

Seasonal climate summary southern hemisphere (spring 1990): chiefly warm anomalies in the tropics and mid-latitudes

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A climate analysis is given of the southern hemisphere spring circulation, September to November 1991, with more detailed treatment of the Australian region. Chiefly positive sea-surface temperature anomalies occurred in the tropics, except in the eastern Pacific and central Atlantic. Similarly the mid-latitudes showed mostly warm anomalies. A three-wave planetary pattern was evident with deep troughs in the mid-Pacific and mid-Indian Oceans, and a weak trough in the Atlantic. Rainfall over Australia was significantly below average.

Introduction

This seasonal summary reviews the southern hemisphere climate for spring 1990 (September to November inclusive), with more detailed attention given to the Australian region.

The main information sources were the Climate Monitoring Bulletins issued by the Bureau of Meteorology, Australia, and reference was also made to climate bulletins issued by other national meteorological services. Data sources are specified in the Appendix.

Climate indices

In the transition from winter to spring 1990 (Gaffney 1991) little change occurred in the main tropical climate indices, although the western equatorial Pacific showed slight warming.

The Southern Oscillation Index* (SOI) was slightly negative having a mean value of -4.5 for spring, as evident in Fig. 1, compared with a mean value of $+3.9$ in spring 1989 (Nydam 1990). The five-month smoothed trend was downwards approximately seven units.

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*The Southern Oscillation Index (SOI) used here is 10 times the Tahiti minus Darwin MSL pressure anomaly divided by the standard deviation for the month, based on the period 1882 to 1985.

Climate indices used for monitoring the El Niño-Southern Oscillation phenomenon were chiefly near average. A notable feature was the positive sea-surface temperature (SST) anomaly in the western tropical Pacific as shown in Fig. 2.

Sea-surface temperatures

In the tropics, sea-surface temperatures were mainly normal to slightly above normal. Positive

Fig. 1 Southern Oscillation Index, January 1986 to November 1990 inclusive.

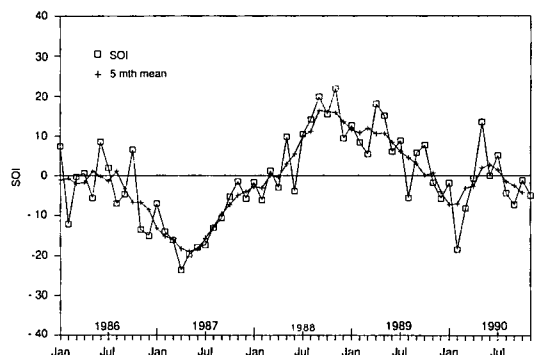
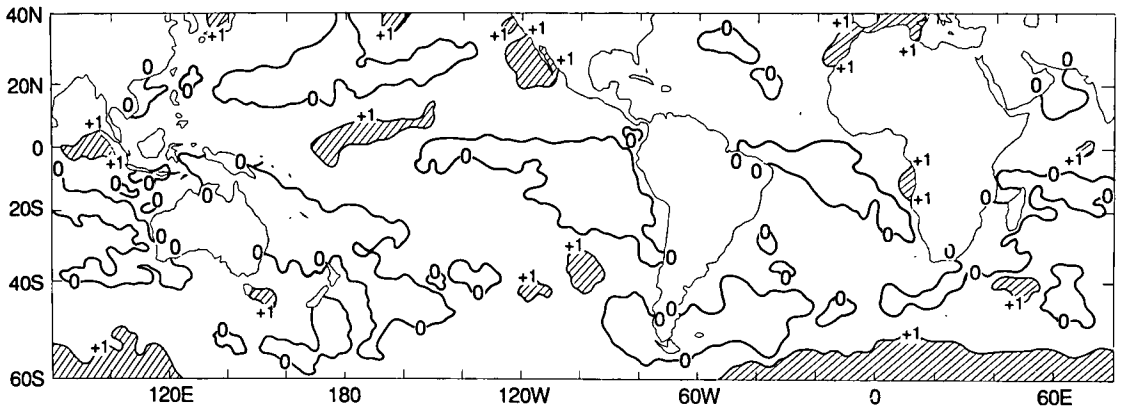


Fig. 2 Spring 1990 (September, October, November) sea-surface temperature anomaly (°C).



anomalies were significant in the western Pacific and the eastern Indian Ocean.

