

ESRL Integrating Theme:

Climate and Water Systems

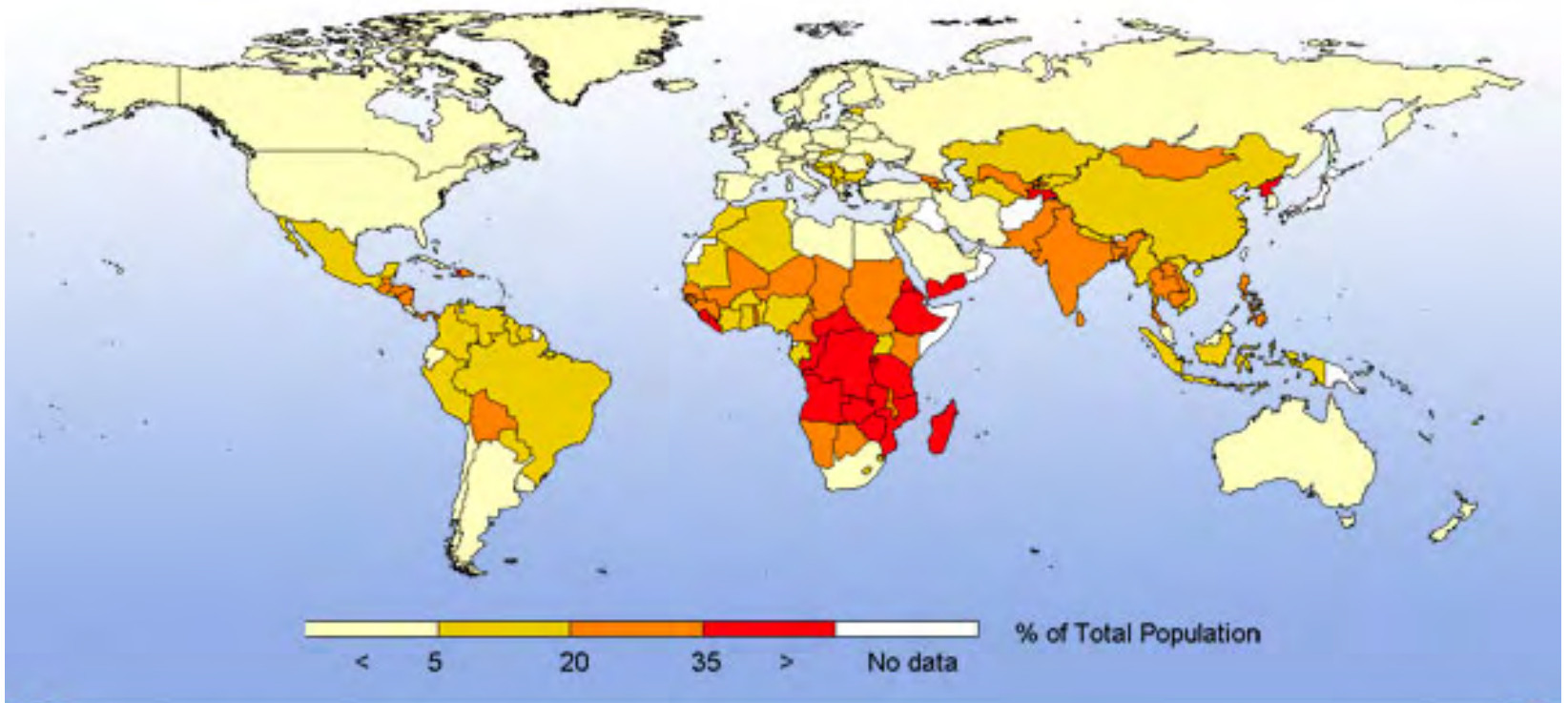
Regional Attribution and Climate Projections

Martin Hoerling

*NOAA CSI Team Lead
Earth System Research Laboratory, Boulder Colorado*

- African monsoon rain failure: *famine*
- Midwest floods: *property and commerce*
- U.S. “warming hole”: *crop yields*
- Colorado river flow: *water supply*





Undernourished Population (2000 - 2002) according to FAO.

Courtesy of FAO 2005.

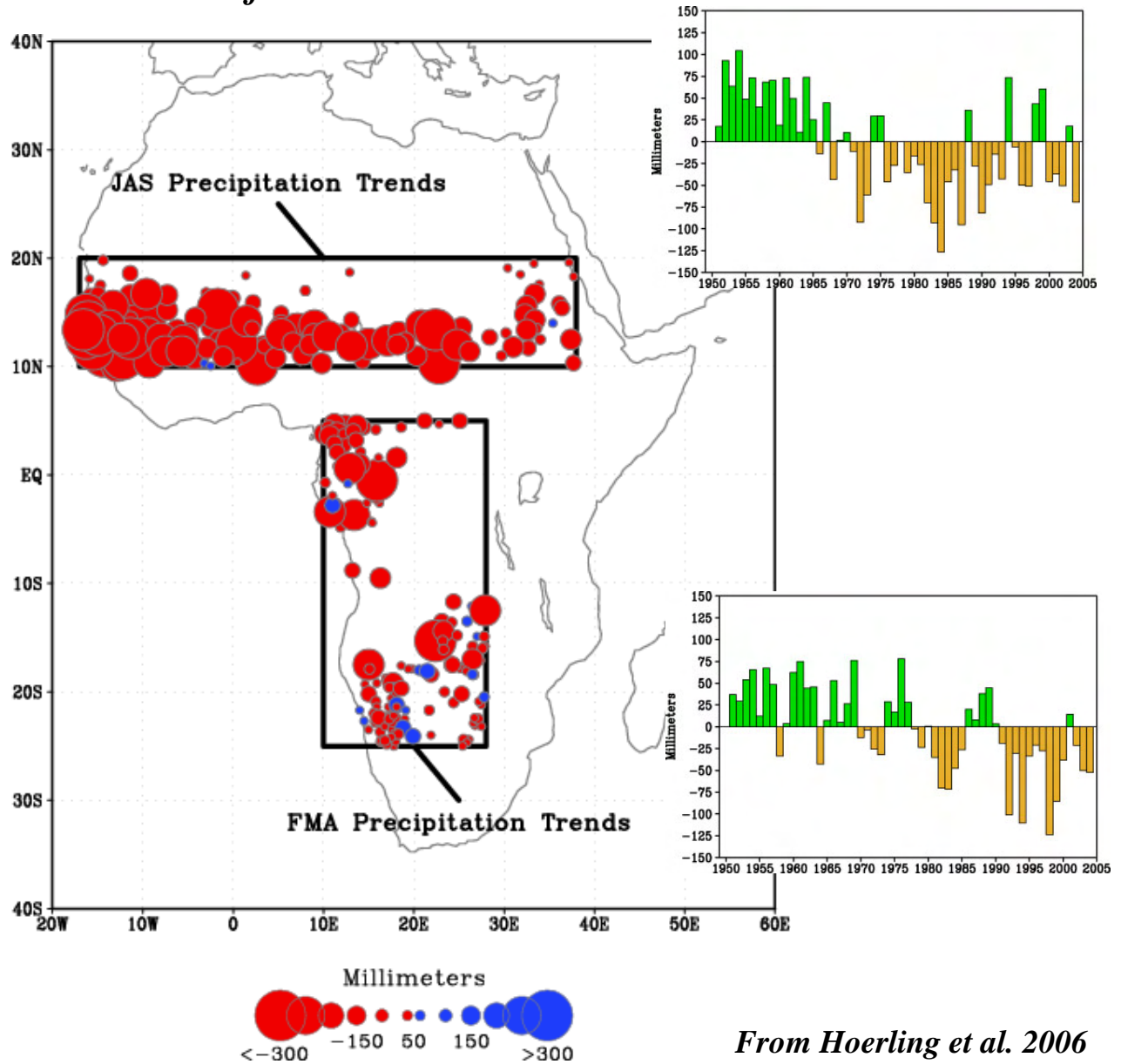


Source: Food and Agriculture Organization (FAO), Statistical databases (FAOStats), 1995.

