

Seasonal climate summary southern hemisphere (winter 1989): the Southern Oscillation Index falls to near average

D. Gaffney

National Climate Centre, Bureau of Meteorology, Melbourne, Australia

(Manuscript received January 1990; revised February 1990)

The climate of the southern hemisphere winter 1989 is summarised with emphasis on the Australian region.

In winter 1989 the Southern Oscillation Index (SOI) and other main climatic indices tended towards average levels from the anomalous values of the previous cold episode winter (1988).

The eastward displacement of a middle to high latitude planetary three-wave pattern in winter 1989, as compared to winter 1988 (cold episode), was a notable feature. In conjunction with this, a westward shift occurred in main Pacific blocking activity in winter 1989 in comparison with winter 1988.

Introduction

This seasonal climate summary reviews the southern hemisphere climate features for winter 1989 (June to August inclusive). Features reviewed include climate indices, sea-surface temperatures and tropospheric pressure patterns. Circulation, rainfall and temperature in the Australian region are given more detailed attention.

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

Climate indices

After reaching a second peak of 18.1 in April 1989, the Southern Oscillation Index* showed a general decline towards normal levels with a slight negative dip to -5.6 in August (Fig. 1). This was the first negative value since June 1988 when the SOI was -3.9.

* 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 generally exhibited a tendency to move from cold episode values in autumn (Gaffney 1990; R. Keith, personal communication) towards normality in winter. Sea-surface temperatures were about average across the equatorial Pacific Ocean; the Pacific trade winds were near average strength; and the upper tropospheric equatorial westerlies were average.

Fig. 1 Southern Oscillation Index, January 1986-August 1989 inclusive.

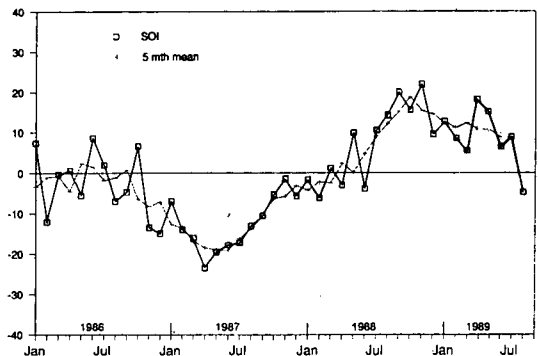
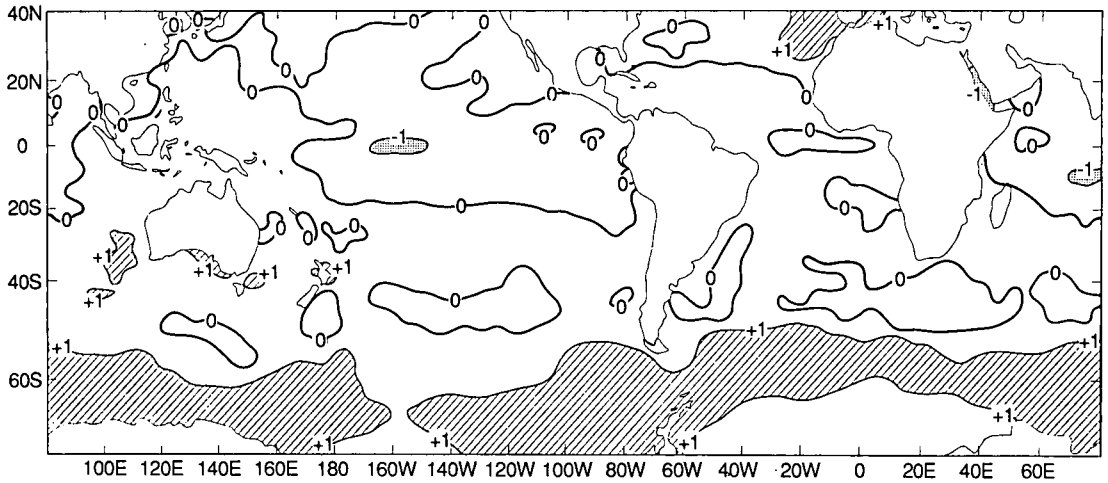


Fig. 2 Winter 1989 (June, July, August) sea-surface temperature anomaly (°C).



