Towards a robustly calibrated FATES SP configuration

Progress down the calibration cascade

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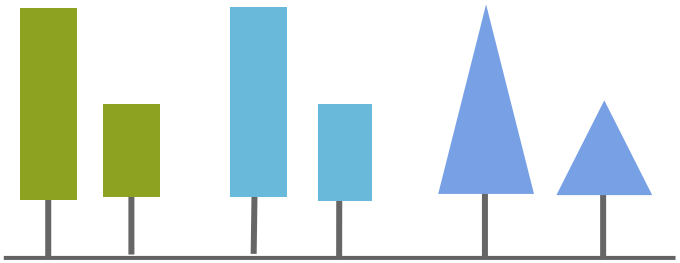
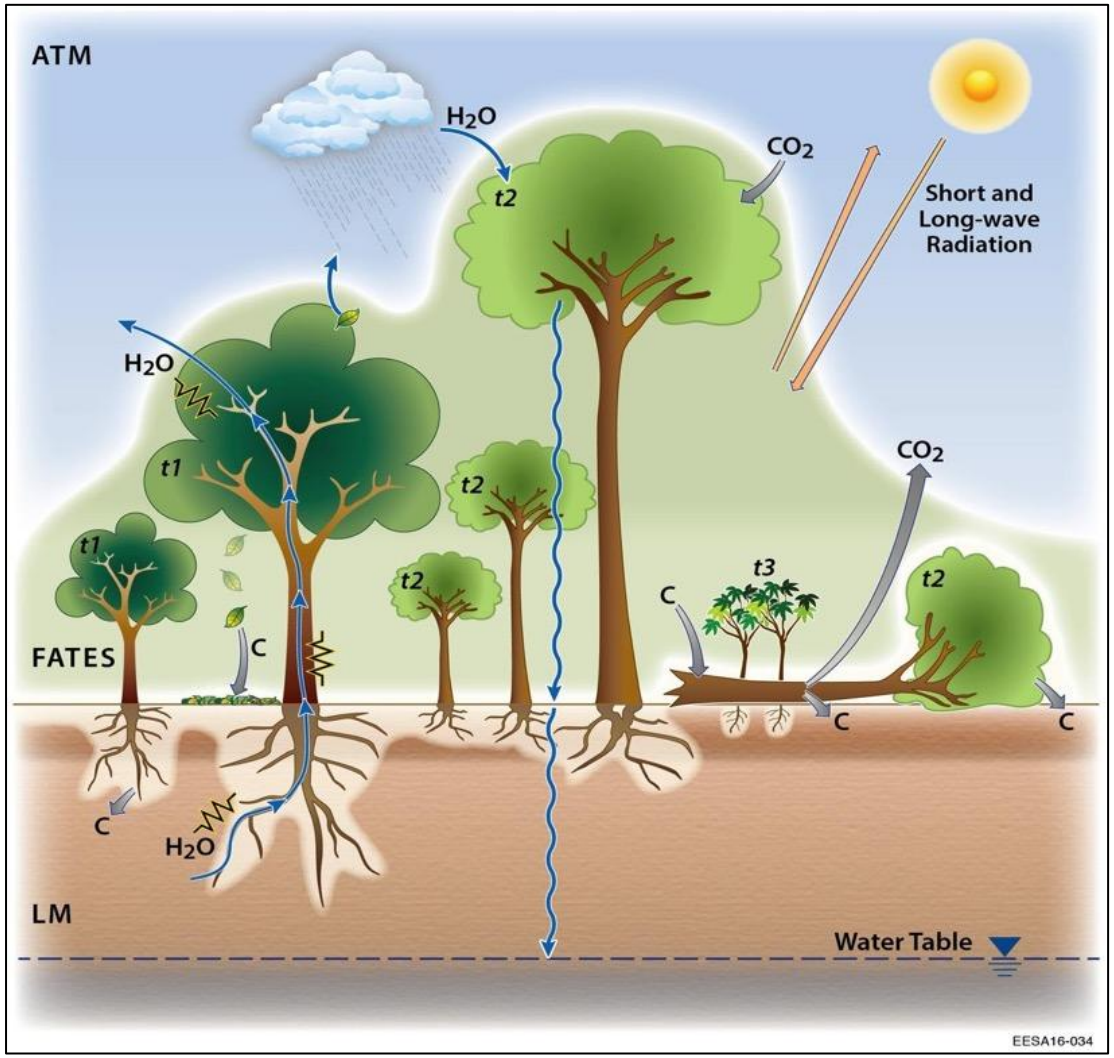
FATES



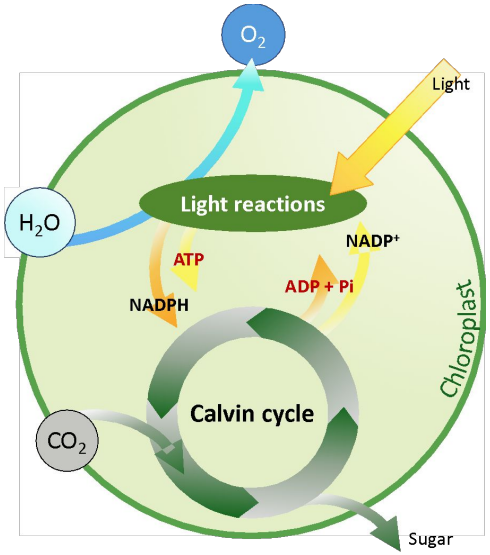
cohort-specific model

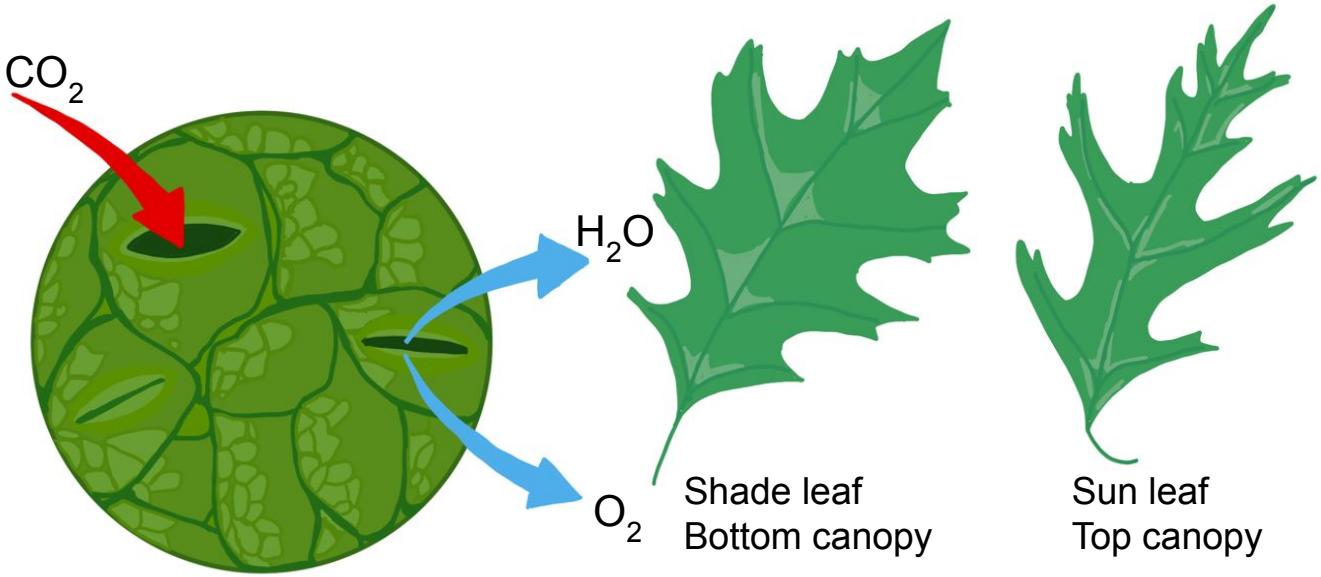
30-minute photosynthesis and fluxes

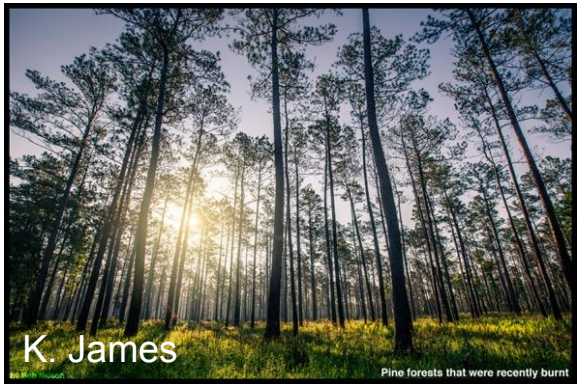
daily growth and allocation



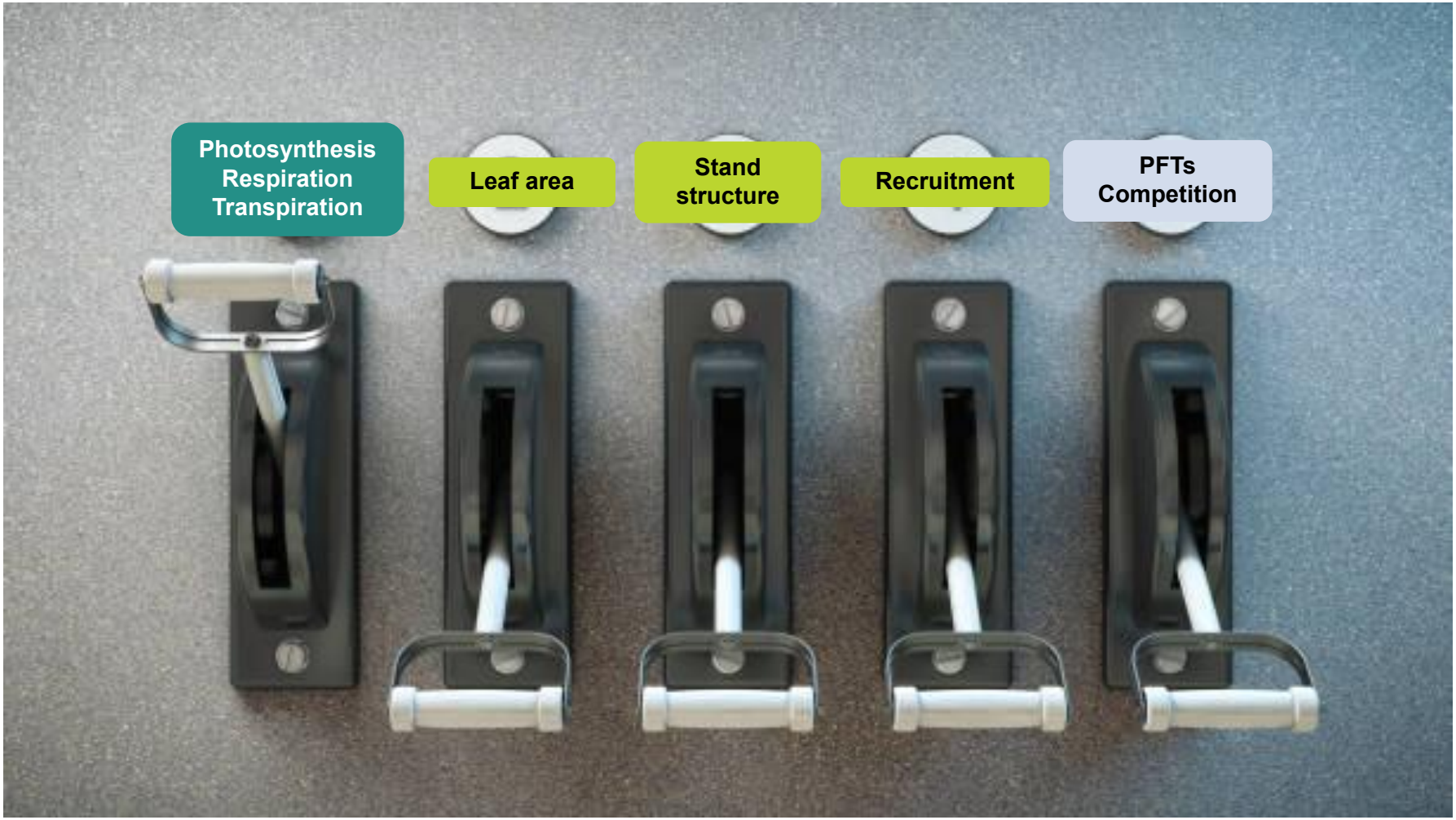
FATES operates at multiple scales of a forested ecosystem







Difficult to calibrate across all scales



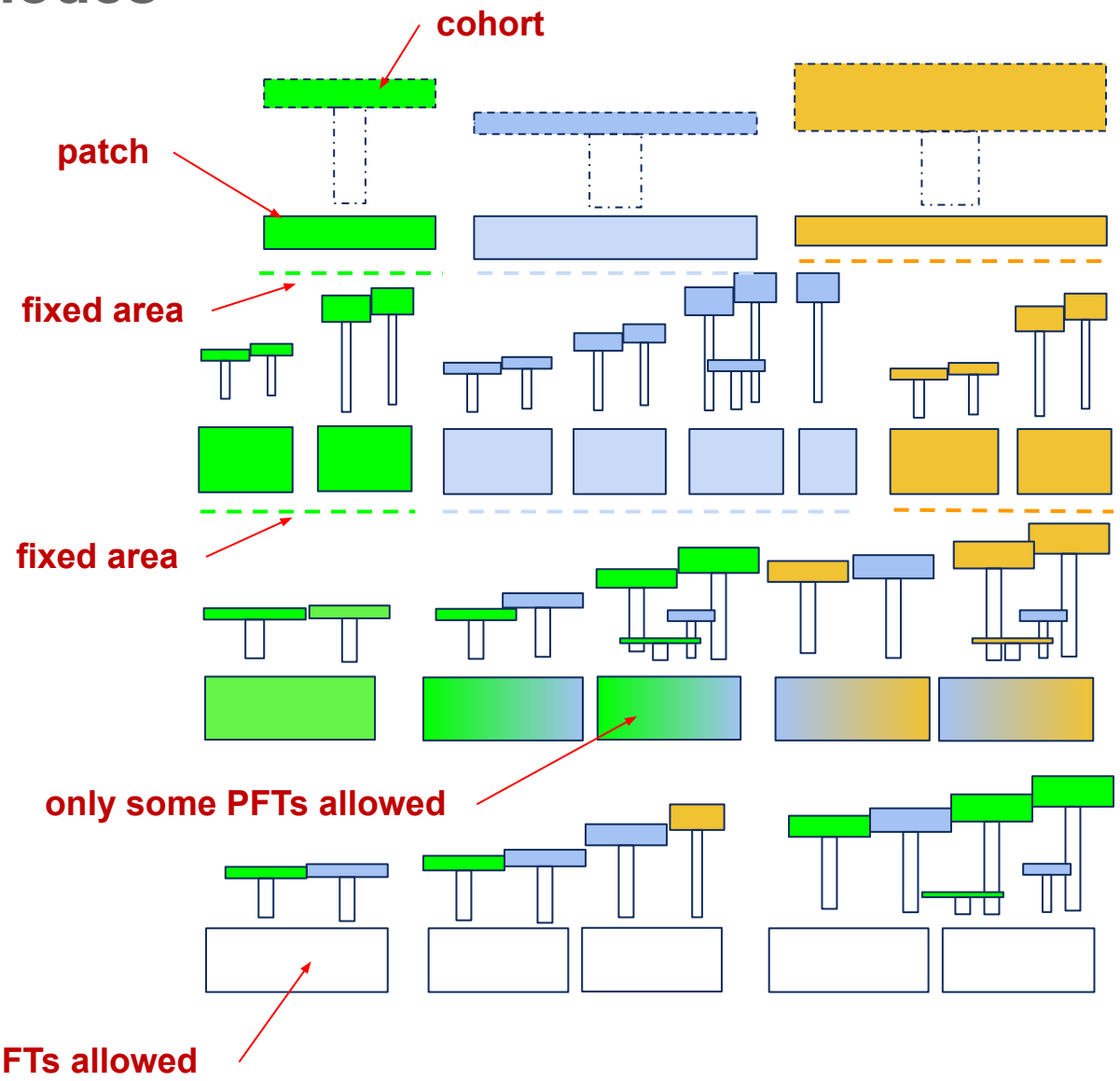
FATES complexity modes

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

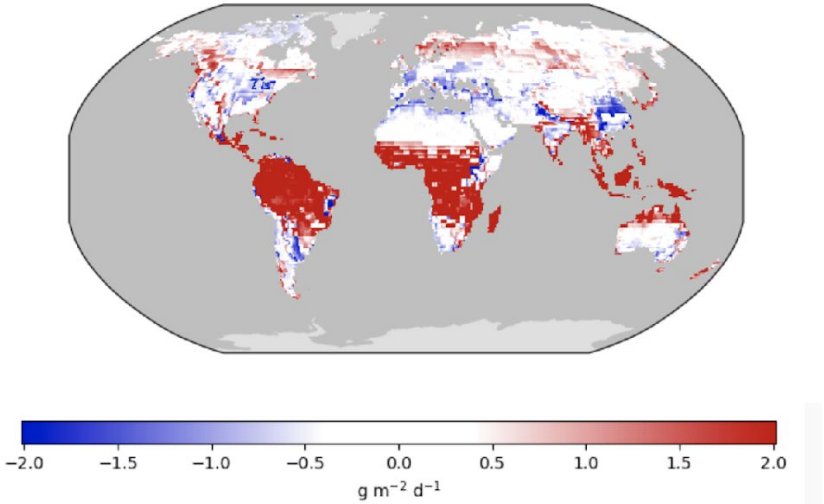
No Competition
All PFTs given a fixed area to grow
Growth & disturbance
Fixed biogeography

