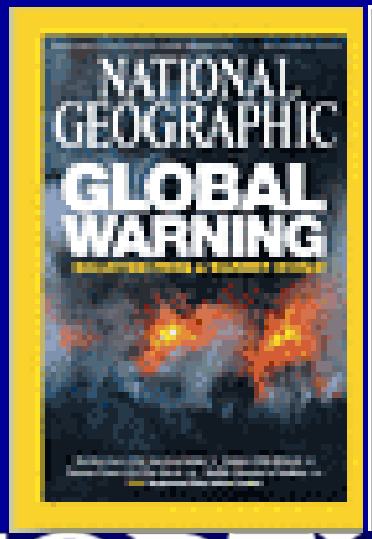
Climate Change Impacts
And
Greenhouse Gas Emissions
In the
Pacific Northwest

Dr. Richard Gammon
Professor of Chemistry and Oceanography,
Adjunct Professor of Atmospheric Science,
Co-Director, Program on the Environment
University of Washington

Presentation to the
CTR Task Force
September 24, 2004

Extensive recent coverage in national weeklies and monthlies



FORTUNE

CLIMATE COLLAPSE
The Pentagon's Weather Nightmare

Intergovernmental Panel on Climate Change 2001

Under the auspices of
the World Meteorological Organization and
the United Nations Environmental Program

About 100 Nations (Including all Industrialized Nations)
have Accepted these Findings

www.ipcc.ch

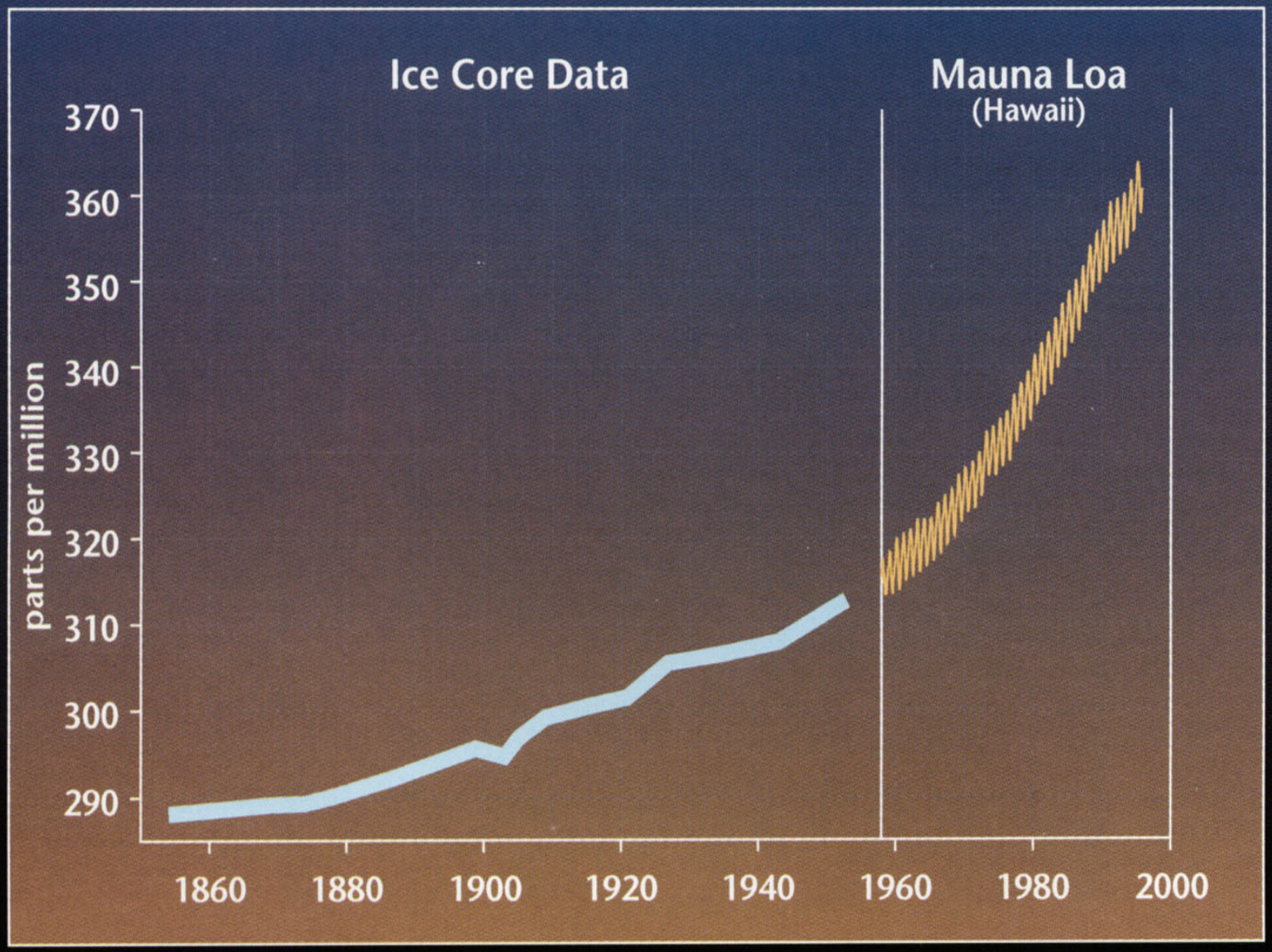
Main Findings of IPCC

- Climate change is underway and the early impacts are already visible.
- Climate impacts over the next 100 years will be much more significant than over the past 100 years.
- Natural systems are the most vulnerable because of their sensitivity to climate and limited capacity to adapt.

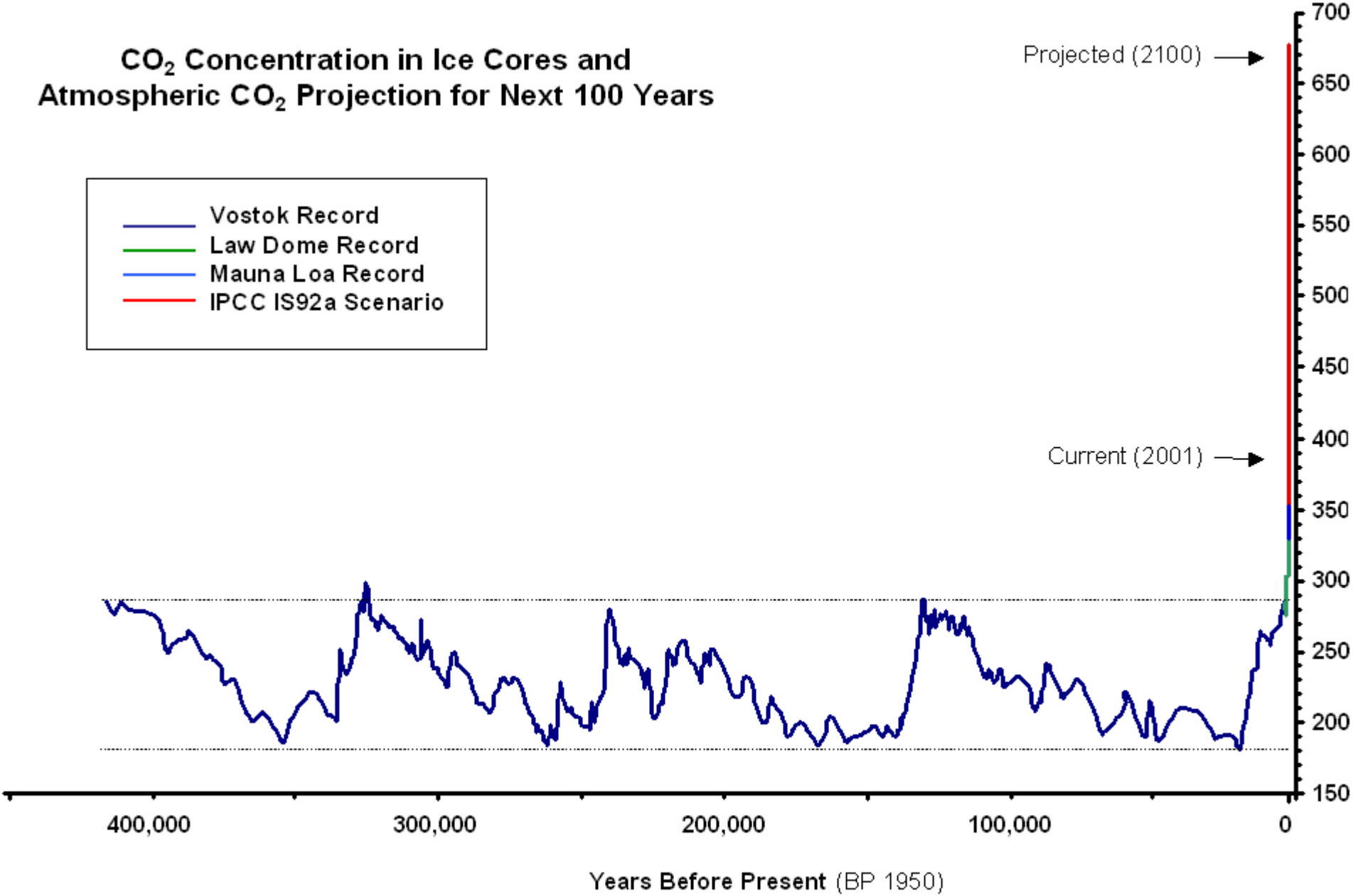
Main Findings of IPCC (cont)

- More frequent, intense weather extremes and severe impacts expected. "Surprises" are possible.
- Developing countries and poor communities in developed countries are most vulnerable.
- Adaptation can reduce impacts, but it's costly and some damages are inevitable.
- Win-win options exist, if action is swift.

