

# The record-breaking heat and sunshine of July 2006

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Sustained warmth and prolonged sunshine resulted in July 2006 being the warmest month on record over much of the UK and the sunniest on record over parts of England. Many station and areal records were broken, mainly for July but in some cases for any month. Notably, it was the warmest calendar month yet recorded in the Central England Temperature (CET) series, which commenced in 1659. The numerous warm, sunny days were associated with anomalously high pressure over northern Europe and a persistent southerly airstream over the UK. The heat and sunshine placed strains on water and energy utilities, road and rail transport and the health and fire services but benefitted the tourist industry, food and drink retailers and, to some extent, farmers and growers.

## Weather summary

The first four days of July saw weather that was to recur on many days later in the month, especially across England and Wales. Each day maximum temperatures exceeded 28°C widely across England and Wales, with 30–32°C in southern England and the Midlands, and over 10 hours of bright sunshine was recorded, with 12–14 hours in some eastern and southern areas of England. On the 5th and 6th, as thundery rain affected the southern half of the UK, it was the turn of the north to experience warm weather with temperatures over 26°C widely. The next few days saw more changeable conditions with near normal temperatures, before England again turned warmer and sunnier on the 11th and 12th.

Anticyclonic weather became firmly established over the UK and the North Sea from the 13th, bringing increasingly warm air from the east or south-east with little or no cloud. This middle part of the month saw the sunniest and warmest weather. Sunshine totals of 14–15 hours were recorded

widely each day from the 11th to the 19th, especially over England and Wales. By the 16th, temperatures were approaching 30°C over much of England and Wales and continued to climb across the UK each day, exceeding 35°C in places on the 19th (Figures 1a and 1b) when new UK and Welsh temperature records for July were set. The surface synoptic situation on the 19th is shown on p. 189 of this issue (Figure 3 of Galvin (2007)).

The value of 36.5°C recorded at Wisley, Surrey, on the 19th overturned the UK record for July of 35.9°C set on 3 July 1976 at Cheltenham, Glos (Shaw, 1977).<sup>1</sup> Other high maximum temperatures included 36.3°C at

<sup>1</sup> 36.0°C was recorded at Epsom, Surrey, on 22 July 1911, but there is doubt about the validity of this value as the thermometer screen may have been a Glaisher stand (Burt, 1992). The Wisley value was recorded in a Stevenson screen using a temperature sensor that had been calibrated in April 2006 and the check manual maximum thermometer in the same screen read 36.3°C.

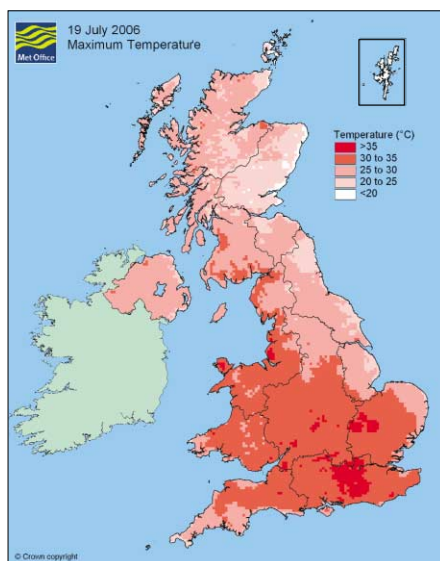


Figure 1a. Maximum temperatures on 19 July 2006.

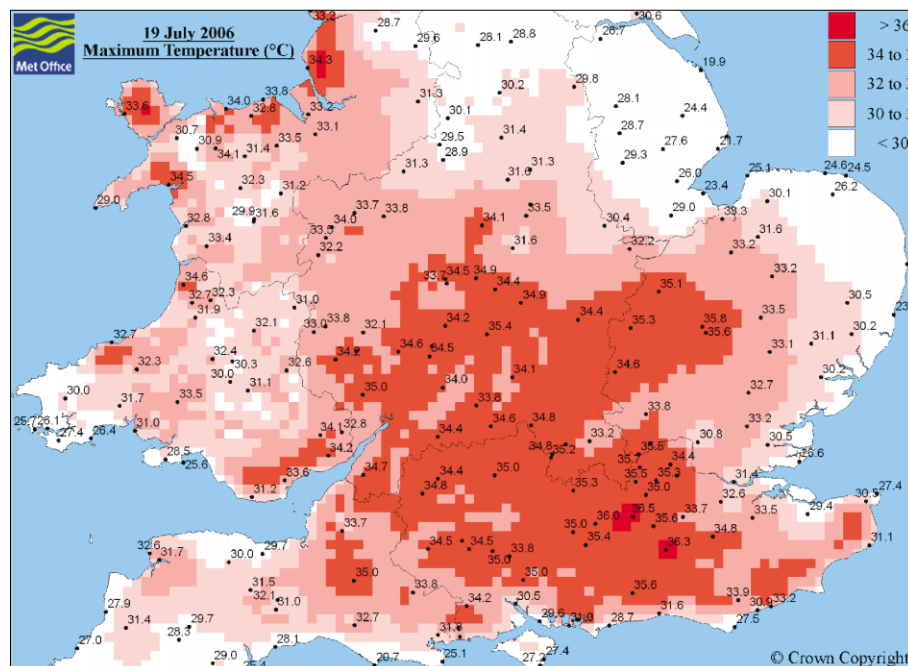


Figure 1b. Maximum temperatures on 19 July 2006 showing plotted values.

