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Seasonal climate summary southern hemisphere (summer 1989–90): weak warming in the western equatorial Pacific and an inactive Australian monsoon

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

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A climate analysis is presented of the southern hemisphere circulation for the austral summer, December 1989 to February 1990, with a more detailed treatment of the Australian region.
A weak warming in the western equatorial Pacific, a fall in the Southern Oscillation Index and shifts in other climate indices were indicative of a weak El Niño situation. Inactive monsoonal conditions in the Australian region were related to a split in the Walker Circulation, which was compatible with a weak El Niño situation. Record low rainfall occurred in extensive parts of north and northeast Australia for the three-month period.
In mid-latitudes a strong four-wave planetary pattern was dominant and the polar vortex was weak.

Introduction

This seasonal climate summary reviews the southern hemisphere climate features for summer 1989–90 (December 1989 to February 1990 inclusive). Features reviewed include climate indices, sea-surface temperatures and tropospheric pressure patterns. Circulation, rainfall and temperature in the Australian region are given specific attention.

The main climate sources were the Climate Monitoring Bulletin — Southern Hemisphere and Darwin Tropical Diagnostic Statement issued monthly by the Bureau of Meteorology, Australia, along with the monthly climate bulletins issued monthly by other national weather services. Data sources are listed in the Appendix.

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

Climate indices

The Southern Oscillation Index (SOI)*, which had fallen to near zero levels in spring (Nydam 1990; Halpert 1990), dropped slightly below zero during December and January and collapsed temporarily to a value of −18.4 in February, as shown in Fig. 1.

In February an anomalously high mean sea level (MSL) pressure of 1010.0 hPa (3.5 above average) occurred at Darwin, accounting for the low SOI value during that month.

The five-month running mean of the SOI fell to a weak negative phase (Fig. 1). Corresponding to this negative SOI, sea-surface temperatures (SST) in the western equatorial Pacific were generally slightly above average. Convection near the equa-

*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. 1 Southern Oscillation Index, January 1986 to February 1990.

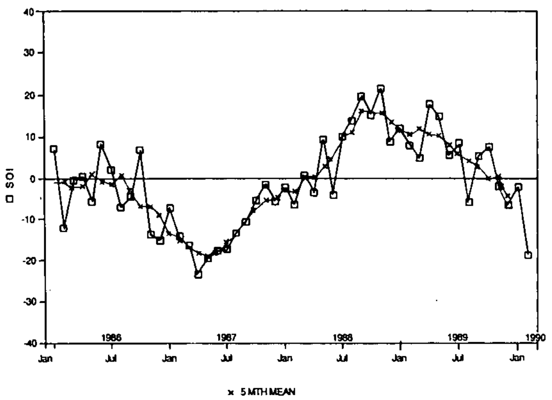
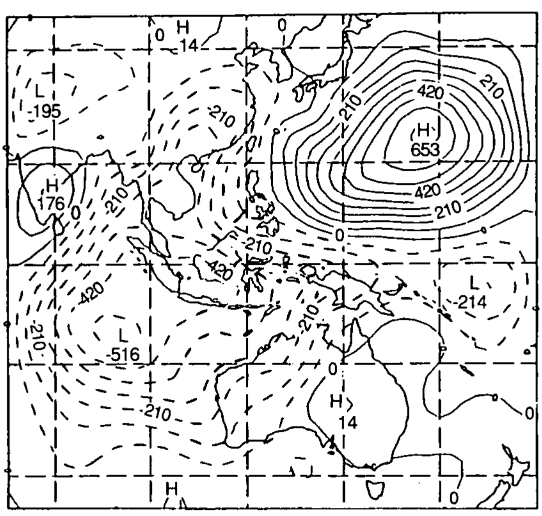


Fig. 2 February 1990, 200 hPa velocity potential.



torial dateline was above average and low-level westerly wind anomalies were present in the western equatorial Pacific. Together these indices were indicative of a weak El Niño situation (Janowiak 1990).

Velocity potential

The velocity potential in the Indonesian region showed a split in the Walker Circulation and this is evident in the 200 hPa velocity potential chart for February at Fig. 2. As can be seen, one strong negative centre is located in the tropical Indian Ocean and another in the western Pacific, delineating ascending nodes in the Walker Circulation.

