

A painting depicting a family in 18th-century attire. A man in a grey coat sits at the top, looking down at a woman who is holding her head in her hands. A young girl in a pink dress looks up at the man. In the foreground, a large glass of punch sits on a table. The scene is dimly lit, with a lamp on the left.

# GLOBAL WARMING

## and the irrelevance of science

Richard Lindzen

The Global Warming Policy Foundation

GWPF Essay 4



# **GLOBAL WARMING** **and the irrelevance of science**

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## **About the author**

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## **Note**

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In many fields, governments have a monopoly on the support of scientific research. Ideally, they support the science because they believe objective research to be valuable. Unfortunately, as anticipated by Eisenhower in his farewell speech from 17 January 1961 (the one that also warned of the military–industrial complex), ‘Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity.’ Under these circumstances, when the government wants a particular scientific outcome the ideal arrangement is vulnerable. However, as I hope to show, the problem is not simply bias. Rather, the powers that be invent the narrative independently of the views of even cooperating scientists. It is in this sense that the science becomes irrelevant. This was certainly the case in the first half of the twentieth century, where we just have to look at Lysenkoism in the former Soviet Union,<sup>1</sup> social Darwinism and eugenics throughout the western world,<sup>2</sup> as well as the unfounded demonisation of DDT in the 1960s.<sup>3</sup> Each phenomenon led to millions of deaths. And, in each case, the scientific community was essentially paralysed, if not actually complicit.

Will climate catastrophism join this list? It appears so. The position of the policy world is clear. Here is President Obama’s constant refrain:

Climate change is contributing to extreme weather, wildfires, and drought, and that rising temperatures can lead to more smog and more allergens in the air we breathe, meaning more kids are exposed to the triggers that can cause asthma attacks.

Pope Francis, President Hollande, and virtually all state leaders have chimed in with similar proclamations. And yet, the whole proposition is largely without basis and highly implausible. The association with asthma that is regularly made by both Obama and Hillary Clinton is a good example of nonsense driven by focus groups who find this to be an effective scare theme.

The other claims are no better. In the 1970s the scientific community regularly designated warm periods as ‘climate optima’. That carbon dioxide was essential to plants and effectively a fertiliser was also widely understood. Thus, it was not surprising that the early environmental movement chose to promote fear of global cooling, which, not surprisingly, was attributed to industrial emissions (most notably sulphates).<sup>4</sup>

However, in the late 1970s it was recognised that sulphates could be scrubbed, that the irreducible product of industrial emissions was carbon dioxide, that carbon dioxide emissions were likely to warm rather than cool, and that there was an hypothetical process whereby this warming could be amplified (by what came to be known as the water vapour feedback).<sup>5</sup> At this point the whole narrative was turned on its head. The hitherto optimal warming was now put forth as a consequence to be feared. President Carter’s science adviser, Frank Press, had the National Research Council investigate the matter, leading to the famous Charney Report from 1979.<sup>6</sup>

This report summarised the results of the primitive climate models of that period, and found that they had a range of sensitivities to a doubling of carbon dioxide concentrations of 1.5–4.5°C.<sup>7</sup> The report regarded such results as possible but attached little credibility to the models, noting the need to better understand why the models behaved as they did. The report nonetheless provided a measure of credibility to the warming hypothesis. The whole situation was eerily reminiscent of Orwell's *Animal Farm*, when 'four legs good, two legs bad' became 'four legs good, two legs better'.

Repetition was the mechanism used to convince. So was the claim, already made by 1988 in *Newsweek*, that 'all scientists agreed.' The larger public thus had no reason to actually dig into the science. Indeed, the actual science had already become irrelevant. This new narrative depended not only on the allegation of consensus, but also on lineage. It was always pointed out that the greenhouse effect had already been identified in the early 19th Century by Tyndall,<sup>8</sup> later by Arrhenius,<sup>9</sup> and still later by Callendar.<sup>10</sup> While this was true, it was also the case that the effect was generally held to be of much less importance than changes in the general circulation related to transport. For example, in an important collection of papers from 1955<sup>11</sup> with contributions from the leading climate scientists of the period – Charney, Phillips, Lorenz, Eliassen, Smagorinsky, etc. – increasing carbon dioxide was barely mentioned, and the greenhouse effect was not mentioned at all. The model favored for global cooling alarm was the Budyko–Sellers model,<sup>12</sup> which also focused on meridional heat transport. Only with the decision to push global warming alarm did the greenhouse effect become central to the discussion of climate. Needless to add, consensus and lineage are not generally regarded as the backbones of science.

