

Submission to the Senate Select Committee on Climate Policy

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The Senate Select Committee on Climate Policy (hereafter The Committee) has as its third term of reference the following:

(c) whether the Government's Carbon Pollution Reduction Scheme is environmentally effective, in particular with regard to the adequacy or otherwise of the Government's 2020 and 2050 greenhouse gas emission reduction targets in avoiding dangerous climate change

In this submission I will show that the chosen targets are inadequate in the extreme and negligent in that if pursued will involve a high risk of dangerous climate change.

I will argue that a change of mindset is necessary, FROM doing what seems appropriate to avoid dangerous climate change in a manner that as an overriding and determining condition does not upset the economy TO doing what is necessary as a matter of urgency to achieve a **safe** climate.

I have divided the submission into two parts, the first addressing the policy on targets and the second on some of the recent science that policy does not fully take into account.

PART A: The Inadequacy of Existing Targets

The outrageous nature of existing targets

Professor Ross Garnaut in his first draft report (Garnaut, 2008) commented thus on his terms of reference:

The Review's terms of reference require it to analyse two specific stabilisation goals: one at which greenhouse gases are stabilised at 550 ppm CO₂-e (strong global mitigation) and one at which they are stabilised at 450 ppm CO₂-e (ambitious global mitigation).

Immediately thereafter Garnaut says this:

A stabilisation target of 450 ppm CO₂-e gives about a 50 per cent chance of limiting the global mean temperature increase to 2°C above pre-industrial levels (Meinshausen 2006), a goal endorsed by the European Union (Council of the European Union 2005) among others.

A temperature increase of 2°C of course represents the well-established guard rail that is supposed to keep us safe from dangerous climate change. So Garnaut was constrained by his terms of reference to formulate a climate change strategy that only gave us a 50:50 chance of avoiding dangerous climate change.

This is sad and actually outrageous. Garnaut, had he acted responsibly at this point, would have gone back to those who commissioned the report and asked for the reference to be changed so that he could develop a strategy for a **safe** climate. By

engaging in the exercise as specified he tended to reinforce the false notion that the project was in fact sane.

Derivation of existing Government policy

The source of the target that Labor took to the election of a 60 per cent reduction in emissions by 2050 can be identified with some precision. Andrew Macintosh and Oliver Woldring in a report that deserved more attention (Macintosh and Woldring, 2008, p6) quote Kevin Rudd in the Leaders debate for the 2007 election as follows:

Why do we pick this number 60 per cent? Because it comes from the science. Unless we are able to stabilise greenhouse gas emissions at something in the order of 450-490 parts per million, then frankly we place the planet in grave danger of not being able to correct itself.

This appears to come directly from the widely cited Table SPM 5 of the *Summary for Policymakers* of the Working Party III contribution to the Fourth Assessment Report of the IPCC (IPCC, 2007, p15). This makes the scientific pedigree of the target ostensibly impeccable. But immediately there are problems.

First, the forecast global mean temperature for stabilisation at 445-490 ppm (the most ambitious scenario included) given by the IPCC is 2C to 2.4C, which is above the 2C guard rail for dangerous climate change.

Second, the 2050 target for global emissions is -50 to -85% compared to 2000 levels. Rudd's 60% is conveniently near the lower bound.

Third, that's the target for **global** emissions. Is Rudd assuming that the developing nations will have no increase, but will in fact also have a corresponding decrease?

In 2007 [a recent study](#) (Hepeng, J. 2007) found that in 2004 73 per cent of global growth in emissions came from developing countries, a growth rate that had almost trebled this century compared with the 1990s. China alone is expected to [almost double emissions](#) in the next two decades compared with 2002 levels according to several studies, most recently in the journal *Geophysical Research Letters* (Mrasek, V. 2009)

A paper by Professor Ross Garnaut with ANU colleagues Frank Jotzo and Stephen Howes warned that under business as usual "China's carbon dioxide emissions would more than treble by 2030 - when they would make up 37% of global emissions, three times those of the United States." ([Colebatch, T. 2008](#))

Any responsible and just target for a safe climate must take into account total global emissions, must conceive targets in per capita terms and must take future world populations at the target date into account. Existing Government targets fail on all counts. The Government targets have been **justified** in per capita terms rather than **conceived** as such.

Meanwhile Macintosh and Woldring quote articles of the UNFCCC framework document which enjoin policy makers to

"take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects." The precautionary principle is to be used and the "lack of full scientific certainty is not to be used as a reason for postponing such measures."

The [UNFCCC](#) (United Nations Framework Convention on Climate Change) as [Wikipedia puts it](#):

“is an international environmental treaty produced at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro from 3 to 14 June 1992. The treaty is aimed at stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”

The UNFCCC is the umbrella group for the Kyoto Protocol and its putative replacement in Copenhagen in December 2009. The injunction quoted by Macintosh and Woldring above should pervade all policy considerations by the member states. Manifestly it doesn't if we can in all seriousness base our targets on the notion that we only have a 50% chance of success.

The emperor stands naked before us and it's time we opened our eyes.

Hence policies should not just be focused on the median effects in a range of uncertainty, but should take into account high-impact, low-probability effects. These upside risks are so grave that to ignore them is folly beyond words to describe.

One of the major thrusts of the Macintosh and Woldring paper is to look at more recent 'coupled' climate models which take better account of feedbacks in the carbon balance between oceans, land and atmosphere. Better, that is, than the ones available to the IPCC at time of writing. In particular such models attempt to take account of diminishing carbon sinks.

They also look at various stabilisation scenarios, taking into account trends in emissions from developing countries.

The sad conclusion they come to is that with current policies we (the world) are heading for 650 ppm of CO₂e and will need to work quite hard to stabilise even at that level. In fact they say that unless something is done quite soon to arrest the current emissions trajectory the growth in developing country emissions will close off the 650ppm CO₂e option.

Australia by choosing targets on the low side of the international norm, as one of the highest per capita emitters, is dragging the chain and eschewing a leadership role in addressing the problem.

Risks inherent in existing policy

The irresponsibility of the 450 ppm target and the ignoring of the precautionary principle is well illustrated by the following graph from the the [Executive Summary \(long\) of the Stern Review - Figure 2:](#)

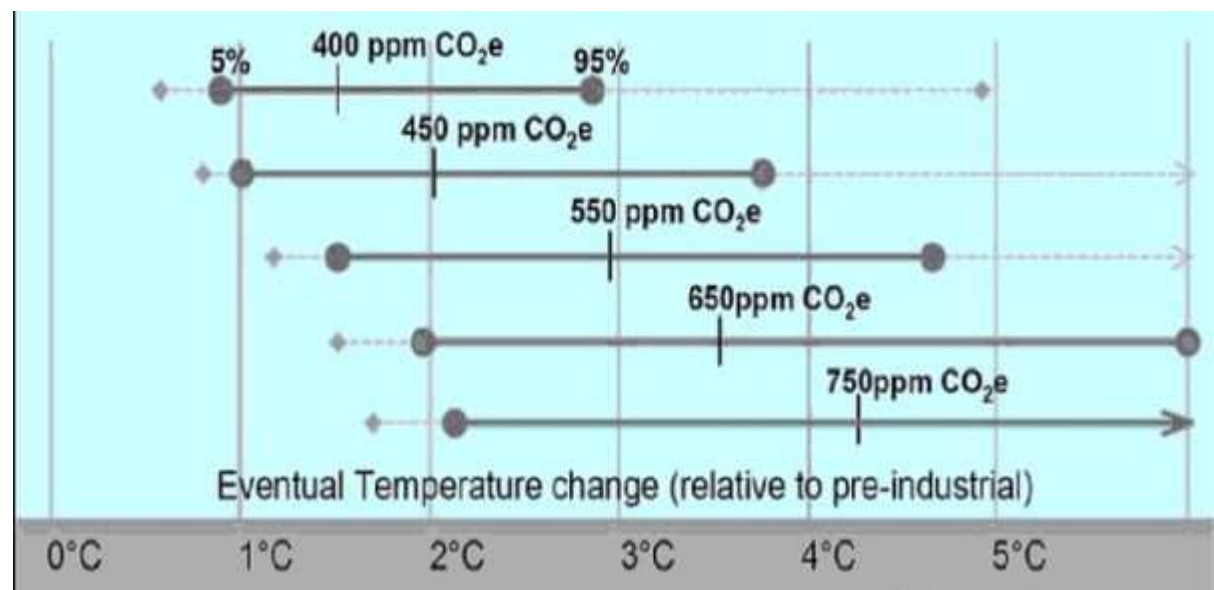


Figure 1: Eventual temperature ranges for various emission levels (relative to pre-industrial levels)

The solid horizontal lines indicate the 5% to 95% range based on climate sensitivity* estimates from the IPCC 2001 report and a 2004 Hadley ensemble study. The vertical lines represent the 50th percentile. The dashed lines represent the 5% to 95% range based on 11 "recent" studies (Meinshausen, M. 2006). You'll notice that at 450ppm and above the 100% values are off the page on the upside, meaning that even for 450ppm there is a better than 1 in a 100 chance of a 6°C outcome.

The problem with outcomes above 2°C is that they are, well, dangerous. This has been taken to mean that there is a danger of "tipping points", runaway feedbacks that will increase world temperature in a nonlinear way to an extent that we just don't know about and could do precious little to prevent.

It is generally accepted that a 4°C would be unrecognisable in terms of human experience as a species, would render civilisation as we know it impossible and result in a vastly reduced numbers of our own and other species. The problem with going beyond 2°C is that there is a totally unacceptable risk of triggering "tipping points" which will take the temperature beyond 4°C.

*Climate sensitivity is the temperature rise flowing from a doubling of atmospheric CO2 concentrations in terms of short-term, so-called "Charney feedbacks", ie. acting over 25-30 years.

