Aust. Met. Mag. 39 (1991) 65–69

Seasonal climate summary southern hemisphere (autumn 1990): near normal conditions in the equatorial Pacific and strong anomalies at mid-latitudes

D. Gaffney
National Climate Centre, Bureau of Meteorology, Melbourne, Australia

(Manuscript received October 1990; revised October 1990)

A climate analysis of the southern hemisphere for the austral autumn (March 1990 to May 1990) is presented with more detailed treatment of the Australian region.
In the equatorial Pacific, autumn sea-surface temperatures were mainly near normal. Other equatorial climate indices were also tending towards normality during the season. In mid-latitudes, sea-surface temperature anomalies were generally positive, notably in the Australian region. A strong three-wave pattern was evident at middle to high latitudes, with strong pressure-height anomalies. Record rains and floods occurred over inland eastern Australia.

Introduction

This seasonal climate summary reviews the southern hemisphere climate features for autumn 1990 (March to May 1990 inclusive). Features reviewed include climate indices, sea-surface temperatures (SSTs) and tropospheric pressure patterns. Conditions in the Australian region are given specific attention.

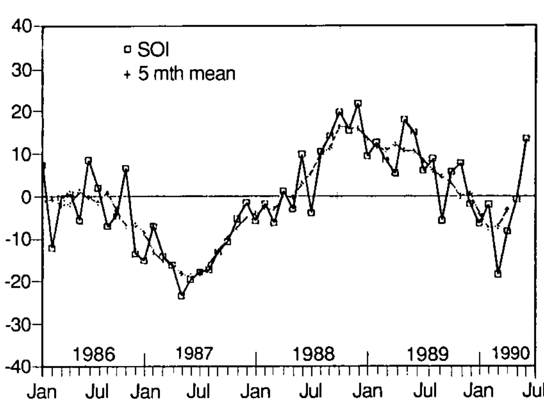
The main climate data sources were the climate monitoring bulletins issued monthly by the Bureau of Meteorology, Australia, along with monthly climate bulletins issued monthly by other national weather services. Data sources are listed in the Appendix.

Climate indices

After falling to a low value of −18.4 in February, the Southern Oscillation Index (SOI)* rose sharply in the autumn months to a positive value of 13.6 in May as shown in Fig. 1. This indicated a change from the weak El Niño-like conditions of the previous summer (Gaffney 1991; Janowiak 1990).

Sea-surface temperatures were about normal in the equatorial Pacific and also in other equatorial oceanic areas (Fig. 2). The remaining climate indices used for monitoring the El Niño-Southern Oscillation phenomenon were near normal.

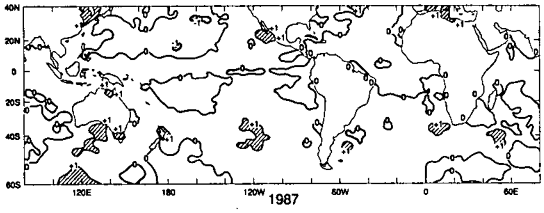
Fig. 1 Southern Oscillation Index, January 1986–May 1990.



Corresponding author address: D. Gaffney, National Climate Centre, Bureau of Meteorology, GPO Box 1289K, Melbourne 3001, Australia.

*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.

Fig. 2 Autumn 1990 (March, April, May) sea-surface temperature anomaly (°C).



Sea-surface temperatures

Continuing the summer pattern, SSTs in autumn were generally near normal throughout the tropics as shown in Fig. 2. An exception was the positive anomaly (1°C) in the Gulf of Carpentaria.

In mid-latitudes positive anomalies (1°C) were prominent around the hemisphere (Fig. 2), notably from Australia southwards. Positive SSTs (0.5, −1.0°C) surrounded the Australian continent. Additionally, an SST gradient pattern was evident in the Indian Ocean, with positive anomalies (0.5°C) northwest of Australia and negative anomalies (0.5°C) in the central Indian Ocean, similar to patterns identified by Nicholls 1989. This pattern was apparently linked to record rainfall over eastern Australia described later.

Surface analysis

The mean sea level analysis given in Fig. 3 and the anomalies in Fig. 4 display a strong characteristic three-wave pattern with deep troughs in the Pacific, Atlantic and eastern Indian Oceans. The

Fig. 3 Autumn 1990 (March, April, May) mean sea level pressure (hPa).

