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# Seasonal climate summary southern hemisphere (winter 1990): generally normal conditions in the tropics and warm in mid-latitudes

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**A climate analysis is given of the southern hemisphere winter circulation, June to August 1990, with more detailed treatment of the Australian region.**
**In the equatorial Pacific, winter sea-surface temperatures were mainly near normal, although slightly above normal in western areas. Other equatorial Pacific climate indices remained near normal. In mid-latitudes, sea-surface temperature anomalies continued positive, especially across the Pacific. A three-wave planetary pattern persisted with the oceanic troughs located in the eastern sectors of the oceans.**

## Introduction

This seasonal summary reviews the southern hemisphere climate features for winter 1990 (June to August 1990 inclusive). Features reviewed include climate indices, sea-surface temperatures and tropospheric pressure patterns. The Australian region is given more detailed attention.

The main climate information sources were the Climate Monitoring Bulletins issued by the Bureau of Meteorology, Australia. Reference was also made to climate bulletins issued monthly by other national weather services. Data sources are given in the Appendix.

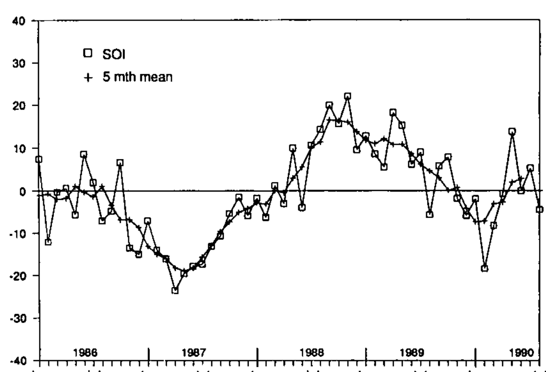
Although there were fluctuations in the Southern Oscillation Index (SOI)* generally the transition from autumn 1990 (Gaffney 1991) to winter 1990 was steady with climate indices chiefly near normal.

## Climate indices

After rising from a negative value of −18.4 in February 1990 to a positive value of +13.6 in May, the SOI fell to −4.4 in August as shown in Fig. 1. Although the SOI was showing appreciable month-to-month variation, due mainly to fluctuations in Darwin mean sea level (MSL) pressures, conditions in the tropical Pacific continued close to normal.

Sea-surface temperatures (SST) were chiefly near normal in the central and eastern equatorial Pacific and in the equatorial Atlantic, and slightly above normal in the equatorial western Pacific and the Indian Oceans, as indicated in Fig. 2.

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

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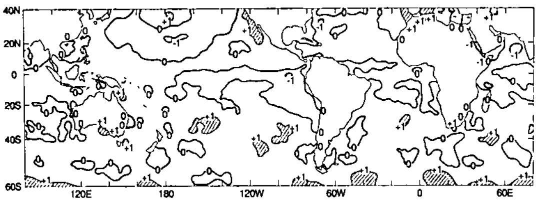
*The Southern Oscillation Index (SOI) used here is 10 times the Tahiti minus Darwin MSL pressure anomaly divided by the standard deviation for the month, based on the period 1882 to 1985.

**Fig. 2 Winter 1990 (June, July, August) sea-surface temperature anomaly (°C).**




Other climate indices used for monitoring the El Niño-Southern Oscillation phenomenon (outgoing long wave radiation and 200 hPa zonal wind) were mostly near normal, although there were weak westerly 850 hPa wind anomalies east of the dateline.

## Sea-surface temperatures

In the tropics sea-surface temperatures (SST) were chiefly about normal as depicted in Fig. 2. Notable features were the two small cold regions, one in the eastern equatorial Pacific and the other in the Arabian Sea area of the western Indian Ocean.

At mid-latitudes positive SST anomalies of about 1°C occurred around the hemisphere, especially in the Pacific.

In the Australian region weak positive anomalies continued through winter around the coasts and to the northwest in the Indian Ocean.

## Surface analysis

The MSL pressure analysis is given in Fig. 3 and the anomalies in Fig. 4. A three-wave pattern persisted from autumn with deep troughs in the Pacific and south of Africa, while a relatively weak trough was situated south of Western Australia. The Pacific trough was deeper and involuted, extending from the tropical central Pacific to south of Cape Horn.

The prominent features of the anomalies (Fig. 4) were:

(a) a strong low centre south of Cape Horn in the Bellingshausen Sea linked to the deep Pacific trough;

(b) a strong high centre in eastern Antarctica.

