

Crops in CLM5

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Outline:



1. Crop Model Basics



2. Considerations for Analysis



3. Yield changes in the future (if time)

CLM5: Active Crop Types

Corn*



Wheat



Sugarcane



Soy*



Cotton



Rice

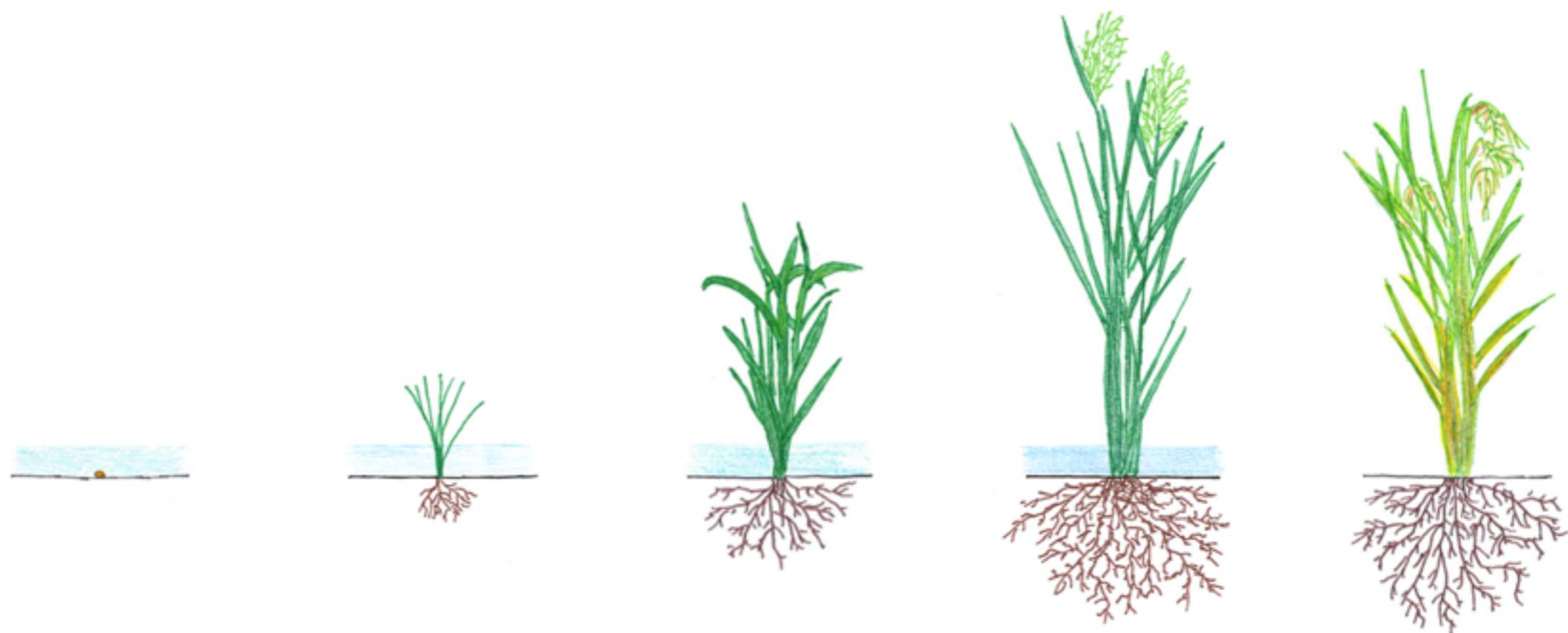
* Temperate and tropical varieties

32 Crop Types Mapped

Irrigated & Rain-fed

Temperate Corn Foddergrass
Tropical Corn Grapes
Spring Wheat Groundnuts
Winter Wheat Millet
Barley Oilpalm
Winter Barley Potatoes
Rye Pulses
Winter Rye Rapeseed
Cassava **Rice**
Citrus Sorghum
Cocoa Sugarbeet
Coffee Sugarcane
Cotton Sunflower
Datepalm Miscanthus
Temperate Soybean Switchgrass
Tropical Soybean

Phenology



1) Plant

Phenology



Phenology

1) Plant



↓
2) Leaf Emergence



Phenology

1) Plant



2) Leaf Emergence



3) Grain Fill



Phenology

1) Plant



2) Leaf Emergence



3) Grain Fill



4) Harvest



Management

Fertilize

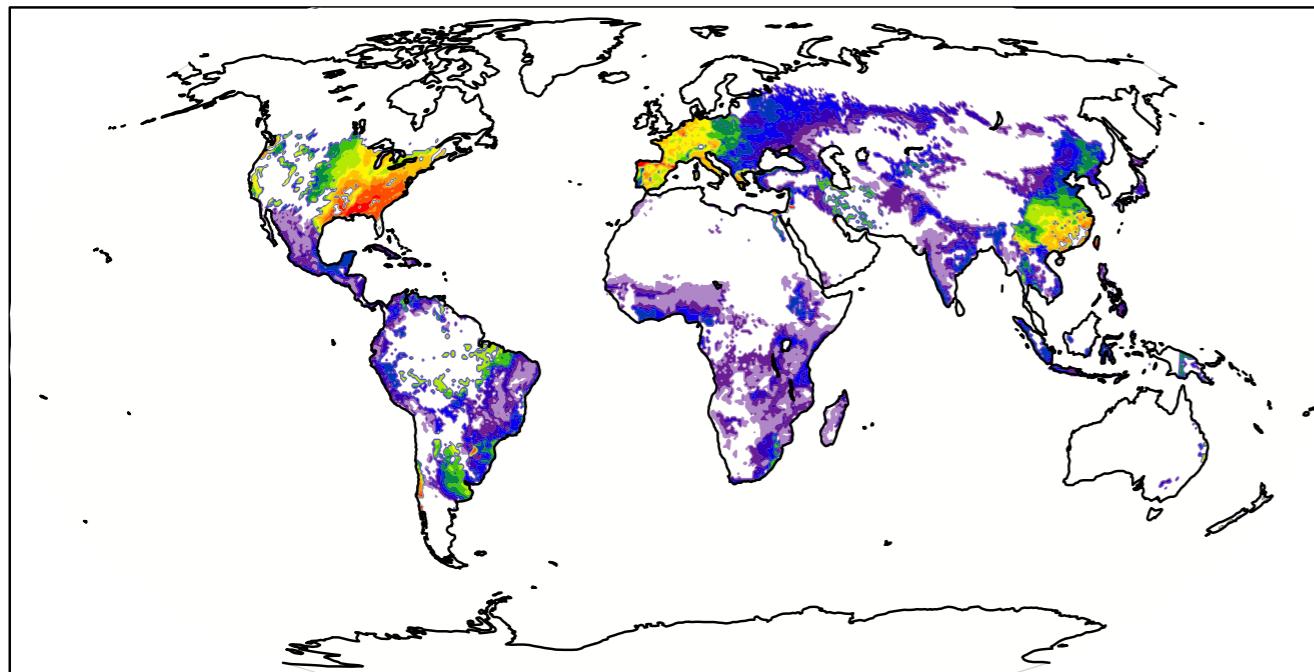


Irrigate

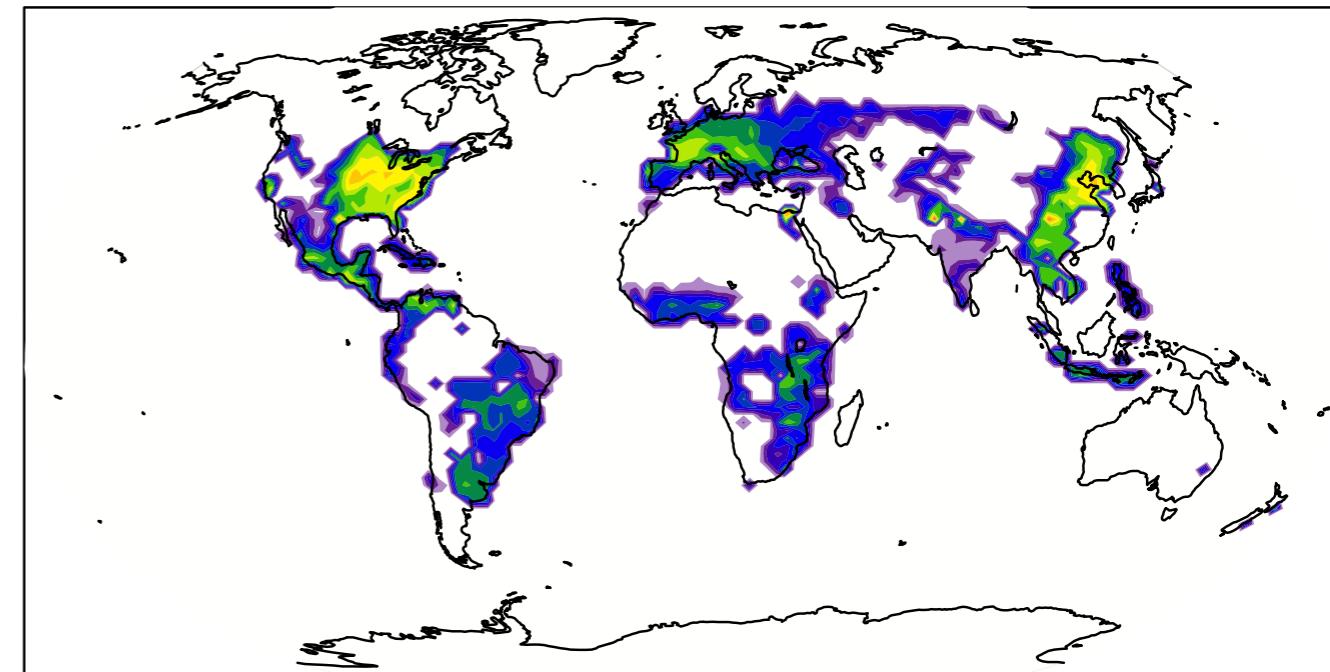


Transient fertilizer and irrigation are now on surface dataset
1850 fertilizer assumed to be from manure only

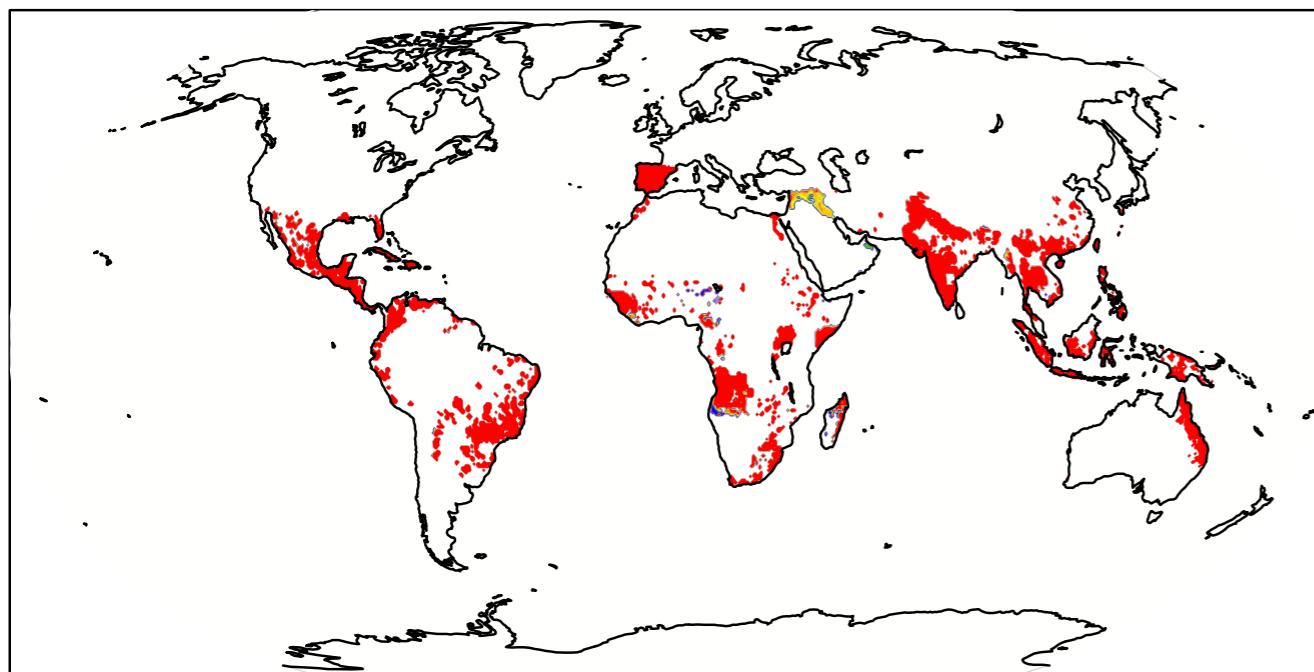
FAO Corn



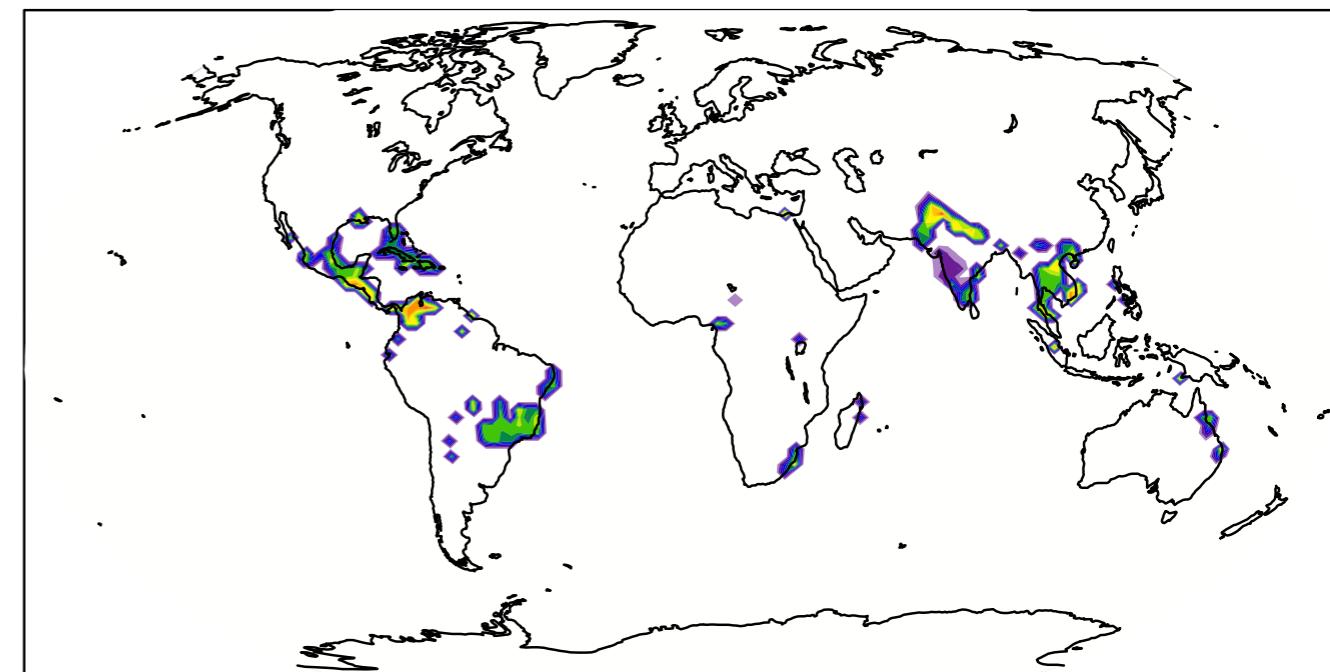
CLM5 Corn



FAO Sugarcane



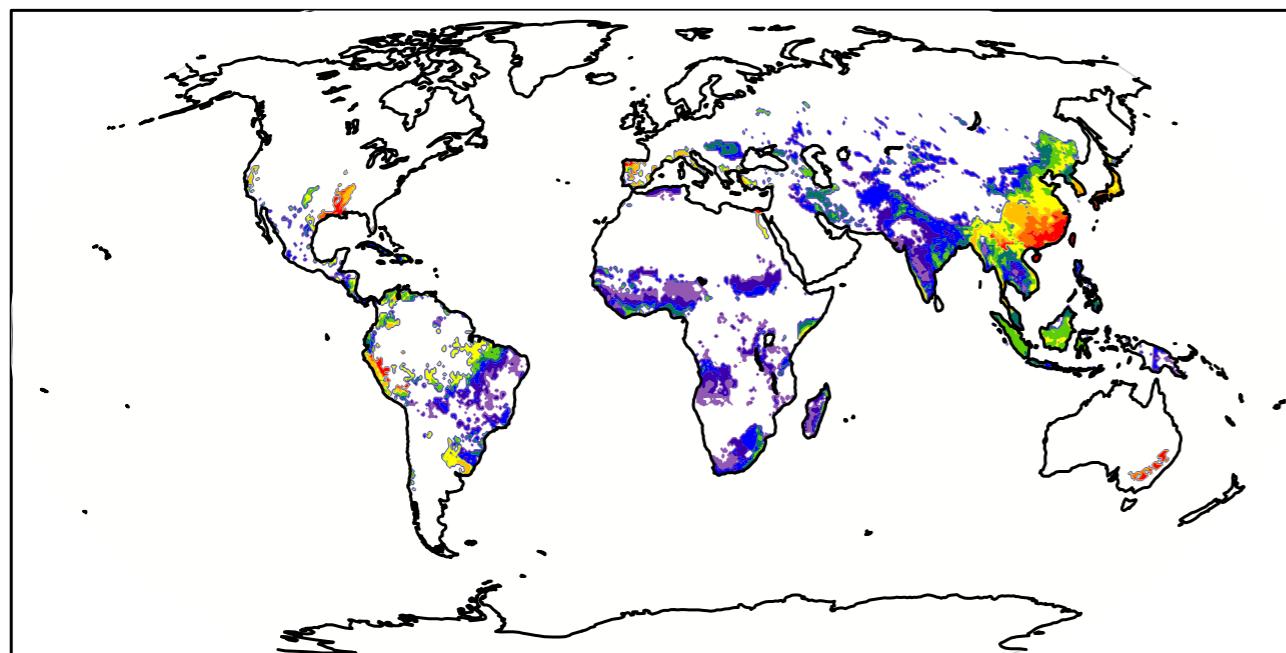
CLM5 Sugarcane



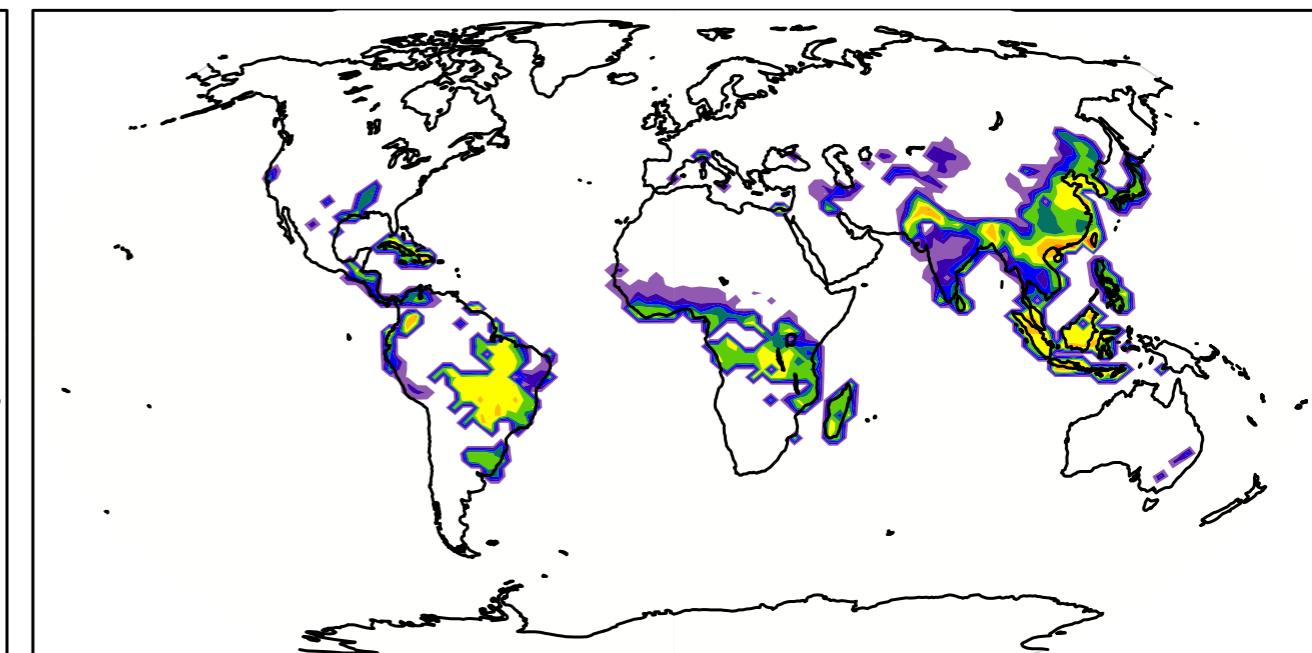
0 1 2 3 4 5 6 7 8 9 10 11 12

Annual Yield (tonnes ha⁻¹)

