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From The Sunday Times

October 18, 2009

## Superfreakonomics: Everything you know about Global Warming is wrong

**Steven Levitt and Stephen Dubner, authors of the bestselling Freakonomics, are back to challenge more accepted views. This time they claim that CO2 may be good, trees are harmful and a giant hosepipe in space could save the planet**



IMAGE :1 of 3

6 COMMENTS | RECOMMEND? (8)

In a nondescript suburb of Seattle there's a charmless and windowless building that used to be a Harley-Davidson repair shop. A sheet of paper taped to the door reads "Intellectual Ventures". Inside is one of the most unusual laboratories in the world. There are lathes and mould makers and 3-D printers, many powerful computers and a fish tank for zapping malarial mosquitoes with lasers.

Intellectual Ventures (IV) is an invention company. Scientists and puzzle solvers of every variety dream up processes and products and file patent applications, more than 500 a year.

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Nathan Myhrvold — a polymath who as a young man did quantum cosmology research at Cambridge with Stephen Hawking — co-founded IV nine years ago. Myhrvold, now 50, recalls watching Doctor Who when he was young: “The Doctor introduces himself to someone who says, ‘Doctor? Are you some kind of scientist?’ And he says, ‘Sir, I am every kind of scientist’. And I was, like, yes! Yes! That is what I want to be: every kind of scientist!”

He did so by playing a variety of roles at Microsoft: futurist, strategist, founder of its research lab and whisperer-in-chief to Bill Gates. “I don’t know anyone I would say is smarter than Nathan,” Gates, an investor in IV, once observed.

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In 1999, when he left Microsoft, Myhrvold appeared on the Forbes list of the 400 richest Americans. At the same time he is famously penny-pinching. As he walks through the IV lab pointing out his

favourite gadgets, his greatest pride is reserved for items he bought on eBay or at bankruptcy sales. He is a firm believer that solutions should be cheap and simple whenever possible.

His small group of scientists and engineers has sent satellites to the moon, helped defend the United States against missile attack and, via computing advances, changed the way the world works. They have also conducted definitive research in many fields, including climate science. So it was only a matter of time before they began thinking about climate change.

On the day we visit IV, Myhrvold convenes roughly a dozen of his colleagues to talk about possible solutions to global warming. They sit around a long oval conference table, Myhrvold near one end. And more than 10 hours later we emerge having heard the most extraordinary but convincing proposal.

Everyone in the room agrees that the Earth has been getting warmer and human activity probably has something to do with it. But they also agree that the standard global warming rhetoric is oversimplified and exaggerated.

Too many accounts, Myhrvold says, suffer from “people who get on their high horse and say that our species will be exterminated”.

When Al Gore’s film, An Inconvenient Truth, is mentioned, the table erupts in a sea of groans. The film’s purpose, Myhrvold believes, was “to scare the crap out of people”. Although Gore “isn’t technically lying”, he says, some of the nightmare scenarios Gore describes — the state of Florida disappearing under rising seas, for instance — “don’t have any basis in physical reality in any reasonable time frame. No climate model shows them happening”.

But the scientific community is also at fault. The current climate prediction models are, as Lowell Wood puts it, “enormously

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crude". Wood is a heavy-set and spectacularly talkative astrophysicist in his sixties who long ago was Myhrvold's academic mentor. (Wood himself was a protégé of the physicist Edward Teller.) Myhrvold thinks Wood is one of the smartest men in the universe.

Off the top of his head, Wood seems to know quite a bit about practically anything: the melt rate of the Greenland ice core (80 cubic kilometres per year); the percentage of unsanctioned Chinese power plants that went online in the previous year (about 20%); the number of times that metastatic cancer cells travel through the bloodstream before they land ("as many as a million").

Wood has achieved a great deal in science on behalf of universities, private firms and the US government. He worked on the "Star Wars" missile defence system. Today he is wearing a rainbow tie-dyed short-sleeved shirt with a matching tie.

"The climate models are crude in space and they're crude in time," he continues. "So there's an enormous amount of natural phenomena they can't model. They can't do even giant storms like hurricanes."

There are several reasons for this, Myhrvold explains. Today's models use a grid of cells to map the Earth and those grids are too large to allow for the modelling of actual weather. Smaller and more accurate grids would require better modelling software, which would require more computing power.

