Climate Change and the Midwest: Issues and Impacts

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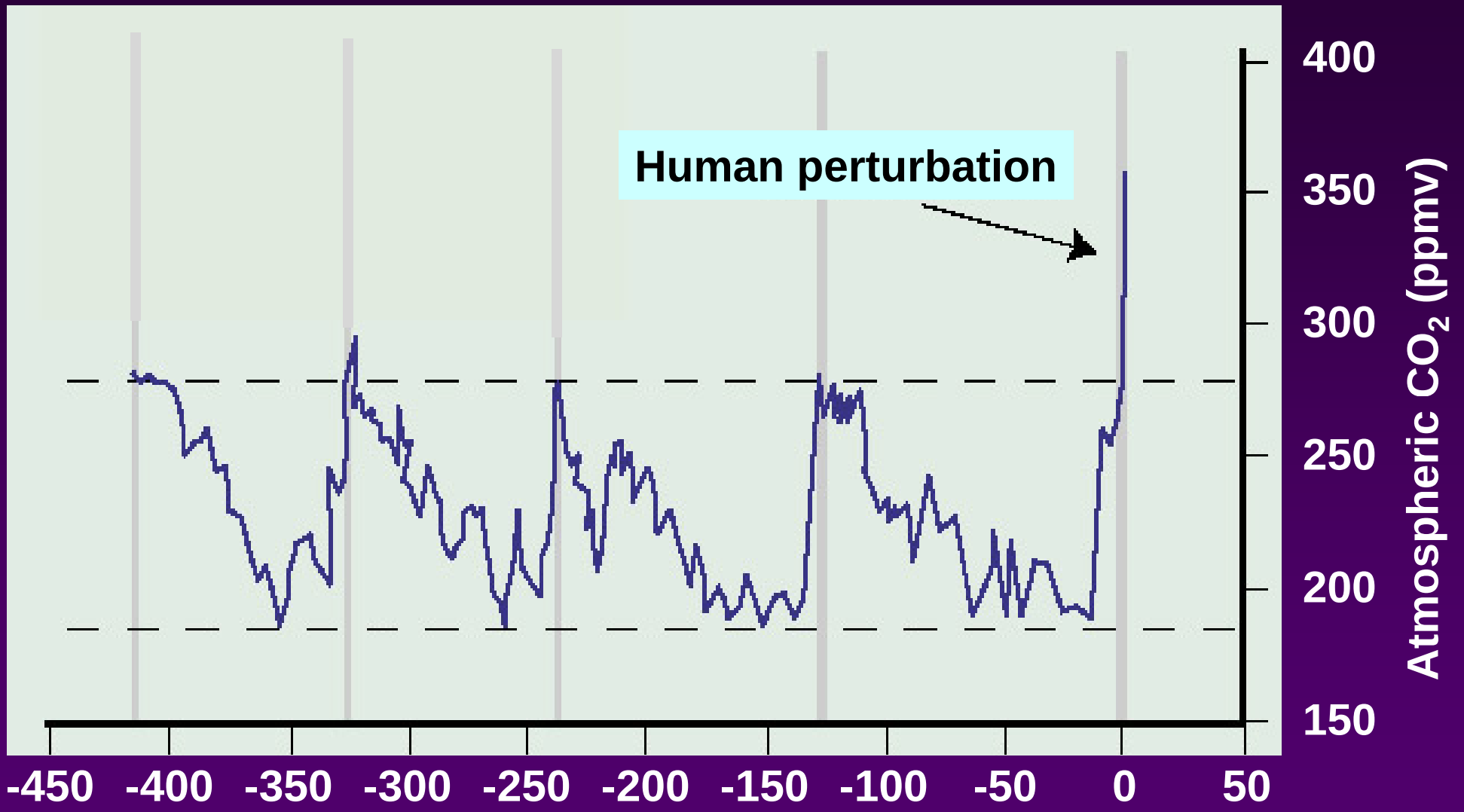
K-State Research and Extension

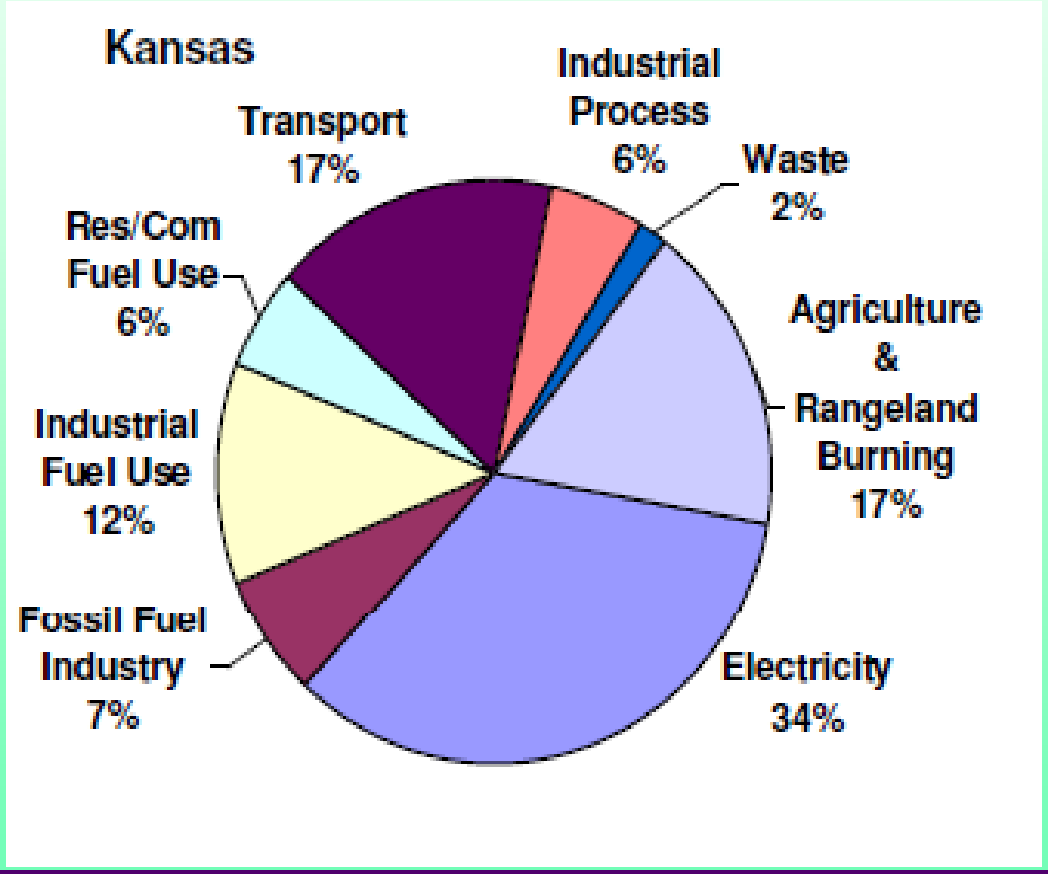
CHANGES IN CLIMATE

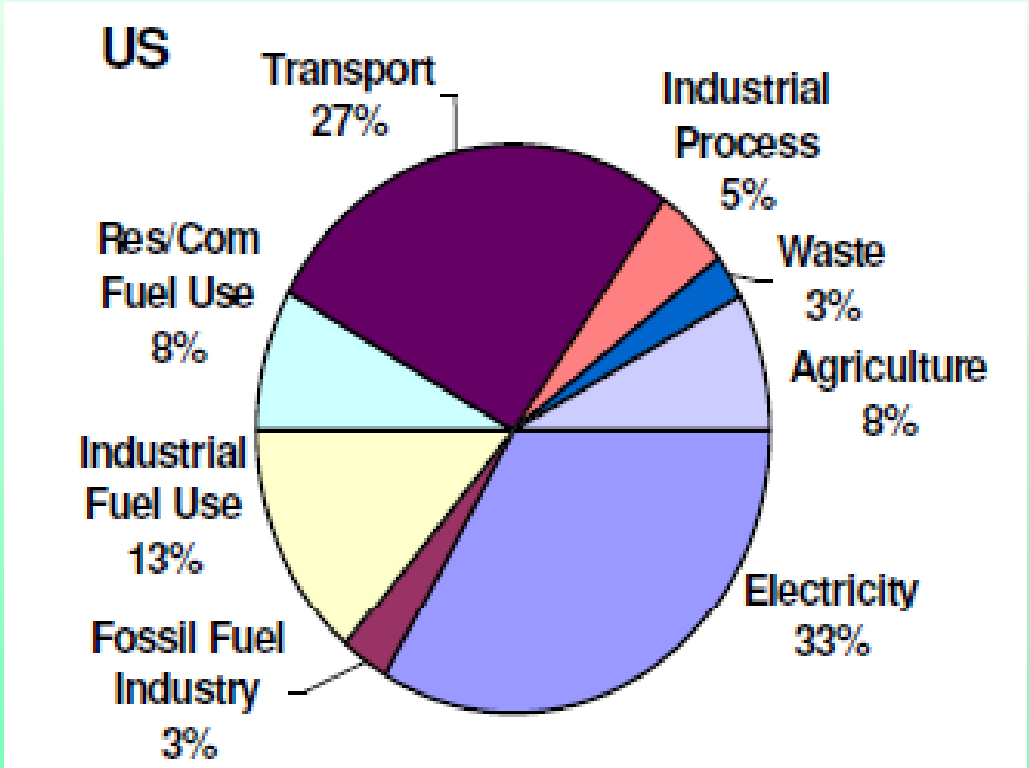
- Rising CO_2 concentrations in the atmosphere
- Warming temperatures over the next 30- 50 years
- Variability in both temperature and precipitation



