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1. Overview

**First cooler-than-average year since 2001**

For the first time in a decade, Australia’s annual mean temperature was below the 1961–1990 average*. Cooler temperatures in Australia are typically associated with high rainfall. The last cooler-than-average year was 2001, which, like 2010, was a La Niña year with well-above-average rainfall.

Heavy rainfall at the start and end of the year, and frequent southerly wind flow in the first half of the year, suppressed temperatures over much of the mainland. Averaged over Australia, the annual mean temperature for 2011 was 21.67 °C.

While 2011 was cooler than average for Australia as a whole, below-average temperatures were mostly confined to northern Australia; southern Australia was warmer than average.

Overnight warmth was especially notable in parts of southern Western Australia and South Australia where annual average minimum temperatures were highest on record. Annual average maxima were also highest on record along the southern west coast of Western Australia.

For Australia overall, maxima were 0.25 °C below average, while minima were 0.03 °C below average. January, July and August temperatures were well above average, excluding the tropics. Cool maxima were widespread between February and May, while December was very cool for New South Wales. Minima were very much below average during May and June over northern Australia.

Cool years have been rare in the last three decades; long-term temperature trends since the 1950s show Australia’s climate is warming. The ten-year average for 2002–2011 was the equal-warmest ten-year period on record for Australia (0.52 °C above average).

While 2011 was 0.14 °C below the 1961–1990 climatological average of 21.81 °C, it ranks slightly above the median (52nd percentile) of all observations since 1910.

Australia experienced three notable heatwave events during 2011; the first from late January to early February across the southern mainland, the second during early August across southeastern Australia, and the third in northwestern Australia at the end of December (see section 9 on page 15).

**Globally, warmest La Niña year on record**

Using three separate datasets, the World Meteorological Organization ranked 2011 as the equal-tenth-warmest year on record. The global combined sea-surface and land air temperature for 2011 was 0.41 °C, ± 0.11 °C, above the 1961–1990 annual average of 14.0 °C. No year since 1985 recorded a below-average global mean temperature, and the 13 warmest years on record all occurred in the last 15 years. The ten-year global average from 2002–2011 was +0.46 °C above average, making it the equal-warmest such period on record.

Of the 23 climate regions monitored by the WMO globally, northern Australia was the only region to record average values for the most recent 10-year period (2002–2011) that were above the 1910–2001 average. The average values for the most recent 10-year period (2002–2011) are shown in darker orange.

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*Unless otherwise stated, all climatological averages are calculated over the 30-year period from 1961–1990, as recommended by the World Meteorological Organization. Anomalies are defined as the differences between the observed temperature and the corresponding average over the reference period 1961–1990.
Due to the exchange of heat between the atmosphere and oceans, years commencing with a strong La Niña have surface temperatures (the temperature of the lower atmosphere) that are typically 0.10 to 0.15 °C cooler than the preceding and following years. Although global temperatures were not as warm as the record-breaking values seen in 2010, 2011 was the warmest La Niña year on record globally. 2011 was considerably warmer than the most recent moderate-to-strong La Niña years: 2008 (+0.36 °C), 2000 (+0.27 °C) and 1989 (+0.12 °C). For Australia, 2008 was the warmest year commencing with a La Niña on record (+0.41 °C).

A tale of two La Niñas—Australia’s wettest two-year period on record

The Australian mean rainfall total for 2011 was 705 mm, 240 mm above the long-term average of 465 mm, placing the year at second-wettest since records began in 1900. Back-to-back La Niña events led to a two-year rainfall total of 1408 mm, the highest two-year total on record, surpassing 1407 mm in 1973–1974. The 2010–2011 La Niña, one of the strongest on record, brought above-average rainfall during the second half of 2010 and the first part of 2011, before decaying in autumn. As has occurred several times in the historical record, La Niña conditions redeveloped during spring, with a second, weaker event continuing into summer 2011–12.

The majority of Australia received very much-above-average rainfall for 2011. Large areas of highest-on-record totals fell in the Kimberley, southeastern Western Australia and across the north of the Northern Territory. For Western Australia, it was the wettest year on record and third-wettest for the Northern Territory. The 2010–2011 La Niña was characterised by numerous and significant floods continuing throughout summer 2010–11 and into autumn. Cumulative rainfall between late November 2010 and mid-January 2011 resulted in flooding amongst the most significant—in terms of extent, impact and severity—in Australia’s recorded history. The most notable flood event occurred in southeast Queensland during the second week of January; severe river and flash flooding affected the Brisbane catchment and nearby towns, resulting in loss of life and extensive property damage. Many other floods occurred, affecting the eastern States and northwest Australia (see section 9 on page 15).