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

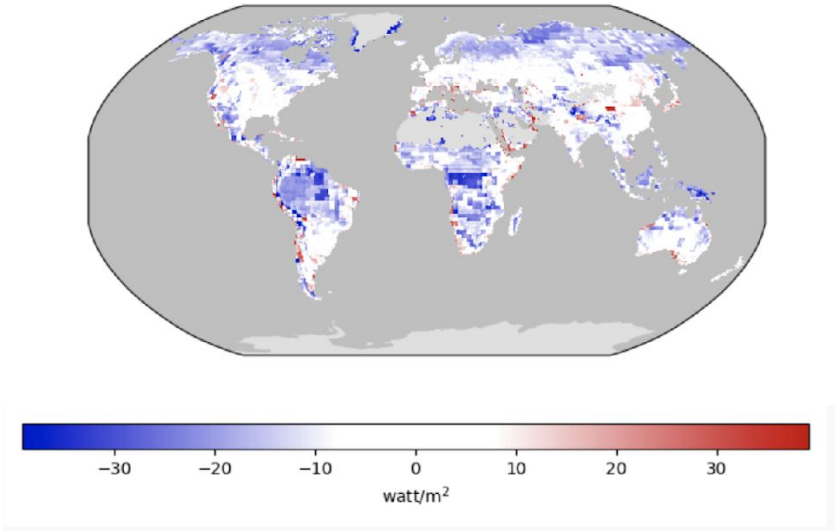
Full FATES
Growth, disturbance, and competition everywhere



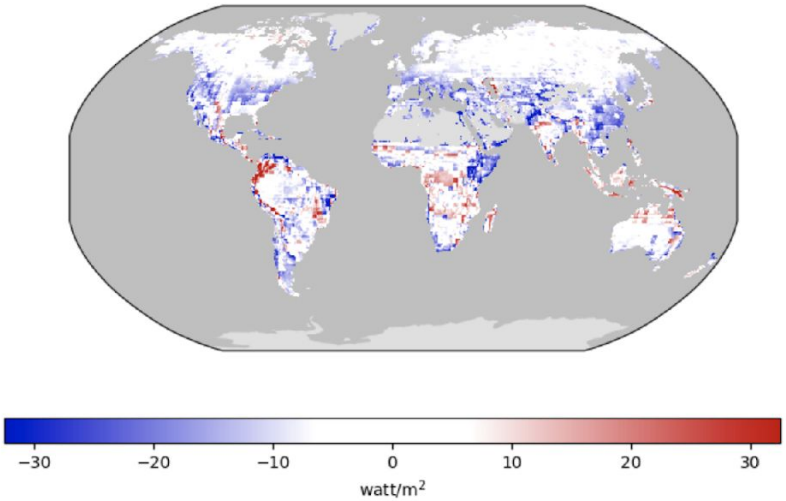
GPP



Sensible Heat



Latent Heat



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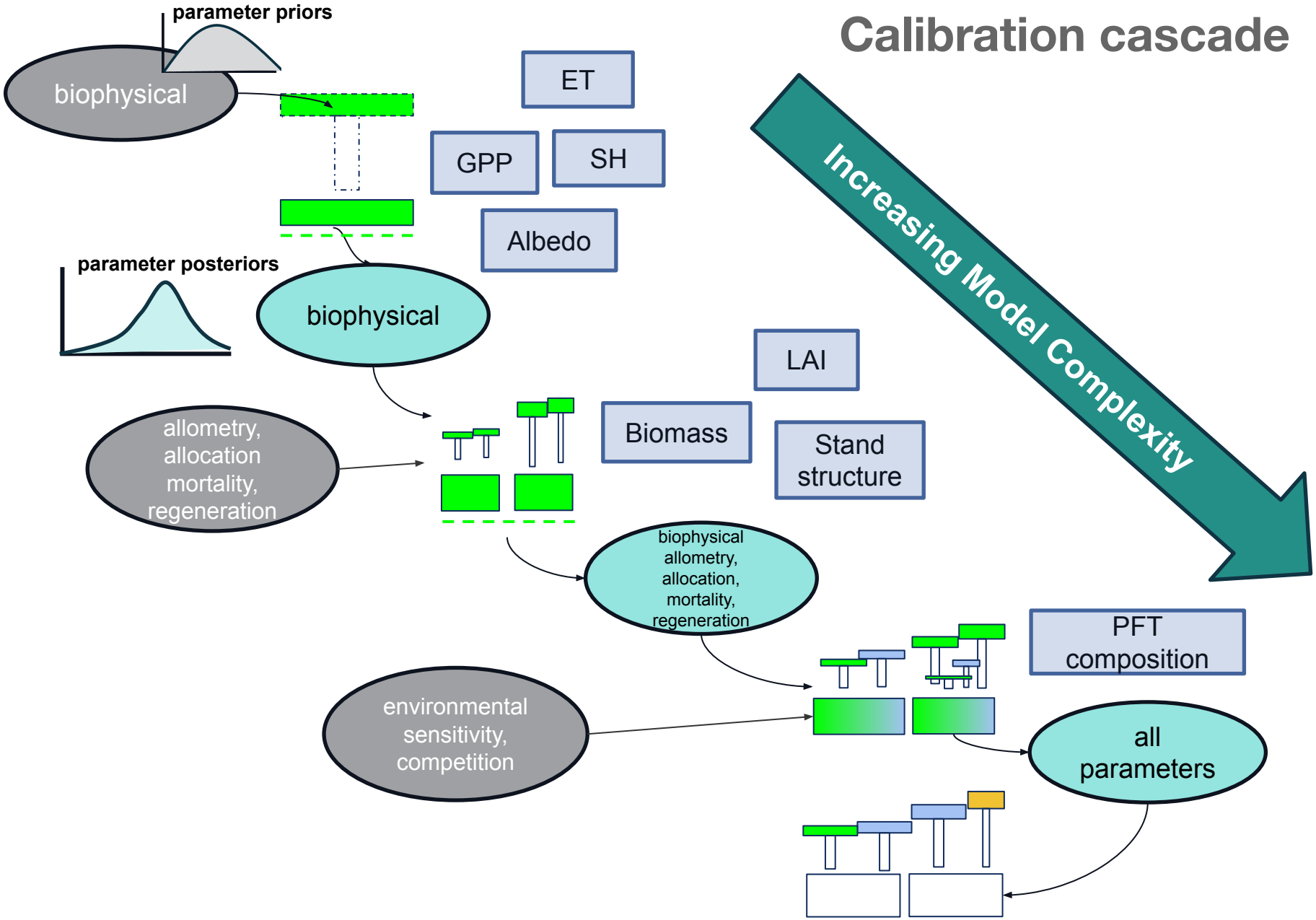
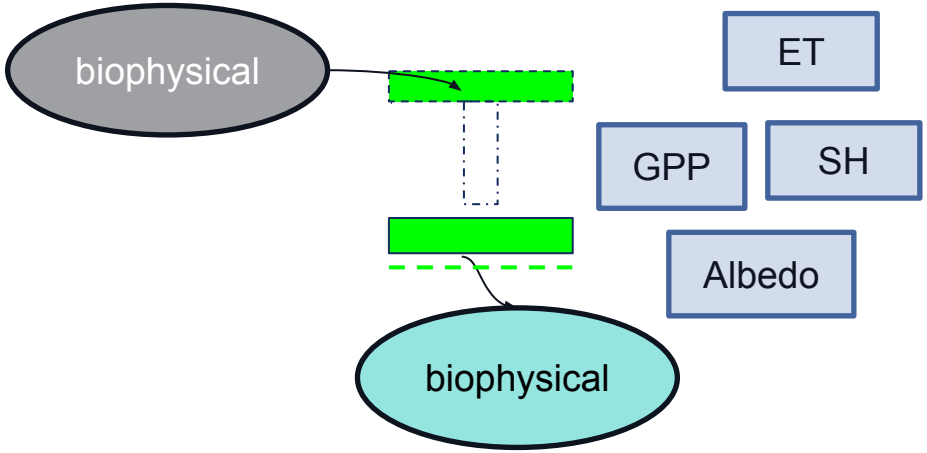
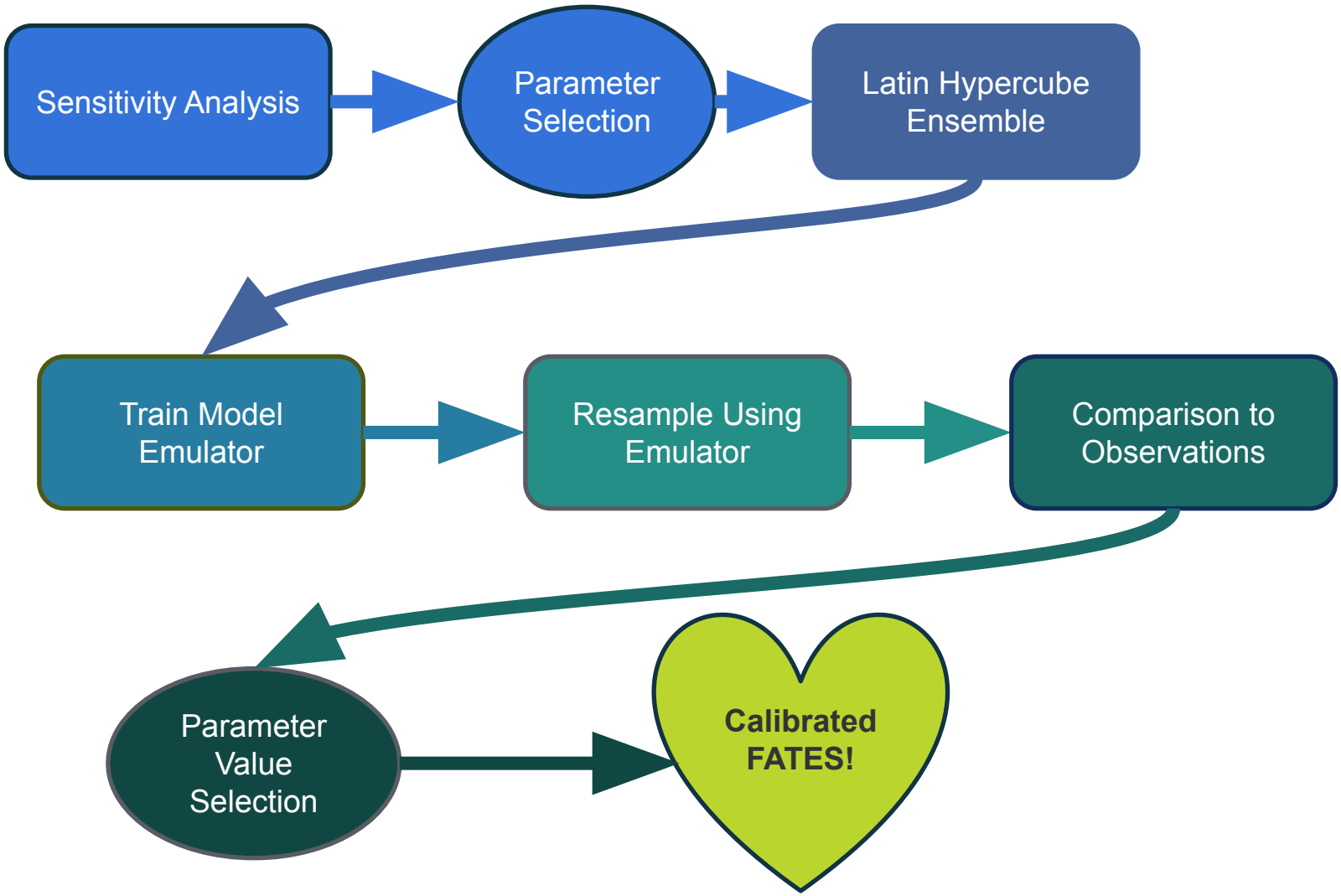
Calibration cascade



Calibration cascade



Overall Roadmap



Model configuration and spin up

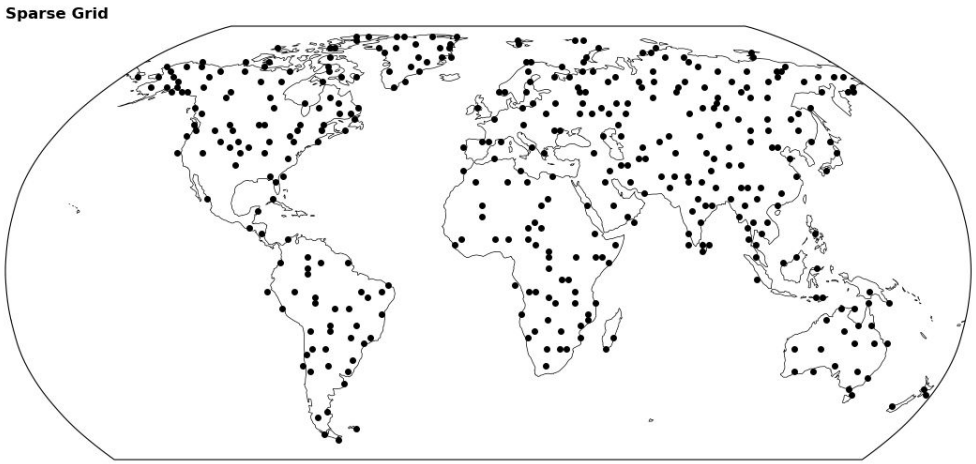
FATES SP Mode

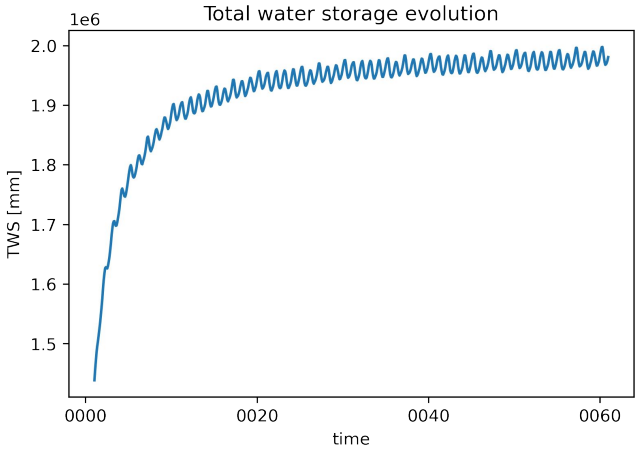
Two-stream radiation (more on this from Ryan Knox later this afternoon)
Atkin respiration
Medlyn stomatal conductance
Kumarathunge temperature acclimation

