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Seasonal climate summary southern hemisphere (autumn 2010): rapid decay of El Niño, wetter than average in central, northern and eastern Australia and warmer than usual in the west and south

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Southern hemisphere circulation patterns and associated anomalies for the austral autumn 2010 are reviewed, with emphasis given to the Pacific Basin climate indicators together with the Australian rainfall and temperature patterns.

Autumn 2010 commenced with a rapid decay of El Niño conditions in the Pacific Ocean and a transition to neutral conditions, with most indices suggesting the possibility of La Niña development in subsequent seasons. Australian rainfall was above to very much above average across much of inland Australia, with some locations observing record autumn rainfall. Drier than usual conditions were experienced in southern Tasmania, northern coastal New South Wales and pockets of the Cape York Peninsula this season, whilst the drying trend continued in Western Australia, where rainfall totals in many areas of the Pilbara and Gascoyne districts did not exceed 25 mm.

Seasonal maximum temperatures were warmer than average throughout Western Australia, Victoria and Tasmania. In contrast, southern parts of the Northern Territory and Queensland experienced cooler than normal daytime temperatures. Minimum temperatures in autumn 2010 were well above the long-term average in all States and Territories, with overnight temperatures Australia-wide for April ranking as the second warmest on record. Autumn 2010 marked the end of the warmest twelve months on record for Australia following on from an extremely warm winter in 2009.

Introduction

This summary reviews the southern hemisphere and equatorial climate patterns for autumn 2010, 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 negative values of the Southern Oscillation Index (SOI) ,which began in October 2009, concluded in March 2010, marking the end of the negative phase of the Southern Oscillation. Monthly values were –10.6 (March), +15.2 (April) and +10.0 (May), resulting in a seasonal mean of +4.9 (ranked 39th of 135 across the period 1876–2010). Darwin's mean sea-level pressure (MSLP) anomalies moved from positive to negative during the season, with monthly anomalies of +1.3, +0.1 and –0.8 hPa. This transition was observed quite markedly in the Tahiti MSLP anomalies with a jump from –0.7 hPa in March to +1.9 hPa in April, becoming less positive in May (+0.5 hPa). Figure 1 shows the monthly SOI from January 2006 to May 2010, together with a five-month weighted moving average.

A composite monthly El Niño Southern Oscillation (ENSO) index, calculated as the standardised amplitude of the first principal component of monthly Darwin and Tahiti MSLP and monthly NINO3, NINO3.4 and NINO4 sea surface temperatures (SSTs) (Kuleshov et al. 2008), concluded a sequence of twelve consecutive positive values which began in May 2009 and persisted through to April 2010 (Fig.2). The

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Fig. 1 Southern Oscillation Index, from January 2006 to May 2010, 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.

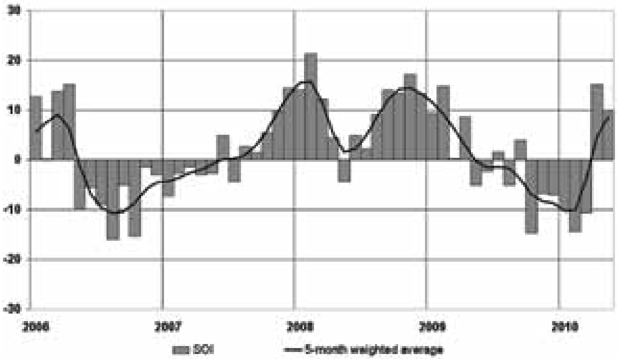
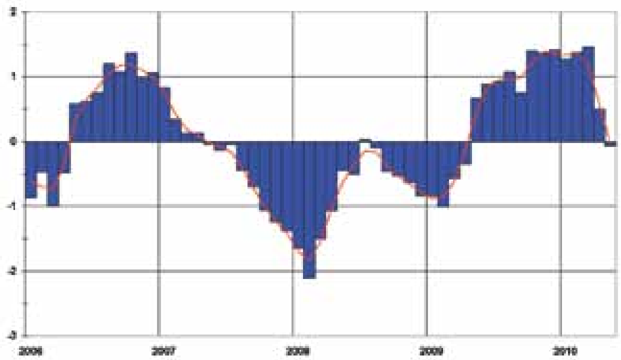


Fig. 2 Composite standardised monthly ENSO index from January 2006 to May 2010, together with a weighted three-month moving average. See text for details.



cessation of an event of ENSO, although quite rapid in this instance, commonly occurs in the autumn season. Monthly values of this index were +1.46 (March), +0.51 (April) and –0.07 (May). The March 2010 value of +1.46 surpasses both the December 2009 and the August 2002 value of +1.42 as the highest value of this index since +1.76 in March 1998, at the end of the 1997–98 El Niño.

The March–April and April–May values of the Climate Diagnostics Center (CDC) bi-monthly Multivariate ENSO index (MEI; Wolter and Timlin 1993, 1998) were +0.875 and +0.539, respectively. The MEI remained consistently positive from the April–May 2009 value of +0.345, continuing a sequence of thirteen positive values. The peak value of the index for the 2009–2010 El Niño event occurred in January–February 2010 and was the most positive value since April–May 1998 (+1.982) during the 1997–1998 El Niño. Values of the index decreased significantly after the peak in January–February 2010 indicating the deterioration of a moderately strong El Niño event, which in terms of the bi-monthly MEI index, surpassed the magnitude of any El Niño observed in the past decade.

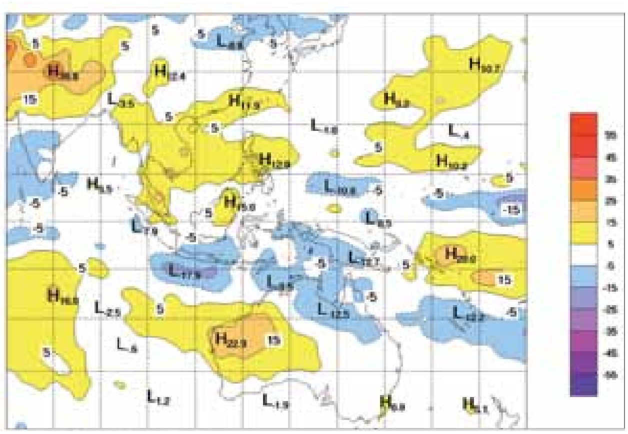
Outgoing long-wave radiation

The Climate Prediction Center, Washington, computes a standardised monthly anomaly of outgoing long-wave radiation (OLR) for an equatorial region ranging from 5°S to 5°N and 160°E to 160°W (not shown). Tropical deep convection in this region is particularly sensitive to changes in the phase of the Southern Oscillation. During El Niño events, convection is generally more prevalent, resulting in a reduction in OLR. This reduction is due to the lower effective black-body temperature and is associated with increased high cloud and deep convection. The reverse applies in La Niña events, with less convection in the vicinity of the date-line (and consequently, positive anomalous OLR).