Carbon Dioxide Concentrations



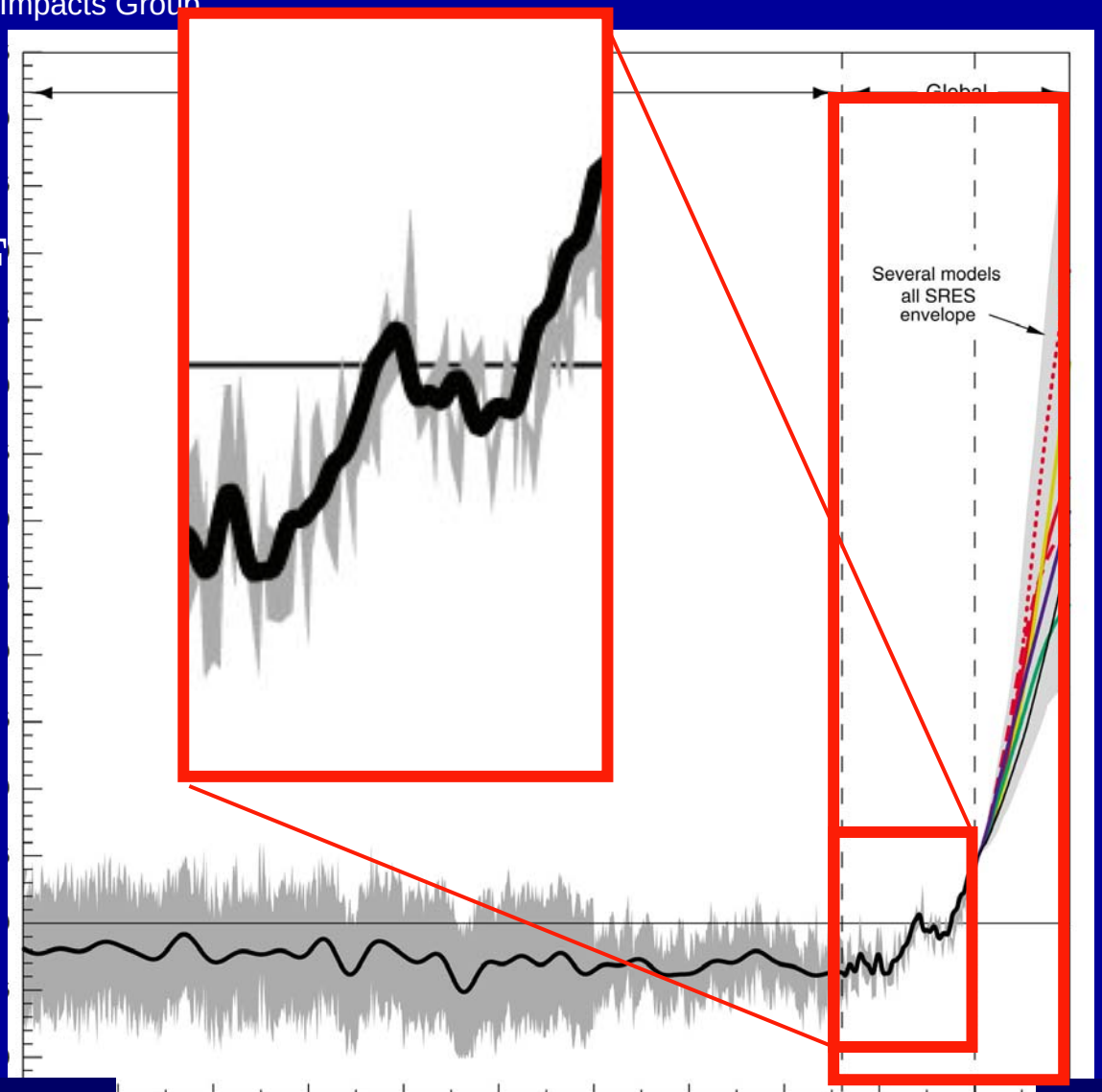
Source: OSTP



Source: C. D. Keeling and T. P. Whorf; Etheridge *et.al.*; Barnola *et.al.*; (*PAGES* / IGBP); IPCC

Global temperature: 1000 years back, 100 forward

Source: IPCC TAR 2001
UW Climate Impacts Group



+ 10° F

+ 5° F

1000

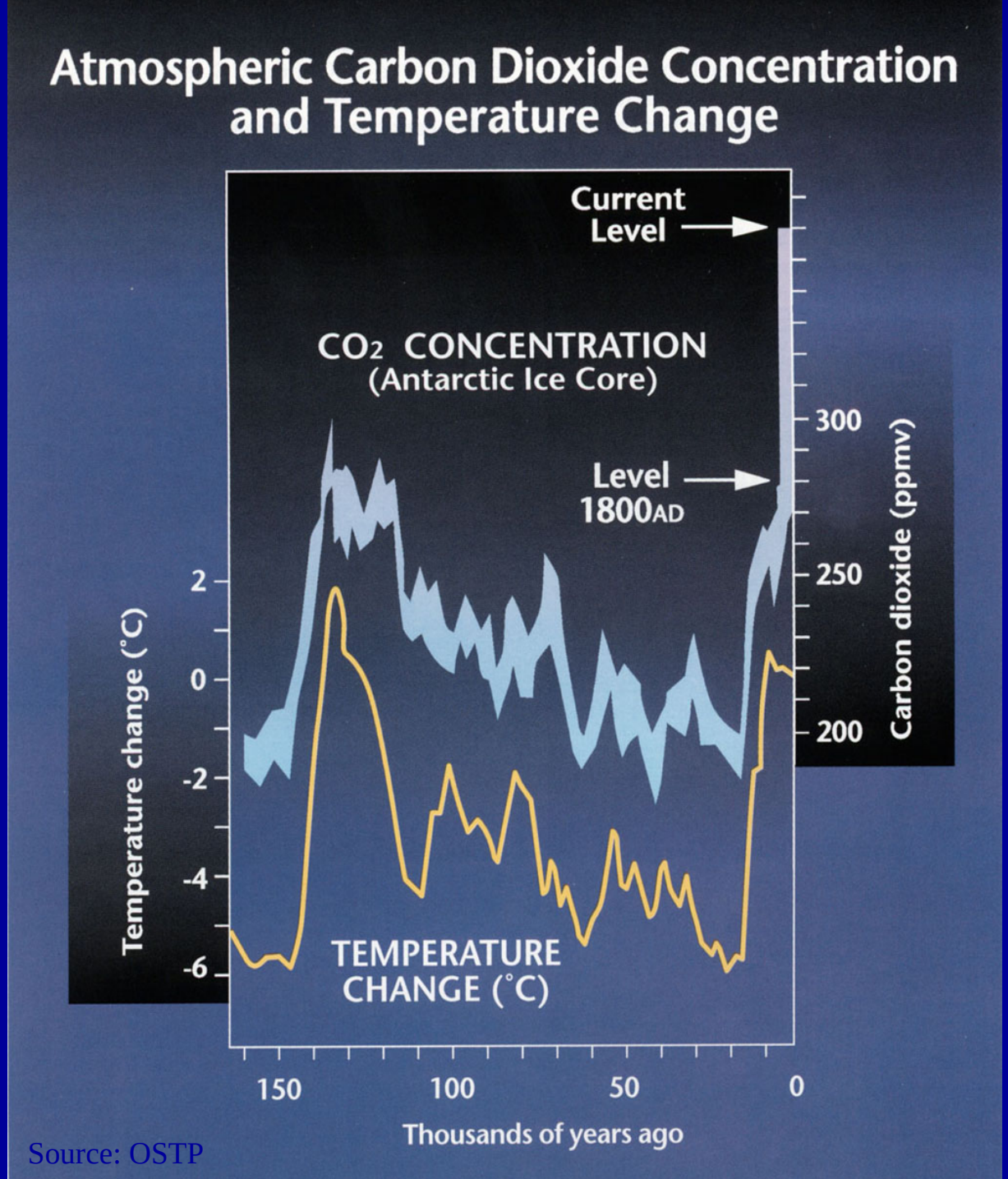
1900 2000

2100

From 1900 to 2000 the planet warmed ~1°F.

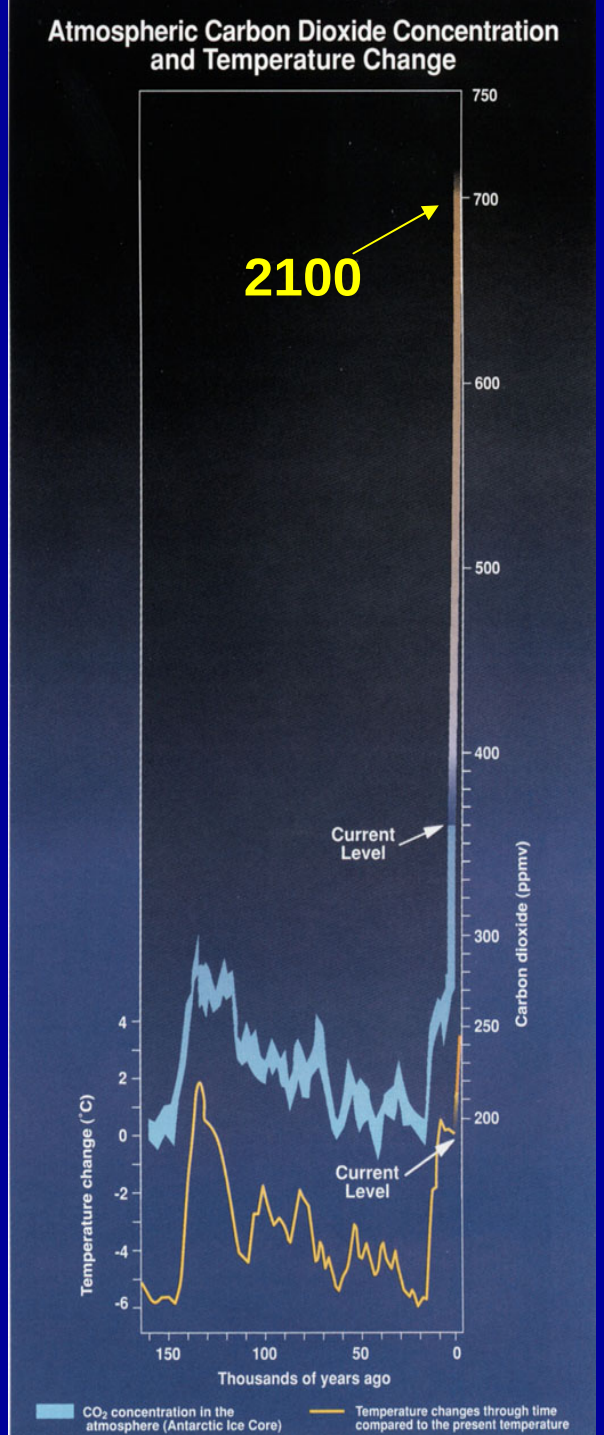
Global average temperature projected to increase 2.5-10.4°F by 2100.

