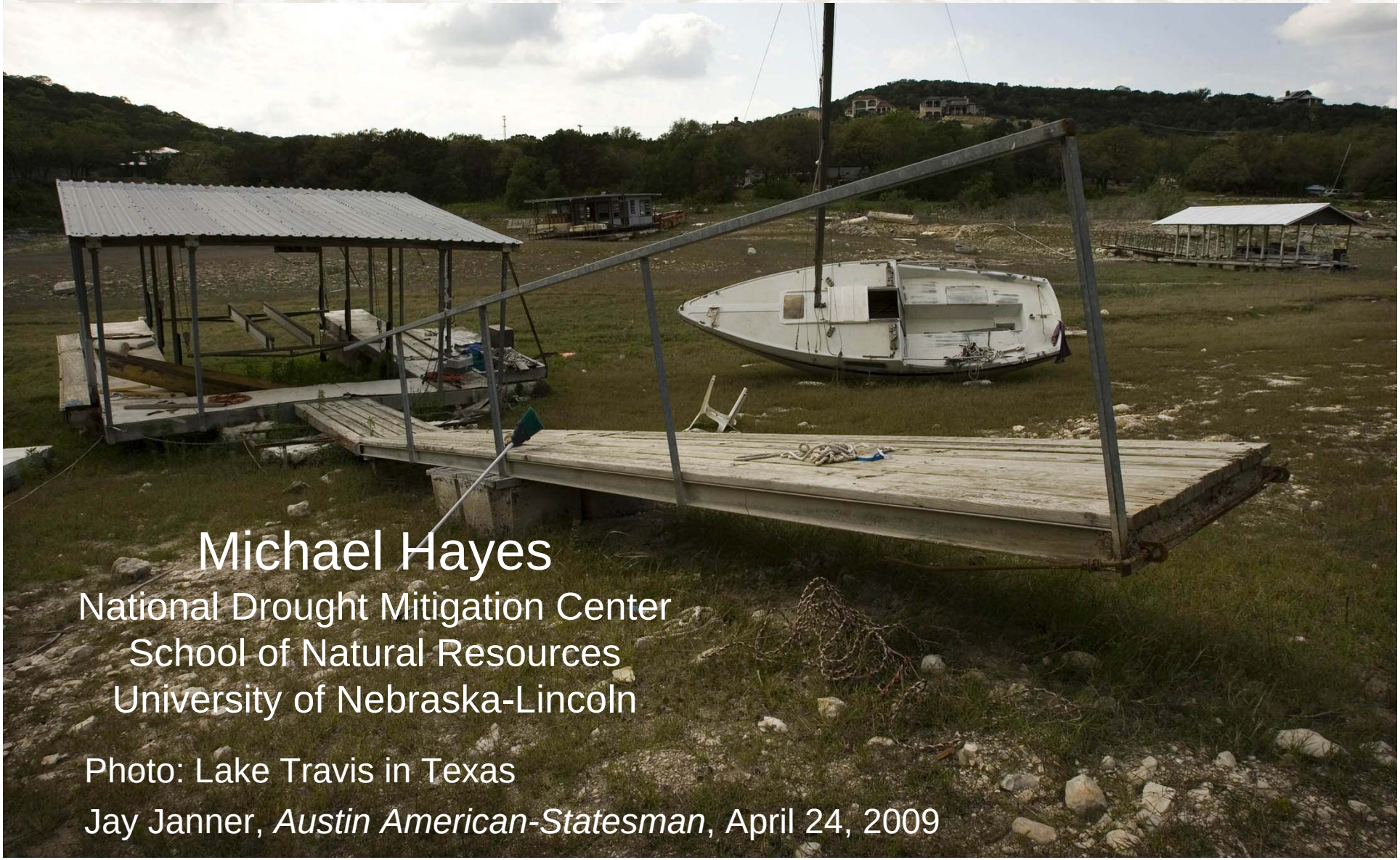
Agricultural Outlook Forum
U.S. Department of Agriculture

Presented: February 18-19, 2010

Water Supplies in a Changing Climate World

Michael Hayes

Water Supplies in a Changing Climate World



Michael Hayes
National Drought Mitigation Center
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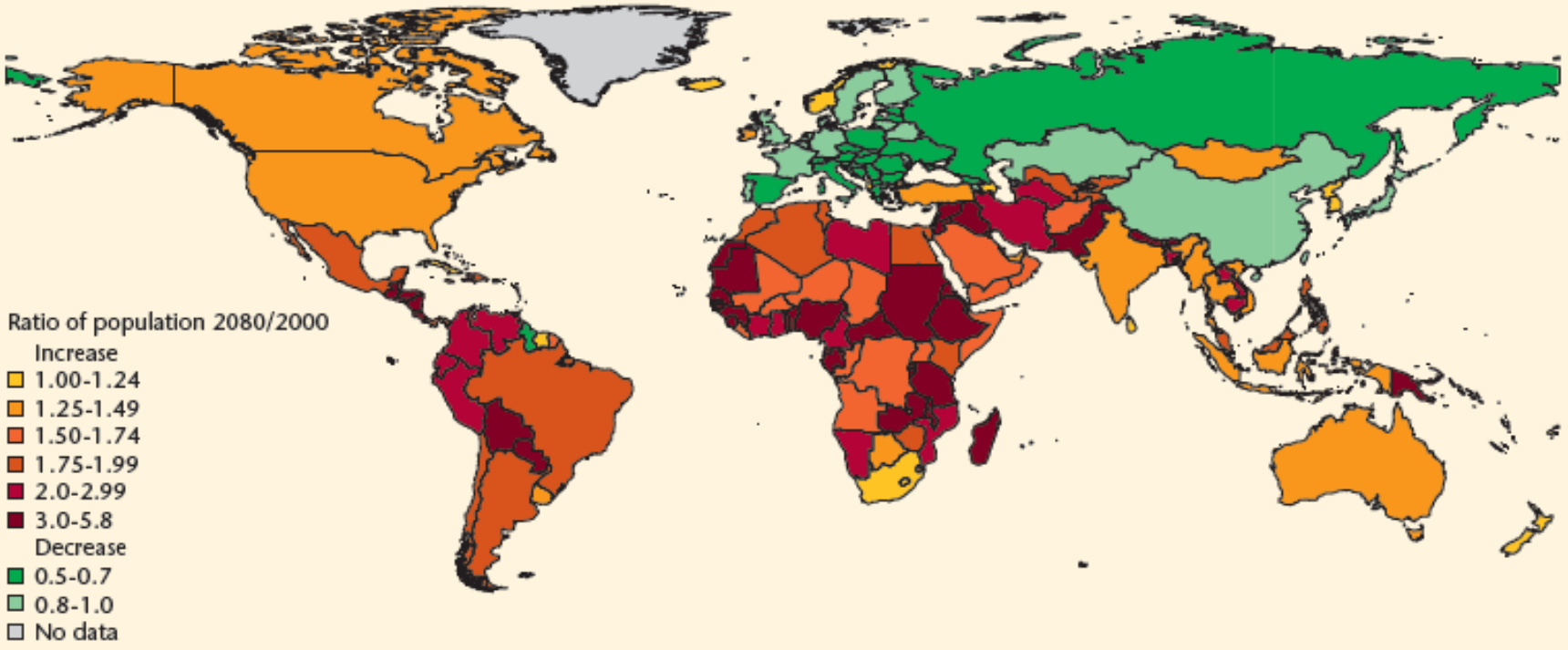
University of Nebraska-Lincoln

