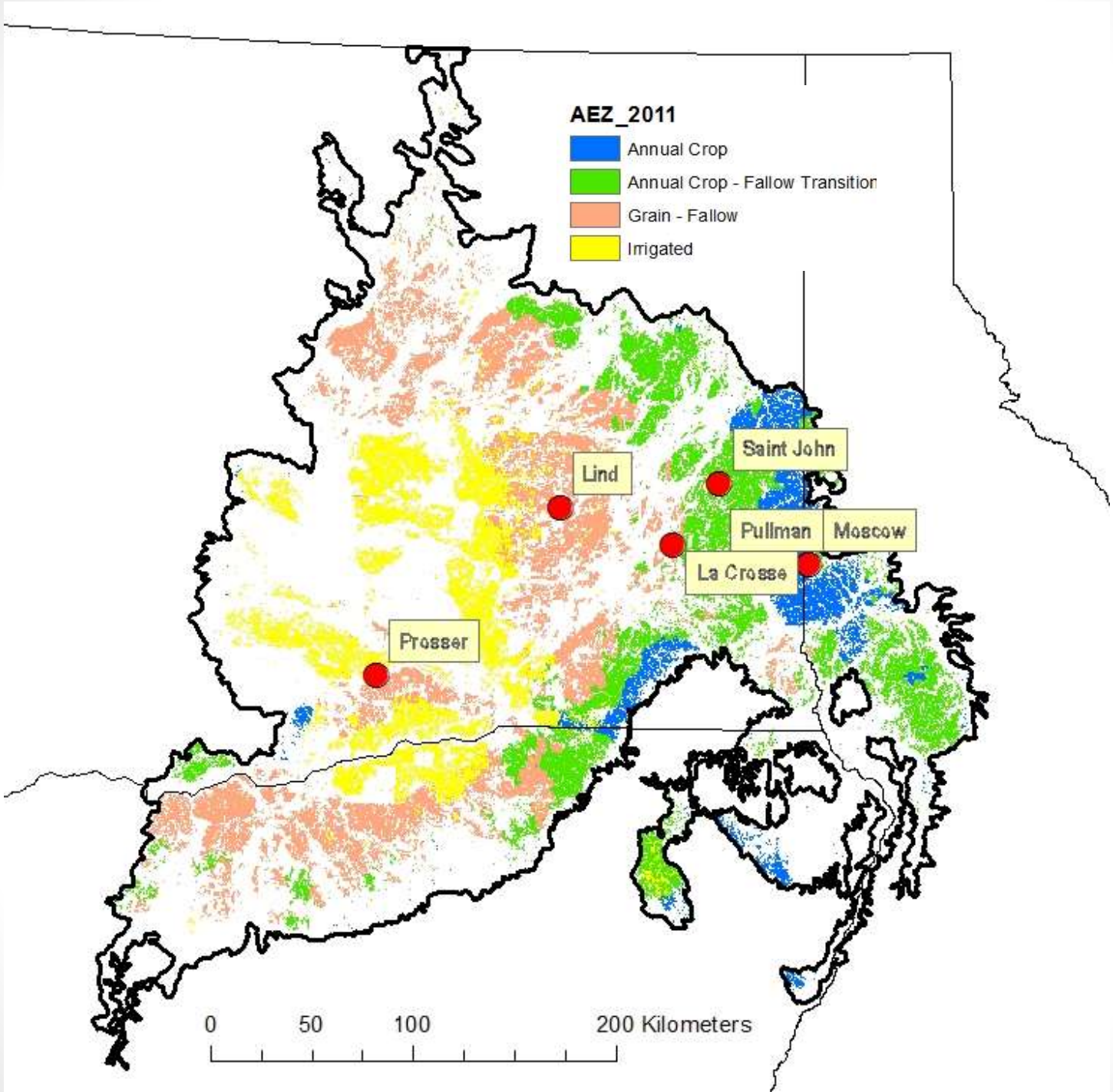
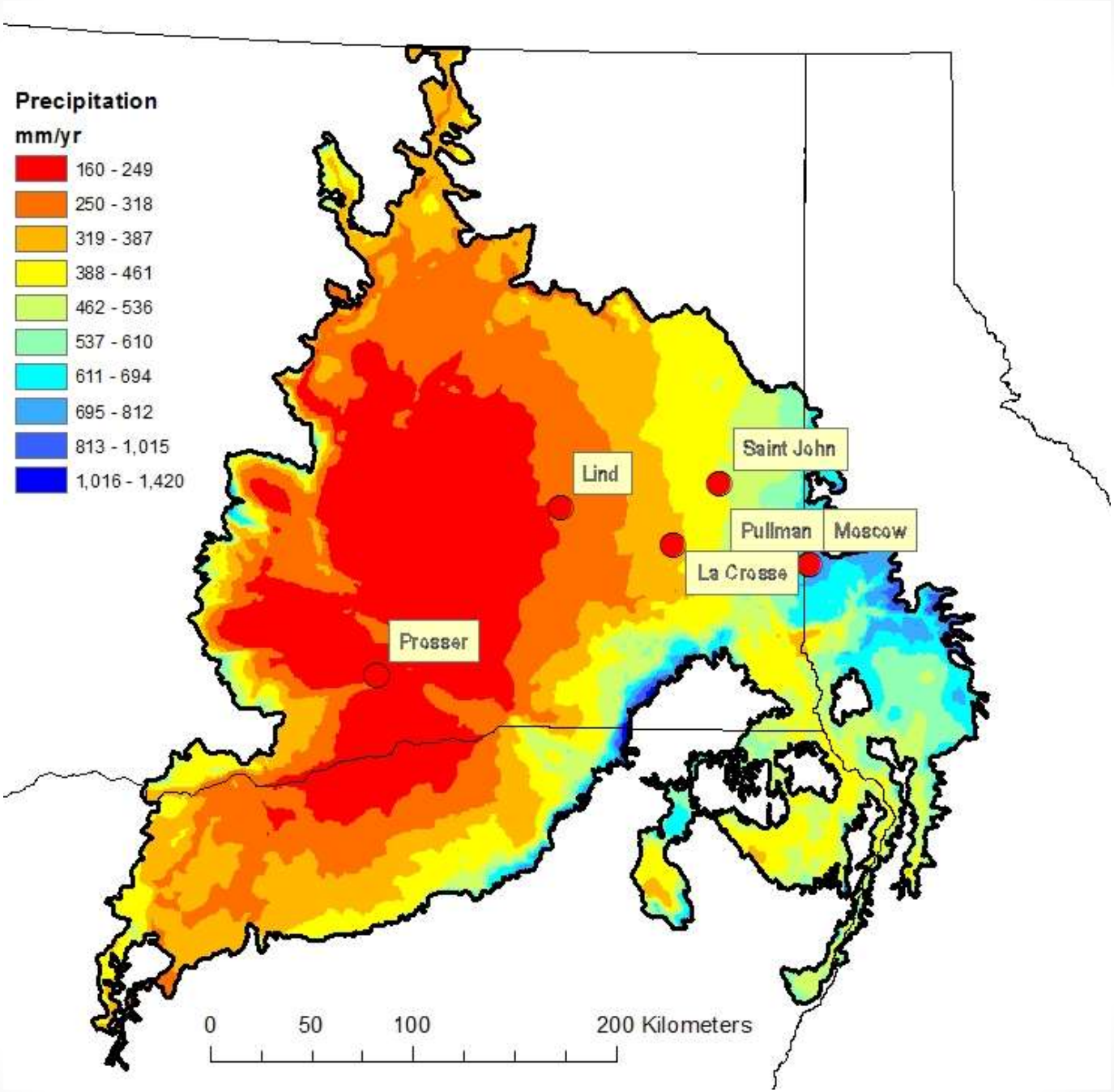
Effects of Climate Change on Cropping Systems in the Palouse

