TOPIC #15

OBSERVATIONS OF SHORT-TERM CLIMATIC VARIABILITY

pp 81 - 82 in Class Notes

All things are connected. Whatever befalls the earth, befalls the children of the earth.

~ Chief Seattle

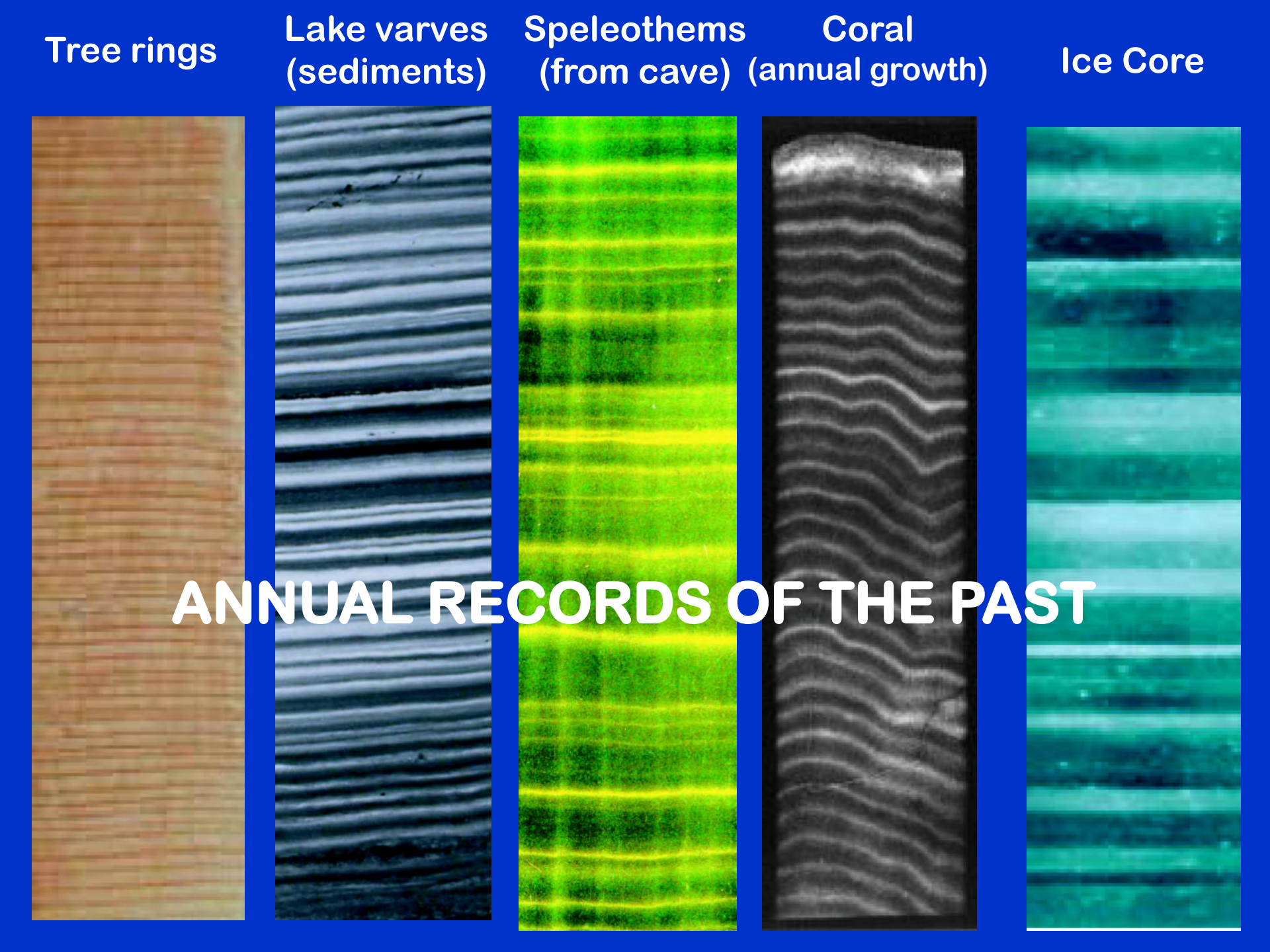
To make an incontrovertible case about the role that humans play in global warming, what do scientists need?

1) a long-term temperature record, i.e., centuries
2) over a large part of the globe
3) To be able to say . . . . .

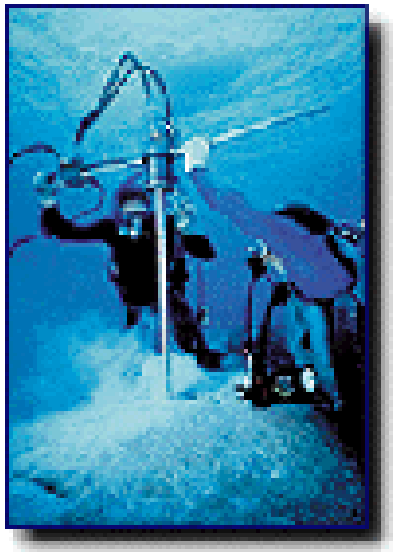
"What's the average been for several hundred years, & is this a significant departure from that?"

"And that's very difficult to do."

(James Trefil, physicist)

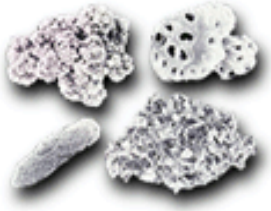

Tree rings
Lake varves (sediments)
Speleothems (from cave)
Coral (annual growth)
Ice Core
ANNUAL RECORDS OF THE PAST

"PROXY" DATA or NATURAL ARCHIVES of CLIMATE

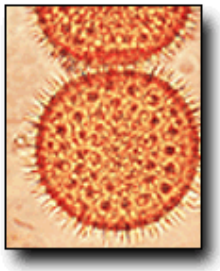


Corals

Ice cores



Lake, bog & ocean sediments



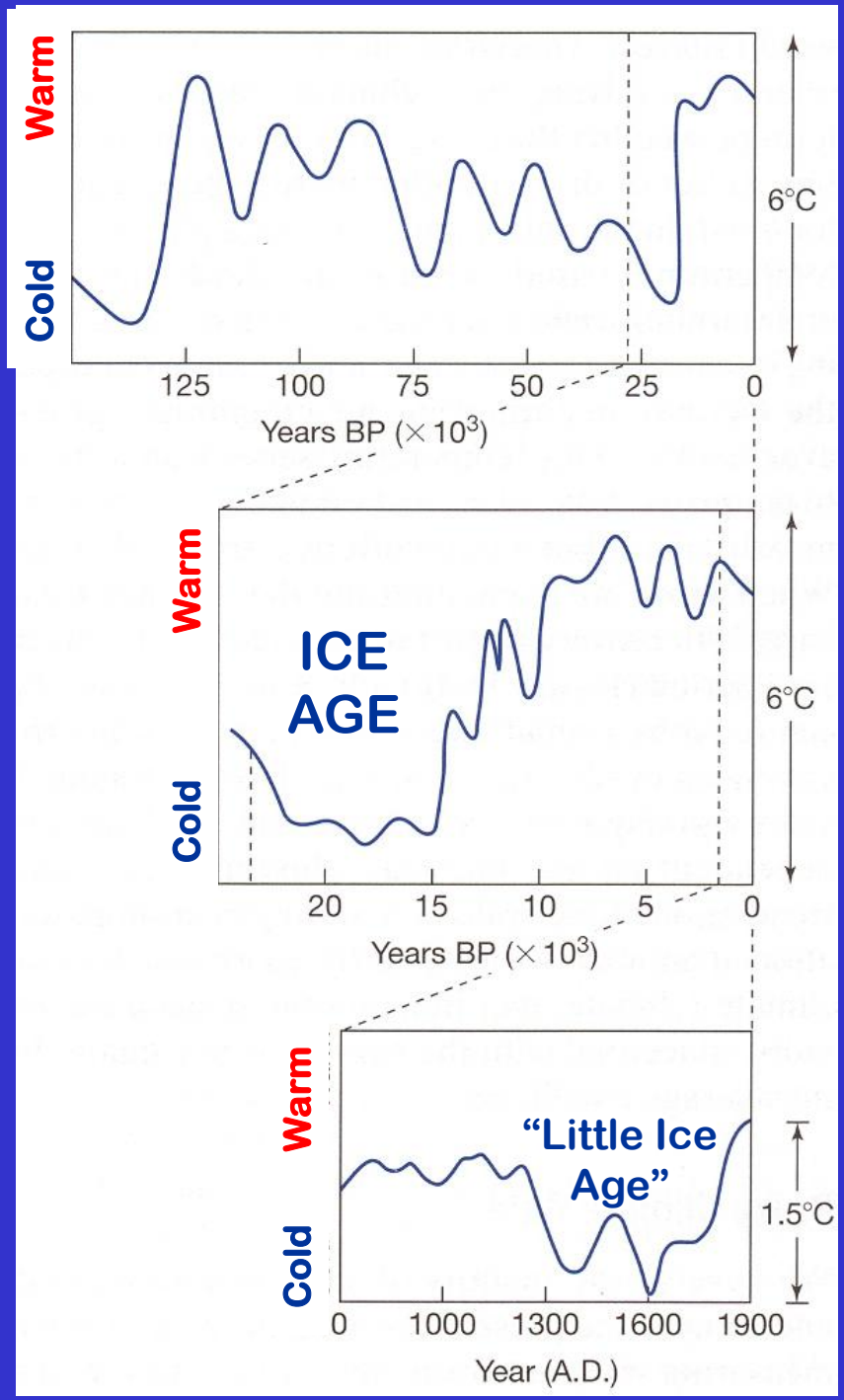
Pollen

WHAT NATURAL ARCHIVES REVEAL:

Over different "Telescoping" Time Scales Of Variability about:

Mean Global Temperature Change

Since The Last Glacial Maximum
(Years BP = "years before present")

