

The IPCC's cardinal error

By Christopher Monckton of Brenchley

ON 5 November 2006, I wrote in the London *Sunday Telegraph*, Europe's largest-selling quality Sunday newspaper, that the United Nations' climate-change panel, the IPCC, had in effect repealed a fundamental physical law so as to exaggerate beyond reason the supposed effect of greenhouse gases on temperature.

Pandemonium followed. Within an hour or two of publication, the *Sunday Telegraph* website received 127,000 hits on my article. Never before or since have so many hits been received in so short a time. The site crashed.

An hour or two after that, the editor began to receive letters from all round the world, claiming that my calculations had treated the Earth as a blackbody, absorbing and emitting all the solar radiation incident upon it, when in fact it is a badly-behaved greybody. The letters were part of a swiftly-organized, extravagantly-funded, well-organized campaign to divert attention away from the elaborately contrived and still more elaborately concealed cardinal error in the official calculations of the IPCC. None of the letters was published, for the newspaper saw through the campaign.

Next, a website run by two of the authors of the now-discredited "hockey-stick" graph repeated the nonsense that I had treated the Earth as a blackbody, adding for good measure that the equation I had used – the Stefan-Boltzmann radiative transfer equation – applied only to blackbodies.

This pseudo-scientific gibberish was picked up and repeated in an 1800-word rant by a more than averagely incompetent zoologist writing for a left-leaning daily newspaper in the UK. I threatened to sue. The newspaper printed a strongly-worded correction by me the following day.

Next, a page repeating the zoologist's nonsense appeared on Wikipedia. All attempts by me to correct the numerous scientific errors on the page were instantly deleted. I threatened to sue. The page was taken down, but a biography of me on Wikipedia was then attacked and filled with the same nonsense. My lawyers are now preparing legal action to ban Wikipedia (now a music-hall joke in the UK for inaccuracy) from broadcasting any mention of me at all on the internet.

Recently I dined with the President of the Royal Society, who is also the Astronomer Royal. Both he and the Royal Society (Britain's oldest taxpayer-funded lobby-group) are fervent climate-change alarmists. He said he had read my article in the *Sunday Telegraph*, but had given up halfway when he realized I had misunderstood the Stefan-Boltzmann equation, in that I had applied it to the Earth (a greybody), when it applied only to blackbodies.

Why would no less a personage than the Astronomer Royal, a year after my original article, so brazenly and so nonsensically participate in the international campaign to divert attention away from the Stefan-Boltzmann equation?

You need to know three things about the equation. First, it is the fundamental physical equation which converts radiant energy to temperature, and without it we could only guess at the effect of greenhouse gases on the Earth's temperature. Secondly, it applies to greybodies like the Earth just as much as to blackbodies, though at the surface and further up in the atmosphere the Earth in fact radiates as a blackbody. Thirdly – and you may find this hard to believe – the Stefan-Boltzmann equation is not mentioned even once in the 1100 pages of the IPCC's 2001 report or in the 1600 pages of the 2007 report.

The IPCC's cardinal error is in its logically inconsistent and prodigiously exaggerated estimate of the effect of what is called the "radiative forcing" effect of increases in greenhouse-gas concentration on global temperature.

We mathematicians call this variable dT / dE – the change dT in temperature in response to a given change dE in radiant-energy flux.

In chapter 6.1 of the 2001 IPCC report, Ramanathan *et al.* are quoted with approval as saying that a radiant-energy-to-temperature conversion factor dT / dE of 0.5 degrees Kelvin per watt per square meter of radiant energy is typical (though, in traditional IPCC fashion, this is qualified with the phrase “other values are possible”).

The IPCC's 2007 report, for the first time, gives figures allowing us to deduce that it thinks dT / dE before allowing for temperature feedbacks is around $0.27 \text{ K W}^{-1} \text{ m}^2$. The report also quantified and tabulated the main climate-relevant temperature feedbacks that IPCC thinks amplify the base forcing. These sum to 2.15 watts per square meter per degree Kelvin of temperature increase occurring as a result of any given forcing.

