An Introduction to Global Climate Change

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Overview

- Global Climate Change: Trends & Projections
- North America: Trends & Projections
- Parting Thoughts

"Long term, I'm worried about global warming— short term, about freezing my ass off."

"I'm starting to get concerned about global warming."

What is Climate

Climate is the aggregated <u>pattern</u> of weather, meaning averages, extremes, timing, spatial distribution of…

- hot & cold
- cloudy & clear
- humid & dry
- drizzles & downpours
- snowfall, snowpack, & snowmelt
- blizzards, tornadoes, & typhoons

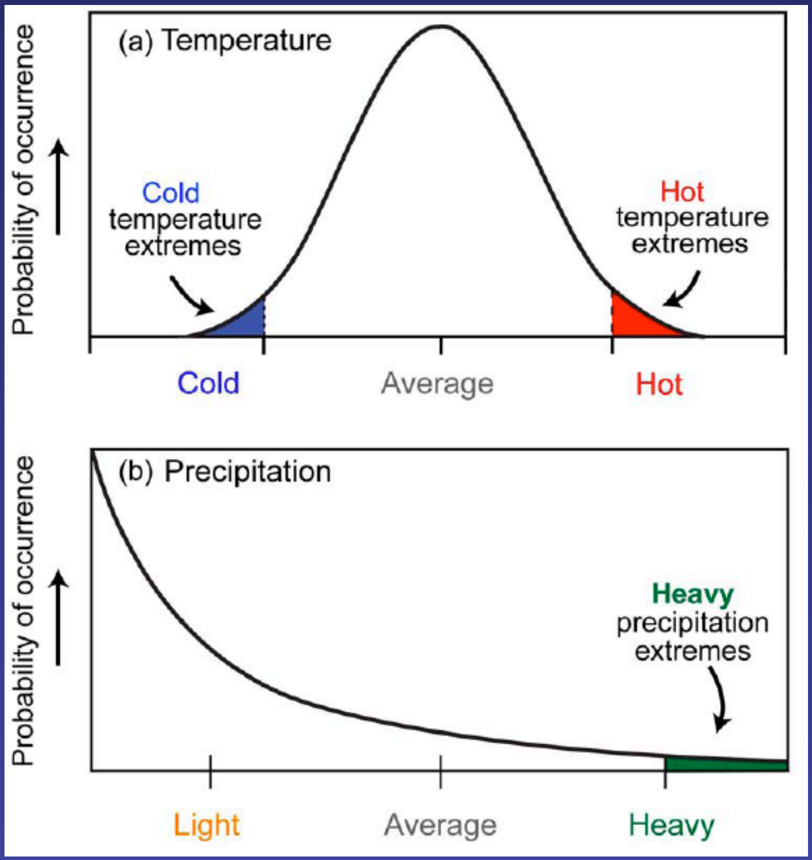
Climate change means <u>altered patterns</u>.

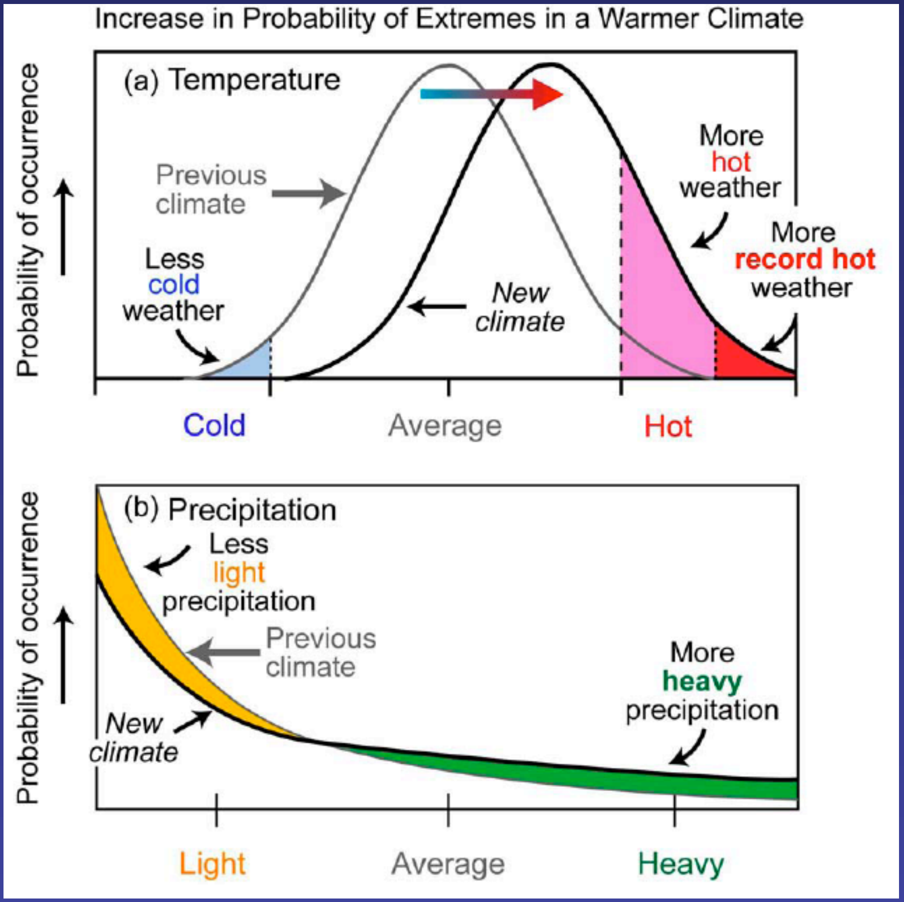
Global average temperature is just one measure of the state of the global climate as expressed in these patterns.

Small temperature changes → big changes in the patterns

(after Holdren NCES, 2008)

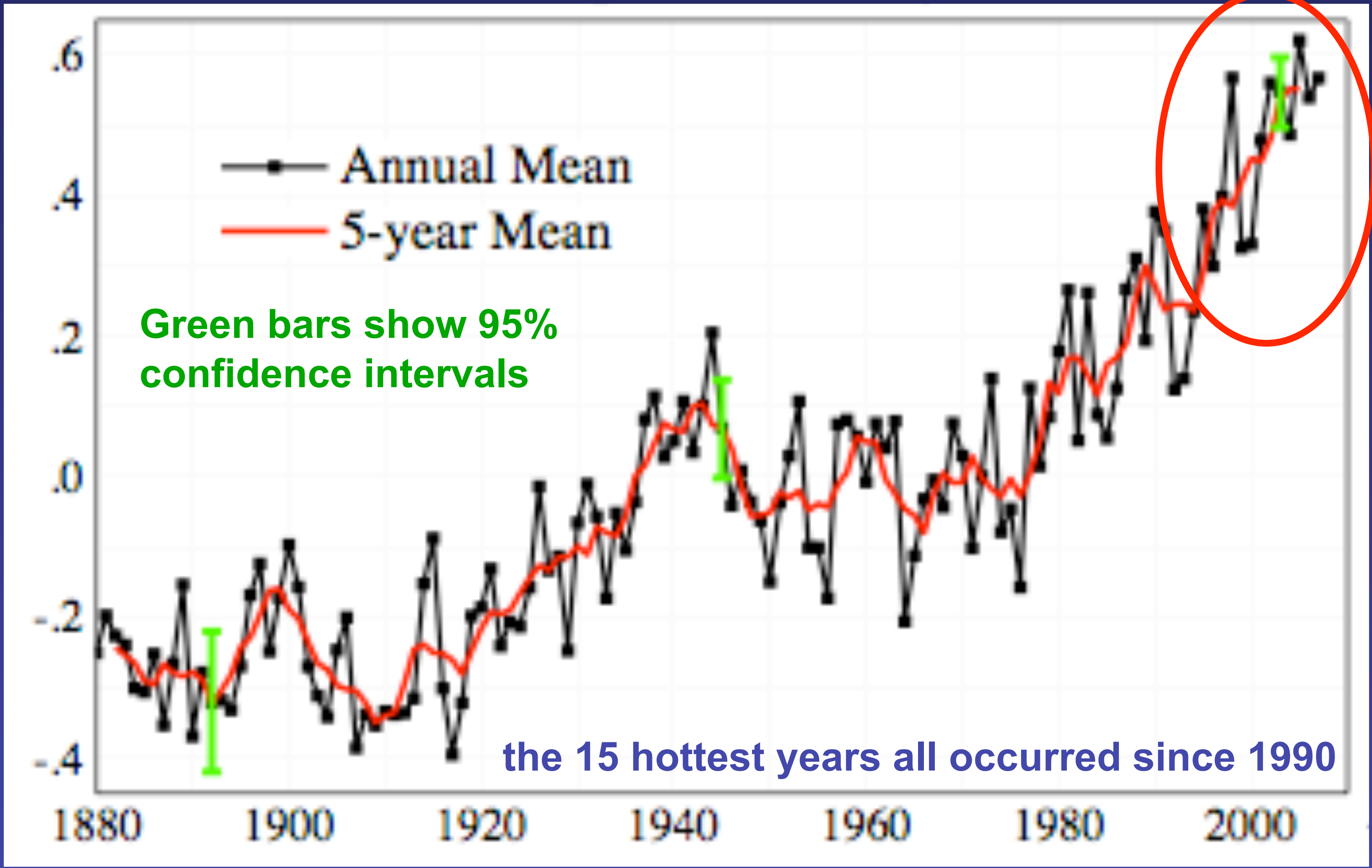
What is an extreme event





(CCSP SAP 3.3)

Global Temperatures are increasing



Green bars show 95% confidence intervals

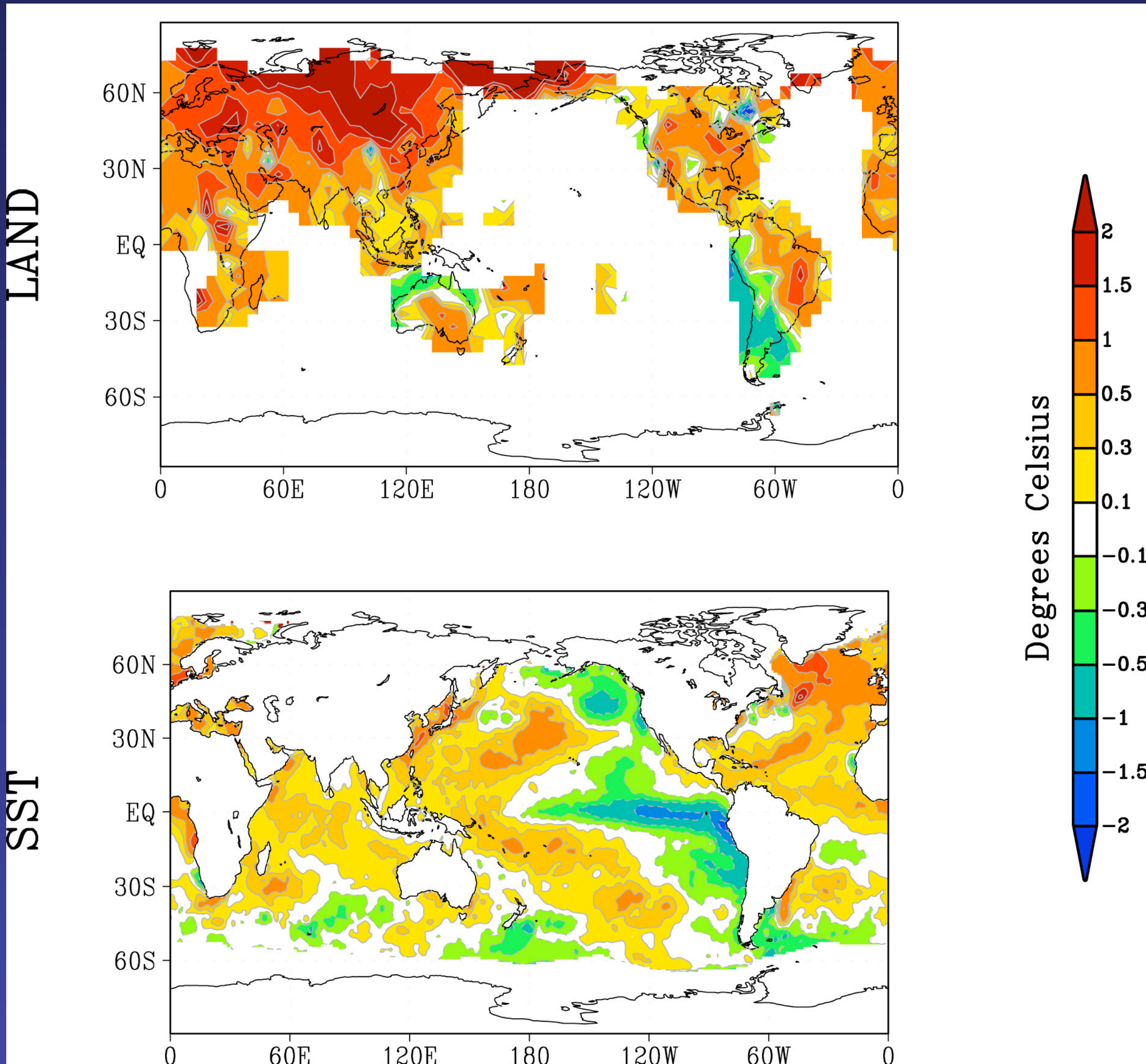
the 15 hottest years all occurred since 1990