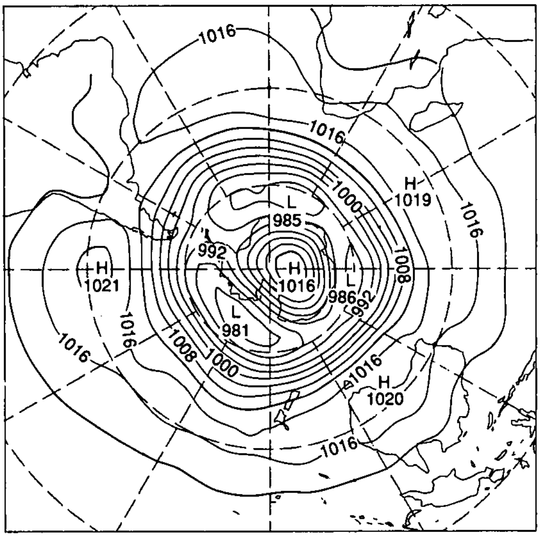
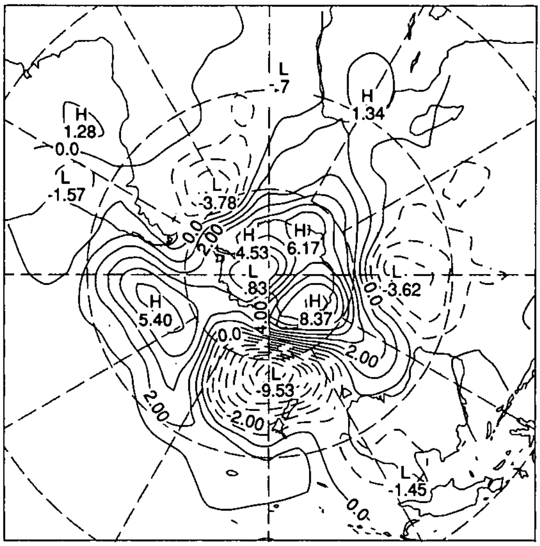


Fig. 4 Autumn 1990 (March, April, May) mean sea level pressure anomaly (hPa).



Pacific trough was particularly deep, extending from Antarctica to the tropics.

The main features of the anomaly chart (Fig. 4) were the:

(a) alternating high and low centres at mid-latitudes consistent with the orientation of the troughs;
(b) strong low centre to the southeast of New Zealand associated with the deep Pacific trough; and
(c) strong high centres over eastern Antarctica, producing strong gradients.

Fig. 5 Autumn 1990 (March, April, May) 500 hPa mean height (dam).

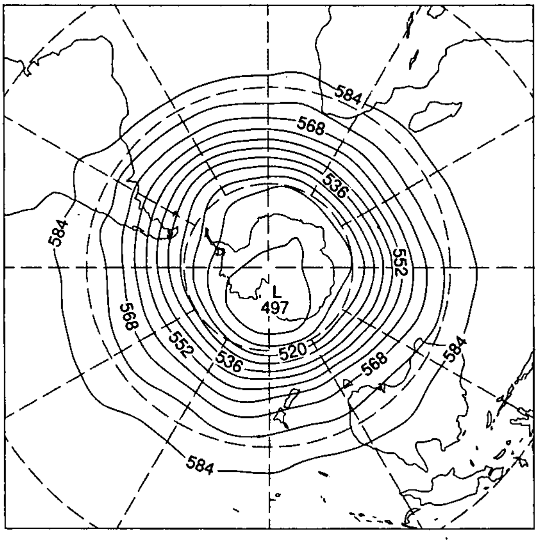


Fig. 6 Autumn 1990 (March, April, May) 500 hPa height anomaly (dam).

