

# CLIMATE DENIERS CREATE DANGEROUS CONFUSION.

Leon Ashby, president of the 'Climate Sceptics Party' has a presentation widely circulated on the web about why the ETS is unnecessary. His basic proposition is that CO<sub>2</sub> is not the problem and therefore moves to reduce it are unnecessary. He states that, although "CO<sub>2</sub> is a greenhouse gas", "*We want you to know that no one has any evidence that CO<sub>2</sub> will over heat the Earth & An Emissions Trading Scheme (ETS) will never ever prevent climate change.*"

The second part of Ashby's assertion is probably correct – any ETS that finally does make it through our parliament will probably be pretty worthless in terms of emission reduction. **The more important question, however, is whether or not it is true that CO<sub>2</sub> will "over heat the Earth"**. If it is true then we had better come up with something much more effective than the current versions of an ETS.

## WISHES AND REALITY

We would all like to believe that Ashby is correct and that we are not in danger of a climate disaster. Unfortunately however, nature does not care about our wishes, she simply obeys her own laws – the laws of physics and chemistry that humanity has taken great pains to discover over the last few centuries. So let's look at Ashby's presentation from the point of view of science. [*You don't need to have seen Ashby's presentation to follow this one. The claims he makes are typical of so called 'climate sceptics'. The purpose of this document is to answer those claims by looking at actual climate science.*]

In his introductory slides Ashby makes various deliberately 'acceptable' points ("We agree we should give the planet much consideration." and so on) but includes some utterly misleading ones "...no one has any evidence that CO<sub>2</sub> will over heat the Earth". This claim is ridiculous. For over one hundred years scientists have had good reason to believe that increased CO<sub>2</sub> in the atmosphere will add to the greenhouse effect – the 'heat trapping' atmospheric process which keeps the Earth about 33°C warmer than it would otherwise be. Given that we humans have increased the CO<sub>2</sub> in the atmosphere by over 35% we have EVERY REASON to believe that we may have caused an increase in the greenhouse effect – ie., global warming.

Way back in 1896 Svante Arrhenius calculated that a doubling of the CO<sub>2</sub> in the atmosphere could result in something like a 5°C global temperature rise – a result not greatly different to that of modern much more sophisticated calculations. Would this sort of rise "over heat the Earth"? Well, it depends how you interpret that statement! The Earth has been that hot in the past and it survived – indeed, as the sceptics keep telling us, life flourished. However, that Earth was a very different scene to our current one and the problem is not life on that very different planet, **but the process of getting there**. Currently fertile areas of the Earth would become deserts centuries before the present deserts started to bloom. In the meantime billions of people would starve, virtually all large coastal cities would be wiped out by sea level rise creating massive refugee problems – not to mention the loss of a millennia of cultural and physical development. It is not 'life on Earth' we are worried about, it is **human civilization!** We really can only describe Ashby's statement that "no one has any evidence that CO<sub>2</sub> will over heat the Earth" as **extraordinarily misleading**. However it is typical of the tactics of deniers. More on this later.

## DENIERS AND SCEPTICS

It is typical of those who call themselves 'climate sceptics' to present facts that are 'true' – but irrelevant. A genuine scientific sceptic looks at **all** the real science and tries to evaluate it as a whole. He or she will not simply cherry pick facts or ideas that suit their point of view and ignore that vast bulk of research on the topic. Indeed scientists are by nature sceptics – always trying to test ideas to see if they stand up against the evidence. For this reason, the likes of Ashby can not possibly claim to be 'sceptics'. If they were, they would look at all the data and not just consistently pick only the few bits that suit their cause.

Ashby gives us a good example of this in his slide "Is CO<sub>2</sub> a pollutant? - NO!" He tells us various good things about CO<sub>2</sub>: "We drink it in soft drinks", "It is necessary for life". He continues with a picture of trees growing better in CO<sub>2</sub> enriched atmosphere. All these things are true, **but completely irrelevant to the discussion!** If he were a genuine sceptic he would go on to say that we also know that as well as these things, CO<sub>2</sub> is a gas which absorbs infrared radiation from the Earth and so traps heat in the atmosphere, thus warming the Earth. Clearly, if we add more CO<sub>2</sub> we must expect more warming. The real question for the genuine sceptic is: how much warming, and what will be the effects? For these reasons, we will refer to Ashby and friends as '**deniers**' rather than 'sceptics'.



Why an Emissions Trading Scheme (ETS) is not necessary

A brief summary compiled by Leon Ashby,  
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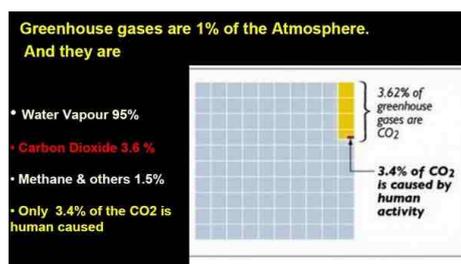
Ashby slide

## So, is CO<sub>2</sub> plant food?

As Ashby shows, some plants grow better in a CO<sub>2</sub> enriched atmosphere – providing other conditions are also controlled. No plant will grow with too little (or too much) water, no matter how much CO<sub>2</sub> it has! The problem is that it is only some types of plants that do better. As well, with the increased CO<sub>2</sub> also come changed temperatures and rainfall conditions which will be far more crucial than the small increase in CO<sub>2</sub>. Other experiments have shown that while some crops do better with added CO<sub>2</sub>, the extra growth is at the expense of the nutritional value. One such study<sup>1</sup> concluded that “the total number of seeds in wheat and barley plants increased by 15% but the amount of nitrogen in the seeds declined by 20%”. The nitrogen is a measure of the nutritional value, as it is needed for protein building, and so on balance, the added CO<sub>2</sub> actually reduced the yield of the crops.

Furthermore, there is good evidence that while the plants initially react to an increased amount of CO<sub>2</sub> with faster growth, as they acclimatise to it their growth rate adjusts back to ‘normal’. It seems to be the increase, not the actual level that stimulates growth.

The main point here is not so much whether CO<sub>2</sub> is a plant food – of course it is – but whether that, on its own, is a relevant fact in this discussion. If we are to look at the science of the effect of climate change on plants we need to consider **all** the factors, not just the ones that suit our argument. As we will see, other factors are far more significant than a small, and questionable, increase in growth rate of plants.



Ashby slide

## IS HUMAN CAUSED CO<sub>2</sub> A PROBLEM?

Ashby continues with a common denier claim: The amount of human caused CO<sub>2</sub> in the atmosphere is too small to matter. The claim is that CO<sub>2</sub> is only 0.036% of the atmosphere and that only 3.4% of that is human caused. Correct on the first point (actually it is now about 0.039%). **Totally wrong** on the second point.

It is important to realise that although the 0.039% figure sounds small, the fact is that over 99% of the atmosphere (the nitrogen, oxygen and argon) is totally irrelevant as far as the greenhouse effect is concerned. Those gases are completely transparent to the infrared (heat) radiation emitted by the Earth and trapped by greenhouse gases. The two main greenhouse gases are water vapour and carbon dioxide. The water vapour concentration varies (with humidity) and can be anything between almost zero and up to around 1% of the atmosphere. It is the most important greenhouse gas, but as we shall see, there are important distinctions between water vapour and carbon dioxide in the way they act.

