BRIEFING NOTES ON RECENT SLOWDOWN IN GLOBAL TEMPERATURE RISE

What has happened to global temperature since the late 1990s?

- The rate of increase in **global average surface temperature** since the late 1990s is less than that of previous decades. Global warming has not stopped, but scientists refer to this as a 'hiatus'.
  - The average rate of warming was 0.17°C/decade from 1970-1998, and 0.04°C/decade from 1998-2012.
- Because some years are hotter than others, the numbers can vary substantially depending on the dates chosen: e.g. warming was +0.03°C/decade from 2001-2010, but -0.04°C/decade from 2002-2011*.
- **Natural climate variability** means we expect temperatures to ebb and flow but gradually to rise over time because of continuing emissions of greenhouse gases (*see graph overleaf*).
- Slower periods of warming have occurred since temperature records began in 1850, some due to natural internal variation and others due to factors, like volcanoes, which are external to the climate system.

What does this mean for what we know about climate change?

- The slower pace of temperature rise since the late 90s is so short term in comparison to the long term warming trend that there is no reason to change our basic expectation that warming will continue.
  - Warming occurs when there is more energy going in to the climate system than going out. Observations confirm that this has been the case over the period 2000-2013.
- Surface temperature is only one measure of climate change that scientists look at – it is useful for measuring long term trends but less informative over short timescales.
  - Trends in other variables over the same period, such as sea level change, Arctic sea ice cover, glacier volume, and ocean temperatures, are consistent with a planet continuing to warm.
- It is highly likely that various factors will have played a role in the slowdown, but there is debate amongst scientists about what weight should be given to specific factors.

So why might it be happening?

- It is becoming increasingly clear that **absorption of heat in deep oceans** is part of the explanation.

> *Recent measurements of deep ocean temperatures indicate heat is being absorbed at deeper levels.*
>
> *Ocean cycles are similar to atmospheric cycles but on longer timescales, so we would expect oceans to respond more slowly – it is likely more energy is being absorbed deeper down than in previous decades.*
>
> *Continued sea level rise shows that the oceans are continuing to absorb heat since the two are related.*

- A pronounced **solar minimum** in 2008-9 and a series of **small volcanic eruptions** since 2000 – which eject reflective particles into the atmosphere - have both contributed to a slowing in temperature rise.

> *The difference in the energy flowing into and out of the climate system as measured from space, which drives global temperature change, is affected by solar and volcanic activity.*
>
> *Increasing concentrations of greenhouse gases still trap ever more energy, which leads to temperature rise, but their effect has been partially offset by recent solar and volcanic activity.*

- Some scientists have suggested man-made **aerosols** – particles trapped in the atmosphere from burning coal, transport, etc. – may also be having an impact, but there is no conclusive evidence these aerosols are significantly affecting the recent slow rate of global temperature rise.

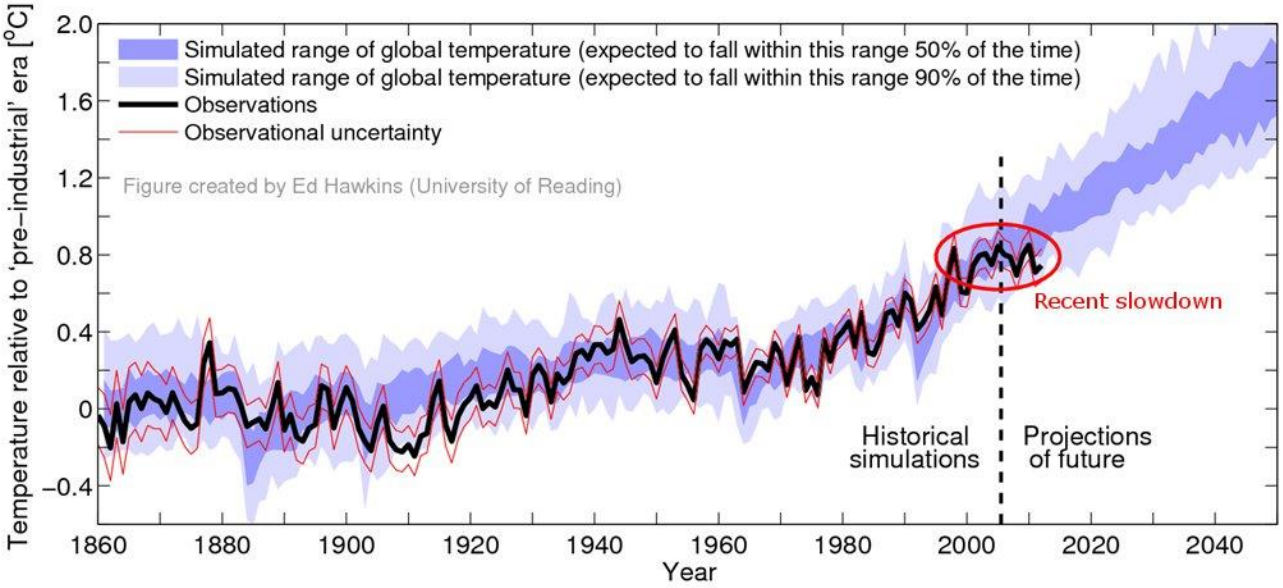
* Numbers are calculated from the Met Office's HadCRUT4 dataset

Why haven't climate models predicted the slowdown?

- Computer models of the climate are not designed to capture the timings of "lumps and bumps" in the temperature record (*see graph*). Directly comparing observations with models in the short term is therefore misleading.
  - It is highly likely that the recent period is a blip and we will soon see a return to faster warming.
- Models can and do simulate periods of slower warming, and even temporary cooling, but the best models currently available don't appear to account for the duration of the recent slowdown.
- The climate is affected by a huge number of interacting factors only some of which we know enough about to correctly include in our models; predictions are made using this incomplete picture.
  - It may be that the models are not taking something properly into account, such as the amount of heat absorbed by the deep oceans or the effect of aerosols.

What is likely to happen in the future?

- Scientists expect to see a return to faster warming. We don't yet know when or at what rate but scientists consider it far more likely that temperatures will continue to rise than that warming will stop.
- Recent observations and improvements in modelling suggest some more extreme estimates of global temperature rise are less likely to occur, and we are becoming more confident of mid-range figures.
- The latest predictions suggest that in a 'medium' emissions scenario, average global temperatures are likely to cross the 2°C threshold between 2040 and 2080, while if emissions rise faster that barrier may be crossed earlier.



This graph of average global temperatures is generated using 42 different climate simulators, assuming 'medium' (RCP4.5) future emissions of greenhouse gases, and compares their projections to observations from the HadCRUT4 dataset. A common reference period of 1961–1990 is used, but the temperatures are presented relative to the 'pre–industrial' era.

These briefing notes have been written by the Science Media Centre in consultation with a number of scientists, science press officers and broadcast journalists. They are not intended as a comprehensive summary on a subject, but rather a snapshot of the basics, of points of controversy and a pointer towards sources of more detailed information. They are subject to change and will be updated as and when the science moves on.