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Bureau of Meteorology

Annual Climate Report 2014

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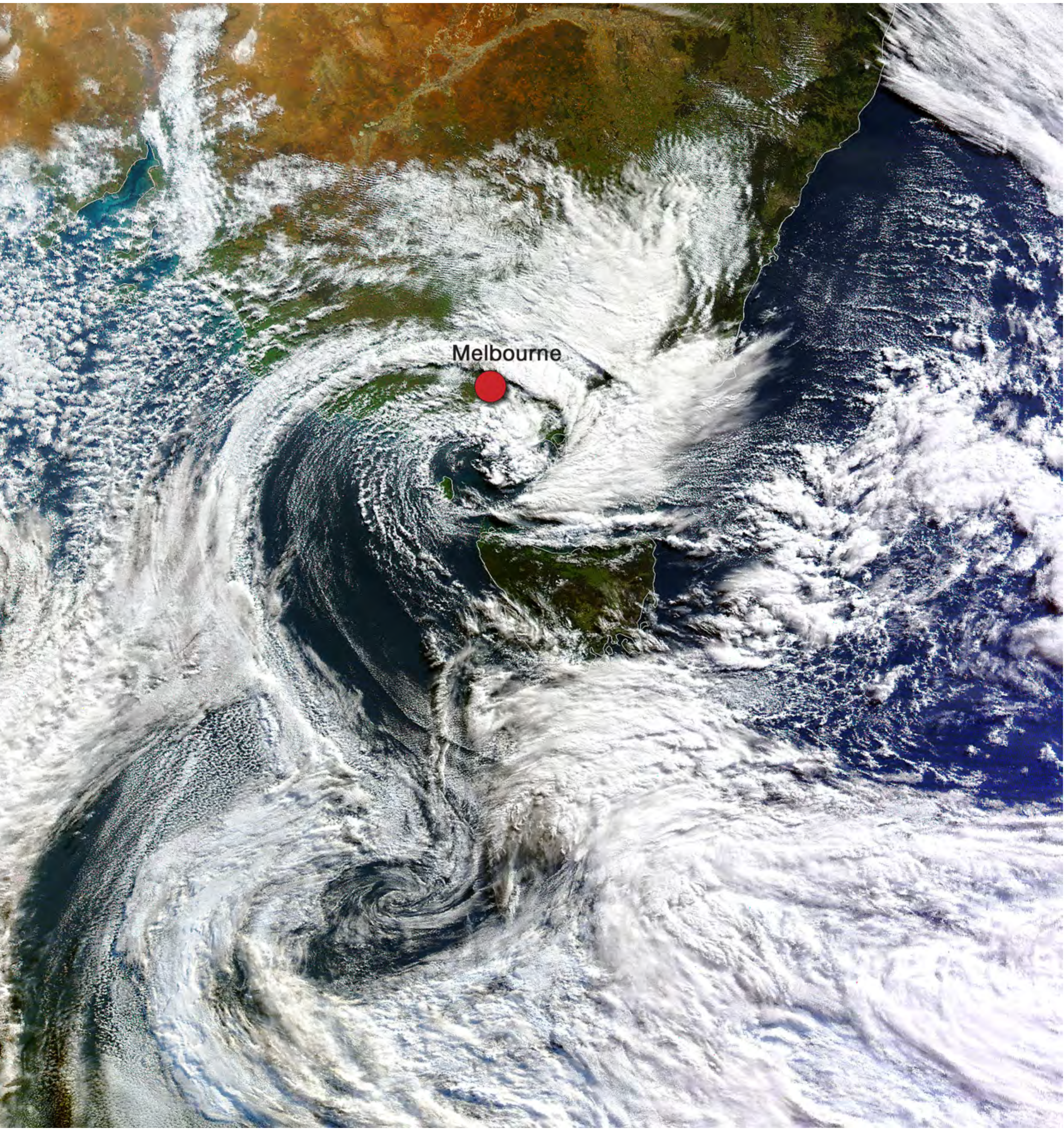
This document is also available online: www.bom.gov.au/climate/annual_sum/2014/

This edition is based on data available as of 21 January 2015. Some data have not yet been fully quality controlled.

Cover picture: Waves crash across St Kilda Pier in Port Phillip, Melbourne, 24 June, driven by the passage of destructive cold fronts. Photograph: Liam Edleston.

Picture on this page: A view from Victoria Valley, 15 November, showing clouds over the Serra Range in the southern Grampians National Park, western Victoria. Photograph: Karl Braganza.

Contents



Complex weather system passing over southeastern Australia captured by NASA's Earth Observation System (EOS) Terra satellite, 24 June. A low pressure centre is present south of Melbourne and another to the southwest of Tasmania, with tight bands of cloud marking the associated cold fronts. This system was responsible for very strong winds across much of southeastern Australia and associated damage in Victoria, Tasmania, South Australia and New South Wales.

1. Overview

2014 was Australia's third-warmest year on record. Following Australia's warmest year in 2013, warmth persisted throughout 2014 with multiple nationally significant heatwaves and several severe bushfires. Australian mean rainfall was slightly above average; however, large parts of the eastern States and the west coast of Western Australia experienced below-average rainfall. The year was also marked by a number of significant storms.

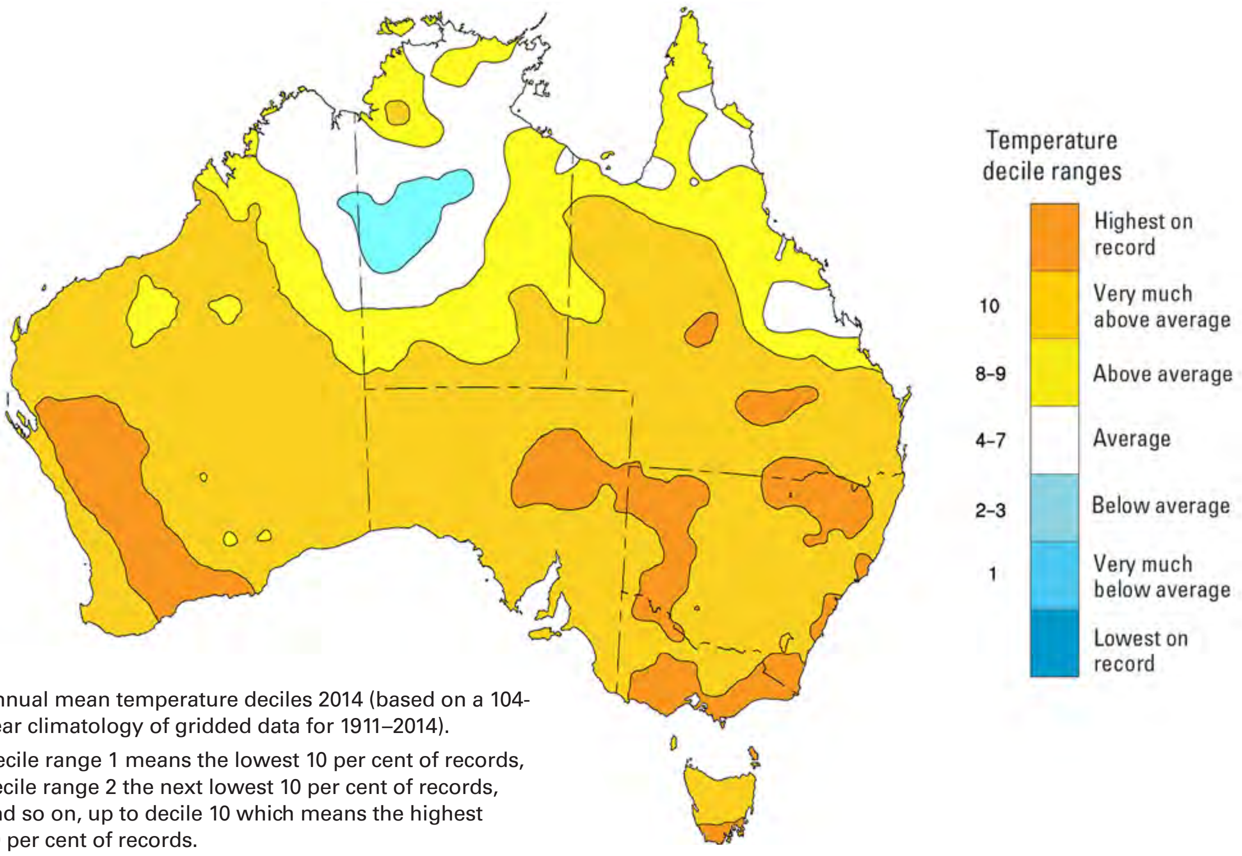
Australia's third-warmest year on record

The area-averaged mean temperature for 2014 was 0.91 °C above the 1961–1990 average, making it the third-warmest year since national records began in 1910.[1] Annual mean temperatures for all States, except the Northern Territory, were also in the four warmest years on record.

Maximum temperatures were 1.16 °C above average nationally, the fourth warmest on record. Minimum temperatures were 0.66 °C above average, the sixth-warmest on record.

Mean, maximum and minimum temperatures were in the highest 10 per cent of observations across the southern half of Australia and parts of inland Queensland. Large areas of southeastern Australia and the South West Land Division of Western Australia recorded highest-on-record annual maximum and mean temperatures. For southern Australia as a whole, the annual mean temperature anomaly was +1.28 °C, the second-warmest on record, behind the record set in 2013. In northern Australia, maximum and mean temperatures were very much above average for northwestern Western Australia and western Queensland, and maximum temperatures were also very much above average for the Top End.

Mean temperatures were near average across the remainder of the north, except for an area northwest of



Annual mean temperature deciles 2014 (based on a 104-year climatology of gridded data for 1911–2014).

Decile range 1 means the lowest 10 per cent of records, decile range 2 the next lowest 10 per cent of records, and so on, up to decile 10 which means the highest 10 per cent of records.

[1]Unless otherwise stated, all climatological averages are calculated over the 30-year period 1961–1990, as defined by the World Meteorological Organization. Anomalies are the difference between an observed value and the corresponding average over the reference period. Unless otherwise noted, rankings are for the period from 1910 for temperature records and for the period from 1900 for rainfall records.

Alice Springs where above-average rainfall brought cooler-than-average temperatures. Minimum temperatures were near average for much of the tropical north and cooler than average for areas in the Northern Territory around the Victoria River District, coastal Top End and a small area north of Rockhampton.

2014 commenced with heatwaves affecting central and eastern Australia at the start of the year and southeast Australia during mid-January. Several other significant heatwaves and warm spells also occurred: during the second half of May affecting most of Australia but especially the southeast; during late October across the southern half of Australia; and during November with two separate heatwaves affecting central Australia, New South Wales, southern Queensland and the Northern Territory in the middle of the month and persisting across New South Wales and Queensland late into the month (see page 18 for more detail). Spring was the warmest on record for Australia, breaking the record set in 2013.

Warmer-than-average years in Australia are often associated with the warm phase of the El Niño–Southern Oscillation (ENSO). Signs of a developing El Niño emerged in early autumn 2014 and, while indicators remained near or just below threshold values for much of the year, the event did not consolidate. Nevertheless, El Niño-like effects were seen through warmer daytime temperatures and drier conditions for much of eastern Australia.

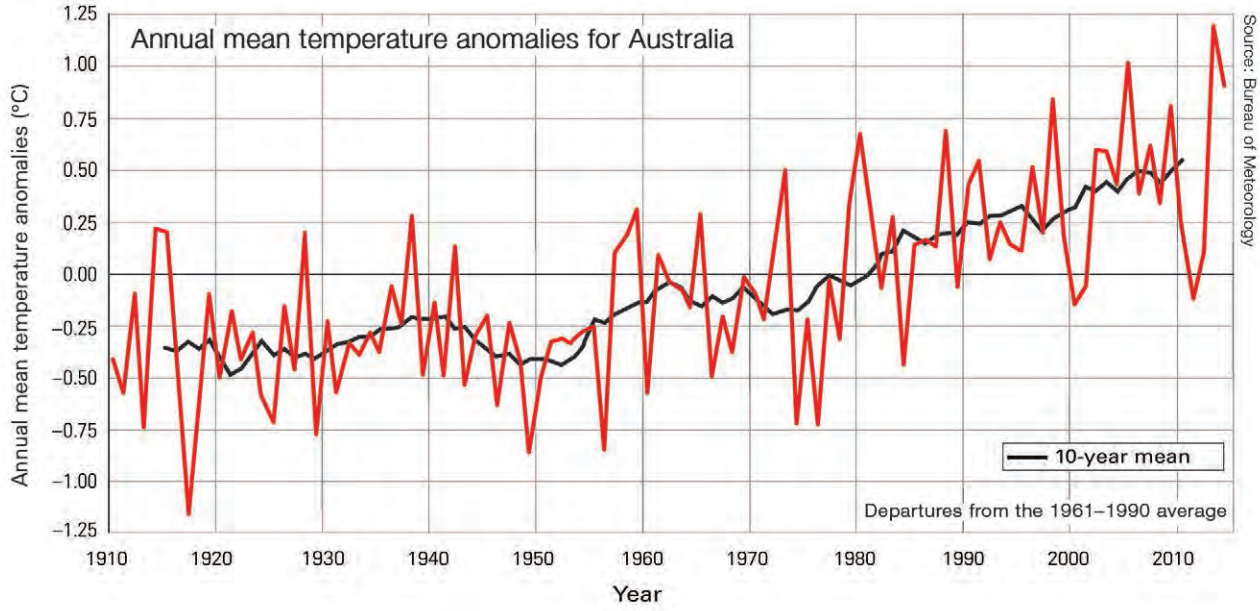
Seven of Australia's ten warmest years on record have occurred in the 13 years between 2002 and 2014, and Australia has experienced just one cooler-than-average year (2011) in the last decade. The ten-year mean temperature for 2005–2014 was 0.55 °C above average, the highest on record. All of the most recent ten-year averages (i.e. 1996–2005 to 2005–2014) have been within the ten warmest on record. Warming in the Australian region is very similar to that seen at the global scale, and the past year emphasises that the warming trend continues. Temperatures over Australia have risen by about one degree since the start of last century, with most of the warming occurring since 1950.

Globally, the warmest year on record

The World Meteorological Organization combines data from three datasets to calculate global mean temperatures.[2] The combined sea surface and land air temperature for 2014 was 0.57 °C ± 0.10 °C above the 1961–1990 average.

Using this method, 2014 ranks as the warmest year on record since global observations commenced in 1880.

No year since 1985 has recorded a below-average global mean temperature and all of the ten warmest years have occurred between 1998 and 2014. The ten-year global average for 2005–2014 was 0.49 °C above the 1961–1990 average, making it the warmest ten-year period since 1880.



[2]UK Met Office Hadley Centre (HadCRUT4), the US National Climatic Data Center (MLOST) and the NASA Goddard Institute for Space Studies (GISTEMP).

Slightly above-average rainfall, but dry in the east and along the west coast

Nationally averaged rainfall was 483.5 mm, which is 18.3 mm above the long-term average of 465.2 mm. This places 2014 somewhat above the median of historical observations.

Annual rainfall was above average for the west of the Cape York Peninsula, from south of the Gulf of Carpentaria; through the Northern Territory except most of the Top End and southeast; across Western Australia away from the west coast; in southwestern South Australia and smaller areas extending to the New South Wales border, and also in a small area covering East Gippsland and far southeastern New South Wales.

