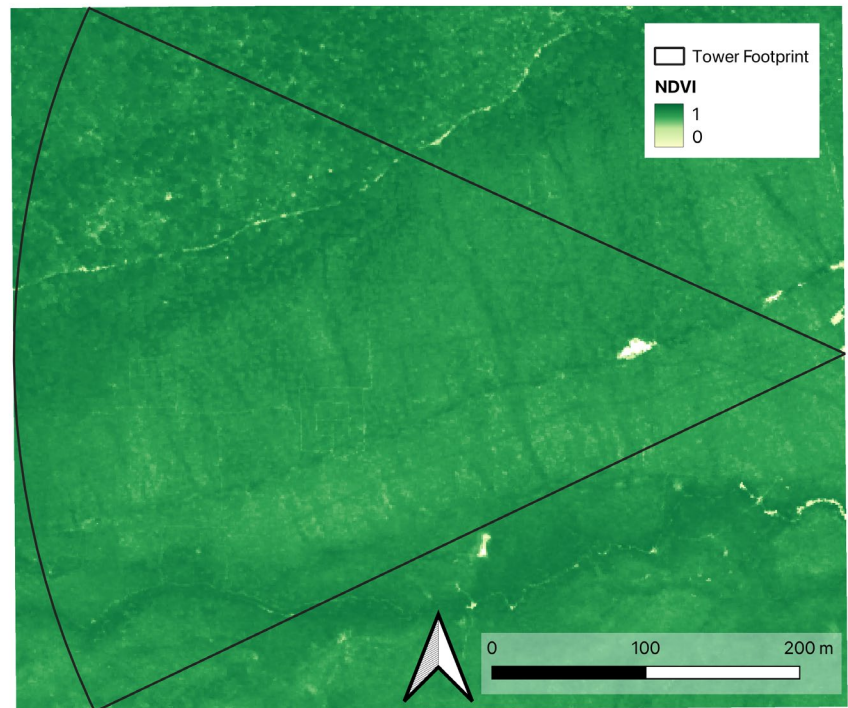
PFT composition
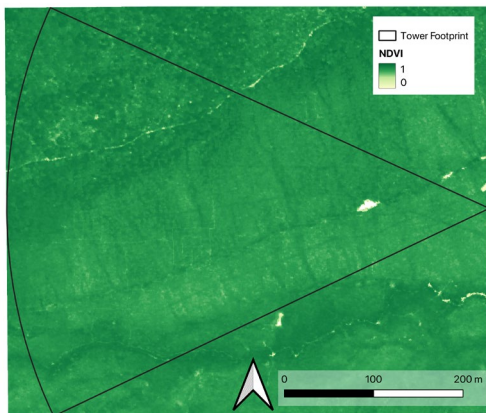
NDVI

Canopy height

NDVI > 0.5
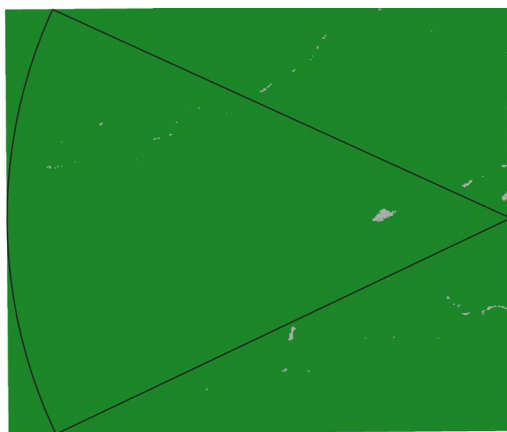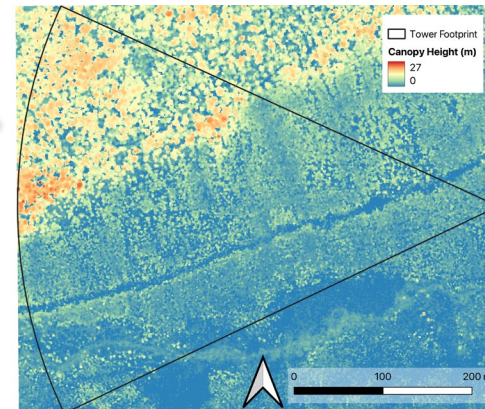
height > 0.5 m

vegetated

woody vegetation

PFT composition
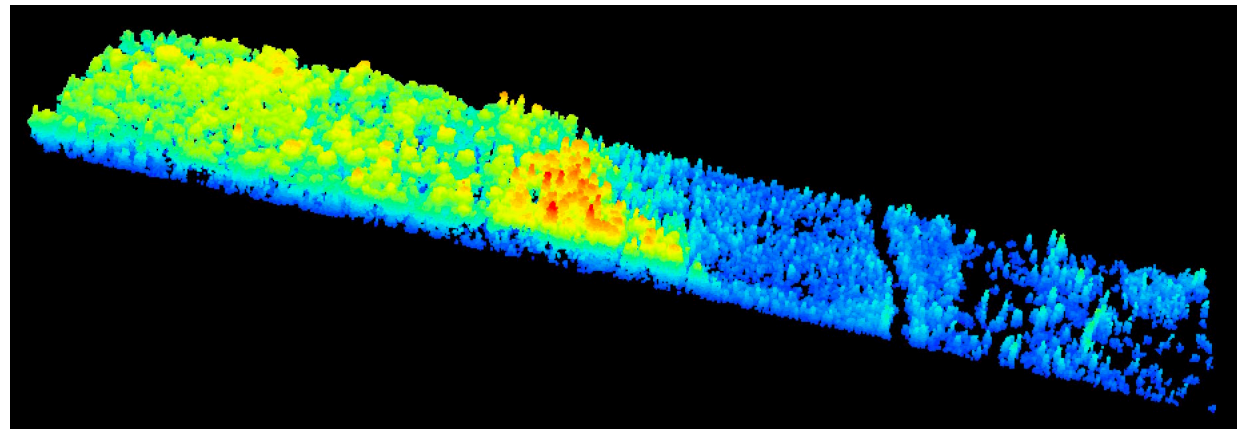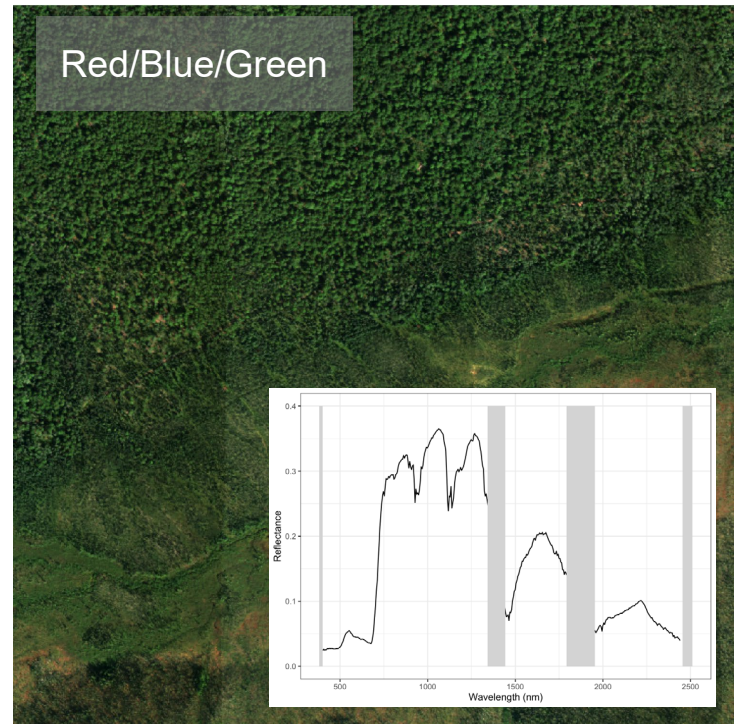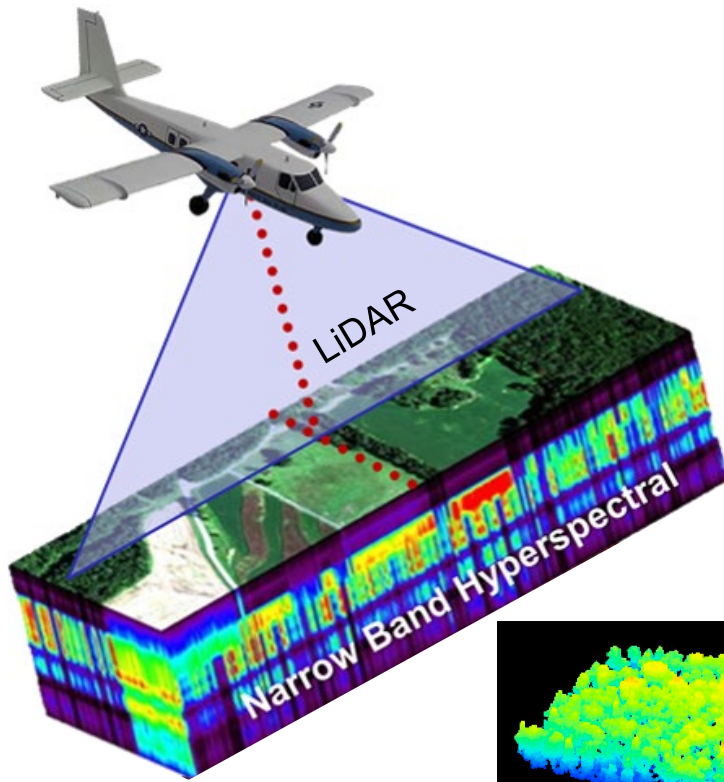

