

# GEOLOGIC

A geological hammer with a wooden handle and a metal head, resting on a dark, textured rock surface. The hammer is positioned diagonally, with the head pointing towards the upper left and the handle extending towards the lower right. The background is a dark, textured rock surface, possibly a field or laboratory setting.

## Constraints on Global Climate Variability

Dr. Lee C. Gerhard

# DISCLAIMER!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

- I have accepted no funding from anyone for my research.
- I have no vested interest in the outcome of the debate.
- I only care that solid science rules in the debate resolution
- Much of this research was conducted while I was at the KGS; many graphics were prepared by the Kansas Geological Survey.

# History of Astronomical Theory

Pre- 600 B. C.	The Ancients	Geocentric Universe
600 B.C.	Pythagoras	Heliocentric Universe
ca. 150 A.D.	Ptolemy	Geocentric Universe
ca. 1500 A.D.	Copernicus	Heliocentric Universe
ca. 1575 A.D.	Tycho Brahe	Geocentric Universe
1610 A.D.	Galileo	Heliocentric Universe
<u>ca. 1990 A.D.</u>	<u>Yuppies</u>	<u>Humanocentric Universe</u>

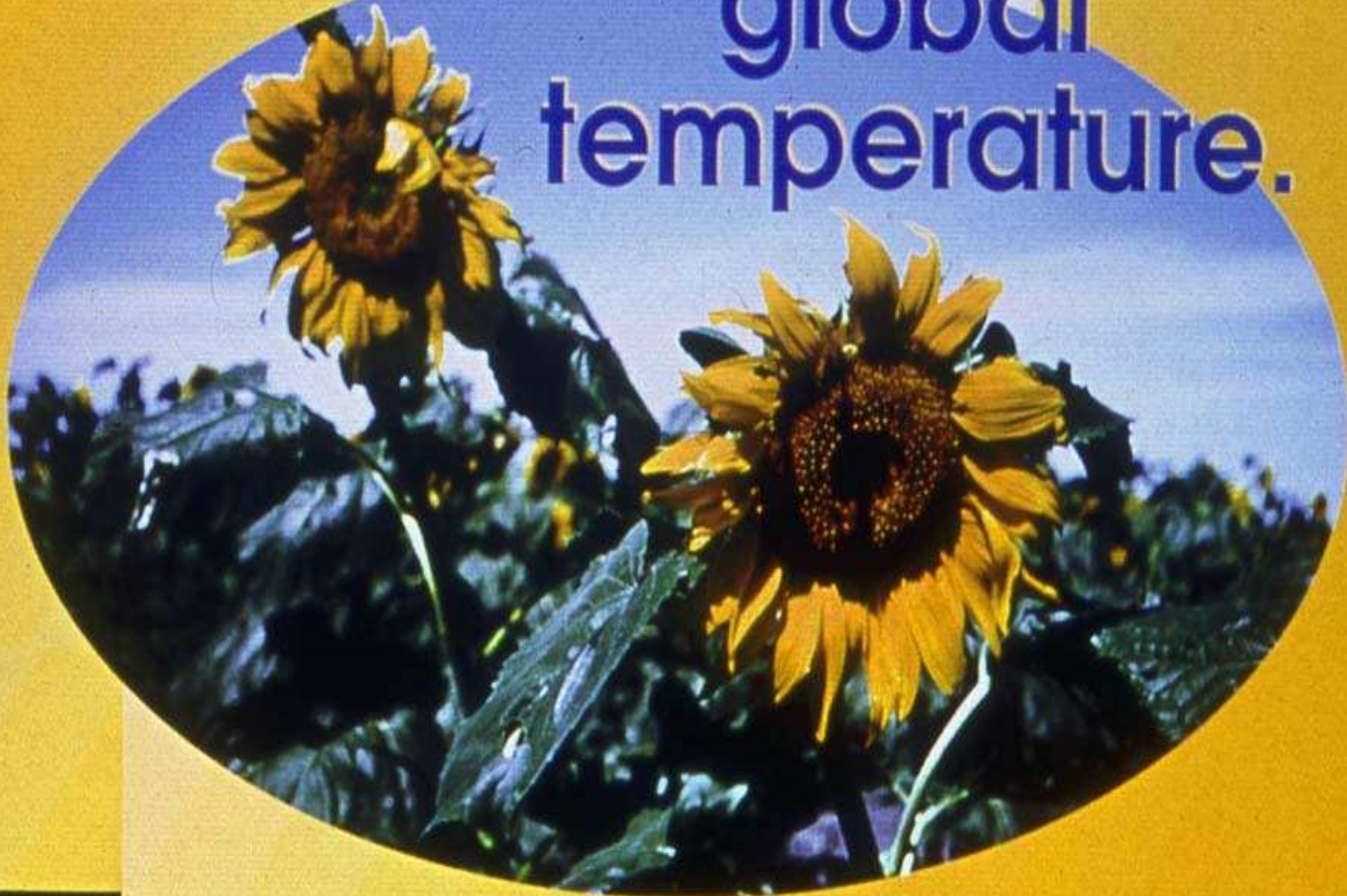
# THE HUMAN CURSE

- Humans abhor change.
- They object to change.
- They feel responsible for change.
- They feel omnipotent.

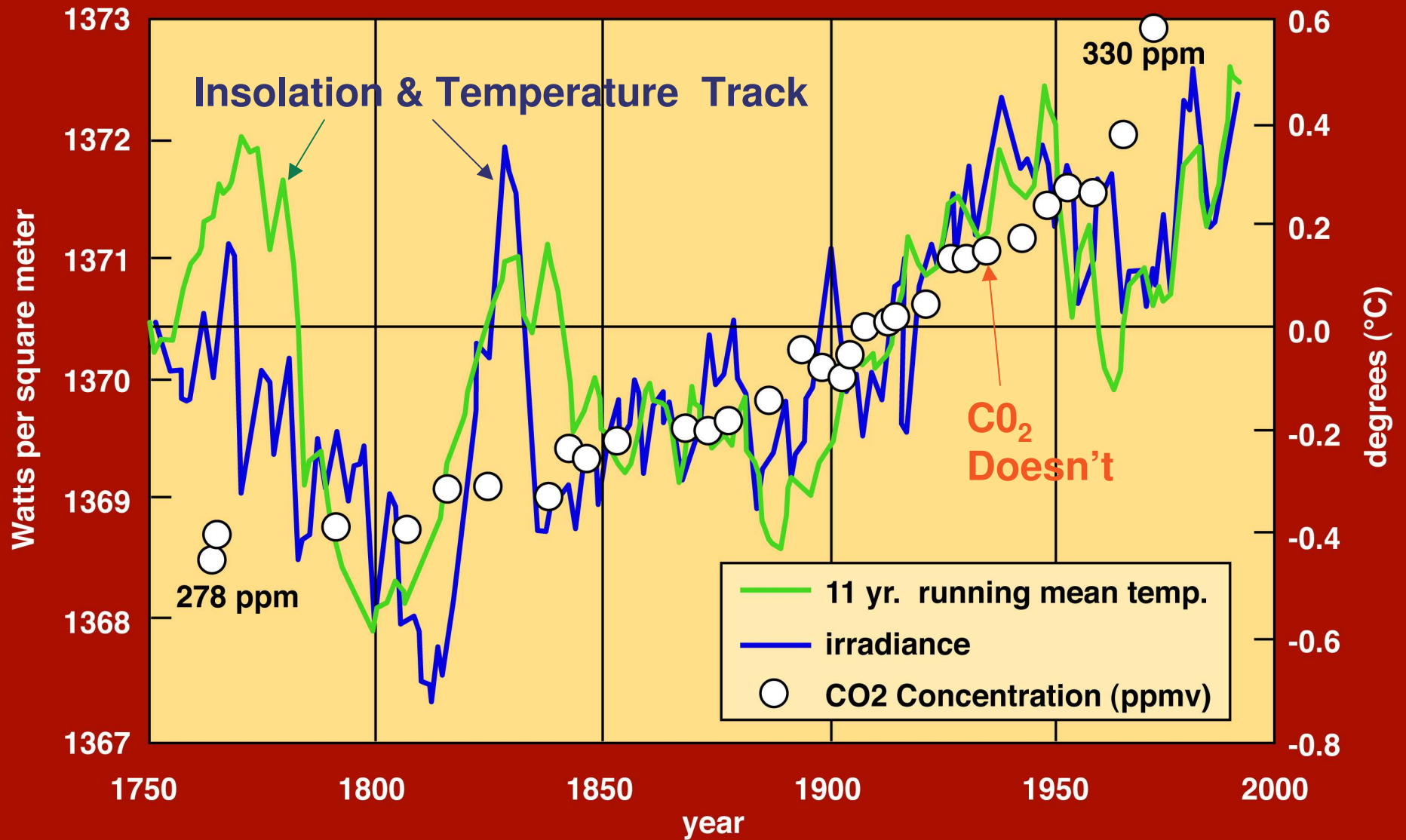
# Global Population Growth History



There is no clear discernible  
effect of human activities on  
global  
temperature.



# Northern Hemisphere Temperature VS. Solar Irradiance



*adapted from Hoyt and Schatten, 1997*

# GEOLOGY

is a temporal

science





# Natural Earth Systems



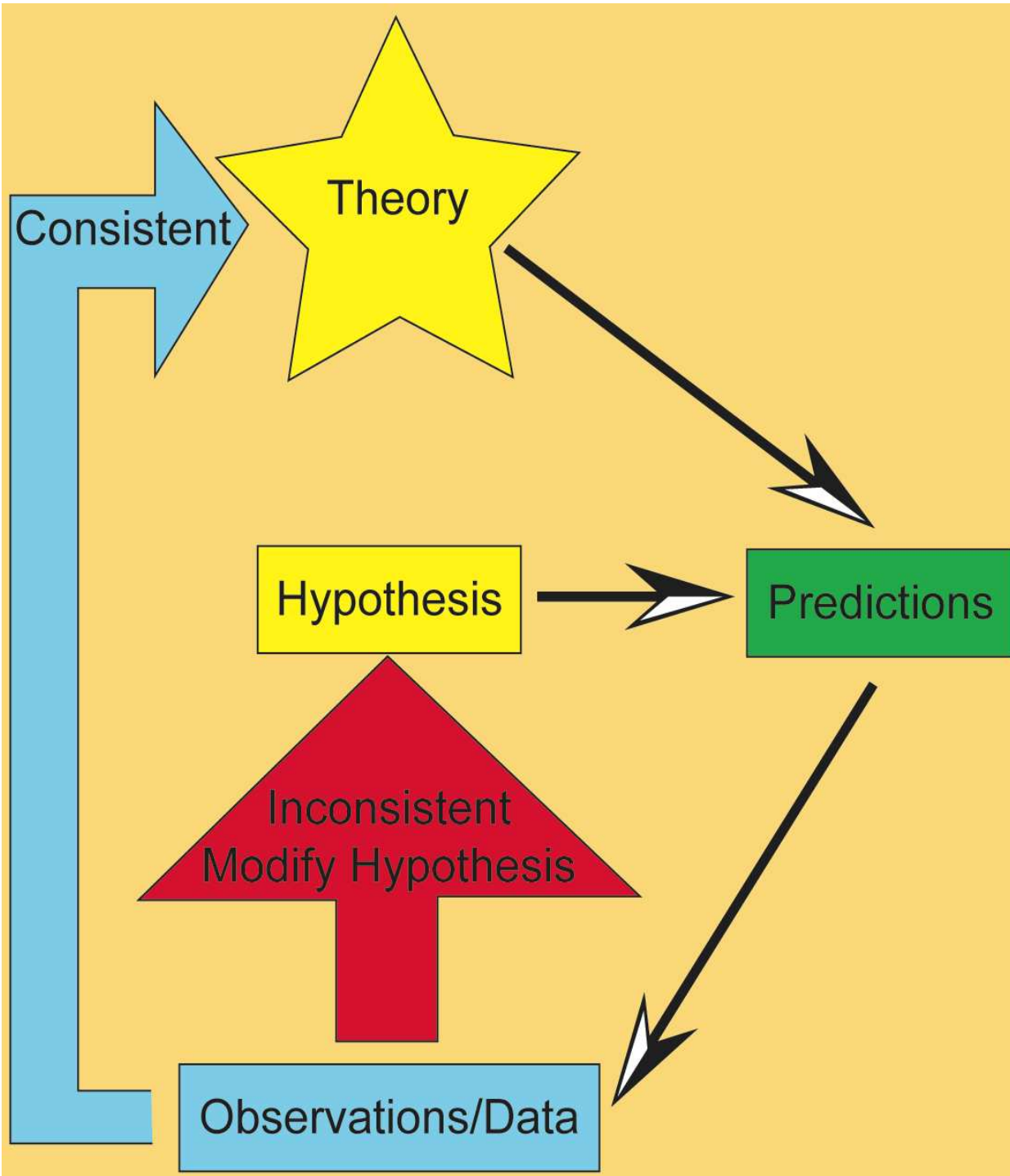
are in disequilibrium

# How Science is Done:

- Theory advanced
- Scientists attempt to falsify theory with data
- If falsified, develop new theory
- If not falsified, continue testing with new data. It is not possible to “prove” a theory

# Three hypotheses:

1. Climate is changing, and is warmer over the last 250 years.
2. Anthropogenic emissions of greenhouse gases are the most significant driver of climate change.
3. Natural processes are the most significant climate drivers.



## The Scientific Method

Hypothesis, testing, falsification or support, results may be theory.

Data (observations) test hypothetical concepts and predictions. If they don't hold up, then the hypothesis requires modification.

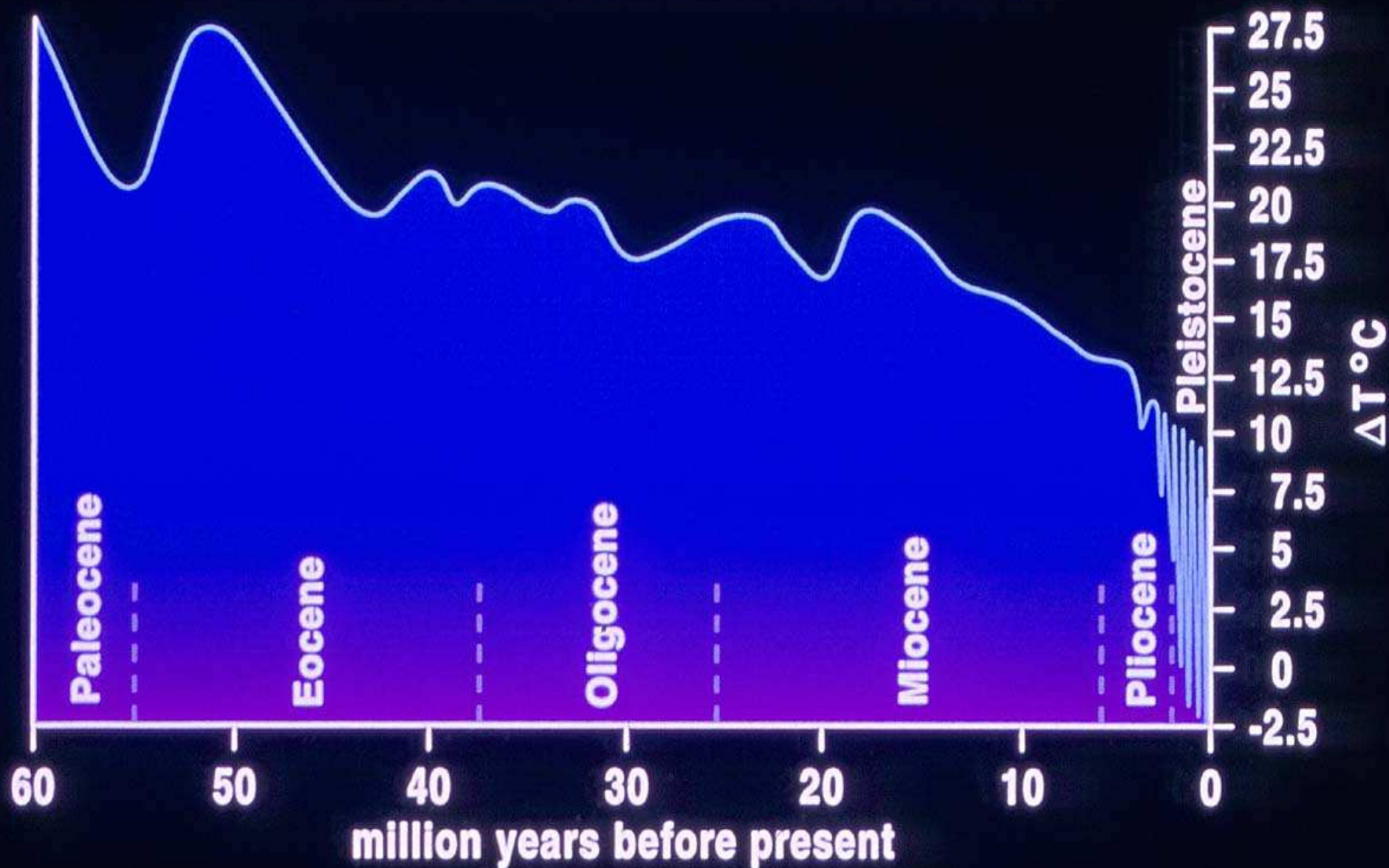
Only when data and predictions coincide and support the hypothesis is it considered a theory, and then it is subject to additional testing. The job of science is to attempt to falsify hypotheses and theories

