



House of Commons
Energy and Climate Change
Committee

**Intergovernmental
Panel on Climate
Change Fifth
Assessment Report:
Review of Working
Group I contribution**

First Report of Session 2014–15

*Report, together with formal minutes relating
to the report*

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The Energy and Climate Change Committee

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Summary

The Intergovernmental Panel on Climate Change (IPCC) was set up by the United Nations in 1988 to provide assessments of the latest peer-reviewed climate science for policy-makers. The Working Group I (WGI) contribution to its Fifth Assessment Report (AR5), published last year, concluded that we can now be more confident than ever that the release of heat-trapping greenhouse gases from deforestation and the use of fossil fuels has caused much of the global warming and other changes in the climate witnessed in the latter half of the 20th Century and, if unabated, will continue to drive warming in the future.

AR5 provides the best available summary of the prevailing scientific opinion on climate change currently available to policy-makers. Its conclusions have been reached with high statistical confidence by a working group made up of many of the world's leading climate scientists drawing on areas of well-understood science. The overall thrust and conclusions of the report are widely supported in the scientific community and its summaries are presented in a way that is persuasive to the lay reader. As in all areas of science that involve highly complex dynamic systems, there are uncertainties. But these uncertainties do not blur the overwhelmingly clear picture of a climate system changing as a result of human influence.

The IPCC has responded extremely well to constructive criticism in the last few years and has tightened its review processes to make AR5 the most exhaustive and heavily scrutinised Assessment Report to-date. We believe that the IPCC would benefit from increasing the level of transparency by recruiting a small team of non-climate scientists to observe the review process from start to finish including during the plenary meetings to agree the Summary for Policymakers. However, the authority of the reports comes not from the process and procedure per se, but from the evidence itself: the thousands of peer-reviewed academic papers that together form a clear and unambiguous picture of a climate that is being dangerously destabilised.

Of course there are those who will continue to be critical of the conclusions and the process through which the IPCC produces its Assessment Reports. But our conclusion here is clear. There is no scientific basis for downgrading the UK's ambition to reduce greenhouse gas emissions. The Government and the international community must heed the IPCC's warning and work to agree a binding global deal in 2015 to limit climate change to manageable levels.

1 Introduction

1. The Intergovernmental Panel on Climate Change (IPCC) is an international body for the assessment of climate change. Its aim is to provide the world with a scientific view on the current state of climate change knowledge and its potential environmental and socio-economic impacts. The IPCC has been influential in providing the justification for national and international action to prevent dangerous climate change. It has, however, come under criticism that it is unduly influenced by national political agendas and that it has not satisfactorily addressed criticisms which have been levelled against it.

2. Our inquiry aimed to explore the latest conclusions of the IPCC's Working Group I (WGI) contribution to its Fifth Assessment Report (AR5) which looked at the physical science of climate change.¹ Specifically, we were interested in the process the IPCC went through to produce the report, the extent to which the conclusions were robust and what impact, if any, these conclusions had on national and international policy making. We launched our inquiry on 22 October 2013. The terms of reference can be found online.² We received 62 pieces of written evidence. We held three oral evidence sessions. A full list of witnesses can be found at the back of this report and on our website.³ We are very grateful to all those who took the time to contribute to this inquiry.

3. In Chapter 1 we provide a summary of the work of the IPCC and the WGI contribution to AR5. Chapter 2 assesses the procedures by which the report was produced. Chapter 3 evaluates the scientific conclusions drawn in the report. Finally, Chapter 4, explores the implications of the report for national and international policy making.

WGI contribution to the Fifth Assessment Report

4. The IPCC was founded in 1988 under the auspices of the United Nations (UN) with the aim of reviewing, assessing and reporting on the most recent scientific, technical and socio-economic information produced worldwide and relevant to the understanding of climate change. The IPCC consists of three Working Groups (WGI, WGII and WGIII). Every six or seven years, each reports on a certain aspect of climate change, together generating a comprehensive Assessment Report. WGI exclusively reports on the physical scientific evidence for climate change, WGII focuses on impacts, adaptation and vulnerability and WGIII examines options for mitigating the impacts. Over the course of its lifetime, the IPCC has overseen the publication of five such Assessment Reports. The latest (AR5) was published over the course of 2013 and 2014.

5. The WGI contribution to the AR5 is large and comprehensive. In over 1,500 pages containing more than 1 million words, it details the current thinking on the state of the

1 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013)

2 Energy and Climate Change Committee, [Call for evidence on IPCC 5th Assessment Review](#), 22 October 2013

3 Energy and Climate Change Committee, ['IPCC 5th Assessment Review, oral evidence'](#) accessed 15 July 2014

climate through reference to 9,200 published scientific papers, compiled over a five-year period by more than 250 authors from nearly 40 countries. Across the 14 chapters of the report, the WGI contribution to AR5 addresses the most recent observations of changes to the land, sea and air temperatures, atmospheric composition and dynamics, rainfall, glaciers, ice sheets and oceans. The report also offers explanations for the observed changes and, crucially, projects what climate changes are likely to occur in the future. The key conclusion from the WGI contribution to AR5 concerns the impact of greenhouse gases emitted by humans:

Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century. [...]. Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.⁴

6. The IPCC's Assessment Reports are respected by the international scientific and policy communities alike. Some have argued that there is no equivalent process in any other area of science.⁵ Professor Sir David King, the Foreign Secretary's Special Representative for Climate Change and a former Chief Scientific Adviser to the Government, remarked that:

[The IPCC AR5] is an enormous piece of work by the scientific community and it can only be said that there is no better account of the current state of understanding of climate science than represented by that report. It is a very hefty piece of work. It has been extremely carefully constructed and the summary is exemplary in its presentation.⁶

The conclusions of the IPCC's past Assessment Reports (notably AR3 and AR4) have provided the justification for national and international action to prevent dangerous climate change and formed the scientific underpinning of UK legislation such as the Climate Change Act 2008. This Act sets a legal obligation for the UK to cut its greenhouse gas emissions by 80% (compared to 1990 levels) by the year 2050.⁷ The target is to be achieved through the setting of a series of interim carbon budgets—which set an emissions reduction trajectory across key sectors in the economy. The scientific conclusions of the IPCC underpin the setting of these targets.⁸ With such challenging targets in place to prevent the impacts of dangerous climate change, it is critical that the IPCC presents the

4 IPCC Working Group I Contribution to AR5, [Summary for Policymakers, Climate Change 2013: The Physical Science Basis](#) (2013) p17 and p19

5 Q232 [Professor MacKay], Corinne Le Quéré and Andrew Watkinson ([IPC 050](#))

6 Oral evidence taken on [25 March 2014](#), HC (2013-14) 1190, Q86 [Professor Sir David King]

7 Climate Change Act 2008, [section 1](#)

8 Climate Change Act 2008, [section 4](#)

most accurate and up-to-date conclusions and projections possible. The importance of the conclusions of the reports in terms of their policy implications understandably places the IPCC under a lot of scrutiny. Criticism has been levelled at both the process by which the IPCC Assessment Review is undertaken and the conclusions that are drawn. We explore these issues further in Chapters 2 and 3.

2 Production of Working Group I contribution to the Fifth Assessment Report

Process

7. The process by which the IPCC's Assessment Report is produced and agreed has improved considerably since the release of the Fourth Assessment Report (AR4) in 2007, mostly as a consequence of a review carried out by the InterAcademy Council (IAC) in 2010. The IAC was created by the world's science academies in 2000. It mobilises scientists and engineers to provide advice to international bodies.⁹ The IAC review of the IPCC was commissioned by the United Nations Environment Programme (UNEP) and conducted by twelve experts who were not climate scientists. It concluded that "significant improvements [to the IPCC] are both possible and necessary for the fifth assessment and beyond".¹⁰ In total, the IAC made 22 recommendations on matters ranging from the review process, treatment of uncertainty and governance and structure.

8. The Department of Energy and Climate Change (DECC) and the Met Office spoke particularly favourably of the IPCC's updated procedures for dealing quickly with errors post-publication.¹¹ Furthermore, the introduction of a common language to describe uncertainty should help to maintain consistency between Working Groups and Assessment Reports.¹² Sir Peter Williams, former Vice President and Treasurer of the Royal Society, who was a member of the IAC review panel, was also pleased with changes to the management and structure of the IPCC, particularly the introduction of an Executive Team:

One recommendation that has been implemented is the way in which the 194 governments operate through the bureau of 30-odd strong, which meets very infrequently. It was crying out for some form of sub-committee in a PLC sense to look after the shop between meetings. The so-called e-team, the executive team, that had been tried previously and did not meet and was not effective, has given way to a properly-appointed executive team that does meet.¹³

However, he was disappointed that:

9 InterAcademy Council, '[About the IAC](#),' accessed 15 July 2014

10 InterAcademy Council, [Climate Change Assessments: Review of the Process and Procedures of the IPCC](#) (August 2010), p26

11 Department of Energy and Climate Change ([IPC 025](#)), Met Office ([IPC 026](#))

12 Q23 [Dr Stott]

¹³13 Q115 [Sir Peter]

In the executive committee, the one element that has not been brought about is the appointment of three independent non-climate scientists to sit alongside the IPCC professionals. That, in a typical PLC-type context, would also improve transparency, openness and good governance.¹⁴

9. A number of contributors commented that the IPCC review does not represent “peer-review” in the traditional sense.¹⁵ Dr Ruth Dixon, Leverhulme Trust Postdoctoral Researcher at the University of Oxford, suggested it is more like a system of “public comment”.¹⁶ Under the IPCC system, a large number of “Expert Reviewers” are invited to comment on a particular chapter (though they are free to choose which sections they do and do not critique) and the authors—who can see the identity of the reviewer—must then respond to each of these comments in turn. For the WGI contribution to AR5, some 50,000 comments were received and responded to. Dr Emily Shuckburgh, Head of the Open Oceans research group at the British Antarctic Survey and Fellow of the Royal Meteorological Society, explained:

It is to be commended that this process has become very transparent now that all these comments have been published. The second thing is to note that it is a very open process. Anybody was able to submit reviews to that process and the way that has now been documented, as was demonstrated in the released documents, is that every single one of those reviewer comments has been looked at, taken account of and then a Review Editor has come in and overseen that each one of those different comments has been addressed. In that sense, it is a very thorough review process. The third point to make is that, of course, the IPCC Working Group 1 primarily draws on the published literature that itself has been peer-reviewed, so what we are talking about is a peer review of a peer review. As a society, we feel that that is a very robust mechanism.¹⁷

10. *The IPCC has continued to strengthen and improve its Assessment Report procedure. The IPCC has put a series of measures in place to help to minimise the risk of errors creeping in, and quickly rectify them if they emerge. The IPCC has responded extremely well to the constructive criticism of the InterAcademy Council (IAC). With regard to the IAC’s recommendations, we would like to see the appointment of non-climate scientists to the Executive Committee.*

11. Donna Laframboise, journalist, founder of NOconsensus.org and author of two books about the IPCC, was concerned that WGI authors can too easily dismiss troublesome comments without good reason, a concern shared by the IAC.¹⁸ The IPCC has since

14 Q116 [Sir Peter]

15 University of Reading ([IPC 035](#))

16 Dr Ruth Dixon ([IPC 023](#))

17 Q113 [Dr Shuckburgh]

18 Q98 [Ms Laframboise], Q100 [Professor Lindzen], Christopher Walter ([IPC 005](#)), Dr Ruth Dixon ([IPC 023](#)), Marcel Crok ([IPC 041](#))

brought in measures to help safeguard against this, primarily through increasing the number of Review Editors and inviting them to write a summary of their impressions of how well the comments have been dealt with. However, Dr Dixon and Marcel Crok, a freelance science writer, still had concerns that it was theoretically possible for critical comments to slip through without being fully addressed, which could damage the image and authority of the IPCC's reports.¹⁹ They recommended:

If the IPCC reports are to be seen as truly authoritative, the IPCC should institute some sort of 'Red Team review' by scientists, statisticians and other experts from outside the climate field, to bring the rigour and expertise of other scientific disciplines to bear on reviewing these important reports. Such a team would have the task of challenging the reports in order to identify significant weaknesses in balance or content, if they can. If it was not practicable to review the whole of the three Working Group reports in this way, certain particularly policy-relevant chapters could be chosen.²⁰

Dr Dixon suggested that these scientists could act in a similar manner to the IAC, but across the entirety of the Assessment Report. The prevailing view was that the IPCC review process for the WGI contribution to AR5 has largely been successful.²¹ As Professor Myles Allen, Professor of Geosystem Science at the University of Oxford and former IPCC Lead Author, commented:

[The review process] means that we draw in comments and thoughts from directions where we might not have done so otherwise. That is very healthy and that is very helpful to the science.²²

It is worth stressing the point made to us by a number of climate scientists, that the strength and authority of the reports does not lie in the complexity of the assessment process, but in the quality of the underlying scientific evidence presented.²³

12. For future Assessment Reports the Government should recommend to the IPCC that they recruit a small team of experts who are not climate scientists to observe the review process from start to finish. The team would not constitute an extra stage of review, but rather oversee the process and arbitrate when controversies arise. The testimony of this independent team would improve the credibility of the report when it is released, and potentially protect it from any unnecessary and unfounded criticism. The team could also feed back to the IPCC in order to facilitate continuous improvement.

19 Dr Ruth Dixon ([IPC 023](#)), Marcel Crok ([IPC 041](#))

20 Dr Ruth Dixon ([IPC 023](#))

21 Q46 [Professor Allen], Q114 [Dr Shuckburgh]

22 Q46 [Professor Allen]

23 Q3 [Professor Allen], Myles Allen ([IPC 037](#)), WeatherAction ([IPC 059](#))

Inclusivity and objectivity

13. The IPCC does not employ climate scientists or conduct any original research in the preparation of its Assessment Reports. Instead, a team of authors is nominated by different United Nations (UN) member countries and invited to volunteer their time to compile an assessment of the peer-reviewed literature on climate change science. It is vital that these authors are acting in an objective manner, and in a manner that is inclusive towards the full range of scientific viewpoints. In order for the report to be credible, it must be an unbiased representation of the views of the scientific community.

