LEAP

Constraining parametric uncertainty in CLM

Linnia Hawkins
Daniel Kennedy, Katie Dagon,
Dave Lawrence, Pierre Gentine

Parameter Estimation Interest Group
& CLM-PPE community

History Matching

Rule out parameter space that does not match historical observations.

- Gradually constrains parameter space
- Quantifies uncertainty along the way

"Tornado of Stars"
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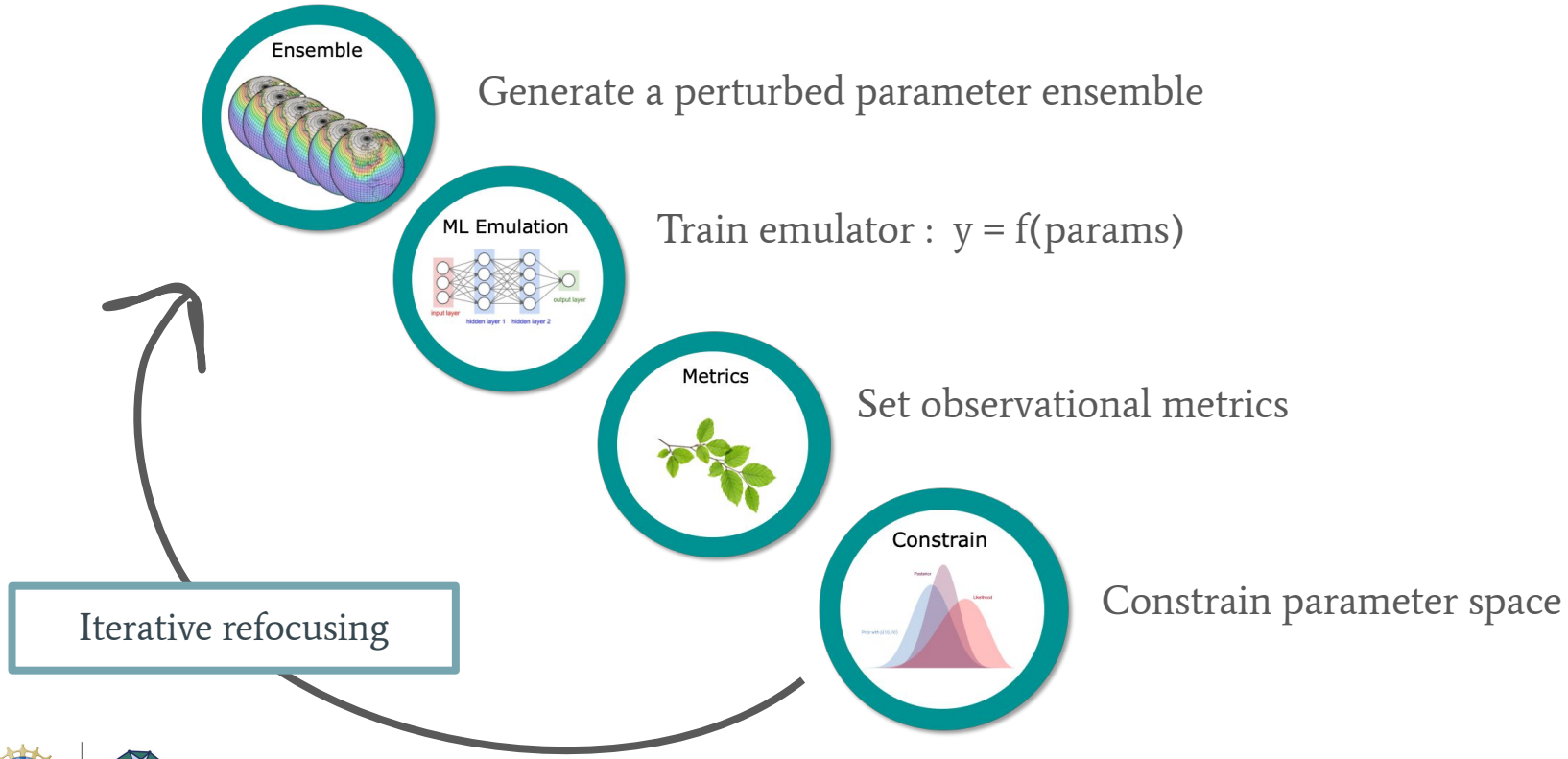
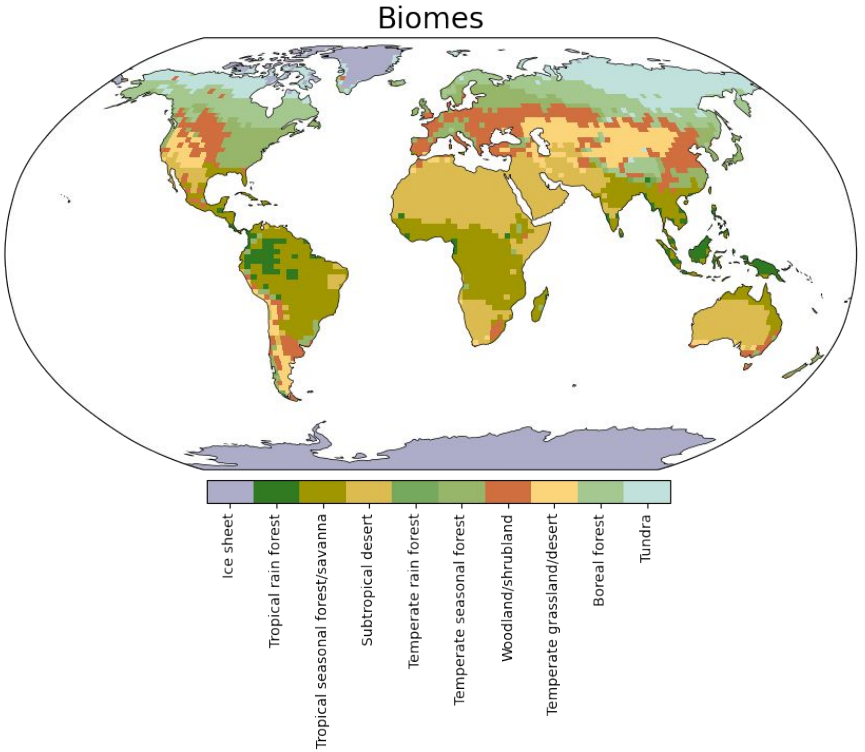
Constraining parametric uncertainty