# Theory 1: Is climate changing?

1. Climate is changing, and is warmer over the last 250 years.

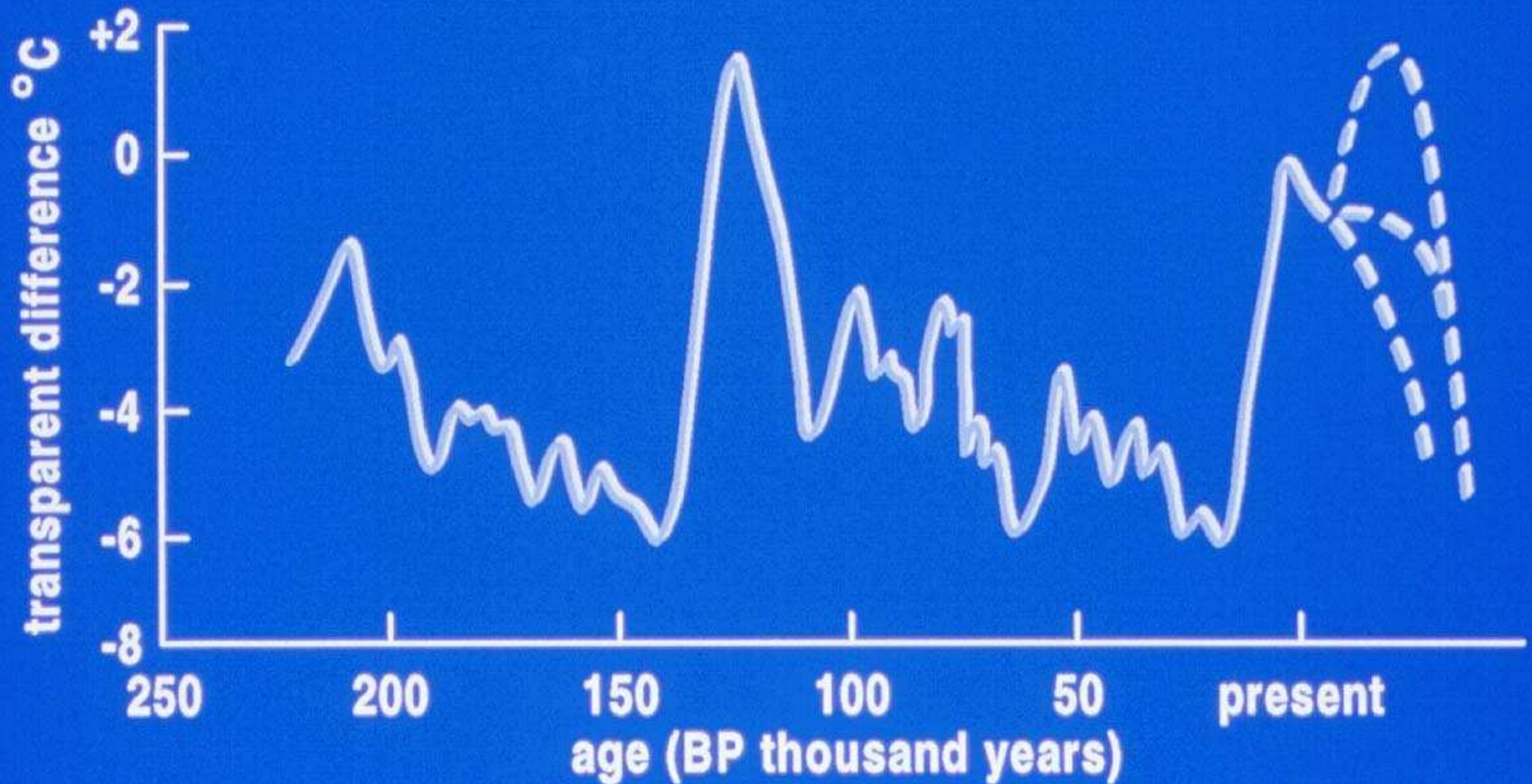
Test: does comparison of theory to all historical records demonstrate that climate is always changing, in both directions, and at many intensities?

## Climate Fluctuation in Central Europe



*adapted from Bluemle et. al., 1999*

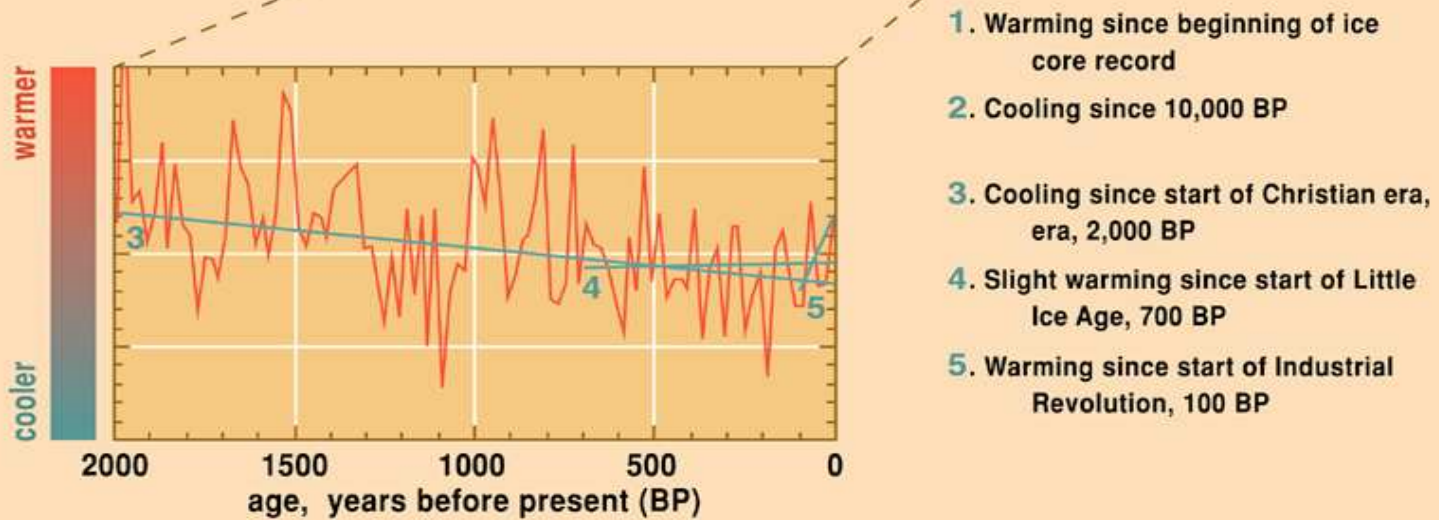
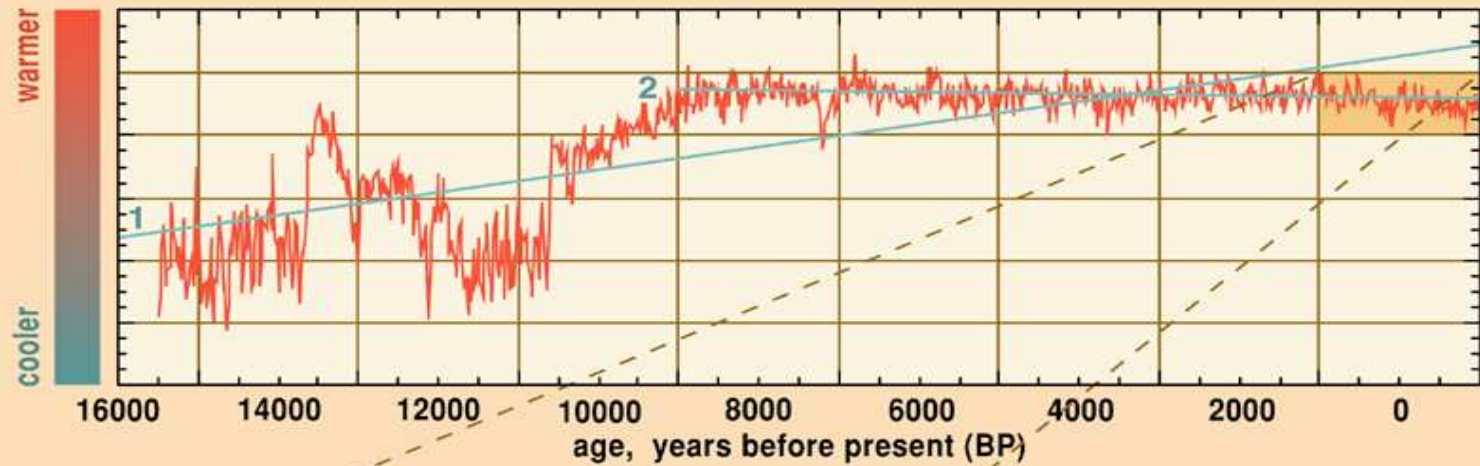
# Temperature Curve of the Past 200,000 Years, with or without the Greenhouse Effect



oxygen isotope data

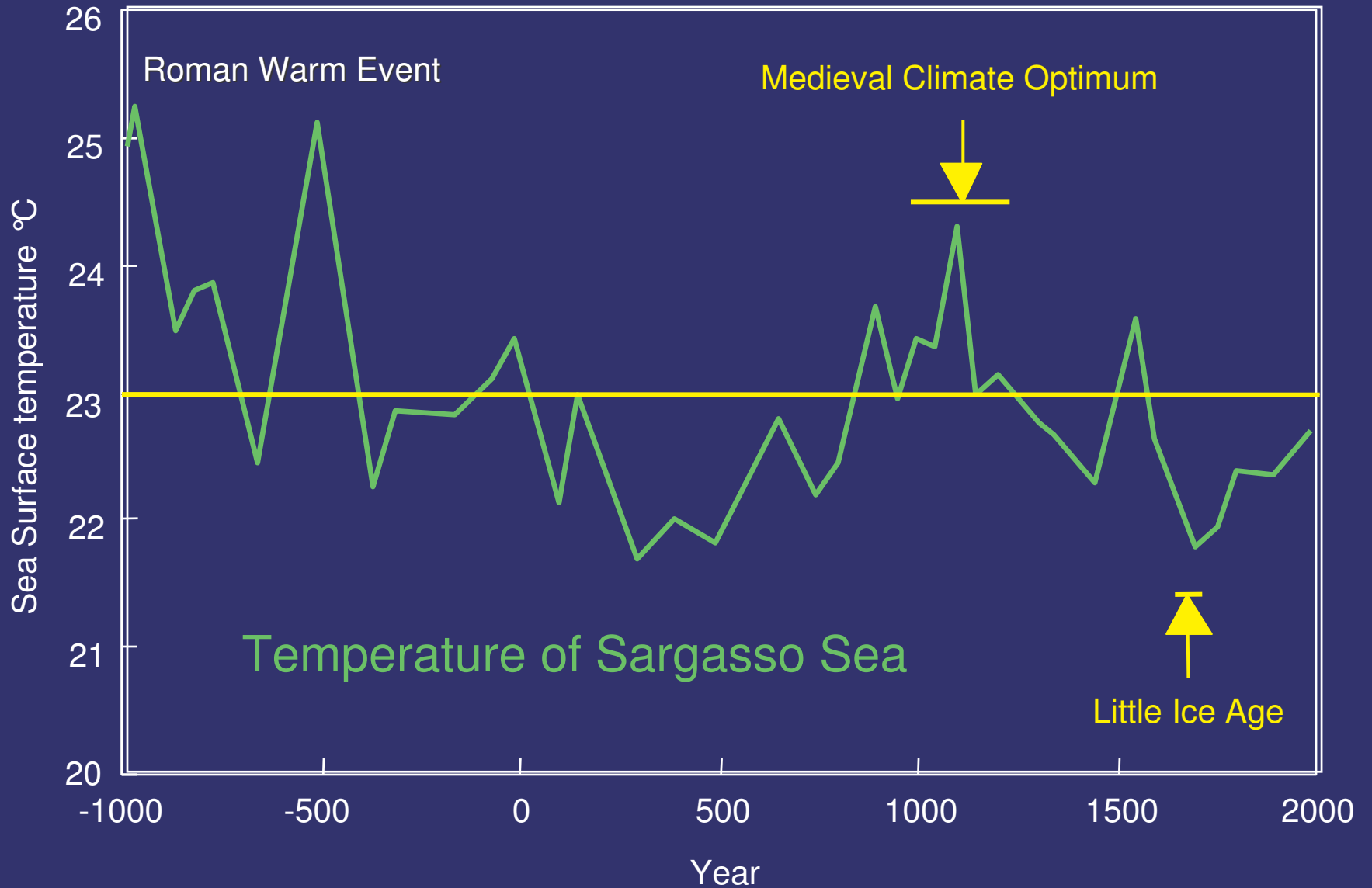
adapted from Moore et. al., 1996

# Earth temperature history from Greenland ice core data



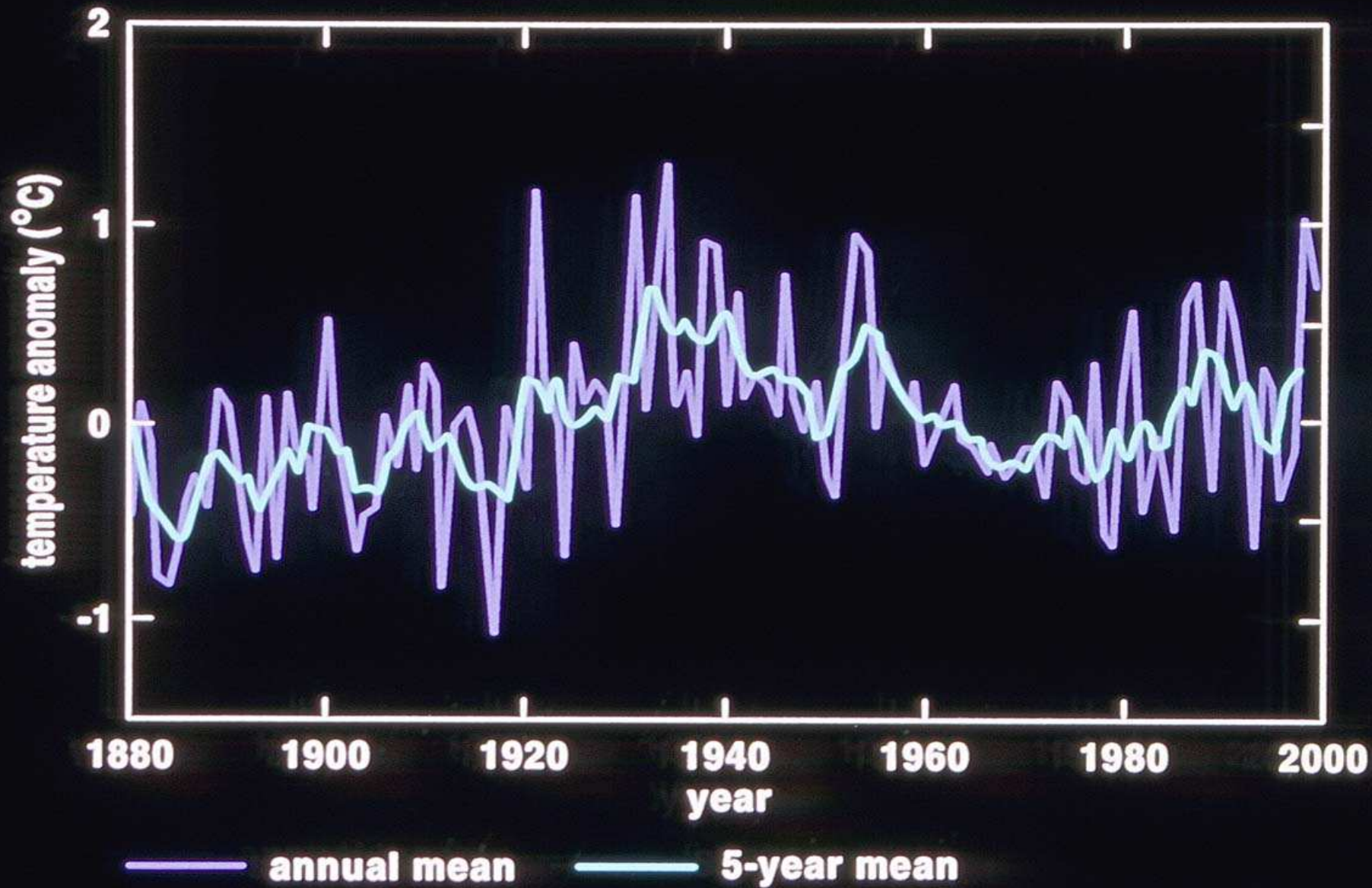
1. Warming since beginning of ice core record
2. Cooling since 10,000 BP
3. Cooling since start of Christian era, era, 2,000 BP
4. Slight warming since start of Little Ice Age, 700 BP
5. Warming since start of Industrial Revolution, 100 BP