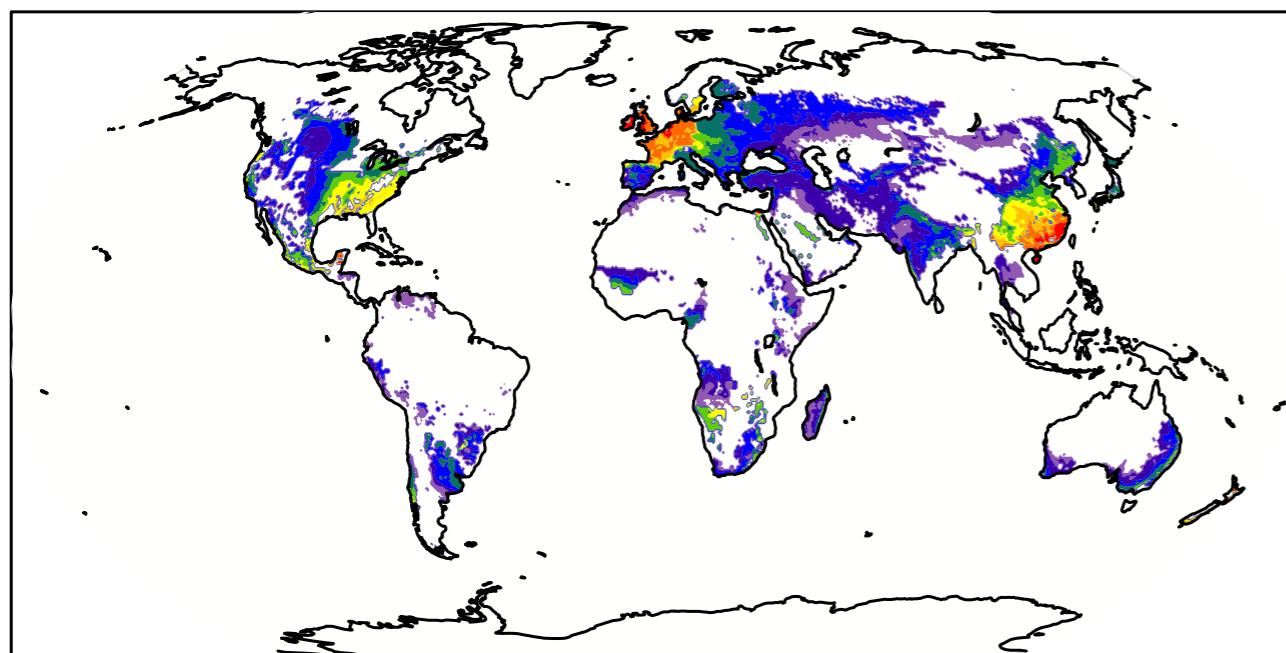
FAO Rice



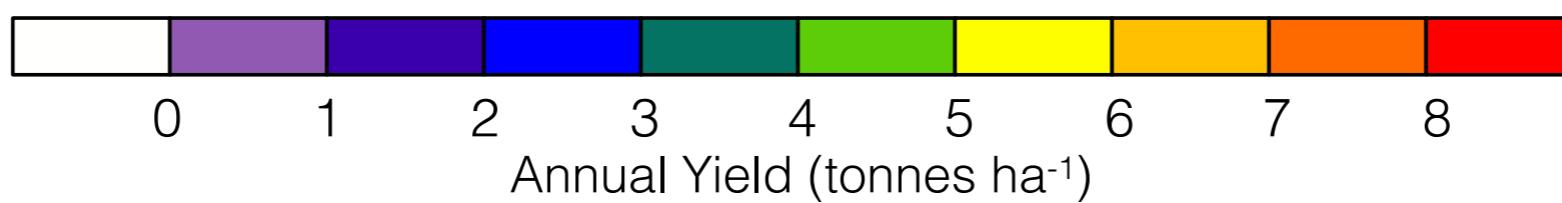
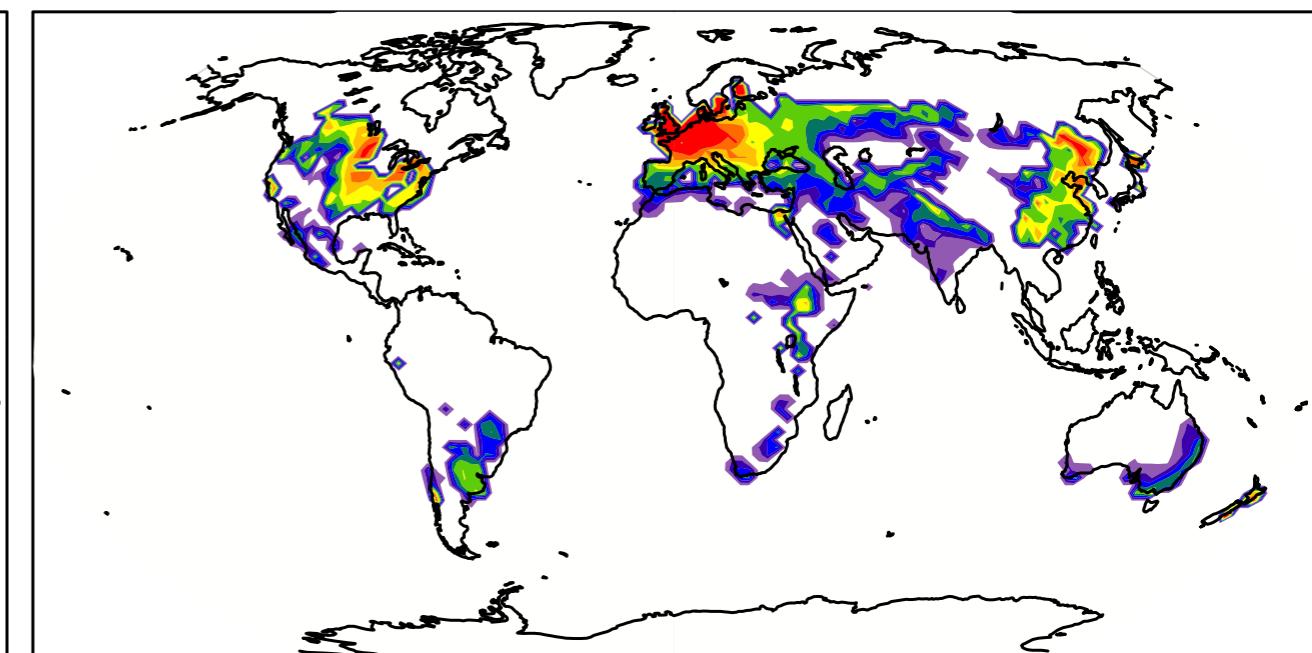
CLM5 Rice



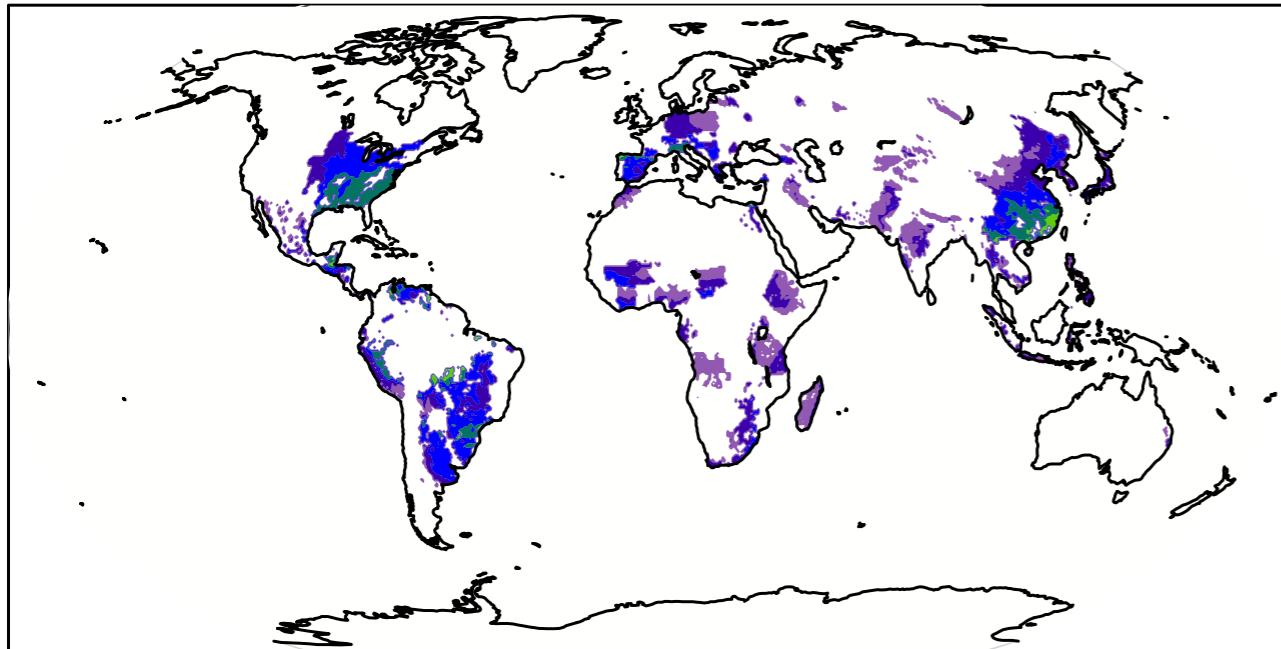
FAO Wheat



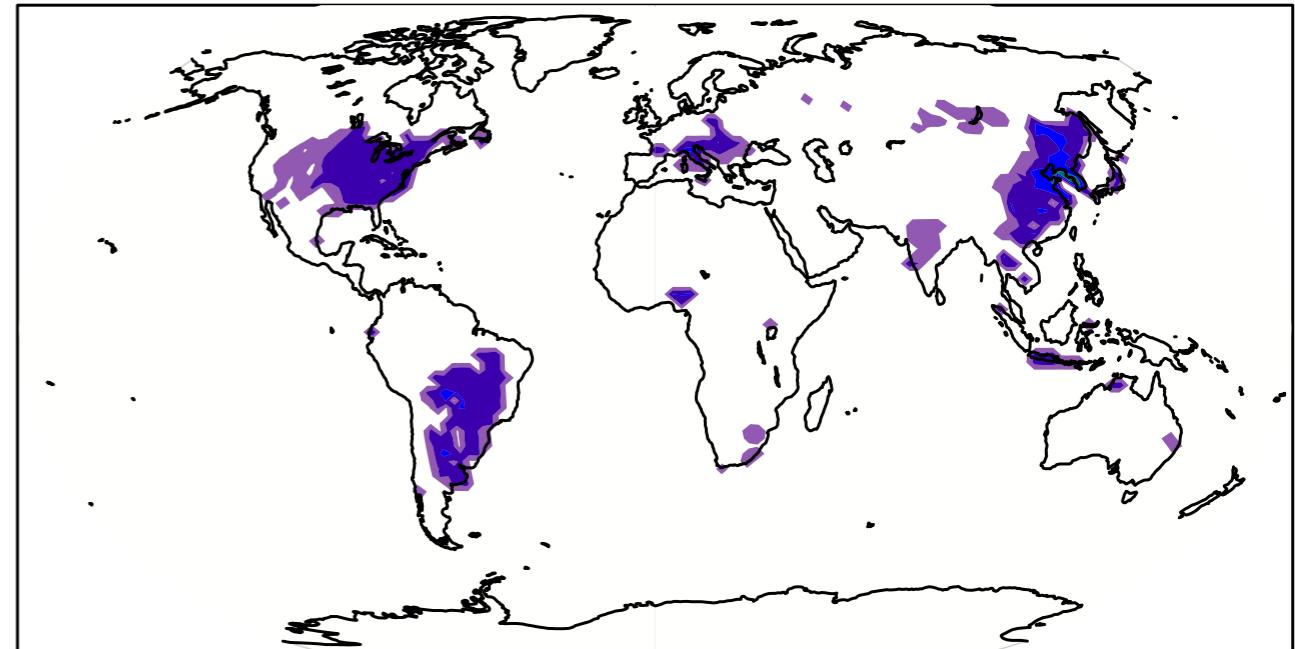
CLM5 Spring Wheat



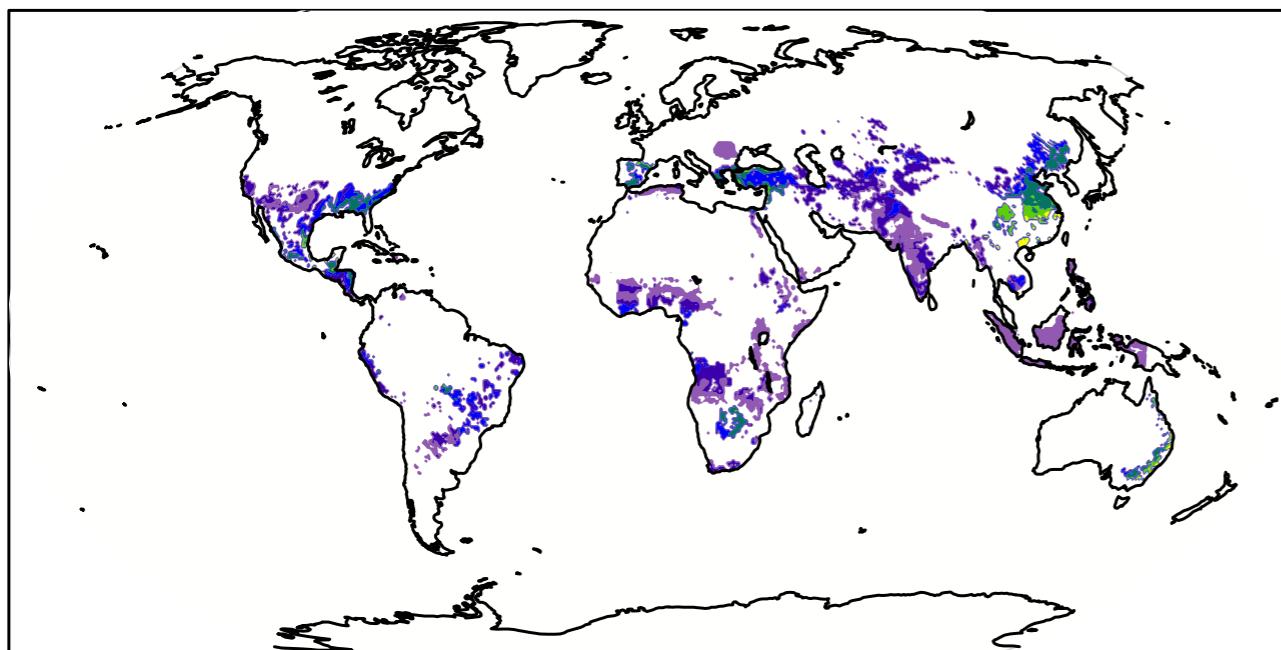
FAO Soy



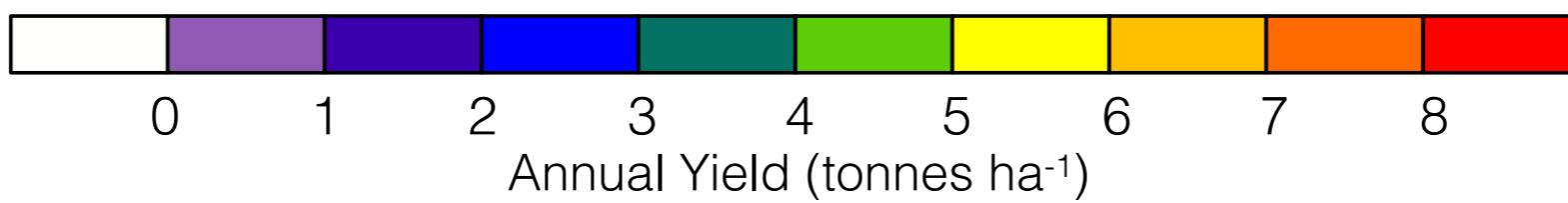
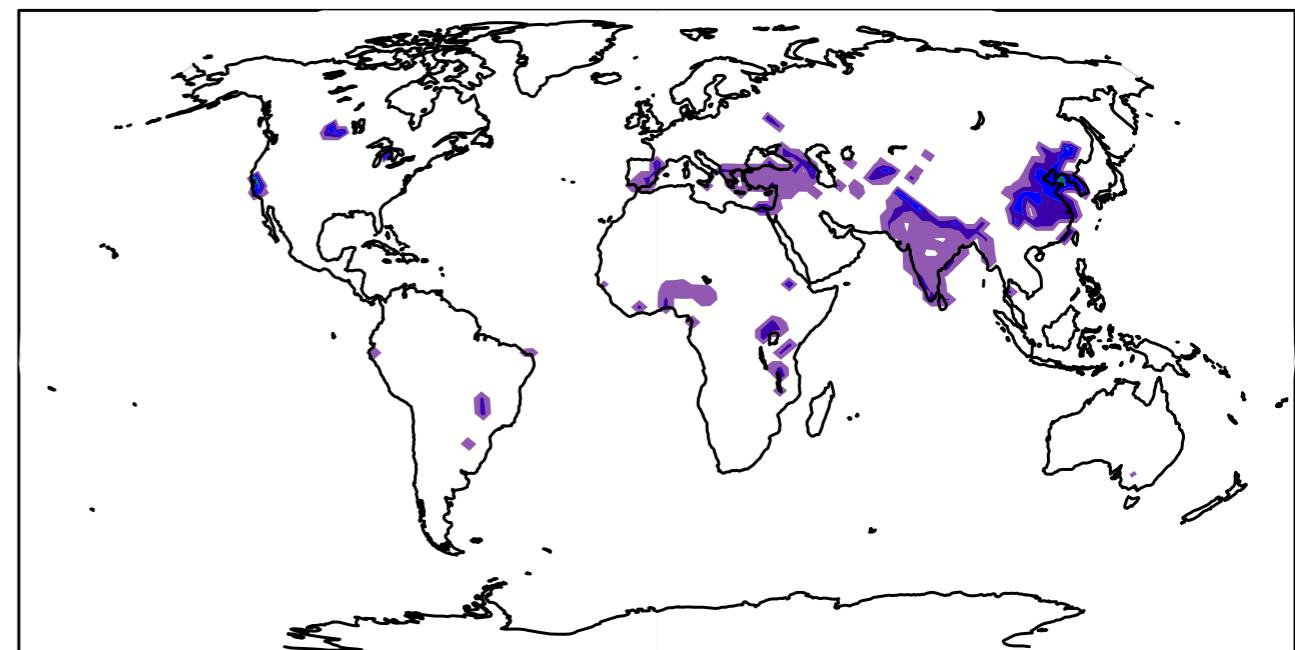
CLM5 Soy



