DECC Topical Orals – Key Facts – Climate Science Update

6 July 2012

Climate Science

1. Summary

- The scientific evidence for recent global warming is robust and continues to strengthen:
    - it is very likely that this is largely a result of greenhouse gas emissions due to human activity;
    - without action, there is a high risk of global warming well beyond a 2°C increase over pre-industrial times, with significant adverse impacts on human society and the natural world;
    - whilst uncertainties remain in our understanding of how the Earth's climate system works, the case for action is compelling.

2. Global warming – a consistent picture

- A consistent picture of global warming comes from several independent datasets showing:
    - a significant increase in global average surface temperature of 0.8°C since about 1900, with much of this warming occurring in the last 50 years;
    - the period 2001 to 2010 was the warmest ten years in the instrumental record, going back to 1850;
    - continuing sea level rise at about 3mm/year, as a global average;
    - increases in the water vapour held in the atmosphere and the heat stored in the oceans;
    - a major decline in Arctic sea ice summer extent (about -40%) and ice thickness (nearly halved where estimated) since 1980, with both the Northwest Passage and Northern Sea Route open to shipping in late summer in the last two years.

- Globally, 2010 was equal-warmest (with 1998 and 2005) on record, whereas 2011 was only the eleventh warmest[1] owing to very strong Pacific La Niña conditions which can temporarily reduce global temperatures – just as El Niños tend to temporarily increase global temperatures (as in 1998). Such natural global and regional weather fluctuations mean that we don't expect every year to be warmer than the last. But globally, the long term warming trend is clear.

3. Recent weather

- **April and June were the wettest on record in the UK and the very wet weather has continued into July, causing widespread, major flooding and**

[1] World Meteorological Organisation statistics.

ending drought restrictions in all the areas that had been affected by the previous two dry winters.

- The United States have been experiencing extreme weather events, with very recent wildfires and severe storms in Western and Eastern states and continuing severe drought conditions affecting many parts of the US.

- Extremes in rainfall and temperatures may just be part of the natural variability we see in the weather around the world, rather than the effect of climate change. However, part DECC-funded research just published (on 10 July) on attributing climate extremes gives us the capability of assessing whether the risk of experiencing recent extreme weather events has changed because of recent climate change due to human activity.

- This developing and ground breaking research methodology can also tell us about the changing risk of extremes in the UK, because of greenhouse gas emissions:
  - the increasing risk of extreme wet seasons and severe flooding (for example, in 2000 - twice as likely as a century ago);
  - the increasing risk of extreme hot summers (for example in 2003 – at least twice as likely as a century ago);
  - the increasing risk of exceptionally warm months – average November temperature in England as high as seen in 2011 (the second warmest since at least 1659) is now about **60 times more likely** than only 50 years ago;
  - and the ***reducing*** risk of extreme cold weather in winter. - the cold UK December in 2010 is now only about **half as likely** as it was in the early 1960s.
  - Recent research indicates that both solar ultra violet variations and Arctic sea ice reductions linked to global warming can cause cold winter conditions over Europe.

4. Greenhouse gas emissions

- Carbon dioxide (CO_2) levels in the atmosphere have increased by about 40% since the beginning of the industrial revolution, from around 280 to above 390 parts per million (ppm). 2010 saw a record rise in global CO_2 emissions.

- Records from ice cores confirm that CO_2 concentration is now higher than for at least the last 800,000 years and the extra CO_2 in the air today is linked to fossil fuel combustion, as identified by its carbon isotope ratio.

- Levels of other GHGs, such as methane and nitrous oxide, have also increased significantly since pre-industrial times, driven by human emissions - primarily from fossil fuel burning, forest clearance and agriculture.

5. A human fingerprint

- Together, the observed spatial patterns of warming, combined with modelling results, provide strong evidence that the recent observed warming has been mostly caused by human activities increasing greenhouse gas concentrations.

- If GHG emissions continue unabated, average global temperatures may rise (relative to 1990-99 temperatures) by between 1.1 and 6.4°C by the end of this century[2].

