

STATE OF THE UK CLIMATE 2023

Executive Summary

According to the Met Office, the UK climate “is continuing to change” and become more extreme (12). But what does the actual evidence tell us?

Using official data up to 2023, from the Met Office and other sources, this paper examines UK climate trends, and assesses the truth of these claims.

The results are as follows:

- Long term average temperatures have barely increased in the last two decades, and the changes are well within the range of natural variability.
- Although June 2023 was the hottest in the UK in records dating back to 1884, it was only fourth hottest on the longer CET series, a full degree cooler than June 1846.
- Previous Met Office studies indicated that much of the warming since the 1970s was the result of increased sunshine, likely due to cleaner air.
- The frequency of days with extreme temperatures has been in decline since the 1970s, as more hot days have been offset by fewer cold ones.
- Annual rainfall averages in England & Wales during the last decade have been at similar levels to earlier periods, such as the 1870s and 1920s.
- While winters have become slightly wetter, there has been little change in rainfall trends for the other seasons. In particular, summers are not getting drier, as projections have suggested.
- Rainfall is not becoming more extreme, whether on an annual, monthly or daily basis
- Sea levels have been rising at between 1.3 and 2.0mm a year around the UK, after taking account of vertical land movement, and there has been no acceleration in the rate of rise on multi-decadal scales.
- Wind storms have been declining in frequency and intensity since the 1990s.

In short, although it is slightly warmer than it used to be, the UK climate has changed very little in recent years. Long-term trends are dwarfed by the natural variability of British weather.

Nor is there any evidence that weather is becoming more extreme. Nothing in the data indicates that climate will become more extreme in future.

1) Review of 2023

The annual mean temperature in the UK was 9.97C in 2023, the second highest on record. Following the warm weather in 2022, the 10-year running average has risen slightly above the peak reached in 2007.

However, the rate of increase has slowed markedly since the rapid rise in the 1980s and 90s:

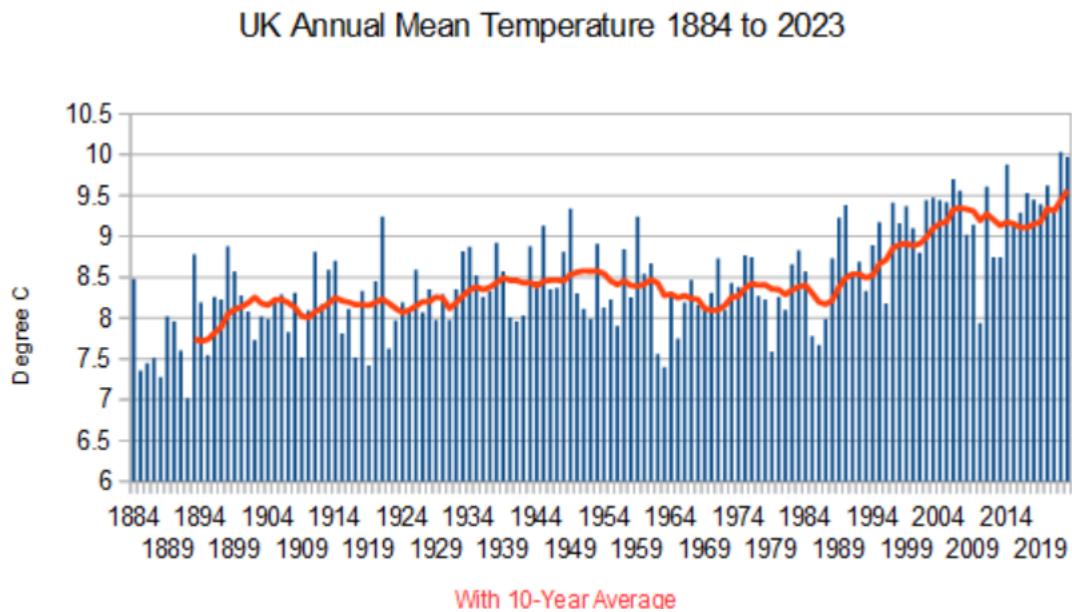


Fig 1: UK Mean Temperatures (1)

The rate of rise since 2007 is similar to the warming trends between the 1880s and 1950s. It is also worth noting that the 10-year average fell at a similar rate during between 1961 and 1987.

This raises the question of how much of recent warming is due to natural variability. Figure 2 shows annual temperature anomalies against the contemporaneous 30-year average, and finds that anomalies of around 1C either above or below average are not unusual throughout the record.

Statistically therefore it is not currently possible to separate the warming trend since the 1998 to 2007 period from the background of natural variability.

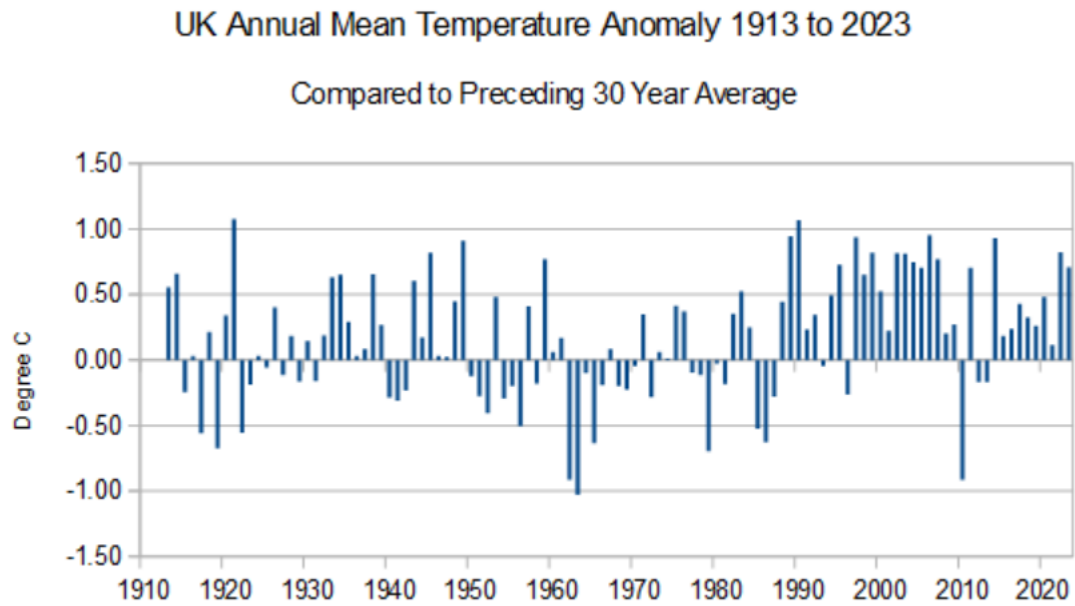


Fig 2: UK Mean Temperature Anomalies (1)

As far as temperatures are concerned, the most notable month was June, which was the warmest June on record since 1884, both in the UK and the Central England Temperature series (CET).

However, although the UK record started in 1884, the CET goes back much further, and this shows that June 1846 was actually 1.2C hotter; the Junes of 1676, 1822 and 1826 were also hotter. This destroys the notion that June 2023 was exceptional.

Moreover daily temperatures did not get anywhere near record levels for the month in June last year, on CET peaking at 28.6C. By contrast they hit 30.3C in June 1976. The UK record for June still stands at 35.6C, set in 1957 and 1976 at in Southampton and London respectively, compared to a high of 32.2C in June 2023.

Despite the warm weather in June, the summer of 2023 overall was unremarkable.

Figure 3 gives the daily CET mean temperatures for the year as a whole, and they indicate that apart from a handful of days, every day was within the “normal band” between 5th and 95th percentiles. However there was a predominance of warmer than average weather.

The British weather is always highly variable, and can swing backwards and forwards from extremes of warmth and cold. In 2023, warmer than average weather predominated, but this is a weather phenomenon, not a climatic one.

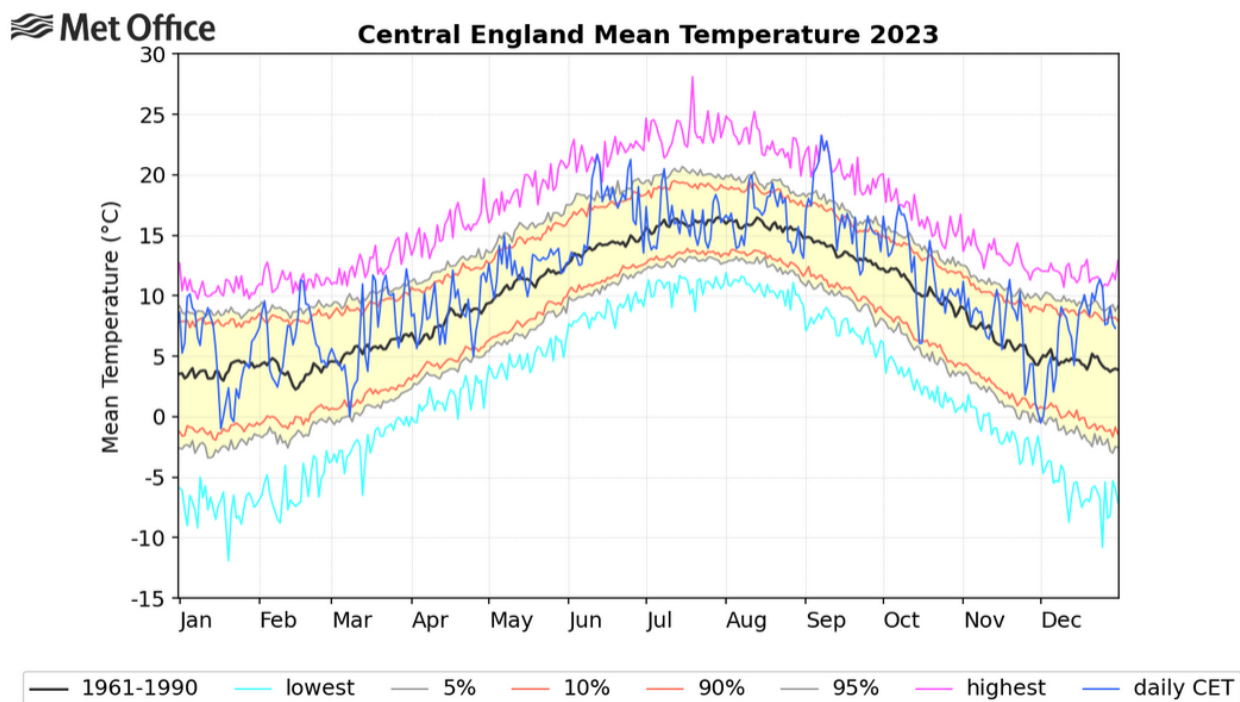


Fig 3: Daily CET temperature values for the year against 1961-1990 climatology (2)

2) Temperature Trends

All seasons display a similar pattern to the annual temperature trends, with a sharp rise in the 1980s and 90s, followed by much slower rise or none at all since 2006.