"We're trying to predict climate change 20 to 30 years from now," he says, "but it will take us almost the same amount of time for the computer industry to give us fast enough computers to do the job."

Most current climate models tend to produce similar predictions. This might lead one to conclude that climate scientists have a pretty good handle on the future. Not so, says Wood.

"Everybody turns their knobs" — that is, adjusts the control parameters and coefficients of their models — "so they aren't the outlier, because the outlying model is going to have difficulty getting funded."

In other words, the economic reality of research funding, rather than a disinterested and uncoordinated scientific consensus, leads the models to approximately match one another.

As Wood, Myhrvold and the other scientists discuss the various conventional wisdoms surrounding global warming, few, if any, survive unscathed.

The emphasis on carbon dioxide? "Misplaced," says Wood. Why? "Because carbon dioxide is not the major greenhouse gas. The major greenhouse gas is water vapour." Current climate models "do not know how to handle water vapour and various types of clouds. That is the elephant in the corner of this room. I hope we'll have good numbers on water vapour by 2020 or thereabouts".

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Myhrvold cites a recent paper asserting that carbon dioxide may have had little to do with recent warming. Instead, all the heavy particulate pollution we generated in earlier decades seems to have cooled the atmosphere by dimming the sun. That sparked a brief panic over global *cooling* in the 1970s. The trend began to reverse when we started cleaning up our air.

“So most of the warming seen over the past few decades,” Myhrvold says, “might actually be due to good environmental stewardship.”

Not so many years ago schoolchildren were taught that carbon dioxide is the naturally occurring lifeblood of plants. Today children are more likely to think of carbon dioxide as a poison. That’s because the amount in the atmosphere has increased substantially over the past century from about 280 parts per million to 380.

What people don’t know, the IV scientists say, is that the carbon dioxide level 80m years ago — when our mammalian ancestors were evolving — was at least 1,000 parts per million. That same concentration, in fact, is the regulation standard inside new energy-efficient office buildings.

So not only is carbon dioxide plainly not poisonous, but changes in carbon dioxide levels don’t necessarily mirror human activity. Nor does atmospheric carbon dioxide necessarily warm the Earth: ice-cap evidence shows that over the past several hundred thousand years, carbon dioxide levels have risen *after* a rise in temperature, not the other way around.

Beside Myhrvold sits Ken Caldeira, a soft-spoken man with a boyish face and a halo of curly hair. He runs an ecology lab at Stanford University for the Carnegie Institution. Caldeira is among the most respected climate scientists in the world, his research cited approvingly by the most fervent environmentalists. He contributes research to the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel peace prize with Al Gore for sounding the alarm on global warming. (Yes, Caldeira got a Nobel certificate.) If you met Caldeira at a party, you would likely place him in the fervent environmentalist camp himself. He remains thoroughly convinced that human activity is responsible for some global warming and is more pessimistic than Myhrvold about how future climate will affect humankind.

Yet his research tells him that carbon dioxide is not the right villain in this fight. For starters, as greenhouse gases go it’s not particularly efficient.

“A doubling of carbon dioxide traps less than 2% of the outgoing radiation emitted by the Earth,” he says.

Caldeira mentions a study he undertook that considered the impact of higher carbon dioxide levels on plant life. While plants get their water from the soil, they get their food — carbon dioxide — from the air.

“Plants pay exceedingly dearly for carbon dioxide,” Wood jumps in. “A plant has to raise about a hundred times as much water from the soil as it gets carbon dioxide from the air, on a molecule-lost-per-molecule-gained basis. Most plants, especially during the active part of the growing season, are water-stressed. They bleed very seriously to get their food.”

So an increase in carbon dioxide means plants require less water to grow. Caldeira’s study showed that doubling the amount of carbon dioxide while holding steady all other inputs — water, nutrients and so forth — yields a 70% increase in plant growth, an obvious boon to agricultural productivity.

“That’s why most commercial hydroponic greenhouses have supplemental carbon dioxide,” Myhrvold says. “And they typically run at 1,400 parts per million.”

“Twenty thousand years ago,” Caldeira says, “carbon dioxide levels were lower, sea level was lower — and trees were in a near state of asphyxiation for lack of carbon dioxide. There’s nothing special about today’s carbon dioxide level, or today’s sea level, or today’s temperature. What damages us are rapid rates of change. Overall, more carbon dioxide is probably a good thing for the biosphere — it’s just that it’s increasing too fast.”

