Australian Government
Bureau of Meteorology

Special Climate Statement 75 – Australia's wettest November on record

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Cover image: Flooding west of Wee Waa, New South Wales, November 2021. Photo by Bryce Guest

Summary

- November 2021 was Australia's wettest November since national records began in 1900. Nationally averaged rainfall for the month was 76.2 mm, 135% above the 1961−1990 average.
- It was also the wettest November on record for New South Wales and South Australia, and for the Murray–Darling Basin.
- Many locations had their wettest November on record, particularly in inland New South Wales and the ACT, southern Queensland, and northern and western South Australia. A few locations, including Bathurst, had their wettest month on record.
- The wet November was the result of multiple rain events during the month which affected large parts of Australia.
- Whilst June to October 2021 saw rainfall close to the 1961-1990 average in many parts of Australia, it was a wet period in many areas on the New South Wales ranges and western slopes, resulting in high soil moisture and high levels in major water storages before the start of November.
- With soil moisture and water storage levels already high, the heavy rains contributed to substantial flooding, especially in inland New South Wales and southern Queensland. River systems which experienced major flooding included the Lachlan, Namoi, Macquarie, Barwon, Macintyre-Weir and Condamine-Balonne.
- The wet conditions in 2021 were in marked contrast to the severe drought of 2017−19. In some parts of northern inland New South Wales and southern Queensland in which 2019 was the driest year on record by a substantial margin, 2021 was one of the wettest years on record.
- The heavy rains led to substantial increases in water storage levels in the Murray–Darling Basin, particularly in the north, with many storages spilling. Total storage levels in the northern Murray–Darling Basin were 90.9% of capacity at the end of November, compared with 24.5% at the end of November 2020 and below 6% in early 2020.
- The wet conditions contributed to Australia having its coolest November since 1999.
- The extremely wet conditions were associated with a developing La Niña in the Pacific Ocean. In eastern Australia, a positive phase of the Southern Annular Mode also contributed to the high rainfall.

1. Antecedent conditions and key climate drivers

1.1. Antecedent conditions

In the Australian Gridded Climate Dataset (AGCD) dataset, rainfall for the first 10 months of 2021 was close to average over many parts of Australia. For Australia as a whole, AGCD rainfall for January to October was less than 0.5% above the 1961−1990 average, with only a few areas more than 50% above average, or more than 40% below average (Figure 1).

One area that experienced consistently high rainfall in 2021 was the eastern two-thirds of New South Wales. In coastal areas, this was largely the result of extreme high rainfalls during March when many records were set. Inland areas also had a wet start to the year, and then followed this with consistently above-average rainfall (wettest 30% compared to all years since 1900 in AGCD). through winter and the first half of spring. This was particularly apparent on the tablelands and western slopes, where June to October rainfall was widely 25% to 50% above the 1961−1990 average (Figure 2).

In contrast, the January to October period was dry along the coast and adjacent areas in eastern Queensland from Mackay to the Sunshine Coast, with the region experiencing significant rainfall deficiencies (driest 10% compared to all years since 1900 in AGCD) over the April 2020 to October 2021 period.

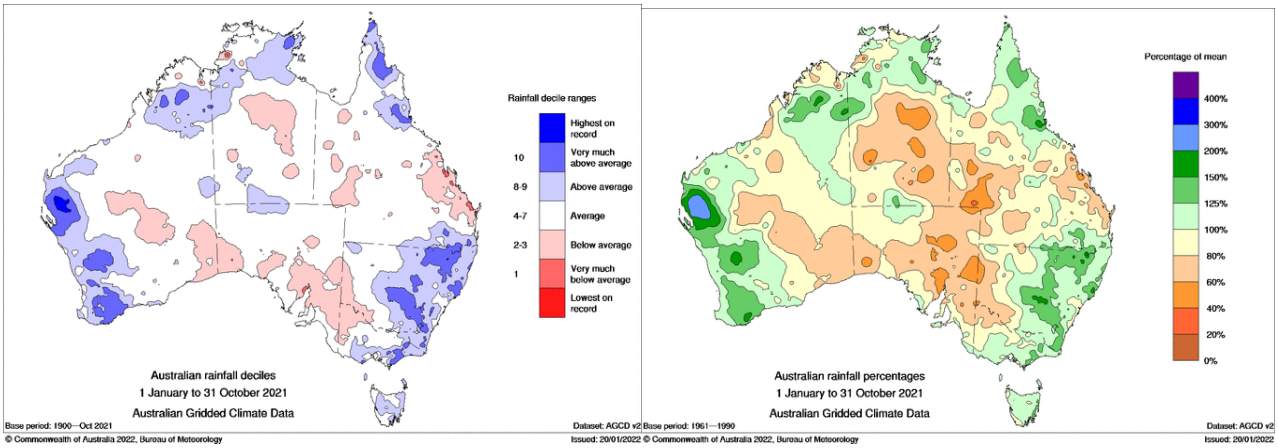

Figure 1. AGCD rainfall for January to October 2021: (left) deciles relative to 1900−2021 (right) percentage of 1961−1990 average

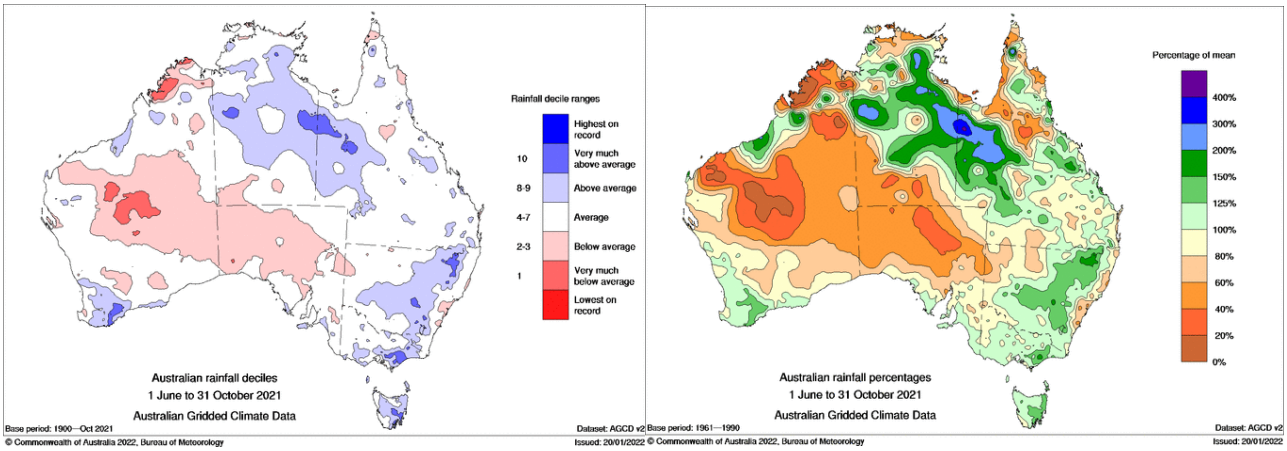

Figure 2. AGCD rainfall for June to October 2021: (left) deciles relative to 1900−2021 (right) percentage of 1961−1990 average.

1.2. Major climate drivers

Following a weak to moderate La Niña event over the summer of 2020−21, the Pacific Ocean had returned to neutral El Niño-Southern Oscillation (ENSO) conditions by March. However, cooling of surface waters resumed in the central and eastern equatorial Pacific from mid-year, and was approaching La Niña thresholds by October. A La Niña was declared by the Bureau of Meteorology on 23 November, with sea surface temperatures 0.4 °C to 0.8 °C below the 1961−1990 average, as seen in the Bureau's sea surface temperature (SST) analyses across most of the central and eastern equatorial Pacific (Figure 3).

The Indian Ocean Dipole (IOD) was in a weak negative mode for most of the period from June to October. The negative IOD phase weakened in November, as is typical at this time of year. However, waters in the region between Indonesia and northern Western Australia, near the eastern node of the IOD, were still significantly warmer than usual in November (Figure 3).

The Southern Annular Mode (SAM) was positive for most of October and November, resulting in easterly wind anomalies over southern Australia. Although it was relatively weak for much of the month, the Madden-Julian Oscillation (MJO) was also centred in the Maritime Continent region for most of November.

These factors were all favourable for above-average rainfall in many parts of Australia. La Niña is associated with an increased chance of above-average spring rainfall in much of eastern and northern Australia, and a negative IOD is associated with above-average spring rainfall in the east and south. In spring, a positive phase of SAM is associated with above-average rainfall in parts of south-eastern Australia, particularly eastern New South Wales, and drier conditions in western Tasmania. An MJO centred over the Maritime Continent region is also favourable for high levels of moisture over tropical and subtropical areas of the continent. In contrast, in November 2020 the MJO was centred in the western hemisphere and western Indian Ocean, contributing to very dry conditions that month for the eastern two thirds of Australia.