## Upper air analysis

The 500 hPa analysis and anomalies, shown in Figs 5 and 6 respectively, exhibited a corresponding three-wave pattern. Similar to the surface trough (Fig.3), the upper trough in the Pacific (Fig.5) was notably deep. The trough to the south of Africa was relatively strong, while the trough to the south of Western Australia was relatively weak. Except for significant negative anomalies in the Tasman Sea (Fig. 6), the anomaly pattern depicted positive departures at mid-latitudes. Negative anomalies predominated at high latitudes with a strong negative centre in the Bellingshausen Sea area.

At 300 hPa (Figs 7 and 8) the equivalent barotropic nature of the circulation pattern was evident. Upper divergence ahead of the trough south of Western Australia could be associated with the well above average rainfall in southeastern Australia.

**Fig. 3 Winter 1990 (June, July, August) mean sea level pressure (hPa).**

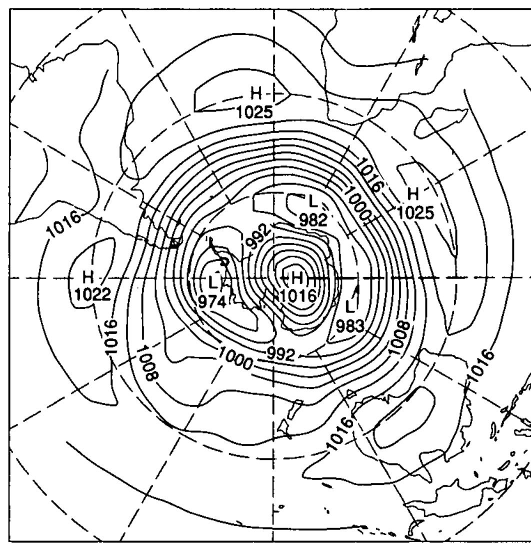



