

# Uncertainty about Future Climates

EES 2110

Introduction to Climate Change

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# What is the Scientific Consensus?

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- Is there a consensus?
- If there is, should we trust it?

# What is the Scientific Consensus?

- Is it important whether most scientists agree or not?
- What if some scientists disagree?
- Do most scientists agree?
  - Careful reviews of scientific literature find 95% of scientists publishing about climate change believe planet is warming because of human activity.

# Skeptics in Wall Street Journal

## No Need to Panic About Global Warming

*Editor's Note: The following has been signed by the 16 scientists listed at the end of the article:*

A candidate for public office in any contemporary democracy may have to consider what, if anything, to do about "global warming." Candidates should understand that the oft-repeated claim that nearly all scientists demand that something dramatic be done to stop global warming is not true. In fact, a large and growing number of distinguished scientists and engineers do not agree that drastic actions on global warming are needed.

In September, Nobel Prize-winning physicist Ivar Giaever, a supporter of President Obama in the last election, publicly resigned from the American

There's no compelling scientific argument for drastic action to 'decarbonize' the world's economy.

Physical Society (APS) with a letter that begins: "I did not renew [my membership] because I cannot live with the [APS policy] statement: 'The evidence is incontrovertible: Global warming is occurring. If no mitigating actions are taken, significant disruptions in the Earth's physical and ecological systems, social systems, security and human health are likely to occur. We must reduce emissions of greenhouse gases beginning now.' In the APS it is OK to discuss whether the mass of the proton changes over time and how a multi-universe behaves, but the evidence of global warming is incontrovertible!"

In spite of a multidecade international campaign to enforce the message that increasing amounts of the "pollutant" carbon dioxide will destroy civilization, large numbers of scientists, many very prominent, share the opinions of Dr. Giaever. And the number of scientific "heretics" is growing with each passing year. The reason is a collection of stubborn scientific facts.

Perhaps the most inconvenient fact is the lack of global warming for well over 10 years now. This is known to the warming establishment, as one can see from the 2009

"Climategate" email of climate scientist Kevin Trenberth: "The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't." But the warming is only missing if one believes computer models where so-called feedbacks involving water vapor and clouds greatly amplify the small effect of CO<sub>2</sub>.

The lack of warming for more than a decade—indeed, the smaller-than-predicted warming over the 22 years since the U.N.'s Intergovernmental Panel on Climate Change (IPCC) began issuing projections—suggests that computer models have greatly exaggerated how much warming additional CO<sub>2</sub> can cause. Faced with this embarrassment, those promoting alarm have shifted their drumbeat from warming to weather extremes, to enable anything unusual that happens in our chaotic climate to be ascribed to CO<sub>2</sub>.

The fact is that CO<sub>2</sub> is not a pollutant. CO<sub>2</sub> is a colorless and odorless gas, exhaled at high concentrations by each of us, and a key component of the biosphere's life cycle. Plants do so much better with more CO<sub>2</sub> that greenhouse operators often increase the CO<sub>2</sub> concentrations by factors of three or four to get better growth. This is no surprise since plants and animals evolved when CO<sub>2</sub> concentrations were about 10 times larger than they are today. Better plant varieties, chemical fertilizers and agricultural management contributed to the great increase in agricultural yields of the past century, but part of the increase almost certainly came from additional CO<sub>2</sub> in the atmosphere.

Although the number of publicly dissenting scientists is growing, many young scientists furtively say that while they also have serious doubts about the global-warming message, they are afraid to speak up for fear of not being promoted—or worse. They have good reason to worry. In 2003, Dr. Chris de Freitas, the editor of the journal *Climate Research*, dared to publish a peer-reviewed article with the politically incorrect (but factually correct) conclusion that the recent warming is not unusual in the context of climate changes over the past thousand years. The international warming establishment quickly mounted a determined campaign to have Dr. de Freitas removed from his editorial



job and fired from his university position. Fortunately, Dr. de Freitas was able to keep his university job.

This is not the way science is supposed to work, but we have seen it before—for example, in the frightening period when Trofim Lysenko hijacked biology in the Soviet Union. Soviet biologists who revealed that they believed in genes, which Lysenko maintained were a bourgeois fiction, were fired from their jobs. Many were sent to the gulag and some were condemned to death.

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.

Speaking for many scientists and engineers who have looked carefully and independently at the science of climate, we have a message to any candidate for public office: There is no compelling scientific argument for drastic action to "decarbonize" the world's economy. Even if one accepts the inflated climate forecasts of the IPCC, aggressive greenhouse-gas control policies are not justified economically.

A recent study of a wide variety of policy options by Yale economist William Nordhaus showed that nearly the highest benefit-to-cost ratio is achieved for a policy that allows 50 more years of economic growth unimpeded by greenhouse gas controls. This would be especially beneficial to the less-developed parts of the world that would like to share some of the same advantages of material well-being, health and life expectancy that the fully devel-

oped parts of the world enjoy now. Many other policy responses would have a negative return on investment. And it is likely that more CO<sub>2</sub> and the modest warming that may come with it will be an overall benefit to the planet.

If elected officials feel compelled to "do something" about climate, we recommend supporting the excellent scientists who are increasing our understanding of climate with well-designed instruments on satellites, in the oceans and on land, and in the analysis of observational data. The better we understand climate, the better we can cope with its ever-changing nature, which has complicated human life throughout history. However, much of the huge private and government investment in climate is badly in need of critical review.

Every candidate should support rational measures to protect and improve our environment, but it makes no sense at all to back expensive programs that divert resources from real needs and are based on alarming but untenable claims of "incontrovertible" evidence.

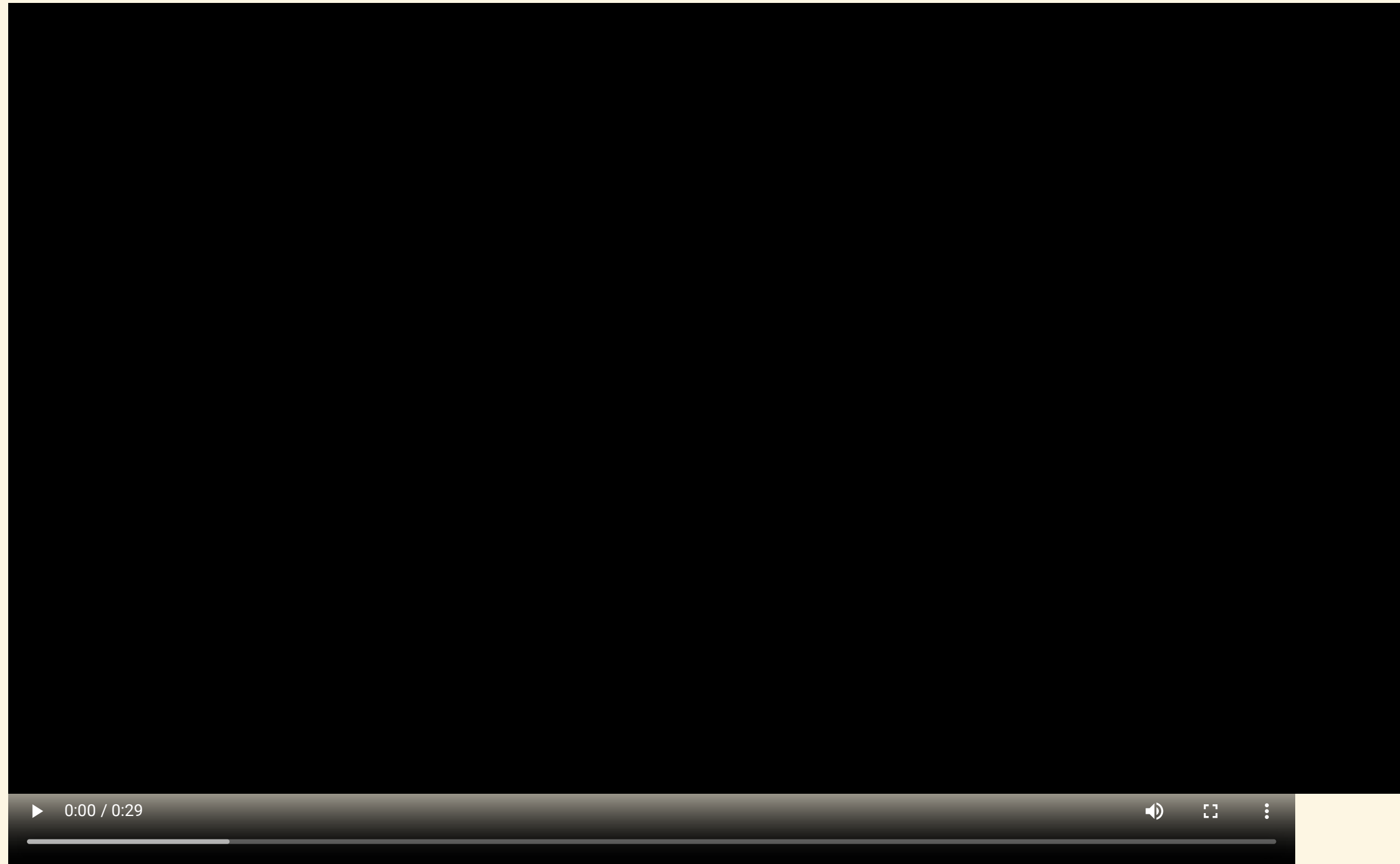
*Claude Allegre, former director of the Institute for the Study of the Earth, University of Paris; J. Scott Armstrong, cofounder of the Journal of Forecasting and the International Journal of Forecasting; Jan Breslow, head of the Laboratory of Biochemical Genetics and Metabolism, Rockefeller University; Roger Cohen, fellow, American Physical Society; Edward David, member, National Academy of Engineering and National Academy of Sciences; William Happer, professor of physics, Princeton; Michael Kelly, professor of technology, University of Cambridge, U.K.; William Kininmonth, former head of climate research at the Australian Bureau of Meteorology; Richard Lindzen, professor of atmospheric sciences, MIT; James McGrath, professor of chemistry, Virginia Technical University; Rodney Nichols, former president and CEO of the New York Academy of Sciences; Burt Rutan, aerospace engineer, designer of Voyager and SpaceShipOne; Harrison H. Schmitt, Apollo 17 astronaut and former U.S. senator; Nir Shaviv, professor of astrophysics, Hebrew University, Jerusalem; Henk Tennekes, former director, Royal Dutch Meteorological Service; Antonio Zichichi, president of the World Federation of Scientists, Geneva.*

# Skeptics in the Wall Street Journal

- Four Arguments:
  1. The planet isn't warming and hasn't been for 10 years
  2. Climate models are wrong about warming
  3. CO<sub>2</sub> is not a pollutant
    - Irrelevant quibble about the definition of "pollutant"
  4. Even if global warming is real, it won't hurt our economy or quality of life

Did Warming Stop?