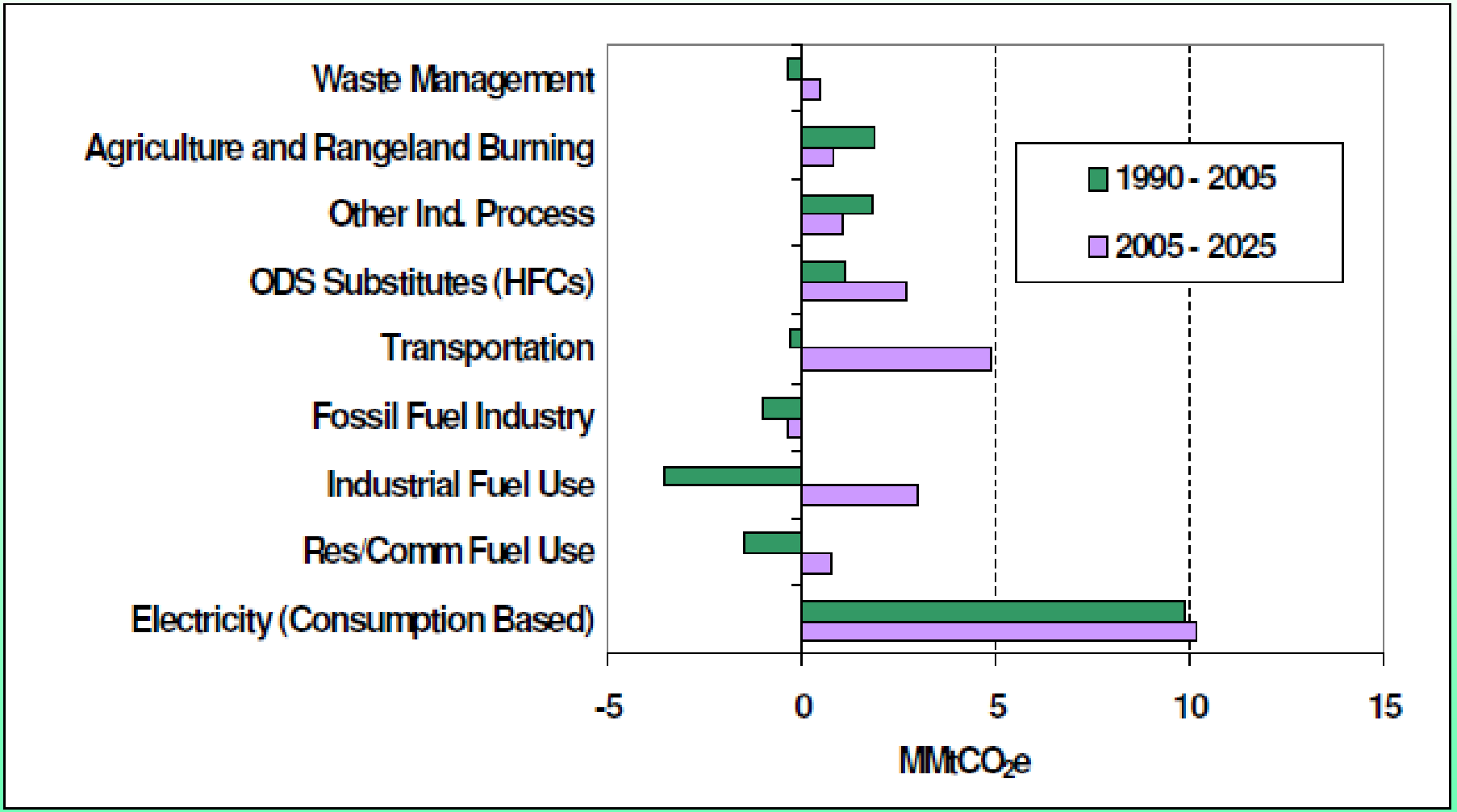
Source: Petit et al. 1999

Kansas & US Gross Emissions By Sector, 2005 (Consumption Based)

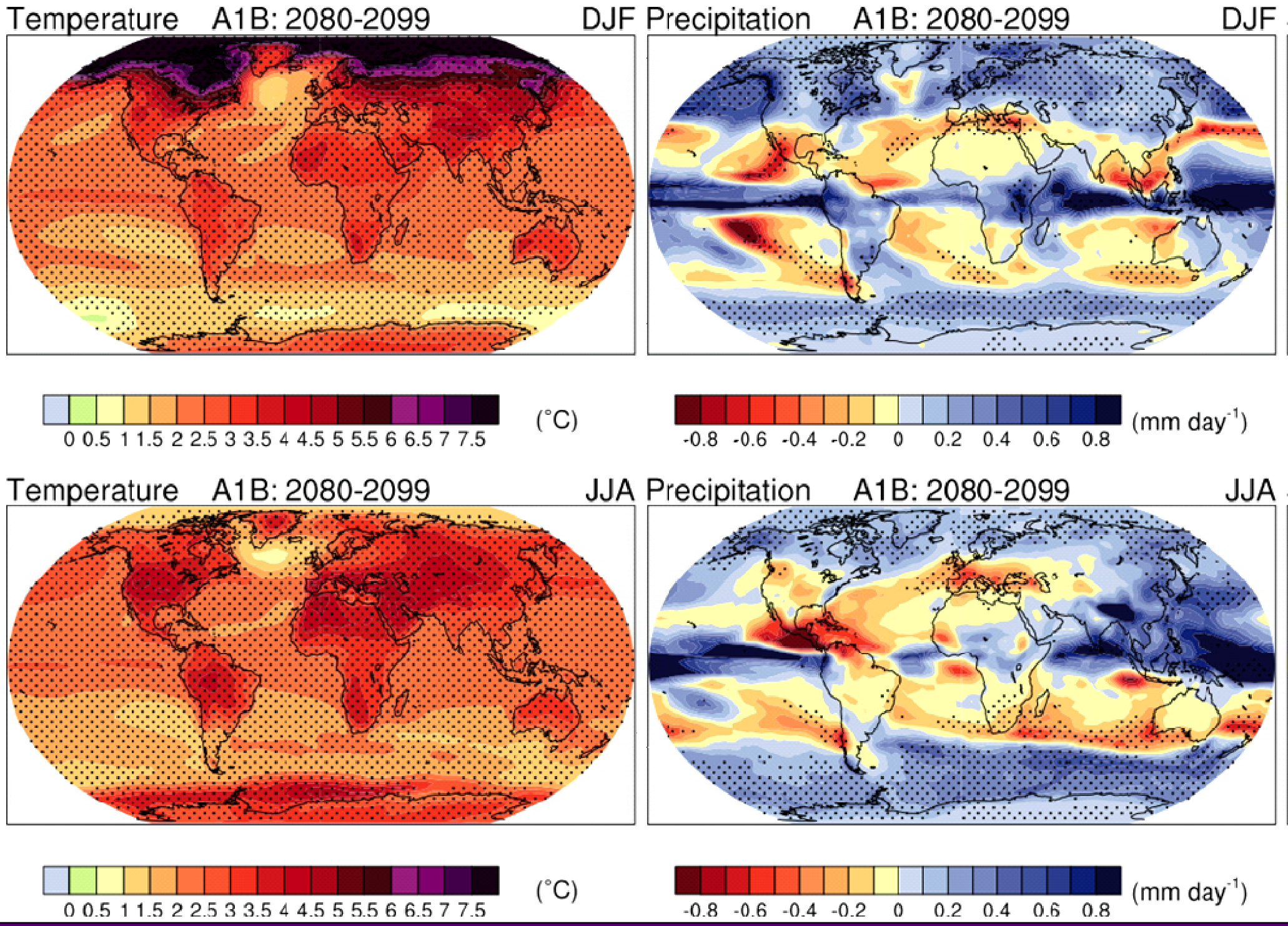




Kansas Gross Emissions Growth
($MMtCO_2e$, Consumption Based)



