

Seasonal Climate Summary southern hemisphere (autumn 1992): signs of a weakening ENSO event

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(Manuscript received August 1993; revised August 1993)

Southern hemisphere climate patterns for autumn (March-May) 1992 are reviewed, with particular emphasis on Pacific Basin climate indicators, and on temperature and rainfall over Australia. The period commenced with atmospheric and oceanic conditions all consistent with a mature El Niño-Southern Oscillation (ENSO) event, but by May there were signs that the event was beginning to decline. Below average rainfall over northern and eastern Australia, and above average temperatures in the north, were typical of the mature phase of an ENSO event.

Introduction

Autumn 1992 commenced with the mature phase of a well-developed warm Pacific, or El Niño-Southern Oscillation (ENSO), event in progress. This event, which commenced in 1991 (de Hoedt 1992), continued to be associated with major anomalies in circulation and climate over the southern hemisphere in autumn, although by May there was evidence that the event could be in decline. This summary reviews southern hemisphere climate patterns in autumn 1992, with particular emphasis on the Pacific Basin region, and especially Australia.

The main information sources were monthly editions of the *Climate Monitoring Bulletin* (Bureau of Meteorology, Australia), and the *Climate Diagnostics Bulletin*, Climate Analysis Center (CAC), Washington. Data sources are given in the Appendix.

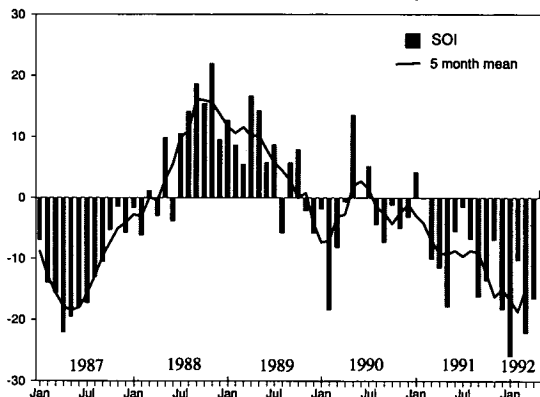
Pacific Basin climate indices

The SOI

Autumn 1992 saw the Southern Oscillation Index (SOI)* finally reverse its long downward trend (Fig. 1), and in May the first positive SOI value

was registered since January 1991. This reflected a return to normal of both Tahiti and Darwin mean sea level pressures (MSLP), following several months of above average Darwin pressure and below average Tahiti pressure. This, along with trends in other atmospheric and oceanic indicators, suggested that the 1991-92 event could be in decline.

Fig. 1 Tahiti-Darwin Southern Oscillation Index, January 1987 to May 1992 inclusive.



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*The SOI used here is ten times the anomaly of the monthly mean Tahiti minus Darwin mean sea level pressure difference divided by the standard deviation of that difference for the relevant month, based on the period 1882-1985.

Fig. 2 Time-longitude section of monthly outgoing long wave radiation anomalies for 5°N–5°S, January 1991 to May 1992. Contour interval is 10Wm^{-2} . Shading indicates negative anomalies (i.e. enhanced convection and rainfall). Anomalies are based on a 1979–88 base period mean. After CAC (1992).

