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Bureau of Meteorology

Special Climate Statement 61—exceptional heat in southeast Australia in early 2017

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1 Introduction

Summer 2016–17 saw prolonged and, at times, extreme heat over New South Wales, southern Queensland, South Australia and parts of northern Victoria. January 2017 saw the highest monthly mean temperatures on record for Sydney and Brisbane, and the highest daytime temperatures on record for Canberra.

In January and February, there were three distinct heatwaves in southeast Australia, with the highest temperatures recorded over 9–12 February 2017. The periods between the waves of extreme heat also saw above average temperatures over large areas of east and southeast Australia. It was the consistency of high temperatures more than the extreme temperatures themselves that made early 2017 an exceptional event.

The summer 2017 heatwaves were comparable to historically significant heatwaves in spatial coverage, duration, and intensity. The longevity of the 2017 high temperatures was similar to that experienced in February 2004 in South Australia and New South Wales, while January–February 2009 saw heatwaves similar to 2017 but they were located further south over Victoria and Tasmania. When looking at all-month records, the 2017 heatwaves broke some long-standing records in central New South Wales, which were set in January 1939. However, the 1939 heatwave remains the hottest on record in many parts of southern and western New South Wales, and border areas of northeast Victoria.

While the January 1939 southeast Australian heatwave remains one of the most significant in recorded history, the frequency of such intense large-scale heatwaves has increased across spring, summer and autumn, and especially over the last 20 years. For New South Wales in February, the 2017 heatwave saw peak maximum temperatures higher than during the 2009 heatwave, and higher than during the 2004 event in all but one location (the New South Wales record highest daily maximum temperature set at Ivanhoe on 15 February 2004 of 48.5 °C). Record maximum temperatures from 2017 now make up eight of the top ten highest February temperatures for New South Wales. Prior to these 2017 heatwaves, events in 2004 and 2009 made up six of the top ten highest February temperatures.

The three heatwaves across January and early February 2017 saw unusually high daily maximum and minimum temperatures for at least three consecutive days over large parts of the country. The first heatwave began around 10 January and continued to 14 January. The highest temperatures during this heatwave were recorded on Thursday the 12th and Friday the 13th, when most sites across inland New South Wales and southern Queensland had daytime temperatures over 40 °C. Heatwave conditions returned on 17 January and continued through to 21 January, when most of the very high temperatures were constrained to Queensland's central coast. The third, and most severe, heatwave began around 31 January and continued until 12 February.

During these heatwaves, daily maximum temperatures across southeast Australia exceeded 40 °C over very large areas and were typically 8 to 12 °C above the January and February averages. The highest temperatures recorded during this

period were 48.2 °C on 9 February at Tarcoola, South Australia, followed by 47.9 °C on 12 February at Walgett, New South Wales; these are new February high temperature records at both these sites. Other site records are listed in the tables at the end of this Statement.

Many sites measured record runs of consecutive days of high temperatures above threshold values. In New South Wales, for example, Moree had 54 consecutive days of 35 °C or above from 27 December 2016 to 18 February 2017, inclusive (the previous record for New South Wales was 50 days at Bourke Airport). Mungindi also broke the old New South Wales record, measuring 51 consecutive days (26 December 2016 to 14 February 2017) and Walgett had 48 consecutive days (27 December 2016 to 12 February 2017) above the same threshold. Furthermore, many sites broke records for the longest run of consecutive nights above minimum temperature thresholds, including Mungindi, which measured 49 consecutive nights of 20 °C or above (Mungindi's previous record was 27 nights in 1997–98).

The exceptional heat peaked from 9 to 12 February, with many records set. South Australia and Queensland had sites that recorded the States' hottest February day on record on the 9th and 12th respectively. In New South Wales, Walgett Airport recorded the State's second-hottest February day. When averaged across the whole State, New South Wales recorded both its hottest and second-hottest February days on record of 44.00 °C and 42.40 °C respectively, and the second-hottest day for any month, behind 14 January 1939. In Victoria, the temperatures at many sites would have been record hot were it not for the exceptionally high temperatures on Black Saturday, 7 February 2009.

The large-scale set-up for this series of very high temperatures included an upper-level (500 hPa) ridge that persisted over the continent for several weeks in January and February, and relatively low upper-layer soil moisture in eastern Australia. The heavy rainfall totals on 29–30 December 2016 over central and southern Australia mostly missed central and northern New South Wales and southern Queensland. Upper-layer soil moisture was therefore relatively low over these areas in January and continued to drop through February. The stationary upper-level ridge over southeast Australia represented large scale subsidence and low cloudiness over this region and blocked the passage of cold fronts.

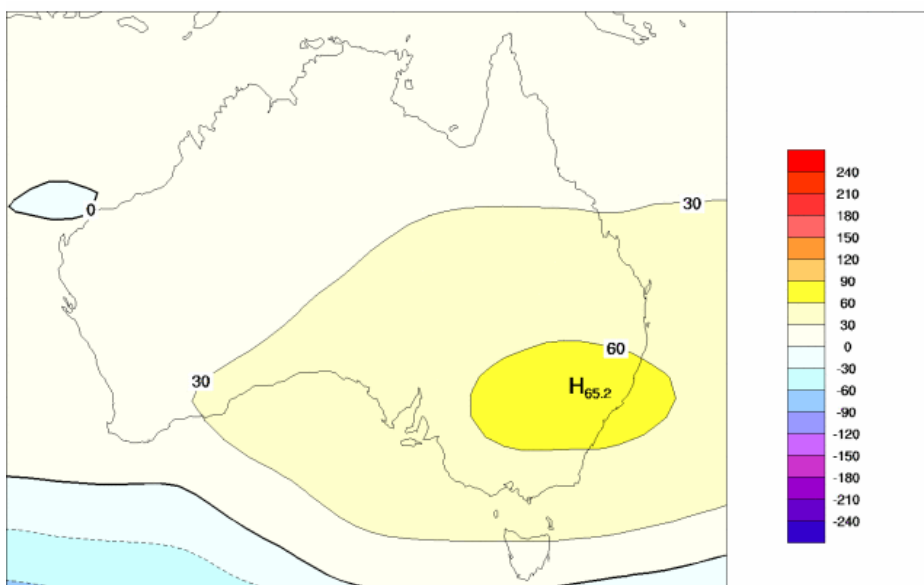


Figure 1: Upper-level pressure difference from the long-term average (500 hPa geopotential height anomaly (m)) over Australia during January 2017, revealing unusually high values over eastern Australia

2 Sustained and widespread period of heat over eastern Australia

One of the most notable features of summer 2016–17 was the prolonged period of above average temperatures. In January and February, even between heatwave periods, the temperatures across southeast Australia remained relatively high, and almost continuously above average. The result was that, on average, January and February 2017 ranked among the hottest months on record for large parts of southeast Australia and up into central Queensland.

As a whole, January 2017 was the warmest month on record for Sydney and Brisbane. Every station in the Sydney metropolitan area recorded its highest January mean temperature on record and most New South Wales sites—including Sydney Observatory Hill—broke records for monthly mean maximum and minimum temperatures. Brisbane (combining old and current sites), Brisbane Aero and Logan City had their highest January mean temperature (average of daily maximum and minimum temperatures) on record. Brisbane had its warmest monthly mean minimum temperature on record, for any month. In Canberra, only five days in January were cooler than the long-term average, which saw it have its warmest mean daily maximum temperature on record and its second highest monthly mean temperature.

February 2017 saw eight individual days where at least one-third of New South Wales had maximum temperatures eight degrees or more above average and, separately, three individual days where over a third of the State was more than ten degrees above average. On 11 February, almost the whole of New South Wales—more than 93%—was ten degrees warmer than average. South Australia broke its area-averaged February maximum daily temperature record on one occasion, and New South Wales twice.

Summer 2017 was the warmest on record for many sites across New South Wales and southern Queensland. Sydney's Observatory Hill was one of those sites, having its warmest summer in 157 years of record. Summer mean temperatures were the warmest on record across almost 45% of New South Wales, covering much of the State's north and east.

Many sites set new records for consecutive days of high temperatures above threshold values. Furthermore, at least 20 sites across Queensland and New South Wales, with 40 or more years of data, set new records for the total number of summer days with maximum temperatures of at least 40 °C. More detail about numbers of hot days and nights can be found in the tables at the end of this Statement.

2.1 January

For most of January, the subtropical ridge included a Tasman High, an area of persistent high pressure over the Tasman Sea. A Tasman High is often, but not always, associated with increased temperatures over southeast Australia (depending on the dynamical characteristics and location of the high). From 10 to 14 January, the combined effects of a slow moving high pressure system over the Tasman Sea, and a trough across central parts of the continent maintained a hot northerly flow over eastern Australia.

A few sites set new overnight temperature records on the morning of 14 January, including at Williamtown with a minimum temperature of 26.1 °C, and at Quirindi with 27.0 °C.

On 14 January, a cold front crossed southeastern Australia bringing a cool change, but this relief from the heat was short-lived as another ridge set up over the region by the next day. Similar to the previous week, by 17 January another high was established over the Tasman and a shallow surface trough stretched across the continent, drawing hot air over the southeast.

On 18 January, several sites set new high minimum temperature records for the month and some locations set new records for the second time in the same month. For example, Murrurundi set a new high January minimum temperature with 27.0 °C on the 14th and then broke that record with 27.2 °C on the 18th—the previous highest January minimum temperature was 26.1 °C on 23 January 1967. Other notable records during this heatwave included Montague Island with 22.9 °C on the 18th, and Brisbane Airport with 27.3 °C on the 21st—the previous highest January record was 26.4 °C on 26 January 1998. A list of new minimum temperature records can be found in the tables at the end of the Statement.

