Observed changes in mean and extreme precipitation over the central U.S.

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Overview

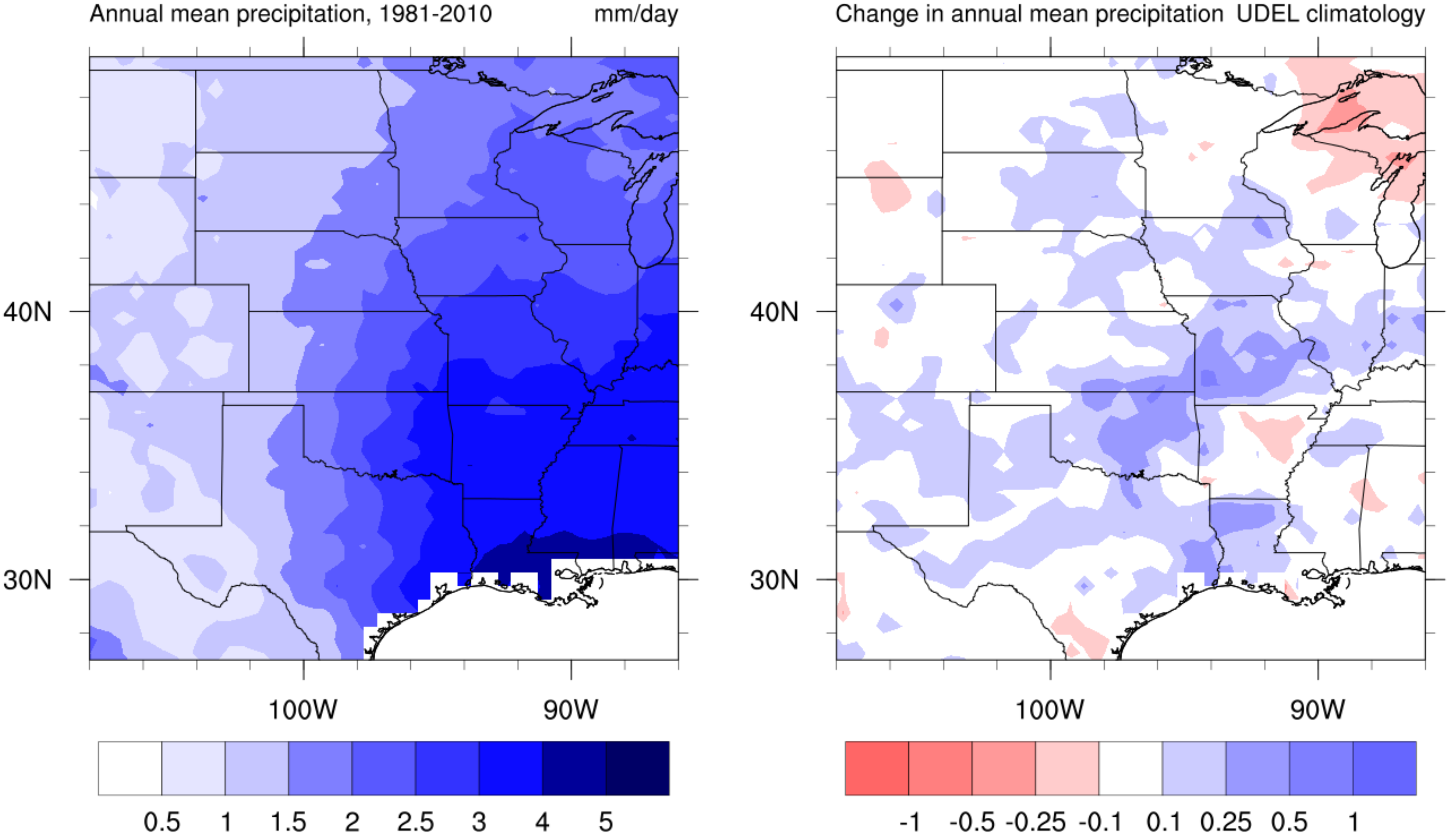
Compare mean and extreme precipitation for two 30-year climate normal periods.

- 1951-1980 versus 1981-2010
- Note half of the CO_2 increase during the industrial era has occurred since 1982.

