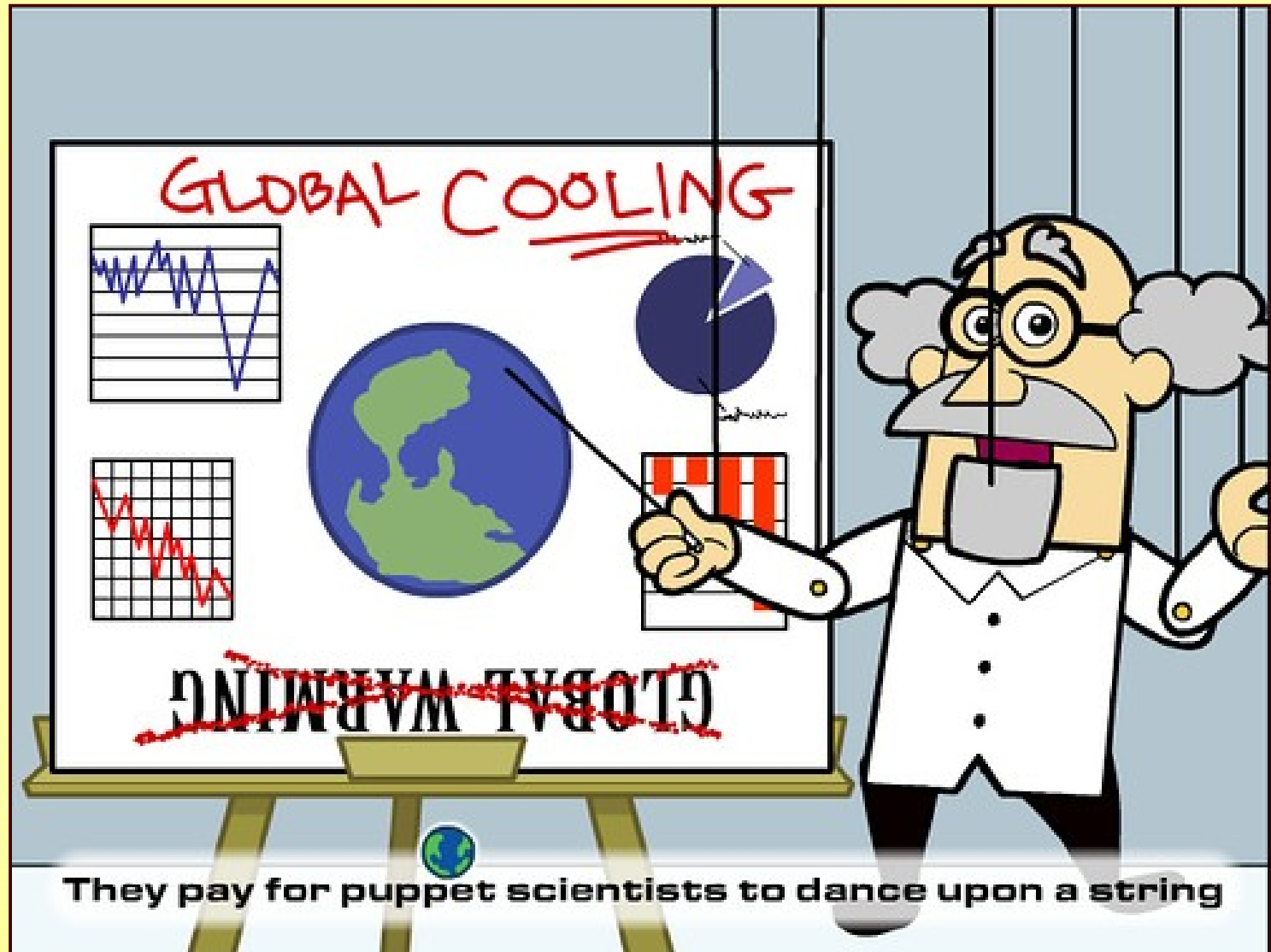


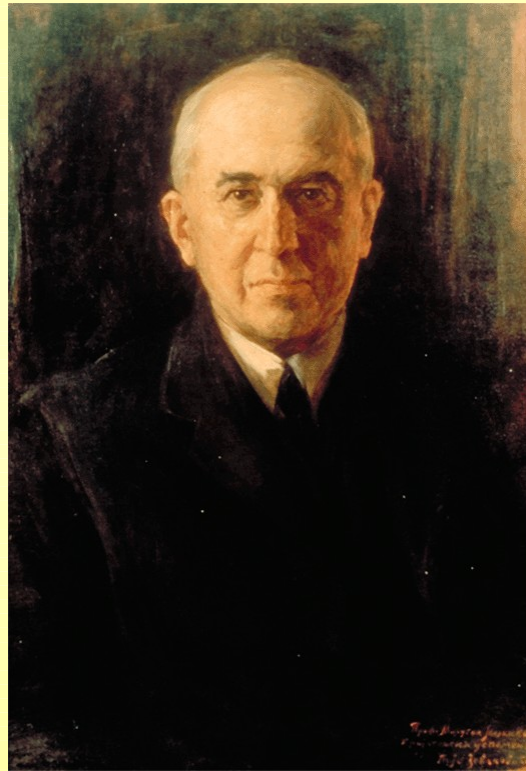
Climate Change: The Science and the Skeptics



Isn't climate change natural?

Yes and No---

Let's first look at the causes of natural changes



Milankovitch

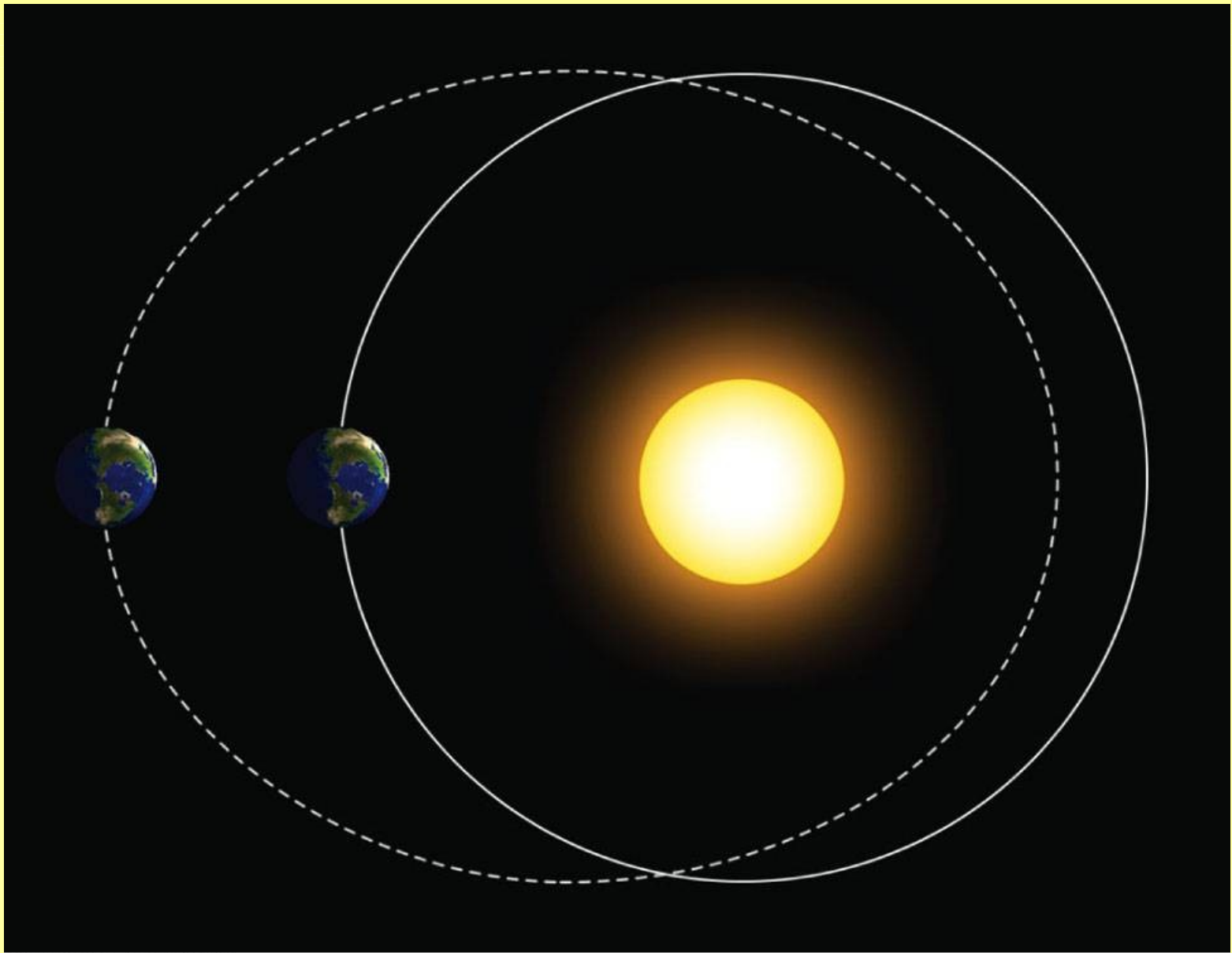
Three astronomical factors influence the timing and intensity of the seasons:

***Eccentricity* - in Earth's orbit around Sun,**

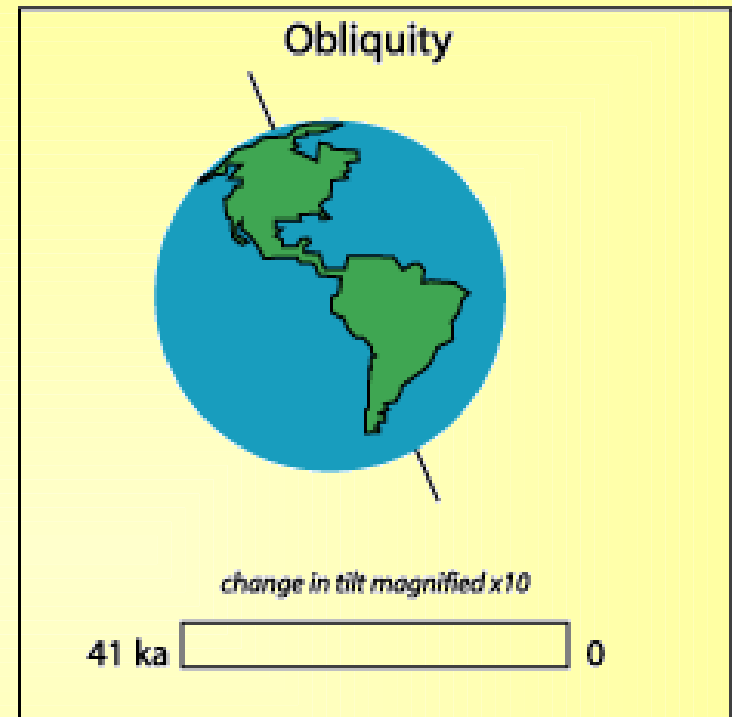
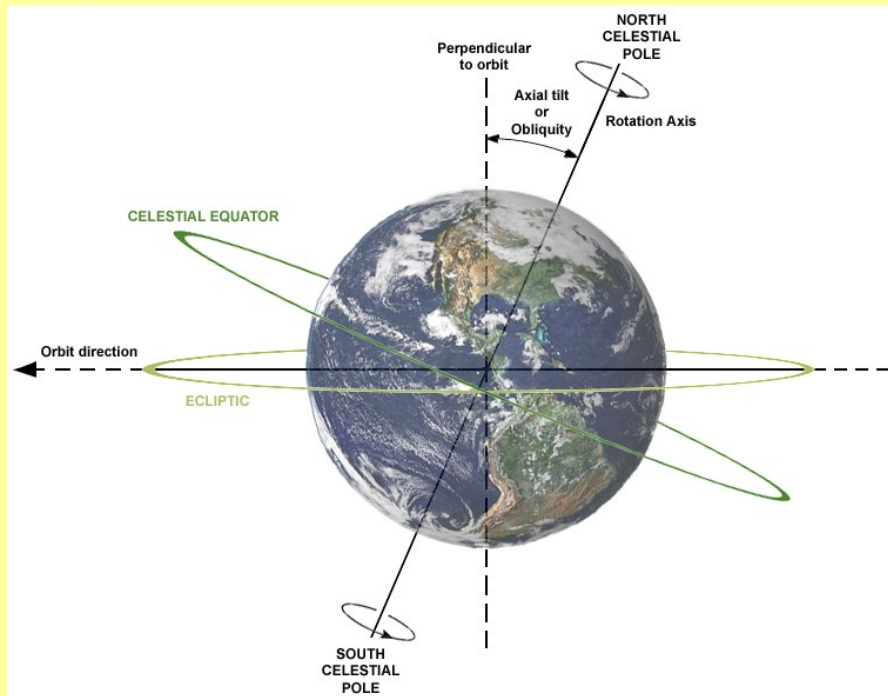
***Obliquity* - Earth's axial tilt -
off the perpendicular to the plane of the orbit,**

**Precession - the timing of aphelion and perihelion
relative to the timing of the equinoxes.**

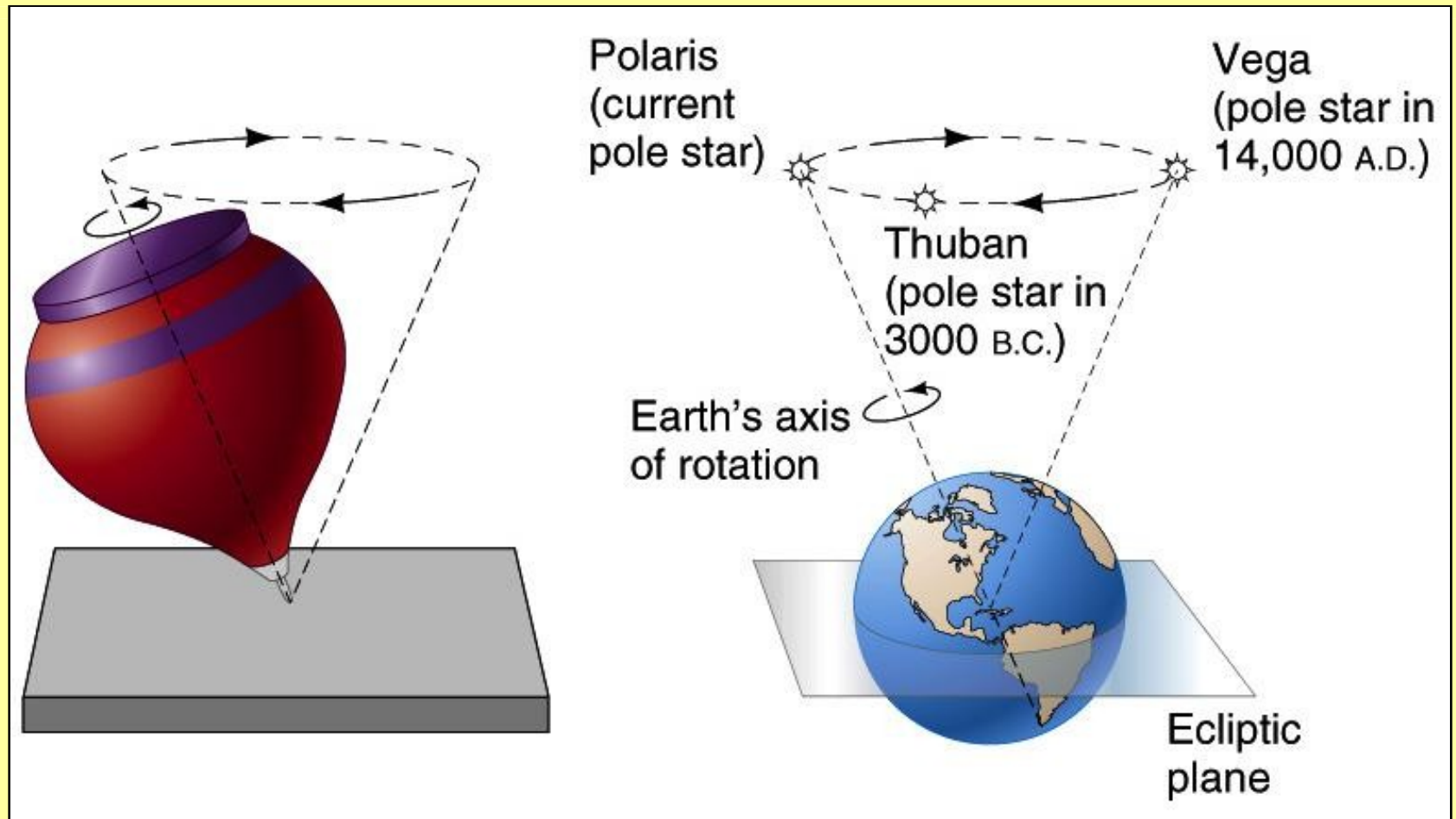
These three factors make up the Milankovitch cycles.



