

# Uncertainties and Considerations of Agricultural Projections over Future Climate

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B.S. & Eng.

**Meteorology**

M.S.

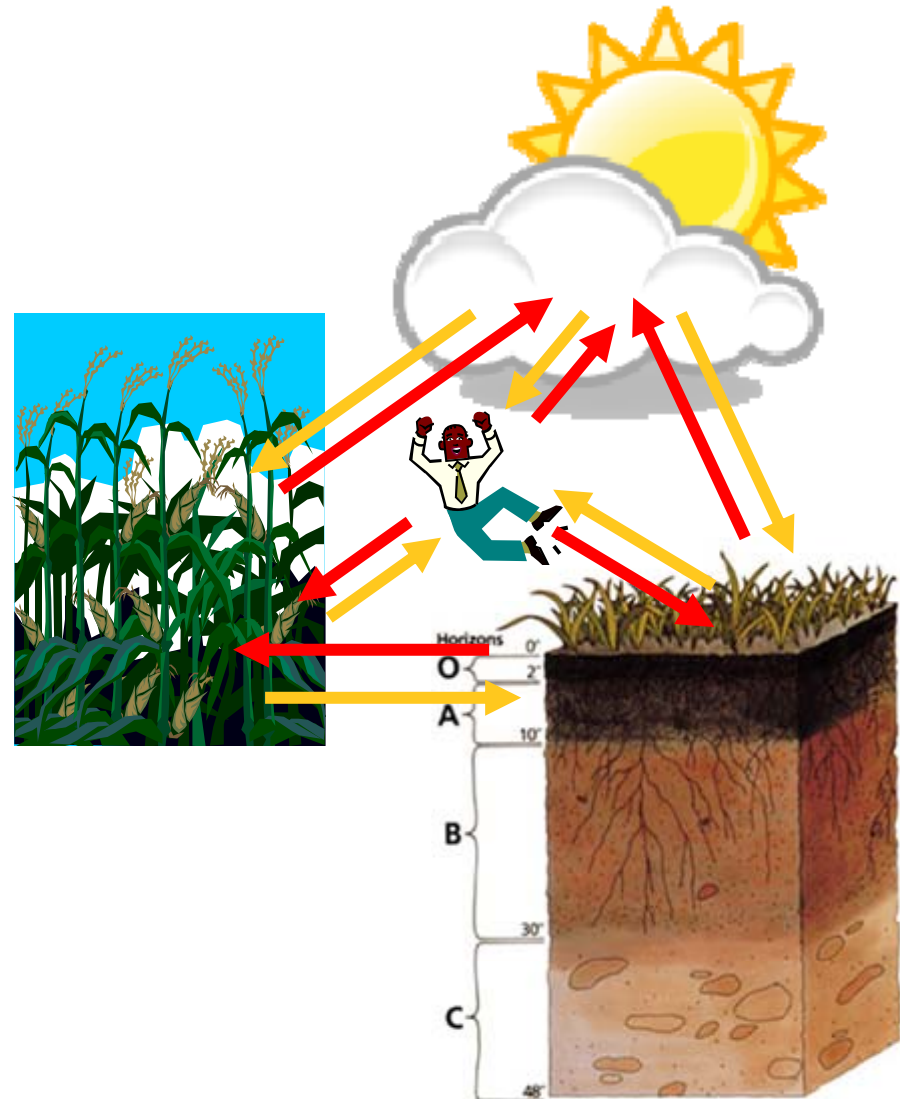
**Crop Production**

Ph.D.

**Soil Science and  
Land Evaluation**

Post Doc

**System Analysis**



# CSM - DSSAT

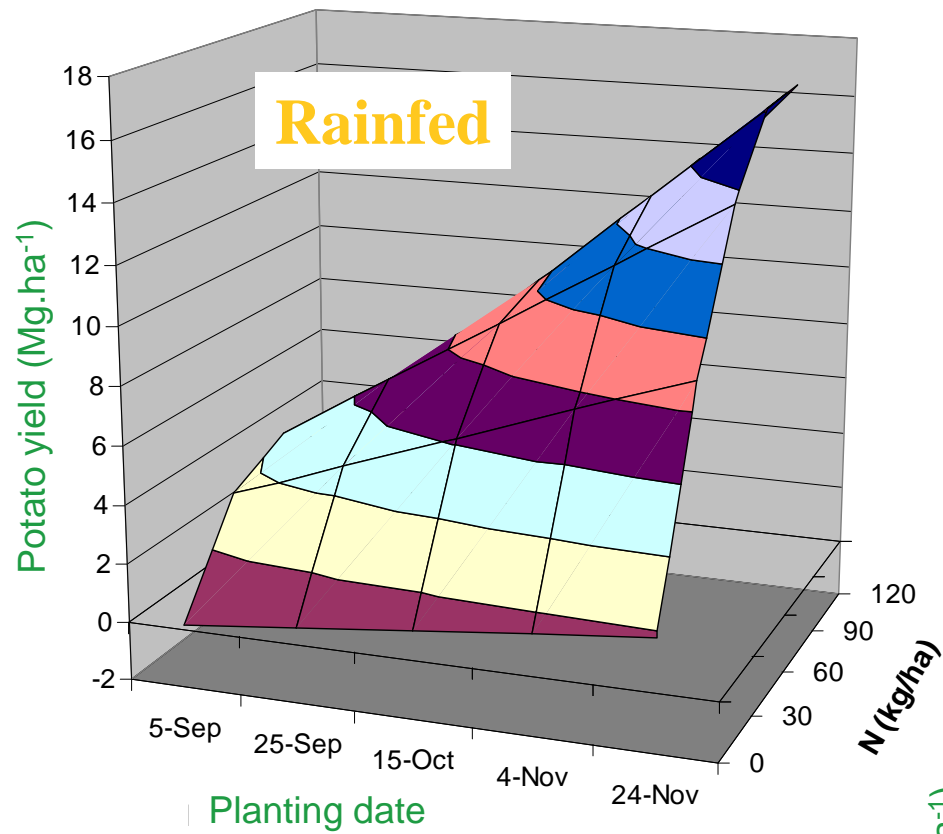
Crop System Model – Decision Support System for Agrotechnology Transfer

The screenshot displays the DSSAT Version 4.5.0.1 software interface. The window is titled "DSSAT Version 4.5.0.1" and has a menu bar with "File", "Data", "Model", and "Help". Below the menu bar is a toolbar with icons for "New", "Run", and other functions. The interface is divided into several panes:

- Tools:** A vertical list of icons and labels for various tools: Crop Management Data, Graphical Display, Soil Data, Experimental Data, Weather Data, Seasonal Analysis, Rotational Analysis, and GenCalc.
- Selector:** A tree view showing the hierarchy of crop and data categories:
  - Crops
    - Cereals: Barley, Maize, Millet, Rice, Sorghum, Wheat
    - Legumes: Chickpea, Cowpea, Drybean, Faba Bean, Peanut, Soybean, Velvet Bean
    - Root Crops: Cassava, Potato, Tanier, Iaro
    - Oil Crops
    - Vegetables
    - Fiber
    - Forages
    - Sugar/Energy
    - Fruit Crops
    - Various
  - Applications: Seasonal, Sequence, Spatial
  - Data: Soil, Weather, Genetics, Economics, Pests, Standard Data
- Data:** A pane showing "Soil Data Files" with a list of files like ARG.SOL, AZ.SOL, BO.SOL, CC.sol, CJ.sol, and CN.sol. Below this is a table of soil data parameters for various sites.

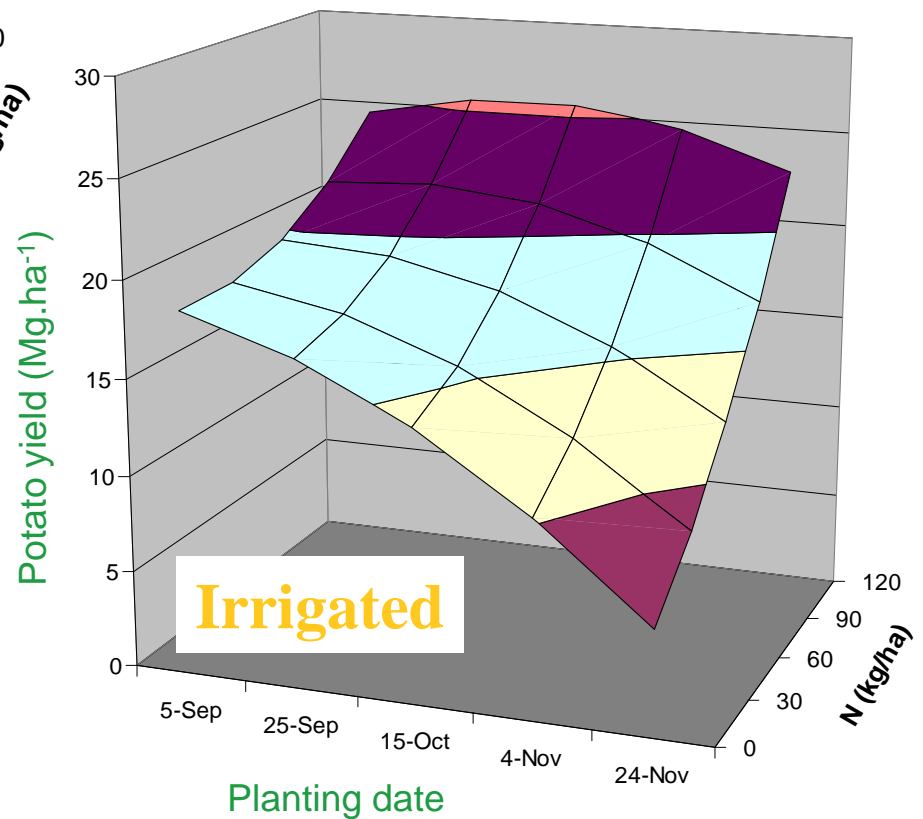
The table in the Data pane shows soil data for three sites: \*CNPE910001 BA2, \*CNPE910002 BA2, and \*CNAN910001 INTA. The table includes columns for site information, soil parameters (SCOM, SALB, SLU1, SLDL, SLRO, SLNF, SLPF, SMHB, SMPX, SMKE), and various soil characteristics (SLB, SLMR, SLLL, SDUL, SSAT, SRGF, SSKS, SBDM, SLOC, SLCL, SLSI, SLCF, SLNI, SLHW, SLHB, SCEC).

Site	Country	Lat	Long	SCS	Family
*CNPE910001	Argentina	-33.560	-60.350		ARGIUDOL TIPICO, FINA. SERIE PERGAMINO
*CNPE910002	Argentina	-33.560	-60.350		ARGIUDOL TIPICO, FINA. SERIE PERGAMINO
*CNAN910001	Argentina	-33.560	-60.350		ARGIUDOL TIPICO, FINA. SERIE PERGAMINO



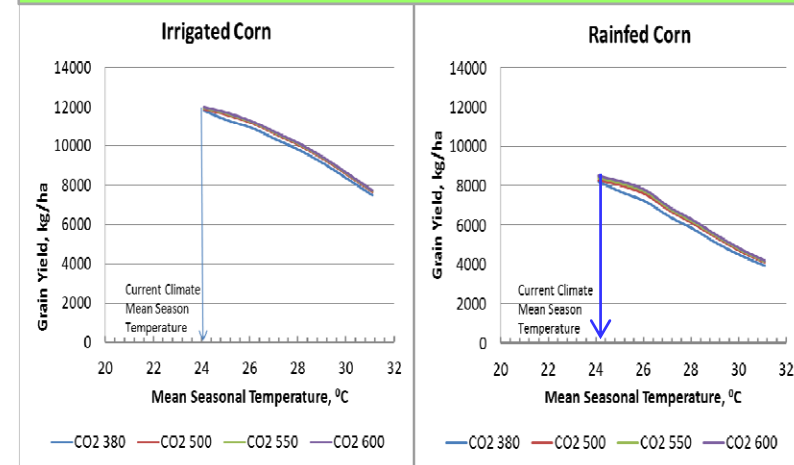
## Mañazo – Puno (4,000 m a.s.l.)

