

# Everyone's clamouring to cut CO<sub>2</sub> but what does the science say?

More and more transport policies are being justified on the basis of cutting carbon dioxide emissions, yet the science underpinning the actions is rarely discussed in transport circles. **Andrew Forster** looks at the latest UN report on climate change

**T**his month's report by the Intergovernmental Panel on Climate Change points the finger firmly at man-made carbon dioxide emissions for rising global average temperatures and other climate changes in the last 50 years. "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations," said the *Summary for policy-makers* (SPM) of the first volume of the fourth assessment report (AR4). In IPCC parlance "very likely" means there is a greater than 90% (but less than 95%) likelihood of the statement being correct. This represents a stronger statement than the SPM of the IPCC's third assessment report (TAR) published in 2001. It said most of the observed warming over the last 50 years was "likely" (a 66%-89% likelihood) to have been due to the increase in greenhouse gas concentrations.

The AR4 report predicts that the continued burning of fossil fuels at or above current rates will cause further warming "and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century." There will be more hot extremes, a decline in Arctic and Antarctic sea ice, more intense tropical cyclones, and extra-tropical storm tracks will move poleward.

Problems indeed, but none of this seems quite on the scale of global catastrophe that features so prominently in the climate change commentary provided by much of the media, politicians, pressure groups and other pundits. It's hard to reconcile *The Independent's* front page headline just before

the report's release that "2,000 climate change scientists deliver the most terrifying report ever" with the measured tone of the report itself, though whether this dichotomy says more about media hyperbole or the conservative language of scientists might be a matter of some debate.

In some important respects the latest SPM is less alarming than the one published as part of the TAR. The upper end of predicted sea level rise has been cut by a third and major changes to the Atlantic Ocean's thermohaline circulation (which transports heat to the high latitudes of the Northern Hemisphere) in the 21st century are now regarded as "very unlikely" and longer-term changes "cannot be assessed with confidence" (the TAR said that beyond 2100 it could shut down completely).

Nevertheless, *New Scientist* magazine reported last week that some of scientists' "more scary scenarios" were "left on the cutting room floor" as the IPCC strove to reach unanimous agreement on the report. "The benefit – that there is now little room left for sceptics – comes at what many see as a dangerous cost: many legitimate findings have been frozen out," it said.

The SPM observes that :

- Eleven of the last 12 years (1995-2006) rank among the 12 warmest years in the record of global surface temperature since 1850.
- The global surface temperature is estimated to have risen by 0.74°C between 1906 and 2005 [within a range 0.56 to 0.92°C].
- Sea level is estimated to have risen by 17cm during the 20th century. The IPCC says there is high confidence that the rate increased between the 19th and 20th centuries but it is unclear whether there has been any accelerating trend in the 20th century.



**"The debate over the science of climate change is well and truly over."**

Environment secretary David Miliband (pictured)

Arctic temperatures increased at almost twice the global average rate in the past 100 years, says the SPM. "Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3] % per decade." There have been increases in precipitation observed in eastern parts of North and South America, northern Europe and northern and central Asia. But drier conditions have been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia.

Evidence on tropical cyclones (typhoons and hurricanes) is ambiguous. "There is observational evidence for an increase of intense tropical cyclone activity in the North Atlantic since about 1970... [but] there is no clear trend in the annual numbers of tropical cyclones," says the SPM.

## Attributing blame

Changes in the atmospheric concentrations of greenhouse gases, aerosols, in solar

## The IPCC: bringing scientists and governments together

**T**he IPCC was set up in 1988 by the World Meteorological Organisation and the United Nations' environmental programme with a remit to assess on a "comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation".

The reports are written by teams of authors that are nominated by governments and international organisations according to their expertise. The IPCC's work takes place in three workstreams. Working Group 1 examines the scientific aspects of the climate system and climate change (the *Summary for policy-makers* of which was published this month). Working Group 2 assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it. Working Group 3 assesses options for limit-

ing greenhouse gas emissions and mitigating climate change. The latter two working groups will report later this year.

All the reports are reviewed by more specialists as well as by Governments. The *Summaries for policy-makers* are prepared concurrently with the main reports and are also subject to expert and government review. Line-by-line approval of the SPM takes place in a plenary session but lead authors must approve any changes. The main report is then modified to make it correspond with the SPMs. That explains why the main report of working group 1 has not yet been released.

The IPCC reports are widely seen to be the most authoritative assessments of the science of climate change. However, some critics say the process of preparing the SPMs allows scientific evidence to be 'cherry picked'. Last week, for instance, the Fraser Institute, a Canadian free market think-tank, published its own *Independent Summary for Policy-makers* which, its authors say, summarises the second

order draft of the IPCC working group 1 main report (the same report used by the IPCC to write its SPM). The Fraser Institute's report comes to somewhat different conclusions. It says the hypothesis that greenhouse gas emissions have produced a significant warming of the planet is credible but that available evidence allows this to be "credibly disputed". Furthermore, it says there is "no compelling evidence that dangerous or unprecedented changes are underway".