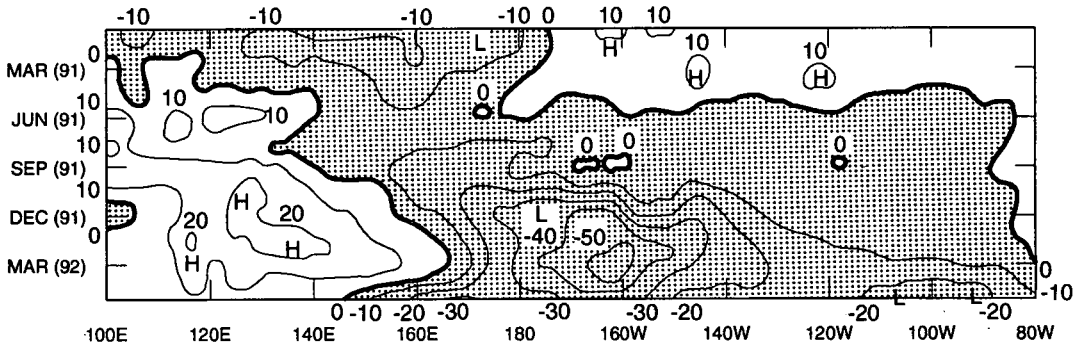
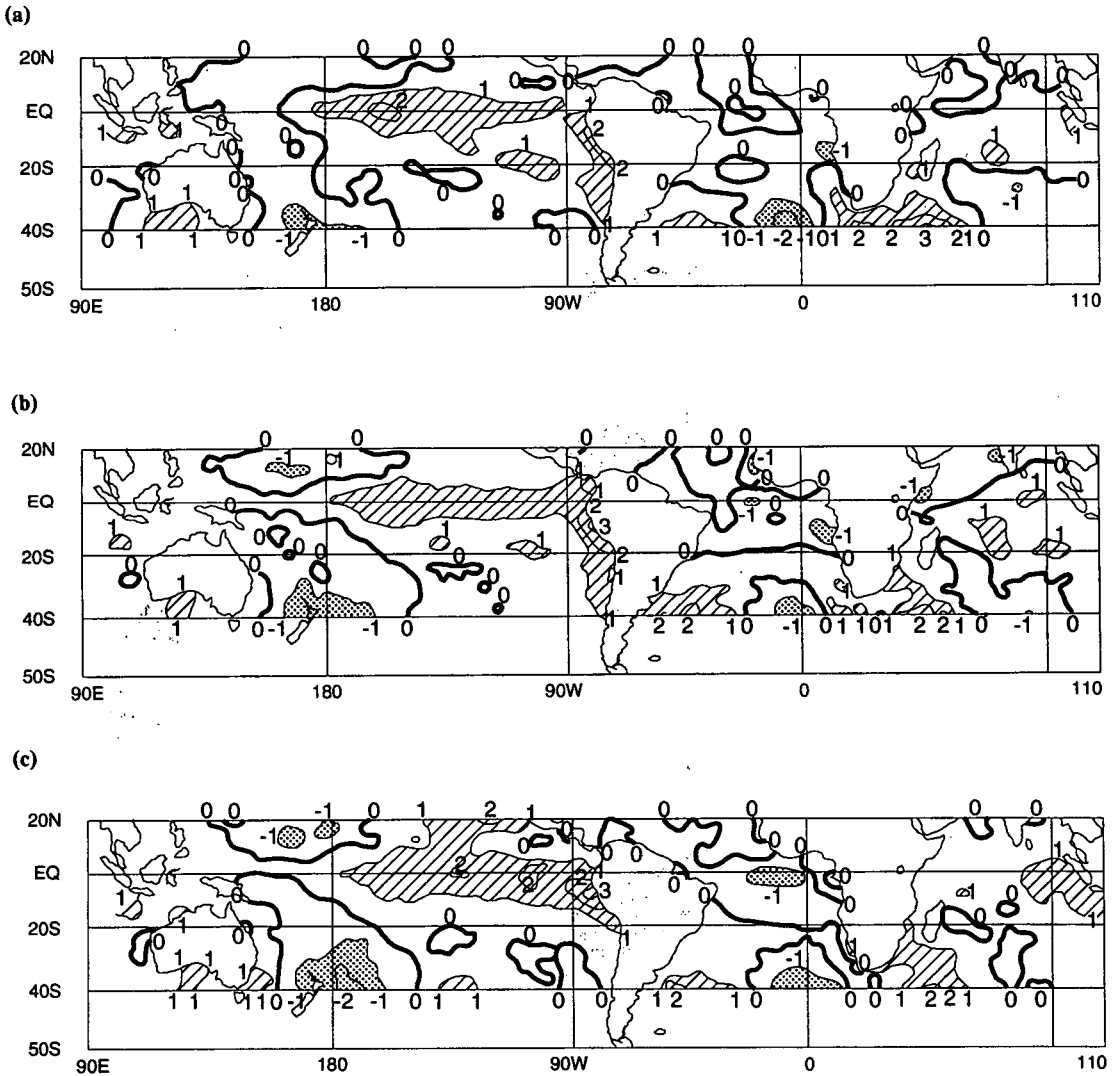


Fig. 3 Monthly mean sea-surface temperature anomalies (°C). (a) March 1992. (b) April 1992. (c) May 1992.



