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Widespread record December temperatures in southeast Australia

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1 Introduction

Extreme heat affected much of southeastern Australia in the third week of December 2015. Above-average temperatures became established in parts of the region, especially South Australia, from 13 December onwards. This followed a consistently warm first half of the month in interior southeast Australia.

The most intense phase of the heatwave began on 16 December, as high pressure became established in the Tasman Sea and directed hot northeasterly winds over South Australia. The heat spread over much of southeastern Australia from 18 December as winds turned more northerly, reaching its most intense levels over the weekend of 19–20 December. A trough and cold front crossed the region on 20 December, bringing the heatwave to an end over the most-affected areas, although hot conditions continued over parts of New South Wales on the 21st. The hot air mass also crossed the Tasman, setting a number of records in the South Island of New Zealand on the 21st.¹

Whilst maximum temperatures during this event were well above average, with numerous December records broken in South Australia, Victoria and Tasmania, the most significant aspect was the exceptionally high minimum temperatures on the night of 19–20 December, due to the combination of the very hot air mass and strong winds ahead of the approaching trough. December record- high minimum temperatures were set over wide areas of Victoria and Tasmania, along with some parts of eastern South Australia and southern New South Wales. Mildura recorded the highest minimum temperature ever observed at a Victorian site and a number of other locations in northern Victoria had their hottest night on record for any month.

¹ Further information on the high temperatures in New Zealand can be obtained from MetService (www.metservice.co.nz).

2 Detailed description of the event

2.1 An extended period of hot weather in South Australia

An extended period of hot weather was focused on Adelaide and surrounding areas. The temperature reached 40 °C in Adelaide on each of the four days from 16–19 December. This was the first occasion that four consecutive days of 40 °C or above had occurred in Adelaide in December: runs of three consecutive days of 40 °C or above had previously occurred from 29–31 December 2007, 28–30 December 1898 and 28–30 December 1897, whilst the previous earliest run of four or more consecutive days of 40 °C or above in summer was from 3–6 January 1906.

High temperatures occurred through much of South Australia during this period, but December records for long spells of consecutive days above thresholds were focused primarily on Adelaide and surrounding areas. These included four consecutive days of 40 °C or above from 16–19 December at Snowtown, and six consecutive days of 35 °C or above from 14–19 December at Eudunda. In some cases, December records were set during this event but they fell short of values which occurred during the November 2009 heatwave. For example, Murray Bridge had six consecutive days of 35 °C or above from 14–19 December, but in November 2009 had a run of nine consecutive days of 35 °C or above, the last six above 40 °C.

2.2 19 December— the peak of the heat in South Australia and western Victoria

The highest temperatures of the heatwave occurred on 19 December. Hottest of all was the upper Spencer Gulf region, where Port Augusta reached 47.2 °C², with 45.8 °C at Whyalla and 45.6 °C at Port Pirie. Numerous December records were set in this region, extending to the Mid-North and some regions northeast of Adelaide. Adelaide itself missed a December record, with 43.2 °C being its fourth-hottest December day.³

Overnight temperatures were also high across South Australia on 19 December. While only a few individual station records were set, the consistency of the heat across the State—only in the southeast and on Kangaroo Island did temperatures fall below 20 °C—led to the statewide South Australian average minimum temperature being the highest on record for December, with a value of 26.64 °C surpassing the previous record of 26.31 °C on 19 December 1994. The high daytime and overnight temperatures on the 19th also combined to set a new December State daily mean temperature record of 34.47 °C (previously 34.11 °C on 21 December 1972). The high

² Port Augusta did not report a 24-hour maximum on 19 December due to an instrument failure that evening, but this occurred well after the time of maximum temperature. The value of 47.2 °C is derived from 1-minute resolution data.

³ Adelaide's December record is 44.2 °C on 31 December 1904.

overnight temperatures also extended into parts of northern Victoria, with Echuca setting a (short-lived) Victorian December record-high minimum temperature of 30.3 °C.

There were two other regions in which particularly extreme temperatures occurred. The first of these was in western Victoria, focused on the Geelong area and a region extending westwards from there. Victoria's highest temperature of 45.0 °C occurred at Avalon Airport, whilst 44.4 °C at Geelong was a December record for any Geelong site. Temperatures also exceeded 44 °C at a number of locations in the Wimmera, but these generally fell short of values observed on 31 December 2005. In metropolitan Melbourne (where most sites were between 41 °C and 43 °C, peaking at 43.8 °C at Laverton) temperatures also fell slightly short of those of 31 December 2005. December records also occurred in central Tasmania.