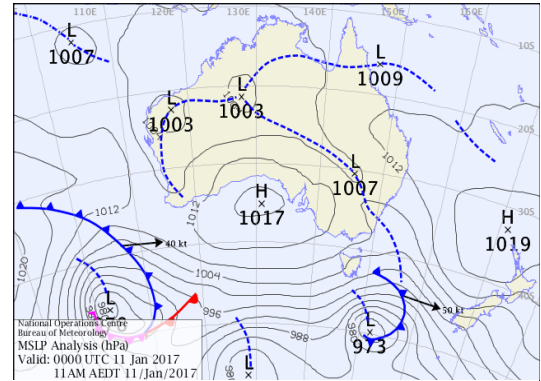


Figure 2: Mean Sea Level Pressure Chart for 11 January. Note the high pressure over the Tasman Sea, which extended over eastern Australia and the pressure trough over the southeast.

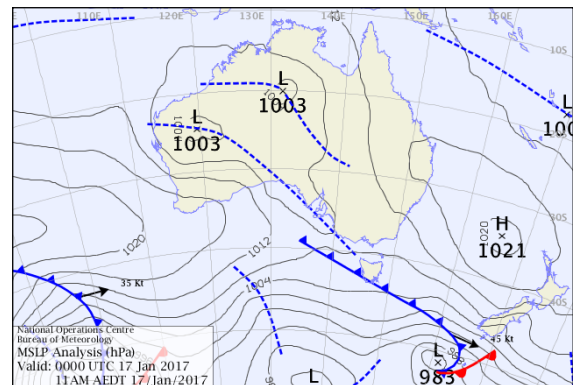


Figure 3: Mean Sea Level Pressure chart for 17 January showed a similar pattern to the 11 January chart.

2.2 February

Near the end of January, a similar weather pattern to those already experienced in the month began building again, with a high pressure system over the Tasman Sea and an upper level ridge over central and eastern Australia. In the first few days of February, a surface trough developed over the east, dragging the heat that had built over central Australia over New South Wales and far southern parts of Queensland. This pattern saw extreme temperatures across New South Wales in particular, including over the more populated eastern areas of the State.

This pattern of pressure systems also drew hot air down across New South Wales and southern Queensland from the central part of the continent from 9–12 February. Widespread severe heatwave conditions developed across the southeast, with extreme heatwave conditions along parts of the East Coast.

On Saturday, 11 February, eight sites reached 47 °C in an area stretching from near the Victorian border to near the Queensland border. New South Wales set a February record for high area-averaged maximum daytime temperatures (the average temperature across the State) two days in a row—on Friday 10 February (42.40 °C) and Saturday 11 February (44.00 °C).

There were many individual sites that set temperature records for either February or for all months. For example, Tarcoola in South Australia, reached 48.2 °C on 9 February, which equalled the hottest February temperature recorded at any site in South Australia—the previous record was 48.2 °C at Renmark on Black Saturday, 7 February 2009. Parramatta North set a new February maximum temperature record on the 10th with 44.5 °C—the previous record in that part of Sydney was 42.5 °C on 1 February 1977 at Villawood. On 11 February, almost 30 sites with 40 or more years of temperature data, across New South Wales and southern Queensland set new February maximum temperature records. For example, Williamtown had 45.5 °C, and Menindee had 47.5 °C on the 11th, which were all-month records at each of those sites.

On 12 February, the area affected by the extreme heat shifted north to include more of southern Queensland. Birdsville set a new February daily maximum temperature

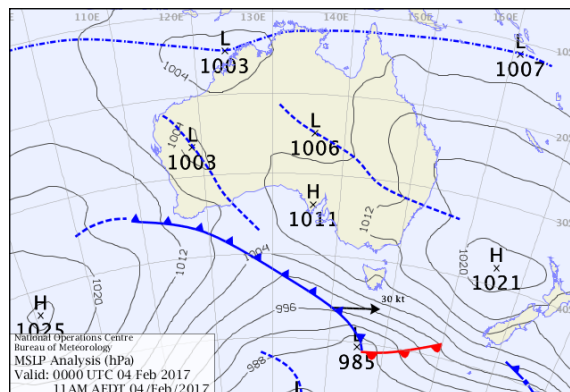


Figure 4: Mean Sea Level Pressure map for 4 February 2017.

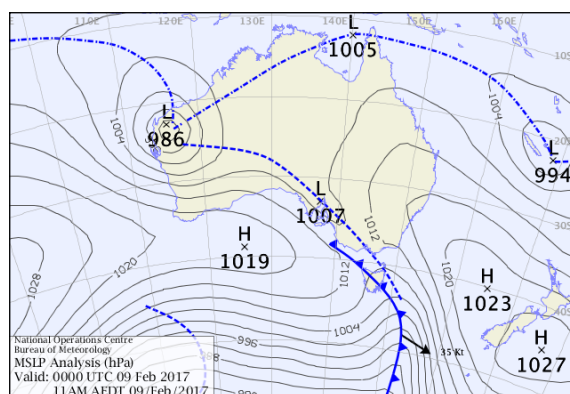


Figure 5: Mean Sea Level Pressure map for 9 February 2017.

record with 47.1 °C. St George and the University of Queensland site in Gatton also had new February records with 46.8 °C and 45.7 °C respectively. The tables list other site records.

The block of four days from 8 to 11 February 2017 resulted in a New South Wales average four-day maximum temperature of 40.62 °C, which just exceeds the previous February record of 40.60 °C, averaged over the four days 12–15 February 2004.

A frontal system swept through New South Wales on Sunday 12 February, leading to some relief from the extreme heat from Monday 13 February. In the wake of the cooler westerly and southerly wind flow, many locations across the State recorded their coolest night for 2017 to-date, to 9am on Monday 13 February.

In contrast to the eastern States, Western Australia experienced very wet conditions, which is the topic of [Special Climate Statement 60](#). These conditions were associated with cooler than average temperatures, most notably around Perth on February 8–9. The cooler temperatures in the country's west lowered the overall national average temperature for the month.

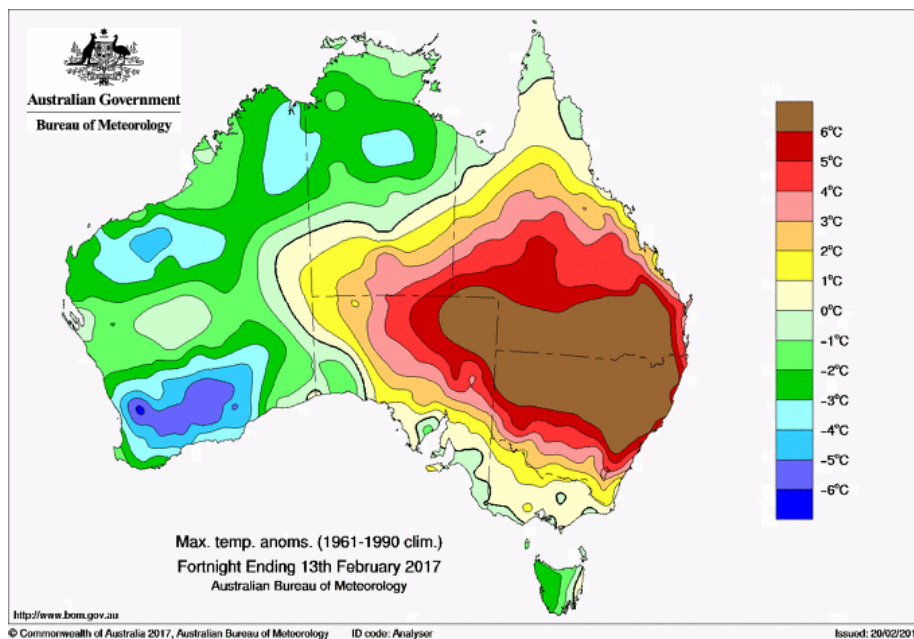


Figure 6: Maximum temperature anomaly (difference from the long-term average) for Australia from 31 January to 13 February 2017.

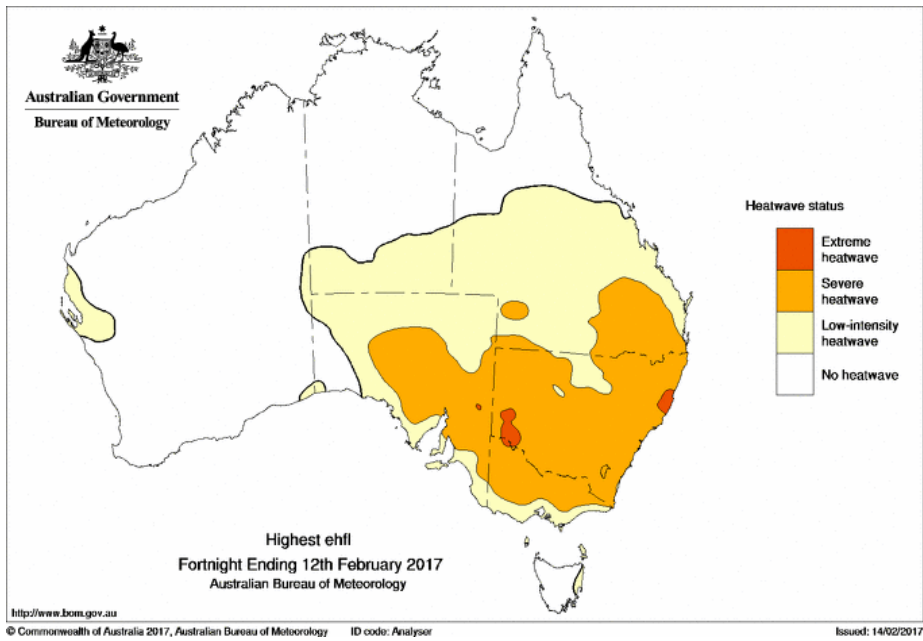


Figure 7: Highest three-day heatwave status observed from 30 January to 12 February 2017.