Atmospheric indices

Low-level easterly winds remained substantially weaker than normal over the entire equatorial Pacific in autumn, especially over the central Pacific. However these anomalies decreased substantially in May.

Figure 2, adapted from CAC (1992), displays anomalies in outgoing long wave radiation (OLR) over the near-equatorial Pacific and Australasian regions between January 1991 and May 1992. Significant negative OLR anomalies — indicative of well above normal convective rainfall — persisted over the central and most of the eastern equatorial Pacific (longitudes 180°E to 80°W), although the central Pacific anomaly weakened in May. Large positive anomalies in OLR north of Australia persisted through autumn, while CAC monthly analyses showed a belt of significant negative anomalies over western and central Australia in April and May.

Oceanic

Sea-surface temperatures (SSTs). Satellite-derived SST data continued to be corrupted by aerosols injected into the stratosphere from Mt Pinatubo in June 1991. Therefore following de Hoedt (1992), monthly blended SST anomaly charts adapted from CAC (and based on Reynolds (1988)) are presented here (Figs 3(a)–(c)).

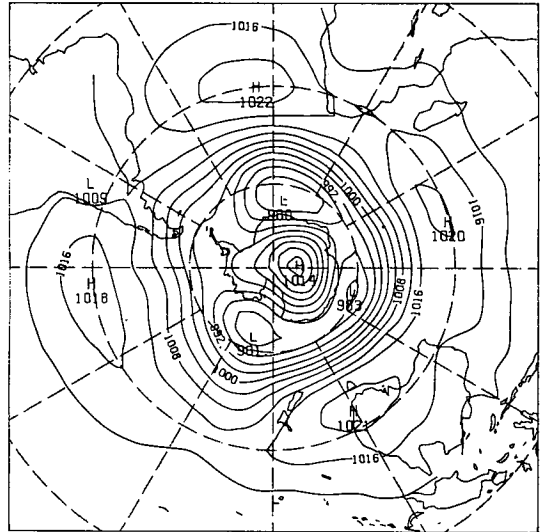
A 'classical' mature ENSO signature is evident (Rasmusson and Carpenter 1982), with significant (1–3°C) positive SST anomalies extending from the central equatorial Pacific to the South American coast, but cooler than normal SSTs over the western Pacific. This general pattern changed little over the season, but individual monthly charts show a tendency for the major anomaly centre over the central Pacific to weaken slightly after March, while anomalies over the eastern Pacific increased.

Subsurface patterns. Subsurface temperature patterns in the tropical Pacific (not shown) strongly hinted that by May the 1991–92 episode could be in decline. CAC (1992) reported a rapid cooling of the central and eastern Pacific in May (following subsurface temperature anomalies of as much as 8°C at 50 metres near South America in March). This was accompanied by a rapid decrease in depth (shoaling) of the thermocline (i.e. the boundary between the upper ocean warm water and the deep ocean cold water), which previously had been considerably deeper than during the previous (1986–87) ENSO.

Surface analyses

Figures 4 and 5 show the mean autumn MSLP analysis and anomaly patterns respectively. Anomalies are deviations from a fifteen-year (1976–90) climatology of southern hemisphere analyses, compiled by the National Climate Centre, Bureau

Fig. 4 Autumn 1992 (March, April, May) mean sea level pressure (hPa).



latitudes, as in summer (Nydam 1993). Other noteworthy features were:

- (a) a marked blocking dipole over the eastern Pacific sector, with strong ridging over the high latitude southeast Pacific;
- (b) An extensive belt of below normal SLPs stretching northeastward from the southern central Atlantic to the central Indian Ocean: this reflects a marked change in circulation in this area after March, with mid-high latitude ridging south and southwest of Africa being replaced by pronounced troughing by May.