Impact On Climate



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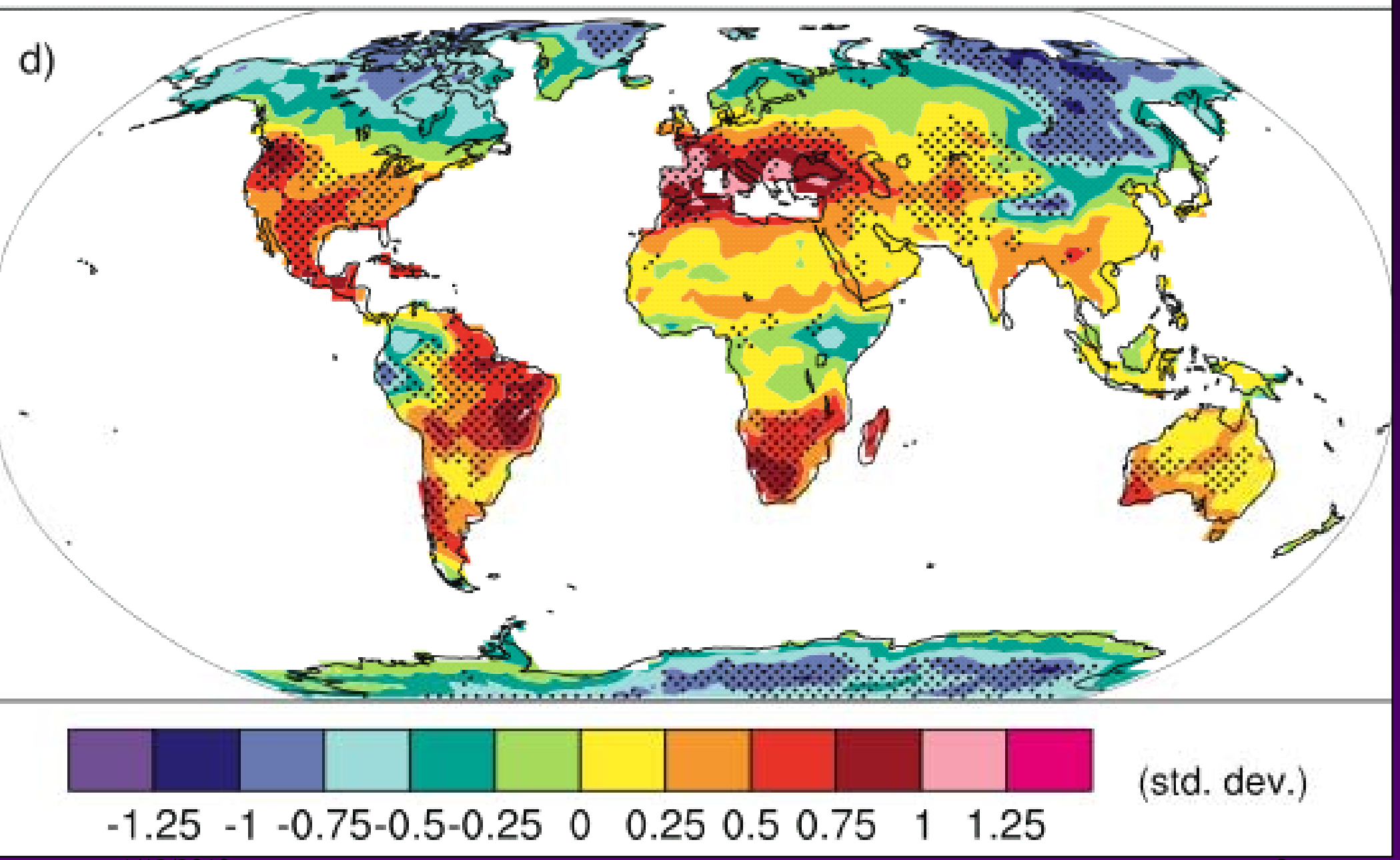
Dry days



United States

- Already affecting U.S. water resources, agriculture, land resources, and biodiversity, and will continue to do so
- Warming is very likely to continue in the United States during the next 25 to 50 years, regardless of reductions in greenhouse gas emissions, due to emissions that have already occurred

Projected Changes for the Climate of the Midwest

Temperature

- Longer frost-free period (high)
- Higher average winter temperatures (high)
- Fewer extreme cold temperatures in winter (high)
- Fewer extreme high temperatures in summer in short term but more in long term (medium)
- Higher nighttime temperatures both summer and winter (high)
- More freeze-thaw cycles (high)
- Increased temperature variability (high)

*Estimated from IPCC reports

Projected Changes* for the Climate of the Midwest

Precipitation

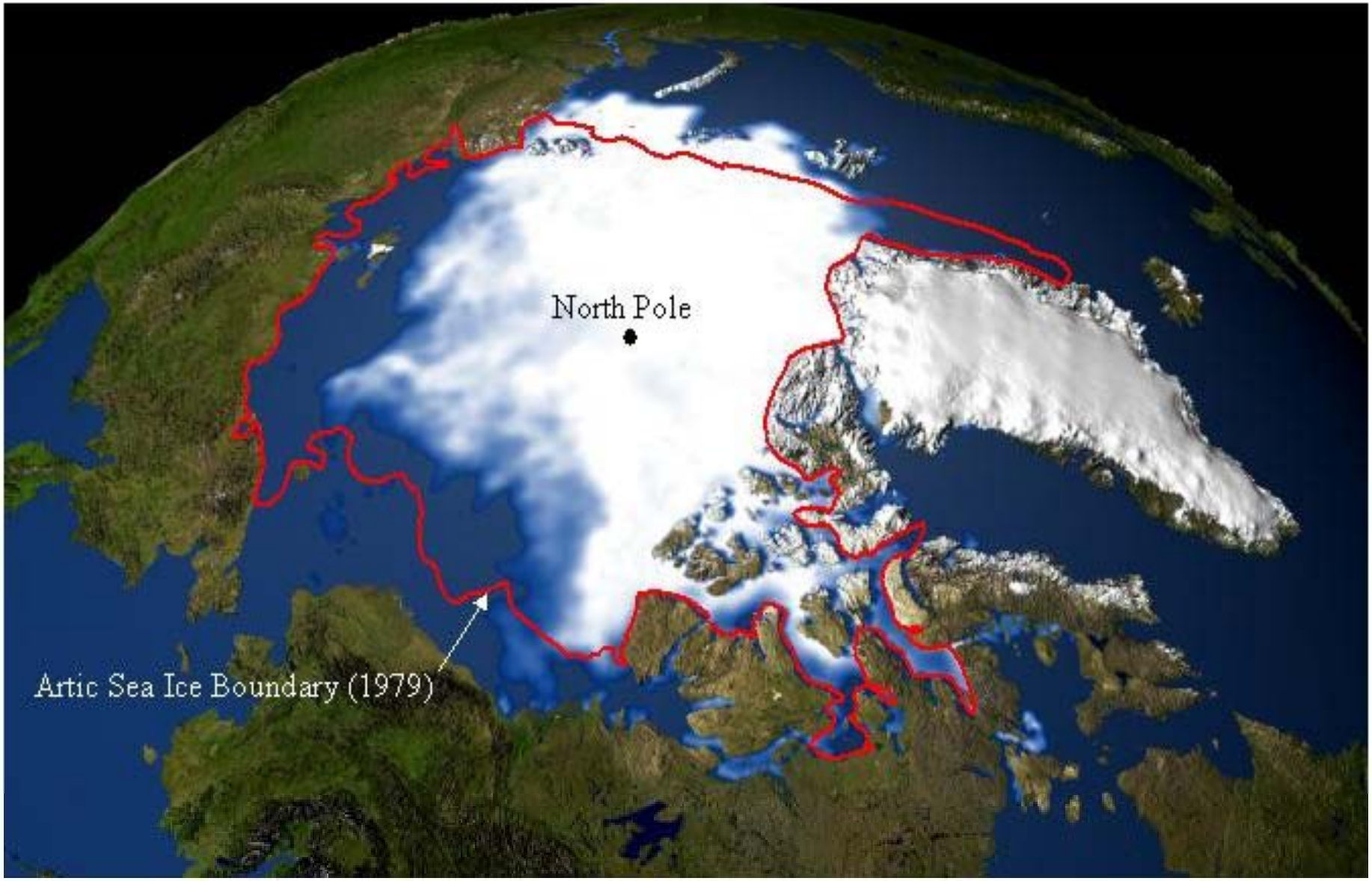
- More (~10%) precipitation annually (medium)
- Change in "seasonality": Most of the increase will come in the first half of the year (wetter springs, drier summers) (high)
- More variability of summer precipitation (high)
  - More intense rain events and hence more runoff (high)
  - Higher episodic streamflow (medium)
  - Longer periods without rain (medium)
- Stronger storm systems (medium)
- More winter soil moisture recharge (medium)
- Snowfall increases (late winter) in short term but decreases in the long run (medium)