The implausibility or even outright silliness through which global warming became global warming catastrophism\* is so extensive that one hardly knows where to begin. It is crucial to emphasise catastrophism because the situation is made even more incoherent by the intentional conflation of simple basic results that are widely agreed upon, but which have no catastrophic implications, with catastrophism itself.

Currently, there really is quite a lot of basic agreement within the climate science world:

- climate change exists
- there has been warming since the Little Ice Age ended around the beginning of the 19th century (well before emissions are regarded as contributing significantly)
- human emissions can contribute to climate change
- levels of CO<sub>2</sub> in the atmosphere have been increasing.

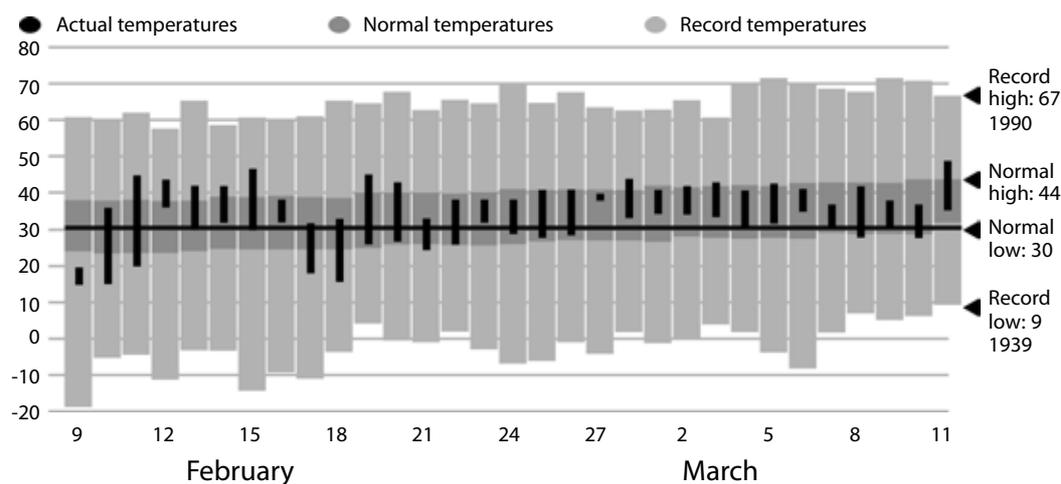
None of this is controversial and none of this actually implies alarm. However, in the policy world, as emerges from virtually any reading of the current political discourse

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\* Sometimes referred to as CAGW, catastrophic anthropogenic global warming.

and its attendant media coverage, the innocuous agreement is taken to be equivalent (with essentially no support from observations, theory or even models) to rampant catastrophism. There are numerous examples of the issuance of unalarming claims, regardless of their validity or lack thereof, that are interpreted as demanding immediate action. Perhaps the most striking example involves the iconic statement of the IPCC: Most of the warming over the past 50 years is due to man. Is this statement actually alarming? First, we are speaking of small changes.  $0.25^{\circ}\text{C}$  would be about 51% of the recent warming. Given the uncertainties in both the data and its analysis, this is barely distinguishable from zero. Evidence of this uncertainty is shown by the common adjustments of this magnitude that are made to the record.

Some charts from the weather page of the *Boston Globe* of 12 March 2013 – any other date would serve as well – illustrate how small the changes really are. In the attached figure we see the high and low temperatures for each day in the preceding month (black), the average high and low temperature for each date (dark grey) and the record high and low temperature for each date (light grey). The width of the black horizontal line corresponds to the change in the global mean temperature anomaly over the past 150 years.



**Figure 1: Actual, normal and record temperatures**

Temperatures in degrees Fahrenheit for a period spanning February and March. Redrawn from the *Boston Globe*, 12 March 2013.