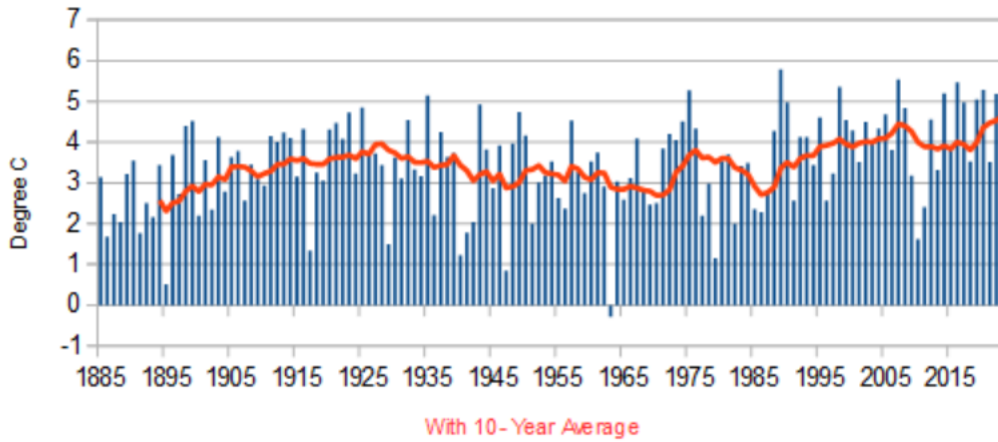
It is significant that this same period was marked by an increase in sunshine hours, particularly in autumn and spring. (Figure 5). This increasing trend appears to have ended in the last decade.

A Met Office study published in 2006 found there was a strong positive correlation between sunshine and mean temperatures, particularly in autumn and spring. (3). It also found little correlation, whether positive or negative during winter.

There is therefore evidence that part of the warming since 1980 could be the result of more sunshine. The report stated that this increase in sunshine was likely linked to reduced air pollution, following successive Clean Air Acts.

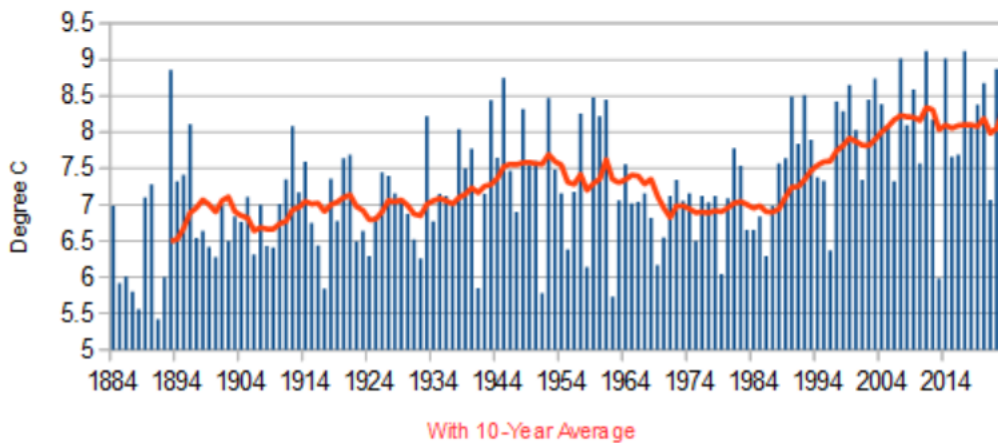
UK Mean Temperature - Winter

1884/85 to 2022/23



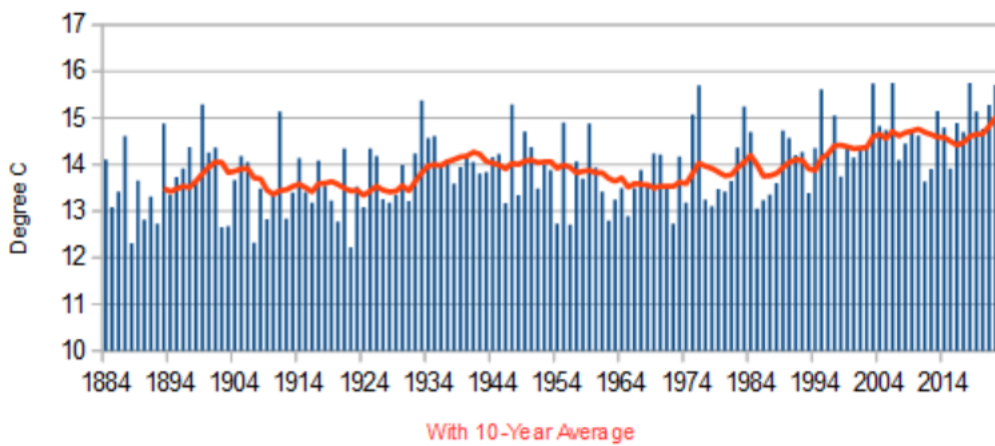
UK Mean Temperature - Spring

1884 to 2023



UK Mean Temperature - Summer

1885 to 2023



UK Mean Temperature - Autumn

1884 to 2023

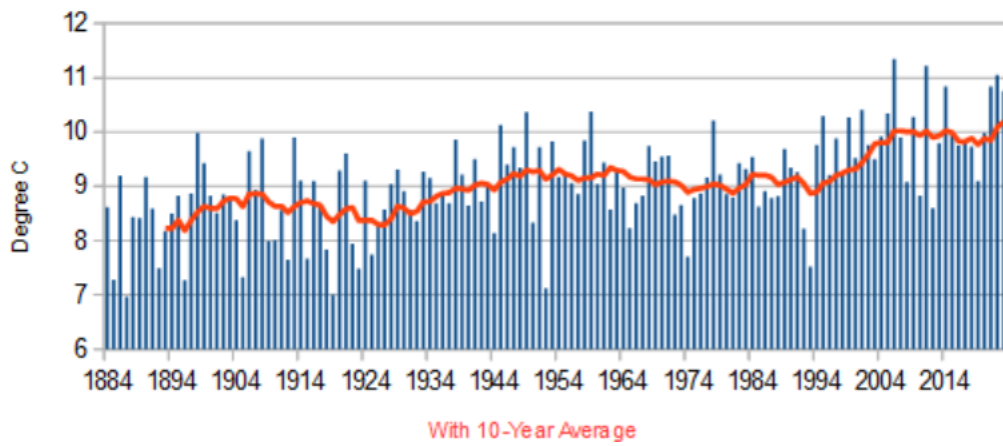


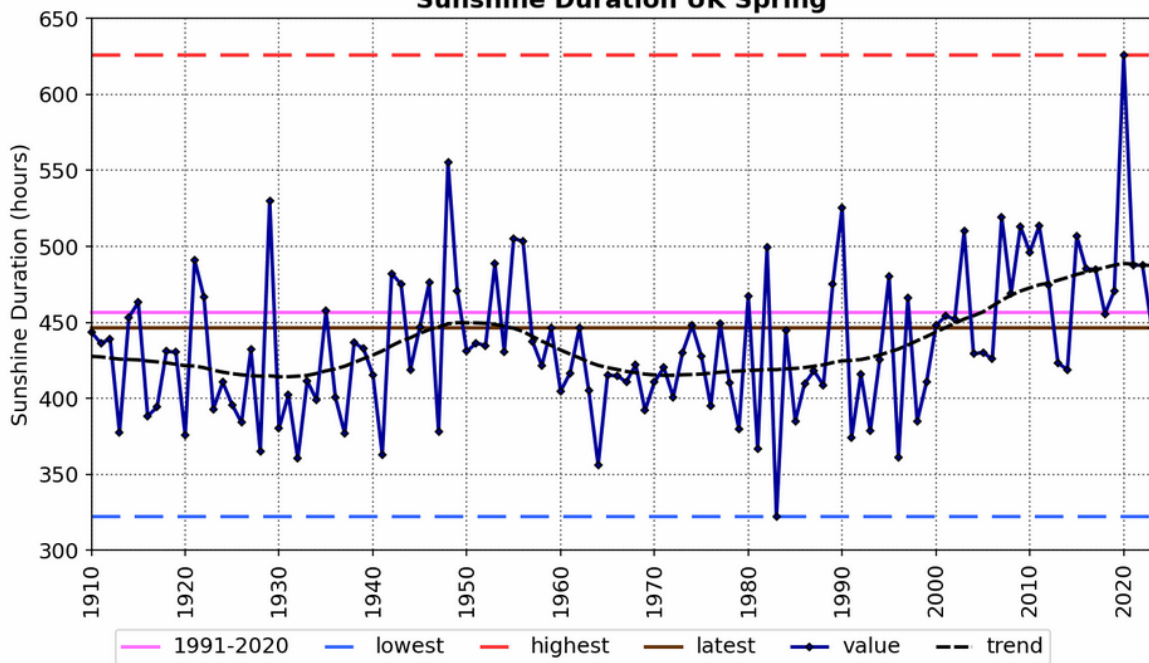
Figure 4: Seasonal Temperature Trends (1)



