

"To a patient scientist, the unfolding greenhouse mystery is far more exciting than the plot of the best mystery novel.

But it is slow reading, with new clues sometimes not appearing for several years. Impatience increases when one realizes that it is not the fate of some fictional character, but of our planet and species, which hangs in the balance as the great carbon mystery unfolds at a seemingly glacial pace."

-- Schindler, David W. (1999). "The Mysterious Missing Sink." Nature 398: 105-106.

Global Climate Change: An Introduction

Supplementary Material for CFB3333/PHY3333
Professors John Cotton, Randy Scalise, and Stephen Sekula



Some Definitions

- Changes in the Earth's environmental conditions, short-term or long-term, are all driven by the flow of energy (e.g. heat) into, throughout, and out of the system.
- "Weather"
 - The conditions of the atmosphere over a short period of time (days, weeks, months, even a few years)
- "Climate"
 - The conditions of the atmosphere over a long period of time (years, decays, centuries, millenia)
- The difference between weather and climate is TIME
 - The long-term trends of weather equal climate

THE SCIENCE (a small primer)

Climate Science History







- 1824: Jean-Baptiste Fourier writes a paper remarking on global temperature
- 1861: John Tyndall publishes work on the absorption of heat radiation by different gases
- 1938: Guy Callendar publishes work on artificial CO₂ production and its possible temperature effects
- 1956: Gilbert Plass publishes a theoretical framework linking CO₂ and climatic change
- and on – it's a RICH history with lots of small steps

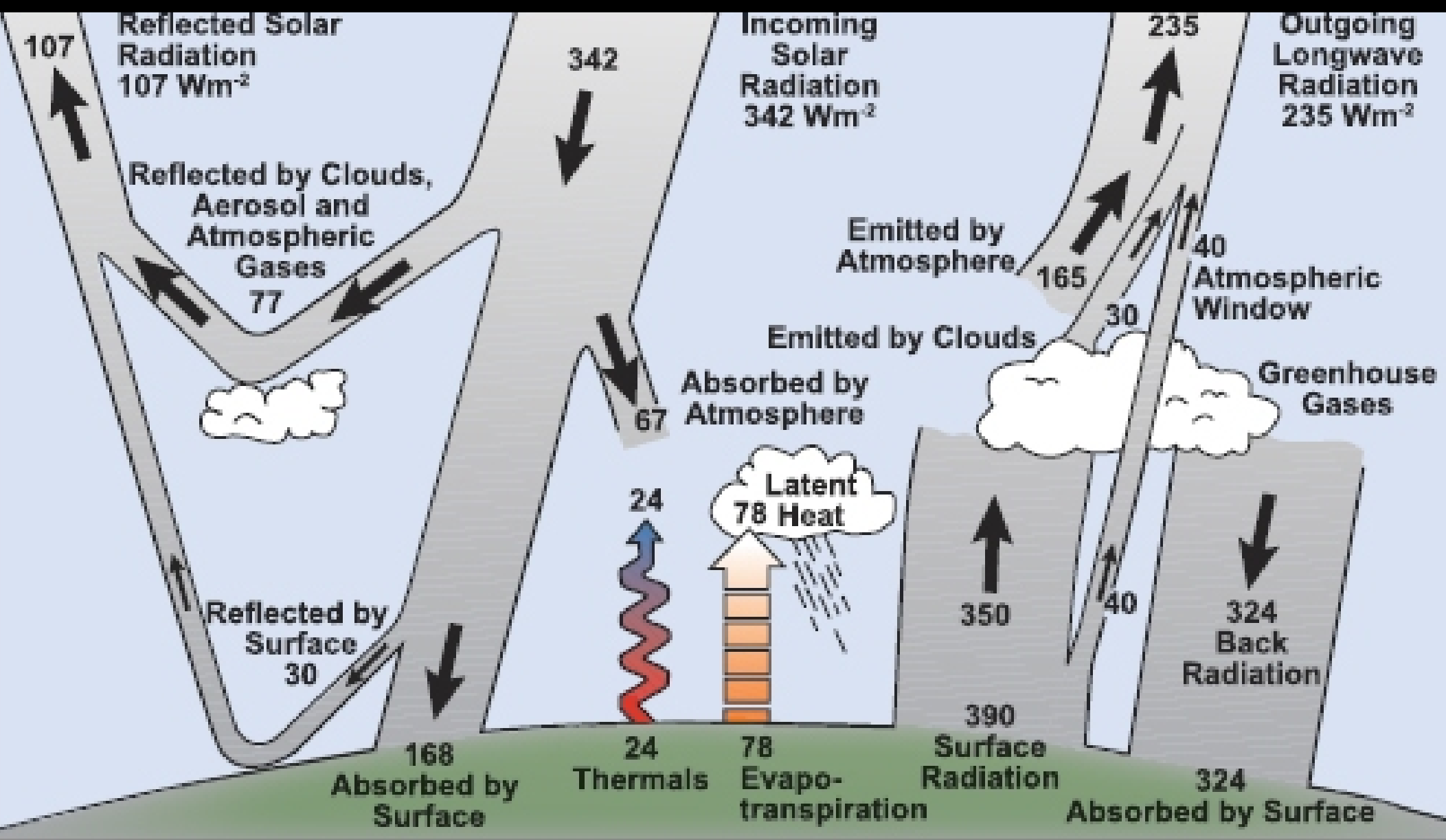
Critical Questions

- Has climate changed in the past?
- Is the climate changing right now?
- What factors influence climate change?
- How much does human activity affect climate change?
- How will climate change affect the world and our society?
- What can we do about climate change?

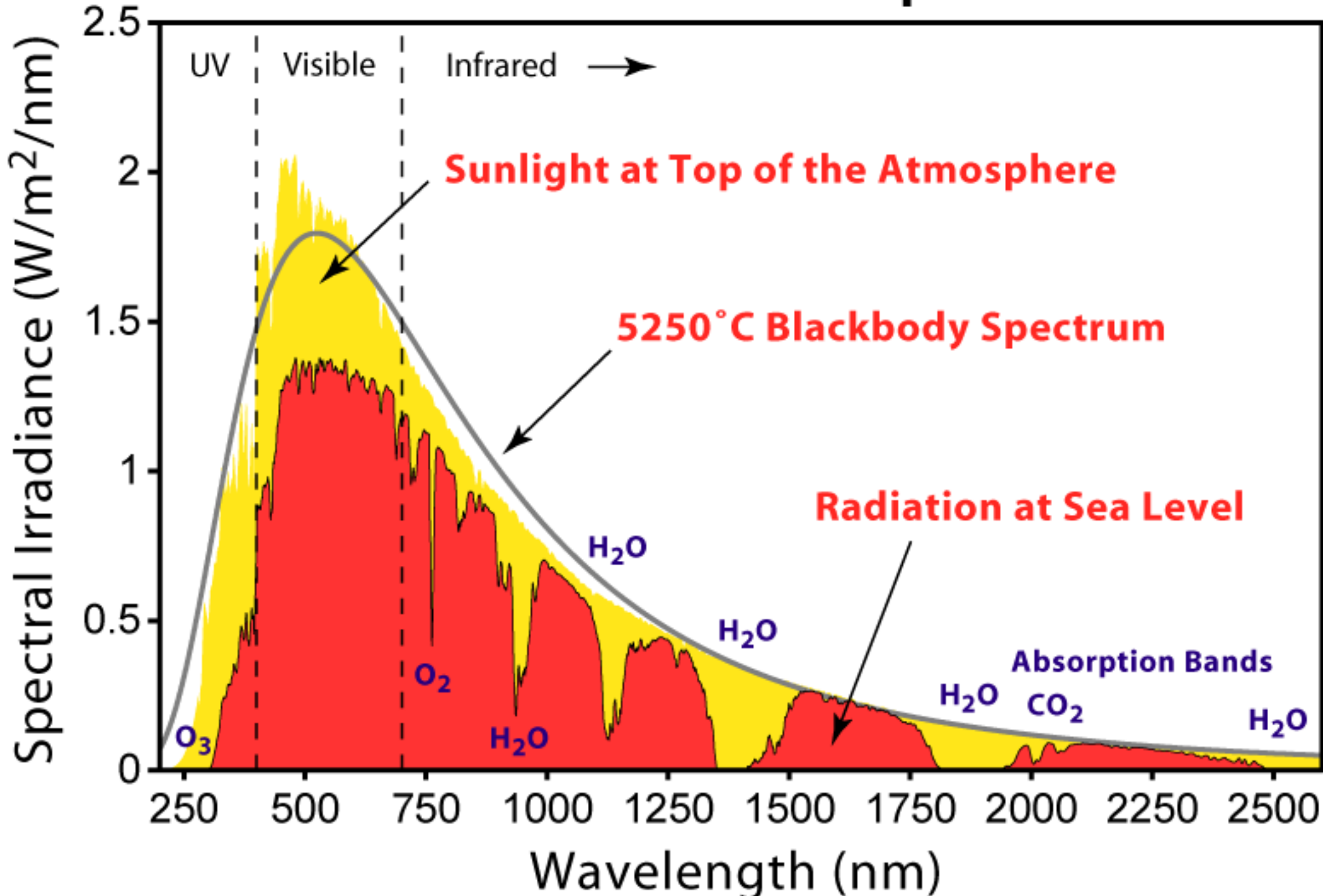
Question

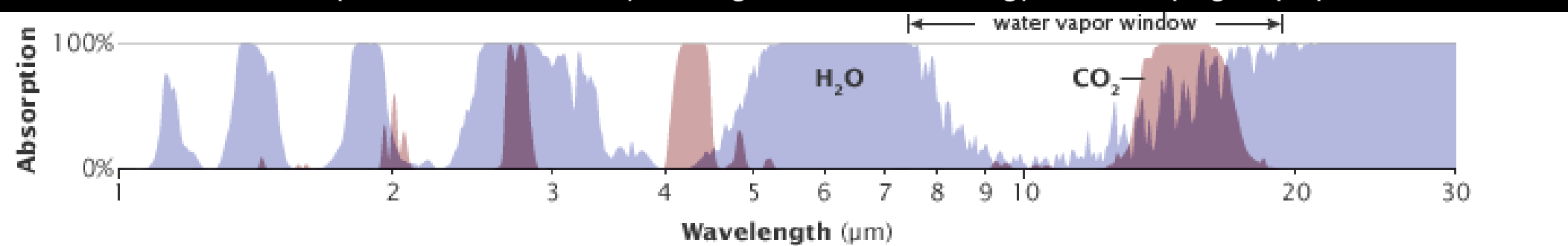
Settled scientifically?

- Has climate changed in the past? 
- Is the climate changing right now? 
- What factors influence climate change? 
- How much does human activity affect climate change? 
- How will climate change affect the world and our society? 
- What can we do about climate change? 



Solar Radiation Spectrum





What makes CO₂ of particular concern?

- It's less potent a greenhouse gas than water, so what's the deal?

The answer is multidimensional:

- Water's melting point is 32F and its boiling point is 212F. It is strongly affected by temperature – during cold parts of the year, it condenses or freezes out of the atmosphere. CO₂'s melting point is -109.2F, and its boiling point is -69.8F – it never condenses or freezes, and always lingers in the atmosphere.
- It absorbs thermal energy in wavelengths that water is not sensitive to, so it amplifies heat trapping.
- More CO₂ traps more heat, transferring more water to gas form, trapping even more heat. Small changes in CO₂ have big effects. CO₂ is an amplifier.

Earth's Surface Temperature

- Without a heat-trapping atmosphere, Earth's temperature would be -18 degrees C (-0.4 degrees F)
 - If Earth were a perfect absorber, it would be 5C; however, Earth is reflective (30% albedo), so it would be colder than without an atmosphere
 - Look at Mars – it has a very thin atmosphere, 0.6% the pressure of Earth's atmosphere. At the same orbit as Earth, it would be much cooler.
- With a heat-trapping atmosphere, Earth enjoys an average surface temperature of 14 C (57F).
 - Venus is an example of a runaway heat-trapping effect
 - Surface temperatures on Venus are around 462C (863F)

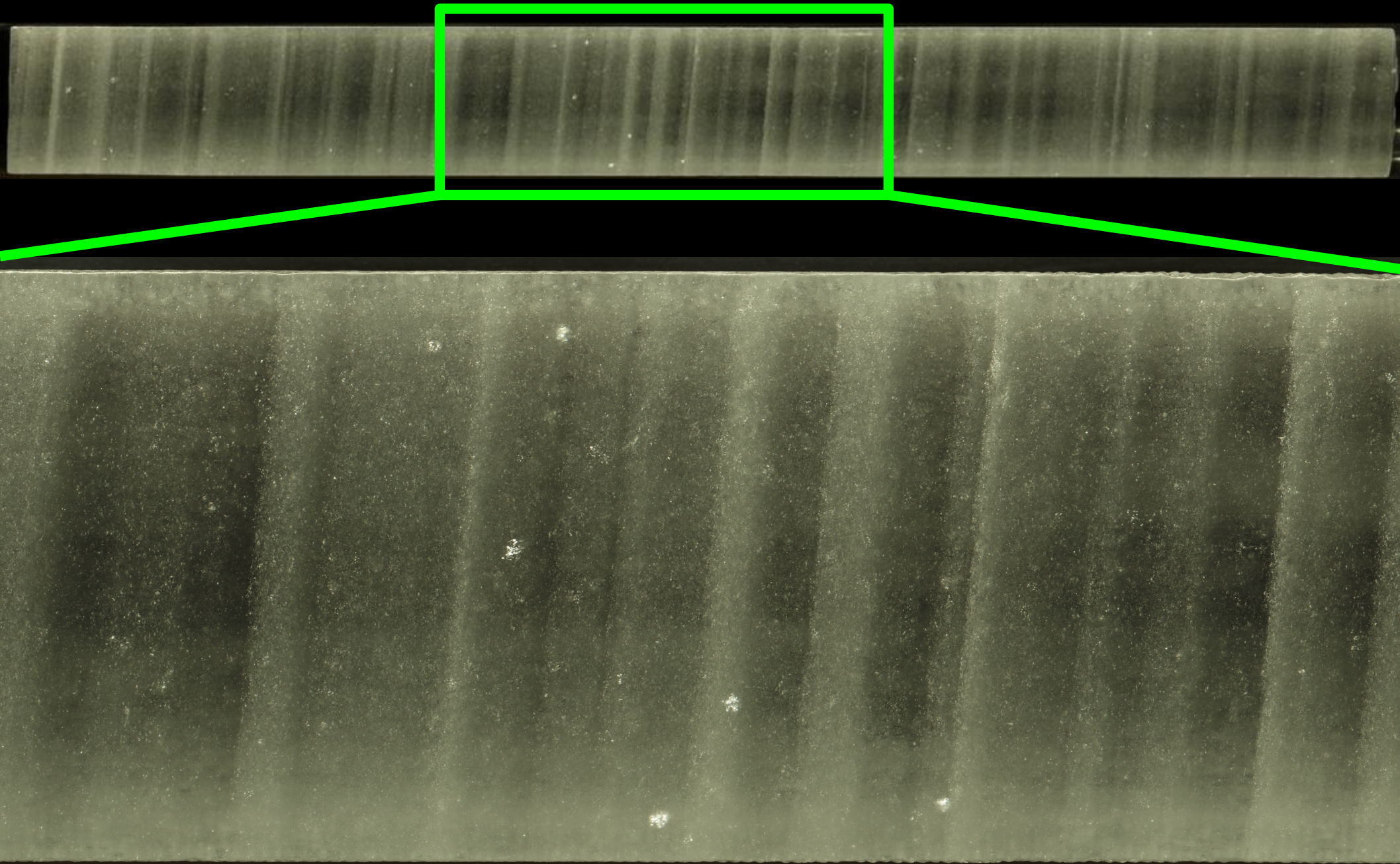
Heat-Trapping is Essential to Life

- Life as we know it evolved on a planet capable of trapping heat and maintaining a “reasonable” high temperature (well above freezing, well below boiling)
- Changes in the climate will change the conditions under which life evolves
 - this will have consequences, some of which are positive for us, some of which are negative for us – it’s complicated!
 - heat trapping is essential, but changes in heat trapping represent a challenge from our environment
- So have conditions changed? Are they changing now? In either case, why and how?

HISTORICAL TRENDS IN CO₂, TEMPERATURE, AND SOLAR RADIATION



Team of researchers at Vostok Station, Antarctica, with ice cores.



Example: GISP2 Ice Core from 1837-1838m depth. This ice was formed 16250 years ago^{1b} and represents 38 years of history. Annual variations are clearly visible.

Ice Core Data: A Time-Capsule of the Earth's Atmosphere

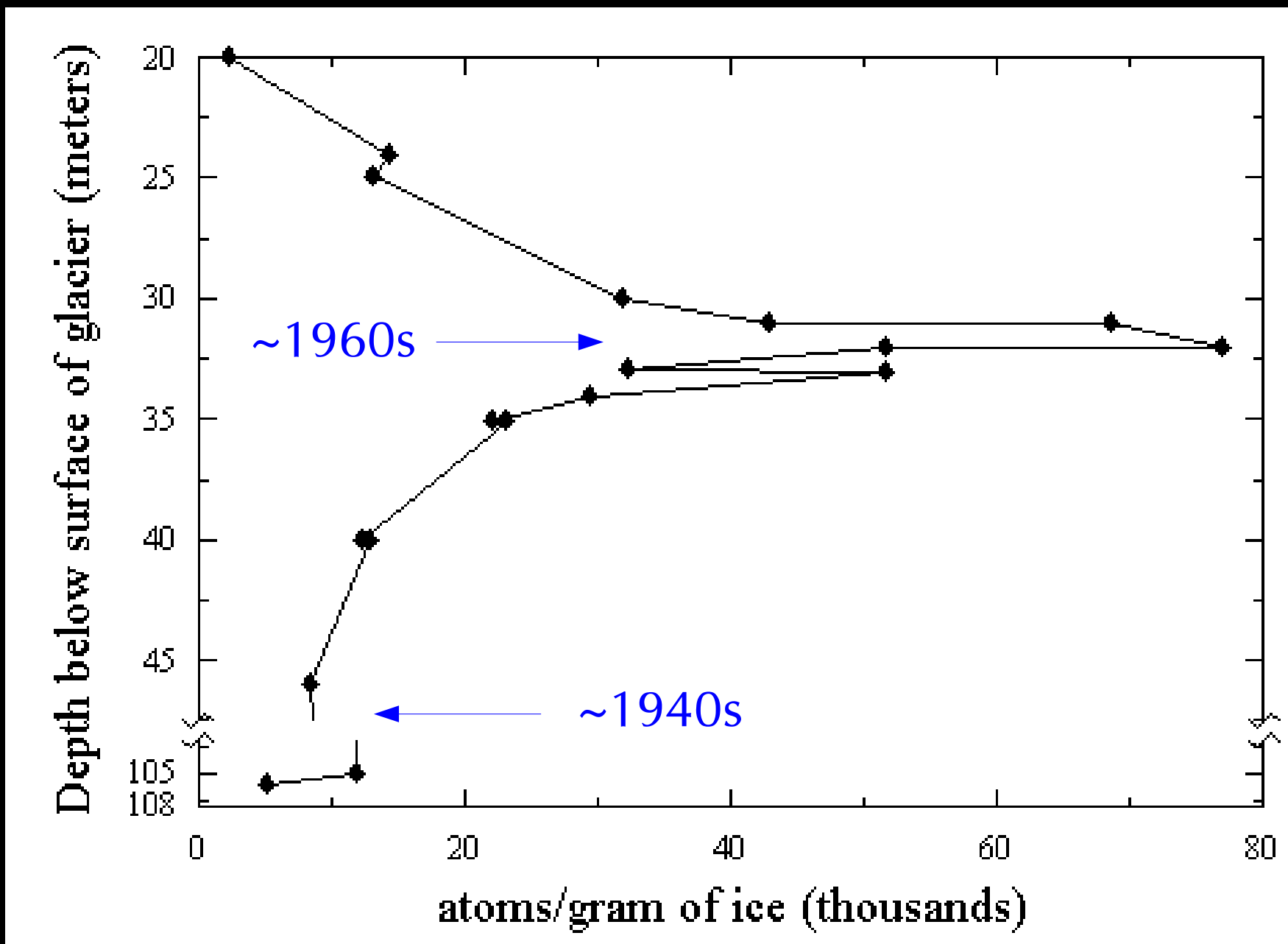
- Ice laid down in layers over hundreds of thousands of years by precipitation
- Precipitation traps atmospheric gases (e.g. bubbles in the ice)
- By sampling the ice layers, one samples a snapshot of the Earth's atmosphere with a time resolution of between ~10-6000 years per sample (mean of ~1000 years)
- Deuterium levels tell you the temperature of the atmosphere at a given moment in time (see next slide)

Deuterium and Temperature

- Deuterium is “Heavy Hydrogen”, but chemically identical to normal hydrogen
 - hydrogen (H) has 1 proton and 0 neutrons
 - deuterium (D) has 1 proton and 1 neutron, making it twice as heavy as normal hydrogen
- Normal water is made from $2\text{H} + \text{O}$
 - Deuterated Water is made from heavy hydrogen: $2\text{D} + \text{O}$
 - Deuterated Water is therefore about 10% heavier than normal water

Deuterium and Temperature

- When temperatures are higher, the ratio of H₂O to D₂O in the air is lower than when temperatures are cold (since D₂O is heavier and requires more energy to evaporate into the air)
- Changes in D₂O content in ice can be calibrated to temperature changes
- Knowing the D₂O to H₂O ratio now for our current average temperatures allows climate scientists to measure temperatures in the past.