The northern Australia and New Guinea region velocity potential indicated reduced ascent and weaker upper level divergence, and this was consistent with little monsoonal activity and record low rainfall.

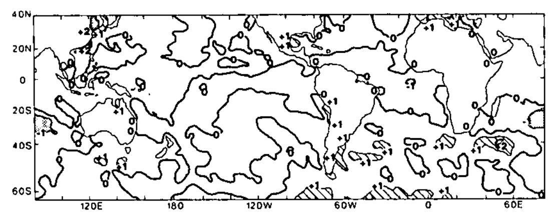
The ascending node in the Walker Circulation, which was displaced towards the equatorial dateline (Fig. 2), could be related to a weak El Niño situation.

Sea-surface temperatures

Sea-surface temperatures (SST) were near normal throughout much of the tropics as depicted in Fig. 3.

In mid-latitudes there were some areas of positive anomaly (1°C), notably in the Atlantic. An extensive negative area (−1°C) emerged in the Indian Ocean.

Fig. 3 Summer 1989–90 (December, January, February) sea-surface temperature anomaly (°C).



Surface analyses

The MSL pressure analysis and the corresponding anomalies for summer are given in Figs 4 and 5 respectively. A strong four-wave pattern was evident with major long wave troughs in the mid-Pacific, near South America, in the Atlantic and in the eastern Indian Ocean.

The main features of the anomaly chart (Fig. 5) were:

(a) the low anomalies at high latitudes in the Pacific which extended across the South Pole to the Atlantic indicating a weak polar vortex; and

(b) the oceanic high anomalies at mid-latitudes reflecting the strong planetary waves.

Upper air analyses

The 500 hPa analysis and anomalies shown in Figs 6 and 7 respectively depict four strong long wave troughs corresponding to the troughs in the surface analyses (Figs 4 and 5). The strong troughs and the meridional character of the mid-latitude circulation were in contrast with the more zonally symmetrical circulation of the previous summer of 1988–89 when there was a peak in the cold episode in the equatorial Pacific (Gaffney 1990).

Fig. 4 Summer 1989–90 (December, January, February) mean sea level pressure (hPa).

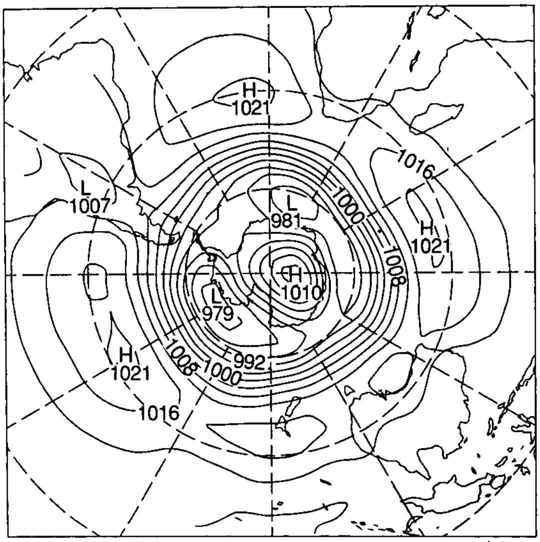
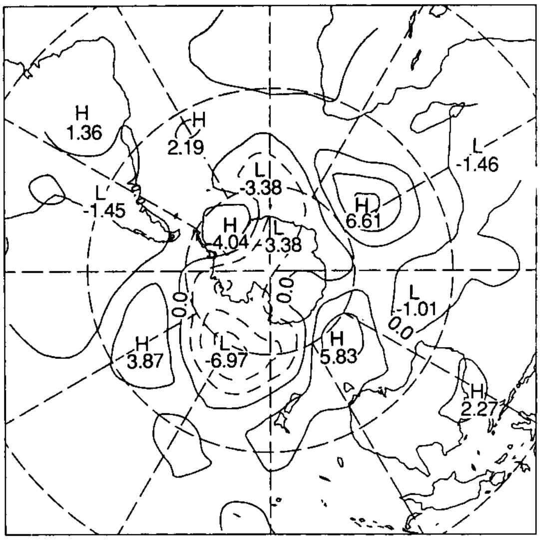


Fig. 5 Summer 1989–90 (December, January, February) mean sea level pressure anomaly (hPa).



