

**Briefing Update**  
**Baron Turnbull's GWPF Paper - *The Really Inconvenient Truth* or**  
***"It Ain't Necessarily So"***

**Issue**

You are meeting Sir Gus O'Donnell to discuss Baron Turnbull's paper for the Global Warming Policy Foundation (GWPF); issued in mid-May. Baron Turnbull criticised the climate science evidence base; the IPCC; and DECC policies based on this evidence. An initial briefing was issued on 18<sup>th</sup> May. Baron Turnbull is a cross-bench peer. He may raise points from his paper in the Lords Debate on the Fourth Carbon Budget.

After a slow start, the paper has been receiving increasing exposure in the media: *The Telegraph* website (16<sup>th</sup> May), the following *Mail on Sunday* in an analysis piece by David Rose and *The Financial Times* 'Notebook Column' yesterday (8<sup>th</sup> June), in which Sue Cameron writes that, whether or not Turnbull is correct, "*he is right to call for more open-mindedness in Whitehall and less reliance on the prevailing orthodoxy*". *The Mail* ran a series of pieces today (9<sup>th</sup> June) including a front page splash largely briefed by Baron Turnbull / GWPF, suggesting 'fuel bills being inflated to pay for government measures based on dodgy climate science'<sup>1</sup>.

**Key Facts / Lines**

- The evidence of mankind's very likely dangerous influence on the climate is compelling, broad and deep. Most recently the 'Garnaut Review' in Australia<sup>2</sup> reconfirms that the evidence for a human influence on climate stronger now than ever and is **'beyond reasonable doubt'**.
- Notwithstanding vociferous critics of the overwhelming climate science consensus, our best estimate of climate sensitivity to CO<sub>2</sub> and other greenhouse gas emissions is that we risk a temperature increase this century of over 2°C, with an unacceptable risk of 4°C or even more.
- We fully understand that such dangerous climate change will likely lead to serious consequences for societies across the world and will have major negative impacts on the natural world. As well as rising temperatures, rainfall patterns, which are already changing, are likely to change radically in coming decades and extreme events are likely to increase in scale and frequency. The military and energy companies, for example, are already mainstreaming the risks of future climate change impacts into their planning decisions. We must take a risk-based approach to policy development.

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<sup>1</sup> Hidden green tax in fuel bills: How £200 stealth charge is slipped on to your gas and electricity bill  
<http://www.dailymail.co.uk/news/article-2001181/Hidden-green-tax-fuel-bills-How-200-stealth-charge-slipped-gas-electricity-bill.html>

Ministers fall for climate folly, warns ex-Civil Service chief

Read more: <http://www.dailymail.co.uk/news/article-2001189/Ministers-fall-climate-folly-warns-ex-Civil-Service-chief.html#ixzz1OISaR7of>

£200 shock on your power bill: Biggest squeeze on families since 1920s as fuel and food prices soar

<http://www.dailymail.co.uk/news/article-2000402/Pain-millions-customers-Scottish-Power-puts-gas-bills-19---electricity-10-too.html#ixzz1OISMxwYU>

<sup>2</sup> Garnaut R. *Climate Change Review – Update 2011*. Page 2. May 31<sup>st</sup> 2011.

- Baron Turnbull presents no new analysis of the scientific evidence on climate change. He merely repeats well-known positions of the GPWF, which has no serious scientific credentials.
- (Notwithstanding Turnbull's contention) the UK's Climate Change policy does not rely on a single source of evidence (the Intergovernmental Panel on Climate Change – 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.
- Turnbull's criticisms of the IPCC are poorly-informed and often out of date. The IPCC has already addressed issues Turnbull raised and remains the most authoritative source of climate science evidence and its assessments are accepted by all governments through a multistage approval process.
- The IPCC came under close scrutiny when, in 2010, an error was found on projected rate of Himalayan glacier melt in its Fourth Assessment Report of 2007 (and two other minor errors). Following an independent InterAcademy Council review, the IPCC last month agreed a suite of changes to strengthen its procedures and governance in preparation for its 2014 Fifth Assessment Report<sup>3</sup>.
- UK climate science is a true world leader and together with the U.S. has had a disproportionately large influence on what we understand about the climate system, the role of human emissions and the risks to future generations; as it has on the content of the IPCC's and other assessments.
- The UK's Natural Environmental Research Council (NERC) spends more than £100m pa on climate related research and DECC, Defra and DfID between them fund the Met Office Hadley Centre (MOHC) at £17.5m pa to provide world-class climate science evidence to policy<sup>4</sup>.
- The Coalition Government stands by its excellent record on green policies over the last year to protect the environment and deliver the low carbon economy, not only to cut carbon, but to make energy cleaner and more secure for the UK.