14. Though the IPCC is a scientific body, it operates through the endorsement of the UN, and is therefore subject to “understandable and inevitable political pressures”.²⁴ Some respondents saw this as a major flaw in the IPCC process.²⁵ Donna Laframboise remarked that the IPCC generates “science for politics’ sake”.²⁶ However, Professor Allen informed us:

I think I would emphasise that, certainly at the chapter level, the scientists involved are contributing based on their expertise entirely and that is all. There is no Government interference at all at that point.²⁷

This sentiment was further reinforced by Professor Sir Brian Hoskins, Director of the Grantham Institute for Climate Change at Imperial College and a former IPCC author, who told us he “certainly did not feel the weight of a Government of any country telling [him] what [he] should say”.²⁸ It has been argued that the perception of interference may serve to undermine the scientific conclusions of the finalised report.²⁹ We consider the political pressures are isolated to the drafting of the Summary for Policymakers (see paragraph 27) rather than the authoring of the full report.³⁰

15. We heard concerns that the personal persuasions of individual contributors may have led to some views being unjustly excluded from the WGI contribution to AR5. A number of possible problems were cited:

- IPCC authors may display a bias towards including papers that agree with their own theory in a process of self-confirmation (so-called “confirmation bias” was also raised by the IAC in its review of the IPCC). This tendency could lead to papers being excluded that disagreed with the prevailing consensus view and could unwittingly lead to a “group-think” mentality.³¹

24 Q114 [Sir Peter]

25 Christopher Walter ([IPC 005](#)), Alex Henney ([IPC 006](#)), John McLean ([IPC 016](#)), Donna Laframboise ([IPC 039](#))

26 Donna Laframboise ([IPC 039](#))

27 Q44 [Professor Allen]

28 Q44 [Professor Hoskins]

29 Ian Strangeways ([IPC 022](#))

30 Q35 [Dr Stott], DECC ([IPC 025](#)), Grantham Institute for Climate Change ([IPC 032](#))

31 Judith Curry ([IPC 052](#))

- IPCC authors may be concerned about threats to their funding or research programmes if they include work that is critical of consensus theories of man-made climate change.³²
- IPCC authors may let their political persuasions (especially towards environmental activism) cloud their judgement as to what should and should not be included in the reports.³³

16. These potential problems were, however, generally not well supported, especially given the changes made by the IPCC since AR4. Sir Peter Williams was particularly robust on this point:

Bearing in mind the number of scientists involved in something like the Working Group I report you are considering today, it is simply impossible for some sort of herd instinct group-think with funding bias to take root in that diverse spectrum of people. All scientists are different. It is a general term that conjures up images of white coats and stereotypical conformity. The truth could not be further from that. The very idea that some form of funding bias, because of the popularity of the topic, could itself skew the observations of what are natural phenomena, which in turn could somehow skew the interpretations that are apt to mislead policymakers, does not bear examination.³⁴

17. Dr Peter Stott, head of the Climate Monitoring and Attribution team at the Met Office and IPCC lead author said, when asked about objectivity in the IPCC:

[I] do not see it as a problem at all. There is a conflict of interest statement that we sign and there are examples given on there. For example, if we are part of some non-governmental organisation or something, there is a recommendation that we should resign. We have signed a conflict of interest statement or we signed it as part of this process. We are first and foremost scientists, good sceptical scientists, scrutinising the science and the discussions that we had were purely on the basis of the science. They are not on the basis of political considerations or activism or anything else. They are on the basis of the science.³⁵

18. Professor Allen further described to us the “very open and collegial attitude” within climate science, evidenced by the shared analysis and scrutiny of data between different groups.³⁶ Professor Allen explained:

32 Conor McMenemie ([IPC 014](#)), John McLean ([IPC 016](#))

33 Q105 [Ms Laframboise], Donna Laframboise ([IPC 039](#))

34 Q150 [Sir Peter]

35 Q45 [Dr Stott]

36 Q48 [Professor Allen]

[...] the discussions in IPCC author meetings are extremely heated. These are the meetings where I see the science tested most critically by other IPCC authors, trying to establish whether statements are robust. That process is tremendously useful for the science.³⁷

The ethos of ensuring robustness, comprehensive assessment and using traceable evidence was emphasised by the leadership team of WGI throughout the writing process.³⁸

19. Professor Allen described the process by which the IPCC took account of dissenting views as “painstaking”.³⁹ The views of climate scientists (and non-climate scientists) who are not in agreement with the core conclusions of the IPCC have been included through direct engagement as contributing authors, consideration of their work in the academic literature, and engagement through the review process. It is obviously necessary for the IPCC reports to be selective about which views are included, and with a vastly growing body of evidence between each report, there will inevitably be parties who continue to be dissatisfied.⁴⁰ Scientists from the Department of Meteorology at the University of Reading stated that they were “unaware of any barrier that prevents scientists wishing to question the IPCC assessment in the peer-reviewed scientific literature”.⁴¹

20. The Assessment Report procedure depends to a large extent on the integrity of the authors and editors involved, but we have found no evidence to suggest that this should give cause for concern. The authors drew upon a wide pool of peer-reviewed literature, highlighting areas of disagreement as readily as areas of agreement. We are satisfied that there was no systemic bias of any kind, be it financial, political or otherwise that would jeopardise the accuracy of the reported scientific conclusions. The procedures in place to safeguard against the influence of such biases appear to be sufficiently robust.

21. The majority of scientists who responded to our inquiry were understandably uneasy about claiming that any area of science is “settled”, as this is contrary to the principles of sceptical inquiry under which science operates.⁴² However, in response to the question of whether the IPCC is an accurate representation of the current views amongst climate scientists, the answer was overwhelmingly that it is. Some were keen to stress that a direct measure of “consensus” is difficult to quantify, and that each researcher may agree with some parts of the report more than others but, regardless of this, it is clear that the WGI contribution to AR5 is reflective of the prevailing majority opinion currently held within

37 Q39 [Professor Allen]

38 Q39 [Dr Stott]

39 Myles Allen ([IPC 037](#))

40 Friends of Science Society ([IPC 015](#)), Nongovernmental International Panel on Climate Change ([IPC 042](#))

41 University of Reading ([IPC 035](#))

42 DECC ([IPC 025](#)), Royal Meteorological Society ([IPC 029](#)), Grantham Institute for Climate Change ([IPC 032](#)), Myles Allen ([IPC 037](#)), Professor Pierre Darriulat ([IPC 049](#)), WWF ([IPC 054](#))

the climate science community.⁴³ Professor Sir Brian Hoskins provided a valuable summary of this view:

There are thousands of scientists and you will get a range of views, but across the vast majority of that they would say, “Well, my view has been taken account of. Perhaps I might have written it slightly differently, but I can see it has been taken account of and essentially it is in the range there” [...] It is not a natural process for scientists to go through this but, given that, I think it is a remarkable job that has been done.⁴⁴

22. Although the terms “consensus” and “settled science” with regards to climate change were generally not thought to be helpful, as uncertainty and debate are required to drive research forward, we conclude that there is clearly strong agreement that the IPCC has captured the prevailing scientific opinion, notwithstanding some disagreement from a number of reputable scientists.

Timeliness

23. The process for producing the WGI contribution to AR5 was an enormous effort for those involved. The Assessment Review process took six years and involved a scoping meeting, two rounds of drafting and expert review, preparation and editing of the Summary for Policymakers (SPM) before final publication.⁴⁵ Having now run through this cycle five times since 1990, we asked witnesses whether they felt the timescale and level of commitment required by the IPCC was appropriate. The responses were clearly mixed. Professor Richard Tol, Professor of Economics at the University of Sussex and an IPCC lead author, told us:

The IPCC process assesses scientific knowledge according to a political timescale. That implies that parts of the literature are assessed too frequently while other parts of the literature are not assessed frequently enough. Instead of a mega-report every 6-7 years, it would be better to have an IPCC Journal with frequent updates where the literature moves fast and infrequent updates where little new is written.⁴⁶

Others agreed with Professor Tol that the six to seven year timeframe was too long.⁴⁷ For example, the National Environment Research Council (NERC) claimed:

43 Q34 [Professor Allen, Professor Hoskins, Dr Stott], Q89 [Professor Lindzen], Ian Strangeways ([IPC 022](#)), Robin Guenier ([IPC 024](#)), Royal Meteorological Society ([IPC 029](#)), Grantham Institute for Climate Change ([IPC 032](#)), Jonathan Cowie ([IPC 033](#)), Natural Environment Research Council ([IPC 036](#)), Corinne Le Quéré and Andrew Watkinson ([IPC 050](#)), Mark Richardson ([IPC 077](#))

44 Q34 [Professor Hoskins]

45 IPCC, ‘[IPCC Process](#),’ accessed 15 July 2014

46 Richard Tol ([IPC 040](#))

47 University of Reading ([IPC 035](#)), Myles Allen ([IPC 037](#))

The long gaps between reports and consensus approach does lead to delays in being able to incorporate the very latest scientific understanding into the assessments.⁴⁸

The need for more frequent assessments was echoed in a statement made by DECC to the IPCC following the release of WGI contribution to AR5:

The assessment cycle should not be more than 6-7 years as presently. However there is great demand from policy-makers for more frequent updates so ways should be considered to bring these into the cycle.⁴⁹

The very large commitment required to contribute to these six to seven year “mega-reports” prompted Professor Sir Mark Walport, Government Chief Scientific Adviser, to describe the process as “undoubtedly burdensome”.⁵⁰ This sentiment was repeated by many of the witnesses who had contributed to the reports.⁵¹ Professor Richard Lindzen, Alfred P. Sloan Professor of Meteorology at Massachusetts Institute of Technology (MIT) and a former IPCC lead author, told us that:

For most of us, it was an extraordinary bother dealing with the IPCC. For about four pages that I was involved in, I had to circumnavigate the globe two or three times and, like most of my fellow participants, I never participated again. It was just too much of a drag on one’s time and effort.⁵²

Professor Sir Brian Hoskins suggested that changes to the procedure from previous reports may have made the process “even more burdensome than it was before”.⁵³

24. It was clear, however, that the exhaustive and periodic nature of the Assessment Reports holds a number of advantages, including providing a focus for research activities such as climate modelling.⁵⁴ Professor Sir Brian Hoskins told us that the benefit of the Assessments reports is that they produce a large body of results that can be analysed in great detail by scientists at the same time.⁵⁵ Additionally, the advantages of the all-encompassing nature of the reports were emphasised by Nicholas Lewis, a climate researcher and mathematician:

I think there is an advantage to having a fairly comprehensive assessment at the state of advice put down at one time because it enables you to examine it as a whole and see what implications the various bits of it have for other parts and see whether they are consistent or not. [...] To expect these academic

48 Natural Environment Research Council ([IPC 036](#))

49 DECC, *Future of the IPCC Review – UK Government 2014 Response to IPCC*, 25 February 2014

50 Q230 [Professor Walport]

51 Q117 [Dr Shuckburgh], Royal Meteorological Society ([IPC 029](#)), University of Reading ([IPC 035](#)), Natural Environment Research Council ([IPC 036](#)), Myles Allen ([IPC 037](#))

52 Q61 [Professor Lindzen]

53 Q35 [Professor Hoskins]

54 Corinne Le Quéré and Andrew Watkinson ([IPC 050](#))

55 Q40 [Professor Hoskins]

scientists to do this on top of their normal workload is not the ideal by a long way, but I think it is useful.⁵⁶

25. Consequently, there was no clear consensus on how the IPCC should adapt and evolve. As Dr Shuckburgh testified, there is a “spectrum of views”, some wish to develop a much less burdensome, policy-relevant and frequent assessment procedure, but others think that this could jeopardise the comprehensive and authoritative nature of the current process.⁵⁷ What is clear however, is that the final publication of AR5 marks a good opportunity for the IPCC to gather views and take stock on its future direction.⁵⁸ Though the work of the IPCC is targeted towards policymakers, it is essential that the scientists that underpin the Assessment Reports are well supported and their efforts are adequately acknowledged to ensure their continued commitment and enthusiasm for a challenging but important task.⁵⁹

26. There are mixed views regarding the frequency and size of IPCC Assessment Reports. Transition to smaller, more frequent reports would arguably relieve the burden on contributing authors and ensure policymakers were kept up to date, but the finished document would lack the comprehensive and authoritative nature of the current Assessment Reports. Any revision of the tried and tested IPCC formula should only be introduced after careful consultation with both the governments who use the IPCC reviews and the scientists who write them. The aftermath of AR5 is an optimum time for this period of reflection to take place.

