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Seasonal climate summary southern hemisphere (winter 2012): dry conditions return to Australia

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Southern hemisphere circulation patterns and associated anomalies for austral winter 2012 are reviewed, with an emphasis on Pacific Basin climate indicators and Australian rainfall and temperatures. Winter 2012 saw warm conditions in the equatorial Pacific that failed to reach sustained El Niño criteria, with sea surface temperatures in the NINO3 region close to El Niño thresholds but near-neutral values in atmospheric-based indices. The Southern Annular Mode entered a positive phase during July and a positive Indian Ocean Dipole event emerged during August. The combination of these phenomena led to drying conditions across southern Australia during winter and the emergence of severe rainfall deficiencies in Western Australia and South Australia. Maximum temperatures were close to normal during winter for most of Australia, although warmer than average for Western Australia. August was warmer than average across the continent, with especially warm conditions developing in Western Australia. Minimum temperatures were well-below average across the country, associated with southerly wind anomalies in central Australia.

Introduction

This summary reviews the southern hemisphere and equatorial climate patterns for winter 2012, with particular attention given to the Australasian and Pacific regions. The main sources of information for this report are analyses prepared by the Bureau of Meteorology's National Climate Centre and the Centre for Australian Weather and Climate Research (CAWCR).

Pacific Basin climate indices

Southern Oscillation Index

The Troup Southern Oscillation Index[1] (SOI) for the period January 2007 to August 2012 is shown in Fig. 1, together with a five-month weighted moving average. Following the moderate La Niña event of summer 2011–12, the 30-day SOI returned to neutral values in late February 2012, with negative values throughout winter 2012. Monthly SOI values ranged from –10.4 in June to –1.7 in July and –5 in August, with an average winter SOI value of –5.7.

The winter MSLP values were generally below average at Tahiti and above average at Darwin, with stronger anomalies at Darwin largely responsible for the negative SOI values. The monthly anomalies for June, July, and August for Darwin were +0.8, –0.3 and +1.0 hPa respectively, and for Tahiti were –0.5, –0.6 and +0.4.

Composite monthly ENSO index (5VAR)

5VAR[2] is a composite monthly ENSO index, calculated as the standardised amplitude of the first principal component of monthly Darwin and Tahiti mean sea level pressure (MSLP)[3] and monthly NINO3, NINO3.4 and NINO4 sea-surface

[1]The Troup Southern Oscillation Index (Troup 1965) used in this article is ten times the standardised monthly anomaly of the difference in mean-sea-level pressure (MSLP) between Tahiti and Darwin. The calculation is based on a 60-year climatology (1933–1992). The Darwin MSLP is provided by the Bureau of Meteorology, and the Tahiti MSLP is provided by Météo France inter-regional direction for French Polynesia.

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[2]ENSO 5VAR was developed at the Bureau's National Climate Centre and is described in Kuleshov et al. 2009. The principal component analysis and standardisation of this ENSO index is performed over the period 1950–1999.

[3]MSLP data obtained from http://www.bom.gov.au/climate/current/soihtm1.shtml. As previously mentioned, the Tahiti MSLP data are provided by Météo France inter-regional direction for French Polynesia.

Fig. 1. Southern Oscillation Index, from January 2007 to August 2012, together with a five-month binomially weighted moving average. Means and standard deviations used in the computation of the SOI are based on the period 1933–1992.

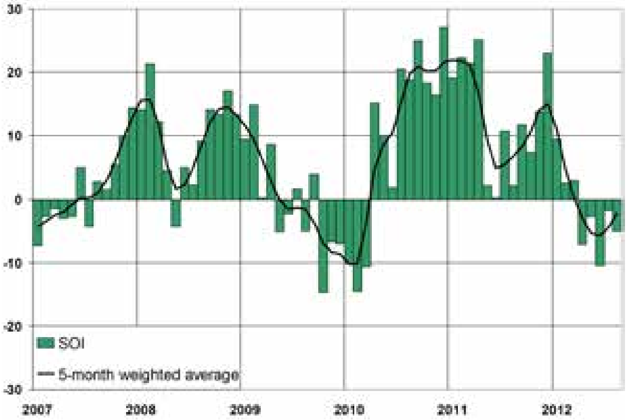


Fig. 2. 5VAR composite standardised monthly ENSO index from January 2007 to August 2012, together with a weighted three-month moving average. See text for details.

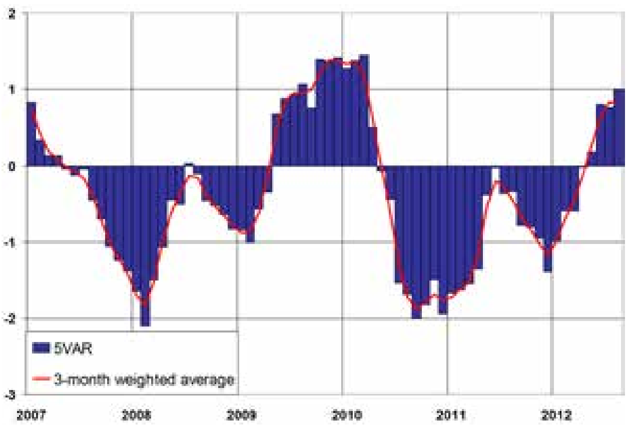


Fig. 3. OLR anomalies for winter 2012 (W m^{-2}). Base period 1979–2000. The mapped region extends from 40°S to 40°N and from 70°E to 180°E.

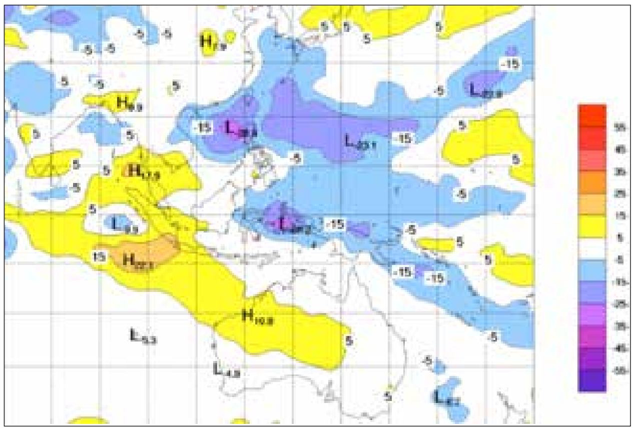
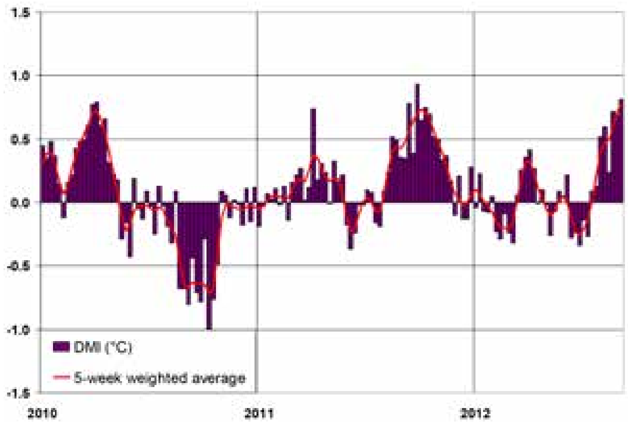