Legend:
- Non-vegetated
- Woody vegetation
- Non-woody vegetation
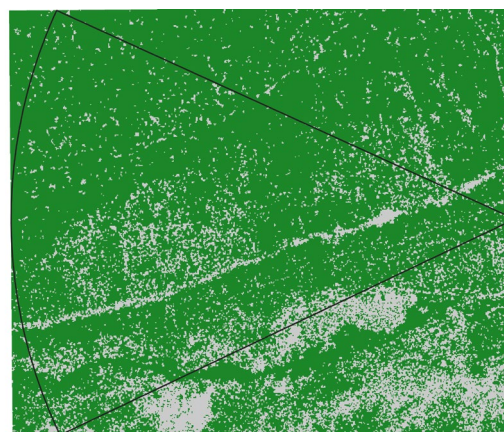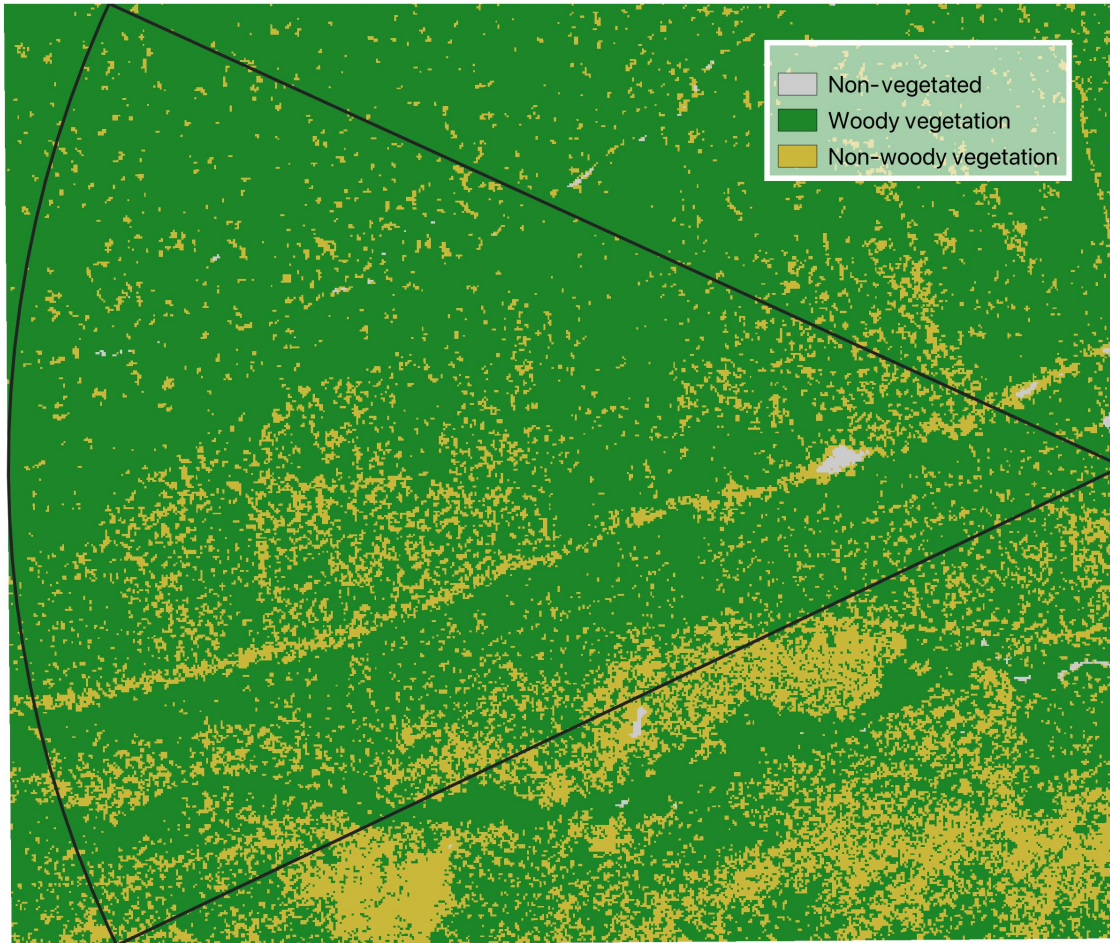
Non-woody vegetation: assume relative proportion of C3/C4 grass on surface dataset is correct (??)

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

Adrianna Foster – afoster@ucar.edu
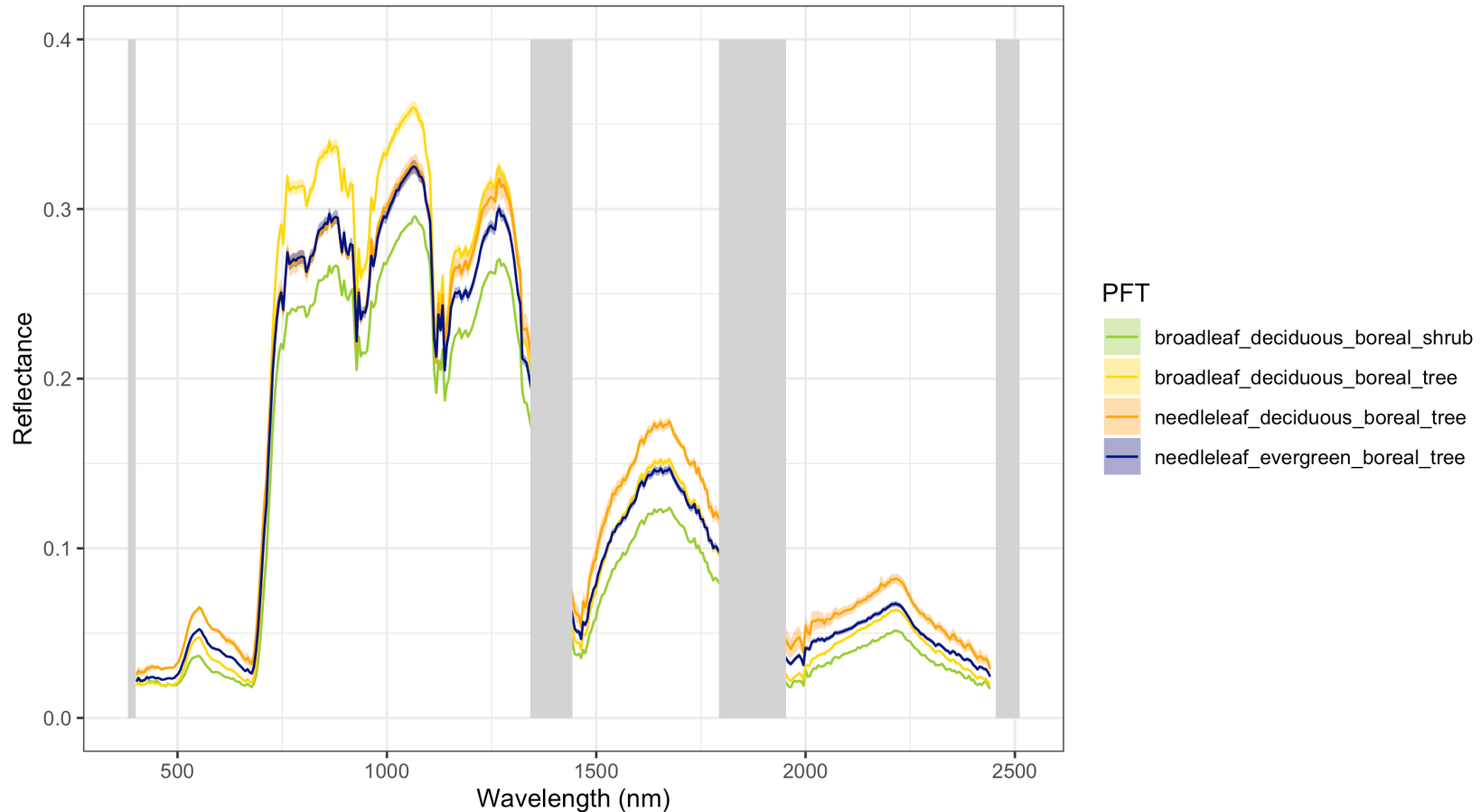
Tree Classification