The eccentricity of Earth's orbit changes cyclically with a cycle of about 100,000 years being especially prominent.



Obliquity is the *tilt* of Earth's axis, which also varies cyclically with a dominant period of about 41,000 years during which it varies between 21.6° and 25.5° off the perpendicular.



Precession (*wobble*) is the change in the orientation of the Earth's axis.

These astronomical forces, or Milankovitch Cycles, coincide and reinforce one another every 100,000 years.

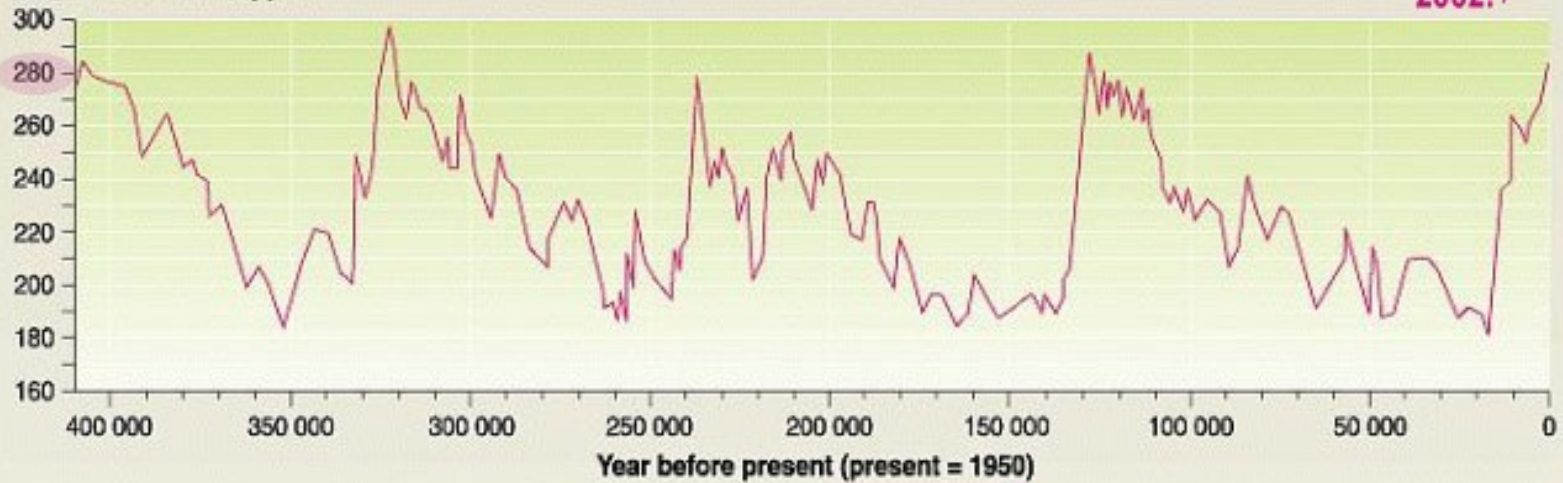
Over time, natural climate change involves 90,000 years of cooling,

followed by 10,000 years of warming.

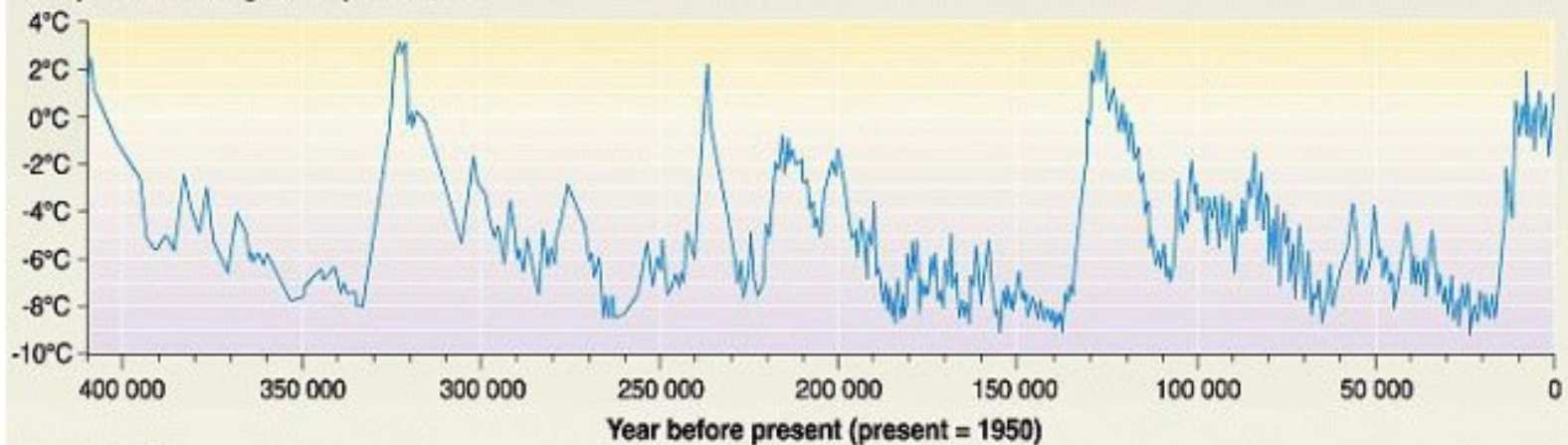
These natural cycles result in glacials/interglacials.

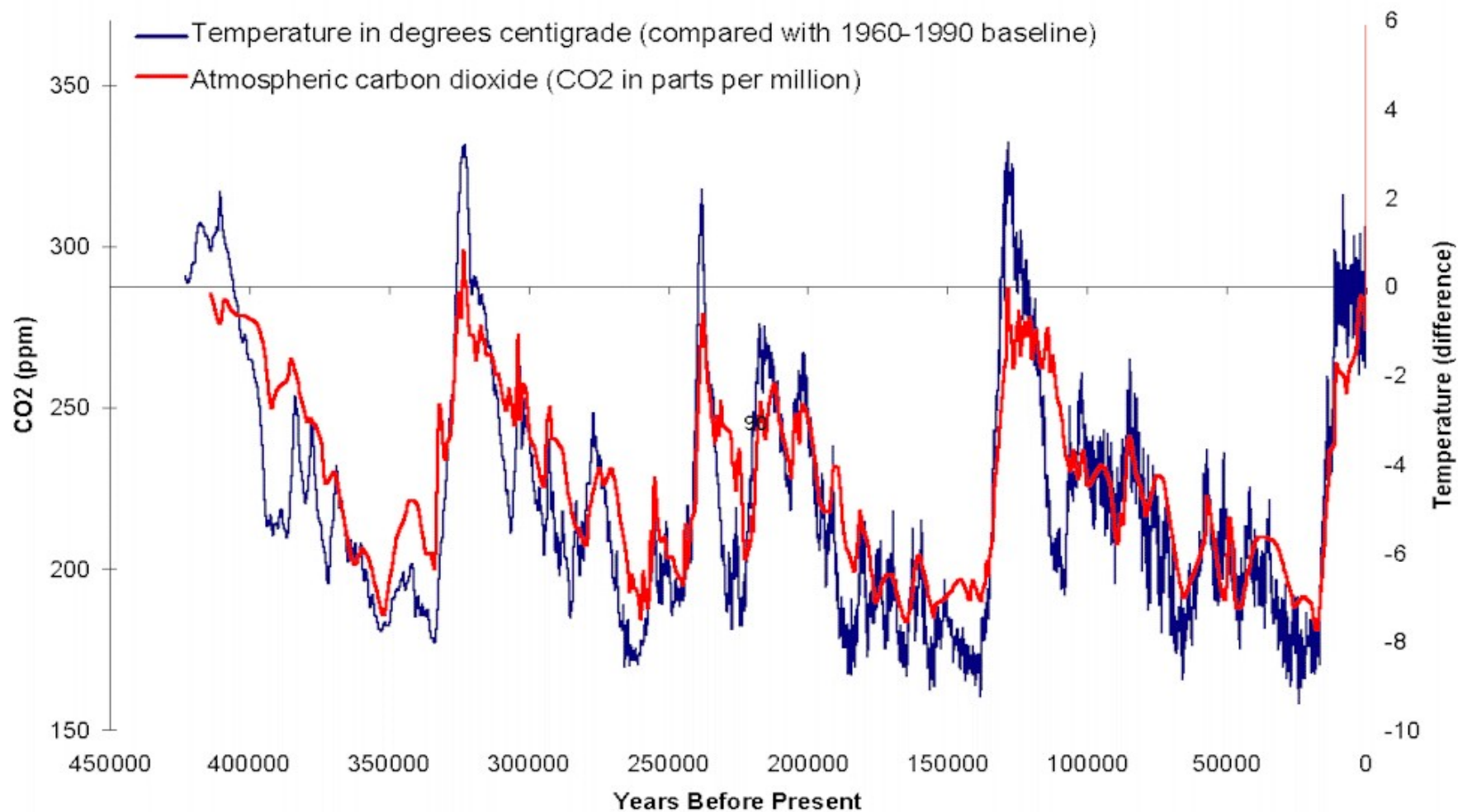
Temperature and CO₂ concentration in the atmosphere over the past 400 000 years (from the Vostok ice core)