Fig. 4. Weekly DMI index from January 2010 to August 2012, together with a weighted five-month moving average. See text for details.



temperatures[4] (SSTs). Monthly 5VAR values for the period January 2007 to August 2012, with a weighted three-month moving average, are shown in Fig. 2. The 5VAR index was moderately positive throughout winter 2012, the first such period since April 2010, following the two La Niña events in recent years. The average 5VAR value for winter was +0.85, with monthly values of +0.80 (June), +0.77 (July) and +1.00 (August). An increase in the 5VAR values indicates warming in the equatorial Pacific Ocean and potential El Niño conditions.

The Multivariate ENSO Index[5] (MEI), produced by the US Climate Diagnostics Center, is derived from a number of atmospheric and oceanic parameters calculated as a two-month mean. Significant positive (negative) anomalies are typically associated with El Niño (La Niña) events. The MEI value for June–July was +1.14 (7th highest over the 1950–2012 period), indicating El Niño-like conditions. However, the MEI value decreased to +0.58 for July–August (21st highest), indicating a reduced chance of an El Niño event during the subsequent spring.

Outgoing long-wave radiation

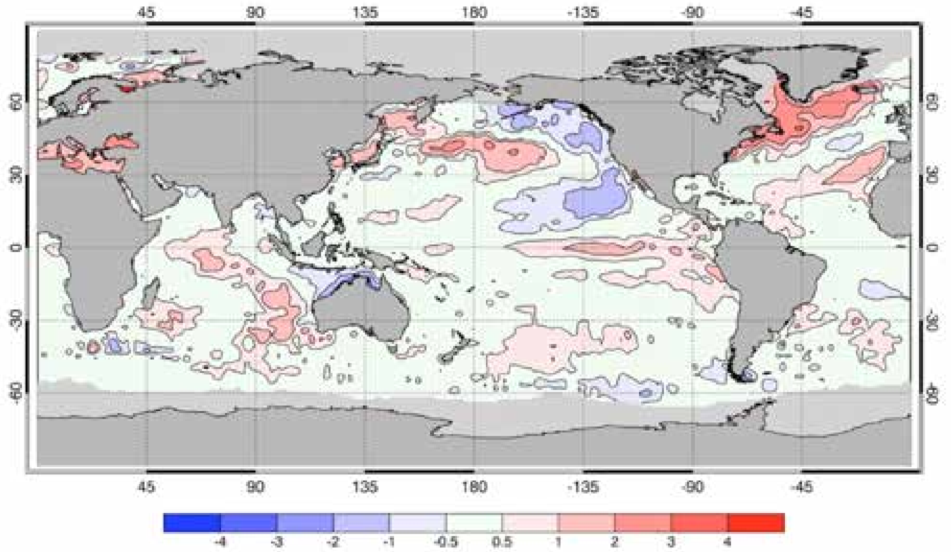
Outgoing long-wave radiation over the equatorial Pacific Ocean is a good indicator of changes in tropical convection patterns, with El Niño (La Niña) years associated with suppressed (enhanced) convection in the western equatorial Pacific and enhanced (suppressed) convection near the dateline. The Climate Prediction Center, Washington, computes standardised monthly anomalies[6] of outgoing long-wave radiation (OLR) for an equatorial region ranging from 5°S to 5°N and 160°E to 160°W. Positive (negative) OLR

[4]SST indices obtained from ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/sstoi.indices.

[5]Multivariate ENSO Index obtained from http://www.esrl.noaa.gov/psd/people/klaus.wolter/MEI/table.html. The MEI is a standardised anomaly index described in Wolter and Timlin 1993 and 1998.

[6]Obtained from http://www.cpc.ncep.noaa.gov/data/indices/olr

Fig. 5. Anomalies of SST for winter 2012 (°C).



anomalies indicate suppressed (enhanced) convection, and are an indicator of La Niña (El Niño) conditions. Monthly OLR anomalies in this region were +0.2 (June), –0.7 (July) and +0.2 (August), with a seasonal mean of –0.1 W m^{-2} for winter 2012, indicating neutral ENSO conditions.

The seasonal OLR anomalies for the Asia-Pacific region between 40°S and 40°N are shown in Fig. 3. Weakly negative anomalies were observed across the Maritime Continent directly north of Australia and in the South Pacific Convergence Zone, a pattern typically associated with La Niña conditions. Anomalies in this region continued to weaken during winter following the breakdown of the 2011–12 La Niña event in autumn.

Indian Ocean Dipole (IOD)

Positive OLR anomalies (suppressed convection) over the eastern tropical Indian Ocean are also evident in Fig. 3, with positive anomalies extending into central Australia. This mirrors patterns of sea surface temperature (SST) anomalies (see next section). A positive (negative) IOD is characterised by cooler (warmer) water near Indonesia and warmer (cooler) water in the tropical western Indian Ocean, and is associated with decreased (increased) rainfall in southern Australia during winter and spring.

The IOD can be represented by the Dipole Mode Index (Saji et al. 1999), the difference in SST anomalies between the western (50°E to 70°E and 10°S to 10°N) and eastern (90°E to 110°E and 10°S to 0°S) equatorial Indian Ocean, with an IOD event indicated by sustained anomalies greater than 0.5 °C. Weekly DMI values[7], shown in Fig. 4 from January 2009 to August 2012, are averaged to obtain monthly values. Monthly DMI values increased from –0.15 °C in June and +0.12 °C in July to +0.56 °C during August, indicating a developing positive IOD event during the season.

Oceanic patterns

Sea-surface temperatures

Global sea surface temperature (SST) anomalies for winter 2012, obtained from the US National Oceanic and Atmospheric Administration (NOAA) Optimum Interpolation analyses (Reynolds et al. 2002), are shown in Fig. 5. The base period is 1981–2010.