Source: HadUK-Grid 01/06/2023 10:46

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Sunshine Duration UK Spring



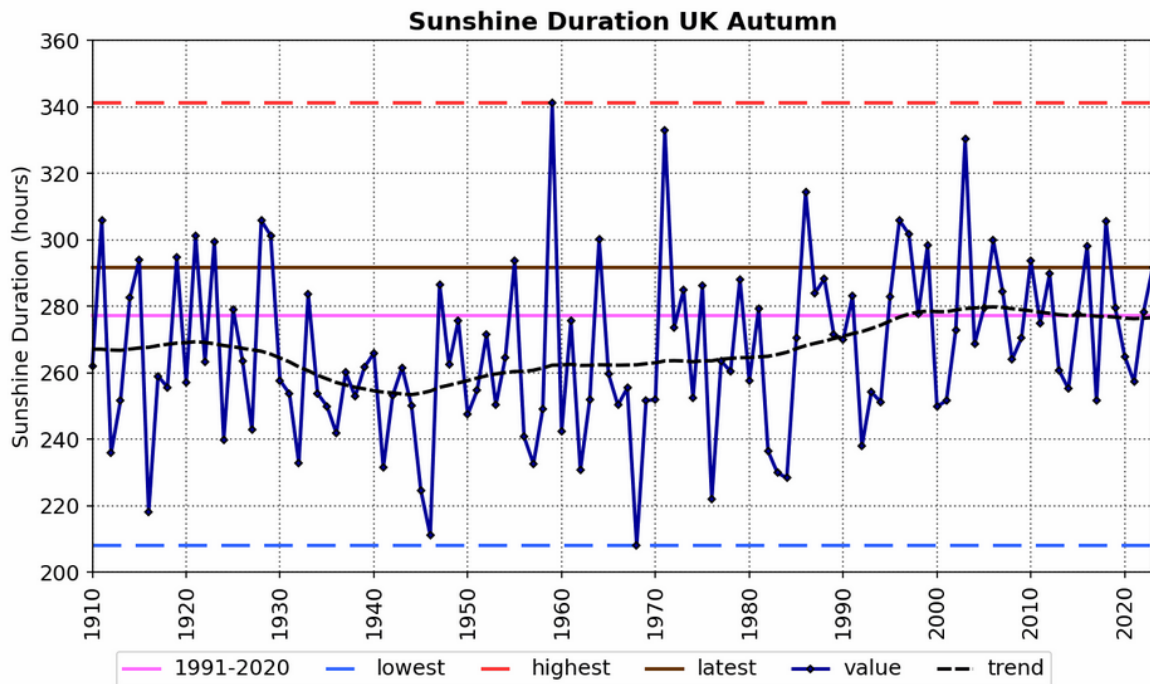
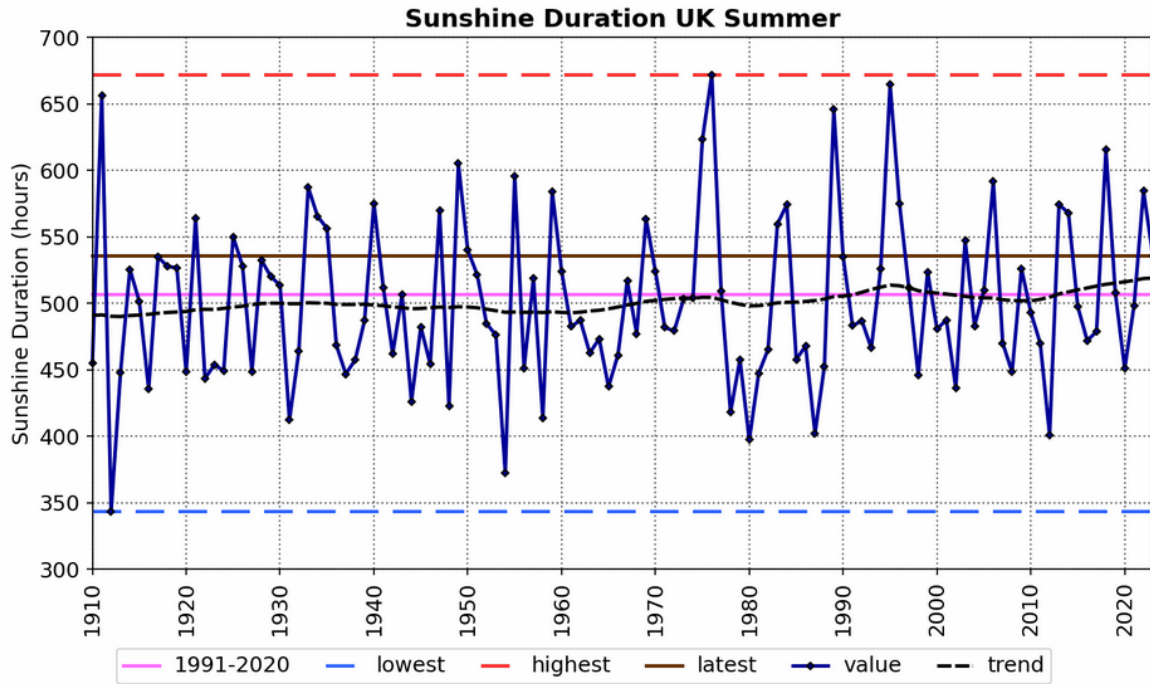


Figure 5: Sunshine Hours (1)

Winter temperatures, which are notably little higher than in the 1920s, are highly linked to the North Atlantic Oscillation (NAO), which has been strongly positive since 1980. Strong positive phases of the NAO in winter tend to be associated with above-normal temperatures in northern

Europe.

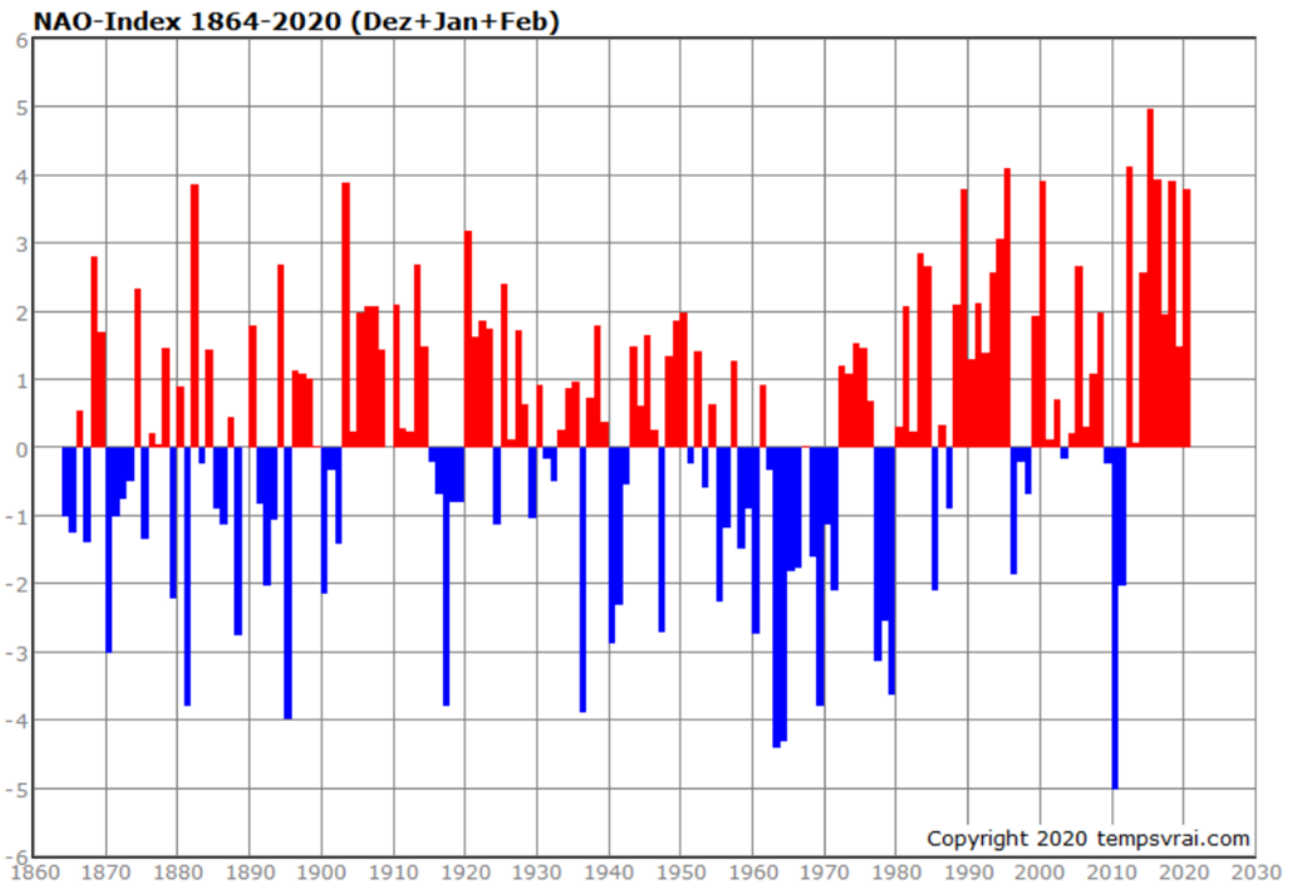


Figure 6: NAO (4)

The extremes of temperatures in Central England, as measured by the difference between average winter and summer mean temperatures have been steadily declining since 1940 (Fig 7).

And daily extremes of temperature, as measured by the 5th and 95th percentiles have tended to decline since the 1970s, with more warmer days offset by fewer cold ones. (Fig 8). The most extreme years were 1963, 1976, 1983, 1995, 2010 and 2018.