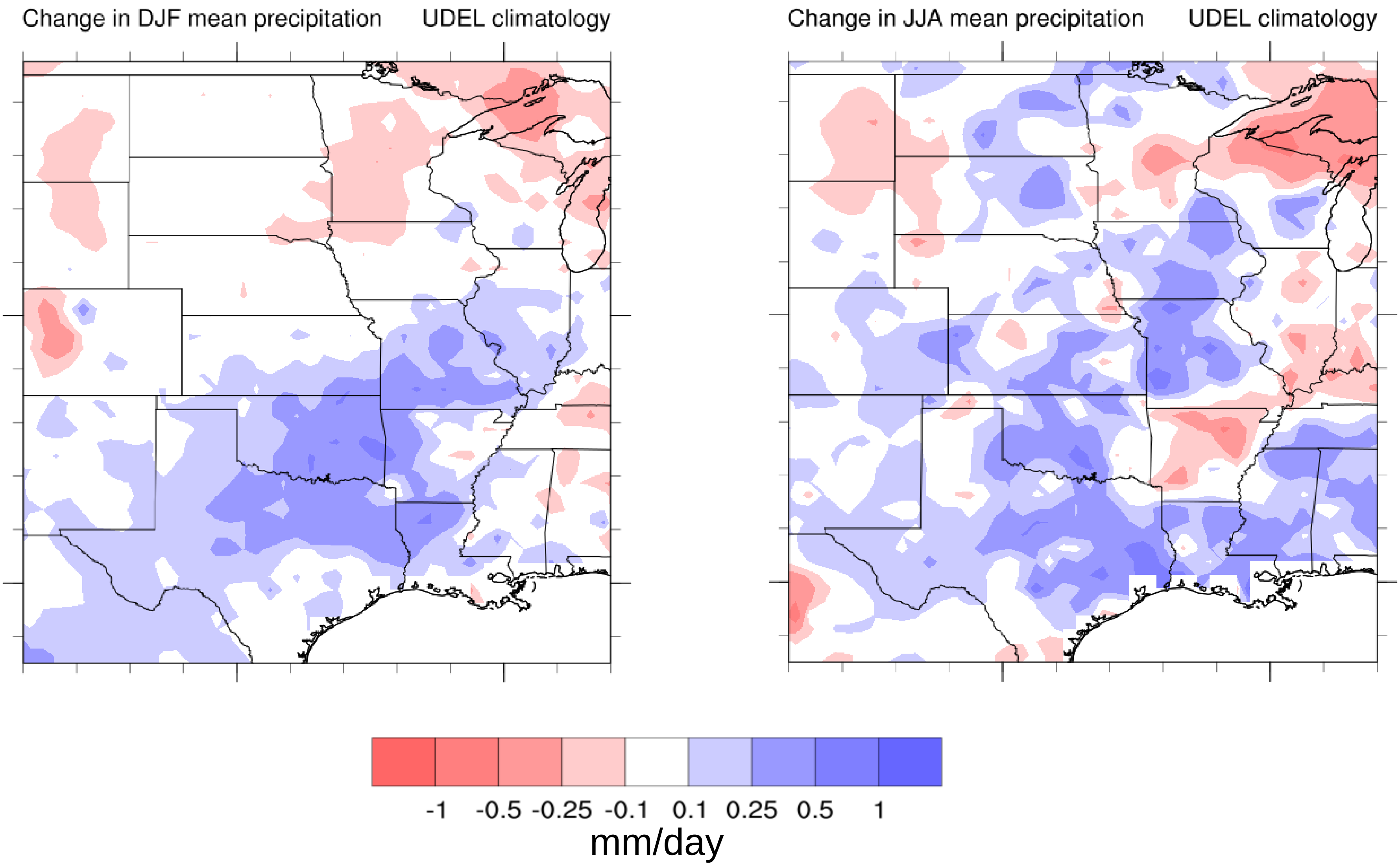
Mean precipitation is from gridded 0.5º analysis (University of Delaware, Willmott and Matsuura).

Extreme precipitation is analyzed from U.S. Cooperative Observer network daily observations.

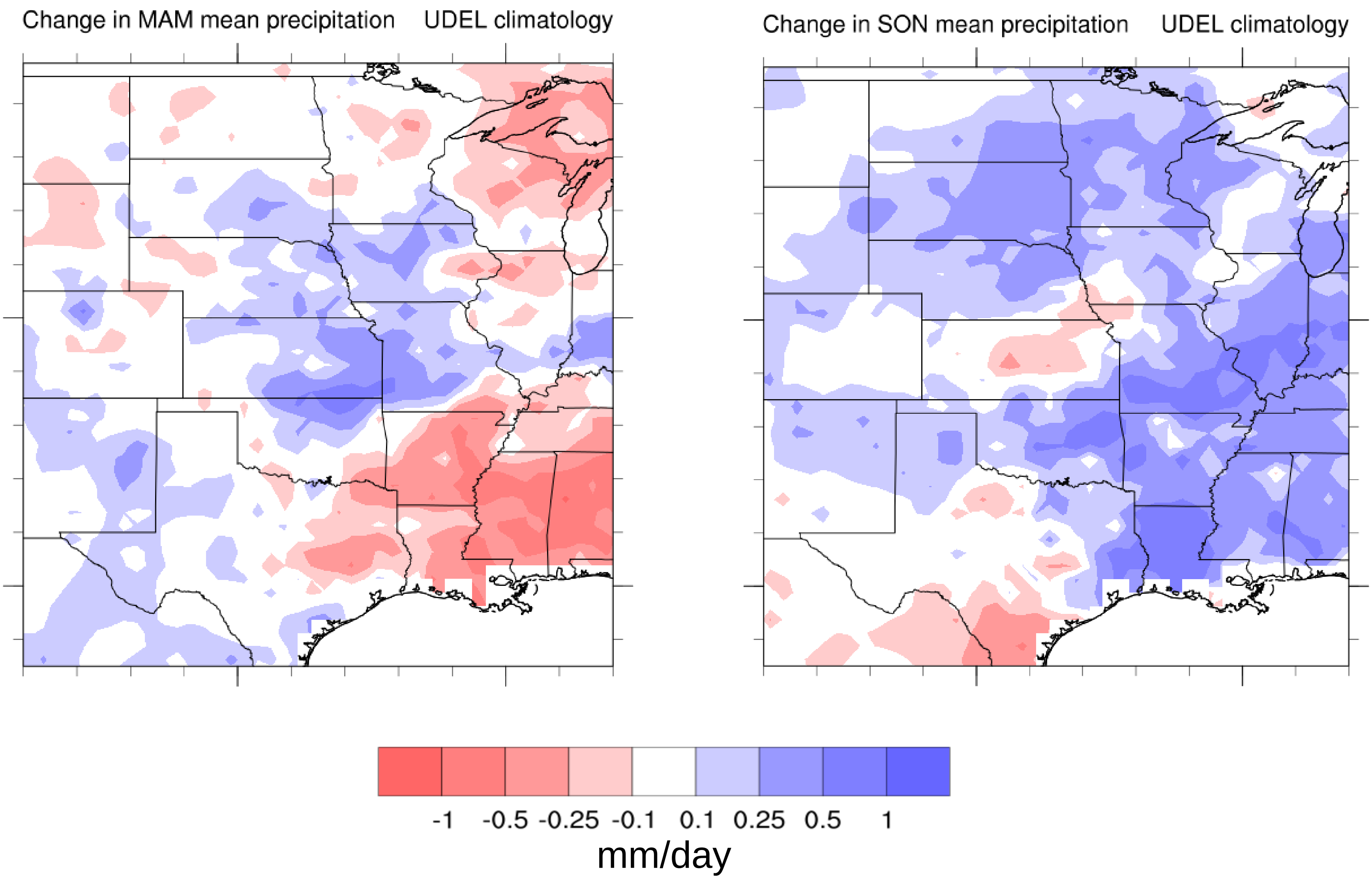
Annual mean precipitation rate and change (1981-2010 vs 1951-1980)