Of course if we go to 4°C there is little prospect that we will stop there for similar reasons. But if we do a [recent article](#) in the *New Scientist* by Gaia Vince sketched the scenario we would face with 4°C warming. Vince writes that “the ramifications for life on Earth are so terrifying that many scientists contacted for this article preferred not to contemplate them” (Vince, G. 2009). The habitable parts of the earth are shown in green in this image:

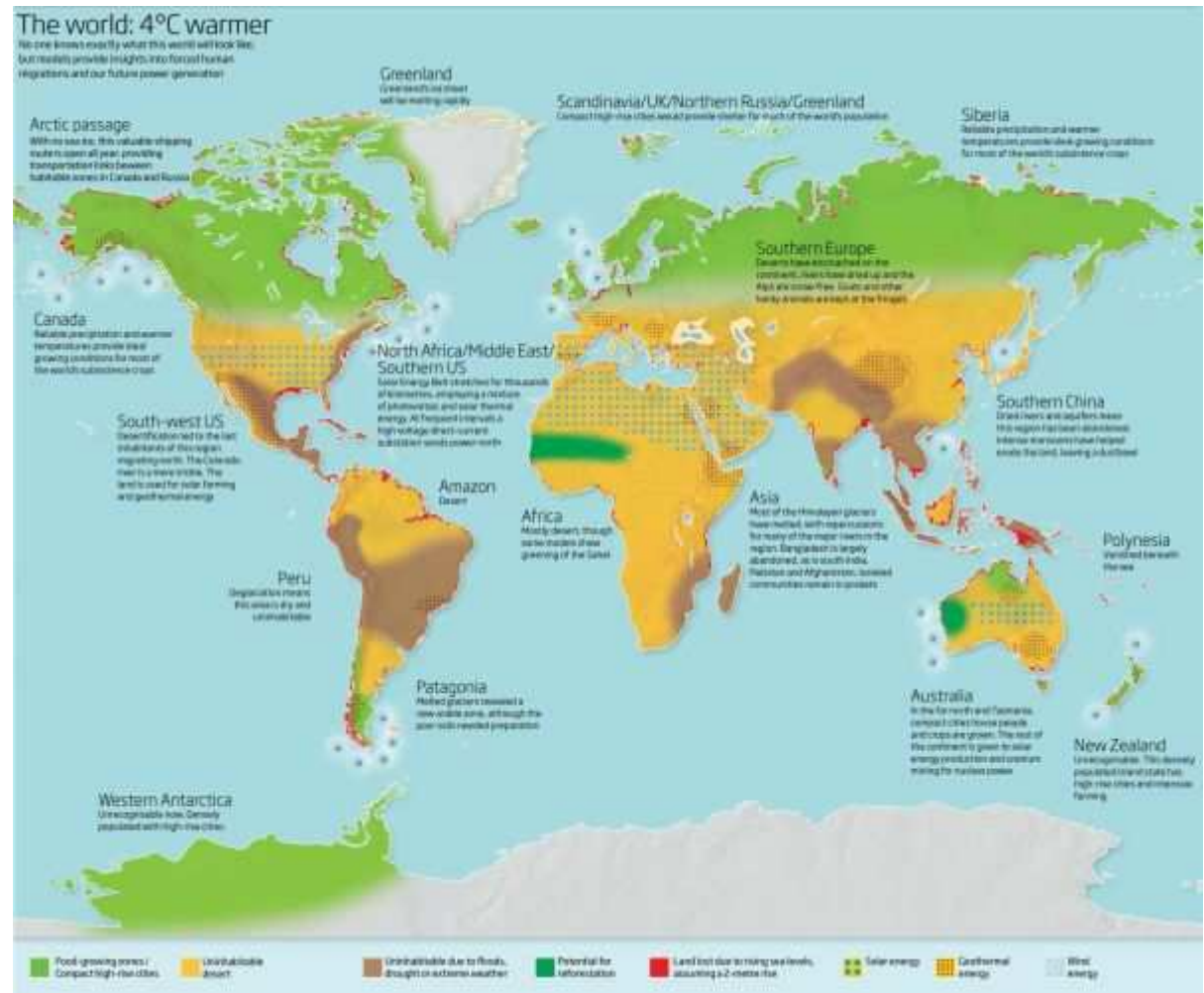


Figure 2: The world 4°C warmer

The red shading represents the incursions made by a sea level rise of 2 metres. That would be just the beginning. If 4°C was maintained for centuries there would be little of the Greenland and Antarctica ice sheets left, which if fully melted would yield 75-80 metres of sea level rise. With 6°C there would almost certainly be no ice sheets left.

No-one knows, of course, whether the grim picture above is exactly how things would work out. There is doubt about the detail. For example some think the African monsoon will get stronger, some weaker. But there is very little doubt that we are heading in the direction portrayed. The direction needs to change from flirting with disaster by applying as little effort as we can get away with to heading for a **safe** climate.

Weitzman's approach to low-probability, high-impact climate outcomes

Last year Harvard economist [Martin Weitzman](#) published a paper *On Modeling and Interpreting the Economics of Catastrophic Climate Change* which he released online in draft form early in 2008. The final was published in February 2009, but was available on the net from June 2008. (Weitzman, 2009). The draft was 45 pages of mostly econospeak, much of it is impenetrable to ordinary mortals. Ditto the final. With a bit of help I tried to render it accessible in [a blogpost on Larvatus Prodeo](#) (Bahnisch, B. 2008a). My effort seemed to get a pass mark from those in possession of the relevant mysterious knowledge.

Weitzman is concerned with the virtually unbounded risk on the upside when we consider the concept of *climate sensitivity*. Climate sensitivity is the temperature rise flowing from a doubling to 560 ppm of atmospheric CO₂ when compared to pre-industrial levels. With short-term feedbacks it is generally accepted to be 3°C, plus or minus 1.5°C.

Weitzman says that uncertainty is tightly bounded on the downside. The chance of the temperature stabilising below a 1.5°C rise is *very unlikely*. But in terms of an upper bound, effectively there is none.

Weitzman points out that at the extremity there is a one in a hundred chance that the temperature outcome will be 10°C warmer with doubled CO₂. You can see the problem of what he calls “thick” or “fat” tails, or again “an extreme tail that is heavy with probability” in this graph:

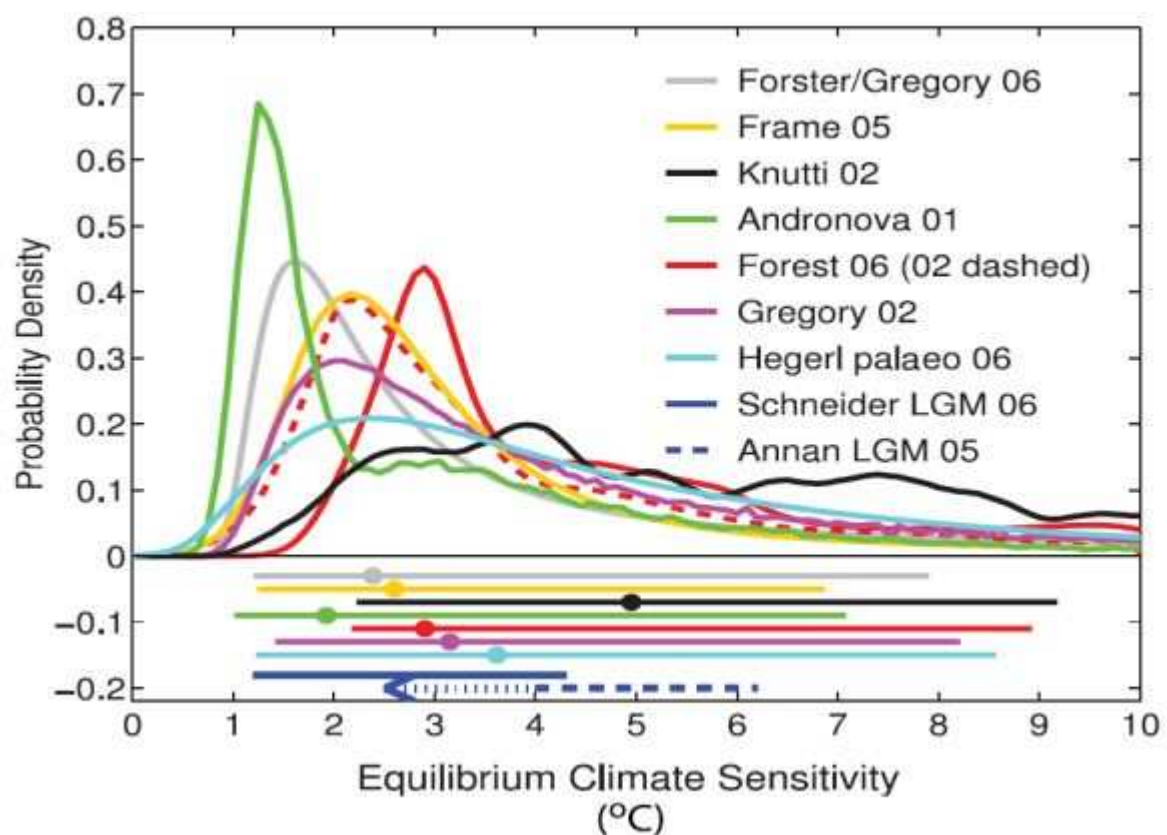


Figure 3: Estimates of equilibrium climate sensitivity (not including slow feedback processes).

From IPCC [AR4], Figure 9.20, page 720.

Whereas Stern (see Figure 1 above) left everything above the 95th percentile out of consideration, that is effectively ignored it, Weitzman is saying that what lies above the 95th percentile contains unacceptable risk with consequences so dire that avoiding such outcomes should be central to our policies.

The Government, on the other hand along with most policymakers everywhere, is taking a position where everything beyond the 50th percentile **when considering short-term risks alone** can be ignored and not reflected in policy.

