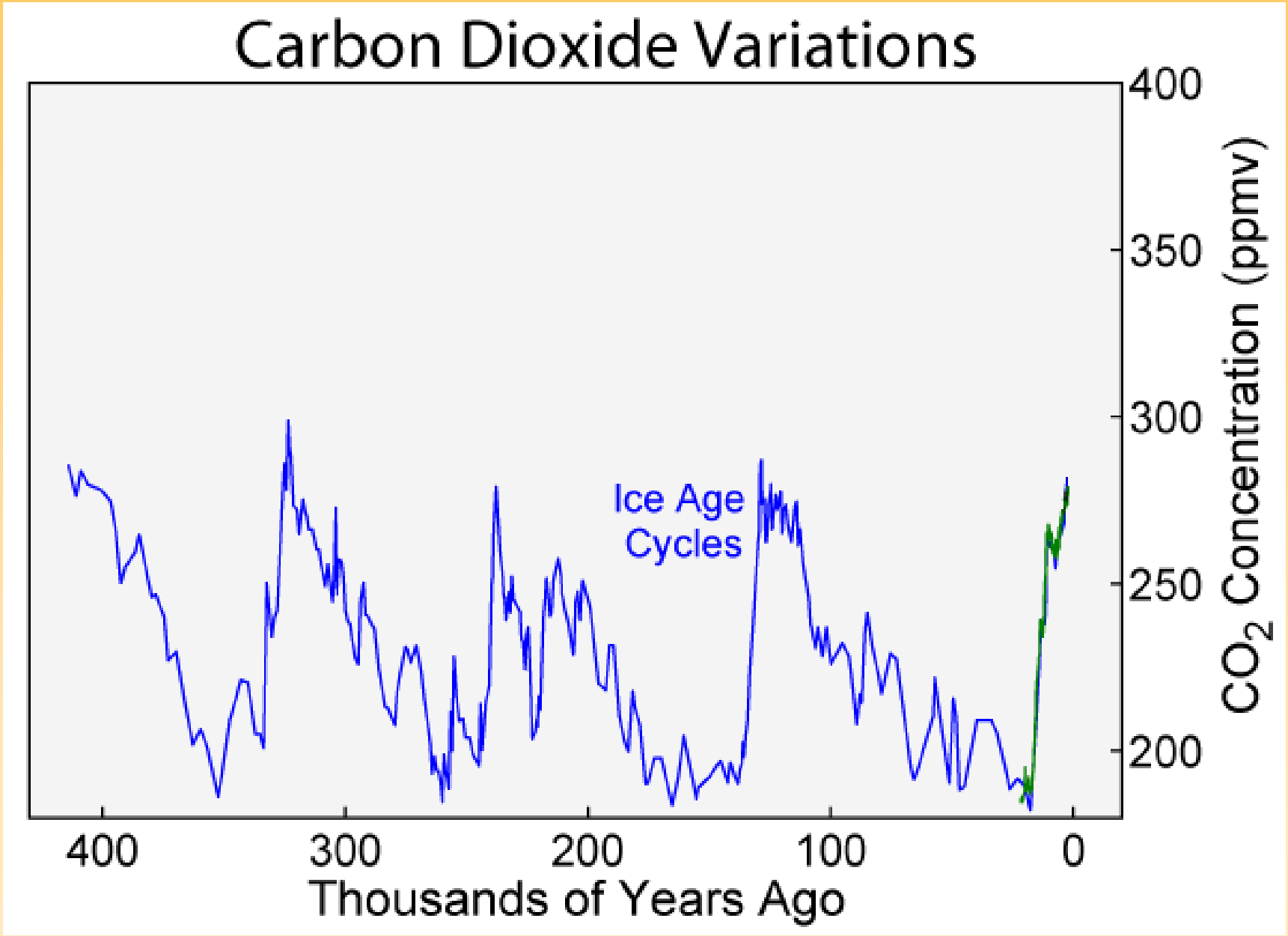
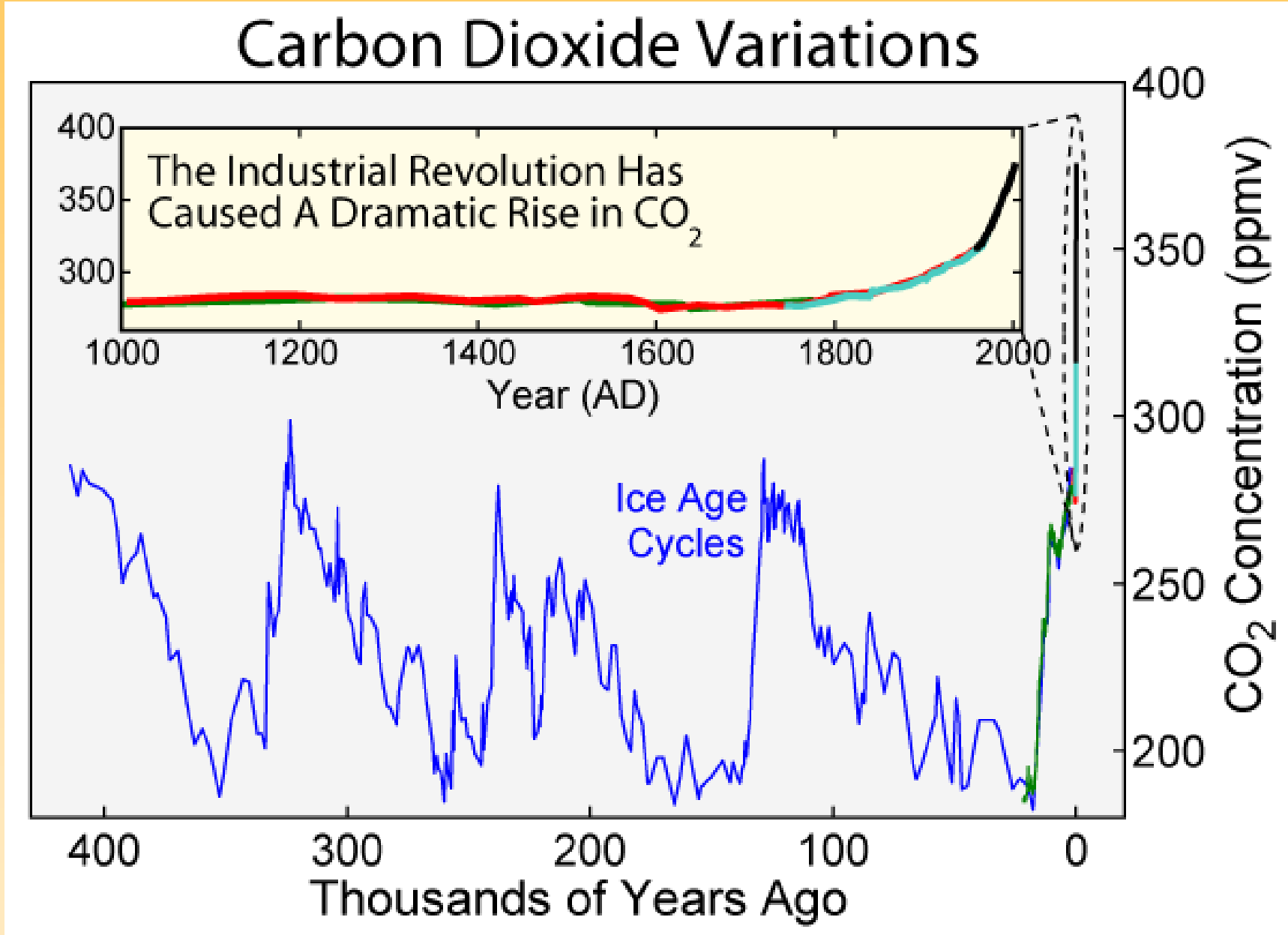
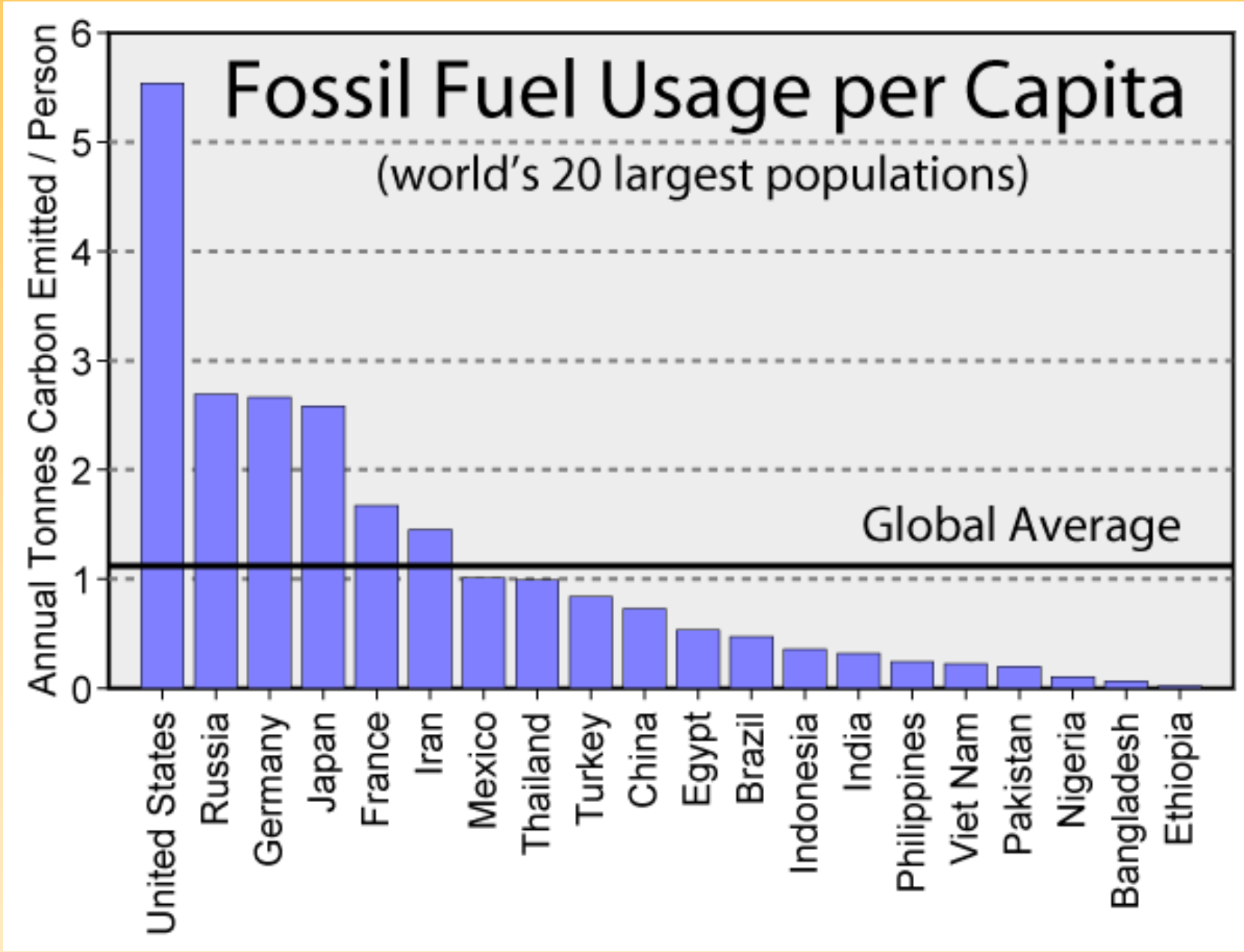
Adapting to the Effects of Climate Change in Pacific Northwest Forests