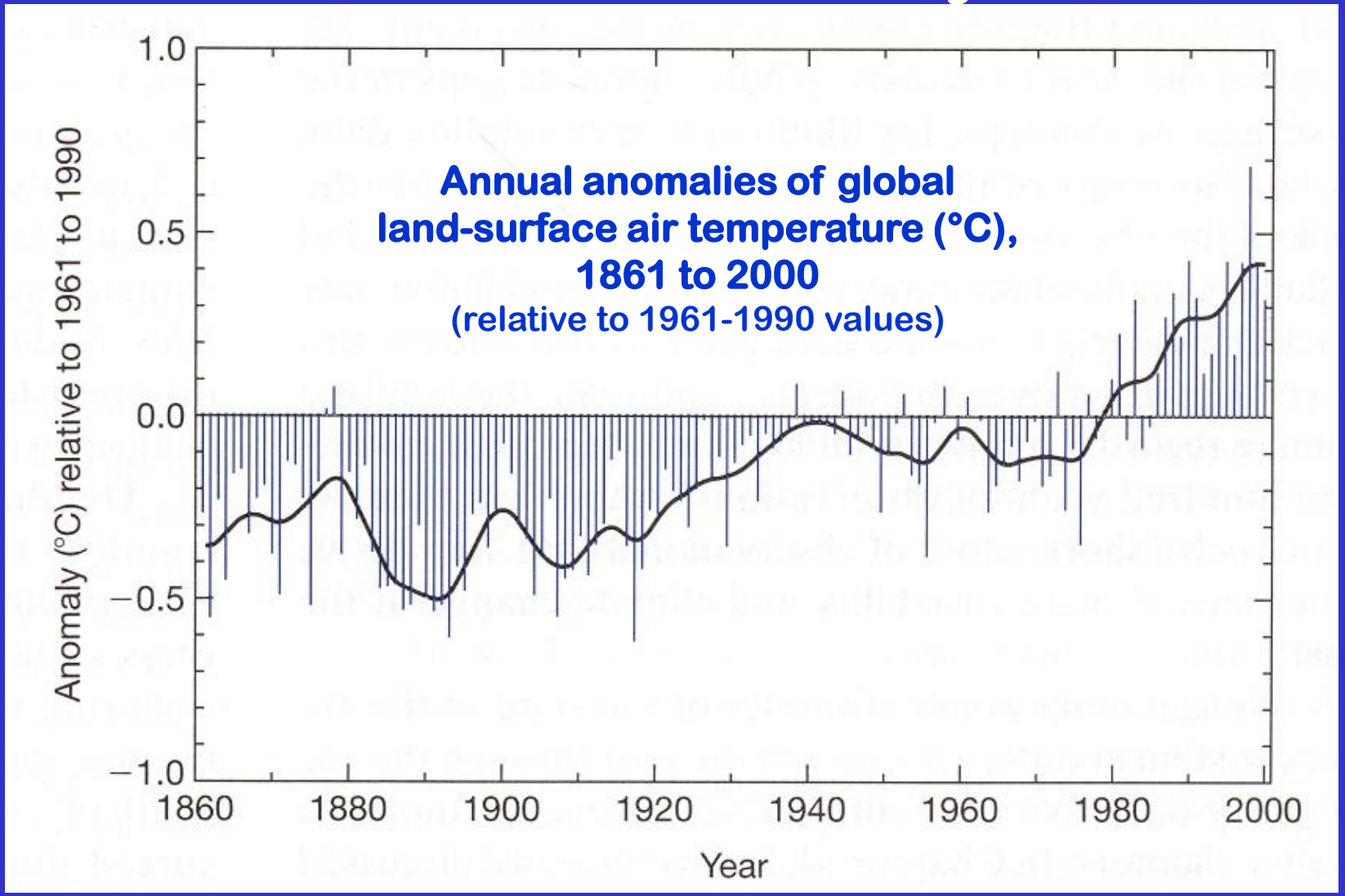


Generalized oxygen isotope curve from **deep-sea sediments**

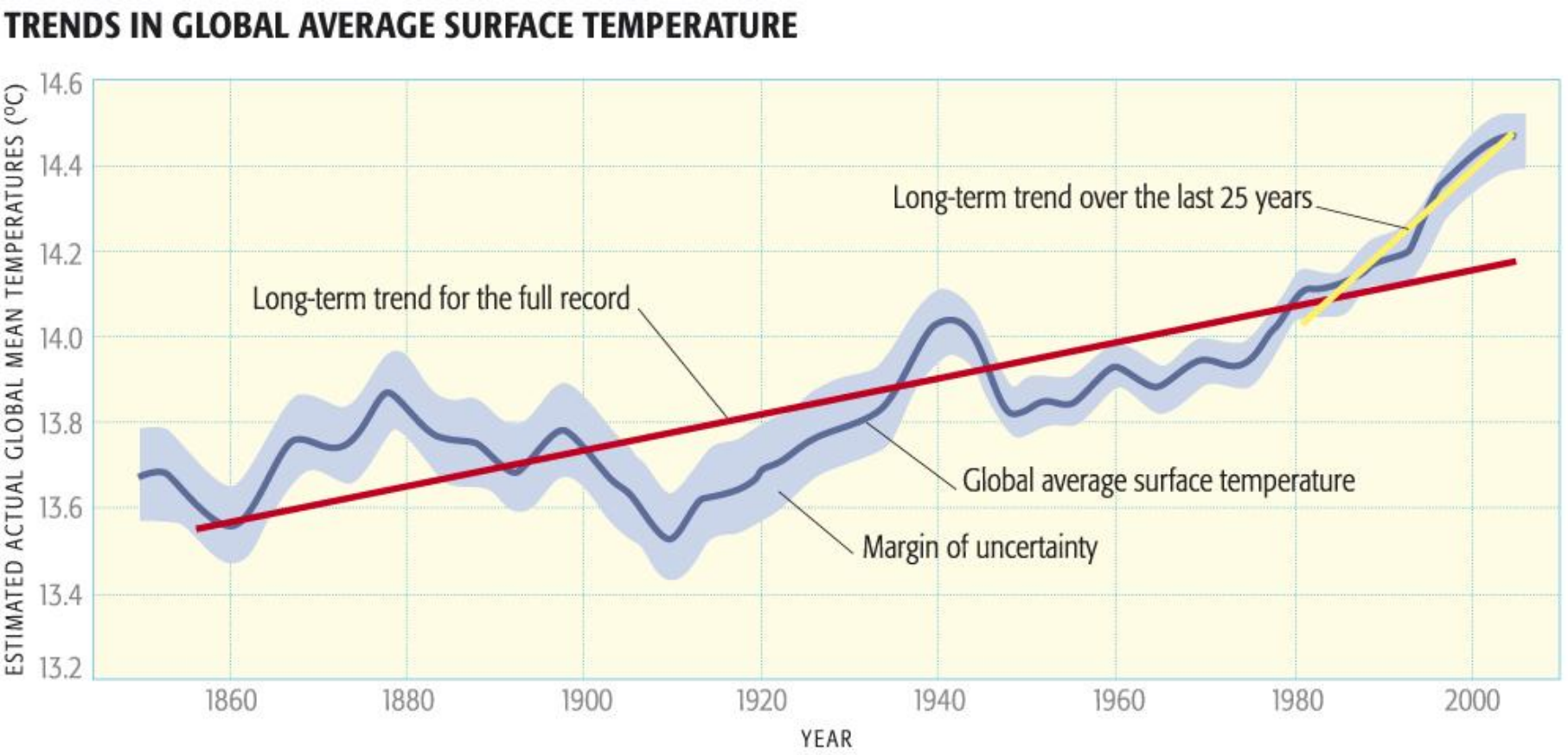
Generalized estimates from **pollen data & alpine glaciers** (mid-latitudes of eastern N. America & Europe)

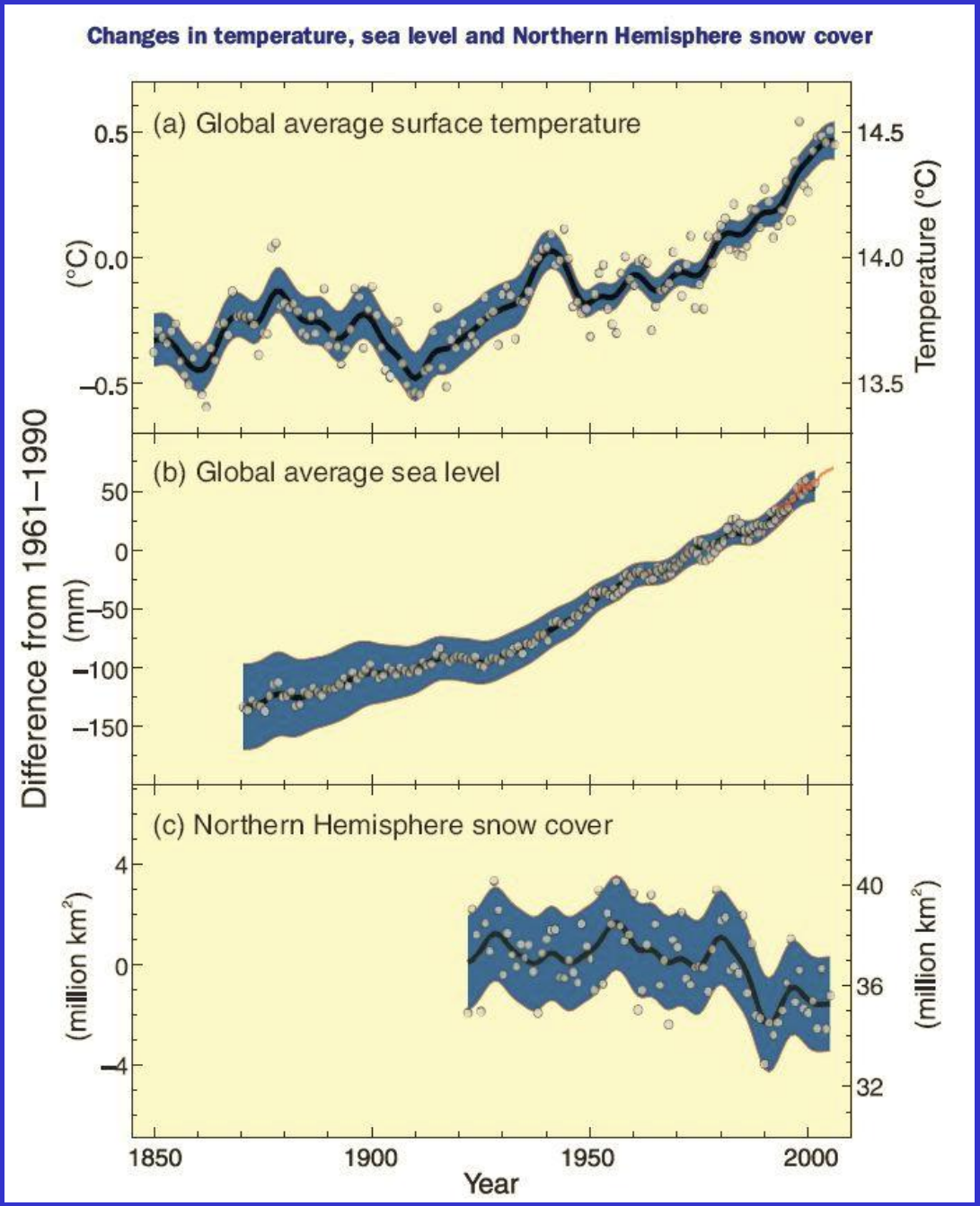
General estimates from **historical documents** (emphasis on the North Atlantic region)

