

Seasonal climate summary southern hemisphere (spring 1992): warm Pacific conditions remain

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The rapid decay in warm Pacific episode conditions observed since late autumn 1992 appeared to cease during spring. The Southern Oscillation Index returned to negative values, cooling in the central and eastern tropical Pacific abated, and anomalous low-level equatorial westerly winds were observed for much of the period. In addition, tropical convection increased near the dateline later in the season, associated with warm sea-surface temperature anomalies in that region. The southern hemisphere circulation was characterised by large-scale anomalies, particularly through the Australian–western Pacific region.

Introduction

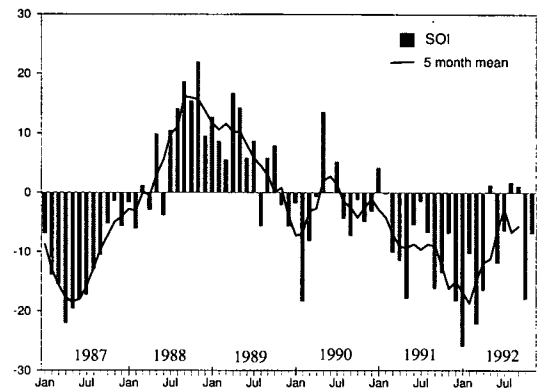
A seasonal climate summary of the southern hemisphere for spring 1992 is presented. Greater emphasis has been given to the Australian region.

The main information sources for this summary were monthly editions of the Australian Bureau of Meteorology's *Climate Monitoring Bulletin*, the *Climate Diagnostics Bulletin* from the Climate Analysis Center (CAC) of the US National Oceanic and Atmospheric Administration, and other bulletins issued by national meteorological services.

Climate indices

The trend towards more positive values of the Southern Oscillation Index* (SOI), observed during late autumn and winter 1992, continued in September (+1.1) and suggested that the 1991–92 warm Pacific episode was continuing to decay (Fig. 1). A dramatic swing in the Southern Oscillation has preceded the decay phases of past warm Pacific episodes (Rasmusson and Wallace 1983). However, the SOI rapidly decreased to

Fig. 1 Southern Oscillation Index, January 1987 to November 1992 inclusive.



negative values during October (−18.1) and November (−6.9). The large negative value in October was primarily due to a mean sea level pressure (MSLP) anomaly of −2.3 hPa at Tahiti.

Equatorial Pacific sea-surface temperature (SST) anomalies showed little change during spring following a rapid dispersion of the warm anomalies in the central and eastern region during late autumn and early winter. While slightly above average temperatures were maintained in the western tropical Pacific during spring, they were close to average in central and eastern re-

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*The SOI used here is 10 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.

gions. A significant subsurface pool of cool water became established in the central and eastern equatorial Pacific in September (not shown) and persisted for the remainder of spring. However, warm subsurface anomalies remained in the regions of the north equatorial and south equatorial counter currents of the central and eastern Pacific, following their development around mid-winter. The southern portion of this couplet weakened later in the period.

Outgoing long wave radiation (OLR) anomalies near the dateline were close to average in September and October (CAC, Washington), further suggesting that the warm Pacific episode was decaying. An increase in tropical convective activity over southeastern Asia during the second half of October was followed by enhanced convection, and consequently negative OLR anomalies, just west of the dateline in November.

Equatorial Pacific low-level westerly wind anomalies were evident in September and November, with the largest departures in central and eastern regions. Low-level winds were close to normal in western and central areas and anomalously easterly in October, possibly associated with increased intraseasonal activity in the western Pacific during the month.

Sea-surface temperatures

Figures 2(a) to (c) show the satellite-derived SST anomalies (National Meteorological Centre, Australian Bureau of Meteorology) for September to November 1992. Cool anomalies spread westward into the central equatorial Pacific during the first half of spring but they tended to weaken later in the period. There was a general tendency towards near-normal SSTs through the equatorial Pacific during spring. A cool bias had been introduced to the satellite-derived SSTs due to the scattering of incoming solar radiation by volcanic effluents following the June 1991 Mt Pinatubo eruption. Although this bias had largely dissipated by spring 1993, it may still have influenced central and eastern equatorial Pacific SSTs which were cooler than those reported by CAC, Washington.