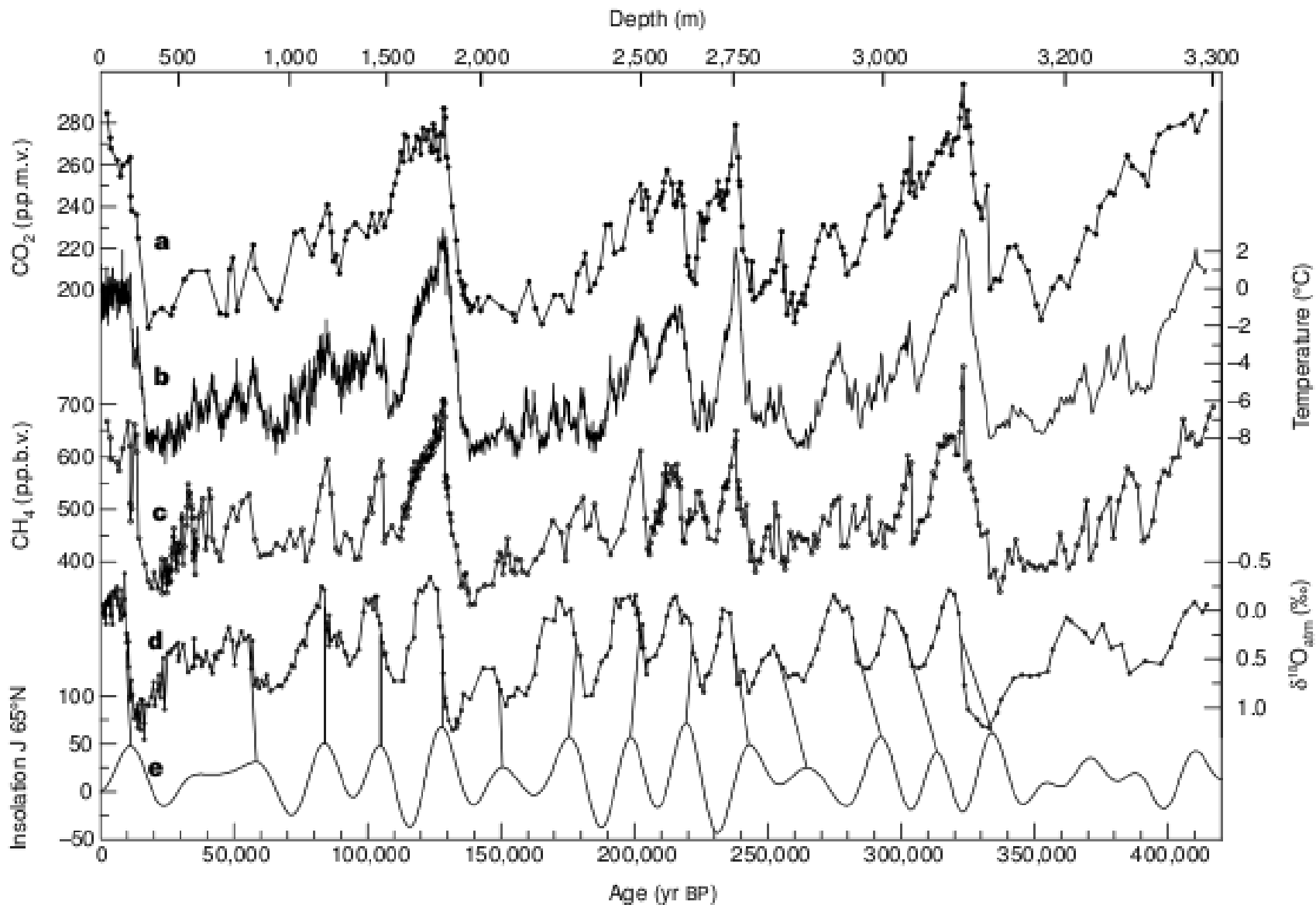


Measurement of Chlorine-36 levels in ice from the Upper Fremont Glacier. Cl-36 is a by-product of atmospheric atomic bomb testing. c.f. Bomb-test ^{36}Cl measurements in Vostok snow (Antarctica) and the use of ^{36}Cl as a dating tool for deep ice cores
R. J. Delmas, J. Beer, H. -A. Synal, R. Muscheler, J. -R. Petit, M. Pourchet

Solar Radiance in the Past

- Determined largely by orbital position, tilt of the Earth, precession of the Earth's rotation axis
 - Astronomical phenomena, predictable with great precision
 - Solar radiance at a specific latitude at a specific time of year can be computed back very far in time, given the laws of physics
 - in the next slide, “insolation” (solar radiance on a specific area) is calculated for June and at a latitude of 65-degrees North.

Berger, André L., 1978: Long-Term Variations of Daily Insolation and Quaternary Climatic Changes. *J. Atmos. Sci.*, 35, 2362–2367. doi:
[http://dx.doi.org/10.1175/1520-0469\(1978\)035<2362:LTVODI>2.0.CO;2](http://dx.doi.org/10.1175/1520-0469(1978)035<2362:LTVODI>2.0.CO;2)



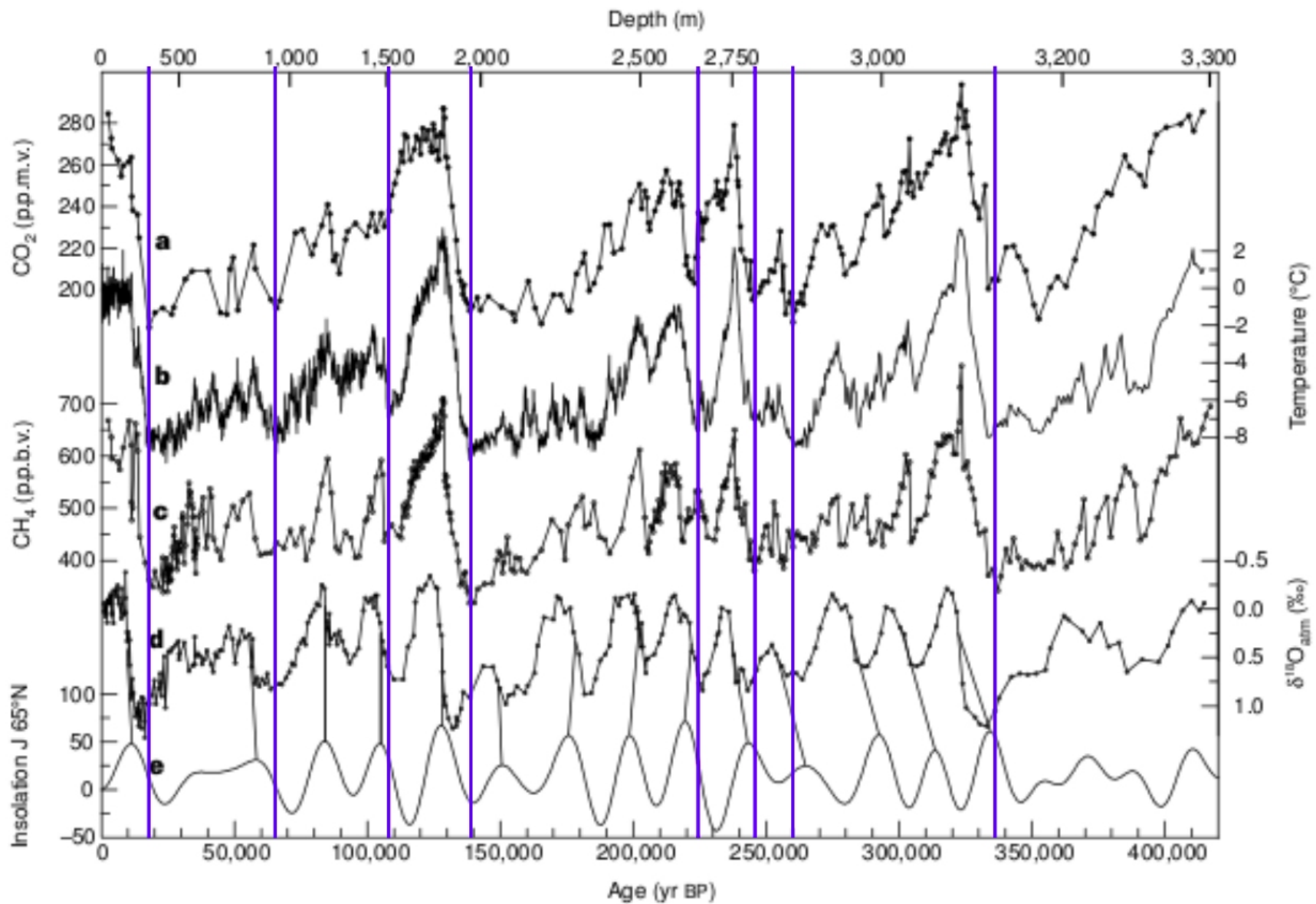
ppmv = parts-per-million by volume

Uncertainty on CO₂ measurements: +/- (2-3) ppmv (mean time resolution: 1500 years)

Uncertainty on CH₄ measurements: +/- 20 ppbv (mean time resolution: 950 years)

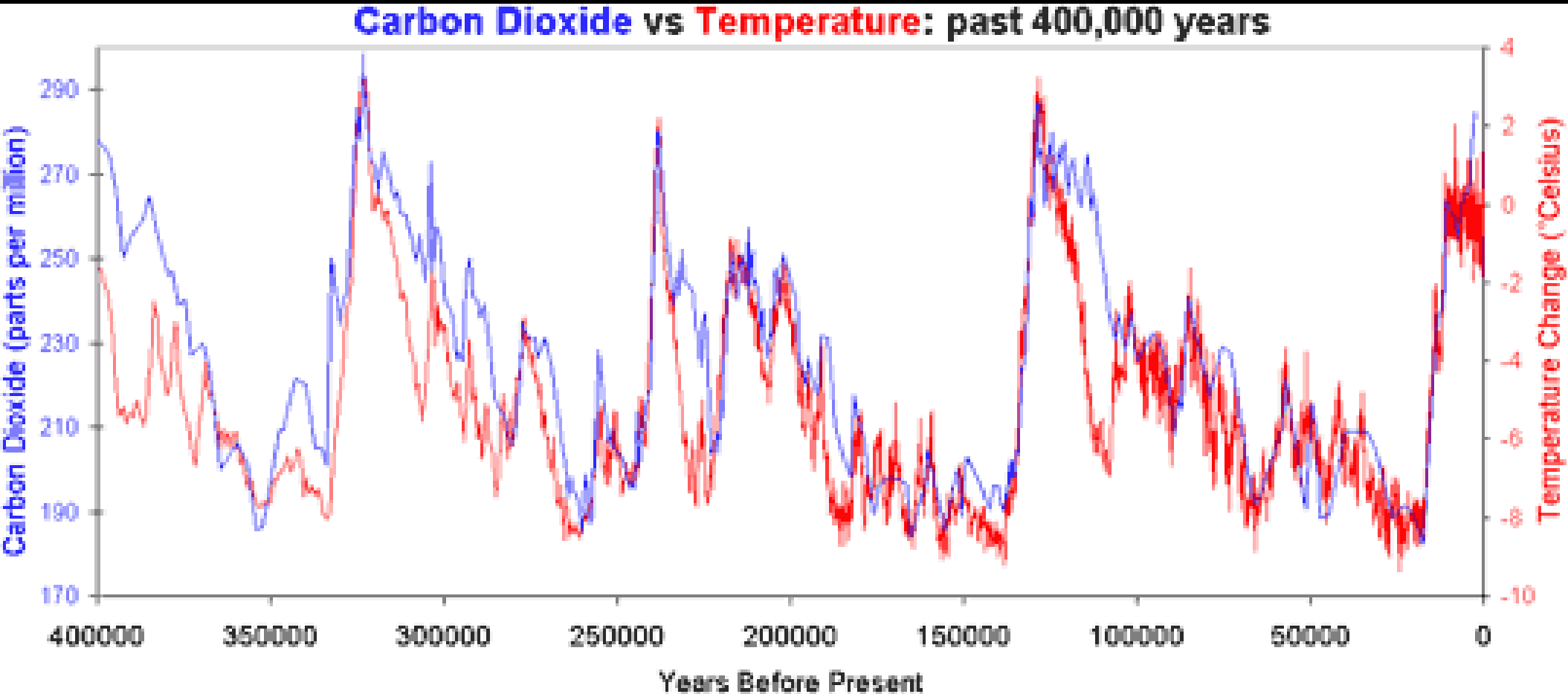
BP = "Before Present" (1999)

R. Petit, J. Jouzel, D. Raynaud, N. I. Barkov, J.-M. Barnola, I. Basile, M. Bender, J. Chappellaz, M. Davis, G. Delaygue, M. Delmotte, V. M. Kotlyakov, M. Legrand, V. Y Lipenkov, C. Lorius, L. Pepin, C. Ritz, E. Saltzman, and M. Stievenard, "Climate and history of the past 420,000 years from the Vostok ice core, Antarctica," *Nature* 399 (1999) 429-436



Lines added by me to indicate periods when temperatures started to take an upswing in the long historical record (marking the end of glacial periods). These are quite often preceded by increases in insolation.

Note that while insolation triggered the present inter-glacial period, insolation is at a low point while temperatures have remained high since the last ice age thanks to CO₂ and CH₄.



Vostok ice core records for carbon dioxide concentration and temperature change. Prior to the 200 years, CO₂ levels often lagged temperature changes by 600-1000 years. So temperature and CO₂ levels are intertwined.

COMPOSITE PICTURE OF HISTORICAL CO₂:

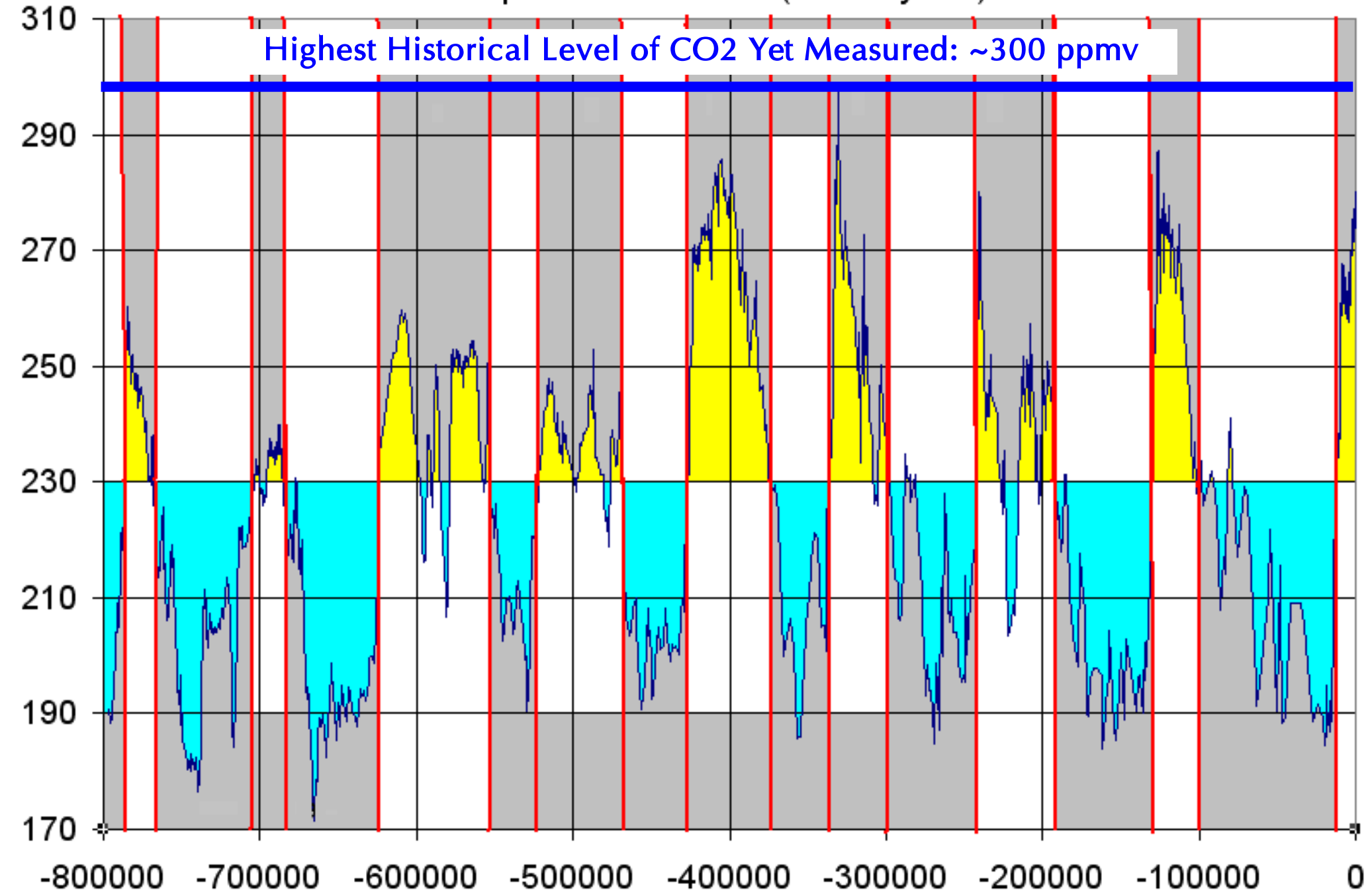
800,000 years of EPICA/Dome C Ice Core Data

The plot shows CO₂ levels changing around the 230 ppmv CO₂ levels marking a transition between glacial (light blue) and inter-glacial (yellow) periods.

http://www.ncdc.noaa.gov/paleo/icecore/antarctica/domec/domec_epica_data.html

Composite CO2 record (0-800 kyr BP)

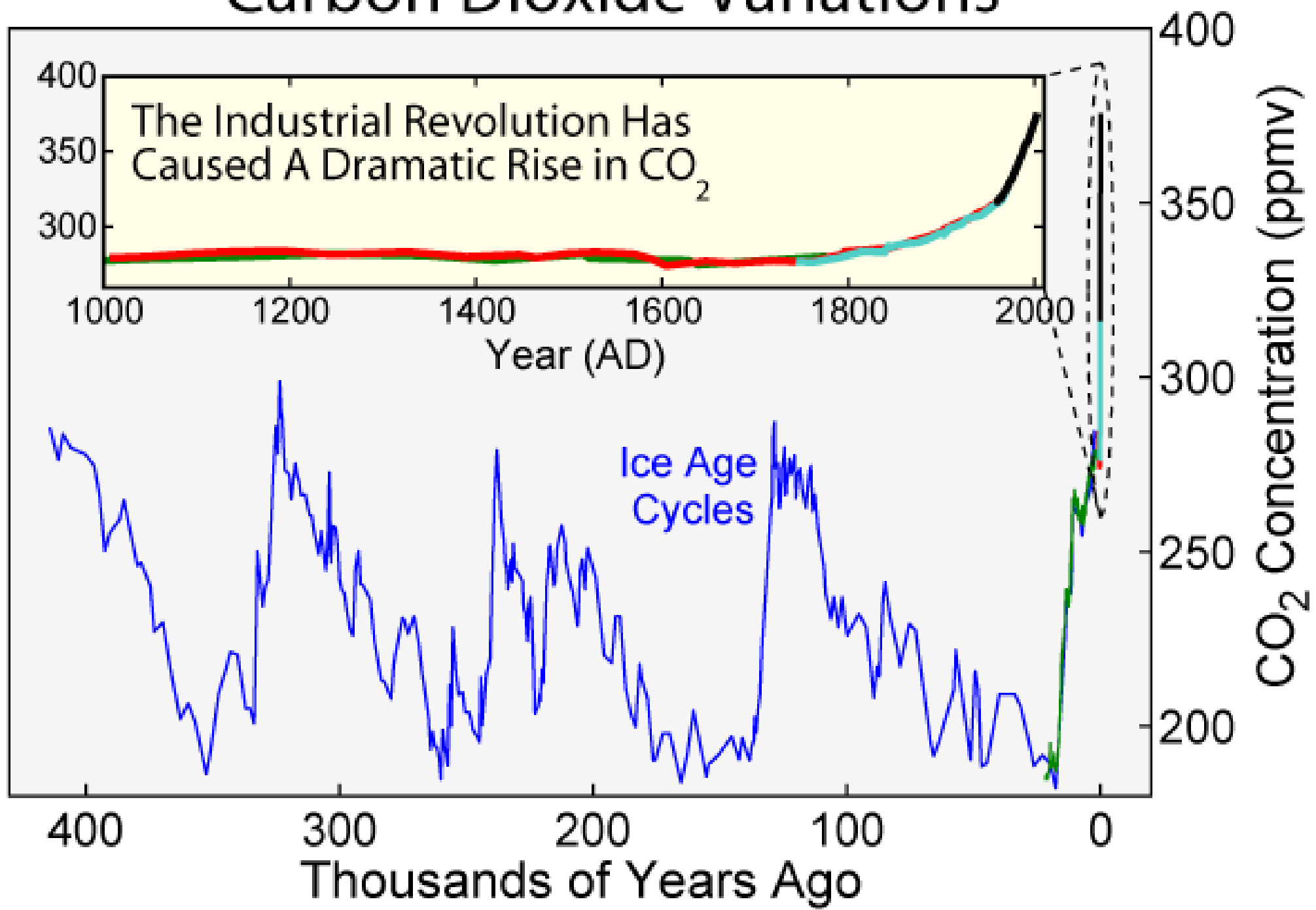
Highest Historical Level of CO2 Yet Measured: ~300 ppmv



Climate in the Past

- In the past, climate has changed
 - average temperatures have fluctuated, changing by ~ 10 degrees C over $\sim 15,000$ years (~ 0.13 C every 200 years).
 - there are highs and lows – the highs and lows (maxima and minima) are roughly the same during each big swing.
 - these swings take thousands of years to occur
 - they are often preceded by upswings in insolation of about 50 W/m^2 , but sustain beyond insolation changes
 - Climate is very sensitive to small changes. Average temperature changes of just a few degrees are correlated with changes in CO_2 (CH_4) at the level of just a few 10s of ppmv (100s of ppbv).
- Is climate changing in the present? How is it the same or different as in the past?