Austin Wardall, Erin Brooks

Motivation

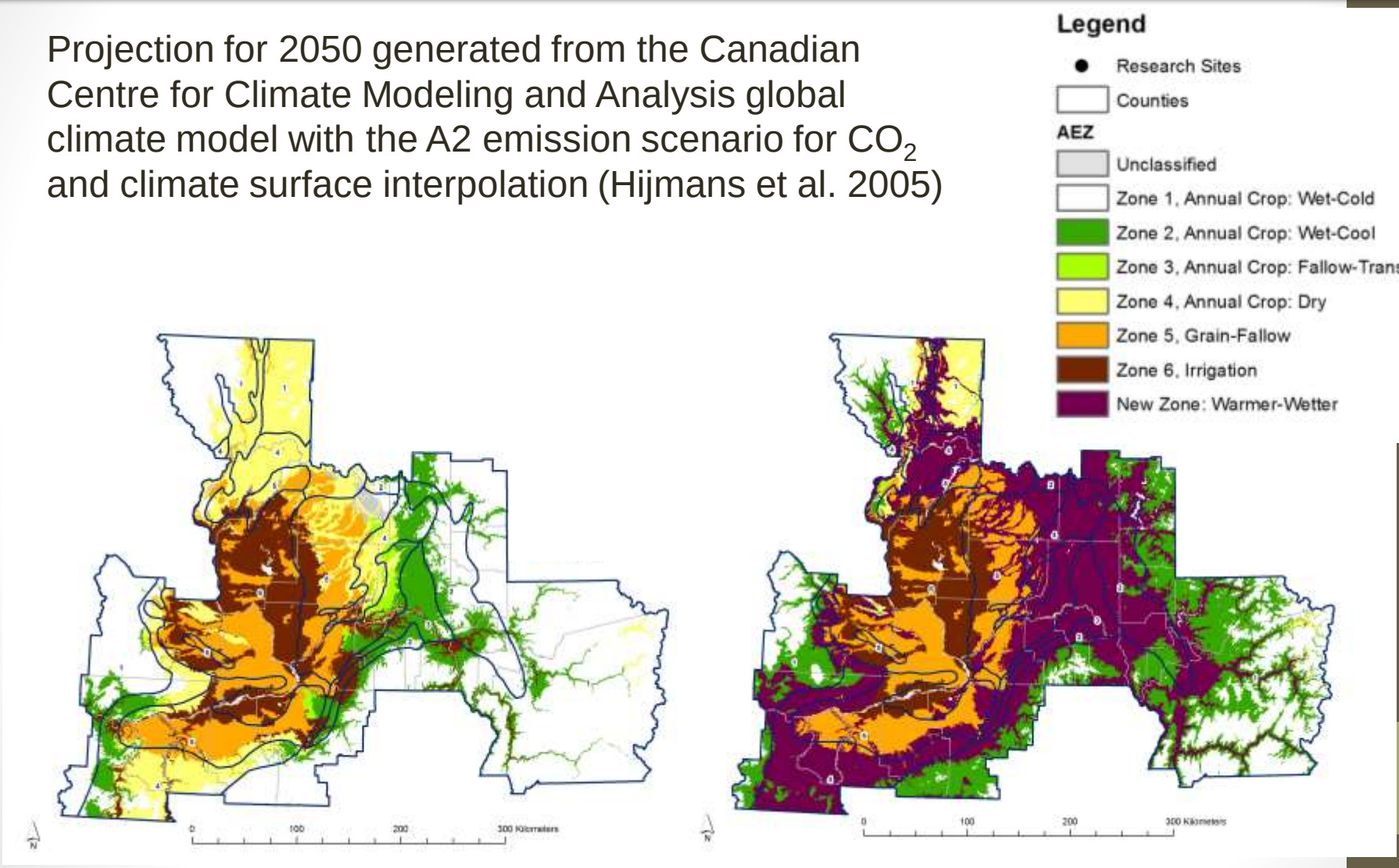
- Uncertain how future climate change may affect dryland cropping systems in the Pacific Northwest
  - AEZs will likely shift


AEZ_2011
Annual Crop
Annual Crop - Fallow Transition
Grain - Fallow
Irrigated
Saint John
Lind
Pullman
Moscow
La Crosse
Prosser
0
50
100
200 Kilometers


Precipitation
mm/yr
160 - 249
250 - 318
319 - 387
388 - 461
462 - 536
537 - 610
611 - 694
695 - 812
813 - 1,015
1,016 - 1,420
Saint John
Lind
Pullman
Moscow
La Crosse
Prosser
0
50
100
200 Kilometers

Motivation and Genesis

Projection for 2050 generated from the Canadian Centre for Climate Modeling and Analysis global climate model with the A2 emission scenario for CO_2 and climate surface interpolation (Hijmans et al. 2005)



"Current"

2050

Rick Rupp

Objectives

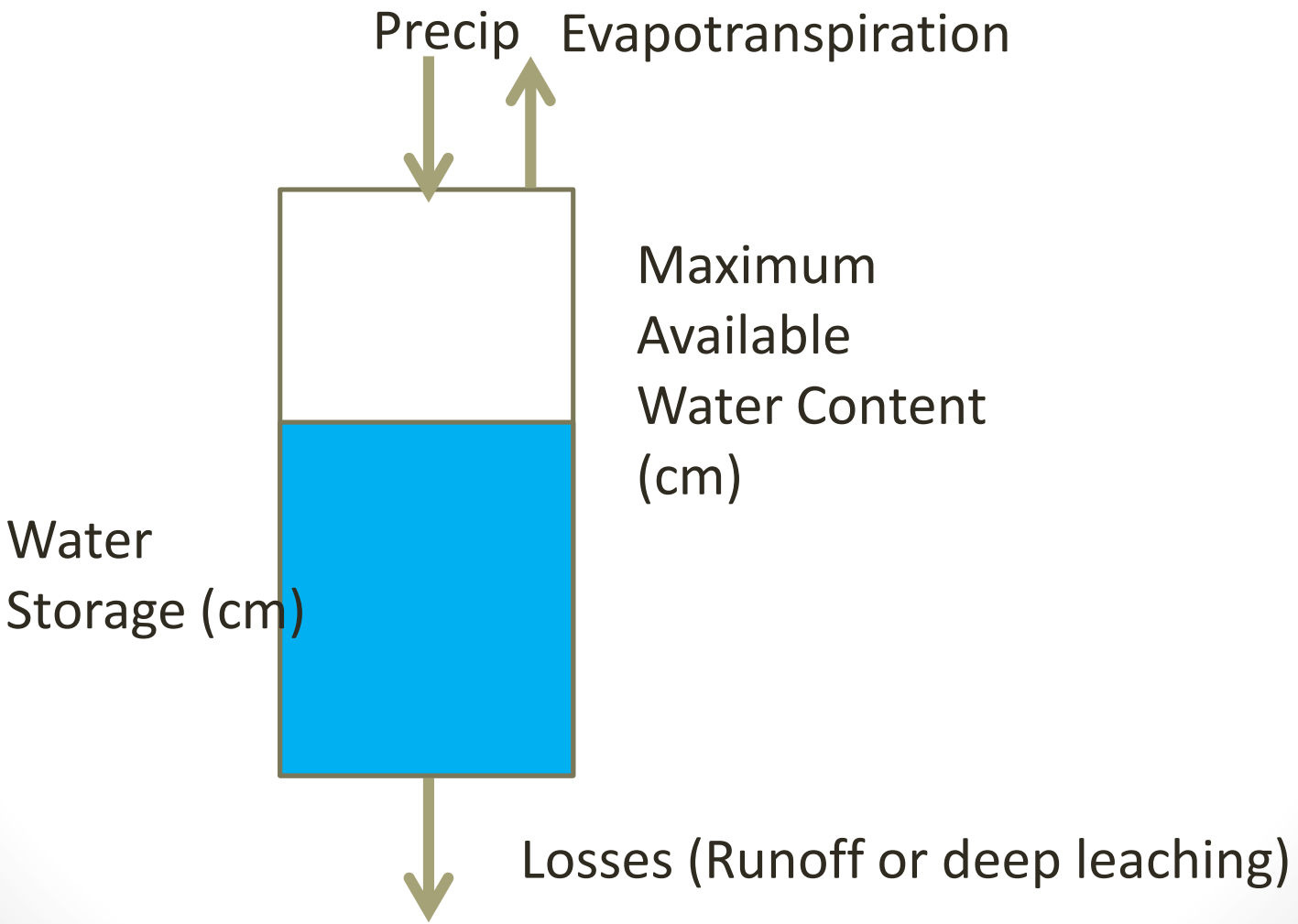
- Discover how AEZs may shift as 21st century progresses
  - Simulate soil moisture response to future climate scenarios
    - Two climate scenarios
    - Six locations across all AEZs
    - Three cropping systems

