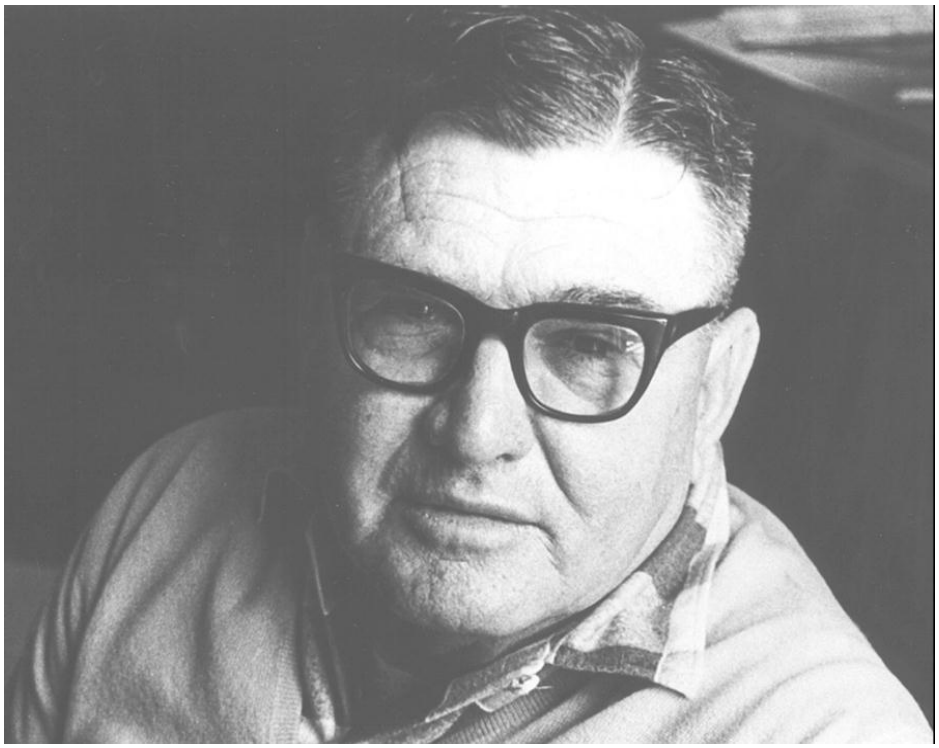
The Climate of Freedom

Background paper for The Hancock Free Enterprise Lecture

University of Notre Dame, Fremantle, June 2011

THREE SCORE years ago, Lang Hancock and his wife took off for Perth in their tiny Auster aircraft from his bush airstrip at the Nunyerry mine. A storm gathered. He ran beneath it through a narrow gorge. At his wing-tips he saw rain-wet bloodstone. Later he returned, landed in the *spinifex* and took samples over 60 miles, sending them to Perth for analysis. It was iron ore – and a rich grade. He had proven one of the world's largest mineral deposits. No one believed him. The scientific consensus, supported by magnetometer surveys, was that his real-world data were wrong. Australia, they said, would be importing iron ore within a decade. The government heeded not the truth but the consensus. It interfered with the free market, embargoing iron-ore exports. For a wearisome decade, Lang Hancock persisted. Later, he said:



"People interested in iron ore knew there was no iron ore in Australia.

"And here was I, a boy from the bush – no experience, no education, no letters after his name or anything – trying to tell them I'd found by far the world's largest iron-ore deposits, a whole field actually.

"And, you know, 30 or 40 firms throughout the world said, 'Run away! It's a lot of rubbish.'"

Lang Hancock defeated the consensus. Under his doughty daughter, Gina Rinehart, the enterprise he founded is now one of the world's great corporations. Like her father, she has had to fight those governmental forces that interfere too zealously in the market-place, caring less for the freedom to create wealth than for its often arbitrary and capricious redistribution from the peerless and the fearless to the reckless and the feckless. Gina instituted the Hancock Free Enterprise Lectures in honour of the man who could and would and did when others couldn't and wouldn't and didn't. To fly your own aircraft in search of riches is freedom. To fly it from a strip you have cleared and graded with your own hands is enterprise. To face down the faceless, to dare to fail and yet to triumph is free enterprise. Lang Hancock was free enterprise. Madame Vice-Chancellor, it is an honour to honour him.

Death by consensus

The globalization of group-think, that comfortable and indolent substitute for rigorous, independent reasoning that Lang Hancock fought, poses a clear and present danger not only to the great enterprise that he bravely founded and his daughter nobly carries forward, but also to the very survival of Australia, and of the wider prosperity, freedom and democracy of the West.

Almost 2500 years ago, the philosopher Aristotle codified the commonest fallacies of relevance. Not the least of these is the consensus fallacy. Merely because we are told many say they think iron ore is absent, it need not be true that many say they think iron ore is absent, still less that they think it, still less that iron ore is truly absent.

The consensus fallacy, which the mediaeval schoolmen would later label the *argumentum ad populum* or "argument by head-count", is akin to the *argumentum ad verecundiam* or "fallacy of reputation". Merely because we are told the proponents of some notion are august, there is no certainty that our informant is knowledgeable, still less that his opinion of their reputation is deserved, still less that they are acting in accordance with their reputation, still less that their notion is necessarily true.

For it is no less the propensity of the great than of the little to assert that a thing is so without regard to whether or to what extent that thing be truly so, wherever it be to its assertor socially convenient, politically expedient, financially profitable or all three.

Consider the following passage from Ross Garnaut's 2008 report on the economics of climate policy in Australia. It is in effect an assertion that climate science should be done by consensus:

> "There is no doubt about the position of most reputed specialists in climate science, in Australia and abroad, on the risks of climate change (Chapter 2). There is no doubt about the position of the leaders of the relevant science academies in all of the major countries."

Dr. Garnaut continues with the following statement:

> "The outsider to climate science has no rational choice but to accept that, on a balance of probabilities, the mainstream science is right in pointing to high risks from unmitigated climate change."

Consensus flings us furth of the scientific Garden of Eden and into the people's republic of partisan politics. I propose to question it today. As a cat may look at a king, so a lay policymaker may question the expert, else the expert will rule and there will be no role for the policymaker, no need for politics, no case for the people to decide for themselves by ballot the future of their nation and of their planet.

Consensus habitually prevails among those whom the French call *bon chic, bon gens* and we call the great and the good, the Establishment, the chattering classes, the regime or the usual suspects. The ancient Greeks contemptuously called them *oí én telseí*: we might say, "those on telly". Time and again in the past century, consensus policies agreed among the *classe politique* have killed millions. The wages of consensus is death. Consensus kills.

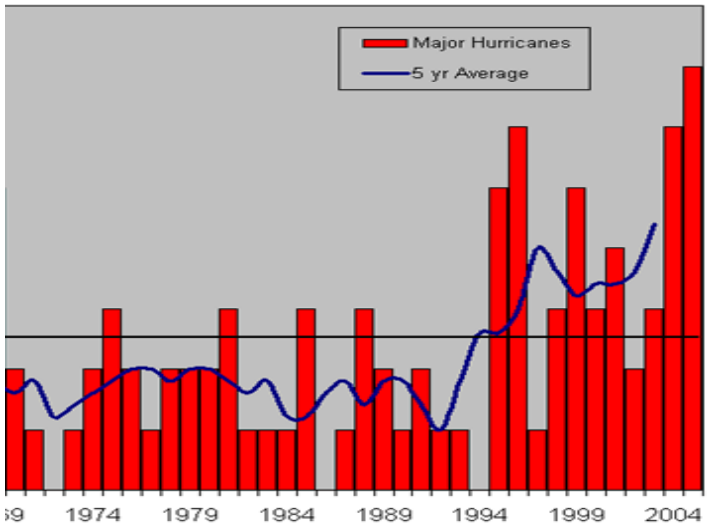
- At the Versailles conference of 1918, consensus among the winners of the First World War sowed the seeds of the Second when they decided the losers should pay reparations so crippling that Germany was handed the excuse to fight again. Churchill, in *The Gathering Storm*, discusses this catastrophic consensus with his characteristically eloquent clarity.
- In the 1920s, the worldwide scientific consensus was that breeding humans like racehorses would strengthen the stock. The near-universal belief in eugenics, seized upon by Hitler, led straight to the dismal shunting-yards of Belsen, Oswiecim and Treblinka. Consensus killed six million Jews.
- In the 1930s, the consensus among the usual suspects was that appeasement of the strutting warmongers of the Thousand-Year Reich would somehow bring peace. Instead, the universally-endorsed policy of the pre-emptive cringe brought war. At least 12 million died.
- In the 1940s and 1950s, the Soviet empire elevated Marxist consensus to the dismal dogma that still infests and infects academe today. The regime, flattering itself that Communism could inspire even an untutored peasant agronomist to do great science, appointed Trofim Denisovich Lysenko head of its Academy of Sciences and ruthlessly enforced his notion that soaking seed-corn in water over the winter would help it to germinate in the spring. Communist consensus wrecked 20 national harvests in 20 years and killed 20 million by needless starvation.
- In the 1960s DDT was banned, though its inventor had won the Nobel Prize for saving more lives than anyone in history. Deaths from malaria rose from 50,000 a year before the ban to 1 million a year after it. Nearly all were children. It was only on 15 September 2006, after 40 million innocents had been killed, that Dr. Arata Kochi of the World Health Organization courageously faced down the consensus, lifted the ban and put DDT once again in the front line of defence against malaria. He said: "In this field, politics usually comes first and science second. We will now take a stand on the science and the data." Yet DDT remains banned almost everywhere. Child deaths by consensus continue.
- In the 1980s HIV appeared. The well-tried public-health response to the emergence of a new and fatal infection is to identify and humanely to isolate all carriers. That policy had eradicated smallpox worldwide a generation previously. Yet the consensus, intending non-discrimination, again flouted the science and the data. Result: 33 million dead, 33 million infected, and counting.

Those who acquiesced in these outbreaks of often genocidal consensus clung dumbly to some abstract, half-understood and often scientifically-nonsensical pseudo-principle, like eugenics or Lysenkoism, non-discrimination or feminism, without regard to whether it was rational or moral, or to the question how many of their fellow-creatures their policy was killing. Lang Hancock's opinion of consensus was characteristically forthright. His biographer once asked him whether he really thought the majority was always wrong. He replied: "Absolutely. There are no two ways about it."

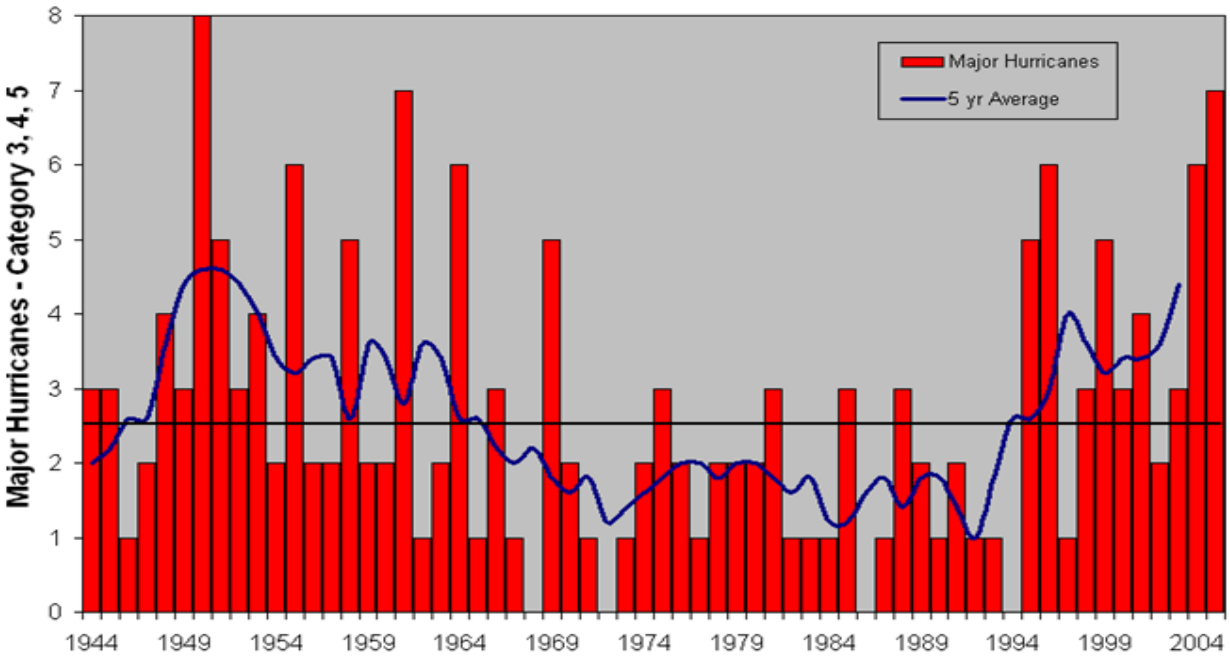
Consensus, that most pernicious denial of the freedom to think, is at once a consequence of bad education and a rejection of good education. Three once-universal scholastic disciplines are today near-extinct: a classical education, to explain that in reason and logic there is a difference between true and false, right and wrong, *το όν* and *το μή όν*, what is on and what is not on; a scientific education, to show us which is which; and a religious education, to teach us why the distinction matters. From the age of chivalry until my own generation, all who aspired to attend the great institutions of higher learning studied the mediaeval *trivium* of grammar, logic and rhetoric, the cheerfully spiritual and intentionally moral formations respectively of the memory, the understanding and the will, the three theological pillars of the Christian soul. My generation was the last to have been thus routinely proofed against the fifth horseman of the Apocalypse – consensus.

Can we trust the consensus?

A scientific paper, published in the peer-reviewed literature in 2006, displayed the following graph and drew from it the conclusion that the frequency of severe (category 3-5) Atlantic hurricanes has been increasing, and that we are to blame –



The truth was as follows –



The publicity poster for Al Gore's climate movie, a still from the film, showed an apparently precipitate increase in temperature in recent times. However, note the indication on the graph that it had not been drawn by any scientist –

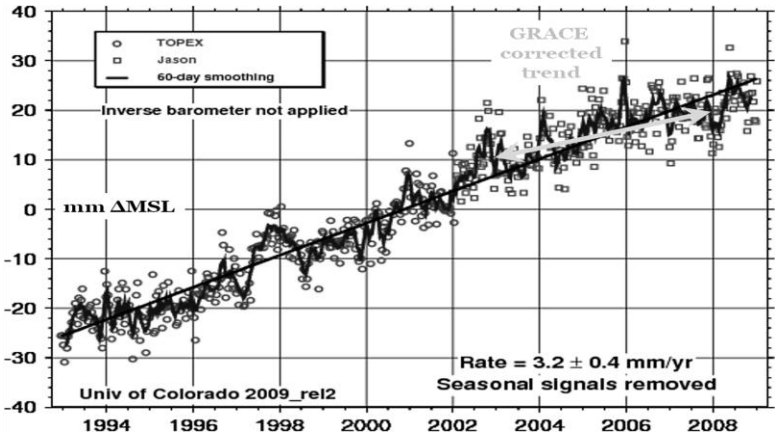
The Professor of "climate change impacts" at University College, London, largely paid by British taxpayers, produced the following propaganda poster showing what the Houses of Parliament would look like if sea level were to rise by 20 feet, as Gore predicted in his movie –

However, Mr. Justice Burton, in the UK High Court – in a very rare instance of a climate-related case that was not a sweetheart action between two publicly-subsidized entities each of which held global warming to be a global crisis – found that, particularly with reference to sea level, Gore had been exaggerating. His judgment said –

> "The Armageddon scenario that he depicts is not based on any scientific view."

Officially, sea level is rising not at 20 ft imminently but at 1 ft/century. The IPCC's 2007 report only predicts a maximum of less than 2 ft/century to 2100, down from more than 3 ft/century predicted in its 2001 report. However, Professor Nils-Axel Mörner of the University of Stockholm, who in his 40-year career has written some 550 learned papers, most of them on sea level, was told by a member of the University of Colorado's satellite-altimetry team at a conference organized by the Russian Academy of Sciences in Moscow in 2004 that the satellite data were not in fact showing any sea-level rise, even after correction for tectonic subduction, isostatic recovery, variations in length of day, etc. Professor Mörner was told that the entire graph of satellite-altimetry-derived sea-level rise since 1993 had been tilted upward to show the sea-level rise that is now used as the basis for numerous papers saying it indicates a sharp and inferentially anthropogenic increase in ocean heat content:

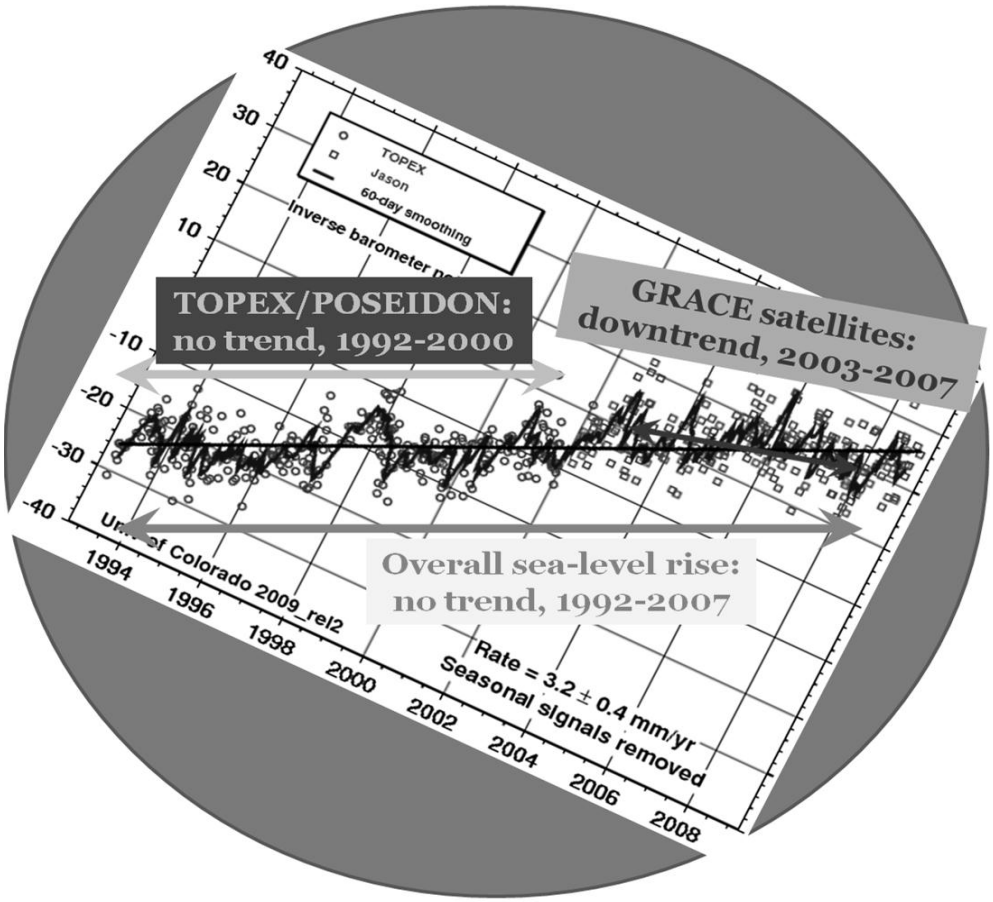
> "The fact of this 'reinterpretation', which turned a near-zero trend in sea-level rise to a trend of 2.3 mm/year (later 3.2), was orally confirmed by a member of the satellite altimetry team in 2005 when I attended a meeting on global warming held by the Russian Academy of Sciences in Moscow. Exactly what was done remains unclear, as the satellite altimetry groups do not specify the "corrections" they carry out. …
>
> "The concept of the global isostatic adjustment is a model supported by some data (see e.g. Peltier, 1998) but contradicted by other data (e.g. Mörner, 2005). Global isostatic adjustment corrections have been applied to tide gauges, to sea level records, to satellite altimetry data, and now to ocean mass changes. It appears that without these corrections there is little or no room for any global sea level rise.
>
> "Correcting tide gauges for global isostatic adjustment or regional crustal movement is not the correct way of treating records of this type. Instead, each site must be evaluated individually with respect to stability, wind, waves, sedimentation, compaction, loading, and tectonics. A blind global isostatic adjustment model correction may provide quite wrong results; it is a dangerous shortcut applied by scientists who are not sea-level specialists by training and hence lack the skill to undertake careful site-specific stability analyses themselves. Fig. A shows the satellite altimetry records as presented by NOAA (2008), which suggest a sea-level rise of 3.2 (±0.4) mm/year:



"Figure A. Satellite altimetry as given by NOAA. The TOPEX-JASON satellite data provide a record suggesting a mean sea-level rise of 3.2 mm/year over the period 1993-2007. The (GRACE) GIA-corrected trend (Fig. 8) for 2003-2007 (**arrowed line**) agrees with the JASON data. This suggests that the satellite record is strongly affected by "corrections." Consequently, this satellite altimetry graph has a long-term trend which is significantly greater than that which actual instrumental measurements provide: it is created by inferred "corrections."

"In Fig. B, the TOPEX/POSEIDON satellite altimetry record of Fig. 9 is back-tilted to fit the original trend in Figs. 5-6 for 1992-2000 and the raw data from the GRACE satellites … for 2003-2007.

"This gives an un"corrected" satellite altimetry graph, *from two independent sources of actual, unaltered data,* showing no signs of any sea-level rise. The original record for 1992-2000 is restored … and the GRACE raw data fit the record perfectly well:



"Figure B. The 'calibrated' satellite altimetry record tilted back to match the original, un'corrected' data. The original TOPEX/POSEIDON raw data for 1992-2000 showed variability around a stable horizontal zero line. … The GRACE raw data … show a gently falling trend for 2002-2007. Together, these two untampered datasets indicate that global mean sea level trend has remained stable over the entire period 1992-2007, altogether eliminating the apparent 3.2 mm/year rate of sea-level rise arising from the "adjusted" data (Fig. A).

"This implies that the Fig. A satellite altimetry record is significantly altered by non-technical 'corrections' (whatever they may be). The 'corrections' applied are not specified by the responsible groups at NOAA and the Centre National des Etudes Spatiales, France's space agency. Various types of corrections may be applied, provide that they are clearly declared and described. This is not the case with the presently-circulated trends in sea-level rise from satellite altimetry (see e.g. Aviso, 2003; NOAA, 2008).

> "If the 'corrections' applied are not clearly specified (and discussed and argued for), then the resulting corrected data cannot be objectively evaluated. It may be mere disinformation, perhaps disseminated with the intention of supporting the IPCC's wild claims about sea-level rise." (Mörner, 2011).

During a climate conference at Downing College, Cambridge, in May 2011, Professor Mörner presented results of detailed surveys by him in all parts of the world, confirming his conclusion that there has been little or no statistically-significant sea-level rise since the satellites began monitoring it in 1993. The moderator of the session at which he spoke was visibly displeased and, in his summing-up, said he had never before been in the same room with anyone who had suggested sea level was not rising. However, he did not refute any of the detailed evidence that Professor Mörner had provided.

Is the "consensus" truly a majority among scientists in climate and related fields? On the questions whose answers we conceded at the outset, there is indeed a consensus, and rightly, for the results in question are long proven by simple experiment. They are not in doubt. However, on the question how much warming we have caused or will cause, there is no consensus, but there are powerful forces, including the IPCC, which would like us to believe that the consensus spreads far more widely through climate science than in fact it does.

For instance, the final scientific draft of the IPCC's 1995 *Third Assessment Report*, completed and submitted by the hundreds of scientists who participated, had concluded on five separate occasions that – as we shall see when we examine the global temperature record – no manmade influence on global temperature is yet discernible:

> "None of the studies cited above has shown clear evidence that we can attribute the observed [climate] changes to the specific cause of increases in greenhouse gases."
>
> "No study to date has positively attributed all or part [of observed climate change] to anthropogenic causes."
>
> "While none of these studies has specifically considered the attribution issue, they often draw some attribution conclusions for which there is little justification."
>
> "Any claims of positive detection of significant climate change are likely to remain controversial until uncertainties in the total natural variability of the climate system are reduced."