Charlwood, Surrey, and 36.0 °C at South Farnborough, Hampshire. The maximum of 35.5 °C at Heathrow on the 19th made it the hottest July day there since records began in 1948. In Wales, 34.6 °C was achieved at Gogerddan, Ceredigion, 34.5 °C at Porthmadog, Gwynedd, and 34.2 °C at Penhow, Monmouthshire, all exceeding the previous Welsh July record of 33.6 °C set at Usk, Monmouthshire, on 3 July 1976. In Scotland no national records were broken on the 19th, the warmest place being Prestwick, Ayrshire, at 31.3 °C, short of the July record of 32.8 °C measured at Dumfries on 2 July 1908. Similarly, in Northern Ireland the 30.3 °C achieved at Peatlands, County Armagh, was just below the 30.8 °C at Shaw's Bridge, Belfast, on 12 July 1983 (the any month record, equalled at Knockarevan, County Fermanagh, on 30 June 1976). Figure 2 shows the locations of weather stations referred to in this paper.

During this third week, maximum air temperature records, for either any month or July, were broken at stations in most areas of the UK. A selection of the long-standing records that were broken is given in Table 1. There were also some warm nights, especially between the 19th and the 26th, and minimum temperatures above 20 °C were recorded across southern England and East Anglia, particularly at urban and coastal sites. The highest 24-hour minimum temperature was 23.2 °C at Guernsey airport overnight on 18/19 July setting a new station record, the previous being 22.9 °C on



Figure 2. Location of places named in the text.

Table 1

Maximum temperatures in July 2006 for a selection of long period stations, compared with historical records.

Station	Highest temperature (°C) / Date	Earliest year for records	Ranking of highest temperature	Current or previous any month record (°C)/Date
Wisley, Surrey	36.5 / 19th	1904	2	37.8 / 10 August 2003
Cambridge Botanic Garden	35.6 / 19th	1904	=4	36.9 / 10 August 2003
Heathrow, Greater London	35.5 / 19th	1948	3	37.9 / 10 August 2003
Alice Holt Lodge, Hampshire	35.4 / 19th	1950	1	35.1 / 10 August 2003
Oxford	34.8 / 19th	1881	=3	35.1 / 3 August 1990
Gogerddan, Ceredigion	34.6 / 19th	1956	1	32.8 / 2 August 1990
Boscombe Down, Wiltshire	34.5 / 19th	1931	1	34.2 / 3 August 1990
Usk, Monmouthshire	34.1 / 19th	1924	1	33.6 / 3 July 1976
Valley, Anglesey	33.6 / 19th	1931	1	33.0 / 5 August 2003
Hastings, East Sussex	33.2 / 19th	1931	1	32.3 / 27 June 1976
Aberporth, Ceredigion	32.7 / 19th	1942	1	31.8 / 2 August 1995
Auchincruive, Ayrshire	30.7 / 19th	1932	1	30.6 / 29 July 1948
Buxton, Derbyshire	30.1 / 19th	1908 <sup>a</sup>	4	32.7 / 3 August 1990
Dyce, Aberdeen	29.8 / 17th	1943	1	29.7 / 21 August 1995
Lough Navar Forest, Co. Fermanagh	29.8 / 19th	1962	1	28.8 / 30 June 1976
Kielder Castle, Northumberland	29.7 / 18th	1951	2	30.0 / 9 August 2003
Helens Bay, Co. Down	28.4 / 17th	1961	2	28.8 / 29 June 1995

<sup>a</sup> Monthly Weather Reports back to 1908.

2/3 August 1990, 4/5 August 2003 and 9/10 August 2003.

Thundery troughs moved in from the south and south-west on the 20th, but high temperatures persisted in the eastern half of England with maxima of 30–31 °C each day from the 20th to the 22nd. Anticyclonic weather re-established itself from the 23rd to the 25th, encouraging temperatures to rise again. By the 25th, maxima were typically 26–28 °C over most of Scotland, northern England and Northern Ireland, 30–32 °C over most of the rest of England and Wales and had reached 33.0 °C at Heathrow and Northolt, Greater London. 34.1 °C was recorded at Charlwood, Surrey, on the 25th, making it the day with the second highest daily maximum in July 2006. The 26th saw similar heat, with 33.4 °C at Cambridge Botanic Garden, 33.6 °C at London Met Office (rooftop site, central London) and 34.0 °C at Faversham, Kent. Maxima around 28 °C were achieved widely across England on the 27th and 28th. As the month drew to a close, Atlantic fronts advanced eastwards so temperatures declined but they remained above average in East Anglia and south-east England.

This sequence of weather is reflected in Figure 3, which shows the daily sunshine durations and temperature maxima and minima recorded at the Radcliffe Observatory in Oxford. This shows examples of the significant diurnal temperature ranges that were experienced widely in the third week, reaching over 20 degC in places. Such ranges occurred on three consecutive days, the 17th to the 19th, in rural areas of East Anglia, the Midlands and south-east England including 26 degC (5.3 °C to 31.3 °C) on the 17th and 25.9 degC (5.2 °C to 31.1 °C) on the 18th at Santon Downham, Norfolk. These ranges are ranked sixth and seventh there since 1959, with 28.4 degC being the highest range (8 June 1962).

The highest temperatures recorded in July 2006, which were in the period 16th–29th, are shown in Figure 4. This uses the same presentation as Burt (2004) to enable comparison with previous notable heatwaves.

The weather stations mentioned above form part of the official network, administered by the Met Office. However, a large number of observations are also made at independent weather stations and these are collected and published by the Climatological Observers Link (see, for example, [www.met.rdg.ac.uk/~brugge/colsites.html](http://www.met.rdg.ac.uk/~brugge/colsites.html)). A proportion of these stations is approximately equivalent to the official network, in terms of equipment, observing practice and exposure, and are classed as 'A' grade sites. Among the highest daily temperature maxima recorded in July 2006 from these sites were 36.5 °C at Epsom Downs, Surrey, and 34.9 °C at Llansadwrn, Anglesey, both on the 19th.

