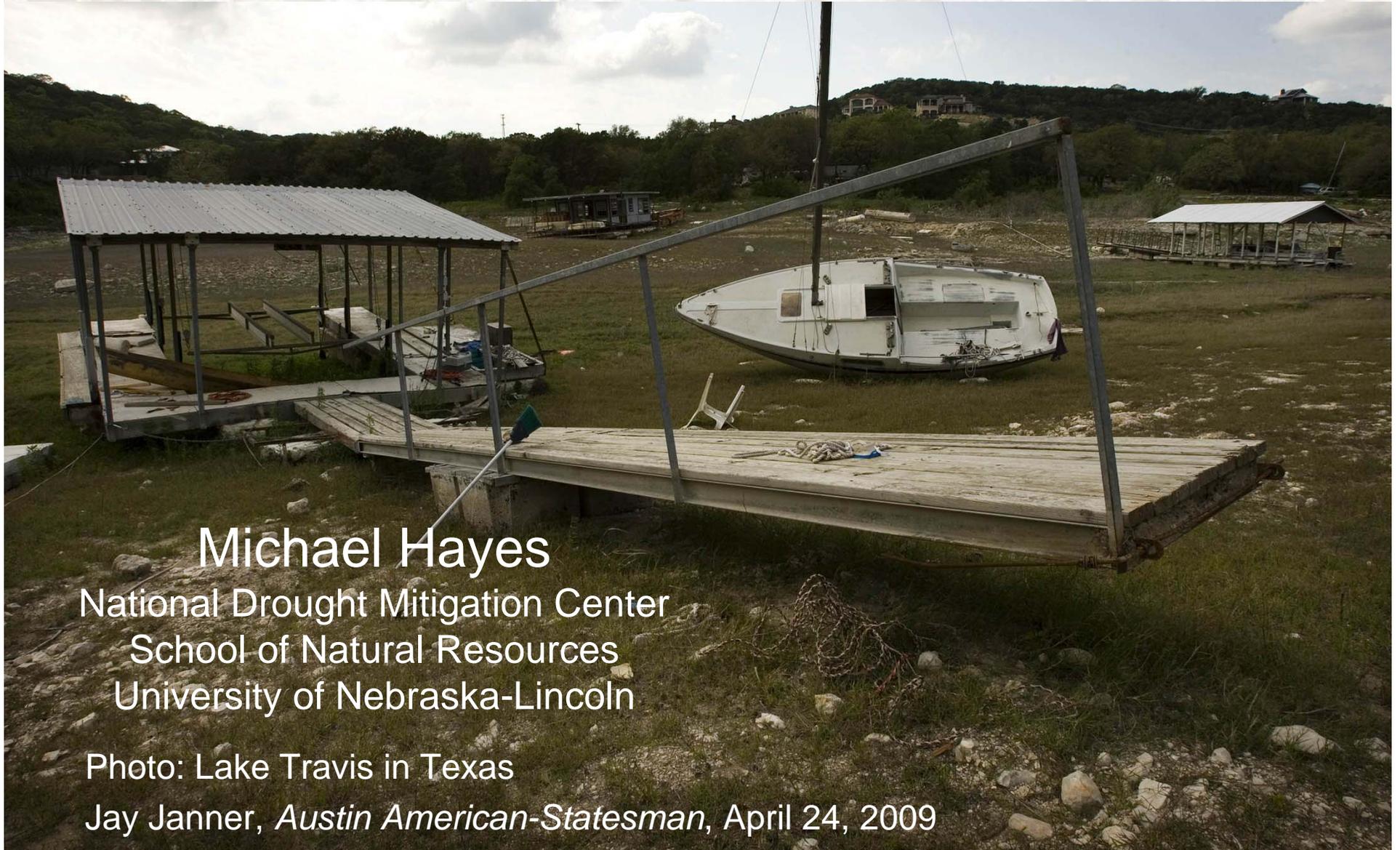


# Water Supplies in a Changing Climate World



**Michael Hayes**

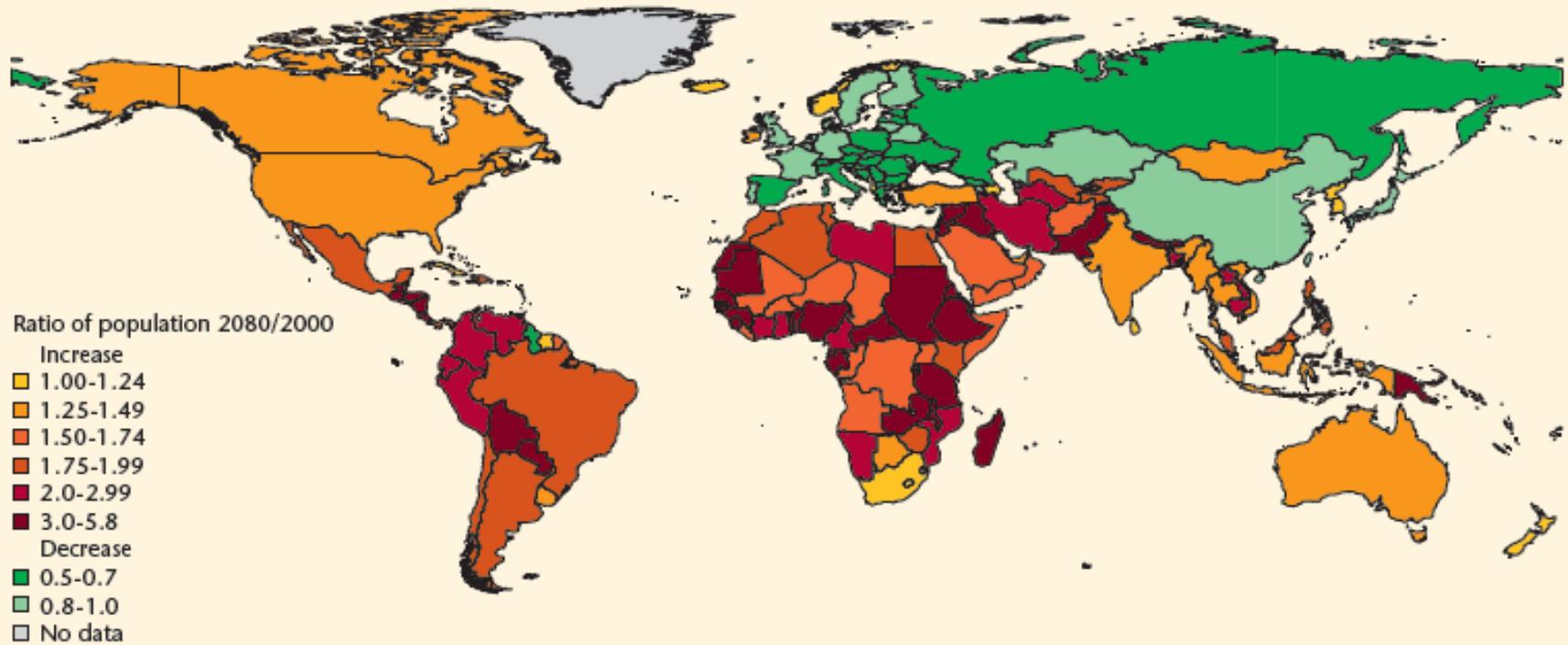
National Drought Mitigation Center  
School of Natural Resources  
University of Nebraska-Lincoln

Photo: Lake Travis in Texas

Jay Janner, *Austin American-Statesman*, April 24, 2009

Map 2.1

Expected areas of population growth and decline, 2000-2080



Source: Lutz, Sanderson, and Scherbov 2008.