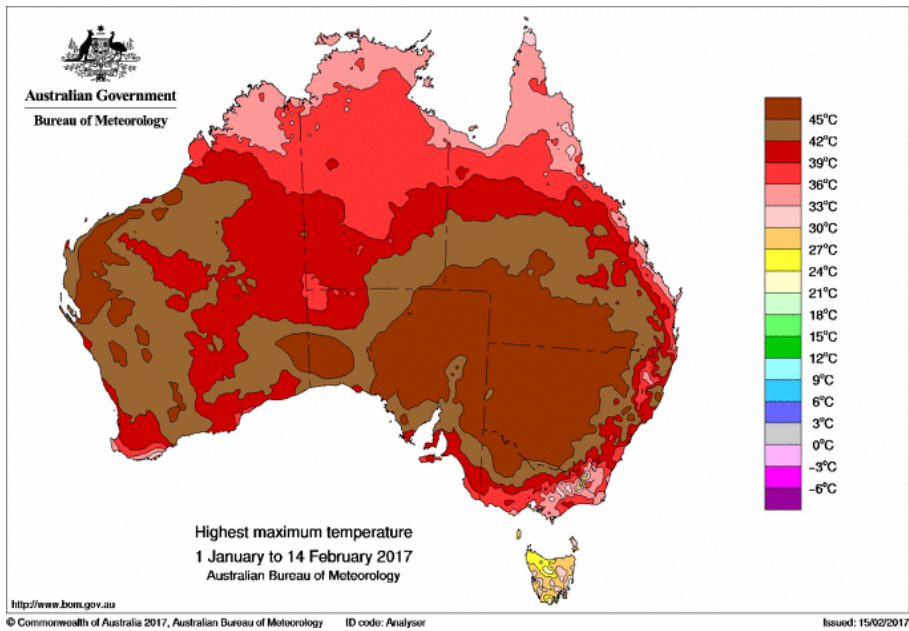


Figure 8: Highest maximum temperature observed from 1 January to 14 February 2017.

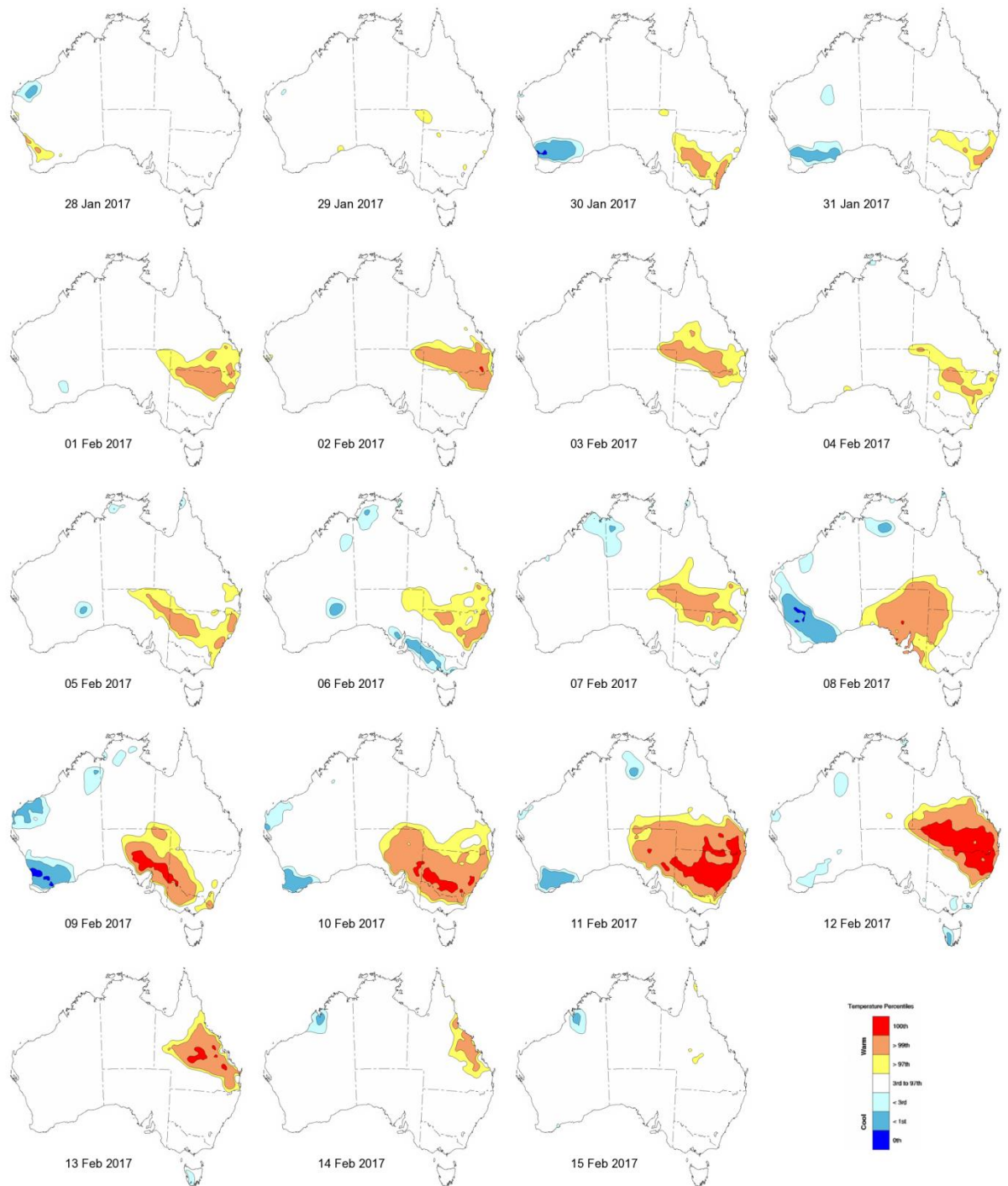


Figure 9: Daily maximum temperature extreme percentiles. Every day from 30 January to 14 February 2017 saw temperatures in the 97th percentile (temperatures which ranked in the top 3% of all January/February days since 1911) observed somewhere in eastern Australia.

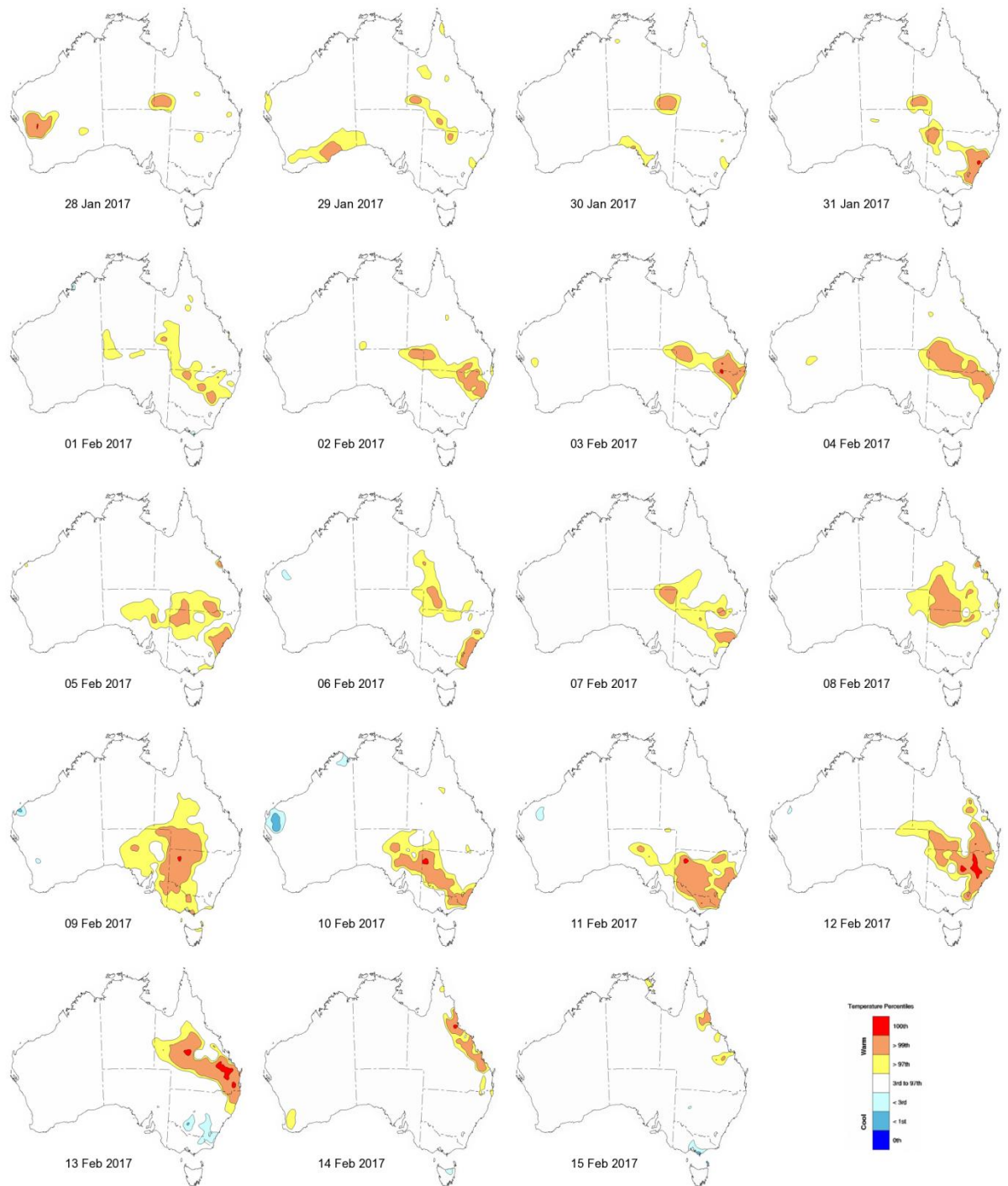


Figure 10: Daily minimum temperature extreme percentiles. Every night from 29 January to 15 February saw temperatures in the 97th percentile (temperatures which ranked in the top 3% of all January/February days since 1911) observed somewhere in eastern Australia.