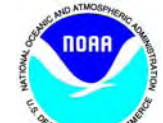
70% of Africans Live by Farming
40% of Exports Are from Agricultural Products

Trend Toward Increased Aridity in the 20th Century

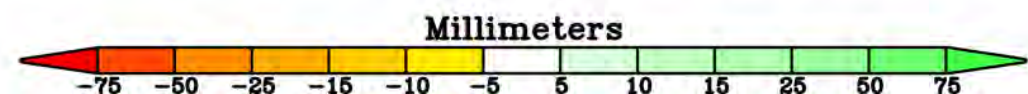
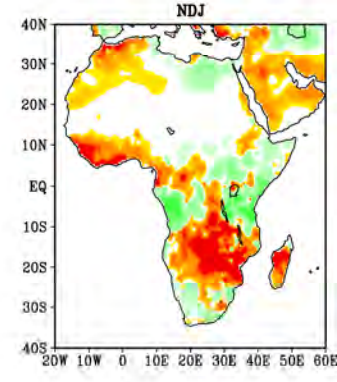
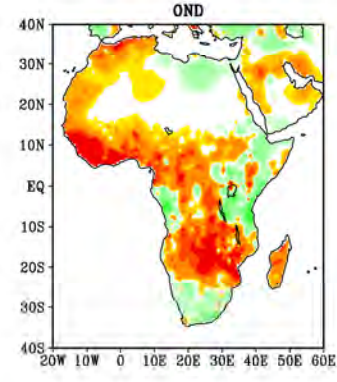
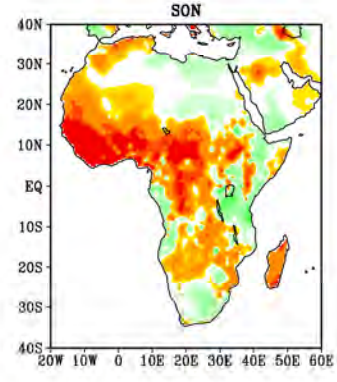
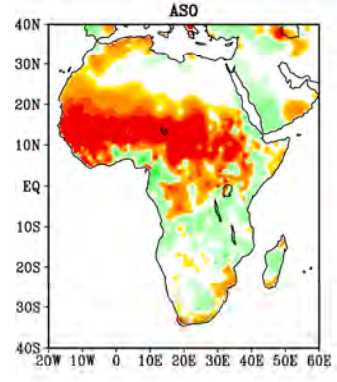
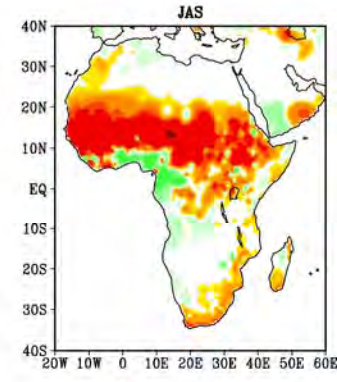
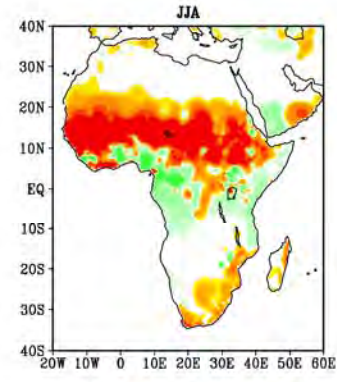
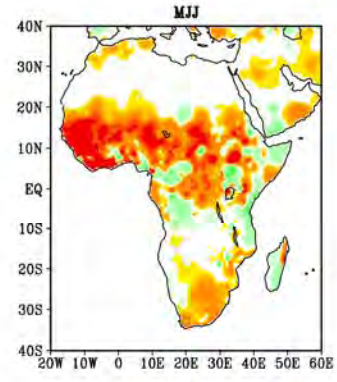
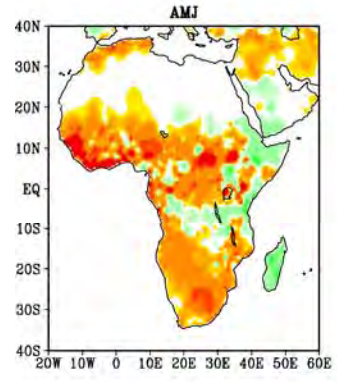
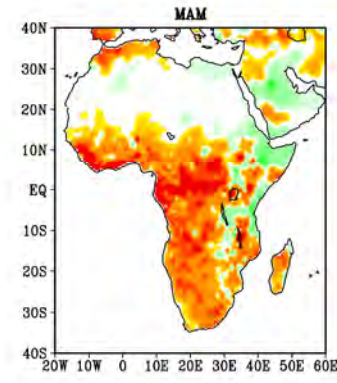
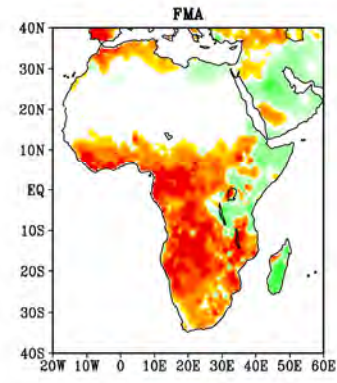
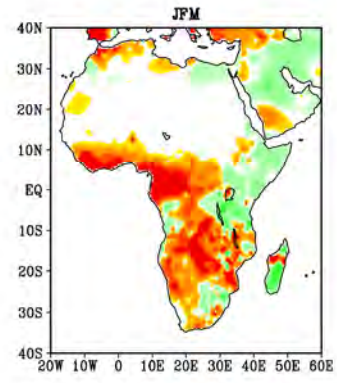
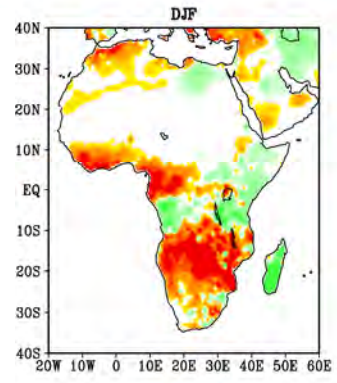
from station data