And the last and plainest of the five –

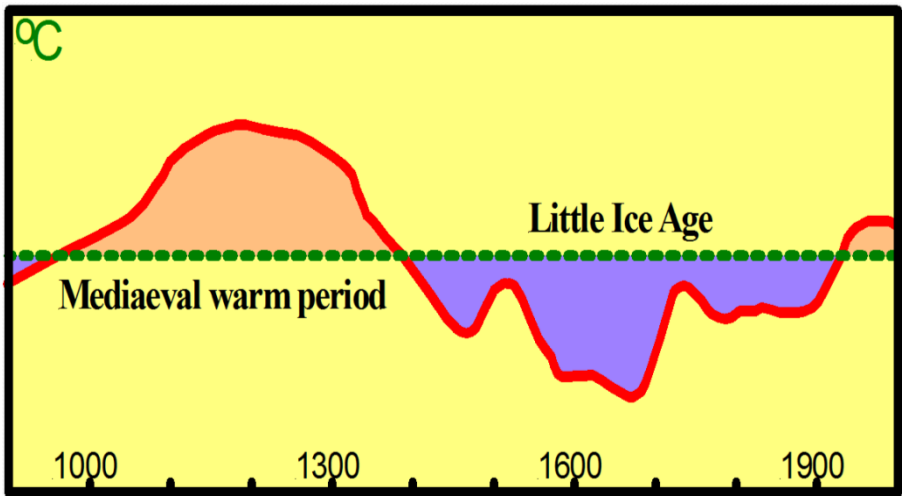
> "When will an anthropogenic effect on climate change be identified? It is not surprising that the best answer to this question is, 'We do not know.'"

The IPCC did not want any of these things said. Accordingly, a single scientist, Dr. Ben Santer of the Lawrence Livermore National Laboratory, was asked to rewrite the already-concluded final draft to remove all five of the statements shown above, and to replace them with –

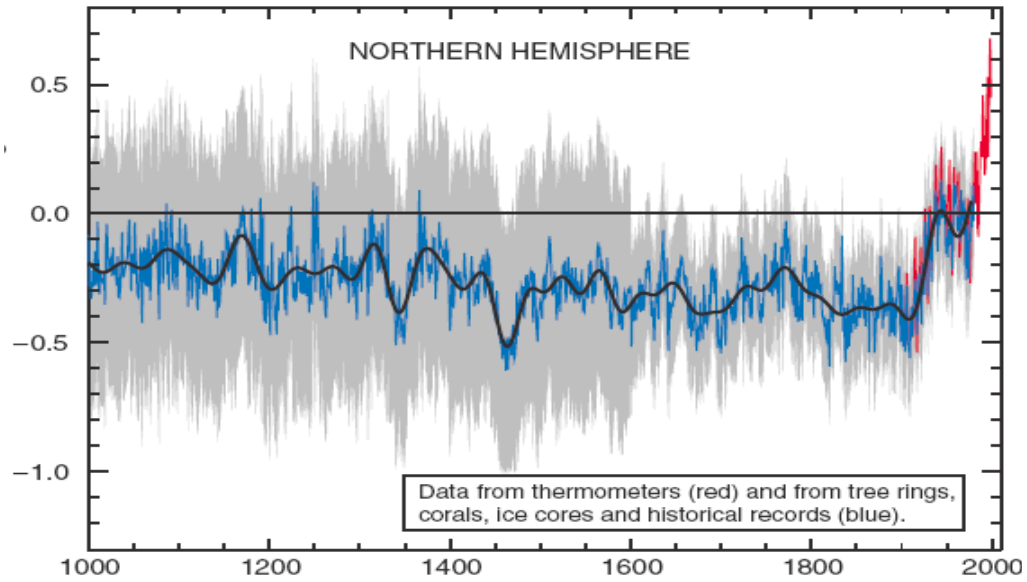
> "The body of evidence now points to a discernible human influence on global climate."

As we shall see, the "body of evidence" in the temperature record shows no such thing.

Another problem with the "consensus" position as the IPCC claims to express it is that it does not always even represent the true consensus. Perhaps the most notorious of many instances is the IPCC's decision in its 2001 report to depart from what had been the near-universally-accepted science expressed in its 1990 *First Assessment Report*, which had shown a schematic indicating that the mediaeval warm period had been appreciably warmer than the present –



However, scarce a dozen years later, in the 2001 *Third Assessment Report*, the mediaeval warm period had been made to disappear –



In 1995, Dr. David Deming had written a paper in *Science* on the reconstruction of pre-instrumental surface temperatures by borehole measurements. As a result, he was congratulated by several scientists. In 2005 he wrote –

> "A major person working in the area of climate change and global warming sent me an astonishing email that said, 'We have to get rid of the Mediaeval Warm Period."

Not "We have to verify the extent and duration of the Mediaeval Warm Period" – that would have been a scientific statement. Instead, "We have to get rid of the Mediaeval Warm Period" – a political statement. And that is exactly what was done.

The IPCC's 2001 *Fourth Assessment Report* reproduced six times, in full colour, a graph that relied upon a number of unorthodox statistical practices. The paper, (Mann *et al.*, 1998-1999), drew heavily upon bristlecone-pine proxies for pre-instrumental temperature change, even though a previous IPCC report had recommended against the use of such proxies on the ground that the width of the tree-rings is influenced not only by temperature change but also by changes in precipitation, and most notably by changes in atmospheric CO_2 concentration.

Recent attempts by Mann and others to revive the unsound graph suffer from some of the same defects as the original: removing the bristlecone proxies and a further defective outlier (the Tiljander proxy) from among the proxy datasets clearly shows that the medieval warm period was real, was global, and was appreciably warmer than the present.

Dr. Craig Idso has collected papers by almost 1000 scientists worldwide, nearly all of which demonstrate the influence of the Mediaeval Warm Period and show that it was at least as warm as, and in most instances warmer than, the present. If the IPCC were to do science by consensus, it would probably not give credence to model-derived results contradicting the consensus.

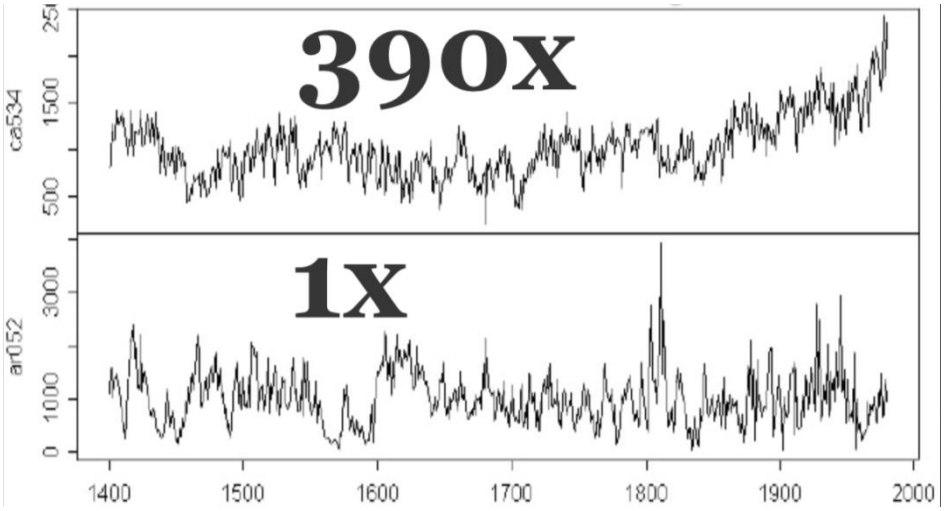
The statistical methods in Mann *et al.* were examined by McIntyre & McKitrick (2003, 2005). In all material respects, the two researchers' findings were powerfully endorsed by a detailed investigative study by three statisticians at the instigation of the House (Wegman, 2005). Among other conclusions, the Wegman report found that a sudden and suspicious spate of papers published after the exposure of the defects in the paper that purported to abolish the Mediaeval Warm Period, all of which used similar methods and came to similar results, had been published by authors associated with the lead author of the original paper via previous joint publication.

The content of the Climategate emails, when they emerged in 2009, was sufficiently disturbing to prompt the Attorney General of the State of Virginia to initiate an investigation of the circumstances surrounding the compilation and publication of what was to become known as the "hockey-stick" graph (with a straight shank showing no Medieval Warm Period and a long blade suggesting a rate of increase in global temperature, and an absolute global temperature, that are unprecedented in the past millennium. It was the hockey-stick graph that wrongly wiped out the Mediaeval Warm Period.

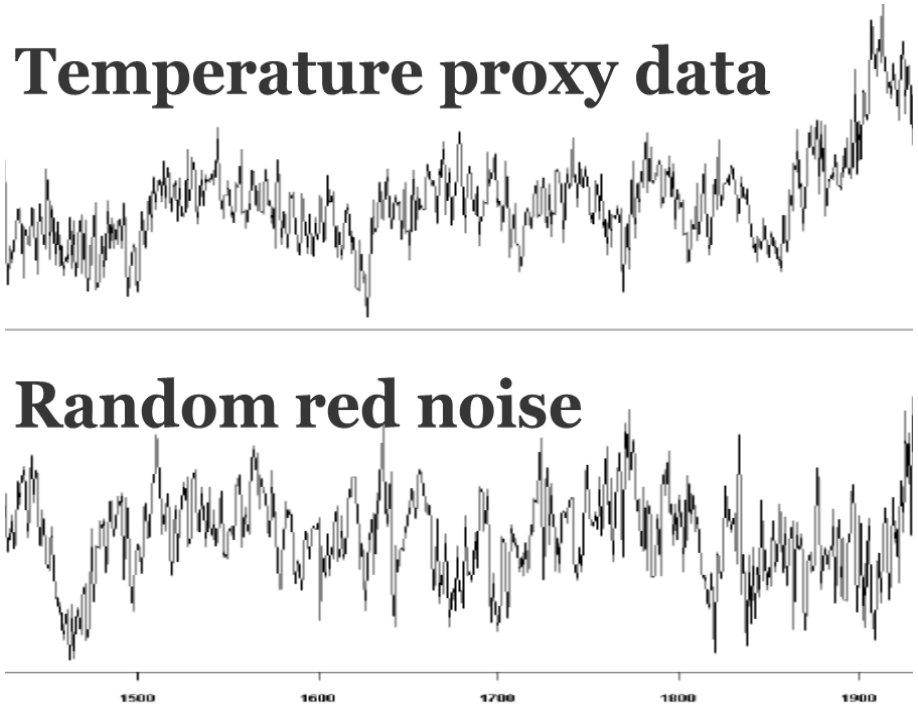
The legislative basis for the Attorney General's investigation is the Fraud against Taxpayers Act. The question he is asking is this: did those who compiled the hockey-stick graph knowingly fabricate data or falsify results in a manner calculated to defraud taxpayers by attracting research grants?

It is not for me to say whether any of those responsible for the hockey stick had committed criminal offences. However, it is worth examining some of the scientific criticisms of the graph that have emerged.

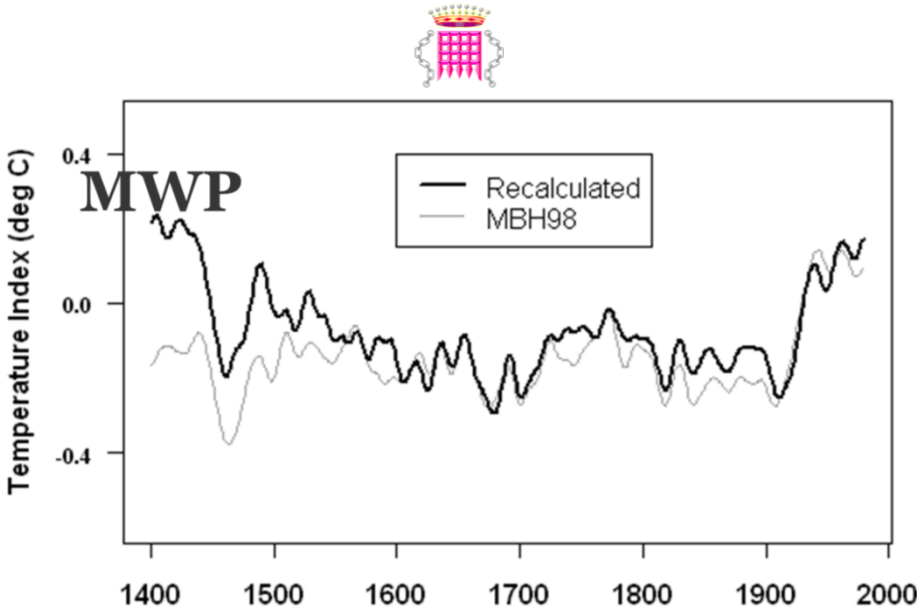
First, the compilers of the hockey-stick graph are said to have given 390 times as much weight to tree-ring data sources that produced a hockey-stick shape, showing apparently exceptional 20th-century global warming, than they did to other sources that showed no such thing.:



Secondly, the algorithm always produced hockey-stick-shaped graphs showing exaggerated and exceptional 20th-century warming, even if proper temperature proxy data (from tree-rings, stalagmites, lake sediments, etc.), were replaced with red noise, a type of entirely random input data. The computer program had been tuned so that it very nearly always produced graphs of the shape the authors produced:



Thirdly, the authors of the graph had suppressed the temperature proxy data for the Mediaeval warm period itself, while saying in the paper that they had relied upon it, and had instead replaced the real data with estimates of their own, without having said that that was what they had done. When the true data were restored, even with the tuned algorithm used by the authors of the "hockey-stick" graph, McIntyre and McKitrick showed that the Mediaeval Warm Period duly reappeared –



Nature, which had originally published the hockey-stick graph, had refused to accept any corrective material from the two Canadian researchers, but eventually published a corrigendum written by the paper's original authors. Nevertheless, the IPCC continues to rely on the hockey stick to this day, though it no longer uses it as its logo, as it did from 2001-2005.

The Climategate emails, released from a server at the University of East Anglia in Britain by a whistleblower in November 2009, showed how the authors of the hockey stick and a surprisingly small coterie of other scientists had engaged in practices which Al-Haytham, Huxley and Popper would not have considered to be consistent with the scientific method:

- Professor Phil Jones, the scientist chiefly responsible for the Climate Research Unit's surface-temperature dataset, at first answered all queries about his computer codes and data by saying that he refused to release any information because those requesting it were only asking for it so that they could verify whether it was correct: yet such verification is precisely how the scientific method works.
- Professor Jones' refusal to make all of his data and codes immediately available when other scientists requested it had long raised concerns, particularly because his results had a direct bearing on the question of how fast the world is warming.
- When the Freedom of Information Act came into force in the UK, Professor Jones and other scientists began writing emails to each other to discuss how they could prevent their codes and data from being made available.
- Professor Jones' first advice to fellow-Climategate emailers was that they should not let anyone know that there was a Freedom of Information Act in the UK.
- Professor Jones subsequently wrote to fellow-emailers that he would destroy data rather than provide it to researchers who requested it under the Freedom of Information Act.
- Professor Jones and others then discussed several reasons for not disclosing data and computer programs to anyone who might request them under the Freedom of Information Act. They discussed –
    - hiding (they repeatedly used the word) behind public-interest immunity;
    - hiding behind the UK's Data Protection Act, which does not prevent disclosure of data or research paid for by taxpayers;

- hiding behind advice from the office of the Information Commissioner, the UK official who enforces the Freedom of Information Act;
- hiding behind the fact that the UN's climate panel is an international entity not subject to the UK freedom-of-information law,
- hiding behind reclassification of as much as possible of their work as UN work, so as to evade their obligation at law to disclose requested information; and
- hiding behind contracts between the Climate Research Unit and other national weather bureaux whose data it had received, on the ground that weather data might be held by some nations to be confidential.

- Professor Jones, in an exchange of emails, discusses the fact – which the emails deplore – that some scientific journals not only have a policy of requiring all computer codes and data to be archived with the journal at the same time as a learned paper is submitted, but also actually go to the trouble of enforcing the policy. The implication was that submitting papers to such journals was best avoided, because it might lead to publication of the information the Climategate emailers were, for some reason, anxious to withhold.

- Professor Jones then worked with Freedom of Information Officers at the University of East Anglia to minimize the scope, categories, and quantity of information to be disclosed to those requesting it. An email to colleagues describes how Professor Jones had shown the University's Freedom of Information Officers details of the website of one of those requesting information about how he had compiled his global-temperature dataset, and had persuaded them to agree that the person requesting the data ought not to be given anything if possible. Yet there is no provision in the Freedom of Information Act in the UK that allows any such discrimination.

- Professor Jones, in an email, discloses how a Freedom of Information officer at the University of East Anglia had told him that he must not destroy any emails, except for the purpose of keeping email traffic manageable. Yet the capacity of the University's servers is likely to be enough to permit all of the Team's emails to be permanently stored, tracked, and made available on request.

- Numerous emails establish that the scientists who sent them were particularly anxious to conceal from other researchers the computer code they were using to create their global-temperature record. The reason for this refusal is readily discernible from one of the document files also released by the whistleblower, a series of notes by a exasperated programmers trying to make sense of the numerous segments of apparently erroneous computer code in the scientists' programs, and of many data files that were missing, incomplete, unlabeled, duplicated or based on incompatible units of measurement.

- The methodology at the University of East Anglia in compiling its temperature records – if the 15,000 lines of commentary by the programmers are right – was unsatisfactory. However, Professor Jones has recently demonstrated that in the last 30 years the temperature trend his data demomstrate the same warming trend as other leading datasets.

- Finally, in 2008 Professor Jones wrote to several scientists inviting them to delete all emails relating to their participation in the preparation of the previous year's *Fourth Assessment Report* of the UN's climate panel. He wrote this email some three weeks after the University of East Anglia had received a request under the Freedom of Information Act for precisely the information that he was recommending his colleagues to emulate him in destroying.

Three inquiries into the Climategate affair in the UK, and another by the Environmental Protection Agency in the United States, did not ask Professor Jones whether he had in fact destroyed any data. One of the inquiries, a scientific advisory panel, began its report with a statement to the effect that the inquiry did not consider itself to be a panel constituted to consider the science behind the affair.

The enquiries found little fault with the Climategate emailers' scientific conduct, though they concluded that the withholding of data and results by the emailers was inappropriate. The University of East Anglia, however, continues to use various exemptions to avoid giving researchers the data they request under the Freedom of Information Act.

We conclude this consideration of the defects in consensus climate science by citing Christy (2011), who well expresses what consensus in climate science means –

> "The term 'consensus science' will often be appealed to in arguments about climate change. This is a form of "argument from authority." Consensus, however, is a political notion, not a scientific notion. As I testified to the Inter-Academy Council last June, the IPCC and other similar Assessments do not represent for me a consensus of much more than the consensus of those who already agree with a particular consensus. The content of these reports is actually under the control of a relatively small number of individuals – I often refer to them as the "climate establishment" – who through the years, in my opinion, came to act as *gatekeepers* of scientific opinion and information, rather than *brokers*. The voices of those of us who object to various statements and emphases in these assessments are by-in-large dismissed rather than acknowledged.
>
> "I've often stated that climate science is a 'murky science'. We do not have laboratory methods of testing our hypotheses as many other sciences do. As a result, opinion, arguments from authority, dramatic press releases, and notions of consensus tend to pass for science in our field when they should not."

Concessions to consensus

As we shall see, the supposed consensus about dangerous anthropogenic "global warming" is scarcely less cruel than those earlier intellectual infections that killed and still kill so many of our fellow men.

However, in the courtly spirit of mediaeval disputation, let this practising but not perfect follower of the Old Religion that founded this university and is the *fons et origo* of its mission and its statutory objectives begin his consideration of the New Religion by conceding to it all that he can.

Is there a greenhouse effect? *Concedo.* Does it warm the Earth? *Concedo.* Is carbon dioxide a greenhouse gas? *Concedo.* If carbon dioxide be added to the atmosphere, will warming result? *Concedo.* Are we adding carbon dioxide to the atmosphere? *Concedo.* Is its concentration higher than for 20 million years? *Concedo.* Will some warming result? *Concedo.*

Professor Ross Garnaut's 2008 report says:

> "There are prominent dissenters on this matter, gathered under the rubric of 'sceptic'. For the most part 'sceptic' is a misnomer for their position, because these dissenters hold strongly to the belief that the mainstream science is wrong." (p. ii)

In fact, very nearly all sceptical scientists would cheerfully agree with my concessions to what Dr. Garnaut calls "mainstream" science. His suggestion that most sceptics disagree with the long-proven results of Fourier, Tyndale and Callander is not well founded. Our quarrel is not with what is known but with what is merely guessed at. The central question in the scientific

debate is not qualitative but quantitative: not *whether* warming will occur but *how much* will occur. As Dr. Garnaut himself rightly concedes –

> "The uncertainty in the science is generally associated with the rate and magnitude, rather than the direction, of the conclusions." (2011, p.18)

It is that particular uncertainty, and not a challenge to the fundamental and long-established science of greenhouse gases, that is at the heart of the argument advanced by those of us – including some of the world's most eminent climatologists – who question *how much* global warming our influence on the climate will bring about.

In the Middle Ages, it was not considered civilized openly to disagree with an opponent. Instead, one politely drew a distinction. I shall politely draw half a dozen distinctions today:

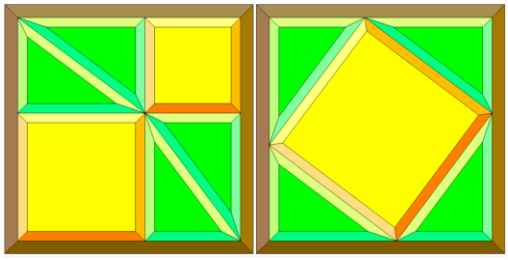
1. Can we model the climate for more than a few weeks ahead? *Distinguo.*
2. Is global temperature rising at an accelerating rate, for which we are to blame? *Distinguo.*
3. Did we cause more than half of the global warming that has occurred since 1950? *Distinguo.*
4. Will our adding carbon dioxide to the atmosphere cause dangerous warming? *Distinguo.*
5. Is it really cost-effective to tax and regulate the very air we breathe out? *Distinguo.*
6. Is it in truth morally superior to spend trillions in the hope of making an imagined and arguably imaginary problem go away the day after tomorrow than to deploy the same trillions now in the hope of ending poverty and disease today? *Distinguo.*

These are the distinctions I propose to draw between the cloud of unthinking among those on telly and the rational standpoint of the reasonable philosopher-king on the Fremantle omnibus.

The first four of these distinctions are scientific; the fifth is economic; the sixth moral. Consensus usually gives purely qualitative answers to questions such as these: yet all six are ineluctably quantitative. Consequently they are susceptible to determination by the most rigorous species of formal logic that the giants on whose shoulders we stand have bequeathed to us – mathematics.

Can we reliably predict long-term future climate states?

We draw a distinction between logically-rigorous mathematical proof, on the one hand, and the scientific method, on the other. The Theorem of Pythagoras has been proven – indeed, there are many hundreds of proofs in existence, including the following simple and elegant proof without words by the 5th-century Hindu mathematician Aryabhatta –



However, most science is not susceptible of such absolute demonstration. Instead, the scientific method has evolved, so as to approach the truth crabwise.

One of the earliest proponents of the scientific method was Abu Ali Ibn al-Hassan Ibn al-Hussain Ibn al-Hussain Ibn al-Haytham, a mathematician, astronomer and philosopher of science in 11th-century Iraq, celebrated on this Iraqi banknote –

Al-Haytham held that "the seeker after truth" – his beautiful phrase for the scientist – "does not place his faith in any mere consensus, however broad or venerable." Instead, said Al-Haytham, he checks and checks and checks again. "The road to the truth is long and hard, but that is the road we must follow."

In this lecture, I shall do my layman's best to seek and speak the truth. Since even scientists tear each other limb from limb on this politically-sensitive subject, I shall expect that – however careful I have tried to be – the limitations of my knowledge will make me particularly vulnerable to justifiable criticism. All I can say is that I have made every effort to get the science, the economics and the morality right. You would not thank me, Madame Vice-Chancellor, if I were merely to pursue some narrow, political line. I shall try not to do so.

T.H. Huxley, who defeated Bishop "Soapy Sam" Wilberforce in the great debate about evolution in 1860, was as opposed to the notion of science-by-consensus as Hancock and al-Haytham –

> "The improver of natural knowledge" – his less satisfactory term for the scientist – "absolutely refuses to acknowledge authority, as such. To him, scepticism is the very highest of duties: blind faith the one unpardonable sin."

Karl Popper, in his celebrated paper of 1934 outlining the scientific method and codifying it for today, presented it as an iterative algorithm which begins with a problem to be solved. Usually the problem is stated in the most rigorous and clear mathematical language, for mathematics is the language of science. Popper labeled this initial hypothesis GP_1, the General Problem. The subscript indicates that this is the first iteration of the algorithm.