Carbon Dioxide Variations



Data Sources (Prev. Page)

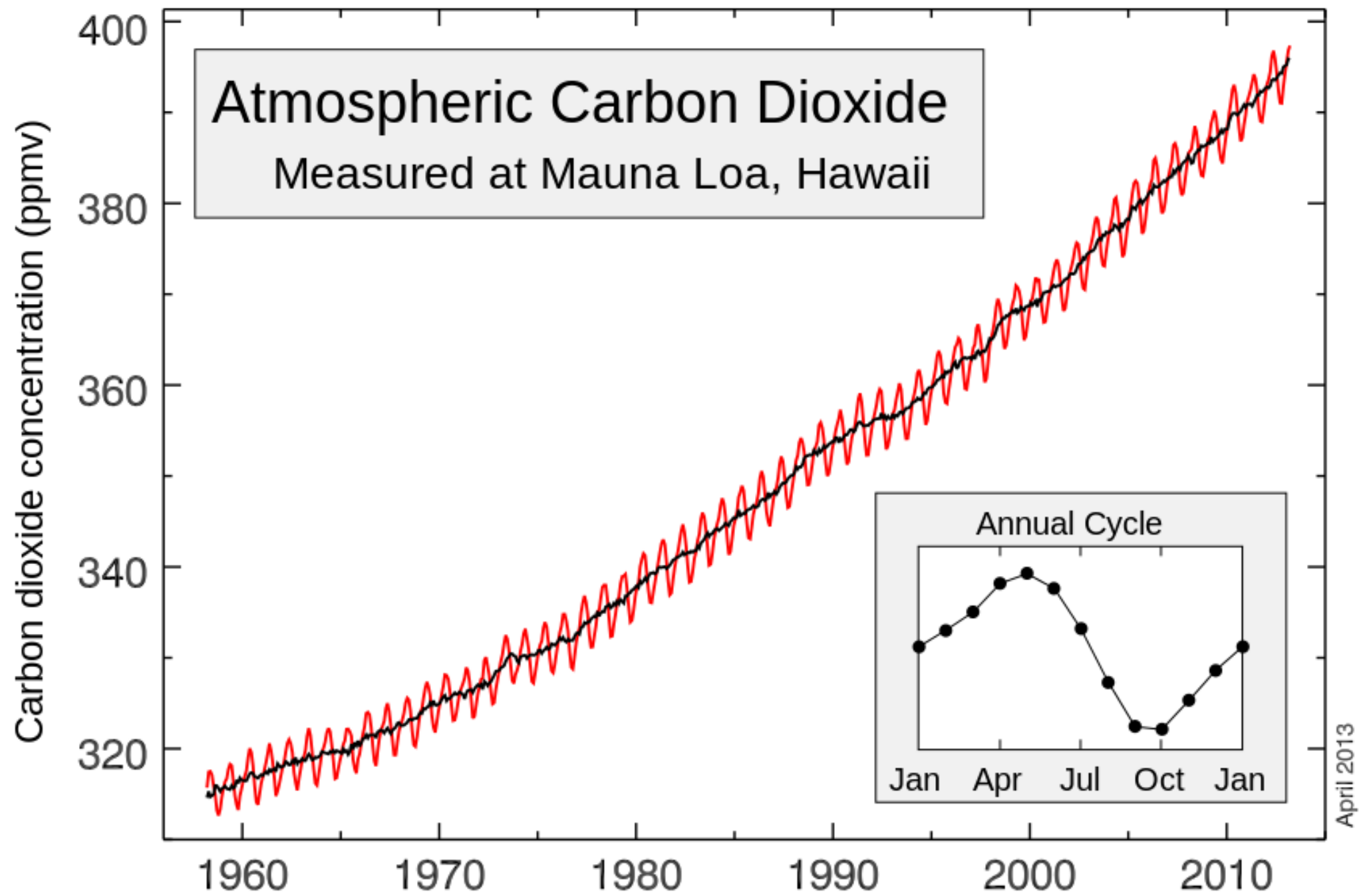
(blue) Vostok ice core: Fischer, H., M. Wahlen, J. Smith, D. Mastroianni, and B. Deck (1999). "Ice core records of Atmospheric CO₂ around the last three glacial terminations". *Science* 283: 1712-1714.

(green) EPICA ice core: Monnin, E., E.J. Steig, U. Siegenthaler, K. Kawamura, J. Schwander, B. Stauffer, T.F. Stocker, D.L. Morse, J.-M. Barnola, B. Bellier, D. Raynaud, and H. Fischer (2004). "Evidence for substantial accumulation rate variability in Antarctica during the Holocene, through synchronization of CO₂ in the Taylor Dome, Dome C and DML ice cores". *Earth and Planetary Science Letters* 224: 45-54. doi:10.1016/j.epsl.2004.05.007

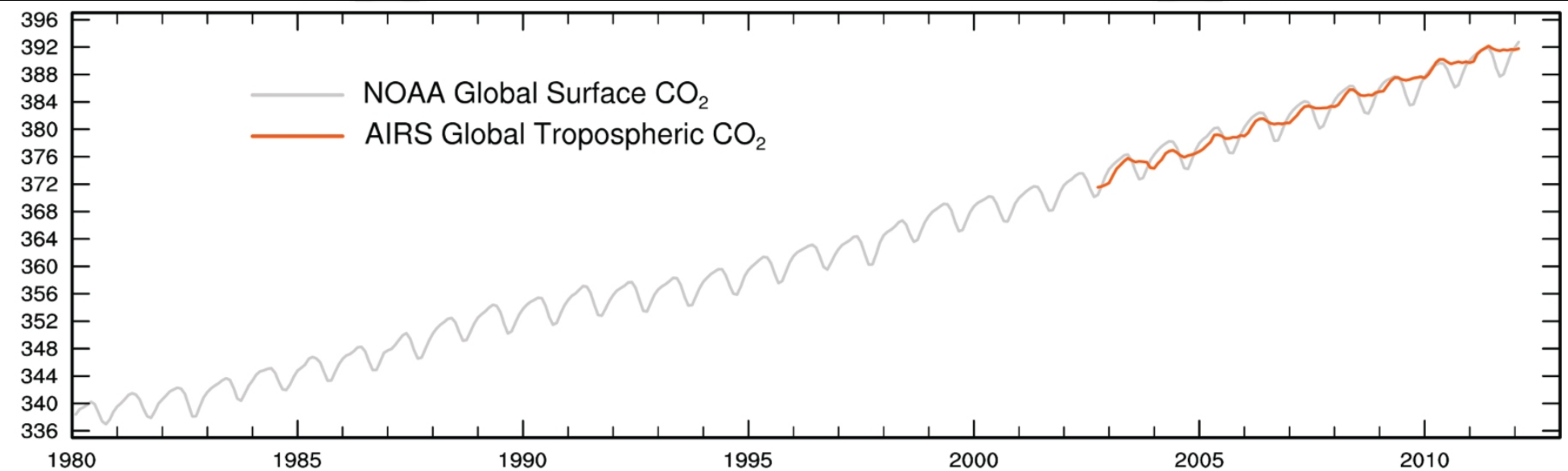
(red) Law Dome ice core: D.M. Etheridge, L.P. Steele, R.L. Langenfelds, R.J. Francey, J.-M. Barnola and V.I. Morgan (1998) "Historical CO₂ records from the Law Dome DE08, DE08-2, and DSS ice cores" in *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

(cyan) Siple Dome ice core: Neftel, A., H. Friedli, E. Moor, H. Lötscher, H. Oeschger, U. Siegenthaler, and B. Stauffer (1994) "Historical CO₂ record from the Siple Station ice core" in *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

(black) Mauna Loa Observatory, Hawaii: Keeling, C.D. and T.P. Whorf (2004) "Atmospheric CO₂ records from sites in the SIO air sampling network" in *Trends: A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.



CO₂ Changes in Recent Times

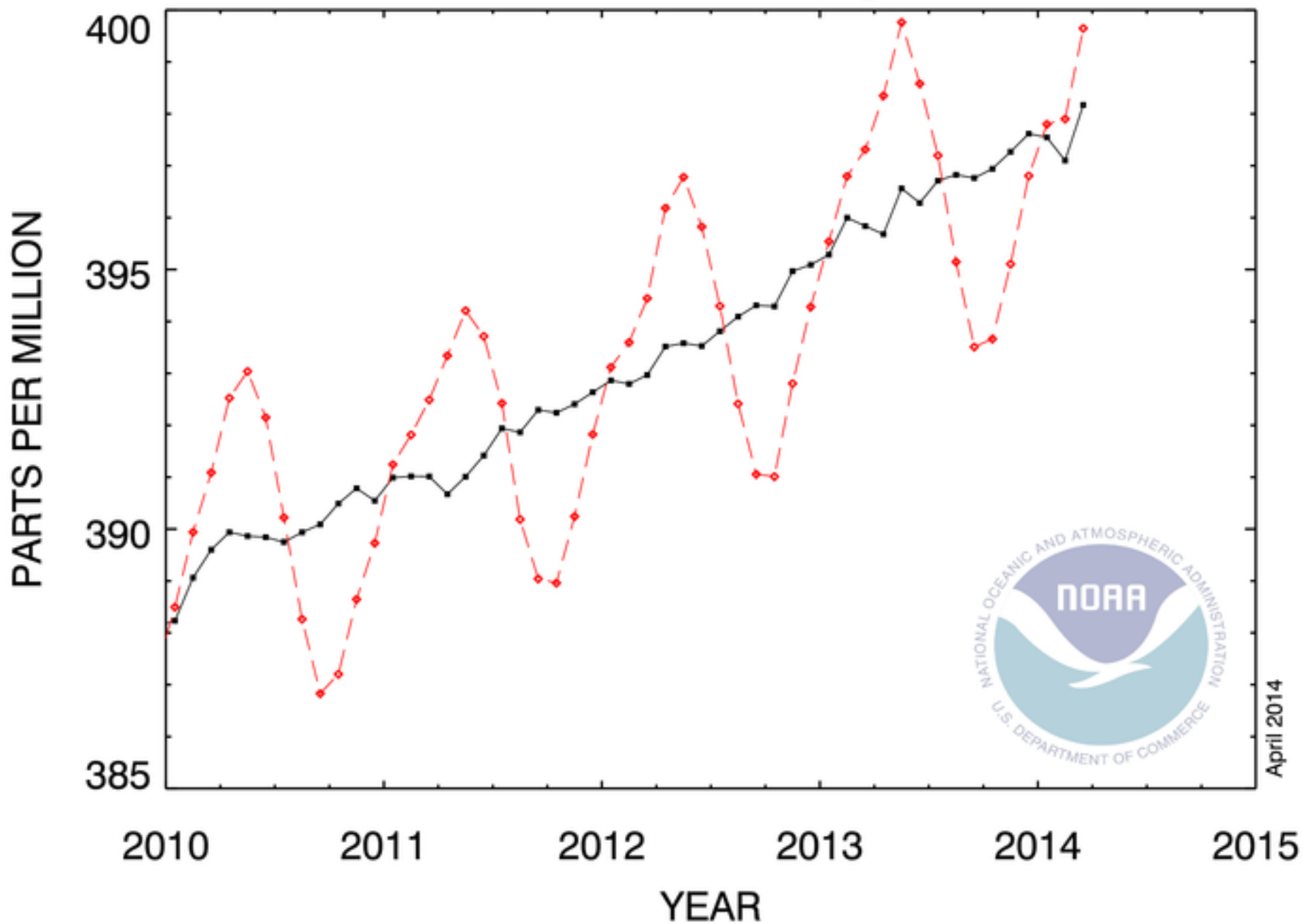


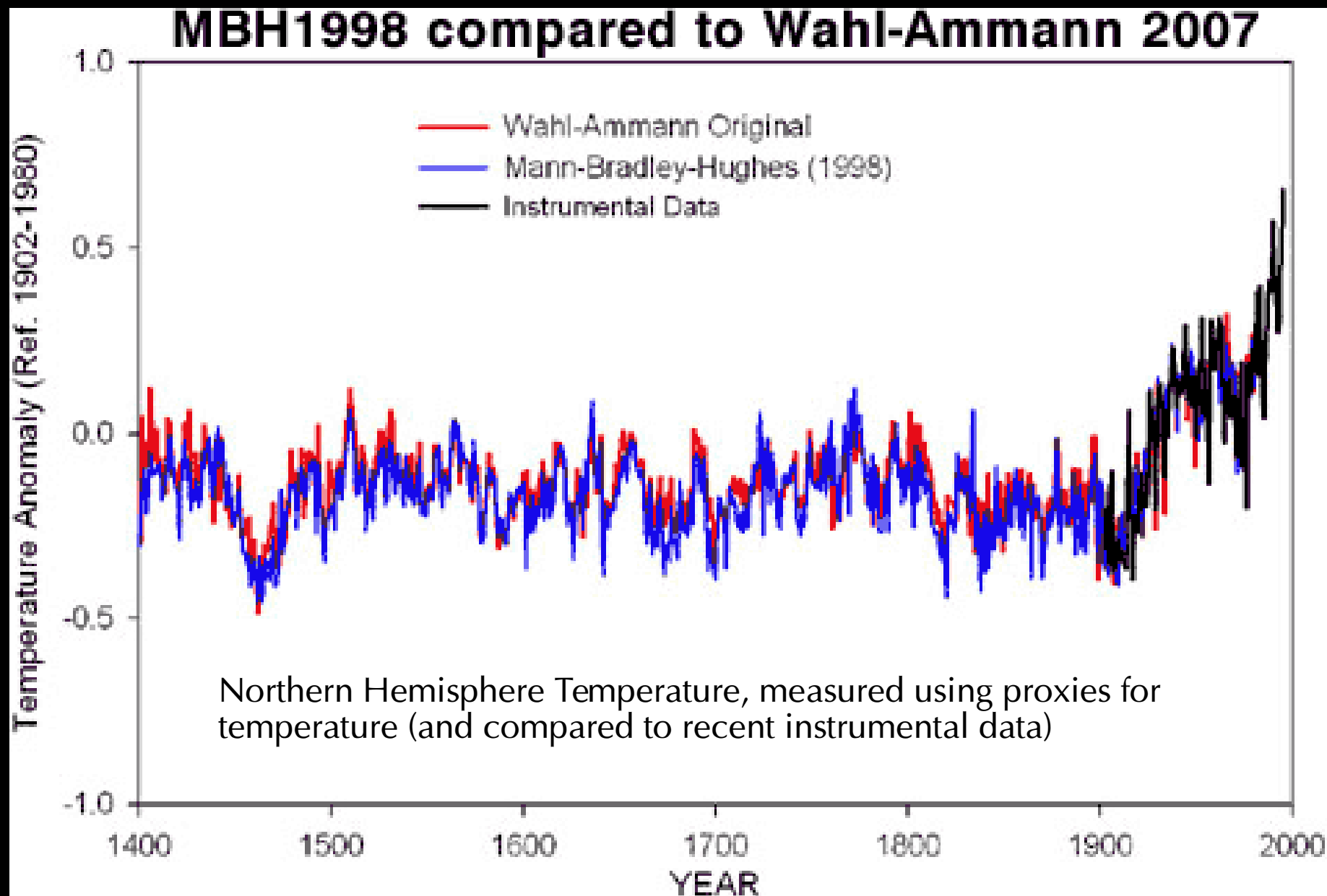
Vertical axis is CO₂ levels in ppmv

Horizontal axis is calendar year. You can see the variation in atmospheric CO₂ levels year by year. Why is this?

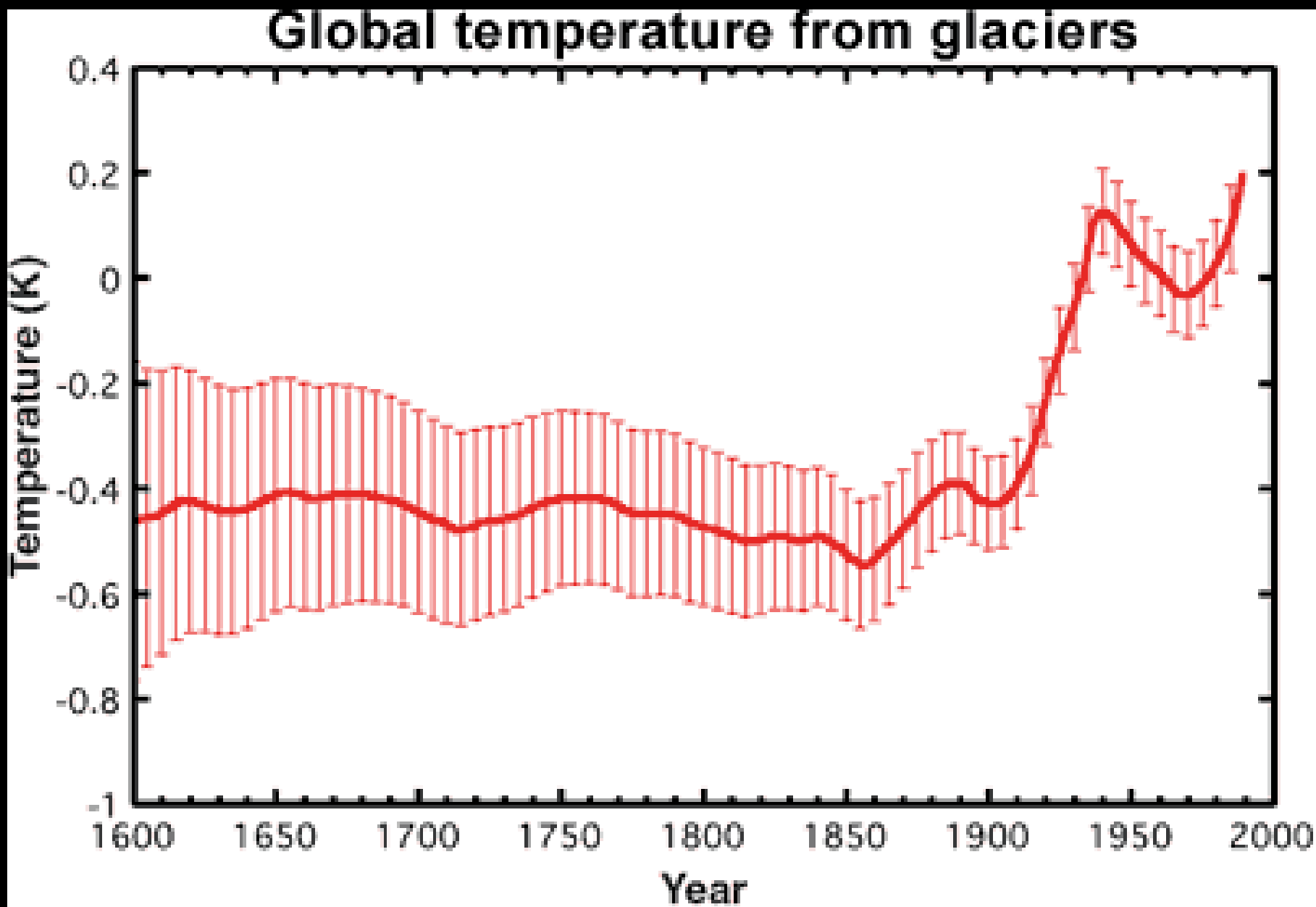
The grey line is surface CO₂ measurements. The red line is more recent tropospheric CO₂ measurements. They coincide.

