



Scientific Response to “The Great Global Warming Swindle”

Compiled by University of Cambridge Programme for Industry

Editor: Claire Parker, Environmental Policy Consultant

You may have watched, or heard about, the television programme ‘*The Great Global Warming Swindle*’, shown on Channel 4 on Thursday 8 March. The programme put into question the prevailing consensus that carbon dioxide (CO₂) released by human activity is the cause of rising global temperatures.

The issues raised in the programme should not be left unanswered. Cambridge Programme for Industry have therefore compiled, with the help of distinguished scientists from world renowned UK institutions, a short summary of what constitutes the present scientific consensus on the most important of these issues.

Internationally, this consensus is embodied in the assessments of the Intergovernmental Panel on Climate Change (IPCC), the world’s most authoritative voice on climate change. These assessments are prepared by thousands of scientists world-wide, on the basis of peer-reviewed science and by an open and transparent review process. The latest such assessment is being published this year. It confirms that human activities are responsible for current global warming and that dangerous climate change can only be avoided if urgent action is taken at global level.

Have temperatures not been as high as they are now - or even higher - in the past?

Temperatures have been higher in the distant past. However, for the Northern Hemisphere at least, it is clear that rapid warming of the past half century has resulted in temperatures not seen in at least 500 years, and likely for at least the past 1,300 years. For the Southern Hemisphere, long records of temperatures are more scarce and it is therefore difficult to draw such clear conclusions. The important characteristic about the current warmth is that it is global, whereas many previous warming periods have occurred over smaller areas.

Climate models indicate that if greenhouse gas emissions continue unabated, by the 2050s the global temperature could reach a level not seen since the last interglacial period, around 125,000 years ago.

Source:

Secretary of State David Miliband

UK Department for Environment, Food & Rural Affairs (DEFRA)

Personal blog: http://www.davidmiliband.defra.gov.uk/blogs/ministerial_blog/default.aspx

Are the changes in global temperature observed during the past century not within the range of natural variability?

The IPCC's Fourth Assessment Report (2007) concludes that there is a more than 90% chance that the observed warming since the 1950s is due to the emission of greenhouse gases from human activities. As shown in the figure below, the warming patterns cannot be explained by natural factors alone: the blue band represents the temperature range derived from the climate models when only natural factors are taken into account. The pink band shows the temperature band to be expected when both human emissions and natural factors are taken into account, and closely follows the curve of measured temperatures.