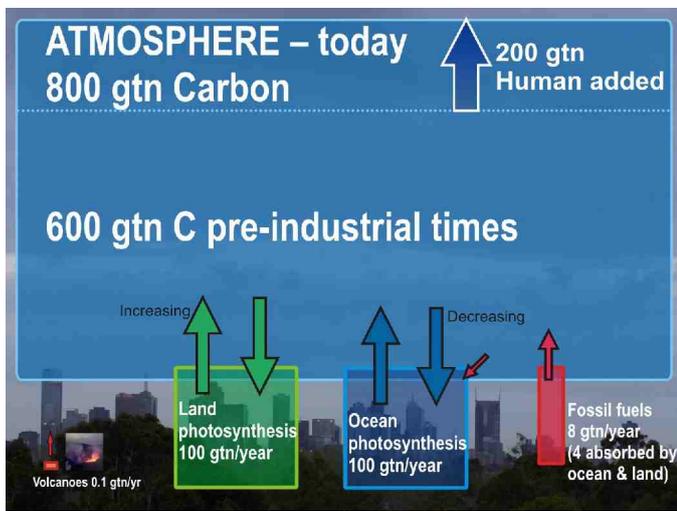
A very simple experiment can convince you that although 0.03% sounds small it can have a very significant effect. For example, would you eat food containing 0.03% arsenic? A somewhat safer experiment is to add 0.03% of ink to a glass of water (1 or 2 drops). That small amount of ink makes the water quite dark - it is absorbing a considerable amount of light. Just as that small amount of CO<sub>2</sub> in the atmosphere absorbs a considerable amount of infrared light from the surface of the Earth. Increase the ink, or CO<sub>2</sub>, and more light is absorbed. The water simply does not absorb any light and is irrelevant. Likewise, nitrogen and oxygen are irrelevant to the greenhouse effect.



The claim that human produced CO<sub>2</sub> is only 3.4% of the total CO<sub>2</sub> is downright dishonest. As we all know, the important figure in this context is the fact that we have increased the greenhouse gas concentration in the atmosphere by over 35%. The amount of CO<sub>2</sub> in the atmosphere has gone from around 280 ppm<sup>2</sup> in pre industrial times to over 380 ppm now. The figure of 3.4% is calculated in a very convoluted way and actually represents the fact that if you could ask any one molecule of CO<sub>2</sub> where it came from in its most recent incarnation, about 3% or 4% would say from human produced emissions. This however totally ignores the fact that every year huge amounts of CO<sub>2</sub> go in and out of the atmosphere from plant growth and decay both on land and in the ocean.

<sup>1</sup> Peter Curtis, a professor of evolution, ecology and organismal biology at Ohio State University. See reference 1.

<sup>2</sup> ppm is parts per million by volume. In one million litres of atmosphere you would find 380 litres of CO<sub>2</sub>. Notice also that while we usually only talk of CO<sub>2</sub>, other greenhouse gases have increased also. They are sometimes taken into account by talking of the equivalent amount of CO<sub>2</sub> that would have the same effect. When this is accounted for we now have about 450 ppm CO<sub>2</sub>e (carbon dioxide equivalent).



This diagram shows the approximate situation. Humans have increased the total amount of carbon<sup>3</sup> (mostly as carbon dioxide) in the atmosphere from around 600 gigatonnes (gtn) to 800 gtn in the last century or two. We are currently putting about 8 gtn in each year, of which around half is absorbed by the ocean, leaving a net 4 gtn added each year.

However, around 200 gtn goes in and out of the atmosphere<sup>4</sup> in the natural carbon cycle each year. That means that any particular molecule that we add has a good chance of being absorbed in the ocean or incorporated into plant material - and reappearing as a 'natural' molecule in the course of time. The result is that the number of actual fossil fuel sourced carbon atoms still in the atmosphere is relatively small – the 3.4% figure. (Ashby's argument is rather like a

criminal claiming that drug money 'laundered' through a casino is now actually 'clean'.) What is significant, however, is the **added 4 gtn of carbon atoms we are putting into the atmosphere every year** – which has led to the 35% increased CO<sub>2</sub> concentration. And unfortunately that 4 gtn figure is still increasing and looks set to continue doing so for the foreseeable future.

Consider this simple analogy: A garden pond with a pump recycling water through a 'fountain'. Say the pond held 800 litres of water and the pump was cycling 200 litres every hour. A hose is then turned on which is adding 4 litres every hour. The water level is going to increase at the rate of 4 litres each hour.

Now imagine that we run the system for 10 hours. After that time we would find an increase of 40 litres. Further imagine that the water coming from the hose was coloured blue, but once it went through the pump a filter removed the blue and it came out clear. We would of course find that the colour of water in the pond was almost clear as most of the colour was removed by the filter. In fact the concentration of the 'blue water' would be tiny – but that is effectively what Ashby would like us to use as a measure of the extra water! What's actually important, of course, is that the water level has risen by 40 litres.

Although the details are a little more complicated, carbon atoms from burning fossil fuels are, in effect, 'coloured'. Rays from the Sun continually create radioactive carbon atoms in the upper atmosphere. The concentration of the radioactive carbon atoms in the atmosphere is very well known. The carbon from fossil fuels, however, has been underground for millions of years and the radioactive atoms have long since decayed and so the CO<sub>2</sub> coming from fossil fuels is a different radioactive 'colour' to that already in the atmosphere. By measuring the changing concentration of radioactive carbon in the atmosphere, and doing the correct arithmetic, scientists have shown that the small decrease in radioactive carbon is completely consistent with the amount of fossil fuels we have burnt. There is no serious doubt at all that the extra 35% of CO<sub>2</sub> in the atmosphere has come from burning fossil fuels. The denier figure of about 3% 'human added CO<sub>2</sub>' is a completely irrelevant distraction.

## AN EXAMPLE OF DELIBERATE DECEPTION

Those who claim that man-made CO<sub>2</sub> is only 3.4% of the atmosphere are correct enough in their claim that only 3½ molecules in every 100 actually originated from a fossil fuel burnt in a human machine. As the pond analogy shows however, this is **totally irrelevant** in measuring the actual increase in total CO<sub>2</sub> molecules in the atmosphere – which of course is what the greenhouse effect is dependent on.

The 'scientists' who make this sort of claim must be perfectly aware of the situation described above. We can only conclude therefore that they are **deliberately setting out to deceive the rest of us** by making a statement which, while being in one sense strictly correct, is **completely misleading**. Of course many other deniers are not scientifically literate and perhaps don't understand (and don't care) where the calculation actually comes from. However, because it suits their cause, they endlessly repeat that figure rather than the far more relevant 35% increase in concentration which anyone who takes an interest in the topic is perfectly aware of.

We have gone into some detail on this point because it is an example of a very common tactic of the deniers. In an area of relatively complex science it is very easy to make some claim which **sounds**

<sup>3</sup> Sometime the mass of carbon is used in these types of figures and sometimes the mass of carbon dioxide (CO<sub>2</sub>) is used. As the CO<sub>2</sub> molecule contains oxygen as well it is about 3.7 times as heavy as a C atom. This is why you will sometimes see it stated that we emit about 25 gtn of carbon dioxide per year.

<sup>4</sup> Note: This figure seems to vary according to the source - but whatever it is, it is very large.

**reasonable, but is fundamentally wrong.** All the deniers need to do is make the claim sound as though it has some scientific basis and then those who **wish to believe** it will spread it like wildfire – particularly around the blogosphere on the internet. Unfortunately we will find that exactly the same sort of trick is used over and over by deniers like Ashby. (Note that he is not a scientist despite his scientific sounding claims.) Indeed all of the rest of his presentation simply repeats the same pattern: Make a misleading claim and allow it to be repeated over and over by those who have neither the knowledge or inclination to check it out.

Unfortunately, to answer these sorts of claims the scientists need to go into considerable detail – as we have above with a comparatively simple example! Many people will not have the inclination or the interest to go into this detail and will instead simply choose to believe what they find convenient. This gives the deniers a big advantage over the scientists – and they are using it with remarkable effectiveness.

## **THE ROLE OF THE MEDIA AND LOBBYISTS**

Deniers are being thoroughly aided and abetted by a host of tabloid newspaper columnists and radio shock-jocks who apparently have no real interest in discovering the truth – only in stirring up controversy. It sells many more papers and grabs many more listeners than a sober presentation of the actual science of the climate.

When this is all combined with strong political and commercial vested interests, who are willing to put lots of money into maintaining the status quo, we have a serious problem in educating the public about the truth of the matter. And because of their strong connections with the media it is relatively easy for deniers to keep the confusion going.