At mid-latitudes SST anomalies were positive with values reaching 1–2 degrees in some areas.

In the Australian region, positive departures off the northwest and south coasts were generally small, apart from a 1–2 degree area eastwards from Tasmania. Slightly negative departures occurred off the northeast coast.

Surface analysis

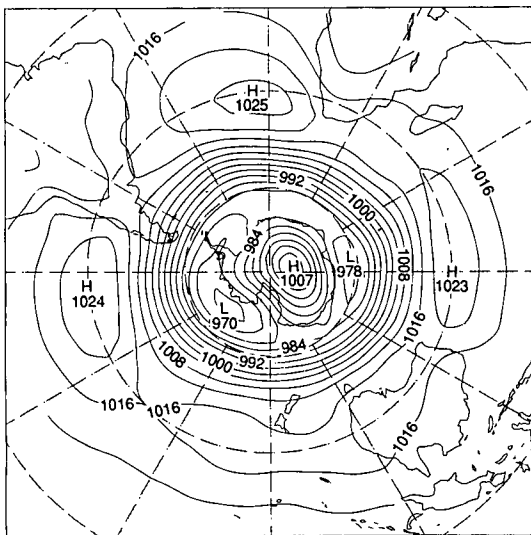
The mean sea level pressure analysis is given in Fig. 3 with anomalies in Fig. 4. A three-wave pattern can be seen in Fig. 3 with deeper than normal troughs in the Pacific and Indian Oceans. The Pacific trough extended from near the coast of

western Antarctica to the subtropics, while the Indian Ocean trough extended from near eastern Antarctica towards Madagascar. A weaker trough was located at higher latitudes in the western Atlantic.

Marked features of the anomalies (Fig. 4) were:

- (a) a strong ridge-trough couplet covering most of the western hemisphere;
- (b) a deep low centre at high latitudes in the Indian Ocean.

Fig. 3 Spring 1990 (September, October, November) mean sea level pressure (hPa).



Upper air analysis

The 500 hPa analysis and anomalies in Figs 5 and 6 depict a corresponding three-wave pattern. Significant features of the anomalies (Fig. 6) were:

Fig. 4 Spring 1990 (September, October, November) mean sea level pressure anomaly (hPa). Dashed lines are negative.

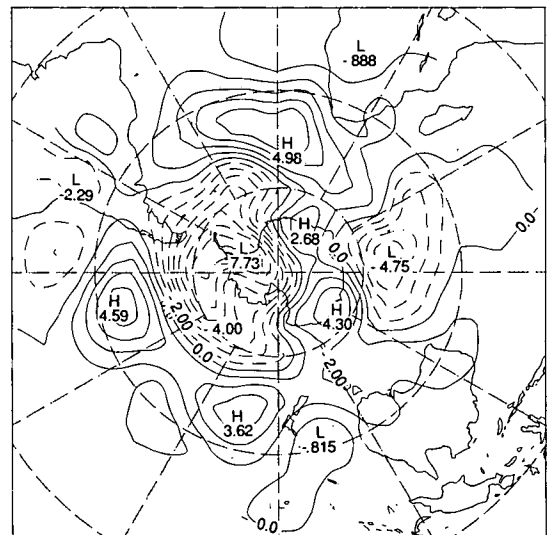


Fig. 5 Spring 1990 (September, October, November) 500 hPa mean height (dam).

