



Regional carbon cycle simulations of pine-plantations using the Community Land

Model

R. Quinn Thomas & Ben Ahlswede

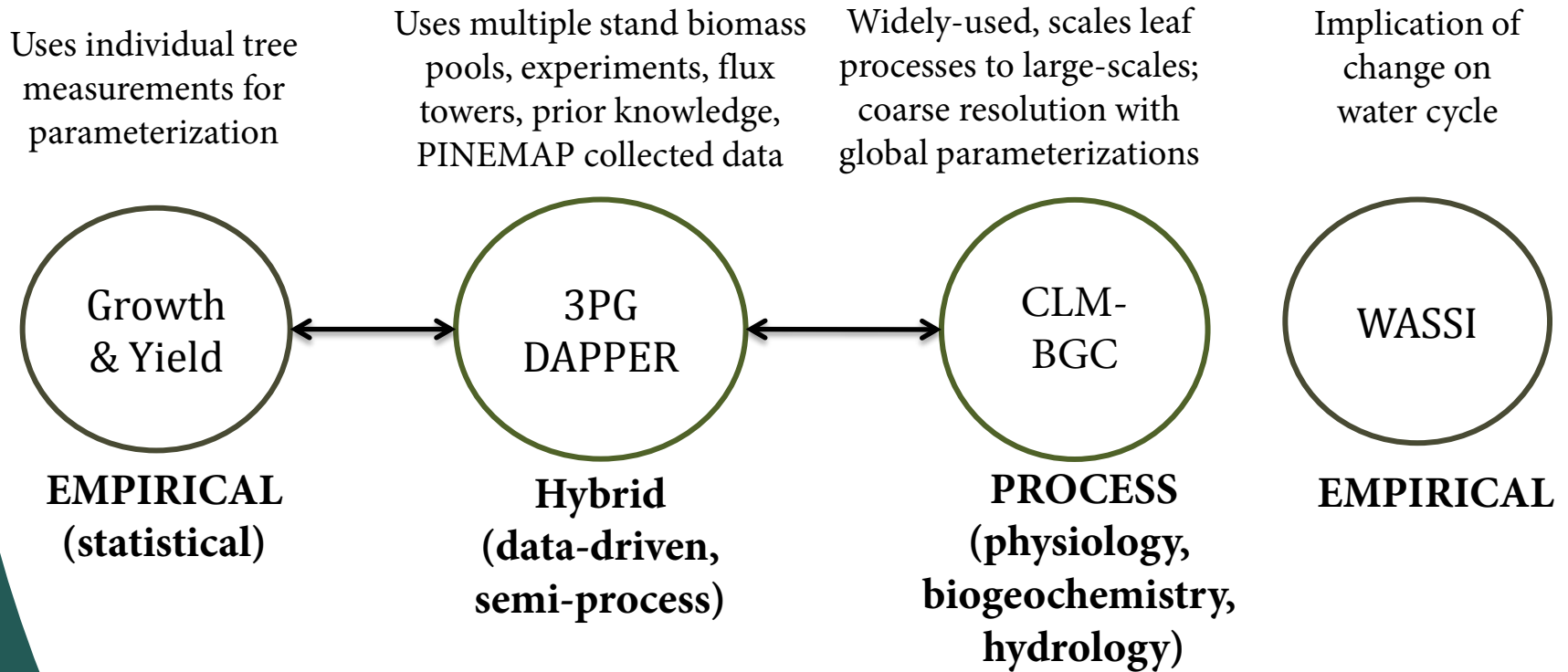
Evan Brooks & Randy Wynne