Equatorial convective activity was being maintained in usual areas west of the dateline as indicated by the outgoing long wave radiation index near the dateline retaining a slightly positive anomaly.

In the Australian region, the axis of the subtropical ridge shifted significantly from 3.5° south of normal in autumn 1989 to 2 – 4° north of normal during winter. This northward shift in MSL pressure distribution and consequential positive pressure anomalies in the Darwin area were directly related to the decline in the SOI.

Sea-surface temperatures

Winter sea-surface temperature (SST) anomalies based on satellite measurements are given in Fig. 2.

In the equatorial Pacific Ocean, SSTs were slightly less than normal east of the dateline and slightly above normal west of the dateline and in the equatorial Atlantic Ocean. In the Indian Ocean, south equatorial SSTs had fallen from average values in autumn to slightly less than average in winter.

Following the autumn pattern, southern hemispheric temperatures continued slightly above normal (+ 0.5°C) along mid-latitudes. At high latitudes departures of +1°C continued from autumn through winter, although these may be partly related to the climatology used for this area.

Surface analyses

The winter mean sea level pressure distribution and anomalies (Figs 3 and 4) showed that the subtropical ridge was chiefly near average or slightly north of average. A three-wave pattern at mid to high latitudes was evident, with a deep trough in the eastern Pacific tilting northeast towards South America. A surface trough was located south of Africa and another off southwest Australia tilted towards the Bight. The polar vortex was strong with above normal pressure extending from the south Atlantic across the pole to the South Pacific.

Upper air analyses

The 500 hPa analyses (Figs 5 and 6) showed that the middle troposphere was equivalent barotropic with a distinctive three-wave pattern in mid to high latitudes. The eastern Pacific trough tilted from the Ross Sea off Antarctica to the west coast of South America. The trough south of Africa was deeper than normal and extended from Antarctica to the west coast of South Africa. The trough south of Western Australia, tilting towards the Bight, was diffluent and generated cut-off lows in the southeastern Australian region.

In the upper troposphere at 300 hPa (Figs 7 and 8), the eastern Pacific trough and the trough south of Africa were notably deep. In the Australian region a marked split flow over the Tasman Sea was associated with blocking activity in the Tasman – New Zealand region.

Fig. 3 Winter 1989 (June, July August) mean sea level pressure (hPa).

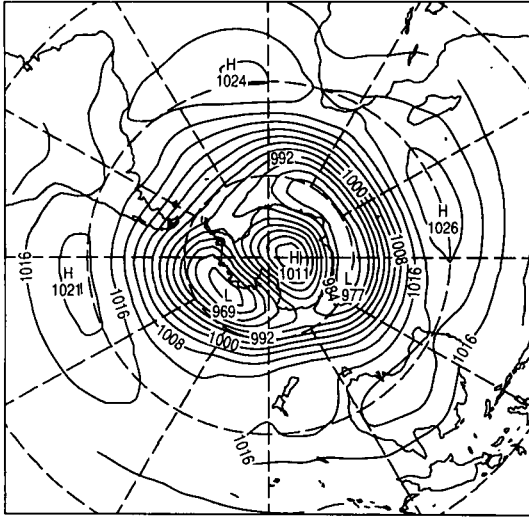


Fig. 7 Winter 1989 (June, July, August) 300 hPa mean height (dam).