Difference between winter and summer average mean temperatures

CET 1660 to 2023

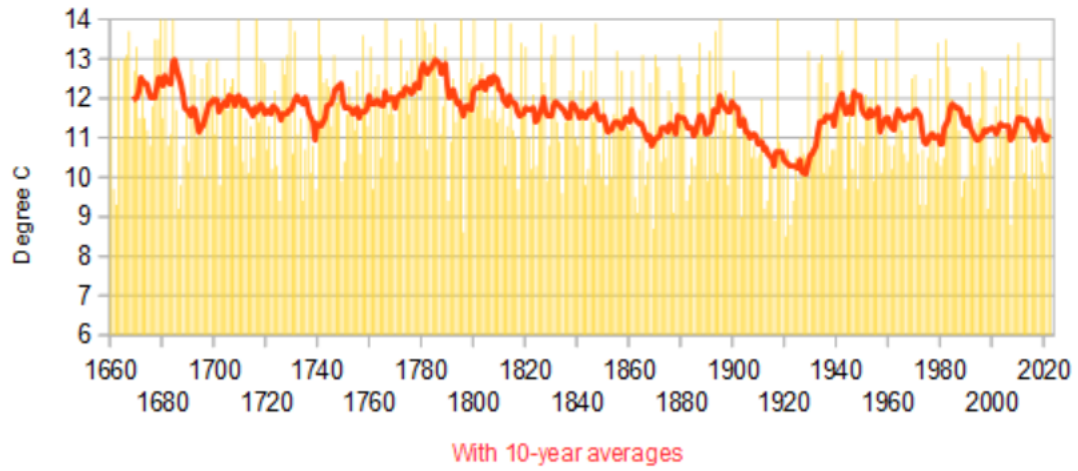


Figure 7: Temperature Extremes (5)

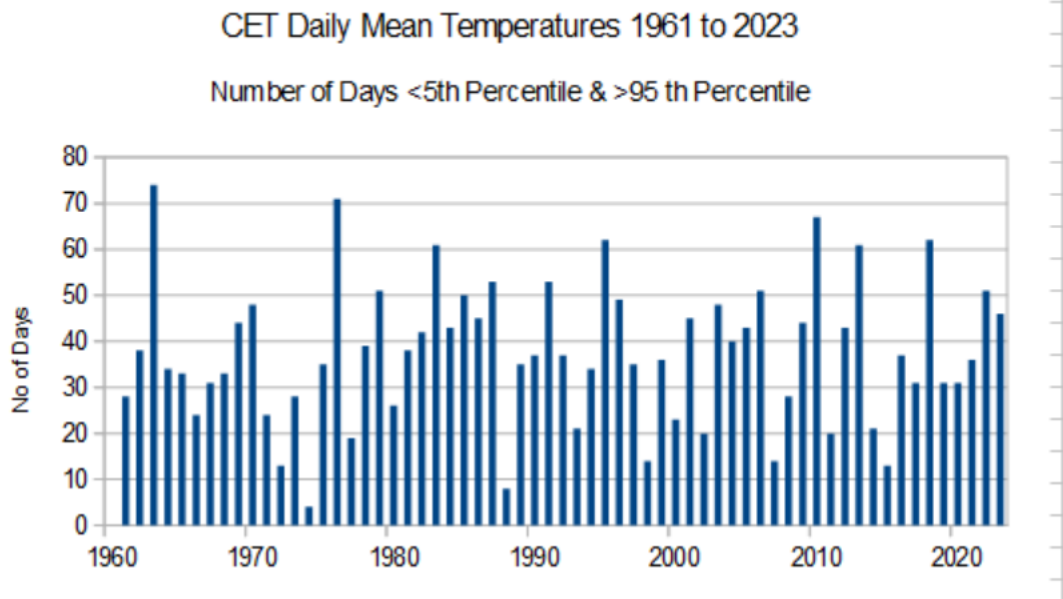


Figure 8: CET Daily Temperatures (6)

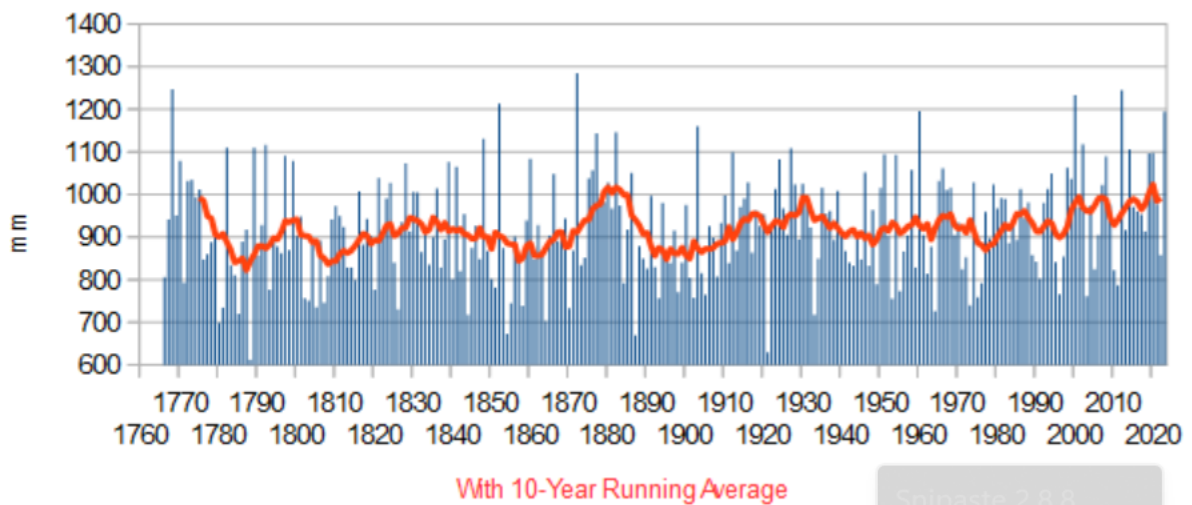
3) Precipitation Trends

Annual rainfall in England & Wales has been increasing since 1980, but the long term average is below the 1870s and 1920s.

There was a significant rise in rainfall in Scotland during the 1980s, but there has been little change in trend since. Rainfall trends in N Ireland have barely changed since 1931.