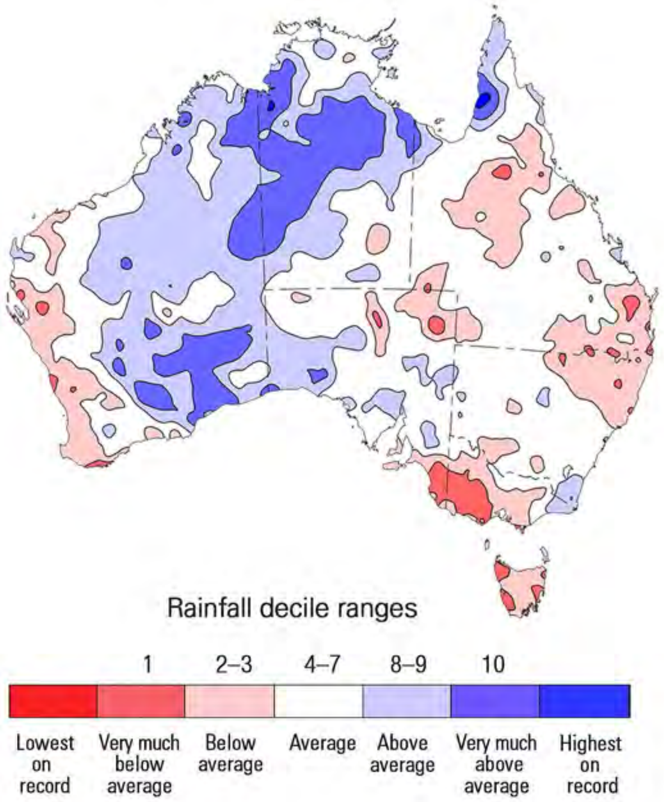
Annual rainfall was below average along the Western Australian coast between the Pilbara and the southwest; across most of Victoria, southeast South Australia, part of southern New South Wales and all of Tasmania; a large part of inland northern Queensland, southeastern Queensland and northeastern New South Wales and an area extending from southwestern Queensland into northeastern South Australia.

Annual rainfall totals were in the lowest 10 per cent of records for much of western Victoria, southeast South Australia and coastal Tasmania, as well as other scattered small areas. For Victoria annual rainfall has been below average for nearly all of the 18 years since 1997—only 2000, 2010 and 2011 recorded above-average rainfall, all years affected by La Niña.

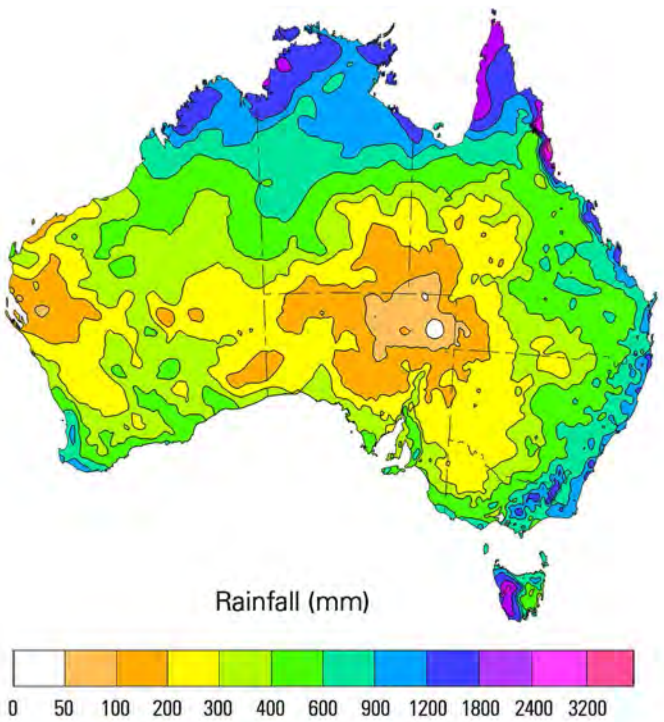
Large parts of eastern Australia began the year with long-term rainfall deficiencies in place. For much of the eastern mainland, rainfall has been below average in the majority of months over the last two and a half years (i.e. since the end of the 2011–12 La Niña), with prolonged drought conditions affecting inland and southeastern Queensland and northeastern New South Wales. Below-average rainfall across much of eastern Australia during 2014, particularly between July and November, saw rainfall deficiencies increase in the western half of Victoria, southeast South Australia and Tasmania. For southeastern Australia as a whole, August–October was the ninth-driest such period on record.

Rainfall patterns during 2014 reinforce the pattern of recent decades, with above-average rainfall during the peak of the summer monsoon season and below-average rainfall during the cooler half of the year.

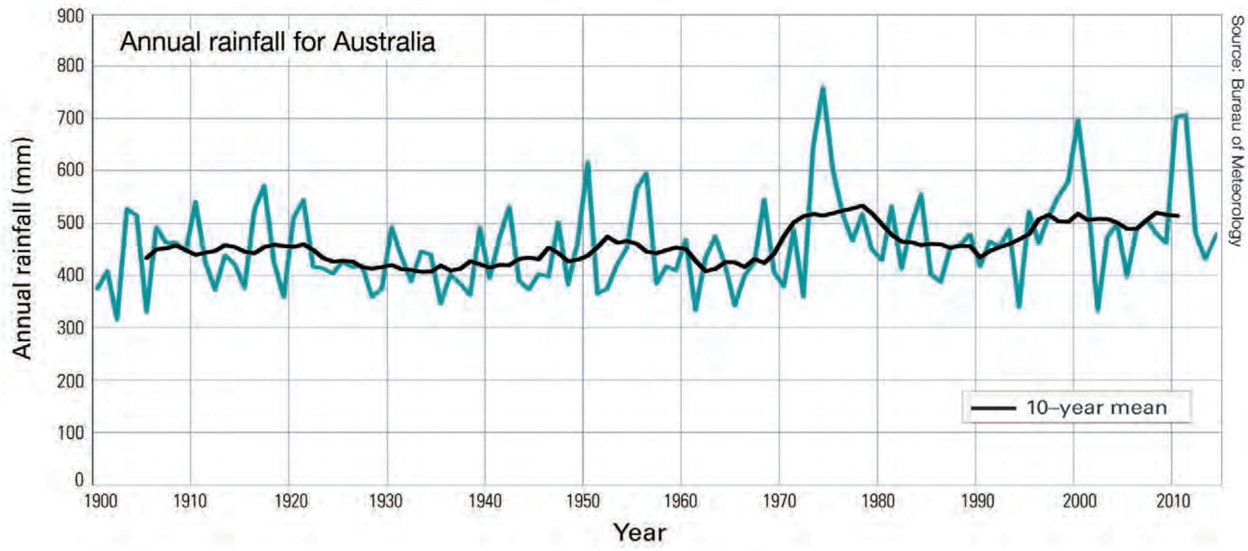
There were a number of flood and storm events during 2014. Tropical cyclone *Ita* caused flooding in coastal northern Queensland in April and a significant East Coast Low brought storm damage and flooding to New South Wales in August. For details of these and other events see page 15.



Annual rainfall deciles 2014 (based on a 115-year climatology of gridded data for 1900–2014).



Annual rainfall totals 2014.



Capital cities

All capital cities recorded warmer-than-average maximum temperatures (see page 5). Annual maximum temperatures for all capital cities except Darwin ranked among the warmest four years on record. Annual mean temperatures were also in the top four for all capital cities except Darwin and Perth. Annual minimum temperatures were among the warmest two years on record for Sydney and Melbourne. Darwin observed cooler-than-average nights.

Adelaide's temperature of 45.1 °C on 14 January was the highest daily maximum temperature for a capital city during 2014. Perth, Canberra and Melbourne recorded their warmest day of the year in the same week.

The lowest temperature recorded at a capital city was –7.6 °C in Canberra on 5 August. Adelaide, Sydney and Melbourne also recorded their coldest night of the year during the same week.

No capital city exceeded its annual average rainfall, although Adelaide did record an annual total above the long-term median. Perth, Brisbane, Sydney, Melbourne and Hobart recorded annual rainfall in the lowest 20 per cent of observations. Hobart and Sydney recorded the highest number of rain days (147 and 146 respectively) while Perth, Canberra and Darwin recorded the fewest (104, 104 and 108, respectively).

	Rainfall (mm)			Maximum temperature (°C)			Minimum temperature (°C)		
	2014 total	1961–1990 average	Rank (of 115)	2014 anomaly	1961–1990 average	Rank (of 105)	2014 anomaly	1961–1990 average	Rank (of 105)
Australia	483.5	465.2	38	1.16	28.55	4	0.66	15.07	6
New South Wales / ACT	467.3	552.8	79	1.76	23.91	=1	1.06	10.75	4
Northern Territory	690.8	540.3	12	0.51	31.88	=17	0.08	18.45	40
Queensland	569.6	623.4	69	1.05	29.88	5	0.87	16.57	7
South Australia	207.6	225.2	53	1.64	26.71	2	1.11	12.20	2
Tasmania	1166.0	1390.4	104	1.09	14.72	1	0.52	5.99	7
Victoria	549.9	660.2	93	1.53	19.85	1	0.77	8.34	=3
Western Australia	405.9	340.9	23	1.16	29.27	1	0.52	15.66	10
Murray–Darling Basin	415.6	488.4	78	1.76	24.45	=1	1.08	10.87	4

Summary of 2014 mean rainfall and temperatures for Australia, the States, the Northern Territory and the Murray–Darling Basin. Ranks are for all years since national records began (1900 for rainfall, 1910 for temperature), with 1 indicating the wettest/warmest year. Annual mean temperatures can be calculated from the average of the mean maximum and mean minimum temperatures. Area averages are calculated over continental Australia and the main island of Tasmania.

2. Capital city summary

Long-term averages are based on the period 1961–1990 with the exceptions of: Adelaide (1981–2010), Brisbane (1961–1985, temperature only), and Perth (1994–2014, temperature only).

Data were recorded at Bureau of Meteorology official city observation stations. Averaging periods are calculated based on the availability of historical data from these or other comparable stations.

Decile ranges are calculated from station data for stations with an available long-term record. They are supplemented with gridded monthly analyses based on all available data where suitable station observations are not available (particularly for Darwin and Canberra during 1900–1940).

City	Highest temp. (°C) Date	Lowest temp. (°C) Date	Average maximum Long-term average Anomaly (°C)	Average minimum Long-term average Anomaly (°C)	Rainfall (mm), no. rain days Long-term average (mm) Decile range (1900–2014)
Perth	43.3 11 January	1.9 14 June	25.4 24.5 +0.9	13.5 12.6 +0.9	674.4 on 104 days 819.4 2
Darwin	37.4 19 September	13.0 23 August	32.6 32.0 +0.6	23.0 23.3 –0.3	1547.4 on 108 days 1705.1 7
Adelaide	45.1 14 January	0.9 4 August	23.6 22.3 +1.3	12.9 12.2 +0.7	534.2 on 111 days 546.3 6
Brisbane	38.9 16 November	2.6 12 July	27.0 25.6 +1.4	16.7 16.4 +0.3	790.2 on 117 days 1217.7 2
Sydney	36.5 1 November	5.5 3 August	23.5 22.1 +1.4	15.2 14.2 +1.0	897.2 on 146 days 1302.2 2
Canberra	40.2 15 January	–7.6 5 August	21.5 19.6 +1.9	6.7 6.5 +0.2	568.6 on 104 days 623.2 4
Melbourne	43.9 17 January	1.4 3 August	21.7 20.0 +1.7	12.4 11.0 +1.4	475.2 on 129 days 638.8 2
Hobart	38.9 28 January	1.2 9 June	18.3 17.1 +1.2	9.3 8.7 +0.6	484.2 on 147 days 586.4 2

3. Monthly maximum and minimum temperatures

January was warmer than average for eastern Australia. New South Wales, Victoria, Tasmania and South Australia recorded monthly maxima in the top ten records for January. Queensland, Victoria and South Australia also recorded top-ten mean temperature anomalies.

February remained warm for both maxima and minima in the southeast, but above-average rainfall meant maximum temperatures were below average across most of the north. Maxima were also below average across the east of Western Australia, extending to the southern coastline.

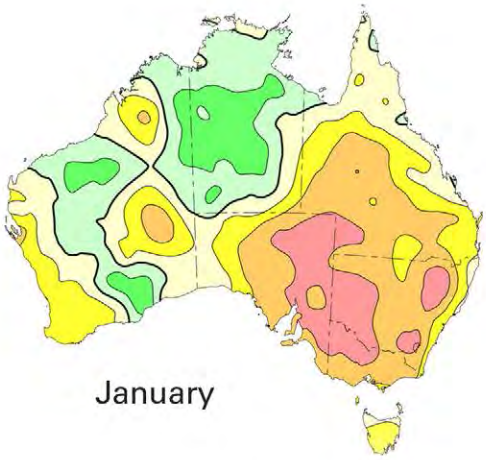
March and April were generally warmer than average for both maxima and minima, with April minima especially warm for the mainland, except Western Australia. The eastern mainland States and South Australia ranked in the top eight warmest April minima. Nationally, April minima were the fourth-warmest on record and mean temperatures the seventh-warmest. Warm nights throughout inland Queensland resulted in the State's warmest April monthly minimum temperature on record.

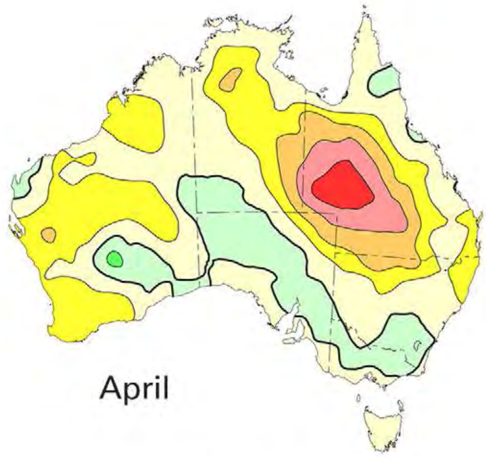
May maxima were in the top ten for all but Tasmania and Western Australia, and minima were also in the top ten for Victoria, South Australia (highest on record for May at +3.03 °C above average) and Western Australia. Rankings for mean temperature anomalies for May were also notable, with only Tasmania not placed within the top eight.

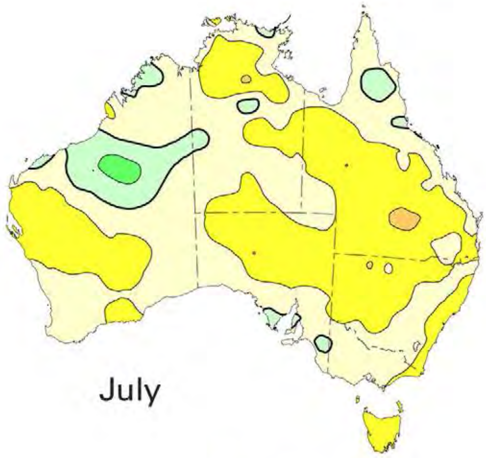
June maxima and minima were above average across eastern Australia, while minima were below average for a large part of Western Australia and the southwest of the Northern Territory.