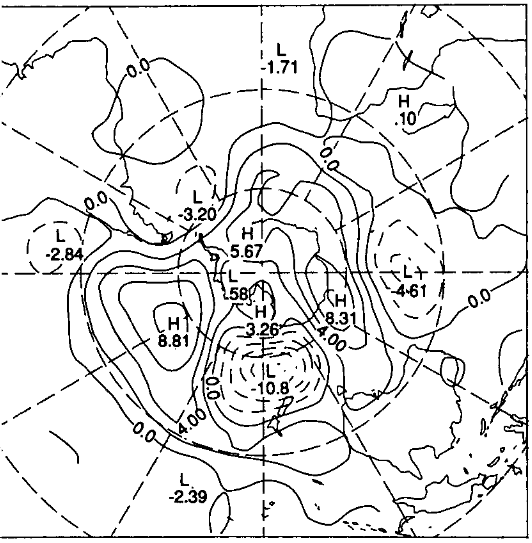
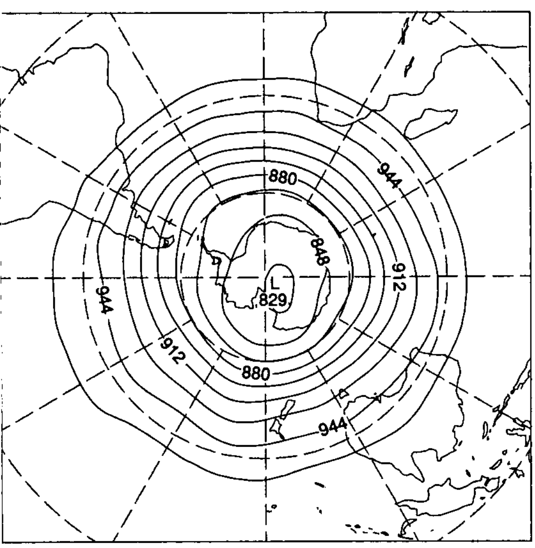


Fig. 7 Autumn 1990 (March, April, May) 300 hPa mean height (dam).



Upper air analysis

The 500 hPa analysis and anomalies (Figs 5 and 6 respectively) indicated the usual equivalent barotropic characteristics in the mid-troposphere. Consistent with the surface trough (Fig. 3), the upper trough in the Pacific was deep. The upper trough in the eastern Indian Ocean was also quite deep, with a slight tilt towards Western Australia.

At 300 hPa (Figs 7 and 8) a similar pattern was displayed with the Pacific trough dominating.

Fig. 8 Autumn 1990 (March, April, May) 300 hPa height anomaly (dam).

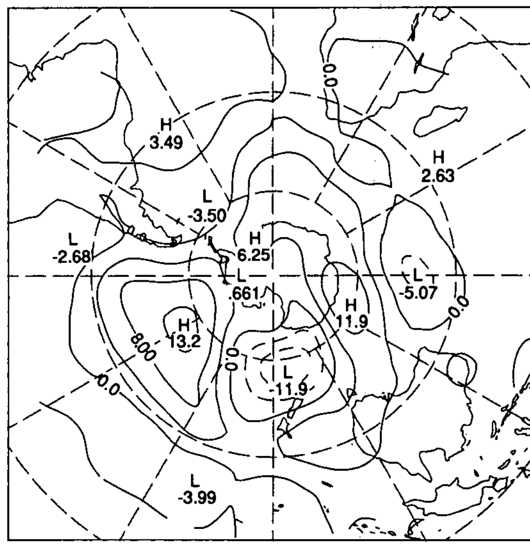
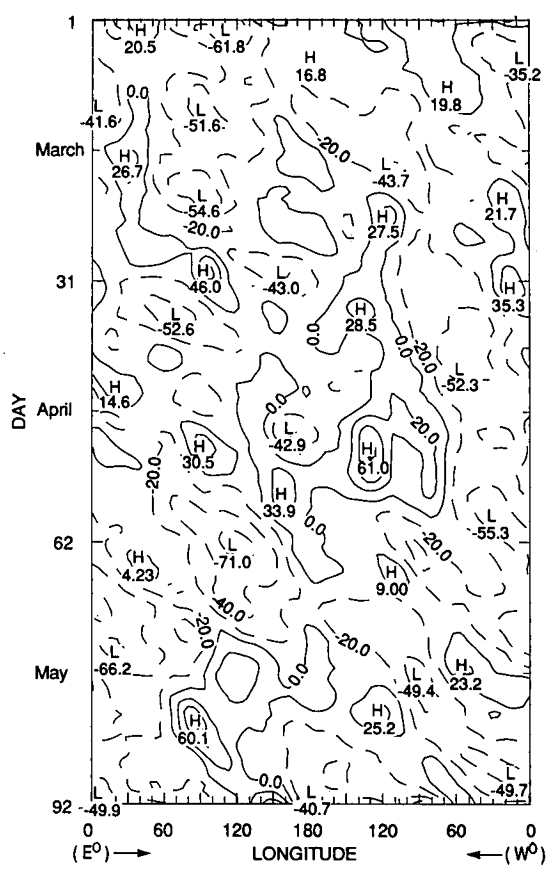


Fig. 9 Autumn 1990 (March, April, May) daily Blocking Index: time-longitude section. Day 1 is 1 March.