### **Key Criticisms in the Turnbull Paper and DECC Responses**

**Lord Lawson's *Foreward* calls the paper:**

**"....a dispassionate but devastating critique of UK climate change policies and of the alleged basis on which those policies rest, ...."**

*The paper is not a 'devastating critique'.* It is a restatement of out-of-date and inaccurate arguments in respect of climate science and the IPCC and uses these to claim that the basis of UK policy is flawed. For example, on page 9, Turnbull asserts that "much" of the "lots of dramatic claims" in IPCC Working Group II Report are based on grey literature. *This is blatantly incorrect.* After four years of scrutiny, only

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<sup>3</sup> It has established an Executive Committee; procedures for handling grey literature and errata; developed a communications strategy; and a policy on conflict of interest.

<sup>4</sup> In late 2009 and on the basis of citations of its climate research, the MOHC was recognised by the THES as the foremost geosciences institute in the world.

three errors<sup>5</sup> have been identified in the interpretations of grey literature in 750+ pages of the Working Group II Report and the large majority of the report referenced fully peer-reviewed science. Furthermore, Turnbull criticises the basic science behind the IPCC's assessment which was, in fact, reviewed by Working Group I, *referencing no grey literature at all*.

### **Is DECC ignoring valid scientific uncertainties to drive forward policy.**

No. We must focus on where the uncertainty is and take a risk-based approach. Greenhouse gases trap heat and warm the planet. This is certain (basic physics). Global GHG emissions continue to climb. This is certain (observation). The world continues to warm, decade on decade. This is certain (observation).

Yes, there are uncertainties; for example, about exactly how much further warming we will see in coming decades, how the Earth will respond and what the future impacts will be. Last year, the Royal Society outlined what we know well and what is still uncertain<sup>6</sup>. We need further scientific analysis, better understanding of the detailed working of the Earth's immensely complex climate system, more observations and more sophisticated modelling, to refine predictions. However, the essential message is clear: *The risks of inaction are potentially huge and very long term but we know enough to act and to act now*.

### **The UK relies too heavily on a climate science narrative from a single organisation - the IPCC**

The IPCC does not generate new climate science – it merely assesses evidence from scientific work that has already been undertaken by thousands of practising scientists around the world. In addition to the IPCC assessments, this evidence has been assessed by many organisations, including the Royal Society, the US National Academies of Science, and the Committee on Climate Change. The UK draws on this broad range of evidence, and is proud to host some of the world's leading climate science institutions – including the Met Office Hadley Centre, and NERC institutes.

### **The IPCC is flawed. For example, it has no procedures for using non-peer-reviewed literature and no conflict of interest policy**

Turnbull's criticisms of the IPCC are poorly-informed and often out of date. The IPCC has already addressed issues Turnbull raises and remains the most authoritative source of climate science evidence. The IPCC is an *intergovernmental* body, its reports are written by working scientists and its findings are accepted and signed-off by all governments, through a multistage approval process.

The IPCC came under close scrutiny when, in 2010, an error was found on projected rate of Himalayan glacier melt in its Fourth Assessment Report of 2007 (and two other minor errors). Following an independent InterAcademy Council review, the IPCC last month agreed a suite of changes to strengthen its procedures and governance in preparation for its 2014 Fifth Assessment Report<sup>7</sup>. It established an

<sup>5</sup> The most serious of these errors misquoted grey literature on the projected date for the melting of Himalayan glaciers.

<sup>6</sup> The Royal Society, September 30, 2010. Climate change: A Summary of the Science.  
<http://royalsociety.org/climate-change-summary-of-science/>

<sup>7</sup> It has established an Executive Committee; procedures for handling grey literature and errata; developed a communications strategy; and a policy on conflict of interest.

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### **“What is frequently described as a “consensus” is no such thing”<sup>8</sup>**

The huge effort expended by the U.S. and UK scientific communities and others around the world continues to build a strong evidence base. Since the IPCC issued its Fourth Assessment Report, other assessments have reviewed the most recent science and all have reported that the evidence for the role of human greenhouse emissions in recent, current and very likely future climate change, is compelling.

