

# Calibrating FATES at NEON tundra sites

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**2025 Land Model Working Group Meeting**

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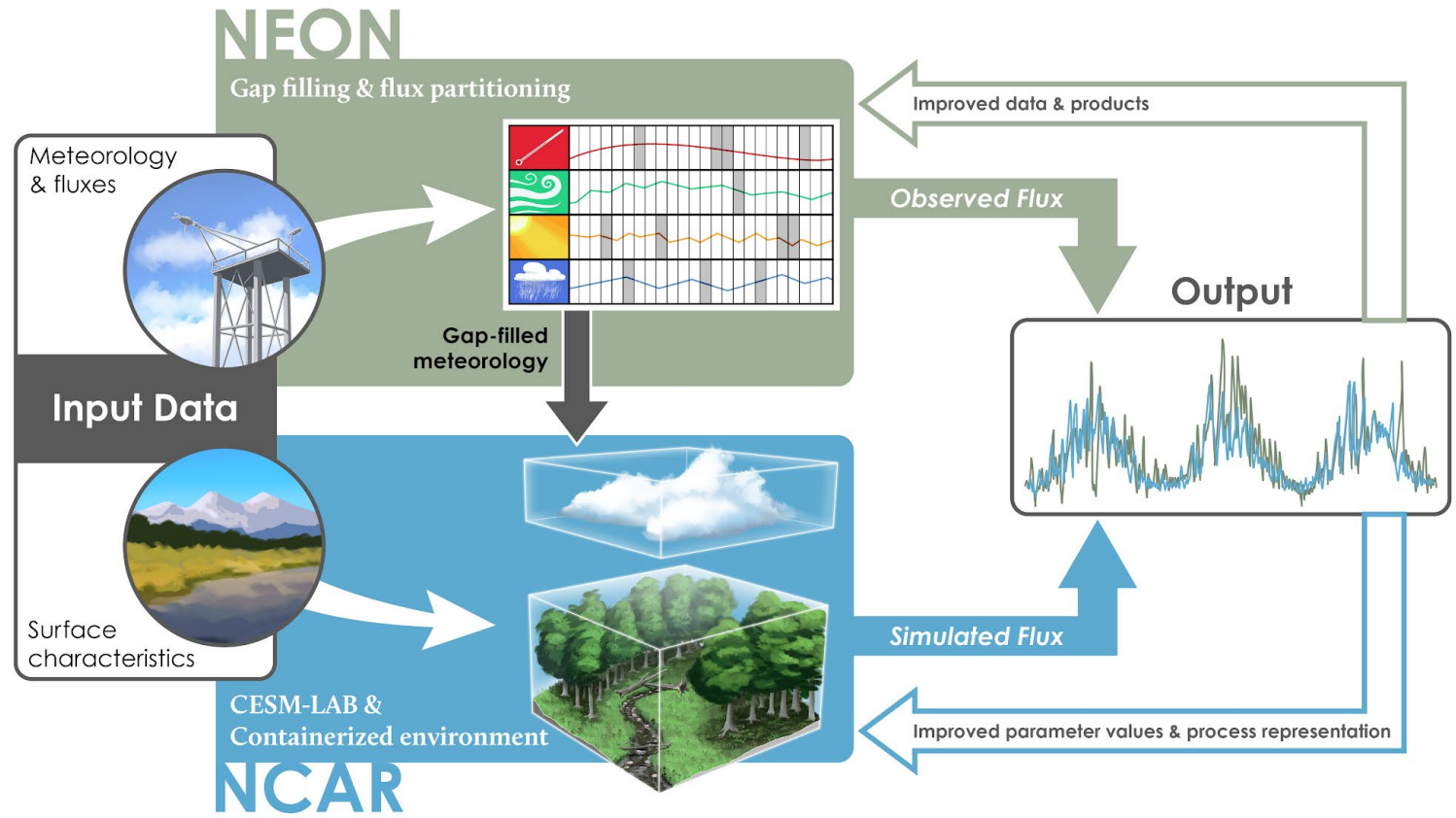


NCAR

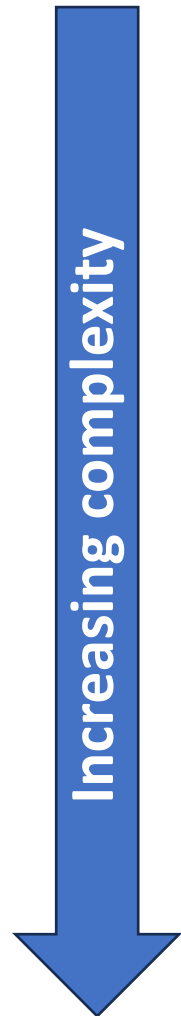
neon  
National Ecological Observatory Network



# Tundra ecosystems are not well represented in models

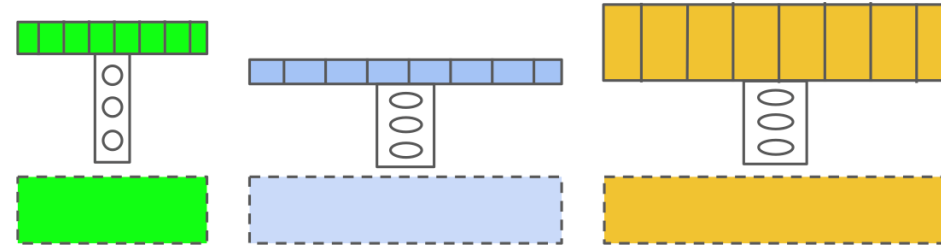


# FATES calibration cascade



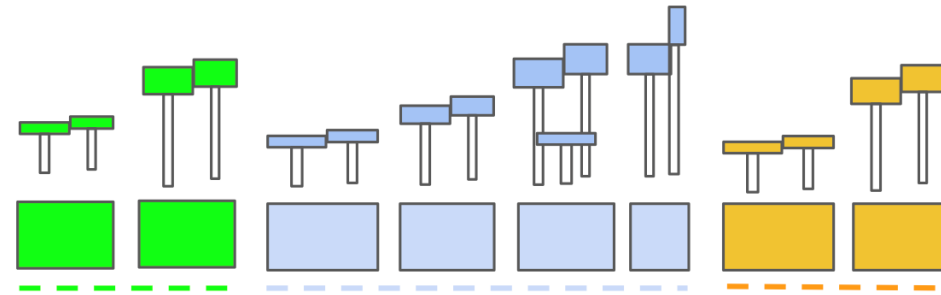
## Satellite Phenology

*One cohort, observed LAI, for each PFT.  
No Disturbance, growth, or mortality.*



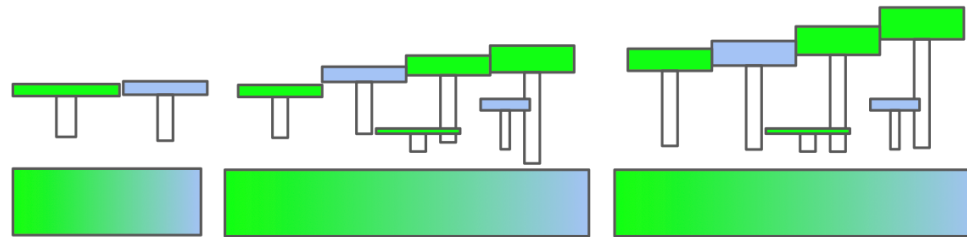
## No Competition

*All PFTs given a fixed area to grow.  
Growth & disturbance but no competition.*