Whilst the number of station records was modest, the extent of the heat across Victoria (including Gippsland, which was relatively mild in the 2005 event) was such that the State-average maximum was the highest on record for December, with 40.76 °C being 0.18 °C above that of 31 December 2005. The daily mean temperature for the State, 31.27 °C, was also a December record (previously 31.09 °C on 24 December 1920).

2.3 An exceptionally hot night on 19–20 December

The most extreme aspect of the event was the very high overnight temperatures which occurred on the night of 19–20 December. Temperatures didn't fall below 30 °C over parts of northern Victoria and western New South Wales, and remained in the mid- to high 20s over much of central and western Victoria. Further south, many Tasmanian sites had minimum temperatures near 20 °C.

At Mildura, the minimum temperature on 20 December was 31.9 °C. This is a new record for the highest overnight minimum temperature observed in Victoria, breaking the previous records of 30.9 °C set at Mildura on 24 January 2001 and Kerang on 26 January 2003. Ouyen (31.1 °C) also surpassed the previous Victorian annual record. Echuca (30.6 °C)—for which it was the second successive night above 30 °C, the first time this has occurred anywhere in Victoria—and Charlton (30.2 °C) were both above the previous Victorian December record of 30.1 °C, set at Swan Hill on 24 December 2009.

Most of the western half of Victoria, and the northern half of Tasmania, had its hottest December night on record. Along with Mildura and Ouyen, it was also the hottest night on record for any month in parts of north-central Victoria, with all-time records set at Bendigo and Castlemaine. In total, record-high minimum temperatures for December occurred over 58 per cent of the area of Tasmania, and 51 per cent of Victoria. A few December records were also set in southern inland New South Wales. Weak onshore flow associated with evening thunderstorms resulted in Melbourne missing a minimum temperature record, but records were set at a number of suburban stations.

Melbourne's 9am temperature of 34.0 °C was, however, a December record, as was Adelaide's 37.5 °C the previous day.

The extent of the warm overnight temperatures contributed to record-high State-average minimum temperatures in both Victoria and Tasmania. The Victorian average of 24.22 °C was more than 1.5 °C above the previous highest December value (22.64 °C on 12 December 1998), and ranks third for any month, only slightly short of the record of 24.40 °C set on 29 January 2009. In Tasmania, the average minimum of 17.86 °C broke the December record of 17.38 °C, also set on 12 December 1998, and ranks sixth on the all-time list (which is headed by 18.74 °C on 30 January 2009).

2.4 20 December—the heatwave concludes

A trough reached eastern South Australia early on the morning of 20 December, then crossed Victoria and Tasmania during the day. As a result, temperatures were substantially cooler than the previous day from central Victoria westwards. However, temperatures did not cool until the late afternoon or evening further north and east, making the 20th the hottest day of the event in eastern Tasmania, parts of Gippsland, northeast Victoria and much of New South Wales.

The most significant extremes occurred on the east coast of Tasmania. Friendly Beaches, in Freycinet National Park, observed a maximum of 39.8 °C, which is the highest December temperature recorded in Tasmania in the post-1910 period. Other station records were also set on the east coast and on Flinders Island, and the Tasmanian daily-mean temperature (23.19 °C) broke the previous December record (22.48 °C on 12 December 1998). Another area where maximum temperature records were set was northeast Victoria and adjacent areas of southern New South Wales. Further north in New South Wales, temperatures were well above normal (including a reading of 41.8 °C at Badgerys Creek in western Sydney) but did not approach record levels.

In total, 33 locations with long-term temperature records, in four States (Victoria, South Australia, Tasmania and New South Wales) set December record-high minimum temperatures during the event (with four of these being records for any month), while 25 locations set December maximum temperature records.

2.5 Monthly temperatures for December 2015

The mid-December heatwave, combined with generally above-average temperatures earlier in the month and at the end of the month, has resulted in many records being set for monthly temperatures in December 2015.

