

Unprecedented extreme heatwave, July 2022

The UK experienced a brief but unprecedented extreme heatwave from 16 to 19 July 2022, as hot air moved north from the near-continent, with extreme temperatures recorded on both 18th and 19th. On 19th, 40.3°C was recorded at Coningsby (Lincolnshire), setting a new UK and England temperature record by a margin of 1.6°C, and multiple stations across England also exceeded 40°C. This heatwave marked a milestone in UK climate history, with 40°C being recorded for the first time in the UK.

The extent of the heatwave was remarkable with temperatures of 39°C being recorded as far north as Topcliffe, North Yorkshire and a large part of England exceeding 37°C. In Wales, on 18th July a new national record of 37.1°C was set at Hawarden Airport, Flintshire, while in Northern Ireland 31.2°C was recorded at Derrylin, County Fermanagh, within 0.1°C of the national record set in 2021. In Scotland, on 19th July a new national record of 34.8°C was set at Charterhall, Borders. The temperature records of many long-running stations were exceeded by wide margins and regional maximum temperature records were also set across all UK climate districts except western and northern Scotland; again for many by wide margins.

Daily minimum temperatures were also exceptionally high, with a new UK and England record on 19th July of 25.8°C at Kenley Airfield, Greater London. A new daily minimum temperature record was also set for Wales. This exceptional heatwave for the UK was associated with a much more prolonged and severe heatwave across Europe, with temperatures also exceeding 40°C in France, 45°C in Spain and 47°C in Portugal.

The heatwave in the UK and more widely across western Europe was associated with a naturally-occurring large-scale wave pattern in the northern hemisphere, with a chain of five high pressure regions around the globe, and heatwaves also being experienced during summer 2022 in China and the US.

Impacts

The Met Office issued its first red warning for extreme heat since the Extreme Heat National Weather Warning Service was introduced in June 2021. The UK Health Security Agency and Met Office also issued a level 4 alert for the first time since the heatwave plan was introduced for England in 2004, resulting in the government declaring a national emergency. A red warning means adverse health effects are expected not just to those most vulnerable.

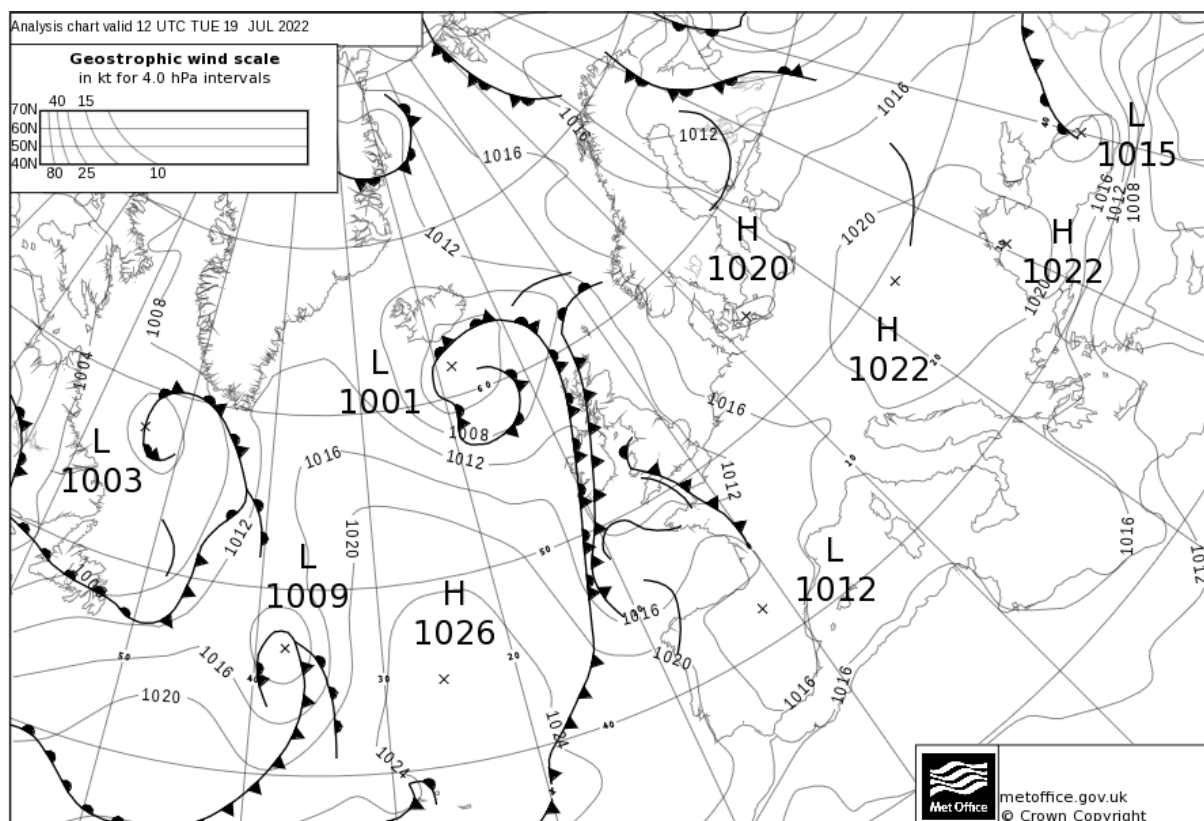
Network rail issued a 'do not travel' warning and rail services were severely disrupted due to tracks buckling and overhead cables sagging. Many services operated a reduced timetable or were cancelled; there were no trains on the East Coast Main Line from London King's Cross station on Tuesday 19th. Flights were suspended at Luton airport after the heat affected the runway. The heat brought challenging conditions for the NHS with a spike in 999 calls, and care services supporting the elderly and vulnerable were put under increased stress, with a likely increase in heat related deaths. Many schools remained open but ran a shorter day in parts of the country. There were several fatalities associated with open water swimming. Several fire services declared major incidents after multiple fires broke out. A number of homes were gutted in Wennington, east London, a nursery was destroyed in Milton Keynes and several homes were damaged by fires in Maltby, Rotherham. There were some problems with power cuts in parts of Yorkshire, Lincolnshire and the North East. In some areas gritters spread sand on some roads

after surfaces began to melt. In North Yorkshire, the Aysgarth Falls ran dry due to the combination of low rainfall and high temperatures

More widely in Europe, the impacts were much more severe with the Gironde region of south-western France particularly badly affected by severe wildfires.