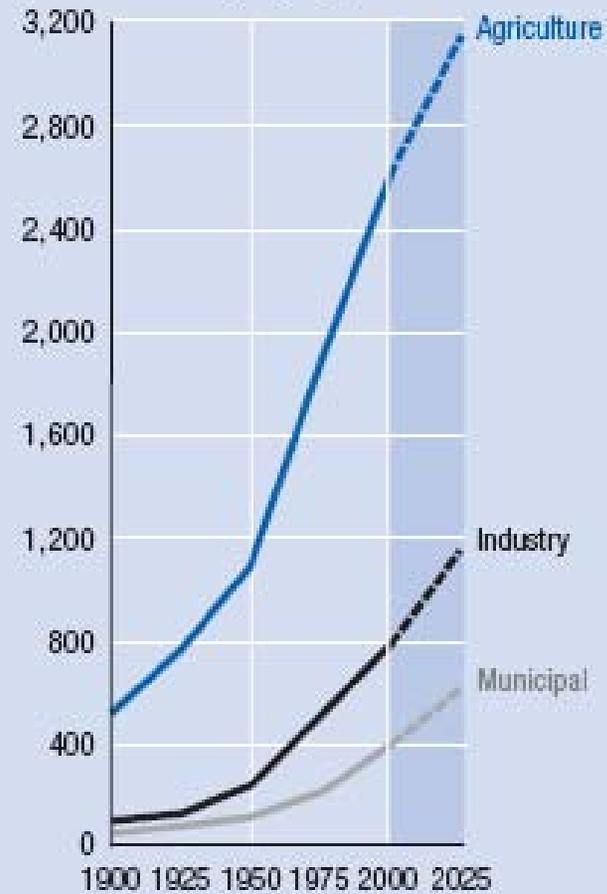
# Global Water Use

- All water uses continue to grow
- Global water withdrawals increased nearly 4 times from 1940-2000
- Altered amounts and timing of availability
- Affects ecosystem services

Figure 4.6

Agriculture is still the largest user of water

Sectoral water withdrawals  
(cubic kilometres per year)



Source: IWMI Forthcoming.

# Water Resources Complexities

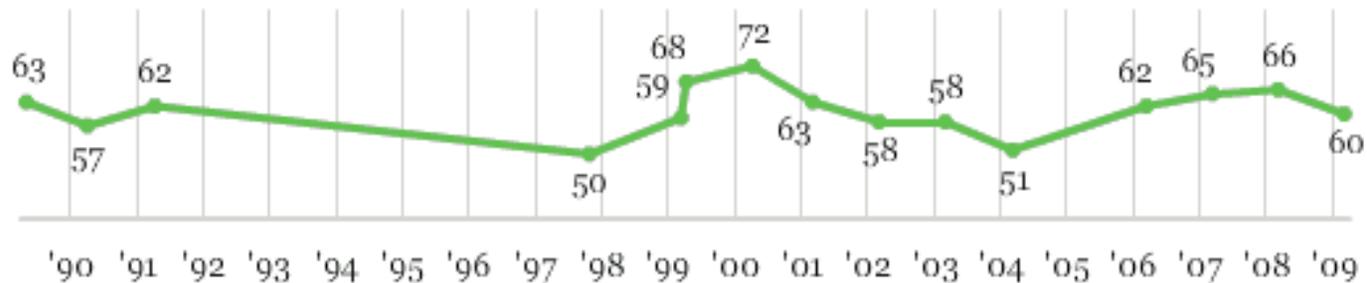


- Non-climatic drivers
- Supplies and demands
- Regional and sector-related impacts
- Snowmelt
- Surface and groundwater
- Water quality
- Adaptation strategies
- Climate change

*I'm going to read you a list of environmental problems. As I read each one, please tell me if you personally worry about this problem a great deal, a fair amount, only a little, or not at all.*

