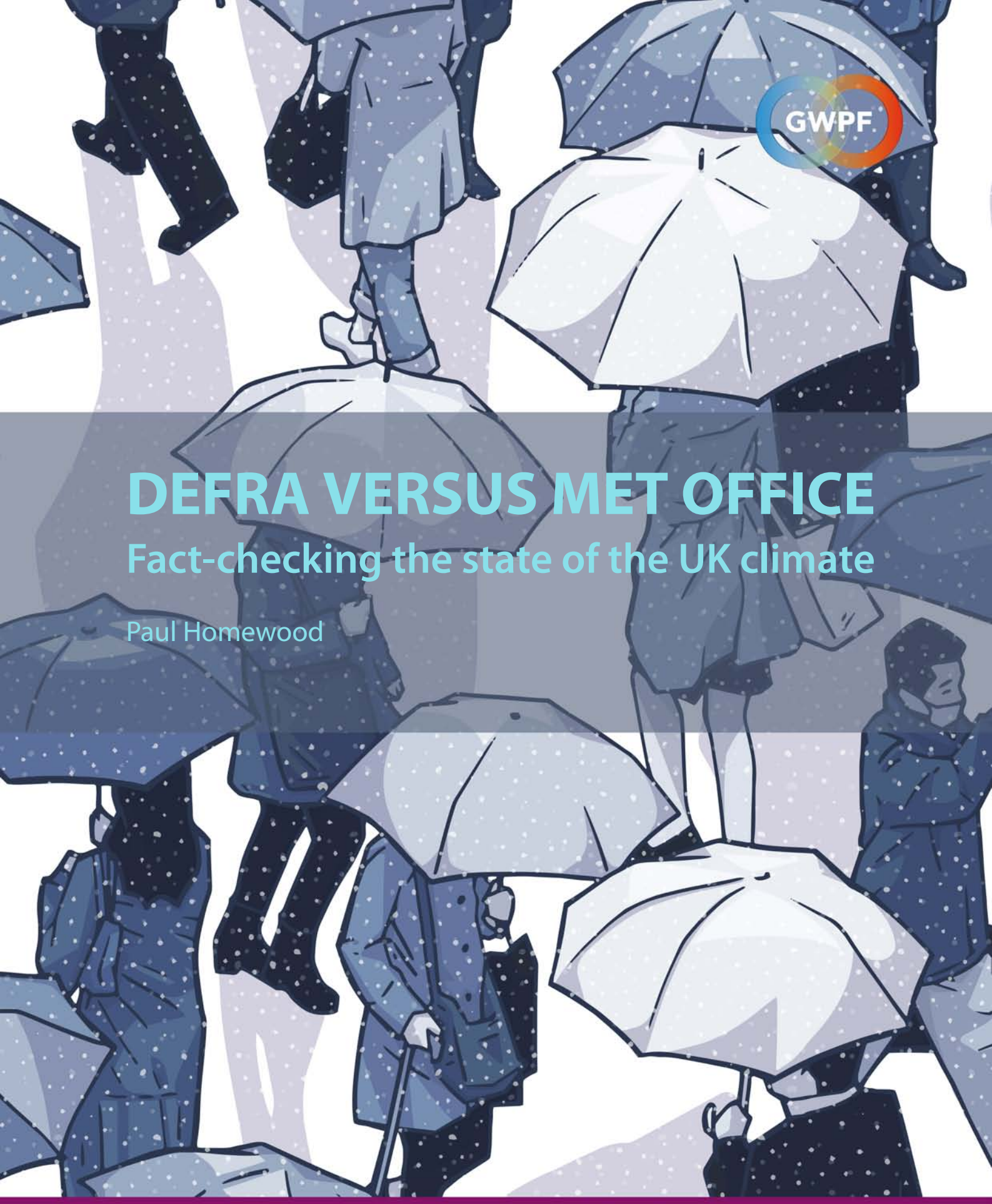

DEFRA VERSUS MET OFFICE

Fact-checking the state of the UK climate

Paul Homewood

The Global Warming Policy Foundation

GWPF Briefing 35

DEFRA VERSUS MET OFFICE

Fact-checking the state of the UK climate

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About the author

Paul Homewood had a career as an accountant in industry. He has been writing on climate and energy issues since 2011.

Executive summary

The UK Climate Change Risk Assessment 2012, published by DEFRA, claimed that severe weather will increase in the UK during the 21st century, as the climate warms. Events such as heatwaves, flooding and droughts will become more severe. By the 2080s, average summer temperatures will rise by up to 8°C, winter rainfall will increase by up to 70%, and summer rainfall will fall by up to 60%. Sea levels could also rise by up to 70 cm by 2095. These projections still underpin the latest DEFRA risk assessments, including the 2017 publication.[1]

Bad weather events are now routinely linked to climate change, usually with the proviso that climate change makes them more likely or more severe. An example is found in the shape of a study by the Energy and Climate Intelligence Unit.[2] But what do the facts actually tell us about what is happening in the UK?

This paper reports the results of a detailed analysis carried out using published UK Met Office data up to 2017. These show:

- UK temperatures rose during the 1990s and early 2000s. This rise is associated with a similar increase in near-coastal sea surface temperatures. There has been no rise in the last decade.
- Seasonal temperatures have followed a similar pattern: a rise during the 1990s, but a levelling off since.
- This sudden rise in UK land temperature is not unprecedented, with the Central England Temperature series (CET) showing a similar occurrence in the early 18th century.
- Analysis of CET shows that despite the rise in average summer temperatures, there has been no increase in the highest daily temperatures, or the frequency of extreme high temperatures, in recent years. In fact the opposite is true. Heatwaves were far more intense in 1975 and 1976, when there were thirteen days over 30°C. By contrast, between 2007 and 2017 there have only been two such days. (Note that there was also only been one day over 30°C in the summer of 2018). The highest daily temperature on CET was 33.2°C, set in 1976 and equalled in 1990.
- According to CET, there has been a marked reduction in the number of extremely cold days since the 1980s.
- Although UK precipitation trends have been rising since the 1970s, analysis shows that this is largely confined to Scotland. In the rest of the UK, there is little long-term trend.
- Analysis of the longer-running England & Wales Precipitation Series (EWPS) shows that the higher rates of rainfall experienced in the last decade are not unprecedented.
- Seasonal analysis of the EWPS shows little trend in winter or summer rainfall since 1900. Nor is there any significant trend in spring or autumn.
- Analysis of the EWPS also provides no evidence that rainfall is becoming more extreme, whether on a decadal, annual, monthly or daily basis. There is, however, evidence that very dry years have become less common.
- Long-term sea-level rise has averaged about 1.4 mm per year, after correcting for vertical land movement. Recent rates of sea-level rise are similar to those in the first half of the 20th century. There is no evidence of sea-level rise accelerating.
- There is little long-term data available for storms, but the limited data from the UK Met Office indicate that storms have not become more frequent or stronger in the last few decades.

In short, although the UK is, on average, slightly warmer than it used to be, there is no evidence that weather has become more extreme. In particular, heatwaves have not become more severe and nor have droughts. Data suggest that recent warming has had little effect on the severity of flooding in the UK. Similarly, there is little in past trends to support suggestions that average summer temperatures will increase by 8°C, winter rainfall will increase by 70%, or that summer rainfall will fall by 60% in the next few decades. There is also nothing to support the prediction that sea levels may rise by 70 cm by 2095.

Apart from being slightly warmer, the UK's climate appears to be little different to the past.

1 Introduction

The UK Climate Change Risk Assessment 2012,[3] published by DEFRA, made some very specific claims about extreme weather:

> The UK's National Risk Assessment (which looks at a range of risks from a number of sources) already recognises current severe weather and major coastal and inland flooding as significant risks to this country. The CCRA projects that these will pose an increasing threat as the climate changes. Other climate risks and also opportunities are projected to become more significant during the 21st century. By the 2080s, the UKCP09 projections for different parts of the UK suggest: an increase in average summer temperatures of between about 1°C and 8°C; an increase in average winter rainfall volumes of between around 3% and 70%; a projected change in average summer rainfall volumes ranging from a decrease of about 60% to an increase of about 10%; and by 2095 a projected rise in sea levels around London, for instance, of between about 20 cm and 70 cm.

Not only did it predict that extreme weather would worsen, but implied that the effects of climate change are already visible.