A large part of the problem is unrestrained consumerism, and so many ‘free market’ interest groups are very keen to encourage the deniers. In fact, one of the largest sources of climate misinformation is the ‘Heartland Institute’ in the USA. It is a right wing ‘think-tank’ whose goals include “to promote free-market solutions to social and economic problems” including “market-based approaches to environmental protection, privatization of public services, and deregulation in areas where property rights and markets do a better job than government bureaucracies”.



It was Heartland to whom our own Senator Steve Fielding went in support of his own ‘climate scepticism’. It is Heartland who supports the “Nongovernmental International Panel on Climate Change” which has put out a report titled “Nature, Not Human Activity, Rules the Climate” – a sort of ‘anti-IPCC’ report. It was also Heartland who campaigned strongly against the link between smoking and lung cancer, and even still claims that “The anti-smoking movement is... largely funded by taxpayers and a few major foundations with left-liberal agendas”. Not surprisingly, Heartland also supports creationists in their fight with evolutionary science. They also attack those in faith-based environmental movements who seek action on climate change saying that “We think that man is the pinnacle of God's creation and he is intended to be the steward of the Earth, the steward of creation.” This apparently means that God created coal and oil for us to burn like crazy. Most Christians see it differently!

Heartland is funded by ‘big money’ in America, particularly the fossil fuel based industries. This included Exxon-Mobil until recent adverse public opinion and particularly action by the UK’s national academy of science, *The Royal Society* forced them to cease funding (at least publicly).

## **SCIENCE AND THE SO-CALLED ‘DEBATE’**

The deniers have a huge advantage over the climate scientists. All they have to do is create confusion. They do not have to establish a case, they simply need to appear to undermine the case of the climate scientists. For this purpose they distort the way good science works.

Scientists are by nature ‘sceptics’. Science has always progressed by a process of questioning what has thought to have been established previously. Galileo found that the Earth revolved around the Sun by questioning the soundness of the previously Earth-centred theory. There are always ‘arguments’ and ‘debates’ within science, it is part of the essential nature of the endeavour.

For this reason the deniers can easily say “the science is not settled”. No scientist will disagree. **No science is ever settled!** That is not the nature of science. Even Newton’s law of gravity is not ‘settled’. (In fact Einstein showed that it failed at high speeds.) This, however, does not stop us from using Newton’s laws everyday in describing the motion of all manner of objects around us. Likewise, while there are many aspects of climate science that are uncertain, there is much that is very reliably known and which we can use with confidence. Just look at the accuracy of the week ahead weather forecasts for example.

Deniers are fond of telling us that we “need a debate about anthropogenic global warming”. They then

proceed to make a few pseudo-scientific claims – such as those in Ashby’s presentation – and expect a public debate about them. The problem is that the debate has already been had in the appropriate place – the scientific community – and, except for details or radically new discoveries, the basic question of whether the current climate change is caused by human generated CO<sub>2</sub> is over for now. All that throwing cherry picked bits of the debate into the public arena achieves is confusion among the public – exactly what the deniers are after of course.

**A debate about scientific detail can not be settled in the public arena.** Consider the question of nuclear energy. There is no point having a public debate about whether nuclear reactors produce dangerous radioactive waste. We believe the scientists who are expert in this field and who tell us that the fission products of the nuclear reactions are radioactive and need to be kept away from humans for a very long time. We **do** need public discussion about **how** to keep this waste safe, and in fact whether we should produce it at all. But there is no point in a debate about **whether** radioactive waste is harmful. It is a complex scientific question requiring expert knowledge.

Likewise, the conclusion that continued emission of CO<sub>2</sub> will, very likely, lead to dangerous climate change is not one that can be settled by public debate – it is simply too complex. This is why world governments set up the IPCC back in 1988. However, the issue of **how to deal with the problem of reducing CO<sub>2</sub> emissions** is a matter for public concern and rightly should be open to public input and debate. In this sense, Ashby’s concerns about whether an ETS will reduce emissions may well be a legitimate topic for debate – but not for the reasons he gives.

This is not to say that interested people should not concern themselves with the science of climate change. However, if we ‘interested observers’ want to be informed about the issue we should be prepared to learn some basic science and to look at the serious scientific journals in which the questions are discussed – not just a few cherry picked bits and pieces. To simply throw around a few bits of disjointed pseudo science as Ashby does is **extraordinarily irresponsible**. Given the potentially disastrous consequences of inaction on emission reductions, for an uninformed, non-scientist to claim that all the climate scientists have got it wrong is extremely irresponsible.

## SO ARE SCIENTISTS AGREED?

Ashby devotes several slides to arguing that the ETS will cost us a fortune. Even to a non-economist his arguments seem to ridiculously extrapolate costs way beyond what more responsible economists have suggested. This paper, however, is about his science, or lack thereof, and so we will confine ourselves to that area. So, is his claim that only 5 scientists supported the major statement of the IPCC report correct?

That claim is about as sensible as saying the American constitution was written by one person because, presumably, only one hand held the pen that actually put the ink on the paper.

The IPCC process involves thousands of scientists having input in their own specialist areas – so of course not all of them looked at all of the report. However, the IPCC is not a research institution. Its function was to collate the research of many more thousands of researchers in many fields related to the central question – is the climate changing due to human caused emissions of greenhouse gases? In this endeavour it was the largest ever attempt to collate all the science in one field. Its reports are compilations of an analysis of thousands of scientific papers.

Ashby seems to have invented many of the various numbers that eventually reduce down to only five scientists who finally supported the major findings. Surely, if indeed his number was correct we should be hearing an enormous racket from the other 2495 scientists who presumably have been misrepresented! Not to mention the tens of thousands whose work has been referenced directly and indirectly.

More sensibly, if one is really interested in what the majority of scientists think, one would of course go to the serious scientific journals and scientific associations to see what is being said. Journals such as the USA’s *AAAS Science* and *Proceedings of the National Academy of Science*, the UK’s premium science journal, *Nature* – as well as a host of specialised publications such as those from the *American Geophysical Union* and of course our own *Bureau of Meteorology* and *CSIRO*. We would then find that paper after paper is adding to the findings that the Earth is warming in just the way the IPCC reports suggested. Indeed, it seems that the IPCC predictions have been on the conservative side with most discoveries since the last report suggesting that climate change is progressing faster than anticipated. It is well known, for example, that the Arctic sea ice has decreased at a much more rapid rate than was predicted by the 2007 IPCC report (which was based on science up to 2005). Likewise, all around the world, glaciers are disappearing faster and sea level is rising faster than predicted.

So the major statement of the review saying what climate change can be attributed to was supported by just 5 independent scientists - a few less than 2,500

On the other hand there are over 31,000 independent US scientists who have signed a petition saying there is no conclusive evidence CO<sub>2</sub> causes climate change. See [www.petitionproject.org](http://www.petitionproject.org)

31,000 Scientists saying CO<sub>2</sub> does not cause climate change

5 independent scientists saying CO<sub>2</sub> could be the cause

Ashby slide

Virtually every major scientific association has issued a statement on climate change stating that it is 'almost certainly' caused by humans and will 'very likely' result in dangerous consequences for humanity unless strong mitigation measures are taken. (Check Wikipedia under Climate Change to find a very long list of such statements by the world's major scientific associations.)

## THE OREGON PETITION

So, where did Ashby get his 31,000 scientists "saying CO<sub>2</sub> does not cause climate change"? From something called the "Oregon petition" which originated in 1998 from the Oregon Institute of Science and Medicine, the web home page of which lists 8 individuals under the 'Faculty' heading. Two of those listed are deceased, and two are sons of OISM's head, Arthur B. Robinson, an eccentric biochemist who has a long history of controversial entanglements with figures on the fringe of accepted research. Even though the OISM has "Faculty", it has no classrooms, or student body. It does, however, publish a home-schooling kit for "parents concerned about socialism in the public schools".

The petition was accompanied by a purported review of the science that was written by the OISM's Robinson and son along with a couple of astrophysicists, none of whom had any standing as climate scientists. It was co-published by the George C. Marshall Institute which has received at least \$715,000 from Exxon Mobil since 1998. (The Institute was originally set up to help promote Ronald Reagan's 'Star Wars' missile defence program.)