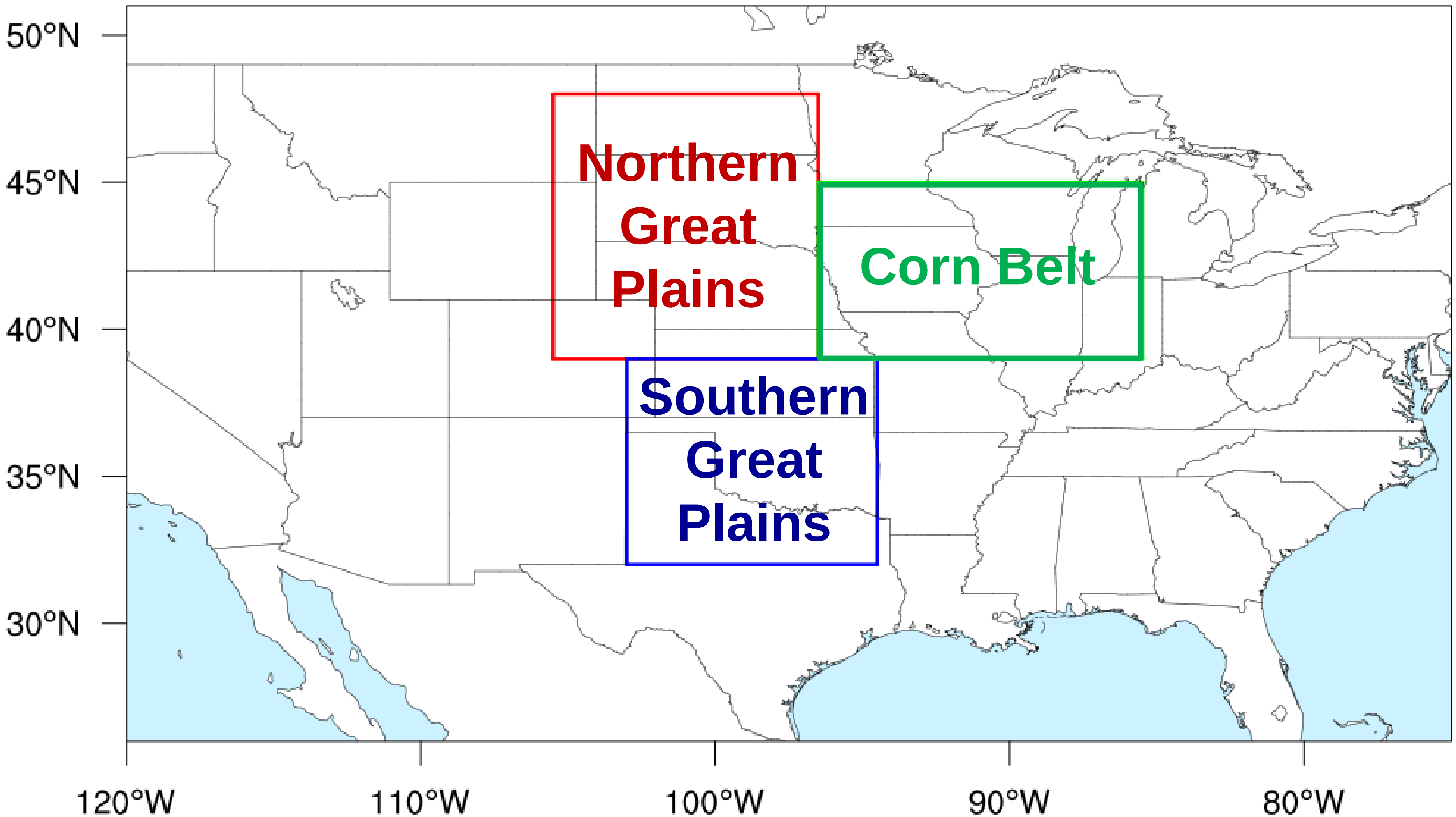
Seasonal changes in precipitation rate, DJF and JJA (1981-2010 vs 1951-1980)