From Hoerling et al. 2006

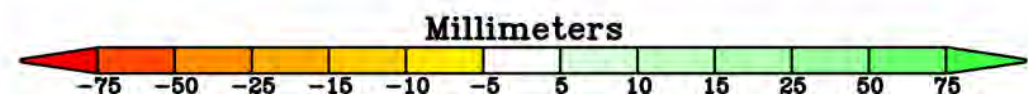
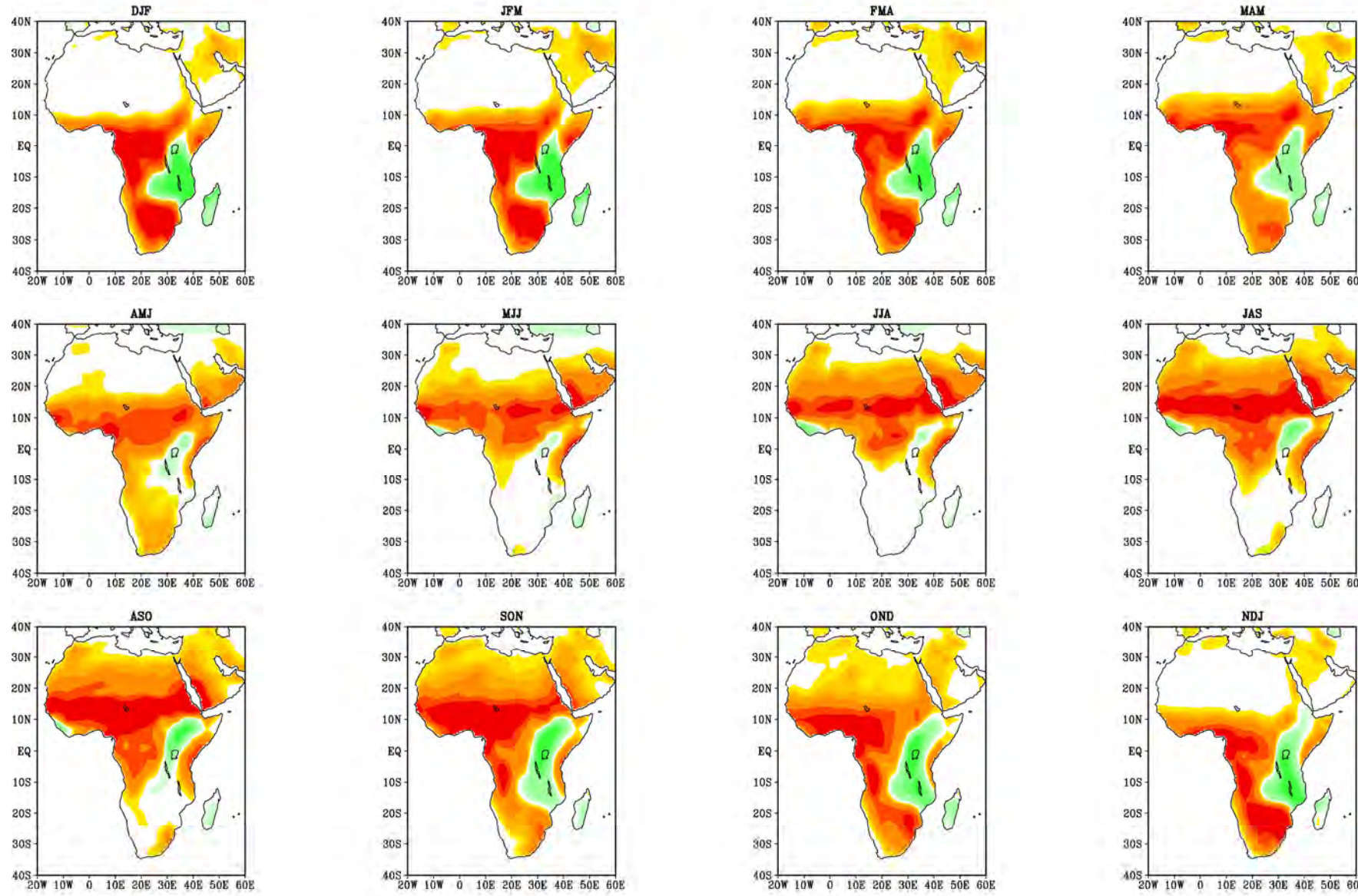