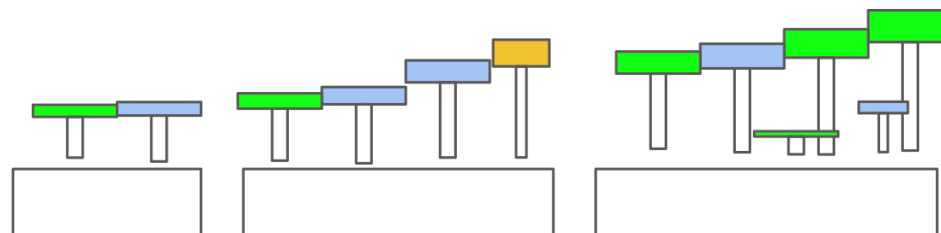
## Prescribed Biogeography

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



## Full FATES

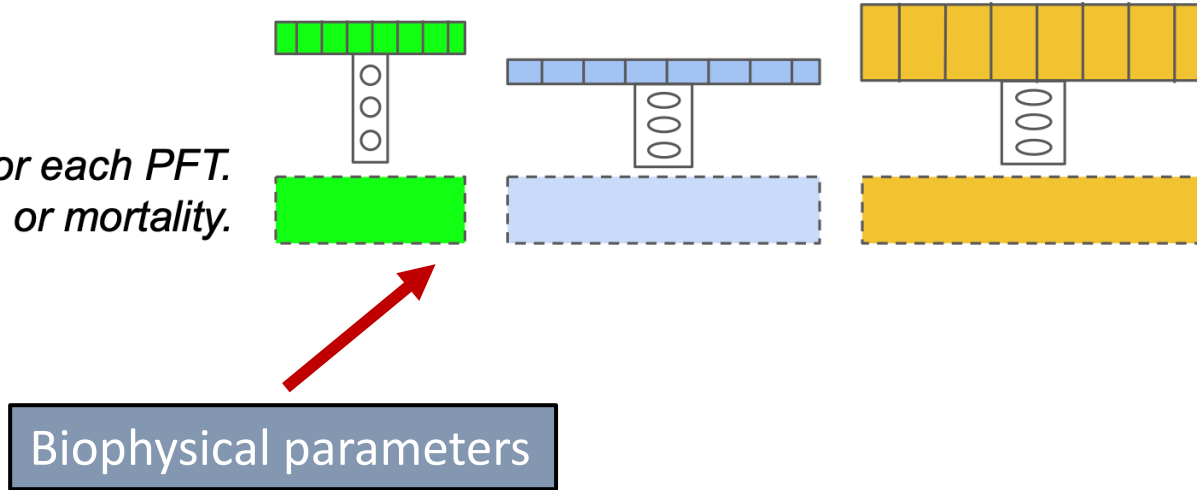
*Growth, disturbance, and  
competition everywhere.*



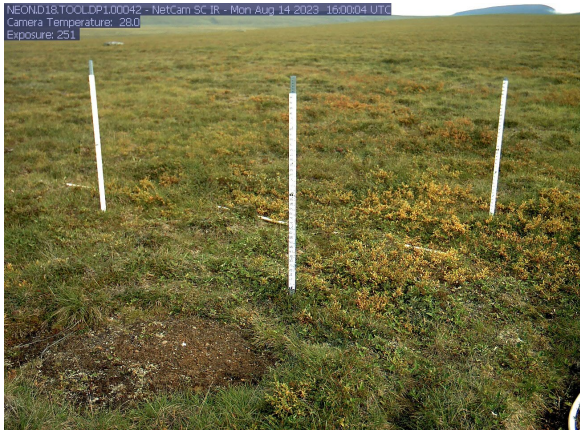
# FATES calibration cascade

## Satellite Phenology

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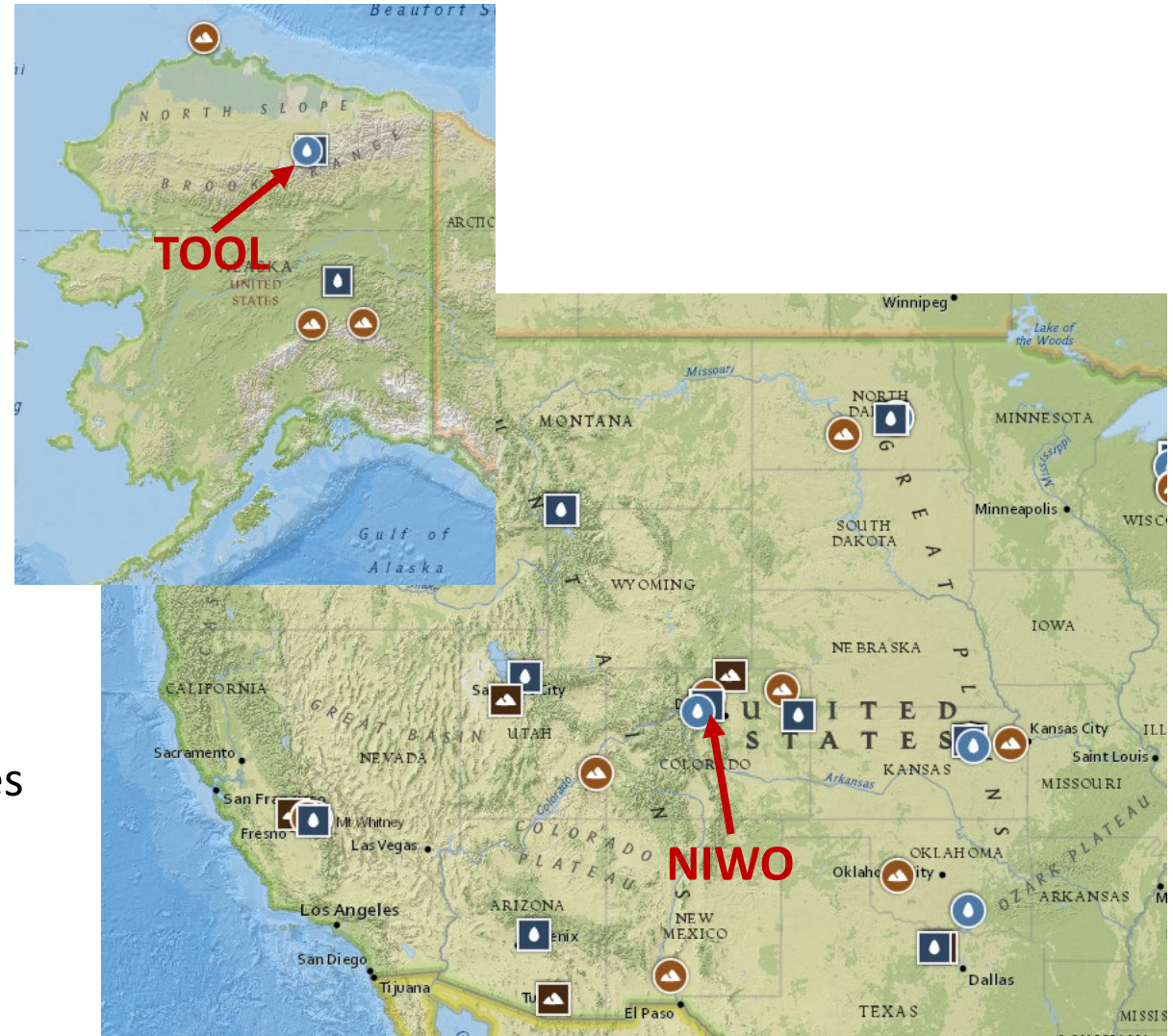
# Sites: Toolik Field Station (TOOL) and Niwot Ridge (NIWO)