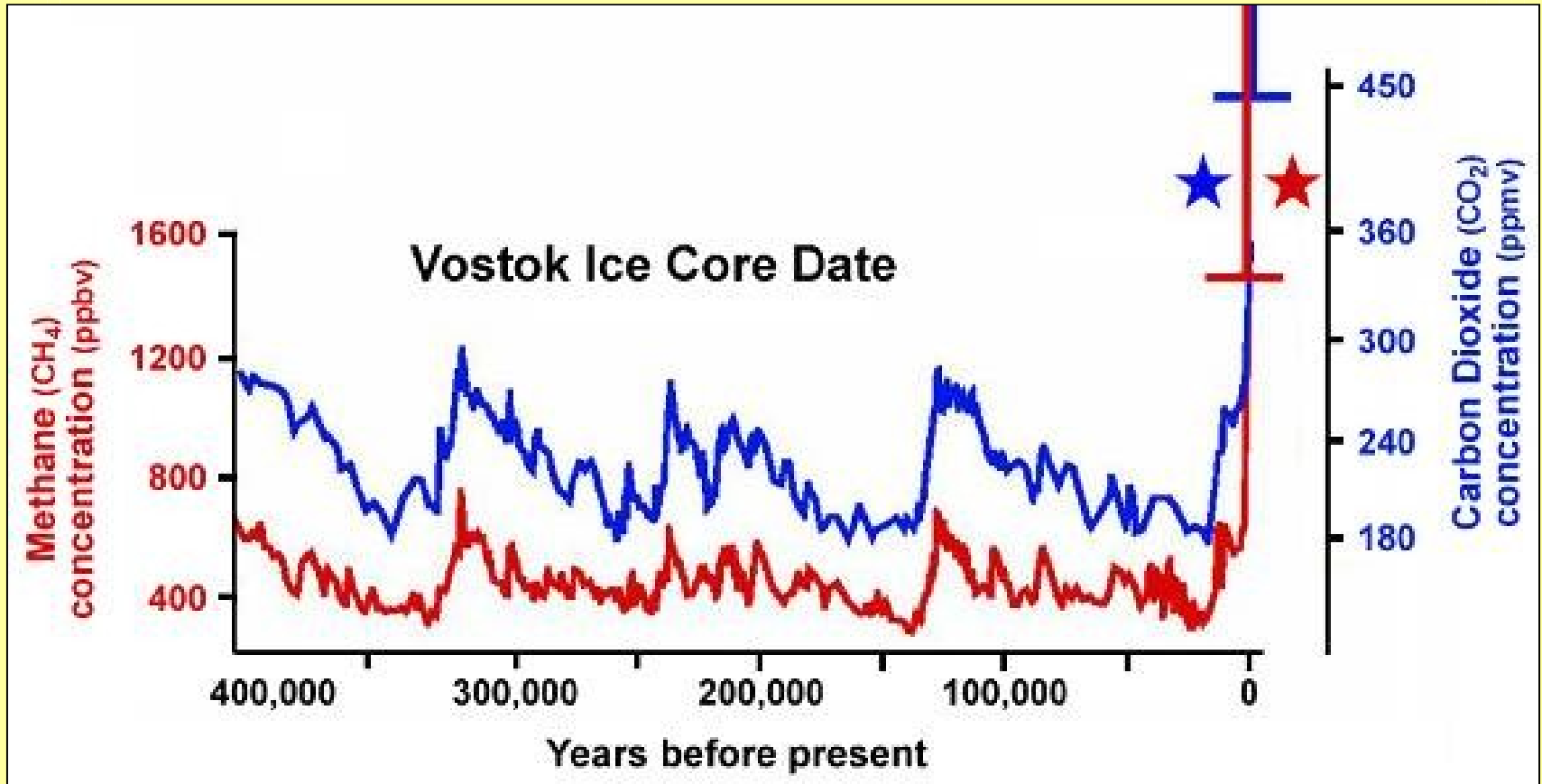
CO₂ concentration, ppmv



Temperature change from present, °C

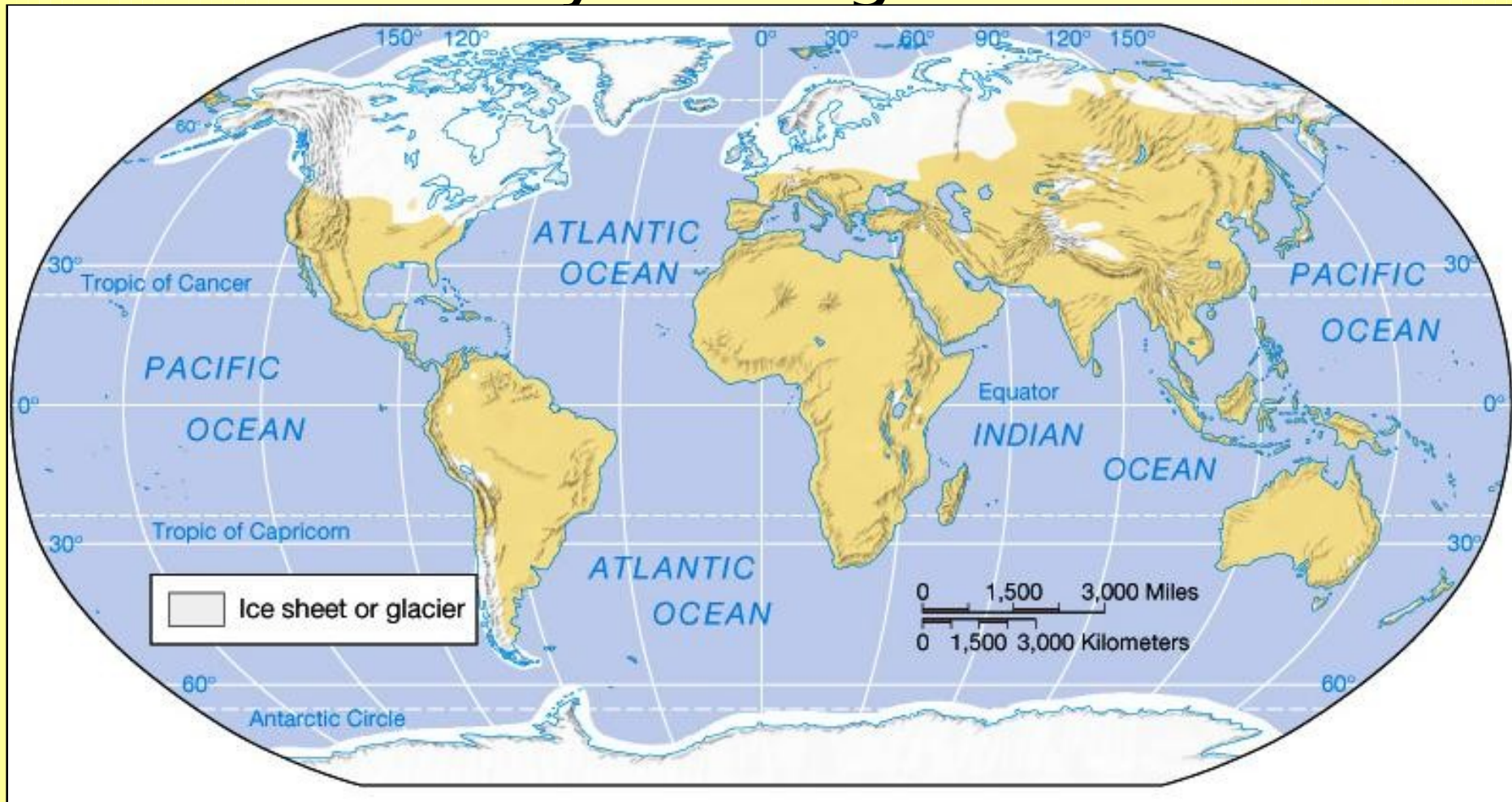




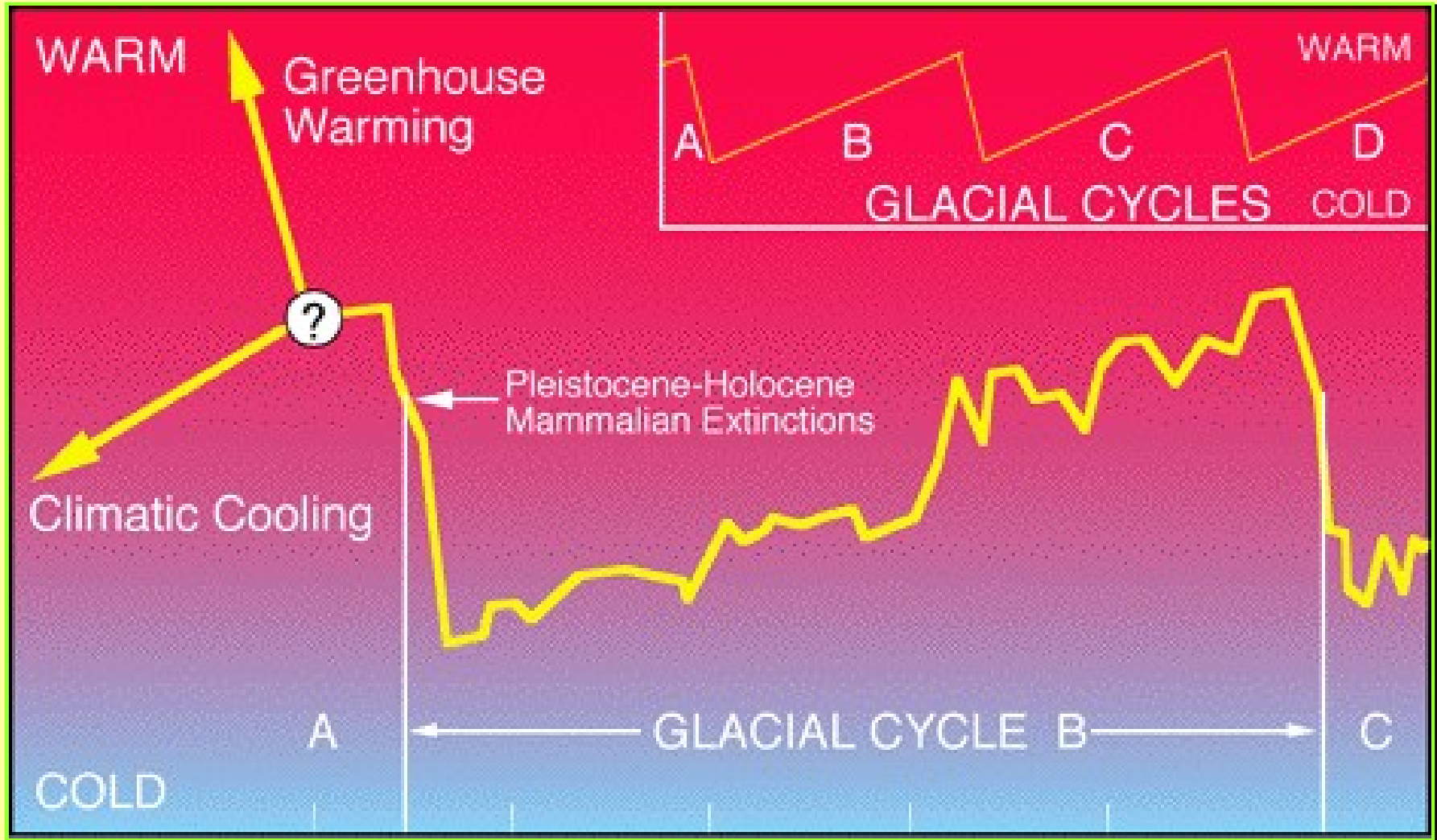


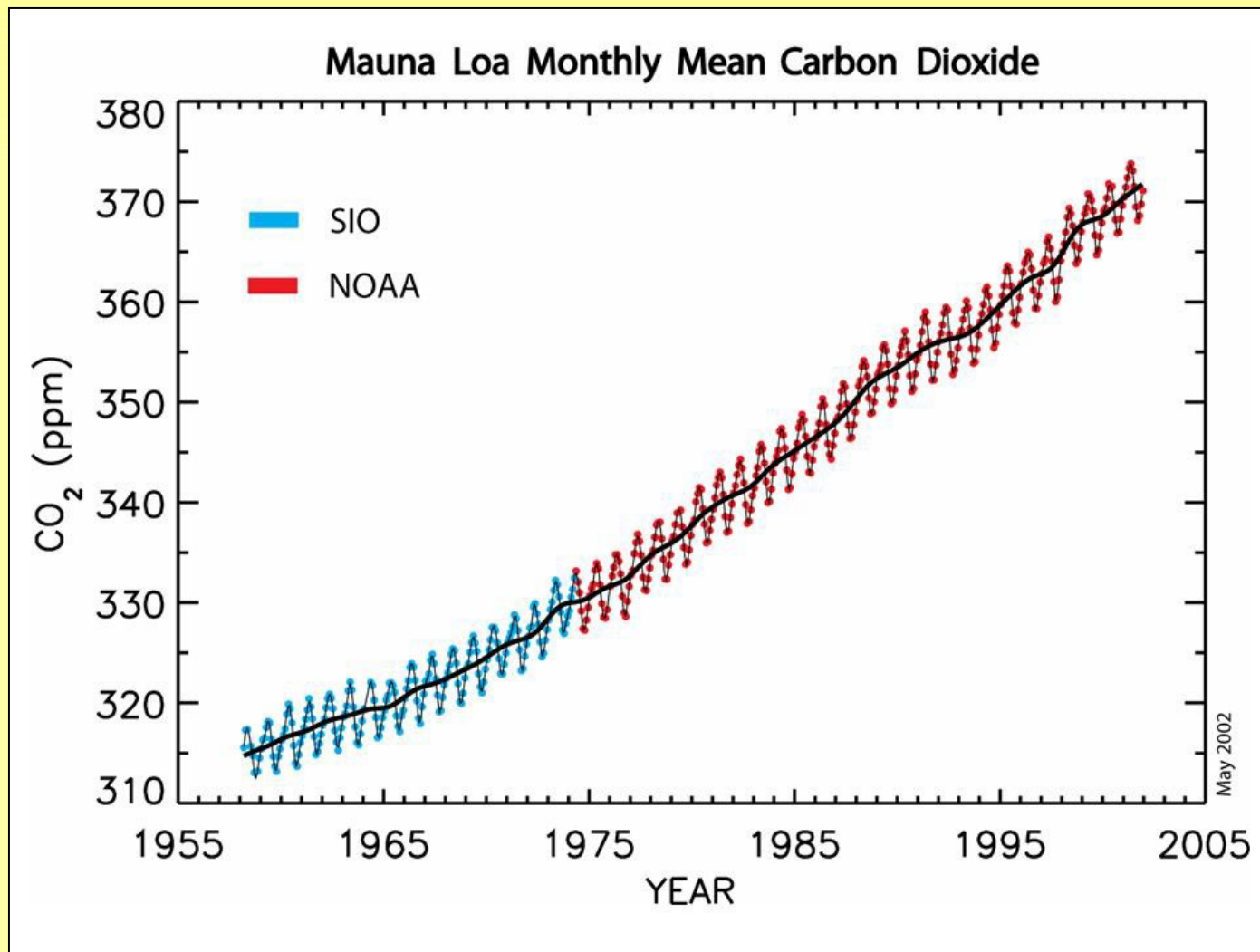
Ice cores reveal methane and carbon dioxide concentrations are at their highest levels in the past 400,000 years.

The end of the last Ice Age was approximately 12,000 years ago.



**Recall the pattern of natural climate change?
We should have “turned the corner” and
entered into a gradual cooling phase.**





According to the US Environmental Protection Agency (2006), greenhouse gases from fossil fuel combustion are responsible for most of the warming of the last 50 years.

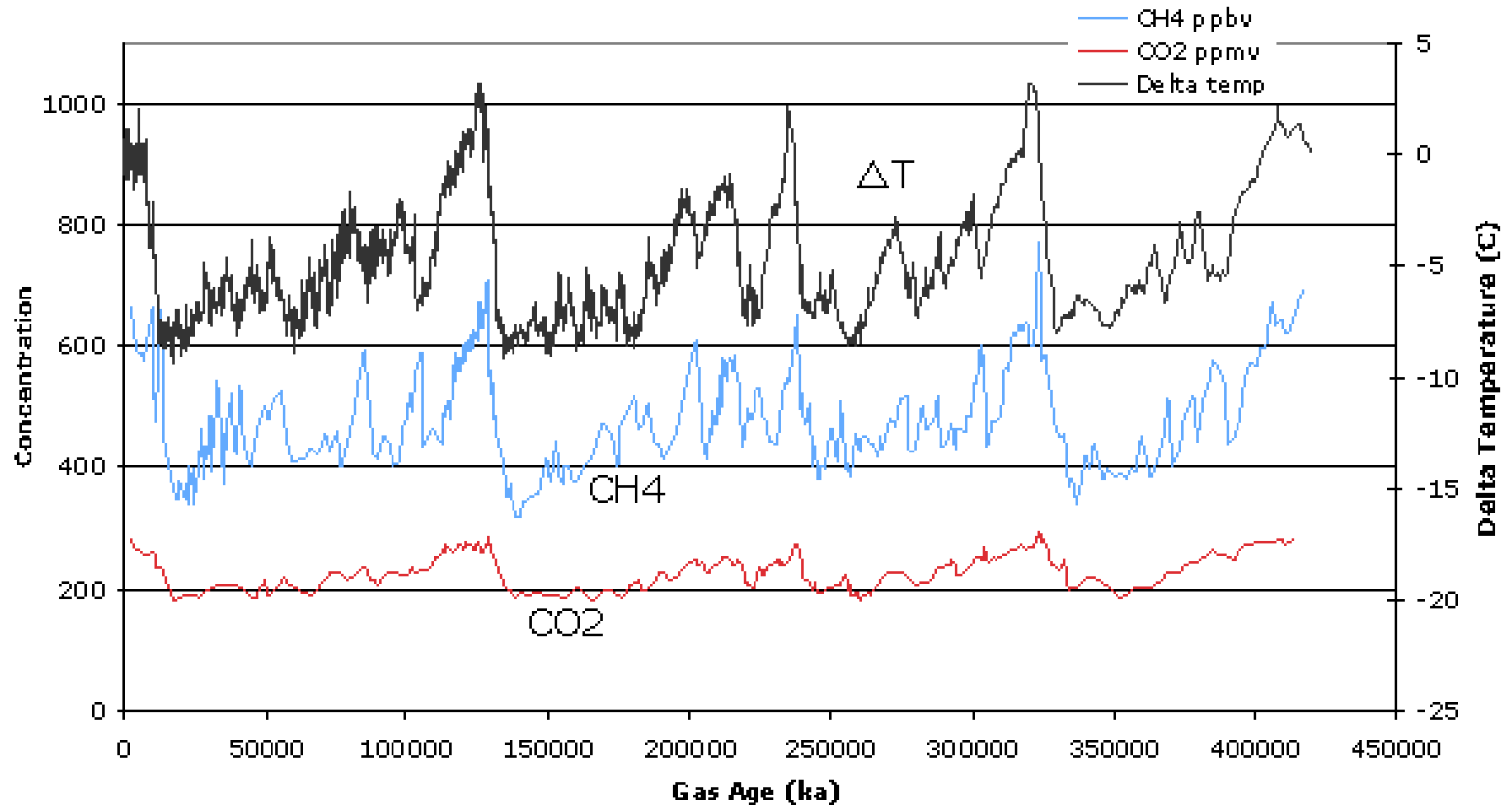
What are the major greenhouse gases?