It was the hottest December on record for most of Victoria, South Australia apart from the north, and northern Tasmania (Figure 3). All three States had their highest

December monthly mean temperatures on record, and maximum temperatures for the month were more than 5 °C above average in parts of southern South Australia and western Victoria (Figure 4). Victoria (3.07 °C above the 1961–90 average) broke its previous record (+2.16 °C in 1994) by nearly a degree, whilst South Australia (+2.69 °C, previously +2.24 °C in 1972) and Tasmania (+2.17 °C, previously +1.61 °C in 1973) also set State records by large margins. Victoria (+3.84 °C) also set a record for the highest mean maximum temperature, and South Australia (+2.42 °C) for the highest mean minimum temperature. Numerous location records were also set for monthly temperatures (Tables 3, 4 and 5). Some of these records were set by large margins – for example, Cape Borda and Mount Gambier exceeded their previous December mean monthly maximum temperature records by 2.9 °C and 2.5 °C respectively.

The consistent warm conditions have also resulted in many locations having large numbers of days above thresholds such as 35 °C or 40 °C. Adelaide had seven days of 40 °C or above for the month. This is a record for December (previously four days in December 1897 and December 1898) and is the second-highest number for any month, after 10 days in January 1908. Adelaide also set a December record for the most days of 35 °C or above (13 days, previously 12 in December 1898), whilst other locations to set records for the greatest number of December days of 35 °C or above include Kyancutta (17), Snowtown (17), Nuriootpa (12), Mildura (18), Nhill (12) and Kerang (14).

Widespread record December temperatures in southeast Australia

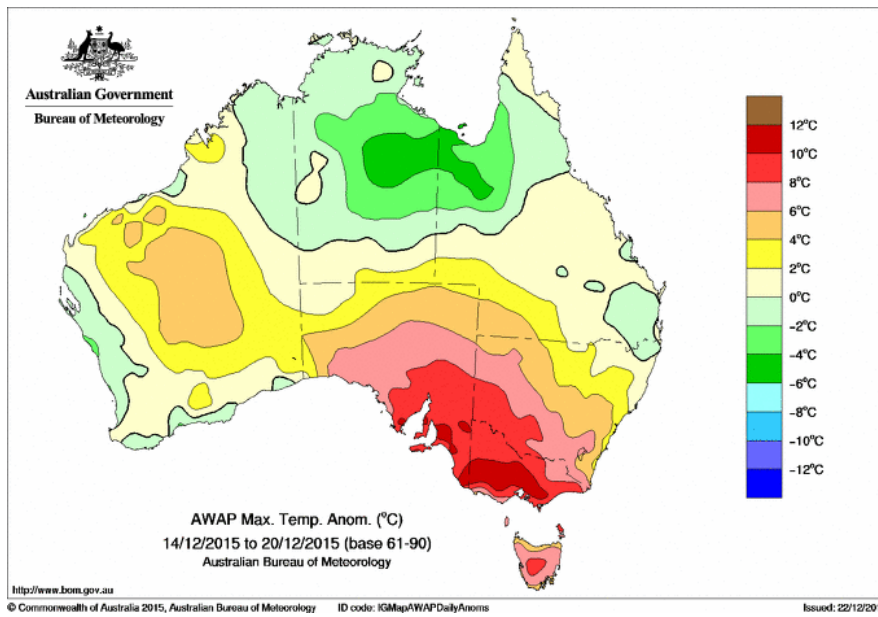
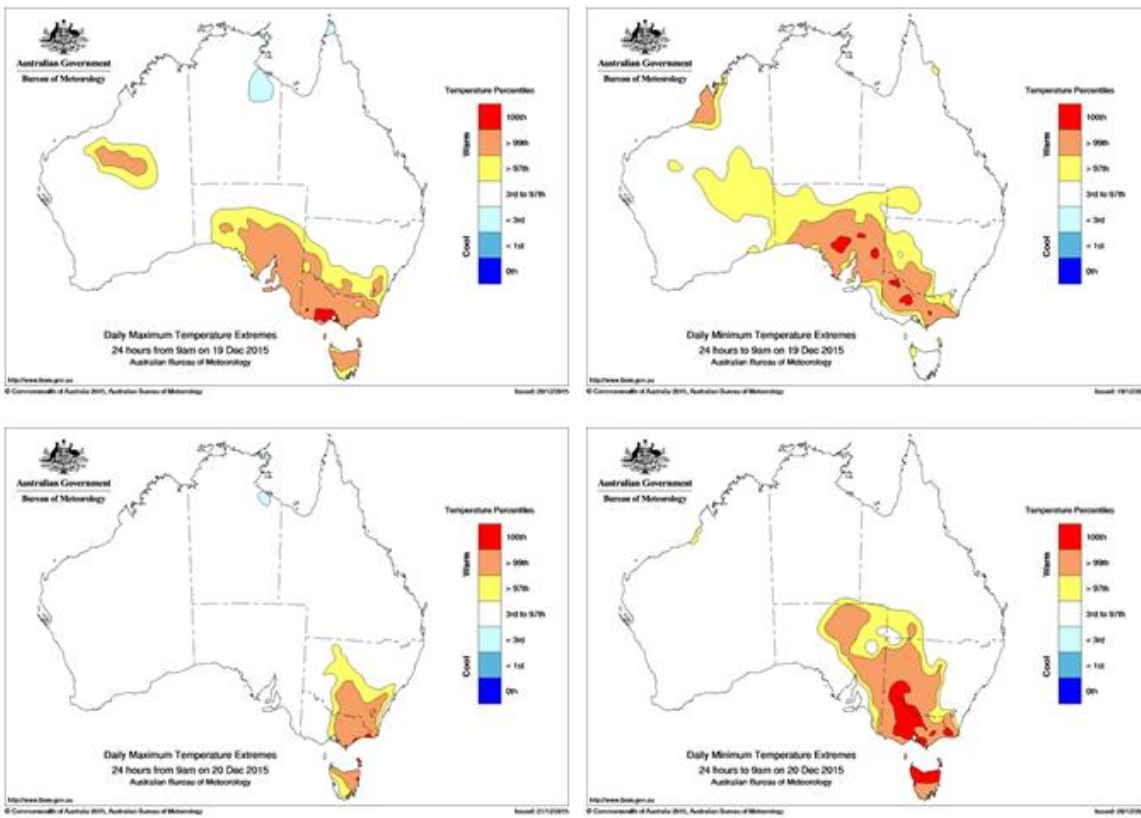