But on top of that Weitzman is cognisant of what [James Hansen has said](#) about climate sensitivity when long-term feedbacks, which are cutting in now, are taken into account, citing his paper [Climate change and trace gases](#) (Hansen, J. et al. 2007). With long-term feedbacks Weitzman points out that we have a one in a hundred chance of a 20°C warming.

But Hansen is saying that with doubled CO₂ our midpoint expectation is not 3°C but 6°C and a world without ice sheets if longer term feedbacks are factored in. The 450-490 ppm mark behind the Governments thinking would be well on the way, probably about 4°C.

I feel bound to say that when I posted at Larvatus Prodeo on Weitzman, Roger Jones, climate scientist, said *inter alia*:

There is one reason why I do not combine the terms low probability with high impact. There is no good reason to suppose any longer that high impact climate outcomes are low probability.

Jones is best read in his own words, so I've given [the link to his comment below](#) (Jones, R. 2008). But I gather that he thinks the real world is not best described in Bell-shaped curves. He referred to an alternative approach ([Jones, R. N. and B. L. Preston, 2006](#)). An alternative approach, but no less alarming.

Sadly, Garnaut showed an awareness of both weitzman's and hansen's work in his early project papers. But they were incompatible with his assigned task, so he has simply left them aside. But I'm sure he had not forgotten and an awareness of what they and others like them have said are behind his occasional dark references to unspeakable consequences.

And so he continues a fine tradition in recent years of economists and others serving the agenda of their political masters, who are more concerned with the electoral cycle than a world suitable for habitation for their grandchildren.

Stern in 2006 chose 550ppm because he thought that 450ppm was unattainable in terms of what governments would do. This flowed into the EU thinking which set the false goal of the 2°C guard rail and 60% or so reductions by 2050. It's doubtful whether such targets would have been met, given no prospect of restraining the rapidly developing countries before the 2020s.

Since then the rhetoric has changed to 450ppm but the policies and actions have changed not one little bit.

At this point I think you really need to see what an ice-sheet free planet would leave Australia looking like when all the effects play out, not in a year, nor a decade or century, but if the Arctic methane, already bubbling away, gets out of hand, that end-state will be hard to avoid. I'm sure that you will get a number of submissions from knowledgeable people arguing that our Government's current policies are unlikely to deliver 450 ppm, more likely 550, 650 or more. But even at 450 ppm we would be likely heading towards this sort of outcome:

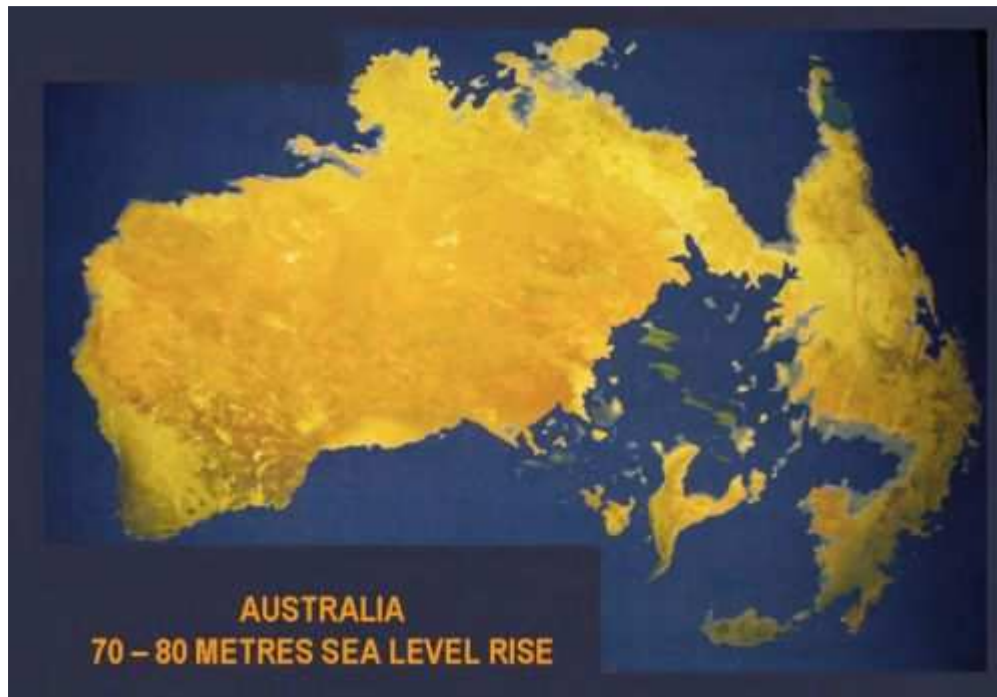


Figure 4: *Australia with 70-80 metres sea level rise*

The image comes from David Spratt's Science A powerpoint, slide 6 which you can find at the (Spratt, D. 2009).

For a 10°C world the best analogy in terms of impact on the biosphere is probably the [End Permian or Permian-Triassic extinction event](#), the "Great Dying" of 251.4 million years ago when 95% of all species went extinct.

As to what 20°C warming would be like at the rate we are pushing the climate, Weitzman says it hasn't happened before, not in a billion years.

The bottom line from Weitzman's approach, is that we should attend to the fat-tailed possibilities first, with urgency, because if they eventuate they have the capacity to do us in. That is *homo sapiens* finito! Got it?

This is a game-changer in terms of our economic approach. A colleague pointed out the necessary change gently on a [blogpost a couple of years ago](#):

the ecological imperative must take priority, and economic and social goals redefined to be attainable within what ecosystems will allow.

I would put it more directly.

Take down the sign "IT'S THE ECONOMY, STUPID" and put one up "IT'S THE ECOSYSTEM, STUPID!" And proceed from there.

Some essential understandings about CO₂ and other greenhouse gases.

In the above the terms CO₂ and CO₂-e have both been used. CO₂-e refers to CO₂ plus the CO₂ equivalent in greenhouse terms of the other six so-called “Kyoto gases” in their effect on the environment. At present CO₂ stands at about 387 ppm, but CO₂-e is at about 455 ppm. As against that aerosols are considered to have a net negative effect on forcing, in the short term at least, which would bring the CO₂ equivalence back to about 375 ppm.

In addressing climate problems we need to reduce the Kyoto six to nothing and aerosols need to be cut drastically for public health reasons (remember China and the “Asian brown cloud”!)

Last year [Cannadel and others](#) (Cannadel, P. and M. Rapauch, 2006 – slide 6) found that emissions were running above the IPCC’s worst scenarios:

Trajectory of Global Fossil Fuel Emissions

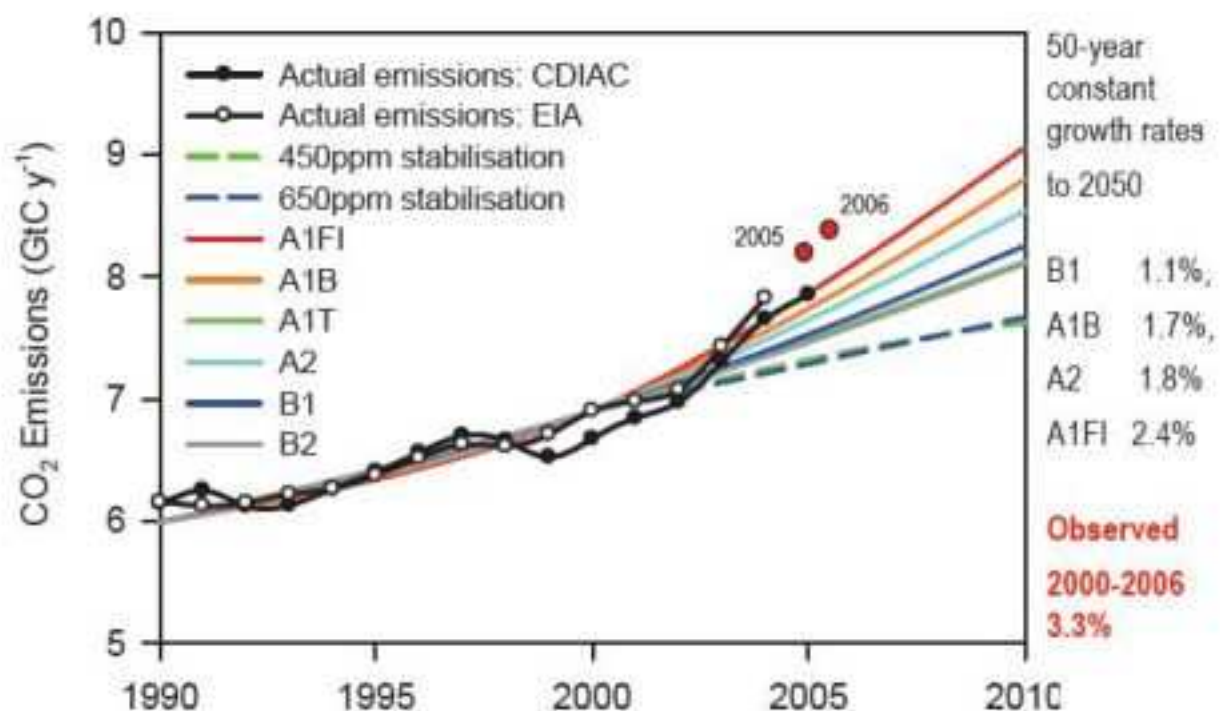


Figure 5: Trajectory of global fossil fuel emissions

Over the eons there has been a very tight relationship between greenhouse gases, temperature and sea level change (original from NASA):