Carbon Dioxide CO_2

Methane CH_4

Water Vapor H_2O

Carbon Dioxide and Methane Concentrations Plotted with Delta Temperature



(Data derived from Lake Bottom sediments.)

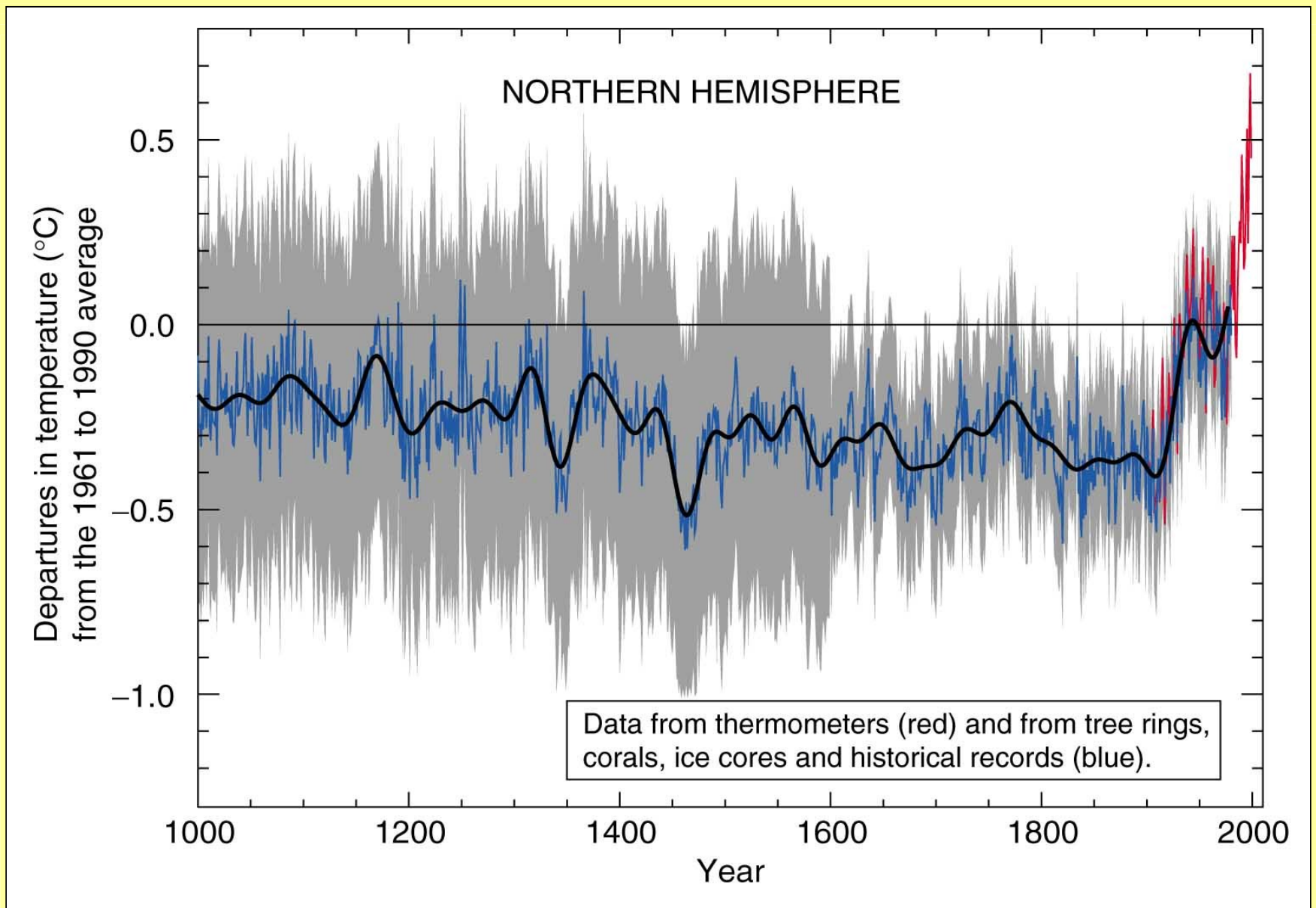
So, the answer is “yes” to question #1.

Climate change is natural.

However, what concerns scientists is that the change that is now occurring is

Outside the Range of Natural Variability.

***When graphed,
we see the proverbial
Hockey Stick***



Variations of Earth's surface temperature
for the past 1,000 years

Earth's mean surface temperature
has increased about 1.5°F since 1900

U.S. Global Climate Change Impacts in the United States (2009)

NOAA's State of the Climate Report (2005)

NASA's Surface Temperature Analysis (2005)

NASA reports that most of the warming
has occurred over the *past 30 years*.

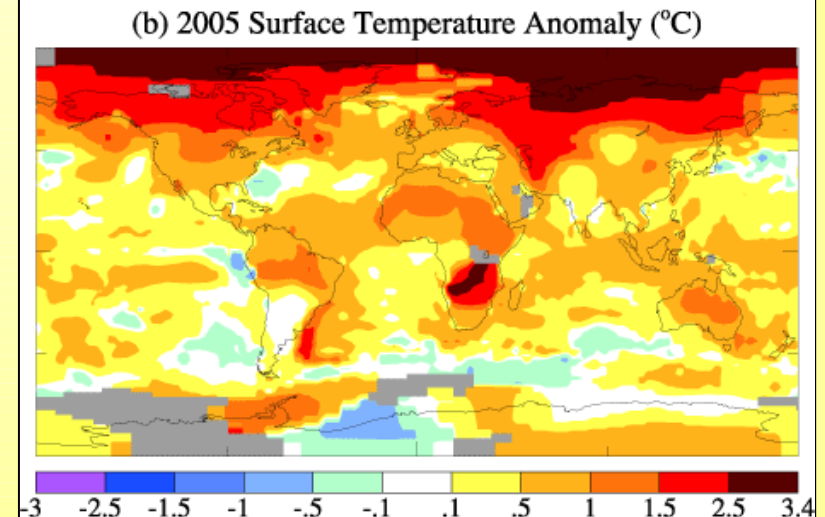
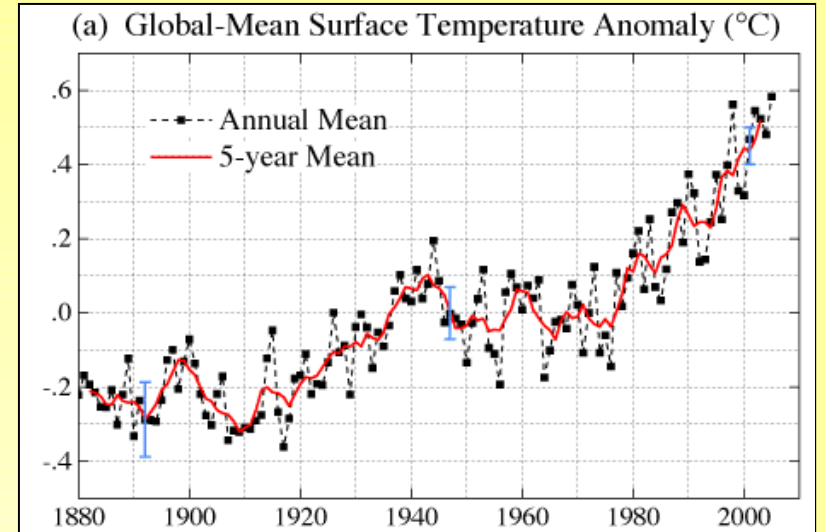


The 8 warmest years on record occurred since 1998.

The 14 warmest years on record occurred since 1990.

2005 was *the* warmest year on record.

2007 and 1998 tied for Earth's second warmest years.



(NASA, 2006)

**Since human civilization began,
(approximately 6000 years ago)**

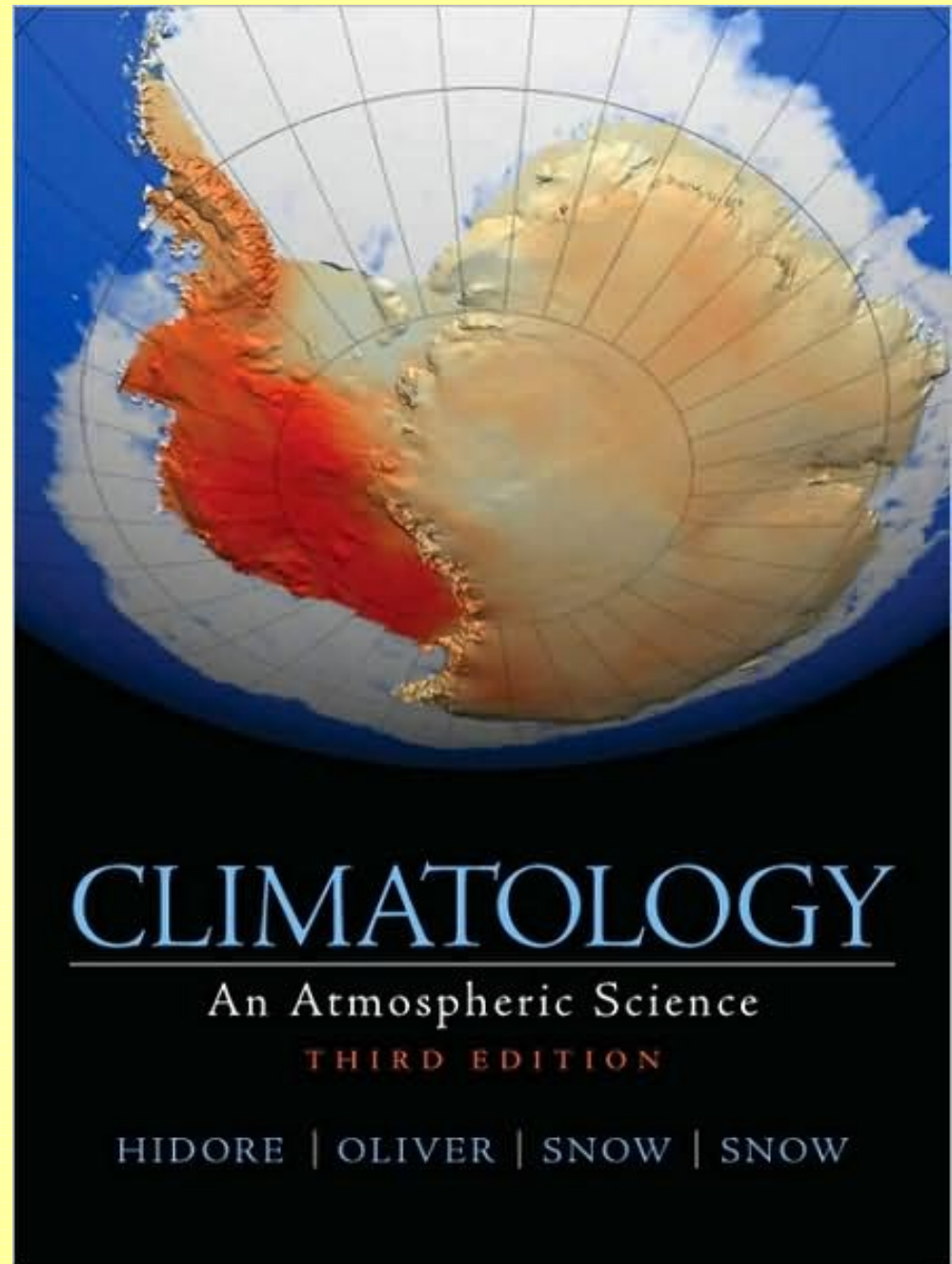
***the global mean temperature
has not varied much.***

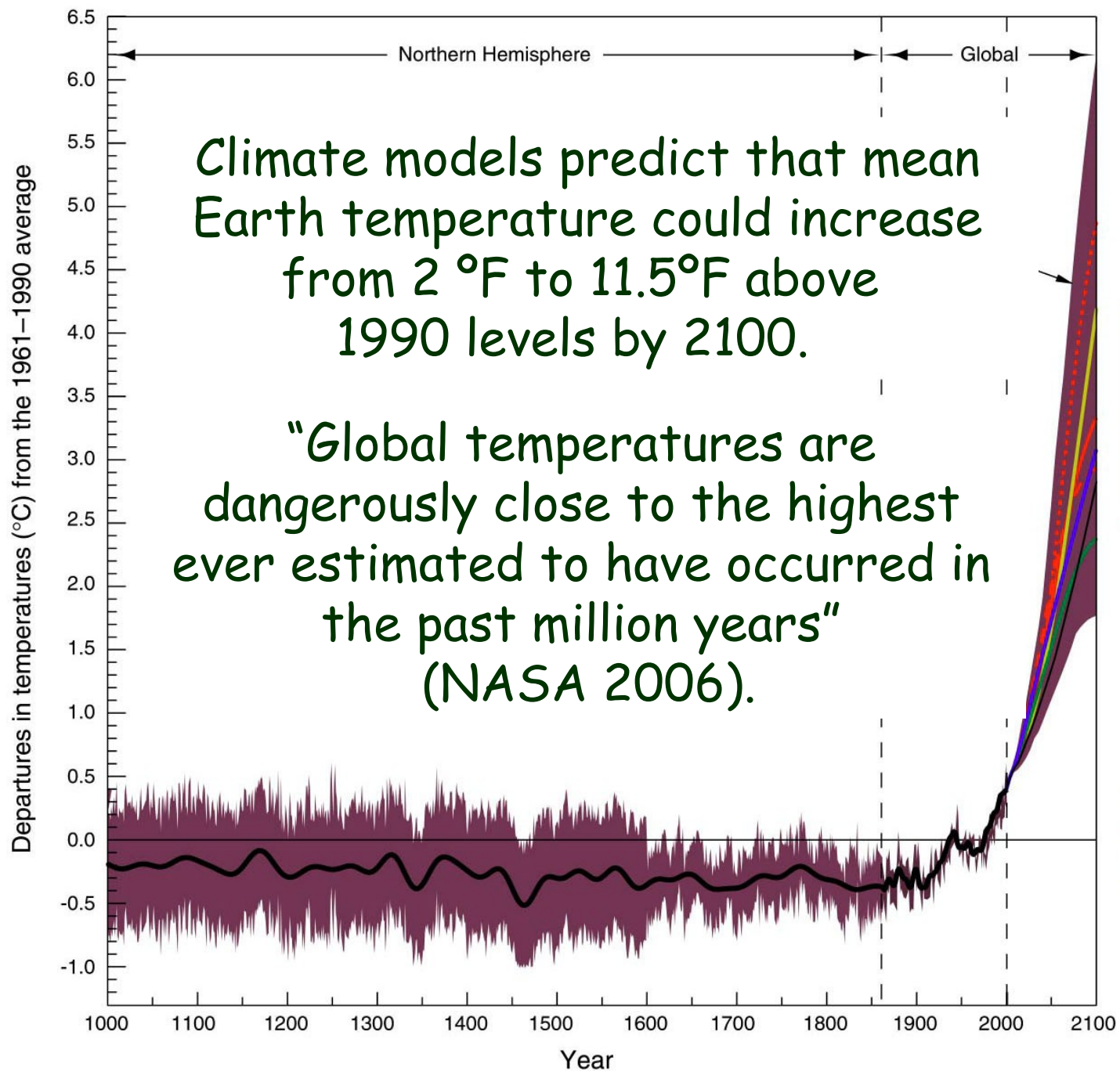
***“The forecast change...has no equal
in the recent history of the planet.”***

Hidore, Oliver, Snow & Snow (2009).