3 Record numbers of hot days and consecutive days of extreme heat

For southeast Australia, summer 2016–17 was exceptional for the large number of days above high temperature thresholds. Not since the summer of 1938–39 has such a large area of New South Wales—more than 40% of the State—recorded 50 or more days of 35 °C or above during summer. The heat often extended to the East Coast, and populated centres such as Sydney and Newcastle had record numbers of days of 35 °C or above this summer.

From the beginning of January to 12 February 2017, area-averaged temperatures across New South Wales were above average on all but two days—2 and 20 January. There were 12 days in which the State area-averaged temperature was more than six degrees above the long-term average.

Moree, in northern New South Wales, recorded 54 consecutive¹ days of 35 °C or above—from 27 December 2016 to 18 February 2017. Mungindi² measured 51 consecutive days. Both these sites exceeded the previous New South Wales³ record for the longest run of days over 35 °C—50 days at Bourke Airport from 13 December 2012 to 31 January 2013. Walgett Airport reached 48 days before the run of 35 °C days at the site ended on 13 February 2017, when it recorded a maximum temperature of 33.1 °C.

Mungindi also recorded 15 consecutive days of 40 °C or above during January and February, breaking the site's previous record of 8 days—to 22 November 2009. Mungindi has had a total of 41 days of 40 °C or above this summer. This site usually sees an average of about seven days above 40 °C each summer, and the previous record was 19 days in the summer of 2005–06.

¹ It is difficult to compare runs of extended heat with historical records. If a daily temperature measurement is missing, it is considered that the run of days has ended. It is quite possible that runs comparable to those experienced in 2017 have been missed in the historical temperature record since 1910 due to non-contiguous measurements. In particular, it was fairly common in the first half of the 20th century to not take Sunday weather observations, which eliminates the possibility of a run of anything longer than six days where this practice was in place. The old Moree Post Office (053027) is an example of a site that did not take Sunday measurements, thus making historical comparisons incomplete. Nonetheless, the runs of consecutive days in 2016–17 are significant to record-breaking over the period since the mid twentieth century.

² Mungindi is on the border of Queensland and New South Wales. The observing site is on the New South Wales side of the border.

³ Note that this is a New South Wales record run of days only, not for the whole of Australia. Sites in Western Australia and Queensland have had much longer runs of days of 35 °C or above (for example, 200 days at Marble Bar in 1923–24, 147 days at Wittenoom in 1963–64, and 107 days at Camooweal Township in 1985–86).

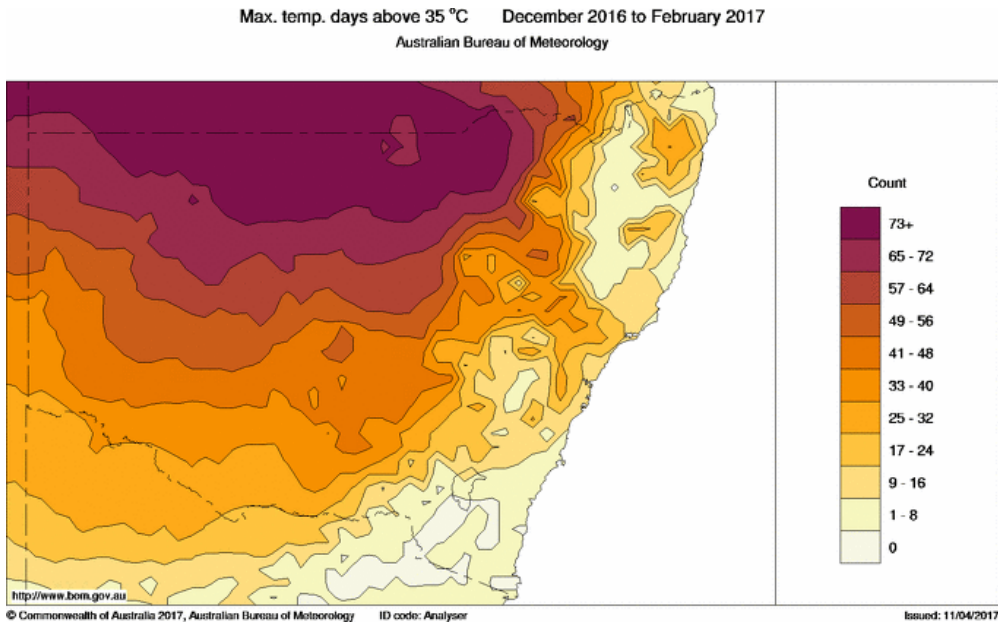


Figure 11: Count of maximum temperature days of 35 °C or above, from 1 December 2016 to 28 February 2017.

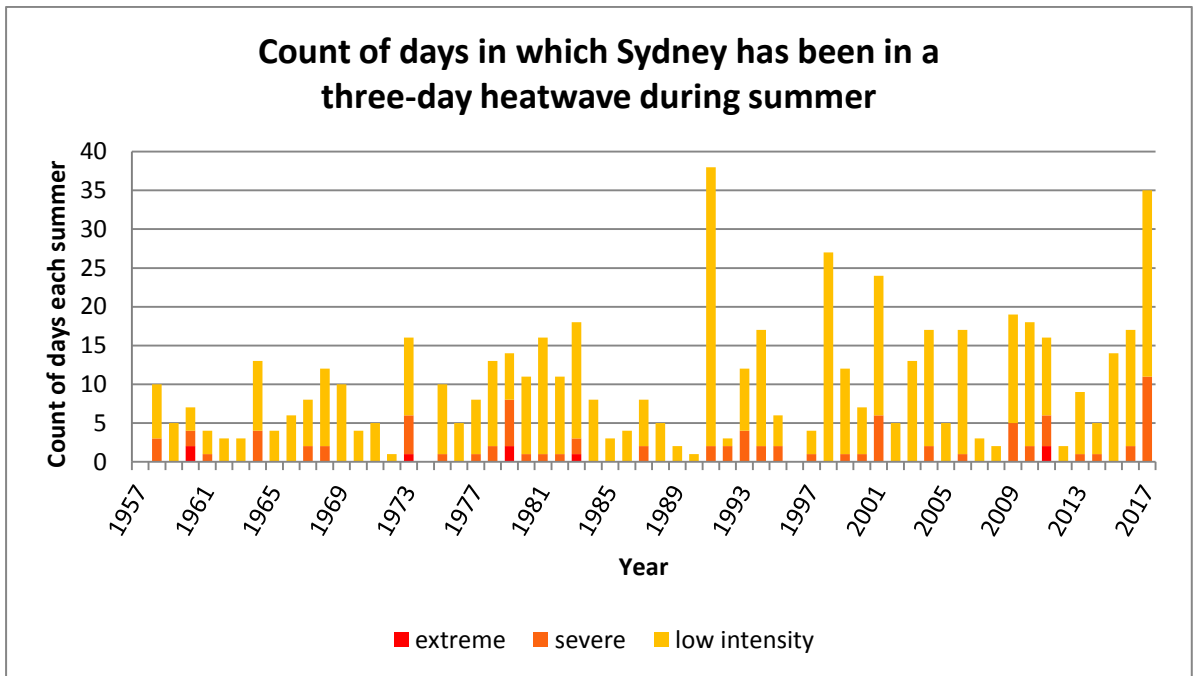


Figure 12: Count of days in which Sydney has been in a three-day heatwave during summer, within each heatwave severity category. Since 1958, only summer 1990–91 has had more days in a heatwave than summer 2016–17.

4 Site records for extreme daily temperatures

There were daily minimum temperature records set at several locations during January in eastern Queensland and New South Wales. However, during January, the individual daily maximum temperatures reached record levels at only five locations with more than 20 years of record and only one location with more than 30 years of record—39.6 °C on 21 January at Maryborough, Queensland.

However, temperatures recorded in February were commonly the highest on record for that month. In the second week of February, as the heat peaked, large numbers of daily maximum and minimum temperature records were set.

On 9 February, Tarcoola, South Australia, recorded 48.2 °C, which was a late-season record for South Australia and equalled the February South Australian record of 48.2 °C set on Black Saturday (7 February 2009) at Renmark.

White Cliffs, New South Wales, had a minimum temperature of 34.2 °C in the 24 hours to 9am on 11 February. This is the highest minimum temperature ever recorded in New South Wales for any site or any month—previous record for New South Wales was 34.0 °C at Ivanhoe on 21 December 1994.

During the day on 11 February, Richmond, New South Wales, had a maximum temperature of 47.0 °C, a record for that site and the highest February temperature ever recorded in the Sydney basin. However, it falls short of the all-month record of 47.8 °C at Richmond in the January 1939 heatwave, which is the highest temperature known to have been recorded in the Sydney basin.

On Sunday 12 February, Walgett Airport recorded 47.9 °C, which was the highest temperature recorded in New South Wales during this event. This is now the second highest February temperature ever recorded in New South Wales—the State's highest February temperature on record is 48.5 °C at Ivanhoe on 15 February 2004.

On Sunday 12 February, five stations across southern Queensland had maximum temperatures that exceeded the old Queensland record for the highest February temperature (which was 46.5 °C at Ballera Gas Field on 6 February 2006): Thargomindah Airport with 47.2 °C; Birdsville Airport with 47.1 °C; Ballera Gas Field with 47.0 °C; St George Airport with 46.8 °C; and Bollon with 46.5 °C.



Figure 13: Sites with 40 or more years of temperature data that recorded their highest daily maximum temperature for the month in either January or February 2017.