Cycle 2004-2015 GSWP3 climate

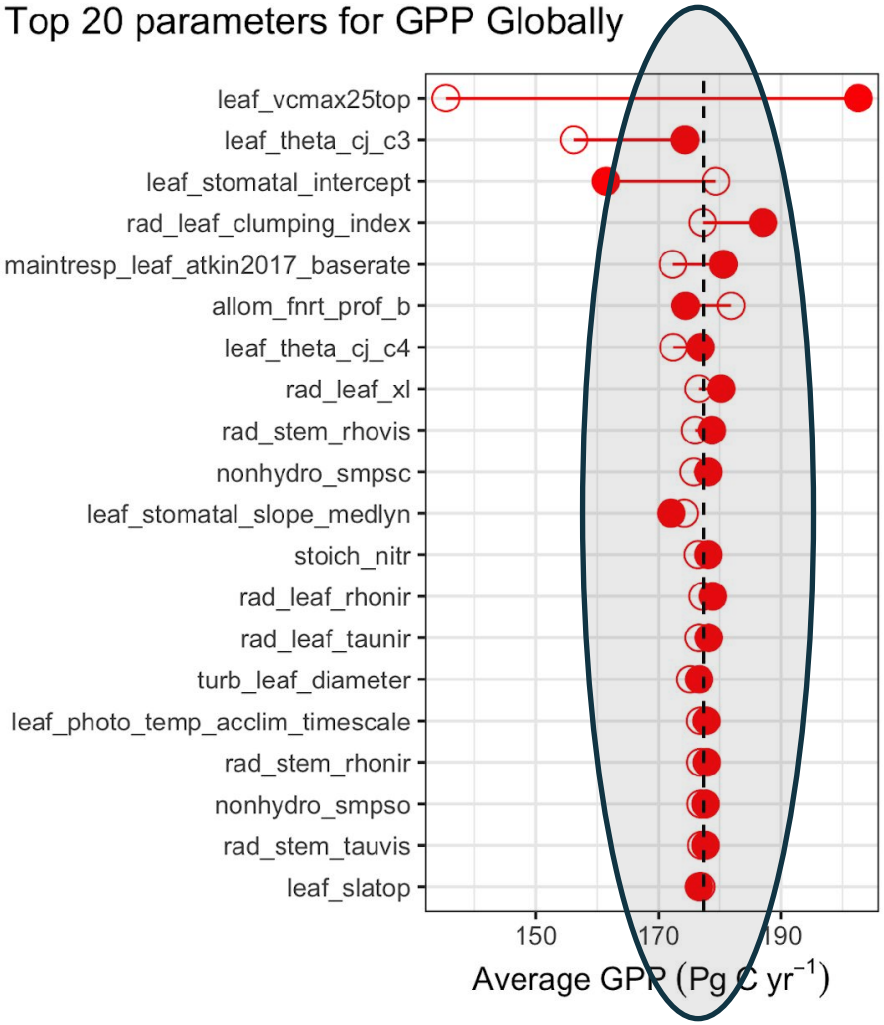
Wait for total water storage to evolve and come to equilibrium
Use last 20 years for analysis

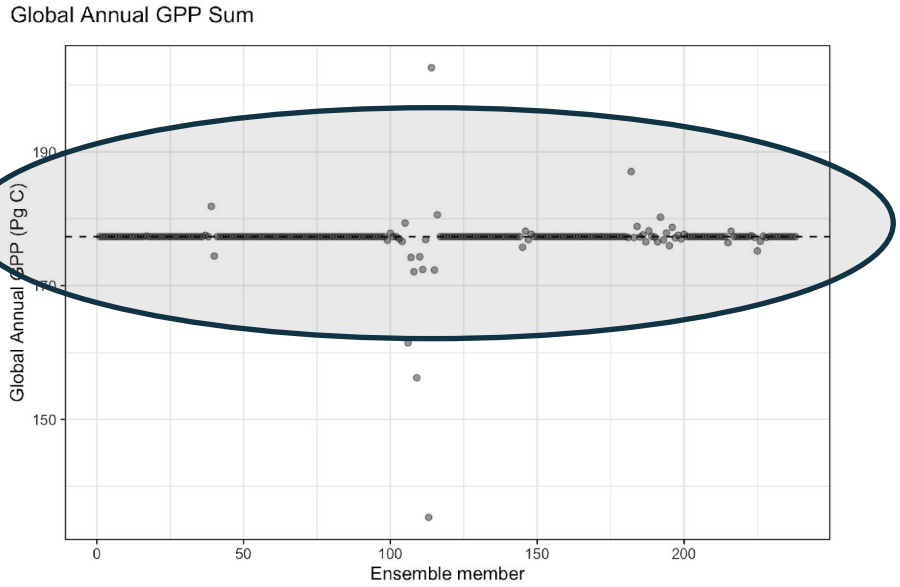
Sparse grid (n = 400)





Initial OAAT sensitivity analysis



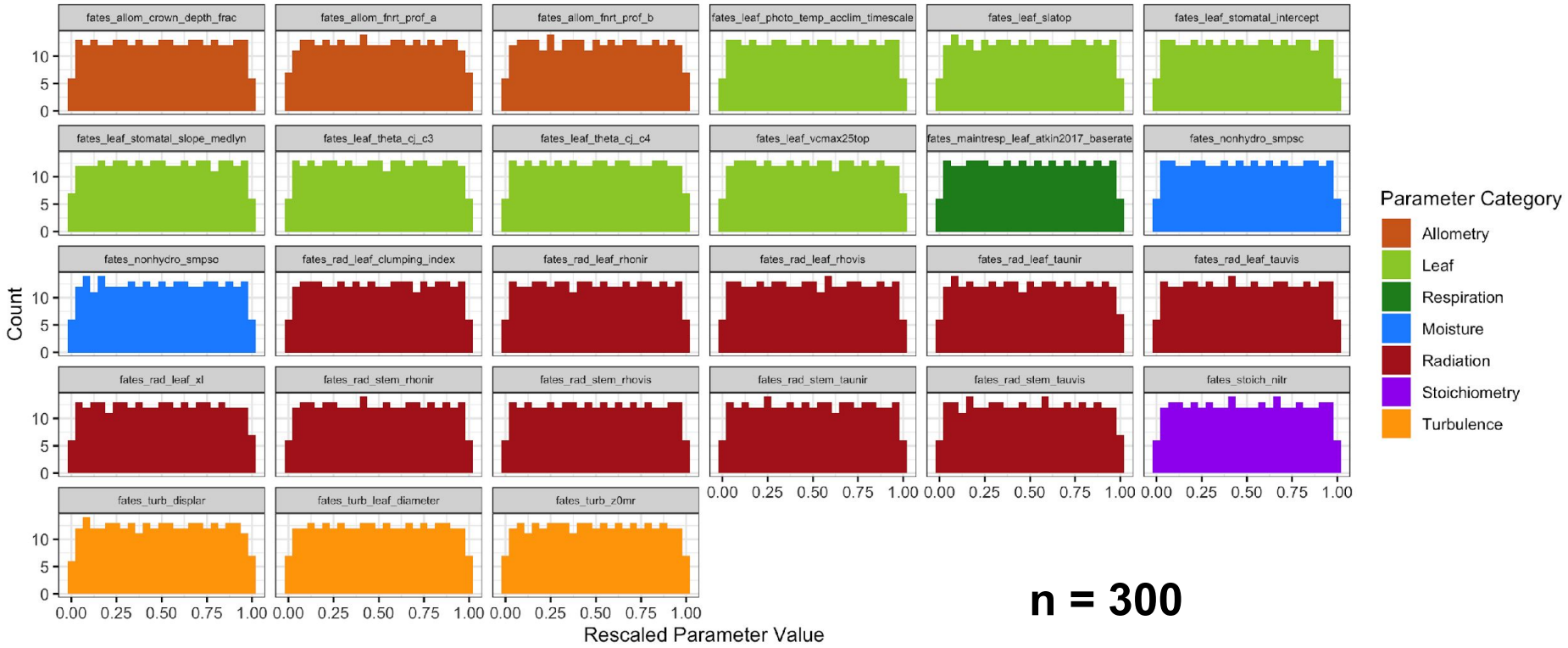


Only calibrating FATES parameters currently*

* proceed with caution

Latin Hypercube Ensemble

Top 27 parameters across GPP, evapotranspiration, sensible heat, albedo, and surface soil moisture output



n = 300

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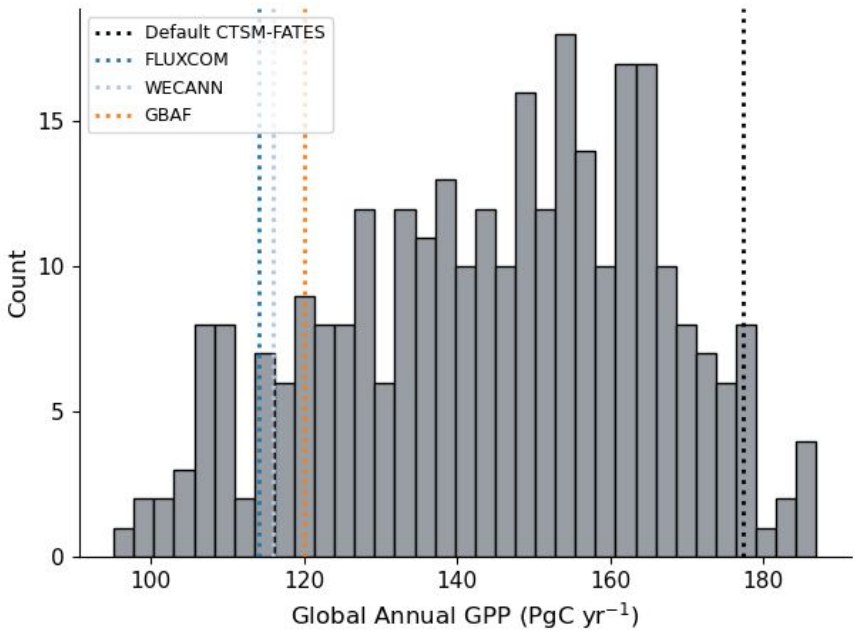
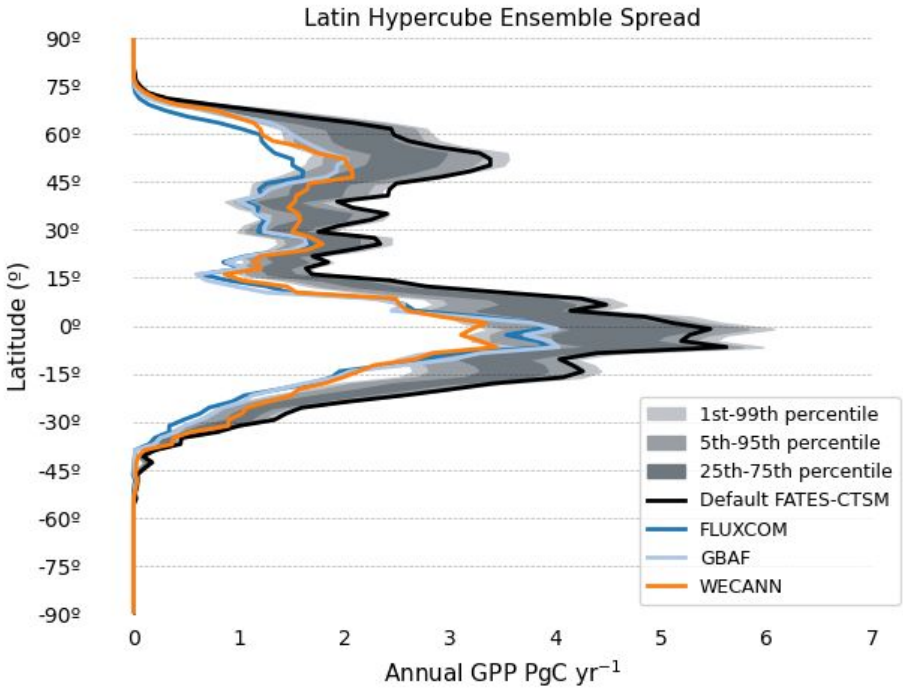
Latin Hypercube Ensemble





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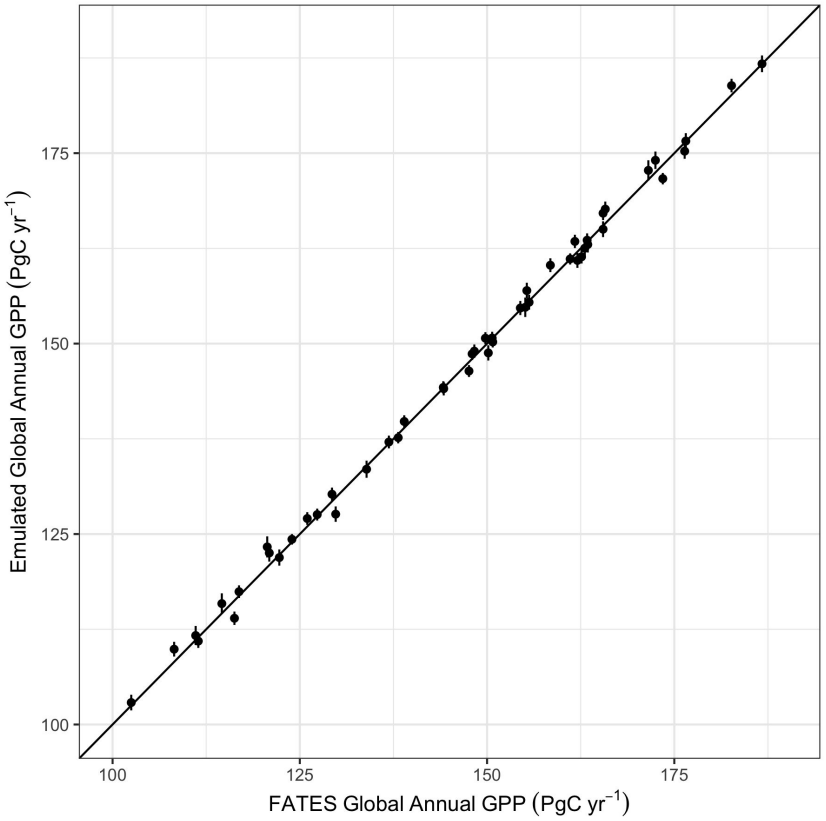
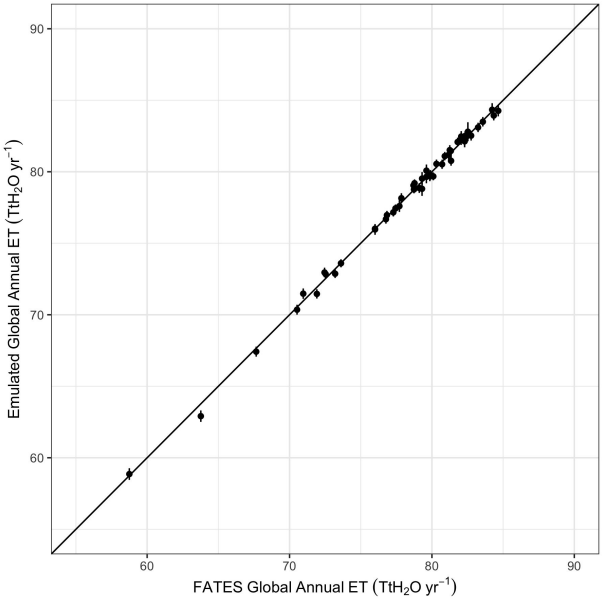
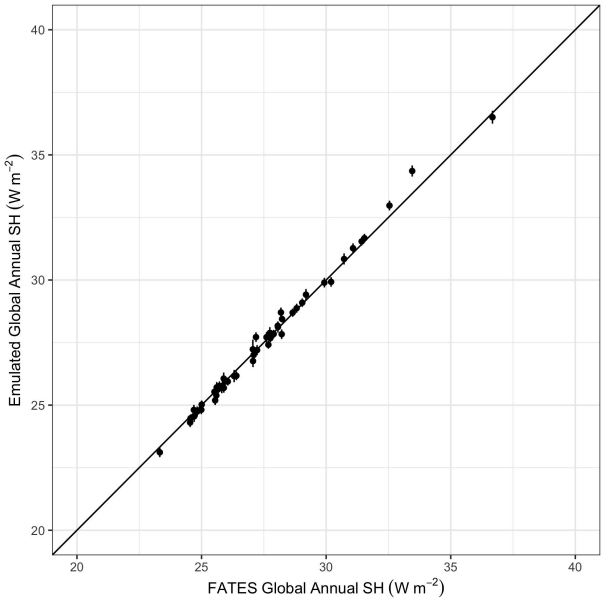
Emulator Validation







