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# Global warming controversy

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The **global warming controversy** is a dispute regarding the nature and consequences of global warming. The disputed issues include the causes of increased global average air temperature, especially since the mid-20th century, whether this warming trend is unprecedented or within normal climatic variations, and whether the increase is wholly or partially an artifact of poor measurements. Additional disputes concern estimates of climate sensitivity, predictions of additional warming, what the consequences are, and what action should be taken (if any). The debate is vigorous in the popular media and on a policy level, with individuals, corporations, and political organizations all being involved.

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## History of public opinion

In the European Union, global warming has been a prominent and sustained issue. All European Union member states ratified the 1997 Kyoto Protocol, and many European countries had already been taking action to reduce greenhouse gas emissions prior to 1990 (for example, Margaret Thatcher advocated action against man-made climate change in 1988<sup>[1]</sup> and Germany started to take action after the Green Party took seats in Parliament in 1983). Both "global warming" and the more politically neutral "climate change" were listed by the Global Language Monitor as political buzzwords or catch phrases in 2005.<sup>[2]</sup> In Europe, the notion of human influence on climate gained wide acceptance more rapidly than in many other parts of the world, most notably the United States.<sup>[3][4]</sup>

There has been a debate among public commentators about how much weight and media coverage should be given to each side of the controversy. Andrew Neil of the BBC stated that "There's a great danger that on some issues we're becoming a one-party state in which we're meant to have only one kind of view. You don't have to be a climate-change denier to recognise that there's a great range of opinion on the subject."<sup>[5]</sup>

The table below shows how public perceptions about the existence and importance of global warming have changed in the U.S. and elsewhere.<sup>[6][7][8][9]</sup>

Statement	% agreeing	Who
Global warming is probably occurring.	85	US/2006
Global warming is probably occurring.	80	US/1998
Human activity is a significant cause of climate change.	71	US/2007
Human activity is a significant cause of climate change.	79	World/2007
Climate change is a serious problem.	76	US/2006
Climate change is a serious problem.	90	World/2006
Climate change is a serious problem.	78	World/2003
It's necessary to take major steps starting very soon.	59	US/2007
It's necessary to take major steps starting very soon.	65	World/2007

A June 2007 Mori poll conducted in the UK found 56% believed scientists were still questioning climate change. The survey suggested that terrorism, graffiti and crime were all of more concern than climate change. Ipsos Mori's head of environmental research, Phil Downing, said people had been influenced by counter-arguments.<sup>[10]</sup>

The Canadian science broadcaster and environmental activist, David Suzuki, reports that focus groups organized by the David Suzuki Foundation showed the public has a poor understanding of the science behind global warming.<sup>[11]</sup> This is despite recent publicity through different means, including the films *An Inconvenient Truth* and *The 11th Hour*.

An example of the poor understanding is public confusion between global warming and ozone depletion or other environmental problems.<sup>[12][13]</sup>

A 15-nation poll conducted in 2006 by Pew Global found that there "is a substantial gap in concern over global warming – roughly two-thirds of Japanese (66%) and Indians (65%) say they personally worry a great deal about global warming. Roughly half of the populations of Spain (51%) and France (46%) also express great concern over global warming, based on those who have heard about the issue. But there is no evidence of alarm over global warming in either the United States or China – the two largest producers of greenhouse gases. Just 19% of Americans and 20% of the Chinese who have heard of the issue say they worry a lot about global warming – the lowest percentages in the 15 countries surveyed. Moreover, nearly half of Americans (47%) and somewhat fewer Chinese (37%) express little or no concern about the problem."<sup>[14]</sup> A 47-nation poll conducted in 2007 found that "Substantial majorities 25 of 37 countries say global warming is a 'very serious' problem".<sup>[15]</sup>

## Controversy concerning the science

### Existence of a scientific consensus

Environmental groups, many governmental reports, and the non-U.S. media often claim virtually unanimous agreement in the scientific community in support of human-caused warming. Opponents either maintain that most scientists consider global warming "unproved," dismiss it altogether, or decry the dangers of consensus science.<sup>[7]</sup> (<http://www.climate-science-international.org/>)<sup>[8]</sup> (<http://www.heartland.org/Article.cfm?artId=22866>)<sup>[16]</sup> Others maintain that either proponents or opponents have been stifled or driven underground.<sup>[17]</sup>

The majority of climate scientists agree that global warming is primarily caused by human activities such as fossil fuel burning and deforestation.<sup>[18][19][20]</sup> The conclusion that global warming is mainly caused by human activity and will continue if greenhouse gas emissions are not reduced has been endorsed by at least 30 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. The U.S. National Academy of Sciences,<sup>[21]</sup> the American Association for the Advancement of Science,<sup>[22]</sup> and the Joint Science Academies of the major industrialized and developing nations<sup>[23]</sup> explicitly use the word "consensus" when referring to this conclusion.

A 2004 essay by Naomi Oreskes in the journal *Science* reported a survey of 928 abstracts of peer-reviewed papers related to global climate change in the ISI database.<sup>[24]</sup> Oreskes stated that "Remarkably, none of the papers disagreed with the consensus position. ... This analysis shows that scientists publishing in the peer-reviewed literature agree with IPCC, the National Academy of Sciences, and the public statements of their professional societies." Benny Peiser claimed to have found flaws in Oreskes' work,<sup>[25]</sup> but his attempted refutation is disputed<sup>[26][27][28]</sup> and has not been published in a peer-reviewed journal. Peiser later withdrew parts of his criticism,<sup>[29]</sup> also commenting that "the overwhelming majority of climatologists is agreed that the current warming period is mostly due to human impact. However, this majority consensus is far from unanimous."<sup>[27][30]</sup>

A 2006 op-ed by Richard Lindzen in *The Wall Street Journal* challenged the claim that scientific consensus had been reached, and listed the *Science* journal study as well as other sources, including the IPCC and NAS reports, as part of "an intense effort to suggest that the theoretically expected contribution from additional carbon dioxide has actually been detected."<sup>[31]</sup> Lindzen wrote in *The Wall Street Journal* on April 12, 2006,<sup>[32]</sup>

“ But there is a more sinister side to this feeding frenzy. Scientists who dissent from the alarmism have seen their grant funds disappear, their work derided, and themselves libeled as industry stooges, scientific hacks or worse. Consequently, lies about climate change gain credence even when they fly in the face of the science that supposedly is their basis. ”

Similarly, Timothy Ball asserts that skeptics have gone underground for "job security and fear of reprisals. Even in University, where free speech and challenge to prevailing wisdoms are supposedly encouraged, academics remain silent."<sup>[33]</sup>

At least one survey of the scientific community has found the opposite problem -- New Scientist notes that in surveys a much larger fraction of U.S. scientists consistently state that they are pressured by their employers or by U.S. government bodies to *deny* that global warming results from human activities<sup>[17]</sup> or risk losing funding.

In response to claims of a consensus on global warming, some skeptics have compared the theory to a religion,<sup>[34][35][36]</sup> to scientific support for the eugenics movement,<sup>[37][38]</sup> and to discredited scientific theories such as phlogiston<sup>[39]</sup> and miasma.<sup>[40]</sup>

In 2008, Fergus Brown, Roger A. Pielke and James Annan submitted a paper titled "Is there agreement amongst climate scientists on the IPCC AR4 WG1?"<sup>[41]</sup> It was rejected for publication by the AGU publication *EOS* and *Nature Precedings*. Pielke writes: "From this experience, it is clear that the AGU EOS and Nature Precedings Editors are using their positions to suppress evidence that there is more diversity of views on climate, and the human role in altering climate, than is represented in the narrowly focused 2007 IPCC report."<sup>[42]</sup>

### Heartland Institute's list

On April 29, 2008, environmental journalist Richard Littlemore revealed that a list of "500 Scientists with Documented Doubts of Man-Made Global Warming Scares"<sup>[43]</sup> propagated by the Heartland Institute included at least 45 scientists who neither knew of their inclusion as "coauthors" of the article, nor agreed with its contents.<sup>[44]</sup> Many of the scientists asked the Heartland Institute to remove their names from the list; for instance, Gregory Cutter from the Old Dominion University was reported by Littlemore as saying,

“ I have NO doubts ..the recent changes in global climate ARE man-induced. I insist that you immediately remove my name from this list since I did not give you permission to put it there. ”

However, the Heartland Institute refused to remove any names from the list. In a statement on 5 May, 2008, Institute CEO Joseph Bast said that the title of the 14 Sep, 2007 news release announcing the list had been changed to "500 Scientists Whose Research Contradicts Man-Made Global Warming Scares."<sup>[45]</sup> In the same statement, Bast also charged that the outraged scientists:

“ ...have crossed the line between scientific research and policy advocacy. They lend their credibility to politicians and advocacy groups who call for higher taxes and more government regulations to "save the world" from catastrophic warming ... and not coincidentally, to fund more climate research. They are embarrassed -- as they should be -- to see their names in a list of scientists whose peer-reviewed published work suggests the modern warming might be due to a natural 1,500-year climate cycle. ”