Challenges

- Error metrics
- Universal & PFT parameters
- Spatial aggregation



Challenges

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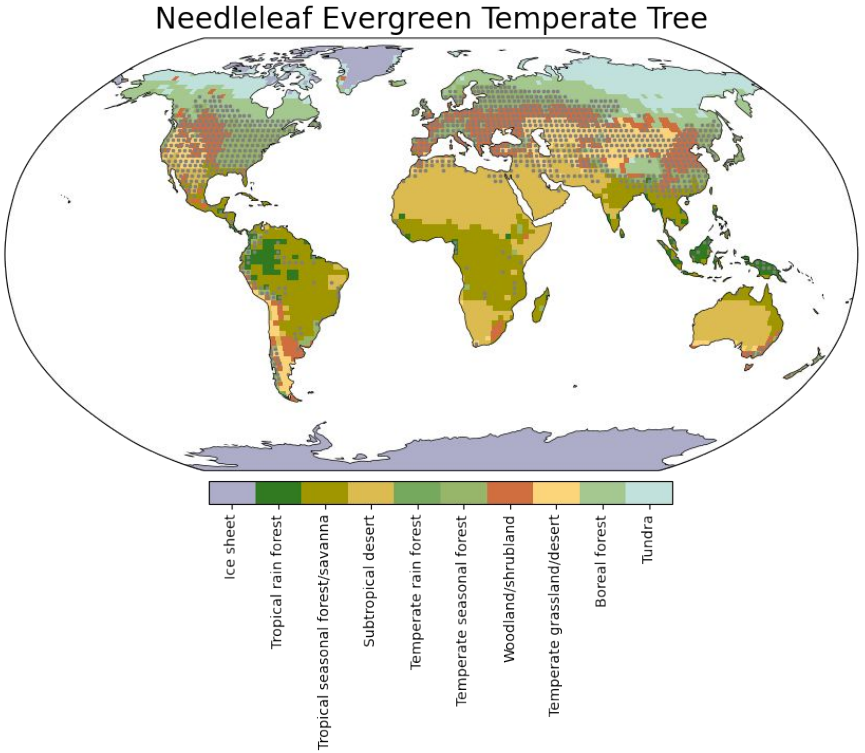
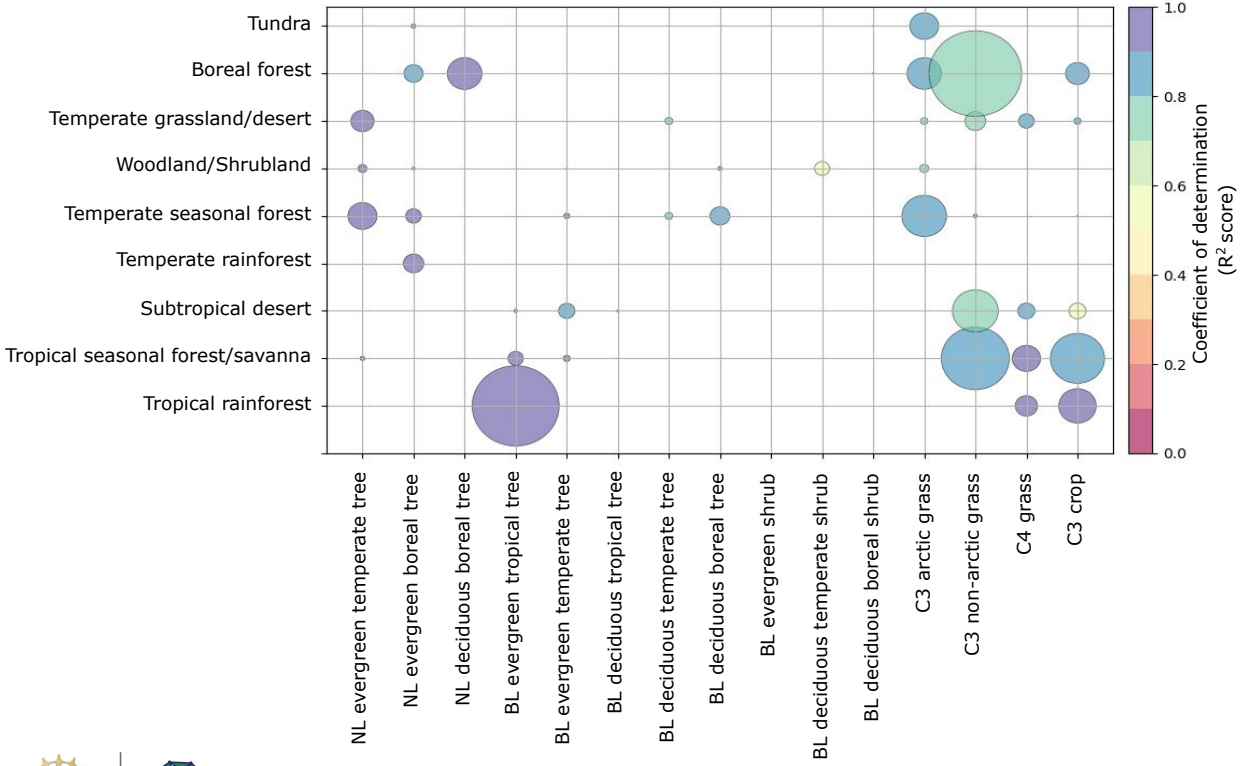
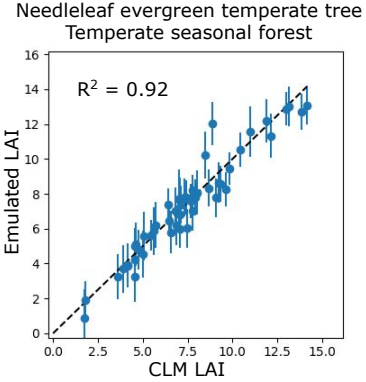
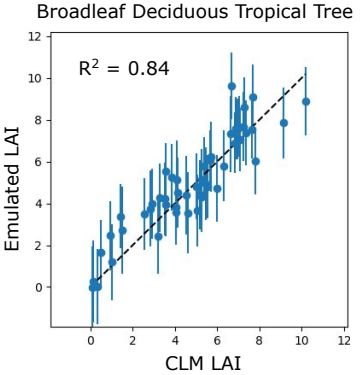