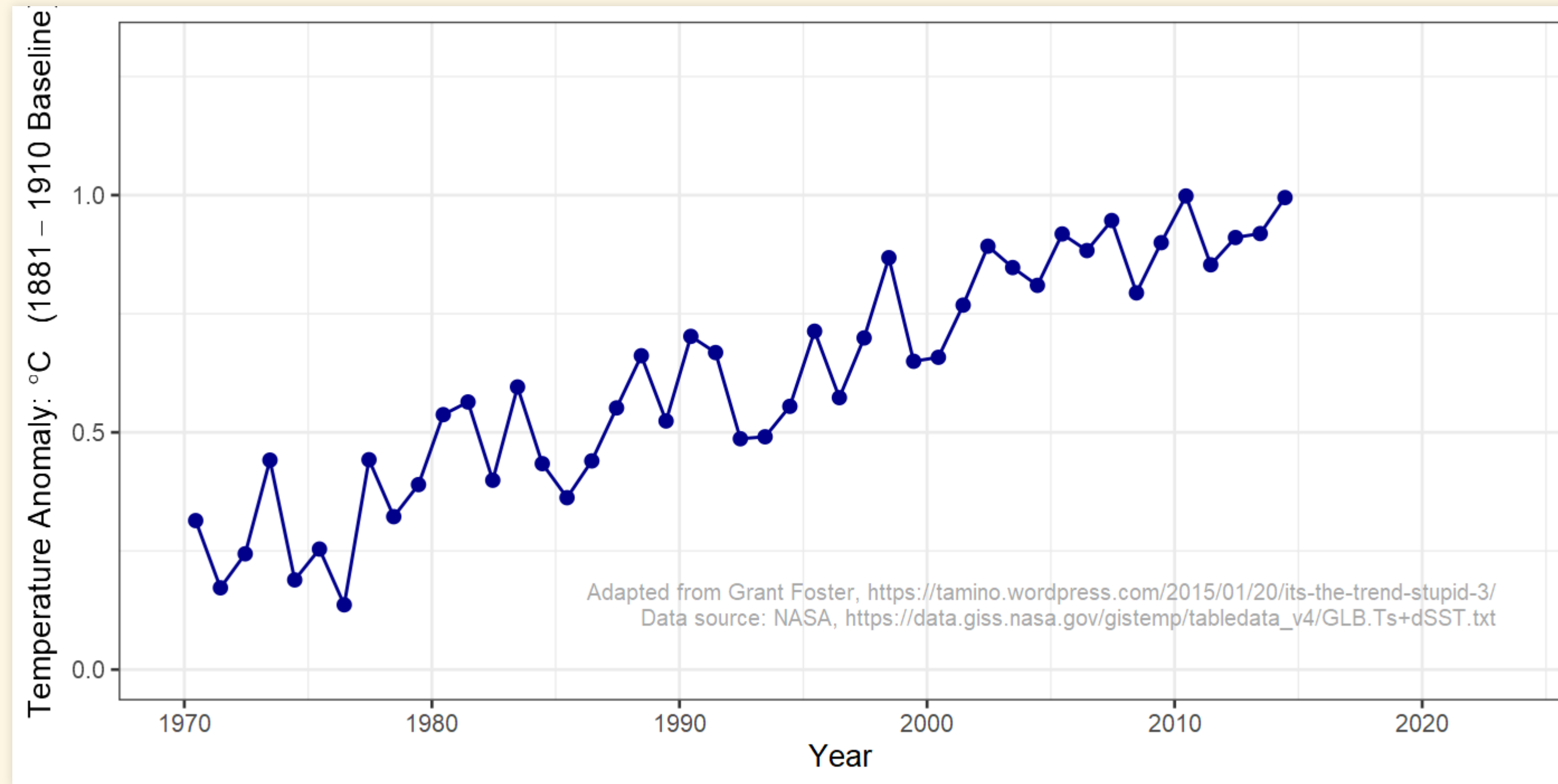
# Did Warming Stop?



