

The AGW Controversy

Many people believe there are two sides to the scientific debate regarding anthropogenic global warming, AGW denial and the AGW acceptance. This is mistaken. There is nothing scientific about the debate and it really isn't even a debate. And there are not just two sides. Even if we just consider the views of the group we notionally consider deniers there are many different opinions. Some deny that the Earth is warming. Some believe the Earth is warming but that it is due to natural causes. Some deny that carbon dioxide is a greenhouse gas and others accept this scientific reality. Some believe that the Earth is warming and it is because of human emissions but that the warming will be slight. Some believe that the Earth will warm a lot but that it will be good for us, opening the Northwest Passage, allowing access to arctic resources, increasing crop production, etc. The physicist Freeman Dyson understands that the Earth is warming, that it is caused by human emissions and that it may be bad for us but that some yet to be discovered human invention, such as genetically modified carbon eating trees, will save the day in the nick of time and therefore early action which he believes will hurt the economy is unnecessarily.

Some deniers such as the ex-tobacco lobbyist S. Fred Singer once introduced as both the leader of scientists, who do not believe the Earth is warming and in the same introduction as the leader of those scientists who believe the warming is due to natural causes, seemingly believe in all of the above despite the obvious self-contradiction and inconsistency. He also testified on behalf of the tobacco industry that second hand smoke is not harmful.

The Science historian Naomi Oreskes observes that what unites global warming deniers, Dyson included, despite the myriad differences of contradictory opinion is not agreement on the science and certainly not a consistent scientific hypothesis but an ideological belief, a secular religion, opposed to all forms of government regulation of big business.

Dyson believes, curiously enough, that environmentalism and concern for global warming is also a new secular religion. There may be a few environmentalists whose concern about global warming approaches religious fervor but they don't have much money, little power and no influence whereas those whose opposition to government regulation is a matter of secular religious ideology have considerable money, power, organization and influence. Both observations may be right but only the latter is dangerously so.

At any rate, the expert witness of choice for the deniers is not the accomplished and very credible physicist Dyson but the novelist Michael Crichton who famously places T. Rex (68-65 Mya) and the turkey sized Velociraptor (83-70 Mya) both Cretaceous Period (145-65 Mya) dinosaurs in the Jurassic (200-145 Mya), proving that even his titles are scientifically inaccurate. One denier explained to me, "but, that was fiction." Yes inventing fantasy is what the guy does for a living and he is very good at it. (Mya = million years ago)

Putting aside fiction, what the debate needs to be about is the science of AGW theory. Otherwise, we are two disparate groups talking passed each other. Realists and critical thinkers struggle to understand climate physics and AGW reality, with no preconceived notions, and want to shape policy to address that scientific reality. Ideologues are concerned only with opposing government regulation, and distort the science to fit a predetermined policy. What kind of debate is that?

While we can dismiss scientifically confused deniers such as Crichton and Singer, it may be useful to examine Dyson's opinions as he at least holds views which appear to be consistent with scientific reality.

In an article, which was not peer-reviewed, published in the New York Times Review of Books, Dyson offers three unscientific arguments to justify opposition to government action on AGW and, quite remarkable for a physicist, no scientific arguments at all. He points out scientific consensus has been overturned by unpopular scientific views in the past and therefore other unpopular views, specifically AGW denial, may also be right.

By example, Alfred Wegener's well defined and consistent theory of plate tectonics, published in 1924 was not well received at first and replaced scientific orthodoxy only after fifty years of accumulated supporting scientific evidence. But this experience does not say anything at all about the correctness of other unpopular opinions especially those like AGW denial that are ill defined and inconsistent. By another example, Nobel Laureate Svente Arrhenius first postulated a well-defined and consistent theory of AGW in 1896 and this minority view did not become the consensus until 80 years later after an extraordinary accumulation of supporting scientific evidence. So yes occasionally unpopular scientific views overturn the consensus.

Interestingly, complex eukaryotic life, like Homo sapiens (people), would not exist on Earth at all were it not for plate tectonics and the fact that carbon dioxide is a greenhouse gas. Wegener's theory of plate tectonics and Arrhenius' theory of atmospheric carbon dioxide driven climate are linked by the rock-carbon cycle, which Robert Berner describes as the Earth's thermostat. This cycle operates over millions of years and maintains the Earth's temperature between remarkably narrow bounds consistent with liquid water on our planet's surface by balancing volcanism, metamorphism and diagenesis with mountain weathering and organic carbon burial (Berner, 2005).

Dyson's first argument is thus flipped on its head.

Dyson next argues that government action addressing AGW would hurt the economy. Dyson assumes that the economy will grow at a 4% rate over the next century and that this accumulated wealth will enable our grand children to be able to afford to clean up our mess. This argument may be irresponsible, selfish and rather spurious economics at best but it is not science at all. Drug addicts apply the same deep discount to the future as AGW deniers to justify their habits, too. In reality, the International Energy Agency in a recent report estimates the cost associated with limiting atmospheric carbon dioxide to 450 ppmV (the consensus-view maximum value we can let it reach if we are to avoid

catastrophic climate change) as about 1.1% of GDP per year. For the US, this would be less than the cost of the Iraq War. But the IEA is quick to point out in the same report that this cost is not an unnecessary expense like the war but a necessary investment in alternative energy, energy security, jobs creation, and the health and welfare of future generations.