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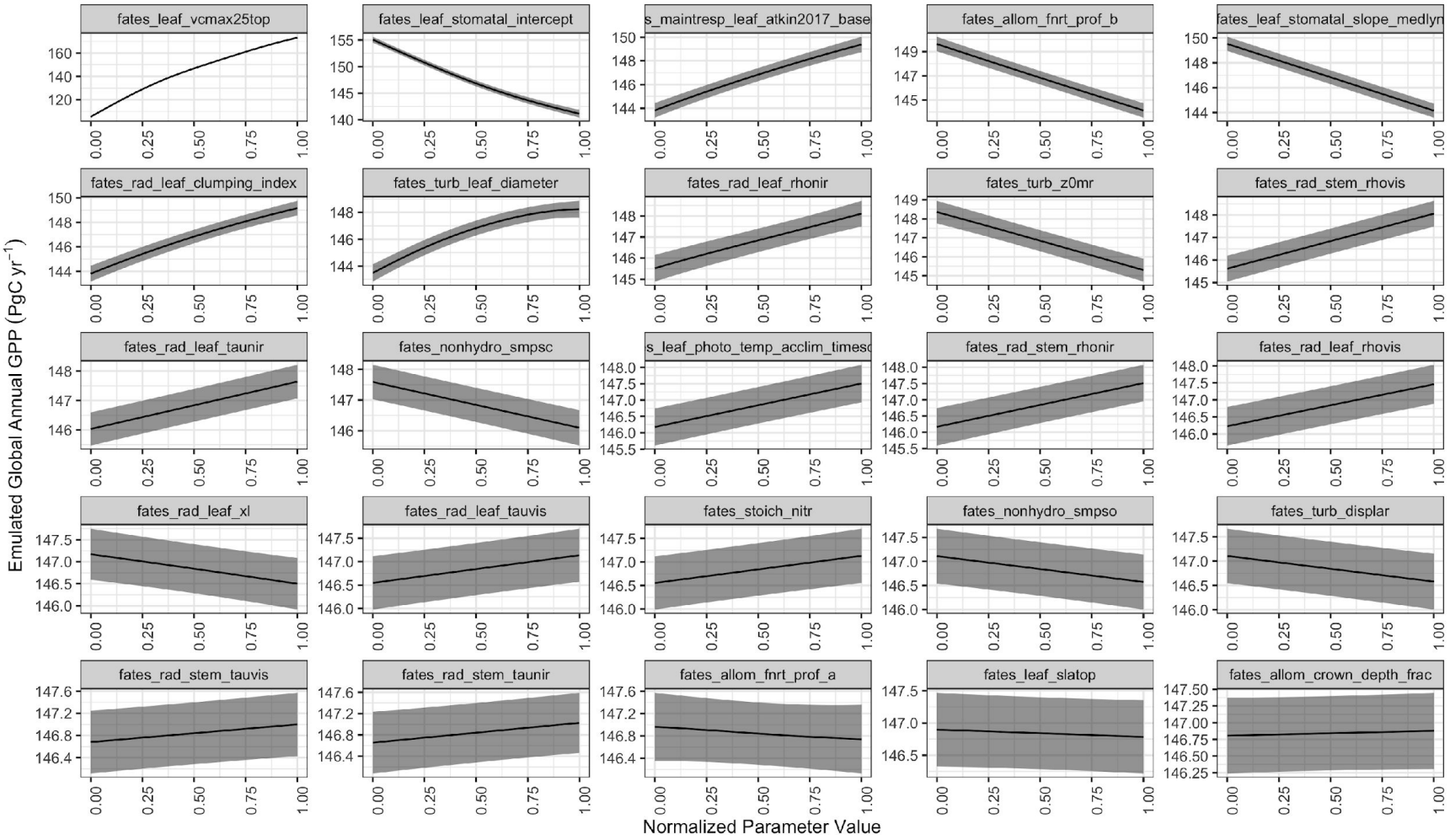
Parameter Sensitivity



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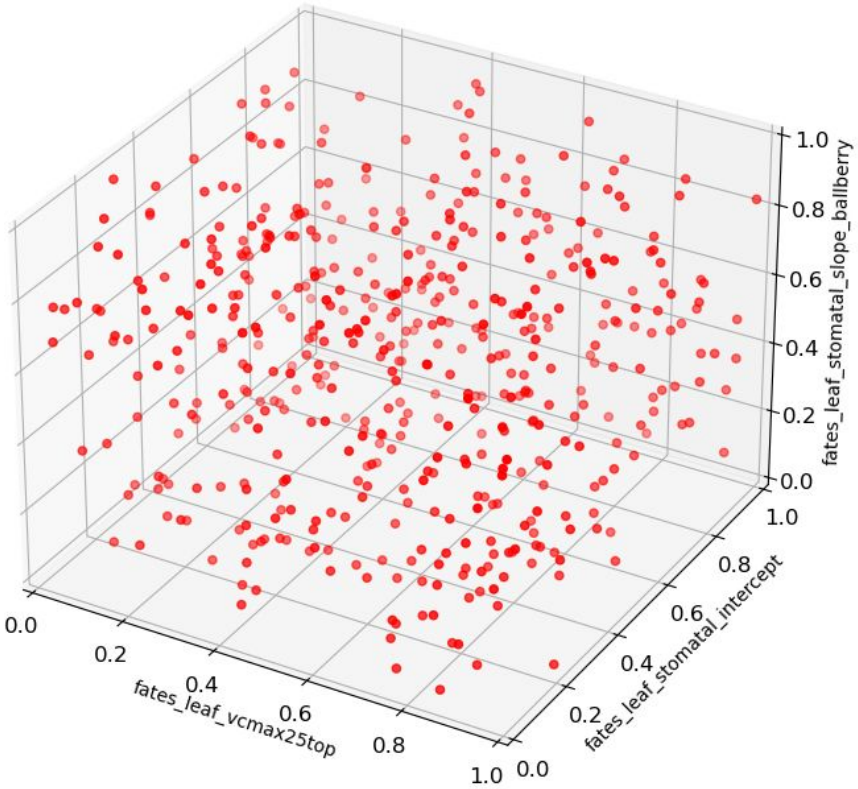
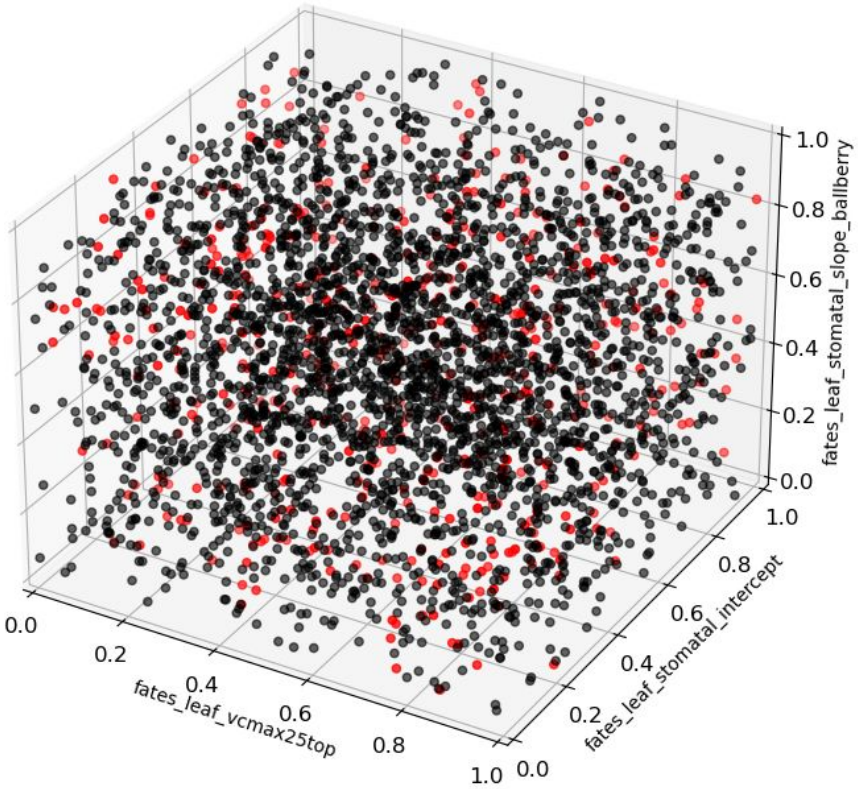
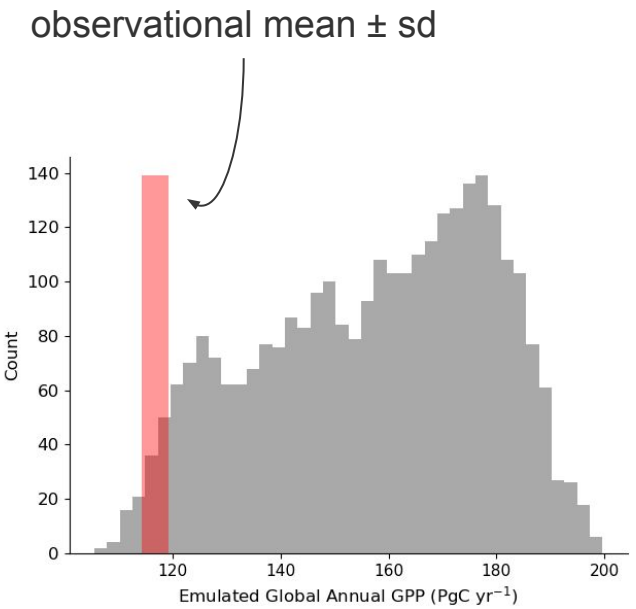
Resample parameter space using emulator

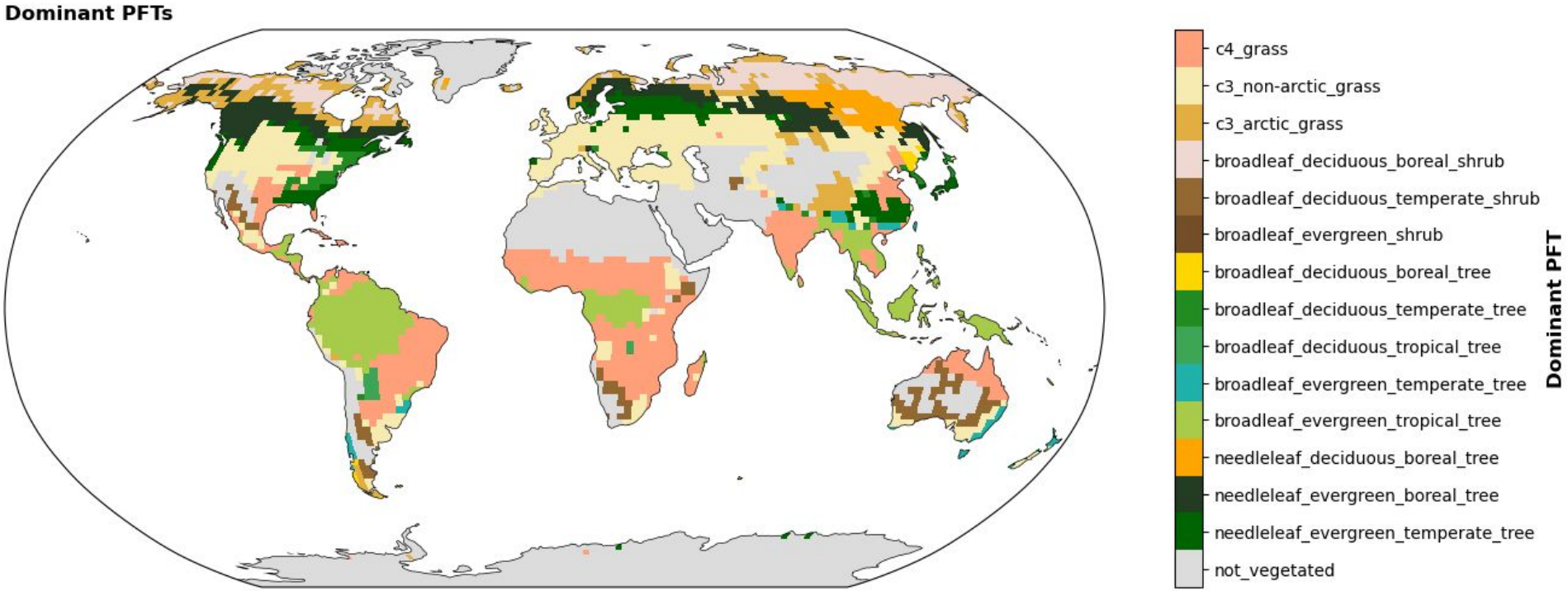


Resample parameter space using emulator





Trying to find PFT-specific gridcells



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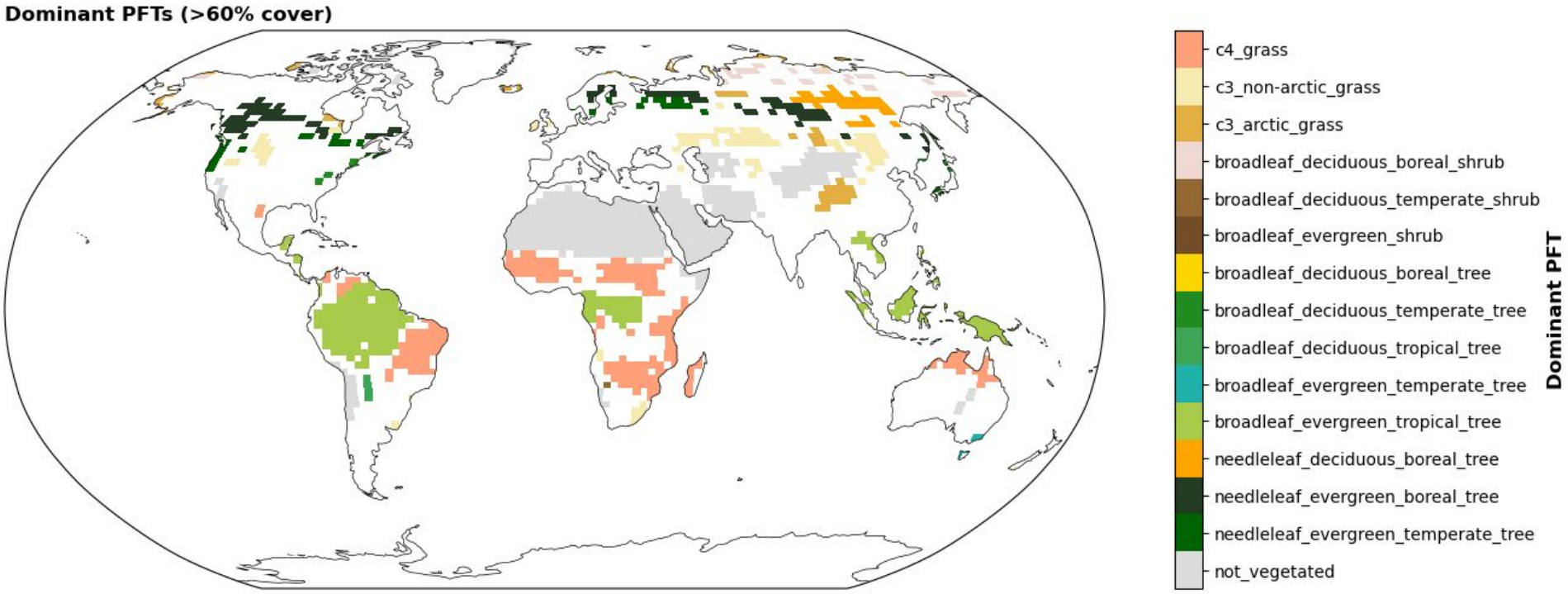

