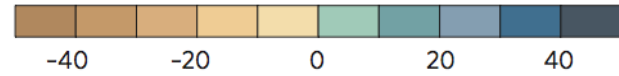
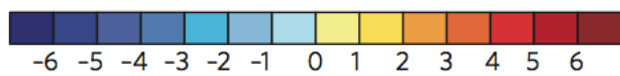
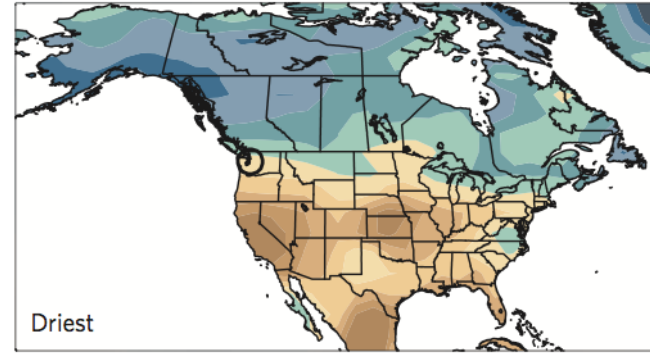
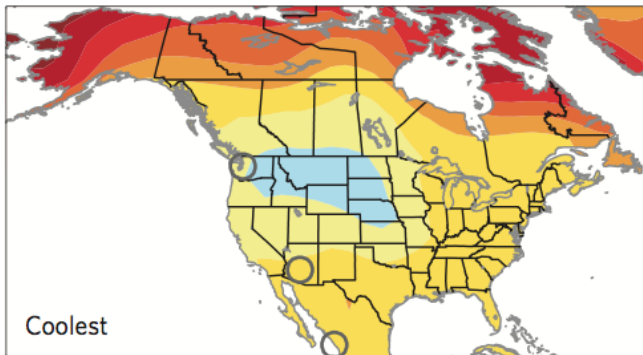
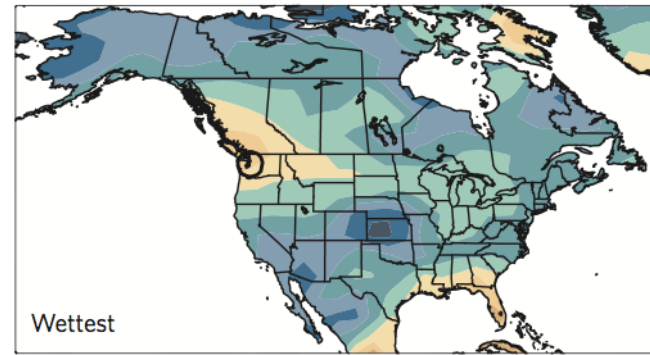
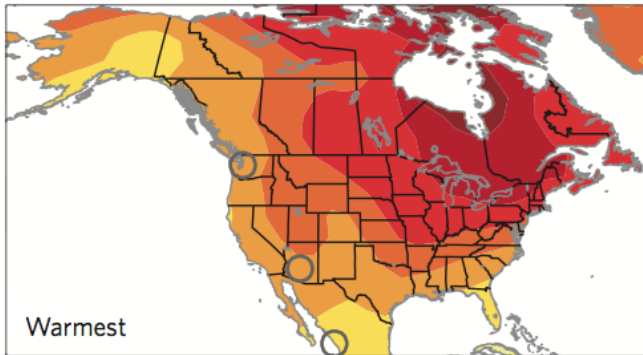


# Ecosystem Carbon Variability in the CCSM 4.0 Ensemble

Danica Lombardozzi, Gordon Bonan, & Doug Nychka  
National Center for Atmospheric Research



# The same model with different initial climate conditions



Temperature trend ( $^{\circ}\text{C}$  per 55 years)

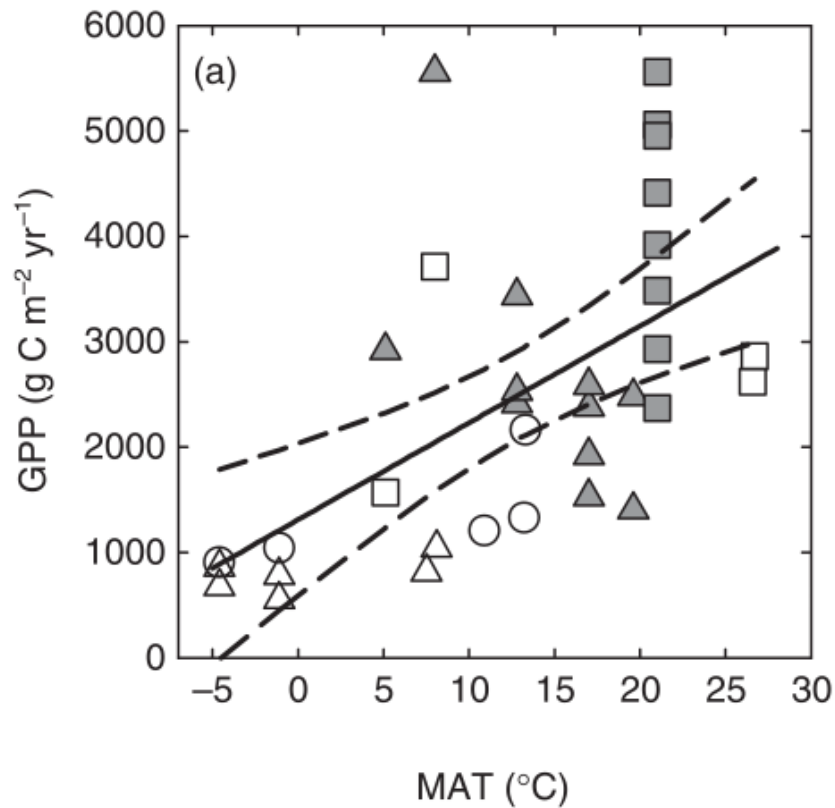
Precipitation trend (% per 55 years)



Why does this matter for the C cycle?