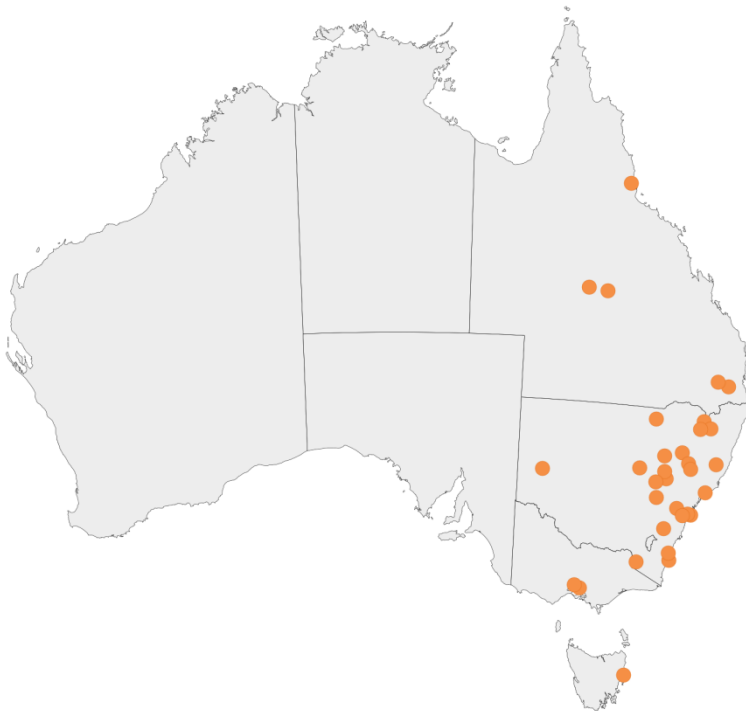


Figure 14: Sites with 40 or more years of temperature data that recorded their highest daily minimum temperature for the month in either January or February 2017.

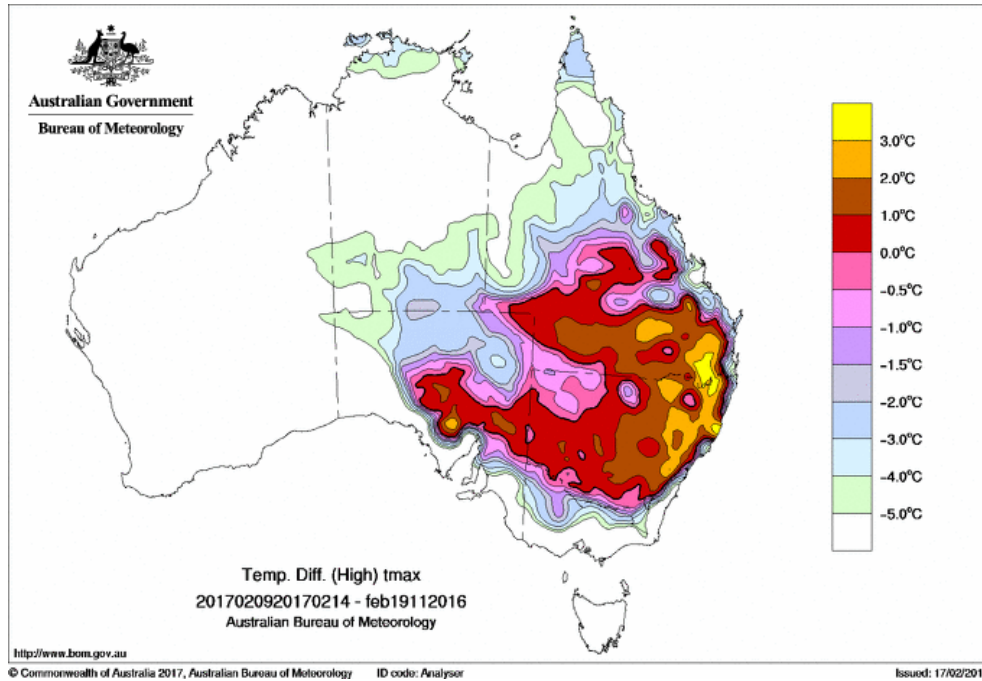


Figure 15: Difference between the highest maximum temperature observed during 9–14 February 2017 from the previous highest February temperature on record (based on AWAP gridded analyses from 1911 to 2016). Areas coloured red to yellow are analysed to have had their hottest February day on record since 1911.

5 Extreme area-average records

The number of statewide area-average records set during January and February 2017, particularly in New South Wales, demonstrates the large spatial extent of the heat across southeast Australia.

On 8 February, South Australia's area-average maximum temperature was 43.92 °C, the hottest February day on record for South Australia as a whole—previous hottest was 43.60 °C on 16 February 1983.

New South Wales as a whole broke its previous February maximum temperature record (41.99 °C on 15 February 2004) on both 10 February (42.40 °C) and 11 February (44.00 °C). Saturday 11 February, was just behind the all-month record for New South Wales from 14 January 1939 (44.06 °C).

The New South Wales area-average mean temperature (the average of daytime maximum and overnight minimum temperatures) of 34.58 °C on 11 February was a new February record, exceeding the month's previous highest daily mean temperature value of 34.39 °C set on 15 February 2004.

As the event peaked in the second week of February, New South Wales broke two-, three- and four-day area-average temperature records for February. The two days from 10–11 February (Friday to Saturday), resulted in a New South Wales two-day mean temperature of 33.78 °C, which exceeded the previous February record of 33.36 °C, averaged over the two days from 14–15 February 2004. The three days from 9–11 February (Thursday to Saturday), resulted in a New South Wales three-day mean temperature of 33.07 °C, which exceeded the previous February record of 33.01 °C, averaged over the three days from 13–15 February 2004.

In addition to the multi-day mean temperature records, two- and three- and four-day area-average maximum temperature records were also set in New South Wales, all for periods ending 11 February 2017. These were 43.20 °C, 41.83 °C and 40.61 °C respectively for the two, three and four day periods; all exceeding previous records set for periods ending 15 February 2004 by 1.88 °C, 0.90 °C and 0.01 °C respectively.

6 Mean monthly and seasonal temperatures

6.1 January

New South Wales recorded its third-warmest January on record (warmest since 2006), and Queensland had its sixth-warmest January.

January 2017 was the warmest January on record for Sydney and Brisbane and the second warmest for Canberra. Every station in the Sydney metropolitan area recorded its warmest January mean temperature on record. Most New South Wales stations (including Sydney Observatory Hill) broke records for monthly mean maximum and minimum temperatures. Brisbane (combining old and current stations), Brisbane Aero and Logan City had their highest January mean temperature (average of daily maximum and minimum temperatures) on record. Brisbane had its warmest monthly mean minimum temperature on record, for any month. While no new daily maximum temperatures were set in Canberra during January, Canberra Airport had only five days in which the daily maximum temperature was below the long-term January average maximum temperature. By the end of the month, Canberra had seen its highest mean daily maximum temperature for January and its second highest monthly mean temperature.

6.2 February

During the first two weeks of February, northern New South Wales and southern Queensland were more than four degrees warmer than the February average mean temperature. Temperatures were closer to average during the second half of the month, but it was still the fifth-warmest February on record for both New South Wales and Queensland. A large area covering northern New South Wales and southern Queensland had mean temperatures that were more than three degrees warmer than average during February.

Many sites in eastern New South Wales and southern Queensland had their warmest February on record, including at least ten sites with 40 or more years of data that had their warmest month for any time of the year.

6.3 Summer

New South Wales recorded its overall warmest summer on record, 2.56 °C above the historical (1961–90) average and 0.12 °C above the previous record set in summer 2005–06. Queensland had its second-warmest summer on record. Most of eastern Australia had warmer than average mean temperatures during summer, with parts of northern New South Wales and southwest Queensland more than three degrees warmer than average.

Many sites in eastern New South Wales and southeast Queensland had their warmest summer on record. Sites such as Bollon, Mungindi, Scone and Gunnedah all broke records for their warmest summer on record and each was more than three degrees warmer than its long-term average.

7 Comparison to previous events

The 2017 summer heatwaves were comparable to some of the most historically significant heatwaves in spatial coverage, longevity, and extremity. These include: New South Wales and southeast Queensland, January 1939; South Australia and New South Wales February 2004; Victoria and Tasmania, January–February 2009; and most of southern and eastern Australia 2013.

A few colonial period temperature records provide evidence of an extreme heatwave across New South Wales in summer 1896, which was likely one of the ten hottest Januarys in southeast Australia in the last 150 years. However, significantly, these earlier data cannot be easily compared with modern recordings, since many observations were taken with non-standard instrument configurations, including exposure of thermometers to sunlight and long-wave radiation, for which little supporting documentary descriptions exist. In particular, detailed study has shown that extreme temperatures recorded at Bourke during the 1896 heatwave were likely suspect due to non-standard exposure, and likely around two degrees warmer than temperatures recorded with standard instrumentation.

7.1 January 1939

Four of the five hottest days on record for New South Wales as a whole were in January 1939; 11 February 2017 now ranks as the second-hottest day since 1911.

The second week of January 1939 is regarded as the most extreme heatwave to affect southeast Australia during the twentieth century. The event culminated in the Black Friday fires of 13 January 1939.

In 2017, the extreme heat extended further east in New South Wales and further north into southeast Queensland. Some of the long-standing all-month temperature records dating from 1939 were broken during this 2017 event. However, the 1939 heatwave remains the hottest on record in many parts of southern and western NSW, and border areas of northeast Victoria.