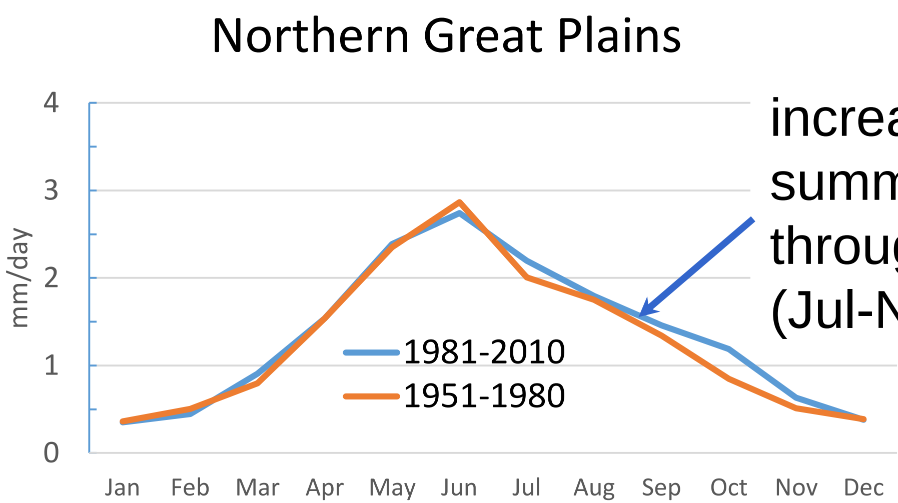
Seasonal changes in precipitation rate, MAM and SON (1981-2010 vs 1951-1980)



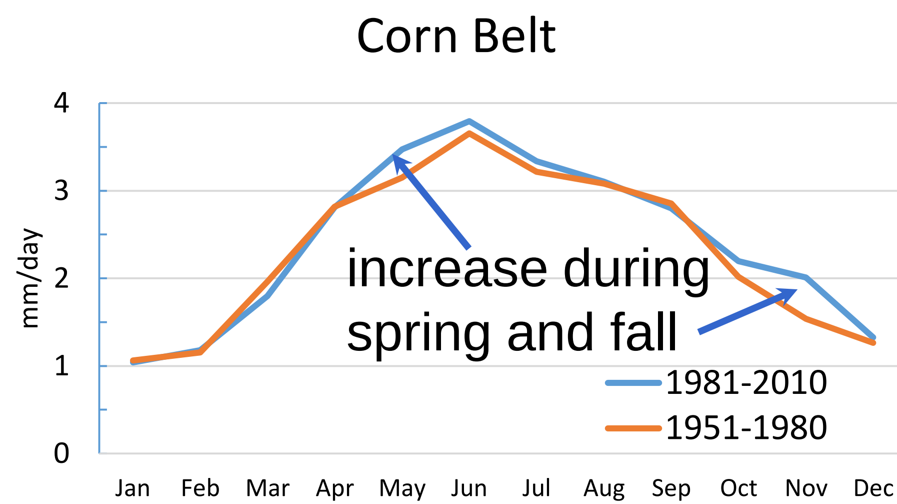
Regions for analysis

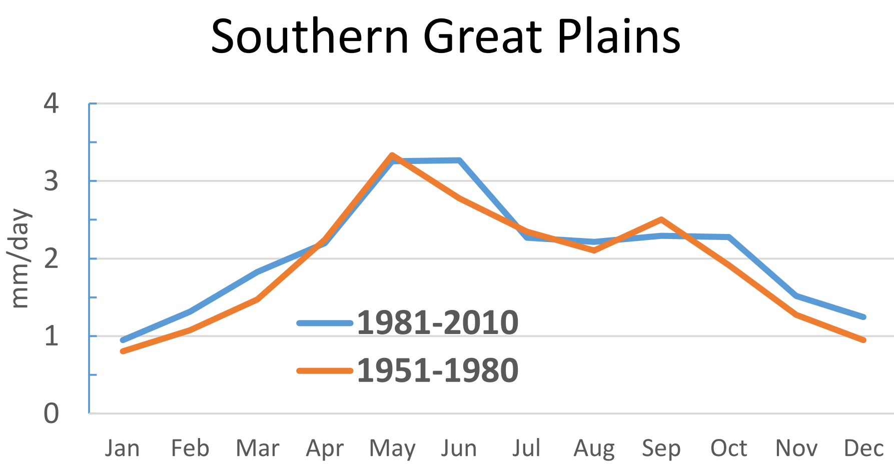


Seasonality of precipitation change varies by region



increase from summer through fall (Jul-Nov)





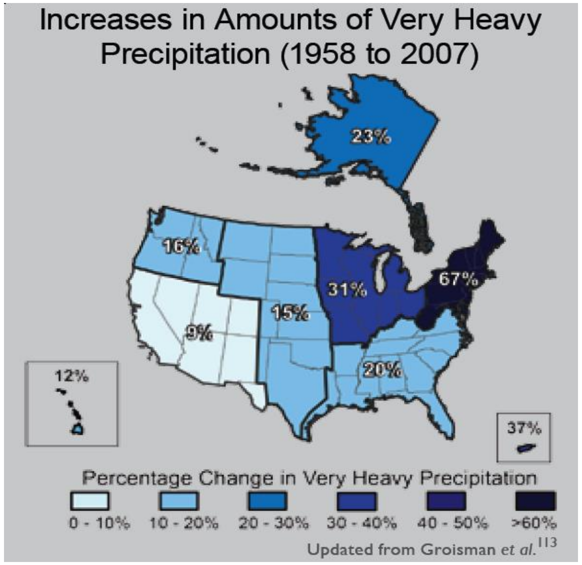
increase mostly in cool season (Oct-Mar)

Heavy rainfall happens more often

Ames, 1993

"**One of the clearest trends** in the United States observational record is an increasing frequency and intensity of heavy precipitation events… **Over the last century there was a 50% increase in the frequency of days with precipitation over 101.6 mm (four inches) in the upper midwestern U.S.;** this trend is statistically significant."