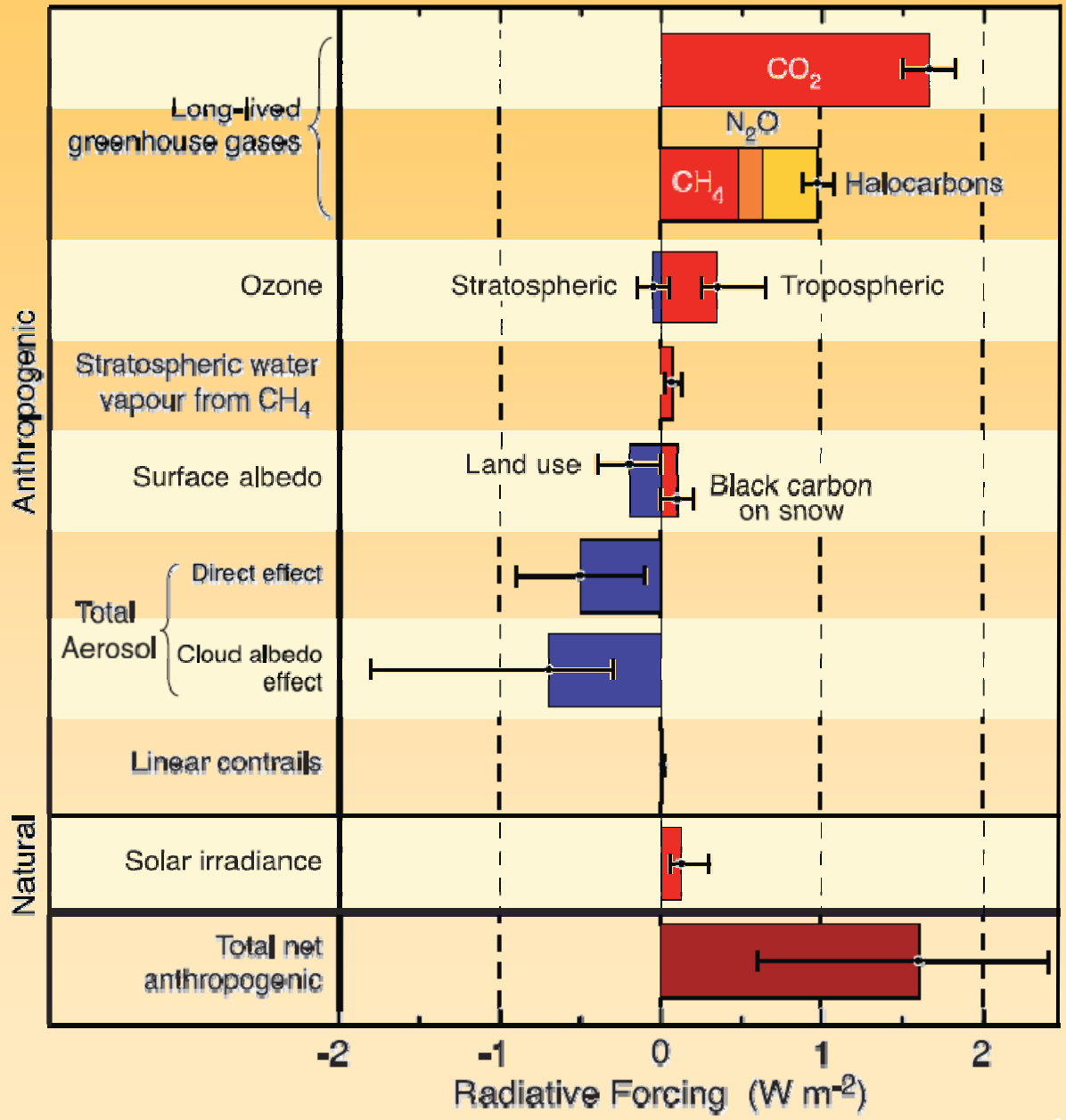
Jessica E. Halofsky
David L. Peterson
Pacific Wildland Fire Sciences Lab
Seattle, WA