Summary for Policymakers

27. In September 2013, following the second round of drafting and expert review of the WGI contribution to AR5, the authors of the report gathered with representatives from United Nations (UN) member governments in Stockholm. During this four-day meeting, the 1,536 pages of the Full Technical Report, was reduced to a 33 page Summary for Policymakers (SPM) and agreed line-by-line. The meeting was held in private and the notes were not released following the session (unlike, for instance, the reviewer comments which were published in full). The SPM is the only part of the report that many people will read. It is unsurprising that it is the focus of many of the criticisms of the IPCC’s alleged lack of transparency.⁶⁰

28. The lack of transparency in this stage of the writing process, and the direct involvement of government representatives, has led to a great deal of speculation about the degree to

56 Q101 [Mr Lewis]

57 Q41 [Professor Hoskins], Q117 [Dr Shuckburgh], Q289 [Mr Barker]

58 Q41 [Dr Stott], Q231 [Professor MacKay]

59 Qq287-290 [Mr Barker, Mr Warrilow]

60 Qq58-59 [Ms Laframboise, Professor Lindzen], Q63 [Mr Lewis], Christopher Walter ([IPC 005](#)), John McLean ([IPC 016](#)), Madhav Khandekar ([IPC 019](#)), Donna Laframboise ([IPC 039](#)), Professor Pierre Darriulat ([IPC 049](#))

which the scientific report is politicised before emerging as the finalised SPM.⁶¹ Donna Laframboise was particularly critical of the process:

Delegations from more than 100 countries were involved in the four day, behind closed doors, barred to the media meeting. Politicians, diplomats, and bureaucrats argued about phrasing and about which tables, graphs, and illustrations should be included. When they were done, the Summary for Policymakers was five pages longer than the draft but contained 700 fewer words.⁶²

In support of this, Christopher Walter, Viscount Monckton of Brenchley, claimed that phrases critical of the performance of climate models had been removed from the SPM on the request of political agents.⁶³ Mr Lewis was also critical of the absence of technical information that he argued was of importance to the understanding of the conclusions of the SPM.⁶⁴

29. Sir Peter Williams suggested that there was no particular cause for concern about the process through which the SPM is prepared:

The one risk that remains, which the IPCC is very resilient against, is that the immensely complex science is ultimately digested by the plenary, which is the government delegations from around the planet. I think it does remarkably well not to be conservatised as a result of that process and nor, from my experience of having attended the plenary, does the message acquire a degree of interpretation or, as you might term it, a spin. From what I can see, the IPCC has done a very good job of resisting those tendencies.⁶⁵

Furthermore, we were informed by WWF that some “observer organisations” are allowed to sit in on this plenary:⁶⁶

Throughout AR5 WGI, WWF observed constructive debate by all governments. Points of intervention were factual, science-based or focusing on improving the clarity of message for policy-makers. WWF did not observe a single intervention by any government that questioned the overall substance and/or general message of the report.⁶⁷

Professor Allen emphasised the importance of involving policymakers in that final stage:

The reason I think we need that process is that if you send scientists away and tell them just to write a report entirely in isolation, it is quite difficult to

61 Qq58-59 [Ms Laframboise, Professor Lindzen], Donna Laframboise ([IPC 039](#))

62 Donna Laframboise ([IPC 039](#))

63 Christopher Walter ([IPC 005](#))

64 Qq63-69 [Mr Lewis]

65 Q142 [Sir Peter]

66 [List of IPCC observers organisations](#) (April 2014)

67 WWF ([IPC 054](#))

predict how people will interpret what they say because we end up just spouting jargon and nobody knows quite what we mean. You need that dialogue to make sure that the conclusions of the scientists have been correctly understood.⁶⁸

30. Other IPCC authors were keen to re-iterate the fact that they have ultimate authority on the final content of the SPM and that all statements are directly traceable back to the relevant evidence given in the Full Technical Report.⁶⁹ Professor Sir Brian Hoskins suggested that this level of traceability in a summary of a technical subject designed for policymakers, was unusual when compared to other disciplines:

On the traceability of this and the review of the whole process, Members of Parliament can be more content over what goes on in this case than, say, much of the information they get in the economic sphere, I suspect, where they would read the summary but not know the details and the traceability would be rather less.⁷⁰

31. Including policymakers in the final stage of the report writing process does not seem to have had any substantial negative effects on the Summary for Policymakers (SPM) and very likely serves to improve the relevance and accessibility of the finished document.

32. It is inevitable that the distillation of such a complex and lengthy report will lead to the omission of some technical detail, but the traceability of the SPM to the full report adequately compensates for that. Any further technical detail that may be required for policymaking, such as in the setting of carbon budgets, is readily obtainable. The SPM succeeds in its purpose of keeping policymakers informed on issues surrounding climate science.

33. We recommend that the Government call on the IPCC to introduce a greater level of transparency in the plenary meetings to agree future Summaries for Policymakers (SPM). This may be through the admission of the independent team of observers to oversee the discussions (see paragraph 12). The feedback from the team would then serve to provide reassurance that the summary-writing process has been carried out objectively.

68 Q44 [Professor Allen]

69 Q4 [Professor Hoskins, Dr Stott], Q11 [Dr Stott], Q35 [Dr Stott], Q44 [Dr Stott], Q124 [Sir Peter], DECC ([IPC 025](#))

70 Q4 [Professor Hoskins]

3 Scientific conclusions of Working Group I contribution to the Fifth Assessment Report

Overall impression

34. A very large number of the respondents to our inquiry, most representing eminent scientific establishments, praised the WGI contribution to AR5 as being an authoritative, comprehensive and robust analysis of the past, present and likely future states of the climate.⁷¹ Many highlighted the consistency of conclusions with previous reports and growing evidence base.⁷² Professor Sir Brian Hoskins, Director of the Grantham Institute for Climate Change at Imperial College London and a former IPCC author, told us:

After more years of research and observations, there is not a huge change in the conclusions of the AR5 report and the science compared with the previous reports. [...] The main thing is there is a continued and stronger message that we can see the changes in the climate system that are consistent with the increase in greenhouse gases [...]. Understandings have increased and models have become more complex, but still the same sorts of conclusions ride through as were there in the previous reports.⁷³

Dr Stott, head of the Climate Monitoring and Attribution team at the Met Office and IPCC lead author, suggested that the WGI contribution to AR5 supported the case for tackling climate change:

You will see further evidence to support the conclusion that warming is unequivocal and then we have more evidence from right across the climate system of the effects of human influence on the observed changes. That is not just in temperatures of the atmosphere. It is also in temperatures of the ocean, reductions in snow and ice, rising sea level, and changes in some climate extremes. We have more evidence that strengthens that assessment on human influence on climate and then we also have new evidence around the future, the conclusion that continued emissions of greenhouse gases will cause further warming and further changes in the climate system. Limiting

71 Ian Strangeways (IPC 022), Dr Ruth Dixon (IPC 023), Department of Energy and Climate Change (IPC 025), Met Office (IPC 026), Royal Meteorological Society (IPC 029), Grantham Institute for Climate Change (IPC 032), Royal Society (IPC 034), University of Reading (IPC 035), Natural Environment Research Council (IPC 036), Myles Allen (IPC 037), Corinne Le Quéré and Andrew Watkinson (IPC 050), Grantham Research Institute on Climate Change and the Environment (IPC 051)

72 Grantham Institute for Climate Change (IPC 032), University of Reading (IPC 035), Corinne Le Quéré and Andrew Watkinson (IPC 050)

73 Q1 [Professor Hoskins]

climate change will require substantial and sustained reductions of greenhouse gas emissions.⁷⁴

There were, however, a number of scientific conclusions reported by the IPCC that have received criticism from both inside and outside the scientific community. This chapter will examine those criticisms in more detail.

Causes of climate change

35. The science of establishing the causes of climate change is known as “attribution” and is dealt with explicitly in Chapter 10 of the WGI contribution to AR5. The IPCC concluded that it is “extremely likely” that more than half of the observed increase in global mean surface temperature (GMST) from 1951 to 2010 was caused by human influence, primarily through increases in greenhouse gases.⁷⁵ The resulting impact of this human-caused surface warming on the atmosphere, oceans (heat content, sea-level, acidification, salinity etc.), global water cycle, global ice-systems and extreme weather events is discussed in the WGI contribution to AR5. The phrase “extremely likely” has a 95% level of certainty associated with it; an increase from the 90% level of certainty attached to a similar statement found in AR4 (which was released in 2007).⁷⁶

36. The Grantham Institute for Climate Change at Imperial College London stated that there is “no real question that the climate is changing and that a significant part of these changes is due to human greenhouse gas emissions”.⁷⁷ We have found no credible scientific source that disputes the claim that human activity has an influence on the climate. There are, however, a small number of scientists who dispute the extent to which human influence is the dominant factor in recently observed climate changes.⁷⁸ Richard Lindzen, Alfred P. Sloan Professor of Meteorology at Massachusetts Institute of Technology (MIT) and a former IPCC lead author, for example, did not agree with the IPCC’s conclusion, claiming that “the attribution of most of the small warming to man is faulty and inconsistent”.⁷⁹ Professor Lindzen and others allege that the IPCC overlooked natural factors such as internal variability and the influence of the sun (through cosmic rays) as considerable contributors in the explanation of the warming trends (see paragraph 39).⁸⁰ Additionally, some have queried the scientific justification for assigning a 95% confidence

74 Q1 [Dr Stott]

75 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p869, The majority of the warming contribution from man-made greenhouse gases is from carbon dioxide, but the IPCC also make clear that other species (such as methane and nitrous oxide) are of considerable significance.

76 IPCC Working Group I Contribution to AR4, [Summary for Policymakers, Climate Change 2007: The Physical Science Basis](#) (2007), p10, A discussion of how the WGI contribution to AR5 treats (un)certainly can be found on pages 138-142 of the IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013).

77 Grantham Institute for Climate Change ([IPC 032](#))

78 Roger A. Pielke Sr ([IPC 011](#)), Friends of Science Society ([IPC 015](#)), Dr A Neil Hutton ([IPC 028](#)), Professor Richard Lindzen ([IPC 047](#)), Judith Curry ([IPC 052](#))

79 Professor Richard Lindzen ([IPC 047](#))

80 Q92 [Professor Lindzen], Dr Norman Page ([IPC 058](#)), Dr A Neil Hutton ([IPC 028](#))

level to the claims about the human-influence on global warming since 1951, and for the IPCC attribution arguments in general.⁸¹

37. The IPCC process for attributing the causes of climate change was well-received by the majority of the scientific community. In this process, the relative size, timing and spatial pattern of phenomena which might influence whether the earth warms or cools (known as climate forcing and including, for example, greenhouse gas emissions) is matched against observed climate change in a method known as “fingerprinting”.⁸² This was explained in detail by Dr Shuckburgh, Head of the Open Oceans research group at the British Antarctic Survey and Fellow of the Royal Meteorological Society:

There are particular patterns that one anticipates, being the pattern of change that you would expect from increasing greenhouse gases. That is a pattern of the change over time and the change in space. The change in space is both the geographical pattern of the change and the change with altitude as you go up through the atmosphere.

There are particular patterns that one can identify that would be characteristic of the changes to the climate system you would anticipate from increasing greenhouse gases and that you would anticipate from natural fluctuations. For example, the most well-known natural fluctuation, the El Niño phenomenon, is associated with particular temperature changes, particularly in the Pacific Ocean. There is a particular pattern that one identifies with the El Niño phenomenon. If you look to the pattern of temperature change geographically, which one would anticipate from increasing greenhouse gases, it is different.

You identify those patterns—those are the fingerprints—and then you can look to the observations of what has occurred over the recent time history and disentangle how much of a contribution has come from one pattern and how much of a contribution has come from another pattern. That is the scientific basis for formulating those statements.⁸³

38. In establishing the clear pattern of human-influence, the importance of ruling-out of the so-called “null hypothesis”⁸⁴ was also emphasised, particularly by Dr Peter Stott:

We, of course, checked out this null hypothesis; that we could explain the observed changes purely by these types of internally generated variability [...] It is fully factored into the assessment where we conclude that the

81 Q87 [Professor Lindzen], Q91 [Professor Lindzen], Christopher Walter ([IPC 005](#)), Nongovernmental International Panel on Climate Change ([IPC 042](#))

82 Q9 [Dr Stott]

83 Q129 [Dr Shuckburgh]

84 The null hypothesis stipulates that the observed climate changes would have occurred with no human intervention through internal variability.

dominant cause of the warming since the mid-20th century is anthropogenic and not these natural factors.⁸⁵

[...] Our null hypothesis starting point is that we can explain it just by internal natural processes and we can rule that out at very high confidence levels.⁸⁶

The importance of the time-scale was made very clear when distinguishing between human influences and natural variability, as stressed by Professor Sir Brian Hoskins:

[Climate change] is not all natural and it is not all anthropogenic. It is a mixture. What we have on all timescales is a mixture and this makes it difficult to understand and a very interesting scientific problem, but on a day-to-day basis it is dominated by natural variability [...] It is disentangling these two, but with the very strong theoretical basis and the observed warming over a 100-year period giving some agreement we are seeing what we think is the fingerprint of our anthropogenic warming on that century timescale. When you get down to the decadal timescale, then we see a lot of the natural variability tending to dominate.⁸⁷

39. In addition to internal variability and changes in the brightness of the Sun as experienced by the Earth (Total Solar Irradiance), the IPCC also considers the plausibility of cosmic rays playing a role in influencing global cloud cover (and thus surface temperatures). The IPCC concluded that the link between cosmic rays and cloud properties did “not prove to be robust on the regional or global scale” despite the fact that “there has been [a] hypothesis for decades”.⁸⁸ Professor Lindzen pointed out that this field is subject to ongoing experiments.⁸⁹

40. The slight increase in confidence in the statement of attribution (95% in AR5 compared to 90% in a similar statement in AR4) was made, in part, on the basis of the ability of the IPCC to draw upon a “larger body of refereed literature”.⁹⁰ Professor Brigitte Nerlich and Dr Luke Colins from the University of Nottingham were critical that there was minimal elaboration of how the 95% figure was achieved, despite the recommendations of the InterAcademy Council.⁹¹ Dr Stott, however, provided the justification for this increased confidence:

Previously in the AR4 there was a lot of variability apparently in the observational records, which we have now understood was an artefact of a

85 Q9 [Dr Stott]

86 Q27 [Dr Stott]

87 Q10 [Professor Hoskins]

88 Q92 [Professor Lindzen], IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p886, Box 10.2

89 Q92 [Professor Lindzen], Richard Lindzen ([IPC 068](#))

90 Q1 [Dr Stott], University of Reading ([IPC 035](#))

91 Brigitte Nerlich ([IPC 031](#)), InterAcademy Council, [Climate Change Assessments: Review of the Process and Procedures of the IPCC](#) (August 2010)

different bias in those measurements. That is one example of where we have improved our confidence, but it is not just in terms of ocean temperatures. It is also in terms of other factors such as the retreating ice and snow. We have developed our understanding of the water cycle. We have developed our understanding of extremes. When you look into our chapter 10, you will see we have a table at the back there with 33 rows where we have itemised all the evidence, both the evidence where we have multiple lines of evidence and also where we have remaining uncertainties. We have a greater wealth of evidence now than we had, with better understanding, with more observations and also with the improved models as well.⁹²

41. There has been some confusion about the IPCC's use of (un)certainty language.⁹³ Professor Brigitte Nerlich and Dr Luke Colins explored the language used to convey the IPCC's conclusions in the media. They argued that conveying scientific information, including information about levels of (un)certainty, is difficult because scientists and the general public understand this word differently.⁹⁴ James Painter, Head of the Journalism Fellowship Programme at the Reuters Institute of Journalism drew a comparison between the IPCC "95% certain" attribution statement and the "95% certain" statement made by scientists concerning the link between smoking and lung cancer.⁹⁵ Professor Brigitte Nerlich and Dr Luke Colins argued, however, that analogies could be misleading.⁹⁶

42. The WGI contribution to AR5 presents the most compelling evidence to date that many of the changes to the climate recorded in the latter half of the 20th Century were driven by post-industrial human activity. We have not found convincing evidence that challenges the IPCC's conclusion in this matter. There is increased confidence in the IPCC projections that, with rising greenhouse gas concentrations, we will continue to see warming (and the changes to the climate associated with warming) in this century and beyond.