Bast also stated that:

“ The point should be obvious: There is no scientific consensus that global warming is a crisis. ”

### Petitions

In 1997, the "World Scientists Call For Action" petition was presented to world leaders meeting to negotiate the Kyoto Protocol. The declaration asserted, "A broad consensus among the world's climatologists is that there is now 'a discernible human influence on global climate.'" It urged governments to make "legally binding commitments to reduce industrial nations' emissions of heat-trapping gases", and called global warming "one of the most serious threats to the planet and to future generations."<sup>[46]</sup> The petition was conceived by the Union of Concerned Scientists as a follow up to their 1992 World Scientists' Warning to Humanity, and was signed by "more than 1,500 of the world's most distinguished senior scientists, including the majority of Nobel laureates in science"<sup>[47][48]</sup>

To support his claim of a lack of consensus, the website of prominent skeptic Fred Singer's Science and Environmental Policy Project (SEPP) lists four petitions. According to SEPP, these petitions show that "the number of scientists refuting global warming is growing."<sup>[49]</sup> The petitions are:

- The 1992 "Statement by Atmospheric Scientists on Greenhouse Warming," signed by 47 scientists, claims "such policy initiatives [those concerning the Earth Summit scheduled to convene in Brazil in June 1992] derive from highly uncertain scientific theories. They are based on the unsupported assumption that catastrophic global warming follows from the burning of fossil fuels and requires immediate action. We do not agree."<sup>[50]</sup>
- The "Heidelberg Appeal" (also from 1992), signed by over 4000 scientists including 72 Nobel Prize winners.<sup>[51]</sup> This appeal makes no mention of climate change or any other specific environmental issue, but is essentially a plea for policy based on "scientific criteria and not on irrational preconceptions".
- Singer's "Leipzig Declaration on Global Climate Change" (1995 and 1997). Critics point out that most of the signatories lack credentials in the specific field of climate research or even physical science in general.<sup>[52]</sup> Followup interviews found at least twelve signers who denied having signed the Declaration or had never heard of it.<sup>[53]</sup>
- The "Oregon Petition", self-signed and unverified by third party, was started in 1998 by physicist Frederick Seitz, past president of the United States National Academy of Sciences. The identical petition card was circulated again in early 2008 and Arthur B. Robinson is presenting the petition with 31,000 signatures in Washington DC on May 19, 2008.<sup>[54]</sup> Critics point out that many of the signatories of the petition lack a background in climate-related sciences<sup>[55][56]</sup> and that the petition itself mentions only "catastrophic heating" and not the broader issue of global warming. The petition's website claims that all of the 31,000 signatories are qualified scientists with "technical training suitable for the evaluation of the relevant research data."<sup>[57]</sup> However, anyone with a degree was entitled to sign the list and this would therefore include many who are not qualified to evaluate the complex data and modelling involved.<sup>[58]</sup>

In April 2006, a group describing itself as "sixty scientists" signed an Open Letter (<http://www.canada.com/nationalpost/financialpost/story.html?id=3711460e-bd5a-475d-a6be-4db87559d605>) to the Canadian Prime Minister Stephen Harper to ask that he revisit the science of global warming and "Open Kyoto to debate." As with the earlier statements, critics pointed out that many of the signatories were non-scientists or lacked relevant scientific backgrounds.<sup>[59]</sup> For example, the group included David Wojick, a journalist, and Benny Peiser, a social anthropologist. More than half the signatories cited past or emeritus positions as their main appointments. Only two (Richard Lindzen and Roy Spencer) indicated current appointments in a university department or a recognized research institute in climate science.<sup>[60]</sup> One of the signatories has since publicly recanted, stating that his signature was obtained by deception regarding the content of the letter.<sup>[61]</sup> In response shortly afterward another open letter to Prime Minister Harper endorsing the IPCC report and calling for action on climate change was prepared by Gordon McBean and signed by 90 Canadian climate scientists initially, plus 30 more who endorsed it after its release.<sup>[62][63]</sup>

### The IPCC

#### Statements Agreeing with the IPCC Positions

A joint statement issued by the Australian Academy of Sciences, Royal Flemish Academy of Belgium for Sciences and the Arts, Brazilian Academy of Sciences, Royal Society of Canada, Caribbean Academy of Sciences, Chinese Academy of Sciences, French Academy of Sciences, German Academy of Natural Scientists Leopoldina, Indian National Science Academy, Indonesian Academy of Sciences, Royal Irish Academy, Accademia Nazionale dei Lincei (Italy), Academy of Sciences Malaysia, Academy Council of the Royal Society of New Zealand, Royal Swedish Academy of Sciences, and Royal Society (UK) said:

The work of the Intergovernmental Panel on Climate Change (IPCC) represents the consensus of the international scientific community on climate change science. We recognise IPCC as the world's most reliable source of information on climate change and its causes, and we endorse its method of achieving this consensus. Despite increasing consensus on the science underpinning predictions of global climate change, doubts have been expressed recently about the need to mitigate the risks posed by global climate change. We do not consider such doubts justified.<sup>[64]</sup>

Many other science academies and scientific organizations support the conclusions of the IPCC.

In Naomi Oreskes's talk *The American Denial of Global Warming*<sup>[9]</sup> ([http://www.youtube.com/watch?v=2T4UF\\_Rmlio](http://www.youtube.com/watch?v=2T4UF_Rmlio)), Oreskes recounted the following incident:

“ In 1995, the IPCC concluded that the human effect on climate is now discernible. The lead author of the key chapter on detection and attribution...was a scientist of the Lawrence Livermore National Laboratory named Benjamin J. Santer.

When the IPCC report came out, Seitz, Nierenberg, and now a 4th physicist — a man by the name of S. Fred Singer — launched a highly personal attack on Santer. In an open letter to the IPCC, which they sent to numerous members of the US Congress, Singer, Seitz, and Nierenberg accused Santer of making "unauthorized" changes to the IPCC report [...]

They followed this with an op-ed piece in the *Wall Street Journal* entitled "A Major Deception on Global Warming". This piece was written by Seitz, in which he claimed that the effect of the alleged changes was "to deceive policy makers and the public".

Now Santer replied, in a letter to the editor of the *Wall Street Journal*, and in the response he explained that he had made changes, but those changes were in response to the peer review process. In other words, totally normal scientific practice...This account was corroborated by the Chairman of the IPCC and by all of the other authors of the chapters. In fact, over 40 scientists were co-authors of this chapter. This letter was signed by Santer and 40 others and published in the *Wall Street Journal* in June 1996. And Santer was also formally defended by the American Meteorological Society.

But neither Seitz nor Singer ever retracted the charges, which was then repeated — many times, over and over again — by industry groups and think-tanks. And in fact, if you google "Ben Santer", these same charges are still in the Internet today. In fact, one site said that it was *proven* in 1996 that Santer had fraudulently altered the IPCC report. ”

## Statements Disagreeing with the IPCC Positions

The work of the IPCC has attracted controversy and criticism, including some from experts invited by the IPCC to submit reports or serve on its panels.<sup>[65]</sup>

In blog posts, Roger A. Pielke contends that the IPCC distorted the evidence by not including scientific results that questioned anthropogenic global warming.<sup>[66]</sup> These criticisms have been described as "failed" by William Connolley.<sup>[67][68]</sup> Pielke also perceived a conflict of interest in the IPCC assessment process, since the "same individuals who are doing primary research in the role of humans on the climate system are then permitted to lead the assessment! ... Assessment Committees should not be an opportunity for members to highlight their own research."<sup>[66]</sup> There is no obvious solution to this problem, since scientists with sufficient knowledge of the field to serve on the IPCC and scientists who have written noteworthy papers in the field are essentially the same group.<sup>[68]</sup>

Christopher Landsea, a hurricane researcher, said of "the part of the IPCC to which my expertise is relevant" that "I personally cannot in good faith continue to contribute to a process that I view as both being motivated by pre-conceived agendas and being scientifically unsound",<sup>[69]</sup> because of comments made at a press conference by Kevin Trenberth of which Landsea disapproved. Trenberth said that "Landsea's comments were not correct";<sup>[70]</sup> the IPCC replied that "individual scientists can do what they wish in their own rights, as long as they are not saying anything on behalf of the IPCC" and offered to include Landsea in the review phase of the AR4.<sup>[71]</sup> Roger Pielke, Jr. commented that "Both Landsea and Trenberth can and should feel vindicated... the IPCC accurately reported the state of scientific understandings of tropical cyclones and climate change in its recent summary for policy makers".<sup>[70]</sup>

In 2005, the House of Lords Economics Committee wrote that "We have some concerns about the objectivity of the IPCC process, with some of its emissions scenarios and summary documentation apparently influenced by political considerations." It doubted the high emission scenarios and its "played-down" positive aspects of global warming.<sup>[72]</sup> The main claims of the House of Lords Economics Committee were rejected in the response made by the United Kingdom government<sup>[73]</sup> and by the Stern Review.