Virginia Tech



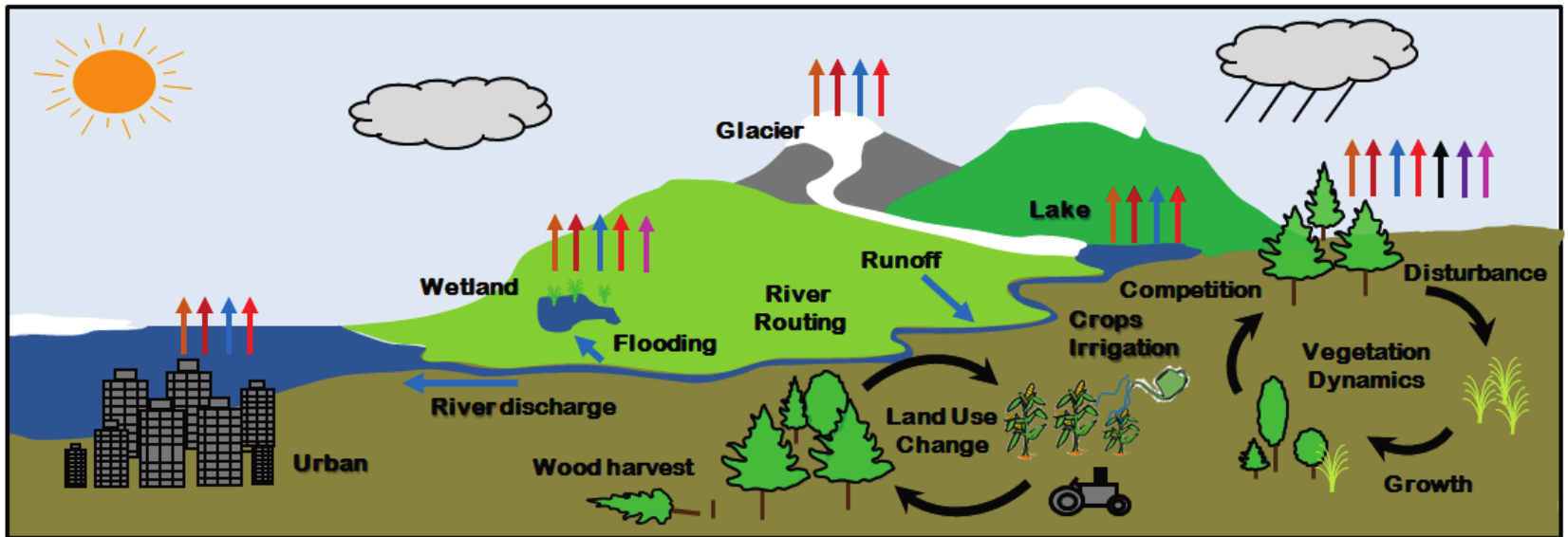
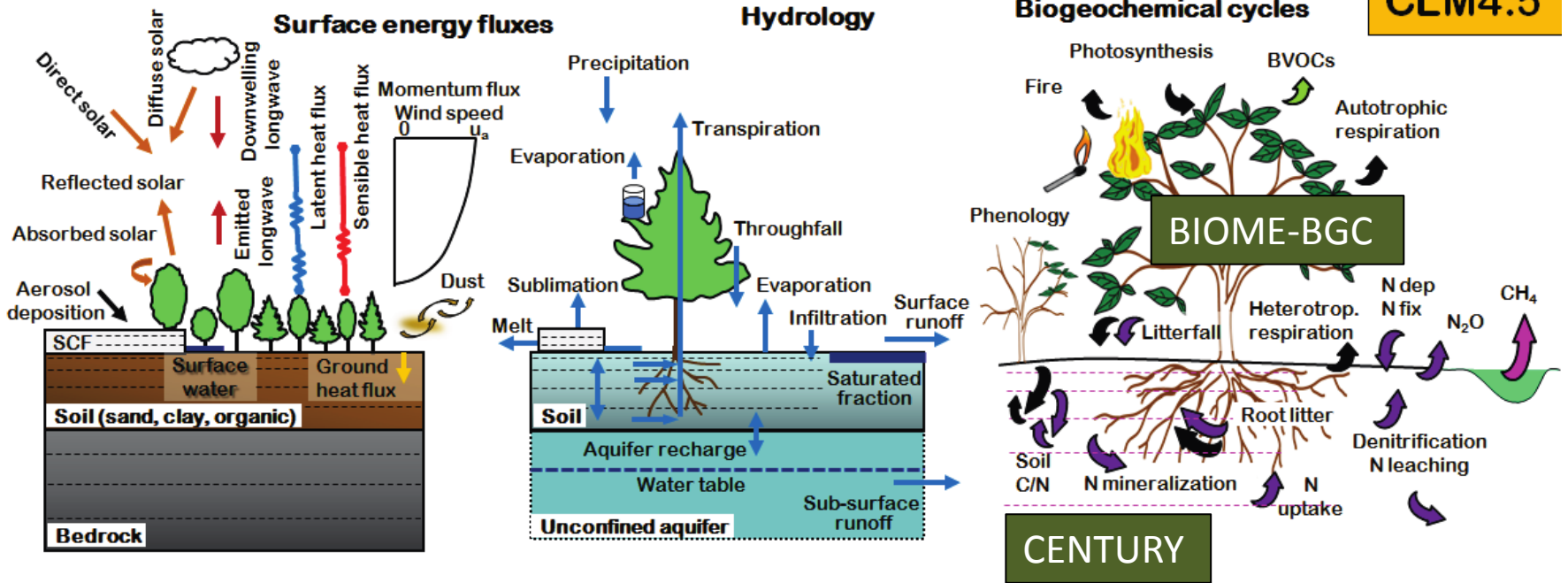
Overview

How are productivity, carbon storage, and water cycling going to change over the 21st century?