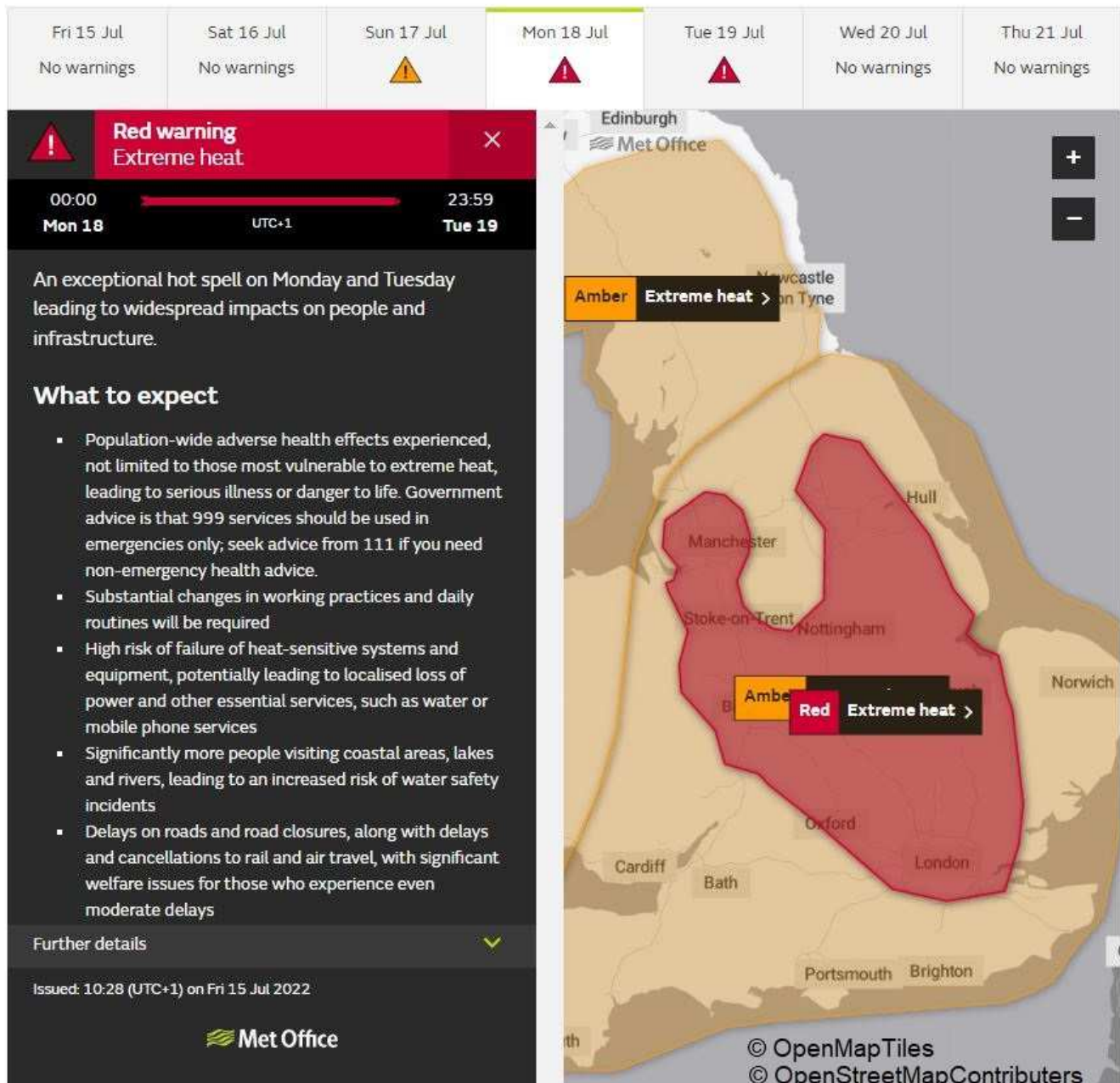
Weather data

The analysis chart at 1200 UTC 19 July 2022 shows the UK located between high pressure over continental Europe and a low pressure system to the north west of Scotland resulting in a southerly flow drawing the hot, dry air airmass from southern Europe to the UK. The exceptionally hot weather was associated with a 'heat-dome'; an area of high pressure with falling air in the atmosphere trapping warm air at the surface. By the 19th a cold front tracking from the west resulted in some thundery rain and somewhat fresher air to parts of the country.

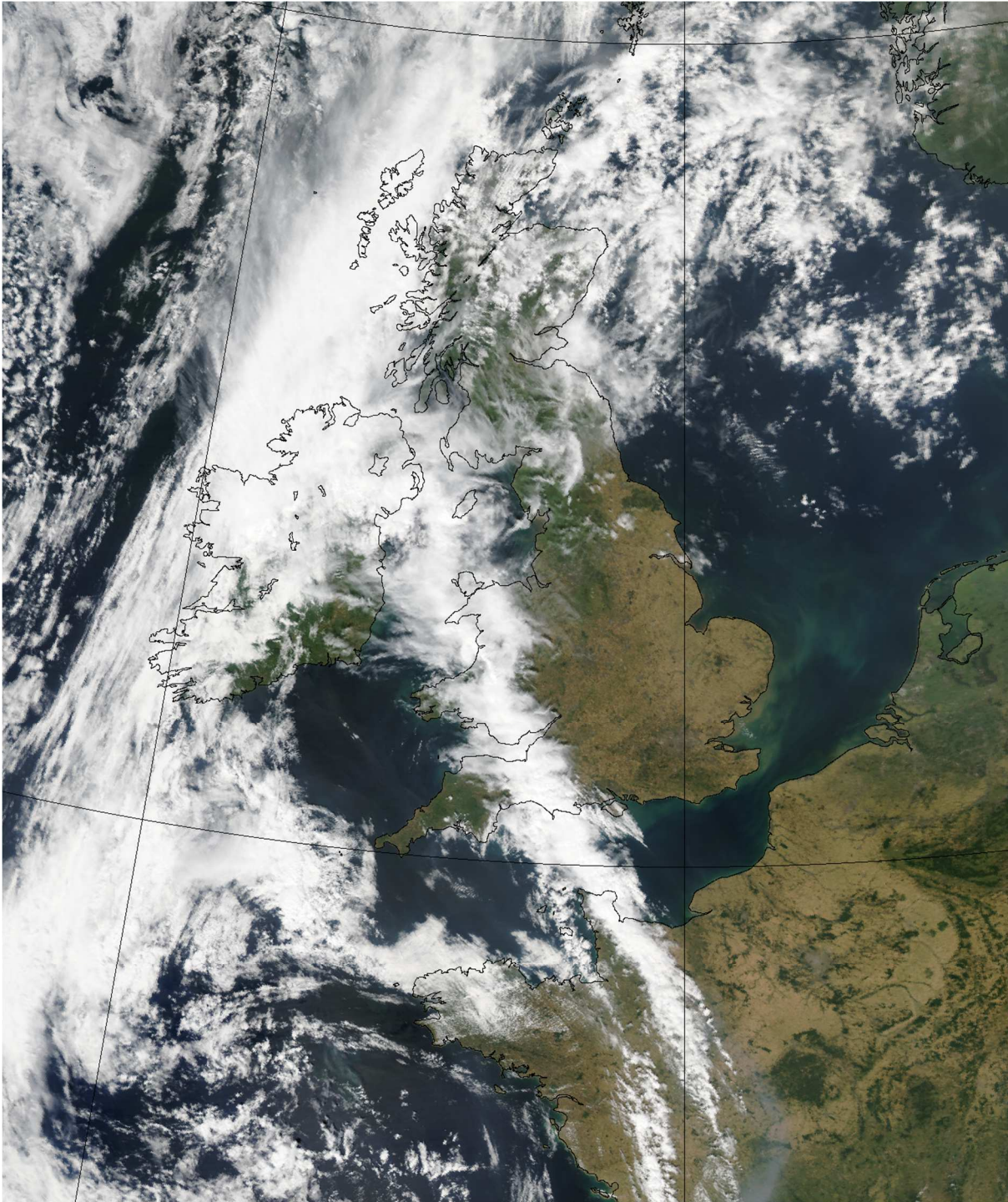


The figure below shows the Met Office red extreme heat area extending from London to Manchester and Leeds with an amber area covering England and Wales and extending to parts of southern Scotland.

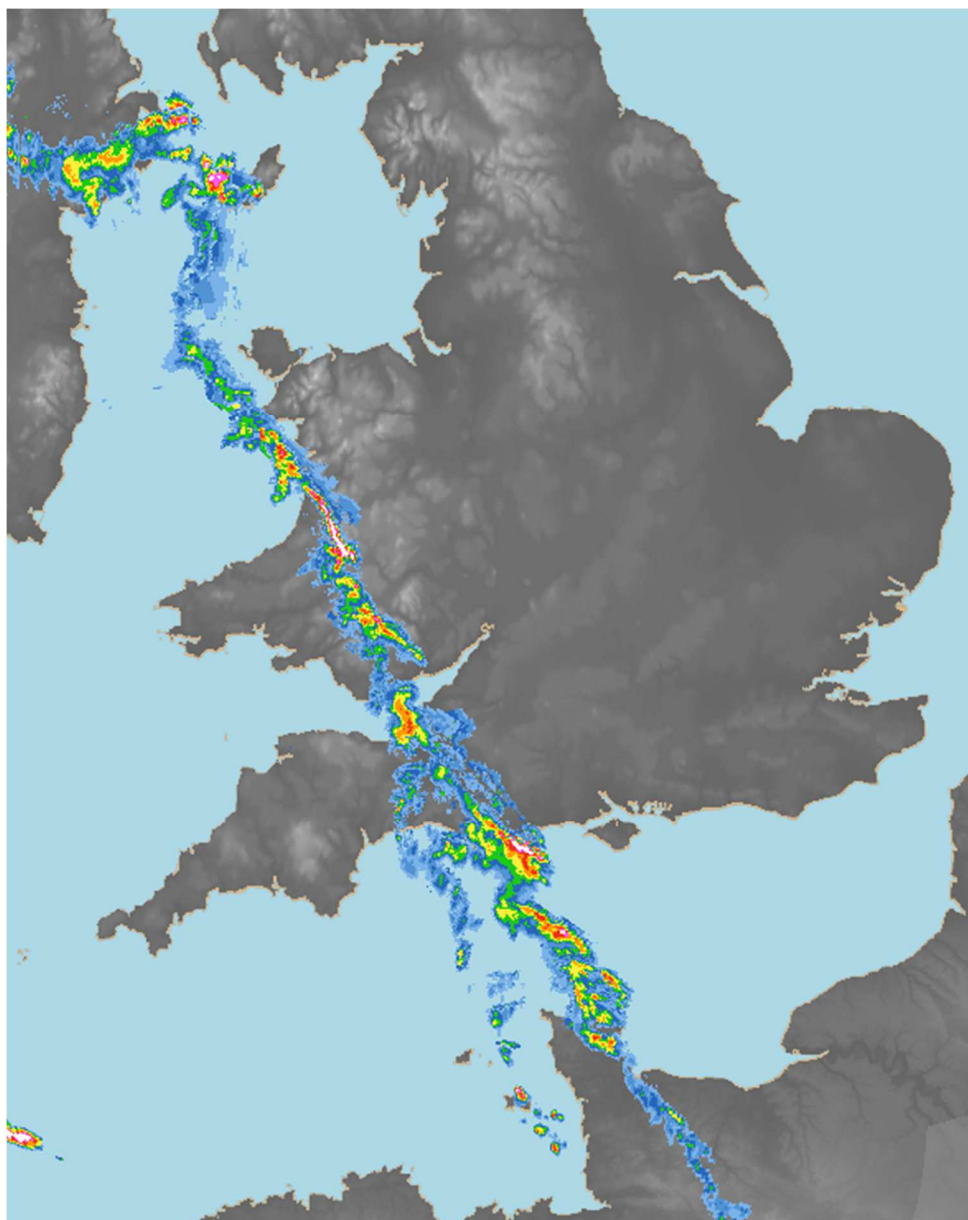
UK weather warnings



The satellite image below on 19 July 2022 shows the cloud-free skies across central and eastern England in a hot, dry airmass. Temperatures soared in mid-summer sunshine, with the relative humidity below 20% in the dry air. Western and northern areas were cloudier with thundery rain at times, associated with a front extending across Wales and south west England. Image copyright Met Office / NOAA / NASA.