TOOL: Tussock tundra  
Sedges, tussock grass  
Birch and willow shrubs



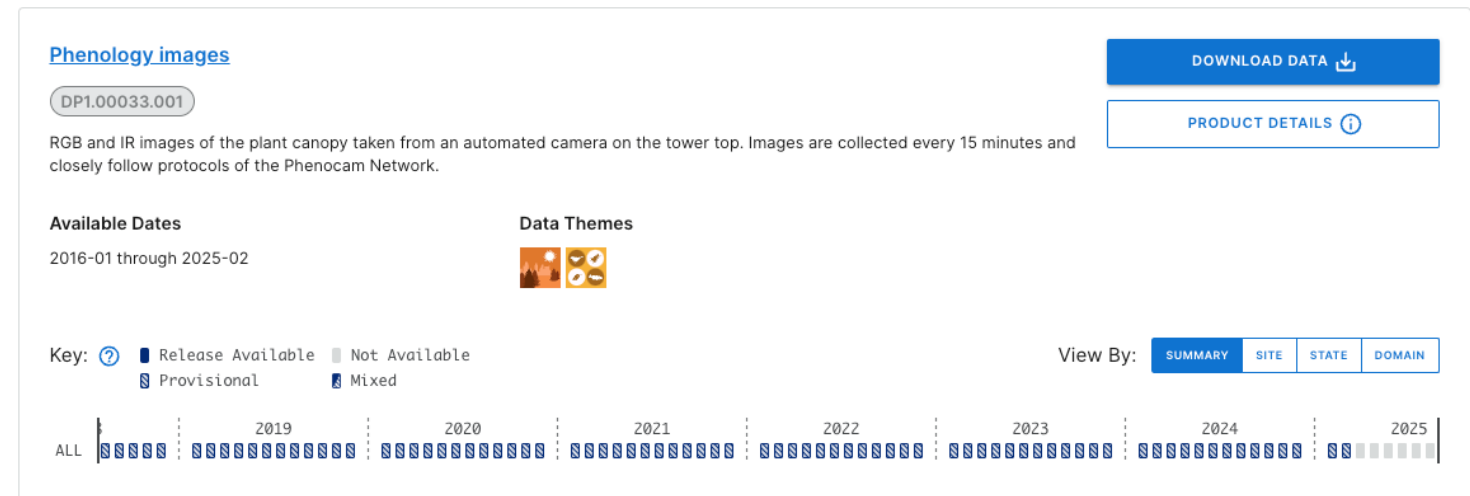
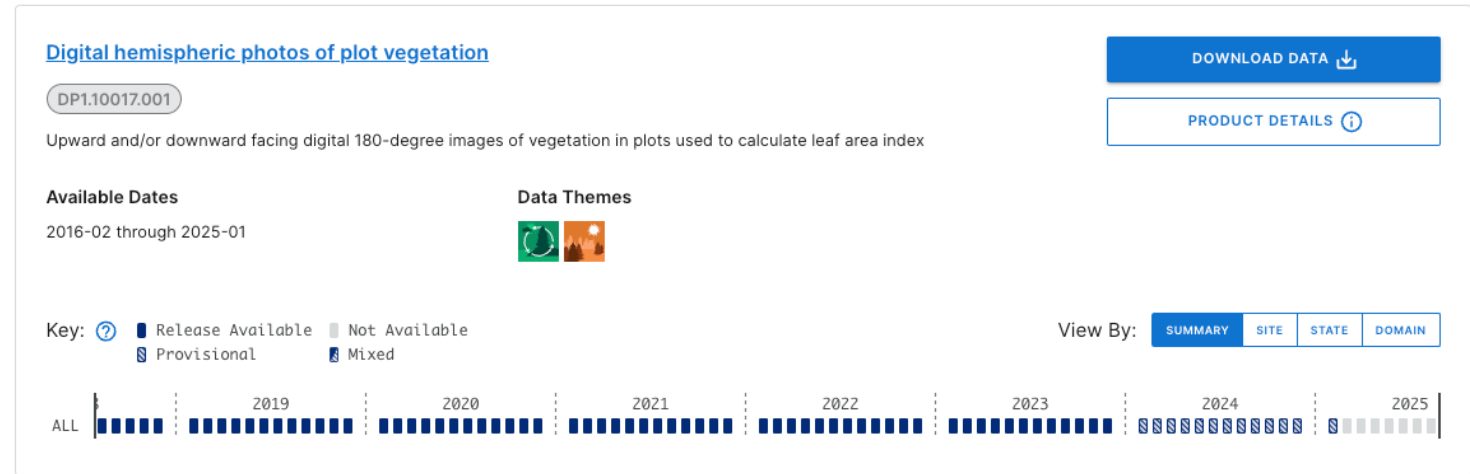
NIWO: Alpine tundra  
Grasses, forbs, and sedges  
Willow shrubs



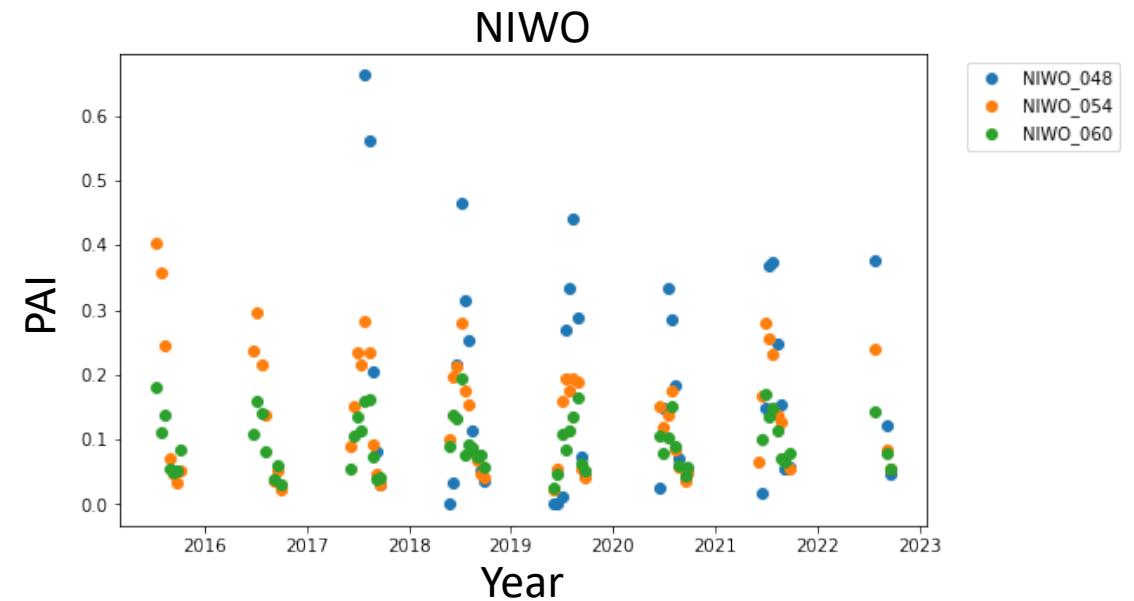
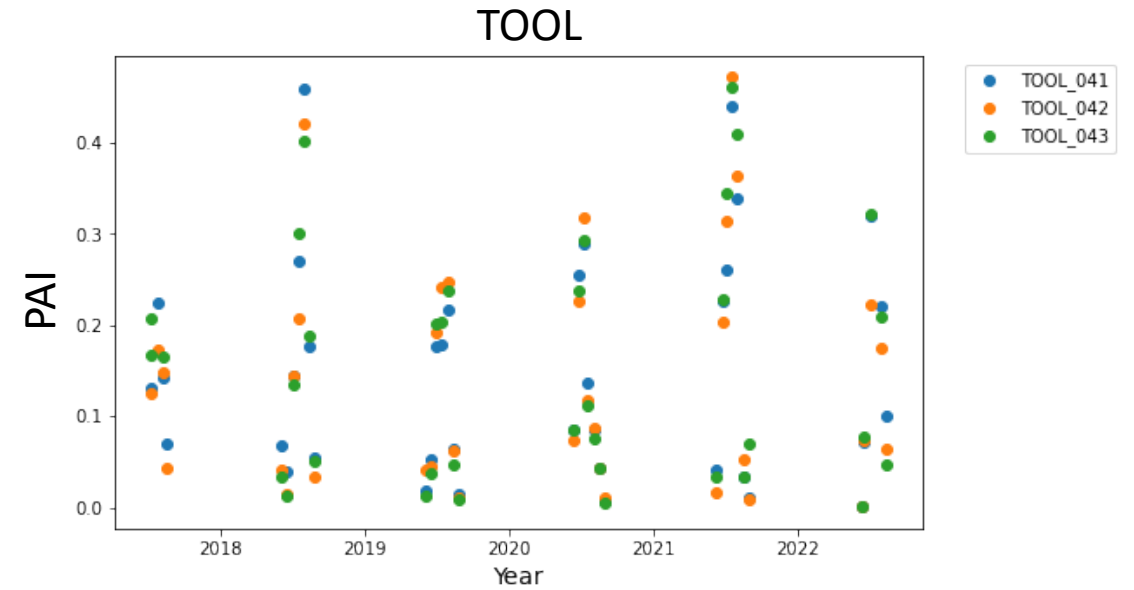
# Incorporating new NEON data products to run CLM

Biophysical metrics including plant area index (**PAI**) from downward facing imagery  
-collected biweekly at NEON plots