Sensitivity of the climate to carbon dioxide

43. In order to ascertain the potential impact of human-influence on the climate system, it is crucial to understand how sensitive the surface temperature of the Earth is to changes in the concentration of carbon dioxide in the atmosphere. The IPCC reports on two important parameters that reflect this relationship: the longer-term Equilibrium Climate Sensitivity (ECS),⁹⁷ and the shorter-term Transient Climate Response (TCR).⁹⁸ The two are

92 Q27 [Dr Stott]

93 Brigitte Nerlich ([IPC 031](#)), James Painter ([IPC 044](#))

94 Brigitte Nerlich ([IPC 031](#))

95 Q164 [Mr Painter]

96 Brigitte Nerlich ([IPC 031](#))

97 Equilibrium Climate Sensitivity refers to the temperature change to the surface of the Earth observed after a doubling of carbon dioxide followed by enough time to allow all the different aspects of the climate to reach equilibrium (a process that may take hundreds of years).

98 Transient Climate Response refers to the warming to the surface of the Earth observed after a doubling of carbon dioxide over a 70 year period.

related, but differ slightly in their definitions so that the TCR is generally lower than the ECS. They can be calculated from combinations of model simulations, observations and references to the historical climate record. On ECS, the WGI contribution to AR5 concluded:

Equilibrium climate sensitivity is likely in the range 1.5°C to 4.5°C (high confidence), extremely unlikely less than 1°C (high confidence), and very unlikely greater than 6°C (medium confidence). The lower temperature limit of the assessed likely range is thus less than the 2°C in the AR4, but the upper limit is the same. This assessment reflects improved understanding, the extended temperature record in the atmosphere and ocean, and new estimates of radiative forcing. [...] No best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies.⁹⁹

On TCR, the WGI contribution to AR5 concluded:

The transient climate response is likely in the range of 1.0°C to 2.5°C (high confidence) and extremely unlikely greater than 3°C.¹⁰⁰

The assessed ranges for these values have remained very similar with each successive IPCC Assessment Report, prompting Professor Sir Brian Hoskins to comment that:¹⁰¹

I think one of the amazing things about the IPCC is how the equilibrium climate sensitivity range has stayed the same over the years. That would seem we have not been doing any science to try and refine this, but during that period those started with an atmosphere-only model with a fixed ocean underneath. Then gradually the system has become the whole depth of the ocean involved, the vegetation on the land and the ice. The system has become so much more complex and interactive that is modelled and uncertainty ranges could well increase as you do that. The triumph has been that most of them have stayed about the same.¹⁰²

44. Most, but not all, of the discussions on the IPCC treatment of sensitivity has related to the ECS. Professor Lindzen and Nicholas Lewis, a climate researcher and mathematician, both argued that the figure in WGI contribution to AR5 is too high. The IPCC's slight increase in uncertainty of the figure was also criticised.¹⁰³ However, Professor Myles Allen, Professor of Geosystem Science at the University of Oxford and former IPCC Lead Author, who took a leading role in the IPCC discussions of ECS urged that the focus should be on the TCR which, he argued, was a better indicator of the warming expected over the coming

99 IPCC Working Group I Contribution to AR5, [Summary for Policymakers, Climate Change 2013: The Physical Science Basis](#) (2013), p16

100 As above

101 Q222 [Professor MacKay]

102 Q24 [Professor Hoskins]

103 Q24 [Professor Allen], Nicholas Lewis ([IPC.017](#)), Professor Richard Lindzen ([IPC.047](#))

century.¹⁰⁴ This point was repeated by a number of others, including Mr Lewis, who told us that “for policy purposes, the transient climate response, which is approximately over a 70-year period during which you have forcing concentrations rising, is more policy relevant”.¹⁰⁵ The TCR is much better known than ECS; there is a smaller intrinsic uncertainty associated with it and, as the IPCC demonstrates, a much better agreement between models and observational estimates.¹⁰⁶ Although efforts to better understand and constrain ECS will continue, Professor Allen told us that:

Everybody talks about it because everybody else talks about it, but nobody can quite remember why we are talking about it in the first place.¹⁰⁷

45. In narrowing the possible range of estimates for both ECS and TCR from observational measurements, the statistical methodology of the IPCC was bought into question by Mr Lewis, who explained to us that:

The bulk of the studies estimating [ECS and TCR] use a subjective Bayesian method, not all of them. Mine uses an objective method. One or two of them use non-Bayesian methods. The non-Bayesian methods and the objective Bayesian methods give very much the same answer. The subjective ones, basically the answer you get depends on the subjective assumptions you have fed in.¹⁰⁸

From this Mr Lewis argued that the range of sensitivities considered by the IPCC was too high. However, the IPCC gave consideration to Mr Lewis’ argument and concluded that:

Bayesian methods to constrain ECS or TCR are sensitive to the assumed prior distribution. They can in principle yield narrower estimates [...] but there is no consensus on how this should be done robustly.¹⁰⁹

The view of the IPCC was strongly reinforced by Professor Allen, who also disagreed with Mr Lewis’ analysis.¹¹⁰ The arguments concerning statistical methodology are likely to continue both in the academic literature and future assessments of climate sensitivity. For the time being, it is important to realise that these arguments only affect one of a number of methodologies for calculating sensitivity, all of which have been taken into account by the IPCC to produce their likely ranges of ECS and TCR.¹¹¹

46. We also examined claims that uncertainties in other areas of the IPCC report (such as those surrounding the role of aerosols and natural variability) could lead to overestimation

104 Qq4-5 [Professor Allen], Q24 [Professor Allen], Myles Allen ([IPC 078](#))

105 Q82 [Mr Lewis]

106 Q5 [Professor Allen]

107 Q5 [Professor Allen]

108 Q69 [Mr Lewis], Q83 [Mr Lewis], Nicholas Lewis ([IPC 017](#)), Nicholas Lewis ([IPC 070](#))

109 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p82-85

110 Q24 [Professor Allen], Myles Allen ([IPC 073](#)), Myles Allen ([IPC 078](#))

111 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p82-85

of climate sensitivity.¹¹² Professor Allen demonstrated that these uncertainties had been accounted for by the IPCC through reference to a simple model.¹¹³ Mr Lewis disagreed and provided evidence to suggest that uncertainties could lead to temperature projections that were below those of the IPCC.¹¹⁴ Professor Allen responded:

These multimodel ranges are only considered “likely” by IPCC, so the fact that it is possible to get below them by assuming a maximally optimistic scenario should not be that surprising.¹¹⁵

A number of witnesses also pointed out that there were unknown aspects of the climate that might lead to increasing sensitivities as the planet warms.¹¹⁶

47. Some argued that, after the cut-off date for submitting academic papers to be considered as part of the WGI contribution to AR5, some results had been released that argued for higher sensitivities, and some for lower.¹¹⁷ Professor Allen reflected on this and claimed that “there is no clear pattern of results after the deadline pointing towards lower or higher sensitivities than results published before the deadline”.¹¹⁸ The debates around climate sensitivity demonstrate the diligence of the IPCC, as Professor Allen went on to illustrate:

I was part of the internal discussion group that made the decision to lower the lower band on climate sensitivity, which made a lot of noise at the time. I have had a lot of feedback from colleagues in the scientific community about whether or not that conclusion was justified. Papers have come out since the IPCC report that point to substantially higher values for the climate sensitivity and people invariably send me emails saying, “See”, when these papers come out. That is the process at work. Scientists continue to check what other scientists have done and obviously high profile statements, such as those made in the IPCC summaries, are checked even more carefully than others. They get a lot of scrutiny.¹¹⁹

48. The WGI contribution to AR5 has considered the full range of both Equilibrium Climate Sensitivity and Transient Climate Response and given the best assessment possible within the constraints of the evidence available at the time. It does not appear that a consistent pattern for higher or lower sensitivities than that stated in the WGI contribution to AR5 has emerged since its publication.

112 Q68 [Mr Lewis], Q81 [Professor Lindzen, Mr Lewis], Professor Richard Lindzen ([IPC 047](#))

113 Q3 [Professor Allen], Myles Allen ([IPC 073](#))

114 Nicholas Lewis ([IPC 070](#))

115 Myles Allen ([IPC 078](#))

116 Grantham Institute for Climate Change ([IPC 032](#)), Myles Allen ([IPC 078](#))

117 Barry Brill ([IPC 018](#)), Myles Allen ([IPC 037](#))

118 Q6 [Professor Allen]

119 Q4 [Professor Allen]

The “hiatus”

49. The observed global mean surface temperature (GMST) reported by the IPCC for the last 15 years shows a much smaller increase than over the past 30 to 60 years, despite the decade of the 2000s being the warmest in the instrumental record.¹²⁰ Depending on which data are used, the temperature rise from 1998–2012 is estimated to be around one-third to one-half of the trend from 1951–2012; this slowdown in warming has become known as the “hiatus” or “pause”.¹²¹ A number of respondents argued that the WGI contribution to AR5 did not adequately address this issue.¹²² For example, Professor Pierre Darrriulat, former Research Director of CERN and currently Professor of Physics at VATLY in Hanoi in Vietnam, said that:

It is undeniable that the pause has come as a surprise in a context where anthropogenic CO₂ emissions keep increasing. It has obvious implications on factors that are not properly taken into account in the climate models. As such, it deserves a very critical study aiming at a proper evaluation of the uncertainties attached to predictions. This is what should be expected from a serious scientific approach.¹²³

The WGI contribution to AR5 explicitly addressed the issue of the hiatus. It concluded that it “is attributable in roughly equal measure to a cooling contribution from internal variability [such as changing patterns in the El Niño-Southern Oscillation] and a reduced trend in external forcing [through volcanic aerosols and a reduction in solar activity]”.¹²⁴ It also concluded that “barring a major volcanic eruption, most 15-year GMST trends in the near-term future will be larger than during 1998–2012”.¹²⁵ On this, an IPCC Review Editor commented:

The issues of a “lack of warming” over the last 10-15 years was raised by several reviewers. I think the way this has been handled via Box 9.2 [where the IPCC explicitly addresses the hiatus] is outstanding. However, so far as I can tell, Box 9.2 has not been subject to external review as a consequence of timing. This is worrisome.¹²⁶

50. Subsequent evidence has confirmed that a number of witnesses supported the conclusions of the IPCC. For example, Dr Stott told us that, “the assessment that was made in the AR5 has been borne out by further evidence we have had since” including the contribution from internal variability such as the Pacific decadal oscillation which could

120 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p769

121 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p192-194

122 Christopher Walter ([IPC 005](#)), John McLean ([IPC 016](#)), Barry Brill ([IPC 018](#)), Nongovernmental International Panel on Climate Change ([IPC 042](#)), Professor Pierre Darrriulat ([IPC 049](#)), Judith Curry ([IPC 052](#))

123 Professor Pierre Darrriulat ([IPC 049](#))

124 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p769-772

125 As above

126 IPCC Working Group I Contribution to AR5, [Reports of the Review Editors, Climate Change 2013: The Physical Science Basis](#) (2013)

play a role in the redistribution of heat within the oceans.¹²⁷ Dr Stott's explanation of internal variability and increased ocean heat uptake was re-iterated by several other witnesses.¹²⁸ Additionally, we were referred, by a number of witnesses, to the body of evidence released since the publication of the WGI contribution to AR5 corroborating the IPCC conclusions on the hiatus.¹²⁹ Not all of the individual pieces of evidence published since the WGI contribution to AR5 are consistent with the IPCC explanation of the hiatus, but this is an area of on-going research that will require long-term, robust data before firm conclusions on the hiatus can be made.¹³⁰

51. Regardless of the discussed explanations for the hiatus, arguably the most frequent criticism of the IPCC was its failure to predict the occurrence of the hiatus in any of the earlier Assessment Reports. The IPCC acknowledged that only 3% out of 251 climate models managed to predict the hiatus as defined above, although each Assessment Report since 1990 has stated that warming will be non-linear and subject to influence by natural variability.¹³¹ More recently, global climate models have factored in periods of reduced warming, temperature stasis and cooling, though they were not designed to be able to predict the timing of these events precisely.¹³² As Professor MacKay, Chief Scientific Adviser to DECC, explained:

Many of the model runs do show slowdowns that last as long as the latest slowdown. They happen at random times, and it would have been an amazing coincidence if any of those simulations had happened to precisely nail [this hiatus].¹³³

We note that the hiatus contributed in part to the IPCC decision to revise short-term model projections and slightly lower the estimates for equilibrium climate sensitivity.¹³⁴ According to Professor Lindzen, as the hiatus continues, it will lead to further downward revisions of estimates of climate sensitivity.¹³⁵

52. Amongst the debate surrounding the hiatus, one point that was frequently re-emphasised is that the pause in GMST must be considered in the context of the long-term

127 Q47 [Dr Stott]

128 Q78 [Mr Lewis], Q198 [Professor MacKay], Q208 [Professor MacKay], Department of Energy and Climate Change ([IPC 025](#)), Met Office ([IPC 026](#)), Grantham Institute for Climate Change ([IPC 032](#))

129 Met Office ([IPC 026](#)), Grantham Institute for Climate Change ([IPC 032](#)), Natural Environment Research Council ([IPC 036](#)), Corinne Le Quéré and Andrew Watkinson ([IPC 050](#)), Grantham Research Institute on Climate Change and the Environment ([IPC 051](#)), WWF ([IPC 054](#)), Royal Meteorological Society ([IPC 074](#))

130 Q80 [Mr Lewis], Q208 [Professor MacKay], Friends of Science Society ([IPC 015](#)), Royal Meteorological Society ([IPC 029](#)), University of Reading ([IPC 035](#)), Natural Environment Research Council ([IPC 036](#))

131 John McLean ([IPC 016](#)), IPCC Working Group I Contribution to AR5, *Summary for Policymakers, Climate Change 2013: The Physical Science Basis* (2013) p15, IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p769-772, Ed Hawkins, Tamsin Edwards and Doug McNeill, *Nature Climate Change*, Vol. 4, March 2014, 154-156

132 Q15 [Dr Stott], Q47 [Professor Hoskins, Dr Stott], Q198 [Professor MacKay]

133 Q206 [Professor MacKay]

134 Myles Allen ([IPC 037](#))

135 Q78 [Professor Lindzen]

global energy budget (which includes all gains of incoming energy and all losses of outgoing energy).¹³⁶ In this regard, Professor Sir Mark Walport, Government Chief Scientific Adviser, explained that:

The hiatus is the change in the atmospheric temperatures. There is absolutely no hiatus in the totality of the global energy inventory, which is going up relentlessly. [...] Well over 90% of the heat uptake is in the oceans, and that is continuing.¹³⁷

This point reflects the fact that short term changes in GMST are not good metrics for discussing overall warming,¹³⁸ thus the WGI contribution to AR5 uses a variety of different measurements to reach its conclusions.¹³⁹ When asked whether Ministers had taken account of the hiatus the Minister for Climate Change, Rt Hon Gregory Barker, told us;

There is a whole barrel of different evidence that informs public debate and underpins our approach. As Minister, I rely principally not on the story of the day but on the ongoing scientific advice [...]. I think if you are making public policy one has to rely on the qualified experts for the long-term advice that they give you rather than be guided by whatever happens to feature on a tabloid headline.¹⁴⁰

53. Periods of hiatus are consistent with earlier IPCC assessments that non-linear warming of the climate is to be expected and that forced climate changes always take place against a background of natural variability. The current period of hiatus does not undermine the core conclusions of the WGI contribution to AR5 when put in the context of the overall, long-term global energy budget. Despite the hiatus, the first decade of the 2000s was the warmest in the instrumental record and overall warming is expected to continue in the coming decades.