The UK rain-radar image at 1330UTC 19 July 2022 shows a band of rain and thunderstorms across south-west England and Wales progressing slowly north-eastwards; the start of a transition to cooler conditions.

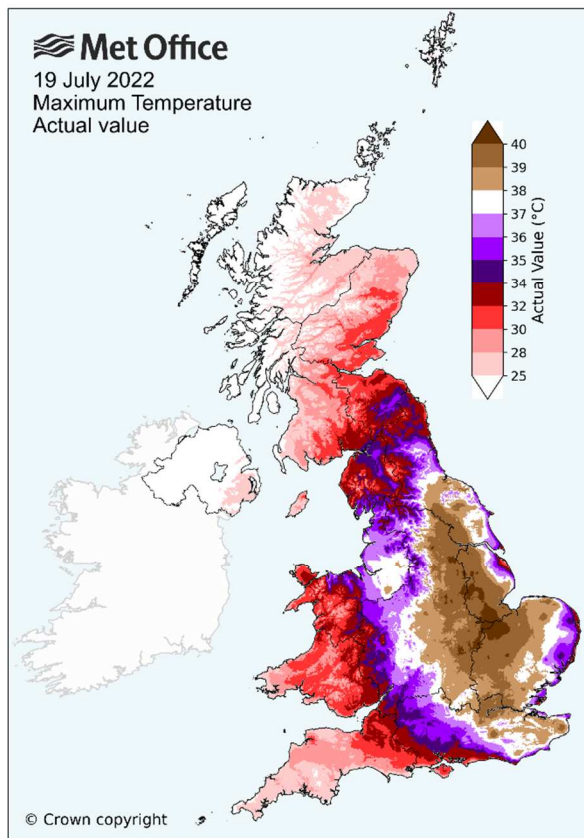
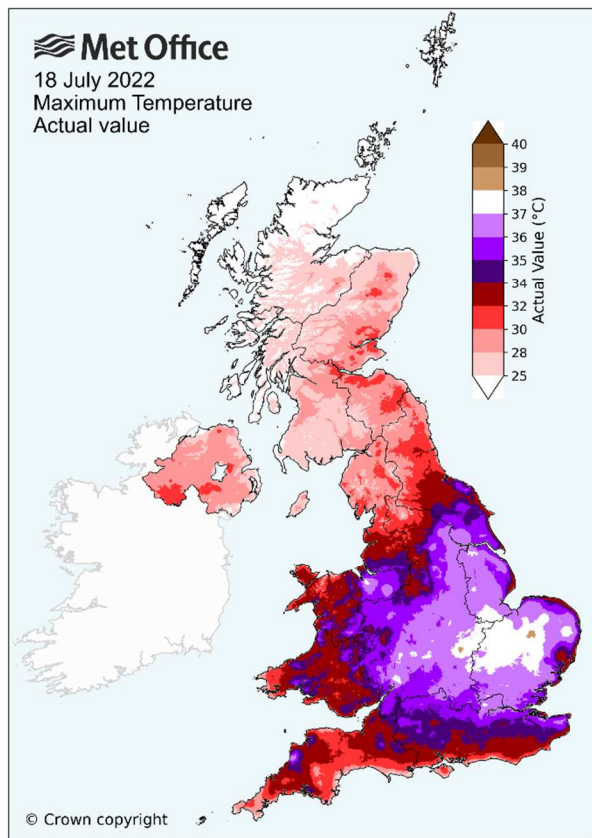


The maps below show daily maximum temperatures on 18 and 19 July 2022, compared to 10 August 2003 and 25 July 2019; these being the four dates in the UK with daily maximum temperatures exceeding 38°C.

Temperatures on 18th July exceeded 35°C widely across central England and east Wales, reaching 36°C to 37°C in some locations, with 37.1°C at Hawarden Airport, Flintshire setting a new Wales record by a margin of 1.9°C. The highest temperature in Northern Ireland (31.2°C) also came within 0.1°C of the national record. The highest temperature on the 18th was 38.2°C at Pitsford (Northamptonshire). Temperatures on this date were broadly comparable with 25 July 2019 (which recorded the previous UK record 38.7°C at Cambridge Botanic Garden) – although the heat extended further west into Wales, south-west England and Northern Ireland on 18 July 2022. On both of these dates the hottest areas were much more extensive than the previous record (10 August 2003) when the heat was confined to the south-east of England.

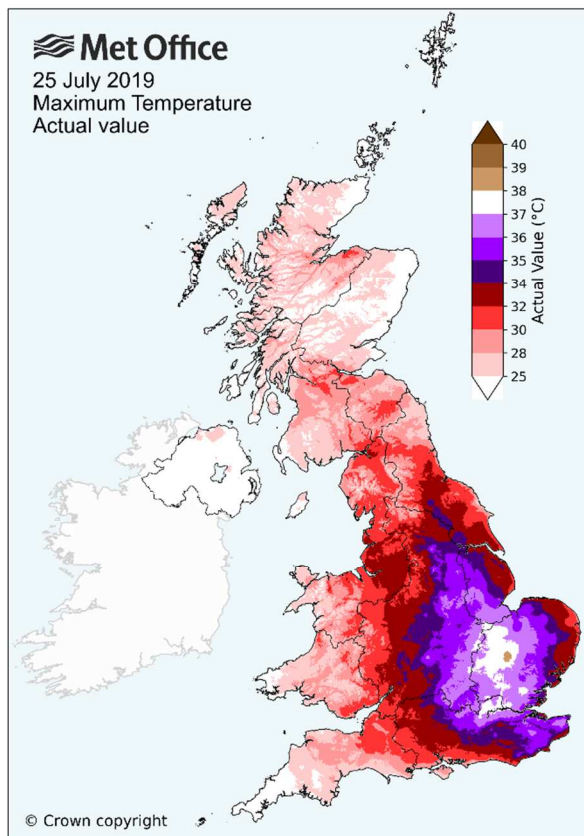
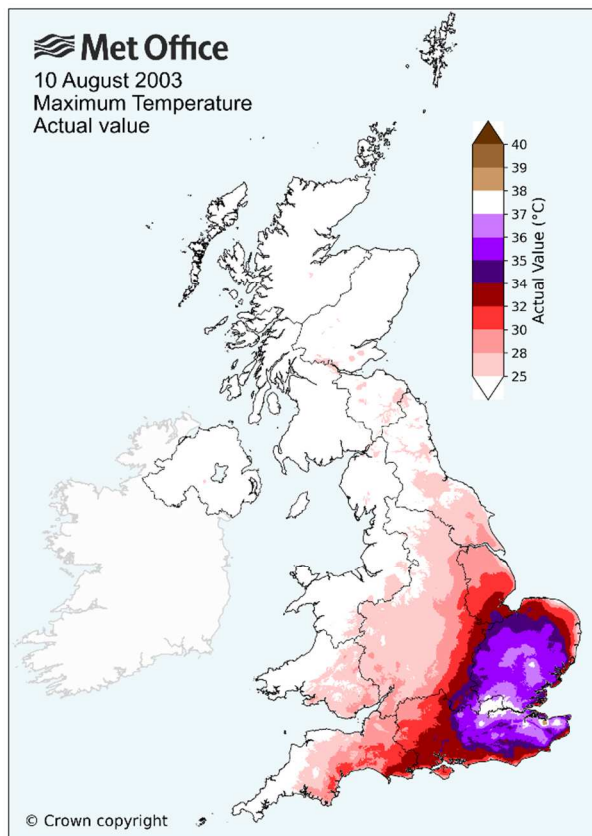
While temperatures on 18th July were exceptional, those of 19th July were typically 2 to 4°C hotter again in eastern areas making this date unprecedented and extraordinary in UK climate history. At

the time of writing, 46 stations met or exceeded the previous national record of 38.7°C, with seven stations at or above 40°C and a further 30 stations at or above 39°C. The hottest areas on these observation maps on 18 and 19 July 2022 align with the red warning extreme heat area issued prior to the event.