The maintenance of equatorial SSTs 1°C to 2°C above average near the dateline was further evidence that, if the warm Pacific episode was in a decaying phase, it was unusual compared to previous events. This warm pool was at least partly responsible for enhanced convection in this re-

Fig. 2(a) September 1992 sea-surface temperature anomaly ($^{\circ}\text{C}$).

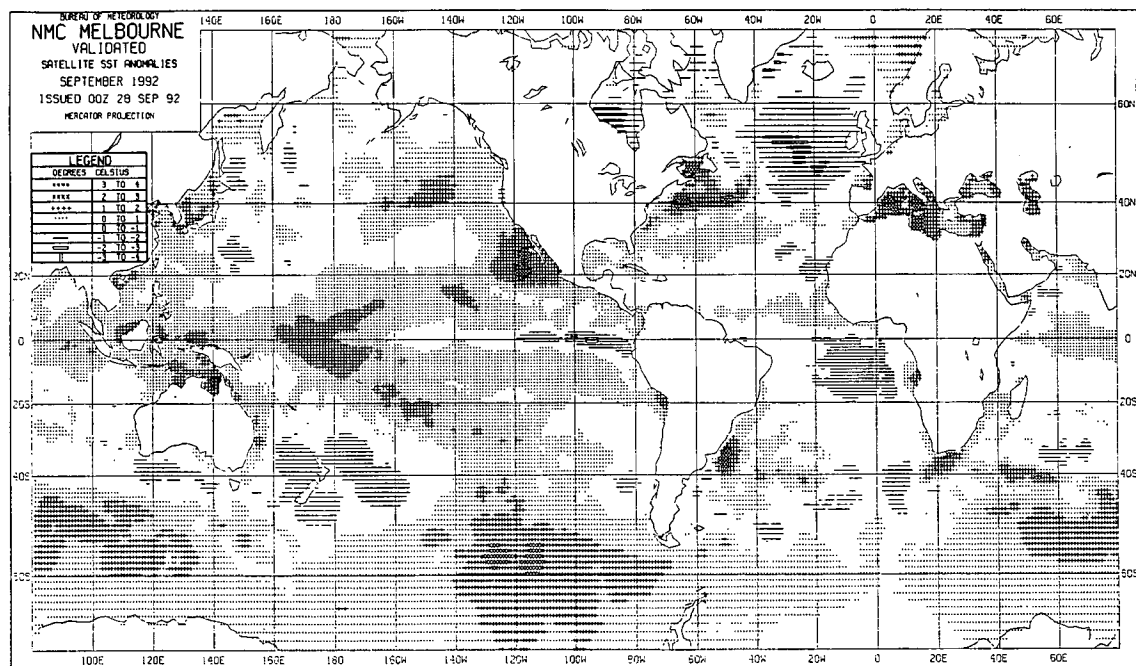


Fig. 2(b) October 1992 sea-surface temperature anomaly (°C).