Capital cities

All capital cities (see page 4), except Darwin, recorded warmer-than-average maximum temperatures, while Darwin, Brisbane and Canberra recorded cooler than average minima. Perth was notable for its warmth, the only capital to record an anomaly greater than 1 °C above average, for both maxima and minima. Annual average maxima for Perth were the warmest in 114 years of record. Adelaide recorded the highest capital city maximum temperature in 2011, with 42.9 °C on 31 January. The lowest capital city temperature was -8.0 °C in Canberra on 29 July, the coolest night in Canberra since 1994. All capital cities, except Adelaide, Brisbane and Canberra, exceeded their long-term annual median rainfall. Darwin reached 2693 mm, its second-highest annual total on record, after 1998. Hobart recorded the highest number of rain days, 183, and Perth the least, 106. As well as being a warmer-than-average year over the southern part of the continent, the general trend of greatly reduced cool weather frequency continued in 2011. Ending on 6 February, Sydney experienced its longest hot spell in 162 years of record with seven consecutive days above 30 °C and five nights above 24 °C. On 6 February, Sydney also had its highest daily minimum temperature (27.8 °C). Sydney’s lowest minimum (73.3 °C, 11 August) and lowest maximum (16.5 °C, 14 August) were the highest recorded for August.

Daytime temperatures for Perth in February were all above 29.6 °C, something that has not occurred since at least 1910. The March average daily maximum temperature (31.9 °C) was the highest on record, with a record period of 22 consecutive days exceeding 30 °C. Hobart’s lowest November maximum (16.1 °C, 2 November) was the warmest on record for the month’s coolest day, while its August average daily minimum temperature (8.1 °C) was the highest on record for the month. It was the first November in Melbourne with no nights below 10 °C.

Summary of 2011 mean rainfall and temperatures for Australia, the States and Territories, and the Murray-Darling Basin. Normal values are calculated using 1961–1990 averages. Ranks are from highest to lowest and are calculated using all years since high-quality records began (1900 for rainfall, 1910 for temperature). 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


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

Decile ranges* are calculated from station data for stations with an available long-term record, and from gridded monthly analyses based on all available data from 1980–2011 for Adelaide, Brisbane and Perth. Some data have not yet been fully quality-controlled.

<table>
<thead>
<tr>
<th>City</th>
<th>Highest temperature Date</th>
<th>Lowest temperature Date</th>
<th>Average maximum Long-term average Anomaly</th>
<th>Average minimum Long-term average Anomaly</th>
<th>Rainfall (mm) &amp; no. rain days</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>°C</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Perth</td>
<td>40.4</td>
<td>29 January</td>
<td>25.7</td>
<td>14.0</td>
<td>861 on 106 days</td>
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<tr>
<td></td>
<td></td>
<td>4 July</td>
<td>+1.2</td>
<td>+1.3</td>
<td>6</td>
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<tr>
<td>Darwin</td>
<td>35.8</td>
<td>27 November</td>
<td>31.6</td>
<td>22.3</td>
<td>2693 on 145 days</td>
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<tr>
<td></td>
<td></td>
<td>14 June</td>
<td>+0.4</td>
<td>–1.0</td>
<td>10</td>
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<tr>
<td>Adelaide</td>
<td>42.9</td>
<td>31 January</td>
<td>22.7</td>
<td>12.9</td>
<td>538 on 120 days</td>
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<tr>
<td></td>
<td></td>
<td>22 July</td>
<td>+0.4</td>
<td>+0.7</td>
<td>5</td>
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<tr>
<td>Brisbane</td>
<td>35.3</td>
<td>20 February</td>
<td>25.9</td>
<td>16.0</td>
<td>1176 on 133 days</td>
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<tr>
<td></td>
<td></td>
<td>9 August</td>
<td>+0.3</td>
<td>–0.4</td>
<td>5</td>
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<tr>
<td>Sydney</td>
<td>41.5</td>
<td>5 February</td>
<td>22.6</td>
<td>14.8</td>
<td>1369 on 175 days</td>
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<tr>
<td></td>
<td></td>
<td>8 July</td>
<td>+0.5</td>
<td>+0.6</td>
<td>8</td>
</tr>
<tr>
<td>Canberra</td>
<td>37.5</td>
<td>31 January</td>
<td>20.3</td>
<td>6.3</td>
<td>580 on 117 days</td>
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<tr>
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<td>29 July</td>
<td>+0.7</td>
<td>–0.2</td>
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<tr>
<td>Melbourne</td>
<td>40.2</td>
<td>1 February</td>
<td>20.9</td>
<td>12.0</td>
<td>835 on 150 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27 July</td>
<td>+0.9</td>
<td>+1.0</td>
<td>10</td>
</tr>
<tr>
<td>Hobart</td>
<td>33.6</td>
<td>8 January</td>
<td>17.5</td>
<td>9.1</td>
<td>691 on 183 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27 July</td>
<td>+0.4</td>
<td>+0.4</td>
<td>8</td>
</tr>
</tbody>
</table>

*Decile range 1 means the lowest 10 per cent of records, decile range 2 the next lowest 10 per cent of records, ... , decile 10 the highest 10 per cent of records.