Emulator evaluation

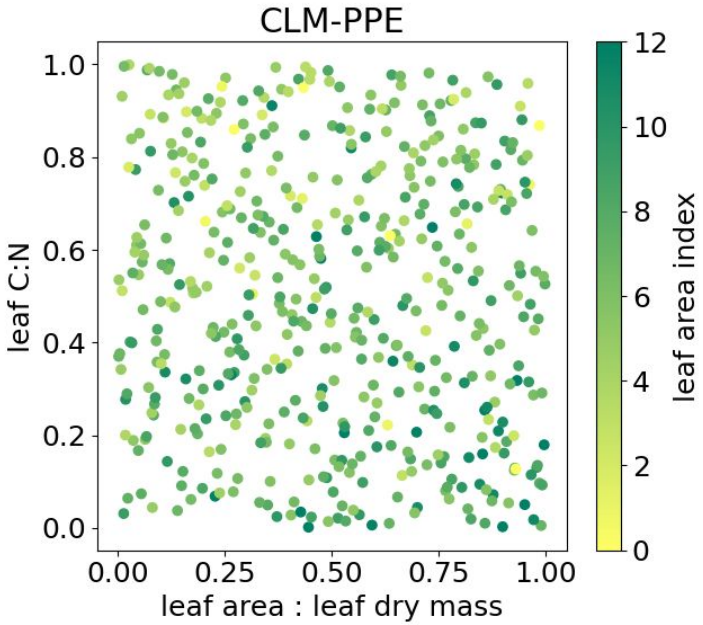






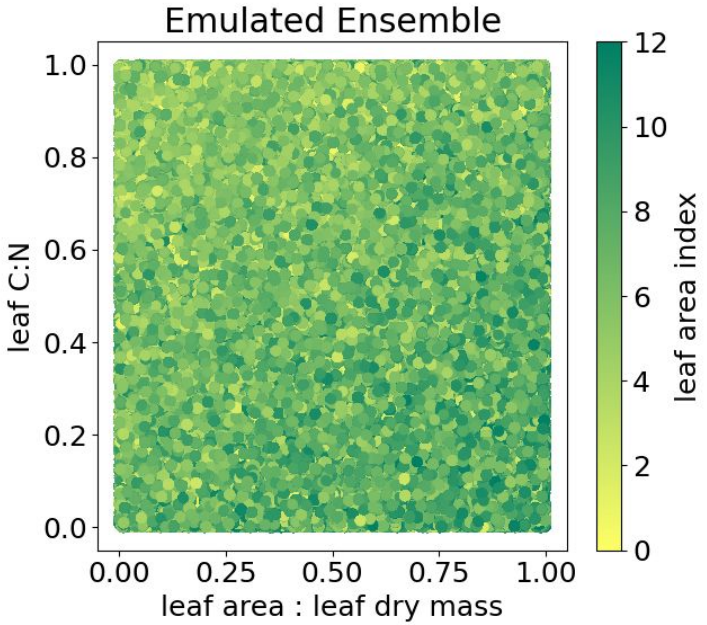
Wave 1: Leaf Area Index

- Initial PPE
  - 32 parameters
  - 500 ensemble members
  - Latin hypercube sampling
  - 150 year simulations (1850-2014)
  - GSWP3 atmospheric forcings