Upper level analyses

Figures 6 and 7 show the 500 hPa mean autumn analysis and anomaly patterns respectively. A four-wave pattern is evident in Fig. 6, with troughs over the eastern sectors of the three southern hemisphere ocean basins, and also just east of New Zealand. Figure 7 shows blocking dipole anomaly patterns over the central/east Indian Ocean and the eastern Pacific-South American sector, with negative height anomalies confined to lower mid-latitudes. Another feature of the anomaly pattern is the marked enhancement of the South Pacific trough east of New Zealand, a feature of ENSO years (Van Loon and Shea 1985).

The weak negative MSLP anomaly over western Australia (Fig. 5) was more evident at 500 hPa, and merged with the area of low heights over the east Indian Ocean. This pattern, reflecting persistent high amplitude trough and cut-off activity, had a marked impact on autumn rainfall over the western half of Australia. Conversely, ridging prevailed over eastern Australia and the Tasman Sea.

Blocking

Figure 8 is a time-longitude section of the daily southern hemisphere Blocking Index (BI)*, measuring the strength of the 500 hPa flow at mid-latitudes relative to that at subtropical and high latitudes. Positive values of the index correspond to a split in the mid-latitude westerlies, and are therefore an indicator of blocking. It is seen that the major blocking over the eastern Pacific sector (longs 240°–300° on Fig. 8) occurred in the second half of March and in May, with the pattern breaking down temporarily in April. Blocking was a feature over the Australian-western Pacific sector (120°–210°) from about mid-April. By contrast, a zonal flow regime prevailed over the eastern Atlantic-western Indian Ocean region throughout autumn.

*Blocking index:

$BI = 0.5 (U_{25} + U_{30} + U_{55} + U_{60} - U_{40} - U_{50} - 2U_{45})$
where U_x is the daily mean 500 hPa zonal wind at latitude x .

Fig. 6 Autumn 1992 (March, April, May) 500 hPa mean geopotential height (dam).

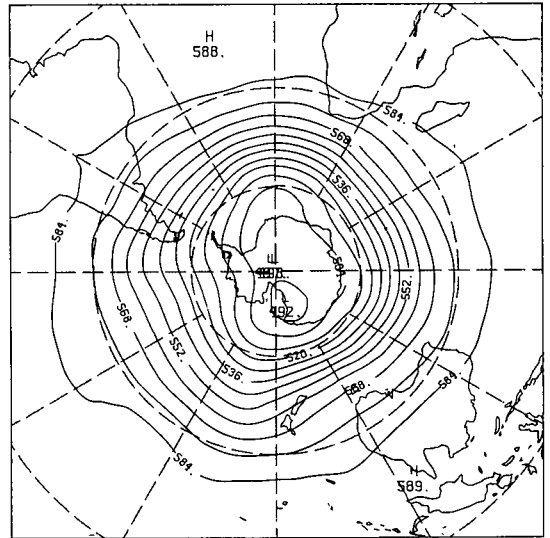


Fig. 7 Autumn 1992 (March, April, May) 500 hPa mean geopotential height anomaly (dam).

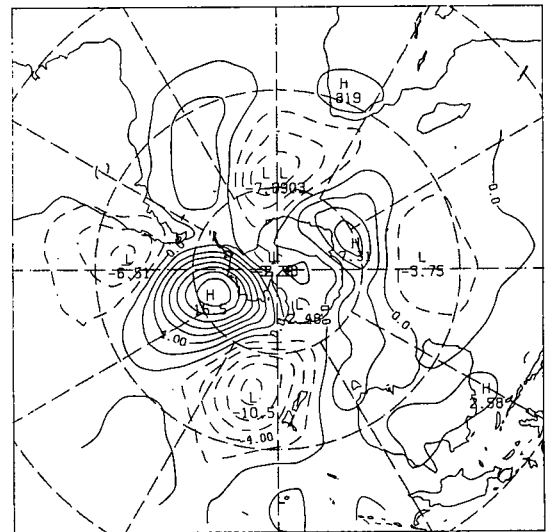


Fig. 8 Time-longitude section of Daily Blocking Index (defined at 500 hPa), Autumn 1992 (March, April, May). Day 1 is 1 March 1992.