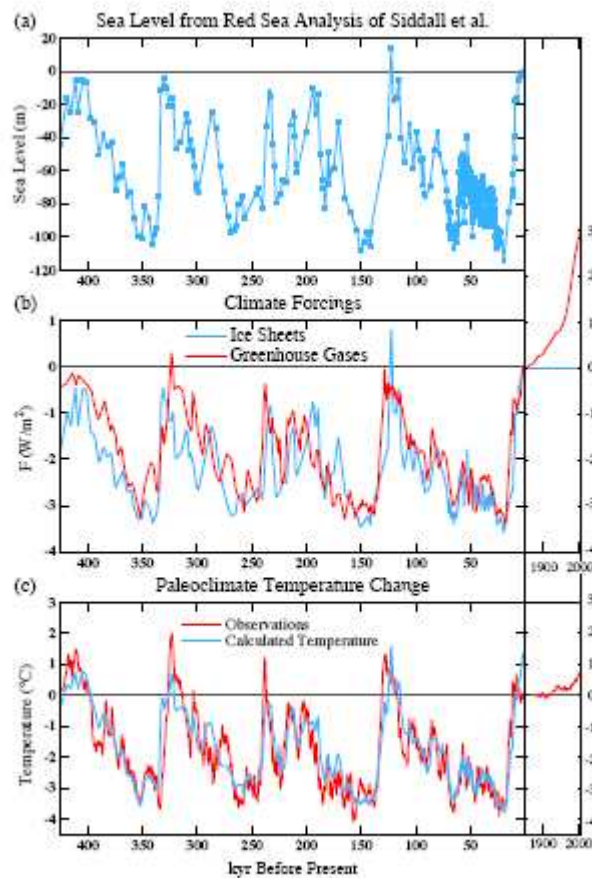


Figure 6: *Three graphs*

The relationship is striking. Sea level change is obviously dependent on and caused by temperature change. Paleoclimate history and physics indicate that greenhouse gases and temperature affect each other. If one goes up the other follows. Hansen in his Iowa testimony (Hansen J. 2005) describes in general terms how this has worked out over the last 65 million years.

Rahmstorf and others have shown how the relationships are in fact working out in recent decades (Rahmstorf, S. et al, 2007):

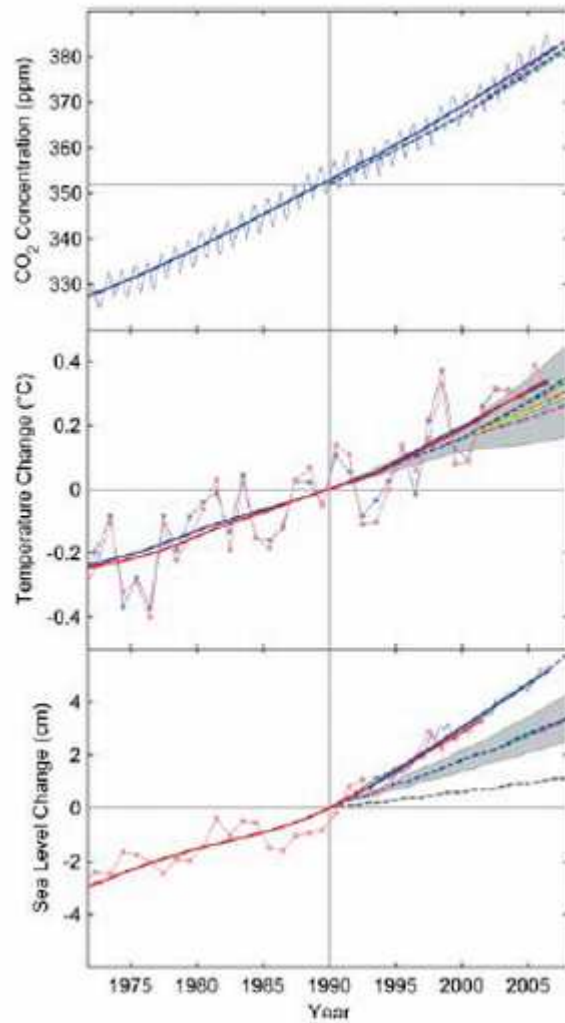


Figure 7: *Three graphs 1975-2005*

This graph shows the way in which CO₂ emissions took off with industrialisation after the Second World War:

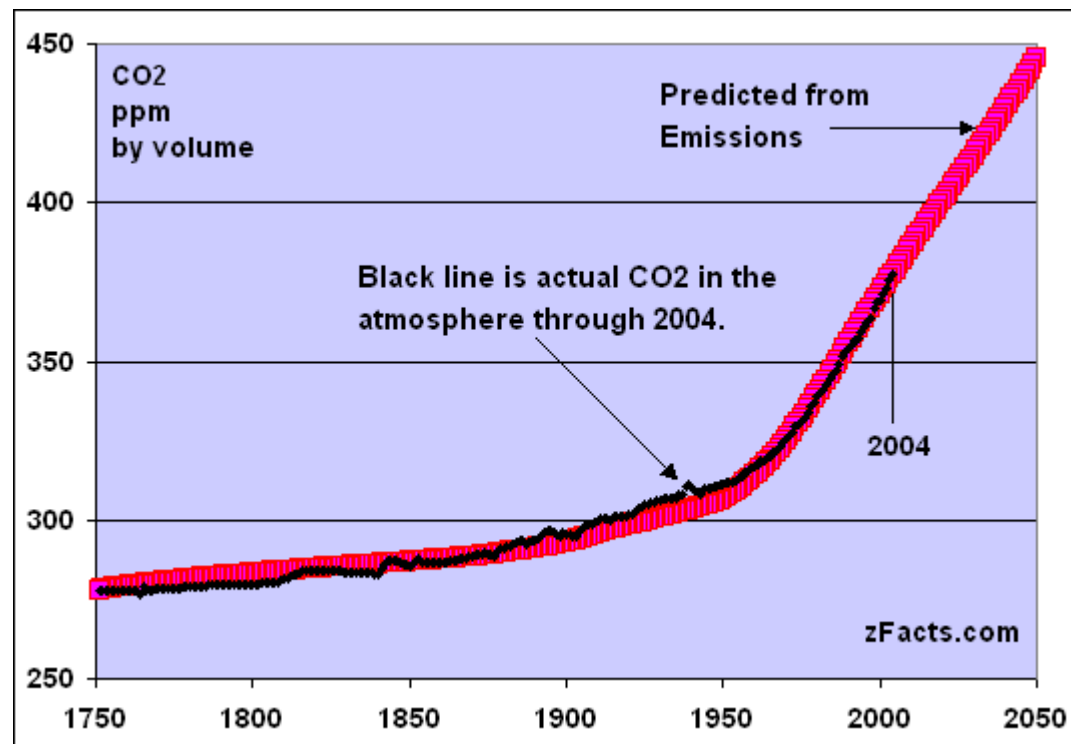


Figure 8: *Uptrend of CO₂ emissions from about 1950*

One of the reasons why the increase in temperature was delayed was in fact the dampening effect of aerosol pollution. Ken Caldeira tells us (Caldeira, K. 2007) that they have found that a new coal-fired power station actually has a net cooling effect during the first 7 years of its life. After that the long-lasting greenhouse gases take over and there is a net warming.

Clearly we would expect, then, the warming effect of the recent Chinese and Indian astonishing enthusiasm for building somewhat dirty power stations to be delayed, but not for long.

What should we do?

What we are looking for, of course, is not a change in office decoration, rather a change in mind-set. You will get heaps of submissions on practical matters, so I'll just stick to the broad directions.

The **world** needs to

1. Limit emissions so that they peak and start to head down ASAP with a view to reaching zero net emissions ASAP.
2. To do this we will need to phase out coal as a top priority, that is invest in renewable forms of energy production and develop a program of replacing existing coal power stations.
3. Persuade developing countries that they too should be heading for zero and to render them assistance. Just because we got rich by robbing future generations of their future doesn't mean that they should try that too, because it simply won't work, we'll all go down the tube together.
4. Work out separate and parallel programs for all the greenhouse gases, not just CO₂.
5. Work on ways to take carbon out of the atmosphere with minimum risk.

As we go we'll be able to work out what level of ppm in the atmosphere we should aim for. I think we'll come to see that we have to take emissions all the way down to pre-industrial levels at 280 ppm if we want sea levels roughly where they are now and a climate that we and the rest of the biosphere have found so bountiful in the last 8,000 years.

Australia needs to:

1. Work on emissions as above. We should nominate as our ambition to reach net zero emissions by 2030. (This is actually a concession to the possible, as I think that nasty things are likely to start happening before then. I'd much prefer 2020.)
2. Embark on a dramatic large-scale program of building renewable energy production capacity. Australia has virtually unlimited potential in terms of solar and geothermal. We could offer to do all sorts of things here on behalf of the world using green energy, as Iceland has just done in relation to computer servers, which produce as much GHG as the airline industry to keep cool. Or so I heard on our ABC.

Australia needs to move beyond its present stance of being a careful also-ran in the climate change game. It needs to get out in front and leverage its leadership to effect change in the world.

In particular it needs to realise that there is no future in ripping up productive farming lands to flog off coal only to see its tourist industry wrecked as the Great Barrier Reef goes down the tube.

Australian energy mining and production companies need to see themselves as energy companies rather than as hydrocarbon companies. AGL for example has taken a 30% stake in Geodynamics' joint venture in geothermal energy development.

The government needs to actively and aggressively develop a public constituency for change to a focus on achieving a **safe** climate rather than engaging in a macabre dance of death with a dangerous one.

At this point I must disclose that I have a small parcel of shares in Geodynamics, which, as it happens, on March 30, completed its externally audited “proof of concept” program.

PART B: Some Recent Science that Policy Does Not Fully Take into Account

Scientists: “It’s later than you think!”

The problem with the IPCC is two-fold. First, its assessment reports are out of date by the time they see the light of day. I understand that the *Fourth Assessment Report* which was issued from February to December 2007, had a cutoff point of June 2006 for published refereed articles. When such articles involve research based on observations then writing and publication can be 3 years or more in the making.

