PROTONS FOR BREAKFAST

December 2009

Week 5

Mobile Phone Safety

Facts, Questions, & Feedback from Week 4

Facts

You Fact	Michael Says
Global warming!!! Cutting down trees causes global warming because trees absorb carbon dioxide and they produce oxygen for us to breathe.	Yes. Cutting down trees is bad for several reasons. Firstly the trees themselves HOLD the CO2 from previous decades as wood. If we chop them down then some of that reservoir is released as the wood decays or is burned. You may be interested to know that the decrease in oxygen concentration is tiny, but I believe I read that it has been measured. I can't remember where though.
Research Camels travelling across the Sahara are short of water because of the shortage of rain. The culture living off the camels is being threatened. The salt they used to carry across the desert is now being transported by trucks! A small by-product of climate change, but very sad!!	I saw that news item on the BBC when I got back from Protons. But I was sceptical. I wondered how much the sheer economics of a truck over a camel had made people change their habits and how much it was actually a climate change issue.
The year 2005 was the warmest on record, and the years 1998 and 2007 are tied for the second warmest. The eight warmest years on record have all occurred since 1998.	Yes. And I heard on the radio that 2009 will probably be the fifth or third warmest. You can check the data for yourself. The data base at CRU East Anglia is off line at the moment but there is a wealth of data available at the NASA Goddard Institute for Space Studies. Their summary for 2008 is **Global Temperature Trends: 2008 Annual Summation** *Originally posted Dec. 16, 2008, with meteorological year data. Updated Jan. 13, 2009, with calendar year data.* Calendar year 2008 was the coolest year since 2000, according to the Goddard Institute for Space Studies analysis of surface air temperature measurements. In our analysis, 2008 is the ninth warmest year in the period of instrumental measurements, which extends back to 1880 (left panel of Fig. 1). The ten warmest years all occur within the 12-year period 1997-2008. The two-standard-deviation (95% confidence) uncertainty in comparing recent years is estimated as 0.05°C [ref. 2], so we can only conclude with confidence that 2008 was somewhere within the range from 7th to 10th warmest year in the record. Look for updates here http://data.giss.nasa.gov/gistemp/ Notice that it wasn't an especially hot year in the UK: this is a global measurement..
The largest source of greenhouse gases in Brazil is cows!	Yes. Methane burps and the deforestation required to farm the cows.

You Fact	Michael Says
Global warming is caused by three 'Greenhouse' gases, carbon dioxide, nitrogen dioxide and water vapour.	Yes and No. Global Warming is caused by water vapour is the best approximation. Then include Carbon dioxide and then include the others: I think methane is next. I think one of the 'unused slides' at the end of the PowerPoint presentation has this data.
Nitrogen dioxide is formed by the heat of the car engine but outside it.	Yes, it's a difficult design optimisation problem for combustion engineers. They seek a higher burn temperature in each explosion in each cylinder of a car engine. This gives complete combustion of the fuel and optimum work output. However it also cause formation of nitrous oxides: N20 and NO2. These are greenhouse gases and form that orange smog visible over major cities such as LA and occasionally London.
• Glaciers and mountain snows are rapidly melting – for example, Montana's Glacier National Park now has only 27 glaciers, versus 150 in 1910. In the Northern Hemisphere, thaws also come a week earlier in spring and freezes begin a week later. • Some experts point out that natural cycles in Earth's orbit can alter the planet's exposure to sunlight, which may explain the current trend. Earth has indeed experienced warming and cooling cycles roughly every hundred thousand years due to these orbital shifts, but such changes have occurred over the span of several centuries. Today's changes have taken place over the past hundred years or less. • Sea level could rise between 7 and 23 inches (18 to 59 centimetres) by century's end, the IPCC's February 2007 report projects. Rises of just 4 inches (10 centimetres) could flood many South Seas islands and swamp large parts of Southeast Asia. • More than a million species face extinction from disappearing habitat, changing ecosystems, and acidifying oceans. • The ocean's circulation system, known as the ocean conveyor belt, could be permanently altered, causing a mini-ice age in Western Europe and other rapid changes. • These gases persist in the atmosphere for years, meaning that even if such emissions were eliminated today, it would not immediately stop global warming. • Coral reefs, which are highly sensitive to small changes in water temperature, suffered the worst bleaching – or die-off in response to stress – ever recorded in 1998, with some areas seeing bleach rates of 70 percent. Experts expect these sorts of events to increase in frequency and intensity in the next 50 years as sea temperatures rise.	I said one fact! • Yes. Glaciers are in retreat around the world. This decline predates the major CO2 emissions after WW2 and may have been initiated by soot. You can monitor it here http://nsidc.org/sotc/ • These natural changes do occur, but this is definitely not one of them • Yes. Sea level rises are really hard to measure, but those estimates seem plausible. • Apparently so. • Yes. A collapse in the thermo-haline circulation would stop the 'gulf stream' and give the UK the climate of Canada or Finland. Apparently it could happen rapidly, but the measurements we need to make to understand it are fearsomely difficult. On the plus side, it would improve global cooling ☺ • Carbon dioxide persists in the atmosphere for hundreds of years. Methane lasts for decades and then breaks down into carbon dioxide and water. • If it stays warm, it seems to be that way ☹