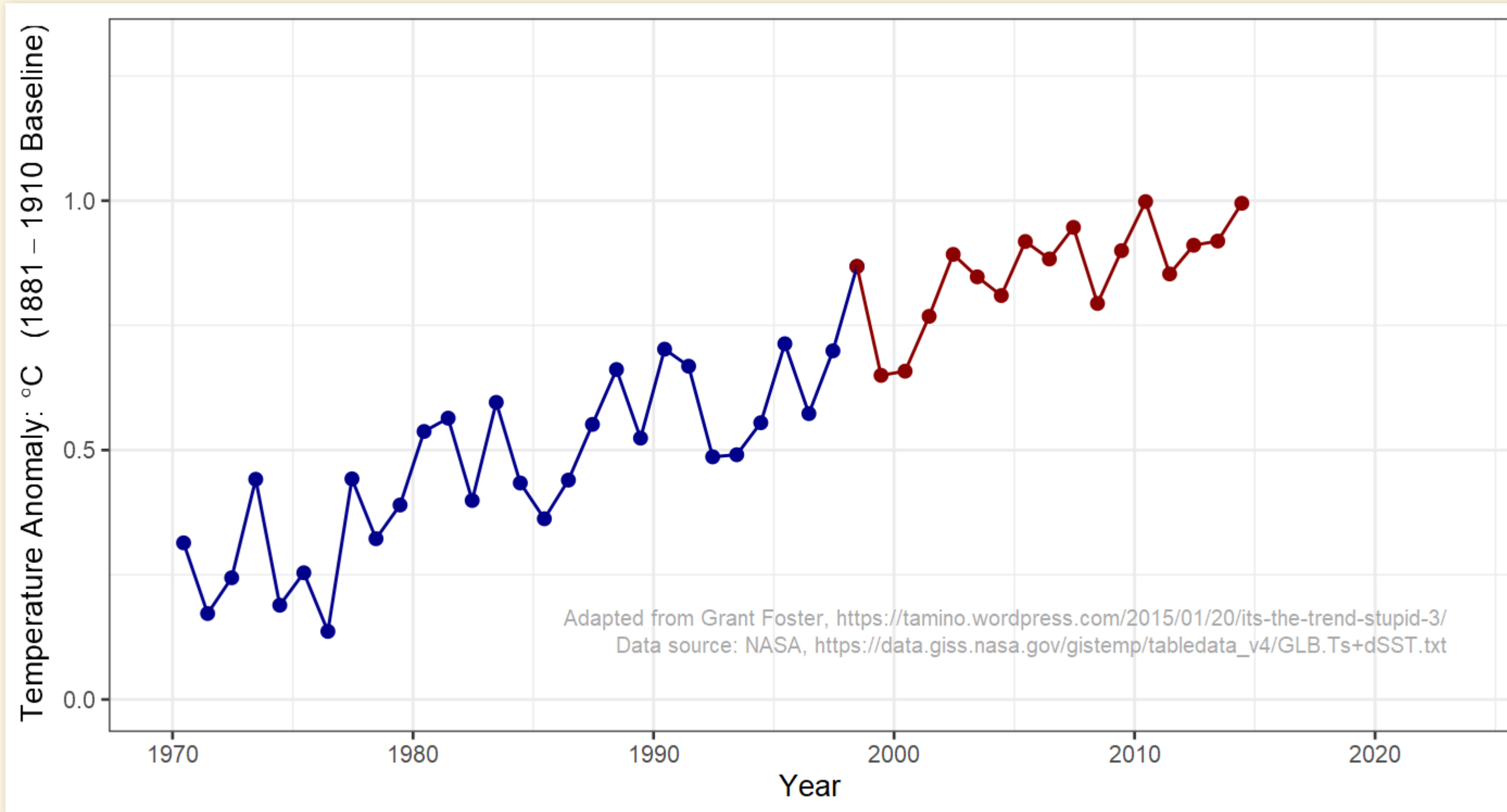


# Did temperatures stop rising 18 years ago?

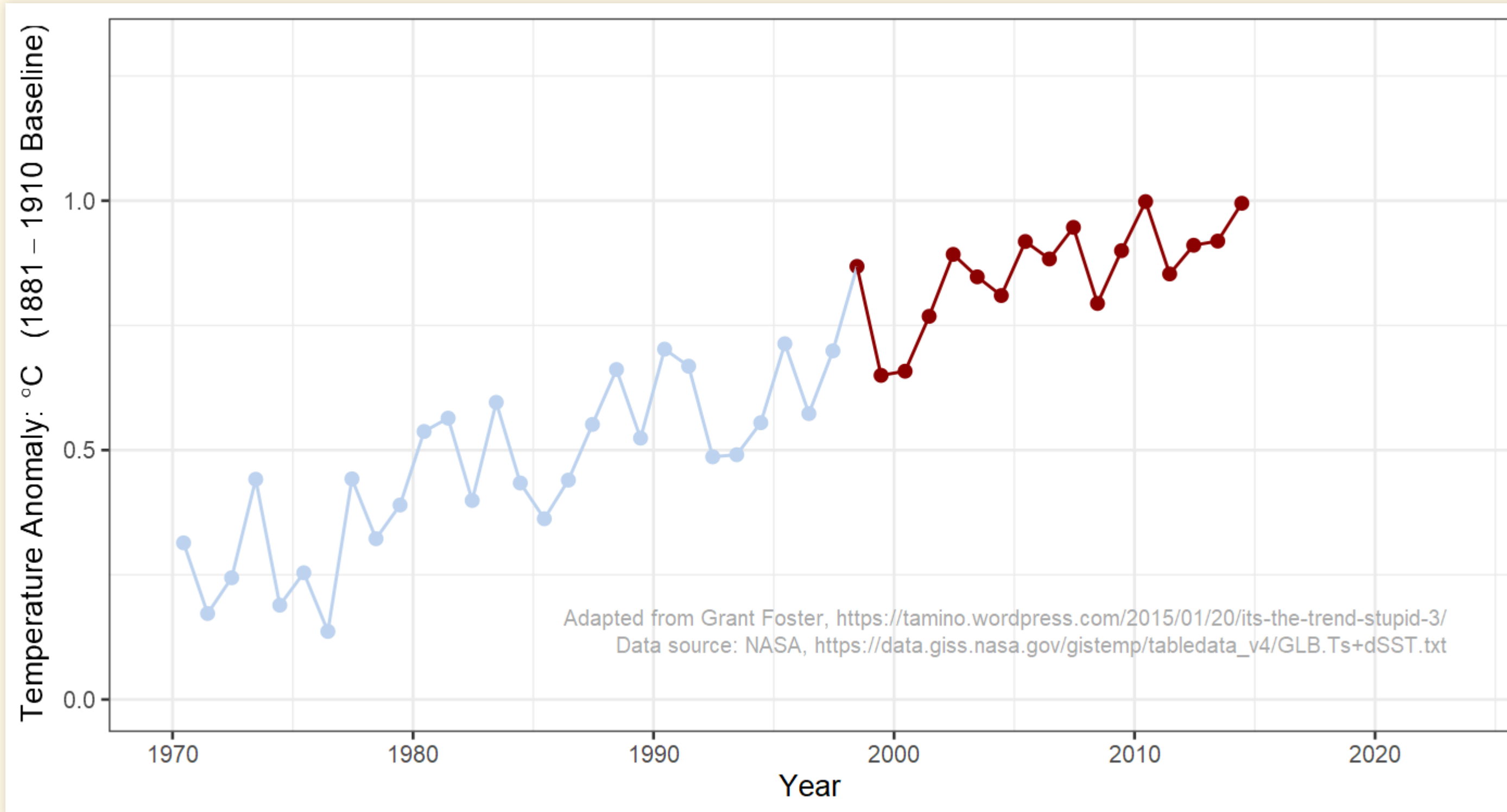
## Look at 1970–2014



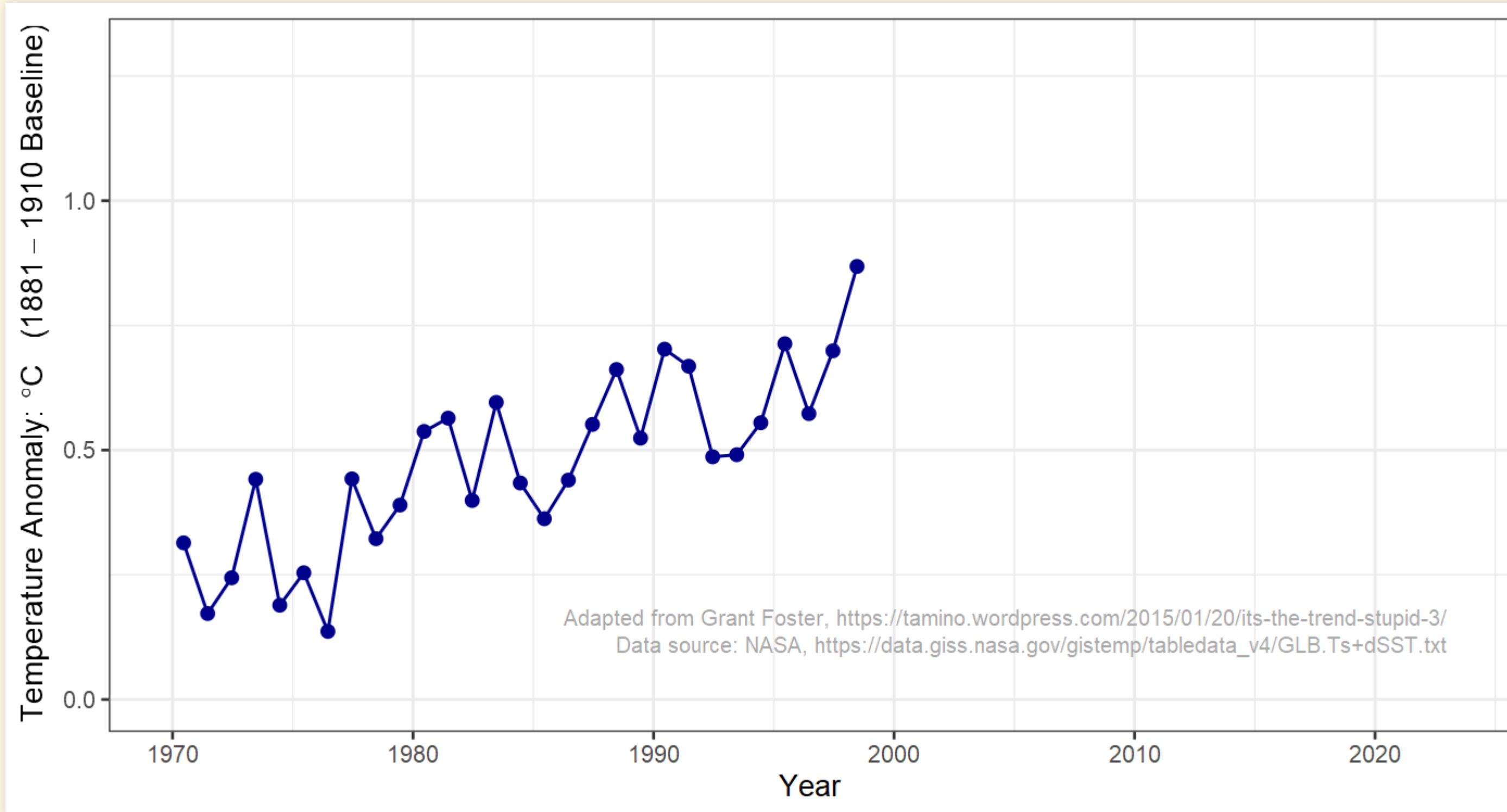
# Did temperatures stop rising?