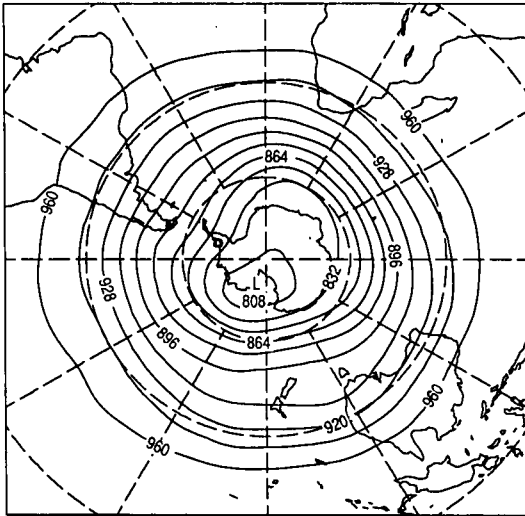
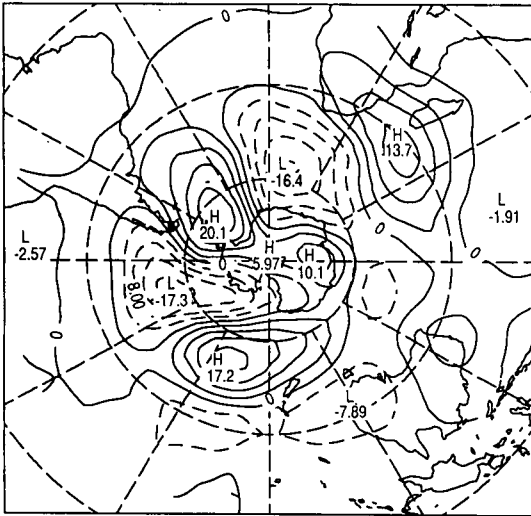


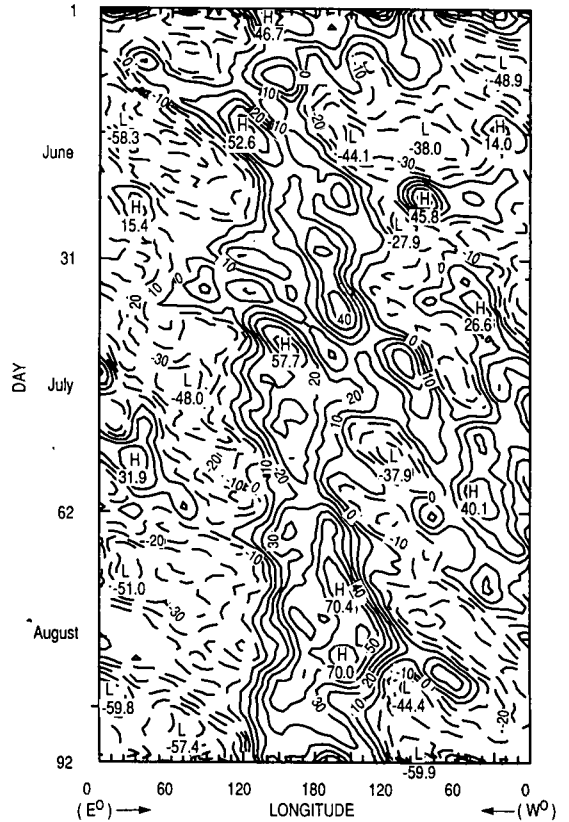
Fig. 8 Winter 1989 (June, July, August) 300 hPa height anomaly (dam).



Winds

In the lower troposphere (850 hPa), meridional wind anomalies were strong in the western sector of the hemisphere (west of 0°, 180° meridian) but were mainly average in the eastern sector (Fig. 10). A strong cyclonic anomaly at mid to high latitudes in the southeast Pacific was consistent with the MSL anomalies (Fig. 4).

Fig. 9 Winter 1989 (June, July, August) daily Blocking Index: time-longitude section. Day 1 is 1 June.



Similar patterns were evident in the upper troposphere (300 hPa) (Fig. 11), with meridional anomalies mainly confined to the western sector of the hemisphere. The wind anomalies were consistent with the 300 hPa height anomalies shown in Fig. 8.