Red/Blue/Green

Tree delineation using LiDAR point cloud

Canopy Height (m)
27
0

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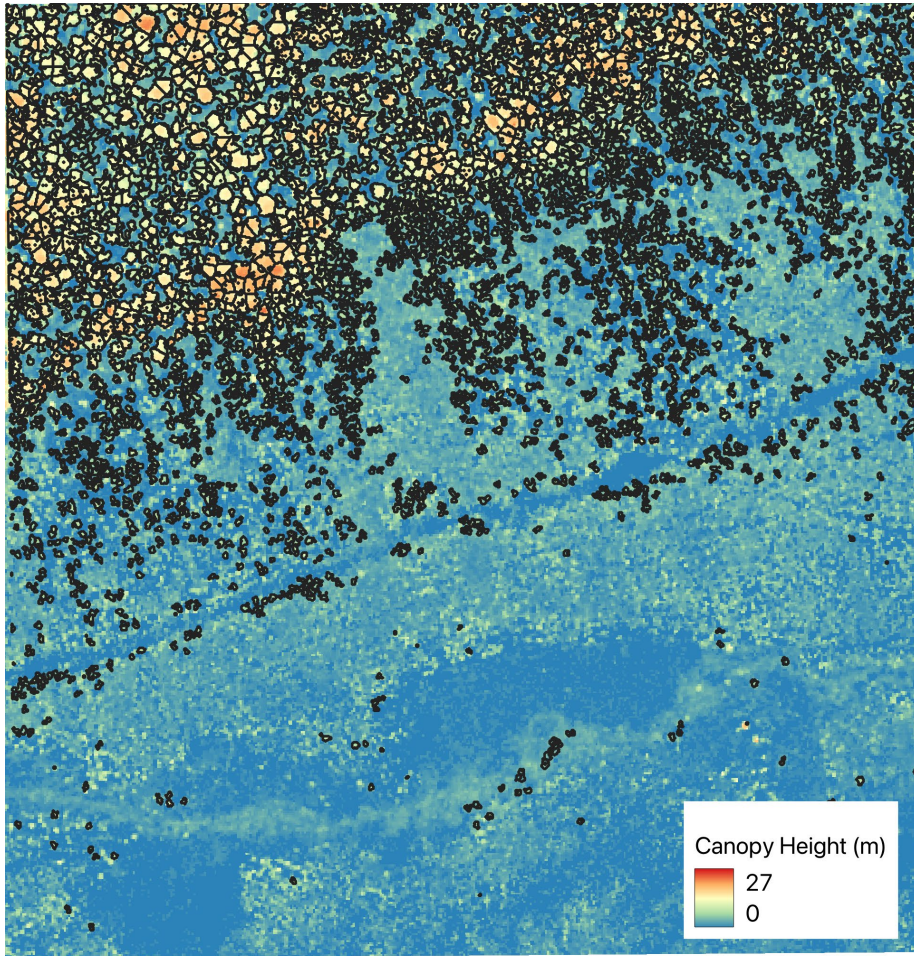
Train classification models with hyperspectral data and inventory data

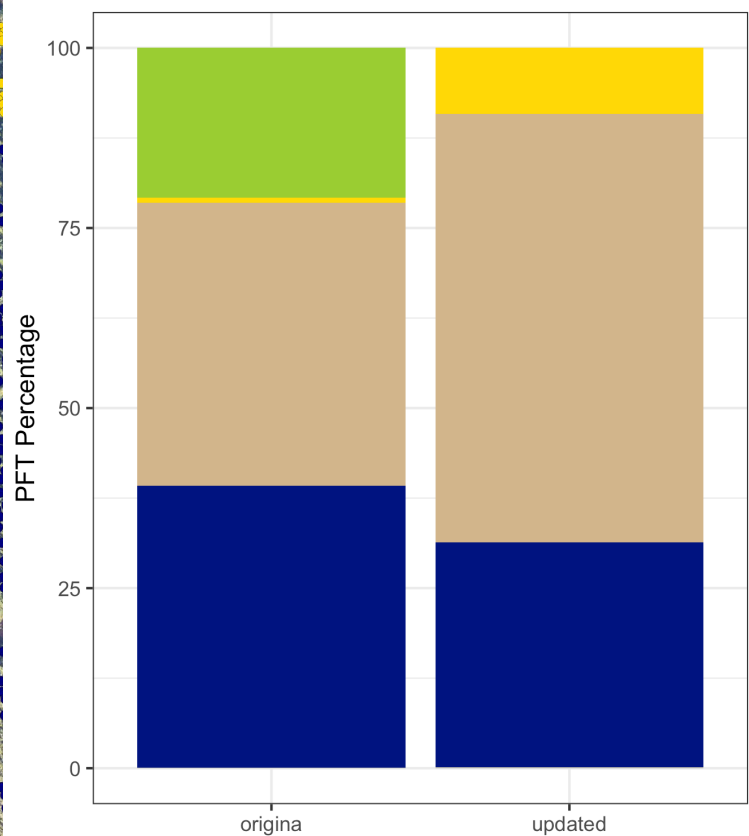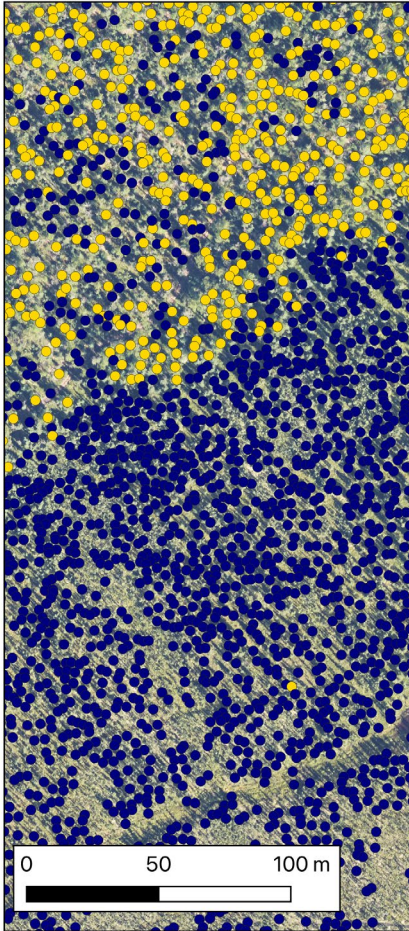# Train classification models with hyperspectral data and inventory data

