

Dave Reay Q & A

From *Science for Public Understanding* Teachers' Conference, July 5th 2006

The following responses are to written questions posed by SPU teachers at the end of Dave Reay's presentation, *Climate Change — What Do We Know and How Do We Communicate It?* A full report of the conference that includes the slides from Dave Reay's presentation is available at www.scpub.org.

How would you advocate that we teach climate change to empower people to “make a difference” rather than generate “weary acceptance”?

Go straight for the statistics on who exactly is responsible for greenhouse gas emissions. Though it may feel as though the dirty great coal-fired power station down the road is the key problem, it's important to remember that it's there to provide electricity for our lights, TVs, fridges, standby power etc. If we break total UK GHG emissions down by end user, then a quarter are from home energy use, a quarter from transport, and the rest from business and industry. Clearly, individuals can have an impact on all these sectors, in particular for our energy use at home and how we travel around.

The statistics for the combined indirect and direct GHG emission from households are even more impressive. For UK GHG emissions, households contributed 155.8 million tonnes of the 718.5 million tonnes total in 2004, a further 456.6 million tonnes arose as indirect emission from households (electricity generation, public transport and final consumption of goods and services). As such, UK households in 2004 were directly and indirectly responsible for more than 85% of total GHG emissions. The buck, then, stops with individuals – every kilogram of GHG that we can keep out of the atmosphere helps hold us back that bit more from enhanced global warming and greater climate change impacts.

Is there any truth that temperature rose during the three day no fly policy after 9/11 and that vapour trails cause cooling?

Yes, in the day time at least. Because the skies were almost entirely free of contrails more energy from the sun was able to reach the earth's surface, rather than being reflected back towards space by the contrails. This was used by some to argue that air travel actually helped to cool the planet through the reflection of sunlight by contrails. However, this overlooks what happened at night. With no contrails the infrared (heat) energy emitted from the earth's surface is able to escape much more easily and so the surface is able to cool to a much greater degree. When there are contrails these act like strips of blanket – trapping the radiated heat and keeping the surface temperatures higher. So, when both day and night time temperatures are considered, contrails have a net warming effect on our planet, even before we consider the GHG emissions that they represent. An interesting recommendation made recently was to restrict night time air travel, and so confine the formation of contrails to the day time - where they have less of a positive climate-forcing effect.

Don't you think that scientists involved in a particular area of research into climate change will like to play up the impact of their particular field (e.g. permafrost)? How can one person have an overview of the relative impacts of each contribution to global warming when they don't have the expertise in all fields?

I don't doubt there are some scientists who play-up the significance of their field in the context of global climate change. However, the Research Councils and other grant-awarding bodies use peer-review panels drawn from a range of disciplines to try and ensure that funding is given in a proportionate way. As far as the relative importance of one research field or finding, versus another. No, I don't think one person can, in isolation, provide a fair appraisal of the whole subject. This is why the Intergovernmental Panel on Climate Change is so important, as it provides a peer-reviewed synthesis of climate change science from around the world. Expert working groups are assigned to each of the key areas (Science, Mitigation and Adaptation), with each drawing together and assessing all of the published findings relating to climate change. Their assessments, published every 5 years or so, provide the best and most objective assessment available on climate change science and policy.

Can you provide more detail, please, on the methane output of plants?

In a 2006 *Nature* paper by Frank Keppler and his research group in Germany, it was reported that living plants produced significant amounts of the greenhouse gas methane. They estimated that, worldwide, such production from plants could constitute as much as 30% of all naturally produced methane. Work is on-going to confirm this initial finding, and quantify exactly how important this newly-discovered source of methane is. However, it should be stressed that even with these methane emissions, the great amount of carbon dioxide that plants take-up would more than offset them in terms of climate-forcing.

Do you think it is possible to take control of 'global warming' or are we all doomed?

The problem is that we've already taken control of it through our emissions of greenhouse gases. As such we can alter just how much global warming we see by how much GHG we go on emitting in coming decades. I don't believe we're doomed, though we are already committed to some warming and some communities (e.g. those on low lying islands, Inuits) are already experiencing severe impacts.

What is the single most effective thing that individuals can do?

For most, simply driving a smaller car would make a big difference.

How do scientists outweigh the influence of politicians and oil companies?

I not sure we do all that often. Our research can help inform politicians, and through them the oil companies, but as scientists we have no powers to set GHG limits for governments or oil companies. I suppose our greatest asset is the objectivity with

which most climate change research is carried out and reported. However, we have had a consensus within the scientific community that human-induced climate change is real for more than a decade, yet political action has by and large failed to reflect this. Maybe the public trust scientists more than politicians, if so we have a key role to play in raising awareness.

So what should we be doing about it? Individually. UK, EU, & global?

Individually: reduce our energy use at home, avoid air-travel wherever possible, give big-engined cars a miss, and opt for public transport, cycling and walking where we can.