Warm SST anomalies are apparent in the eastern equatorial Pacific, with anomalies typically weaker than +2 °C. SST anomalies in the NINO3 region were persistently warm during winter, with monthly values of +0.75 °C (June), +0.94 °C (July) and +0.80 °C (August), close to El Niño thresholds. In contrast, NINO1 cooled significantly from +1.13 °C in June to +0.28 °C in August, while NINO4 warmed from +0.06 °C (June) to +0.64 °C (August), indicating a westward movement of warm anomalies during the season.

SSTs were above average across much of the Indian Ocean, with SSTs more than 1 °C above normal to the west of Australia. Warm SSTs in this region have now persisted for close to two years following their emergence during the 2010–11 La Niña event (Ganter 2011). Cool SST anomalies also emerged to the north of Australia during the season, contributing to the development of a positive Indian Ocean Dipole event (as discussed above).

Subsurface patterns

The equatorial thermocline is the region where the vertical gradient in subsurface temperatures is strongest, and is the boundary between warm near-surface waters and the cooler deep ocean. This can be approximated using the depth of the 20 °C isotherm, with positive (negative) anomalies corresponding to a deeper (shallower) thermocline. Changes in thermocline depth may act as a precursor to surface temperature changes, with a deeper thermocline associated with suppressed upwelling and warming sea

[7] Available at http://www.bom.gov.au/climate/enso/indices.shtml

Fig. 6. Time-longitude section of the monthly anomalous depth of the 20 °C isotherm at the equator (2°S to 2°N) for January 2010 to August 2012. (Plot obtained from the TAO Project Office).

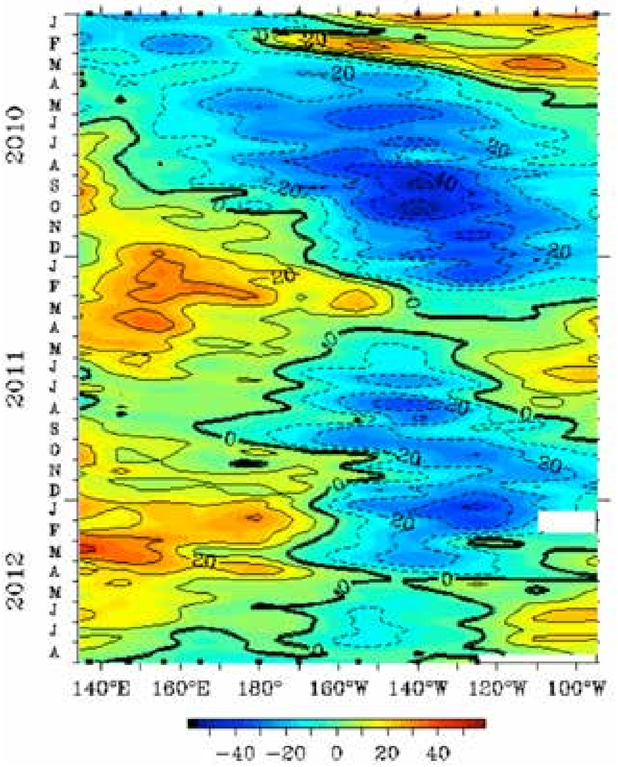
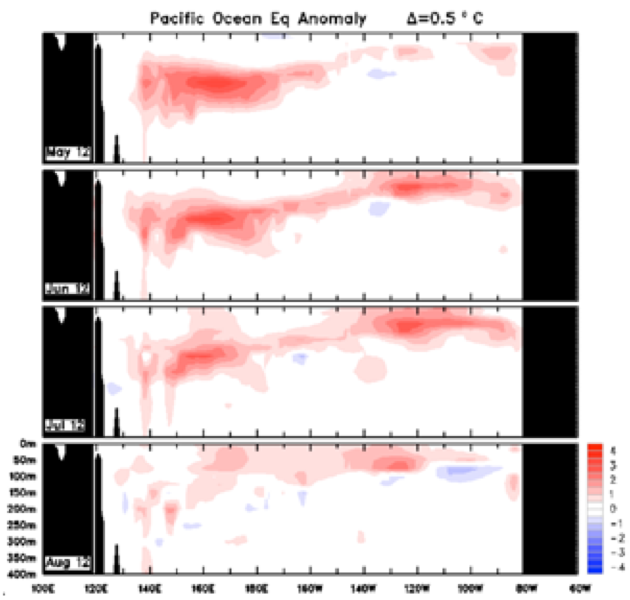


Fig. 7. Four-month May 2012 to August 2012 sequence of vertical sea subsurface temperature anomalies at the equator for the Pacific Ocean. The contour interval is 0.5 °C. (Plot obtained from CAWCR).



surface temperatures.

The Hovmöller diagram for the 20 °C isotherm depth anomaly (obtained from NOAA's TAO Project Office[8]) along the equator between January 2010 and August 2012 is shown in Fig. 6. Following the La Niña events of 2010–11 and 2011–12, the thermocline returned to close to average depths across most of the equatorial Pacific during winter 2012, with positive anomalies in the western Pacific weakening throughout the season. Positive anomalies emerged east of 120°W in June, but weakened slightly over August.

Figure 7 shows a cross-section of monthly vertical temperature anomalies from May to August 2012, from 120°E to 80°W and to a maximum depth of 400 m across the equatorial Pacific Ocean[9]. Following the breakdown of the 2011–12 La Niña event, warm subsurface water persisted in the western Pacific during May 2012. This spread eastward during June and July, associated with surface warming in the eastern Pacific, before weakening in August, indicating a reduced chance of El Niño development.

Atmospheric patterns

Surface analyses

The mean sea-level pressure (MSLP) pattern for winter 2012 is shown in Fig. 8, computed using data from the 0000 UTC daily analyses of the Bureau of Meteorology's Australian Community Climate and Earth System Simulator (ACCESS)[10] model. The MSLP anomalies are shown in Fig. 9, relative to a 1979–2000 climatology obtained from the National Centers for Environmental Prediction (NCEP) II Reanalysis data (Kanamitsu et al. 2002); anomalies are not shown over areas of elevated topography (grey shading).

The winter 2012 pattern of MSLP was zonal around Antarctica, with the subtropical ridge forming a band of high pressure centred on 30°S. Centres of high pressure were located in the southern Indian Ocean (1025.8 hPa), the southern South Atlantic (greater than 1025 hPa), and in the South Pacific west of the Chilean coast (1023.9 hPa), with a relatively weak subtropical ridge across the remaining southern Pacific. The circumpolar trough is evident around Antarctica, with a peak low pressure of 977.9 hPa around 120°W.