Wave 1: Leaf Area Index

- Initial PPE
- Sample & emulate
  - 10,000,000 new parameter sets

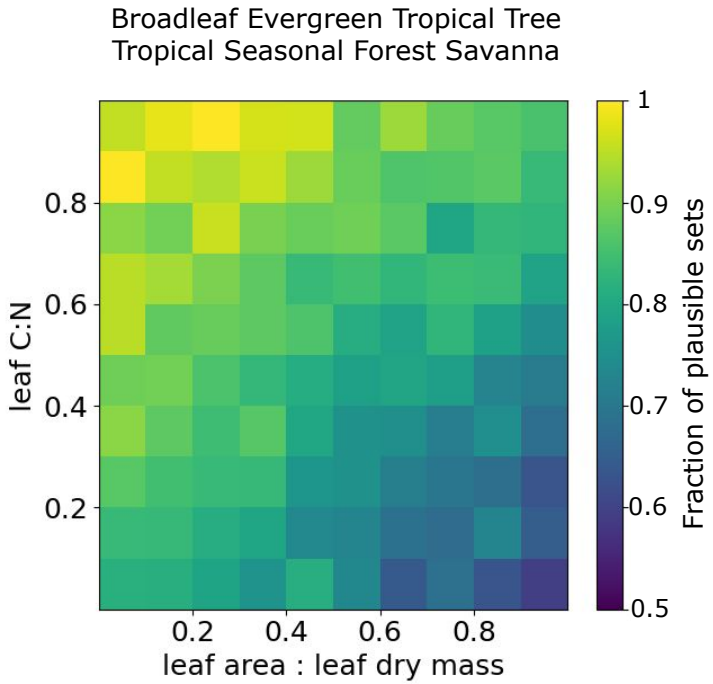


Wave 1: Leaf Area Index

- Initial PPE
- Sample & emulate
- Rule out implausible sets

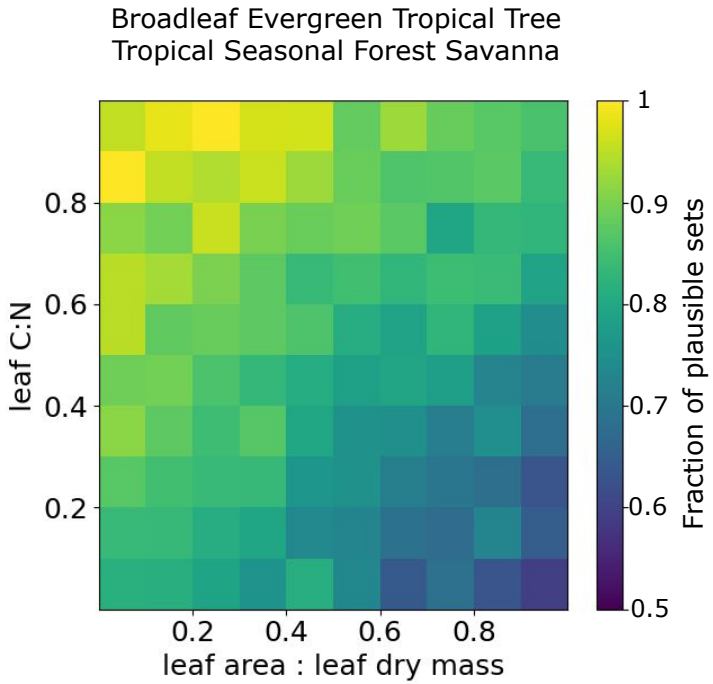
$$Implausibility(x) = \frac{|\ Observation - Emulator(x)\ |}{\sqrt{var(Observations) + var(Emulator)}}$$

$$\{\ x\ :\ I(x)\ <\ 3\ \}$$



Wave 1: Leaf Area Index

- Initial PPE
- Sample & emulate
- Rule out implausible sets
- Sample from plausible sets
  - Reduce emulator uncertainty
  - Close to Latin hypercube