Monthly values for the season were –1.3 (March), –0.1 (April) and +0.8 (May). The change of OLR towards positive values in the equatorial region over the three months reflects a reduction of convection, consistent with the conclusion of an El Niño event. In 1998, the OLR standardised monthly anomalies became positive in March, whilst in 2003 the transition occurred in April; the later shift to positive values in 2010 indicating lingering convection in the vicinity of the date-line, which is most likely associated with residual warm anomalies in the sea surface temperatures in the western equatorial Pacific. The seasonal mean of autumn 2010 was –0.2.

Figure 3 shows the seasonal OLR anomalies for the Asia-Pacific region between 40°S and 40°N. Negative anomalies were observed over northern Australia and the Maritime Continent, with the strongest negative anomalies in the Indian Ocean to the south of Indonesia. Increased convection in this region is consistent with above average rainfall observed during autumn across northern Australia (Fig. 16). Positive anomalies extended across much of the central Indian Ocean into Western Australia, with the highest positive anomalies stretching inland from the North West Cape of Western Australia. Positive OLR anomalies were also present in the central Pacific immediately south of the equator.

Fig. 3 OLR anomalies for autumn 2010 (W m^{-2}). Base period 1979 to 1998. The mapped region extends from 40°S to 40°N and from 70°E to 180°E.



Oceanic patterns

Sea-surface temperatures

Figure 4 shows autumn 2010 sea-surface temperature (SST) anomalies in degrees Celsius (°C). These have been obtained from the US National Oceanic and Atmospheric Administration (NOAA) Optimum Interpolation analyses (Reynolds et al. 2002). The base period is 1961–1990. Seasonal SSTs were above average across the entire equatorial Pacific. Peak anomalies between +1.0 °C and +1.5 °C were centrally located between 180°E and 150°W and had weakened significantly since the peak anomalies of +2.0 °C to +2.5 °C were recorded in early summer 2009–2010. Negative SST anomalies in the eastern Pacific, close to the South American coastline, had intensified since the summer season. Autumn saw a steady decline in warm anomalies in the central equatorial Pacific. Warm SST anomalies of between +1.0 °C and +2.0 °C extended across the central Pacific in March, but dissipated in April and May, with only very weak positive anomalies remaining in the western Pacific close to the equator by the end of the season. A very slight cool anomaly developed in May in the central Pacific between 150°W and 120°W.

This cooling can also be seen in the standard SST indices. The monthly SST anomaly indices for the NINO3 region were +0.80 °C (March), +0.81 °C (April) and +0.18 °C (May), while the corresponding values for the NINO4 region were +1.16 °C, +0.93 °C and +0.43 °C, both indices continuing a sequence of positive values which began in April 2009. The values for the NINO3.4 region were +1.17 °C (March), +0.79 °C (April) and +0.07 °C (May), continuing a sequence of positive values which began in May 2009. These values are also consistent with the equatorial pattern of the anomalies shown in Fig. 4, and in conjunction with the atmospheric indicators, illustrate the decline of the El Niño event from peak values in December for NINO3 (+1.65) and NINO3.4 (+1.80), and November for NINO4 (+1.50).

SSTs were also above average across the entire tropical Indian Ocean, with little gradient in anomalies along the equator and hence neutral Indian Ocean Dipole (IOD) conditions. In the Australian region, positive SST anomalies circled most of the country, with the strongest anomalies (+1.0 °C to +1.5 °C) to the south of Tasmania and off the coast of northwest Western Australia. Negative anomalies of up to –1.0 °C stretched from the North West Cape down to the southwest corner of Western Australia.

Subsurface patterns

The Hovmöller diagram for the 20 °C isotherm depth anomaly (obtained from the Tropical Atmosphere Ocean project) across the equator (June 2008 to May 2010) is shown in Fig. 5. The 20 °C isotherm is generally situated close to the equatorial thermocline, the region of greatest temperature gradient with depth and the boundary between the warm near-surface and cold deep-ocean waters. Positive anomalies correspond to the 20 °C isotherm being deeper than average, and negative anomalies to it being shallower than average. Changes in the thermocline depth may act as a precursor to changes at the surface.

The down-welling Kelvin wave (positive anomalies in Fig. 5) seen initially in mid to late spring continued to proceed eastward across the equatorial Pacific, with positive anomalies present in the central and eastern Pacific through to late March. This Kelvin wave was the strongest one seen in the eastern equatorial Pacific since the 2002–2003 El Niño event. A shallowing of the thermocline (negative anomalies), propagating across the western Pacific in March and April, had established very cool anomalies in the central Pacific by the end of May. These cool anomalies can also be seen in Fig. 6, which shows a vertical cross-section of equatorial subsurface temperature anomalies from February 2010 to May 2010. The strengthening of subsurface cooling in the western and central Pacific, and the stretching of the pattern eastwards, indicates the further erosion of surface and subsurface warm anomalies, which is consistent with the conclusion of an El Niño event. The rapid and enhanced transition to cool subsurface temperature anomalies indicates the possibility of the development of a La Niña event in the winter season.

Fig. 4 Anomalies of SST for autumn 2010 (°C). The contour interval is 0.5 °C.

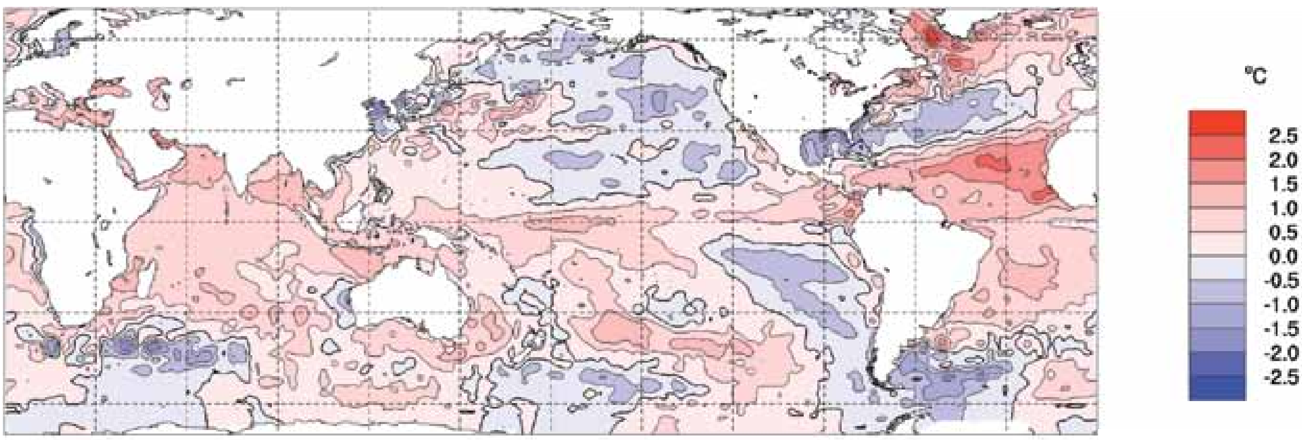


Fig. 5 Time-longitude section of the monthly anomalous depth of the 20 °C isotherm at the equator for June 2008 to May 2010. The contour interval is 10 m.