High and low temperatures result from the advection of air roughly along the path of the jet stream. This path changes from day to day and year to year. Record breaking temperatures, regardless of the year that they occurred, correspond roughly to the warmest and coldest temperatures on the temperature map for 11 March.

Second, the recent warming episode is not at all unprecedented. The almost identical episode from about 1919–1940 cannot be attributed to man.

Third, the observed warming is completely consistent with low climate sensitivity. Alarm requires, for starters (and only for starters), high sensitivity. By sensitivity, we mean how much warming we expect for each doubling of carbon dioxide concentrations. High sensitivity is generally regarded as 3°C or more. If we were to assume that *all* warming over the past 50 years were due to added greenhouse gases, we would conclude that the sensitivity was about 1°C. How do models with much higher sensitivity manage to replicate the past 50 years? They do so by subtracting from the greenhouse warming essentially unknown aerosols, which they then include as due to human emissions. However, in a recent paper from the Max Planck Institute, Stevens (2015) finds that aerosols are limited and unable to compensate for the higher sensitivities.<sup>13</sup> If man accounts for only 51% of the recent warming, then even modest future warming becomes implausible.

Although it has become commonplace to fear warming, it is worth noting that the approximately 1°C warming since the 19th century has been accompanied by the improvement of all indices of human welfare, including environmental quality.

Indeed, the very notion that climate is described by a single number that is forced by another single number, is itself a bit strange. For example, the force on a piston acting on a gas in a cylinder certainly does determine the pressure. However, as Budyko and Izrael noted long ago,<sup>14</sup> climate change is characterised by relatively stable tropics and changes in the equator-to-pole temperature difference. This, crudely speaking, has to do with heat transport. Pursuing the analogy with the piston, would we really expect the flow through a pipe to depend on the mean pressure in the pipe rather than the gradient of pressure along the pipe?

Why then do scientists go along with this? The situation has been described by me earlier as consisting of an iron triangle.<sup>15</sup> At one vertex are the scientists who make meaningless or ambiguous statements. The scientific assessment of Working Group I of the IPCC is full of such statements. Then there is the second vertex: that of the advocates and media who 'translate' the statements into alarmist declarations. The advocates also include the IPCC's Working Groups II and III, which deal with impacts and mitigation by assuming worst case scenarios from Working Group I. Politicians also are often part of the advocacy efforts. The third vertex consists of the politicians who respond to alarm by feeding more money to the scientists in the first vertex. As far as the scientists are concerned, what's not to like? Should the scientist ever feel any guilt over the matter, it is assuaged by two irresistible factors:

1. The advocates define public virtue.
2. His administrators are delighted with the grant overhead.

Of course, scientists are hardly the main beneficiaries. The current issue of global warming/climate change is extreme in terms of the number of special interests that opportunistically have strong motivations for believing in the claims of catastrophe despite the lack of evidence. In no particular order, there are:

- leftist economists for whom global warming represents a supreme example of market failure, as well as a wonderful opportunity to suggest correctives
- UN apparatchiks for whom global warming is the route to global governance
- Third World dictators, who see guilt over global warming as providing a convenient claim on aid, in other words the transfer of wealth from the poor in rich countries to the wealthy in poor countries
- environmental activists, who love any issue that has the capacity to frighten the gullible into making hefty contributions to their NGOs
- crony capitalists, who see the immense sums being made available for 'sustainable' energy
- government regulators, for whom the control of a natural product of breathing is a dream come true
- newly minted billionaires, who find the issue of 'saving the planet' appropriately suitable to their grandiose pretensions
- politicians, who can fasten on to CAGW as a signature issue where they can act as demagogues without fear of contradiction from reality or complaint from the purported beneficiaries of their actions (the wildly successful London run of 'Yes, Prime Minister' dealt with this)
- etc., etc.

All of the above special interests, quite naturally, join the chorus of advocates.

Strange as it may seem, even the fossil fuel industry is generally willing to go along with the movement. After all, they realise better than most that there is no current replacement for fossil fuels. The closest possibilities, nuclear and hydro, are despised by the environmentalists. As long as fossil fuel companies have a level playing field, and can pass expenses on to consumers, they are satisfied. Given the nature of corporate overhead, the latter can even form a profit center.