Next, we go to a footnote in Chapter 8 of the 2007 report, which, for the first time, gives a function that allows calculation of mutual reinforcement of temperature feedbacks. A temperature feedback is an additional increase in temperature which the IPCC thinks will arise simply because temperature has already increased as a result of a forcing.

The footnoted function increases the forcing arising from climate feedbacks from 2.15 to $3.01 \text{ W m}^{-2} \text{ K}^{-1}$. Armed with these data, you can calculate the IPCC's implicit final value dT / dE after allowing for its listed feedbacks, as follows: $0.27 \text{ K W}^{-1} \text{ m}^2$ for the base forcing, plus $3.01 \times (0.27)^2 = 0.22 \text{ K W}^{-1} \text{ m}^2$ for the mutually amplified feedbacks, gives $0.5 \text{ K W}^{-1} \text{ m}^2$. This is respectably close to Ramanathan's value as in IPCC (2001).

However, if we multiply $0.5^\circ \text{ K W}^{-1} \text{ m}^2$ by the 3.65 W m^{-2} of forcing for a doubling of CO_2 concentration, we get only 1.8 degrees Kelvin of temperature increase in response to the CO_2 doubling, compared with the IPCC's central estimate of 3.2° K .

Note that this internal logical inconsistency allows the IPCC almost to double the true effect of CO_2 on temperature, implying that the central estimate of the crucial parameter dT / dE is $3.2 / 3.65 = 0.9^\circ \text{ K W}^{-1} \text{ m}^2$, not the $0.5^\circ \text{ K W}^{-1} \text{ m}^2$ previously stated by the IPCC.

The true exaggeration is actually far worse, as we can tell the moment we abandon the model-based guesswork of the IPCC in favour of doing some not particularly complex real-world observations.

In 1990 the total greenhouse effect, natural and anthropogenic caused an increase in temperature of little more than 20°K , and Kiehl & Trenberth (1997) say that the additional radiant energy caused by the total greenhouse effect in 1990, as opposed to having no greenhouse gases in the atmosphere at all, was about 100 W m^{-2} . So observed dT / dE in 1990, which must by implication include all feedbacks resulting from the natural greenhouse effect, equals not $0.9^{\circ}\text{K W}^{-1}\text{ m}^2$, as implied by the IPCC's central estimate of climate sensitivity, nor $0.5^{\circ}\text{K W}^{-1}\text{ m}^2$, as stated by Ramanathan in IPCC (2001) and as calculated from IPCC (2007), but only $0.2^{\circ}\text{K W}^{-1}\text{ m}^2$.

We get much the same result by considering the anthropogenic greenhouse effect on its own. Taking the 0.4°K of temperature increase attributable to us since 1750, adding half as much again to allow for the possibility that the climate has not yet reached equilibrium as a result of our perturbation of it, and dividing the resulting 0.6°K by the 3.01 W m^{-2} of radiant-energy forcing caused by us between 1750 and 1990, you get a similar value for dT / dE .

Our empirical approach, looking at real-world observations rather than elaborately modelled guesswork, suggests that a doubling of CO_2 concentration would add only $0.2 \times 3.65 = 0.73^{\circ}\text{K}$ to global temperature, not the 3.2°K central estimate of the IPCC.

Can we confirm this result by using the theoretical physics of the atmosphere? Step forward the missing Stefan-Boltzmann equation.

We know from Kiehl & Trenberth (1997), in their seminal paper on the Earth's radiation budget, that at the surface there is 390 W m^{-2} of radiant-energy flux. Mean global surface temperature in 1990, the reference date for that paper, was 288 degrees Kelvin.