The mean sea-level pressure for July 2006

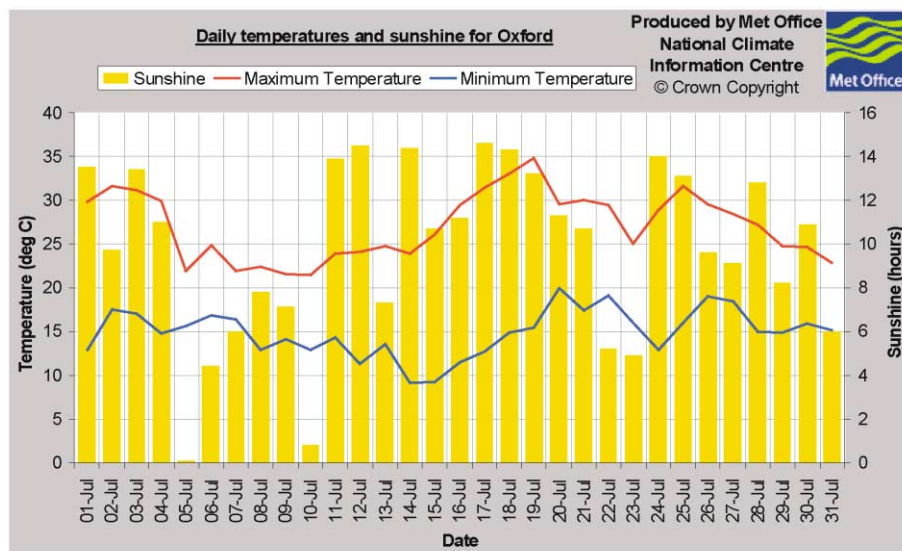


Figure 3. Daily temperatures and sunshine for Oxford in July 2006.

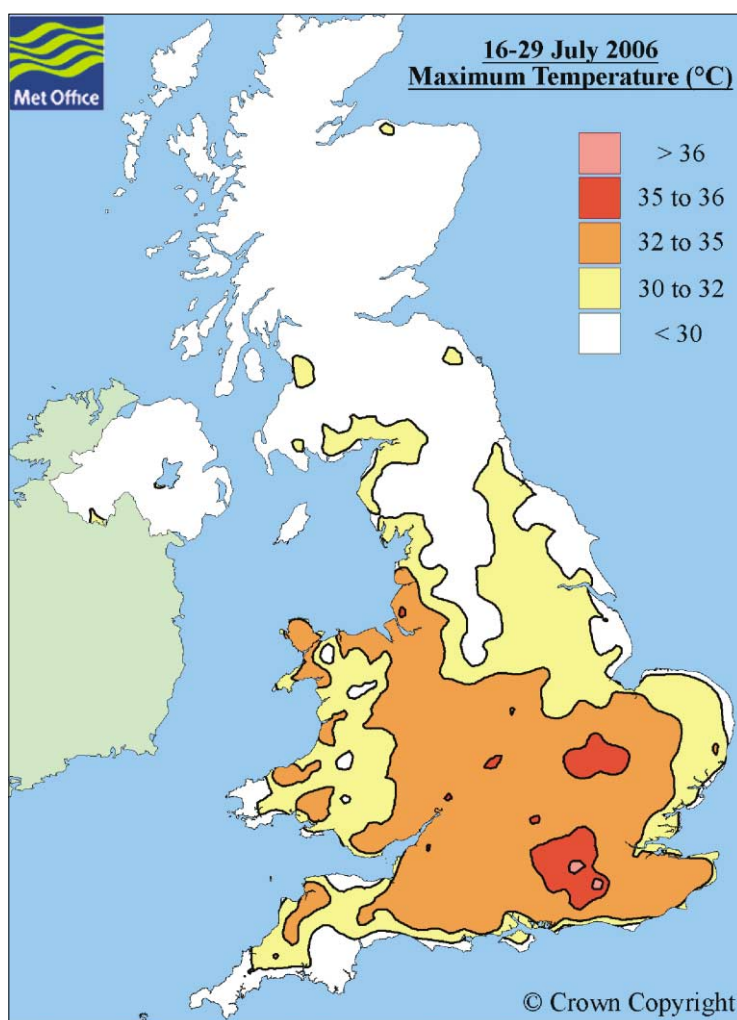


Figure 4. Highest temperature during the notable heatwave, July 2006.

was above normal over most of Europe, with an anomaly of +7 mbar over the southern Baltic, and below normal over much of the North Atlantic, reaching an anomaly of

–7 mbar. Therefore, throughout the month, the surface air flow across the UK was persistently southerly, with a lack of cool airstreams.



## July 2006 in context

Areal values of mean temperature, mean daily maximum temperature, mean daily minimum temperature, sunshine duration and other variables are produced by the Met Office for each month, season and year. These are based upon values at 5 km grid points, estimated using the methods described by Perry and Hollis (2005). The areal values produced include those for the UK, Scotland, Northern Ireland, England, Wales, nine climate districts (e.g. Midlands)

and administrative areas (e.g. counties). These areal values have been calculated from 1914 for temperature and from 1929 for sunshine. Therefore these series may be used to place July 2006 into context, in terms of both an anomaly (relative to an averaging period such as 1961–1990) and a ranking. The results for the temperature variables and sunshine are given in Table 2. These have been calculated following receipt and quality control of all official UK station data and therefore in some cases differ from the provisional values given in

the *Weather log* for July 2006 (*Weather*, 2006).

In terms of mean temperature, July 2006 was the warmest calendar month on record (in the areal series from 1914) over much of the UK, with the east and north-east England climate district exceeding the previous record by the highest margin. The exceptions were westernmost districts where August 1947, July 1983 or August 1995 were warmer (Figure 5).