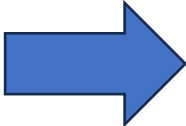
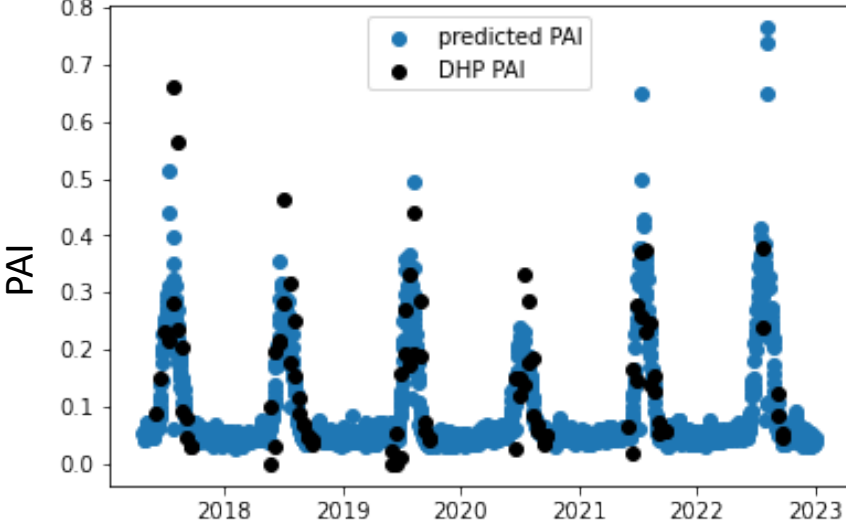
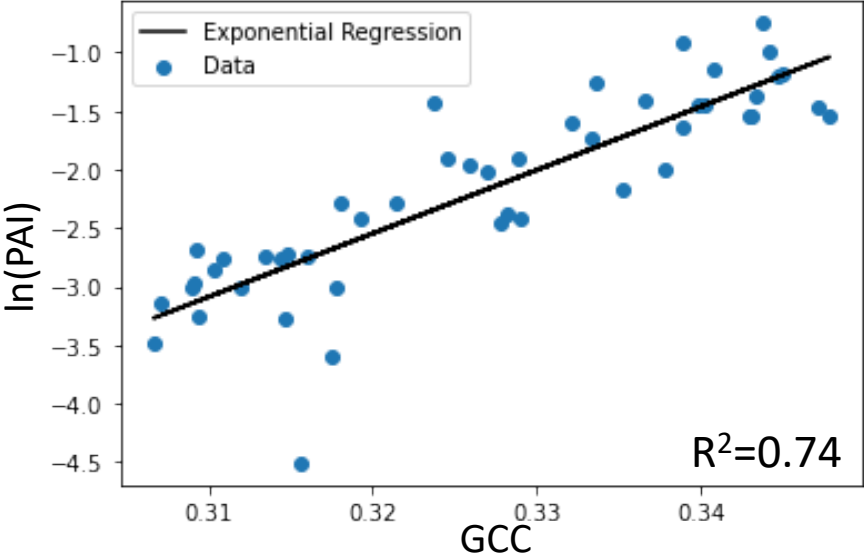
Greenness index (**GCC**) derived from automated digital images  
-15-minute frequency at tower



# Digital hemispherical photos → Plant Area Index



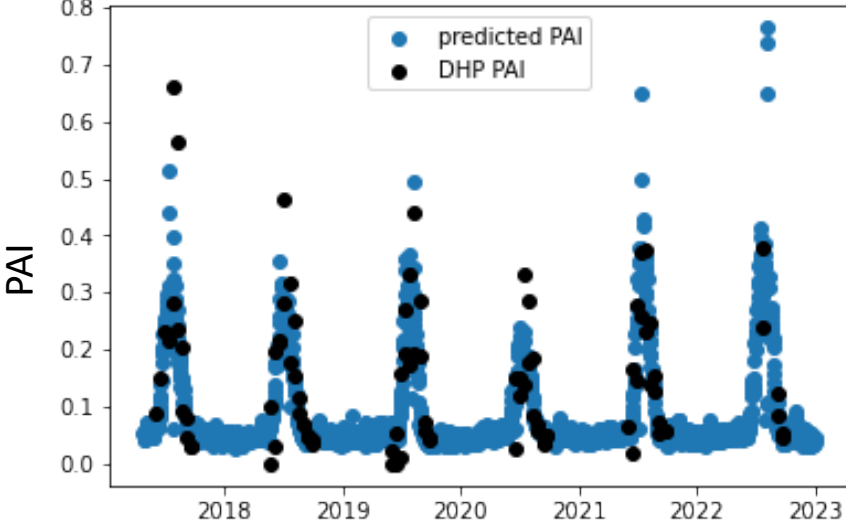
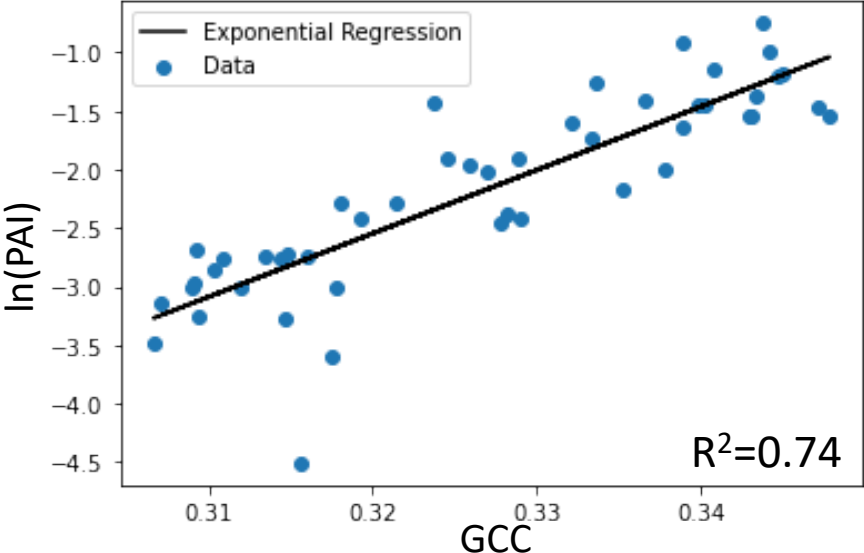
# Predict daily PAI using GCC