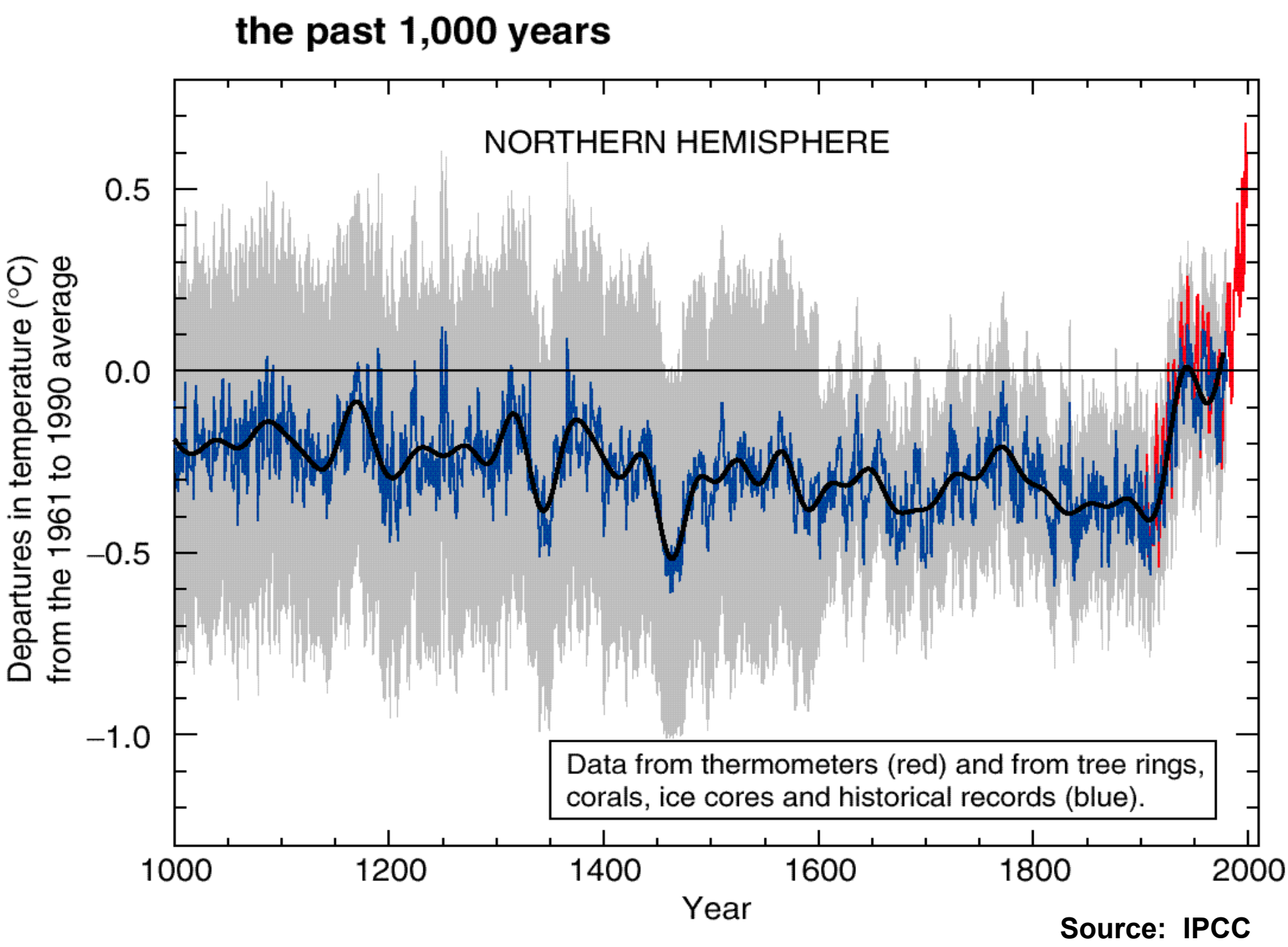

Carbon Dioxide Variations
400
350
300
250
200
CO_2 Concentration (ppmv)
Ice Age
Cycles
400
300
200
100
0
Thousands of Years Ago


Carbon Dioxide Variations
The Industrial Revolution Has Caused A Dramatic Rise in CO_2
400
350
300
1000
1200
1400
1600
1800
2000
Year (AD)
Ice Age Cycles
400
300
200
100
0
Thousands of Years Ago
400
350
300
250
200
CO_2 Concentration (ppmv)

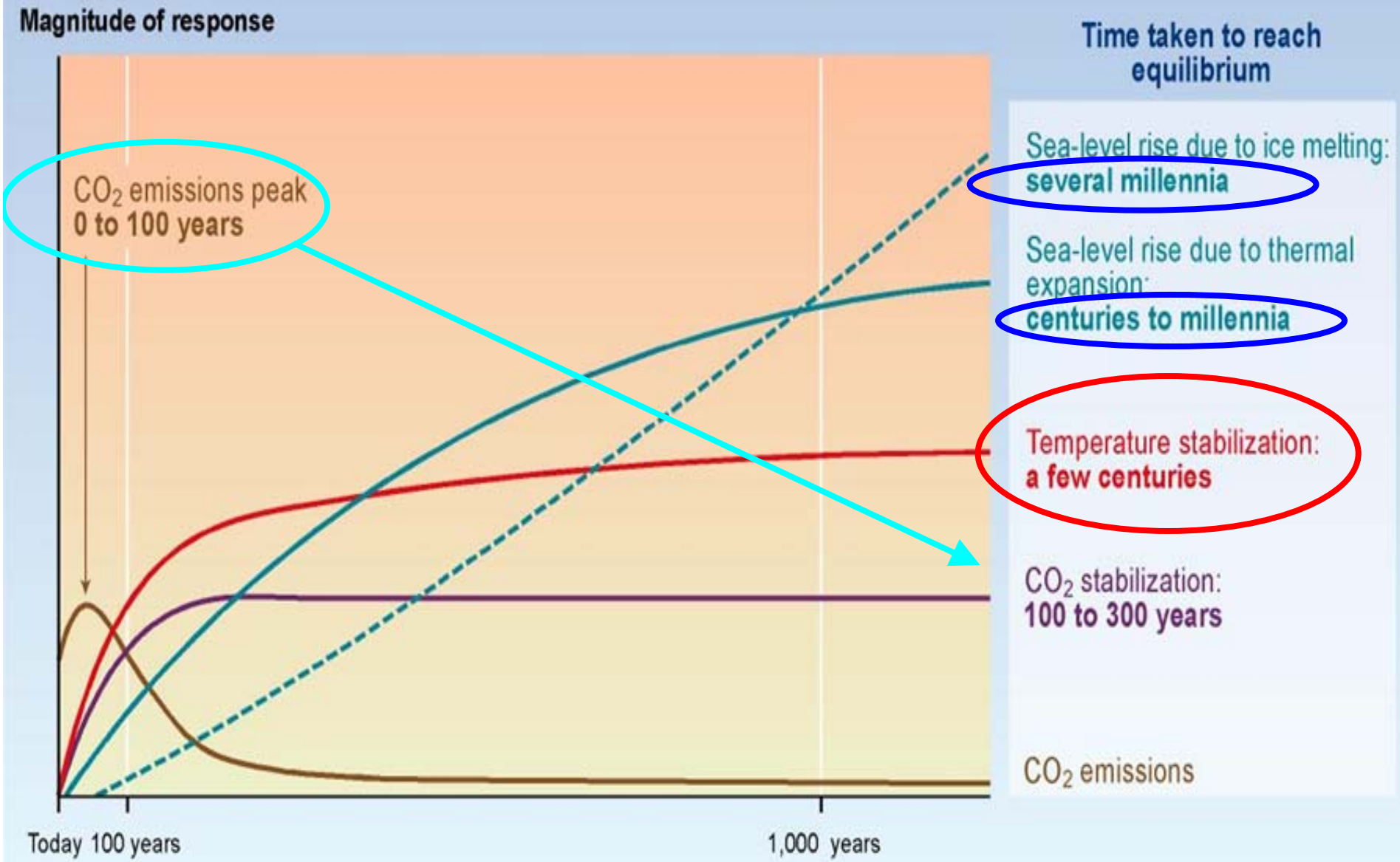

Fossil Fuel Usage per Capita
(world's 20 largest populations)
Annual Tonnes Carbon Emitted / Person
0
1
2
3
4
5
6
Global Average
United States
Russia
Germany
Japan
France
Iran
Mexico
Thailand
Turkey
China
Egypt
Brazil
Indonesia
India
Philippines
Viet Nam
Pakistan
Nigeria
Bangladesh
Ethiopia

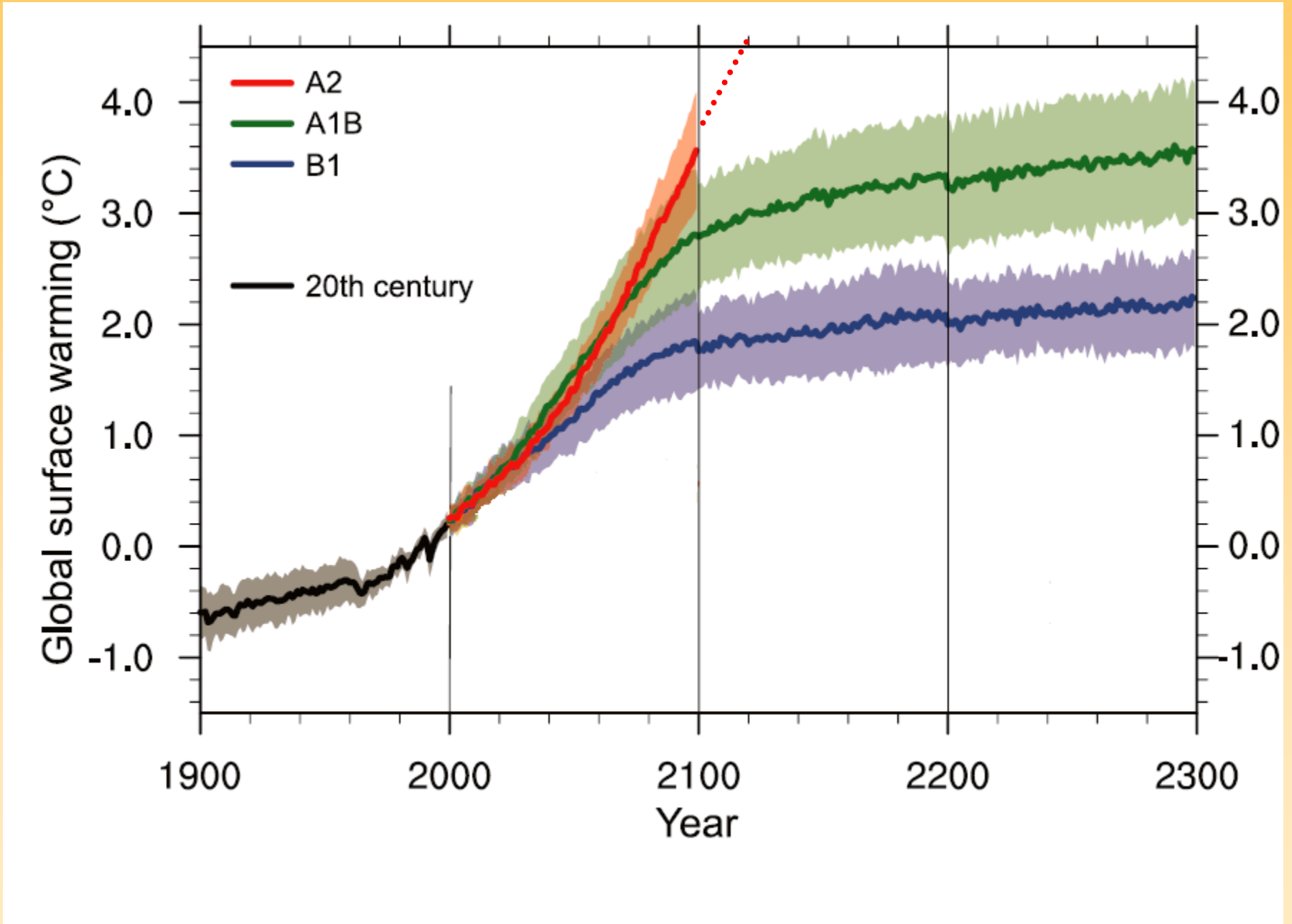
Radiative Forcing Components of Global Warming