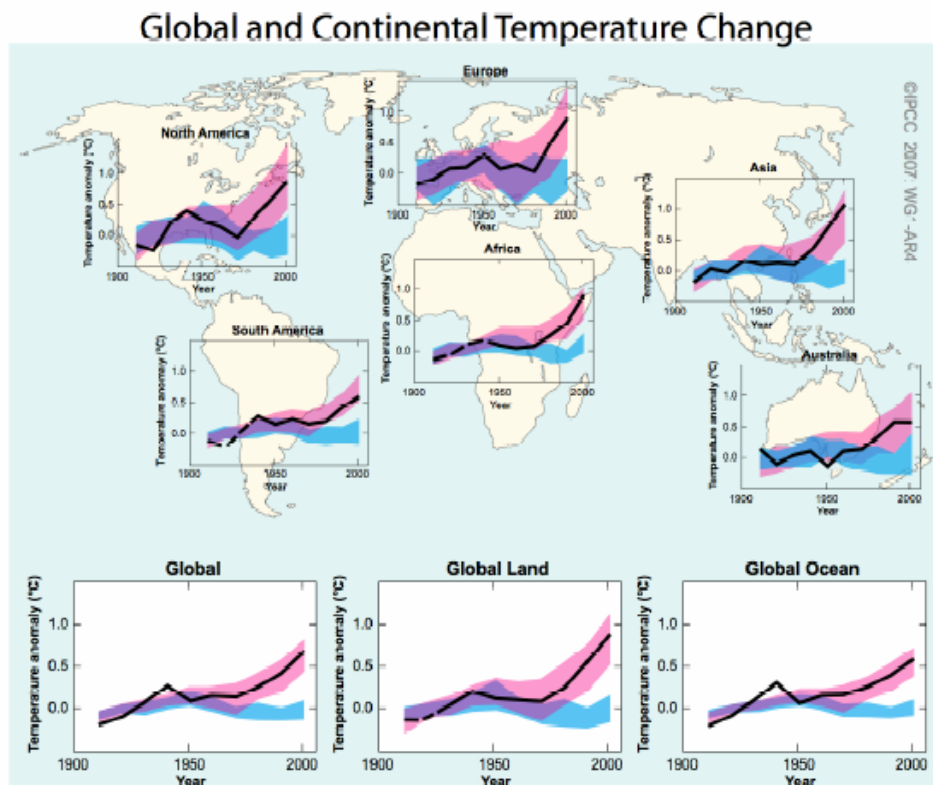


FIGURE SPM-4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906–2005 (black line) plotted against the centre of the decade and relative to the corresponding average for 1901–1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5–95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5–95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. {FAQ 9.2, Figure 1}

Source:

IPCC, Fourth Assessment Report, The Physical Science Basis, Summary for Policy Makers
<http://www.ipcc.ch/SPM2feb07.pdf>

Why are the trends of CO₂ concentrations and temperature over the past century not consistently similar?

There was a cooling period from the 1940s to the 1970s: this was a period of increasing industrial activity during which sulphate aerosols were emitted in large quantities, before emission were reduced as a result of legislation to control air pollution (SO₂).

In addition, CO₂ induced changes in temperature lag behind changes in CO₂ concentrations. When this lag is taken account of in models, the results are consistent with a correlation, as shown in the Figure SPM-4 above.

In the past, CO₂ changes have actually preceded temperature changes - does that not invalidate the correlation?

PROFESSOR CHRIS RAPLEY CBE, BRITISH ANTARCTIC SURVEY, writes:

This refers to the records of Antarctic climate and CO₂ obtained from Antarctic ice cores covering the last 650,000 years. In these, the Earth can be seen to undergo natural changes from glacial conditions to warmer times like the present. When temperature is warm, the CO₂ concentration is high, and when temperature is cold, the CO₂ concentration is low. During the exit from glacial periods (for example the transition from the last cold period, between about 18,000 and 11,000 years ago), both temperature and CO₂ increased slowly and in parallel.

Close analysis of the relationship between the two curves shows that, within the uncertainties of matching their timescales, the temperature led by a few centuries. This is expected, since it was changes in the Earth's orbital parameters (including the shape of its orbit around the Sun, and the tilt of Earth's axis) that caused the small initial temperature rise. This then raised atmospheric CO₂ levels, in part by out-gassing from the oceans, causing the temperature to rise further. By amplifying each other's response, this "positive feedback" can turn a small initial perturbation into a large climate change. There is therefore no surprise that the temperature and CO₂ rose in parallel, with the temperature initially in advance. In the current case, the situation is different, because human actions are raising the CO₂ level, and we are starting to observe the temperature response.

Are human emission not small compared to emission from volcanoes?

PROFESSOR CHRIS RAPLEY CBE, BRITISH ANTARCTIC SURVEY, writes:

This is untrue: current annual emissions from fossil fuel burning and cement production are estimated to be around 100 times greater than average annual volcanic emissions of CO₂. That large volcanoes cannot significantly perturb the CO₂ concentration of the atmosphere is apparent from the ice core and atmospheric record of CO₂ concentrations, which shows a steady rise during the industrial period, with no unusual changes after large eruptions.

As most of the CO₂ is in the ocean, are the (relatively small) amounts released by burning fossil fuels not irrelevant?

