

Are humans causing dangerous climate change?

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Outline

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Hypothesis

Hypothesis

If the amount of carbon dioxide (a "greenhouse gas") emitted from earth is larger than natural processes can remove, it will trap more infrared radiation in the atmosphere, leading to a rise in temperatures

In various ways, but especially by burning fossil fuels, we have dramatically increased carbon dioxide emissions

Also, warm air holds more water vapor than cold air, and water vapor causes additional trapping of heat

The planet should therefore be warming

Evidence

Evidence

Cause

Measurements taken since the 1950s show the level of carbon dioxide in the atmosphere rising steadily, from 316 parts per million (ppm) in 1959 to 387ppm in 2009

Data from ice core drilling in Antarctica suggest that in the 800,000 years prior to 1750 (when the industrial revolution began) ...

the average level of CO₂ was about 280ppm, and never exceeded 300ppm

CO₂ levels never changed more than 25ppm in any 1,000-year period

Evidence

Effect

A polar bear floating on a small patch of ice

An individual heavy-damage storm, such as a powerful hurricane or a hundred-year flood

These are *not* evidence of human-caused climate change

Evidence

Effect

Warming temperatures

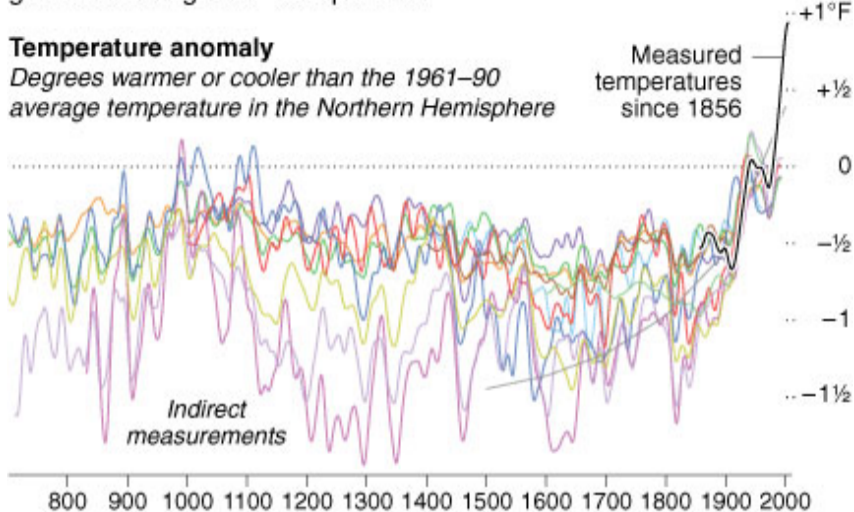
Sustained shifts in rainfall: wet regions getting wetter, dry regions drier

Increased melting of ice in Antarctica, Greenland, and the Arctic

Temperature anomaly

Degrees warmer or cooler than the 1961–90 average temperature in the Northern Hemisphere

Measured temperatures since 1856



Source: Intergovernmental Panel on Climate Change

THE NEW YORK TIMES
The New York Times

Evidence

Because the historical temperature records are incomplete, scientists introduce corrections. Are these corrections biased?

This was the concern at the heart of the "climategate" controversy in 2009

But the Berkeley Earth Surface Temperature (BEST) project has gathered together all existing temperature measures. The data, even with no corrections, show a similar trend