As Ross Garnaut writes on page 2 of his latest assessment<sup>9</sup>:

“Since the 2008 Review, the science of climate change has been subjected to intense scrutiny and has come through with its credibility intact. Unfortunately, new data and analysis generally are confirming the likelihood that outcomes will be near the midpoints or closer to the bad end of what had earlier been identified as the range of possibilities for human-induced climate change.”

and....

“Since 2008, advances in climate change science have broadly confirmed that the earth is warming, that human activity is the cause of it and that the changes in the physical world are likely, if anything, to be more harmful than the earlier science had suggested. I have replaced the premise of the 2008 Review that the reputable science was right ‘on a balance of probabilities’, with the premise that it is ‘beyond reasonable doubt’.”

### **The UK Government contends that the climate science ‘debate’ is settled**

No. Science focuses on exploring uncertainty. What policy makers need to know is: do we know enough to act? When the overwhelming majority of climate experts confirm that recent warming is unequivocal, that there is a very high likelihood that we are causing the warming – **beyond reasonable doubt** - and that the sooner we act, the more opportunity we have to limit the impacts of the warming; the answer is: yes, we know enough to act.

### **Climate scientists and the IPCC underplay the role of natural climate variation**

There is no doubt of the importance of natural cycles in the Earth’s climate. However, natural variation can’t convincingly explain the pattern of warming observed over the last 50 years. This can only be explained by considering the impact of anthropogenic greenhouse gases.

### **The impacts of warming are unknown and may be positive**

Predicting exactly how a warming climate will influence the Earth in future decades, especially at a local scale, is certainly a major challenge for scientists. However, the science clearly shows that a continuing warming will very likely have significant knock-on effects on weather, heatwaves, storms and rainfall patterns, and water availability. There is very good evidence that the more we allow warming to continue, the higher will be the risk of serious negative impacts. This is why the UK is committed to a global deal that keeps global temperature rise below 2°C above pre-industrial levels.

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<sup>8</sup> Turnbull Report, Page 4

<sup>9</sup> Garnaut R. *Climate Change Review – Update 2011*. May 31<sup>st</sup> 2011.

## **The UK is acting unilaterally without similar commitments from others**

It is not true that the UK and EU is currently acting unilaterally. Taken together, the emission reduction pledges all major emitters inscribed in the UN system at COP-16 in Cancun, could amount to a 7Gt reduction from forecasted 'business as usual emissions' in 2020. This represents about 60% of the effort needed to keep us on a 2°C trajectory. We must continue to encourage others to do more, but this will always be more effective if we can demonstrate – through domestic action on the ground – that we believe our own arguments about why making a low-carbon transition is in both the national and global interest.

It is true that the Climate Change Act imposes legal duties on the UK, regardless of what other countries do. This is because part of the rationale for the Act's introduction (as well as providing a long-term legally binding framework for emissions reduction) is to provide greater certainty for business to help enable the transition to a low carbon economy which in itself has many 'no regret benefits'. These benefits stand regardless of the impact our action has on overall global emission reductions.

A greater investment in energy efficiency measures and renewables provides greater energy security, makes economic sense in the longer-term (with oil trading at ~\$110/bl and the potential for high prices to become the norm as the global economy recovers) and will give us competitive advantage in the industries of the future, for example, in offshore wind where we are world leaders. As other countries continue to take increasingly ambitious measures to reduce their emissions, we will be well placed to export our technology and expertise.

In addition, the UK's first three carbon budgets, covering 2008-22, have been set in line with our share of the EU 20% emissions reduction target by 2020, and we will amend our carbon budgets once there is agreement at EU level to move to a collective 30% target.

The Government also recently announced its proposed fourth carbon budget level for 2023-27 which, unlike the first three carbon budgets, is being set in advance of EU decisions. If by 2014 however, our UK commitments place us on a different emissions trajectory than the Emissions Trading System trajectory agreed by the EU, we will, as appropriate, revise up our budget to align it with the actual EU trajectory.

## **The EU is arguing over whether to move to a 30% by 2020 target**

The UK is committed to pushing for the EU to move to a 30% target at the earliest opportunity. We believe that it is in the EU's self interest to move early. This is supported by the European Commission's recent 2050 Low Carbon Roadmap which sets out the cost effective trajectory to meeting the EU's 2050 objective of cutting EU domestic emissions by 80% on 1990 levels which passes through (a domestic target of) 25% in 2020.