John Christy, an IPCC lead author and global warming skeptic, wrote that contributing authors and reviewers have little influence, so that "to say that 800 contributing authors or 2,000 reviewers reached consensus on anything describes a situation that is not reality."<sup>[74]</sup>

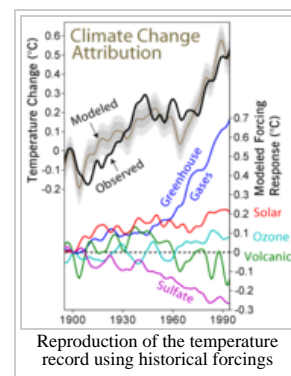
While some critics have argued that the IPCC overstates likely global warming, others have made the opposite criticism. David Biello, writing in the *Scientific American*, argues that, because of the need to secure consensus among governmental representatives, the IPCC reports give conservative estimates of the likely extent and effects of global warming.<sup>[75]</sup> Climate scientist James Hansen argues that the IPCC's conservativeness seriously underestimates the risk of sea-level rise on the order of meters—enough to inundate many low-lying areas, such as the southern third of Florida.<sup>[76]</sup>

## Causes

### Attribution to greenhouse gases

Attribution of recent climate change discusses how global warming is attributed to anthropogenic GHGs. Correlation of CO<sub>2</sub> and temperature is not part of this evidence. Nonetheless, one argument against anthropogenic global warming claims that rising levels of carbon dioxide (CO<sub>2</sub>) and other greenhouse gases (GHGs) do not correlate with global warming.<sup>[77]</sup>

- General circulation models and basic physical considerations predict that in the tropics the temperature of the troposphere should increase more rapidly than the temperature of the surface. Models and observations agree on this amplification for monthly and interannual time scales but not for decadal time scales in most observed data sets. It is uncertain whether the discrepancy is attributable to deficiencies in model formulation, biases in the observations, or both. The present view is that because of large uncertainties in observed tropospheric temperature trends along with other evidence for tropospheric warming (such as the increasing height of the tropopause), the more likely explanation is observational bias.<sup>[78]</sup> Furthermore, if greenhouse gases were causing the climate warming then scientists would expect the troposphere to be warming faster than the surface, but observations do not bear this out.<sup>[79]</sup> Satellite temperature measurements show that tropospheric temperatures are increasing with "rates similar to those of the surface temperature," leading the IPCC to conclude that this discrepancy is reconciled.<sup>[80]</sup>
- Studies of ice cores show that carbon dioxide levels rise and fall with or after (as much as 1000 years) temperature variations.<sup>[81]</sup> This argument assumes that current climate change can be expected to be similar to past climate change. While it is generally agreed that variations before the industrial age are mostly timed by astronomical forcing,<sup>[82]</sup> the current variations, of whatever size, are claimed to be timed by anthropogenic releases of CO<sub>2</sub> (thus returning the argument to the importance of human CO<sub>2</sub> emissions). Analysis of carbon isotopes in atmospheric CO<sub>2</sub> shows that the recent observed CO<sub>2</sub> increase cannot have come from the oceans, volcanoes, or the biosphere, and thus is not a response to rising temperatures as would be required if the same processes creating past lags were active now.<sup>[83]</sup>
- Between 1940 and 1970, global temperatures went down slightly, even though carbon dioxide levels went up. This could be attributed to the cooling effect of sulphate aerosols.<sup>[84][85]</sup>
- Carbon dioxide accounts for about 383 parts per million by volume (ppm) of the Earth's atmosphere, increasing from 278 ppm in the 1880s to over 380 ppm in 2005. Carbon dioxide itself causes 9-26% the natural greenhouse effect.



- The Earth has been in an ice age with a much higher level of CO<sub>2</sub>. The Ordovician period of the Paleozoic era, the Earth was in an ice age with atmospheric CO<sub>2</sub> estimated at 4400ppm<sup>[86]</sup> (or 0.44% of the atmosphere). However, a recent study suggests the Ordovician period began with a reduction in CO<sub>2</sub>.<sup>[87]</sup>

As noted above, climate models are only able to simulate the temperature record of the past century when GHG forcing is included, which is consistent with the findings of the IPCC which has stated that: "Greenhouse gas forcing largely the result of human activities has very likely caused most of the observed global warming over the last 50 years"<sup>[88]</sup> (See also: attribution of recent climate change.)

### Alternate hypotheses

*See also: Solar variation theory*

Scientists opposing the mainstream scientific assessment of global warming express varied opinions concerning the cause of global warming. Some say only that it has not yet been ascertained whether humans are the primary cause of global warming (e.g., Balling, Lindzen, and Spencer). Others attribute global warming to natural variation (e.g., Soon and Baliunas), ocean currents (e.g., Gray), increased solar activity (e.g., Shaviv and Veizer), cosmic rays (e.g., Svensmark), or unknown natural causes (e.g., Leroux).

A few studies claim that the present level of solar activity is historically high as determined by sunspot activity and other factors. Solar activity could affect climate either by variation in the Sun's output or, more speculatively, by an indirect effect on the amount of cloud formation. Solanki and co-workers suggest that solar activity for the last 60 to 70 years may be at its highest level in 8,000 years; Muscheler *et al.* disagree, suggesting that other comparably high levels of activity have occurred several times in the last few thousand years.<sup>[89]</sup> Both Muscheler *et al.* and Solanki *et al.* conclude that "solar activity reconstructions tell us that only a minor fraction of the recent global warming can be explained by the variable Sun."<sup>[90][91]</sup>

Another point of controversy is the correlation of temperature with solar variation.<sup>[92]</sup>

Solar physicists Mike Lockwood and Claus Fröhlich reject the claim that the warming observed in the global mean surface temperature record since about 1850 is the result of solar variations.<sup>[93]</sup> Lockwood and Fröhlich conclude that:

There are many interesting palaeoclimate studies that suggest that solar variability had an influence on pre-industrial climate. There are also some detection-attribution studies using global climate models that suggest there was a detectable influence of solar variability in the first half of the twentieth century and that the solar radiative forcing variations were amplified by some mechanism that is, as yet, unknown. However, these findings are not relevant to any debates about modern climate change. Our results show that the observed rapid rise in global mean temperatures seen after 1985 cannot be ascribed to solar variability, whichever of the mechanisms is invoked and no matter how much the solar variation is amplified.

Svensmark and Friis-Christensen dispute this in a recent reply<sup>[94]</sup> arguing that tropospheric air temperature records, as opposed to the surface air temperature data used by Lockwood and Fröhlich, do show a significant negative correlation between cosmic-ray flux and air temperatures up to 2006. A linear warming trend of about 0.14 K/decade is however left unaccounted for. As of October 2007, this reply has not yet been published in a peer-reviewed journal.

The consensus position (as represented for example by the IPCC Fourth Assessment Report) says that solar radiation may have increased by 0.12 W/m<sup>2</sup> since 1750, compared to 1.6 W/m<sup>2</sup> for the net anthropogenic forcing.<sup>[95]</sup> The TAR said, "The combined change in radiative forcing of the two major natural factors (solar variation and volcanic aerosols) is estimated to be negative for the past two, and possibly the past four, decades."<sup>[96]</sup> The AR4 makes no direct assertions on the recent role of solar forcing, but the previous statement is consistent with the AR4's figure 4.

### Instrumental temperature record

Skeptics have questioned the accuracy of the instrumental temperature record on the basis of the urban heat island effect, the quality of the surface station network and what they view as unwarranted adjustments to the temperature record.

#### Urban heat island

Skeptics contend that stations located in more populated areas could show warming due to increased heat generated by cities, rather than a global temperature rise. The IPCC Third Assessment Report acknowledges that the urban heat island is an important *local* effect, but cites analyses of historical data indicating that the effect of the urban heat island on the *global* temperature trend is no more than 0.05 °C (0.09 °F) degrees through 1990<sup>[97]</sup> More recently, Peterson (2003) found no difference between the warming observed in urban and rural areas.<sup>[98]</sup> Stephen McIntyre analyzed Peterson's raw data. He claimed to find "actual cities have a very substantial trend of over 2 °C per century relative to the rural network - and this assumes that there are no problems with rural network - something that is obviously not true since there are undoubtedly microsite and other problems."<sup>[99]</sup> McIntyre has not published his results in a peer-reviewed journal.