Divergence ahead of the trough in the eastern Indian Ocean could be related to record high rainfall in eastern Australia.

Blocking

Blocking* episodes were chiefly brief during autumn, as depicted in Fig. 9. One sustained episode occurred in the Indian Ocean in the second half of March, and another in the east central Pacific from late March into early April. In May there was little activity. Mean monthly charts indicated that blocking activity was mainly average in March and April and significantly less than average in May.

Winds

In the lower troposphere (850 hPa) meridional wind anomalies shown in Fig. 10 were compatible with the surface height anomalies seen in Fig. 4. The anomalies near and south of New Zealand and in the southern Indian Ocean were relatively strong, consistent with the surface anomalies (Fig. 4).

In the upper troposphere (300 hPa) the pattern was similar, as given in Fig. 11. At this level, anomalous easterlies were prominent across the subtropical Pacific associated with a relatively strong positive height anomaly (Fig. 8).

Australian region

Circulation

In March, a main centre of tropical convection was located over New Guinea and an easterly dip extending southwards over Queensland induced well above average rains over that State. In April and May northwest cloud bands, interacting with cut-off lows, were the main features of the circulation in the Australian region. Such a development in the third week of April was coincident with the amplification and eastward progression of a 30 to 60-day oscillation peak across the north of the continent leading to record rains and floods in eastern Australia.

Rainfall

Autumn rainfall was markedly above average over eastern Australia with record seasonal totals and flooding over an extensive area of the inland, as indicated in Fig. 12. By contrast, record low autumn rainfall occurred in the Central and Upper Southeast districts of South Australia. Elsewhere over Australia seasonal rainfall was chiefly average to less than average.

*Blocking Index:

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

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

Fig. 10 Autumn 1990 (March, April, May) 850 hPa wind anomalies (m s^{-1}). (The figures near the H and L are vector values at respective locations.)

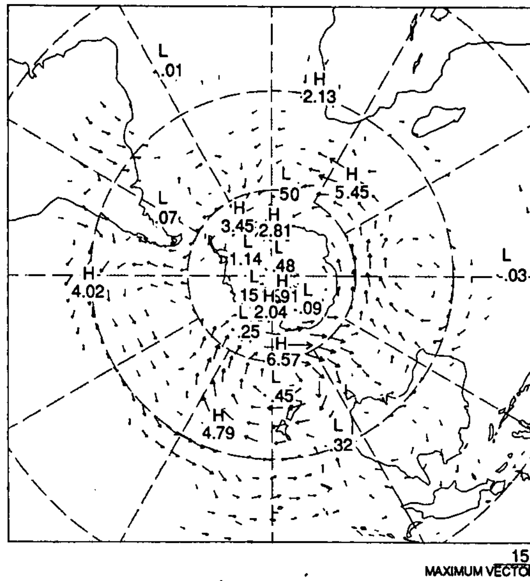
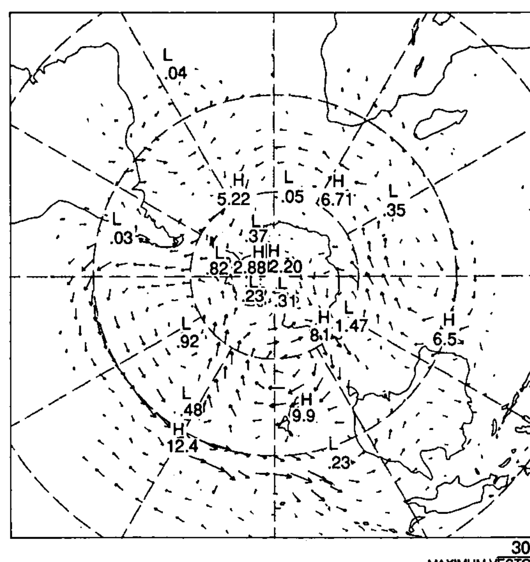


Fig. 11 Autumn 1990 (March, April, May) 300 hPa wind anomalies (m s^{-1}). (The figures near the H and L are vector values at respective locations.)



Temperature

Autumn maximum temperatures were generally above average in the west of the continent with positive anomalies of 2°C as shown in Fig. 13(a). In contrast, negative anomalies of 2°C were dominant in the east. Generally this distribution could be related to the rainfall pattern (Fig. 12).

Autumn minimum temperatures were above average throughout Australia with positive anomalies exceeding 2°C in some areas as indicated in Fig. 13(b).