The gentlemen of IV abound with further examples of global warming memes (ideas that replicate across society) that are all wrong.

Rising sea levels, for instance, “aren’t being driven primarily by glaciers melting”, Wood says, no matter how useful that image may be for environmental activists. The truth is far less sexy: “It is driven mostly by water warming — literally, the thermal expansion of ocean water as it warms up.”

Sea levels have been rising, Wood says, for roughly 12,000 years since the end of the last ice age. The oceans are about 425ft higher today, but the bulk of that rise occurred in the first thousand years. In the past century the seas have risen less than 8in.

Rather than the catastrophic 30ft rise some people have predicted over the next century, Wood notes that the most authoritative literature on the subject suggests a rise of about 1½ft by 2100. That’s much less than the twice-daily tidal variation in most coastal locations.

“So it’s a little bit difficult,” he says, “to understand what the purported crisis is about.”

Caldeira, with something of a pained look on his face, mentions a most surprising environmental scourge: trees. Yes, trees. As much as Caldeira personally lives the green life — his Stanford office is cooled by a misting water chamber rather than air-conditioning — his research has found that planting trees in certain locations exacerbates warming because dark leaves

absorb more incoming sunlight than, say, grassy plains, sandy deserts or snow-covered expanses.

Then there is this little-discussed fact about global warming: while the drumbeat of doom has grown louder over the past several years, the average global temperature has in fact decreased.

In the darkened conference room, Myhrvold cues up an overhead slide that summarises IV's views of current proposed global warming solutions. The slide says:

- Too little Too late Too optimistic

Too little means that typical conservation efforts simply won't make much of a difference. "If you believe there's a problem worth solving," Myhrvold says, "then these solutions won't be enough to solve it. Wind power and most other alternative energy things are cute, but they don't scale to a sufficient degree. At this point wind farms are a government subsidy scheme, fundamentally."

What about the beloved Toyota Prius and other low-emission vehicles? "They're great," he says, "except that transportation is just not that big a sector."

Also, coal is so cheap that trying to generate electricity without it would be economic suicide, especially for developing countries.

Myhrvold argues that cap-and-trade agreements, whereby coal emissions are limited by quota and cost, can't help much, in part because it is already . . .

Too late. The half-life of atmospheric carbon dioxide is roughly 100 years and some of it remains in the atmosphere for thousands of years. So even if humankind immediately stopped burning all fossil fuel, the existing carbon dioxide would remain in the atmosphere for several generations.

And by the way, that zero-carbon society you were dreamily thinking about is way . . .

Too optimistic. "A lot of the things that people say would be a good thing probably aren't," Myhrvold says.

As an example he points to solar power. "The problem with solar cells is that they're black, because they are designed to absorb light from the sun. But only about 12% gets turned into electricity and the rest is re-radiated as heat — which contributes to global warming."

The energy consumed in building thousands of new solar cell factories would also create a huge long-term "warming debt".

"Eventually we'd have a great carbon-free energy infrastructure but only after making emissions and global warming worse every year until we're done building out the solar plants, which could take 30 to 50 years," says Myhrvold.

But what happens if the doomsayers turn out to be right? What if the Earth is becoming dangerously warmer, whether because of our fossil fuel profligacy or some natural climate cycle? We don't really want to sit back and stew in our own juices, do we?

Myhrvold, Wood and Caldeira have developed a cunning plan.

Even as a kid, Myhrvold was fascinated by geophysical phenomena — volcanoes, sunspots and the like — and their history of affecting the climate. In 1815, the gargantuan eruption of Mt Tambora in Indonesia produced “the year without a summer”, a worldwide disaster that killed crops and prompted widespread starvation and food riots. As Myhrvold puts it: “All really big ass volcanoes have some climate effects.”

The typical volcano sends sulphur dioxide into the troposphere, the atmospheric layer closest to the Earth's surface. This is similar to what a coal-burning power plant does with its sulphur emissions. In both cases the gas stays in the sky only a week or so before falling back to the ground as acid rain.

But a “big ass” volcano shoots sulphur dioxide far higher into the stratosphere. That's the layer that begins at about seven miles above the Earth's surface, or six miles at the poles. Above that threshold altitude, the sulphur dioxide absorbs stratospheric water vapour and forms an aerosol cloud that circulates rapidly, blanketing most of the globe.