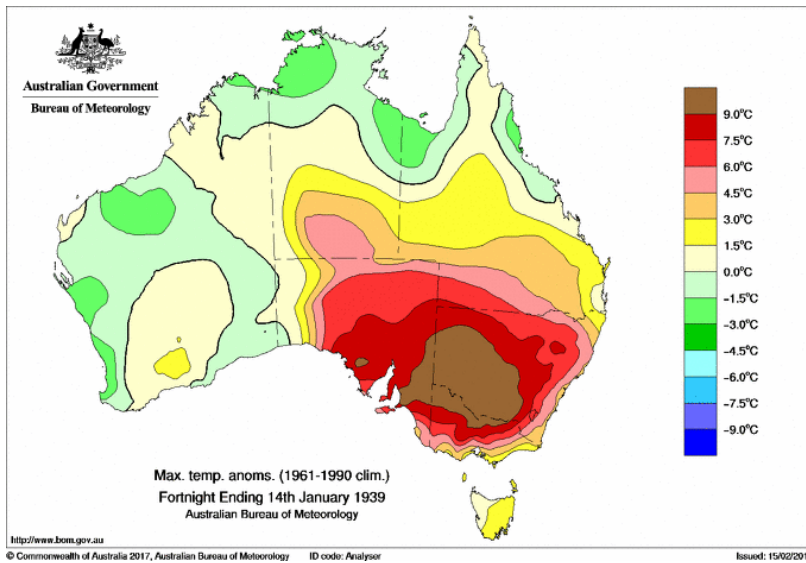


Figure 16: Maximum temperature anomaly for Australia from 1–14 January 1939.

7.2 February 2004

The spatial and temporal extent of the 2004 summer heatwave ranked it amongst the most severe of the past century, but short of the January 1939 event.

Compared to the 2017 event, the anomalously high temperatures were further south and west during February 2004. Average daytime temperatures during the first half of February 2004 were more than six degrees above average over much of eastern South Australia, inland New South Wales, and neighbouring regions of northwest Victoria and southwest Queensland.

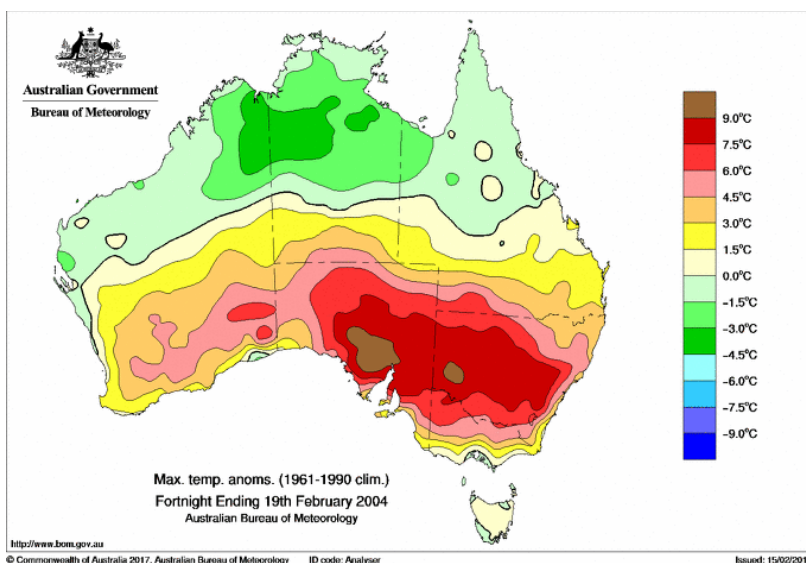


Figure 17: Maximum temperature anomaly for Australia from 6–19 February 2004.

7.3 January–February 2009

An exceptional heatwave affected southeastern Australia during late January and early February 2009⁴. The most extreme conditions occurred in northern and eastern Tasmania, most of Victoria and adjacent border areas of New South Wales, and southern South Australia. There were many records set both for high daytime and night time temperatures, as well as for the duration of extreme heat.

Compared to the 2017 event described here, the heat in 2009 was concentrated further south, with heatwave conditions throughout most of the southern half of Australia. Almost all of Victoria, Tasmania, and southeast South Australia reached extreme heatwave conditions during the 2009 event.

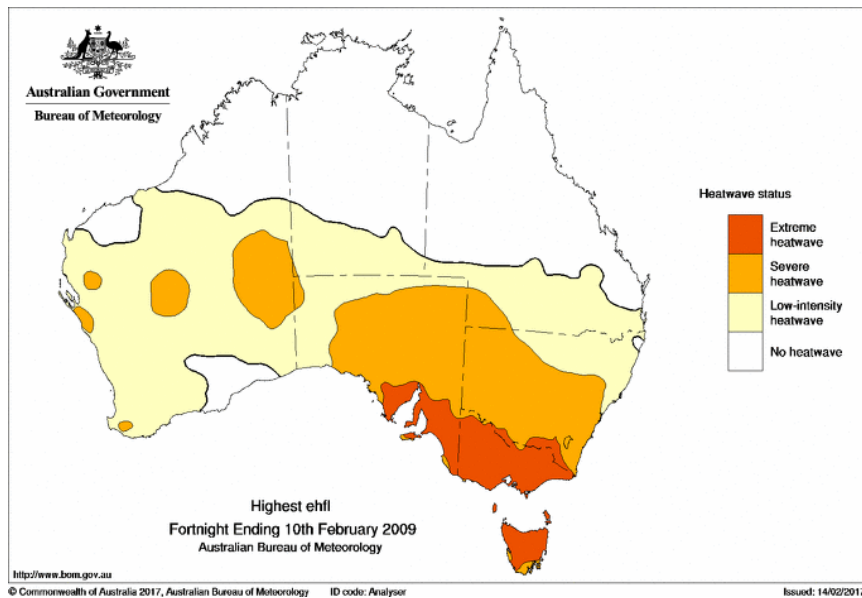


Figure 18: Highest three-day heatwave category observed during the fortnight to 10 February 2009.

⁴ See *Special Climate Statement 17 — The exceptional January-February 2009 heatwave in south-eastern Australia* at www.bom.gov.au/climate/current/statements/scs17d.pdf

7.4 January 2013

An extensive and long-lived heatwave affected large parts of Australia in late December 2012 and the first weeks of January 2013⁵. While the heat was most extreme and persistent in the central and southern interior of the continent, most of Australia experienced extreme heat at some stage during the event.

The event was notable for its extent, with records set in every State and Territory, and the nationally averaged daily temperature rose to levels never previously observed, and did this for an extended period. The heatwave was a major factor in January 2013 being Australia's hottest month on record and summer 2012–13 being the hottest summer on record for Australia.

In February 2017, the extreme heat extended further into northeastern New South Wales and southeast Queensland. The February 2017 temperatures in Western Australia were much cooler than those during these previous major heat events.

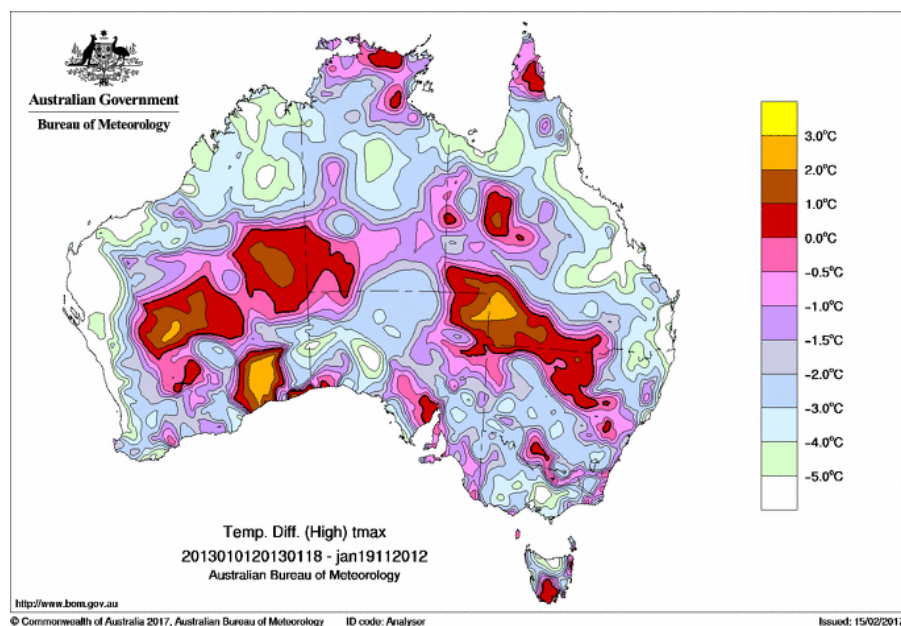


Figure 19: Many areas of Australia recorded their highest daily maximum temperature on record during January 2013. Map of the difference between the highest maximum temperatures observed during 1–18 January 2013 from the previous highest January temperature on record (based on AWAP gridded analyses from 1911 to 2012). Areas coloured red to yellow are analysed to have had their highest January temperature on record (at the time until 2013).

⁵ See *Special Climate Statement 43 — Extreme heat in January 2013* at <http://www.bom.gov.au/climate/current/statements/scs43e.pdf>

8 Longer-term climatological context

While all exceptional climate events have proximate causes in antecedent and concurrent weather conditions, long-term trends now also play a role.

Australian annually averaged temperature has warmed by around one degree since 1910, and summer has warmed by a similar amount. The annual warming trend is consistent with that observed for the globe.

Temperature data for New South Wales shows that from late spring to early autumn, the frequency of warm events is increasing. The 2017 warm event is the latest in a sequence of prolonged or intense warm spells that have affected Australia roughly every six weeks since the end of 2012 and, overall, the time between heat events is shortening.

9 Summary tables and figures

Table 1: Sites with 40 or more years of data that had January daily minimum temperature records. All-month (annual) records are in bold.

