Uncertainties and Considerations of Agricultural Projections over Future Climate

Guillermo A. Baigorria
gbaigorria@unl.edu

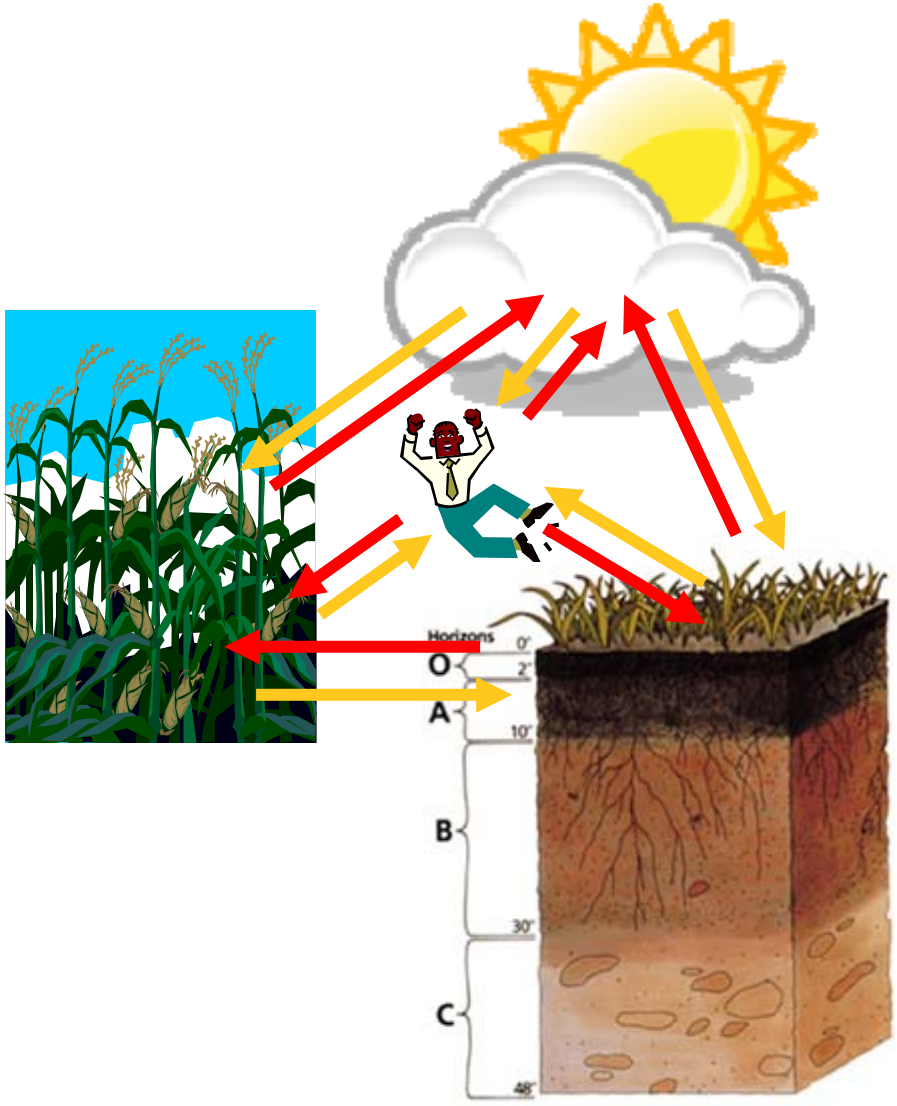
University of Nebraska – Lincoln
School of Natural Resources & Dpt. Agronomy and Horticulture

B.S. & Eng. **Meteorology**

M.S. **Crop Production**

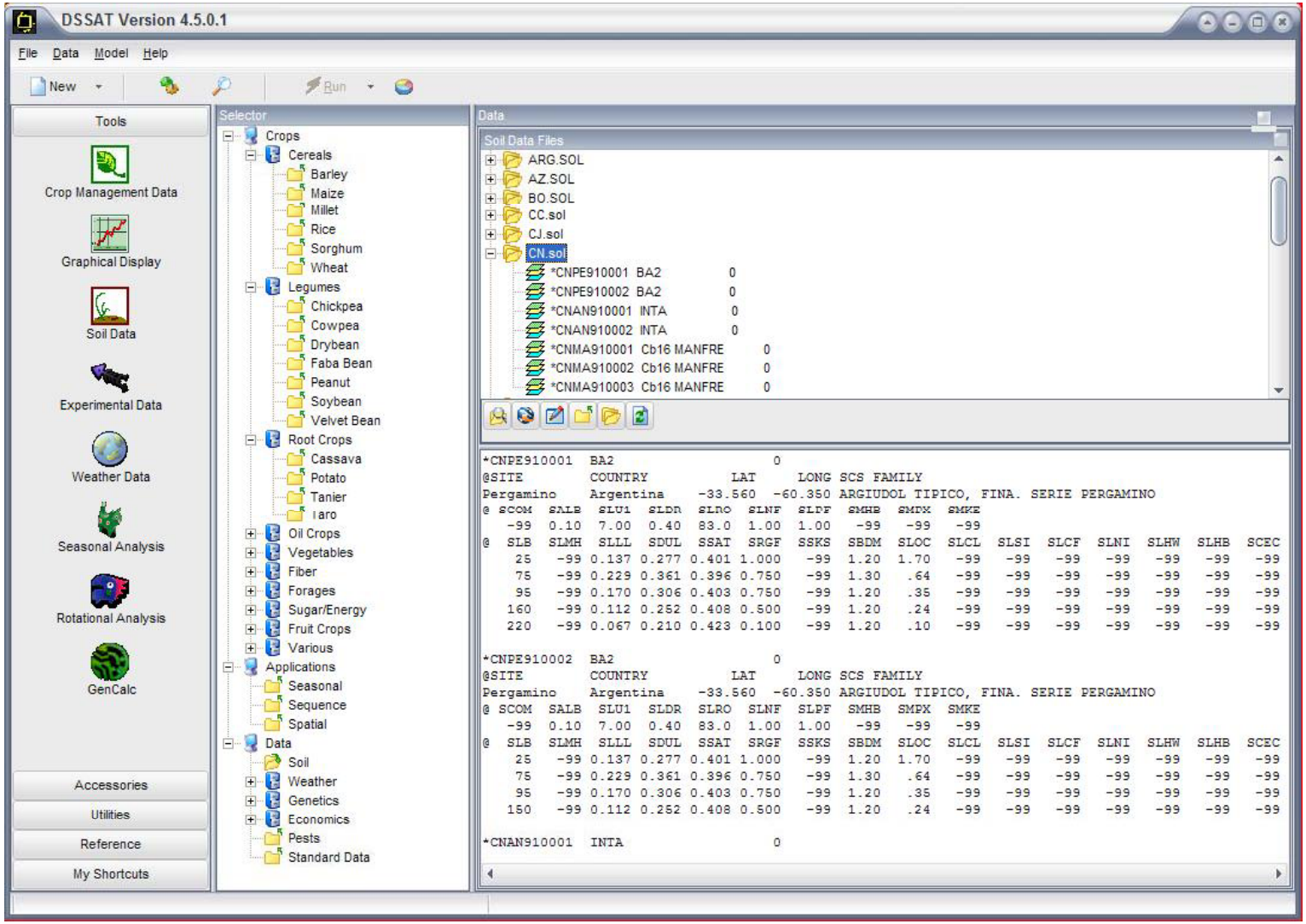
Ph.D. **Soil Science and Land Evaluation**

Post Doc **System Analysis**



CSM - DSSAT

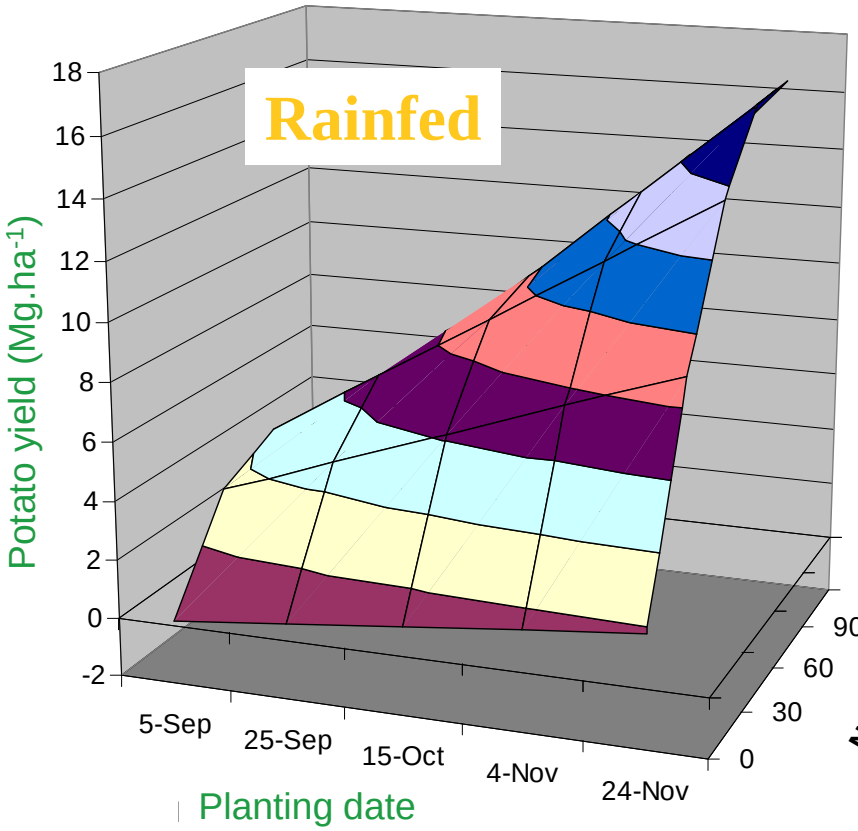
Crop System Model – Decision Support System for Agrotechnology Transfer

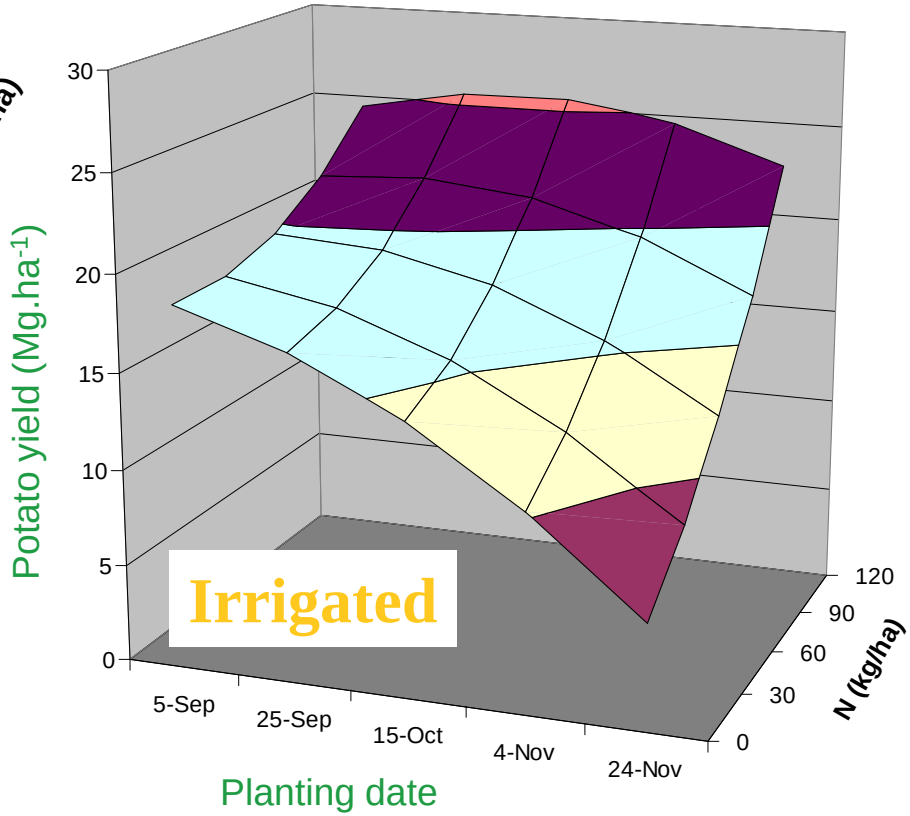


Mañazo – Puno

(4,000 m a.s.l.)