Here's where the equation ignored in thousands of pages of the IPCC's ramblings comes in. The equation, first discovered empirically by the Slovenian physicist Stefan and demonstrated theoretically a decade or so later by his Austrian pupil Boltzmann, says that radiant-energy flux E in watts per square meter is equal to the propensity of the astronomical body under consideration to absorb and emit radiation (i.e. the emissivity, usually labelled epsilon), multiplied by the constant sigma = 0.000000567, multiplied by the fourth power of the temperature T in degrees Kelvin. Thus –

$$E = \epsilon \sigma T^4 \quad \text{W m}^{-2}$$

Since we know the values of the terms E , sigma, and T , we can readily calculate that emissivity at the surface is 1, indicating that, if Kiehl & Trenberth's analysis is correct, the Earth/troposphere system radiates as a blackbody at the surface.

If we hold emissivity constant, as we must if we are to compare radiative forcings like for like over time as the IPCC does (and no significant error will arise if we do), then we can calculate dT / dE directly from the Stefan-Boltzmann equation by taking the reciprocal of its first derivative, and the answer is – you've guessed it – $0.2^{\circ}\text{K W}^{-1}\text{ m}^2$, not the $0.9^{\circ}\text{K W}^{-1}\text{ m}^2$ central value given by the IPCC.

We can do a similar calculation at what is known as the “characteristic emission level,” around four or five miles up in the troposphere. Here, the incoming and outgoing radiant-energy flux are in balance.

We know that the incoming energy flux at the top of the atmosphere is 1368 W m^{-2} . First, we discard 31% of this flux, because it is reflected straight back into space by the clouds and causes no warming. Next, we divide by four, to allow for the ratio of the area of a disk to the surface area of a sphere. Therefore the energy flux at the characteristic emission level is 236 W m^{-2} . The temperature at this level is 254 degrees Kelvin.

Once again, we check that emissivity is equal to 1, and then take the reciprocal dT / dE of the first derivative dE / dT of the Stefan-Boltzmann equation. This time $dT / dE = 0.27^\circ \text{ K W}^{-1} \text{ m}^2$. There is a good reason why this is rather higher than the $0.2^\circ \text{ K W}^{-1} \text{ m}^2$ we calculated before. All the IPCC's computer models predict that at the tropical mid-troposphere, roughly coincident with the characteristic emission level, the change in temperature over the decades should be two or three times greater than the change in temperature at the surface. Averaged over the whole mid-troposphere, the rate of change at altitude should be – and, on our figures, must be – about half as much again as the change in surface temperature.

So far we have not only exposed a logical inconsistency at the heart of the IPCC's calculations: we have also demonstrated by two empirical experiments and by two theoretical calculations that all of the IPCC's estimates of the temperature response to anthropogenic enhancement of the greenhouse effect are excessive by a factor of two and a half to seven.

There are also experimental ways to confirm this result. One of these, of course, is simply to measure whether the temperature in the tropical mid-troposphere has in fact been rising over recent decades at two or three times the rate of increase in surface temperature. Not one of the many radiosonde and satellite records of mid-tropospheric temperature shows the differential in warming rates that the IPCC predicts. Most show no differential at all. Indeed, the temperature actually seems to be rising more slowly at altitude than at the surface, strongly suggesting that anthropogenic enhancement of the natural greenhouse effect has very little to do with the relatively small and harmless warming that has occurred.

The IPCC is, of course, aware of this failure of observation to confirm the predicted tropical mid-tropospheric “hot-spot.” It circumvents the difficulty by saying that the measurements taken at altitude are so unreliable that the predicted “hot-spot” might in reality exist after all.

Remember this when you next hear your government advocating the destruction of the economy on the ground that “the science is settled.” The IPCC's entire case rests on the assumption that an effect essential to the IPCC's case that is predicted by its computer models must occur in reality, even though measurements have indicated that it does not occur in reality.

In the absence of the model-predicted tropical mid-troposphere “hot spot,” climate sensitivity – again, you guessed it – cannot be more than one-third of the IPCC's central estimate.

A knowledgeable colleague who has been working with me on these calculations believes that one reason for the IPCC's incorrect and prodigiously exaggerated value for dT / dE , upon which its entire argument for climatic alarm depends, arises because it is incorrectly assuming that the water vapor feedback (even after deducting an element for the moist adiabatic lapse rate) is strongly positive.