**Fig. 4 Winter 1990 (June, July, August) mean sea level pressure anomaly (hPa).**

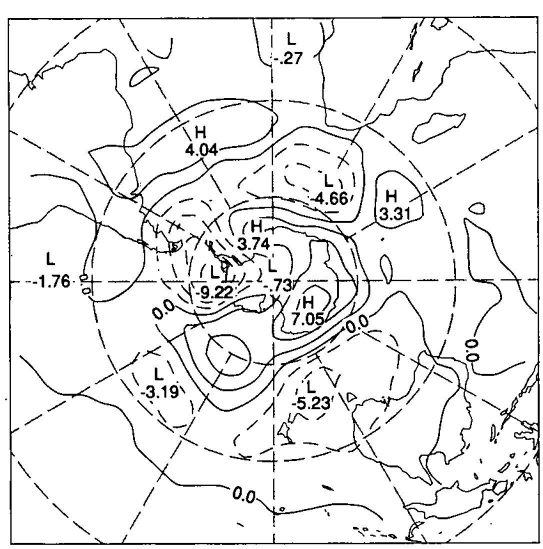


**Fig. 5 Winter 1990 (June, July, August) 500 hPa mean height (dam).**

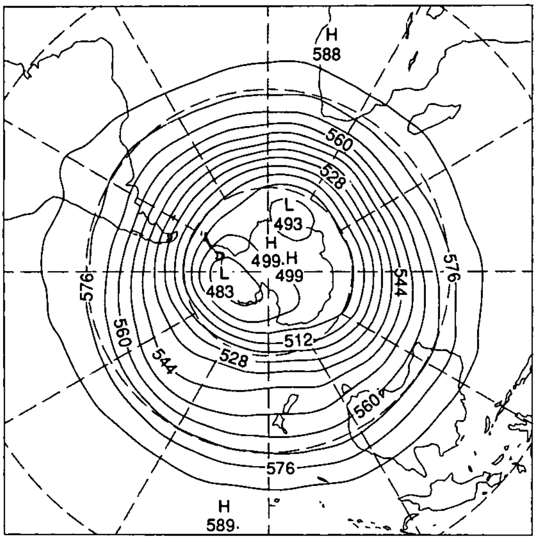



**Fig. 6 Winter 1990 (June, July, August) 500 hPa height anomaly (dam).**

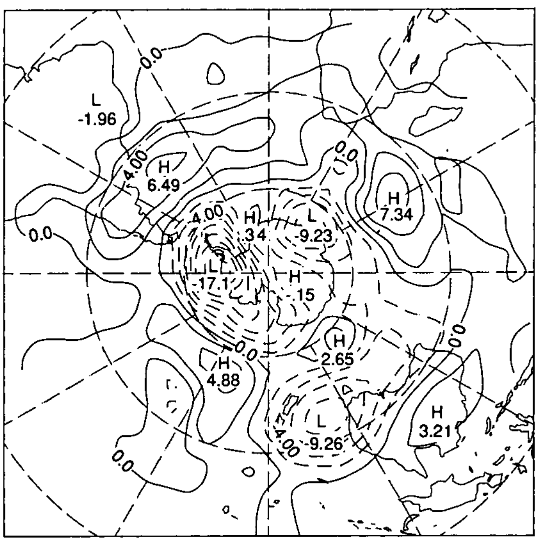



**Fig. 7 Winter 1990 (June, July, August) 300 hPa mean height (dam).**

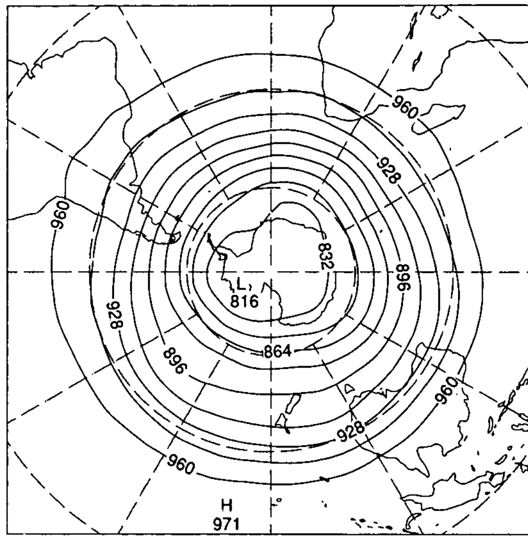
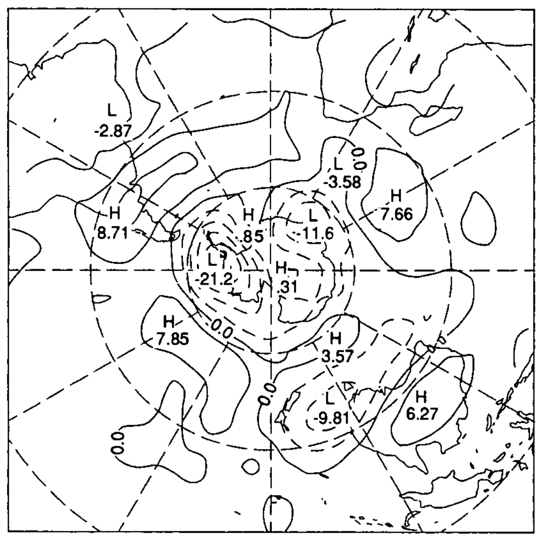



**Fig. 8 Winter 1990 (June, July, August) 300 hPa height anomaly (dam).**




## Blocking

Blocking episodes* in winter occurred in the Pacific (Fig. 9) with a lengthy episode in June and relatively brief occurrences in July and August. The remainder of the hemisphere was chiefly free of blocking activity. Mean monthly blocking graphs (not shown) indicated that blocking in the Pacific was above average in June and less than average elsewhere during that month. July and August were chiefly average around the hemisphere.

*Blocking Index (BI)