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

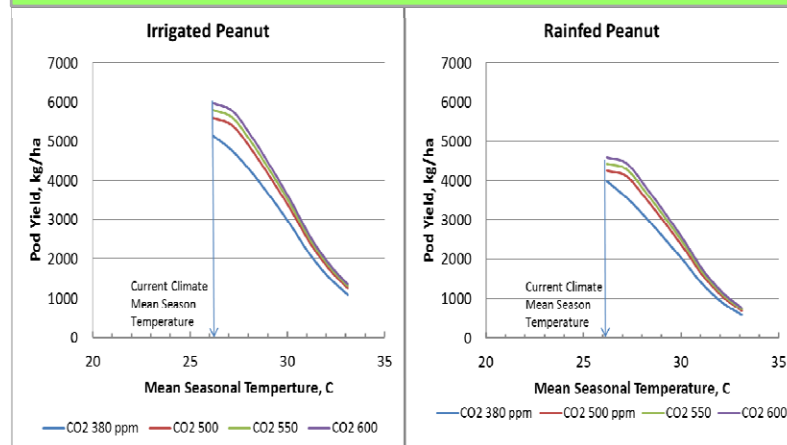


# Simulated effect of increased temperatures and CO<sub>2</sub> on yields

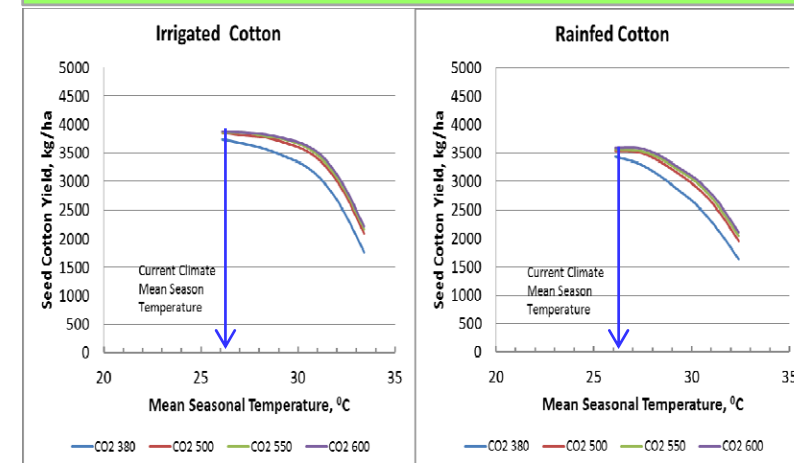
## Corn



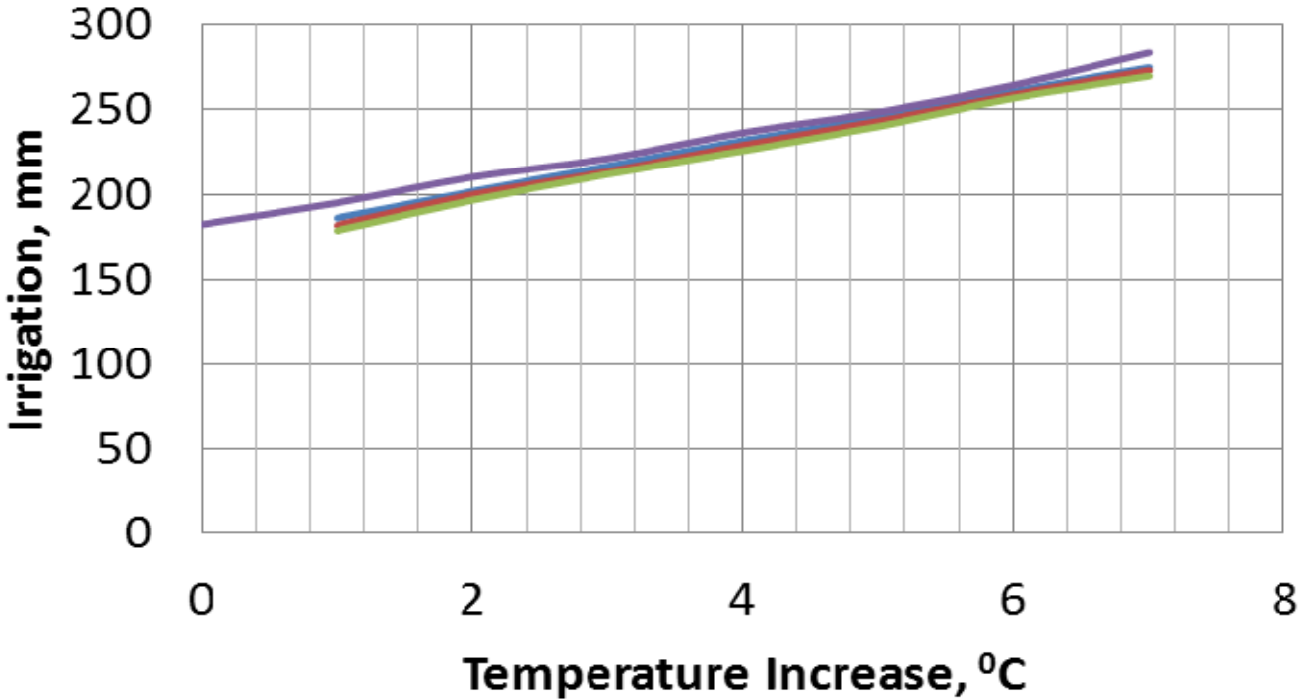
## Peanut



## Cotton



# Corn Irrigation Demand



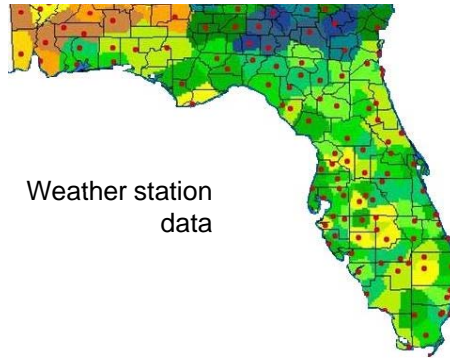
— CO2 500 — CO2 550 — CO2 600 — CO2 380

## Linking Climate Models and Crop Models

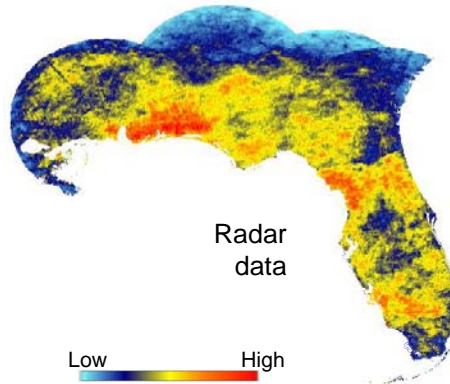


# Spatial resolution

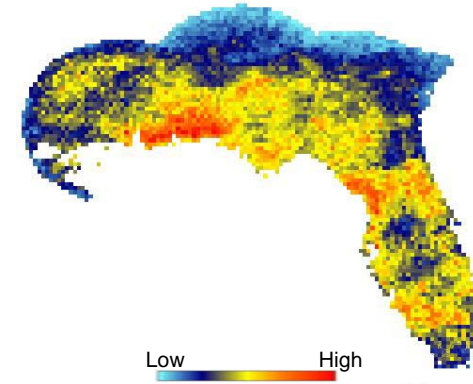
1 m



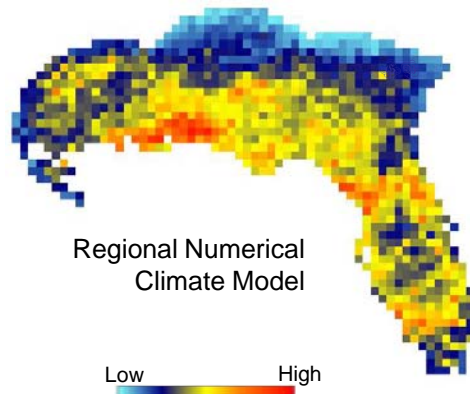
0.5 km