3. Rainfall and temperature extremes by State

Temperatures are in degrees Celsius, rainfall totals are in millimetres. Daily minimum temperatures and daily rainfalls are for the 24 hours ending at 9 am on the date shown. The mean temperature is the average of all minimum and maximum temperatures.

**WESTERN AUSTRALIA**
- Highest daily maximum temperature: 49.4 at Roebourne on 21 December
- Lowest daily minimum temperature: –4.1 at Eyre on 24 September
- Highest average maximum temperature: 34.5 at Fitzroy Crossing Aerodrome
- Lowest average minimum temperature: 9.5 at Newdegate Research Station
- Highest daily rainfall: 389 at Kulin on 11 January
- Highest annual rainfall: 2468 at Dongara

**NORTHERN TERRITORY**
- Highest daily maximum temperature: 46.4 at Yulara Aerodrome on 28 January
- Lowest daily minimum temperature: –6.1 at Artunga on 25 July
- Highest average maximum temperature: 33.9 at Bradshaw
- Lowest average minimum temperature: 11.3 at Artunga
- Highest daily rainfall: 385 at Edith Falls Ridge on 27 December
- Highest annual rainfall: 3815 at Lake Evie*

**SOUTH AUSTRALIA**
- Highest daily maximum temperature: 48.5 at Olympic Dam Aerodrome on 26 January
- Lowest daily minimum temperature: –5.5 at Gluepot Reserve (Gluepot) on 22 July
- Highest average maximum temperature: 29.6 at Moonta Airport
- Lowest average minimum temperature: 8.0 at Yorke
- Highest daily rainfall: 174 at Ermabella (Pukajal) on 7 February
- Highest annual rainfall: 1084 at Craters (Mount Lofty)

**QUEENSLAND**
- Highest daily maximum temperature: 47.4 at Birdsville Airport on 27 January
- Lowest daily minimum temperature: –7.3 at Stanthorpe (Leslie Parade) on 12 July
- Highest average maximum temperature: 32.7 at Scharbier RAAF
- Lowest average minimum temperature: 8.8 at Applethorpe
- Highest daily rainfall: 477 at Mouringa Island on 1 March
- Highest annual rainfall: 10 078 at Bellenden Kar Top Station

**NEW SOUTH WALES**
- Highest daily maximum temperature: 46.9 at Condobolin Agricultural Research Station on 26 January
- Lowest daily minimum temperature: –16.0 at Charlotte Pass (Kosciusko Chalet) on 27 July
- Highest average maximum temperature: 278 at Mungiindi Post Office
- Lowest average minimum temperature: 0.7 at Thredo AWIS
- Highest daily rainfall: 398 at Mount Dangar TM on 22 March
- Highest annual rainfall: 2840 at Bowra Sugarloaf

**VICTORIA**
- Highest daily maximum temperature: 42.3 at Walpeup Research Station on 1 February
- Lowest daily minimum temperature: –9.9 at Mount Buller on 10 September
- Highest average maximum temperature: 24.0 at Mildura Airport
- Lowest average minimum temperature: 1.8 at Mount Hotham
- Highest daily rainfall: 155 at Mildura Airport on 5 February
- Highest annual rainfall: 2439 at Falls Creek (Rocky Valley)

**TASMANIA**
- Highest daily maximum temperature: 35.0 at Fingal Legege Street and Flinders Island Airport on 1 February
- Lowest daily minimum temperature: –11.2 at Lavinia on 23 July
- Highest average maximum temperature: 18.5 at Lake Cottontail
- Lowest average minimum temperature: 7.1 at Mount Wellington
- Highest daily rainfall: 327 at Grey Dalmayne Road on 24 March
- Highest annual rainfall: 3443 at Mount Read*

**AUSTRALIA**
- Highest mean temperature: 28.4 at Coconut Island (Queensland)
- Lowest mean temperature: 4.2 at Thredo AWIS (New South Wales)

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*This is also a new December record for Western Australia.

*Mount Read was affected by snow on some days. The true value is unknown, but higher than the measured 3443 mm.
4. Monthly maximum temperatures

January maximum temperatures were very much above average in southern Australia, but below average across the north. February and March were cool months with below-average temperatures through most of Australia. Record low March maxima were recorded in parts of northern and southern Australia. Maxima were above average along the western coast in both months and near average through most of Queensland during February, with above-average temperatures extending inland along the mid-New South Wales coast to Brisbane.

Northern Australia was cool during April while the south was mostly near average, although the Australian Alps and inland New South Wales were slightly cool. Temperatures were more than 2 °C above average along the coast of southwest Western Australia. May was a cool month, except for continued above-average warmth in the southwest. The north/south division of cooler tropics and a warmer south returned in June, while July temperatures were near average with scattered warm areas. The most widespread positive anomalies occurred in August, with the majority of Australia south of the Tropic of Capricorn recording departures of +2 and +3 °C.

Temperatures were above to very much above average over the southeast during September and cooler than average around the north. October temperatures were mostly near average, with cooler conditions in parts of Western Australia and South Australia, and on the east coast. November was cool for the northwest half of the country, and generally warmer than average for the southeast. December was cool for much of Australia, especially for eastern New South Wales and southern Queensland where temperatures were locally the lowest on record for the month.