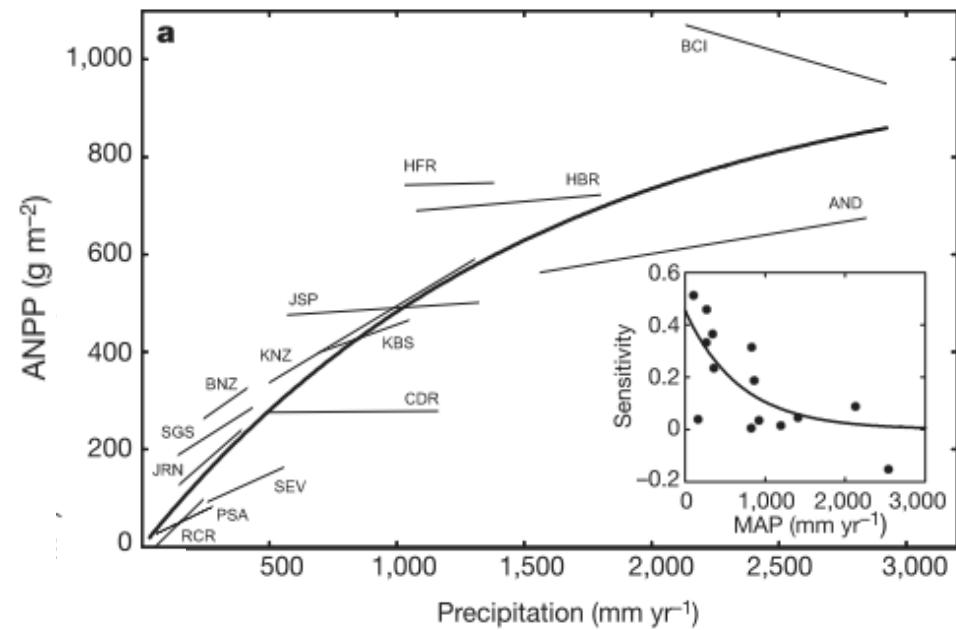


## Carbon gain responses to Temperature (Trees)



Litton et al. 2008. *Functional Ecology*

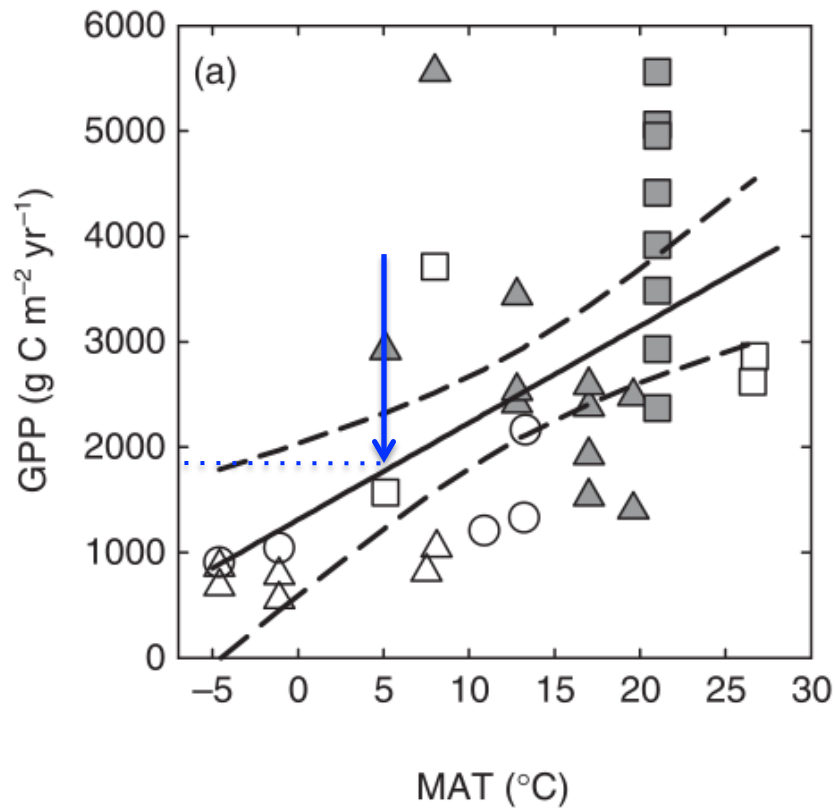
## Carbon gain responses to Precipitation (Multiple Biomes)