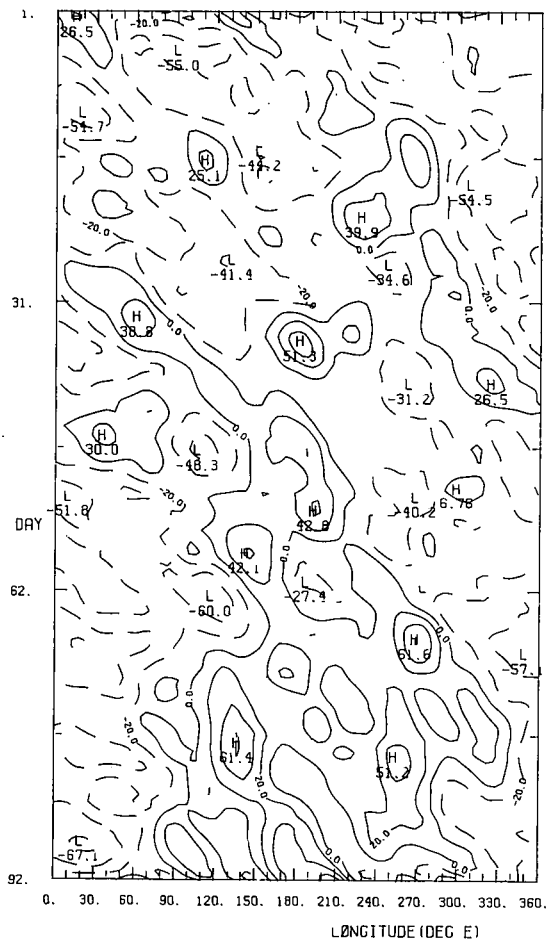


Fig. 9 Autumn 1992 (March, April, May) 850 hPa vector wind anomalies ($m s^{-1}$).

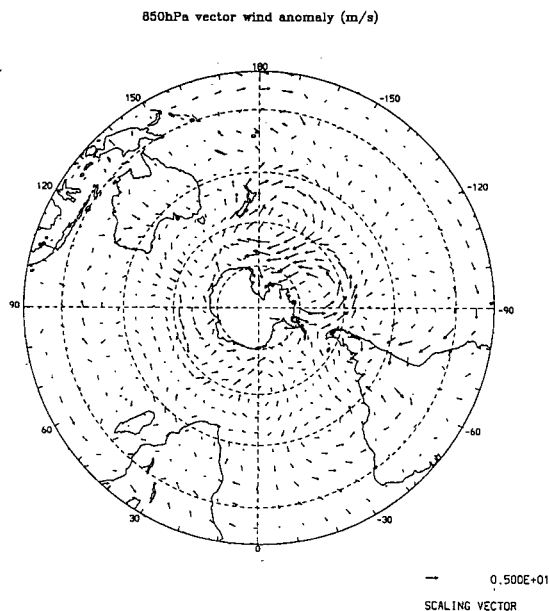
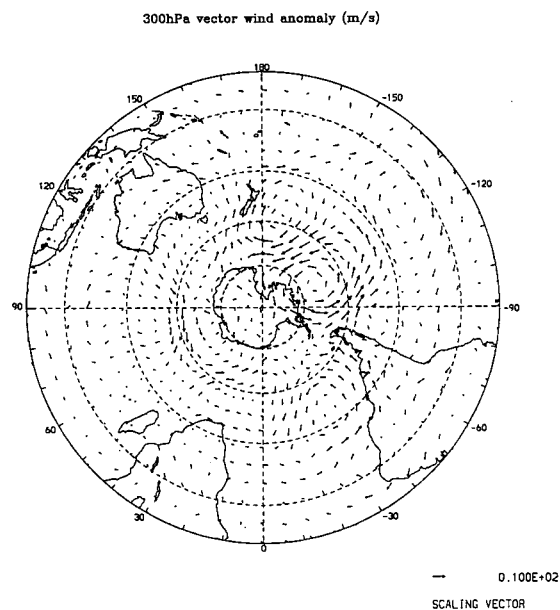