Predicted values align well with data

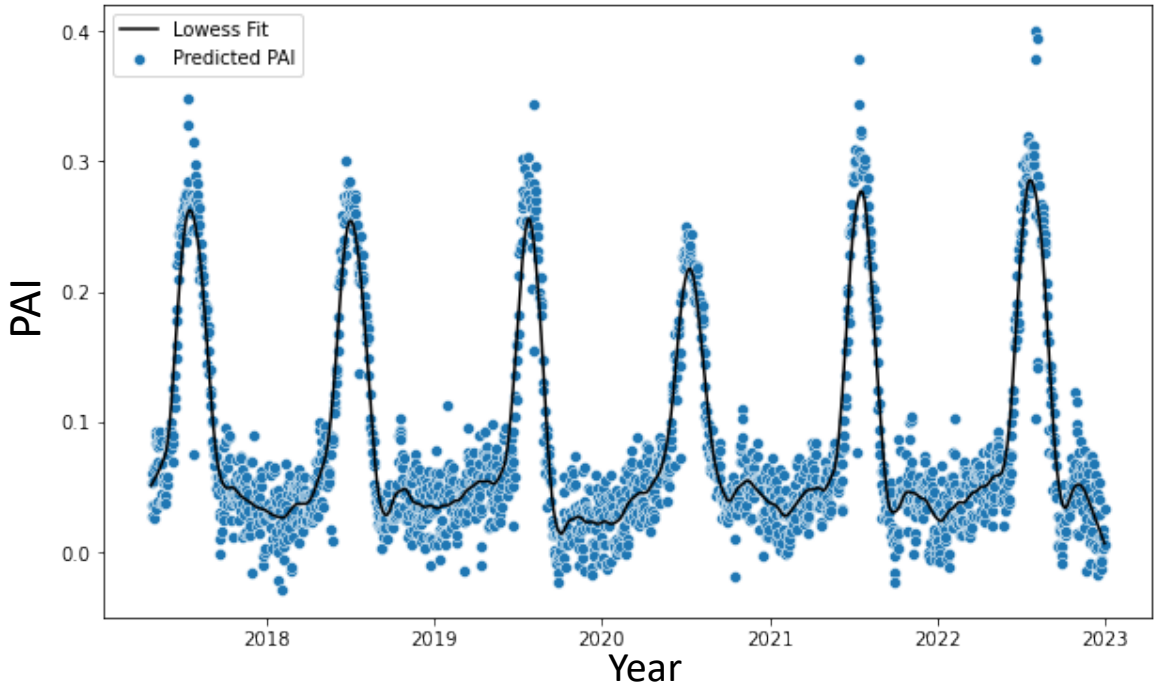


# Predict daily PAI using GCC

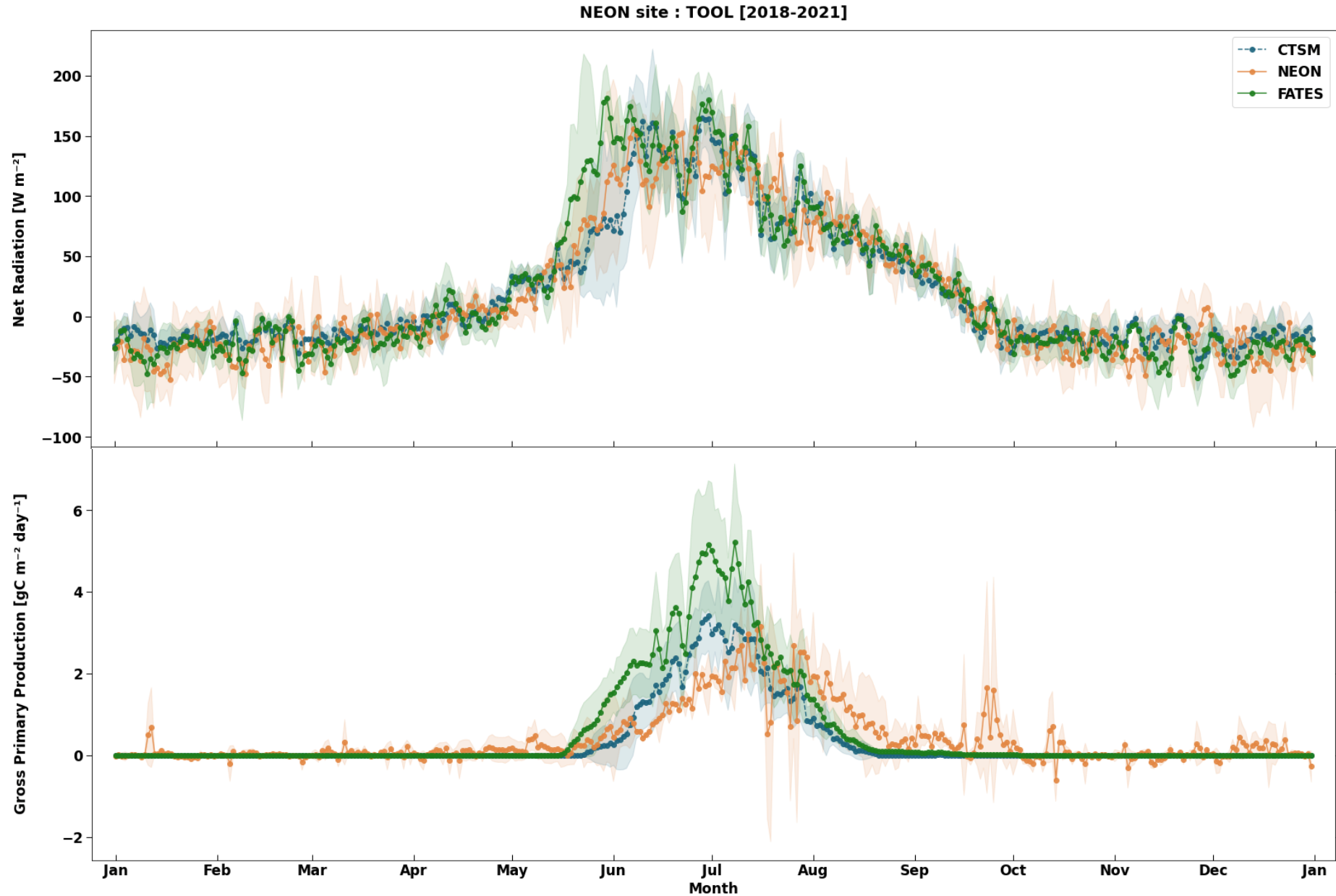


Predicted values align well with data

## Smoothed PAI = LAI stream for CLM

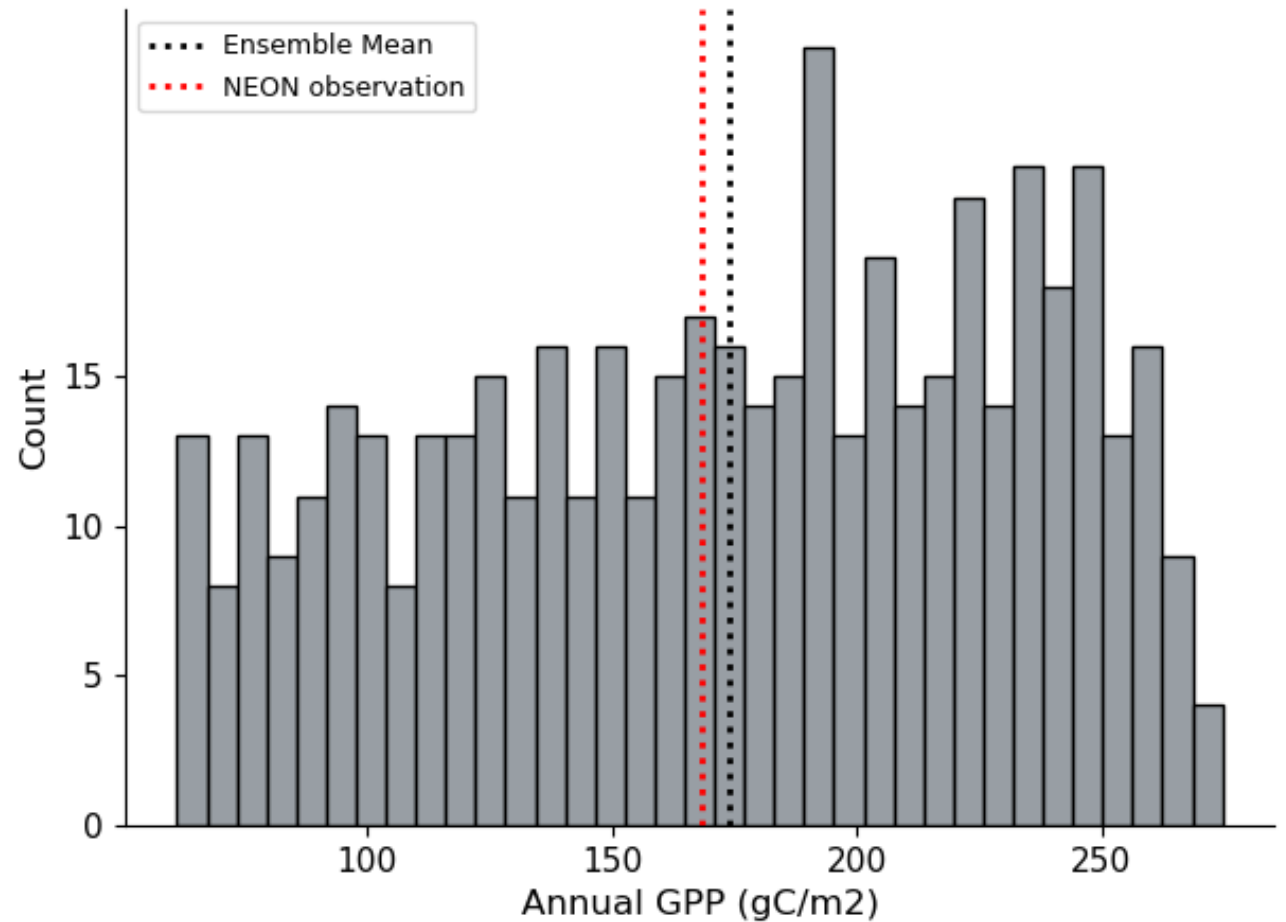


# CLM SP simulations with NEON LAI streams

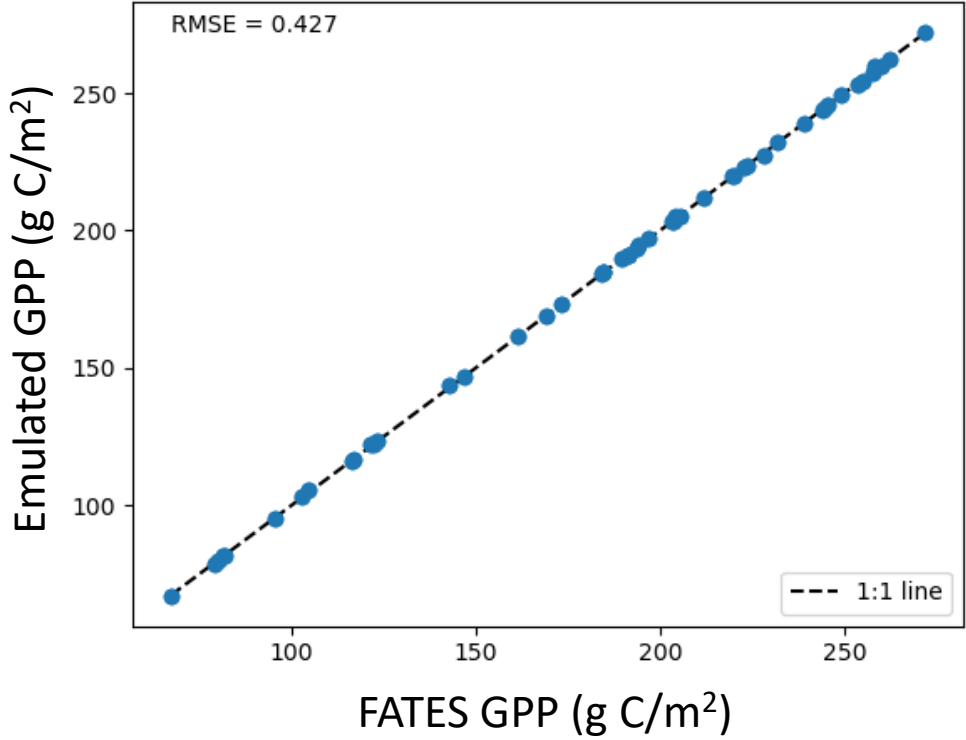


# Create a Latin hypercube ensemble of FATES-SP runs

- Variable to calibrate to:  
Annual GPP
- Check that observations fall within the ensemble spread

