



THE CLIMATE MODEL AND THE PUBLIC PURSE

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Summary

A significant problem has been identified in the Met Office's HadCM3 climate model.

The nature of the problem is highly technical, but its implications are that the model, as it is currently used, will always produce high estimates of future warming. Observations suggest that long-term warming will be relatively low.

The estimates of future warming generated by the HadCM3 model are much higher than those implied by several recent studies based on observations.

The problem in the HadCM3 model has important implications for UK policy, since this model is used to generate the UK's official climate projections.

These climate projections are used to inform investment decisions across the public and private sectors.

It is therefore likely that the HadCM3 problem is leading to considerable malinvestment of public and private funds.

The error

A significant problem in the use of the Met Office's HadCM3 climate model has been identified and described by independent climate scientist Nic Lewis.¹ Lewis's report on the subject has been acknowledged by the Met Office, which has indicated that it will respond in due course.

The error, assuming it is substantiated, has important implications for UK policy. The HadCM3 model underpins the current version of the official UK Government climate projections, known as UKCP09. HadCM3 was also used in the previous version, UKCIP02, as well as being used in the Met Office's regional modelling system and, until recently, its decadal forecasting system.

In this section, a detailed description of the error is set out for the lay reader. However, it is not necessary to understand these details and readers may prefer to accept the existence of the error and skip to the next section.

The HadCM3 model generates a virtual representation of the global climate starting from basic physics – the greenhouse effect, evaporation of the oceans, cloud formation, rainfall, sunlight and so on. By increasing the concentrations of greenhouse gases in the model, an attempt can be made to predict how much warmer the planet will become in the future. In common with other climate models, HadCM3 includes a very large number of input assumptions. In normal usage, these are set to standard best-estimate values, and the model produces a quite high estimate of future warming. This was how the previous set of official UK climate predictions, UKCIP02, was generated.

¹ http://niclewis.files.wordpress.com/2013/09/metoffice_response2g.pdf

However, in reality, the best values to use for many of the inputs are highly uncertain. In recent years, the Met Office, recognising this problem, has started to deal with this uncertainty by processing a range of values for each input,² rather than a single value.³ The result is a range of alternative virtual climates, each one of which can then be weighted by how well it matches recent observations of the real climate, such as sea and land temperatures, rainfall and humidity, and also historical changes in surface temperatures. The Met Office claims that doing so enables HadCM3 to take into account all plausible uncertainties in the response of the climate to greenhouse gas warming, enabling end-users to understand not only the most likely future climate, but also how good or bad things might become.

However, it seems that the Met Office's claim is mistaken.

A critical factor in the model's estimate of long-term future warming ('climate sensitivity') is the way in which it represents low-level clouds.⁴ However, these clouds also turn out to be pivotal in the representation of the cooling caused by pollution ('aerosol forcing'), which is critical in the shorter term.⁵ It is therefore difficult for climate modellers to represent both factors independently at the same time. It appears that the Met Office have been unable to do so, with the result that HadCM3 can only simulate certain combinations of these two factors.

In the understanding of most mainstream scientists, the real climate response to carbon dioxide currently lies between one of two extremes:

- large long-term warming is being heavily masked by a strong cooling effect from pollution
- lower long-term warming is being lightly masked by a much smaller aerosol cooling.

However, the HadCM3 model does not behave in this way. If the input assumptions are adjusted so as to generate relatively low long-term warming,⁶ the model simultaneously adjusts the cooling effect of pollution to be very large. In fact, the values the model generates for the effects of pollution in such circumstances are implausibly large when compared to estimates derived from observations. Moreover, if long-term rates of warming are low and the cooling effect of pollution is high then we should have seen little or no warming since industrialisation. This means that the virtual climate generated by the model in these circumstances does not match global temperature observations either.

What appears to have happened is that in the HadCM3 model, the representations

2 In other words, a probability distribution.

3 Within ranges that are considered plausible by Met Office or other scientists.

4 For example, their extent and other properties.

5 The terms aerosol and pollution are not entirely synonymous, but the difference is beyond the scope of this paper.

6 It should be noted that the 'relatively low' values for of long-term warming that lead to a strong cooling effect from pollution are by no means very low – they are above the estimates from several recent observational studies. In fact, apart from the inconsistently high aerosol cooling problem, the HadCM3 model does not produce a climate sensitivity as low as some of those estimates at any of the varied parameter value combinations used.

of the effects of low-level clouds on long-term warming and short-term cooling have become inextricably linked, with the result that when the inputs are set in such a way that they give low long-term warming the outputs generated – the cooling effect due to pollution and the virtual climate – are unrealistic.

As noted above, the final prediction generated is a weighted average of a set of alternative virtual climates, the weight each receives being determined by how well it matches the observations. The problems described above mean that when the input assumptions are such that long-term warming is low, the consequent mismatch between the virtual and real pollution effects and the virtual and observed global climates mean that the allocated weight is extremely low. Such scenarios are therefore effectively written out of the final result.

This means that, contrary to the Met Office's claim, not all plausible climates can be generated by HadCM3: climates with low long-term warming and low cooling due to pollution are impossible to simulate. Since observational evidence suggests that both factors are indeed low, this means that HadCM3 must be considered an unsatisfactory model for generating the UKCP09 climate projections. As a result of this problem, those projections will have a substantial warm bias.