Not one Member State spoke out against the Road Map's findings at the Environment Council on 14 March and in fact six other members states (Denmark, Germany, Greece, Portugal, Spain, Sweden) joined with the Secretary of State in signing up to a letter in support of the Roadmap moving and endorsing a move to a 30% target.

We are convinced that the EU needs to set out a clear framework for reducing emissions over the long term to provide certainty to the global investment community, avoid lock-in to high-carbon energy infrastructure and minimise the risks of exposure to volatile oil prices.

### **It is not sensible to subsidise renewables and set a Renewables Obligation**

Renewables are absolutely crucial to securing our energy supplies and reducing our carbon emissions in the decades ahead and the UK has committed to a legally-binding target of generating 15% of our energy from renewable sources by 2020.

Meeting the 15% target could reduce fossil fuel demand by around 10% and gas imports by 20-30%. Around half a million jobs could be created in the renewable energy sector by 2020; the UK leads the way in offshore wind deployment, and continued support for renewables should bring further inward investment and jobs.

Meeting our target is expected to lead to carbon savings of 17MtCO<sub>2</sub> in the non-traded sector in 2020. The Government has accelerated the banding review of the Renewables Obligation, these reviews ensure that renewable electricity technologies are supported at the appropriate level for maintaining investment, whilst providing value for money for consumers.

Under the proposals put forward in the consultation on Electricity Market Reform, the Government is considering moving away from the Renewables Obligation to a more efficient support mechanism for all low carbon, including renewable, generation.

### **Feed-in Tariffs cost consumers too much**

All parts of society will have a role to play if we are to meet our challenging renewables and carbon targets. A key objective of Feed-in Tariffs (FITs) is engaging individuals, small businesses and other non-energy professionals in this agenda, by encouraging the uptake of small-scale, low-carbon electricity generating technologies. Just over 30,000 installations, the vast majority of which are domestic installations, were registered for FITs in the first year of the scheme (which started in April 2010).

FITs are paid by electricity supply companies who can be expected to pass on the costs of this to their customers. Consequently, FITs is subject to the DECC levy control framework to ensure that the policy's objectives are achieved cost effectively and affordably.

The Spending Review also committed to find savings from FITs of 10%, about £40million, in 2014/15 and a key objective of the first comprehensive review of FITs (announced in February 2011) is delivering this commitment. As part of this review, DECC recently announced the decision to reduce tariffs for larger scale solar PV to address the risk that such projects could lead to long term pressure on FITs costs.

### **We should focus on shale gas not renewables**

We support industry's endeavours in pursuing energy sources such as shale gas so long as tapping of such resources proves to be technically, economically, and environmentally viable. However, outside of the US, the size of this resource has yet

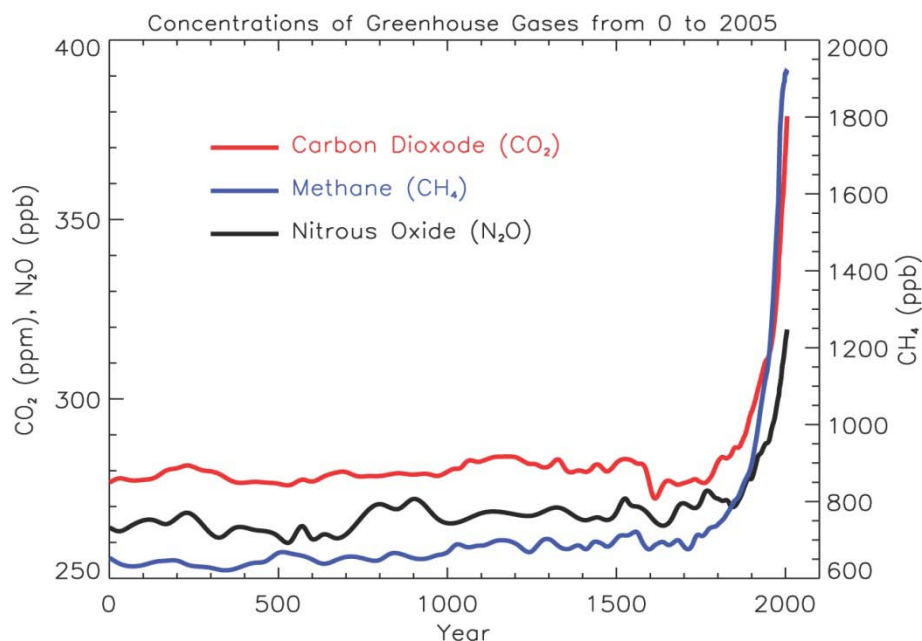
to be fully quantified and it will be several years at least before we have a clear view of what shale gas means for the UK.