RECENT MONTHLY MEAN CO₂ AT MAUNA LOA



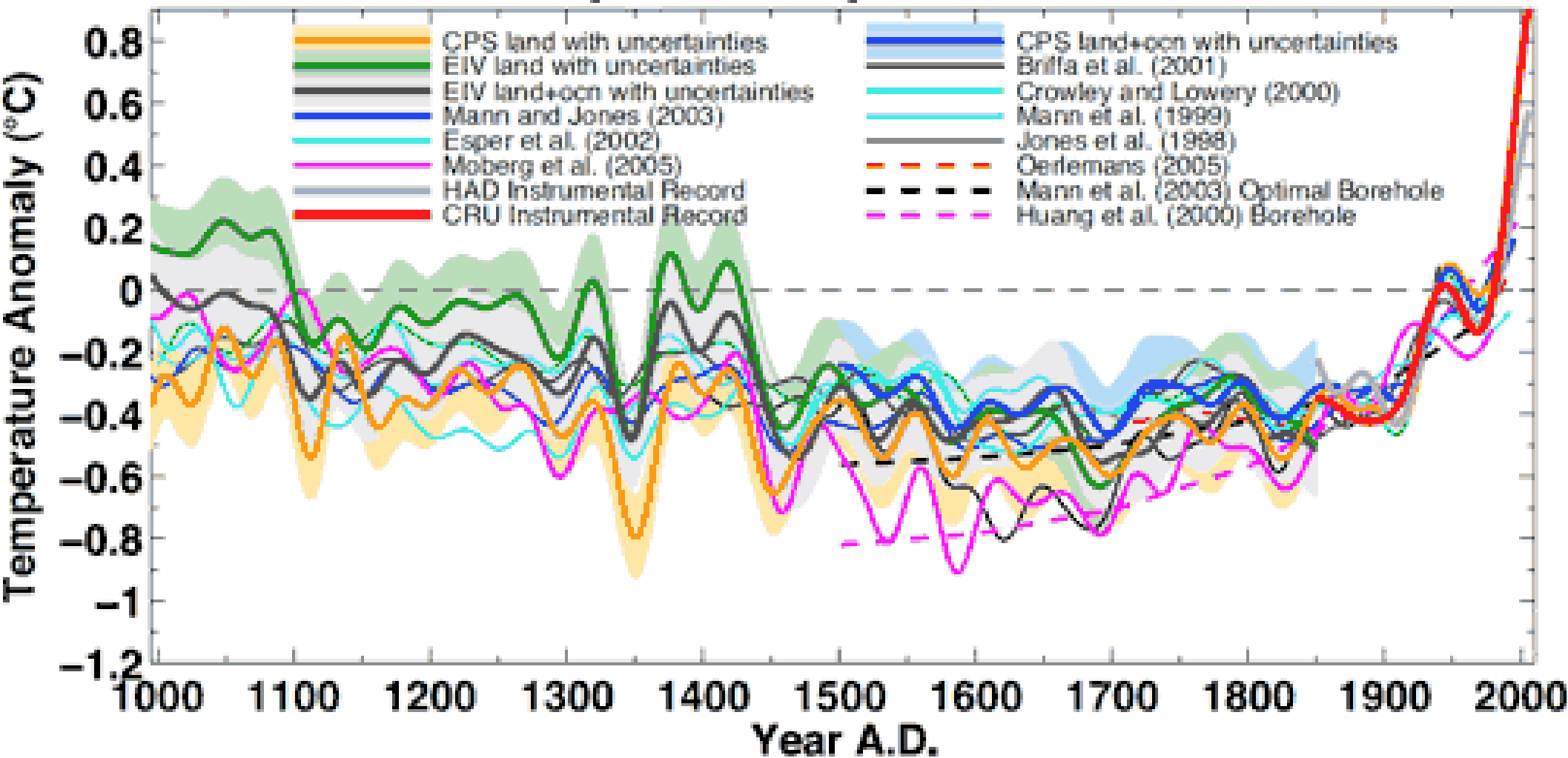


Wahl, E and Ammann, C. "Robustness of the Mann, Bradley, Hughes reconstruction of Northern Hemisphere surface temperatures: Examination of criticisms based on the nature and processing of proxy climate evidence." *Climatic Change*. Nov. 2007. Vol. 85, Issue 1-2, pp. 33-69

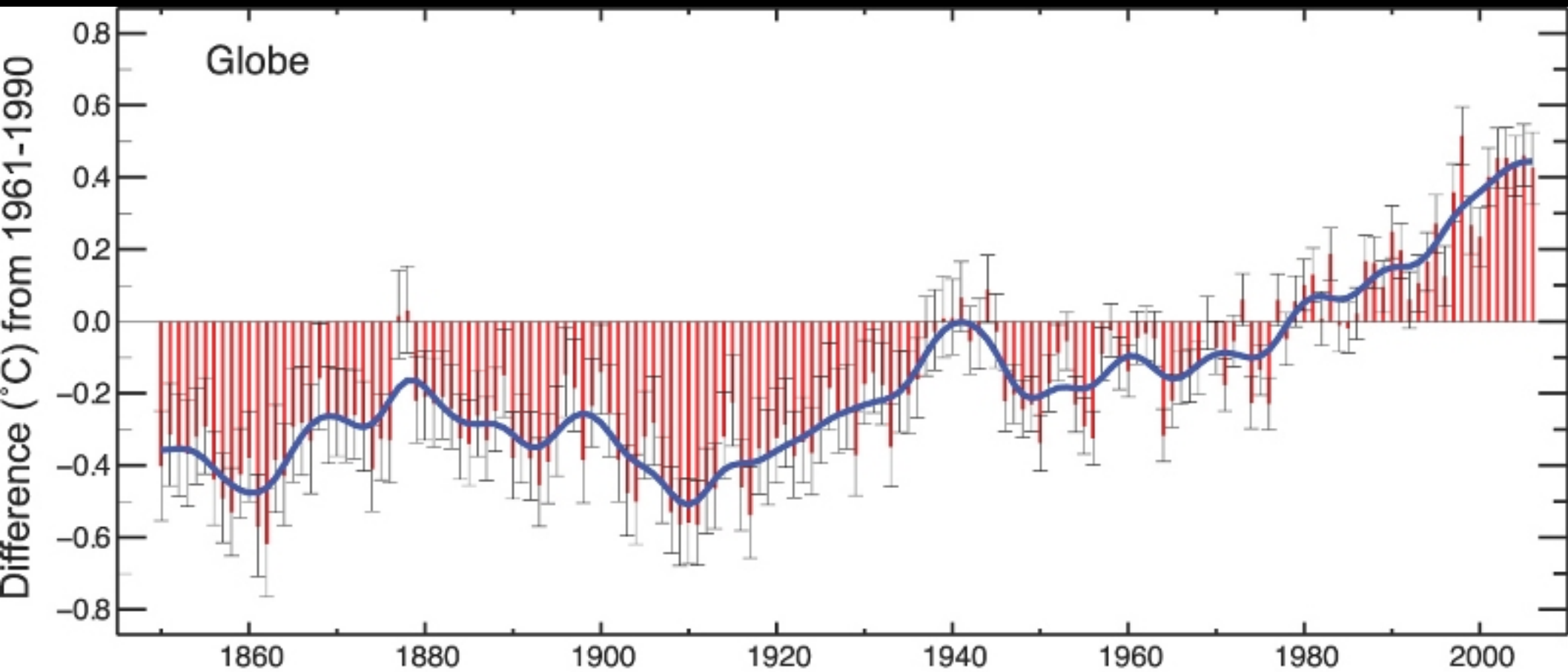


Historical measures of glacier length can be related to historical temperatures. From this independent assessment, we see the same trend. Temperature deviations are measured relative to the mean from 1834-1990. Oerlemans, J. "Extracting a Climate Signal from 169³⁴ Glacier Records." *Science* 308.5722 (2005): 675-677.

Northern Hemisphere temperature reconstructions



Mann, M. et al. "Proxy-based reconstructions of hemispheric and global surface temperature variations over the past two millennia " Proceedings of the National Academy of Sciences. Vol. 105, No. 36, pp. 13252-13257, September 9, 2008. doi:10.1073/pnas.0805721105

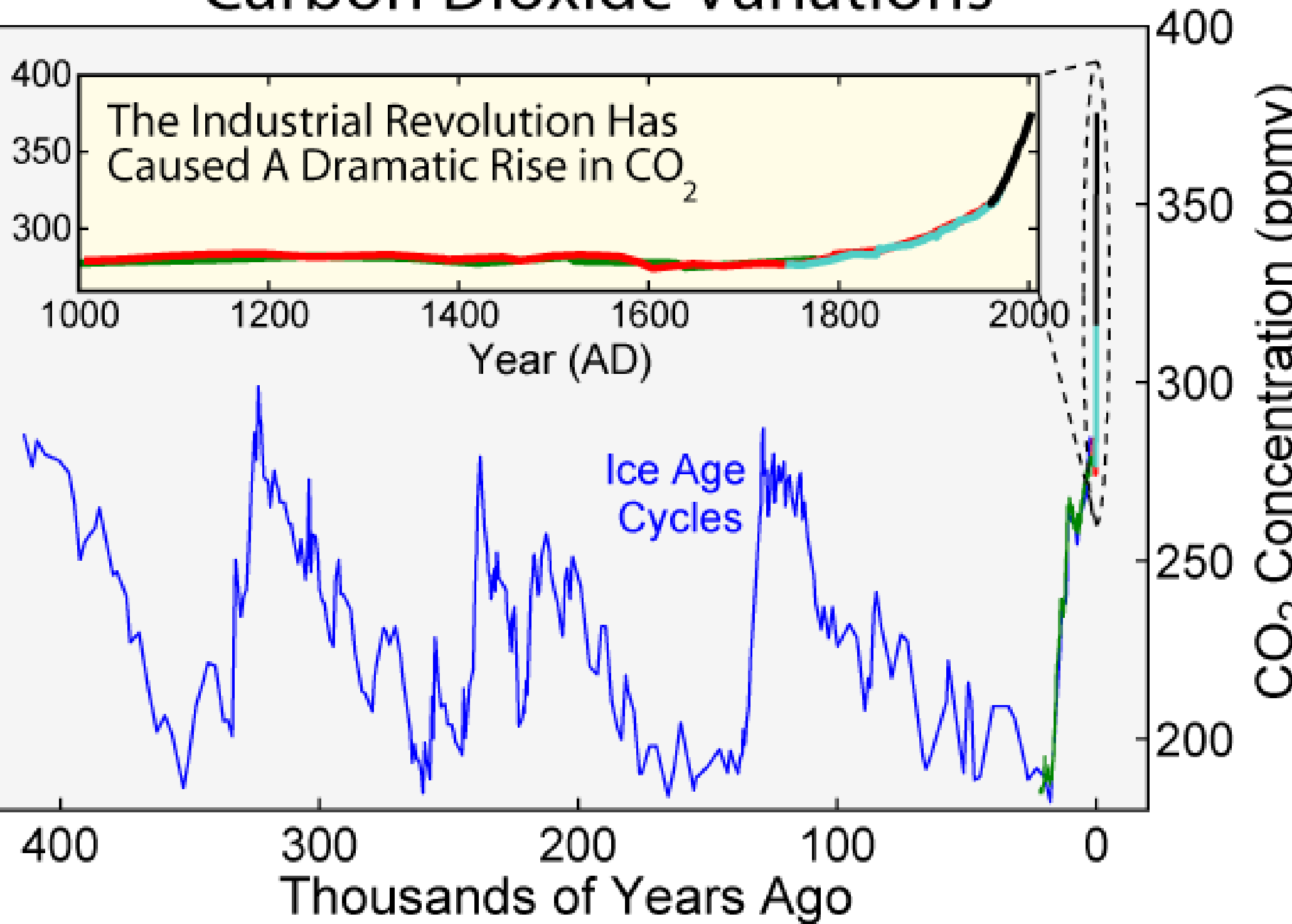


"Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007," Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.) http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html

Summary of Temperature Data

- Current period is warmest in last 1300-1700 years
 - data from glaciers, tree rings, stalagmites (layer thickness is a proxy for temperature), bore hole temperature data from across the globe, etc.
 - that data all points to significant warming since about 1900
- What's causing the change? Solar activity? CO₂ or other heat-trapping gases?

Carbon Dioxide Variations

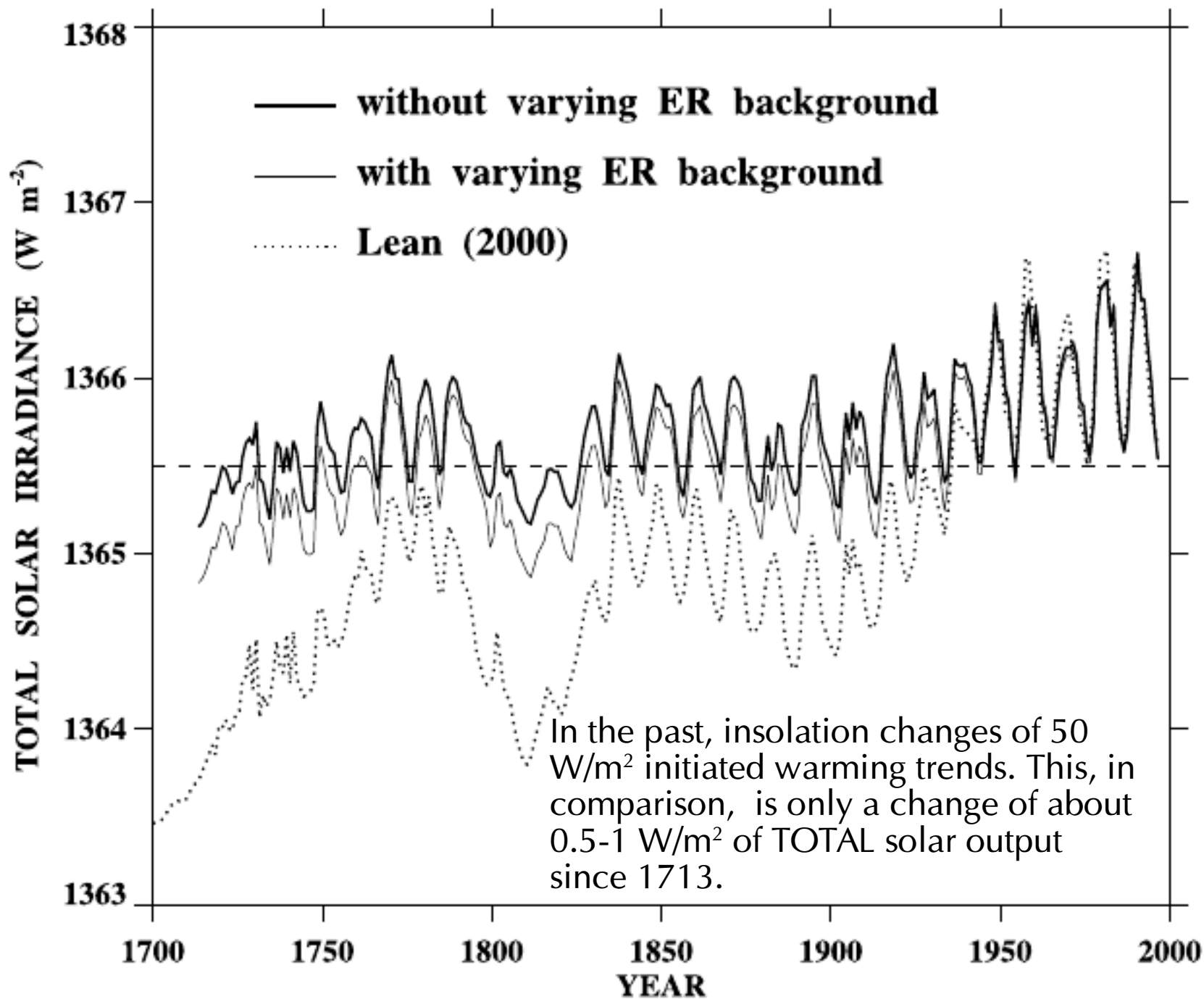


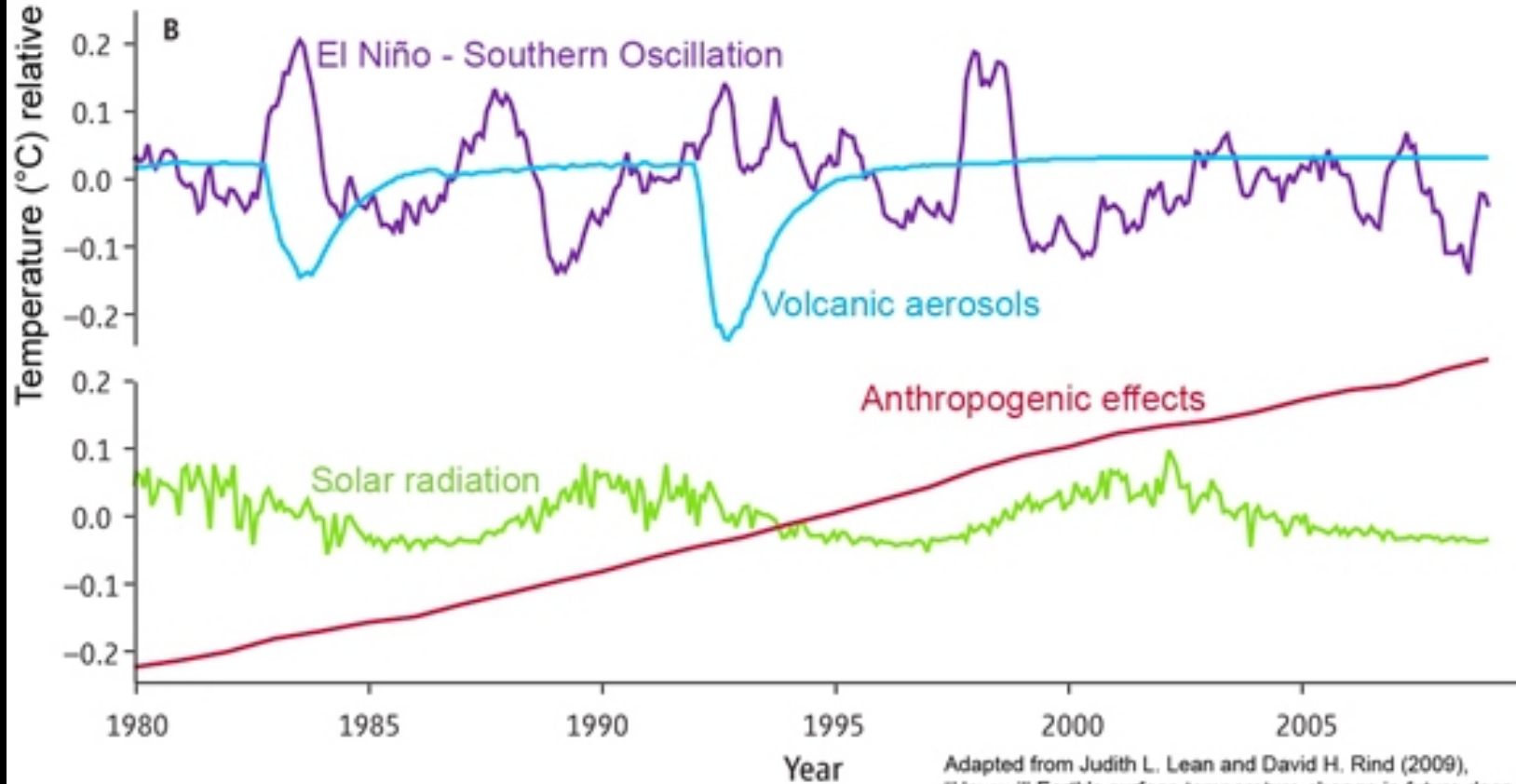
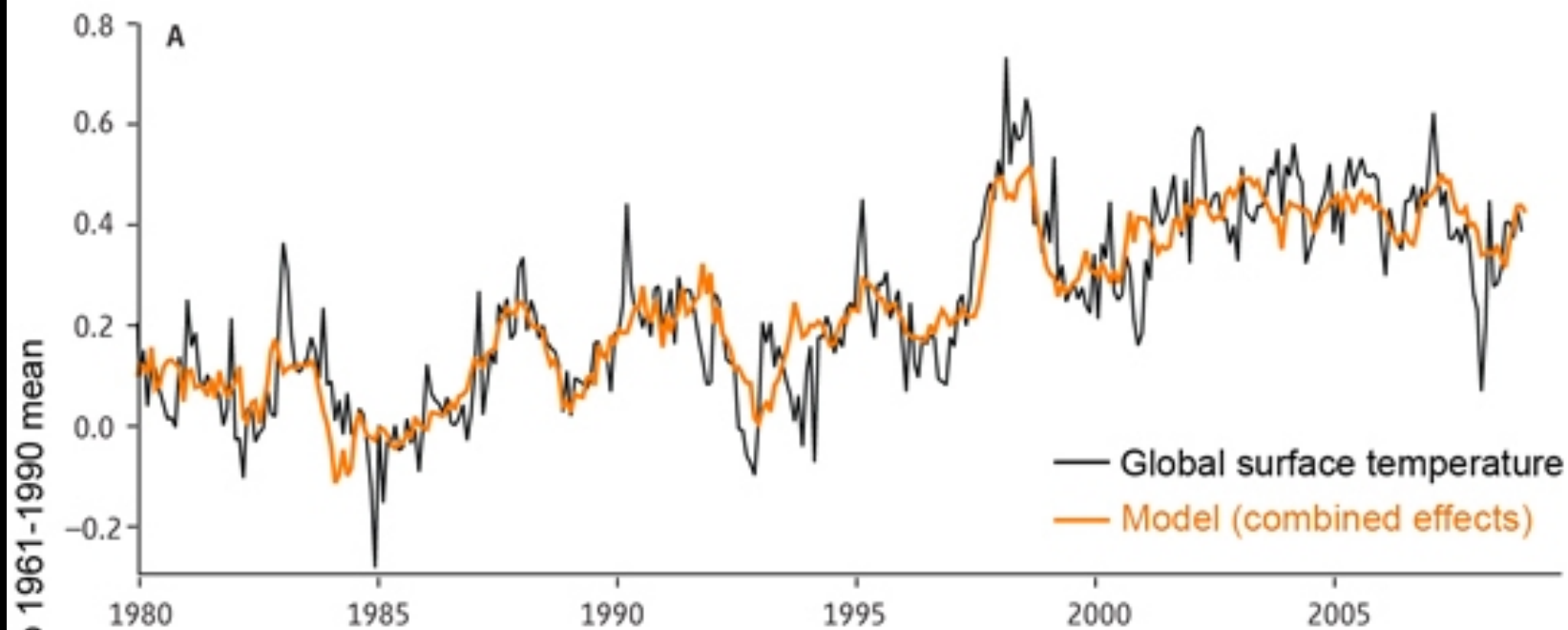
CO₂ Levels Began Rising in the early 1800s

- We know from past climate data that temperature and CO₂ are linked
 - In the past, rising temperature led rising CO₂ levels by about 600-1000 years
 - but that's because those temperature changes lasted thousands of years, with CO₂ levels rising by ~50 ppmv over that same period.
 - CO₂ has amplified warming trends in the past, and we know from its physical and chemical properties how it traps heat and how much it traps heat.