The largest positive anomalies occurred in January and August in central Australia, with small areas recording temperatures more than 4 °C above average in both months. Below-average maximum temperatures were widespread in March, although the largest cool anomalies occurred in February, with areas of southeast Western Australia more than 6 °C below average. For Australia as a whole, seven months recorded below-average maximum temperatures; anomalies ranged from -2.19 °C in March to +1.75 °C in August.

Maximum temperature: departures from average (°C)
Based on a 30-year mean calculated from 1961–1990.
5. Monthly minimum temperatures

January and February minimum temperatures were above average across southern Australia and slightly cool in the tropics. Areas of highest-on-record minima occurred in Western Australia in both months. March saw generally cool conditions in Western Australia, barring the western coast, and warm conditions around the northern and eastern coast and parts of central Australia. April was warm in the far west, but abnormally cool for almost the entire north and east.

May temperatures were cool, with temperatures very much below average for most of New South Wales, the Northern Territory and Queensland, where minima were 4 to 5 °C below average in the Gulf Country. June was also unusually cool for the north; large areas of record low minima (departures of –4 to –6 °C) occurred in the north of Western Australia and the Northern Territory.

The south of Western Australia was warm in June, while in July anomalies greater than +2 °C were widespread in Western Australia and South Australia. Eastern Queensland minima were slightly cool during July. August was below average in the north and above to very much above average across southern Australia. September was generally a cool month, while October was warm in the south and near average in Tasmania and northern Australia. The eastern States and southern coast were warm in November, with minima in the northwest below average. December was warm along the southern and western coast, as well as in northern Queensland, and cool through much of the north and east.

The largest negative anomalies for the year occurred in June, with minima more than 6 °C below average near Elliot in the Northern Territory. Above-average minima were most widely recorded in January; anomalies exceeded +4 °C in central Australia. Similar anomalies also occurred in small parts of central Australia during July and on the west coast north of Geraldton in February. For Australia as a whole, seven months recorded above-average minima and five below; anomalies ranged from –1.75 °C in May to +1.07 °C in January.
January brought record-breaking rainfall to the west of New South Wales and Victoria. For Victoria, it was the wettest January on record. Rainfall was above to very much above average for most of Western Australia, northern Australia, southeast Queensland, northern Tasmania, and parts of South Australia.

Unusually heavy rainfall continued through the next two months, affecting southern and northwestern Australia in February and most of the country except the far west, northern New South Wales, and central Victoria in March. February was the wettest on record for South Australia, second-wettest for Western Australia and Australia as a whole, and third-wettest for Victoria. March was the wettest on record for Australia, as well as for the Northern Territory and Queensland, and third-wettest for South Australia.

As the La Niña decayed, April saw very-much-above-average rainfall in the Kimberley and Top End, while central Australia was seasonally dry. May rainfall was generally below average across Tasmania and the seasonally dry northern tropics.

Widespread light June rain in the subtropics was sufficient for above average totals in the interior, while rainfall was very much below average for parts of the southeastern mainland, parts of the southwest, and the far north. July was similar, although below-average rainfall was restricted to inland eastern New South Wales and above-average rainfall was more widespread in Western Australia and the interior.

August brought wetter conditions around the coast and inland Western Australia, but widespread below-average falls elsewhere. September rainfall was above average in a band from Birdsville to the mid-New South Wales coast and in inland Western Australia. Central and northern Australia received below-average rainfall in these months. La Niña’s influence returned in October, with very-much-above-average rainfall in the north and west, and large areas of record high falls in southern inland Western Australia. November rainfall was generally above to very much above average, except for east coast Queensland, which was below average. December totals were very much above average for the southwest and parts of Queensland.
Monthly rainfall totals

Above-average rainfall was recorded during the first four months of the year, as the 2010–2011 La Niña peaked and subsequently declined. Rainfall was below average from May through September, before returning to above average with a second La Niña developing in spring. For Australia as a whole, it was the second-wettest year on record. Australian area-averaged rainfall ranged from a low of 13 mm in September, to 148 mm in March. March was the third-wettest month on record, for any month of the year, and the wettest month since January 1984.

The tropical north received heavy falls from January through March, with monthly totals exceeding 400 and 600 mm widespread for coastal regions. January rain was heaviest on the Kimberley coast, exceeding 800 mm in some areas. Northern and southeast Queensland also recorded totals locally exceeding 600 mm. February rainfall was highest in areas affected by tropical cyclones Yasi and Carlos, exceeding 800 mm around Cairns and parts of the Top End. February also saw falls of between 300 and 480 mm in the Australian Alps and surrounds in Australia’s southeast. Falls greater than 300 mm across much of the tropics led to the wettest March on record, with the Australian area-averaged rainfall 23 mm above the previous record.