Wave 1: Leaf Area Index

- Initial PPE
- Sample & emulate
- Rule out implausible sets
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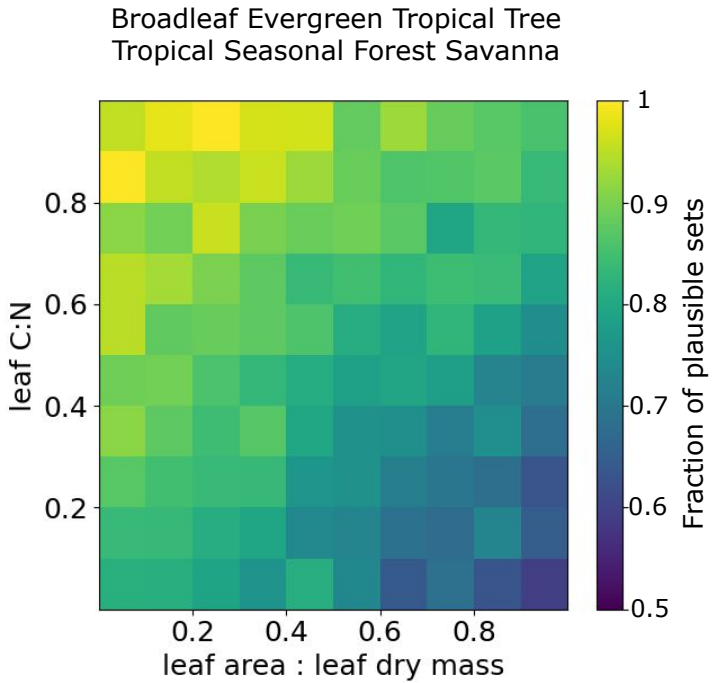
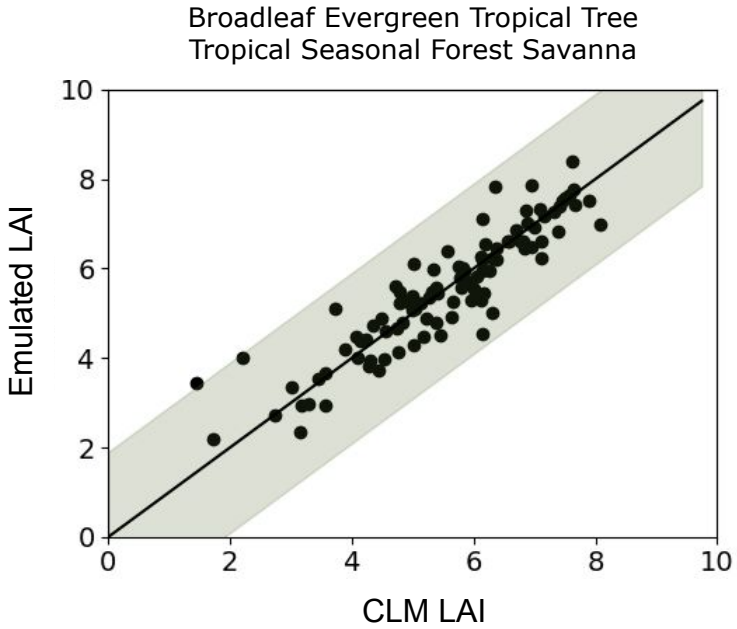
Run a new 100-member ensemble on Derecho!