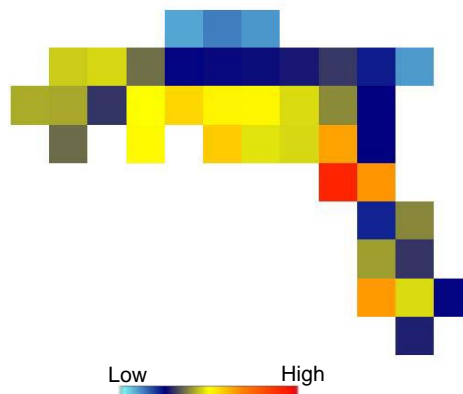
10 km



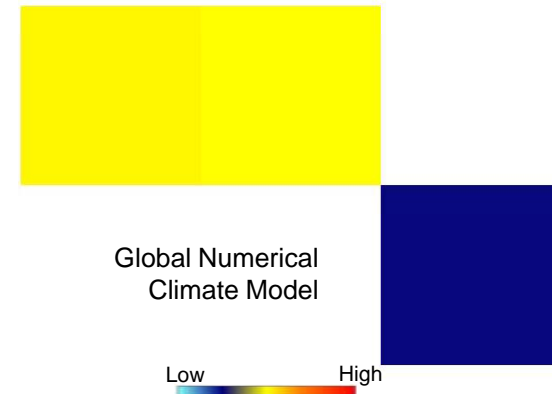
20 km



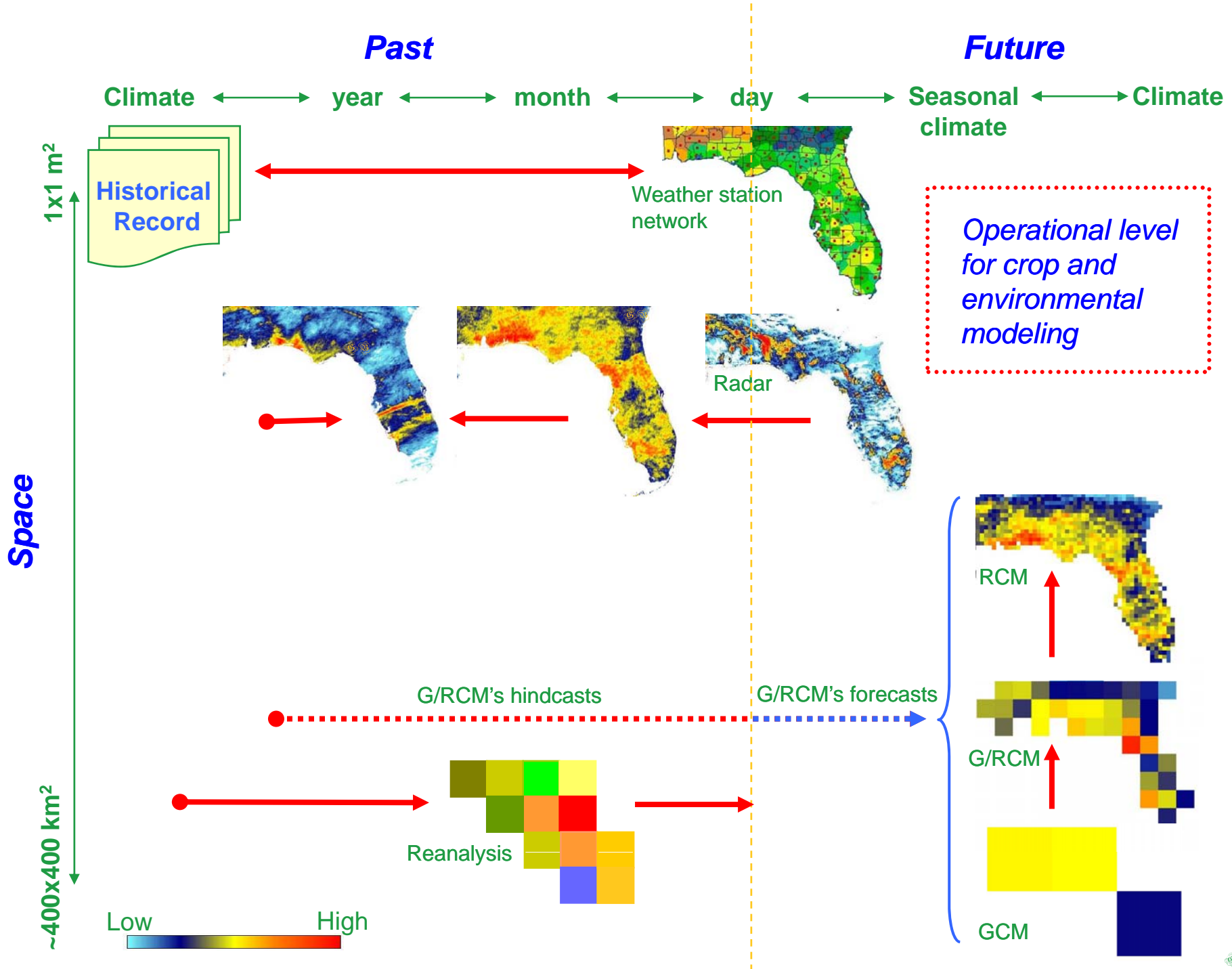
100 km



400 km

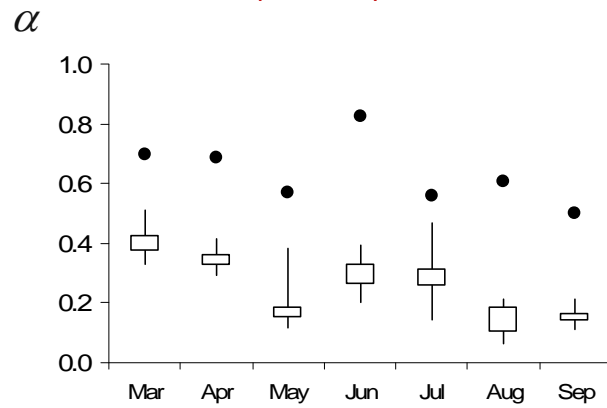




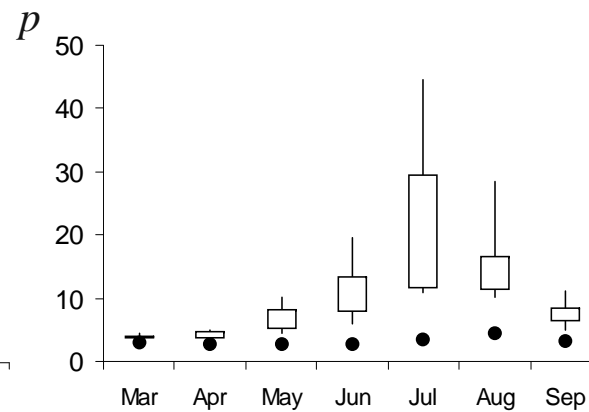


# County: DeKalb

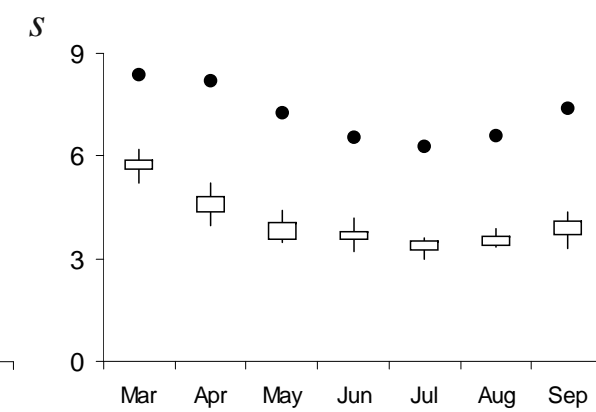
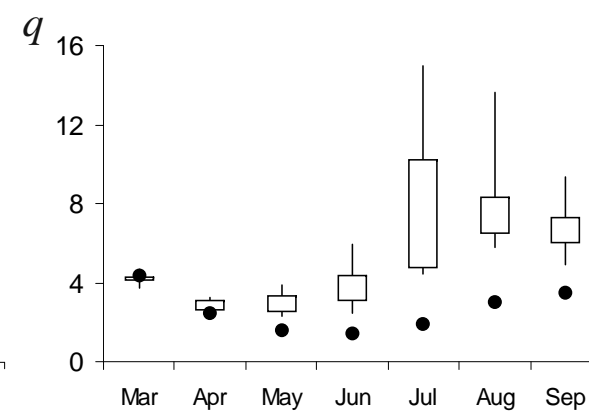
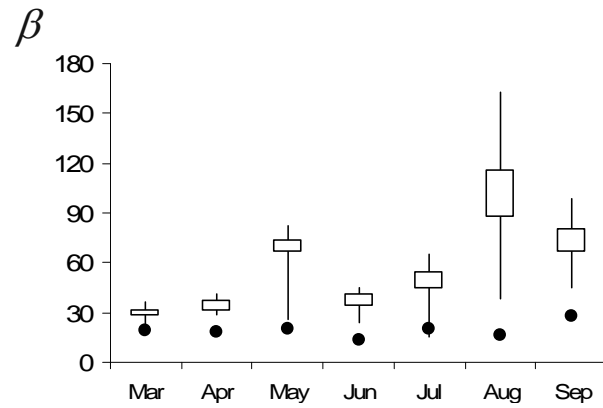
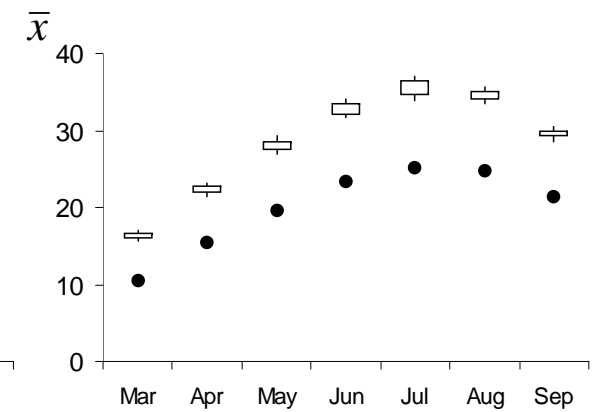
## Gamma distribution (rainfall)



## Beta distribution (Incoming solar radiation)



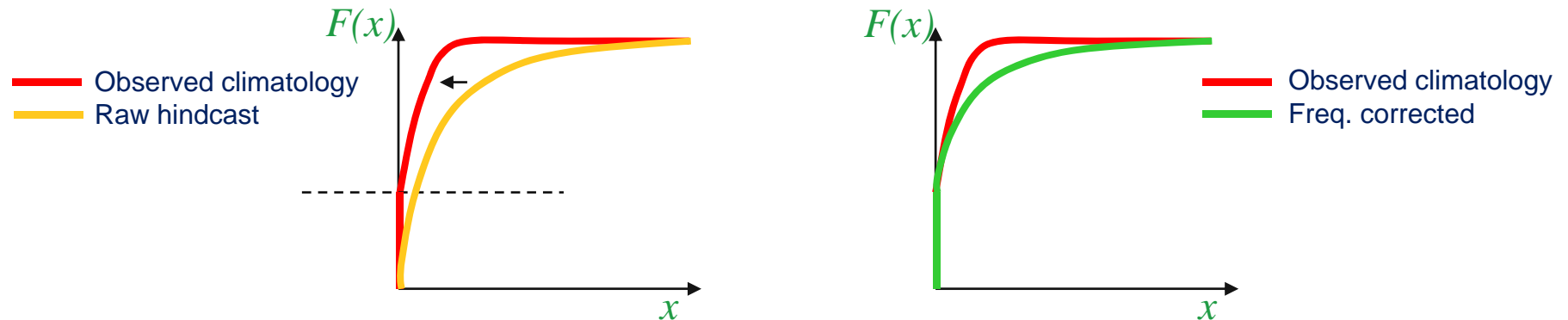
## Gaussian distribution (Max. and Min. Temperatures)