If shale gas does prove commercially viable in the UK we would see this as reducing our dependence on imported gas, rather than displacing the vital role of renewable energy in a future secure and low-carbon energy mix.

### **Specific Criticisms on Climate Science**

#### **Isn't the current global warming just natural variability?**

No. Long-term (decadal and longer) warming continues. Both the spatial patterns and trend of warming can only be explained by taking account of human emissions, especially of carbon dioxide but also of methane and nitrous oxide.



Atmospheric greenhouse gas concentrations in the last two millennia

#### **Many reputable scientists disagree about climate change? Climate change may not be caused by human activities.**

It is relatively easy to look at how climate change issues are covered in the media and believe that there are balanced scientific arguments for and against climate change. This is absolutely not the case. The physics is incontrovertible and the overwhelming majority of climate science *experts* agree on the fundamentals: that climate change is happening and has recently been caused mainly by increased greenhouse gases from human activities.

In 2010 Met Office Hadley Centre climate experts published a seminal paper showing that discernible human influence on climate now extends, not only to temperature increase, but also to increases in atmospheric humidity, changes to the hydrological cycle causing changes in global rainfall patterns, increases in Atlantic ocean salinity in the tropics, reductions in Arctic sea ice extent, and changes in Antarctic temperatures.

## **‘Climategate’ casts doubt over whether the Earth is warming?**

No. Two independent data sets agree with the Climatic Research Unit's. All show clear evidence of warming going back to before 1900. These findings have most recently been confirmed by an independent study from Berkeley University.

Professor Phil Jones of the CRU admitted using the term ‘trick’ to ‘hide the decline’ in a temperature graph used in the World Meteorological Organization (WMO) report in 2000. The Muir Russell Review confirmed that the graph was misleading. But this was **not** a criticism of the science Jones was leading but rather of how it was communicated. *DECC supports moves led by Sir John Beddington and supported by the Royal Society and NERC, to improve climate science communication and transparency.*

## **Can we trust climate models if they are based on these flawed CRU data?**

Confidence in climate models comes from several independent evidence strands. They are based on fundamental physics and are rigorously tested to ensure their reliability. They do not depend on observational or proxy data for their projections but are tested and validated by comparing their outputs with observational data. Today's models are able to simulate key features of major climate and weather systems and processes, and past climate variability.

## **Water Vapour is the primary greenhouse gas in the atmosphere. How can carbon dioxide being added by human actions really make a difference?**

While water vapour is the most abundant greenhouse gas in the atmosphere (making 95% of the total), individual water vapour molecules only stay in atmosphere for a few days, whereas carbon dioxide remains for decades, continuously increasing global temperatures over that time.

## **The sensitivity of the climate system to increasing carbon dioxide is much lower than the IPCC says. Doubling CO<sub>2</sub> concentration will only increase global temperature by about 1°C.**

It's true that the main uncertainty in climate science is the climate's sensitivity to CO<sub>2</sub>. This is mainly because of uncertainties concerned with cloud feedbacks. However, nearly all recent scientific analysis and modelling strongly suggests that climate sensitivity ranges between around 2.5 and 4°C and perhaps even more.