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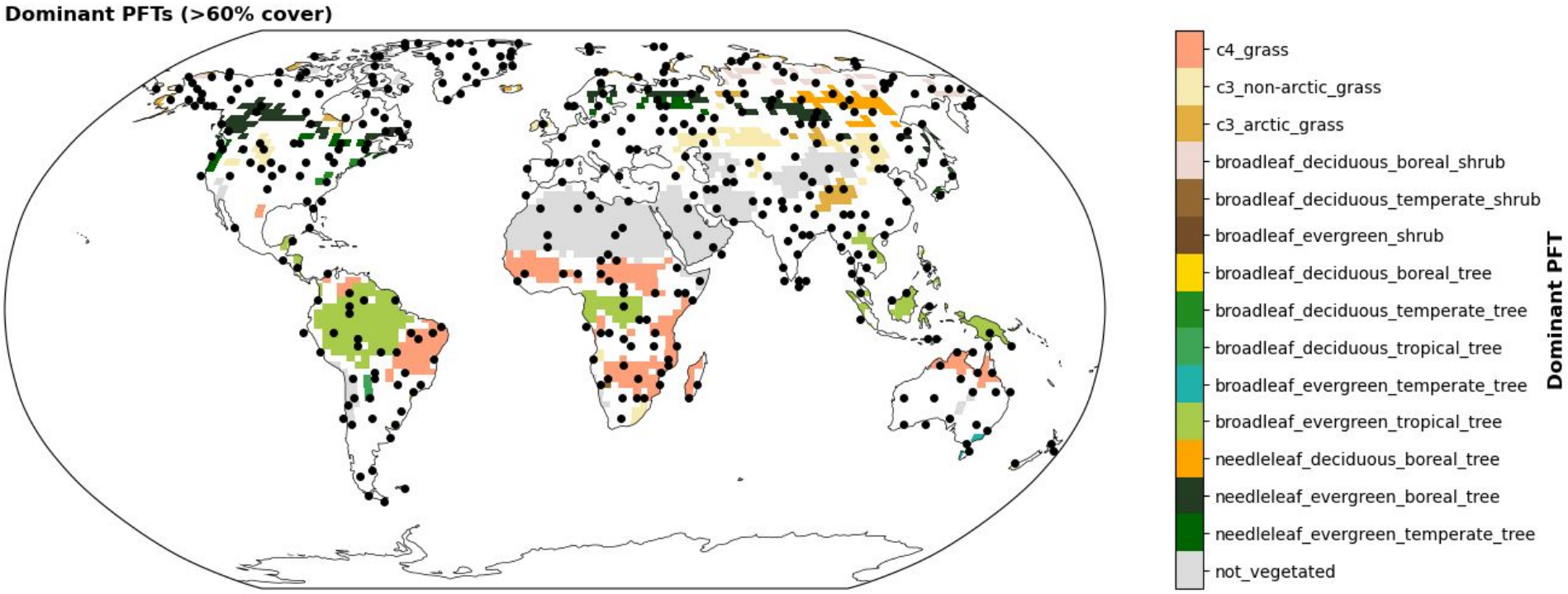

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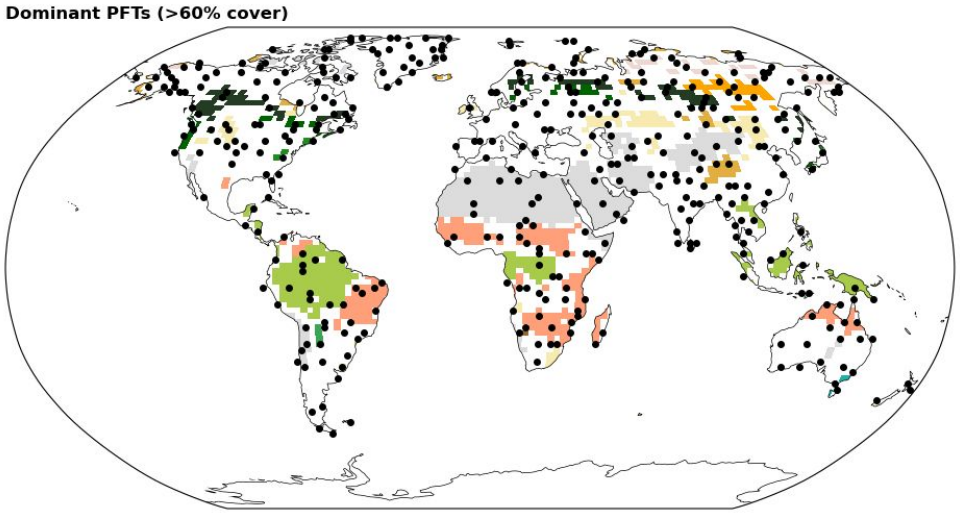
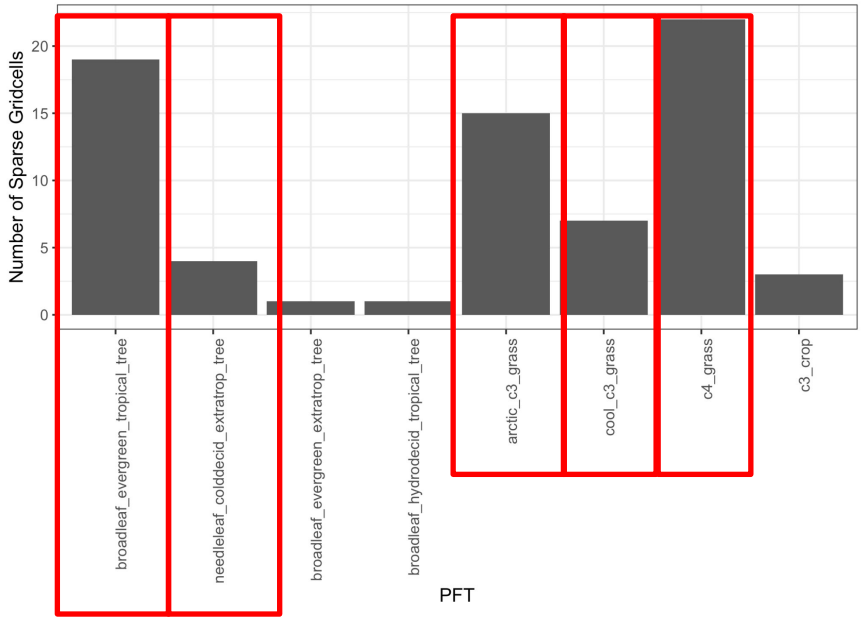
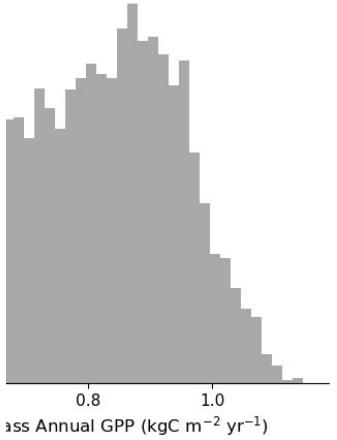
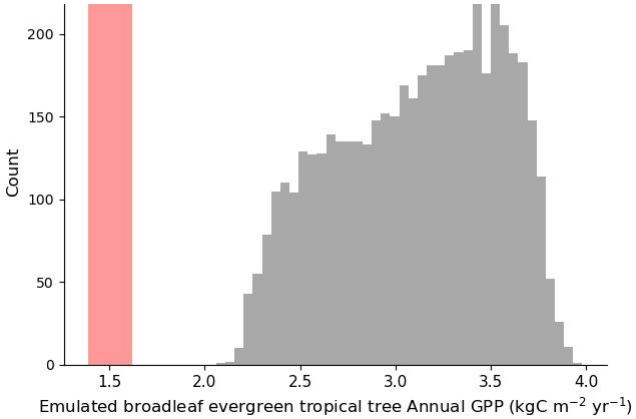
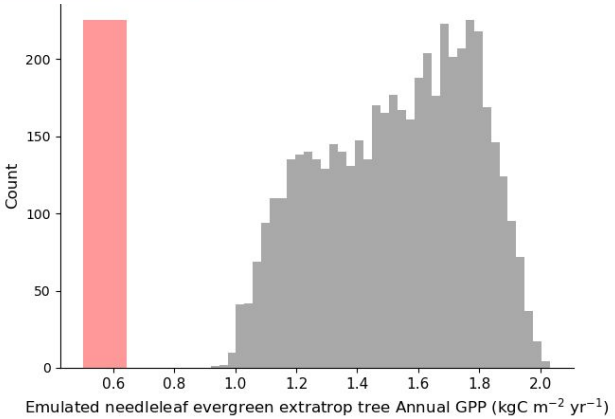




Emulate CTSM-FATES output at PFT-specific grids







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Back to model configuration

FATES SP Mode

Two-stream radiation (more on this from Ryan Knox later this afternoon)

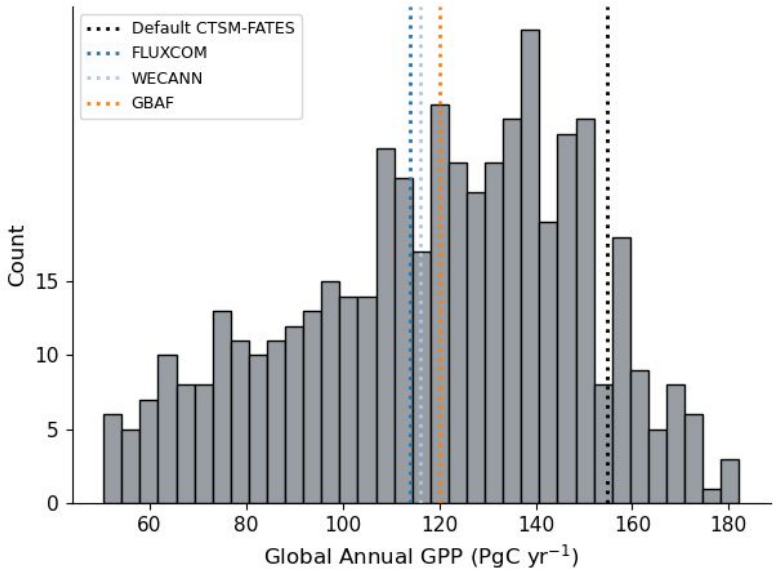
Atkin respiration

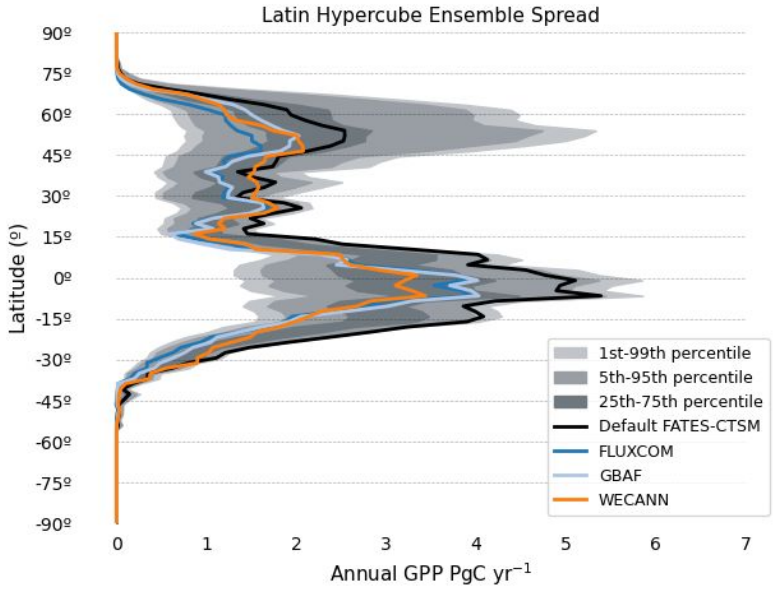
~~Medlyn stomatal conductance~~ Ball-Berry