Next, Popper says, a scientist comes along and puts forward a hypothesis that is intended to address the problem. This hypothesis, or Tentative Theory, is labeled TT_1. Once the hypothesis is published, with all supporting evidence, other scientists try to destroy the new theory in the Error Elimination phase, which Popper marks as EE_1. If the hypothesis is disproved at this point, it dies and – in the absence of new evidence – cannot be resurrected. The algorithm that is the scientific method ends there.

However, if the tentative theory survives the onslaught of other scientists, it gains a measure of credibility, and the credibility grows stronger with each passing year. Accordingly, at some point the tentative theory becomes widely accepted, so that it is then respectable to amend the General Problem in the light of it, and po label the refined and improved version of the General Problem GP_2. Then the whole algorithm goes around again, and again, and again, for as long as is

necessary to reach the truth. Rarely – all too rarely – a formal proof will appear. Otherwise, the iterative algorithm that is the scientific method continues, and the truth gradually – all too gradually – becomes clearer.

In climate science, which is in its infancy, there are very few absolutely proven results. Climate cannot be accurately predicted more than a few weeks ahead with any respectable degree of reliability. The unpredictability even of the very simplest mathematical object whose initial state is not known in sufficiently fine detail has long been established. Climate, however, behaves as a complex, non-linear, mathematically-chaotic object (IPCC, 2001) and is, therefore, *a fortiori,* impossible to predict long-term.

Precisely because it is long established that long-run climate prediction is not possible, it cannot be appropriate to claim that there is a "consensus" that global warming caused by increased greenhouse-gas concentrations has caused most of the warming since 1950, or will be dangerous if it continues. Scientific dissent on the question of climate is and will always be legitimate, because long-run prediction of the behavior of mathematical objects such as climate is not possible unless the initial climatic state at any chosen moment is known to a fineness of detail that is in practice impossible to attain, and unless the processes for the subsequent evolution of the object are also known in sufficiently fine detail, which they are not.

It is the proven characteristic of mathematically-chaotic objects, or of objects that behave as though they were chaotic, such as climate, that neither the magnitude nor the timing nor the direction nor even the sign of their phase-transitions or, in modern mathematical parlance, bifurcations or, in environmentalist jargon, "tipping points" can be predicted (Lorenz, 1963; IPCC, 2001).

There is simply too little information about the state of the climate in the present to permit us to begin at some known starting-point and look as far as 100 years into the future and say with any degree of confidence how little or how much the world will warm. Predicting the future evolution of a chaotic object is like trying to plan a journey from A to B without knowing exactly where A is, and without having a route-map of any kind.

Dr. Garnaut says of what scientists call bifurcations and he joins the Greens in calling "tipping points" –

> "A number of measurable changes are pointing to more rapid movement towards climate tipping points than previously suggested by the mainstream science. The rates of reduction in Arctic sea ice and the accumulation of methane in the atmosphere are examples." (2011, p. 17)

However, as Edward Lorenz (1963) put it in the landmark paper that founded chaos theory –

> "When our results concerning the instability of non-periodic flow are applied to the atmosphere, which is ostensibly non-periodic, they indicate that prediction of the sufficiently distant future is impossible by any method, unless the present conditions are known exactly. In view of the inevitable inaccuracy and incompleteness of weather observations, precise, very-long-range weather forecasting would seem to be non-existent."

And climate, of course, is very-long-range weather. Recently another scientist has considered the limitations upon climatic prediction with some care. Giorgi (2005) defines two types of prediction:

> "In the late 1960s and mid 1970s the chaotic nature of the climate system was first recognized. Lorenz defined two types of predictability problems:
>
> "1) Predictability of the first kind, which is essentially the prediction of the evolution of the atmosphere, or more generally the climate system, given some knowledge of its initial state. Predictability of the first kind is therefore primarily an **initial-value** problem, and numerical weather prediction is a typical example of it.
>
> "2) Predictability of the second kind, in which the objective is to predict the evolution of the statistical properties of the climate system in response to changes in external forcings. Predictability of the second kind is thus essentially a **boundary-value** problem."

Giorgi explains:

> "… Because of the long time-scales involved in ocean, cryosphere, and biosphere processes a first-kind predictability component also arises. The slower components of the climate system (e.g. the ocean and biosphere) affect the statistics of climate variables (e.g. precipitation) and since they may feel the influence of their initial state at multi-decadal time scales, it is possible that climate changes also depend on the initial state of the climate system … For example, the evolution of the thermohaline circulation in response to greenhouse-gas forcing can depend on the initial state of the thermohaline circulation, and this evolution will in general affect the full climate system. As a result, the climate change prediction problem has components of both first and second kind which are deeply intertwined. … The relevance of the first-kind predictability aspect of climate change is that we do not know what the initial conditions of the climate system were at the beginning of the 'industrialization experiment' and this adds an element of uncertainty to the climate prediction."

Giorgi also points out that the predictability of a mathematical object such as climate is adversely affected by non-linearity:

> "A system that responds linearly to forcings is highly predictable, i.e. doubling of the forcing results in a doubling of the response. Non-linear behaviors are much less predictable and several factors increase the non-linearity of the climate system as a whole, thereby decreasing its predictability."

Climatic prediction is, as Lorenz said it was, an initial-state problem. It is also a boundary-value problem, whose degrees of freedom – the quantity of independent variables that define it – are approximately equal to the molecular density of air at room temperature, an intractably large number. It is also a non-linearity problem. It is also a problem whose evolutionary processes are insufficiently understood.

When studying the climate we are in the same predicament as Christopher Columbus. When he set out for the Americas, he did not know where he was going; on the way there, he did not know what route he was following; when he got there he did not know where he was; when he returned he did not know where he had been; and, like very nearly every climate scientist worldwide, he did the whole thing on taxpayers' money.

To illustrate the difficulty further, let us conduct a short voyage of mathematical discovery, a thought-experiment that we call a "heuristic", to examine the mathematical impossibility of predicting the future state of a complex, non-linear, chaotic or quasi-chaotic object except under conditions forever inapplicable to the climate.

For our little experiment we shall use the Mandelbrot fractal, which is defined using the simple, iterative function $f(z) = z^2 + c$. Compare the extreme simplicity of this function with the complications inherent in the million-variable computer models upon which the UN so heavily and perhaps unwisely relies in attempting to predict the future evolution of the climate.

In the function that generates the Mandelbrot fractal, the real part a of the complex number $c = a + bi$ lies on the x axis of what is called the Argand plane; the imaginary part b lies on the y axis. Let $z = 0$. Compare this certainty and clarity with the uncertainty and confusion of the climate object, where, as Lorenz proved, accurate long-term projection into the future cannot be made unless an exceptionally precise knowledge of the initial state of every one of millions of parameters at any chosen starting point is known to a very great degree of precision. The UN presumes to make predictions a millennium into the future. This, as our thought-experiment will convincingly demonstrate, it cannot possibly do.

With the Mandelbrot fractal, then, there is no initial-state problem, for we can specify the initial state to any chosen level of precision. However, with the climate object, there is a formidable and in practice unsolvable initial-state problem. Likewise, we know the process by which the Mandelbrot fractal will evolve, namely the simple iterative function $f(z) = z^2 + c$.

However, our understanding of evolutionary processes of the climate object, though growing, is insufficient, and the computer models which try to project future climatic states continue to be caught by surprise as events unfold. The computers did not predict the severity of the El Nino event in 1998; they did not predict the cooling of the oceans from 2003 onwards; and the operators of one of the UN's leading computer models have admitted that their model makes errors that are orders of magnitude greater than the rather small phenomena which they are trying to predict.

In the Mandelbrot fractal, therefore, we have consciously chosen for our heuristic an object which is like the climate in that it is chaotic and non-linear, but which is unlike the climate in that it has initial conditions which we can specify precisely, and processes for future evolution that are entirely known and prescribed.

So to the experiment itself. The game is to take a region of the Argand plane within the field of the Mandelbrot object, and to try to predict – at least in rough outline – the picture that will appear as all of the pixels within the specified region of the object are generated. We shall choose values of c, to 16 significant figures (Eq. 1):

$$\begin{aligned} &\text{Top left:} && c = 0.250073950770\mathbf{2906} + 0.0000010137903\mathbf{618}\ i; \\ &\text{Bottom right:} && c = 0.250073950770\mathbf{3702} + 0.0000010137903\mathbf{127}\ i. \end{aligned} \qquad (1)$$

The real and imaginary elements in the complex number c vary between the top left and bottom right pixels of the picture only in the last three or four digits, which are highlighted above, even though each element of the initial values of c is specified to 16 significant digits – a far greater

precision than is possible with any of the millions of parameters that define the climate object. Yet, as we shall see when the picture is drawn, even within the very narrow interval of values for *c* that we have chosen, very many fundamental bifurcations will occur.

From this instance, we shall learn that even a very small perturbation in the initial value of just one of the parameters that define the object in question can radically alter the pattern of future bifurcations – the sudden, major changes from a previously steady state that are characteristic of the chaotic object. As we shall see later, the short-term fluctuations in global temperature that occur by natural causes are greater than the very small year-to-year differences in atmospheric carbon dioxide concentrations. So it is these natural fluctuations, rather than the small but unidirectional perturbation caused by ever-increasing greenhouse-gas concentrations, that will cause bifurcations with apparent and exasperating randomness.

In fact, like all chaotic objects, the climate is deterministic – each change from a previous state occurs for a reason. But we do not know either the initial state of the millions of parameters that define the climate or the rules for its evolution precisely enough to make reliable, long-term predictions of how it will evolve in the future. For this reason, it is impossible – certainly at present, when the total anthropogenic perturbation of the atmosphere amounts to one-ten-thousandth of its volume – to distinguish between bifurcations caused by our adding carbon dioxide to the atmosphere and bifurcations caused by the far greater natural ups and downs of the climate.

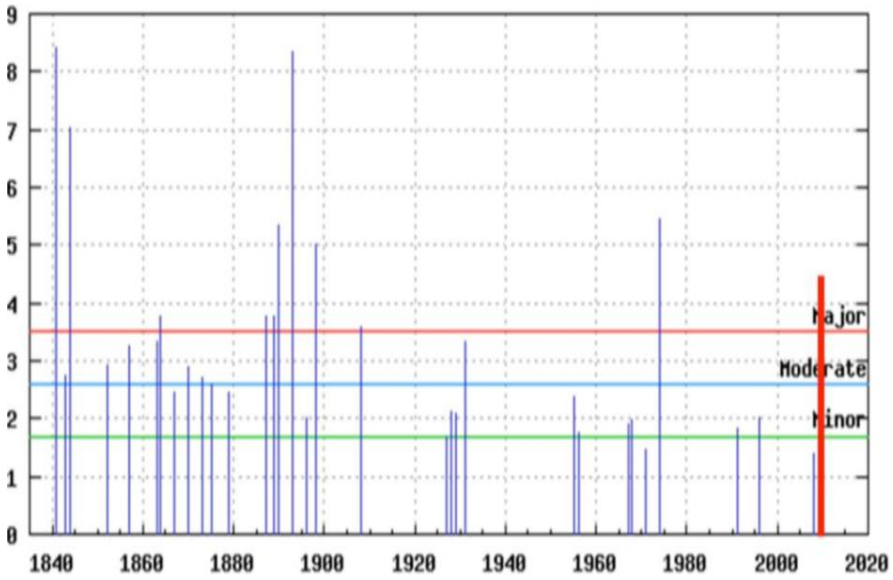
For instance, here is a picture of the Brisbane flood –

However, this flood occurred in 1893, long before we could have had any detectable influence over the climate, and also when the global mean surface temperature was around 0.75 C° below today's. Yet that has not stopped Dr. Garnaut and many others from saying – quite wrongly – that such extreme-weather events are exactly the sort of thing we must expect because the world is getting warmer.

Floods in Johnstown (top left: 1889: 2500 dead); Dayton, Ohio (top right: 1913: 527 dead); and Smith's Bridge, North Carolina (bottom: 1916).

The truth is that such events are exactly the sort of thing we must expect whether the weather gets warmer or colder, or even if the temperature scarcely changes at all in either direction: for temperature is only one – and not necessarily the most significant – of the parameters whose behaviour triggered the Brisbane floods.

The graph below, produced by the Australian Government's Bureau of Meteorology on 28 May 2010 and showing gauge heights in metres for Brisbane River floods since 1840, does not suggest that a human influence has made the flooding either more frequent or more severe –



Christy (2011) studied the Brisbane floods and reported as follows –

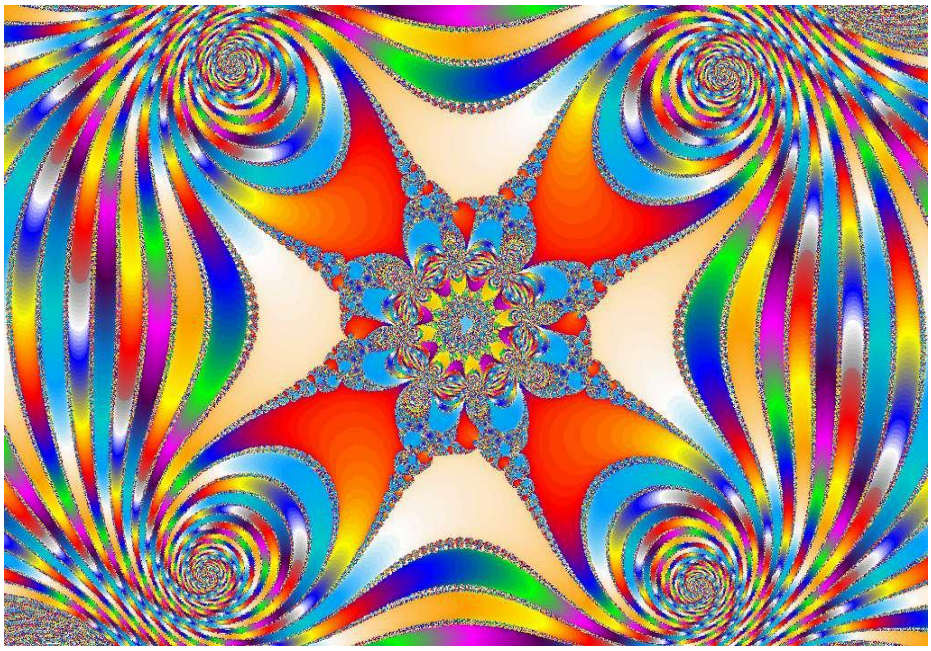
> "The tragic flooding in the second half of 2010 in NE Australia was examined in two ways, (1) in terms of financial costs and (2) in terms of climate history. First, when one normalizes the flood costs year by year, meaning if one could imagine that the infrastructure now in place was unchanging during the entire study period, the analysis shows there are no long-term trends in damages. In an update of Crompton and McAneney (2008) of normalized disaster losses in Australia which includes an estimate for 2010, they show absolutely no trend since 1966.
>
> "Secondly, regarding the recent Australian flooding as a physical event in the context climate history (with the estimated 2010 maximum river height added to the chart below) one sees a relative lull in flooding events after 1900. Only four events reached the moderate category in the past 110 years, while 14 such events were recorded in the 60 years before 1900. Indeed, the recent flood magnitude had been exceeded six times in the last 170 years, twice by almost double the level of flooding as observed in 2010. Such history charts indicate that severe flooding is an extreme event that has occurred from natural, unforced variability."

To demonstrate how multiple bifurcations are likely to appear in the evolution of a chaotic object even when the initial and subsequent values of a parameter are near-identical, we shall set the color of each point in our picture, starting at the top left, by counting the iterations before the absolute value $|z|$ reaches infinity (or here, for convenience, a bailout value of 1000). Up to 250,000 iterations will be performed to determine the colour of each individual point.

You have been told the initial state of z, and the range of initial values for c. You have been told the processes for defining the value of every pixel, which will be expressed as a colour on the picture. What will the picture of our chosen part of the Mandelbrot fractal look like?

In trying to draw the picture, we are in a far better position than the IPCC is in trying to predict future states of the climate. We know the initial value of the single parameter that defines the object, and we have complete knowledge of the process by which the object evolves. But do you have any idea what the picture might look like?

When you have sketched your predicted picture on a piece of paper, compare your prediction with what the specified portion of the Mandelbrot fractal actually looks like. It is an extraordinarily beautiful picture, which appears to have been painted by an artist with an eye for colour and form: yet the simple equation with which we launched this heuristic was entirely responsible for what you see here –



It would be no surprise if your picture looked nothing like this picture of the ribbon-festooned Maltese Cross. If you were unable to predict what the picture would look like, even though the fundamental initial-state and subsequent-process uncertainties that prevent the IPCC or anyone from predicting the climate accurately have been deliberately engineered out of our thought experiment, you will begin to appreciate why Lorenz was right to state that the reliable, very-long-term prediction of future climate states is not possible. And "very-long-term", with the climate, means more than 10 days or so into the future.

Lorenz's paper – one of the most elegant and influential in the history of mathematics – also used a thought-experiment: an artificial climate object with just five variables. He demonstrated that a very small perturbation in the initial state of just one of the variables could produce major bifurcations at a later state of the model. This is often called the "butterfly effect" – a butterfly flaps its wings in the Himalayas and a consequent hurricane devastates Florida.

Of course, the computer – on being given the precise co-ordinates we have specified to a precision of 16 decimal places – can model the Mandelbrot object accurately. However, even a very small variation in the initial state of the object, as defined by the co-ordinates expressing the range of values of the complex variable *c*, leads to an entirely different picture – or even to no picture at all. This illustrates the reason why, even with the aid of the world's most sophisticated computers, climate cannot be predicted for the long term: we do not know the initial state of the millions of relevant variables at any chosen moment with sufficient precision to make reliable projections of the long-term future state of the climate.

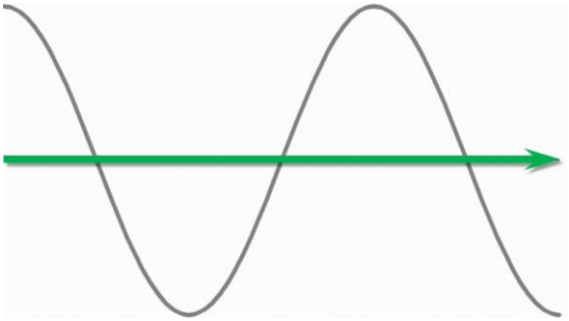
This heuristic is a way of demonstrating that anyone who says, "The Debate Is Over," or "The Science Is Certain," must be wrong. Climate science cannot, by its very nature, be certain. We conclude, and are compelled to conclude, that long-run prediction of future climatic states is not possible, and that accordingly any output from the climate models – however large the models – should be treated with a modesty and caution appropriate to the fundamental and largely irreducible uncertainty inherent in the mathematical nature of the climate object.

As IPCC (2001) itself admits –

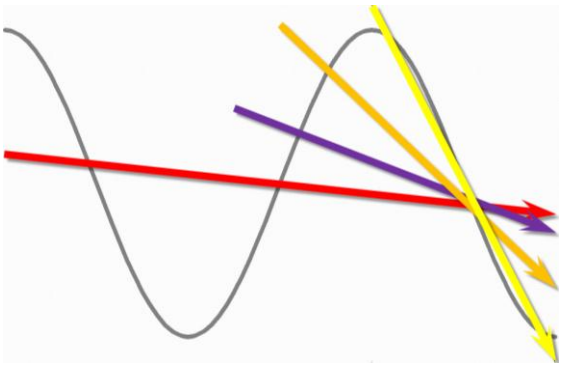
> "In climate research and modeling, we should recognize that we are dealing with a coupled non-linear chaotic system, and therefore that the long-term prediction of future climate states is not possible." (ch. 6.1)

Is the rate of global warming itself accelerating?

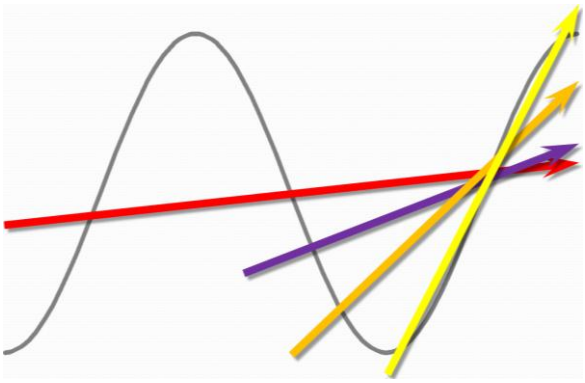
We now set sail with another heuristic. Consider a sine-wave, propagated horizontally from left to right *ad infinitum.* A segment is shown here. The sinusoid's trend is by definition zero –



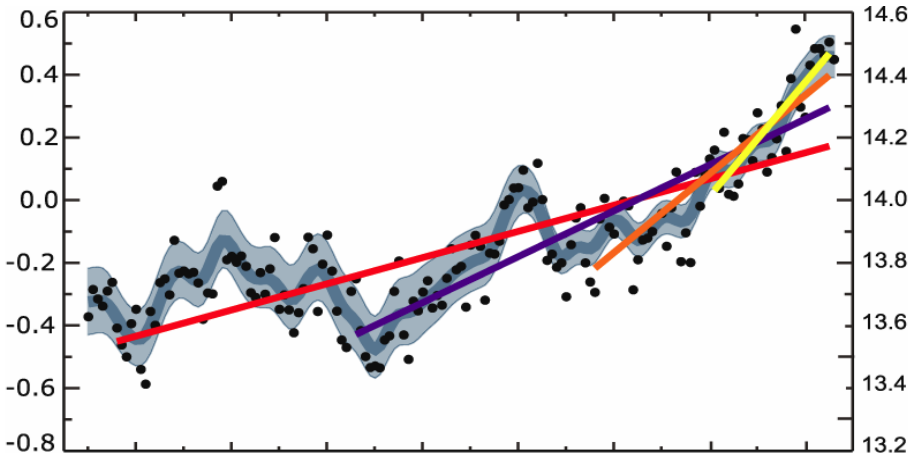
Or is it zero? We freeze the sine-wave at some local minimum and calculate four overlapping linear-regression trends on the data, all terminating at that minimum. The first trend-line covers the entire displayed segment, but the starting-points of the three remaining trend-lines are carefully chosen, located successively closer to the rightward endpoint of the curve:



Each successively-commencing trend-line has a steeper slope than its predecessor. The trend of the wave seems to be declining – and declining ever more precipitately. Yet we know from the very definition of our horizontally-propagated sine-wave that its true long-run trend must be zero. For this reason, the statistical technique we have deployed is unquestionably false, as we may further demonstrate by shifting the phase of the sine-wave by half a cycle. Suddenly, the graph appears to climb – and climb ever more rapidly. That is the opposite of the previous result:

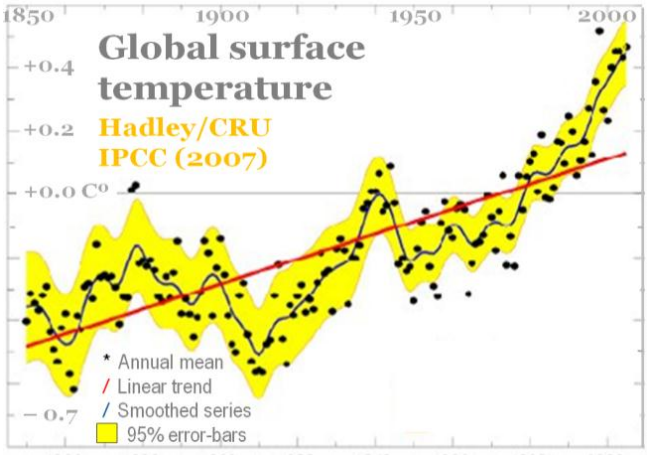


Informed by this heuristic, we consider the following graph, which appears thrice, prominently, in full colour, in the IPCC's *Fourth Assessment Report*, published in 2007:



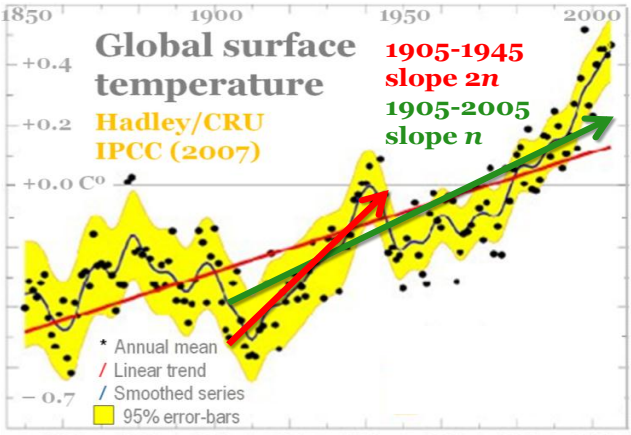
The IPCC has used the same false statistical technique that we had demonstrated on the neutral ground of our sine-wave heuristic. This time, the underlying data are anomalies in mean global surface temperature as measured by thermometers throughout the world from 1850-2005 and compiled by the Hadley Centre and the Climatic Research Unit of the University of East Anglia.