April falls above 200 mm, and in places exceeding 400 mm, along the Top End and Kimberley coast, and parts of far northern Queensland closed the second-wettest northern wet season on record. Central Australia was seasonally dry through April, as was much of northern Australia between May and September.

Inland areas of the southeast were very dry during June. The northern New South Wales coast recorded between 300 and 600 mm for June, while similar totals fell in western Tasmania. Tasmania recorded local totals above 200 mm in the following five months, mostly in the west of the State. In October, widespread above-average rainfall returned, exceeding 50 mm across much of the western interior and coastal fringes, while the region around Cairns exceeded 400 mm. November was generally wet for the north and southeast, as was December for the Top End and Queensland, with widespread totals above 100 mm in both months.
8. Annual rainfall deciles and totals

2011 annual rainfall deciles (based on a 112 year climatology of gridded fields from 1900–2011).

9. Annual review and significant events

January: Flooding in Queensland, Tasmania, and Victoria.

Heavy rainfall at the start of 2011, on top of already wet soil profiles, resulted in some of the most significant flooding—in terms of extent, impact and severity—in Australia’s recorded history. The most notable flood events occurred in southeast Queensland and areas of northern New South Wales, where many catchments were already subject to, or recovering from, flooding. Flooding around Rockhampton in the Fitzroy basin continued into early January. During the second week of January, severe river and flash flooding affected the Brisbane River catchment and nearby towns including Toowoomba and Grantham, resulting in loss of life and extensive property damage. On 13 January, Brisbane recorded its second-highest flood level in the last 100 years, after January 1974.

Between 12 and 15 January, complex and persistent low pressure systems brought exceptional rain to Tasmania and Victoria. Victoria surpassed its January rainfall record by mid-month, eventually reaching 119 mm, breaking the January 1941 record of 109 mm. Four-day totals of 100–300 mm fell across much of northern Tasmania and the western two-thirds of Victoria. Some Tasmanian stations received more than eight times their average January rainfall, while in western Victoria some received more than 12 times their usual. On the northeast Tasmanian coast, Falmouth and Scamander recorded 282 mm and 265 mm respectively on 13 January, setting new first and second place Tasmanian January daily rainfall totals. Flash flooding affected western and central Victoria and northern and northeastern Tasmania, while major riverine flooding in northwest Victoria continued on some rivers until the end of the month. Northeastern and western New South Wales also experienced heavy rainfall, resulting in flash flooding.

Tropical cyclone Anthony, named on 23 January in the northwestern Coral Sea, initially moved away from the Queensland coast and weakened below tropical cyclone strength before returning on a west-southwest track to cross the central Queensland coast near Bowen just before 10 pm on 3 February 2011. Yasi was the strongest cyclone to make landfall in Queensland since at least the 1918 La Niña. Yasi maintained a strong core as it penetrated inland, finally weakening to a tropical low near Mount Isa. The largest rainfall totals were near and to the south of the

February: Cyclones, heatwaves and thunderstorms.

Severe tropical cyclone Yasi developed northwest of Fiji, intensifying to a category 4 storm on 1 February before making landfall near Mission Beach, between Cairns and Townsville, as a marginal category 5 storm early on 3 February 2011. Yasi was the strongest cyclone to make landfall in Queensland since at least the 1918 La Niña. Yasi maintained a strong core as it penetrated inland, finally weakening to a tropical low near Mount Isa. The largest rainfall totals were near and to the south of the

Decile distribution of January to March rainfall totals (based on 112-year climatology of gridded fields from 1900–2011). Areas shaded dark blue recorded the highest rainfall total on record for any January to March period between 1900 and 2011.

Rainfall decile ranges

Highest on record

Very much above average

Above average

Average

Below average

Very much below average

Lowest on record
cyclone, generally in the order of 200–300 mm in the 24 hours to 9 am on 3 February. A remnant of tropical cyclone Anthony brought extreme rainfall to Victoria on 2 February 2011. Thunderstorms developed as moist tropical air associated with ex-tropical cyclone Yasi interacted with a persistent surface pressure trough. Flash flooding affected numerous locations, most severely in Mildura and the southeastern suburbs of Melbourne where daily rainfall totals of 100–200 mm were widespread. Slow-moving tropical cyclone Carlos brought heavy rainfall to the Top End between 15 and 17 February. Daily totals exceeding 300 mm were common in the greater Darwin area, with a record highest daily rainfall of 367.3 mm at Darwin Airport on 16 February, and a record three-day total of 684.8 mm at Darwin Airport. For February in total, Darwin received 1110 mm, its highest monthly total on record, passing its annual average just two months into the year. During the afternoon of 21 February, while Carlos was off the coast near Port Hedland, a tornado associated with severe thunderstorms in an outer rainband caused extensive damage in Karratha, Western Australia.