PFT classification: random forest model

- 75/25 Training/Testing split

92% accuracy against testing data
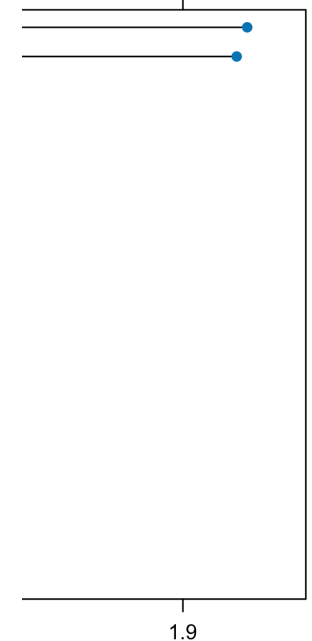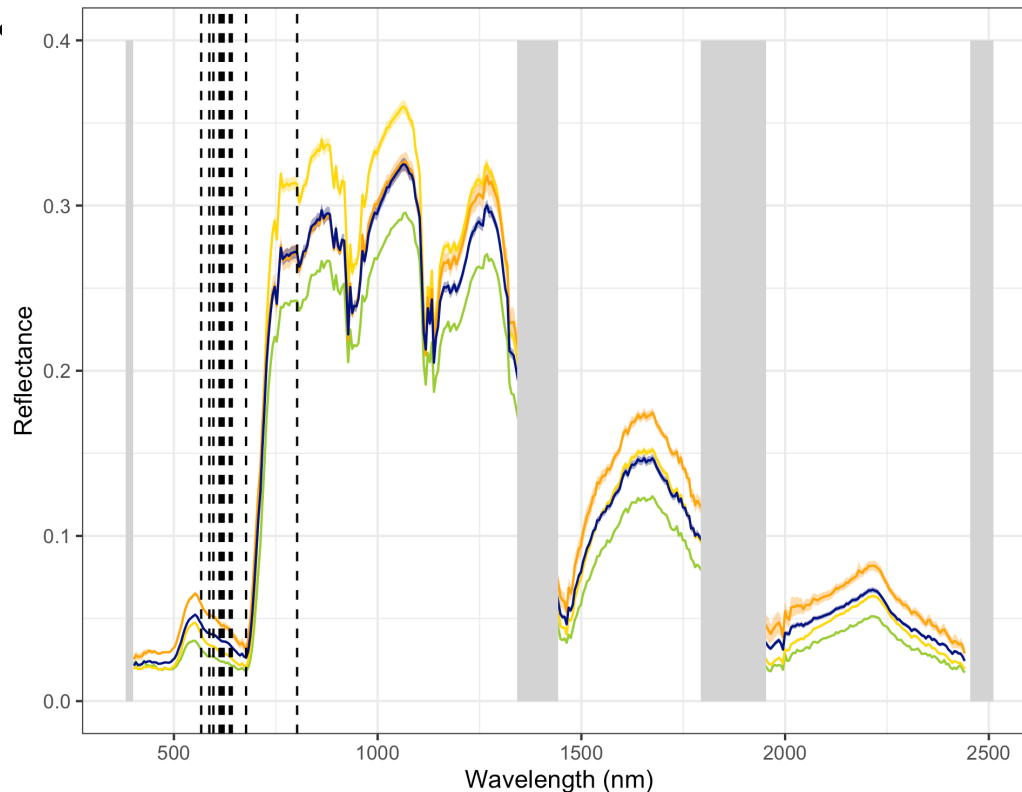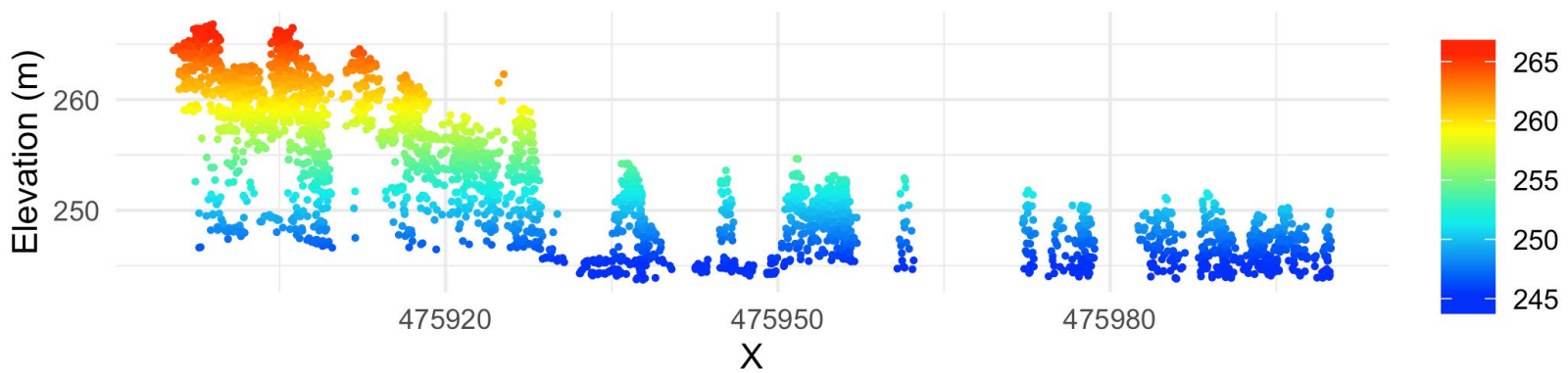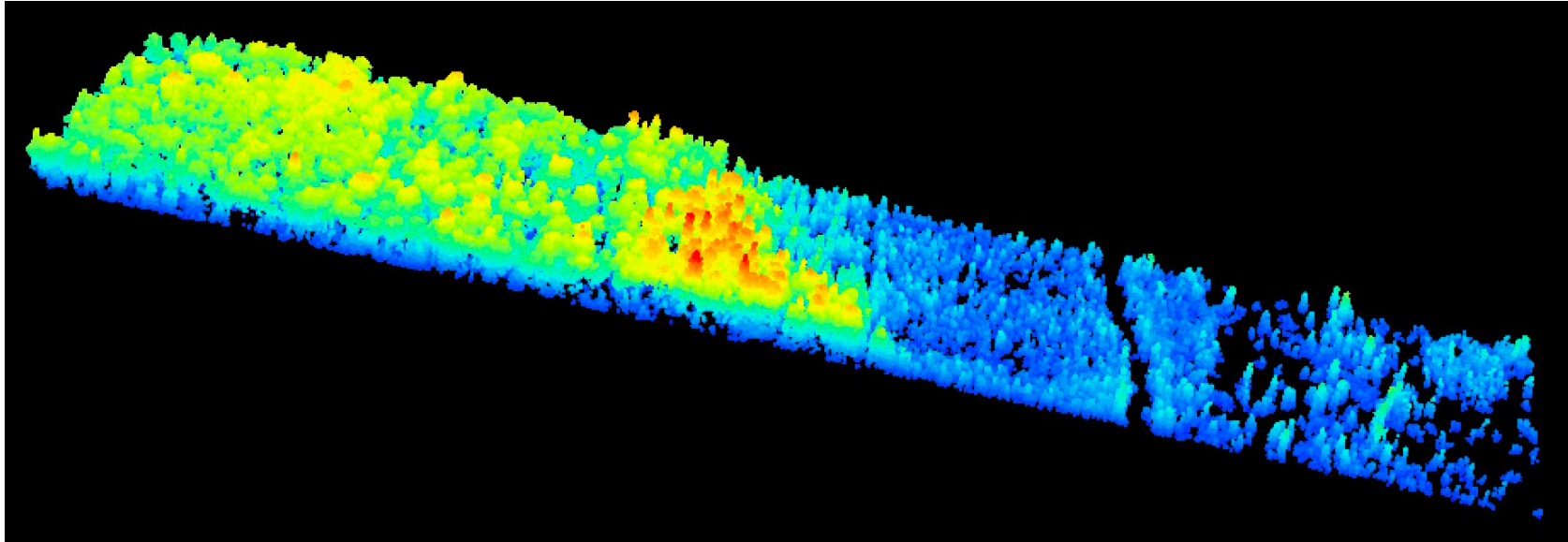
Apply classification model to tree crowns
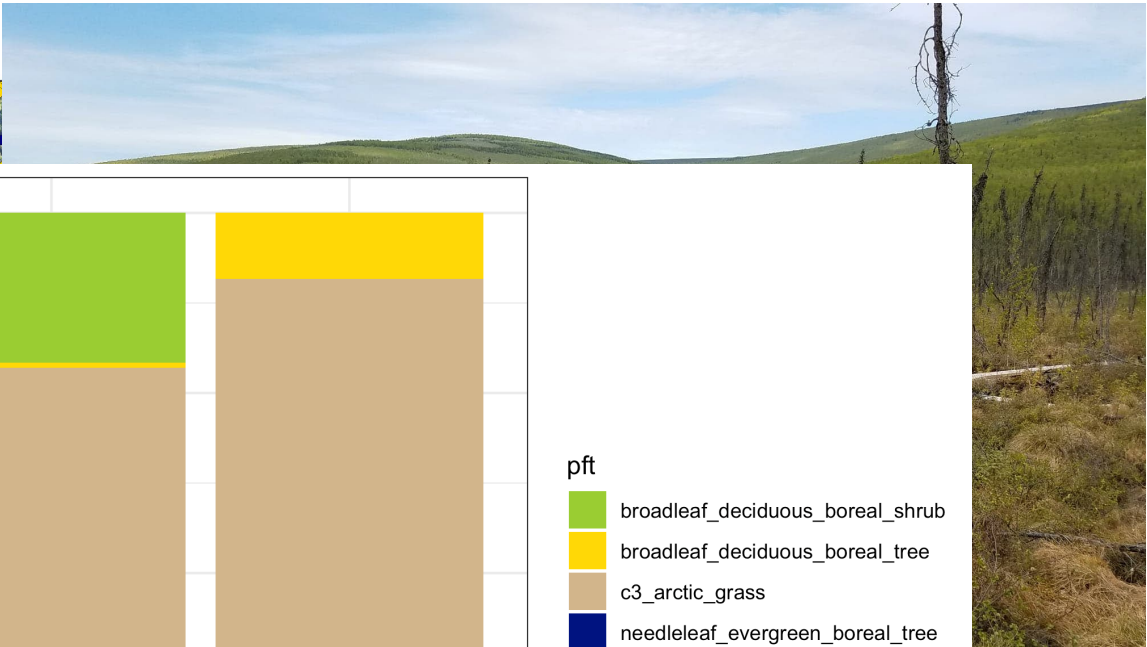
Canopy height top and bottom