Economic arguments mistakenly, and rather egotistically, assume the paper we print has real value beyond the next hyperinflationary event. When President Bush took office, 82 cents purchased a Euro and now it takes \$1.60, which suggests that US inflation is really averaging about 10%. Energy, not money, is the currency of society and nature.

Dyson finally actually does propose that humans will invent carbon eating trees (I was not kidding) some time in the future which will reduce atmospheric carbon, assuming that we don't cut them down and burn them for fuel. In fact, trees are already extremely good at carbon capture as demonstrated by the grand performance of the first gymnosperms (ancestors of pines and firs) during the Carboniferous (350-300 Mya) in reducing atmospheric carbon from thousands of ppmV (parts per million by Volume), which was the case during the hot house Devonian, more than an order of magnitude to hundreds of ppmV causing an ice age similar to Pleistocene climate (1.8 Mya to 10,000 years ago). These first trees also succeeded in raising oxygen levels to more than 30% of the volume of atmospheric gases.

However, human caused deforestation is contributing 14% or about 1.4 GtC (Billion tons Carbon) to annual human emissions. We don't need a better tree. We need to become more responsible with the trees we have. Or perhaps another way to look at it from the perspective of nature is that it is not trees which need genetic re-engineering perhaps but humans.

Healthy skepticism drives scientific advancement, but believing unquestioningly in a work of fiction (Crichton's State of Fear) and a rigid ideological orthodoxy (opposition to any form of central planning which does not benefit the already wealthy) is not skepticism but mental rigor mortise.

Climate physics is hard core difficult science involving fluid dynamics, thermodynamics, geology, paleontology, biology, chemistry, astrophysics, biophysics and indirectly all observational sciences and lots of mathematics. Svente Arrhenius' Theory of Anthropogenic Global Warming is entirely consistent with all of science.

To understand the problem, it is useful to review the numbers. During the Last Glacial Maximum, 18,000 years ago, there was 400 GtC in the atmospheric or about 190 ppmV (parts per million by Volume). Earth was 5 degrees Celsius cooler at the time. In 1850, the atmosphere contained 580 GtC, equivalent to 280 ppmV. Today the atmosphere contains 810 GtC or 387 ppmV. We have emitted via fossil fuel combustion about 340 GtC since the start of the industrial revolution. This cumulative number does not include cement manufacture, currently about 800 MtC (million tons carbon) or deforestation, currently about 1.4 GtC.

David Rutledge of CalTech estimates that we have the equivalent of 540 GtC of fossil fuel reserves remaining, which will only raise the atmospheric carbon level to about 460 ppmV in 2070, assuming the climate response is linear. This is the most optimistic estimate if one is concerned about AGW and the most pessimistic estimate if one is concerned about running out of energy from oil, natural gas and coal, society's currency. Either future is bleak assuming we continue to ignore these problems but they do share the same solution space if we choose to do something proactive about them. It does point out the absurdity of Dyson's argument that we can just go on growing the economy at 4% per year by ignoring these problems and expect to leave future generations the wherewithal to pay for our depravity. Energy potential from fossil fuels is not growing at 4% per annum. The IEA is worried about energy availability, and considers spending 1.1% of our GDP on a solution for both is quite rightly a bargain. Dyson asks the wrong question. We should not ask whether we can afford investing 1.1% of GDP in our future but whether we can afford not to.

Even assuming Rutledge's "optimistic" numbers, we have to consider deforestation, which amounts to about 1.4 GtC per year or more than 50 Gt by 2050. Can you see that accelerating as we run out of fossil fuels? Furthermore, there is over 1000 GtC locked up in the permafrost and that is already starting to thaw much earlier than the global climate models are predicting. This carbon is not included in Rutledge's analysis or the IPCC scenarios. As a matter of fact, even the direst simulations do not yet include the positive feedback from permafrost. Some combination of deforestation, permafrost and ocean productivity loss can easily lead to atmospheric carbon levels between 600 and 1500 ppmV, even without a methane hydrate burp, as is believed to have happened during the Paleocene-Eocene Thermal Maximum (PETM), 55 Mya. The Earth might then have the hot house climate it had during the Eocene when there was no polar ice. Sea level would be about 80 meters higher than today. This might take a few centuries of course, but it would be an inevitable expensive and complex engineering problem for those poor sots who inherit the Earth after us, especially without fossil fuels.

What we need to do then, is forget about all the superfluous, distracting and rather meaningless arguments against action, and discuss reality and alternatives. What is the actual human condition in raw hard scientific terms and what are we going to do about it today?