Methods

- Spreadsheet hydrology model (Thornthwaite-Mather, 1955)
  - Compare spreadsheet output with observed eddy covariance data at the Cook Farm
  - Use the hydrology model to calculate likelihood of water shortage at each location

Thornthwaite-Mather Model

Precip – Et – Losses = change in Water Storage

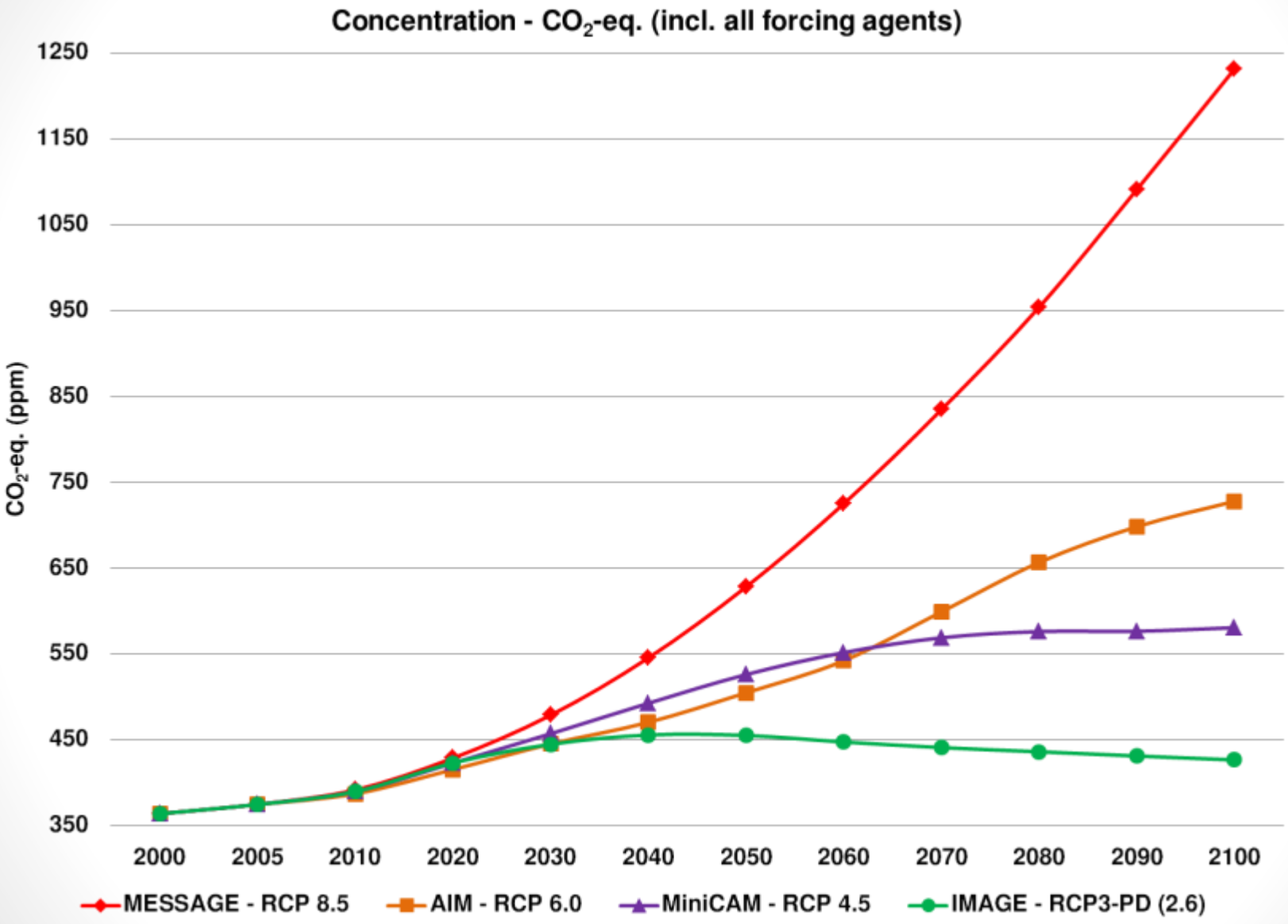


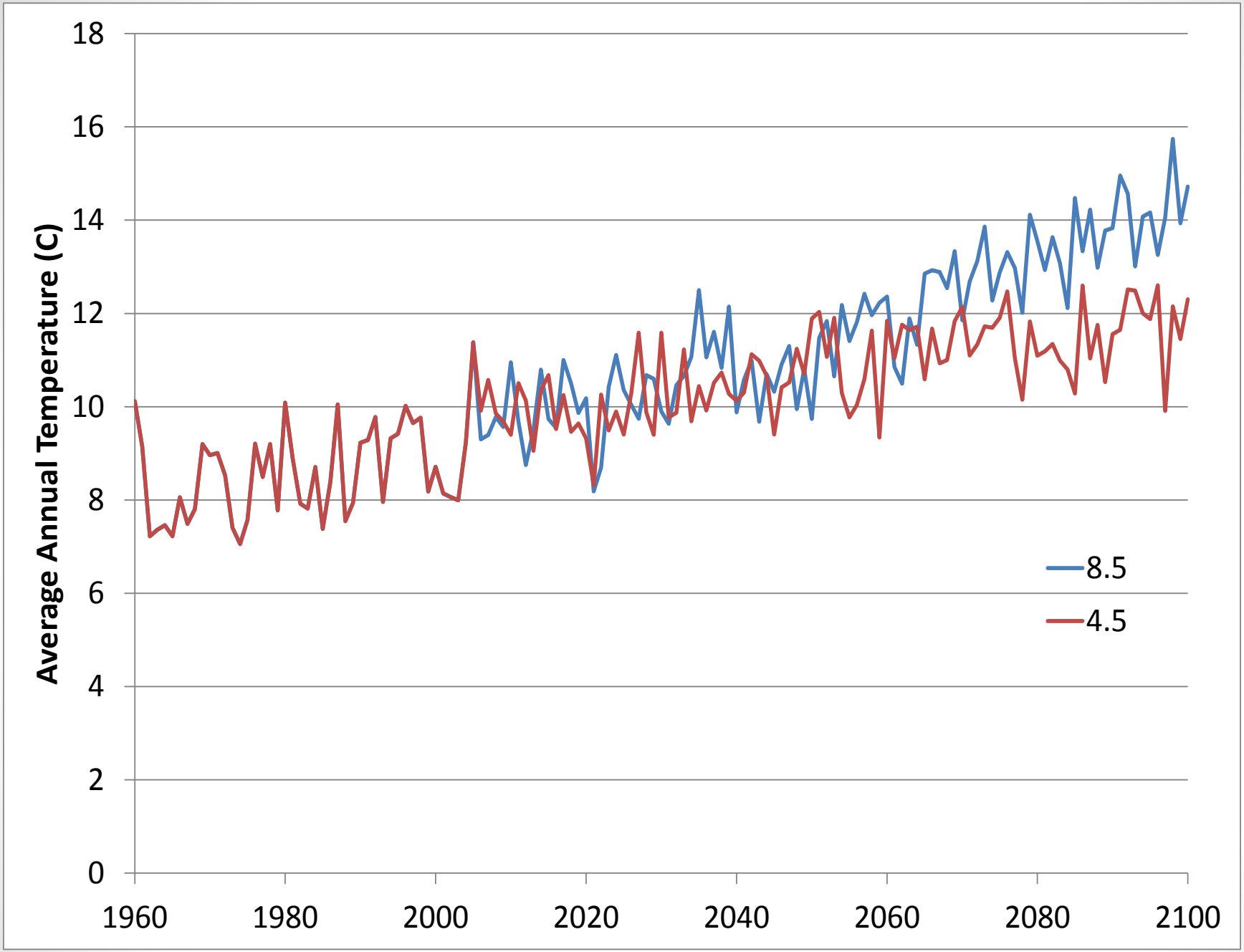
Thornthwaite-Mather Model

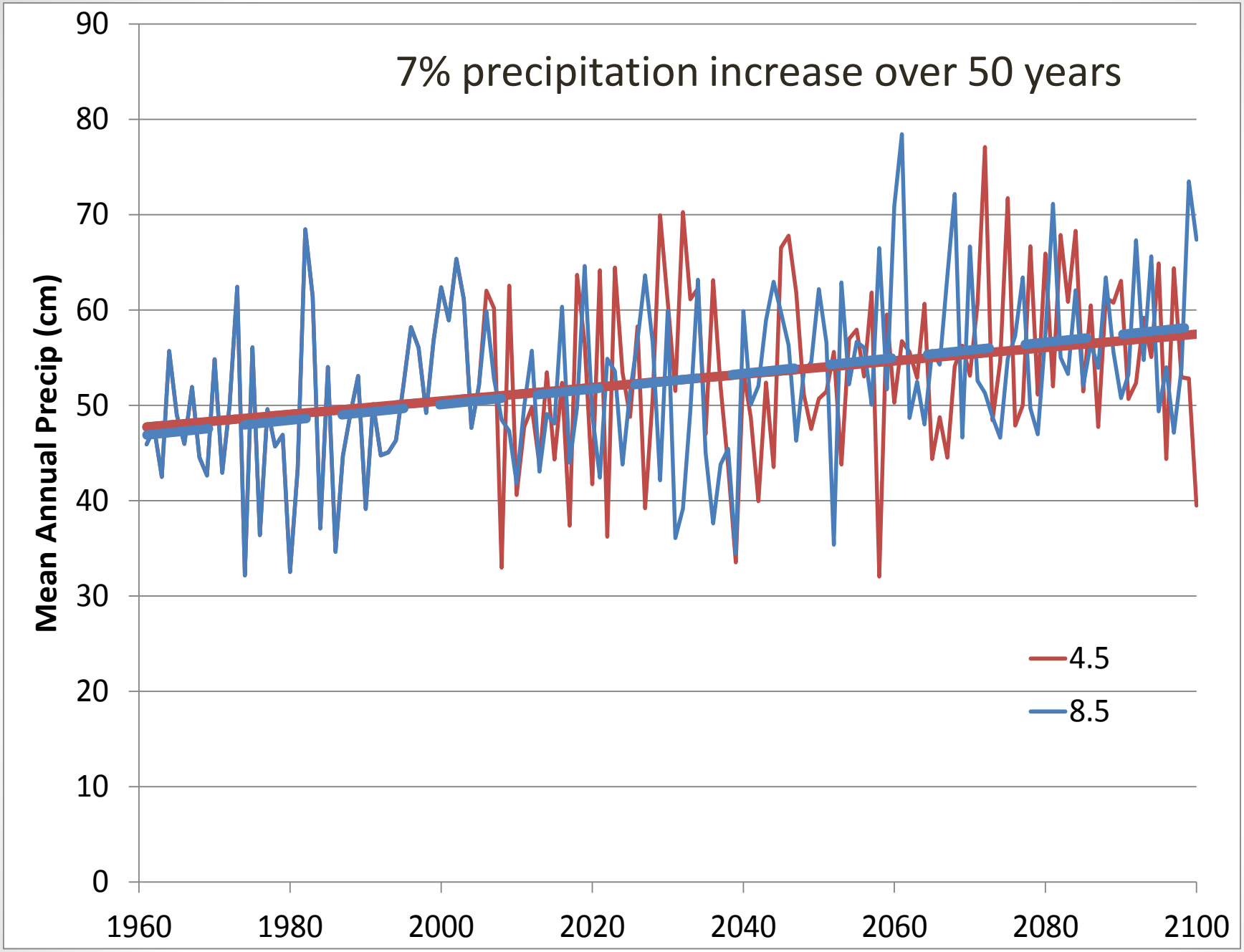
- Inputs:
  - Daily Tmax, Tmin, and Precipitation
  - Maximum soil available water content
  - Crop rotation
    - Crop coefficients
    - Plant date
    - Length of growing season
- Output
  - Daily soil water storage
  - Daily ET
  - Daily Losses
  - Daily Snowmelt

Input Climate Data

- Daily precip, Tmax, Tmin from MACA dataset, CNRM-CM5 model, both RCP 8.5 and 4.5 scenarios
  - RCP:
    - Stands for Representative Concentration Pathway
    - Is a projection of greenhouse gas concentrations in the future.