The supposed 'review' was made to look like a paper published in the prestigious "Proceedings of the National Academy of Science". To this end it was accompanied by a cover letter from a Dr Frederick Seitz, a past president of the US National Academy of Science (NAS). He was indeed a very past president – from the 1960s. In the 1970's he was a lobbyist for the tobacco companies. So many people thought the paper was actually from the NAS that the NAS had to take the unusual step of publishing a disclaimer stating, in part, that "The NAS Council would like to make it clear that this petition has nothing to do with the National Academy of Sciences ...The petition does not reflect the conclusions of expert reports of the Academy" and "even given the considerable uncertainties in our knowledge of the relevant phenomena, greenhouse warming poses a potential threat sufficient to merit prompt responses."

The petition was (and still is) open to signing by anyone who claims to be a scientist. There is no requirement for any knowledge of climate science. It has, however, been 'signed' by such people as Geraldine Halliwell – formerly known as pop singer Ginger Spice of the Spice Girls. (Halliwell's field of scientific specialization was listed as "biology".) Very few of the signers are actually people known to be genuine climate science researchers. Given that there are thought to be over a million and a half 'scientists' in the USA (and many more who might like to call themselves that) the number of signers is actually a very small proportion. Again, Ashby's claim is extremely misleading.

## YET MORE NONSENSE ☹

Miskolczi found the greenhouse effect (g) is a constant and equals 0.33 (of the available heat)

- In other words the Earth's temperature varies according to the amount of heat from the Sun and other sources.
- But extra greenhouse gases like CO<sub>2</sub> will not change the Earth's greenhouse effect.

In yet another example of extraordinary cherry picking, Ashby quotes a supposedly peer reviewed paper published in an obscure Hungarian science journal by Dr Ferenc Miskolczi. He further claims that it has not been refuted and shows that the greenhouse effect is saturated and won't increase with more CO<sub>2</sub>. The simple reason it has not been refuted in serious journals is that it contains so many elementary errors it is not worthy of serious consideration. However, climate scientists<sup>5</sup> have indeed looked at it carefully and identified a number of incorrect

usages of basic thermodynamic equations and bad assumptions about 'initial conditions' (the constants that must be put in to tell the equations where we are starting). It is in the same sort of category as the hundreds of 'crackpot' papers that claim to prove that Einstein was wrong. In any field of science it is easy to find 'fringe' papers claiming to dispute the main bodies of evidence. For obvious reasons climate science is particularly prone to this sort of thing.

It is very curious (or perhaps not!) that the very people who like to quote Miskolczi's paper as some sort of authority on climate predications also claim that computer based climate models are not reliable. The computer models are using the same sort of basic physics that Miskolczi is using, but in a much more sophisticated and reliable way – they are checked over and over by large numbers of different scientists. The other big difference is that while Miskolczi's work is entirely theoretical – with various very questionable assumptions about initial conditions – the assumptions in the computer models are checked against actual climate data. The computer models can be tested by putting in conditions, say one hundred years ago, and seeing if their predictions agree with what actually happened. Miskolczi's prediction that temperatures are affected very little by atmospheric CO<sub>2</sub> simply flies in the face of the actual data of the

<sup>5</sup> See [www.rabett.blogspot.com/2008/06/gigo-eli-has-learned-over-years-that.html](http://www.rabett.blogspot.com/2008/06/gigo-eli-has-learned-over-years-that.html) for example.

last few decades – not to mention the Earth’s whole climate history!

Miskolczi’s ‘greenhouse effect is saturated’ argument is a common thread in denier arguments but has been thoroughly investigated over and over by climate scientists. There is not space here for the details, but in brief, the deniers ignore the fact that as atmospheric CO<sub>2</sub> increases, the height from which radiation escapes to space increases, and becomes colder (and therefore less efficient at radiating heat away). We would all **like** to believe that we are not affecting the climate, but unfortunately the science, and the evidence, tells us that we are.

Perhaps what is most interesting about Ashby’s use of Miskolczi’s paper is that it indicates the difficulty deniers have in finding any serious science that supports their claims. There are literally hundreds of reputable papers published on the subject every year, and thousands more which are indirectly relevant. And yet deniers will seize on one obscure paper, such as this one, and then try to tell us that it contradicts the huge mass of scientific thought on the subject.

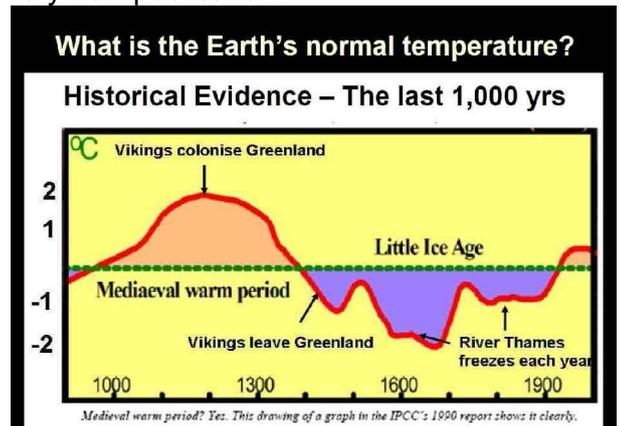
There **are** a handful of serious ‘scientific sceptics’. This is an important part of the way science works. Their work questions some of the assumptions put into the global circulation models (the computer models). As a result of this sort of questioning and testing, science gradually develops a clearer picture of the way the world works. Unfortunately, however, the picture of manmade greenhouse enhancement dangerously changing our climate is becoming clearer with every new publication.

## THE LAST THOUSAND YEARS

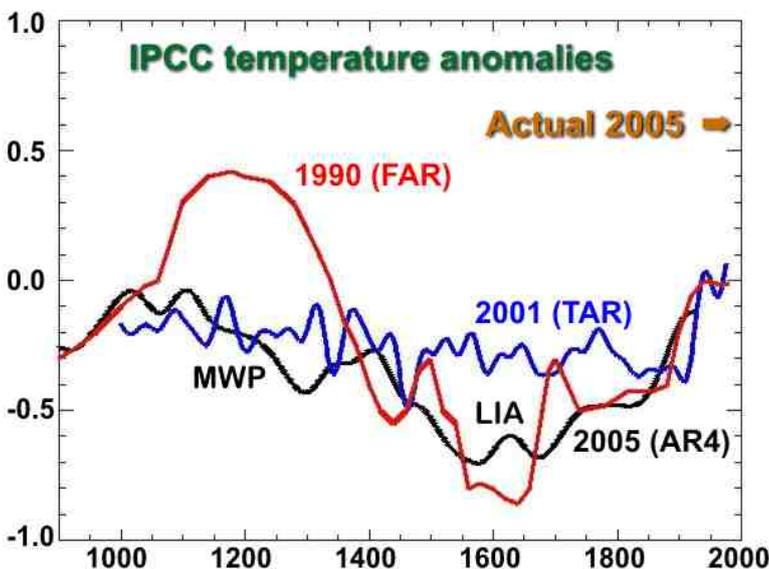
Ashby’s graph ‘The last 1,000 yrs’ is extraordinarily misleading – but it gives us a good insight to the sort of tactics used by deniers. First, it ends around 1970 (despite appearances) and so doesn’t show the last 40 years of warming. Second, it grossly exaggerates the Mediaeval warm period which was actually no warmer than last century. Third, the scale is simply fraudulently wrong. So where did he get it? His answer: the IPCC!

It is worth noting that versions of this same graph have been used in the infamous 2006 TV program “The great global warming swindle”, as well as numerous denier publications, including Ian Plimer’s recent *Heaven+Earth* (his Figure 11).

Yes, it did come from the IPCC – **in 1990**, the time of the *First Assessment Report* (FAR) twenty years ago! (The most recent was the fourth, AR4, in 2007.) At that time there had been little research into the climate of the last 1000 years and the best they could do was a small number of studies with very uncertain results. Since that time, however, a lot of research has gone into the history of the climate and now there is much more reliable data available. The last three IPCC reports contain much more up to date graphs which of course Ashby had easy access to – but chose not to use.