This combination of climate drivers favouring rain was reflected in seasonal outlooks. The Bureau's seasonal climate outlook issued on 28 October 2021 showed a greater than 60% chance of above-median November rainfall (relative to 1981–2018) over almost all the eastern mainland states and South Australia, as well as eastern Tasmania and parts of the Northern Territory. The forecast chance of above-median rainfall exceeded 75% in regions including southern inland New South Wales, the Eyre Peninsula and Mid-North of South Australia, and some far northern areas of the Northern Territory and Queensland.

La Niña is also associated with below-average maximum temperatures in many parts of Australia, but above-average maximum temperatures in spring in the northern tropics. Both of these were apparent in November 2021 (section 3.4).

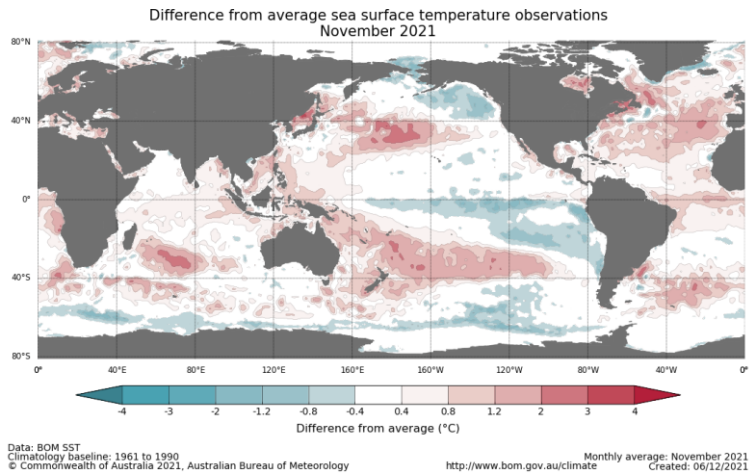

Figure 3. Sea surface temperature anomalies (from 1961−1990 average) for November 2021.

2. Heavy rainfall during November

2.1. Major weather systems contributing to heavy rainfall

November 2021 was marked by the frequency of rainfall over many parts of the country, especially eastern Australia (Figure 4). Only a brief period in mid-month, from the 14th to the 18th, was largely free of widespread rain over the continent.

The most significant weather systems during the month were:

- A cold front that crossed south-eastern Australia on the 3rd and 4th, bringing substantial rain to Victoria and southern New South Wales.

- A low pressure system that formed over the interior of Western Australia on the 9th deepened and moved across South Australia and New South Wales and northern Victoria, before finally moving out to sea off far southern New South Wales on the 13th. Most of the continent, except for parts of Western Australia, received substantial rain from this low or cold fronts and troughs associated with it. The heaviest falls were in southern and western Queensland, eastern New South Wales and eastern Victoria, the southern Northern Territory, and the northern Eyre Peninsula and Mid-North of South Australia. In these areas, totals for the week ending on the 13th were generally over 50 mm, exceeding 100 mm in places.

- A low pressure trough developed on the 19th and 20th, extending from interior Western Australia, through South Australia and the southern Northern Territory to east-central New South Wales and the low in the Tasman Sea. Heavy falls occurred on the northern side of this trough, particularly in the northern half of New South Wales.

- A low pressure system formed near Adelaide on the 24th, moving north-east to be centred over north-western New South Wales on the 25th and central New South Wales on the 26th before weakening. This interacted with a moist air mass which had remained in place following the previous trough to produce widespread rain, particularly in eastern New South Wales and the south-east quarter of Queensland.

In addition to these large-scale systems, there was regular localised thunderstorm activity in eastern Australia, particularly in Queensland. In Queensland, significant rainfall also extended into the first two days of December.

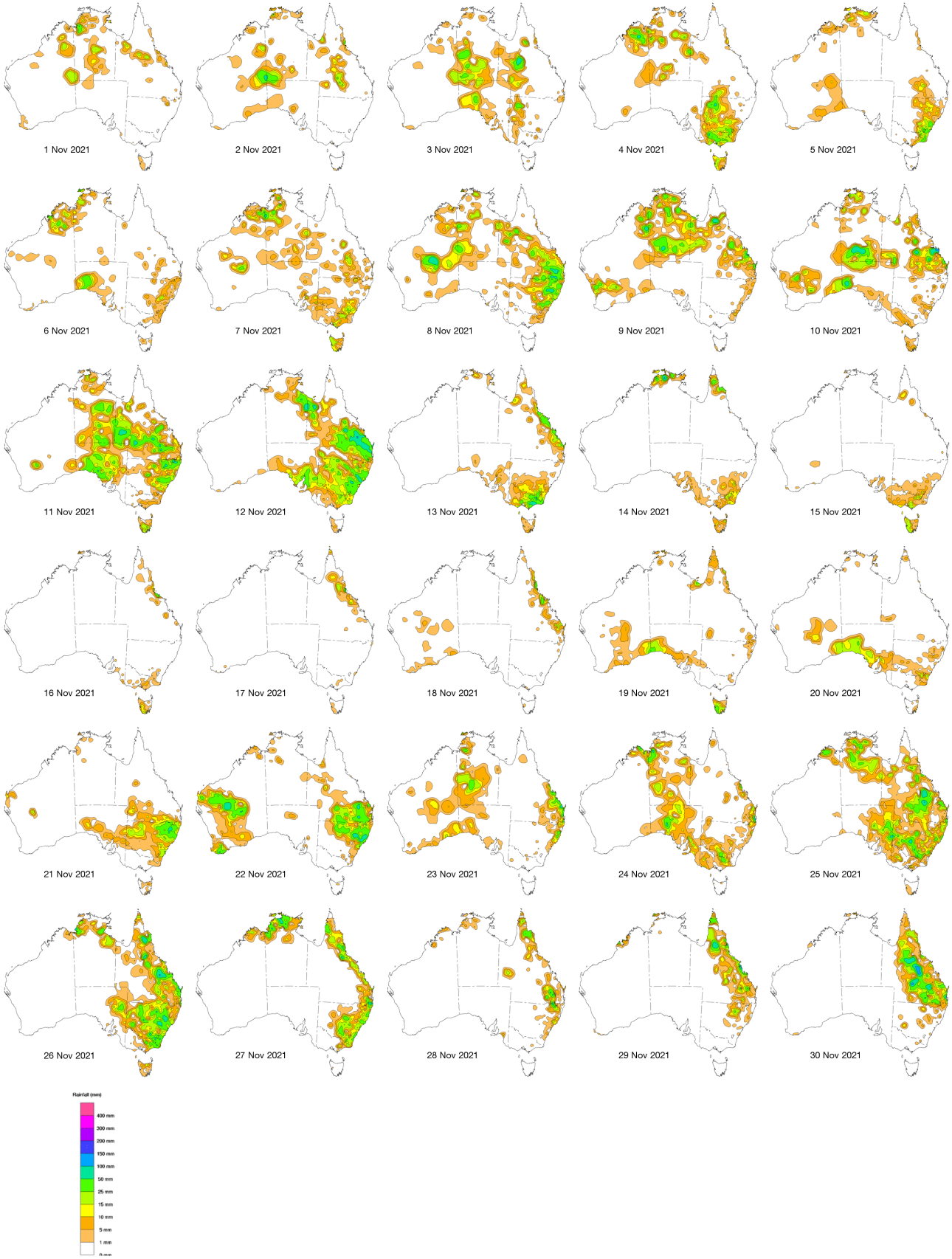

Figure 4. AGCD daily rainfall totals (mm) for each day from 1 to 30 November 2021.

2.2. Monthly rainfall totals in November

2.2.1. Large-scale patterns and area averages

Rainfall in the AGCD dataset in November was above the 1961−1990 average over most of the continent (Figure 5). It was very much above average (wettest 10% of all Novembers from 1900−2021) over almost all New South Wales, apart from some coastal areas and the extreme north-west; Queensland south of the tropics; South Australia from Adelaide northwards; the southern Northern Territory; eastern Victoria; and large parts of the interior and south-east of Western Australia, extending west to the coast around Exmouth. Over many parts of this region, November rainfall was more than three times the 1961−1990 average.

It was the wettest November on record (from 1900−2021) in many areas. These included scattered areas of inland New South Wales, particularly on the western slopes of the ranges; a region extending from the Nullarbor across northern Eyre Peninsula; and a region extending inland from the Queensland coast between Hervey Bay and Rockhampton.

The only regions with rainfall significantly below the 1961−1990 average were western Tasmania, far south-western Victoria and adjacent areas of far south-eastern South Australia, and parts of south-western Western Australia (although a localised heavy shower brought Perth its wettest November day on record, 40.4 mm on the 9th).

It was the wettest November on record for Australia as a whole (Table 1). The national average of 76.2 mm was 135% above the 1961−1990 average, and broke the previous record of 70.1 mm set in 1973, at the start of the very strong 1973−74 La Niña event.