*Estimated from IPCC reports

Impact on Ecosystems and Human Health and Well Being

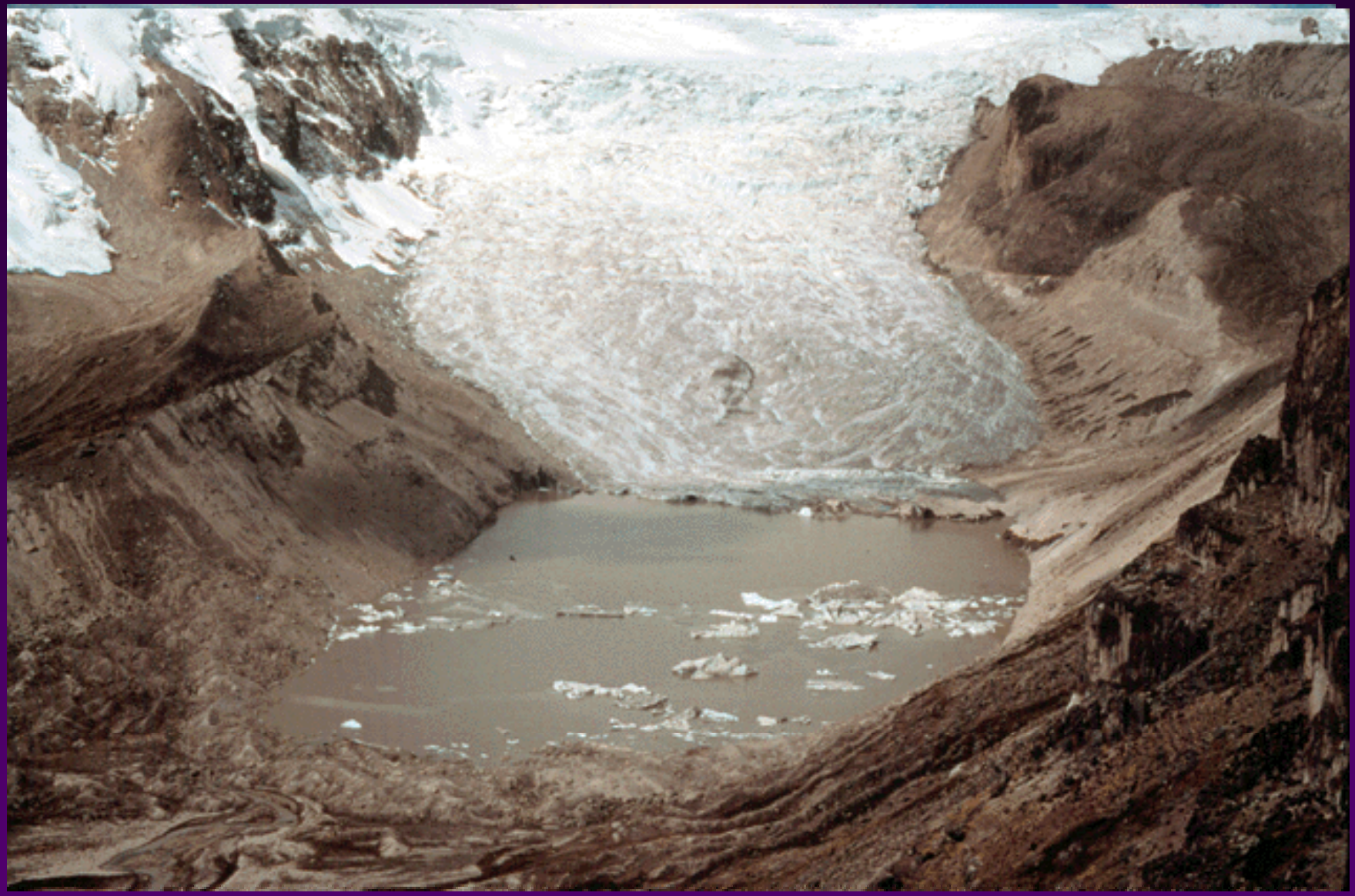
Arctic Sea Ice Loss: Greater than Land Area of Texas, California, and Maryland Combined