~~Kumarathunge temperature acclimation~~

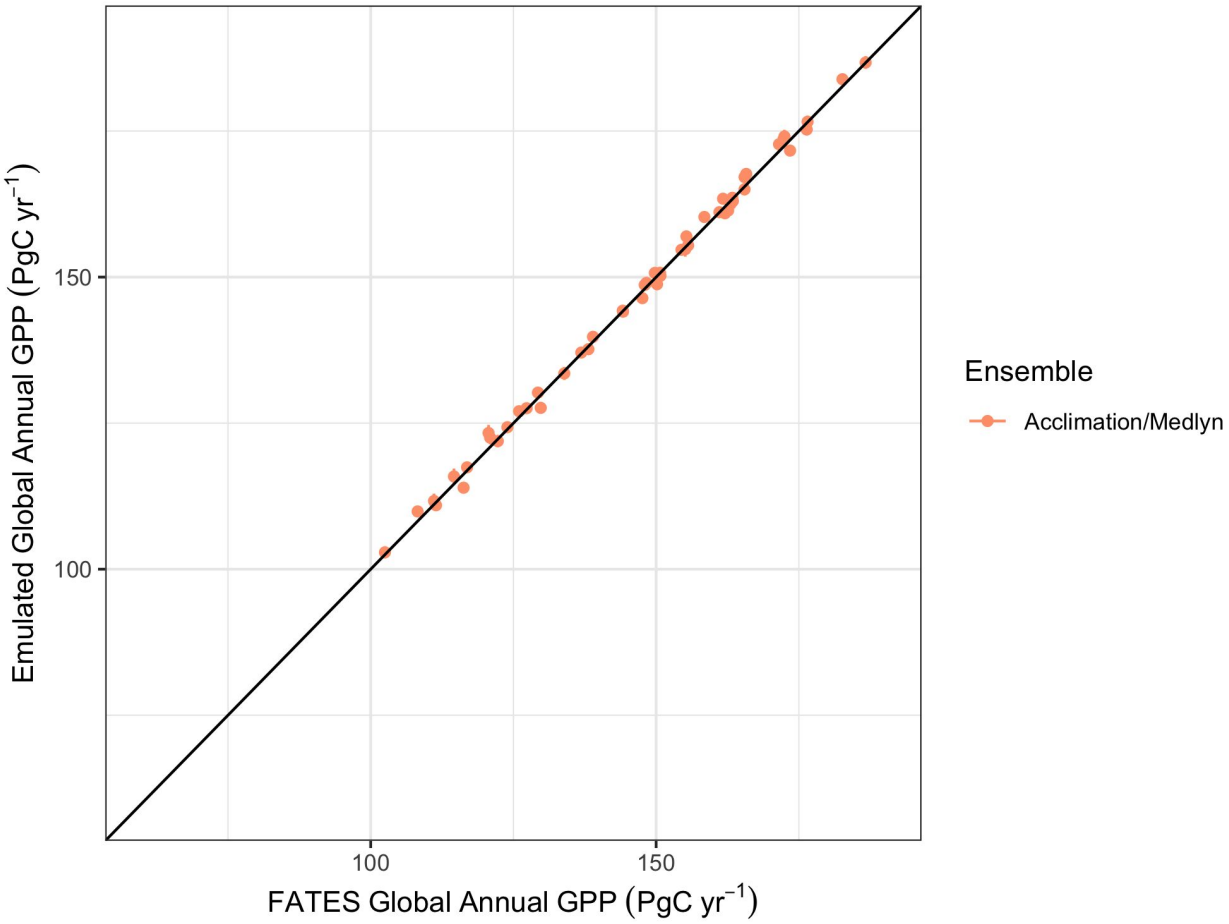
6 new parameters related to activation/deactivation energy or entropy for Vc_{max} & J_{max}

22 parameters total





Updated emulator validation



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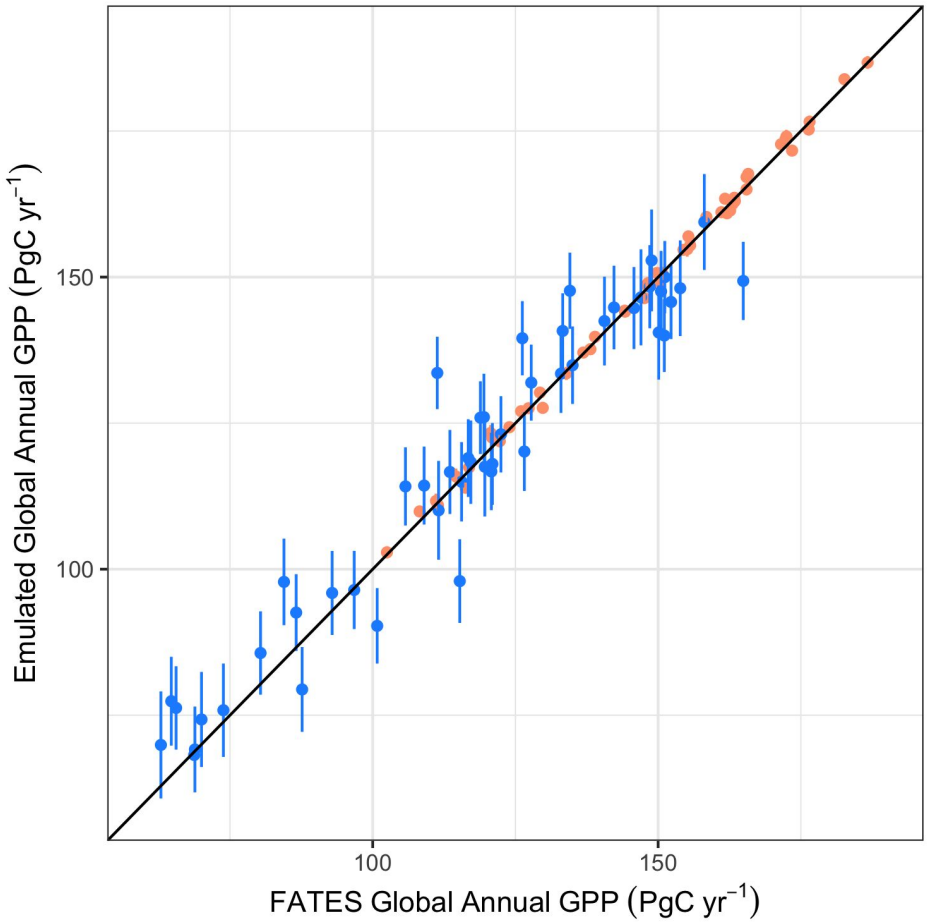
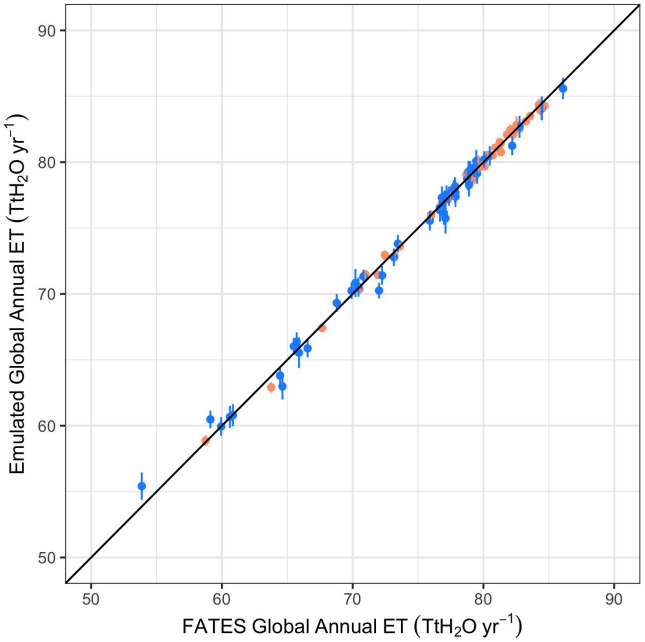
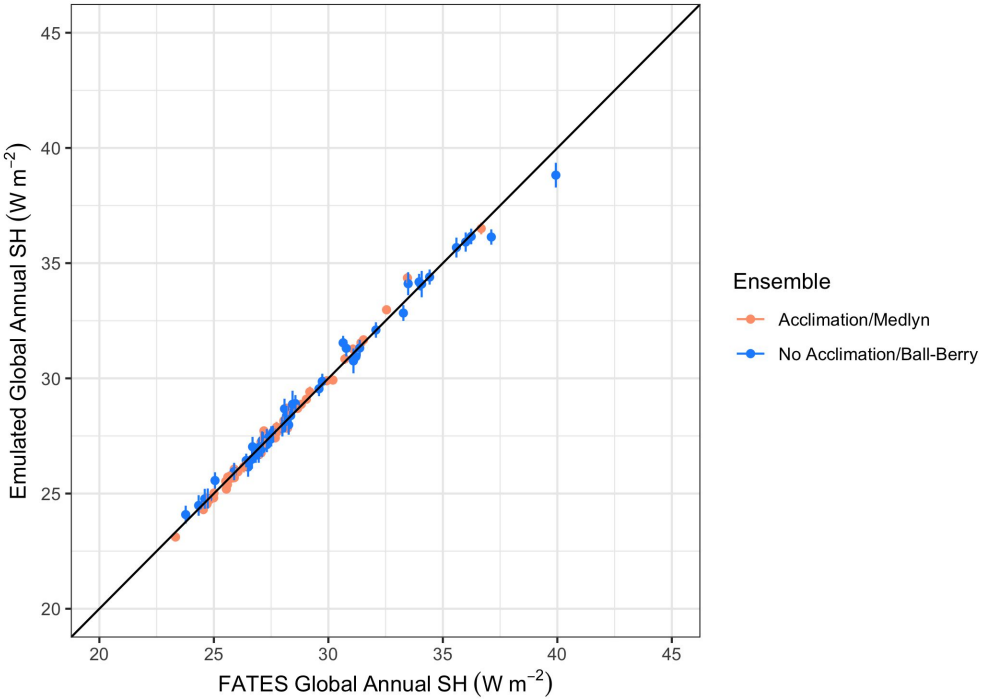


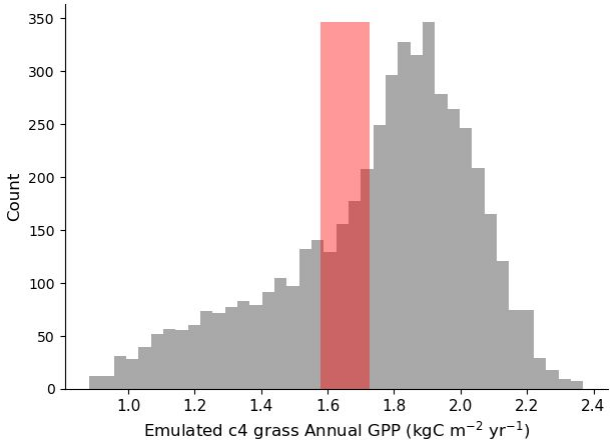
Helped with bias but also gained some uncertainty

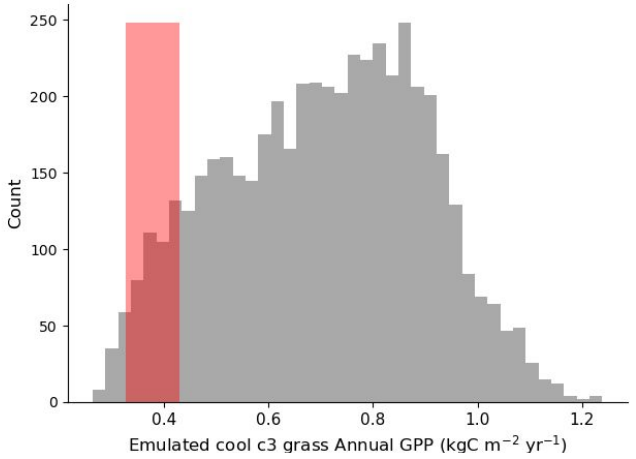
Updated emulator validation

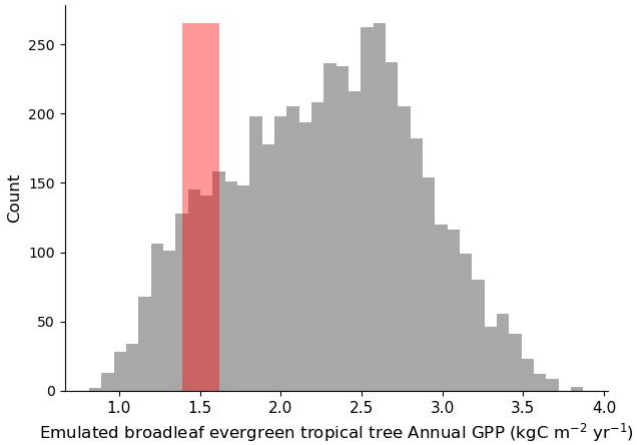


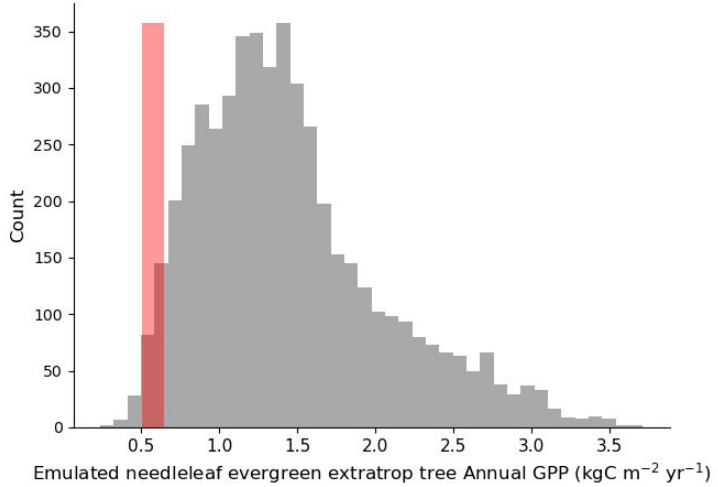


Emulate CTSM-FATES output at PFT-specific grids (take two)









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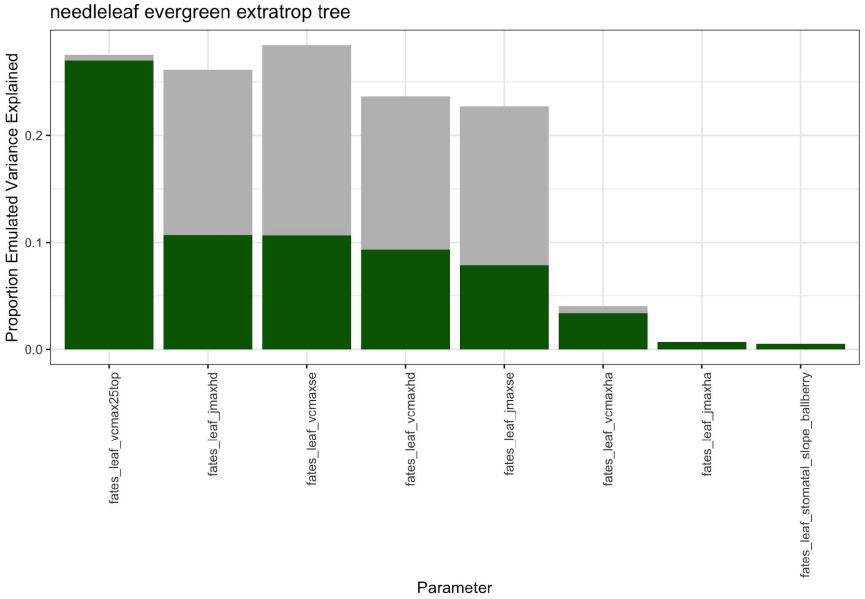
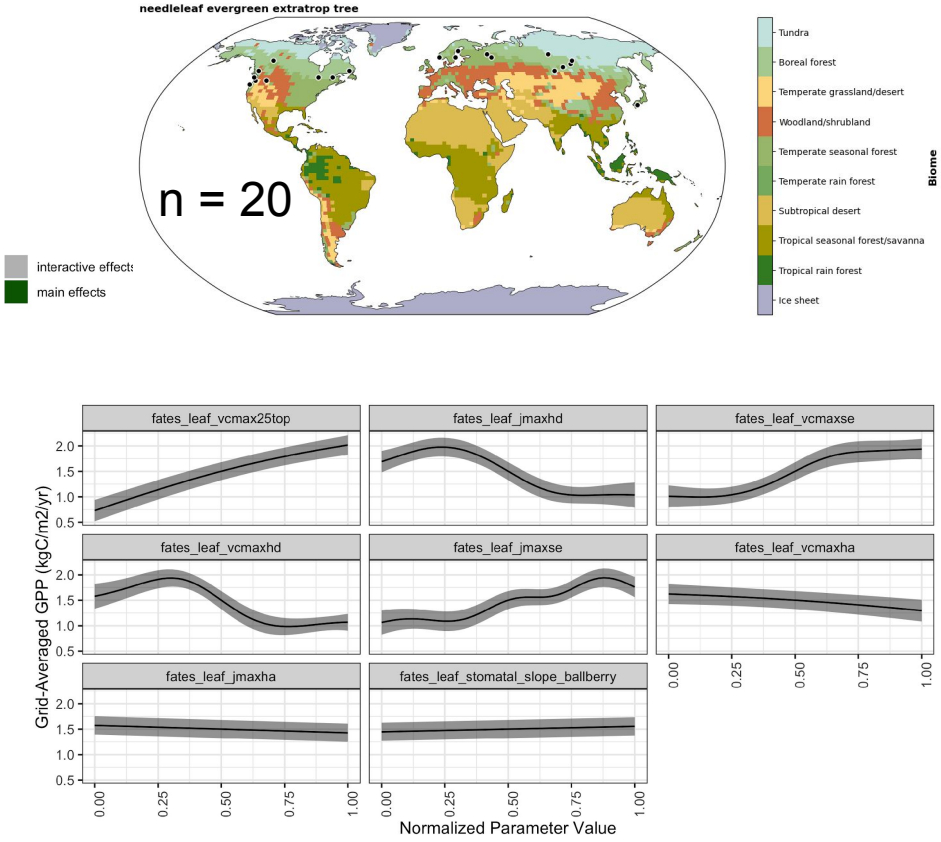
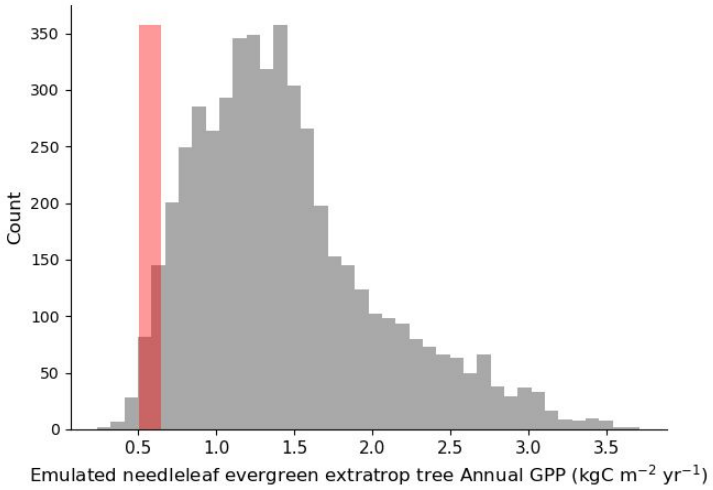
Updated PFT-specific emulators