July 2006 was the warmest July on record (from 1914) over almost all of the UK,

**Table 2**

*Monthly areal values of mean daily maximum temperature, mean daily minimum temperature, mean temperature and sunshine duration in July 2006. The anomalies are with respect to the averaging period 1961–1990. The rankings are in series from 1914 for temperature and from 1929 for sunshine.*

Mean daily maximum temperature						
Region	Actual (°C)	Anomaly (degC)	Rank – July	Comments – previous July values	Rank – any month	Comments – previous any month values
UK	23.3	+4.7	1	22.2 °C in July 1983	1	22.8 °C in August 1947
England	25.2	+5.1	1	24.2 °C in July 1983	1	24.3 °C in August 1995
Wales	23.1	+4.4	=1	Equals July 1983	=2	23.4 °C in August 1995
England & Wales	24.9	+5.0	1	24.0 °C in July 1983	1	24.2 °C in August 1995
Scotland	20.4	+4.1	1	19.8 °C in July 1955	2	20.8 °C in August 1947
Northern Ireland	21.7	+3.8	1	21.4 °C in July 1983	3	22.1 °C in August 1995 and 22.0 °C in August 1947
Mean daily minimum temperature						
Region	Actual (°C)	Anomaly (degC)	Rank – July	Comments – previous July values	Rank – any month	Comments – previous any month values
UK	12.5	+2.2	1	12.1 °C in July 2003	2	12.7 °C in August 1997
England	13.5	+2.5	1	13.1 °C in July 1983	2	13.8 °C in August 1997
Wales	12.6	+2.1	=1	Equals July 1983	=2	13.1 °C in August 1997
England & Wales	13.3	+2.4	1	13.0 °C in July 1983	2	13.7 °C in August 1997
Scotland	11.0	+2.1	=3	11.1 °C in July 1933 and July 2003, 11.0 °C in July 1991	=3	11.0 °C in August 1997 and August 2004
Northern Ireland	11.7	+1.5	=5	—	=9	—
Mean temperature						
Region	Actual (°C)	Anomaly (degC)	Rank – July	Comments – previous July values	Rank – any month	Comments – previous any month values
UK	17.8	+3.4	1	17.3 °C in July 1983	1	17.3 °C in July 1983 and August 1995
England	19.3	+3.8	1	18.7 °C in July 1983	1	18.7 °C in July 1983
Wales	17.8	+3.2	2	18.1 °C in July 1983	3	18.0 °C in August 1995
England & Wales	19.1	+3.7	1	18.6 °C in July 1983	1	18.6 °C in July 1983
Scotland	15.6	+3.1	1	15.0 °C in July 1983	1	15.4 °C in August 1947
Northern Ireland	16.7	+2.7	1	16.5 °C in July 1983	2	17.1 °C in August 1995
Sunshine duration						
Region	Actual (°C)	Anomaly (%)	Rank – July	Comments – previous July values	Rank – any month	Comments – previous any month values
UK	253.3	152	2	256.1 hours in July 1955	6	—
England	291.8	158	1	262.6 hours in July 1989	1 <sup>a</sup>	284.3 hours in June 1957
Wales	261.0	149	3	297.5 hours in July 1955 and 268.1 hours in July 1940	7	—
England & Wales	287.6	157	1	265.0 hours in July 1955	1 <sup>a</sup>	284.6 hours in June 1957
Scotland	195.4	138	4	—	39	—
Northern Ireland	207.9	149	4	—	34	—

<sup>a</sup> The ranking is on the basis of monthly totals but if hours/day is used then the June 1957 values of 9.48 hours/day for England and 9.49 hours/day for England & Wales exceed those for July 2006 (9.41 hours/day and 9.28 hours/day respectively).

notably over East Anglia where the mean temperature of 20.5°C was 1.4 degC above the previous warmest (July 1995). The exception was the south-west England and south Wales district (mean temperature 18.4°C), which was warmer in July 1983 (19.0°C).

The sunshine total for July 2006 was the highest on record (in the areal series from 1929) over England, surpassing June 1957. The sunniest district compared to the 1961–1990 average was east and north-east England, centred on Yorkshire, with over 180%. This district's areal value of 294.9 hours exceeded those of June 1940 (279.0 hours) and July 1976 (258.6 hours) by some margin. The distribution of sunshine duration in July 2006 is shown in Figure 6, with values exceeding 325 hours close to the south coast, from Poole Harbour eastwards to Thanet. Shanklin, on the Isle of Wight, recorded the highest sunshine total (340.4 hours<sup>2</sup>), making it the second-sunniest July there behind 1959 when 345.1 hours were recorded. Other high totals included 340 hours at Hastings and 335.3 hours at Eastbourne, but these fall short of the 384 hours recorded at these sites in July 1911. To find long-standing July station records being broken, attention has to turn to sites further north in England. Examples for July include:

- (i) 290.8 hours at Sheffield, where records began in 1898, the next highest July value being 285.2 hours in 1976,
- (ii) 304.5 hours at Waddington, Lincolnshire, with records from 1947, the next highest July value being 276 hours in 1976,
- (iii) 306.4 hours at Morpeth (Cockle Park), Northumberland, with records from 1898, the next highest July value being 252.5 hours in 1955,
- (iv) 313.9 hours at High Mowthorpe, North Yorkshire, with records from 1952, the next highest July value being 283 hours in 1955.

The estimation of 5 km grid point values also enables contoured anomaly maps to be produced. The monthly anomaly maps for daily mean, maximum and minimum temperature in July 2006 are shown in Figures 7–9, and that for sunshine duration in Figure 10.

## Central England Temperatures

The CET series is representative of an area from the south Midlands to Lancashire. The

<sup>2</sup> All station sunshine durations quoted have been measured using the Campbell–Stokes sunshine recorder; any automatic sunshine data used in areal calculations for July 2006 have been adjusted to give Campbell–Stokes equivalents, using the factors given in Kerr and Tabony (2004).