In the upper troposphere at 300 hPa (Figs 8 and 9), similar patterns were evident showing the equivalent barotropic character of the systems. At this level the troughs in the mid-Pacific and in the Atlantic were intensely deep, whereas the troughs in the eastern Indian Ocean and near South America were of lesser intensity.

Blocking activity

Summer blocking activity in mid-latitudes, as determined by the daily Blocking Index (BI)*, is represented in Fig. 10.

Fig. 6 Summer 1989–90 (December, January, February) 500 hPa mean height (dam).

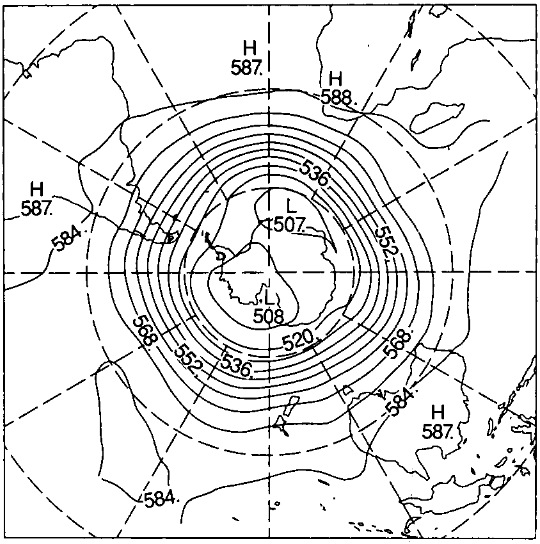
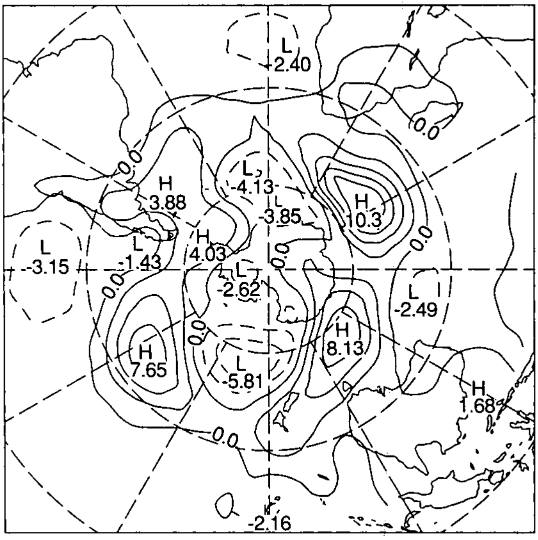


Fig. 7 Summer 1989–90 (December, January, February) 500 hPa height anomaly (dam).



In December and January, blocking was generally brief around the hemisphere and in both months the mean graphs indicated that blocking activity was chiefly below normal.

In February, blocking was prominent particu-

*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. 8 Summer 1989–90 (December, January, February) 300 hPa mean height (dam).

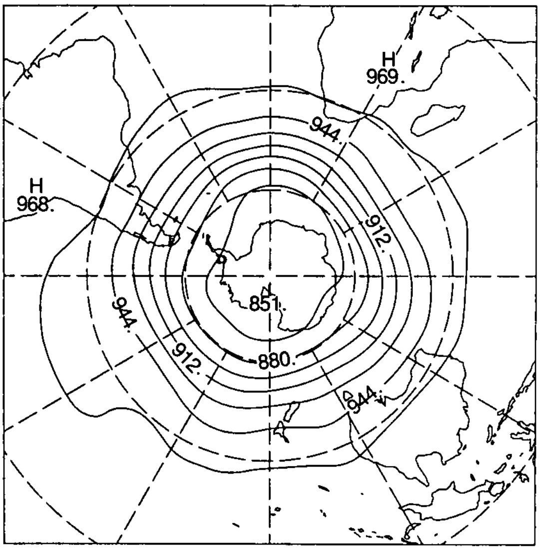
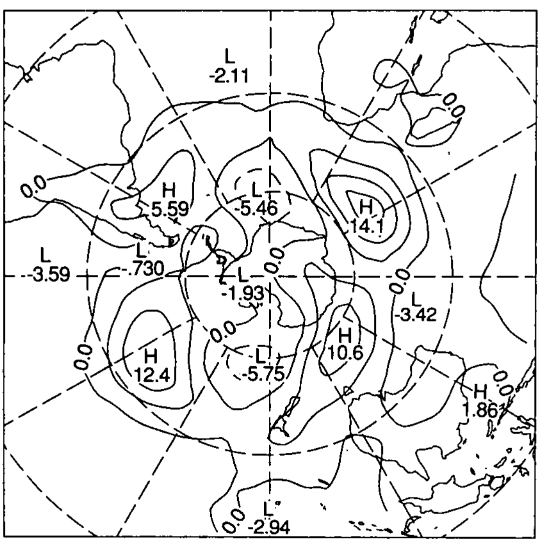