6. Dangerous climate change

- Increasing temperatures will be accompanied by a higher risk of triggering dangerous changes such as melting of the Greenland Ice Sheet, changes in Atlantic Ocean circulation, release of large amounts of methane from the sea bed and Amazon forest dieback.

- Global temperature rise needs to be limited to 2°C above pre-industrial levels, to help to avoid the risks of the worst impacts of climate change (such as more droughts, floods and heatwaves).

7. Unmitigated future impacts

- More warming means more risk of major impacts across the world.

- Agricultural yields for all major cereal crops will likely decrease in all major production regions if global average temperatures increase by more than 2 degrees above pre-industrial. There could also be significantly less fresh water available, affecting up to 250 million people in Africa[3].

- Other projected impacts include adverse effects on the health of millions of people and damage to coastal regions and low lying areas because of rising sea levels. There will also be an increased risk of species extinction.

8. Country level impacts of Climate Change

- The Met Office Hadley Centre has carried out a research project for DECC to collate information on observed and projected impacts of climate change in 24 countries.

- The project delivered detailed impact assessments at COP17. These provide information on observed changes in climate to date, projected physical impacts of climate change and projected impacts of climate change for agriculture, water availability, flooding risk and impacts in coastal regions.

9. More extreme weather

- The Intergovernmental Panel on Climate Change (IPCC) released, on 28 March, a Special Report '*Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation'*. The report states that human influence has already led to changes in some extremes, including temperature, rainfall and extreme coastal high water. The report projects says that by the end of the 21st century:

[2] IPCC Fourth Assessment Report: the range of 'likely' values (all scenarios).
[3] IPCC Fourth Assessment Report: Working Group II Report, 2007.

- substantial warming in temperature extremes is virtually certain;
- intense tropical cyclone activity is likely to increase in some areas;
- increased extreme sea levels are very likely.

- Increasing temperature will likely come with increases in extreme weather events, including more heavy rainfall, more heatwaves and heat-related deaths and more intense tropical cyclones and hurricanes.

- We cannot readily attribute an individual extreme weather event solely to climate change - largely because it's unlikely to be a simple cause and effect relationship. However, we know from the latest developments in the research methodology on risk attribution that the chances of certain extreme weather events have already increased because of climate change. *[See section 3 above.]*

10. Mitigation actions

- Limiting global warming to less than 2°C above pre-industrial temperatures is extremely challenging and becomes more difficult and costly for every year we delay action.

- To give us a reasonable chance of limiting warming to no more than 2°C without prohibitive costs or relying on spectacular technological development, we need to reverse the current rise in global emissions and see emissions level start to fall by 2020 at the latest. From there we need to continue to reduce them to at least 50% lower than 1990 emissions by 2050 and cut them further beyond that, to reduce the risk of dangerous climate change, extreme weather and major impacts.

- UNEP[4] estimates that current pledges take us at best half way to a 2020 emission level consistent with a 2 degree trajectory so there is a clear need to raise ambition in both the near and long-term.

- A later peak would very likely require emissions by the end of the century to go to very low or even negative and this may be beyond economic or technological feasibility[5].

11. Geo-engineering

- Based on the evidence currently available, the UK Government is clear that it is premature to consider geo-engineering as a viable option for addressing the climate change. Our priority is, and must be, to tackle the root cause by reducing emissions of greenhouse gases from human activities, and adapting to those impacts that are unavoidable.

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[4] United Nations Environmental Programme

[5] Analysis from the DECC-funded AVOID (Avoiding Dangerous Climate Change) programme suggests that a peak in emissions in 2020 or later necessitates a reduction in emissions of 5% per year or more and long-term levels of emissions to reach zero, or negative emission later in the century, to maintain a 50% chance of limiting warming to below 2°C. This may be beyond economic or technological feasibility and such emissions reductions have never been realised outside of wartime.

- The Government recognises that it is possible that in the future geo-engineering may have a role to play in supplementing our efforts to mitigate climate change. However, for most techniques, current understanding of the costs, feasibility, environmental and societal impacts is at a very low level.

- Research is needed to develop this understanding and DECC is working with other key Government departments to identify gaps in knowledge and inform future research requirements.