You Fact	Michael Says
The normal balance of release and absorbing of carbon dioxide involving plants, oceans and atmosphere has suffered from a huge increase of carbon dioxide into the atmosphere from industries. The subsequent layer of carbon dioxide prevents heat from escaping from the atmosphere.	Yes: a simple summation of the problem.
Global warming is 'melting' (or was it 'subliming'…?) frozen methane hydrate …? under the ocean, releasing methane gas and adding to the "greenhouse effect" problems.	The methane hydrates under the oceans would, if warmed – result in a release of methane into the atmosphere. There is no evidence that this will happen.
The Arctic ice field is steadily reducing in size. In August 2007 – a month before the end of the melt season – the biggest decline ever in Arctic sea ice minimum extent was recorded.	Yes. You can monitor that here http://nsidc.org/sotc/
Ice caps will melt, water levels will change and many people world wide, will suffer but, God willing (and it is His World) these disasters can be avoided and warnings heeded.	I certainly hope we can heed the warnings. Although I am not a religious person I do agree strongly that treating the Earth as if we (in our generation) 'owned it' is just a ridiculous and dangerous idea.
Recent rises in population must mean that there are more atoms moving with an accompanying rise in temperature	Each extra person adds some consumption to our energy demand. But it is not the energy consumption *per se* that is the problem, it is the way we produce that energy by burning fossil fuels. This affects the balance of the energy flows on and off the Earth.

Feedback	Michael Says
Is our main data on CO_2 from ice cores only from the last 1-2m years? 150m yrs ago the earth was warmer by 1-3 °C(?) What was the world like then, for life and would it be similar if the temp were to increase by that amount again?	Yes. The deepest ice cores stretch back just shy of 1 million years. At those depths, the ice layers are twisted under the immense pressure and the data is more difficult to interpret than the first 400,000 years of data. Going back more than 1 million years means going back to a time before humans existed as a separate species. I don't know the details of the paleo-climate: it has changed a lot: but the Equatorial regions are pretty much always warm (with one possible exception), and the poles are pretty much always cold. And in between are the green bits. There is no doubt that even in the face of drastic climate change, that people would somehow survive somewhere. But the dramatic changes which may come about threaten the food and water supply of, literally, billions of people and could lead to terrible conflict, suffering and loss of life. Think of the collapse of Rome and multiply by three or four powers of ten.

Feedback	Michael Says
If global warming continues at the rate that it is at the moment, how long will it take for all of the ice in the world to melt, and how much will sea levels rise?	You can read about the current state of play here http://nsidc.org/sotc/sea_level.html If the ice at the North pole melts this will make almost no difference to sea levels. If the ice sheet on Greenland melts – something which would take several hundred years, that would add 7 metres to Global Sea Level. If the Antarctic ice sheet melted – which it is not really showing signs of doing very much – then this would add around 20 metres to sea level. NPL's main gate is 11 metres above sea level.
Thank you for a good evening and helping me to understand the consequences of global warming. You really made me think on how I could make a difference. Is there anything we can do to stop global warming completely? Thank you again.	Good! No. To the best of our understanding, the carbon dioxide we have put in the atmosphere already has committed us to around another 0.5 °C of temperature rise. But we are not going to stop right now. The rate of emission is still increasing year on year and shows no sign of stopping. What can you do? Be prepared to change, and talk (gently) to people who are hostile.
Do you think if we all consume less we can contribute positively to global warming.	Yes, but collectively we show no sign of consuming less. Our entire economic model is based on the importance of growth, which means increased consumption and increased production. And if we don't have that growth, then the money to take action on CO_2 emissions won't be there… Mmmm. That's a tricky one!
Sadly a 'one-off' visit for me – I like the idea of "blow-ups" next week – explosive or inflatable or whatever else! I was a bit worried I might not keep up – having missed the previous lectures – but managed to, on the whole I think. The info was presented in an easily understandable and thought-provoking way. Thanks.	It will be explosive - sort of – a sort of mini lightning storm. I am glad it made sense.
The best thing is that people are aware of the problem and are anxious to save the world. I think that we should worldwide stop deforestation. It is the growing plant life that absorbs carbon dioxide and produces oxygen. Teach the next generation to be more aware of the wonders of this world – God's world that reaches to eternity. Thank you for your descriptions.	Yes. I have seen a real change in people's perception in the 6 years I have been running this course, and I think that consciousness will grow. I think so too, but unfortunately it is unlikely. Wherever people go in the world, they cut down the trees – that's what we do and always have done. A consciousness that we are not owners of the world but guardians of it for future generations would lead to a change in our behaviour in many ways.
This session has been useful/informative. → How about all schools, universities, work places nationally having the same talk – I'm sure it would make a difference, although not good for your own time, sanity and carbon foot print!!	Thank you. We are looking at ways of extending the impact of the course through video and web. But it all takes time and resources: if you know a web/video producer with time on their hands – do put them in touch!