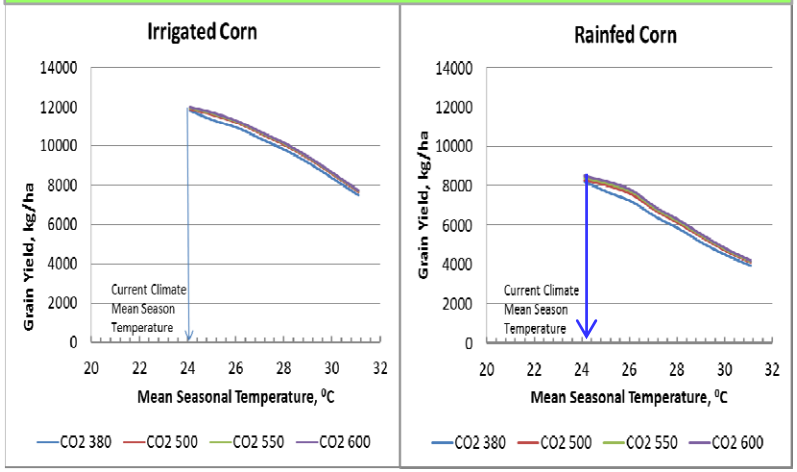
New irrigation scenarios for potato farmers with hundreds of years of tradition



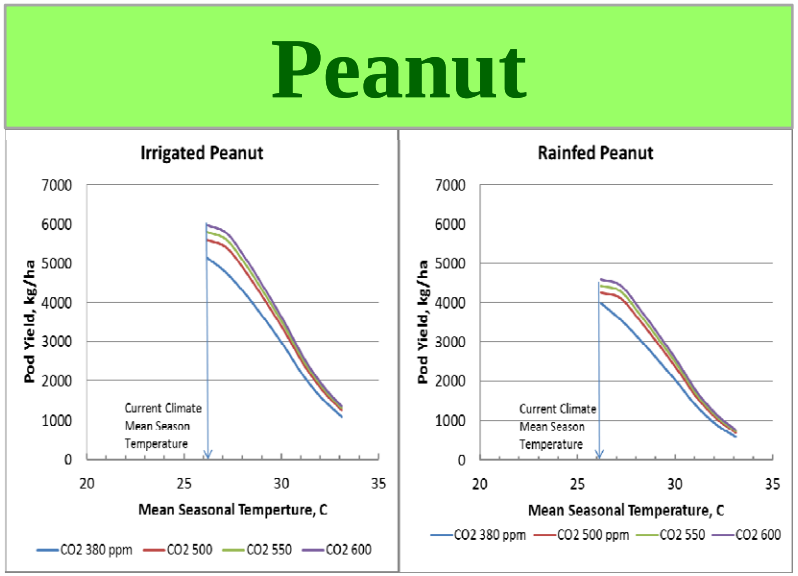


Simulated effect of increased temperatures and CO_2 on yields

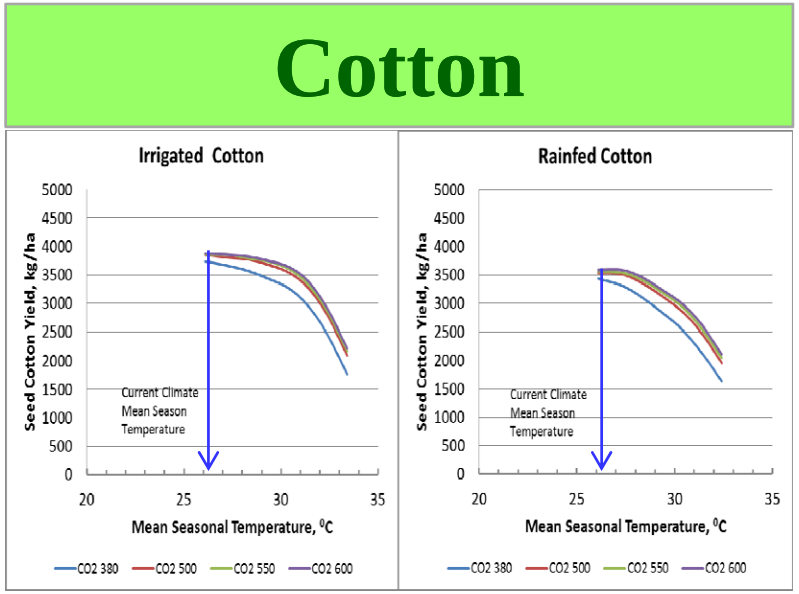
Corn

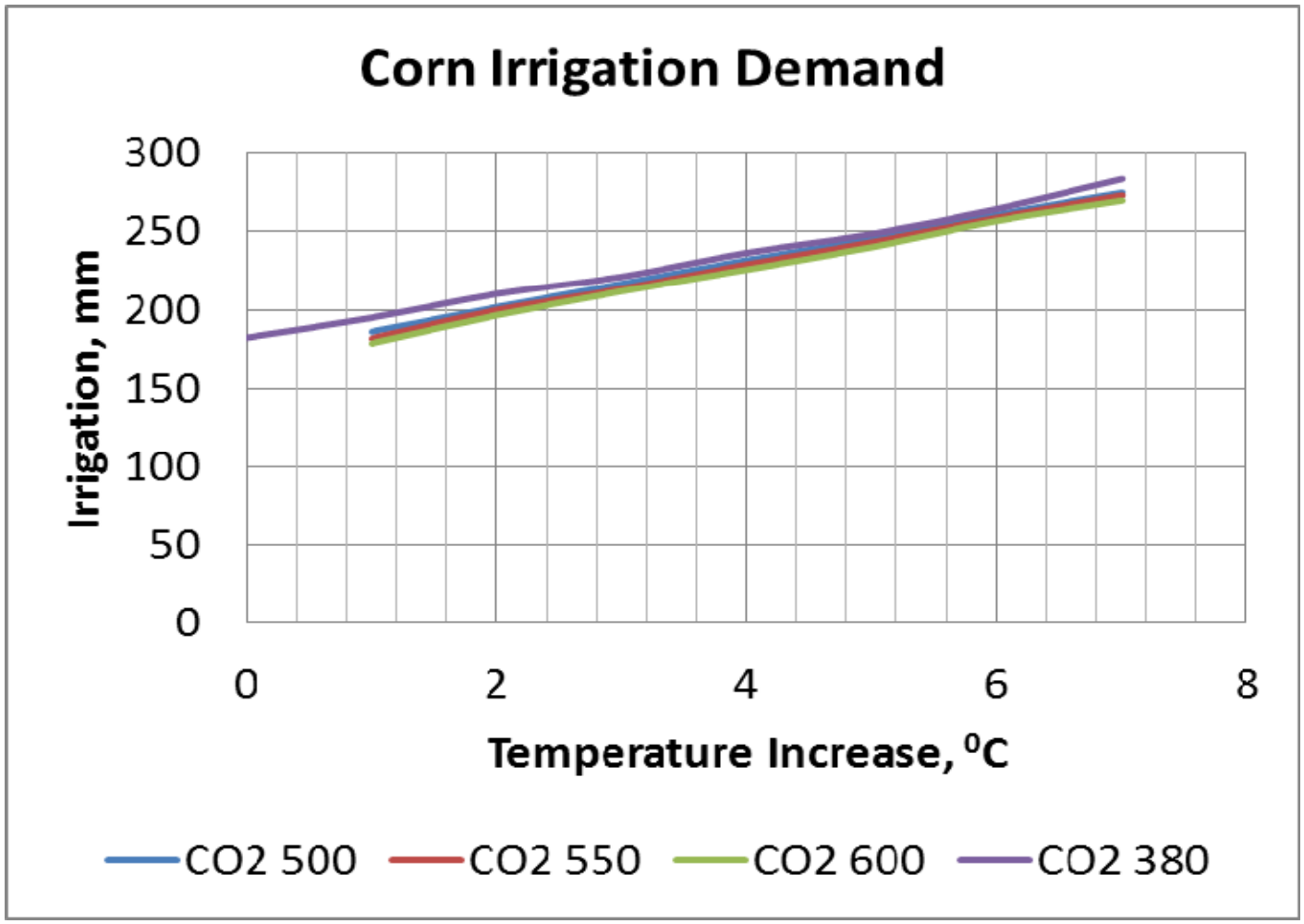


Peanut



Cotton

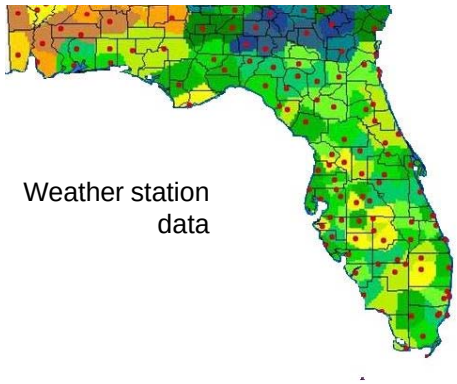



Corn Irrigation Demand
Irrigation, mm
300
250
200
150
100
50
0
0
2
4
6
8
Temperature Increase, °C
CO2 500
CO2 550
CO2 600
CO2 380