Anomalous high pressure covered most of the region between 30°S and 60°S, with anomalies reaching +6.9 hPa to the east of New Zealand and +6.3 hPa southwest of Australia. Anomalous low pressure covered most of the area south of 60°S, with anomalies of up to –10 hPa to the south of South America, while negative anomalies were also apparent south of Madagascar. Equatorward of 30°S, MSLP was generally close to normal, with slightly positive anomalies in central Australia and the western Pacific and negative anomalies in

[8]http://www.pmel.noaa.gov/tao/jsdisplay/
[9]http://www.bom.gov.au/oceanography/oceantemp/pastanal.shtml
[10]For more information on the Bureau of Meteorology's ACCESS model, see http://www.bom.gov.au/nwp/doc/access/NWPData.shtml

Fig. 8. Winter 2012 MSLP (hPa). The contour interval is 5 hPa.

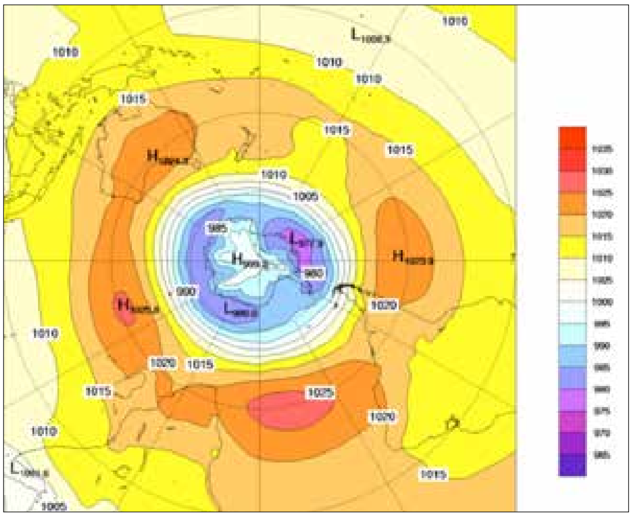


Fig. 10. Winter 2012 500 hPa mean geopotential height (gpm).

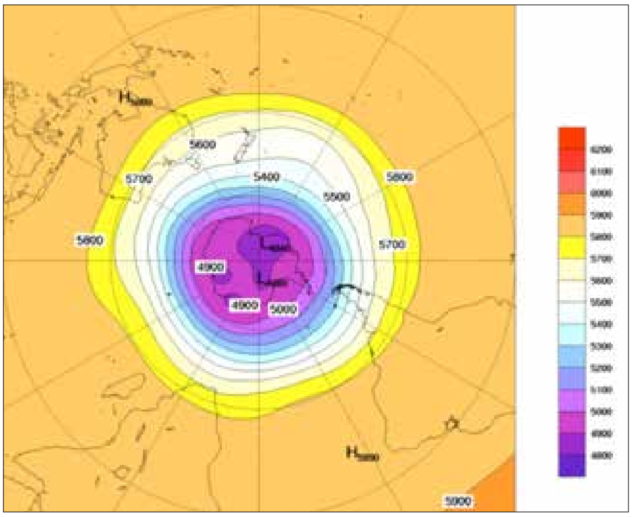


Fig. 9 Winter 2012 MSLP anomalies (hPa), from a 1979–2000 climatology.

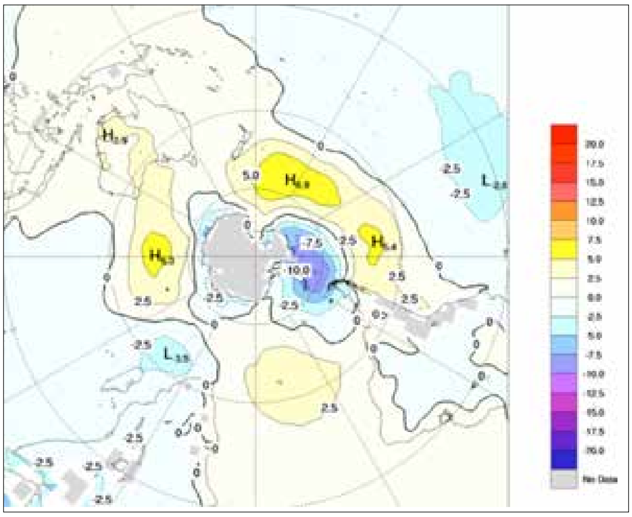
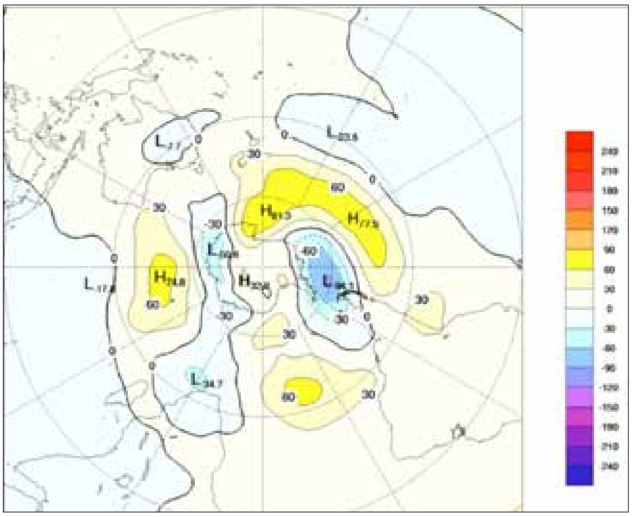


Fig. 11. Winter 2012 500 hPa mean geopotential height anomalies (gpm), from a 1979–2000 climatology.



the eastern Pacific. Anomalies reached –2.8 hPa on the equator at 110°W, associated with areas of warm SST anomalies.

Mid-tropospheric analyses

The 500 hPa geopotential height (an indicator of the steering of surface synoptic systems across the southern hemisphere, measured in gpm) is shown in Fig. 10 for winter 2012, with the associated anomalies shown in Fig. 11. The winter 500 hPa geopotential height field shows the southern hemisphere high latitudes were characterised by zonal flow. The patterns of geopotential height anomalies are similar to those observed for MSLP, with negative anomalies over the Antarctic Peninsula and Weddell Sea, reaching +94.1 gpm to the south of South America, and weaker anomalies over coastal western Antarctica between the Amery Ice Shelf and Casey Station and to the south of Africa. Positive anomalies are apparent across the southern Pacific between 40° and 60°S and 90° and 180°W, reaching +81.3 gpm near the Ross Ice Shelf, as well as in the southern Indian Ocean, reaching +74.8 gpm near 90°E, and in the South Atlantic, reaching more than +60 gpm between South America and South Africa.