Canopy height top and bottom

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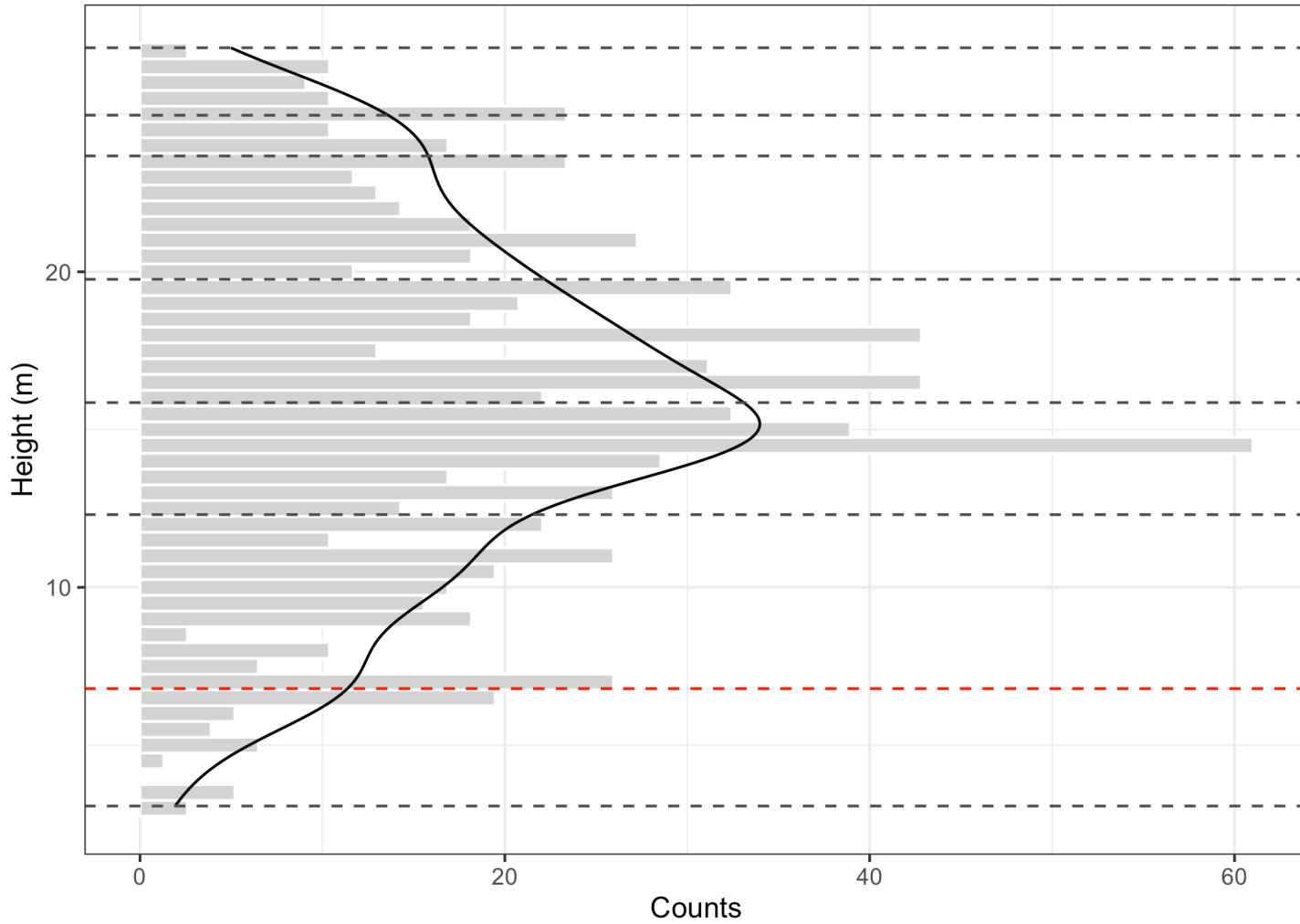
LAI and SAI
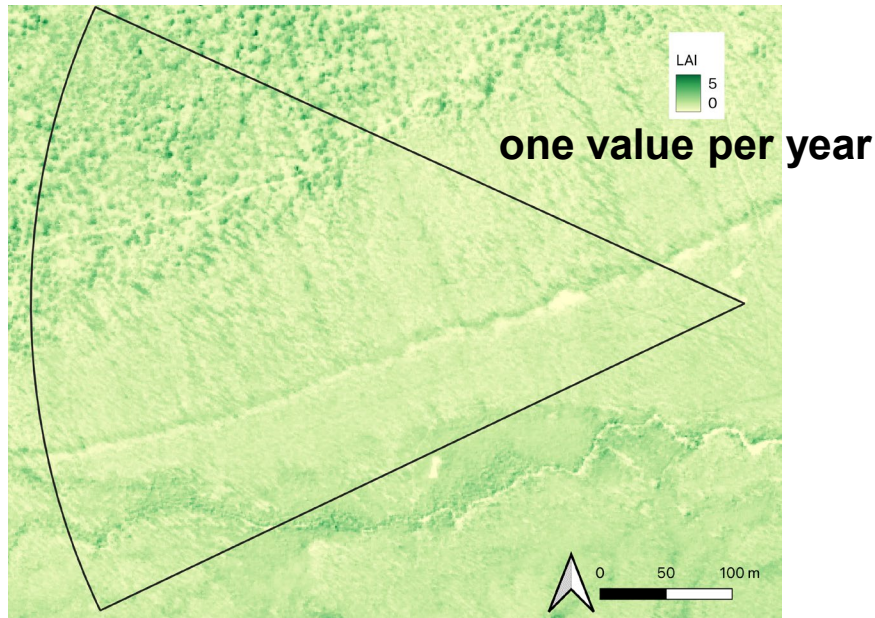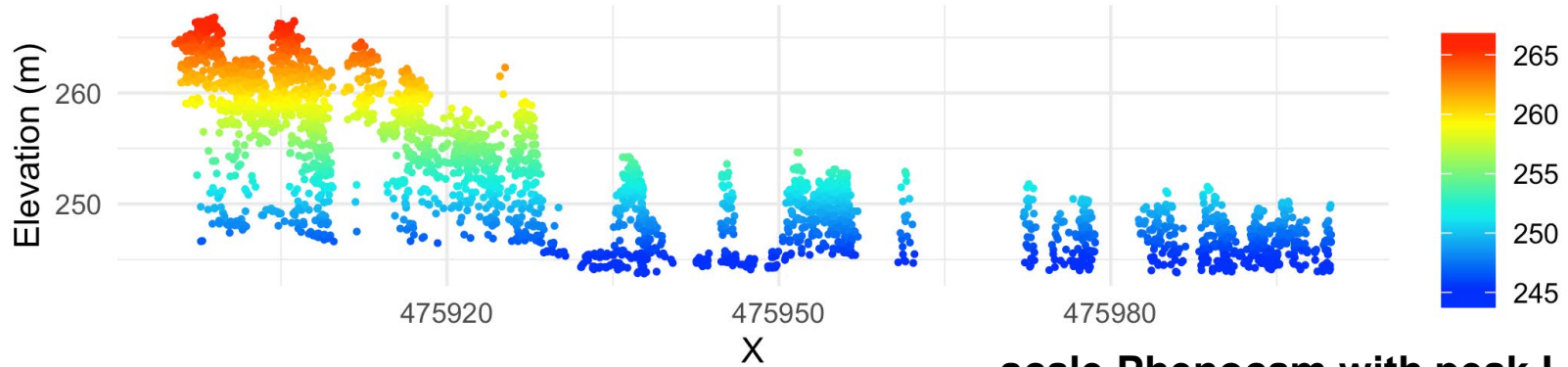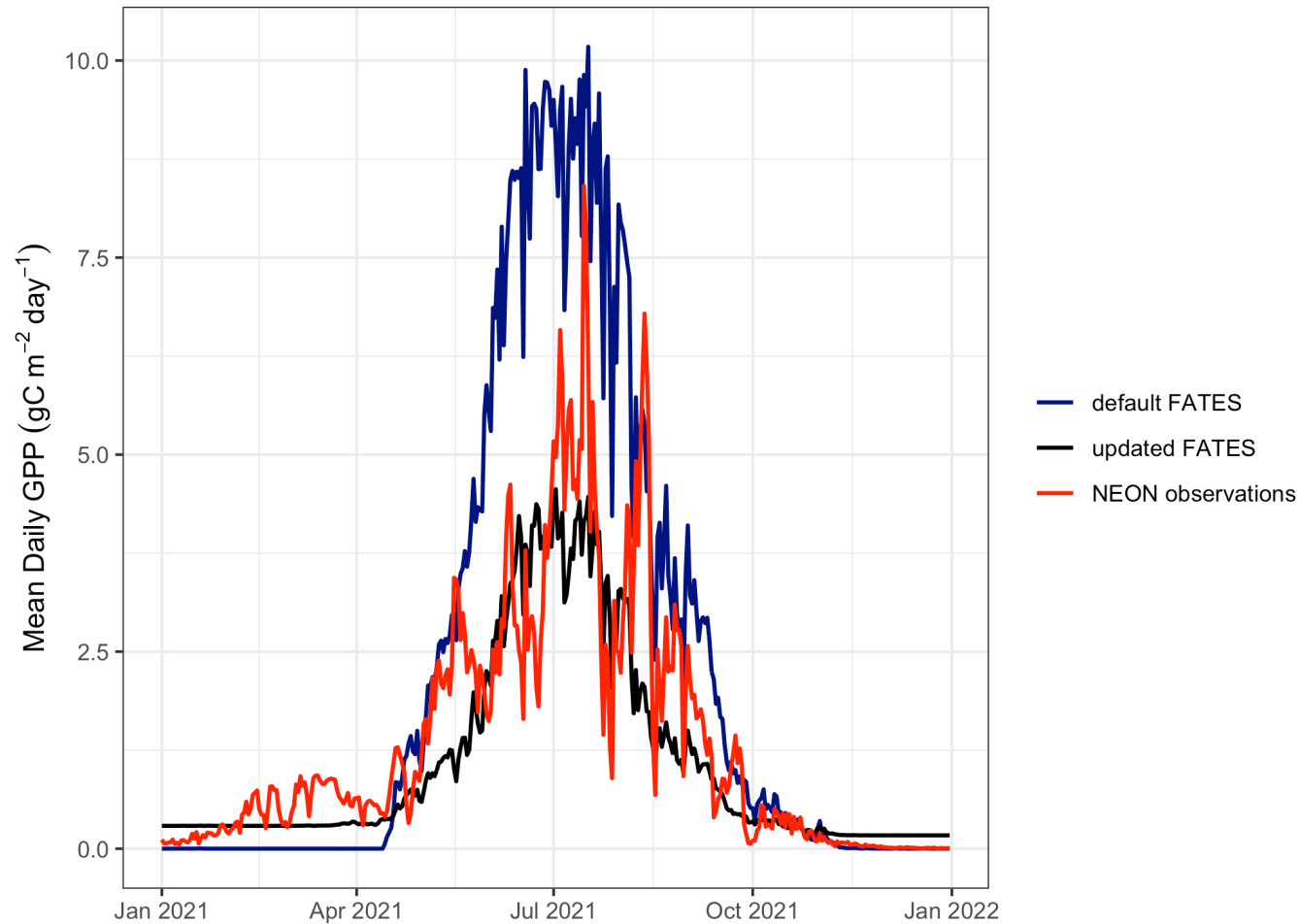