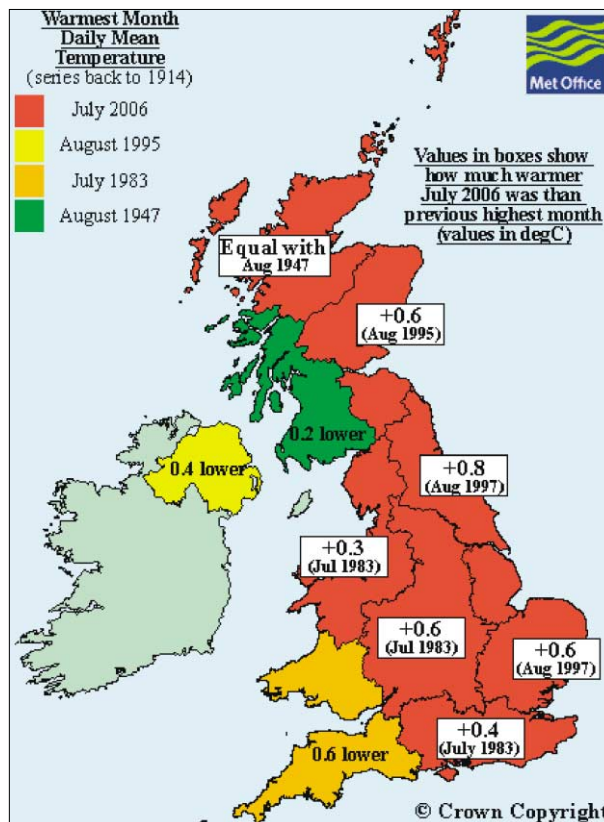


Figure 5. Warmest calendar month for climate districts using series back to 1914.

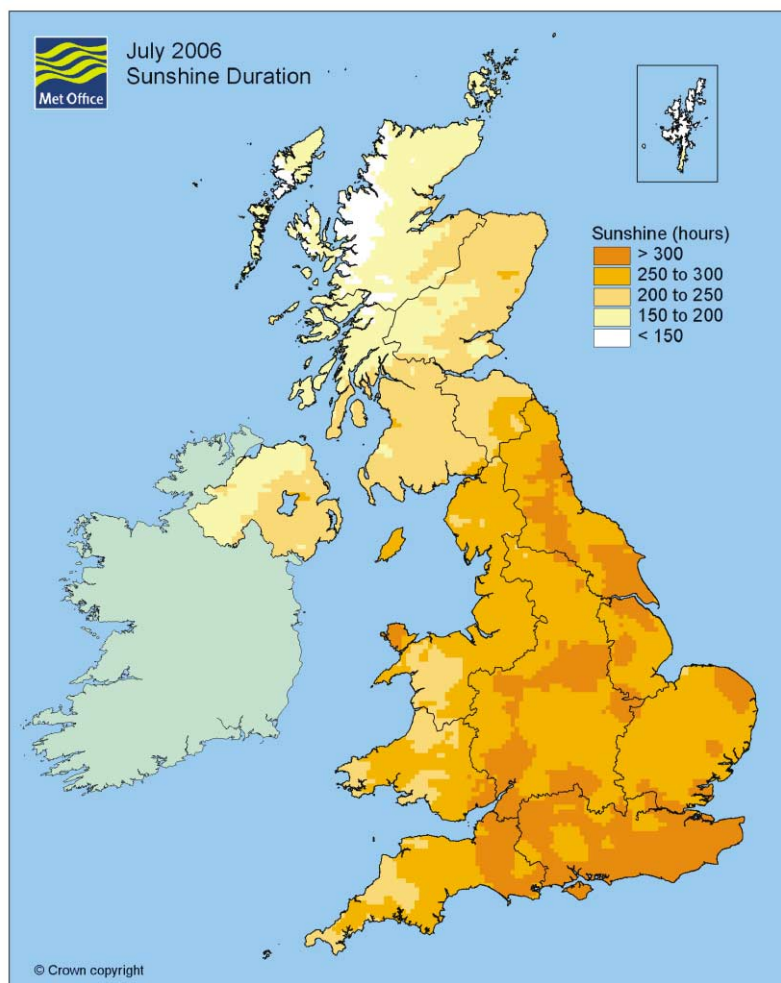


Figure 6. Actual sunshine duration for July 2006.

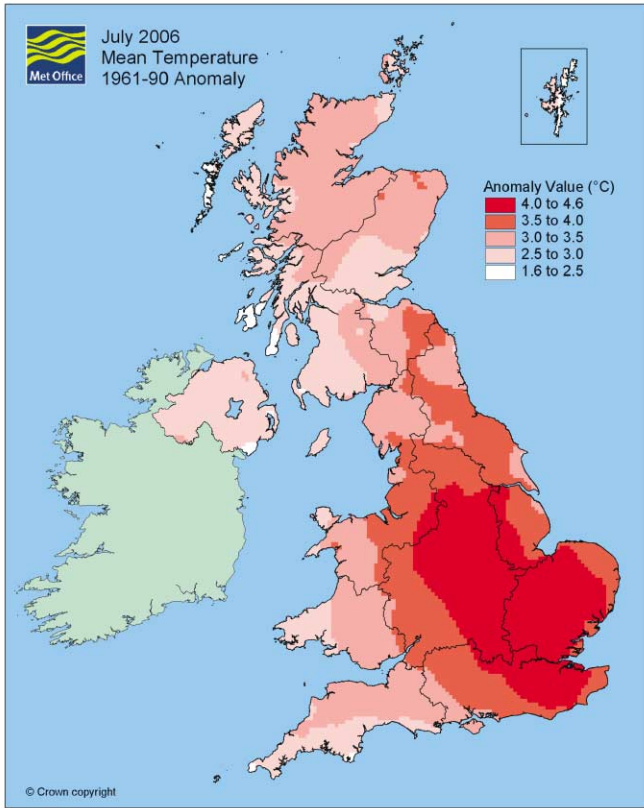


Figure 7. Mean temperature anomalies for July 2006.