2003 vs. 1979 Comparison



Qori Kalis, Peruvian Andes

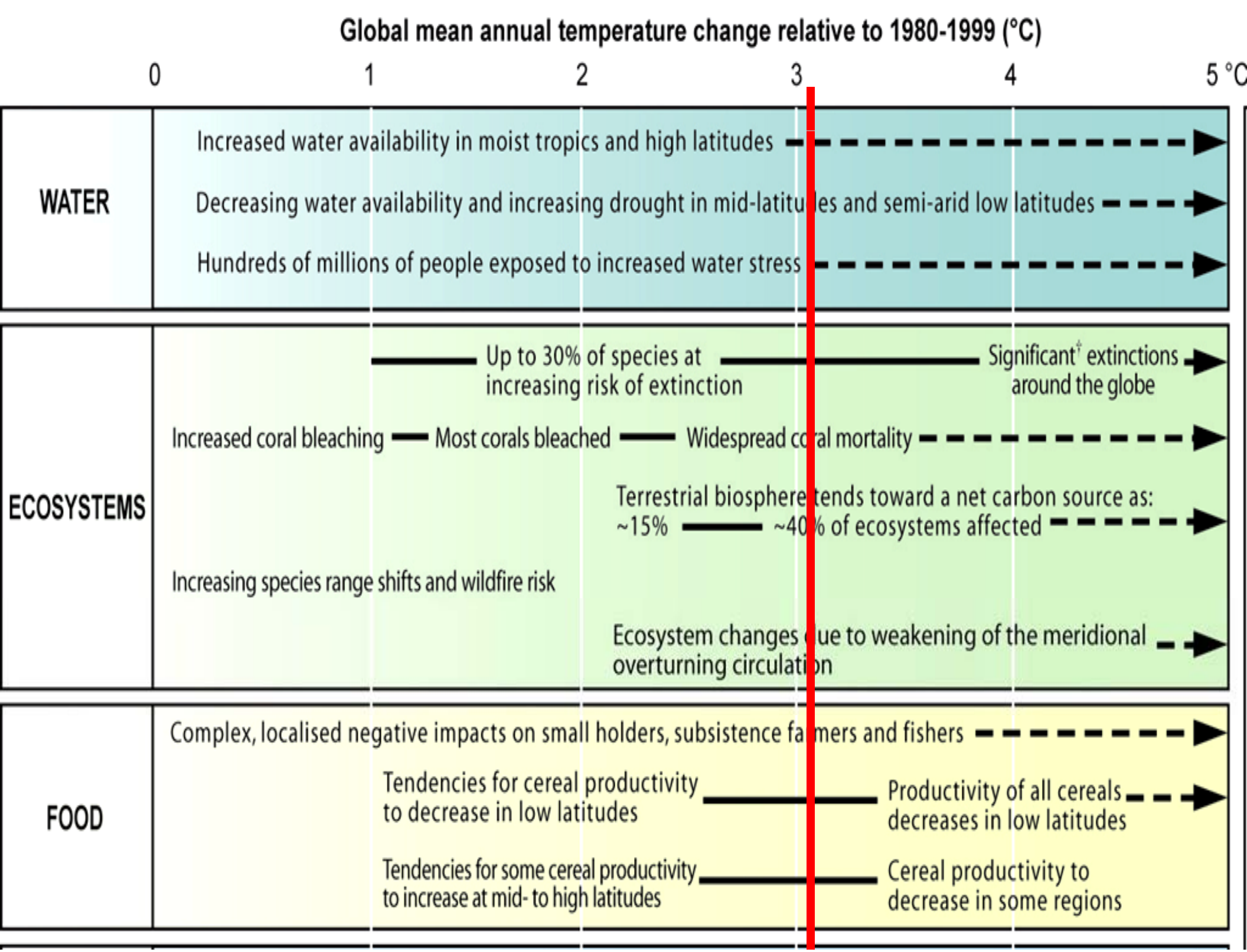
1978… …And Today

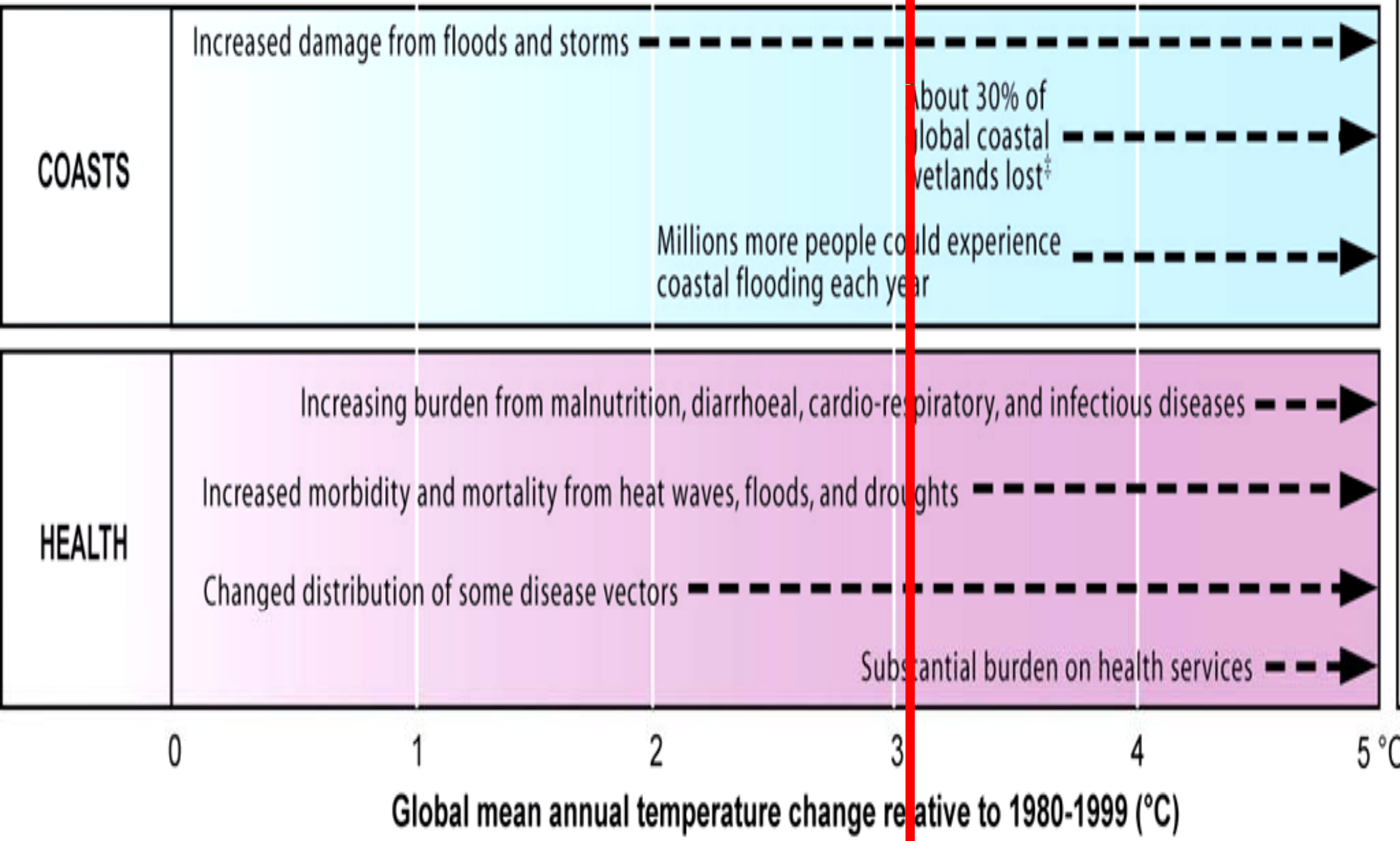


- In 1978, the Qori Kalis Glacier looked like this, flowing out from the Quelccaya Ice Cap in the Peruvian Andes Mountains.

Glaciers are shrinking nearly worldwide

Source: L. Thompson


Global mean annual temperature change relative to 1980-1999 (°C)
0
1
2
3
4
5 °C
WATER
Increased water availability in moist tropics and high latitudes
Decreasing water availability and increasing drought in mid-latitudes and semi-arid low latitudes
Hundreds of millions of people exposed to increased water stress
ECOSYSTEMS
Up to 30% of species at increasing risk of extinction
Significant† extinctions around the globe
Increased coral bleaching
Most corals bleached
Widespread coral mortality
Terrestrial biosphere tends toward a net carbon source as:
~15%
~40% of ecosystems affected
Increasing species range shifts and wildfire risk
Ecosystem changes due to weakening of the meridional overturning circulation
FOOD
Complex, localised negative impacts on small holders, subsistence farmers and fishers
Tendencies for cereal productivity to decrease in low latitudes
Productivity of all cereals decreases in low latitudes
Tendencies for some cereal productivity to increase at mid- to high latitudes
Cereal productivity to decrease in some regions



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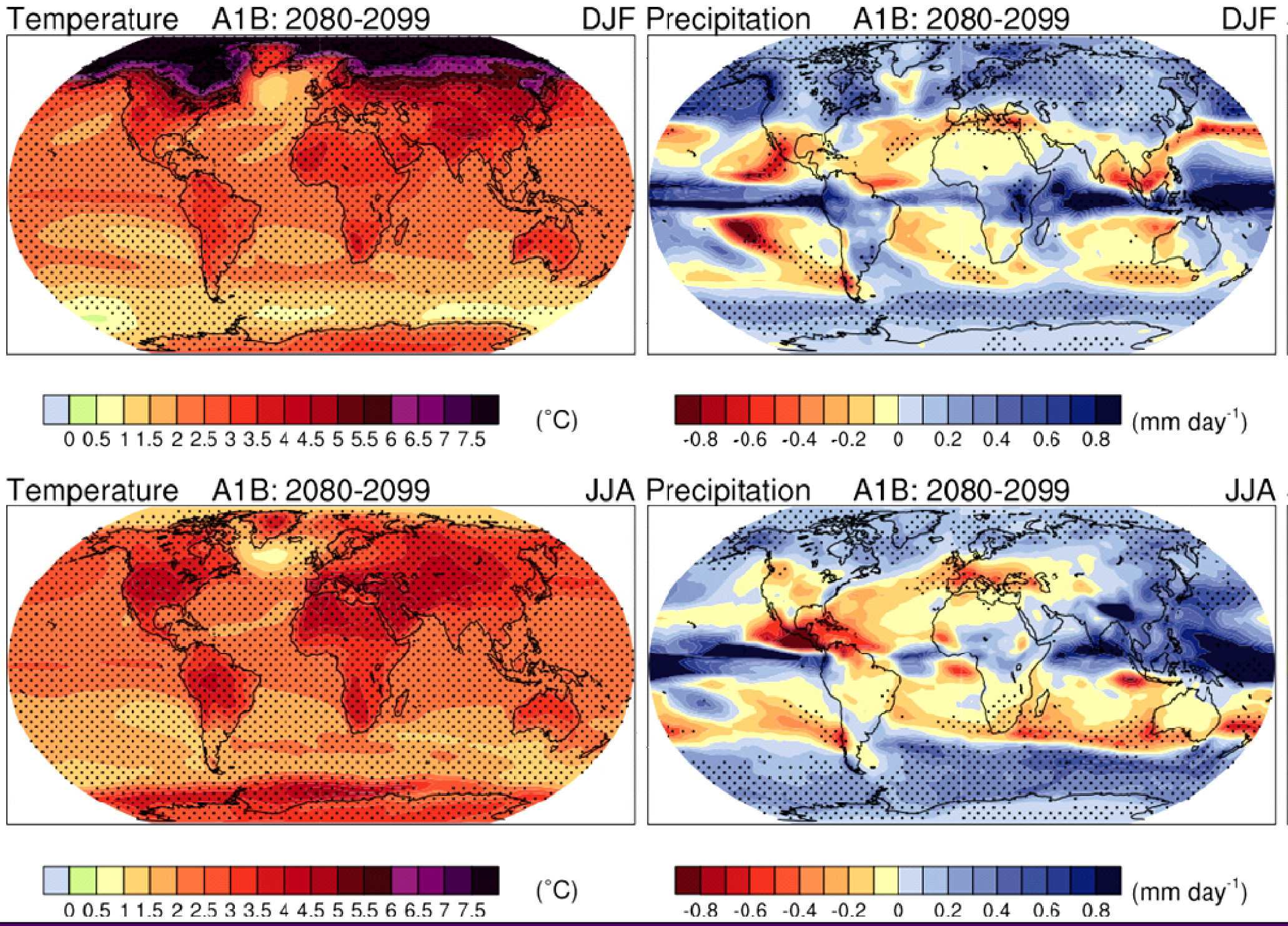