Feedback	Michael Says
These real issues should be taught on the National Curriculum – perhaps we could then educate the next generation to take positive action to save the world.	Yes. These are covered to some extent, but I am not really very impressed with the 'bittiness' of the national curriculum approach. I think the 'next generation' have the will to change the world, but it is us – the 40 and 50 year olds and above - who have the economic and voting power to make things change. We just need to vote and act to achieve what we really want.
What would be the effect of planting more evergreen trees?	People have been investigating this with complicated experiments involving hundreds of CO_2 and O_2 and methane (CH_4) sensors in vast tents. If I recall the results correctly they were that evergreen forests were only barely storing carbon at all. It may be that they were in a region of mature forest – which was very slow growing. Trees store CO_2 in wood as they grow and this storage rate is a maximum between 10 and 30 years after planting. As I mentioned above, forests are like a stored carbon 'reservoir'. So if we plant them we need to leave them planted! Also note that planting trees means ***not*** planting something else, which might be something someone could make money from or eat. Is this what we want to do?
Is it possible that CO_2 levels being measured in ice sections being drilled out of the polar caps are not right because CO_2 from the past has escaped from the ice?	Good thought. This is pretty robust data. There is not just one ice core, but many at the North and South poles. As I mentioned, the gas can diffuse a little from bubble to bubble, and obviously the older levels have had more time to diffuse, but scientists can compensate for this trend. You can read about the data on Wikipedia http://en.wikipedia.org/wiki/Ice_core We can also measure other gases in the bubbles and they add even more interest to the story and allow us to estimate global temperature for the last 1 million years! But I didn't have time to talk about that… Also we can get some similar data for at least part of the period from analysing tree rings in very old trees. Some trees (bristlecone pines) are nearly 5000 years old!
I feel strongly that there is no clear guidance from adults/experts as to what we should actually try. Education of young people is key and the way forward. Politics will get in the way always unless people resist it.	Yes, there is a need for leadership. Our current leaders are talking the talk, but not walking the walk. Yes, this is a key element of the solution. Mmmm. I disagree here. Politics is the mechanism of all collective action in a democracy. Tainted and petty minded and internally focussed as it is, it is all we have. Although direct action and pressure groups can influence things, ultimately it will come down to laws and building regulations and boring stuff like that. One of my colleagues who measures the heat flow through 'structures' (walls and windows to you and me) gives a talk called –"***How I saved the world from Global Warming***" Subtitle is "***Measurements of the thermal transmittance of double glazed windows and insulated walls***" Running this course is one of the things I do help things change – I would like to do more but this is something and not nothing. I feel sure there is an equivalent proactive choice that we can all make to move things along.