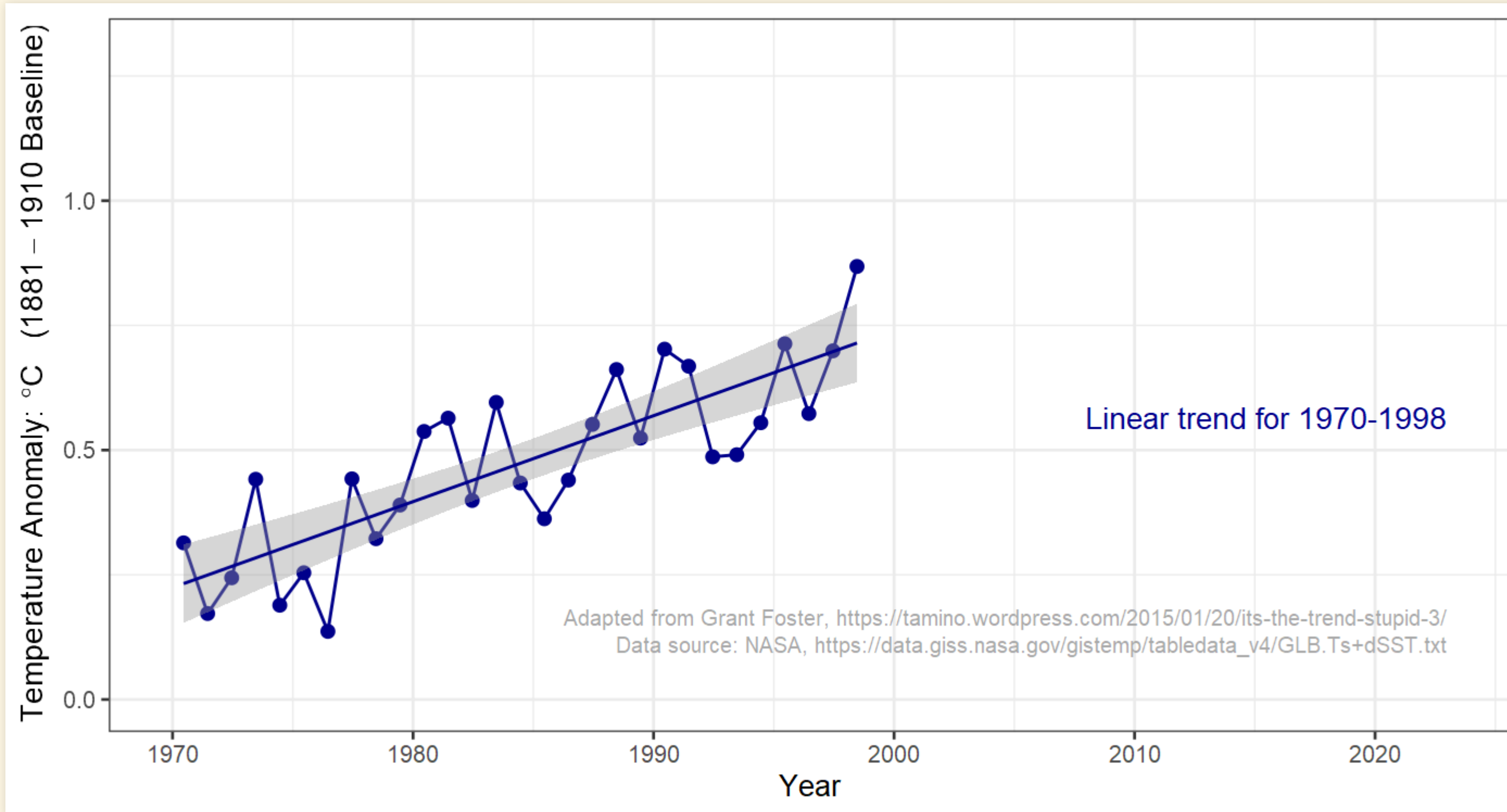
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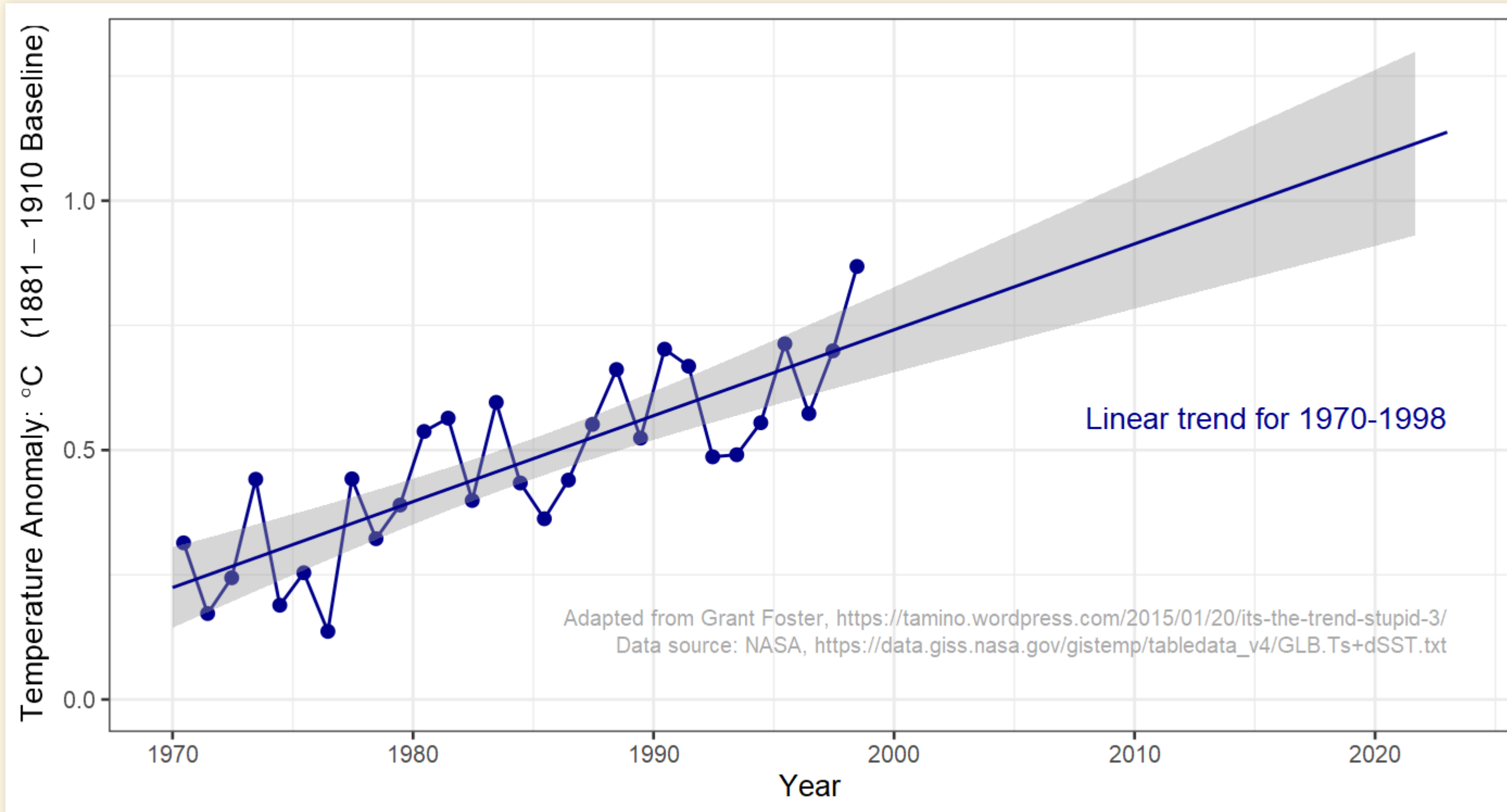
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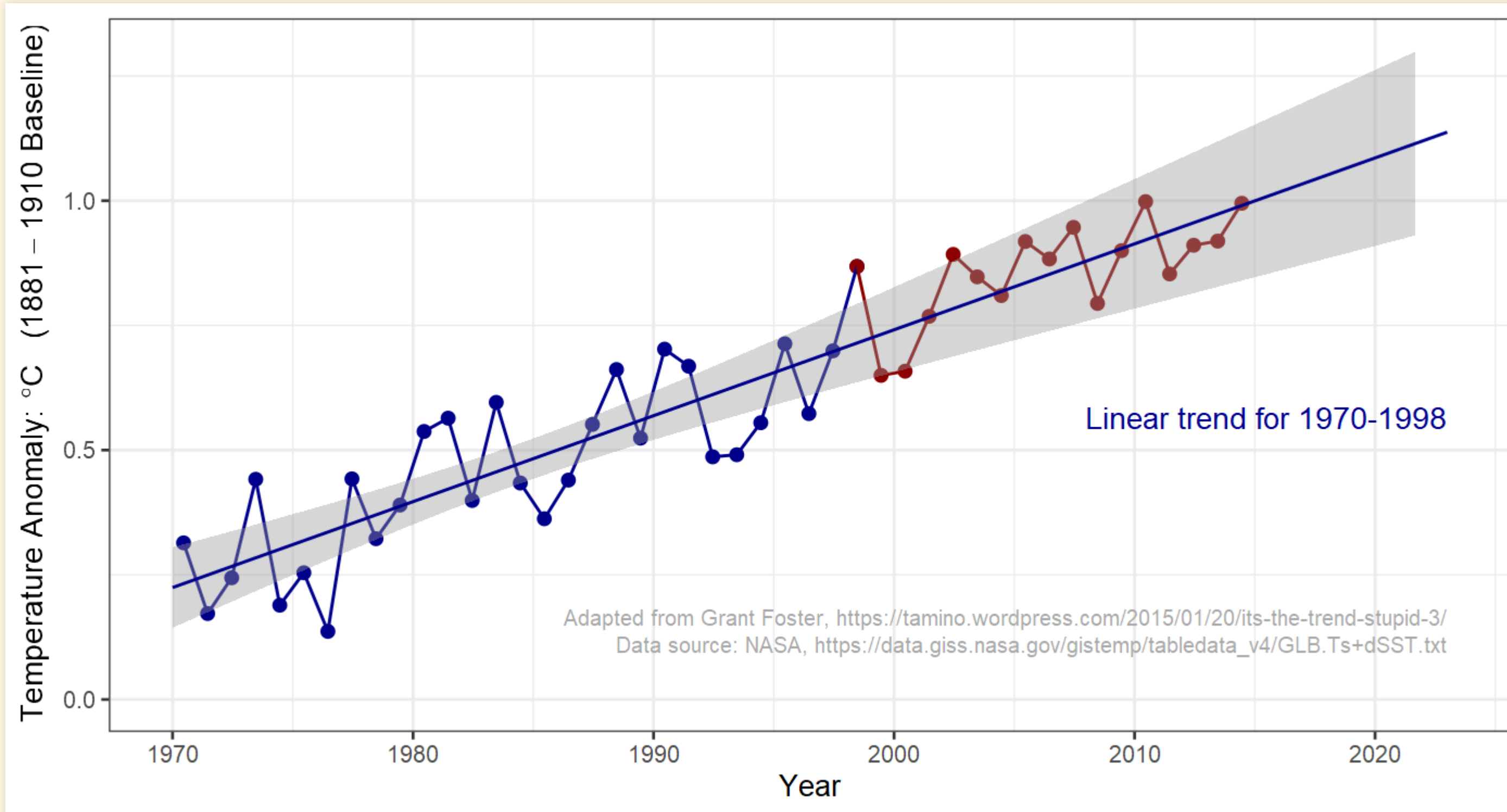
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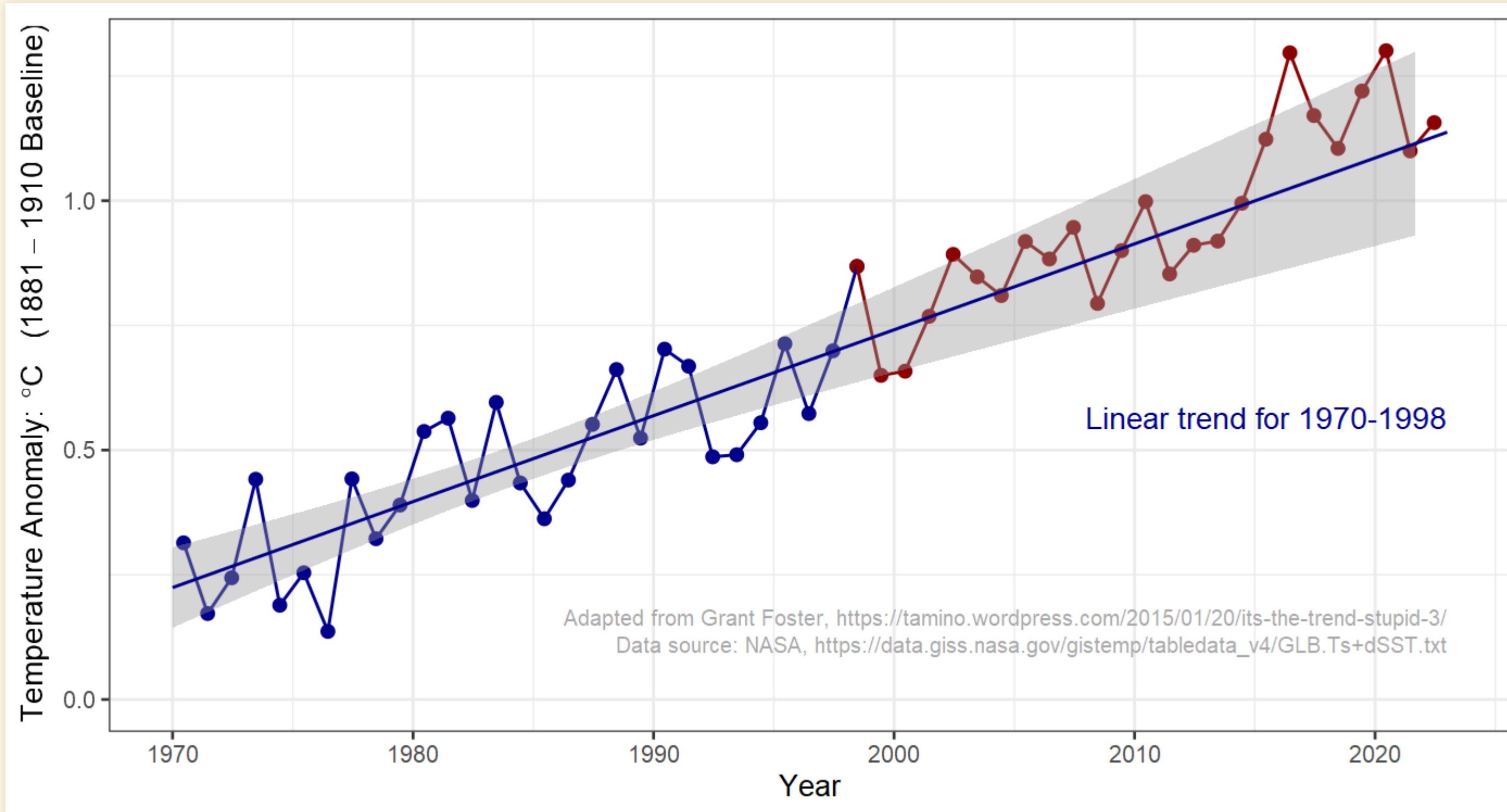
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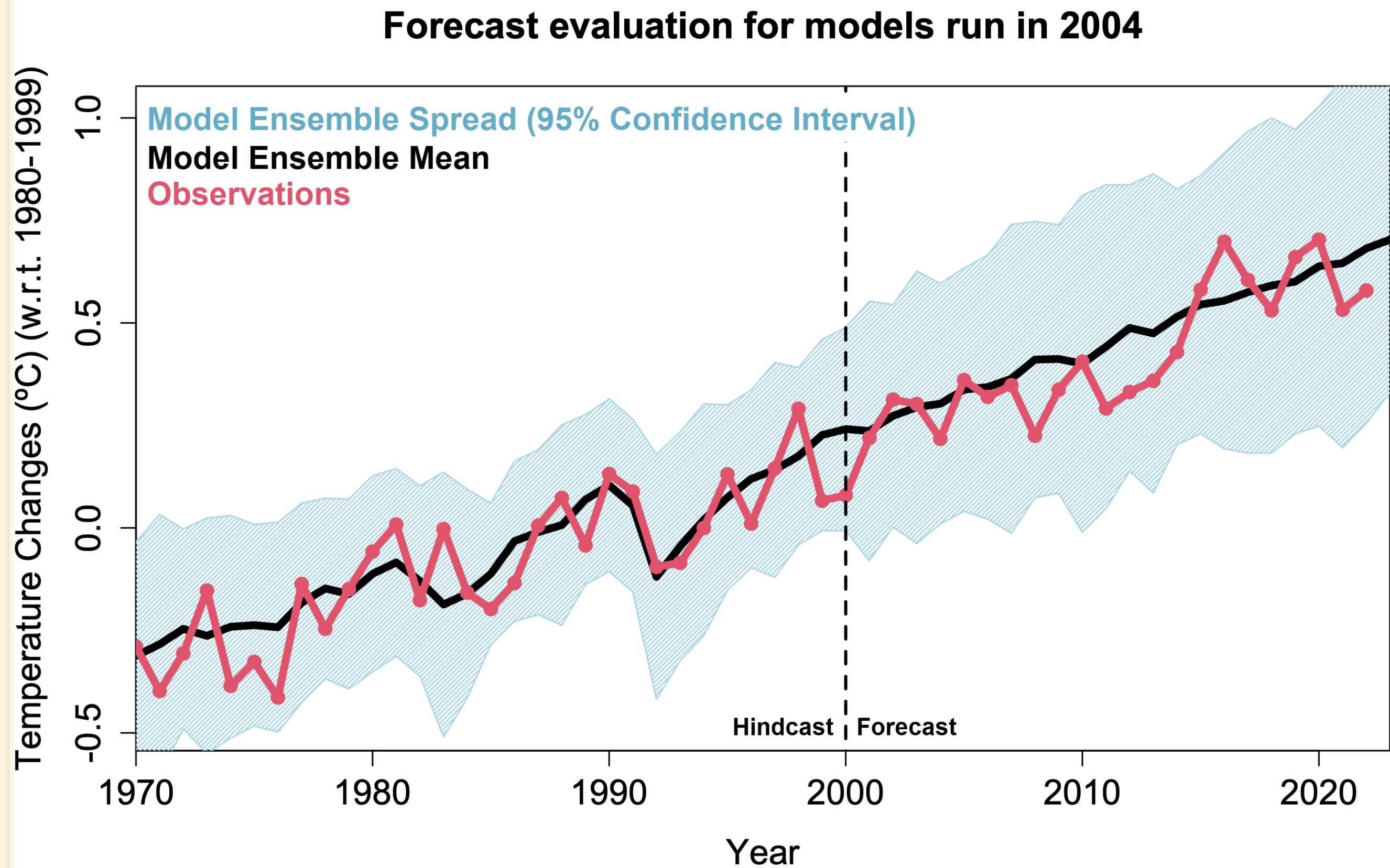
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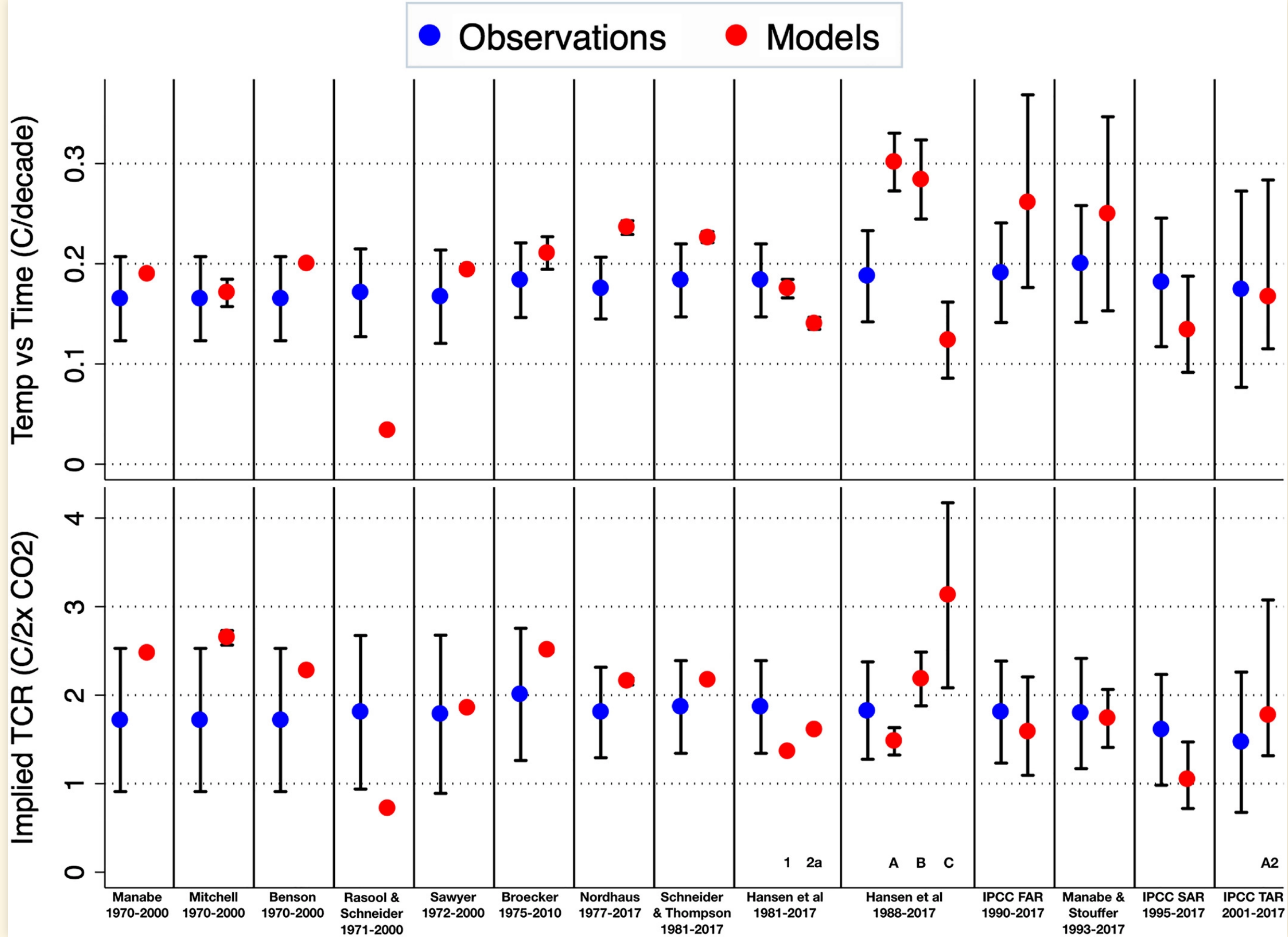