Change in Observed Precipitation: 1950–1999



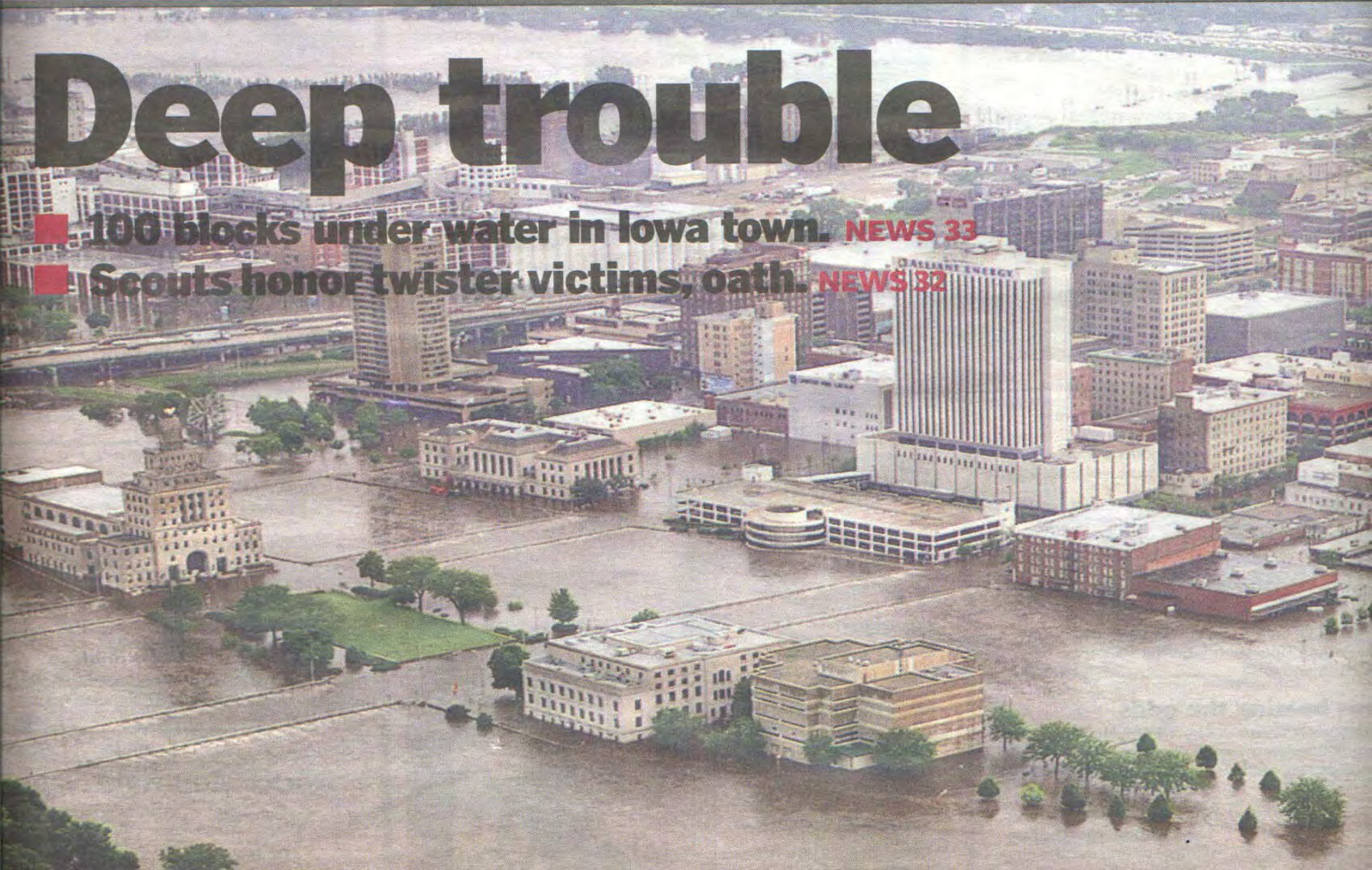


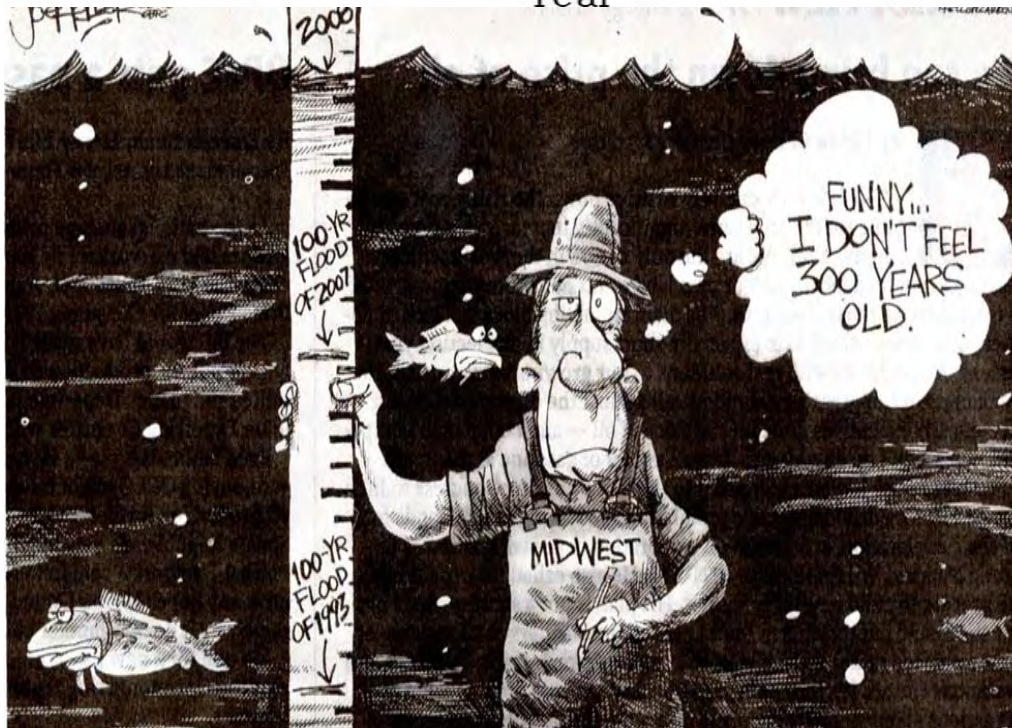
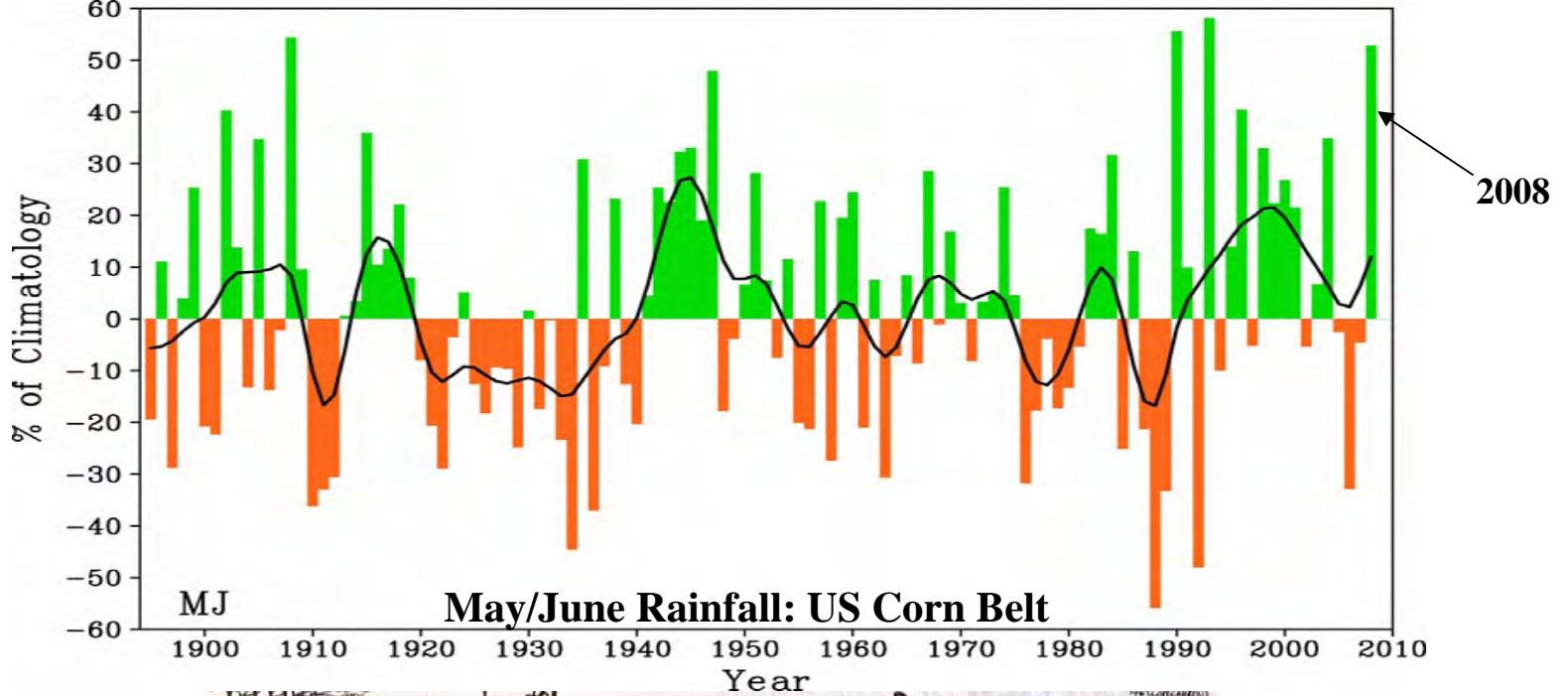
Change in Ensemble AMIP Precipitation: 1950–1999



Deep trouble

- 100 blocks under water in Iowa town. **NEWS 33**
- Scouts honor twister victims, oath. **NEWS 32**