Feedback	Michael Says
Very thought-provoking! My attempts to reduce, re-use, rethink, repair and recycle are so outshadowed by my visit (via plane) to the USA at Christmas – Guilt, guilt, guilt!!	Provoking thought is my aim! – Because thought is the mother of action. Don't feel guilty: its pointless. I think your comment brings home to me again the understanding of the nature of the problem. CO_2 emissions are not the product of evil people, they are the product of our way of life with all its great benefits – what could be more life affirming than spending Christmas with friends and family? Don't beat yourself or demonise others. If you first understand the problem, then when the opportunity for change arises, we will all be able to grasp it.
(Last week) Re heat. Does the liquid nitrogen cooled balloon become solid and brittle?	The rubber becomes solid and brittle: If I tried I could have broken the rubber easily.
As heat = energy = calories, why don't I get fatter if I consume heated food as opposed to cold food, or do I?	Heating food helps a little, but the chemical energy content of food is phenomenal. If you eat around 2000 kCal per day (we call these units *calories* colloquially) that corresponds to 8.2 Mega joules (MJ) of energy. Heating one litre of (say) soup to 50 °C takes only around 0.1 MJ compared to the typically 2 MJ of chemical energy. So the heat only constitutes a few percent of the total energy.
At what point will CO_2 cease to be a problem, i.e. all the IR radiation at the particular wavelength the CO_2 vibration absorbs will be being absorbed already? i.e. at what point is saturation reached?	What a great question. We are already at that point. The emissions from the Earth are absorbed within (very approximately) a kilometre of the earth's surface. If we could 'see' at these wavelengths, the atmosphere would not look clear but would look like a dense fog. Increasing the CO_2 concentration increases the density of the fog, and changes the temperature *gradient* within the atmosphere., moving the warmer layers closer to the Earth. Overall, the calculations show that this still has a warming effect, like a putting on an extra blanket in bed. If you understand the problem at this level then you will enjoy the guide to the issue produced by the Australian Meteorology Bureau. http://www.bom.gov.au/info/GreenhouseEffectAndClimateChange.pdf This a 5.6 Mb pdf download. It discusses this point directly.
Very interesting. Even better if: we had less time for the discussion (went on too long). Very good.	I am glad you found it so. Less time? I was getting sick of the sound of my voice – and it is *your* voice which really matters.
This showed me another side re global warming. I've always thought changes would affect us within a few years, but some of the points showed me it could take 50+ years. Really good presentation.	Yes. One of the slides I withdrew this time was a repeat of the slide from Week 1 on the relative timescales of different processes. And it is very hard for us to act rationally in the face of such slow apparently unstoppable change. We consider a 5 year plan to be 'long term' but it is just a blink on the timescale on which the Climate system works. For example, the deep ocean currents send surface water down to the deep oceans where it may not emerge for hundreds of years.
Thank you, it was very interesting tonight!	I am glad you found it so.

What should we do?

Group A

PAUL QUINCEY, STEPHANIE & PETER

Written on large sheet	Michael Says
Clouds? - particulates nucleate; hard to model accurately. Ongoing. - seeding – to help climate change?	Easy to appreciate how important clouds are – very hard to predict numerically their effect. Seeding clouds to precipitate rainfall does work and is practiced in various places but it is still inexact. And like all interventions in the climate system is subject to the law of unintended consequences. "Whose rain is it any?" Seeding the atmosphere to reflect sunlight seems to me even more dangerous!
Contrails: - lots in the UK, another side of air transport? - 9/11 showed obvious effect …. bigger than expected!	Look on a summers day and you can see the contrails form clouds. It is clearly a significant effect, at least in this part of the world.
'Warming' – could <u>cool</u> the UK. <u>Change</u> is better description.	Yes. I keep meaning to change the title of the session but I then reflect that GLOBAL warming is the problem and that this is how we refer to the issue colloquially.
Solar Panels – fill energy gap. Collect sunlight – will it affect climate?	Solar panels are a pretty benign technology. They work, and their cost probably reflect the true cost of energy which fossil fuels are not paying.
Deforestation – less trees, less CO_2 uptake. Should we plant more trees? ↳stop people chopping down.	Stopping people chopping down the trees would be a really good idea – personally I think there is almost no chance of success here, but one could imagine richer countries paying a subsidy to poorer countries to not chop down the existing forests. But they would need to keep paying year upon year!
Reduce population of planet by 50% - Big effect, but which 50%?	Good idea. What's your plan? See below for graphs of human population versus time.
Catastrophes – affect food production. Temp ↑, plankton die off + rainforests. ↳ effect our O_2 supply? <u>Unlikely</u>.	Yes, there probably will be some catastrophes. But is very difficult to cope with low probability events which will be catastrophic if they occur. No real danger to O2 supply just yet. But 60% of O2 production comes from the phytoplankton in the oceans, so its best not to acidify the place where they live!