# Can We Trust Climate Models

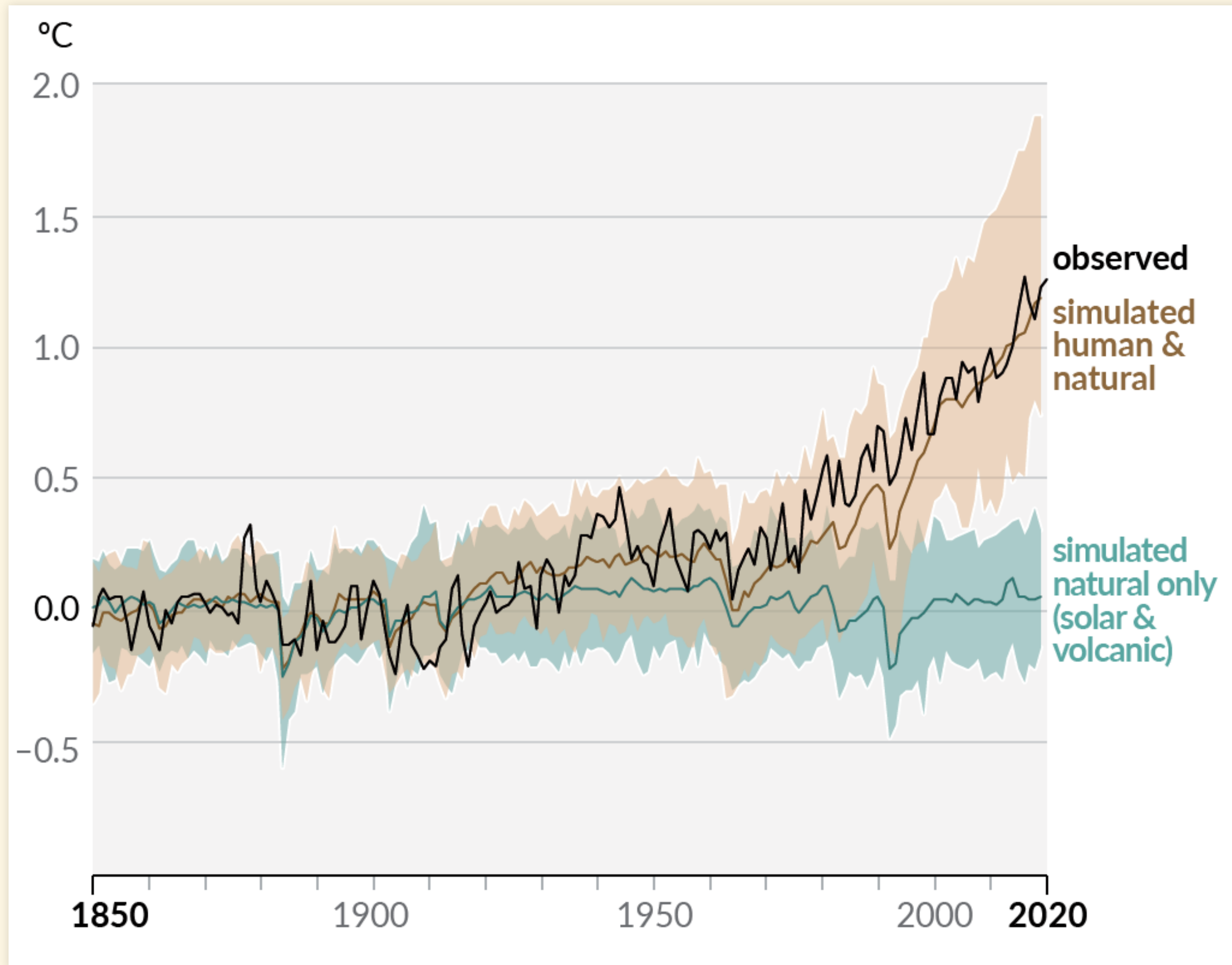
# Can We Trust Climate Models?