Secondly, the reports represent a consensus statement which is finally approved by governments, as well as by scientists. As a result the reports are conservative, because they must be acceptable to states with an overwhelming interest in producing hydrocarbon fuels.

In order to overcome these problems and the long interval between reports the United Nations Environment Program (UNEP) has begun to release annual yearbooks. The *UNEP Year Book 2009* (UNEP, 2009) has recently been released. [Chapter 3](#) addresses Climate Change.

It is well worth a read. It begins:

The changing climate is pushing many earth systems towards critical thresholds that will alter regional and global balances and threaten stability at multiple scales. Alarmingly, we may have already passed tipping points that are irreversible within the time span of our current civilisation.

Here are a couple of quotes from the conclusion:

For now, the evidence suggests that we may be within a few years of crossing tipping points with potential to disrupt seasonal weather patterns that support the agricultural activities of half the human population, diminish carbon sinks in the ocean and on land, and destabilize major ice sheets that could introduce unanticipated rates of sea level rise within the 21st century.

Unless action is taken to stabilize **and then decrease concentrations of greenhouse gases in the atmosphere**, these changes will cause widespread damage to ecosystems, natural resources, human populations, and their fragile economic activities. Such damages could certainly **end prosperity in the developed countries and threaten livelihoods in developing countries**. (Emphasis added)

In other words, we’ve already overshot, we need to take CO₂ and other greenhouse gases out of the atmosphere.

And forget about discount rates and richer subsequent generations paying to patch things up. If we don't act decisively now they'll likely be poorer, not richer. Weitzman said the same.

Another useful approach is to gain the current opinions of working scientists. There was an interesting article in the *New Scientist* recently by Catherine Brahic ([Brahic, C. 2009](#)) reporting on research done by the Stratus Consulting in Boulder, Colorado ([Smith, J. et al. 2009](#)) repeating the “burning embers” diagram that appeared in the *IPPC Third Assessment Report* (TAR) in 2001. Smith reconvened the group who were asked an opinion about what temperature increase was considered dangerous in relation to five “reasons for concern”. The results are shown below:

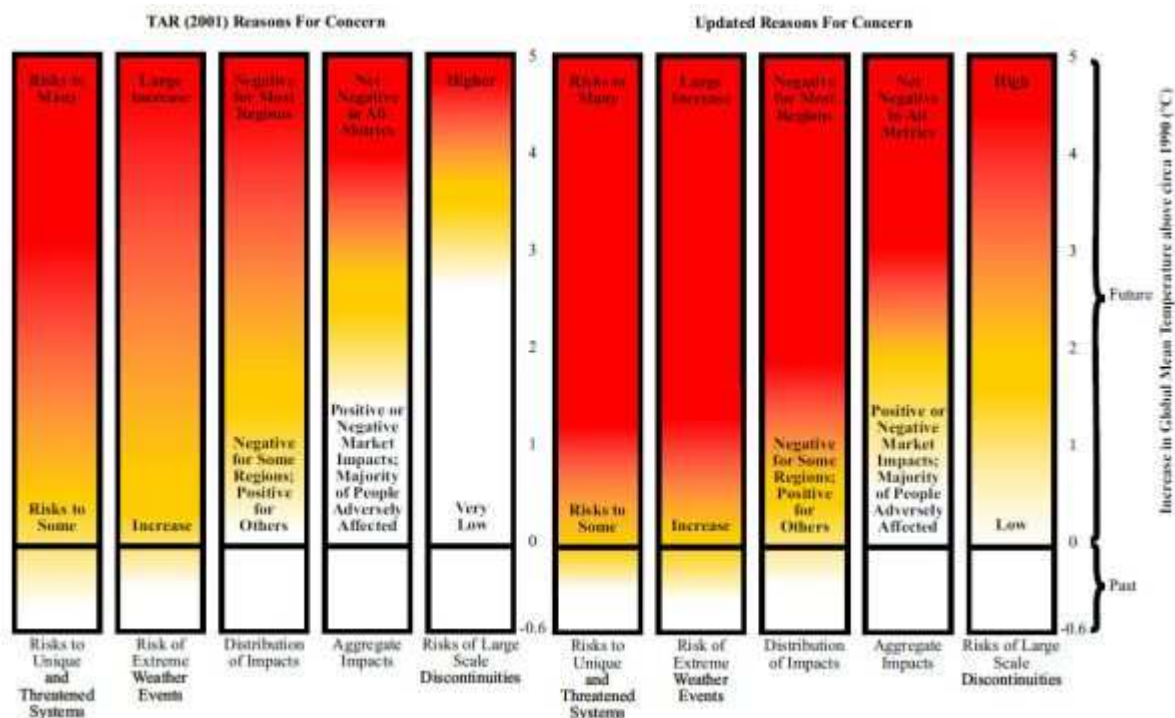


Figure 9: “Burning embers” diagram, 2001 and 2008 update

A glance will tell that scientists now think that danger is likely with less warming than before. There is little if any wriggle room available.

To be annoying they have adopted 1990 as their zero reference point for temperature, which probably means the 1980-2000 average rather than the specific year of 1990. In any case it is 0.6°C above pre-industrial. The diagram shows up the inadequacy of the 2°C above pre-industrial, which is equivalent to 1.4°C on the diagram.

Rule a line at 1.4 and you will see red below the line in three columns and yellow in the other two. Danger is now. A **safe** climate would see all five comfortably in the white.

Moreover, there is momentum in the system. Most have said that if we stopped emitting now there would be a further 0.5°C or 0.6°C in the system. That is in terms of short-term feedbacks. Hansen says the true figure is 2°C, which brings us to 2.8°C above pre-industrial (because “now” is not 1990). But rule your line at 2.2°C on the diagram, which if he’s right is what we may well be committed to within the 21st century even if we stop emitting now. We actually need to take greenhouse gases out of the atmosphere.

Copenhagen calling

In recent months there has been a flood of papers and reports highlighting the fact that events in global warming and climate change are running ahead of expectations in a range of specific areas. The reason was [an international scientific congress on climate change](#) hosted by the University of Copenhagen under the heading "*Climate Change: Global Risks, Challenges and Decisions*" from 10-12 March, 2009 where more than 2,500 researchers and economists gathered to update the world on the state of climate research ahead of key political negotiations later this year.

The key message [summarised in a BBC report](#) (McGrath, M. 2009) was that things are moving faster than the IPCC anticipated only two years ago and there is a greater risk of 'tipping points' being reached where climate change becomes irreversible.

George Monbiot's report (Monbiot, G. 2009a) is worth a look. He picks out just three areas where events are running ahead of expectations - the melting of the Greenland ice sheet (which the IPCC left out of its calculations), increasing methane emissions (a gas more than 20 times more potent in greenhouse terms than CO₂) from the huge carbon stores of the Arctic permafrost and (a certainty if the methane takes off) the potential collapse of the Amazon, giving another large carbon pulse to the atmosphere.

The problem here is that the methane pulse, possibly already underway, is potentially large enough to take us through to 4-6°C on its own. At 4°C or sooner the Amazon pulse could be triggered, destroying a carbon sink and itself probably worth a couple more degrees.

It's over!

Monbiot also reports (Monbiot, G. 2009b) extreme pessimism on the part of scientists at Copenhagen:

Quietly in public, loudly in private, climate scientists everywhere are saying the same thing: **it's over. The years in which more than two degrees of global warming could have been prevented have passed, the opportunities squandered by denial and delay. On current trajectories we'll be lucky to get away with four degrees.** Mitigation (limiting greenhouse gas pollution) has failed; now we must adapt to what nature sends our way. If we can.

This, at any rate, was the repeated whisper at the climate change conference in Copenhagen last week. It's more or less what Bob Watson, the environment department's chief scientific adviser, has been telling the British government. It is the obvious if unspoken conclusion of scores of scientific papers. **Recent work by scientists at the Tyndall Centre for Climate Change Research, for example, suggests that even global cuts of 3% a year, starting in 2020, could leave us with four degrees of warming by the end of the century.** At the moment emissions are heading in the opposite direction at roughly the same rate. If this continues, what does it mean? Six? Eight? Ten degrees? Who knows? (Emphasis added)

One of the least surprised about current developments would be climate scientist James Hansen, who doesn't think it's over, not quite yet, and was at the conference

telling people his opinions about what we need to do (Hansen, J. et al, 2009). The most important action by far? Phase out coal. ASAP. Simple as that!

Some specific areas of concern

I'd like to sketch briefly some of the specific area of concern raised at Copenhagen, in the UNEP Year Book and in the recent literature more generally.

Arctic ice and methane

I've bracketed these two because they are related.

Summer ice coverage has been on the decline since the 1950s with a 7% per decade decline since satellite monitoring from 1979. In recent years the trend decline has 'fallen out of bed' with a record low in 2005, a slight recovery in 2006, a new record low by over 20% in 2007 and a 10% recovery in 2008. However, ice coverage is defined as greater than 15% ice on water, which is quite low. Moreover the thinning and volume loss, while harder to measure, has been much more dramatic than the surface area decline. In 2008, the wind dispersed the ice over a larger area without blowing as much out into the North Atlantic. It was actually thinner than in 2007.