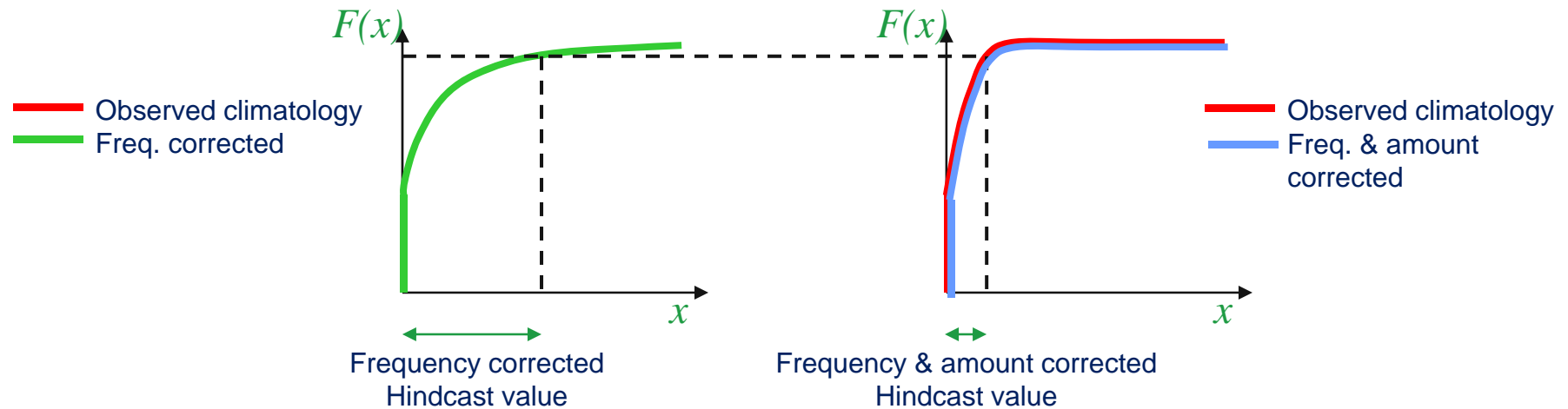
● Observed    □ RCM ensemble

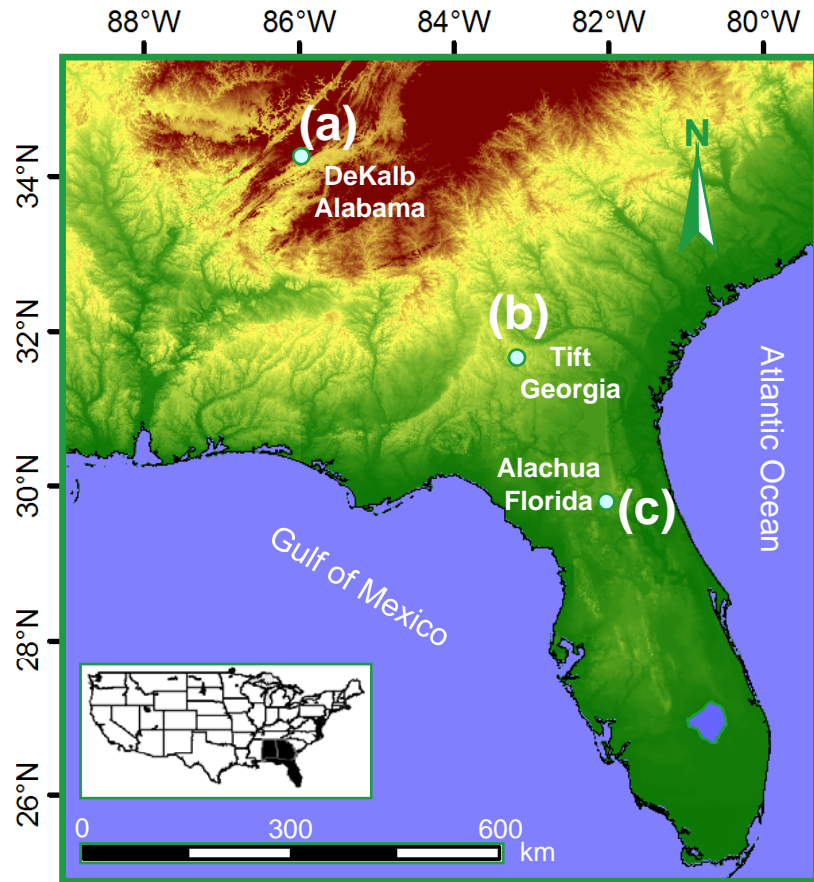
# Bias correction based on cumulative probability distributions

(a) Frequency correction



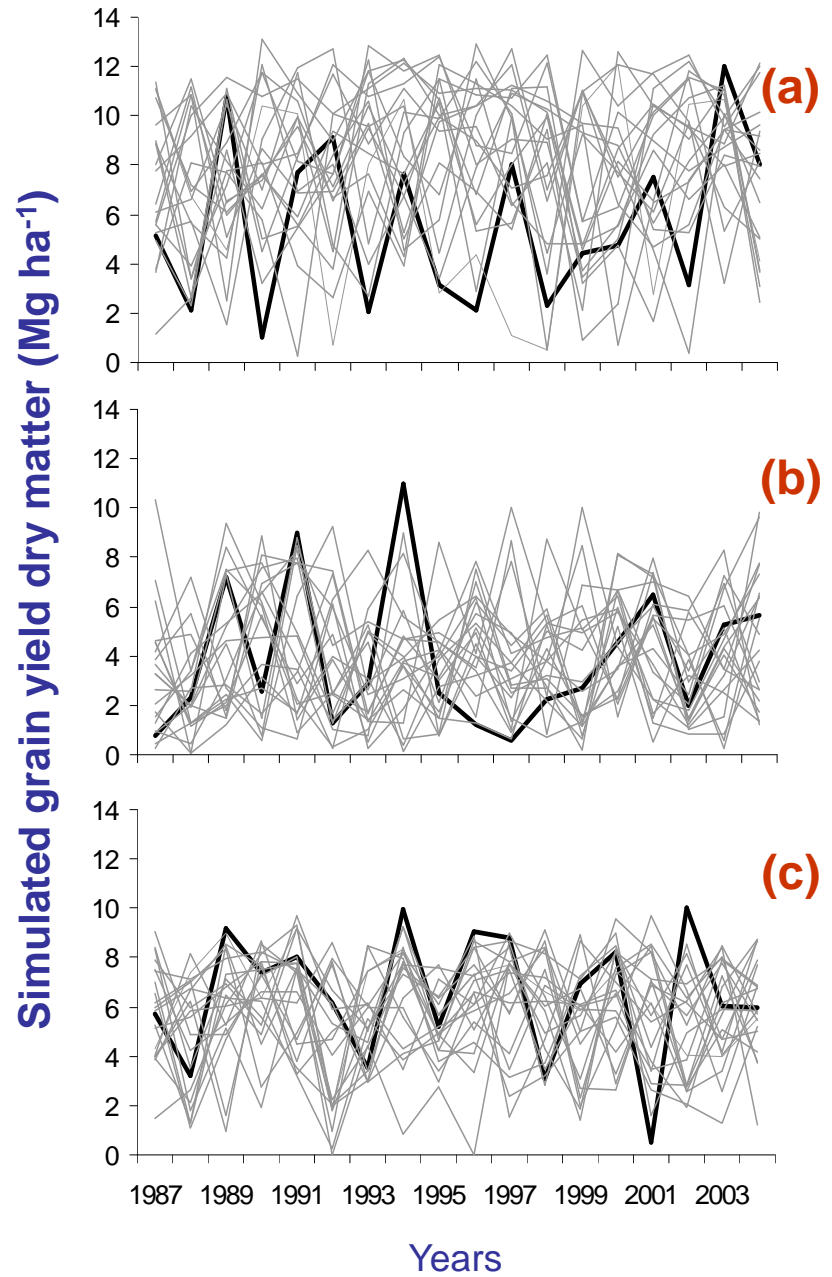
(b) Amount correction



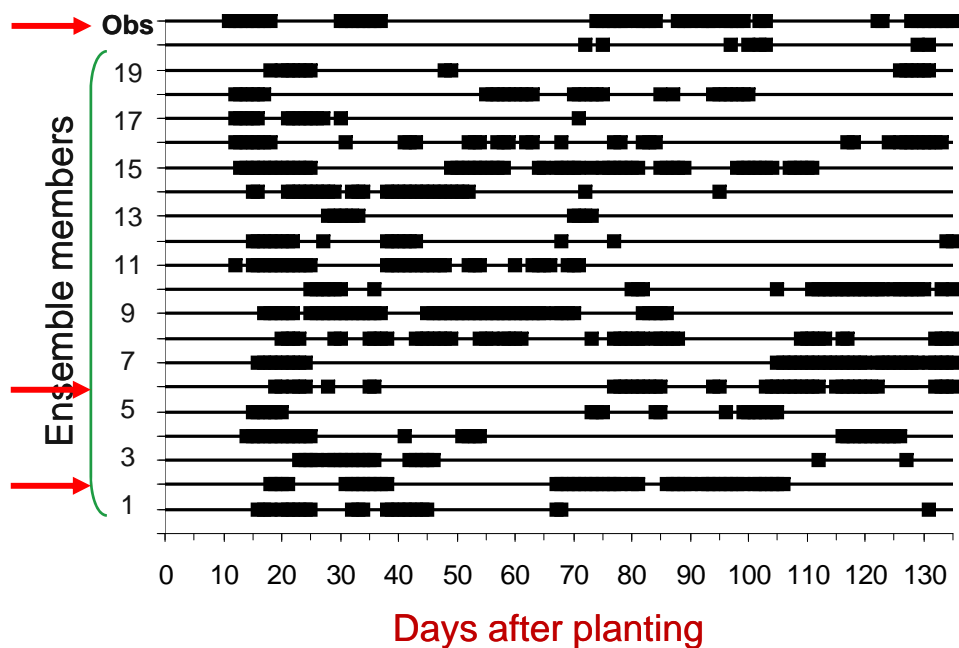


Simulated grain yield using:

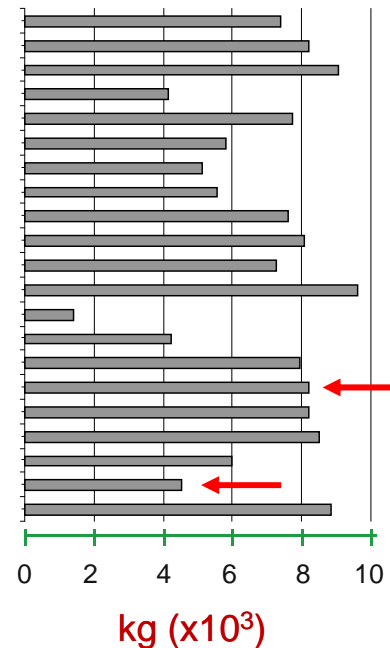
- Observed Weather
- Daily seasonal climate hindcast



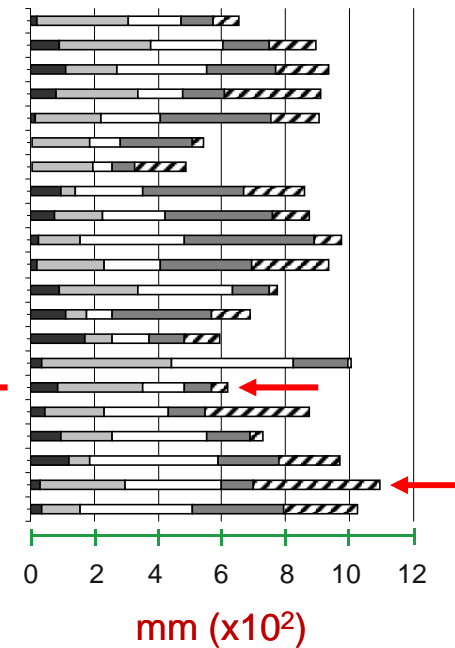
### Periods of water stress affecting growth



### Yields

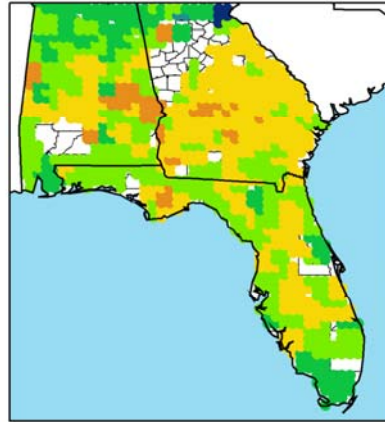


### Rainfall



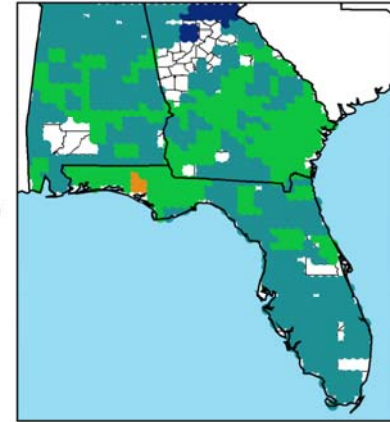
**Simulated  
Corn  
using  
observed  
weather  
data  
(1961-2010)**