# 50 Years of Model Predictions

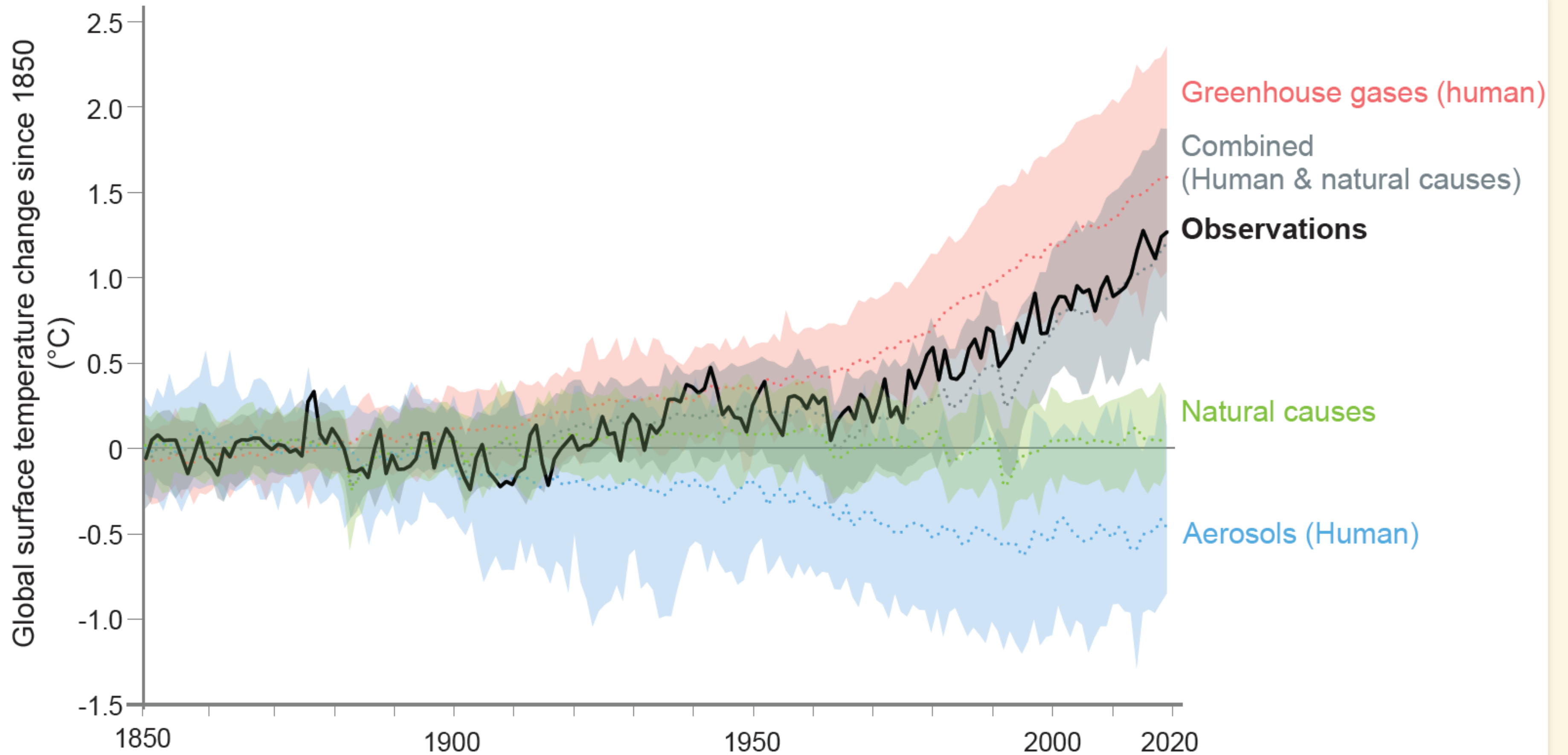


# Smoking Gun



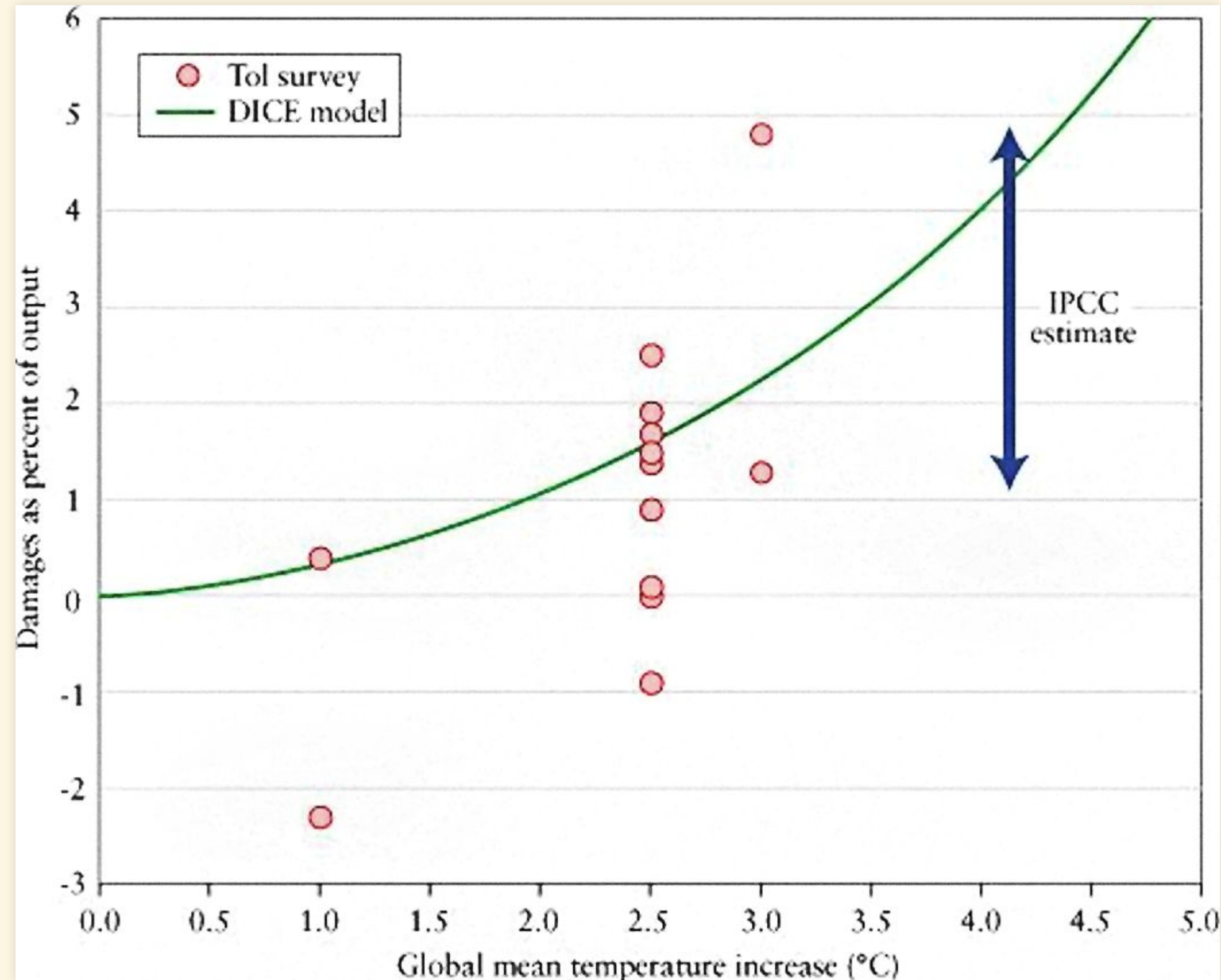


# Smoking Gun in Detail



# Climate and the Economy

# 2009 Economic Assessment



Source: R.S.J. Tol, J. Econ. Perspect. 23, 29 (2009). doi:10.1257/jep.23.2.29

- Note benefits at 1.0 and 2.5 degrees...

# Oops! Gremlins!

*“Gremlins intervened in the preparation of my paper ... minus signs were dropped from the two impact estimates ...”*