scale Phenocam with peak LAI

one value per year

LAI updates to surface dataset

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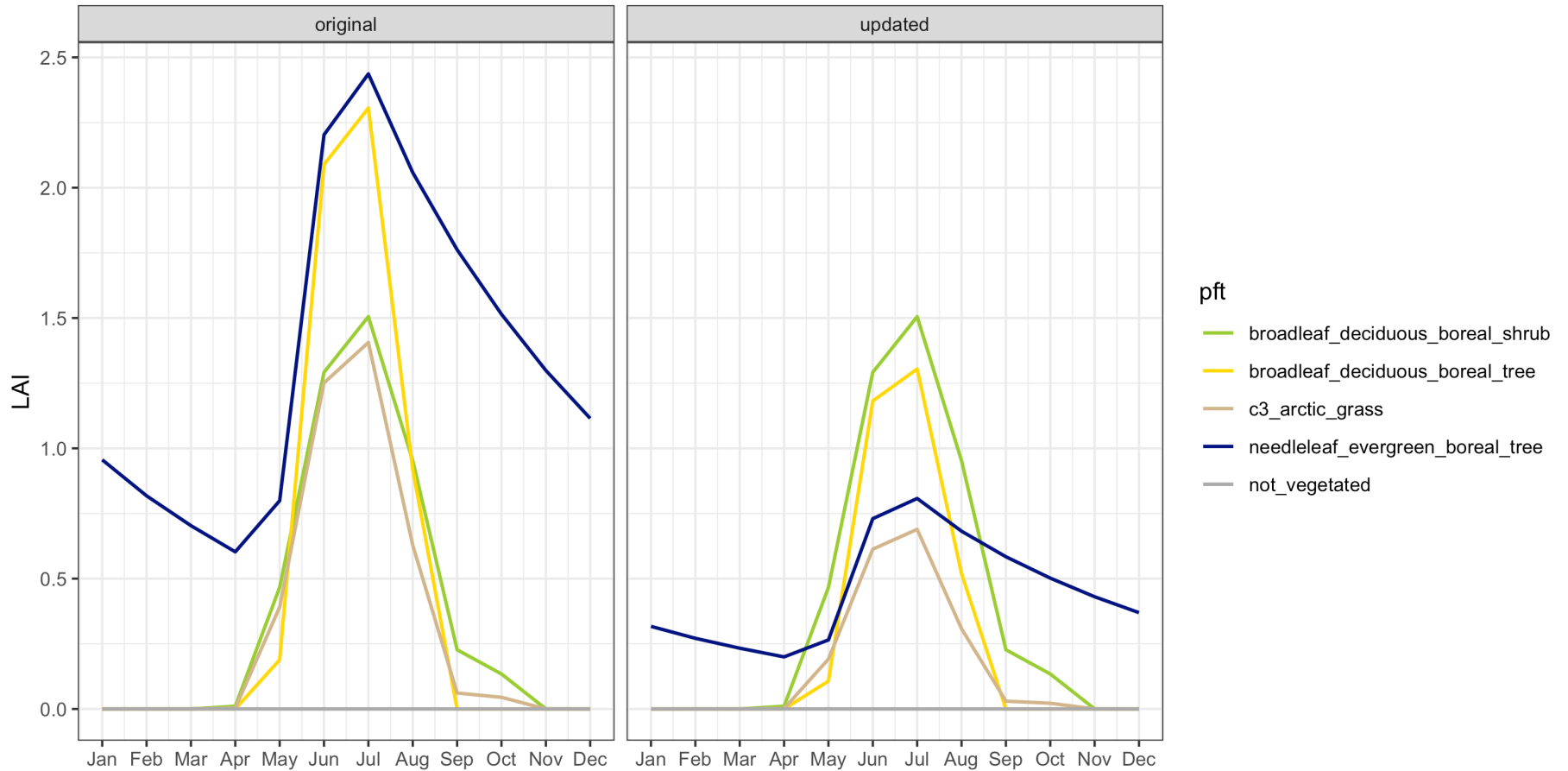
Surface data updates improve simulation