38.2°C at Pitsford, Northamptonshire

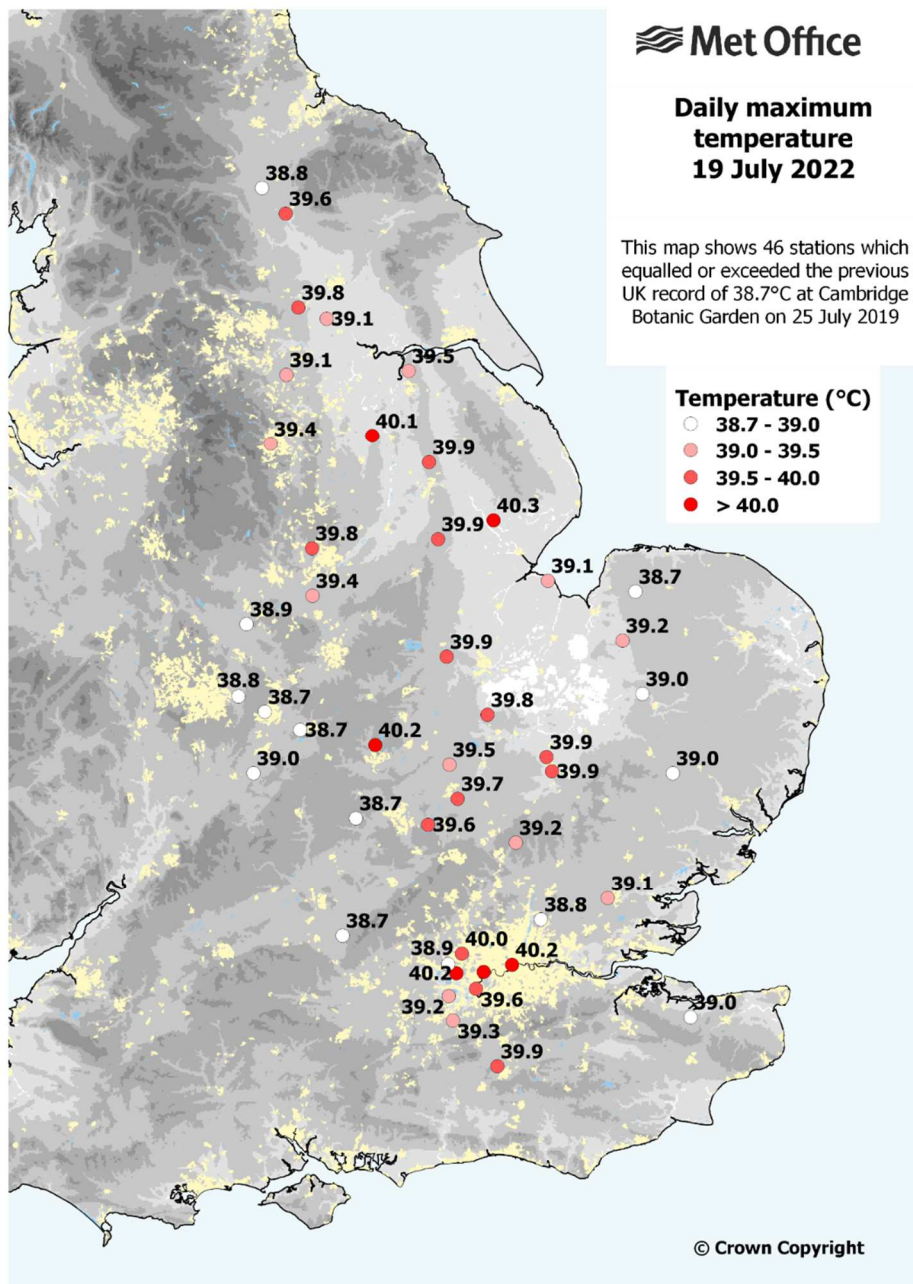
40.3°C at Coningsby, Lincolnshire



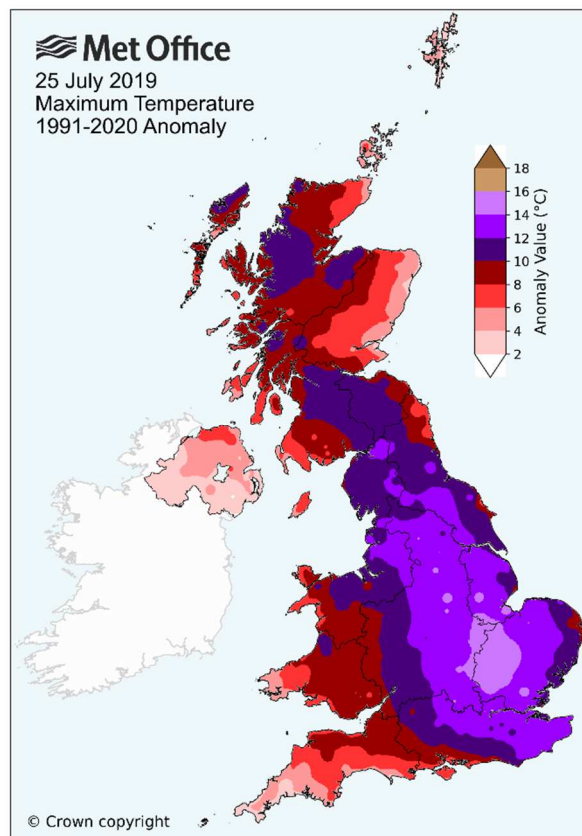
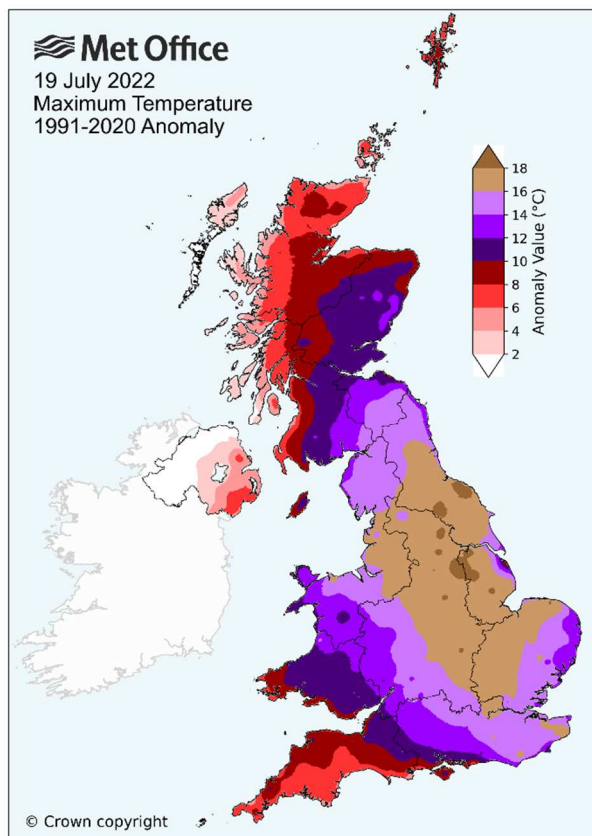
38.5°C at Faversham, Kent

38.7°C at Cambridge Botanic Garden

The map below shows the 46 stations across the UK on 19 July 2022 which exceeded the previous UK record of 38.7°C. Normally records tend to be broken by narrow margins; on this date the record was broken not only by a wide margin (1.6°C) but across an extensive area extending from Kent to North Yorkshire and from Suffolk to Warwickshire.



The map below shows daily maximum temperature anomalies on 19 July 2022 against the 1991-2020 July long-term average. For comparison, 25 July 2019 is also shown. On 19 July, temperature anomalies exceeded 14°C extensively across England and parts of north Wales and southern Scotland, with anomalies of 16°C widely across central and northern England and in some locations 18°C. These represent temperatures of around 39 to 40°C compared to a July 1991-2020 average maximum temperature of around 21 to 22°C that might typically be expected in these areas at this time of year.



The table below lists the highest temperatures recorded at selected individual stations on 19 July. A notable feature of the heatwave was how far north the extreme heat extended, with 39.6°C at Topcliffe, North Yorkshire and 38.4°C at Nantwich, Cheshire. The most northerly station to exceed the previous UK record was Leeming, North Yorkshire (near Northallerton) which recorded 38.8°C.