1/2 uncertainty is climate sensitivity; 1/2 is GHG input (policy, tech)



Source: OSTP

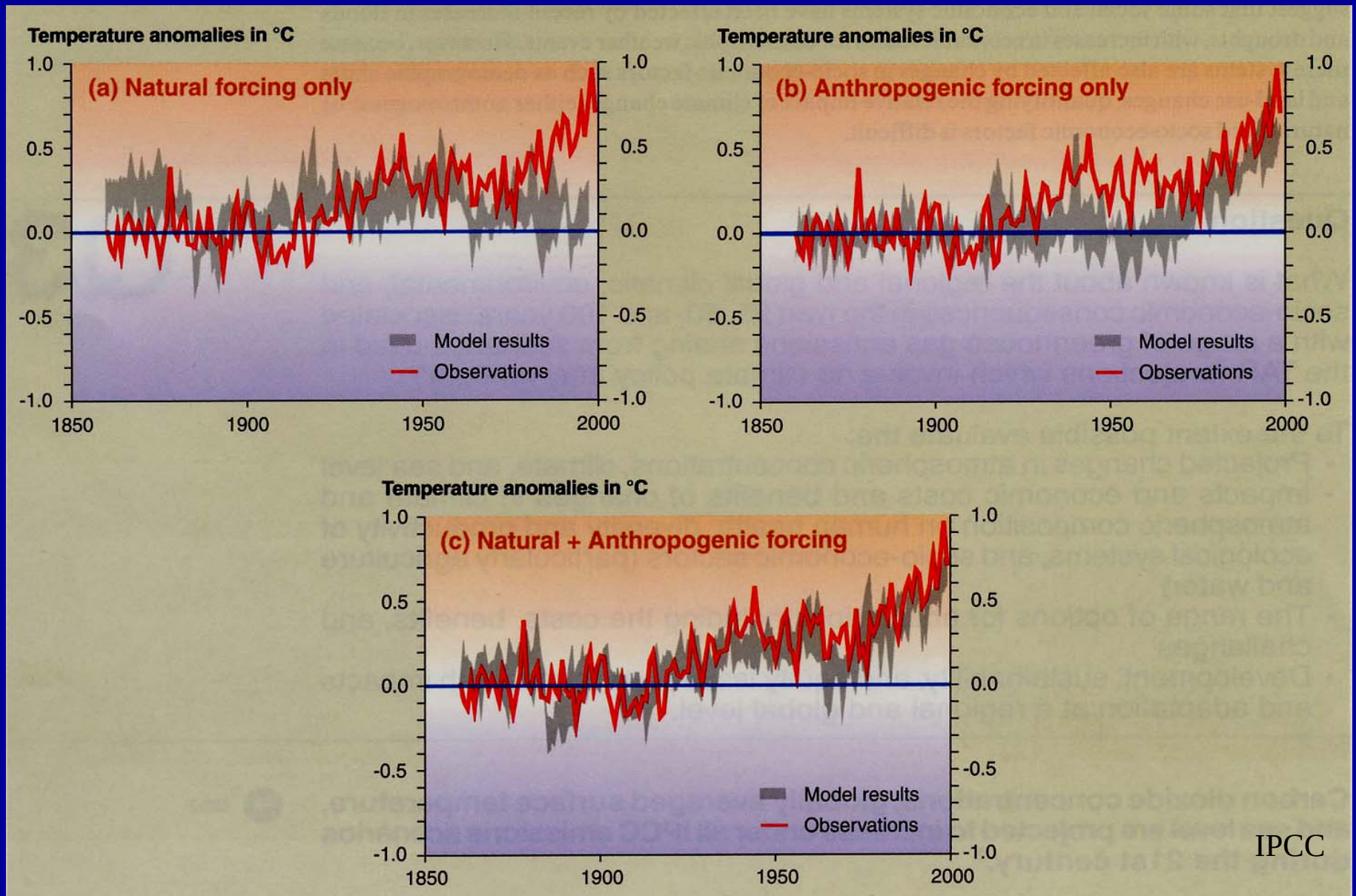
- Clear correlation between CO_2 and temperature
- Current level of CO_2 is *outside* bounds of natural variability
- *Rate* of change of CO_2 is also unprecedented



If nothing is done to slow greenhouse gas emissions ("business-as-usual"). . .

- **CO_2 concentrations will likely be more than 700 ppm by 2100**
- **Global average temperatures projected to increase between 2.5 - 10.4°F**

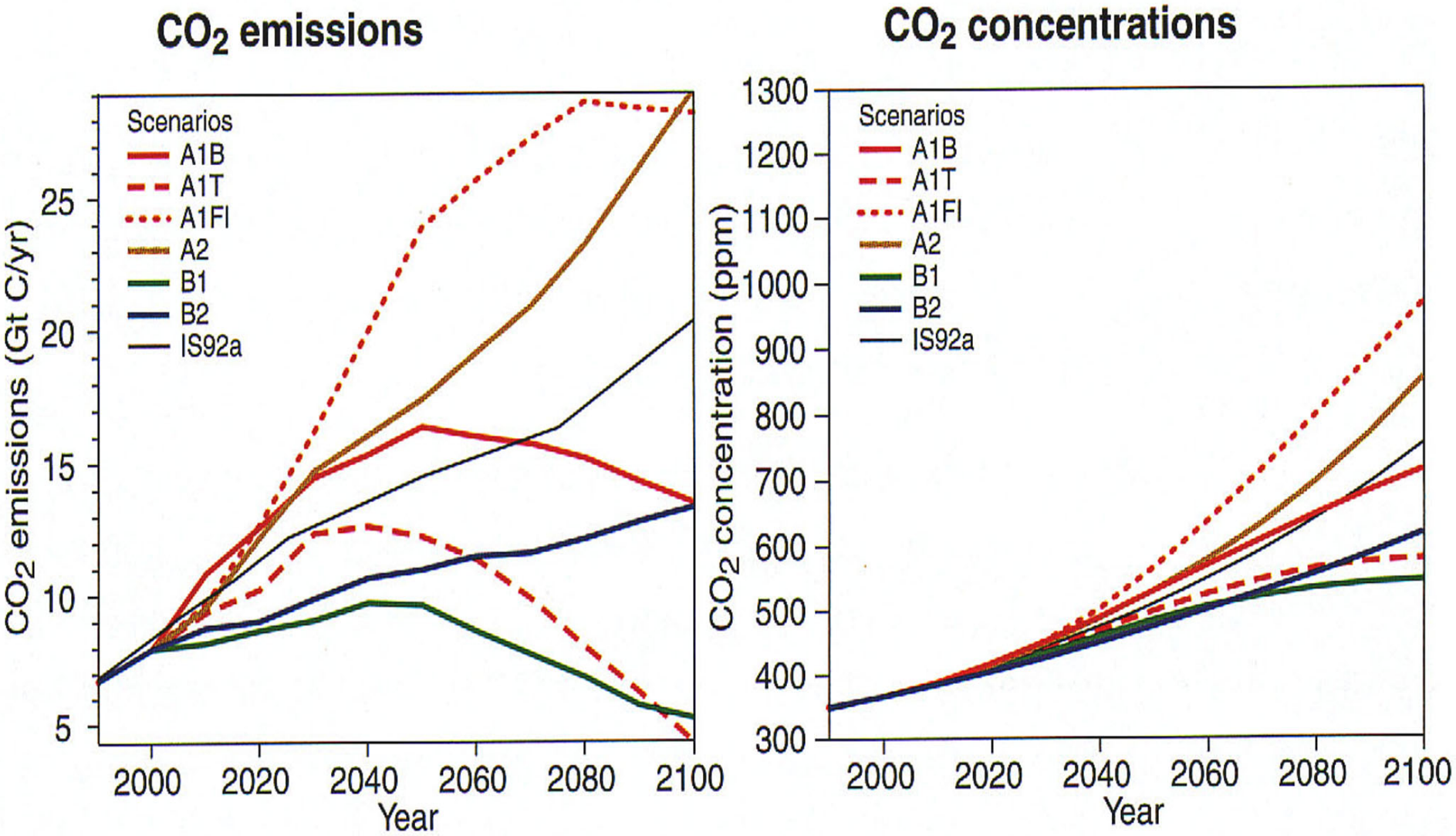
Observed vs. modeled temperature rise since 1860



IPCC

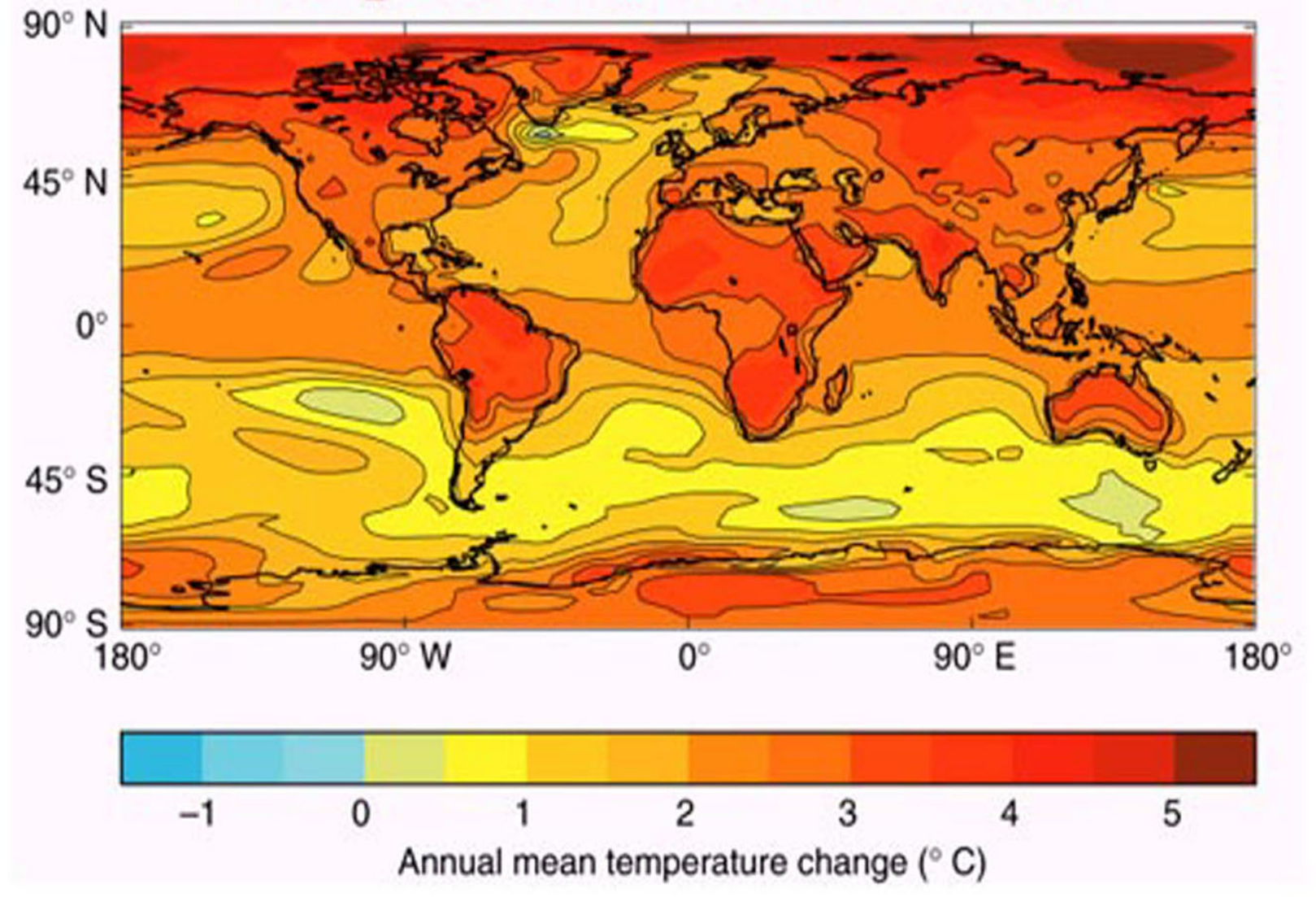
CO_2 Emissions and Concentrations:

The environment responds to *concentrations;* aggressive emission reduction needs to begin quickly



IPCC

Projected Changes in Annual Temperatures for the 2050s



The projected change is compared to the present day with a ~1% increase per year in equivalent CO_2

Potential Climate Change Impacts

Climate Changes

Temperature

Precipitation

Sea Level Rise

Health

Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses

Agriculture

Crop yields
Irrigation demands

Forests

Change in forest composition
Shift geographic range of forests
Forest health and productivity

Water Resources

Changes in water supply
Water quality
Increased competition for water

Coastal Areas

Erosion of beaches
Inundation of coastal lands
Costs to protect coastal communities

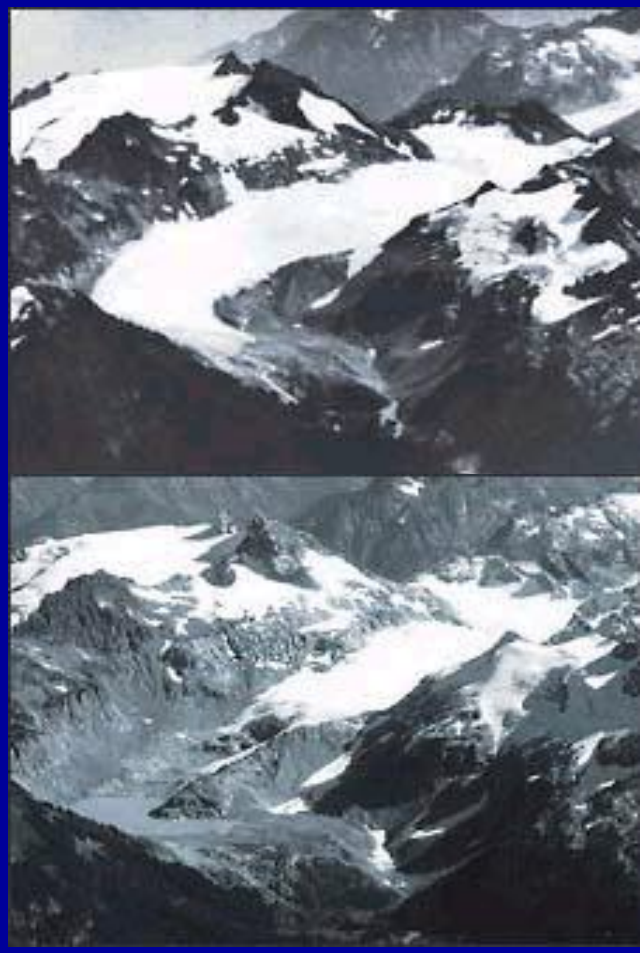
Species and Natural Areas

Shift in ecological zones
Loss of habitat and species

Source: EPA

Physical signal: observed changes in ice and snow cover

South Cascade Glacier, 1928 and 2000



- *Duration of ice cover on rivers and lakes has decreased* **by 2.5 weeks over the last century in mid- & high latitude areas**
- *Arctic sea ice loss* **in area (10 - 15%) and thickness (40%) over the last half century.**
- *Decline in snow cover* **(10%) for N hemisphere since 1960**
- *World-wide retreat in alpine glaciers* **over last century**
- *Widespread changes in permafrost*

IPCC

Sea-Level Rise

Ocean Shores, WA

- Thermal expansion and glacier/icecap melting
- 4 to 8 inches over the last century
- IPCC projects 4 to 35 inches this century
- Erodes beaches and wetlands, inundates low-lying areas

© Susanne Moser

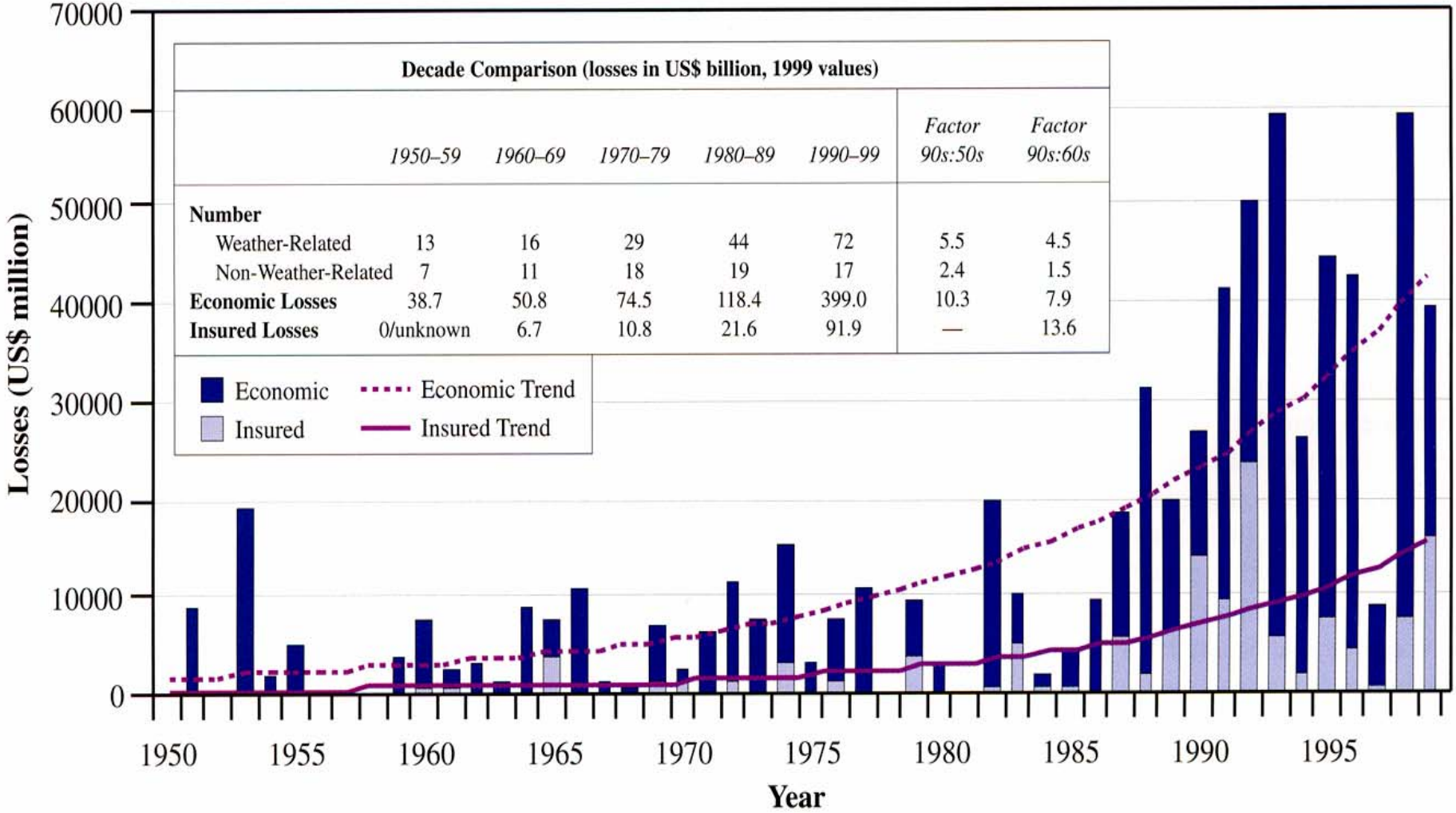
Effects of global warming on water cycle

Global warming → Speeds up global water cycle → More extreme weather events

9/19 Washington Post: "Warning in the Winds"

"Hurricanes are essentially heat engines, forming over warm ocean waters and gaining strength from the latent heat …. This released heat drives rapid updrafts that cause more water to evaporate from the ocean surface and form a self-reinforcing vortex of swirling clouds generating wind speeds, as in Hurricane Ivan's case, of up to 160 miles per hour."

Costs of extreme weather events



Decade Comparison (losses in US$ billion, 1999 values)

	1950–59	*1960–69*	*1970–79*	*1980–89*	*1990–99*	*Factor 90s:50s*	*Factor 90s:60s*
Number							
Weather-Related	13	16	29	44	72	5.5	4.5
Non-Weather-Related	7	11	18	19	17	2.4	1.5
Economic Losses	38.7	50.8	74.5	118.4	399.0	10.3	7.9
Insured Losses	0/unknown	6.7	10.8	21.6	91.9	—	13.6

Figure TS-5: The costs of catastrophic weather events have exhibited a rapid upward trend in recent decades. Yearly economic losses from large events increased 10.3-fold from US$4 billion yr^{-1} in the 1950s to US$40 billion yr^{-1} in the 1990s (all in 1999

Potential human health impacts

Air Quality + Climate changes:

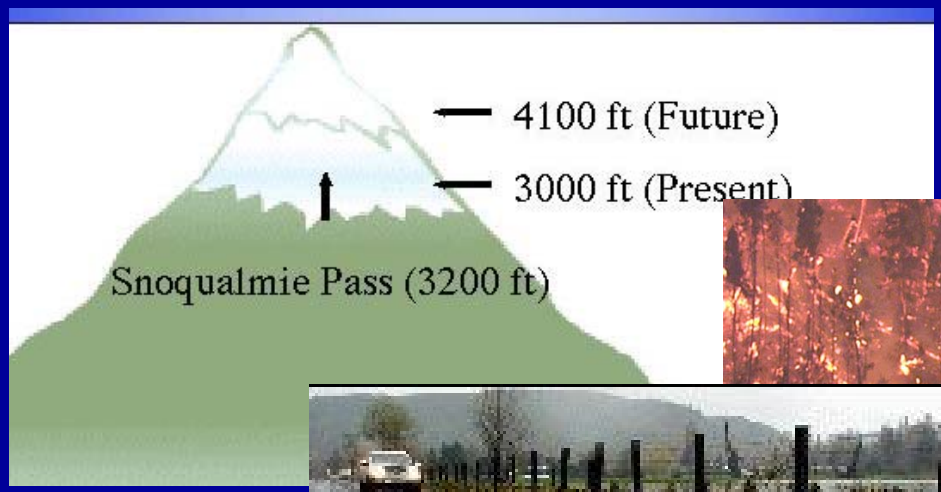
- temperature
- precipitation
- sea level rise

altered food and crop productivity	regional malnutrition and hunger
extreme weather events; sea-level rise	deaths, injuries; infectious disease; refugees
thermal extremes	altered rates of heat- and cold-related illness and death
worsened air pollution, allergens	acute and chronic respiratory disorders
effects on vectors and infective parasites	infectious diseases, waterborne diseases

Source: "Human Population Health," IPCC

Harvard Medical School, Center for Health and the Global Environment: www.med.harvard.edu/chge/resources.html

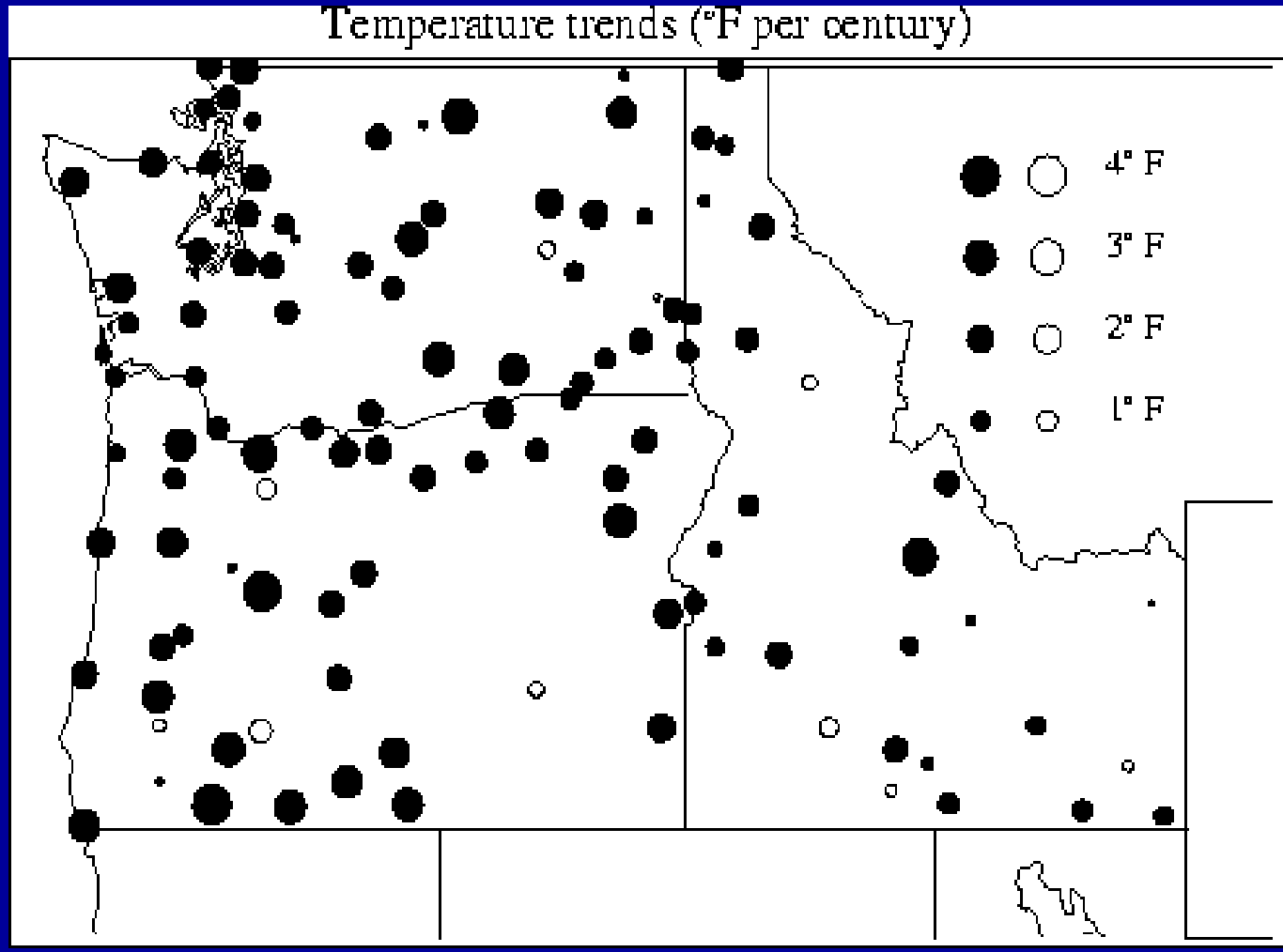
PNW trends, expected impacts



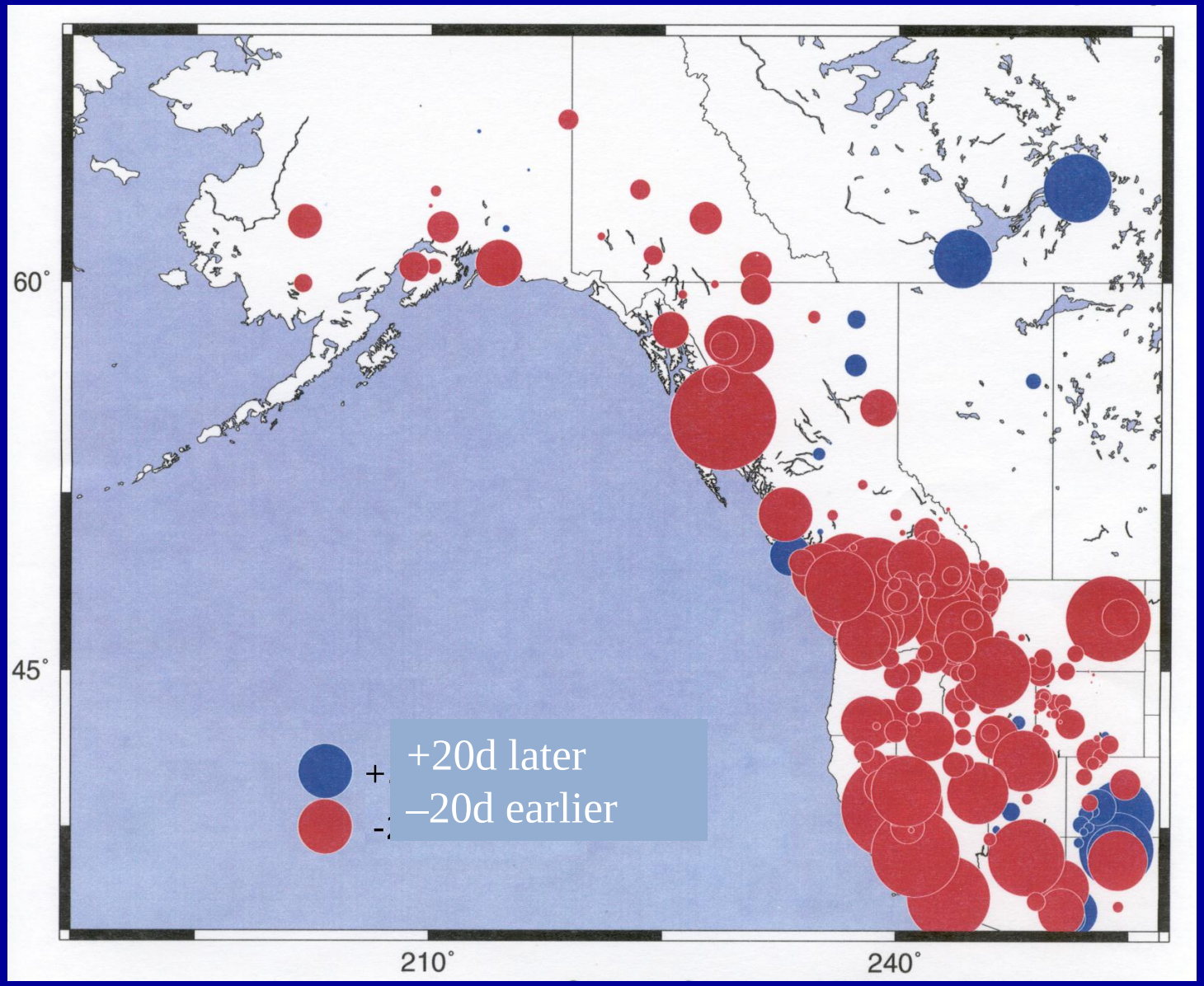
Source for PNW impacts:
UW Climate Impacts Group
http://tao.atmos.washington.edu/PNWimpacts/

Temperature trends in the PNW

- 113 stations with long records
- Almost every station shows warming
- Urbanization not a major source of warming



Trends in timing of spring snowmelt (1948-2000)



Courtesy of Mike Dettinger, Iris Stewart, Dan Cayan

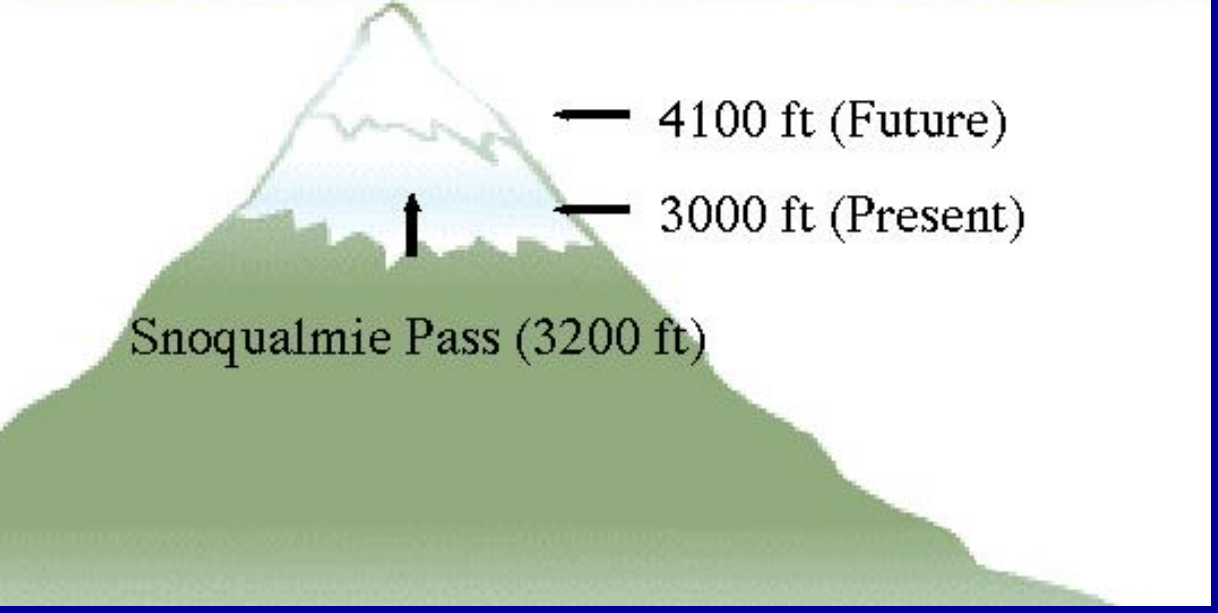
Climate change in the PNW

	Temperature		Precipitation	
	summer	winter	summer	winter
low	+3.1°F	+3.2°F	-7%	-2%
mean	+4.7°F	+5.2°F	+2%	+9%
high	+6.7°F	+6.7°F	+9%	+22%

Warmer wetter winters.