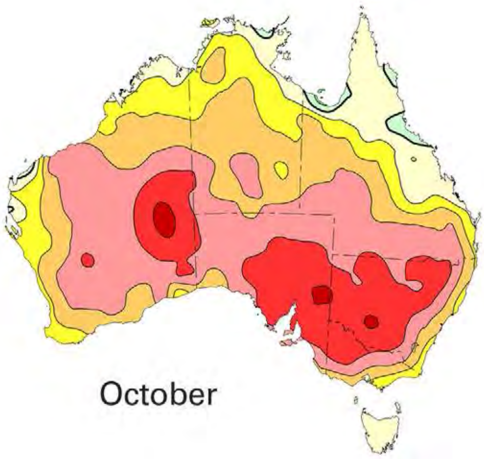
July maxima were above average across most of Australia and the fifth-warmest on record for Tasmania, while minima were above average along the southern coast and in Tasmania and below average for large parts of the rest of the mainland.

August maxima were warmest on record along the west coast of Western Australia, with a large area around the Gascoyne recording anomalies in excess of five degrees. Minima were also warmest on record for a smaller part of the west coast. August maxima were notable for Tasmania (fourth-warmest on record) and warmer than average for the southeast.


January

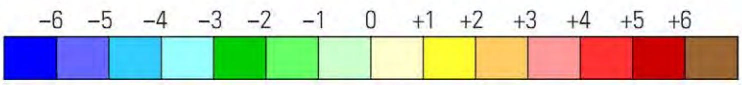

April

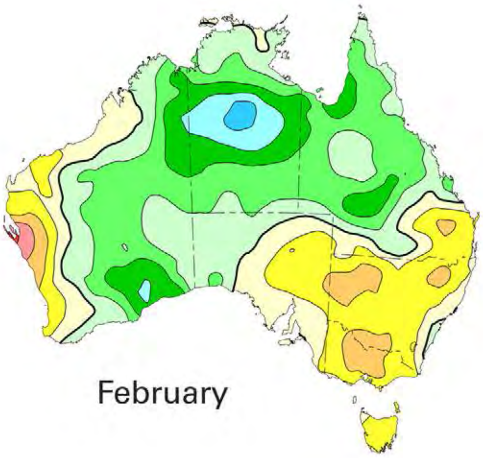

July


October

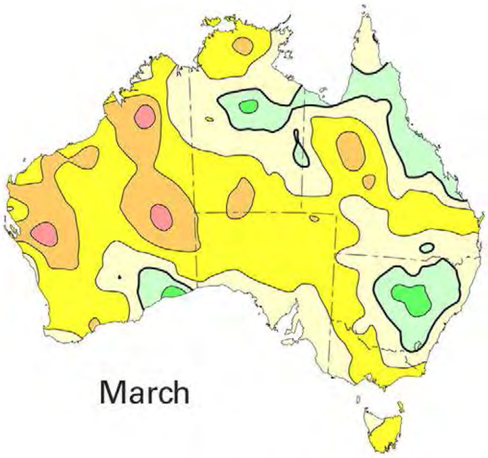
Maximum temperature: departures from average (°C)

Based on 30-year mean calculated from 1961–1990

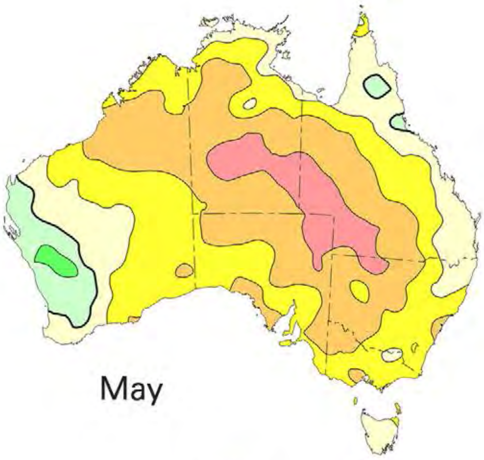




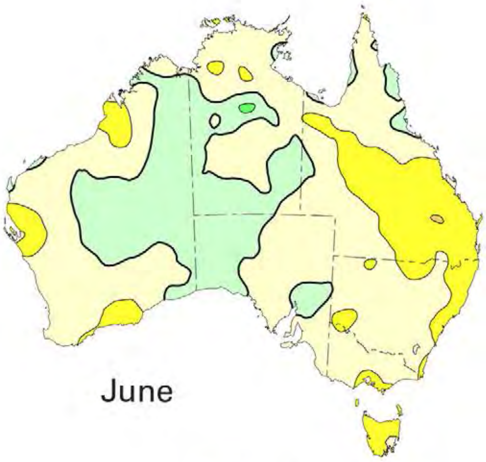
February



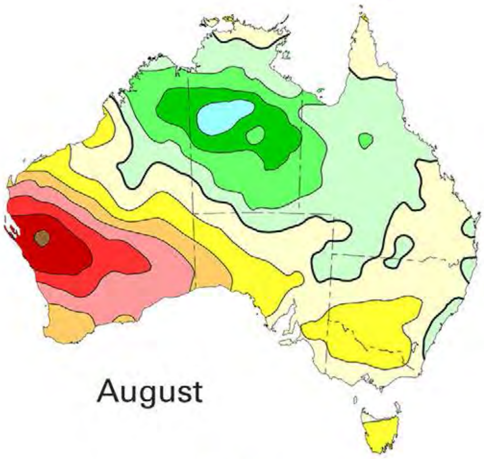
March



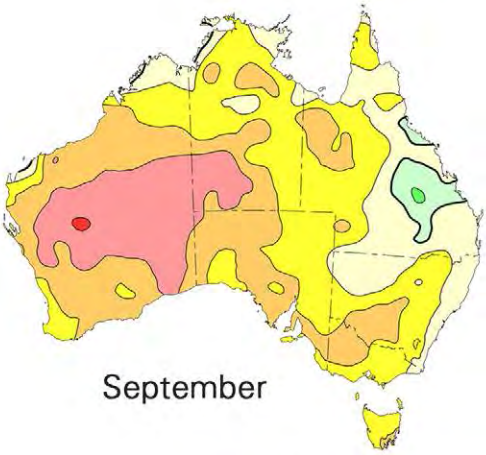
May



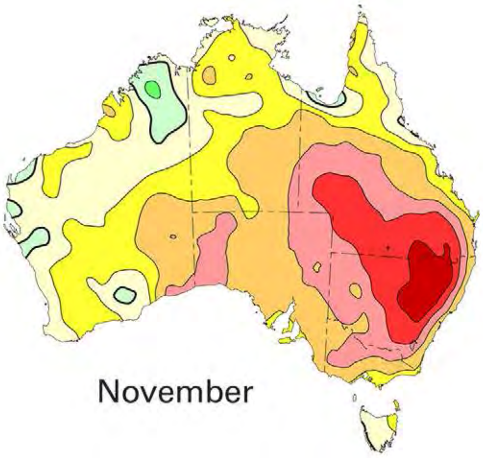
June



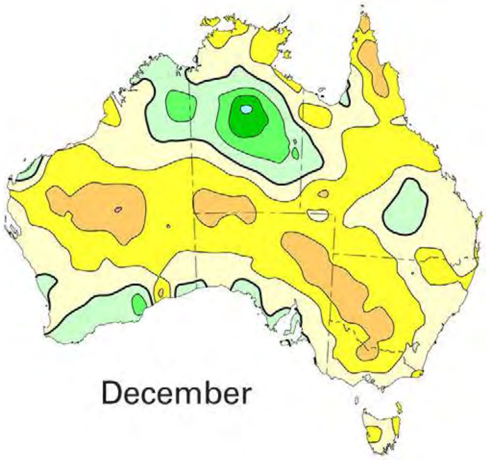
August



September



November



December

August minima were very much below average across much of the mainland southeast, with some areas coolest on record. August minima were below average across the Northern Territory and northeast of Western Australia, and the Northern Territory recorded its fourth-coolest August for both minimum and mean temperatures.

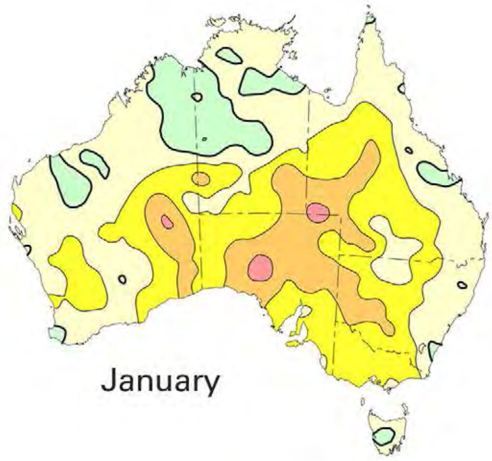
Spring was Australia's warmest on record for both mean and maximum temperatures, with anomalies of +1.67 °C (previous record +1.57 °C in 2013) and +2.33 °C (previous record +2.06 °C in 2013), respectively. Spring maxima were generally very much above average to highest on record for most of the continent, with only small areas of average temperatures for coastal Queensland and coastal Western Australia. Mean temperatures during the period were generally average in the north and mostly very much above average to highest on record throughout the remainder of the country.

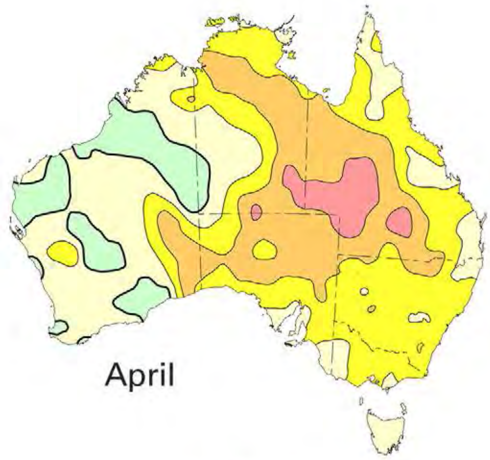
September maximum temperature anomalies were in excess of two degrees nationally and for Victoria, South Australia, the Northern Territory and Western Australia (highest on record at +2.74 °C); and in excess of one degree for the remaining States. Minima were below average across much of the north.

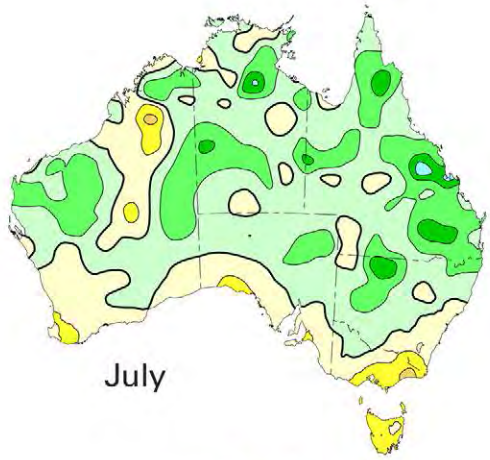
For October, Tasmania and Queensland were the only regions to rank below the top two warmest maximum temperature anomalies. The October national maximum temperature anomaly was +2.76 °C (previous record +2.63 °C in 1988). Mean temperature anomalies were similarly notable—with New South Wales, Victoria, South Australia and Western Australia ranking as warmest or second-warmest for October. The national mean temperature anomaly for October was +1.91 °C, the second-warmest on record.

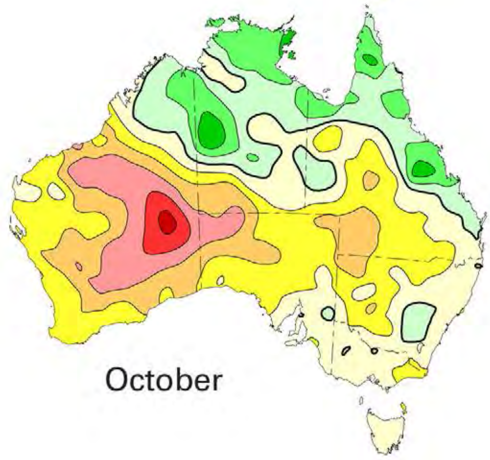
November was also a record-warm month for national maximum temperature anomalies (+2.19 °C; previous record +2.13 °C in 2006) and mean temperature anomalies (+1.88 °C; previous record +1.87 °C in 2009). National minimum temperatures were the third-warmest on record (1.58 °C above average). Monthly maxima were in the top six for all regions but Tasmania and Western Australia, with anomalies in excess of three to five degrees across much of eastern Australia. Minima were in the top nine warmest for all regions except Victoria and Tasmania. November maxima and minima were the warmest on record for a large part of Queensland.

December maxima were above average for parts of the north coast, much of Western Australia, central Australia, the west of the eastern States and Tasmania. Minima were above average in a similar area, but covering nearly all of eastern Australia. December minima ranked in the top ten for Queensland, New South Wales and Tasmania, while both mean and minimum temperatures were the sixth-warmest on record nationally.



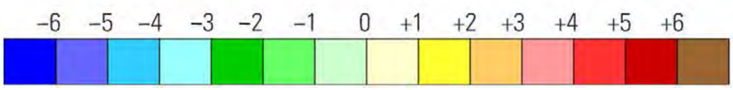


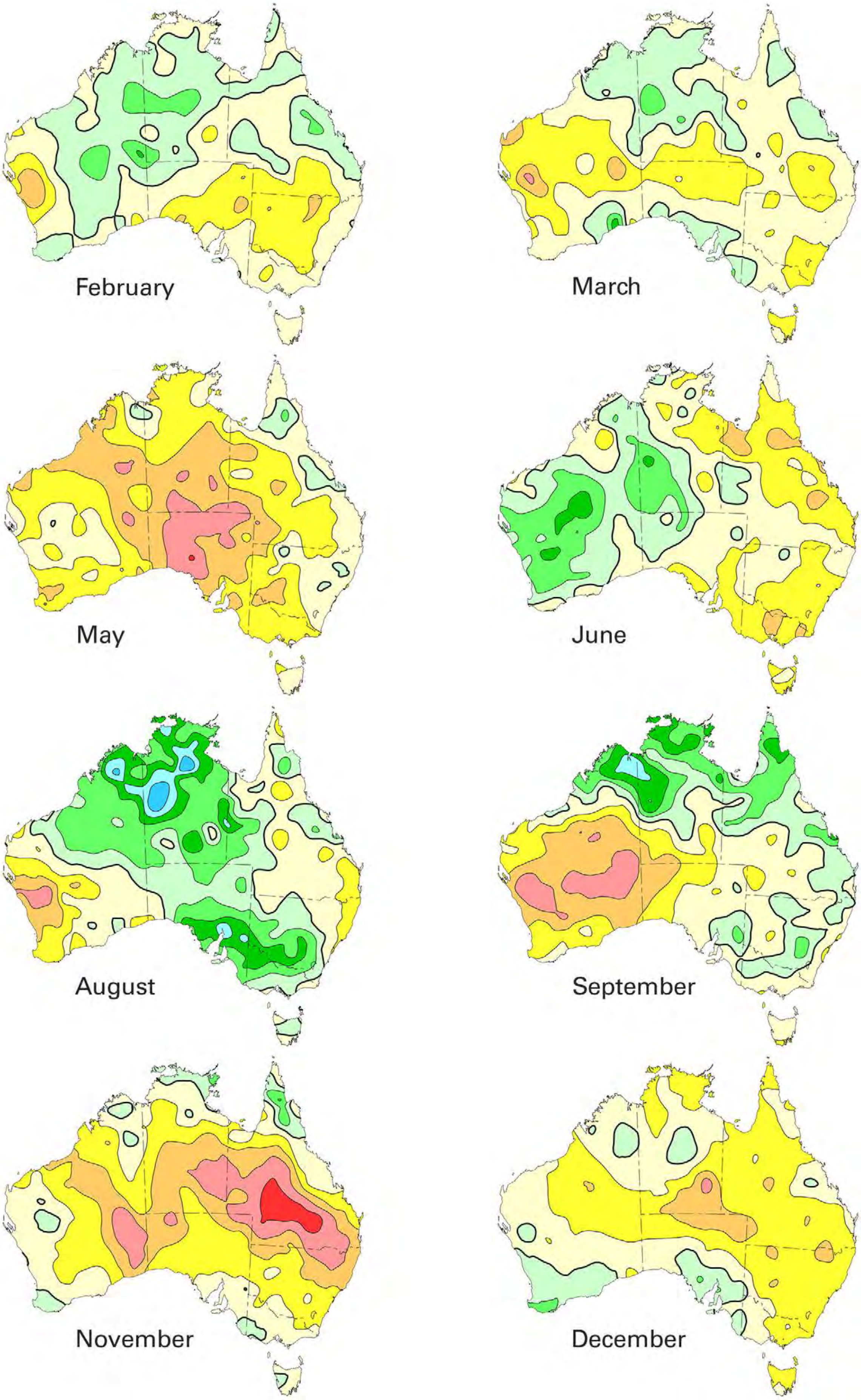




Minimum temperatures: departures from average (°C)

Based on a 30-year mean calculated from 1961–1990




February
March
May
June
August
September
November
December

4. Monthly rainfall

Despite El Niño not fully establishing in the Pacific Ocean, Australian rainfall showed an El Niño-like pattern during 2014, with drier-than-average conditions in much of eastern Australia. Southeastern Australia, and to some extent eastern Australia more generally, has seen a return to the drier-than-average conditions that were prevalent before the above-average rainfall associated with the 2010–12 La Niña events.