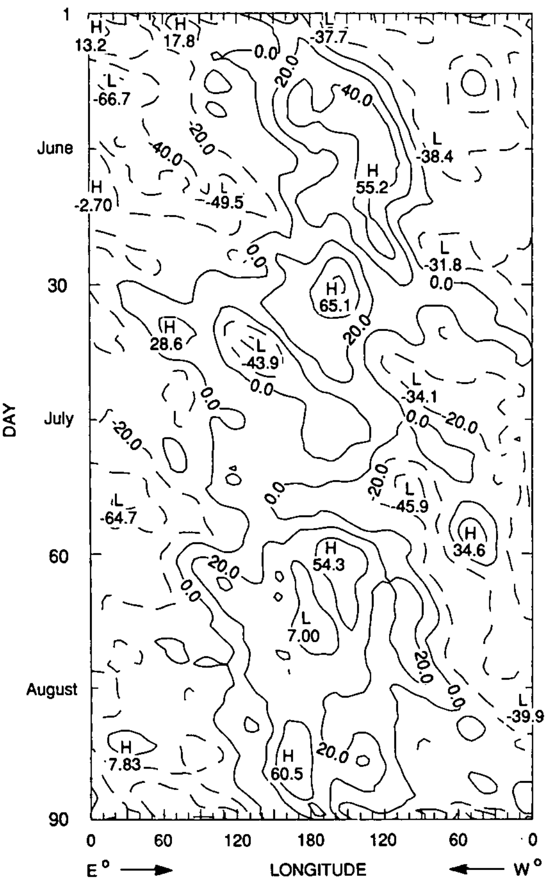
$$BI = U_{27.5} + U_{57.5} - (U_{42.5} + U_{47.5})$$

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

## Winds

Wind anomalies in the lower troposphere (850 hPa) are given in Fig. 10, and may be compared to the surface height anomalies as shown in Fig. 4.

**Fig. 9 Winter 1990 (June, July, August) daily Blocking Index: time-longitude section. Day 1 is 1 June.**




The strong cyclonic wind anomalies over the Bellingshausen and Tasman Seas were consistent with the surface height anomalies (Fig. 4)

In the upper troposphere (300 hPa), anomalous westerlies were prominent along the southern fringes of Australia and South America as shown in Fig. 11.

## Australian region

### Circulation and rainfall

As depicted in Figs 6 and 8, the positive height anomalies over northwest Australia were evidently linked to the below average rainfall in western areas of the continent as seen in Fig. 12. Conversely the upper trough south of Western Australia, and slightly positive SST anomalies to the northwest of the continent, evidently induced at least five northwest cloud band formations during winter and above average rainfall in southeastern Australia (see, for example, Nicholls (1989)). Three cloud band episodes in August were noteworthy in view of an average of about one for that month, derived in the climatology of Tapp and Barrell (1984). The positive SST anomalies in the Tasman Sea combined with negative height anomalies could also be linked to above average rainfall in the southeast of the continent (Fig. 12).

**Fig. 10 Winter 1990 (June, July August) 850 hPa wind anomalies (m $s^{-1}$). (The figures near the H and L are values at respective locations.)**

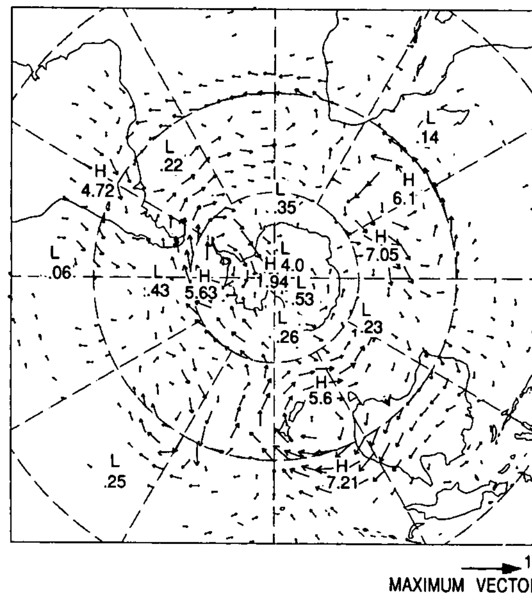
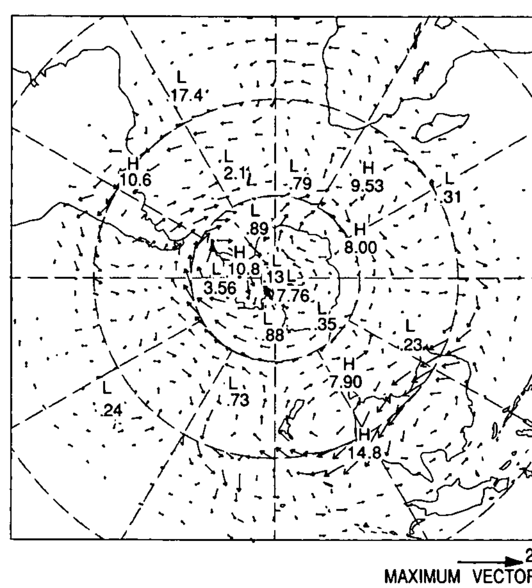