12. Confidence in Climate Science

- From its inception, the Intergovernmental Panel on Climate Change (IPCC) has been the primary authority on the global consensus on the science of climate change. It remains so. Its processes and management have been extensively reformed over the last year and we are confident the organisation is strengthened for its important future work.

- The UK's Climate Change policy does not rely on a single source of evidence (the IPCC) but on the peer-reviewed work of many research groups in the UK and around the world. Analysis in the Committee on Climate Change's reports also drives UK Government policy.

- Findings just published (on 9 July) from the first round of the DECC Public Attitudes Tracker Survey suggest that about two thirds of people in the UK are very or fairly concerned about climate change but that overall, the level of concern may be falling compared to previous findings from other surveys.

  This reinforces the need to ensure everyone is fully aware of the adverse impacts that climate change will likely have on us all, in the UK and worldwide, and that urgent action is required to mitigate and adapt to climate change.

13. Solar activity

- The influence of the Sun's variability on the climate is very small: around 10% of the influence of human greenhouse gases since 1750; warming over recent decades cannot be explained by solar variability.

- Similarly, new research has found that solar output is likely be lower in coming decades but this will not substantially delay expected increases in global temperatures caused by greenhouse gas emissions. The need for urgent global emissions reductions remains paramount.

- Research recently published provides very strong evidence that low ultraviolet output from the Sun, as observed during recent years, helps drive cold winters in the UK and elsewhere in Northern Europe. This finding may have implications for long-range weather forecasting but it does not change our understanding that further increases in global temperature will result from greenhouse gases.

- Counter-intuitively, there is also increasing evidence from other research that the reducing extent of Arctic sea ice could be leading to more frequent spells of cold

winter weather over Europe. This may be because of the effects of warmer Arctic temperatures in Autumn on atmospheric pressure systems, bringing cold Easterly winds over Europe.

14. Climate Change Risk Assessment

- The Climate Change Risk Assessment (CCRA) was laid before parliament on the 25th January. This world leading and ground breaking study gives the most comprehensive assessment of what climate change could mean for the UK and will help us ensure that the UK and our economy are amongst the best prepared for climate change anywhere in the world.

- The CCRA gives us the evidence we need to make the right decisions in how to prepare for the future risks of climate change. Government, led by Defra, is now developing the National Adaptation Programme (required by the Climate Change Act 2008) to boost our resilience to climate change and take advantage of the opportunities it presents. DECC, Defra and other stakeholders are working together to develop the National Adaptation Programme.

15. Climate change and geological hazards

- Recent articles have suggested that climate change could increase the risk of geological hazards such as earthquakes, volcanic eruptions and tsunamis, largely due to loss of land ice, rising sea levels and loss of permafrost.

- It is important to recognise the potential risks of geological hazards due to climate change but also note that this an emerging area of study which is quite uncertain and depends very much on the future scale of climate change.

- We welcome growing collaboration between climate scientists and geoscientists who are addressing this matter.

16. Investment in the Met Office Hadley Centre

- At a recent launch event (on 20 June), DECC and Defra recently confirmed future investment of nearly £50 million in a programme of climate research and modelling at the Met Office Hadley Centre's Climate Programme, up to 2015; together with £11m additional funding for high performance computing capacity (supercomputing).

- This investment delivers on the recommendations from a review, led by Sir John Beddington in 2010, of the government's needs for climate science evidence and policy advice. The review concluded that the MOHC provides essential services to government and is a critical national capability.

- The planned Hadley Centre research, which will include close collaboration with other research centres in the UK and across the world, will significantly enhance the climate science evidence available to government, supporting both mitigation and adaptation actions.

- For example, it will deliver new evidence in support of international mitigation actions, transitioning to a low carbon economy, understanding future

renewable resource availability and will provide information to help decision-makers to take a risk-based approach to uncertainty.

- The Met Office Hadley Centre has helped make the UK a world leader in climate science. The new investment will ensure that they have the capacity to continue to produce the ground breaking and robust evidence for which they are internationally renowned.