Station	Temperature (°C)	Previous UK record exceeded by (°C)	Difference from July 1991-2020 long-term average (°C)
Coningsby, Lincolnshire	40.3	1.6	18.1
St James's Park, London	40.2	1.5	16.6
Gringley-on-the-Hill, Nottinghamshire	40.1	1.4	18.5
Charlwood, Surrey	39.9	1.2	16.8
Wittering, Cambridgeshire	39.9	1.2	17.8
Bramham, West Yorkshire	39.8	1.1	18.5
Topcliffe, North Yorkshire	39.6	0.9	18.5
Sheffield, South Yorkshire	39.4	0.7	18.1
Marham, Norfolk	39.2	0.5	16.7
Santon Downham, Suffolk	39.0	0.3	16.1
Faversham, Kent	39.0	0.3	15.9
Wellesbourne, Warwickshire	39.0	0.3	16.2
Coton-in-the-Elms, Derbyshire	38.9	0.2	17.0
High Beach, Essex	38.8	0.1	15.9
Houghton Hall, Norfolk	38.7	0.0	16.9
Coventry, West Midlands	38.7	0.0	16.7
Benson, Oxfordshire	38.7	0.0	15.9

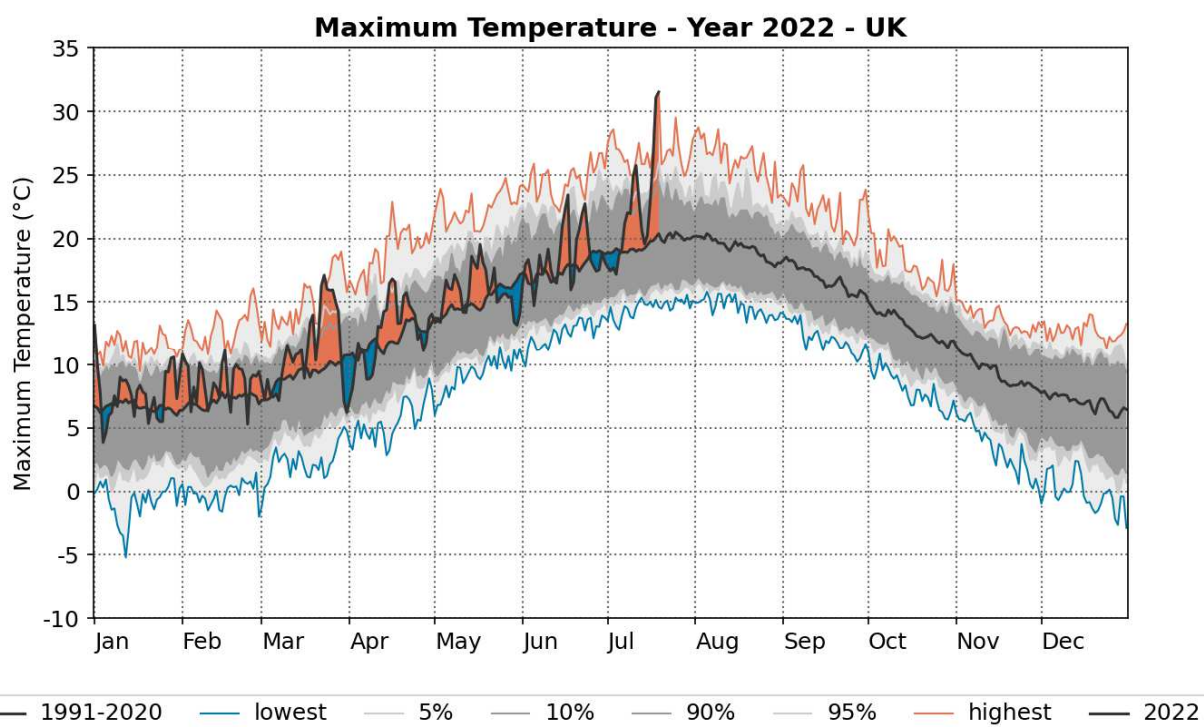
Many long-running stations across the UK network recorded their hottest day on record by extraordinary margins. Selected stations include Durham (36.9°C +4.0°C 155 years), Sheffield 39.4°C +3.8°C 138 years), Bradford (37.9°C +4.0 °C 134 years), Wisley, Surrey (39.3°C, +1.5°C 108 years), Rothamsted, Hertfordshire 38.5°C, +1.9°C 108 years), Eskdalemuir, Dumfries-shire 32.3°C, +2.4°C, 108 years), Cranwell, Lincolnshire (39.9°C +3.3°C 106 years), Woburn, Bedfordshire (39.6°C +2.5°C 105 years), Buxton, Derbyshire (35.9°C, +3.2°C 105 years), and Aberporth, Ceredigion (33.6°C, +0.9°C, 80 years).

The chart below shows UK daily area-average maximum temperatures for the UK for year 2022, and emphasises the extreme nature of this heatwave. 18 and 19 July 2022 were the two hottest days on record when averaged across the whole UK (in a series from 1960), and the UK-average exceeded 30°C for the first time. The second of these graphs illustrates how extreme this heatwave was across northern England in particular.