Bluemle, Sabel, and Karlen, 2001

# U.S. Temperature



*Goddard Institute for Space Studies, 2000*

# Hypothesis 1: Substantiated

- Climate changes constantly, both warmer and colder, at variable intensities & rates
- All paleoclimate records demonstrate constantly changing climate

# The Real Climate Question: (Separate the Issues)

- The question is not: Is the climate changing? It constantly does, based on geological and historical data. It is likely warmer now than in 1880. Global warming exists. Global cooling will follow.
- The debatable question is: Do humans control earth's dynamic climate system? Or does nature, through normal physical processes?

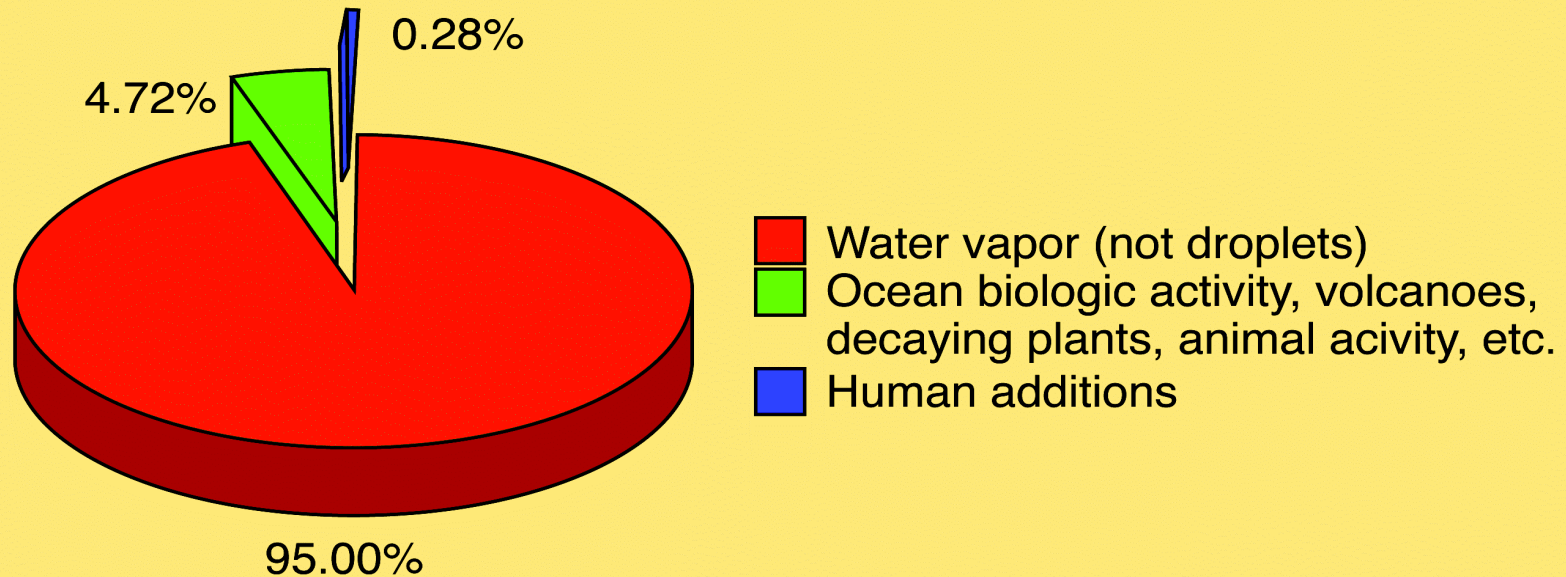
# Hypothesis 2

- Anthropogenic emissions of greenhouse gases are the most significant driver of climate change.
- Test: Correlation with temperature history?

**Carbon Dioxide  
is a  
Trace Gas  
(.0325%)**

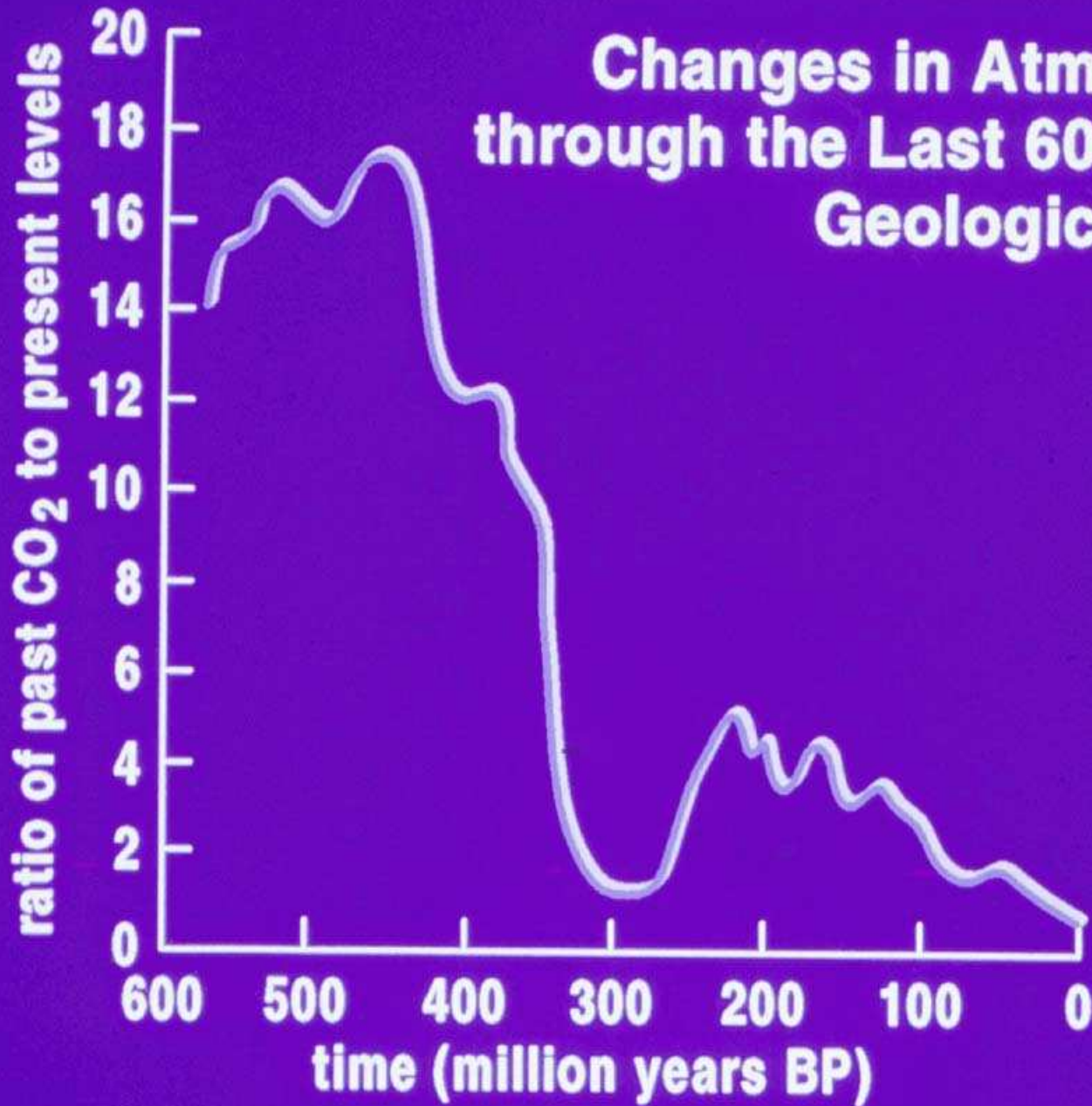
# Sources of Greenhouse Gases

Contributions to the “Greenhouse Effect” expressed as % of total



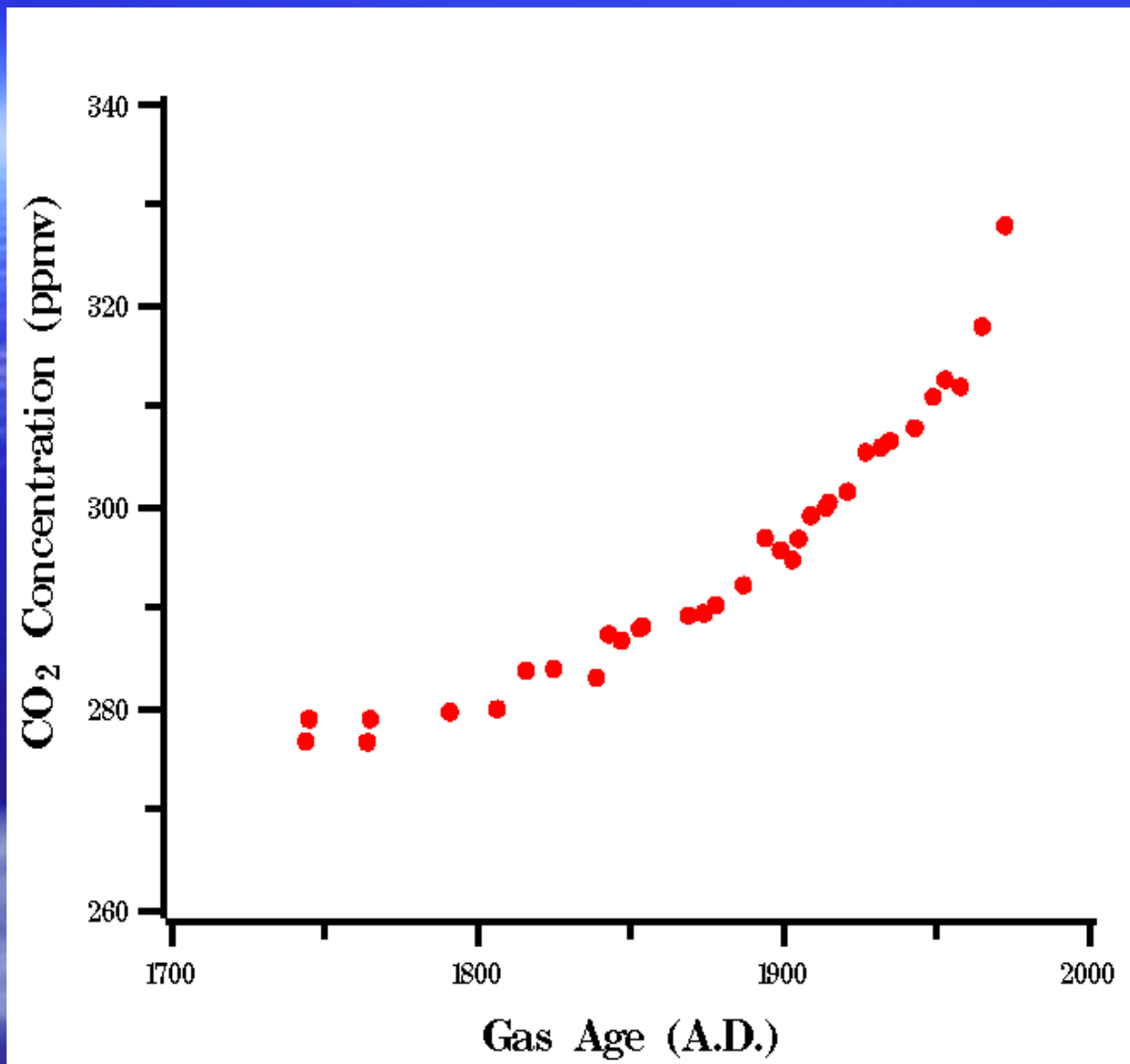
NOTE: “Contributions” are defined as concentrations adjusted for GWP (global warming potential, relative to CO<sub>2</sub>)