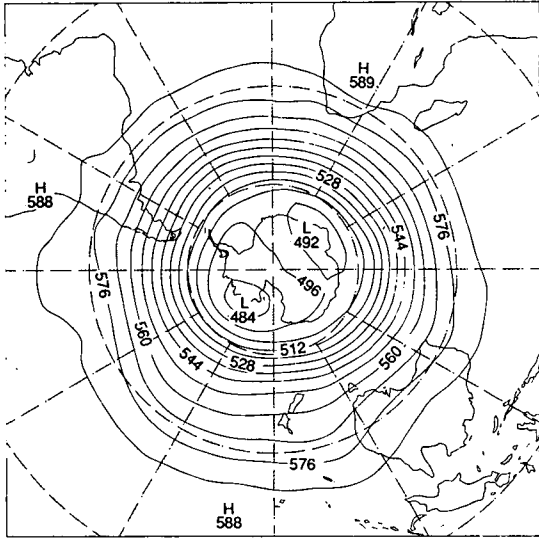


Fig. 7 Spring 1990 (September, October, November) 300 hPa mean height (dam).

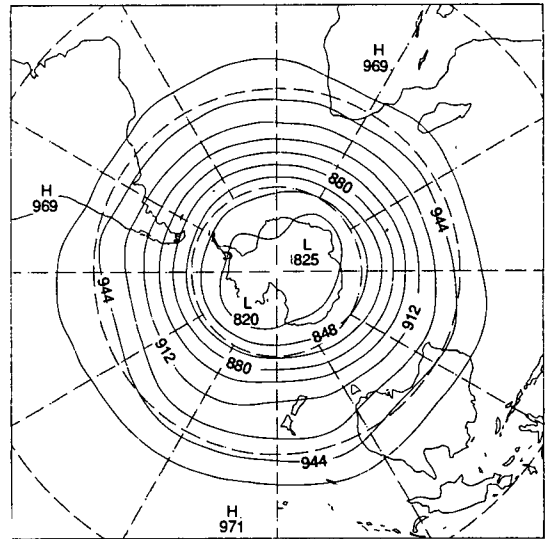


Fig. 6 Spring 1990 (September, October, November) 500 hPa height anomaly (dam). Dashed lines are negative.

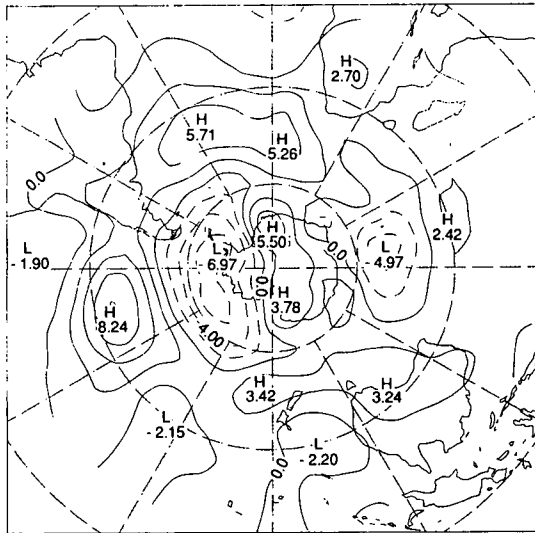
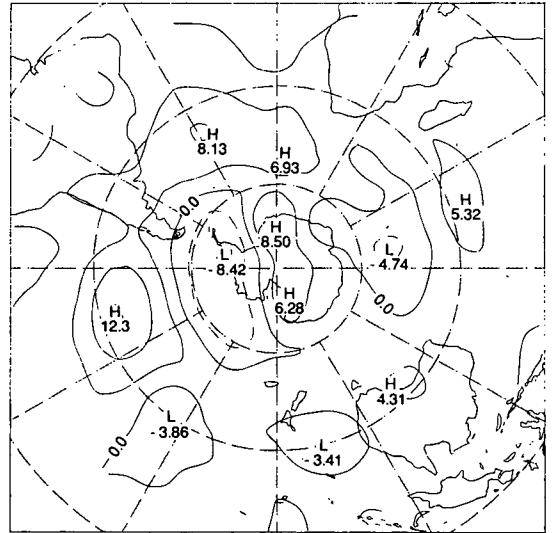


Fig. 8 Spring 1990 (September, October, November) 300 hPa height anomaly (dam). Dashed lines are negative.