Figure 1. Maximum temperature anomalies (from 1961–90 average) for 14–20 December 2015.

Figure 2. Areas of extreme high temperatures on 19 and 20 December: maximum (left) and minimum (right). Areas of record-high December temperatures are in red.



Widespread record December temperatures in southeast Australia

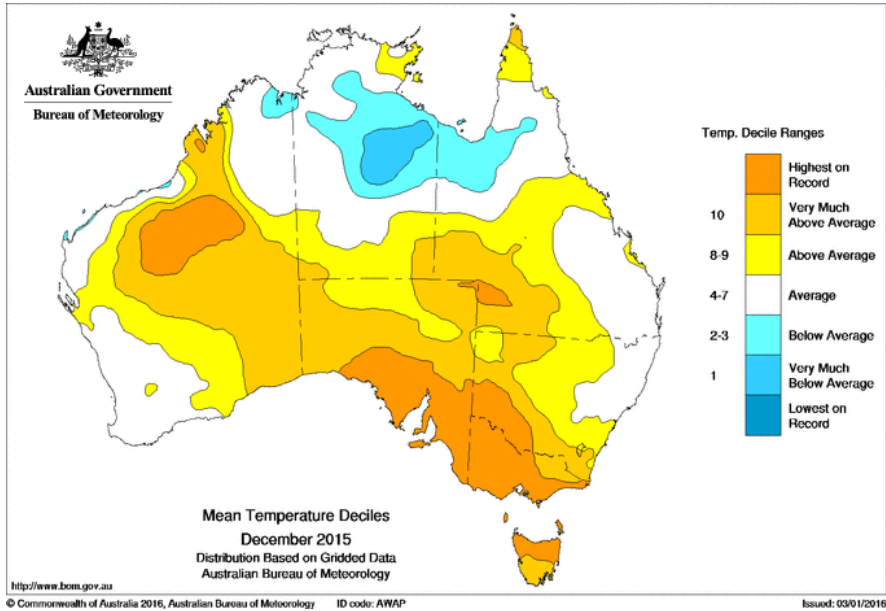


Figure 3. Mean temperature deciles for December 2015.