The most recent 150 years:

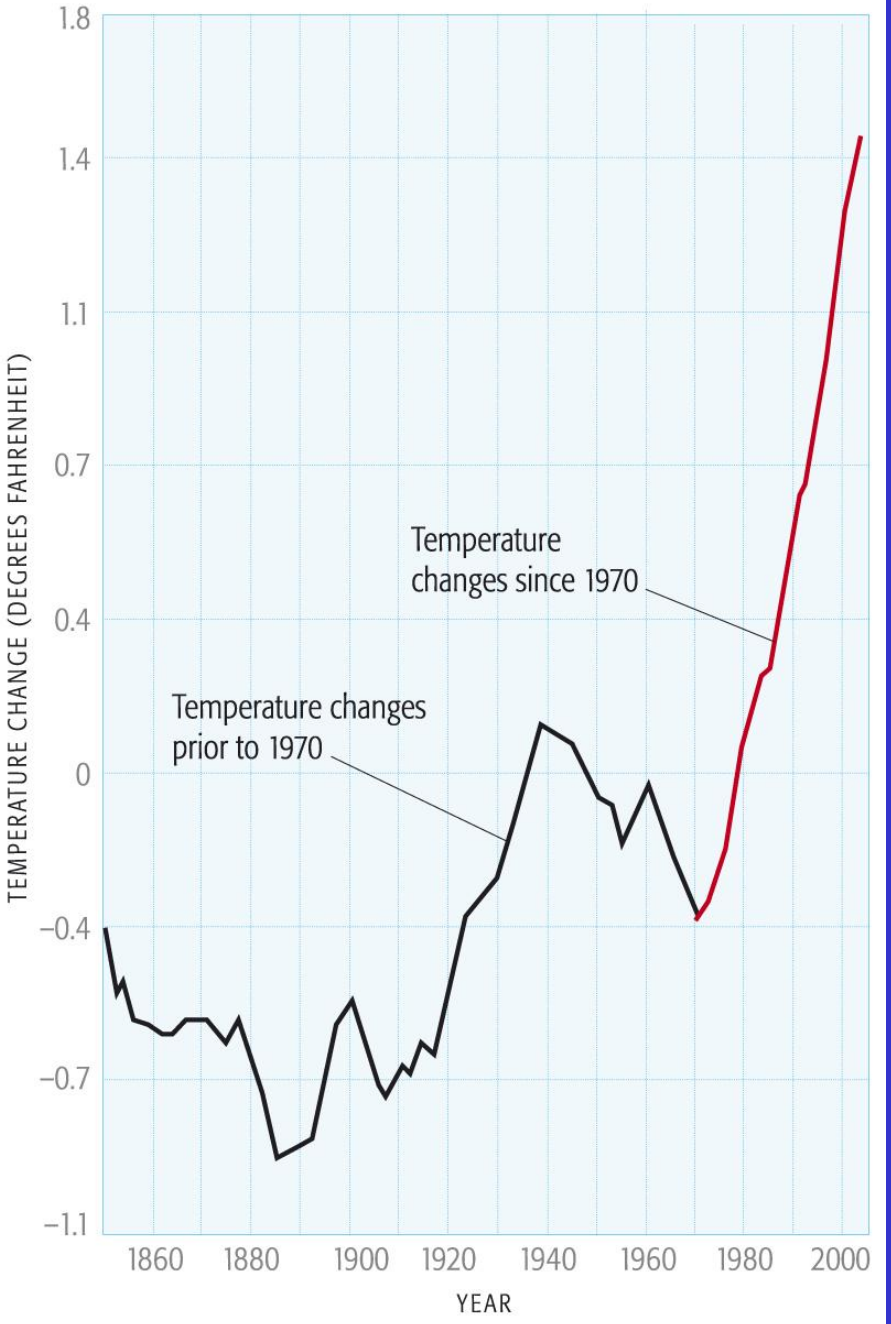


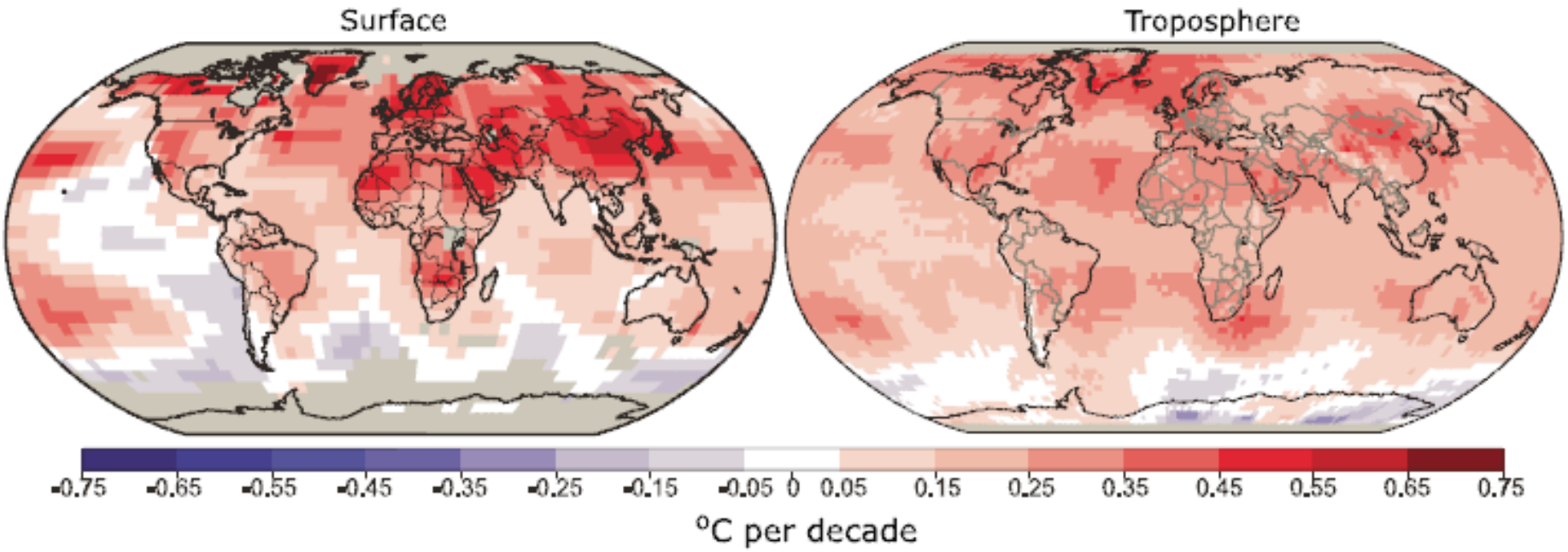
How is the Earth's GLOBAL Mean Temperature Changing?




Changes in temperature, sea level and Northern Hemisphere snow cover
(a) Global average surface temperature
(b) Global average sea level
(c) Northern Hemisphere snow cover
Difference from 1961–1990
(°C)
(mm)
(million km²)
Temperature (°C)
(million km²)
0.5
0.0
−0.5
14.5
14.0
13.5
50
0
−50
−100
−150
4
0
−4
40
36
32
1850
1900
1950
2000
Year

NORTHERN HEMISPHERE CONTINENTAL TEMPERATURE TRENDS



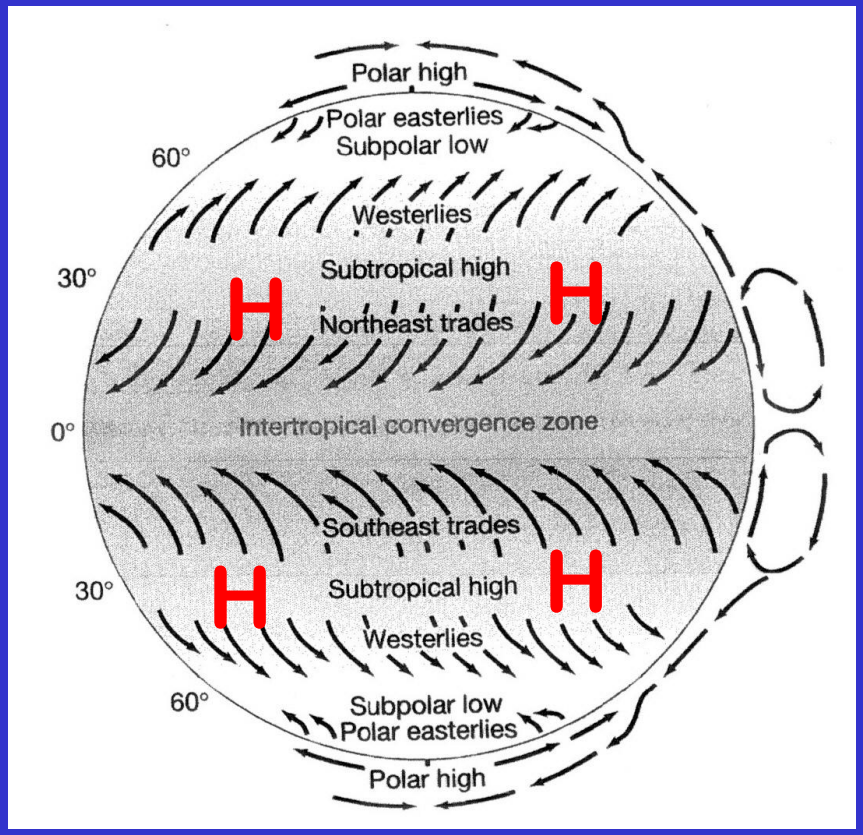


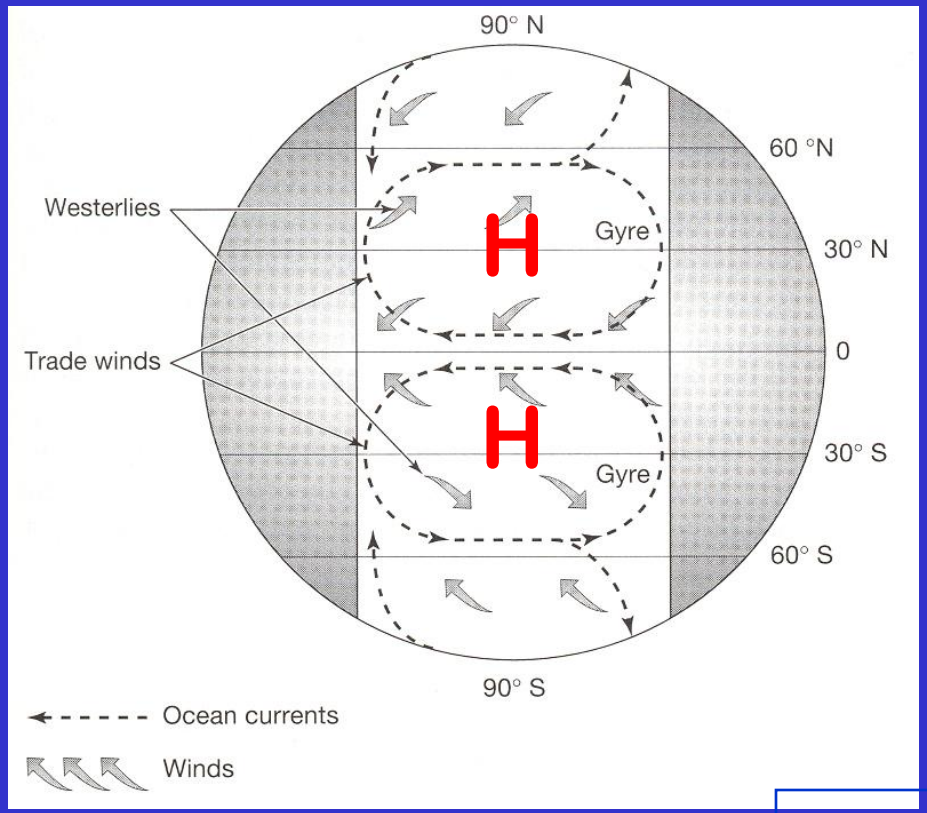
Patterns of linear global temperature trends from 1979 to 2005 estimated at the surface (left), and for the troposphere (right) from the surface to about 10 km altitude, from satellite records.