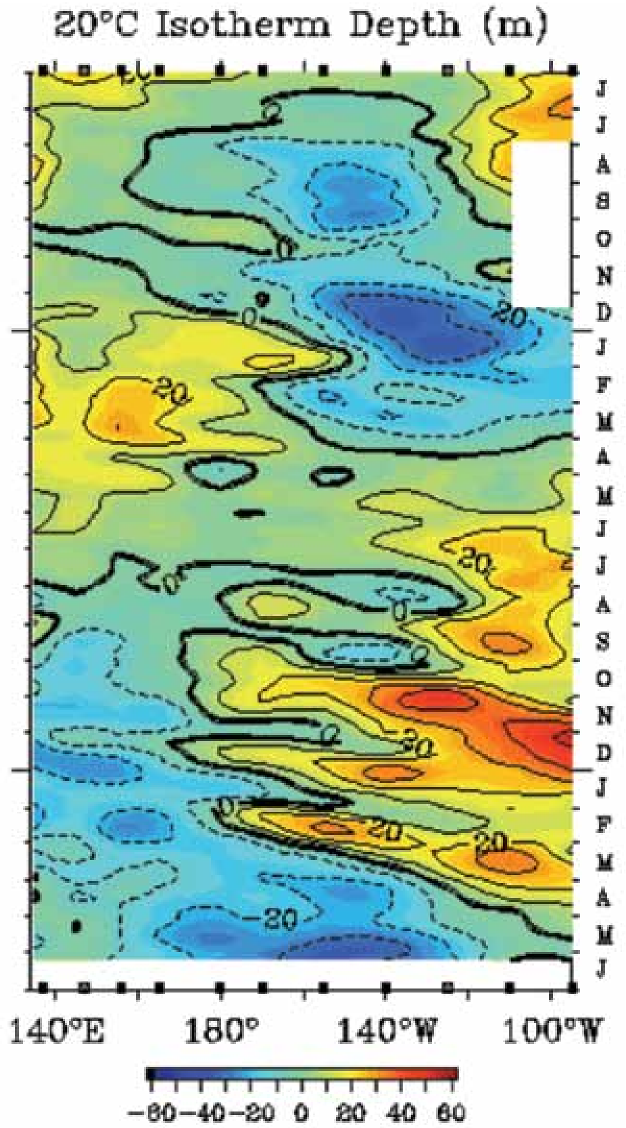
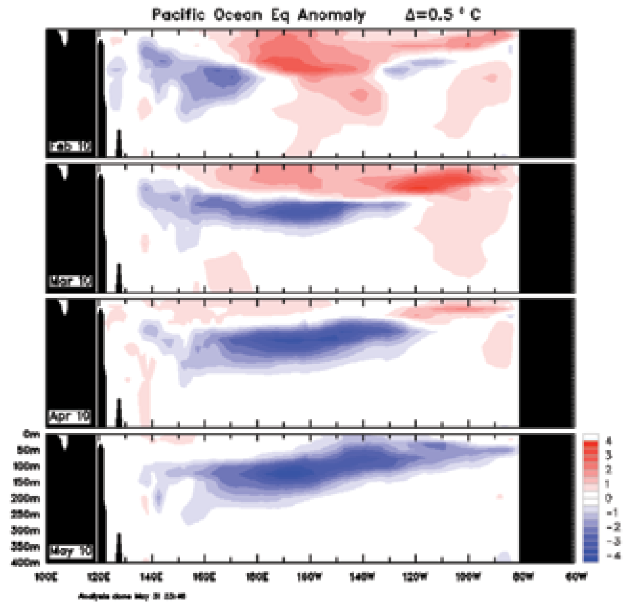


Fig. 6 Four-month February 2010 to May 2010 sequence of vertical sea-subsurface temperature anomalies at the equator for the Pacific Ocean. The contour interval is 0.5 °C.



Atmospheric patterns

Surface analyses

The autumn 2010 mean sea-level pressure (MSLP) pattern, computed by the Bureau of Meteorology's Global Assimilation and Prognosis (GASP) model, is shown in Fig. 7, and the associated anomaly pattern in Fig. 8. These anomalies are the difference from a 1979–2000 climatology obtained from the National Centers for Environmental Prediction (NCEP) II Reanalysis data (Kanamitsu et al. 2002). The MSLP analysis has been computed using data from the 0000 UTC daily analyses of the GASP model. The MSLP anomaly field is not shown over areas of elevated topography (grey shading).

The autumn 2010 MSLP pattern (Fig. 7) was markedly zonal in the southern hemisphere mid- to high-latitudes. The subtropical ridge was evident across central Australia, with centres of high pressure over Victoria (1020.3 hPa) and over the Indian Ocean to the southwest of Australia (1023.0 hPa). A polar low can be seen in Fig. 7, with a peak low pressure of 974.3 hPa around 130°W. MSLP was generally substantially lower than normal south of 50°S, with two areas of significant low pressure anomalies (anomalies below –5.0 hPa) over the Antarctic region (Fig. 8). The area of strongest negative anomalies (–9.1 hPa) was located to the south of South America and extended around the polar region to the south of New Zealand. Weak positive anomalies of between +2.5 hPa and +5.0 hPa were positioned immediately to the north of the negative anomalies, creating a very strong gradient in pressure anomalies for the season.

Mid-tropospheric analyses

The 500 hPa geopotential height (an indicator of the steering of surface synoptic systems across the southern hemisphere) for autumn 2010 is shown in Fig. 9, with the associated anomalies in Fig. 10. The seasonal 500 hPa height field in the southern hemisphere was characterised by almost uniformly zonal flow, with a weak trough between the Australian continent and the date-line. The negative pressure anomaly, to the south of South America stretching around to New Zealand at the surface (Fig. 8), was also evident at the mid-levels (Fig. 10). A strong positive anomaly was located directly over Antarctica, whilst the high pressures evident at the surface to the north of the strong negative anomalies near South America were also present at this height.

Blocking

The time-longitude section of the daily southern hemisphere blocking index is shown in Fig. 11, with the start of the

Fig. 7 Autumn 2010 MSLP (hPa).