CO₂ Levels Began Rising in the early 1800s

- In the current period:
 - CO₂ levels have risen since 1800 by 100 ppmv, to almost 400 ppmv – levels unseen in at least 800,000 years.
 - That's 100 ppmv over 200 years, as opposed to 50 ppmv over a few thousand years
 - The temperature changes are happening over a much shorter period. This behavior is consistent with the physics of CO₂ and with past climate data – it is merely accelerated.
 - In the past, upward temperature changes were 0.13C over 200 years; in the present, we've seen 0.7C in 200 years.
- What about solar radiation? Did that initiate the CO₂ rise?





Adapted from Judith L. Lean and David H. Rind (2009),
"How will Earth's surface temperature change in future decades?",
Geophysical Research Letters **36**, L15708

For more depth
on the various
possible climate-
forcing
mechanisms, c.f.

Lean, Judith L.,
and David H.
Rind. "How
Natural and
Anthropogenic
Influences Alter
Global and
Regional Surface
Temperatures:
1889 to 2006."
*Geophysical
Research Letters*
35.18 (2008):
L18701.

Summary of the Science So Far

- Past climate data clearly indicates climate is sensitive to changes
 - temperature can influence CO₂, and CO₂ can amplify temperature changes. A change of 10 degrees C can be correlated with a CO₂ rise of 50 ppmv over 15,000 years.
- Current climate data indicates CO₂ led temperature rise by nearly a century.
 - CO₂ is pulling temperature by the nose now. We've had a 100 ppmv change in 200 years, and a 0.7C change in temperature in 200 years.
- Other sources of climate forcing alone or together cannot explain the temperature changes. Total solar output has only risen by 0.5 W/m² – in the past, changes of insolation (solar radiation incident on Earth) of 50 W/m² preceded warming.
- But is this a human-made CO₂ rise? If this is the science, how is it misused or misrepresented? What issues are conflated or confused in the public discussion about climate change?

Future Lectures

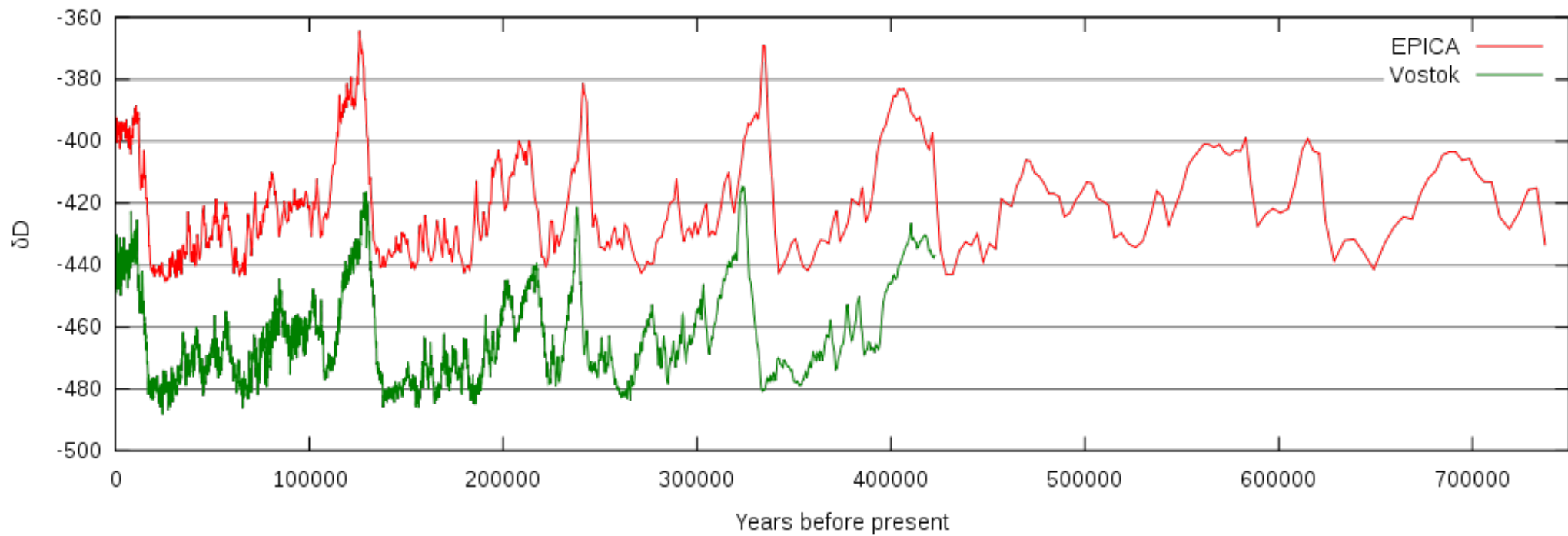
- This was just a small taste of some of the evidence that climate has changed, is changing, and that the change is linked to CO₂ rise.
- Up next:
 - Pseudoscience in Climate Change discussions
 - Separating the issues: science, policy, and values
 - Dr. Bonnie Jacobs – SMU Anthropology
 - Dr. Robert Gregory – SMU Geology
 - “carbon chemistry” - how do we know that human activity is responsible?

ADDITIONAL MATERIAL

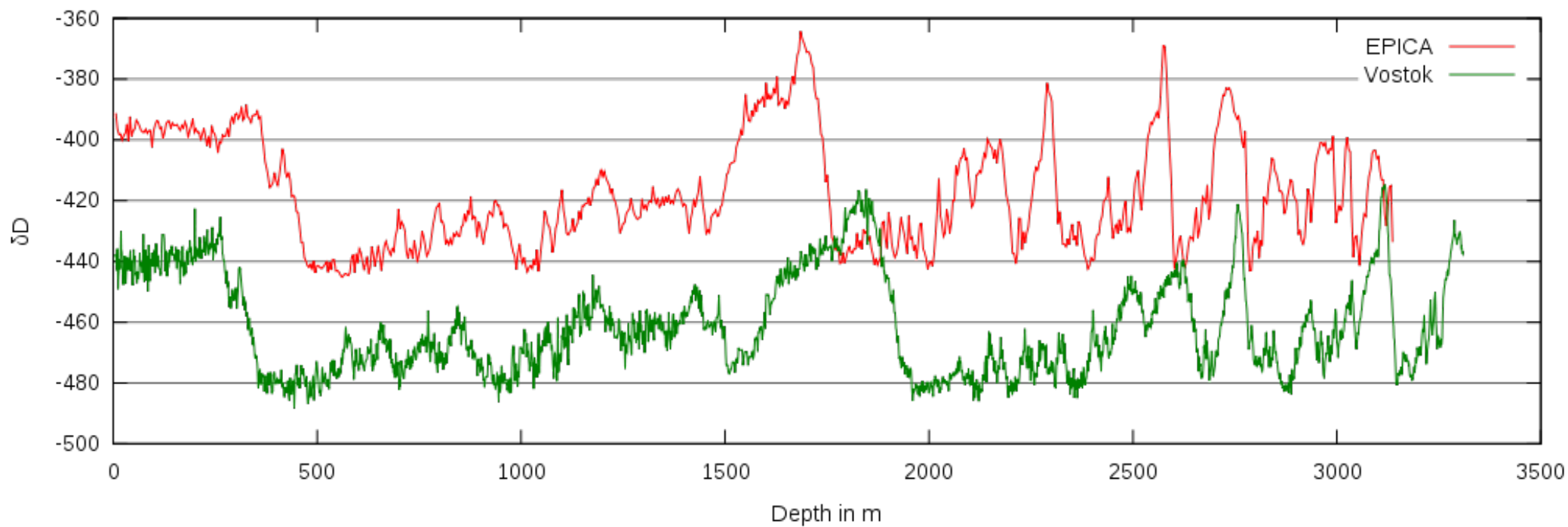
More Detail: Ice Core Reliability

- Are ice core measurements (e.g. Vostok alone) reliable?
- We can compare to another ice core, taken independently, and see how Deuterium levels change with depth (time) there.
- See next two slides for comparison of EPICA/Dome C Ice Cores and Vostok Ice Cores.

δD versus age



δD versus depth

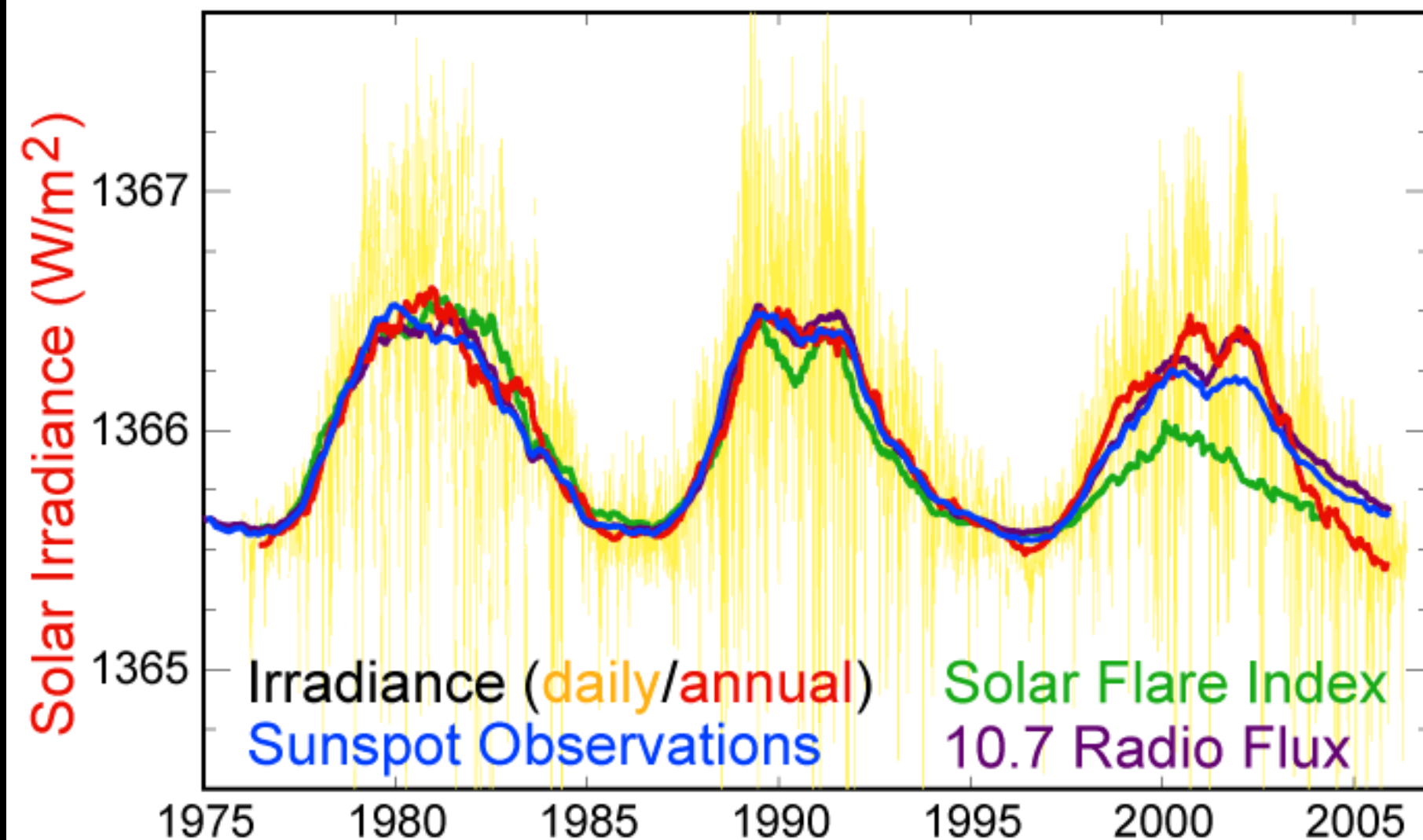


Notes on Previous Slide

- The EPICA core goes back further in time than Vostok
- There is obviously a time calibration issue, in the horizontal offset
 - depth must be converted to time, using some method
 - other than this small calibration effect, the ice cores agree on relative changes in Deuterium levels as a function of time.
- The y-axis offset is real – Vostok is colder, causes a larger negative change in Deuterium with time.

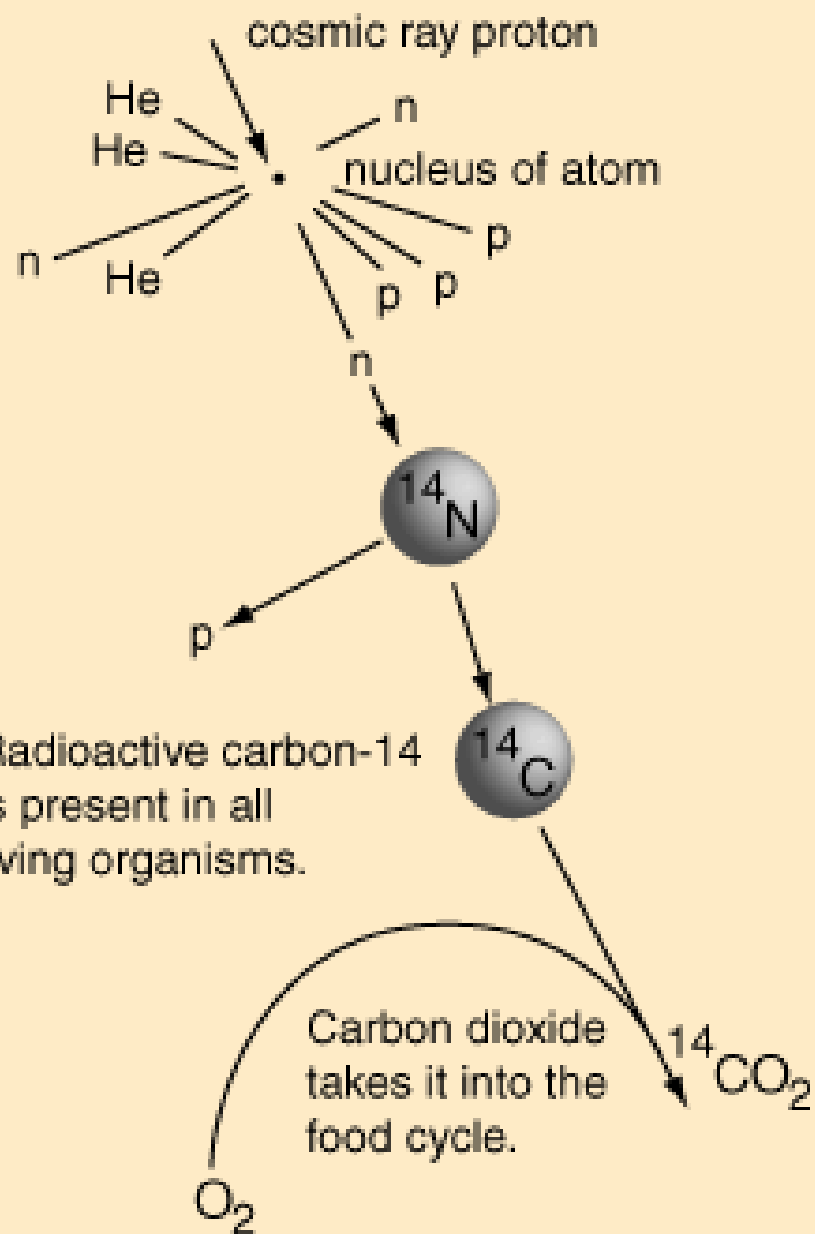
Solar Radiation in the Present

Solar Cycle Variations



More sunspots correlate strongly with stronger solar irradiance.

Solar Radiation in the Past



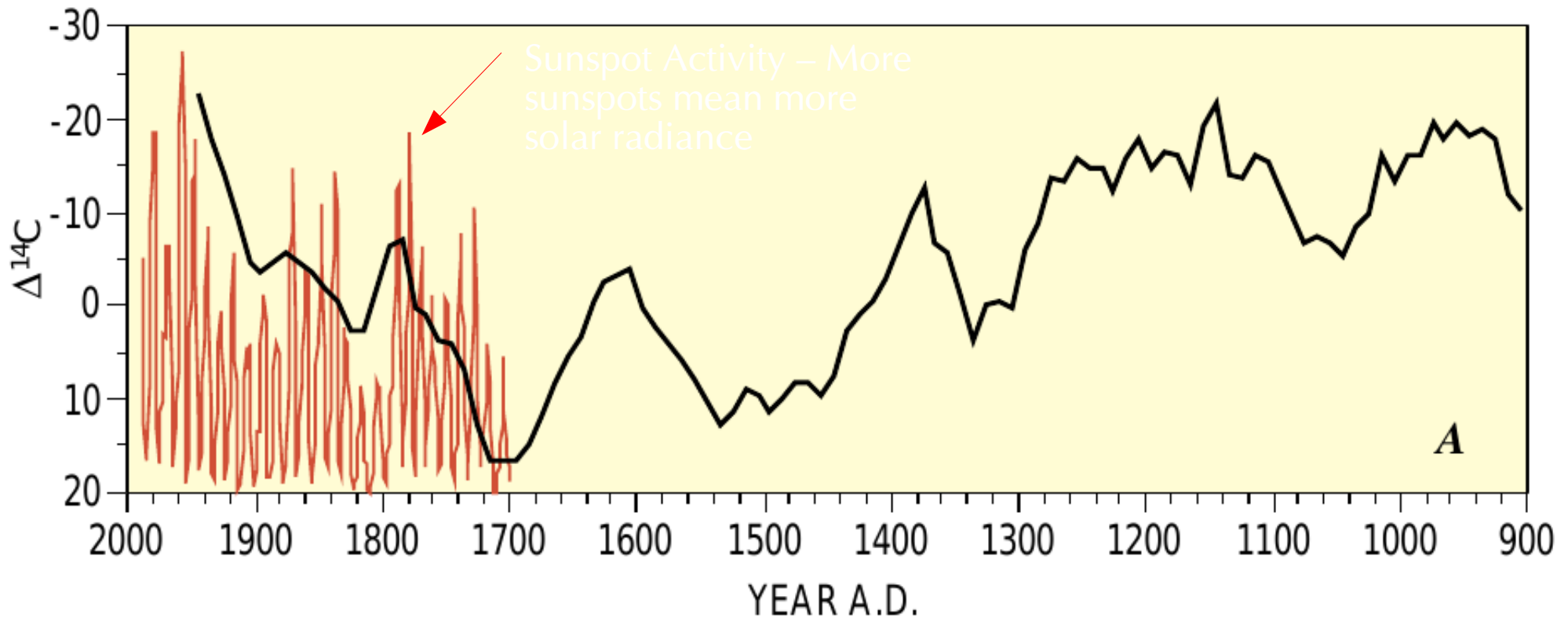
Periods of high sunspot activity and high solar radiance also correspond to periods of high solar wind activity.

More solar wind in the solar system means fewer galactic cosmic rays reach Earth.

This leads to variations in Carbon-14 and other isotope production, since fewer cosmic rays interacting in the Earth's atmosphere translated into lower levels of radioactive isotopes.

Carbon-14 and Oxygen-18 serve as a "proxy" for solar activity, prior to 1950. Direct sunspot measurements exist back to ~1700.

Solar Radiation in the Past



"The Sun and Climate." U.S. Geological Survey Fact Sheet 0095-00.
<http://pubs.usgs.gov/fs/fs-0095-00/>

Global Climate Change: The Misuse of the Science

Supplementary Material for CFB3333/PHY3333
Professors John Cotton, Randy Scalise, and Stephen Sekula

Problems in the Way Climate Change Is Discussed in/by the Public

- Misuse of the Science
 - Cherry-picking is a big problem
 - Discredit the scientists in an attempt to discredit the science itself
 - ... and others ...
- Conflating Values, Social, or Political Issues with Scientific Issues
 - e.g. try to cast the science as only being possible from a specific political world view
 - e.g. claim accepting the science invalidates a belief system

CHERRY-PICKING

LOTS AND LOTS OF
CHERRY-PICKING

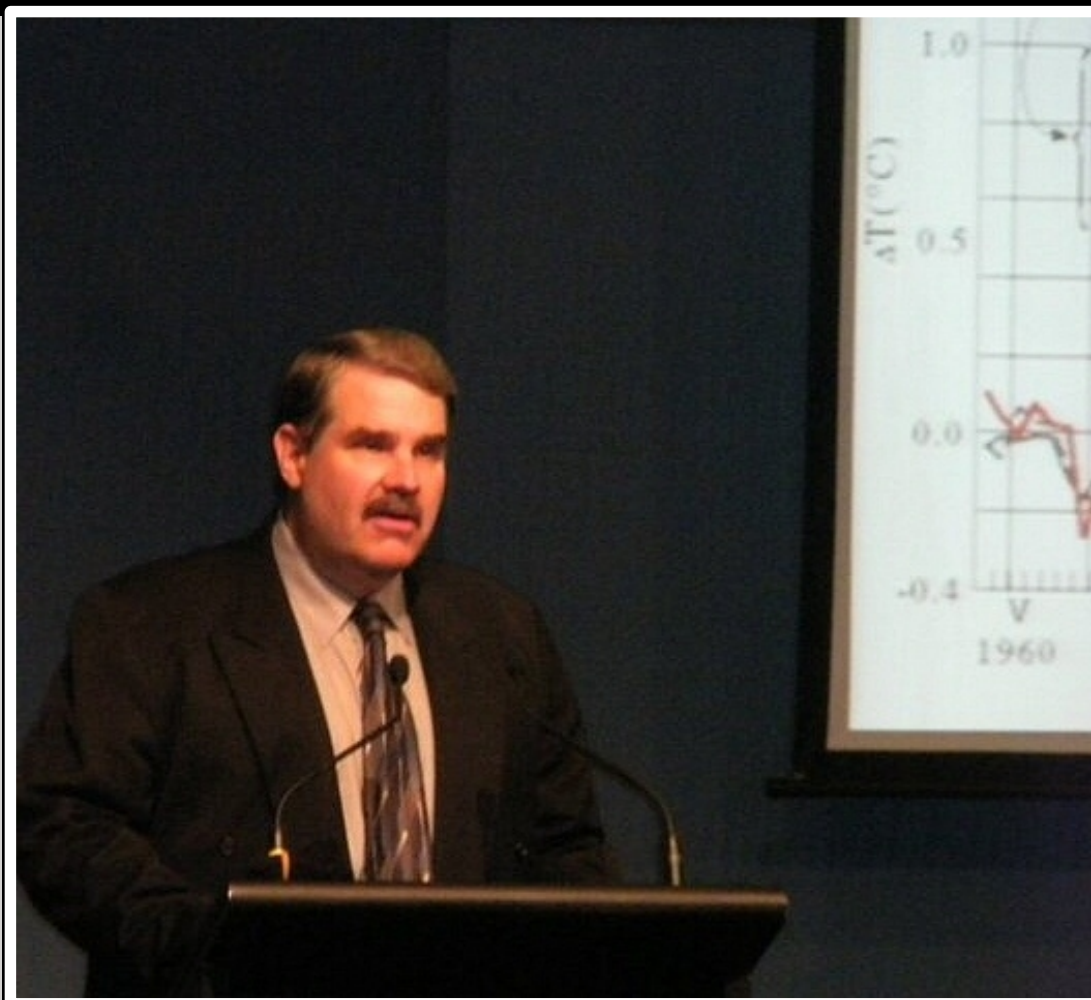
Cast Doubt on the Science

Is the U.S.
Surface Temperature
Record Reliable?