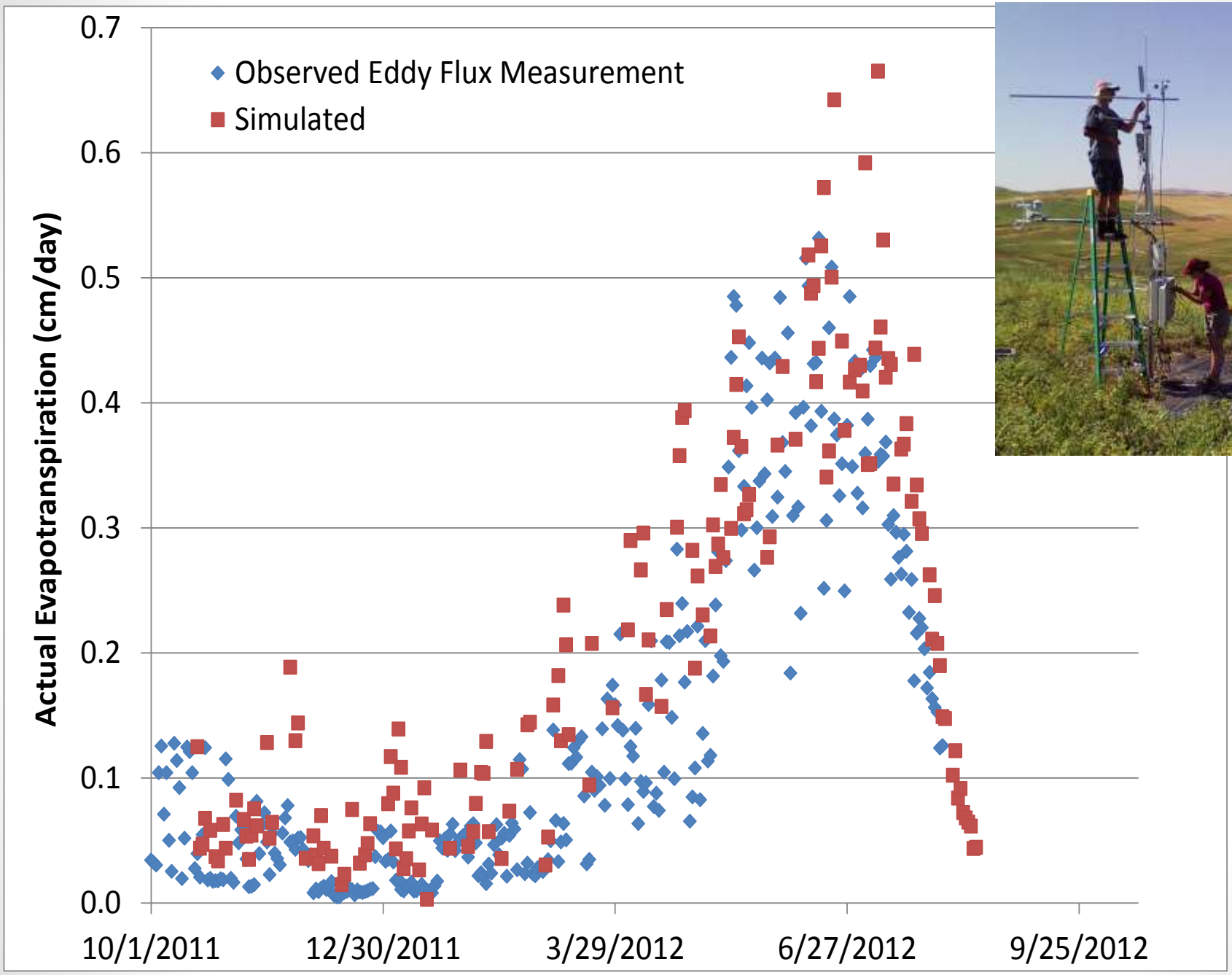

Concentration - CO_2-eq. (incl. all forcing agents)
CO_2-eq. (ppm)
1250
1150
1050
950
850
750
650
550
450
350
2000
2005
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
MESSAGE - RCP 8.5
AIM - RCP 6.0
MiniCAM - RCP 4.5
IMAGE - RCP3-PD (2.6)

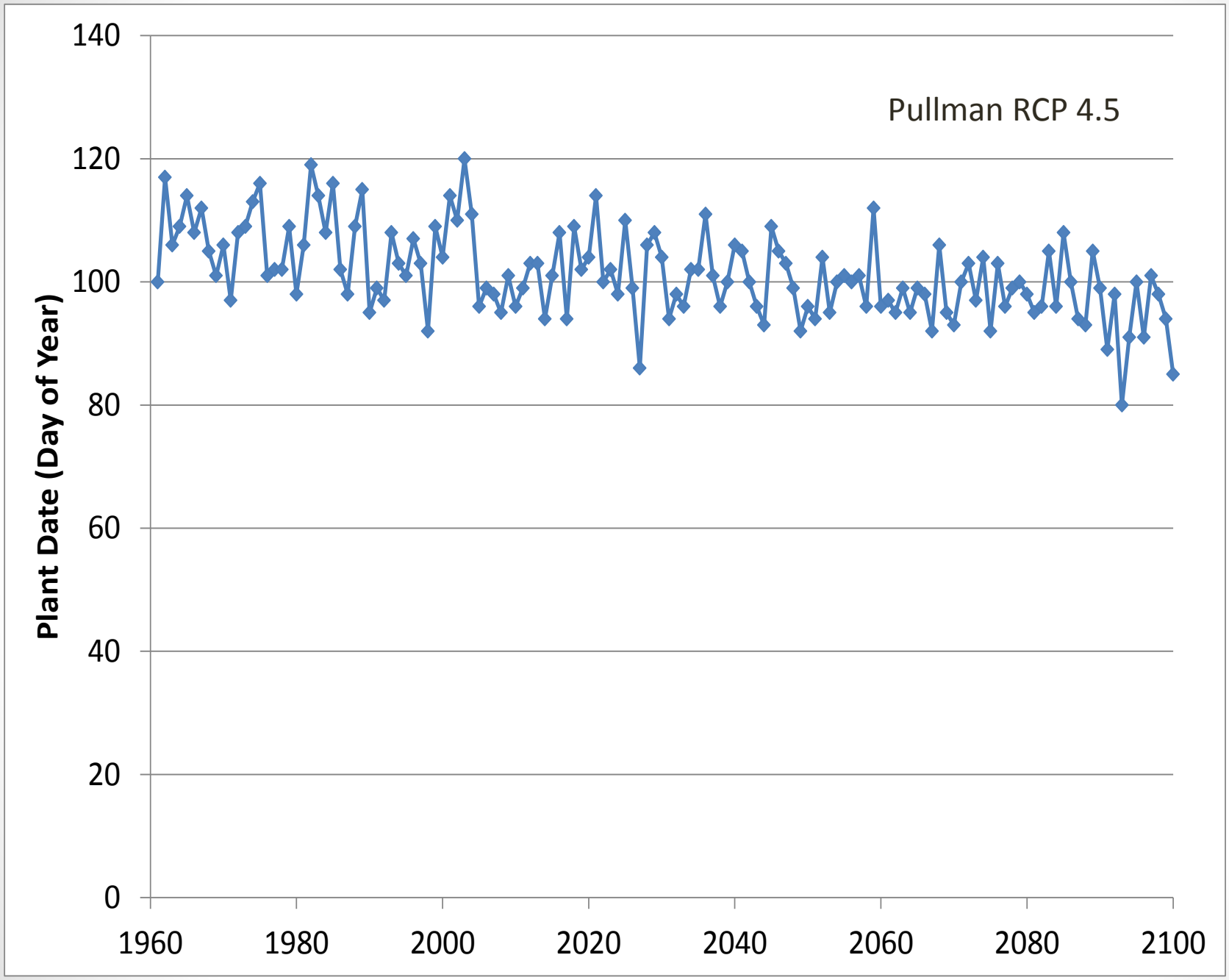

Average Annual Temperature (C)
18
16
14
12
10
8
6
4
2
0
1960
1980
2000
2020
2040
2060
2080
2100
8.5
4.5