Fig. 12 Autumn 1990 (March, April, May) rainfall in Australia: decile range values based on district averages.

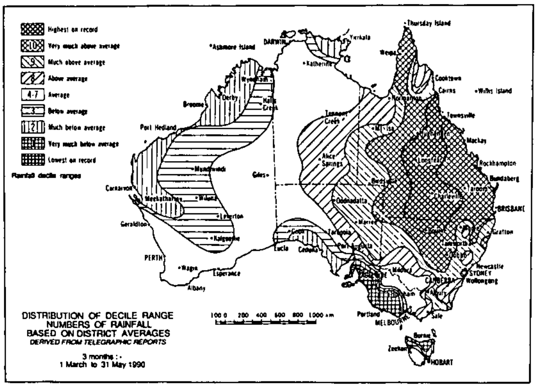
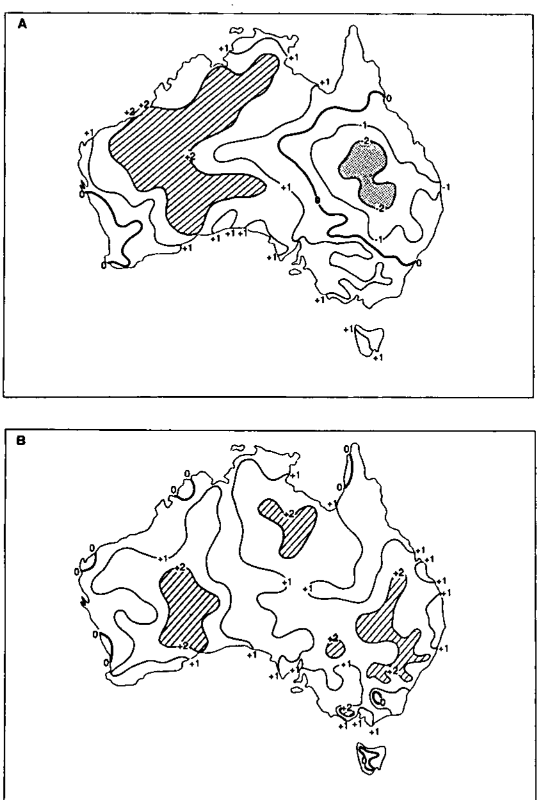


Fig. 13 Autumn 1990 (March, April, May) temperature anomalies (°C) Australia: (a) maximum; (b) minimum.



Differences between autumn 1990 and autumn 1989

There were significant differences in circulation patterns between autumn 1990 and autumn 1989 (Gaffney 1990; Mo 1989), even though both seasons were characterised by widespread record rainfall in Australia.

In autumn 1990 the Walker Circulation was close to average. The SOI was also near average, but showing appreciable short-term variability. At mid-latitudes around the hemisphere noteworthy features were:

(a) substantial pressure/height anomalies and enhanced meridional flow (Figs 4,6,8,10 and 11); and
(b) a deep anomalous low south of New Zealand linked to the anomalous low near the east coast of Australia (Figs 4 and 6).

By contrast, in autumn 1989, even though the cold episode of 1988–89 in the Pacific was showing signs of decay, the Walker Circulation remained strong. At mid-latitudes:

(a) pressure/height anomalies were generally less and meridional flow weaker; and
(b) pressure/height anomalies were weak in the New Zealand to eastern Australian region (Gaffney 1990).

References

Gaffney, D. 1990. Seasonal climate summary southern hemisphere (autumn 1989): a second peak in the Southern Oscillation Index. *Aust. Met. Mag., 38*, 73–9.

Gaffney, D. 1991. Seasonal climate summary southern hemisphere (summer 1989–90): weak warming in the equatorial Pacific and Australian monsoon inactive. *Aust. Met. Mag., 39*,

Janowiak, J.E. 1990. The Global Climate of December 1989–February 1990: Extensive Temperature Variations in North America, Persistent Warming in Europe and Asia, and the Return of ENSO-like Conditions in the Western Pacific. *Jnl climate, 3*, 685–709.

Mo, Kingtse C. 1989. Seasonal Climate Summary. The Global Climate for March–May 1989: Cold Episode in the Tropical Pacific Decays. *Jnl climate, 2*, 1107–29.

Nicholls, N. 1989. Sea Surface Temperatures and Australian Rainfall. *Jnl climate, 2*, 965–73.

Appendix

Data sources used for this review were:

Climate Analysis Centre — 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 D.C. 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.