Factors in the 2008 Midwest Flood

Floodplain development

- Drainage districts.....rapid runoff
- Reduced grazing grounds...corn and soybeans
- Reduced wetlands...folks want land, not water
- For a given rain, runoff now higher than before

Meteorological Conditions

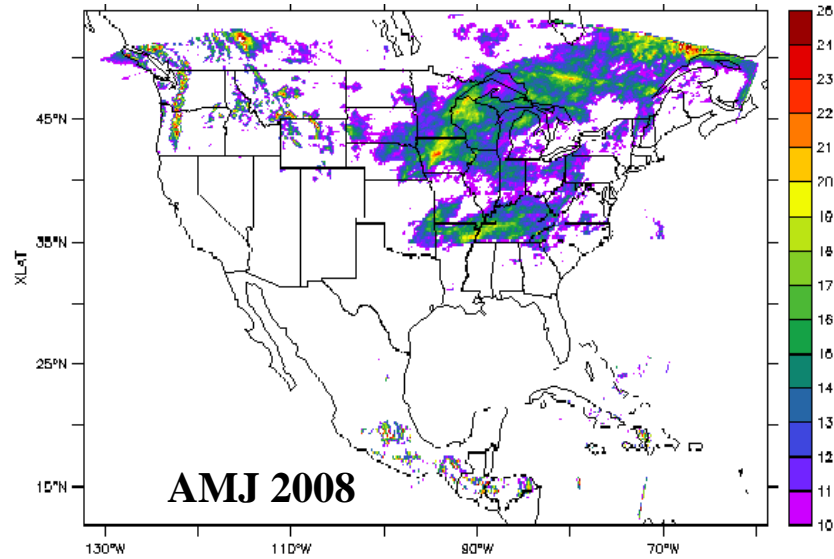
- Antecedent saturated soils..wet winter/early spring
- Heavy and frequent daily rain events



High Resolution Modeling (WRF) of Midwest Flood

◦ *Sensitivity to Initial Soil Moisture: C. Anderson, X. Quan*

OBS Soil

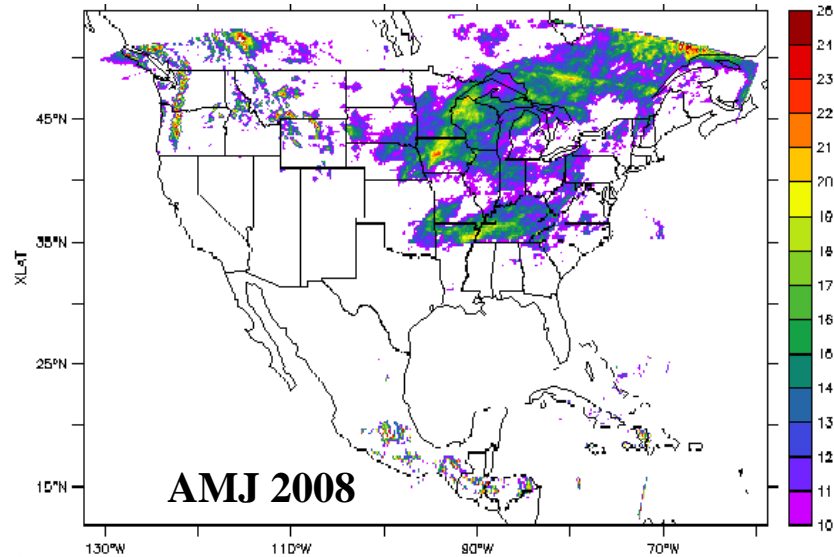




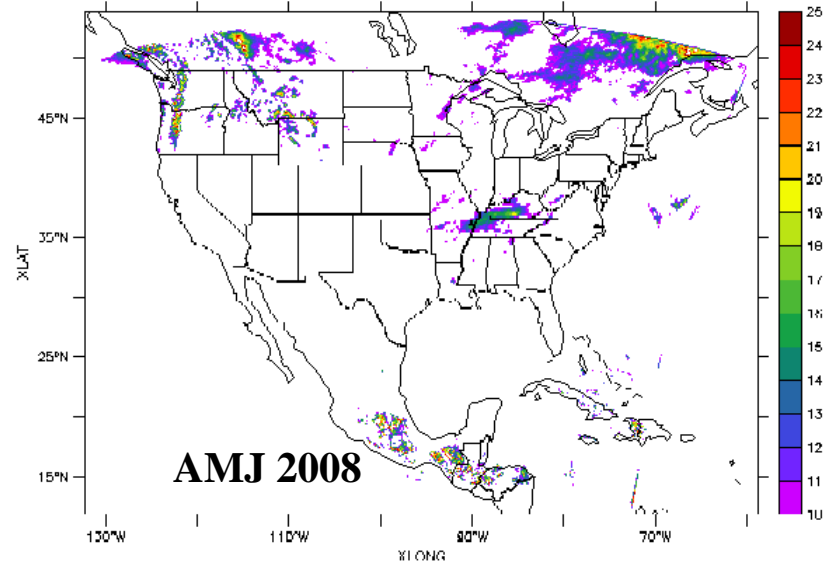
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OBS Soil