Photo: Lake Travis in Texas

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

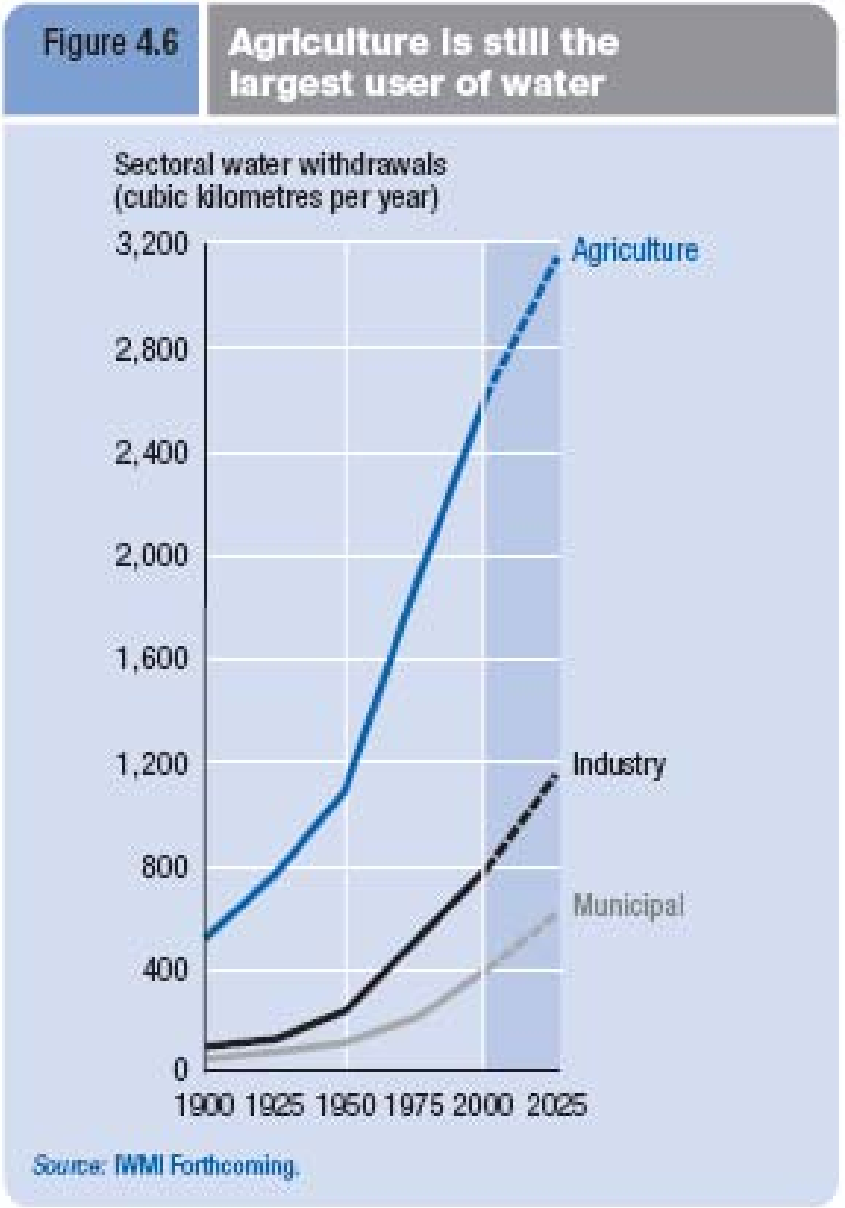
Map 2.1 **Expected areas of population growth and decline, 2000-2080**



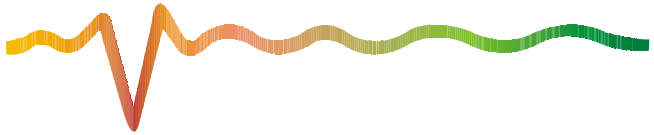
Source: Lutz, Sanderson, and Scherbov 2008.

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



Water Resources Complexities



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

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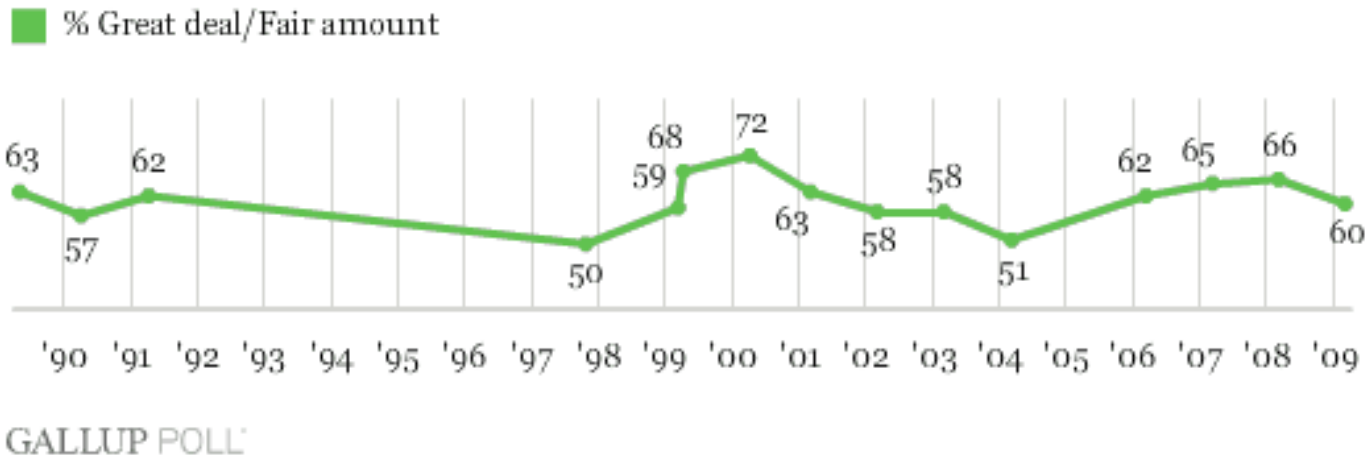
I'm going to read you a list of environmental problems. As I read each one, please tell me if you personally worry about this problem a great deal, a fair amount, only a little, or not at all.