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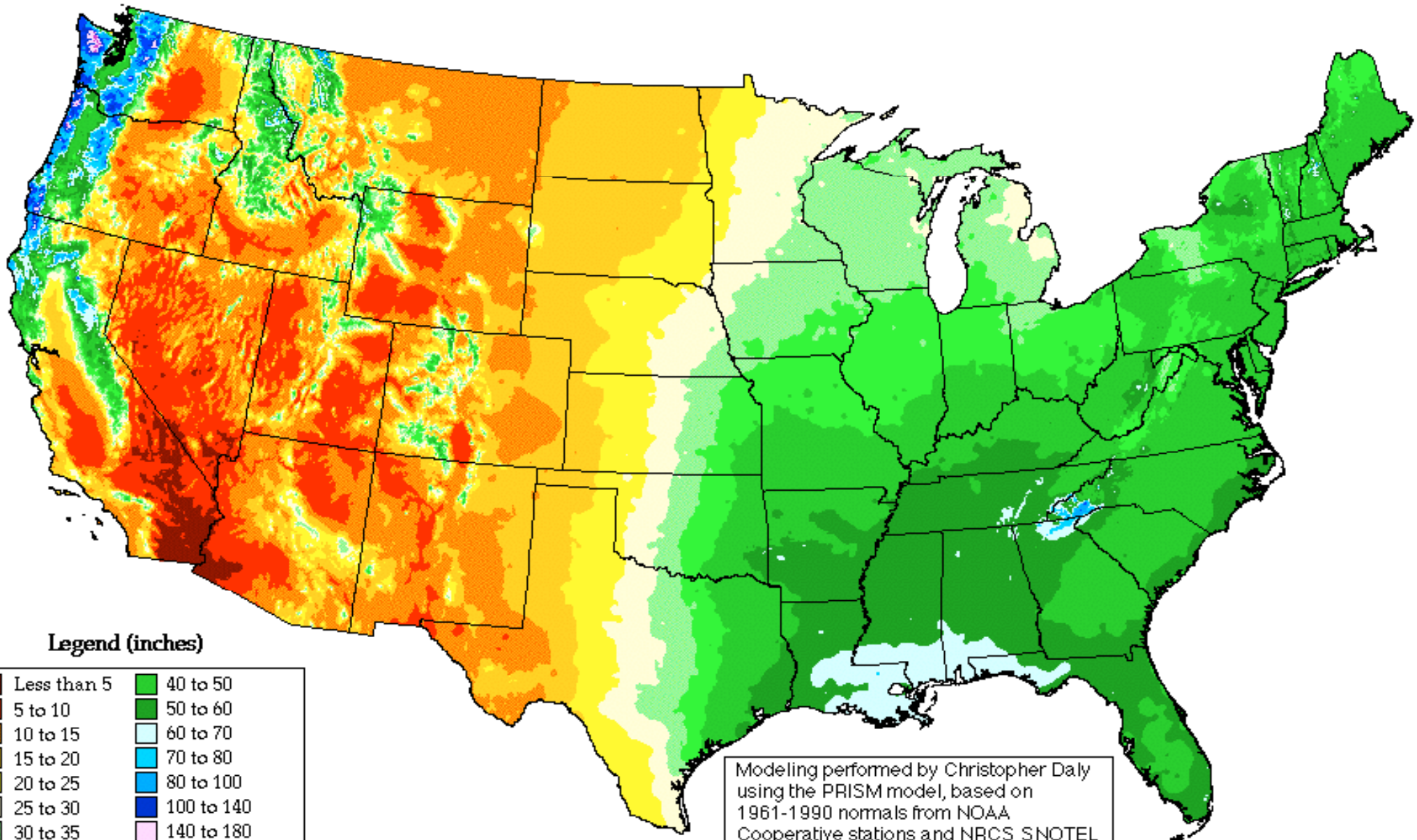
Annual Average Precipitation

United States of America



Legend (inches)

Less than 5	40 to 50
5 to 10	50 to 60
10 to 15	60 to 70
15 to 20	70 to 80
20 to 25	80 to 100
25 to 30	100 to 140
30 to 35	140 to 180
35 to 40	More than 180

Period: 1961-1990

Modeling performed by Christopher Daly using the PRISM model, based on 1961-1990 normals from NOAA Cooperative stations and NRCS SNOTEL sites. Sponsored by USDA-NRCS Water and Climate Center, Portland, Oregon.

Oregon Climate Service
George Taylor, State Climatologist
(541) 737-5705

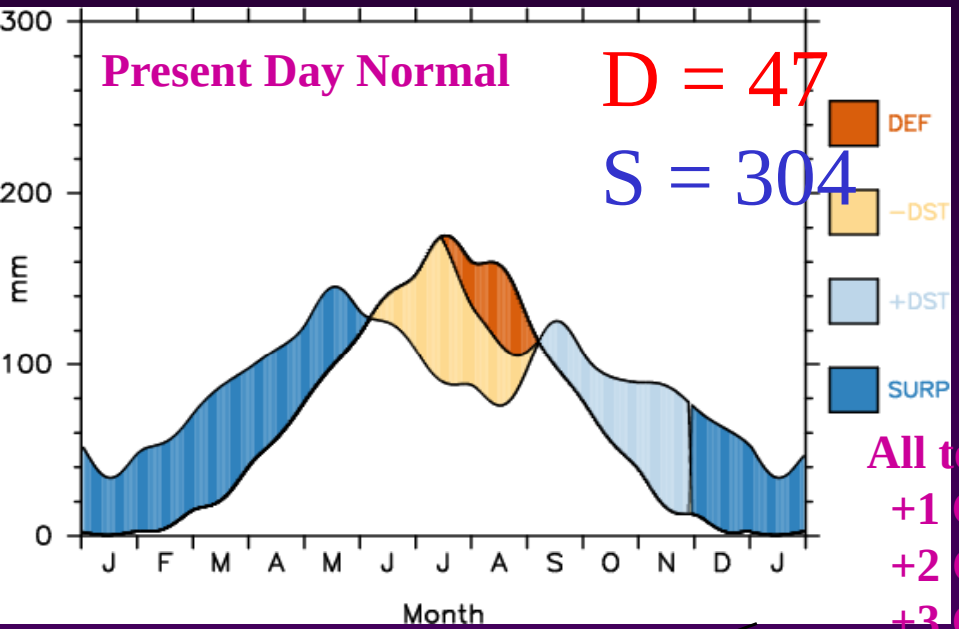
Climate projections

Feddema,2008

Eastern Kansas (37N, 95W)

D = Annual Deficit (mm)

S = Annual Surplus (mm)