Prentice Hall
Publishing (2009)

What scenarios are
being forecast?





So, are the “Skeptics” genuinely skeptical?



In light of the overwhelming amount of evidence reaching the media and public in the late-1980s,

The claim that global warming is not real, became, “Well yes, it is real, but people are not causing it.”

Questions #2

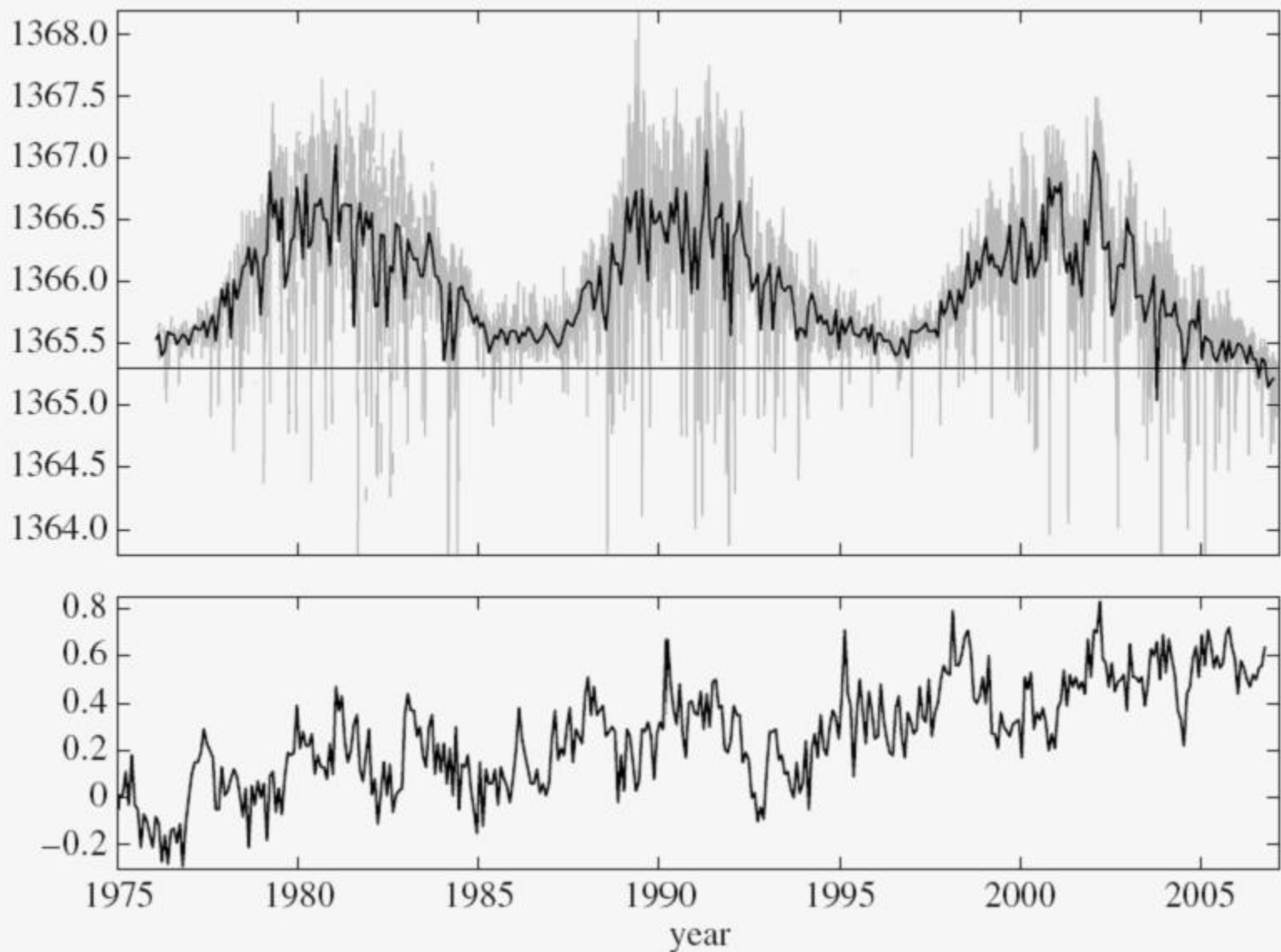
Do changes in solar activity cause climate change?



Yes and No!

In the *past*, solar activity was a major climate forcing mechanism.

***Today*, the rapid and abundant output of GHGs dwarfs the solar influence.**



**Solar activity has been decreasing since 1985.
Global temperatures have steadily increased.**

No Sun Link to Climate Change

“A new scientific study concludes that changes in the Sun's output cannot be causing modern-day climate change. It shows that for the last 20 years, the Sun's output has declined, yet temperatures on Earth have risen.”

Writing in the Royal Society's journal *Proceedings A*, the researchers say cosmic rays may have affected climate in the past, but not the present.

“This should settle the debate,” said Mike Lockwood, from the UK's Rutherford-Appleton Laboratory, who carried out the new analysis together with Claus Froehlich from the World Radiation Center in Switzerland.

The Intergovernmental Panel on Climate Change (IPCC)

What do the world's best 2,500 atmospheric scientists say?

The IPCC's February summary report concluded that greenhouse gases were about 13 times more responsible than solar changes for rising global temperatures.

Question #3

**Which produces more CO₂
volcanic or human activity?**

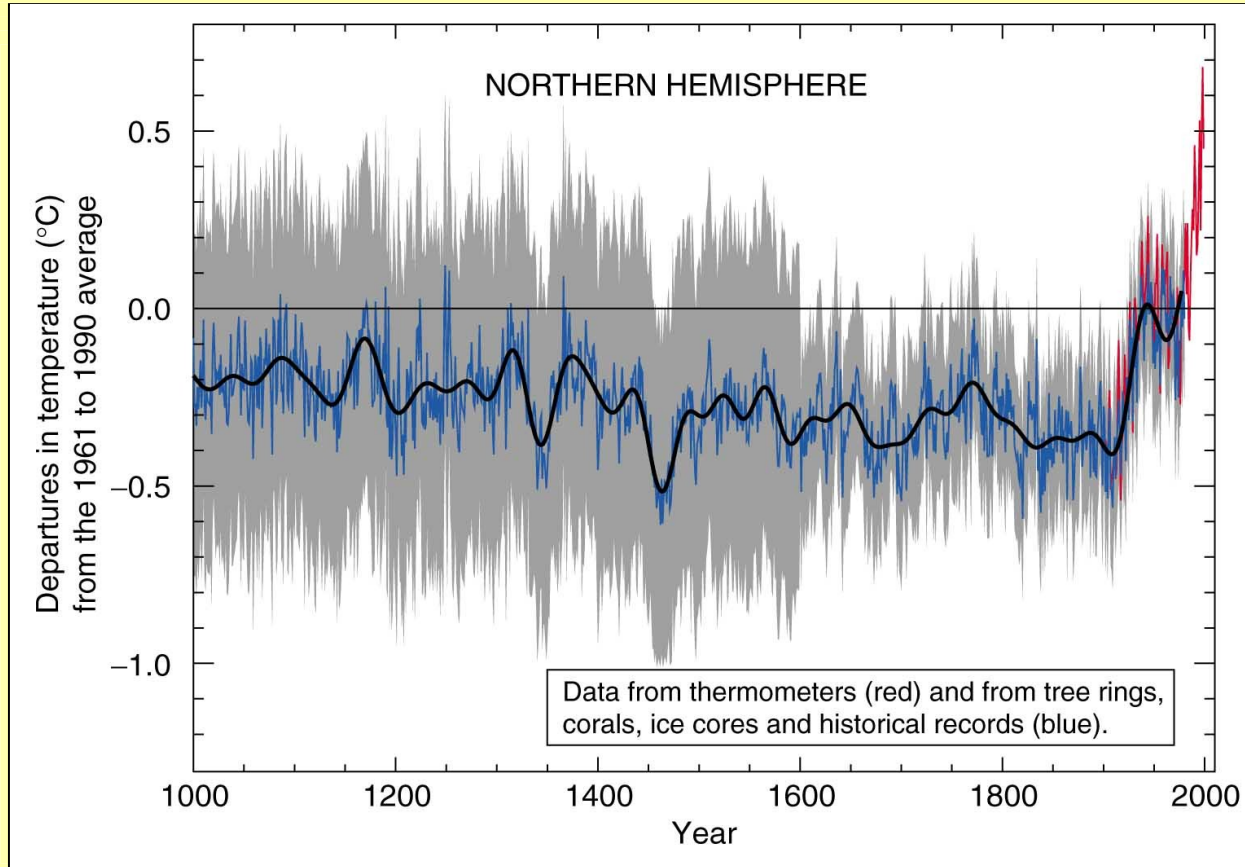
**Volcanoes on land and under the sea release
about 200 million tons of CO₂ annually.**

**Global fossil fuel CO₂ emissions in 2003
tipped the scales at 26.8 billion tons per year (USGS)**

<1%.



Speaking of Evidence, Recall this graph?

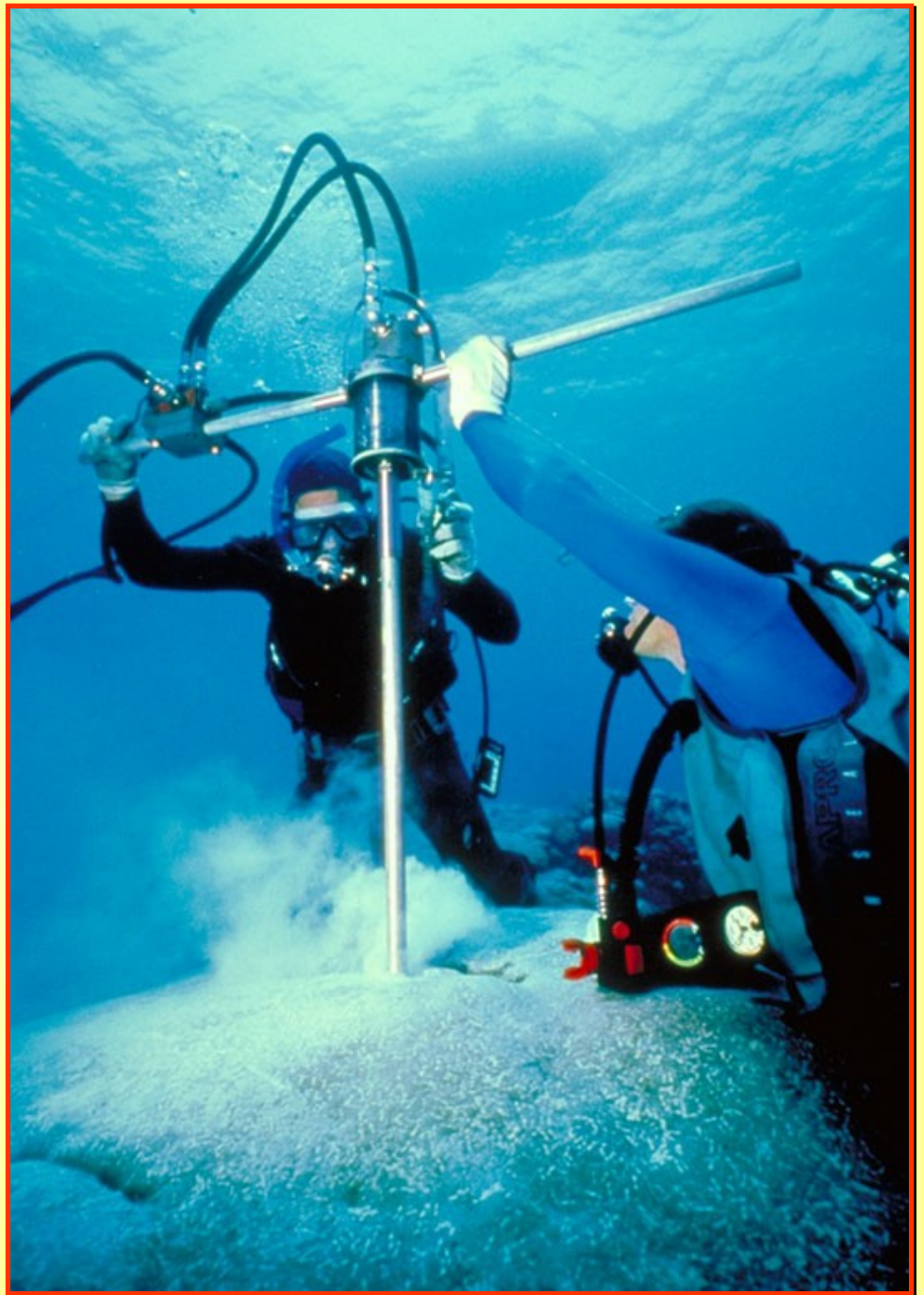


**Where does the
proxy data come from?**

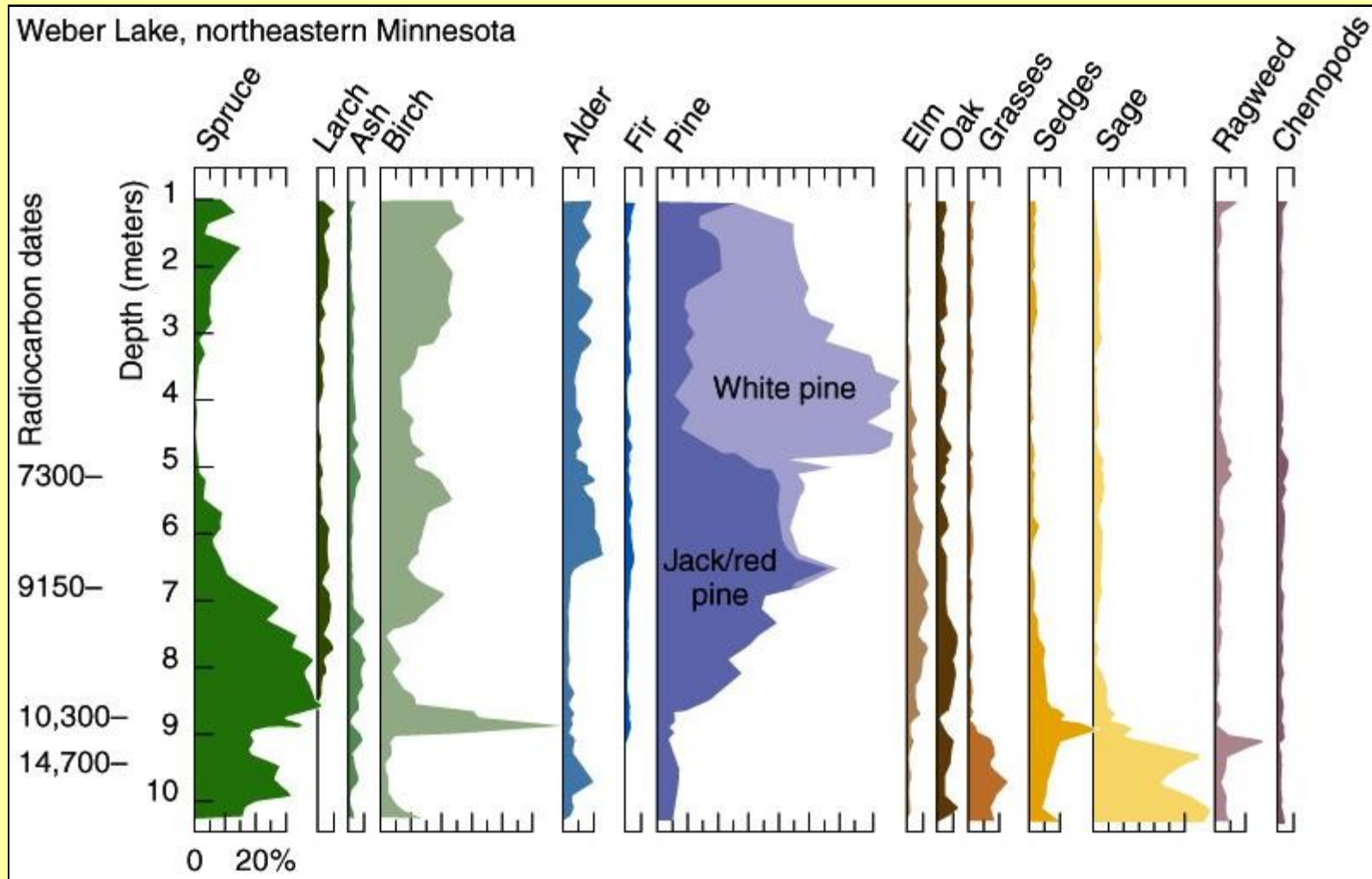
Core samples taken
by drilling through...