**Rainfed**

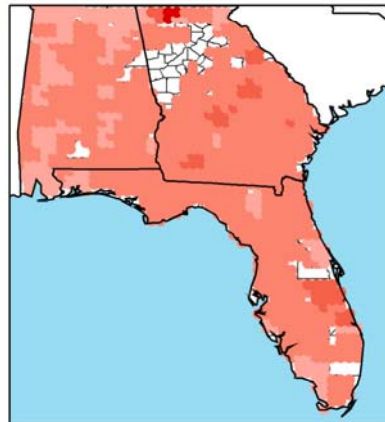


**Yield dm  
(kg.ha<sup>-1</sup>)**

- < 5500
- 5501 - 7000
- 7001 - 8500
- 8501 - 10000
- 10001 - 11500
- 11501 - 13000
- 130001 - 145500

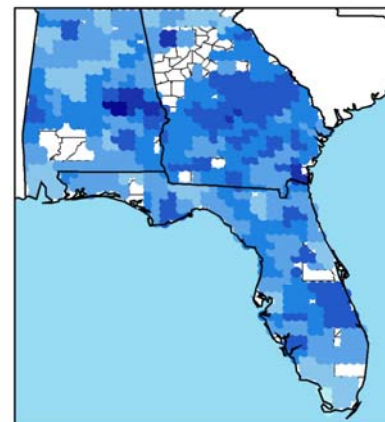
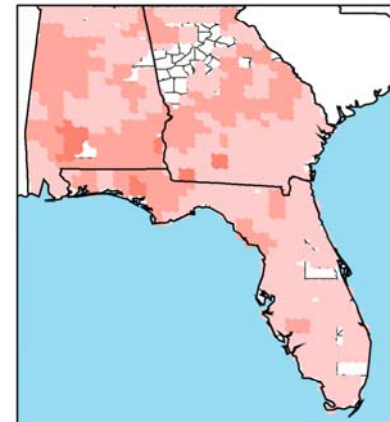


**Irrigated**



**Yield dm  
(Stdev)**

- 200 - 1300
- 1301 - 2400
- 2401 - 3500
- 3501 - 4600
- 4601 - 5700
- 5701 - 6800

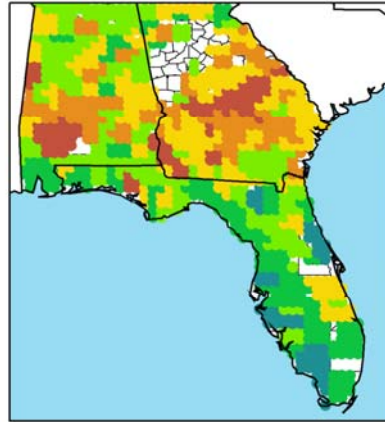


**Irrigation  
(mm)**

- < 100
- 101 - 135
- 136 - 170
- 171 - 205
- 206 - 240
- 241 - 275
- 276 - 310

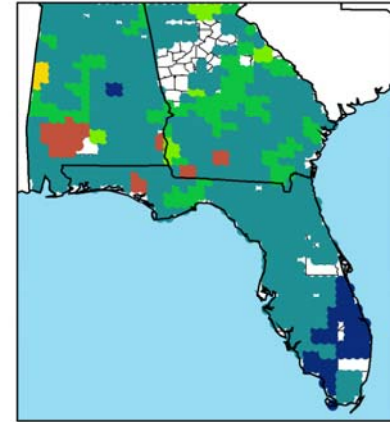
**Simulated Peanut  
using  
observed  
weather  
data  
(1961-2010)**

**Rainfed**

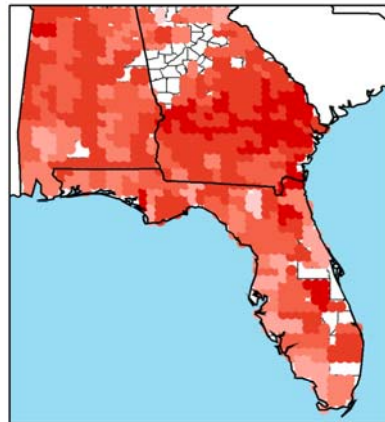


**Yield dm  
(kg.ha<sup>-1</sup>)**

- < 2500
- 2501 - 3000
- 3001 - 3500
- 3501 - 4000
- 4001 - 4500
- 4501 - 5000
- 5001 - 5500

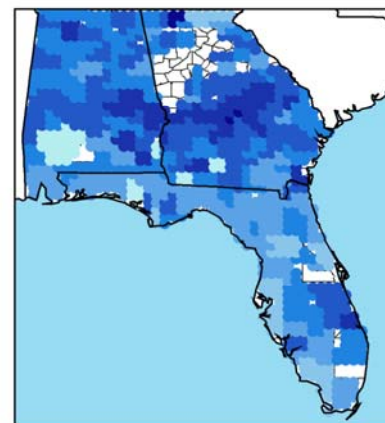
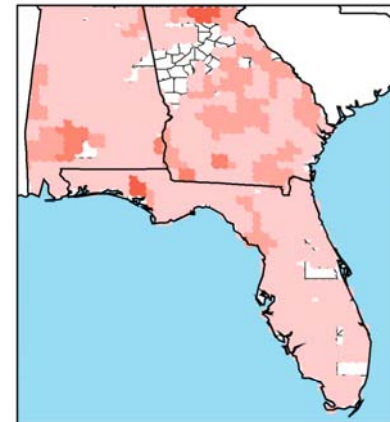


**Irrigated**



**Yield dm  
(Stdev)**

- < 400
- 401 - 600
- 601 - 800
- 801 - 1000
- 1001 - 1200
- 1201 - 1400



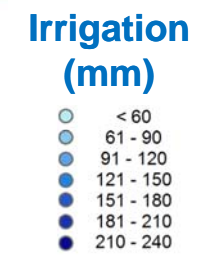
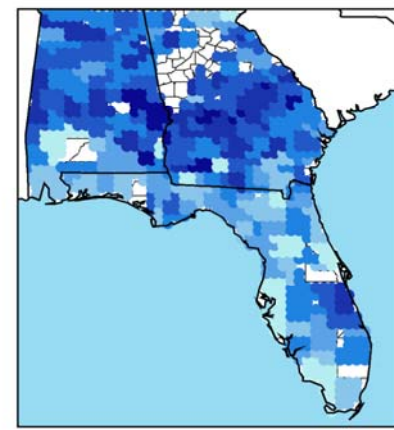
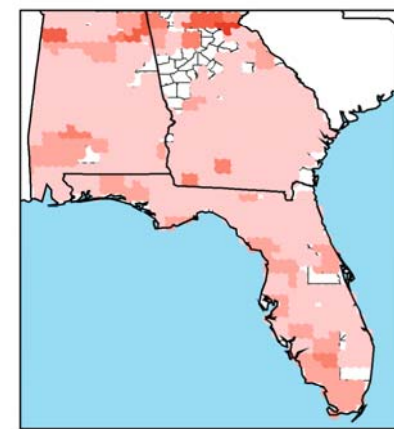
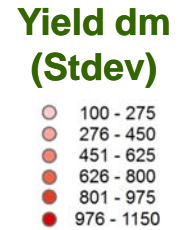
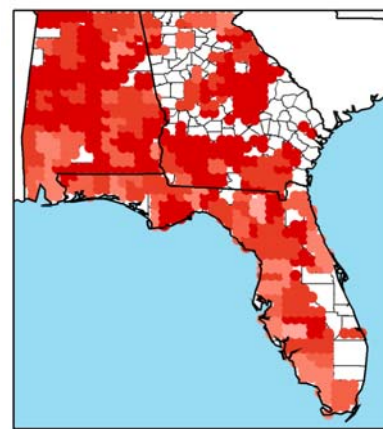
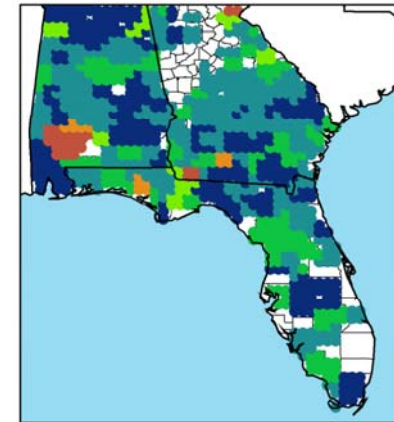
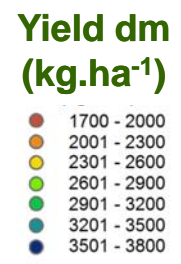
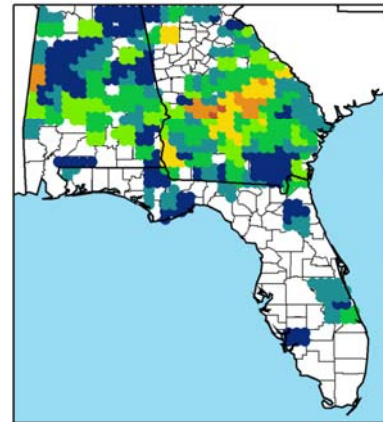
**Irrigation  
(mm)**

- < 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 250
- 251 - 300
- 300 - 350