The "greenhouse effect" or global warming

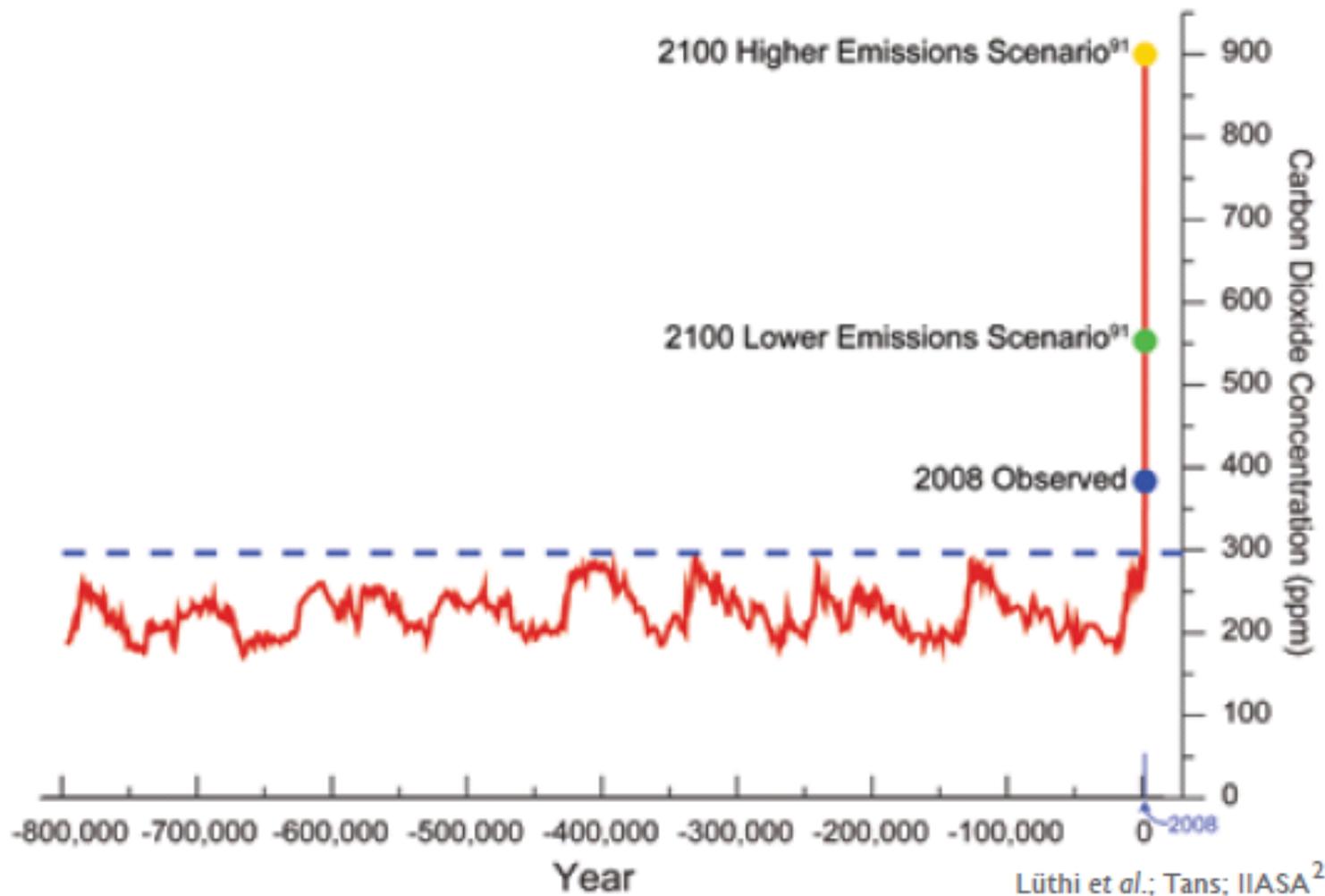
■ % Great deal/Fair amount



GALLUP POLL

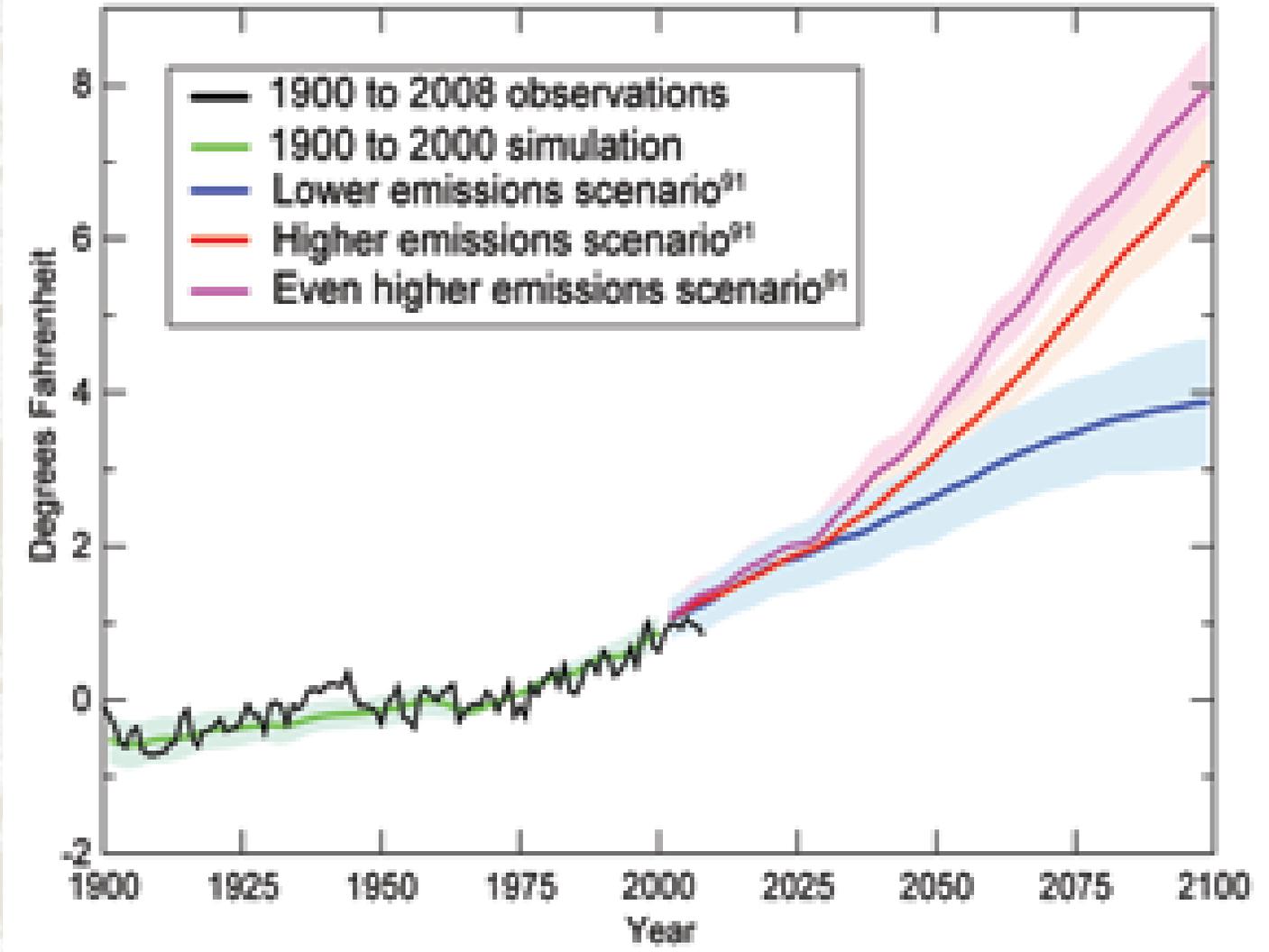
- Public opinion plays a role
- How would this look in rural areas?
- <http://www.gallup.com>