How do we know global
warming is a problem if
we can't trust the U.S.
temperature record?

BY ANTHONY WATTS

SurfaceStations.org



Anthony Watts, a meteorologist with no training in scientific research, routinely broadcasts science doubt about the existence of climate warming trends.

Cast Doubt on the Science

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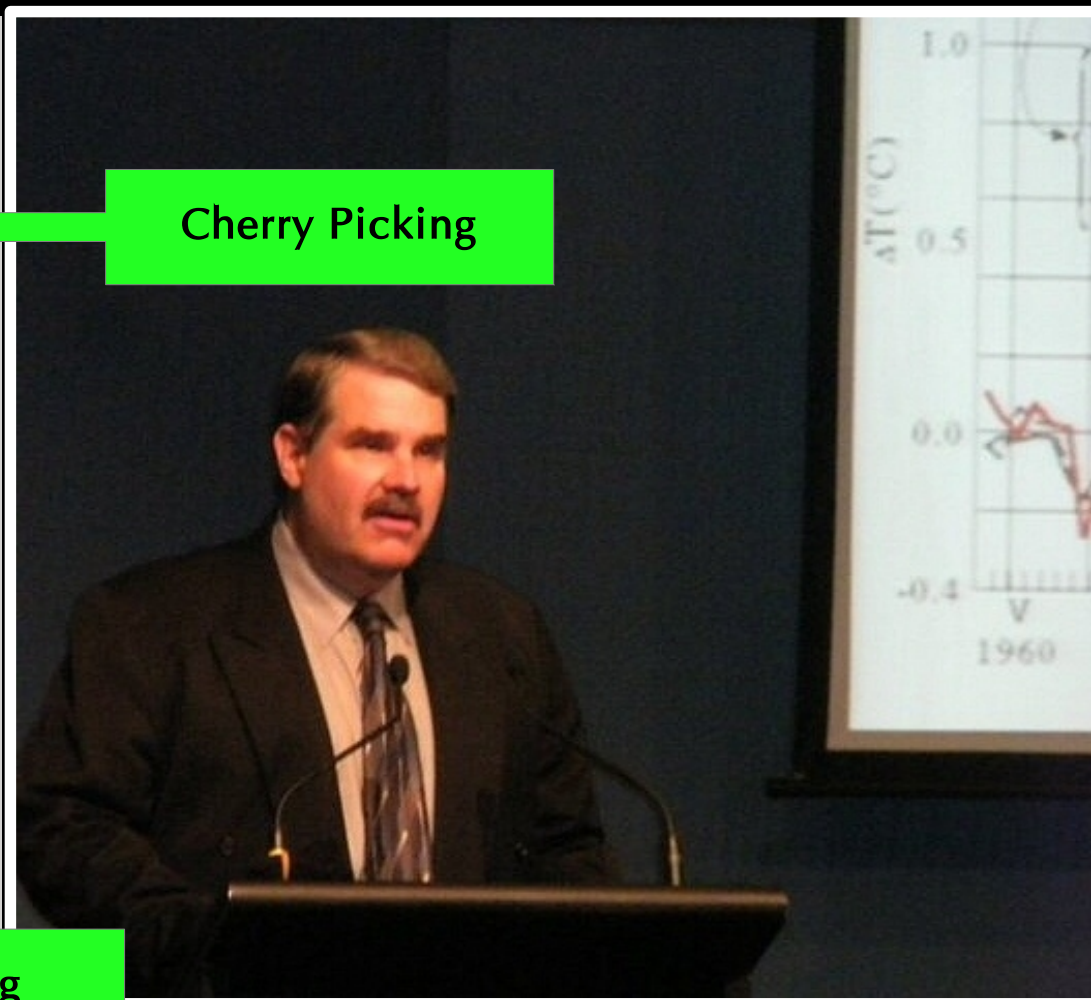
Cherry Picking

How do we know global
warming is a problem if
we can't trust the U.S.
temperature record?

Red Herring

BY ANTHONY WATTS

SurfaceStations.org



Anthony Watts, a meteorologist with no training in scientific research, routinely broadcasts science doubt about the existence of climate warming trends.



Temperature and Cherry-Picking

- The U.S. land area is just 2% of the globe's surface area, and an even smaller fraction of the volume from the bottom of the ocean to the top of the atmosphere.
 - this is an excellent example of cherry-picking and trying to distract an audience from the point
- Let's look at other ways that cherry-picking is used to distract you from the big picture.
 - some of the following example comes from Peter Gleick's "Forbes" article (May. 2, 2012), entitled "'Global Warming Has Stopped'? How to Fool People Using 'Cherry-Picked' Climate Data"

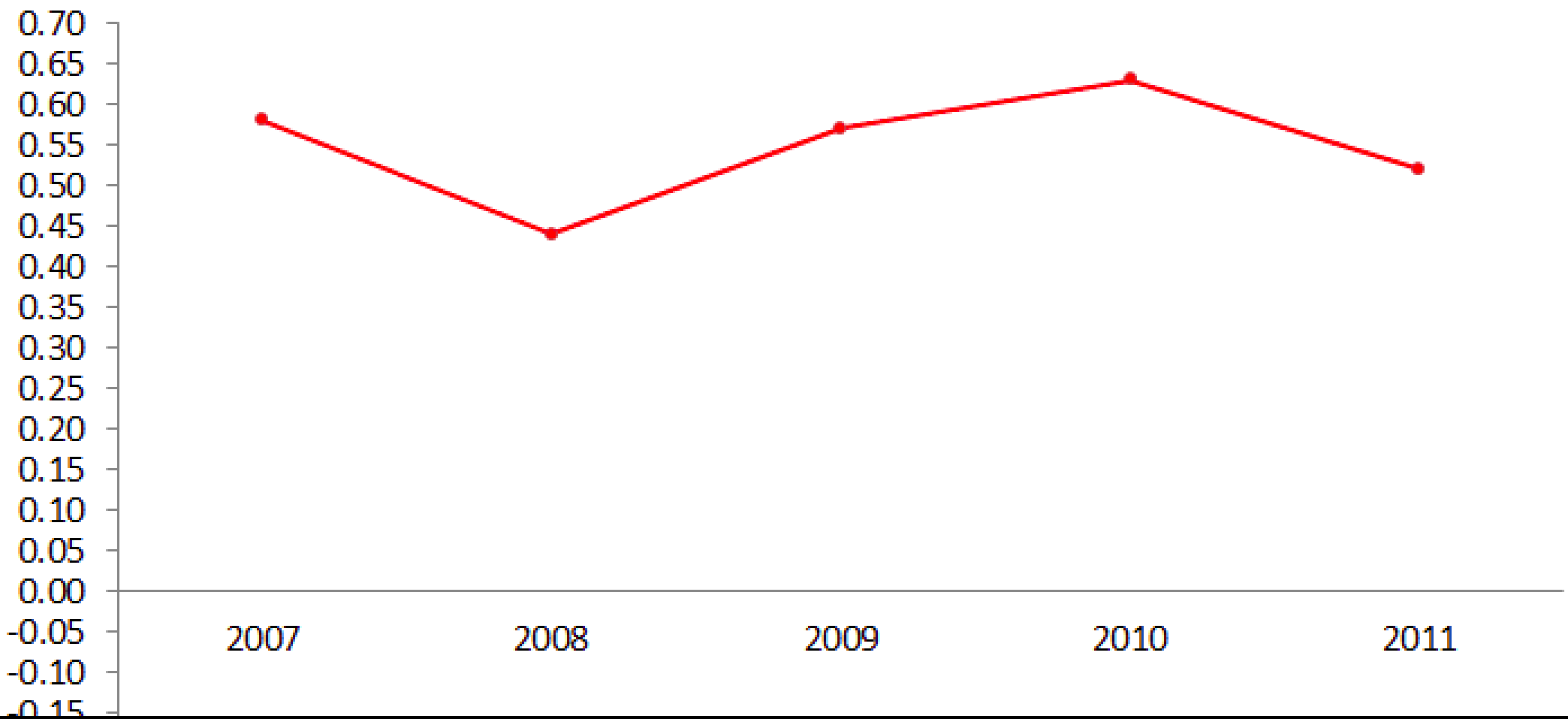
Prof. Steven Hayward, at the time a Visiting Scholar at the University of Colorado-Boulder. He holds a Ph.D. in American Studies from Claremont Graduate School



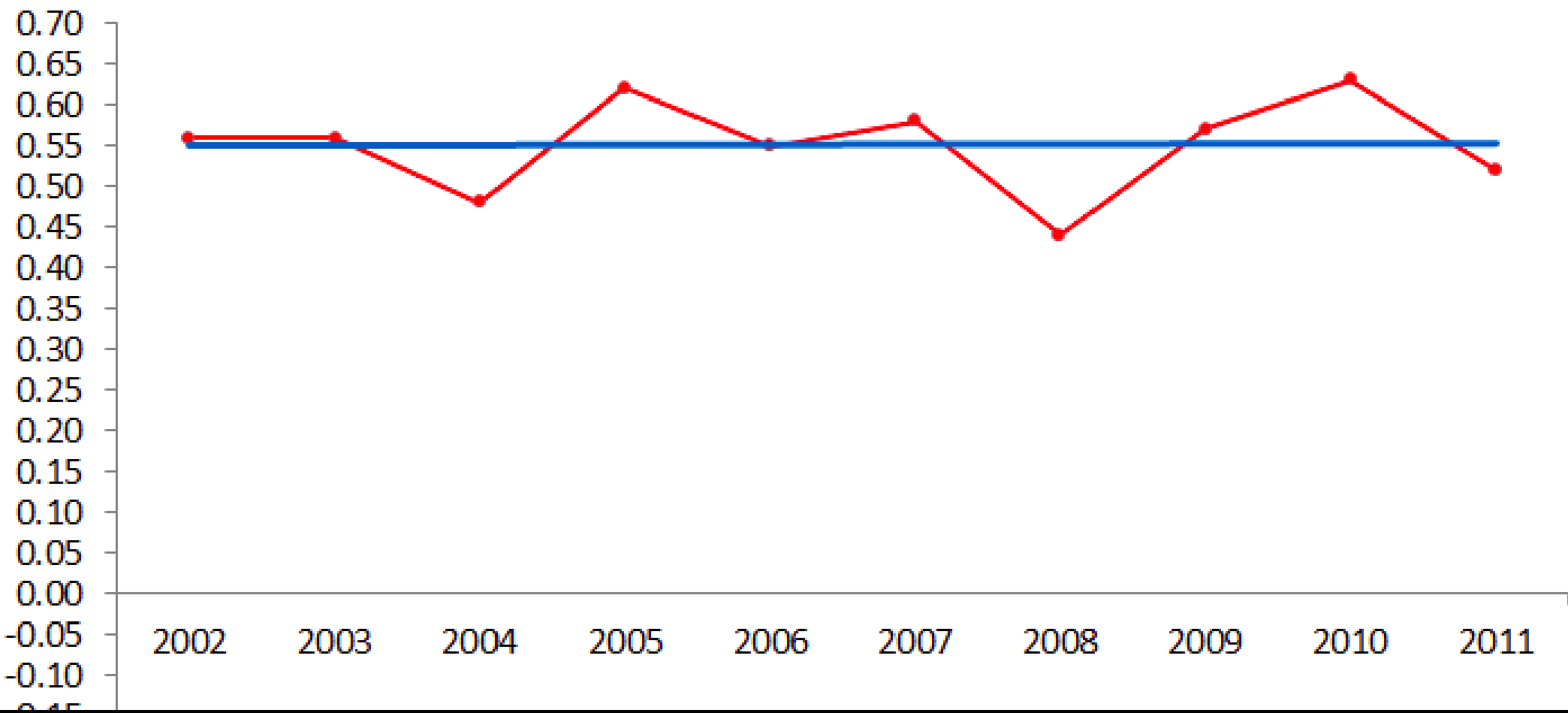
Kudlow: “In fact it’s been 15 years, if I’m not mistaken, that temperatures are on the rise <muttering to correct himself> are falling rather than rising. The predictions are all wrong.”

Hayward: “... 5 years ago, Al Gore said that we might have an ice free arctic ocean by now. He actually mentioned 2013. We have just seen one of the largest rebounds of arctic ice in the last 15 years.”

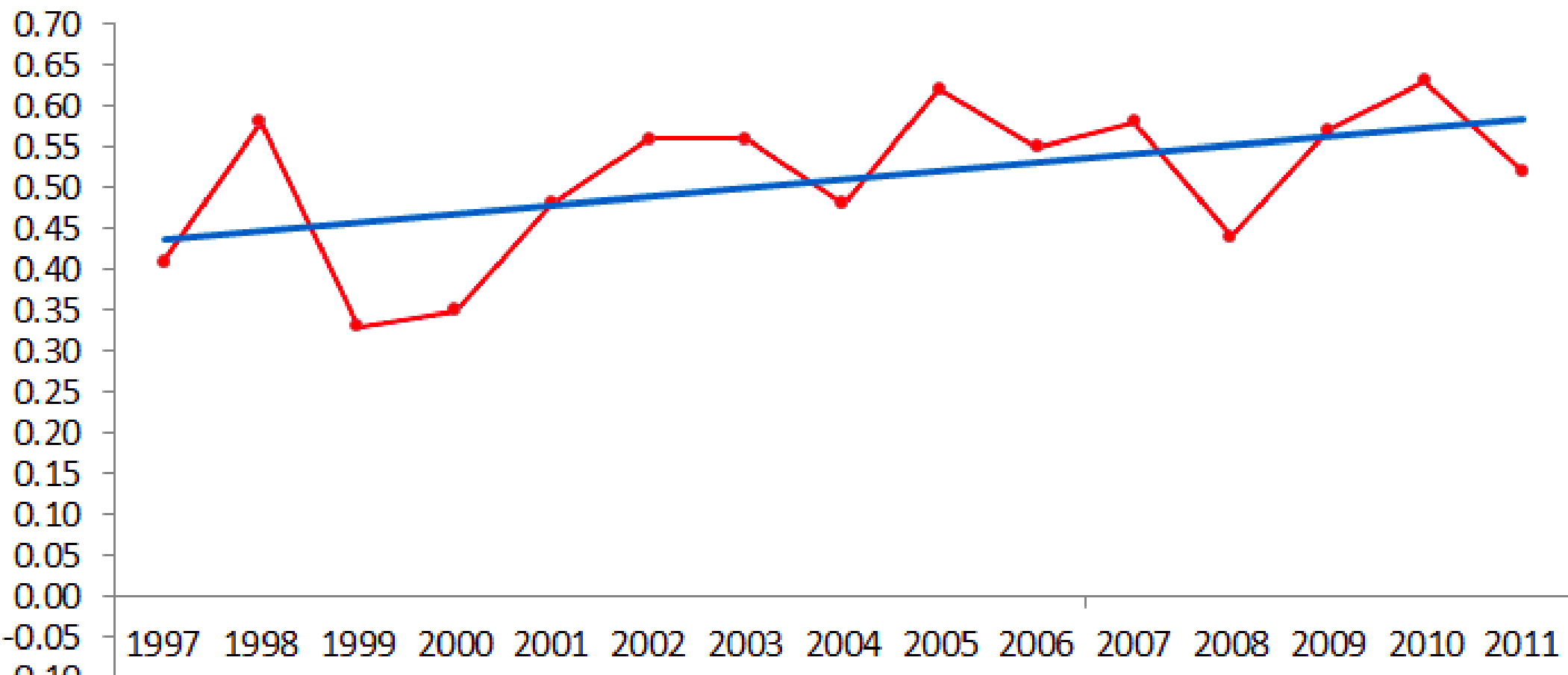
Global Temperature Anomalies from 20th Century Average 2007 to 2011 (degrees C)



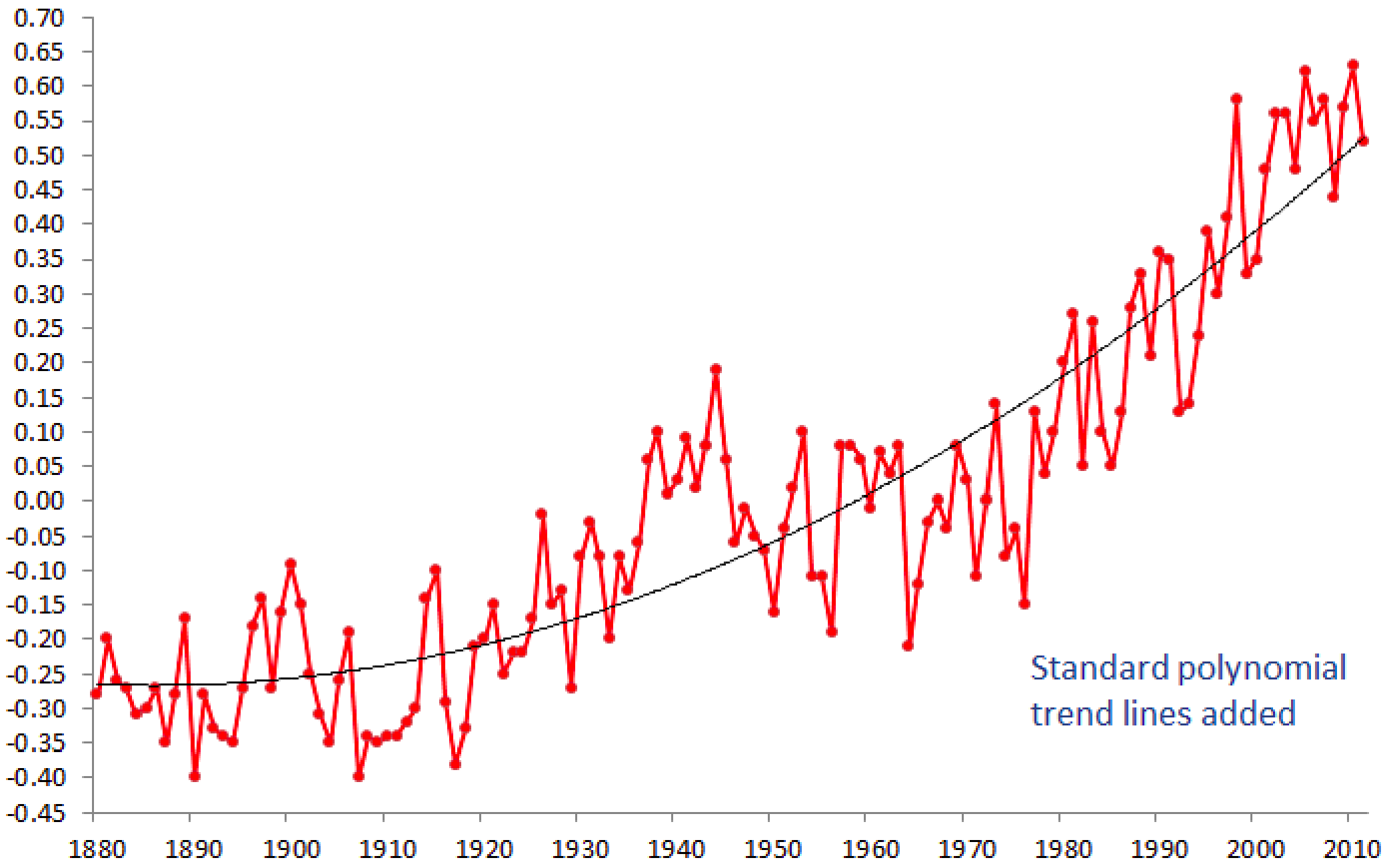
Global Temperature Anomalies from 20th Century Average. Past decade (degrees C)