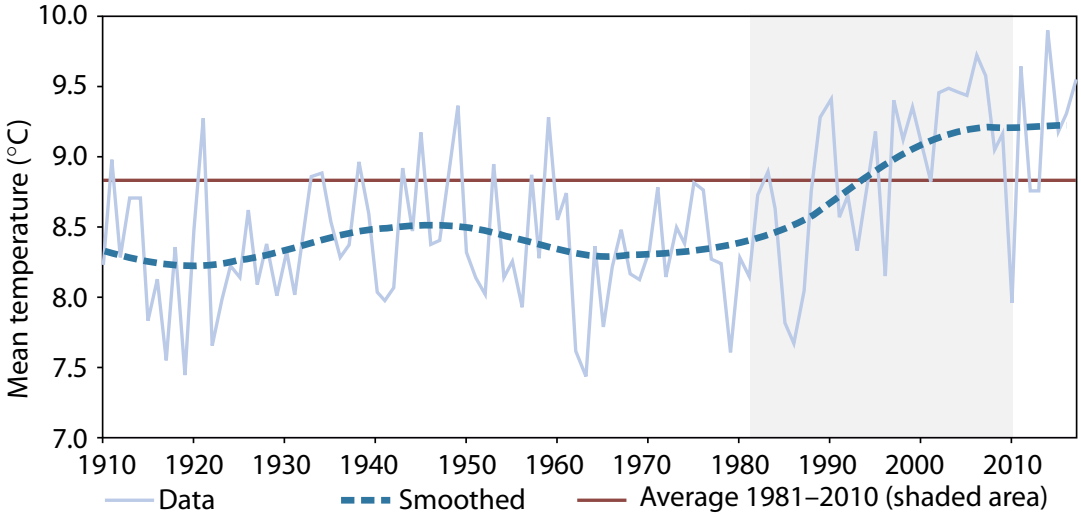
> Few parts of the UK have been unaffected by extreme weather in recent years. For example:
>
> - In 2003, around 2000 excess deaths were recorded in England and Wales during the August heatwave. In London, the Urban Heat Island effect meant that nighttime temperatures were as much as 9°C higher than in the surrounding countryside.
> - In 2007, summer floods affected England, Wales and Northern Ireland, costing the economy more than £3 billion in England alone. In 2009, the Cumbria floods resulted in £100s of millions of damage, including the loss of 20 road bridges and long-term disruption for local communities.
> - In 2009 and 2010, prolonged cold caused wide-ranging problems for UK transport and water infrastructure. For example, in December 2009, thousands of households in Northern Ireland experienced difficulties with water supplies; in December 2010, heavy snow across Scotland's Central Belt resulted in hundreds of motorists being stranded overnight.
> - In 2011, parts of the UK experienced a much drier than average spring, resulting in insufficient rainfall for some crops. Over Easter, the higher temperatures, static weather pattern and increased sunshine contributed to a pollution warning across England and Wales unusually early in the year. In Berkshire, forest fires led to the closure of businesses and schools and evacuation of homes.
>
> Natural climatic variability means that, with or without climate change, episodes like these will continue to occur in future. However, events such as heat waves, flooding and drought are all projected to become more severe due to a changing climate, with vulnerable groups tending to experience disproportionate negative effects.

But has the UK's climate changed in any significant way in recent years, other than a slight warming? And is extreme weather getting worse?

This report aims to summarise climatic trends in the UK, and put recent extreme weather events into historical perspective.

2 Temperature trends

Figure 1a shows the annual mean temperature for the UK since 1910 according to the Met Office.



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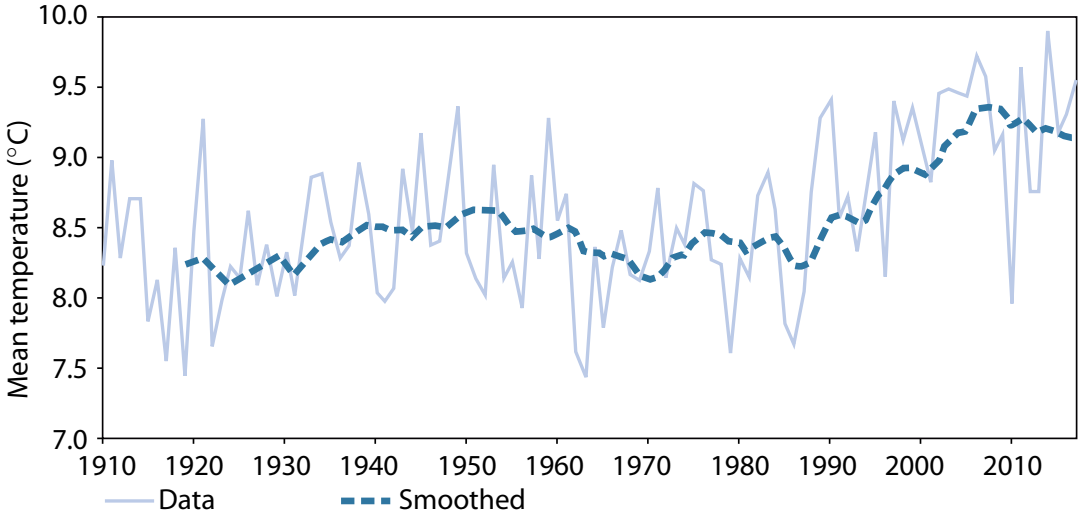


(b)

Figure 1: UK annual mean temperatures.

Smoothed with (a) kernel filter; (b) ten-year average. Source: UK Met Office data.[4]

The annual mean temperature for the UK in 2017 was 9.6°C, making it the fifth warmest year on record, behind 2014, 2006, 2011 and 2007 (in that order). These are the bald facts. However, as Figure 1a indicates, there was a rapid rise in temperature that began in the late 1980s, but which has levelled off in the last decade.

Figure 1a uses a kernel smoothing filter, but we can get a clearer picture from the 10-year averages, as shown in Figure 1b. The 10-year average has been falling since 2008, and now stands at its lowest level since 2003. Significantly, the 10-year average would still have been falling since 2008, even if the cold year of 2010 was excluded from the figures.

The most recent decade, 2008–17, was colder than the previous one (see Table 1).

Table 1: UK mean temperatures for selected decadal periods.

	Mean (°C)
1988–1997	8.87
1998–2007	9.36
2008–2017	9.14

The seasonal trends all show a similar pattern: a steady rise in mean temperature through the 1990s, which has since levelled off (Figure 2).