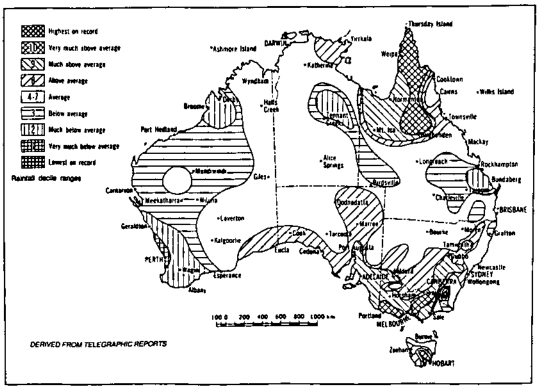

**Fig. 11 Winter 1990 (June, July, August) 300 hPa wind anomalies (m $s^{-1}$). (The figures near the H and L are vector values at respective locations.)**




### Temperatures

Winter maximum temperatures (Fig. 13(a)) were chiefly below average in the south and east of the continent, and above average in the northwest.

**Fig. 12 Winter 1990 (June, July, August) rainfall in Australia: decile range values based on district averages.**




Elsewhere over the continent and in Tasmania winter maxima were near average.

Winter minimum temperatures were chiefly average to above average, except for below average areas in eastern Queensland and the lower west coast of Western Australia, as shown in Fig. 13(b).

## Comparison between winters 1990 and 1989

It is interesting to compare the winters of 1990 and 1989 when the climate indices for each season were similar in value (Gaffney 1990). The Australian rainfall anomaly patterns were comparable for the two winters with above average rainfall in the east and below average amounts in the southwest in each season. Temperature anomalies were similar, although the interior was slightly warmer in 1990.

The main similarities were:

(a) three-wave patterns with troughs near eastern sectors of oceans;
(b) SST near normal in most of tropics; and
(c) tropical climate indices chiefly near normal.

Minor differences were:

(a) SST warmer at mid-latitudes in 1990; and
(b) negative height anomalies greater in the Tasman Sea in 1990 with above average rainfall in Tasmania.

## References

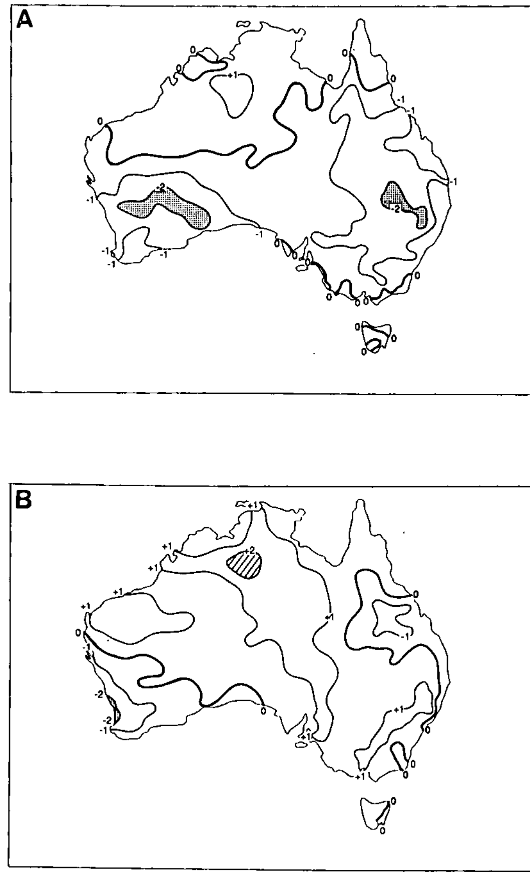
Gaffney, D. 1990. Seasonal climate summary southern hemisphere (winter 1989): the Southern Oscillation Index falls to near average. *Aust. Met. Mag., 38,* 81–6.

Gaffney, D. 1991. Seasonal climate summary southern hemisphere (autumn 1990): near normal conditions in the equatorial Pacific and strong anomalies at mid-latitudes. *Aust. Met. Mag., 39,* 65–9.

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

Tapp, R.G. and Barrell, S.L. 1984. The north-west Australian cloud band: climatology, characteristics and factors associated with development. *J. Climatol., 4,* 411–24.

**Fig. 13 Winter 1990 (June, July, August) temperature anomalies (°C) for Australia: (a) maximum; (b) minimum.**




## 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 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.