NEON flux observations
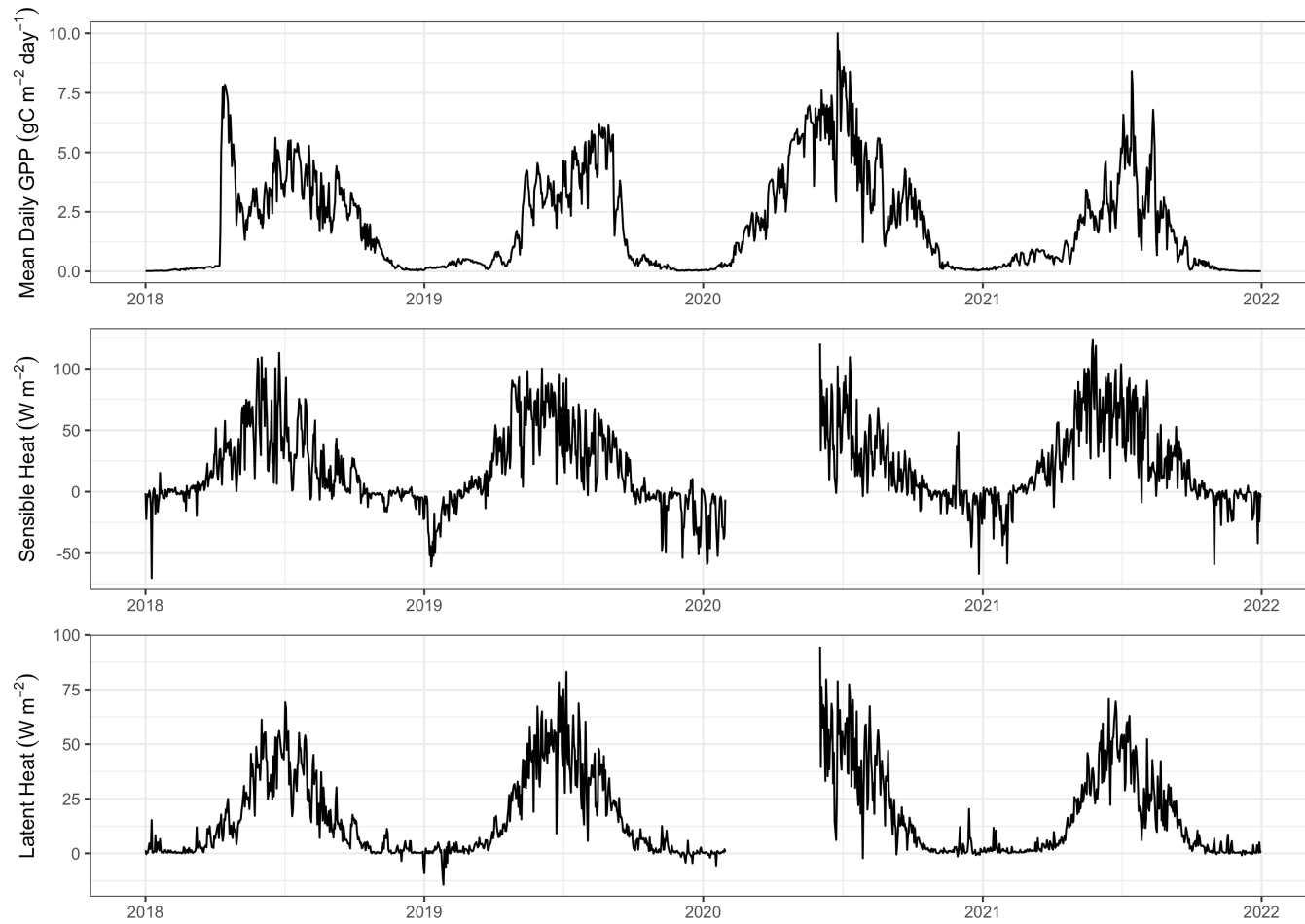
NEON flux observations
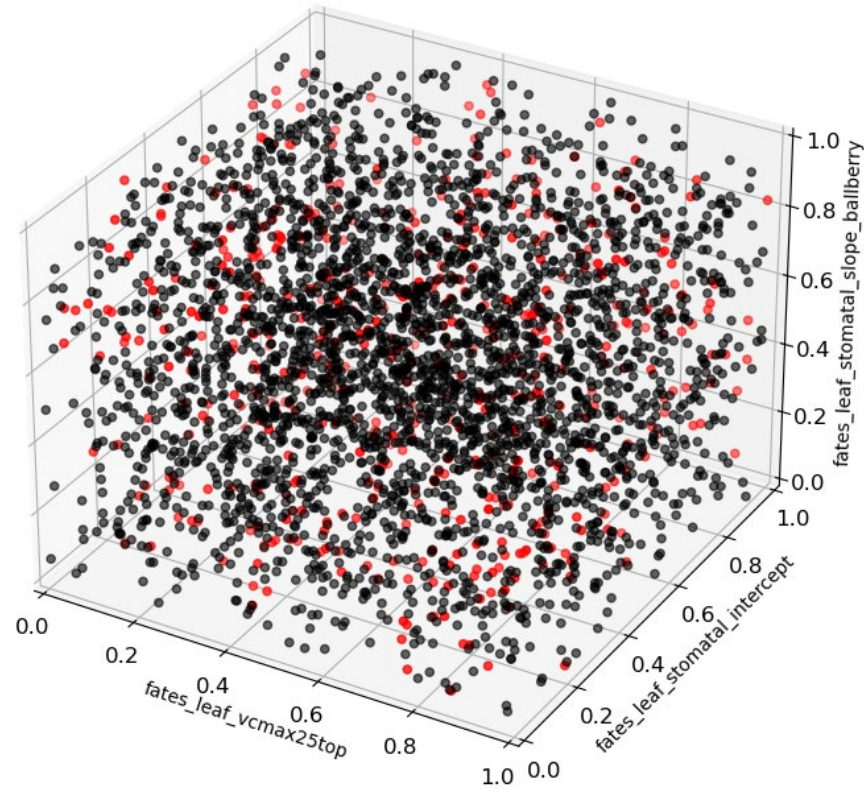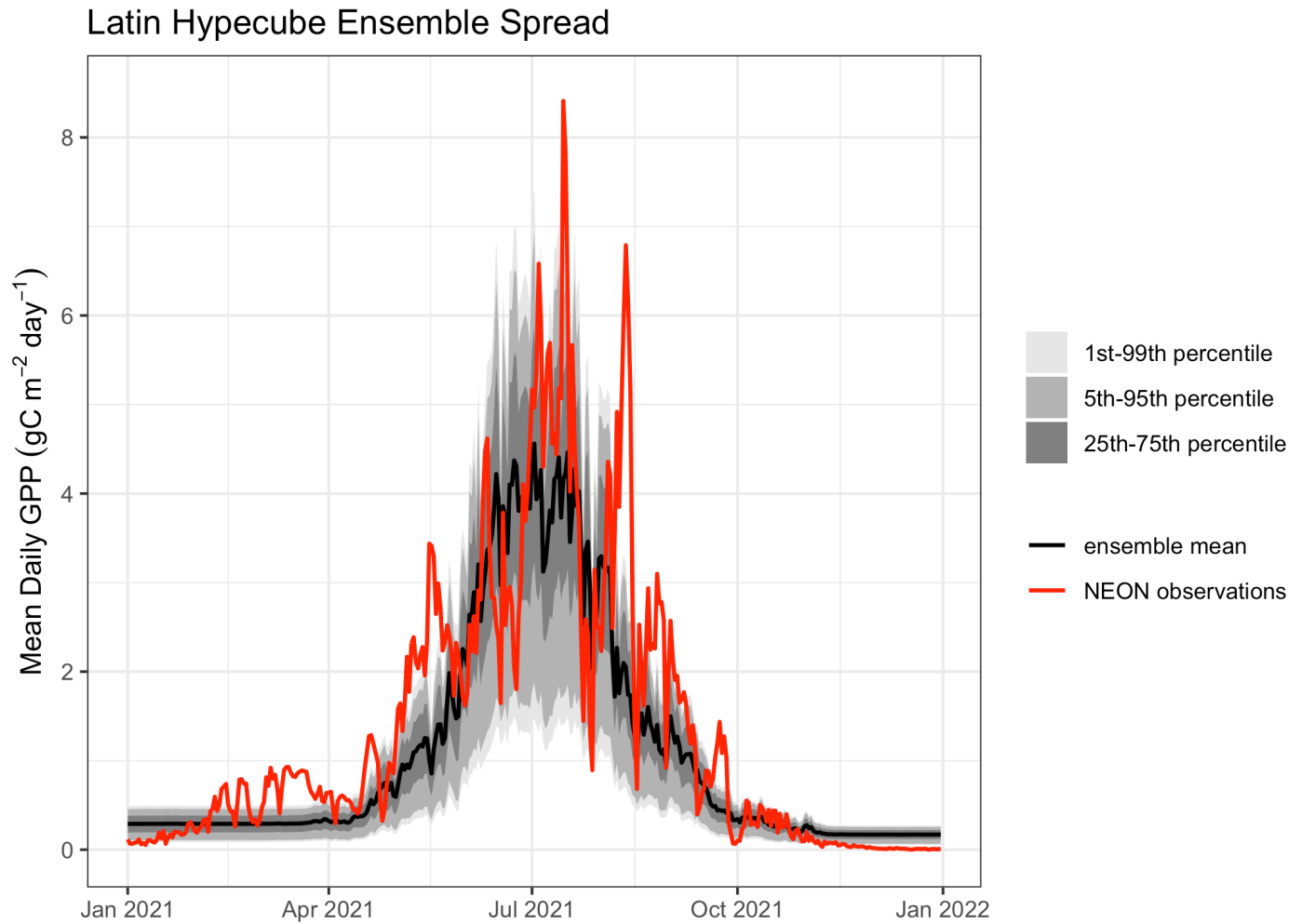
Latin Hypercube Ensemble
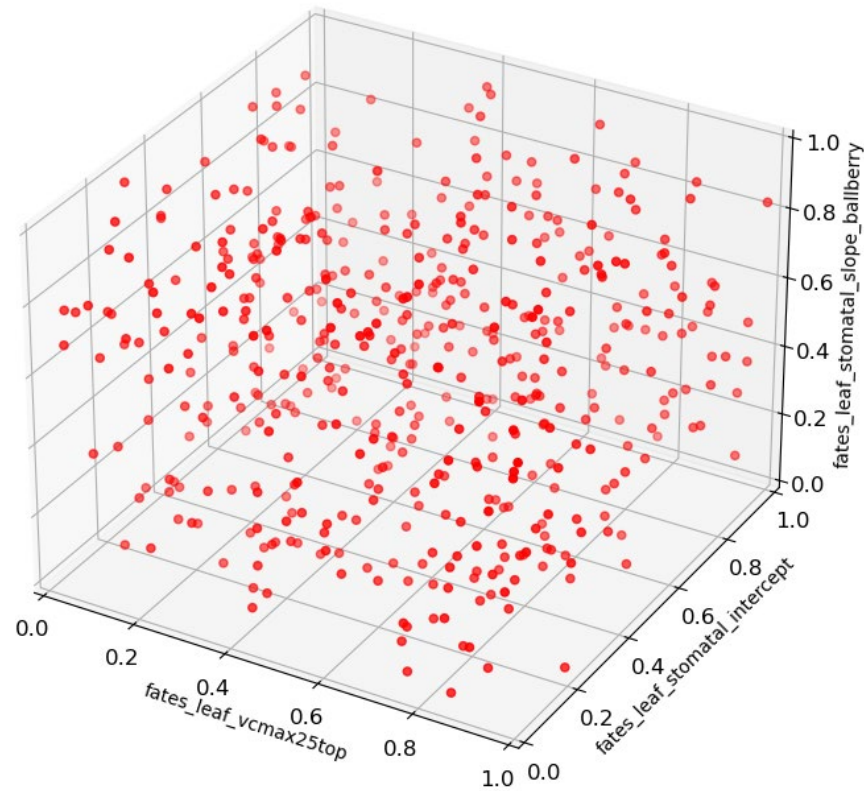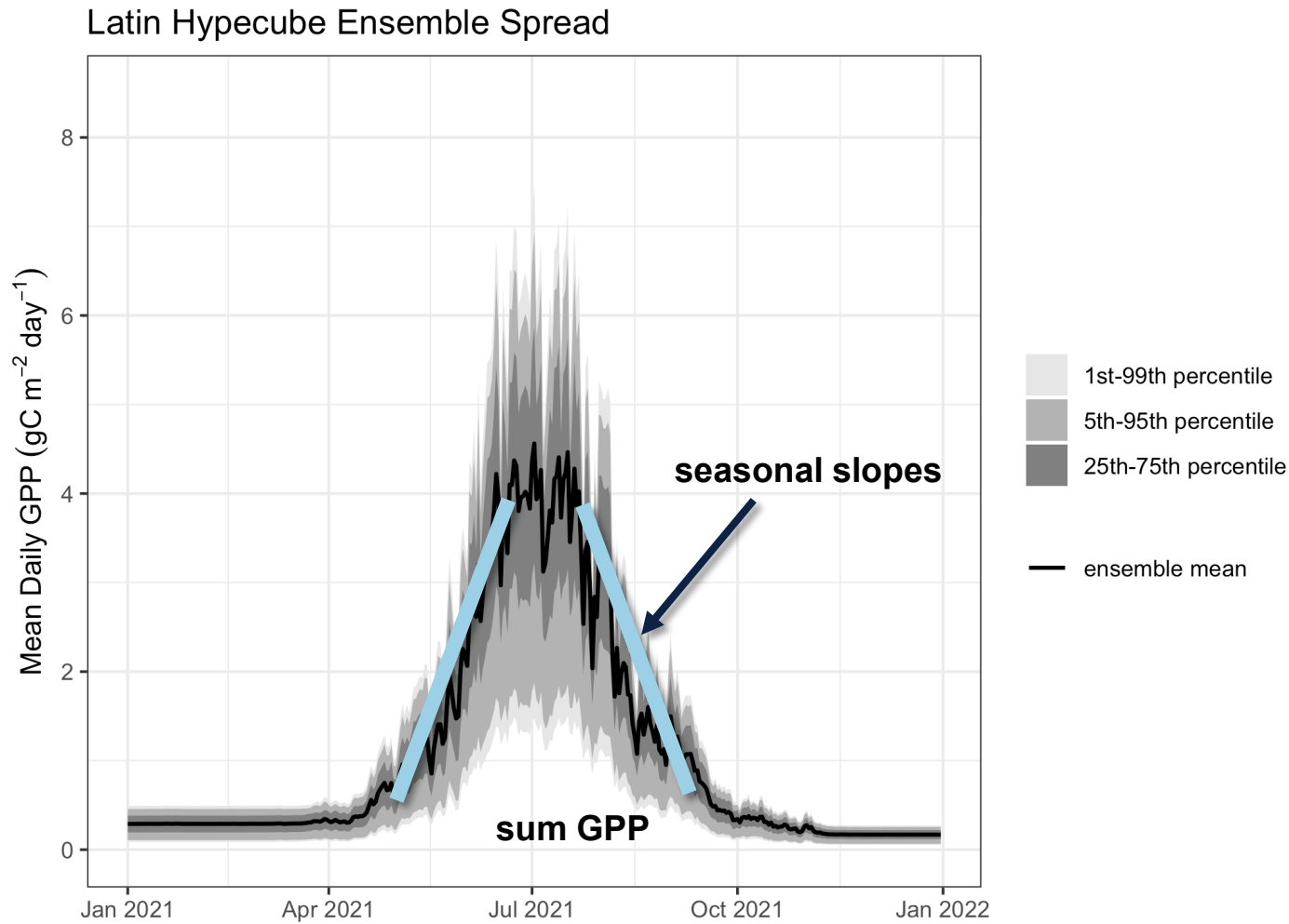
16 parameters
500-member ensemble