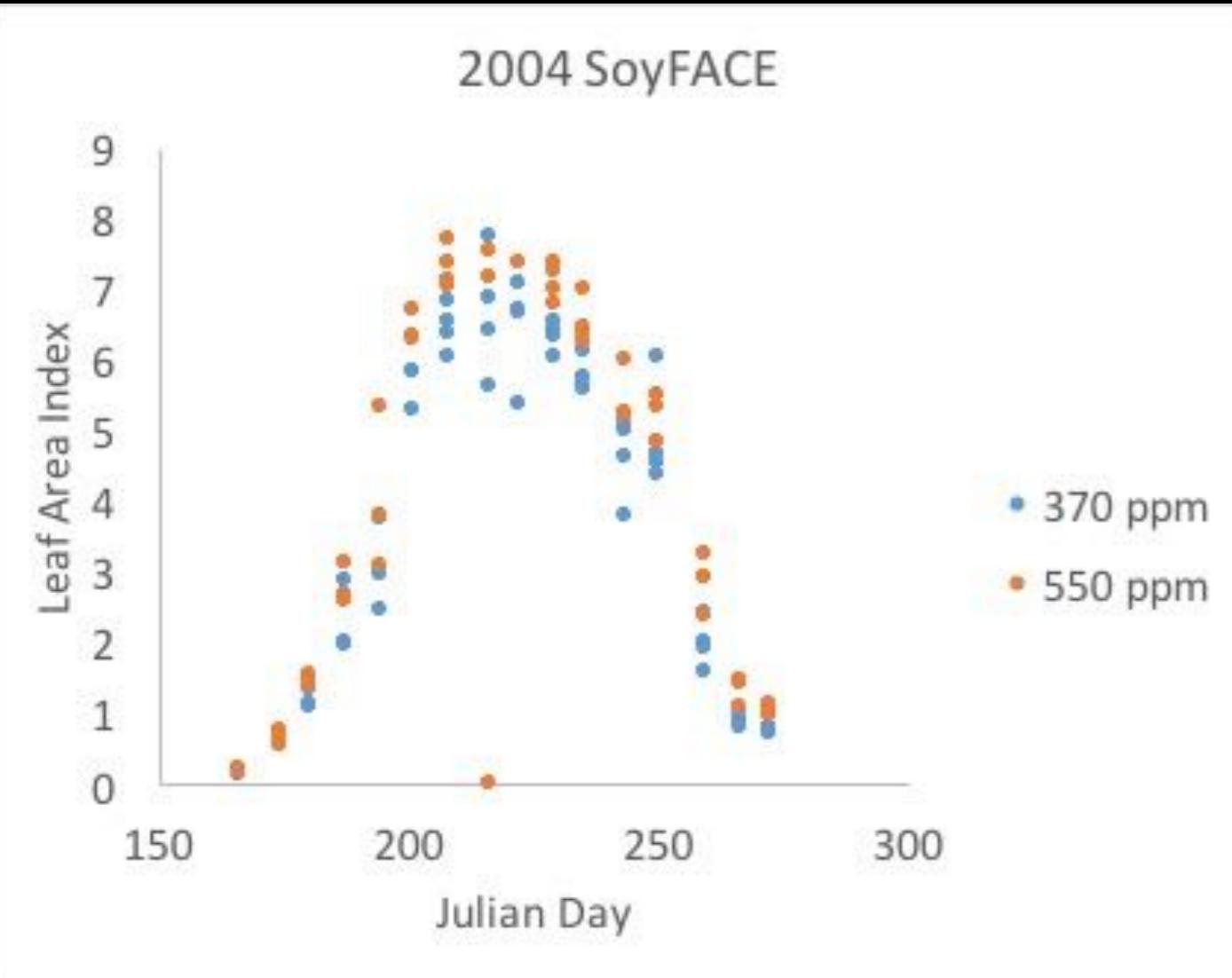
FAO Cotton



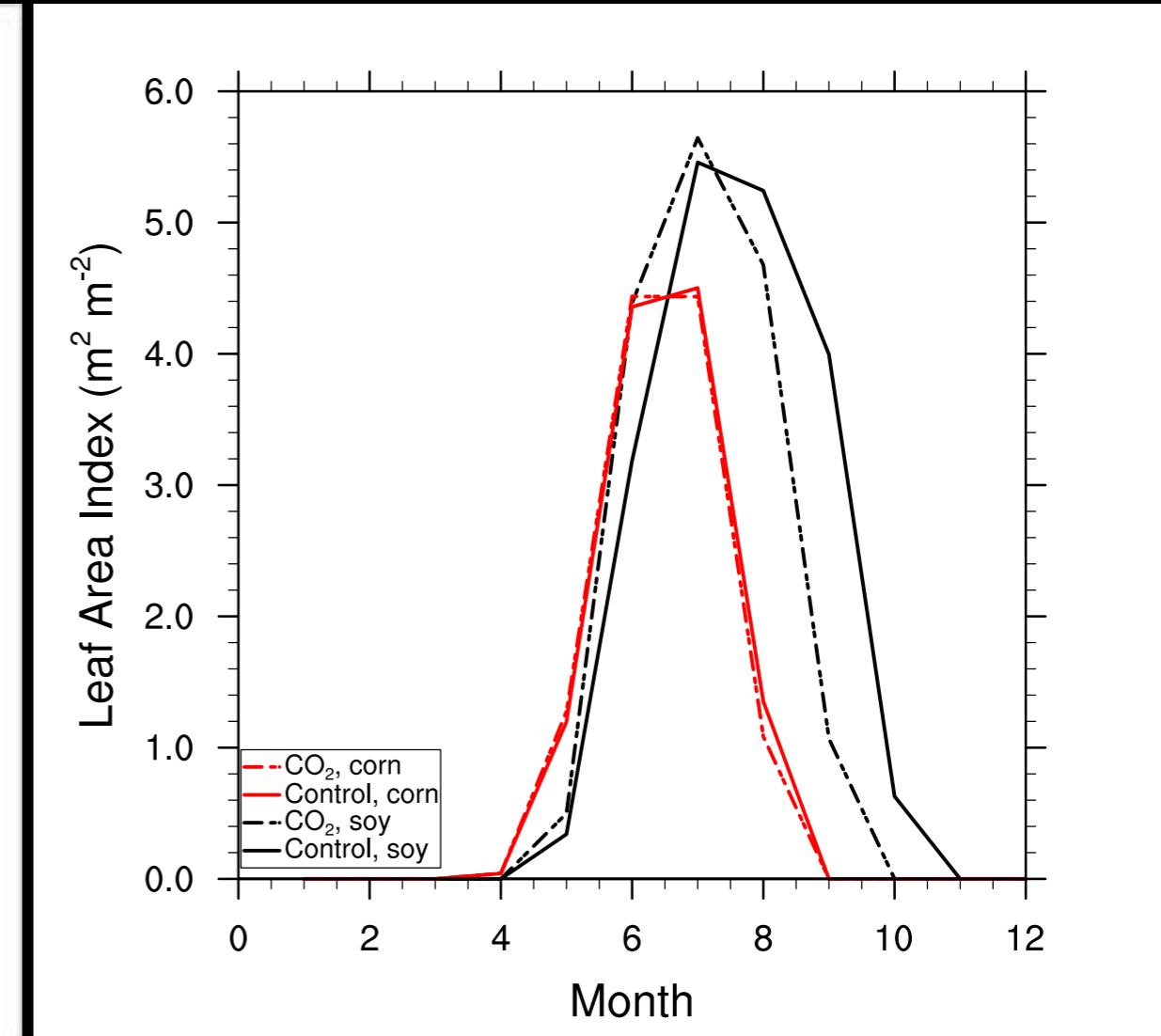
CLM5 Cotton



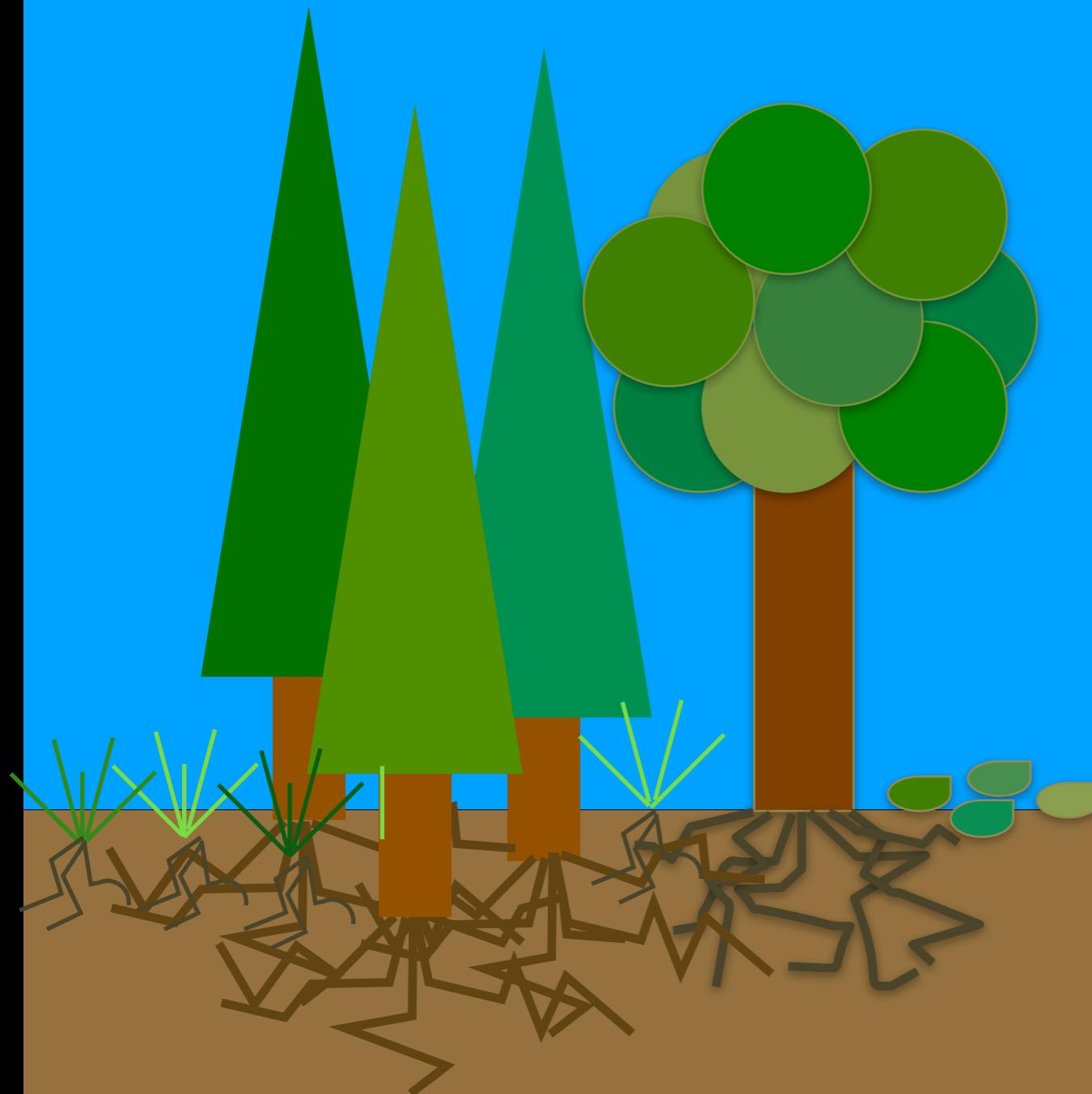
LAI data from SoyFACE



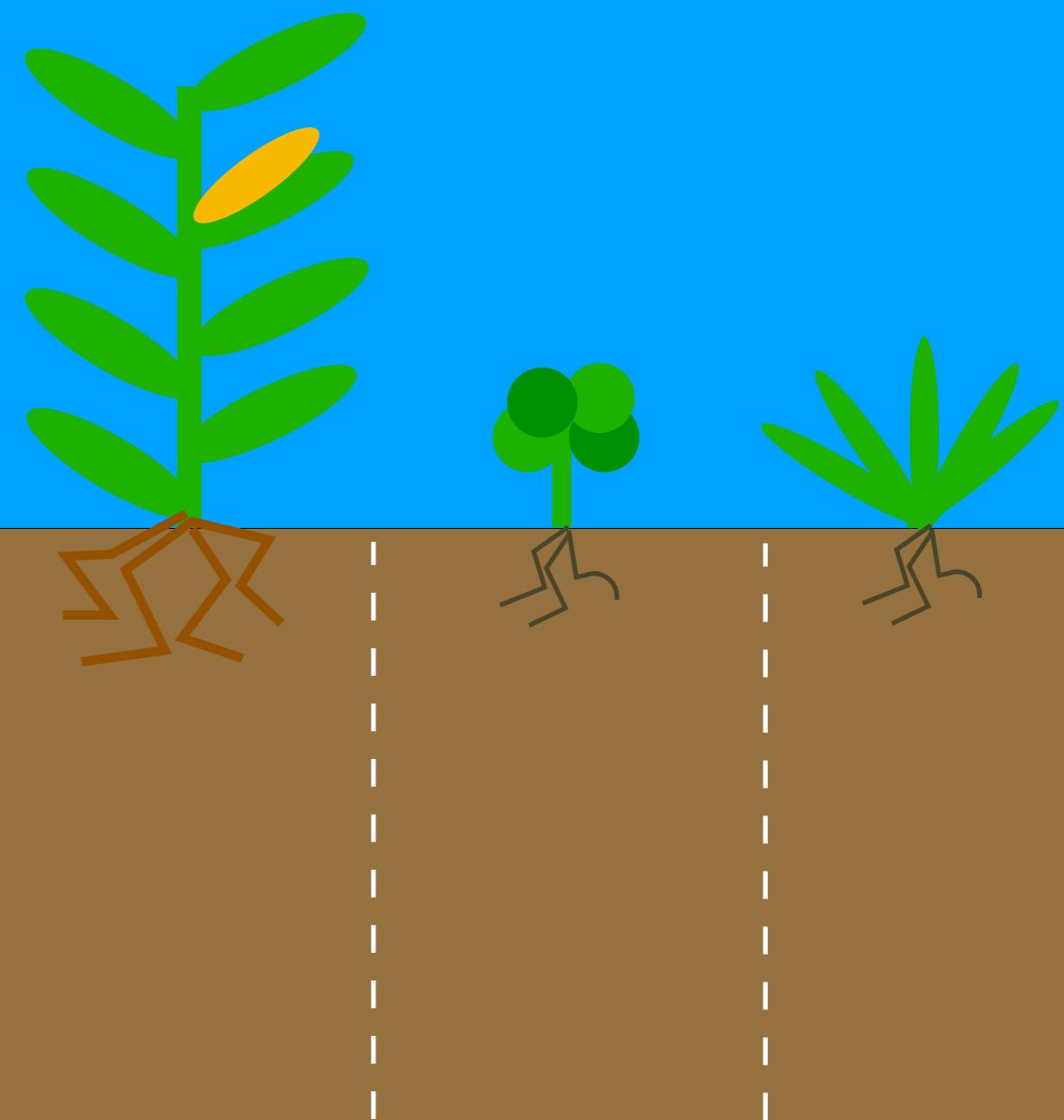
CLM5 simulation of SoyFACE



Natural Vegetation = shared soil column



Crops = independent soil column



Outline:



1. Crop Model Basics



2. Considerations for Analysis



3. Yield changes in the future (if time)







Corn

Soybean

Spring Wheat

Barley



Yields can be calculated for 31 crop types

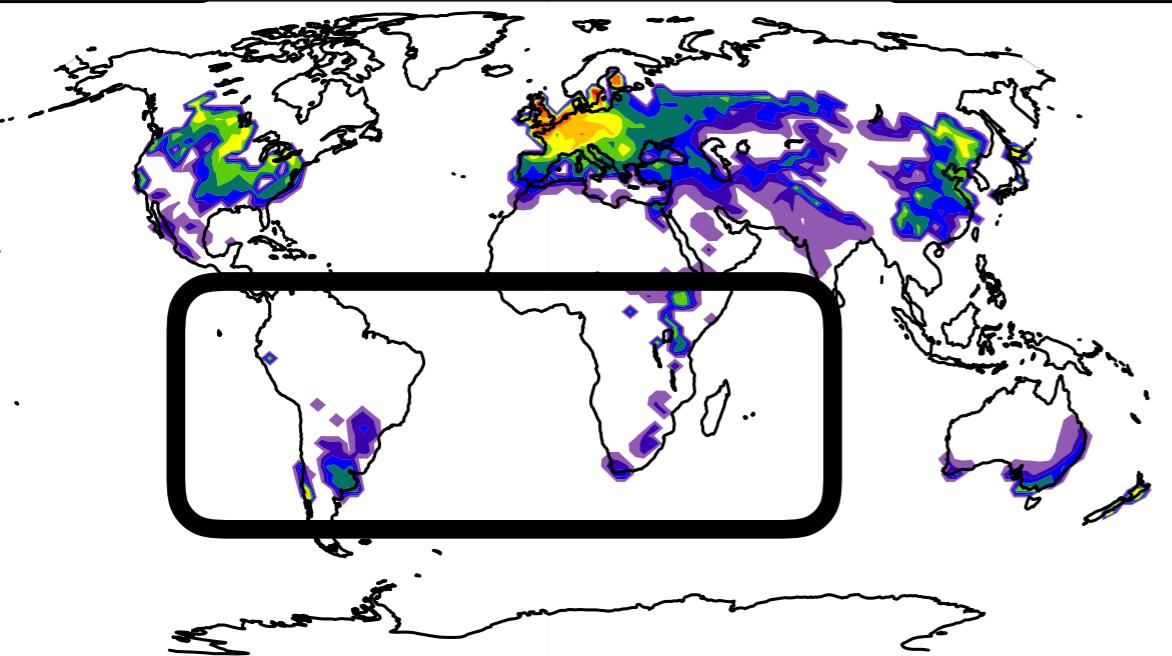
Assumption that inactive crops have same growing triggers & allocation as the active crop
Need to use surface dataset for remapping during analysis

Table 25.1 Crop plant functional types (pfts) included in CLM5BGCCROP.