Ashby slide



The set of graphs<sup>6</sup> at left shows three IPCC versions of the last thousand years temperatures and clearly shows that the original 1990 one had a much exaggerated MWP. Note that these graphs still end around 1990.

Also, notice the temperature scale on Ashby’s graph – showing a variation of ± 2°C. This is simply a lie. Compare his scale with that on the original – the actual variation is only a little over ± ½°C. And notice that current temperatures are well above the MWP!

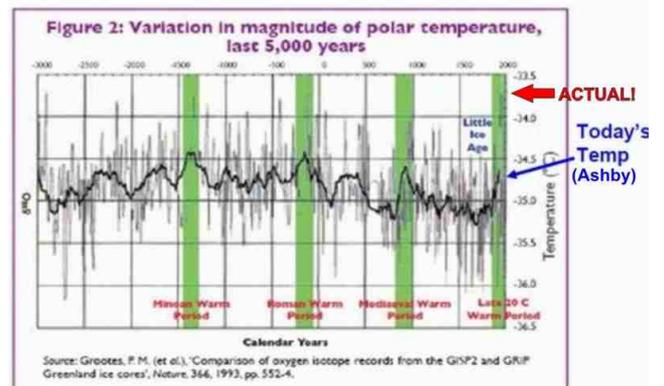
Remember that Ashby had access to all this latest data, but chose to use an extraordinarily inaccurate graph. Enough said.

The purpose, of course, of this sort of deception is to convince us that the climate change we are now experiencing is ‘natural’ and therefore we can’t do anything about it.

<sup>6</sup> Adapted from Wikipedia: <http://upload.wikimedia.org/wikipedia/en/e/eb/1pcc7.1-mann-moberg.png>

## “CLIMATE HAS ALWAYS CHANGED!”

A very common denier claim is that “Climate change is natural, and warmer periods occur without human CO<sub>2</sub> emissions being the cause.” Ashby presents us with the graph at right as evidence of this. It goes back 5000 years and shows changes in **polar temperatures** that actually vary by less than about  $\pm\frac{1}{2}^{\circ}\text{C}$ . He also adds a label ‘Today’s Temp’ (blue) pointing to the long term average temperature around the middle of last century. He ignores the short term variation lines which are clearly visible – and show that the end of twentieth century temperature was about one degree higher (added red arrow) than his (blue) arrow!



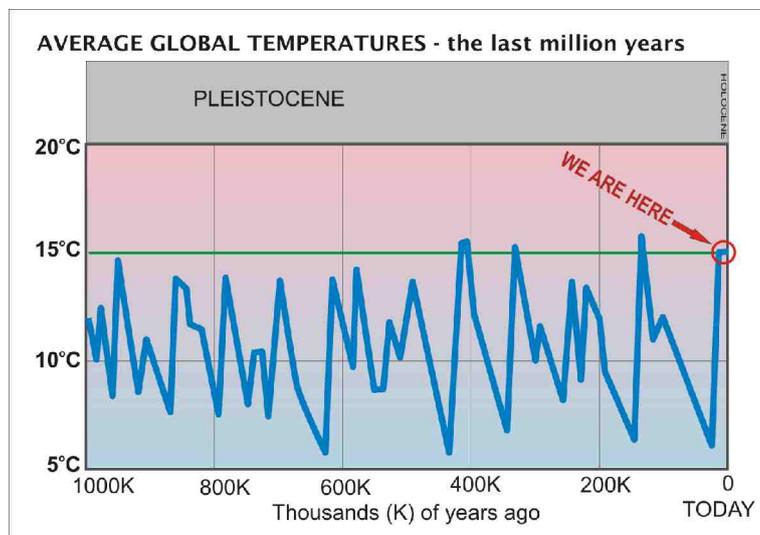
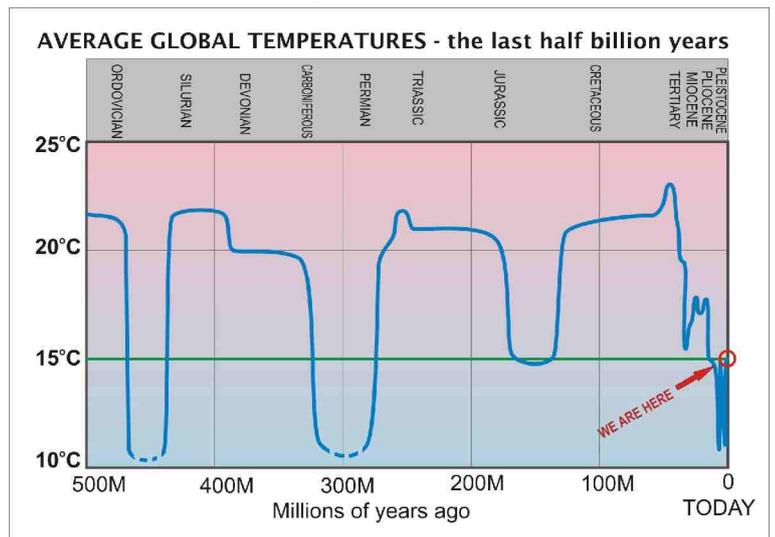
Ashby slide. Note: Vertical interval only  $\frac{1}{2}^{\circ}\text{C}$   
Red arrow indicates actual approximate temperature today.

His graph serves well to remind us that indeed while the climate over the period of human history has varied, that variation is very small – **only about  $\pm\frac{1}{2}^{\circ}\text{C}$** . Indeed he could have gone back further to around 10,000 years ago when the Earth was just coming out of the last full ice age and agriculture was just beginning to develop. In fact, **human civilization has developed in a remarkably stable climate** with very small changes – even in the so called warm periods and little ice ages.

## NATURAL CLIMATE VARIATION

To understand natural climate variation we need to go to much longer time scales. On the Earth's time scale, human civilization has existed for a mere blink of an eye. The graph<sup>7</sup> at right shows approximate temperature changes over hundreds of millions of years. It is clear that the Earth's temperature has swung between a 'hothouse' and a 'snowball'. This is serious climate change!

The blue section below the green line (today's temperature) at the right of the graph represents the recent ice age cycles. For the last million or so years the Earth has swung between full ice age conditions and so called 'inter-glacials', such as we are in now. The next graphs expand that more recent period.



The graph at left shows the glacial–interglacial swings that have occurred over the last million years. Most of this period has been much colder than our current temperatures. These were the ‘full’ ice ages with ice covering much of Europe and North American. However, every hundred thousand years or so ice has melted quite rapidly (geologically speaking) and an interglacial climate similar to the current has lasted several thousands of years. In fact, at around 10,000 years, our current interglacial has lasted longer than most. Notice that several previous interglacials (the spikes above the green line) have been a little warmer than the current one. That is a significant point to which we will return.

<sup>7</sup> Based on the Scotese Paleomap Project. Temperatures in the distant past are of course not well known, but certainly varied considerably. We know for example that trees grew and animals once roamed on Antarctica. Also that northern Europe has been under ice a mile thick. By comparison, the temperatures for the last million years are well known.

The final graph in this series shows the temperatures over the period of human history (at the same scale). While our early ancestors had to endure ice ages, human civilization has developed only since the beginning of the current interglacial period about 10,000 years ago. Clearly, the climate in which human civilization has developed has been remarkably stable in comparison to previous changes.

So, yes, "the climate has always changed" as the deniers like to repeat, but the changes in human history are nothing compared to what the Earth can do! Ashby's graph of the last 5000 years appears to show variability, but it shows us nothing of the real possibilities of Earth's climate changes.

But it is those possibilities that concern us now.