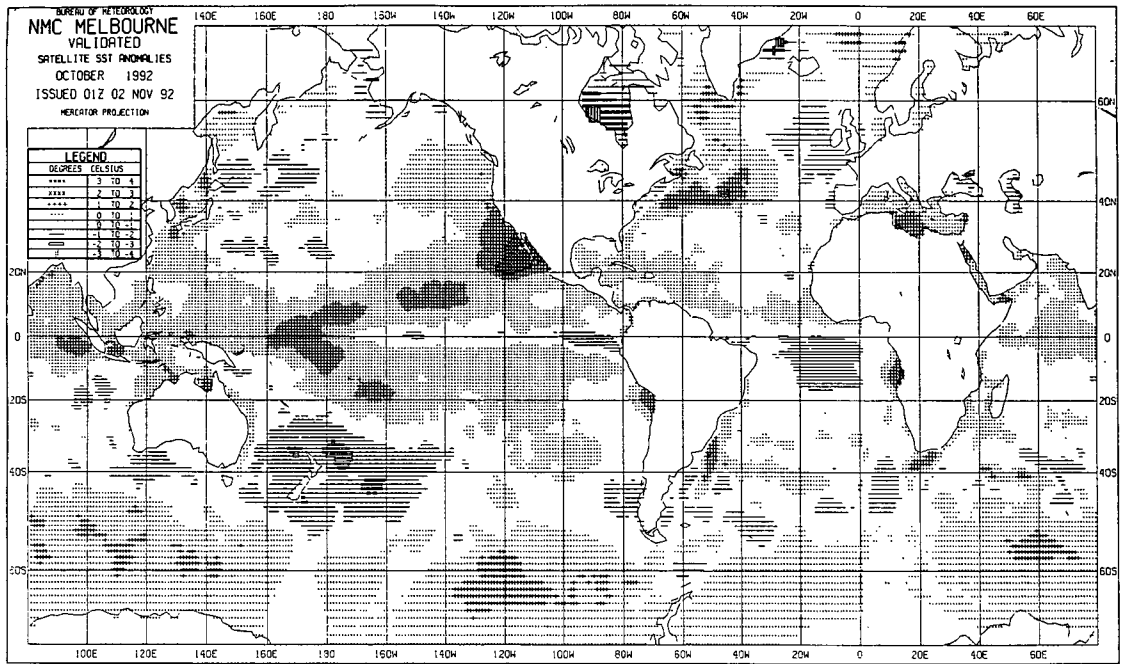
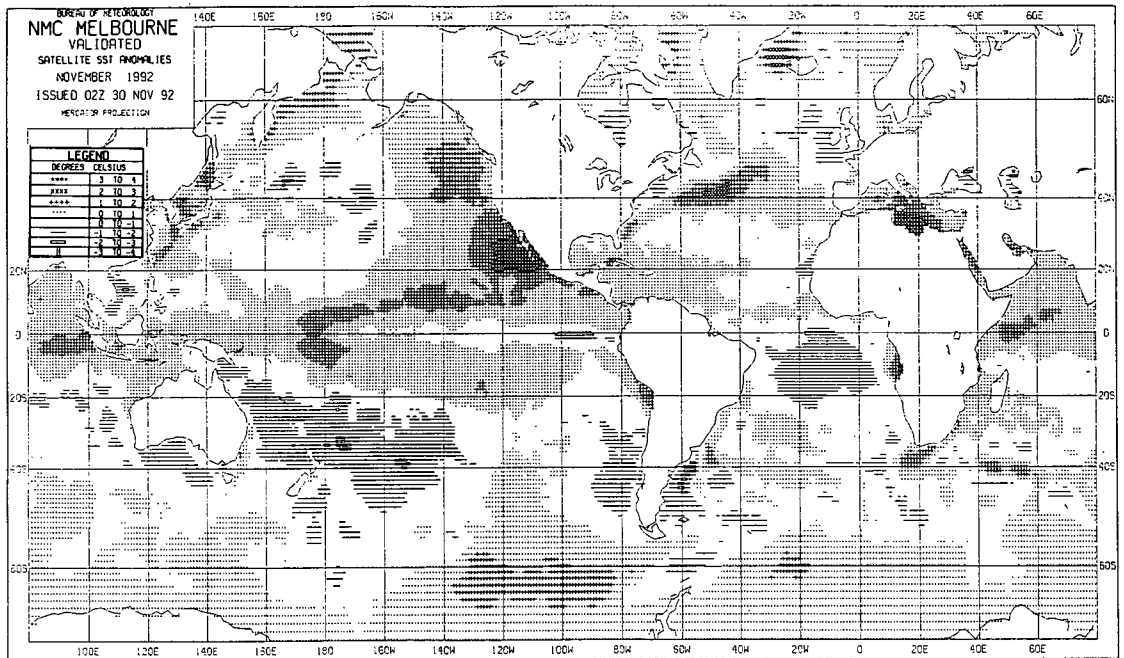


Fig. 2(c) November 1992 sea-surface temperature anomaly (°C).