The decaying tropical cyclone *Christine* in the first days of January and the slow passage of a tropical low later in the month brought above-average monthly rainfall for much of the west of Australia. Conversely, January rainfall was below average for eastern Australia, particularly in New South Wales and southeast Queensland, and for the southwest of Western Australia.

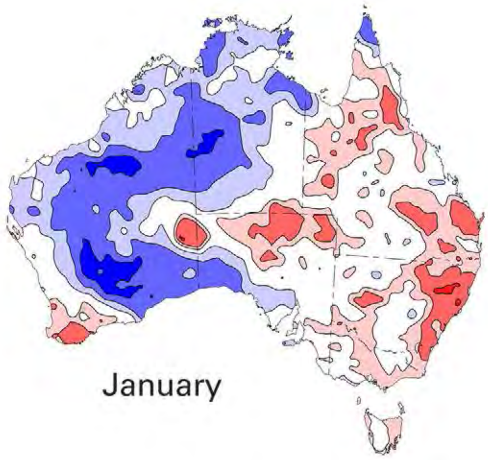
February rainfall was above average for much of Australia away from the east and west coasts, with heavy rain early in the month breaking monthly rainfall totals in parts of Queensland's Gulf coast and between Longreach and Emerald. However, February rainfall was below average for southeastern Queensland and northeastern New South Wales, southern Victoria and northern Tasmania, and much of the west of Western Australia.

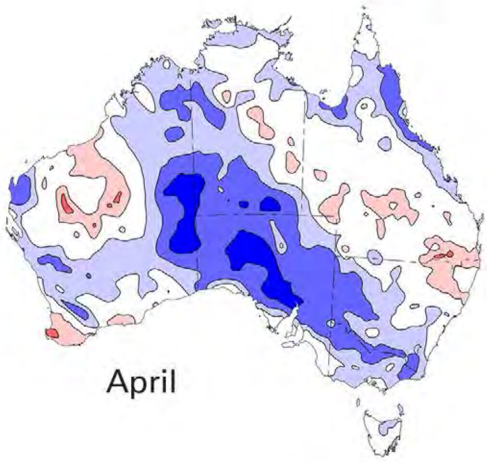
March brought significant rainfall in southern and southeastern Queensland and New South Wales, mostly late in the month (see page 16 for details of flooding), and below-average rainfall in the Top End, inland northern Queensland, Western Australia and South Australia.

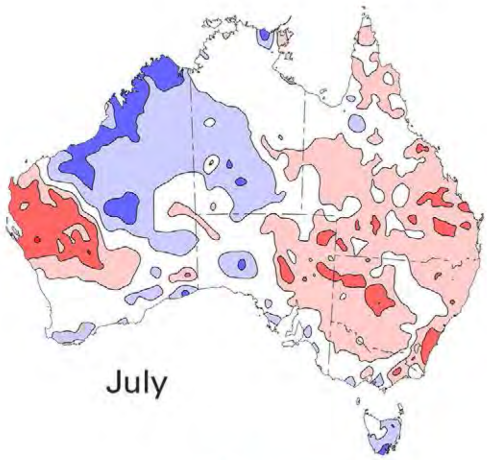
In April, a northwest-orientated surface trough early in the month contributed to above-average monthly rainfall for the east of Western Australia, the southeastern half of the Northern Territory, South Australia, New South Wales and Victoria. For South Australia as a whole it was the second-wettest April on record.

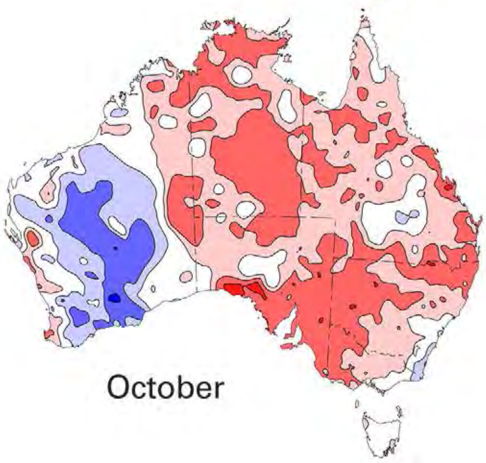
For the remainder of the year, conditions again turned drier across most of southern and southeastern Queensland and most of New South Wales, broken only during August, September and December.

May rainfall was above average for much of Western Australia and southern South Australia.



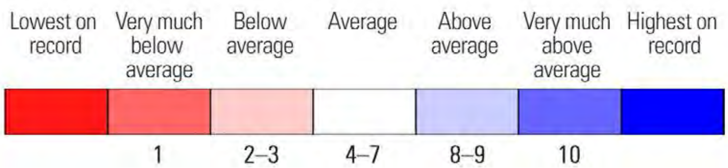


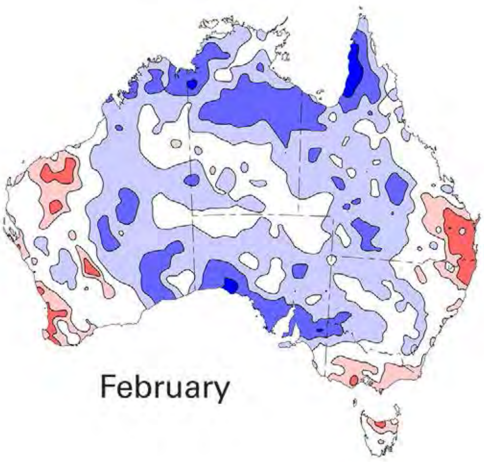




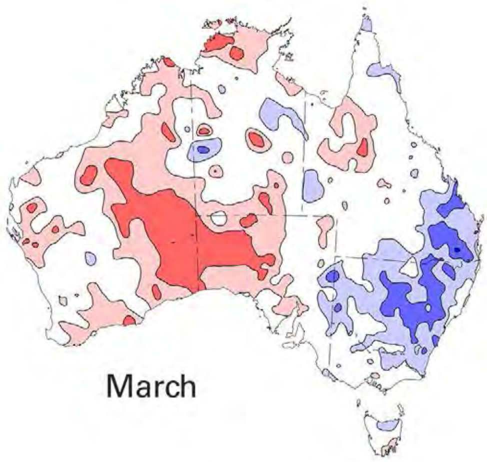
Monthly distribution of rainfall deciles

Based on a 115-year climatology of gridded data from 1900–2014





February



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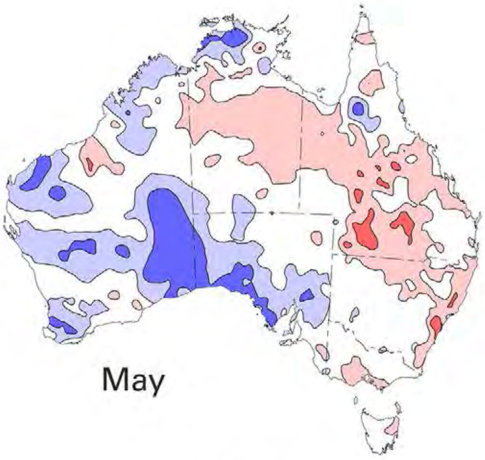

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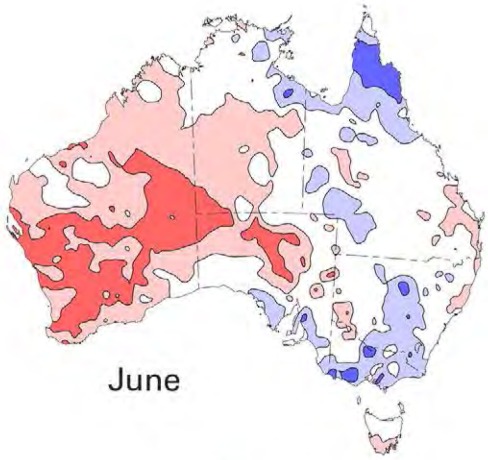

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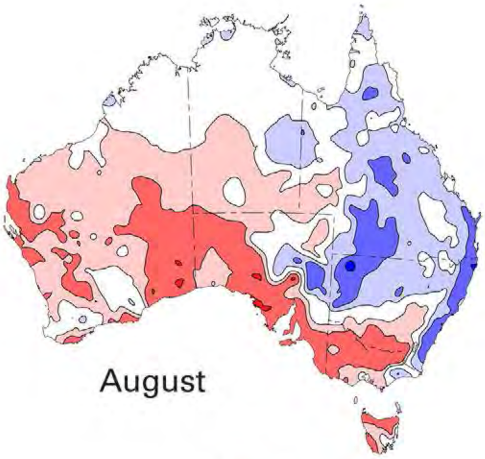

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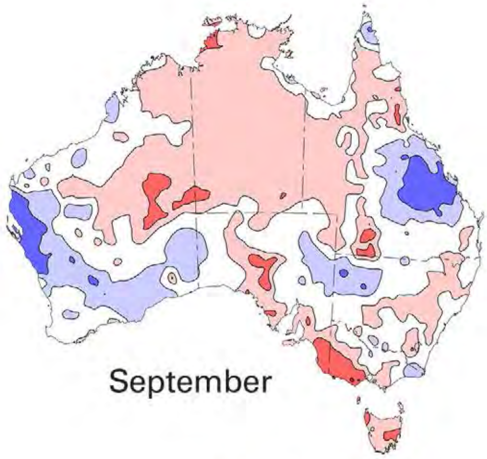

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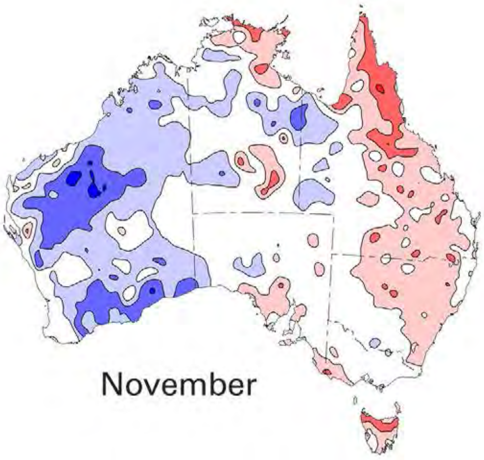

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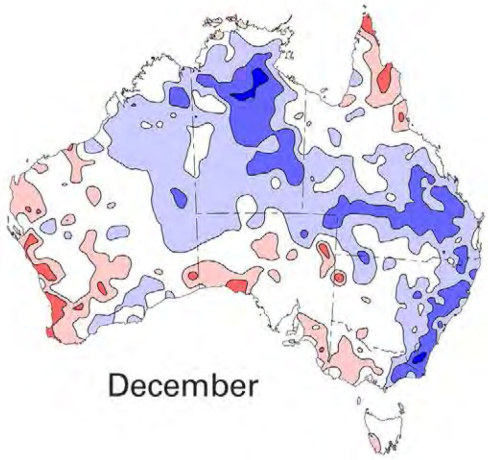


December

June was the seventh-driest on record for Western Australia, with below-average rainfall across the State and also in northern South Australia and the central Northern Territory (although anomalies were small in the Northern Territory and northern Western Australia, where this is typically a dry month). Above-average June rainfall in the southeast mainland was associated with the cold fronts which brought some severe weather.

July rainfall was also below average for the mainland east and for the central west coast, with above-average totals in the north of Western Australia and south of the Northern Territory, although falls were generally modest.

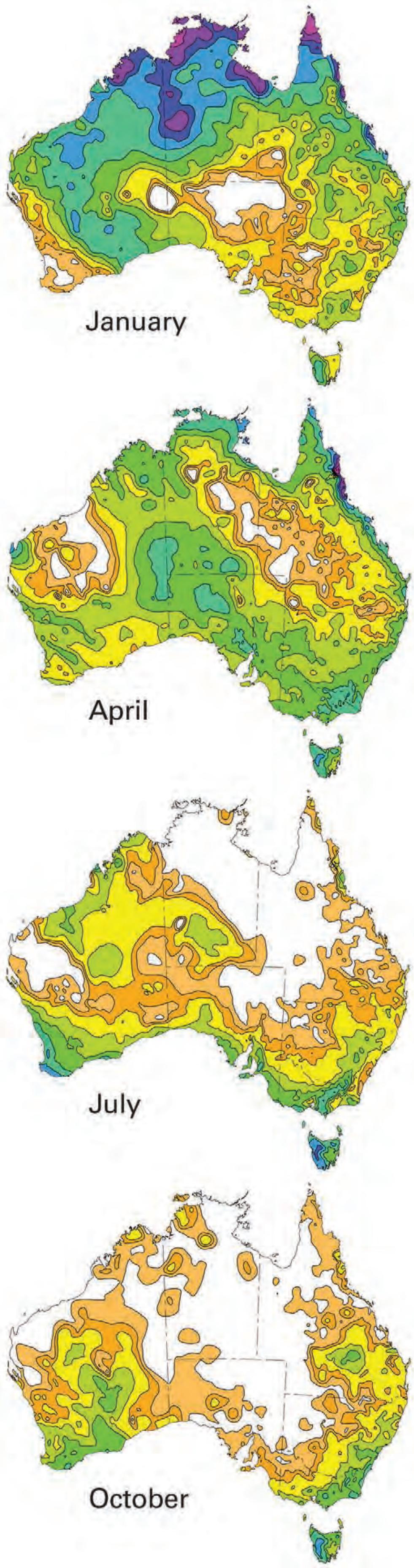
During August, an East Coast Low and persistent onshore flow resulted in above-average rainfall along most of the east coast and more broadly across Queensland and northern New South Wales. However, August rainfall was very much below average along the mainland southern coast and across Tasmania. For Tasmania it was the tenth-driest August on record, and for southern Australia as a whole it was the driest August on record outside of an El Niño year. This very dry month contributed to the evolution of significant rainfall deficits in the southeast—affecting southeast South Australia, Victoria (particularly western Victoria) and Tasmania—with a run of dry months from August onwards.