Climate models

54. The results of climate models dominate the second half of the WGI contribution to AR5. They are used to simulate a variety of near- and long-term global and regional climatic behaviours. The results of the simulations are then used in the projection of future climate changes and in the attribution of the cause of observed climate changes.¹⁴¹ Climate

136 Q118 [Dr Shuckburgh], Q123 [Dr Shuckburgh], Q198 [Professor Mackey, Professor Walport], Q208 [Professor Walport], Q223 [Professor Mackey, Professor Walport], Grantham Research Institute on Climate Change and the Environment ([IPC 051](#))

137 Q198 [Professor Walport]

138 Roger A. Pielke Sr ([IPC 011](#))

139 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p38

140 Q239 [Mr Barker]

141 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p867-1136

models have continued to become increasingly sophisticated and capable, now factoring in a greater level of complexity than ever before.¹⁴²

55. Critics have called into question a number of issues surrounding climate models, particularly relating to short-term projections for global mean surface temperature (GMST).¹⁴³ Notably, less successful areas of the short-term regional model outputs are used to bring into question the ability of the IPCC to predict climate changes over the long-term and global scales. For example, Professor Lindzen considered that:

You can add complexity to a model and that has happened a lot, but it has not helped [the IPCC] do major things with ocean processes that are still known to be important. We like to think of progress as kind of linear. You spend more money, you make it bigger and get it better, but there has been no discernible increase in scale that has been associated with the advances. There are claims that regional climate has improved, but there are still notable errors in describing today's regional climate with current models, so that naturally gives one pause with predictions [...] If they can't get today's distribution of regional climate right, why would they be reliable for the future?¹⁴⁴

56. Under closer scrutiny, many of the criticisms of model projections appear unfounded. Firstly, generalised statements concerning their reliability do not reflect the complexity and diversity of the models. As Professor MacKay illustrated:

There are many models. There are complex, general-circulation models; there are simpler energy-balance models. One of the things the IPCC did was to evaluate the models that are used, and this evaluation looked at their abilities to simulate mean climate, historical events in climate change, variability on multiple timescales and regional modes of variability. There is a mixed scorecard. There are some things that are modelled well but some things such as regional variability are not yet well captured by the models. They are improving in many of these areas. As the computers become more powerful and the models are able to represent the earth's system at higher resolution, the accuracy of many of these features in the system is improving.¹⁴⁵

This point was also emphasised by Professor Allen:

Yes, the IPCC does consider the reliability of climate models and finds they are much more reliable for some variables (like global temperature) than

142 IPCC Working Group I Contribution to AR5, *Climate Change 2013: The Physical Science Basis* (2013), p741-866

143 Christopher Walter (IPC 005), Roger A. Pielke Sr (IPC 011), Friends of Science Society (IPC 015), Alan Gadian (IPC 020), Dr Norman Page (IPC 058), Ian Strangeways (IPC 022), Dr A Neil Hutton (IPC 028), Nongovernmental International Panel on Climate Change (IPC 042), Professor Richard Lindzen (IPC 047)

144 Qq76-77 [Professor Lindzen]

145 Q194 [Professor Mackay]

others (like local precipitation). If the question is posed as “are the models reliable in all respects” the answer is trivially “no”.¹⁴⁶

57. Secondly, many of the criticisms brought to our attention gave a distorted impression of the models’ performance by selectively emphasising areas in which the models have behaved less well (particularly across the hiatus period, see paragraph 49).¹⁴⁷ We note that the WGI contribution to AR5 devoted an entire chapter to the evaluation of climate models and demonstrated that:¹⁴⁸

- i) Models generally have a good record of replicating GMST, and other climate observations, dating back to the first IPCC report in 1990;¹⁴⁹
- ii) Models have improved, and continue to improve, in terms of their agreement both with themselves and with observed climate data;¹⁵⁰
- iii) The increasing levels of complexity within models, though introducing additional uncertainties, have helped to improve climate projections;¹⁵¹
- iv) The models are not perfect, their limitations are recognised by the IPCC authors and poorer performing areas are highlighted and discussed at length.¹⁵² The increasing use of performance metrics, which judge models against their ability to reproduce observable climate data, has helped to safeguard against undue weight being given to poorer quality results.¹⁵³

58. The process through which model results are interpreted and used to generate projections for future climate shows an appropriate level of critical scepticism by the IPCC authors. The output of the climate simulations are subject to scrutiny and expert judgement and the results are tested against the sensitivity towards their initial conditions and key uncertainties.¹⁵⁴ This fact was emphasised repeatedly, including by Professor Allen, who said:

146 Myles Allen ([IPC 037](#))

147 Christopher Walter ([IPC 005](#)), Friends of Science Society ([IPC 015](#)), John Christy ([IPC 055](#))

148 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p741-866

149 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p64-65

150 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p824-825

151 Q7 [Dr Stott], Met Office ([IPC 026](#)), IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p748-753

152 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p815-816, p1013-1015

153 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p753-759, p809-810, p821-828

154 Q12 [Professor Allen, Dr Stott], Q123 [Dr Shuckburgh], Q195 [Professor MacKay], Q207 [Professor Mackay], Grantham Institute for Climate Change ([IPC 032](#)), Myles Allen ([IPC 073](#)), Royal Meteorological Society ([IPC 074](#)), Met Office ([IPC 076](#)), IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p959-961, p1009-1012

The key point is there is an enormous amount of judgment in running climate models. There is nothing sacrosanct about ranges that come out of the CMIP5¹⁵⁵ ensemble. We rely on a whole range of lines of evidences, including observations and these models, to provide these projections and those are the projections that are elevated to the *Summary for Policymakers*.

Just to pick up on the notion, “You no longer rely on the models”, there are certain things for which I would never rely on these models and there are other things that I would. That is where the expert judgment comes in. You have to look at a model and ask yourself, “Is it appropriate to the question that I am asking with it?” If you wanted me to use one of these models to predict whether there is a white Christmas in 2030, it wouldn’t work, but that doesn’t mean that the model is useless for giving us the big picture estimates of what warming we should expect over the coming century. There is no mechanical process for taking a set of model results and turning a handle and getting a set of answers out.¹⁵⁶

59. It is widely acknowledged that decadal forecasts and the difficulties and uncertainties associated with short-term forecasting should not be confounded with the longer-term projections and “broad direction of travel” in respect of overall warming.¹⁵⁷ The Grantham Institute for Climate Change at Imperial College London emphasised the requirement to contrast the differences between the types of projections:

We have less confidence in projected near-term changes which are likely to remain heavily influenced by internal variability [...] Nevertheless there is no evidence of a mechanism that would significantly reduce the intensity of the projected climate change by 2100.

If you do the assessment of the models against a whole raft of climate indicators over those longer-term time scales that you need to do to assess their fitness for purpose for the longer-term changes [...] we see that the models do a good job of representing the larger time-scale changes.¹⁵⁸

It further criticised a pre-occupation with observations and projections made on the decadal time-scale:

This emphasis on decadal temperature changes is, we believe, ill-advised. In the context of climate change, relatively short-term indices of the state of the climate system have little relevance. It is quite conceivable for there to be a

155 CMIP5 stands for Coupled Model Intercomparison Project Phase 5 and represents a set of coordinated climate model experiments.

156 Q13 [Professor Allen]

157 Q3 [Professor Allen, Professor Hoskins, Dr Stott],¹⁴ [Professor Allen], Qq195-196 [Professor MacKay, Professor Walport], Q199 [Professor Walport], Met Office ([IPC_026](#)), IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis](#) (2013), p964-965

158 Grantham Institute for Climate Change ([IPC_032](#))

future decade in which the Earth's surface temperature cools even with continued climate change.¹⁵⁹

60. We were pleased to see that officials at DECC had a good understanding of both the strengths and weaknesses of climate models. David Warrilow, Head of Climate Science and International Evidence at DECC, highlighted that models are not trying to project; they are trying to simulate a process:

When you come down to projection on the near term, like one to two decades, we are into a very different set of problems and I do not think there is an easy answer to doing that. It is something that the scientific community is now working on because they are conscious that there is an interest in trying to project what would happen in the near term, but it is almost analogous for weather forecasting. Weather forecasting is good for up to four or five days, probably, but if you try to look forward two to three weeks, the chaos of the system makes it much more difficult to predict. Even predicting a season ahead is quite difficult, but if you want to predict a decade you are trying to predict a level of chaos that is very difficult to predict. I think the IPCC has done the best that it can with the information available, but I do not think people in the IPCC would say that this is the final answer to the problem.¹⁶⁰

61. Crucially, when considering climate change it is important to recognise that the models represent one of multiple lines of evidence. Professor Sir Mark Walport made it clear that:

It simply is not just models. There are an awful lot of observations here as well. The models are part of the story and the models look into the future, but they also use the past to see whether they have modelled accurately. One of the interesting things about the fifth report is how little changed it is from the fourth report and the third report. What is happening is that the uncertainty is gradually reducing. The very short report on the physical science base is absolutely clear: warming of the climate system is unequivocal. Each of the last three decades has been successively warmer. The rate of sea-level rise has been larger. Human influence on the climate system is clear. That is the conclusion of the report. I think that is enough for policymakers to start making decisions.¹⁶¹

62. Finally, we have found that the WGI contribution to AR5 plays a pivotal role in encouraging the development of more complex computer models, as pointed out by Professor Corinne Le Quéré, Director of the Tyndall Centre for Climate Change Research and an IPCC lead author, and her colleague Professor Andrew Watkinson, Professor in Environmental Sciences, both based at the University of East Anglia:

159 As above

160 Q237 [Mr Warrilow]

161 Q203 [Professor Walport]

The IPCC process provides a major incentive to co-ordinate modelling activities, without which it would be more difficult to make intermodal comparisons and assess the reliability of climate models [...]

One of the major advantages of the current system is that it provides a focus for modelling activities in WGI, which are essential to review the projections of climate change. Furthermore, the assessment process provides the only forum where all the components of the climate system can be looked at (e.g. the atmosphere, ocean, ice, land, biogeochemical cycles), and consistency across different streams of research can be analysed.¹⁶²

It is essential that these vast, modelling infrastructures are being used as effectively as possible and that consideration is given to their future direction. Professor Allen questioned whether modelling capacity was being used to answer the right questions. He stressed the need to develop high resolution, regional, real-time attribution systems:

The most obvious and important area in which further effort is required to reduce uncertainty is the implications of these global changes for regional climate and extreme weather events. It is shameful, in my view, that we are still unable as a community to quantify the role of human influence on high-impact events like Typhoon Haiyan. The IPCC process may inadvertently have contributed to this situation through its focus (mandated by the commissioning governments) on long-term projections of global climate change, which are necessarily reliant on coarse-resolution models.¹⁶³

63. A number of witnesses highlighted a requirement to maintain and improve modelling hardware, for example the Met Office Hadley Centre, a UK-based institute for climate modelling, reported to us that “along with the need to run large ensemble simulations, there is a clear need for supercomputing capacity and infrastructure”.¹⁶⁴ In this regard, it is vital that modelling research institutes receive the support they require if key uncertainties about the climate are to be resolved. DECC responded to this point stating:

Just looking at the Hadley Centre, we have that regularly reviewed and the last review indicated that we were getting very good value for money from it; that the spend was not dissimilar to what was being spent in other modelling centres around the world and that it was at an appropriate level. The only real question was whether we would be able to maintain our position vis-à-vis computing power and that is something that is now being actively pursued by BIS. I think we are looking at the availability of computing power, which is one of the constraints on getting better predictions.¹⁶⁵

The Minister told us:

162 Corinne Le Quéré and Andrew Watkinson (IPC 050), University of Reading (IPC 035)

163 Myles Allen (IPC 037)

164 Q34 [Dr Stott], Met Office (IPC 026), Grantham Institute for Climate Change (IPC 032)

165 Q253 [Mr Warrilow]

I think we definitely punch above our weight in terms of the reputation and quality of the science that is produced by those centres and it is a huge tribute to the people that work there.¹⁶⁶

64. The models used in the IPCC's Assessment Reports have a successful history of simulating past climate and their future projection of substantial warming over the next century in all but the most aggressive mitigation scenarios is well founded and overwhelmingly clear.

65. In the light of the WGI contribution to AR5, the Government should commission a strategic review of UK modelling facilities to discern how current computing capacity could be used more effectively to reduce remaining uncertainties. The review should highlight areas of potential national and international collaboration between modelling centres and any funding shortfalls that need to be met.