The "greenhouse effect" or global warming



GALLUP POLL

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

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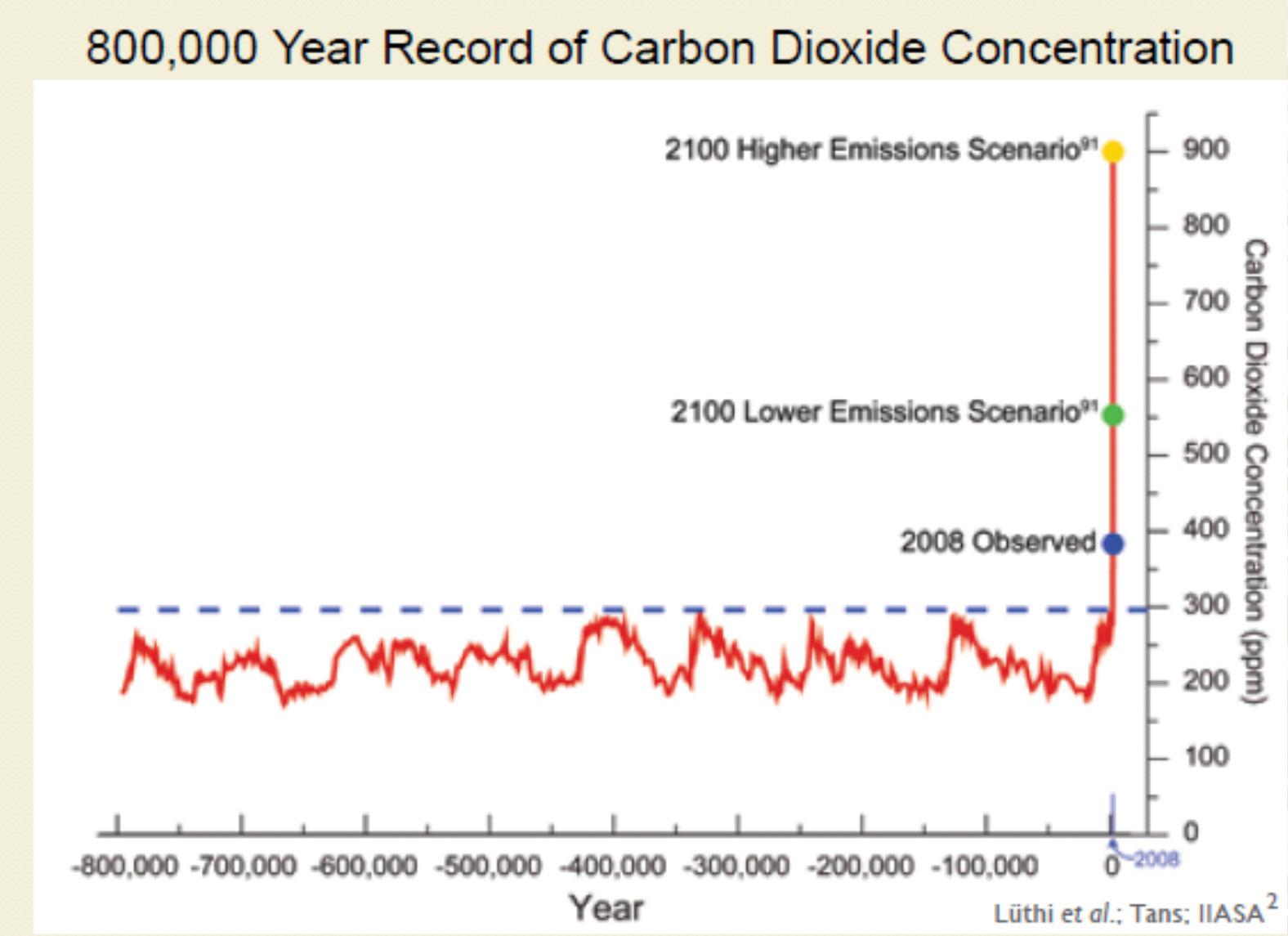
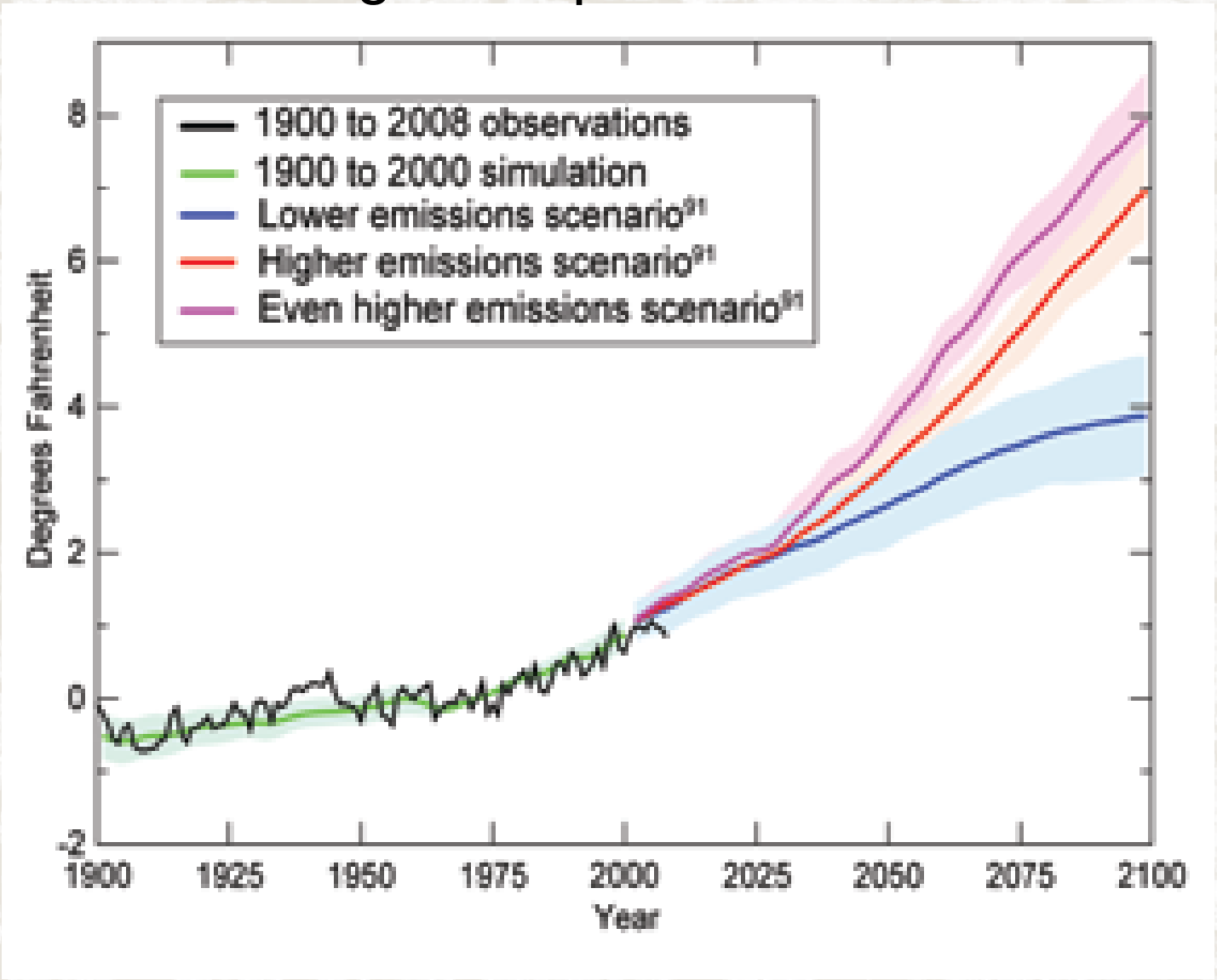
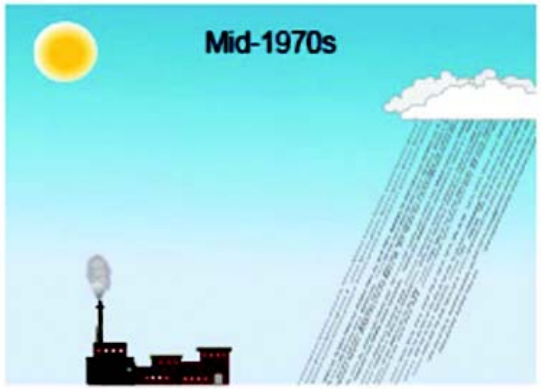

800,000 Year Record of Carbon Dioxide Concentration
2100 Higher Emissions Scenario[91]
2100 Lower Emissions Scenario[91]
2008 Observed
900
800
700
600
500
400
300
200
100
0
Carbon Dioxide Concentration (ppm)
-800,000 -700,000 -600,000 -500,000 -400,000 -300,000 -200,000 -100,000 0
2008
Year
Lüthi et al.; Tans; IIASA[2]