Of course, as deniers keep telling us, climate change in the past has been natural! But the clear message from climate change in the past is that while the climate over the period of human history has been unusually stable, Earth's climate is NOT inherently stable and can be pushed by relatively small triggers into **very different** states. What is worrying climate scientists is that many of these past triggers were much smaller than the trigger we are currently pulling – by pouring vast amounts of extra greenhouse gases into the atmosphere. And already the rate at which the climate is changing far exceeds any 'natural' change.

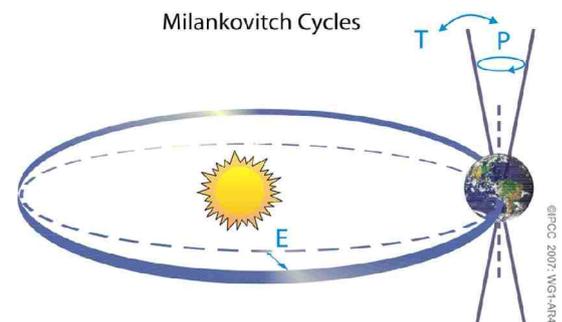
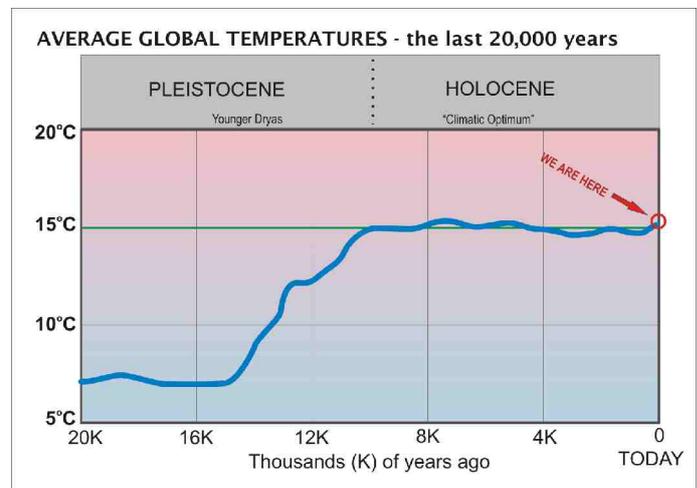
## CLIMATE TRIGGERS AND FEEDBACK

There are many possible triggers that have caused the climate swings that have occurred in the past. They include major catastrophes such as meteor impacts and massive volcanic activity as well as continental movements.

Of more relevance to our current situation, however, are more subtle changes such as the so called 'Milankovitch cycles'. These are small changes in the Earth's orbit which result in small changes in the amount and distribution of solar radiation over the Earth's surface. The swings between full ice ages and interglacials over the last million years are almost certainly the result of these cycles.

These small orbital changes, however, result in very small changes in the amount of solar radiation reaching the Earth's surface. Initially scientists were puzzled as to how such small changes in solar radiation could result in such major changes in the Earth's climate. The answer was found from studies of the air trapped in ice at the poles. It was found that the amount of greenhouse gases in the atmosphere varied closely with the temperatures. These gases (notably of course carbon dioxide) trap heat in the atmosphere by processes which have been very well known to physicists for the last century or more. Indeed, we know that if it weren't for the greenhouse effect the Earth would be a lifeless frozen snowball at around  $-18^{\circ}\text{C}$ !

The small extra warming from the Sun results in a slight warming of the oceans. This slight warming results in a decrease in the amount of carbon dioxide dissolved in the ocean and therefore an increase in the amount in the atmosphere. This extra greenhouse gas in the atmosphere traps heat which results in more warming of the ocean and hence still more carbon dioxide released. This type of process is called a 'positive feedback'. It can also be called an amplifying effect – initial small changes are amplified by factors which are themselves the result of the changes. The warming of the ocean also results in another major positive feedback. Water vapour, more of which is evaporated from warmer water, is also a major greenhouse gas and so this again adds to the warming. There is an important difference between carbon dioxide and water vapour however. Once released into the atmosphere  $\text{CO}_2$  stays there for around a century, while water vapour goes in and out of the atmosphere rapidly with the weather. For this reason  $\text{CO}_2$  is referred to as a 'forcing greenhouse gas' while water vapour is a 'feedback greenhouse gas'.





Ice reflects far more sunlight than water

Another important positive climate feedback is the melting of polar and glacial ice. Ice and snow reflect about 90% of the sunlight that falls on them while open water reflects only about 30%. As the ice melts, more sunlight is absorbed by the darker areas of sea and land – resulting in still more melting ice. This is one reason that the Arctic region seems to be warming faster than most of the planet at present.

Fortunately there are negative feedback effects as well – otherwise the Earth would simply get hotter and hotter. (It is worth noting that Venus does have a runaway greenhouse effect which has resulted in its surface temperature of over 450°C!)

One major negative feedback effect is the formation of clouds. Warmer water results in more evaporation and hence increased formation of clouds which reflect sunlight, reducing the heating. Cloud feedback is complex however, as there are both negative and positive feedbacks. Clouds also trap heat – as is obvious on cloudy nights as compared to clear ones.

So, while it was not greenhouse gases which triggered the glacial – interglacial cycles, it was greenhouse gases which amplified them. Which brings us to:

## ANOTHER DENIER DECEPTION:

### “CO<sub>2</sub> FOLLOWS TEMPERATURE RISES SO CAN'T CAUSE THEM”

Ashby presents a graph (similar to the one at right) called “Evidence of Ice Cores” in which he shows that, over the last few hundred thousand years, CO<sub>2</sub> levels rose after temperatures had started to rise. This, of course, is just as we would expect from our understanding of Milankovitch cycles and greenhouse feedback. Ashby, however, claims that this shows CO<sub>2</sub> did not cause the warming. This is simply another example of his deliberate deception. No, as we have seen, the CO<sub>2</sub> did not trigger the warming, **it amplified it.** Ashby must be aware of the science involved, but continues to use this thoroughly discredited denier argument. If he is not aware of the science he has no right to claim any understanding of the subject and should shut up.

Clearly, if increasing CO<sub>2</sub> levels **amplify** the greenhouse effect, increasing CO<sub>2</sub> levels could also **cause** an increase in the greenhouse effect. That is the relevant issue now.

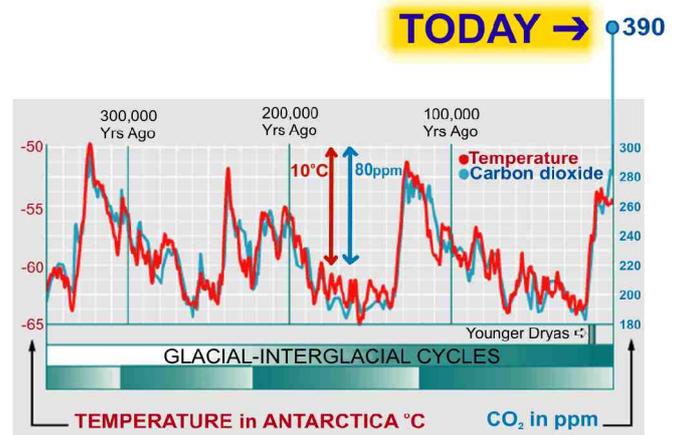
It is, in fact, quite probable that natural releases of greenhouse gases in the past have triggered climate changes. Notice those ups and downs in the temperatures about 50 million years ago. It is thought that some of those changes could well have been caused by natural greenhouse gas release – possibly from volcanic activity or the melting of ‘clathrates’ – frozen methane ice crystals which form from decaying plant matter in polar oceans.

## THE HUMAN TRIGGER

Certainly for 800,000 years (the period of the ice core record) and most likely for around 15 million years, the CO<sub>2</sub> level in the atmosphere has been less than about 300 ppm. Since we started burning fossil fuels the atmospheric concentration has increased to around 390 ppm now and is accelerating. In view of the strong link between temperature and CO<sub>2</sub> levels in the past, **it is madness to think that by increasing the level of a major greenhouse gas by over 35% we will not increase the greenhouse effect.**

For sure, we can't be certain of the exact amount of warming we will induce, but there are several techniques by which this can be estimated and scientists are working very hard to pin down the so called ‘sensitivity’ of the climate to greenhouse gas increases. The most likely estimate at present is that a doubling of CO<sub>2</sub> levels would cause at least a 3°C rise. If anything, current science is pointing to higher rather than lower degrees of sensitivity. Already, with the 35% rise of CO<sub>2</sub>, we have seen a 0.6°C rise and there is probably that much again ‘locked in’ for the next few decades because of the slow response of the ocean to temperature increases – and that is not counting continued increases in CO<sub>2</sub> which seem inevitable.