Latin Hypercube Ensemble

16 parameters
500-member ensemble

Latin Hypercube Ensemble

Latin Hypecube Ensemble Spread
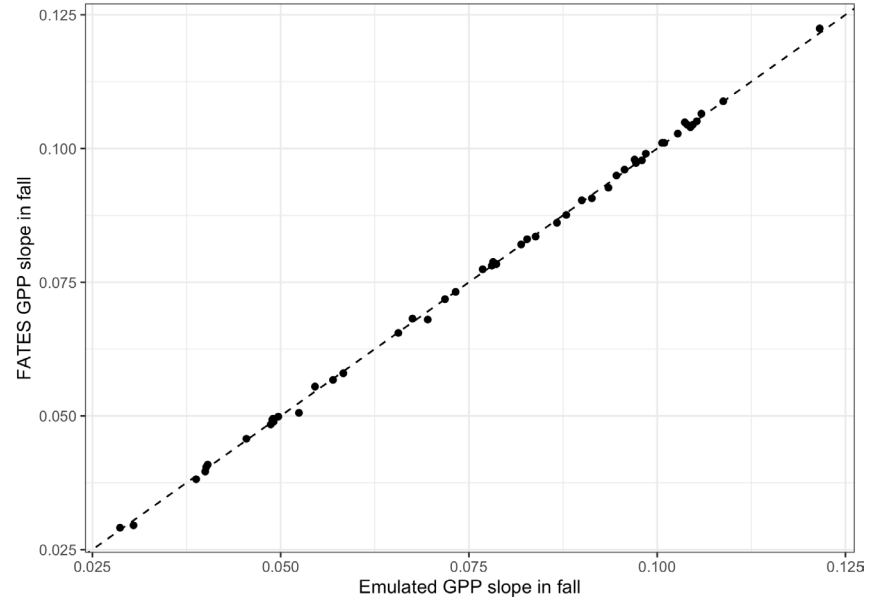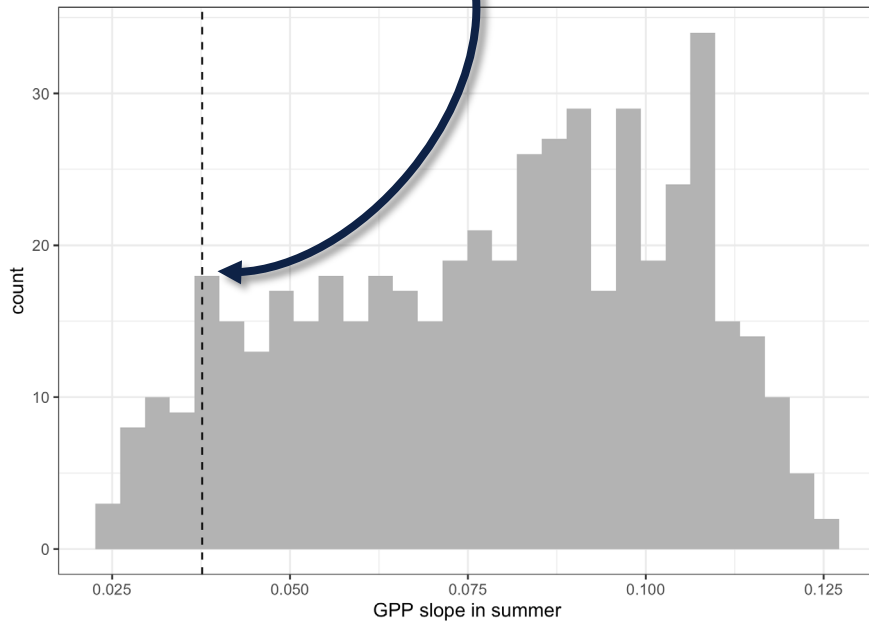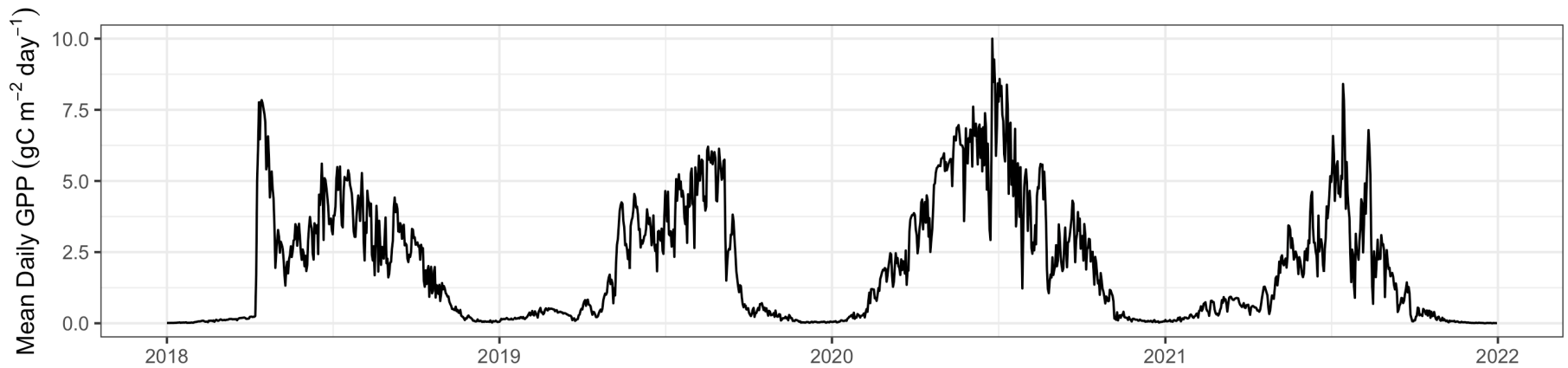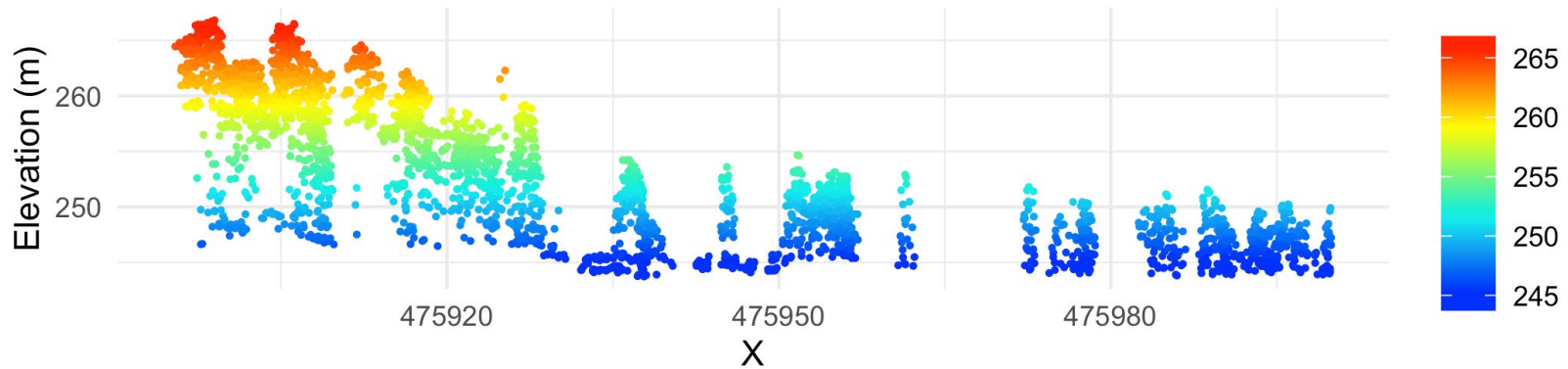
Latin Hypercube Ensemble

Latin Hypecube Ensemble Spread

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Emulator testing

NEON observations

How to get around noisy, sparse observational data?

Thank you!

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@LadyFortran