Southern Annular Mode

The Southern Annular Mode (SAM, also known as the Antarctic Oscillation or AAO) refers to shifts in the location of the belt of strong westerly winds in the middle to high latitudes of the southern hemisphere. Positive (negative) phases of SAM are associated with negative (positive) MSLP anomalies over Antarctica and positive (negative) anomalies in the mid-latitudes. This results in a poleward contraction (equatorward expansion) of the belt of westerly winds. In the Australian region positive SAM is associated with easterly wind anomalies, with decreased rainfall in southwest Western Australia and southeast Australia during the winter months (Hendon et al. 2007).

Fig. 12. Winter 2012 850 hPa vector wind anomalies (m s^{-1}).

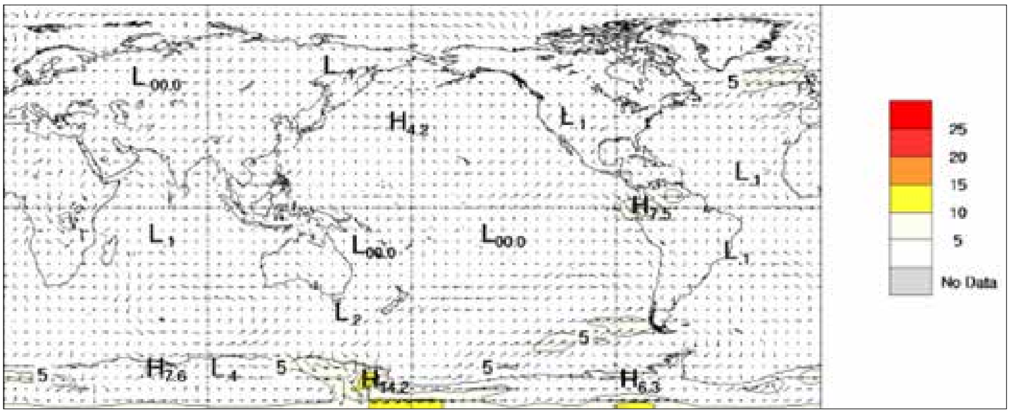
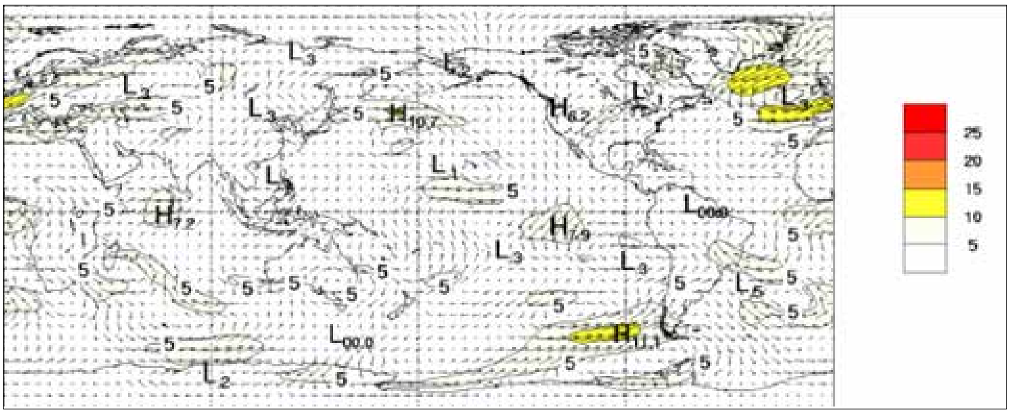


Fig. 13. Winter 2012 200 hPa vector wind anomalies (m s^{-1}).



The Climate Prediction Center produces a standardised monthly SAM index (Climate Prediction Center 2010)[11]. During winter 2012 SAM anomalies increased from –0.20 (June) to +1.26 (July) and +0.49 (August), with a seasonal SAM value of +0.52. The positive SAM in winter 2012 is consistent with Figs 9 and 11, which demonstrate negative anomalies over Antarctica and positive anomalies over much of the Southern Ocean.

Winds

Winter 2012 low-level (850 hPa) and upper-level (200 hPa) wind anomalies (from the 22-year NCEP II climatology) are shown in Fig. 12 and Fig. 13 respectively. Isotach contours are at 5 m s^{-1} intervals. Low-level winds during winter 2012 show weak westerly anomalies in the eastern equatorial Pacific, strongest off the South American coast, but near-normal patterns in the Maritime Continent and the western Indian Ocean. The upper level wind anomalies (200hPa) show a clockwise gyre in the central tropical Pacific, with southerly wind anomalies in the Australian region and strong westerly anomalies across much of the Southern Ocean.

[11]For more information on the SAM index from the Climate Prediction Center (NOAA), see http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/aao/aao.shtml.

Australian region

Rainfall

Australian winter rainfall totals for 2012 are shown in Fig. 14, with rainfall deciles shown in Fig. 15. The deciles are calculated with respect to gridded rainfall data for all winters between 1900 and 2012.

Averaged across Australia, winter rainfall was 16 per cent below the 1961–1990 average of 64 mm (see Table 1). Winter was particularly dry in the western half of Australia, with large areas of the Northern Territory, eastern Western Australia and northeast South Australia recording no rainfall at all during the season and very much below-average rainfall across much of southwest Western Australia. Totals were 44 per cent below average in Western Australia (the eighth driest on record), 83 per cent below average in the Northern Territory, and 28 per cent below average in South Australia, with below-average rainfall also recorded in eastern Tasmania and southern New South Wales. In comparison, rainfall was 43 per cent above average in Queensland, with above-average falls across most of the State. Rainfall was also above average in southern Victoria and small areas of southeast South Australia, as well as in the Albany region in southern coastal Western Australia.

Winter rainfall was in the lowest decile (driest ten per cent of

Table 1. Summary of the seasonal rainfall ranks and extremes on a national and State basis for winter 2012. The ranking in the last column goes from 1 (lowest) to 113 (highest) and is calculated over the years 1900–2012.