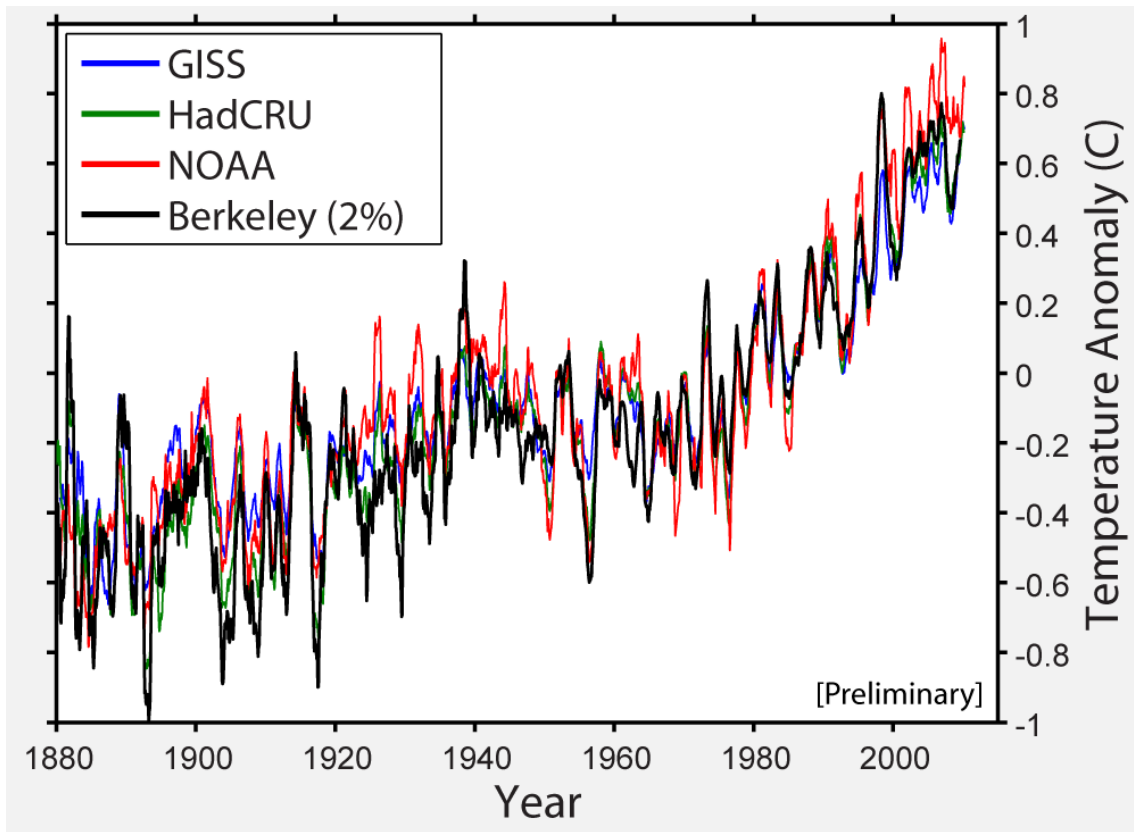


Figure: Land average temperatures from the three major programs, compared with an initial test of the Berkeley Earth dataset and analysis process. Approximately 2 percent of the available sites were chosen randomly from the complete set of 39,028 sites. The Berkeley data are marked as preliminary because they do not include treatments for the reduction of systematic bias.

Evidence

The measurement might indicate warming because a number of the stations are near towns that have been growing

But ...

This "heat island" effect is likely to be strongest on still nights, yet trends from data recorded on still nights are similar to those on windy nights

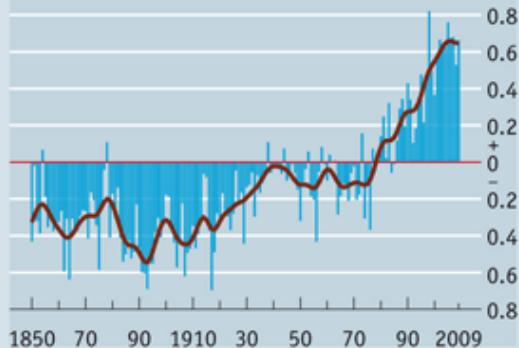
The temperature of waters at the surface of oceans shows similar trends to that on land; so does the record of air temperature over the oceans

Temperature readings from non-heat-island stations show a similar trend

Rising together

Deviation from average temperature 1961-90, °C

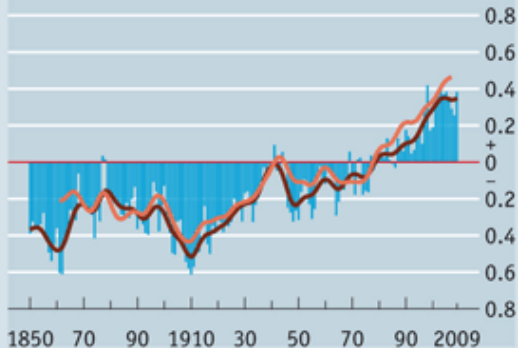
World land temperature



Annual average Smoothed annual average

Marine air temperature, smoothed annual average

World ocean temperature



Source: Met Office Hadley Centre for Climate Change, CRUTEM3, HadSST2 & HadMAT

Evidence

Could the observed temperature rise, rainfall shifts, and ice melting be a result of something else?