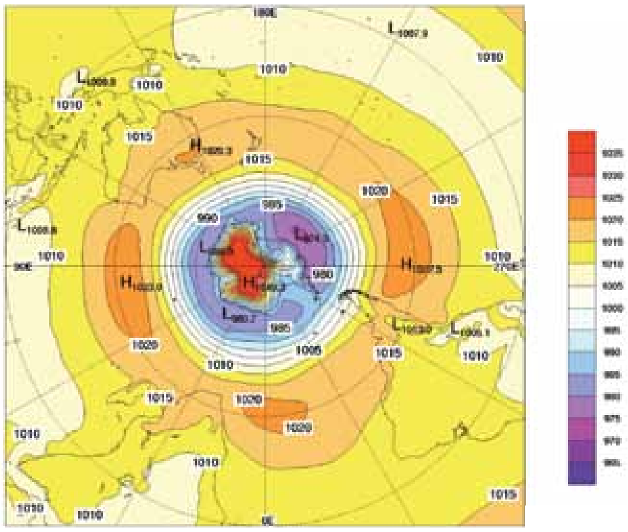


Fig. 8 Autumn 2010 MSLP anomalies (hPa).

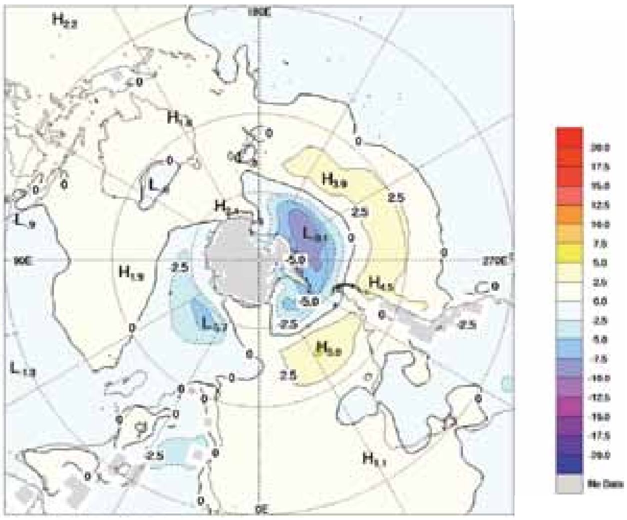


Fig. 9 Autumn 2010 500 hPa mean geopotential height (gpm).

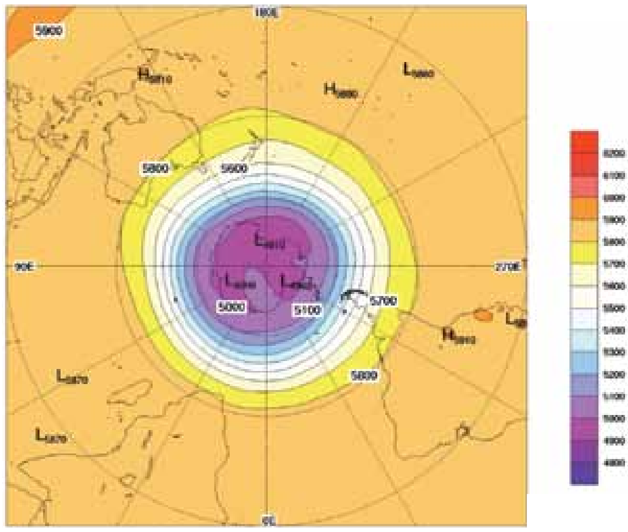
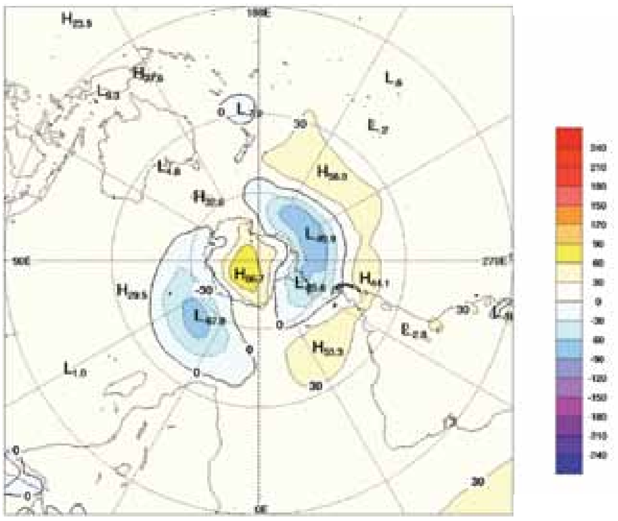


Fig. 10 Autumn 2010 500 hPa mean geopotential height anomalies.



season at the top of the figure. This index is a measure of the strength of the zonal 500 hPa flow in the mid-latitudes (40°S to 50°S), relative to that of the subtropical (25°S to 30°S) and high (55°S to 60°S) latitudes. Positive values of the index are generally associated with a split in the mid-latitude westerly flow near 45°S and mid-latitude blocking activity. Figure 12 shows the seasonal index for each longitude.

Southern hemisphere blocking during autumn 2010 was close to, or slightly above average across the Australian region through the Pacific and Atlantic Oceans to the coast of Africa (100°E to 10°W) , but below average between Africa and Australia (10°E to 90°E). Peak values of the blocking index were seen over the western and central Pacific throughout May, with the highest negative values stretching across Africa and the Indian Ocean into Australia in the first week of May.

Winds

Autumn 2010 low-level (850 hPa) and upper-level (200 hPa) wind anomalies (from the 22-year NCEP II climatology) are shown in Fig. 13 and Fig. 14, respectively. Isotach contours are at 5 m s^{-1} intervals, and in Fig. 13 regions where the surface rises above the 850 hPa level are shaded. Weak westerly anomalies were present over the central and eastern Pacific to the north of the equator, while winds were near neutral over the western tropical Pacific Ocean and around the Maritime Continent. This weakening of the Walker circulation is characteristic of an El Niño, with the circulation moving to the north of the equator, as expected with the change in season. The strongest wind anomalies in the Australian region were located over central and northern parts of the continent and indicated the presence of anomalous northwesterly flow throughout the season.

Fig. 11 Autumn 2010 daily southern hemisphere blocking index (m s[−1]) time-longitude section. The horizontal axis shows degrees east of the Greenwich meridian. Day one is 1 March.

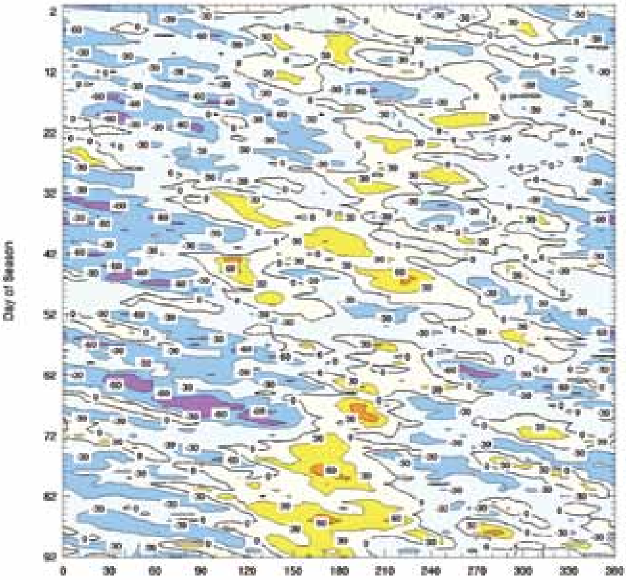


Fig. 12 Mean southern hemisphere blocking index (m s[−1]) for autumn 2010 (solid line). The dashed line shows the corresponding long-term average. The horizontal axis shows degrees east of the Greenwich meridian.