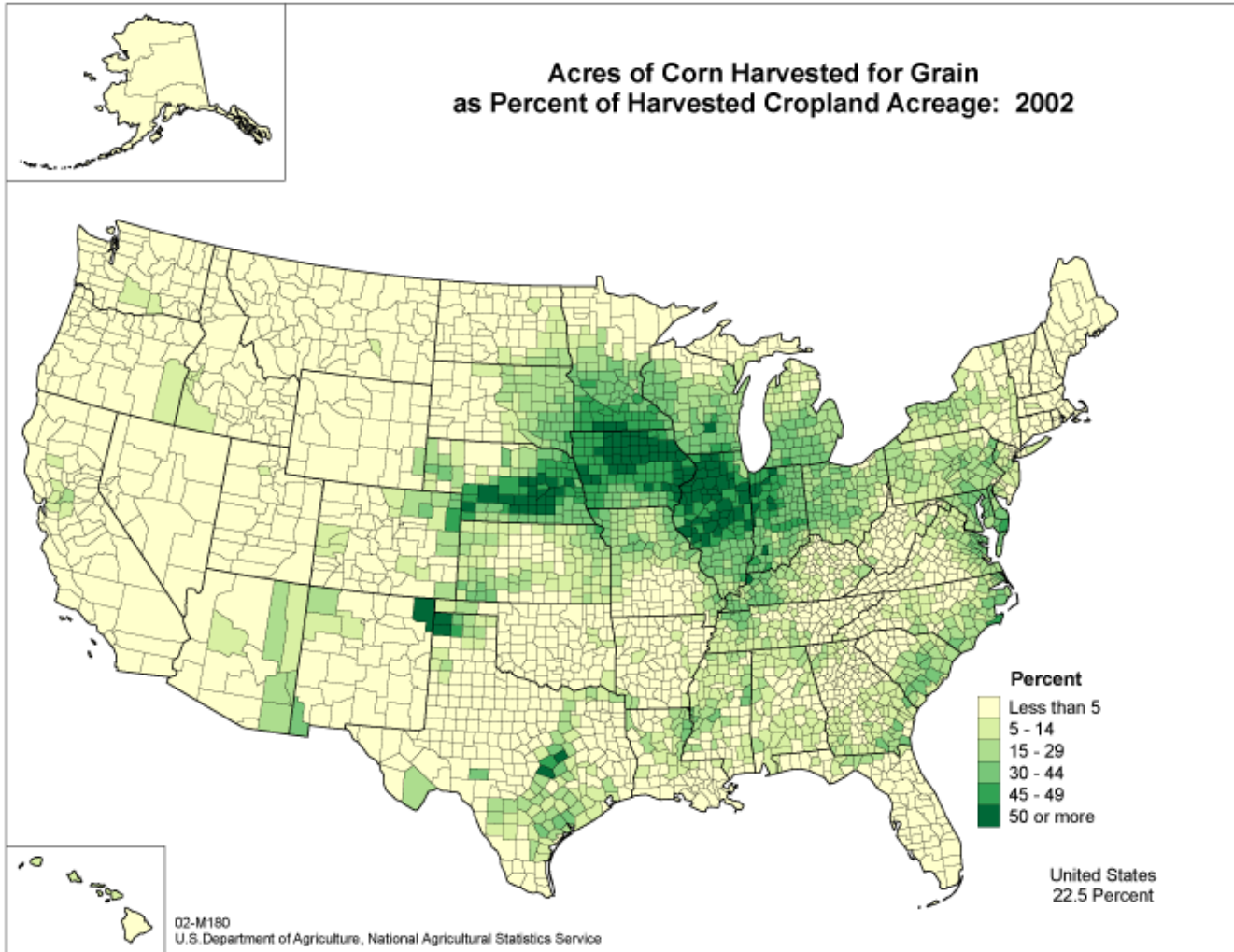


DRY Soil



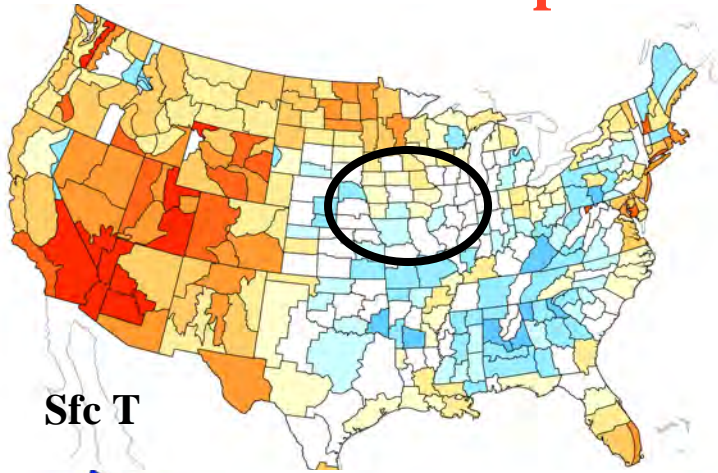


Climate Variability and Change in the Corn Belt

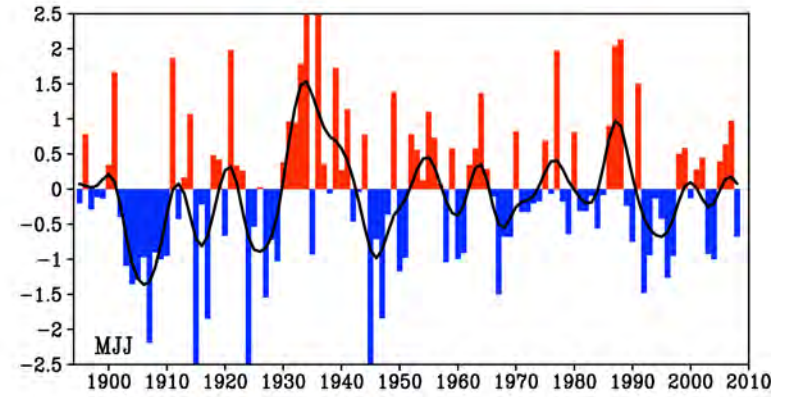


Corn Belt Temp/PCPN Variations: May-July

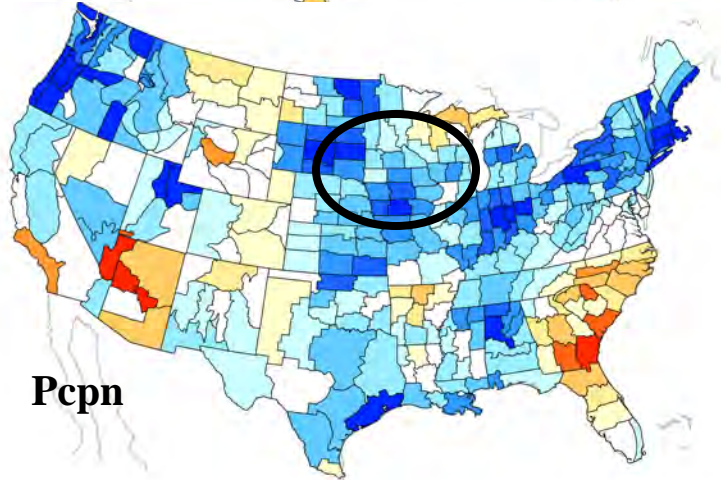
OBS



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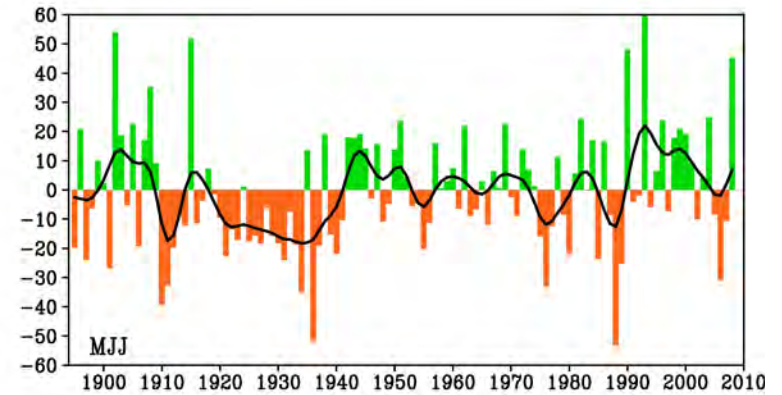