Here is the graph of those data as the world's scientists had correctly presented it in their final draft of the IPCCs 2007 report:



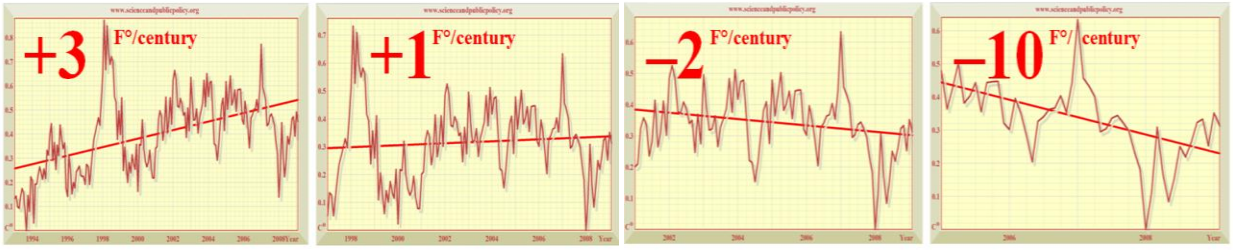
The IPCC's *apparat* tampered with the scientists' graph before publication. They were so pleased with their erroneous version that they used it thrice in the published report. On each occasion, two entirely false conclusions were drawn: that the Earth's surface is warming ever faster (the warming is "accelerating"), and that we are to blame.

From our heuristic we observed that, by a careful selection of the start-points or end-points of multiple trend-lines, we might arbitrarily show the rate of change in the underlying data to be accelerating in either direction. We now apply this observation to the global temperature data. The long-run trend (the thin red line in the graph above) is upward, as it has been for more than 300 years, during all but the last few decades of which we cannot have been responsible. We can illustrate the error of the IPCC's statistical method by adding some trend-lines of our own to the Hadley Centre's graph:



Here we have adopted the IPCC's trend-line for 1905-2005, shown as the arrowed green line, and we have added an arrowed red trend-line of our own, starting in 1905 but ending in 1945. Our earlier-terminating trend-line is twice as steep as the IPCC's later-terminating trend. On this analysis, which is every bit as false as that of the IPCC, the rate of global warming has halved.

We can even use the IPCC's false technique to show that the trend has reversed itself:



Here, using an index that combines two satellite and two terrestrial monthly global-temperature-anomaly datasets, we have calculated four successive regression trend-lines, starting in 1993, 1997, 2001 and 2005 respectively and all terminating in 2009. The results suggest – once again, falsely – to be heading straight into a new Ice Age.

The baseless conclusion that we are accelerating the warming rate is now the central contention of the IPCC consensus. Without it, there is little cause for alarm. After 60 years of accelerating increases in carbon dioxide concentration that may have been chiefly caused by us, there has

been no discernible acceleration in the long-run warming rate, and certainly no increase in the maximum supra-decadal warming rate. In the temperature record, then, there is no evidence to suggest that there will be much anthropogenic acceleration of warming in the future.

This, then, is the central falsehood in the IPCC's 2007 *Fourth Assessment Report*, just as the "hockey-stick" graph that falsely purported to abolish the mediaeval warm period had been the central falsehood in its 2001 report. That graph has triggered an investigation by the attorney-general of the State of Virginia on grounds of alleged fraud against taxpayers in that the graph's compilers are said to have obtained research grants on the basis of false and manipulated data.

Is the IPCC's unsound basis for its central finding about the imagined acceleration in the global warming trend and our role in that imagined acceleration deliberate? In December 2009, I publicly asked Dr. Rajendra Pachauri, the railway engineer who is for some reason chairman of the IPCC's climate science working group, to have the defective graph and the conclusions drawn from it corrected. Dr. Pachauri did not have the graph corrected. He did not explain why he would not do so. He did not provide any justification for this fundamental error at the very heart of the IPCC's analysis.

I recently asked Dr. Martin Manning, the third-listed lead author of the *Fourth Assessment Report*, to have the error corrected. His initial reaction was identical to that of Dr. Pachauri. Therefore, there is some evidence that the IPCC's latest falsehood about the key conclusion on which the IPCC's case rests may be deliberate.

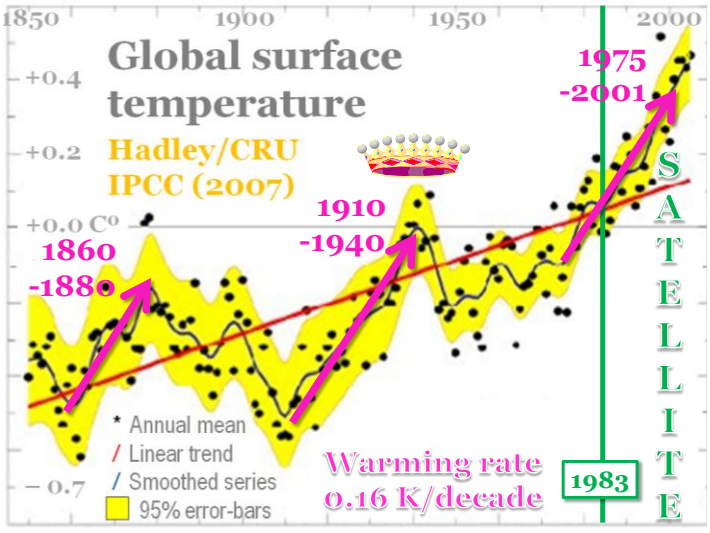
Yet Dr. Garnaut's 2011 update to his 2008 report says this:

> "Since the 2008 Review, the science of climate change has been subjected to intense scrutiny and has come through with its credibility intact." (p. x)

Perhaps the Attorney-General for the State of Virginia would disagree.

Did we cause more than half the global warming since 1950?

Let us remove the superfluous trend lines from the IPCC's graph and establish what has really been happening to global temperature:

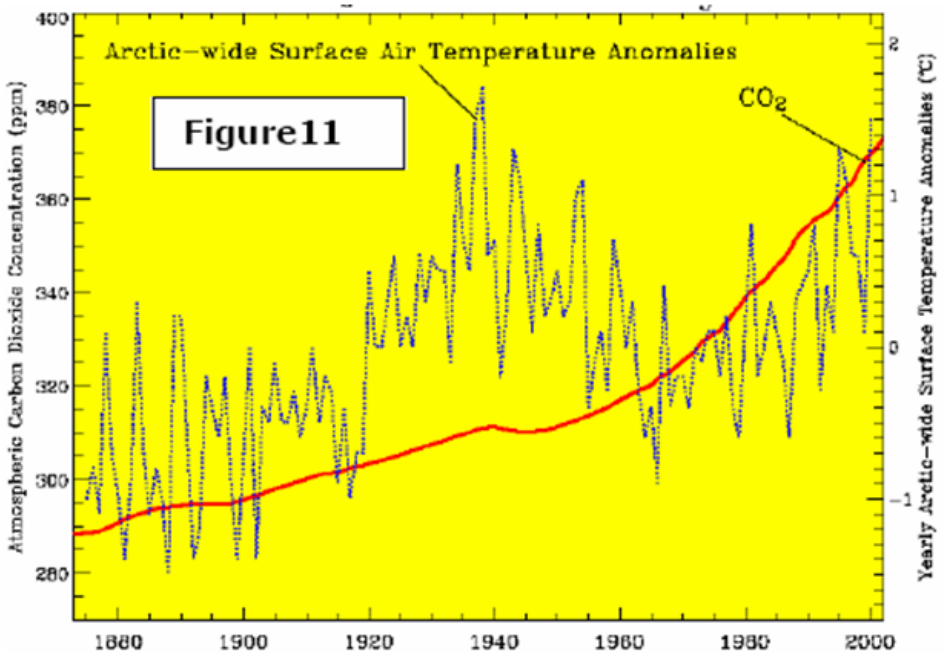


In the essentially stochastic global instrumental temperature record, there appears to be a quasi-periodicity of some 60 years. The most rapid multi-decadal rates of warming in the entire observed global record – just 0.16 C°/decade – occurred thrice: from 1860-1880, from 1910-1940 and from 1976-2001. On any view, we cannot have much influenced the first two periods of warming. We were not adding enough carbon dioxide to the atmosphere in those days.

We could in theory have influenced the third and most recent period of warming. Yet the warming rate during that period was statistically identical with the warming rates in the two previous periods of rapid warming. There has been no statistically-significant increase in the warming rate.

Two years ago I confirmed this fact by arranging for a Parliamentary Question to be put down in the House of Lords. Lord Hunt, for the then government, admitted that the three rates of warming were identical, but added a rider to the effect that mere facts were not going to alter the government's policy.

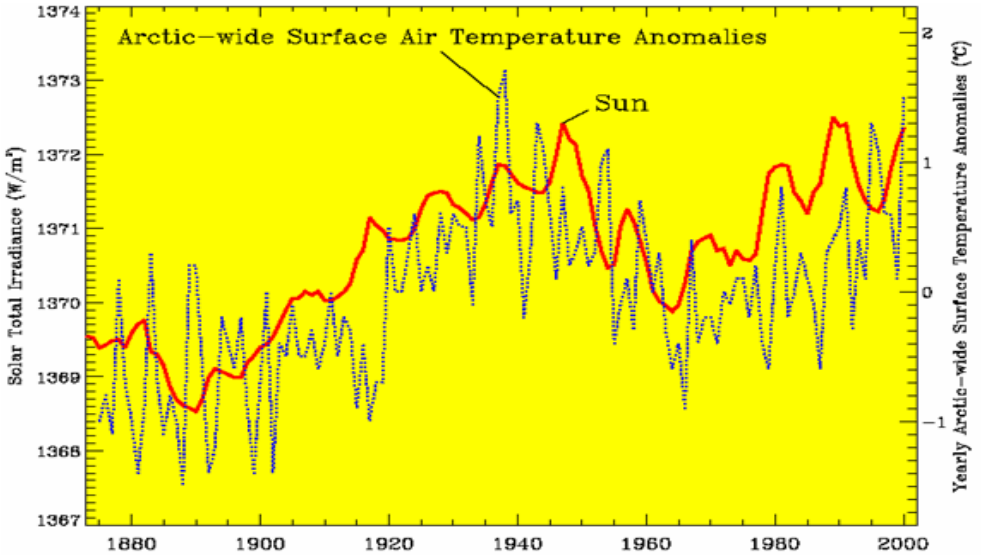
Since 1950 we have been able to measure the concentrations of greenhouse gases accurately. The record of carbon dioxide concentration shows a near-monotonic increase throughout the period, yet the temperature fluctuations have been stochastic. There is no correlation between the steady increase in carbon dioxide concentration and the ups and downs of the global temperature graph, as this Arctic chart from Soon (2005) demonstrates –



Though correlation does not necessarily imply causation, absence of correlation necessarily implies absence of causation. Accordingly, the fluctuations in warming that appear in the 160-year global instrumental record were not caused by anthropogenic carbon dioxide emissions.

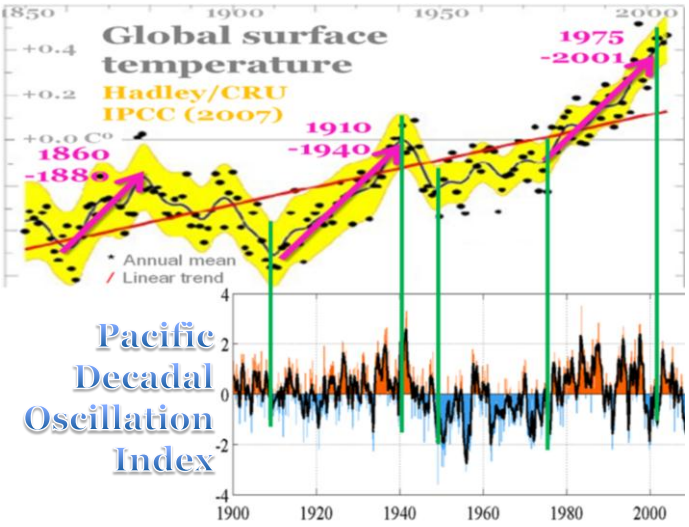
In fact, in the Arctic – which is a good place to examine correlations between temperature change and change in other climate variables, because the Arctic climate is more volatile and hence sensitive to radiative or other forcings than the climate elsewhere – Dr. Soon has

demonstrated a better fit between changes in solar activity and changes in surface temperature than between changes in carbon dioxide concentration and changes in surface temperature –

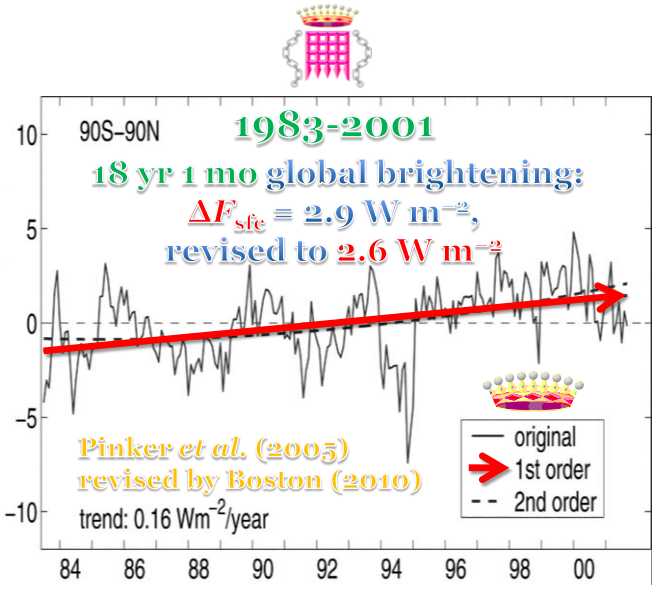


Let us make the logic clear. We may legitimately assume that if the data underlying Dr. Soon's graphs are correct the absence of correlation between changes in carbon dioxide concentration and changes in surface temperature shows that the fluctuations in the latter cannot have been caused by the former. Yet we may not assume that the mere correlation between solar activity and surface temperature changes is causative: in logic, it may be merely coincidental.

The proximate cause may have been the cycles of the Pacific Decadal Oscillation, which may themselves be closely connected to various indices of solar activity:



There were no satellites to watch the first two periods of rapid warming. However, the satellite era began in the early 1980s. From 1983 to late in 2001, the satellites showed a rapid withdrawal of low-altitude, optically-dense cloud cover from the tropics, the engine-room of the Earth's climate. More sunlight reached the Earth, rather than being reflected harmlessly back into space:

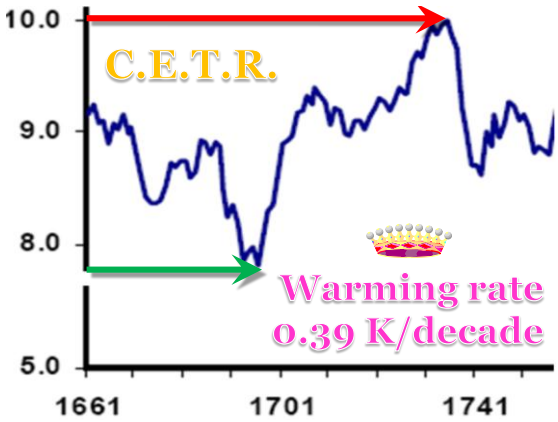


It is this very large – though not permanent – increase in the radiative flux incident upon the Earth's surface that was surely the *primum mobile* of the rapid warming of 1976-2001. The two previous periods of rapid warming may – I stress *may* – have been similarly caused.

Given what we have seen of the global instrumental temperature record, it is not all that easy to agree with Dr. Garnaut's conclusion that –

> "The increase in concentrations of greenhouse gases in the atmosphere over the last two centuries has generated the climate change that we have experienced to date …" (2008, p. xx)

A warming rate equivalent to 1.6 C°/century is by no means the fastest rate of warming that has been measured. The Central England Temperature Record is the oldest regional instrumental record in the world, dating back to 1659. From 1695-1730, at the end of the 70-year period of record-breaking solar inactivity known as the Maunder Minimum, temperatures in central England – a reasonable proxy for global temperatures because England is in a temperature latitude – rose by 2.2 C°, at a rate three or four times faster than the maximum supra-decadal warming rate observed over the entire 160-year global instrumental record. Yet that very rapid warming entirely preceded the Industrial Revolution:



Again, much caution is necessary: in those days Stevenson screens did not protect the thermometers from the glare of direct sunlight: nor, no doubt, were the instruments themselves as accurate as today's. Nevertheless, the record does provide a further reason to apprehend that the rate of warming from 1976-2001 is by no means unprecedented even in recent history, despite frequent assertions to the contrary.

The question arises whether the absolute magnitude of today's temperature is unprecedented. However, multiple lines of evidence demonstrate that most of the 11,400 years since the end of the last Ice Age were warmer than the present, in some places by several Celsius degrees. An index of papers by close to 1000 authors is available from www.co2science.org. Though it may be easy to find fault with some of the papers, there are enough data in the relevant learned papers powerfully to confirm what is well established at least in the history of Europe and north America – that the mediaeval warm period was warmer than the present.

We conclude, with the scientists' 1995 final draft of the *Second Assessment Report*, as follows –

> "When will an anthropogenic effect on climate change be identified? It is not surprising that the best answer to this question is, 'We do not know.'"

Yet that statement, and four others like it, were excised from the published version of the IPCC's 1995 report, together with some 200 consequential amendments. The IPCC had invited a single scientist to rewrite the report so that the conclusion was the exact opposite of what the scientists' final draft had found. This is what he wrote:

> "The body of evidence now points to a discernible human influence on global climate."

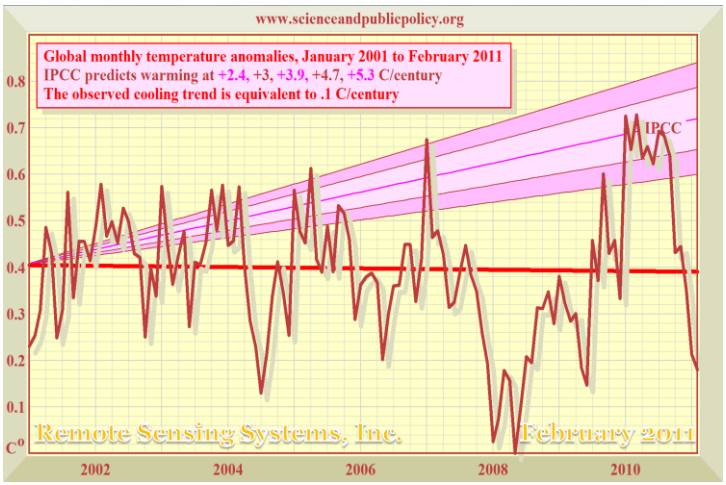
And that is what was published. In short, the supposed "consensus" about the human influence on global climate is the opinion of one scientist, out of step with the hundreds of scientists who had helped to prepare the scientific final draft of the IPCC's 1995 report. Yet that one man's opinion has been presented to us as the official "consensus" ever since. Dr. Garnaut does not question it. Instead, his 2011 report says:

> "It is highly probable that the central proposition of the mainstream science is correct. Most of the global warming since the mid-20th century is very likely due to human-caused increases in greenhouse gas concentrations." (p. 2)

Yet, as our examination of the temperature record has shown, there is no evidence for an acceleration in the warming rate. Without any such evidence, the official conclusion that more than half of the warming that has occurred since 1950 is anthropogenic seems difficult to justify.

How much 'dangerous' global warming are we likely to cause by 2100?

The significance of the IPCC's statistical fabrication established by our heuristic can scarcely be overstated. For it conceals a remarkable truth – remarkable because, like the graph showing no growth in global temperatures for a decade, it has gone almost entirely unreported. The truth is that "global warming" is simply not occurring as fast as the IPCC and its computer models predict. On the A2 emissions scenario, which comes closest to replicating today's emissions of carbon dioxide, the IPCC had predicted that 0.2 C° of "global warming" should have occurred in the past decade. The outturn was zero:

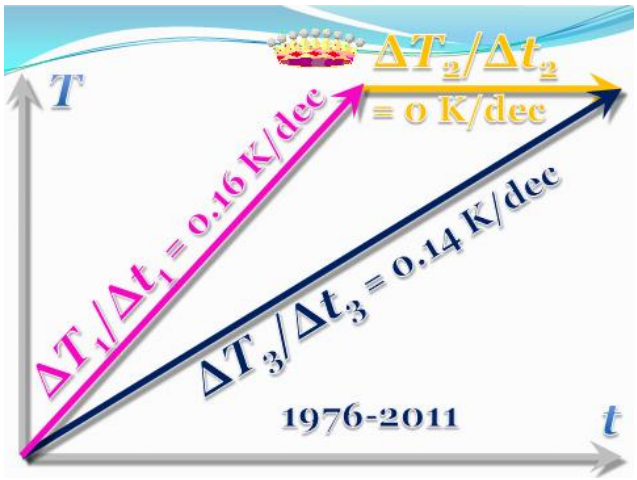


Dr. Garnaut's 2008 report (at pp. xvii-xviii) says of this decade-long stasis or near-stasis in global warming –

> "Much prominence [has been] given to assertions that the warming trend [has] ended over the last decade. This is a question that is amenable to statistical analysis, and we asked econometricians with expertise in analysis of time series to examine it. Their response [was] that the temperatures recorded in most of the last decade lie above the confidence level produced by any model that does not allow for a warming trend."

One does not need to resort to econometrics to determine whether there is a warming trend. It is a simple matter of taking the linear-regression trend on the data. There has been global warming for three and a half centuries. Indeed, according to the Central England Temperature Record, the world's longest continuous instrumental dataset, in the 353 years since 1659 the trend shows 0.9 C° of global warming. That is a very long warming trend over a period nearly all of which cannot have been much influenced by us. No one is suggesting that that trend has ended.

What, then, should Dr. Garnaut have said about the non-warming of the first decade of the new millennium? Lang Hancock would have used a vector diagram like those he drew when calculating the effect of wind-speed and direction on his aircraft's course:



From 1976-2001, the global warming rate was 0.16 Cº/decade, just as it had been from 1860-1880 and 1910-1940. The effect of the decade without warming is to reduce the gradient of the temperature trend since 1976 from 0.16 to 0.14 Cº/decade: still a warming trend, but a lesser trend than before.

However, just as a week is a long time in politics, so a decade is a short time in climatology. Let us look at a longer timescale. We shall go back to 1950, for three reasons. First, as the IPCC itself says in its 2001 report, that is the first year in which we were able to obtain reliable measurements of the atmospheric concentrations of carbon dioxide and the other climate-relevant greenhouse gases. Secondly, we have already seen that 60 years is approximately the length of the combined warming and cooling cycles of the Pacific Decadal Oscillation, so a period of about the same length will remove perhaps the most important naturally-occurring distortion that might otherwise affect our calculations. Thirdly, 1950 is the date after which the IPCC says it is 90% certain – and Dr. Garnaut indicates he is more like 95% certain – that we caused more than half of the measured global warming.

The warming from 1950-2011, expressed as the least-squares linear-regression trend on the HadCRUt3 monthly mean global surface temperature anomaly dataset that the IPCC itself relies upon, was 0.72 C°, a rate of approximately 0.12 C°/decade.

Yet the IPCC, again on its A2 scenario, predicts 3.4 C° warming this century, or an average of 0.38 C°/decade. That *average* is almost as great as the *maximum* supra-decadal warming rate seen in the central England temperature record over a third of a millennium. Dr. Garnaut, in his report for the Australian Government, adds 50% to that surely already excessive prediction. Much like Stern for the British Government in 2006, Dr. Garnaut takes 5.1 C° as his central 21st-century warming rate, implying that the mean warming rate over the coming nine decades (for there has been none in the first decade of the century) will be 0.57 C°/decade – almost five times the mean warming rate observed globally in the past six decades, and three and a half times the maximum global warming rate sustained for more than a decade throughout the past 161 years.