http://data.giss.nasa.gov/gistemp/graphs/

2007 Surface Temperature

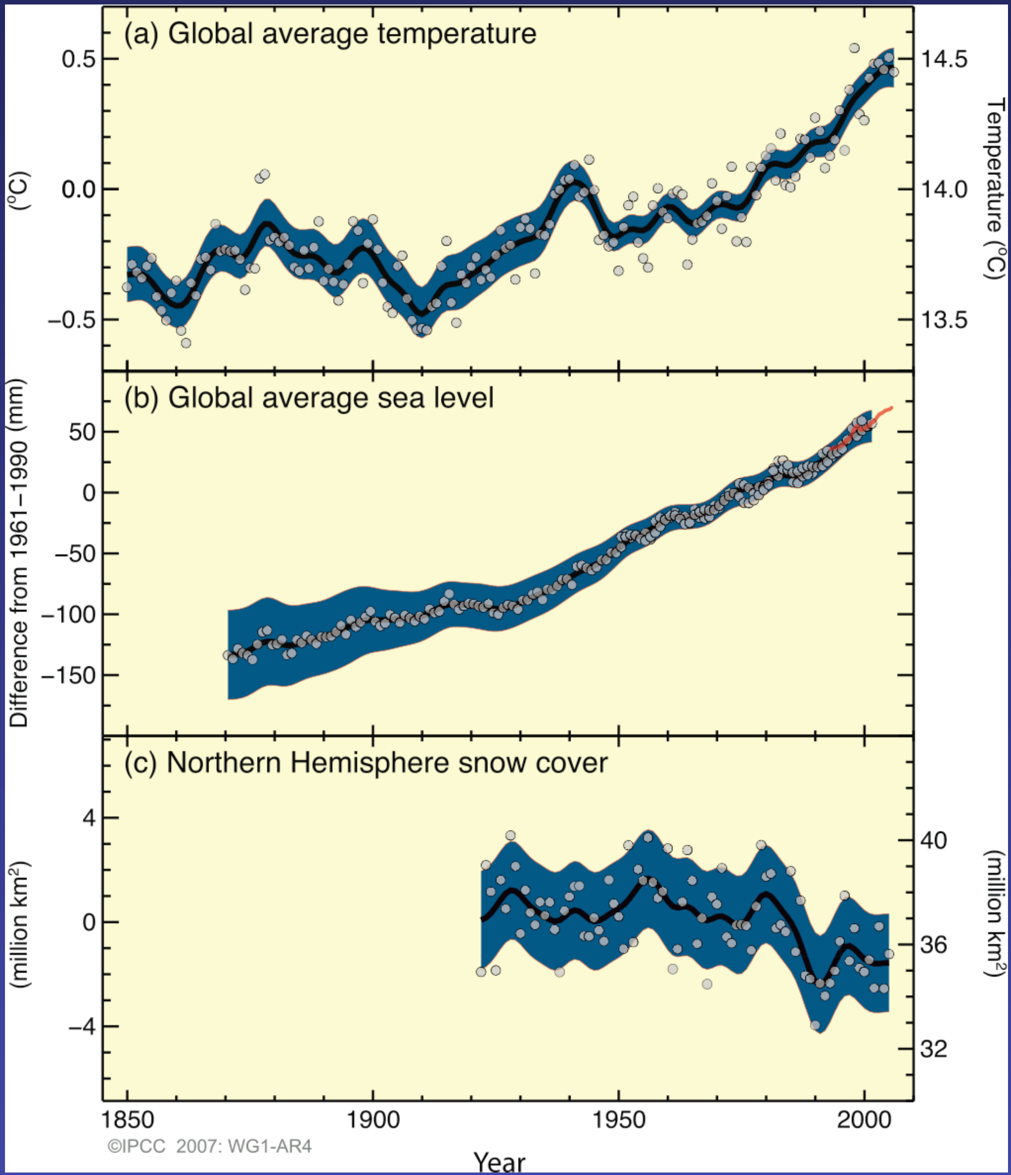
Warmest

9th Warmest

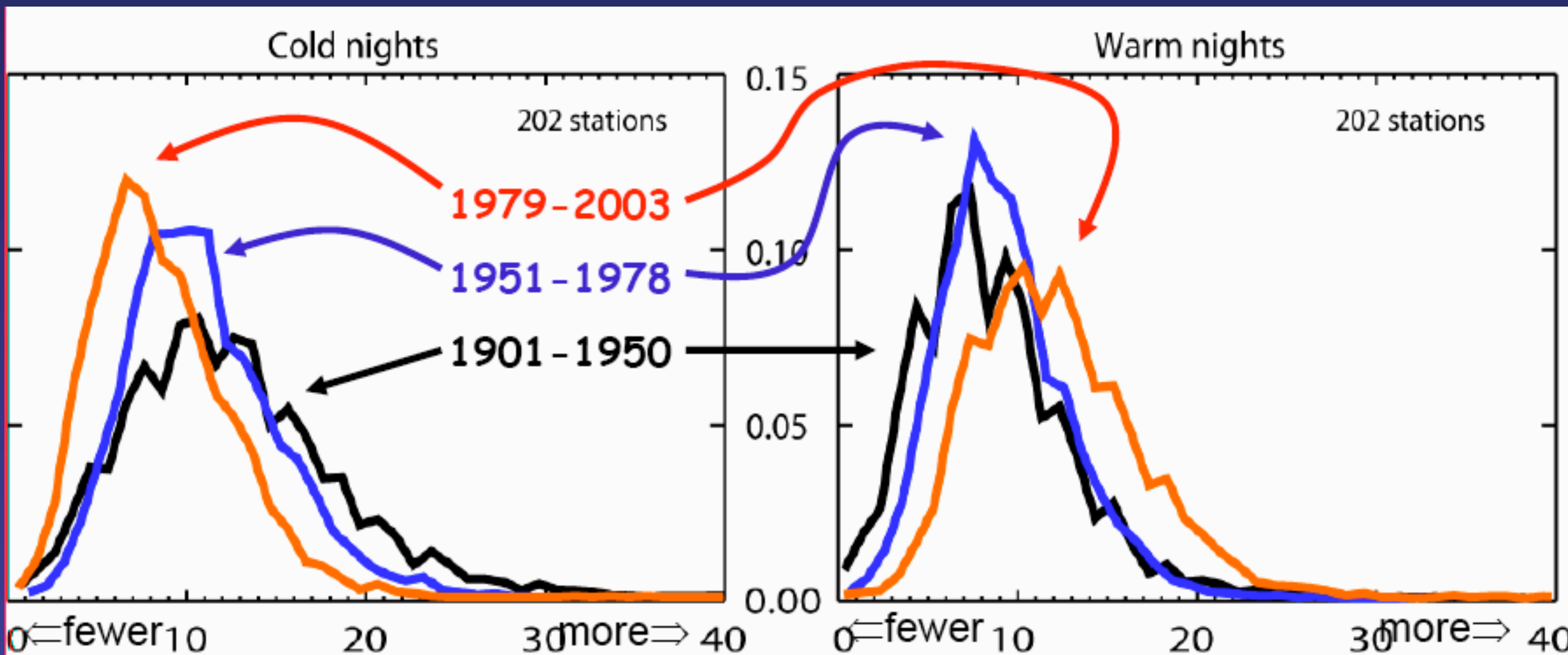


Historic record of global climate change

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level.

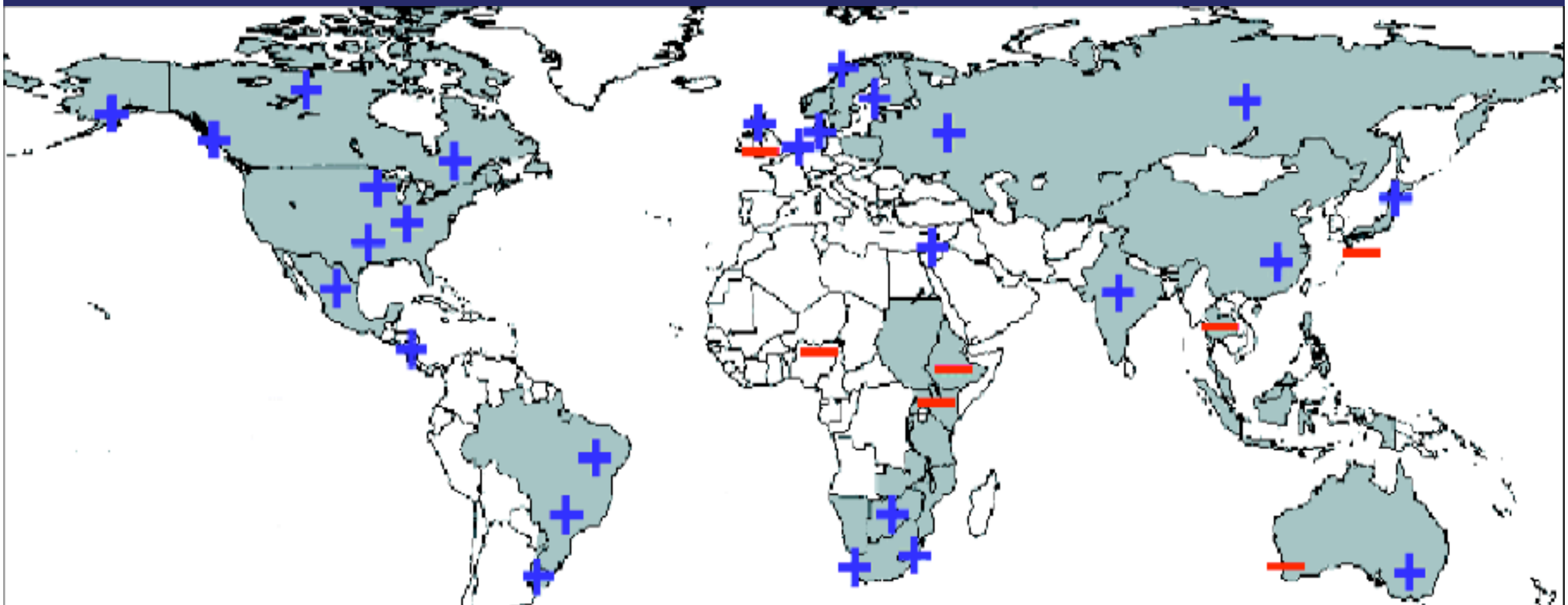


Warm nights increasing Cold nights decreasing



Frequency of occurrence of cold or warm temperatures for 202 global stations for 3 time periods:1901 to 1950 (black), 1951 to 1978 (blue) and 1979 to 2003 (red).

Proportion of extreme precipitation events increasing in most areas

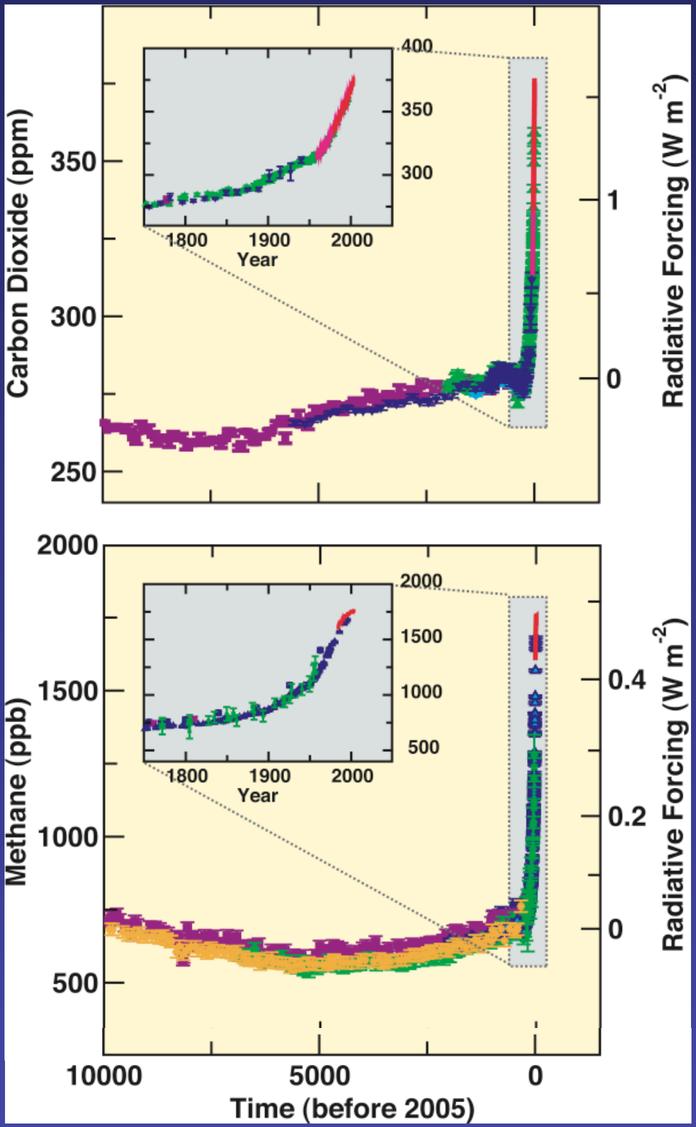


The frequency of heavy precipitation events has increased over most land areas - consistent with warming and increases of atmospheric water vapor while more intense and longer droughts have been observed since the 1970s, particularly in the tropics and subtropics.