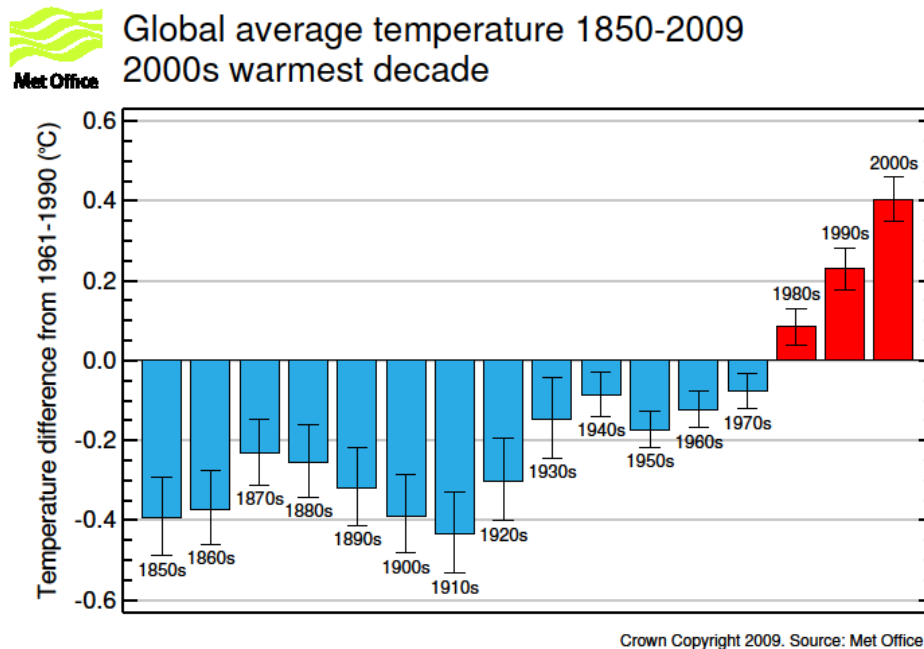
Why is this? We know that, on its own, doubling the pre-industrial concentrations of CO<sub>2</sub> from around 275ppm to 550ppm would lead to around 1 to 1.2°C of warming, as some, including Baron Turnbull, assert. However, the effect of increasing carbon dioxide concentrations is magnified by the so-called ‘water vapour feedback’ – warmer air holds more water vapour and as a powerful greenhouse gas, this added water vapour greatly exacerbates the warming due to CO<sub>2</sub> alone. Taking other feedbacks into account, the real-world ‘climate sensitivity’ is very likely closer to 3.1°C ± 0.7°C.

Famously, Prof Richard Lindzen is at odds with the consensus, insisting that doubling CO<sub>2</sub> concentration will lead to only about 1°C of warming but his evidence is almost universally considered weak and his arguments misplaced.



**There's been no global warming in the last 15 years - 1998 was the warmest year.**

This is a case of cherry picking data. Over short intervals of a few years, natural climate variations can temporarily mask long term warming. 1998 is the warmest year on record but globally, the decade **2000 – 2009 was significantly warmer than any previous decade in the record**, going back to 1850. Individual years have not been quite as warm as 1998 and this is quite normal because the human-forced warming trend is taking place on top of natural variations. We will always see such short-term fluctuations but to confirm climate change, we need to rely on long-term trends of decades and longer.



**Satellite data doesn't support the 'theory' of global warming.**

Not true. In the early 1990s, initial estimates of temperatures in the lowest parts of the atmosphere, based on satellite and weather balloon measurements, did not appear to mirror the temperature rises measured at the Earth's surface. However, these discrepancies have long since been found to be related to problems with how the satellite and balloon data were gathered and analysed and have now been resolved. The observations are all in accord.

**Temperatures were higher in the last 1000 years - The 'Hockey Stick' graph is discredited.**

In 2006, the US National Academies of Science carried out a full review of the evidence of temperatures in the last millennium, including the so-called 'Hockey Stick' diagram. They found that for the Northern Hemisphere at least, the rapid warming of the past half century has resulted in a level of warmth not seen in at least 500 years, and likely for at least the past 1300 years.

Natural processes, including changes in solar output, volcanic eruptions and changes in the Earth's orbit, do affect climate and have led to relatively warm (and very cold) periods in the past but what matters *now* is that we're seeing warming

*now*. Temperatures are rising rapidly due to human activities and are set to increase by between 1.1 and 6.4°C over the coming century, depending on emission levels.

### **What about the Mediaeval Warm Period and Little Ice Age?**

We know that the climate has varied naturally in the past but there is compelling evidence that today's warming is linked to human activities. The Medieval Warm Period and Little Ice Age are often quoted as examples of past temperature changes as large as that of the late 20<sup>th</sup> century. But the changes being observed today are global - there is little evidence that either of these periods of temperature change were observed globally only mainly in parts of the Northern Hemisphere.

### **In the distant past, CO<sub>2</sub> changes lagged behind temperature changes. How can we now say that CO<sub>2</sub> is driving temperature?**

We know that CO<sub>2</sub> and temperature are closely linked but we also know that the current rise in CO<sub>2</sub> is caused by the increase in human emissions. The corresponding temperature rises are occurring much faster than those of the distant past, which were caused by, for example, long-term changes to the Earth's orbit.