the past 1,000 years
NORTHERN HEMISPHERE
Departures in temperature (°C)
from the 1961 to 1990 average
0.5
0.0
–0.5
–1.0
1000
1200
1400
1600
1800
2000
Year
Data from thermometers (red) and from tree rings,
corals, ice cores and historical records (blue).
Source: IPCC

CO_2 concentration, temperature, and sea level continue to rise long after emissions are reduced




A2
A1B
B1
20th century
Global surface warming (°C)
4.0
3.0
2.0
1.0
0.0
-1.0
1900
2000
2100
2200
2300
Year

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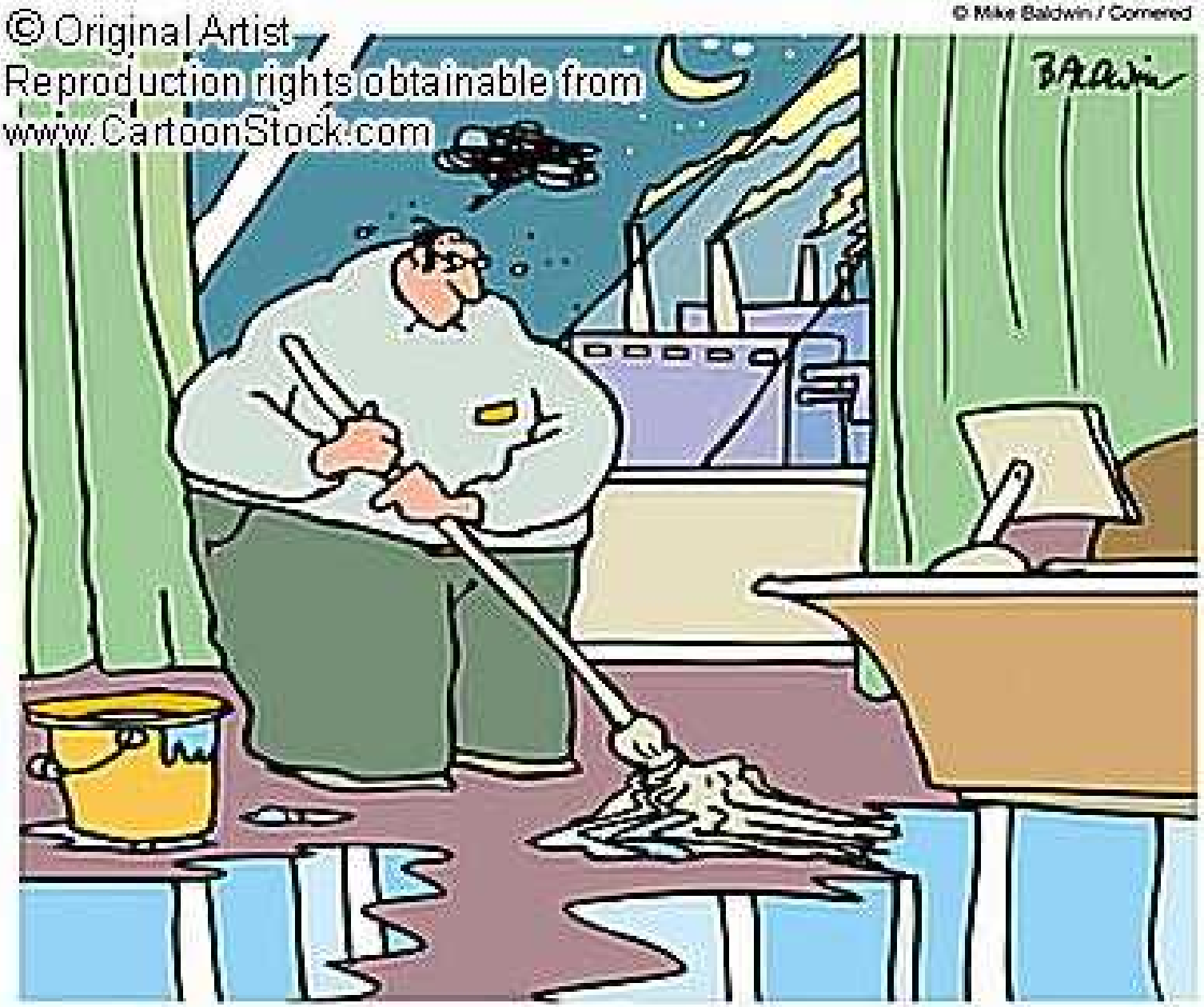
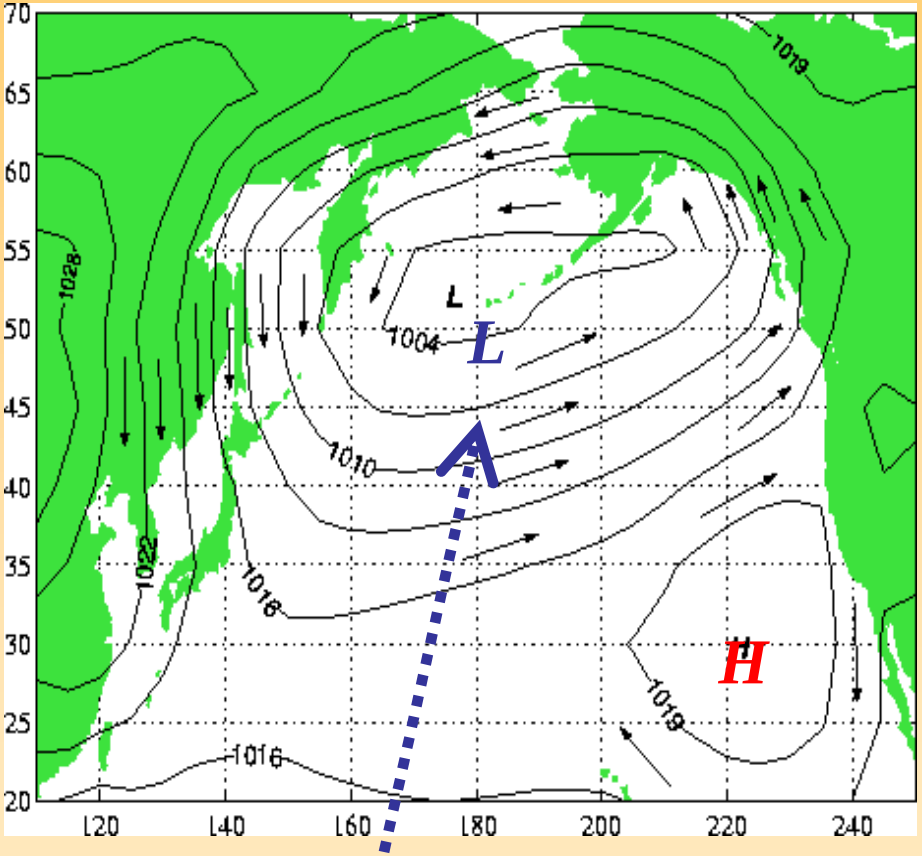