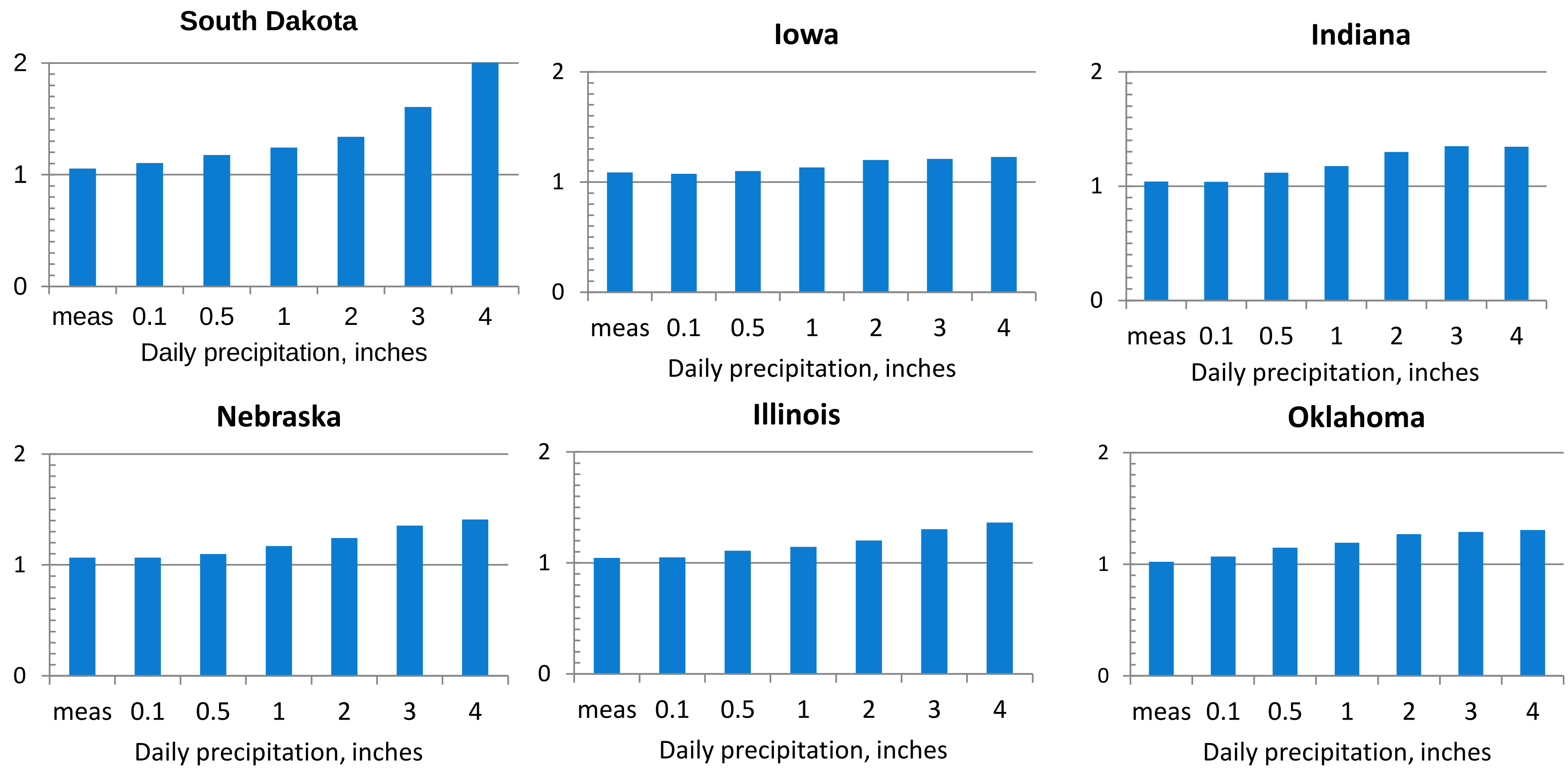
Ames, 2010



Karl, T. R., J. M. Melillo, and T. C. Peterson, (eds.), 2009: Global Climate Change Impacts in the United States. Cambridge University Press, 2009, 196pp.

Heavy rainfall has become much more frequent despite total rainfall increasing only slightly

Ratio of mean frequency in 1981-2010 versus mean frequency in 1951-1980 for each threshold. Based on Cooperative Observer network.



More precipitation isn't always better for agriculture

Excess moisture can negatively affect

- ✧ erosion
- ✧ nutrient runoff
- ✧ soil moisture (root zone anaerobia)
- ✧ field operations
- ✧ crop drying

photos from
agresearchmag.ars.usda.gov and
extension.purdue.edu

Summary

Annual precipitation has increased around 5% in most of the central U.S. Seasonality varies:

- Southern Great Plains: increase mostly in the cool season, also in June.
- Northern Great Plains: increase during summer-fall.
- Corn Belt: increase in spring and fall.
- No obvious relation to patterns of warming.

More frequent occurrence of heavy precipitation:

- Events > 4 in (101.6 mm) per day have increased in frequency by 20-40%, in some places more.

Both global and regional models predict the trend of more frequent heavy precipitation will continue and strengthen.