**Simulated Cotton using observed weather data (1961-2010)**

**Rainfed**

**Irrigated**





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

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

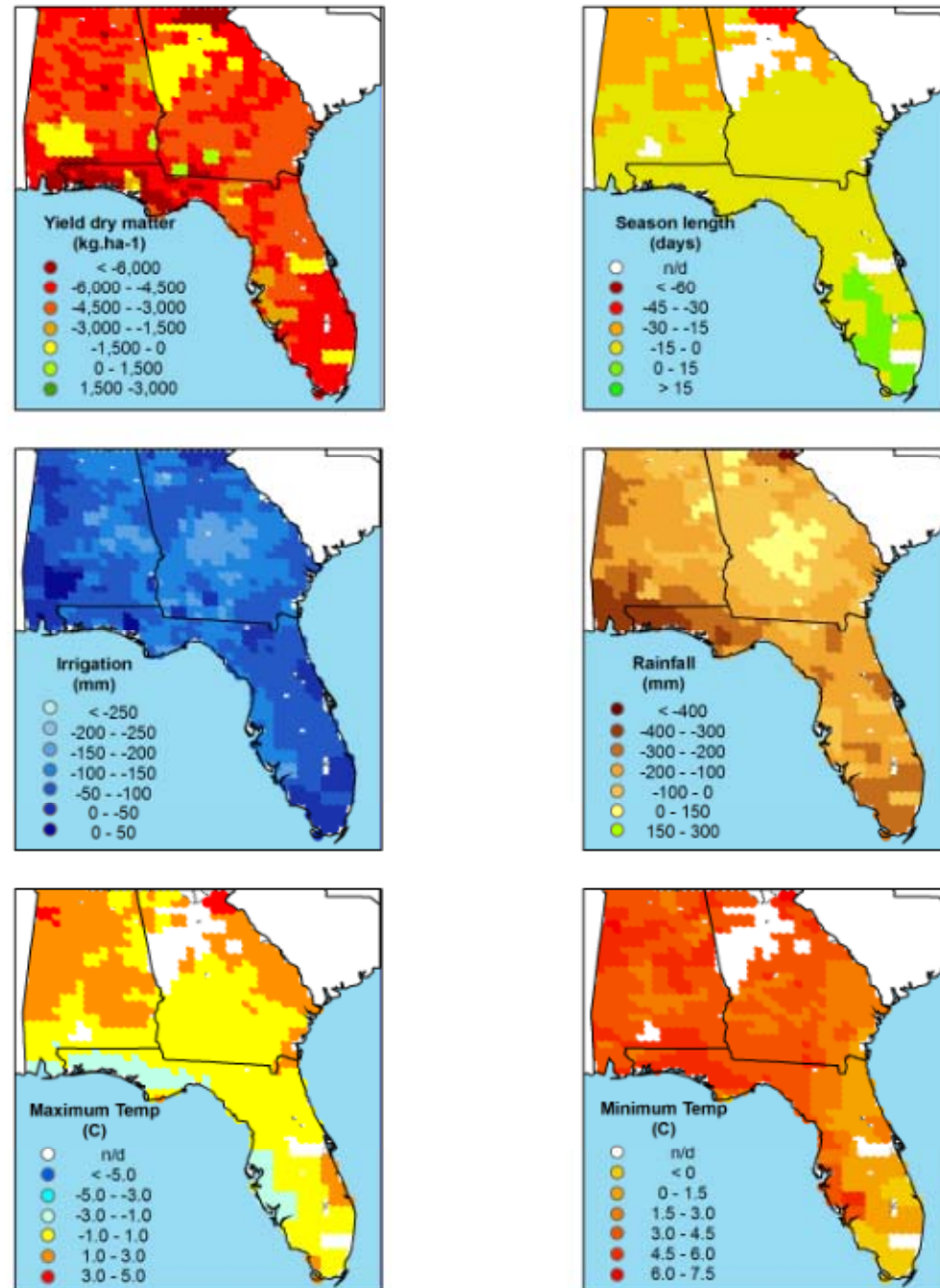
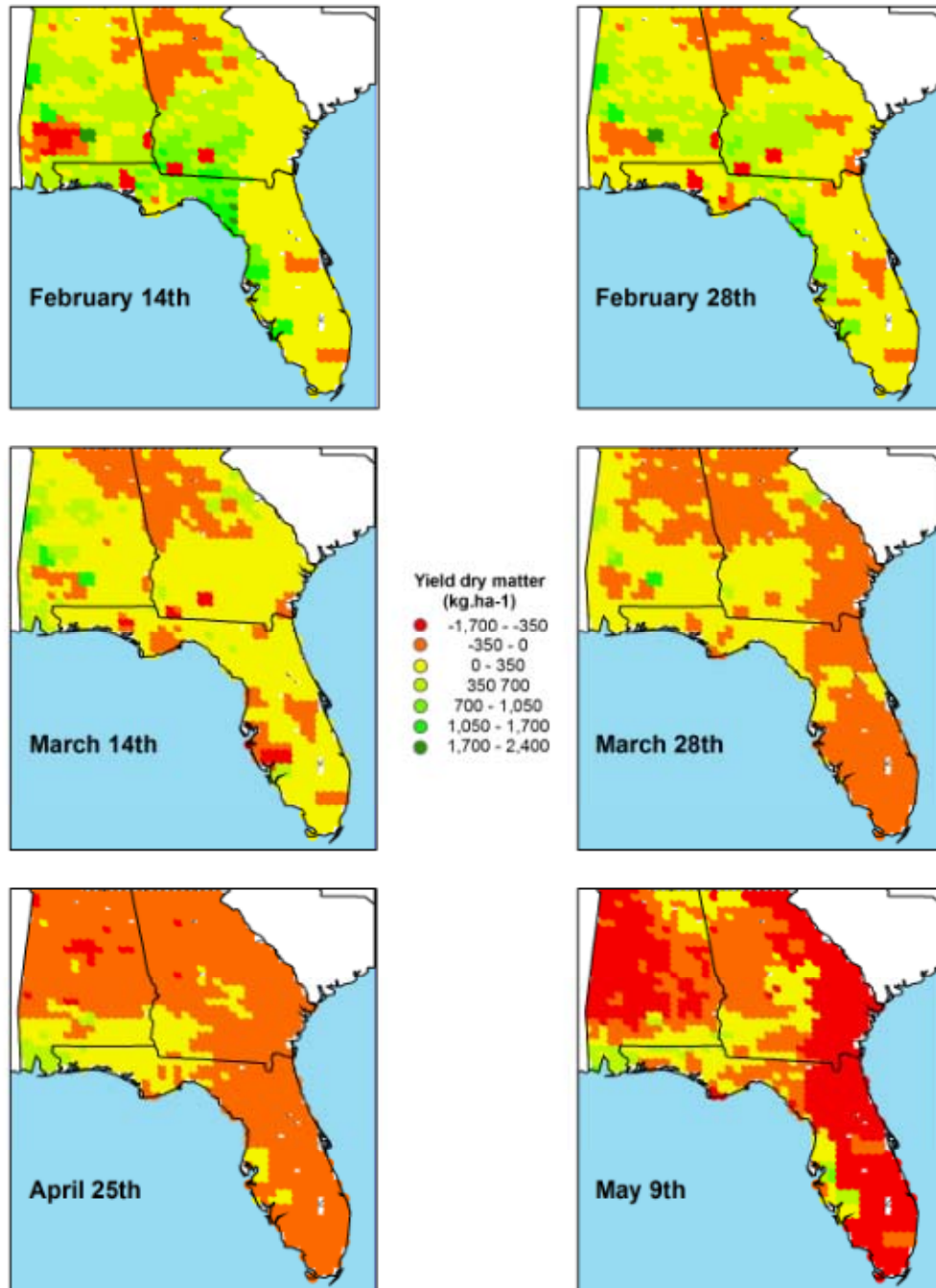


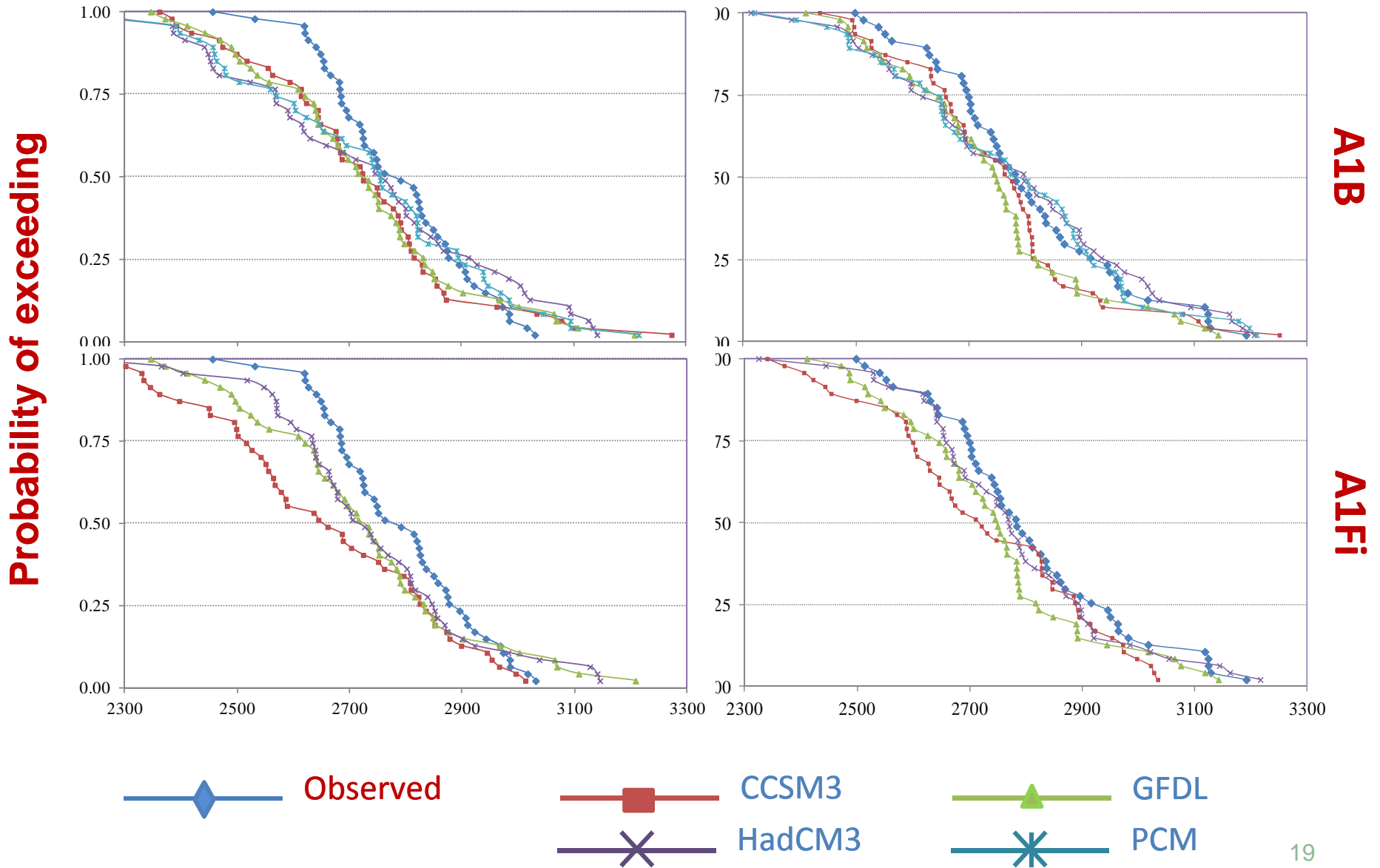
Fig 12: Corn - Irrigated - CMIP5/CanCM4/1980/SE