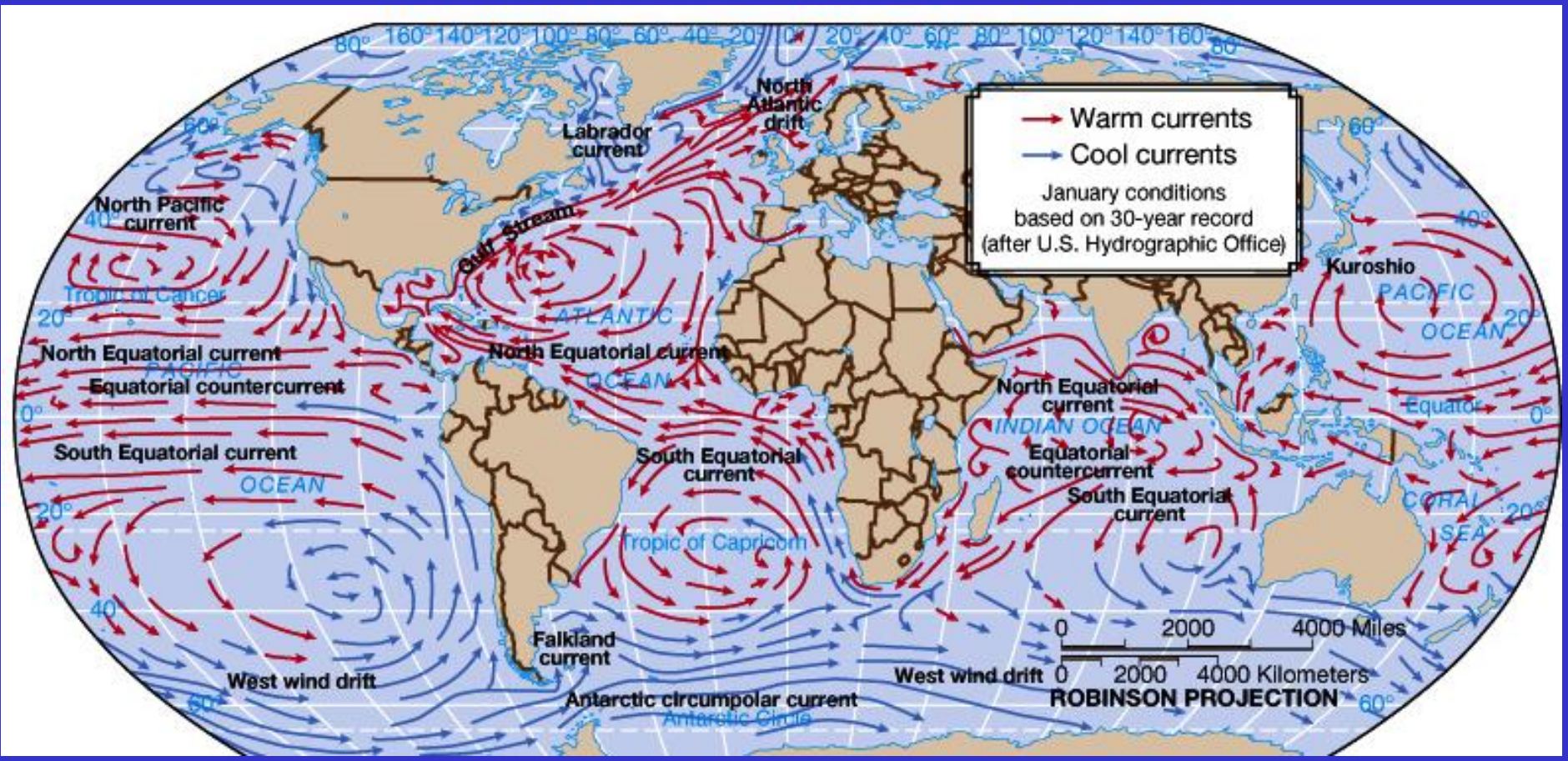
Grey areas indicate incomplete data.

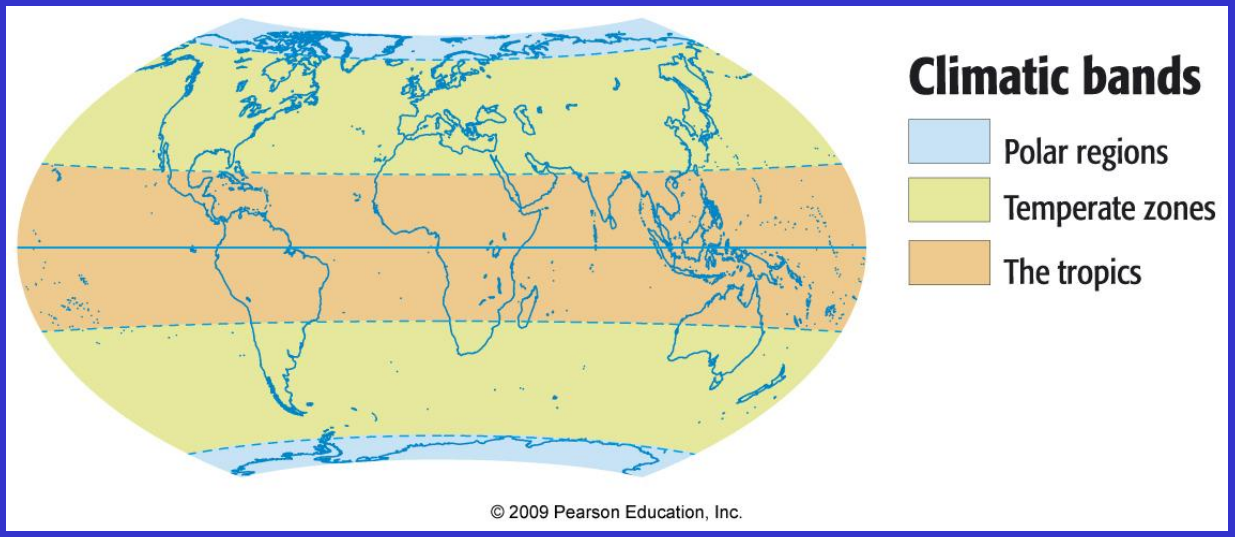
Note the more spatially uniform warming in the satellite tropospheric record while the surface temperature changes more clearly relate to land and ocean.

REVIEW:
Atmosphere & Ocean Circulation






Warm currents
Cool currents
January conditions
based on 30-year record
(after U.S. Hydrographic Office)
North Atlantic drift
Labrador current
North Pacific current
Gulf Stream
Kuroshio
North Equatorial current
Equatorial countercurrent
South Equatorial current
North Equatorial current
South Equatorial current
North Equatorial current
Equatorial countercurrent
South Equatorial current
Falkland current
West wind drift
Antarctic circumpolar current
West wind drift
Tropic of Cancer
Tropic of Capricorn
Antarctic Circle
Equator
PACIFIC OCEAN
ATLANTIC OCEAN
INDIAN OCEAN
CORAL SEA
0 2000 4000 Miles
0 2000 4000 Kilometers
ROBINSON PROJECTION