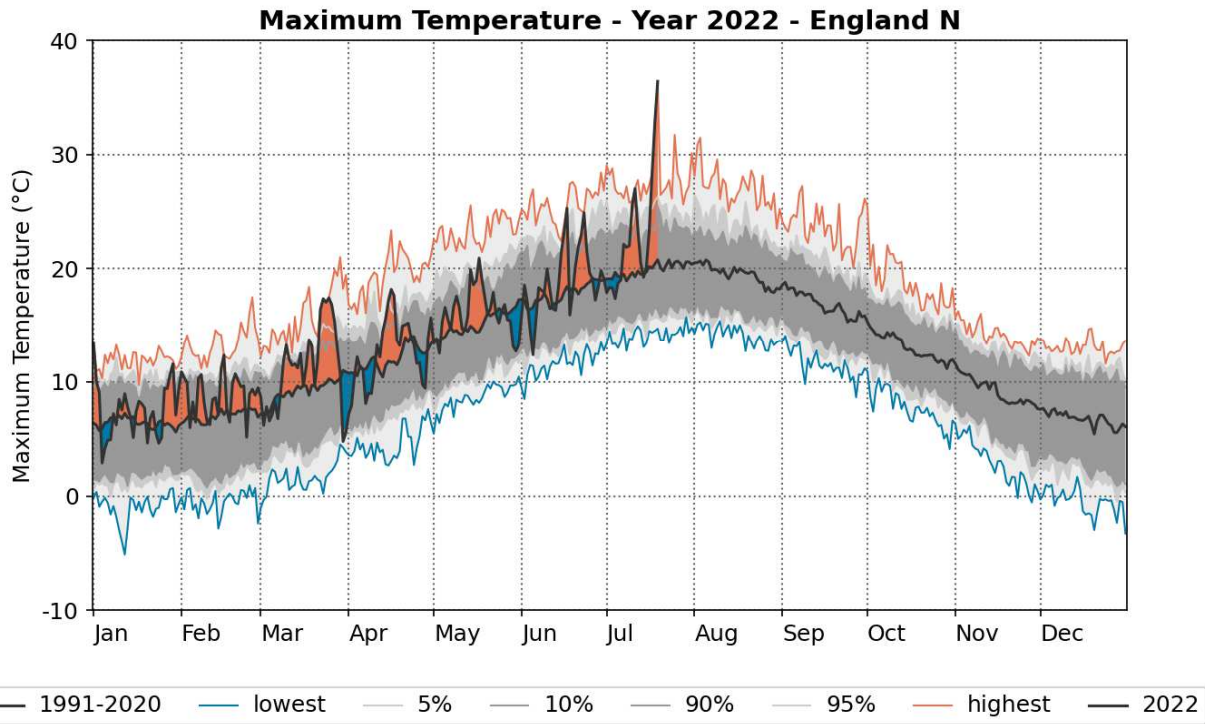


Source: HadUK-Grid 20/07/2022 11:01

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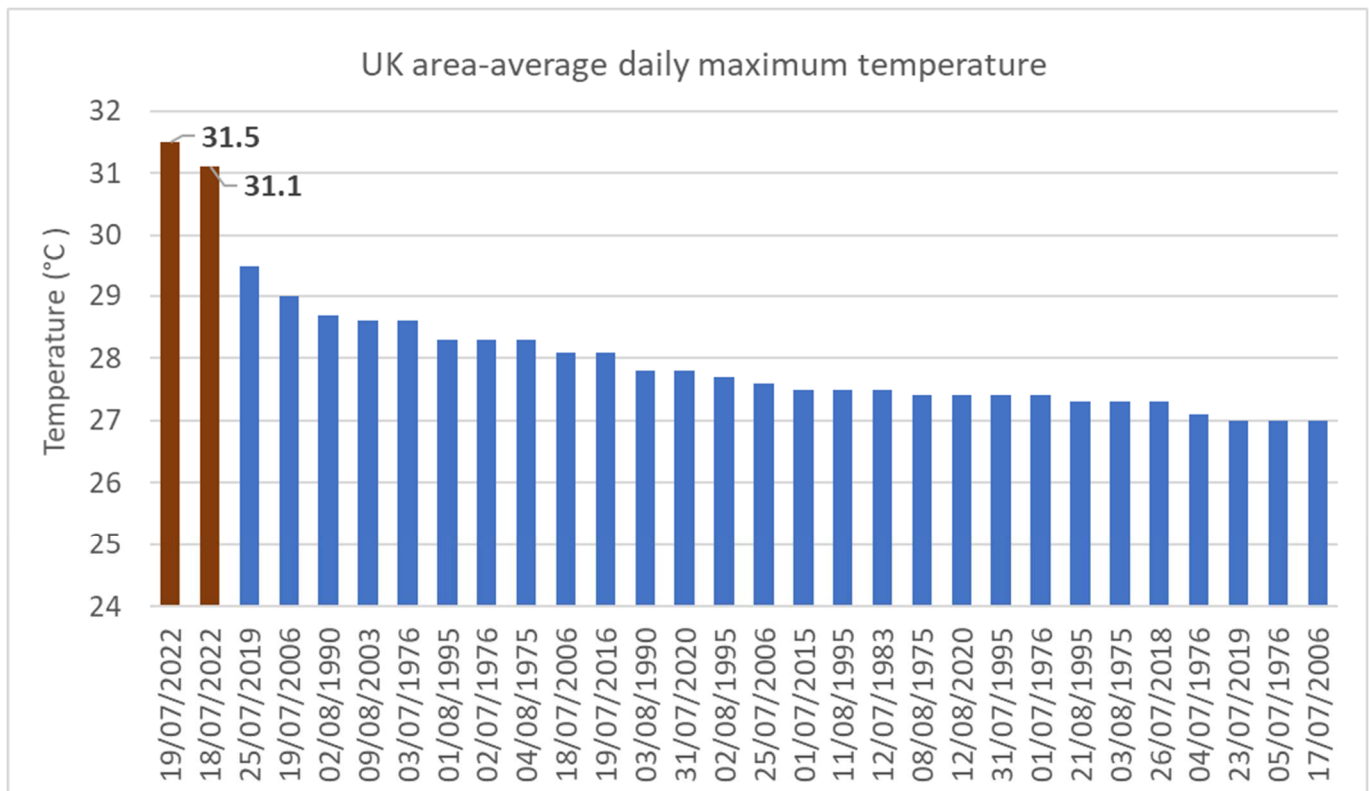


UK area-average daily maximum temperatures for 2022. The graph plots the daily values against the 1991-2020 average for each day and the 5th, 10th, 90th and 95th percentile and extreme values for each day to indicate the historical range of values, based on the series 1960-2022.

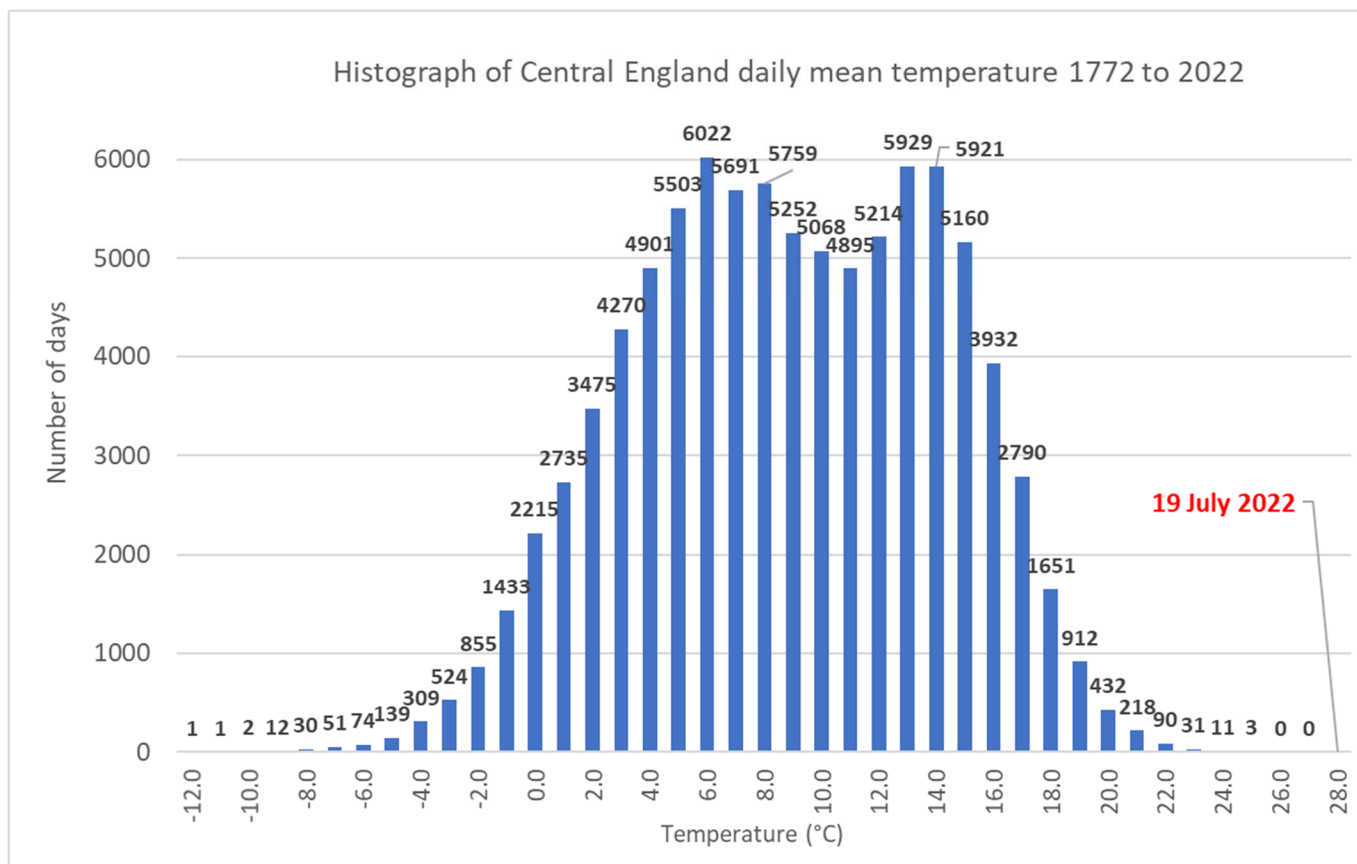


Northern England area-average daily maximum temperatures for 2022. (Graph as above).

The graph below plots the UK's 30 hottest days on record in a series from 1960 (for UK area-average daily maximum temperature). 18 and 19 July were the UK's hottest days on record with the average maximum temperature exceeding 30°C for the first time. The average maximum temperature on 19 July 2022 was 2°C hotter than the previous maximum of 29.5°C on 25 July 2019 – a huge margin. Of note is that 14 of these 30 dates have occurred since 2003. This chart includes five dates in summer 1976 which was less intense than that of 2022, although it was a prolonged heatwave.



The chart below shows a histogram of daily mean Central England Temperature (CET), 1772 to 2022. The daily mean CET for 19 July 2022 was 28.1°C making this the warmest day in this series with a margin of 2.8°C from the next warmest (25.9°C on 25 July 2019); an exceptional outlier in this 250 year series.



The tables below list UK, national and regional records broken in July 2022. What is most exceptional is the number of records broken during this event, and the margin by which they were broken, with previous records for the Midlands and NW England exceeded by over 3°C and England E & NE exceeded by 4°C.

National records for maximum temperature

Record	Station	Temperature (°C)	Date	Previous record (°C)	Previous station	Previous date	Margin (°C)
UK	Coningsby, Lincolnshire	40.3	19 July 2022	38.7	Cambridge Botanic Garden	25 July 2019	1.6
England	Coningsby, Lincolnshire	40.3	19 July 2022	38.7	Cambridge Botanic Garden	25 July 2019	1.6
Wales	Hawarden Airport, Flintshire	37.1	18 July 2022	35.2	Hawarden Bridge, Flintshire	2 August 1990	1.9
Scotland	Charterhall, Borders	34.8	19 July 2022	32.9	Greycrook, Borders	9 August 2003	1.9

Regional records for maximum temperature

Record	Station	Temperature (°C)	Date	Previous record (°C)	Previous station	Previous date	Margin (°C)
England E & NE	Coningsby, Lincolnshire	40.3	19 July 2022	36.3	Cranwell, Lincolnshire	25 July 2019	4.0

England NW	Nantwich, Cheshire	38.4	19 July 2022	34.6	Nantwich, Cheshire	3 August 1990	3.8
N Wales	Hawarden Airport, Flintshire	37.1	18 July 2022	35.2	Hawarden Bridge, Flintshire	2 August 1990	1.9
Midlands	Pitsford, Northamptonshire	40.2	19 July 2022	37.1	Cheltenham, Gloucestershire	3 August 1990	3.1
East Anglia	Cambridge, NIAB	39.9	19 July 2022	38.7	Cambridge Botanic Garden	25 July 2019	1.2
England SW	Bude, Cornwall	36.0	18 July 2022	35.4	Saunton Sands, Devon	3 August 1990	0.6
S Wales	Gogerddan, Ceredigion	35.8	18 July 2022	34.6	Crossway, Gwent	3 August 1990	1.2
England SE & Central S	Heathrow and St James's Park, London	40.2	19 July 2022	38.5	Faversham, Kent	10 August 2003	1.7