Huxman et al. 2004. *Nature*

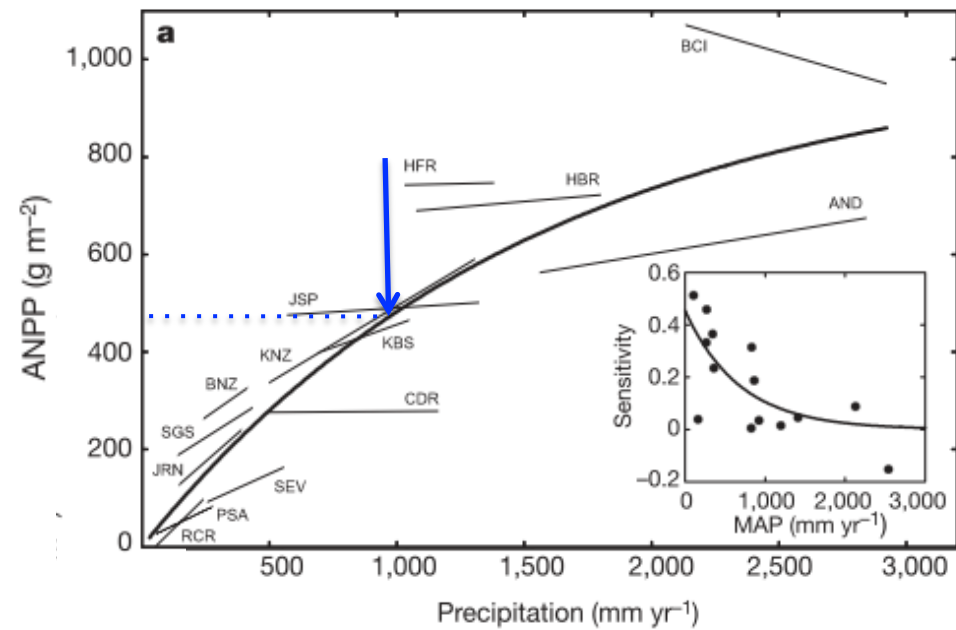


## Carbon gain responses to Temperature (Trees)



Litton et al. 2008. *Functional Ecology*

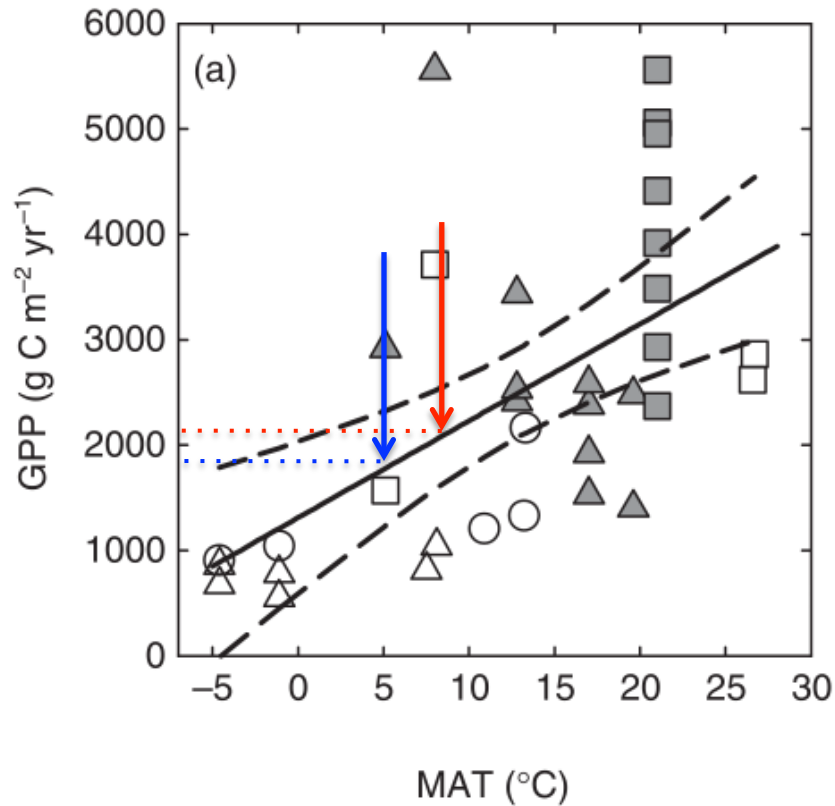
## Carbon gain responses to Precipitation (Multiple Biomes)



Huxman et al. 2004. *Nature*

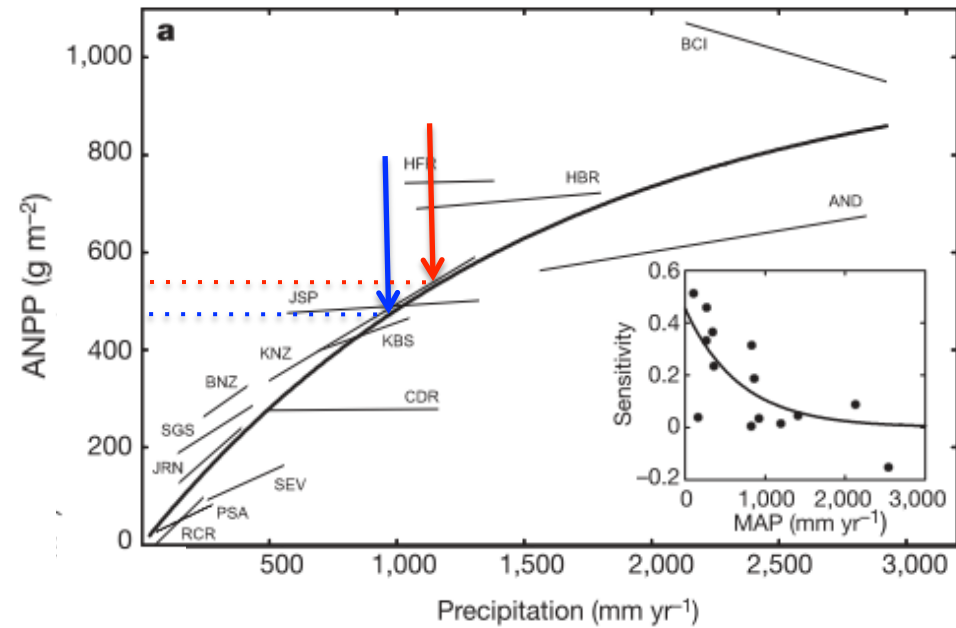


## Carbon gain responses to Temperature (Trees)



Litton et al. 2008. *Functional Ecology*

## Carbon gain responses to Precipitation (Multiple Biomes)



Huxman et al. 2004. *Nature*



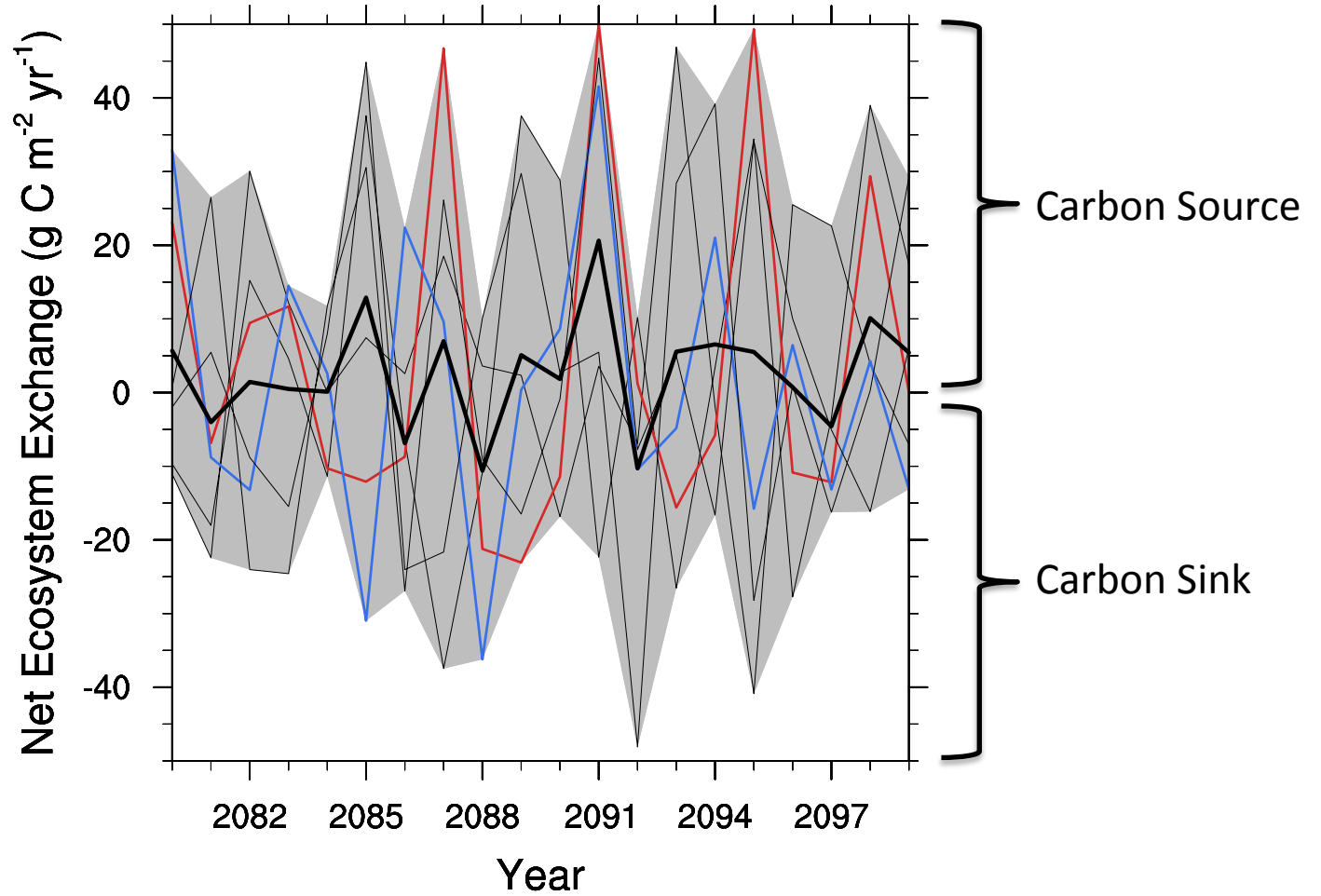
A photograph of a dirt path winding through a lush green forest. The path is made of dark soil and gravel, leading into the distance. The forest is dense with tall trees and thick undergrowth, including various green plants and shrubs. The lighting is bright, suggesting a sunny day. A semi-transparent white box is overlaid on the upper portion of the image, containing the text.