4 Policy implications of Working Group I contribution to the Fifth Assessment Report

Economic implications

66. The Fifth Assessment Report was published in four instalments (WGI, II and III as well as a Synthesis Report (SYR)) over the course of a year. WGII and III were both published after the start of this inquiry in March and April 2014 respectively. The SYR is due to be finalised in October 2014. WGII, which focused on impacts, adaptation and vulnerability aspects of climate change, concluded that:

The effects of climate change are already occurring on all continents and across the oceans. The world, in many cases, is ill-prepared for risks from a changing climate. [...] there are opportunities to respond to such risks, though the risks will be difficult to manage with high levels of warming.¹⁶⁷

WGIII, which examined options for mitigating the impact of climate change, concluded that:

Global emissions of greenhouse gases have risen to unprecedented levels despite a growing number of policies to reduce climate change. Emissions grew more quickly between 2000 and 2010 than in each of the three previous decades. [...] it would be possible, using a wide array of technological measures and changes in behaviour, to limit the increase in global mean temperature to two degrees Celsius above pre-industrial levels. However, only major institutional and technological change will give a better than even chance that global warming will not exceed this threshold.¹⁶⁸

The focus of this inquiry was to look at the WGI contribution to AR5 which exclusively reports on the physical science basis of climate change. We do not intend, therefore, to make any firm conclusions on the economic impacts of climate change in this report.

67. However, we note that two full Assessment Reports (AR4 and AR5) have now been published since the release of Lord Stern's 2006 review on the economics of climate change.¹⁶⁹ At the time, Lord Stern concluded that the estimated cost of reducing climate change impacts to a level that would be manageable at 1% of global GDP per year. This is compared to an estimated permanent loss of GDP of between 5% and 20% for a business-as-usual scenario.¹⁷⁰ The Stern Review was widely supported and provided an economic

167 "A changing climate creates pervasive risks but opportunities exist for effective responses", IPCC press release [2014/11/PR](#), 31 March 2014

168 "Greenhouse gas emissions accelerate despite reduction efforts", IPCC press release [2014/19/PR](#), 13 April 2014

169 HM Treasury, [Stern Review of the Economics of Climate Change](#), (2006)

170 HM Treasury, [Stern Review of the Economics of Climate Change](#), (2006), vi

justification for tackling climate change. It did, however, face several criticisms including a lack of peer review.¹⁷¹

68. It is timely, therefore, that the Government working with a number of other countries across the world has set up a Global Commission on the Economy and Climate that, along with its flagship project, *The New Climate Economy*, will help governments, businesses and society make better informed decisions.¹⁷² Reporting in September 2014, the project will make recommendations on actions and policies to achieve high quality economic growth at the same time as addressing dangerous climate change.¹⁷³

69. During the course of our inquiry we took evidence on the business and policy implications of the IPCC's conclusions of the climate science. Jonathan Grant, Director, Sustainability and Climate Change at PricewaterhouseCoopers, highlighted how, "business views have evolved over time with the science, as the science has become increasingly clear".¹⁷⁴ He also told us "as the science has become more certain, businesses are less inclined to argue the science and they get more actively engaged in the debate about the policy response".¹⁷⁵ Guy Newey, Head of Environment and Energy Policy Exchange, suggested that AR5 did not change the position for policy-makers. While there were debates about the detail of the science, the "broad thrust is roughly the same".¹⁷⁶

70. The Government should ensure that the report it has commissioned to look at the benefits and opportunities in tackling climate change, *The New Climate Economy*, considers evidence about the costs of climate change to business. We believe that this report should be peer reviewed to avoid attracting the same criticism that was made of the Stern Review.

Domestic climate policy

71. The Climate Change Act 2008 commits the UK to a legally binding target of a reduction of greenhouse gas emissions by 80% on 1990 levels by the year 2050, to be achieved by adhering to a set of five-yearly carbon budgets.¹⁷⁷ Carbon budgets are set by Parliament with advice provided by the Committee on Climate Change (CCC). Since 2008, four, five-year, budgets have been set up covering the period until the end of 2027.¹⁷⁸ DECC is obliged to review the fourth carbon budget (covering the years 2023–2027) in the first half of 2014. In anticipation of this review, and in the light of the release of the WGI contribution to AR5, the CCC issued advice to DECC explaining that:

171 Global Warming Policy Foundation, [What is wrong with Stern?](#) (2012), p18

172 Oral evidence taken on [5 November 2013](#), HC (2013-14) 807, Q5 [Professor Lord Stern], HC Deb, 3 April 2014, [col 998](#)

173 The Global Commission on the Economy and Climate, '[The New Climate Economy](#),' accessed 15 July 2014

174 Q154 [Mr Grant]

175 Q155 [Mr Grant]

176 Q156 [Mr Newey]

177 Climate Change Act 2008, [section 4](#)

178 The Committee on Climate Change, '[The Climate Change Act and UK regulations](#),' accessed 15 July 2014

Based on a thorough assessment of the latest evidence [primarily WGI AR5], we have found no significant change in relation to climate science or international and EU circumstances since we provided our original advice in December 2010. There is therefore, based on these legislated criteria, no legal or economic basis for a change in the budget at this time.¹⁷⁹

Dr David Kennedy, CEO of the CCC also told us that based on their own analysis the CCC had come to the same conclusion as the IPCC.¹⁸⁰ We found a large number of respondents supported the CCC's conclusion concerning the latest climate change science and the Fourth Carbon Budget.¹⁸¹

72. Reducing uncertainties in estimates of climate sensitivity (discussed in paragraph 43) has been highlighted as a priority for the climate science community in the coming years.¹⁸² It should not, however, have an impact on climate change policies. Professor David MacKay, Chief Scientific Advisor to the Department of Energy and Climate Change (DECC), for example, argued that there “is a very clear policy message that is completely independent of the uncertainty about the climate sensitivity”.¹⁸³ This was supported by the Committee on Climate Change (CCC) in its recent assessment of the Fourth Carbon Budget.¹⁸⁴ Dr David Kennedy, CEO of the CCC, told us that:

[The CCC] said “Rather than assume the most benign number for climate sensitivity or the most concerning, let us look across the range of that sensitivity”. We did a lot of modelling of global emissions pathways across the range of uncertainty for climate sensitivity and we concluded, given those uncertainties and given the risks, the previous assumptions we made are still appropriate at the moment.¹⁸⁵

73. We believe that the Committee on Climate Change (CCC) was right to consider a range of values for climate sensitivity (and their relative uncertainties) when reviewing the Fourth Carbon Budget. We agree with its conclusion that the IPCC's latest assessment of the sensitivity of the climate towards greenhouse gas emissions gives no grounds for a change in policy action.

74. With regard to carbon budgets, we were made aware that a focus on reducing domestic net emissions is not always helpful; an alternative approach would be to keep track of so-called “embedded” emissions (which take account of the carbon content of goods that are

179 Committee on Climate Change, [Fourth Carbon Budget Review – Part 1](#) (2013), p4

180 Oral evidence taken on [8 January 2014](#), HC (2013-14) 959, Q20-27 [Dr Kennedy, Lord Deben]

181 Grantham Institute for Climate Change ([IPC 032](#)), University of Reading ([IPC 035](#)), Myles Allen ([IPC 037](#)), Grantham Research Institute on Climate Change and the Environment ([IPC 051](#)), WWF ([IPC 054](#))

182 Ian Strangeways ([IPC 022](#)), Met Office ([IPC 026](#)), Grantham Institute for Climate Change ([IPC 032](#))

183 Q204 [Professor MacKay]

184 Committee on Climate Change, [Fourth Carbon Budget Review – Part 1](#) (2013)

185 Oral evidence taken on [8 January 2014](#), HC (2013-14) 959, Q18 [Dr Kennedy]

being consumed by a country through imports).¹⁸⁶ As Professor David MacKay, Chief Scientific Advisor to DECC explained:

Our overall carbon footprint for most of the last 15 years has trended up. There has been a slight drop in the last couple of years, but, yes, because of our imports from other countries of what we call embedded emissions, in that way of accounting things our net emissions have gone up. I do not think it is right to blame our policies for causing that outcome.¹⁸⁷

The benefits of considering embedded carbon emissions alongside territorial emissions in the policy-making process were highlighted in our 2012 report, *Consumption-Based Emissions Reporting* and our 2014 report, *Carbon Capture and Storage*.¹⁸⁸ The Minister of State Climate Change, Rt Hon. Gregory Barker, said he thought the approach, “has a great deal of intellectual merit” but cautioned:

For the UK unilaterally to report its emissions in a different way would be very complex and would undermine the whole system of international reporting, but it is something that any sensible analysis of our overall progress in reducing emissions needs to take into account. In terms of being a primary measure and benchmark, I think the overall national emissions should, until there was some international consensus to do otherwise, continue to be the primary benchmark for judging success or failure.¹⁸⁹

75. The WGI contribution to AR5 re-affirms the scientific underpinning of the Climate Change Act 2008 and hence the UK’s ambitious greenhouse gas emission reductions targets. We believe that there is merit in considering embedded carbon emissions alongside territorial emissions in the policy making process.

International climate policy

76. The WGI contribution to AR5 sets, for the first time, a cumulative global carbon budget required to stay below a 2° Celsius rise in global mean surface temperature (GMST) by 2100.¹⁹⁰ The UK accounts for less than 2% of total global greenhouse gas emissions.¹⁹¹ It is clear that unilateral action by the UK will not be sufficient to mitigate dangerous climate change: a global agreement is required.¹⁹² The Government assured us that it was aiming to achieve “an ambitious global deal” at the upcoming Conference of the Parties (COP) in

186 Q174 [Mr Grant], Q221 [Professor MacKay], Q264 [Mr Barker]

187 Q221 [Professor Mackay]

188 Energy and Climate Change Committee, Twelfth Report of Session 2010-12, [Consumption-Based Emissions Reporting](#) HC 1646, para 39 and 53, Energy and Climate Change Committee, Ninth Report of Session 2013-14, [Carbon capture and storage](#), HC 742, para 28

189 Q264 [Mr Barker]

190 Grantham Institute for Climate Change ([IPC 032](#))

191 Jonathan Drake ([IPC 030](#))

192 Q184 [Mr Newey], Department of Energy and Climate Change ([IPC 025](#))

Paris 2015.¹⁹³ The Minister acknowledged that a global agreement was, “by no means a done deal and there is a lot of work that needs to be done in order to avoid a Copenhagen-style outcome”.¹⁹⁴ We received evidence from Professor Sir David King, the Foreign Secretary’s Special Representative on Climate Change, who described the task ahead as “the biggest diplomatic challenge of our time”.¹⁹⁵ Professor King explained a number of preparatory measures he was undertaking in order to ensure the best outcome from Paris.¹⁹⁶ Both Professor King and the Minister have emphasised the importance of high-level leadership at an early stage. The Minister said:

I think the global community has learnt from Copenhagen, where too much was left until the last moment. Too much weight was put on the ability of leaders to turn up in the final two days and conclude a deal, which is why we need a clear roadmap. I will be going to Abu Dhabi in May for the pre-leaders meeting to talk about the agenda for the Ban Ki-Moon summit in September, which will be an important milestone on the road to Paris 2015.¹⁹⁷

77. Recently, senior government figures have shown strong commitments to tackling climate change. Earlier this year, the Prime Minister said that “manmade climate change is one of the most serious threats that this country and this world face”.¹⁹⁸ In a speech to business leaders in Hong Kong in February 2014, the Chancellor of the Exchequer said “I’m someone who believes climate change is happening, that it’s caused by human beings. We should do what we can to prevent it”.¹⁹⁹ We were also pleased to see a recent joint statement from the UK and China recognising the “threat of dangerous climate change as one of the greatest global challenges”, the publication of AR5 confirming that “climate change is already happening, much of it as a result of human activity” and the “clear imperative to work together towards a global framework for ambitious climate change action”.²⁰⁰

78. The WGI contribution to AR5 strengthens the scientific case for rapid, drastic action to reduce global greenhouse gas emissions in order to avoid a 2° Celsius rise in global mean surface temperature (GMST). It is generally agreed that such dramatic emissions reductions strategies could best be implemented within the framework of a unified global agreement. Attempts to reach an agreement in the past have lacked early high level leadership: a public commitment from the UK Government is required early in the preparations of COP 2015 in order to guarantee the highest chance of success.

193 Q267 [Mr Barker]

194 Q268 [Mr Barker]

195 Oral evidence taken on [25 March 2014](#), HC (2013-14) 1190, Q1 [Professor King]

196 Oral evidence taken on [25 March 2014](#), HC (2013-14) 1190, Q60-69 [Professor King]

197 Q268 [Mr Barker]

198 HC Deb, 26 February 2014, [col 255](#)

199 “[George Osborne wants climate change tackled as cheaply as possible](#)”, The Guardian, 20 February 2014

200 DECC, [UK-China joint climate change statement](#) (17 June 2014)

79. The Government should provide an explicit commitment on the involvement of senior figures in the early stages of the Paris COP 2015. Senior Government members should be actively involved in the strategy for obtaining a global climate deal. The early commitment of the Prime Minister, Chancellor of the Exchequer and DECC ministers to the preliminary stages of the global climate negotiations will encourage other world leaders to similarly get involved.

5 Conclusions

80. The conclusions of this inquiry are very clear: the WGI contribution to AR5 is the best available summary of the prevailing scientific opinion on climate change currently available to policy-makers. Its conclusions are derived with a high confidence from areas of well understood science. Uncertainty remains in a small number of important areas but these are diminishing. It is important to consider all lines of evidence together when assessing climate change rather than focusing on particular aspects of the report. The overall thrust and conclusions of the report are widely supported in the scientific community and summaries are presented in a way that is persuasive to the lay reader.

81. The size and scale of the report reflects the huge effort by the international climate science community, who volunteer their time and expertise. We can now be more confident than ever that human activity is the dominant cause of the warming witnessed in the latter half of the 20th Century. The most significant human impact is through the release of carbon dioxide, which is predicted to continue to cause warming in the coming decades and centuries.

82. The IPCC has updated its processes. The WGI contribution to AR5 is the most exhaustive and heavily scrutinised Assessment Report to-date. Tightened review processes ensure that the report has been compiled to the highest standards of scholarship; a remarkable feat given the size of the operation. The authority of the reports comes not from the process and procedure, but from the evidence itself, the thousands of peer-reviewed academic papers that form a clear and unambiguous picture of the state of the climate. Collectively, this evidence reveals a pattern of expanding observations, increasing computational ability and improving understanding across the climate system. There are, as there ever will be, uncertainties in the science, but these uncertainties do not blur the overwhelmingly clear picture of a climate system changing as a result of human influence. The report offers an excellent vantage point from which the scientific community can reflect on the state of climate science, and develop research strategies for the future.