In fact, however, the IPCC has failed to allow for the cooling effect of the additional evaporation that must occur as the space occupied by the atmosphere carries near-

exponentially more water vapour as temperature rises, in accordance with the long-established Clausius-Clapeyron relation.

My eminent colleague's initial calculations, which are now being refined to harmonize with mine and those of another colleague, indicate - you guessed it - that dT / dE ought to be around 0.15 including only the water vapour feedback, and probably 0.2 if other temperature feedbacks are also taken into account.

A number of scientists are watching our email debate on this with more than passing interest. None has yet said that we are entirely wrong. One - an astrophysicist of formidable knowledge and experience - has reviewed the calculations in detail and has found them to be correct.

If we are right (which is possible, given the number of different ways of reaching the same far lower climate sensitivity figure than the IPCC), then the debate on climate change is indeed over, and in an unexpected direction.

Bottom line: if the climate sensitivity parameter dT / dE is only 0.2, then a 3.65 W m^{-2} doubling of CO_2 concentration would raise temperature not by the IPCC's imagined 3.2 K central estimate, but by about 0.75 K . And that is before allowing for other forcings, which the IPCC, in its increasing desperation to make its predictions bear some relation to observed reality as temperatures continue for the seventh year running to fail to rise, has now sharply adjusted downward.

The effect of including the other forcings thus reduced by the IPCC is to cut the estimated temperature response from a doubling of CO_2 concentration from 0.73 to 0.6° K . The IPCC's 3.2° K estimate is approximately five times too big. Our results are broadly consistent with those of Idso (1998), who, via a variety of empirical methods over almost a third of a century, concludes that 0.4° K for a CO_2 doubling is the right answer.

To put it another way, merely by correcting the IPCC's artfully-concealed cardinal error we achieve the equivalent of an 80% global cut in carbon emissions overnight.

To put it another way still, we can put as much carbon dioxide in the atmosphere as we like, and it will make very little difference to temperature. Even a quadrupling of atmospheric CO_2 , which is about as far as it can go before we run out of fossil fuels altogether, gives a warming of no more than 1.2° K .

How do we verify these results? You may have noticed that the 5-year moving average of global temperatures has flatlined since the IPCC's last report in 2001. This comes as a painful surprise to the alarmists, who are becoming more and more concerned that temperature is simply not rising as fast as they told us it would.

Try plotting the NCDC global land and sea surface temperature anomalies against Hansen's original scaremongering chart presented to Congress in 1988 and you will see what I mean. Global temperature has risen far more slowly than he predicted.

Of course, a few short years do not constitute a clear trend: but they are a warning to the alarmists. Hansen will almost certainly try to keep the flag flying by announcing as early as he can in the New Year that global temperatures are at a new 150-year record. The US

National Climate Data Center, however, which is less *parti pris*, will almost certainly not confirm his finding. Nor will the Hadley Center in the UK.

Given the calculations I have outlined here, the flatlining of temperatures in recent years is unsurprising. The true cause of the recent warming is almost certainly the Sun, which has been more active in the past 70 years than at almost any time in the whole of the past 11,400 years (Usoskin *et al.*, 2003; Solanki *et al.*, 2005).

The 2004 Symposium of the International Astronomical Union concluded that it was the recent solar “Grand Maximum” that had caused the 20th century’s warming; that anthropogenic climate change had very little to do with it; and that the warming would shortly come to an end. There have been very few sunspots for almost two years. This exceptional prolongation of the 11-yearly solar minimum presages a long period of slower solar activity and consequent global cooling, commencing in about ten years’ time.

When I outlined some of these results before a large audience at Lloyds of London recently, one of the audience asked, “Why don't the Press realize what a huge story there is in the fact that the IPCC has got its sums so wrong?” Alas, there is a simple answer to that. Which headline will sell more papers – “World To End Shock!” or “Climate Continuing Changeable”? The former is false but fun: the latter is true but tedious.