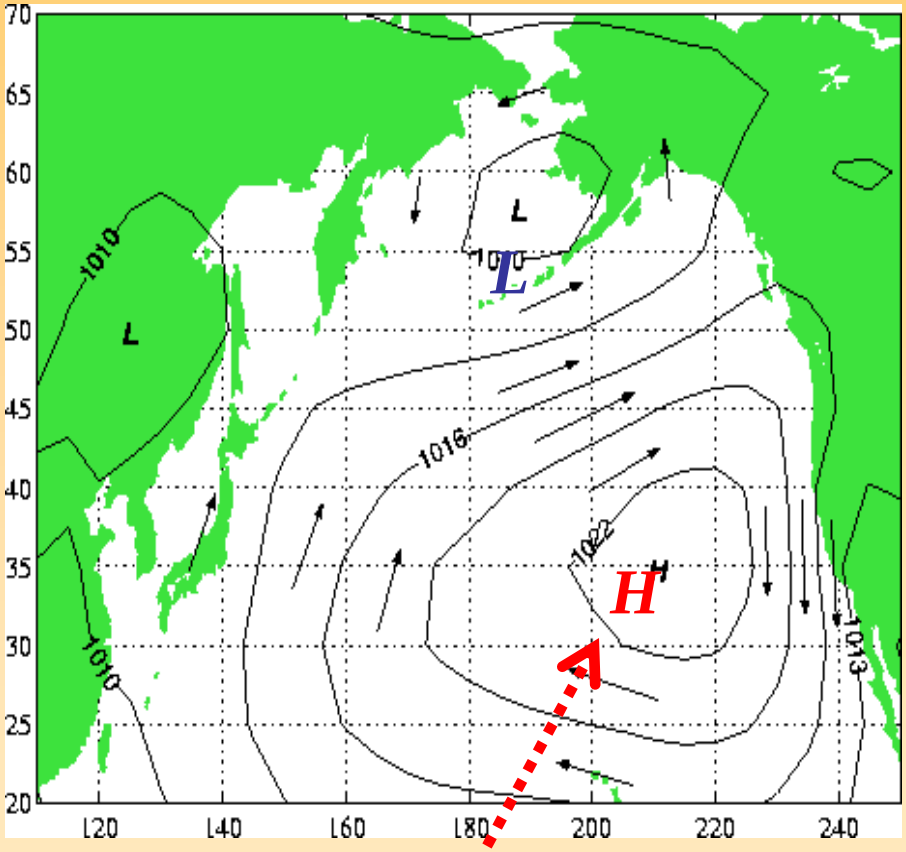
The ice caps were melting and no one seemed to care. Except the guy who had to clean it up.

Winter winds and pressure over the North Pacific



"Aleutian Low"

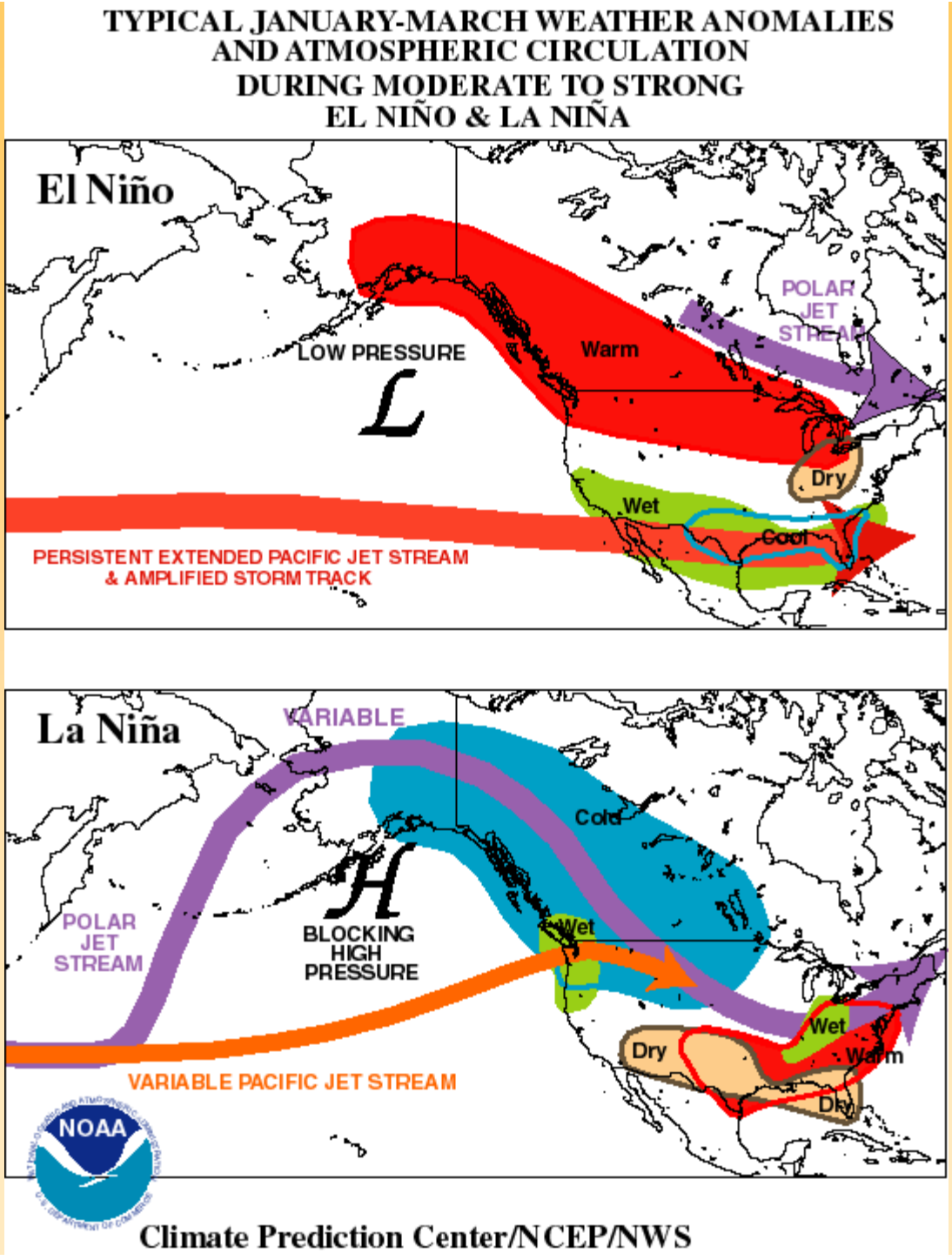
Summer winds and pressure over the North Pacific



"Subtropical High"