What is the magnitude of  
variability in ecosystem C fluxes?



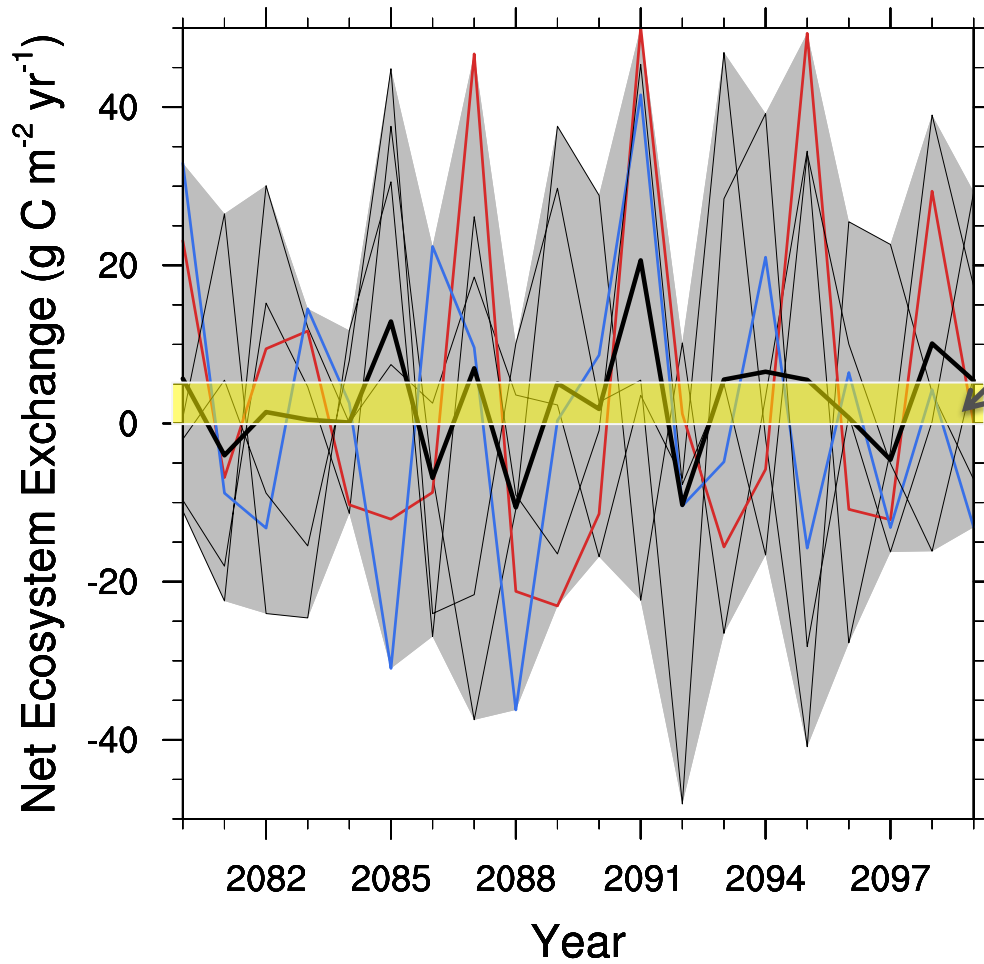
# North America

RCP 8.5, 6-member Ensemble Mean



# North America

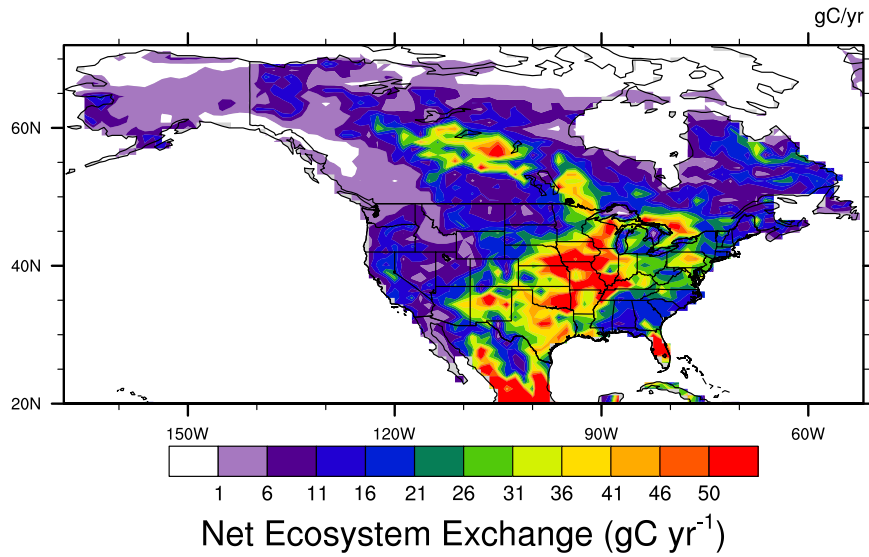
RCP 8.5, 6-member Ensemble Mean



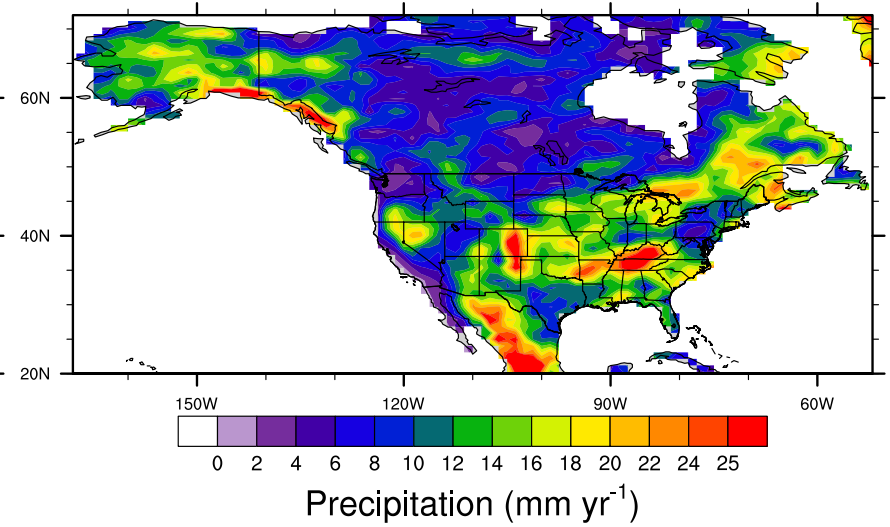