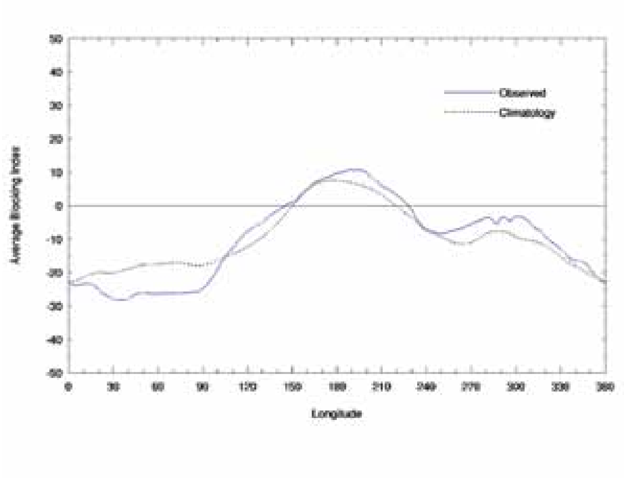


Fig. 13 Autumn 2010 850 hPa vector wind anomalies (m s[−1]). The anomaly field is not shown over areas of elevated topography.

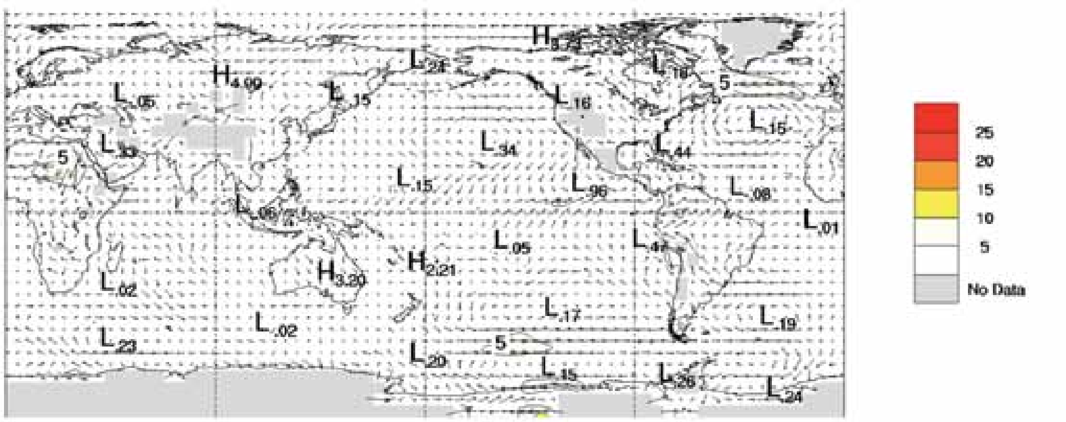
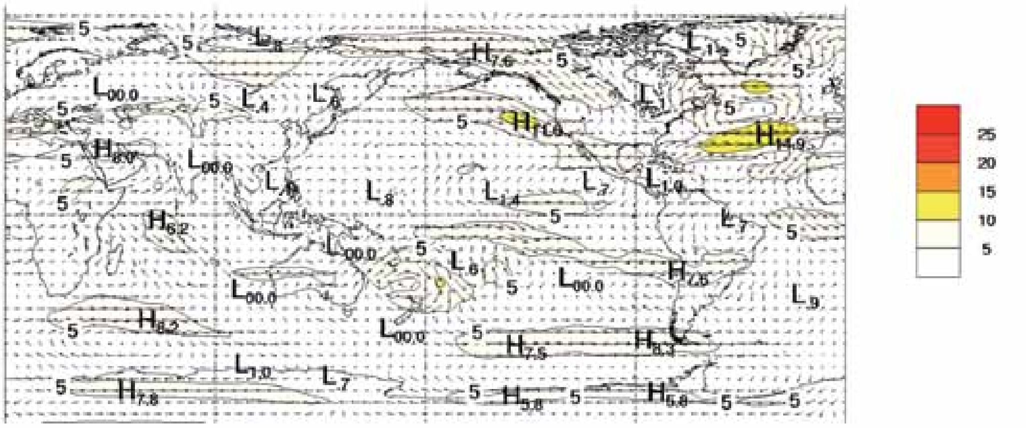


Fig. 14 Autumn 2010 200 hPa vector wind anomalies (m s[−1]).



In the upper levels (Fig. 14), a cyclonic anomaly pattern covered much of the western Pacific Ocean, with the circulation centred just north of New Zealand and peak north-northwesterly wind anomalies of between 10 and 15 m s^{-1}. This feature can also be seen in the 500 hPa height anomalies (Fig. 10) with a weak low pressure anomaly and there is also an indication of the anomalous circulation in a similar position at the surface (Fig. 8). The regions of very strong pressure anomalies in the Southern Ocean in both the surface (Fig. 8) and upper level (Fig. 10) pressure anomalies are also present in the wind anomalies at both levels and indicate strong cyclonic flow.

Australian region

Rainfall

Figure 15 shows the autumn rainfall totals for Australia, while Fig. 16 shows the autumn rainfall deciles, where the deciles are calculated with respect to gridded rainfall data for all autumns from 1900 to 2010.

Autumn rainfall averaged over Australia was thirteen per cent above the 1961–1990 normal (26th highest in a record of 110 years—see Table 1). Autumn rainfall was above to very much above average across the majority of the Northern Territory (the Territorial area average of 190.83 mm was 36.9 per cent above mean), South Australia (the State area average of 73.99 mm was 31.4 per cent above mean) and Queensland (the State area average of 196.58 mm was 20.5 per cent above mean), with the exception of parts of the Cape York Peninsula. Rainfall was also above average in inland New South Wales, through the Murray Darling Basin and into northern parts of Victoria, with all three regions recording their wettest autumn in the past decade.

In contrast to the rest of the country, Western Australia recorded an area-averaged rainfall total for the season of 79.43 mm, twelve per cent below their usual autumn rainfall. Below to very much below average rainfall was recorded across more than twenty five per cent of the State and was concentrated in the west and southwest, continuing a trend of declining autumn rainfall in this part of the State since the late 1960's. Parts of the Pilbara and Gascoyne districts received only 2 to 25 mm for the entire season. The eastern parts of the State recorded average to above average rainfall associated with low pressure systems, which brought high rainfall totals to most other parts of the country, particularly during April.