Scientists use computer simulations that allow them to project climate effects in scenarios with little or no human emission of greenhouse gases

According to the simulations, none of those scenarios can produce the climate patterns we currently observe

When the simulations add the greenhouse gases that we know humans are generating, they come close to matching the observed climate patterns

Evidence

There's no way to be 100% certain, but the computer simulations coupled with the observed evidence yield a conclusion of "very likely" that humans are causing climate change

Evidence

2007 report of the Intergovernmental Panel on Climate Change (IPCC)

Conclusion: "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG [human-generated greenhouse gas] concentrations."

Evidence

In 2010 Britain's Met (Meteorological) Office examined more than a hundred peer-reviewed studies that have appeared after the 2007 IPCC report

Conclusion: "We can say with a very high significance level that the effects we see in the climate cannot be attributed to any other forcings [factors that push climate in one direction or another]."

Evidence

How much consensus is there among climate scientists?

In 2010, the *Proceedings of the National Academy of Sciences* reported the findings of a survey of 1,372 climate researchers

97-98% of those publishing in the field believe humans are causing climate change

And "The relative climate expertise and scientific prominence of the unconvinced researchers ... are substantially below that of the convinced researchers"

Projections

Projections

How much more warming will occur?

In a 2007 report, the Intergovernmental Panel on Climate Change (IPCC) estimated that if the current carbon dioxide output trend continues, we should expect warming of 2°F to 11°F over the course of the 21st century

Projections

Warming in and of itself might not be so bad, except in certain vulnerable and already-hot places, such as the American southwest

But warming could cause significant melting of the Greenland and West Antarctic ice sheets

That in turn could raise sea levels — perhaps substantially, which could threaten hundreds of millions of people who live in coastal areas

It also could disrupt wind and water currents in such a way as to make parts of the planet uninhabitable

Projections

Predicting how much the two ice sheets will melt and what impact that will have is extremely difficult

In its 2007 report, the IPCC said this was too complex to even hazard a guess, so it left the possibility out of its calculations about the future impact of climate change

Estimates range from little melting with a sea level rise of a few inches to full melting with a rise of 16 feet (from the West Antarctic sheet) or 20 feet (Greenland sheet)

A sea level rise of 20 feet or more, along with other catastrophic developments, is unlikely but possible



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November 13, 2010

As Glaciers Melt, Science Seeks Data on Rising Seas

By **JUSTIN GILLIS**

TASIILAQ, Greenland — With a tense pilot gripping the stick, the helicopter hovered above the water, a red speck of machinery lost in a wilderness of rock and ice.

To the right, a great fjord stretched toward the sea, choked with icebergs. To the left loomed one of the immense glaciers that bring ice from the top of the [Greenland](#) ice sheet and dump it into the ocean.

Hanging out the sides of the craft, two scientists sent a measuring device plunging into the water, between ice floes. Near the bottom, it reported a temperature of 40 degrees. It was the latest in a string of troubling measurements showing that the water was warm enough to melt glaciers rapidly from below.

Policy options

Policy options

1. Focus our money and effort on other problems where the payoff might be greater

2. Focus on addressing climate change

Reduce carbon emissions

Invest in research on clean energy

Policy options

If we're confident the impact of climate change will not be catastrophic and/or irreversible, we should weigh costs versus benefits of various courses of action

There are many other sources of death, bad quality of life, and unhappiness. Perhaps we should focus our attention on those rather than on climate change

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BJORN LOHMEYER

Policy options

Is this wise?