lake bottom sediments,
coral beds,
river beds,
seafloors,
and trees.

Deeper cores go
further back in time.



Biologists Analyze The Types and Locations of Past Vegetation (Palynology)



**Pollen grains are preserved through their
very hard polymer cases.**



Dendroclimatology:

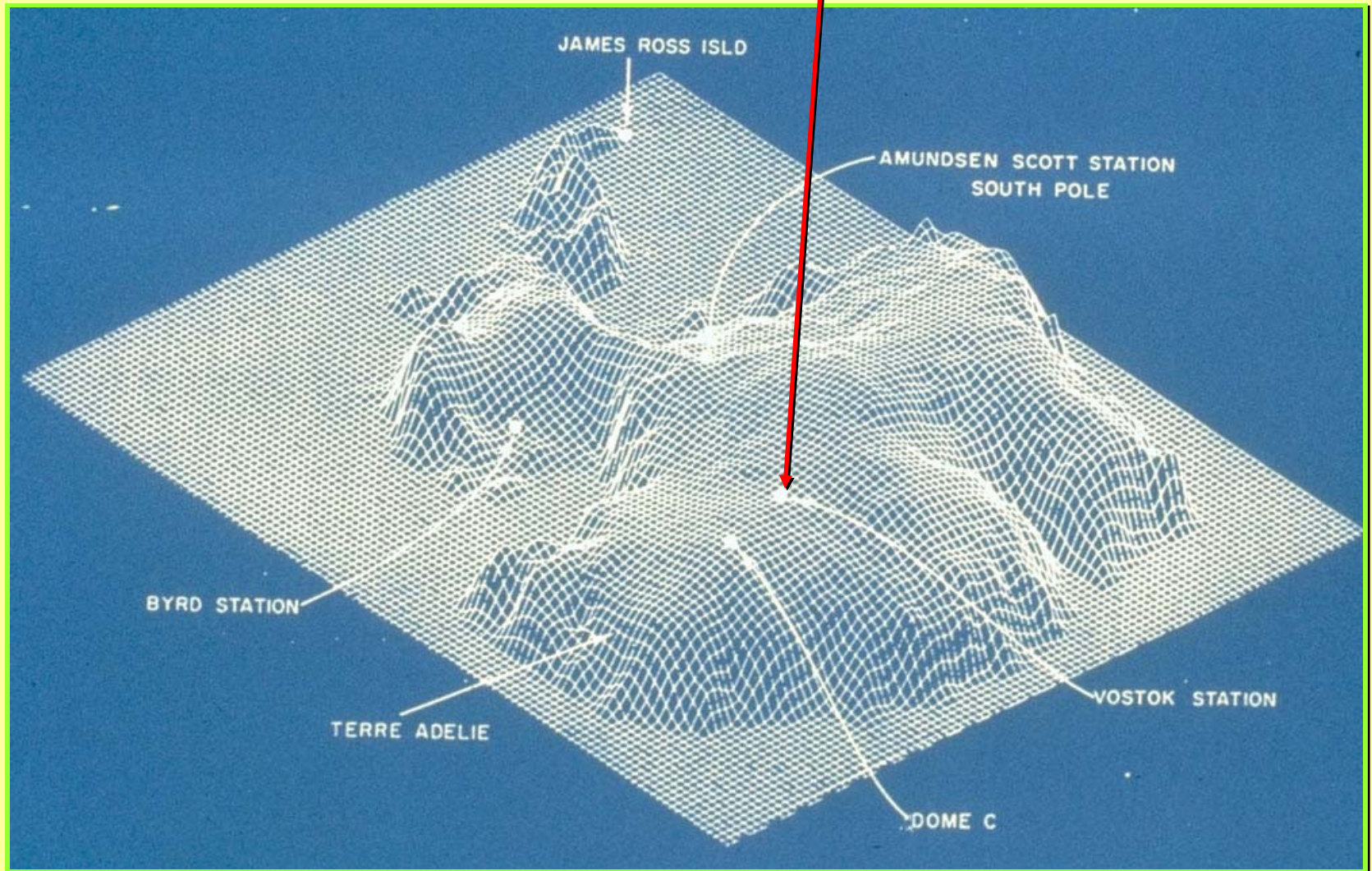
**Tree Rings Provide
a Record
of Good Growth Years
and Years of Scant Growth**

**Petrified Logs at the Bottom
of Ancient Lakes
Provide Older Data**

Ice cores: air bubbles contain samples of ancient atmospheres

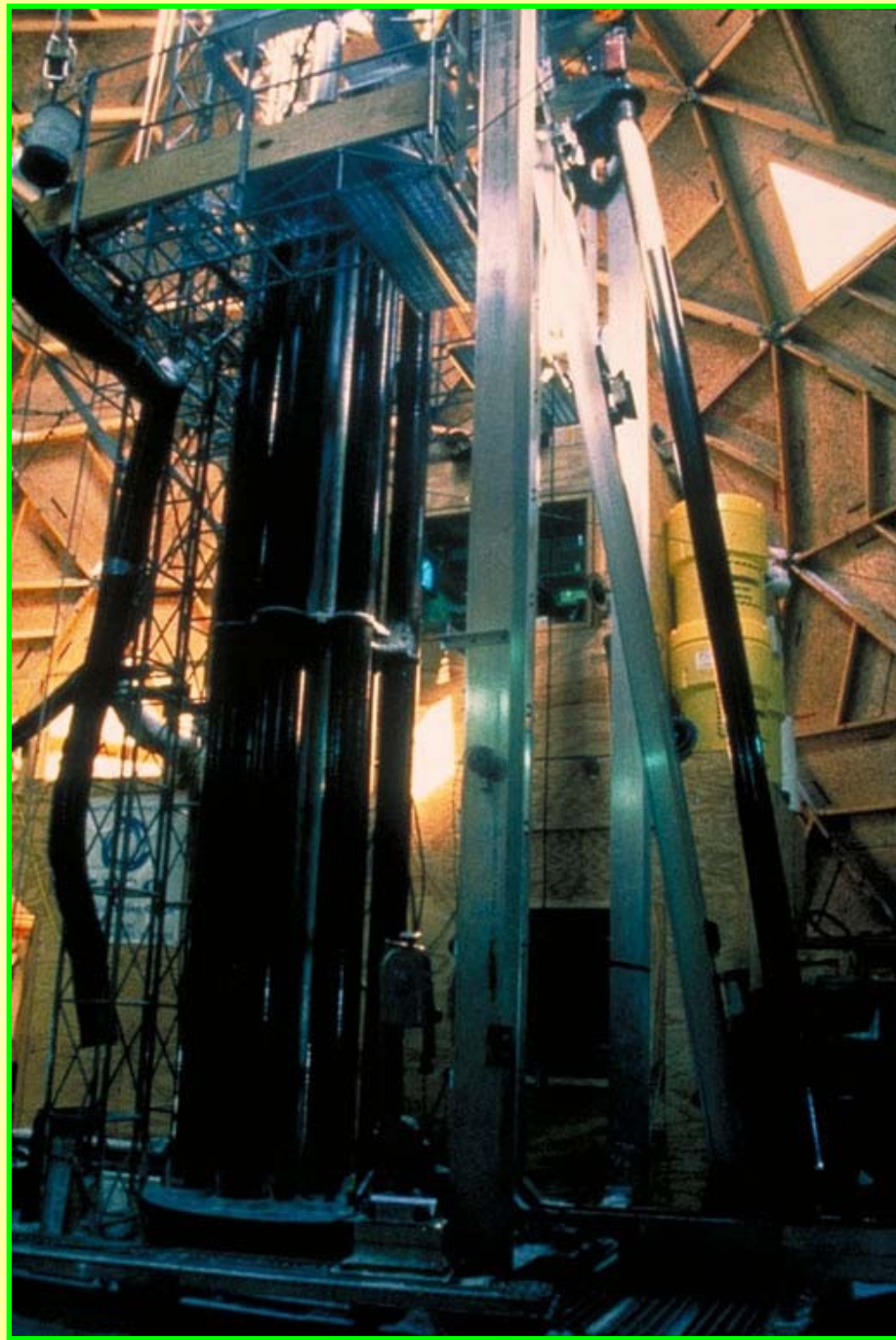


Drilling Sites in Antarctica: Vostok Station



Drilling Station











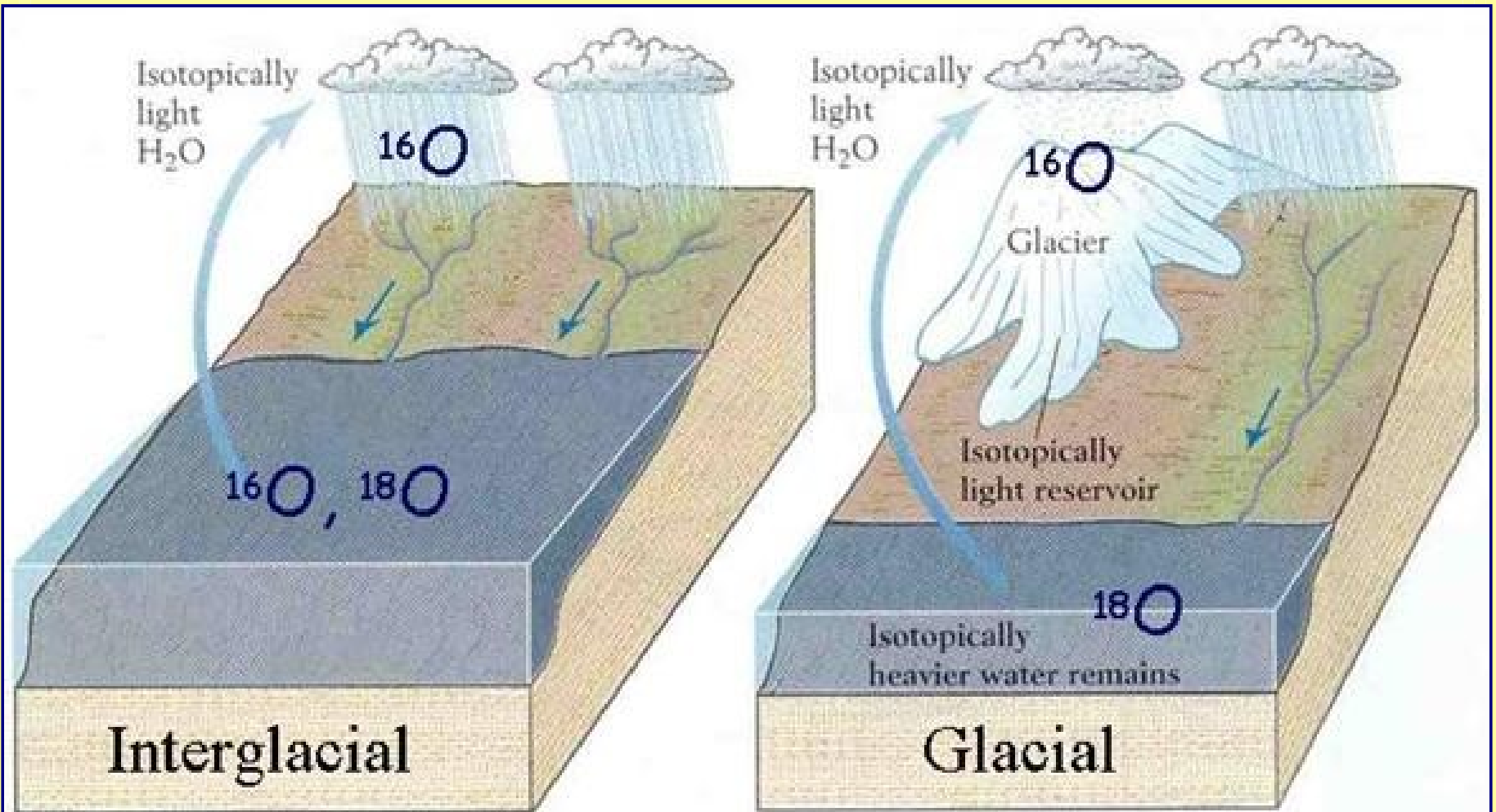
Oxygen Isotope Analysis

542,000,000 years BP

Ratio of Oxygen-18 to Oxygen-16 in calcite
from deep sea sediment cores measured
with a mass spectrometer