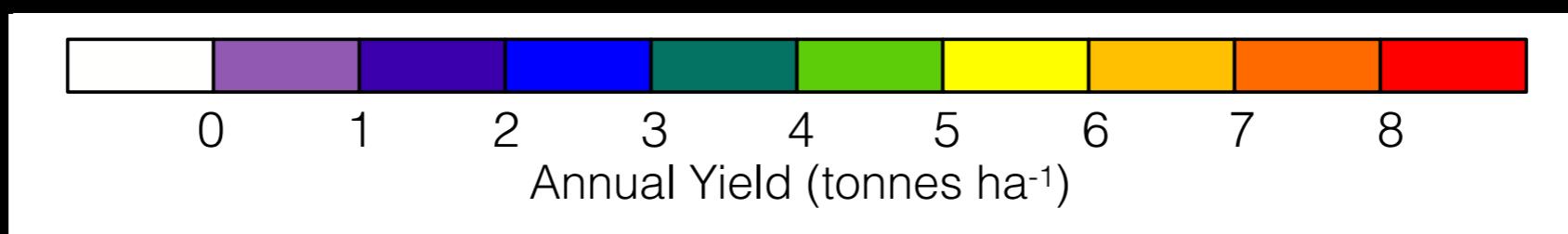
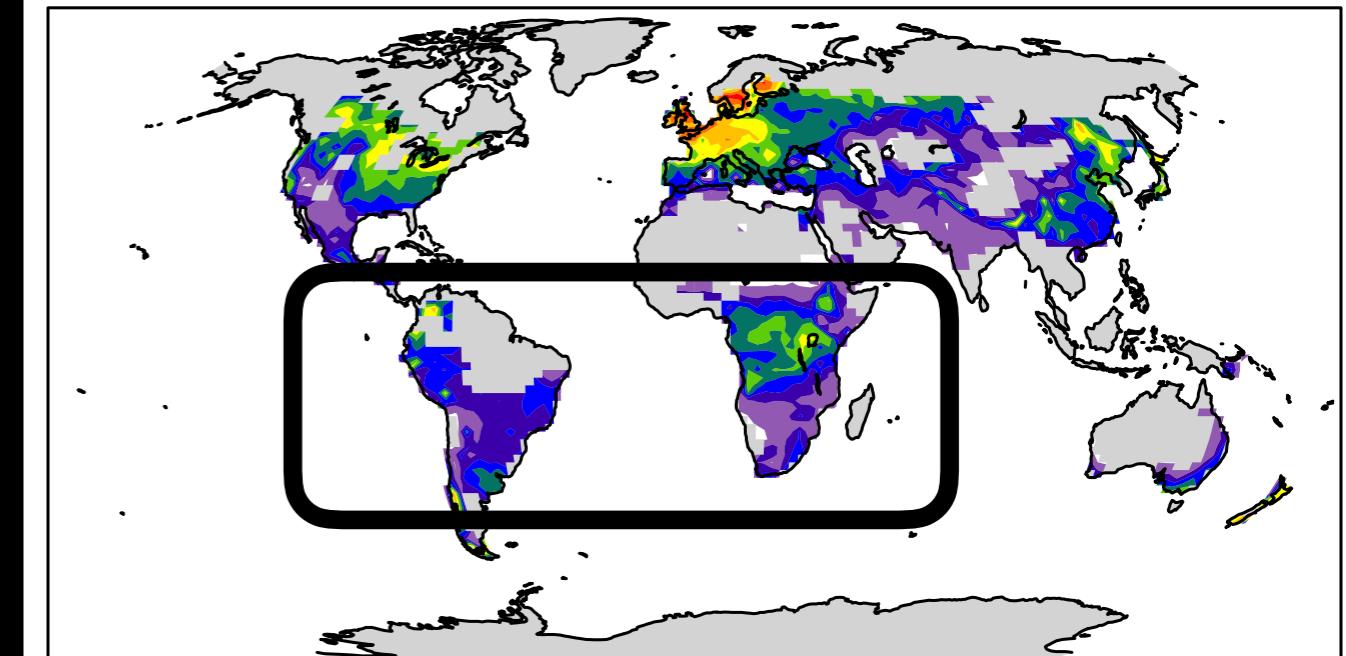
ITV	Plant function types (PFTs)	Management Class	Crop Parameters Used
15	c3 unmanaged rainfed crop	none	not applicable
16	c3 unmanaged irrigated crop	none	not applicable
17	rainfed temperate corn	active	rainfed temperate corn
18	irrigated temperate corn	active	irrigated temperate corn
19	rainfed spring wheat	active	rainfed spring wheat
20	irrigated spring wheat	active	irrigated spring wheat
21	rainfed winter wheat	inactive	rainfed spring wheat
22	irrigated winter wheat	inactive	irrigated spring wheat
23	rainfed temperate soybean	active	rainfed temperate soybean
24	irrigated temperate soybean	active	irrigated temperate soybean
25	rainfed barley	inactive	rainfed spring wheat
26	irrigated barley	inactive	irrigated spring wheat
27	rainfed winter barley	inactive	rainfed spring wheat
28	irrigated winter barley	inactive	irrigated spring wheat
29	rainfed rye	inactive	rainfed spring wheat
30	irrigated rye	inactive	irrigated spring wheat
31	rainfed winter rye	inactive	rainfed spring wheat
32	irrigated winter rye	inactive	irrigated spring wheat
33	rainfed cassava	inactive	rainfed rice
34	irrigated cassava	inactive	irrigated rice
35	rainfed citrus	inactive	rainfed spring wheat
36	irrigated citrus	inactive	irrigated spring wheat
37	rainfed cocoa	inactive	rainfed rice
38	irrigated cocoa	inactive	irrigated rice
39	rainfed coffee	inactive	rainfed rice
40	irrigated coffee	inactive	irrigated rice
41	rainfed cotton	active	rainfed cotton
42	irrigated cotton	active	irrigated cotton

Spring Wheat

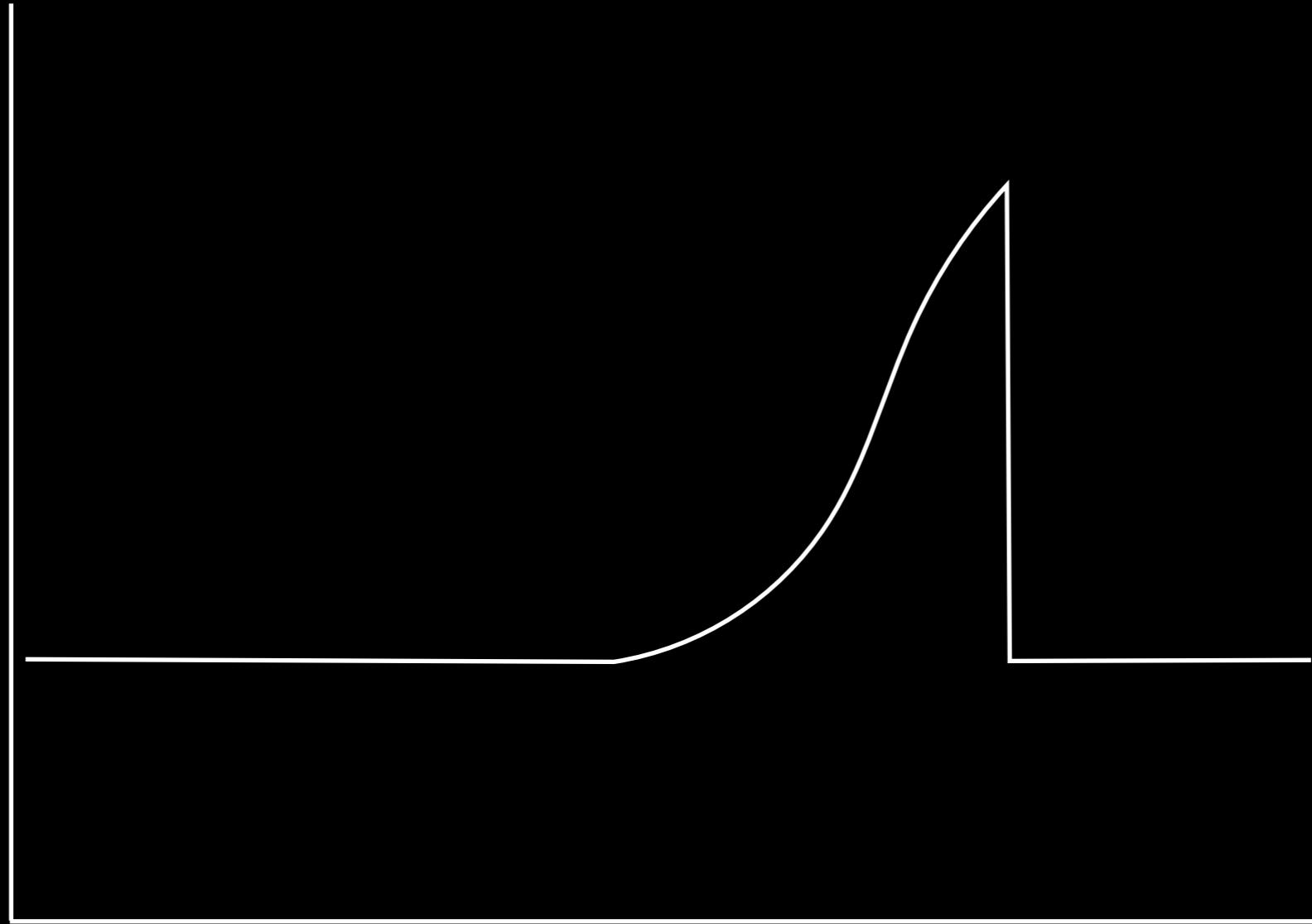
With Surface Dataset Mask



Without Surface Dataset Mask

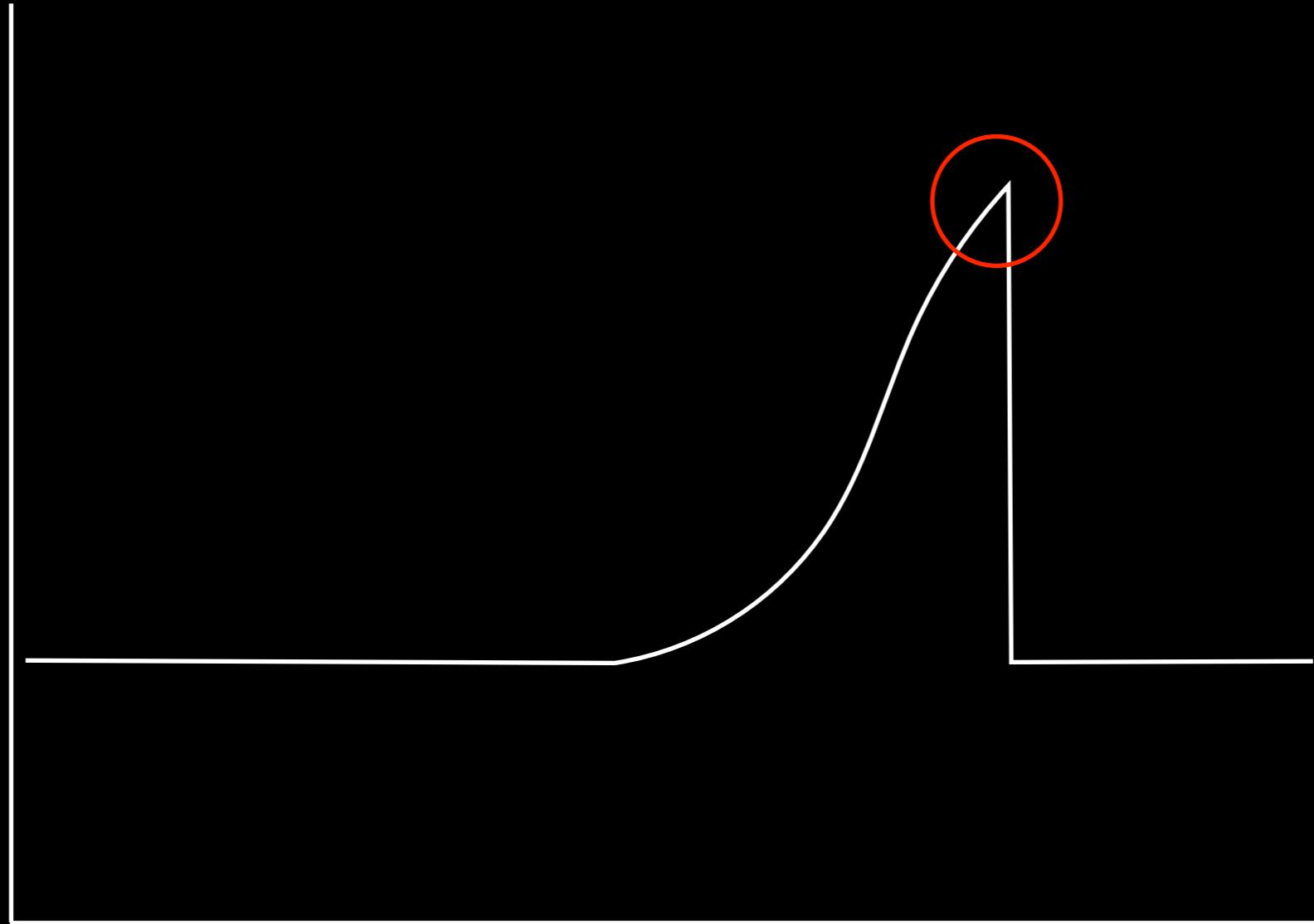


Grain C



Month

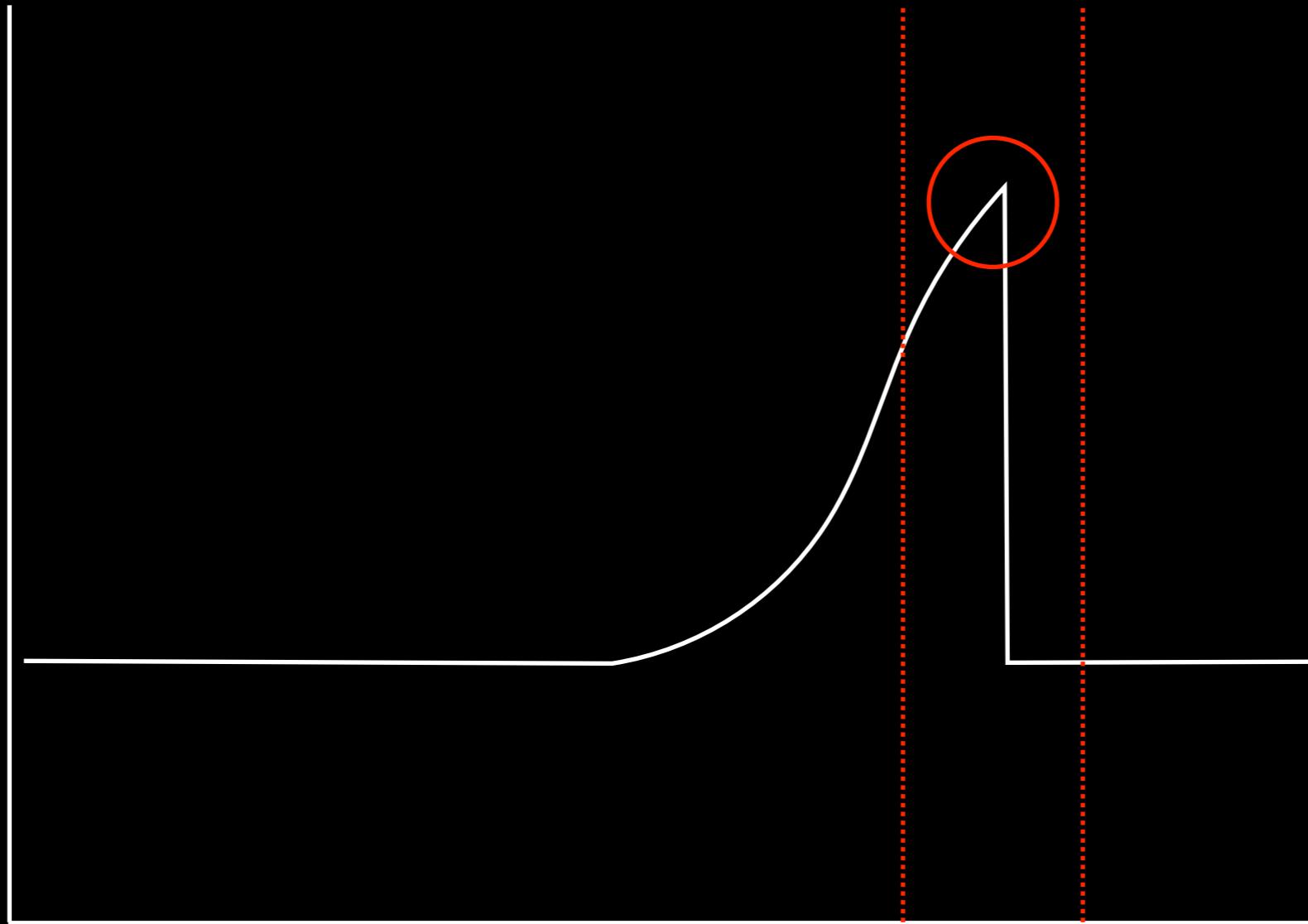
Grain C



Month

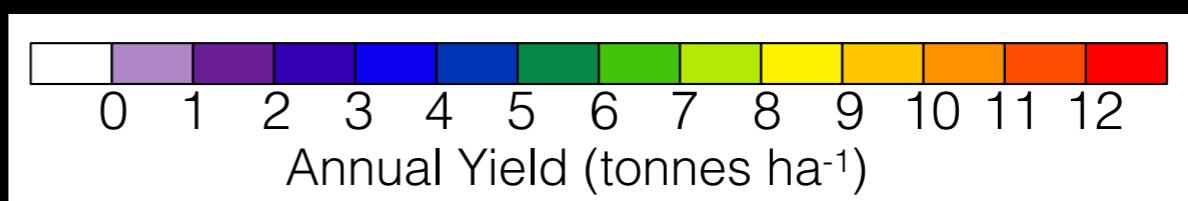
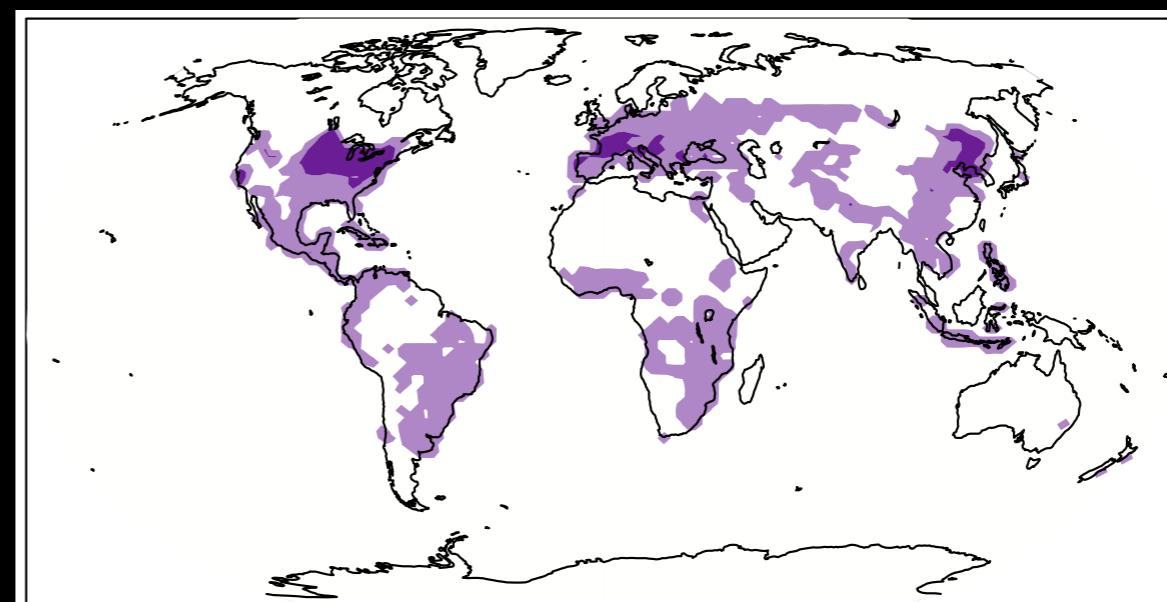
Grain C