Meanwhile, the impression that the assessment reports are shaped by hundreds of scientists is misleading, according to climate scientist Roger Pielke Snr of the University of Colorado, Boulder. "The assessment reports are managed by only a small subset of climate scientists who often use a platform as Lead Author to promote their research and their particular perspective," he says.

*Independent summary for policymakers* is available at [www.ltonline.co.uk](http://www.ltonline.co.uk)

radiation and changes to land-use can all alter the energy balance of the climate system, notes the *SPM*. Climate computer models have been used to try and explain how such influences shape the global temperature record. These models are not discussed in detail in the *SPM* but their importance in helping to shape understanding was explained by Alan Thorpe, chief executive of the Government's Natural Environment Research Council, during last month's 'Climate Change Challenge' run on the organisation's website. "The size of the recently observed global warming, over a few decades, is significantly greater than the natural variations in long simulations with climate models if CO<sub>2</sub> is kept at pre-industrial levels," Thorpe explained. "Only if the human input of greenhouse gases is included does the simulated climate agree with what has been recently observed. Clearly factors currently unknown to science can't be included but we have no reason to suppose they exist."

The *SPM* says changes in solar irradiance since 1750 have caused a radiative forcing (the influence a factor has in altering the balance of incoming and outgoing energy in the Earth atmosphere system) of only +0.12 Watts per square metre. Of far greater importance, says the *SPM*, are the increasing global atmospheric concentrations of carbon dioxide brought about largely by fossil fuel use and land-use change, and emissions of methane and nitrous oxide arising from agriculture.

CO<sub>2</sub> is the most important anthropogenic greenhouse gas, says the *SPM*, with an estimated radiative forcing value of +1.66 watts per square metre. The *SPM* says that global atmospheric concentrations of CO<sub>2</sub> rose from a pre-industrial level (in 1750) of 280 parts per million (ppm) to 379ppm in 2005 and grew by 1.9ppm per year between 1995 and 2005. Burning of fossil fuels is the primary source of increased atmospheric CO<sub>2</sub> emissions, it says, with land-use change providing another significant but smaller contribution (the ratio was about 4:1 in the 1990s).

## Looking ahead

The *SPM* estimates that a global average surface warming following a doubling of CO<sub>2</sub> concentrations is "likely [that is, more than 66%] to be in the range 2 to 4.5°C with a best estimate of about 3°C and is very unlikely [less than 10% chance] to be less than 1.5°C."

The final section of the 21-page *SPM* discusses predictions of future changes in climate, drawing on climate modelling. Critics believe that too much credence is given to the model results (see panel right) when some important aspects of the climate system are, by the IPCC's own admission, still poorly understood (the *SPM* notes, for instance, that there is still medium-low understanding of important radiative forcings such as aerosols).

The media made much play of the 6.4°C temperature change cited in the *SPM* but this is the upper limit of change predicted in a scenario in which CO<sub>2equivalent</sub> concentrations would reach 1,550ppm by 2100 – a near quadrupling from today's levels of 430ppm. Furthermore, the *SPM* says the likely temperature range in this scenario is actually

## Cosmic rays and concerns about modelling

Last month the National Environment Research Council invited those sceptical of the science underpinning man's effect on the climate to challenge NERC's panel of experts in a web-based Climate Change Challenge. Alan Thorpe, NERC's chief executive, told contributors: "We are confident about the greenhouse effect. We are confident that warming is going on. We are confident that human activity is adding carbon dioxide to the atmosphere. Carbon dioxide is a greenhouse gas. The onus is now on those who deny this to say why that additional greenhouse effect is not responsible for warming the planet."

Although the perception is often of a polarised debate within the scientific community between a majority who endorse the IPCC viewpoint and a minority who attribute change to natural factors, this oversimplifies a discussion with many different facets and a diversity of views.

Some scientists do believe that natural factors can explain climate change. In the book *The chilling stars*, to be published next month, Danish physicist Henrik Svensmark and Nigel Calder, the former editor of *New Scientist*, will point the finger at cosmic rays. Calder, writing in *The Sunday Times* last weekend, said: "More cosmic rays [equals] more clouds. The sun's magnetic field bats away many of the cosmic rays and its intensification during the 20th century meant fewer cosmic rays, fewer clouds, and a warmer world... We are not exaggerating, we believe, when we subtitle the book 'A new theory of climate change'."