It was also the wettest November on record for New South Wales (136.0 mm, 204% above the 1961−1990 average), South Australia (61.9 mm, 305% above average) and the Murray–Darling Basin (125.1 mm, 211% above average). Queensland had its seventh-wettest November, the Northern Territory its eighth-wettest and Western Australia its ninth-wettest. For the Murray–Darling Basin it was also the eighth-wettest month on record, and only the second of the top 10 months (alongside September 2016) to occur outside the January to April period. It was also the wettest month that New South Wales has experienced outside the January to April period.

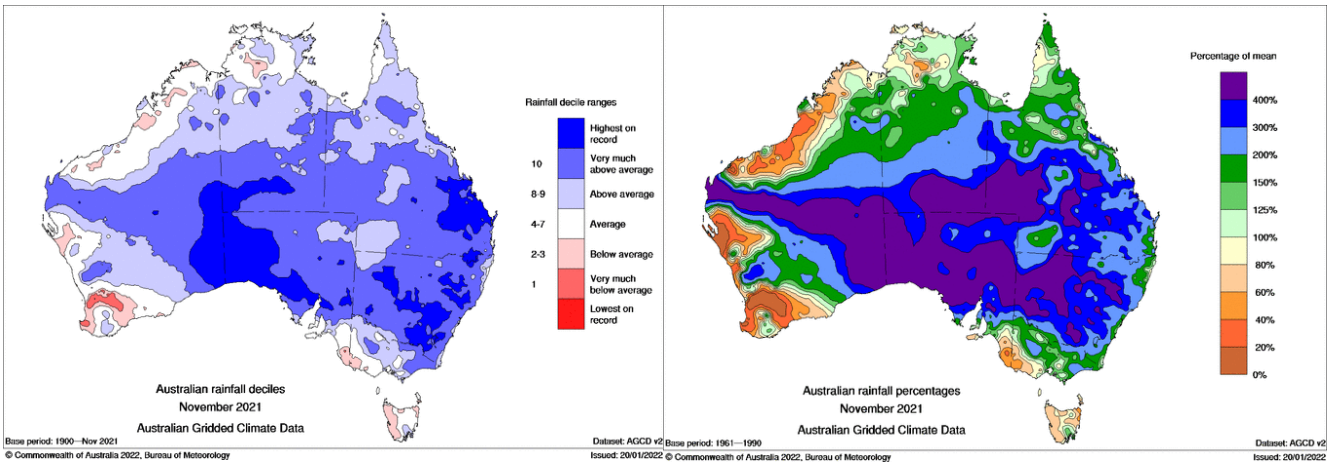

Figure 5. AGCD rainfall for November 2021: (left) deciles relative to 1900-2021, (right) percentage of 1961−1990 average.

2.2.2. Extreme rainfalls for individual stations and regions

306 stations with 50 years or more of data had their wettest November on record (Figure 6, Table S1). 152 of these stations were in New South Wales or the Australian Capital Territory, the majority of them near the ranges, but with some also in the Hunter region, and across the southern inland. There were also numerous stations with their wettest November on record in the south-eastern quarter of Queensland, and in a band in South Australia extending from the Nullarbor across northern Eyre Peninsula into the Mid-North. A few other stations outside these regions also had their wettest November on record, notably Alice Springs.

Some of the most exceptional monthly totals were in the Central Tablelands and Upper Hunter of New South Wales. A number of sites in this region had monthly totals above 300 mm, unusual for an inland area. Bathurst had 242.4 mm for the month, its highest monthly total for any month in a data set going back to 1858. [1]A number of shorter-term sites in the Bathurst region also had their wettest month on record, while elsewhere in New South Wales, highest monthly totals for any month also occurred at a few locations in the North-West Slopes and Plains, and the Riverina.

It was one of the five wettest Novembers on record (compared with all Novembers from 1900−2021 in AGCD) in 16 of the 26 catchments within the Murray–Darling Basin (Table 2, see Figure 10 for the catchment map). Of these, it was the wettest November on record in the Lachlan, Namoi, Border Rivers, Upper Murray, Murrumbidgee and Lake George catchments. The average over the Lachlan catchment of 136.8 mm was 22% above its previous November record, set in 1924, while the Murrumbidgee exceeded its previous record by 17%. Outside the Murray–Darling Basin, it was the wettest November on record for the Hunter catchment in New South Wales, and the Fitzroy and Burnett catchments in Queensland. It was also the wettest November on record for the Lower North and Western Agricultural[2] districts in South Australia.

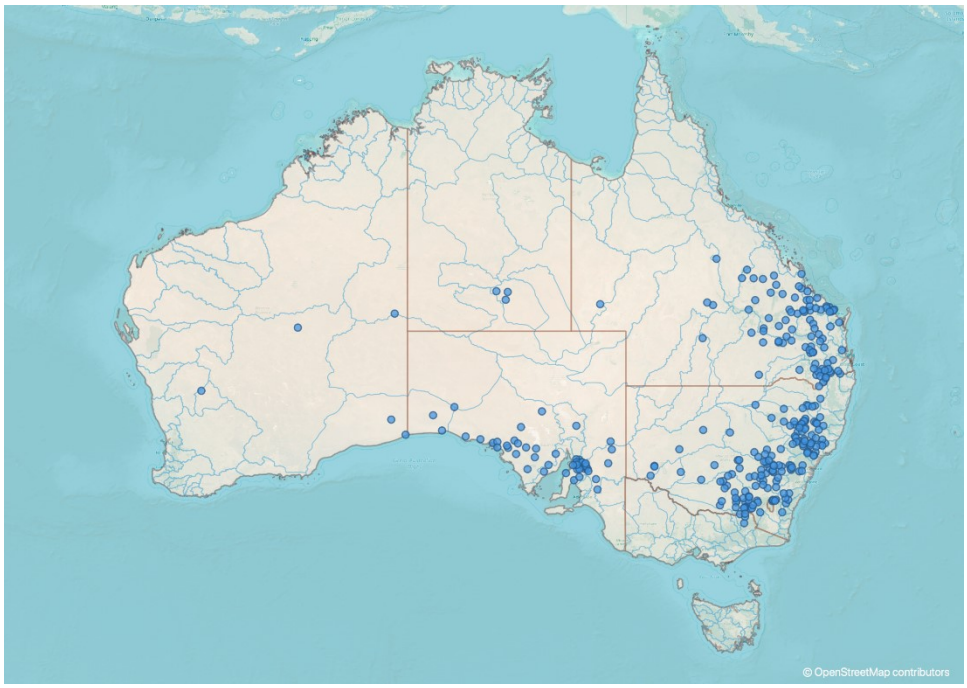

Figure 6. Sites with 50 years or more of data which had their wettest November on record in 2021.

[1] This encompasses data from Bathurst Agricultural Station (63005) from 1908 to the present, and Bathurst Gaol (63004) from 1858 to 1983. The previous highest monthly totals at these sites were 235.5 mm in February 1971 at Bathurst Agricultural Station, and 239.8 mm in February 1973 at Bathurst Gaol.

[2] The Western Agricultural district encompasses the Eyre Peninsula and the South Australian part of the Nullarbor.

2.3. Extreme daily rainfalls

November was distinguished more by the frequency of significant rainfall events than the intensity of individual events. This is reflected in the fact that there were 9 separate days during the month on which rainfall averaged over the Murray–Darling Basin exceeded 5 mm, the second-most in November (from 1900–2021 in AGCD) after 10 days in 2000.[3]

Another indicator of the rainfall being less extreme at the daily than monthly timescale was that 107 stations with 50 years or more of data had their highest November daily total on record (Figure 7, Table S2), compared with 306 that had their highest November monthly total. These record values were widely scattered compared with monthly records, a reflection of many of them occurring as the result of localised severe storms. Only one location with 50 years or more of data, Wedderburn in Victoria, had its wettest day on record for any month.

The highest individual daily rainfall totals during the month were in eastern Queensland, associated with severe storms. These were 340.8 mm at Samuel Hill (north of Rockhampton) on the 10th, 227.4 mm at Mackay Airport on the 29th, and 192.0 mm at Bundaberg Alert on the 26th. Noteworthy daily totals in inland Queensland included 142.0 mm at Carnarvon Station on 25 November.

Daily totals exceeding 100 mm also occurred during November in New South Wales, Victoria and the Northern Territory. In New South Wales, the heaviest daily fall was 153.0 mm at Orama, on the Mid-North Coast, on the 23rd and in Victoria, 122.4 mm at Mount Moornapa on the 13th. Alice Springs Desert Park had 106.0 mm on the 10th; on the same day, Alice Springs Airport recorded 100.2 mm, a November record for the site and its heaviest daily total since 111.8 mm on 12 February 2000.