Written on large sheet	Michael Says
Young trees absorb more – rapid uptake. ↳ how many per year to absorb TONS of CO_2?	I have calculated this before, but at this moment I can't recall where I put the answer. Roughly speaking a big 30 year old tree is 1 m indiameter and 10 metres tall and a density of 1000 kg per cubic metre. So its mass is around 10 tonnes (ish). Suppose 10 trees such as this can live in an area of 30 m x 30 m then in 1 sqare kilometre we can grow 9000 such trees and sequester around 90,000 tonnes of carbon – ish. Expressing this per year we can sequester 3000 tonnes per year with 1 square kilometre. So to sequester 1 million tonnes per year we would need 300 square kilometres. To Sequester the 8 billion tonnes we emit each year globally would require 8000 x 300 = 2.4 million square kilometres This is around 10 times the land area of the UK. There is lots of room for error – factors of two or so – but we would need to find a place where treese grew well where people didn't mind having their arable land taken over and used to grow trees in perpetuity. This solution would only work for 30 years and then we would need to plant another forest as this one matured. A forest is like a reservoir for CO_2
Natural CO_2 emissions e.g. volcanoes. Limited global effect.	They are small in comparison with anthropogenic (human-made) emissions. They are also episodic coinciding with major eruptions. They are included in climate models.
Technology to reduce impact of lifestyle – rather than just <u>stop</u> doing – more CO_2 info to help guide choice.	Yes and No. If we can use some new technology to achieve the same convenience without CO_2 emissions, then this is a good thing. If we seek simply more *efficiency* then this doesn't (unfortunately) work. Research has shown that if we save money on something such as heating, we spend it on other things which are equally, or more polluting.
Tap geothermal energy …. renewable. Limited areas available unless deep. ↳moving energy …. like heat pumps in domestic.	Very sensible in areas where sources are abundant. As I mentioned in the presentation, generally the flow of heat to the surface is very low, and one needs to collect heat from a large area. Generally not feasible across most of the UK, though it can make sense for businesses.
Mid December still get 30-50 °C water out of solar tubes on roof!	Yes, there is still solar energy available even in mid winter. However heating water is a small component of our overall energy expenditure. Heating the spaces in our homes and businesses is the major expenditure.
If generate all from solar – not affect climate due to less solar radiation.	As I mentioned, we need only to capture 0.01% of all the solar radiation which falls on the Earth and we would be sorted! This is probably impossible, but we should still try to catch what we can.
'Junk mail' … council generated!	Irritating, but not directly a climate change issue.
Carbon trading? Useful or fudge? ↳too many issued? ↳some exemptions. Hard to implement, BIG measurement problem! – to <u>prove</u> emissions.	If there were a price for carbon emissions that reflected their ***true*** cost then economics tells us that we would all make the 'right' choices. Carbon trading is a way to establish such a price but it has been highly imperfect in its current implementation.
<u>Increase costs</u> – makes people <u>think</u>.	Yes. In our society the way we mark something as valuable is either to ration it, or make it expensive. Either choice is uncomfortable for something as essential as energy.

Written on large sheet	Michael Says
Can we do anything?	Lots of things. There is not one solution, but hundreds.
Lovelock … gone too far – cope with future.	James Lovelock has a hypothesis that the Earth is a self-regulating system. By Earth he includes the climate system and the living organisms on the planet. He believes the system (he calls it *Gaia*) will be fine, but that humans will undergo a catastrophic decline. He may be correct, but personally I detest his casual dismissal of human of human suffering on an unprecedented scale. I feel it is our compassion for each other which will drive us to solutions, albeit imperfect solutions.
2nd year pupils – not felt any eco role models – no leadership of next generation!	I am not sure what this is about! But it is hard to find role models who are genuinely eco-focused and who simultaneously don't appear to be martyrs or self-flagellating misery-guts.
Politics vs climate change ↳ if they won't make the decisions.	Politics is the tool we use in democracies to effect the 'will of the people'. Politicians may seem to have lost the plot but if we make them aware that we wish to address this issue honestly, then ultimately they have to respond. Don't they?
Methane - independent greenhouse gases - less impact than CO_2 - from animals farmed for food – go vegetarian! - oil – fertilizer – crops → animal → human. Crops vs human.	Food production is a major source of greenhouse cases. It is also even more essential to us than energy production. If the cost we paid for farm products reflected the *true* cost of production (including climate change consequences) then the price we paid would reflect the true costs, and we would see directly in the price effect of eating meat over other protein sources.
Food miles.	Yes, it is amazing that we buy apples from New Zealand at the same price as apples from the UK. How does that come about? I think I calculated that for each kilogram of freight shipped from New Zealand emitted approximately a quarter of kilogram of CO_2. I can't find the source of that figure right now.
Elec car – H_2 cell – C neutral if use carbon neutral generation. ↳ power station more efficient than cars?) - U mining …….) week 6	Personally I think the use of electric cars will increase rapidly. If they are re-charged at night using mainly nuclear electricity (see week 6 for more details), then the carbon emissions associated with transport could be reduced significantly.
Nuke testing under sea – Tsunamis … not global warming.	I would not recommend testing nuclear weapons under the sea – to the best of my knowledge there never have been any such tests in the sea itself. Nothing do with Global Warming.
Spread PFB globally – key stage *n*	I am working on it!
Silence the sceptics – remove confusion ↳inform debate ↑ ↑ vested interests complex information	No, Yes, Yes. We should not silence the sceptics: we should hear them out, acknowledge the points they make, and expose them to the facts of the matter. Trying to 'silence' sceptics has not worked well for the University of East Anglia Climate Research Unit! In my opinion, Sceptics are motivated by a number of reasons: Scepticism (Good!); Mistrust and Conservatism (understandable) but there are also some malicious people who cynically seek to exploit the situation for their own ends. That's people for you!
Ask questions and find out.	Yes!