## 800,000 Year Record of Carbon Dioxide Concentration



USGCRP 2009

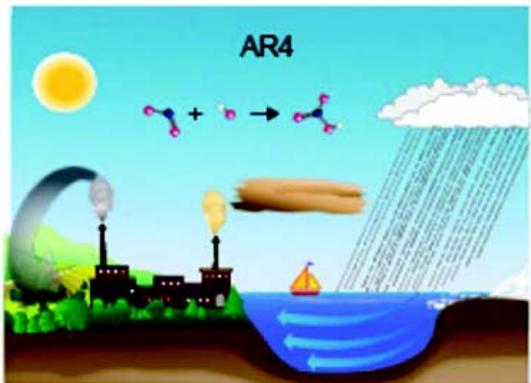
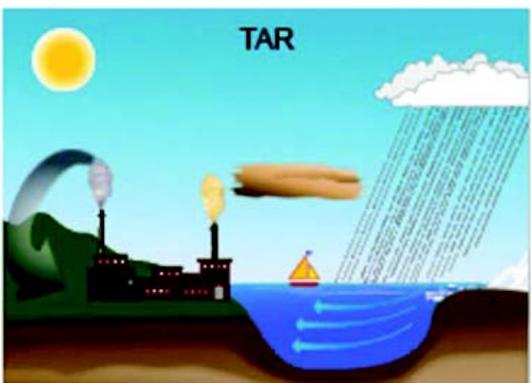
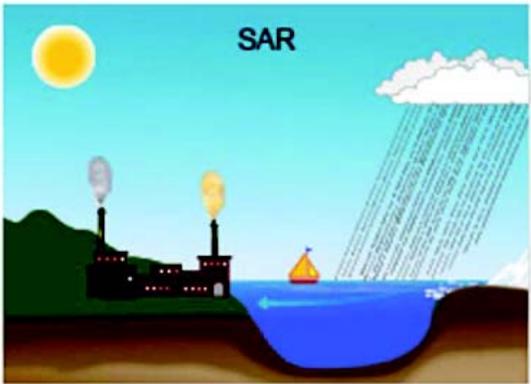
# Global Average Temperature, 1900 to 2100



USGCRP 2009

1990

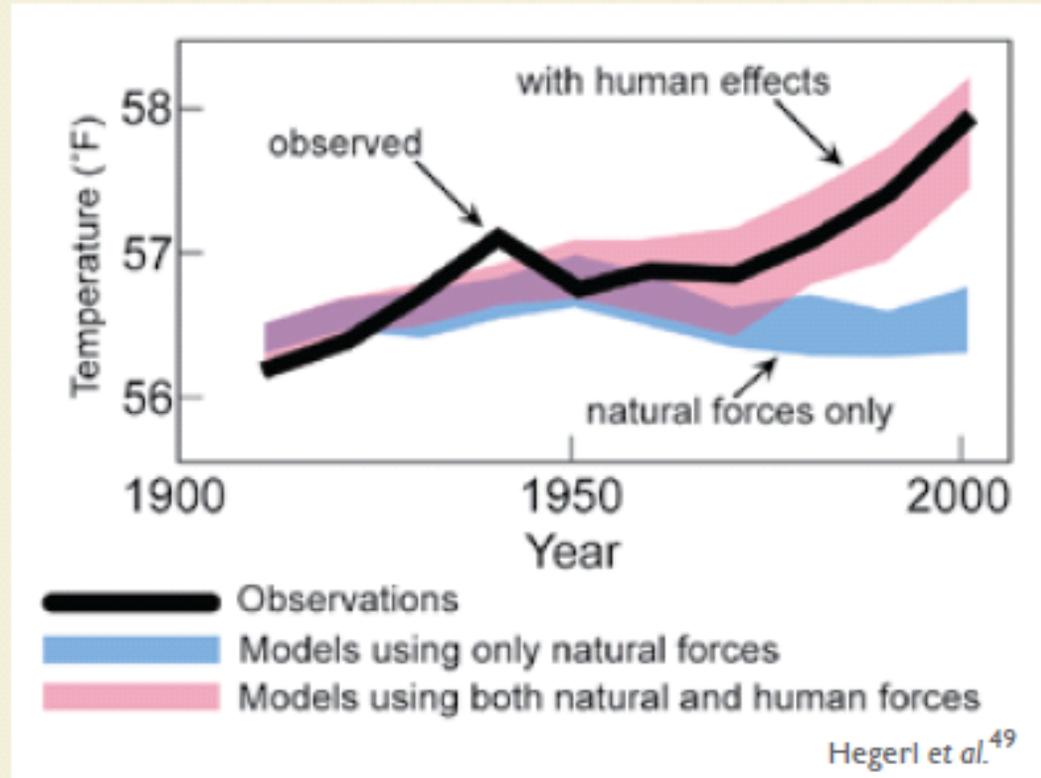
2001



1995

2007

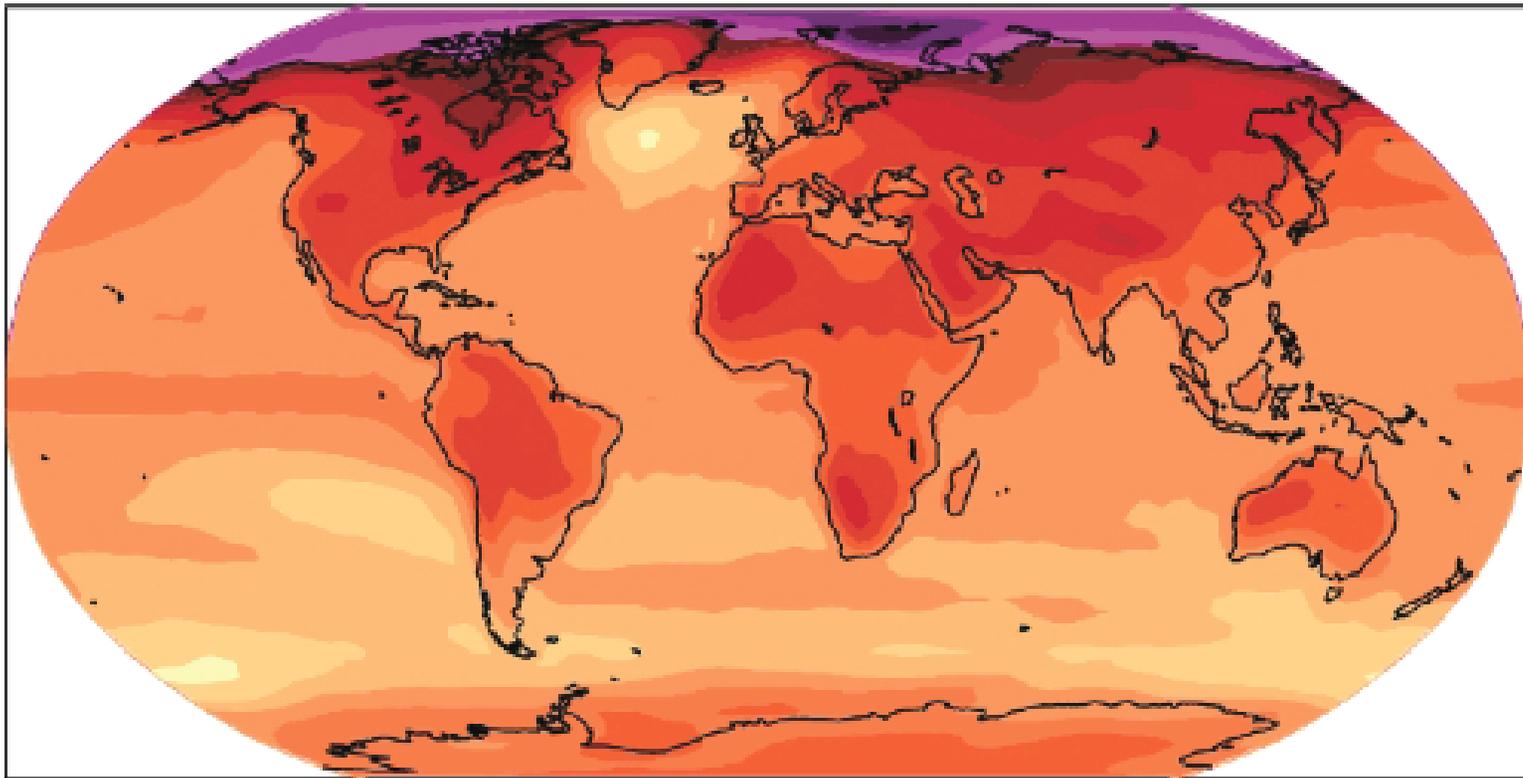
## Separating Human and Natural Influences on Climate