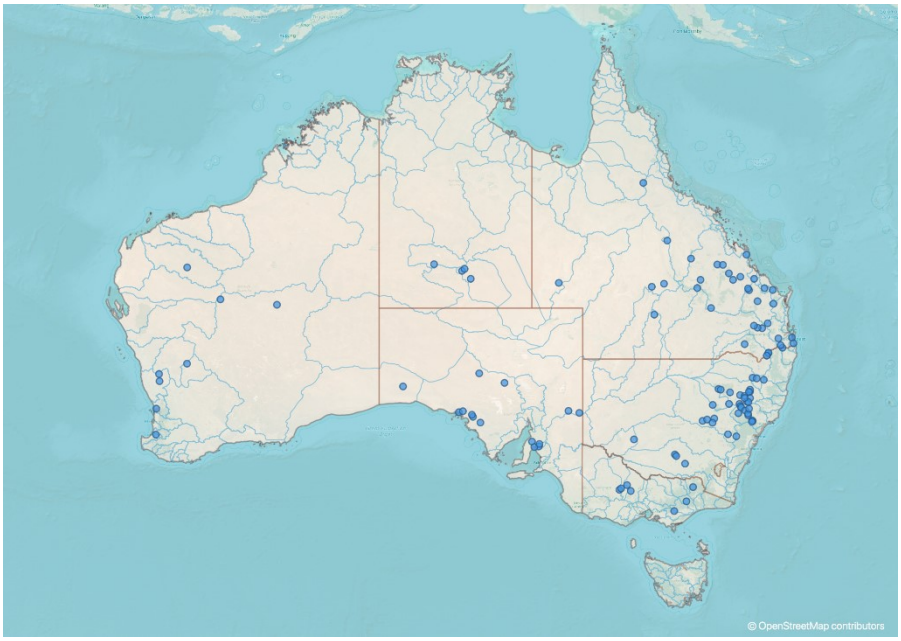

Figure 7. Sites with 50 years or more of data which had their wettest November day on record in November 2021.

2.4. Cool temperatures in November

The wet conditions were associated with below-average temperatures over much of Australia, particularly during the day. Mean maximum temperatures for the month were more than 2 °C below the 1961−1990 AWAP average

[3] The record for any month is 13 days in January 1974.

over much of the southern and central interior (Figure 8), and more than 4 °C below average over parts of the Nullarbor. Alice Springs (29.8 °C, 3.9 °C below the 1961−1990 average) and Forrest (24.9 °C, 4.5 °C below the 1961−1990 average) had their lowest November mean maximum temperatures on record. On the other hand, temperatures were above average in the far north, with Darwin Airport (34.7 °C) having its equal second-warmest mean November maximum on record.

Averaged over Australia, maximum temperatures were 1.21 °C below the 1961−1990 ACORN-SAT average, and mean monthly temperatures (day and night combined) 0.64 °C below average (Table 3). Both were the lowest for November since 1999, and November 2021 was the first month since March 2012 with a national mean maximum temperature more than 1 °C below average. New South Wales and South Australia also had their coolest November since 1999.

The month's most significant low temperatures occurred in association with the low pressure system that crossed Australia in the second week of the month, and a strong cold outbreak which affected the south-east in its wake. Many South Australian sites had their coldest November day on record on the 11th with some, including Yongala (8.4 °C, previously 11.8 °C) and Hawker (11.1 °C, previously 14.9 °C) breaking their records by more than 3 °C. Record low maximum temperatures also occurred in parts of southern Western Australia and western New South Wales during this period.

In the south-east, the coldest day was the 15th. Snow fell above 200 metres in the Hobart area and locally to sea level on Bruny Island. kunanyi (Mount Wellington Pinnacle) had a maximum temperature of −2.1 °C, the lowest on record for November in Tasmania. Canberra set a November record with 3 consecutive days of 14 °C or below from the 13th to the 15th, whilst Melbourne equalled a November record with 7 consecutive days below 17 °C from the 10th to the 16th.

The month was also notable for a lack of hot weather in the south-east. The 30th was the first day of spring 2021 in which the temperature reached 30 °C in Melbourne or 35 °C at any Victorian site, the latest such date since 2001 and 1971 respectively. Canberra did not reach 27 °C in spring for the first time since 1998.

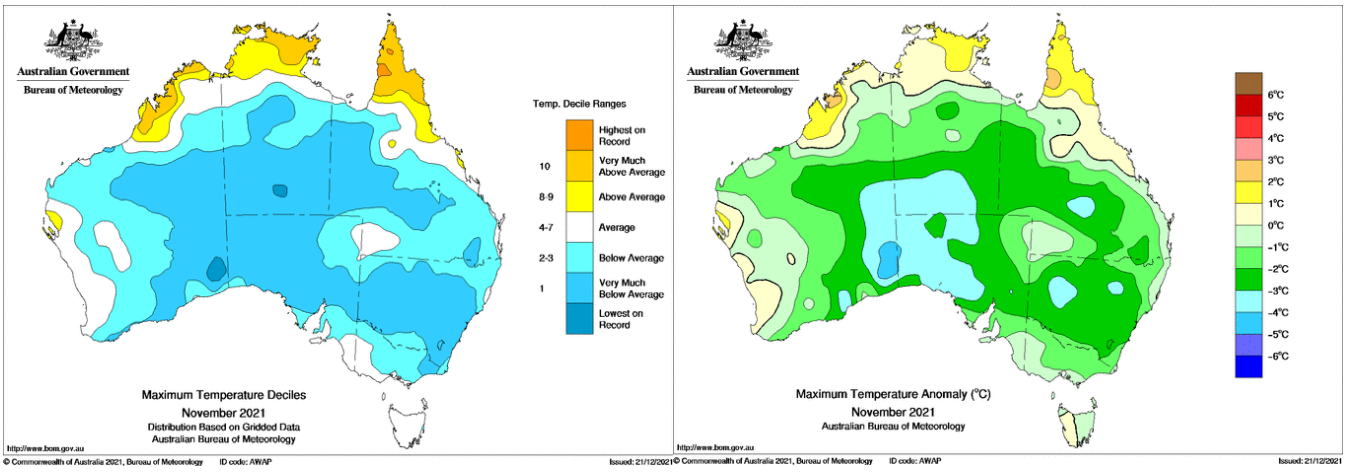

Figure 8. AWAP temperature for November 2021: (left) maximum temperature deciles relative to 1910-2021, (right) Maximum temperature anomalies (from 1961−1990 average).

3. November rainfall contributing to high spring and annual totals

3.1. Spring rainfall

The high November rainfall totals were a major contributor to a wet spring over many parts of Australia (Figure 9). Australia had its ninth-wettest spring on record (from 1900–2021 in AGCD), New South Wales its fourth-wettest and the Murray–Darling basin its seventh-wettest. In all three regions, the very wet November was sufficient to lift

spring rainfall into the 10 highest totals, despite September–October totals being very close to the 1961–1990 average. It was the wettest spring since 2010 for all three regions, as well as for Queensland and South Australia.

Spring rainfalls were the highest on record in a few regions, mostly in the Central and Southern Tablelands of New South Wales, the Australian Capital Territory, and parts of East Gippsland in Victoria. Canberra Airport had its wettest spring on record with 321.6 mm, exceeding the previous record of 304.0 mm in 1959.

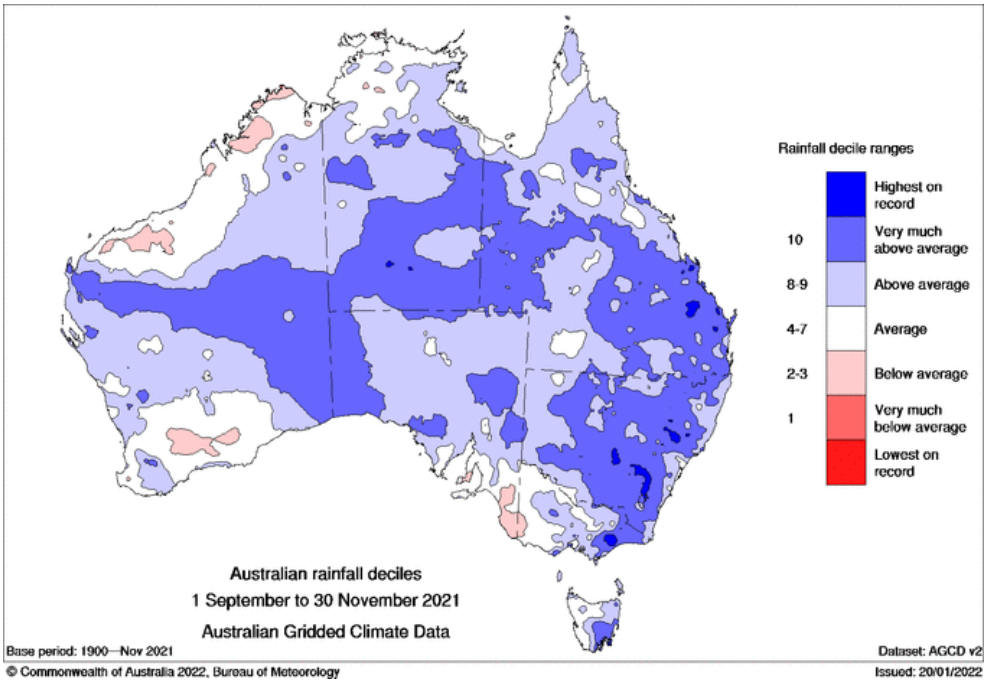

Figure 9. AGCD rainfall deciles for spring 2021, relative to 1900-2021.