Greenhouse gas concentrations

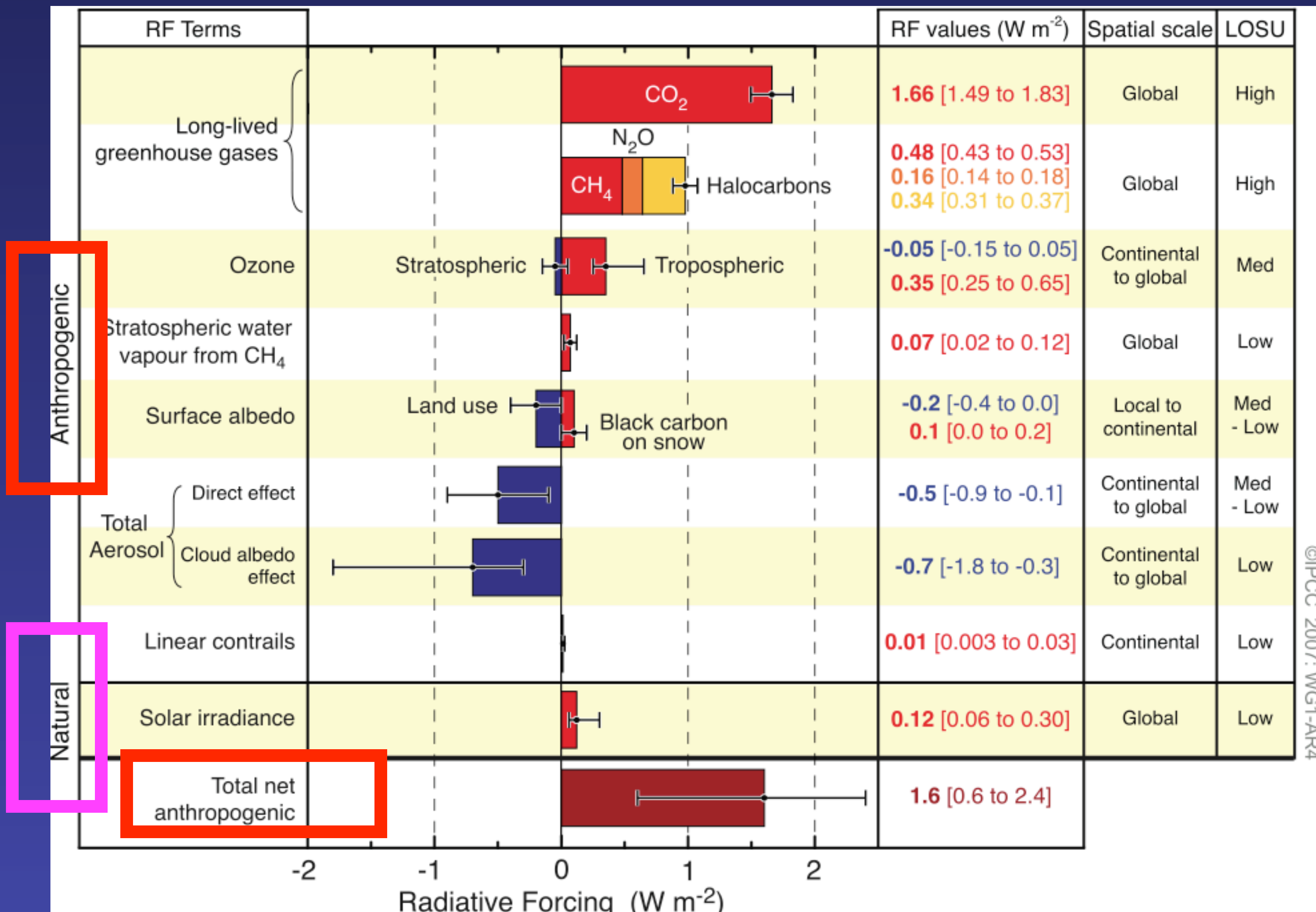
Compared to natural changes over the past 10,000 years, the spike in concentrations of CO_2 & CH_4 in the past 250 years is extraordinary.

Humans are responsible for the recent dramatic increase emissions. Fossil CO_2 & CH_4 lack carbon-14, and the observed drop in atmospheric C-14 is measurable.



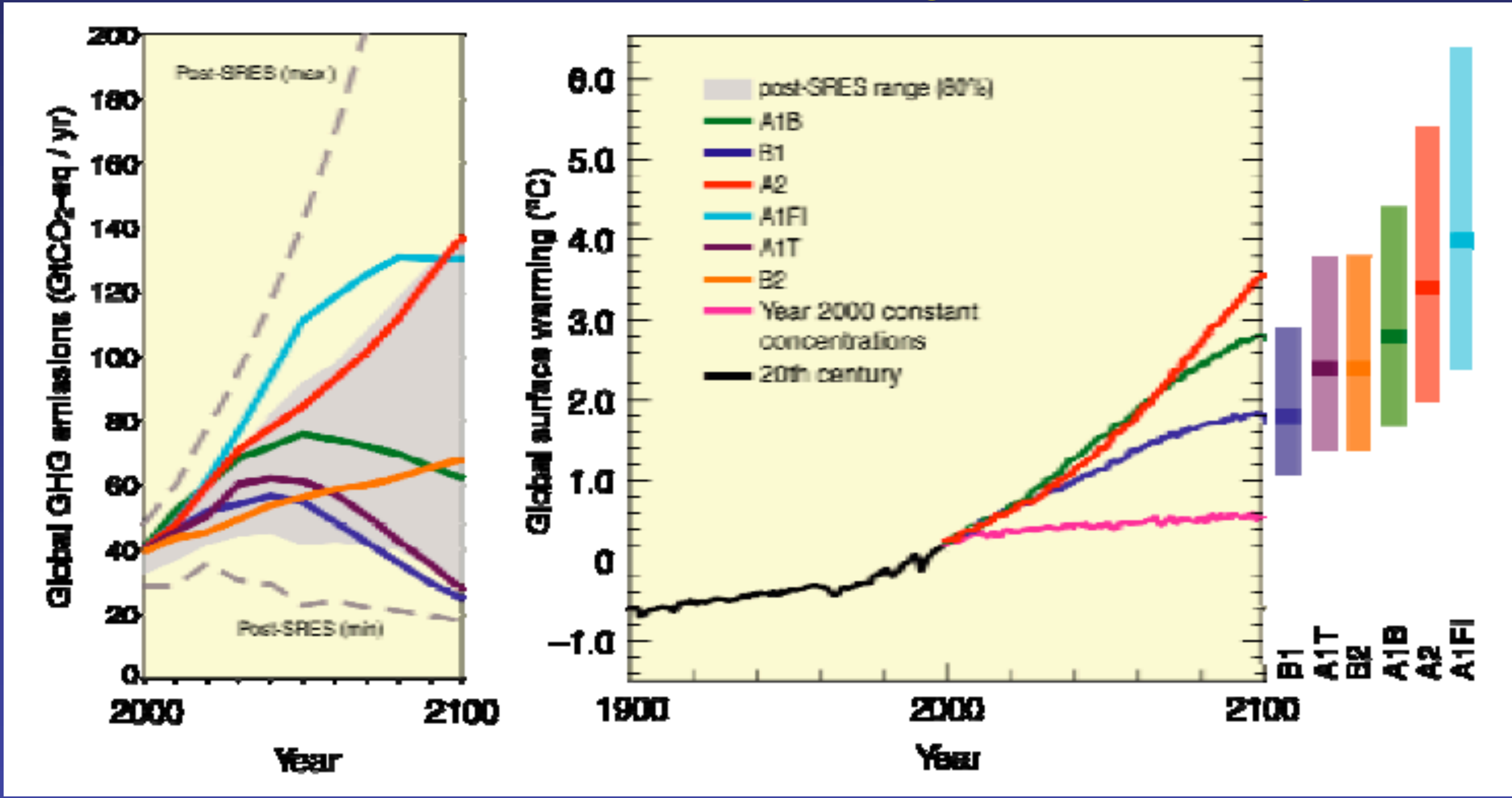
(IPCC AR4 WG1, 2007)

Best estimate of global radiative forcing



Ranges of projected surface warming

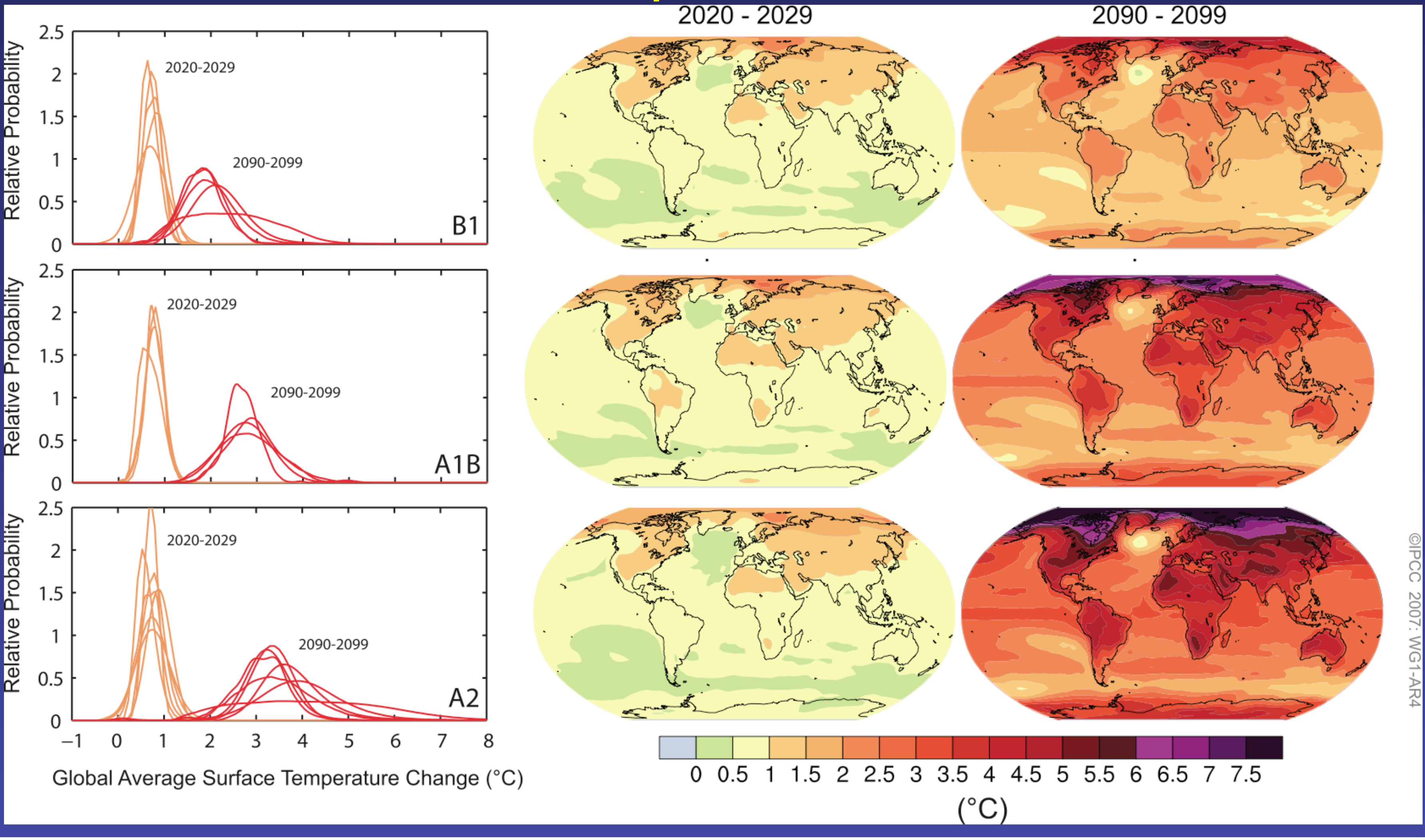
multi-model averages for different emission scenarios and assessed ranges of warming



(IPCC AR4, 2007)