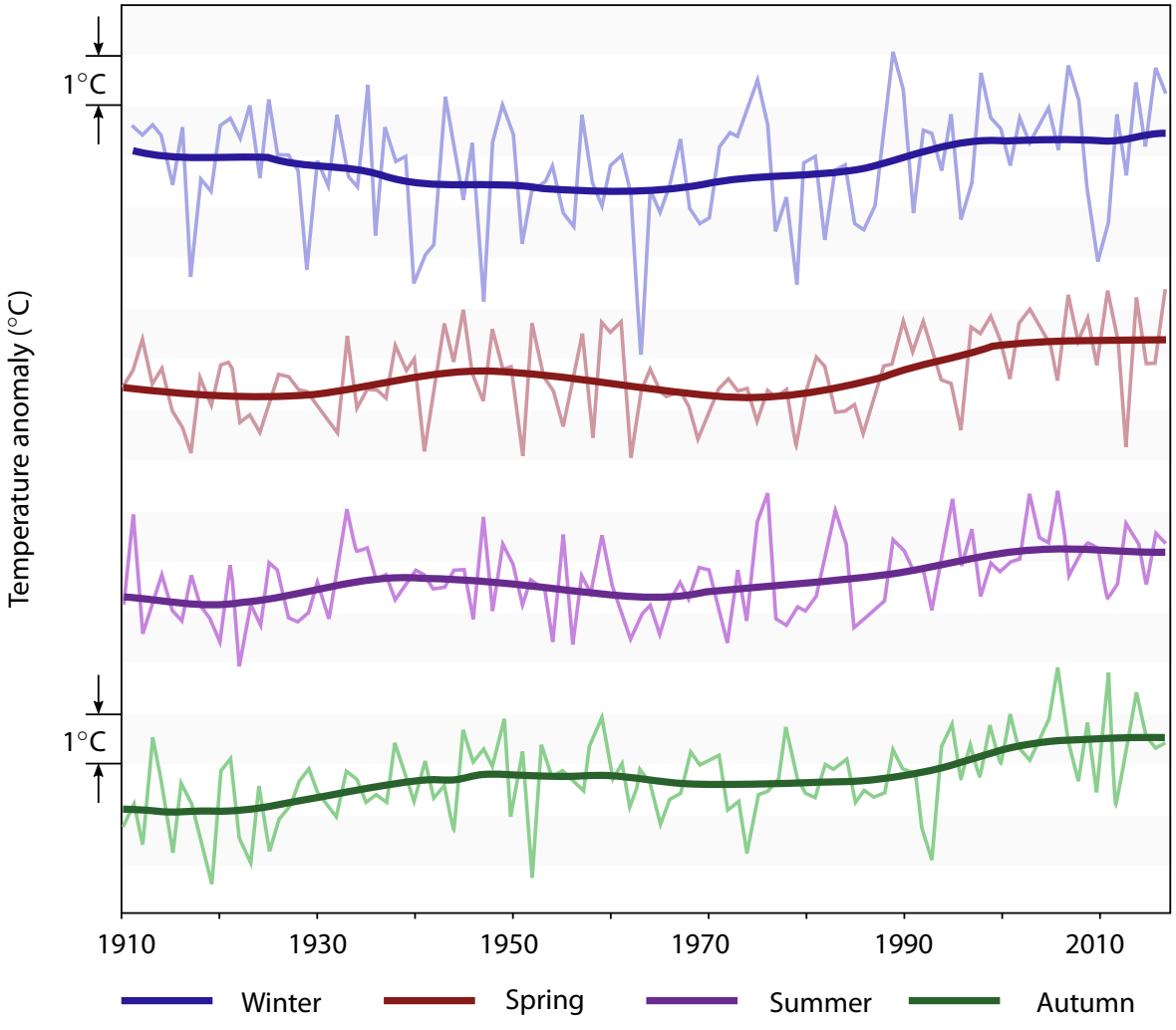


Figure 2: UK seasonal mean temperatures, 1910–2017

Source: State of the UK Climate 2017 Report.[5]

Comparison of land and coastal sea surface temperatures shows that both exhibited the same rapid rise from the late 1980s to the early 2000s (Figure 3).

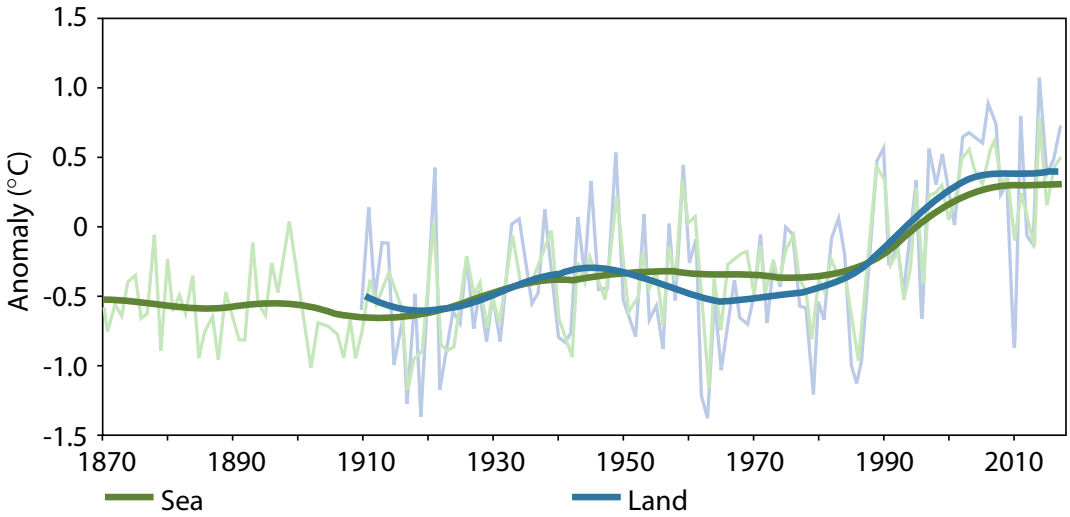


Figure 3: UK annual mean land and sea-surface temperatures.
Land temperatures 1910–2017, sea surface temperatures (across near-coastal waters) 1870–2017. Anomalies relative to the 1981–2010 long-term average. Source: State of the UK Climate 2017 Report.[5]

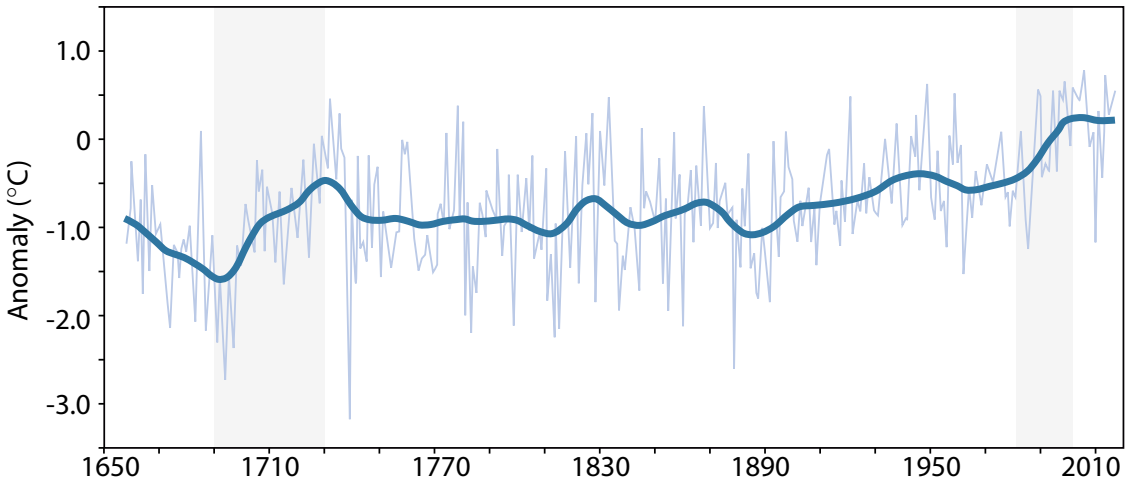


Figure 4: Central England temperatures 1660–2017.[5]
Data with 10-yr moving average superimposed.

It is well accepted that ocean temperatures can affect nearby land temperatures.[6] However, it is not clear that land temperatures can affect ocean temperatures to any significant degree. This raises the question of what caused this rise in sea surface temperatures. Possible factors include ocean currents, shifts in the Atlantic Multidecadal Oscillation, and changing patterns of cloud cover and sunshine hours and/or intensity.

There is, of course, a precedent for the rapid rise in temperature seen in the 1990s. This was the period from the late 1690s to the early 1730s, when the increase in temperatures was even greater than recently (see Figure 4).

Two claims are commonly made about recent temperature trends in the UK, both of which are highly questionable:

- *UK temperatures are increasing:* This is not true as far as the last ten years is concerned.
- *The recent rise in UK temperatures is a result of manmade global warming* : This fails to explain the sudden rise in both land and sea temperatures, followed by a ten-year pause.

3 Temperature extremes

Despite the increase in average summer temperatures since the 1980s (Figure 2), there has been no rise in daily temperatures at the top end of the scale. Figure 5a shows the distribution of days of 30°C and over in the Central England Temperature series. The hottest day