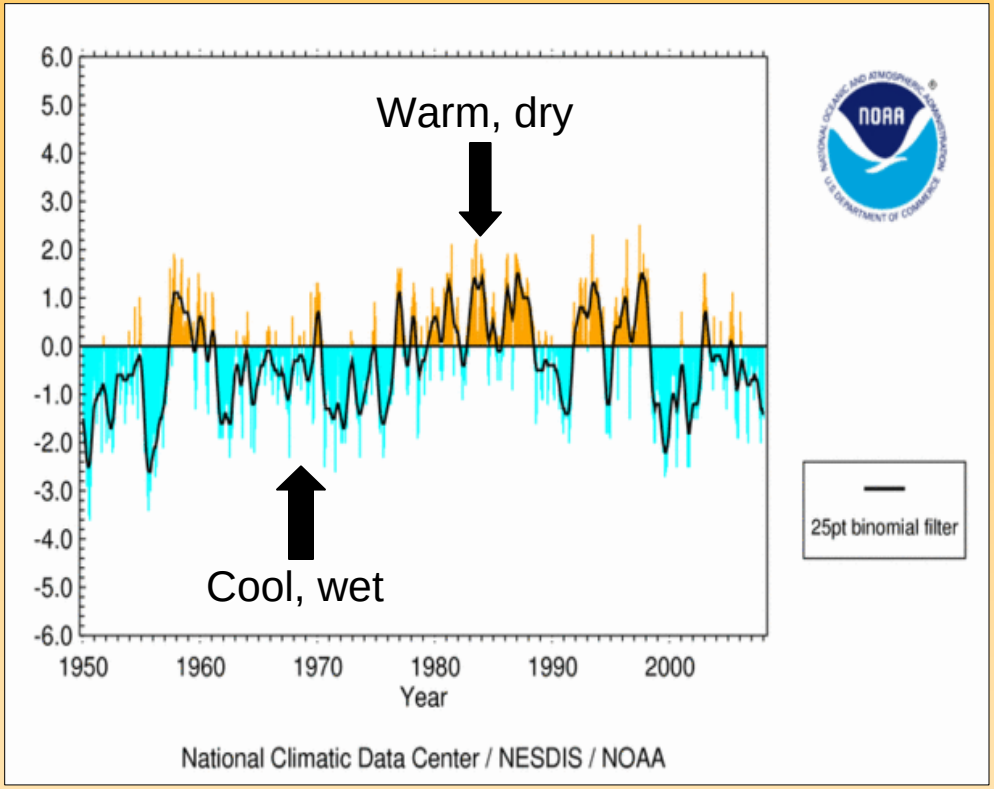
Warm, dry

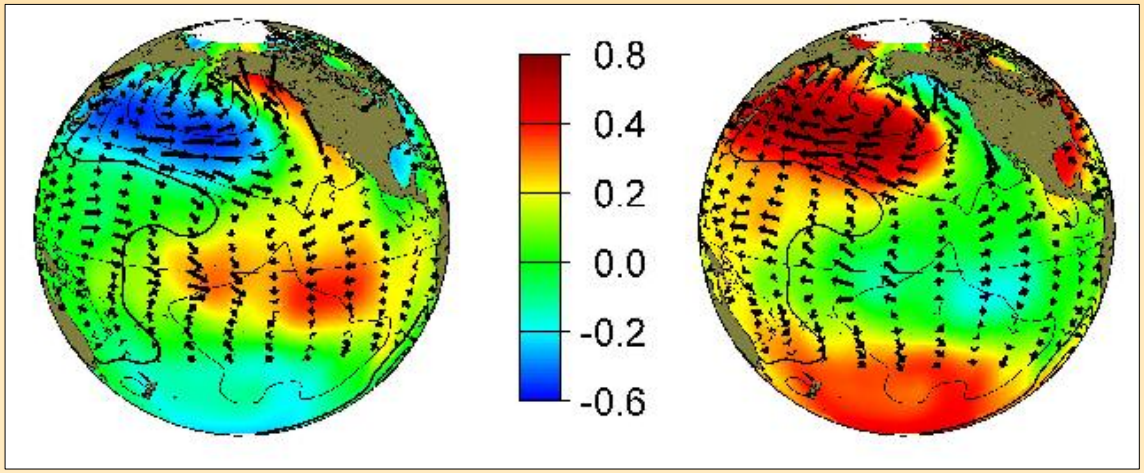
Cool, wet



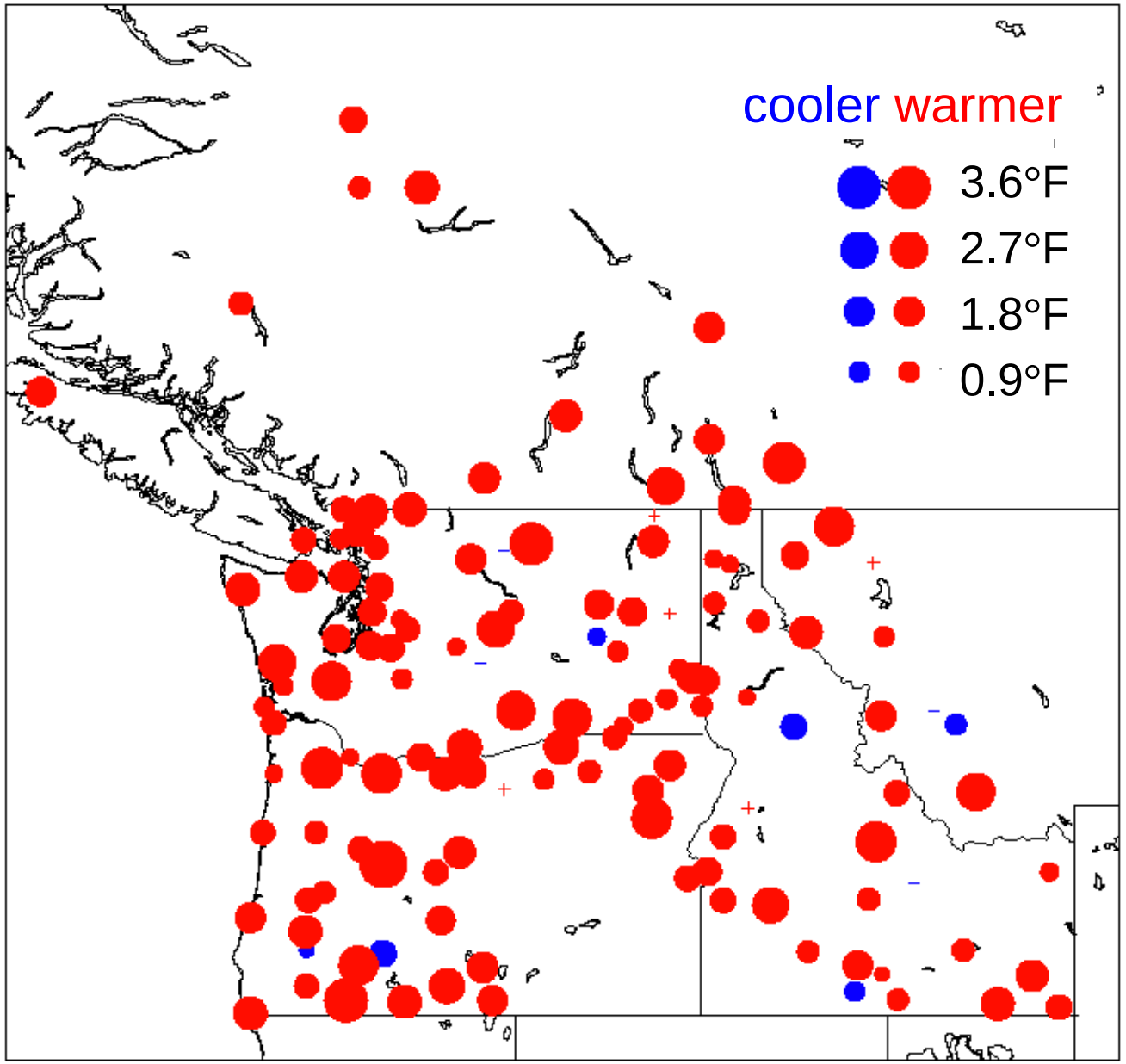
Pacific Decadal Oscillation

- **An El Niño-like pattern of climate variability**
- **20 - 30 year periods of persistence in North American and Pacific Basin climate**





Temperature trends (°F per century) since 1920



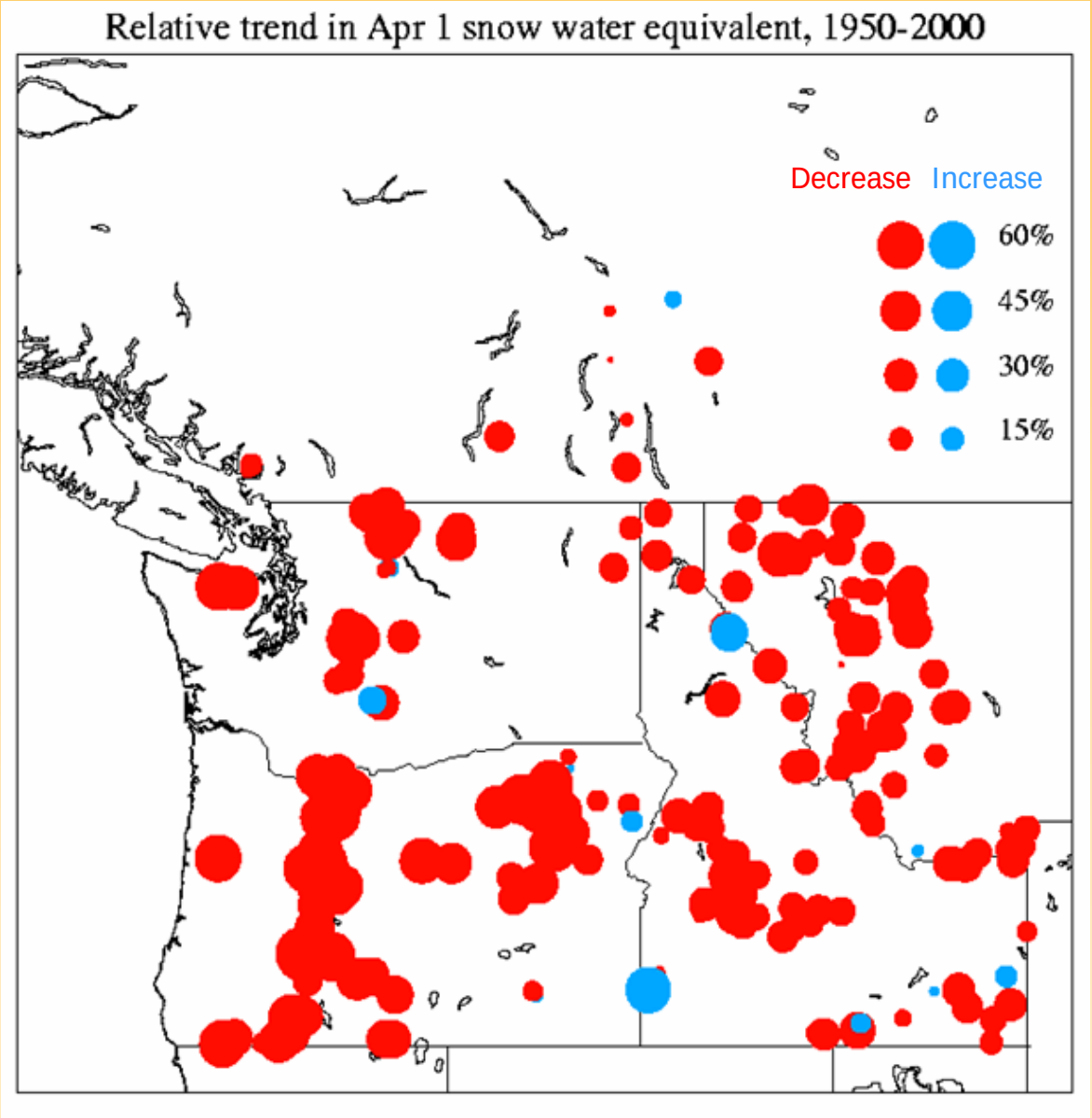
Nearly every glacier in the Cascades and Olympics has retreated during the past 50-150 years