Climate scientist Roger Pielke Snr of the University of Colorado, Boulder believes the IPCC and policy-makers generally are too focused on CO<sub>2</sub> emissions. "Humans are significantly altering the global climate but in a variety of diverse ways beyond the radiative effect of carbon dioxide," says Pielke, a former co-chief editor of the *Journal of Atmospheric Science*, on his *Climate Science* weblog. He praises the analysis in the US National Research Council's 2005 report *Radiative Forcing of Climate Change*, which concluded that changes in land-use and industry emissions (aerosols) have much larger regional climate impacts than revealed in the way the IPCC calculates radiative forcing.

Pielke says the spatial concentration of aerosol emissions and land-use changes means that they present a greater threat of bringing about 'threshold' changes to the climate system than rising global CO<sub>2</sub> concentrations. "As a simple example of this, we find a greater impact of sunlight on a piece of paper when we focus it with a lens," he told *LTT*. He says the emphasis on cut-

ting CO<sub>2</sub> to control temperature is "scientifically flawed", estimating that man's CO<sub>2</sub> emissions have accounted for about 30% of warming up to the present – substantially lower than the IPCC estimates.

Pielke (who is a co-author of the book *Human impacts on weather and climate*, the second edition of which is to be published by Cambridge University Press this month) also disputes many of the observational records that underpin the IPCC analysis, such as global surface land surface temperature, glacier retreat and ocean temperature. "The reported 'warming' from the Hadley Centre/University of East Anglia's Climatic Research Unit data [the source of the IPCC's 0.7°C warming estimate] has a warm bias of significant value (certainly tenths of a degree) in its construction," he says. On glacier evidence he says recent peer reviewed research shows that "the general message that glaciers are receding almost everywhere is clearly not accurate when the data is evaluated in detail".

Climate physicist Professor Richard Lindzen of the Massachusetts Institute of Technology in the US disagrees vehemently with alarming global warming predictions. Lindzen, who was a lead author for the IPCC's third assessment report, says there is broad agreement that the world warmed in the 20th century, that CO<sub>2</sub> is a greenhouse gas and that man has been responsible for recent increases in CO<sub>2</sub>. But he says the temperature change of a few tenths of a degree recorded in the late 20th century is so small that it could be explained by nothing more than "natural, internal, unforced variability".

Lindzen says climate models vastly overestimate temperature changes resulting from increases in CO<sub>2</sub>. All other things being equal, Lindzen says a doubling of CO<sub>2</sub> should result in a global mean warming of just 1°C. "Alarming predictions all require that water vapour and clouds act so as to greatly amplify the impact of CO<sub>2</sub>," he (and fellow critics) say in a recent critique of the Stern Review published in *World Economics*. "But it is freely acknowledged, including by the IPCC, that water vapour and especially clouds are poorly modelled, while the underlying physics for determining their behaviour is missing or even unknown."

Pielke believes many scientists, policy-makers, journalists and other commentators place too much confidence in climate model results. "The overselling of regional and global models as robust projections rather than as sensitivity simulations, adds to the existing politicisation of climate science and provides justifiable criticism of the [IPCC] assessment reports," he says.

2.4°C-6.4°C with a best estimate of 4°C. Concentrations of 600ppm CO<sub>2e</sub> are predicted to raise temperatures by 1.8°C under a best estimate on a range of 1.1-2.9°C.

The predicted sea level rise presented in the *SPM* now ranges from just 18cm to 59cm (comparing 2090-2099 with 1980-1999) depending on the emission scenario modelled. This is a narrower band than the 9-88cm presented in the TAR. The AR4 emphasises that the new figures do not assume significant increases in melting of the Greenland and Antarctic ice sheets, which it says is a possibility as global temperatures rise.

The *SPM* predicts that:

- sea ice will shrink in both the Arctic and Antarctic. "In some projections, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century."
- hot extremes, heat waves and heavy precipitation events will become more frequent.
- tropical cyclones are likely to become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures. Extra-tropical storm tracks are projected to move poleward.
- increases in the amount of precipitation are very likely in high latitudes, while decreases

are likely in subtropical land regions.

## Political consensus

Environment secretary David Miliband said the *SPM* represented "another nail in the coffin of the climate change deniers and represents the most authoritative picture to date, showing that the debate over the science of climate change is well and truly over." Miliband's statement is hard to defend scientifically because even if one accepts anthropogenic warming there remain great uncertainties about the size of impacts. But his statement is a more accurate portrayal of the policy debate. Benny Peiser, a climate change policy analyst at Liverpool John Moores University, says that with policy-makers around the world agreeing (for the timebeing at least) that the science is settled, the debate is now on policy responses. "From a policy perspective this is now about the most cost-effective approach to dealing with climate change," says Peiser. "Do we go for revolutionary change as advocated by climate alarmists, or gradual adjustment as suggested by climate moderates?"

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Roger Pielke Snr, University of Colorado