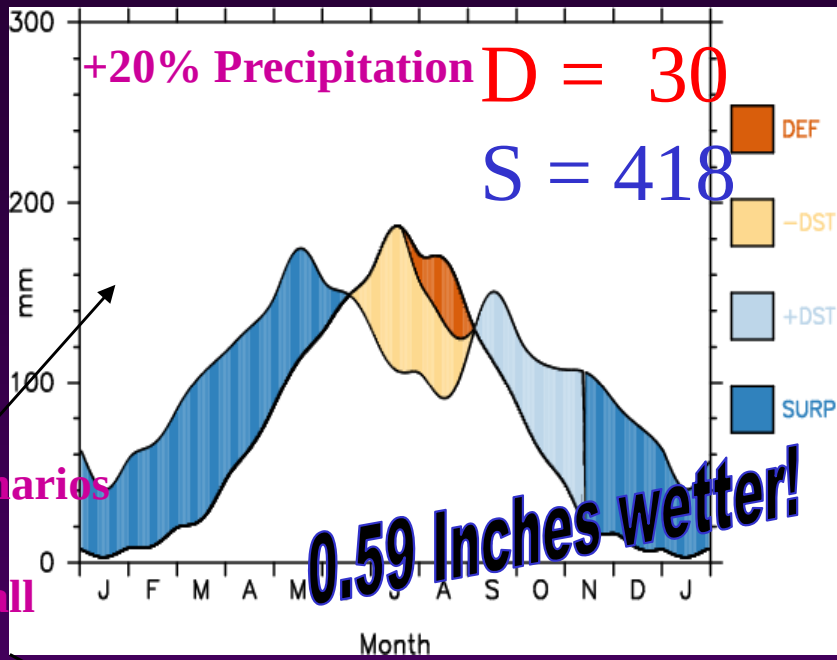


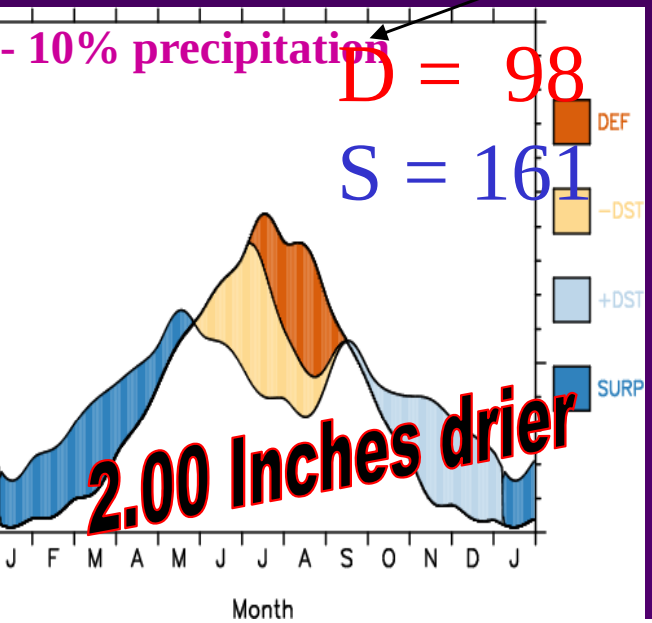
All temperature scenarios

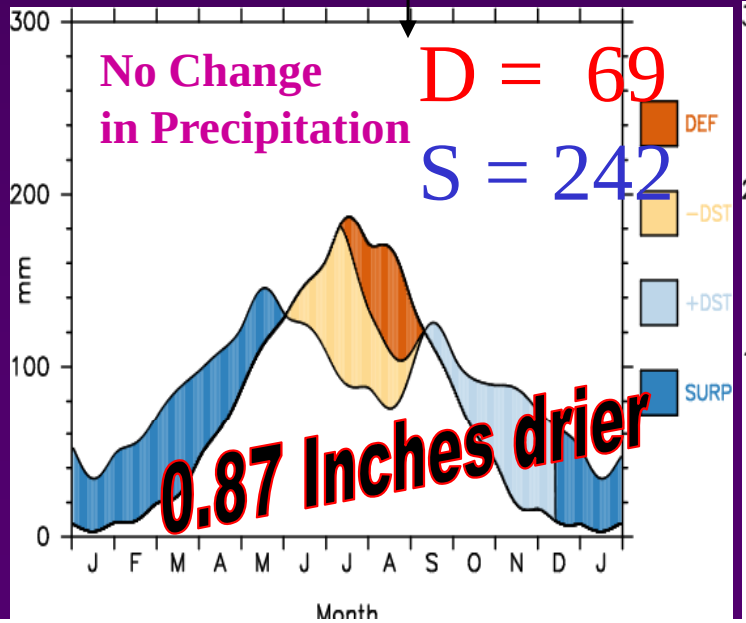
+1 C Summer

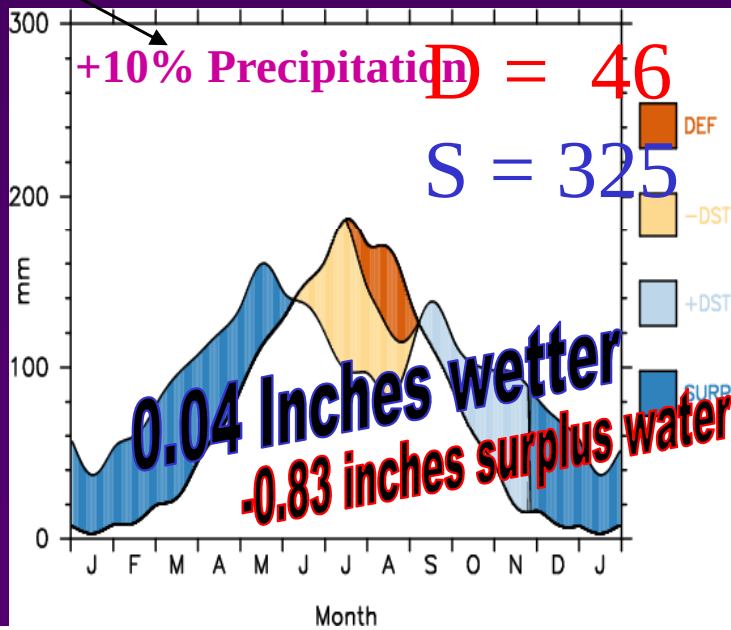
+2 C Spring and Fall

+3 C Winter









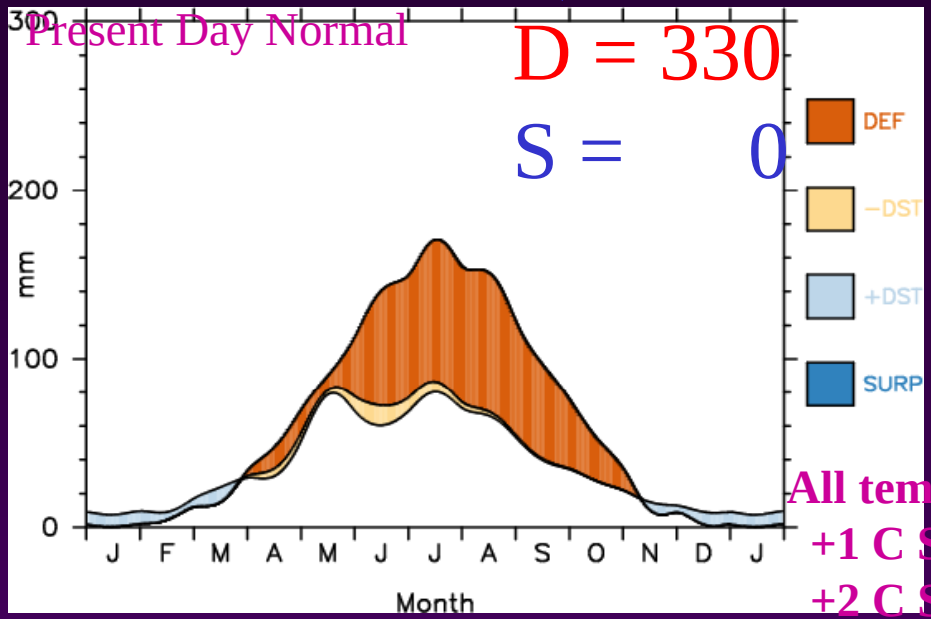
Climate projections

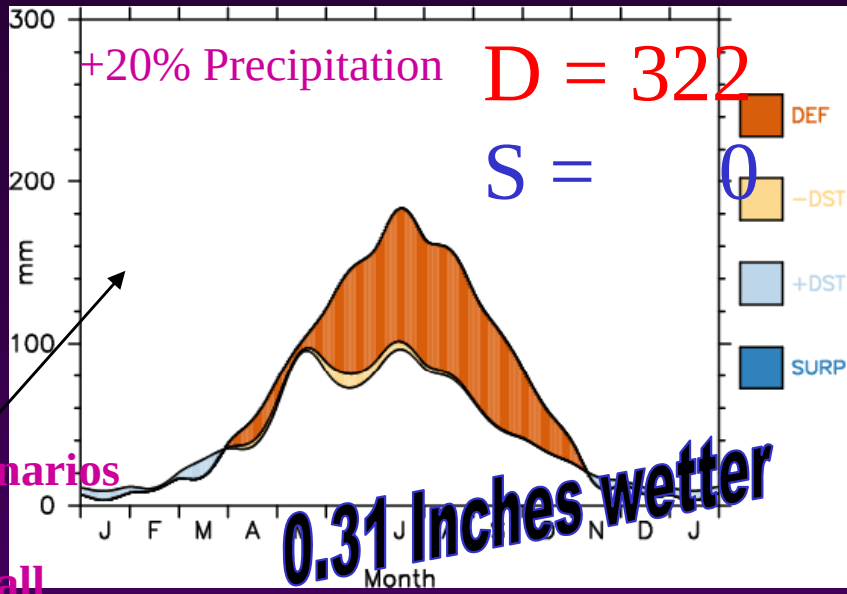
Western Kansas (37N, 102W)

Feddema,2008

D = Annual Deficit (mm)

S = Annual Surplus (mm)