Warmer summers.

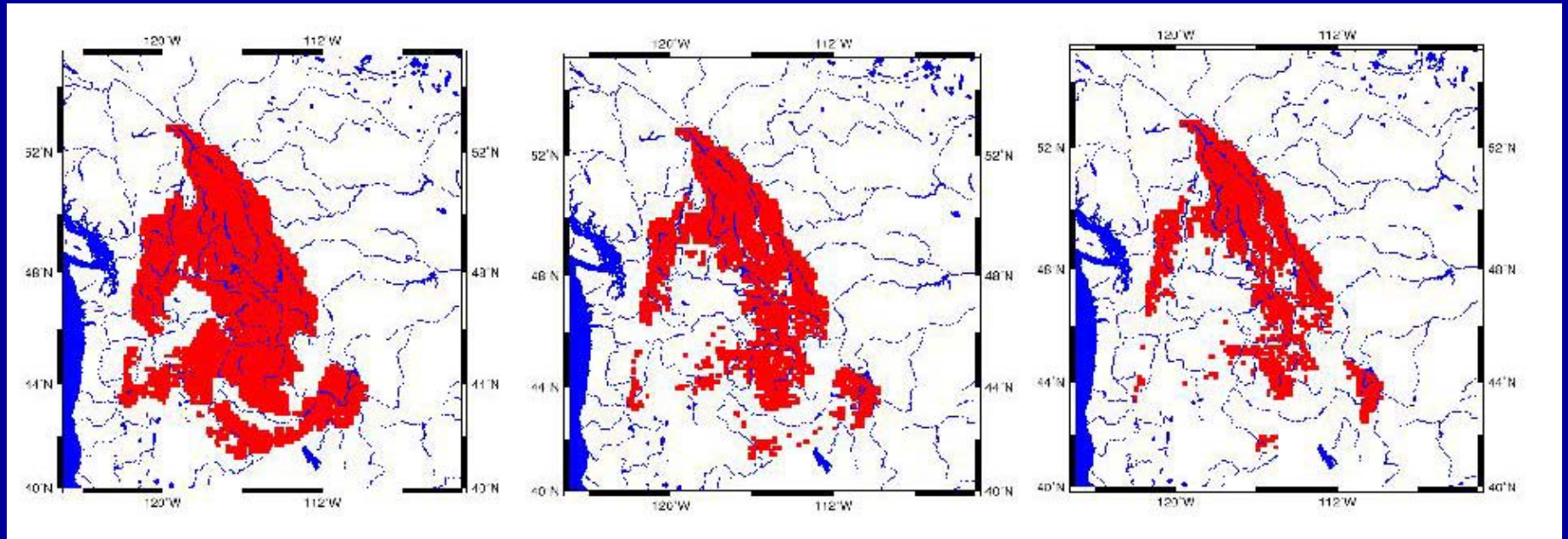
Estimated climate change from 20th century to the 2040s using 8 climate model scenarios ("summer"=April-September, "winter" = October-March).



The Main Impact: Less Snow

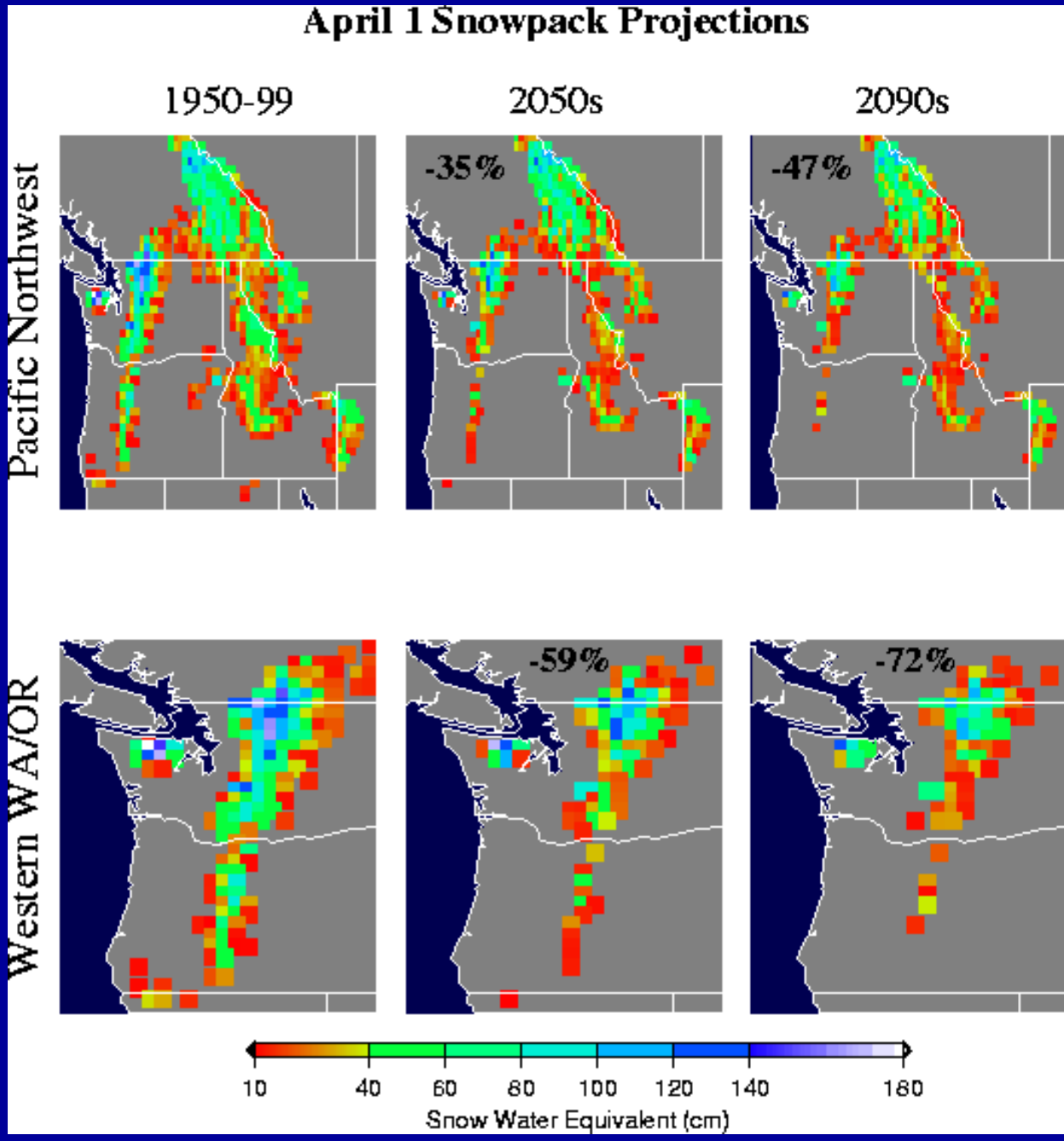
April 1 Columbia Basin Snow Extent

Historical Average **~ 2025** **~ 2045**



Snowpack loss

Western Washingon and Oregon are especially sensitive



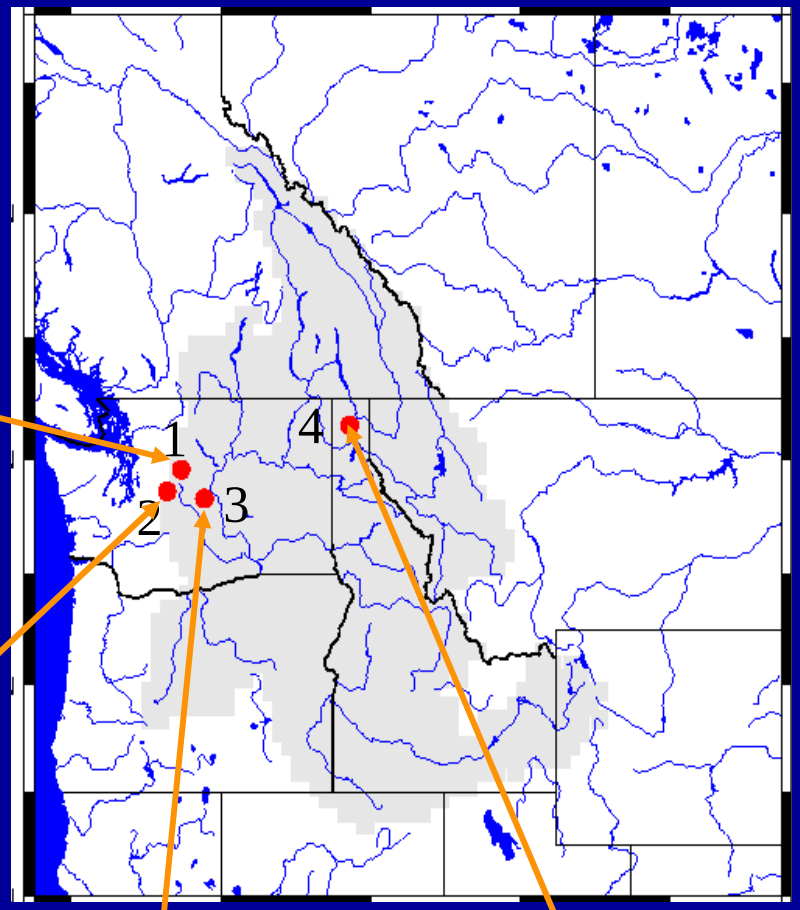
Changes in the Water Cycle

Landslides

- Increased frequency / magnitude
- Exacerbated by sea level rise around Puget Sound