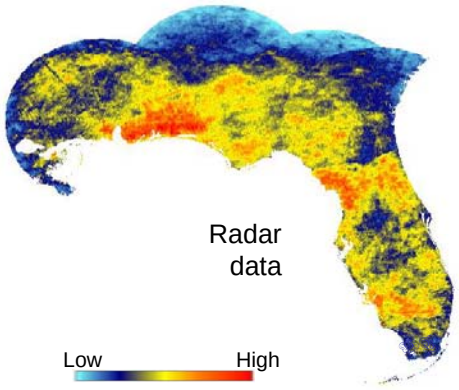
Linking Climate Models and Crop Models

Spatial resolution

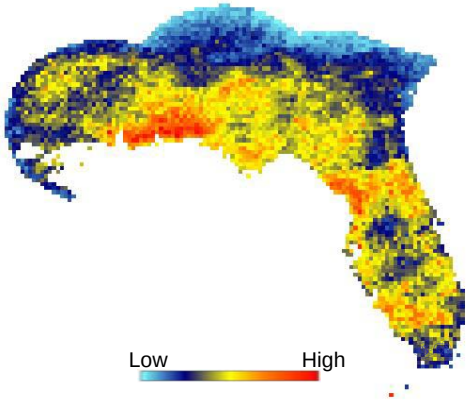
1 m



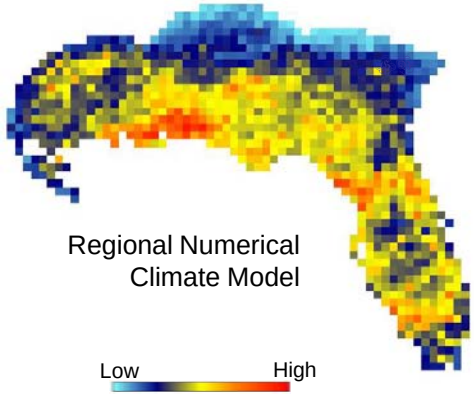
0.5 km



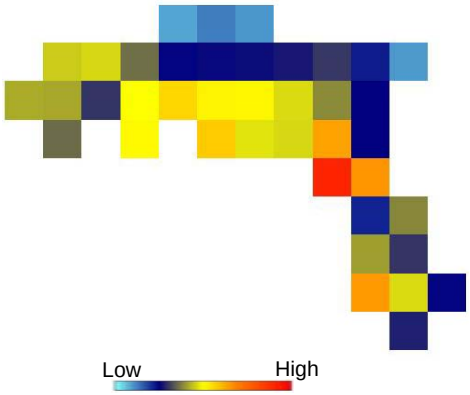
10 km



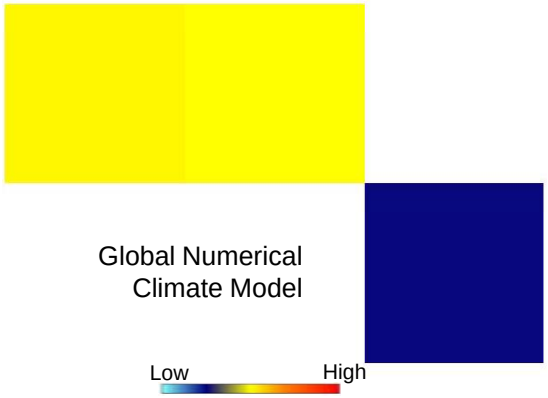
20 km

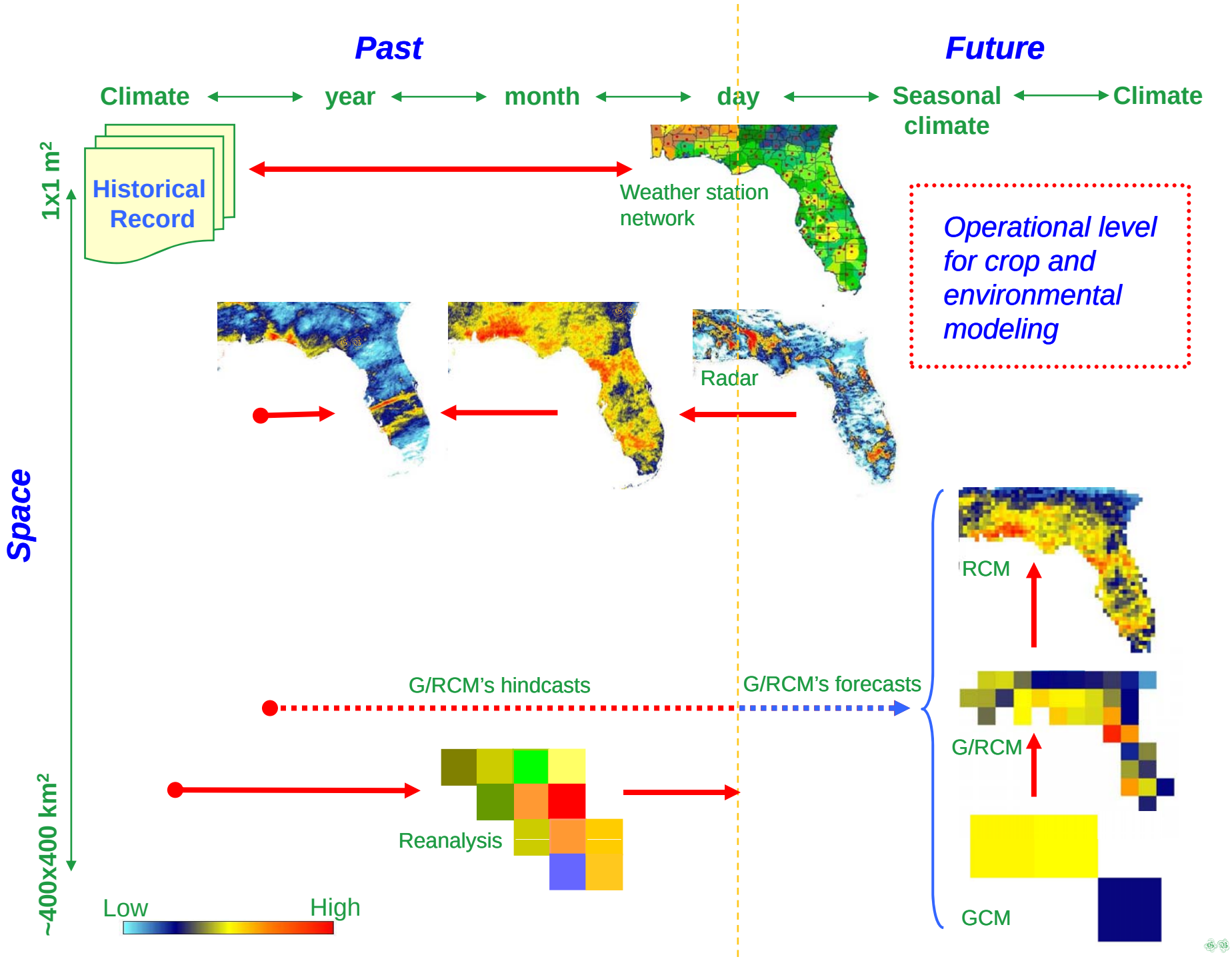


100 km



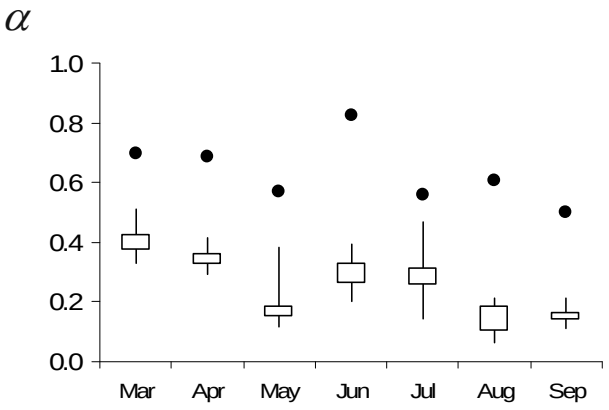
400 km

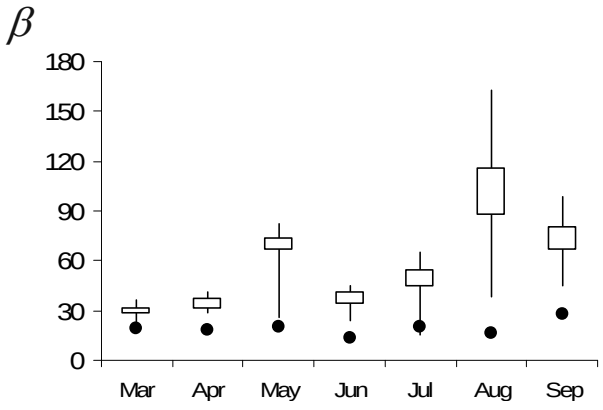



Past
Future
Climate
year
month
day
Seasonal climate
Climate
Historical Record
1x1 m²
Weather station network
Operational level for crop and environmental modeling
Radar
Space
RCM
G/RCM's hindcasts
G/RCM's forecasts
G/RCM
Reanalysis
GCM
~400x400 km²
Low
High

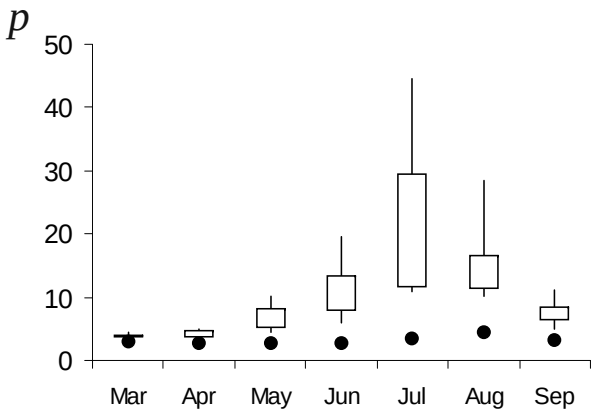
County: DeKalb

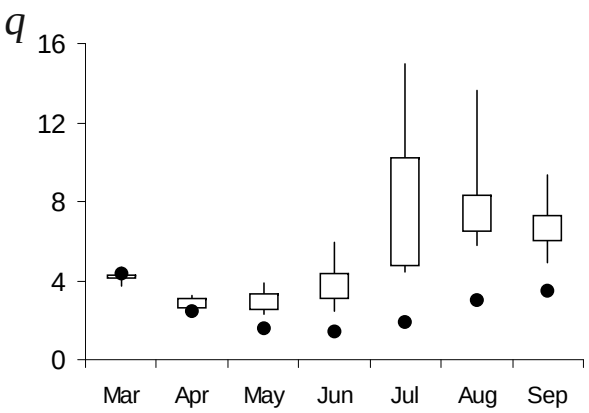
Gamma distribution
(rainfall)



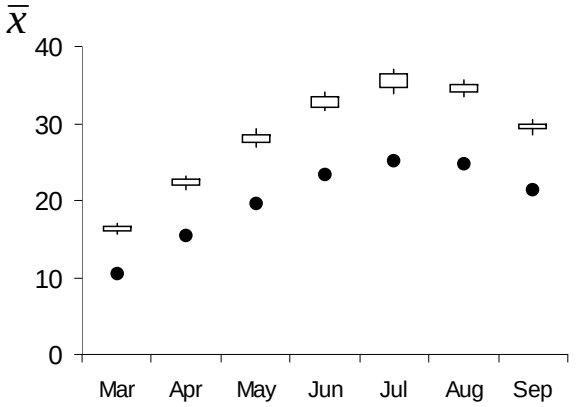


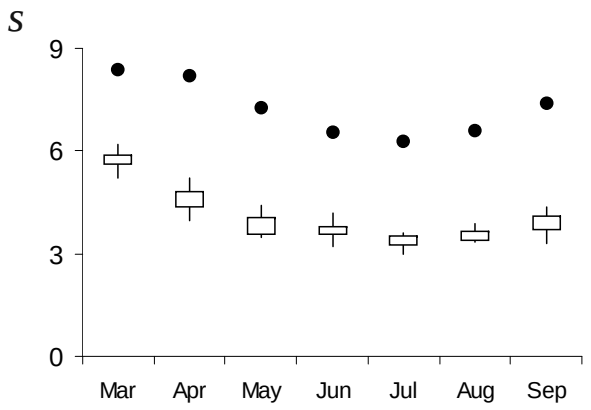
Beta distribution
(Incoming solar radiation)





Gaussian distribution
(Max. and Min. Temperatures)