# Changes in Atmospheric CO<sub>2</sub> through the Last 600 Million Years of Geological Time

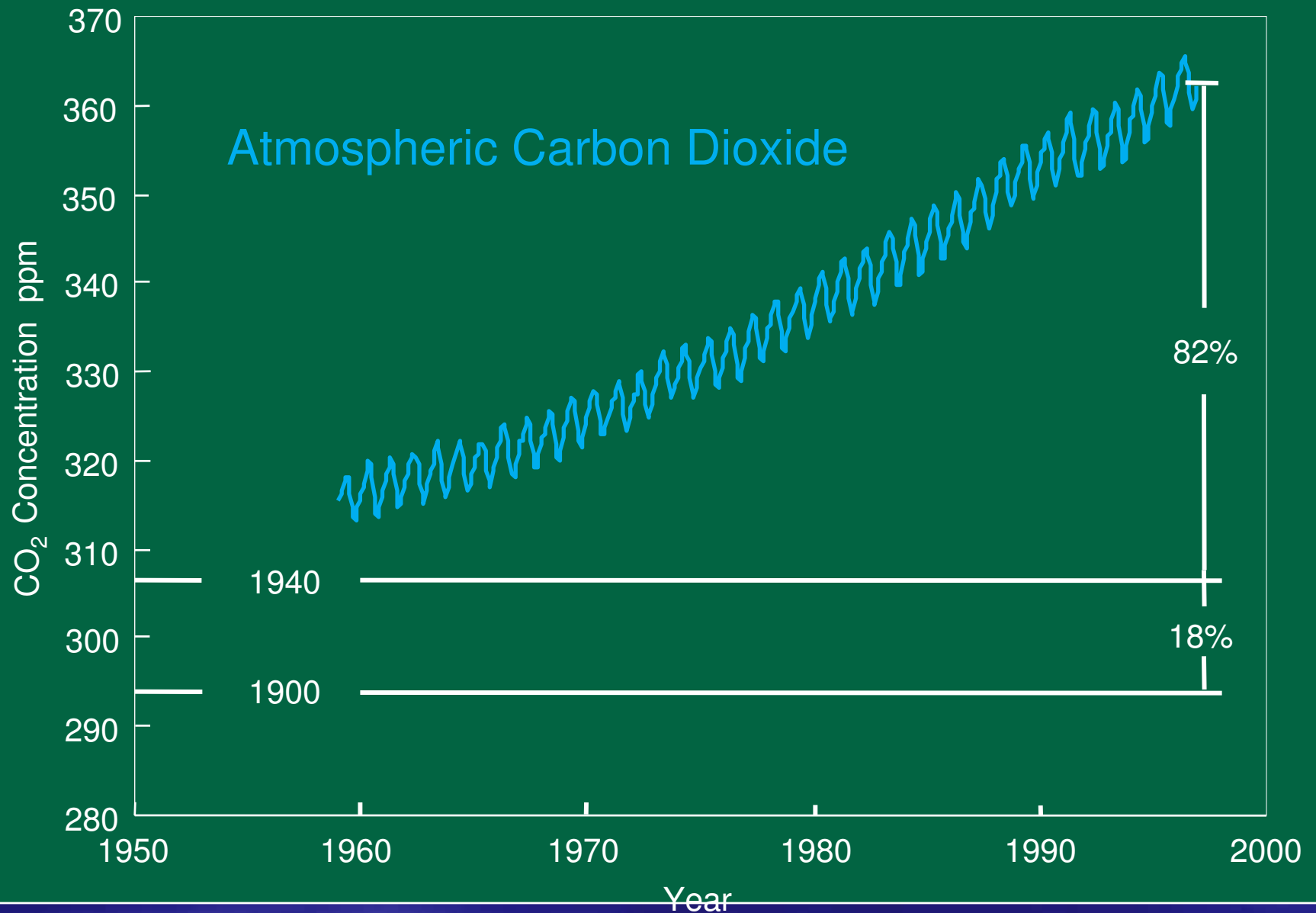


*adapted from Berner, 1994*



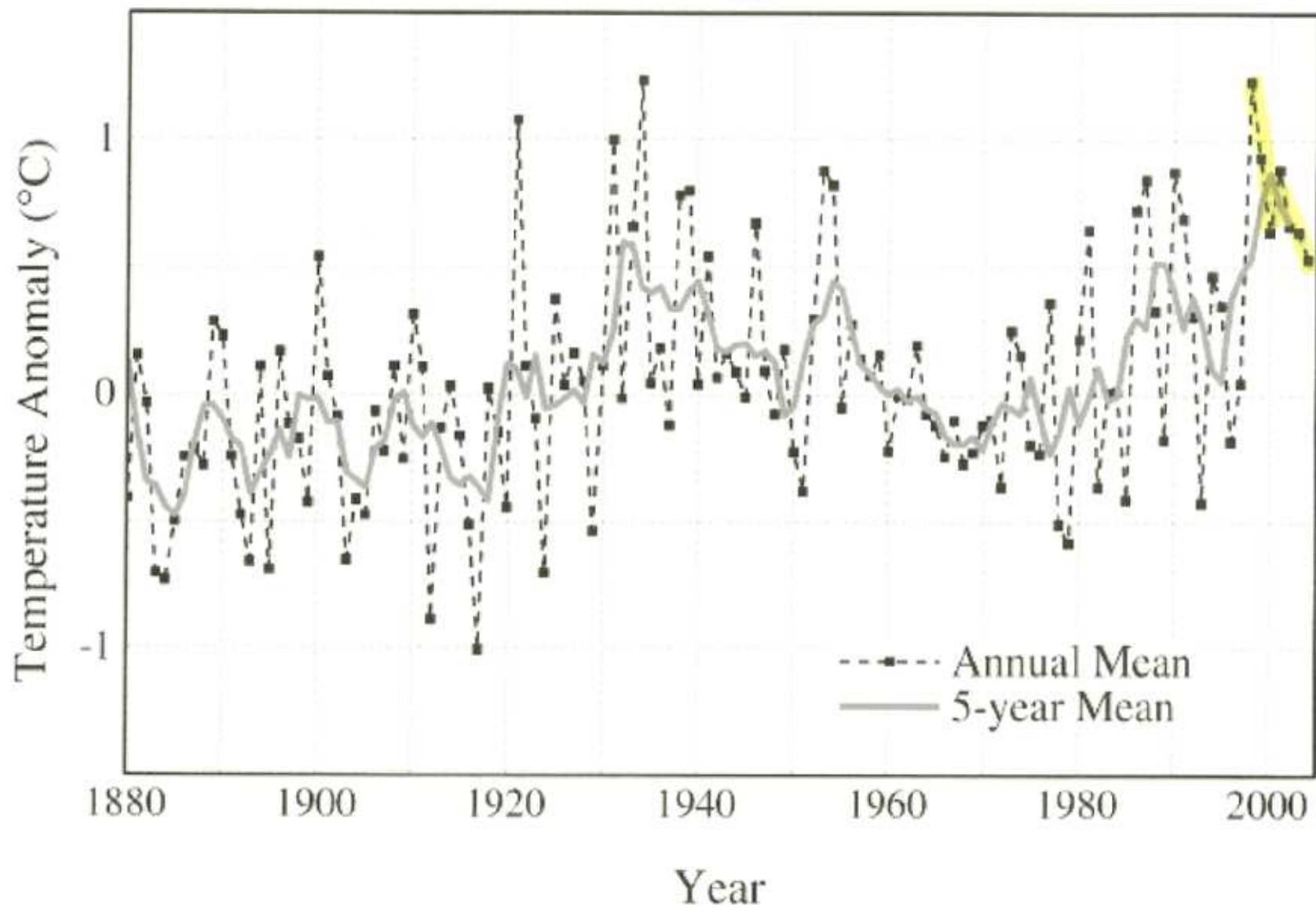


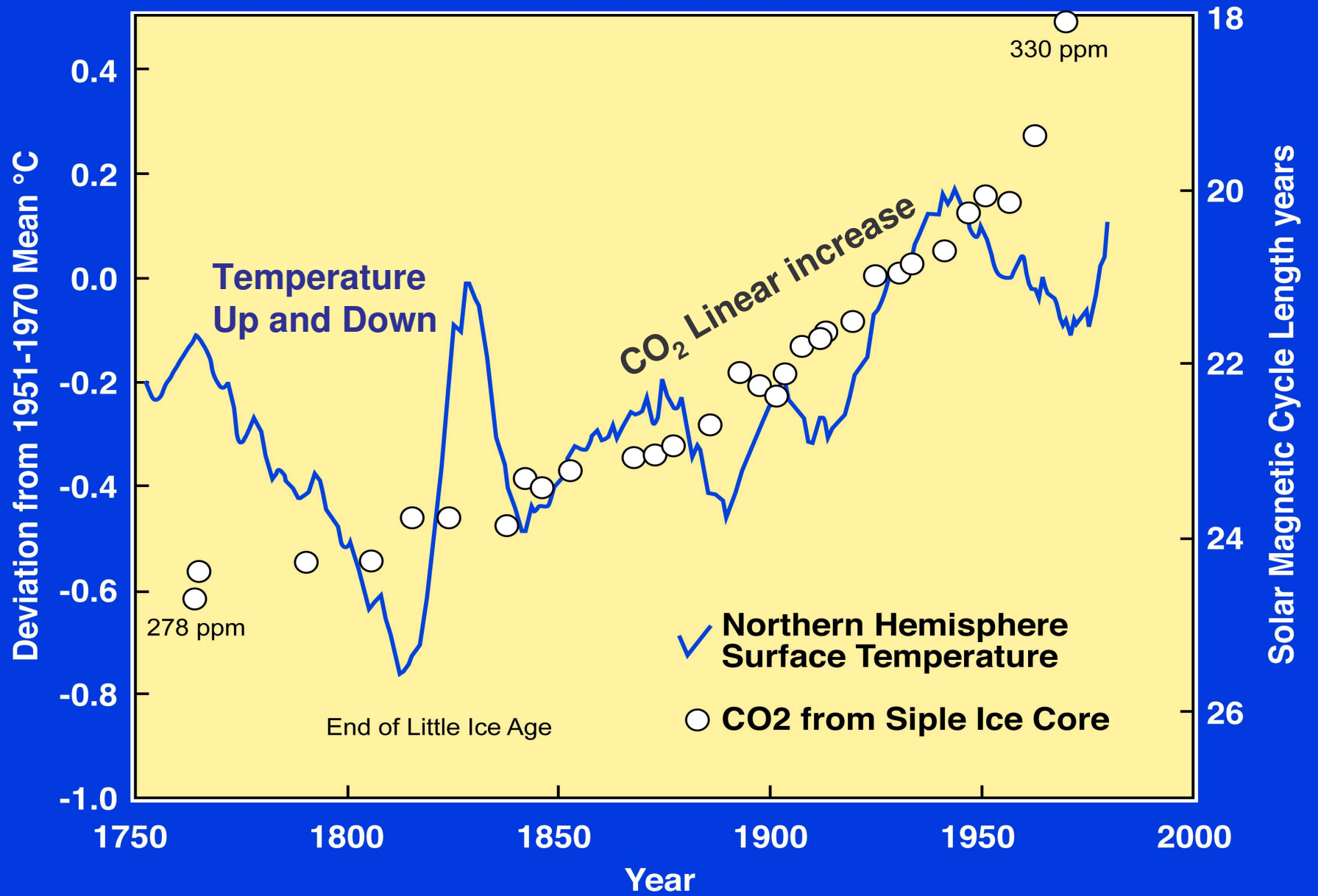
CO<sub>2</sub>  
from  
Siple  
Ice  
Core  
vs. age.

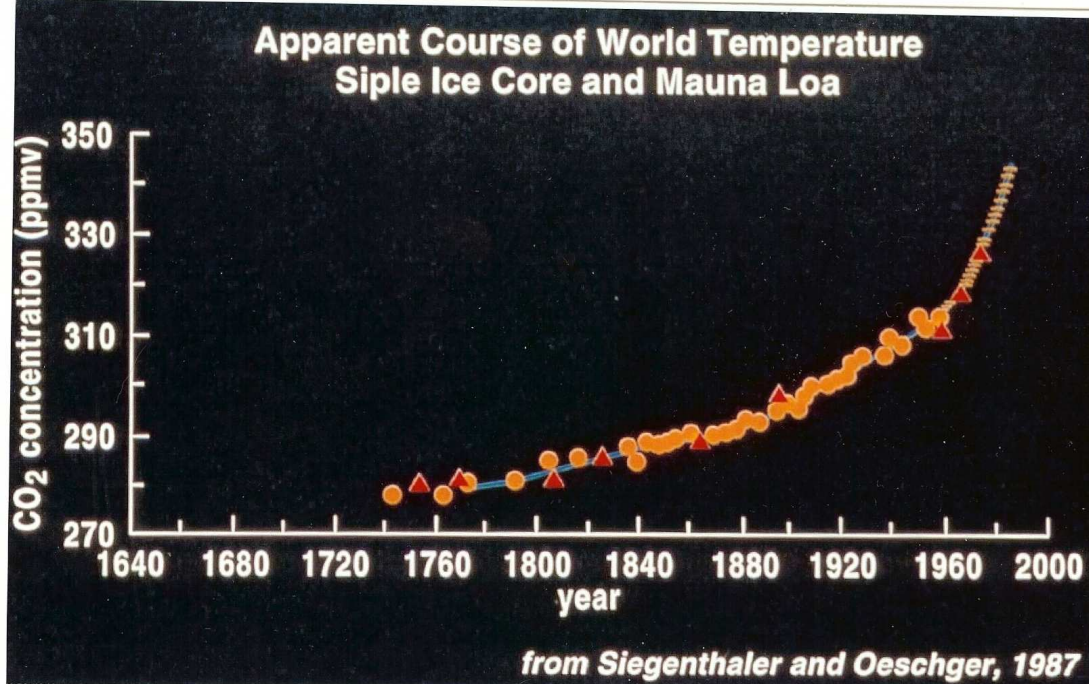
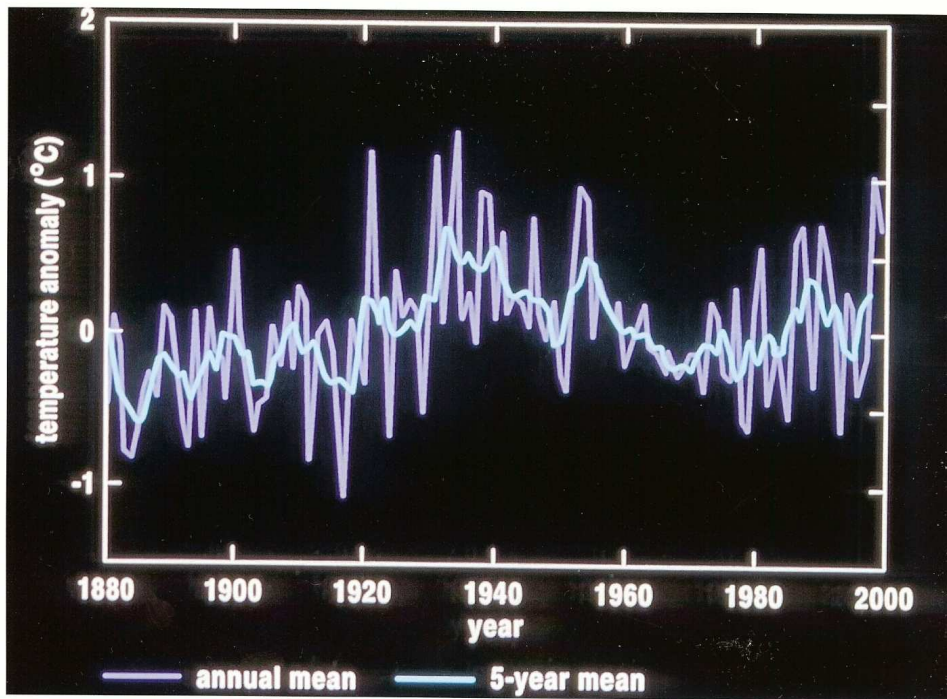


ARTHUR B. ROBINSON, SALLIE L. BALIUNAS, WILLIE SOON, AND ZACHARY W. ROBINSON, 1998

# U.S. Temperature



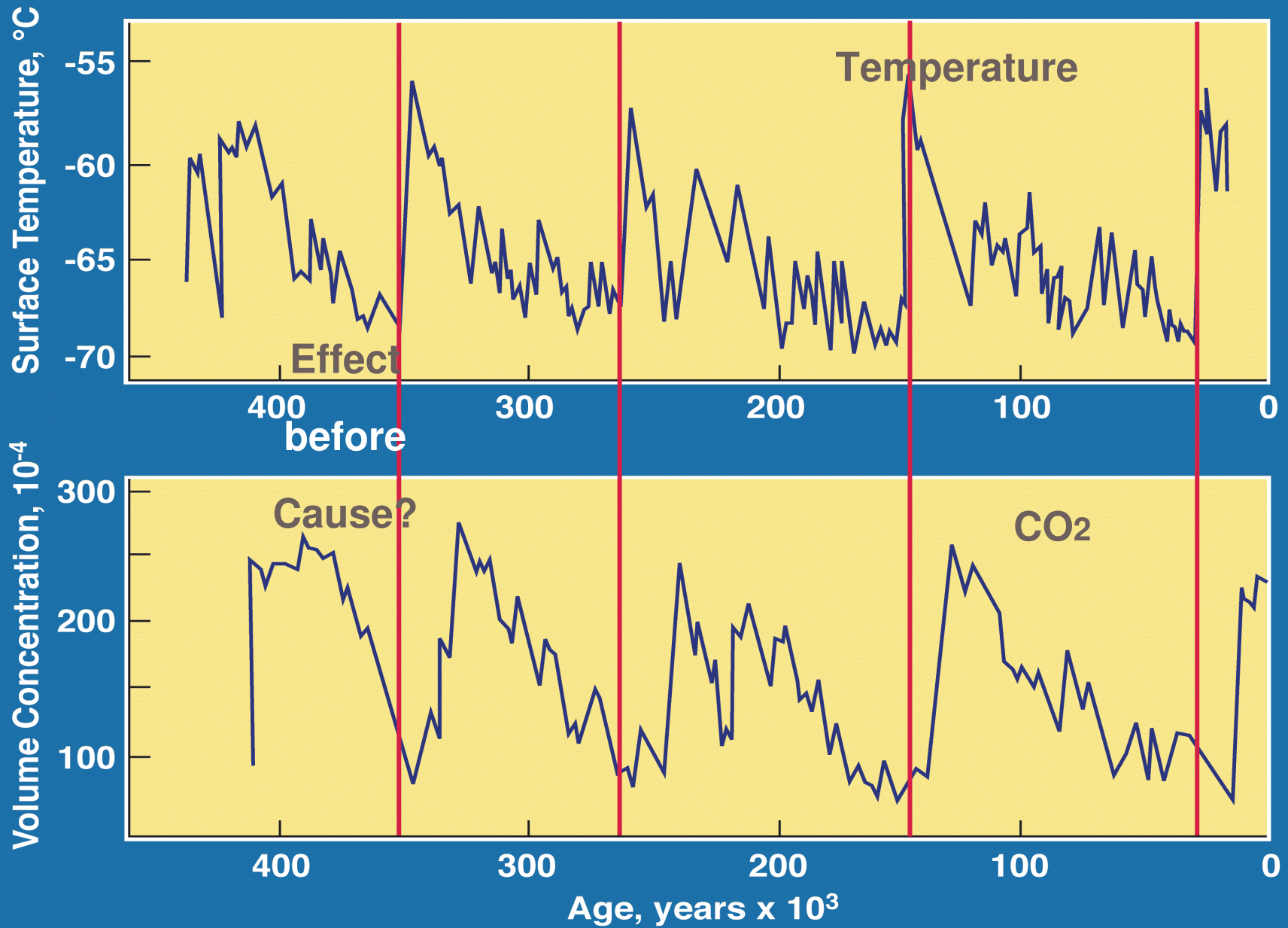




Correlation of  
U.S. temperature  
to  
CO<sub>2</sub>  
concentration

Can we demonstrate that  
greenhouse gas rises  
precede temperature rise,  
thus inferring them as a driver?