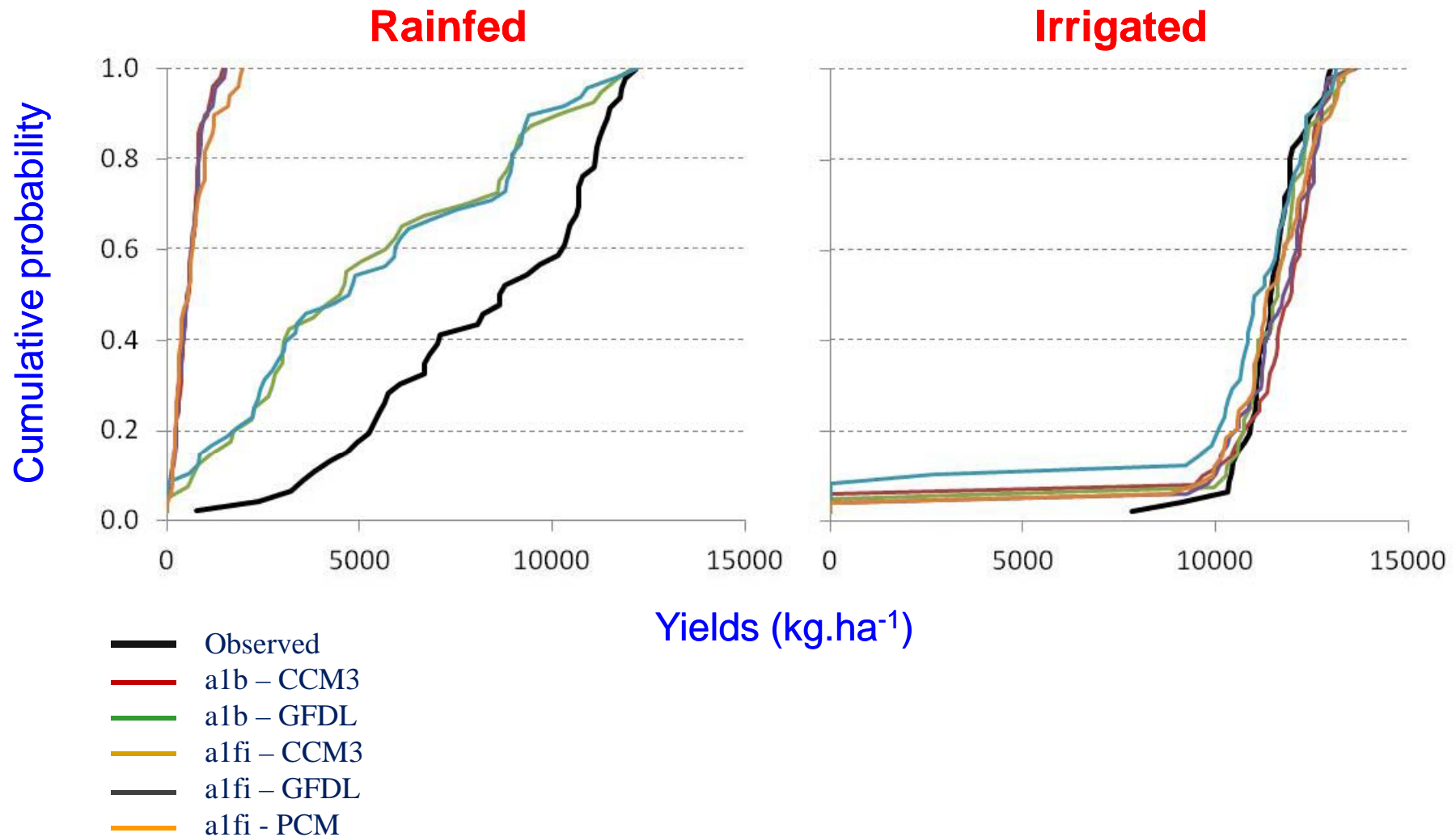
**Adaptation:  
Changes on  
projected yields by  
moving  
planting dates  
(Current: April 11<sup>th</sup>)**

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

**Validation:  
1961-2010**



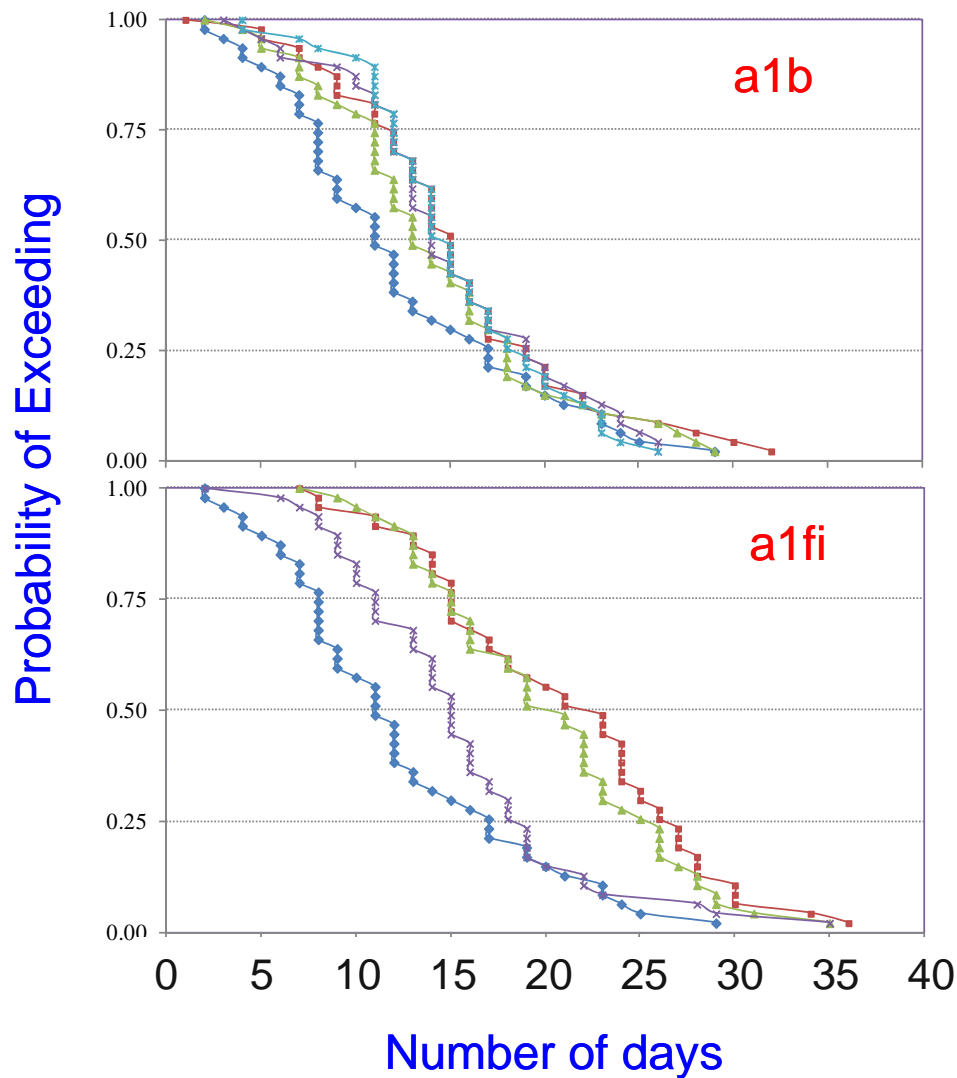
# Validation of Downscaled Climate Change GCM models Using Crop Simulations (Mitchell County: 1961-2010)