- (a) a strong ridge-trough couplet covering most of the western hemisphere;
- (b) a high-low wave train extending from the southeast Pacific across the pole to the Indian Ocean;
- (c) a low centre at high latitudes in the Indian Ocean;
- (d) a ridge extending across Australia and a high cell over southern Africa.

At 300 hPa (Figs 7 and 8), a similar pattern was evident. The troughs in the Pacific and Indian

Oceans could be distinguished but the flow was zonal in the Atlantic.

Blocking

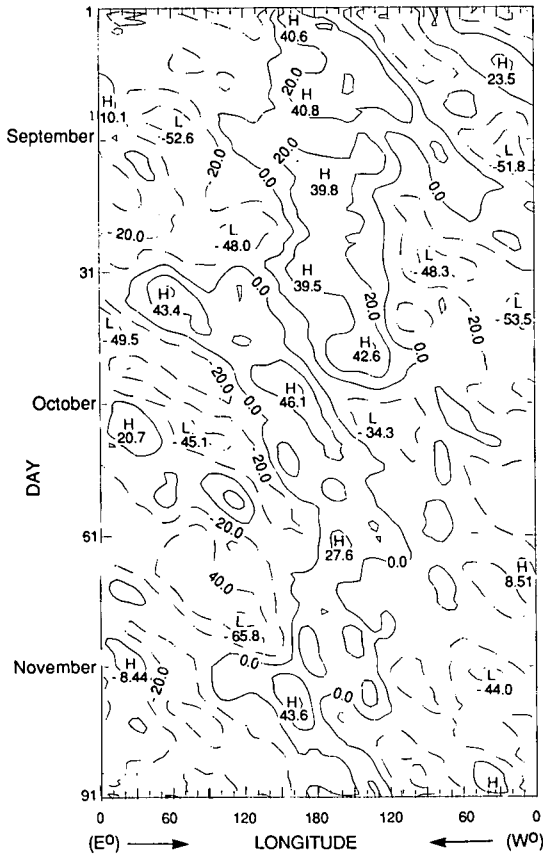
Blocking events, as measured by the Blocking Index (BI)*, were prominent in the Pacific

*Blocking Index (BI)

$$BI = U_{27.5} + U_{57.5} - (U_{42.5} + U_{47.5})$$

where U is the 500 hPa mean zonal wind and the subscript is the corresponding latitude.

Fig. 9 Spring 1990 (September, October, November) daily Blocking Index: time-longitude section. Day 1 is 1 September. Dashed lines are negative.



throughout spring (Fig. 9). Only brief blocking activity occurred elsewhere in the hemisphere during the season. In September, mean monthly blocking graphs (not shown) indicated that blocking was above normal in the Pacific during that month. In October, blocking was mostly about normal around the hemisphere, although there was above normal activity in the Indian Ocean during that month. November saw above normal blocking again in the Pacific, but chiefly below normal blocking elsewhere.

Winds

Wind anomalies in the lower troposphere at 850 hPa given in Fig. 10 may be related to the surface height anomalies specified previously in Fig. 4. Strong anticyclonic wind anomalies in the southeast Pacific and south Atlantic (Fig. 10) correspond to the positive height anomalies (Fig. 4). Likewise the cyclonic wind anomalies in the Indian Ocean relate to the low anomalies seen in Fig. 4.

Fig. 10 Spring 1990 (September, October, November) 850 hPa wind anomalies ($m s^{-1}$). (The figures near the H and L are vector values at respective locations.)