Region	*Highest seasonal total (mm)*	*Lowest seasonal total (mm)*	*Highest daily total (mm)*	*Area-averaged rainfall (mm)*	*Rank of area-averaged rainfall*	*% difference from mean*
Australia	850.2 at Wyelangta (Vic.)	0.0 at several locations	203.4 at Reeves Knob, 5 June (Vic.)	56	35	–16
Queensland	515.6 at Tree House Creek	0.0 at several locations	198.0 at Dunk Island, 10 July	73	92	+43
New South Wales	620.6 at Perisher Valley	27.0 at Broken Hill (Buckalow)	117.6 at Yamba, 12 June	98	35	–15
Victoria	850.2 at Wyelangta	50.2 at Kiamal	203.4 at Reeves Knob, 5 June	213	70	+4
Tasmania	1154.6 at Mt Read	64.8 at Little Swanpool (Lisdillon Farm)	68.6 at Gray, 4 June	394	41	–10
South Australia	536.2 at Hindmarsh Valley	0.0 at several locations	70.4 at Belair, 21 June	40	25	–28
Western Australia	597.0 at Alexandra Bridge	0.0 at several locations	174.2 at Peppermint Grove, 2 June	34	8	–44
Northern Territory	27.7 at Calvert Hills	0.0 at several locations	17.5 at Calvert Hills, 9 July	3	22	–83

Table 2. Percentage areas in different categories for winter 2012 rainfall. 'Severe deficiency' denotes rainfall at or below the 5th percentile. Areas in 'decile 1' include those in 'severe deficiency' which in turn include those which are 'lowest on record'. Areas in 'decile 10' include those which are 'highest on record'. Percentage areas of highest and lowest on record are given to two decimal places because of the small quantities involved; other percentage areas to one decimal place.

Region	*Lowest on record*	*Severe deficiency*	*Decile 1*	*Decile 10*	*Highest on record*
Australia	0.76	9.0	19.3	3.0	0.00
Queensland	0.00	0.0	0.1	11.2	0.00
New South Wales	0.00	0.0	0.0	0.0	0.00
Victoria	0.00	0.0	0.0	3.5	0.00
Tasmania	0.00	0.0	0.0	0.0	0.00
South Australia	5.15	21.4	32.5	0.4	0.00
Western Australia	0.29	12.5	32.3	0.2	0.00
Northern Territory	0.00	12.8	26.0	1.2	0.00

Fig. 14. Winter 2012 rainfall totals (mm) for Australia.

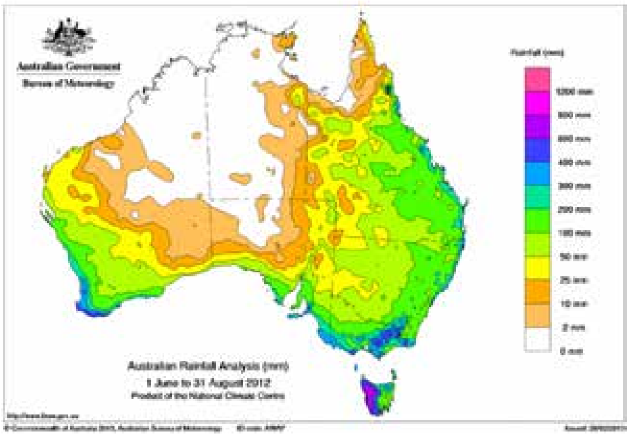
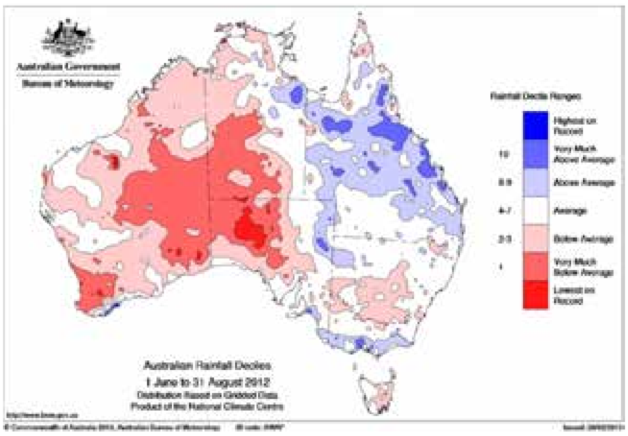


Fig. 15. Winter 2012 rainfall deciles for Australia: decile ranges based on grid-point values over the winters 1900–2012.



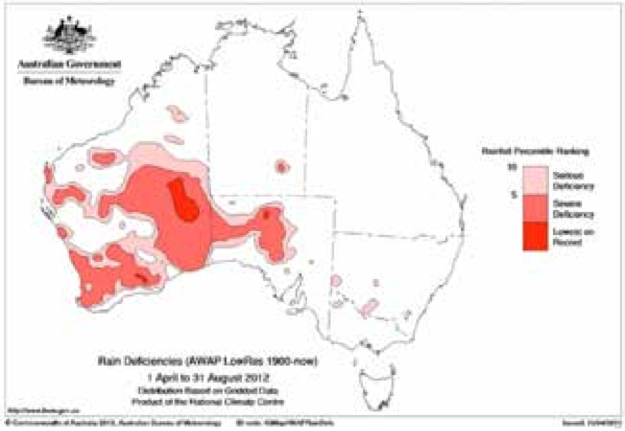
years) across 19.3 per cent of the country, mostly in southwest Western Australia and a large area of central Australia and Western Australia's Interior (see Table 2). Almost a third of the western States recorded rainfall in the lowest decile: Western Australia (32.3 per cent), South Australia (32.5 per cent), and the Northern Territory (26 per cent). Winter rainfall was the lowest on record across 0.76 per cent of the country and 5.15 per cent of South Australia, incorporating a large area of western pastoral South Australia. In comparison, three per cent of Australia recorded rainfall in the highest decile, most widespread in Queensland (11.2 per cent), with no areas experiencing record high rainfall.

Australia-wide rainfall was slightly above average in June (+7.5 per cent), with close to average rainfall across most areas but well-above-average falls on parts of the south coast and in southeast Queensland and northeastern South Australia. Very heavy rain in southern and eastern Victoria, during an East Coast Low on 3–5 June, broke daily rainfall records in several areas and generated major flooding in central and eastern Gippsland.

July saw the emergence of positive SAM conditions, with a strong high pressure ridge across southern Australia and easterly wind anomalies. Large areas of southwest Western Australia experienced their driest July on record, with the statewide average rainfall for Western Australia the third driest on record and the driest since 1977 (70 per cent below average). Dry conditions extended across much of the western half of Australia, while Tasmania experienced its driest July since 2001 (40 per cent below average). Totals remained above average across most of eastern Australia during July, with Queensland totals 99 per cent above average.