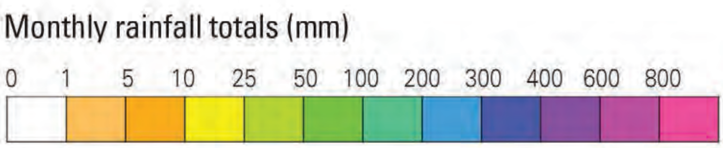
September was also drier than average for much of Victoria, southeast South Australia and Tasmania, but late in the month a surface trough contributed to above-average rainfall for Queensland's central coast and adjacent inland areas.

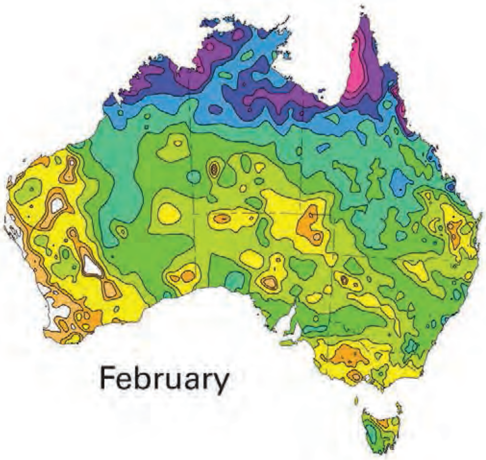
October was a very dry month, with rainfall below to very much below average for the mainland excluding much of Western Australia. October was the driest on record for South Australia and the seventh-driest on record nationally.

November rainfall was above average for Western Australia owing to showers associated with a surface trough early in the month and another during the last week of November. Rainfall was below average for the eastern States and the Top End.

December rainfall was above average for much of the east coast and across northern Australia but below average for the Cape York Peninsula, parts of Western Australia, South Australia and western Victoria. Storms were frequent on the east coast during the first half of December, and included some very heavy rain in New South Wales (see page 19).



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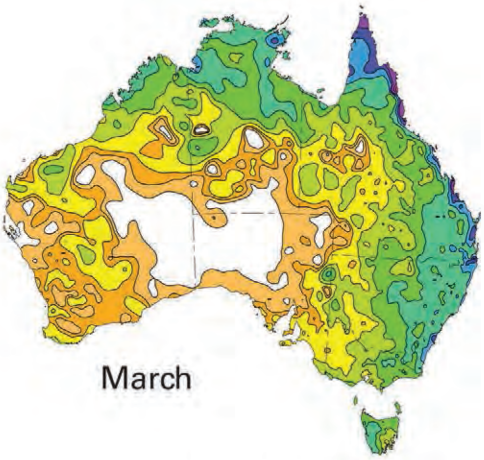
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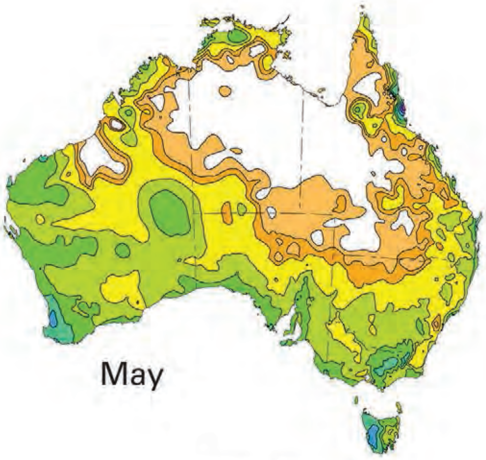
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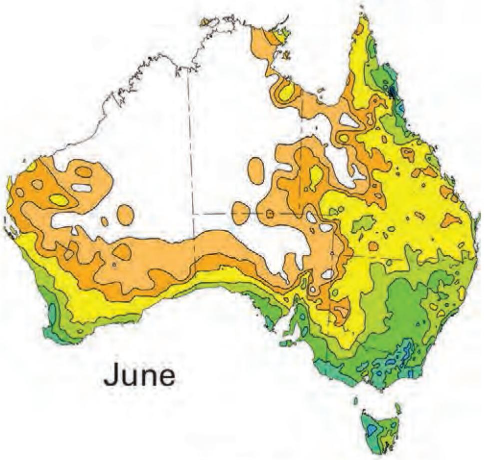
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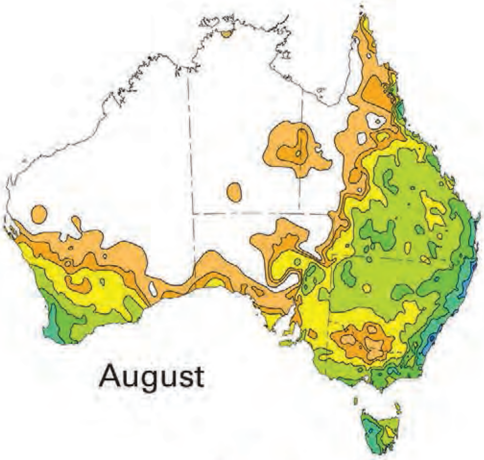
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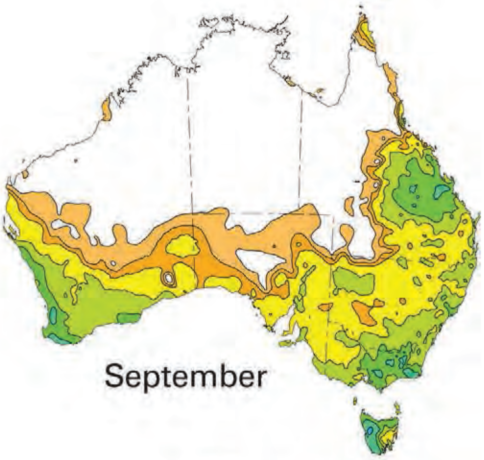
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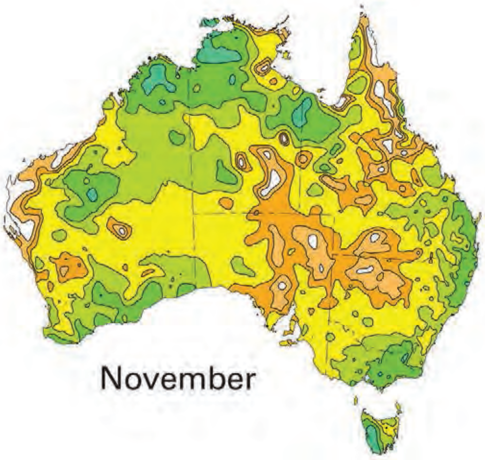
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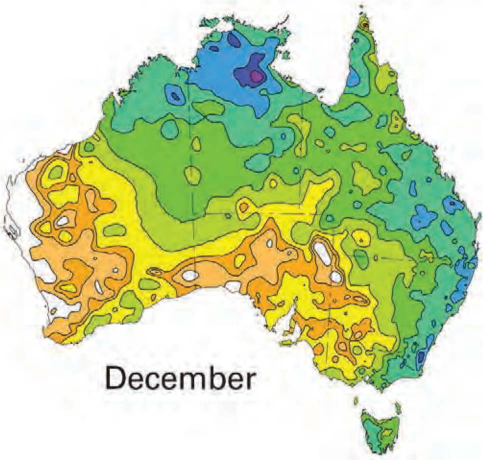

December

5. Rainfall and temperature extremes

Temperatures are in degrees Celsius, rainfall totals are in millimetres. Daily minimum temperatures and daily rainfalls are for 24 hours ending 9.00 am on the date shown. The mean temperature is the average of maximum and minimum temperature.

NEW SOUTH WALES	
Highest daily maximum temperature	49.1 at Walgett Airport automatic weather station (AWS) on 3 January
Lowest daily minimum temperature	–13.0 at Perisher Valley AWS on 3 August
Highest average maximum temperature	29.9 at Mungindi Post Office
Lowest average minimum temperature	1.6 at Perisher Valley AWS
Highest daily rainfall	317.0 at Boat Harbour (Rous River) on 28 March
Highest annual rainfall	2355.6 at Yarras (Mount Seaview)
NORTHERN TERRITORY	
Highest daily maximum temperature	46.4 at Jervois on 2 January
Lowest daily minimum temperature	–6.0 at Arltunga on 7 July
Highest average maximum temperature	35.0 at Victoria River Downs
Lowest average minimum temperature	13.3 at Alice Springs Airport
Highest daily rainfall	262.0 at Walker Creek on 18 February
Highest annual rainfall	2422.7 at Walker Creek
QUEENSLAND	
Highest daily maximum temperature	48.7 at Birdsville Airport on 2 January
Lowest daily minimum temperature	–7.0 at Stanthorpe Leslie Parade on 12 July
Highest average maximum temperature	35.1 at Julia Creek
Lowest average minimum temperature	9.4 at Applethorpe
Highest daily rainfall	450.7 at Numinbah State Farm on 28 March*
Highest annual rainfall	8158.8 at Bellenden Ker Top Station
SOUTH AUSTRALIA	
Highest daily maximum temperature	49.3 at Moomba Airport on 2 January
Lowest daily minimum temperature	–6.6 at Yunta Airstrip on 6 August
Highest average maximum temperature	30.7 at Moomba Airport
Lowest average minimum temperature	8.2 at Keith (Munkora) and Naracoorte Aerodrome
Highest daily rainfall	115.0 at Coober Pedy Airport on 10 April
Highest annual rainfall	1009.5 at Uraidla
TASMANIA	
Highest daily maximum temperature	40.2 at Bushy Park (Bushy Park Estates) on 4 January
Lowest daily minimum temperature	–8.7 at Liawenee on 9 June
Highest average maximum temperature	19.4 at Launceston (Ti Tree Bend)
Lowest average minimum temperature	2.0 at Liawenee
Highest daily rainfall	162.6 at Mount Read on 21 February
Highest annual rainfall	at least 3333 at Mount Read#
VICTORIA	
Highest daily maximum temperature	46.5 at Charlton on 14 January
Lowest daily minimum temperature	–9.3 at Mount Hotham on 12 August
Highest average maximum temperature	25.8 at Mildura Airport
Lowest average minimum temperature	2.6 at Mount Hotham
Highest daily rainfall	123.4 at Madalya on 8 December
Highest annual rainfall	1777.6 at Mount Baw Baw
WESTERN AUSTRALIA	
Highest daily maximum temperature	49.2 at Emu Creek Station on 10 January
Lowest daily minimum temperature	–5.0 at Eyre on 11 August
Highest average maximum temperature	36.6 at Fitzroy Crossing Aero
Lowest average minimum temperature	9.0 at Bridgetown, Collie East, Jarrahwood and Newdegate Research Station
Highest daily rainfall	269.4 at Cygnet Bay on 10 February
Highest annual rainfall	1497.8 at Theda
AUSTRALIA	
Highest mean temperature	29.1 at Wyndham Aero (WA)
Lowest mean temperature	5.4 at Thredbo AWS (NSW)

*The true daily total is unknown but likely higher, as the gauge overflowed in heavy rainfall.

#Mount Read's true total is unknown but likely higher, as the gauge was affected by snow and equipment failure several times during the year.

6. Annual review and significant events

January and February: heatwaves, bushfires, storms and flooding

The year commenced with a heatwave underway in central and inland eastern Australia.[3] A very hot air mass had moved from western South Australia into southern and central Queensland in the final days of 2013. A second pulse of hot air followed, passing from the southern interior of Western Australia to northern South Australia on 1 January 2014 before being driven eastward ahead of a low pressure trough on 2 January.

Most of the records set during the heatwave occurred on 3 January, and were concentrated in northern New South Wales and southern Queensland (see page 23). The heat retreated into the central and northern interior of Queensland by 5 January, with temperatures returning to near average over the following days.

During the first week of January a series of intense low pressure systems passed south of Tasmania. Their associated cold fronts caused very strong westerly winds, with damage resulting in a number of road closures, cutting power to at least 9000 properties and causing significant stone fruit losses. A Tasmanian January wind gust record of 165 km/h was set at Mount Wellington on 2 January.

Severe thunderstorms were recorded across southeast Queensland on 6 January causing wind damage, flash flooding and extensive power outages affecting more than 70 000 properties.

One of the most significant multi-day heatwaves on record for southeast Australia occurred between 13 and 18 January.[4] A dome of hot air developed over Western Australia in the second week of January before moving over the southeast of the continent. A near-stationary high pressure system over the Tasman Sea directed northerly winds into inland southeastern Australia, resulting in very high temperatures. A number of records were set early in the period in Western Australia and later in southeast South Australia, Victoria, around and west of the Snowy Mountains in New South Wales, and in Tasmania. The event was notable for consecutive days of very high temperatures rather than for individual hot days. Melbourne endured four consecutive days of at least 41 °C, Adelaide five days of at least 42 °C and Canberra four days of at least 39 °C.

From 15 to 24 January, significant heavy rain, thunderstorms and flooding associated with a tropical low were observed in the west of the Northern Territory and large parts of Western Australia. Road links were cut in parts of central Australia and northwest Western Australia as the system brought cumulative totals in excess of 100 mm to much of the Kimberley, eastern Pilbara and a broad band through inland Western Australia extending to the Nullarbor coast.

Severe storms were also recorded in the Brisbane region on the afternoon and night of 23 January, causing flash flooding, power outages and commuter disruptions.

A third heatwave affected southern Australia during the last days of January and early February. Heat developed at the top of the Great Australian Bight on 26 January, extending from the Nullarbor to southern Victoria over the following days. Temperatures more than ten degrees above average were observed across much of southern Australia between 30 January and 2 February. Maximum temperatures were in the 99th percentile for southeast South Australia, western Victoria and southern Tasmania on 28 January. After a brief reprieve, heat again built over the southeast from 6 February before dissipating by mid-month.

Heatwave conditions and antecedent below-average rainfall created circumstances favourable for bushfires. Significant fires included:

- Perth Hills on 12 January, affecting Parkerville, Stoneville, Hovea and Mount Helena with a total loss of 56 residential dwellings.
- Grampians National Park in Victoria, starting on 15 January and spreading across the northern third of the park (around 60 000 ha), destroying 7000 stock animals and at least 30 homes.
- A number of fires in East Gippsland, with several continuing well into February, including fires around the Snowy River and Errinundra National Parks and west of Cann River. An estimated 210 000 ha burnt in East Gippsland between 28 January and 26 February.
- A long-lived fire in the Mallee in Victoria's northwest, where 40 000 ha were burnt.
- At least 16 separate significant fires in South Australia between 14 and 17 January, including the Bangor fire and those in the southern Flinders Ranges and in the Billiatt and Ngarkat Conservation Parks. In total

[3] *Special Climate Statement 47: An intense heatwave in central and eastern Australia*, Bureau of Meteorology, 21 January 2014: www.bom.gov.au/climate/current/statements/scs47.pdf

[4] *Special Climate Statement 48: One of southeast Australia's most significant heatwaves*, Bureau of Meteorology, 21 August 2014: www.bom.gov.au/climate/current/statements/scs48.pdf

Grampians fire as seen from Mount Zero Olive Farm, 16 January. The fire was intense and generated pyrocumulus clouds that were visible for some distance. Photograph: Mount Zero Olives.

approximately 425 000 ha were burnt and 12 houses destroyed in the Flinders Ranges, Murraylands and southern Barossa Valley.