How plausible are such assumptions? In the face of the ever-mounting evidence that warming is not happening as fast as predicted, the IPCC has been compelled to revise downwards its central estimates of climate sensitivity. It has done so in each of its four successive *Assessment Reports.* Its estimate of the equilibrium warming to be expected following a doubling of atmospheric carbon dioxide concentration was 3.8 C° in 1995, 3.5 C° in 2001 and 3.26 C° in 2007. The consensus, it seems, no longer agrees with itself. The question arises how much further the central estimate should fall. On the evidence from the temperature record, it should fall very substantially.

How much global warming are we really likely to cause between now and 2100? The "stranger to climate science" – assuming that he is willing to do science by some method better than mere head-count – must do what any scientist would do: he must apply established theory to observations and draw rational conclusions.

We shall study what actually happened to greenhouse gases and to temperature from 1950 to 2010, and draw some tentative conclusions from that study.

Anthropogenic warming occurs when outgoing long-wave radiation from the Earth's surface interacts at certain characteristic wavelengths with molecules of greenhouse gases, establishing a quantum resonance that turns the gas molecules into minuscule radiators, each emitting heat. Any increase in the net downward-minus-upward flux of long-wave radiation at the top of the atmosphere is called a "radiative forcing". (IPCC, 2001, ch. 6.1)

We begin by establishing the IPCC's estimate of the 21st-century "transient-climate-sensitivity" parameter. This parameter, which we shall call λ, is the quantity – in Kelvin per Watt per square meter – by which any given radiative forcing is multiplied to obtain the consequent temperature change that is expected to occur over a specified period.

The "equilibrium-climate-sensitivity" parameter will of course be considerably greater than the transient parameter, but equilibrium only occurs after several millennia, so – as Dr. Garnaut himself agrees – it is the 20th-century warming, and implicitly the 20th-century transient-climate-sensitivity parameter, that is policy-relevant.

Note that we here express λ as the reciprocal of the parameter that the literature generally refers to as λ. We do so because we are here treating radiative forcings as the independent or driving variable and temperature change as the dependent or driven variable. As we shall see, the picture is more complex than this, but it is essential to the IPCC's theory that the trigger for global warming is a radiative forcing. Thus, in Kelvin per Watt per square metre, the climate-sensitivity parameter is – at its simplest – the change ΔT in mean global surface temperature in response to the change ΔF in the net down-minus-up flux of radiation at the tropopause (which is the top of the troposphere, the climatically-active region of the atmosphere) (Eq. 2) –

$$\lambda = \Delta T / \Delta F. \qquad (2)$$

Note also that, although the IPCC describes λ as "a typically near-invariant parameter", and holds that this near-invariance more or less applies as between different radiative forcings, the near-invariance does not apply over time. In general, until equilibrium – which does not occur for 1000-3000 years (Solomon *et al.,* 2009), the value of λ will tend to increase with time, though the greater part of the equilibrium value will have been reached after a century or so, and the warming thereafter will be slow enough to do little in the way of avoidable harm.

Henceforth I shall generally use Kelvin, rather than Celsius degrees, as the unit of measurement for temperature change. For this purpose, the two are identical.

The IPCC's *Fourth Assessment Report* predicts that, on the A2 emissions scenario that comes closest to today's real-world emissions of greenhouse gases, there will be 3.4 K warming from 2000-2100 in response to 8 W m^{-2} of radiative forcings. From this, as Eq. (3) shows, the IPCC's implicit central estimate of the transient-climate-sensitivity parameter for the 21st century is, simply,

$$\begin{aligned} \lambda &= \Delta T / \Delta F \\ &= 3.4 / 8 \\ &= 0.425 \text{ K W}^{-1} \text{ m}^2. \end{aligned} \qquad (3)$$

Would Dr. Garnaut agree with that central estimate? Let us check. His 2011 update talks of keeping the anthropogenic component in the concentration of greenhouse gases down to the equivalent of 450 parts per million by volume of carbon dioxide, so as to keep manmade global warming in the 21st century at or below 2 K –

> "The Review recommended—and the government accepted—that Australia should also make pledges of stronger commitments calibrated to what other countries were doing. Australia should offer to reduce 2020 emissions by 25 per cent in the context of a strong international agreement focused on holding concentrations at 450 ppm, corresponding to a temperature increase of about 2 C°." (2011, p. 63)

Dr. Garnaut has this to say about the desirability of keeping anthropogenic warming to 2 K compared with the pre-industrial value at some unspecified date, presumably the IPCC's reference date of 1750 –

> "We are already feeling some impacts of climate change when the increase so far is less than 1°C since pre-industrial times. How will Australians in future manage 2 C°, which for the moment seems a lower bound on a wide range of possibilities? Even an increase of 2 C° above pre-industrial levels would have significant implications for the distribution of rainfall in Australia, the frequency and intensity of flood and drought, the intensity of cyclones and the intensity and frequency of conditions for catastrophic bushfires. The difference between 2 C° and 3 C° was examined in detail in the 2008 Review. It is large. And every degree upwards after that is worse. There is no point at which we can say that so much damage has been done that there is not much point in stopping more." (2011, p. 100)

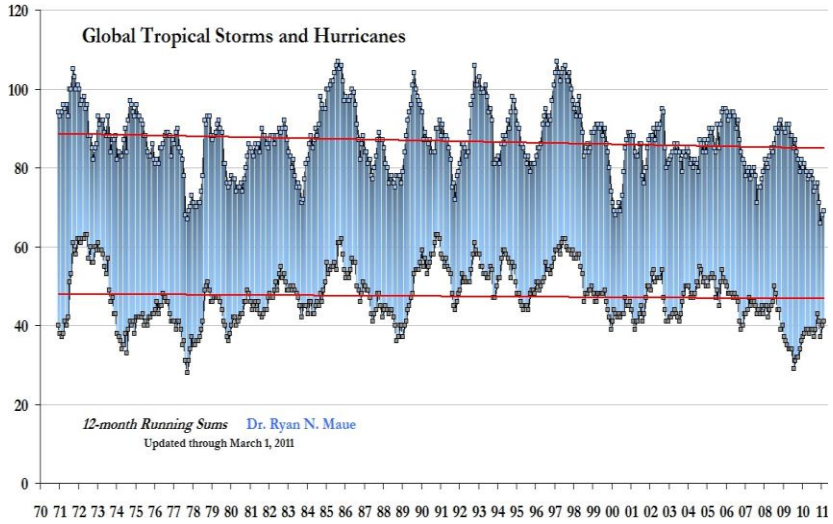
This revealing passage begs an obvious question. What is the ideal global mean surface temperature? Dr. Garnaut here implies that the temperature as it is thought to have been in 1750 was better for life on Earth than any temperature since then, and that the warmer the planet becomes the worse the existential threats he graphically imagines.

Should we try to make the planet colder than it was in 1750? We are not told. That begs the question on what evidence the imagined global temperature in 1750 is thought to have been the best of temperatures in the best of all possible worlds.

Until the recent emergence of the global warming storyline, warmer weather was near-universally regarded as better for life on Earth than colder. Warm periods such as the mediaeval period were described as "climate optima" precisely because they were warmer and warmer was better. Also, approaching 90% of all life on Earth lives in the tropics or sub-tropics, where it is warm and wet, compared with perhaps 1% at the Poles, where it is cold and dry (Antarctica being the driest continent on Earth).

Dr. Garnaut also assumes without question that both floods and droughts, as well as tropical cyclones and bush fires, will become more frequent and more severe as the world warms. However, most extremes of weather occur as a result of a sharp differential, over a short time in a particular place, between extremes of hot and cold. Yet, as the IPCC points out, these temperature differentials will tend to be less sharp as the world warms. Accordingly, the frequency and intensity of extreme-weather events may well tend not to increase but actually to diminish, especially outside the tropics.

Here, for instance, is Dr. Ryan Maue's record of the Accumulated Cyclone and Tropical Storm Energy Index, a 12-month running sum of the frequency, intensity and duration of all hurricanes, typhoons, tropical cyclones and tropical storms worldwide –



There was rapid warming from 1976-2001, yet there has been a downtrend throughout the period since then. In fact, whether tropical storms are included in or excluded from the index, current levels of hurricane and tropical-storm activity are the lowest in at least 30 years and perhaps in 50 years.

To verify that Dr. Garnaut and I are assuming approximately the same implicit value for the IPCC's 21st-century climate-sensitivity parameter, we establish the value of the 21st-century climate-sensitivity parameter that is implicit in his statement about 450 ppmv of carbon dioxide equivalent causing 2 K of global warming by 2100.

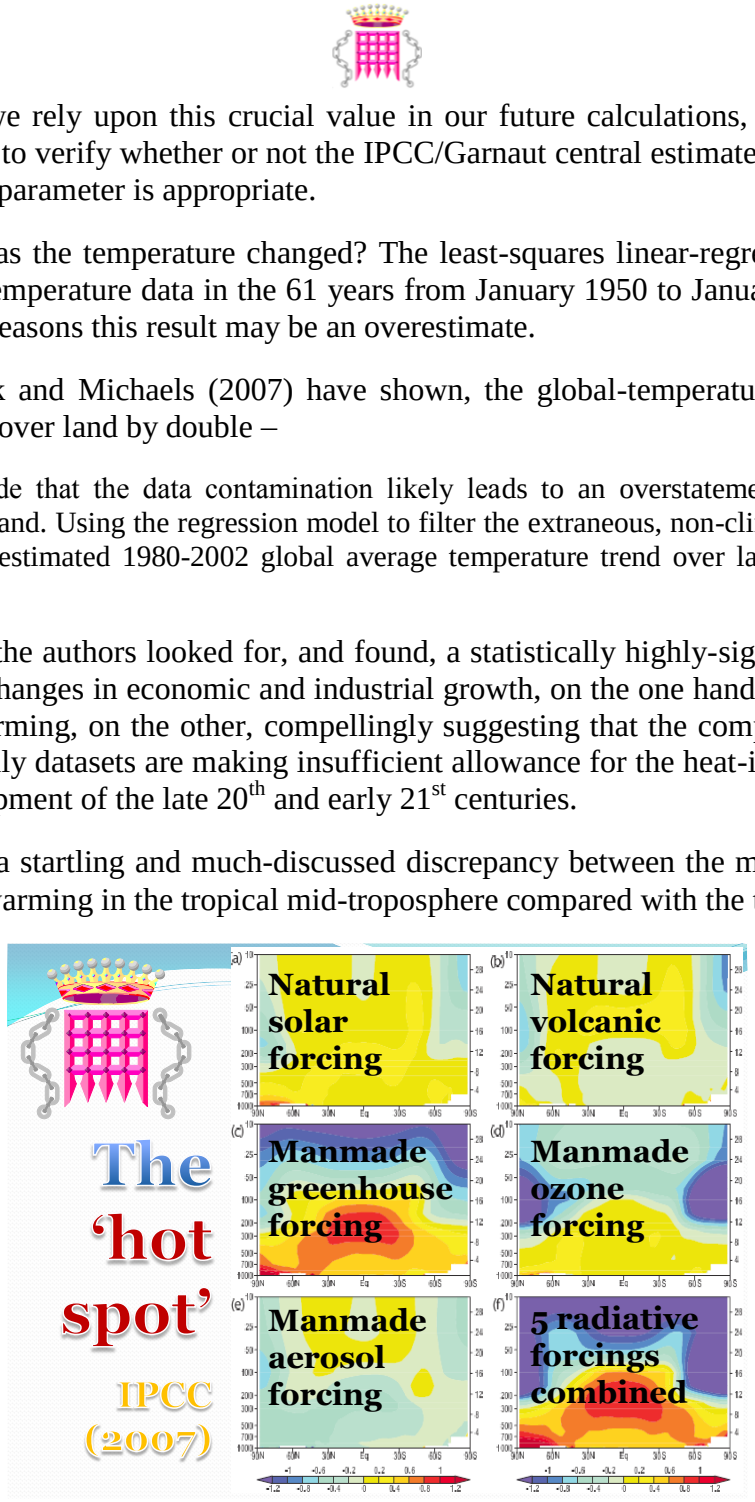
The first step is to establish the radiative forcing that an increase in carbon dioxide concentration by 450 ppmv from the pre-industrial 280 ppmv to 730 ppmv would cause. We use the IPCC's own radiative-forcing function for carbon dioxide (taken from Myhre *et al.*, 1998), where C_a is the unperturbed concentration (Eq. 4) –

$$\begin{aligned} \Delta F &= 5.35 \ln(C_b / C_a) \\ &= 5.35 \ln[(280 + 450) / 280] \\ &= 5.13 \text{ W m}^{-2}. \end{aligned} \quad (4)$$

Dr. Garnaut's implicit central transient climate-sensitivity parameter follows (Eq. 5) –

$$\begin{aligned} \lambda &= \Delta T / \Delta F \\ &= 2 / 5.13 \\ &= 0.390 \text{ K W}^{-1} \text{ m}^2. \end{aligned} \quad (5)$$

That result is indeed sufficiently close to the IPCC's implicit 0.425 K W^{-1} m^2 from Eq. (3).



However, before we rely upon this crucial value in our future calculations, we shall study the climate since 1950 to verify whether or not the IPCC/Garnaut central estimate of the 21st-century climate-sensitivity parameter is appropriate.

First, how much has the temperature changed? The least-squares linear-regression trend on the HadCRUt global temperature data in the 61 years from January 1950 to January 2011 is 0.72 K. However, for two reasons this result may be an overestimate.

First, as McKitrick and Michaels (2007) have shown, the global-temperature datasets tend to overstate warming over land by double –

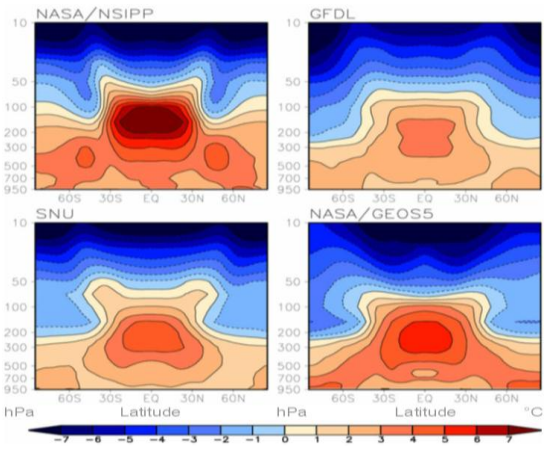
> "We conclude that the data contamination likely leads to an overstatement of actual trends over land. Using the regression model to filter the extraneous, non-climatic effects reduces the estimated 1980-2002 global average temperature trend over land by about half."

The reason is that the authors looked for, and found, a statistically highly-significant correlation between regional changes in economic and industrial growth, on the one hand, and regional rates of atmospheric warming, on the other, compellingly suggesting that the compilers of the global temperature-anomaly datasets are making insufficient allowance for the heat-island effects of the rapid urban development of the late 20th and early 21st centuries.

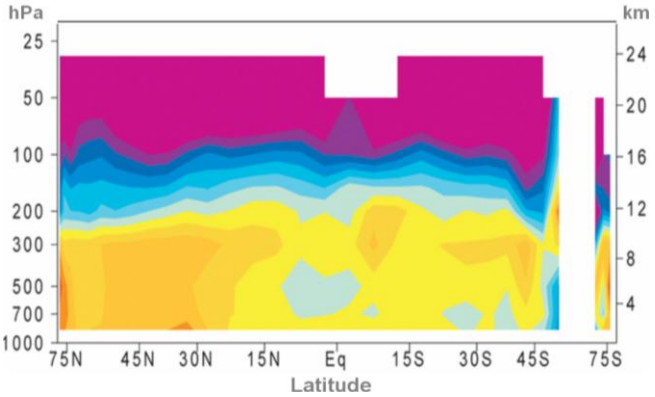
Secondly, there is a startling and much-discussed discrepancy between the model-predicted and observed rates of warming in the tropical mid-troposphere compared with the tropical surface:

The latitude-vs.-altitude diagram, adapted from Santer (2003), reproduced in IPCC (2007), suggests that if and only if manmade greenhouse-gas forcing is the reason for the warming then the rate of warming in the tropical mid-troposphere about 10 km above the surface will be thrice the surface rate. This "hot spot" – I had the honour of naming it – predominates even if all sources of radiative forcing are combined, as the bottom right panel in the diagram shows.

As the following diagram demonstrates, many of the models on which the IPCC relies are tuned to predict the existence of the tropical mid-troposphere "hot spot" –



However, the "hot spot" is not observed in reality, as the following latitude-vs.-altitude diagram from the Hadley Centre for Forecasting graphically demonstrates –



Dr. Garnaut's 2011 report says of this troubling discrepancy –

> "Greenhouse theory and modelling anticipated that a hot spot should occur in the atmosphere about 10 to 15 kilometres above the earth's surface at the tropics, but this was not previously supported by observations. More accurate temperature observations are now available and greater warming has been detected in that area, which has provided another 'fingerprint' of changes caused by greenhouse gases." (p. 17)

Dr. Garnaut provides no reference for his statement that "more accurate temperature observations" show "greater warming" in the tropical mid-troposphere. Of a dozen tropospheric-temperature datasets, all but one show a picture similar to that of the Hadley Centre: little or no differential between tropical surface and mid-troposphere warming.

The single dataset that purports to show the apparently-missing "hot spot" is RAOBCORE, first mentioned in this context by Santer *et al.* (2008). It appears to be an outlier.

The truth about the hot spot is subtler than Santer and Garnaut suggest. The hot spot must exist, regardless of the origin of the forcing that caused the warming. It is not really a signature or "fingerprint" of anthropogenic warming at all. If it were, as the IPCC thinks it is, then its absence would compellingly and perhaps conclusively disprove the official theory of high climate sensitivity and consequent dangerous global warming.

However, as Professor Richard Lindzen of MIT recently explained during a seminal lecture at a high-level climate conference in Pereira, Colombia –

> "The hot spot is simply a consequence of the fact that tropical temperatures approximately follow what is known as the moist adiabat [the propensity of a packet of moist air, especially in the tropics, to rise through the lower troposphere without either affecting or being affected by the temperature of the air through which it rises]. This is a consequence of the dominant role of moist convection in the tropics."

The hot spot occurs at that altitude in the tropics at which the latent heat of evaporation contained within the parcel of air that is the moist adiabat becomes sensible heat through re-condensation.

Therefore, the computer models on which the IPCC perhaps unwisely places such heavy reliance are correct to show the existence of the hot spot, but incorrect insofar as they state or imply that the hot spot only occurs if anthropogenic greenhouse-gas forcings are the cause of the warming.

One of three conclusions follows: that mid-troposphere temperatures are being incorrectly measured; that surface temperatures are being incorrectly measured; or both. As Professor Lindzen (*ibid.*) points out –

> "In dynamic meteorology, there is something called the Rossby Radius. It is the distance over which variables like temperature are smoothed out. This distance is inversely proportional to the Coriolis Parameter (twice the vertical component of the Earth's rotation), and this parameter approaches zero as one approaches the tropics so that temperature is smoothed over thousands of kilometers. However, this smoothing is only effective where turbulent diffusion is small. Below about 2 km, we have the turbulent trade wind boundary layer, where such smoothing is much less effective, so that there is appreciable local variability of temperature. In practice, this means that for the sparsely sampled tropics, sampling problems above 2 km are much less important than at the surface. Thus, errors are more likely at the surface."

Because the temperature gradients in the tropical mid-troposphere are few and gentle, a quite small number of radiosonde, drop-sonde or satellite observations is all that is required to establish a reliable profile of temperature change over the whole of the tropical mid-troposphere. For this reason, it is very likely that the great majority of the mid-troposphere datasets are likely to be correct. One might add that, since the IPCC claims to be presenting and representing the scientific "consensus", it and its adherents should accept that all but one questionable dataset show the same results for the mid-troposphere, and that – for the reason explained by Professor Lindzen – these results are very likely to be reliable.

However, far more sampling points are essential to detect true temperature change at the tropical surface, where convection causes substantial and often highly localized variations in temperature over small distances. Yet nearly all of the tropical surface is ocean, over which there are very few temperature measurements. Accordingly, the least improbable conclusion is that the instrumental record is overestimating tropical surface temperature change by up to threefold – and the tropics between 30 N and 30 S account for a third of the Earth's surface.

On this evidence, it seems appropriate to make the admittedly rough-and-ready adjustments in the warming observed since 1950 that is shown in Table 1:

Table 1	% of surface	Adjustment	Result
Land surface	28%	/ 2	= 14%
Tropics (exc. land)	30%	/ 1.25	= 24%
Rest of world	42%	None	= 42%
Adjustment from	100%	Adjusted to	80%

Note that we do not divide the tropical warming by 3, but only by 1.25, because most global warming – however caused – will not occur in the tropics, for advection will carry much of the additional heat poleward. Accordingly, we shall take the warming since 1950 as 80% of 0.72 K, or 0.58 K. Note also that we here assume that the systematic land-temperature error identified by McKitrick and Michaels applied not only from 1980 but from 1950.

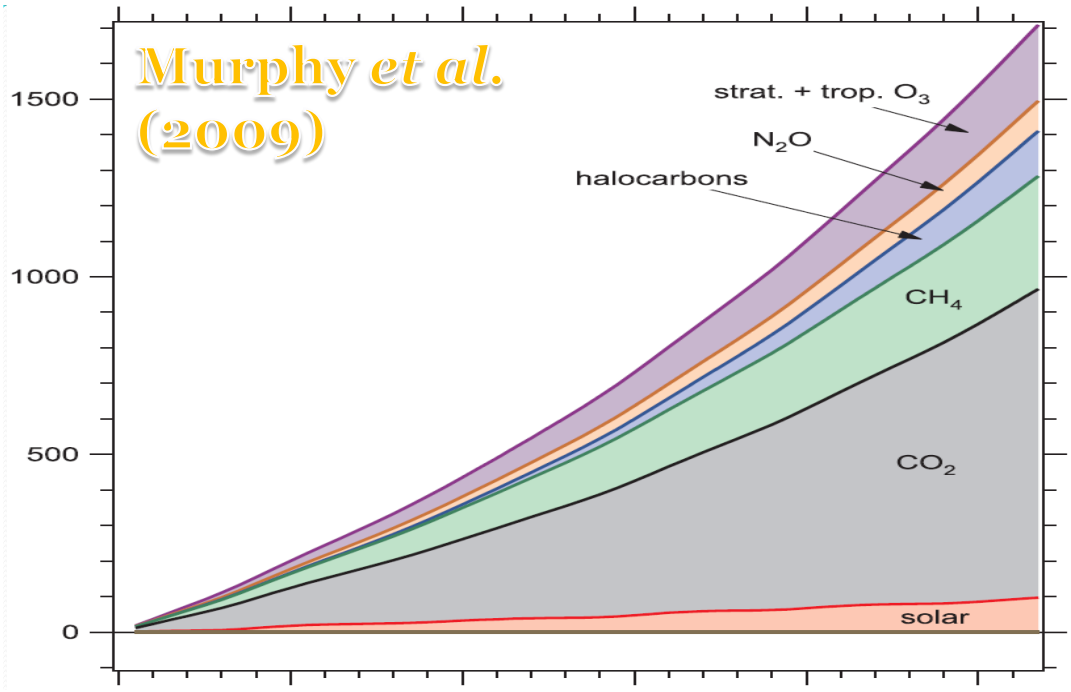
As we have seen, it is not very likely that even half of the warming since 1950 was anthropogenic, for no detectable increase in the most rapid rates of warming is visible in the temperature record. The IPCC, though, considers that more than half of the warming was anthropogenic.

For present purposes, we shall split the difference and assume that half of it – or 0.29 K – was anthropogenic. We multiply this by 100 years / 61 years to make rough-and-ready allowance for the fact that we are looking for a 100-year parameter, not a 61-year parameter, giving 0.47 K manmade warming over the period.