### **The CO<sub>2</sub> increase over the past century doesn't match the temperature trends.**

First, warming caused by human greenhouse gas emissions lags behind the emissions because of the 'inertia' of the climate system (primarily because of the huge thermal inertia of the world's oceans). Second, greenhouse gases are not the only determinant of temperature. Aerosols also emitted by human activities are important and it has been shown that they explain much of the slight cooling observed between the 1940s and 1950s (see Figure above). Volcanic eruptions<sup>10</sup> and small changes in solar output also complicate the picture.

Climate and earth system models include the physics and chemistry that factor in all these natural and human drivers. Models now simulate historic changes in global and regional temperatures and show that nearly all of the warming over the past half century has been caused by human greenhouse gas emissions.

### **Human emissions of carbon dioxide are tiny in relation to natural flows of carbon dioxide, so how can humans be responsible for global warming?**

Isotopic analyses confirm the human sources of carbon dioxide. There is no doubt that the amount of human (or 'fossil') carbon in the atmosphere is increasing. While human emissions are indeed relatively small compared to natural emissions from terrestrial ecosystems and the oceans, these natural emissions are in close balance with natural removal: the amount emitted is reabsorbed by 'sinks' in the geosphere and biosphere. Human emissions have tipped the balance, leading to an accumulation of carbon dioxide and other greenhouse gases in the atmosphere.

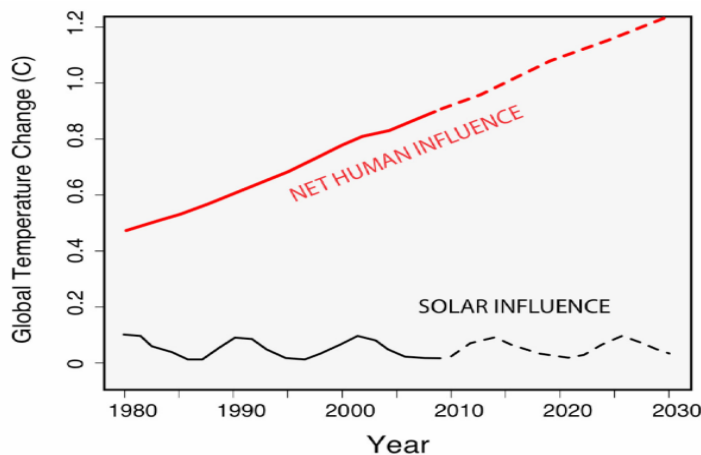
### **Variations in the Sun's output has caused recent climate change.**

Yes, the Sun's output varies slightly with the famous 11-year sunspot cycle and also has longer term variations. However, the sun's brightness has been constant or decreasing slightly over the past few decades and thus can't account for recent global temperature increases. The influence of the Sun's recent variability on the

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<sup>10</sup> the largest volcanic eruptions can cause surface cooling for up to four years

climate is very small: around 10% of the influence of human greenhouse gases over the last 50 years, according to the last IPCC assessment. This has been confirmed by most recent research.



The recent relative influence of the Sun.  
Source "The Copenhagen Diagnosis", 2009

### Isn't global warming caused by cosmic rays?

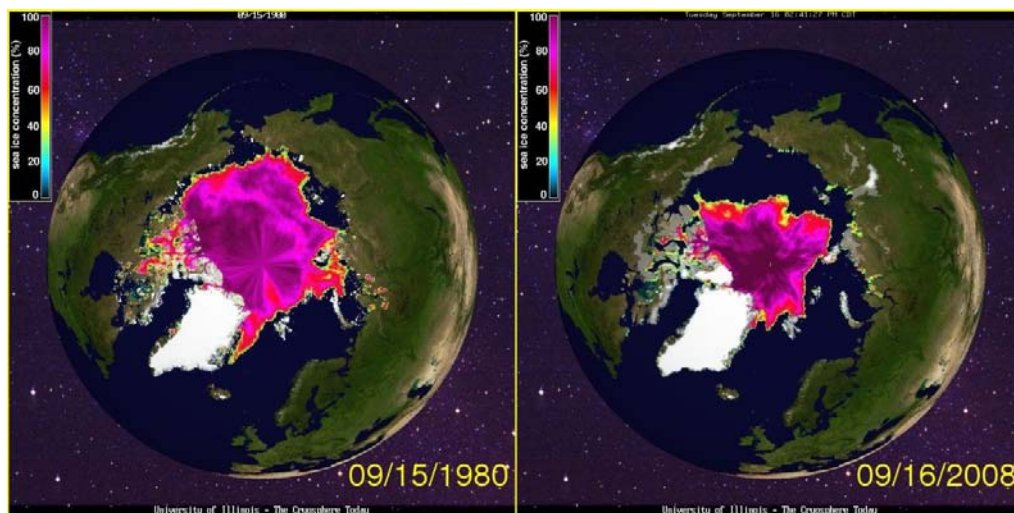
No. Variations in cosmic rays over the past few decades cannot explain the long-term global warming trend. Some laboratory experiments have indicated their possible influence on cloudiness but these have not been validated in the real world and even if a viable mechanism were confirmed, the size of the effect is thought very unlikely to be significant. Further improvements in atmospheric models will help us improve our understanding of this second-order effect.