National records for minimum temperature

Record	Station	Temperature (°C)	Date	Previous record (°C)	Previous station	Previous date	Margin (°C)
UK	Kenley Airfield, Greater London	25.8	19 July 2022	23.9	Brighton, East Sussex	3 August 1990	1.9
England	Kenley Airfield, Greater London	25.8	19 July 2022	23.9	Brighton, East Sussex	3 August 1990	1.9
Wales	Aberporth, Ceredigion	24.5	19 July 2022	22.2	Swansea, Victoria Park, West Glamorgan	29 July 1948	2.3

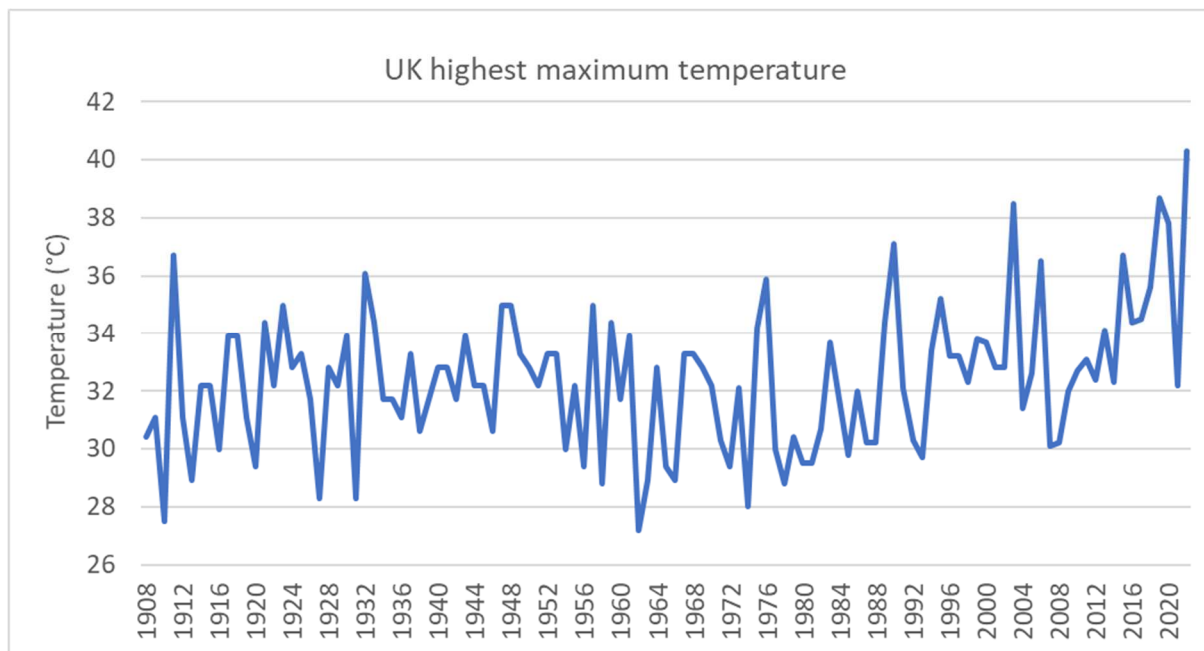
The UK national record of 36.7°C (98°F) at Raunds, Northamptonshire, set on 9 August 1911 stood for almost 80 years until it was broken by a reading of 37.1°C at Cheltenham, Gloucestershire on 3 August 1990. This was broken again with 38.5°C at Faversham, Kent on 10 August 2003, which in turn was broken by 38.7°C at Cambridge Botanic Garden on 25 July 2019, and then 40.3°C at Coningsby, Lincolnshire on 19 July 2022. So, in contrast to the record being unbroken for almost 80 years during the last century, it has now been broken three times this century so far.

The table below lists the UK's 10 hottest days on record, of which seven have occurred this century and five within the last decade.

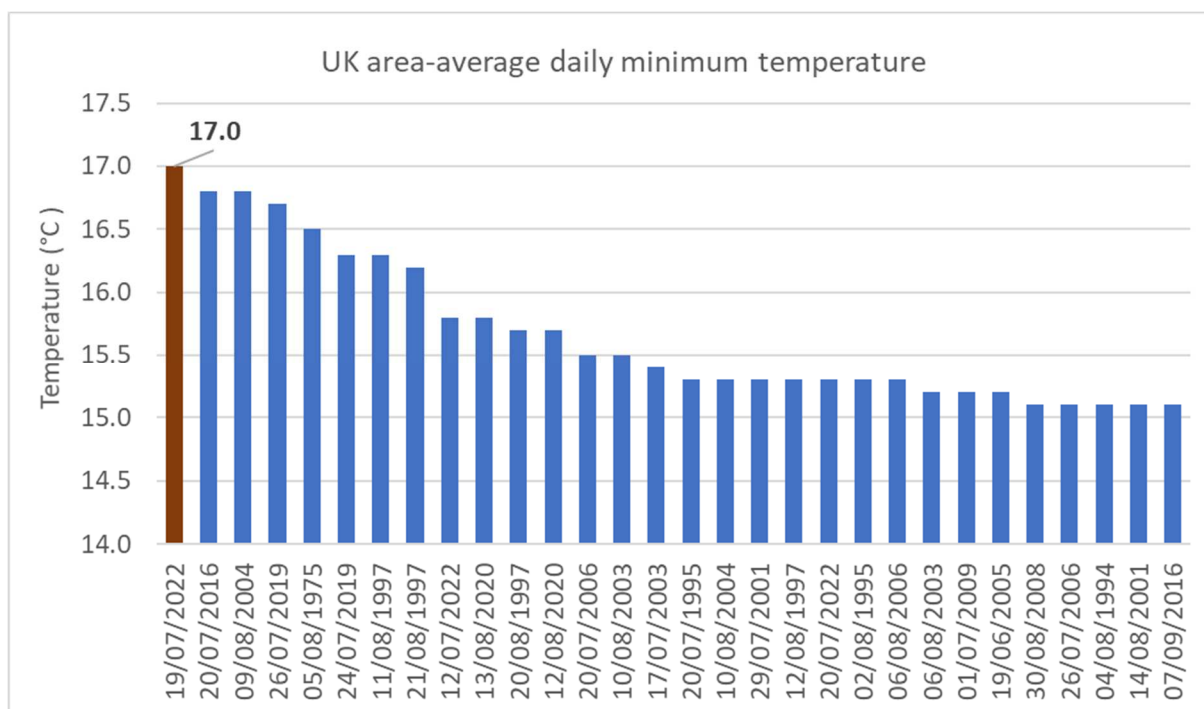
Station	Temperature (°C)	Date
Coningsby, Lincolnshire	40.3*	19 July 2022
Cambridge Botanic Garden	38.7	25 July 2019
Faversham, Kent	38.5	10 August 2003
Pitsford, Northamptonshire	38.2*	18 July 2022
Heathrow, London	37.8	31 July 2020
Cheltenham, Gloucestershire	37.1	3 August 1990
Heathrow, London	36.7	1 July 2015
Raunds, Northamptonshire	36.7	9 August 1911
Worcester, Worcestershire	36.6	2 August 1990
Wisley, Surrey	36.5	19 July 2006

*Provisional records at time of writing as quality assurance and data collection is ongoing

The time-series below shows the highest maximum temperature recorded in the UK by year from 1908. This does not account for variations in the number or distribution of observing stations through time, but the highest temperature risen from a 1961-1990 average of 31.4°C to a 1991-2020 average of 33.5°C, and for the most recent decade 2013-2022 is 35.7°C. This indicates that the temperature of the hottest day of the year has increased much more than the mean temperature.