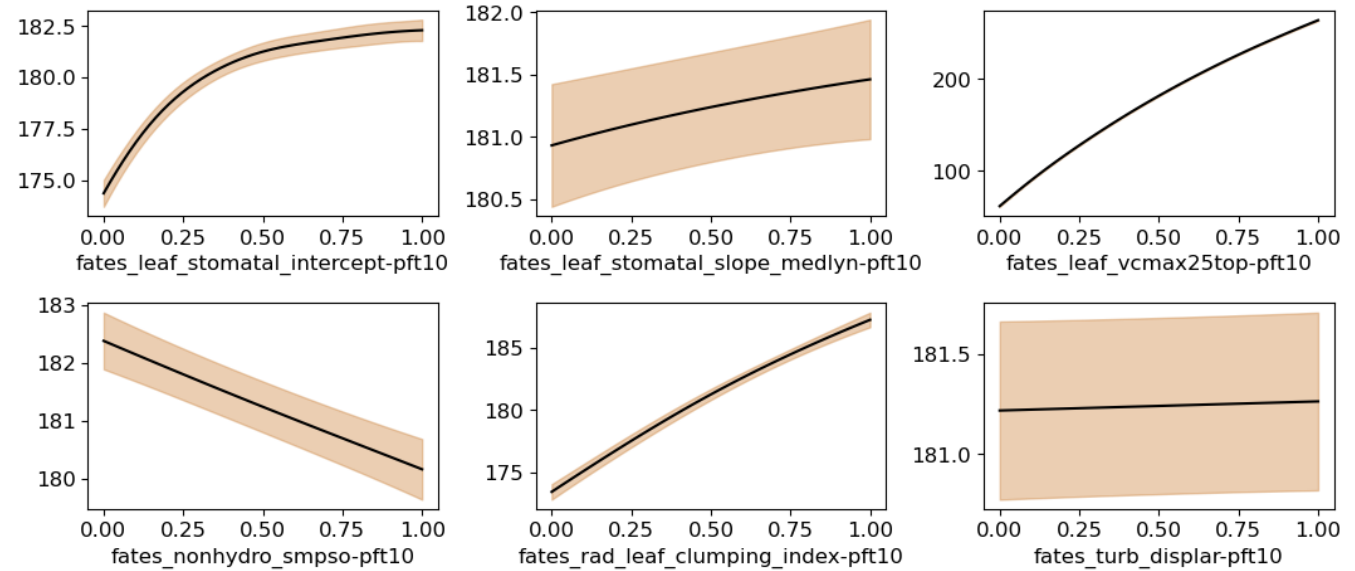
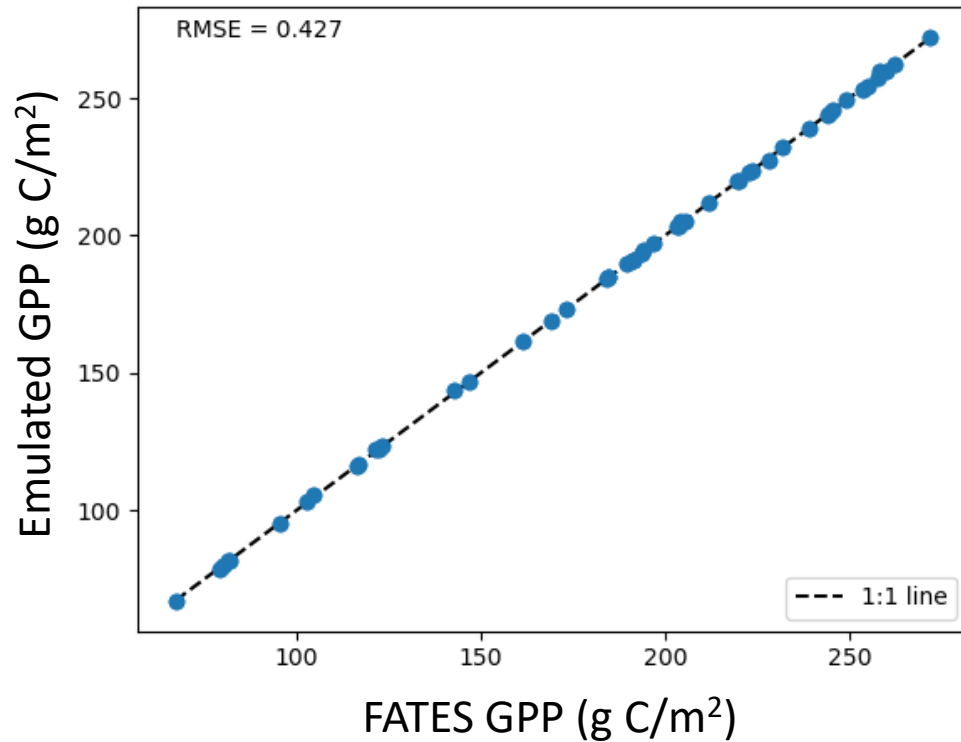