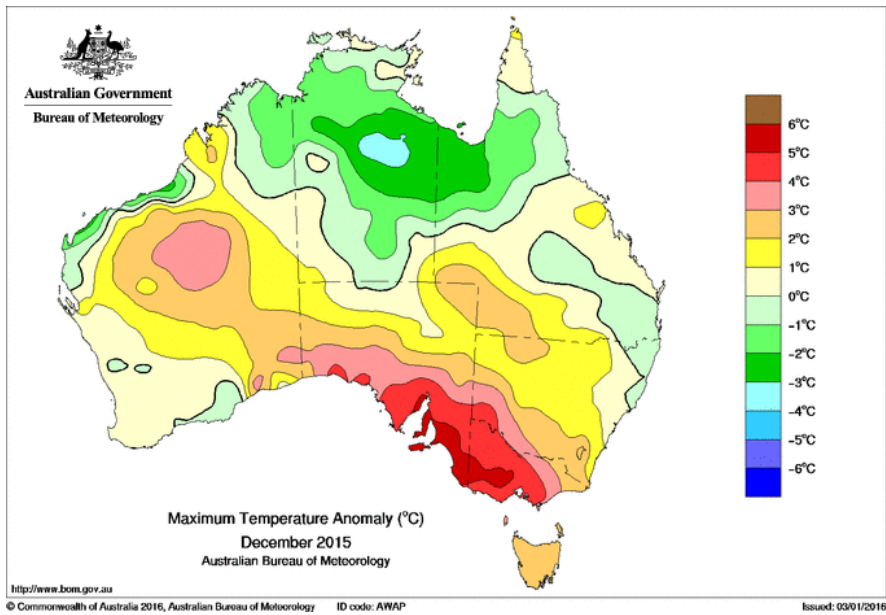


Figure 4. Maximum temperature anomalies (from 1961-90 average) for December 2015.

Station number(s)	Location	State	Temperature (°C)	Previous record
018115	Neptune Island	SA	35.1 (19 Dec)	34.3 (11/12/1998)
018120/018103	Whyalla	SA	45.8 (19 Dec)	44.9 (30/12/1981, 23/12/2012)
018201/016092/ 019066/019036	Port Augusta	SA	47.2 (19 Dec)	46.1 (19/12/1957, 30/12/2005)
021131/021014	Clare (=)	SA	41.7 (19 Dec)	41.7 (19/12/1957)
<i>021133/021046</i>	<i>Snowtown</i>	SA	<i>45.2 (19 Dec)</i>	<i>45.0 (10/12/1919)</i>
021139/021118/ 021043	Port Pirie	SA	45.6 (19 Dec)	44.6 (30/12/2005)
023083	Edinburgh (=)	SA	43.5 (19 Dec)	43.5 (10/12/1980)
024511	Eudunda	SA	41.8 (19 Dec)	41.7 (30/12/2005)
072162/072060	Khancoban	NSW	40.7 (20 Dec)	39.7 (31/12/2005, 17/12/2009)
074148/074221	Narrandera	NSW	43.2 (20 Dec)	43.0 (31/12/2005, 21/12/2013)
082138/082053	Wangaratta	VIC	42.2 (20 Dec)	41.7 (19/12/2013)
084070	Point Hicks	VIC	41.4 (20 Dec)	39.6 (11/12/1980)
<i>084145/084030</i>	<i>Orbost (=)</i>	VIC	<i>41.3 (20 Dec)</i>	<i>41.3 (30/12/2003)</i>
084150/084083	Lakes Entrance	VIC	41.7 (20 Dec)	41.4 (12/12/1998)
085279/084108/ 084080	Bairnsdale	VIC	41.6 (20 Dec)	41.0 (12/12/1998)
086104	Scoresby (=)	VIC	41.5 (19 Dec)	41.5 (31/12/2005)
086127	Wonthaggi	VIC	41.7 (19 Dec)	39.7 (11/12/1998)
087184/087163/ 087117/087025	Geelong	VIC	44.4 (19 Dec)	43.1 (31/12/2007)
089002	Ballarat (=)	VIC	40.6 (19 Dec)	40.6 (31/12/2005)
090035/090022/ 090174/090147	Colac	VIC	42.6 (19 Dec)	41.8 (10/12/1980)
090186/090172/ 090082	Warrnambool	VIC	43.0 (19 Dec)	42.5 (10/12/1980)
092027	Orford	TAS	37.5 (20 Dec)	37.2 (14/12/1972)
<i>096003</i>	<i>Butlers Gorge</i>	TAS	<i>32.6 (19 Dec)</i>	<i>32.2 (29/12/1960)</i>
096071/096015	Lake St. Clair	TAS	32.7 (19 Dec)	32.6 (31/12/2007)
099005	Flinders Island Airport	TAS	38.3 (20 Dec)	36.5 (12/12/1998)

Table 1. December record-high maximum temperatures at locations with 40 years or more of data. ACORN-SAT locations are shown in italics.