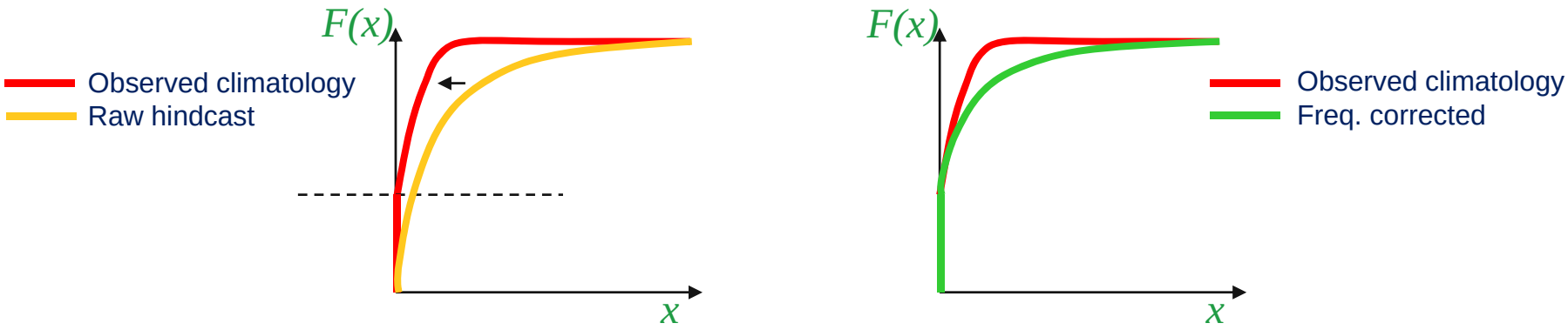




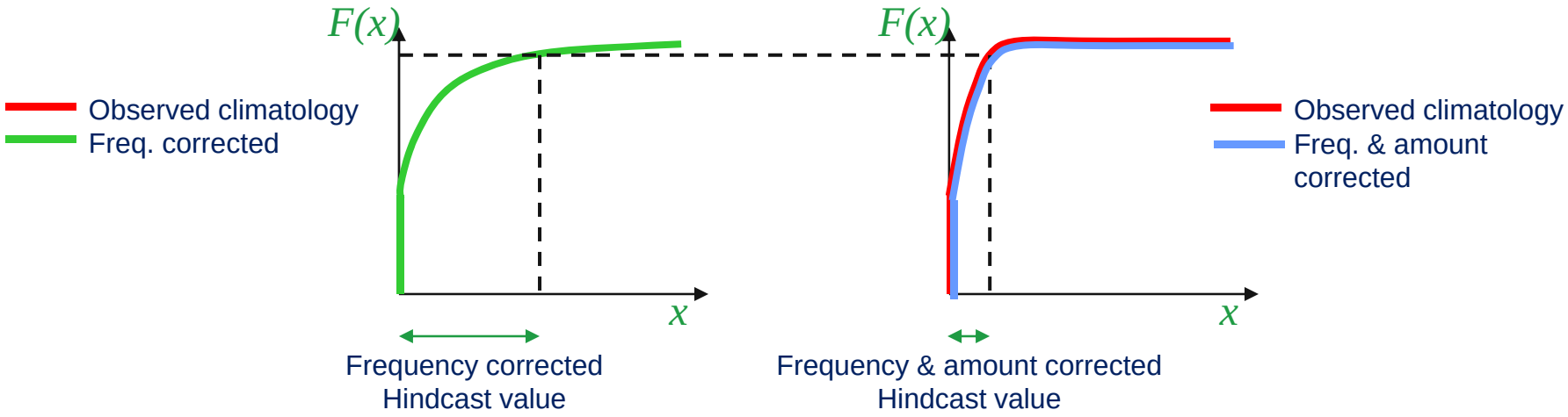
Observed RCM ensemble

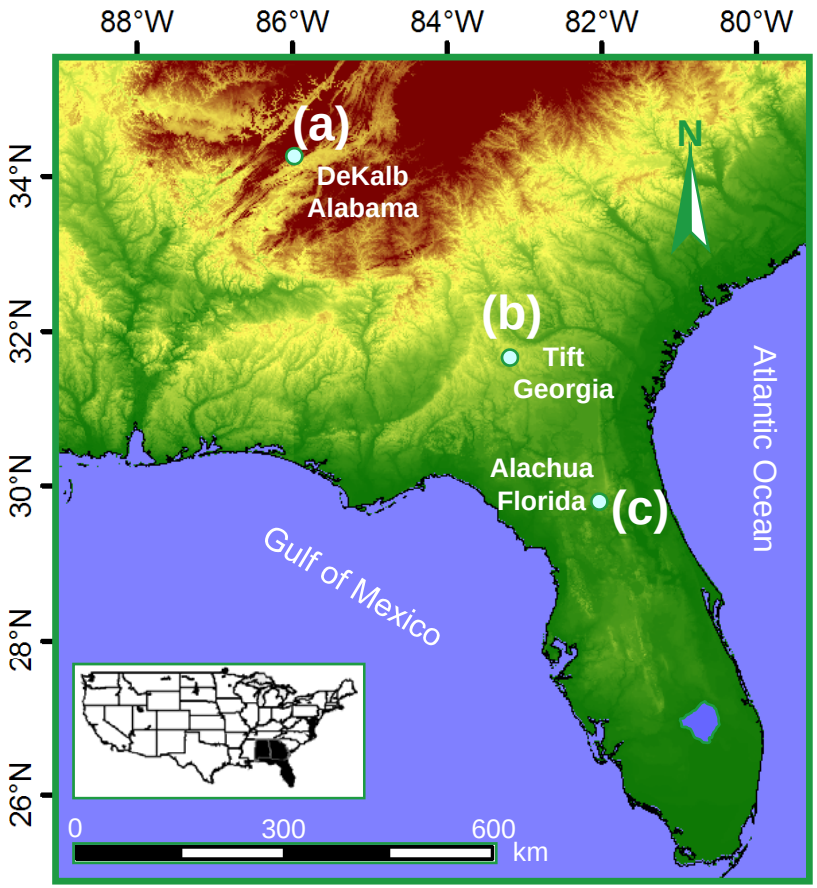
Bias correction based on cumulative probability distributions