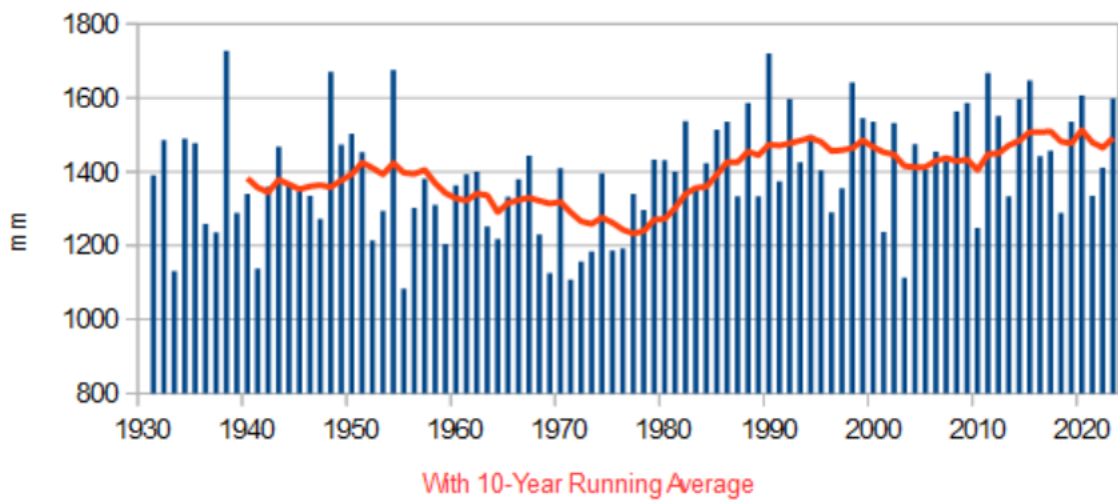
England & Wales Annual Rainfall

1766 to 2023



Scotland Annual Rainfall

1931 to 2023



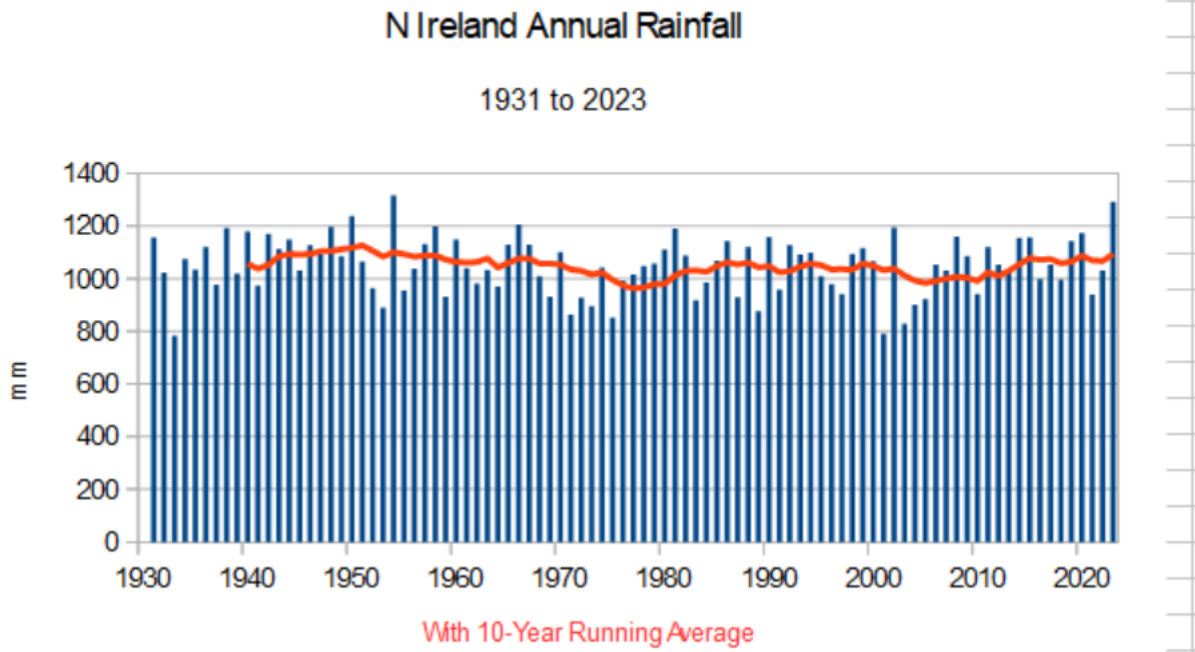
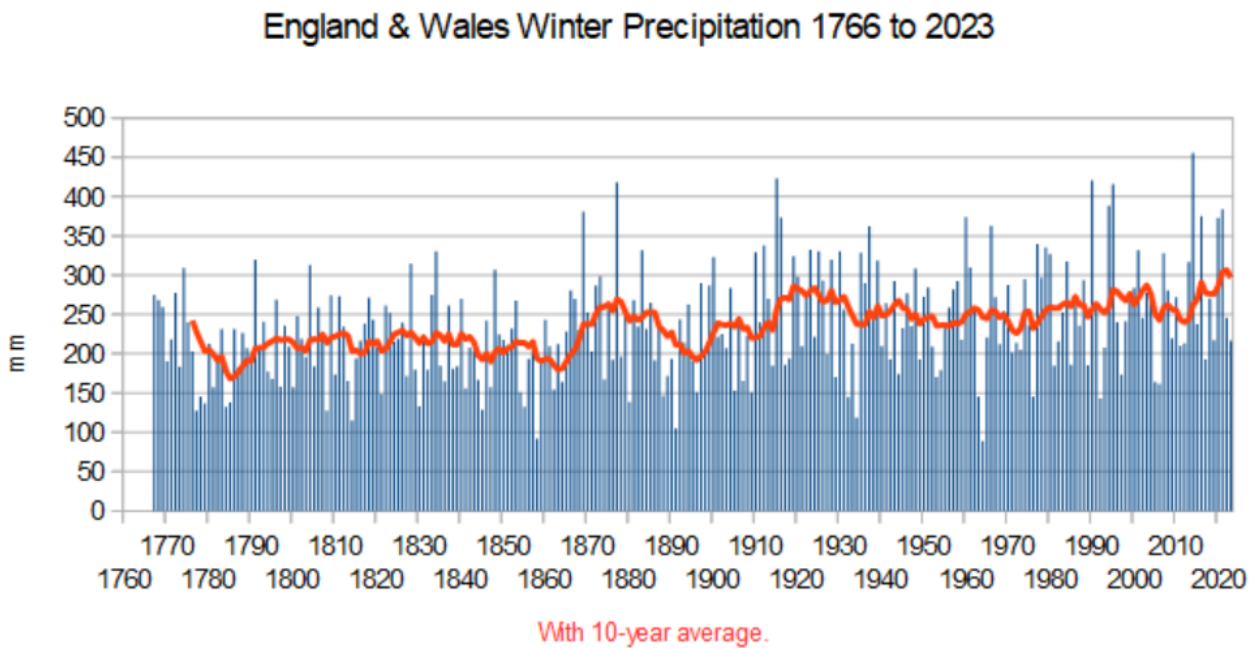
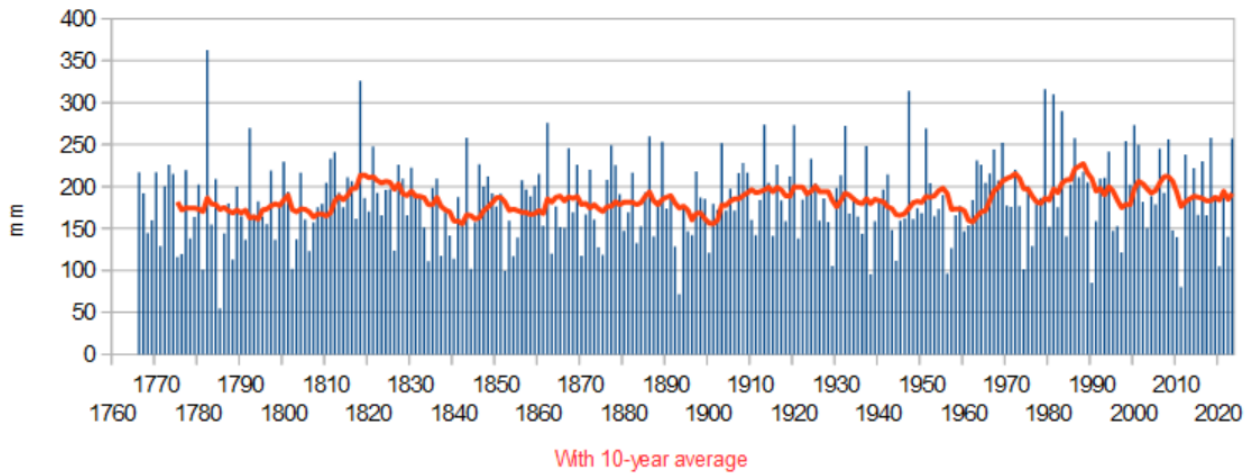


Figure 9: Annual Rainfall by country (7)

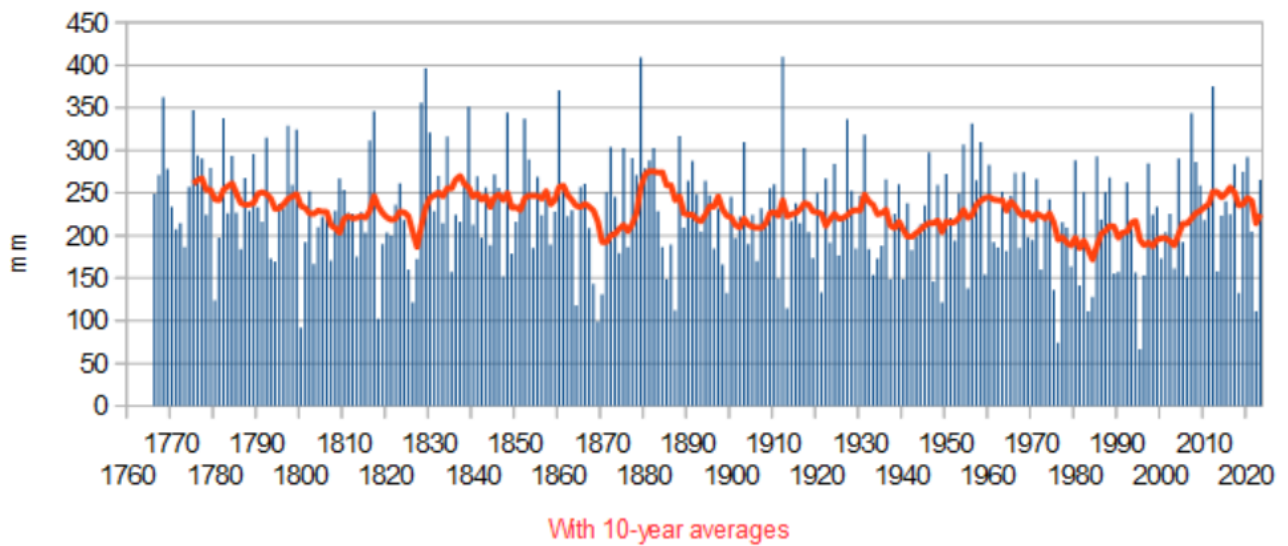
Other than winter, there are no obvious long term trends in seasonal rainfall. Although winters have been wetter than average in recent years, the 10-year average is only slightly greater than during the 1910s and 20s. The principle reason for this is the record wet winter of 2013/14.



England & Wales Spring Precipitation 1766 to 2023



England & Wales Summer Precipitation 1766 to 2023



England & Wales Autumn Precipitation 1766 to 2023

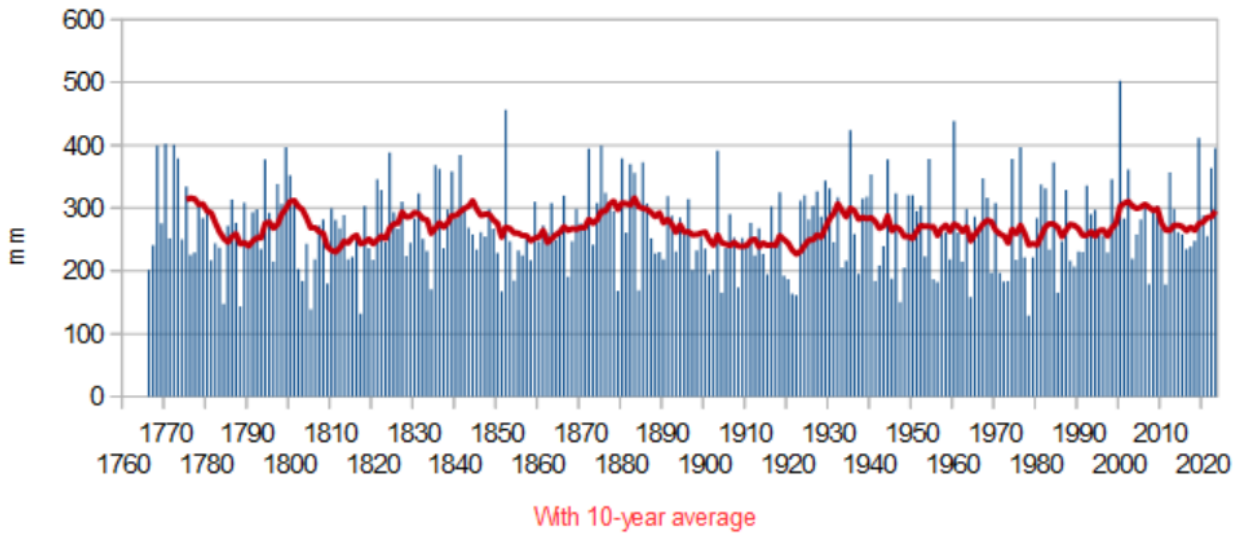
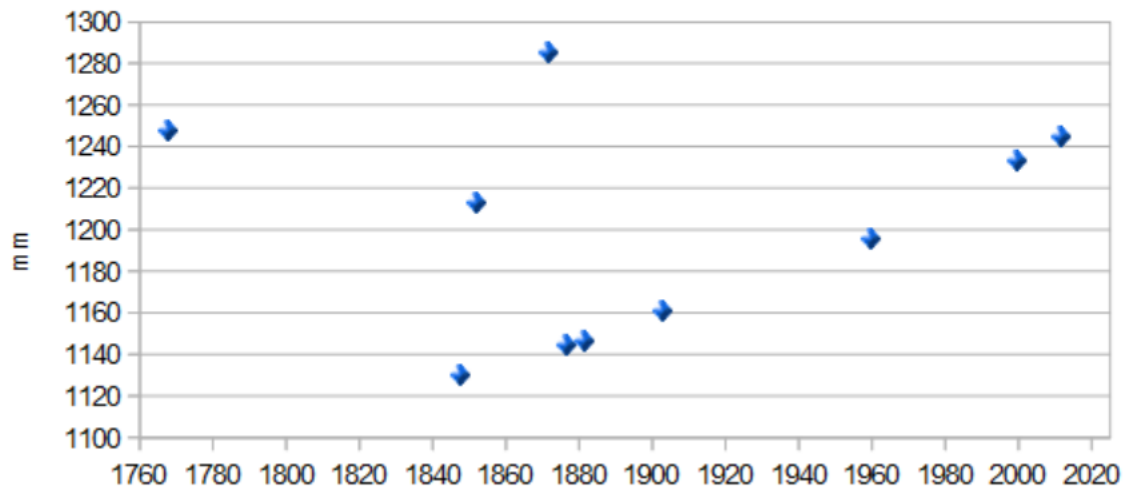