USGCRP 2009

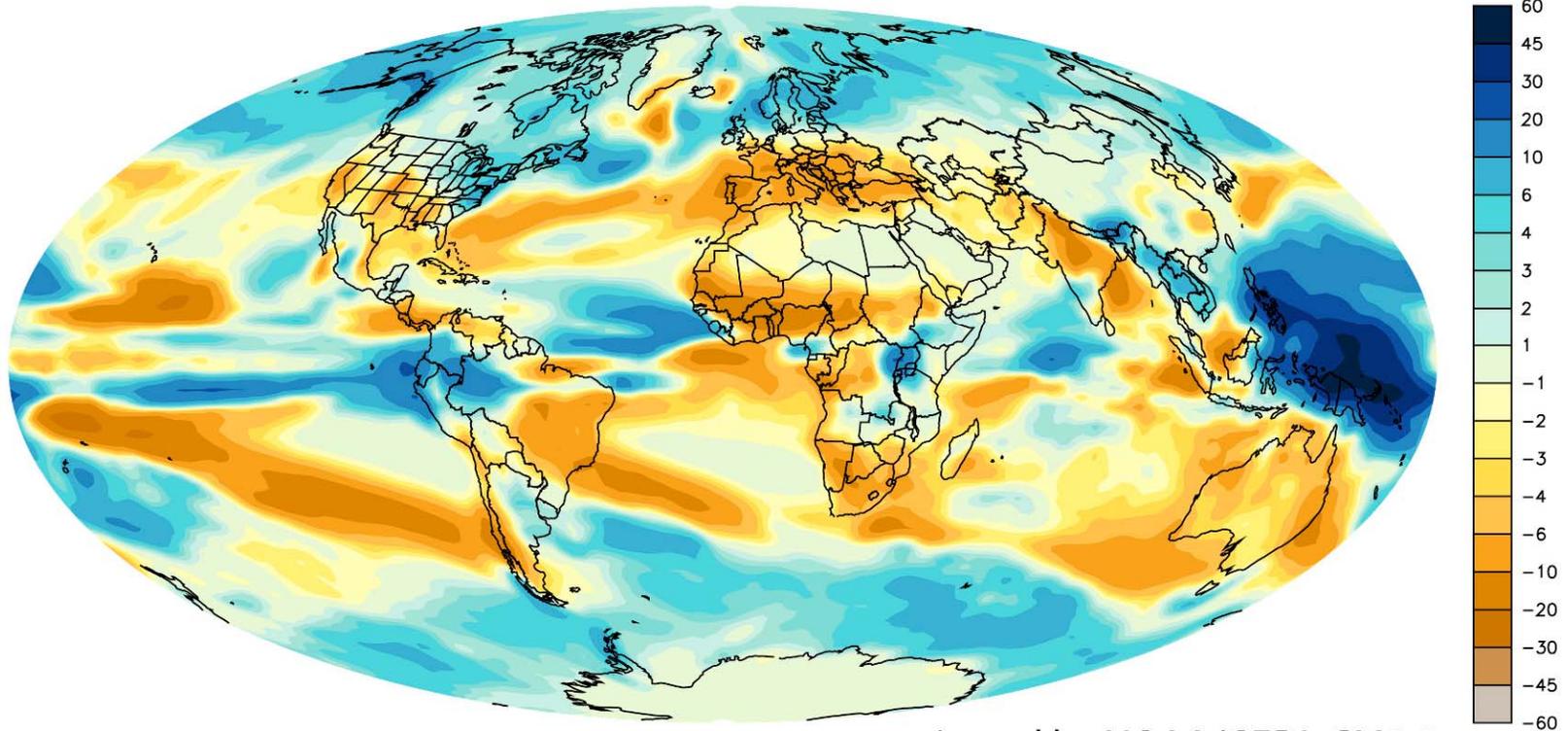
# Global Temperatures

## A1B: 2090-2099



IPCC 2007

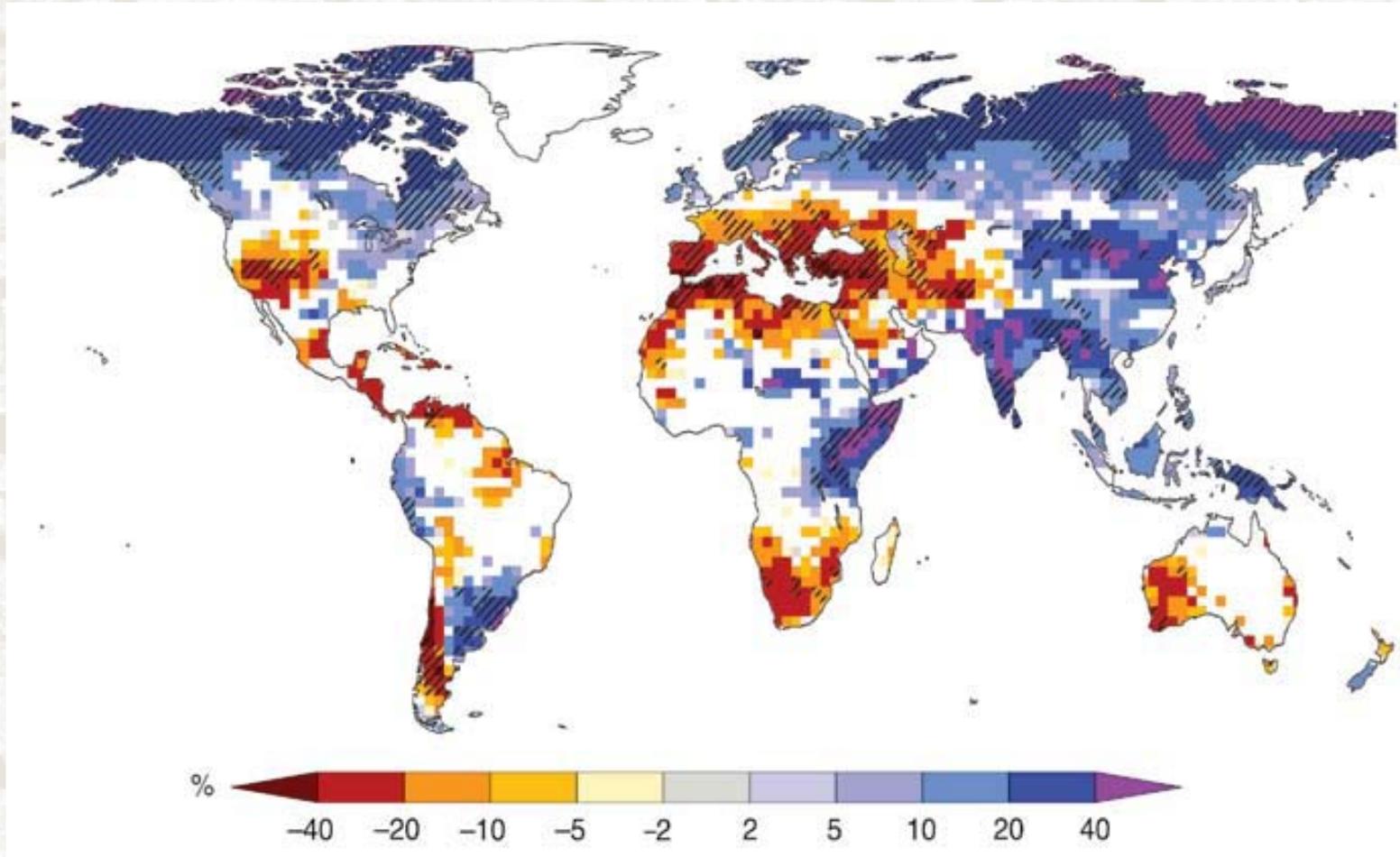
CHANGE IN PRECIPITATION BY END OF 21st CENTURY  
inches of liquid water per year