Simply looking at the ice core record (graph above) over the last few hundred thousand years suggests that an increase from 200 ppm to 280 ppm was associated with something like a 10°C rise in polar



temperatures. Another 100 ppm rise to 380 ppm would not induce a 10°C rise, but it certainly should give us cause for considerable concern! Knowing that the Earth has spent most of its history in the hothouse state – with temperatures at least 5°C hotter and sea levels 100 metres higher – should make us very wary of even the remote possibility of triggering changes which could well take us back to those conditions (even if over several centuries).

In fact we don't need to go back millions of years to see a warmer Earth. As can be seen on the graph above, the last interglacial was warmer than the current one. Probably only by two or three degrees, but that resulted in enough melted ice to raise sea levels several metres higher than today – enough to drown all major coastal cities and displace a billion people.

The big problem are those positive feedbacks. As polar ice continues to melt, positive feedbacks will accelerate the process. As polar areas thaw, frozen methane, an even more effective greenhouse gas than carbon dioxide, in the permafrost will be released at increasing rates – we know that this is already happening. As glaciers retreat more dark land is exposed and warming increases. As the ocean warms, still less CO<sub>2</sub> can be absorbed – and the chances of releasing enormous amounts of stored methane in the frozen clathrates increases. We know that once these processes begin accelerating there will be virtually no chance of reversing them. What we don't know is just how close we are to the trigger point.

## “GLOBAL WARMING STOPPED IN 1998.” OR DID IT?

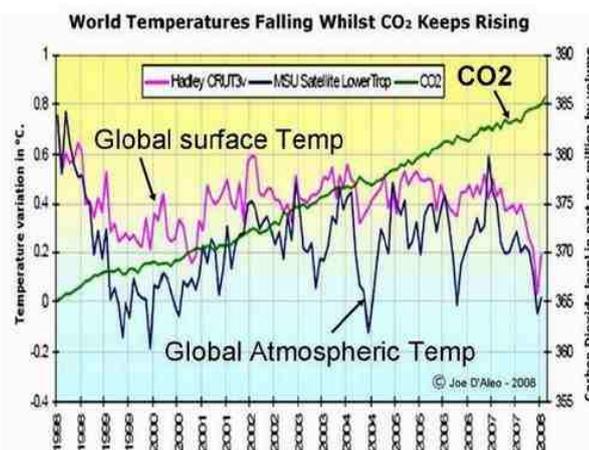
Ashby, and other deniers, are very keen to claim that the world is no longer warming, or that “Earth has been cooling since 1998”. To convince us of this we are shown various graphs, such as the one at right. As with most of these graphs we are shown a short time interval (10 years in this case) starting with the hottest year on record (1998). It is a classic case of “How to lie with statistics”. The fact that they have used every trick in that book should give us reason enough to believe that they have no genuine case.

Deniers are keen to tell us that every year since 1998 has been cooler. This is about as useful as the equally true statement that every year since 1999 has been hotter! Both these statements are blatant examples of ‘cherry picking’ data. The point is that short term trends (anything less than a decade) are so subject to other variations that they are meaningless.

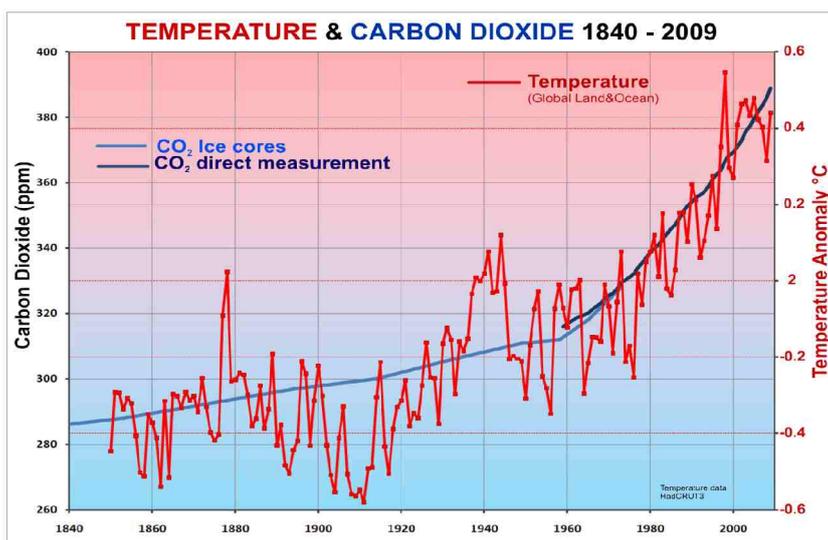
In fact we know why 1998 was the hottest year so far. It was in an exceptionally strong El Niño event and the sunspot cycle (a measure of solar radiation) was at a maximum. Both these factors have declined since 1998. We are now in a particularly low period of solar radiation and recent years have seen La Niña conditions. We should therefore have seen a drop in temperature. In fact, temperatures have not dropped, but have remained relatively constant – and much higher than those of the last decade.

No climate scientist has ever suggested that CO<sub>2</sub> levels are the **only** factor driving the climate – and of course deniers say the same thing. Despite this, the deniers consistently try to tell us that because the temperature doesn't exactly follow the CO<sub>2</sub> levels they are not related. Scientists have made it very clear that the warming trend of around 0.2°C per decade is often masked by short term fluctuations resulting from variations in the many other factors that affect weather. These include solar radiation, oscillations in ocean–atmosphere heat exchange patterns (such as El Niño - La Niña and other cycles) as well as natural events such as volcanoes. All these factors cause annual variations of up to **ten times** the annual warming trend.

For these reasons it makes no sense to look for the warming trend in anything less than decades (10 year). The graph, right, based on the same data as Ashby's shows the temperature and the carbon dioxide levels over a much longer period.



Ashby slide. Note: only 1998-2008 - each year is listed twice and monthly figures are used to make it look like a longer period



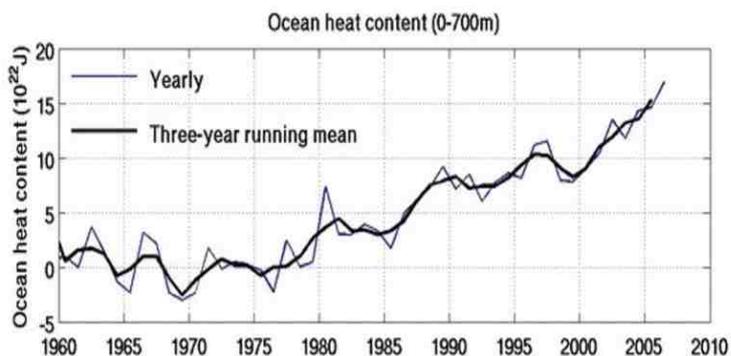
Ashby has taken the tiny little section from the top corner starting, of course, with 1998. Just imagine the difference it would make if his graph started with 1996! Three things are very clear from this graph. First, there is a **strong** relationship between the temperature rise and the CO<sub>2</sub> rise. Second, this last decade has been the hottest on record – **by a long way**. Third, natural temperature variation masks the obvious steady upward trend over anything less than a decade. You will also notice that to say that the warming trend has stopped since 1998 is simply absurd. Clearly 1998 was an exceptionally hot year (due to the conditions discussed earlier).

Ashby presents us with several other graphs claiming to show decreasing temperatures, stable sea levels and increasing Arctic sea-ice. They all suffer from the same problem – very short term fluctuations. **ALL graphs** of these quantities over reasonable time periods show the same trends – warming temperatures, rising sea levels and decreasing ice.