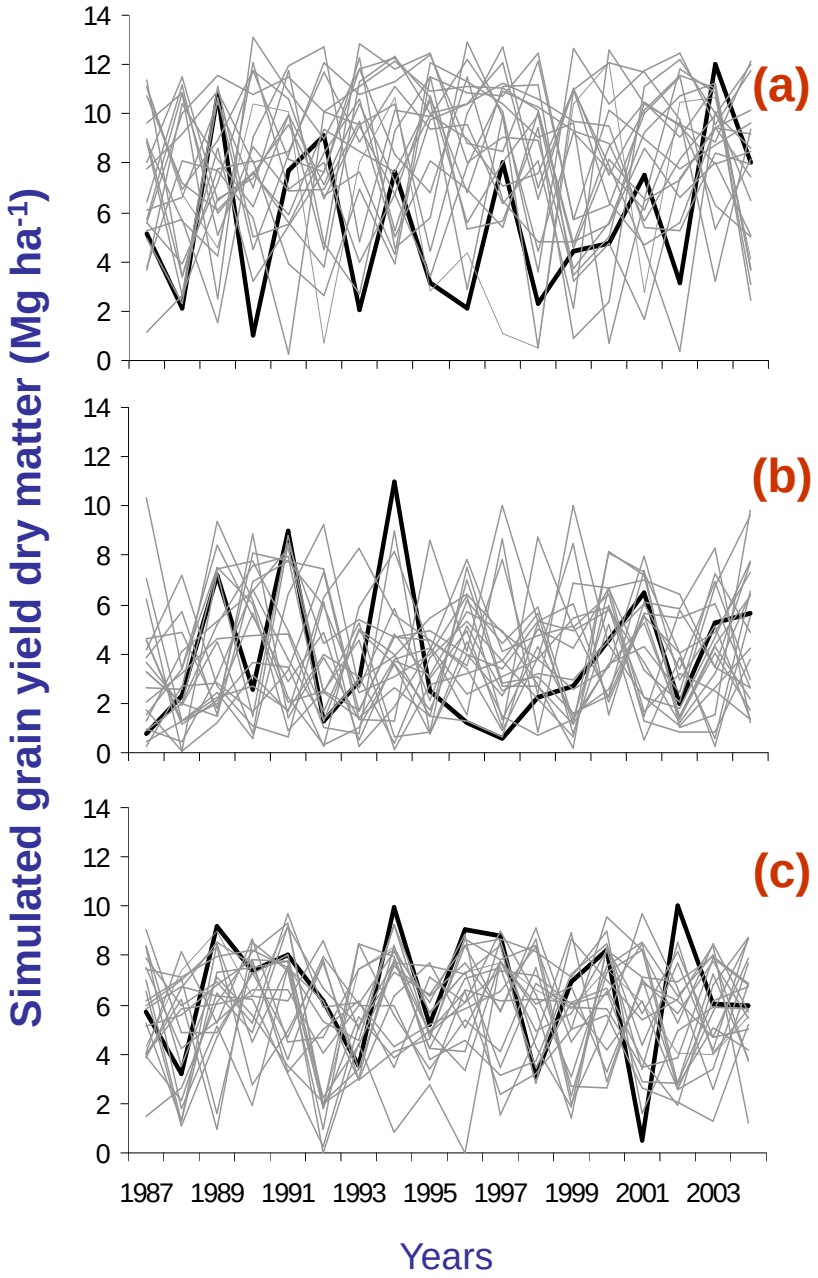
(a) Frequency correction



(b) Amount correction



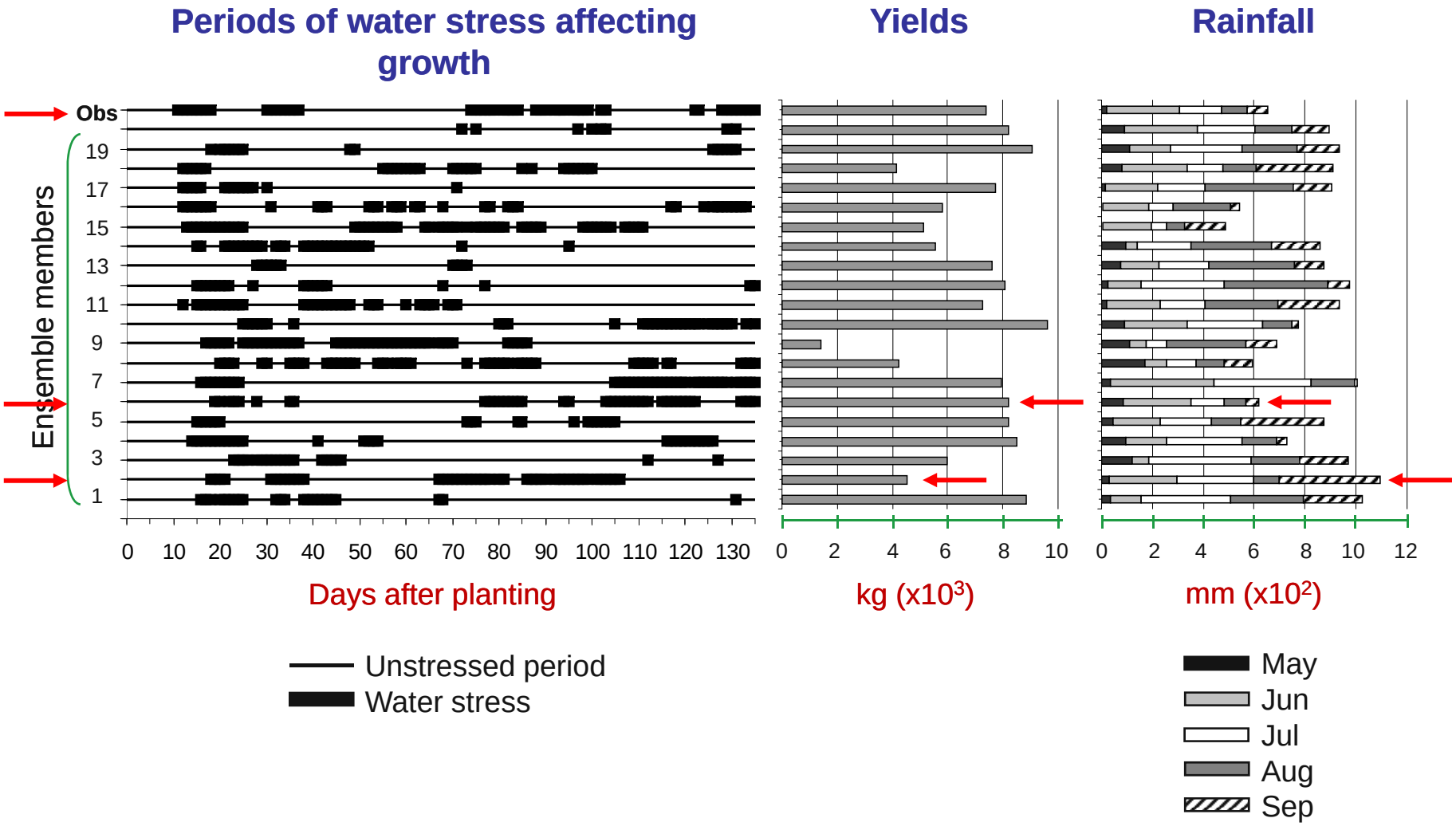




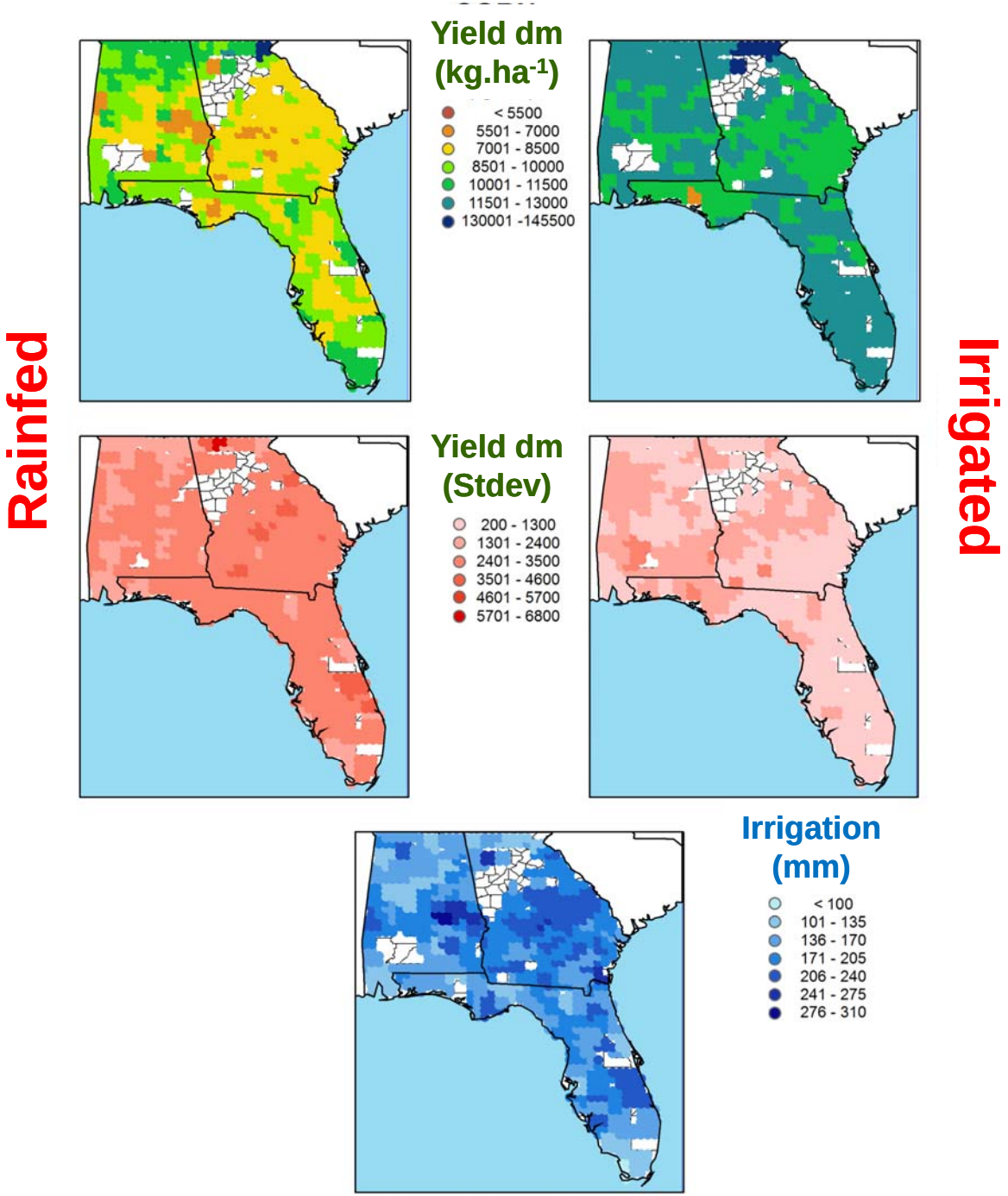
Simulated grain yield using:

Observed Weather

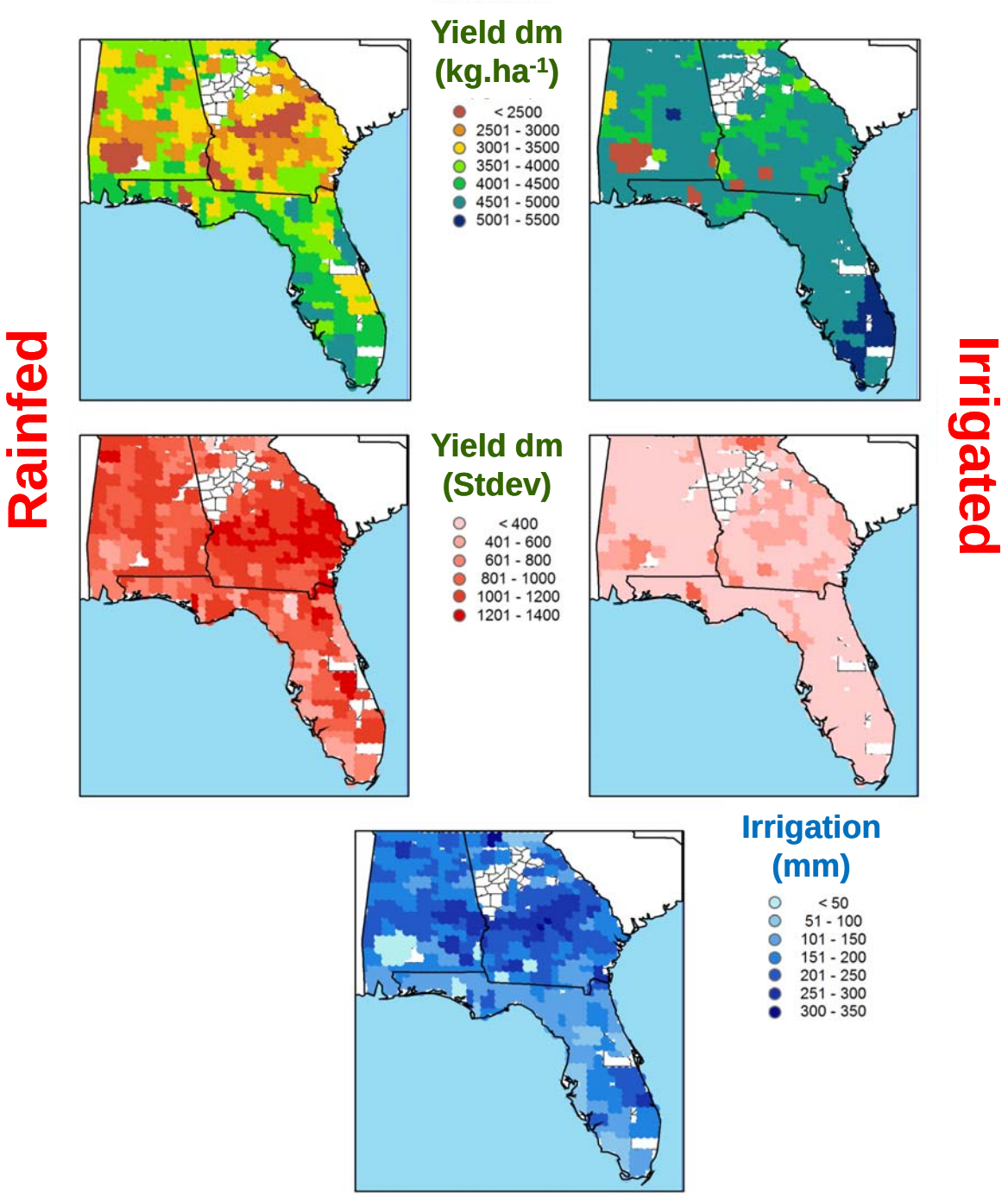
Daily seasonal climate hindcast


Periods of water stress affecting growth
Yields
Rainfall
Obs
19
17
15
13
11
9
7
5
3
1
Ensemble members
0 10 20 30 40 50 60 70 80 90 100 110 120 130
Days after planting
0 2 4 6 8 10
kg (x10³)
0 2 4 6 8 10 12
mm (x10²)
Unstressed period
Water stress
May
Jun
Jul
Aug
Sep

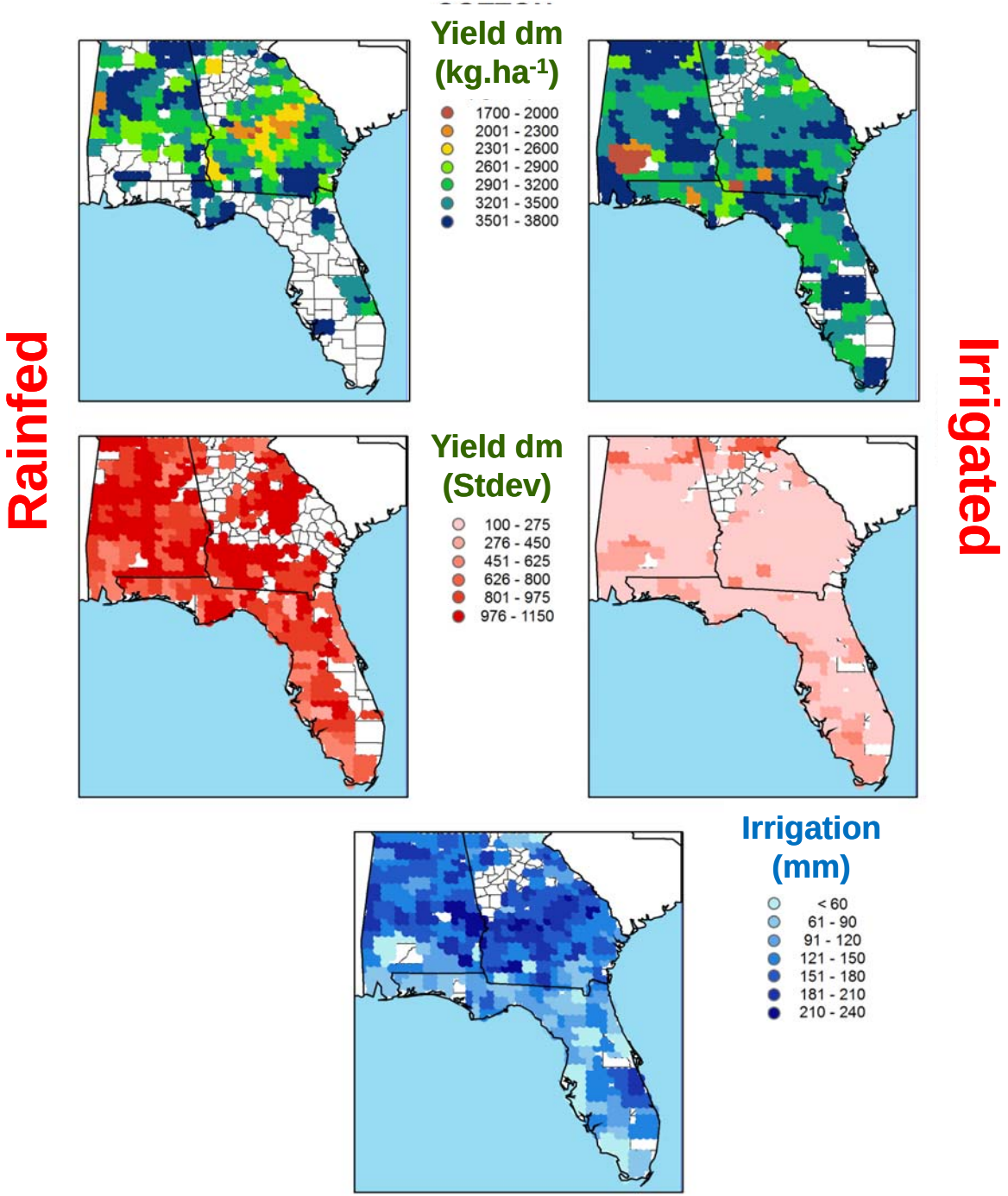
Simulated Corn using observed weather data (1961-2010)



Simulated Peanut using observed weather data (1961-2010)



Simulated Cotton using observed weather data (1961-2010)



Changes on important parameters related to corn production (2006-2035)