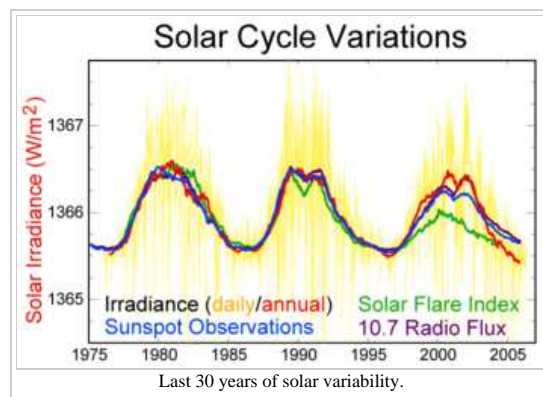
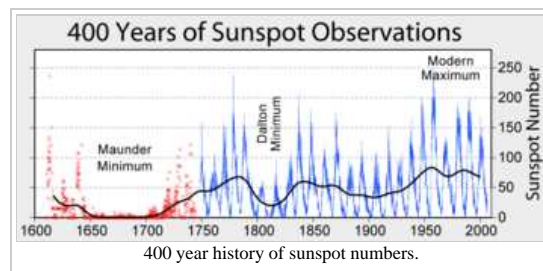
Parker (2006) found that there was no difference in warming between calm and windy nights. Since the urban heat island effect is strongest for calm nights and is weak or absent on windy nights, this was taken as evidence that global temperature trends are not significantly contaminated by urban effects.<sup>[100]</sup> Pielke and Matsui published a paper disagreeing with Parker's conclusions.<sup>[101]</sup>

#### Surface station siting and adjustments

More recently, Roger A. Pielke and Stephen McIntyre have criticized the US instrumental temperature record and adjustments to it, and Pielke and others have criticized the poor quality siting of a number of weather stations in the United States.<sup>[102][103]</sup> In response, Anthony Watts began a volunteer effort to photographically document the siting quality of these stations.<sup>[104]</sup> Based on the work of Watts, Stephen McIntyre has completed a reconstruction of U.S. temp history using only those weather stations identified so far as meeting the requirements to be CRN level 1 (excellent) or level 2 (good) stations. The higher quality stations indicate the warmest years in the U.S. were 1934 and 1921, followed by 1998 and 2006.<sup>[105]</sup> McIntyre has made all of his methods, data and code available for others to reproduce his findings. McIntyre's analysis has not been published in the peer-reviewed literature.

### Estimates of climate sensitivity

Equilibrium climate sensitivity refers to the equilibrium change in global mean surface temperature following a doubling of the atmospheric (equivalent) CO<sub>2</sub>





concentration. This value is estimated by the IPCC Fourth Assessment Report as "likely to be in the range 2 to 4.5 °C with a best estimate of about 3 °C."

Using a combination of surface temperature history and ocean heat content, Stephen E. Schwartz has proposed an estimate of climate sensitivity of  $1.9 \pm 1.0$  K for doubled CO<sub>2</sub>.<sup>[106]</sup>, revised upwards from  $1.1 \pm 0.5$  K<sup>[107]</sup>. Grant Foster, James Annan, Gavin Schmidt, and Michael Mann<sup>[108][109]</sup> argue that there are errors in both versions of Schwartz's analysis. Astronomer Nir Shaviv also has proposed a low value for climate sensitivity.<sup>[110][111]</sup>

### Stabilizing "Infrared Iris" Effect

Richard Lindzen proposed an Infrared Iris hypothesis of compensating meteorological processes that tend to stabilize climate change.<sup>[112]</sup> Roy Spencer et al. discovered "a net reduction in radiative input into the ocean-atmosphere system" in tropical intraseasonal oscillations that "may potentially support" the idea of an "Iris" effect, although they point out that their work is concerned with much shorter time scales.<sup>[113]</sup> If confirmed, this effect might reduce the positive "amplifying" feedback assumed in climate models.

### Internal Radiative Forcing

Roy Spencer hypothesizes there is an "Internal Radiative Forcing" affecting climate variability,<sup>[114][115]</sup>

"...mixing up of cause and effect when observing natural climate variability can lead to the mistaken conclusion that the climate system is more sensitive to greenhouse gas emissions than it really is. . . . it provides a quantitative mechanism for the (minority) view that global warming is mostly a manifestation of natural internal climate variability."

"...low frequency, internal radiative forcing amounting to little more than 1 W m<sup>-2</sup>, assumed to be proportional to a weighted average of the Southern Oscillation and Pacific Decadal Oscillation indices since 1900, produces ocean temperature behavior similar to that observed: warming from 1900 to 1940, then slight cooling through the 1970s, then resumed warming up to the present, as well as 70% of the observed centennial temperature trend."

### Predictions of greenhouse gas rises

The "standard" set of scenarios for future atmospheric greenhouse gases are the IPCC SRES scenarios. The purpose of the range of scenarios is not to predict what exact course the future of emissions will take, but what it may take under a range of possible population, economic and societal trends.<sup>[116]</sup> Climate models can be run using any of the scenarios as inputs to illustrate the different outcomes for climate change. No one scenario is officially preferred, but in practice the "A1b" scenario roughly corresponding to 1%/year growth in atmospheric CO<sub>2</sub> is often used for modelling studies.

There is debate about the various scenarios for fossil fuel consumption. Global warming skeptic Fred Singer stated that "some good experts believe" that atmospheric CO<sub>2</sub> concentration will not double since economies are becoming less reliant on carbon.<sup>[117]</sup>

However, The Stern report, like many other reports, notes the past correlation between CO<sub>2</sub> emissions and economic growth and then extrapolates using a "business as usual" scenario to predict GDP growth and hence CO<sub>2</sub> levels, concluding that:

“ Increasing scarcity of fossil fuels alone will not stop emissions growth in time. The stocks of hydrocarbons that are profitable to extract are more than enough to take the world to levels of CO<sub>2</sub> well beyond 750ppm with very dangerous consequences for climate change impacts.<sup>[118]</sup> ”

According to Lawrence Livermore National Laboratory, "the earth would warm by 8 degrees Celsius (14.4 degrees Fahrenheit) if humans use the entire planet's available fossil fuels by the year 2300."<sup>[119]</sup>

### Predictions of temperature rises

Conventional predictions of future temperature rises depend on estimates of future GHG emissions (see SRES) and the climate sensitivity. Models referenced by the Intergovernmental Panel on Climate Change (IPCC) predict that global temperatures are likely to increase by 1.1 to 6.4 °C (2.0 to 11.5 °F) between 1990 and 2100. Others have proposed that temperature increases may be higher than IPCC estimates. One theory is that the climate may reach a "tipping point" where positive feedback effects lead to runaway global warming; such feedbacks include decreased reflection of solar radiation as sea ice melts, exposing darker seawater, and the potential release of large volumes of methane from thawing permafrost.<sup>[120]</sup>

Some scientists, such as David Orrell or Henk Tennekes, say that climate change cannot be accurately predicted. Orrell says that the range of future increase in temperature suggested by the IPCC rather represents a social consensus in the climate community, but adds that "we are having a dangerous effect on the climate".<sup>[121]</sup>

A 2007 study by David Douglass and coworkers concluded that the 22 most commonly used global climate models used by the IPCC were unable to accurately predict accelerated warming in the troposphere when tuned to match actual surface warming, concluding that "projections of future climate based on these models should be viewed with much caution."<sup>[122]</sup> This result contrasts a similar study of 19 models which found that discrepancies between model predictions and actual temperature were likely due to measurement errors.<sup>[122]</sup>

### Confidence in GCM forecasts

The IPCC states it has increased confidence in forecasts coming from General Circulation Models or GCMs. Chapter 8 of AR4 reads:

*There is considerable confidence that climate models provide credible quantitative estimates of future climate change, particularly at continental scales and above. This confidence comes from the foundation of the models in accepted physical principles and from their ability to reproduce observed features of current climate and past climate changes. Confidence in model estimates is higher for some climate variables (e.g., temperature) than for others (e.g., precipitation). Over several decades of development, models have consistently provided a robust and unambiguous picture of significant climate warming in response to increasing greenhouse gases.*<sup>[123]</sup>

Certain scientists, skeptics and otherwise, believe this confidence in the models' ability to predict future climate is not earned. <sup>[124][125]</sup>

### Computer models versus Evidence-based forecasting

Kesten Green and J. Scott Armstrong have criticized the validity of model projections of future climate, arguing "Advocates of complex climate models claim that they are based on well-established laws of physics. But there is clearly much more to the models than physical laws, otherwise the models would all produce the same output, which they do not, and there would be no need for confidence estimates for model forecasts, which there certainly is. Climate models are, in effect, mathematical ways for experts to express their opinions."<sup>[126]</sup> Green and Armstrong contend that the possibility of accurate long-term climate forecasts has never been proven, and argue that simple methods always outperform more complex forecasting methods.<sup>[126]</sup> The work of Green and Armstrong has been criticized for showing insufficient domain knowledge to evaluate their own criteria and for failing to distinguish between forecasts based on past experience and projections based on physical models.<sup>[127][128]</sup>

**The poles**

**Arctic sea ice**

One unsettled question related to temperature rises is if or when the Arctic sea may become ice-free in the summer (winter sea ice remains in all scenarios). Arctic specialist Mark Serreze said, following the record low in 2007,<sup>[129]</sup> "If you asked me a couple of years ago when the Arctic could lose all of its ice then I would have said 2100, or 2070 maybe. But now I think that 2030 is a reasonable estimate."<sup>[130]</sup>