Month



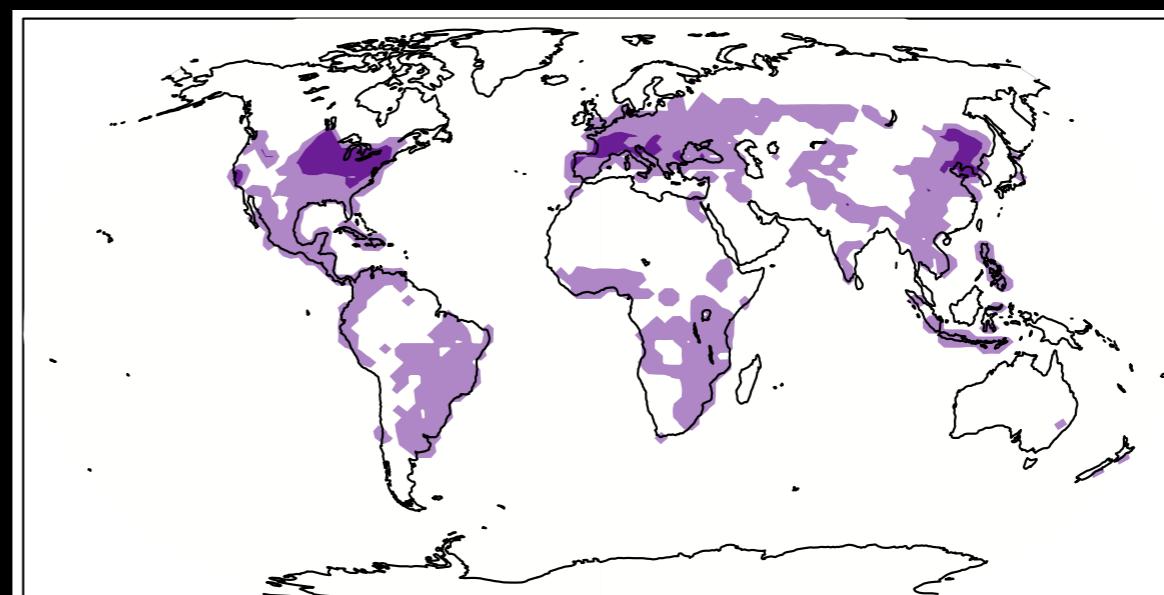
Corn

Grain C Annual Average

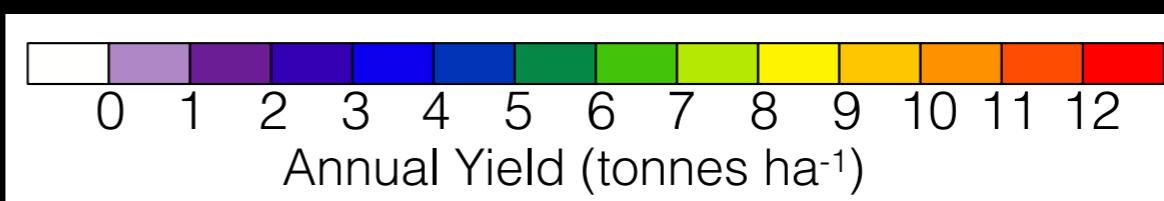
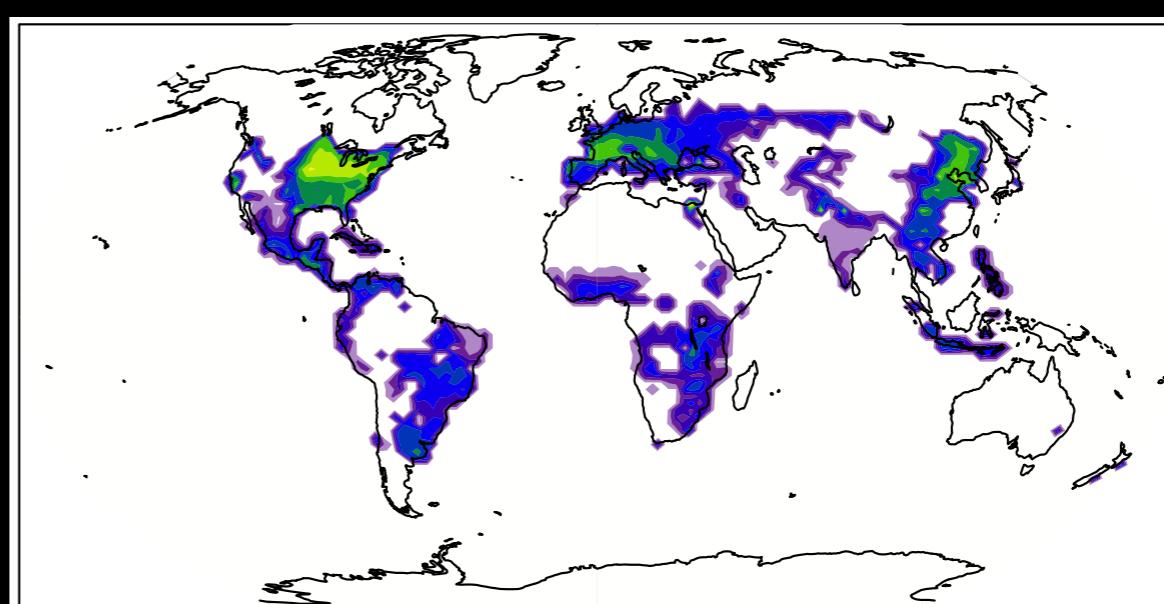


Corn

Grain C
Annual Average

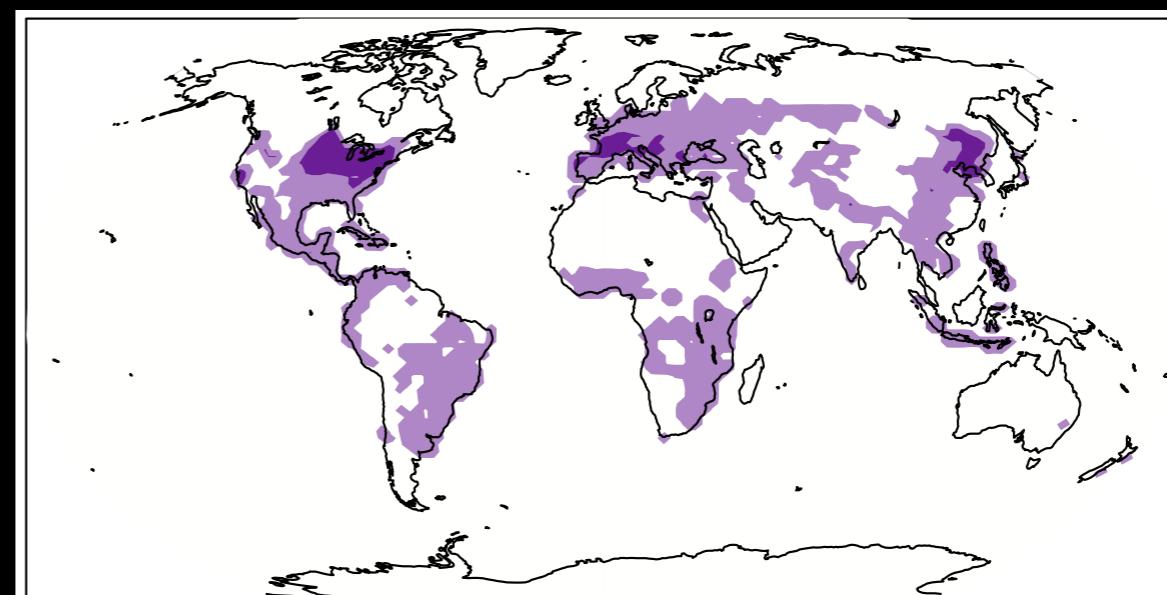


Grain C
Max Monthly Average

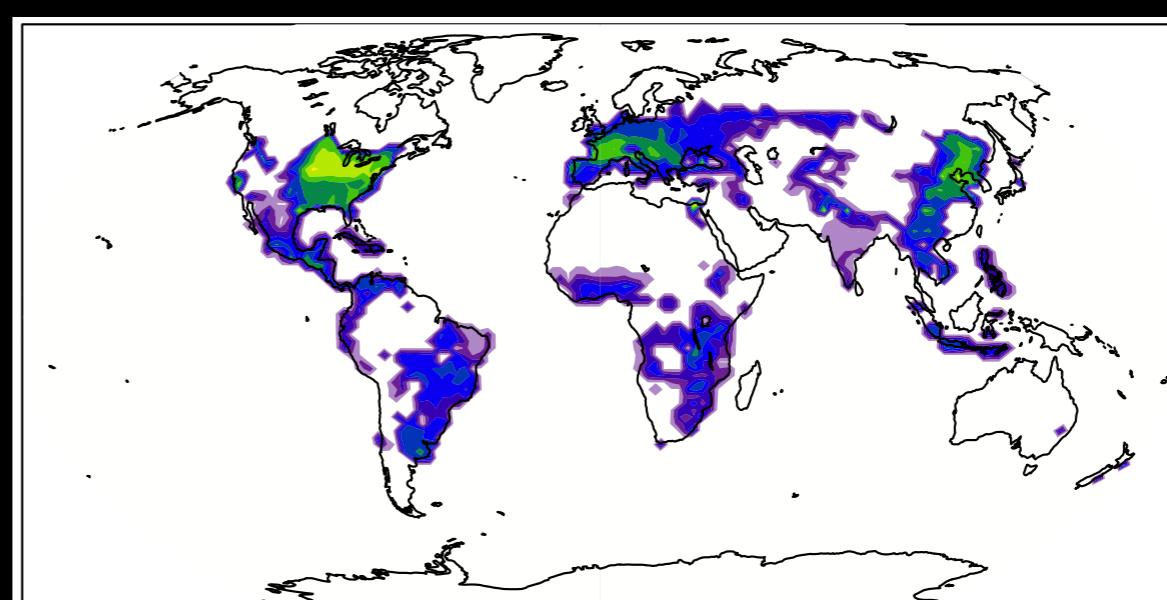


Corn

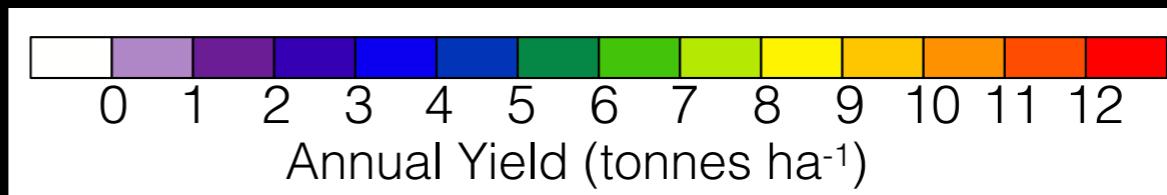
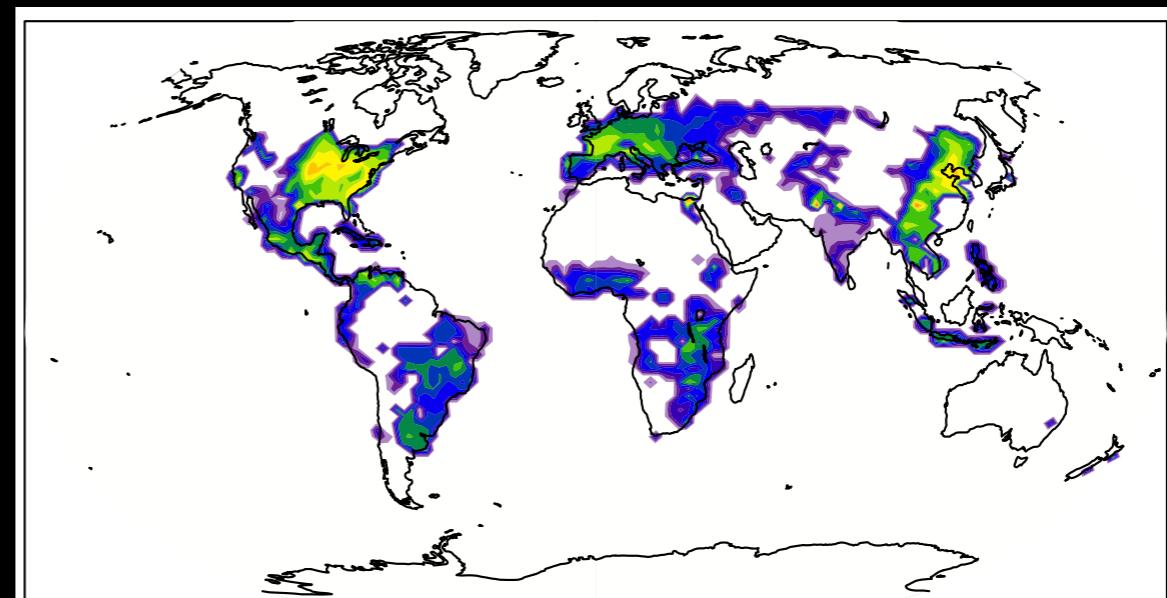
Grain C
Annual Average



Grain C
Max Monthly Average



Grain C to Food
Annual Sum



Outline:



1. Crop Model Basics



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3. Yield changes in the future (if time)



Expectations:

O_3

Climate

N deposition

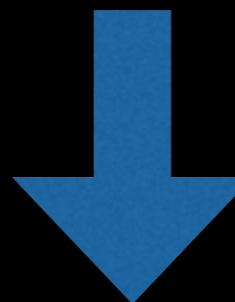
CO_2



Expectations:

O_3

Phytotoxicity



Climate

N deposition

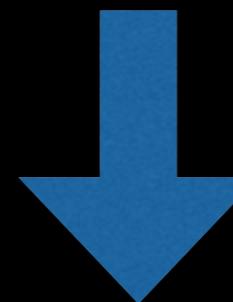
CO_2



Expectations:

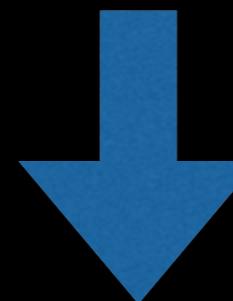
O_3

Phytotoxicity



Climate

Heat stress



N deposition

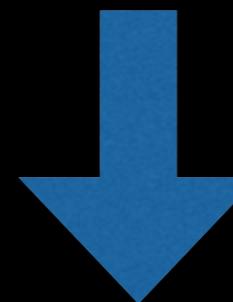
CO_2



Expectations:

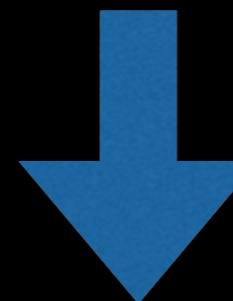
O_3

Phytotoxicity



Climate

Heat stress



N deposition

Fertilization



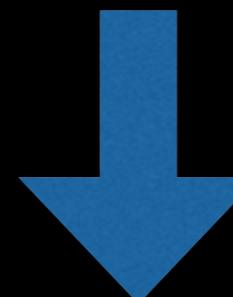
CO_2



Expectations:

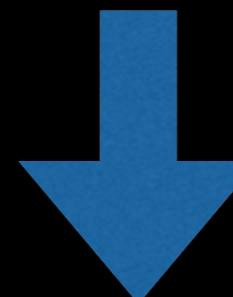
O_3

Phytotoxicity



Climate

Heat stress



N deposition

Fertilization



CO_2

Fertilization



Net impact on crop yields?

Experimental Design

Simulation Name	Physical Climate	CO ₂	O ₃	N deposition
Constant Forcings				
Climate Change				
CO ₂ Fertilization				
O ₃ Change				
N deposition				
Transient Forcings				

Transient = RCP 8.5

Experimental Design

Simulation Name	Physical Climate	CO ₂	O ₃	N deposition
Constant Forcings	2000	2000	2000	2000
Climate Change				
CO ₂ Fertilization				
O ₃ Change				
N deposition				
Transient Forcings				

Transient = RCP 8.5

Experimental Design

Simulation Name	Physical Climate	CO ₂	O ₃	N deposition
Constant Forcings	2000	2000	2000	2000
Climate Change	Transient	2000	2000	2000
CO ₂ Fertilization				
O ₃ Change				
N deposition				
Transient Forcings				

Transient = RCP 8.5

Experimental Design

Simulation Name	Physical Climate	CO ₂	O ₃	N deposition
Constant Forcings	2000	2000	2000	2000
Climate Change	Transient	2000	2000	2000
CO ₂ Fertilization	2000	Transient	2000	2000
O ₃ Change	2000	2000	Transient	2000
N deposition	2000	2000	2000	Transient
Transient Forcings				