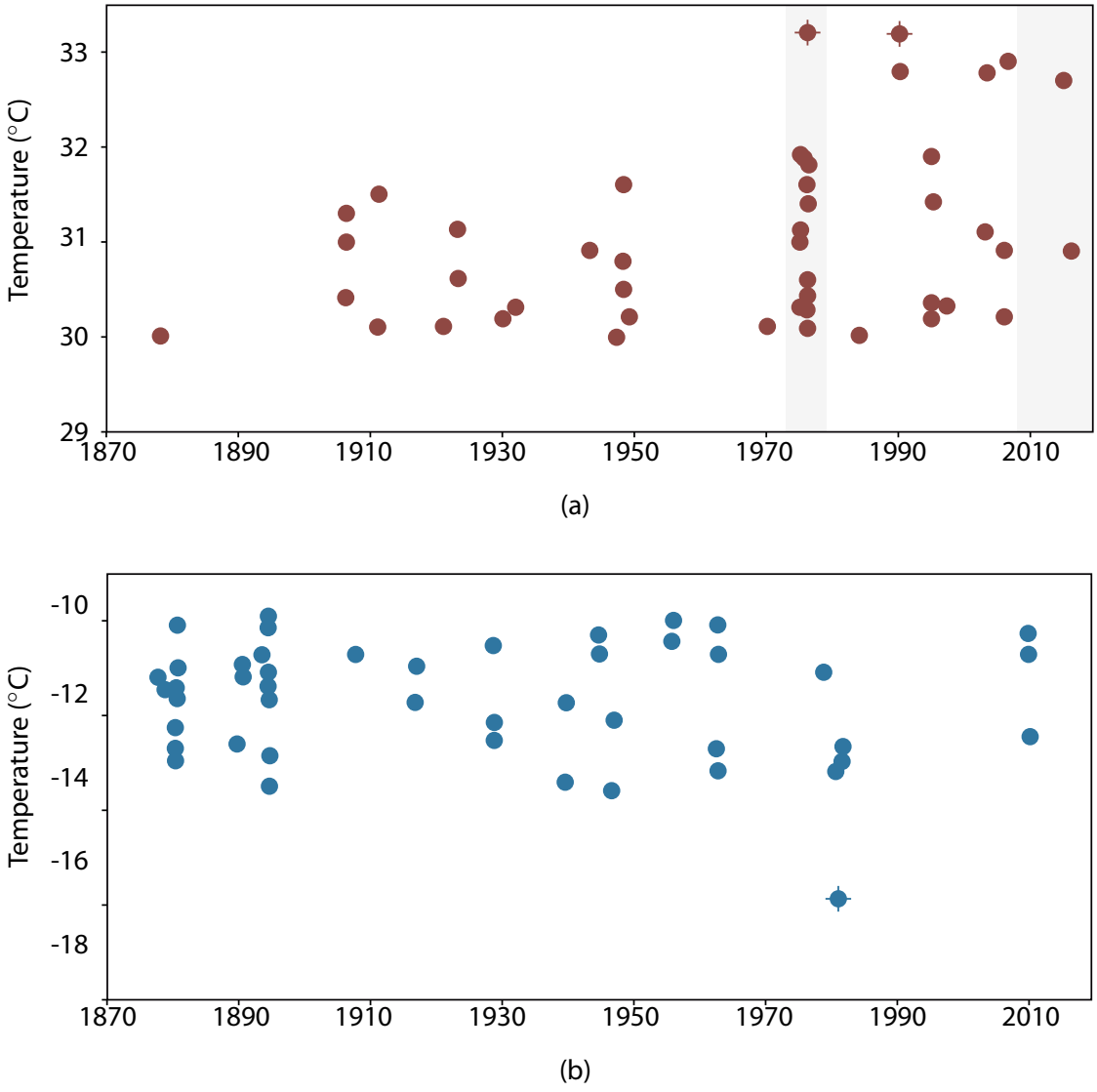


Figure 5: Distribution of extreme temperatures in Central England Temperature Record.
(a) days over 30°C; (b) days under -10°C.[7]

was 33.2°C, set in 1976, and matched in 1990. Examining the two shaded areas, in the first (1975 and 1976), there were four days and nine days respectively of 30°C and over. Between 2007 and 2017, however, there were only two such days, the highest of which was 32.7°C in 2015. By contrast, exceptionally cold days are now a rarity (Figure 5b). Apart from three days in 2010, there have been no days below −10°C in the Central England Temperature Record since 1982.

It can therefore be argued that daily temperatures are actually becoming *less* extreme. We see the same phenomenon in average seasonal temperatures. Figure 6 shows that differences between winter and summer temperatures have been at historically *low* levels in recent decades, similar to the 1910s. Much of the Central England Temperature Record exhibits much greater extremes between the two seasons.

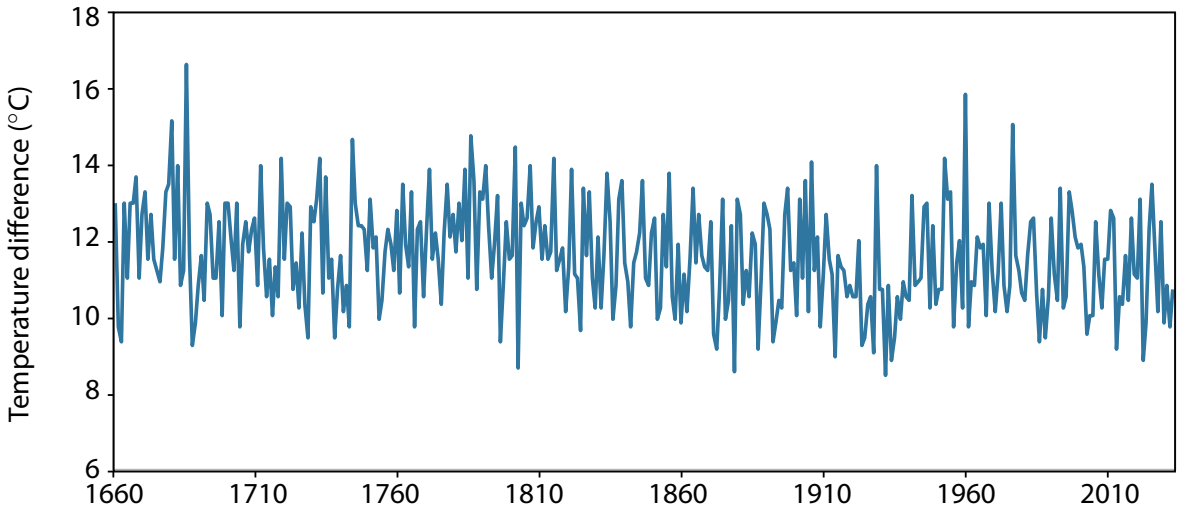


Figure 6: Difference between average Central England summer and winter temperatures.[7]

4 Precipitation trends

Precipitation in the UK last year was close to average. Long-term trends suggest a wetter climate since around 2000 (Figure 7). However, regional analysis (Figure 8) shows that this is due to higher rainfall in Scotland. In England, Wales and Northern Ireland, there is little long-term trend at all.

Also evident from the data in Figure 7 is a drier interlude between 1960 and the 1990s. Professor Lane of the Institute of Hazard and Risk at Durham University has examined rainfall and river flow patterns, and noted that:

> In terms of river flooding, the period since the early 1960s and until the late 1990s appears to be relatively flood free, especially when compared with some periods in the late 19th century and early 20th century.[9]

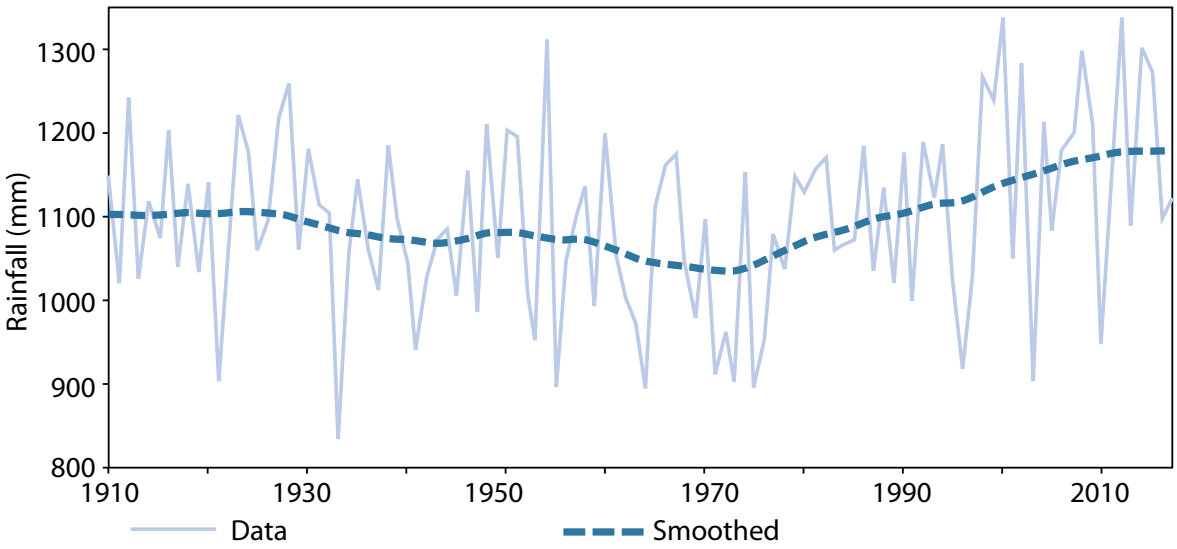


Figure 7: UK annual precipitation.

Source: UK Met Office.[8]

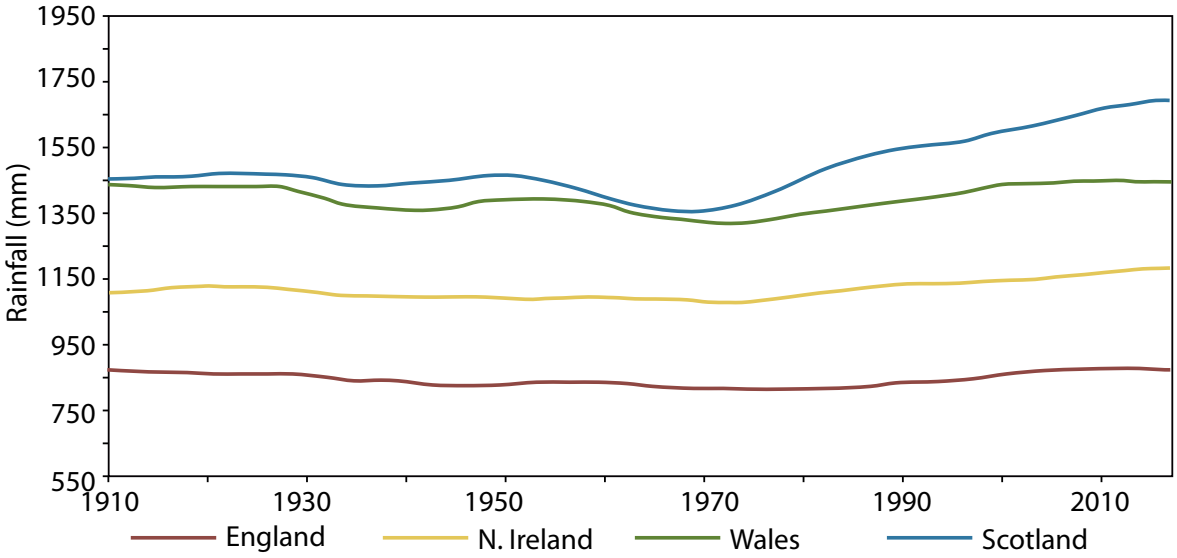


Figure 8: Regional precipitation trends.