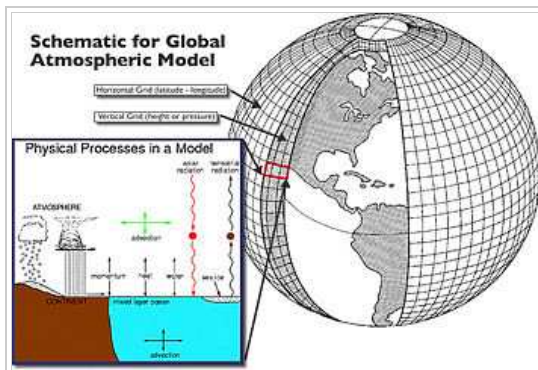
However, a 2003 paper in Nature claims that computer models predictions poorly represent observed changes in Arctic sea ice:<sup>[131]</sup>

“ The observed variability of Arctic sea ice thickness, which shows that the sea ice mass can change by up to 16% within one year, contrasts with the concept of a slowly dwindling ice pack, produced by greenhouse warming. ”

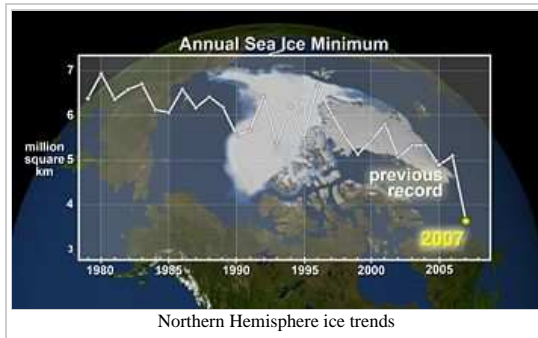
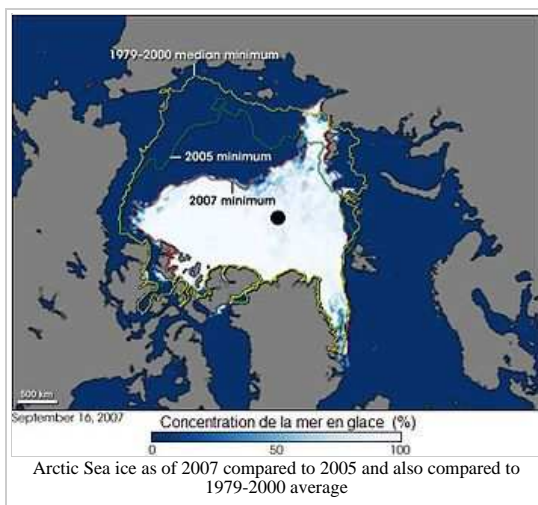
Roger A. Pielke claims melting Arctic sea ice is a result of regional warming and not global warming.<sup>[132]</sup>

“ However, in terms of relating to the global average lower tropospheric temperature changes, in June 2007 (which is the latest data posted), the global average anomaly is +0.22 after being as high recently as +0.51C in January. Thus, it is regional warming, not “global warming” that appears to be the reason for this melting (Indeed, if it were global warming, we should see a similar reduction in Antarctic sea ice coverage, which, however, is not occurring (see<sup>[133]</sup> and see<sup>[134]</sup>). ”

**Antarctic cooling**



Climate models are systems of differential equations based on the basic laws of physics, fluid motion, and chemistry. To “run” a model, scientists divide the planet into a 3-dimensional grid, apply the basic equations, and evaluate the results. The atmospheric component of the model calculates winds, heat transfer, radiation, relative humidity, surface hydrology, and surface fluxes of heat and moisture within each grid and evaluates interactions with neighboring points. The ocean component calculates currents, heat content and salinity. The atmospheric and oceanic components interact, for example with evaporation from the oceans into the atmosphere and with atmospheric winds affecting ocean currents. Different models vary in such basics as grid size and therefore do not give the same results.



The **Antarctica cooling controversy** relates to the question of whether or not current temperature trends in Antarctica contradict or cast doubt on the theory of global warming. Observations unambiguously show the Peninsula to be warming. The trends elsewhere show both warming and cooling but are smaller and dependent on season and the timespan over which the trend is computed.<sup>[135][136]</sup> Climate models predict that future trends in Antarctica are much smaller than in the Arctic.<sup>[137]</sup>

To the extent that a controversy exists it is confined to the popular press and blogs; there is no evidence of a related controversy within the scientific community. Various skeptics, most notably Michael Crichton,<sup>[138]</sup> have asserted the findings of Doran et al.<sup>[139]</sup> contradict global warming. Peter Doran, the lead author of the paper, stated that "...our results have been misused as "evidence" against global warming by Crichton in his novel 'State of Fear'..."<sup>[140]</sup> Others, for example RealClimate, agree there is no contradiction.<sup>[141]</sup>

### Dispute over data archiving and sharing

Scientific journals and funding agencies generally require authors of peer-reviewed research to archive all of the data necessary to reproduce their research. If another scientist attempts to reproduce the research and needs additional data, authors are expected (with few exceptions) to provide the data, metadata, methods and source code that may be necessary.

Skeptics have charged that climate scientists do not abide by these policies and complained to Congress.<sup>[142]</sup> One example of this dispute relates to the surface temperature record. Hadley Centre at University of East Anglia is the keeper of the HADCRUT3 temperature record and has refused to provide any temperature data or source code. NASA's GISS keeps the GISTEMP record and provides a data archive but until recently had refused to provide enough information about its methods and its source code to reproduce its results.

## Political, economic, and social aspects of the controversy

*See also: Politics of global warming and Economics of global warming*

In the U.S. global warming is often a partisan political issue. Republicans tend to oppose action against a threat that they regard as unproved, while Democrats tend to support actions that they believe will reduce global warming and its effects through the control of greenhouse gas emissions.<sup>[143]</sup> Recently, bipartisan measures have been introduced.<sup>[144]</sup>

Kevin E. Trenberth stated:

“ The SPM was approved line by line by governments. . . .The argument here is that the scientists determine what can be said, but the governments determine how it can best be said. Negotiations occur over wording to ensure accuracy, balance, clarity of message, and relevance to understanding and policy. The IPCC process is dependent on the good will of the participants in producing a balanced assessment. However, in Shanghai, it appeared that there were attempts to blunt, and perhaps obfuscate, the messages in the report, most notably by Saudi Arabia. This led to very protracted debates over wording on even bland and what should be uncontroversial text... The most contentious paragraph in the IPCC (2001) SPM was the concluding one on attribution. After much debate, the following was carefully crafted: "In the light of new evidence, and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse-gas concentrations."<sup>[145]</sup>

As more evidence has become available over the existence of global warming debate has moved to further controversial issues, including:

1. The social and environmental impacts
2. The appropriate response to climate change
3. Whether decisions require less uncertainty

The single largest issue is the importance of a few degrees rise in temperature:

“ Most people say, "A few degrees? So what? If I change my thermostat a few degrees, I'll live fine." ... The point is that one or two degrees is about the experience that we have had in the last 10,000 years, the era of human civilization. There haven't been--globally averaged, we're talking--fluctuations of more than a degree or so. So we're actually getting into uncharted territory from the point of view of the relatively benign climate of the last 10,000 years, if we warm up more than a degree or two. (Stephen H. Schneider<sup>[146]</sup>)

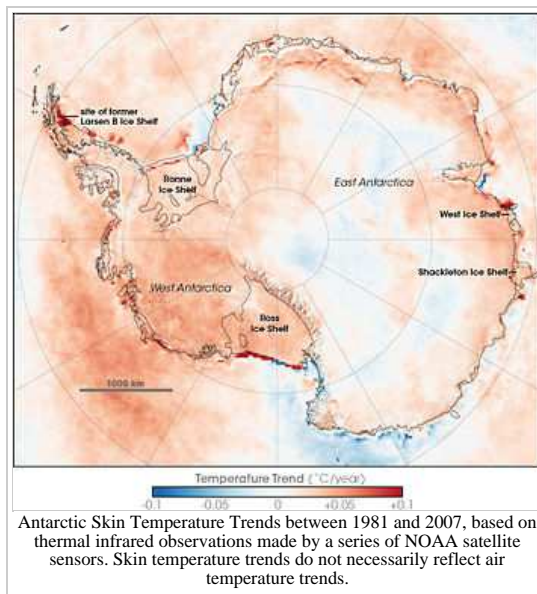
The other point that leads to major controversy—because it could have significant economic impacts—is whether action (usually, restrictions on the use of fossil fuels to reduce carbon-dioxide emissions) should be taken now, or in the near future; and whether those restrictions would have any meaningful effect on global temperature.