Community Land Model

CLM4.5





Overview

Regional Models

	3PG	G&Y	CLM-BGC 4.5
Basic Operating Level	Stand (HUC)	Stand (HUC)	Grid-cell (1° x 1°)
Inputs			
<i>Climate</i>	MACA (20 models), two scenarios	MACA (20 models), two scenarios	CCSM4 (1 model), two scenarios
<i>Soil</i>	SSURGO	SSURGO	IGBP global soils map
<i>Site Index</i>	Sabatia & Burkhart 2014	Sabatia & Burkhart 2014	--
<i>Other</i>	Species parameters	--	Plant functional type parameters



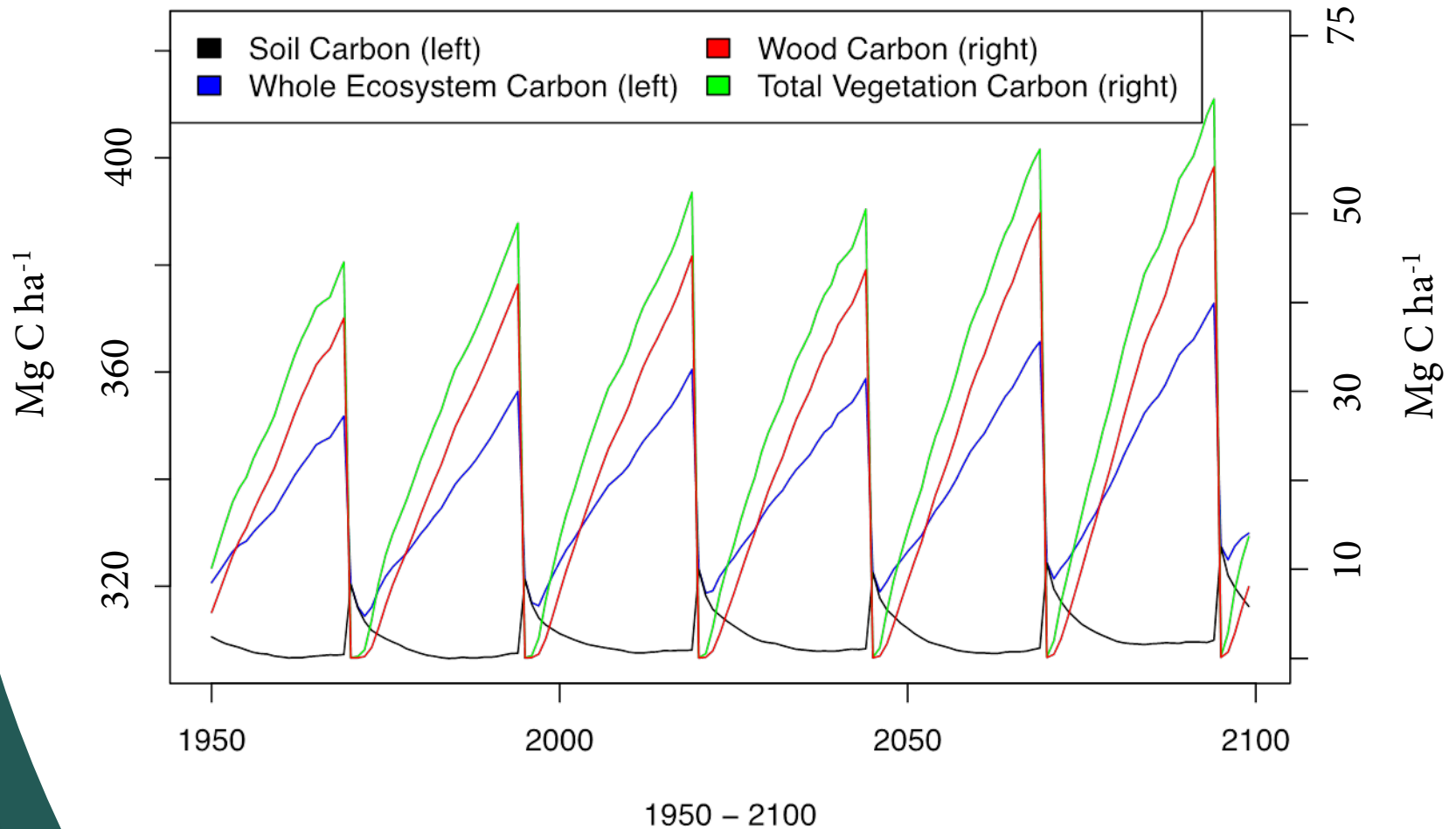
Simulation description

- Full PINEMAP region
- 1° x 1° degree resolution (~100 km)
- 1945 to 2100 simulation using RCP 8.5
- Climate data from CESM (not down-scaled)
- 100% of each grid-cell is pine
- Region-wide harvest every 25 years followed by replanting (starting in 1970).
- Focus on simulating a plantation forest in each grid cell.