Widespread record December temperatures in southeast Australia

Station number(s)	Location	State	Temperature (°C)	Previous record
016001	Woomera	SA	31.8 (19 Dec)	30.5 (30/12/1949)
017110/017005	Leigh Creek	SA	32.5 (19 Dec)	32.4 (31/12/1981)
020062/020026	Yunta	SA	29.3 (19 Dec)	28.5 (17/12/2003)
024048/024016	Renmark ⁴	SA	29.9 (19 Dec)	27.8 (31/12/2009)
047016	Lake Victoria	NSW	28.1 (19 Dec)	27.8 (4/12/1970)
049002	Balranald	NSW	29.4 (20 Dec)	29.0 (22/12/1972)
072161/072091	Cabramurra (=)	NSW	19.0 (20 Dec)	19.0 (21/12/1994, 17/12/2009)
074258/074128	Deniliquin	NSW	30.0 (20 Dec)	29.9 (24/12/2009)
076031	Mildura	VIC	31.9 (20 Dec)	28.9 (24/12/2009, Dec), 30.9 (24/1/2001, all months)
076047	Ouyen	VIC	31.1 (20 Dec)	28.8 (20/12/2013, Dec), 30.3 (28/1/1957, all months)
078077	Warracknabeal	VIC	29.0 (20 Dec)	27.0 (12/12/1998)
080015	Echuca	VIC	30.6 (20 Dec)	29.0 (24/12/2009)
080023	Kerang	VIC	30.0 (20 Dec)	28.8 (23/12/1968)
080091	Kyabram	VIC	29.1 (20 Dec)	27.4 (24/12/2009)
081123/081003	Bendigo	VIC	29.0 (20 Dec)	26.5 (24/12/1942, Dec), 28.6 (16/1/2014, all months)
082042	Strathbogie	VIC	25.0 (19 Dec)	23.1 (24/12/2009)
086038	Essendon	VIC	26.2 (20 Dec)	25.9 (24/12/2012)
086077	Moorabbin	VIC	28.5 (20 Dec)	26.3 (7/12/1994)
086104	Scoresby	VIC	27.6 (20 Dec)	26.6 (27/12/1970)
087031	Laverton	VIC	28.0 (20 Dec)	26.0 (24/12/2012)
088043	Maryborough	VIC	23.9 (19 Dec)	23.0 (7/12/1990)
088109	Mangalore	VIC	26.4 (20 Dec)	25.3 (11/12/1980)
088110	Castlemaine	VIC	28.9 (19 Dec)	26.7 (11/12/1980, Dec), 28.5 (12/1/2010, all months)
089085	Ararat	VIC	25.2 (20 Dec)	22.8 (13/12/2012)
090035/090022/ 090147/090174	Colac	VIC	24.9 (20 Dec)	21.5 (17/12/2013)
091107/091112	Wynyard	TAS	18.6 (20 Dec)	18.1 (15/12/1973)

⁴ Previous record shown is prior to 2015. Renmark also observed 28.8 °C on 7 December 2015.

091126/091232/ 091111	Devonport	TAS	19.5 (20 Dec)	18.2 (15/12/1973)
091219	Scottsdale	TAS	19.8 (20 Dec)	18.6 (12/12/1998)
091223	Marrawah	TAS	20.0 (20 Dec)	19.0 (30/12/1979)
091292/091092	Smithton	TAS	20.1 (20 Dec)	18.3 (31/12/2002)
<i>091293/091057</i>	<i>Low Head</i>	<i>TAS</i>	<i>19.3 (20 Dec)</i>	<i>18.6 (29/12/1916, 25/12/1920)</i>
<i>091311/091104</i>	<i>Launceston Airport</i>	<i>TAS</i>	<i>19.5 (20 Dec)</i>	<i>19.0 (13/12/1994)</i>
<i>092045</i>	<i>Larapuna (Eddystone Point)</i>	<i>TAS</i>	<i>18.8 (20 Dec)</i>	<i>18.3 (16/12/1960)</i>

Table 2. December record-high minimum temperatures at locations with 40 years or more of data. ACORN-SAT locations are shown in italics. Records for any month are shown in bold.