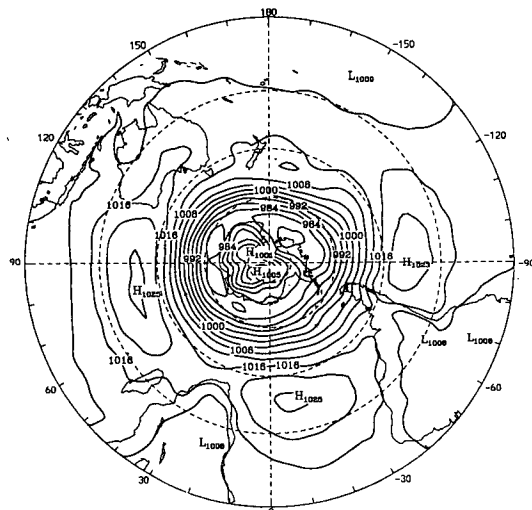
gion in November. Warm anomalies were also observed straddling the equator in the central and eastern Pacific during spring.

An area of cool SSTs in the southwest Pacific surrounding New Zealand was observed and had persisted since the beginning of 1992. Local negative anomalies in excess of 3°C were recorded in this region, which expanded eastward during spring.

Surface analysis

Figure 3 shows the mean spring MSLP analysis, with the associated anomaly pattern in Fig. 4. A three-wave pattern is evident at high latitudes in the anomaly analysis. A broad region of negative MSLP anomalies dominated the mid-latitudes of the South Pacific. Lower than normal MSLP was generally observed over South Africa, South America, southeastern Australia and the Antarctic continent.

Fig. 3 Spring 1992 (September, October, November) mean sea level pressure (hPa).



Upper air analysis

The 500 hPa geopotential height analysis and anomaly pattern are shown in Figs 5 and 6, respectively. The anomalies show a two-wave pattern at high latitudes with below average geopotential height dominating subtropical lati-

Fig. 4 Spring 1992 (September, October, November) mean sea level pressure anomaly (hPa).

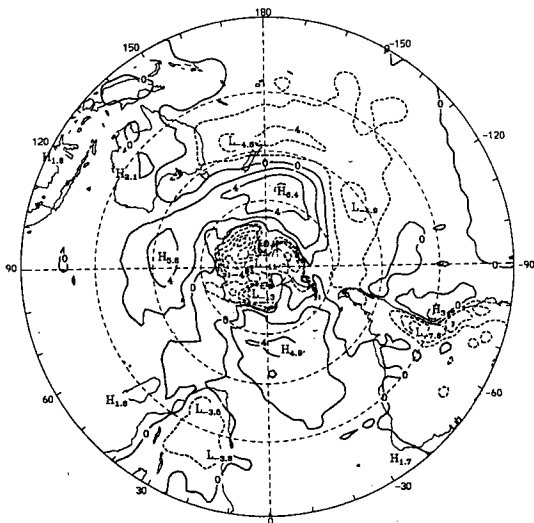


Fig. 5 Spring 1992 (September, October, November) 500 hPa mean height (dam).

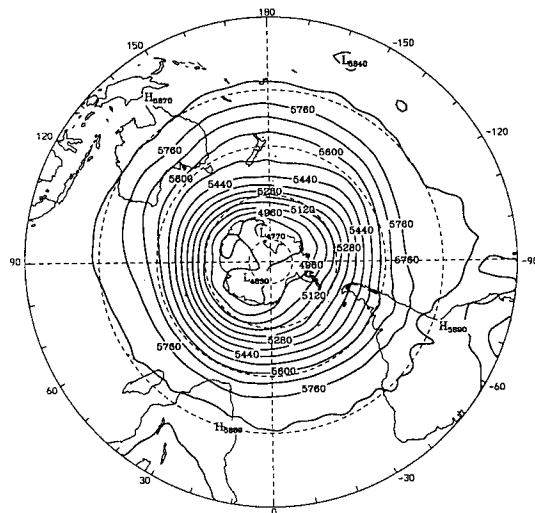


Fig. 6 Spring 1992 (September, October, November) 500 hPa mean height anomaly (dam).