UK: raise public awareness of climate change, provide better public transport, recycling facilities and incentives for energy saving in homes and microgeneration. Set more stringent limits on emissions from business and industry, with an overall target of a 3% cut in UK GHG emission every year. Put more pressure on the US to re-enter negotiations on cutting emissions. Invest more heavily in renewable energy and development of renewable energy technologies.

EU: Set a EU-wide tax on air-travel to discourage the rapid growth in short-haul flights. Meet and exceed current EU targets for GHG emissions agreed under the Kyoto Protocol. Invest more in low carbon technologies, including Carbon Capture and Sequestration, with all new power stations being CCS-compliant. Ensure technology transfer to the developing world, allowing economic development in China and India to progress with the most efficient power-generation technology available (e.g. clean coal power generation). Bolster the EU-wide carbon trading scheme, with independent assessment of point sources (power stations etc.) and setting of annual emissions limits to achieve real year-on-year reductions.

Global: agree on a 'son-of-Kyoto' that brings in the developing-world countries and sets limits for GHG emissions for key economies such as China and India. Bring back on board the US and Australia, with ambitious GHG emission reduction targets and big penalties for non-compliance.

My students are BORED with the topic of climate change. How can it be made interesting?

Make it personal. Climate change will hit them and their friends alike. Visit UKCIP.org.uk and find how climate change will affect your region. Explore the ideas of making a difference as an individual or school, not just through dry numbers about the savings possible with good insulation, but by getting a smart meter in the classroom and seeing the impact changes really have on the power that is used up. Some schools have gone as far as getting wind turbine or solar panels, with the students monitoring its impact on the energy-use at school.

If a square mile of trees is replaced by a square mile of grass, what is the difference in stored carbon?

A square mile of growing forest can be expected to lock away about 25 tonnes of carbon each year. In contrast, a square mile of farmed grassland would usually store about 1-4 tonnes of carbon per year. This is before you account for the carbon losses that result from deforestation and soil disturbance.

Why do trees release methane?

Watch this space! I'll hopefully be able to tell you next year.

How do you develop a consensus of opinion with conflicting evidence/

See comment on IPCC above. Their assessments provide an objective synthesis of the evidence, conflicting or otherwise.

Is there a computer model (online) that students could put different sets of data into to explore different scenarios of climate change?

One good site is climateprediction.net where students can run their own climate model and at the same time contribute to a greater understanding of how global temperature will change during this century.

What about volcanoes and sunspots? (I thought you were going to mention more about it...)

Volcanoes and sunspots (an indicator of increased solar activity) are both important drivers of the earth's climate. Up until the 20th century variations in these were pretty good at determining how the earth's temperature changed. Since then they have been underestimating global temperature to a greater and greater degree, with rising anthropogenic greenhouse gas emissions being the widely-accepted culprit for the observed increases (human-induced global warming).

Our students (sixth form biologists) attended a debate hosted almost Newsnight style with a panel of climate change experts where they prepared questions. They got a lot out of it and felt more informed. Are there plans to do more of this activity and how could people find out about it?

I hope so – I think these panel debates can be really useful. I just been part of one at the Natural History Museum (student summit 2006) and the students seemed to get a lot out of it.

On the graph showing wavelength against absorption, where does methane fit in?
Does it close the window further?

Yes, methane absorbs infrared radiation at wavelengths of between about 7.5 and 8.5 microns.

On the graph showing the relationship between wavelength and water vapour and CO₂ — where do methane and N₂O fit?

See above – between 7.5 and 8.5 microns, N₂O is most powerful at 7.8 microns.

A while ago a paper was published which showed a startling correlation between the *length* of the sunspot cycle and global temperature. Has this ever been accounted for?

Yes, works well up until the 20th century, but cannot explain more recent increases in global temperature.

Is there *any* ‘good news’ from recent research on global warming / climate change or is everything worse than predicted previously?

Carbon Capture and Sequestration (CCS) technology is looking much more of a possibility. Recent pilot projects have shown that capturing the CO₂ and putting it back underground in old oil and gas wells can be done on a large scale and indicate that the CO₂ will remain stable and locked away from the atmosphere for more than 5,000 years.

How far away are we from the point of no return? The ultimate tipping point?

Your guess is as good as mine. We’re already committed to some warming, at least 1-2 degrees this century would be my best estimate. Given the lag time inherent in global warming caused by the massive heat-store that is the oceans, it is unlikely our climate will return to what it was for our grand parents for at least 50,000 years. Some models suggest that tipping points such as drying of the Amazon will be passed within the next few decades but, as ever, there are substantial uncertainties. The only certainty we have is that the tipping points are there and we are moving closer toward them.

Is enough being done to inform the public about this huge catastrophe?

No, I don’t think so. Things are improving and awareness is increasing. But too often raised awareness comes in the form of “we’re all doomed!” rather than laying out the facts and showing that we actually have a choice in all this.

What can I do as a teacher to get across the severity of the problem?

Make it personal. The students we teach today, wherever they live, face potentially severe climate change impacts. From heatwaves and floods, to mass immigration, disease and terrorism. Climate change is a threat to the UK, as well as the developing world nations.