Figure 10: Seasonal Rainfall (7)

In England & Wales, most of the ten wettest years occurred in the years up to and including 1960. The only two exceptions are 2000 and 2012. The situation regarding the ten driest years is even starker, with the most recent year being 1964:

England & Wales Precipitation - Top 10 Wettest Years

1766 to 2023



England & Wales Precipitation Top 10 Driest Years

1766 to 2023

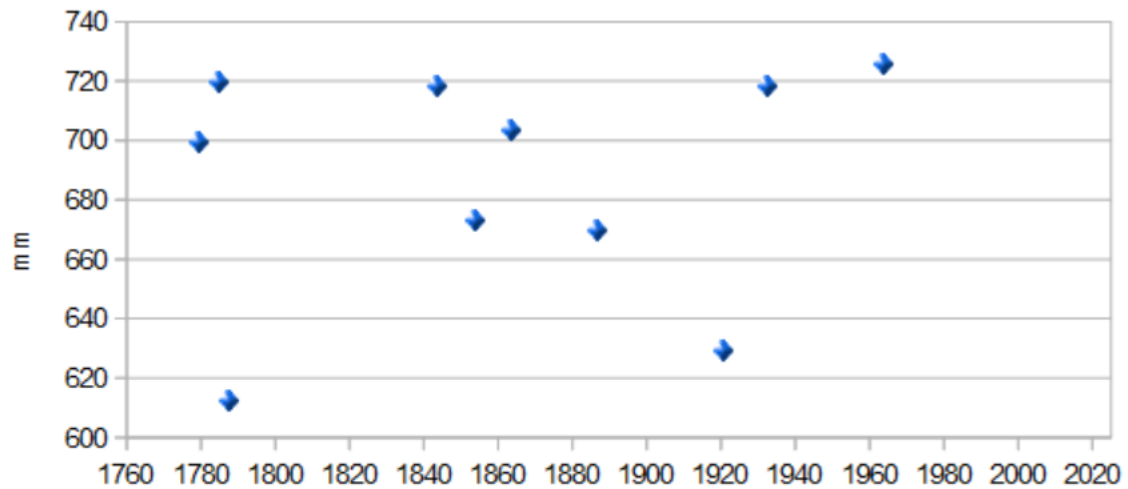


Figure 11: Wet and Dry Years (7)

October was the wettest month in 2023 in England & Wales, with 177.6mm of rain. This was the 25th wettest month in the series, but well below the record set in October 1903 of 218.1mm.

There have been 37 months with 170mm and over since 1766, about once every seven years on average. Prior to last year, the previous month in the list was January 2014, an indication that extreme rain months are not becoming more common. Indeed of the ten wettest months, only one has occurred since 1970; this was November 2009.

Analysis of daily rainfall also shows there is no evidence of rainfall becoming more extreme (Fig 12). During Storm Babet, 22.82mm fell on 19th October 2023, the 44th highest daily rainfall in England & Wales since 1931, a not unusual event. That day was the only one last year when more than 20mm fell.

Seven days have exceeded 30mm since records began in 1931, but none of these have occurred since 2000.

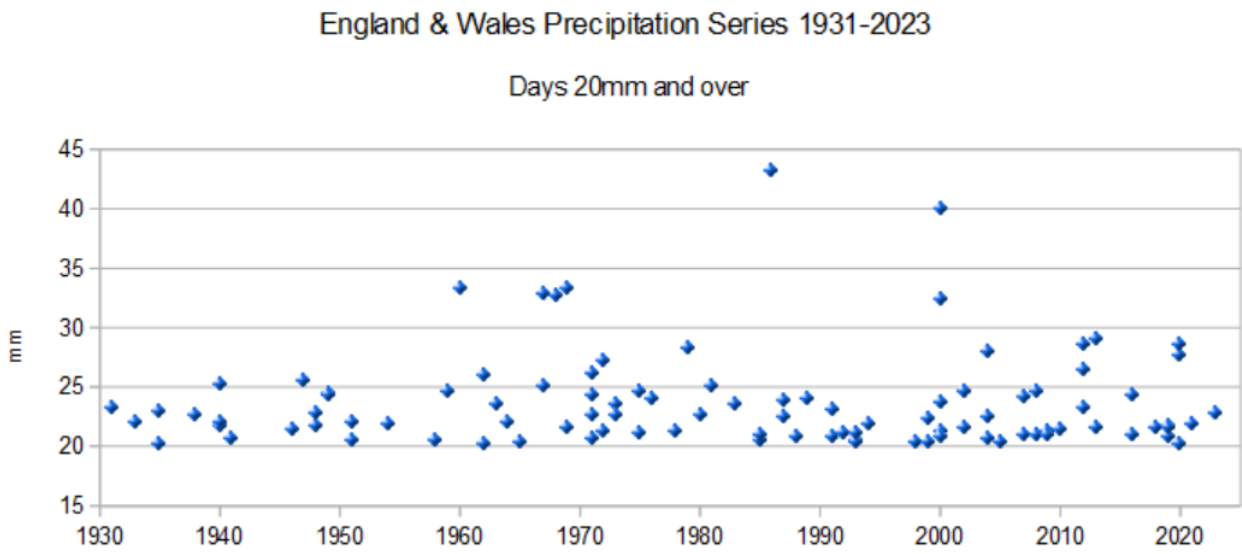
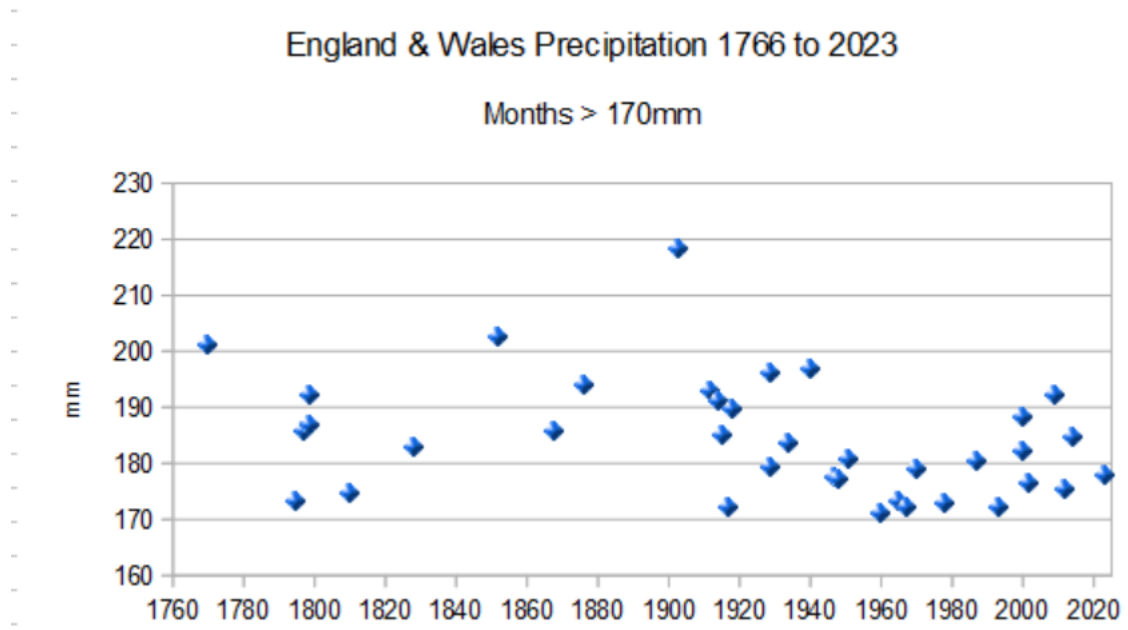


Figure 12: Extreme Wet Months & Days (7)

4) Sea Level Rise

Any analysis of sea-level trends needs to first consider vertical land movement. Generally speaking, the land mass of Scotland and Northern Ireland is rising, while the rest of the UK is sinking, by maybe as much as 1 mm per year in the extreme south west, as a result of isostasy:

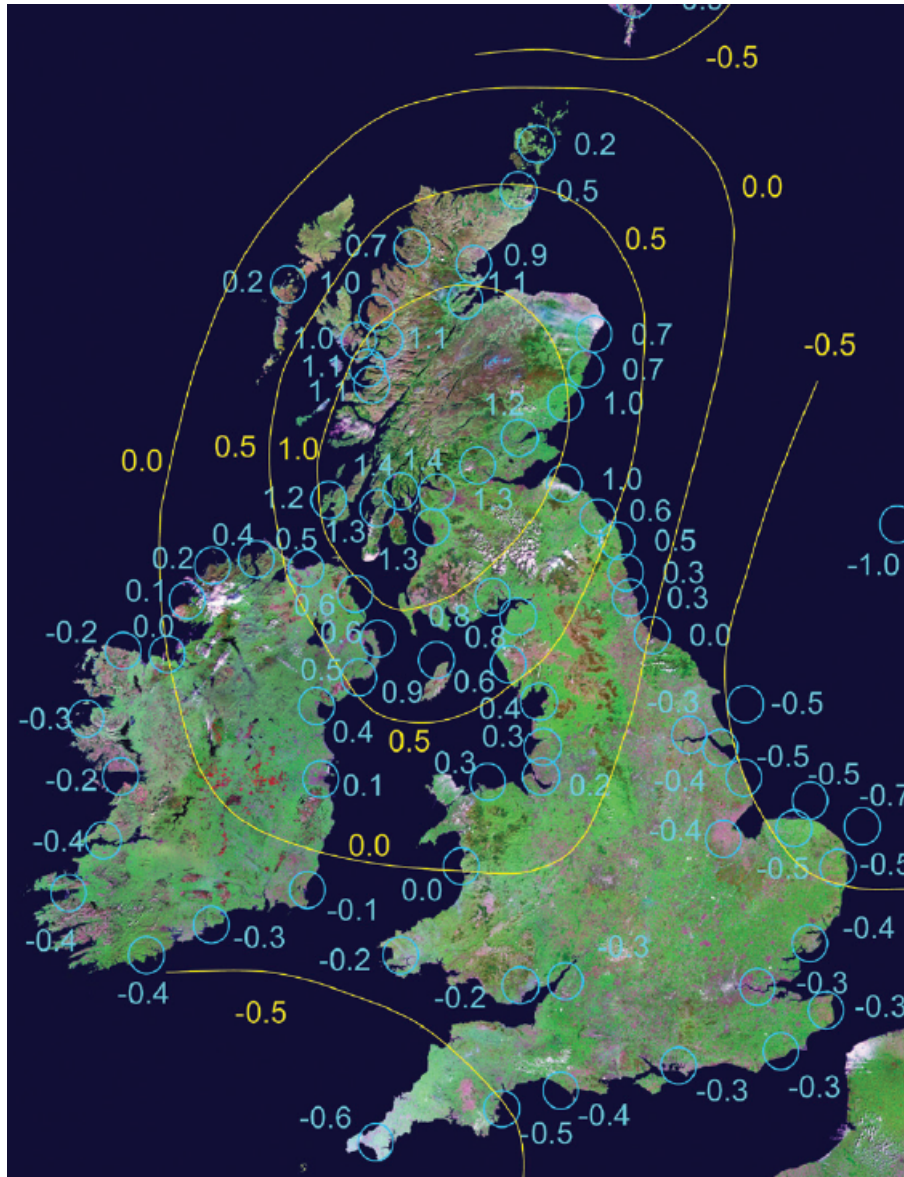
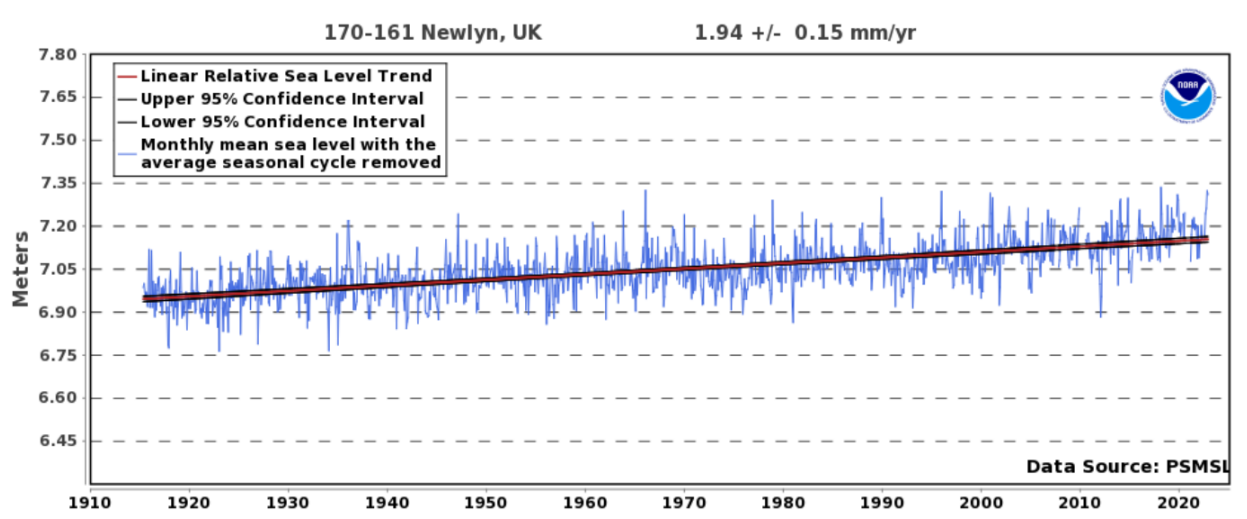
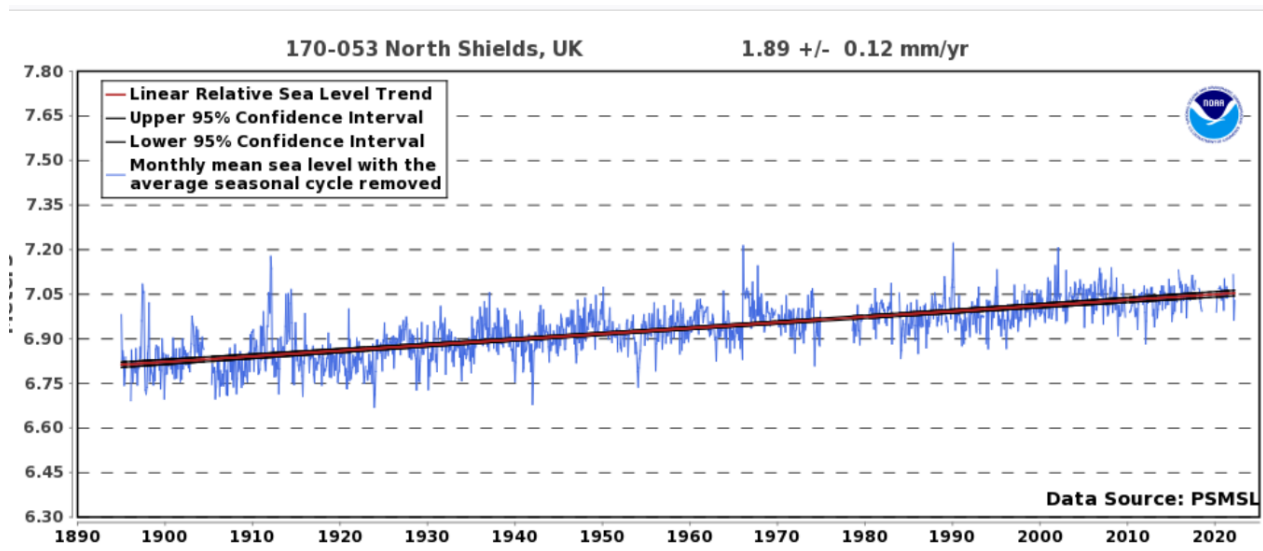


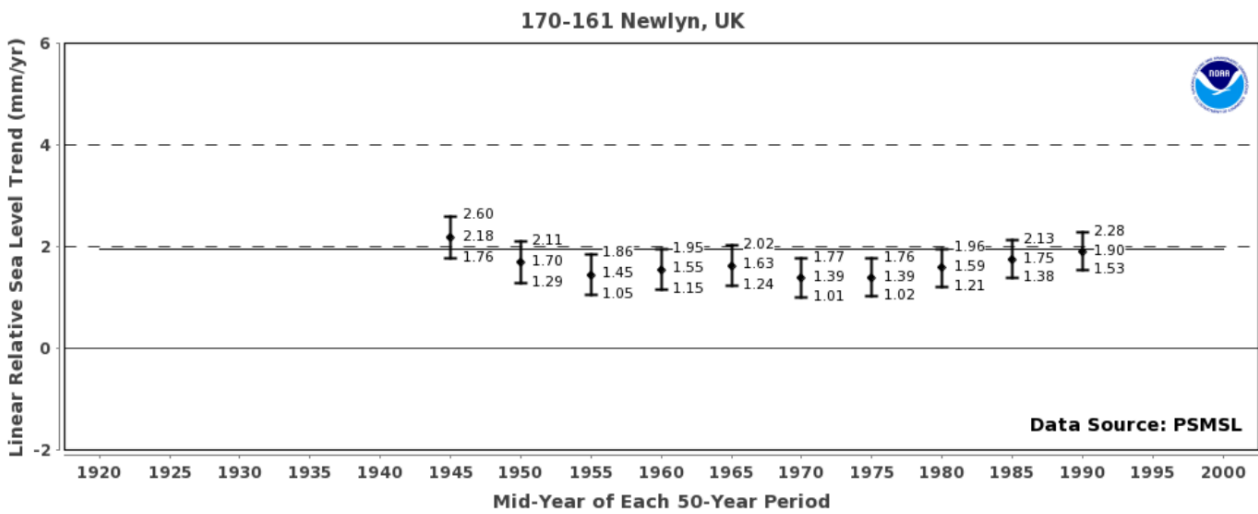
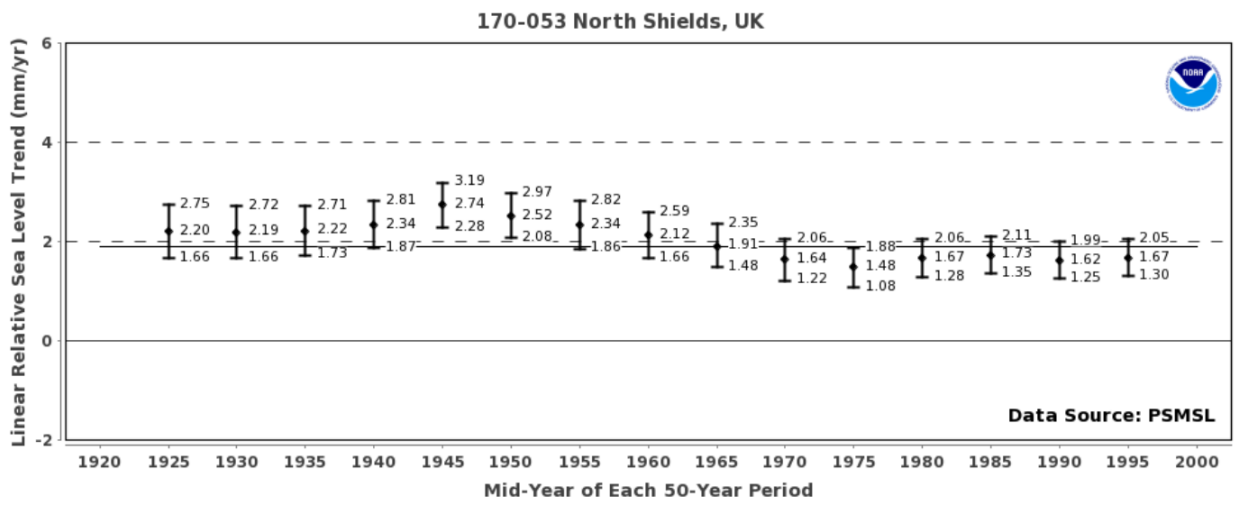
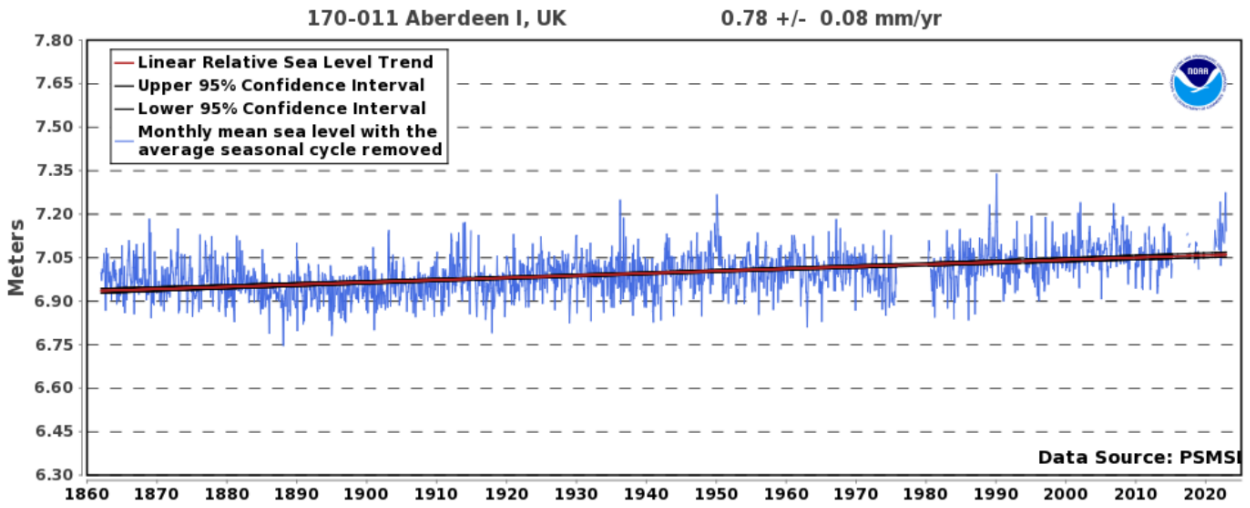
Figure 13: Current rate of relative land- and sea-level change in the British Isles in mm , showing relative land uplift as positive and relative subsidence as negative (8)