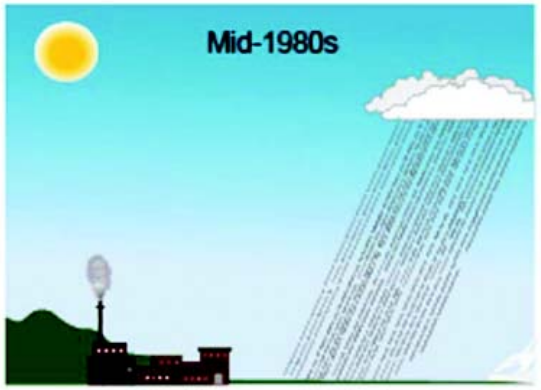
USGCRP 2009

Global Average Temperature, 1900 to 2100

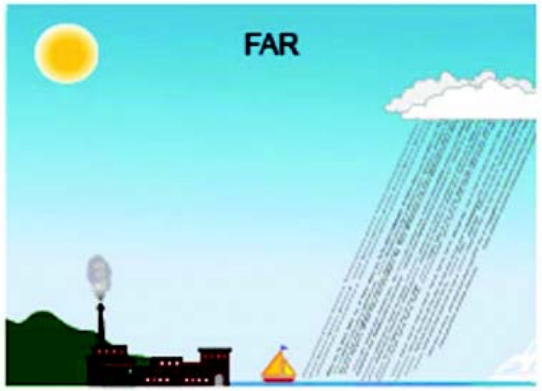


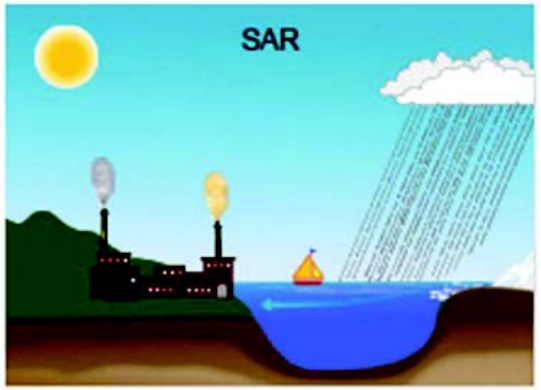
USGCRP 2009





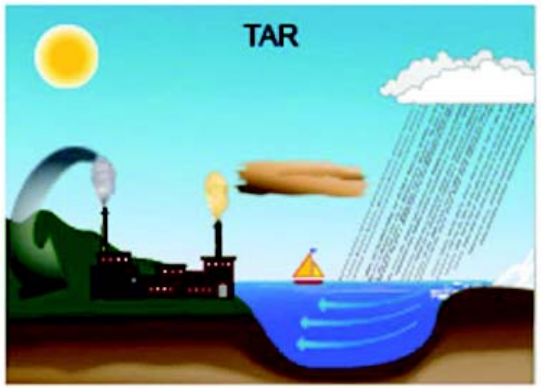
1990

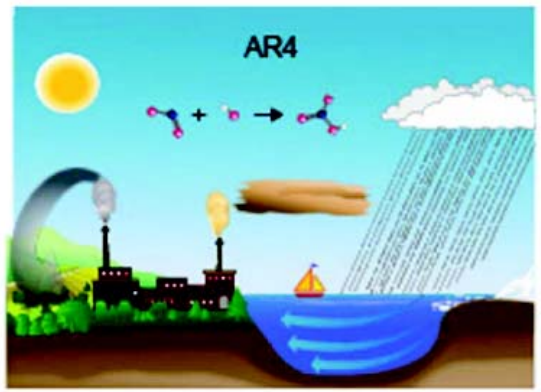




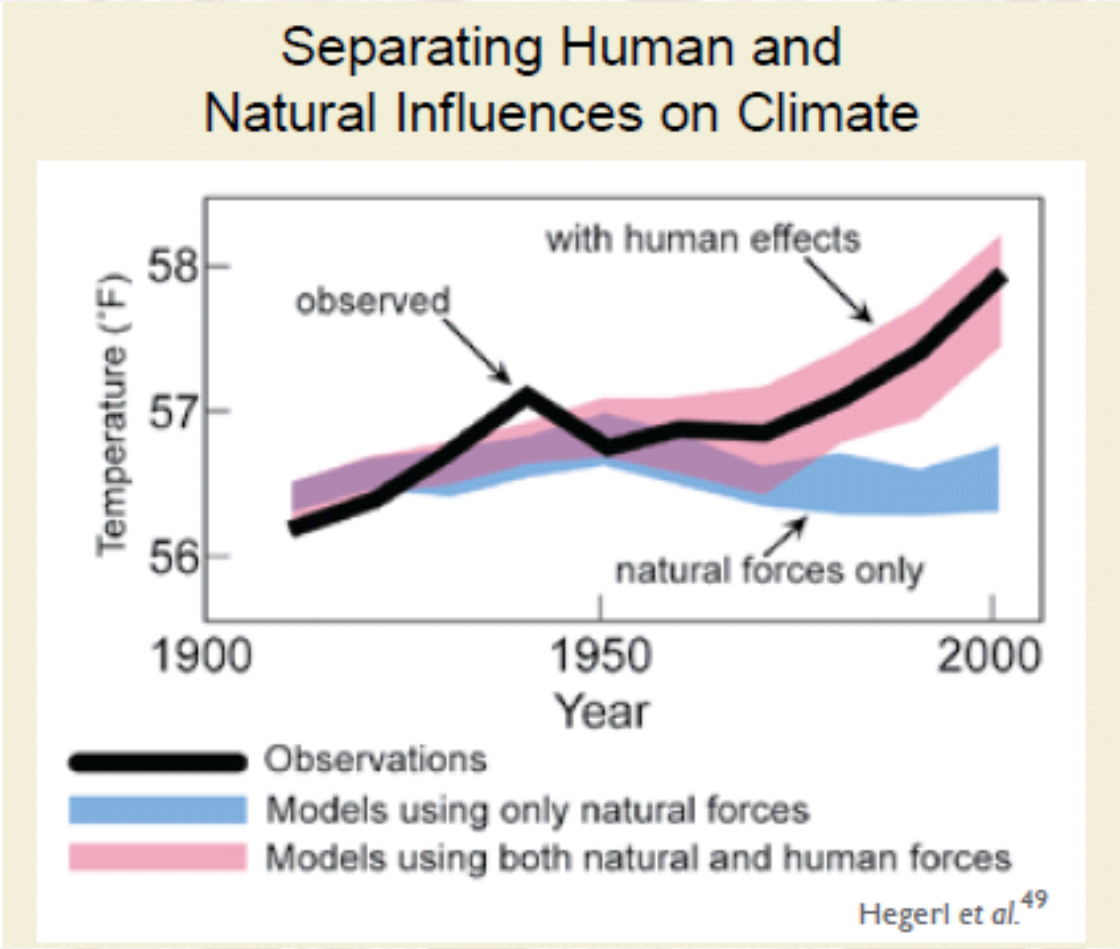
1995

2001



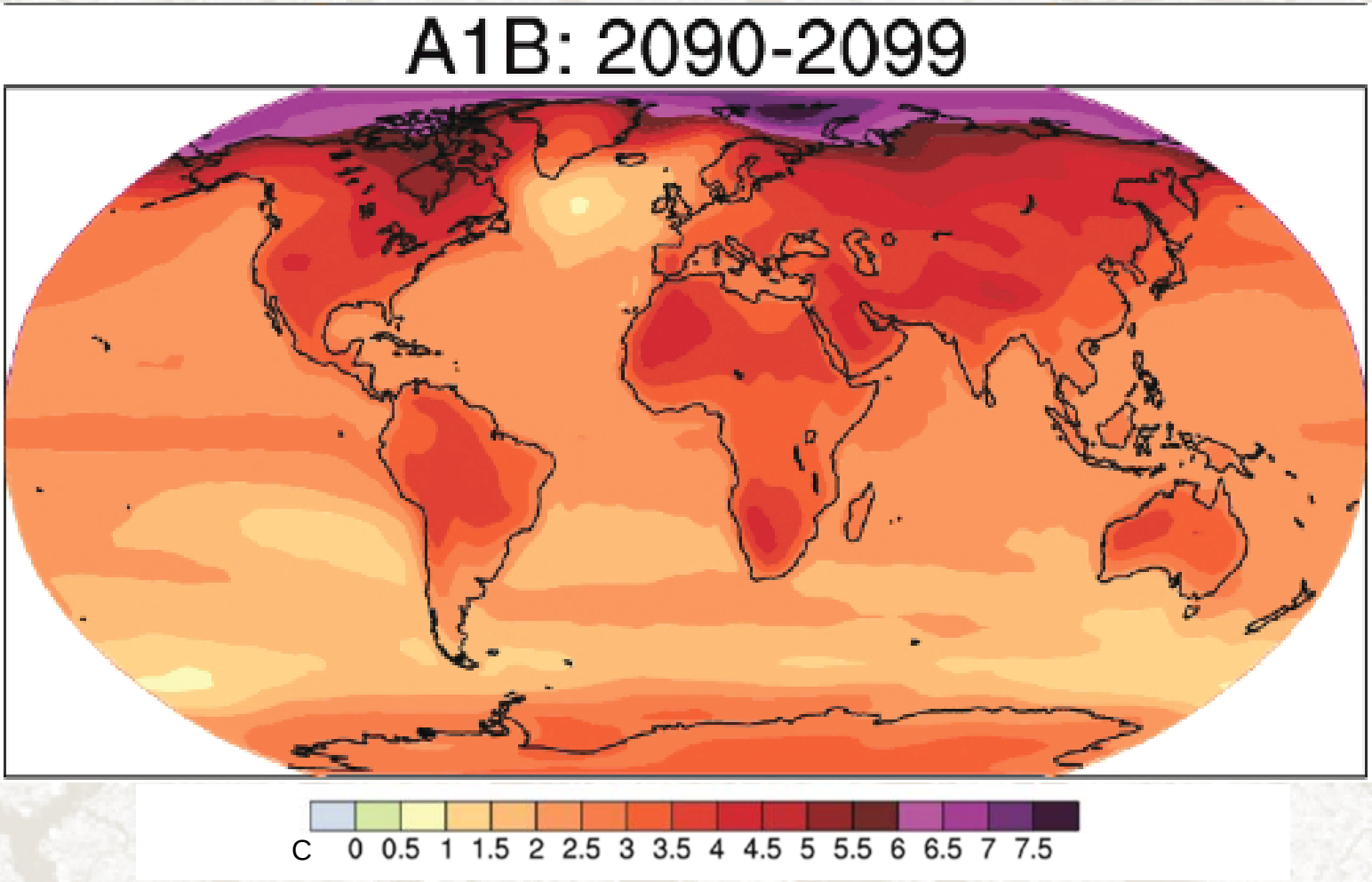


2007


Separating Human and
Natural Influences on Climate
with human effects
observed
natural forces only
Temperature (°F)
58
57
56
1900
1950
2000
Year
Observations
Models using only natural forces
Models using both natural and human forces
Hegerl et al.[49]