- Extensive fire activity in New South Wales during January, although with smaller losses. The most notable were near Singleton in the Hunter Valley, around Bathurst, and both to the east and southeast of Wagga Wagga where five houses were destroyed by the Murraguldrie State Forest fire.
- Extensive fire activity around Melbourne and eastern Victoria from 9 February, including the Mickleham–Kilmore–Wallan fire north of Melbourne and fires in Warrandyte (northeast of Melbourne), Gisborne, (northwest of Melbourne), East Gippsland and the Latrobe Valley. 35 properties were destroyed—many of those in the suburbs around Melbourne.

Tropical cyclone *Dylan* made landfall at Dingo Beach, 35 km east of Bowen on Queensland's eastern coast, early on the morning of 31 January as a category 2 system.[5] A storm surge of about one metre coinciding with king tides of about four metres resulted in coastal inundation along the east coast of northern Queensland, both well ahead of the main storm and at a later tide several hours after the storm had made landfall.

Strong to gale force southeasterly winds affected southern South Australia ahead of a high pressure system on 3 and 4 February, with widespread damage in the eastern suburbs of Adelaide and the Adelaide Hills. Damage was extensive with clean-up costs estimated at several million dollars. Power was cut to 90 000 properties, many for periods in excess of 24 hours, some in excess of 48 hours.

A vigorous cold front crossed Tasmania on 9 February, bringing damaging winds and widespread thunderstorms—particularly in the south of the State. At least 70 000 properties lost power, some for over 48 hours. Hobart registered a February record gust of 130 km/h, with several other sites observing gusts in excess of 100 km/h.

On 19 February thunderstorms associated with a surface trough caused flash flooding in Canberra as falls of more than 50 mm exceeded the average monthly total during a three-hour period in the afternoon. The worst storm damage was reported around Tuggeranong but flooding, fallen trees, cut power lines and several injuries were reported across many suburbs.

March: storms and heavy rain on the east coast

New South Wales experienced severe storms on 15 and 16 March, with wind gusts exceeding 90 km/h across much of the northeast; and again on 30 March, affecting western Sydney and the Illawarra. Heavy rain and large hail were reported, with flash flooding in western Sydney and substantial roof damage to the Katoomba Hospital and the Katoomba Sports Centre.

Heavy rain and thunderstorms associated with a low-level trough affected much of eastern New South Wales and Queensland between 24 and 28 March, resulting in widespread flash flooding. On 24 March, very heavy rain was reported in southern Sydney and the Illawarra, with up to 55 mm in 30 minutes at Cronulla, and daily totals of up to 297 mm at Wattamolla. On 26 March the worst damage was reported around Gladstone, Yeppoon and Rockhampton in Queensland, with many sites in the southeast setting March daily rainfall records.

High winds brought widespread damage across the Adelaide metropolitan and Hills districts, 4 February, with scenes such as this fallen tree in Leabrook a common sight. Photograph: Spence Denny, 891 ABC Adelaide.

[5]Tropical cyclone summary: www.bom.gov.au/announcements/sevwx/qld/qldtc20140130.shtml

Severe tropical cyclone *Ita* approaching Queensland's coast, captured by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) on the Aqua satellite, 11 April.

April: severe tropical cyclone *Ita*

Severe tropical cyclone *Ita* was the most intense storm to make landfall during 2014, crossing the coast as a category 4 system near Cooktown, in far north Queensland, on 11 April.[6] *Ita* weakened rapidly as it tracked down the coast until 13 April when it moved offshore near Proserpine. Gale force winds and damaging gusts were observed along the coast, although most damage during this time was tied to rainfall and flooding. Widespread 24-hour rainfalls of over 300 mm were recorded in Queensland's North Tropical Coast and Herbert and Lower Burdekin districts. The estimated total damage bill was $1.2 billion including extensive damage to banana and sugar crops.

May: autumn warmth

Following a brief cold period at the start of May, most of Australia experienced a long-lived warm spell linked to a blocking high pressure system over the Tasman Sea. Warm northerly flow dominated most of southeastern Australia, with temperatures six to eight degrees above average over large areas for many days. A number of individual locations set records for their warmest day so late in the season, but the event was especially significant because of its persistence and for unusually warm overnight temperatures.[7] Of the 112 long-term reference temperature stations in Australia, 48 set May records for consecutive days above thresholds, while 12 set May records for consecutive warm nights.[8] Nationally, it was the fifth-warmest May on record for maximum and minimum temperatures and third-warmest for mean temperatures.

June and July: storms and snow

A sequence of strong cold fronts crossed southeast Australia between 22 and 29 June, bringing gusts in excess of 90 km/h across many areas. In central Victoria, the associated low pressure system caused a storm surge, large waves and tidal flooding. Flooding in bayside suburbs and along the Yarra River caused significant disruption to power and transport as well as widespread coastal erosion. Flash flooding was also reported in northern Tasmania. Extensive storm damage was reported in Victoria, New South Wales and South Australia. In Victoria more than 80 000 properties lost power and two deaths were associated with collapsed walls.

Substantial snowfall was reported in the alpine regions of New South Wales and Victoria, elevated regions of Tasmania and the highest peaks of South Australia's Mount Lofty Ranges during this event. Snow settled at altitudes as low as 700 m in the Alps and the Brindabellas, in the Australian Capital Territory, on 24–25 July and again on 29–30 July. Snow depths at Spencers Creek (elevation 1830 m) increased by 88 cm between 19 and 26 June, the largest weekly increase since July 2011.

Cold fronts between 6 and 8 July produced strong winds, widespread showers and isolated thunderstorms in southern Western Australia and southern South Australia. A storm tide was recorded in southwest Western Australia, while about 26 000 homes in Perth and the South West lost power.

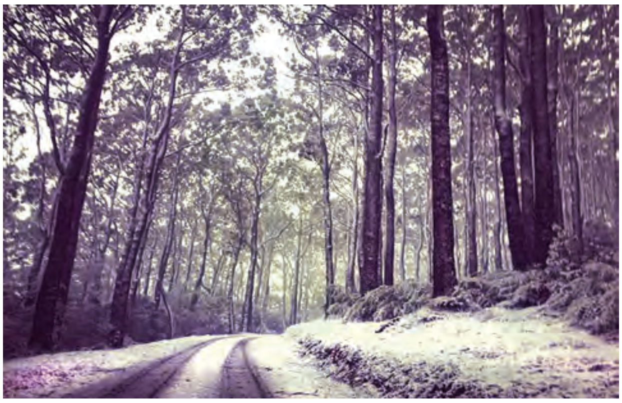
A cold front crossing southwest Western Australia on 14 July caused significant property damage and power outages, with tornadoes reported in the western suburbs of Perth, near Yallingup in the South West, and at Geraldton. When it reached the southeast, this front and one closely following produced snow across the New South Wales Tablelands on 16 and 17 July, falling to as low as 600 m in the central and southern Tablelands, and 800 m in the north. A depth of 3 cm was reported at Guyra, inland of Coffs Harbour. Snow and black ice also led to the closure of Orange Airport and the Great Western Highway between Bathurst and Lithgow.

A series of cold fronts embedded in a vigorous westerly stream passed over Tasmania and southern Victoria in the days following 27 July, bringing damaging winds, thunderstorms, locally heavy rain, flash flooding and moderate riverine flooding. Significant storm damage was reported in northwest Tasmania on 28 July, with heavy rain and some flash flooding in northern Tasmania on 30 and 31 July.

[6] Tropical cyclone summary: www.bom.gov.au/announcements/sevwx/qld/qldtc20140405.shtml

[7] *Special Climate Statement 49: An exceptionally prolonged autumn warm spell over much of Australia*, Bureau of Meteorology, 4 June 2014: www.bom.gov.au/climate/current/statements/scs49.pdf

[8] The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) has a dedicated web page providing data access and methodology documentation: www.bom.gov.au/climate/change/acorn-sat



Strong cold fronts crossed southeast Australia at the end of July and start of August, bringing a significant cold outbreak and some severe weather as well as more peaceful scenes such as snow covering this road near Lorne, Victoria, 31 July. Photograph: Swing Bridge Café, Lorne.

August: a cold snap and East Coast Lows

During the first few days of August, one of the more significant cold outbreaks of the last decade occurred in southeastern Australia. Snow fell across Tasmania during deep southwesterly flow ahead of a high pressure system over southwest Western Australia, settling overnight and on the morning of 1 August at altitudes as low as 300 m in the south and below 400 m in the northwest. Many elevated roads were closed by snow, which was at least 20 cm deep in some places. Widespread, severe frosts were observed across southeastern Australia as the high migrated east, with several consecutive days of frost causing extensive damage to crops in some regions inland of the Great Dividing Range.

Southwesterlies ahead of another high brought snow to Tasmania on 10 August, settling at altitudes as low as 200 m in the south and to depths of over 15 cm in some areas. Several elevated roads were closed due to ice and snow. Three walkers were rescued on the morning of 11 August from Collins Cap, northwest of Hobart, having become lost in deteriorating weather the evening before.

Later in the month, a strong cold front crossed southwestern Western Australia on 17 and 18 August. In Fremantle, a container ship broke its moorings and crashed into the Fremantle rail bridge, closing the rail line for inspection and repairs. A second cargo vessel also broke its moorings and hit a refuelling vessel.

An East Coast Low developed on 17 August, causing two days of heavy rain and storm damage along the central and southern coast of New South Wales. Cumulative totals in excess of 100 mm were widespread, reaching 304 mm at Robertson on the south coast. The system also generated large waves along the southern coast with significant wave heights of four to five metres, and maximum wave heights of seven to eight metres.

Three days of heavy rain were observed across coastal New South Wales between 26 and 28 August under conditions of persistent onshore flow. Rain was heaviest on the north coast, with large areas recording two-day totals in excess of 100 mm, reaching 248.6 mm at Ballina. Minor flooding was observed in the Bellingen and Orara rivers in the northeast.

Spring: Australia's warmest on record, storms and bushfires in the east

Spring 2014 was the warmest on record for Australia for both maximum and mean temperatures,surpassing records set in 2013 by 0.26 °C for maxima and by 0.10 °C for mean temperatures.[9] Each of the three spring months was very much warmer than average.

September was the fifth-warmest on record for maximum temperatures nationally. Frequent warm days occurred as warm northerly winds across southern Australia preceded the passage of surface troughs.

October maxima were the warmest on record for Australia, largely due to persistent above-average temperatures and a notable warm period late in the month across northern New South Wales and southern Queensland.

November's national maximum temperature was also a record, largely as a result of two significant heatwaves. The first affected central Australia, New South Wales, southern Queensland and the Top End around mid-month. Widespread flying fox deaths were reported during this event, with more than 5000 reported dead in Casino and 2000 in the Richmond Valley. Heat persisted in inland Queensland and central New South Wales before a low pressure trough drew hot air eastward from 20 November, bringing record maximum temperatures of 45 °C and above to western parts of Sydney. A number of records for consecutive warm days were set as prolonged heat continued for northern parts of Queensland and the Northern Territory until the end of the month.

The persistent warmth and below-average spring rainfall saw increased fire danger across southeastern Australia.

In the last days of September a series of strong cold fronts brought high temperatures (in generally northerly airflow ahead of the system), strong winds and severe weather across much of southern Australia. Strong to

[9] *Special Climate Statement 50: Australia's warmest spring on record*, Bureau of Meteorology, 2 December 2014: www.bom.gov.au/climate/current/statements/scs50.pdf

gale force northwest winds were recorded across much of southeast South Australia on 28 September, causing widespread power disruptions and some property damage. On the same day strong winds cut power to about 7000 premises in southern Tasmania and the fire service issued a total fire ban, the earliest in Tasmania's fire season since 1987. A number of small fires broke out in Tasmania, with grass fires also in southeastern South Australia and western Victoria.

On 29 and 30 September, southern Victoria was affected by strong to gale force winds with extensive storms in the Melbourne region. Storm damage, flash flooding, heavy hail and extensive power outages were reported, mostly in Melbourne's inner-north, east and southeast. A lightning strike at Camberwell caused extensive delays for trains on the eastern lines, exacerbated by heavy hail in the eastern suburbs and flooded tracks in the inner-north and east.

During the last days of October and first days of November many bushfires occurred in Queensland and New South Wales, including large fires in Queensland at Ballandean, near Stanthorpe; at Hookswood, north of Miles; at Ravenshoe, inland of Innisfail; and at Ravensbourne, northeast of Toowoomba. In New South Wales, a fire in the Blue Mountains destroyed a house near Katoomba. Fires were also associated with the heatwave in mid-November, with more than 30 fires in Queensland and more than 50 in New South Wales, while lightning on 23 November contributed to around 90 fires in New South Wales.

Damaging storms and strong winds occurred throughout spring in New South Wales and Queensland. Notable storms produced large hail and severe wind gusts in Sydney, southeast Queensland and parts of the Central Highlands and Coalfields districts on 25 September and in Queensland's Southeast Coast district and the Northern Rivers district of New South Wales on 27 September.

An East Coast Low affected the southern half of coastal New South Wales on 14 and 15 October, producing strong winds, widespread damage, heavy rain and high seas. October daily rainfall records were set in parts of southern Sydney and flash flooding trapped a passenger train at Bexley. Strong winds on 27 October caused damage in western Sydney and the Central Tablelands.

Frequent thunderstorms during November produced heavy rain and large hail along the east coast. Thunderstorms on 1 November affected eastern New South Wales with damage reported across western and southern Sydney. Storms on 5 November produced large hail across much of central eastern New South Wales,

Severe thunderstorms in southeast Queensland, 27 November, caused extensive damage in and around Brisbane, including this light aircraft flipped by wind at Archerfield aerodrome, south of Brisbane. Photograph: Michael O'Brien.

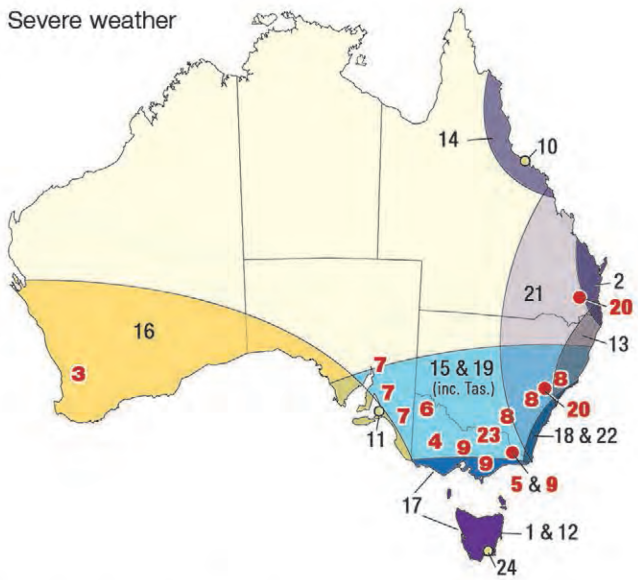
with widespread power outages in Sydney and crop damage around Comboyne. Very severe thunderstorms in Brisbane on 27 November brought flash flooding, tennis-ball-sized hail and destructive winds across the metropolitan region, resulting in 39 injuries, power loss to around 100 000 properties and an estimated damage bill of $1.5 billion.