Fig 3: Corn - Irrigated - CMIP5/CanCM4/2005/SE

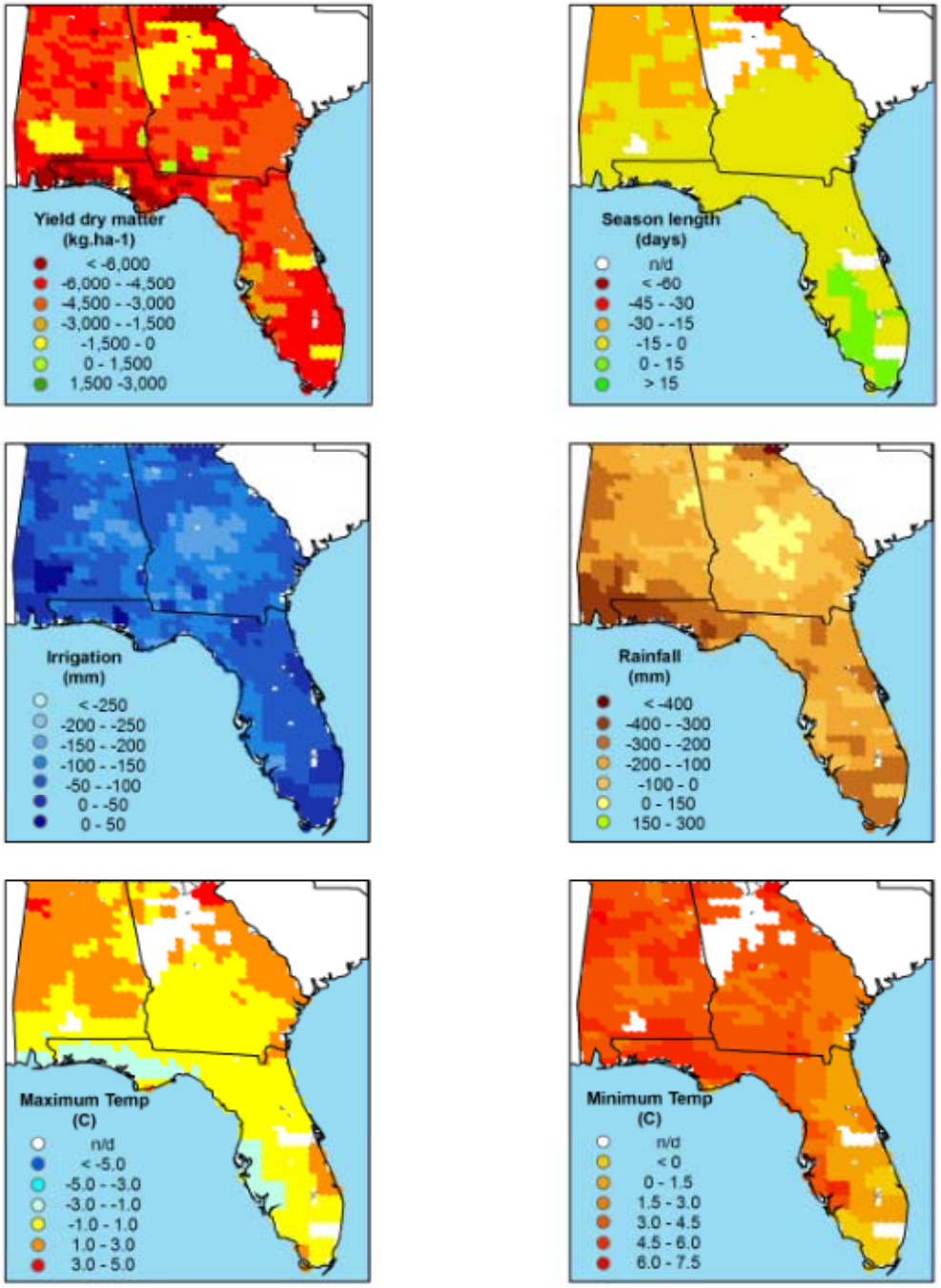
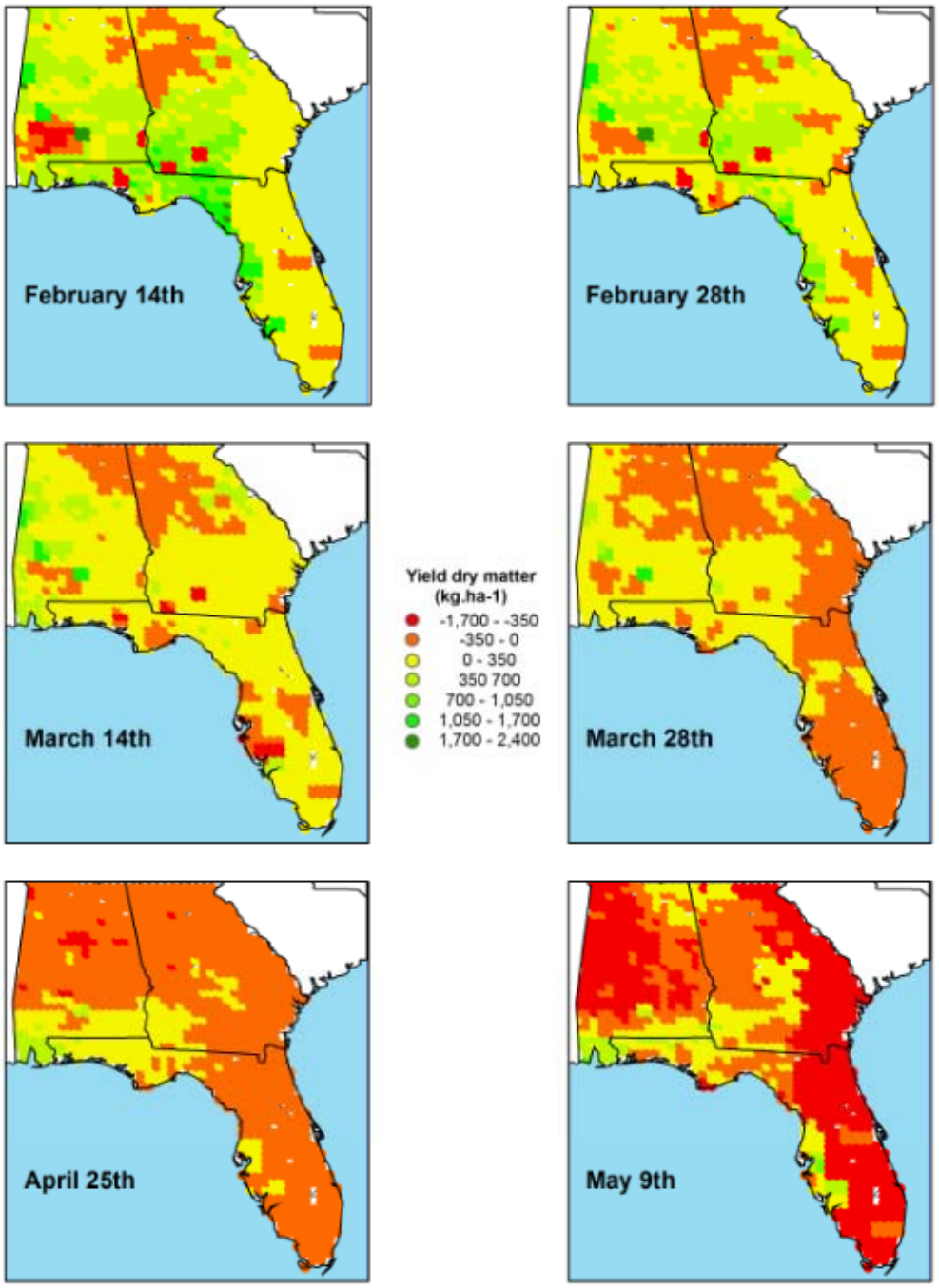


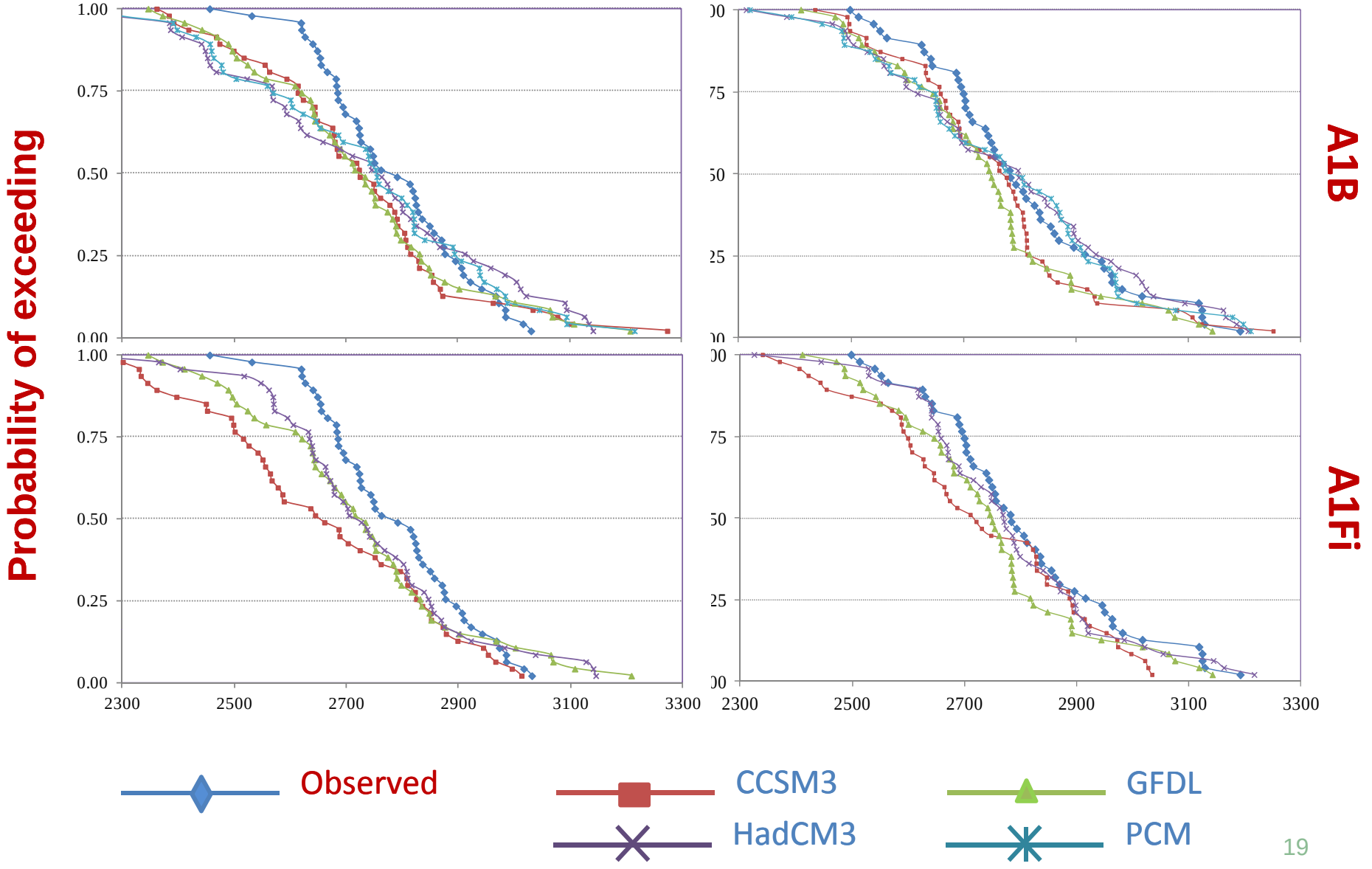
Fig 12: Corn - Irrigated - CMIP5/CanCM4/1980/SE



Adaptation: Changes on projected yields by moving planting dates (Current: April 11th)