Next, we examine the radiative forcings since 1950. The forcings from long-lived greenhouse-gases are determined in Table 2:

LLGHG	1950	2010	Source	Forcing
Carbon dioxide	308 ppmv	390 ppmv	Tans, 2011	+1.26 W m^{-2}
Methane	1100 ppbv	1816 ppbv	ESRL, 2011a	+0.29 W m^{-2}
CFC-12	20 pptv	530 pptv	ESRL, 2011b	+0.17 W m^{-2}
Nitrous oxide	287 ppbv	324 ppbv	ESRL, 2011c	+0.12 W m^{-2}
CFC-11	10 pptv	241 pptv	ESRL, 2011d	+0.06 W m^{-2}
Other LLGHGs			Estimate	+0.20 W m^{-2}
All LLGHGs				**+2.1** W m^{-2}

These forcings were calculated from the concentrations shown, using the individual functions for each principal greenhouse gas given in IPCC (2007). We verify that they are in the right ballpark by comparing their relative magnitudes with those shown in Murphy *et al.* (2009):



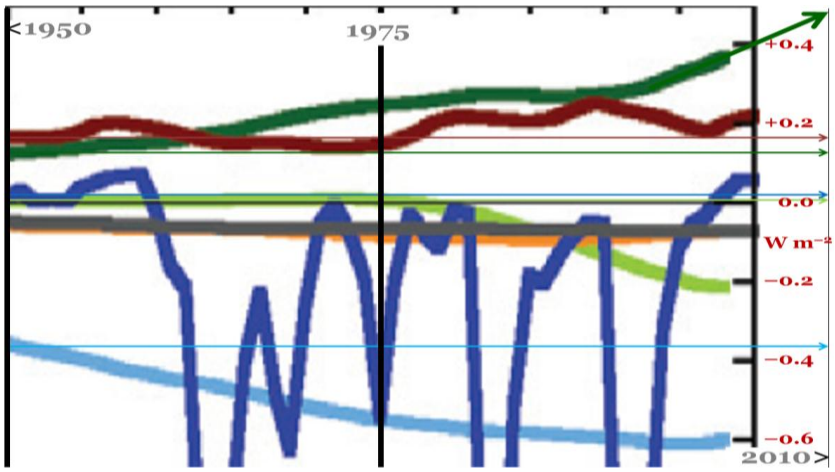
Next, we consider the non-greenhouse-gas forcings, which are estimated in Table 3:

Other	1950	2010	Source	Forcing
Tropo. ozone			IPCC, 2007	+0.34 W m^{-2}
Solar			IPCC, 2007	+0.03 W m^{-2}
Volcanic			IPCC, 2007	+0.02 W m^{-2}
Dir.Aer.; land			IPCC, 2007	+0.00 W m^{-2}
Strato. ozone			IPCC, 2007	−0.21 W m^{-2}
Cloud albedo			IPCC, 2007	−0.23 W m^{-2}
Non-LLGHG				**−0.05** W m^{-2}

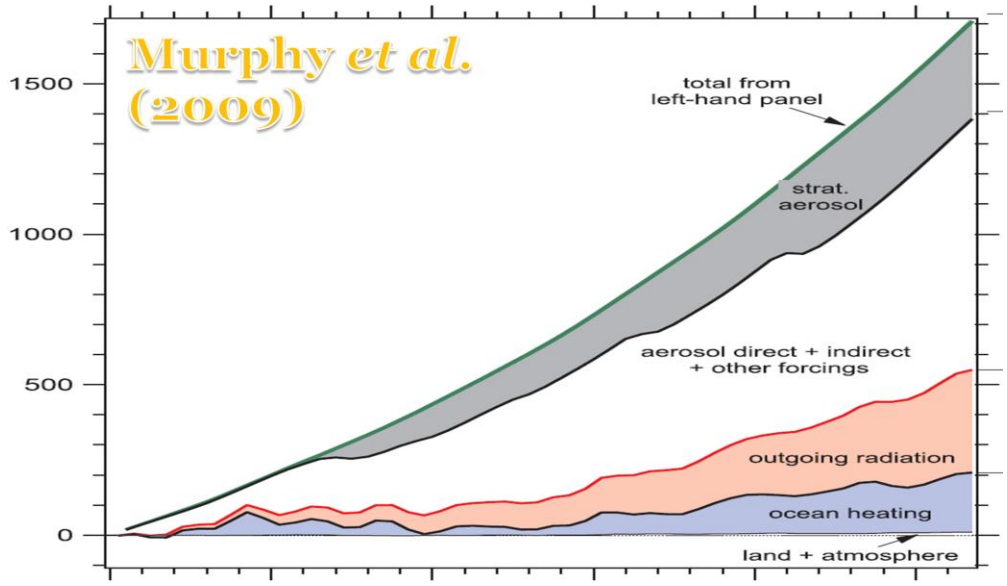
These forcings, many of which are subject to very large uncertainties, were obtained by enlarging the following graph of forcings since 1950 derived from a typical model, given in IPCC (2007, p. 208, fig. 2.23, lower panel).

Each forcing was simply read off the graph as a change between the value in 1950 and that in 2010. For the tropospheric ozone forcing, the 1992-1998 trend was extrapolated to 2010. Other forcings shown were assumed to have changed little from 1998-2010.

Dark green: tropospheric ozone. Brown: solar. Dark blue: volcanic eruption. Light green: stratospheric ozone. Gray: land use. Orange: direct aerosol effect. Light blue: cloud albedo effect.



Once again, we check against Murphy *et al.* (2009):



Here, a substantial discrepancy is evident. Murphy *et al.* calculate the increase in ocean heat content over the period, estimate the amount of additional radiation emitted to space, make a further allowance for the negative forcing from stratospheric aerosols, and then find themselves left with a very substantial residual, which they attribute to aerosol direct and indirect forcings, and other unspecified negative forcings.

It is questionable whether allowing climate sensitivity to depend so crucially upon so very large a residual term is appropriate. The IPCC follows a somewhat similar approach in its table of forcings since 1750, assuming a very large negative forcing from the direct and indirect aerosol effects over the period. The magnitude of this negative forcing – and, recently, even its sign – have been questioned in the literature.

Without this assumption – which is essentially a guess, for the effect and even the sign of the forcing exerted by anthropogenic particulate forcings is not known and is not at present measurable because the latitudinal as well as altitudinal distribution is highly variable – climate sensitivity, and consequently projected future anthropogenic warming, would be substantially below the IPCC's estimates. It is perhaps not unfair to describe the IPCC's strongly-negative aerosol forcing as something of a fudge-factor, calculated to magnify climate sensitivity.

Admittedly, our own method of attempting to determine the magnitude of the non-long-lived-gas forcings is even cruder than that of Murphy *et al.* The uncertainties attendant upon the determination of such forcings are, however, self-evident. For now, we shall proceed on the basis that our determination of those forcings is reasonably in line with typical IPCC models.

Combining the long-lived greenhouse-gas forcings (+2.10 W m^{-2}) and the other forcings (–0.05 W m^{-2}), it appears that some 2.05 W m^{-2} of net-positive radiative forcing has arisen since 1950.

Taking the 0.47 K anthropogenic warming and dividing it by 2.05 W m^{-2} of net-positive anthropogenic forcing, we obtain a centennial transient-climate-sensitivity parameter of 0.23 K W^{-1} m^2, or little more than half the IPCC's implicit central estimate 0.425 K W^{-1} m^2.

It is also appropriate to consider that the exponential increase in carbon dioxide emissions that is predicted on the IPCC's A2 scenario and is occurring today is not being matched by a corresponding exponential increase in atmospheric concentration. For a decade, the rate of increase in concentration has been declining from exponentiality towards mere linearity, suggesting that by 2100 it could be as low as 570 ppmv, compared with the IPCC's central estimate of 836 ppmv. For our purposes, we shall assume 730 ppmv, the lower bound of the IPCC's interval of estimates for 2100 on the A2 emissions scenario.

Finally, it is also right to consider how much of the 3.4 K warming predicted by the IPCC for the 21st century is attributable to carbon dioxide rather than to other forcings. Using the IPCC's own carbon dioxide forcing function, the IPCC's implicit central estimate is that the carbon-dioxide-induced warming from now to 2100 will be as shown in Eq. (6) –

$$\begin{aligned} \Delta T_{CO2} &= \lambda \Delta F \\ &= 0.425 \text{ x } 5.35 \ln(836/390) \\ &= 1.7 \text{ K}, \end{aligned} \qquad (6)$$

or little more than half of the total warming the IPCC predicts for the 21st century. Note that this quite small warming is all that could be expected to be forestalled this century even if all carbon dioxide emissions were cut off today.

Also, note that chapter 6.1 of the IPCC's 2001 *Third Assessment Report* assumed that by 2100 only one-quarter of the warming would have been caused by forcings other than that from carbon dioxide – a substantial apparent discrepancy between the two "consensus" reports.

Bearing in mind all of the considerations we have briefly examined, many of which are warranted in the reviewed literature, the true warming from increases in carbon dioxide concentration may be as little as 0.8 K (Eq. 7) –

$$\Delta T_{CO2} = \lambda \Delta F$$
$$= 0.23 \text{ x } 5.35 \ln(730/390)$$
$$= 0.8 \text{ K}, \quad (7)$$

or less than half of the IPCC's implicit central estimate. Allowing for all other forcings in the approximate proportion given in the IPCC's 2001 report (we assume this because methane and many other non-carbon-dioxide greenhouse-gas forcings have shown signs of slowing over the past decade) brings 21st-century warming up to 1 K, or 30% of the IPCC's central estimate 3.4 K.

Once again, we verify our 1 K estimate by reference to the literature. In 2009, Lindzen and Choi proposed a remarkably direct though at present technically difficult and accordingly somewhat uncertain method of estimating climate sensitivity, by taking the regression trend on a scatter-plot of measured changes in outgoing long-wave radiation compared with simultaneous changes of 0.1 K or more (to exclude statistical noise) in sea surface temperature.

Taking account of some criticism of the method, Lindzen and Choi (2011) recalculated their results and concluded, much as they had in their original paper, that a doubling of carbon dioxide concentration would cause 0.7 K warming, implying that net-negative, not net-positive, feedbacks are operating in the climate and that a possible value of the transient climate-sensitivity parameter might be close to 0.2 K W^{-1} m^2, much in line with our 0.23 K W^{-1} m^2.

Similarly, Spencer & Braswell (2010) say they have succeeded in identifying and measuring a temperature feedback for the first time: the cloud feedback. The IPCC had previously considered this feedback to be strongly positive, but Spencer and Braswell found it to be just as strongly negative, implying that a doubling of carbon dioxide concentration might cause a warming similar to that found by Lindzen and Choi.

Wentz *et al.* (2007) report that, though models predict a 1-3% increase in surface evaporation in response to 1 K of surface warming, the measured increase is almost thrice the mean of these predictions, at 5.7%. From this observation, climate sensitivity in response to a doubling of carbon dioxide concentration may be determined directly by Eq. 8 –

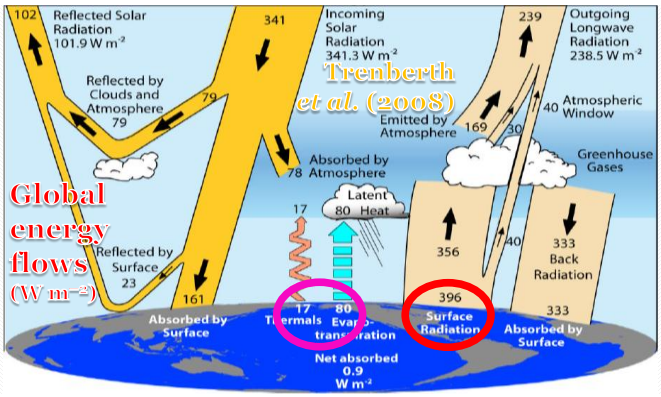
$$\Delta T_{2x} = (5.35 \ln 2) / (0.82 \Delta E/\Delta T), \quad (8)$$

where the differential is expressed as a percentage change in evaporation per Kelvin of warming. Thus, as Table 4 shows –

$\Delta E/\Delta T$, as % K^{-1}	Climate sensitivity ΔT_{2x}
Model range: 1-3%	1.5-4.5 K
Observed: 5.7%	0.8 K

Once again, the implicit climate sensitivity is similar to those found by Lindzen and Choi, and by Spencer and Braswell, This result is also consistent with our own estimate that anthropogenic warming may prove to be less than one-third of the IPCC's central estimate.

Perhaps the most startling inadvertent indication that climate sensitivity may be well below the IPCC's estimates is to be found in a paper by Trenberth *et al.* (2008) on the Earth's radiation budget:



The value circled in red, 396 W m^{-2} of surface radiative flux, would – if correct – strongly indicate very low climate sensitivity. The authors of the diagram admit that they reached this value not by observation but by making the (actually incorrect) assumption that the fundamental equation of radiative transfer (Eq. 9), relating radiative flux to the fourth power of temperature by way of the emissivity ε of the emitting surface and the Stefan-Boltzmann constant σ –

$$F = \varepsilon\sigma T^4, \quad | \quad \sigma = 5.67 \text{ x } 10^{-8} \text{ W m}^{-2} \text{ K}^{-4} \tag{9}$$

applies strictly at the Earth's surface rather than at the characteristic-emission altitude high in the mid-troposphere. On the further (and not unreasonable) assumptions that the Earth's mean surface temperature is 289 K and the emissivity ε at the surface with respect to the long-wave radiation under discussion is close to unity, the surface radiative flux F = 396 W m^{-2}.

To demonstrate the effect on climate sensitivity if Trenberth's surface-flux value were true, we take the first differential κ of the radiative-transfer equation, incorporating also the two surface values within the pink circle, c = 17 W m^{-2} for thermal convection and e = for evapo-transpiration respectively (Eq. 10) –

$$\begin{aligned} \kappa &= T / [4(F + c + e)] \\ &= 289 / [4(396 + 17 + 80)] \\ &= 0.1466 \text{ K W}^{-1} \text{ m}^2. \end{aligned} \tag{10}$$

See Kimoto (2009) for an illuminating discussion of this point. Eq. (10) has a similar form to the equation for the climate-sensitivity parameter λ: for κ is the precursor or no-feedbacks climate-sensitivity parameter, which applies where feedbacks are net-zero or absent. The unitless feedback factor f is determined by Eq. (11), from Bode (1945), allowing mutual amplification of feedbacks –

$$f = (1 - b\kappa)^{-1}, \tag{11}$$

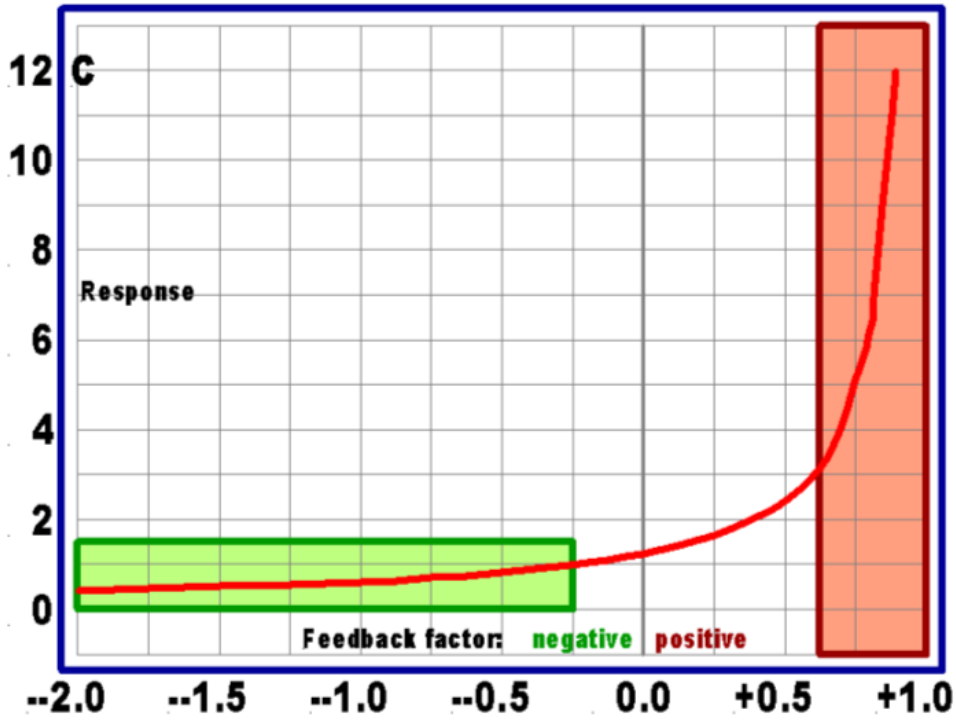
where b is the sum of all unamplified temperature feedbacks. Then final climate sensitivity after all feedbacks are taken into account and mutually amplified is given by Eq. (12) –

$$\begin{aligned} \Delta T &= \Delta F \, \kappa(1 - b\kappa)^{-1}, \\ \text{where } \lambda &= \kappa(1 - b\kappa)^{-1}. \end{aligned} \tag{12}$$

Accordingly, the final-climate-sensitivity parameter λ is dependent not merely upon κ but upon its square, κ^2. The IPCC's implicit value for κ – higher than any in the mainstream literature (Monckton of Brenchley, 2008) – is 0.3125 K W^{-1} m^2. Accordingly, if Trenberth were right, climate sensitivity according to the IPCC would, on this ground alone, be overstated by a factor (0.3125^2 / 0.1466^2): i.e., more than four and a half times the value implicit in Trenberth's diagram – again implying a warming of just 0.7 K.

In fact, however, the IPCC's value for κ, though somewhat excessive, is closer to the truth than that which seems implicit in Trenberth's diagram.

The fundamental difference between the high-sensitivity and low-sensitivity cases lies in the IPCC's assumption that climate sensitivity is chiefly determined by net-positive temperature feedbacks – consequential forcings triggered by the warming caused by the original forcing. A growing body of evidence in the literature, however suggests that temperature feedbacks are net-negative. The following diagram, based on a graph by Prof. Lindzen, shows the distinction between two "ballparks": red for net-positive feedbacks, green for net-negative feedbacks –



In the IPCC's realm of net-positive feedbacks, feedbacks account for almost twice as much warming as the forcings that triggered them, and climate sensitivities become impossible to distinguish from one another – indeed, near-infinite warming could be triggered by quite a small initial forcing if feedbacks were as strongly positive as the IPCC assumes as its high-end case.

It is only in the realm of net-negative feedbacks that climate sensitivity becomes clearly distinguishable – at 0.5-1.5 K for a doubling of carbon dioxide concentration, an interval on which our own estimate of climate sensitivity based on the evolution of the climate since 1950 falls.

It is remarkable, then, that the IPCC only assigns quantitative values to the principal climate feedbacks for the first time in its *Fourth Assessment Report*, and only then by citing a single paper in justification for the values it adopts:

> "In AOGCMs, the water vapor feedback constitutes by far the strongest feedback, with a multi-model mean and standard deviation … of 1.80 ± 0.18 W m^{-2} K^{-1}, followed by the negative lapse rate feedback (–0.84 ± 0.26 W m^{-2} K^{-1}) and the surface albedo feedback (0.26 ± 0.08 W m^{-2} K^{-1}). The cloud feedback mean is 0.69 W m^{-2} K^{-1} with a very large inter-model spread of ±0.38 W m^{-2} K^{-1}." (Soden & Held, 2006).

Considering the importance of these net-positive feedbacks to the IPCC's case, it is also perplexing that the IPCC has not assigned a "level of scientific understanding" to each feedback, as it has to each forcing. An honest level of scientific understanding for all feedbacks in the real atmosphere would surely be "very low". Temperature feedbacks, then, are another major uncertainty in the determination of climate sensitivity, and arguably *the* major uncertainty.

In particular, the high values that the IPCC assigns to the two most strongly positive feedbacks – from water vapour and from clouds – are controversial.

Paltridge *et al.* (2009) find that, though the long-proven Clausius-Clapeyron relation mandates that the space occupied by the atmosphere is capable of carrying near-exponentially more water vapour as it warms, in the upper troposphere – where the principal absorption wavelengths of water vapour are not saturated, so that an increase in absolute humidity might in theory amplify the warming that triggered it – the water vapour tends to subside to lower altitudes, where the principal absorption bands of water vapour are close to saturation.

This subsidence drying of the upper atmosphere, if real, would substantially reduce the magnitude of the water-vapour feedback and hence of overall climate sensitivity. Paltridge heavily and cautiously qualifies his conclusions, but the water vapour question is another source of uncertainty.

Spencer and Braswell (2010), as we noted earlier, find the cloud feedback as strongly net-negative as the IPCC imagines it to be net-positive. If so, then climate sensitivity is less than one-sixth of the IPCC's central estimate, and it is firmly in the realm of net-negative feedbacks that counteract to some extent the warming triggered by a forcing.

In this realm, shown in green on Professor Lindzen's graph, climate sensitivity is near-identical across a wide interval of negative feedbacks. Professor Lindzen argues, powerfully, that a climate dominated by net-positive feedbacks would be a great deal less stable than the climate we observe, while a climate dominated by net-negative feedbacks would be quite stable.

Lindzen & Choi (2011) find feedbacks generally net-negative by the closest and simplest attempt to direct measurement that has yet been attained.

It will be evident from this discussion that the determination of climate sensitivity is fraught with multiple uncertainties, but that the IPCC in most instances chooses values that are at the high end of available estimates, and often higher than is plausible. It is worth briefly summarizing some of the uncertainties we have come across:

Chaos: The climate acts as a mathematically-chaotic object and is, therefore, inherently unpredictable by any model running for more than a week or two into the future. Chaoticity may be one reason why models that have been tuned and retuned so as to replicate past climatic changes have proven unreliable when attempting to predict future changes.

Climate sensitivity: The IPCC's 1995, 2001 and 2007 reports adopt successively smaller central estimates of the equilibrium global warming to be expected from a doubling of atmospheric carbon dioxide concentration – 3.8, 3.5 and 3.26 K respectively. The consensus does not agree with itself.

The IPCC's estimate of 21st-century warming: Table 10.26 on page 803 of the IPCC's *Fourth Assessment Report* appears to indicate a warming of 4 K in response to 8 W m^{-2} of forcing under the A2 emissions scenario. However, the *Summary for Policymakers*, which ought to have been written last but was published first, gives the value 3.4 K. The "consensus" again disagrees with itself. We have taken what is presumptively the later value, 3.4 K, as the basis for determining the IPCC's implicit central estimate of the 21st-century climate-sensitivity parameter.

Dr. Garnaut's estimate of 21st-century warming: Dr. Garnaut's 2008 report assumes that the global warming over the 21st century will be 50% above the IPCC's central estimate, at 5.1 K as opposed to the IPCC's 3.4 K. However, the statement in his 2011 report that adding 450 ppmv carbon dioxide equivalent to the 280 ppmv of pre-industrial atmospheric concentration will cause just 2 K of warming implies close agreement with the IPCC's central estimate after all. Inconsistencies such as these are remarkably difficult to avoid when considering the climate. Another internal disagreement in the "consensus" camp.

Carbon dioxide forcing: The IPCC has already been compelled to reduce the coefficient in the carbon dioxide forcing equation from 6.3 to 5.35, a fall of 15%. Once again, the "consensus" is not in accord with itself. That this crucial coefficient should have been reduced by so much when the IPCC assigns a "high" level of scientific understanding to it does raise legitimate questions about the robustness and certainty of its central case.

Other forcings: The IPCC's 2001 report said non-carbon-dioxide forcings would account for about one-quarter of all forcings by 2100, but the 2007 report says it will account for half of all forcings. If the 2007 report is wrong and the 2001 report right, the IPCC is overstating 21st-century climate sensitivity by half on this ground alone. Here again, the "consensus" is at odds with itself.

Urban heat island adjustment: The apparent failure of the compilers of surface temperature r4ecords to take sufficient account of the urban heat-island effect – i.e. non-greenhouse-gas sources of warming from human activity – has the effect of overstating observed temperature change and hence climate sensitivity if derived from observation.

No tropical mid-troposphere hot spot: The absence of the hot spot may imply a further overstatement of global temperatures and hence of climate sensitivity on the IPCC's part.

Warming since 1950 is subject to uncertainties connected with urban heat-island adjustments, the absence of the hot spot, the sharp reduction in the number of stations reporting temperatures globally, the absence of a unified standard or method of temperature measurement, the variable

and often poor siting of measurement stations, etc. Overall, it appears that the warming, and hence climate sensitivity, have been overstated.

Forcings since 1950, particularly in connection with the effect of clouds and of anthropogenic particulate aerosols, introduce such large uncertainties that the reliable determination of climate sensitivity by theory based on observation is not possible. The IPCC admits these uncertainties, and yet claims near-certainty that we caused most of the global warming since 1950. Here again is an inconsistency.

Rate of carbon dioxide concentration increase: The IPCC's central estimate, on the A2 scenario, is that atmospheric carbon dioxide concentration, now 390 ppmv, will be 836 ppmv by 2100. However, if the concentration continues to decay from exponential increase towards a merely linear increase over the next 90 years as it has over the past 10 years, then the concentration by 2100 could even be as little as 570 ppmv, not 836 ppmv, greatly reducing the global warming to be expected from anthropogenic influences over the 21st century.