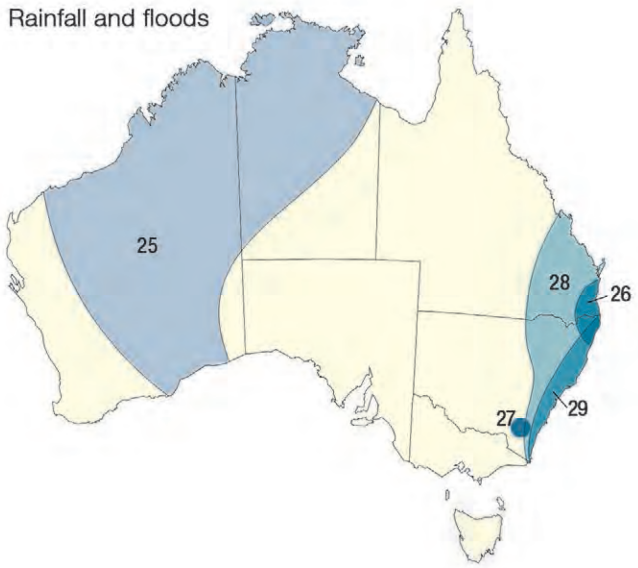
December: a stormy finish, significant bushfires in Victoria

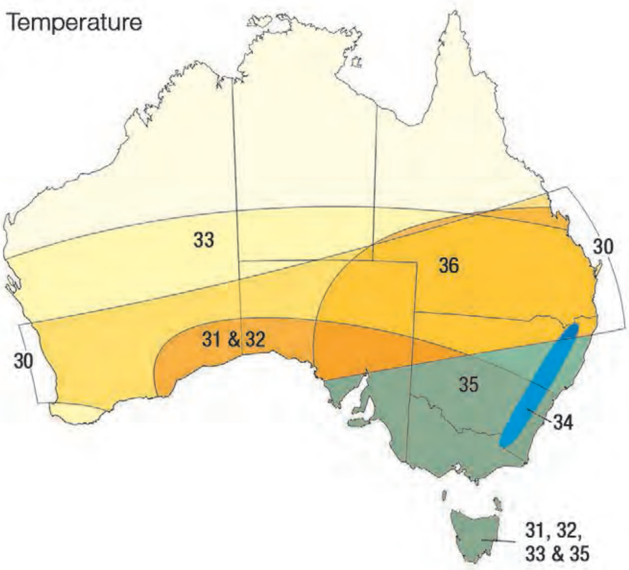
Thunderstorm activity continued in eastern Australia in December with an extended period of storms between 1 and 11 December, with Sydney Airport reporting an annual record of seven consecutive thunderstorm days. Storms on 6 and 7 December in areas west of Sydney, northern Sydney and between the Australian Capital Territory and the coast caused heavy rain, flash flooding, storm damage and some large hail.

Lightning from thunderstorm activity over Victoria on 15 December ignited several significant fires in central and northeastern Victoria, inland of the Great Dividing Range. The four most significant fires were the 3500 ha Stewarton fire northwest of Benalla, a 120 ha fire at West Wodonga, the 6800 ha Lake Rowan–Crawbys fire between Benalla and Yarrawonga, and the 6500 ha Longwood–Creightons Creek fire south of Euroa. The Lake Rowan–Crawbys and Longwood–Creightons Creek fires burnt for a number of days, destroying five houses and more than 2000 stock animals.

A hailstorm in Hobart on the afternoon of 16 December caused some flash flooding and damage to buildings, with reports of significant small hail and larger hailstones up to 2.5 cm in diameter.







Severe weather and bushfires

1. Intense low pressure systems and cold fronts bring strong westerly winds to Tasmania during the first week of January, causing wind damage, road closures, stone fruit losses and power outages.
2. Severe thunderstorms in southeast Queensland on 6 January causing wind damage, flash flooding and extensive power outages.
3. Bushfire in the Perth Hills on 12 January, destroying numerous houses.
4. Bushfire started in the Grampians National Park, Victoria, on 15 January, burning the northern third of the park and destroying thousands of stock animals and numerous houses.
5. Bushfires in East Gippsland from late January to late February, burning an estimated 210 000 ha.
6. Bushfire in the Mallee in Victoria's northwest in January, burning 40 000 ha.
7. Extensive fire activity in southeastern South Australia and the Flinders Ranges between 14 and 17 January, burning 425 000 ha and destroying a number of houses.
8. Extensive fire activity in New South Wales during January, notably in the Hunter Valley, around Bathurst, and to the east and southeast of Wagga Wagga.
9. Extensive fire activity in eastern Victoria and around Melbourne from 9 February, destroying numerous houses.
10. Tropical cyclone *Dylan* makes landfall east of Bowen on Queensland's eastern coast early on 31 January. A storm surge coinciding with king tides causes coastal inundation.
11. Strong to gale force southeasterly winds in southern South Australia on 3–4 February, causing widespread damage and extensive power outages around Adelaide.
12. Strong cold front on 9 February, causing damaging winds, thunderstorms and extensive power outages in Tasmania.
13. Severe storms with strong winds and hail in northeastern New South Wales on 15–16 March, and around Sydney and the Illawarra on 30 March.

14. Severe tropical cyclone *Ita* makes landfall near Cooktown in far north Queensland on 11 April, causing damaging winds and heavy rain along Queensland's central east coast over the following days.

15. Cold fronts bring strong winds and storm damage to southeast Australia during 22–29 June—with a storm surge, large waves and tidal flooding around Port Phillip in Victoria, substantial snow in alpine regions, and flash flooding in northern Tasmania.

16. Cold fronts bring damaging winds to the south of Western Australia and South Australia during 6–8 July, with a storm tide in southwest Western Australia. Another front crosses the southwest on 14 July, causing significant property damage, power outages and reports of tornadoes in several locations.

17. Cold fronts and strong westerly winds bring damaging winds, thunderstorms and locally heavy rain to Tasmania and southern Victoria during 27–31 July, with some flash flooding in northern Tasmania.

18. East Coast Low during 17–19 August brings heavy rain, large waves and storm damage to central and southern coastal New South Wales.

19. Cold fronts bring high temperatures and strong winds to southern Australia at the end of September, followed by extensive storms and severe weather, contributing to some grassfires in the southeast.

20. Numerous bushfires in Queensland and New South Wales at the end of October and in early November, with significant fires in southeast Queensland and in the Blue Mountains.

21. Frequent severe thunderstorms during spring and December along the east coast, including notable storms causing damage in and around Sydney in early November and a very destructive storm in Brisbane on 27 November.

22. East Coast Low brings damaging winds, heavy rain and high seas to the southern half of coastal New South Wales during 14–15 October.

23. Bushfires ignited by lightning on 15 December in northern, central and inland northeastern Victoria, including several large fires between Euroa, Yarrawonga and Wodonga that destroyed a number of houses and many stock animals.

24. A hailstorm in Hobart on 16 December, causing some flash flooding and building damage.

Rainfall and floods

25. Tropical low brings heavy rain and thunderstorms to the west of the Northern Territory and large parts of Western Australia between 15 and 24 January, causing flooding and cutting road links.

26. Severe storms around Brisbane on the night of 23 January causing flash flooding, power outages and commuter disruptions.

27. Thunderstorms on 19 February causing flash flooding in Canberra, as the monthly average rainfall fell in a three-hour period in the afternoon.

28. Heavy rain and thunderstorms during 24–28 March, causing flash flooding in eastern New South Wales and Queensland.

29. Heavy rain during 26–28 August, causing some flooding in coastal northeast New South Wales.

Temperature

30. Heatwave affecting inland southern Western Australia, inland South Australia, southern and central Queensland and northern New South Wales between 27 December 2013 and 9 January 2014.

31. Second heatwave, affecting southeast Australia during 13–18 January, with record-long runs of very warm days at multiple locations.

32. Third period of abnormally hot weather affecting southern Australia between 27 January and 13 February.

33. Long-lived warm spell affecting most of Australia throughout May, particularly the southern mainland.

34. Cold fronts bring snow and black ice to the New South Wales Tablelands on 16 and 17 July.

35. Significant cold outbreak in early August for southeast Australia, with snow to low levels in Tasmania on the morning of 1 August and further snow to low levels in Tasmania on 10 August.

36. Australia's warmest spring on record, with notable periods of abnormal warmth in southern Australia during the second half of October and affecting central Australia and the southeastern quadrant of Australia from mid to late November.

New site records

New site records set in 2014, for selected stations with at least 50 years of record, are shown below.

Record-high daily rainfall

Station name	State	Highest daily rainfall (mm)	Previous record (mm)	Years of record
Doolgunna	WA	151.0 on 22 Jan.	126.4 on 20 May 1984	86
Leonora	WA	109.2 on 23 Jan.	105.9 on 27 Feb. 1995	116
Edjudina	WA	127.0 on 23 Jan.	98.0 on 27 Feb. 1995	114
Arubiddy	WA	84.8 on 24 Jan.	77.0 on 14 Mar. 1996	51
Belmont Agforce	Qld	315.0 on 1 Feb.	302.4 on 29 Dec. 1990	61
Kowanyama Airport	Qld	361.2 on 8 Feb.	342.9 on 15 Feb. 1949	103
Cygnet Bay	WA	269.4 on 10 Feb.	268.0 on 5 Mar. 1972	52
Streaky Bay	SA	109.0 on 14 Feb.	77.5 on 20 Feb. 1938	136
Smoky Bay	SA	88.0 on 14 Feb.	81.0 on 14 Jan. 1995	103
Mundoora	SA	82.6 on 15 Feb.	79.2 on 22 Jan. 1933	131
Apoinga (Wilivere)	SA	82.4 on 15 Feb.	73.4 on 30 Jan. 1974	58
Mundoora (Barunga North)	SA	81.0 on 15 Feb.	80.4 on 31 Oct. 1997	51
Hamilton	SA	87.2 on 15 Feb.	73.0 on 12 Dec. 2008	51
Berri	SA	84.0 on 15 Feb.	72.4 on 17 Nov. 1961	55
Cooranbong (Avondale)	NSW	233.0 on 28 Feb.	221.0 on 16 Apr. 1927	104
Kukerin	WA	120.0 on 20 Oct.	94.0 on 9 Mar. 1934	103

Record-high annual mean temperature

Station name	State	Annual mean (°C)	Previous record (°C)	Years of record
Mullewa	WA	22.1	22.0 in 2013	62
Bencubbin	WA	19.7	19.6 in 1994	54
Narrogin	WA	17.2	17.1 in 2013	80
Corrigin	WA	18.2	18.0 in 2013	62
Salmon Gums Research Station	WA	17.3	17.2 in 1991	63
Cobar MO	NSW	20.4	20.3 in 2005	51
Gunnedah Resource Centre	NSW	19.8	19.7 in 2009	60
Hay (Miller Street)	NSW	18.7	18.6 in 1914	132
Mildura Airport	Vic.	18.4	18.3 in 2013	67
Walpeup Research	Vic.	17.9	17.7 in 2013	61
Longerenong	Vic.	15.7	15.6 in 1919	67
Kerang	Vic.	17.5	17.4 in 2007	91
East Sale Airport	Vic.	14.8	14.7 in 2007	68
Cape Sorell	Tas.	13.5	13.4 in 2013	71

Record-high daily maximum temperature

Station name	State	Highest temperature (°C)	Previous record (°C)	Years of record
Brunette Downs	NT	45.6 on 2 Jan.	45.5 on 2 Dec. 2007	55
Tambo Post Office	Qld	44.5 on 3 Jan.	44.2 on 4 Jan. 1973	58
Surat	Qld	45.7 on 3 Jan.	44.0 on 7 Dec. 1981	52
Cunnamulla Post Office	Qld	47.2 on 3 Jan.	47.0 on 13 Jan. 2013	58
Quilpie Airport	Qld	47.1 on 3 Jan.	46.5 on 12 Jan. 2013	58
Collarenebri (Albert Street)	NSW	48.0 on 3 Jan.	47.8 on 15 Jan. 1939	101
Mungindi Post Office	NSW	48.2 on 3 Jan.	46.8 on 12 Jan. 2013	50
Gunnedah Resource Centre	NSW	45.9 on 3 Jan	43.1 on 19 Nov. 1968	67
Quirindi Post Office	NSW	45.1 on 3 Jan.	43.4 on 2 Feb. 2006	50
Inverell Research Centre	NSW	41.1 on 3 Jan.	39.9 on 25 Jan. 2003	50
Murrurundi Post Office	NSW	41.2 on 3 Jan.	40.9 on 12 Jan. 2013	50
Coonabarabran (Namoi Street)	NSW	44.0 on 3 Jan.	42.6 on 4 Jan. 1973	58
Taroom Post Office	Qld	45.3 on 4 Jan.	44.0 on 30 Dec. 2013	58
Gympie	Qld	42.4 on 4 Jan.	42.0 on 26 Dec. 2001	50
Neptune Island	SA	36.9 on 16 Jan.	36.8 on 8 Feb. 1970	53
Tumbarumba Post Office	NSW	40.5 on 16 Jan.	40.2 on 7 Feb. 2009	50
Keith	SA	46.5 on 2 Feb.	45.5 on 28 Jan. 2009	53
Mount Gambier Aero	SA	44.9 on 2 Feb.	43.6 on 4 Jan. 2013	73
Scone SCS	NSW	43.8 on 23 Nov.	43.5 on 27 Jan. 2011	50

Extremely high daytime and warm overnight temperatures occurred several times through the year. The table above shows only those sites with at least 50 years of record that set new records for warmest day of the year. More details can be found in *Special Climate Statement 47: An intense heatwave in central and eastern Australia*, *Special Climate Statement 48: One of southeast Australia's most significant heatwaves*, *Special Climate Statement 49: An exceptionally prolonged autumn warm spell over much of Australia*, and *Special Climate Statement 50: Australia's warmest spring on record*. Special Climate Statements are accessible via: www.bom.gov.au/climate/current/statements

Record-low daily minimum temperature

Station name	State	Lowest temperature (°C)	Previous record (°C)	Years of record
Hay (Miller Street)	NSW	–3.8 on 3 Aug.	–3.6 on 7 Jul. 2012	58
Hillston Airport	NSW	–4.6 on 3 Aug.	–4.4 on 11 Jul. 1958	57

7. Oceans: sea level and sea surface temperatures

The El Niño–Southern Oscillation (ENSO) is a significant influence on sea level and sea surface temperature in the tropical Pacific Ocean.

The Pacific Ocean showed signs of a developing El Niño in early autumn 2014, and these conditions persisted for most of the year. While both ocean and atmospheric indicators surpassed threshold values for sustained periods from late spring, the event did not consolidate and the climate system did not progress to a full El Niño.

Surface temperatures in the central equatorial Pacific were near average during early 2014 and mid-winter, and warmer than average over the remainder of the year. Temperatures in the eastern equatorial Pacific rose steadily from autumn and remained warmer than average until the year's end.