Due to the economic ramifications of such restrictions, there are those, including the Cato Institute, a libertarian think tank, who feel strongly that the negative economic effects of emission controls outweigh the environmental benefits.<sup>[147]</sup> They claim that even if global warming is caused solely by the burning of fossil fuels, restricting their use would have more damaging effects on the world economy than the increases in global temperature.<sup>[148]</sup>

“ The linkage between coal, electricity, and economic growth in the United States is as clear as it can be. And it is required for the way we live, the way we work, for our economic success, and for our future. Coal-fired electricity generation. It is necessary.(Fred Palmer, President of Western Fuels Association<sup>[148]</sup>)

Conversely, others feel strongly that early action to reduce emissions would help avoid much greater economic costs later, and would reduce the risk of catastrophic, irreversible change.<sup>[118]</sup> In his December 2006 book, *Hell and High Water*, energy technology expert Joseph J. Romm

“ discusses the urgency to act and the sad fact that America is refusing to do so.... Romm gives a name to those such as ExxonMobil who deny that global warming is occurring and are working to persuade others of this money-making myth: they are the Denyers and Delayers. They are better rhetoricians than scientists are.... Romm gives us 10 years to change the way we live before it's too late to use existing technology to save the world. ...humanity already possesses the fundamental scientific, technical, and industrial know-how to solve the carbon and climate problem for the next half-century. The tragedy, then, as historians of the future will most certainly recount, is that we ruined their world not because we lacked the knowledge or the technology to save it but simply because we chose not to make the effort”





(*Hell and High Water*, p. 25).<sup>[149]</sup>

Ultimately, however, a strictly economic argument for or against action on climate change is limited at best, failing to take into consideration other potential impacts of any change.

## Kyoto Protocol

The Kyoto protocol is the most prominent international agreement on climate change, and is also highly controversial. Some argue that it goes too far<sup>[150]</sup> or not nearly far enough<sup>[151]</sup> in restricting emissions of greenhouse gases. Another area of controversy is the fact that India and China, the world's two most populous countries, both ratified the protocol but are not required to reduce or even limit the growth of carbon emissions under the present agreement. Furthermore, it has also been argued that it would cause more damage to the economy of the U.S. than to those of other countries, thus providing an unfair economic advantage to some countries.<sup>[152]</sup> Additionally, high costs of decreasing emissions may cause significant production to move to countries that are not covered under the treaty, such as India and China, claims Fred Singer.<sup>[153]</sup> As these countries are less energy efficient, this scenario is claimed to cause additional carbon emissions.

The only major developed nation which has signed but not ratified the Kyoto protocol is the USA (see signatories). The countries with no official position on Kyoto are mainly African countries with underdeveloped scientific infrastructure or are oil producers.

## Funding for partisans

Both sides of the controversy have alleged that access to funding has played a role in the willingness of credentialed experts to speak out.

### Funding for scientists who do not acknowledge anthropogenic global warming

Several skeptical scientists—Fred Singer, Fred Seitz and Patrick Michaels—have been linked to organizations funded by ExxonMobil and Philip Morris for the purpose of promoting global warming skepticism (see section: Risks of passive smoking). Similarly, groups employing global warming skeptics, such as the George C. Marshall Institute, have been criticized for their ties to fossil fuel companies.<sup>[154]</sup>

On February 2, 2007, *The Guardian* stated<sup>[155][156]</sup> that Kenneth Green, a Visiting Scholar with AEI, had sent letters<sup>[157]</sup> to scientists in the UK and the U.S., offering US\$10,000 plus travel expenses and other incidental payments in return for essays with the purpose of "highlight[ing] the strengths and weaknesses of the IPCC process," specifically regarding the IPCC Fourth Assessment Report.

A furor was raised when it was revealed that the Intermountain Rural Electric Association (an energy cooperative that draws a significant portion of its electricity from coal-burning plants) donated \$100,000 to Patrick Michaels and his group, New Hope Environmental Services, and solicited additional private donations from its members.<sup>[158][159][160]</sup>

The Union of Concerned Scientists have produced a report titled 'Smoke, Mirrors & Hot Air',<sup>[161]</sup> that criticizes ExxonMobil for "underwriting the most sophisticated and most successful disinformation campaign since the tobacco industry" and for "funneling about \$16 million between 1998 and 2005 to a network of ideological and advocacy organizations that manufacture uncertainty on the issue." In 2006 Exxon claimed that it was no longer going to fund these groups<sup>[162]</sup> though that claim has been challenged by Greenpeace.<sup>[163]</sup>

The Center for the Study of Carbon Dioxide and Global Change, a skeptic group, when confronted about the funding of a video they put together (\$250,000 for "The Greening of Planet Earth" from an oil company) stated, "We applaud Western Fuels for their willingness to publicize a side of the story that we believe to be far more correct than what at one time was 'generally accepted.' But does this mean that they fund The Center? Maybe it means that we fund them!"<sup>[164]</sup>

Donald Kennedy, editor-in-chief of *Science*, has said that skeptics such as Michaels are lobbyists more than researchers, and that "I don't think it's unethical any more than most lobbying is unethical," he said. He said donations to skeptics amounts to "trying to get a political message across."<sup>[165]</sup>

### Funding for scientists who acknowledge anthropogenic global warming

A number of global warming skeptics, such as the following, assert that grant money is given preferentially to supporters of global warming theory. Atmospheric scientist Reid Bryson said in June 2007 that "There is a lot of money to be made in this... If you want to be an eminent scientist you have to have a lot of grad students and a lot of grants. You can't get grants unless you say, 'Oh global warming, yes, yes, carbon dioxide.'"<sup>[166]</sup> Similar claims have been advanced by climatologist Marcel Leroux,<sup>[167]</sup> NASA's Roy Spencer, climatologist and IPCC contributor John Christy, University of London biogeographer Philip Stott,<sup>[168]</sup> and Accuracy in Media.<sup>[169]</sup>

Richard S. Lindzen, the Alfred P. Sloan Professor of Meteorology at MIT, makes the specific claim that "in the winter of 1989 Reginald Newell, a professor of meteorology at MIT, lost National Science Foundation funding for data analyses that were failing to show net warming over the past century." Lindzen also suggests four other scientists "apparently" lost their funding or positions after questioning the scientific underpinnings of global warming.<sup>[170]</sup> Lindzen himself, however, has been the recipient of money from energy interests such as OPEC and the Western Fuels Association, including "\$2,500 a day for his consulting services",<sup>[171]</sup> as well as funding from federal sources including the National Science Foundation, the Department of Energy, and NASA.<sup>[172]</sup>

## Changing position of some skeptics

In recent years some skeptics have changed their positions regarding anthropogenic global warming. Ronald Bailey, author of *Global Warming and Other Eco-Myths* (published by the Competitive Enterprise Institute in 2002), stated in 2005, "Anyone still holding onto the idea that there is no global warming ought to hang it up".<sup>[173]</sup> By 2007, he wrote "Details like sea level rise will continue to be debated by researchers, but if the debate over whether or not humanity is contributing to global warming wasn't over before, it is now.... as the new IPCC Summary makes clear, climate change Pollyannaism is no longer looking very tenable".<sup>[174]</sup> Others have shifted from claims that global warming is unproven to advocating adaptation, sometimes also calling for more data, rather than take immediate action on *mitigation* through consumption/emissions reduction of fossil fuels. "Despite our intuition that we need to do something drastic about global warming, we are in danger of implementing a cure that is more costly than the original affliction: economic analyses clearly show that it will be far more expensive to cut carbon dioxide emissions radically than to pay the costs of adaptation to the increased temperatures," says Danish academic Bjørn Lomborg.<sup>[175]</sup> Lomborg has been severely questioned by groups in Denmark.<sup>[176]</sup> Nordhaus and Schellenberger<sup>[177]</sup> present similar, more sophisticated, arguments in favor of adaption.

"There are alternatives to its "the climate-change crusade's" insistence that the only appropriate policy response is steep and immediate emissions reductions.... a greenhouse-gas-emissions cap ultimately would constrain energy production. A sensible climate policy would emphasize building resilience into our capacity to adapt to climate changes.... we should consider strategies of adaptation to a changing climate. A rise in the sea level need not be the end of the world, as the Dutch have taught us." says Steven F. Hayward of American Enterprise Institute, a conservative think-tank.<sup>[178]</sup> Hayward also advocates the use of "orbiting mirrors to rebalance the amounts of solar radiation different parts of the earth receive" -- an example of so-called geoengineering.