The water vapour feedback may have been greatly overstated by the IPCC, which has perhaps not taken sufficient account of factors such as subsidence drying, the non-uniform distribution of water vapour both latitudinally and altitudinally in the real atmosphere and the probability of increased evaporation and precipitation in a warmer world.

The cloud feedback may also have been overstated: it may prove to be as strongly negative as the IPCC finds it strongly positive.

Clouds are among the greatest sources of uncertainty in predicting future climate states, as the IPCC itself rightly admits. The substantial withdrawal of low-altitude, low-latitude, optically-dense cloud cover from 1983-2001, and the consequent very rapid surface warming, cannot really be attributed to anthropogenic causes: it appears to be part of the natural variability of the climate.

The surface evaporation rate: as Wentz *et al.* have perhaps unwittingly demonstrated, the true increase in the rate of evaporation at the Earth's surface as it warms is approximately three times greater than the increase assumed by the computer models on which the IPCC relies. If Wentz's values are correct, true climate sensitivity is less than one-quarter of the IPCC's central estimate.

Particulate aerosols are another major source of uncertainty, and there is some evidence that the IPCC and some of its leading supporters in the scientific community are using it as a fudge-factor to increase climate sensitivity considerably above where it should be.

The applicability of the fundamental equation of radiative transfer at the Earth's surface (as assumed by Trenberth *et al.*) rather than at the characteristic-emission altitude (the orthodox position) introduces a further uncertainty.

Without looking very hard, we have identified more than a dozen material uncertainties in the determination of climate sensitivity, of warming since 1950 and, looking forward, of predicted 21st-century warming. The IPCC's treatment of these uncertainties leads to many apparent exaggerations in its predictions of warming. In combination, the IPCC's apparent exaggerations seem very likely to have led it greatly to exaggerate the warming that our activities will cause in the remaining decades of the 21st century.

Should we, then, calculate the economic consequences of global warming based on our own estimate that 21st-century global warming triggered by increases in atmospheric carbon dioxide concentration may be as little as 0.8 K, or should we work from the IPCC's implicit central estimate 1.7 K?

Our analysis indicates that the IPCC's central estimate of 21st-century carbon-dioxide-driven global warming ought really to be treated as a high-end estimate. Since the probability that carbon-dioxide-induced global warming over the 21st century will be as high as 1.7 K seems small, and may be vanishingly different from zero, *a fortiori* the probability that the warming will exceed 1.7 K is negligible.

Nevertheless, in our economic calculations we shall adopt the IPCC's central estimate of the 21st-century climate-sensitivity parameter, which we have shown is implicitly adopted by Dr. Garnaut.

We now turn to the costs and benefits of policies to mitigate future global warming by attempting to control carbon dioxide emissions.

Is mitigation by controlling carbon dioxide emissions cost-effective?

For simplicity, central estimates from IPCC's A2 emissions scenario are used throughout. Eq. (13) determines C_{pol}, the atmospheric carbon dioxide concentration in ppmv (somewhat below IPCC's projected A2 business-as-usual concentration C_y that would otherwise obtain) that is achievable by following any proposed policy to mitigate the radiative forcing from atmospheric carbon dioxide enrichment from 2010 (when C_{2010} = 390 ppmv) till a target calendar year y.

$$\begin{aligned}\Delta T_{\text{nix}} &= \lambda \Delta F \\ &= \lambda \left[5.35 \ln\left(\frac{C_y}{C_{\text{pol}}}\right)\right] \\ &= \lambda \left[5.35 \ln\left(\frac{C_y}{C_{\text{y}} - p(C_{\text{y}} - 390)}\right)\right]. \end{aligned} \quad (13)$$

Eq. (13) also determines ΔT_{nix}, the quantum (in Kelvin) of transient global warming that the policy will be likely to forestall if pursued until year y. Only two case-specific inputs are required: C_y itself, and p, the proportion of projected global business-as-usual carbon dioxide emissions till year y that the policy is intended or expected to forestall.

A non-case-specific input is the climate-sensitivity parameter λ, which may be set to encompass the interval of IPCC global-warming projections under all emissions scenarios. IPCC (2001, p. 354, citing Ramanathan, 1985) takes 0.5 K W^{-1} m^2 as a typical value of λ. On the A2 emissions scenario, IPCC (2007, p. 13, table SPM.3) projects 3.4 K warming by 2100 in response to forcings from all sources summing to 8 W m^{-2} (*ibid.*, p. 803, fig. 10.26), implying a 21st-century transient-sensitivity parameter λ_{tra} = 3.4 / 8 = 0.425 K W^{-1} m^2, which will be used here.

As a check, at doubling of carbon dioxide concentration Eq. (14) gives 0.425(5.35 ln 2) = 1.6 K, within the model-derived transient-climate-response interval [1, 3] K (*ibid.*, p. 749). Eq. (13)

may be tuned to represent warming in response to any forcing (see Table 2 below): but only that from atmospheric carbon-dioxide enrichment is demonstrated here.

IPCC (2001), following Myhre *et al.* (1998), takes the carbon dioxide forcing in W m^{-2} as 5.35 times the logarithm of a given proportionate change C_b/C_a in atmospheric concentration, where C_a is the unperturbed value. Where λ is a climate-sensitivity parameter in K W^{-1} m^2, consequent global warming in K may thus be expressed generally by Eq. (2):

$$\Delta T = \lambda \, \Delta F = \lambda \, [5.35 \ln (C_b/C_a)]. \quad (14)$$

Where p, on [0, 1], is the fraction of future global emissions that a given carbon-dioxide-reduction policy is projected to forestall by a target calendar year y, and C_y is the IPCC's projected unmitigated concentration in year y, Eq. (15) gives C_{pol}, the somewhat lesser concentration in ppmv that may be expected to obtain in year y if the policy is followed:

$$C_{\text{pol}} = C_y - p(C_y - 390). \quad (15)$$

Table 5 gives decadal values of C_y from 2010-2100 on the IPCC's A2 emissions scenario, whose central projection is that the anthropogenic fraction of carbon dioxide concentration will grow exponentially from 110 ppmv now to C_{2100} = 556 ppmv by 2100, and the total concentration will consequently grow from 390 to 836 ppmv over the century:

y	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
C_y	390	412	438	469	506	551	604	668	744	836

Table 5. Business-as-usual carbon dioxide concentrations, 2010-2100, on scenario A2 (IPCC, 2007). Carbon dioxide concentration in 2010 is 390 ppmv (Tans, 2011) compared with 280 ppmv in 1750, so that the anthropogenic component is 110 ppmv.

Assuming all increases in carbon dioxide concentration since 1750 are anthropogenic, Eq. (16) determines values of C_y not shown in Table 5 for any calendar year y in the 90 years 2011-2100:

$$C_y = 280 + 110e^{\left(\frac{y-2010}{90}\ln\frac{C_{2100}-280}{110}\right)}. \quad (16)$$

Eq. (17), of similar form to the general Eq. (15), gives the quantum of warming ΔT_{nix}, in K, that a specific policy intended to cut carbon dioxide emissions will forestall in the 21st century:

$$\begin{aligned} \Delta T_{\text{nix}} &= \lambda_{\text{tra}} [5.35 \ln(C_y/C_{2010}) - 5.35 \ln(C_{\text{pol}}/C_{2010})] \\ &= \lambda_{\text{tra}} [5.35 \ln (C_y/C_{\text{pol}})]. \end{aligned} \quad (17)$$

The second expression of Eq. (17) is identical to the second expression of Eq. (13), demonstrating the derivation of that equation.

Mitigation cost-effectiveness, a concept well known in economics but perhaps too little considered in climate discussions, is here defined as the cost of forestalling 1 K carbon-dioxide-driven global warming on the assumption that all measures to mitigate all such warming to year y are as cost-effective as the policy under consideration.

On the same assumption, the policy's *global abatement cost* is defined as the cost (expressed either as a percentage of real global GDP from 2010 to year y or as a cash cost per capita to year

y) of forestalling all global warming from all forcings that the IPCC projects will occur by year *y* without mitigation.

Where ΔT_{all} is all projected carbon-dioxide-driven warming to year *y*, where *x* is the net present value of the cost of the policy, and where *x*/*p* is the cost of mitigating all carbon-dioxide-driven warming to year *y*, Eq. (18) gives the mitigation cost-effectiveness in dollars per Kelvin of global warming forestalled by carbon-dioxide mitigation policies whose cost-effectiveness is equivalent to that of the policy. The less the value of *M*, the more cost-effective is the policy, enabling researchers and decision-makers reliably to compare competing mitigation proposals.

$$M = \left(\frac{x}{p}\right)\Delta T_{\text{all}}^{-1} = \frac{x}{p\lambda[5.35\ln(C_y/390)]}. \quad (18)$$

Where *q* is the fraction of total radiative forcing attributable to carbon dioxide, Eq. (19) gives the policy's global abatement cost as a percentage of total real global 21st-century GDP *r* to year *y*:

$$H = \frac{100x}{pqr}. \quad (19)$$

Eq. (20) gives the per-capita abatement cost in US $/head assuming 7 bn world population:

$$J = \frac{x}{7\text{ x }10^9 pq}. \quad (20)$$

We now illustrate the use of these deliberately simple but not *simpliste* equations by some real-world case-studies. The intention in keeping the equations very simple is to allow policymakers unfamiliar either with climate science or with economics to determine with minimal effort a respectable, credible and not too unreliable estimate of the mitigation cost-effectiveness and global abatement cost of any given carbon dioxide mitigation strategy, from an overall government policy down to the scale of a single, small windmill.

Case study 1: Australia reduces carbon dioxide emissions by 25% over ten years

In Eq. (13), *y* = 2020 and λ = 0.425. Since Australia accounts for 1.2% of global emissions, the proportion *p* of those emissions forestalled by the policy is 25% of Australia's contribution, or 0.3%. From Table 1, business-as-usual atmospheric carbon dioxide concentration C_y will be 412 ppmv by 2020; however, if the policy recommended by Dr. Garnaut is implemented, this will fall to C_{pol} = 411.934 ppmv, by Eq. (15).

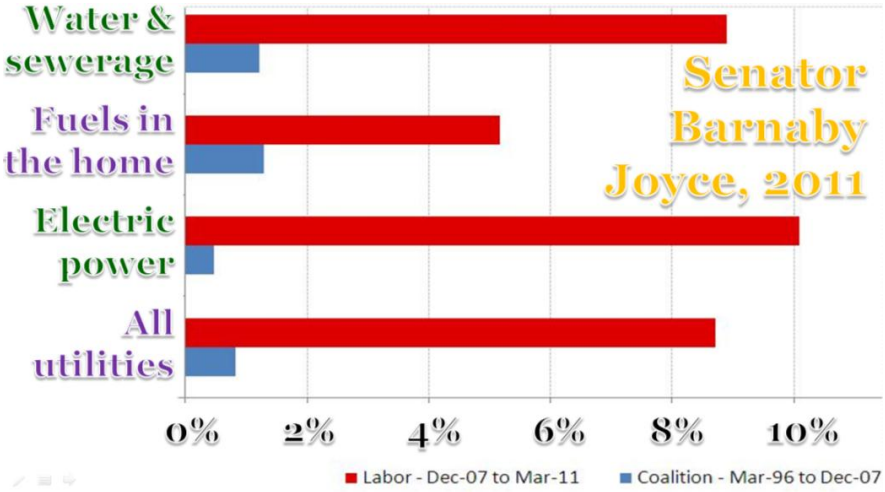
Accordingly, Eq. (16) gives the global warming that the policy will forestall: <0.0004 K, or some 1/2750 of a Kelvin, or well below 1% of the minimum threshold for detection of a global temperature change using modern methods and instruments.

Assuming GDP growth of 3% a year from US $60 trillion in 2010 (World Bank, 2011), cumulative world GDP will be $708 trillion by 2020.

The cost of Dr. Garnaut's suggested policy will not be less than $11.5 billion/year in carbon trading, plus $2.5 billion/year in new-technology investment, plus $1.6 bn/year in departmental costs (Wong, 2011), a total of at least $15.6 billion/year. Furthermore, he says, the cost of carbon trading – set initially at $26 for the right to emit a single ton of carbon dioxide – will be raised by 4% per year above the general growth rate of GDP –

> "It is my assessment that a mature market would come to apply something like an interest rate of about 4% in real terms – 2% representing the risk-free real rate, and the other 2% a risk premium. This is the rate at which a well-informed market could be expected to raise the rate over time if the initial rate had been set appropriately to meet an emissions reduction target that is not changed over time. It is appropriate, then, to simulate the likely market movement by raising the fixed price of emissions by 4%/year in real terms." (2011, pp. 72-3)

To make some small allowance for the fact that our analysis of Dr. Garnaut's proposal will exclude many additional costs already imposed by various Australian governments, such as the $5.1 billion Clean Energy Initiative, and the very large recent and planned increases in electricity costs (see Senator Joyce's summary below), we shall raise not only the carbon trading cost but also the new-technology and departmental costs by 4% annually above the general GDP growth-rate, here taken as 3% per year. Other assumptions could be made, but these seem modest.



Published estimates of *global mitigation cost* are given as 1% of global GDP (Stern, 2006; Lomborg, 2007), and 3.2% (Garnaut (2008). We shall examine whether individual policies to address global warming will in fact be as cost-effective as these estimates suggest.

Next, for comparison, the *global inaction cost*, which is the welfare loss arising from the consequences of unmitigated global warming over the 21st century requires to be established. Dr. Garnaut estimates 6% of Australia's GDP by 2100; Stern (2006) estimates 5-20% of GDP. Both of these economists assume at least 5 K warming by 2100, half as much again as the IPCC's 3.4 K central A2-scenario estimate. Their justification for adopting a central climate-sensitivity estimate that is some 50% higher than that of the IPCC is not entirely clear.

Some estimates from the peer-reviewed economic journals are as follows, broadly suggesting that the global inaction cost will be 2-5% of GDP:

1.0 K warming will cost 2.5% of GDP (Tol, 2002).

2.5 K warming will cost 0.9% (Nordhaus, 2006), 1.4% (Fankhauser, 1995), 1.5% (Nordhaus & Boyer, 2000), 1.7% (Nordhaus & Yang, 1996), 1.9% (Tol, 1995), 2.5% (Plamberk & Hope, 1996), or 0.0-0.1% of GDP (from market impacts only: Mendelsohn *et al.*, 2000).

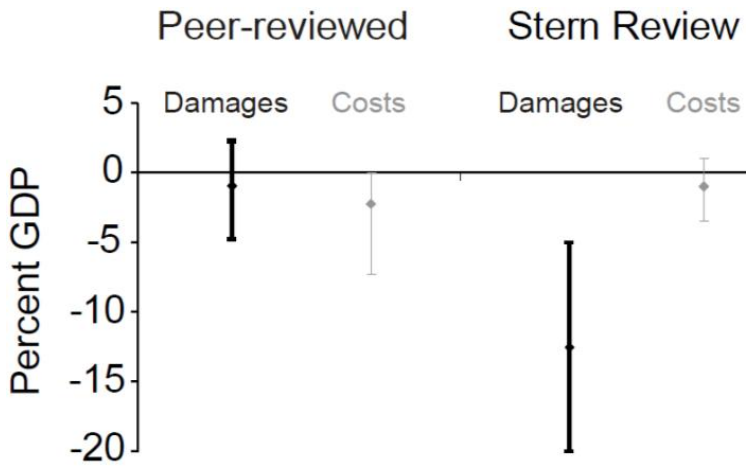
3 K warming will cost 1.3-4.8% of GDP (Nordhaus, 1994ab).

There are three main reasons for the differences between the peer-reviewed literature and the Stern report. First, Stern adopts extreme a very high central estimate of the warming to be expected by 2100: 5 K compared with the IPCC's 3.4 K. The adoption by Stern of a central climate-sensitivity estimate half as much again as that of the IPCC provides a margin of caution, allowing us to use it as a starting point for determining global inaction costs on the basis of various discount rates that occur in the literature.

Secondly, Stern adopts extreme estimates of various specific welfare losses (such as that from malaria, which will in fact be near-zero in response to global warming). Again, if we merely adopt his analysis *ad argumentum*, any analysis that we base upon it will err on the side of caution.

Thirdly, Stern adopts a 0.1% pure rate-of-time preference. The inter-temporal discount rate is, as we shall see, the prime determinant of variations between published cost-benefit estimates.

The following comparison between peer-reviewed papers and Stern's review was presented in Lomborg (2007). Peer-reviewed studies show costs of attempted mitigation rather higher (i.e. lower on the graph) than the welfare losses from inaction. The Stern Review, however, reverses the literature:



By how much should we discount future costs and benefits to net present value to take account of the uncertainties inherent in any long-term investment appraisal, and particularly inherent in an appraisal of the effect of a given policy on the future behaviour of the chaotic climate object?

Stern's surprisingly low 0.1% discount rate is based – according to a document linked from HM Treasury's website – on a misunderstanding by him of the literature on the economic treatment of inter-generational equity. Certainly, this near-zero rate is a long way below HM Treasury's standard 3.5% discount rate.

However, the Treasury has gone a small step in Stern's direction by adopting two reduced "climate-change" discount rates, that are initially commercial and are then reduced after year 30 and again after year 75 to allow for "very-long-term, substantial, and for practical purposes irreversible wealth transfers between generations" (Grice, 2011; Lowe, 2008). Over the entire 21st century these variable rates are broadly the equivalent of 3.22% and 2.75% respectively – much closer to the Treasury's standard 3.5% discount rate than to Stern's 0.1%.

Dr. Garnaut chooses two discount rates: 1.35% and 2.65%.

Finally, Dr. Vaclav Klaus, President of the Czech Republic, recommends a 5% discount rate to allow for the considerable uncertainties in climate prediction (Downing College climate conference, May 2011).

In Table 6, all of these rates are modelled on a very simple basis. First 3% annual GDP growth throughout the 21st century is assumed. Secondly, low-end and high-end estimates of the welfare loss owing to climate inaction are determined by multiplying Stern's 5%- and 20%-of-GDP estimated 21st-century inaction costs by the ratio of total 21st-century GDP discounted at Stern's 0.1% rate to total 21st-century GDP discounted at the mean discount rates shown in Table 6:

Table 6	Mean rate (%)	Yr 0 -30 (%)	Yr31 -75 (%)	Yr76 -100 (%)	Low est. of inaction cost	High est. of inaction cost
Stern (2006)	0.10				5.0% GDP	20% GDP
Garnaut (2011): #1	1.35				2.2% GDP	8.6% GDP
Garnaut (2011): #2	2.65				1.0% GDP	4.1% GDP
HM Tsy reduced (Lowe, 2008)	2.75	3.00	2.57	2.14	1.0% GDP	3.9% GDP
HM Tsy Green Book (Grice, 2011)	3.22	3.50	3.00	2.50	0.8% GDP	3.1% GDP
HM Treasury flat discount rate	3.50				0.7% GDP	2.7% GDP
President Klaus' discount rate	5.00				0.4% GDP	1.5% GDP

In Table 7, the effect of the interval of published discount rates is illustrated by comparing the mitigation and inaction costs of Dr. Garnaut's suggested carbon dioxide mitigation policy for Australia after applying Stern's and Garnaut's rates, as well as the Treasury's standard 3.5% flat rate and President Klaus' recommended 5% rate.

The table shows the policy cost *x*, the mitigation cost-effectiveness *M*, the per-capita global abatement cost *J*, the cash global abatement cost *H*, *H* expressed as a percentage of GDP, the global welfare loss interval *I* arising from inaction (with the upper and lower bounds of the interval expressed as percentages of GDP), and the ratio of *H* to the upper bound of *I*:

Table 7	Stern (2006)	Garnaut #1	Garnaut #2	Treasury	Klaus
Discount rate	0.1%	1.35%	2.65%	3.5%	5.0%
Policy cost *x*	\$231 bn	\$214 bn	\$199 bn	\$189 bn	\$174 bn
Mitigat. cost-effect. *M*	\$634 tr K^{-1}	\$588 tr K^{-1}	\$545 tr K^{-1}	\$520 tr K^{-1}	\$479 tr K^{-1}
Abatement cost/head *J*	\$21,500	\$20,000	\$18,500	\$17,500	\$16,500
Global abatemt. cost *H*	\$151 tr	\$140 tr	\$130 tr	\$124 tr	\$114 tr
H as % GDP	21.3%	19.8%	18.3%	17.5%	16.3%
Global inaction cost *I*	5-20%	2.2-8.6%	1.0-4.1%	0.7-2.7%	0.4-1.5%
Ratio $H:I_{max}$	1.1	2.3	4.5	6.5	10.9

Even the use of Stern's minimalist discount rate shows that the global abatement cost – i.e., the cost of forestalling all global warming between now and 2020 if all measures to mitigate global warming from all anthropogenic causes were as cost-effective as Dr. Garnaut's proposal – will exceed Stern's own estimated maximum cost of climate-related damage arising from worldwide inaction.

At Dr. Garnaut's own discount rates, the global abatement cost would be 2.3-4.5 times the inaction cost. At the Treasury's 3.5% discount rate, the global abatement cost would be almost 6.5 times the inaction cost. At President Klaus' recommended 5% discount rate, the cost of doing what Dr. Garnaut proposes would be an order of magnitude above the maximum cost of doing nothing.

These results are not without interest, and for more than one reason. First, though the methodology is crude, it is sufficient to indicate that the cost of attempting to prevent global warming from occurring is likely to exceed – and perhaps greatly to exceed – the maximum welfare loss through climate-related damage arising from worldwide inaction.

Secondly, though Dr. Garnaut, in his 2011 update, gives the annual cost of his proposal, he does not go on to display any such calculation as that which we have attempted here, relating the specific costs of his specific proposal via the specific proportion of Australian and hence of global emissions he calculates his proposal will forestall to the specific quantum of global warming actually likely to be forestalled as a result of the full and successful implementation of his proposal. Nor does he provide any comparison between the mitigation cost-effectiveness of his proposals and that of competing carbon dioxide mitigation policies worldwide.

Thirdly, he proposes a surely costly and complex distortion that would interfere so radically in the operation of the market that the very notion of a free market might, in effect, disappear in Australia:

> "The carbon pricing scheme will generate large amounts of revenue—about 20 per cent of that collected by the goods and services tax. With careful use, the revenue can fully compensate low- and middle-income earners for the costs of the scheme while supporting a substantial efficiency-improving tax reform. At the same time, it can support assistance to avoid uneconomic reduction of production in emissions-intensive industries, incentives for large-scale utilisation of opportunities for bio-sequestration in the land sector, and fiscal incentives for innovation in low-emissions technologies. Some funds would be made available for structural adjustment if it emerged that there were regions in which economic activity and employment were hit heavily by carbon pricing. Provision would be made for the possibility that loan guarantees to secure energy security were called through the early years of transition to a low-emissions economy." (2011, pp. 87-88)

One difficulty arising from any such centralized redistribution of the proceeds of carbon trading is that among its beneficiaries it diminishes or even altogether removes any incentive to consume less electricity or gasoline, commensurately reducing the cost-effectiveness of the proposed arrangements. Another difficulty is that the sheer cost of attempted mitigation will worsen the terms of trade as between Western countries and rapidly-emerging countries such as China and India, who have the advantage of far lower wages and far lighter regulation than we.

The central weakness of any attempt to mitigate carbon dioxide emissions by regulating, reducing, replacing, taxing or trading carbon dioxide is that if it is cheap enough to be affordable it will be ineffective, but if it is costly enough to be effective it will be unaffordable.

Australia's Productivity Commission has found that –

> "No country imposes an economy-wide tax on greenhouse gases or has in place an economy-wide emissions-trading scheme".

However, the Australian Government is proposing to extend its carbon trading not only to electricity generation but also to the high-emitting industries – chiefly in the mining and heavy metals sector – that are particularly sensitive to international competition from countries which, if they trade carbon at all, do not extend the trading much beyond electricity generation.

Understandably, the Commission is concerned that without a level-playing field, where other nations run emissions-trading schemes as widespread in their adverse impact as the Australian scheme, output – and emissions – will merely be driven overseas to Australia's competitors.

Brian Gilbertson, former chief executive officer of BHP/Billiton and of Jupiter Mines, has reinforced the Commission's warning:

> "Global competition for resource investment is growing year by year, and is likely to intensify as strong demand from China, India and others continues. Australia already has a high royalty rate and a high corporate tax rate, and that is before the MRRT and carbon tax. These erode Australia's ability to compete.
>
> "If Australia is to remain a world leader in the sector, a major developer of resource projects and an exporter of commodities, it is imperative that public policy, particularly taxation policy, should not deter foreign investment, thus eroding the nation's long-term competitiveness."