needleleaf evergreen extratropical tree

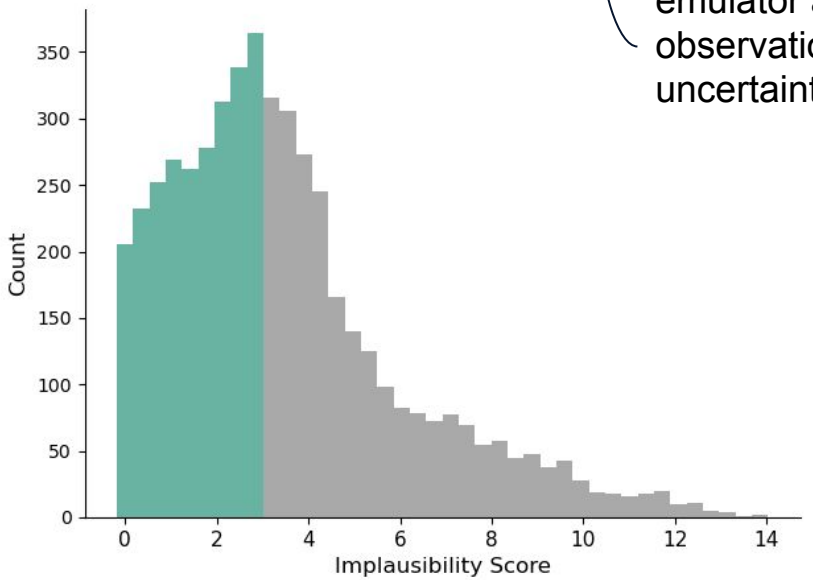
Find “plausible” parameter sets



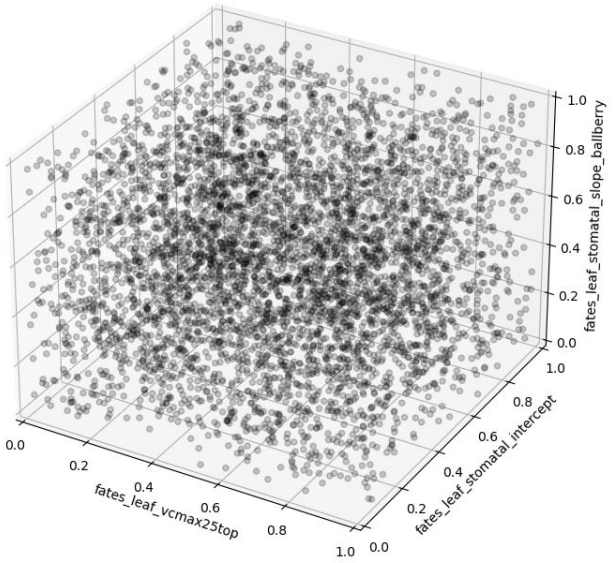
difference from observations

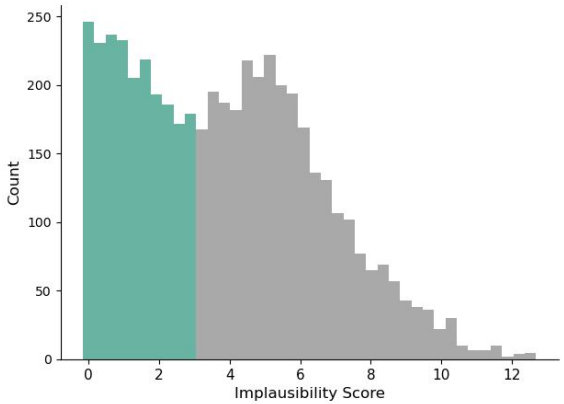
$$p = \frac{|x_i - \overline{X}|}{\sqrt{\sigma_i^2 + \overline{\sigma^2}}}$$

emulator and observational uncertainty



Find “plausible” parameter sets





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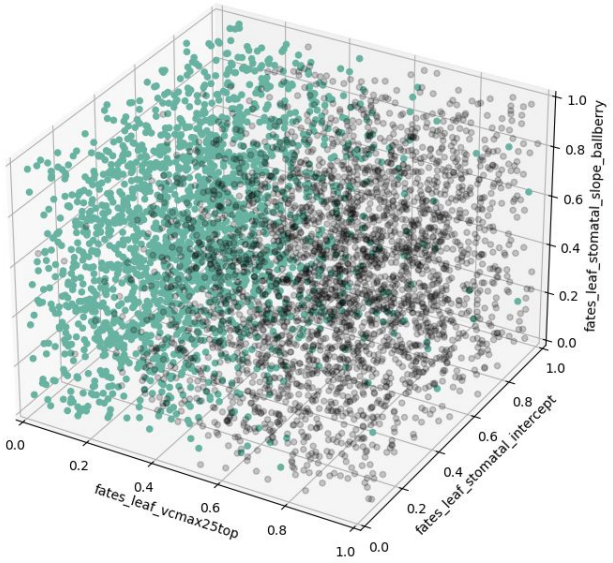
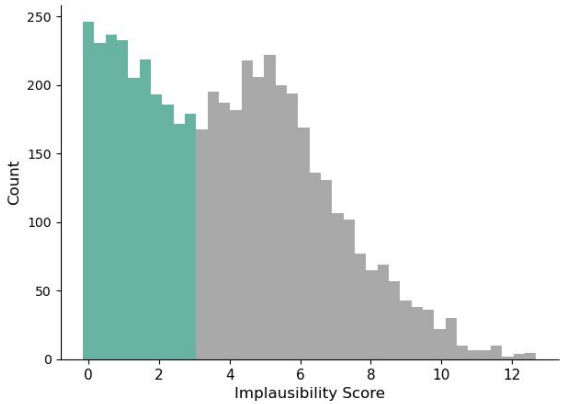
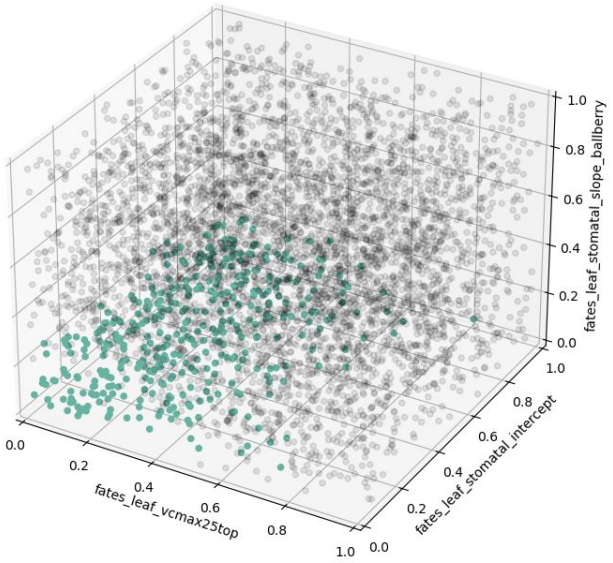
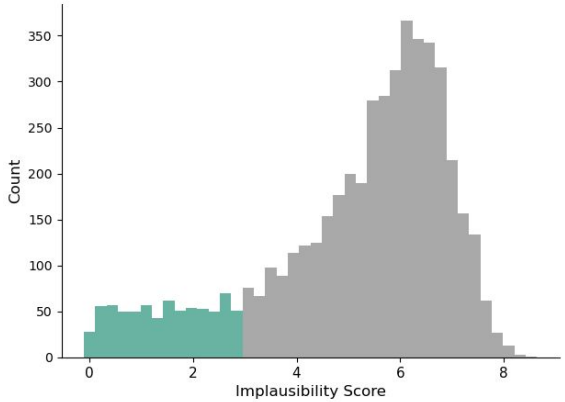


GPP output compared to observations



Find “plausible” parameter sets





GPP output compared to observations &
SH output compared to observations

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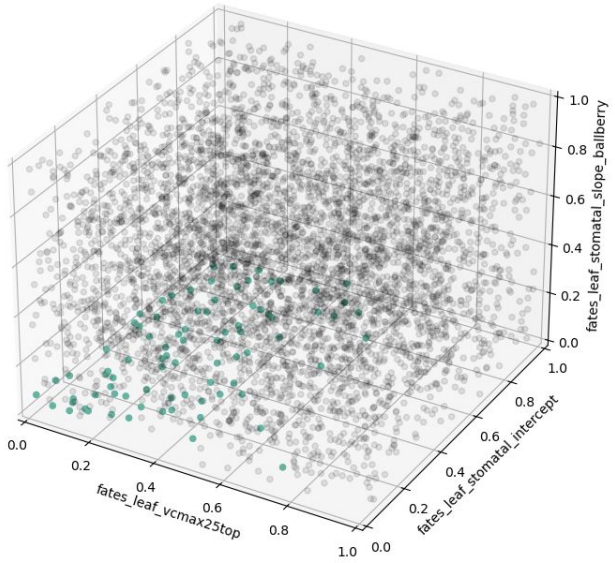
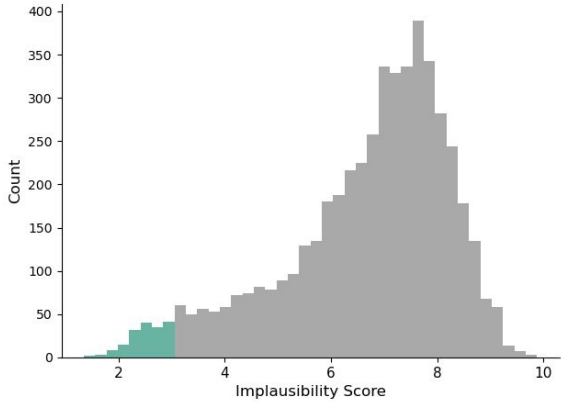
Find “plausible” parameter sets





GPP output compared to observations &
SH output compared to observations &
ET output compared to observations