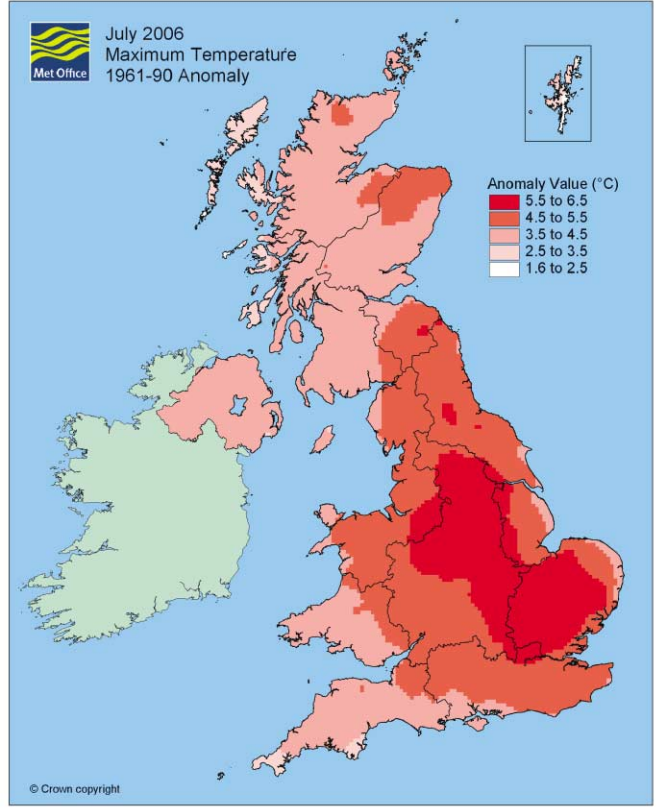


Figure 8. Mean daily maximum temperature anomalies for July 2006.

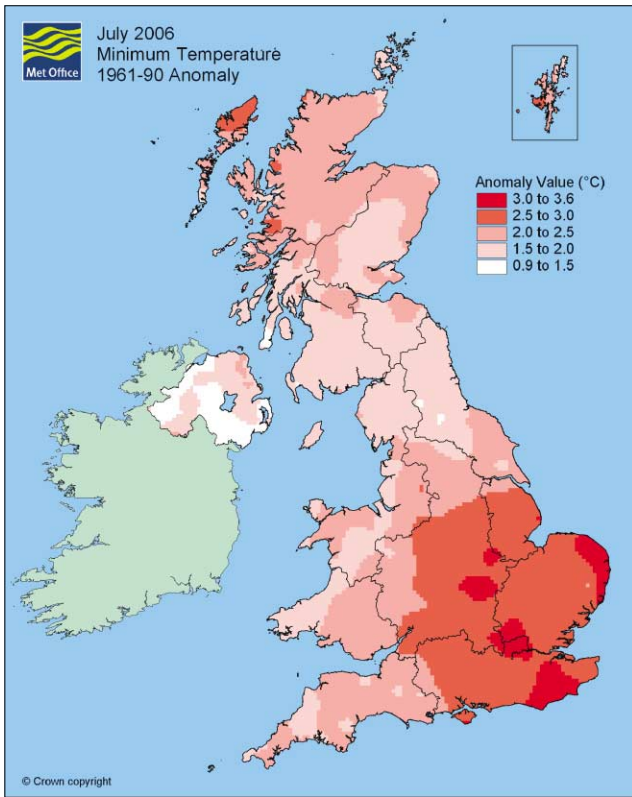


Figure 9. Mean daily minimum temperature anomalies for July 2006.

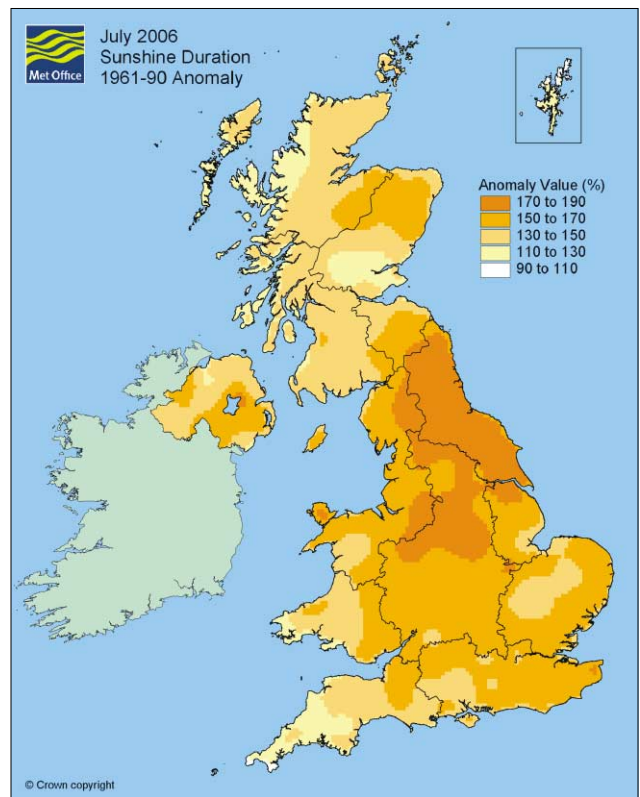


Figure 10. Sunshine duration anomalies for July 2006.



monthly series begins in 1659 (Manley 1953; 1974) and the daily one in 1772 (Parker *et al.*, 1992). In order to maintain homogeneity, since 1974 these series have been adjusted downwards by 0.1–0.3 degC to allow for urban warming. A variety of stations has been used over the years to calculate the CET values, the current network being Rothamsted (Herts), Pershore (Worcs) and Stonyhurst (Lancs).

The mean CET for July 2006 was 19.7°C (with an uncertainty of  $\pm 0.4$  degC, representing  $\pm 2$  standard errors), which is 3.7 degC above the 1961–1990 July average and exceeds the previous record for all months of 19.5°C ( $\pm 0.4$  degC) set in July 1983. There was only one other month in the 348-year series with a mean CET exceeding 19°C, August 1995 with 19.2°C (Figure 11). However, there are uncertainties in the early years of the series, of order  $\pm 0.5$  degC during the period 1772 to 1877 but larger before 1772 (Manley, 1974) and the use of temperatures rounded to whole degrees Fahrenheit (Parker and Horton, 2005). However, it is virtually certain that July 2006 was one of the warmest five months in the mean CET series and there is about 70% probability that it is the warmest month in the series.