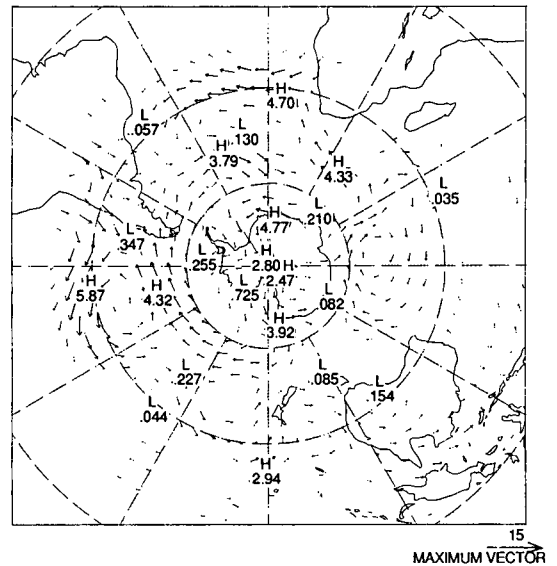
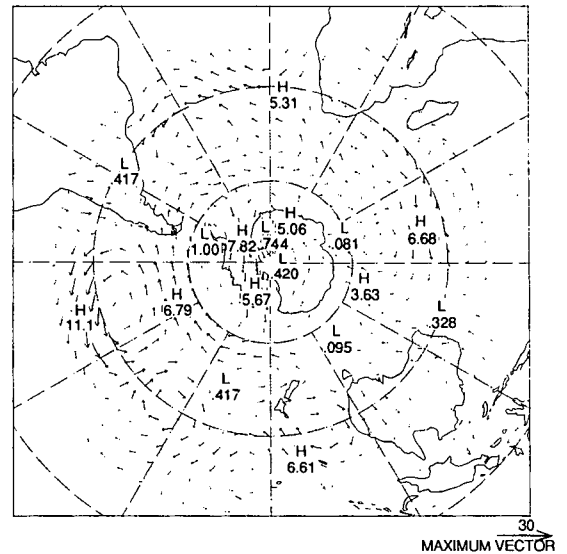


Fig. 11 Spring 1990 (September, October, November) 300 hPa wind anomalies ($m s^{-1}$). (The figures near the H and L are vector values at respective locations.)



The upper troposphere (300 hPa) wind anomalies given in Fig. 11 can be related to Fig. 8. The main characteristics of the upper tropospheric wind anomalies were:
 (a) a general poleward shift of the jet stream, linked to the ridge-trough couplet (Fig. 8);
 (b) strong anticyclonic anomalies in the southeast Pacific associated with a ridge-trough dipole.

Australian region

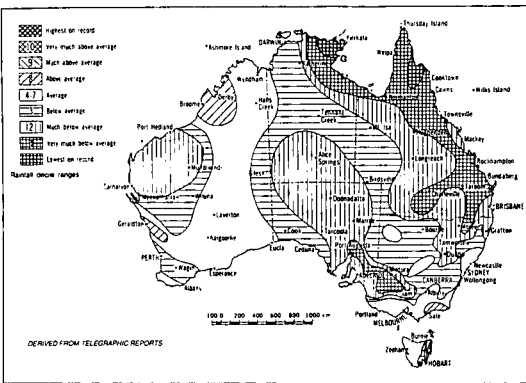
Circulation

Upper air height anomalies (Figs 6 and 8) were generally associated with suppression of spring rainfall over southern Australia. Additionally, the 200 hPa velocity potential over central and eastern Australia was significantly high (see Australian Climate Monitoring Bulletins) causing suppression of rainfall.

Rainfall

Spring rainfall was well below average over most of Australia, particularly in eastern areas as seen in Fig. 12. Lowest totals on record occurred in parts of north Queensland and in the northeast of the Northern Territory. The slightly negative SST anomalies off the northeast coast of Australia (Fig. 2) could have contributed to the strong negative rainfall anomalies in northeastern Australia (Fig. 12).

Fig. 12 Spring 1990 (September, October, November) rainfall in Australia: decile range values based on district averages.



November 1990 was an abnormally dry month over most of Australia with record low rainfall totals across the eastern interior of the continent and in northeast Queensland contributing to the dry spring (Fig. 12). The 200 hPa velocity potential in the Australian-Asian region, given in Fig. 13, shows a strong high centre over eastern Australia with a ridge extending westwards across the interior. This high velocity potential was associated with tropospheric subsidence and suppression of rainfall in the Australian region during November. This pattern was typical of the spring of 1990.