Fig. 10 As for Fig. 9, but for 300 hPa wind anomalies.



- (a) the strong anomalous circulation over middle and higher latitudes of the Pacific Ocean. Persistent, strong, northerly flow anomalies are evident over central Pacific longitudes, while anomalous southwesterly flow over New Zealand led to below-normal autumn temperatures there.
- (b) Westerly flow anomalies are clearly evident over the near-equatorial western and far eastern Pacific.

The 300 hPa flow anomaly analysis features a relatively strong subtropical jet over the eastern Pacific and the east Indian Oceans, reflecting a sharpening of the upper tropospheric barocline over the subtropics in these areas. In turn, this

reflects the presence over lower middle latitudes of relatively cold air above 700 hPa (not shown), associated with anomalous troughing and cut-off activity.

Australian region

Circulation and rainfall

Autumn 1992 was characterised by relatively frequent incursions of tropical moisture across particularly the southwestern half of Australia, accompanied by heavy rains in that area. This arose from a favourable combination of frequent high amplitude trough and cut-off activity over and west of Western Australia (Fig. 7), an enhanced upper level barocline, and northerly flow anomalies from the tropical Indian Ocean (Fig. 9). Autumn rainfall (Fig. 11) was therefore well above normal over southern Western Aus-

tralia apart from the coast (with record amounts in inland areas), and also over southern South Australia, western Victoria and northern Tasmania. This cloudband activity over western areas of the continent appears to be a feature of decaying ENSO events (Wright 1993), and was prominent in the autumn and winter following the ENSO years 1972, 1976-77, 1982 and 1987.

In May, a similar combination of cut-off lows and so-called 'Northwest Cloudbands' (Tapp and Barrell 1984) produced heavy rains over most of tropical and subtropical Australia, with some stations registering over 100 mm against a normal of below 20 mm.

Unfortunately, this rain was insufficient to relieve deficiencies in drought-affected areas of Queensland, brought about by the relative failure of monsoon rains during the summer and early autumn. For the same reason, much of northern Australia also received below normal autumn rainfall. The majority of inland eastern Australia experienced a dry autumn, due to the persistent ridging over the area.

Fig. 11 Autumn 1992 (March, April, May) rainfall in Australia, expressed as decile ranges. Values based on district averages.