In point of fact, many of the foremost scientific supporters of alarm acknowledge the absence of a basis for catastrophism. Here are some remarks the presidents of the Royal Society (Martin Rees) and of the National Academy (Ralph Cicerone) published in the *Financial Times*.<sup>16</sup>

Straightforward physics tells us that this rise is warming the planet. Calculations demonstrate that this effect is very likely responsible for the gradual warming observed over the past 30 years and that global temperatures will continue to rise – superimposing a warming on all the other effects that make climate fluctuate. Uncertainties in the future rate of this rise, stemming largely from the 'feedback' effects on water vapour and clouds, are topics of current research.

Rees and Cicerone are counting on the fact that most readers won't notice that the so-called 'uncertainties' are, in fact, the main issue; the straightforward physics is trivial. They continue:

Our academies will provide the scientific backdrop for the political and business leaders who must create effective policies to steer the world toward a low-carbon economy.

Clearly, despite the implicit fact that the need for action is uncertain, the policy is taken for granted and even endorsed.

Here is an exchange from the BBC Radio 4 interview of Ralph Cicerone on 13 July 2012. John Humphrys is the interviewer.

JOHN HUMPHRYS: You don't sound, if I can use this word, 'apocalyptic'. I mean, you're not saying 'If we don't do these things, we're going to go to hell in a hand-basket, we're going to fry, in a few years'.

RALPH CICERONE: Well, there are people who are saying those things, John.

JOHN HUMPHRYS: But not you.

RALPH CICERONE: No. I don't think it's useful, I don't think it gets us anywhere, and we don't have that kind of evidence.

The situation may have been best summarised by Mike Hulme, director of the Tyndall Centre at the University of East Anglia, a centre of concern for global warming:

To state that climate change will be 'catastrophic' hides a cascade of value-laden assumptions which do not emerge from empirical or theoretical science.

Even Gavin Schmidt, Jim Hansen's successor as head of NASA's Goddard Institute of Space Studies, whose website, [Realclimate.org](http://Realclimate.org), is a major defender of global warming, does not agree with claims of extremes:

General statements about extremes are almost nowhere to be found in the literature but seem to abound in the popular media... It's this popular perception that global warming means all extremes have to increase all the time, even though if anyone thinks about that for 10 seconds they realise that's nonsense.

Interestingly, basic meteorological theory tells us that extremes depend significantly on the temperature difference between the tropics and the poles – something that is expected to diminish in a warmer world.

On the other hand, there is quite a lot of 'science on demand' as Eisenhower anticipated.

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The well-established Medieval Warm Period is a problem for the narrative.	Michael Mann's Hockey Stick gets rid of the Medieval Warm Period.
The physics of moist convection requires that warming maximise in the tropical upper tropospheric troposphere, and models agree, but the data doesn't show this.	Ben Santer reworks the data to show the maximum.
Significant warming ended about 18 years ago showing that carbon dioxide is not the major factor in climate.	Tommy Karl adjusts and rearranges the data to eliminate the pause.
Quite a few independent studies show that the outgoing radiation from the earth indicate low climate sensitivity.	Andy Dessler ignores the physical and mathematical constraints to claim the opposite (at a truly negligible significance level).
Antarctic sea ice is increasing.	Jim Hansen absurdly claims that this is what one should expect from global warming (which, however, has not been occurring for 18 years).
Basic dynamics of the atmosphere calls for reduced extremes and storminess in a warmer world.	John Holdren invents a cockamamie theory of tropospheric polar jets to claim that such an imaginary jet is destabilised with warming, leading to more and more extreme storminess.

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It should be noted that the first four items in the above list of 'science on demand' represent dubious data manipulation, but little that is alarming. For example, Karl's 'elimination' of the pause still leaves his resulting temperature series well below almost all model projections. That is to say, the models are still 'running hot.' The last two items, on the other hand, simply represent the pure imagination of alarmists.