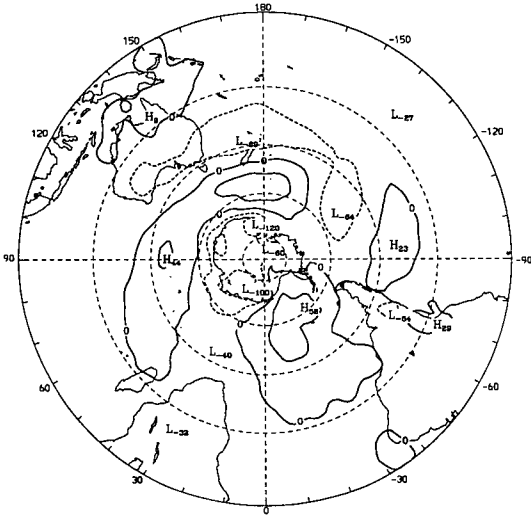
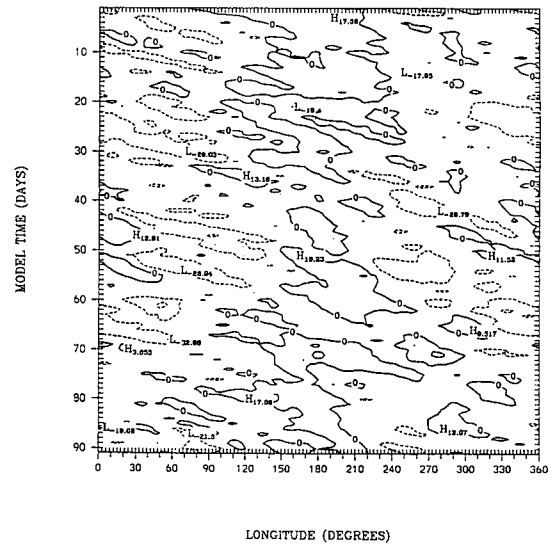


Fig. 7 Spring 1992 (September, October, November) daily Blocking Index: time-longitude section. Day 1 is 1 September.



tudes. The largest departures were associated with the negative anomalies through the Australian-western Pacific sector.

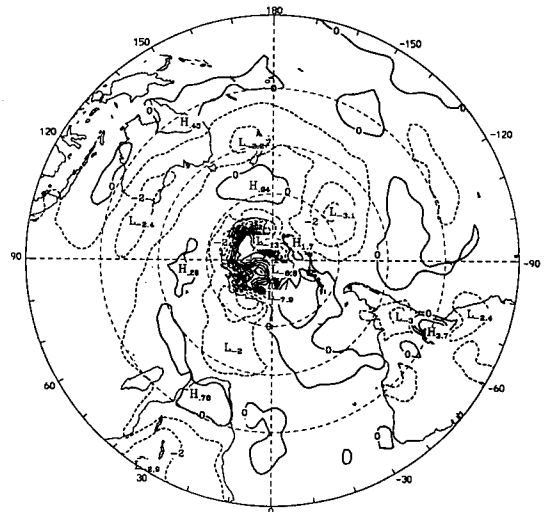
Blocking

A time-longitude section of the daily hemispheric Blocking Index* is shown in Fig. 7. The circulation was dominated by anomalously high values of the index near the dateline during spring except for early October when more zonal flow was observed. In September, particularly, high values of the index were associated with a tendency for mobile mid-latitude depressions to move north of their normal latitudes, rather than any marked stagnation of systems.

Temperatures

Temperature anomalies in the lower troposphere are shown in Fig. 8. The analysis suggests hemispheric temperatures were generally cooler than normal. Large negative anomalies were observed

Fig. 8 Spring 1992 (September, October, November) 700 hPa temperature anomaly (°C).



*Blocking Index (BI) = $0.5(U_{25} + U_{30} + U_{55} + U_{60} - U_{40} - U_{50} - 2U_{45})$ where U is the westerly wind component at 500 hPa. Subscripts refer to latitude.

over the Antarctic continent, and in a broad band over southern Australian and western Pacific longitudes. Pan and Oort (1983) noted that a maximum in global temperature tends to show up about three to six months after the peak of a warm Pacific event. Since SSTs in the central and eastern tropical Pacific peaked around May 1992, ENSO-induced warmth would have been expected to occur in spring. Therefore, the absence of any significant warm anomalies, particularly in tropical and subtropical regions, suggests that other factors were strongly influencing temperatures.