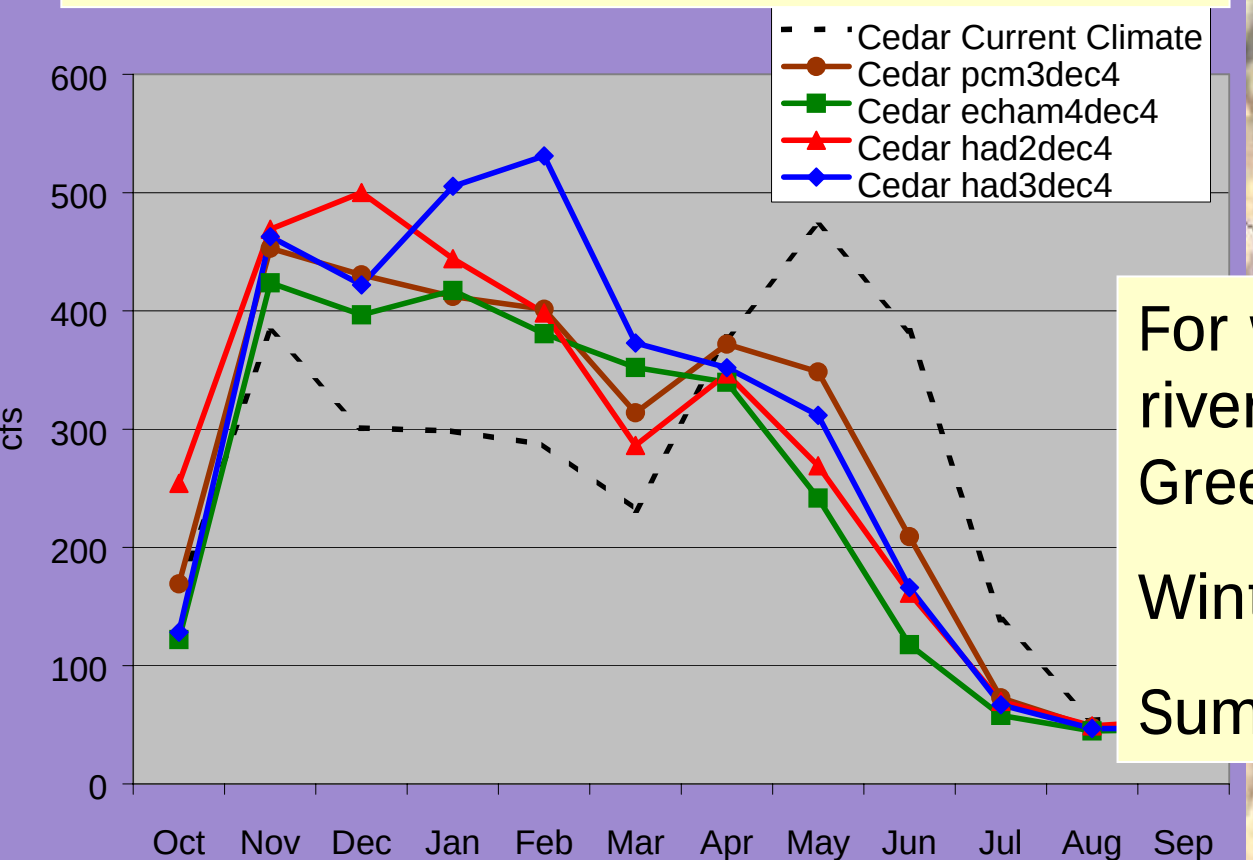
Skiing

- Later season opening
- Shorter season
- More rainy days



Municipal water supply

- More winter streamflow
- Less spring/summer streamflow



For western Washington rivers (Sultan, Tolt, Cedar, Green) in the 2040s:

Winter: +30 *to* 40%

Summer: -20 *to* –30%

Climate disruption and forest health

Rise in disturbances due to warm winters, hot summers: pest, diseases, fires

Loss of forests after disturbances – difficulty regenerating in dry, hot summer conditions

The pine beetle has destroyed an area over twice as big as Vancouver Island; $4.2 billion in timber losses - BC Ministry of Forests

Climate disruption and NW Salmon

- Increased winter flooding – habitat destruction
- Decreased summer and fall streamflow
- Higher stream and ocean temperatures
- Salmon impacts symptomatic of larger water resource impacts

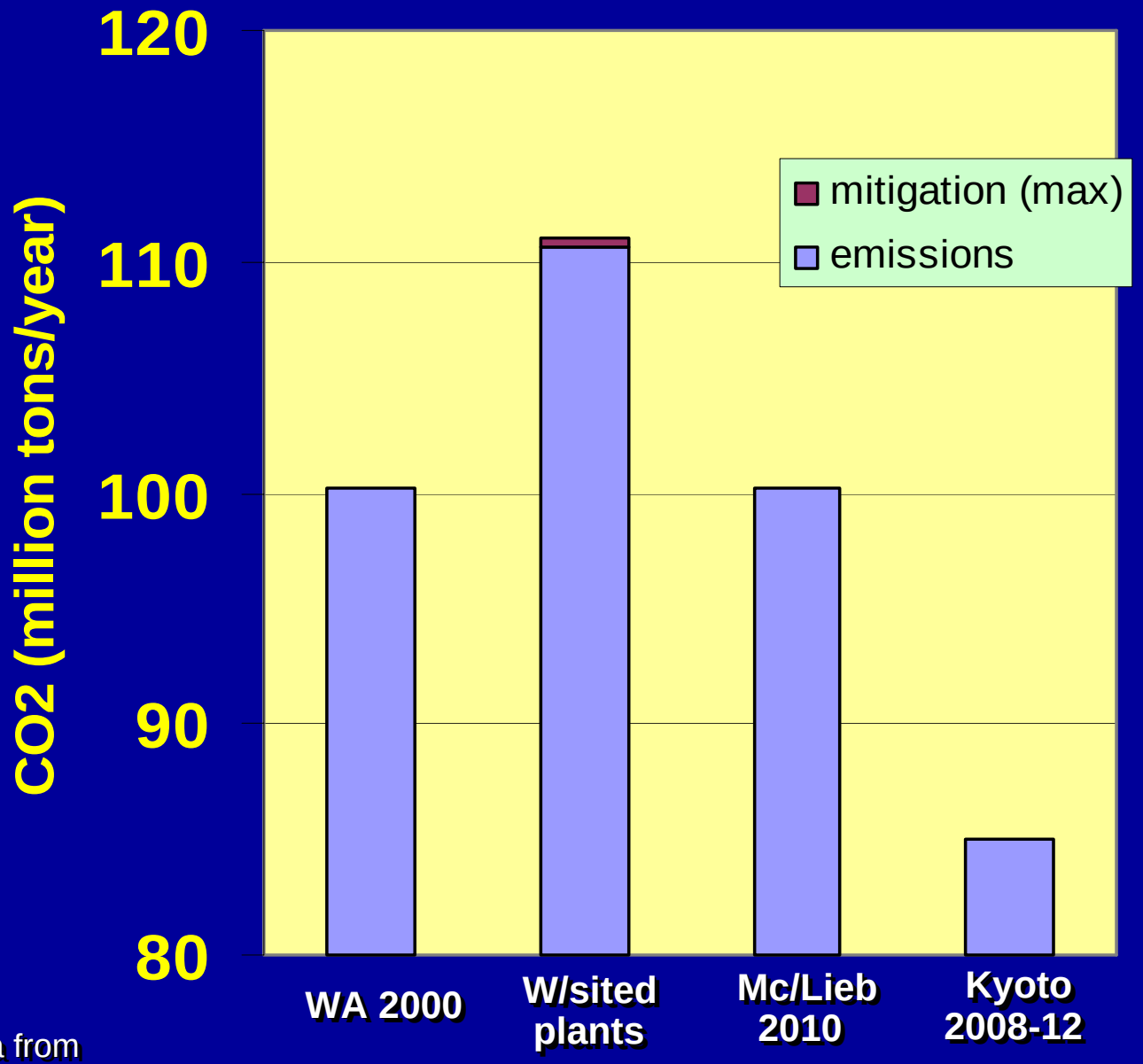
"For the factors we can simulate with some confidence, the prospects for many PNW salmon stocks look bleak"

- UW Climate Impacts Group

Solutions: UN Framework Convention on Climate Change

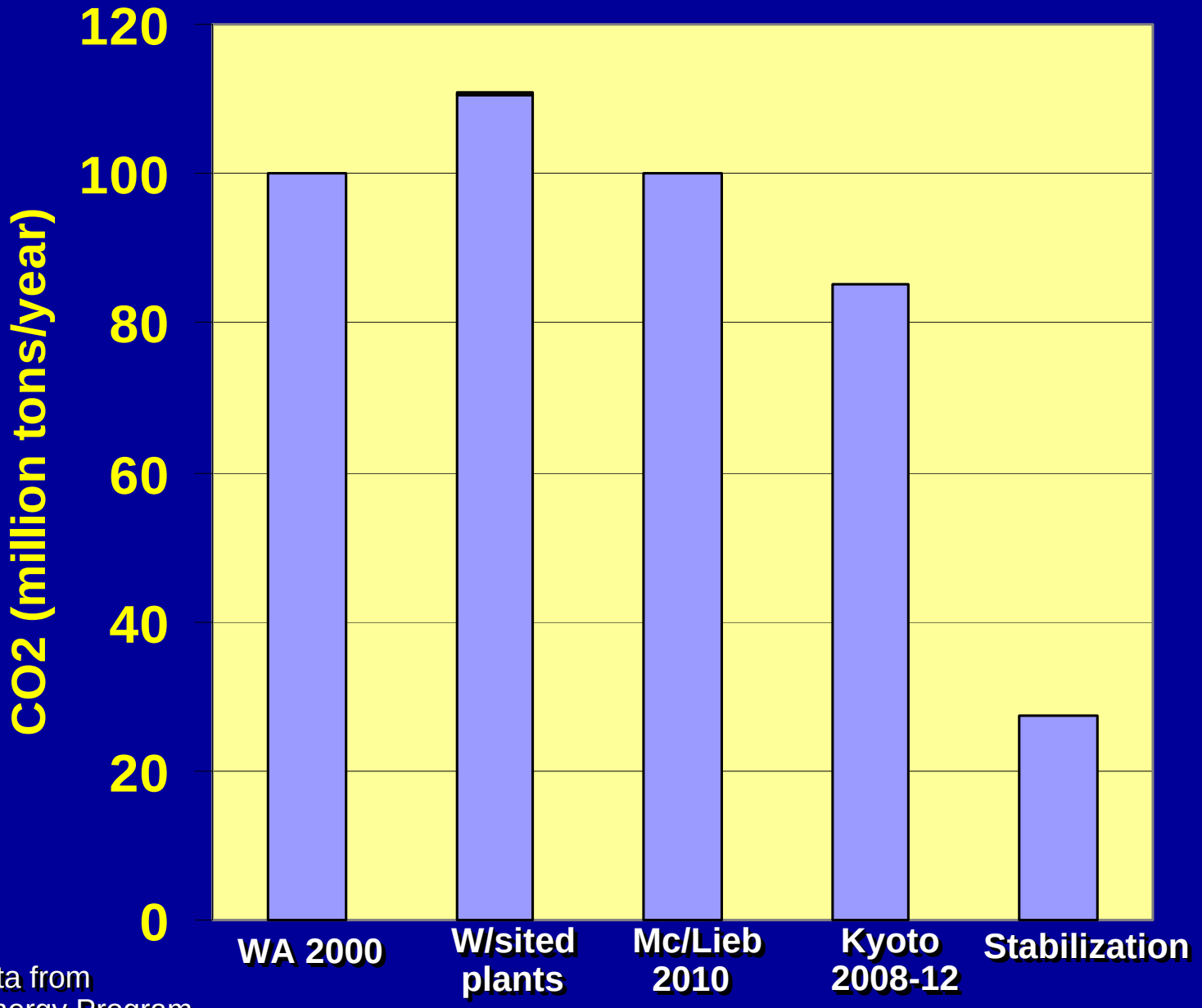
- Foundation of international efforts to combat global warming
- Objective: “stabilize GHG concentrations in the atmosphere at a level that would prevent dangerous human interference with the climate system”
- Kyoto protocol sets binding limits: Ratified by over 100 nations; emission trading and markets are evolving rapidly