Does the fact that tropical plants use carbon for photosynthesis have any mitigating effect on CO₂/O₂ balance?

Yes, in fact they are vital for keeping a lid on things. Of the 6 billion tonnes of carbon we kick out into the atmosphere each year from burning fossil fuels, only about half stays in the atmosphere and contributes to enhanced global warming. The rest is taken up and stored by the land the oceans through primary production via photosynthesis.

Developing countries are becoming massively industrial. Could they produce so many atmospheric pollutants (how regulated are emissions?) that 'global dimming' may reduce the extent of global warming?

We're already seeing the effects of this, the skies are clearing above North America and Europe while they are dimming over large areas of Asia. However, the particles that cause global dimming usually only last weeks or months in the atmosphere, while greenhouse gases hang about warming the planet for years, decades or centuries (methane -12 years, carbon dioxide – 100 years, nitrous oxide – 120 years)

Can GM technology offer any solutions to counteract the effects of drought caused by climate change (drought resistant / salt resistant crops)?

Yes, there is some exciting work going on in this field and it is hoped that such GM crops may help negate some of the drought effects on crop yields that are predicted.

How did the "hockey stick" model scientists get "pilloried"? Can we learn a narrative of their experience — it would make a good lesson structure about science in action?

Because thermometer records extend no further back than 150 years ago, scientists have to rely on "proxy data" to glean information about Earth's climate prior to that time. Tree rings, corals, ocean and lake sediments, cave deposits, ice cores, bore holes, and glaciers are all used to infer the climate of the distant past.

The published a paper examining the uncertainties (in the proxies) of global temperature change over the last 1,000 years. They found strong evidence for an increase in global temperature in the last 400 years, and good evidence that current global temperatures were higher than at any time in the last 1,000 years. Though they were careful in their wording, the climate change sceptics accused them of bias and of overstating their case. In particular they were accused of underestimating the global temperature during the mediaeval warm period.

What does David Bellamy say?

He's been quiet for a while, but he has been an outspoken climate change sceptic. He argued that more CO₂ was a good thing as the plants would grow better, and then that most glaciers weren't actually retreating. He has been proved wrong on both counts and now seems to be focussing on attacking wind farms.

What's your response to Bjørn Lomborg, *Sceptical Environmentalist*?

Bjørn's book relied rather too much on secondary sources and failed to give an objective view of predicted impacts and their associated costs. He also failed to fully discuss the externalities of climate change – its many interactions with water shortages, disease and famine. As such he argues that these latter issues are much more pressing than that of tackling climate change, while in fact it is through tackling climate change that we have a real chance of addressing the others.

Why are the government / oil companies not putting more money into bioethanol / non-fossil fuelled transport systems?

They are starting to. BP and British Sugar have just announced a large-scale scheme to produce biodiesel and the government is aiming for a big rise in the percentage of biofuels used by transport: 5% by 2010. However, there is a limit to what is possible via biofuels without growing food specifically for their production. My own view is that they should be confined to the use of waste (straw, paper waste, forest residues) rather than relying on the growth of extra crops that could feed people rather than cars.

What impact has any of the changes we have made over the last 20 years had on temperature change? Have temperatures gone down as people have tried to implement them?

Greenhouse gas emissions have continued to rise rapidly, and so have global temperatures. Compared to a business as usual scenario, greenhouse gas emissions have been cut by some nations, but as yet the impact of this reduction is too small to have made a significant difference to global temperature.

What can a student do to lower CO₂ levels?

Use the school bus, walk or cycle. Be the scourge of energy waste at home – stop standby power wastage, turn of lights etc. when they're not being used, recycle, holiday in the UK, lobby their MP, their council, their parents and their head teacher to cut emissions. Grow some of their own food in their garden or at school, pull on a jumper rather than ramp up the thermostat. Become a Climate Change Champion, see: <http://www.defra.gov.uk/news/latest/2006/climate-0126.htm> for details of the current Champions.

What is the effect of volcanic eruptions on global CO₂ levels?

Very minor. Volcanic eruptions can be big 'point sources' but to put their total CO₂ emissions into perspective (from US Geological Survey):

Volcanoes emit between about 130-230 million tonnes (145-255 million tons) of CO₂ into the atmosphere every year ([Gerlach, 1999, 1992](#)). This estimate includes both subaerial and submarine volcanoes, about in equal amounts. Emissions of CO₂ by human activities, including fossil fuel burning, cement production, and gas flaring, amount to about 22 billion tonnes per year (24 billion tons) [([Marland, et al., 1998](#)) - The reference gives the amount of released carbon (C), rather than CO₂.]. Human activities release more than 150 times the amount of CO₂ emitted by volcanoes--the equivalent of nearly 17,000 additional volcanoes like Kilauea (Kilauea emits about 13.2 million tonnes/year)!

At what point does global warming become irreversible?

We are already committed to a certain amount of warming, so in that sense it is already irreversible. In the longer term (millennia) one might expect human-induced warming to once again become secondary to natural drivers of climate (e.g. solar activity) and so the earth's temperature may decrease once more.