Source: UK Met Office data.[8]

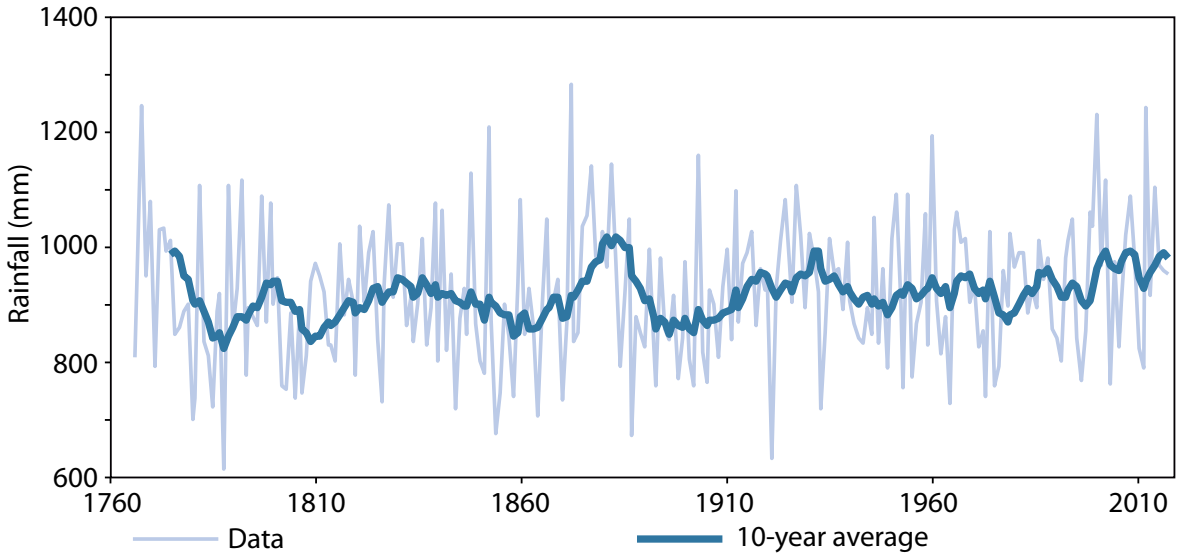


Figure 9: Long-term precipitation record for England and Wales.

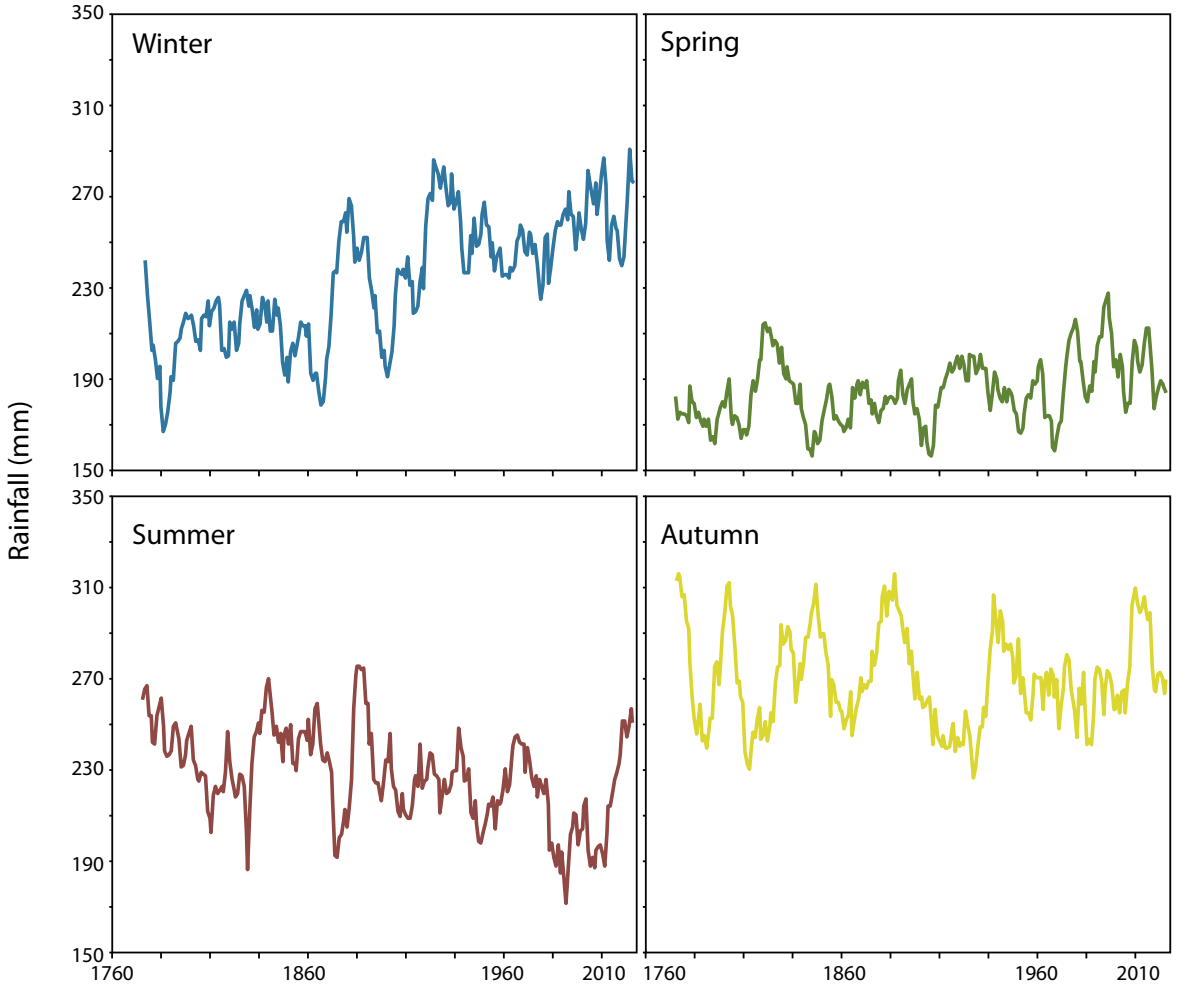


Figure 10: Long-term records of seasonal rainfall.[8]

When we look at longer trends from the England & Wales Precipitation series (Figure 9), we can see that the current 10-year average is not unprecedented. Previous periods have been just as wet, notably in the 1870s and 80s, and later in the 1920s.

Figure 10 illustrates seasonal trends in the England & Wales Precipitation series. A number of points should be noted:

- Winter precipitation has risen significantly since the beginning of the record, but since around 1900 this rise has stopped and trends have remained flat, despite fluctuations around the trend line.
- Summer rainfall fell to unprecedentedly low levels during the 1970s and 80s, but has since returned to earlier levels.
- There has been little trend in spring and autumn precipitation during the whole of the record.

Very often, misleading claims are made about rainfall trends, which tend to fall into two categories:

They are based on only part of the data: For example, the UK Met Office has claimed:[5]

> UK summers for the most recent decade (2008–2017) have been on average 17% wetter than 1981–2010 and 20% wetter than 1961–1990, with only summer 2013 drier than average.

The implication is, of course, that summers are getting wetter. As Figure 10 shows, however, summer rainfall has simply returned to earlier levels, after a particularly dry period.

Applying linear trends: Again, from the UK Met Office:[5]

> England & Wales Precipitation shows a marked increase in winter rainfall.

Again, there is an implication that winters are becoming wetter, but as Figure 10 shows, this has not been the case since around 1900.

5 Precipitation extremes

It is sometimes claimed that a warmer climate has led to more extreme rainfall events, but what do the facts say?