USGCRP 2009

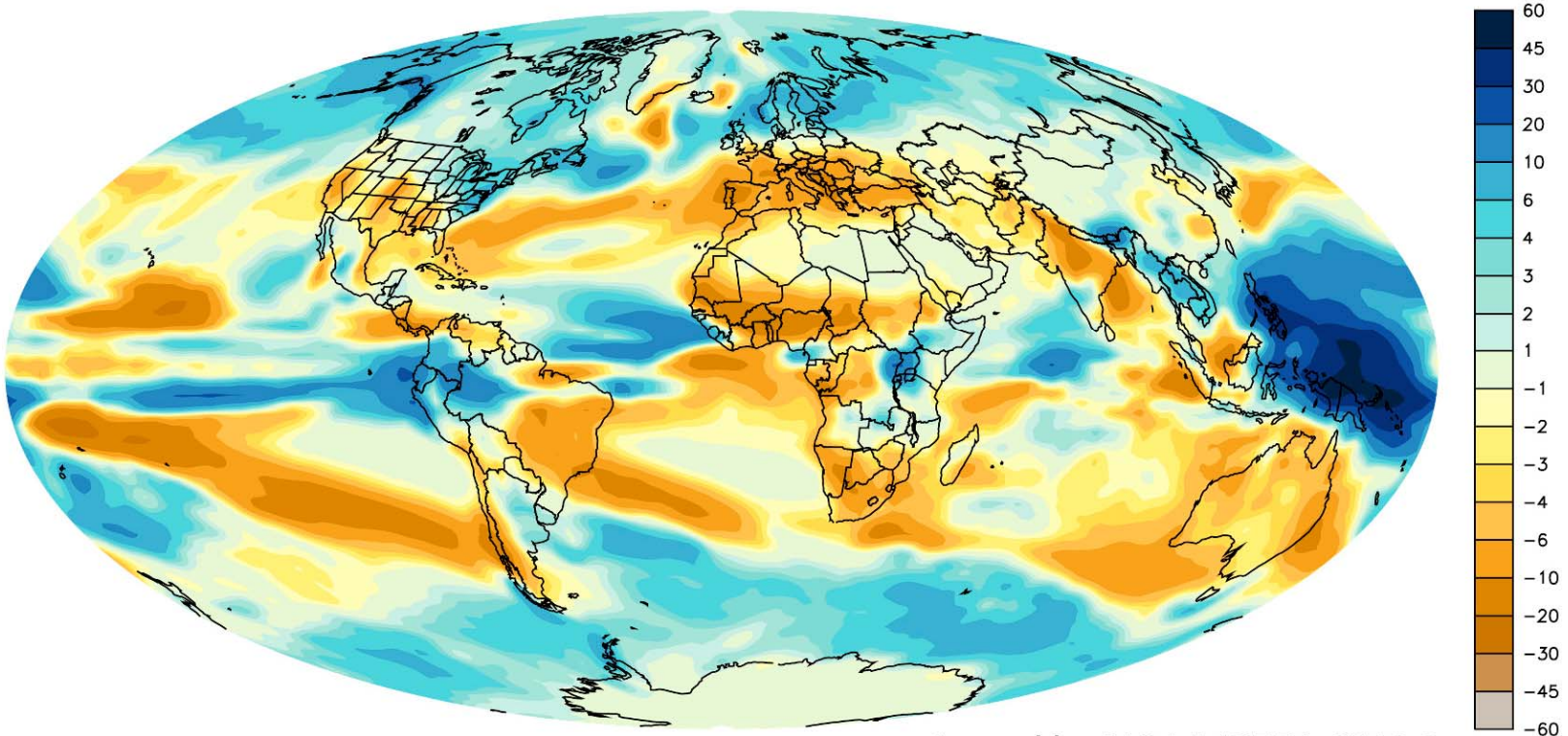
Global Temperatures



IPCC 2007

CHANGE IN PRECIPITATION BY END OF 21st CENTURY

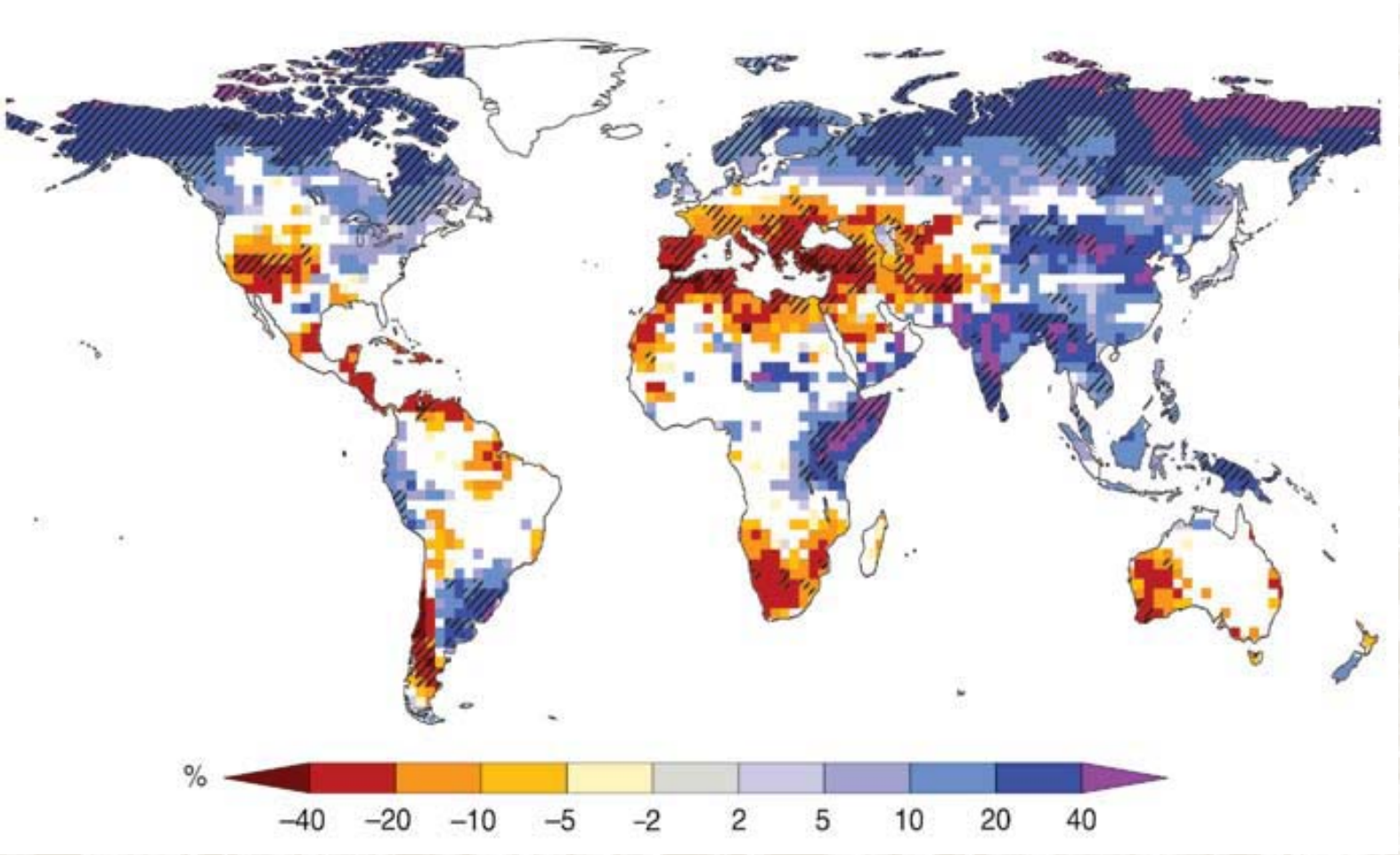