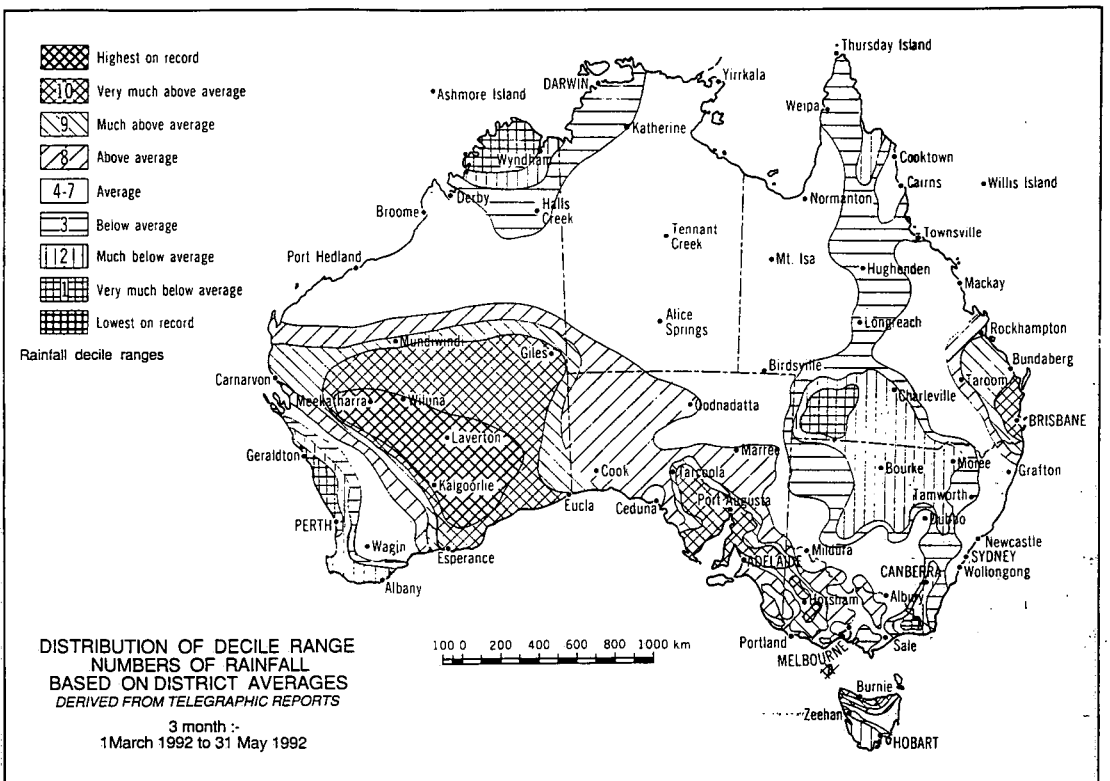


Fig. 12 Monthly mean minimum temperature anomalies (°C). (a) March 1992. (b) April 1992. (c) May 1992.