The highest daily mean CET value in July 2006 was 24.5°C on the 19th and this is the joint sixth warmest in the series (from 1772). Again there are considerable uncertainties, being about  $\pm 2$  degC from 1772 to 1877 and about  $\pm 1.2$  degC since 1878. Given these uncertainties, 19 July could have been the warmest day in the series (about 4% probability) or not even in the top 20 days (Figure 12).

The heat of July 2006 coincided with the calendar month. However, the daily CET series may be used to assess 30-day periods starting on any day. On this basis, the highest value in 2006 was 19.8°C for 1–30 July, but the heatwaves of June/July 1976 and July/August 1995 are more noteworthy as each had 30-day spells with a mean CET over 20°C. The warmest 30 days in the series from 1772 was 22 June to 21 July 1976, with a mean CET of 20.6°C.

## Comparisons

When the July 2006 regional values are compared with other noteworthy warm, sunny months in the series since 1914 (temperature) or 1929 (sunshine), those that appear similar are July 1955 and June 1957 for sunshine and July 1983 and August 1995 for temperature (Table 2).

July 1955 was an outstandingly sunny month, particularly over Scotland and Northern Ireland where it remains the sunniest July on record. It was particularly sunny in areas bordering the Irish Sea, with

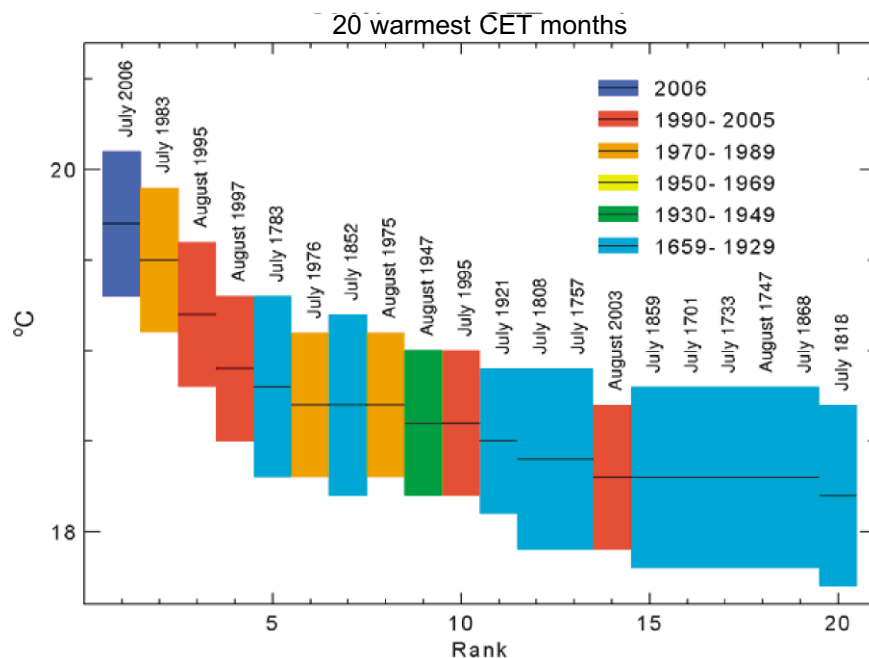


Figure 11. Ranked 20 warmest Central England Temperature months, with uncertainties. The 20 highest monthly mean Central England Temperatures shown in rank order. The central black line of each coloured bar indicates the average temperature and the height of the bar indicates the 2-standard-error range. The colours indicate the period the temperature comes from. Data are from Parker and Horton, 2005.

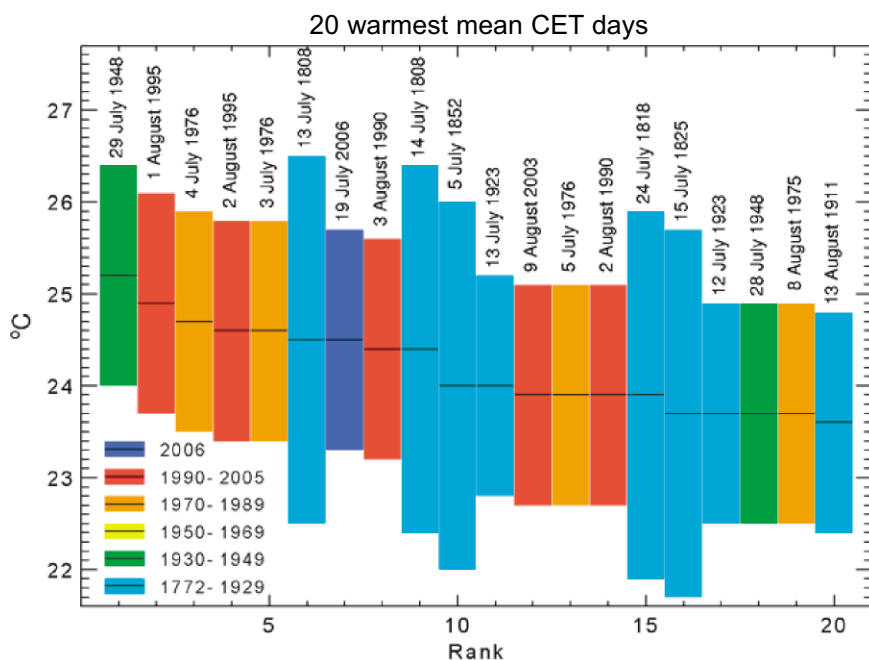


Figure 12. Ranked 20 warmest Central England Temperature days, with uncertainties. The 20 highest daily mean Central England Temperatures shown in rank order. Key as shown in Figure 11.

an average of over 10 hours of sunshine per day (Met Office, 1955).