As Pat Michaels showed, there is a remarkable bias in publications.<sup>17</sup> For articles in *Nature* and *Science* during the period 1 July 2005–30 July 2006, he found a total of 116 publications dealing with climate data. Of these, 84 were 'worse', 10 were 'better', and 22 were 'neutral' with respect to earlier claims. The relative numbers for *Science* and *Nature*, respectively, were 34 and 50 (worse), 5 and 5 (better) and 9 and 13 (neutral). Assuming existing studies were equally likely to be better or worse, this result would have negligible likelihood. Of course, given Michaels' findings, it is almost certain that the existing studies were already biased – thus rendering likelihood almost infinitesimal.

In point of fact, the Climategate 1 and 2 email releases showed explicitly the breakdown in peer review.<sup>18</sup>

We have, thus far, ignored the 'impacts' industry, in which papers are published (and research is supported) attributing hundreds of things to the minimal warming that has occurred. The website WhatReallyHappened.com lists some of these, ranging from acne to walrus stampedes to typhoid fever.<sup>19</sup> Note that even in this extensive list, asthma is not mentioned.

Stefan Rahmstorf of the Potsdam Institute for Climate Impacts has reflected on the failure of his alarmist position to sway the world:

Sometimes I have this dream...I call the fire brigade. But they don't come because some mad person keeps telling them it's a false alarm. The situation is getting more and more desperate, but I can't convince the firemen to get going.

Such nightmares over a few tenths of a degree seems a little exaggerated. One expects that a counsellor might be more effective than a fireman.

The take of political figures is generally misinformed, and commonly transcends the absurd. Senators McCain and Lieberman offered the standard misreading of the IPCC Working Group I's iconic statement:

The recent report by the Intergovernmental Panel on Climate Change concluded there is a greater than 90 percent chance that greenhouse gases released by human activities like burning oil in cars and coal in power plants are causing most of the observed global warming. This report puts the final nail in denial's coffin about the problem of global warming.<sup>20</sup>

Of course, the IPCC Working Group I wisely avoided making the claim that 51% of a small change in temperature constituted a 'problem.' This, they left to the politicians.

Secretary of State John Forbes Kerry went much further in a lengthy speech delivered in Indonesia in February of 2015. Here are some selections:

...When I think about the array of global climate – of global threats – think about this: terrorism, epidemics, poverty, the proliferation of weapons of mass destruction – all challenges that know no borders – the reality is that climate change ranks right up there with every single one of them. And it is a challenge that I address in nearly every single country that I visit as Secretary of State, because President Obama and I believe it is urgent that we do so...

...it's compelling us to act. And let there be no doubt in anybody's mind that the science is absolutely certain...

...I know sometimes I can remember from when I was in high school and college, some aspects of science or physics can be tough – chemistry. But this is not tough. This is simple. Kids at the earliest age can understand this... [It should come as no surprise that Kerry proceeds to get literally everything wrong in his subsequent description of the science.]

...First and foremost, we should not allow a tiny minority of shoddy scientists and science and extreme ideologues to compete with scientific fact...

...This is not opinion. This is about facts. This is about science. The science is unequivocal. And those who refuse to believe it are simply burying their heads in the sand. Now, President Obama and I believe very deeply that we do not have time for a meeting anywhere of the Flat Earth Society...

As usual, political figures improperly associate science as a source of unquestionable authority rather than a successful mode of inquiry.

Secretary Kerry's unsurprising lack of understanding as to what science is, is duplicated by Gina McCarthy, the head of the US EPA – which is spearheading America's War on Fossil Fuels – whose education consists of a BS in Anthropology from the University of Massachusetts, Boston Branch, and an MS in Environmental Health Engineering, Planning and Policy from Tufts University.

By now we all know that climate change is driven in large part by carbon pollution<sup>†</sup> and it leads to more extreme heat, cold, storms, fires and floods.

We are way past any further discussion or debate. Scientists are as sure that humans are causing climate change as they are that cigarette smoke causes lung cancer. So, unless you want to debate that point, don't debate about climate change any longer because it is our moral responsibility to act. That responsibility right now is crystal clear. And that is why we have taken action.

...the science has spoken on this. A low-carbon future is inevitable. We're sending exactly the right signals on what, at least EPA believes to be, a future of lower pollution that is essential for public health and the environment, that EPA's not just authorised but responsible to acknowledge and push towards.