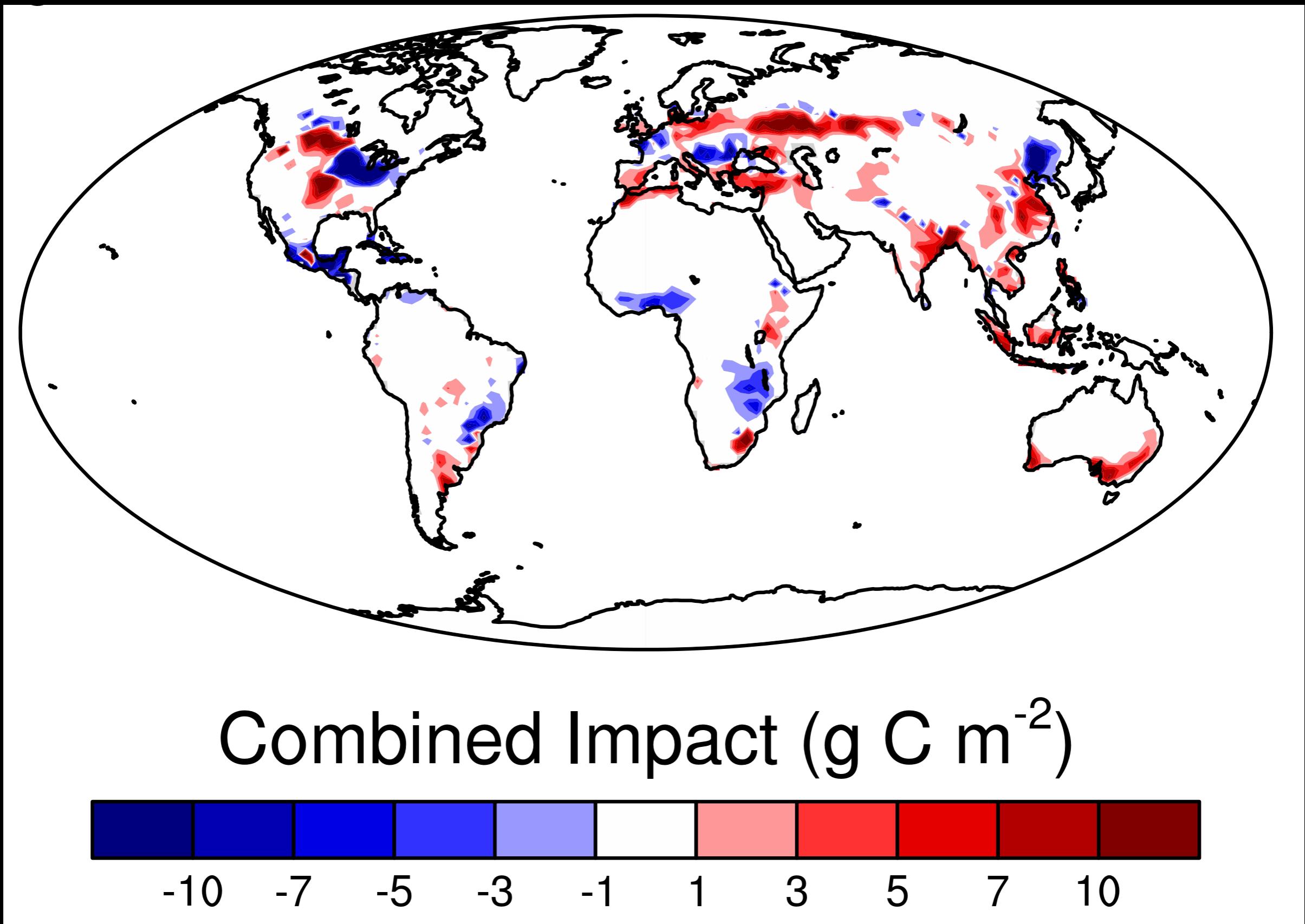
Transient = RCP 8.5

Experimental Design

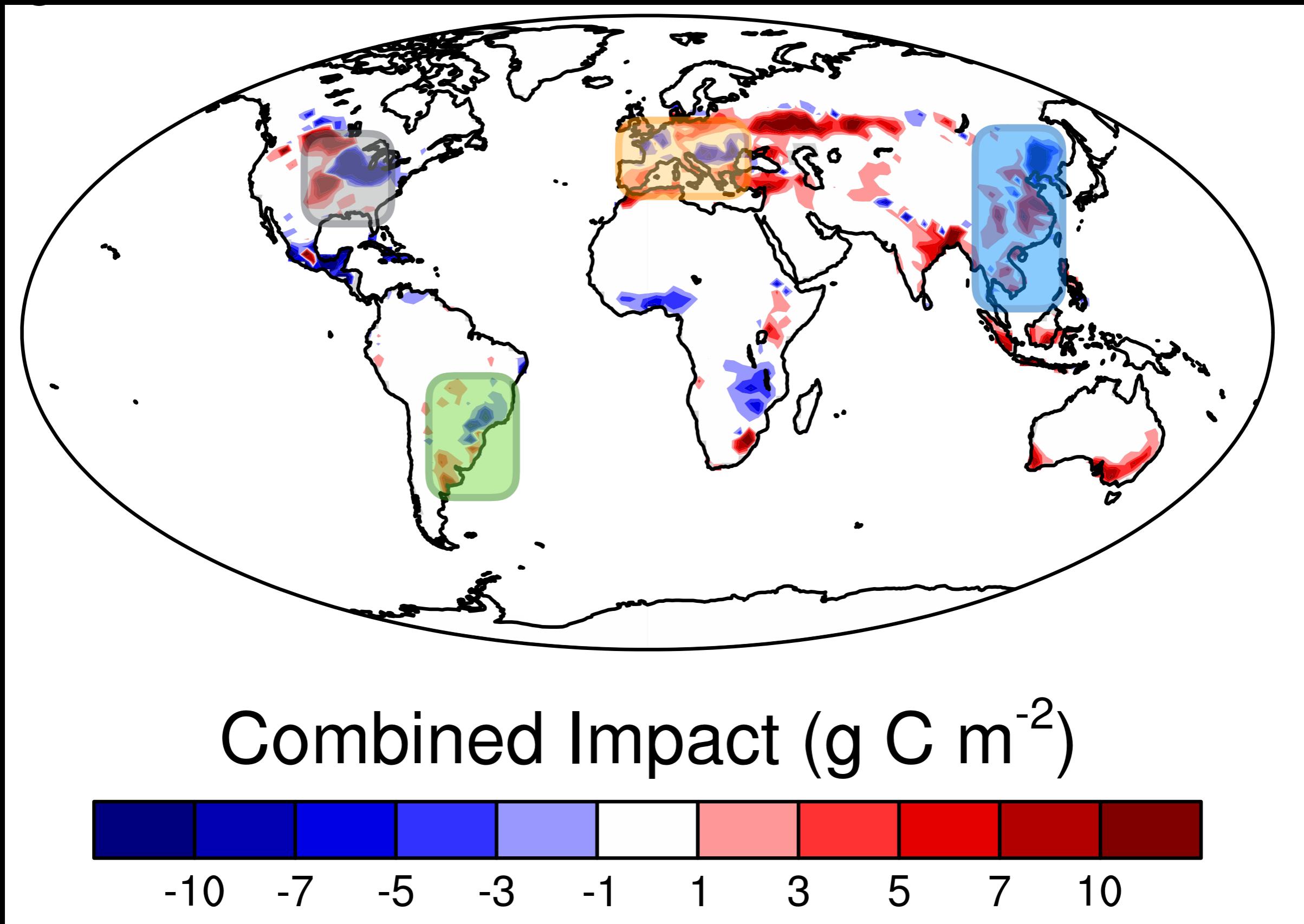
Simulation Name	Physical Climate	CO ₂	O ₃	N deposition
Constant Forcings	2000	2000	2000	2000
Climate Change	Transient	2000	2000	2000
CO ₂ Fertilization	2000	Transient	2000	2000
O ₃ Change	2000	2000	Transient	2000
N deposition	2000	2000	2000	Transient
Transient Forcings	Transient	Transient	Transient	Transient

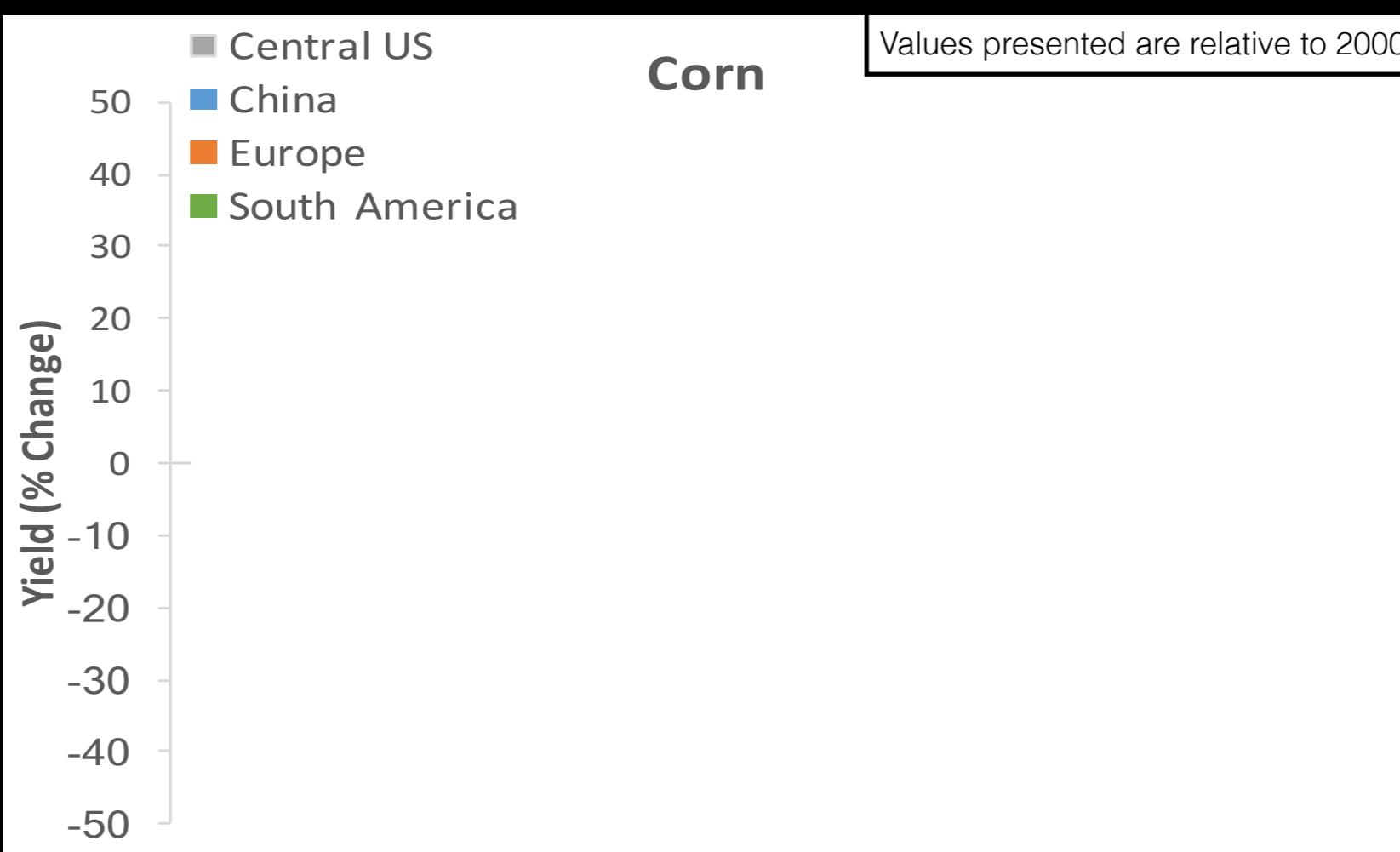
Transient = RCP 8.5

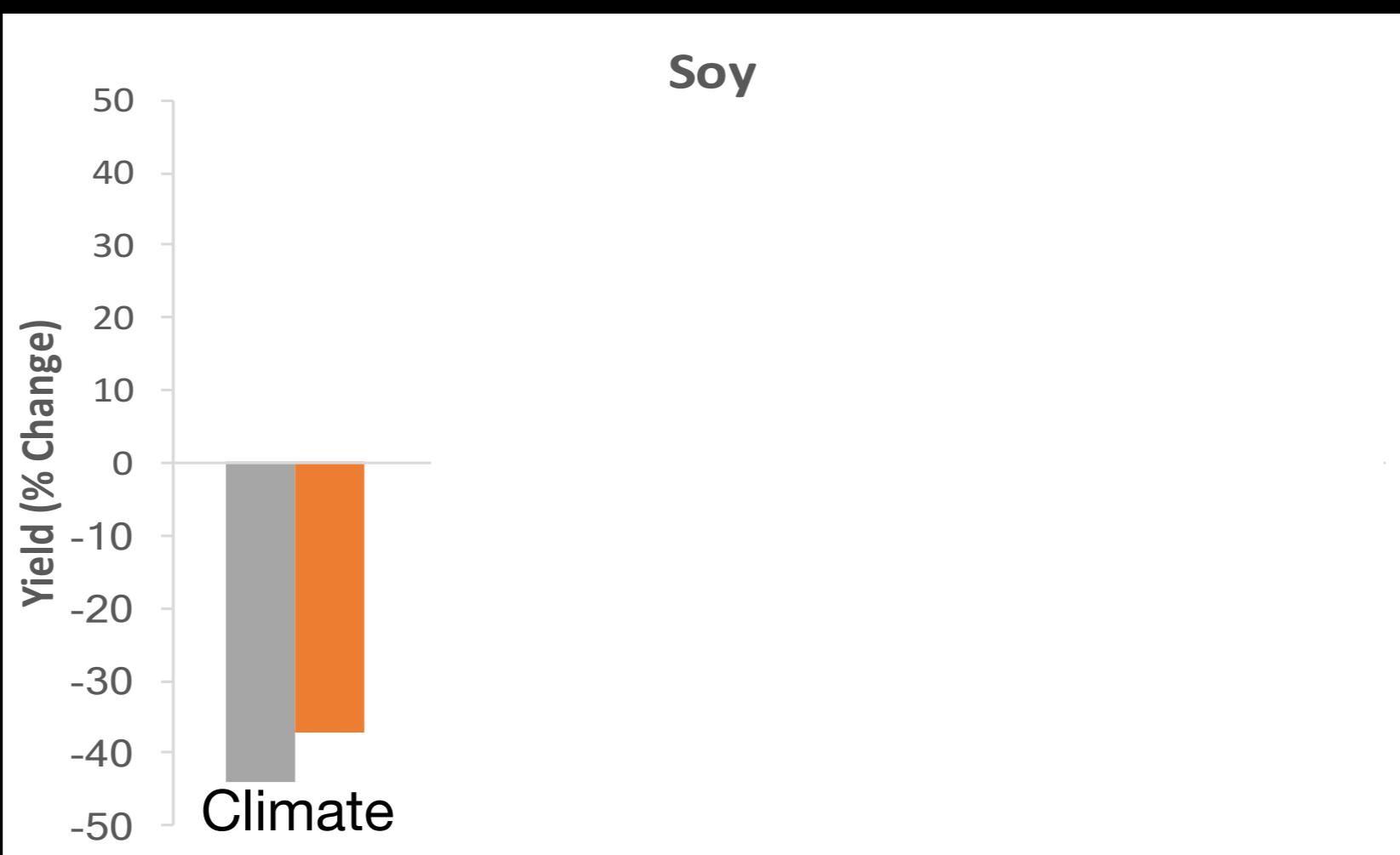
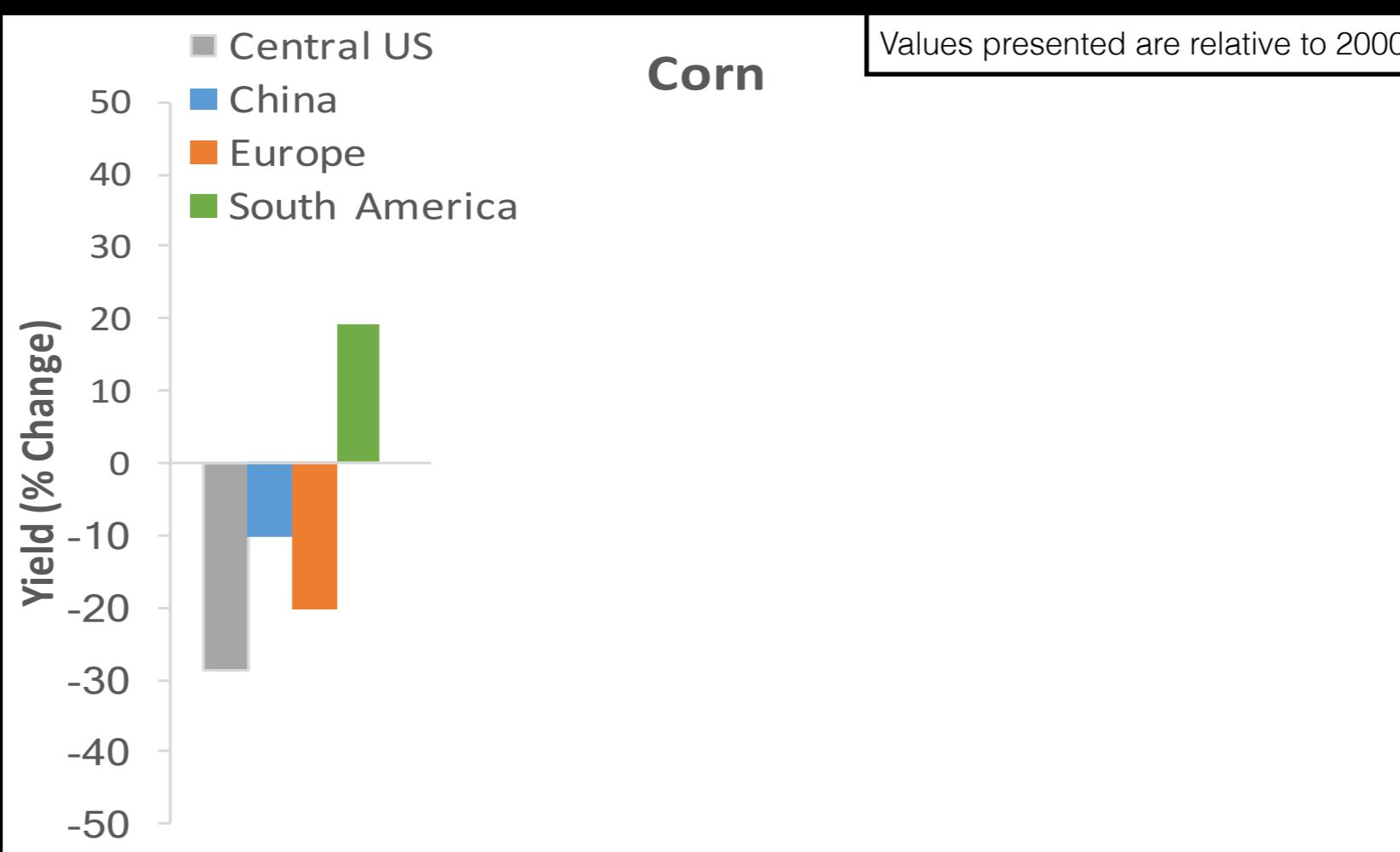
Δ 2100 Average Crop Yield

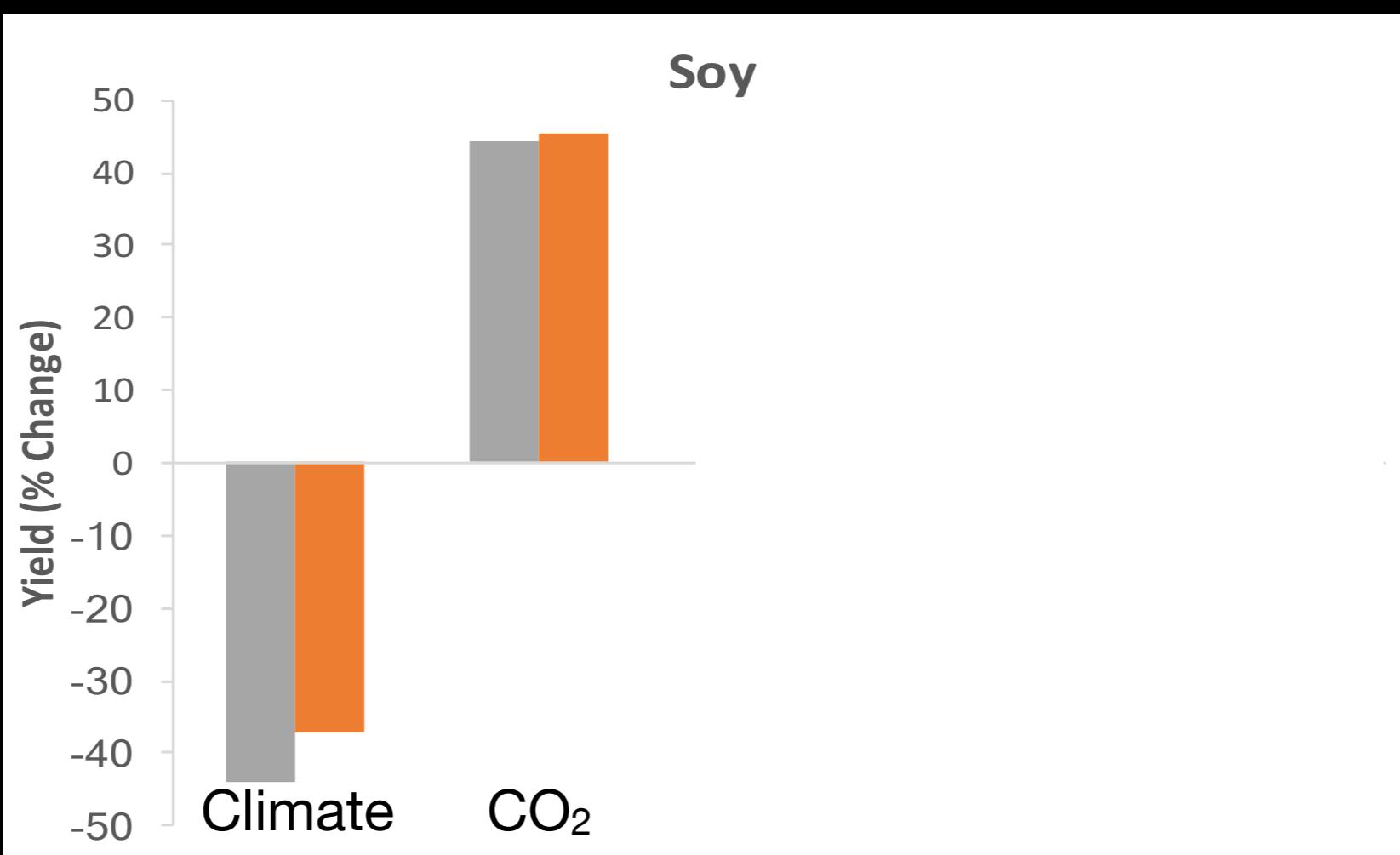
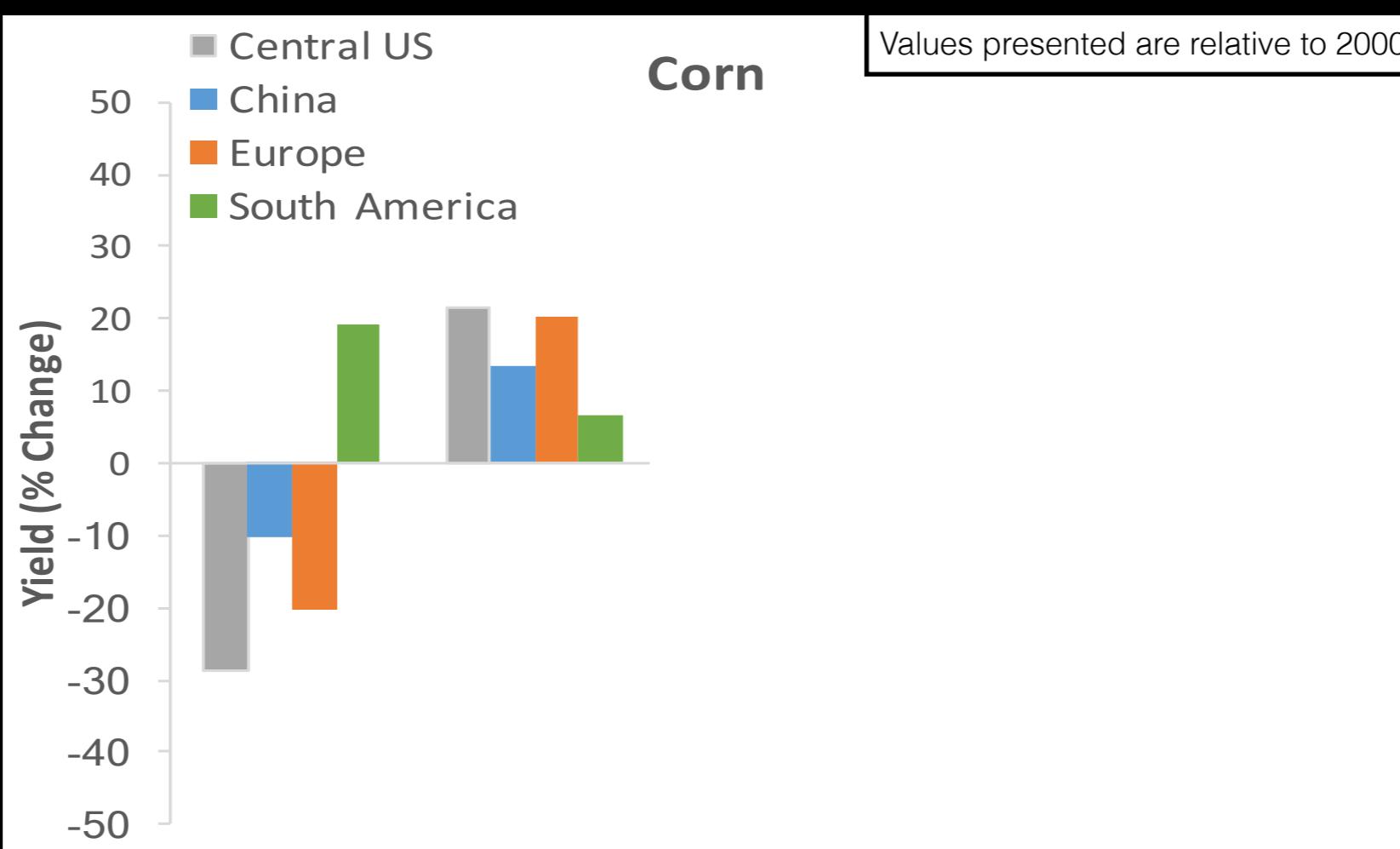