OBS



Pcpn

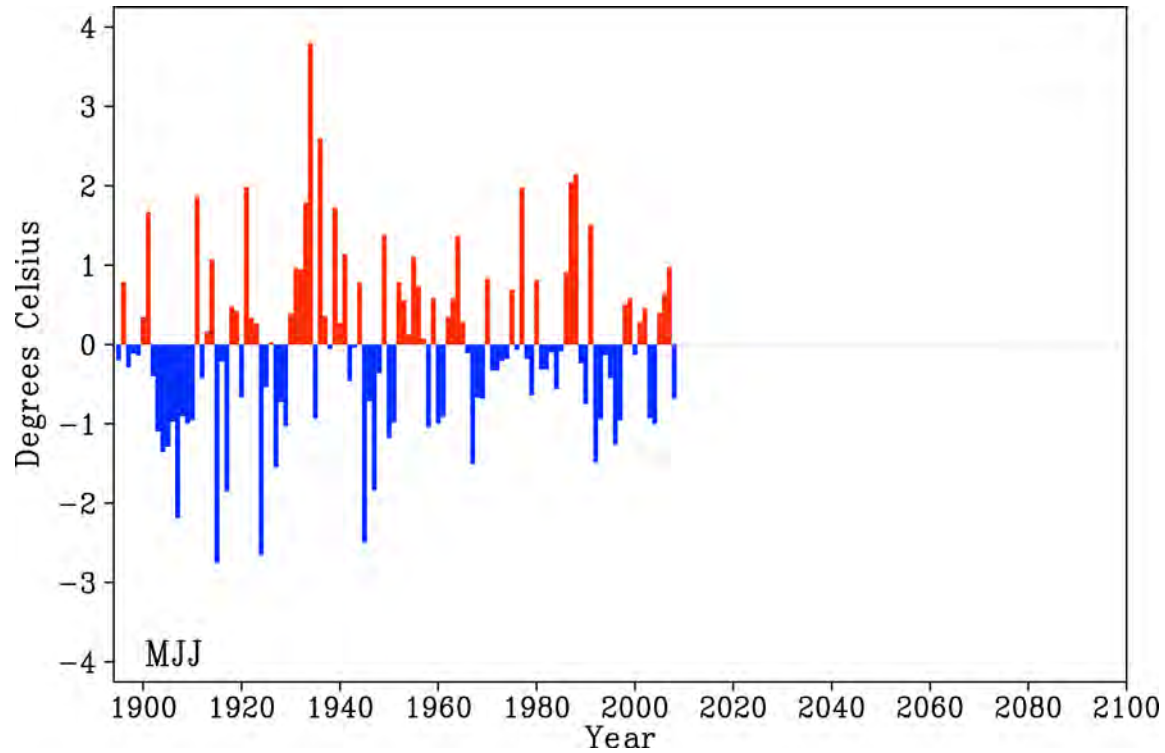
(1980-2006) minus (1895-1980)



A Time of “Milk and Honey” in the Grain Belt...Why?

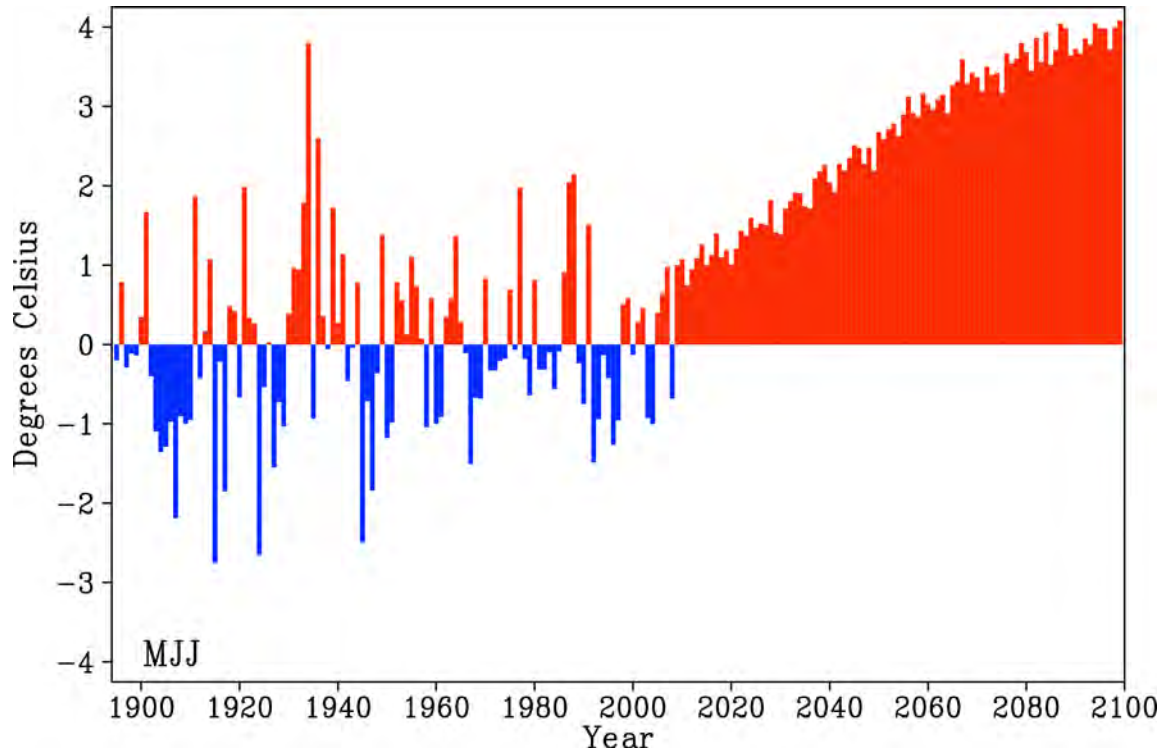


The Time of ‘Milk and Honey in the Corn Belt Will it Last?





The Time of ‘Milk and Honey in the Corn Belt Will it Last?’