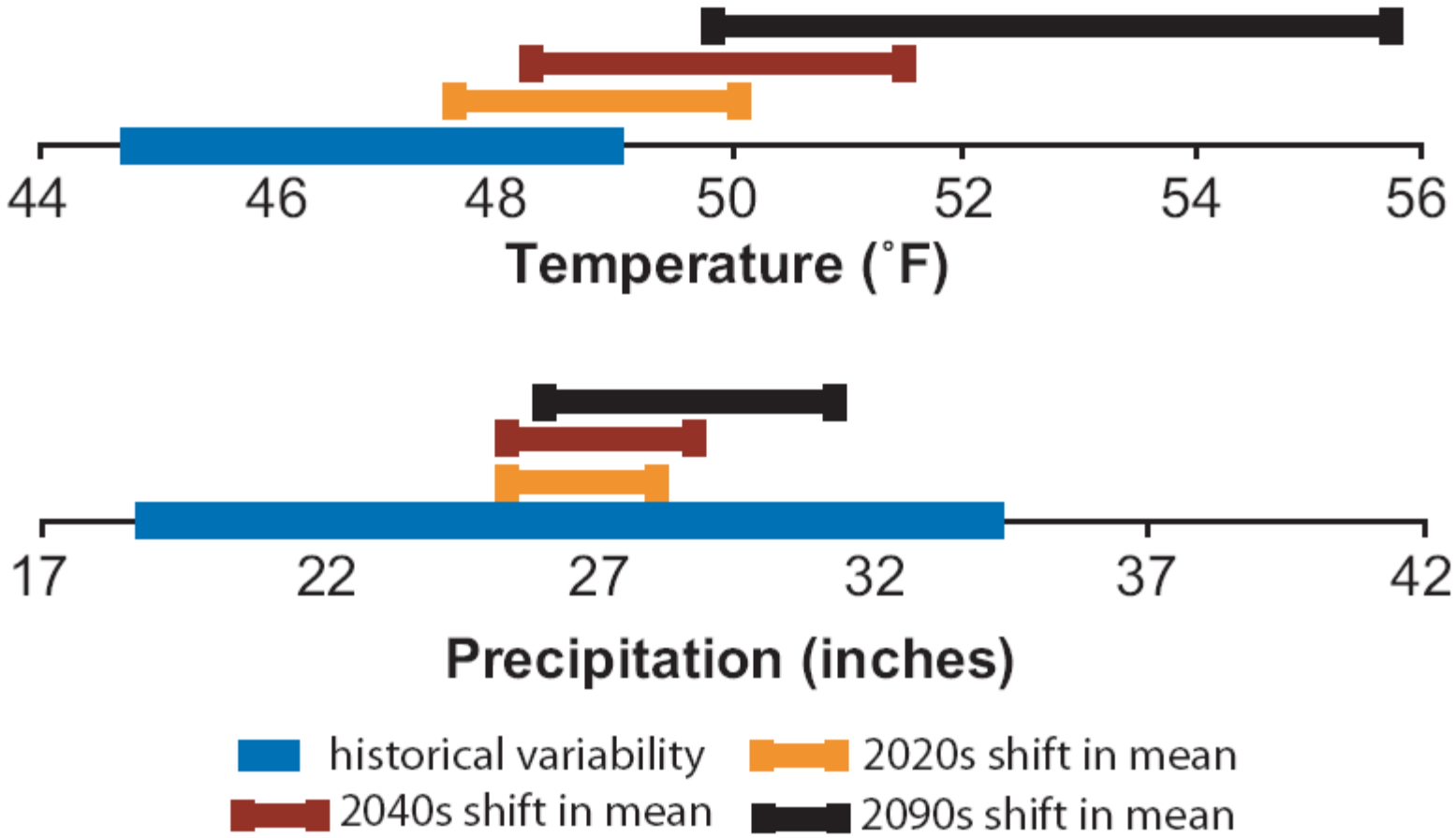
South Cascade Glacier, 1928 (top) and 2000 (right)

Photos courtesy of Dr. Ed Josberger, USGS Glacier Group, Tacoma, WA

Snow Water Equivalent Trends

- **Most PNW stations show a decline in snow water equivalent**
- **Numerous sites in the Cascades with 30% to 60% declines**
- **Similar trends throughout the western U.S.**

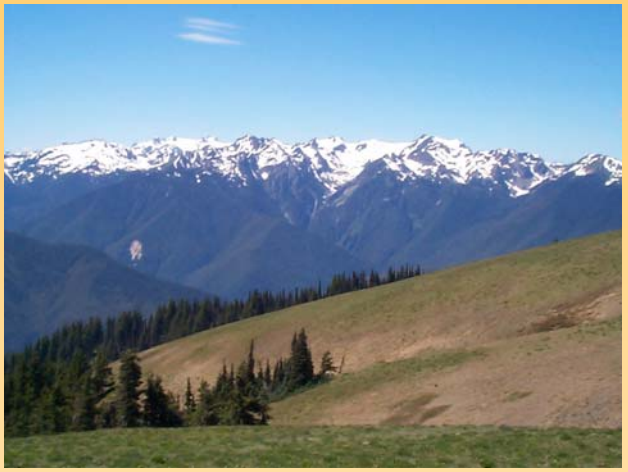




Comparison of observed year-to-year variability and projected shifts in temperature and precipitation from climate models

Climate controls ecosystem processes

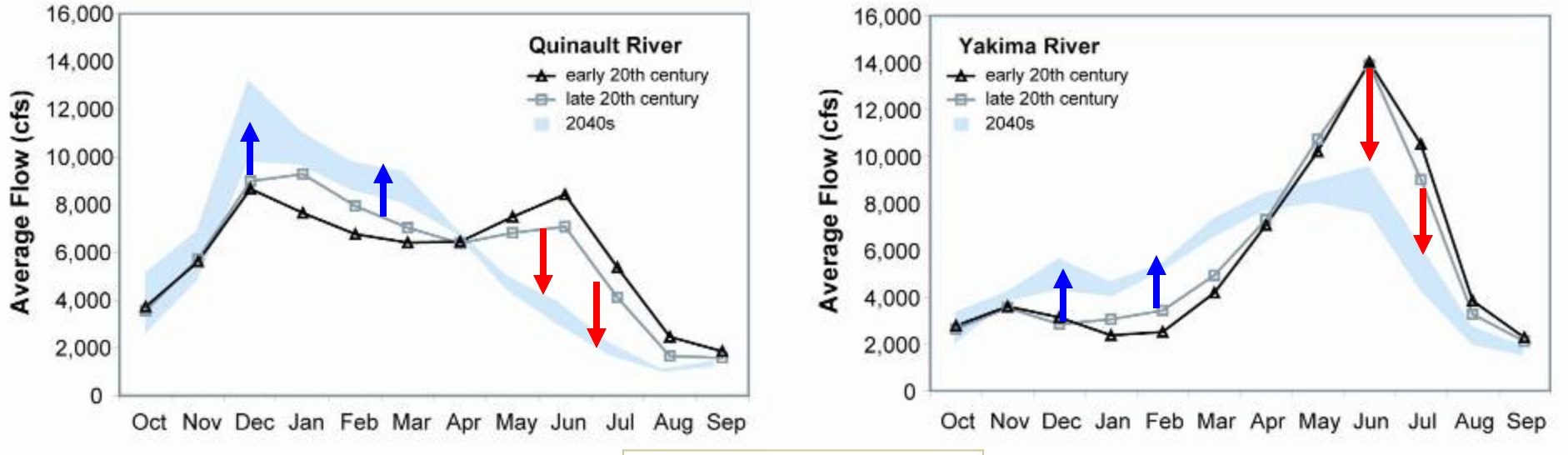
- Species distribution and abundance
- Vegetation productivity and growth
- Hydrologic cycle
- Disturbance
  - Fire
  - Insect outbreaks