Projected surface temperature changes for the early and late 21st century

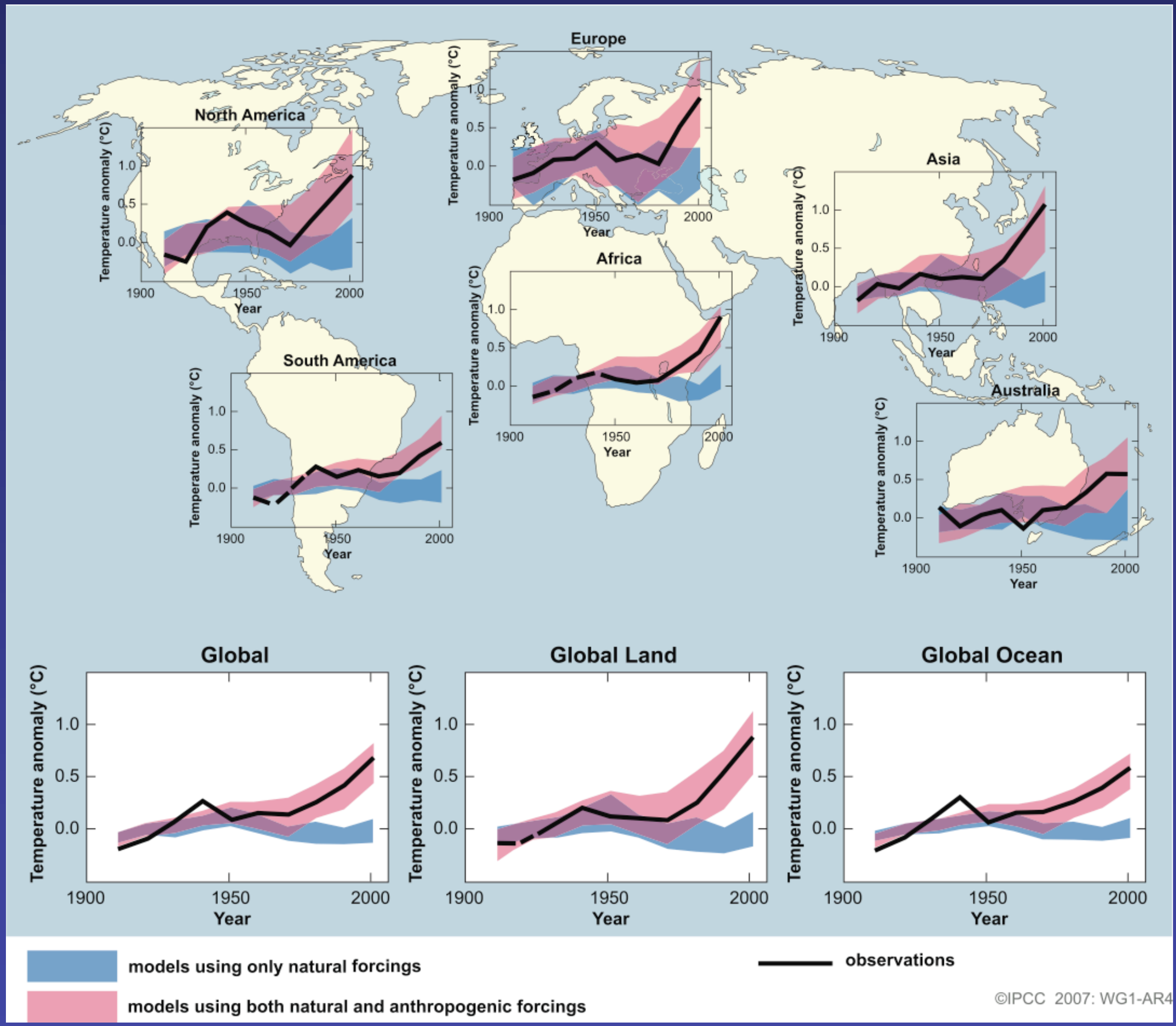
relative to the period 1980–1999



Continents Warm 50% more than oceans

Observed & simulated continental & global scale changes in surface temperature

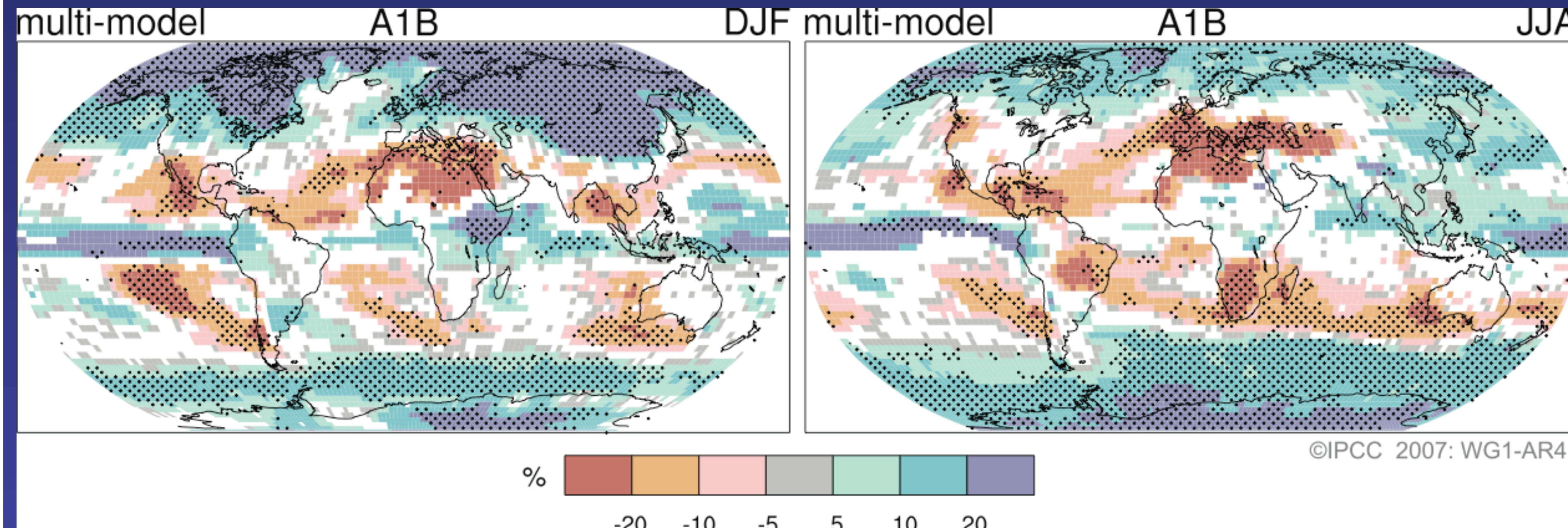
observed change (black line); climate models simulations using natural (blue) and anthropogenic (red) forcings



Projected percent changes in precipitation for the period 2090–2099

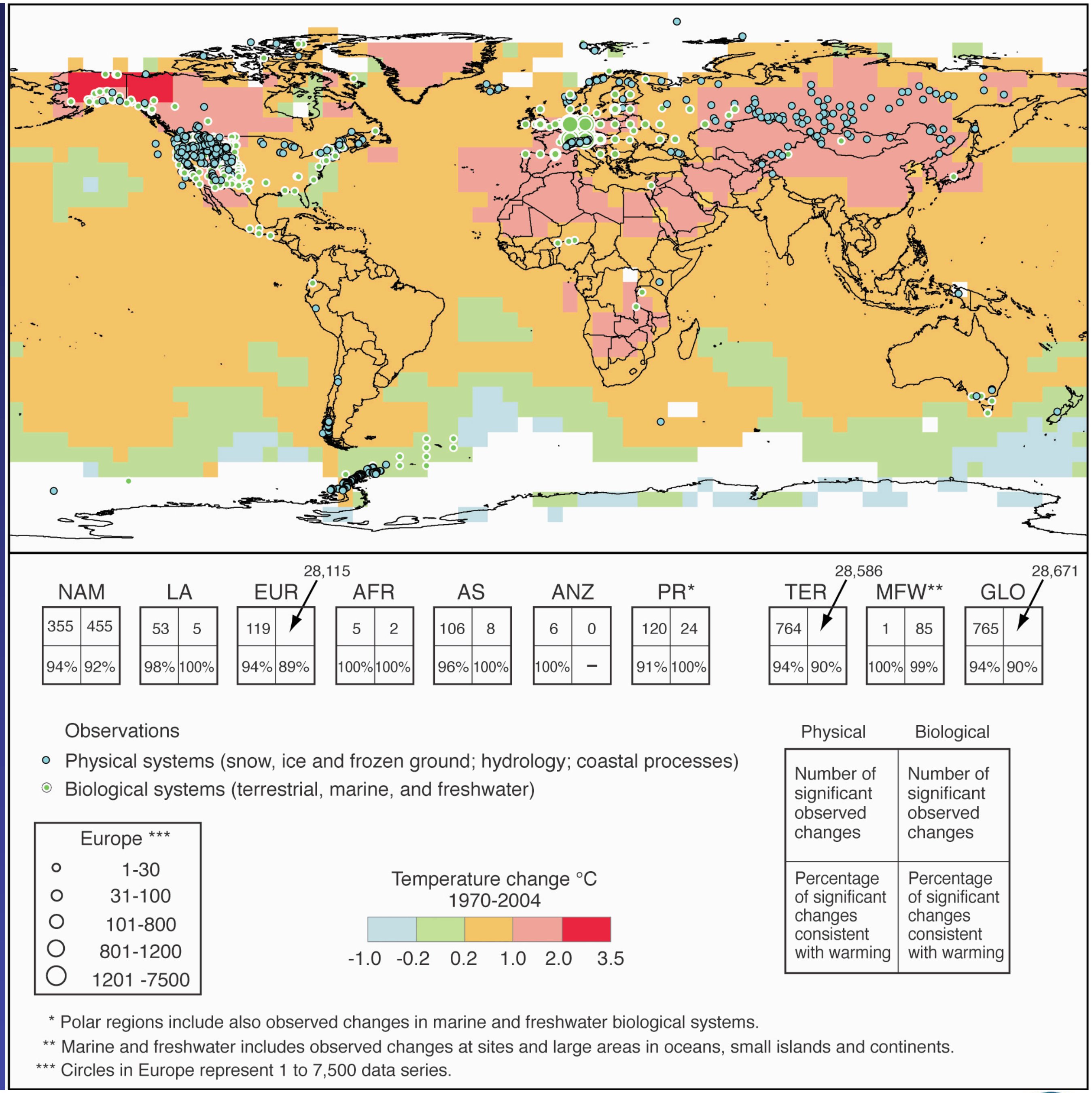
(relative to 1980–1999)

NH Winter **NH Summer**



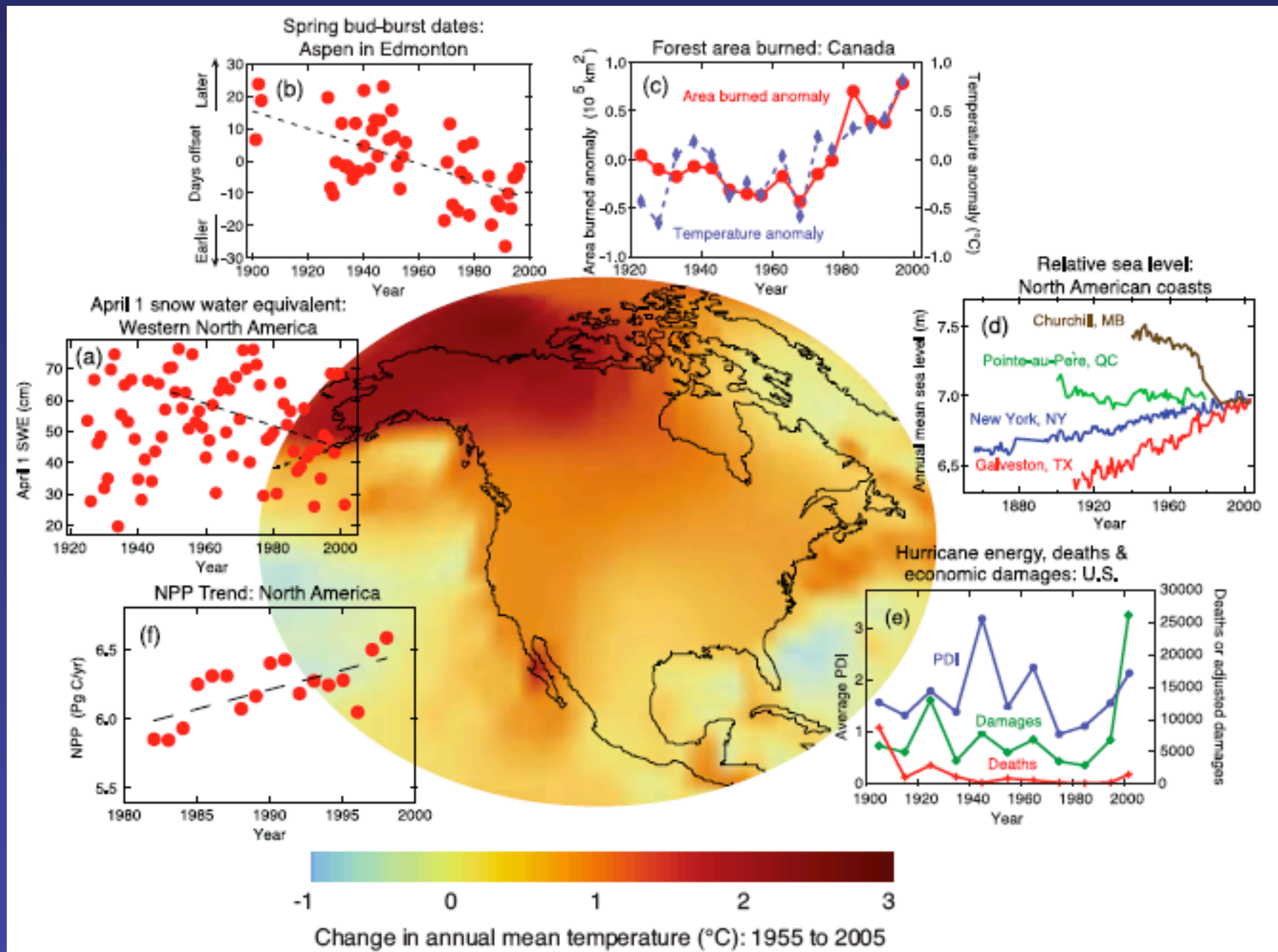
Warmer climate → More Water Vapor in the atmosphere but an expanded belt of subtropical aridity

Changes in the physical and biological systems and surface temperature 1970-2004



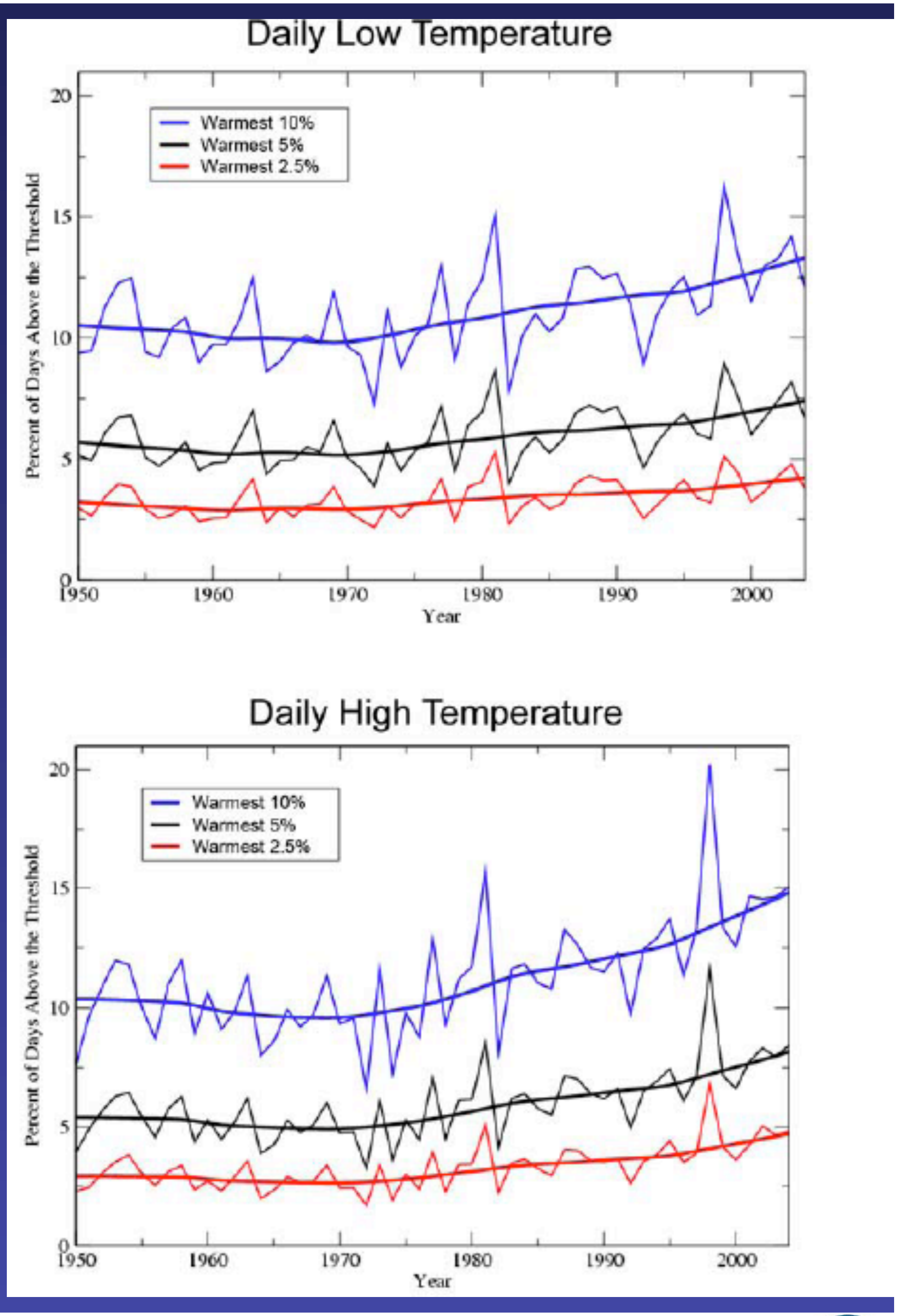
(IPCC WG2, 2007)