Sea level

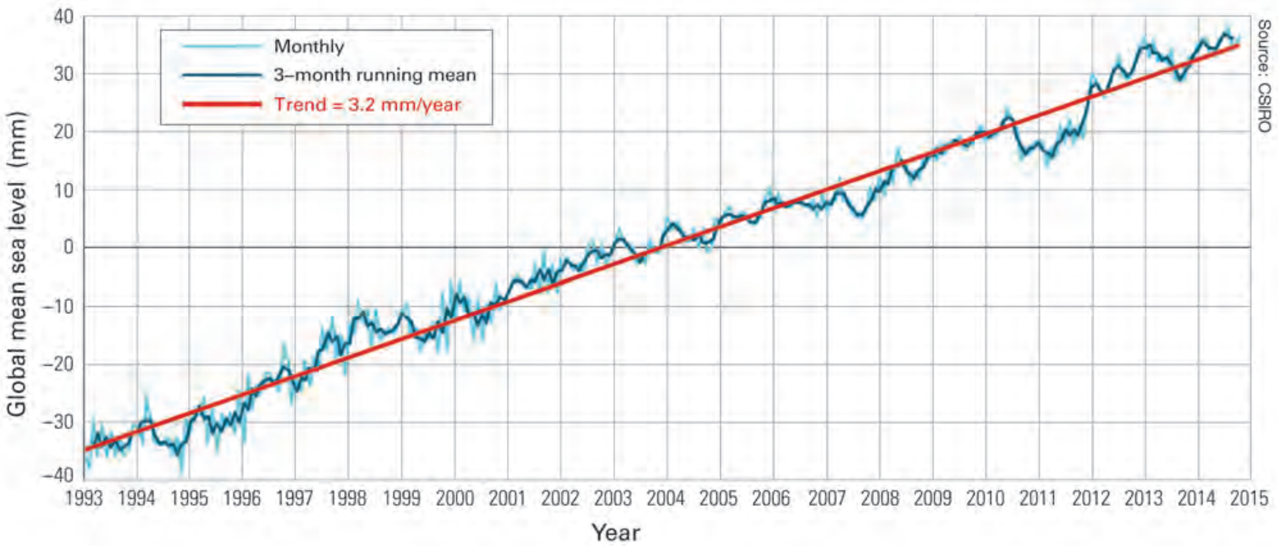
Preliminary results of global sea-level measurements from satellite altimetry over January 1993 to October 2014 indicates globally averaged sea level has risen at a rate of 3.2 mm/year. This corresponds to an increase of approximately 7 cm in global mean sea level since 1993. Year-to-year variations in sea level reflect natural climate variability. Global mean sea level for 2014 tracked slightly above the background rate of increase since 1993.

Global average sea-level rise is the result of thermal expansion of the oceans as they warm and the addition of mass to the ocean from glaciers and small ice caps, and the ice sheets of Greenland and Antarctica.

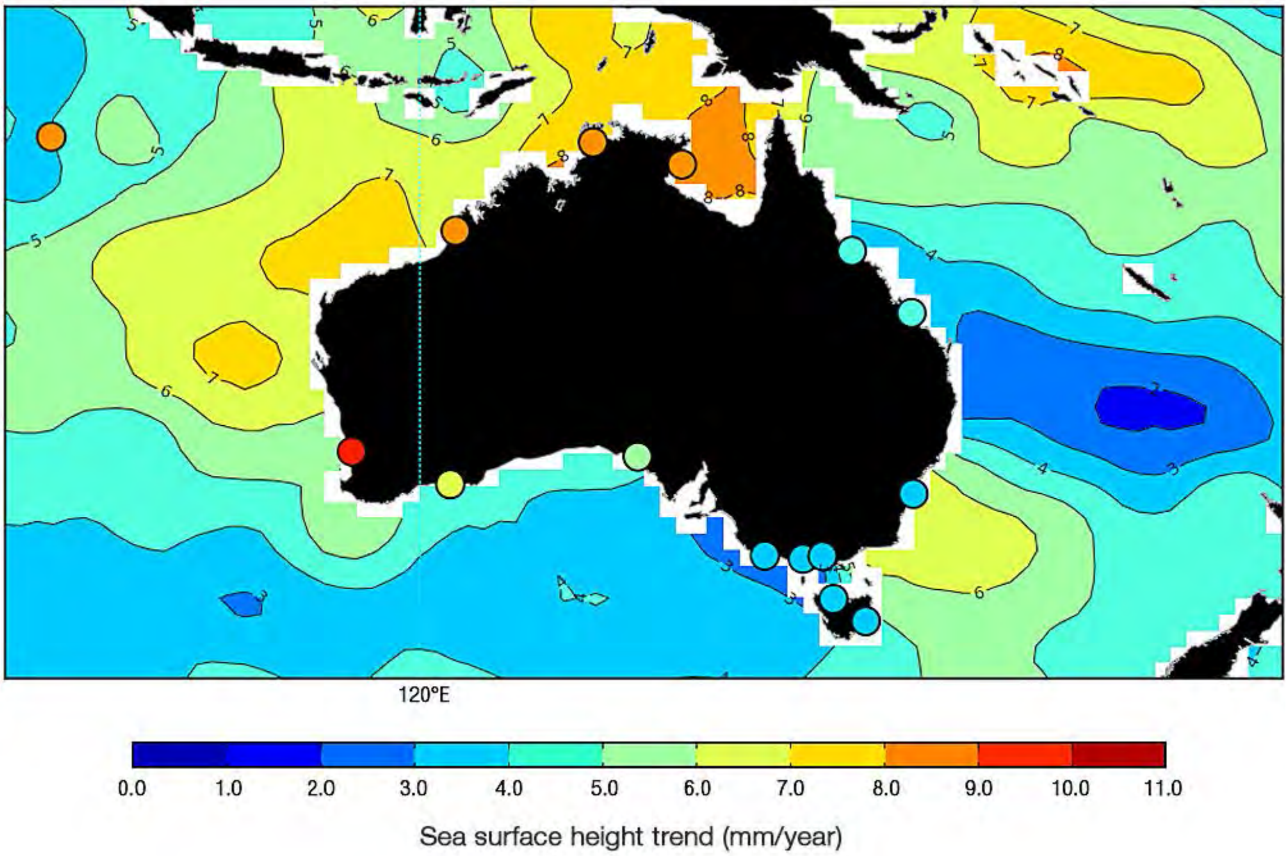
Sea level (and changes in sea level) are not uniform around the globe and are influenced by events such as ENSO and changes in winds and currents on different timescales. Local and regional sea-level rise can be above or below the global mean rate. Rates of sea-level rise to the north and northwest of Australia over the satellite measurement period have been two to three times the global average (i.e. 8 mm to 10 mm/year). This is at least partly the result of the early 1990s being dominated by El Niño events (which lowered sea level in this region) contrasting with very strong La Niña events in recent years.

Care must be taken in interpreting individual tide gauges. For instance, the greater apparent sea-level rise at tide gauges located at Hillarys, near Perth, and in the Cocos Islands is thought to be associated with sediment compaction and sinking of the coastal tide gauge, possibly due to ground water extraction. While the local sea-level rise relative to the coast felt at these sites is real, it cannot be compared directly with the absolute sea-level rise.

Oceans play a major role in the global climate system by absorbing heat energy, including upwards of 90 per cent of that arising from recent global warming, and act to reduce the rate of atmospheric warming. Over the past 40 years heat has been accumulating primarily in the upper ocean, with 60 per cent of the net energy increase in the climate system stored in the upper ocean (0–700 m), and about 30 per cent stored in the ocean below 700 m.



Monthly global mean sea level from satellites (January 1993 to October 2014). The seasonal signal has been removed and small corrections applied for changes in atmospheric pressure. The light blue line shows the monthly data, the dark blue line the three-month moving average, and the red line the linear trend. Source: CSIRO.



Sea surface height trend (January 1993 to October 2014). The rate of sea surface height rise measured by coastal tide gauges (coloured dots) and satellite observations (note the satellite observations have had the seasonal signal removed and small corrections applied for changes in atmospheric pressure). Source: CSIRO and the Australian Baseline Sea Level Monitoring Project: www.bom.gov.au/oceanography/projects/abslmp/abslmp.shtml

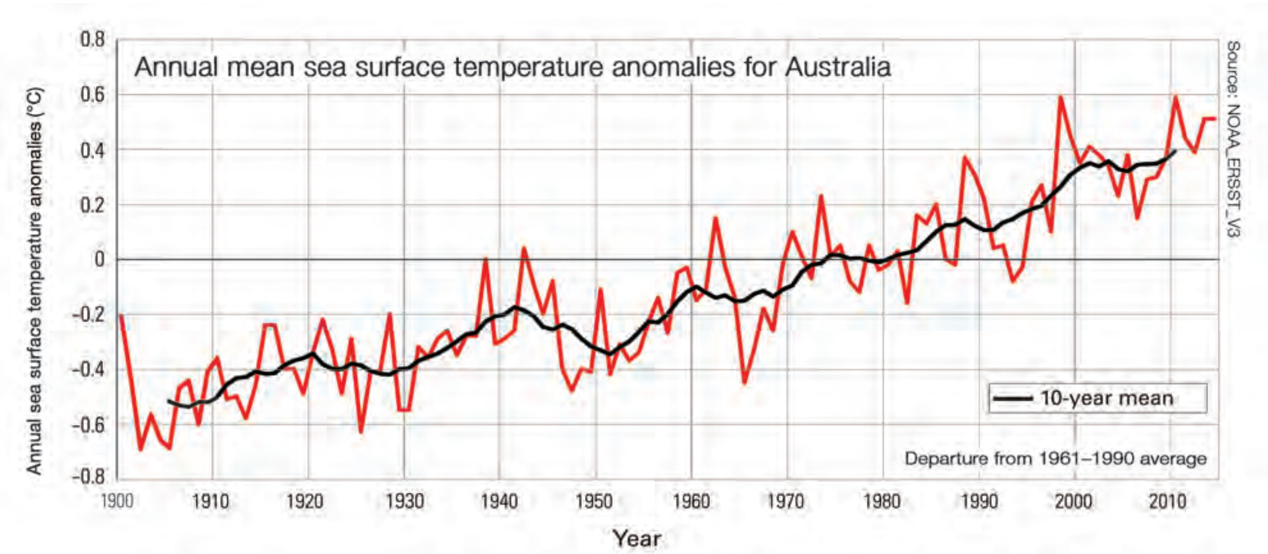
Sea surface temperatures

Sea surface and sub-surface temperatures in the Pacific Ocean were persistently above average for much of 2014. Atypical of a developing El Niño, above-average sea surface temperatures also persisted across the northern and western Pacific Basin. This pattern of sea surface temperatures may have been partly responsible for the failure of the atmospheric circulation to respond in a manner more typical of El Niño until late in the year.

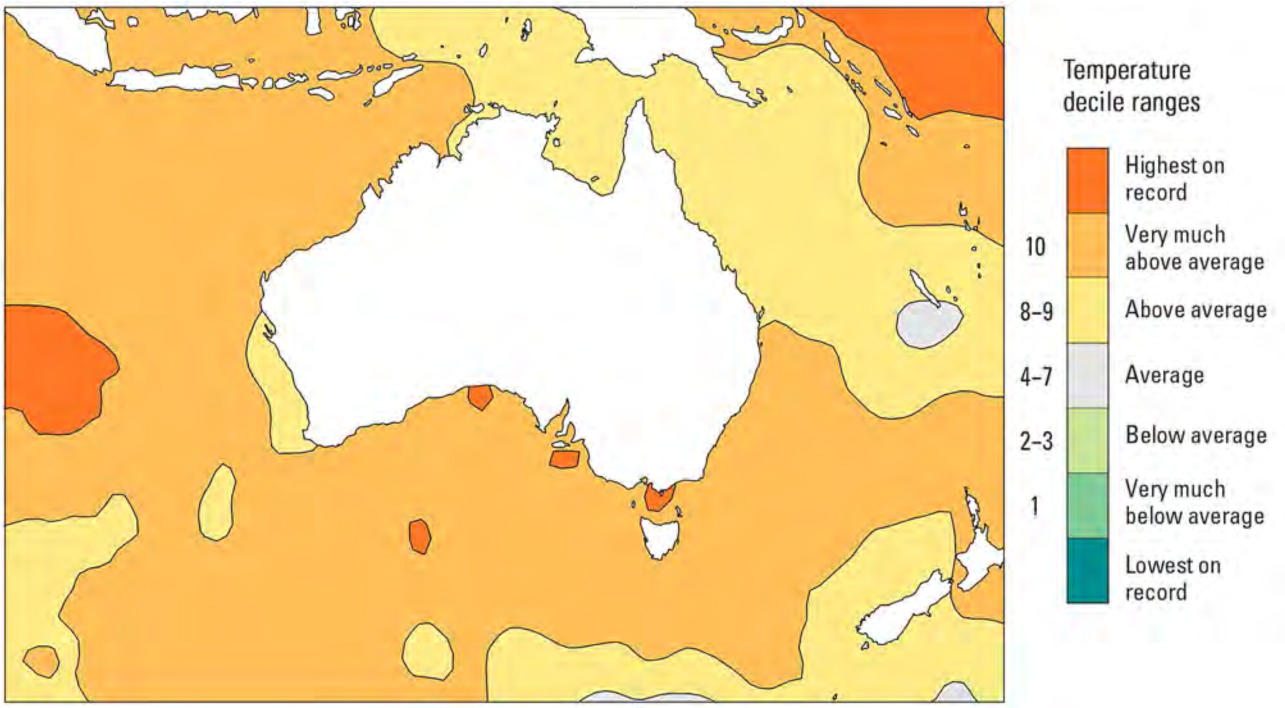
Sea surface temperatures (SSTs) have remained high around Australia in recent years, with all five years between 2010 and 2014 within the eight warmest on record. Below-average annual SSTs have not been observed for the Australian region since 1994. The annual SST anomaly for 2014 was the equal-third-highest since 1900 (0.51 °C above the 1961–1990 average), equal to the ENSO-neutral year 2013 and surpassed only by the record-setting La Niña years of 2010 and 1998. SSTs in the Australian region have increased by approximately one degree since 1910, very similar to the observed warming of the near-surface atmosphere as measured over land.

Monthly-averaged SSTs around Australia were unusually warm throughout the year—anomalies for all months except February ranked within the top nine observations for that month. SSTs were very much above average in the Great Australian Bight for the entire year. From April, areas of very much above average SSTs extended to the southeastern coastline and across waters to Australia's west and north, although the warmth became less pronounced in the north from mid-winter. For the southern region, monthly anomalies for all months from April were within the top four—with June, September and October the warmest on record for their respective months.

Monthly SSTs in the Indian Ocean and off the coast of Western Australia were warmer than average throughout the year. Following a brief dip into negative values during March and early April, the Indian Ocean Dipole (IOD) rapidly entered a negative phase during mid-June and remained there until the event broke down during the second half of September. Weekly values of the IOD index were between −0.5 °C and −0.8 °C for all but two weeks between late June and early September.



Sea surface temperature anomalies for the Australian region are averages over the area defined by a box from 0°S to 50°S and from 94°E to 174°E. Values are from the National Oceanographic and Atmospheric Administration ExtendedReconstructed Sea-Surface Temperature dataset (NOAA_ERSST_V3).



Annual sea surface temperature deciles 2014, based on a 115-year climatology of gridded data for 1900–2014 from NOAA_ERSST_V3.

For further information

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