When I first developed the mitigation cost-effectiveness equations that I have presented here – which are unique in that they permit individual schemes even down to the individual windmill to be costed and compared for mitigation cost-effectiveness, the results seemed startling. The world is diverting trillions towards causes of dubious environmental benefit and of negligible economic utility: the real cost very greatly exceeds any likely benefit.

Mr. Greg Boyce, chairman of Peabody Energy, has made a similar point:

> "Energy Minister Martin Ferguson recently highlighted Australia's electricity crisis, stating that rates are up 40 percent in the last three years and are on a path to rise another 30 percent in the next three. This warning is just one more reason why the Australian government should reject a carbon tax, which would punish electricity consumers and hamper employment, manufacturing and mining. Industries and individuals would be doubly impacted by a carbon tax – first by the inevitable rise in electricity rates, and then by the direct cost to businesses that would pass on to Australian consumers. And both of these factors would make Australia far less competitive in the global marketplace and to global investments."

How much more strongly might these and other businessmen in Australia's great mining and energy industries have spoken out if they had appreciated that the cost of attempting to mitigate future anthropogenic global warming comfortably exceeds the cost of doing nothing about it?

The Department of Climate Change in the UK admitted in 2010 that it had done no calculations demonstrating how much global warming the £18.3 billion per year that it is mandated to spend by 2050 under the Climate Change Act, and which the Department's own website said at the time it would spend, would be likely to forestall. The largest tax increase in human history was about to be imposed on the people of the United Kingdom: yet no one had verified whether the

stated purpose of further taxing an already heavily-taxed nation would be advanced materially – or at all.

Further case studies will now demonstrate that the cost-ineffectiveness of Dr. Garnaut's proposals for Australia is by no means unique.

We shall use Stern's 0.1% discount rate throughout, since its use operates – surely more heavily than sound, commercial economics would allow – in favour of costly action now rather than the later and otherwise far lesser cost of focused adaptation to such adverse consequences of future global warming as may occur.

Case study 2: US carbon-trading Bill

At $180 bn/year for 40 years, total $7.2 tr, discounted to $7 tr at net present value, the climate Bill (HR 2454, 2009, s. 311) would have forestalled 83% of US carbon dioxide emissions by 2050. The US emits 17% of global carbon dioxide (derived from Olivier & Peters, 2010, table A1). Thus p = 0.1411. Business-as-usual carbon dioxide concentration in 2050 would be 506 ppmv, falling to 489.632 ppmv via the Bill. Warming forestalled is 0.07 K; Mitigation cost-effectiveness is $84 tr/K; global abatement cost of all projected warming to 2050 is almost $100 tr, or more than 2% of global GDP to 2050, or $14,000 per capita of global population. Since Stern's estimated inaction cost is 5-20% of GDP, this proposal seems a bargain. However, there is no evidence that so small a cost as $7 trillion would achieve as much reduction in US carbon dioxide emissions as 83%.

Case study 3: UK Climate Change Act

The UK accounts for 1.5% of global carbon dioxide emissions (derived from Olivier & Peters, 2010, table A1). At an officially-estimated cost of $1.2 tr by 2050, the Climate Change Act (2008, s. 1(1)), will cut 80% of UK emissions, which are 1.5% of world emissions. Thus, in Eq. (13), p = 0.012. Business-as-usual carbon dioxide concentration in 2050 is 506 ppmv, falling to 504.608 ppmv via the Act. Warming forestalled is 0.006 K; mitigation cost-effectiveness is $167 tr/K; and global abatement cost to 2020 is $193 tr, or 4% of global GDP to 2050, or $27,500 per capita. Again, the cost seems almost reasonable compared with the 5-20% cost of inaction. However, again the cost and benefit figures are perhaps-optimistic government estimates. As we shall see as soon as we examine specific measures to mitigate global warming, rather than looking at government projections, the GDP cost rises significantly.

Case study 4: EU carbon trading

EU carbon trading costs $92 bn/year (World Bank, 2009, p. 1), or $915 bn at net present value by 2020. The EU aims to halt 20% of its emissions, which are 13% of global emissions (derived from Boden *et al.*, 2010ab). Thus p = 0.026. Business-as-usual carbon dioxide concentration would be 412 ppmv by 2020, falling to 411.428 ppmv via the policy. Warming forestalled is 0.003 K; mitigation cost-effectiveness, excluding non-carbon-trading costs, is $282 tr/K; and the global abatement cost of $69 tr is 8% of GDP to 2020, or almost $10,000 per capita. The GDP cost is now within Stern's 5-20% interval of inaction costs. All measures to mitigate global warming in the EU except carbon trading itself are excluded: including them would push up the GDP cost to the higher end of the 5-20% welfare-loss interval.

Case study 5: Thanet Wind Array

Subsidy to the world's largest wind-farm, off the English coast, guaranteed at $100 mn annually for its 20-year life, is £1.96 bn at net present value. Rated output of the 100 turbines is 300 MW, but wind-farms yield only 24% of rated capacity (Young, 2011, p. 1), so total output, at 72 MW, is 1/600 of mean 43.2 GW UK electricity demand (Department for Energy and Climate Change, 2011). Electricity is 33% of UK carbon dioxide emissions, which are 1.5% of global emissions, so $p = 8.333 \times 10^{-6}$. Business-as-usual carbon dioxide concentration in 2030 would be 438 ppmv, falling to 437.9996 ppmv as a result of the subsidy. Warming forestalled is 0.000002 K; mitigation cost-effectiveness is almost $900 tr/K; and the global abatement cost of $461 tr is 28% of GDP to 2030, or $66,000 per capita. Here, it is unquestionably more cost-effective to endure the welfare loss from inaction than to subsidize wind power.

Case study 6: Oldbury Primary School wind turbine

From the largest wind-farm in the world to one of the smallest: on 31 March 2010 Sandwell Council, England, answered a freedom-of-information request (McCauley, 2010), disclosing that it had spent $9694 (£5875) on buying and installing a small wind-turbine like one at a primary school in Oldbury which had in a year generated 209 KWh – enough to power a single 100 W reading-lamp for <3 months. Assuming no maintenance costs, and discounting revenues of $0.18 (£11)/KWh for 20 years to net present value, net cost is $8943. p = 209 KWh / 365 days / 24 hrs / 43.2 GW x 0.33 x 0.015 = 2.76×10^{-12}. carbon dioxide concentration of 438 ppmv will fall to 437.9999999999 ppmv. Warming forestalled is 0.0000000000007 K; mitigation cost-effectiveness is $12,000 tr/K; and the global abatement cost, at >$6000 tr, is close to 400% of global GDP to 2030, or $900,000 per capita. The global abatement cost exceeds the maximum estimated cost of inaction by a factor 20.

Case study 7: London bicycle-hire scheme

In 2010 the Mayor of London set up what he called a "Rolls-Royce" scheme at US$130 mn for 5000 bicycles (>$26,000 per bicycle). Transport represents 15.2% of UK emissions (from Office for National Statistics, 2010, table C). Cycling represents 3.1 bn of the 316.3 bn vehicle miles travelled on UK roads annually (Department for Transport, 2011). There are 23 mn bicycles in use in Britain (Cyclists' Touring Club, 2011). Global emissions will be cut by 1.5% of 15.2% of 3.1/316.3 times 5000/23 mn. Thus $p = 4.886 \times 10^{-9}$. If the lifetime of bicycles and docking stations is 20 years, business-as-usual carbon dioxide concentration of 438 ppmv will fall to 437.9999998 ppmv through the scheme. Warming forestalled is 0.000000001 K; mitigation cost-effectiveness exceeds $100,000 tr/K; and the global abatement cost of $52,000 tr exceeds 3000% of global GDP to 2030, representing almost $7.5 mn per capita. Here, as elsewhere, co-benefits have been excluded: but so have many costs and disbenefits. On any basis, it is not easy to justify expenditure averaging $26,000/bicycle.

For the sake of simplicity and accessibility, the focus of the method we have deployed here is deliberately narrow. Potential co-benefits external to greenhouse-gas mitigation, or changes in global-warming potentials over long timescales, or relatively higher mitigation costs in regions with lower emission intensities, are ignored. Little error arises. Given the small quanta of warming forestalled by greenhouse-gas-reduction policies, as well as the breadth of the intervals

of published estimates of inaction and mitigation costs, greater complexity may in any event be otiose.

The case studies suggest official projections may be optimistic against the actual cost-effectiveness of specific policies whose subsidy cost is now known. For instance, the abatement cost of EU carbon-trading is within Stern's inaction-cost interval, suggesting that the policy should probably be abandoned. The abatement cost of subsidy to the Thanet wind array, a large but typical government mitigation exercise, is well above the inaction-cost interval, *a fortiori* suggesting desubsidization. In general, smaller projects seem less mitigation-cost-effective than larger projects – an unsurprising result.

A substantial reduction in global carbon dioxide emissions, maintained over centuries, might offset some of the warming caused by the pre-existing increase in atmospheric carbon dioxide concentration from 278 ppmv in 1750 to 390 ppmv in 2010. After a sufficiently long period of global emissions reduction ($y \gg 2100$), it may become justifiable to reduce the value 390 in the denominator of Eq. (1) stepwise towards the pre-industrial carbon dioxide concentration 278 ppmv, increasing ΔT_{nix} and consequently reducing *M*. However, as we have seen, within the 21st century even the immediate and total elimination of carbon dioxide emissions will only forestall 1.7 K global warming.

For numerous reasons, Eq. (13) and the case studies tend to overstate the warming that any greenhouse-gas reduction policy may forestall, and also to overstate mitigation cost-effectiveness:

It is here assumed that any policy-driven reduction in carbon dioxide concentration occurs at once, when it would be likely to occur stepwise between now and year *y*, approximately halving the warming otherwise forestalled by that year. The IPCC takes carbon dioxide's mean atmospheric residence time as 50-200 years, in which event very little reduction in warming will occur within the 21st century. In some case studies – for example, the EU carbon trading scheme – it is assumed that the policy will meet the emissions-reduction target on its own, ignoring the often heavy cost of all other mitigation measures intended to contribute to achievement of the target. In most case studies capital costs only are counted and running costs excluded. Capital costs external but essential to a project, such as provision of backup generation for wind turbines on windless days, are excluded here. Carbon dioxide emissions arising from project construction and installation, such as in burning lime to make concrete bases for wind turbines, are ignored, as are costs and carbon dioxide emissions arising from necessary external operating expenditures such as spinning-reserve backup generation for wind turbines.

If the IPCC's central projections exaggerate the warming that may arise from a given increase in atmospheric carbon dioxide concentration, the warming forestalled may be less than shown. Though emissions are rising in accordance with the IPCC's A2 emissions scenario, concentration growth has been sub-exponential for a decade, so that outturn by 2100 may be considerably below the IPCC's A2-scenario central estimate 836 ppmv. The A2 scenario is one of the more extreme emissions scenarios: use of any of the four less extreme scenarios would lead to lesser warming and hence to reduced mitigation cost-effectiveness. The transient-climate-sensitivity parameter λ_{tra} used in the case studies is centennial-scale: accordingly, over the shorter periods covered by the studies a somewhat lesser coefficient (allowing for the fact that longer-term temperature feedbacks may not yet have acted) and consequently less warming forestalled would reduce mitigation cost-effectiveness. Using standard commercial discount rates rather than the

outlier low discount rate of Stern (2006) would tilt the balance in favour of inaction in almost any case. For all these reasons, it is likely that the case studies tend very much understate the true costs of attempted mitigation and to overstate its benefits.

It is not likely that any policy to forestall global warming by taxing, regulating, reducing, or replacing greenhouse-gas emissions will prove cost-effective solely on grounds of the welfare benefit foreseeable from global-warming mitigation. High abatement costs, and the negligible returns in warming forestalled, imply that focused adaptation to the consequences of such future warming as may occur will prove to be some orders of magnitude more cost-effective than any attempted mitigation. If so, since the opportunity cost of diverting trillions of dollars to mitigation is heavy, the question arises whether mitigation should be attempted at all. We shall consider that opportunity loss shortly. First, however, it is necessary to raise the question whether the voters in democratic countries will in future have any meaningful control over the climate policies that are now chiefly decided by unelected supranational or global entities.

What about freedom and democracy?

Lang Hancock once said this:

> "Government has poked its incompetent nose into every facet of the commercial and private lives of Australians. It has become so large, so all-embracing and so inefficient that no cabinet of men elected through the parliamentary process could possibly expect to have the competence to administer it properly."

The rapid expansion of all levels of government that the consensus policy to address global warming seems to entail, not only in direct taxation but also in vastly-increased and ever-more-prescriptive regulation, is a grave threat to individual freedom worldwide. It is compounded by a stated desire on the part of the consensus to establish what the now-failed draft of the Copenhagen climate treaty described as a world "government" to dictate fiscal and environmental policy and even to set the rules of the formerly-free market. Lang Hancock would have disliked that notion.

There is nothing wrong in principle with nations agreeing among themselves that supranational or even global bodies should be established to exercise some of the functions of government in those matters – the environment among them – where international co-operation is arguably beneficial. However, the democratic ideal is that there should be no taxation and no legislation without representation. Yet, as things now stand, every transfer of fiscal or legislative power from those countries fortunate enough to be democracies to the growing number of global governing entities has been from elected hands nationally to unelected hands supranationally.

If global governments are not to be elected – and the words "election", "democracy", "ballot" and "vote" did not appear in the context of free elections for the world "government" anywhere in the 186 pages of the Copenhagen treaty draft – the inexorable globalization of governance will entail the ineluctable erosion of democracy itself.

To prevent any further transfer of powers from elected to unelected hands, and indeed to enhance democracy rather than to extinguish it, the supreme governments of the supranational institutions, such as the European Union, and of the global institutions, such as the UN and its Framework

Convention on Climate Change, should in future be elected by frequent, regular, universal suffrage among the peoples of the states parties to the relevant treaties.

Three further assaults on the free market, and on individual freedom itself, are self-evident in the current international proposals for what I have here argued is the non-problem of our influence on the climate. First, the draft Copenhagen treaty – which fortunately failed when its contents were exposed before the event – contained provisions not only establishing a world "government" but also giving that "government" the supreme power to set the rules of the formerly-free market. In practice, there would no longer have been a free market, anywhere in the world. It would have been stamped out.

Secondly, the draft treaty made provision for massive increases in taxation, imposed not by elected governments but by the unelected world "government". Here, in passing, it is worth stating that I agree with Mr. Brown, the leader of Australia's Green Party, that if we are to transfer our powers from elected hands here, they should go to elected hands in a global parliament, not to the burgeoning global bureaucracies of which nearly 1000 were created by the Cancun climate agreement alone.

Yet it is arguable that taxation worldwide is already far too high. Economic democracy demands that, in the memorable words of King Charles II on the scaffold –

> "Liberty and freedom consists in having of government those laws by which the people's life and goods may be most their own."

True, the King went on to say something that all true democrats would disapprove of –

> "It is not in having a share in government. A subject and a sovereign are clean different things."

In a true democracy, the subject – by his cross on the ballot-paper – *is* sovereign. Yet the greater the share of the citizen's personal income the State confiscates by way of taxation, the lesser is the subject's democratic freedom to decide for himself how his income should be spent. Beyond a certain point – and we have perhaps reached that point already – taxation becomes so harsh that the free market cannot operate with sufficient freedom to be called truly free.

Thirdly, the vast powers of highly intrusive regulation that the Copenhagen draft envisaged would again interfere both with the freedom of the individual citizen and with the operation of the free market.

Nor should it be believed that, merely because the Copenhagen draft had failed, the instinctive *etatistes, dirigists,* bureaucratic-centralists and other species of totalitarian who had influenced that draft have lost their appetite for what we might not altogether inaccurately describe, in the language of the children's comic-books, as "world domination".

The Cancun agreement encompassed the establishment of almost 1000 new, interlinked bureaucracies, all of them directly or indirectly answerable to the shadowy, unelected, increasingly-powerful secretariat of the States parties to the UN Framework Convention on Climate Change. Not one of these new, supererogatory entities is answerable directly to the voters anywhere via the ballot-box.

The Cancun agreement, like it or not, is now being put quietly into effect. The organizational structure of global "government" is being built as we speak, with scarce a squeak from any of the mainstream news media. All the media attended the Cancun conference: nearly all failed to explain the contents of the Cancun agreement at all.

Though Lang Hancock declared that the majority were always wrong, there are two circumstances in which the majority are – by definition – always right. The first circumstance is the operation of the free market, which is the net sum of what ought to be, as far as possible, the free selling and buying and pricing decisions and choices of every citizen. As Adam Smith pointed out in his *Inquiry into the Nature and Causes of the Wealth of Nations*,

> "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest."

If the butcher, the brewer, and the baker cannot exercise their own self-interest to the extent that the State deprives them of the fruits of their labours via taxation, society as a whole becomes not only less free but also less prosperous. The very existence of taxation creates a significant and damaging market distortion, which may be justifiable to the extent that the purposes for which the taxation is intended to be levied are of unquestionable benefit to the body politic. Excessive taxation, however, is so severe a distortion or even a denial of the economic democracy of the individual citizen that it renders the free market near-inoperable.

The second circumstance in which the majority is by definition right is a general election. For democracy is the most direct and sensitive method of permitting each individual to express his or her own hopes and aspirations via free and secret election of the local, national or – one day, perhaps – global leadership.

If national government should be elected government, then *a fortiori* global government should be elected government.

The justification for democracy is this: the people know best what is best for the people.

The State may know best what is best for the State, but the State is pernicious unless its sole purpose is to serve the people who constitute it. It is most frequently and most compellingly reminded of its role as the people's servant whenever its leadership is compelled to face the voters at an election – whether the scale be local, regional, national, continental or global.

Save our lords the poor and the sick now or save the planet later?

Who would not wish to save our lords the poor and the sick now, and also to save the planet later? Though ambitions are infinite, resources are finite. Every trillion we spend on cost-ineffectively attempting to save the planet from its improbable future fate is a trillion we cannot be spending, and yet should be urgently spending, on the elimination of the poverty and disease that still needlessly, cruelly afflict billions of our fellow-citizens of Earth in the here and now.

Finally, something should be said about the opportunity loss inherent in the State – whether national, supranational or global – squandering trillions of the taxpayers' hard-earned dollars on a purpose which is arguably altogether unnecessary and which – even to the extent that it be

necessary – would by no means be as cost-effectively addressed by attempts at prophylaxis today as it would be by focused adaptation to tomorrow's welfare losses arising from today's inaction.

As Dr. Garnaut pithily – and rightly – puts it:

> "Every dollar of revenue from carbon pricing is collected from people, in the end mostly households, ordinary Australians. Most of the costs will eventually be passed on to ordinary Australians. Every dollar handed out for one purpose is not available for something else." (2001, p. 77)

He might have added that, under the superficially appealing but in truth pietistic pretext of 'Saving The Planet', the greatest transfer of power and wealth in human history is furtively gathering pace – from the poor to the rich, from the weak to the strong, from the powerless to the powerful, from the risk-taker to the rent-seeker, from the worker to the boardroom, from the taxpayer to the bureaucrat, from the *sans-culottes* and the *tricoteuses* to the *classe politique*, from the governed to their grasping governors, from national democracies to global dictatorship.

The world, in talking of climate change, has been mentioning hundreds of billions and even trillions. Yet for just $8 it is possible to save the eyesight of an African patient suffering from trichiasis, an excruciating and ultimately blinding ingrowth of the eyelashes into the eye that is caused by repeated exposure to the trachoma pathogen.

The UN has itself estimated that for $75 billion a year – less by one-quarter than the $100 billion that the Cancun agreement says should be spent on making global warming go away – it would be possible to give clean water and good health to that large fraction of the world's population that now has neither.

Accordingly, a moral question arises: should we not be taking advantage of the ten years without global warming that have just passed, by doing nothing about the climate for a further ten years, watching closely the rate at which warming occurs, and meanwhile diverting the climate trillions – at least *ad interim* – towards nobler, more immediate and and surely more morally imperative ambitions that, unlike Saving The Planet, can be realistically and affordably achieved?

As a direct result of the "global warming" consensus, world food prices and energy prices have doubled in the past few years, causing widespread but meticulously-unquantified deaths from starvation, cold and lack of electrical power. Herr Jean Ziegler, the UN's Right-to-Food Rapporteur, said not long ago,

> "When millions are starving, it is a crime against humanity" – his words, not mine – "that food should be diverted to biofuels."

"Crime against humanity!" If I were to use such language, there would be the usual complaints from the usual suspects. Yet that is what Herr Ziegler said, and with much justification. Why did the doubling of world food prices occur? Why, in consequence, were there major food riots in a dozen of the world's poorest regions – riots that went almost entirely unreported in the news media of the West because they did not fit the consensus story-line?

The World Bank, in a revealing report, attributed three-quarters of that murderous doubling of staple food prices to the astonishing acreage of agricultural land that had been diverted from growing food for people who need it to fuel for clunkers that do not.

Yet I recently saw one of the leading IPCC scientists, at an international conference, showing the graph of the sudden, painfully sharp increase in global food prices over recent years and attributing it not to the economic law of supply and demand, not to the "diversion of food to biofuels", but to disruption of the climate owing to global warming – a disruption and a warming that have not occurred for a decade or more. This species of mendacity by the IPCC and those who profit by it via an enhancement of their status is a kick in the teeth for our lords the poor and our lords the sick.

The mathematics of the law of supply and demand are by now well understood. Drastically reducing the world's supply of food while population and consequently demand continued to rise was bound to cause – and duly caused – a steep and sudden rise in food prices. Doubling the price of a hamburger is an inconvenience to us in the wealthy West, but it is starvation and death to the very poor elsewhere in the world. Not one adherent of the New Religion has yet apologized for this catastrophic effect not of global warming itself but of the profoundly misguided policies to address it that the "consensus" has so cruelly and so profitably adopted.

The free market – provided that it remains free – is as much a guarantee of individual freedom as is the right to vote for those who make our laws and set our taxes. It is no mere accident that the free market and free elections have operated hand in hand in so many nations of the free world. But the freedom not to be involuntarily poor, the freedom not to starve, the freedom not to be ill without the best and swiftest treatment – these, too, are fundamental freedoms, though too few of the declarations of human rights and freedoms that are now in circulation recognize them.

The scientific argument that the global warming of the coming century will not be great enough to do significant, unavoidable harm is at least a statable case. The economic argument that even if the world were to warm as much as the "consensus" has declared the cost of preventing that warming would greatly exceed the cost of inaction is so compelling that there is arguably no statable case for spending a single cent on attempting to prevent global warming. Let none imagine for a moment longer that diverting trillions towards allegedly saving the planet can ever be a no-regrets, no-cost option mandated by some half-baked notion of a "precautionary principle". As Dr. Garnaut himself points out –

> "Mitigation at a given level is justified if the benefits exceed the costs." (2008, p. xxiii)

And not if they don't. To put it another way, the ancient law of the London insurance market is not up for repeal:

> "If the cost of the premium exceeds the cost of the risk, don't insure."

Now, that is a precautionary principle worthy of the name.

So let the warming happen if it will, and deal with its consequences by focused adaptation only if, only when, only where and only to the extent that those consequences are real and adverse. There is really no statable economic case for doing otherwise than that, and not much of a scientific case. The correct policy to address any non-problem is to have the courage to do nothing.

Instead, we should reallocate the otherwise-wasted climate trillions from the attempted manufacture of some pointless tomorrow towards providing immediate, urgent assistance to those who are uneducated at this very moment, who are starving in the present, who are homeless today, who are sick now.

If we are deaf to their cries, unmoved by the thundering silence of the pleading, hopeless, hopeful eyes of the very neediest and most desperate members of our own race, do we even deserve the name "human"? While they are not taught, not fed, not housed, not healed, they are not free. If they are not free, what price our own freedom, or our free market?

Let us abandon these interminable, wasteful, purposeless climate conferences. Let us take from them their one good outcome – co-operation between nations to a remarkable degree that has never been achieved before. Let us rededicate that great spirit of collaboration, nation speaking peace unto nation at last, and redirect it towards the immediate and urgent service of our lords the sick and our lords the poor.

That, surely, above all else, is what the Lord of Life inspired us to do when He stood by the sea of Galilee and gently spoke that single, great commandment that has rung down the centuries to us in the single Greek word *ἀγαπῆσεις,* in the single Latin word *diliges,* and in the three small English words that too often mean too little and too seldom mean enough: "Thou shalt love."

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