3.2. January to November rainfall

January to November 2021 had very much above average rainfall (wettest 10% compared to all years since 1900 in AGCD) over much of the eastern halves of New South Wales and Victoria, as well as some border areas of Queensland. Some locations have had their wettest January-November on record, especially near the Queensland-NSW border (Table S3).

The Gwydir catchment[4] (Figure 10) has had its third-wettest January to November on record, and the Border Rivers[5] catchment its fourth-wettest. Both regions have been consistently wet through most of the year. The Gwydir catchment had its tenth-wettest autumn, thirteenth-wettest winter and tenth-wettest spring out of 122 years. Catchment average rainfall for January to November also ranks in the top ten for the Lachlan (5th), Namoi (5th), Lake George (6th), Castlereagh (8th) and Macquarie-Bogan (8th) catchments.

It was also the wettest January to November for a significant period in some other regions[6]. The East Gippsland, and West and South Gippsland, districts have had their wettest January-November since 1978. Orbost (1233.6 mm) and Bairnsdale (934.2 mm) went on to have their wettest years since 1978. Canberra's annual total of 912.6

[4] Catchment boundaries are available at http://www.bom.gov.au/water/about/image/basin-hi_grid.jpg.

[5] The Border Rivers catchment encompasses the Macintyre, Severn and Dumaresq Rivers.

[6] Record high January to November rainfall totals have also occurred at a few locations in Western Australia, but this is primarily the result of a tropical low in February and is outside the scope of this statement.

mm was its highest annual total since 2010 and its fifth-highest on record, while the Southern Tablelands (Goulburn-Monaro) have had their wettest January-November since 1978.

The wet conditions near the Queensland-NSW border in 2021 stand in marked contrast to the severe drought in this area in 2019. Some of the most extreme rainfall anomalies observed during the 2019 drought occurred in the area, with many locations having annual rainfall in 2019 which was 70% or more below the 1961−1990 average, and 40% or more below previous record lows. One example is at Inverell, went on to have its wettest year on record in 2021 (1268.9 mm); in 2019 it had by far its driest year on record, with 241.2 mm (69% below the 1961−1990 average, and the only instance of a year with less than 400 mm). Texas (1143.0 mm) also followed its driest year in 2019 with its wettest in 2021 The Northwest Slopes (North) rainfall district had its second-wettest January−November on record in 2021 (from 1900–2021 in AGCD), after having an annual total in 2019 which was more than 40% below that of any other year.

Figure 10. Major rivers and catchment boundaries within the Murray–Darling Basin.

3.3. Impact of November rainfall on rainfall deficiencies

The rainfall in November 2021 removed almost all remaining rainfall deficiencies (driest 10% compared to all years since 1900 in AGCD) in eastern Australia at timescales of 2 years or less. Low rainfall through much of 2020 and 2021, particularly during the 2020−21 wet season, had led to the development of significant rainfall deficiencies. for

periods starting in April 2020, in many parts of eastern Queensland south of the tropics, particularly coastal areas between Mackay and the Sunshine Coast (Figure 11, left). The heavy November rains, which were the highest on record for November in many of the affected areas (Figure 5), were sufficient to almost eliminate rainfall deficiencies completely in this region (Figure 11, right).

Whilst the situation improved substantially in November, long-term rainfall deficiencies at varying levels of severity still affect most of the southeast quarter of Queensland, with 4-year totals still at record low levels along parts of the coast (Figure 12). Another area of severe rainfall deficiencies on this timescale covers a region extending east from the Yorke Peninsula and Mid-North of South Australia to the Mallee on both sides of the Victoria–South Australia border. The November rains had little impact on these deficiencies, although they did weaken long-term deficiencies further north in eastern South Australia and far western New South Wales.

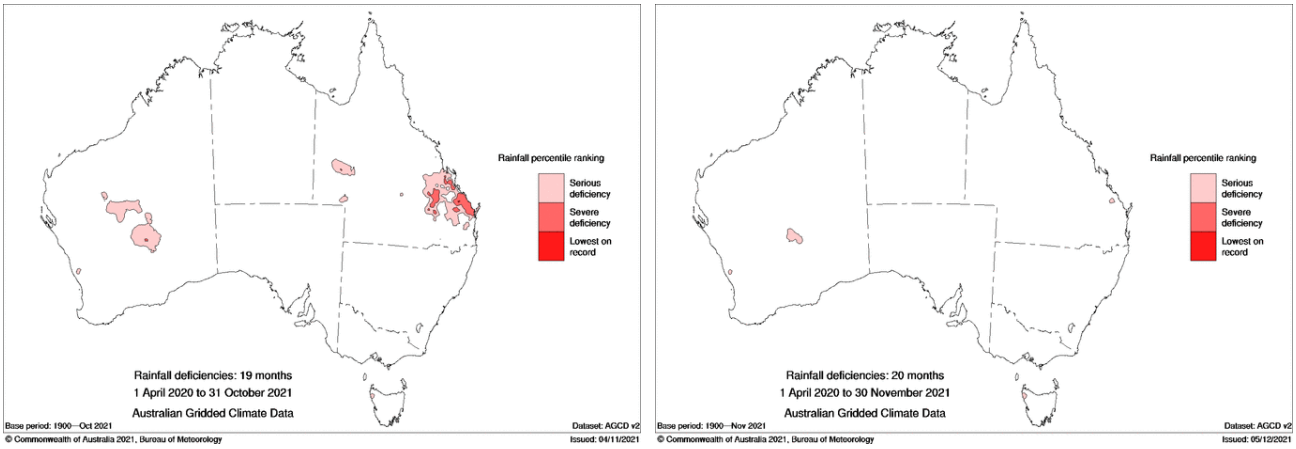

Figure 11. AGCD rainfall deficiencies for the periods (left) 19 months April 2020 to October 2021 (right) 20 months April 2020 to November 2021. Rainfall deficiencies are relative to 1900–2021.

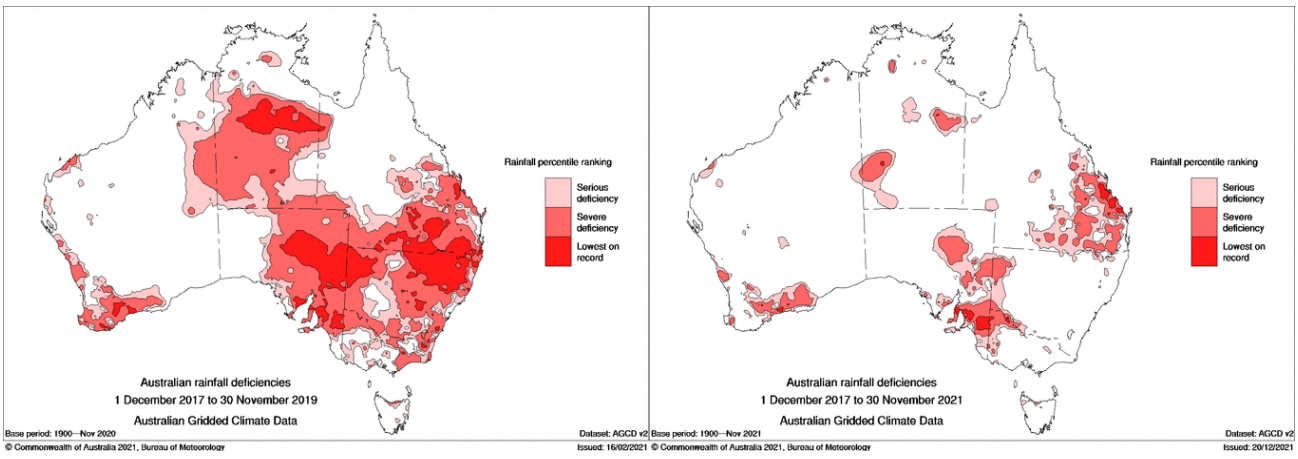

Figure 12. AGCD rainfall deficiencies for the period commencing December 2017: (left) as of 30 November 2019, (right) as of 30 November 2021. Rainfall deficiencies are relative to 1900–2021.

4. Hydrological conditions

4.1. Soil moisture

Root-zone soil moisture (soil moisture in the top 100 cm) was already above average (highest 30% in 1911–2021 in AWRA-L) at the start of November 2021 over large areas of inland NSW and southern Queensland (Figure 13).

This included the upper parts of most of the catchments which experienced flooding in November and early December.