That's what happened in 1991 when Mt Pinatubo erupted in the Philippines. It put more sulphur dioxide into the stratosphere than any volcano since Krakatoa, more than a century earlier. The atmospheric after-effects were undeniable: a decrease in ozone, more diffuse sunlight and a sustained drop in global temperature.

Myhrvold, then working at Microsoft, followed the scientific literature on the Pinatubo climate effects. One year later he read the 900-page report from the US National Academy of Sciences (NAS) called Policy Implications of Greenhouse Warming. This included a chapter on geoengineering, which the NAS defined as “large-scale engineering of our environment in order to combat or counteract the effects of changes in atmospheric chemistry”. In other words: if human activity is warming up the planet, could human ingenuity cool it down?

The NAS report raised the possibility of intentionally spreading sulphur dioxide in the stratosphere. After Pinatubo there was no doubt that stratospheric sulphur dioxide cooled the Earth. But wouldn't it be nice not to have to rely on volcanoes to do the job?

Unfortunately, the proposals for getting sulphur dioxide into the stratosphere were complex, costly and impractical. Loading up artillery shells, for instance, and firing them into the sky.

Or launching a fleet of fighter jets with high-sulphur fuel and letting their exhaust paint the stratosphere.



“It was more science fiction than science,” says Myhrvold. “None of the plans made any economic or practical sense.”

Many scientists, particularly nature-friendly ones such as Caldeira, found the idea abhorrent. Dump chemicals in the atmosphere to reverse the damage caused by . . . dumping chemicals in the atmosphere? It was a crazy, hair-of-the-dog scheme that seemed to violate every tenet of environmentalism.

After hearing Wood give a lecture on stratospheric sulphur dioxide, Caldeira also thought it simply wouldn't work. However, being a scientist who prefers data to dogma he ran a climate model to test Wood's claims.

“The intent,” he says, “was to put an end to all the geoengineering talk.”

He failed. As much as Caldeira disliked the concept, his model backed up Wood's claims that geoengineering could stabilise the climate even in the face of a large spike in atmospheric carbon dioxide — and he wrote a paper saying so. Caldeira, the most reluctant geoengineer imaginable, became a convert — willing, at least, to explore the idea.

Which is how it comes to pass that Caldeira, Wood and Myhrvold are huddled together in the former Harley-Davidson repair shop showing off their scheme to stop global warming.

IT wasn't just the cooling potential of stratospheric sulphur dioxide that surprised Caldeira. It was how little was needed to do the job: about 34 gallons per minute, not much more than the amount of water that comes out of a heavy-duty garden hose.

Warming is largely a polar phenomenon, which means that high latitude areas are four times more sensitive to climate change than the equator. By IV's estimations, 100,000 tons of sulphur dioxide per year would effectively reverse warming in the high Arctic and reduce it in much of the northern hemisphere.

That may sound like a lot but, relatively speaking, it is a smidgeon. At least 200m tons of sulphur dioxide already go into the atmosphere each year, roughly 25% from human sources such as motor vehicles and coal-fired power plants, 25% from volcanoes and the rest from other natural sources such as sea spray.

So all that would be needed to produce a globe-changing effect is one-twentieth of 1% of current sulphur emissions, simply relocated to a higher point in the sky. How?

Once you eliminate the moralism and the angst, the task of reversing global warming boils down to a straightforward engineering problem: how to get 34 gallons per minute of sulphur dioxide into the stratosphere. The answer: a garden hose to the sky.

For anyone who loves cheap and simple solutions, things don't get much better. Here's how it would work. At a base station sulphur would be burnt into sulphur dioxide and then liquefied.



The hose, stretching from the base station into the stratosphere, would be about 18 miles long but extremely light, its diameter just a couple of inches.

It would be suspended from a series of high-strength helium-filled balloons fastened to it at 100 to 300-yard intervals (a “string of pearls”, IV calls it), ranging in diameter from 25ft near the ground to 100ft near the top.

The liquefied sulphur dioxide would be sent skyward by a series of pumps, fixed to the hose every 100 yards. These, too, would be relatively light, about 45lb each — “smaller than the pumps in my swimming pool”, Myhrvold says.