While reduced insolation, associated with the injection of volcanic effluents into the stratosphere following the June 1991 eruption of Mount Pinatubo in the Philippines, may have contributed to the cool temperature anomalies, large-scale circulation anomalies were probably at least equally responsible.

Winds

Lower and upper tropospheric vector wind anomalies are shown in Figs 9 and 10, respectively. The lower-level zonal winds either side of the subtropical ridge were significantly weaker than normal (with westerly anomalies to the north and easterly anomalies to the south) through Australian and western Pacific longitudes. This was probably a consequence of the tendency for extratropical cyclones to be directed north of their normal latitudes through this region. Weak meridional exchange at high latitudes (as shown by a tendency for zonal wind anomalies through the region) was associated with below-normal lower tropospheric temperatures over the Antarctic continent. The upper-level analysis indicates the presence of a strong subtropical jetstream over Australia.

Australian region

Circulation and rainfall

Negative mid-tropospheric height anomalies over southern Australia (Fig. 6) reflected a greater-than-normal tendency for extratropical cyclones and active frontal systems to affect the region. Interactions between cut-off low pressure systems and tropical moisture also affected the southern half of the continent. In contrast, positive mid-tropospheric height anomalies over northern Australia (Fig. 6) were associated with relatively stable conditions in the tropics.

Fig. 9 Spring 1992 (September, October, November) 850 hPa vector wind anomalies (m s^{-1}).

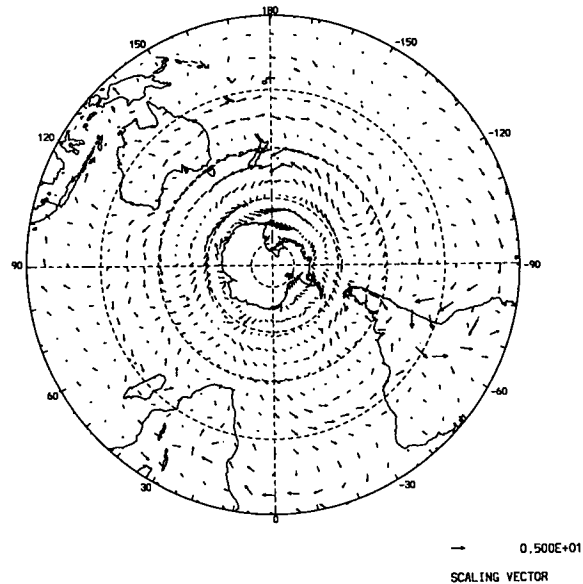
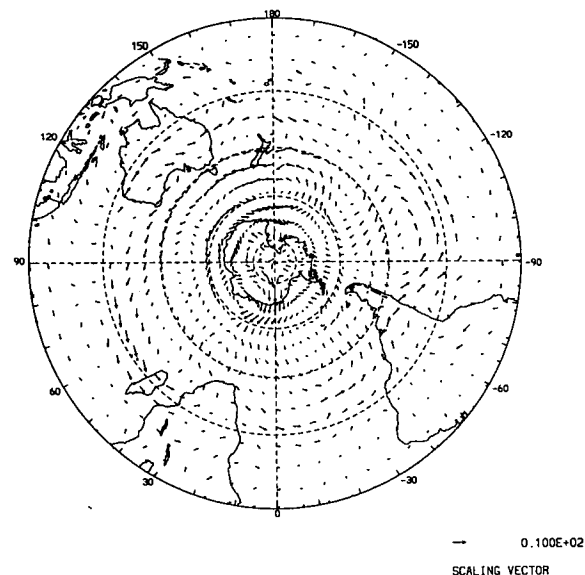


Fig. 10 Spring 1992 (September, October, November) 300 hPa vector wind anomalies (m s^{-1}).



Spring rainfall over Australia is shown in Fig. 11. Rainfall over southern Australia was mostly well above average, with the highest spring rainfall on record observed in southern South Australia and northern Victoria. Major flooding occurred in South Australia and Victoria during October. Rainfall was average to below average over the north of the continent. Zhang and Casey (1992) have shown that breakdown of warm Pacific episodes is often associated with above average rains in southeastern Australia.