Observed trends in some biophysical and socio-economic indicators in North America



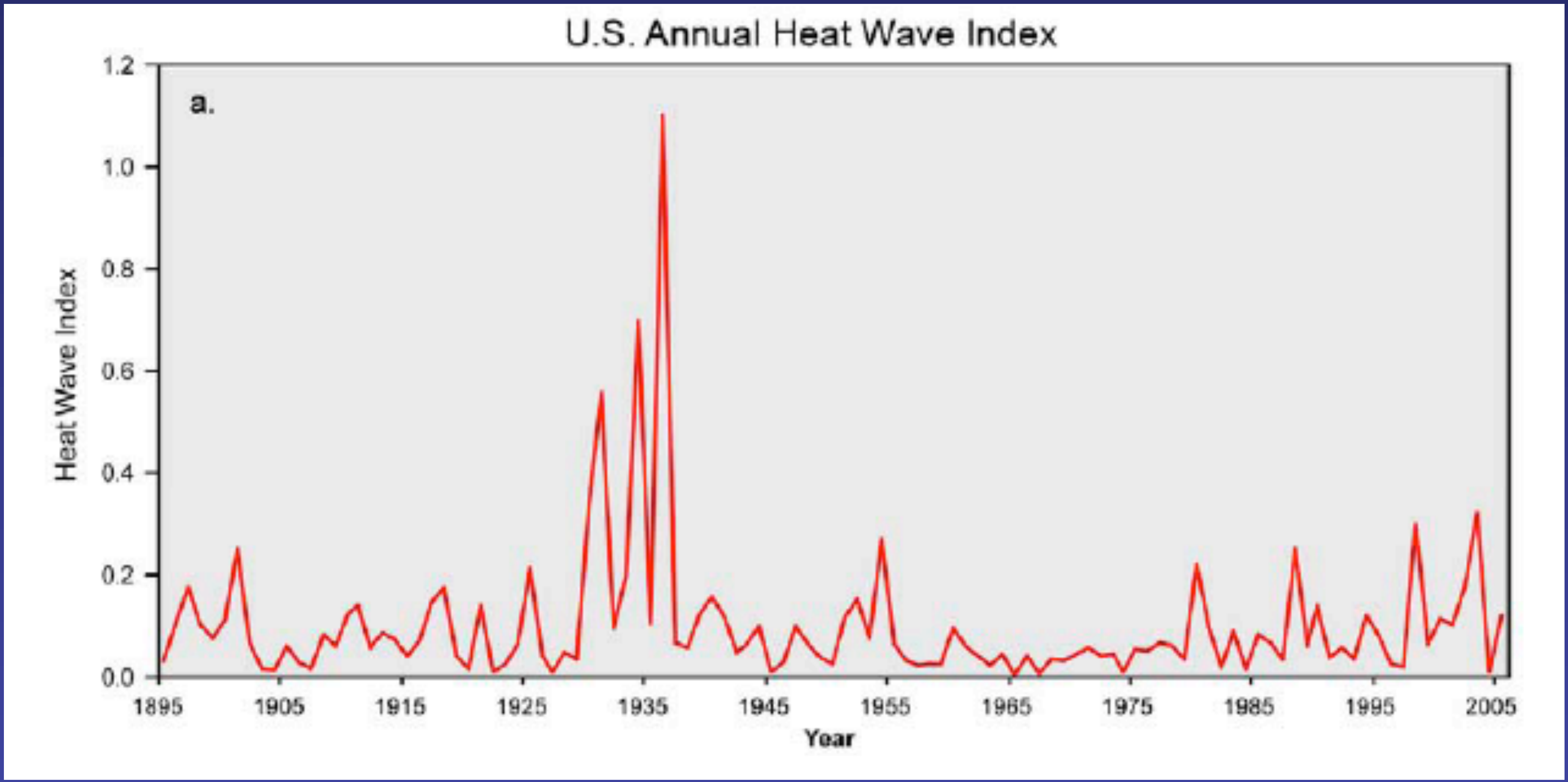
(IPCC WG1, 2007)

Changes in the percent of days in a year above three thresholds for North America for daily high (top) and low (bottom) temperature

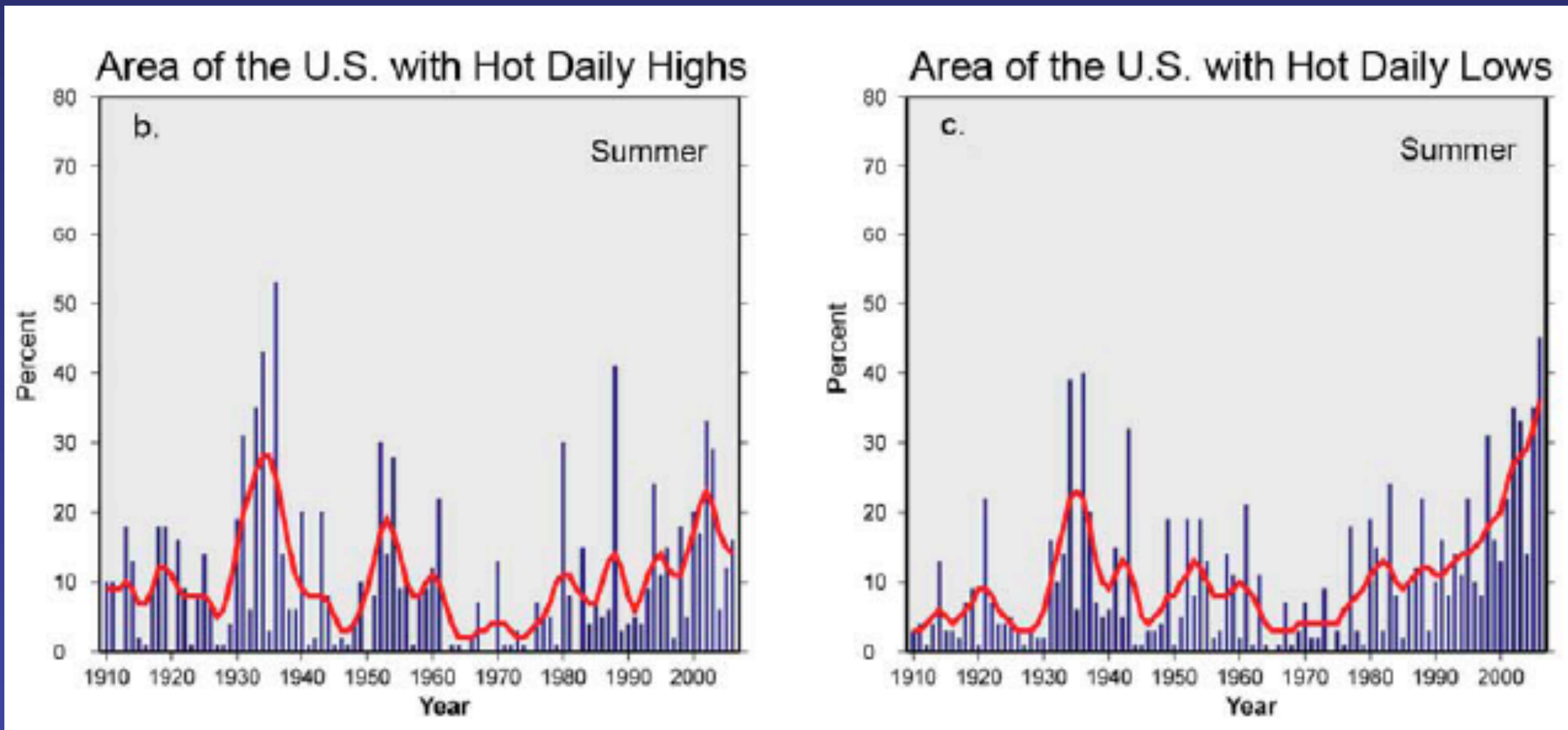


U.S. national average "heat wave" index

defined as warm spells of 4 days in duration with mean temperature exceeding the threshold for a 1 in 10 year event