Khilyuk and Chilingar, 2003

There is an average of 400 years lag of cause after effect; recent work suggests 1600 years lag.

Fischer, H., M. Wahlen, J. Smith, D. Mastoianni, and B. Deck, 1999, Ice Core Records of Atmospheric CO<sub>2</sub> Around the Last Three Glacial Terminations: *Science*, v. 283, p.1712-1714.

Siegenthaler, Urs, et al, 2005, Stable Carbon Cycle-Climate Relationship During the Late Pleistocene: *Science*, v. 310, p. 1313-1317.



# Hypothesis 2: Falsified

- There is little or no correlation between CO<sub>2</sub> concentration and temperature change.
- Therefore, the theory that human derived CO<sub>2</sub> is the most significant climate driver is falsified.
- That does not mean that there is no effect, but it is likely not measurable against background.

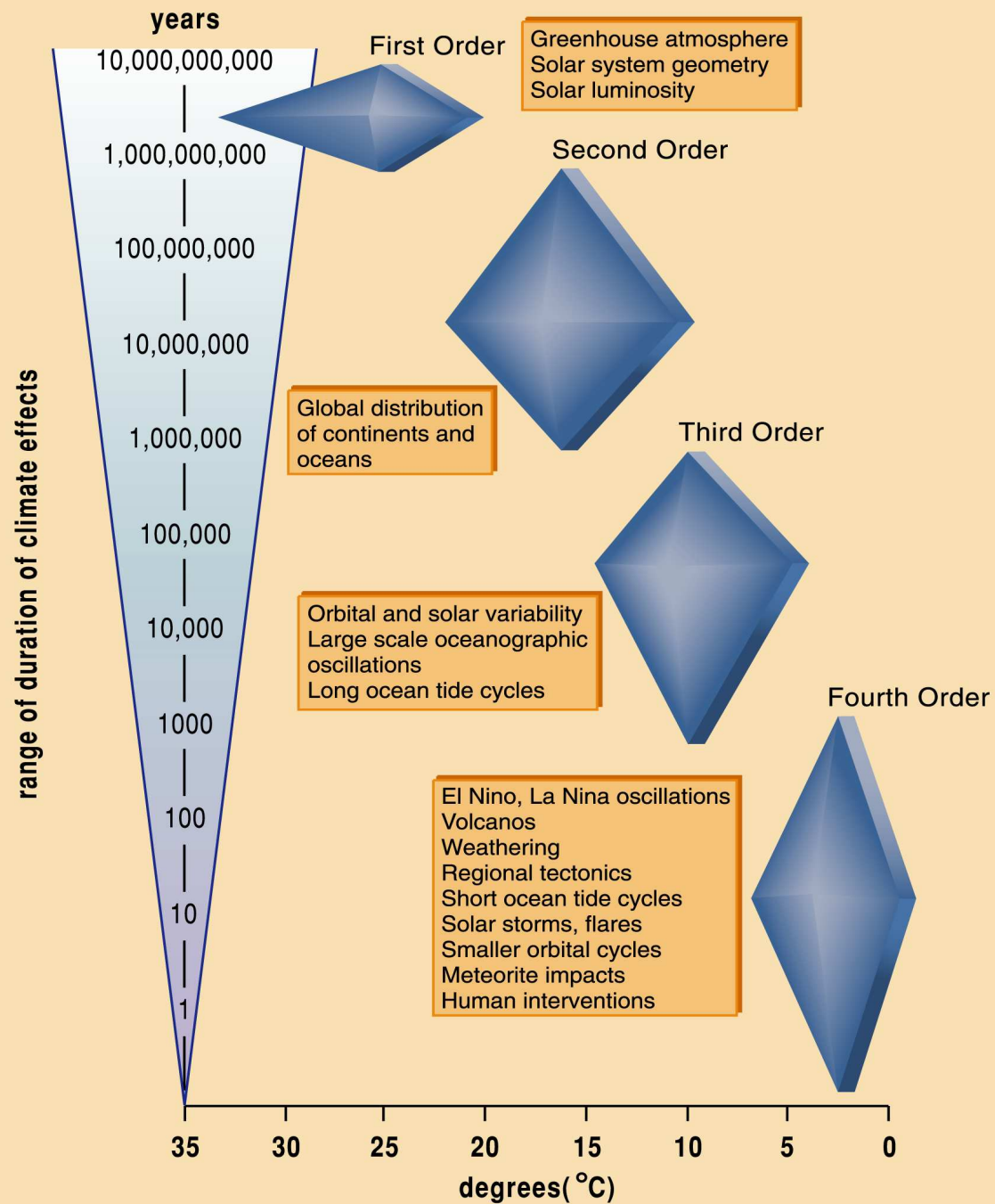
# Hypothesis 3

Natural processes are the most significant climate drivers.

Test: Correlation of changes in rates of natural processes with temperature changes.

# What natural processes drive climate?

- Many processes.....
- Operating over many time scales.....
- With many scales of influence.

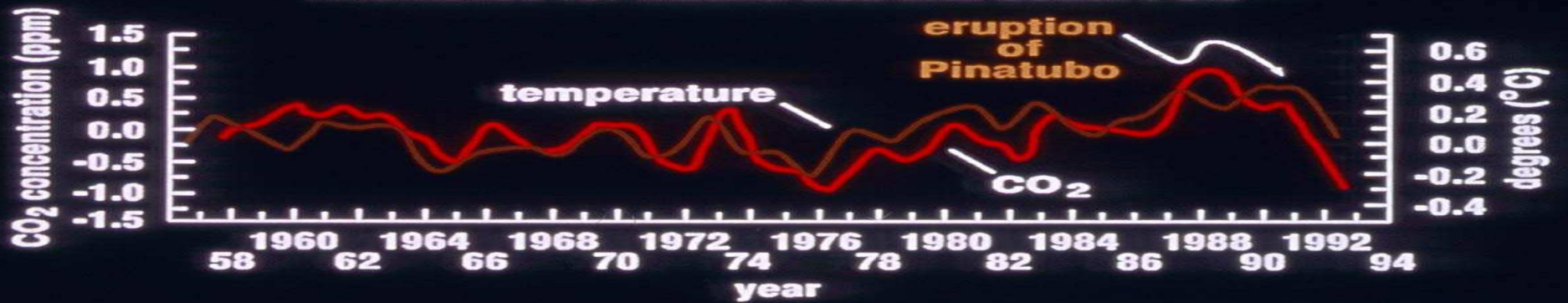


- Natural climate drivers, ranked by intensity and duration





### Anomalies for Mauna Loa and South Pole



from Keeling et al., 1989 modified

# Fourth Order Climate Drivers

- Meteorite impacts and volcanic eruptions are examples of fourth order climate drivers, changing climate a few degrees over a few years.
- If humans have any impact on earth climate, it is fourth order impact, and almost impossible to differentiate from many other natural causes..



Oceans Dominate Earth's Climate



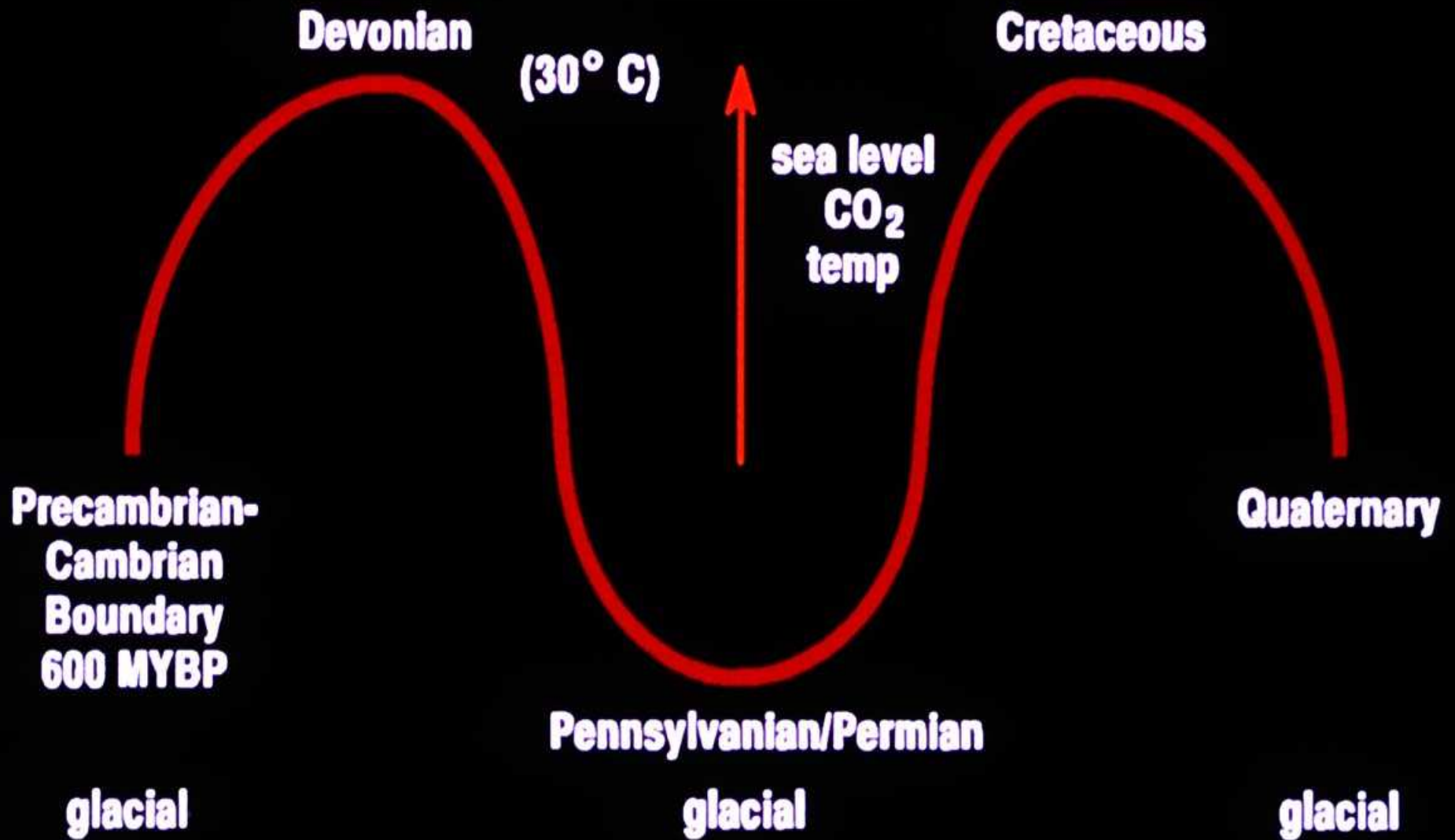
# Oceans move heat around the earth

Glaciation occurs when sufficient heat is present at the poles to create an open polar ocean, a source of snow to create glaciers.

This occurs when continents divert heat from the equator to the poles.

(Ewing and Donn, 1958)