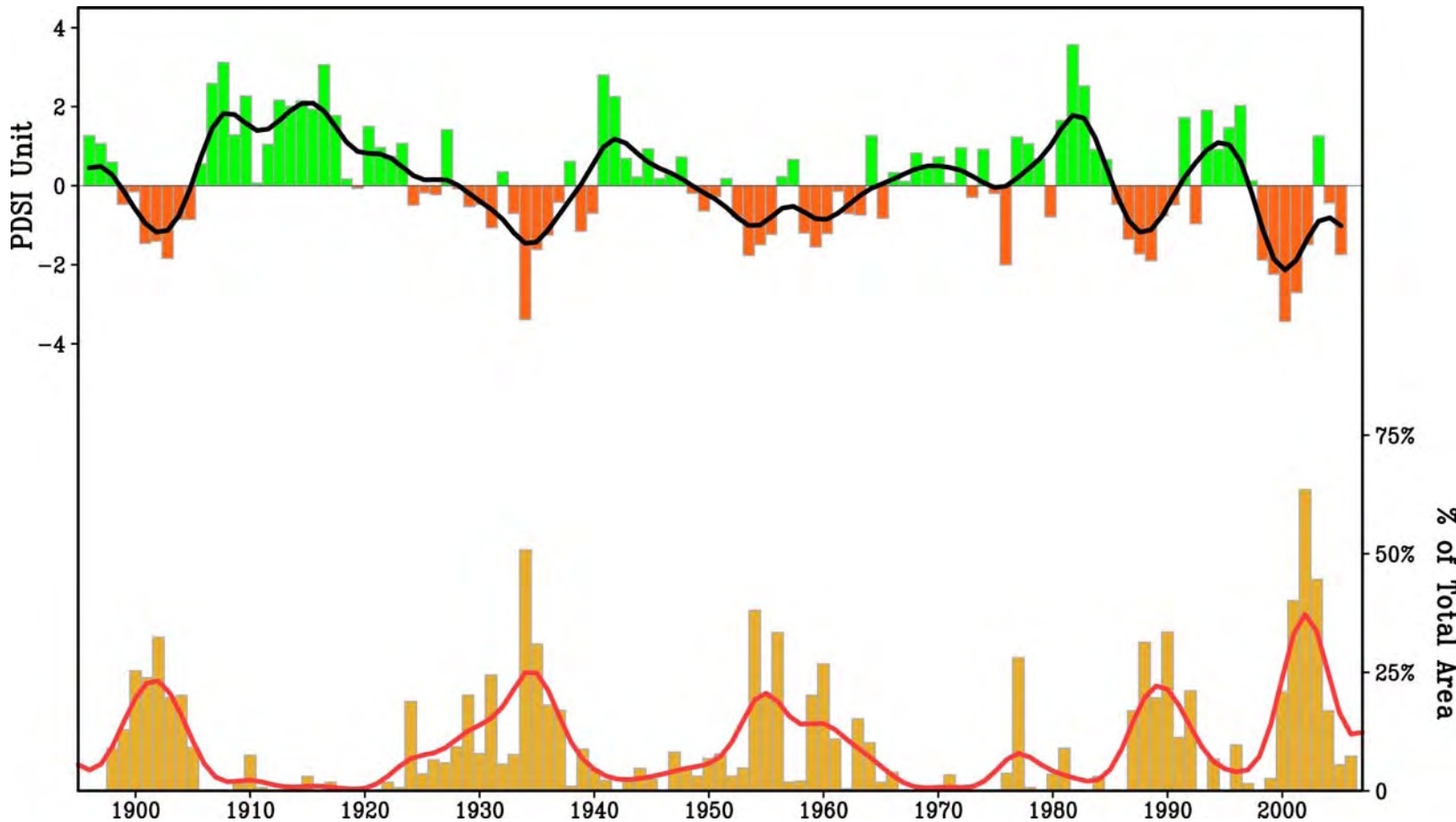


Human induced warming would consistently exceed the most recent hot summer (+2°C in 1988) by 2040, and would consistently exceed the warmest summer ever recorded (+3.8°C in 1934) by 2070.



Western U.S. Drought Since 1895

- *Are water resources resilient to climate variations & change?*
- *What are early warning capabilities for drought?*

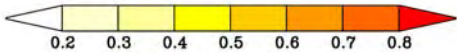
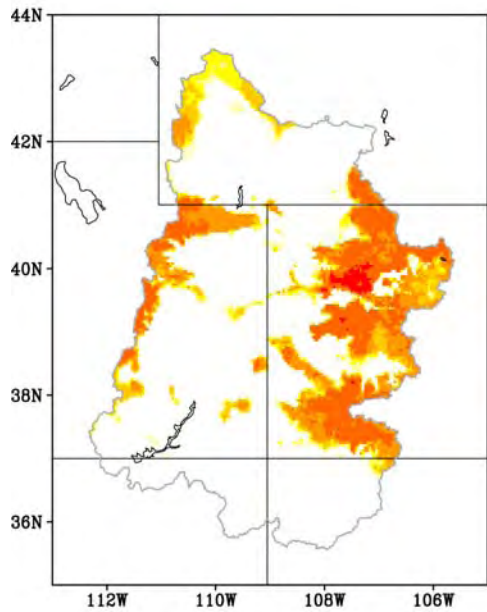
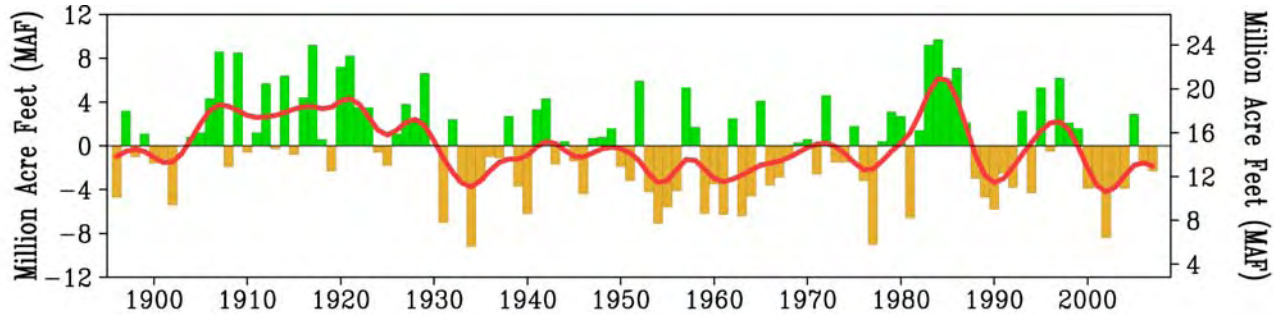


Colorado River Basin

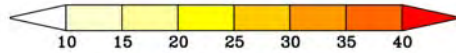
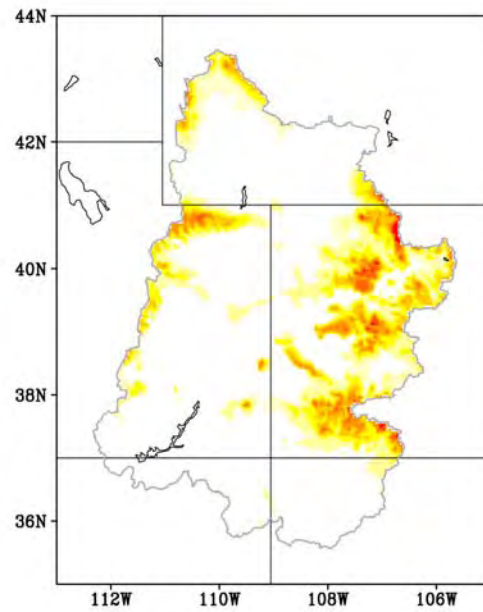




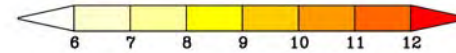
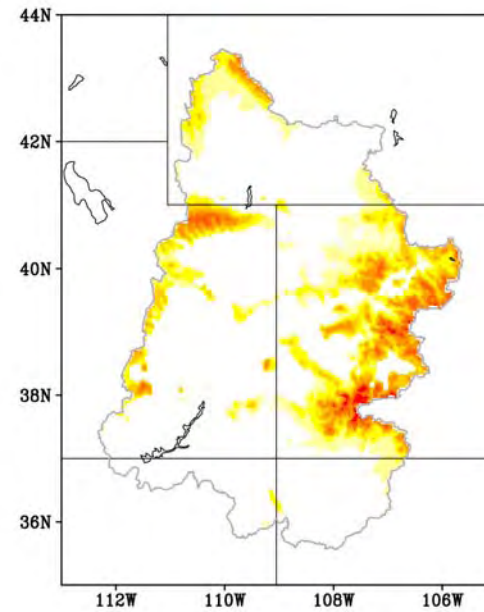
Annual Flow at Lees Ferry



Correlation



Annual PRCP (in)



Elevation (1000 ft)



Was is the Sensitivity of Colorado River Flow to Climate Change?

What is the Resilience of Colorado Basin Water Supply?