Tasmania was also divided, with the north experiencing slightly above average falls, whilst the south was below to very much below average, especially around Hobart. Overall Tasmania was 7.3 per cent below the long-term average for autumn, with May being the driest month of the season for both Tasmania and Victoria. This is consistent with the commencement of a positive phase in the Southern Annular Mode (SAM), which is negatively correlated with rainfall in these States during autumn and winter months.

In the Northern Territory, the Arnhem and Roper-McArthur districts received the highest rainfall totals of the season, which were delivered over several days at the end of March and beginning of April by Tropical Cyclone Paul. Associated with this system, Bulman, east of Darwin, recorded the highest daily total for the Territory for the autumn season, with 442.8 mm falling in the twenty four hours to 0900 on the 31 March. March was a particularly wet month across much of southern and eastern Australia. Southern inland Queensland was especially wet, with rainfall in the highest decile throughout most of the southern quarter of the State. Records were set locally across this very widespread area, with Taroom and Windorah exceeding long-standing records to observe their highest March daily rainfall in over a century. Most of the rain fell in the first week of the month, with 17.1 per cent of Queensland experiencing its wettest March day on record on either the first or second day of the month (7.9 per cent on the 1st and 9.2 per cent on the 2nd), resulting in severe flooding across the region.

Fig. 15 Autumn 2010 rainfall totals (mm) for Australia.

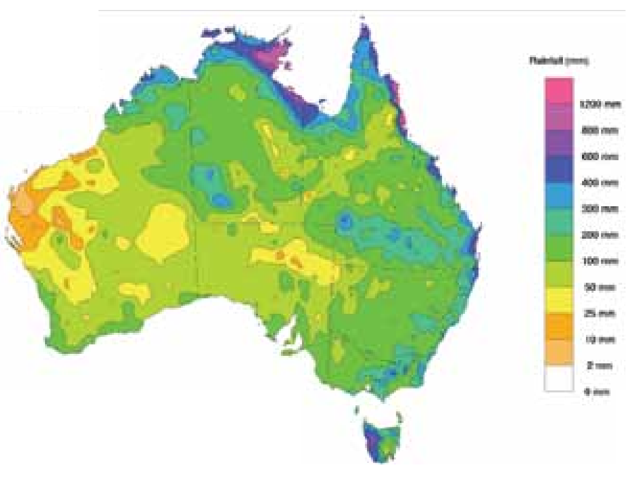


Fig. 16 Autumn 2010 rainfall deciles for Australia: decile ranges based on grid-point values over the autumns 1900 to 2010.

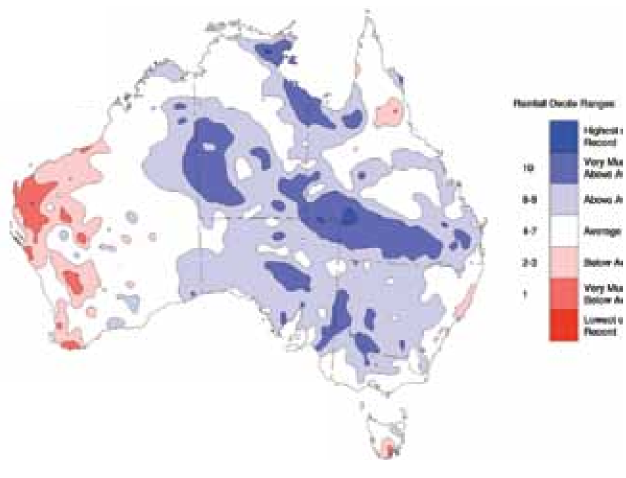


Table 2 shows the percentage area in various categories for autumn rainfall. 13.2 per cent of Australia had autumn rainfall at or above the 90th percentile. Autumn rainfall was in the highest decile (wettest ten per cent of all years) over much of the Northern Territory (25.5 per cent of the Territory), adjacent areas of northeast South Australia (14.3 per cent of the State), and most of southern Queensland (23.8 per cent of the State). Seasonal rainfall totals in the highest decile were also present through parts of the pastoral districts of South Australia, western New South Wales and northern Victoria. Rainfall in the lowest decile was almost entirely confined to western parts of Western Australia, southeastern Tasmania and a small area inland of Cairns.

Drought

Above to very much above average rainfall across central, northern and eastern Australia during autumn 2010, especially in March and April, eased short-term deficiencies across most of Australia, removing deficiencies that had existed in eastern Queensland, the Northern Territory and parts of northern Western Australia. However, the autumn rainfall failed to alleviate deficiencies in Western Australia, with serious and severe deficiencies remaining around the Pilbara and Gascoyne districts and a severe deficiency emerging in the southwest of the State in areas east of Geraldton and also around Albany.

For the three months of autumn ending May 2010, 2.4 per cent of Australia had experienced rainfall at or below the 10th percentile (serious deficiency), with 0.6 per cent of the country experiencing severe deficiency (rainfall at or below the 5th percentile) for the period. The areas of serious and severe deficiencies were almost entirely confined to the west of Western Australia (7.0 and 1.9 per cent of the State respectively) and Tasmania (6.2 and 0.0 per cent of the State respectively). The area of Tasmania in serious deficiency eased considerably compared to the summer season, which

Table 1. Summary of the seasonal rainfall ranks and extremes on a national and State basis for autumn 2010. The ranking in the last column goes from 1 (lowest) to 111 (highest) and is calculated over the years 1900 to 2010.

Region	*Highest seasonal total (mm)*	*Lowest seasonal total (mm)*	*Highest daily total (mm)*	*Area-averaged rainfall (mm)*	*Rank of area-averaged rainfall*
Australia	3782.0 at Bellenden Ker Top Station (Qld)	0.0 at Minderoo and Winning (WA)	452.0 at Clarke Range (Qld) on 21/03	136.2	86
Western Australia	476.4 at Kuri Bay	0.0 at Minderoo and Winning	215.6 at Cape Leveque on 19/05	79.4	51
Northern Territory	1077.0 at Alyangula Police	25.8 at Tarlton Downs	442.8 at Bulman on 31/03	190.8	95
South Australia	263.5 at Piccadilly	22.4 at Cameron Corner	124.0 at Roxby Downs Station on 09/04	74.0	94
Queensland	3782.0 at Bellenden Ker Top Station	20.2 at Thorner Station	452.0 at Clarke Range on 21/03	196.6	91
New South Wales	579.4 at Harwood Island	39.2 at Wanaaring	212.0 at Quaama on 26/05	145.9	85
Victoria	576.8 at Falls Creek	70.6 at Nhill Aerodrome	87.4 at Mount Wellington on 31/05	169.5	82
Tasmania	1150.0 at Mount Read	44.8 at Cambridge	214.4 at Killymoon on 29/05	315.5	46

Table 2. Percentage areas in different categories for autumn 2010 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	0.05	0.6	2.4	13.2	0.38
Queensland	0.00	0.0	0.2	23.8	1.09
New South Wales	0.00	0.0	0.0	7.8	0.00
Victoria	0.00	0.0	0.0	8.2	0.00
Tasmania	0.00	0.0	6.2	0.0	0.00
South Australia	0.00	0.0	0.0	14.3	0.35
Western Australia	0.14	1.9	7.0	1.6	0.00
Northern Territory	0.00	0.0	0.0	25.5	0.51

saw 25.1 per cent of the State in serious deficiency by the end of February.