Station number	Station name	State	New January record (°C)	Date of new record	Previous January record (°C)	Date of previous January record	Previous annual record (°C)	Date of annual record
66137	Bankstown	NSW	24.4	2017-01-14	24.3	2001-01-27	26.0	2011-02-02
36007	Barcaldine	QLD	30.9	2017-01-13	30.5	2014-01-04	30.5	2014-01-04
92003	Bicheno	TAS	19.0	2017-01-24	19.0	2015-01-04	20.0	2010-03-26
68192	Camden	NSW	24.3	2017-01-14	23.5	1982-01-25	24.0	2011-02-03
64008	Coonabarabran	NSW	25.0	2017-01-18	25.0	1964-01-07	25.1	1987-12-28
64009	Dunedoo	NSW	27.0	2017-01-18	26.0	2006-01-11	28.3	2011-02-03
56013	Glen Innes	NSW	20.5	2017-01-01	20.5	1971-01-11	22.5	2014-11-16
70263	Goulburn	NSW	26.2	2017-01-18	25.3	2010-01-23	25.3	2010-01-23
62013	Gulgong	NSW	27.6	2017-01-18	25.2	2006-01-01	28.0	1997-11-26
87031	Laverton	VIC	28.9	2017-01-08	28.9	1997-01-21	28.9	1997-01-21
69017	Montague Island	NSW	22.9	2017-01-18	22.0	1991-01-25	22.9	1973-02-05
86077	Moorabbin	VIC	28.7	2017-01-08	28.6	2014-01-15	28.6	2014-01-15
69018	Moruya Heads	NSW	22.4	2017-01-31	22.2	1932-01-28	23.9	1946-02-01
61051	Murrurundi	NSW	27.2	2017-01-18	26.1	1967-01-23	28.3	1965-12-31
63254	Orange	NSW	23.5	2017-01-18	22.6	1982-01-25	24.4	1983-02-17
55049	Quirindi	NSW	27.0	2017-01-14	26.6	2006-01-11	28.0	1975-12-14
66037	Sydney Airport	NSW	26.1	2017-01-18	25.8	2010-01-23	27.5	2016-12-14
65034	Wellington	NSW	27.5	2017-01-18	25.8	1983-01-24	27.8	1973-02-05

61078	Williamtown	NSW	26.1	2017-01-14	25.7	1983-01-10	26.9	2011-02-06
60085	Yarras (Mount Seaview)	NSW	24.6	2017-01-14	23.8	2016-01-23	24.3	1995-11-28

Table 2: Sites with 40 or more years of data that had January daily maximum temperature records.

Station number	Station name	State	New January record (°C)	Date of new record	Previous January record (°C)	Date of previous January record	Previous annual record (°C)	Date of annual record
40126	Maryborough	QLD	39.6	2017-01-21	38.4	1995-01-31	40.6	1979-12-11

Table 3: Sites with 40 or more years of data that had February daily minimum temperature records. All-month (annual) records are in bold. Locations with data back to the 1939 heatwave are in italics.

Station number	Station name	State	New February record (°C)	Date of new record	Previous February record (°C)	Date of previous February record	Previous annual record (°C)	Date of annual record
32004	Cardwell	QLD	28.3	2017-02-14	27.8	2015-02-22	28.8	1985-01-23
48031	Collarenebri	NSW	30.2	2017-02-12	28.7	2004-02-22	32.3	2004-01-07
64009	Dunedoo	NSW	29.0	2017-02-12	28.3	2011-02-03	28.3	2011-02-03
40082	Gatton	QLD	27.3	2017-02-13	25.6	1966-02-16	28.5	1979-12-21
55024	Gunnedah	NSW	31.2	2017-02-12	27.9	2004-02-22	31.0	2004-01-07
<i>56242</i> <i>56017</i>	<i>Inverell</i>	<i>NSW</i>	<i>24.1</i>	<i>2017-02-12</i>	<i>24.0</i>	<i>1969-02-10</i>	<i>25.0</i>	<i>1957-12-29</i>
63039	Katoomba	NSW	24.6	2017-02-06	24.0	2009-02-07	25.0	1960-01-28
36030 36031	<i>Longreach</i>	<i>QLD</i>	<i>31.5</i>	<i>2017-02-13</i>	<i>31.3</i>	<i>1925-02-20</i>	<i>31.8</i>	<i>1902-01-05</i>
47019	Menindee	NSW	31.0	2017-02-09	30.0	2009-02-07	30.6	1965-12-30
41359	Oakey	QLD	25.9	2017-02-13	24.5	2006-02-05	27.1	1994-01-07
54104	Pindari Dam	NSW	25.0	2017-02-03	24.5	1979-02-16	25.2	2004-01-07
71041	Thredbo Village	NSW	20.5	2017-02-10	20.2	2009-02-08	21.0	2013-01-08
51049	Trangie	NSW	32.5	2017-02-12	29.3	2004-02-12	31.3	2013-01-18

Table 4: Sites with 40 or more years of data that had February daily maximum temperature records. All-month (annual) records are in bold. Locations with data back to the 1939 heatwave are in italics.

Station number	Station name	State	New February record (°C)	Date of new record	Previous February record (°C)	Date of previous February record	Previous annual record (°C)	Date of annual record
40004	Amberley	QLD	43.0	2017-02-12	42.6	1952-02-01	44.3	1994-01-06
41175	Applethorpe	QLD	39.7	2017-02-11	36.1	1983-02-17	37.8	2014-01-03
49002	Balranald	NSW	46.0	2017-02-10	46.0	2004-02-14	46.7	1990-01-03
66137	Bankstown	NSW	44.5	2017-02-10	43.3	1977-02-01	46.1	2013-01-18
36007	Barcaldine	QLD	43.6	2017-02-13	42.6	1983-02-18	45.1	2006-11-30
54003	Barraba	NSW	44.0	2017-02-12	41.8	2006-02-03	44.9	2014-01-03
63005	<i>Bathurst</i>	<i>NSW</i>	<i>41.5</i>	<i>2017-02-11</i>	<i>40.1</i>	<i>2004-02-15</i>	<i>40.6</i>	<i>1939-01-13</i>
38002 38026	Birdsville	QLD	47.1	2017-02-12	45.9	1986-02-01	49.5	1972-12-24
44010	Bollon	QLD	46.5	2017-02-12	45.0	1980-02-22	47.0	2014-01-04
48015	Brewarrina	NSW	45.8	2017-02-11	45.4	2004-02-15	48.1	2013-01-13
68192	Camden	NSW	45.6	2017-02-11	43.2	1980-02-21	46.4	2013-01-18
44022 44021	<i>Charleville</i>	<i>QLD</i>	<i>45.2</i>	<i>2017-02-12</i>	<i>45.0</i>	<i>1926-02-18</i>	<i>47.0</i>	<i>1947-01-27</i>
48030 48027	Cobar	NSW	46.6	2017-02-11	46.1	2004-02-15	47.8	1939-01-11
50052	Condobolin	NSW	46.6	2017-02-11	45.3	2004-02-15	46.0	1973-01-03
64008	Coonabarabran	NSW	42.9	2017-02-11	41.3	2004-02-21	44.0	2014-01-03
44026	Cunnamulla	QLD	45.6	2017-02-12	45.0	2006-02-04	47.2	2014-01-03
65012 65070	<i>Dubbo</i>	<i>NSW</i>	<i>46.1</i>	<i>2017-02-11</i>	<i>44.5</i>	<i>2004-02-15</i>	<i>45.2</i>	<i>1939-01-13</i>

64009	Dunedoo	NSW	45.4	2017-02-11	43.1	2004-02-22	44.2	2014-01-03
40436 40082	Gatton	QLD	45.7	2017-02-12	42.0	2004-02-22	44.5	1994-01-06
56013	Glen Innes	NSW	36.5	2017-02-11	34.5	2016-02-26	36.0	2014-01-03
70263	Goulburn	NSW	41.2	2017-02-11	39.7	2009-02-07	40.1	2003-01-30
73014	Grenfell	NSW	43.8	2017-02-11	43.1	2004-02-15	43.9	2001-01-15
75041	Griffith	NSW	45.8	2017-02-10	45.2	2009-02-07	46.0	2001-01-23
62013	Gulgong	NSW	43.5	2017-02-11	43.0	2006-02-02	43.0	2006-02-02
55024	Gunnedah	NSW	45.6	2017-02-12	42.7	1952-02-07	45.9	2014-01-03
40093	Gympie	QLD	41.3	2017-02-12	40.5	1969-02-10	42.4	2014-01-04
19017	Hawker	SA	45.5	2017-02-09	44.5	2009-02-07	46.0	2003-01-19
75032	Hillston	NSW	47.2	2017-02-11	45.2	2004-02-15	46.0	2006-01-01
43015	Injune	QLD	44.2	2017-02-12	42.2	1969-02-10	44.1	2013-12-30
36026	Isisford	QLD	46.1	2017-02-13	44.6	2006-02-05	47.0	1973-01-04
63039	Katoomba	NSW	37.7	2017-02-11	37.6	2009-02-08	37.6	2009-02-08
18040	Kimba	SA	44.8	2017-02-10	44.5	2009-02-06	46.0	2013-01-04
18044	<i>Kyancutta</i>	SA	46.8	2017-02-09	46.8	1933-02-12	49.3	1939-01-09
75039	Lake Cargelligo	NSW	46.8	2017-02-11	46.6	2004-02-15	47.0	1973-01-03
61288	Lostock Dam	NSW	45.6	2017-02-12	42.5	2004-02-21	43.7	2014-11-23
47019	Menindee	NSW	47.5	2017-02-11	46.8	2009-02-07	47.5	2001-01-14
42023 42112	Miles	QLD	43.4	2017-02-12	42.6	1925-02-18	45.6	1940-01-26
43020	Mitchell	QLD	46.1	2017-02-12	43.0	1980-02-24	46.8	1980-01-19
53027 53048 53115	Moree	NSW	47.3	2017-02-12	45.0	1952-02-08	47.3	2014-01-03
52020	Mungindi	NSW	47.8	2017-02-12	45.0	1980-02-24	48.2	2014-01-03