There are only three tidal gauge stations in the UK with long term, relatively uninterrupted and high quality data – North Shields in Northumberland, Newlyn in Cornwall and Aberdeen in Scotland.. According to Peltier 2004, the land at Newlyn is sinking at about 0.64mm a year, and rising by 0.11mm a year at North Shields, and 0.56mm at Aberdeen. (9)

Tidal gauges at the three sites show that sea levels have been rising at 1.89mm, 1.94mm and 0.78mm a year respectively, or 2.00mm, 1.30mm and 1.34mm after excluding the element of vertical land movement. Note though that start dates are different for the three sites, so direct comparisons cannot be made.

Analysis of the rolling 50-year trends shows a higher rate of rise than now in the first half of the 20thC at North Shields and Newlyn, and a similar rate at Aberdeen. This was followed by a decline in the rate of rise, which hit a minimum in the 50-year period of 1950 to 2000. This minimum coincides with the long period of Northern Hemisphere cooling after the war, particularly in the 1960s and 70s, and is associated with the cold phase of the Atlantic Multidecadal Oscillation. (11)





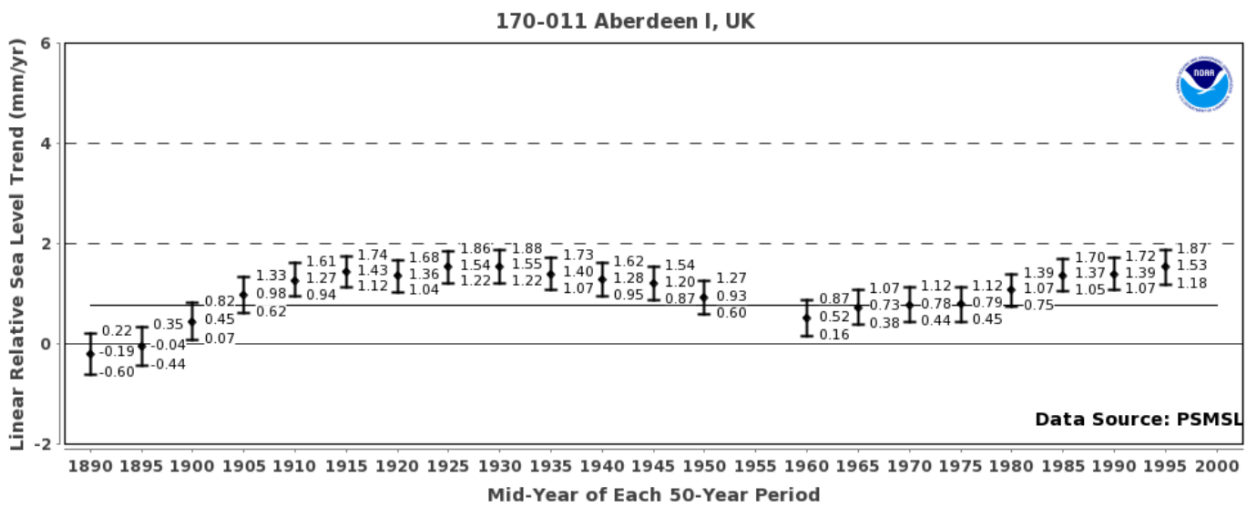


Figure 14: Sea Level Rise (10)

Despite an acceleration in sea level rise since 1970 at all three sites, the data shows that this is not part of a longer term trend, and that sea level rise has merely returned to previous levels.

5) Storms

The naming of UK storms by the Met Office in 2015 may have encouraged the belief that storms are becoming more powerful. In fact the opposite is true, as the Met Office have themselves frequently confirmed – see Figure 15.

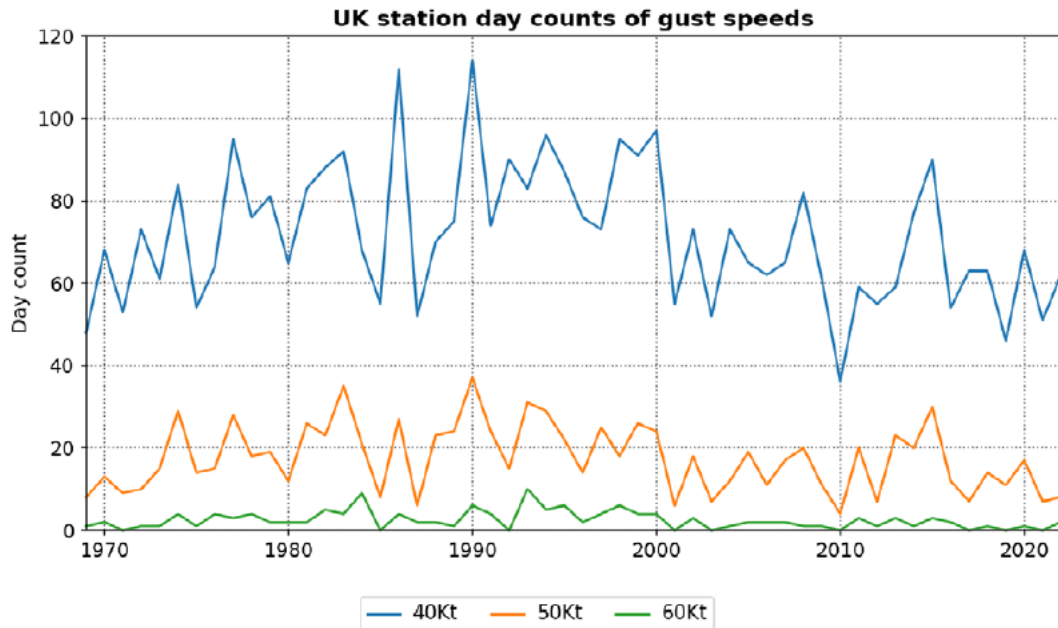


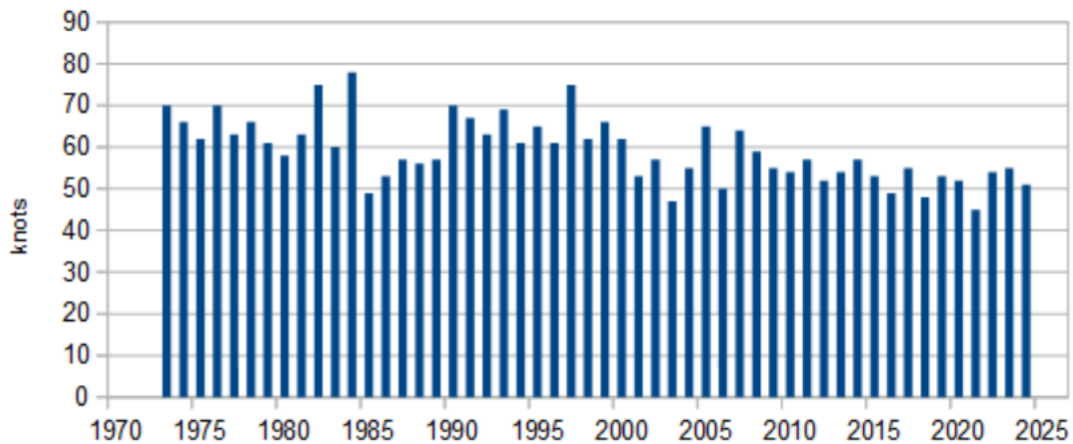
Figure 15: Count of the number of individual days each year during which max gust speeds $\geq 40, 50$ and 60 Kt (46, 58, 69 mph; 74, 93, 111 kph) have been recorded by at least 20 or more UK stations, from 1969 to 2022. Stations above 500 m above sea level are excluded. (12)

The Met Office's State of the UK Climate 2022 report makes it clear that the Burns Day storm in 1990, the Boxing Day storm in 1998 and the Great Storm of 1987 were very much more severe than any storm in the last decade.

Another Met Office report found that there is no evidence of any upward trend in wind gust speeds since 1969, when reliable data is available from. (13). One analysis of the top wind gust speeds at Bingley each year confirms these findings, and suggests that if anything wind speeds have been falling. (14)

Wind Gusts at Bingley 1972 to Jan 2024

Highest Gust Each Year



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- 4) meteo.plus- <https://meteo.plus/nao-index.php>
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- 12) Met Office State of the UK Climate 2022 - <https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate>
- 13) Met Office - <https://www.metoffice.gov.uk/research/news/2021/recent-trends-and-future-projections-of-uk-storm-activity>
- 14) Data supplied by Met Office - <https://notalotofpeopleknowthat.wordpress.com/2024/02/08/wind-speeds-at-bingley/>