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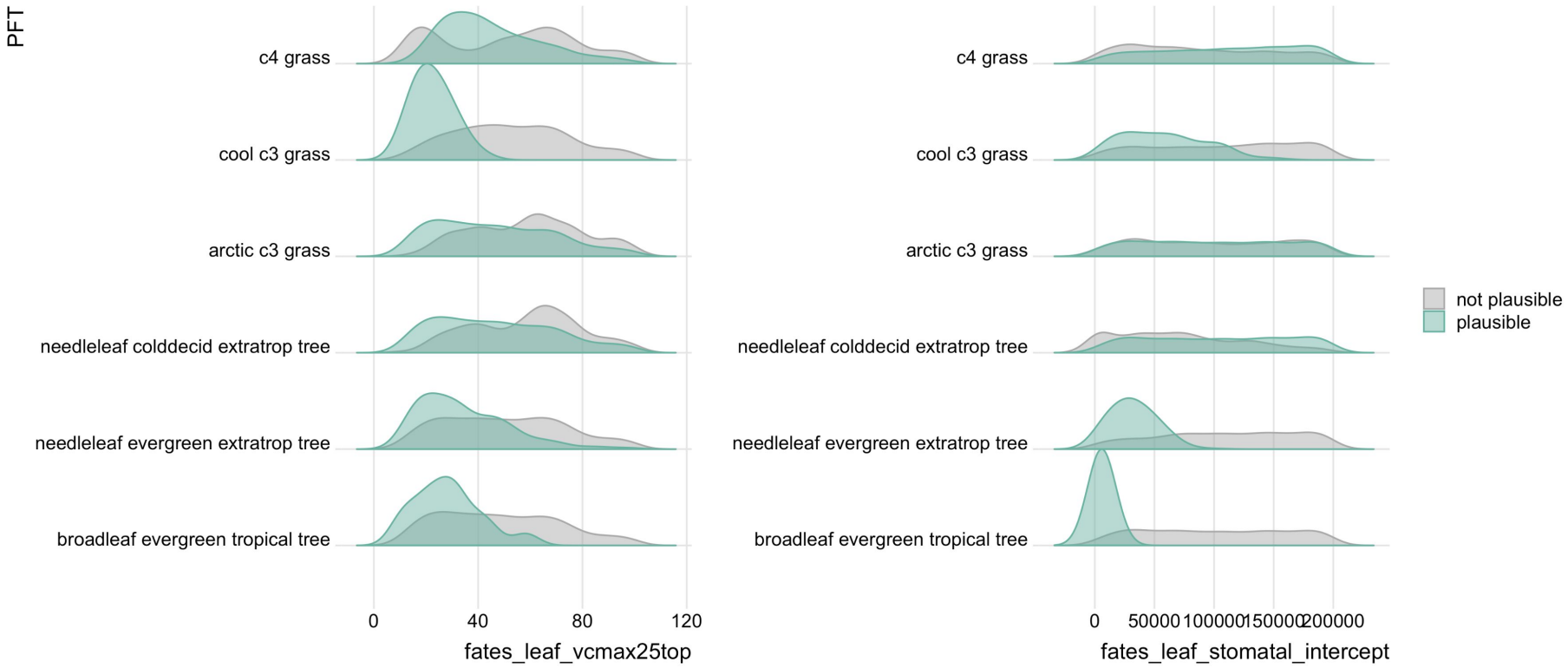
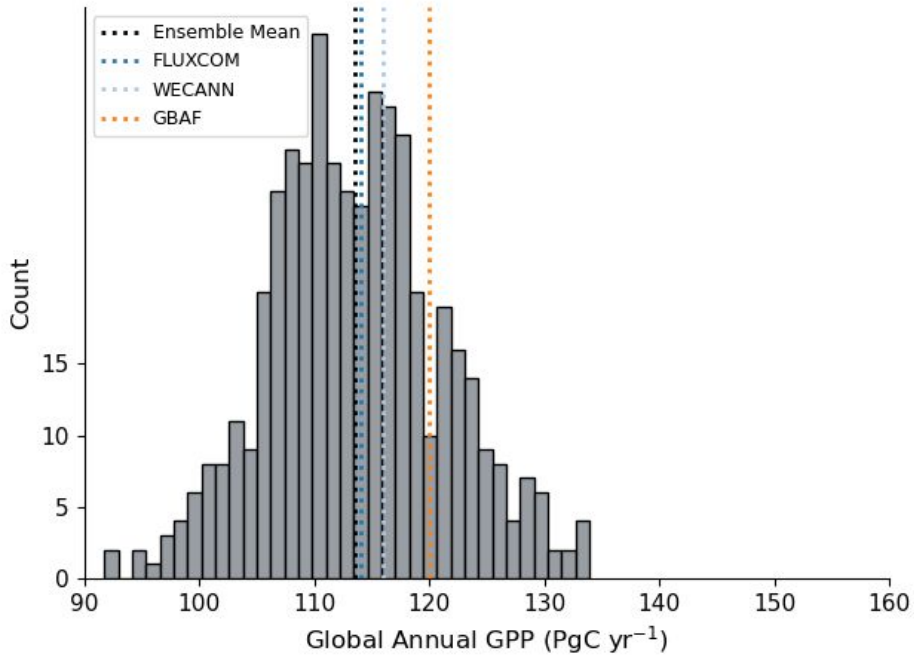
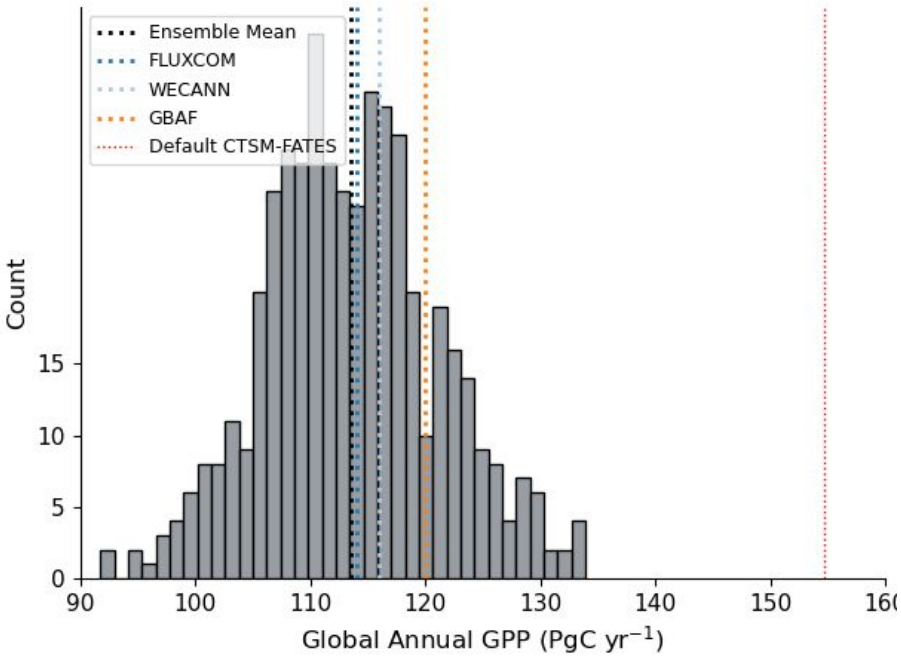
Find “plausible” parameter sets

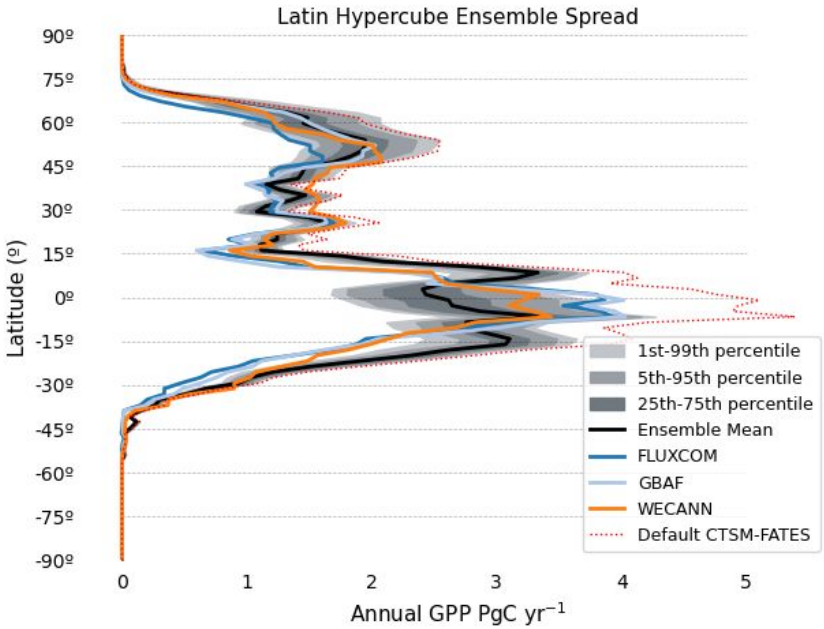


Re-run CTSM-FATES with plausible parameter sets

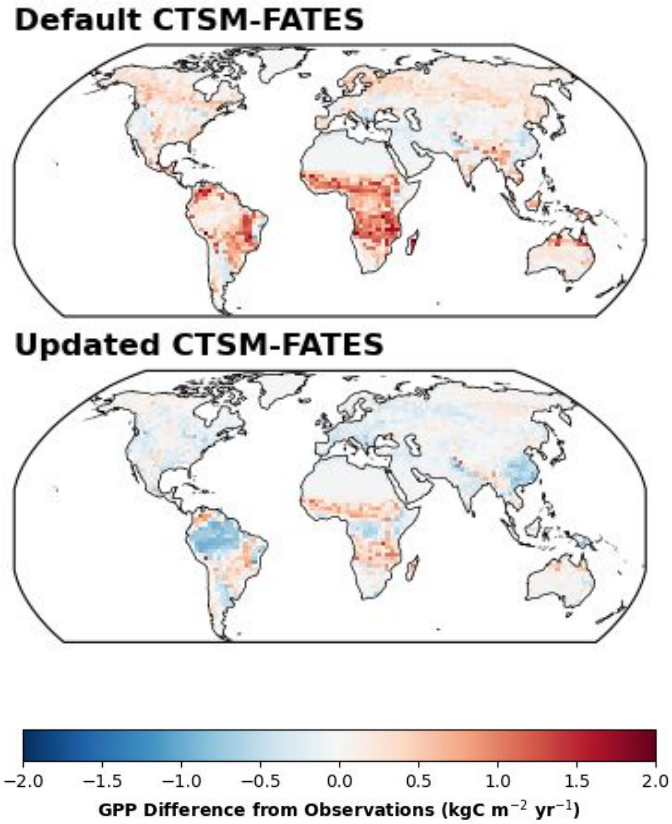


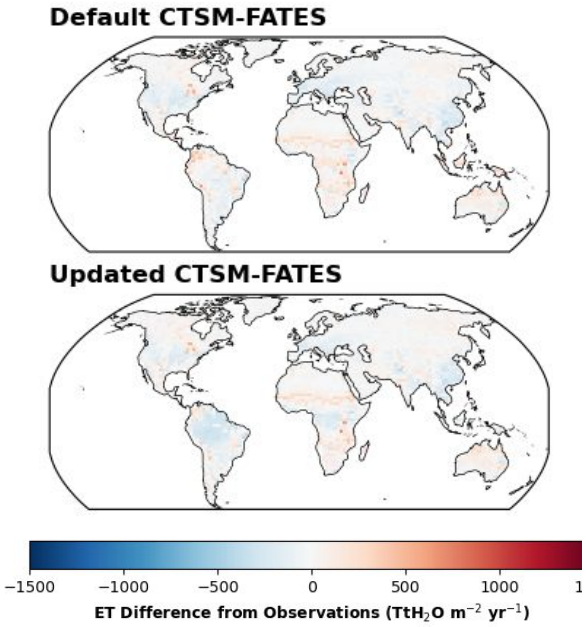
Re-run CTSM-FATES with plausible parameter sets

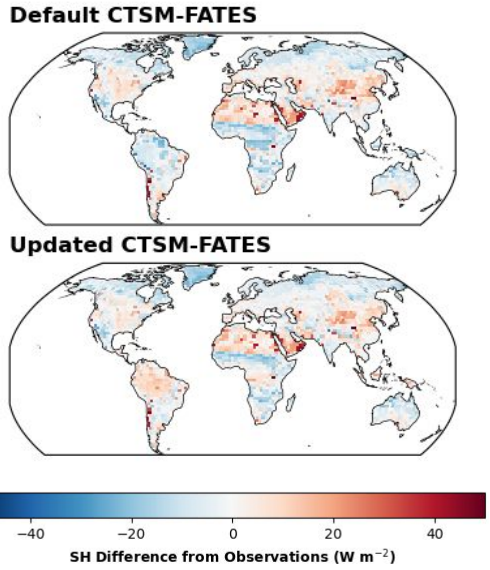




Re-run CTSM-FATES with plausible parameter sets







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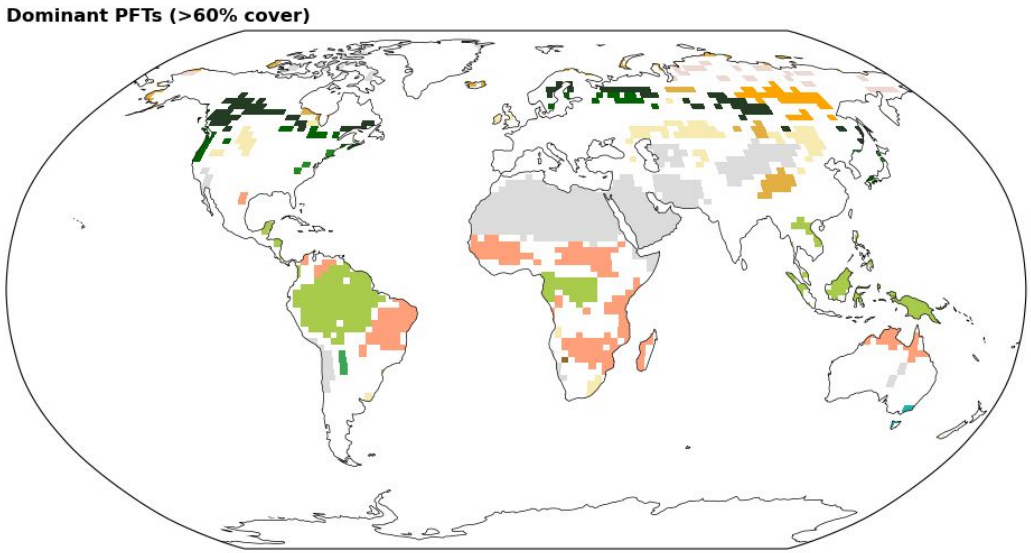
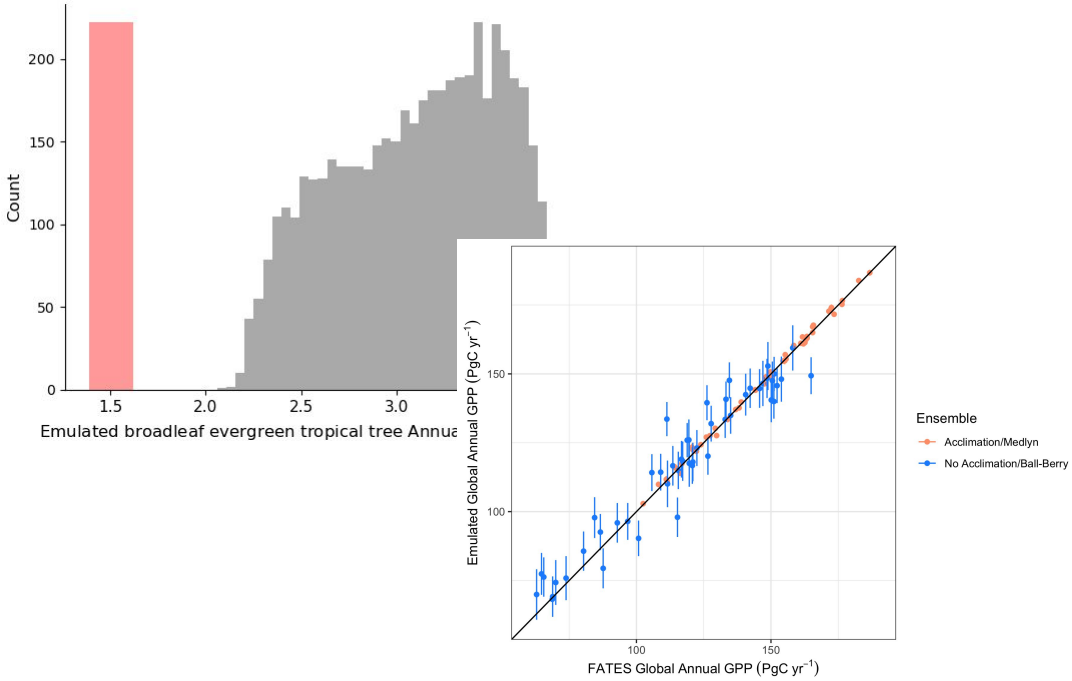
Next steps

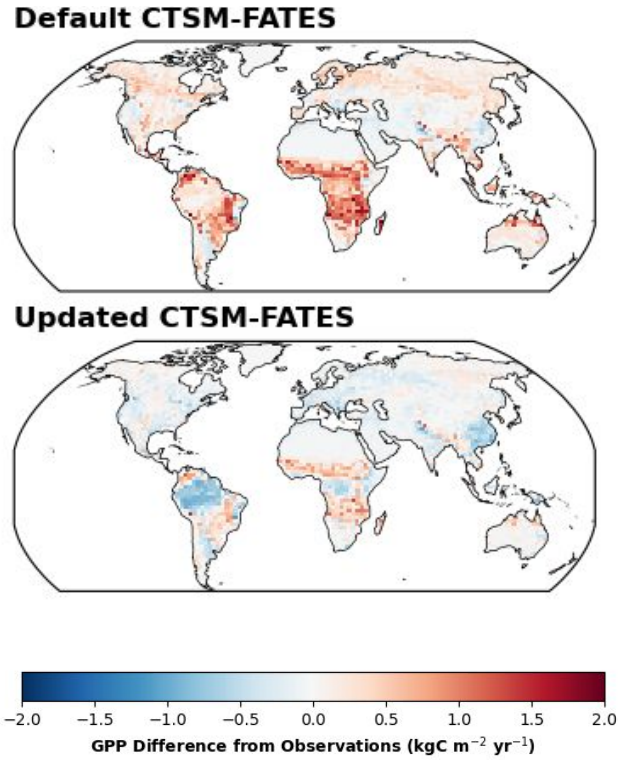
- Re-run LH ensembles with expanded PFT-specific grids for better representability
- Use more output variables to constrain parameter space (e.g., soil moisture, etc.)



Conclusions

- Emulators can be used to uncover structural problems in our models
- Reduced complexity models are useful for calibrating specific model parameters and reducing confounding/interactive factors





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