Climate Science: the Fifth IPCC Assessment Report

Summary of a joint seminar of the All Party Parliamentary Group on Climate Change, the Royal Society & the Parliamentary Office of Science & Technology (POST)
Tuesday 15th October, 5.00 – 7.00pm, Attlee Suite, Portcullis House

Seminar Purpose

One of the main IPCC (Inter-governmental Panel on Climate Change) activities is the preparation of comprehensive Assessment Reports. These reports cover the state of scientific, technical and socio-economic knowledge on climate change, its causes, potential impacts and possible response strategies. The Fifth Assessment Report (AR5) is being released in phases from September 2013 to October 2014. This event followed publication of the IPCC Working Group 1 report, the Physical Science Basis, AR5 Summary for Policymakers Report on the 27th September, with the draft chapters of the WG1 report released on the 30th September. The purpose of the event was to allow Parliamentarians to debate this report. Experts in this area, including authors of the report, were present to stimulate debate and answer questions. The seminar was chaired by **Lord Oxburgh** and attendees heard from the following seven speakers before the discussion began:

- **Professor John Pethica FRS**, Vice-President of the Royal Society
- **Professor John Mitchell FRS**, Principal Research Fellow Met Office & Visiting Professor University of Reading
- **Professor Keith Shine FRS**, University of Reading
- **Professor Corinne Le Quéré**, Director of the Tyndall Centre for Climate Change Research University of East Anglia
- **Professor Sir Brian Hoskins FRS**, Director of the Grantham Institute on Climate Change Imperial College & member of the Climate Change Committee
- **Professor Tim Palmer FRS**, University of Oxford
- **Professor Stephen Belcher**, University of Reading & Head of the Met Office Hadley Centre

Slides and audio for each presentation are available on the POST website at http://www.parliament.uk/mps-lords-and-offices/offices/bicameral/post/post-events/climate-science-the-fifth-ipcc-assessment-report/. Short summaries of each presentation and the discussion are given below.

Professor John Pethica FRS

- Professor Pethica started the meeting by outlining the achievements of the IPCC AR5 report and the international policy context in which it sits. Professor Pethica also thanked the organisers for creating an event that allows policy makers to come face to face with the scientists involved in the writing and research that comprises the report.

Professor John Mitchell FRS

What are the main drivers of climate change?

- CO_2 concentrations in the atmosphere are double that of the range of concentrations in the atmosphere for the past 800,000 years, based upon ice core data, with current CO_2 concentrations in the atmosphere standing at 400 ppm.

- The IPCC report states the rate of increase of atmospheric CO_2 concentrations in the last 150 years is far higher than anything previously observed, with the rise in other Green House Gases (GHGs) such as methane and aerosols also contributing to rises in temperature. Variations in solar output and volcanoes alone are insufficient to describe the current observed global warming patterns.

Professor Keith Shine FRS, University of Reading

How sensitive is the climate?

- The presentation gave an overview of the fundamentals of the climate system and discussed how sensitive the climate system is to increases in CO_2 concentrations. AR5 stated that it was extremely likely that the temperature increase will be between 1.5°C - 4.5°C, although extremely unlikely that it will be less than 1°C and very unlikely of being greater than 6°C.
- This is a slightly lower sensitivity limit than AR4 as the models become more refined, with representation of uncertainties in temperature rise in understandable semi-quantitative confidence bands in AR5.
- There are numerous feedback systems that exist in the climate system that can amplify or perhaps reduce warming. An example of a feedback is an increase in water vapour in the atmosphere due to warming from increased CO_2 emissions (as a warmer atmosphere can hold more water vapour) that in turn traps more heat in the atmosphere causing it to warm up further and exacerbating the process.
- Computer models are necessary to simulate the internal climatic variability by incorporate complex atmospheric interactions (with a large number of simulations yields higher confidence in results), as this complexity means observations alone are not enough to validate climate change. However, an increase in the spatial scale of modelling and that satellite imagery could provide advanced observations that have a higher resolution, thereby increasing the confidence of model predictions.

Professor Corinne Le Quéré, Director of the Tyndall Centre for Climate Change Research University of East Anglia

What is the evidence that climate change is due to human activity?

- Natural drivers of climate change alone, for example, solar activity and volcanic eruptions cannot explain the observed levels of global warming. It is only when the models include an increase in greenhouse gas emissions and aerosols from anthropogenic sources that they are able to replicate the observed patterns in space and time.
- Based on the current scientific report that encompassed quantitative assessments of precipitation, hydrology, salinity of oceans, melting snow and ice and arctic sea extremes in the climatic models, there is a strong evidence of human influence on climate at 95% certainty.
- By comparison, the impact of natural drivers on climate was small but the underlying uncertainties in climatic models need to be adequately quantified.