Temperatures

Figures 12(a) to (f) show the monthly maximum

and minimum temperature anomalies over Australia. Spring temperatures were dominated by a north-warm, south-cool dipole. The contrast was more clearly evident in the daytime maximum temperatures in September and November with anomalies of -4° to -5°C over large southern areas (Figs 12(a), (e)). Repeated incursions of cold air from well south of the continent, and frequent widespread rainfall (and therefore increased cloudiness) were mainly responsible for these anomalies. Reduced rainfall, and therefore cloudiness, over northern areas probably resulted in the average to above average temperatures there.

Fig. 11 Spring 1992 (September, October, November) rainfall over Australia: decile range values based on district averages.

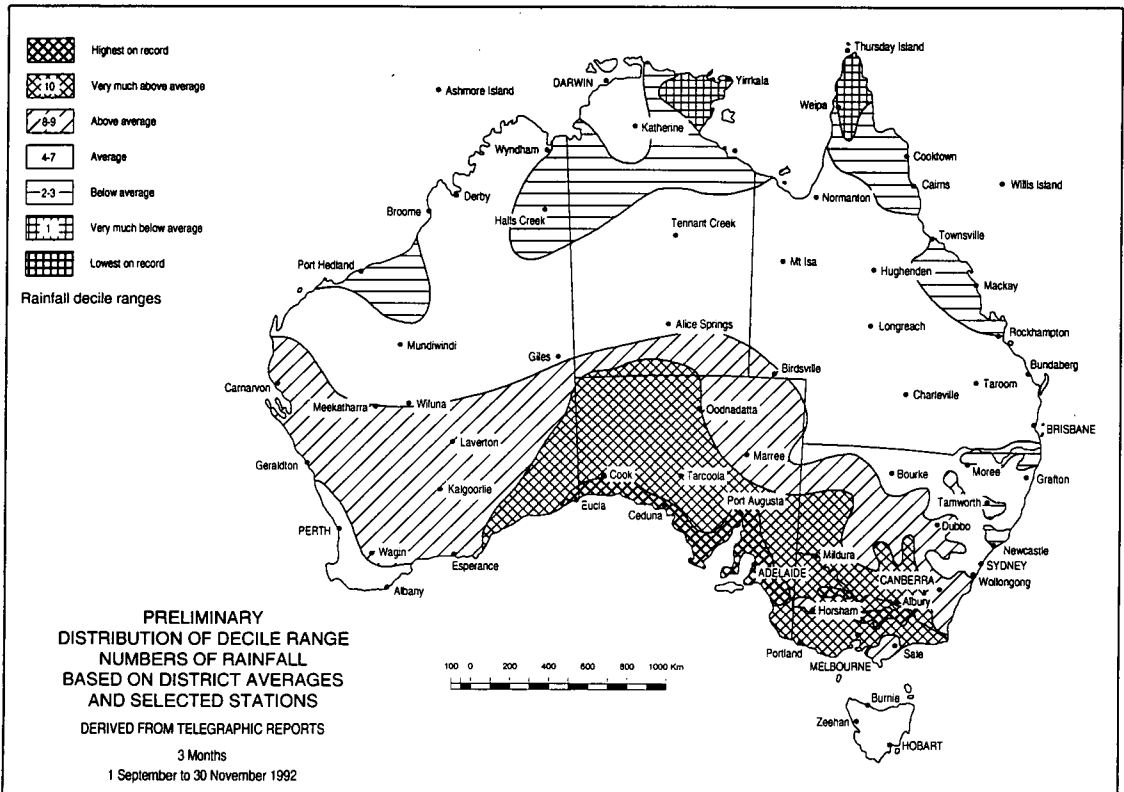


Fig. 12(a) September 1992 maximum temperature anomalies for Australia (°C).