## WHAT TEMPERATURE GRAPHS DON'T TELL US ABOUT GLOBAL WARMING

While the graphs of surface or air temperatures indicate global warming, they don't actually tell us much about where all the heat is going! This is because it doesn't take a lot of heat to raise the temperature of air – which is why it goes up and down so much each day. On the other hand it takes an enormous amount of heat to increase the temperature of the world's oceans. This is actually where most of the extra heat trapped by the greenhouse gases is ending up. It is not easy to measure however. To accurately determine how much heat is stored in the oceans we need to know the temperatures at all depths in every ocean. New instruments are helping to collect better data, but we already have some fairly good indications.

The graph of total 'ocean heat content' at right is one produced by our own CSIRO and shows a very obvious upward trend. In Ashby's presentation he provides another short term graph (only 4 years) which was produced by a well known 'sceptic'<sup>8</sup>. Notice that it would also be easy to select a 4 year period from the CSIRO graph that showed a downward trend – but that would be in complete contradiction to the obvious general upward trend. Needless to say, all reliable estimates of the long term changes in total ocean heat content show the relentless upward rise that is clear on this graph<sup>9</sup>.



CSIRO graph of total ocean heat content 1960 - 2007

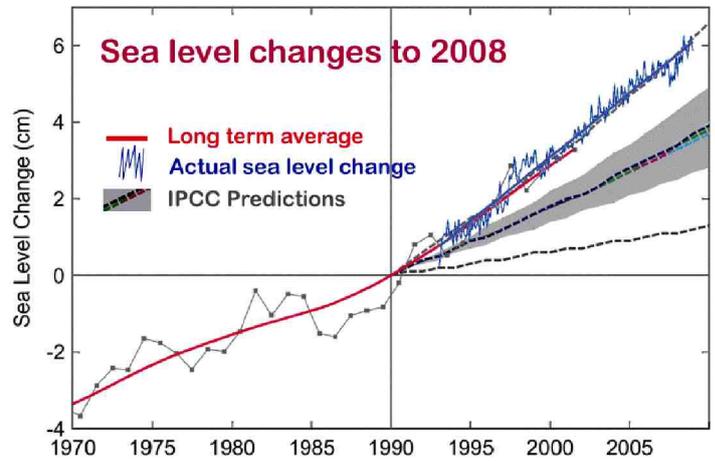
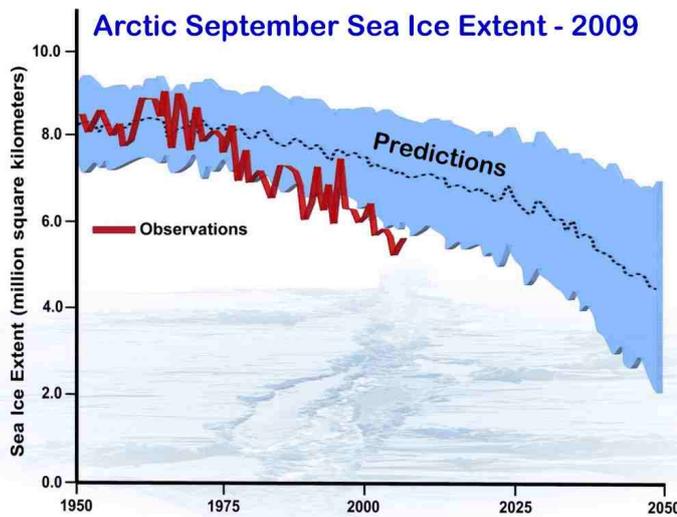
Again, we find that deniers will quote one very limited set of data which suits their purpose, when overwhelmingly the mass of data is pointing in the direction of accelerating, human caused climate change. In the huge mass of scientific data being produced on this subject there will always be some material which can be taken out of context and used to suggest conclusions opposite to those of the climate scientists. This has caused extreme frustration among scientists because it means that they can't openly discuss any problems with their data for fear of it being misused. This concern was what was behind much of the annoyance with 'sceptics' expressed in the recent leaked emails from the UK Climate Research Centre.

## RISING SEAS, FALLING ICE

The heat going into the ocean is not only warming the ocean, it is doing two other things which are critically important. First, it is expanding the ocean (all warm things expand) which results in sea level rise. Second, it is melting ice – particularly Arctic sea ice. Despite denier claims that sea level is not rising according to IPCC predictions and that sea ice is 'recovering', the long term trends are very clear – as can be seen in the graphs below (next page).

<sup>8</sup> Furthermore, the accuracy of his graph has been questioned by other scientists. See this website for a good discussion of Ashby's graph: [www.skepticalscience.com/cooling-oceans.htm](http://www.skepticalscience.com/cooling-oceans.htm)

<sup>9</sup> It is interesting that there was a downturn in this graph around 1998. That is not a coincidence - the heat was going into the atmosphere to make that a very hot year rather than into the ocean. That is what the ENSO (El Niño) cycle is about.

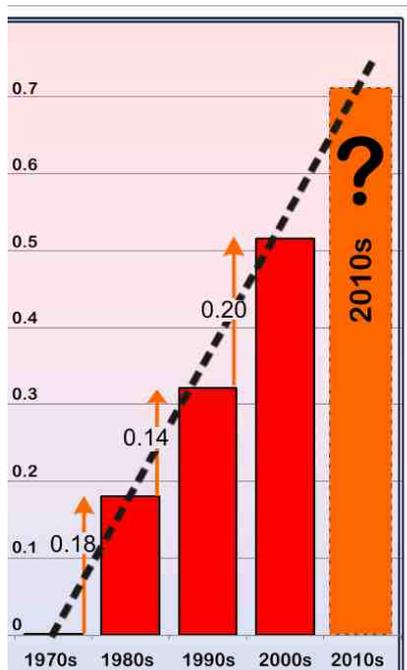


As can be seen in both these graphs<sup>10</sup>, the worry is that in fact both trends are actually **exceeding** the IPCC predictions. Ashby, however, would have us believe that the tiny little upturn at the end of the Arctic sea ice graph is “increasing back toward the average...opposite to predictions”. Oh, really?

## DENIAL IS DANGEROUS!

Most people have neither the time nor the expertise to look for themselves at the masses of science being published in this area and so when they come across claims that appear to be ‘scientific’, even if they doubt them, they are left with the impression that the ‘science is not settled’. The deniers don’t admit to the fact that what they are saying has often been taken out of context, usually by people with little understanding of the science, and comes from a very small section of a vast array of material, the bulk of which overwhelmingly gives us enormous cause for concern. All the deniers need to do is create confusion – that is easy, and they are doing it very effectively.

## GAMBLING WITH OUR FUTURE



The discussion about climate change is of much greater importance than virtually any other scientific issue which enters the public domain. At stake is nothing less than the future of humanity – the future of our children and grandchildren, not to mention ourselves. Ashby and other deniers are betting this future on the amazing idea that the trend which is so clearly visible in the decade temperature graphs (left) is suddenly going to stop (right).

We know why the temperature has been going up. To suggest that it is not the result of our addition to the atmosphere of a major greenhouse gas, when there is no other feasible reason, is very odd indeed. To hope that somehow the Earth won’t respond in the way it always has before is irresponsible to say the least.

It is one thing to have a view on climate change, it is quite another to have an informed view. But to publicly promulgate uninformed opinion about the future of our planet, contrary to the overwhelming scientific evidence, is extraordinarily dangerous.

*This document was prepared by Keith Burrows for ‘Science Teachers for Climate Awareness’ an initiative of the Australian Institute of Physics (Vic) Education Committee Feb 2010 It may be distributed freely provided the source is acknowledged and it is not used for commercial purposes.*

<sup>10</sup> The Arctic sea ice graph is based on an illustration by Steve Deyo, UCAR, based on research by NSIDC and NCAR. The sea level graph is from Climate Change: Global Risks, Challenges & Decisions Copenhagen March 2009 [www.climatecongress.ku.dk](http://www.climatecongress.ku.dk)