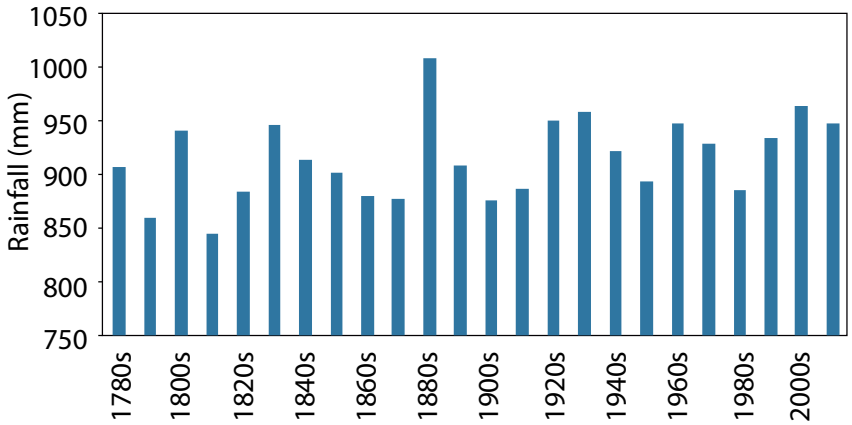


Figure 11: Decadal precipitation in England and Wales.[8]

At the longer term end of the scale, the 1870s were the wettest decade in the long-running England & Wales Precipitation series, followed by the 1990s, 1920s and 1910s. The data shows no evidence at all of a wetter climate.

Figure 12 shows the wettest and driest years. The two wettest years were 1872 and 1768. Wet years appear to come in clusters, but recent wet years are not unprecedented. As far as the driest years are concerned though, the most recent top 20 year was 1973, a strong indication that extremely dry years have become much less common.

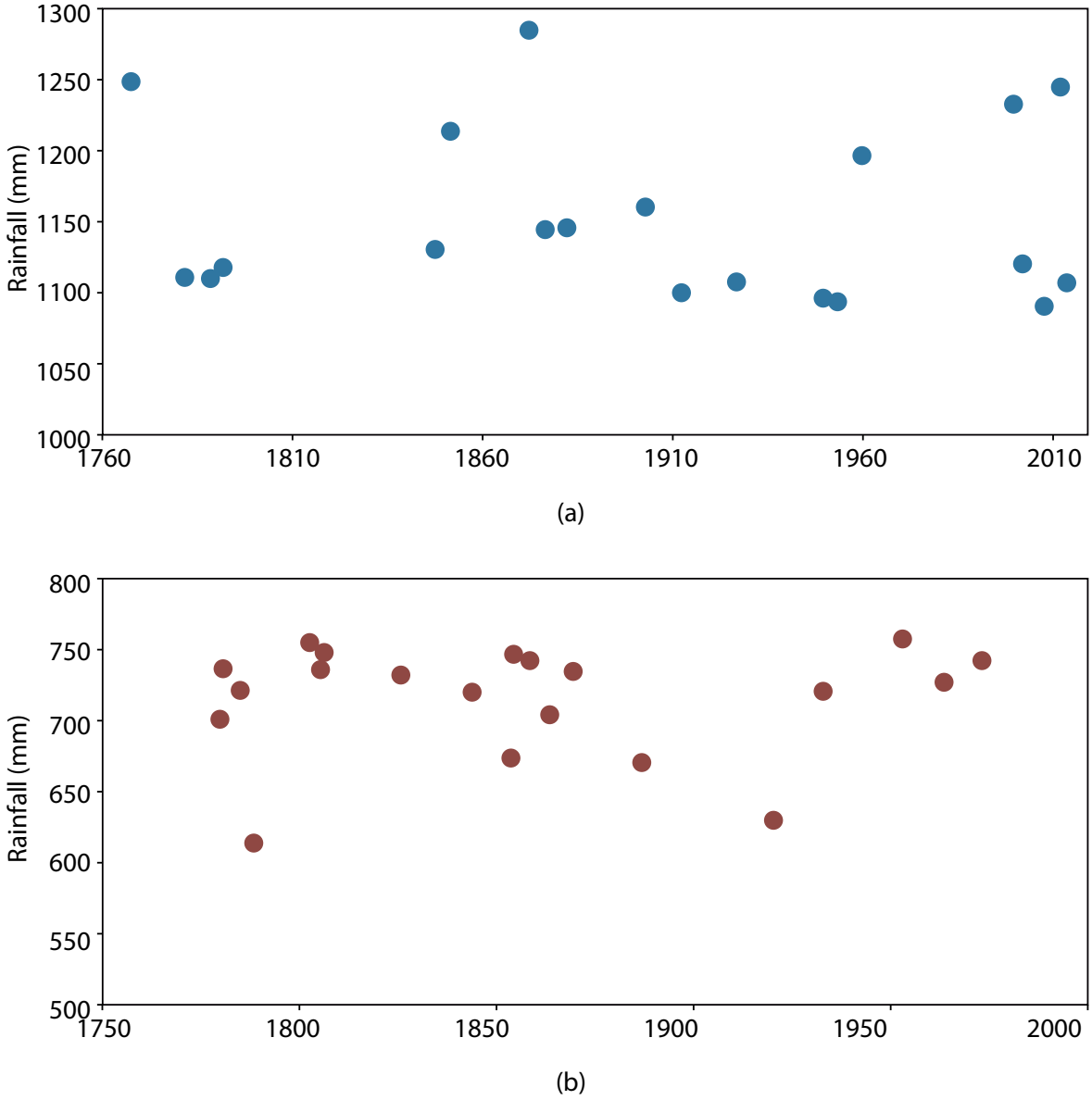


Figure 12: Years of extreme precipitation.
(a) 20 wettest and (b) 20 driest years. Source: Met Office data.[8]

Figure 13 shows all months with more than 150 mm of rain. Altogether there have been 98 such months since 1766, 3% of the total. By far the wettest month was October 1903. Although they appear to have been less common prior to 1900, there is no evidence of a significant change in the distribution of extremely wet months since.

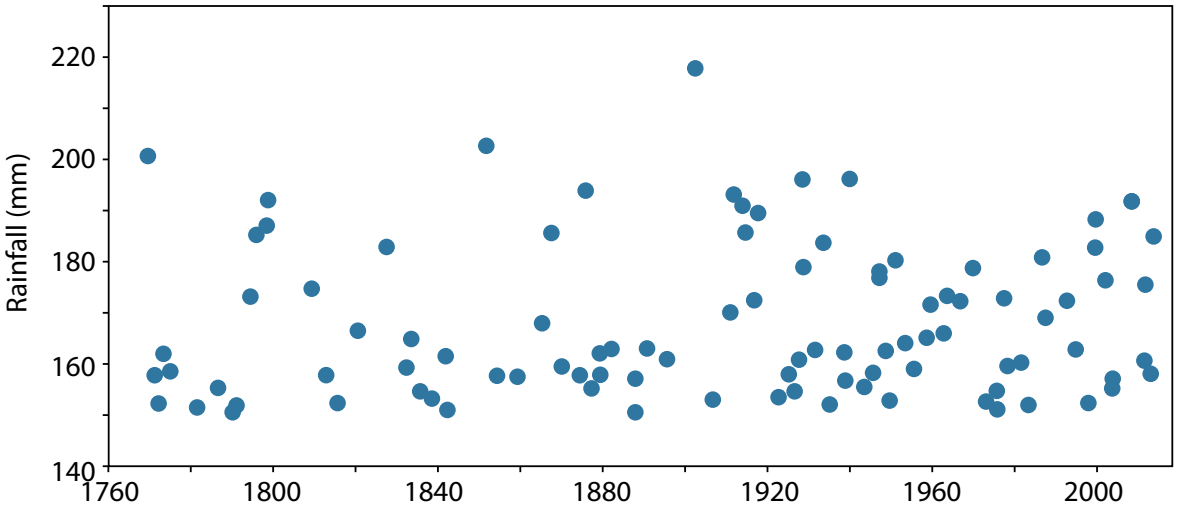


Figure 13: Years of heavy precipitation.
All years with rainfall >150 mm. Source: Met Office data.[8]