More Oxygen-18 = colder climatic periods





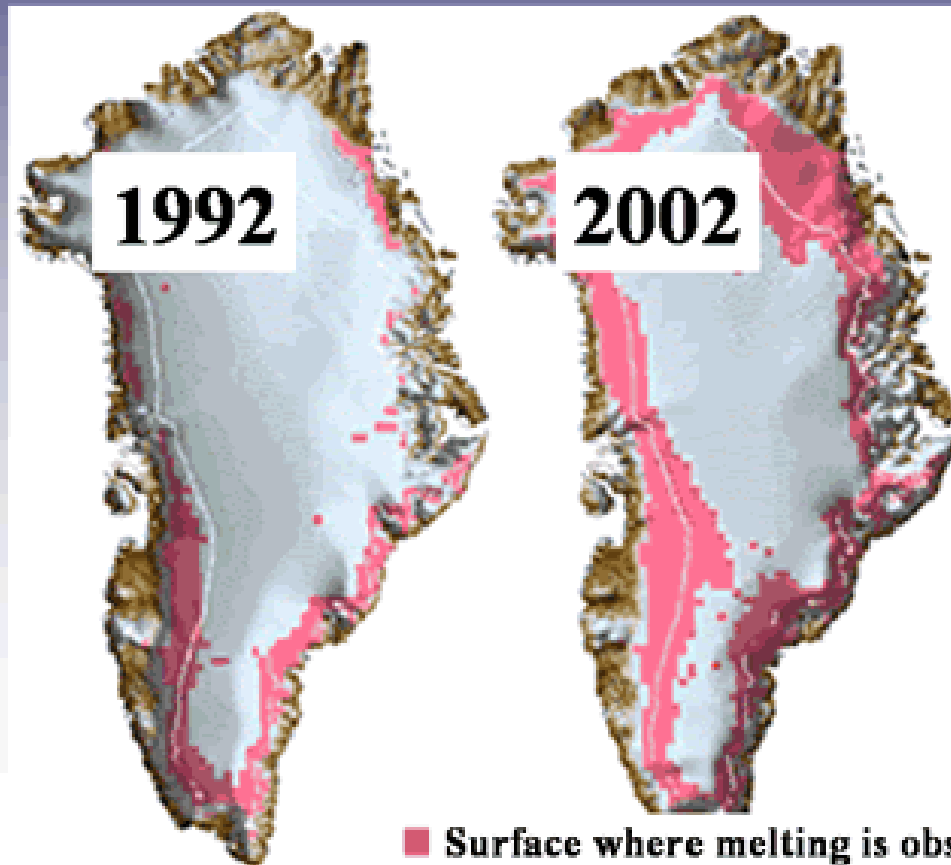
Isotopically light water evaporates from the ocean and returns via rivers: the system is in balance

Glaciers expand, forming a new reservoir of isotopically light water on the land: sea level drops and the ocean becomes isotopically heavy

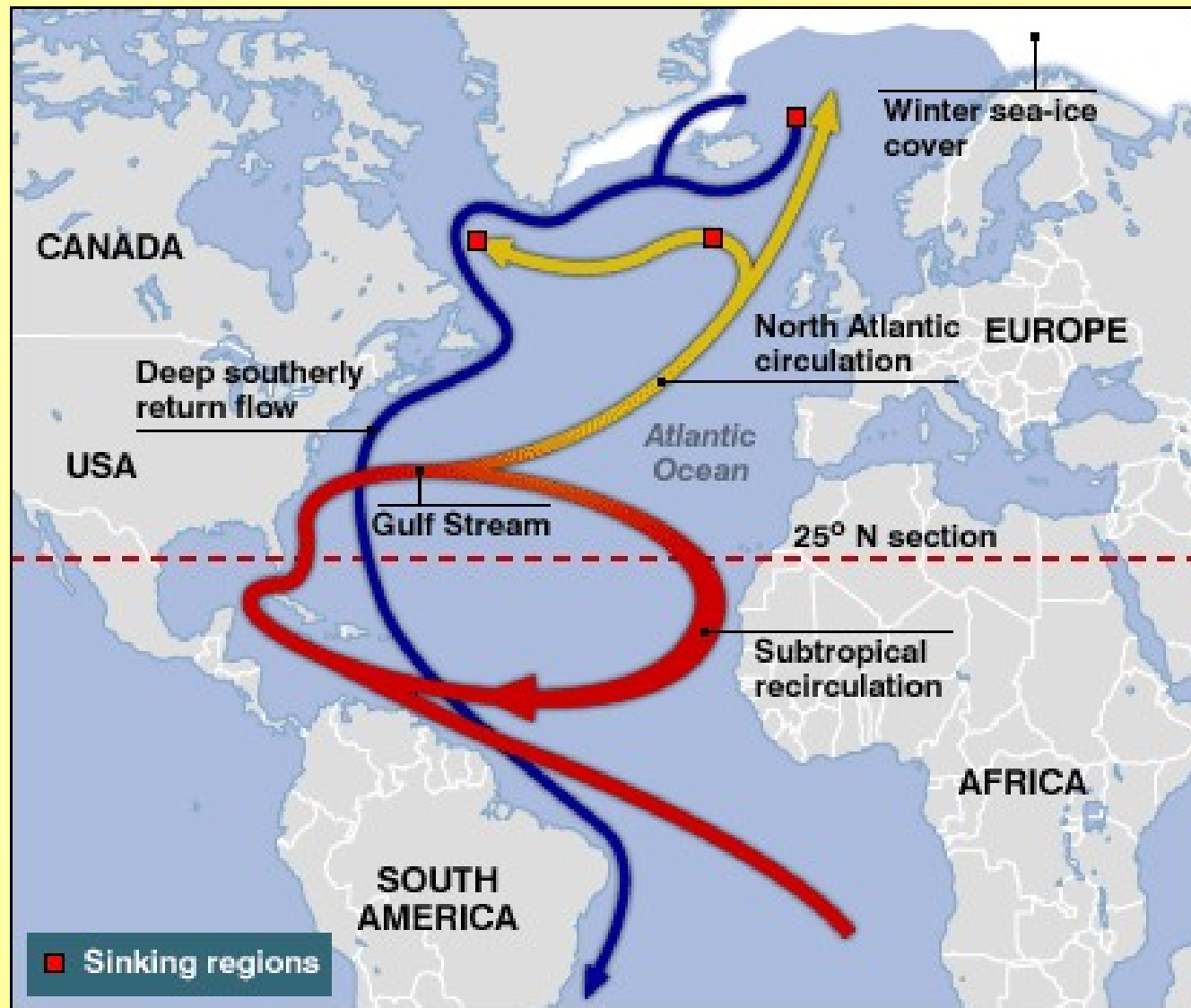
What evidence is there beyond temperature data?

Melting of the Greenland ice sheet

Increase of maximal seasonal melting surface by 16%



Thermohaline Circulation in the Atlantic





The Snows of
Kilimanjaro 1912

2000



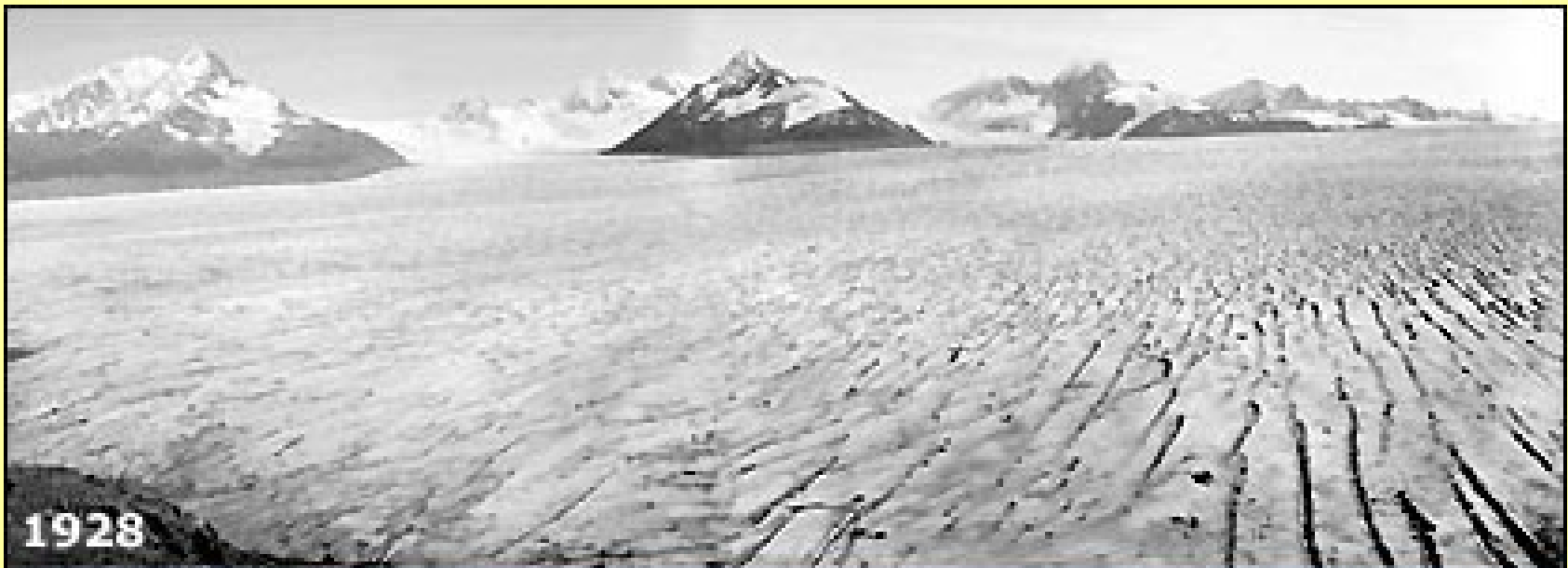


Qori Kalis glacier in Peru
shown in 1978

2000



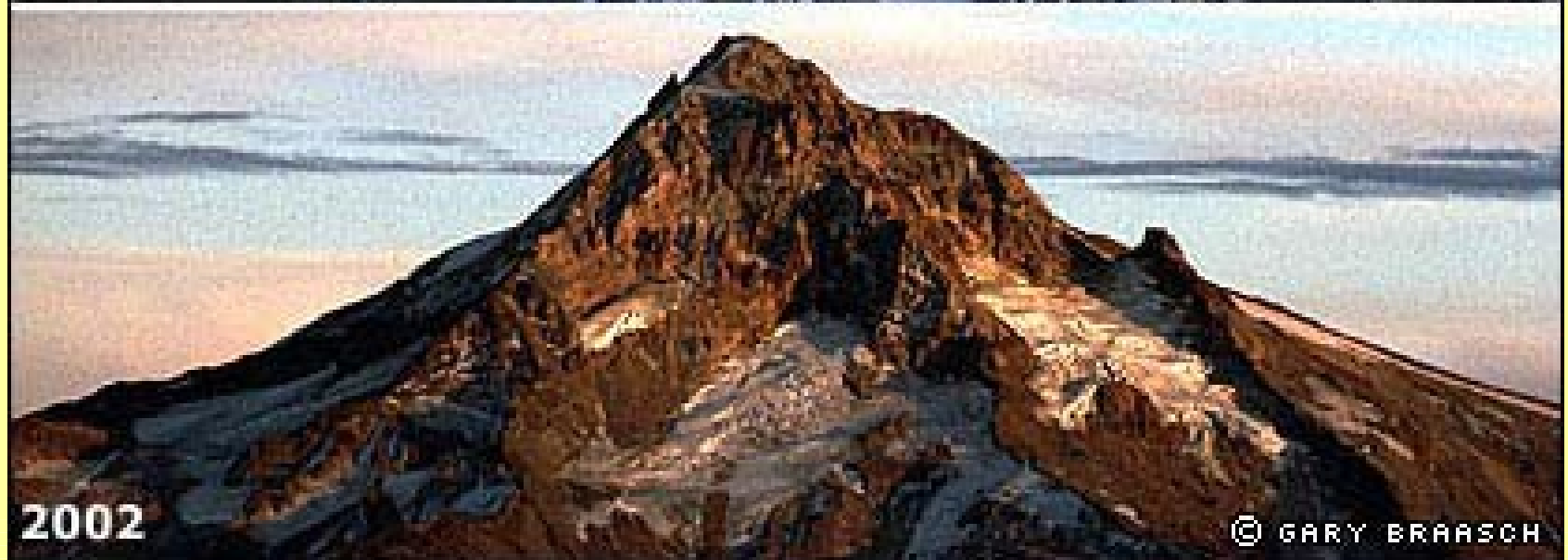
Argentina's Upsala Glacier



Rhone Glacier in Switzerland,

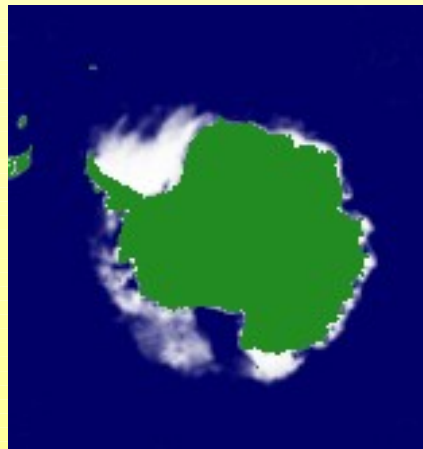


Mt. Hood, Oregon



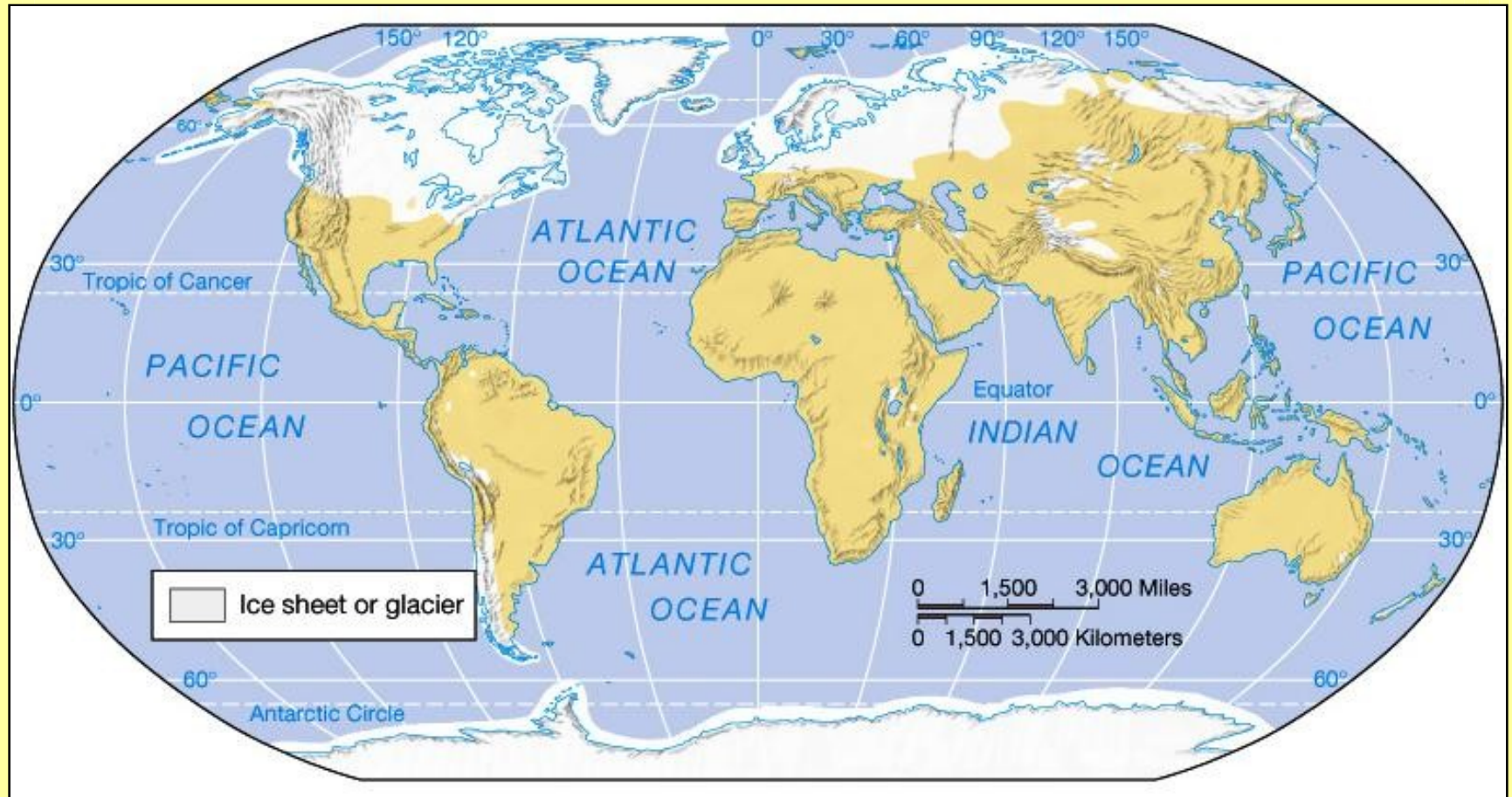


A comprehensive study by NASA found Antarctica's ice sheet mass has decreased significantly losing approximately 150 cubic kilometers of ice annually between 2002-2005 (1 cubic km = 260 billion gallons of water).