The extremely wet conditions in November further increased root-zone soil moisture across most of Australia, (Figure 13). Moving into December, soil moisture was very much above average (highest 10% in 1911–2021 in AWRA-L) across eastern areas of NSW and Queensland including the Hunter, Namoi, and Border Rivers catchments, with some record high soil moisture in the upper Lachlan catchment and north of Canberra.

The very high soil moisture during November in conjunction with the heavy rainfall resulted in large inflows into water storages and flooding across large areas in NSW and south-east Queensland.

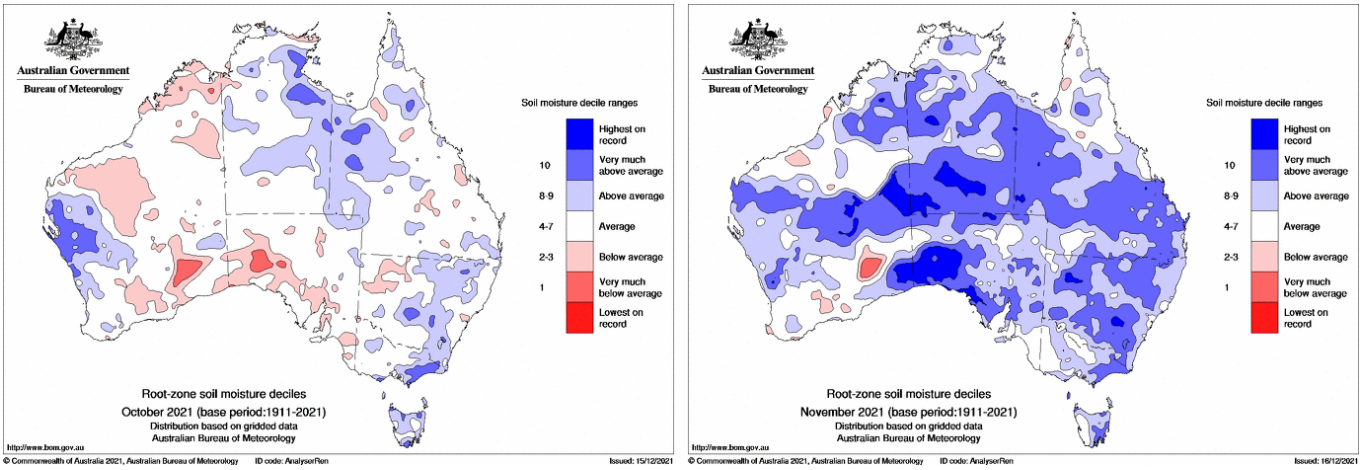

Figure 13. AWRA-L root zone soil moisture (top 100 cm of the soil profile) deciles for October and November 2021. Deciles relative to 1911−2021).

4.2. Water storages

The wet antecedent conditions saw many storages across the Murray–Darling Basin and eastern Australia fill and, in some instances, spill during November.

As seen in Figures 14 and 15, many of the storages in the Murray–Darling Basin, in particular, the northern Murray–Darling Basin were spilling during November, combining with flows from downstream tributaries and contributing to flooding. The total storage in the northern Basin increased to 90.9% of capacity (4222 GL) at the end of November. This is the highest level since May 2012 and a significant increase from the same time last year when it was only 24.5%. In the southern Basin (comprising more than 80% of the total storage volume in the Basin) the total storage reached 90.4% (18,688 GL) of accessible capacity in November. This is considerably higher than the same time in 2020 when it was only 68.8%.

In the Border Rivers catchment in the northern Murray–Darling Basin, Coolmunda and Pindari storages fell to 15% and 13% respectively over the period from 2019−2020. In March 2021, in response to heavy rainfall, Coolmunda filled in less than one week, and Pindari rose to 48% and then continued to fill reaching full supply level in August. The rainfall in November resulted in both storages spilling contributing to flooding in the Macintyre River and around Goondiwindi.

In the southern Murray–Darling Basin, Hume dam reached at 97.1% of capacity by the end of November, the highest level since November 2016. During the spring, the dam has been operated in controlled release mode to create airspace and prevent the dam from spilling. In November, the release volume was further increased for safe operations as a consequence of widespread rainfall over the Upper Murray catchment and very wet soils. The releases were reduced during the first week of December in response to reduced inflows, but further releases took place during December and January before a return to normal operations at the end of January.

In the Macquarie-Castlereagh catchment, Burrendong storage fell to 1.5% full in January 2020 and Drought Stage 3 conditions were in place. With improved rainfall conditions over the past 18 months, the storage filled reaching full capacity in September 2021. However, the very much above average rainfall over the Burrendong storage catchment in November saw the storage increase to 128% in one week. The dam was operated to store the water with only small releases being made, in order to mitigate potential downstream flooding in the Macquarie River where levels were already increased due to flows from the downstream tributaries.

The Menindee Lakes system has seen a period of rapid filling during the 2021 spring and reached 109% of capacity in November. Flood waters resulting from above average rainfall in the northern Murray–Darling basin moving down the Darling-Barka River have resulted in the highest water levels in the Lakes since November 2012; significantly higher than the same time in 2020 when it was only 23.1% full. Releases from the Menindee Lakes continued to increase in December and January in order to reduce the storage to accommodate forecast flows from the Namoi, Border Rivers, and Southern Queensland tributaries and to meet the operational requirement that the lakes be at 100% capacity by the end of December.

However, despite the very much above average rainfall that occurred in November, storages in south-east Queensland saw little increase although the decline in storage levels that has been observed over recent months did cease. In particular, Wivenhoe storage was only at 44.4% of capacity at the end of November which is similar to the same time in 2020 when it was 39.5%. Smaller storages in the area saw increases over late November and early December, including the Somerset storage increasing from 60% to 75% over two weeks and North Pine storage increasing from 60% to 67%.

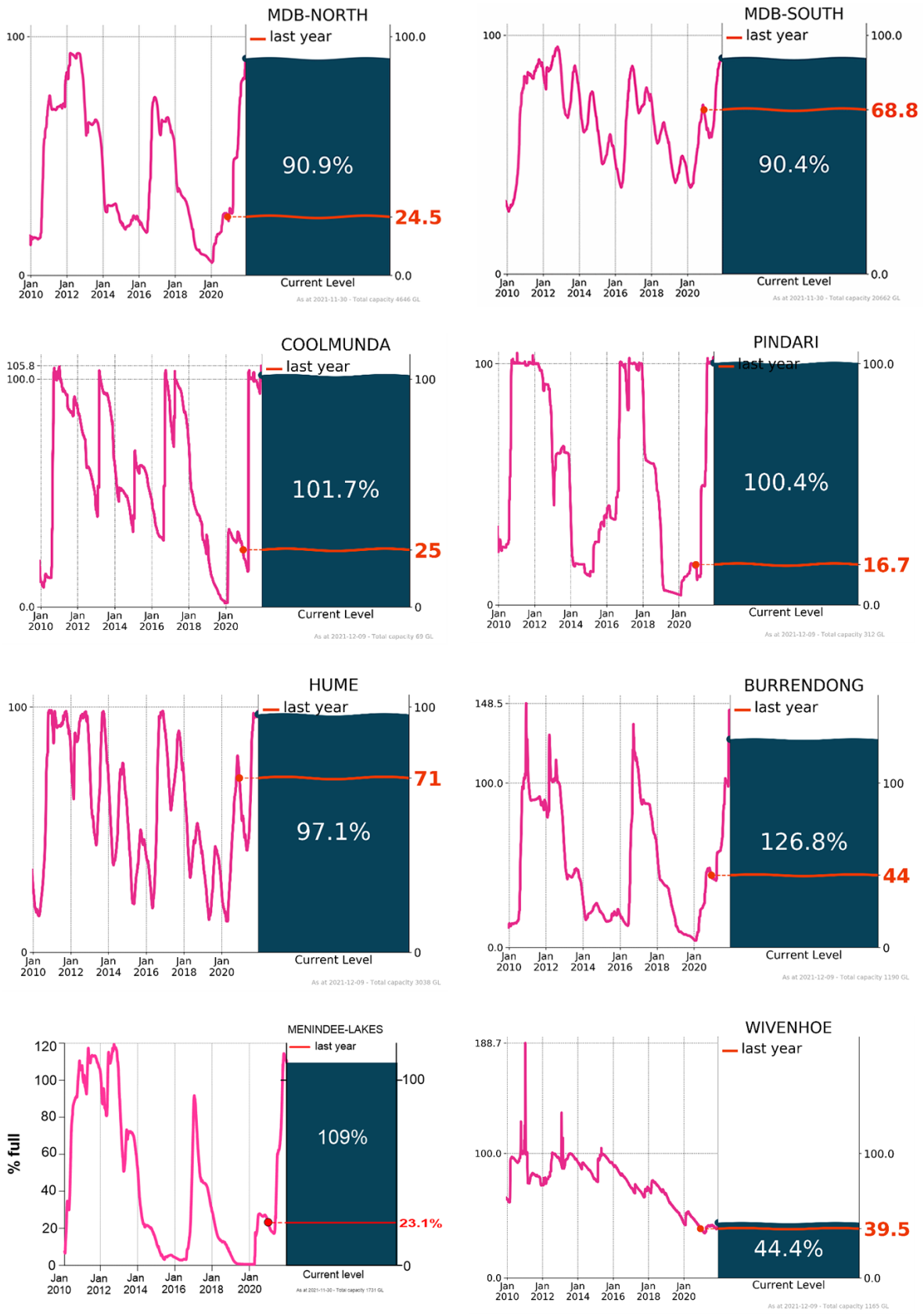

Figure 14. Total storage volumes in the northern and southern Murray–Darling Basin as of 30 November 2021, and selected storages as of 9 December 2021.