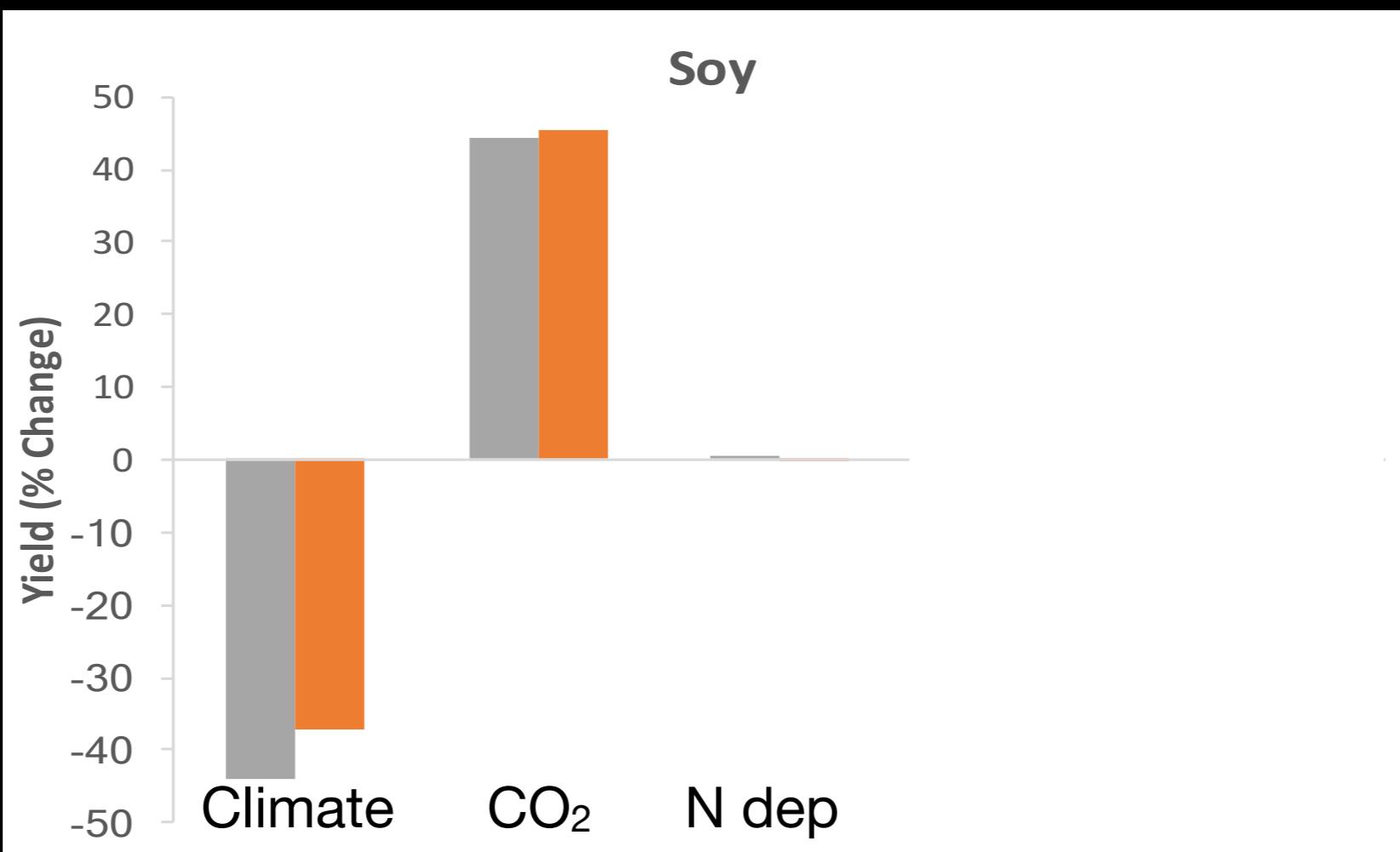
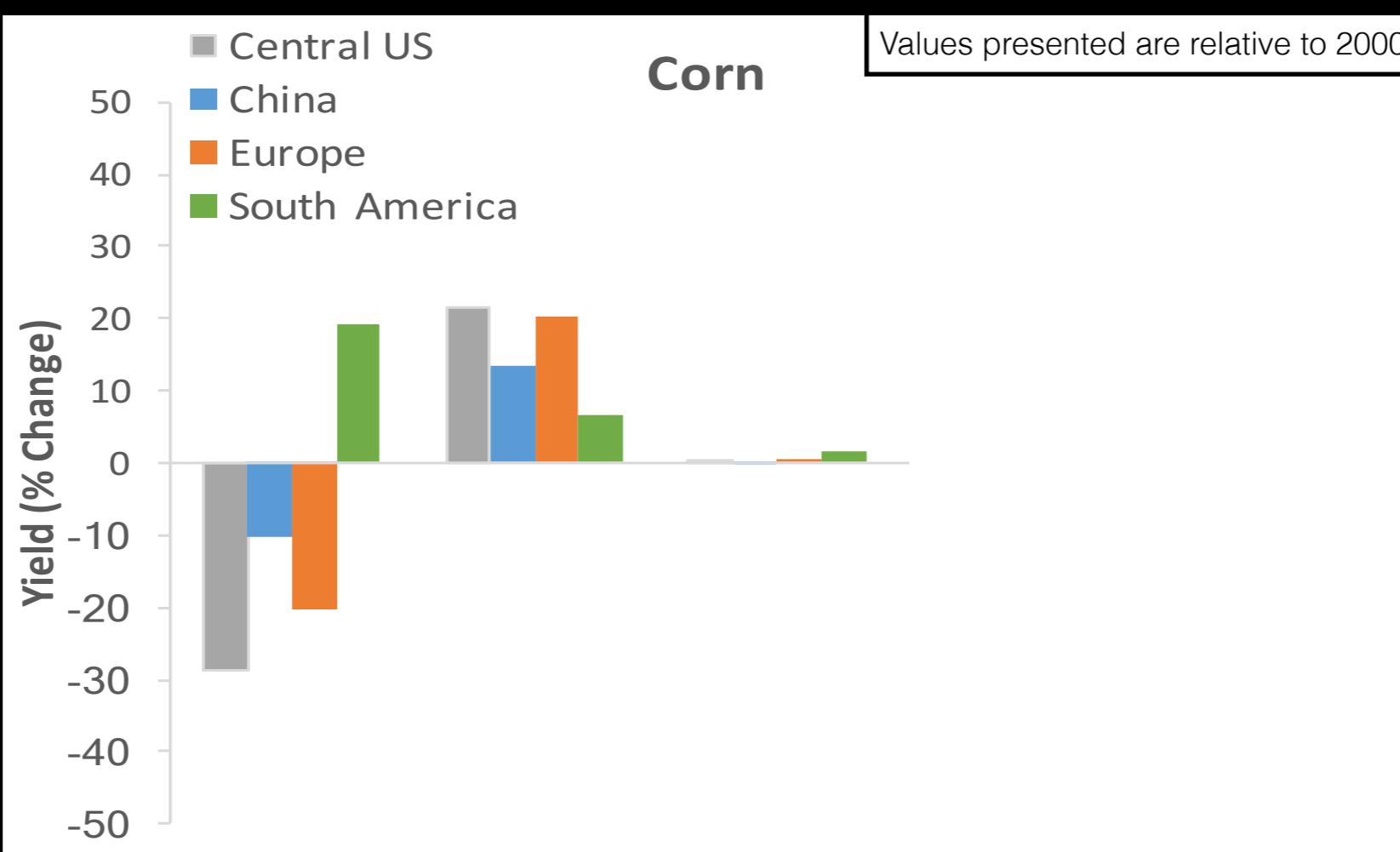
$\Delta 2100$ Average Crop Yield

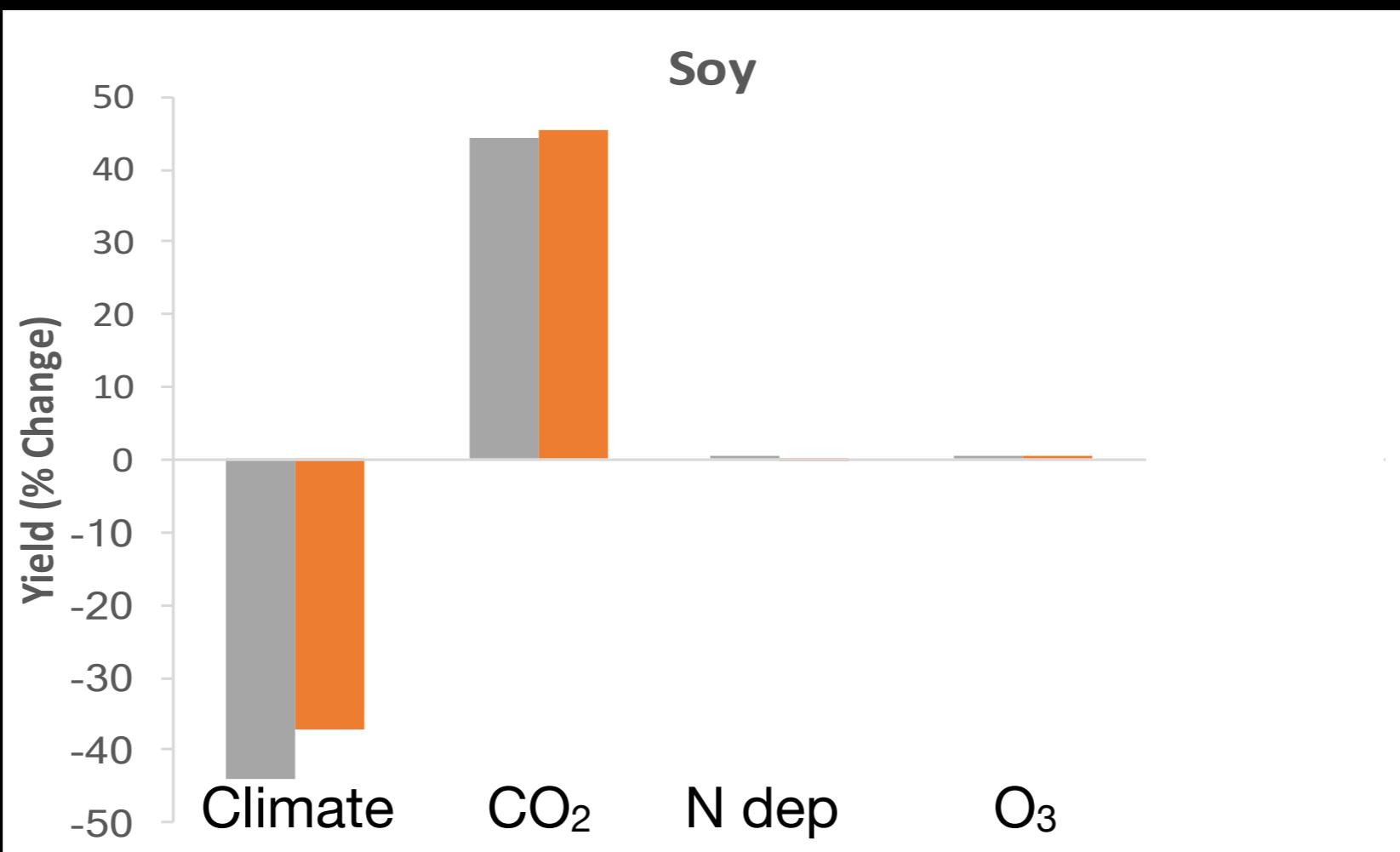
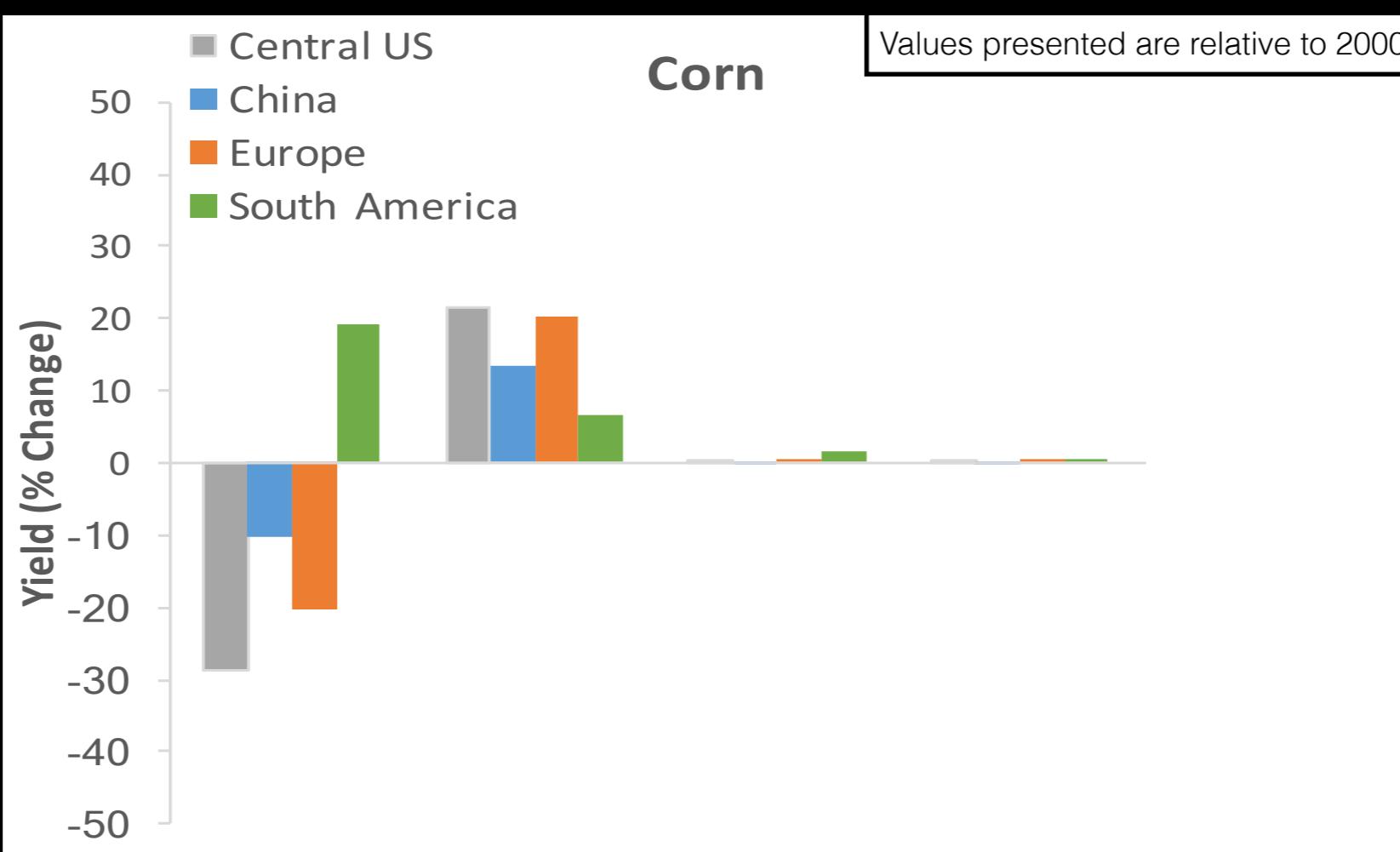