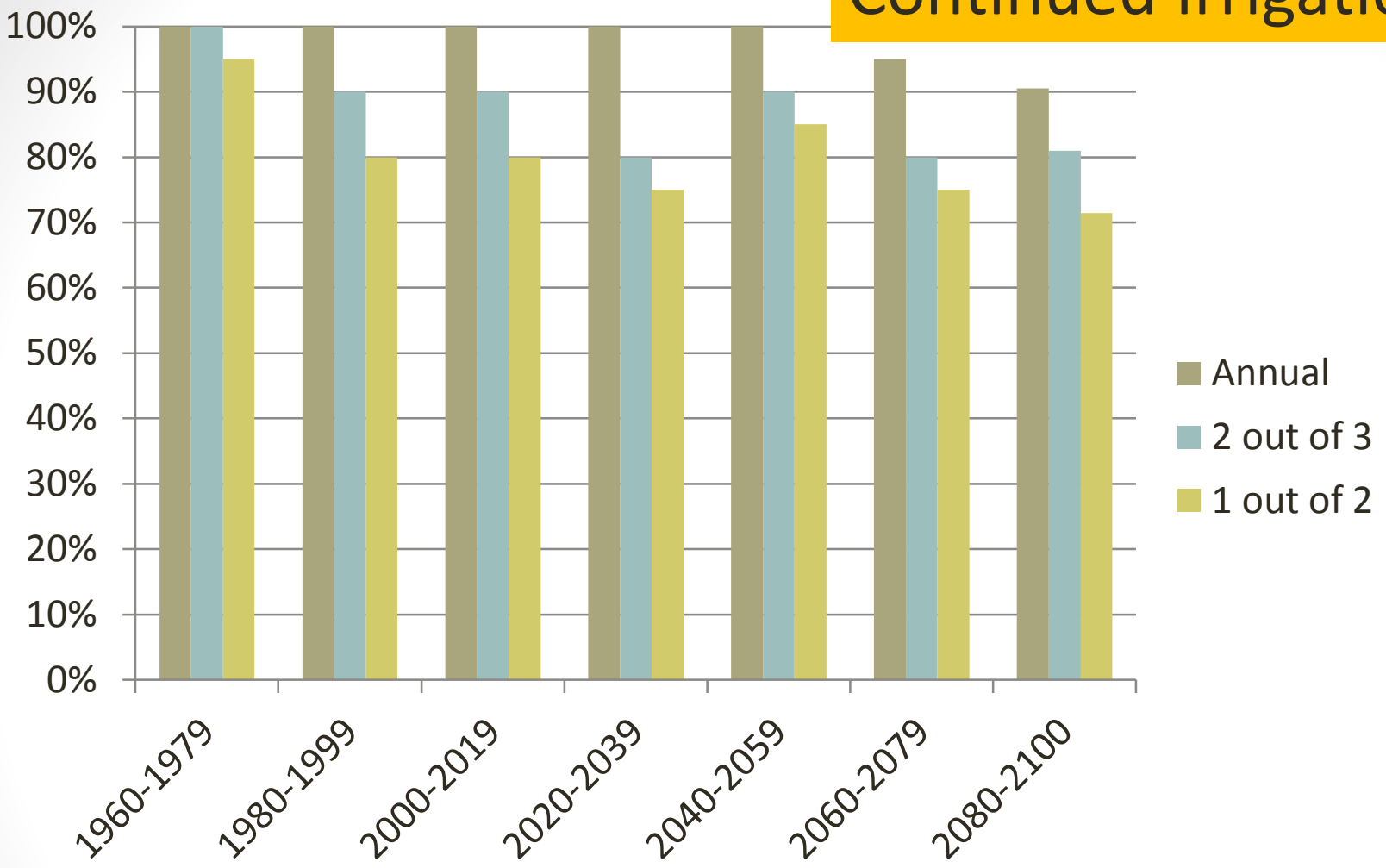
Pullman RCP 8.5

Results


Observed Eddy Flux Measurement
Simulated
Actual Evapotranspiration (cm/day)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10/1/2011
12/30/2011
3/29/2012
6/27/2012
9/25/2012


Pullman RCP 4.5
Plant Date (Day of Year)
140
120
100
80
60
40
20
0
1960
1980
2000
2020
2040
2060
2080
2100