# Sea Level Curve



*adapted from Vall, MacKenzie*

Late Cretaceous 94 Ma



Paleogeographic maps by C. R. Scotese  
Artwork by Ralph Scotese

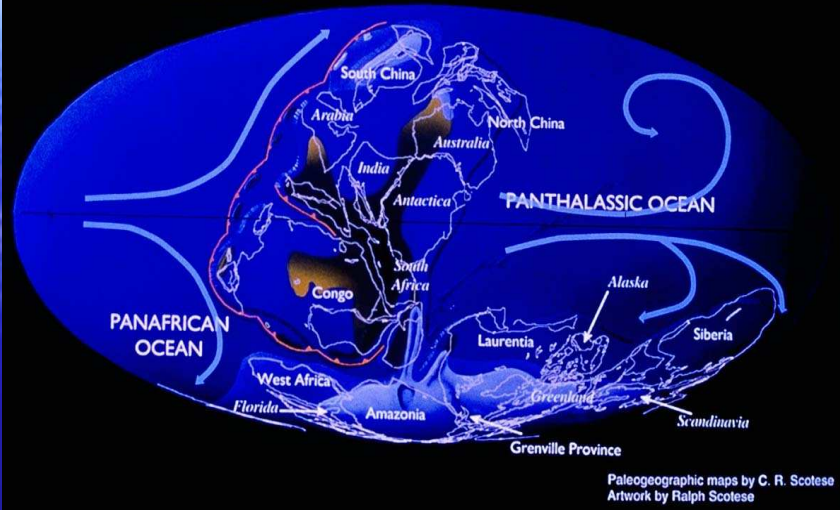
# Modern World



Paleogeographic maps by C. R. Scotese  
Artwork by Ralph Scotese

# Equatorial currents determine climate (Gerhard and Harrison, 2001)

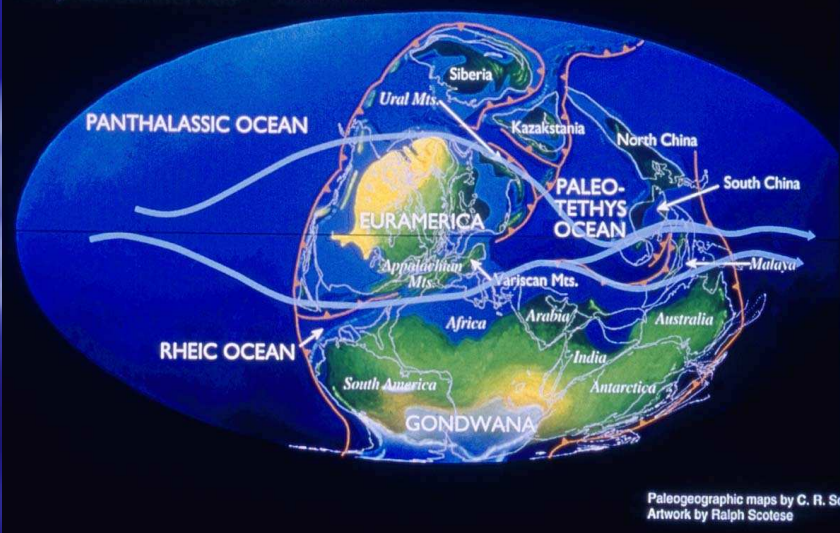
Late Proterozoic 650 Ma



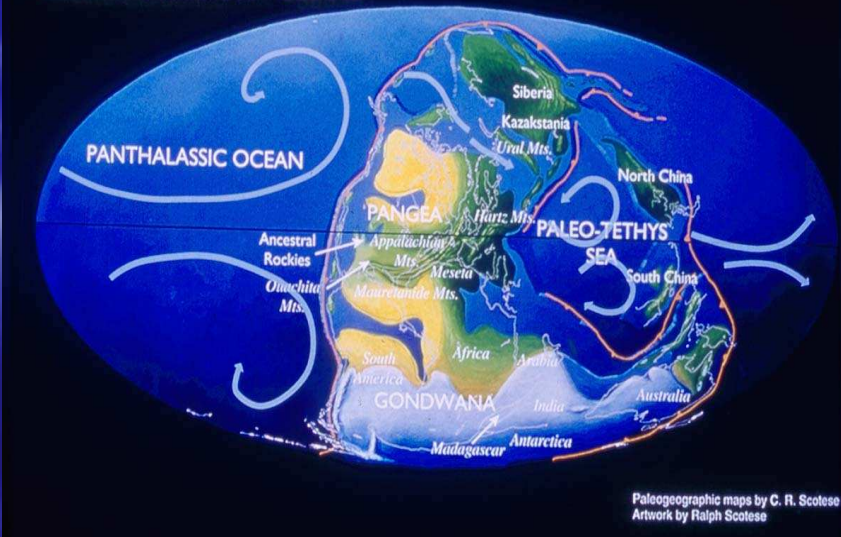
Early Devonian 390 Ma



Early Carboniferous 356 Ma



Late Carboniferous 306 Ma



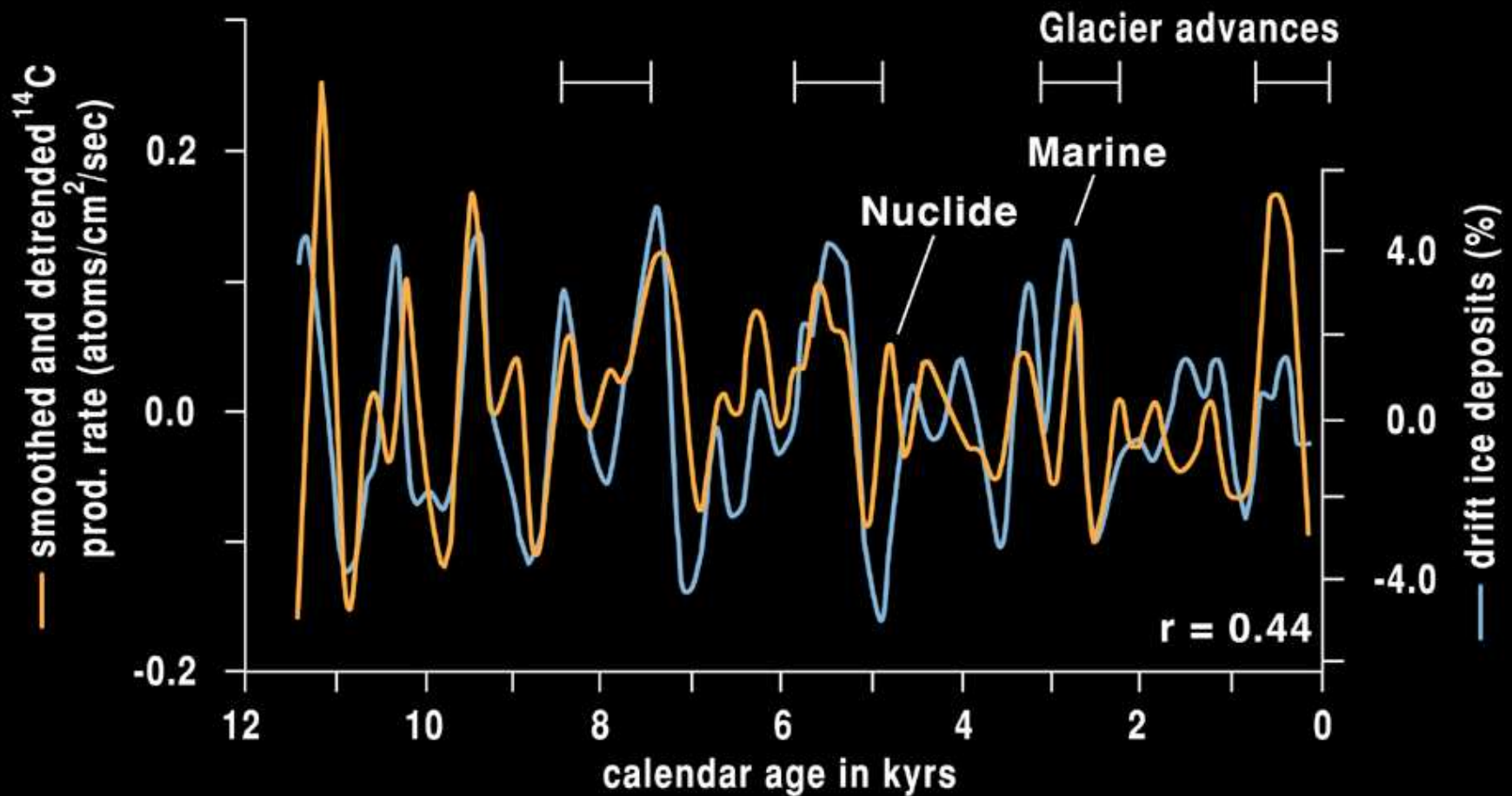
# Continental Drift as Climate Driver

- Distribution of oceans and continents on the face of the Earth is a second order climate driver, driving glacial vs. non-glacial periods, by polar vs. equatorial currents
- Continental glaciation occurs via snowfall from evaporation of polar ocean, and consequent earth cooling, until ocean freezes



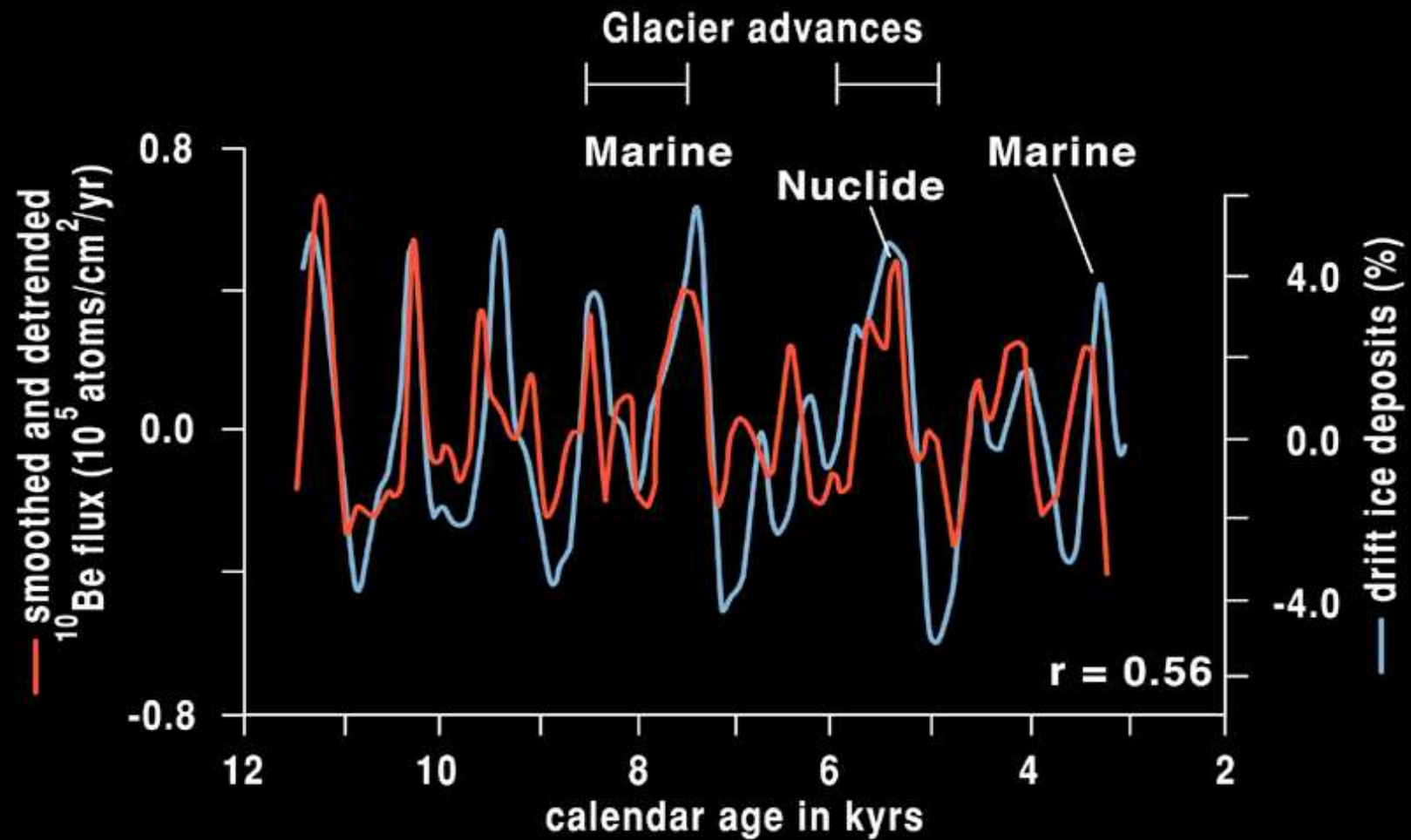
**What is the full variability of solar energy?**

## Solar proxy vs. temp proxy vs. time

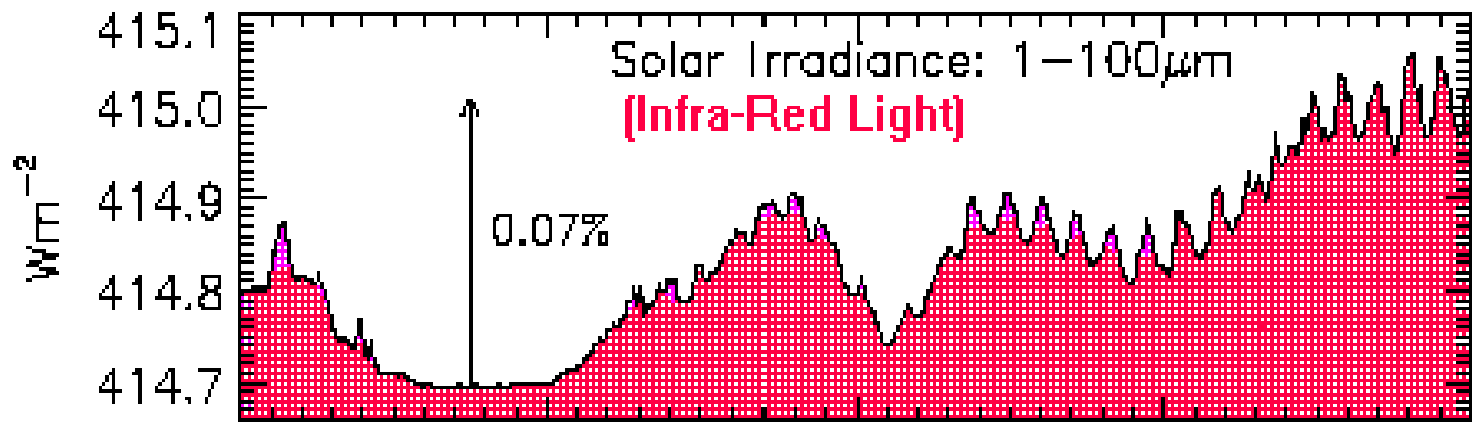
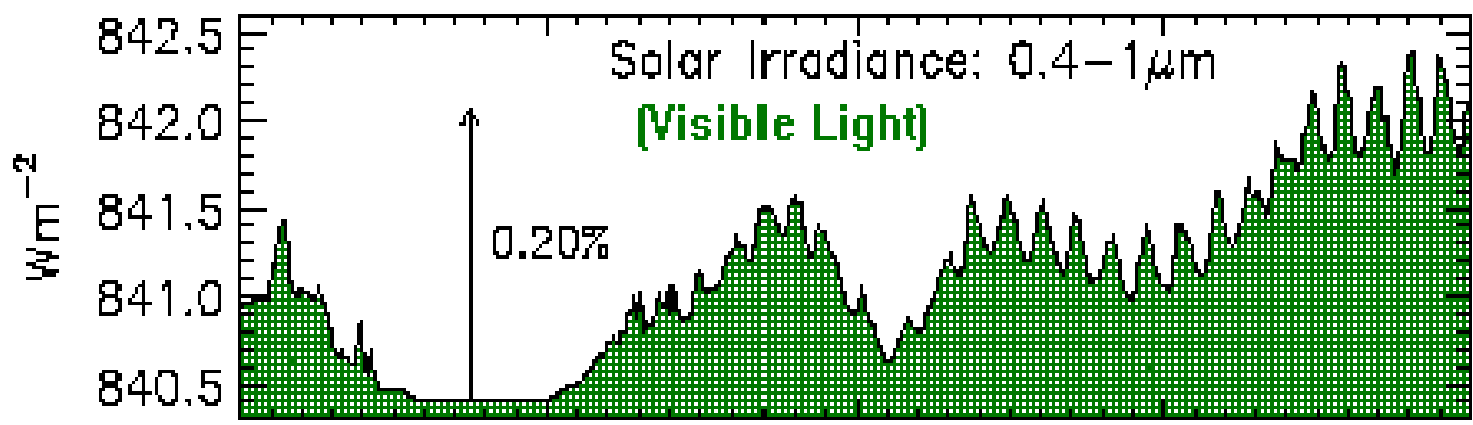
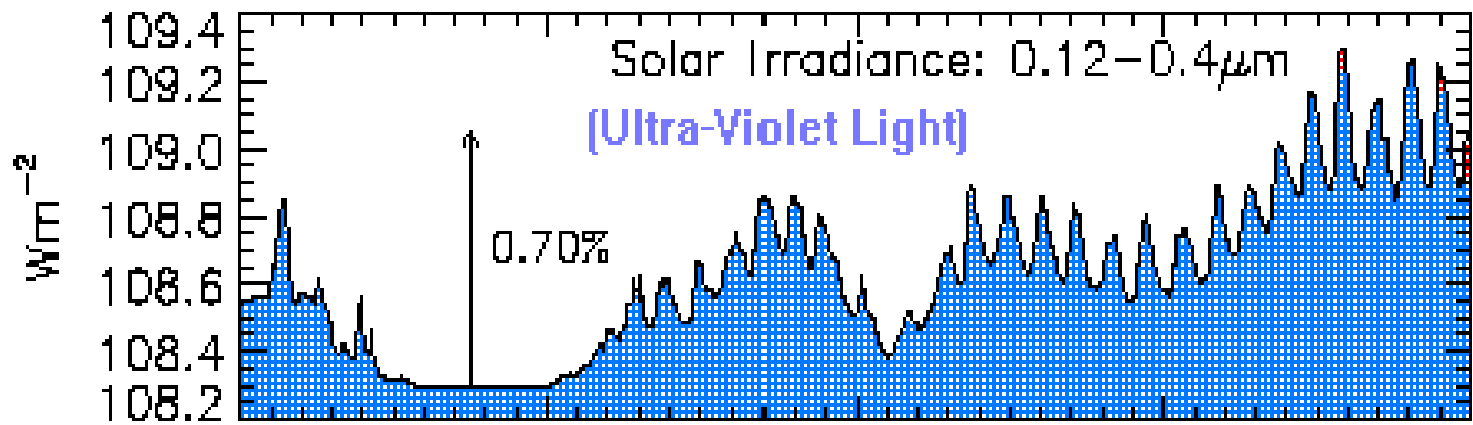