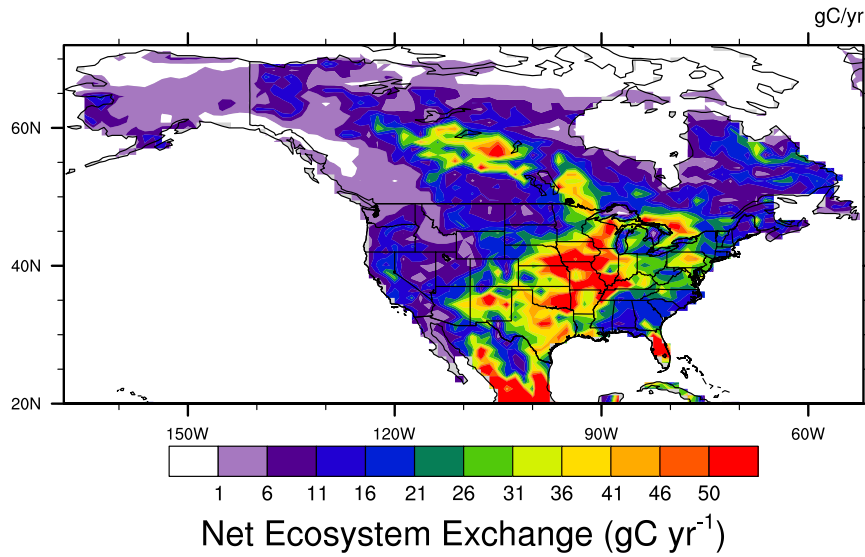
Range of variability  
when ensembles are  
averaged over this  
20-year time period.



# Summer (JJA) Standard Deviation of Ensemble Mean

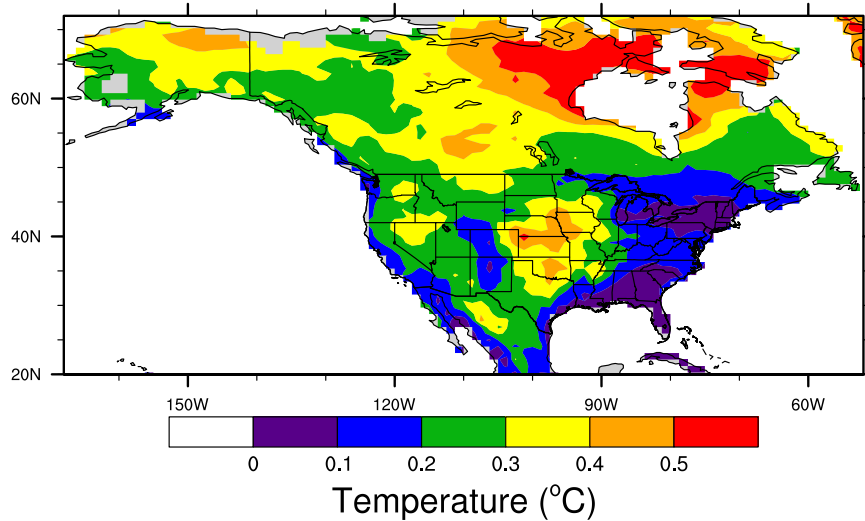
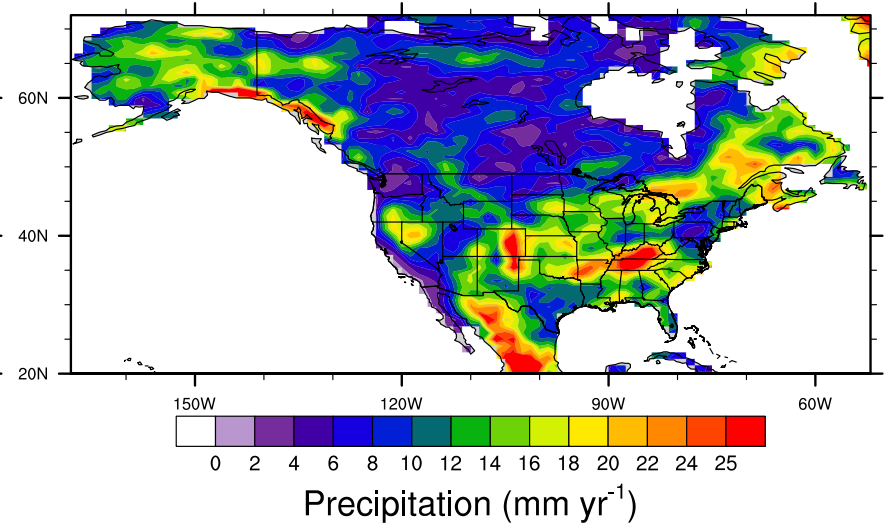
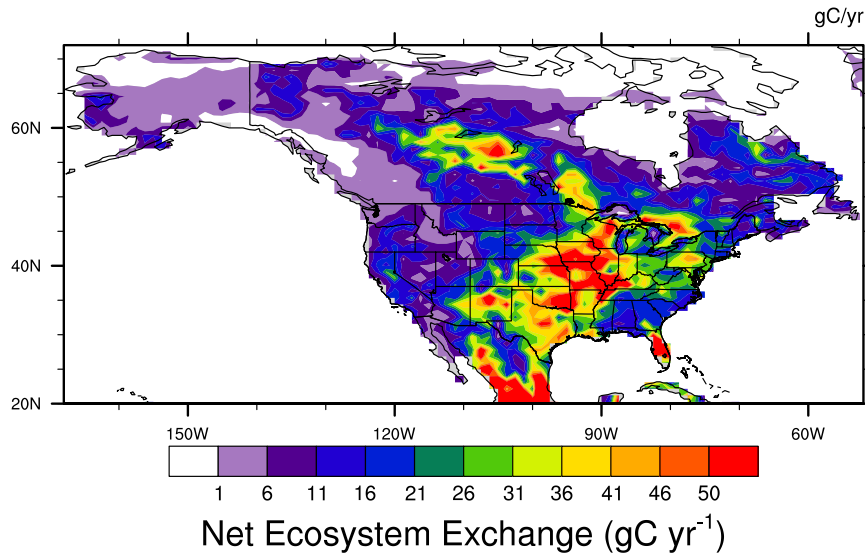