83. The implications of the report for policy-makers in the UK are simple: there is no scientific basis for downgrading the UK's ambition to reduce greenhouse gas emissions. It is imperative that this message is also understood by the international community. The Government must renew its commitment to achieve a global deal on climate change.

Conclusions and recommendations

Process

1. The IPCC has continued to strengthen and improve its Assessment Report procedure. The IPCC has put a series of measures in place to help to minimise the risk of errors creeping in, and quickly rectify them if they emerge. The IPCC has responded extremely well to the constructive criticism of the InterAcademy Council (IAC). With regard to the IAC's recommendations, we would like to see the appointment of non-climate scientists to the Executive Committee. (Paragraph 10)
2. For future Assessment Reports the Government should recommend to the IPCC that they recruit a small team of experts who are not climate scientists to observe the review process from start to finish. The team would not constitute an extra stage of review, but rather oversee the process and arbitrate when controversies arise. The testimony of this independent team would improve the credibility of the report when it is released, and potentially protect it from any unnecessary and unfounded criticism. The team could also feed back to the IPCC in order to facilitate continuous improvement. (Paragraph 12)

Inclusivity and objectivity

3. The Assessment Report procedure depends to a large extent on the integrity of the authors and editors involved, but we have found no evidence to suggest that this should give cause for concern. The authors drew upon a wide pool of peer-reviewed literature, highlighting areas of disagreement as readily as areas of agreement. We are satisfied that there was no systemic bias of any kind, be it financial, political or otherwise that would jeopardise the accuracy of the reported scientific conclusions. The procedures in place to safeguard against the influence of such biases appear to be sufficiently robust. (Paragraph 20)
4. Although the terms “consensus” and “settled science” with regards to climate change were generally not thought to be helpful, as uncertainty and debate are required to drive research forward, we conclude that there is clearly strong agreement that the IPCC has captured the prevailing scientific opinion, notwithstanding some disagreement from a number of reputable scientists. (Paragraph 22)

Timeliness

5. There are mixed views regarding the frequency and size of IPCC Assessment Reports. Transition to smaller, more frequent reports would arguably relieve the burden on contributing authors and ensure policymakers were kept up to date, but the finished document would lack the comprehensive and authoritative nature of the current Assessment Reports. Any revision of the tried and tested IPCC formula should only be introduced after careful consultation with both the governments who use the IPCC reviews and the scientists who write them. The aftermath of AR5 is an optimum time for this period of reflection to take place. (Paragraph 26)

Summary for Policymakers

6. Including policymakers in the final stage of the report writing process does not seem to have had any substantial negative effects on the Summary for Policymakers (SPM) and very likely serves to improve the relevance and accessibility of the finished document. (Paragraph 31)
7. It is inevitable that the distillation of such a complex and lengthy report will lead to the omission of some technical detail, but the traceability of the SPM to the full report adequately compensates for that. Any further technical detail that may be required for policymaking, such as in the setting of carbon budgets, is readily obtainable. The SPM succeeds in its purpose of keeping policymakers informed on issues surrounding climate science. (Paragraph 32)
8. We recommend that the Government call on the IPCC to introduce a greater level of transparency in the plenary meetings to agree future Summaries for Policymakers (SPM). This may be through the admission of the independent team of observers to oversee the discussions (see paragraph 12). The feedback from the team would then serve to provide reassurance that the summary-writing process has been carried out objectively. (Paragraph 33)

Causes of climate change

9. The WGI contribution to AR5 presents the most compelling evidence to date that many of the changes to the climate recorded in the latter half of the 20th Century were driven by post-industrial human activity. We have not found convincing evidence that challenges the IPCC's conclusion in this matter. There is increased confidence in the IPCC projections that, with rising greenhouse gas concentrations, we will continue to see warming (and the changes to the climate associated with warming) in this century and beyond. (Paragraph 42)

Sensitivity of the climate to carbon dioxide

10. The WGI contribution to AR5 has considered the full range of both Equilibrium Climate Sensitivity and Transient Climate Response and given the best assessment possible within the constraints of the evidence available at the time. It does not appear that a consistent pattern for higher or lower sensitivities than that stated in the WGI contribution to AR5 has emerged since its publication. (Paragraph 48)

The hiatus

11. Periods of hiatus are consistent with earlier IPCC assessments that non-linear warming of the climate is to be expected and that forced climate changes always take place against a background of natural variability. The current period of hiatus does not undermine the core conclusions of the WGI contribution to AR5 when put in the context of the overall, long-term global energy budget. Despite the hiatus, the first decade of the 2000s was the warmest in the instrumental record and overall warming is expected to continue in the coming decades. (Paragraph 53)

Climate models

12. The models used in the IPCC's Assessment Reports have a successful history of simulating past climate and their future projection of substantial warming over the next century in all but the most aggressive mitigation scenarios is well founded and overwhelmingly clear. (Paragraph 64)
13. In the light of the WGI contribution to AR5, the Government should commission a strategic review of UK modelling facilities to discern how current computing capacity could be used more effectively to reduce remaining uncertainties. The review should highlight areas of potential national and international collaboration between modelling centres and any funding shortfalls that need to be met. (Paragraph 65)

Economic implications

14. The Government should ensure that the report it has commissioned to look at the benefits and opportunities in tackling climate change, The New Climate Economy, considers evidence about the costs of climate change to business. We believe that this report should be peer reviewed to avoid attracting the same criticism that was made of the Stern Review. (Paragraph 70)

Domestic climate policy

15. We believe that the Committee on Climate Change (CCC) was right to consider a range of values for climate sensitivity (and their relative uncertainties) when reviewing the Fourth Carbon Budget. We agree with its conclusion that the IPCC's latest assessment of the sensitivity of the climate towards greenhouse gas emissions gives no grounds for a change in policy action. (Paragraph 73)
16. The WGI contribution to AR5 re-affirms the scientific underpinning of the Climate Change Act 2008 and hence the UK's ambitious greenhouse gas emission reductions targets. We believe that there is merit in considering embedded carbon emissions alongside territorial emissions in the policy making process. (Paragraph 75)

International climate policy

17. The WGI contribution to AR5 strengthens the scientific case for rapid, drastic action to reduce global greenhouse gas emissions in order to avoid a 2° Celsius rise in global mean surface temperature (GMST). It is generally agreed that such dramatic emissions reductions strategies could best be implemented within the framework of a unified global agreement. Attempts to reach an agreement in the past have lacked early high level leadership: a public commitment from the UK Government is required early in the preparations of COP 2015 in order to guarantee the highest chance of success. (Paragraph 78)
18. The Government should provide an explicit commitment on the involvement of senior figures in the early stages of the Paris COP 2015. Senior Government members should be actively involved in the strategy for obtaining a global climate deal. The early commitment of the Prime Minister, Chancellor of the Exchequer and

DECC ministers to the preliminary stages of the global climate negotiations will encourage other world leaders to similarly get involved. (Paragraph 79)

Overall conclusions

19. The conclusions of this inquiry are very clear: the WGI contribution to AR5 is the best available summary of the prevailing scientific opinion on climate change currently available to policy-makers. Its conclusions are derived with a high confidence from areas of well understood science. Uncertainty remains in a small number of important areas but these are diminishing. It is important to consider all lines of evidence together when assessing climate change rather than focusing on particular aspects of the report. The overall thrust and conclusions of the report are widely supported in the scientific community and summaries are presented in a way that is persuasive to the lay reader. (Paragraph 80)
20. The size and scale of the report reflects the huge effort by the international climate science community, who volunteer their time and expertise. We can now be more confident than ever that human activity is the dominant cause of the warming witnessed in the latter half of the 20th Century. The most significant human impact is through the release of carbon dioxide, which is predicted to continue to cause warming in the coming decades and centuries. (Paragraph 81)
21. The IPCC has updated its processes. The WGI contribution to AR5 is the most exhaustive and heavily scrutinised Assessment Report to-date. Tightened review processes ensure that the report has been compiled to the highest standards of scholarship; a remarkable feat given the size of the operation. The authority of the reports comes not from the process and procedure, but from the evidence itself, the thousands of peer-reviewed academic papers that form a clear and unambiguous picture of the state of the climate. Collectively, this evidence reveals a pattern of expanding observations, increasing computational ability and improving understanding across the climate system. There are, as there ever will be, uncertainties in the science, but these uncertainties do not blur the overwhelmingly clear picture of a climate system changing as a result of human influence. The report offers an excellent vantage point from which the scientific community can reflect on the state of climate science, and develop research strategies for the future. (Paragraph 82)
22. The implications of the report for policy-makers in the UK are simple: there is no scientific basis for downgrading the UK's ambition to reduce greenhouse gas emissions. It is imperative that this message is also understood by the international community. The Government must renew its commitment to achieve a global deal on climate change. (Paragraph 83)

Annex: Glossary of technical terms and abbreviations

In addition to the phrases listed here, a more comprehensive glossary is provided by the IPCC.²⁰¹

Aerosols–Very small particles of solid or droplets of liquid suspended in the atmosphere. They are known to influence cloud formation.

Albedo–A measure of how reflective the Earth is to incoming radiation from the sun.

Anthropogenic–A process that is caused by human activity. Typically used to describe man-made climate change.

Assessment Report (AR4, AR5 etc.)–Large reports written by the IPCC every six/seven years on the most current thinking surrounding climate change. The reports consist of a huge assessment of peer-reviewed literature by eminent climate scientists that is subsequently summarised, reviewed, revised and then published.

Atmosphere–The layer of gases, clouds and aerosols that surround the surface of the Earth.

Attribution–The process of determining the reasons behind a detected change in the climate system (such as increases in temperature).

Calibrated uncertainty language–Uncertainty language is the wording used to describe how confident the IPCC authors are of a particular statement. This language is said to be calibrated when the authors have agreed mathematically what the particular words mean. For example, the phrase “very likely” is only used to describe a statement if the IPCC authors believe it has a greater than 90% chance of being correct. A table showing the likelihood terms associated with outcomes can be found on page 142 of the WGI contribution to AR5.²⁰²

Climate Forcing–The difference between the energy received by the Earth from the Sun and the energy radiated back into space. A “positive” radiative forcing means that more energy is being received by the Earth (hence it warms) and a negative forcing means that more energy is being lost by the Earth (hence it cools).

Conference of the Parties (COP)–An annual meeting of all the parties involved in the United Nations Framework Convention on Climate Change (UNFCCC). It is during these meetings that global climate agreements (such as the Kyoto protocol) are formulated.

201 IPCC Working Group I Contribution to AR5, [Climate Change 2013: The Physical Science Basis, Annex III, Glossary](#) (2013), p1447

202 IPCC Working Group I Contribution to AR5, [Summary for Policymakers, Climate Change 2007: The Physical Science Basis](#) (2007), p138-142

Cosmic rays–High energy particles originating from space that are constantly bombarding the Earth. The effect of cosmic rays on the atmosphere is not fully understood.

Coupled Model Intercomparison Project (CMIP)–A framework that enables climate modellers to carry out common computational experiments and then compare the results. This enables the identification of strengths and weaknesses of certain models for future development. The latest phase of the project is the fifth generation of model intercomparison experiments, CMIP5. The output of CMIP5 was used heavily in AR5.

Energy budget (of the Earth)–The Earth is a physical system with an energy budget that includes all gains of incoming energy and all losses of outgoing energy. The Earth’s energy budget is determined by measuring how much energy comes into the Earth system from the Sun, how much energy is lost to space, and accounting for the remainder on Earth and its atmosphere.

El Niño Southern Oscillation (ENSO) - the Earth undergoes a number of natural climatic oscillations of which ENSO is the most frequently discussed. During the ENSO cycle, anomalously warm ocean water temperatures develops off the western coast of South America and can cause climatic changes across the Pacific Ocean.

Equilibrium Climate Sensitivity (ECS)–As with the Transient Climate Response (TCR), ECS is a predicted measure of the effect on global average surface temperature of a change to the Earth system that alters the amount of energy coming in or going out. Throughout this report, ECS specifically refers to the temperature change due to the effect of doubling carbon dioxide over a very long period (thousands of years), allowing time for the excess heat to be distributed within oceans.

Expert Reviewers–Expert reviewers nominate themselves to the IPCC to provide a critique of the content of individual chapters of Assessment Reports. All of the comments of the expert reviewers are responded to by the author team and improvements are made where necessary. There were 21,400 comments on the first draft of the WGI contribution to AR5 by 659 reviewers.

Global mean surface temperature (GMST)–The global average temperature of the surface of the Earth.

Greenhouse gas (GHG)–Greenhouse gases (such as carbon dioxide) absorb energy escaping from the surface of the Earth, causing it to warm.

InterAcademy Council (IAC) - The IAC is a multinational organisation of joint science academies created to advise national governments and international organisations (such as the United Nations (UN)). In 2010, the IAC were commissioned by the UN to produce a report examining the processes and procedures of the IPCC.

Intergovernmental Panel on Climate Change (IPCC)–A scientific organisation set up by the UN in 1988 with the objective of writing reports to inform member governments and the UNFCCC. In 2014, the IPCC published their fifth Assessment Report on the state of the climate, AR5.

Natural internal climate variability/internal variability—Changes in the global climate system brought about internally by natural cycles (such as El Niño). Internal variability is distinct from external variability which are changes brought about by either human activity or the behaviour of the Sun.

Null hypothesis—A null hypothesis is equivalent to asking what would happen if the variable under investigation was absent altogether. In this case, the IPCC considered whether observed climate changes would take place without any influence from human activity.

Review Editors—Review Editors are tasked with overseeing the review process of IPCC Assessment Reports (with around three editors per chapter). The editors ensure that all of the Expert Reviewer comments have been properly responded to and acted upon where necessary. The Review Editors subsequently write a report to summarise the review of their particular chapter.

Summary for Policymakers (SPM)—The SPM is the summarised version of the full technical IPCC Assessment Report. Each Working Group produce an SPM of about 30 pages covering their contribution to the overall report.