Widespread record December temperatures in southeast Australia

Station number(s)	Location	State	Temperature (°C)	Previous record
004106/004020	Marble Bar (=)	WA	43.9	43.9 (1961, 1986)
005026	Wittenoom	WA	42.7	41.8 (2014)
016001	Woomera	SA	35.7	35.3 (1994)
018012	Ceduna	SA	31.7	30.4 (1951)
018044	Kyancutta (=)	SA	35.1	35.1 (1931)
018192/018070	Port Lincoln	SA	28.9	27.2 (2005)
021133/021046	Snowtown	SA	34.1	32.9 (2000)
022823/022801	Cape Borda	SA	26.7	23.8 (1965)
023090/023000	Adelaide	SA	32.5	31.6 (1898)
023373/023321	Nuriootpa	SA	31.3	29.5 (1965)
026021	Mount Gambier	SA	28.7	26.2 (1960)
026026	Robe	SA	25.1	23.6 (1960)
076031	Mildura	VIC	34.6	33.5 (1994)
078015/078031	Nhill	VIC	32.1	31.3 (1994)
080023	Kerang	VIC	33.5	33.0 (1994)
084016	Gabo Island	VIC	22.1	22.0 (2000, 2005)
084145/084030	Orbost	VIC	26.5	26.0 (2005)
087031	Laverton	VIC	27.8	27.7 (2005)
091311/091104	Launceston Airport	TAS	24.9	24.4 (1960)

Table 3. ACORN-SAT locations which set records for highest December mean maximum temperature in December 2015.

Station number(s)	Location	State	Temperature (°C)	Previous record
003003	Broome	WA	28.0	27.7 (2011)
016001	Woomera	SA	20.7	20.1 (1965)
022823/022801	Cape Borda	SA	14.8	14.0 (1980)
023373/023321	Nuriootpa (=)	SA	14.6	14.6 (1965)
036031	Longreach	QLD	24.9	24.3 (2009)
080023	Kerang	VIC	16.2	15.8 (1914)
084145/084030	Orbost	VIC	14.2	14.1 (1988)
092045	Larapuna (Eddystone Point) (=)	TAS	13.7	13.7 (1985)

Table 4. ACORN-SAT locations which set records for highest December mean minimum temperature in December 2015.

Station number(s)	Location	State	Temperature (°C)	Previous record
016001	Woomera	SA	28.2	27.5 (1965)
016098/16044	Tarcoola	SA	28.5	27.8 (1972, 1994)
018012	Ceduna	SA	23.6	23.2 (1965)
018044	Kyancutta	SA	24.9	24.3 (1965)
018192/018070	Port Lincoln	SA	21.6	20.8 (1950)
021133/021046	Snowtown	SA	24.1	24.0 (1913)
022823/022801	Cape Borda	SA	20.7	18.9 (1965)
023090/023000	Adelaide	SA	25.3	24.7 (1897)
023373/023321	Nuriootpa	SA	22.9	22.1 (1965)
026021	Mount Gambier	SA	19.8	18.5 (1965)
026026	Robe	SA	19.4	18.8 (1973)
038026/038002	Birdsville	QLD	33.5	33.2 (2012)
074258/074128	Deniliquin	NSW	24.7	24.5 (1914)
076031	Mildura	VIC	26.2	25.2 (1965)
078015/078031	Nhill	VIC	23.4	22.3 (1950)
080023	Kerang	VIC	24.9	24.2 (1994)
084145/084030	Orbost	VIC	20.6	20.2 (1980)
085072	Sale	VIC	19.5	19.1 (2003)
087031	Laverton	VIC	20.7	20.1 (2003)
091311/091104	Launceston Airport	TAS	17.3	17.1 (1960)
092045	Larapuna (Eddystone Point)	TAS	17.9	17.8 (2007)

Table 5. ACORN-SAT locations which set records for highest December monthly mean temperature in December 2015.

Widespread record December temperatures in southeast Australia

Notes and contacts

Values in this statement are current at 5 January 2016, and subject to the Bureau's quality control processes.

The dataset from which area averages and spatial analyses are drawn from commences in 1911. 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 (as is the case at Adelaide from 1887 onwards). This matter 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/>. New Zealand information is sourced from MetService (<http://www.metservice.co.nz>) and NIWA (<http://www.niwa.co.nz/climate/summaries/monthly>).