Washington CO2 emissions



CO2 data from
WSU Energy Program

Washington CO2 emissions

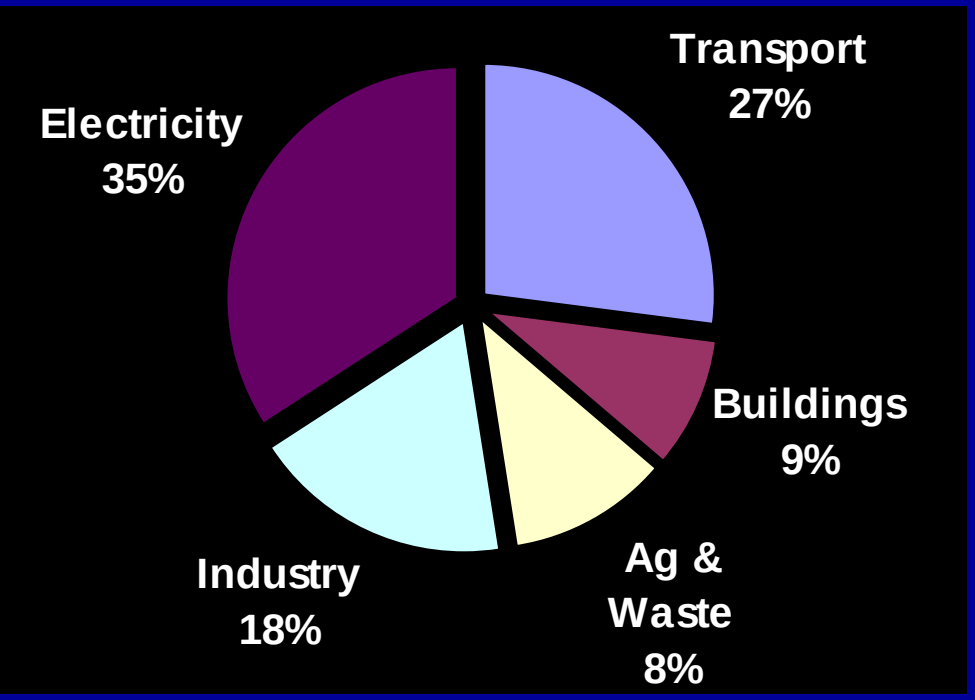


CO2 data from
WSU Energy Program

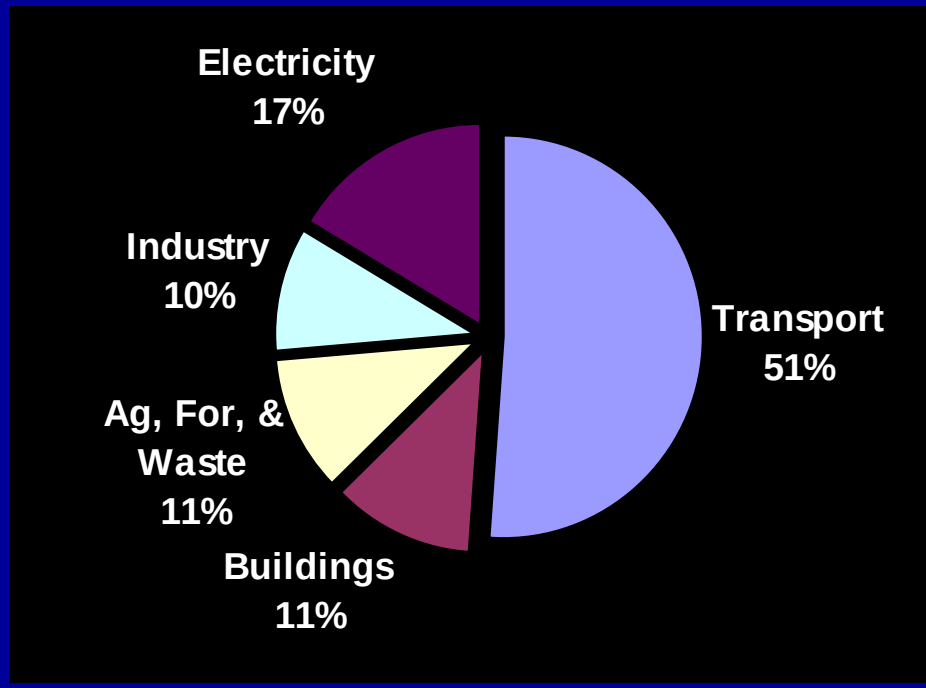
Transportation accounts for a disproportionate share of Washington's CO_2 emissions
(but electricity may grow rapidly with new fossil fueled resources)

CO_2 emissions by sector

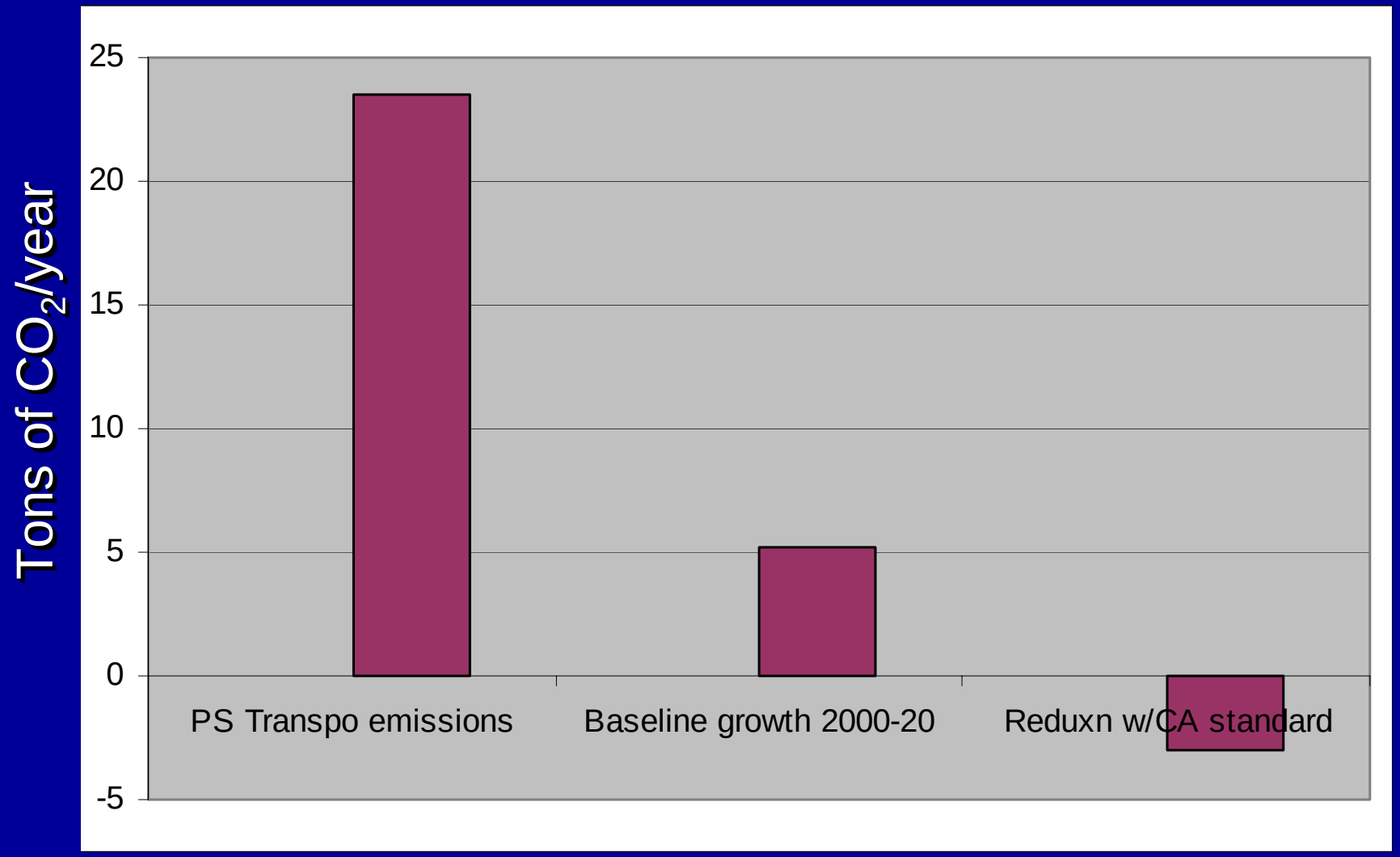
U.S.



Puget Sound
(WA is similar)



Puget Sound CO_2 emissions from transportation:
Projected impact of VMT growth compared to impact of applying California CO_2 standard for new vehicles



Source: Puget Sound Clean Air Agency Climate Protection Advisory Committee

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