In 2001 Richard Lindzen in response to the question, "*Kyoto aside for a moment, should we be trying to reduce carbon dioxide emissions? Do our concerns about global warming require action?*" said "We should prioritize our responses. You can't just say, "No matter what the cost, and no matter how little the benefit, we'll do this." If we truly believe in warming, then we've already decided we're going to adjust...The reason we adjust to things far better than Bangladesh is that we're richer. Wouldn't you think it makes sense to make sure we're as robust and wealthy as possible? And that the poor of the world are also as robust and wealthy as possible?"<sup>[179]</sup>

Others argue that if developing nations reach the wealth level of the United States this could greatly increase CO<sub>2</sub> emissions and consumption of fossil fuels. Large developing nations such as India and China are predicted to be major emitters of greenhouse gases in the next few decades as their economies grow.<sup>[180][181]</sup>

The conservative National Center for Policy Analysis whose "Environmental Task Force" contains a number of climate change skeptics including Sherwood Idso and S. Fred Singer<sup>[182]</sup> says, "The growing consensus on climate change policies is that adaptation will protect present and future generations from climate-sensitive risks far more than efforts to restrict CO<sub>2</sub> emissions."<sup>[183]</sup>

The adaptation only plan is also endorsed by oil companies like ExxonMobil, "ExxonMobil's plan appears to be to stay the course and try to adjust when changes occur. The company's plan is one that involves adaptation, as opposed to leadership," <sup>[184]</sup> says this Ceres report.<sup>[185]</sup>

The Bush administration has also voiced support for an adaptation only policy. "In a stark shift for the Bush administration, the United States has sent a climate report [*U.S. Climate Action Report 2002*] to the United Nations detailing specific and far-reaching effects it says global warming will inflict on the American environment. In the report, the administration also for the first time places most of the blame for recent global warming on human actions -- mainly the burning of fossil fuels that send heat-trapping greenhouse gases into the atmosphere". The report however "does not propose any major shift in the administration's policy on greenhouse gases. Instead it recommends adapting to inevitable changes instead of making rapid and drastic reductions in greenhouse gases to limit warming."<sup>[186]</sup>

This position apparently precipitated a similar shift in emphasis at the COP 8 climate talks in New Delhi several months later,<sup>[187]</sup> "The shift satisfies the Bush administration, which has fought to avoid mandatory cuts in emissions for fear it would harm the economy. 'We're welcoming a focus on more of a balance on adaptation versus mitigation,' said a senior American negotiator in New Delhi. 'You don't have enough money to do everything.'"<sup>[188]</sup> see also [10]

(<http://www.washingtonpost.com/wp-dyn/content/article/2007/04/06/AR2007040600291.html>) . The White House emphasis on adaptation was not well received however:

“ *Despite conceding that our consumption of fossil fuels is causing serious damage and despite implying that current policy is inadequate, the Report fails to take the next step and recommend serious alternatives. Rather, it suggests that we simply need to accommodate to the coming changes. For example, reminiscent of former Interior Secretary Hodel's proposal that the government address the hole in the ozone layer by encouraging Americans to make better use of sunglasses, suntan lotion and broad-brimmed hats, the Report suggests that we can deal with heat-related health impacts by increased use of air-conditioning ... Far from proposing solutions to the climate change problem, the Administration has been adopting energy policies that would actually increase greenhouse gas emissions. Notably, even as the Report identifies increased air conditioner use as one of the 'solutions' to climate change impacts, the Department of Energy has decided to roll back energy efficiency standards for air conditioners.*"<sup>[189]</sup> Letter from 11 State Attorneys General to George W. Bush. ”

Some find this shift and attitude disingenuous and indicative of an inherent bias against prevention (i.e. reducing emissions/consumption) and for the prolonging of profits to the oil industry at the expense of the environment. "Now that the dismissal of climate change is no longer fashionable, the professional deniers are trying another means of stopping us from taking action. It would be cheaper, they say, to wait for the impacts of climate change and then adapt to them" says UK Journalist George Monbiot<sup>[190]</sup> in an article addressing the supposed economic hazards of addressing climate change. Others argue that adaptation alone will not be sufficient.<sup>[191]</sup> See also Copenhagen Consensus.

To be sure, though not emphasized to the same degree as mitigation, adaptation to a climate certain to change has been included as a necessary component in the discussion early as 1992<sup>[192]</sup>, and has been all along.<sup>[193][194]</sup> However it was not to the *exclusion*, advocated by the skeptics, of *preventative* mitigation efforts, and therein, say carbon cutting proponents, lies the difference.

## Political pressure on scientists

Many climate scientists state that they are put under enormous pressure to distort or hide any scientific results which suggest that human activity is to blame for global warming. A survey of climate scientists which was reported to the US House Oversight and Government Reform Committee noted that "Nearly half of all respondents perceived or personally experienced pressure to eliminate the words 'climate change', 'global warming' or other similar terms from a variety of communications." These scientists were pressured to tailor their reports on global warming to fit the Bush administration's climate change scepticism. In some cases, this occurred at the request of a former oil-industry lobbyist.<sup>[195]</sup> In a report by NASA's Office of the Inspector General it has been revealed that NASA officials censored and suppressed scientific data on global warming in order protect the Bush administration from controversy close to the 2004 presidential election<sup>[196]</sup>.

U.S. officials, such as Philip Cooney, have repeatedly edited scientific reports from US government scientists,<sup>[197]</sup> many of whom, such as Thomas Knutson, have been ordered to refrain from discussing climate change and related topics.<sup>[198][199][200]</sup> Attempts to suppress scientific information on global warming and other issues have been described by journalist Chris Mooney in his book *The Republican War on Science*.

Climate scientist James Hansen, director of NASA's Goddard Institute for Space Studies, claimed in a widely cited *New York Times* article<sup>[201]</sup> in 2006 that his superiors at the agency were trying to "censor" information "going out to the public." NASA denied this, saying that it was merely requiring that scientists make a distinction between personal, and official government, views in interviews conducted as part of work done at the agency. Several scientists working at the National Oceanic and Atmospheric Administration have made similar complaints;<sup>[202]</sup> once again, government officials said they were enforcing long-standing policies requiring government scientists to clearly identify personal opinions as such when participating in public interviews and forums.

The BBC's long-running current affairs series *Panorama* recently investigated the issue, and was told that "scientific reports about global warming have been systematically changed and suppressed."<sup>[203]</sup>

On the other hand, some American climatologists who have expressed doubts regarding the certainty of human influence in climate change have been criticized by politicians and governmental agencies. Oregon Governor Ted Kulongoski publicly clarified that Oregon does not officially appoint a "state climatologist" in response to Oregon State University's George Taylor's use of that title.<sup>[204][205]</sup> As a result of scientific doubts he has expressed regarding global warming, the Delaware Department of Natural Resources and Environmental Control reportedly attempted to remove David Legates from his office of Delaware State Climatologist. In late 2006, Virginia Governor Tim Kaine (D) reportedly began an investigation of Virginia State Climatologist and global warming skeptic Patrick Michaels.

Mike Hulme, director of the Tyndall Centre for Climate Research, wrote how increasing use of pejorative terms like "catastrophic," "chaotic" and "irreversible," had altered the public discourse around climate change: "This discourse is now characterised by phrases such as 'climate change is worse than we thought', that we are approaching 'irreversible tipping in the Earth's climate', and that we are 'at the point of no return'. I have found myself increasingly chastised by climate change campaigners when my public statements and lectures on climate change have not satisfied their thirst for environmental drama and exaggerated rhetoric."<sup>[206]</sup>

According to an Associated Press release on January 30, 2007,

"Climate scientists at seven government agencies say they have been subjected to political pressure aimed at downplaying the threat of global warming."

"The groups presented a survey that shows two in five of the 279 climate scientists who responded to a questionnaire complained that some of their scientific papers had been edited in a way that changed their meaning. Nearly half of the 279 said in response to another question that at some point they had been told to delete reference to "global warming" or "climate change" from a report."<sup>[207]</sup>

Critics writing in the *Wall Street Journal* editorial page claim that the survey<sup>[208]</sup> was itself unscientific.<sup>[209]</sup>

## Litigation

Several lawsuits have been filed over global warming. For example, *Massachusetts v. Environmental Protection Agency* before the Supreme Court of the United States forces the US government to regulate greenhouse gases under the Clean Air Act. A similar approach was taken by California Attorney General Bill Lockyer who filed a lawsuit *California v. General Motors Corp.* to force car manufacturers to reduce vehicles' emissions of carbon dioxide. This lawsuit was found to lack legal merit and was tossed.<sup>[210]</sup> A third case, *Comer v. Murphy Oil USA, Inc.*, a class action lawsuit filed by Gerald Maples, a trial attorney in Mississippi, in an effort to force fossil fuel and chemical companies to pay for damages caused by global warming. Described as a nuisance lawsuit, it was dismissed by District Court.<sup>[211]</sup> The Sierra Club sued the U.S. government over failure to raise automobile fuel efficiency standards, and thereby decrease carbon dioxide emissions.<sup>[212][213]</sup>

## Betting

A betting market on climate futures, like other kinds of futures markets, could be used to establish the market consensus on climate change.<sup>[214][215]</sup> British climate scientist James Annan proposed bets with global warming skeptics concerning whether future temperatures will increase. Two Russian solar physicists, Galina Mashnich and Vladimir Bashkirtsev, accepted the wager of US\$10,000 that the average global temperature during 2012-2017 would be lower than during 1998-2003.<sup>[216]</sup> Annan first directly challenged Richard Lindzen. Lindzen had been willing to bet that global temperatures would drop over the next 20 years. Annan claimed Lindzen wanted odds of 50-1 against falling temperatures. Lindzen, however, claims that he asked for 2-1 odds against a temperature rise of over 0.4 °C.<sup>[217]</sup> *The Guardian* columnist George Monbiot challenged Myron Ebell of the Competitive Enterprise Institute to a GB£5,000 bet of global warming versus global cooling.<sup>[218]</sup> Annan and other proponents of the consensus state they have challenged other skeptics to bets over global warming that were not accepted,<sup>[219]</sup> including Annan's attempt in 2005 to accept a bet that had been offered by Patrick Michaels in 1998 that temperatures would be cooler after ten years. [11] (<http://julesandjames.blogspot.com/2005/05/yes-more-betting-on-climate-with-world.html>) A different, \$6,000-to-\$9,000 bet, where both sides expect warming but differ on the amount, with one break-even point at 0.15 °C/decade, was made between Dr David Evans and Brian Schmidt. [12] (<http://backseatdriving.blogspot.com/2007/04/new-global-warming-bet-for-7-10.html>) Dr Evans' reasons are described here. [13] (<http://backseatdriving.blogspot.com/2007/04/climate-skeptics-guest-post-why-david.html>)

## Global warming and the precautionary principle

Numerous authors have applied the precautionary principle to the global warming debate,<sup>[220][221]</sup> some likening the debate to Pascal's wager.<sup>[222]</sup> The principle stems out of the debate on whether or not governments should adopt the precautionary principle and act to reduce emissions even in the absence of certainty regarding warming. The principle postulates that it is a better "bet" to act as if global warming exists than otherwise, because the expected value of acting — that is, the fact that the impending crises due to global warming will have been averted — is always greater than the expected value of inaction.