as projected by NOAA/GFDL CM2.1

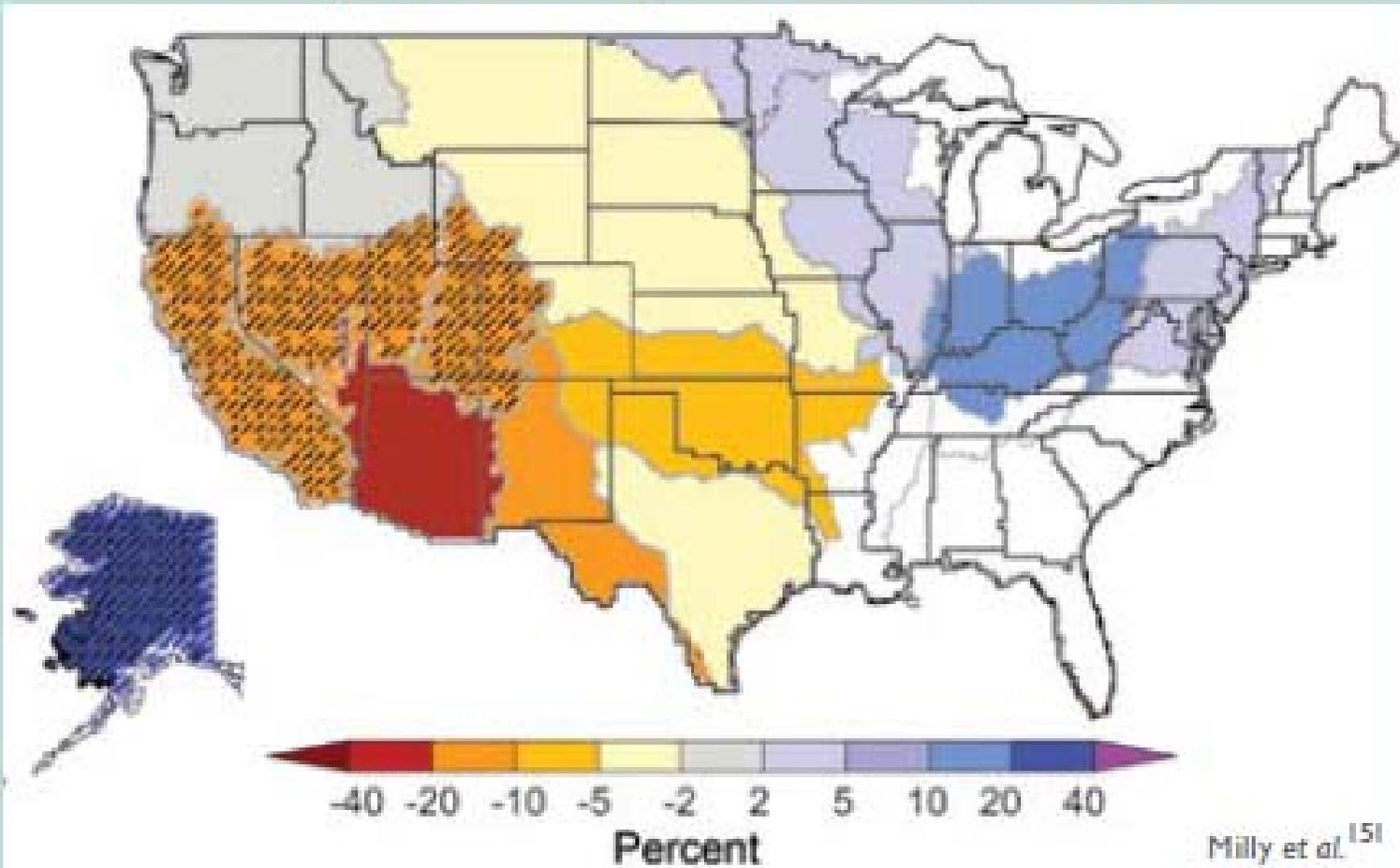
NOAA 2007

# Annual Runoff for 2080-2099



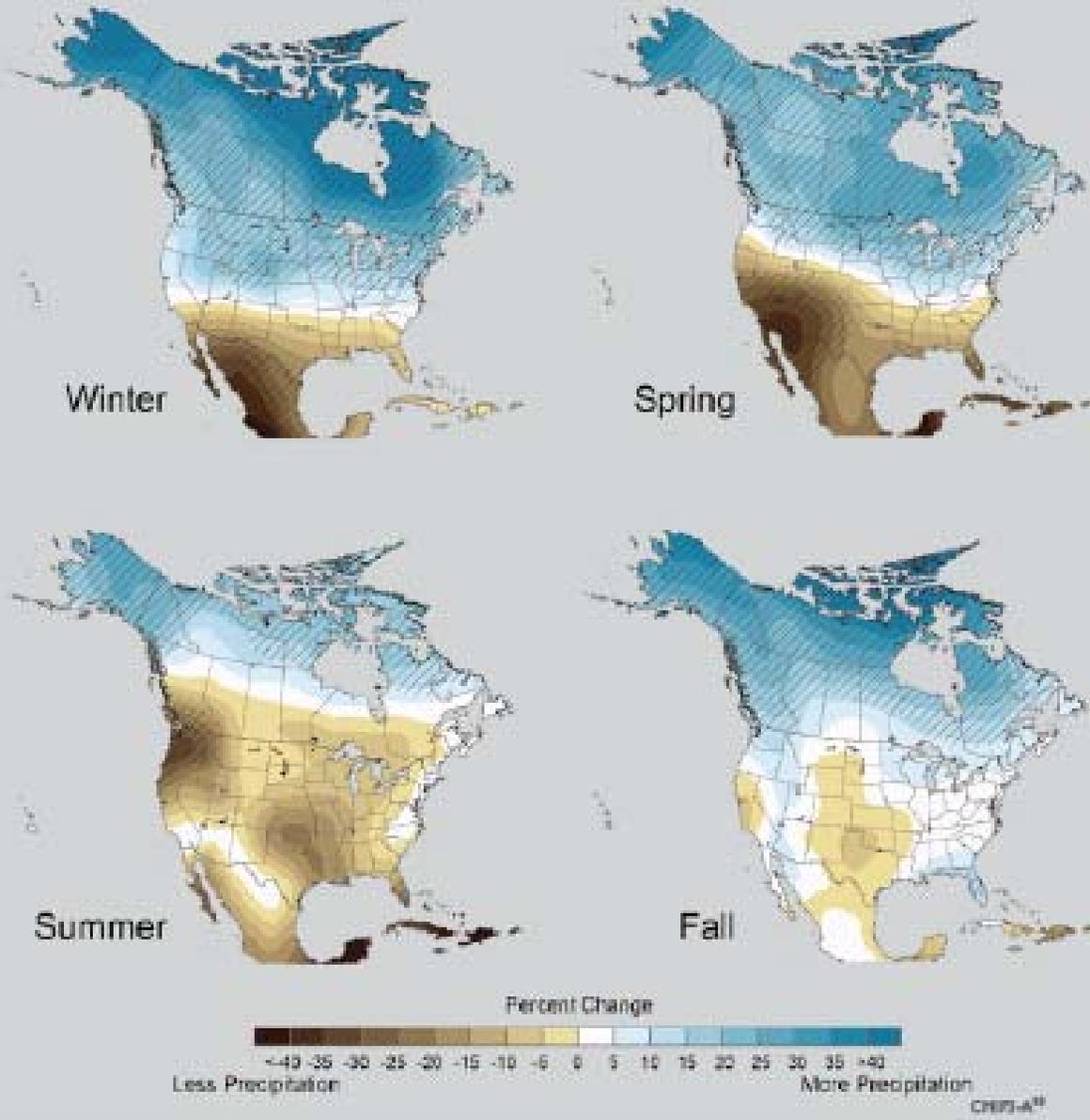
IPCC 2007

## Projected Changes in Annual Runoff



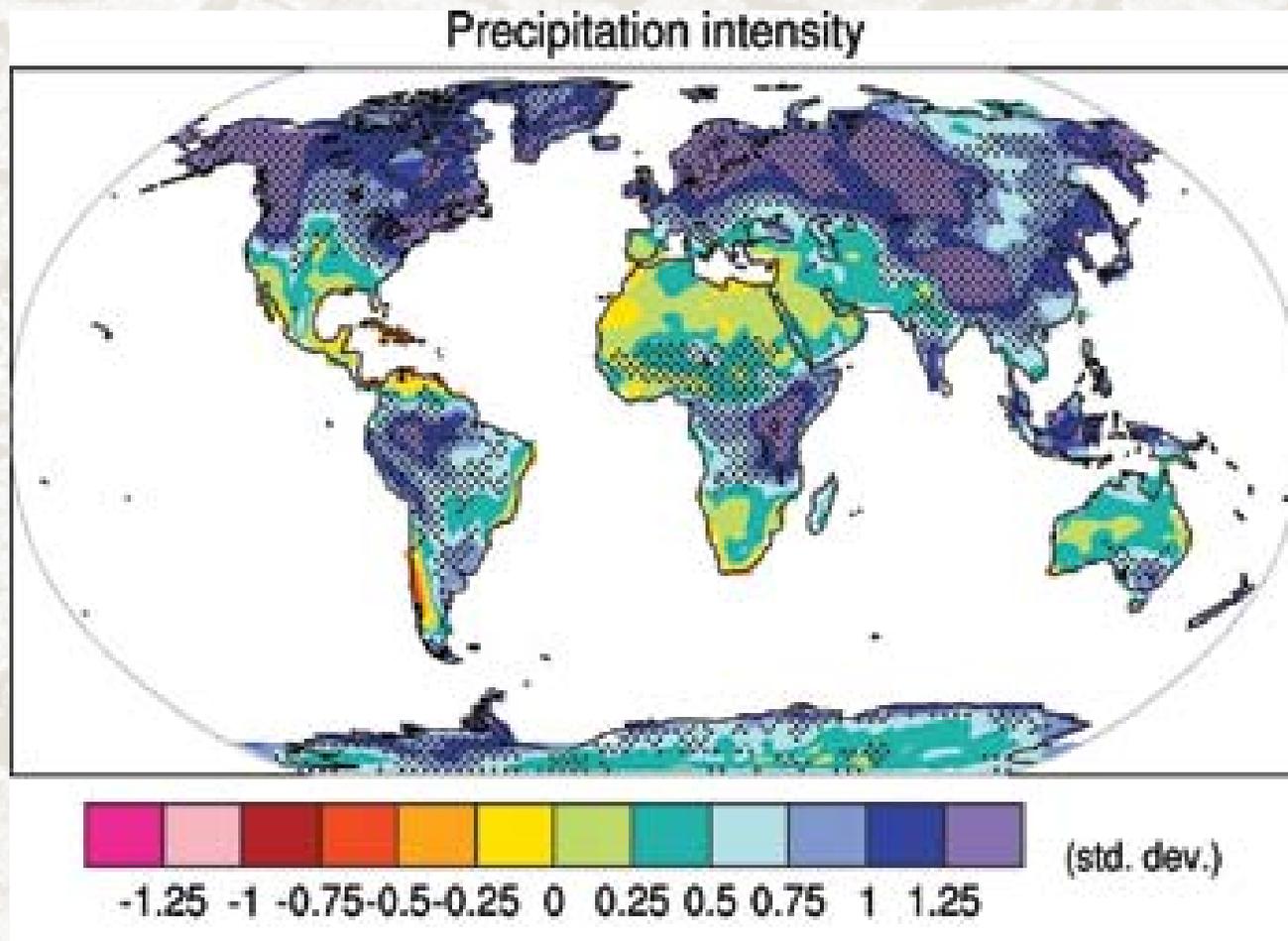
USGCRP 2009

Projected Change in North American Precipitation  
by 2080-2099



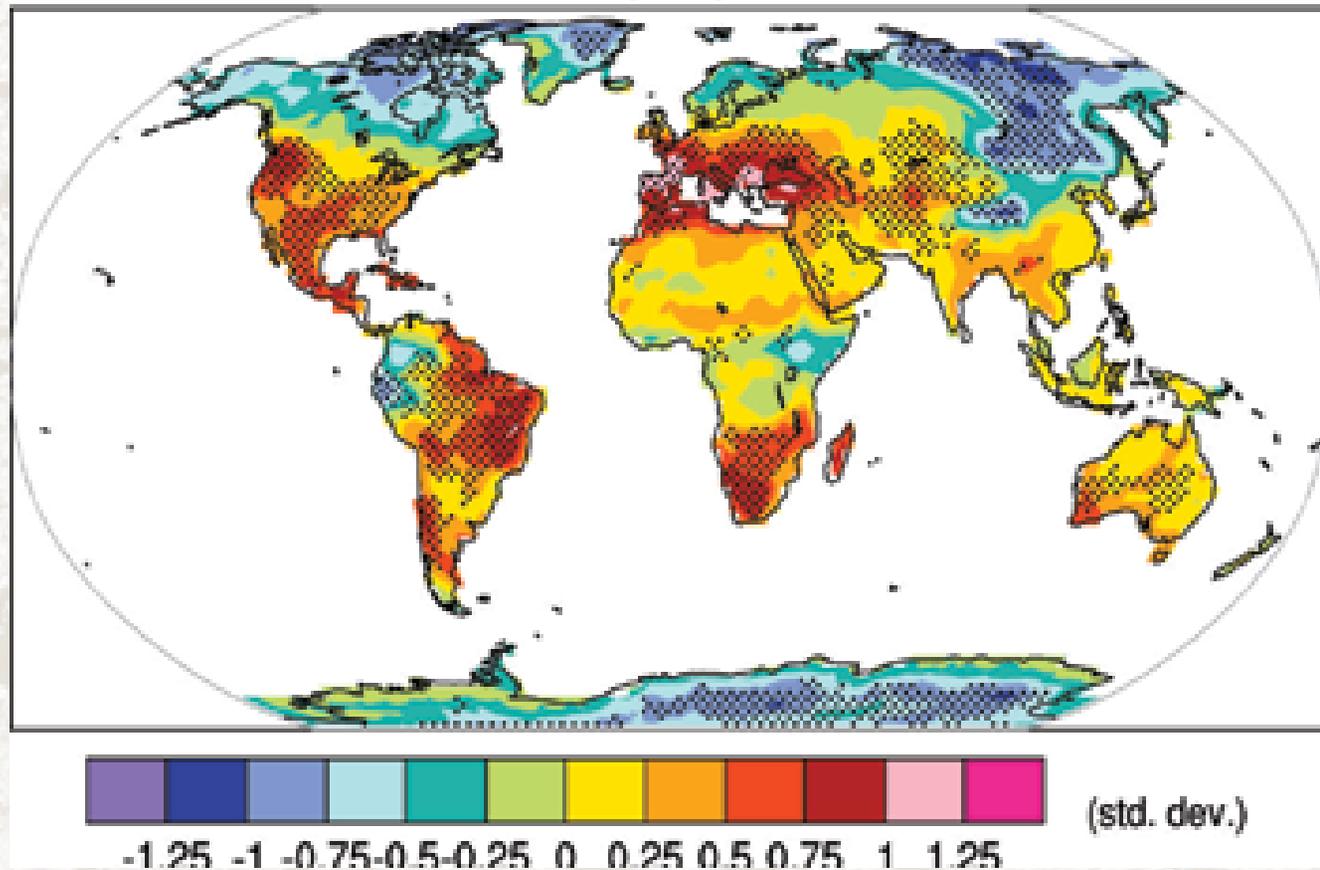
USGCRP 2009

# 2080-2099 Relative to 1980-1999



# 2080-2099 Relative to 1980-1999

Dry days



# Global/Regional Water Resources

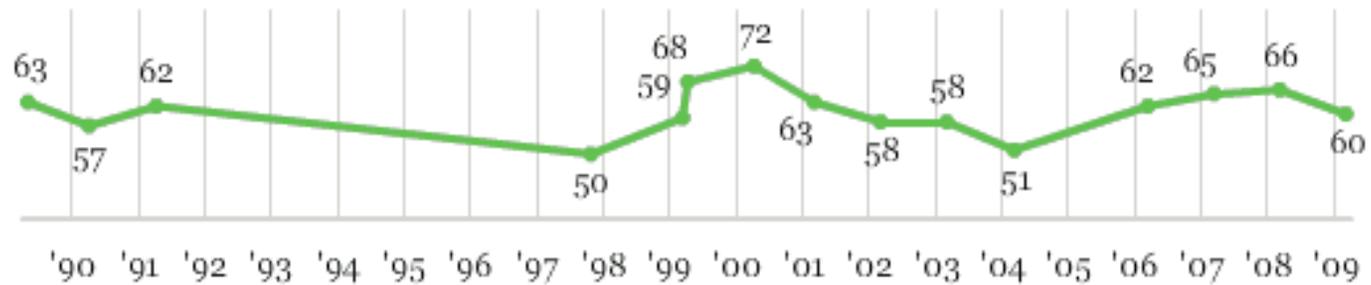


- “Wet get wetter and the dry get drier” but...
- Temperature matters
- Seasons matter
- Potentially more floods and droughts
- Water quality is likely to decrease
  - Sediments, nutrients, dissolved organic carbon, pathogens, pesticides, salt, thermal
- Snow, snowmelt, runoff components
- We have a long way to go to understand seasonal, regional, and local impacts

*I'm going to read you a list of environmental problems. As I read each one, please tell me if you personally worry about this problem a great deal, a fair amount, only a little, or not at all.*

The "greenhouse effect" or global warming

■ % Great deal/Fair amount



GALLUP POLL

■ “The consequences of climate change are being felt, most acutely, in waters and watersheds throughout the United States.”

G. Tracy Mehan III, 2008

Arlington, VA, Environmental Consultant

A photograph of a dry, hilly landscape under a cloudy sky. The foreground is a field of dry, yellowish-brown grass. A single, bare tree stands in the middle ground. The background shows rolling hills under a blue sky with light clouds. The overall scene suggests a drought-affected area.

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mhayes2@unl.edu  
<http://drought.unl.edu>