Comparison between winters 1989 and 1988

In the 1989 winter, the vertical motion associated with the Indian and South-East Asian monsoons was displaced eastward of its 1988 position and was weaker (Gaffney 1989). This displacement, together with weaker Hadley cells, could be linked to the eastward shift of the southern hemisphere three-wave planetary pattern in 1989 relative to 1988. In 1989, the winter planetary long wave troughs were near the eastern sides of the three oceans, whereas in the 1988 winter they were located in mid-ocean positions.

Fig. 10 Winter 1989 (June, July, August) 850 hPa wind anomalies ($m s^{-1}$).

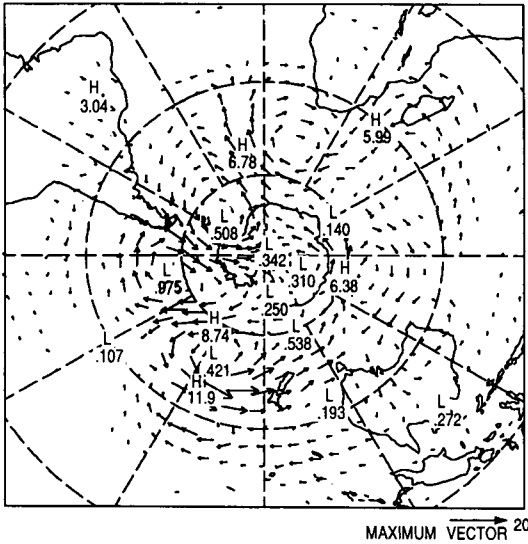
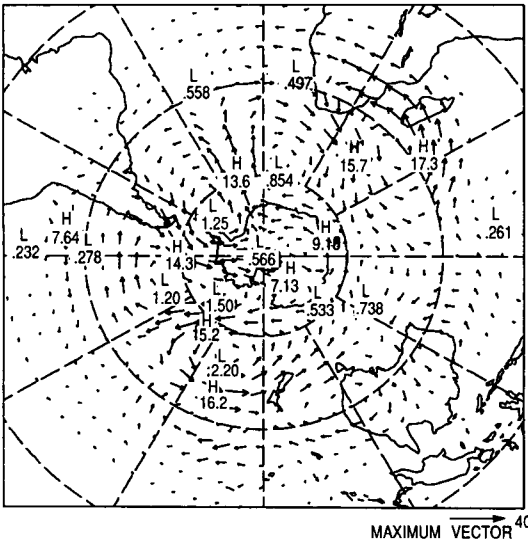


Fig. 11 Winter 1989 (June, July, August) 300 hPa wind anomalies ($m s^{-1}$).



During the 1989 winter, blocking activity was above average in the western Pacific and slightly below average in the eastern Pacific. However, in winter 1988 a reversal was the case, with below average blocking in the western Pacific and well above average blocking in the east. Likewise this reversal may be linked to an eastward shift in 1989 of weaker Hadley cells associated with the eastward displacement of the northern hemisphere monsoonal activity.

Australian region

Circulation

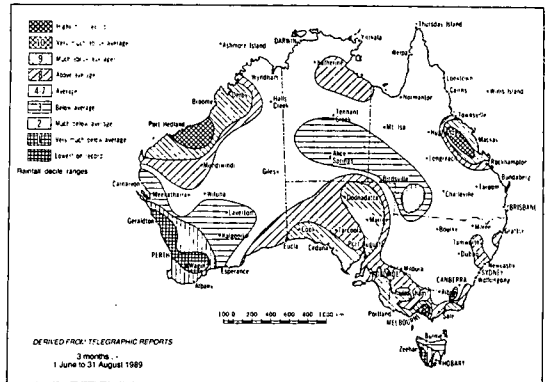
As indicated previously, the northward shift of the subtropical ridge to a position 2–4° north of normal (Figs 3 and 4) was a feature in the Australian region. The long wave trough off southwest Australia, tilting towards the Bight with divergent flow in the Bight longitudes (Figs 5 to 8), resulted in the formation of blocking dipoles in the Tasman Sea region.