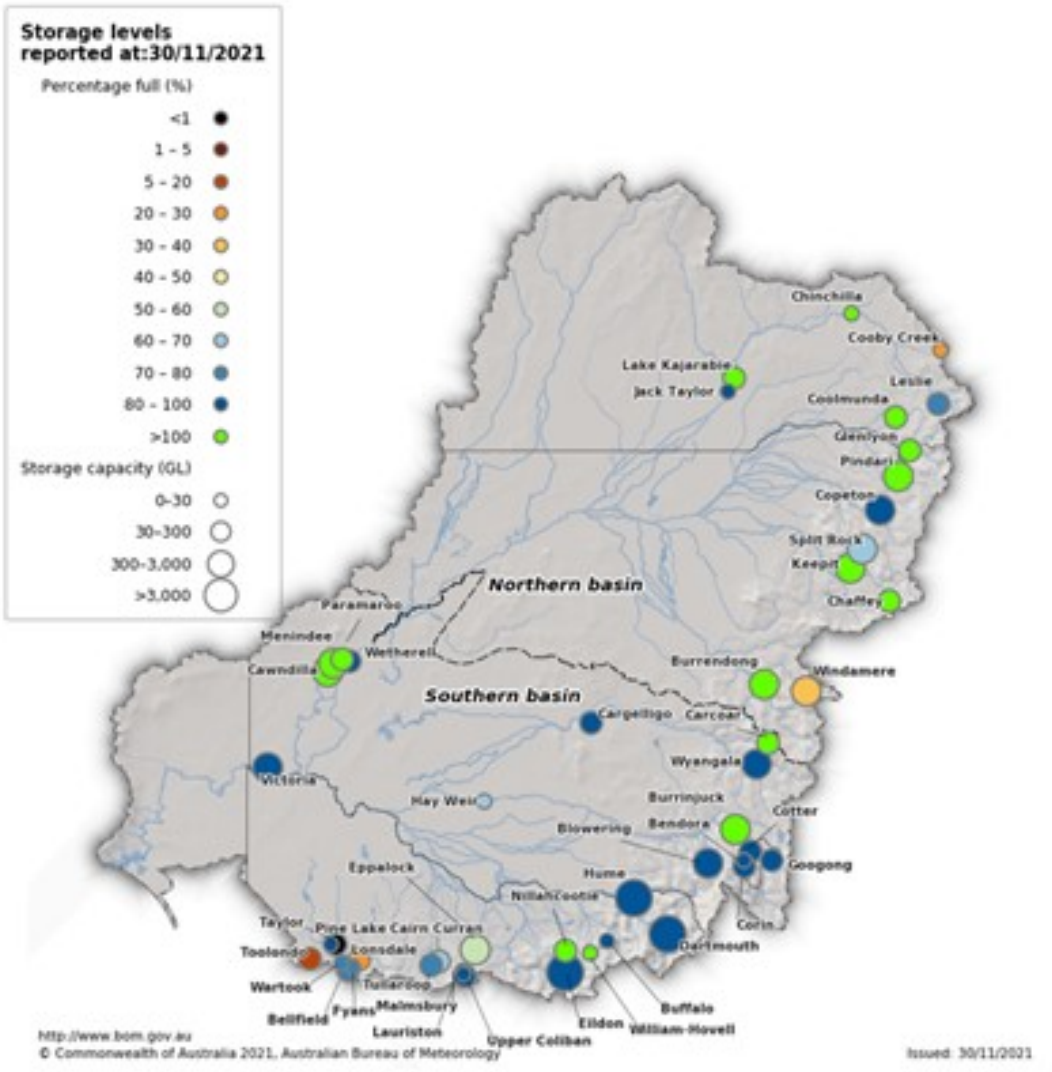

Figure 15**.** Total storage volumes in the northern and southern Murray–Darling Basin as of 30 November 2021.

4.3. Streamflow

Streamflows across much of eastern Australia were above averagein November (highest 30% in 1980–2021) in response to the very wet conditions.

In the Murray–Darling Basin, 64% of the sites had streamflows which were very much above average (highest 10% in 1980–2021) and 20 sites, in the eastern parts of the Basin, had highest on record streamflows for November since 1980 (Figure 16). Highest on record streamflows were recorded at streamflow gauges including in the Lachlan, Namoi, Gwydir and Border Rivers catchments.

In the south-east quarter of Queensland, 10 sites had streamflows that were the highest on record for November since 1980 inlcuding streamflow gauges on the Burnett and Logan Rivers. Similarly, highest on record streamflows for November were observed in the New South Wales coastal rivers including the Clarence, Richmond, Hunter and Shoalhaven.

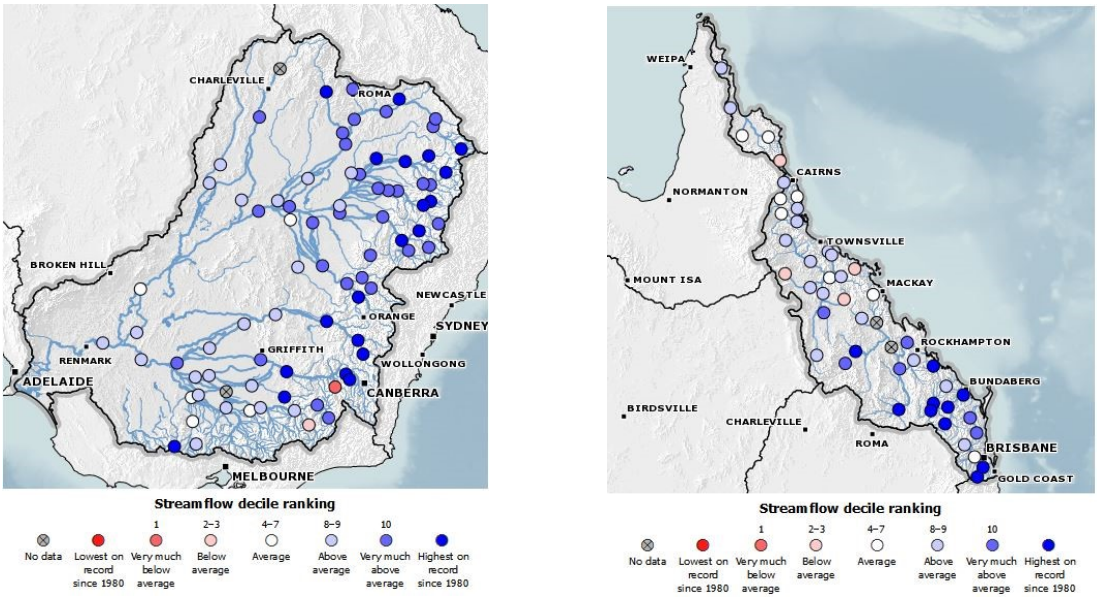

Figure 16. Streamflow deciles for November (based on data from 1980) for (left) the Murray–Darling Basin and (right) eastern Queensland.

4.4. Flooding

The heavy rainfall in November resulted in widespread flooding. The most significant flooding was in the rivers of the Murray–Darling Basin, particularly from the Lachlan northwards, but there was also flooding in a number of catchments which drain to the east coast. Major flooding was observed in November and early December at locations in catchments including the Macintyre-Weir, Condamine-Balonne, Barwon, Namoi, Macquarie, Lachlan, Dawson, Logan-Albert and Hunter. Many of these catchments were already wet at the start of November (Figure 13) before the November rains occurred. [7]

The first river to experience major flooding was the Lachlan, which had already had a number of lesser flood events earlier in the spring. Heavy rains in the second week of November, combined with releases from Wyangala Dam which was at capacity, led to significant flooding downstream. At Nanami, the peak of 12.45 m on 15 November was higher than that observed in the 2016 flood, although further downstream flood peaks were generally slightly lower than those in the 2016 event. Forbes (Iron Bridge) peaked at 10.54 m on 18 November, just below the major flood level of 10.55 m and lower than the 10.67 m in 2016. Jemalong remained above the major flood level (7.70 m) for more than two weeks from 19 November to 3 December, peaking at 7.94 m on 22 November.