Questions

Water-related limitations in understanding:

- Relative role of large-scale climate change and variability versus local influences (e.g., LULCC, land feedback).

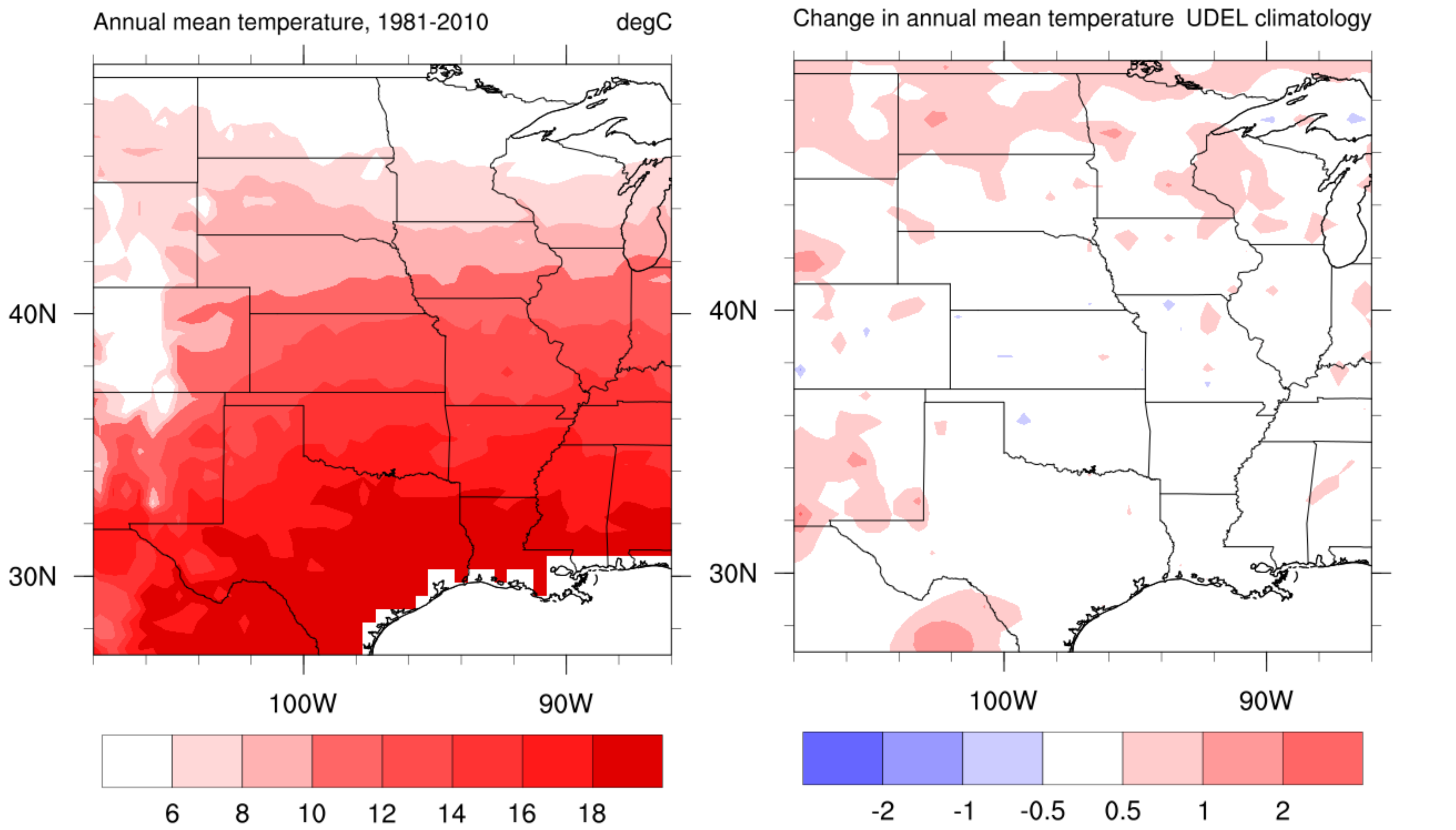
Key objectives and tasks:

- Detailed assessment of LULCC: change in cover type, intensity (urbanization, ag management, tiling, etc).
- Improved detail and realism of land surface processes in models, including comparison to observations.