Written on large sheet	Michael Says
Recycling – not user friendly – some packaging – get fined if errors ↳guidance needed. ↳need regulation to make it. Very varied local approaches. different councils, different recycling.	Yes, I am surprised at how each council seems to invent its own scheme. I don't think there are any fines for wrongly categorising recycling in this borough. Fines seem just completely out of place in this arena.
Plastic …. still too much in packaging in shops.	I think there is exactly as much packaging as we want! The way we live, packaging is essential to reducing waste and damage to goods in transit. I think manufacturers would reduce packaging if they could – it would save them money! The alternative to advanced packaging is either more waste of goods in transit, or that we would need to eat food which had travelled less. I think we should make all the plastic in packaging able to be burned cleanly. We should regard it as fuel which has been temporarily used as packaging on its way to the power station
No 'Tetrapak' recycling in UK?	I think the cartons have a plastic, a card and a metal layer which makes it difficult to characterise and recycle.
- for Al, less energy used by recycling - good practice - <u>less landfill</u>	Yes. Aluminium is one of the most obvious materials to recycle.
Make cycling more popular + user friendly. ↳lots in this group.	Yes. I think we might need to be radical here. We can't build cycle paths on the roads in this country because most roads are not wide enough. But what about the pavements? Look at the pavements in most areas and they are empty: is it really such a sin for cyclists to use the pavements?
Do nothing and cope.	That seems to be the default policy, and despite many fine words, that is what we are actually doing. The question is: In 50 years, ***will*** we cope? Or will we wish we had acted differently in 2010?
Money to doing something else.	I can't quite follow this remark. Sorry.
Reduce CO_2	Good idea
Increase fuel costs.	Do you mean ***fossil*** fuel costs? In the end, I think this is the only thing which will really change our habits. But it won't be popular!

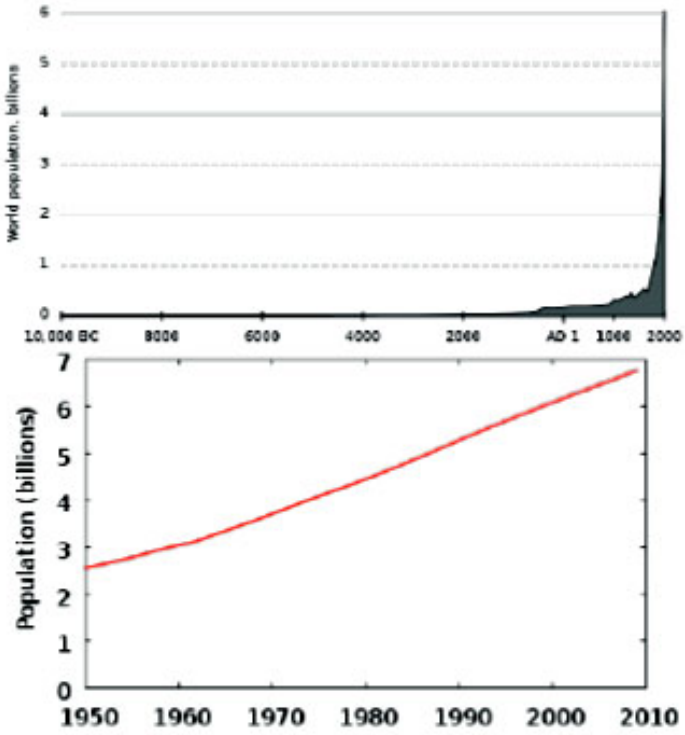
CHILDREN

You Said	Michael Says
<u>Questions</u>	
How bad is methane from cow burps + farts	Methane from farm animals is a significant source of methane, which is a greenhouse gas. In our current estimation it is not quite as significant as carbon dioxide.
If temp stays flat like in last 10 years, why can't we continue as we are?	Well, as we saw in the presentation, we basically expect the temperature to rise in future years. We could all be completely mistaken, but sadly this is not very likely.
If we can do low energy light bulbs - why not energy efficient computers and other things	Yes. There is plenty of opportunity to reduce energy consumption. But it is important that we don't then consume more of more of something else with the money we save!