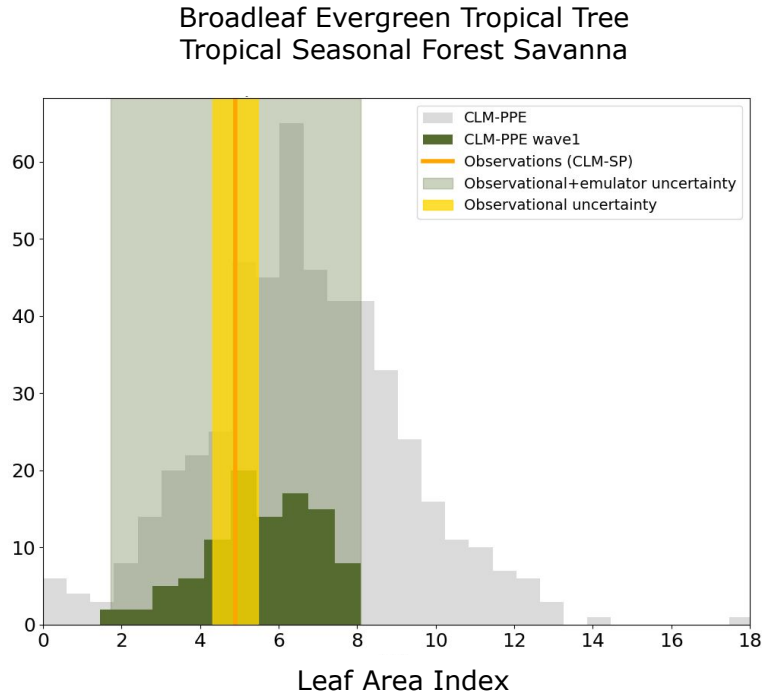
Wave 1 results

- How did our emulators do?



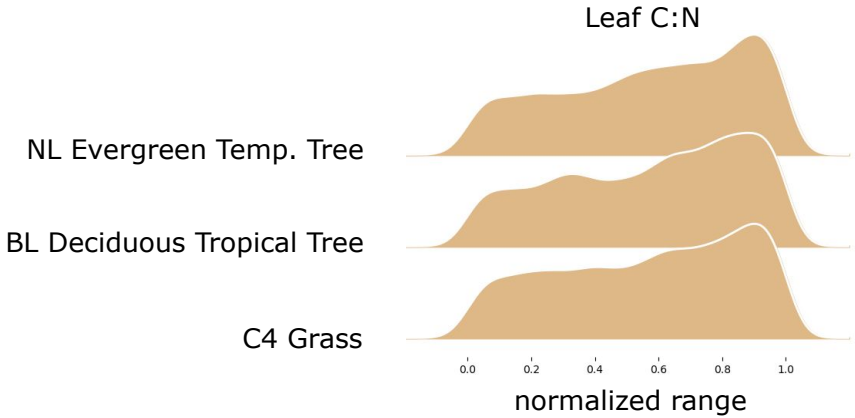
Wave 1 results

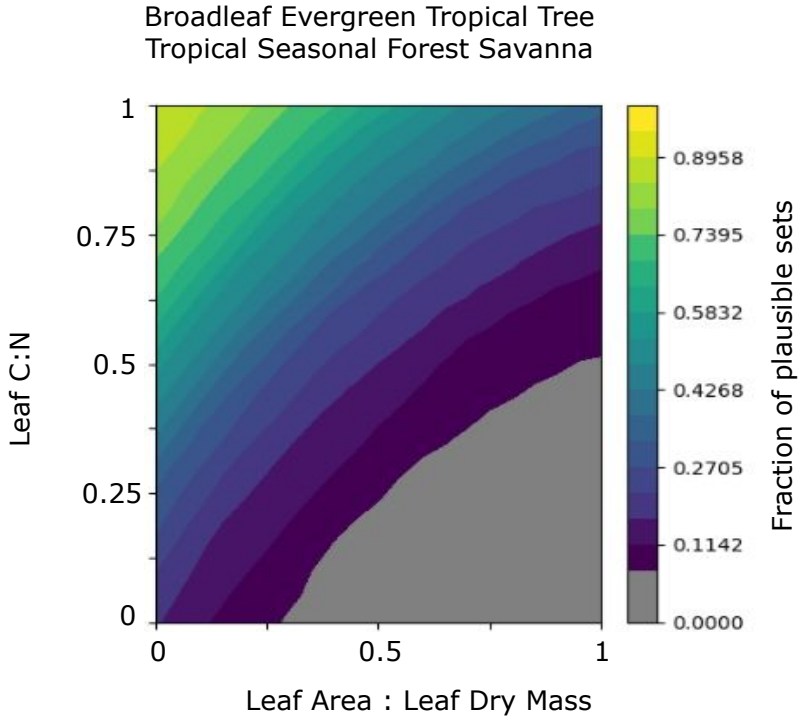
- How did our emulators do?
- Did we improve LAI?