Region-wide means (stocks)

Carbon Stocks

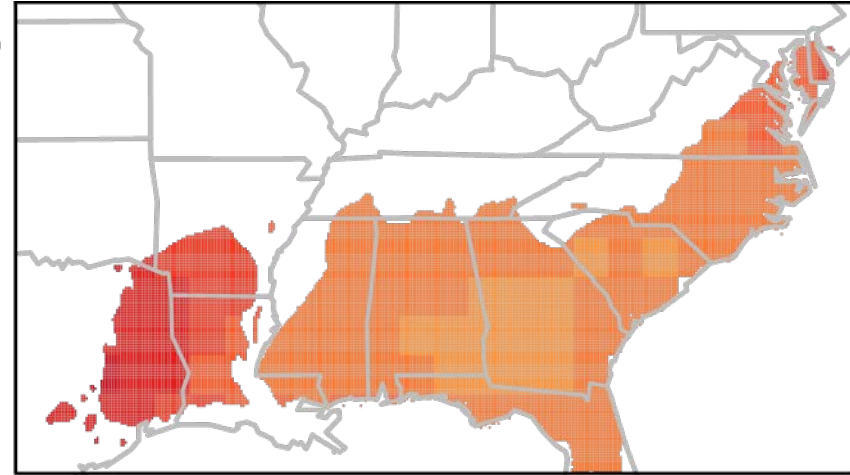
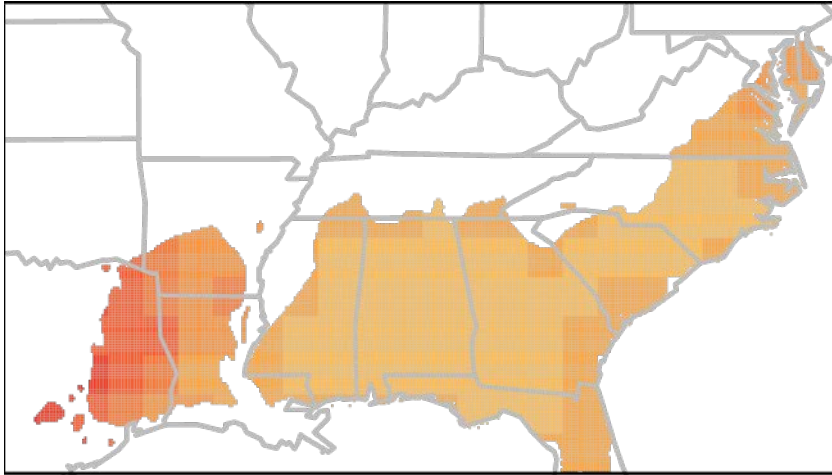




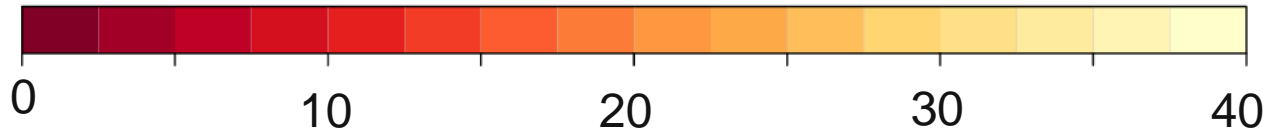
Photosynthesis (Gross Primary Productivity)

1970-1994 (Mean)

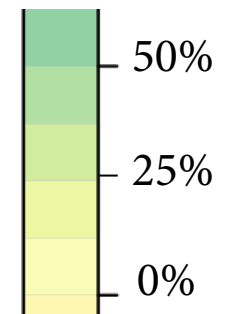
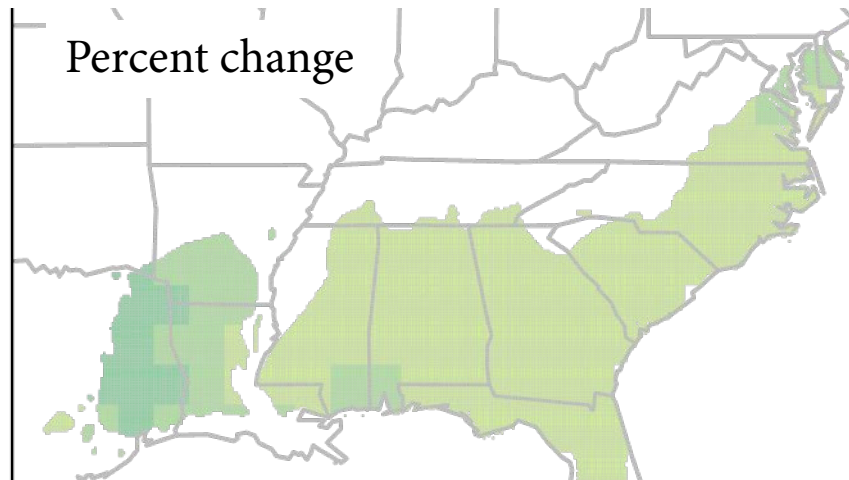
RCP 8.5 2070-1994 (Mean)