There are several advantages to using many small pumps rather than one monster pump at the base station: a big ground pump would create more pressure, which would require a far heavier hose; even if a few of the small pumps failed, the mission itself wouldn't; and using small standardised units would keep costs down.

At the end of the hose, a cluster of nozzles would spritz the stratosphere with a fine mist of colourless liquid sulphur dioxide. Thanks to stratospheric winds that typically reach 100mph, the spritz would wrap around the Earth in roughly 10 days.

Because stratospheric air naturally spirals toward the poles, and because the Arctic regions are more vulnerable to global warming, it makes sense to spray the sulphur aerosol at high latitude — with perhaps one hose in the southern hemisphere and another in the northern.

Myhrvold, in his recent travels, happened upon one potentially perfect site. Along with Gates and Warren Buffett, the American investor, he was taking a whirlwind educational tour of various energy producers — a nuclear plant, a wind farm and so on.

One of their destinations was the Athabasca oil sands in northern Alberta, Canada. Billions of barrels of petroleum can be found there, but it is heavy, mucky crude mixed in with the surface dirt. You scoop up gigantic shovels of earth and then separate the oil from it.

One of the most plentiful waste components is sulphur, which commands such a low price that oil companies simply stockpile it. “There were big yellow mountains of it, like a hundred metres high by a thousand metres wide,” says Myhrvold. “So you could put one little pumping facility up there and with one corner of one of those sulphur mountains you could solve the whole global warming problem for the northern hemisphere.”

It is a fiendishly simple plan and startlingly cheap. IV estimates a “save the poles” project could be set up in just two years at a cost of roughly \$20m, with an annual operating cost of about \$10m.

If cooling the poles alone proved insufficient, IV has drawn up a “save the planet” version, with five worldwide base stations instead of two and three hoses at each site. This would put

about three to five times the amount of sulphur dioxide into the stratosphere. Even so, that would still represent less than 1% of current worldwide sulphur emissions.

IV estimates this plan could be up and running in about three years, with a start-up cost of \$150m and annual operating costs of \$100m. It could effectively reverse global warming at a total cost of \$250m.

Nicholas Stern, the economist who prepared an encyclopedic report on global warming for the British government, suggested we spend 1.5% of global GDP each year — that would be a \$1.2 trillion bill today — to attack the problem.

By comparison, IV's idea is practically free. It would cost \$50m less to stop global warming than Gore's foundation is paying just to increase public awareness about global warming.

Would it work? The scientific evidence says yes. Perhaps the stoutest scientific argument in favour of it came from Paul Crutzen, a Dutch atmospheric scientist whose environmentalist bona fides run even deeper than Caldeira's — he won a Nobel prize for his research on atmospheric ozone depletion.

In 2006 he wrote an essay in the journal *Climatic Change* lamenting the "grossly unsuccessful" efforts to emit fewer greenhouse gases and acknowledging that an injection of sulphur in the stratosphere "is the only option available to rapidly reduce temperature rises and counteract other climatic effects".

Crutzen's embrace of geoengineering was considered such a heresy within the climate science community that some of his peers tried to stop the publication of his essay. How could the man reverently known as "Dr Ozone" possibly endorse such a scheme? Wouldn't the environmental damage outweigh the benefits?

Actually, no. Crutzen concluded that damage to the ozone would be minimal. The sulphur dioxide would eventually settle out in the polar regions but in such relatively small amounts that significant harm was unlikely.

Perhaps the single best objection to the garden hose idea is that it is too simple and too cheap. There is no regulatory framework to prohibit anyone — a government, a private institution, even an individual — from putting sulphur dioxide in the atmosphere. Still, Myhrvold admits that "it would freak people out" if someone unilaterally built the thing.

Of course, this depends on the individual. If it were Gore, he might snag a second Nobel prize.

Myhrvold is not arguing for an immediate deployment of the sulphur shield but, rather, that technologies like it be researched and tested so they are ready to use if the worst climate predictions come true. He is also eager to get geoengineering moving forward because of what he sees as "a real head of steam" that global warming activists have gathered in recent years.

“They are seriously proposing doing a set of things that could have enormous impact — and we think probably negative impact — on human life,” he says. “They want to divert a huge amount of economic value toward immediate and precipitous anti-carbon initiatives, without thinking things through.