Southern mainland Australia experienced a heatwave from late January to early February. Maximum temperature records were set in southeast Western Australia and central South Australia, including an all-time record of 48.1 °C at Woomera on 25 January. Sydney experienced its hottest spell in 152 years of record

March was very wet for most of Australia, excluding the west of Western Australia and northeastern New South Wales. It was the wettest March on record for Australia, the Northern Territory and Queensland. It was also the third-wettest month of any month on record, following February which was the second-wettest on record for that month and fifth-wettest for any month. February was also South Australia’s wettest and Western Australia’s second-wettest month.

In the week ending 14 March, a monsoonal burst caused extensive flooding in the eastern Kimberley and adjacent parts of the Northern Territory, isolating communities across the Fitzroy, Ord and Pentecost River catchments. Storm cells embedded in a slow-moving low pressure complex over southeastern Australia in late March brought flooding to northeastern Tasmania, including major flooding in the South Esk River basin and flash flooding and minor to moderate flooding on a number of rivers in the northeast and central north of Tasmania. Nearly every site in the northeast third of Tasmania had either its wettest or near-wettest March on record, with some sites recording five times their usual March rainfall. This system also brought very heavy rain along the New South Wales South Coast and Illawarra, and Gippsland (including flash flooding in Sydney on the 29th and at Wilsons Promontory on the 22nd). At the end of March, prolonged flooding affected many catchments through western Queensland and along the tropical coast, including the Balonne River, coastal rivers between Townsville and St. Lawrence, the Concor and Isaac rivers, the Fitzers and Norman rivers, the Don River, the Mitchell River, the Mauna River and the Burdekin.

Eastern Tasmania was subject to a fourth heavy rain event for 2011 between 10 and 13 April, causing local flash flooding and river flooding. Strong and gusty southeasterly winds accompanied the event, causing loss of power and some damage.

On 29 May, the passage of a cold front across southwest Western Australia resulted in a tornado passing through Bunbury and significant damage to several houses in the suburb of Usher.

Winter: Cold for the tropics, a hot spell for the southeast.

Persistent low temperatures in the northern tropics from late May to mid-June brought the Northern Territory’s coldest start to the dry season on record. In June, the Northern Territory saw six consecutive days in which the temperature remained below 15 °C in at least one location over the region, the longest such streak for any month since 1998. Darwin minimum temperatures dropped below 20 °C for 47 consecutive nights (25 May to 10 July); not only the first run of cool nights this early in the dry season, it was the fourth-longest run of cool nights since records began in 1941.

An East Coast Low caused heavy rain along the New South Wales North Coast between 12 and 16 June, resulting in substantial flooding, wind gusts reaching

Flooded landscape between Rochester and Serpentine, northern Victoria, January 2011. Photograph courtesy of North Central Catchment Management Authority.
Spring into December: Storms and record heat in Western Australia.

The spring months saw numerous thunderstorms across Australia. Areas of Queensland, Western Australia, New South Wales, South Australia and Victoria were all subject to storms at least minor damage and flash flooding.

In October in Western Australia, thunderstorms producing large hail were reported near Salmon Gums on the 12th, causing significant damage to several hundred hectares of wheat and canola crops. On the afternoon of 3 November, heavy rainfall centred on the Great Southern district brought widespread falls of over 40 mm and some falls over 60 mm, causing significant crop damage in the region. As well as storms, Western Australia was affected by significant fires near Margaret River in late November, destroying more than 30 houses.

Late November saw extensive flooding through northeastern New South Wales west of the Great Divide under the influence of a slow-moving trough, bringing persistent heavy rain. Hundreds of properties and smaller towns, including Wee Waa, were isolated by the water.

### New site records

New site records set in 2011, for selected stations with more than 40 years of record, are shown below. Values marked with * indicate that the value recorded in 2011 equalled the existing record for that site.

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<th>Station name</th>
<th>State</th>
<th>State</th>
<th>Highest temperature</th>
<th>Previous record</th>
<th>Years of record</th>
<th>Annual average</th>
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<tr>
<td>Salmon Gums Research Station</td>
<td>WA</td>
<td>46.3 °C (28 January)</td>
<td>45.7 °C (8 January 2010)</td>
<td>76</td>
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<tr>
<td>Norfolk Island Aerodrome</td>
<td>NSW</td>
<td>28.4 °C (4 March)*</td>
<td>28.4 °C (11 February 1996)</td>
<td>73</td>
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<td>Woombaa Aerodrome</td>
<td>SA</td>
<td>48.1 °C (25 January)</td>
<td>47.6 °C (1 January 1960)</td>
<td>63</td>
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<td>Giles Meteorological Office</td>
<td>WA</td>
<td>44.8 °C (2 January)*</td>
<td>44.8 °C (17 December 1986)</td>
<td>56</td>
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<td>Roebourne</td>
<td>WA</td>
<td>49.4 °C (21 December)</td>
<td>49.1 °C (18 February 1998)</td>
<td>55</td>
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<tr>
<td>Onslow Airport</td>
<td>WA</td>
<td>49.2 °C (22 December)</td>
<td>48.9 °C (11 January 2008)</td>
<td>48</td>
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<td>Sydendrood Airport</td>
<td>NSW</td>
<td>27.6 °C (6 February)</td>
<td>22.6 °C (19 February 1973)</td>
<td>153</td>
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<td>Sydney Airport</td>
<td>NSW</td>
<td>26.4 °C (6 February)</td>
<td>25.8 °C (23 January 2010)</td>
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<td>Greendrada Airport</td>
<td>SA</td>
<td>34.2 °C (2 January)*</td>
<td>34.2 °C (1 January 2004)</td>
<td>64</td>
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<td>Willamtown RAAG</td>
<td>SW</td>
<td>26.9 °C (6 February)</td>
<td>25.7 °C (1 January 1983)</td>
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<td>Eucla</td>
<td>WA</td>
<td>30.7 °C (30 January)</td>
<td>30.2 °C (26 February 2009)</td>
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<td>Newcastle Nobbys Signal Station AW5</td>
<td>NSW</td>
<td>26.0 °C (6 February)</td>
<td>25.5°C (15 January 1978)</td>
<td>55</td>
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<tr>
<td>Wyndham</td>
<td>WA</td>
<td>8.3 °C (14 June)</td>
<td>8.6 °C (29 June 2004)</td>
<td>44</td>
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</table>
Rainfall/floods