Mg C ha yr⁻¹



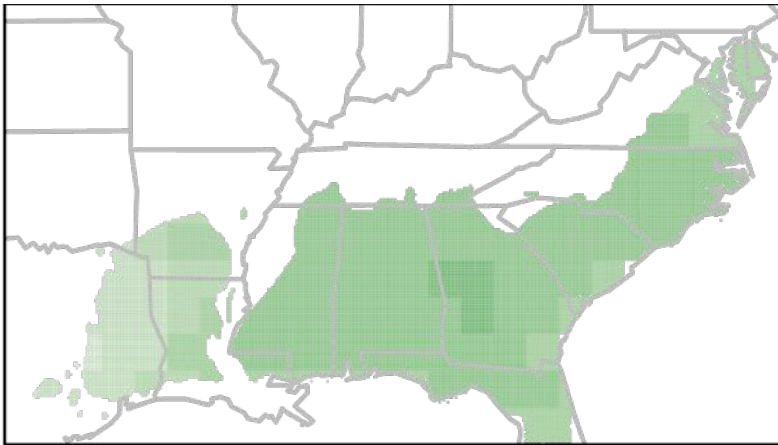
Percent change



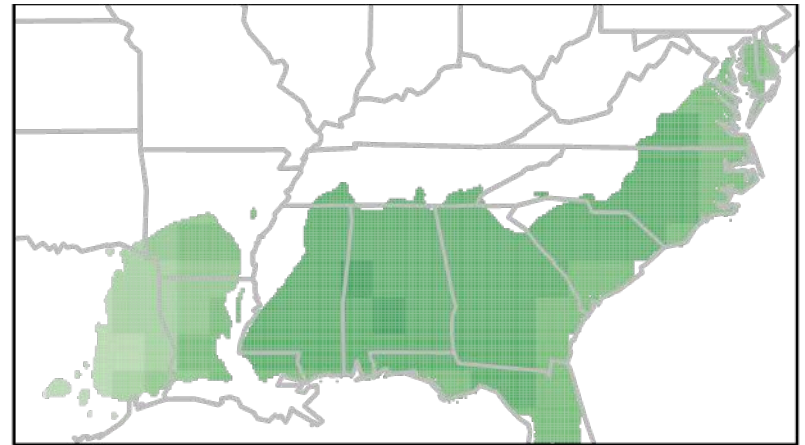


Stem Biomass (Age 25)

1994



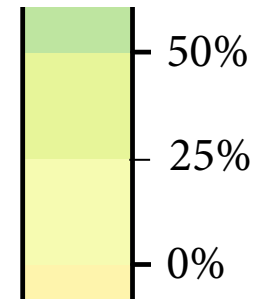
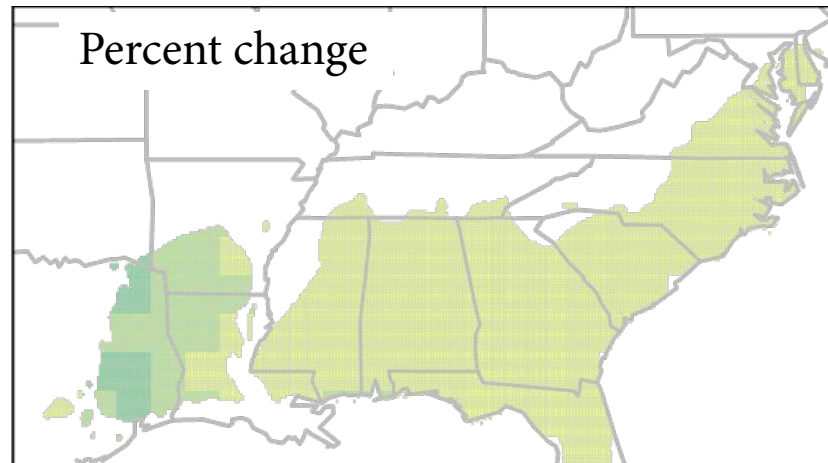
RCP 8.5 2095