The national figure of 2.4 percent for the three months ending May 2010 has shown a reduction from the 2.9 percent for the three months ending February 2010 and is significantly smaller than the 13.1 per cent for the three months ending November 2009. Together these suggest that summer and autumn rainfall brought relief from short-term deficiencies for much of the country, particularly in the north and northeast.

Temperature

Figures 17 and 19 show the maximum and minimum temperature anomalies, respectively, for autumn 2010. The anomalies have been calculated with respect to the 1961–1990 period, and use all stations for which an elevation is available. Station normals have been estimated using gridded climatologies for those stations with insufficient data within the 1961–1990 period to calculate a station normal directly. Figures 18 and 20 show autumn maximum and minimum temperature deciles, respectively, calculated using monthly temperature analyses from 1911 to 2010.

Maximum temperatures for autumn 2010 were below average through much of inland and interior northeastern Australia, including the majority of Queensland and the Northern Territory. Anomalies greater than 1 °C below average were seen in the southeast of the Northern Territory, also approaching 2 °C below average in a small area of southern Queensland. In contrast, seasonal maximum temperatures were warmer than average across much of western, northern and southern parts of the country (Fig. 17).

Autumn maxima in the Northern Territory (excluding the Top End), Queensland (excluding Cape York), northeastern South Australia and parts of inland New South Wales were average or below average. Anomalies in excess of +2 °C were seen across large areas of central Western Australia (covering 16.1 per cent of the State). The area average for

Fig. 17 Autumn 2010 maximum temperature anomalies (°C).

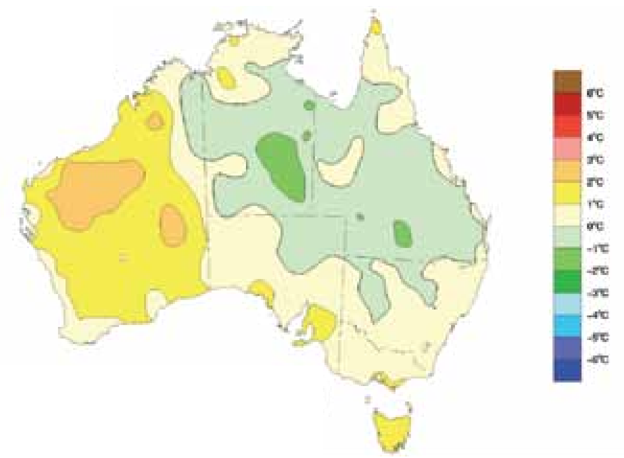


Fig. 18 Autumn 2010 maximum temperature deciles: decile ranges based on grid-point values over the autumns 1911to 2010.

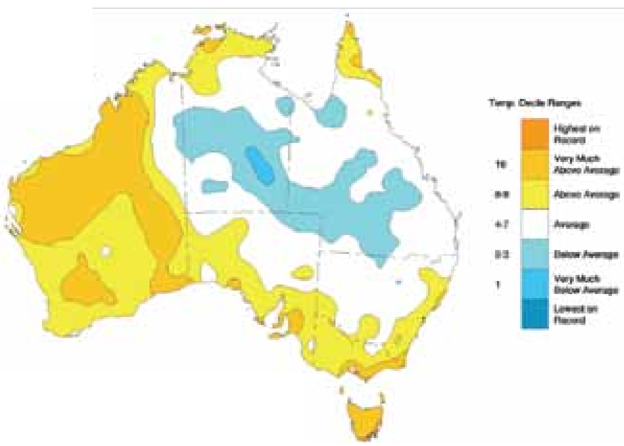


Fig. 19 Autumn 2010 minimum temperature anomalies (°C).

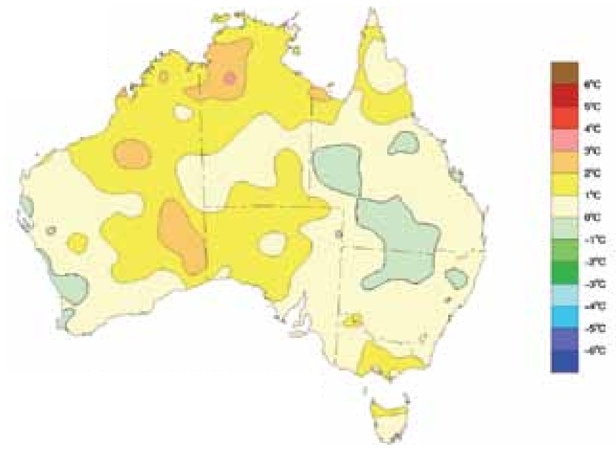
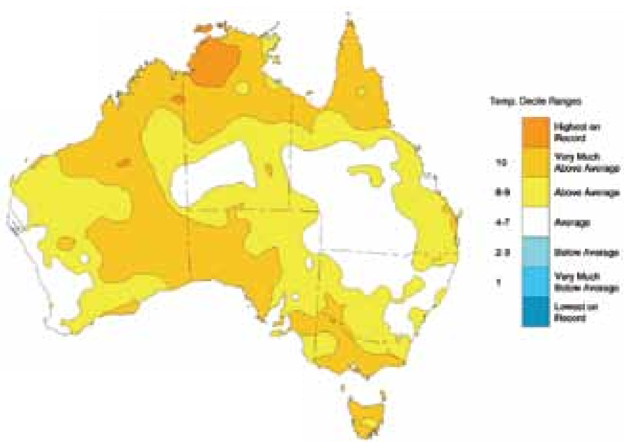


Fig. 20 Autumn 2010 minimum temperature deciles: decile ranges based on grid-point values over the autumns 1911 to 2010.



Western Australia was 31.1 °C, 1.4 °C above the long-term average and the sixth warmest autumn on record. The entire State of Tasmania experienced maximum temperature anomalies between +1 °C and +2 °C, equalling 1988 as the warmest autumn for the State.

The southern coast of Victoria east of Melbourne also experienced daytime temperature anomalies between +1 °C and +2 °C, with autumn ending a warm spell which started in Melbourne in late 2009. Melbourne Regional Office experienced 123 consecutive days of maxima of 20.0 °C or above between 9 December 2009 and 10 April 2010. This was the longest such run on record. The previous longest warm spell of maximum temperatures of 20.0 °C or above at this site only lasted 78 days.