A. Flooding near Rockhampton, Queensland, continued into early January.
B. Flooding in western and central Victoria and northern Tasmania from exceptional rain between 12 and 15 January, including new record Tasmanian January daily rainfall (282 mm at Eumundi on the 13th). Flooding also in northeastern and western New South Wales and southeast Queensland, notably in Brisbane River catchment and severe flash floods in Toowomba/Lockyer Valley.
C. Thunderstorms associated with ex-tropical cyclone Anthony cause flash flooding in Victoria on 4 February, severe flooding in Mildura and southeastern Melbourne.
D. 13 to 19 February, tropical cyclone Carlos brings widespread flooding to Darwin/Daly District, including Darwin and along the Daly River. Darwin Airport records second highest Northern Territory February daily rainfall, 367 mm on the 16th.
E. Prolonged flooding across western Queensland in March.
F. Monsoonal burst caused extensive flooding in the week ending 14 March in the eastern Kimberley.
G. Storm cells in late March bring flooding to northeastern Tasmania, New South Wales South Coast and Illawarra, and Gippsland (including flash flooding in Sydney on the 20th and at Wilsons Promontory on the 22nd). Third highest Tasmanian daily total recorded at Grey, 327 mm on the 24th.
H. Local flash flooding and river flooding in eastern Tasmania between 10 and 13 April.
I. East Coast low causes substantial flooding with heavy rain along New South Wales North Coast between 12 and 16 June.
J. Flooding in Gippsland and northeastern Tasmania from 7 to 10 August, and between the 16th and 19th in northeastern Tasmania.
K. Australian record highest October rainfall total: 1494 mm at Bellenden Ker.
L. Extensive flooding through northeastern New South Wales west of the Great Divide in late November.
M. Heatwave in southern Australia from late January to early February. Maximum temperature records set in southeast Western Australia and central South Australia, including all-time record 48.1 °C at Woomera on the 25th. Sydney’s longest hot spell in 152 years of record: seven days above 30 °C, five nights above 24 °C.
N. Tasmanian record low March maximum temperature, –0.6 °C at Mount Wellington on the 4th. Second place low minimum temperature, –5.3 °C at Liawenee on the 9th.
O. Persistent low temperatures in northern tropics late May to mid-June, including Northern Territory’s longest-run of days below 15 °C since 1998. May record low, –4.2 °C at Arltunga on the 31st.
P. Second place record low Tasmanian July temperature at Liawenee, –11.2 °C on the 23rd.
Q. High pressure system brings unseasonable early August warmth in southeastern Australia. Melbourne early-season record high overnight temperature 17.3 °C on the 4th, record warmest August for Tasmania.
R. Severe tropical cyclone Yasi brings rain and strong winds to the Kimberley and Pilbara coasts between 29 and 30 January.
S. Thunderstorms track through the Kimberley, Pilbara and Gascoyne on 28 January, before causing widespread damage in the Central/Wheat Belt and Great Southern on the 29th.
T. Severe tropical cyclone Yasi, the strongest cyclone to make landfall in Queensland since at least 1918, crossed the coast between Cairns and Townsville on 3 February.
U. Fires burn out of control near Red Hill and Swan Valley, driven by strong winds between 5 and 7 February. Over 100 homes destroyed or damaged in Kelmscott and Roleystone areas southeast of Perth.
V. Damaging winds and waves in Tasmania from 9 to 11 July. Cape Sorell buoy records its highest-ever wave, 18.88 m on the 11th.
W. Increased vegetation following high rainfall in 2010 and 2011 fuels widespread grassfires in central Australia from August.
X. December record high temperature for Western Australia, second-highest for Australia: 49.4 °C at Roebourne Airport on 21 December.
Y. Tropical cyclone Grant causes flooding and significant infrastructure damage north of Katherine.