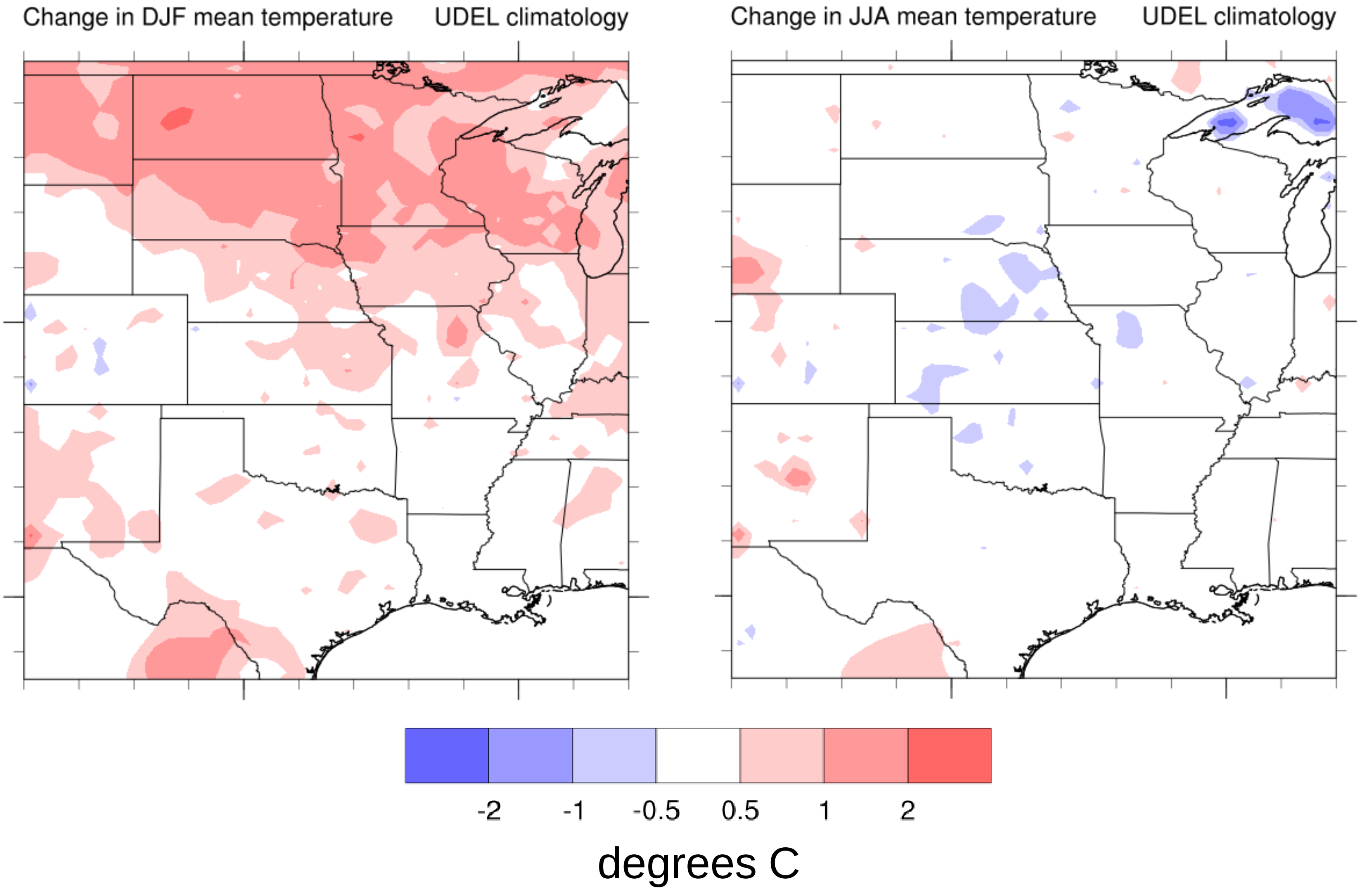
Social, economic, and environmental benefits:

- More effective management of water quantity (local and regional infrastructure, ag uses), water quality (drinking water, recreation, Gulf hypoxia), transportation.

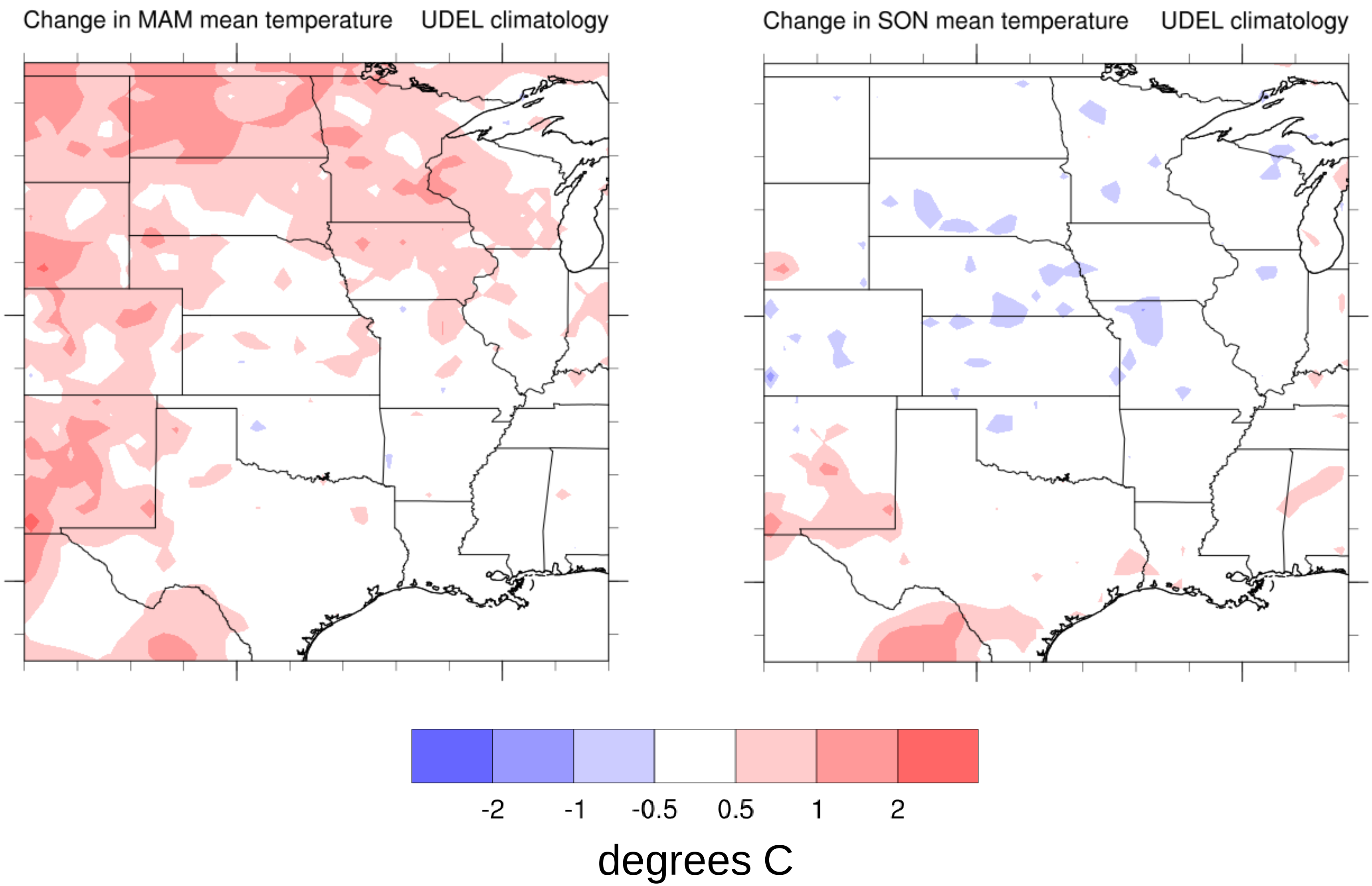
Annual mean temperature and change (1981-2010 vs 1951-1980)