Temperature

In spring, maximum temperature anomalies were positive over much of Australia, notably over parts of the interior as depicted in Fig. 14(a). These anomalies were consistent with the dry cloudless conditions during the season.

Similarly, minimum temperature anomalies were chiefly positive with some parts of the interior showing positive departures of 2° C, as seen in Fig. 14(b).

Fig. 13 November 1990 200 hPa velocity potential.

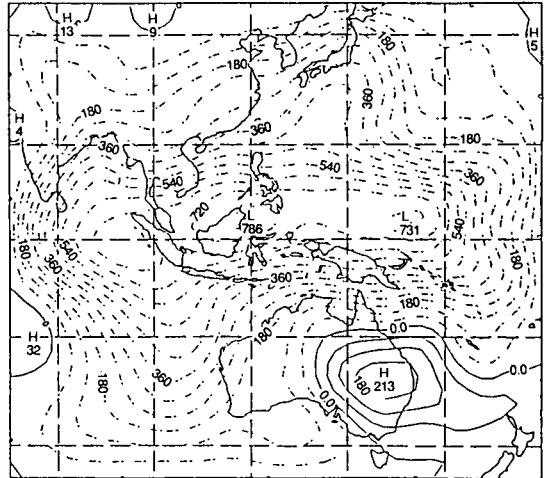
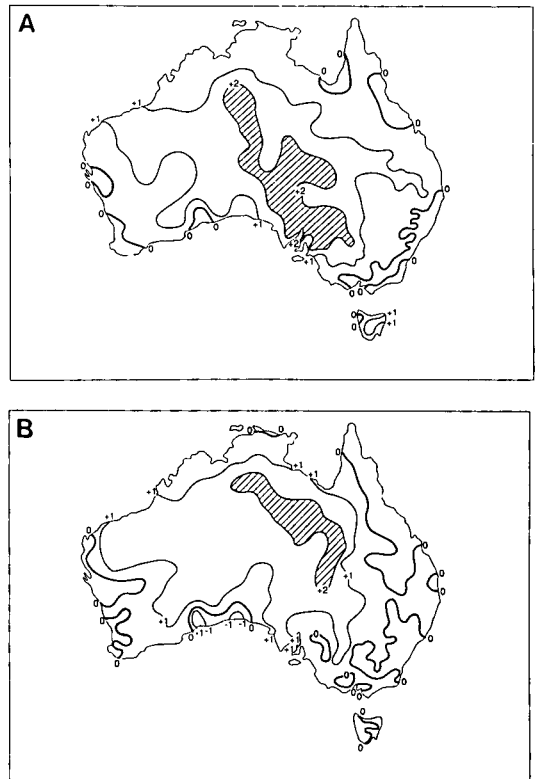


Fig. 14 Spring 1990 (September, October, November) temperature anomalies (°C) for Australia: (a) maximum; (b) minimum.



References

- Gaffney, D. 1991. Seasonal climate summary southern hemisphere (winter 1990): generally normal conditions in tropics and warm in mid-latitudes. *Aust. Met. Mag.*, 39, 131-5.
- Nydam, P.G. 1990. Seasonal climate summary southern hemisphere (spring 1989): the 1988/89 positive phase of the Southern Oscillation draws to an end. *Aust. Met. Mag.*, 38, 293-8.

Appendix

Data sources used for this review were:
 Climate Analysis Center Climate Diagnostics Bulletin.*
 Darwin Tropical Diagnostic Statement.†

Monthly report on Climate System.§
 National Climate Centre — Climate Monitoring Bulletin — Southern Hemisphere.‡
 Southern hemisphere grid-point analysis data archived by the World Meteorological Centre, Melbourne.‡

Obtainable from:

*Climate Analysis Center, National Weather Service, Washington DC 20233, USA.

†Northern Territory Regional Office, Bureau of Meteorology, PO Box 735, Darwin 0801, Australia.

§Japan Meteorological Agency, 1-3-4, Ote-machi chiyoda-ku, Tokyo, Japan.

‡National Climate Centre, Bureau of Meteorology, GPO Box 1289K, Melbourne 3001, Australia.