You Said	Michael Says
What does 1 °C temp rise actually mean?	Great Question. Of course nobody knows for sure, but our best estimates are summed up in maps on this BBC web page http://news.bbc.co.uk/1/hi/sci/tech/8394886.stm It doesn't seem that dramatic, but represents a serious challenge to the way people live in different parts of the world.
What to do!	
1. recycle!	Everything we make uses energy, so if recycling means that there are some resources we don't need to mine in the first place (aluminium for example) then this has a significant positive effect
2. reduce flights.	It is not flying in itself which is harmful – all forms of mechanised transport emit carbon dioxide – its just the number of miles we travel by air can be so great! If we drove 3000 miles in a car, that would emit almost as much carbon as flying that distance. The difference is that flying 3000 miles takes 6 hours and driving that distance would take 6 days!
3. Plant trees – Conifers	Probably a good idea, but unlikely to really sequester much carbon – we need to leave the forest untouched once planted and people are spectacularly bad at leaving forests alone!
4. Solar panels in sunny places	Yes: It makes sense – and it borderline makes sense in the UK!
5. Make solar panels cheaper and more available	There are *lots* of scientists and engineers working on doing just that
6. Population control	It would definitely help. When I was a child there were roughly 3 billion people on Earth. Now there are 6 billion and we will probably top out at somewhere just shy of 10 billion. This represents a massive increase in demand for every resource: food, land water, and energy. But it is a very tricky problem and has only really been effectively used in China, and only there because of a lack of personal freedoms that most people in the West consider essential. See the graphs below for details of population growth versus time.
7. Electric cars.	As I mentioned above, I really think we will see more and more of these.
8. + buses.	Electric buses would be a good idea too. Buses in themselves are a good idea, but only when people use them! Empty buses with just a driver are much worse even than single occupancy cars.
9. Use Gov. money for green energy.	The government has no money! They have just borrowed £40,000 from each family in the UK to rescue the banks and we (Me, you and your parents) will need to pay that back. Would you like to lend them some more?
10. Solar powered carbon capture planes.	Great idea and sometimes such ideas can make sense. But not this one ☹

MARTIN, PETER, Averil,

You Said	Michael Says
Split $CO_2 \rightarrow C + O_2$. Large amount of energy. Very difficult. (i) Oceans (ii) Umbrella	Yes driving the chemical reaction backwards to make CO_2 from carbon and oxygen takes energy – exactly as much energy as we got in the first place when we burned the carbon.
Grow more trees.	Generally a good idea. But these form a reservoir which will 'fill up' in around 30 to 40 years. We then need to leave the forest untouched!

You Said	Michael Says
Double summer time	Probably a good idea – and also we could switch to European time in the winter. This would reduce lighting requirements and mortality on the roads.
More water vapour → rain	Yes. Generally true. Unless the temperature of the Earth rises in which case we expect the atmosphere to hold more water vapour.
Control population? → Contraception	As I mentioned above, it's a good idea, but not without its problems. However the graphs below show the scale of the problem. The first one shows population since the last ice age, and illustrates how much the world has changed : chopping down trees was OK when there were 1 million people on Earth. Doing it when there are 6 billion is not so smart. 
Modify plants/drop leaves	We need to be careful about such activities. Some may work, but others may have unintended consequences – we are not the only creatures on Earth who use plants.
Lock up in ground. (Release oil/etc)	Oil contains so much energy and is so cheap, it will be hard to stop people digging it up, but your suggestion is basically what we need to do!
Bio fuel → grow (absorb C) → CO_2 when used (not using oil).	Certainly this could be part of a solution.
(Less land for fuel) → good / bad	Yes, we use land to grow to food on, and using the land to grow fuel essentially increases the price of food, which is bad news for poorer people.
By-passing → industrial revolution	Yes, we need to help countries develop power sources that are not dirty and bypass the astonishingly polluting stages of industrial development that we went through.
Not reduced emissions/person in Rich Areas.	No. We haven't reduced emissions at all really. The UK switched from coal-fired to gas-fired power stations, but has made no significant reductions in carbon emissions since that switch.
Scientific → bias → politics / self-industry	I can't follow this. Sorry