Rainfall

Winter rainfall was average over most of Australia with parts of the States of South Australia and Victoria receiving much above average rains (Fig. 12). These rains resulted from cut-off lows which formed at the apex of the long wave troughs at the head of the Bight and then moved eastwards to the Tasman Sea cradled by blocking highs. The latter caused well below average winter rainfall over Tasmania.

In the southwest of Western Australia, winter rainfall was very much below average (Fig. 12) due to the upper long wave trough being east of its normal position and tilting towards the Bight (Figs 5 and 6).

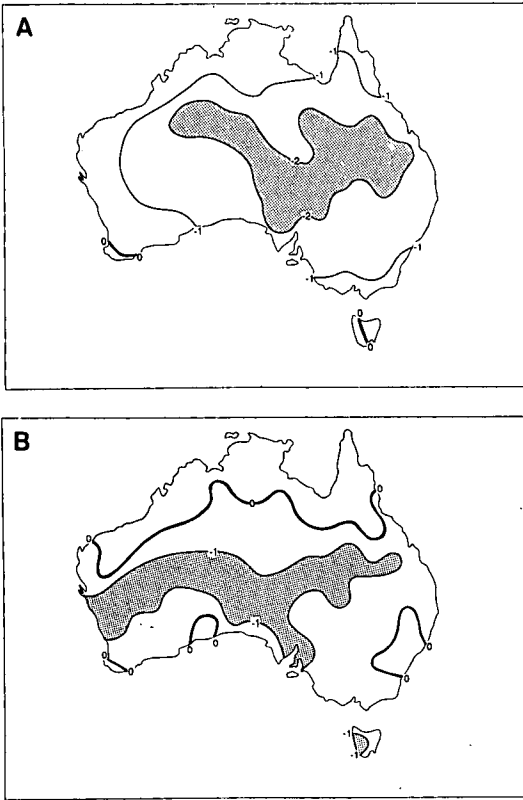
Fig. 12 Winter (June, July, August) rainfall in Australia: decile range values based on district averages.



Temperatures

Winter maximum temperatures were about 2°C below average over the interior of Australia and chiefly about 1°C below average around the coastal areas (Fig. 13(a)). This temperature distribution could be partially related to areas of above average rainfall and associated cloudiness. Seasonal minimum temperatures were about average except for a belt of slightly negative anomalies across the interior (Fig. 13(b)).

Fig. 13 Winter 1989 (June, July August) temperature anomalies (°C) Australia: (a) maximum; (b) minimum.



References

- Gaffney, D. 1989. Seasonal climate summary southern hemisphere (winter 1988): eastern equatorial Pacific cold episode established. *Aust. Met. Mag.*, 37, 177-84.
- Gaffney, D. 1990. Seasonal climate summary southern hemisphere (autumn 1989): a second peak in the Southern Oscillation Index. *Aust. Met. Mag.*, 38, 73-9.

Appendix

Data sources used for this review were:

Climate Analysis Center Climate Diagnostics Bulletins, June, July August 1989 and seasonal analyses.*

Darwin Tropical Diagnostic Statement, June, July, August 1989.†

Monthly report on Climate System, June, July, August 1989.§

National Climate Centre Climate Monitoring Bulletin — Southern Hemisphere, June, July August 1989.‡

Southern hemisphere grid-point analysis data archived by the World Meteorological Centre, Melbourne.‡

* Obtainable from the Climate Analysis Center, National Weather Service, Washington D.C. 20233, USA.

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

§ Obtainable from the Japan Meteorological Agency, 1-3-4, Otemachi chiyoda-ku, Tokyo, Japan.

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