Professor Sir Brian Hoskins FRS, Director of the Grantham Institute on Climate Change Imperial College & member of the Climate Change Committee

The state of the climate system

- Short term variability in the climate is known as weather, i.e. the difference in climate between two different years could be described as a difference in the weather. Climate can also be studied in the medium term by observing the differences in average climate variables (e.g. rainfall, temperature) over a period such as a decade. Long-term changes in climate, such as those over centuries, are indicators of a long term trend in the state of the climate system. The earth's temperature has risen by 0.8°C over the last century.
- Although there are numerous uncertainties and climatic fluctuations associated within the natural systems, when the decadal averages are compared, the last three decades were significantly warmer than any others in the last 200 years. Additionally, the long term trend over the past two centuries clearly demonstrates a warming trend.
- The climate system also comprises the atmosphere, ice sheets and the deep oceans. It is likely the deep oceans have recently absorbed more heat than expected and therefore it is likely the climate system is still warming. However, the inability to measure the temperature of the deep oceans leads to reliance on measurements of only some parts of the climate system (i.e. land and ocean surface temperatures) to infer what is occurring in the whole system. The recent "hiatus" does not represent a halt in the trend of global warming, merely natural variability combined with a lack of monitoring of all areas of the climate system.
- Sea levels are currently rising by 3mm a year, or 30cm a century. The rate of sea level rise could increase as the climate gets warmer. A third of the observed rise is from decreasing ice sheets (the ice melt of Greenland and Antarctica).

Professor Tim Palmer FRS, University of Oxford
Future Projections

- With the amount of carbon dioxide already in the atmosphere, future emissions will need to be reduced by half to that of historical emissions to limit global average temperature rise to 2°C. However, if emissions are not curbed (under the business as usual scenario), the amount of carbon dioxide in the atmosphere will be three times the historical emissions and the temperatures might rise up to 4°C.
- Since the earth's climatic system cannot be simulated and experimented upon in labs, the only option available is to use climate models (which embody the laws of physics) to understand the natural variability of the climate systems and how the climate system is likely to respond to increased levels of greenhouse gases.
- Climate models are only flawed only if the basic principles of physics are, but they can be improved. Many components of the climate system could be better quantified and therefore allow for greater parameterisation in the models to make the models more accurate. Additionally increasing the resolution of models to allow them to model processes at a finer scale, again increasing the accuracy of the results. However, advances in computing technologies would be needed to perform all the necessary calculations. However, although the accuracy of predictions could be improved, the underlying processes of the models are accurate.
- Climate change is likely to impose a major stress on humanity, with changes in precipitation patterns in Asia, drier areas getting a lot drier and wetter regions receiving more rainfall. However, the climate change projections produced by models should be viewed as a risk/probabilistic approach (these results are averaged after numerous iterations, so final projections are mean values).

Professor Stephen Belcher, University of Reading & Head of the Met Office Hadley Centre
Extreme events and climate change

- Extreme climatic events are already occurring in the UK, for example, 2012 was the wettest and 2003 was the hottest summer, and have become more common in recent decades due to changes in the ocean and atmospheric cycles.
- The exceptionally hot UK summer of 2003 could become the norm by 2040 and maybe considered cool by 2080 if current levels of emissions remain as they are. Substantial efforts will be required to increase resilience to limit the effects of these extreme events

Discussion

- Uncertainties in measuring ice cover and in how the ocean carbon cycle will respond to a lack of summer ice were discussed. The role of the arctic ice permafrost into carbon feedback mechanism was neither modelled nor included in the current report as there was little evidence for the process and very few research papers were available It is clear more research is needed in this area.
- Potential positive feedbacks are rarely included in models of predicted future climate change. It was acknowledged that this is a deficiency in the models but that these feedbacks are poorly quantified and therefore cannot currently be parameterised in future models.
- Current models are global models. However, emissions are not evenly distributed across the globe. It was therefore asked if current models of future climate might be ignoring potential regional differences. The panel answered that as many greenhouse gases are relatively long lived and well circulated in the atmosphere this was not an issue. However, some aerosols are more unevenly dispersed and models do try to account for local emissions. Examples would be localised production of sulphur dioxide and black Carbon.
- When asked what evidence would disprove climate change, the panel responded that they would expect to see a global cooling of temperatures for a sustained period of time which they had not. They would also expect the sea ice to get thicker and cover a larger extent, which it is not. The panel also responded that global temperature does not monotonically track atmospheric CO_2 concentrations due to a variety of different natural processes. They suggested that if August's mean temperature was colder than May's you would not say summer didn't happen – likewise if the climate has cooled for a couple of years you would not say it never warmed in the preceding century.
- Climate change is happening fast in a geological timescale but in accordance with human perception the timescale is relatively slow, but effects will be felt by the end of the century (rise of temperature will be unprecedented but not steady). The report provides policy makers with the carbon budget so that carbon can be allocated rationally to be within the within 2°C estimate by the end of 21st century.