By the last week of November, flooding had become much more widespread. The Namoi catchment experienced long-lived flooding with major flood levels reached at locations including Gunnedah, Narrabri and Wee Waa. At Wee Waa (Glencoe), major flood levels (6.70 m) persisted for 11 days from 25 November to 5 December, with a peak of 7.56 m on 29 November. A second flood peak reached major levels at Wee Waa on 13 December. The Macquarie also reached major flood level at Warren.

In Queensland, the most extreme flooding occurred in the Macintyre-Weir catchment. The Macintyre Brook at Inglewood had its second-highest flood on record, with a peak of 11.2 m on 1 December ranking only behind 11.7 m in February 1976. There was also major flooding at Goondiwindi and various other locations downstream. The Condamine-Balonne system also reached major flood level at a number of locations.

[7] Flooding resulting from rainfall after 2 December (e.g. in eastern Victoria and south-eastern New South Wales from 10 December) is outside the scope of this statement. Flooding continued to move downstream on inland rivers over December and January, with flooding still occurring on the Darling downstream of Bourke, and the Lachlan downstream as of Euabalong, as of 1 February 2022.

Tables

Three longer tables (S1, S2 and S3) are provided in a supplementary document.

Table 1: National and regional rainfall area averages for November 2021 using AGCD. Rankings cover the period from 1900 to 2021 (122 years).

Region	Value (mm)	Rank (1=highest, 122=lowest)	% above/ below 1961–90 average	Previous record/highest since
Australia	76.2	1	+135	Previous record 70.1 mm (1973)
WA	35.0	9	+96	Highest since 2012
NT	75.5	8	+84	Highest since 2011
SA	61.9	1	+305	Previous record 56.9 mm (1920)
Queensland	115.5	7	+153	Highest since 2010
NSW	136.0	1	+204	Previous record 120.2 mm (1917)
Victoria	79.5	18	+53	Highest since 2011
Tasmania	79.3	84	−21	Highest since 2019
Murray–Darling Basin	125.1	1	+211	Previous record 108.4 mm (1924)

Table 2: Rainfall in catchments within the Murray–Darling Basin. Rankings cover the period from 1900 to 2021 (122 years) using AGCD.

Catchment	November			Spring			January-November		
	Value (mm)	Rank	% above/ below 1961–90 average	Value (mm)	Rank	% above/ below 1961–90 average	Value (mm)	Rank	% above/ below 1961–90 average
Upper Murray	193.7	1	+133	442.6	6	+49	1255.0	11	+26
	Previous record: 192.0 (1924)								
Kiewa	155.0	9	+99	385.3	26	+27	1201.5	31	+12
Ovens	131.2	14	+90	333.3	26	+26	1016.3	37	+7
Broken	81.7	15	+92	208.0	27	+32	620.9	36	+9
Goulburn	80.1	27	+38	257.2	37	+20	804.6	46	+4
Campaspe	62.4	29	+56	190.4	36	+20	582.2	48	+2
Loddon	53.8	28	+59	158.9	30	+25	468.3	47	+4
Avoca	49.7	22	+72	129.2	30	+24	331.9	60	−7
Murray-Riverina	63.6	14	+110	144.0	27	+34	390.3	47	+2
Murrumbidgee	136.5	1	+212	252.1	5	+68	687.0	11	+30
	Previous record: 117.0 (1924)								
Lake George	212.3	1	+206	361.2	2	+74	977.1	5	+48
	Previous record: 183.4 (1961)								
Lachlan	136.8	1	+268	232.3	2	+87	670.5	5	+47
	Previous record: 111.8 (1924)								
Benanee	83.3	4	+259	137.3	12	+74	288.5	44	0
Mallee	37.3	27	+52	88.3	50	−1	237.6	95	−20
Wimmera-Avon	51.7	21	+67	138.7	37	+17	388.2	59	−3
Border Rivers	178.2	1	+166	272.7	9	+67	851.3	4	+45
	Previous record: 174.9 (1917)								
Moonie	142.6	5	+162	214.4	16	+62	674.9	11	+35
Gwydir	170.0	4	+166	274.1	10	+71	907.9	3	+51
Namoi	220.5	1	+265	330.0	3	+105	878.9	5	+46
	Previous record: 201.7 (2000)								
Castlereagh	184.4	2	+288	286.0	4	+110	770.6	8	+46

Macquarie-Bogan	155.5	2	+249	238.3	6	+80	719.5	8	+41
Condamine-Culgoa	151.3	2	+201	217.4	9	+89	595.5	15	+29
Warrego	150.1	2	+268	204.8	9	+134	501.5	29	+19
Paroo	97.1	3	+330	130.2	12	+127	326.0	35	+13
Darling	90.5	2	+334	130.7	10	+87	333.3	25	+17
Lower Murray	66.7	2	+234	110.6	23	+48	249.1	68	−6

Table 3: National and State monthly area-averaged temperature (°C) anomalies (from 1961−1990 average) for November 2021. Rankings cover the period from 1910 to 2021 (112 years) using ACORN-SAT.

Region	Maximum temperature			Mean temperature			Minimum temperature		
	Value	Rank	Lowest since	Value	Rank	Lowest since	Value	Rank	Lowest since
Australia	−1.21	17	1999	−0.64	27	1999	−0.09	53	2001
WA	−0.77	28	2008	−0.82	23	2008	−0.89	20	1992
NT	−1.34	19	2011	−1.16	18	2010	−1.00	22	2010
SA	−2.41	9	1999	−1.16	25	1999	+0.08	60	2019
Queensland	−0.76	28	2010	+0.18	66	2017	+1.11	99	2019
NSW	−2.00	10	1999	−0.49	37	1999	+1.01	79	2019
Victoria	−1.01	28	2001	−0.28	46	2013	+0.44	76	2019
Tasmania	+0.31	69	2019	−0.12	59	2019	−0.58	45	2006

Table 4: Lowest daily maximum temperature for November at locations with 30 years or more of data.

Site number(s)	Location	State	Value (°C)	Date	Previous record	Years of data
11052/11004	Forrest	WA	14.3	10/11	14.9 (3/11/1948)	76
12038	Kalgoorlie-Boulder	WA	13.5	9/11	13.9 (1/11/1939)	81
16001	Woomera	SA	13.1	11/11	14.5 (15/11/1999)	73
16090/16007	Coober Pedy	SA	15.4	11/11	16.7 (10/11/1970)	57
16098/16044	Tarcoola	SA	13.1	11/11	16.0 (15/11/1999)	96
18040	Kimba	SA	12.0	11/11	14.0 (2/11/1976)	55
18044	Kyancutta	SA	13.0	11/11	13.9 (16/11/1961)	92
18079	Streaky Bay	SA	13.7	11/11	15.8 (2/11/1976)	64
18116/18014	Cleve	SA	10.9	11/11	13.2 (16/11/1961)	65
18120/18103	Whyalla	SA	12.8	11/11	14.4 (16/11/1961)	65
18195/18052	Minnipa	SA	11.8	11/11	14.9 (3/11/1976)	57
18201/16092/ 19066/19036	Port Augusta	SA	13.8	11/11	15.6 (16/11/1961)	65
19017	Hawker	SA	11.1	11/11	14.9 (15/11/1999)	49
19062	Yongala	SA	8.4	11/11	11.8 (24/11/1971)	64
20062/20026	Yunta	SA	11.1	11/11	14.3 (24/11/2018)	56
21133/21046	Snowtown	SA	12.4	11/11	12.8 (7/11/1944)	114
21139/21118/ 21043	Port Pirie	SA	14.6	11/11	15.0 (16/11/1961)	64
22018	Warooka	SA	14.0	11/11	14.2 (2/11/1994)	57
23013	Parafield	SA	13.8	11/11	13.9 (6/11/1953)	65
23083	Edinburgh	SA	13.6	11/11	15.1 (3/11/1994)	50
23122/23020	Roseworthy	SA	13.0	11/11	13.9 (9/11/1992)	62
23373/23321	Nuriootpa	SA	11.4	11/11	11.8 (9/11/1992)	64
24511	Eudunda	SA	10.7	11/11	12.4 (9/11/1992)	57
47048/47007	Broken Hill	NSW	13.7	11/11	14.8 (8/11/1999)	68
49002	Balranald	NSW	12.9	12/11	13.9 (8/11/1971)	56
94087	kunanyi (Mount Wellington)	TAS	−2.1	15/11	−1.7 (4/11/1963)	38
96033/96065	Liawenee	TAS	1.9	15/11	2.4 (7/11/1994)	37

References and further information

National gridded rainfall analyses, and regional and catchment averages based on them, are for the period since 1900 using AGCD and national gridded temperature analyses are for the period since 1910 using AWAP.

This Statement covers information available as of 1 February 2022.

Links to further information

Australia's changing climate: State of the Climate 2020

Climate information: http://www.bom.gov.au/climate/

Australian Rainfall Analyses: http://www.bom.gov.au/climate/maps/rainfall/

Australian Landscape Water Balance: http://www.bom.gov.au/water/landscape