Climatic bands
Polar regions
Temperate zones
The tropics
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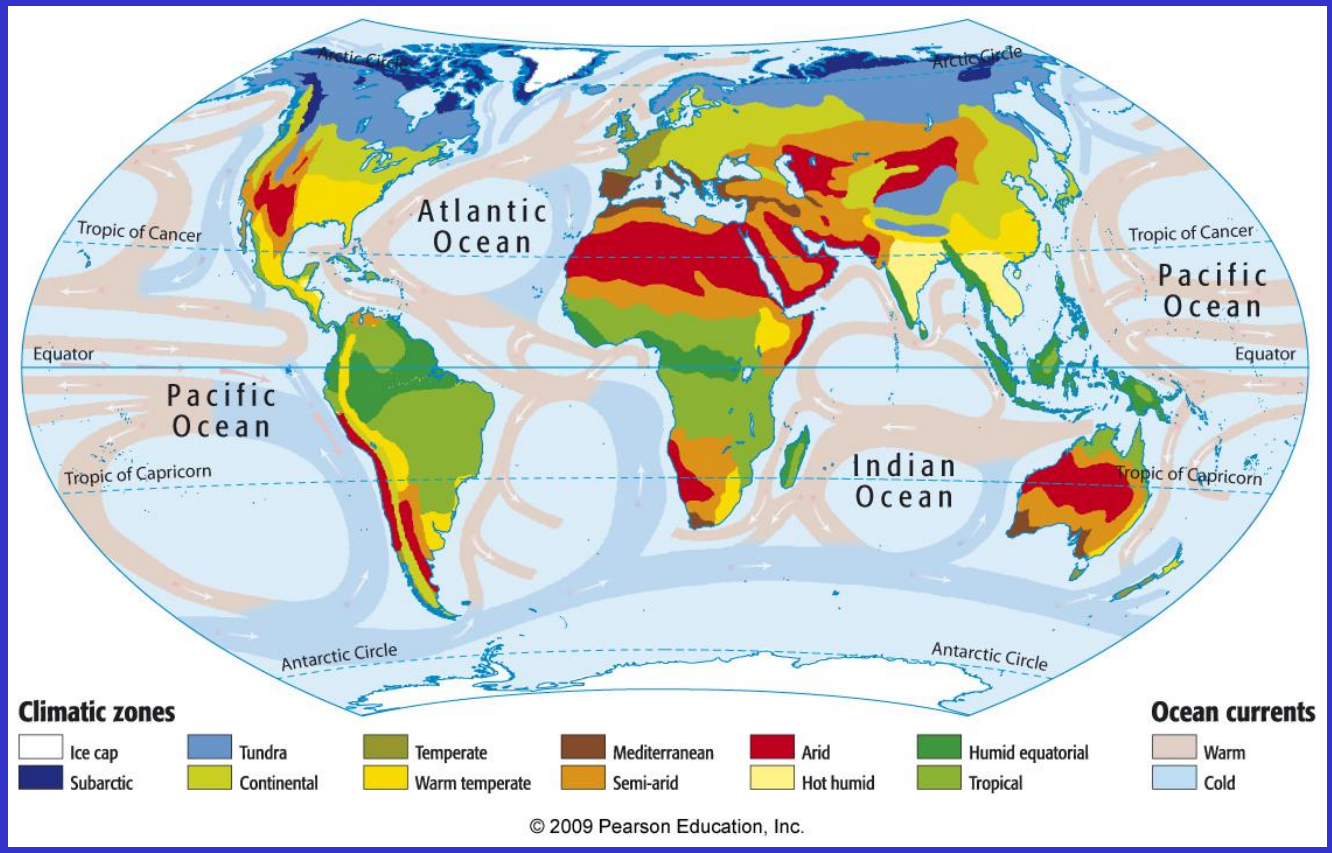
Arctic Circle
Arctic Circle
Tropic of Cancer
Tropic of Cancer
Atlantic Ocean
Pacific Ocean
Equator
Equator
Pacific Ocean
Indian Ocean
Tropic of Capricorn
Tropic of Capricorn
Antarctic Circle
Antarctic Circle
Climatic zones
Ice cap
Subarctic
Tundra
Continental
Temperate
Warm temperate
Mediterranean
Semi-arid
Arid
Hot humid
Humid equatorial
Tropical
Ocean currents
Warm
Cold
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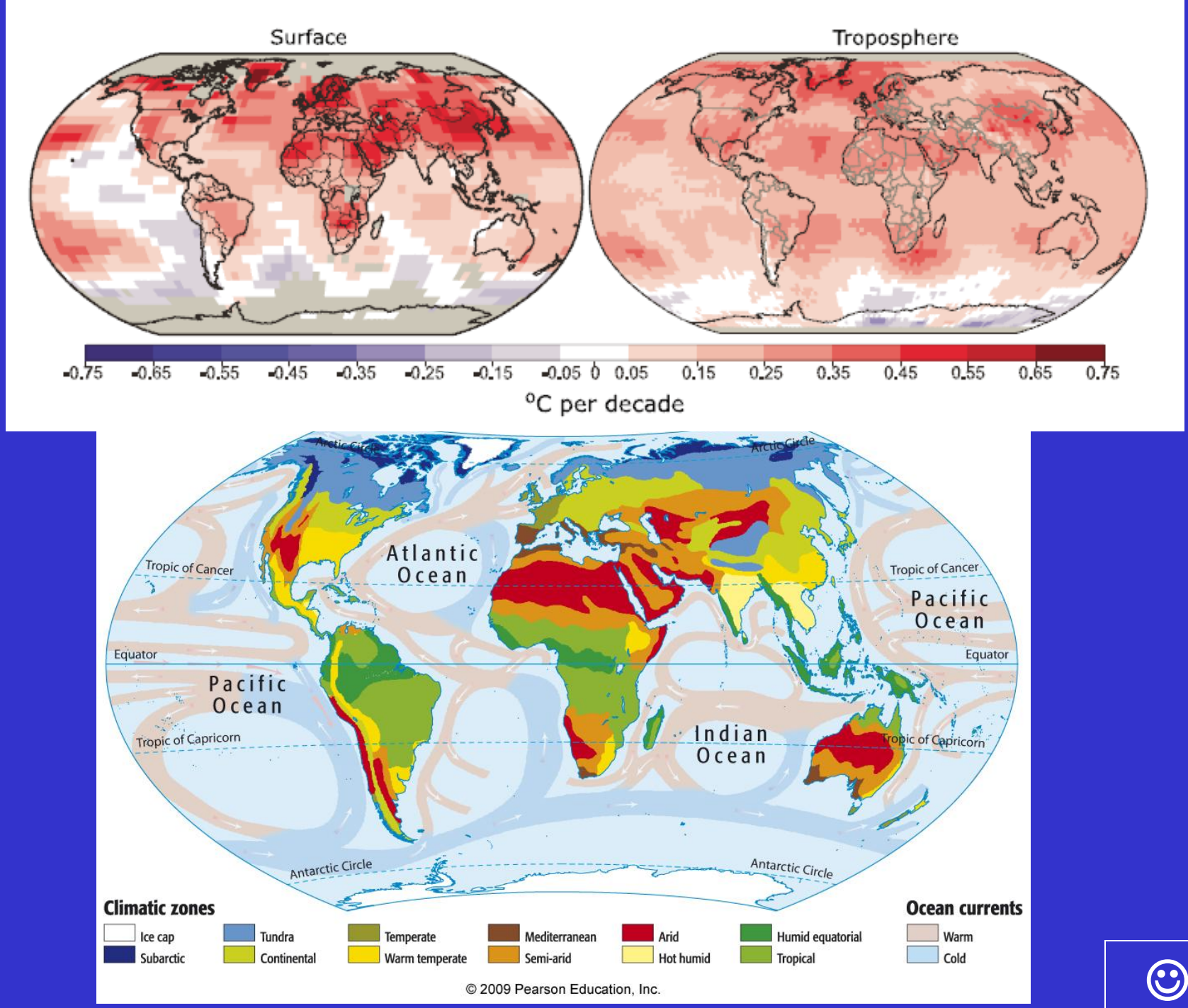
Surface
Troposphere
-0.75 -0.65 -0.55 -0.45 -0.35 -0.25 -0.15 -0.05 0 0.05 0.15 0.25 0.35 0.45 0.55 0.65 0.75
°C per decade
Arctic Circle
Arctic Circle
Tropic of Cancer
Tropic of Cancer
Atlantic Ocean
Pacific Ocean
Equator
Equator
Pacific Ocean
Tropic of Capricorn
Tropic of Capricorn
Indian Ocean
Antarctic Circle
Antarctic Circle
Climatic zones
Ice cap
Subarctic
Tundra
Continental
Temperate
Warm temperate
Mediterranean
Semi-arid
Arid
Hot humid
Humid equatorial
Tropical
Ocean currents
Warm
Cold
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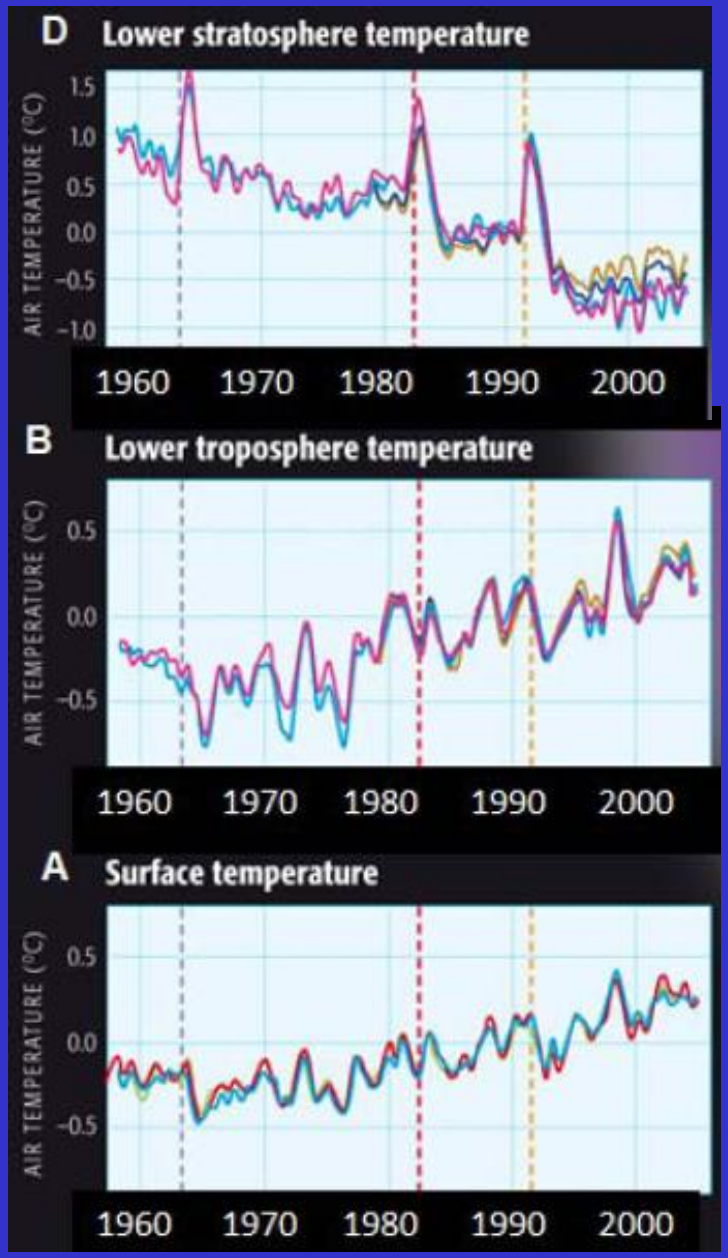
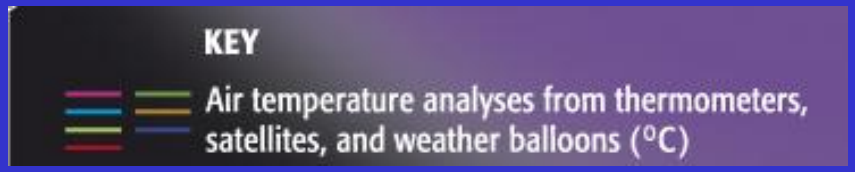