### Isn't the apparent warming just due to urbanisation?

No. Climate scientists have conducted rigorous tests to determine the effects of urbanisation on temperatures trends and found it to be minimal. The IPCC concluded that urban heat island effects have a negligible influence on the global scale, contributing less than 0.006°C per decade (<1%) to observed trends over land and zero over the oceans.

### Isn't Arctic sea ice re-growing?

Absolutely not. The late summer Arctic sea ice extent in 2009 was almost as low as in 2007 and 2008 and last year's 2010 extent was only fractionally higher than the 2007 record low. The long-term decline in summer sea extent continues, on top of weather-related year-on-year variability.



Late summer Arctic sea ice extent in 1980 and 2008

### **The evidence is equivocal. Shouldn't we wait until it is certain before acting?**

Some individuals are keen to suggest that climate science is so uncertain that we should delay action on climate change. But we cannot afford to wait. We know that limiting warming to 2°C (over a pre-industrial temperatures) gives us the best chance of avoiding the worst impacts of climate change during this century.

Yet more warming is unavoidable owing to past and current greenhouse gas emissions. Each year we delay action it is becoming increasingly difficult to keep below our two degree target and emissions need to peak soon and then fall rapidly.

### **Climate change varies across the world. This gives climate-change 'proponents' the chance to 'cherry pick' examples to support their position.**

Climate change caused by greenhouse gas emissions is not expected to be uniform across the world. All the examples presented in for example, *Lord Lawson's book*, including those that he presents as 'inconsistent' with global warming, are actually fully consistent with our understanding of how greenhouse gases affect climate and how the climate system works. Specifically, the physics tells us that high latitudes should warm faster than low latitudes, owing to feedback effects associated with the retreat of snow and ice. This is exactly what we are seeing.

### **So where is the smoking gun - the human fingerprint?**

Taken together, the observed patterns of warming across the world and through the whole depth of the atmosphere, provide compelling evidence that the recent observed warming has been mostly caused by human activities. So, it's already happening. We already know that the European intensely hot summer of 2003 was made at least twice as likely by 20<sup>th</sup> century CO<sub>2</sub> emissions. Most recent research shows that human greenhouse gas emissions have contributed to the observed increases in the intensity of heavy rainfall events in the Northern Hemisphere. And new research led by the Met Office Hadley Centre shows that the damaging UK floods of 2000 were about twice as likely than they would have been a century ago, because of greenhouse gas emissions.

If greenhouse gas emissions remain unabated, average global surface temperature may rise (relative to 1990) by between 1.1 and 6.4°C by the end of this century, with a most likely value towards the centre of this range.

Finally, because of human CO<sub>2</sub> emissions, the world's ocean are already more acidic (or strictly speaking less alkaline) than at any time in millions of years. **As atmospheric CO<sub>2</sub> concentration continues to increase, ocean acidification will get worse**, with likely major consequences for key ocean ecosystems.

We know enough to *know* that delaying action *will* risk dangerous climate change and risk serious consequences for *all* societies.

### **Wouldn't we be better off just adapting to climate change?**

Some future climate change is unavoidable – its already in the system because of the delay between emissions and temperature rise (climate system inertia), so it is right that we research and fund adaptation strategies to manage heat-stress, build flood defences and improve water management. However, compelling scientific evidence shows us that the more our emissions grow, the more we risk dangerous climate change, leading to severe impacts for all societies.

It will not be possible to adapt to *all* the potential impacts of climate change if emissions are unrestrained. Only by cutting greenhouse gas emissions can we hope to keep future climate change impacts to manageable levels.