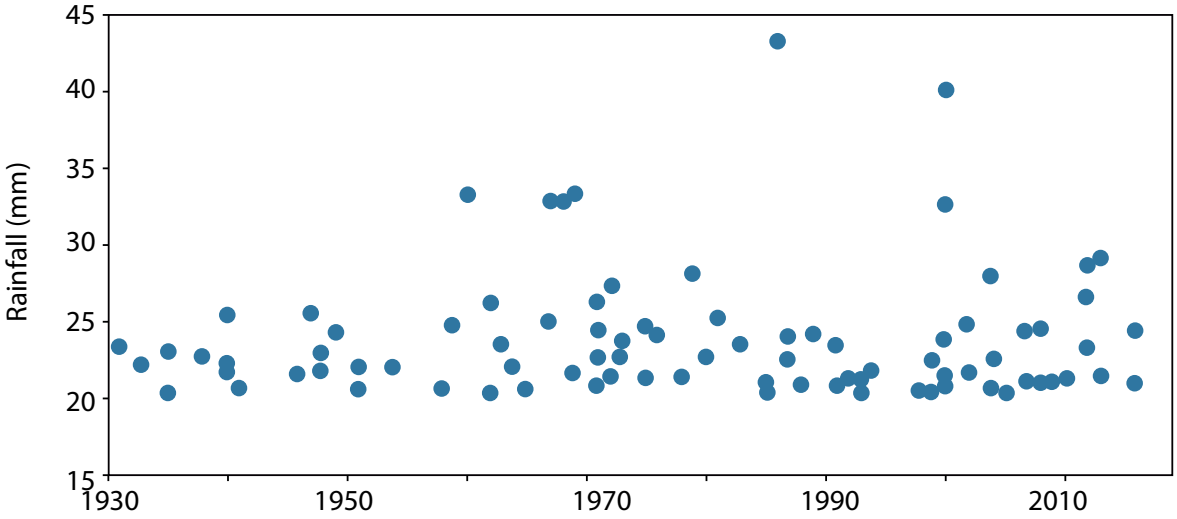


Figure 14: Days of heavy precipitation.
All days with rainfall >20 mm. Source: Met Office data.[8]

Finally Figure 14 shows daily rainfall of 20 mm and over in the England & Wales Precipitation series. Note that this refers to the average rainfall across England and Wales as a whole, and that this series only begins in 1931. The wettest day by far was in 1986. There appear to be fewer days prior to around 1960, but little trend since. A longer database would be needed to assess the significance of this change. As mentioned above, the period from the

early 1960s to late 90s is regarded as a 'flood dry period'. Any assessment of short-term trends needs to bear this in mind.

In summary, there is little evidence that rainfall is becoming more extreme, whether in decadal, annual, monthly or daily terms. There is evidence though that exceptionally dry years have become much less common.

6 Sea levels

Any analysis of sea-level trends needs to first consider vertical land movement. Generally speaking, the land mass of Scotland and N Ireland is rising, while the rest of the UK is sinking; by as much as 1 mm/yr in the extreme south-west.

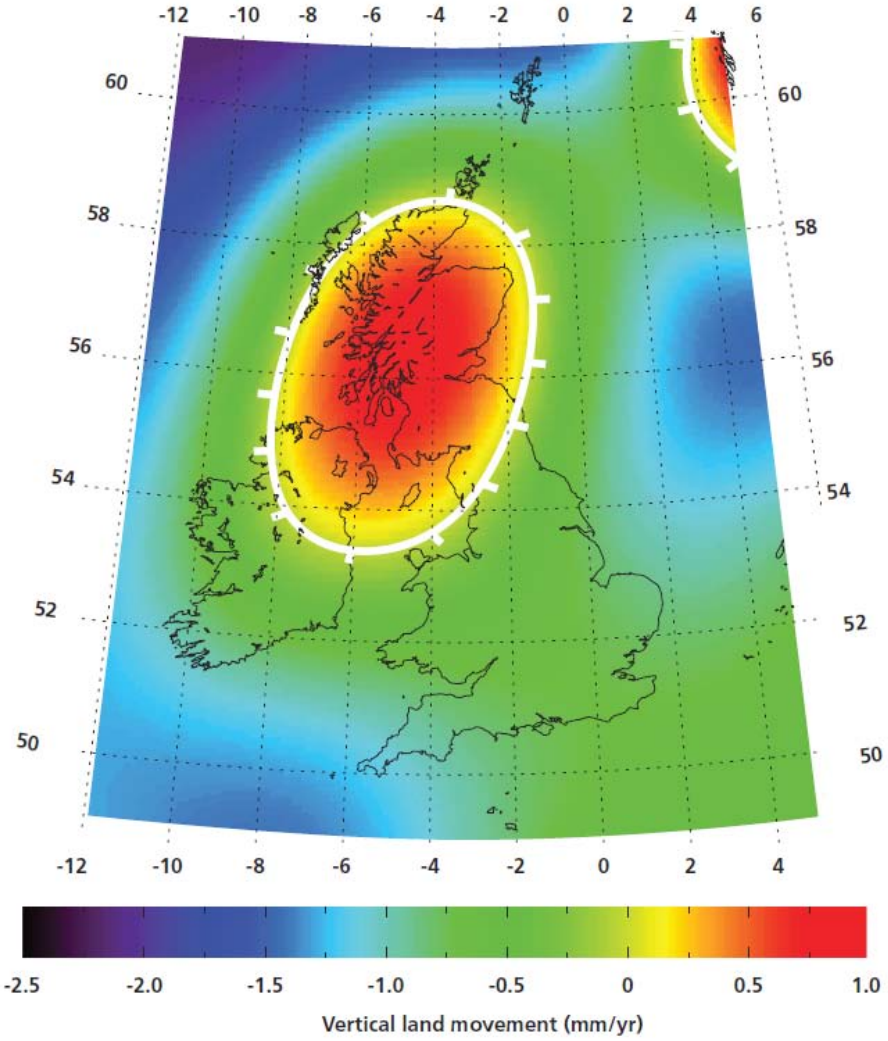
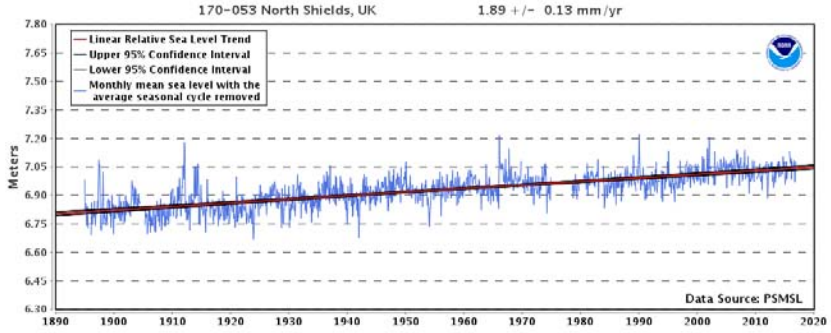


Figure 15: Vertical land movement for the UK.
UK Climate Projections.[10]

An analysis by Woodworth *et al.* estimated a rise in sea levels since 1901 of 1.4 mm/yr, after correcting for land movement. This figure was based on readings from five stations: Aberdeen, North Shields, Sheerness, Newlyn and Liverpool. However, there is a lot of missing data for Aberdeen, Liverpool and Sheerness.



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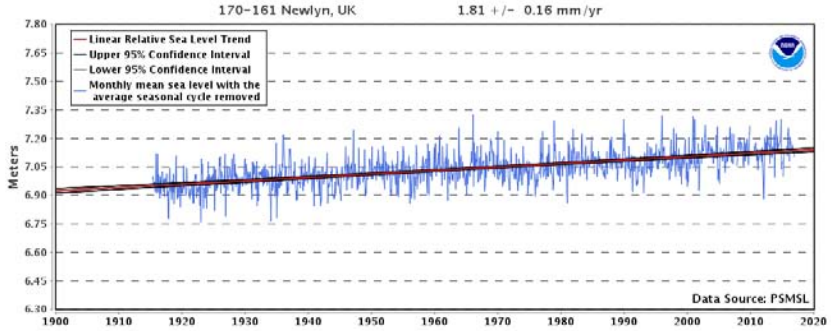

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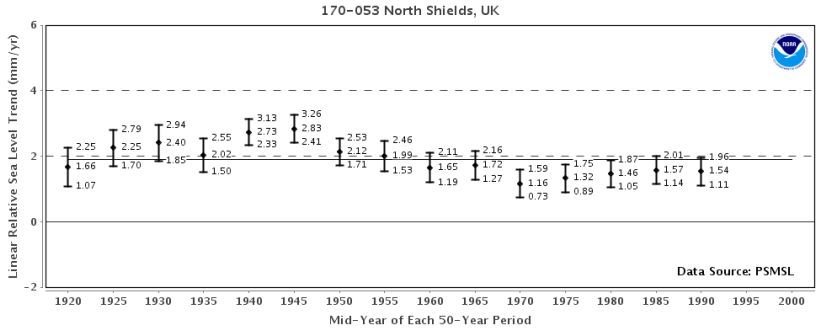

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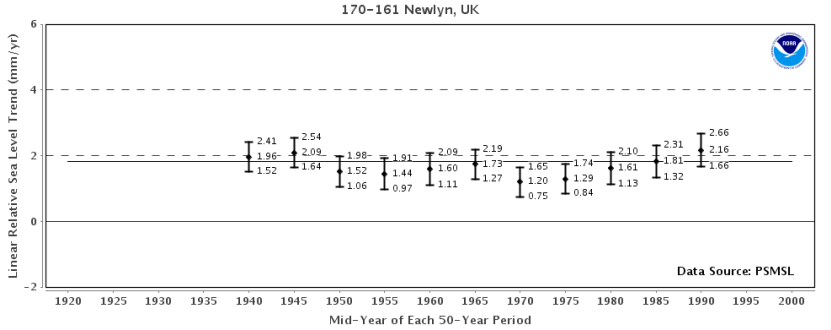

(d)

Figure 16: Sea level at two UK towns.