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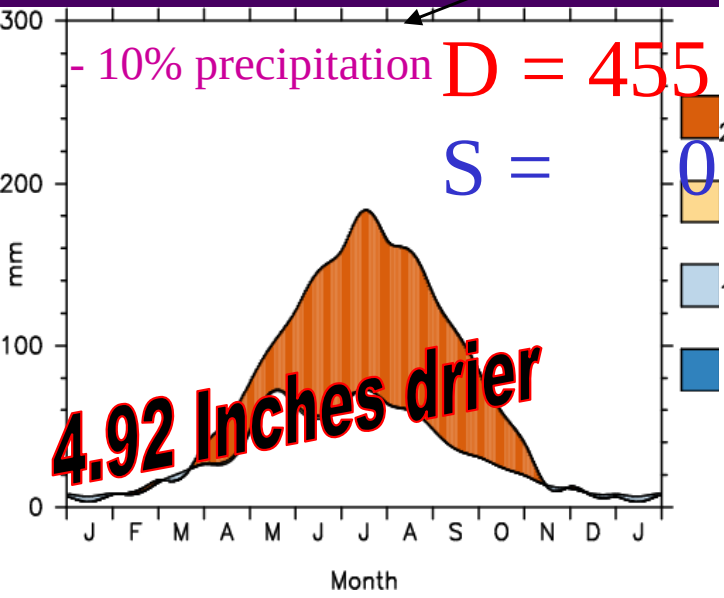
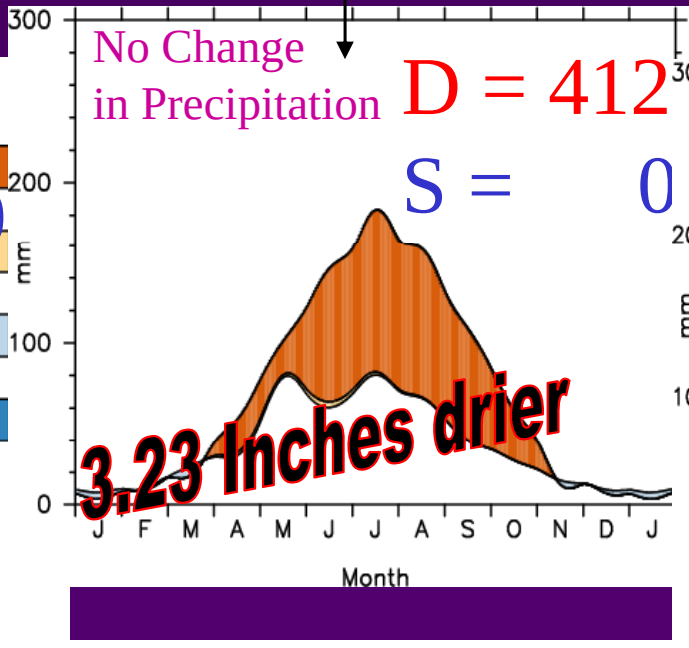
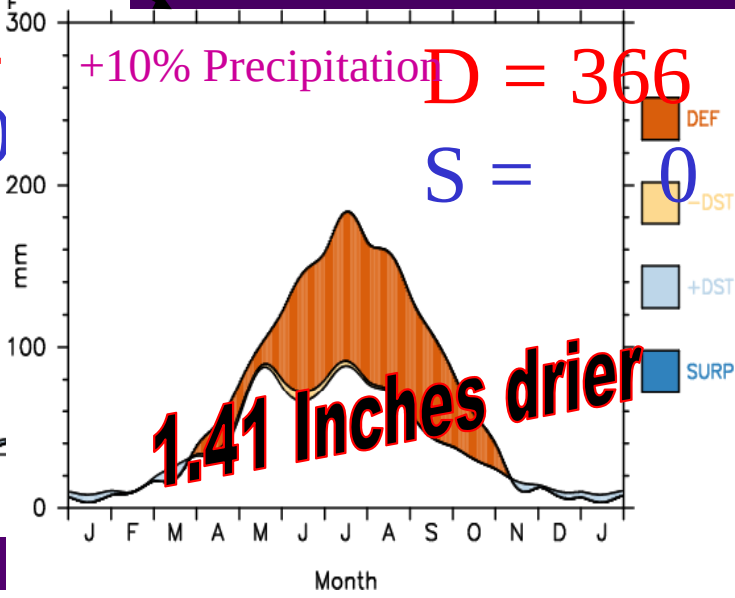






Temperature

Crop	Optimum Temp (C)		Temp Range (C)		Failure Temp (C)
	Veg	Reprod	Veg	Reprod	
Maize	34		18-32	18-22	35
Soybean	30	26	25-37	22-24	39
Wheat	26	26	20-30	15	34
Rice	36	33	33	23-26	35-36
Cotton	37	30	34	25-26	35
Tomato	22	22		22-25	30

Hatfield et al., 2008

Climate Impacts

Crop	Yield Change
Maize	-4.0%
Soybean-Midwest	+2.5%
Soybean-South	-3.5%
Wheat	-6.7%
Rice	-12.0%
Sorghum	-9.4%
Cotton	-5.7%
Peanut	-5.4%
Bean	-8.6%

Hatfield et al., 2008

Impacts on Grasslands

- Variability of precipitation will impact growth of pastures and rangeland
- Increasing CO_2 will impact forage quality and species composition in rangelands
- Interactions of grazing management, climate change, and species composition will impact the long-term use and sustainability

Hatfield et al., 2008

Projected Impacts for the Midwest

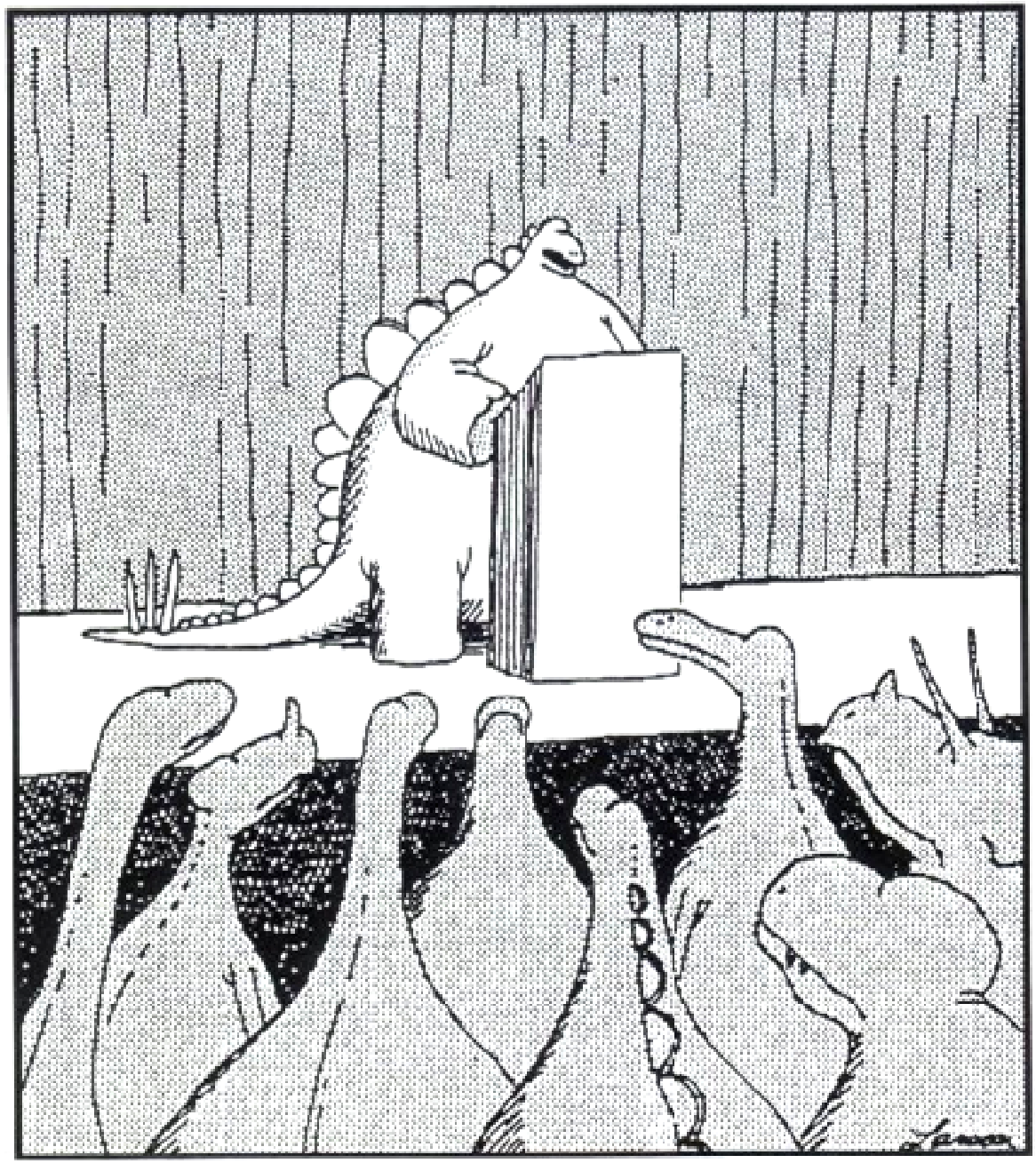
- Phenological stages are shortened (high)
- Weeds grow more rapidly under elevated atmospheric CO2 (high)
- Weeds migrate northward and are less sensitive to herbicides (high)
- Plants have increased water used efficiency (high)

*Estimated from IPCC and CCSP reports

North America: Key messages

- A wide range of impacts of climate change are now clearly documented
- Risks from future impacts concentrated on extreme events
- Vulnerable people and activities (including ag) in almost every region
  - Increase number, intensity, and duration of heat waves
  - Changes in precipitation patterns
- Water resources will constrain potential crop yield increases and increase competition for water resources
- Warmer nights and winters may increase
  - Pest and disease in agriculture
  - Invasive weeds

IPCC Fourth Assessment Report, 2007



"The picture's pretty bleak, gentlemen. . . . The world's climates are changing, the mammals are taking over, and we all have a brain about the size of a walnut."

The Far Side®

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