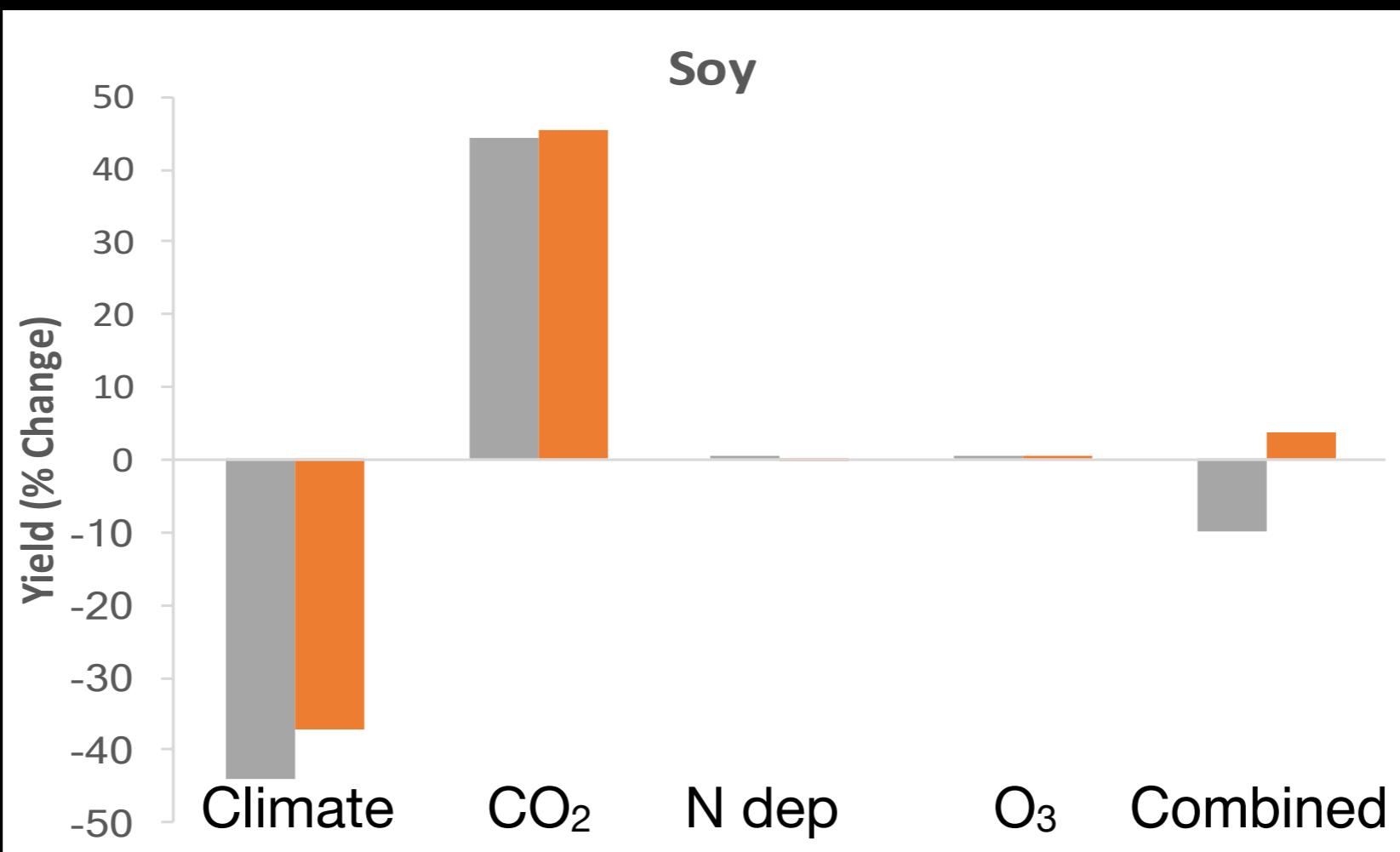
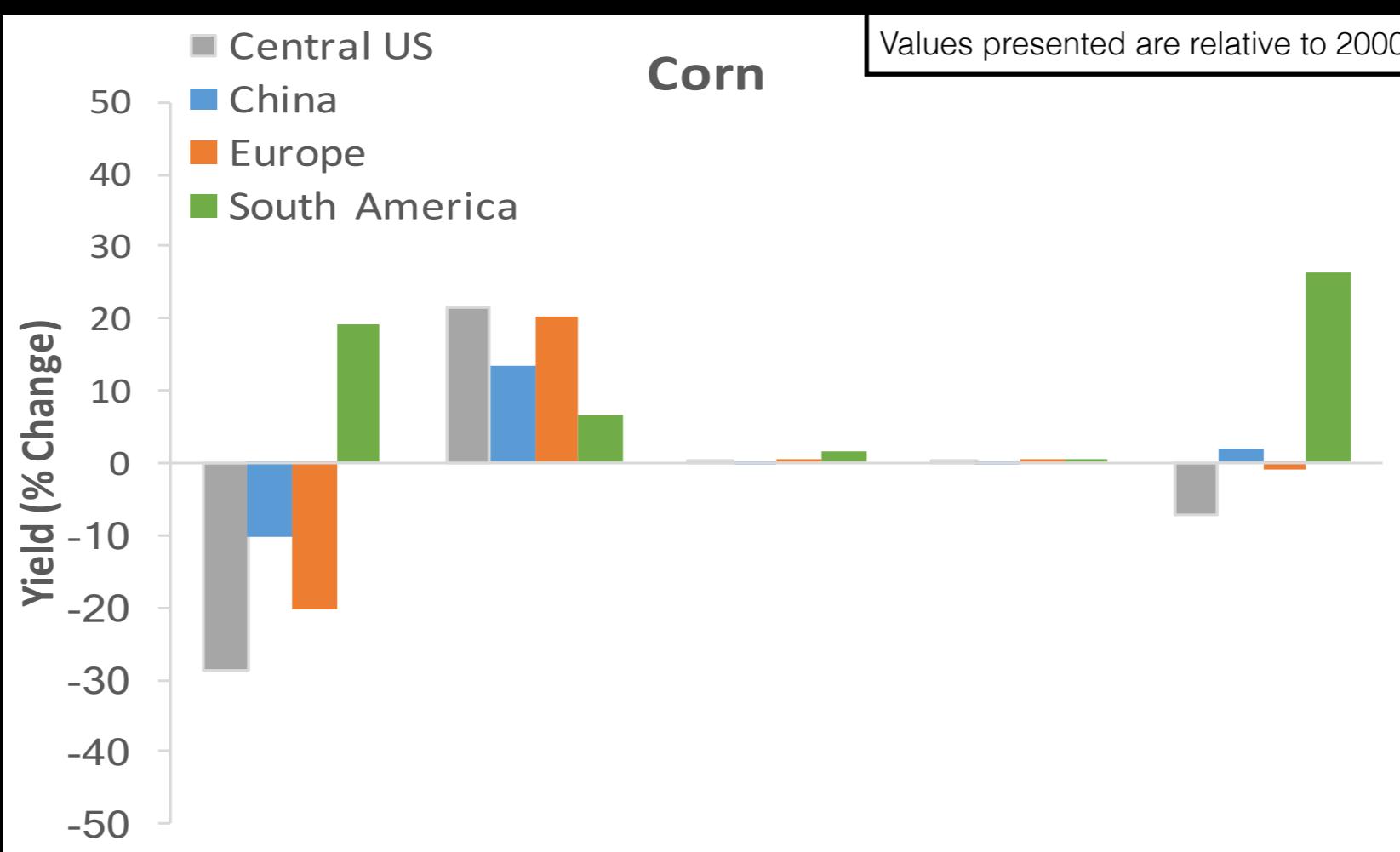


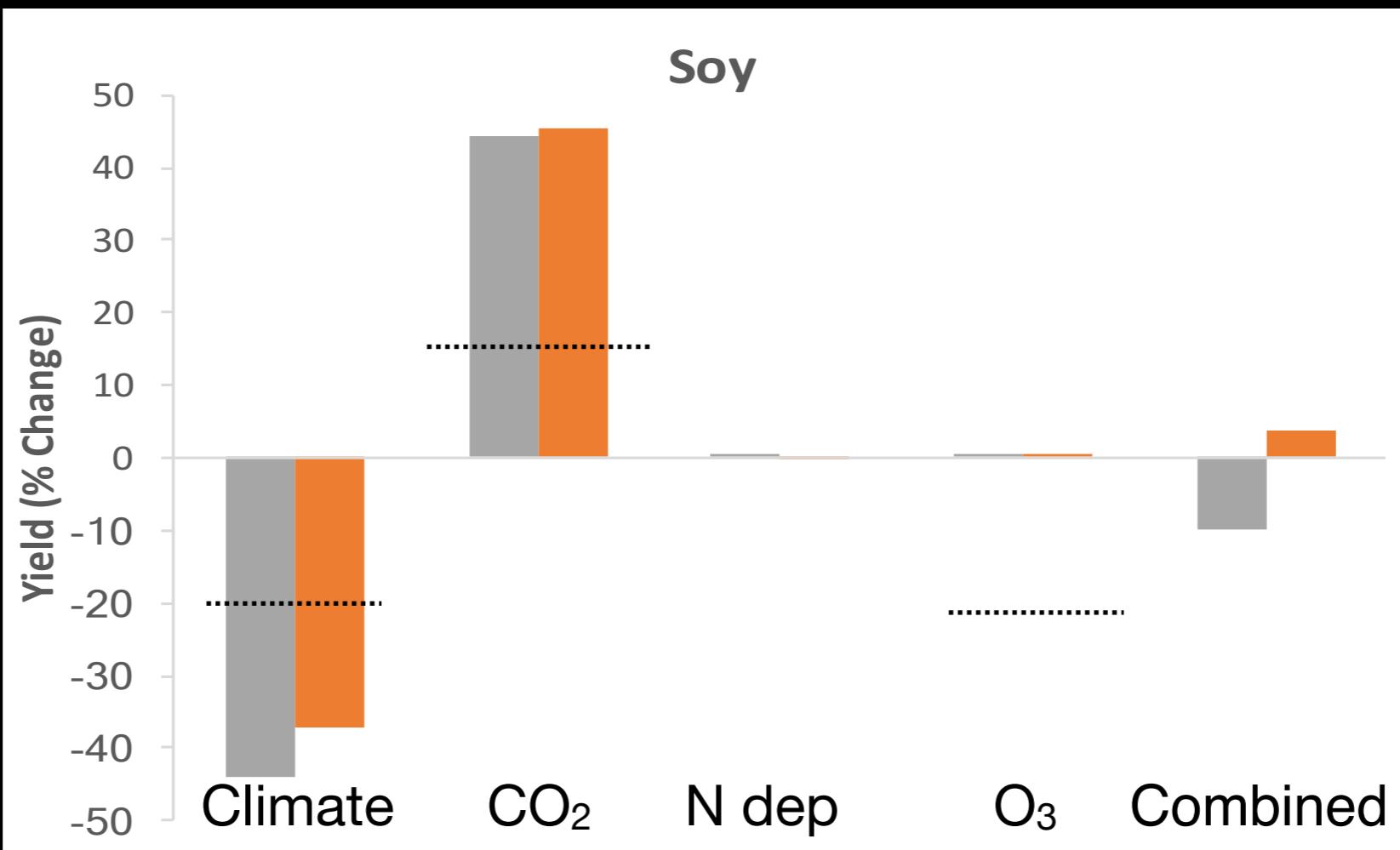
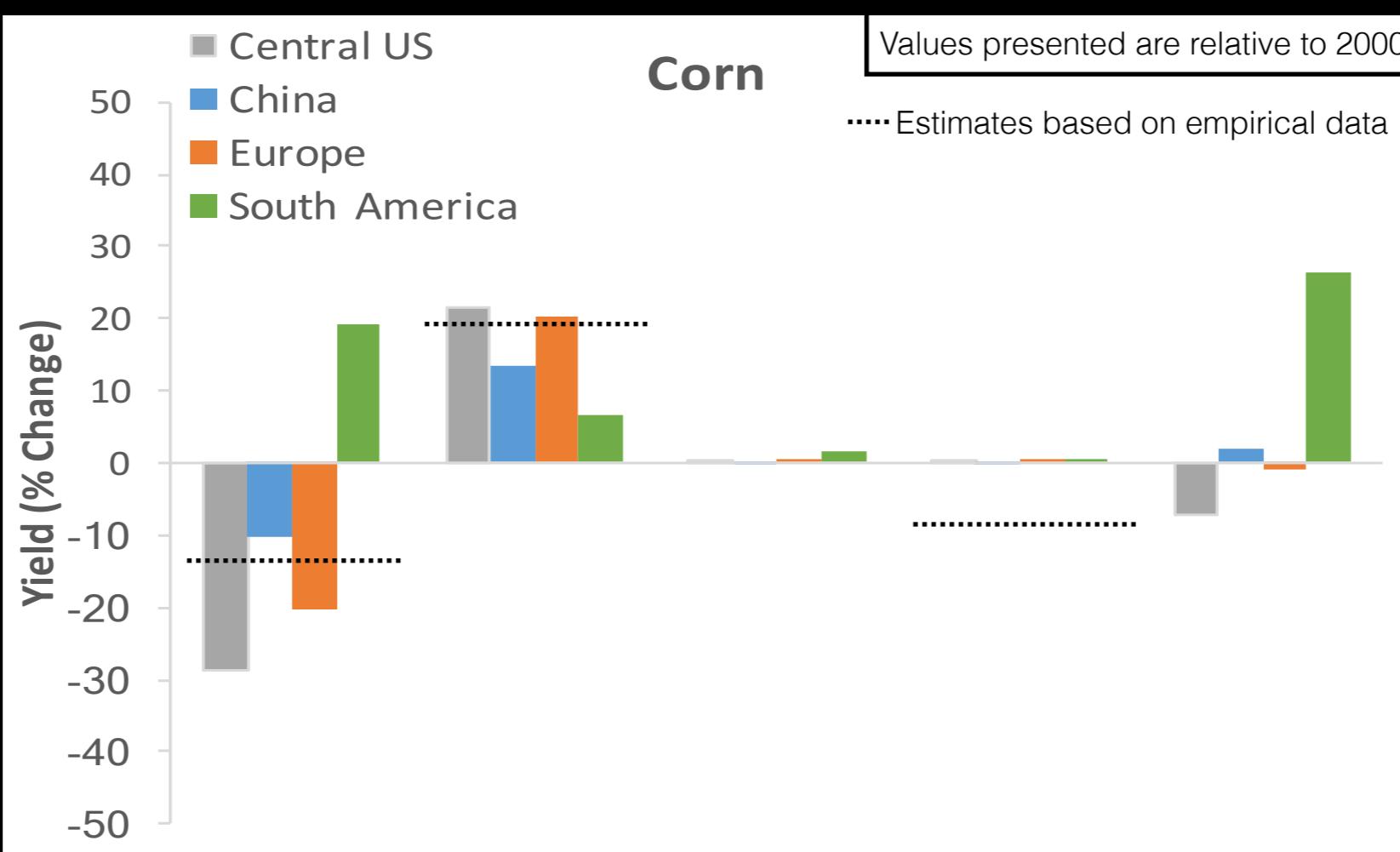










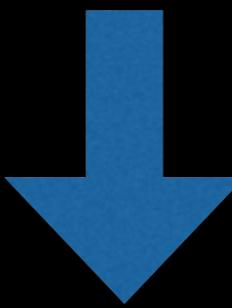




Expectations: Corn Soy

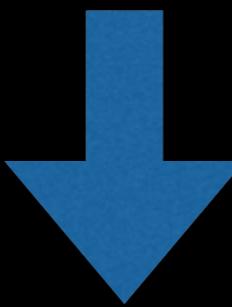
O_3

Phytotoxicity



Climate

Heat stress



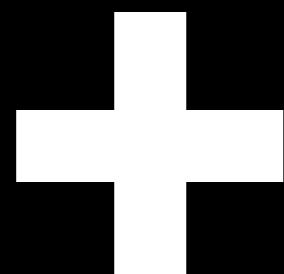
N deposition

Fertilization



CO_2

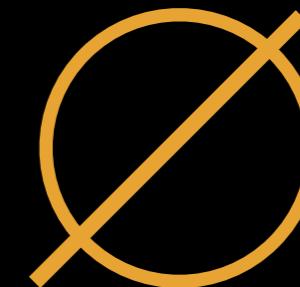
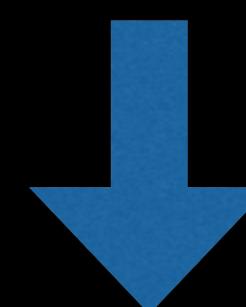
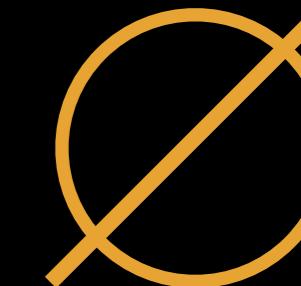
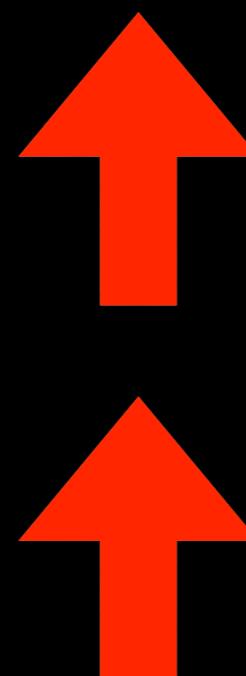
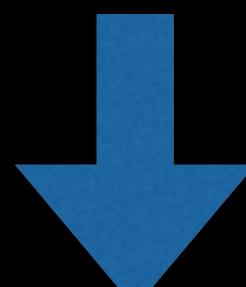
Fertilization



?



Expectations:

	Corn	Soy
O ₃ Phytotoxicity		
Climate Heat stress		
N deposition Fertilization		
CO ₂ Fertilization		
?	Varies Regionally	

O₃

Phytotoxicity

Climate

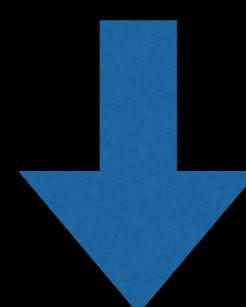
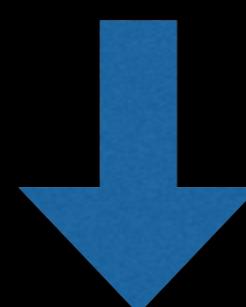
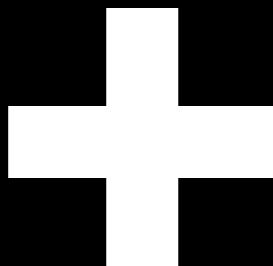
Heat stress

N deposition

Fertilization

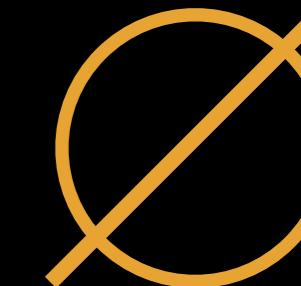
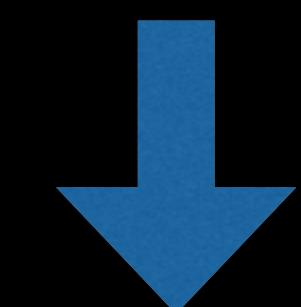
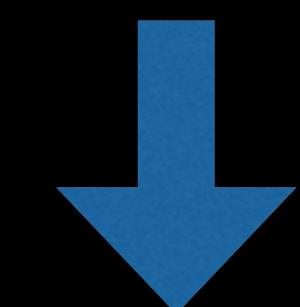
CO₂

Fertilization



Corn

Soy



Varies
Regionally

A landscape photograph showing a vast field in the foreground, likely a crop field, under a dramatic sky at sunset or sunrise. The sky is filled with large, billowing clouds, some illuminated from below by the setting sun, which casts a warm orange glow across the horizon. In the distance, a range of mountains is visible, and a set of power transmission towers and lines cuts across the scene. A white rounded rectangle, resembling a speech bubble, is positioned in the upper right quadrant of the image, containing the text.

How will crop yields change in the future?

How will crop yields change in the future?

- Yield depends on region and crop type
- climate: decreases future yields
- CO₂: increases future yields

Future crop yields might not meet the estimated 65% increased demand*.

* Simulations do not account for areal expansion, varietal improvements, intensification, or other technological advances

Crop Model

- Yields available for 31 different crop types
 - rain-fed & irrigated
- Ability to run transient
 - land area, irrigation, fertilizer
- Several considerations for analysis
 - conversion of 1-D output; variable analyzed; remapping crop types