# Summer (JJA) Standard Deviation of Ensemble Mean

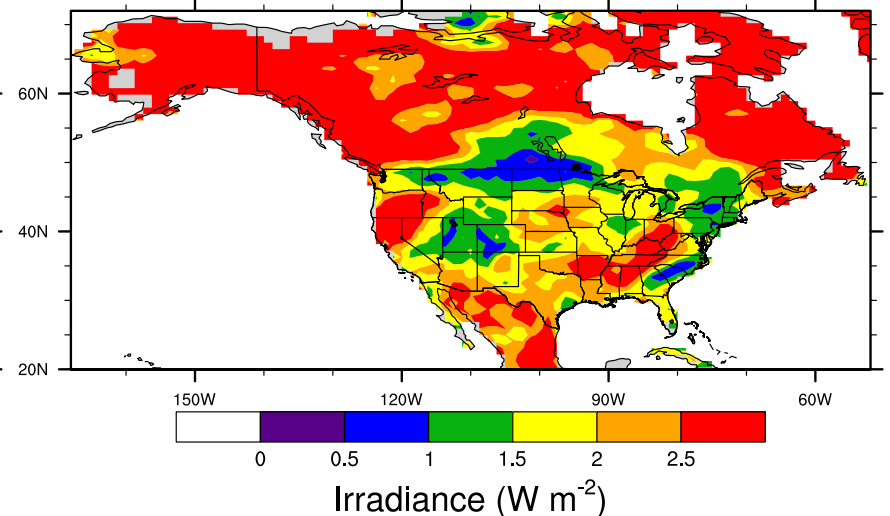
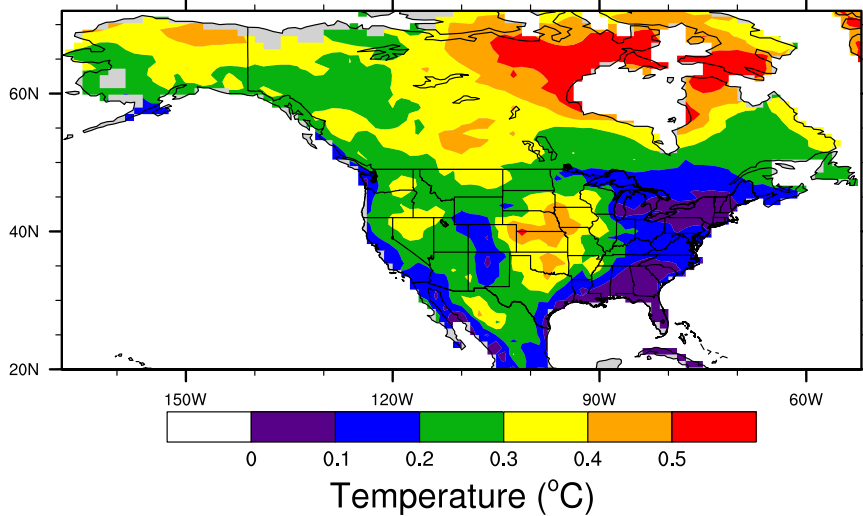
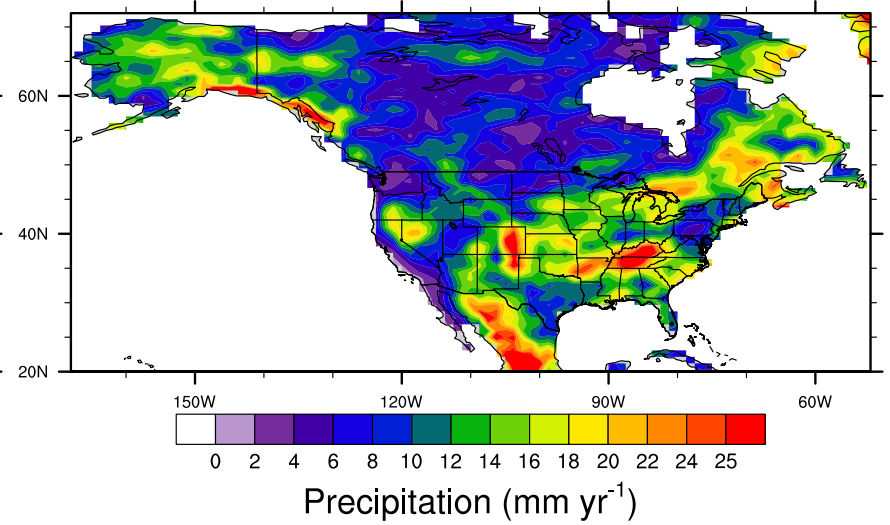
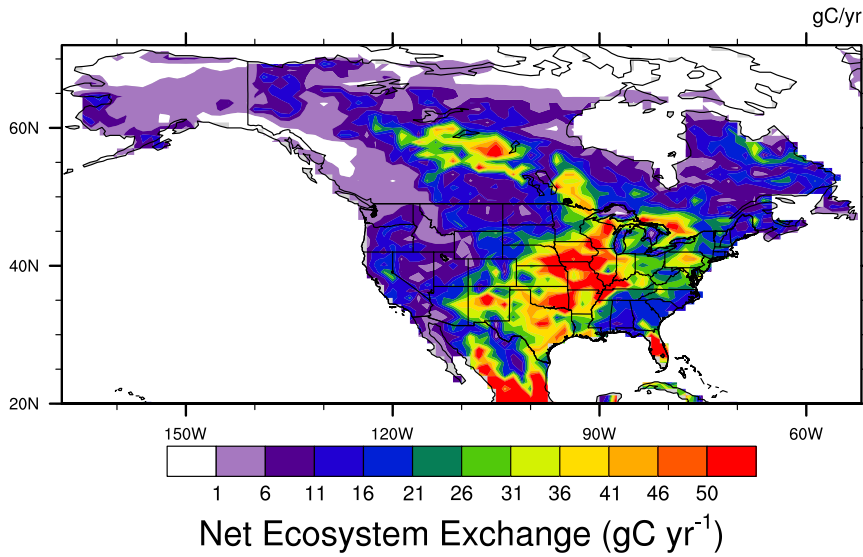