inches of liquid water per year



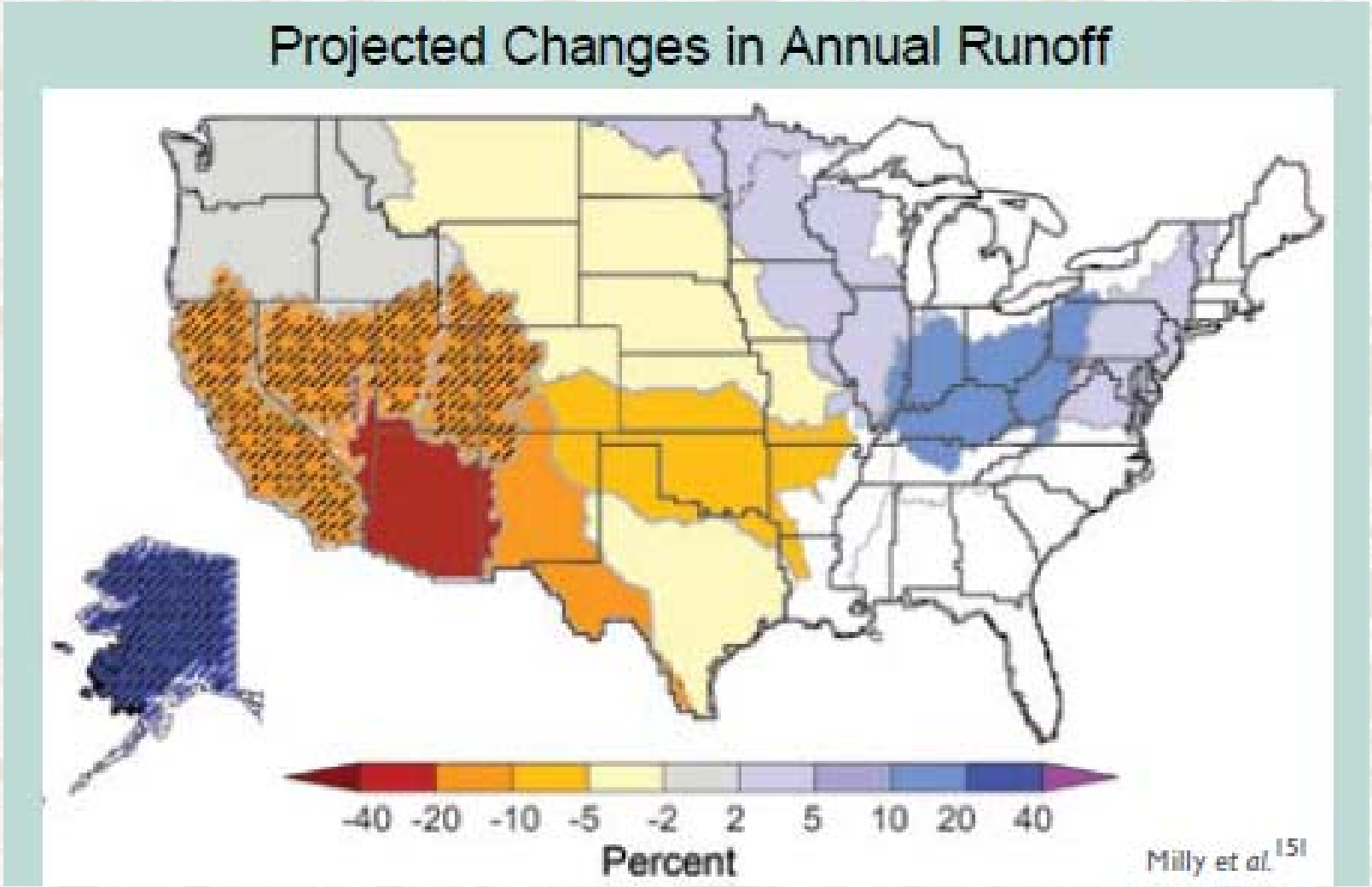
as projected by NOAA/GFDL CM2.1

NOAA 2007

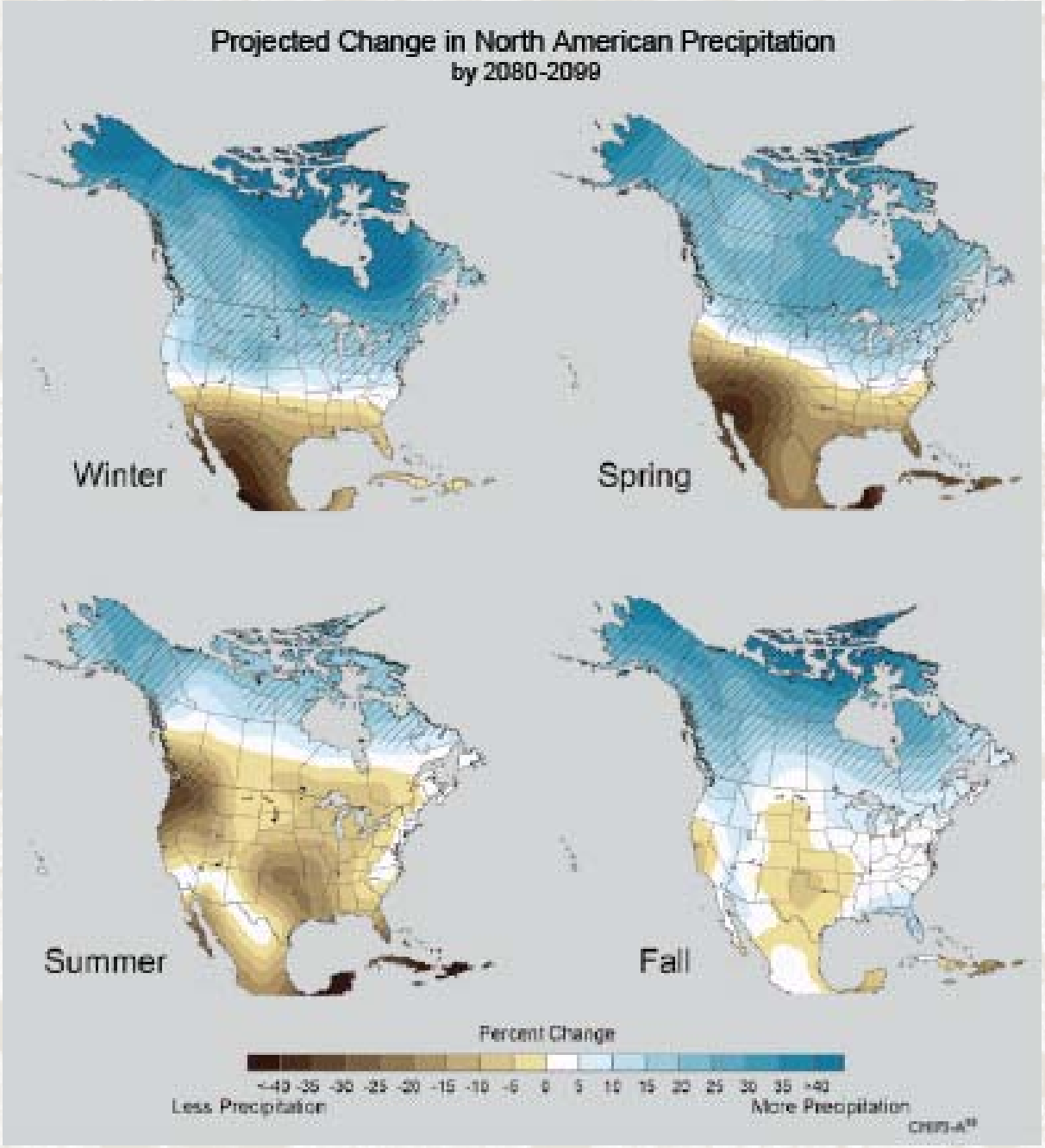