This graphic from a Dr Sorteberg [via Carbon Equity](#) gives a stark impression of what is going on in terms of surface coverage:

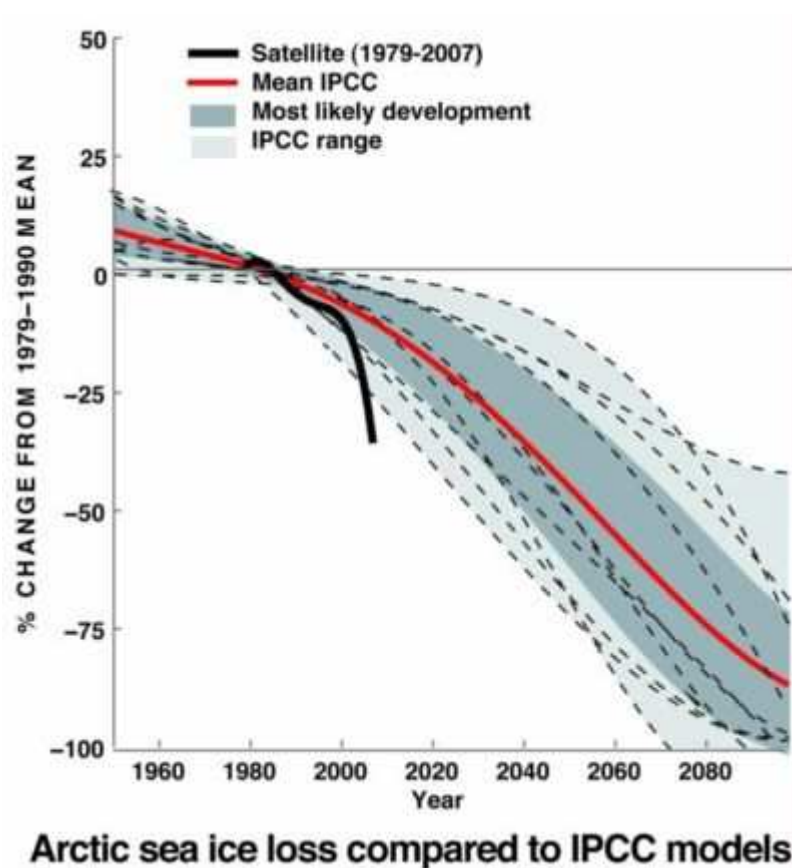


Figure 10: Trend sea ice coverage in the Arctic

An ice clear summer Arctic could occur as soon as 2013. No-one knows. But no-one expects the ice to outlast 2030, whereas a few short years ago scientists thought it would last until 2070 at least.

One of the factors at work in the Arctic involves the change in albedo, that is the reflectivity of ice as against open sea. This is illustrated in another image from the *New Scientist* (Pearce, F. 2009):

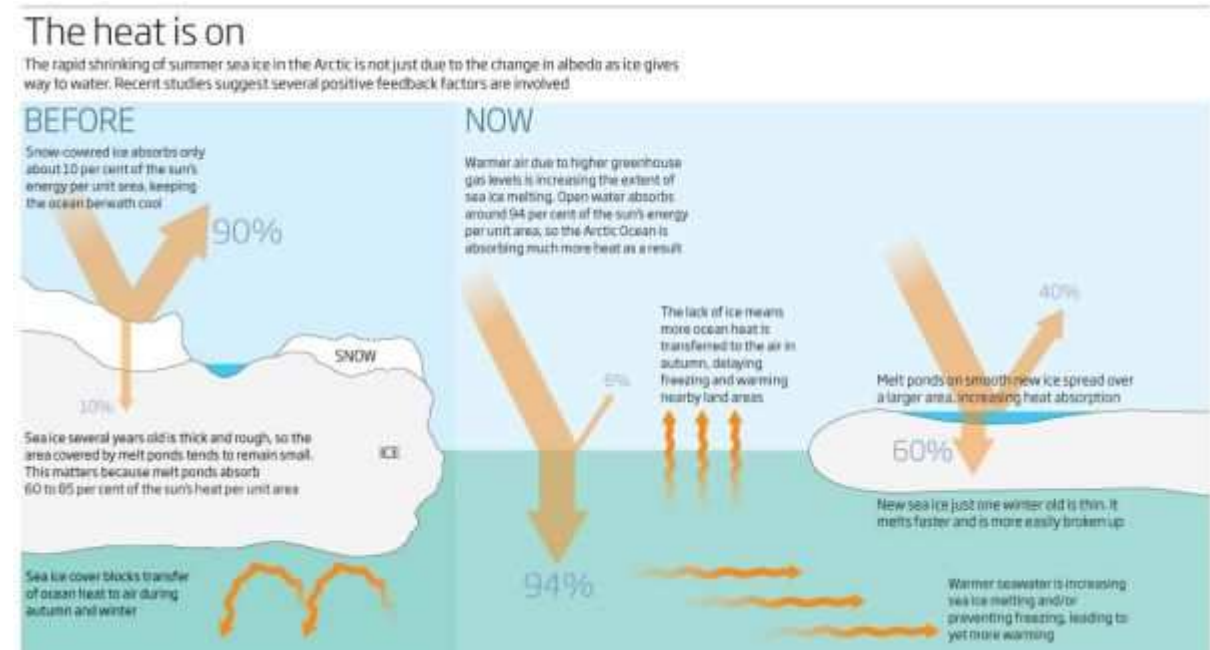


Figure 11: *Reflectivity of ice and open water*

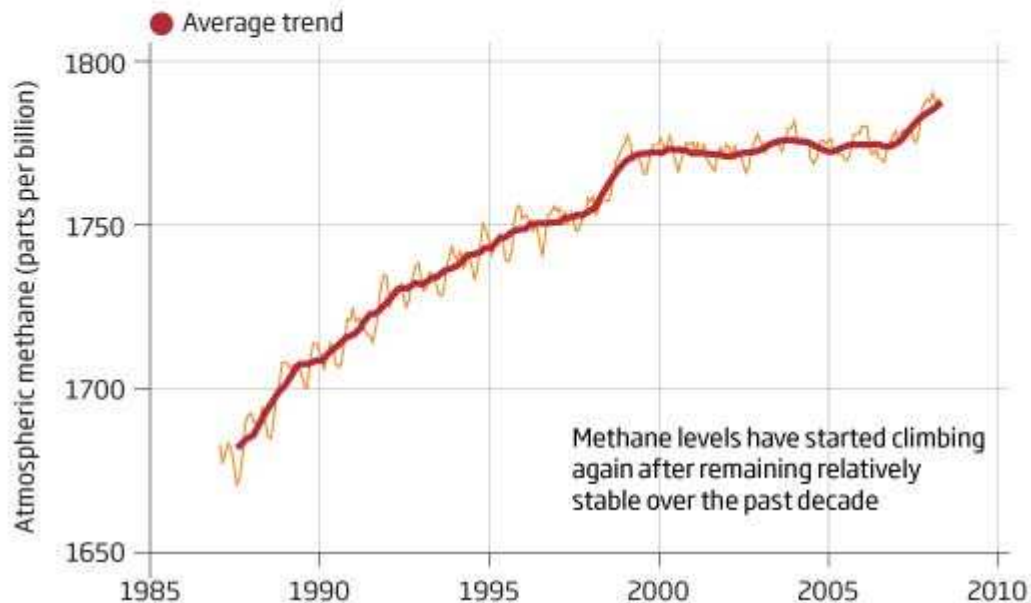
There is a range of influences at work including warmer water through the Bering Strait, cloud cover, wind direction as well as the heat entrapped by the greenhouse effect. But dry ice reflects 90% of insolation, open water less than 10%, wet ice and meltwater are somewhere in between. So as ice melts from 'normal' global warming, the more warmth is absorbed in the area leading to more warming and less ice, which leads to more warming etc etc.

The warming of the whole area means a warmer Greenland, which means more melting of the Greenland ice-sheet. It also means warmer land, which means more methane released as permafrost areas, especially in Siberia, melt. Methane emissions had flatlined for 10 years, but a disturbing uptick which started in 2007 has scientist worried.

This image from the same source shows methane emissions and 2008 Global Mean Temperature:

Danger signal

In 2007 and 2008, temperatures across Siberia were way above average.
At the same time, atmospheric methane levels suddenly increased.
Some think the rise in methane is partly due to melting permafrost



GRAPH COMPILED FOR NEWS SCIENTIST BY R. PRININ, R. WANG AND THE AGAGE TEAM

In 2008, temperatures across much of the far north were more than 2 °C higher than the 1951-1980 average

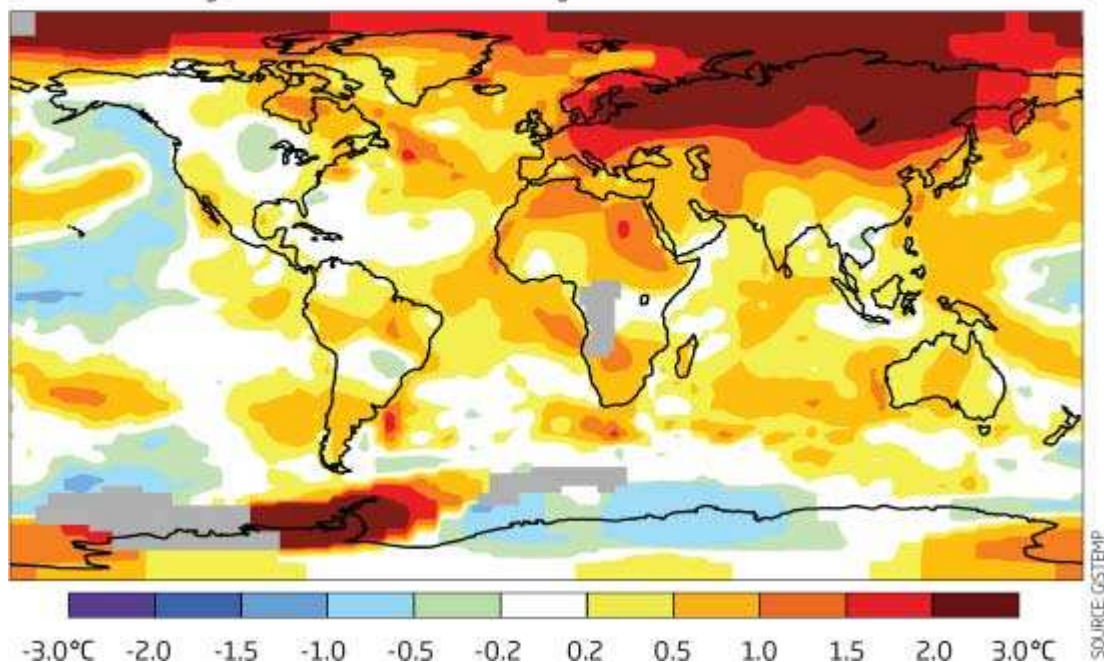


Figure 12: Methane emissions and 2008 world temperature anomalies

Please note that the temperature is referenced to the 1951-1980 average rather than to pre-industrial. Surface temperature warming is generally double over land

compared with sea. Warming in the polar regions tends to be double or more than at the equator. Parts of Siberia have warmed 5°C or more.