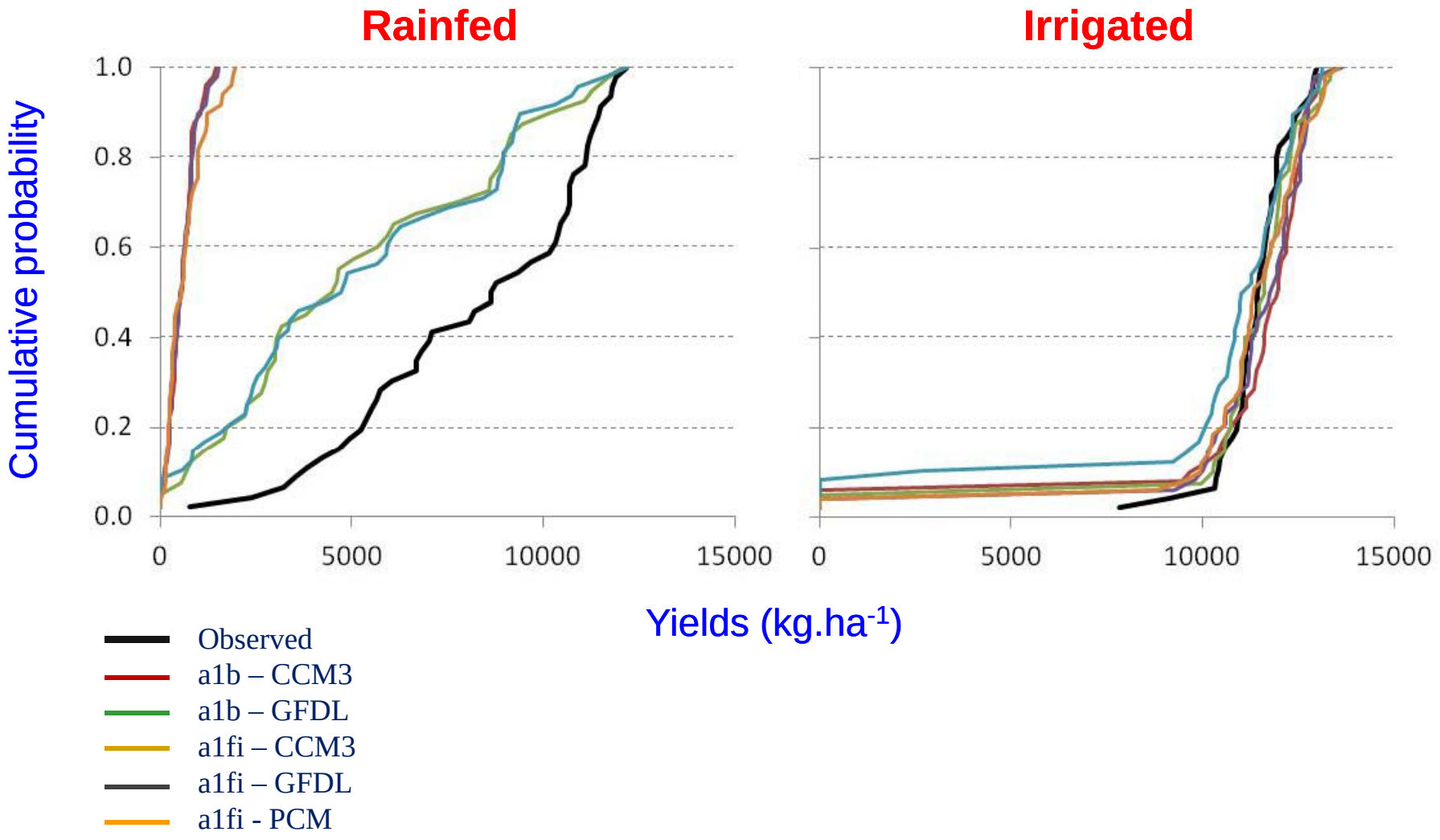
Cumulative growing degree-days using 60F threshold from May 1 to Sep 31

Validation: 1961-2010



Validation of Downscaled Climate Change GCM models Using Crop Simulations

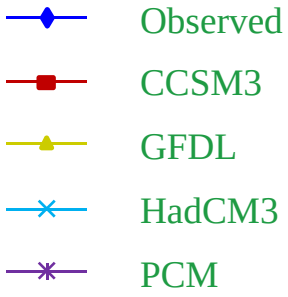
(Mitchell County: 1961-2010)

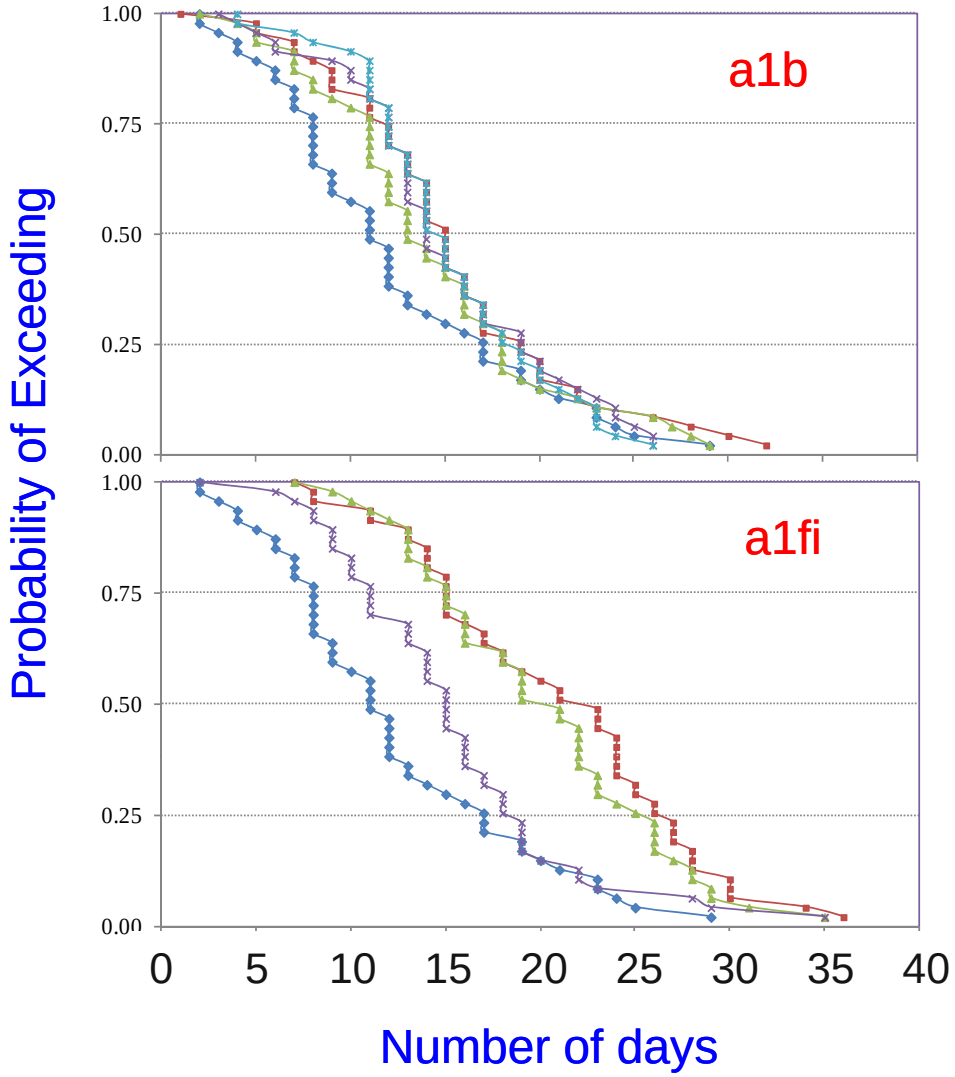


Number of Days per Year with Minimum Temperature Below 28F

(Mitchell County: 1961-2010)