Temperature

A. Heatwave in southern Australia from late January to early February. Maximum temperature records set in southeast Western Australia and central South Australia, including all-time record 48.1 °C at Woomera on the 25th. Sydney’s longest hot spell in 152 years of record: seven days above 30 °C, five nights above 24 °C.
B. Extreme heatwave in southern Australia and central Australia from November to early January, notable in Brisbane River catchment and severe flash floods in Toowomba/Lockyer Valley.
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Severe weather

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Y. Tropical cyclone Grant causes flooding and significant infrastructure damage north of Katherine.

A freight train derailed at a collapsed bridge due to heavy flooding caused by cyclone Grant at Edith River in the Northern Territory. Photograph courtesy of Michael Franchi, Northern Territory News.

Cyclone Yasi approaches the north Queensland coast, 2 February 2011. Satellite image processed by the Bureau of Meteorology from the Geostationary satellite MTSAT-2 operated by the Japan Meteorological Agency.

Black Sunday: Flames and smoke from bushfires in Roleystone, Perth, Western Australia. Photograph courtesy of Colin Murray, PerthNow.
10. Oceans: sea level and sea-surface temperatures

Sea level

Global average mean sea level for 2011 was 2.10 ± 0.30 mm above the 1980 level (intertide estimates of global average mean sea level are not available prior to 1880). Since the start of 1993, high-quality global sea-level measurements have been available from satellite altimetry in addition to tide gauges. These satellite data indicate that sea level rose at a global-averaged rate of 3.1 mm/year between 1993 and 2011. During the latter half of 2010 and the first half of 2011, sea level fell below this rising trend line (see figure on the next page), in part as a result of the transfer of water from the oceans to the land as experienced in exceptionally high rainfall and associated floods in Australia, and elsewhere around the world. These floods were associated with a very strong La Niña event. This is expected to be a short-term anomaly and in the latter half of 2011, the sea level began rising as the floodwater flowed out to sea.

Regional rates of sea-level rise are strongly influenced by seasonal and annual fluctuations in the climate system, such as La Niña. For this reason, the rate of sea-level rise is not uniform around the globe and varies from year to year. Local and regional trends can be above or below the global mean.

The rates of sea-level rise to the north and northwest of Australia from January 1993 to December 2011 (19 years) are two to three times the global average over this period (i.e. 7 to 11 mm/year). On the central east coast and areas to the south of the continent, the rates are similar to the global average. These departures from the global-averaged rate are at least partly the result of natural climate variability and these local variations remain superimposed on the underlying long-term trend of rising global sea levels.

Trends as observed by coastal tide gauges and offshore altimeters are in general agreement. The average of the Australian Baseline Sea Level Monitoring Array trends is 5.2 mm/year, and the average of the altimeter trends from the nearest data points to the tide gauges is 5.3 mm/year, compared to the global average of 3.1 mm/year. Two of the larger differences are at Hillarys, where the tide gauge is situated on compacting sediments (i.e. the area is sinking), and Port Kembla, where the coastal rate of sea-level rise is less than the offshore rate, possibly as a result of an increase in flow of the East Australian Current.

Sea-surface temperatures

Sea-surface temperatures (SSTs) in the Australian region were slightly cooler than 2010, but still well above average with an anomaly of +0.39 °C, as compared to the 1961–1990 average. January and November were the most notable, ranking second (+0.39 °C) and third (+0.43 °C) warmest on record for their respective months. Furthermore, during 2011, nine out of 11 months ranked in the top ten warmest months on record. SSTs in the tropical Pacific Ocean demonstrated a typical La Niña pattern from late winter 2010, with below-average SSTs in the central to eastern Pacific and above-average SSTs in the western Pacific region. The La Niña pattern is also apparent below the surface across the tropical Pacific. Subsurface temperature anomalies in the western Pacific reached a maximum (+4 °C) during February 2011 and have since weakened. In addition, below the surface, temperatures in the eastern Pacific approached 4 °C below average through the 2011 spring.

Throughout the year, positive SST anomalies were generally located in the Tasman Sea and off the southwest Western Australian coast. SST anomalies to the north of Australia, including the waters off the northwest coast of Western Australia and Coral Sea areas, experienced slightly negative SST anomalies through much of the year. Waters off the northern Australian coast during the June to November 2011 period were also cooler than average. This is in stark contrast to 2010 when the SSTs in the region were the highest on record. The year ended with very warm waters around southern and southwest Australia which in part explain the above-average temperatures experienced in these regions during 2011.
Average sea-surface temperature anomalies for the period July to December 2011. Anomalies are calculated with respect to the 1971–2000 average. Values are calculated from the NOAA Optimum Interpolation Reynolds Sea-Surface Temperature (NOAA_OI_SST_V3) data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA.

Subsurface temperature anomaly along the equatorial Pacific for the period July to December 2011 from BLUElink OceanMAPS. Anomalies are calculated with respect to the 1993–2006 period based on BLUElink ReANalysis (BRAN).
Climate Service Centres

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