Table 3 shows percentage areas in 'decile 10' (i.e. at or above the 90th percentile) for autumn seasonal maximum

Table 3. Percentage areas in different categories for autumn 2010. 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 to 2010.

Region	*Maximum temperature*				*Minimum temperature*			
	Lowest on record	*Decile 1*	*Decile 10*	*Highest on record*	*Lowest on record*	*Decile 1*	*Decile 10*	*Highest on record*
Australia	0.00	0.5	18.0	0.11	0.00	0.0	36.5	2.19
Queensland	0.00	0.0	1.1	0.00	0.00	0.0	19.8	0.18
New South Wales	0.00	0.0	1.3	0.00	0.00	0.0	3.4	0.00
Victoria	0.00	0.0	17.0	0.00	0.00	0.0	68.6	0.00
Tasmania	0.00	0.0	100.0	10.67	0.00	0.0	81.2	0.00
South Australia	0.00	0.0	4.5	0.00	0.00	0.0	46.0	0.07
Western Australia	0.00	0.0	47.3	0.06	0.00	0.0	46.3	0.61
Northern Territory	0.00	3.2	1.4	0.00	0.00	0.0	45.2	11.30

Table 4. Summary of the seasonal maximum temperature ranks and extremes on a national and State basis for autumn 2010. The ranking in the last column goes from 1 (lowest) to 60 (highest) and is calculated over the years 1950 to 2010[10].

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	37.0 at Roebourne (WA)	8.9 at Mount Hotham (Vic)	45.0 at Roebourne (WA) on 28/03	–0.4 at Mount Wellington (Tas) on 21/05	+0.36	37.5
Western Australia	37.0 at Roebourne	20.9 at Albany	45.0 at Roebourne on 28/03	11.1 at Katanning on 13/05	+1.10	56
Northern Territory	35.7 at Bradshaw	27.0 at Alice Springs	41.1 at Rabbit Flat on 06/03	14.9 at Alice Springs on 20/05	–0.46	18.5
South Australia	28.8 at Marree Comparison	18.1 at Mount Lofty	39.0 at Marla on 25/03	9.9 at Mount Lofty on 12/05	+0.41	40
Queensland	33.5 at Julia Creek	21.3 at Applethorpe	39.1 at Julia Creek on 11/04	11.1 at Stanthorpe and at Applethorpe on 30/05	–0.25	20.5
New South Wales	27.9 at Mungindi	9.9 at Thredbo Top Station	36.8 at Menindee on 27/03	–0.7 at Thredbo Top Station on 05/05	+0.42	43
Victoria	24.3 at Mildura	8.9 at Mount Hotham	36.6 at Walpeup on 17/03	–1.5 at Mount Baw Baw on 11/05	+0.86	54
Tasmania	20.3 at Campania	9.4 at Mount Wellington	32.4 at Ouse on 04/03	–0.4 at Mount Wellington on 21/05	+1.42	60.5 (equal highest)

temperature for each State and Territory. Eighteen per cent of the country saw autumn maximum temperatures in the highest decile, with all of Tasmania in the top decile and much of the southern coastline of the State experiencing their warmest autumn days on record.

Minimum temperatures were warmer than average across the country, with only very weak negative anomalies across southern Queensland, northern New South Wales and the western coastline of Western Australia. The pattern of autumn seasonal minimum temperatures (Fig. 19) showed more areas of warmer than average than that for maximum temperatures, with none of the States or Territories observing below average night-time temperatures this season. Parts of the interior of Western Australia, and the Darwin–Daly and Victoria River districts of the Northern Territory, had overnight temperatures 1 – 2 °C above average, with 0.6 per cent of the Territory observing temperature anomalies in excess of 2 °C.

Regions experiencing minimum temperatures in the highest decile stretched across northern Australia, through inland Western Australia, southern parts of South Australia and most of Victoria and Tasmania. Western Australia and South Australia respectively observed their 4th and 5th warmest autumn nights on record, with a total of four States ranking in the top ten. A large area of the northwest Northern Territory broke seasonal records (Fig. 20), with 11.3 per cent of the Territory registering highest on record minimum temperatures for autumn.

In area-averaged terms with respect to maximum temperatures, autumn 2010 nationally was the twenty-fourth warmest since 1950, the equal warmest for Tasmania and the sixth warmest for Western Australia. Tasmania was consistently warm during all months in the season, with March being the warmest since 1950 (anomaly +2.14 °C) and April the seventh warmest (+1.32 °C)

In area-averaged terms for minimum temperature, the autumn was nationally the eleventh warmest since 1950, the fourth warmest for Western Australia and the fifth warmest for South Australia. As with maximum temperature, Tasmania was consistently warm during all months in the season, with April the third warmest since 1950 (+1.35 °C). April contributed strongly to the warm autumn with minimum temperatures for the month area-averaged across Australia ranking second highest since 1950, along with Western Australia, which also came in second, whilst Victoria, Tasmania and South Australia all had their third warmest April on record.

Table 5. Summary of the seasonal minimum temperature ranks and extremes on a national and State basis for autumn 2010. The ranking in the last column goes from 1 (lowest) to 60 (highest) and is calculated over the years 1950 to 2010.

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	27.7 at Troughton Island (WA)	0.4 at Charlotte Pass (NSW)	31.7 at Marble Bar (WA) on 31/03	–10.2 at Liawenee (Tas) on 22/05	+0.72	51
Western Australia	27.7 at Troughton Island	9.1 at Jarrahwood	31.7 at Marble Bar on 31/03	–1.7 at Eyre on 30/05	+1.09	58
Northern Territory	26.3 at Cape Don	13.4 at Alice Springs	29.6 at Dum In Mirrie on 06/04	0.1 at Arltunga on 31/05	+0.68	48
South Australia	15.7 at Neptune Island	7.8 at Yongala	26.0 at Oodnadatta on 17/03	–3.0 at Yongala on 14/05	+1.21	57
Queensland	26.1 at Coconut Island	9.9 at Appletho-rpe	29.2 at Horn Island on 03/03	–3.5 at Stanthorpe on 14/05	+0.21	39.5
New South Wales	17.9 at Byron Bay	0.4 at Charlotte Pass	24.6 at Tibooburra on 07/04	–9.0 at Perisher Valley on 24/05	+0.17	40.5
Victoria	14.3 at Wilsons Promontory	3.4 at Mount Hotham	23.0 at Melbourne Regional Office on 19/03	–4.8 at Mount Hotham on 12/05	+0.75	53
Tasmania	13.3 at Swan Island	2.5 at Liawenee	20.0 at Bicheno on 26/03	–10.2 at Liawenee on 22/05	+0.73	56

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