In addition to the positive SAM conditions, a positive IOD event developed during August 2012. This saw the emergence of dry conditions across most of southern Australia, with nationally-averaged rainfall the sixth driest on record (53 per cent below average) and below-average totals in all States except Tasmania.

Fig. 16. Five-month (April to August) rainfall deficiencies for Australia: decile ranges based on grid-point values over the winters 1900–2012.



Drought

Following the decay of the 2011–12 La Niña in March 2012, dry conditions emerged in southern Australia during April and May, following a long-term trend of reductions in late autumn and early winter rainfall over recent decades. Western Australia entered the winter with severe autumn rainfall deficiencies (rainfall in the driest five per cent of years) across 11 per cent of the State (Martin 2013), notably in southwest Western Australia. Below-average rainfall during winter 2012 saw the expansion of these deficiencies, with severe deficiencies for the five-month period between April and August 2012 across 35 per cent of Western Australia and 17 per cent of South Australia (Fig. 16).

Temperature

Figures 17 and 18 show the maximum and minimum temperature anomalies (relative to a reference period of 1961–1990), respectively, for winter 2012. The anomalies have been recalculated with respect to the 1971–2000 period, and use all stations for which an elevation is available. Station

Table 3. Percentage areas in different categories for winter 2012. Areas in 'decile 1' include those which are 'lowest on record'. Areas in 'decile 10' include those which are 'highest on record'. Percentage areas of highest and lowest on record are given to two decimal places because of the small quantities involved; other percentage areas to one decimal place. Grid-point deciles calculated with respect to 1911–2012.

	Maximum temperature				*Minimum temperature*			
Region	*Lowest on record*	*Decile 1*	*Decile 10*	*Highest on record*	*Lowest on record*	*Decile 1*	*Decile 10*	*Highest on record*
Australia	0.00	0.1	16.1	0.75	2.98	36.4	0.1	0.00
Queensland	0.00	0.2	0.0	0.00	0.00	15.0	0.0	0.00
New South Wales	0.00	0.0	0.0	0.00	0.24	22.7	0.0	0.00
Victoria	0.00	0.0	0.0	0.00	0.00	0.3	3.2	0.00
Tasmania	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.00
South Australia	0.00	0.0	0.5	0.00	3.13	56.3	0.0	0.00
Western Australia	0.00	0.0	49.0	2.30	6.41	28.2	0.0	0.00
Northern Territory	0.00	0.2	0.0	0.00	2.66	81.5	0.0	0.00

normals have been estimated using gridded climatologies for those stations with insufficient data within the 1971–2000 period, to calculate a station normal directly (see Jones et al. 2009 for more details relating to the spatial analyses of temperature data). Figures 19 and 20 show the corresponding maximum and minimum temperature deciles, calculated using monthly temperature analyses from 1911 to 2012. A summary of maximum and minimum temperature deciles for each State and Territory is shown in Table 3, with ranks and extremes in Tables 4 and 5.

Averaged across the season, winter maximum temperatures were 0.42 °C above-average nationally. Temperatures were within 1 °C of normal across most of the country, with most States and Territories recording close to

Table 4. Summary of the seasonal maximum temperature ranks and extremes on a national and State basis for winter 2012. The ranking in the last column goes from 1 (lowest) to 103 (highest) and is calculated over the years 1910–2012*.

Region	*Highest seasonal mean maximum (°C)*	*Lowest seasonal mean maximum (°C)*	*Highest daily temperature (°C)*	*Lowest daily maximum temperature (°C)*	*Area-averaged temperature anomaly (°C)*	*Rank of area-averaged temperature anomaly*
Australia	32.8 at Noonamah	–0.5 at Thredbo (Top Station)	38.5 at Fitzroy Crossing, 27 August	–4.9 at Thredbo, 6 August	+0.42	76
Queensland	31.4 at Scherger	15.0 at Applethorpe	37.0 at Normanton, 24 August	7.7 at Applethorpe, 5 June	–0.08	49
New South Wales	21.5 at Grafton	–0.5 at Thredbo (Top Station)	32.3 at Wanaaring, 22 August	–4.9 at Thredbo (Top Station), 6 August	+0.63	81
Victoria	16.7 at Mildura	–0.4 at Mt Hotham	22.8 at Mildura, 28 August	–4.5 at Mt Hotham, 31 August	+0.30	72
Tasmania	14.3 at Eddystone Point	2.9 at Mt Wellington	20.3 at Hobart, 23 August	–2.9 at Mt Wellington, 25 June	+0.12	69
South Australia	20.7 at Oodnadatta and Moomba	9.5 at Mt Lofty	34.3 at Moomba, 22 August	5.0 at Mt Lofty, 23 August	+0.36	62.5
Western Australia	31.7 at Wyndham	15.7 at Rocky Gully	38.5 at Fitzroy Crossing, 27 August	10.1 at Norseman, 10 July	+1.06	95
Northern Territory	32.8 at Noonamah	20.0 at Kulgera	38.1 at Middle Point, 26 August	13.2 at Arltunga, 2 July	–0.19	52

Table 5. Summary of the seasonal minimum temperature ranks and extremes on a national and State basis for winter 2012. The ranking in the last column goes from 1 (lowest) to 103 (highest) and is calculated over the years 1910-2012*.

Region	*Highest seasonal mean minimum (°C)*	*Lowest seasonal mean minimum (°C)*	*Highest daily minimum temperature (°C)*	*Lowest daily temperature (°C)*	*Area-averaged temperature anomaly (°C)*	*Rank of area-averaged temperature anomaly*
Australia	24.3 at Coconut Island	–5.0 at Thredbo (Top Station)	26.0 at Coconut Island, 1 June	–14.0 at Charlotte Pass, 6 July	–0.86	11
Queensland	24.3 at Coconut Island	1.5 at Stanthorpe	26.0 at Coconut Island, 1 June	–6.0 at Stanthorpe, 4 July	–0.55	33
New South Wales	12.5 at Byron Bay	–5.0 at Thredbo	19.1 at Byron Bay, 24 August	–14.0 at Charlotte Pass, 6 July	–0.34	32
Victoria	9.3 at Wilsons Promontory	–4.0 at Mt Hotham	13.4 at Gabo Island, 15 June	–8.0 at Mt Hotham, 6 July	–0.18	41.5
Tasmania	8.4 at Swan Island and Cape Grim	–1.3 at Liawenee and Mt Wellington	12.9 at Burnie, 14 June	–10.6 at Liawenee, 27 June	+0.03	55.5
South Australia	11.6 at Neptune Island	2.5 at Marla, Yongala and Yunta	16.8 at Moomba, 23 August	–7.5 at Yunta, 6 July	–0.86	8.5
Western Australia	21.3 at Troughton Island	3.5 at York	24.7 at Troughton Island, 3 June	–4.2 at Yeelirrie, 7 July, and at Warburton, 8 July	–0.70	14.5
Northern Territory	23.0 at Cape Wessel	2.0 at Alice Springs	25.4 at Cape Don, 16 July	–5.2 at Alice Springs, 7 July	–2.04	4