You Said	Michael Says
Majority Government → not limit.	I can't follow this either!
Scientific orthodoxy is accepted.	Yes I think that now the 'Climate Change' tribe – who once viewed themselves as the 'outsiders'– have convinced most people and they have now become the 'insiders'
Man made climate change → scientists	I can't follow this. It looks you are saying that scientists have caused climate change! Or has climate change caused scientists?
We won't run out of fuels. (Fuel sources available).	That's right. There is no shortage of fossil fuels whatsoever for the foreseeable future – hundreds of years. The problem is the carbon emissions that come from using them
Nuclear is a good thing?	We will look at that question in Week 6. It's your opinion that counts.
Terrorism risk! How do we manage it?	Practically. Nuclear facilities are relatively isolated and can be guarded relatively easily. There are multiple levels of safety at nuclear reactors, but attacking waste storage could create chaos rather more easily.
Perceived risk.	Yes. We perceive nuclear risks especially keenly. Whether that is sensible or not is something we could look at in Week 6
Sources of fuel → make it.	You mean we could make the fuel? Nuclear fuel is rather limited in supply. There is maybe enough for 100 years of intense use. So nuclear power is really only a transitional solution to our energy requirements.
Stockpile of Pu.	The UK has a stockpile of 100 tonnes of separated plutonium. This could be used as nuclear fuel if we built the right type of reactor, or could make 10,000 nuclear bombs!
Oil spill / nuclear spill /	Are you contrasting the relatively benign nature of an oil spill compared with the long-term persistence of nuclear pollution. – Good point
Volcanic activity → SO_2 Shield from, global warming. Encourage volcanoes → ships → water → clouds → artificial umbrella. Pay / rain in dry countries. What are the consequences.?	Sulphate particles are white and reflect sunlight and so can reduce the solar input to the Earth's surface, and we have observed the cooling of the Earth after major volcanic events (e.g. Mount Pinatubo) . However attempting to geo-engineer such effects seems to me to be highly risky.
Global warming → Caribbean → storms	Despite looking very hard, there is really only rather weak evidence of an association between the severity of storms and increased sea surface temperature.
Life style + New methods / technology	I think the idea here was that we need changes of lifestyle AND new technology AND (I think) any other thing we can think of!
Pull every level.	Yes: We need every trick we can think of.
Nuclear Renewables	In week 6 we will look at the 'opposition' between nuclear and renewables.
Insulation Life style	Not sure about this. But if you spend money on something green, then insulating your house is the best thing you can do. Its not glamorous., but it is the most effective 'green' thing you can do.
Food / Cars /	Sorry. I can't follow this.
Fly → internet	The technology exists to replace some fraction of long distance journey's with internet teleconferences. I do this regularly and it is cheap and easy.
Is life style too late!	Too late for what? It's never too late to begin.

You Said	Michael Says
1 person in car" Traffic jams.	Yes, one car weighing 1000 kg carrying one person is just a bad idea
2 people in car. 35 mpg.	I don't know what the point is here, but 4 people in a car is one of the greenest ways to travel. It is easily greener (i.e. lower CO2 emissions per person) than a train in any country other than France.
Green taxes → US	Sorry. Can't follow this point
Carrot and stick	Yes. We need to motivate people to change. As I mentioned in the talk, we are not personally aware that there is 'a problem' and so every motivational tool needs to be used.
10 times fuel cost	If fuel costs increase by such a factor then I thing people's habits will change, and difficult as it would be for many, this level of change – or something like it - is what is required. Such a change will make many surprising alternatives economically sensible.
Expectations need to be changed	Yes. We need to lose any expectations that energy should be cheap.
Education	More is better. Generally.
Technological solution	Technology is part of the solution, but a focus on technology is probably not really helpful.
Change in working practices etc.	Yes. We could use the web more to avoid some fraction our travel.
Wind turbines	We need to build more – but NIMBY's constantly stop them being built! It seems to me that people who live in the countryside want all the benefits of an advanced urban civilisation, and all the benefits of living in the country, but refuse to pay the price. I think this is a national emergency and we just ned to get on with it.
Hydro power	Bad for canoeists, but good for everyone else. Unfortunately we have used almost all the appropriate geological structures in the UK and in most places on the Earth.
Solar Panels	Actually Solar PV just about makes sense in the UK. If you have £10k that needs a long-term investment you could do worse than get solar PV panels. We will look at this in Week 6
Change life style	Some change in lifestyle will be involved, but it has to be at a rate that we can all cope with
(i) Reduce (ii)	What?
Solar panel vs solar cell	Solar panel's for heating hot water work well, but actually heating water is a relatively small part of our energy expenditure. Solar PV panels are much more expensive, but in many ways represent a better solution.
New build	New build houses have dramatically lower energy requirements than older houses, but we can't rebuild everything!
Better insulation	Yes Yes Yes Yes Yes.
Exercising	It's a good idea, but I don't get the Global Warming connection!
Livestock	**?**
Change food habits	Yes. But we don't have to all become vegan! Just changing our diet a small amount can have a significant effect. Part of our response is to identify things that we ***can*** do that will make a difference, and then to ***do*** them!

You Said	Michael Says
Rich and poor countries on level playing field	Will that ever be the case? But I agree that fairness has to be an element of any global agreement.
Rich poor common interest	We do all indeed share a common interest in limiting climate change.
Change in lifestyle	Some change will be involved. But we have to proceed from where we are to where we need to be in steps that we can actually take. Requiring that we all go 'completely' green overnight is not realistic.
Alternative energy / insulation	Insulation first – it is a much better use of resources – and then alternative energy.
Making poor and rich countries having a common interest	I think the Copenhagen conference is hoping to clarify the common interests that we all share and to enable us to act together. Let's hope something good comes of it all!