*Bond, et al., 2001*





*Bond, et al., 2001*

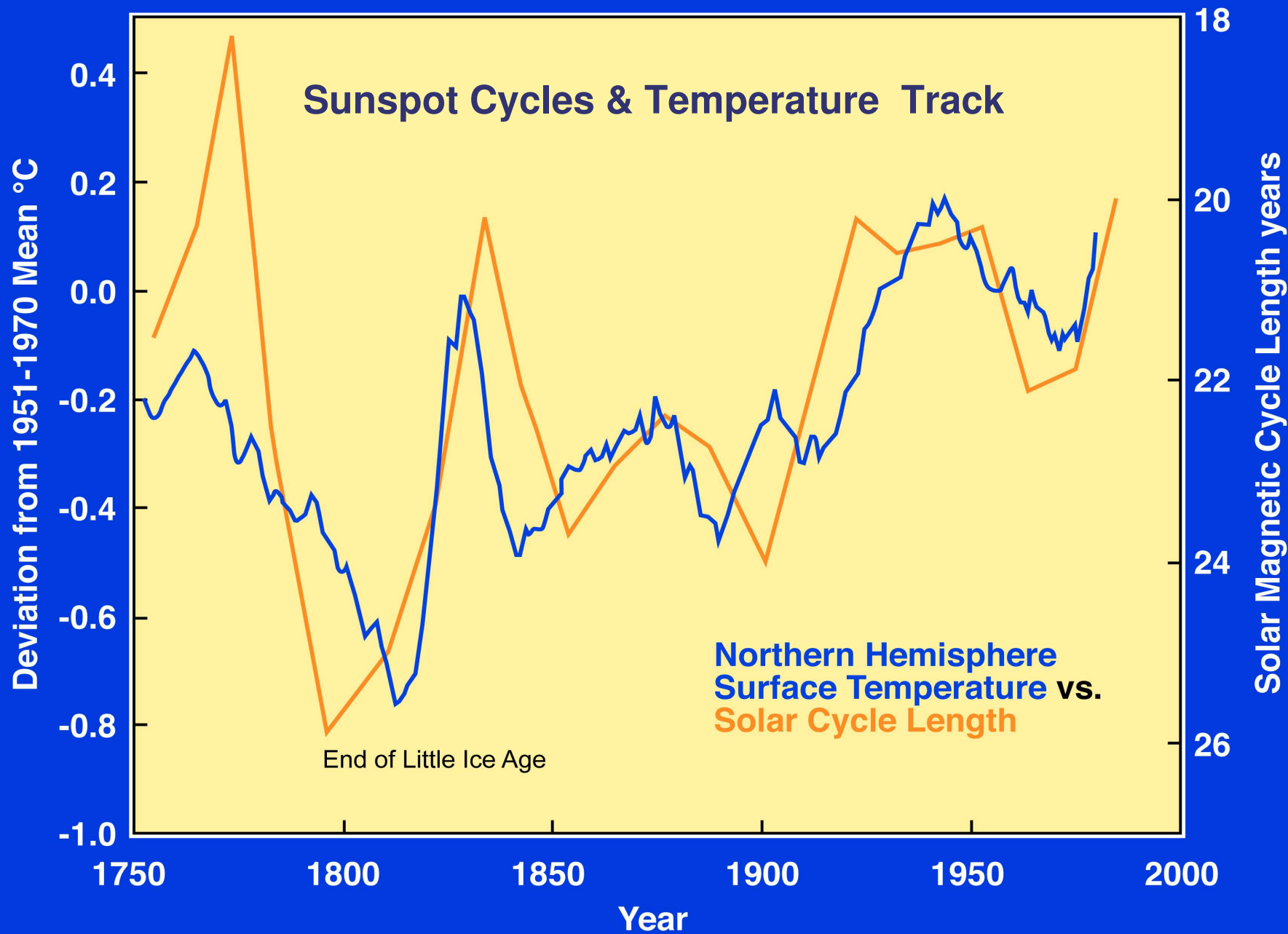


1600      1700      1800      1900      2000

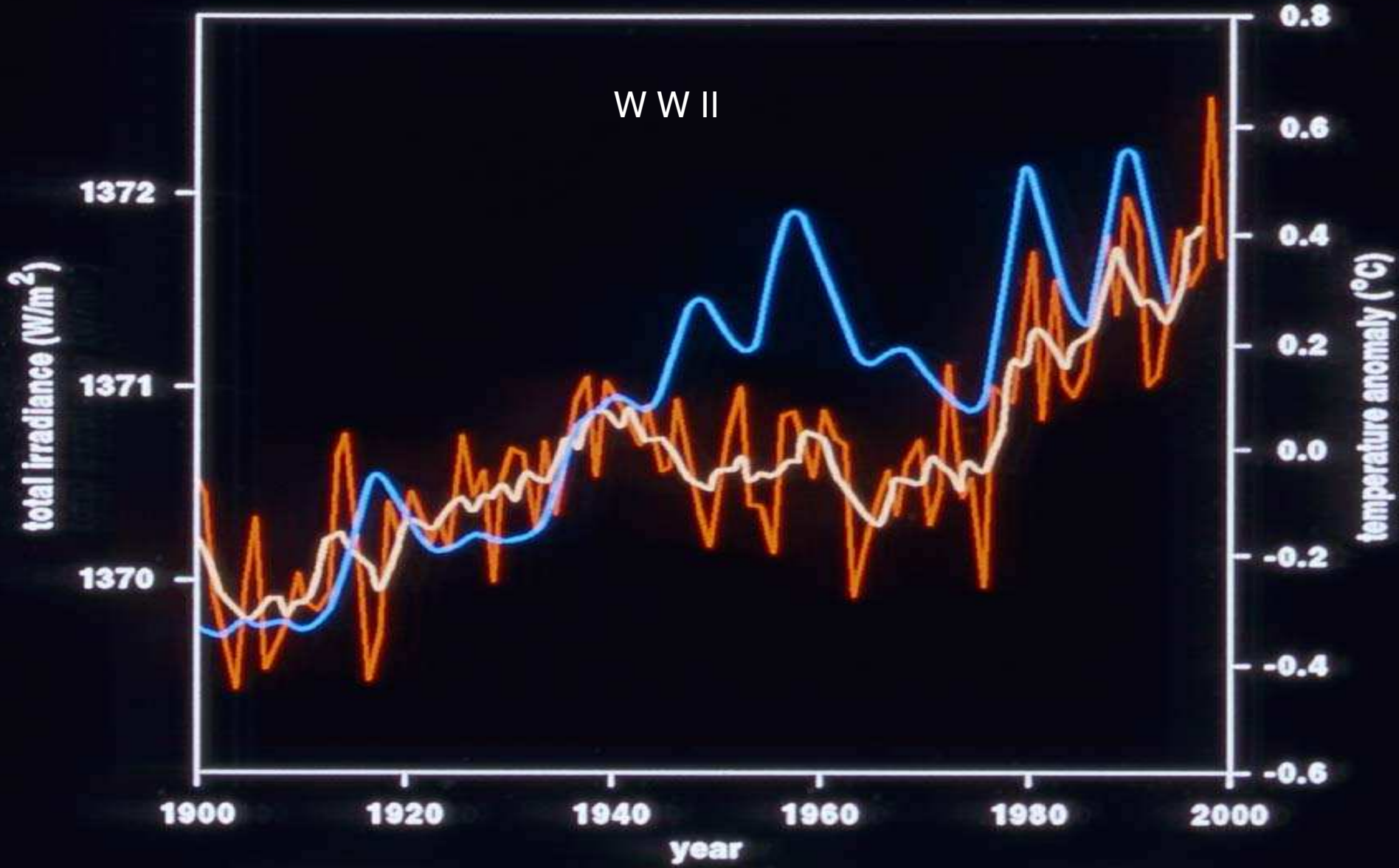
Solar intensity, 1600-2000

Last millennial cycle

Daly, 2005



W W II



— global temp. annual mean    — global temp. 5-year mean    — irradiance

data from: *Goddard Institute for Space Studies, 2000 (temp)*  
*Bond, et al., 2001 (irradiance)*

Solar variability is both a third and fourth order climate driver.

- The 1100 year millennial solar cycle is a third order climate driver.
- The 80 year and 11 year solar cycles are fourth order climate drivers.
- Orbital variations are second and third order drivers, accounting for major glacial cycles

# Hypothesis 3: Substantiated

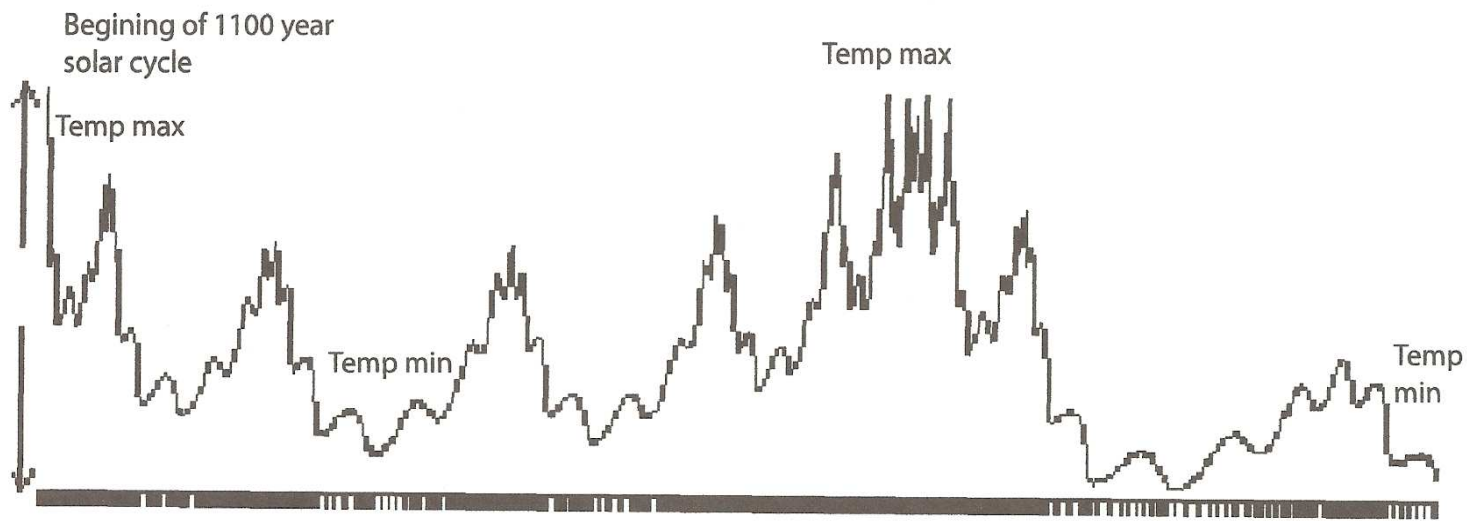
- Natural climate drivers correlate well with temperature changes, especially solar variations in sunspots and irradiation.
- Long term orbital cycles are apparent drivers as well, although not illustrated.

# Where do computer models fit in this equation?

- Models must reasonably back-model recorded climate history. No GCM so far has replicated either the Medieval or Roman events.
- Therefore, they cannot be used to predict.
- The reason for their failure is greenhouse assumptions.

Modern Warm, Medieval Warm, Roman Warm, and potential Future Warm solar cycles are spaced about 1100 years apart. Cold minimums also modeled.

Curve from Cross and Lessenger sedimentary 1-D model.

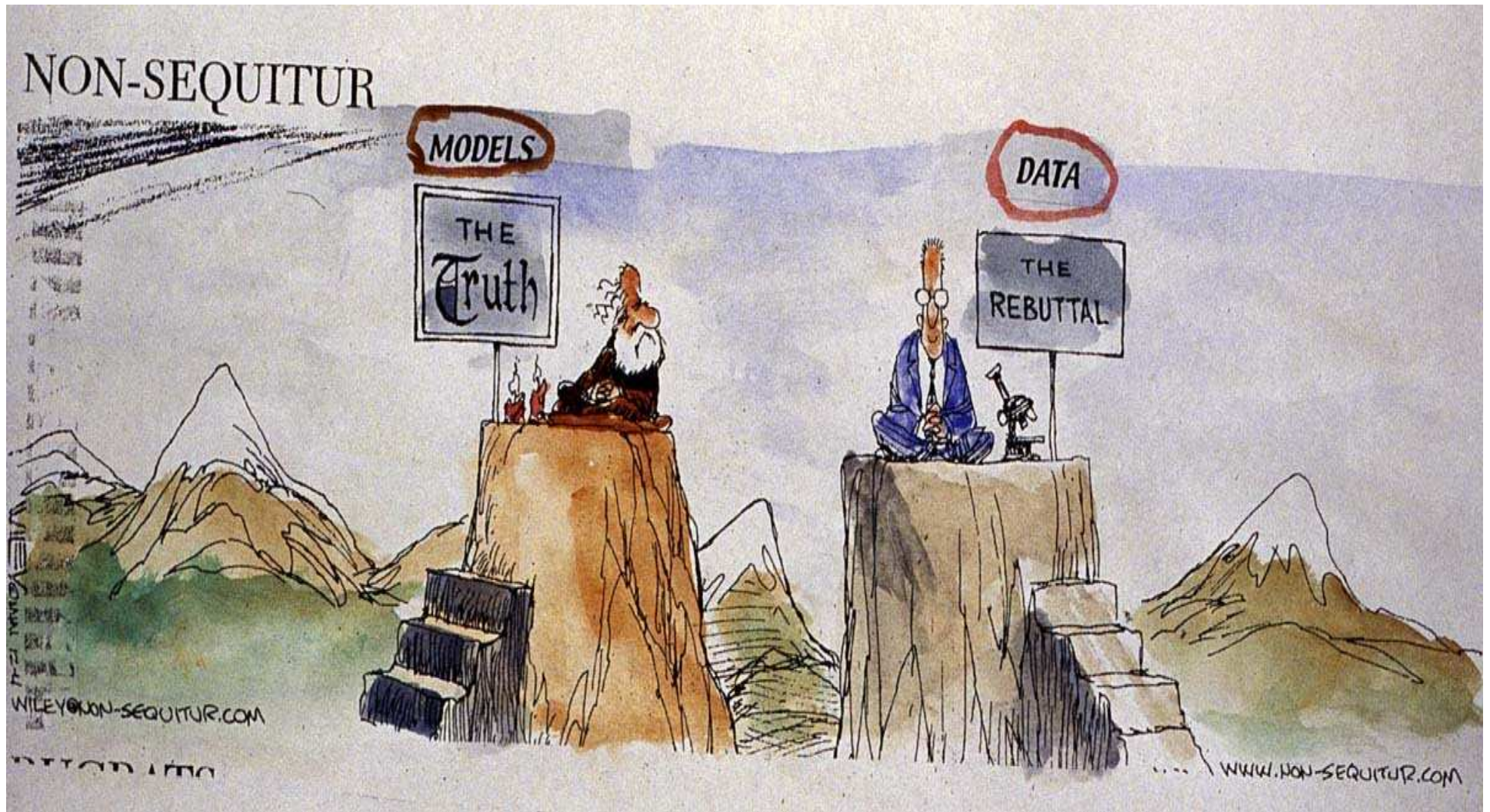


Solar model for past and future, if there were no people.



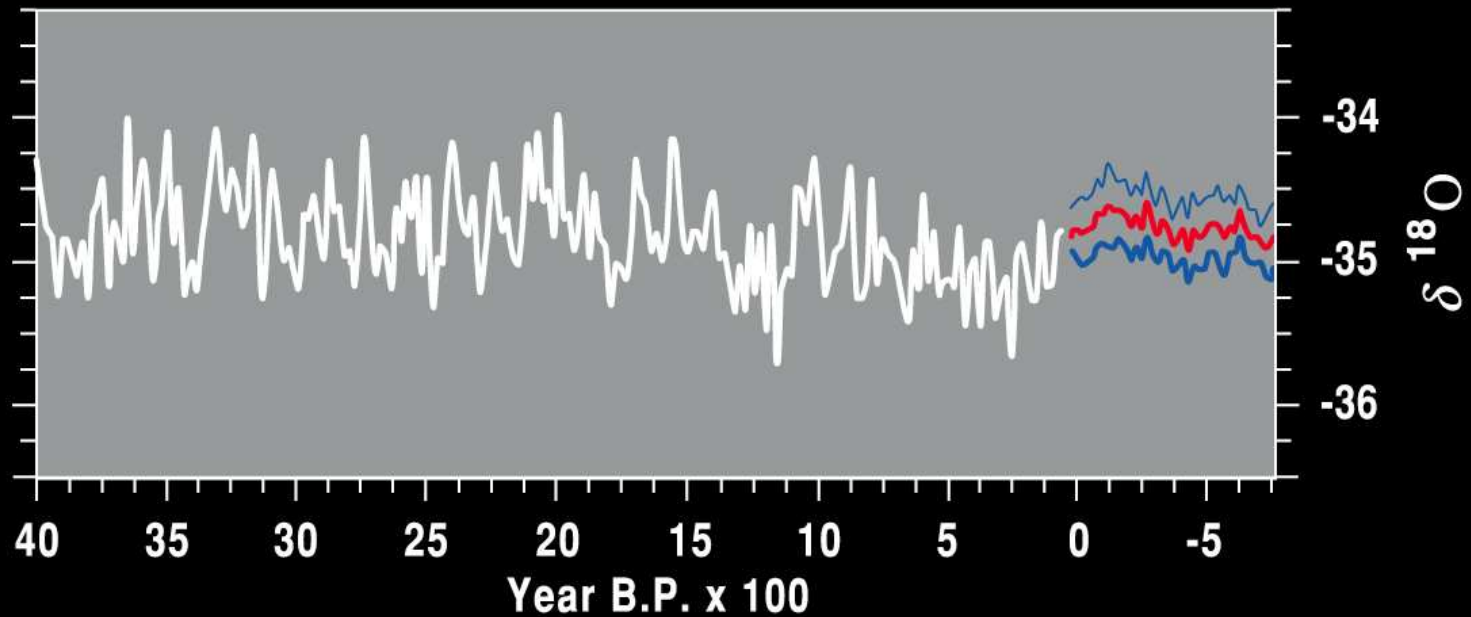
# Why don't all scientists agree that solar variability drives climate?