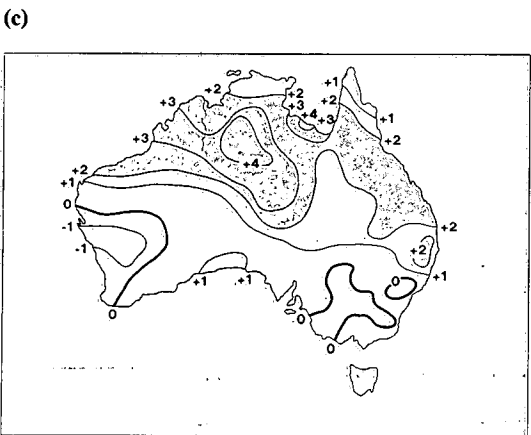
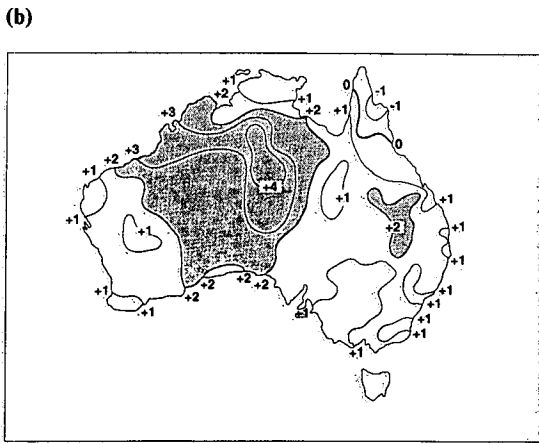
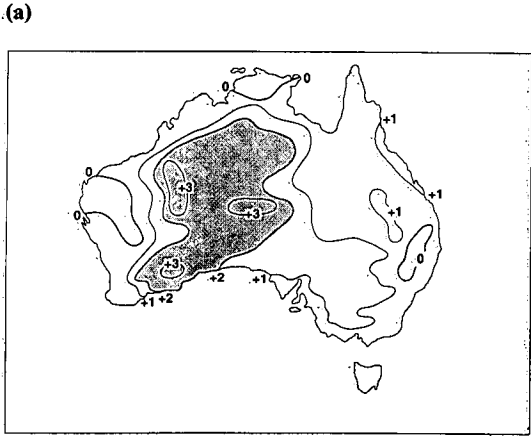
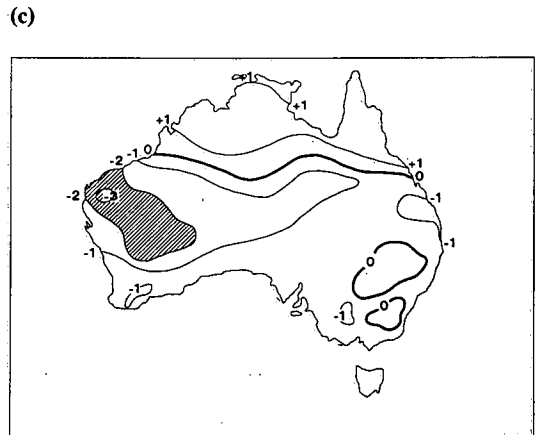
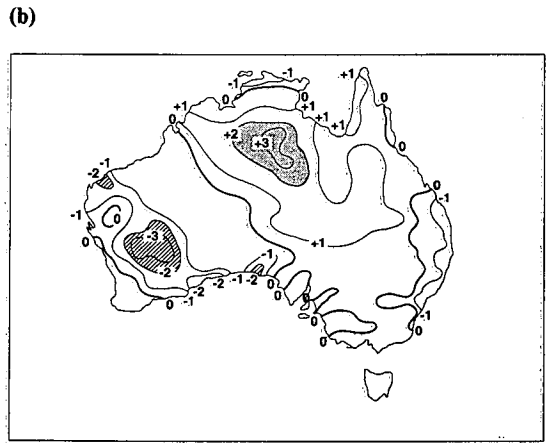
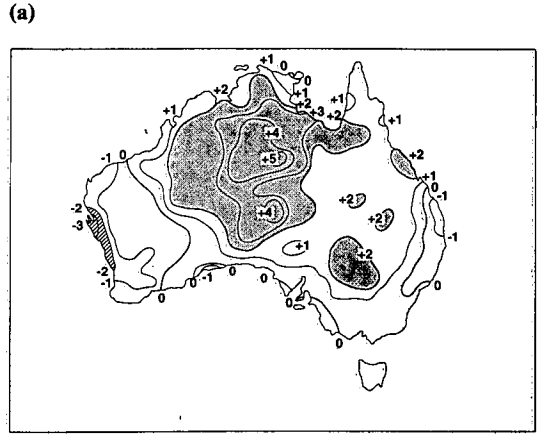


Fig. 13 Monthly mean maximum temperature anomalies (°C). (a) March 1992. (b) April 1992. (c) May 1992.



Temperatures

Mean minimum and maximum temperature anomalies for each autumn month are shown in Figs 12(a)–(c) and 13(a)–(c) respectively. Frequent cloudiness accompanying the rain over southwestern Australia depressed maximum temperatures there by between one and three degrees, particularly in April and May, while keeping minima generally a little above normal.

Temperatures generally over northern and central Australia were considerably above normal, but this was less evident in May maxima. The relative warmth in northern areas is typical of years following the development of ENSO events (Kiladis and Diaz 1989; Halpert and Ropelewski 1992), and owes much to increased insolation in March and April, resulting from the below normal cloudiness. The substantial anomalies over central Australia in those months largely reflect anomalous northerly flow over this area.

Temperatures over eastern Australia were generally a little above average, although for the most part they were within one or two degrees of normal. The chief exception was in May, when minimum temperatures in the north were two to four degrees above normal, a consequence of increased cloudiness over this area.

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Appendix

Data sources used for this review were:

- Climate Analysis Center (CAC), *Climate Diagnostics Bulletin*.*
- National Climate Centre, *Climate Monitoring Bulletin — Southern Hemisphere*.†

Obtainable from:

*Climate Analysis Center (CAC), National Weather Service, Washington D.C., 20233, USA.

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