# Number of Days per Year with Minimum Temperature Below 28F (Mitchell County: 1961-2010)

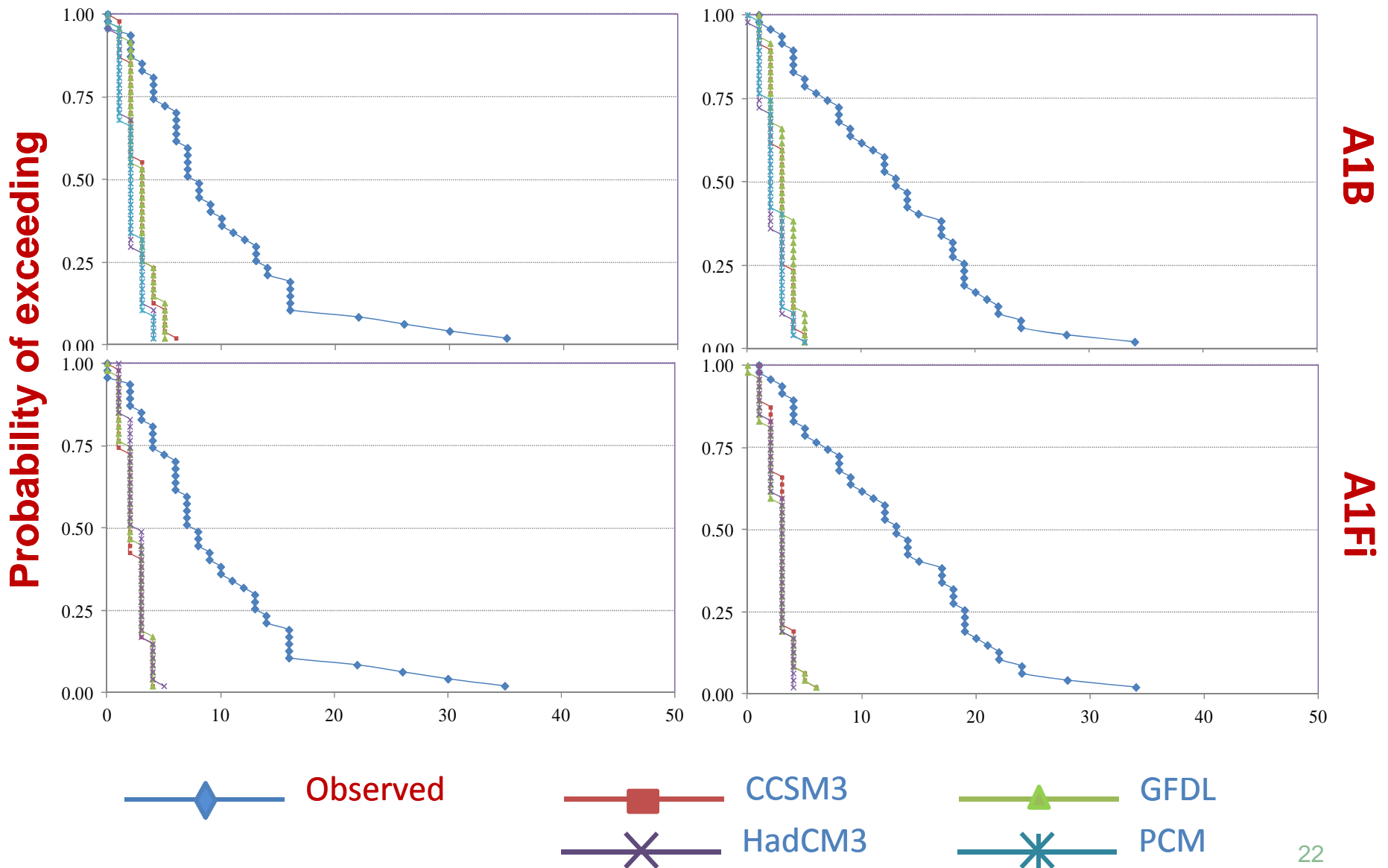
## Validation

- Observed
- CCSM3
- GFDL
- HadCM3
- PCM



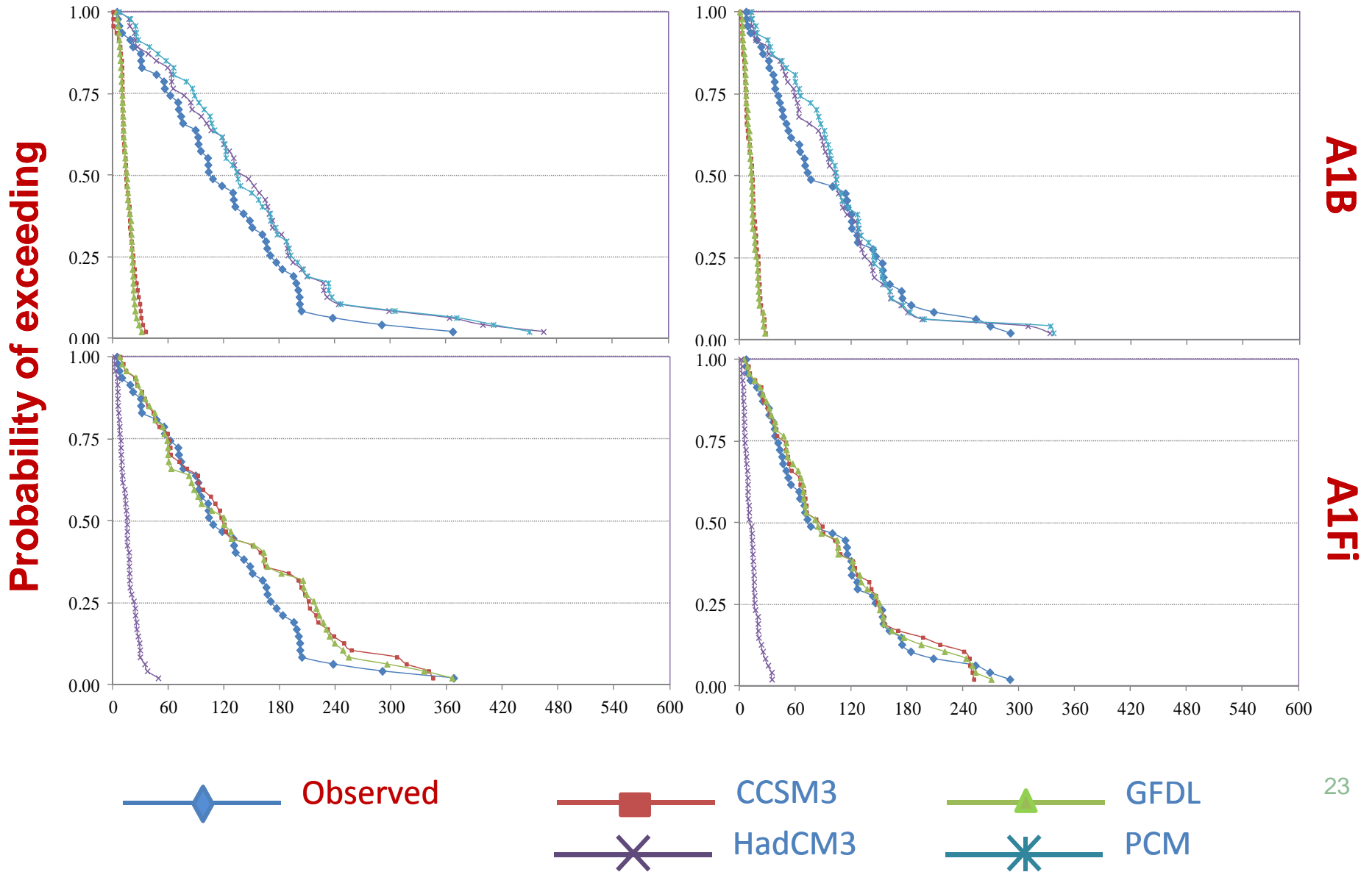
# Number of dry periods lasting >10 days for three months centered on April

**Validation:  
1961-2010**

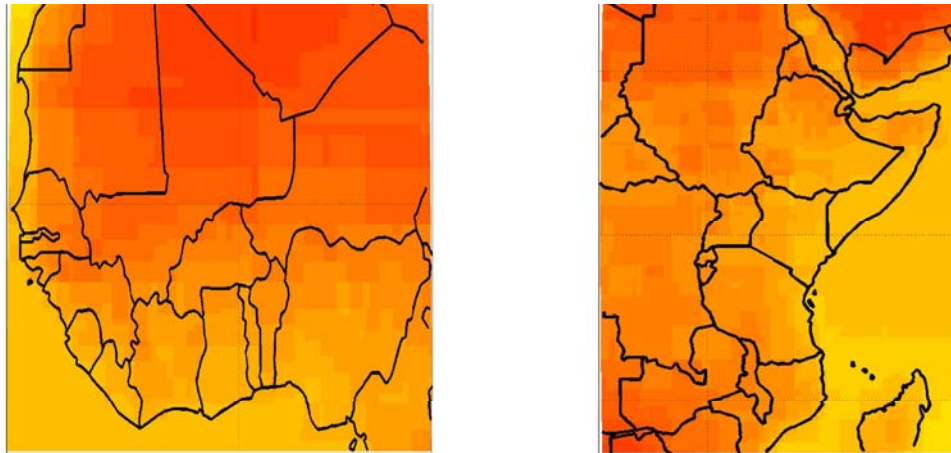


# Total precipitation for April (mm)

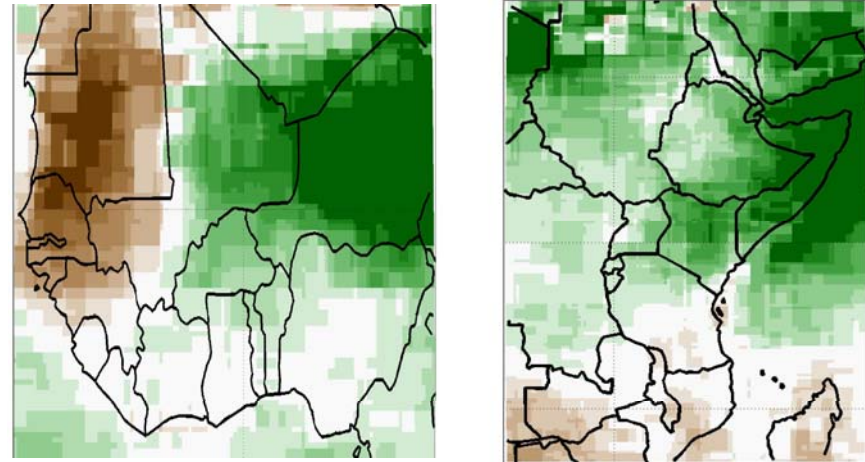
Validation:  
1961-2010



## Temperature changes (°C)

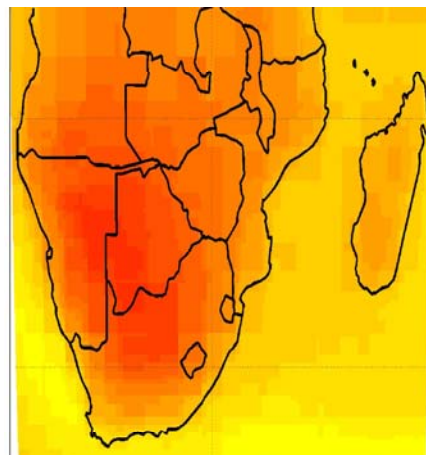


## Precipitation changes (%)

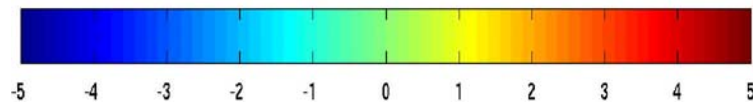
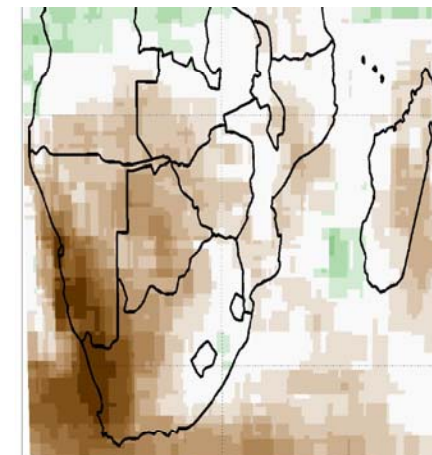


**Mid-Century  
(2040-2069)  
RCP8.5  
Compared to  
1980-2009 period**

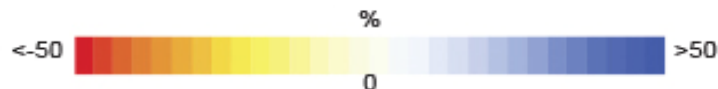
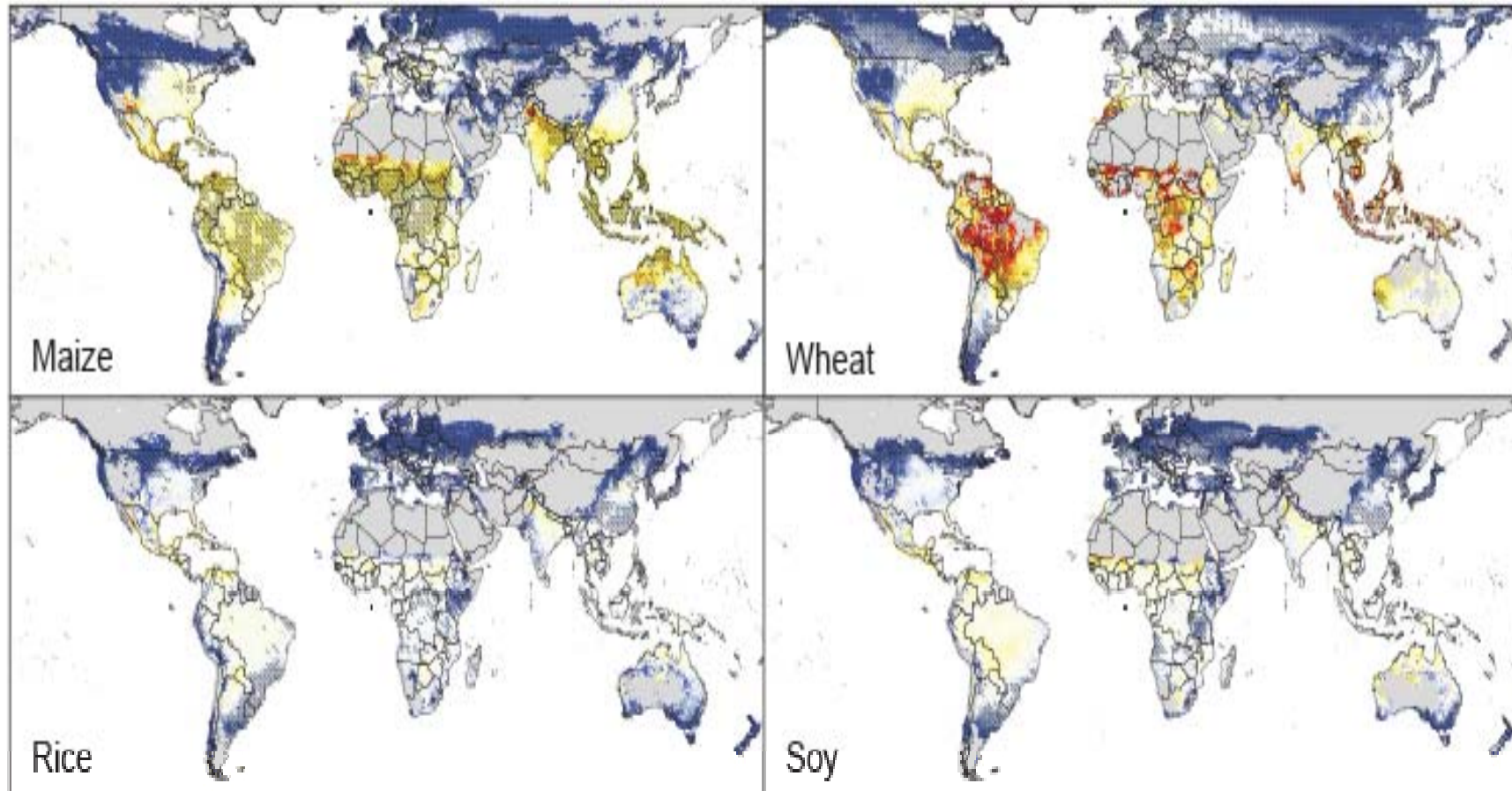
**Median of 20  
CMIP5 GCMs**



**Substantial  
uncertainty in  
projections,  
particularly in  
precipitation  
changes**







*median of 7 GGCMs and 5 GCMs*

***Lower latitudes are more vulnerable to climate change***



**Thank you!**

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**University of Nebraska – Lincoln**