- Measured solar variability is relatively small compared to temperature variation.
- Think about continental drift: Many dismissed it because they couldn't identify a driver.
- Problem: ignoring correlation and data for lack of a causal mechanism.



In the game of science, data always trump theory.

# Distribution of $\delta^{18}\text{O}$ for the period 0 - 4,000 years B.P. Data and Prediction



— Data  
— Mean Pred.

— IntMin  
— IntMax

*Kotov, 2001*

# What's the resolution of the debate?

- We have substantiated that climate is changing. It is warming from the depths of the LIA, as part of an 1100 year solar cycle
- We have falsified by correlation that humans are the major cause.
- We have correlated climate change to solar and orbital variations and other natural phenomena.

So, If there were no people, how  
would climate be different?  
It wouldn't be different.

What if humans wish to take action  
“just in case?”

The only solution urged is for U.S. to cut energy use

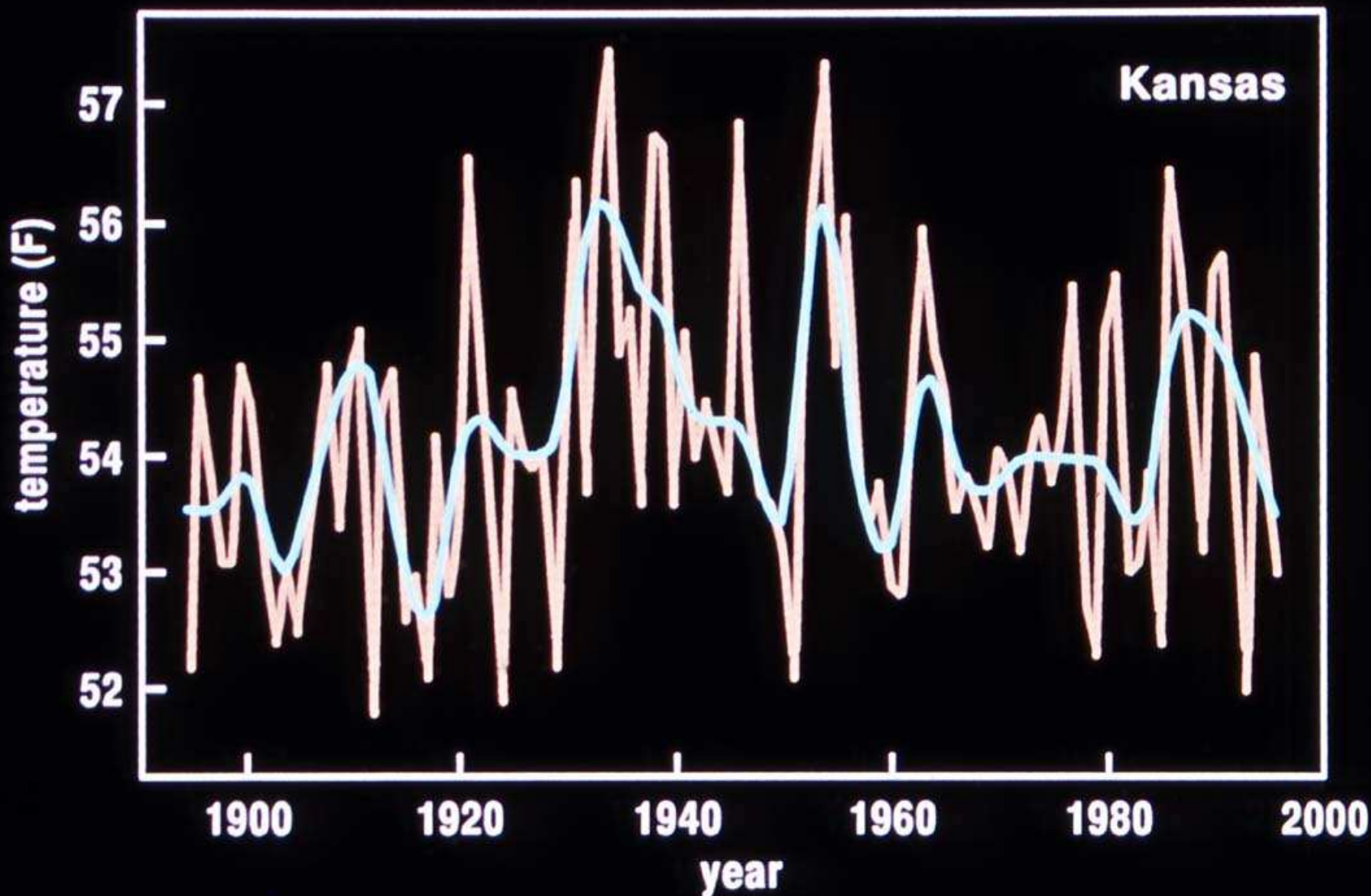
For Kyoto, cut fossil energy use to 7% below 1990  
levels for carbon dioxide. Would require more than  
19.8% reduction in energy consumption.(2003  
calculations)

# The U.S. may not be the problem:

“A North American terrestrial sink is implied by the data because the observed gradient shows a decrease from North Pacific to North Atlantic of about 0.3 ppm.” (CO<sub>2</sub>)

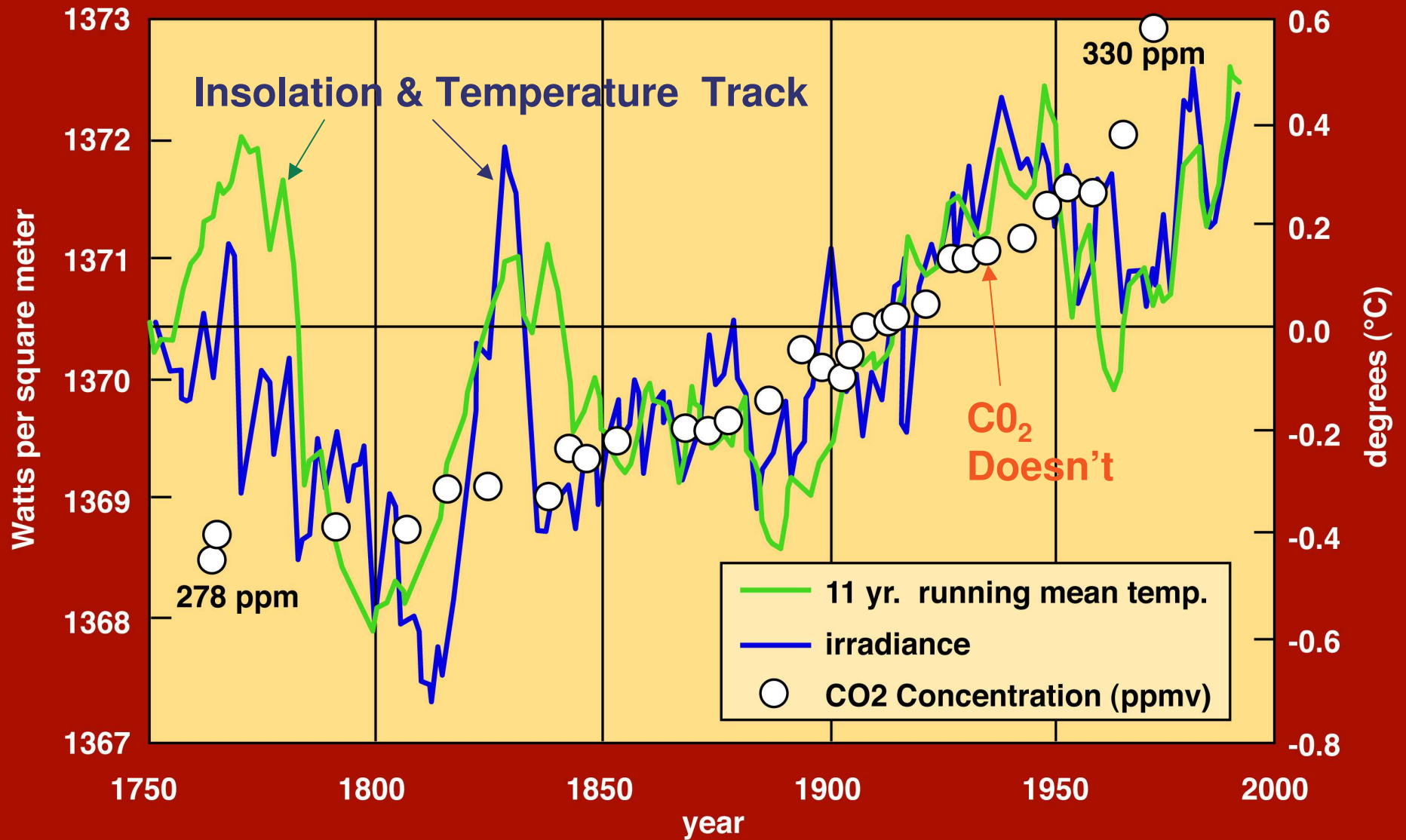
Fan, S., M. Gloor, J. Mahlman, S. Pacala, J. Sarmiento, T. Takahashi, and P. Tans, 1998, A Large North American Carbon Sink Implied by Atmospheric and Oceanic Carbon Dioxide Data and Models: *Science*, v. 282, p. 442-446.

***There is no flat line in climate.***



***National Climate Center, via. Derek Winstanley, III. State Water Survey***

# Northern Hemisphere Temperature VS. Solar Irradiance



adapted from Hoyt and Schatten, 1997



An aerial photograph of a vast mountain range covered in snow. The peaks are jagged and partially obscured by white snow, with deep shadows in the valleys. The overall scene is a high-altitude, winter landscape.

1 short term is  
continued natural warming.

2 long term is  
ice house.

Geologic  
Prognosis

# Conclusion:

In the end, even if human-induced climate change were to be verified, it makes no difference – we have no alternative to using fossil fuels.

We must insist that government prepare for the culmination of the Modern Warm Event, similar to the Roman and Medieval Warm Events, but perhaps a bit cooler.



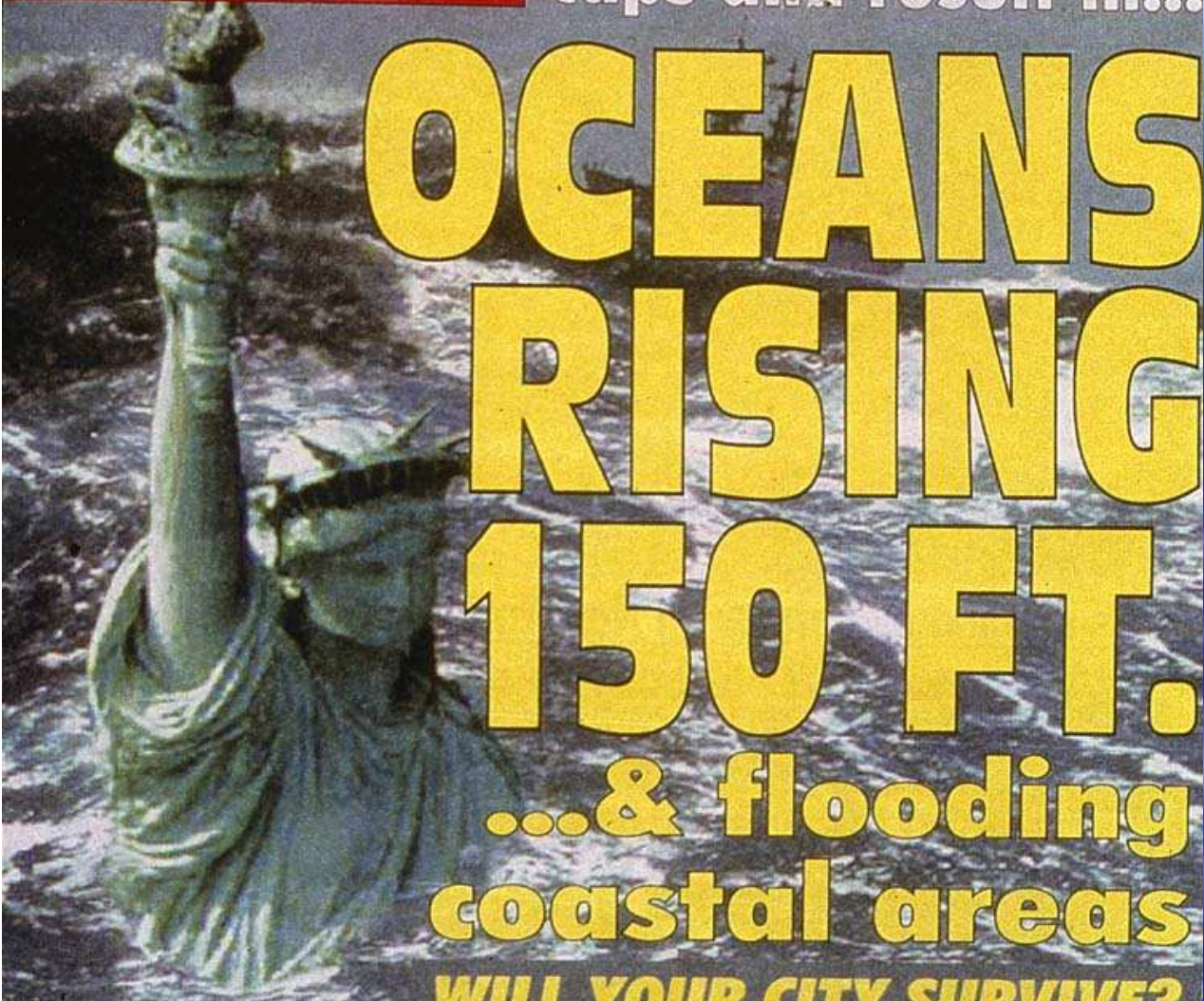
# Snowman at Galveston, Texas, Gulf of Mexico

2005

Global  
cooling?

\$1.09/\$1.19 Canada  
Vol. 13 - No. 30 July 23, 1995  
**Sun**

Summer heat waves  
will melt polar ice  
caps and result in...



**OCEANS  
RISING  
150 FT.**

**...& flooding  
coastal areas**

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San Francisco • Houston • Philadelphia • Baltimore • Halifax  
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\$1.09 / \$1.19 Canada



0 70989 06715 8

- Some people get their information from the media.....

# NEWS

November 26, 1996

\$1.09/\$1.19 CANADA 70p U.K.

**Man who died for 24 minutes gives  
vivid details of frozen netherworld!**



**TO HELL & BACK:**  
Amos Cavano, 58,  
suffered a massive  
heart attack and  
visited Hell.

# HELL FREEZES OVER

**Satan's domain has  
become an Arctic  
wasteland, say  
religious experts**



Really  
interesting  
media.....



**Future  
generations  
depend on  
us to make  
good  
decisions.**

**Our job is to maintain the integrity of science in the face of  
contrary social agendas.**