Annual Runoff for 2080-2099



IPCC 2007

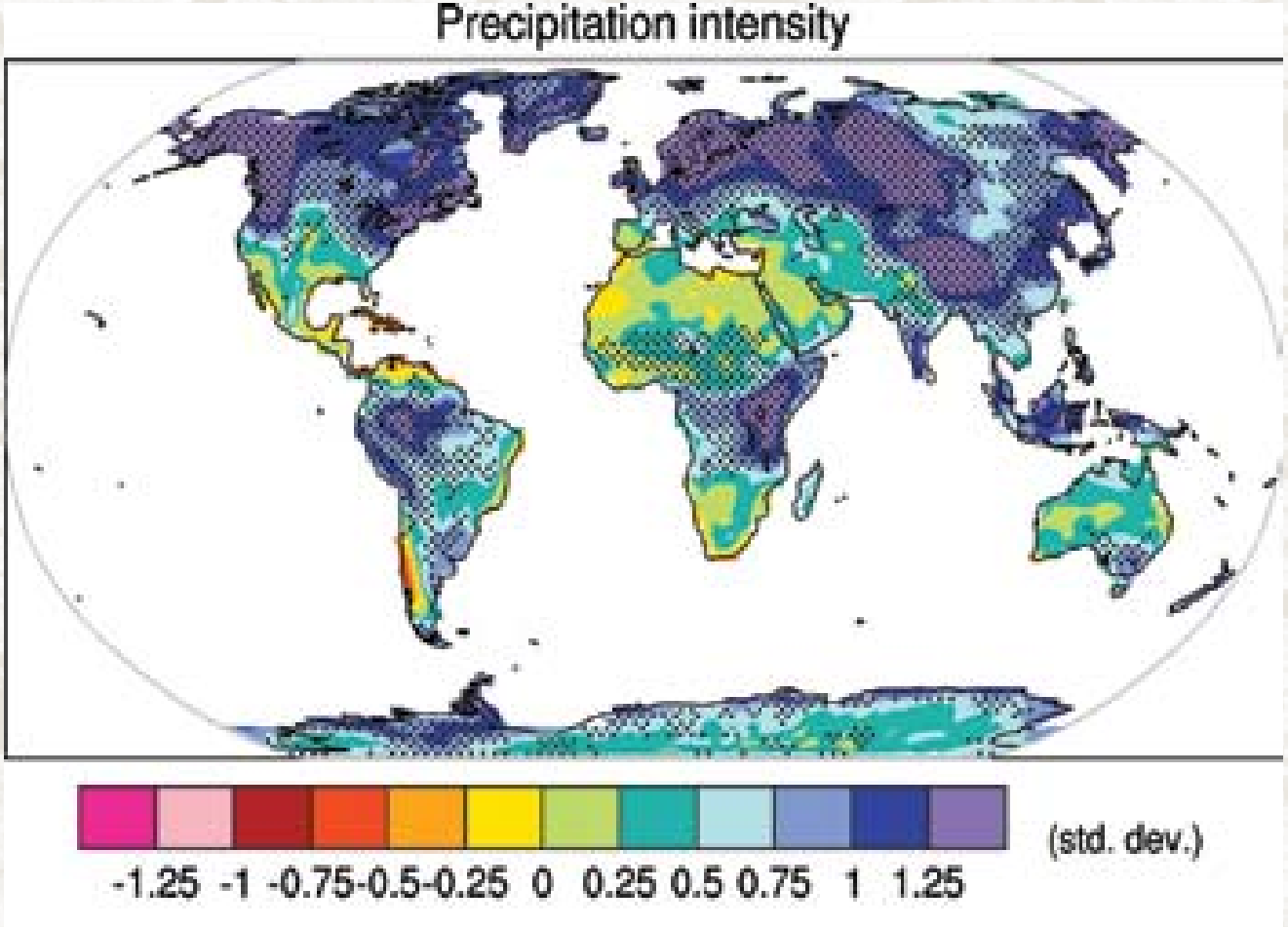

Projected Changes in Annual Runoff
-40 -20 -10 -5 -2 2 5 10 20 40
Percent
Milly et al.[15]