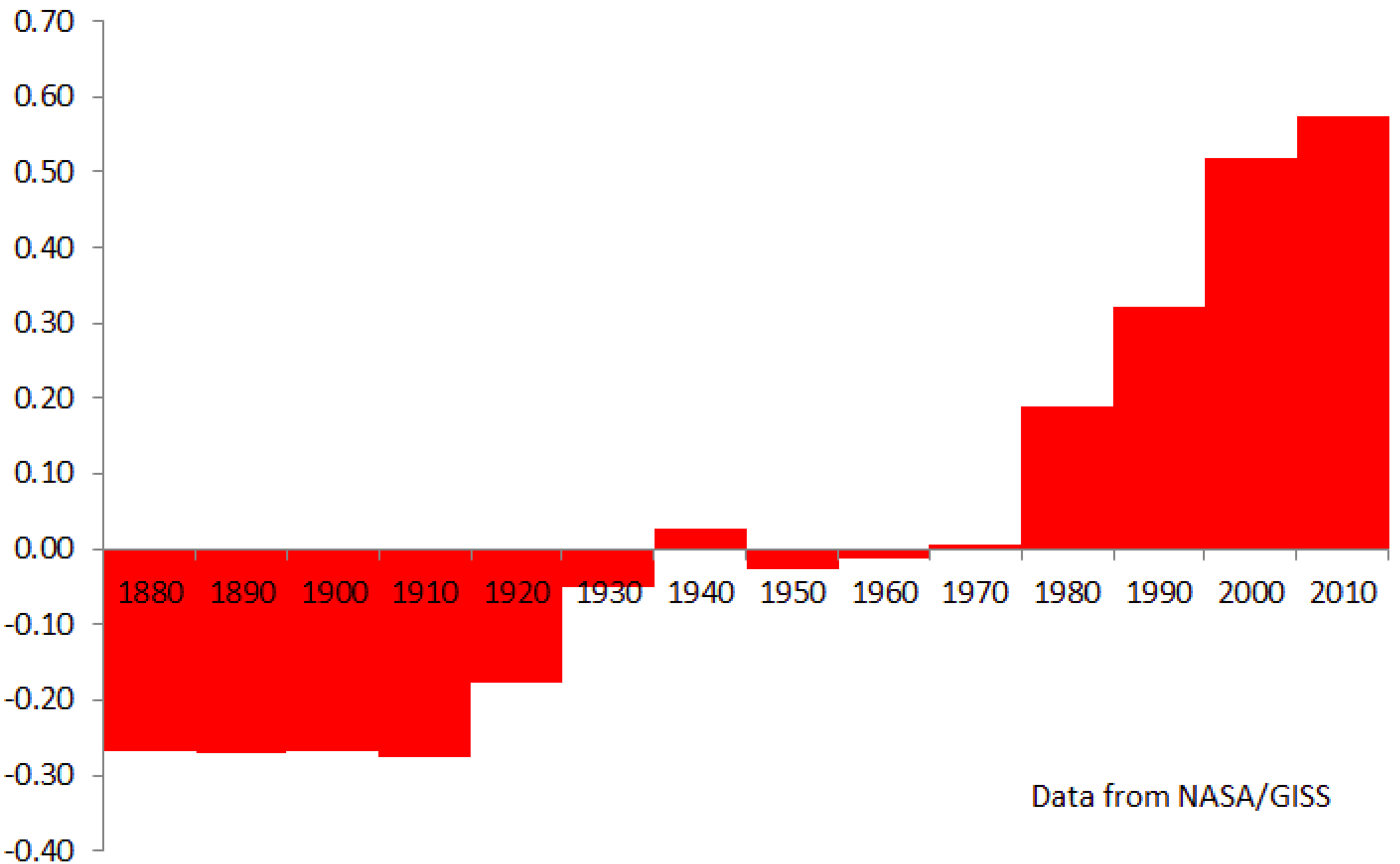
Global Temperature Anomalies from 20th Century Average. Last 15 Years (degrees C)



Global Surface Temperature Changes from the 20th Century Average (degrees C)



Decadal Average Deviations of Global Temperatures from 20th Century Average

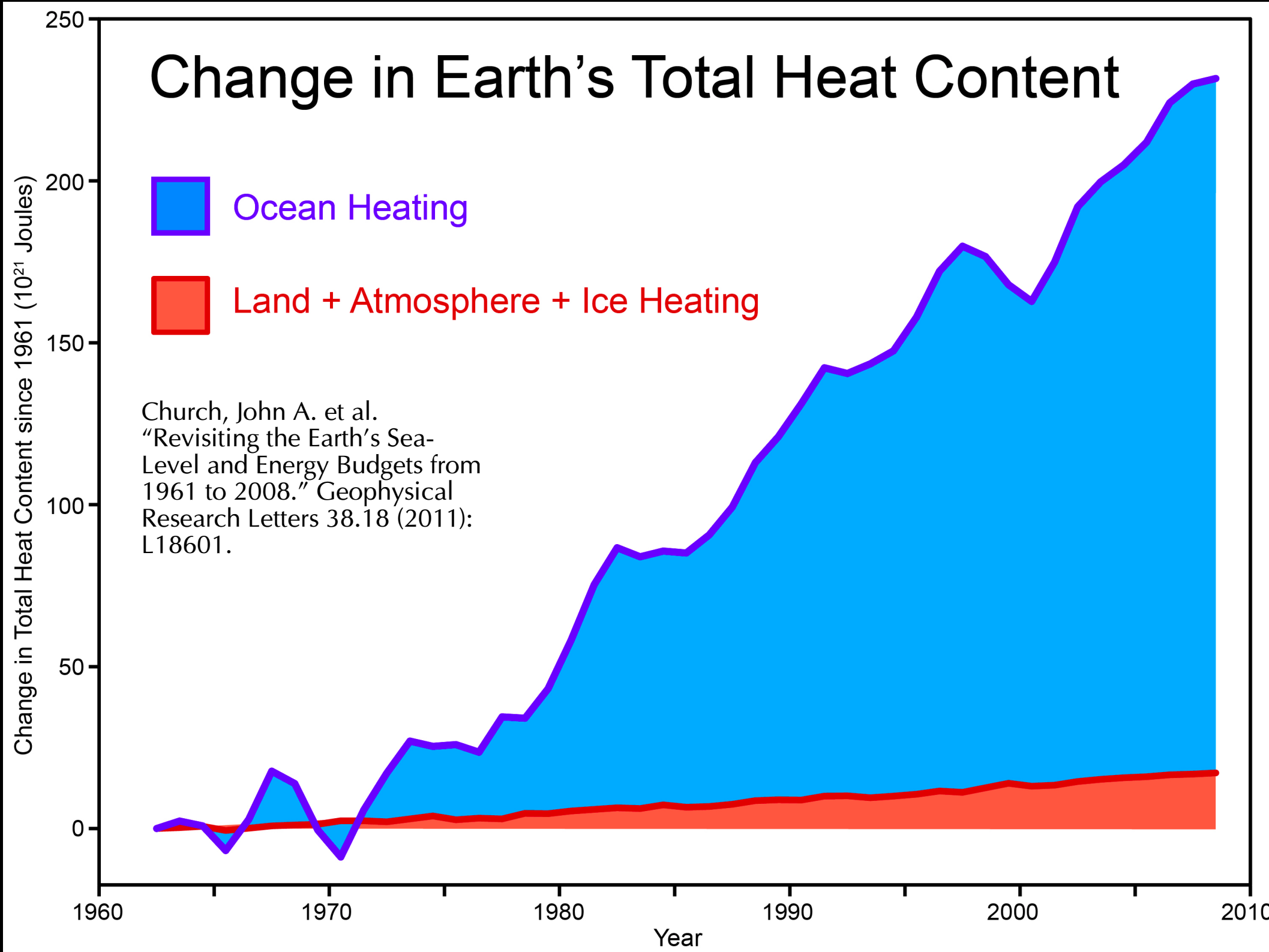


Change in Earth's Total Heat Content

 Ocean Heating

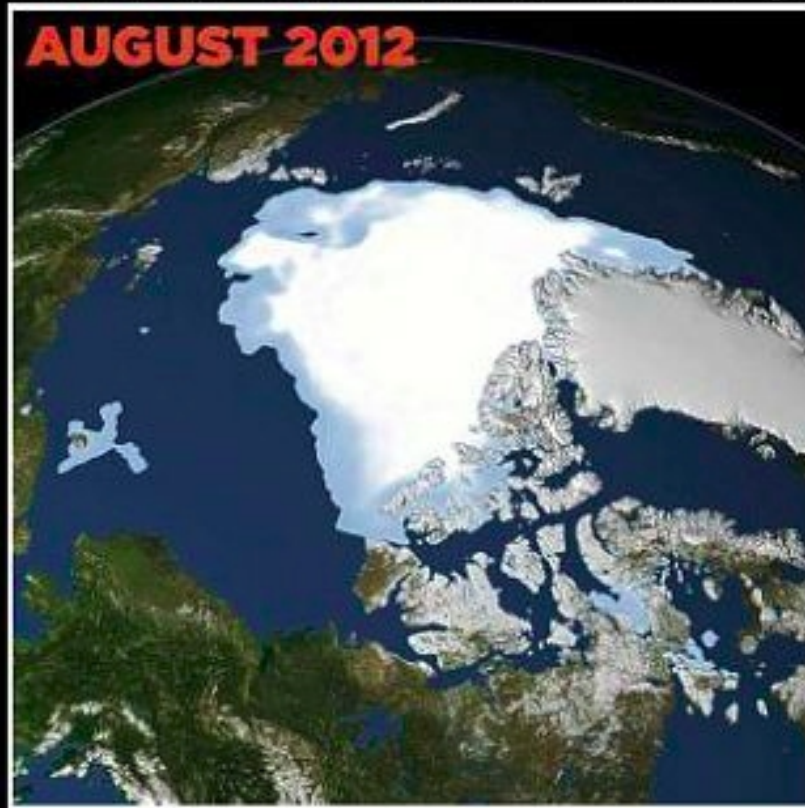
 Land + Atmosphere + Ice Heating

Church, John A. et al.
"Revisiting the Earth's Sea-Level and Energy Budgets from 1961 to 2008." Geophysical Research Letters 38.18 (2011): L18601.



The “Arctic Ice” claim of Hayward and others.

HOW ICE SHEET GREW 533,000 SQUARE MILES IN A YEAR



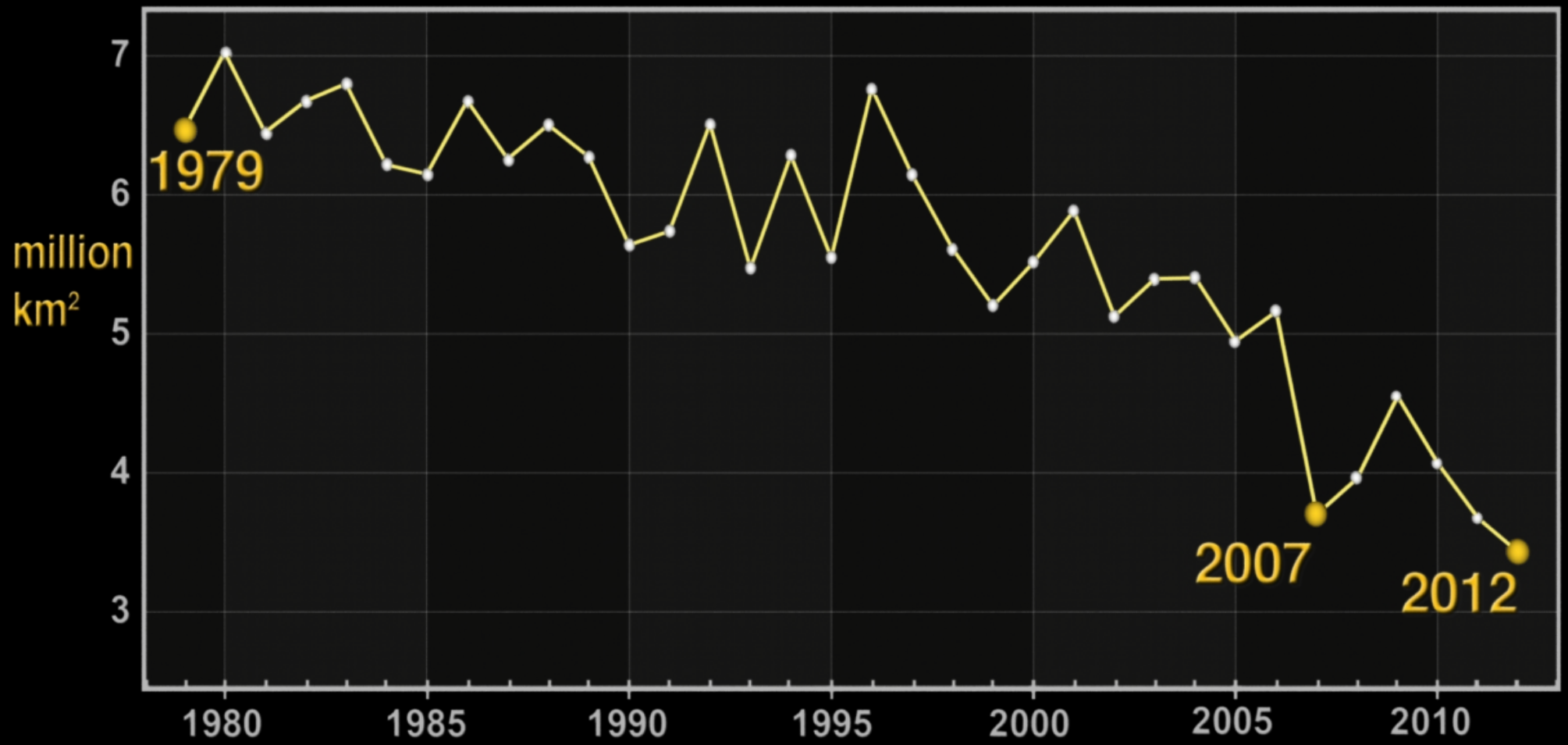
CONTRACTION: This Nasa satellite image shows the ice at the smallest extent on record, with much of the Arctic Ocean uncovered



RECOVERY: Contrary to predictions that the ice would have vanished by this summer, it has actually increased by 29 per cent from last year

<http://www.dailymail.co.uk/news/article-2415191/And-global-COOLING-Return-Arctic-ice-cap-grows-29-year.html>

Arctic Sea Ice Area



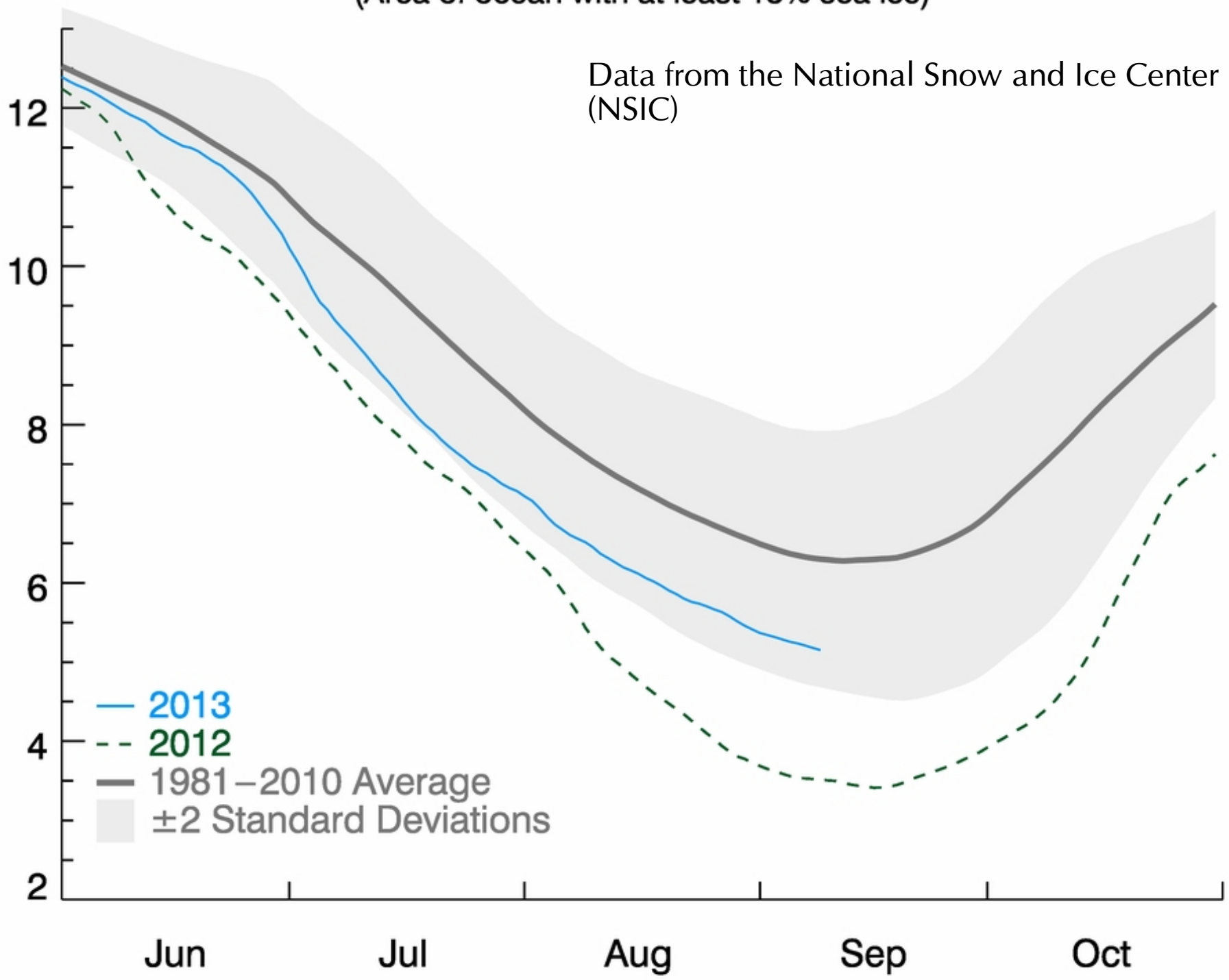
<http://svs.gsfc.nasa.gov/vis/a000000/a003900/a003991/index.html>

Arctic Sea Ice Extent

(Area of ocean with at least 15% sea ice)

Data from the National Snow and Ice Center (NSIC)

Extent (millions of square kilometers)



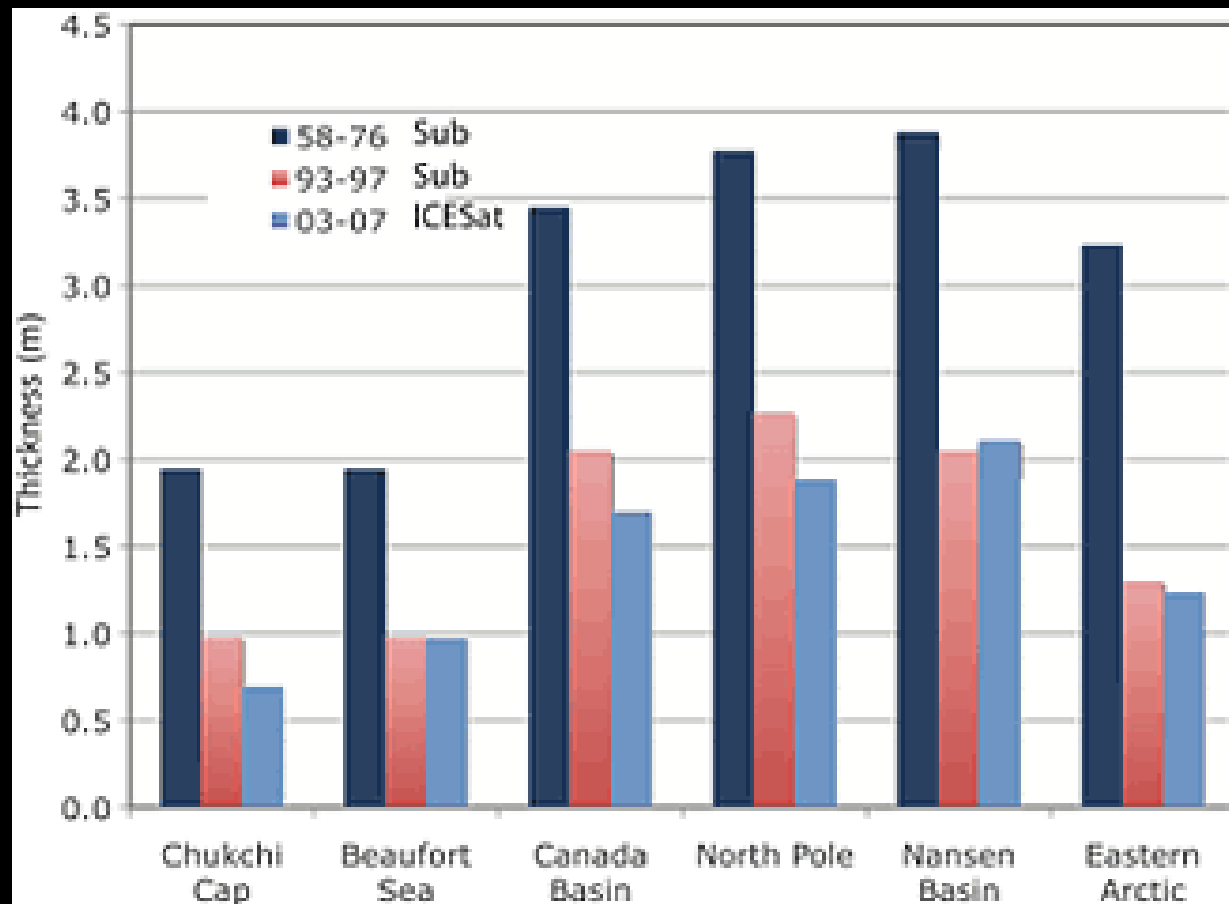
- 2013
- - - 2012
- 1981–2010 Average
- ±2 Standard Deviations

National Snow and Ice Data Center, Boulder CO

What are the lessons from the “Arctic Ice” Cherry-Picking Episode

- Misuse of the data came in several forms:
 - Cherry-picking 1 month to compare between two years
 - Cherry-picking 2 years to compare – we see that arctic sea ice area has large variations and those have to be accounted
 - neglecting uncertainty
 - Cherry-picking sea ice area – what about total sea ice volume (thickness plus area)?
 - that turns out to be a much more useful statistic to assess sea ice changes, one ignored completely in this whole discussion.