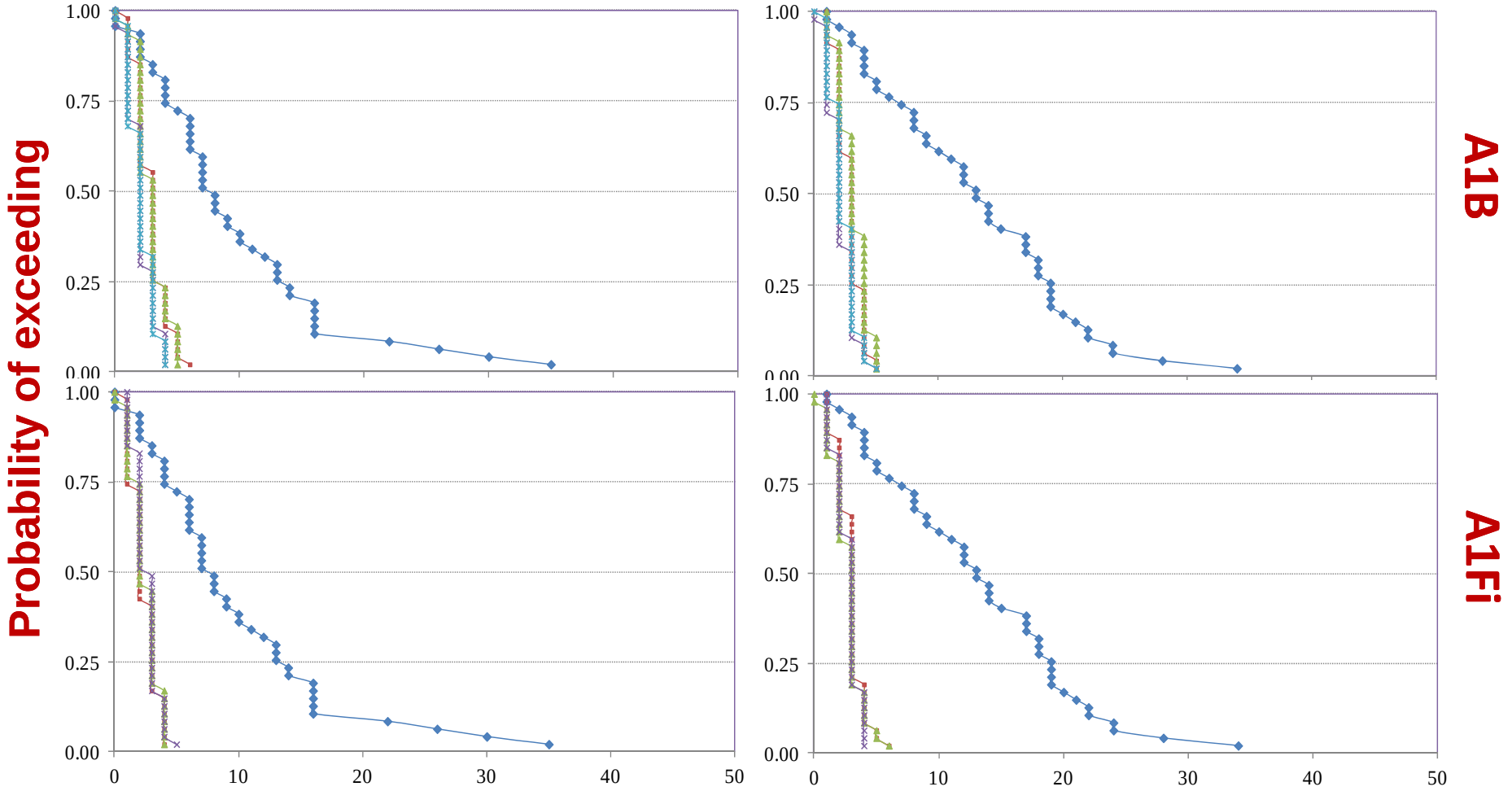
Validation





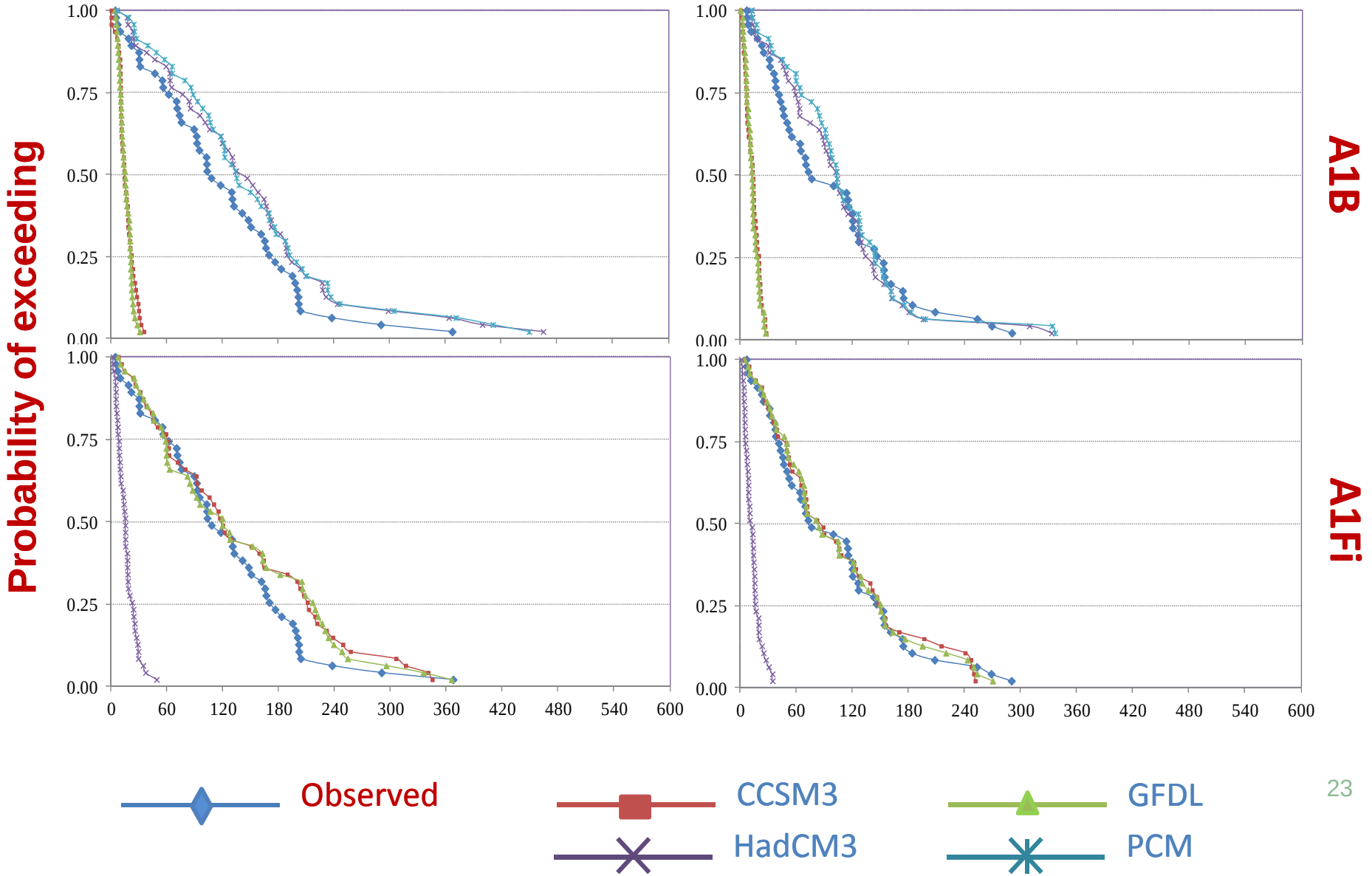
Number of dry periods lasting >10 days for three months centered on April

Validation: 1961-2010



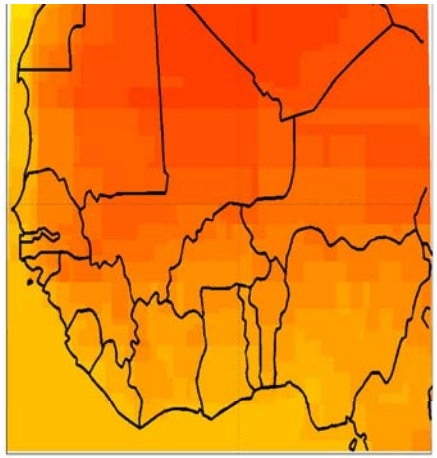
Total precipitation for April (mm)

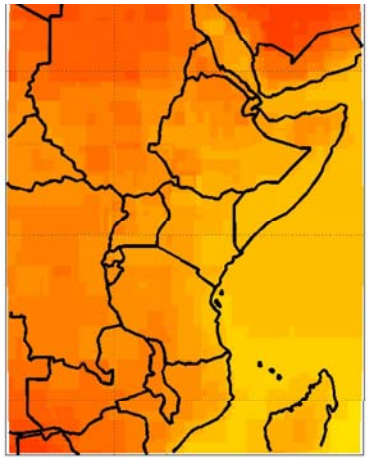
Validation: 1961-2010



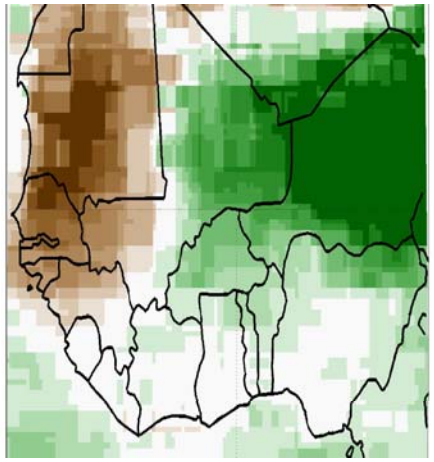
Local Climate Change Projections

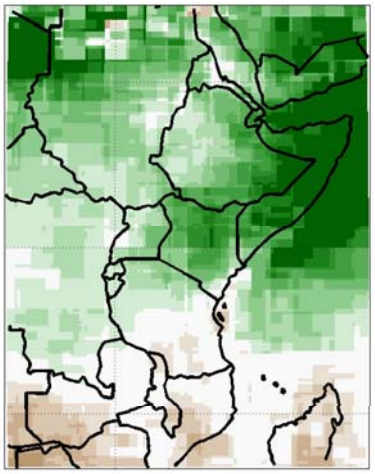
Temperature changes (˚C)





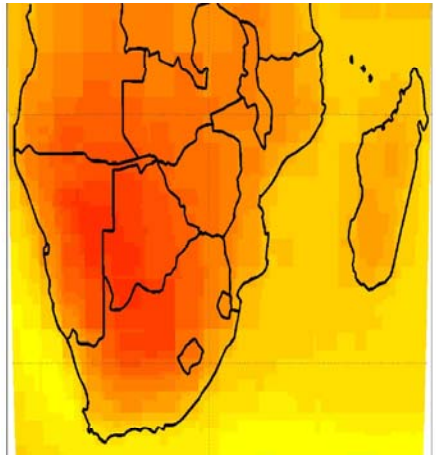
Precipitation changes (%)

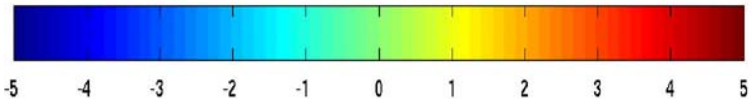




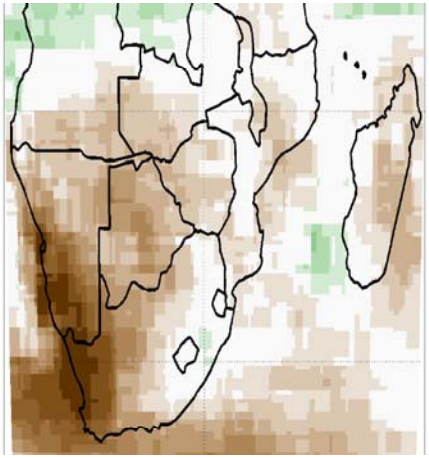
Mid-Century (2040-2069) RCP8.5 Compared to 1980-2009 period

Median of 20 CMIP5 GCMs

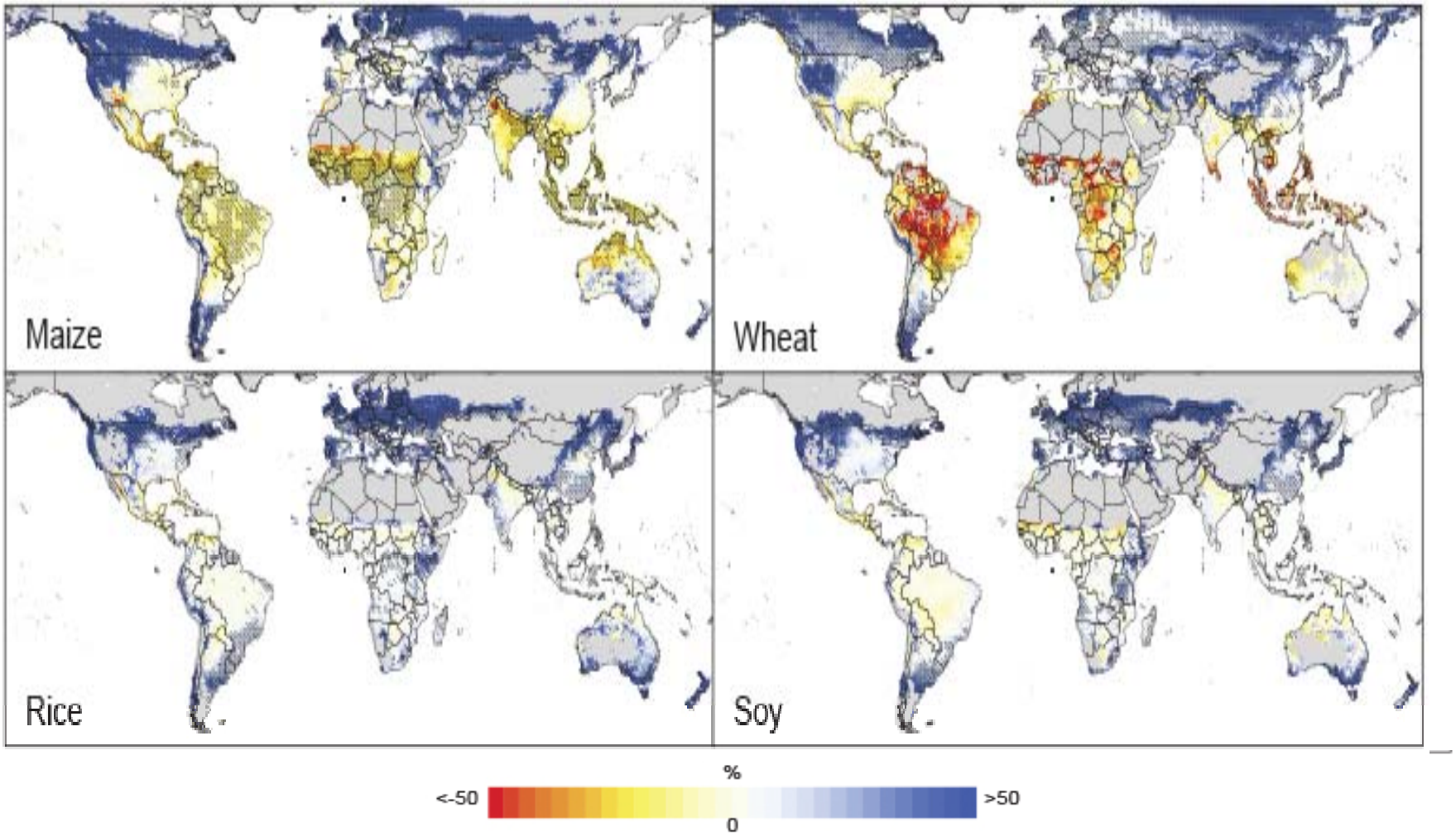




Substantial uncertainty in projections, particularly in precipitation changes



Global Gridded Crop Model Results



median of 7 GGCMs and 5 GCMs

Lower latitudes are more vulnerable to climate change

Thank you!

Guillermo A. Baigorria
gbaigorria@unl.edu

University of Nebraska – Lincoln