Stem Biomass
Mg Biomass ha⁻¹

0 35 70 105 140 175

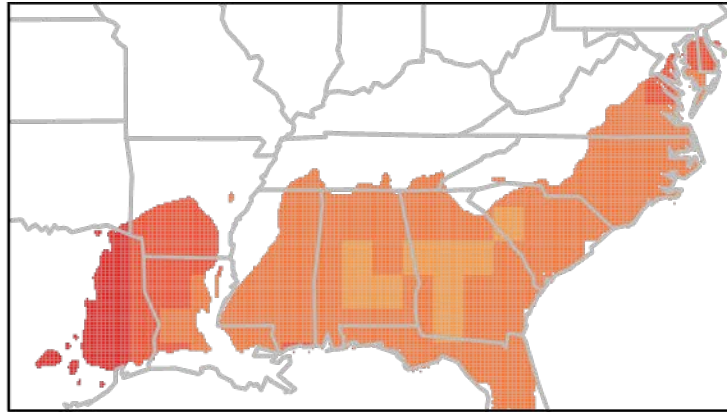
Percent change



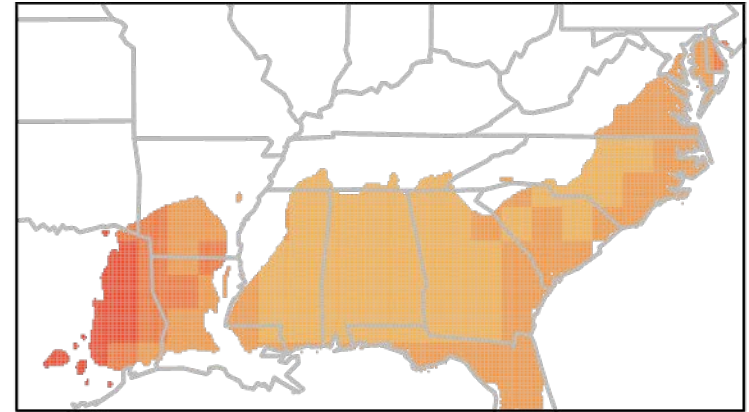


Net Ecosystem Production

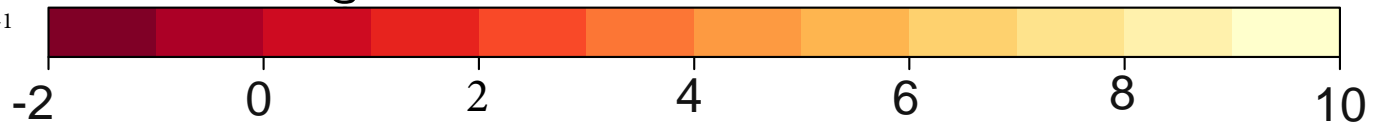
1970-1995 (Mean)



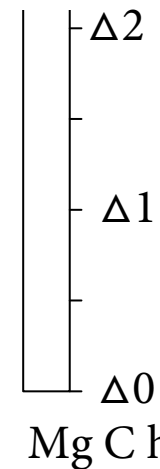
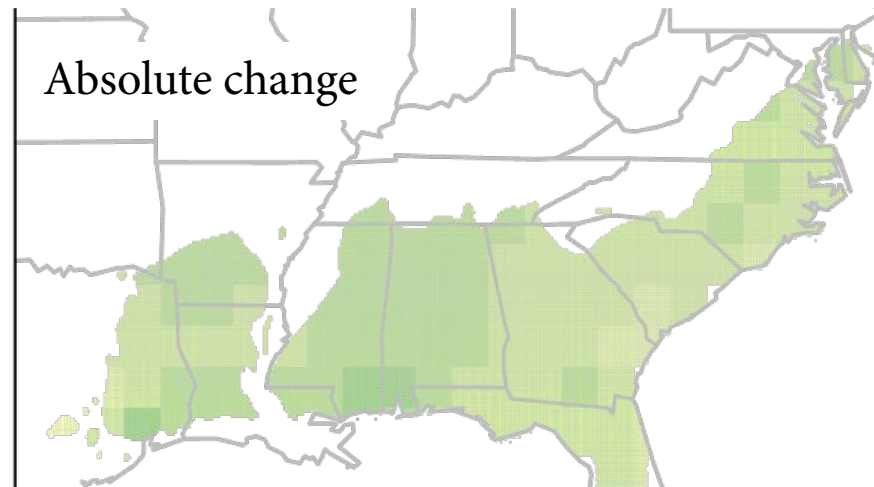
RCP 8.5 2070-2095 (Mean)