# Train and validate emulator



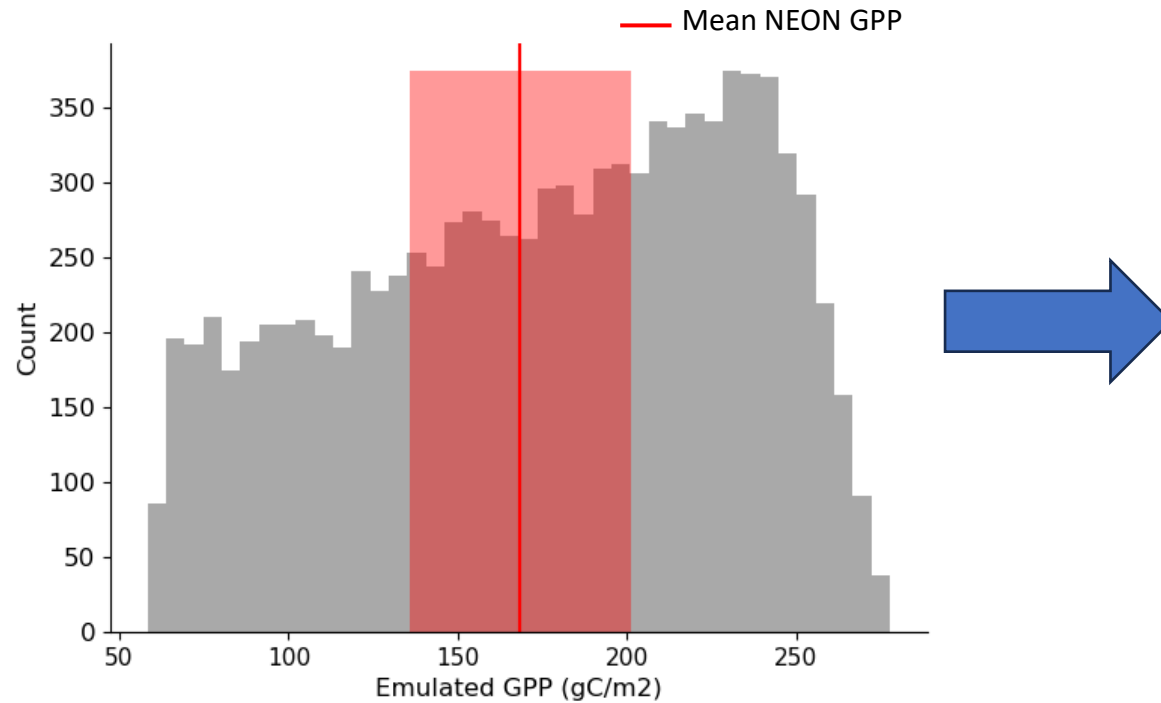
# Train and validate emulator

# Check parameter sensitivity



GPP is most sensitive to leaf\_vcmax\_25top

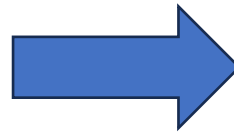
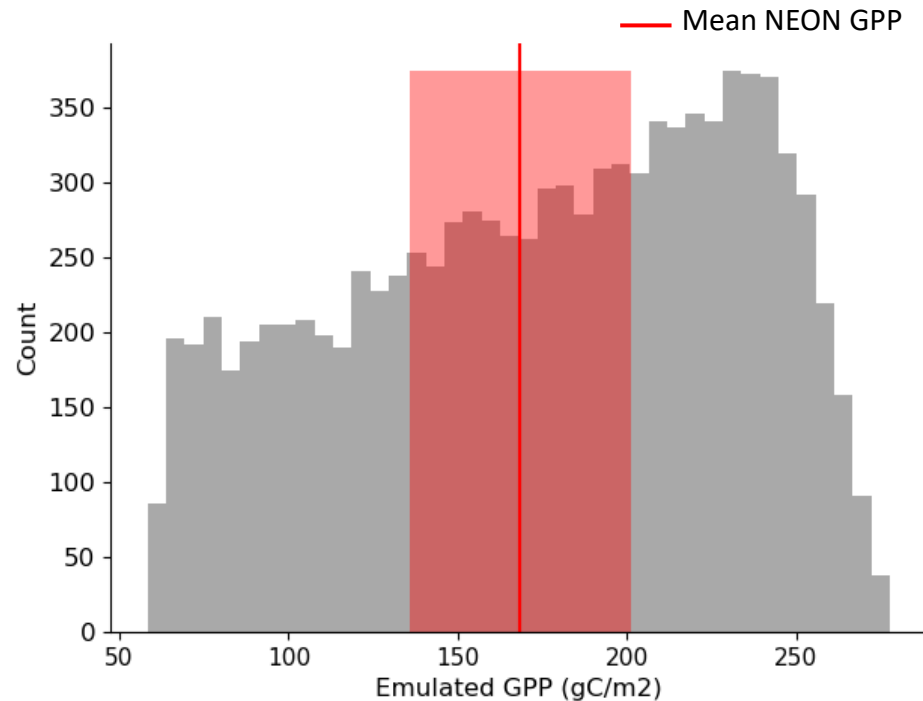
# Use emulator to resample parameter space



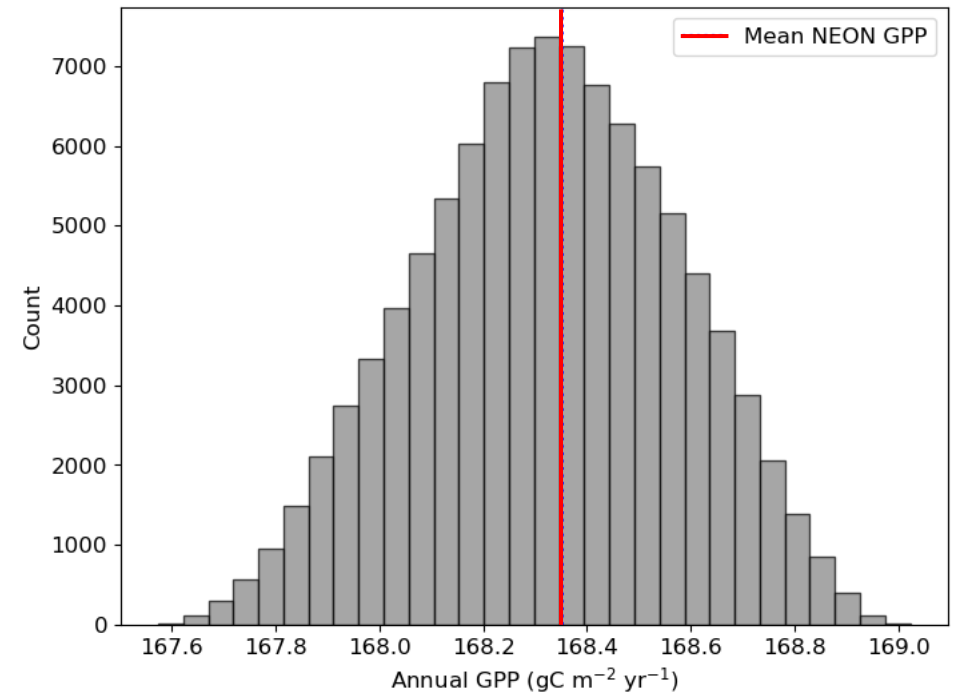
Calculate implausibility metric to determine most plausible parameter values

→ Sensitive parameters with low implausibility

# Use emulator to resample parameter space



Fix sensitive parameter(s) and resample



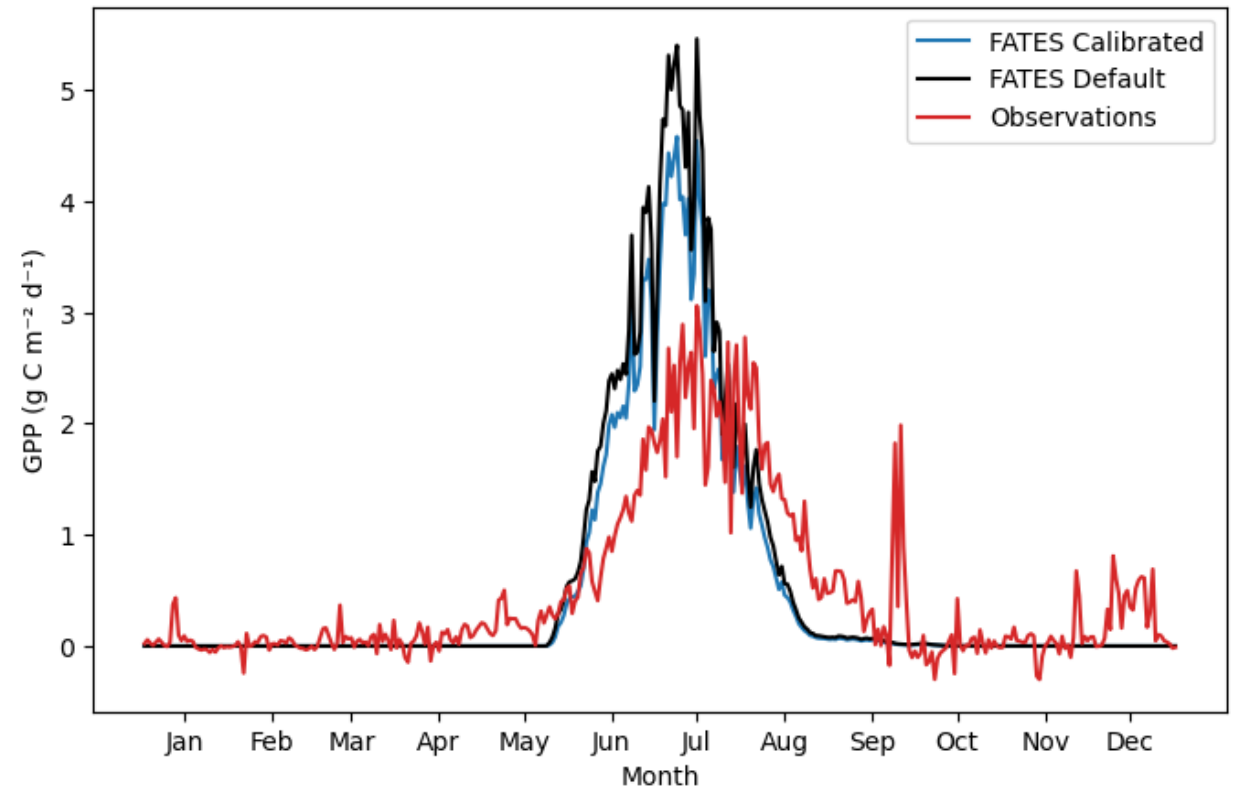
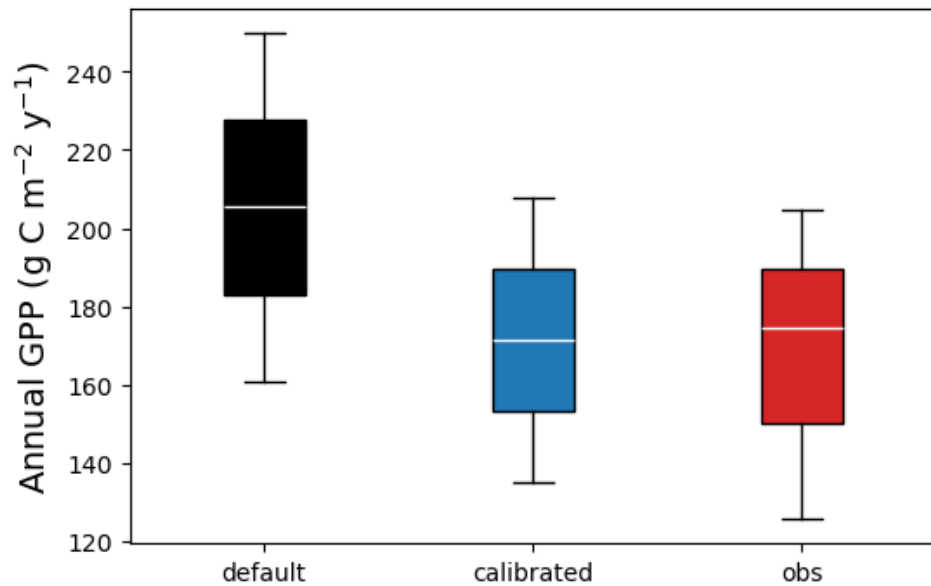
Updated sample after fixing v<sub>max</sub>

Calculate implausibility metric to determine most plausible parameter values

→ Sensitive parameters with low implausibility

After fixing v<sub>max</sub>, one more round of calibration  
→ re-run FATES-SP with updated parameter values!