The earlier UKCIP02 projections did not use the probabilistic approach of UKCP09 – in other words there was no attempt to produce multiple alternative virtual climates and to weight each one by how well it matched observations. The model was simply run in its default mode with a single value for each input assumption. Since the default input assumptions lead to high long-term warming, the problem described above, which relates to scenarios in which there is low long-term warming, simply does not come into play. However, the single virtual climate generated by UKCIP02, with high long-term warming, currently heavily masked by cooling due to pollution, matches observational evidence just as badly as the one produced by UKCP09. It should in fairness be noted that the Met Office did not claim that the UKCIP02 projections comprehensively sampled the uncertainty in the response of the climate system to greenhouse gases, there being no attempt to match the projections to observations

Implications

The UKCP09 projections generated using the HadCM3 model have large values of long-term warming built in and are incapable of matching the observational evidence, no matter how the input assumptions about the modelled physics of the atmosphere and oceans are varied. The earlier UKCIP02 projections similarly fail to match the observations.

HadCM3's estimate of long-term warming is approximately double the value

suggested by several recent estimates based on observations of the real climate.^{7 8} Its figure for expected warming over the rest of this century – the so-called transient climate response – is also substantially higher than observations indicate.⁹

The UK's official climate predictions are therefore unreliable and excessively alarmist. It should be noted that the credibility of the UKCP09 projections has also been criticised on other grounds, including their usefulness at local scales and the way in which they apply Bayesian statistics.^{10 11 12}

The UKCP09 projections were developed at a cost of £11 million and launched with considerable publicity in June 2009. At the time, they were described by the Government Chief Scientific Adviser Sir John Beddington as offering 'new insights', and by WWF's head of climate change as 'scientifically robust'.

At the launch of UKCP09, the government listed projects already undertaken to address climate change, in areas such as housing, transport and water management. Although the link to the earlier UKCIP02 projections is not explicit, many of the projects can be shown to be based on them. For example, the Highways Agency Climate Adaptation Plan is based on UKCIP02 data and records that:

...the Highways Agency has already adopted French temperature standards for road surfaces (EME-2). This is an example of the Agency putting in place adaptation to ensure that design standards and operating practices can adapt to the changing climate expected over the lifetime and replacement cycle of the Agency's highways infrastructure.¹³

The foolishness of trusting unvalidated computer models for policy decisions was demonstrated by the failure of many road surfaces during the cold winters of 2009/10 and 2010/11. In Scotland, meanwhile, the focus has been on designing drainage systems to cope with the greater rainfall predicted by the official climate projections.¹⁴

Water companies have a statutory requirement to take steps to balance supply and demand and Ofwat has prescribed the use of UKCP09 as the basis of the climate change element of this calculation. According to the Committee on Climate Change:

Water companies proposed additional investments totalling around £1.5 billion to address the impacts of climate change on supply and demand between

7 This is true both of the figures generated in the model's standard UKCIP02 configuration and for the mean calculated from the UKCP09 observationally-constrained probabilistic projections.

8 The HadCM3 effective climate sensitivity is estimated at 3.3°C per doubling of carbon dioxide concentrations, compared to a typical best estimates bracketing 1.7°C for several recent observationally based studies.

9 HadCM3 TCR is 2.0°C (both in standard parameterisation and mean of the observationally-constrained probabilistic projections pre-carbon-cycle) vs 1.3°C per Otto et al 2013; a strong carbon cycle feedback boosts the warming further in the final probabilistic projections.

10 <http://news.bbc.co.uk/1/hi/8106513.stm>

11 <http://www.defra.gov.uk/sac/files/sac-mod-subgroup-finalreport-december-20101.pdf>

12 <http://www.ccecep.ac.uk/Publications/Working-papers/Papers/120-129/WP121-laplaces-demon-climate-change.pdf>

13 <http://archive.defra.gov.uk/environment/climate/documents/adapt-reports/06road-rail/highways-agency.pdf>

14 <http://www.scotland.gov.uk/Publications/2005/07/08131510/15238>

2010 and 2015, primarily based on evidence from the UKCIP02 climate change scenarios.¹⁵

But such figures may obscure larger amounts of malinvestment, since it is hard to separate spending on climate change measures from commercial investment.

Based on a view of climate change based on UKCIP02, the Department of Communities and Local Government has developed a Strategy for Sustainable Construction, from which has flowed such initiatives as the Code for Sustainable Homes, which specifies a range of adaptations to warmer weather that should be incorporated into new buildings. The code has now been adopted as policy by many councils. Whether such efforts would remain cost effective under a realistic estimate of future climate change – if indeed they were cost effective in the first place – remains unclear.

The climate projections also feed directly into the Environment Agency's advice to risk managers, underpinning investment decisions across the UK.¹⁶ For example, the Environment Agency advises that rainfall in Northumbria will increase by 20% by 2080, with figures of 75% not impossible. It expects local government to plan accordingly.

UKCP09 has also spawned a specialism in analysis and application of the projections. The UKCP09 website describes a large number of projects where estimates derived from the HadCM3 climate model have been used as the key input data.¹⁷ Eighteen projects have been completed, 29 more are under way and there are proposals for 11 more.¹⁸ So as well as provoking malinvestment, the erroneous climate predictions are generating a great deal of misleading data.

Conclusions

It is certain that large sums of money are being wasted on projects to extend the erroneous UKCP09 projections into other fields. The extent of malinvestment based on the same projections is harder to gauge but it is probably enormous.

The government therefore appears to have little choice but to withdraw the UKCP09 projections pending a review of the underlying climate model. There is an overwhelming need for ministers to ensure the credibility of the UK's climate projections by having an independent panel of statisticians and climate scientists examine the way in which HadCM3 has been used to generate the UK's official climate projections.

15 http://archive.theccc.org.uk/aws/ASC/ASC%20Adaptation%20Report_print_spreads.pdf

16 Environment Agency. Advice for Flood and Coastal Erosion Risk Management Authorities. <http://bit.ly/1eUyNpM>

17 <http://ukclimateprojections.defra.gov.uk/>

18 <http://ukclimateprojections.defra.gov.uk/23081#table>

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Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice.

Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

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