How confident must we be about the likelihood of a catastrophe before we're willing to spend a lot of money and effort in order to prevent it?

Policy options

The "reasonable doubt" standard in our criminal justice system

We consider imprisoning (or executing) an innocent person to be a very bad outcome

If a juror thinks there is reasonable doubt about the accused person's guilt, the juror must vote "not guilty"

Policy options

The "precautionary principle"

If an action or policy has a reasonably suspected risk of doing harm, the burden of proof is on those taking the action to provide compelling evidence that the harm is minimal

Use of this principle is now a requirement in the European Union (e.g. with genetically modified food)

Policy options

When there is an uncertain but potentially catastrophic outcome, we often undertake costly action in order to prevent it

Terrorist attack

Nuclear proliferation

Disease (vaccination)

Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change

Martin L. Weitzman*

February 23, 2011. REEP Symposium on Fat Tails.

Abstract

In this article I revisit some basic issues concerning structural uncertainty and catastrophic climate change. My target audience here is general economists, so this article could also be viewed as a somewhat less technical exposition that supplements my previous work. Using empirical examples, I argue that it is implausible that low-probability high-negative-impact events would not much influence an economic analysis of climate change. I then try to integrate the empirical examples and the theory together into a unified package with a unified message that the possibility of ruinous climate change needs to be taken seriously.

JEL classification: Q54; keywords: catastrophic climate change.

Policy options

How expensive will it be?

One careful estimate puts the cost of an aggressive carbon-reduction effort at 1-3% of output (GDP) by the end of this century

The gains from green technology and jobs are estimated to be around 5% of GDP

So a shift away from carbon may well be a net economic boost, rather than a cost

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April 5, 2010

Building a Green Economy

By **PAUL KRUGMAN**

If you listen to climate scientists — and despite the relentless campaign to discredit their work, you should — it is long past time to do something about emissions of carbon dioxide and other greenhouse gases. If we continue with business as usual, they say, we are facing a rise in global temperatures that will be little short of apocalyptic. And to avoid that apocalypse, we have to wean our economy from the use of fossil fuels, coal above all.

But is it possible to make drastic cuts in greenhouse-gas emissions without destroying our economy?

Policy options

Reduce carbon emissions

Domestic: carbon tax or cap-and-trade

International: agreement on emissions limits or carbon tariff

Recent developments on both fronts have been discouraging

Harry Reid: Senate will abandon cap-and-trade energy reform

Senate majority leader Harry Reid said Thursday that Democrats faced too much Republican opposition to pass a comprehensive cap-and-trade energy reform bill. The Senate will pursue a scaled down version.



Senate Majority Leader Harry Reid (D-Nev.), center, with Sen. John Kerry (D-Mass.), left, and Director of the White House office of Energy and Climate Change Policy Carol Browner, talk to the media on Capitol Hill in Washington Thursday, July 22.

Senate Democrats abandoned plans to pass a comprehensive cap-and-trade energy reform bill, saying Republicans refuse to support the measure.



December 11, 2010

Climate Talks End With Modest Deal on Emissions

By **JOHN M. BRODER**

CANCÚN, Mexico — The United Nations climate change conference began with modest aims and ended early Saturday with modest achievements. But while the measures adopted here may have scant near-term impact on the warming of the planet, the international process for dealing with the issue got a significant vote of confidence.

The agreement fell well short of the broad changes scientists say are needed to avoid dangerous [climate change](#) in coming decades. But it lays the groundwork for stronger measures in the future, if nations are able to overcome the emotional arguments that have crippled climate change negotiations in recent years.

Policy options

Invest in research on clean energy

Ted Nordhaus & Michael Shellenberger

Break Through

Reversing the Death of Environmentalism to Set Politics of Possibility

From the Death of Environmentalism
to the Politics of Possibility

Summary

Summary

The hypothesis that humans are causing climate change is compelling

The evidence in support of the hypothesis is strong, and there is near-consensus among experts about this

There is disagreement about how aggressive we should be in trying to slow the process, due to disagreement about how we should weight the real but seemingly small possibility that the outcome will be catastrophic