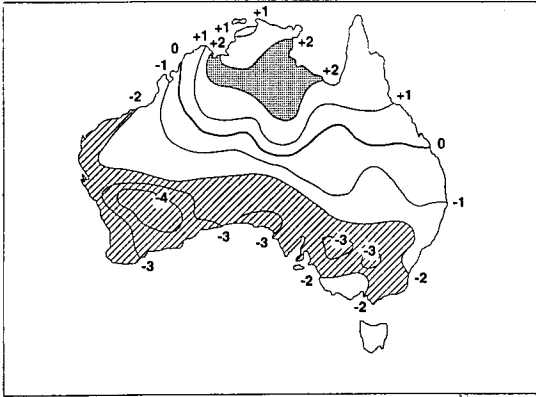


Fig. 12(b) September 1992 minimum temperature anomalies for Australia (°C).

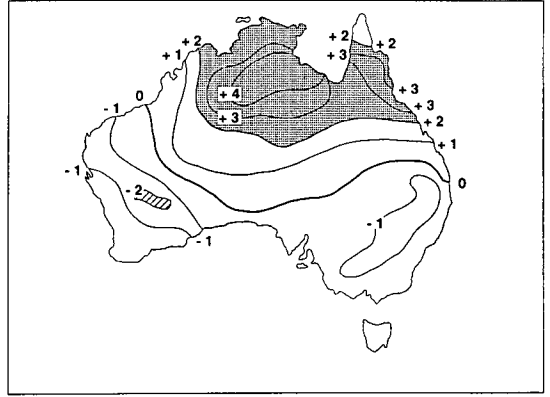


Fig. 12(c) October 1992 maximum temperature anomalies for Australia (°C).

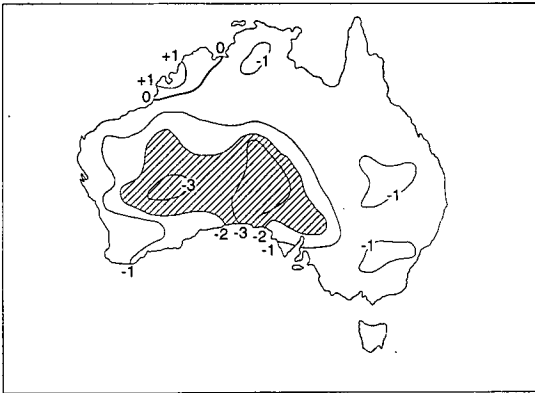


Fig. 12(d) October 1992 minimum temperature anomalies for Australia (°C).



Fig. 12(e) November 1992 maximum temperature anomalies for Australia (°C).

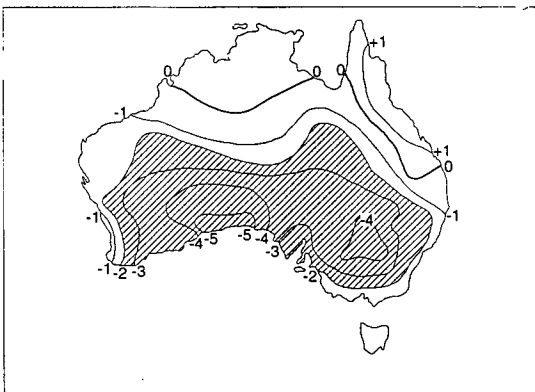
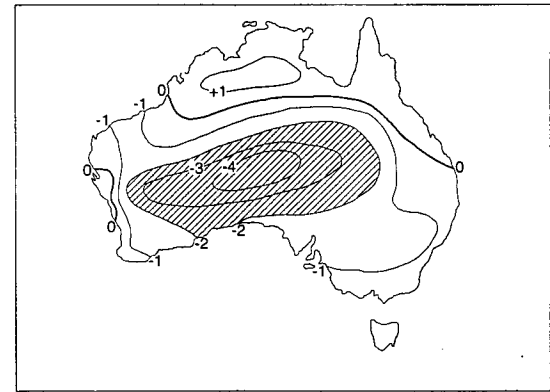


Fig. 12(f) November 1992 minimum temperature anomalies for Australia (°C).



References

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- Rasmusson, E.M. and Wallace, J.M. 1983. Meteorological aspects of the El Niño/Southern Oscillation. *Science*, 222, 1195-202.
- Zhang, X.-G. and Casey, T.M. 1992. Long-term variations in the Southern Oscillation and relationships with Australian rainfall. *Aust. Met. Mag.*, 40, 211-25.

Appendix

Data sources used for this review were:

Climate Analysis Center — *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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