Climate Change and Streamflow

- More winter rain, less snow → **higher winter streamflows**
- Warmer temperatures → **earlier snowmelt and shift in timing of peak runoff**
- Lower winter snowpack → **lower spring and summer flows**

Projected streamflow changes, 2050s

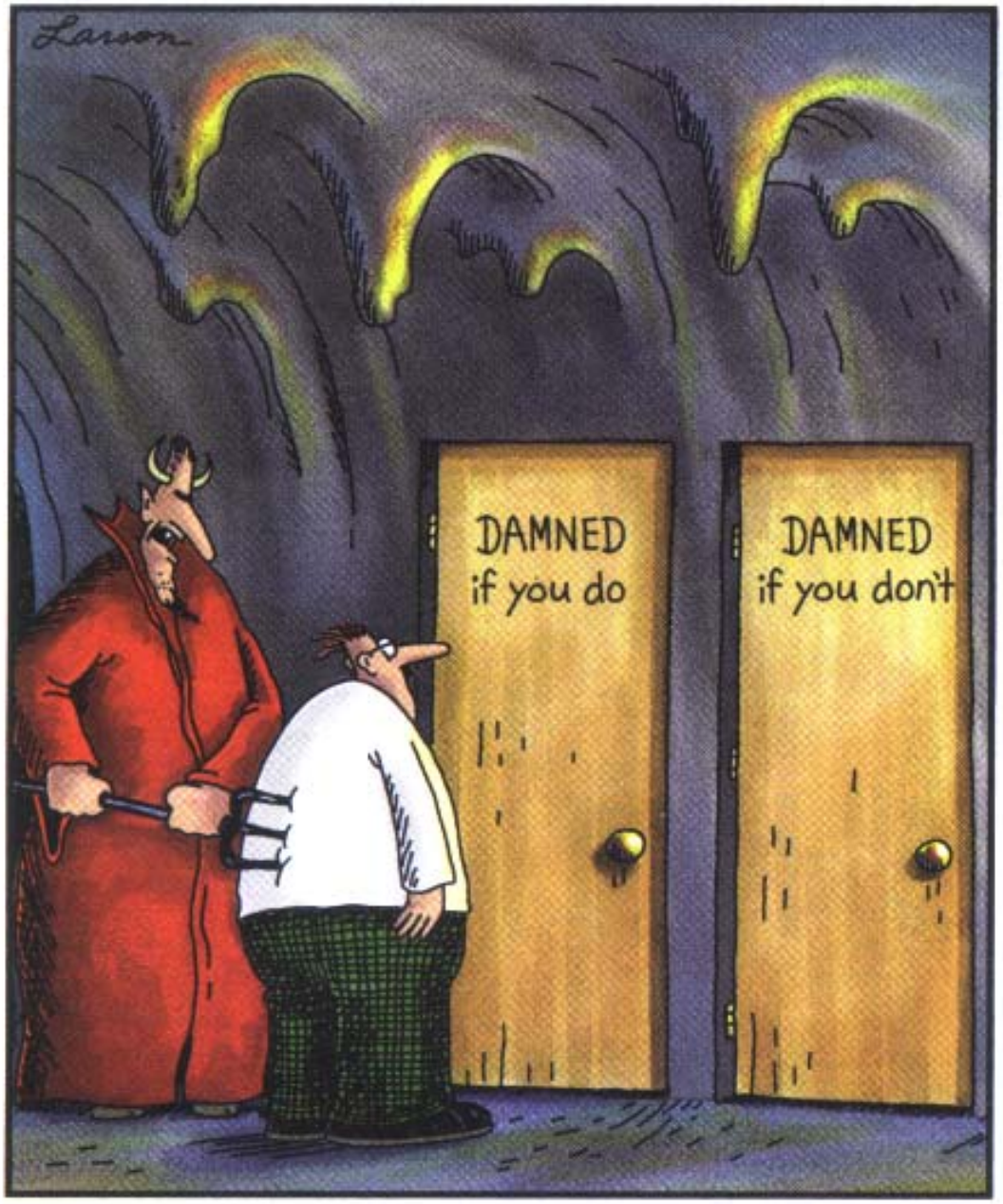


+3.6 to +5.4°F
(+2 to +3°C)

Climate Change and Fire

- Warmer and drier spring conditions =
  - early snowmelt
  - lower summer soil and fuel moisture
  - longer fire seasons
  - increased fire frequency and extent
- Fire intensity and severity may also increase

Adaptation strategies for natural resource management?



"C'mon, c'mon—it's either one or the other."

Can resource management help <u>adapt</u> to climate change?

General adaptation strategies

- *Implement* adaptive management
- Incorporate uncertainty in science and management
- View fire disturbance (and ecological disturbance in general) as an opportunity
- Work with your neighbors – collaboration among organizations

Adaptation strategy #1

Increase landscape diversity

Increase resilience at large spatial scales

--Treatments and spatial configurations that minimize loss of large number of structural and functional groups

Increase size of management units

-- Much larger treatments and age/structural classes

Connectivity

Adaptation strategy #2

Maintain biological diversity

Modify genetic guidelines

Experiment with mixed species, mixed genotypes

Assist colonization, establish neo-native species

Identify species, populations, and communities that are sensitive to increased disturbance

Adaptation strategy #3

Manage for realistic outcomes

Identify key thresholds for species and functions

Determine which thresholds will be exceeded (e.g., Pacific salmon)

Prioritize projects with high probability of success; abandon hopeless causes

Identify those species and vegetation structures tolerant of increased disturbance

Adaptation strategy #4

Incorporate climate change in restoration

Reduce emphasis on historical references

Reduce emphasis on guidelines based on static relationships (e.g., plant associations, habitat types)

Develop performance standards appropriate for accomplishing realistic restoration trajectories

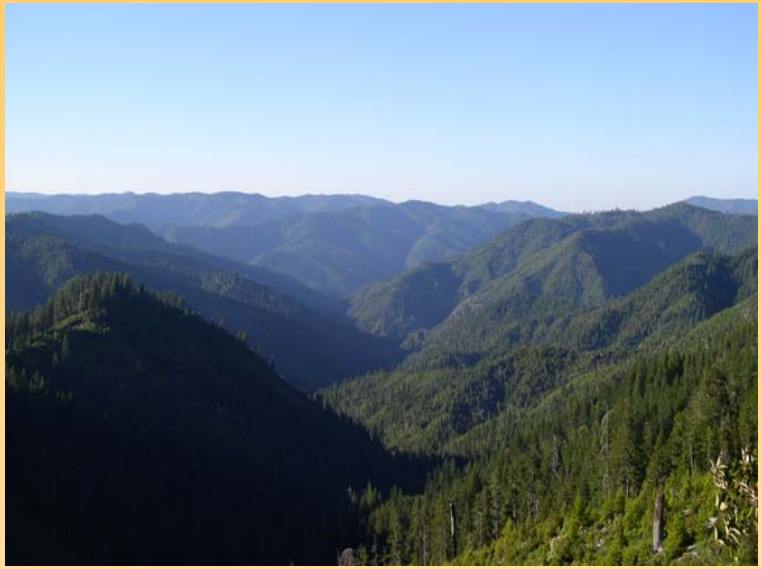
Adaptation strategy #5

Anticipate big surprises

Expect mega droughts, larger fires, system collapses, species extirpations, etc.

Incorporate these phenomena in planning

Thank you!



Jessica Halofsky: jhalo@u.washington.edu

Other Resources:

Climate Change Resource Center: http://www.fs.fed.us/ccrc

US Climate Change Science Program Synthesis and Assessment Product 4.4 (SAP 4.4):

http://www.climatescience.gov/Library/sap/sap4-4/default.php

Carbon in forest ecosystems

Carbon dioxide (CO_2) is emitted by human activities
-- Fossil fuel combustion (autos, industry)

CO_2 is emitted by natural processes
-- Fire, decomposition, respiration

Trees conduct photosynthesis by assimilating CO_2, a limiting factor for productivity and growth.

Forests take up and store large quantities of carbon on a global and regional basis
-- But annual uptake in Oregon only ~20% of emissions

Can resource management help <u>mitigate</u> climate change?

Increase rotation length

Retain woody debris on site or utilize it for products

Extend the life cycle of wood products; encourage recycling, re-use

Protect forests from crown fire (suppression, fuel management)

Potential market for carbon credits?

Carbon budgets

Storage (quantity) vs. uptake (rate)

Storage	Uptake
ton / ac	ton / ac / yr
25 - 50	3 - 6
250 - 500+ (300?)	+0.5?