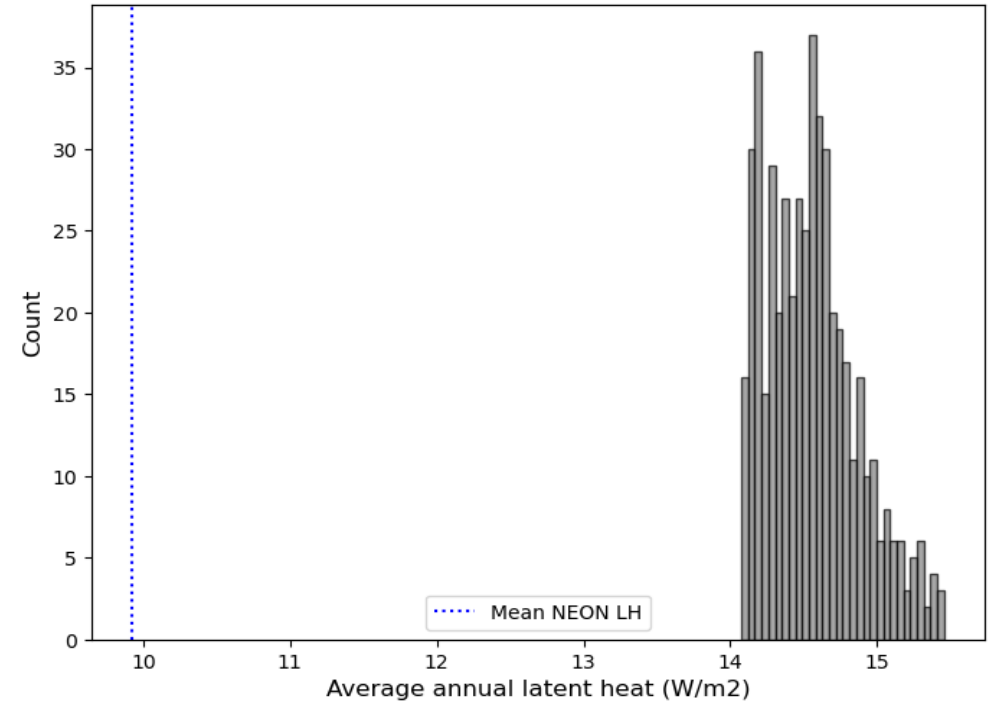
# Annual GPP looks better, but need to incorporate timing of greenup into calibration





# Next steps

- Incorporate phenology/seasonality of GPP in addition to total annual GPP
- Calibrate to latent heat and sensible heat fluxes
- Expand to other herbaceous NEON sites!



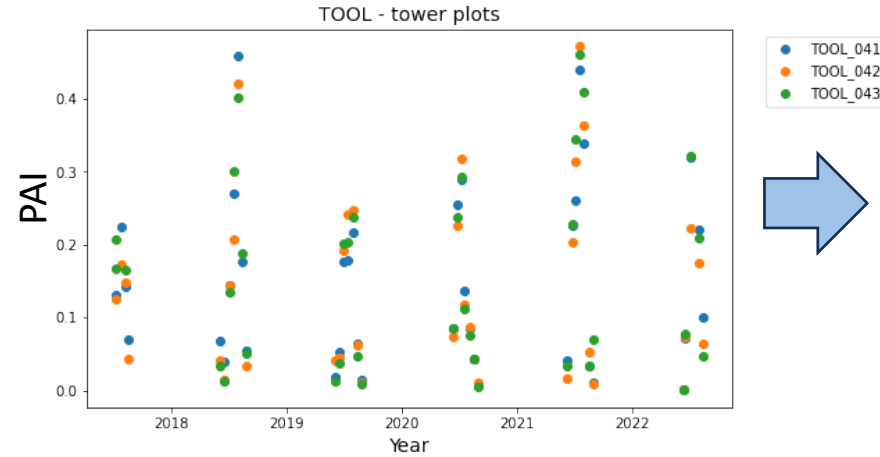


# Additional NEON data products: leaf area index

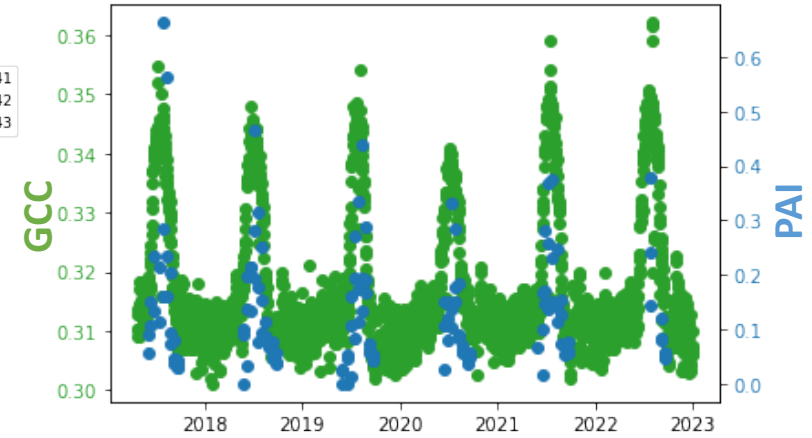
NEON Digital Hemispherical Photos (DHP)



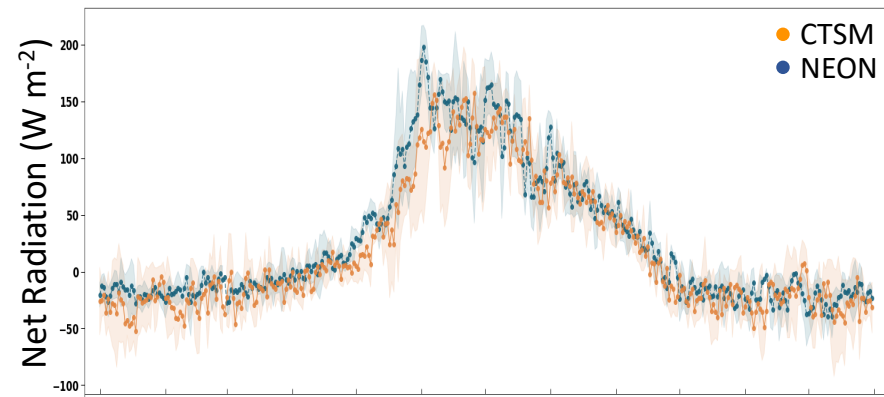
Biweekly biophysical metrics from DHP, e.g. plant area index (PAI)



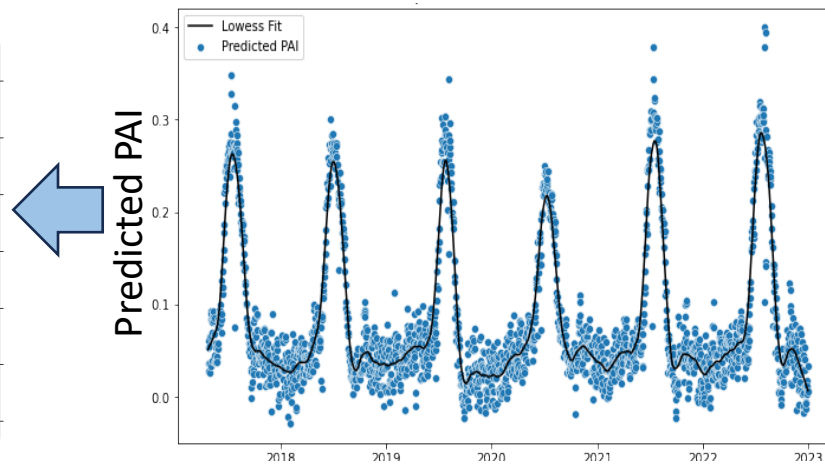
NEON PhenoCam time series (GCC)



CLM-SP simulations with LAI streams



Smooth time series for CLM forcing (LAI streams)



Fit PAI - GCC relationship; use to predict daily PAI