PROFESSOR JOHN SHEPHERD FRS, TYNDALL CENTRE FOR CLIMATE CHANGE RESEARCH,
NATIONAL OCEANOGRAPHY CENTRE, UNIVERSITY OF SOUTHAMPTON, writes

“The oceans contain indeed about 95% of the natural CO₂ in the ocean/atmosphere/biosphere system, and about 90% of the man-made CO₂ will also end up in the oceans eventually (i.e. in about 1,000 years’ time). The atmosphere normally contains only about 2% of the total CO₂ (the rest is in the terrestrial vegetation and soils). However, the amount released by burning fossil fuels has been sufficient to increase atmospheric concentrations by about 35%, even though about half of it has actually already been absorbed by the oceans and the terrestrial biosphere. It is CO₂ left in the atmosphere that really matters, because that is where it causes the greenhouse effect, and whether or not there is also a large amount in the ocean is irrelevant.

The oceans release CO₂ as they get warmer : the solubility of CO₂ in water decreases by about 4% per °C, so the atmospheric CO₂ concentration in equilibrium with seawater would increase by the same amount, per °C. This process leads to a fairly small positive feedback (and hence amplification) of any global warming processes. However, this is not sufficient to explain the natural glacial-interglacial variations of atmospheric CO₂ observed in the ice-core record. Correlation does not necessarily imply causation (although it may provide support for a quantitative and plausible mechanism of the causal linkage). However, the glacial-interglacial temperature difference is estimated to have been only about 5 °C, so this effect would only explain a 20% increase (5 times 4%) in CO₂ during warm interglacial periods like the present one. The observed increase from the pre-industrial level was actually about 55% (280 ppm compared to 180 ppm) so this simple temperature effect is only about one third of the size needed to provide an adequate explanation of the increase.

In fact, we still do not have a full quantitative explanation of the very high correlation between CO₂ and temperature during glacial-interglacial cycles. The estimated greenhouse effect due to the change of CO₂ (i.e. assuming that this alone might have caused the warming) is also only about half of that required to explain the temperature change. Thus although there are known effects by which temperature raises CO₂ and vice versa, in a mutual closed loop relationship, the estimated magnitudes of the effects are too small (by a factor of two or three in both directions) for this to be the whole story. This is an outstanding “greenhouse puzzle” and the subject of intensive current research.”

Is there not a discrepancy between the patterns of warming in the atmosphere and what would be expected from the effect of rising greenhouse gas concentrations?

PROF. JOHN MITCHELL OBE FRS, DIRECTOR OF CLIMATE SCIENCE AT THE MET OFFICE, writes:

“We expect greater warming in the upper atmosphere than at the surface in the tropics, but the reverse is true at high latitudes. This expectation holds whether the cause of warming is due to greenhouse gases or changes in the Sun’s output. Until recently, measurements of the temperature changes in the tropics in recent decades did not appear to show greater warming aloft than at the surface. It has now been shown that allowing for uncertainties in the observations, the theoretical and modelling results can be reconciled with the observations.

The bottom line is that observations are now consistent with increased warming through the troposphere.”

Can the effects of cosmic radiation, and of solar activity, explain the observed increase in global temperatures?

Changes in solar activity do affect global temperatures. However, increased greenhouse gas concentrations have had a much greater effect than changes in the sun’s energy over the last 50 years. Variations in cosmic rays over the past decades cannot explain the warming trend either.

PROFESSOR JOANNA D. HAIGH, IMPERIAL COLLEGE LONDON, writes:

“Changes in the solar radiation reaching the Earth do influence climate. Variations in the Earth’s orbit around the Sun are the main driver for the 100,000 year cycle in Ice Ages. Warming produced thus is likely enhanced by carbon dioxide and methane subsequently released from the warmer oceans (and cooling likewise enhanced by re-absorbance). This does not allow the interpretation that current increases in carbon dioxide concentration are in response to (solar-induced) global warming because the rate of increase is far too fast..

Changes in solar output do influence climate. Estimates of variations in the Sun’s radiative output over the past century suggest that it made significant contributions to the warming in the first half of the 20th century, and to the temperature stability between about 1940 and 1970, but that it could not be responsible for the warming over the latter part of the century.