Fig. 9 Summer 1989–90 (December, January, February) 300 hPa height anomaly (dam).



larly in the western Pacific and activity was above normal over most of the hemisphere.

Winds

The 850 hPa and 300 hPa wind anomalies in Figs 11 and 12 respectively are consistent with the tropospheric analyses. Notable features were:

(a) the relatively strong meridional anomalies at mid-latitudes; and

Fig. 10 Summer 1989–90 (December, January, February) daily Blocking Index: time-longitude section. Day 1 is 1 December.

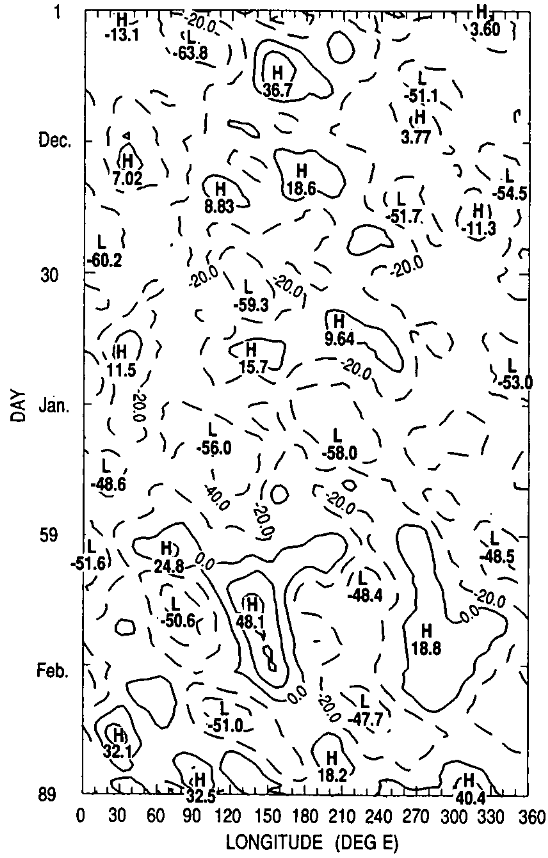
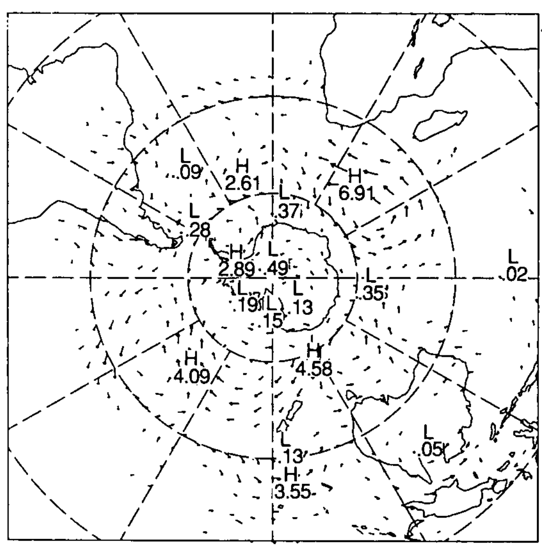


Fig. 11 Summer 1989–90 (December, January, February) 850 hPa wind anomalies (m s^{-1}). (The figures near the H and L are vector values at respective locations.)



(b) the generally weak anomalies in the subtropics and at high latitudes.

Australian region

Circulation

Monsoonal activity was relatively quiescent over northern Australia. As indicated previously the dominant feature was the split in the Walker Circulation which suppressed convection in the area.

Fig. 12 Summer 1989–90 (December, January, February) 300 hPa wind anomalies (m s^{-1}). (The figures near the H and L are vector values at respective locations.)