Mg Carbon $\text{ha}^{-1} \text{yr}^{-1}$



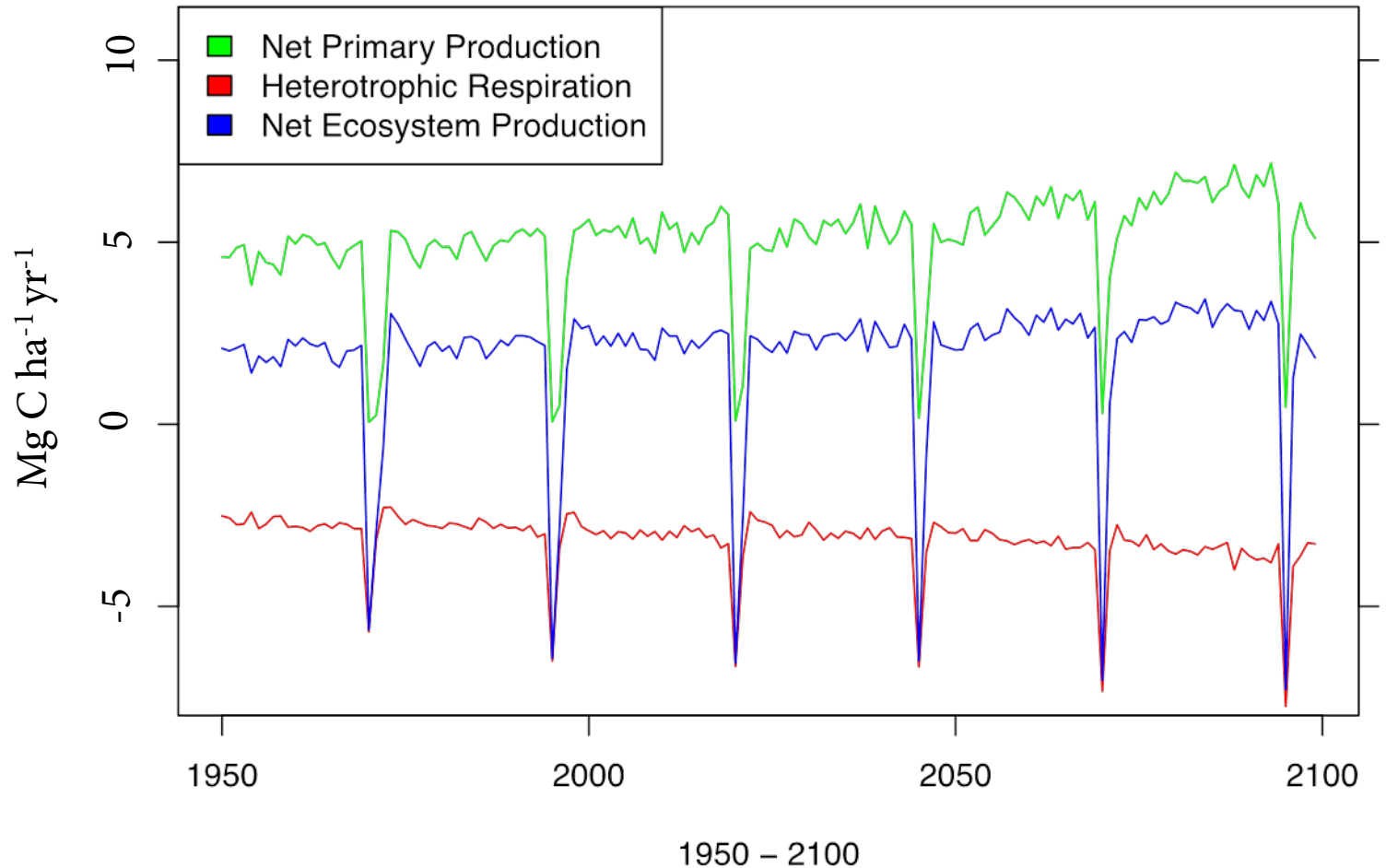
Absolute change





Region-wide means (fluxes)