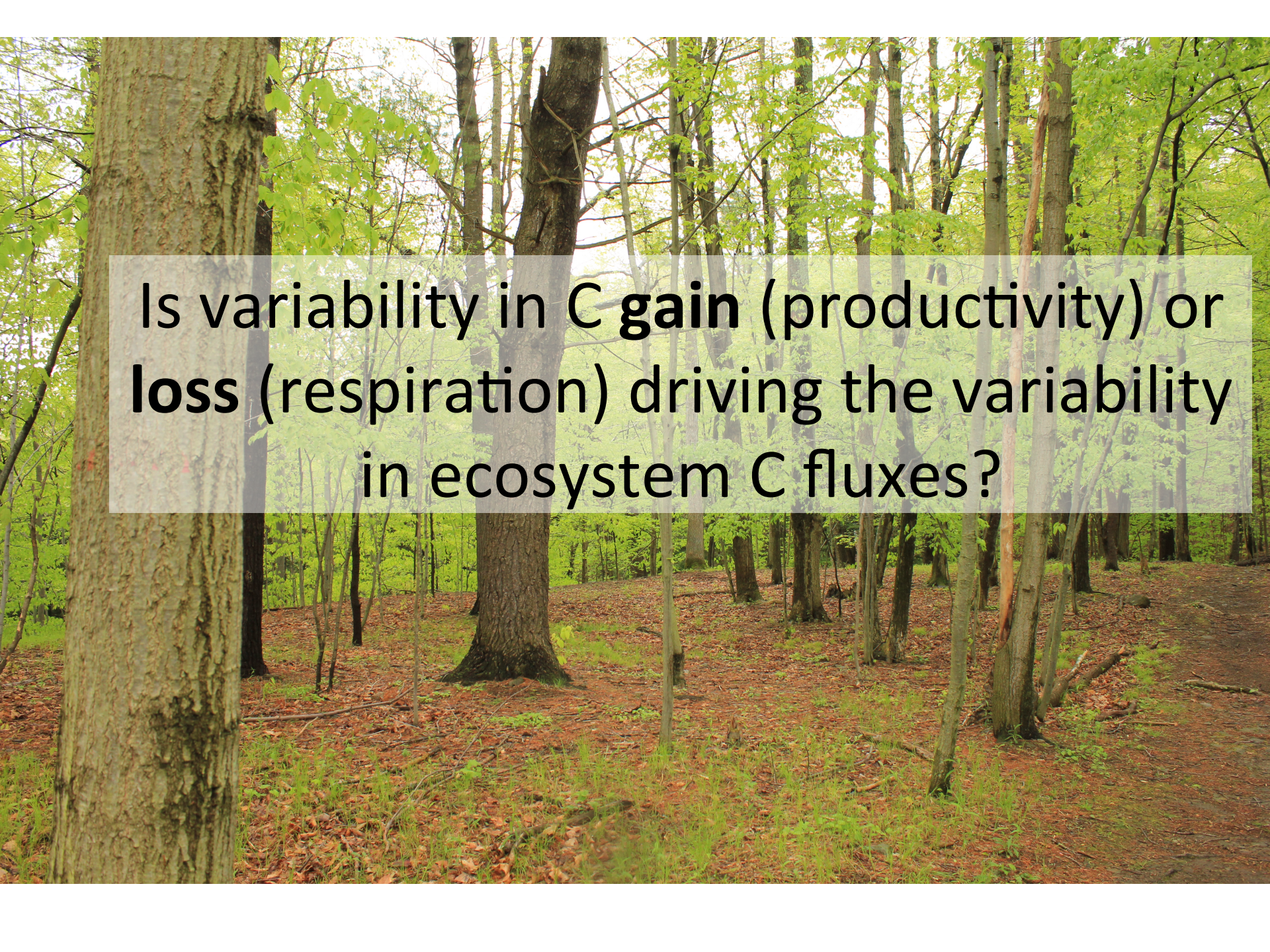
# Summer (JJA) Standard Deviation of Ensemble Mean



# Summer (JJA) Standard Deviation of Ensemble Mean

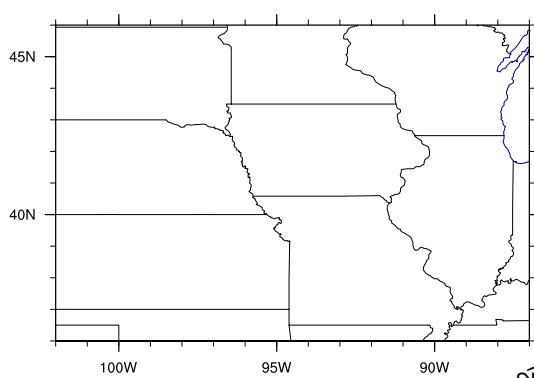






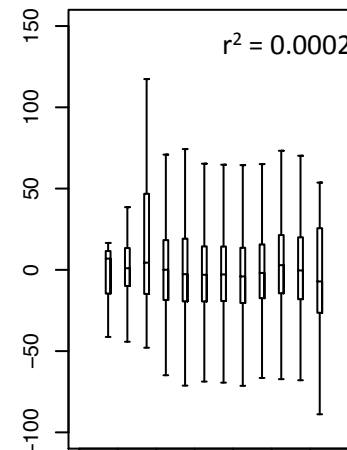
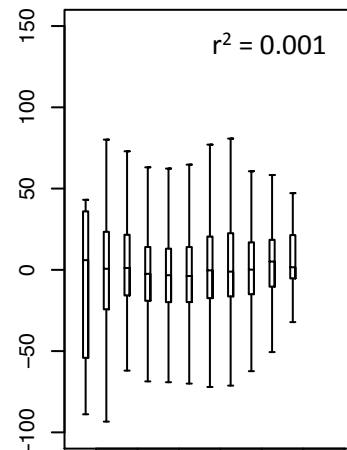
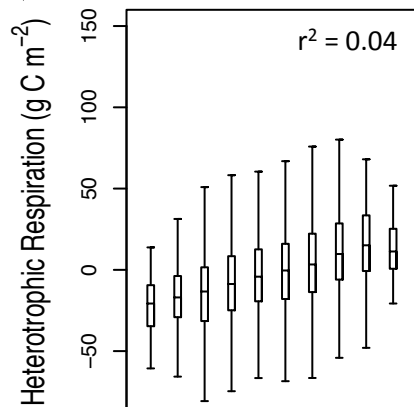
Is variability in **C gain** (productivity) or **loss** (respiration) driving the variability in ecosystem C fluxes?