Of course, some political figures skip any embarrassing pretenses concerning science and move directly to their agenda. Christiana Figueres, executive secretary of UN's Framework Convention on Climate Change has said:

This is the first time in the history of mankind that we are setting ourselves the task of intentionally, within a defined period of time, to change the economic development model that has been reigning for at least 150 years, since the Industrial Revolution.

Ms. Figueres is not alone in taking this approach. Pope Francis' closest adviser castigated conservative climate change sceptics in the United States, blaming capitalism for their views. Speaking with journalists, Cardinal Oscar Rodríguez Maradiaga criticised certain 'movements' in the United States that have preemptively come out in opposition to Francis's planned encyclical on climate change.

The ideology surrounding environmental issues is too tied to a capitalism that doesn't want to stop ruining the environment because they don't want to give up their profits.

It is difficult to know whether the statements of prominent political figures represents dishonesty, ignorance or both.

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<sup>†</sup> Her conflation of carbon and carbon dioxide is typical.

Ms. Figueres may be the most honest. No proposed measures will have any discernible impact on climate (regardless of one's view of the physics) unless one rolls back the industrial revolution everywhere and permanently – and even then significant impact on global climate is dubious. Of course, no country outside the western world would even consider this, though they are perfectly happy to endorse the efforts of the West to do so.

A constant feature of the public presentation of the issue is the exploitation of public ignorance. A large poster appearing in the Paris Metro showed the World Wildlife Fund's signature panda leading young people in mass demonstration (intentionally mimicking the storming of the Bastille) calling for the elimination of carbon dioxide. Presumably these young people have never heard of photosynthesis and fail to realise that advanced forms of life would largely cease at levels of carbon dioxide less than about 150 parts per million.<sup>21</sup>

So where does the issue of global warming stand? In retrospect, we are confronting three rather different narratives.

The first I would term the IPCC Working Group I narrative. This narrative, while broadly supportive of the proposition that increasing greenhouse gas concentrations are a serious concern, nevertheless, is relatively open about the uncertainties and even contradictions associated with this position, and its public pronouncements tend to be vague, with ample room for denial, carefully avoiding catastrophist hyperbole while also avoiding outright rejection of such hyperbole. The first narrative is very much the narrative of many of the major supporters of the global warming agenda.

The second narrative is that of what are referred to as 'sceptics.' To an extent not generally recognised, there is considerable overlap with the first narrative. Thus, although sceptics might agree that alpine glaciers have been retreating since the early 19th century, they are also aware that alpine glaciers were largely absent during the Medieval Warm Period, and that their more recent retreat preceded by well over a century the period when anthropogenic greenhouse warming became moderately significant. Moreover, sceptics generally regard the fact that virtually all models 'run hot' - in other words their projections for the period 1979 to the present for the most part greatly exceed observed warming – strongly supports low climate sensitivity. They generally believe in testing the physics underlying the positive feedbacks in sensitive models rather than averaging models. Sceptics also are much more open to the numerous known causes of climate change, including long-period ocean circulations, solar variability, and the various impacts of ice, and do not regard carbon dioxide as the climate's ultimate 'control knob.' The main difference between these first two groups, however, is that the second group openly opposes catastrophism while the first group does not.

The third narrative is that of the political promoters of climate alarm, including

many of the environmental NGOs, and most of the mass media. The promoters of this narrative also include many of the contributors to Working Group II (impacts) and Working Group III (mitigation) of the IPCC. The latter generally emphasise alleged consequences of the worst-case scenarios presented by Working Group I. It is this narrative for which the science is largely irrelevant. Few scientists will endorse the notion that the planet is at risk, though this is standard fare for the catastrophists. It is also this narrative that invariably claims virtually unanimous support. Such claims generally rely on bogus studies which, moreover, dishonestly conflate the points on which both the Working Group I and the sceptical narratives agree, with the third catastrophic narrative. Anyone looking at any statement concerning global warming will readily identify which narrative is in play. Unfortunately, for most people, the third narrative is all they will see.