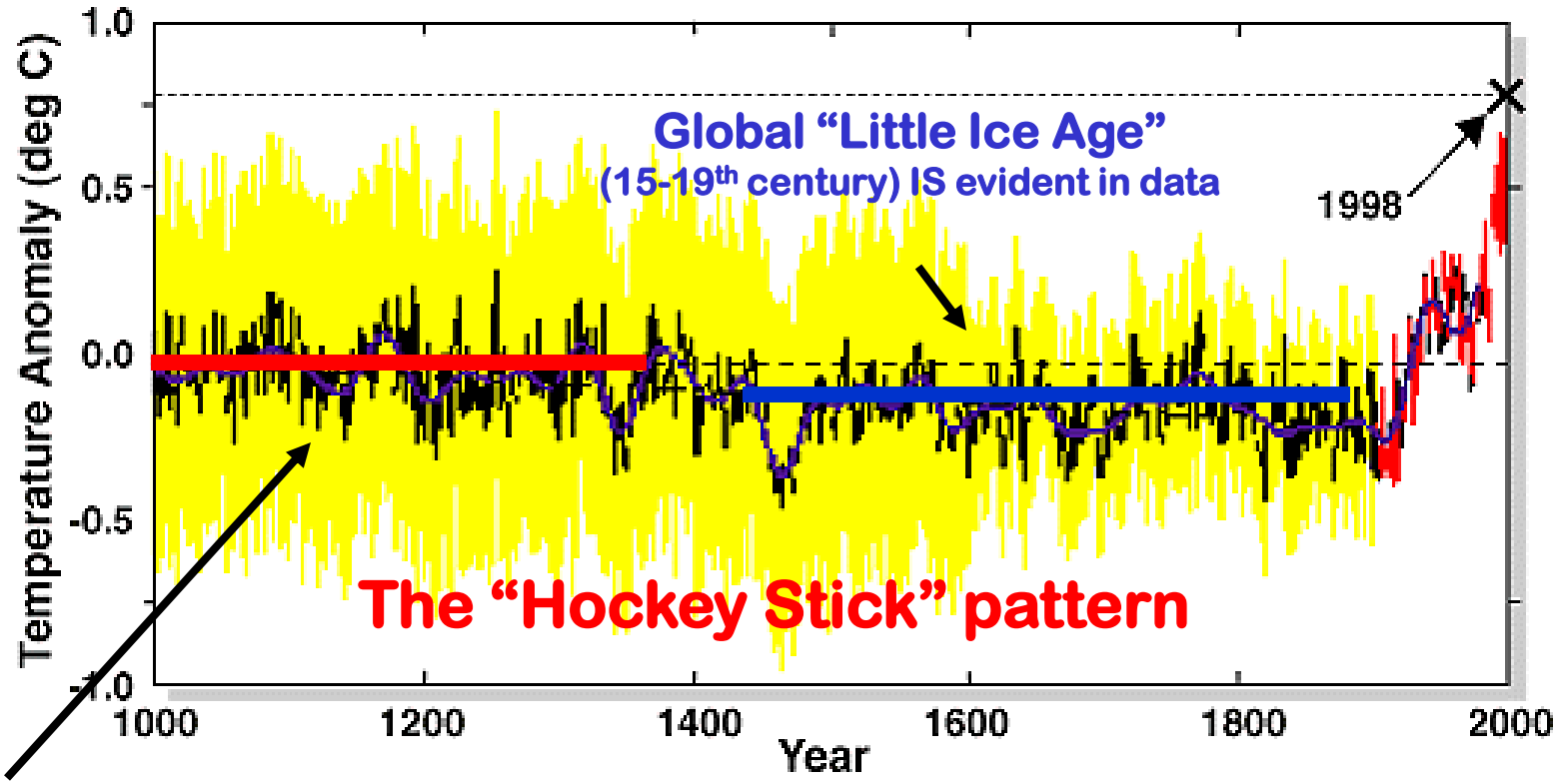
BUT! As the surface & the TROPOSPHERE warm . . . The STRATOSPHERE is COOLING!

Why?



KEY GRAPH! Temperature change over the last 1000 years from multi-proxy records: shows there is NO period of global or hemispheric temperatures warmer than the 20th century

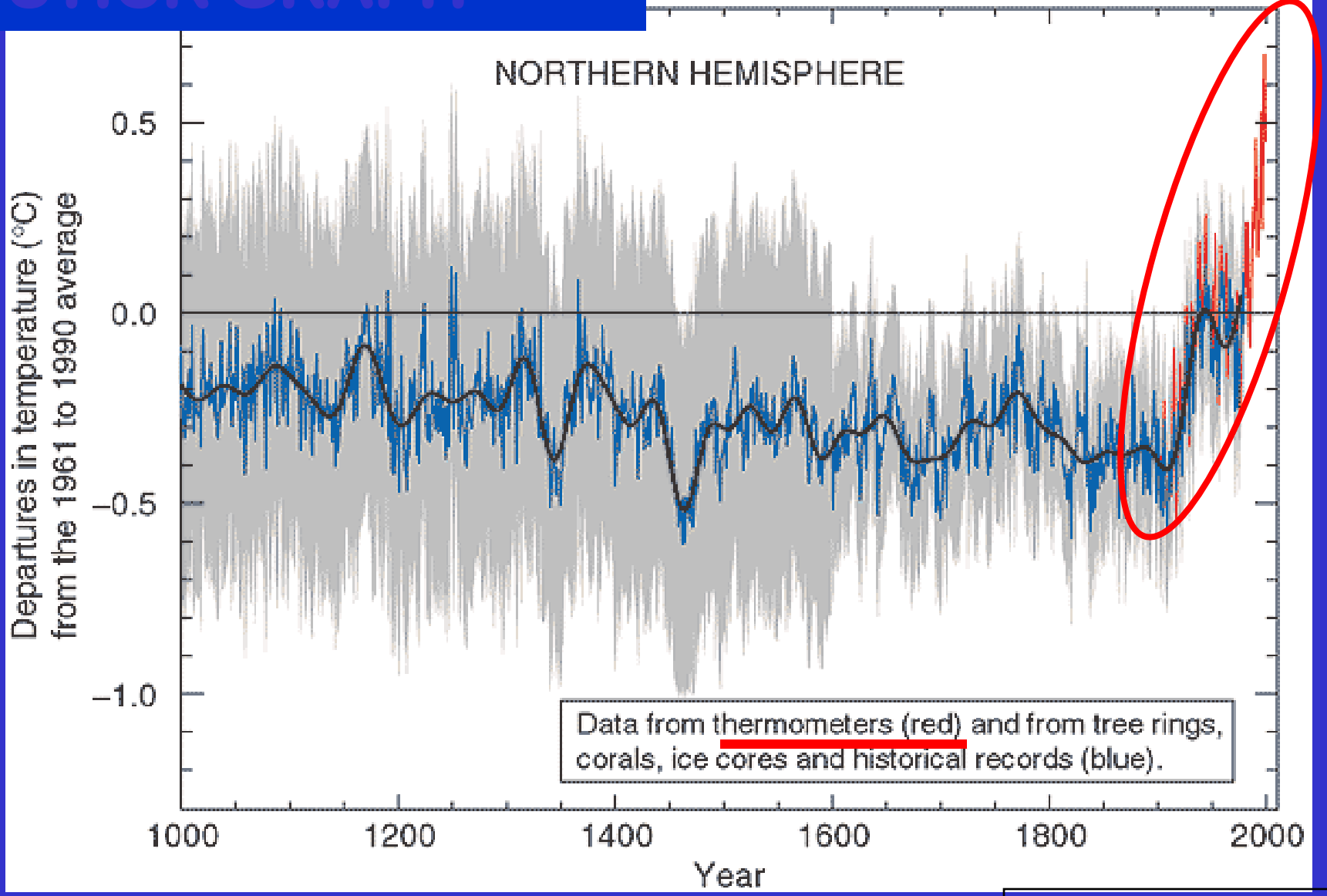
1902 -80 global mean



"Medieval Warm Period" (9-14th century) is a regional phenomenon only -- not globally warmer than 20th century!