Temperature Anomaly—A temperature anomaly is used to describe changes in a measured land and/or sea surface temperatures over time. The “anomaly” is the difference between the recorded value and an average value for a defined period.

Total Solar Irradiance (TSI)—This is a measure of the total radiation from the Sun falling on a certain area at the top of the Earth’s atmosphere.

Transient Climate Response (TCR) - As with the Equilibrium Climate Sensitivity (ECS), TCR is a predicted measure of the effect on global average surface temperature of a change to the Earth system that alters the amount of energy coming in or going out. Throughout this report, TCR specifically refers to the effect on the climate of doubling the atmospheric carbon dioxide concentration over a 70-year period.

United Nations Framework Convention on Climate Change (UNFCCC) - The UNFCCC is an international environmental treaty agreed by the membership of the UN in June 1992. The UNFCCC aims to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

Working Group (WG)—The IPCC reports are comprised of three large sections written by an appropriate working group. Working Group I (WGI) contribution to the IPCC’s Fifth Assessment Report (AR5), is tasked with investigating the physical scientific evidence for climate change. Working Groups II and III (WGII and WGIII) examine impacts and mitigation of climate change.

Formal Minutes

Tuesday 15 July 2014

Members present:

Mr Tim Yeo, in the Chair

Ian Lavery
Mr Peter Lilley
Albert Owen
John Robertson

Sir Robert Smith
Graham Stringer
Dr Alan Whitehead

The following declarations of interest relating to the inquiry were made:

28 January 2014, 11 February 2014 and 11 March 2014

Sir Robert Smith declared interests, as listed in the Register of Members' Interests, in the oil and gas industry, in particular a shareholding in Shell Transport and Trading (oil-integrated)

Draft Report (*Intergovernmental Panel on Climate Change Fifth Assessment Report: Review of Working Group I contribution*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 11 read and agreed to.

Motion made, and Question put, That paragraph 12 stand part of the Report.

The Committee divided:

Ayes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Noes, 1
Graham Stringer

Paragraph accordingly agreed to.

Paragraphs 13 to 19 read and agreed to.

Paragraph 20 read.

Amendment proposed, in line 2, to leave out from “involved” to the end of the paragraph, and insert “**.We have received evidence which gives us cause for concern of chronic political and “activist” interference. The procedures to safeguard against this influence are either non-existent or ineffective.**”—(*Graham Stringer.*)

The Committee divided:

Ayes, 2
Mr Peter Lilley
Graham Stringer

Noes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Amendment accordingly negatived.

Paragraph agreed to.

Paragraph 21 read and agreed to.

Paragraph 22 read.

Amendment proposed, in line 3, to leave out from “**agreement**” to the end of the paragraph, and insert “**within the IPCC process although there remains significant disagreement from a number of reputable scientists.**”—(*Graham Stringer.*)

The Committee divided:

Ayes, 2
Mr Peter Lilley
Graham Stringer

Noes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Amendment accordingly negatived.

Paragraph agreed to.

Paragraphs 23 to 30 read and agreed to.

Motion made, to leave out paragraphs 31 to 33 and insert the following new paragraph:

Representatives from a hundred governments were involved in a secret four daylong meeting which reduced the original draft summary for policymakers by 700 words but increased it by 5 pages. This document is clearly a negotiated political statement. Astonishingly the IPCC announced that they would change the underlying report of 14 chapters to be consistent with the Summary for Policymakers. This turns normal procedure on its head. The IPCC is fundamentally a political body that from its inception has been subject to undue influence from governments and “activists”. This has distracted it from its ability to collect and summarise the science. The claim from the IPCC that it is a scientific body is false. The IPCC should be abolished and a new more transparent body should be set up in its place. This should be controlled by scientists with an international reputation and achievements in climate science and other relevant disciplines. It should report more frequently. Its objective should be to summarise the latest science in this field.—(*Graham Stringer.*)

Question put, That the new paragraph be read a second time.

The Committee divided:

Ayes, 2
Mr Peter Lilley
Graham Stringer

Noes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Paragraphs 31 to 33 read and agreed to.

Paragraph 34 read and agreed to.

Motion made, and Question put, That paragraph 35 stand part of the Report.

The Committee divided:

Ayes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Noes, 2
Mr Peter Lilley
Graham Stringer

Paragraph accordingly agreed to.

Paragraphs 36 to 41 read and agreed to.

Paragraph 42 read.

Amendment proposed, in line 1, to leave out from “presents” to the end of the paragraph, and insert “evidence that many of the changes to the climate recorded in the latter half of the 20th Century were driven by post-industrial human activity. We have found no credible scientific source that disputes the claim that human activity has an influence on the climate. There is still a debate about the quantification of this impact.”—(*Graham Stringer.*)

The Committee divided:

Ayes, 2
Mr Peter Lilley
Graham Stringer

Noes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Amendment accordingly negated.

Paragraph agreed to.

Paragraphs 43 to 52 read and agreed to.

Motion made, to leave out paragraph 53 and insert the following new paragraph:

Only 3% of the 251 climate models predicted the current hiatus in warming. Although the IPCC has qualified its previous reports by predicting that warming would be non-linear, it is difficult to have greater confidence in the IPCC's conclusion at a time when the vast majority of the models' predictions

have failed. At the present time there is no method known for measuring directly the Earth's energy budget and therefore projections of future temperature and climate are difficult to make.—(Graham Stringer.)

Question put, That the new paragraph be read a second time.

The Committee divided:

Ayes, 2
Mr Peter Lilley
Graham Stringer

Noes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Paragraph 53 read and agreed to.

Paragraphs 54 to 56 read and agreed to.

Motion made, and Question put, That paragraph 57 stand part of the Report.

The Committee divided:

Ayes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Noes, 2
Mr Peter Lilley
Graham Stringer

Paragraph accordingly agreed to.

Paragraphs 58 to 63 read and agreed to.

Motion made, and Question put, That paragraph 64 stand part of the Report.

The Committee divided:

Ayes, 5
Ian Lavery
Albert Owen
John Robertson
Sir Robert Smith
Dr Alan Whitehead

Noes, 2
Mr Peter Lilley
Graham Stringer

Paragraph accordingly agreed to.

Paragraphs 65 and 66 read and agreed to.

Motion made, and Question put, That paragraph 67 stand part of the Report.

The Committee divided:

Ayes, 5	Noes, 2
Ian Lavery	Mr Peter Lilley
Albert Owen	Graham Stringer
John Robertson	
Sir Robert Smith	
Dr Alan Whitehead	

Paragraph accordingly agreed to.

Paragraphs 68 to 74 read and agreed to.

Motion made, to leave out paragraph 75 and insert the following new paragraph:

In our previous report “Consumption-based emissions reporting” we recommended that the Government acknowledge that the United Kingdom’s consumption is driving up territorial emissions in other countries. The increased cost of energy in this country because of the move to renewables will inevitably exacerbate this situation. The United Kingdom’s and Europe’s carbon footprint has increased as greenhouse gas emissions has reduced. The recognition of this does not just have “intellectual merit” it represents the perverse consequences of the United Kingdom’s ambitious greenhouse gas emission reduction targets. This policy should be reviewed.—(Graham Stringer.)

Question put, That the new paragraph be read a second time.

The Committee divided:

Ayes, 2	Noes, 4
Mr Peter Lilley	Ian Lavery
Graham Stringer	John Robertson
	Sir Robert Smith
	Dr Alan Whitehead

Paragraph 75 read and agreed to.

Paragraphs 76 to 83 read and agreed to.

Annex and Summary agreed to.

Motion made, and Question put, That the Report be the First Report of the Committee to the House.

The Committee divided.

Ayes, 5	Noes, 2
Ian Lavery	Mr Peter Lilley
Albert Owen	Graham Stringer
John Robertson	
Sir Robert Smith	
Dr Alan Whitehead	

Question accordingly agreed to.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Tuesday 22 July at 9.15 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the Committee's inquiry page at <http://www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/inquiries/parliament-2010/the-ipcc/?type=Oral#pnIPublicationFilter>.

Tuesday 28 January 2014

Question number

Professor Sir Brian Hoskins, Grantham Institute, **Professor Myles Allen**, Oxford University, and **Dr Peter Stott**, Met Office

[Q1-51](#)

Professor Richard Lindzen, Massachusetts Institute of Technology, **Nicholas Lewis**, and **Donna Laframboise**

[Q52-112](#)

Tuesday 11 February 2014

Sir Peter Williams, Royal Society, **Dr Emily Shuckburgh** Royal Meteorological Society

[Q113-153](#)

James Painter, Reuters Institute, Oxford University, **Guy Newey**, Policy Exchange, and **Jonathan Grant**, PricewaterhouseCoopers

[Q154-193](#)

Tuesday 11 March 2014

Professor David Mackay, Chief Scientific Adviser, DECC and **Professor Sir Mark Walport**, Government Chief Scientific Adviser

[Q194-235](#)

Rt Hon Gregory Barker MP, Minister of State for Climate Change, and **David Warrilow**, Department for Energy and Climate Change

[Q236-290](#)

Published written evidence

The following written evidence was received and can be viewed on the Committee's inquiry web page at <http://www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/inquiries/parliament-2010/the-ipcc/?type=Written#pnlPublicationFilter>. INQ numbers are generated by the evidence processing system and so may not be complete.

- 1 Alan Gadian ([IPC0020](#))
- 2 Alex Henney ([IPC0006](#))
- 3 Alex Henney ([IPC0012](#))
- 4 Alex Henney ([IPC0056](#))
- 5 Barry Brill ([IPC0018](#))
- 6 Bob Ward, Grantham Research Institute on Climate Change and the Environment ([IPC0060](#))
- 7 Brigitte Nerlich ([IPC0031](#))
- 8 Carbon Tracker ([IPC0038](#))
- 9 Christopher Walter, Viscount Monckton Of Brenchley ([IPC0005](#))
- 10 Clive Best ([IPC0053](#))
- 11 Conor McMenemie ([IPC0014](#))
- 12 Corinne Le Quéré and Andrew Watkinson ([IPC0050](#))
- 13 David Holland ([IPC0027](#))
- 14 Department of Energy and Climate Change ([IPC0025](#))
- 15 Donna Laframboise ([IPC0039](#))
- 16 Donna Laframboise ([IPC0071](#))
- 17 Dr Fenton F. Robb ([IPC0004](#))
- 18 Dr Norman J Page ([IPC0058](#))
- 19 Dr Ruth Dixon ([IPC0023](#))
- 20 Dr. A Neil Hutton ([IPC0028](#))
- 21 EDF Energy ([IPC0043](#))
- 22 Friends of Science Society ([IPC0015](#))
- 23 Grantham Research Institute on Climate Change and the Environment ([IPC0051](#))
- 24 Ian Strangeways ([IPC0022](#))
- 25 James Painter ([IPC0044](#))
- 26 John Christy ([IPC0055](#))
- 27 John McLean ([IPC0016](#))
- 28 Jonathan Cowie ([IPC0033](#))
- 29 Jonathan Drake ([IPC0030](#))
- 30 Judith Curry ([IPC0052](#))
- 31 Lucian B. Platt ([IPC0057](#))
- 32 Madhav Khandekar ([IPC0019](#))
- 33 Marcel Crok ([IPC0041](#))
- 34 Mark Richardson ([IPC0077](#))
- 35 Met Office ([IPC0026](#))
- 36 Met Office ([IPC0076](#))

- 37 Myles Allen ([IPC0037](#))
- 38 Myles Allen ([IPC0073](#))
- 39 Myles Allen ([IPC0078](#))
- 40 Natural Environment Research Council ([IPC0036](#))
- 41 Nicholas Lewis ([IPC0017](#))
- 42 Nicholas Lewis ([IPC0069](#))
- 43 Nicholas Lewis ([IPC0070](#))
- 44 Nongovernmental International Panel on Climate Change ([IPC0042](#))
- 45 Paul Matthews ([IPC0046](#))
- 46 Philip Richens ([IPC0021](#))
- 47 Piers Corbyn, WeatherAction ([IPC0059](#))
- 48 Professor Michael J Kelly FRS FREng ([IPC0013](#))
- 49 Professor Pierre Darriulat ([IPC0049](#))
- 50 Professor Richard Lindzen ([IPC0047](#))
- 51 Richard Lindzen ([IPC0068](#))
- 52 Richard Tol ([IPC0040](#))
- 53 Robin Guenier ([IPC0024](#))
- 54 Roger A. Pielke Sr ([IPC0011](#))
- 55 Royal Meteorological Society ([IPC0029](#))
- 56 Royal Meteorological Society ([IPC0074](#))
- 57 Royal Society ([IPC0034](#))
- 58 Scottish Climate & Energy Forum ([IPC0048](#))
- 59 Susan Morrow ([IPC0003](#))
- 60 The Grantham Institute For Climate Change ([IPC0032](#))
- 61 University of Reading ([IPC0035](#))
- 62 WWF-UK ([IPC0054](#))

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the Committee's website at www.parliament.uk/ecc.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2010–12

First Report	Emissions Performance Standards	HC 523 (807)
Second Report	UK Deepwater Drilling—Implications of the Gulf of Mexico Oil Spill	HC 450 (882)
Third Report	The revised draft National Policy Statements on energy	HC 648
Fourth Report	Electricity Market Reform	HC 742 (HC 1448)
Fifth Report	Shale Gas	HC 795 (HC 1449)
Sixth Report	Ofgem's Retail Market Review	HC 1046 (HC 1544)
Seventh Report	A European Supergrid	HC 1040 (HC 1684)
Eighth Report	The UK's Energy Supply: Security or Independence?	HC 1065 (HC 1813)
Ninth Report	Solar Power Feed-In Tariffs	HC 1605 (HC 1815)
Tenth Report	The EU Emissions Trading System	HC 1476
Eleventh Report	The Future of Marine Renewables in the UK	HC 1624
Twelfth Report	Consumption-Based Emissions Reporting	HC 1646
First Special Report	Low carbon technologies in a green economy: Government Response to the Committee's Fourth Report of Session 2009–10	HC 455
Second Special Report	Fuel Poverty: Government Response to the Committee's Fifth Report of Session 2009–10	HC 541
Third Special Report	The future of Britain's electricity networks: Government Response to the Committee's Second Report of Session 2009–10	HC 629

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