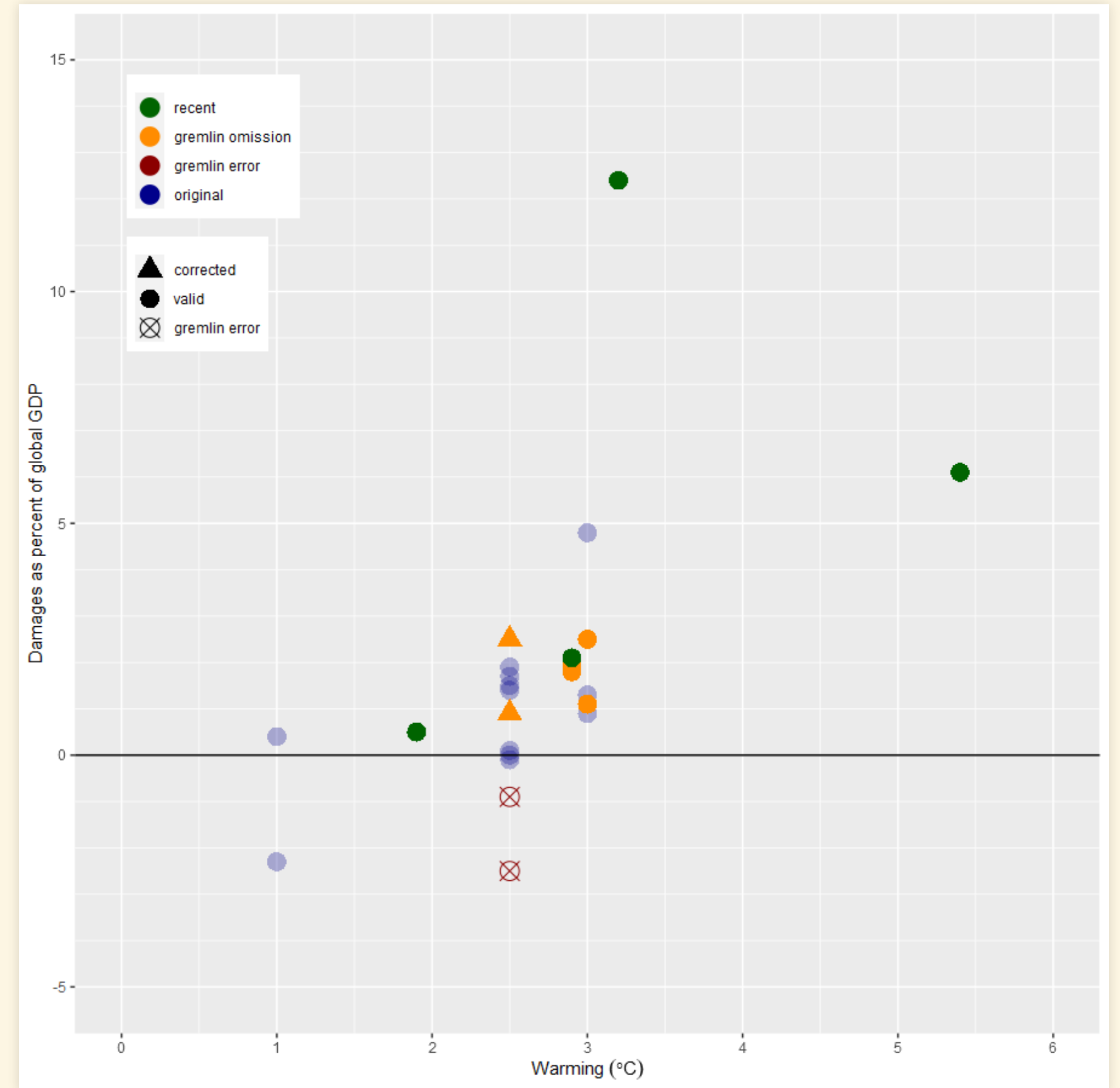
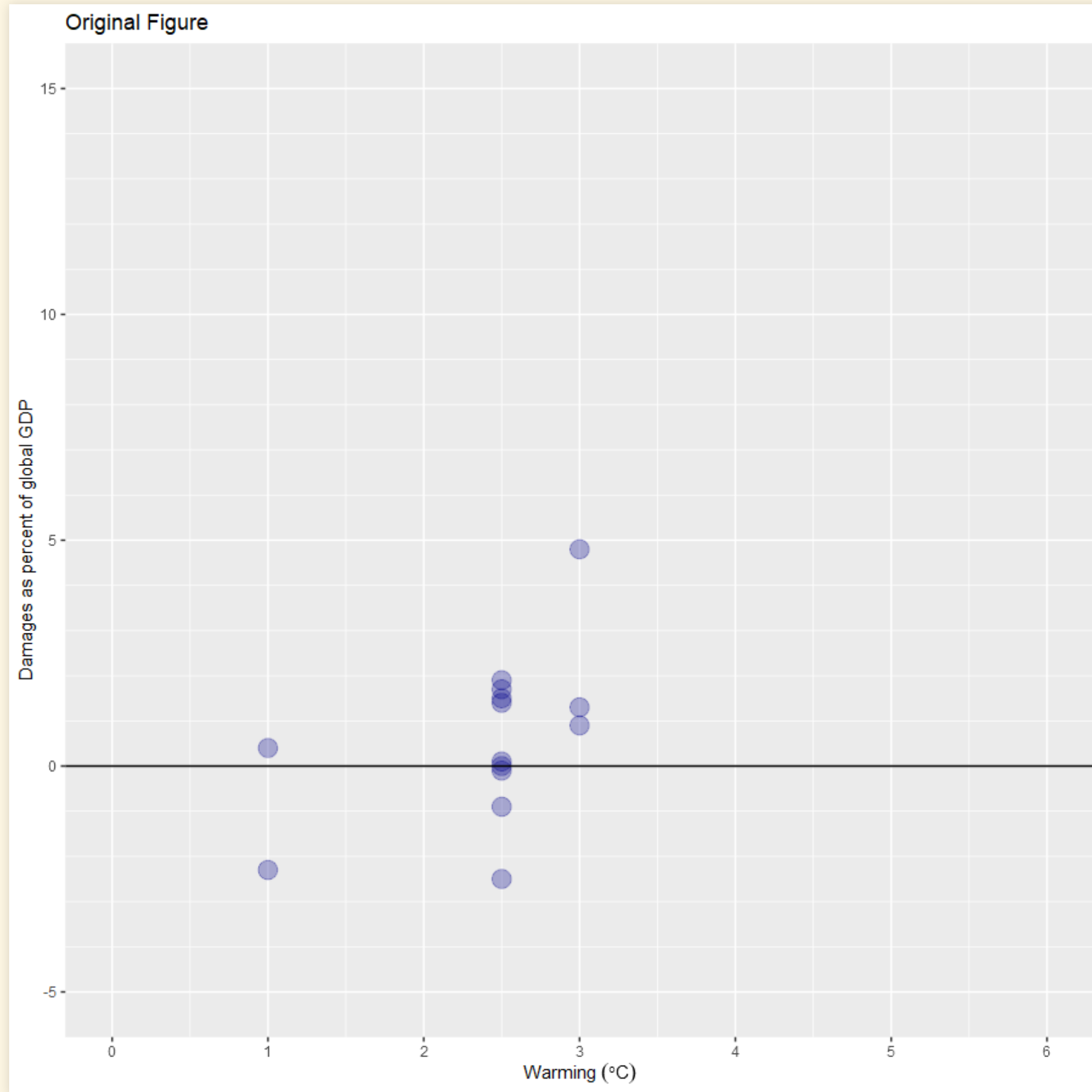
R.S.J. Tol, J. Econ. Perspect. 28, 221 (2014) doi: 10.1257/jep.28.2.221



- Global warming was worse than Tol thought:
  - Two studies that found net harm from global warming were reported as net benefits.
  - Four studies that found net harm were simply omitted.
- Then, in 2015, more Gremlins:
  - numbers were not even calibrated correctly.



# Damages from Warming



# Scientific Consensus

# Meaning of Consensus

- Does scientific consensus mean we can be 100% certain that people are warming the planet?
- What about the future impacts of climate change?

What Gets in the Way of Policy?

# What Gets in the Way of Policy?

- Politicians don't understand science?
- Public doesn't understand science?
- Scientists don't understand politics?

Pielke and Nordhaus

# Pielke and Nordhaus

## **Pielke:**

*Although some scientists believe that there may be “tipping points”  
... no one knows if or when there might be a threshold effect.*

## **Nordhaus:**

*Humans are in effect spinning the roulette wheel when we inject CO<sub>2</sub>  
and other gases into the atmosphere. The balls may land in the  
favorable black pockets or in the unfavorable red pockets, or  
possibly in the dangerous zero or double-zero pockets.*

# Goals for Climate Policy



# Goals for Climate Policy

- Limit temperature rise?
- Limit greenhouse gas concentrations?
- Focus only on CO<sub>2</sub>?
- Focus broadly on all kinds of climate change (natural and human)?
- What do Pielke and Nordhaus say about these questions?
- What do you think?
- Pielke:

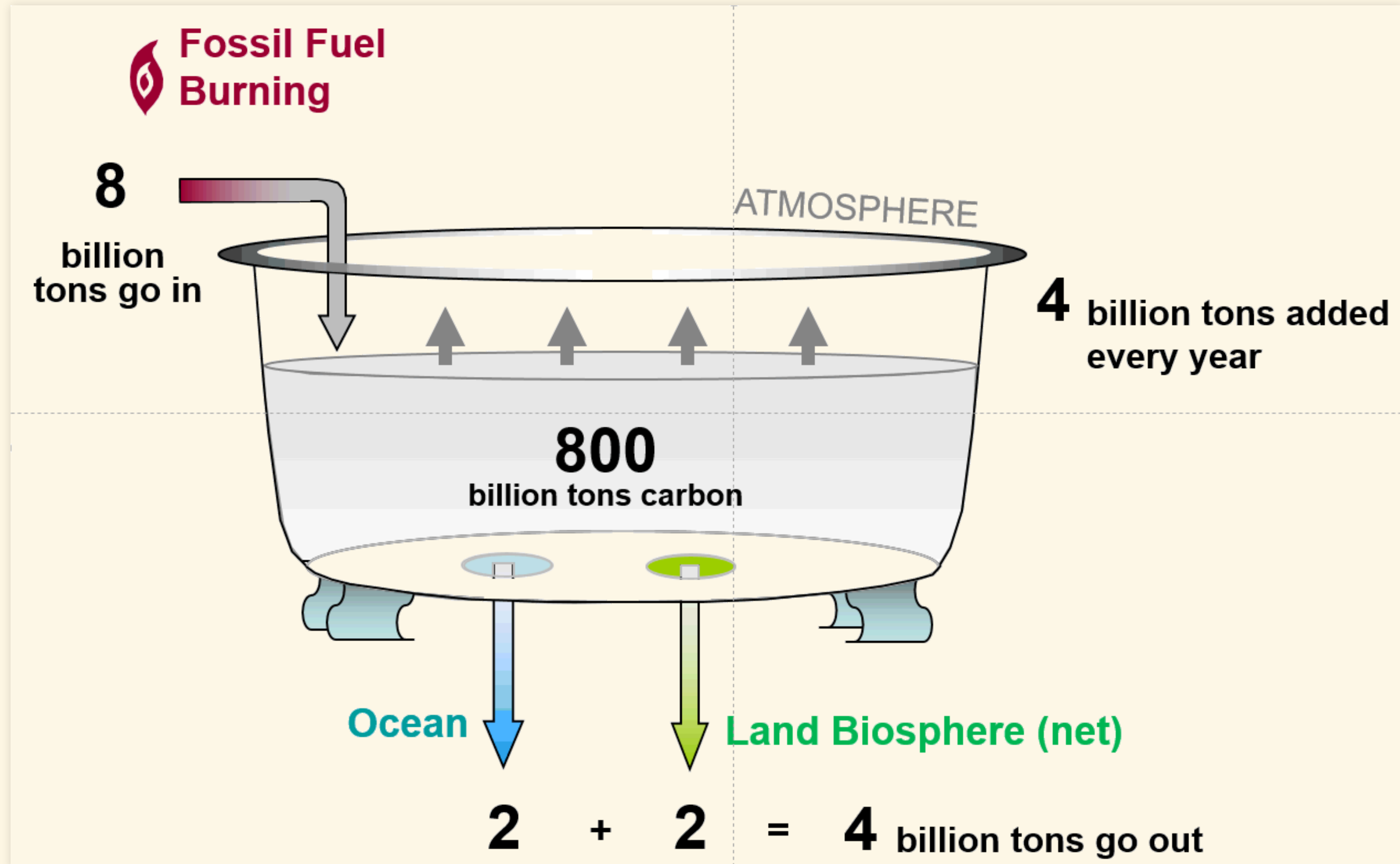
*“A narrow focus on carbon dioxide is double-edged: it gives priority to a very important aspect ..., but it can obscure the fact that ... climate change involves so much more.”*

# Scientific Uncertainty

- How does scientific uncertainty affect policy?
  - Should we wait for more certainty before acting?
  - What do Pielke and Nordhaus say?
  - What do you think?
- 
- Nordhaus:  
*“A sensible policy would pay an insurance premium to avoid playing the roulette wheel.”*  
*“The cost of delaying action for 50 years ... is [estimated] as \$6.5 trillion.”*
  - Pielke:  
*“Policy makers routinely make decisions ... with a similar (or even less well-developed) state of understanding.”*