Land ice at the depth of the last glaciation



Global Sea Level was about 120 m lower than it is now, so that a land bridge existed between Siberia and Alaska. As Earth's atmosphere continues to warm, sea levels will continue to rise.



ALABAMA

GEORGIA

Atlantic Ocean

Pensacola

Panama City

Tallahassee

Jacksonville

Gainesville

Daytona
Beach

Orlando

Cape
Canaveral

Gulf of Mexico

Saint
Petersburg

Tampa

FLORIDA

Fort
Myers

Fort
Lauderdale

Miami

Present

Key West

USA: Florida

Weiss and Overpeck
The University of Arizona

0 100 km













**So, in light of ALL the evidence,
the peer-reviewed research conducted
by the best climate scientists,
and the seriousness of the effects...**

**Why would anyone deny
or trivialize
Global Warming?**





**Oil and Gas Industry,
especially Exxon who later became,
ExxonMobil, began a well-organized**

disinformation campaign.

**Between 1998 and 2005,
ExxonMobil funneled
~\$16,000,000
to a network of
organizations to
manufacture uncertainty
about climate change.**



A Bit of History...

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) established the Intergovernmental Panel on Climate Change (IPCC).

The role of the IPCC's 2500 climate scientists is to “assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of human-induced climate change, its potential impacts, and options for adaptation and mitigation.”



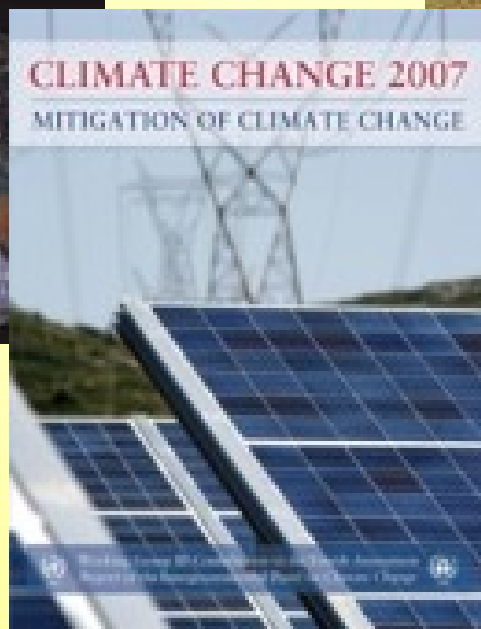
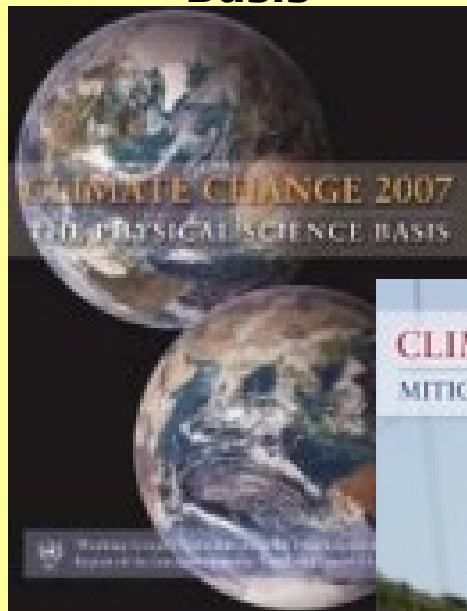
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



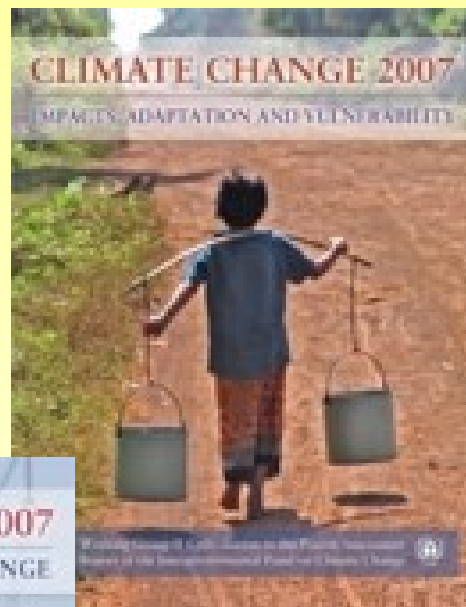
The first report of the IPCC was published in 2001

2007: IPCC Fourth Assessment Report (AR4)

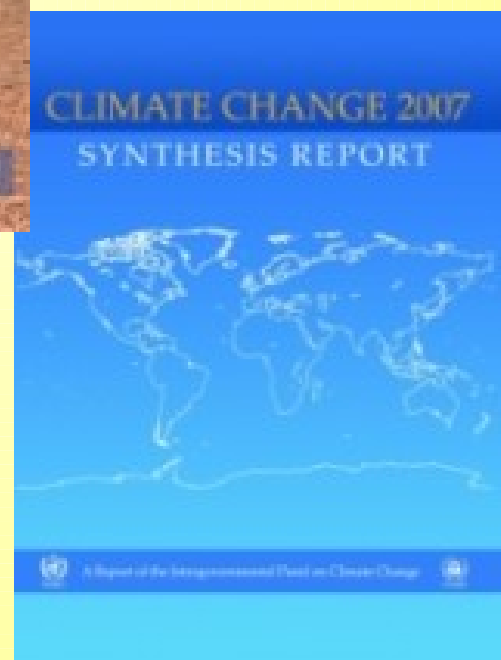
Climate Change 2007: The Physical Science Basis



Climate Change 2007: Mitigation of Climate Change



Climate Change 2007: Impacts, Adaptation and Vulnerability



Climate Change 2007: Synthesis Report

ExxonMobil Mobilized



**Hiring many of the same “scientists”
who worked in PR
for RJ Reynolds and Philip Morris,**

These folks boast:

“Our product is doubt.”

**In order to give the appearance
of widespread and legitimate debate
among scientists:**

Numerous front organizations were formed.

***Only, most of the members
were the same people.***



***George Marshall Institute and
the Oregon Institute of Science and Medicine***

**“The Petition Project” was designed to
undermine and discredit the scientific authority of the IPCC.**

**Petition was sent to 1000s of scientists with an
article formatted to mimic the journal of the
*National Academy of Sciences.***

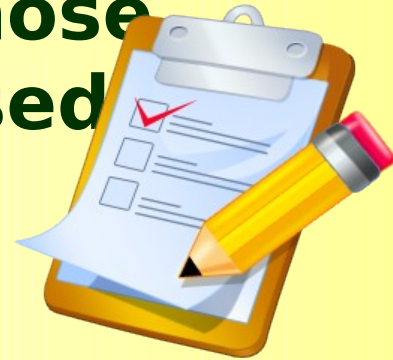
**The article had not been peer- reviewed, published,
or accepted for publication in that journal.**

**(The Academy released a strong statement
disclaiming any connection to this effort
and reaffirming the reality of climate change.)**



The goal of the Petition Project was to gain signatures from those in climate related fields to opposed

Kyoto Protocol.



17,000 signatures were collected.

It was “riddled with names of fictional characters”



and fewer than 1% were climatologists



**The names of the front groups
Funded by ExxonMobil and the
amounts of money they received
Can be found on the website for
The Union of Concerned Scientists**

<http://www.ucsusa.org/>

***“Smoke, Mirrors, and Hot Air:
How ExxonMobil Uses
Big Tobacco’s Tactics to
Manufacture Uncertainty
on Climate Science”***



UCS's Executive Summary

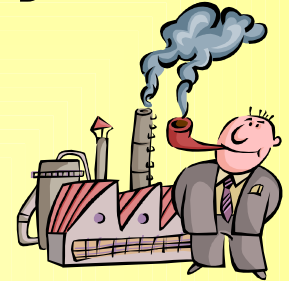


In an effort to deceive the public about the reality of global warming, ExxonMobil has underwritten the most sophisticated and most successful **disinformation campaign** since the tobacco industry misled the public about the scientific evidence linking smoking to lung cancer and heart disease.

As this report documents, the two Disinformation campaigns are strikingly similar. ExxonMobil has drawn upon the tactics and even some of the organizations and actors involved in the callous disinformation campaign the tobacco industry waged for 40 years.



Like the tobacco industry, ExxonMobil has:



- ***Manufactured uncertainty by raising doubts*** about even the most indisputable scientific evidence.

- Adopted a strategy of ***information laundering***

by using seemingly independent front organizations to publicly further its desired message and thereby confuse the public.



- ***Promoted scientific spokes-people who misrepresent***

peer-reviewed scientific findings or cherry-pick facts in their attempts to persuade the media and the public that there is still serious debate among scientists that burning fossil fuels has contributed to global warming and that human-caused warming will have serious consequences.



- ***Attempted to shift the focus away from meaningful action on global warming***
with misleading charges about
the need for “sound science.”



- ***Used its extraordinary access to the ...
... administration to block federal policies and***

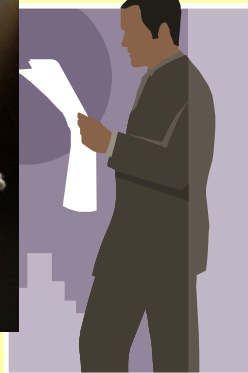
shape government communications on global warming.



James Hansen, NASA Goddard

"In my more than three decades in the government
I've never witnessed such restrictions
on the ability of scientists
to communicate with the public."

"The White House is now reviewing
all climate related press releases."
(2005)



Appendix A
The Scientific Consensus on Global Warming

The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action.

It is vital that all nations identify cost-effective steps that they can take now, to contribute to substantial and long-term reduction in net global greenhouse gas emissions.

—Joint Statement by the
Science Academies of 11 Nations



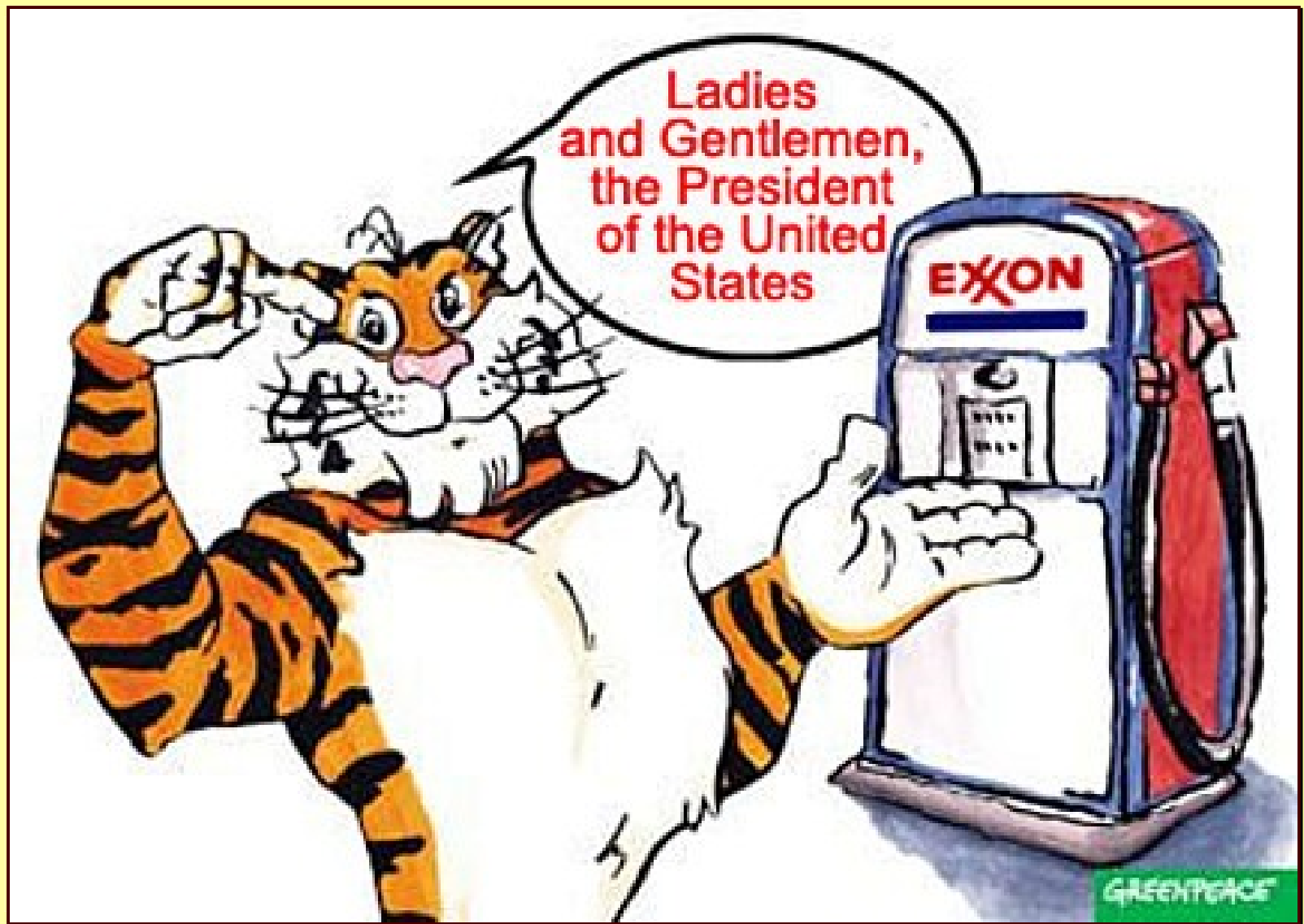
We know enough to act,
already,

We have the technologies available,
now,

We need to remain informed,

And participate in the process....

If we don't,
We know who will



Thank you for being here with us this evening!