Models have indicated that “during episodes of rapid sea-ice loss, the rate of Arctic land warming is 3.5 times greater than the average 21st century warming rates predicted in global climate models.” (NCAR 2008)

In addition to permafrost, more methane is available in peat soils just south of the permafrost which aren't frozen. Scientists estimate that these soils in Canada would release 86% of their methane with 4°C of warming (UNEP, 2009).

Furthermore, huge stores of methane are trapped in clathrates under the sea which will be released with warming, or in the case of the Northern Indian Ocean, with more violent monsoons.

The amount of methane in these stores is unknown, but is multiples the carbon existing in the atmosphere. Scientists monitoring methane plumes in Siberia are shocked by the way it is increasing. But the *UNEP Year Book* tells us that the southern hemisphere is leaking methane too.

This is the big one. Be afraid, be very afraid!

Sea level rise

The IPCC made a thorough botch of this one, giving the impression in their 2007 report that prospects had improved. If you want to know what they did and didn't do, visit my summary of Stefan Rahmstorf's analysis (Bahnisch, B. 2008b) but basically their nominated levels are irrelevant for practical purposes.

UNEP reports (UNEP, 2009) a typical recent study that suggest 21st century sea level rise may be 0.8 to 1.5 metres. Coming out of Copenhagen were reports of studies suggesting at least a metre, some saying perhaps two.

I think most of the studies will be found to have used linear projections. Rahmstorf used the information available to the IPCC and came up with a range of 0.5 to 1.4 metres on the basis of a linear projection (Rahmstorf, S. 2007). Rahmstorf knows a thing or two about mathematics, having cut his teeth on general relativity theory. It's a case of where one clever and well-informed person can do better than the compromise that comes out of a bunch of people.

Scientists know that non-linear decay of ice-sheets has happened in the past and is likely to happen again in the future, very possibly soon. But they have no way of quantifying this, so they don't. Hansen thinks it is his responsibility as a scientist to give an informed opinion. His best estimate is two metres by 2100, noting that it could be more.

In my humble opinion two metres sounds very credible. Last year in a post “*Sea level rise: how much by 2100?*” (Bahnisch, B. 2008c) I explained that 85cm is available by 2100 from GIC (glaciers and ice-caps, which will almost certainly go, very likely by mid-century) plus thermal expansion taken together. In addition there is Greenland and Antarctica.

The Greenland ice mass is in clear trend decline (image from NASA):

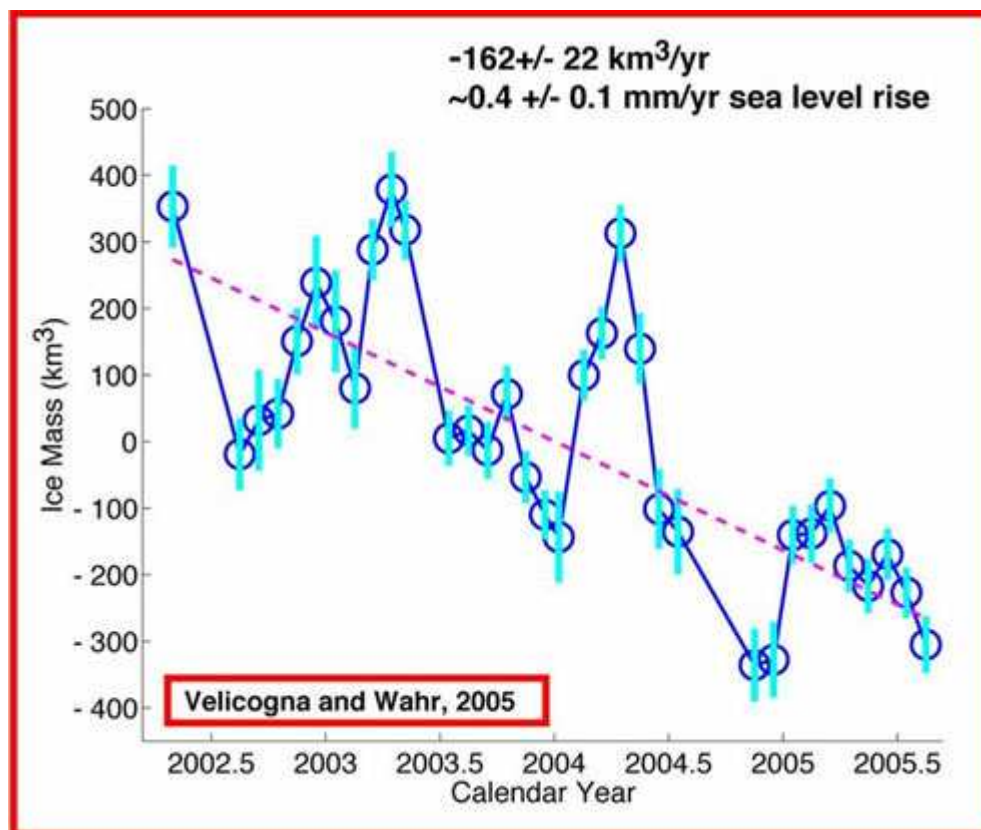


Figure 13: Ice mass loss from Greenland

The trend continued in 2006 and 2007.

Antarctica in terms of the whole continent is in decline also but there the future is uncertain. Most scientists seem to think it will decline, but the ice loss in West Antarctica and the Antarctic Peninsula may be compensated somewhat by increased snow on the giant East Antarctica ice sheet, worth 57 metres and four kilometres high, as it warms.

During the last interglacial 125,000 years ago the sea level was 4-6 metres higher when the temperature was 1-2°C warmer than now. This is a worry, especially since Antarctica and Greenland are thought to have contributed 2 metres each.

This means that West Antarctica is potentially as vulnerable as Greenland. Not a complete surprise when you consider that much of the bedrock on which the West Antarctica ice sheet sits is in fact below sea level, like a huge ship foundered on a rock.

One metre of sea level change if uniform would displace about 150 million people, 100 million in Asia. Coming out of Copenhagen was the notion that 600 million people could be affected. This probably refers to salt water penetration of soils and inundation from cyclones, storms and tidal surges. The *UNEP Year Book* however tells us that a pulse of meltwater from either of the ice sheets would take 50 years or more to cross the equator. Models indicate that meltwater from Greenland would hug the coast of North America. This is a worry for New York, which is very much in the front line.

The full effects of sea level for any given temperature take centuries to reach their full effects. During the last glacial maximum the sea was 120 metres lower when the temperature was 5-6°C lower. It is a no-brainer therefore that each degree of temperature rise can make a significant difference. Rahmstorf and Archer considered this issue in 2006 and came up with this diagram:

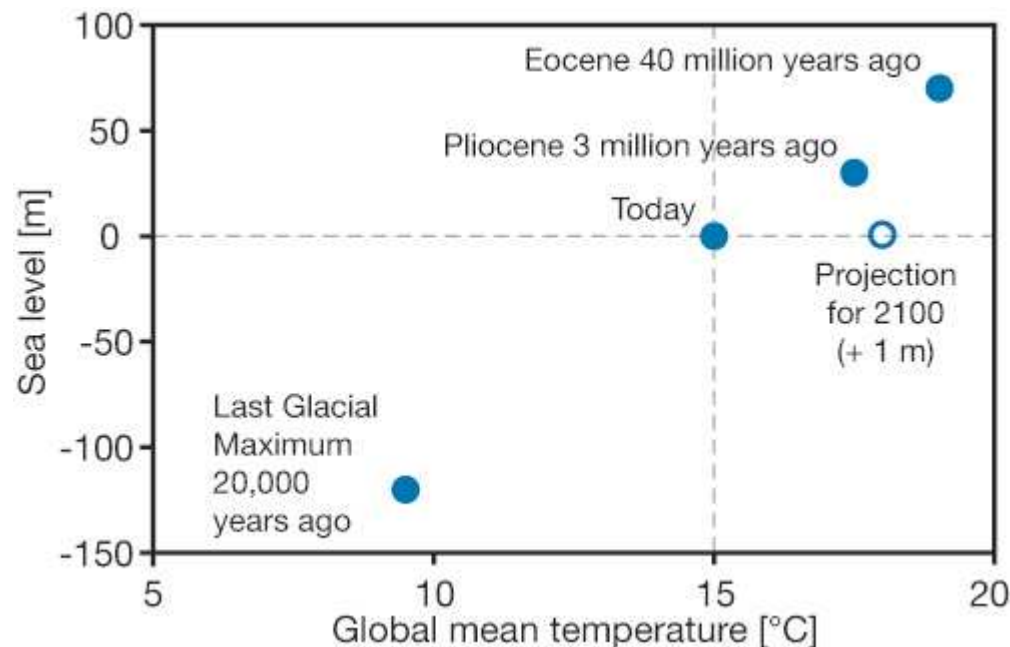


Figure 14: Sea level against temperature change

We need to be concerned about our legacy on this one. The 4-6 metres we got in the Eemian interglacial 125,000 years ago came with CO₂ of less than 300 ppm but for levels persisting in the atmosphere for an extended period.

Food production

The inundation of sea and the incursion of saltwater will have obvious adverse effects on food production in delta areas such as Bangladesh, Vietnam and Burma. But food production is under threat from other sources, principally the drying of the sub-tropics and the mid-latitude belt, plus the melting of glaciers and ice-caps.