USGCRP 2009


Projected Change in North American Precipitation
by 2080-2099
Winter
Spring
Summer
Fall
Percent Change
<-40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 >40
Less Precipitation
More Precipitation

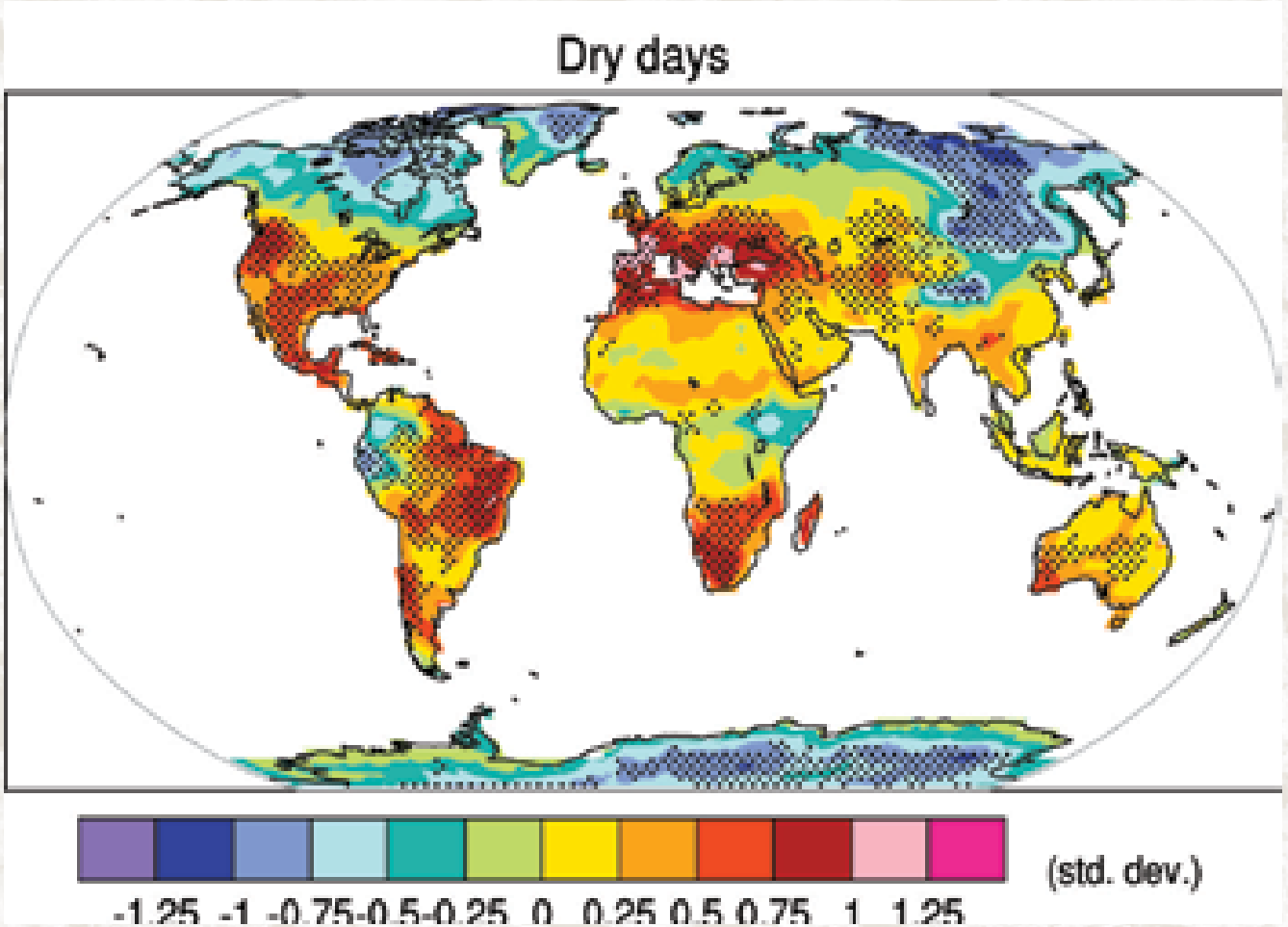
USGCRP 2009

2080-2099 Relative to 1980-1999



IPCC 2007

2080-2099 Relative to 1980-1999



IPCC 2007

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

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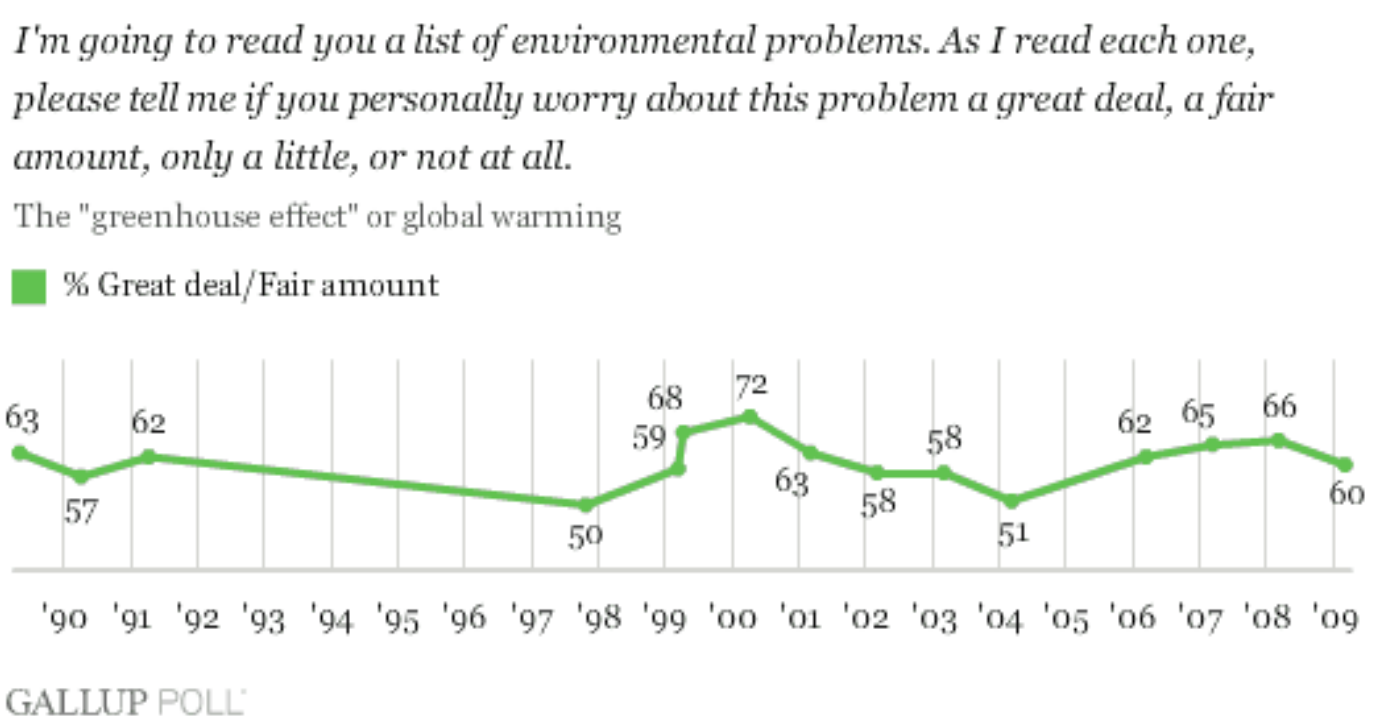

- "The consequences of climate change are being felt, most acutely, in waters and watersheds throughout the United States."

G. Tracy Mehan III, 2008

Arlington, VA, Environmental Consultant

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