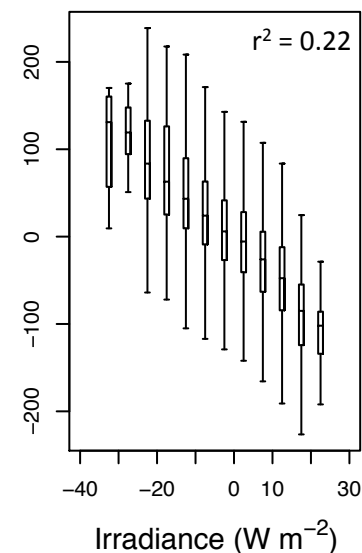
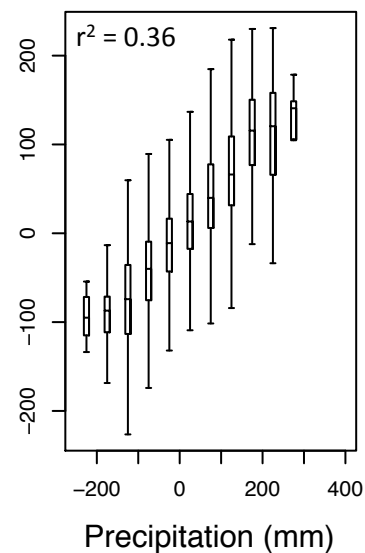
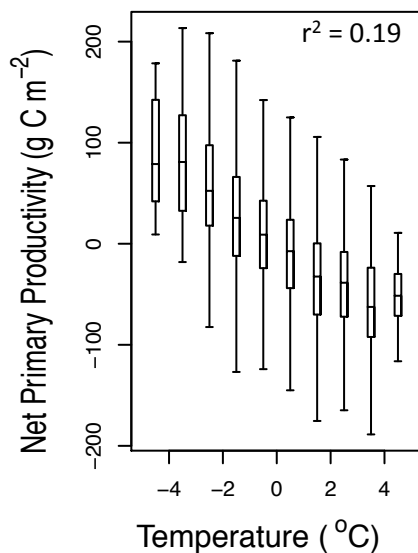


## Summer Anomalies in Central US

Carbon source →



Carbon gain →

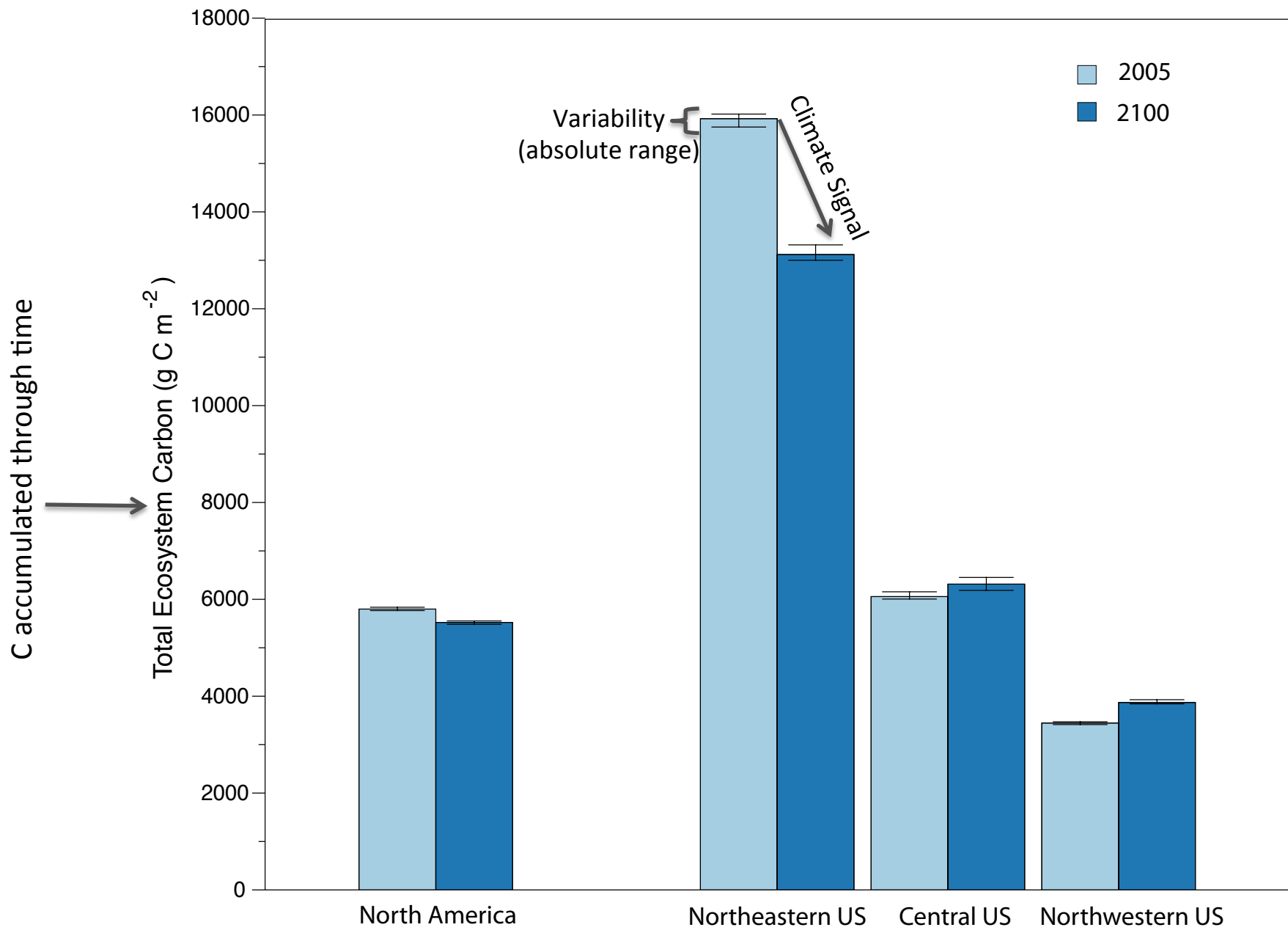




A photograph of a lush forest with green trees and ferns. A semi-transparent text box is overlaid in the center, containing the question: "Is the climate change signal over the 21<sup>st</sup> century larger than the variability?".

Is the climate change signal over the 21<sup>st</sup> century larger than the variability?





# Conclusions

- Variability is higher over shorter timescales
- Size of region can change magnitude of variability
- Importance of using ensembles to estimate C depends on objective