## Related controversies

Many of the critics of the consensus view on global warming have disagreed, in whole or part, with the scientific consensus regarding other issues, particularly those relating to environmental risks. Chris Mooney, author of *The Republican War on Science*, has argued that the appearance of overlapping groups of skeptical scientists, commentators and think tanks in seemingly unrelated controversies results from an organised attempt to replace scientific analysis with political ideology. Mooney claims that the promotion of doubt regarding issues that are politically, but not scientifically, controversial has become increasingly prevalent under the Bush Administration and constitutes a "Republican war on science". This is also the subject of a recent book by Environmental lawyer Robert F. Kennedy Jr. entitled *Crimes Against Nature: How George W. Bush and Corporate Pals are Plundering the Country and Hijacking Our Democracy*. Another book on this topic is *The Assault on Reason* by former U.S. Vice-President Al Gore. Earlier instances of this trend are also covered in the book *The Heat Is On* by Ross Gelbspan.

Some critics of the scientific consensus on global warming have argued that these issues should not be linked and that reference to them constitutes an unjustified ad hominem attack.<sup>[223]</sup> Political scientist Roger Pielke, Jr., responding to Mooney, has argued that science is inevitably intertwined with politics.<sup>[224]</sup>

## CFCs and ozone layer

Human emissions of chlorofluorocarbons (CFCs) lead to depletion of the ozone layer in the atmosphere and intensify ozone holes over the Antarctic. This concept was politically controversial in the 1990s but was broadly accepted in the scientific community (e.g., by the U.S. National Academy of Sciences and other national academies); Paul Crutzen, Mario Molina, and F. Sherwood Rowland were awarded the 1995 Nobel Prize in Chemistry for discovering the chemical mechanism that links CFCs to ozone depletion. The Montreal Protocol was negotiated under the auspices of the United Nations and is widely seen as a model for the Kyoto Protocol. The scientific basis of ozone depletion has been disputed by some global warming skeptics and related institutions, including Sallie Baliunas,<sup>[225]</sup> Patrick Michaels,<sup>[226]</sup> Kary Mullis,<sup>[227]</sup> Steven Milloy,<sup>[228][229]</sup> Patrick Michaels,<sup>[230]</sup> Kary Mullis,<sup>[231]</sup> Steven Milloy,<sup>[232][233]</sup> Fred Singer,<sup>[234][235]</sup> and Frederick Seitz.<sup>[236]</sup>

## Risks of passive smoking

By the early 1980s,<sup>[237]</sup> concerns began to arise regarding the health risks of passive smoking and whether policy responses such as smoking bans are appropriate. Medical, governmental, and UN organizations such as the United States Surgeon General,<sup>[238]</sup> the United States Environmental Protection Agency,<sup>[239]</sup> and the International Agency for Research on Cancer (IARC) of the World Health Organization<sup>[240]</sup> have concluded that the scientific evidence shows that passive smoking is harmful. The risks of passive smoking were disputed by some global warming skeptics and related institutions, including Richard Lindzen,<sup>[241][242]</sup> Steven Milloy,<sup>[243]</sup> Fred Singer (1994),<sup>[244]</sup> Fred Seitz,<sup>[245]</sup> Michael Crichton,<sup>[16]</sup> Michael Fumento in 1997<sup>[246][247]</sup> the Cooler Heads Coalition (Consumer Alert)<sup>[248][249]</sup> and the Institute of Public Affairs.<sup>[250][251]</sup> According to the Union of Concerned Scientists<sup>[252][253]</sup> criticism of the scientific consensus on smoking and on global warming was embodied in The Advancement of Sound Science Coalition, a lobby group<sup>[254][255]</sup> directed by Milloy and established with support from Philip Morris and subsequently from ExxonMobil. Science advisors to TASSC included Fred Singer, Fred Seitz and Patrick Michaels.<sup>[252][256]</sup> TASSC originally campaigned against restrictions on passive smoking, and later on global warming.

## See also

- Avoiding Dangerous Climate Change
- Center for the Study of Carbon Dioxide and Global Change
- Climate change denial
- Environmental skepticism
- Global cooling
- Hockey stick controversy
- Hubbert peak theory
- Supporters and opponents:
  - Scientific organizations that have stated support for, or opposition to, the scientific opinion on climate change
  - List of scientists opposing the mainstream scientific assessment of global warming
  - Skeptical organizations and individuals
  - Former skeptics
- Scientific skepticism
- 1500-Year climate cycle
- *An Inconvenient Truth*
- *Hell and High Water*
- *The Great Global Warming Swindle*
- *The Republican War on Science*
- Michael Crichton

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## External links

### Related to debates

- A Public Debate on the Science of Global Warming (<http://www.pitt.edu/~gordonm/Pubdeb/SPFtranscript.pdf>) : Dr. James E. Hansen and Dr. Patrick J. Michaels, November 20, 1998.
- Debate (<http://www.npr.org/templates/story/story.php?storyId=9082151>) on March 15, 2007 sponsored by Intelligence Squared involving Richard Lindzen, Philip Stott, Michael Crichton, Gavin Schmidt, Brenda Ekwurzel, and Richard C. J. Somerville

### Related to the hockey stick graph

- ClimateAudit: statistical criticism of "hockey stick" climate history reconstructions (<http://www.climateaudit.org>)
- False Claims by McIntyre and McKittrick regarding the Mann et al. (1998) reconstruction (<http://www.realclimate.org/index.php?p=8>) : Contains links to several sources disputing the McIntyre and McKittrick critique of Michael Mann’s famous graph.

### Climate-specialized media

- Friends of Science: Providing Insight into Climate Science (<http://www.friendsofscience.org/index.php?id=2>)
- National Oceanic & Atmospheric Administration article (<http://www.noaanews.noaa.gov/stories2006/s2720.htm>) , September 2006 Global temperatures 4th warmest on record/local U.S. temperatures 0.7 °F (−17.4 °C) below 20th century average.
- Climate Catastrophe Canceled: What You’re Not Being Told About the Science of Climate Change (<http://www.friendsofscience.org/index.php?id=158>) : Five-part documentary from the Canadian "Friends of Science Society".

### Other media

- CO<sub>2</sub> or Solar? (<http://www.sciencebits.com/CO2orSolar>) A discussion about the evidence for anthropogenic warming and the possible role of solar activity increase.
- Climate scepticism: The top 10 ([http://news.bbc.co.uk/2/hi/in\\_depth/629/629/7074601.stm](http://news.bbc.co.uk/2/hi/in_depth/629/629/7074601.stm)) , a list from the BBC of the top reasons why climate sceptics dispute the evidence that human activities such as industrial emissions of greenhouse gases and deforestation are bringing potentially dangerous changes to the Earth’s climate.
- The Greenhouse Conspiracy (<http://www.rightmarch.com/media/greenhouse.ram>) : British television documentary aired in 1990, noting the lack of concrete evidence for global warming in 1990.
- MU Professor Refutes National Television Ads Downplaying Global Warming (<https://cf.iats.missouri.edu/news/NewsBureauSingleNews.cfm?newsid=9842>) Engineering Professor Curt Davis says CEI TV Spots are Misrepresenting His Research.
- The Denial Machine (<http://www.cbc.ca/fifth/denialmachine/index.html>) : Information about a documentary arguing that the fossil fuel industry kept the global warming debate alive long after the science had been settled.
- Global Warming or Global Governance? (Google video) (<http://video.google.com/videoplay?docid=3069943905833454241&q=Global+warming&total=30530&start=10&num=10&so=0&type=search&plindex=4>) - the other side of the global warming story
- Kyoto protocol based on flawed statistics ([http://www.uoguelph.ca/~rmckitri/research/Climate\\_L.pdf](http://www.uoguelph.ca/~rmckitri/research/Climate_L.pdf)) by Marcel Croc, translation by Angela den Tex, *Natuurwetenschap & Techniek*, February, 2005.
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