*A high-quality subset of the temperature network is used to calculate the spatial averages and rankings shown in Table 4 (maximum temperature) and Table 5 (minimum temperature). These averages are available from 1910 to the present. As the anomaly averages in the tables are only retained to two decimal places, tied rankings are possible.

Fig. 17. Winter 2012 maximum temperature anomalies (°C).

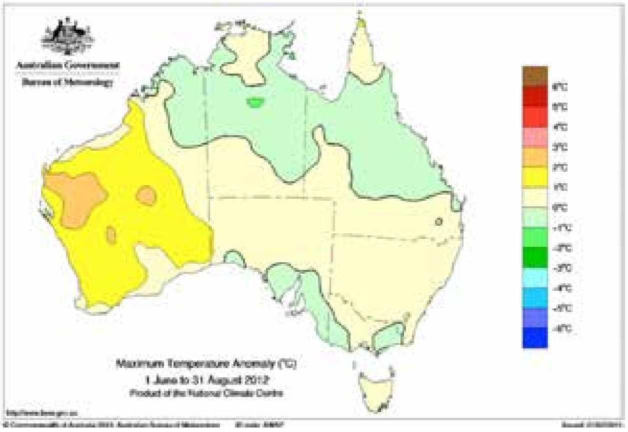
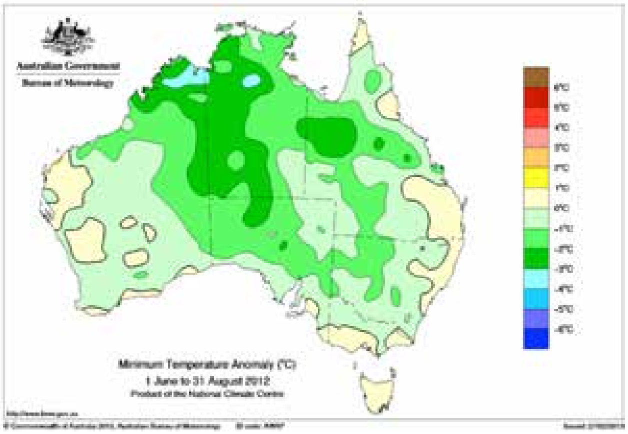


Fig. 18. Winter 2012 minimum temperature anomalies (°C).



normal maxima. The exception was Western Australia, with large areas of the State recording temperatures more than 1 °C above normal and 49 per cent of the State in the highest decile; the statewide maximum temperature anomaly for Western Australia was +1.06 °C.

Maximum temperatures warmed throughout the season, with national temperature anomalies of –0.22 °C and +0.01 °C in June and July respectively, reflecting above-average temperatures in western Western Australia but average to below-average temperatures elsewhere. By August, the nationwide maximum temperature was 1.47 °C above average, with positive anomalies in every State and Territory and 2.5 °C above average in Western Australia, the second-warmest August on record.

The nationally-averaged minimum temperature for winter 2012 was 0.86 °C below average and the coldest since winter 1982. Temperatures were below average across most of the country with the exception of coastal regions where warm sea surface temperatures were a moderating factor; Tasmania was the only State or Territory to record above-average minimum temperatures (+0.03 °C). Minimum temperatures were below average throughout the season, with nationally-averaged anomalies of –0.88 (June), –0.81 (July), and –0.88 (August).

Fig. 19. Winter 2012 maximum temperature deciles: decile ranges based on grid-point values over the winters 1911–2012.

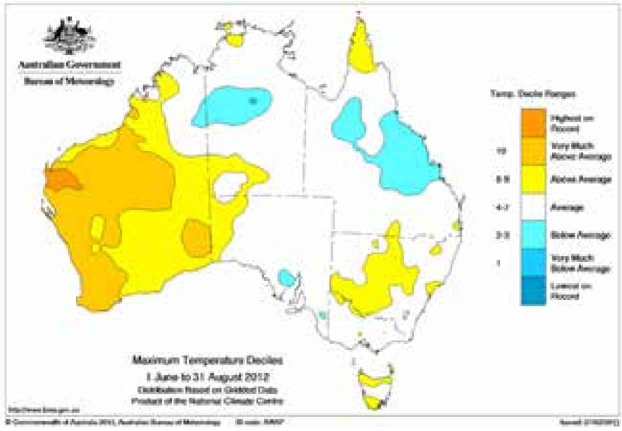
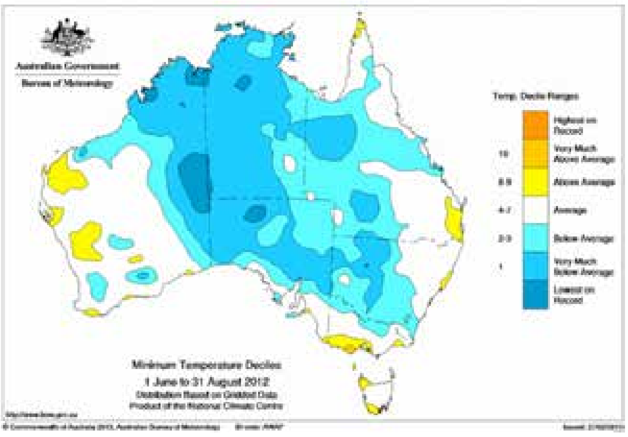


Fig. 20. Winter 2012 minimum temperature deciles: decile ranges based on grid-point values over the winters 1911–2012.



Minimum temperatures were in the lowest decile across 36.4 per cent of the country, particularly in central Australia, associated with dry conditions and southerly wind anomalies (see Fig. 13). The Northern Territory recorded its fourth-coldest winter on record with 81.5 per cent of the State in the lowest decile; 56.3 per cent of South Australia was in the lowest decile, with the statewide average minimum temperature the equal-ninth-coldest on record.

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