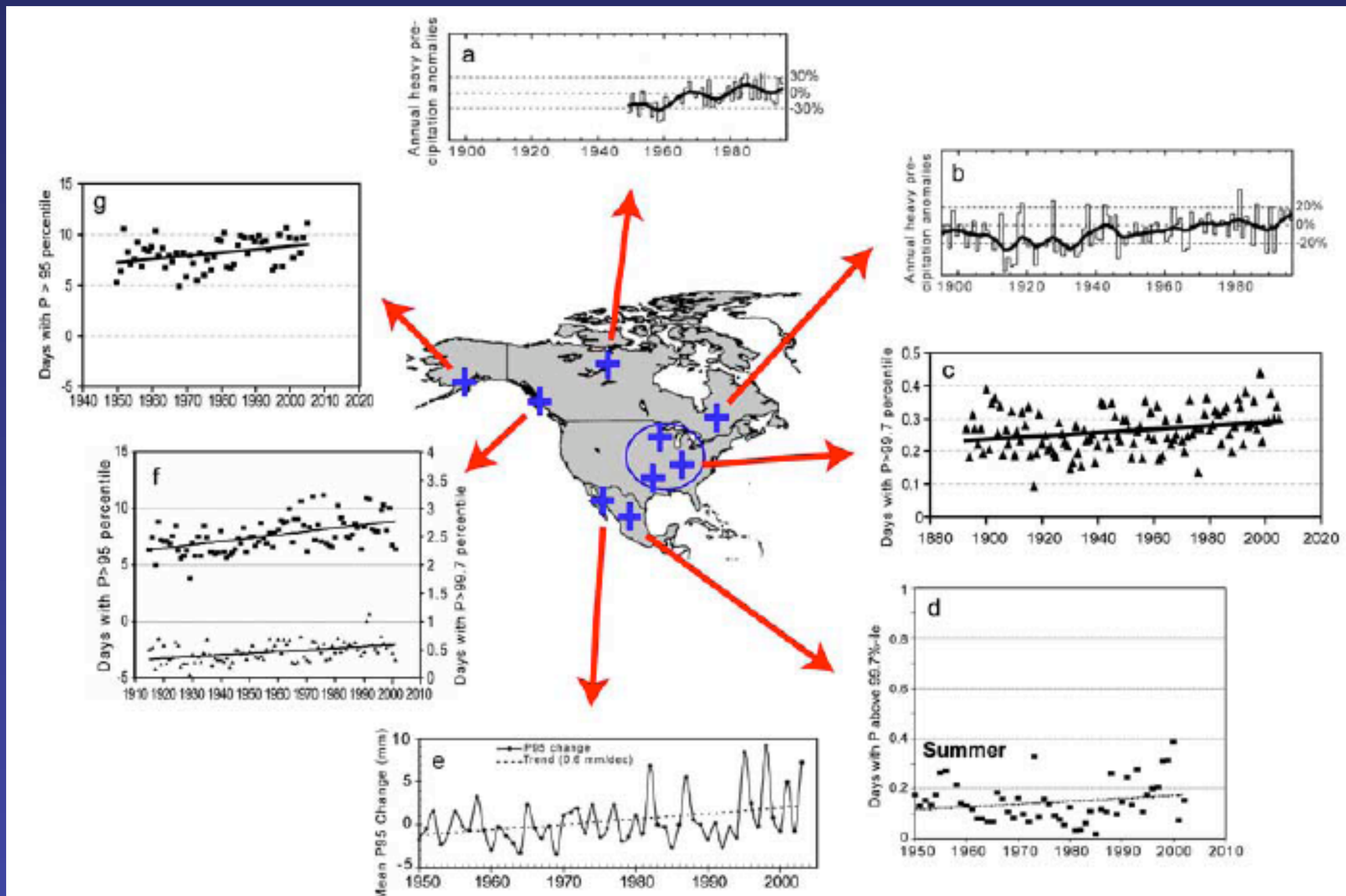


Area of the U.S. with much above normal daily high and low summer temperatures

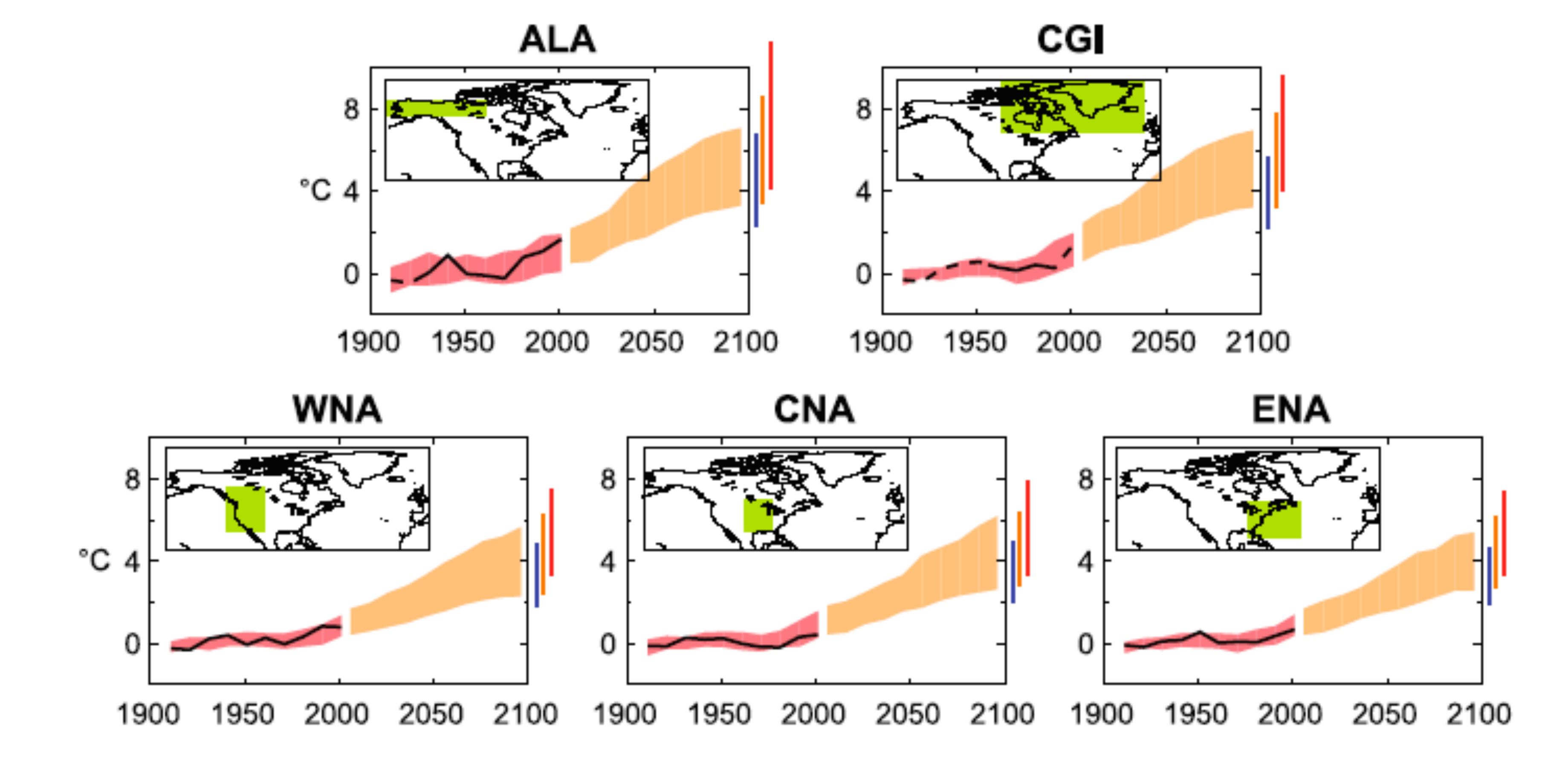


CCSP SAP 3.3

Regions in where heavy and very heavy precipitation has increased

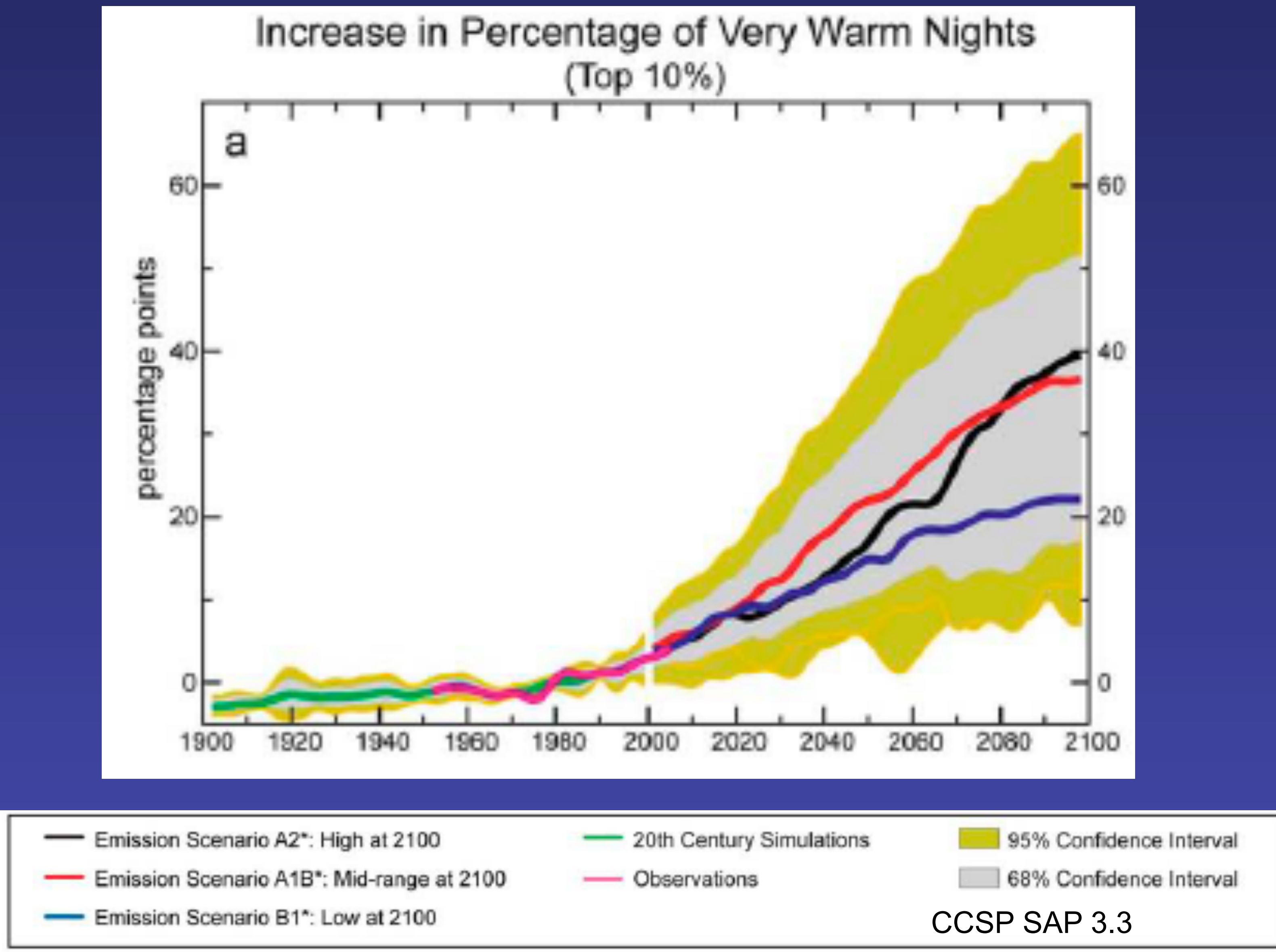


Observed & simulated changes in regional surface temperature



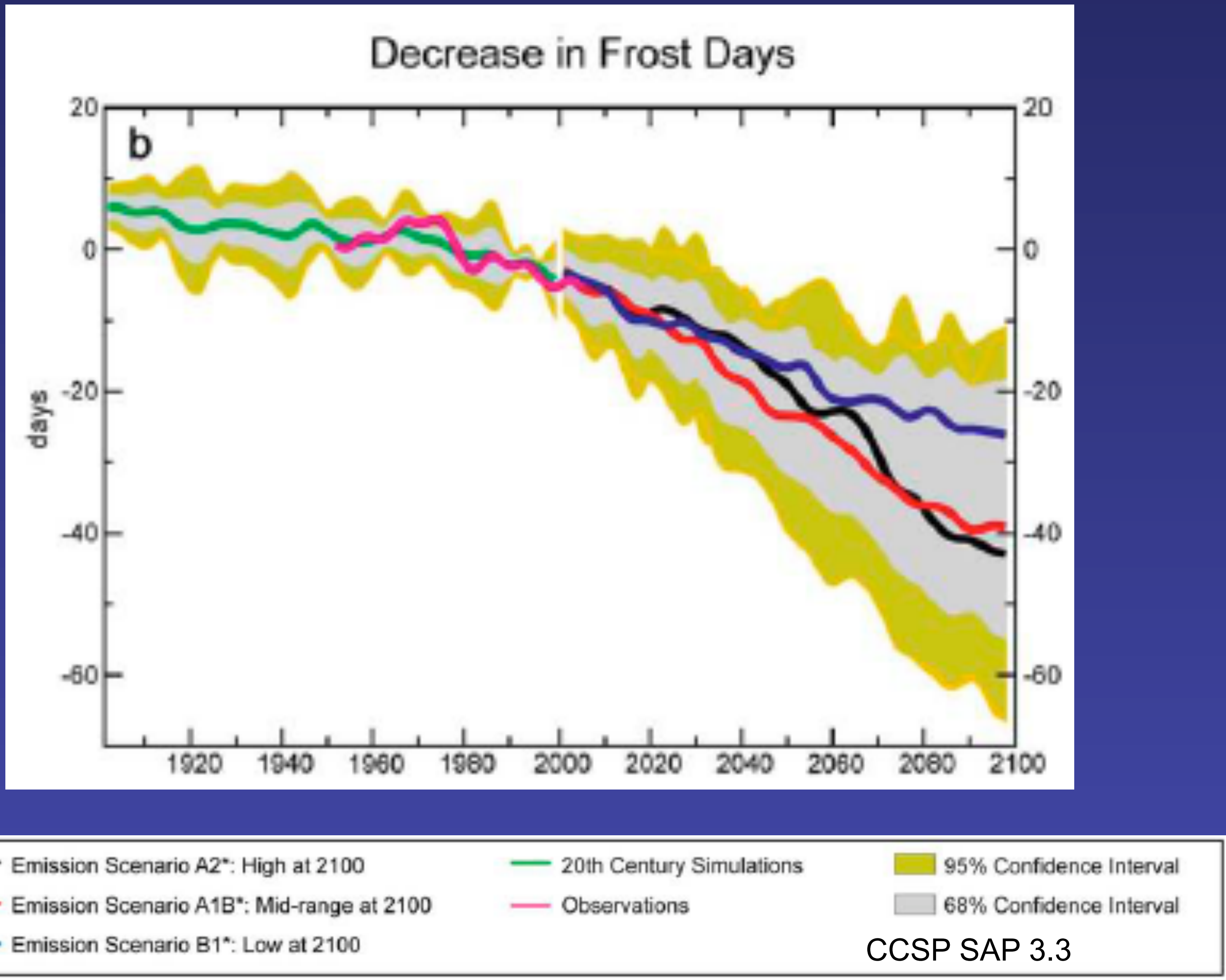
IPCC WG1, 2007

Days in a year averaged over North America when daily low temperature is in the top 10% of warm nights for 1961-90