Clouds and cosmic rays. Cosmic rays are more abundant in the atmosphere when the Sun is less active and it has been suggested that enhanced incidence of cosmic rays may induce an increase in cloudiness. The evidence which has been produced apparently showing a correlation between cloud cover and cosmic rays relies on judicious choice and dubious manipulation of cloud datasets.

The physical mechanism whereby an increase in cosmic rays can induce cloudiness is also not well established. The air ions produced by the cosmic rays may act as condensation nuclei and there is some evidence suggesting that charged molecular clusters grow faster than neutral clusters. However, to reach the size for an embryo cloud droplet would take several days and it has not been demonstrated that ion-induced cloud nucleation will have a significant effect in competition with all the other processes producing cloud droplets.”

PROFESSOR N.O. WEISS FRS, D.A.M.T.P., CENTRE FOR MATHEMATICAL SCIENCES, UNIVERSITY OF CAMBRIDGE, writes:

“Solar magnetic activity manifests itself in sunspots, flares and coronal mass ejections, which give rise to magnetic storms on earth. The incidence of sunspots, which are the sites of strong magnetic fields, varies cyclically with a period of about 11 years. This cyclic pattern is occasionally interrupted by grand minima, like the Maunder Minimum in the 17th century, when scarcely any spots appeared. From variations in abundances of cosmogenic isotopes such as C-14 (which is preserved in trees) and Be-10 (which can be measured in polar ice cores) we know that grand minima have recurred irregularly for at least the last 50,000 years. For the past 50 years, solar activity has in fact been abnormally high, but such grand maxima do not last forever. The current boom will inevitably be followed by a slump, though it is impossible to forecast quite when this will happen, or how deep the ensuing grand minimum will be.

Although sunspots are themselves dark, they are accompanied by bright faculae. Satellite observations show that the solar irradiance is actually greater at sunspot maximum than at sunspot minimum, though the change of only 0.1% is slight, corresponding to a variation of 0.1 degrees Celsius in average global temperature. A grand minimum might lead to a similar reduction in irradiance. Of course, the effects of solar variability on the earth's climate, which is a very complex system, could be amplified by other processes. For instance, the Sun's ultra-violet emission doubles from sunspot minimum to maximum, and ultra-violet radiation affects the ozone content of the stratosphere, which is coupled to the troposphere below it and so influences the overall climate. Again, it has been suggested that solar modulation of the flux of galactic cosmic rays affects cloud formation, altering the earth's albedo and thereby affecting climate (though this hypothesis is very shaky). There might also be resonant coupling between variations in solar activity and natural oscillations in the atmosphere or ocean.

The extent of any such climatic modulation can be estimated from the long-term record of global temperatures. Until the beginning of the last century, variations in solar activity, along with aerosol emission from volcanoes, dominated climatic variability. There is persuasive evidence that grand minima were indeed associated with colder periods and grand maxima with warm periods. During the past millennium, there were several such maxima and minima, with associated fluctuations of around 0.3 degrees Celsius in global temperature. Such changes are significantly smaller than the increase of almost one degree over the last hundred years.

It follows, therefore, that solar activity is not a major contributor to current global warming.”

Will measures taken to avoid dangerous climate change - such as reducing emissions of CO₂ and other greenhouse gases - be detrimental to developing countries?

The impacts of climate change are already occurring and the poorest countries (and the poorest vulnerable communities world-wide) are and will be the most affected. However, as a matter of fairness, these countries should be allowed to develop in a sustainable way. This is being recognized by the policy makers who are negotiating a new phase in the international climate regime.

The communiqué of the meeting of the G8 Ministers for Environment (Potsdam, 16 March 2007) recognizes that:

“ economic and social development, poverty alleviation and access to affordable energy and raw materials are all part of an overall package...”