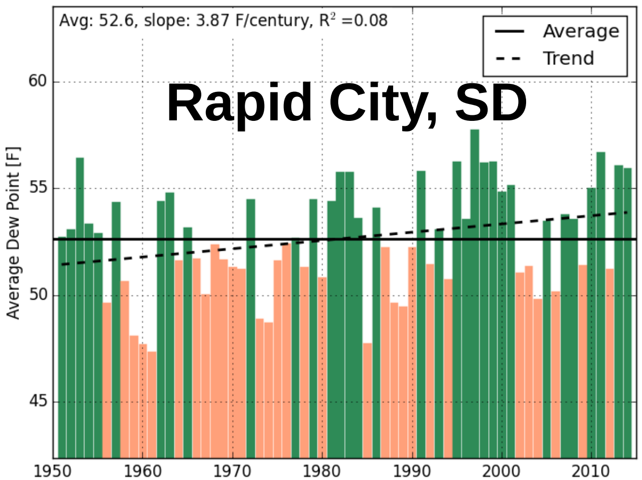
Seasonal changes in temperature, DJF and JJA (1981-2010 vs 1951-1980)



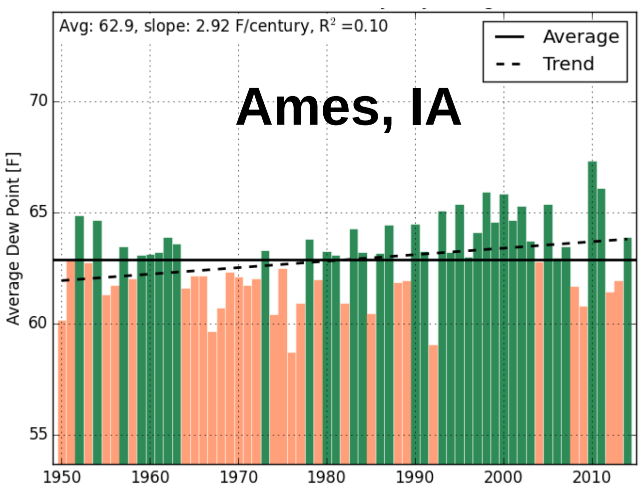
Seasonal changes in temperature, MAM and SON (1981-2010 vs 1951-1980)

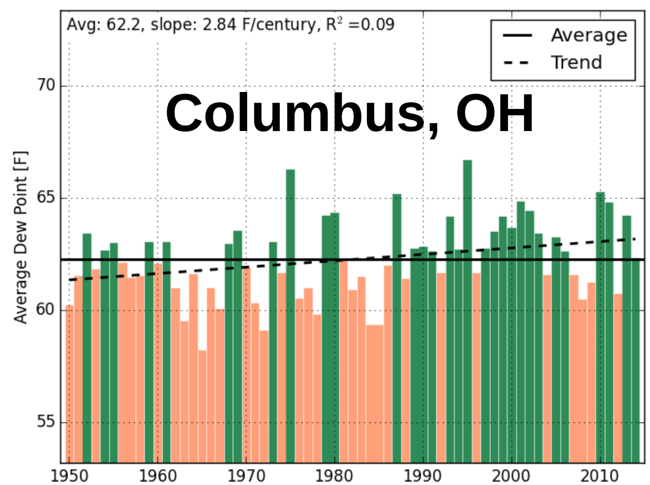


More summer humidity in most of the region



Average for June-July-August of each year, 1950-2014.
Green bars indicate years that are above the mean.





D. Herzmann, Iowa Environmental Mesonet

Summary

- Based on global climate model scenarios, corn yields are expected to
  - ✧ Decrease with climate change by -17% (mean value for Midwest using RCP 2.6 scenario) to -40% (mean value for Midwest using RCP 6).
  - ✧ Decrease is steady across management scenarios.
- N-NO3 leaching is expected to
  - ✧ Increase with climate change.
  - ✧ The increase in leaching under climate change is reduced when CC or extended rotation are implemented.
- SOC is expected to
  - ✧ Decrease with climate change.
  - ✧ The decrease under climate change is reduced when CC or extended rotation are implemented.