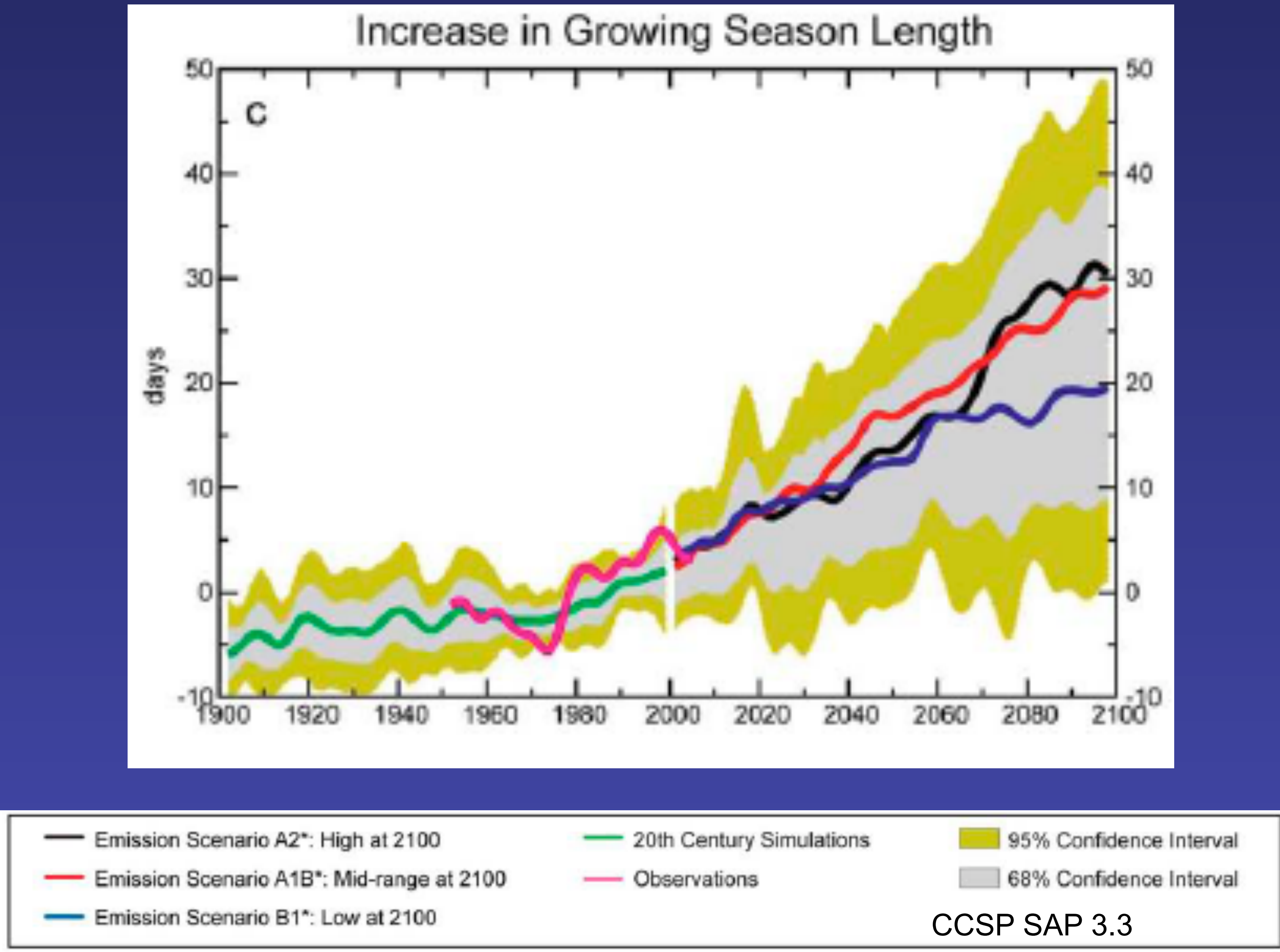
CCSP SAP 3.3

Number of frost days per year averaged over North America

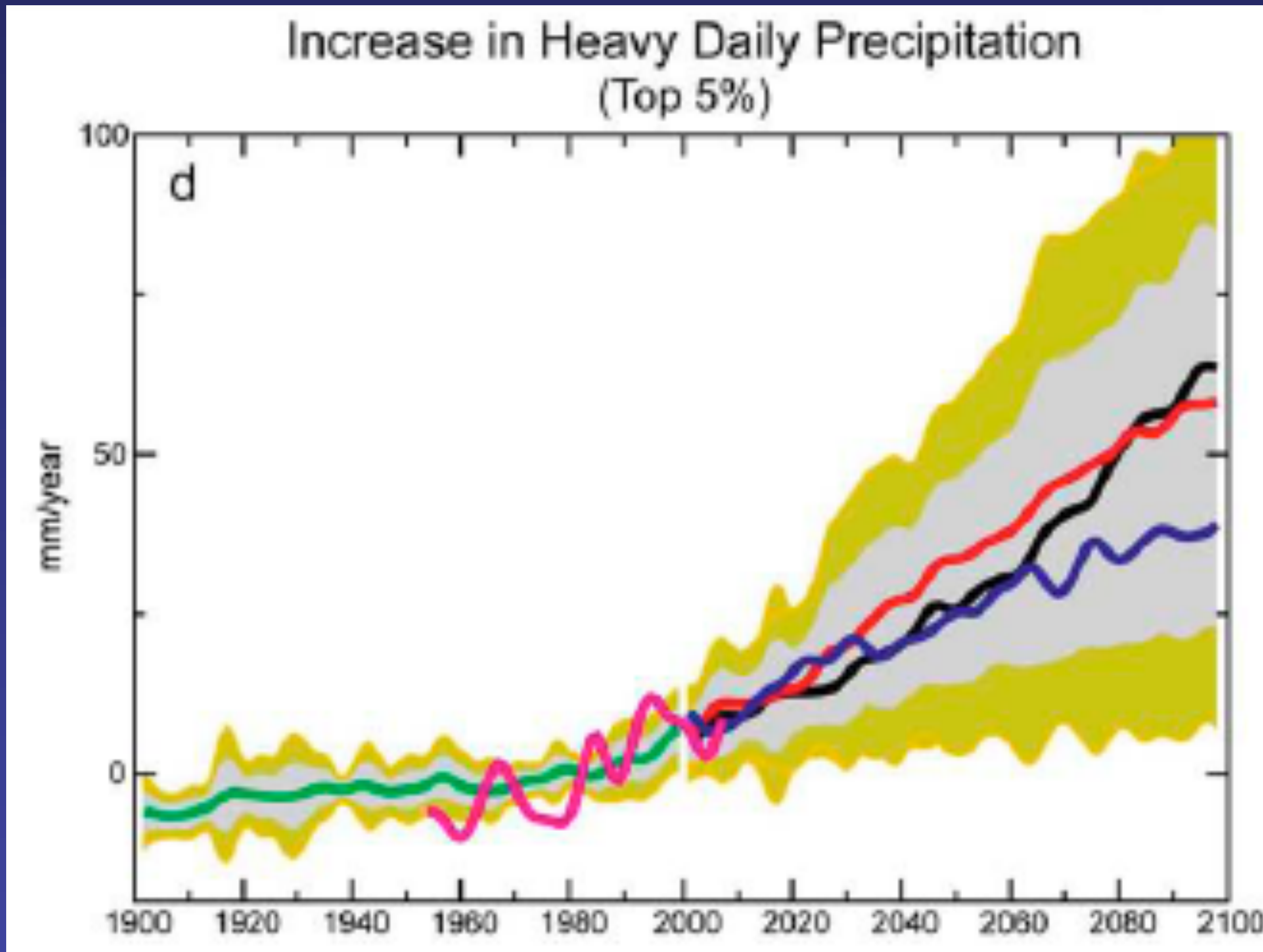


CCSP SAP 3.3

Growing season length averaged over North America



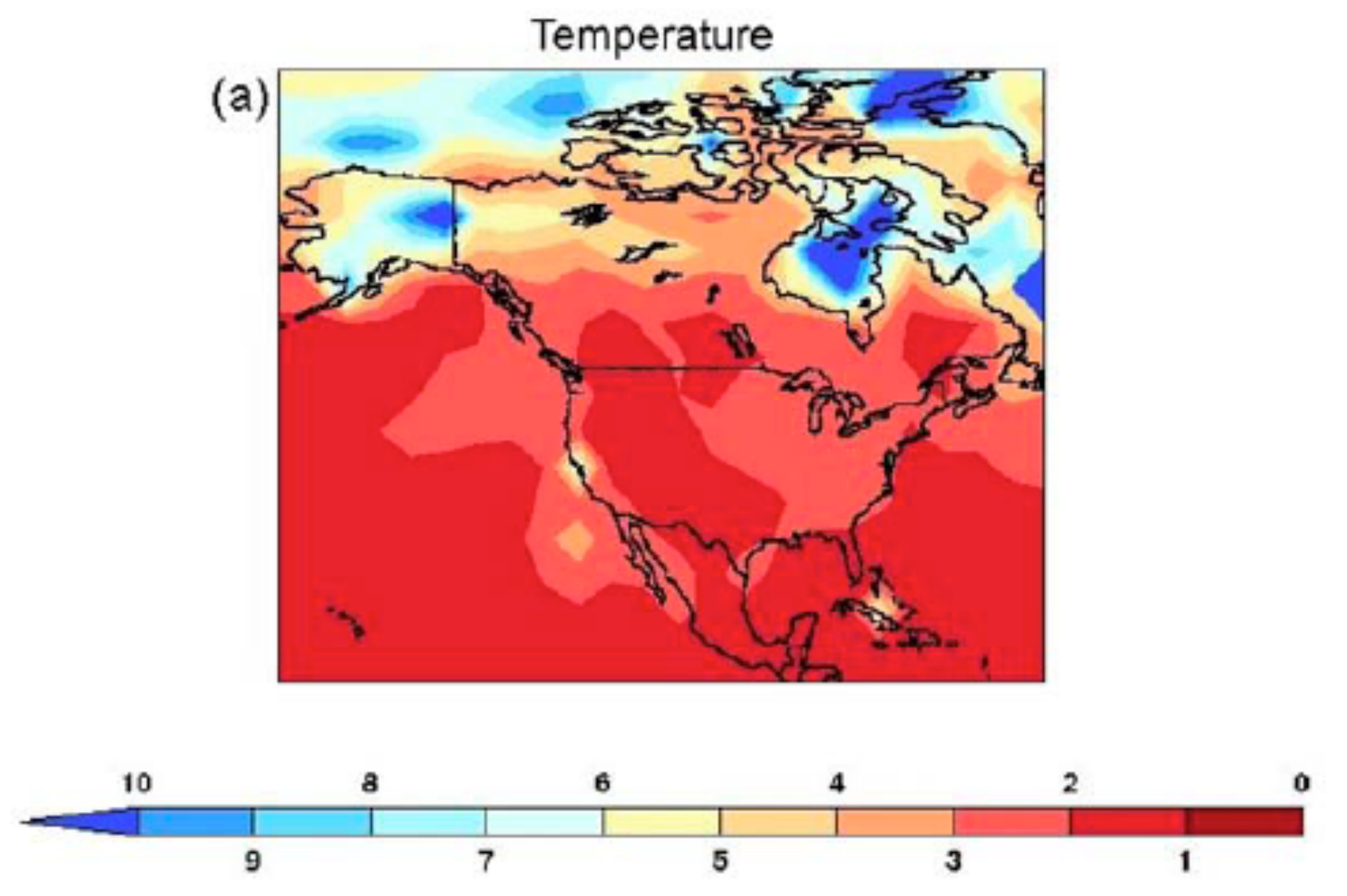
Rainfall on days in the top 5% of heavy precipitation days for the period 1961-1990 averaged over North America



Emission Scenario A2*: High at 2100
Emission Scenario A1B*: Mid-range at 2100
Emission Scenario B1*: Low at 2100
20th Century Simulations
Observations
95% Confidence Interval
68% Confidence Interval

CCSP SAP 3.3

Projected increase in occurrence of extremely rare hot days (a 1 in-20 year event)



(from Wehner 2005)

Possible impacts of climate change due to projected changes in extreme weather and climate events (IPCC, 2007)

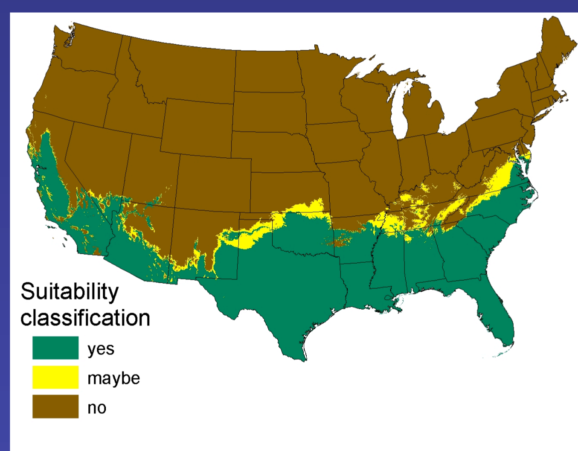
Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems {WGII 4.4, 5.4}	Water resources {WGII 3.4}	Human health {WGII 8.2, 8.4}	Industry, settlement and society {WGII 7.4}
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increased over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding: pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water-and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food- borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	*Likely*[d]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Emerging Challenges

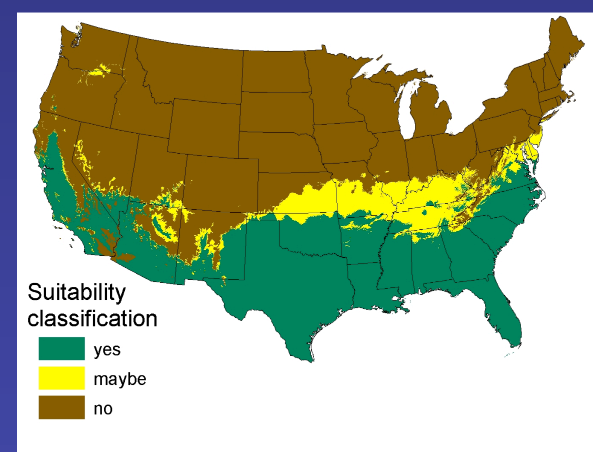
Pythons could squeeze lower third of USA

USA TODAY

Feb 21, 2008 By Elizabeth Weise**,** As climate change warms the nation, giant Burmese pythons could colonize one-third of the USA, from San Francisco across the Southwest, Texas and the South and up north along the Virginia coast, according to U.S. Geological Survey maps released Wednesday.The pythons can be 20 feet long and 250 pounds. They are highly adaptable to new environments.