In June 1957, the sunniest weather was over England and Wales, especially in southern England where several places averaged over 11 hours of sunshine each day (Met Office, 1957).

In July 1983, mean temperatures were over 4 degC above average across southern England from London towards Bristol. It had been the warmest month for over 100 years in places as far apart as London, Plymouth, Durham and Armagh, Northern Ireland. At the time, July 1983 was the warmest calen-

dar month in the CET series back to 1659 (Met Office, 1983).

The summer of 1995 was dry, sunny and at times very hot, resulting in the July and August period being the warmest in the CET series. August 1995 is now the third-warmest calendar month in the CET series, after July 2006 and July 1983 (Figure 11).

Before the start of the areal series, July 1911 was also an unusually sunny month, being part of a noteworthy hot, dry summer (Harding, 1912). There was an average of over 10 hours of sunshine per day south of a line from Norfolk to the Bristol Channel and an impressive 384 hours of sunshine was recorded at Eastbourne and Hastings, both East Sussex, which still stands as the UK monthly sunshine record.

## Impacts

The heat and sunshine placed strains on everyday life, mainly during the hottest period in the third week of the month. Three examples of impacts have been chosen – health, land transport and rural fires.

The heat brought health risks, especially for the very young, very old or those with chronic diseases. In order to reduce the impact, the seasonal Heatwave Plan in England and Wales was in operation from 1 June to 15 September 2006 (Department of Health, 2006). Temperature forecasts were provided by the Met Office in association with advice from the Department of Health. The system comprises four levels of response based upon threshold maximum daytime and minimum night-time temperatures. These thresholds vary by region, but typical values are 30°C by day and 15°C overnight. In July 2006, the response was at level 2 ('alert') or higher for 12 days (1st–4th, 17th–19th, 21st–23rd, 26th–27th) mainly in the Midlands, eastern England, London and south-east England. It was at level 3 ('heat-wave') on 7 days, covering most of England on the 18th and all of England and Wales on the 19th. Level 4 ('state of emergency') was not reached. The advice and publicity associated with the Plan encouraged preventative measures, such as drinking fluids and using protection from the sun. The high temperatures during July 2006 did not affect mortality in England and Wales to the extent seen in the August 2003 heatwave. During the heat of the first week, there was no increase in mortality nationally and in the second hot spell (16th–28th) there was a 4% increase over baseline mortality, with an estimated 680 excess deaths. This compares to a 16% increase during August 2003, representing 2139 excess deaths. The baseline mortality is calculated as the average for the same period in the previous five years (Office of National Statistics, 2006).

In the hottest period of 18th–19th, a combination of prolonged sunshine and air

temperatures in excess of 30°C caused the surface temperature of exposed roads to soar and there was heat-damage from Cornwall to Cumbria. Emergency measures were brought in, with gritters spreading sand and granite dust, after asphalt began to melt and traffic began to remove the surface. As a typical example, in Oxfordshire 37 roads were affected, particularly those with high volumes of HGVs. Extensive traffic delays and diversions resulted and the cost of repairing the heat damage has been estimated at £3.6 million. The heat at this time also raised the risk of railway lines buckling. As a precaution, temporary speed restrictions were in force across most of England and Wales, including the above-ground lines of London Underground. The West Coast Main Line from London to north-west England was particularly affected and many services in the Birmingham area were cancelled or delayed. The Met Office provided five-day forecasts to Network Rail, as part of the OpenRail service. These included warnings when the air temperature was likely to exceed 25°C. On days with high insolation, such temperatures can lead to rail temperatures in excess of 45°C, which could result in buckling. In July 2006, Network Rail was able to use a new system to monitor rail temperatures at 170 sites across the UK in order to have early warning of potential problems.

Numerous grassland, moorland and forest fires broke out during the month, particularly from the 14th to the 20th. Examples included sites in the North York Moors, the Peak District and the Vale of Clwyd in North Wales. One of the most devastating affected the 326-hectare national nature reserve at Thursley Common in Surrey, where fires that started on the 14th and 20th destroyed about 75% of this heathland reserve (Natural England, 2006). Relevant authorities in England used the Met Office Fire Severity Index (Marno, 2005) to decide when to implement fire prevention restrictions on open access land, under the Countryside and Rights of Way Act of 2000. This index is calculated for 10 km grid squares using forecast values of wind speed, air temperature and relative humidity at midday and rainfall over the 24 hours ending at midday, for the current day and five days ahead. It has a scale of increasing fire severity from 1 to 5, with access restrictions triggered when a value of 5 (exceptional fire severity) occurs on the current day or following day. In the current day forecasts, this severity level was reached in parts of East Anglia and south-east England from the 2nd to the 4th and then more widely on a few days in the second half of July, principally the 18th, 19th and 29th, with smaller areas affected on the 20th, 21st, 25th, 30th and 31st (see [www.openaccess.gov.uk](http://www.openaccess.gov.uk)). Linked to this, 107 fire prevention restrictions were activated

in July 2006, mainly in the northern half of England. The hydrological impacts are examined by Marsh (2007; this issue p. 191).

## Summary

July 2006 was a remarkable month over the UK in terms of temperature and sunshine, with many long-standing areal and station records broken. Inevitably, the hot, sunny weather had impacts on daily life but it appears that the effects on health were not as great as in the last major heatwave in August 2003. It was part of a year when many UK records fell, mostly for unusual warmth (Kennedy *et al.*, 2007).

## Acknowledgements

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## Royal Meteorological Society 2007 Conference

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A rainbow and reflected rainbow, Lake Te Anau, South Island, New Zealand, at sunrise, February 2002. The Murchison mountains of Fiordland National Park, in the background, are covered in cloud. A reflected rainbow is produced when light that has first been reflected within raindrops then reflects off a body of calm water before reaching the observer. (© M. C. Kendon)