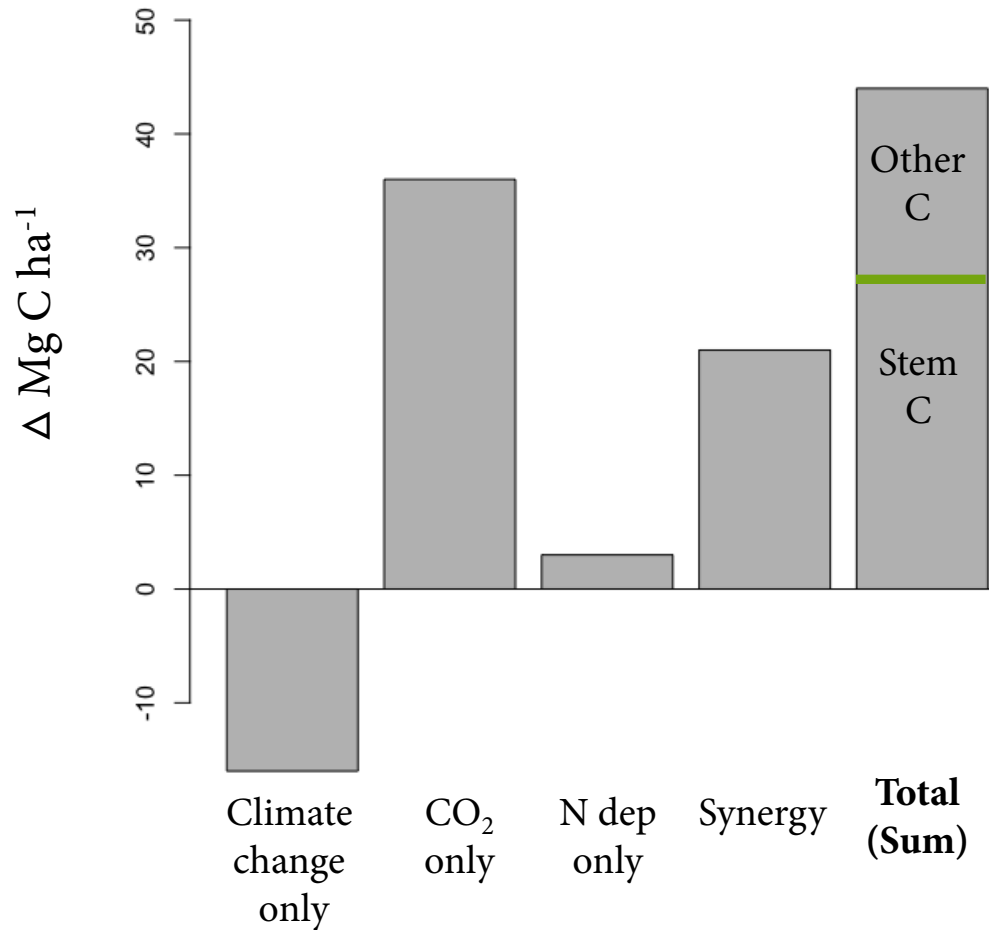
Carbon Fluxes





Drivers of net Δ carbon storage

Δ Total ecosystem carbon
RCP 8.5 (2095-1994)





Conclusions

- Physiological and biogeochemical process model at coarse resolution (includes nutrient limitation)
- Region-wide mean 43% increase in stem biomass between 1994 and 2094.
- $\sim 1 \text{ Mg ha}^{-1} \text{ yr}^{-1}$ increase in NEP
- Rising alone atmospheric CO₂ increases growth rates but climate change alone decreases growth rates
- Important positive synergy between climate change and atmospheric CO₂
- Growth change: G&Y > 3PG > CLM

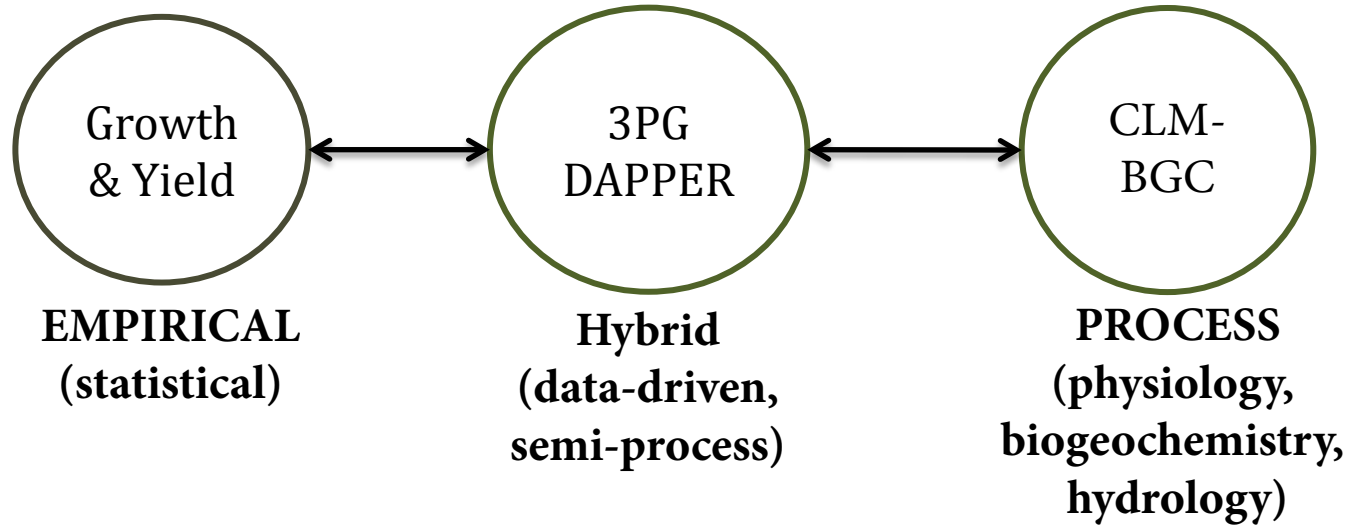


Intercomparison of results (Preliminary!)

Uses individual tree measurements for parameterization

Uses multiple stand biomass pools, experiments, flux towers, prior knowledge, PINEMAP collected data

Widely-used, scales leaf processes to large-scales; coarse resolution with global parameterizations





Intercomparison of results (Preliminary!)

Stem Biomass
% Change
RCP 8.5