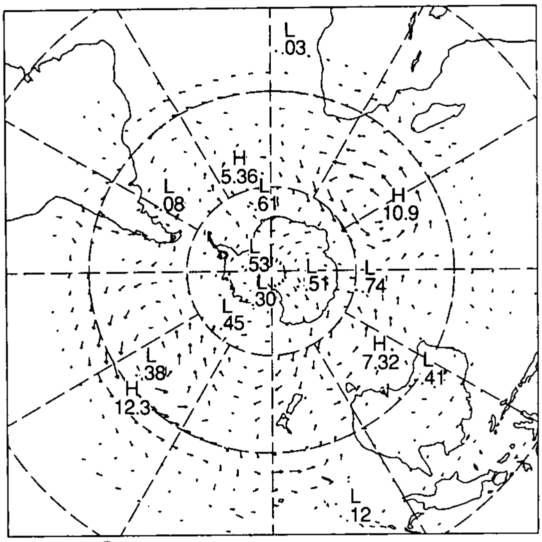
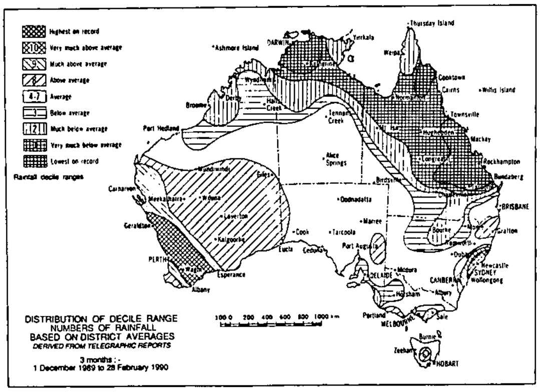


Fig. 13 Summer 1989–90 (December, January, February) rainfall in Australia: decile range values based on district averages.



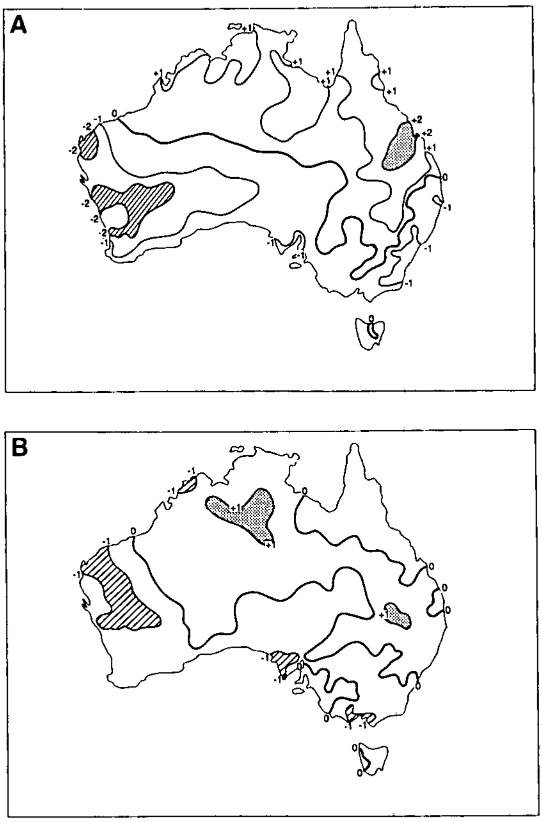
Rainfall

Record low rainfall occurred in eastern Queensland and in the Darwin-Daly district of the Northern Territory, and an extensive area of northeast Australia was markedly below average, as seen in Fig. 13. Apart from well above average rainfall in southwest Australia and along a strip of the New South Wales coast, most of the remainder of the continent was near average.

Temperature

Maximum and minimum temperature anomalies are given in Figs 14(a) and 14(b) respectively. Generally positive anomalies to the northeast and negative anomalies to the southwest can be related to the cloud and rainfall distribution.

Fig. 14 Summer 1989–90 (December, January, February) temperature anomalies (°C) for Australia: (a) maximum; (b) minimum.



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Halpert, M.S. 1990. The Global Climate for September-November 1989: Normal Tropical Pacific Conditions Continue. *Jnl climate, 3*, 394–413.

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

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 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.