Sea level at (a) North Shields (b) Newlyn; relative sea level trends at (c) North Shields and (d) Newlyn. Source: Sea-level trends, NOAA.[11]

Charts provided by NOAA in Figure 17 give sea-level trends for North Shields and Newlyn, both of which have very long and largely complete tide gauge records. Due to late updating of data by NOAA for 2017, both finish in 2016. At neither of these stations is there any evidence of recent acceleration in the rate of rise. Sea-level rise at these stations also appears to be broadly consistent with the Woodworth study.

NOAA also provide graphs which illustrate the variation of sea-level trends (Figure 16c,d). These are based on overlapping 50-year periods, and are updated every five years. For instance, at Newlyn (Figure 16d) the linear sea-level trend was 2.16 mm/yr between 1966 and 2015. At both sites, there is clear evidence of a cyclical pattern, with a rate of rise similar to present or higher until the mid 20th century. There followed a slow down in the rate of rise, which seems to have bottomed out in the 1970s.

Sea-level rise in recent years has been higher than the 20th-century average, but this is only because the latter includes the slow down. It is important to look at sea-level trends over at least 50 years, as it is well established that trends obtained from tide-gauge records shorter than about 50–60 years are corrupted by interdecadal sea-level variation.[12]

The above pattern of sea-level rise is also exhibited globally. IPCC AR5 stated:

> It is very likely that the mean rate of global averaged sea-level rise was 1.7 [1.5 to 1.9] mm/yr between 1901 and 2010 and 3.2 [2.8 to 3.6] mm/yr between 1993 and 2010. Tide gauge and satellite altimeter data are consistent regarding the higher rate during the latter period. It is likely that similarly high rates occurred between 1920 and 1950.

7 Winds

According to the Met Office, 2017 was a fairly typical year as far as storms are concerned. Although there is no established database of storms in the UK, the Met Office have published this graph:

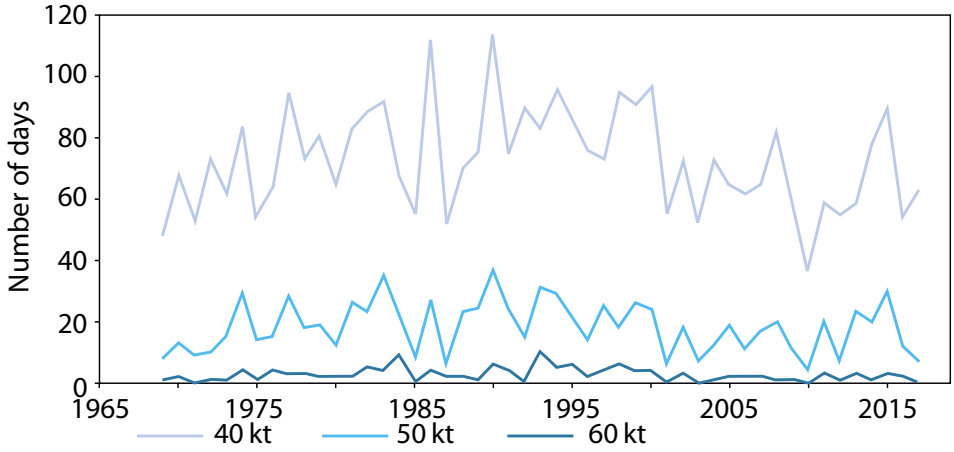

Figure 17: Winds and storms in the UK.
Count of number of days each year in which a maximum gust of particular speeds are recorded at more than 20 UK weather stations. Source: UK State of the Climate Report 2017.[5]

They conclude:

> There are no compelling trends in max gust speeds recorded by the UK wind network in the last four decades.

8 Conclusions

In short, although the UK is slightly warmer on average than it used to be, there is no evidence that extreme weather events have become more frequent or extreme. There is also nothing in the data to support official temperature or rainfall projections for the rest of the century.

In particular, heatwaves have not become more severe, nor droughts. Rainfall data also does not support the contention that floods have become worse. There is certainly no evidence, based on past trends, that either average summer temperatures will increase by 8°C, winter rainfall increase by 70%, or summer rainfall fall by 60% in the next few decades.

There is also nothing to support the prediction that sea levels will rise by 70 cm by 2095. Apart from being slightly warmer, the UK's climate appears to be little different to the past.

Notes

1. https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2017.
2. https://www.independent.co.uk/environment/climate-change-natural-disasters-link-increase-global-warming-report-warning-a8103556.html.
3. Defra. UK Climate Change Risk Assessment 2012 http://randd.defra.gov.uk/Document.aspx?Document=Summary_of_Key_Findings.pdf.
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6. NOAA https://oceanexplorer.noaa.gov/facts/climate.html.
7. Met Office Hadley Centre Central England Temperature Data https://www.metoffice.gov.uk/hadobs/hadcet/data/download.html.
8. England & Wales Precipitation Series, https://www.metoffice.gov.uk/hadobs/hadukp/data/download.html.
9. https://www.dur.ac.uk/news/newsitem/?itemno=6468.
10. UK Climate Projections. Marine and Coastal Projections http://ukclimateprojections.metoffice.gov.uk/22530.
11. NOAA. Sea Level Trends https://tidesandcurrents.noaa.gov/sltrends/sltrends_global_country.html?gid=1222
12. Bruce Douglas, Global Sea Rise: a Redetermination http://www.psmsl.org/train_and_info/training/gloss/gb/gb3/douglas.html.

About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

GWPF BRIEFINGS

1	Andrew Turnbull	The Really Inconvenient Truth or 'It Ain't Necessarily So'
2	Philipp Mueller	The Greening of the Sahel
3	William Happer	The Truth about Greenhouse Gases
4	Gordon Hughes	The Impact of Wind Power on Household Energy Bills
5	Matt Ridley	The Perils of Confirmation Bias
6	Philipp Mueller	The Abundance of Fossil Fuels
7	Indur Goklany	Is Global Warming the Number One Threat to Humanity?
8	Andrew Montford	The Climate Model and the Public Purse
9	Philipp Mueller	UK Energy Security: Myth and Reality
10	Andrew Montford	Precipitation, Deluge and Flood
11	Susan Crockford	On the Beach
12	Madhav Khandekar	Floods and Droughts in the Indian Monsoon
13	Indur Goklany	Unhealthy Exaggeration
14	Susan Crockford	Twenty Good Reasons not to Worry about Polar Bears
15	Various	The Small Print
16	Susan Crockford	The Arctic Fallacy
17	Indur Goklany	The Many Benefits of Carbon Dioxide
18	Judith Curry	The Climate Debate in the USA
19	Indur Goklany	The Papal Academies' Broken Moral Compass
20	Donoughue and Forster	The Papal Encyclical: a Critical Christian Response
21	Andrew Montford	Parched Earth Policy: Drought, Heatwave and Conflict
22	David Campbell	The Paris Agreement and the Fifth Carbon Budget
23	Various	The Stern Review: Ten Years of Harm
24	Judith Curry	Climate Models for the Layman
25	Fritz Vahrenholt	Germany's *Energiewende*: a Disaster in the Making
26	Hughes, Aris, Constable	Offshore Wind Strike Prices
27	Michael Miersch	Truly Green?
28	Susan Crockford	20 Good Reasons not to Worry About Polar Bears: Update
29	Mikko Paunio	Sacrificing the Poor: *The Lancet* on 'pollution'
30	Mikko Paunio	Kicking Away the Energy Ladder
31	Bill Gray	Flaws in Applying Greenhouse Warming to Climate Variability
32	Mikko Paunio	Save the Oceans: Stop Recycling Plastic
33	Andy Dawson	Small Modular Nuclear: Crushed at Birth
34	Andrew Montford	Quakes, Pollution and Flaming Faucets
35	Paul Homewood	DEFRA vs Met Office: Factchecking the State of the UK Climate

For further information about the Global Warming Policy Foundation, please visit our website at www.thegwpf.org. The GWPF is a registered charity, number 1131448.

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