Much of the food of the world is produced in an arc from Pakistan around to Northern China. The Himalayas and the Tibetan plateau are losing ice at the rate of 7% each year, which will mean halving in 10 years. Gwynne Dyer in researching his book *Climate Wars* (Dyer, G. 2008) was told of an Indian study projecting a loss of food production in India of over 20% by 2030. In China an equivalent study showed over 30% loss in the same time frame. Both studies were suppressed.

Pakistan relies heavily on irrigation from rivers that start in other countries.

Southern Europe and the grain belts of Mexico and much of the US will dry possibly to the point of desertification.

All this and much more in a world set to have over 9 billion people by 2050.

Internationally syndicated columnist Gwynne Dyer in researching *Climate Wars* trekked around a dozen countries early in 2008. Talking to scientists, soldiers, bureaucrats, politicians and others immersed in the topic on a daily basis, he found

that “the first and most important impact of climate change on human civilisation will be an acute and permanent crisis in food supply.” Money won’t be able to buy it, he says.

Security concerns

Dyer also found (defence is his specialty) that within the major powers, “climate-change scenarios are already playing a large and increasing role in the military planning process.”

At Copenhagen Lord Stern (McGrath, M. 2009) was in fine form:

He said that if the world was to warm by 5°C over the next century, there would be dramatic consequences for millions of people. Rising seas would make many areas uninhabitable leading to mass migrations and inevitably sparking violent conflict.

“You’d see hundreds of millions people, probably billions of people who would have to move and we know that would cause conflict, so we would see a very extended period of conflict around the world, decades or centuries as hundreds of millions of people move,” said Lord Stern.

“So I think it’s very important that we understand the magnitude of the risk we are running.”

Dyer thinks people will move or fight rather than starve. Countries to which people want to move will not be able to let them in if they are to survive themselves. He thinks for example that the border between Mexico and the United States will be militarised.

The pressure of population from Africa to Southern Europe may end up fracturing the EU, with a new Northern European Union being formed and the borders closed.

Russia is aware that that Northern China will dry out, which could send 100 million people into Siberia, which will become more productive.

Three quarters of Pakistan’s food is grown on land irrigated by the Indus River system. Five of the six rivers that flow into the system arise in Indian controlled territory. Pakistan’s population was 34 million at partition in 1951, was 170 million in 2008 and is projected to be 290 million by 2036. As the glaciers and ice caps melt water availability could be halved. The deal on sharing water struck at partition will not meet the needs of either party.

And so on.

Dyer thinks that unless something drastic is done about climate change the second half of this century is not a time you would want to be alive.

References

- Bahnisch, B. 2008a, Weitzman's approach to low-probability, high-impact climate outcomes. *Larvatus Prodeo*, July 24, 2008.
<http://larvatusprodeo.net/2008/07/24/weitzmans-approach-to-low-probability-high-impact-climate-outcomes/>
- Bahnisch, B. 2008b, Scientific caution or climate change politics? The IPCC and sea level change. *Larvatus Prodeo*, June 19, 2008.
<http://larvatusprodeo.net/2008/06/19/scientific-caution-or-climate-change-politics-the-ipcc-and-sea-level-change/>
- Brahic, C. 2009, Earth may be entering climate change danger zone. *New Scientist*, March 10, 2009. <http://www.newscientist.com/article/dn16729-earth-may-be-entering-climate-change-danger-zone.html>
- Caldeira, K. 2007, *Ken Caldeira - Carnegie Institute - Stabilizing Carbon Emissions Only Option*. Radio interview, March 7, 2007.
<http://beyondzeroemissions.org/2008/03/07/ken-caldeira-zero-emissions-carnegie-climate-change>
- Cannadel, P. and M. Rapauch, 2006, *A Changing Global Carbon Cycle*, Slides of a talk, http://www.greenhouse2007.com/downloads/papers/071005_Canadell.pdf
- Colebatch, T. 2008, *Alarm on carbon trading scheme*, in *The Age*, July 15, 2008.
<http://www.theage.com.au/environment/alarm-on-carbon-trading-scheme-20080714-3f3w.html?page=fullpage#contentSwap1>
- Garnaut, R. 2008, *Garnaut Climate change review: Draft Report*. Commonwealth of Australia, Canberra. http://www.hm-treasury.gov.au/d/Executive_Summary.pdf
- Hansen, J. 2005, *Direct Testimony of James E. Hansen before Iowa State Board of Utilities*. July 11, 2005.
<http://www.climateandenergy.org/LearnMore/Library/JamesEHansenTestimony.htm>
- Hansen, J. et al. 2007, Climate change and trace gases. In *Philosophical Transactions of the Royal Society A*, vol. 365, pp. 1925 - 1954, published online may 18, 2007.
http://pubs.giss.nasa.gov/docs/2007/2007_Hansen_etal_2.pdf
- Hansen, J. et al, 2009, *Air pollutant Climate Forcings within the Big Picture Climate Future: talk given by J. Hansen at the Climate Change Congress, "Global Risks, Challenges & Decisions", Copenhagen, Denmark, March 11, 2009*.
http://www.columbia.edu/~jeh1/2009/Copenhagen_20090311.pdf
- Hepeng, J. 2007, *Developing nations blamed for CO2 increase*, Science and Development Network, News, May 23, 2007.
<http://www.scidev.net/en/news/developing-nations-blamed-for-co2-increase.html>
- IPCC 2007, *Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change: Summary for Policymakers*, IPCC, Geneva.
http://arch.rivm.nl/env/int/ipcc/pages_media/FAR4docs/final_pdfs_ar4/SPM.pdf
- Jones, R. 2008, Blog comment at <http://larvatusprodeo.net/2008/07/24/weitzmans-approach-to-low-probability-high-impact-climate-outcomes/#comment-489916>

Jones, R.N. and B. L. Preston, 2006, Climate Change Impacts, Risk and the Benefits of Mitigation: A report for the Energy Futures Forum, CSIRO.

<http://www.csiro.au/files/files/pb9u.pdf> or downloadable with other links from <http://www.csiro.au/resources/pfnq.html>

Macintosh, A and O. Wodring, 2008, *Climate-Carbon Cycle Feedbacks: The Implications for Australian climate policy*, ANU Centre for Climate Law and Policy, Canberra.

[http://law.anu.edu.au/CCLP/WP%203%202008%20\(Climate%20carbon%20cycle%20feedbacks\)%20\(Final\).pdf](http://law.anu.edu.au/CCLP/WP%203%202008%20(Climate%20carbon%20cycle%20feedbacks)%20(Final).pdf)

McGrath, M. 2009, *Climate scenarios 'being realised'*. BBC, News, Science & Environment, (online) March 12, 2009.

<http://news.bbc.co.uk/2/hi/science/nature/7940532.stm>

Meinshausen, M. 2006, *What does a 2°C target mean for greenhouse gas concentrations? A brief analysis based on multi-gas emission pathways and several climate sensitivity uncertainty estimates*. In H. J Schellnhuber et al (eds.) *Avoiding Dangerous Climate Change*, Cambridge University press, 2006, pp.265 - 208.

Monbiot, G. 2009b, *A Self-Fulfilling Prophecy*. Online at Monbiot.com, March 17, 2009

<http://www.monbiot.com/archives/2009/03/17/a-self-fulfilling-prophecy/>

Mrasek, V. 2009, *China's Greenhouse Gas Emissions Threaten to Double*, Spiegel Online, March 6, 2009.

<http://www.spiegel.de/international/world/0,1518,611818,00.html>

NCAR 2008, *Permafrost Threatened by Rapid Retreat of Arctic Sea Ice*, NCAR Study Finds. UCAR, June 10, 2008.

<http://www.ucar.edu/news/releases/2008/permafrost.jsp>

Pearce, F. 2009, Arctic meltdown is a threat to humanity. In *New Scientist*, March 25, 2009.

<http://www.newscientist.com/article/mg20127011.500-arctic-meltdown-is-a-threat-to-humanity.html?DCMP=OTC-rss&nsref=climate-change>

Rahmstorf, S. 2007, A Semi-empirical Approach to Projecting Future Sea level Rise. In *Science*, Vol. 315, January 19, 2007, pp. 398-370.

http://www.pik-potsdam.de/~stefan/Publications/Nature/rahmstorf_science_2007.pdf

Rahmstorf, S. et al, 2007, Recent Climate Observations Compared to Projections. In *Science*, Vol. 316, May 4, 2007, p.709.

http://www.pik-potsdam.de/~stefan/Publications/Nature/rahmstorf_et_al_science_2007.pdf

Smith, J. et al. 2009, *Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) "reasons for concern"*. PNAS Early Edition.

<http://www.pnas.org/content/early/2009/02/25/0812355106.full.pdf+html>

Spratt, D. *Climate science: implications for policy Australian*. Powerpoint and notes for a talk given at the Climate Action Summit, 31 January, 2009.

<http://www.climatecoded.net/>

Stern, 2006, *Stern Review: The Economics of Climate Change, Executive Summary (long)*, HM Treasury, London.

http://www.hm-treasury.gov.uk/d/Executive_Summary.pdf

UNEP Year Book 2009, United nations Environment program, Chapter 3, Climate Change, February 2009.

http://www.unep.org/geo/yearbook/yb2009/PDF/UNEP_Year_Book_2008_EN_Full.pdf

Vince, G. 2009, How to survive the coming century. In New Scientist, February 23, 2009, <http://www.newscientist.com/article/mg20126971.700-how-to-survive-the-coming-century.html>

Weitzman, M. On Modeling and interpreting the Economics of Catastrophic Climate Change. In *The Review of economics and Statistics*, vol. XCI, no.1, February 2009, pp.1 - 19.
<http://www.economics.harvard.edu/faculty/weitzman/files/REStatFINAL.pdf>