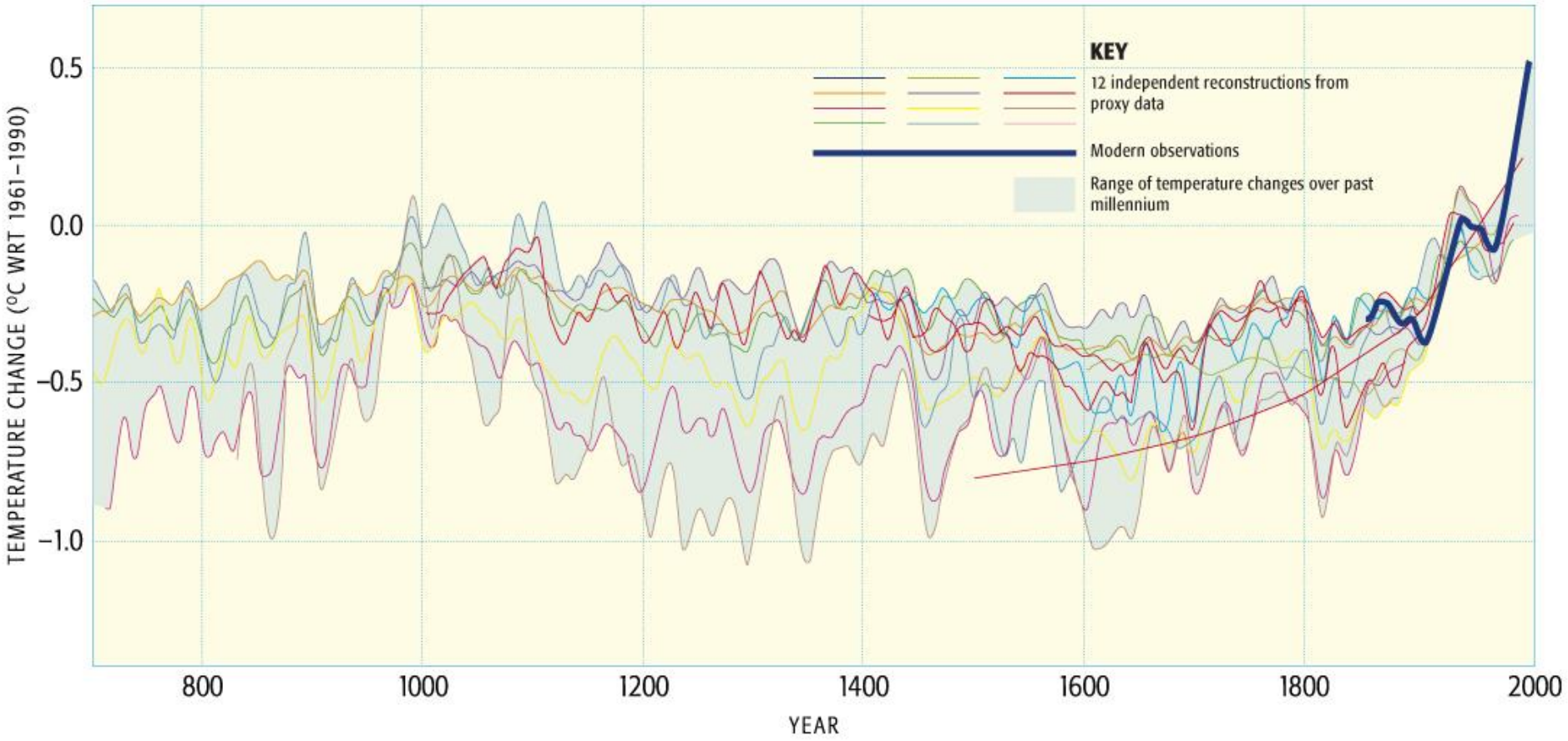
THE "HOCKEY STICK GRAPH

"proxy" data added to thermometer records



Like p 86

NORTHERN HEMISPHERE TEMPERATURE CHANGES OVER THE PAST MILLENNIUM



16 Intro to GLOBAL WARMING

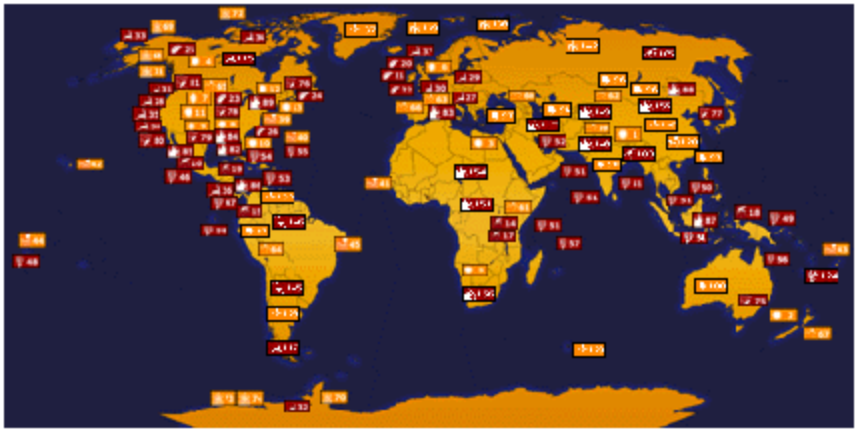
PART D:
Global Warming Early Warning Signs

Flip to p 88 in Class Notes
& take additional notes

GLOBAL WARMING: Early Warning Signs

"An increasing body of observations gives a collective picture of a warming world and other changes in the climate system."

Intergovernmental Panel on Climate Change (IPCC), 2001



This map illustrates the local consequences of global warming.

FINGERPRINTS: Direct manifestations of a widespread and long-term trend toward warmer global temperatures

Heat waves and periods of unusually warm weather

Ocean warming, sea-level rise and coastal flooding

Glaciers melting

http://www.climatehotmap.org/

"Global Warming Fingerprints"

Events that are direct manifestations of a widespread and long-term trend toward warmer global temperatures as projected by models of a changing climate.

The following events are identified as global warming fingerprints:

Heat waves and periods of unusually warm weather

Ocean warming, sea-level rise and coastal flooding

Glaciers melting

Arctic and Antarctic warming


Grinnell Gl, Glacier Nat. Park, 1911. Nat. Park Service


Grinnell Gl, Glacier Nat. Park © 2000 Braasch • worldviewofglobalwarming.org


Marr Glacier, Anarctica. © 2000 Gary Braasch. www.worldviewofglobalwarming.org


Alaska • © 2002 Gary Braasch • www.worldviewofglobalwarming.org

"Harbingers" of climate change

Events that foreshadow the types of impacts likely to become more frequent and widespread with continued warming.


Spreading disease


Earlier spring arrival

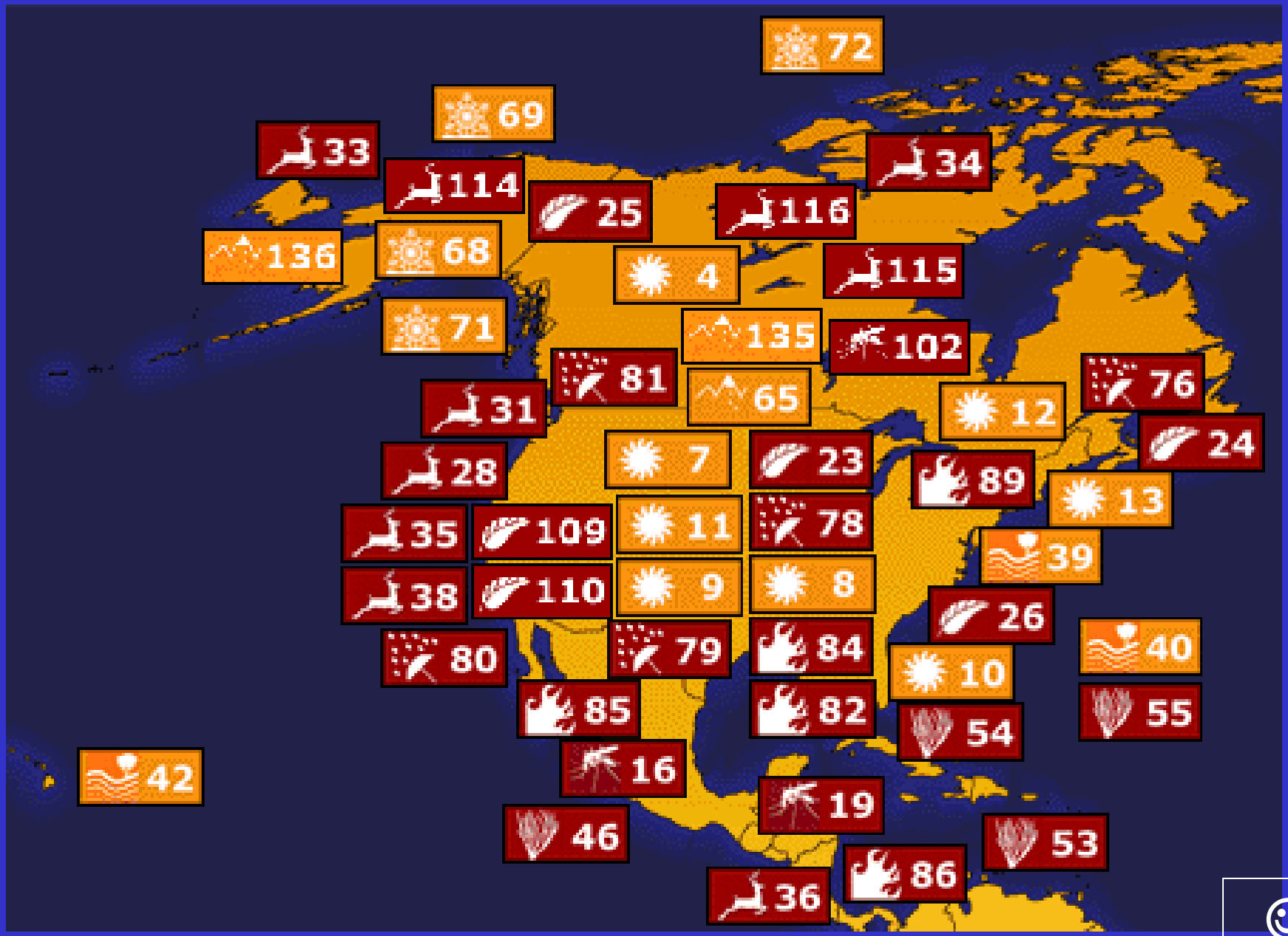

Plant & animal range shifts & population changes


Coral reef bleaching


Downpours, heavy snowfalls, and flooding


Droughts and fires

NORTH AMERICA: Early Warming Signs




Quercus robur.
© 2001 Gary Braasch • www.worldviewofglobalwarming.org


Edith's Checkerspot.
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Alaska • © 2000 Gary Braasch • www.worldviewofglobalwarming.org