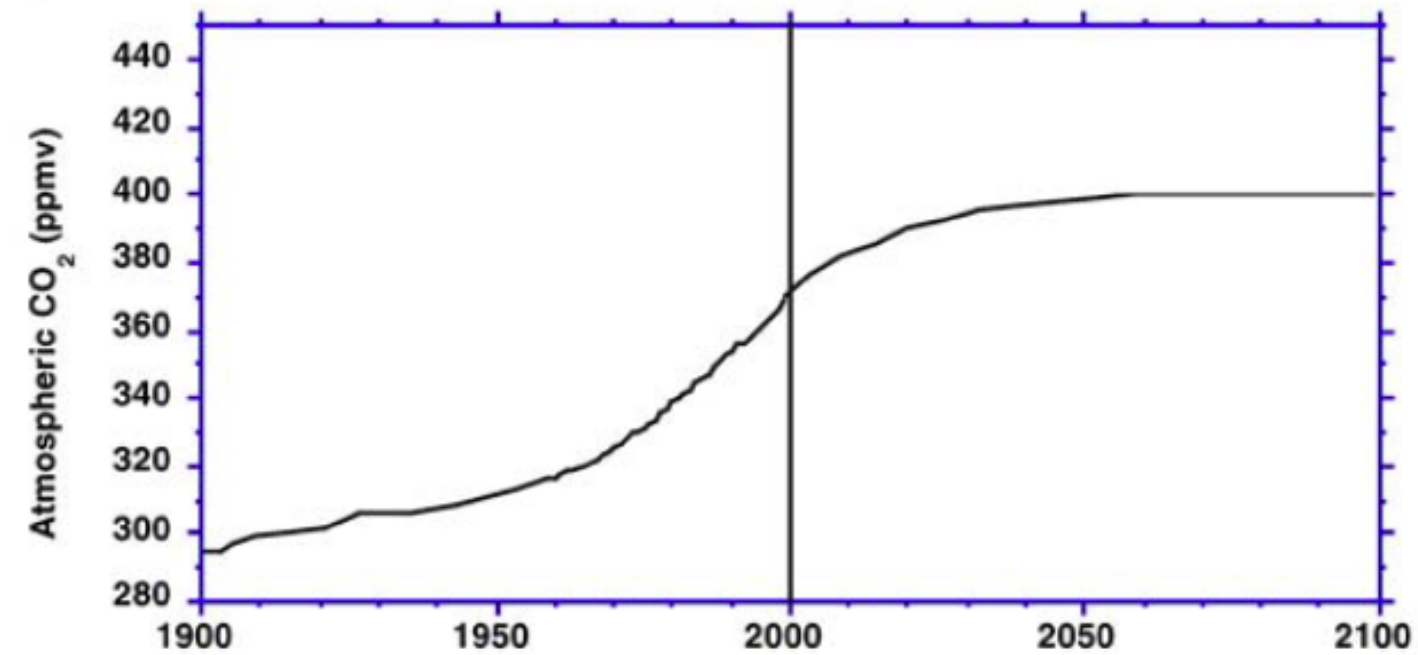
# Bathtub model

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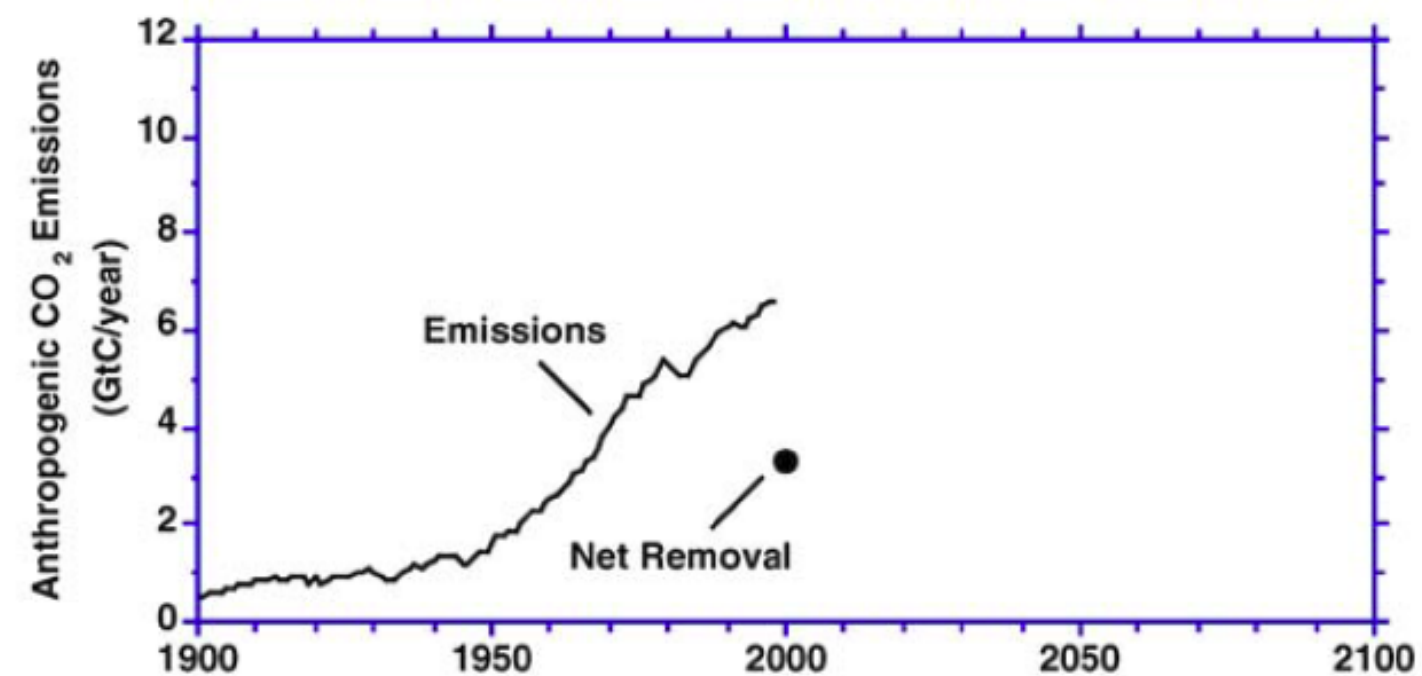


# Bathtub model

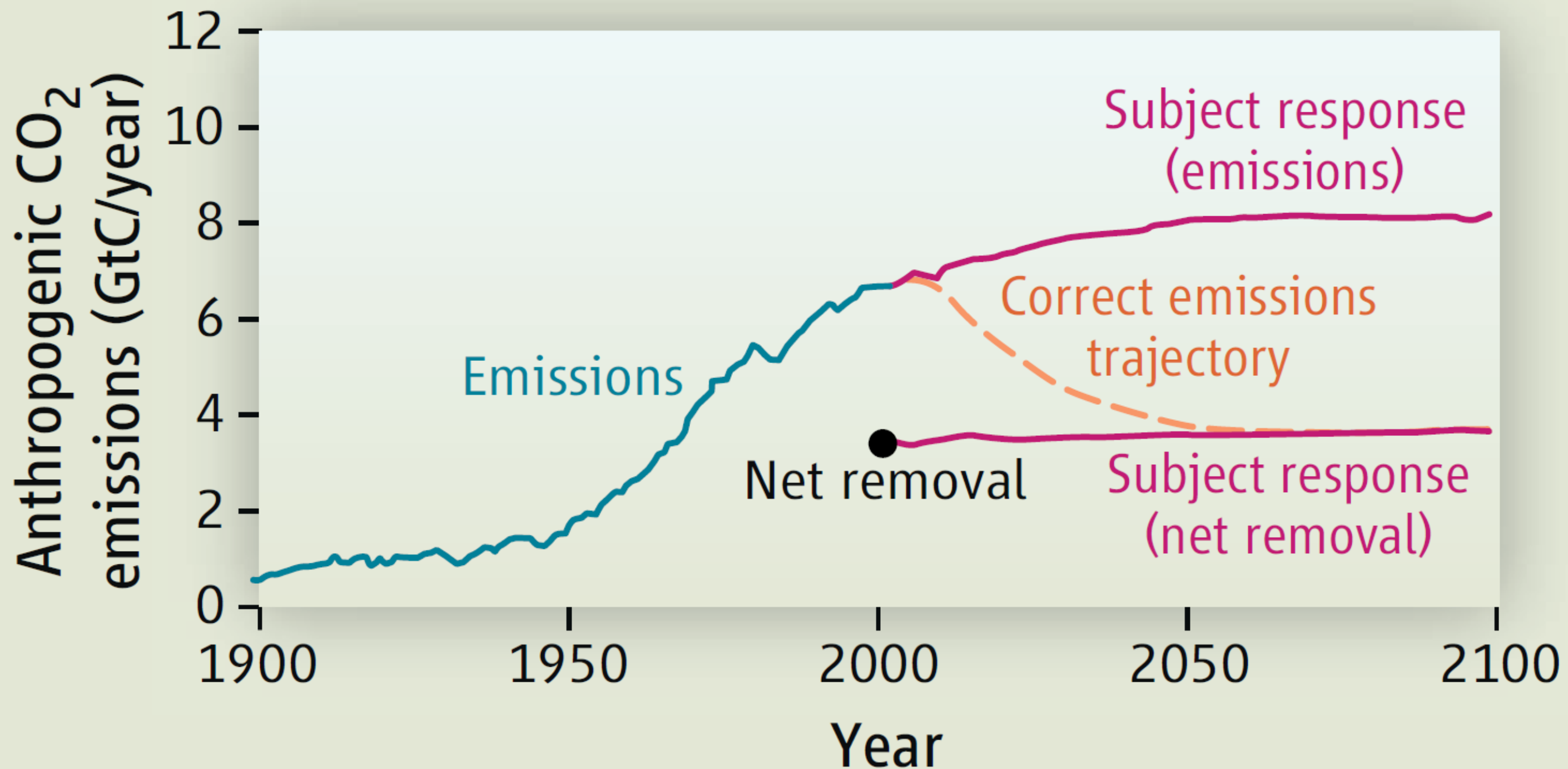
Now consider a scenario in which the concentration of  $\text{CO}_2$  in the atmosphere gradually rises to 400 ppm, about 8% higher than the level today, then stabilizes by the year 2100, as shown here:



1. The graph below shows anthropogenic  $\text{CO}_2$  emissions from 1900-2000, and current net removal of  $\text{CO}_2$  from the atmosphere by natural processes. Sketch:
  - a. Your estimate of likely future net  $\text{CO}_2$  removal, given the scenario above.
  - b. Your estimate of likely future anthropogenic  $\text{CO}_2$  emissions, given the scenario above.



# Bathtub model



J.D. Sterman, Science **322**, 532 (2008).

- 212 MIT MBA and graduate students.
- 60% majored in science or engineering