“This will have a huge drag on the world economy. There are billions of poor people who will be greatly delayed, if not entirely precluded, from attaining a First World standard of living.”

Certain new ideas, no matter how useful, are invariably seen as repugnant. The hosepipe may simply be too repugnant a scheme ever to be given a chance. Intentional pollution? Futzing with the stratosphere? Putting the planet’s weather in the hands of a few arrogant souls from Seattle?

It is one thing for climate heavyweights such as Crutzen and Caldeira to endorse such a solution. But they are mere scientists. The real heavyweights in this fight are people like Gore.

And what does he think of geoengineering?

“In a word,” Gore says, “I think it’s nuts.”

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**Neil Linaker wrote:**

Pumping sulphur dioxide into the stratosphere? Paul Crutzen's contribution clinches it, for me

Research and test viability

November 14, 2009 9:17 PM GMT

RECOMMEND?

**Jonnie Marbles wrote:**

Is anybody going to be particularly surprised when this "solution" disappears again, or is discredited, not long after Copenhagen?

November 13, 2009 2:10 AM GMT

RECOMMEND?

**Mark McLaughlin wrote:**

I followed up on the source of their sulfur idea... It is from this book:  
<http://www.nap.edu/openbook.php?isbn=0309043867>

It only has text OCR'd from the original book so it is a bit hard to read. I don't think it claims at all that it would be a fix. It was part list of many ideas that MIGHT help.

Of course whatever these guys have said it is filtered through this article, but from what is reported I'm not sure how they jumped from that idea to the conclusion it would be a fix. I'd assert that the reasoning is weak too. The article implies that it should have a greater effect by shooting it into the air just in the polar regions because it would have a greater effect there. However the original theory was that it would help by reflecting light from the sun. I'm not sure how much reflection would come into play in the polar regions.

It might, but work but it is just a theory. Also think about the longer term... If it does work, great. Does that mean we can continue to pump more heat into the system? Then what? Put more SO<sub>2</sub> into the atmosphere? You can't just keep pumping more crap into the atmosphere indefinitely. You need to stop causing the problem in the first place. This is the real point - we need to get off the carbon economy anyway.

November 1, 2009 10:29 PM GMT

RECOMMEND?

**Don Lewis wrote:**

What an interesting excerpt, all hinging on an apparent consensus at IV; for existing global warming solutions it is 'Too little Too late Too optimistic'. Is that what the readers of this article were expected not to know? or is it that plants use carbon dioxide? or is that heating the oceans will cause them to expand? or is it that all the lands in Florida won't disappear in the next few decades? The freakogens won't even present a straw man, but seem to be content to hack away at straw children.

Caldeira actually believes reduction of carbon dioxide emissions is the most effective way to reduce the risk of a global warming crisis.

[http://www.ciw.edu/news/global\\_sunscreen\\_won\\_t\\_save\\_corals](http://www.ciw.edu/news/global_sunscreen_won_t_save_corals)

But I guess that view won't sell many books for the Freakonomics boys.

October 19, 2009 9:43 PM BST

RECOMMEND? (3)

**Pete Ridley wrote:**

Thank you for at long last presenting opinion from the other side of the debate about The (significant human-made global climate change) Hypothesis. It is long overdue but timely, taking into consideration the UN-inspired propaganda being blasted out by the media ahead of the December Climate Change Conference in Copenhagen.

A couple of years ago you had an article summarising Mark Lynas's propaganda booklet "Six Degrees .." but made no mention of the distortions and misrepresentations within it. After reading your article then I was rather concerned about the future,

to say the least. I subsequently researched the subject and soon realised that the entire global warming/fossil fuel issue was being hyped out of all proportion to the understanding of climate science or level of risk.

Please let us have more of the sceptical view so that lay people can form an opinion from a better understanding of BOTH sides of the debate.

Best regards, Pete Ridley, human-made global climate change agnostic.

October 19, 2009 12:13 PM BST

RECOMMEND? (7)

**Derek Cox wrote:**

Cannot see the proposal getting through the Panic Now community who shout loud and long at anyone who denies Global Warming Caused by Man. The proposal should be investigated rigorously and the Panic Now people should produce their evidence so that all may read and understand. All I've seen are the assertions.

October 18, 2009 6:27 PM BST

RECOMMEND? (2)

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