SALEEMUL HUQ, HEAD, CLIMATE CHANGE GROUP, INTERNATIONAL INSTITUTE FOR ENVIRONMENT AND DEVELOPMENT (IIED), LONDON , writes

“The forthcoming *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) will make it clear that the impacts of human induced climate change may already be discernible in many parts of the world. While it is not possible to attribute any single climatic impact (such as Hurricane Katrina) to human induced climate change, nevertheless the

accumulation of severe climatic impacts across the globe, from hurricanes in the Pacific, Indian and Atlantic oceans, to floods in the major river deltas in Asia, to the droughts in mid-continent of Africa and Latin America, to heat waves in Europe and forest fires in the North America, all point to strong evidence that climate change may already be occurring (and is therefore, no longer just a problem of the future).

The IPCC assessment also makes it clear that some parts of the world, both in terms of ecosystems and people, will be more adversely affected than others. Thus the poor countries as well as poor and vulnerable communities in all countries (even in the richer countries) will be more adversely affected than others. This means that climate change needs to be tackled by both continuing to reduce emissions of the greenhouse gases that cause the problem as well as adapting to the inevitable and unavoidable impacts in the near term.

While richer countries will be (by and large) able to take care of their own vulnerable populations (though this is not at all a given, as the poorer people of New Orleans learned during Hurricane Katrina), the poor countries (such as the small island developing states, the least developed countries and the sub-Saharan African countries) will suffer the most severe impacts which they have very little capacity to deal with. These, vulnerable countries cannot deal with climatic shocks of today - let alone more severe shocks due to climate change in future.

Thus, the issue of how to deal with the climate change problem for most developing countries is intimately linked to their own development strategies as they try to combat poverty and attain sustainable development. This manifests itself in two ways; firstly, the larger developing countries such as China, India and Brazil, who are both major emitters of greenhouse gases and vulnerable to impacts of climate change, need to integrate climate issues in their development for both mitigation as well as adaptation. This means making their energy, transport and industrial development more climate-friendly (i.e. emitting less greenhouse gases) while making other sectors (e.g. water management, agriculture, disaster management,) more climate-proof (i.e. more resilient to the possible adverse impacts of future climate change).

Secondly, for the most vulnerable developing countries (i.e. the small island developing states, the least developed countries and the countries in sub-Saharan Africa) who are not major emitters of greenhouse gases, it means focusing primarily on adaptation by making their development actions and investments more climate-proof.

It also means developing greater adaptive capacity amongst all relevant groups within all the developing countries, including government, sectoral planners, investors, non-governmental organisations and the vulnerable communities themselves. It will also mean providing the poorer countries with external help as they do not have the capacity to do all of this themselves.

The rich countries who have signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) are obliged (under Articles 4.8 and 4.9 of the Convention) to provide such financial and other assistance to the poorer and more vulnerable developing countries to assist them to adapt to the potentially adverse impacts of climate change. A number of new funds to support such adaptation activities in the poorer developing countries have been approved but the amounts of funding pledged so far (a few hundred million Dollars) has been quite small compared to the needs (tens of Billions of Dollars).”

Acknowledgements

Cambridge Programme for Industry wishes to express its gratitude to all contributing authors. In addition to the contributions, information from the following websites has been used to compile this summary:

The Met Office

<http://www.metoffice.gov.uk/corporate/pressoffice/myths/index.html>

DEFRA, Secretary of State David Miliband's blog

http://www.davidmiliband.defra.gov.uk/blogs/ministerial_blog/default.aspx

RealClimate

<http://www.realclimate.org/index.php/archives/2007/03/swindled/#more-414>

The John Ray Initiative, by Sir John Houghton

http://www.jri.org.uk/index.php?option=com_content&task=view&id=137&Itemid=83

The Royal Society "Guide to facts and fictions about climate change"

<http://www.royalsoc.ac.uk/page.asp?id=2986>

For more general scientific background:

Houghton, J. T. (1997). The Physics of Atmospheres, second edition, CUP.

Maslin, M. (2004). Global warming: a very short introduction. Oxford, OUP.

see also some basic Climate Dynamics lectures (Nos. 1 to 4) at

<http://www.jgshepherd.com/lectures/index.htm>