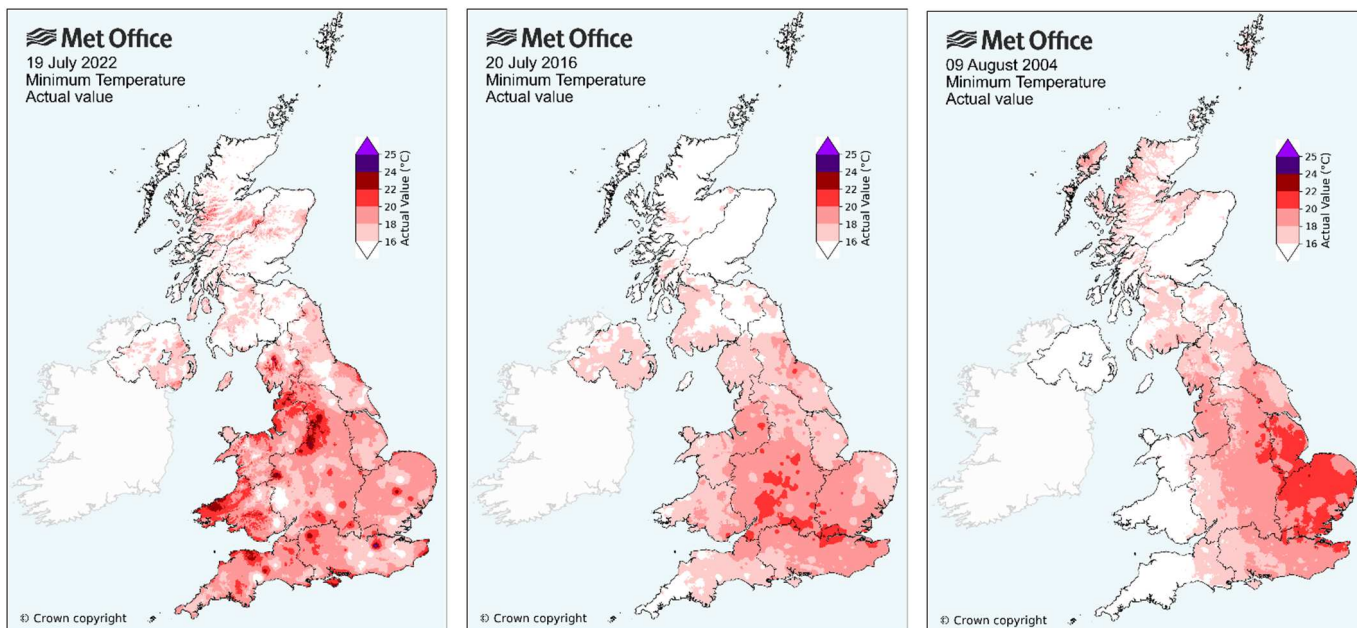


Daily minimum temperatures on 19 July 2022 were also exceptionally high, with over 60 stations recording a 'tropical night' – which is defined as a 24 hour period with temperatures remaining above 20°C. New daily minimum temperature records were set for the UK, England, Wales and Scotland as listed in the table above. The graph below plots the 30 days with the UK's highest area-average daily minimum temperature.

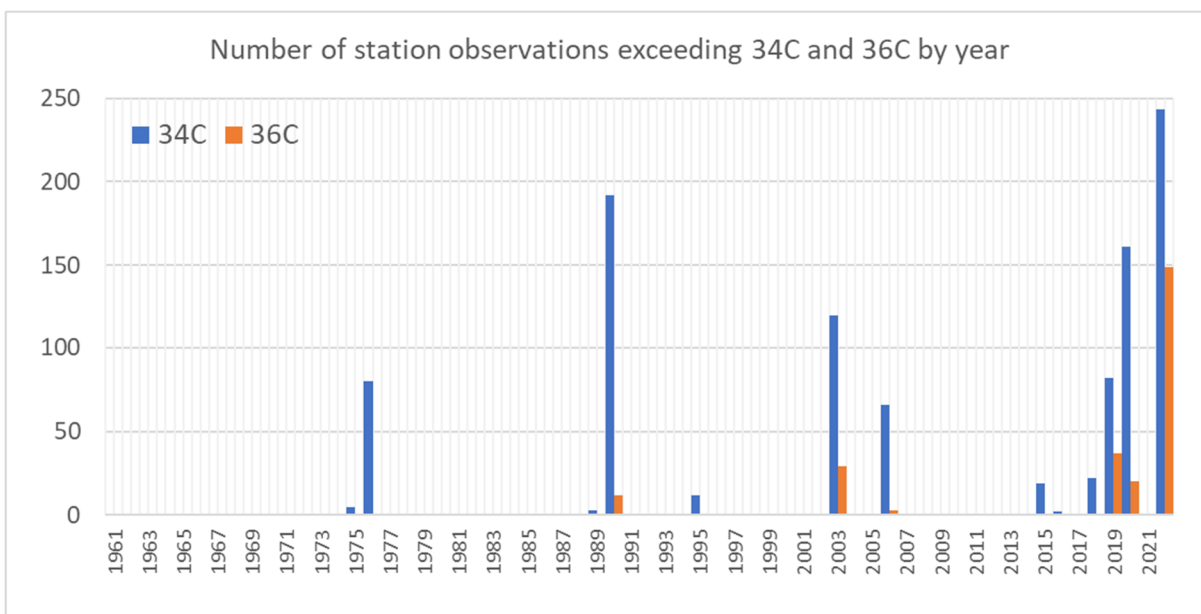
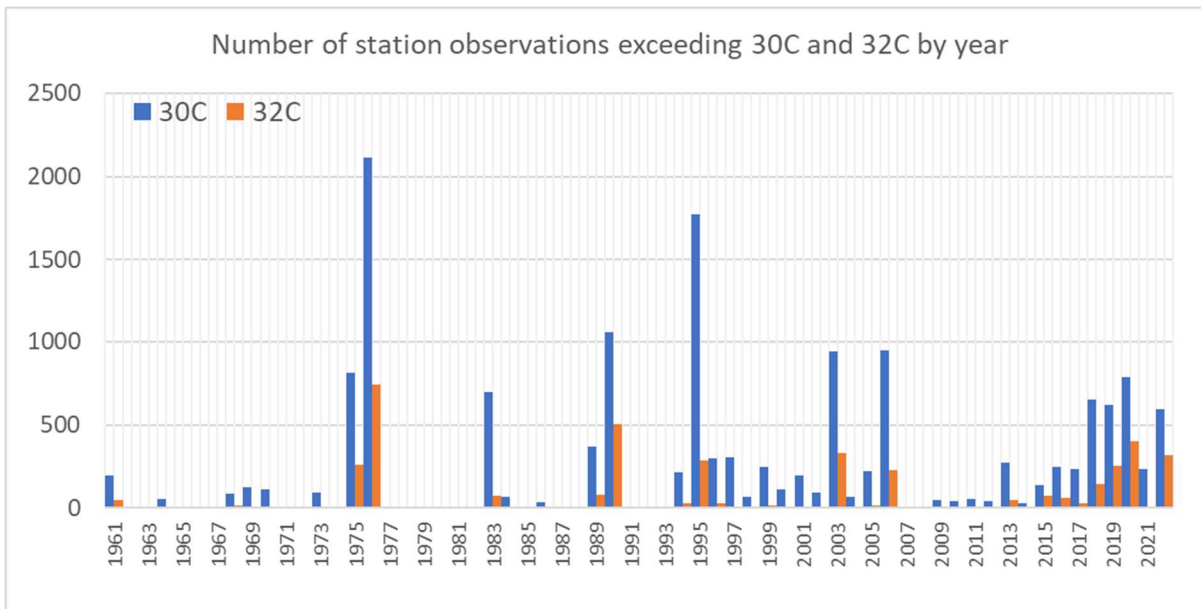


The map below compares daily minimum temperatures across the UK on 19 July 2022 against 20 July 2016 and 9 August 2004. On 19 July 2022, daily minimum temperatures were above 18°C widely across England and Wales, across a larger area than either of the other dates, however the

map shows the very patchy nature of temperatures exceeding 20°C. In contrast, there was a much more coherent pattern on 9 August 2004 of temperatures exceeding 20°C across East Anglia. There was some unusual meteorology occurring overnight 18 to 19 July 2022 with an inversion effect and higher temperatures at stations with higher elevations (for example 24.6°C at Emley Moor, West Yorkshire (259masl) and 23.0°C at Dunkeswell Aerodrome, Devon (252masl)) but daily minimum temperatures of 15°C in some nearby locations at lower elevations.



The graphs below provide a count, by year, of the number of station observations in the UK from 1961 which have exceeded 30°C, 32°C, 34°C and 36°C. These graphs illustrate both the large annual variability in the UK's climate (i.e. showing the years in which heatwaves happen to occur) but also the changing nature of the UK's climate. The first graph illustrates the prolonged and widespread nature of the heatwave of summer 1976, with over 2000 station observations exceeding 30°C during this event; and there were also significant heatwaves in the summers of 1995, 2003 and 2006. However, in the 1960s and 1970s there were a significant number of years where 30°C was not reached anywhere in the UK, whereas in contrast the last year when 30°C was not exceeded in the UK was 1993. In contrast, far fewer stations exceeded 34°C in the 1976 heatwave compared to recent events, and with 36°C in the UK exceeded during four years in the last decade compared to only three of the previous 50 years (1990, 2003 and 2006). The last five years have seen more than four times as many observations exceeding 36°C compared to the rest of the series.



This report is mainly based on data available at time of writing (03/08/2022). It was updated on 20/09/2022 to remove references to 35.1°C at Floors Castle and 21.3°C at Nunraw Abbey which did not pass subsequent verification checks.

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