61051	Murrurundi	NSW	42.2	2017-02-12	40.7	2006-02-02	41.2	2014-01-03
51039	Nyngan	NSW	47.4	2017-02-11	46.0	2004-02-15	47.0	2013-01-12
41359	Oakey	QLD	42.8	2017-02-12	39.5	2006-02-04	41.8	1994-01-06
63254	Orange	NSW	39.2	2017-02-11	38.3	2004-02-15	38.3	2004-02-15
66124	Parramatta North	NSW	44.5	2017-02-10	41.9	1979-02-13	45.5	2013-01-18
61250	Paterson (Tocal AWS)	NSW	47.0	2017-02-11	44.6	2004-02-21	44.6	2004-02-21
50031	Peak Hill	NSW	46.0	2017-02-11	45.1	2004-02-15	45.1	2004-02-15
54104	Pindari Dam	NSW	42.8	2017-02-12	41.2	2004-02-21	41.5	2014-01-05
67019	Prospect Reservoir	NSW	43.3	2017-02-11	42.5	1977-02-01	45.1	2013-01-18
55049	Quirindi	NSW	44.4	2017-02-11	43.4	2006-02-02	45.1	2014-01-03
61363 61089	Scone	NSW	46.5	2017-02-12	43.5	2006-02-02	44.2	2012-01-12
43034 43109	<i>St George</i>	<i>QLD</i>	<i>46.8</i>	<i>2017-02-12</i>	<i>45.6</i>	<i>1925-02-17</i>	<i>47.2</i>	<i>2014-01-03</i>
18079	Streaky Bay	SA	44.0	2017-02-08	44.0	2014-02-11	47.2	1982-01-23
43035	Surat	QLD	44.5	2017-02-12	43.6	1993-02-05	45.7	2014-01-03
66037	Sydney Airport	NSW	42.9	2017-02-10	42.6	1980-02-21	46.4	2013-01-18
57095	Tabulam (Muirne)	NSW	39.7	2017-02-12	37.8	2004-02-22	39.8	2003-01-31
16044 16098	Tarcoola	SA	48.2	2017-02-09	47.9	1992-02-17	48.9	2014-01-01
35070	Taroom	QLD	44.6	2017-02-12	43.3	1969-02-10	45.3	2014-01-04
56032	Tenterfield	NSW	39.9	2017-02-12	36.7	1965-02-23	38.3	1994-01-08
41100	Texas	QLD	44.5	2017-02-12	43.0	2004-02-21	44.6	1980-01-20
45017 45025	Thargomindah	QLD	47.2	2017-02-12	46.3	2004-02-16	48.8	2013-01-13
51049	Trangie	NSW	47.0	2017-02-11	45.8	2004-02-21	46.1	2013-01-12
72043	Tumbarumba	NSW	40.5	2017-02-10	40.2	2009-02-07	40.5	2014-01-16

52026 52088	Walgett	NSW	47.9	2017-02-12	46.9	1952-02-07	49.1	2014-01-03
65034	Wellington	NSW	45.0	2017-02-11	44.5	2004-02-15	44.5	2004-02-15
73054 50017	West Wyalong	NSW	46.3	2017-02-11	44.8	1968-02-01	45.3	1973-01-03
46043 46012	Wilcannia	NSW	47.4	2017-02-11	47.1	2004-02-15	48.2	1973-01-03
61078	Williamtown	NSW	45.5	2017-02-11	42.9	2011-02-05	44.8	2013-01-18
55136	Woolbrook	NSW	38.0	2017-02-12	38.0	2006-02-03	38.0	2006-02-03
16001	Woomera	SA	46.8	2017-02-09	46.2	2009-02-07	48.1	2011-01-25
60085	Yarras (Mount Seaview)	NSW	43.2	2017-02-12	42.0	2004-02-21	42.5	2014-11-23

Table 5: Sites with 40 or more years of data that have had their highest number of daily minimum temperatures of 20 °C or above in summer 2016–17.

Station number	Station name	State	New record (days)	Previous record (days)	Summer of previous record
68192	Camden	NSW	29	21	1990/91
56013	Glen Innes	NSW	3	2	2003/04
70263	Goulburn	NSW	9	6	1982/83
62013	Gulgong	NSW	30	23	1980/81
55024	Gunnedah	NSW	56	51	2005/06
56018	Inverell	NSW	22	16	2003/04
63039	Katoomba	NSW	12	8	1959/60
52020	Mungindi	NSW	76	69	2003/04
61051	Murrurundi	NSW	17	14	2005/06
41359	Oakey	QLD	35	32	2005/06
63063	Oberon (Springbank)	NSW	3	2	2010/11
66124	Parramatta North	NSW	37	27	2009/10
43035	Surat	QLD	76	66	2009/10
70080	Taralga	NSW	5	2	2010/11
41100	Texas	QLD	50	47	2009/10
72043	Tumbarumba	NSW	9	8	2010/11
61078	Williamtown	NSW	40	36	1997/98
55136	Woolbrook	NSW	3	2	1980/81
60085	Yarras (Mount Seaview)	NSW	35	29	2010/11

Table 6: Sites with 40 or more years of data that have had their highest number of daily minimum temperatures of 25 °C or above in summer 2016–17. Locations with data back to the 1939 heatwave are in italics.

Station number	Station name	State	New record (days)	Previous record (days)	Summer of previous record
44010	Bollon	QLD	36	31	2005/06
48015	Brewarrina	NSW	34	26	2005/06
64009	Dunedoo	NSW	5	4	2005/06
86038	Essendon	VIC	3	2	1966/67
62013	Gulgong	NSW	4	2	1972/73
55024	Gunnedah	NSW	9	8	2005/06
86077	Moorabbin	VIC	2	1	2015/16
52020	Mungindi	NSW	26	17	2005/06
61051	Murrurundi	NSW	2	1	2012/13
51039	Nyngan	NSW	20	19	1980/81
66124	Parramatta North	NSW	4	1	2010/11
61250	Paterson (Tocal AWS)	NSW	3	2	2010/11
61089	Scone	NSW	3	2	1982/82
43035	Surat	QLD	24	16	2003/04
66062	<i>Sydney (Observatory Hill)</i>	<i>NSW</i>	5	4	<i>2010/11</i>
41100	Texas	QLD	10	7	2003/04
65034	Wellington	NSW	5	3	2005/06

Table 7: Sites with 40 or more years of data that have had their highest number of daily maximum temperatures of 35 °C or above in summer 2016–17. Sites with data back to the 1939 heatwave are in italics.

Station number	Station name	State	New record (days)	Previous record (days)	Summer of previous record
41175	Applethorpe	QLD	8	4	2013/14
66137	Bankstown	NSW	22	15	1997/98
68192	Camden	NSW	28	22	1990/91
61260	Cessnock	NSW	32	27	2005/06
64009	Dunedoo	NSW	47	40	2005/06
40082	Gatton	QLD	37	30	1997/98
56013	Glen Innes	NSW	2	1	2013/14
62013	Gulgong	NSW	37	34	2005/06
55024	Gunnedah	NSW	48	45	1951/52
63039	Katoomba	NSW	5	2	2012/13
40126	Maryborough	QLD	23	12	1989/90
39104	Monto	QLD	34	32	2005/06
52020	Mungindi	NSW	78	65	2002/03
61051	Murrurundi	NSW	29	24	1965/66
61055	Newcastle	NSW	9	8	1979/80
41359	Oakey	QLD	37	25	2005/06
63063	Oberon (Springbank)	NSW	4	2	2012/13
66124	Parramatta North	NSW	23	20	1997/98
61250	Paterson (Tocal AWS)	NSW	30	27	1990/91
67019	Prospect Reservoir	NSW	22	18	2005/06
55049	Quirindi	NSW	48	45	2005/06

66062	<i>Sydney (Observatory Hill)</i>	NSW	11	9	1895/96
66037	Sydney Airport	NSW	16	10	1990/91
57095	Tabulam (Muirne)	NSW	11	10	1979/80
70080	Taralga	NSW	13	12	2013/14
41100	Texas	QLD	57	47	2013/14
51049	Trangie	NSW	56	53	2005/06
61078	Williamtown	NSW	20	18	1979/80
60085	Yarras (Mount Seaview)	NSW	29	16	2001/02

Table 8: Sites with 40 or more years of data that have had their highest number of daily maximum temperatures of 40 °C or above this summer 2016–17.

Station number	Station name	State	New record (days)	Previous record (days)	Summer of previous record
66137	Bankstown	NSW	7	4	1978/79
48015	Brewarrina	NSW	34	31	2005/06
68192	Camden	NSW	8	5	2009/10
61260	Cessnock	NSW	13	5	2012/13
48027	Cobar	NSW	24	21	2003/04
64008	Coonabarabran	NSW	4	3	2003/04
44026	Cunnamulla	QLD	44	40	2005/06
64009	Dunedoo	NSW	12	8	2003/04
55024	Gunnedah	NSW	11	10	1951/52
61288	Lostock Dam	NSW	8	4	2000/01
52020	Mungindi	NSW	41	19	2005/06
61051	Murrurundi	NSW	3	2	1965/66
66124	Parramatta North	NSW	8	5	1972/73
61250	Paterson (Tocal AWS)	NSW	13	6	1972/73
67019	Prospect Reservoir	NSW	9	4	2008/09
55049	Quirindi	NSW	13	7	2005/06
43035	Surat	QLD	15	14	1979/80
35070	Taroom	QLD	17	12	2013/14
41100	Texas	QLD	12	9	1979/80
61078	Williamtown	NSW	8	5	1957/58

Notes

This statement is based on data available as of 10 April 2017. There may be some changes because of late-arriving data or the Bureau's standard quality control processes.

The dataset from which area averages and spatial analyses are drawn from commences in 1911. The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) data set (<http://www.bom.gov.au/climate/change/acorn-sat/>) commences in 1910. Station data prior to national introduction of standardised instrument shelters in 1910 are used only if they are known to have been measured using standard equipment comparable with current standards. This is discussed further at <http://www.bom.gov.au/climate/change/acorn-sat/#tabs=Early-data>.

Further information is available from <http://www.bom.gov.au/climate>.