Kwok, R., and D. A. Rothrock. "Decline in Arctic Sea Ice Thickness from Submarine and ICESat Records: 1958–2008." *Geophysical Research Letters* 36.15 (2009): L15501.



This illustrates how you have to step back and think very carefully about the scope of the claim. Comparing sea ice areas for two months in two neighboring years misses most of the picture, in both time AND space.

CERTAINTY AND UNCERTAINTY

Cast Doubt on the Science



Photo from Wikipedia

"... there is a great amount of uncertainty associated with climate science. These uncertainties undermine our ability to accurately determine how carbon dioxide has affected the climate in the past. They also limit our understanding of how anthropogenic emissions will affect future warming trends."

Rep. Lamar Smith (R-TX). "Overheated rhetoric on climate change doesn't make for good policies". Op-Ed. Washington Post. May 20, 2013.

Note: at the time, Rep. Smith was chairman of the House Committee on Science, Space, and Technology.

He's equating "uncertainty" with "unreliability" - those are not the same thing.

Cast Doubt on the Science



Photo from Wikipedia

*“... the **Equivocation** of uncertainty associated with the science. These uncertainties undermine our ability to accurately determine how carbon dioxide has affected the climate in the past. They also limit our understanding of how anthropogenic emissions will affect future warming trends.”*

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FALSE ANALOGY, AD HOMINEM
ATTACKS, AND IN GENERAL
TRYING TO DISCREDITING PEOPLE
AND THUS DISCREDIT THE
FINDINGS

Question the Scientists' Motives and Integrity

"Why is there so much passion about global warming, and why has the issue become so vexing that the American Physical Society, from which Dr. Giaever resigned a few months ago, refused the seemingly reasonable request by many of its members to remove the word "incontrovertible" from its description of a scientific issue? There are several reasons, but a good place to start is the old question "cui bono?" Or the modern update, "Follow the money."

Alarmism over climate is of great benefit to many, providing government funding for academic research and a reason for government bureaucracies to grow. Alarmism also offers an excuse for governments to raise taxes, taxpayer-funded subsidies for businesses that understand how to work the political system, and a lure for big donations to charitable foundations promising to save the planet. Lysenko and his team lived very well, and they fiercely defended their dogma and the privileges it brought them."

-- From an Op-Ed piece in the Wall Street Journal, printed in January, 2012 and signed by 16 scientists.

"The WSJ OpEd makes a lot of hay from having 16 scientists sign it, but of those only 4 are actually climate scientists. And that bragging right is crushed to dust when you find out that the WSJ turned down an article about the reality of global warming that was signed by 255 actual climate scientists."
-- Phil Plait, author of the "Bad Astronomy" blog hosted at Discover Magazine.

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Appeal to Authority

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Red Herring

Ad Hominem/
False Analogy

"The WSJ Op-Ed makes a lot of hay from having 16 scientists sign it, but of those only 4 are actually climate scientists. And that bragging right is crushed to dust when you find out that the WSJ turned down an article about the reality of global warming that was signed by 16 actual climate scientists."
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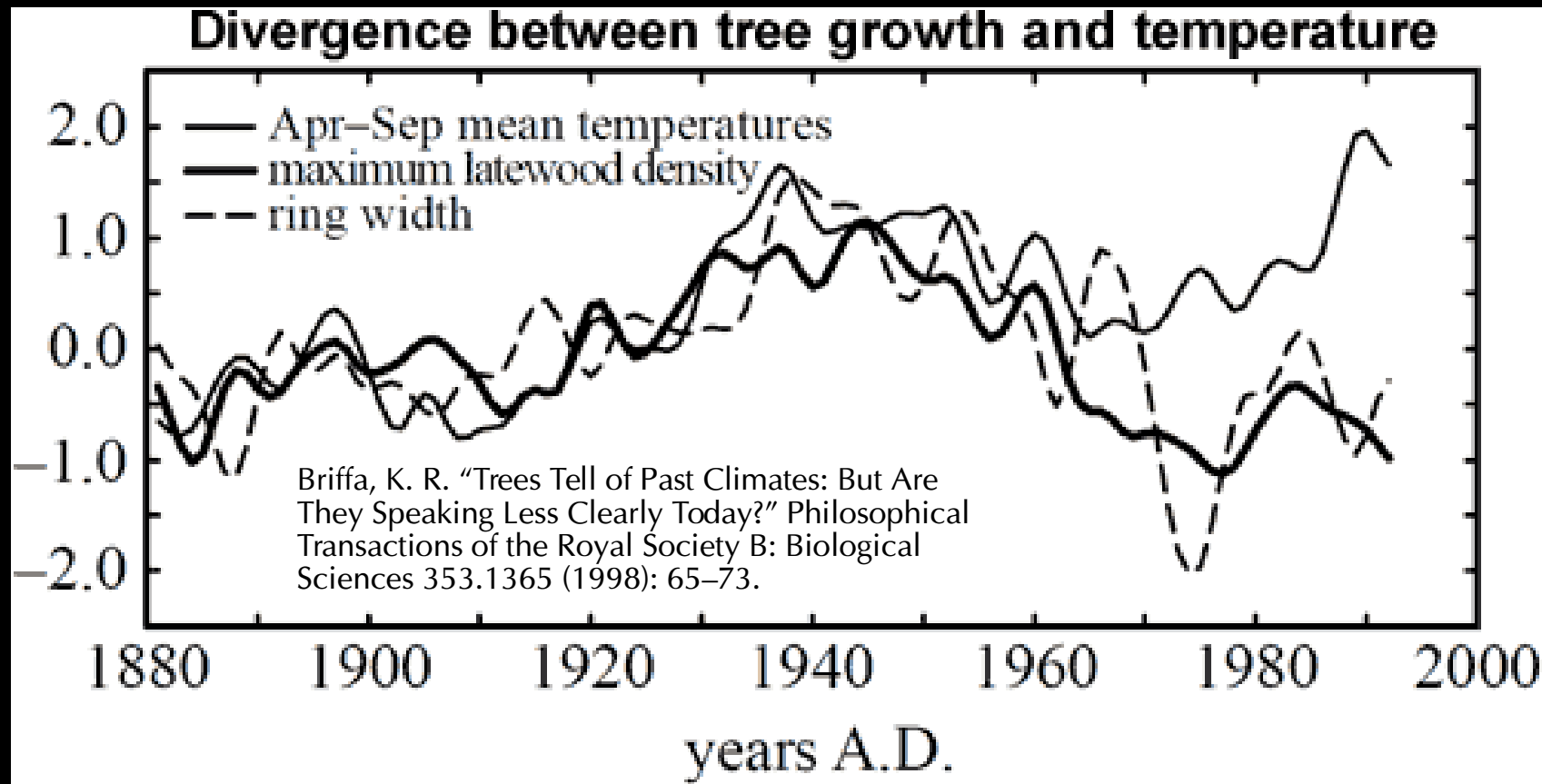
Stolen Emails and Cherry-Picking

- A famous theft of climate researcher emails occurred in Nov. 2009 from the Climate Research Unit of the University of East Anglia
 - somebody broke into the email system and stole 1,073 emails from 16 researchers spanning 13 years of correspondence with colleagues.
- Critics tried to use the disclosed emails to discredit some climate scientists
 - cherry-picked a few sentences out-of-context from >1000 mails to make it look like climate scientists had conspired to fake data

Email from Phil Jones

- “I’ve just completed Mike [Mann]’s Nature trick of adding in the real temps to each series for the last 20 years (ie from 1981 onwards) and from 1961 for Keith’s to hide the decline.”
- What do you infer from this sentence?

What was Jones actually talking about?

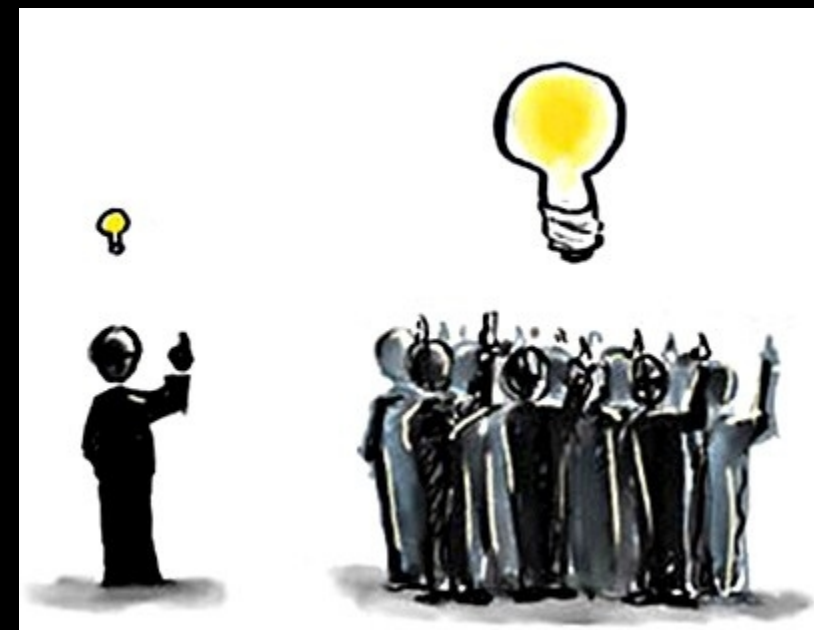


“The decline” refers to the declining tree ring thickness, diverging away from temperatures after 1960 (whereas before 1960 tree ring thickness was an excellent proxy for temperature). This has been publicly discussed since 1995, when the effect was first published.

What was the meaning?

- “The decline” is in reference to tree ring thickness diverging from temperature data, known since 1995 and published and publicly discussed
- “Mike’s Nature trick” refers to something else entirely, separate from the above.
 - the “trick (of the trade)” is to show actual temperature instrumental data where it’s available, to place recent trends in context with historical proxy data.
- These two phrases are often misquoted as referring to the same thing - “Mike’s trick to hide the decline” - and intentionally left vague and context-free to imply “decline in temperature.”

Cite only disagreements/amplify the small minority opinions



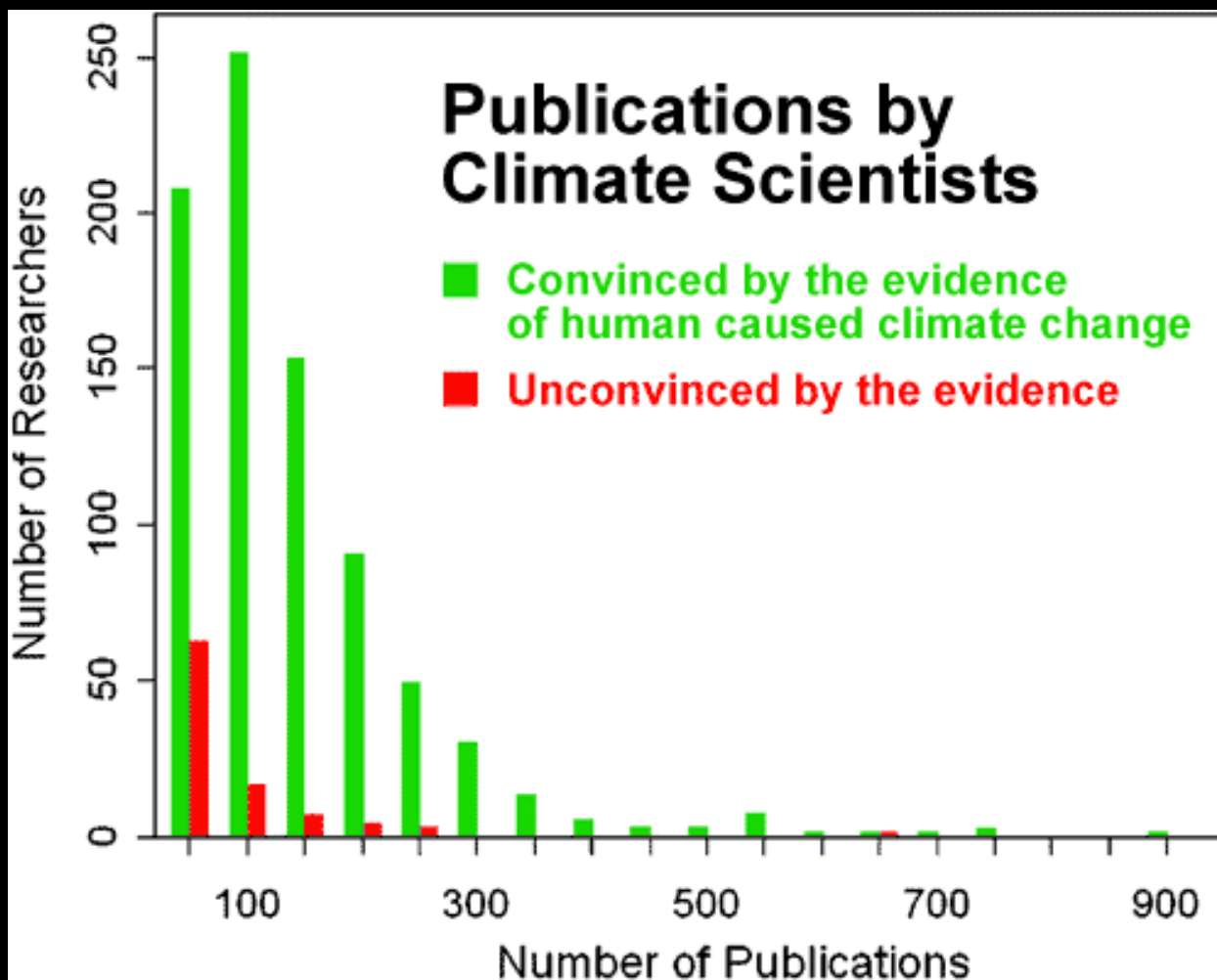
“Despite media claims to the contrary, the debate is not over. There is no consensus among scientists concerning global warming. While most appear to subscribe to the theory, thousands of others do not.”

-- From the “About” page of <http://noconsensus.org>

There are about 10.6 million science graduates with at least a B.S. degree since 1970-1971 [1]. “Thousands,” be that 2000 or 30000, represents only 0.1-1% of all such credentialed people. But that misses the point – what about practicing climate scientists?

[1] http://nces.ed.gov/programs/digest/d08/tables_3.asp#Ch3aSub4

Cite only disagreements/amplify the small minority opinions



Survey of actively publishing climate scientists – 97-98% of them are convinced by the evidence that climate change is happening and caused by human activity. This is one of a few detailed studies of this issue that all find the same conclusions.

Publication: *“Expert credibility in climate change.”* Anderegg, William R. L., Prall, James W., Harold, Jacob, and Schneider, Stephen H. *Proceedings of the National Academy of Sciences*. 2010.

Project Steve



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for Science Education
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Project Steve

October 17th, 2008



NCSE's "Project Steve" is a tongue-in-cheek parody of a long-standing creationist tradition of amassing lists of "scientists who doubt evolution" or "scientists who dissent from Darwinism."

Creationists draw up these lists to try to convince the public that evolution is somehow being rejected by scientists, that it is a "theory in crisis." Not everyone realizes that this claim is unfounded. NCSE has been asked numerous times to compile a list of thousands of scientists affirming the validity of the theory of evolution. Although we easily could have done so, we have resisted. We did not wish to mislead the public into thinking that scientific issues are decided by who has the longer list of scientists!

Project Steve pokes fun at this practice and, because "Steves" are only about 1% of scientists, it also makes the point that tens of thousands of scientists support evolution. And it honors the late Stephen Jay Gould, evolutionary biologist, NCSE supporter, and friend.

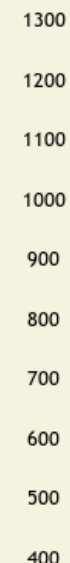
We'd like to think that after Project Steve, we'll have seen the last of bogus "scientists doubting evolution" lists, but it's probably too much to ask. We hope that when such lists are proposed, reporters and other citizens will ask, "How many

TOP LINKS

- [Talk Origins index of creationist claims](#)
- [Clergy Letter Project](#)

STEVE-O-METER

as of 9/18/12



Stephen J. Sekura - SMU

I am Steve #1211!

PROPAGANDA, POLITICS, VALUES, AND OTHER ISSUES USED TO CLOUD THE SCIENCE



Ted Kaczynski
The Unabomber

**I still believe in
Global Warming.
Do you?**

www.heartland.org



**I still believe in
Global Warming.
Do you?**

Ted Kaczynski
The Unabomber

www.heartland.org

“Billboards in Chicago paid for by The Heartland Institute point out that some of the world’s most notorious criminals say they ‘still believe in global warming’ — and ask viewers if they do, too... The billboard series features Ted Kaczynski, the infamous Unabomber; Charles Manson, a mass murderer; and Fidel Castro, a tyrant. ... These rogues and villains were chosen because they made public statements about how man-made global warming is a crisis and how mankind must take immediate and drastic actions to stop it.”

-- The Heartland Institute press release. It’s been disappeared from the Heartland Institute’s website, but you can still find the page on the Internet Archive Wayback Machine.

<https://web.archive.org/web/20120503233315/http://climateconference.heartland.org/our-billboards/>

Exaggerate the potential harm

“The U.S. Environmental Protection Agency (EPA) seems to be on a drunken binge to impose increasingly *economy-killing regulations* to reduce CO2 emissions. These new regulations are based on flimsy pseudoscience and what amounts to religious tenants of faith that humans are destroying mother earth. Nonetheless, the EPA claims that current air and water emissions endanger human health. The most ridiculous of these assertions is carbon dioxide (CO2) emissions.”

-- Michael S. Coffman, August 12, 2012
(emphasis is mine)



His Ph.D. is in forest science from the Univ. of Idaho at Moscow (<http://www.uidaho.edu/cnr/frfs>). He has no formal training in economics, physics, or chemistry.

This person is equivocating a political issue with a scientific issue.

Appeal to personal freedom

“Democrats have another energy problem, namely bipartisan opposition to a proposed average Fuel Economy Standard of 35 miles per gallon by 2020, a 40 percent increase over current rules. The auto industry calls this unrealistic. Its new radio ad campaign, which can be heard at the website DriveCongress.com, features a so-called SUV mom fretting about Congress forcing her to drive a smaller car.”

-- From “Special Report with Brit Hume,” June 19, 2007. Reported by Major Garrett, a Fox News Correspondent, during the segment.

<http://www.foxnews.com/story/0,2933,285113,00.html#ixzz26xJwae34>



Argue that acceptance would invalidate a philosophical tenet



“Well actually the Genesis 8:22 that I use in there is that ‘as long as the earth remains there will be springtime and harvest, cold and heat, winter and summer, day and night.’ My point is, God’s still up there. The arrogance of people to think that we, human beings, would be able to change what He is doing in the climate is to me outrageous.”

-- Senator James Inhofe, in an interview with Vic Eliason of Christian Youth America. March 7, 2012.

Senator James Inhofe (R-OK) is a key, outspoken denier of the scientific evidence for human-induced climate disruption.

This person is equating a religious issue with a scientific issue.

Separating the Issues

- What does the science tell us?
 - past and present climate changes, as well as their causes.
 - the range of possible outcomes of climate change – ocean level rise, weather pattern changes, etc.
- What issues are people fighting about when they talk about “controversy in climate science”
 - political controversy - “Republican v. Democrat”
 - values controversy - “Personal Freedom vs. Public Responsibility”
 - religious controversy - “God would never let this happen” or “Humans don’t have the power to change what God created,” etc.
 - None of these have anything to do with the science

Other Ways to Frame the Non-Science Issues

- Political
 - there are likely both market-based and governance-based policies to deal with climate change – people only need the courage and creativity to find and pursue them. Science can inform both.
- Values
 - personal and public are both needed to deal with an issue this huge. No one person or nation can solve this problem. Science can inform all parts of any approach.
- Religious
 - it's not only about what can't happen, or what we are/are not capable of – cherry-picking one religious example: from a Christian perspective, there is an aspect of “stewardship of the world”. Other religions can offer similar, more positive views. The science can inform actions of responsibility and stewardship.

A Complex Issue, Clouded by Pseudoscience

- Climate science is complex, but well-understood
 - past climate changes are well-observed in the data
 - present climate changes are equally clear.
 - the causes of climate change are well-established – the outcomes of climate change require more efforts but plenty of reliable information is already available
- For a variety of reasons – values, politics, policy, religious – many have chosen to cloud the science
 - the reasons and methods are complex – you have to apply what you learn here in this course to find the reliable science and filter out the nonsense.

Future Lectures

- Up next – let's hear from practicing climate researchers:
 - Dr. Bonnie Jacobs – SMU Anthropology
 - how do we know what we know about climate?
 - Dr. Robert Gregory – SMU Geology
 - “carbon chemistry” - how do we know that human activity is responsible?