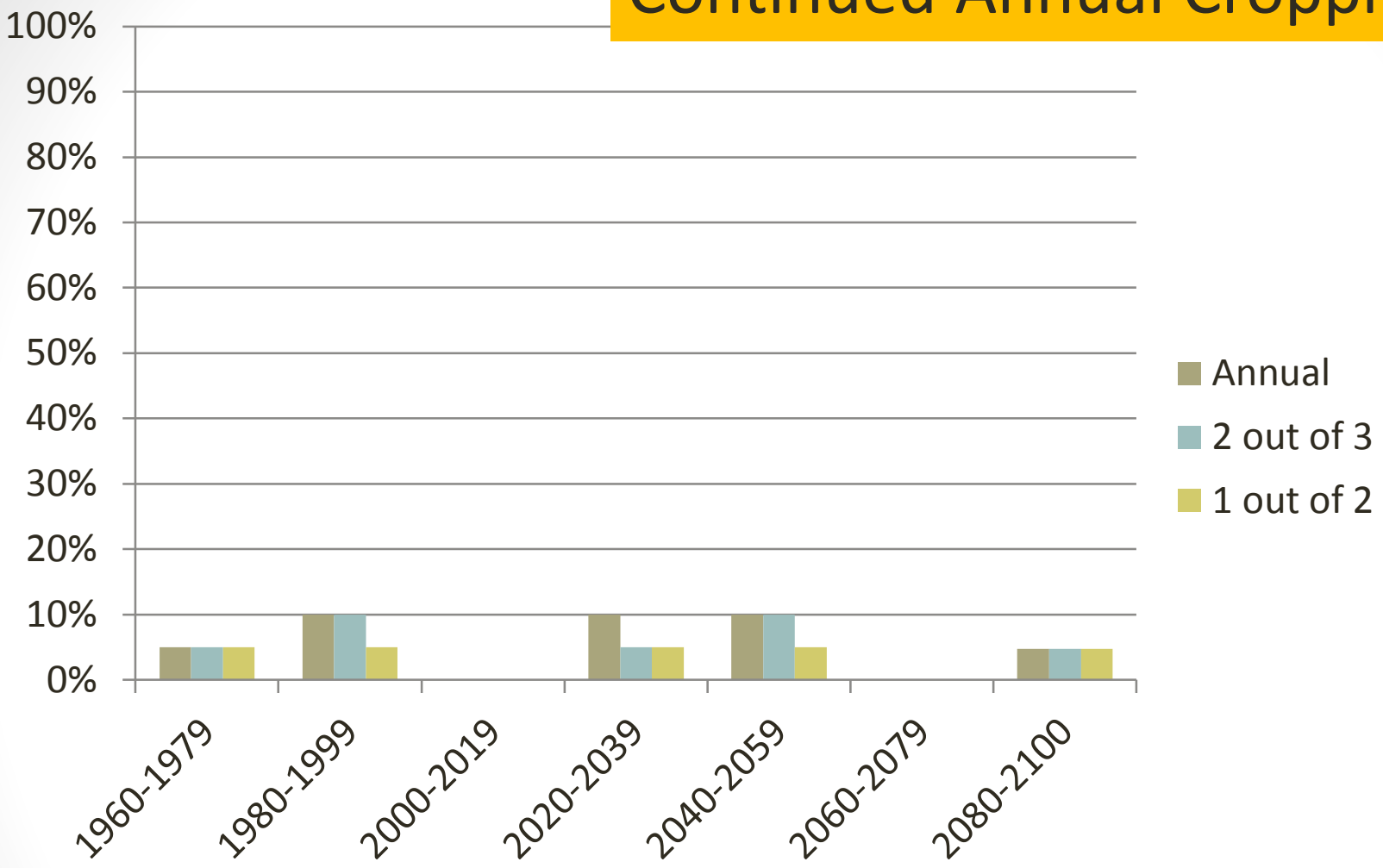
Continued Irrigation



Frequency with which available water capacity is not reached

Prosser

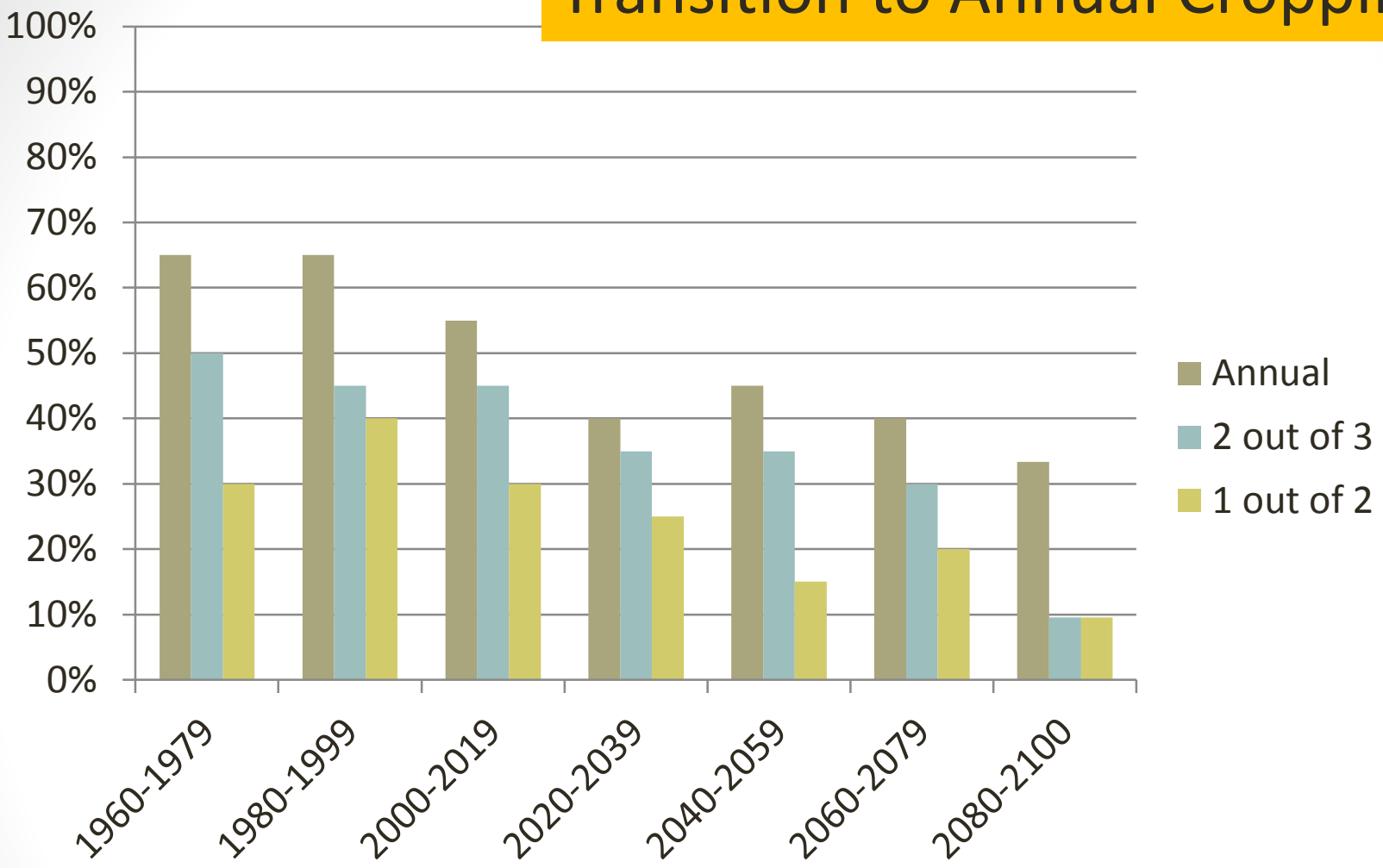
Continued Annual Cropping



Frequency with which available water capacity is not reached

Pullman

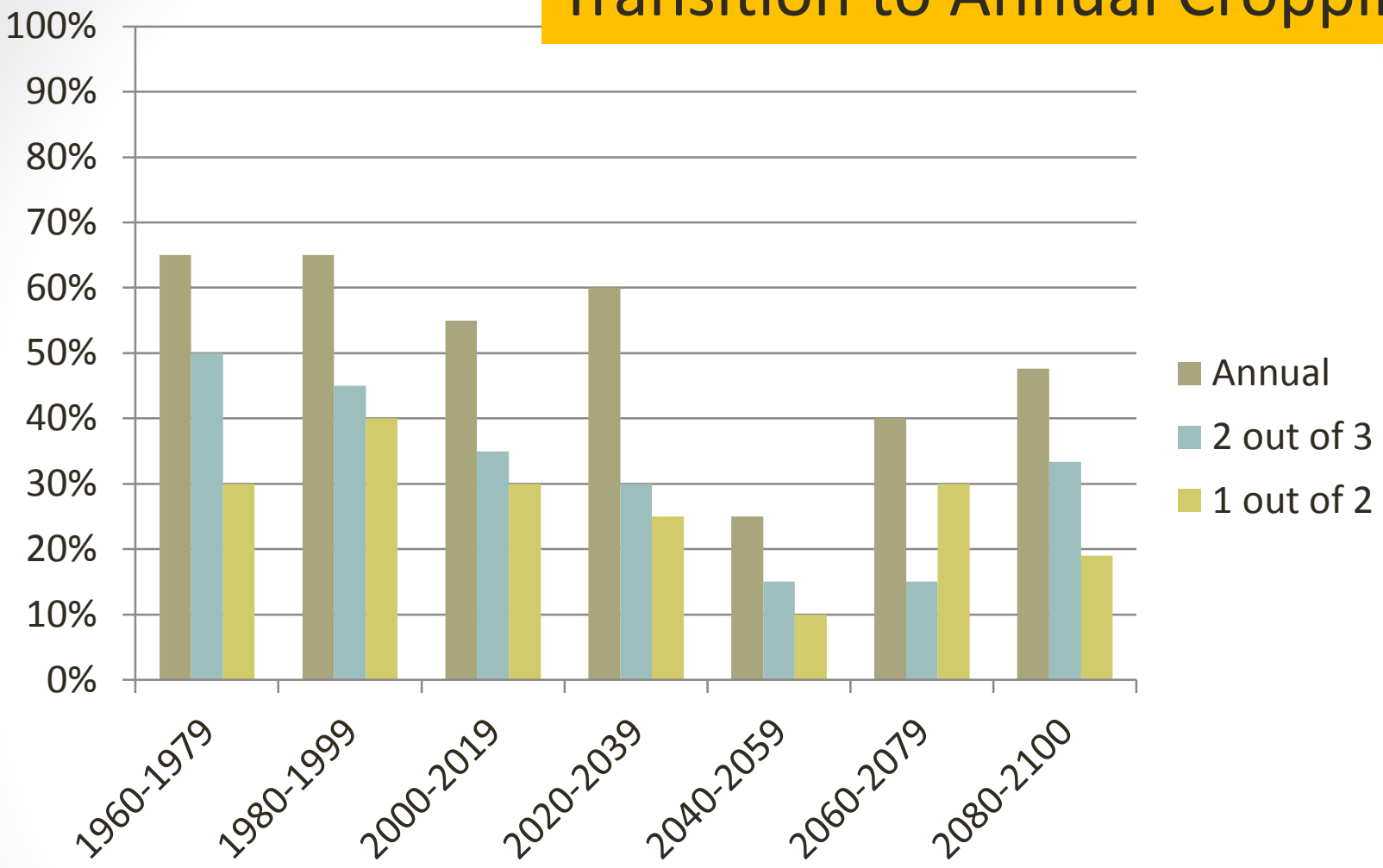
Transition to Annual Cropping



Frequency with which available water capacity is not reached

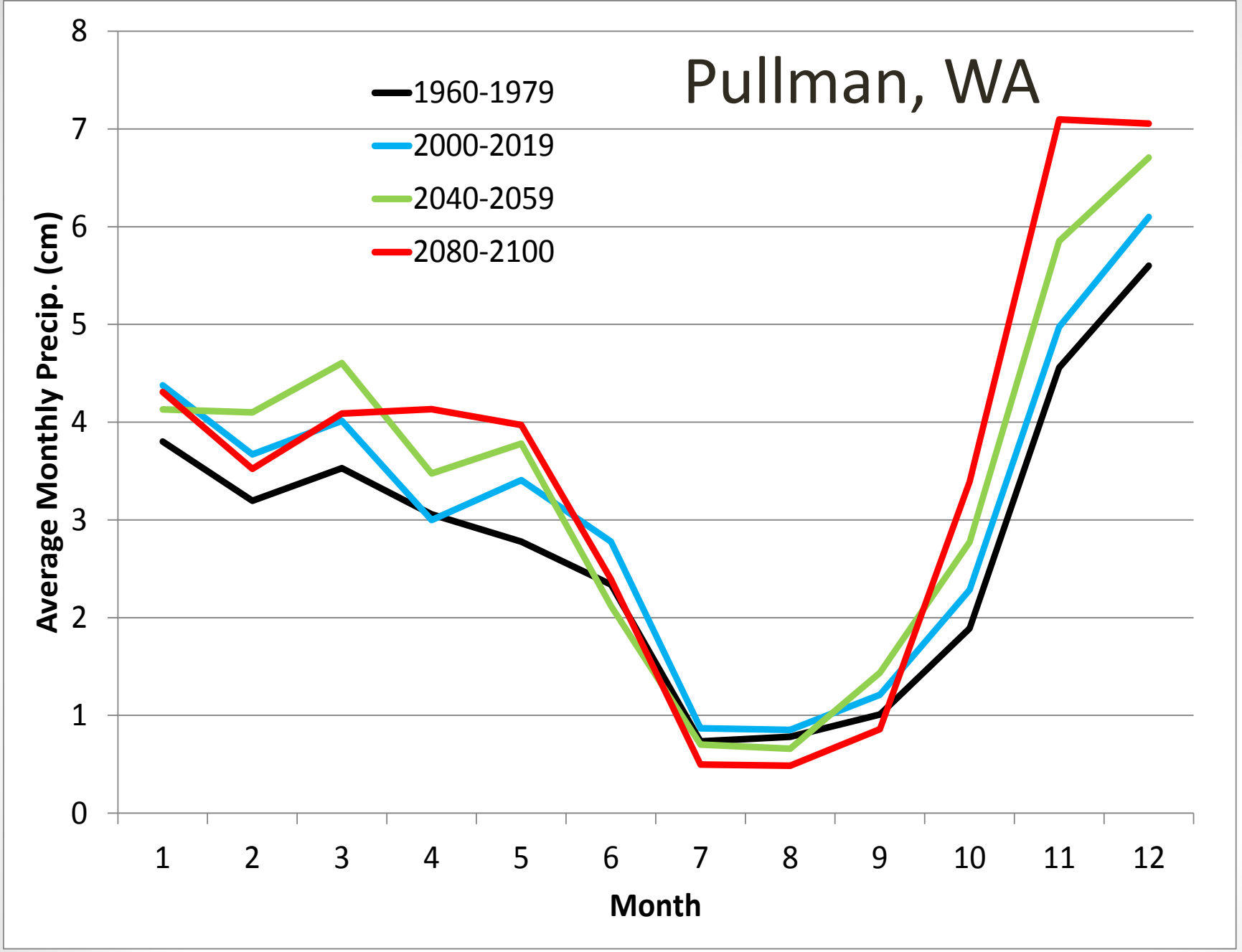
Lacrosse RCP 4.5

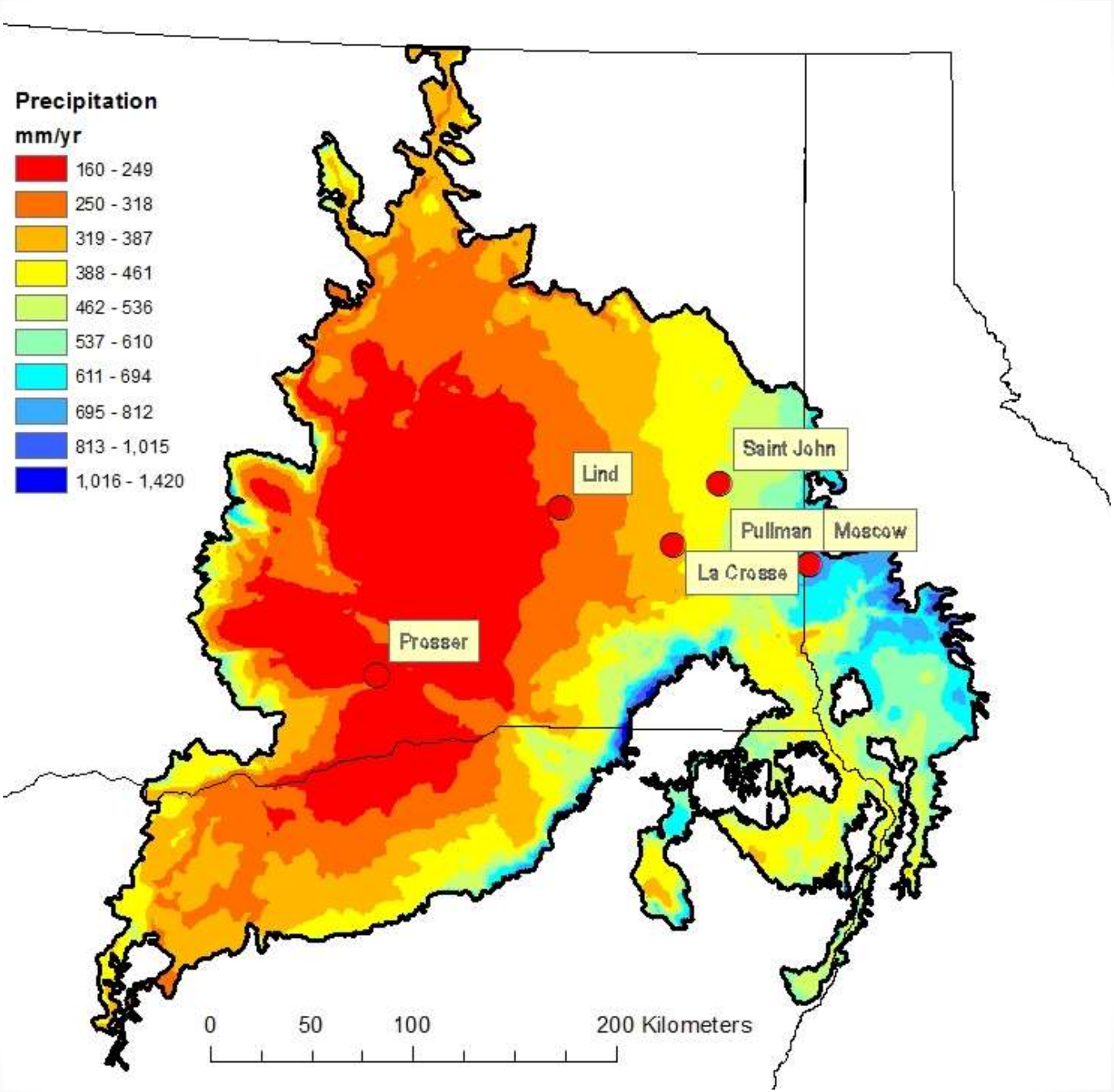
Transition to Annual Cropping



Frequency with which available water capacity is not reached

Lacrosse RCP 8.5


Pullman, WA
1960-1979
2000-2019
2040-2059
2080-2100
Average Monthly Precip. (cm)
0
1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8
9
10
11
12
Month


Precipitation
mm/yr
160 - 249
250 - 318
319 - 387
388 - 461
462 - 536
537 - 610
611 - 694
695 - 812
813 - 1,015
1,016 - 1,420
Saint John
Lind
Pullman
Moscow
La Crosse
Prosser
0
50
100
200 Kilometers

Summary

- Simulations suggest a general transition to more annual cropping in the REACCH region
- Increased overwinter precipitation in the REACCH region
- Earlier plant dates by ~3 weeks
- Average annual statistics are sometimes misleading
- Seasonal differences in climate predictions are important for hydrology

Recommendations

- Develop a grid-based GIS version of the model to visualize the transition in AEZs
- Give farmers access to this information with online tool
- Compare results to a more detailed cropping model (e.g. CropSyst)

Acknowledgements

- Erin Brooks
- Stephen Fricke, John Abatzoglou
- Shelley Pressley, Brian Lamb, Sarah Waldo
- Sanford Eigenbrode