Marmot
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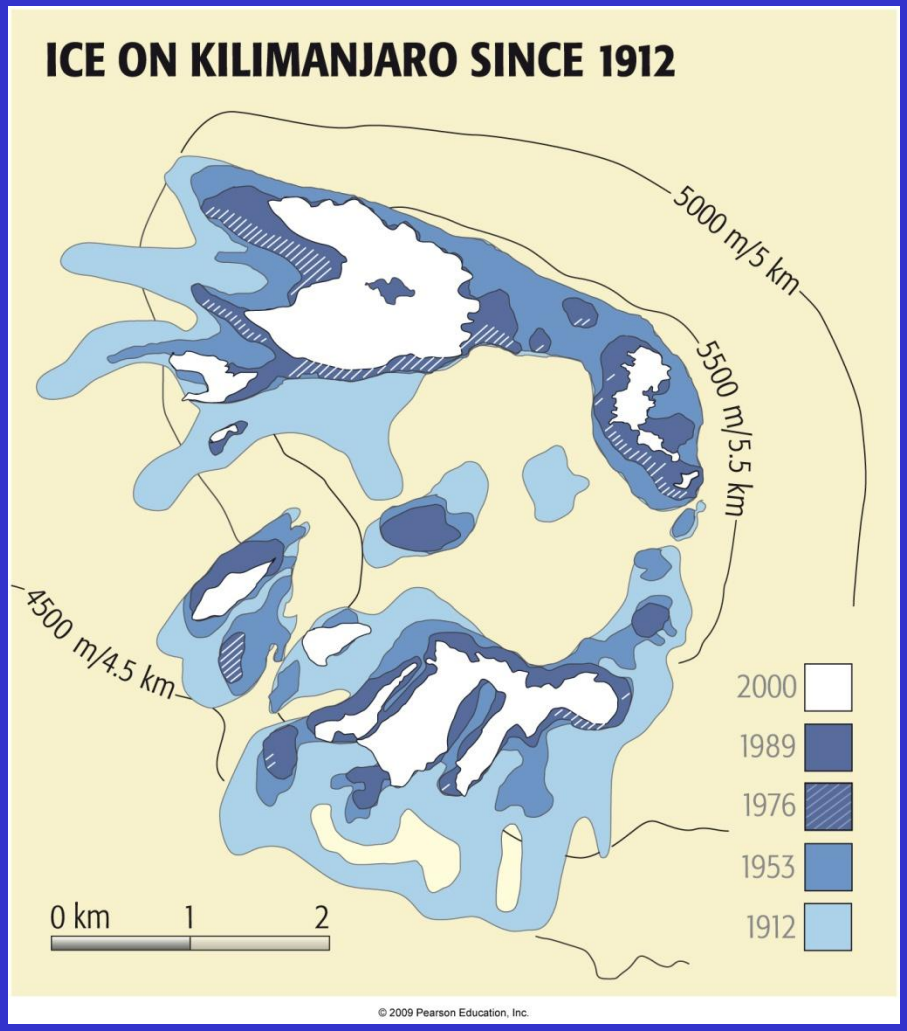
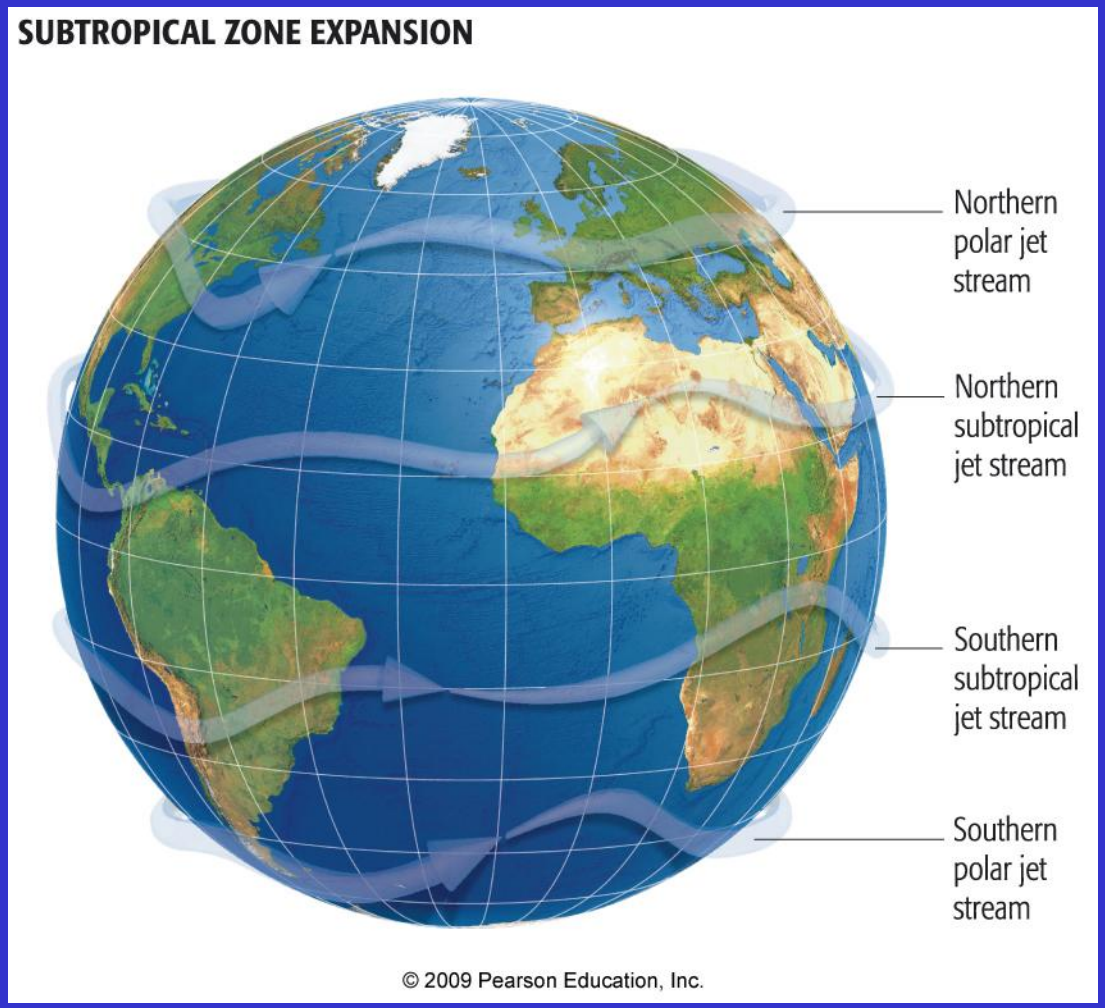
From *Dire Predictions:*



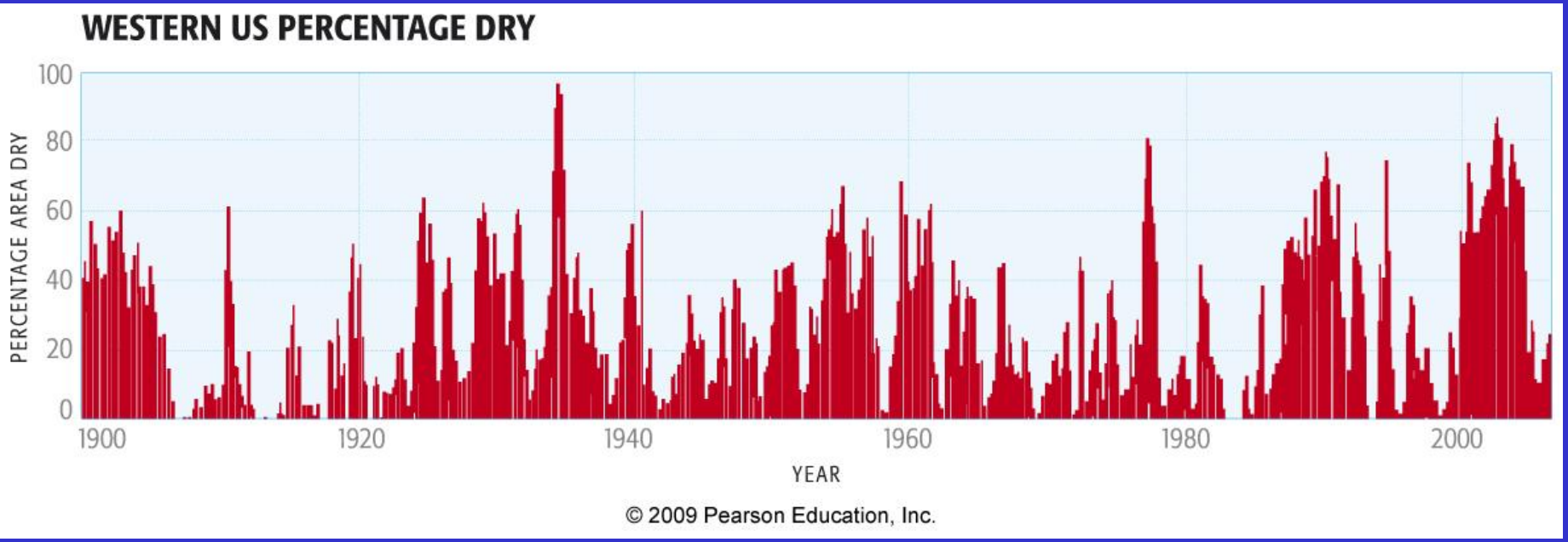
ICE & SNOW COVER LOSS!

From *Dire Predictions:*



SUBTROPICAL DRY-AREA EXPANSION!

From *Dire Predictions:*

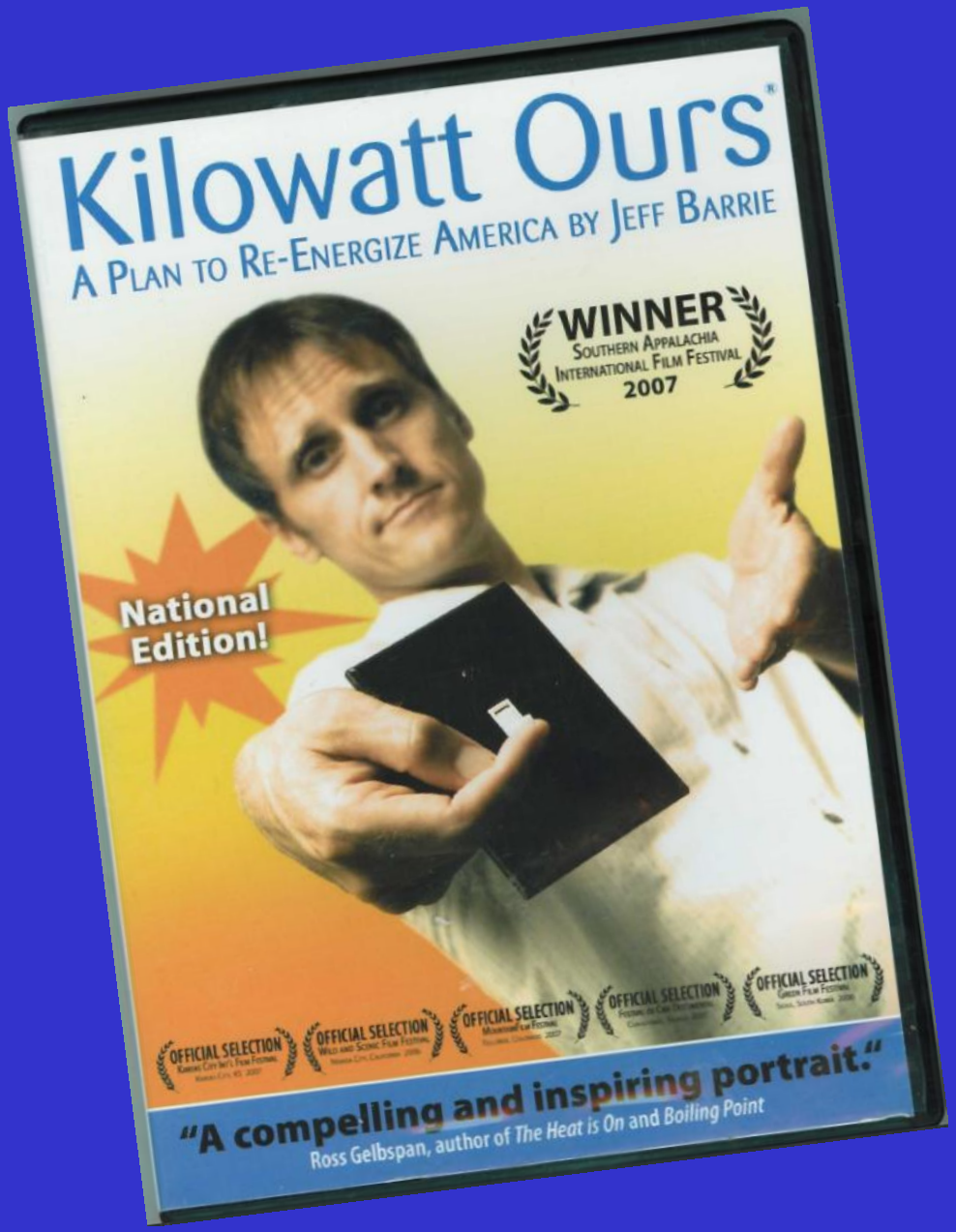


DROUGHT!

http://www.earthweek.com/

G-6 DIRE PREDICTIONS PLANNING

- Double check your assignment
- Select a date
- Your group has 5 minutes to present the topic in an interesting way to your classmates!



MOVIE TIME!!

http://www.kilowattours.org/