Wave 1 results

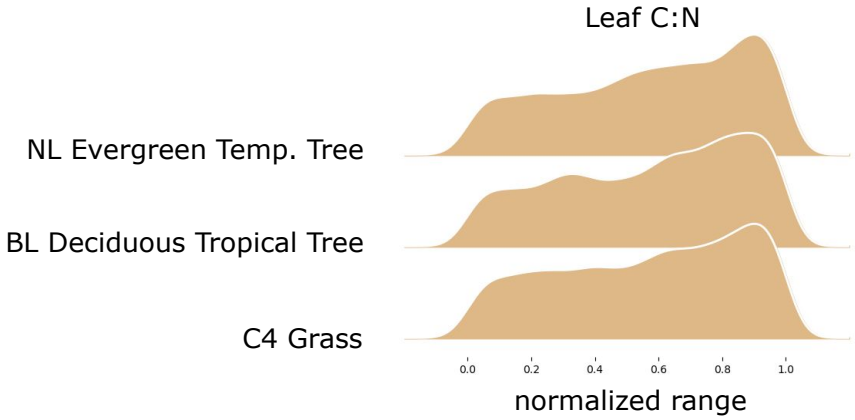
- How did our emulators do?
- Did we improve LAI?
- Did we constrain the parameter space?

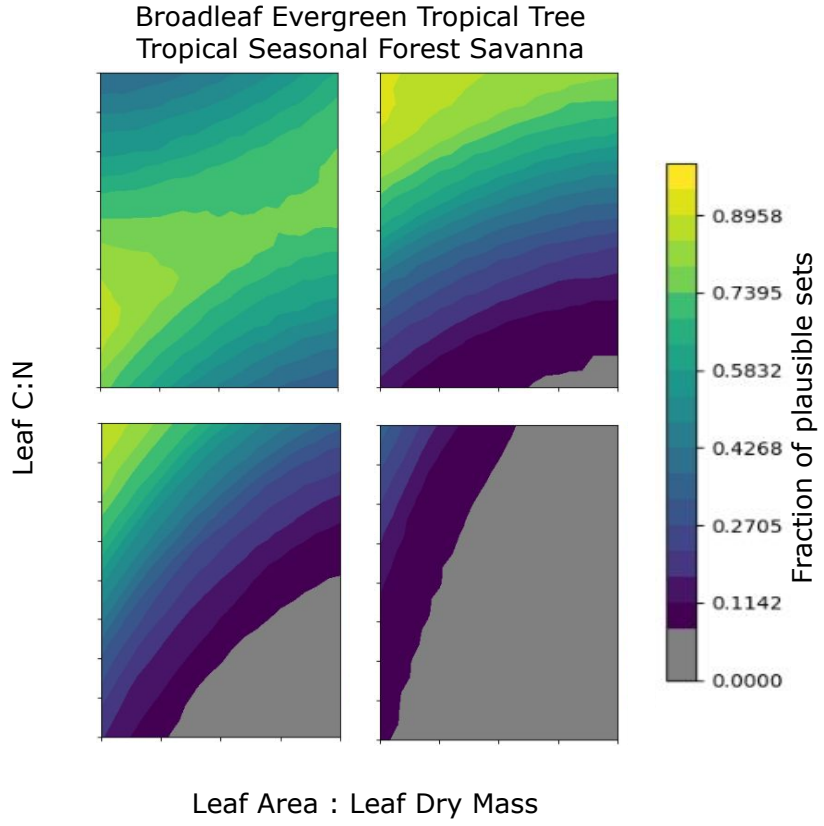




Wave 1 results

- How did our emulators do?
- Are results within the plausible space?
- Did we constrain the parameter space?





Where are we headed?

More waves of history matching

- Introduce additional constraints

Then what?

- Bayesian optimization
- Resample from constrained space
  - Span emergent behavior

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