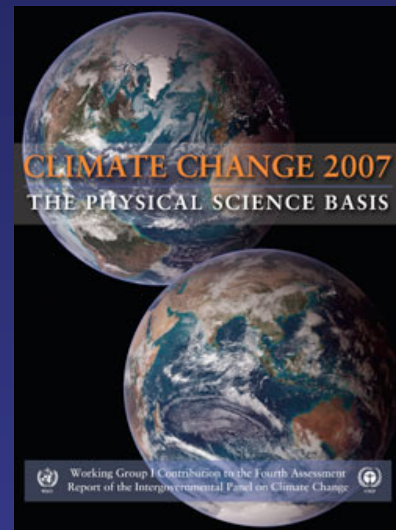
Current Range

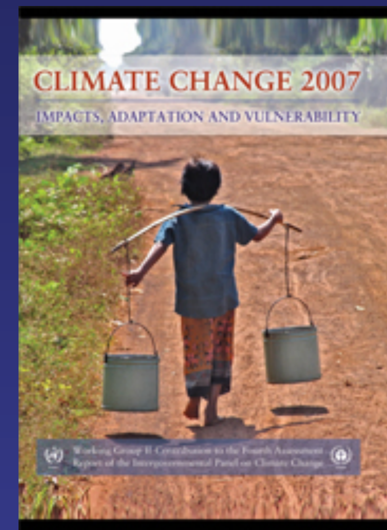


Projected Range ca. 2100

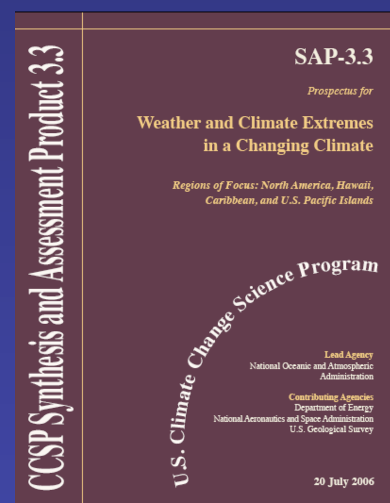
Valuable Resources

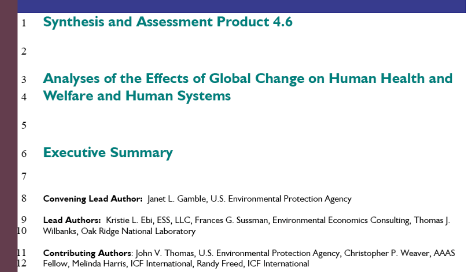
IPCC Reports
www.ipcc.ch





CCSP Reports
www.climatescience.gov





Synthesis and Assessment Product 4.6

Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems

Executive Summary

Convening Lead Author: Janet L. Gamble, U.S. Environmental Protection Agency

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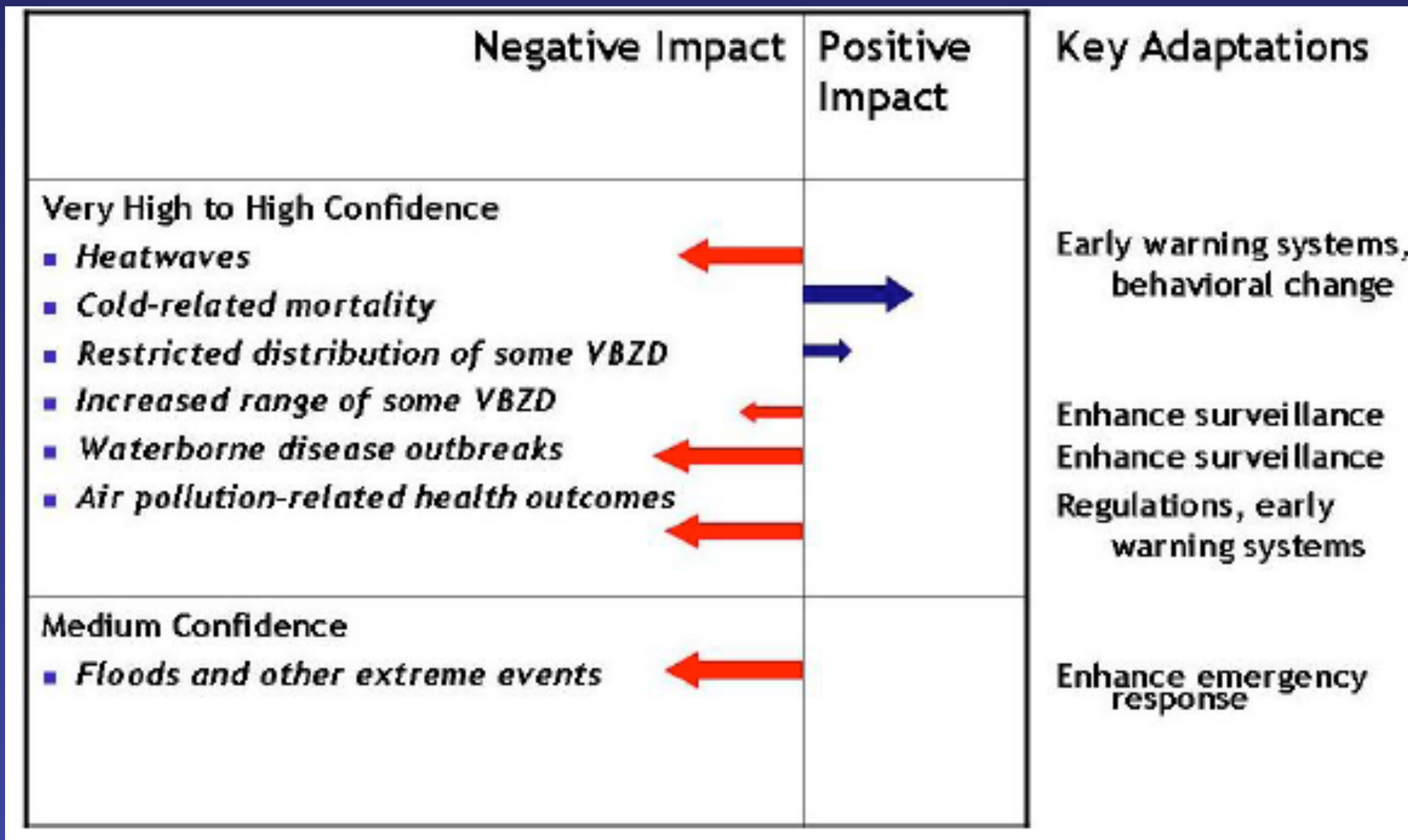
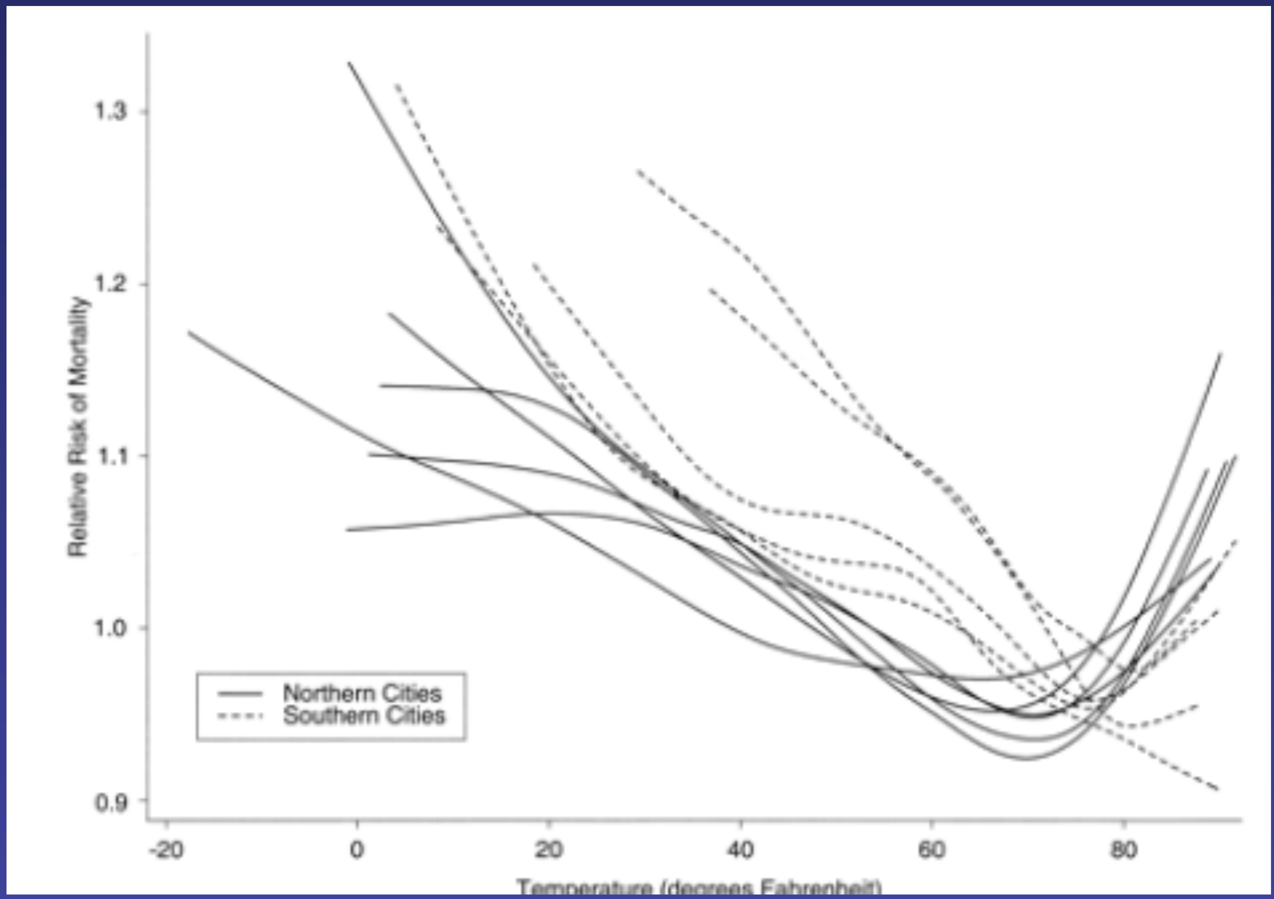
Backup Slides

Summary of relative direction, magnitude and certainty of health impacts to changes in climate

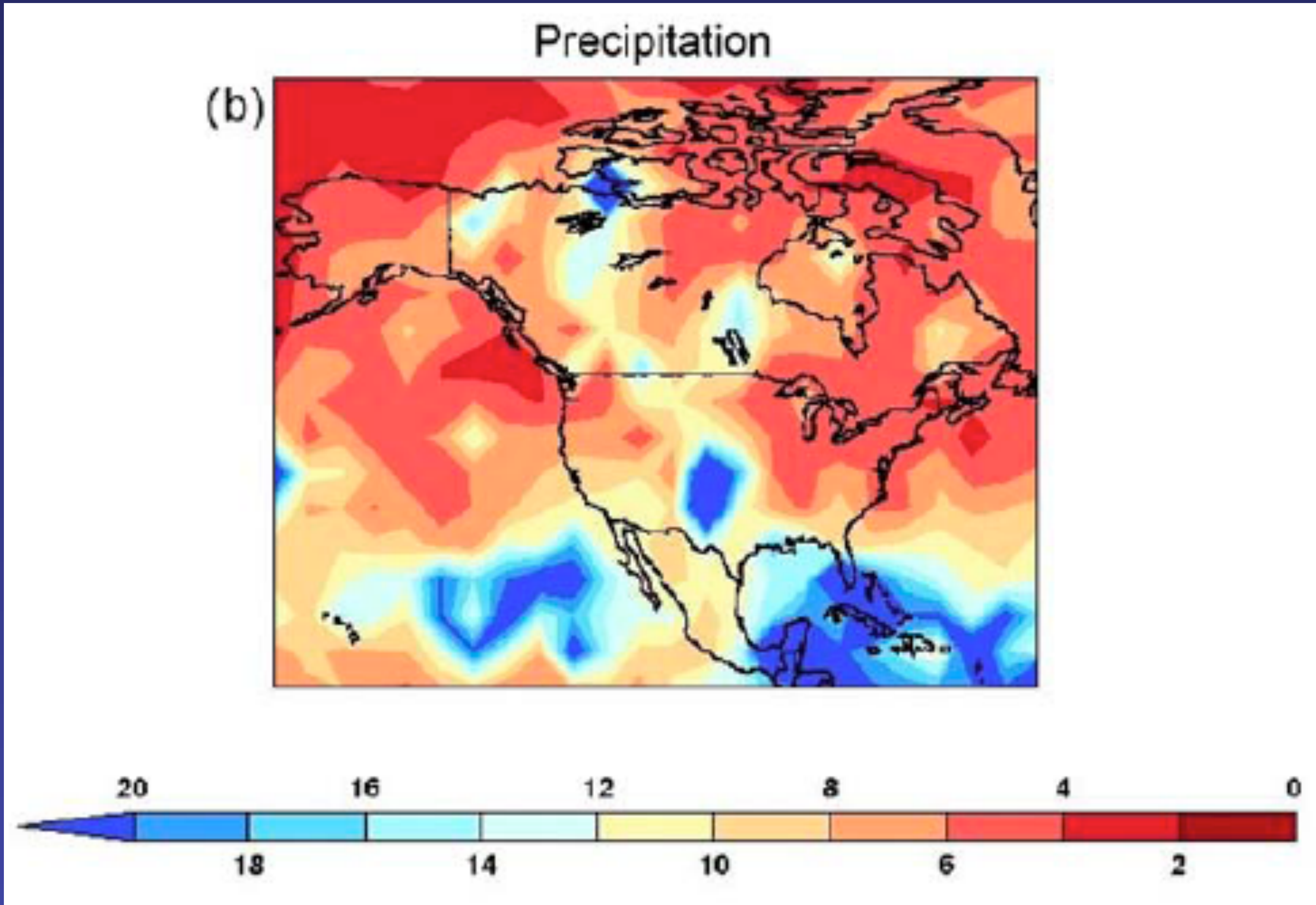


Temperature-mortality relative risk functions for 11 U.S. cities, 1973–1994



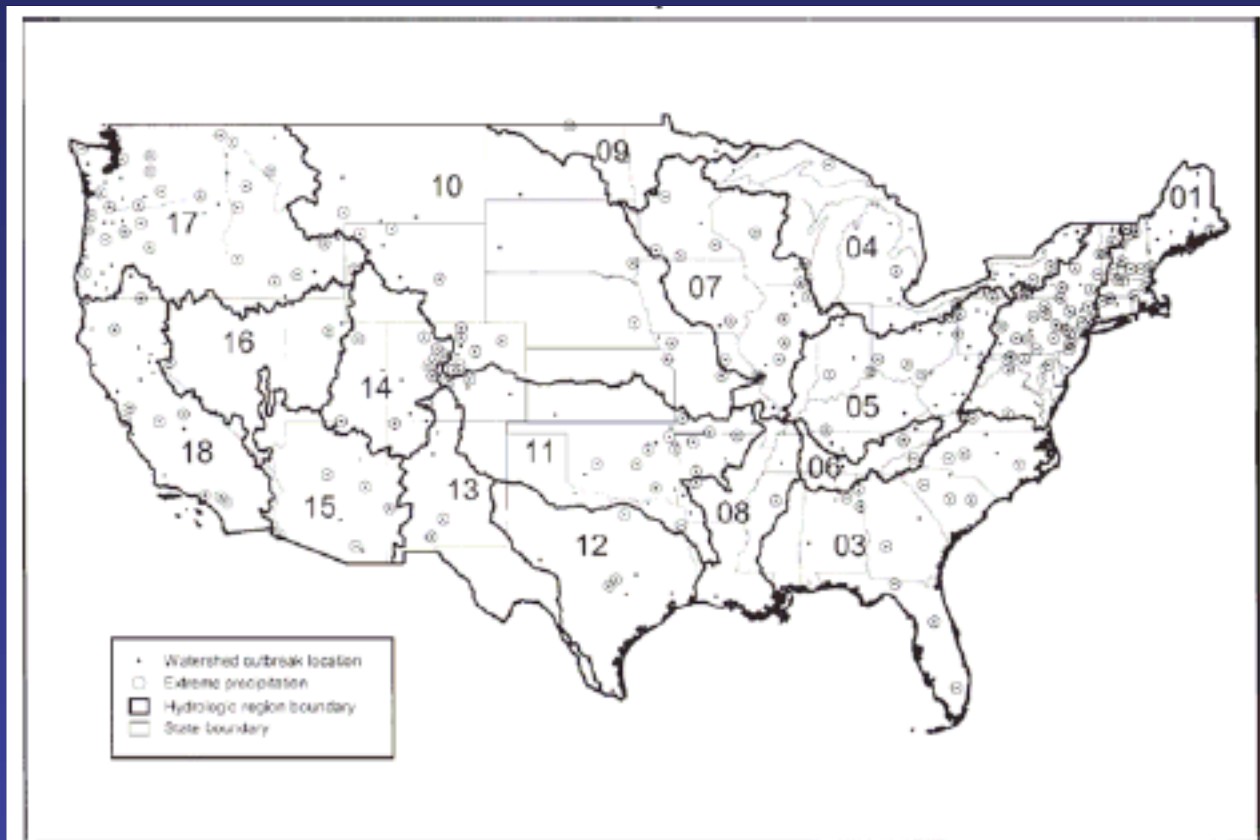
(Curriero et al. 2002)

Projected increase in occurrence of extremely high rainfall days (a 1 in-20 year event)



(from Wehner 2005)

Drinking waterborne disease outbreaks and 90 percentile precipitation events



(Curriero et al. 2001)