The overwhelming emphasis on the third narrative, has very serious implications for proposed policies alleged to deal with global warming, such as the restriction of access to electricity for the 1.3 billion human beings currently without it, and the increased poverty for billions more, with obvious implications for health and longevity, not to mention foregoing the well-established agricultural benefits of added carbon dioxide,<sup>22</sup> a chemical essential to life as we know it rather than a pollutant.<sup>‡</sup> It is clear that the issue of climate does constitute an emergency. However, as is so often the case, the emergency does not arise from science and technology, but rather from politics. It is worth examining whether science can play a role in the mitigation of this emergency. It is doubtful whether the answer will consist in research grants. However, science has much at stake. Its hard-earned *raison d'être* as our most effective tool for objective assessment is being squandered, and with it, the basis for public trust and support.

If we do nothing to stop this insanity, science will rightly be regarded as just another racket. This might just be more collateral damage than we can readily afford.

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<sup>‡</sup> The US Navy regards levels of 5000 ppmv on nuclear submarines as safe; ambient levels are currently 400 ppmv.



## Notes

1. Medvedev, ZhA. *The Rise and Fall of T.D. Lysenko*, Columbia University Press, 1969.
2. Lindzen RS. Science and politics: global warming and eugenics. In: R Hahn (ed), *Risks, Costs, and Lives Saved*, Oxford University Press, 1996.
3. <http://www.jpands.org/vol9no3/edwards.pdf>
4. Ponte L, *The Cooling*, Prentice-Hall, 1976
5. Manabe S and Wetherald RT. The effects of doubling the CO<sub>2</sub> concentration on the climate of a general circulation model, *J. Atmos. Sci.* 1975; 32: 3. For definitions of feedback and discussions of water vapour see Lindzen, RS. Climate dynamics and global change. *Ann. Rev. Fl. Mech.* 1993; 26: 353–378.
6. Carbon Dioxide and Climate: A Scientific Assessment: Report of an Ad Hoc Study Group on Carbon Dioxide and Climate Woods Hole, Massachusetts July 23–27, 1979 to the Climate Research Board Assembly of Mathematical and Physical Sciences National Research Council. This is commonly referred to as the Charney Report. Jule Charney was the chairman of the panel.
7. The Intergovernmental Panel on Climate Change (IPCC) has not changed this range except for the Fourth Assessment, which increased the lower bound to 2°C. The Fifth Assessment brought it back to 1.5°C while peculiarly, but revealingly, claiming that there was no basis for preferring one value to another.
8. Tyndall, J. On radiation through the Earth's atmosphere. *Philosophical Magazine* 1863; 4(25): 200–206.
9. Arrhenius, S. On the influence of carbonic acid in the air upon the temperature of the ground. *Philosophical Magazine* 1896; 41: 237–76.
10. Callendar, GS. The artificial production of carbon dioxide and its influence on climate. *Quarterly J. Royal Meteorological Society* 1938; 64: 223–40.
11. Pfeffer, R. (ed) *Dynamics of Climate*, Pergamon Press.
12. A critical discussion of these models can be found in Lindzen, RS. *Dynamics in Atmospheric Physics*, Cambridge University Press, 1990
13. Stevens, BJ. Rethinking the lower bound on aerosol radiative forcing. *J. Climate* 2015, 705: doi: 10.1175/JCLI-D-14-00656.1.
14. Budyko, MI and Izrael YA. In: MI Budyko and YA Izrael (eds), *Anthropogenic Climate Change*, Univ. Ariz. Press, 1991: pp. 277–318.
15. Lindzen RS. Science in the public square, *Journal of American Physicians and Surgeons* 2013; 18, Fall issue.
16. *Financial Times*, 9 April, 2010
17. Michaels P. Evidence for 'publication bias' concerning global warming in *Science and Nature*. *Energy & Environment* 2008; 19: 287–301
18. For example: <http://www.lavoisier.com.au/articles/greenhouse-science/climate-change/climategate-emails.pdf> and <http://wattsupwiththat.com/2012/01/06/250-plus-noteworthy-climategate-2-0-emails/>.

19. <http://whatreallyhappened.com/WRHARTICLES/globalwarming2.html>
20. *Boston Globe*, 13 February 2007
21. Strictly, parts per million by volume.
22. Goklany IM. Carbon dioxide: The good news. Global Warming Policy Foundation, GWPF Report 18, 2015. Available from <http://www.thegwpf.com/content/uploads/2015/10/benefits1.pdf>.





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