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# Seasonal climate summary southern hemisphere (spring 1989): the 1988/89 positive phase of the Southern Oscillation draws to an end

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**An analysis of Pacific basin tropical indicators and the southern hemisphere circulation for the austral spring, September to November 1989, is presented, along with a discussion of seasonal rainfall and temperature over the Australian region. During the season, sea-surface temperatures were slightly below normal over the central and eastern equatorial Pacific, whilst in the western equatorial Pacific they were slightly above normal. Surface winds associated with the Walker Circulation were, on average, marginally stronger than normal. A notable exception was over the western Pacific in November when strong westerly bursts occurred on two occasions. The five-month mean of the Southern Oscillation Index showed a general decline since spring 1988 to near-zero values in spring 1989.**
**Seasonal rainfall over the eastern half of Australia was very variable and temperatures over the continent showed a tendency to be slightly above normal.**

## Introduction

This climate summary reviews the southern hemisphere circulation for spring 1989 (September to November). Features reviewed include tropical indicators, sea-surface temperatures (SST), tropospheric pressure patterns, and rainfall and temperature over Australia.

Spring 1989 marked the end of the 1988/89 El Niño/Southern Oscillation (ENSO) cold episode. This episode became established in autumn 1988, reached a peak the following spring, then showed a general decline in the following months with the five-month mean of the Southern Oscillation Index (SOI)* reaching near-zero values by the end of spring 1989.

## Data

Many data sources were used in the preparation of this summary. Most of these are described in Nydam (1989). Washington Climate Analysis Center Diagnostics Bulletins were used to obtain information on low and upper level winds in the equatorial Pacific. The SST anomaly map for spring 1989 was produced from validated grid-point satellite data archived by the World Meteorological Centre Melbourne, and the Comprehensive Ocean-Atmosphere Data Set (COADS)/ICE climatology (Reynolds 1988). Further information on data sources can be found in the Appendix.

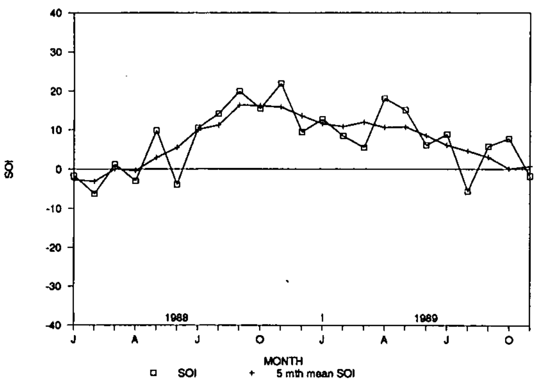
## Discussion of the spring circulation

### Tropical climatic indicators

The SOI started to fluctuate about zero from about July 1989 onwards. However, some of this variability could be attributed to the 30 to 60-day oscillation, so to reduce this effect, five-month means of the SOI were calculated. Figure 1 shows the SOI and the five-month mean for the period January 1988 to November 1989. There has been a general decline of the five-month mean since spring 1988 to near-zero values in spring 1989. Monthly average mean sea level pressures for Darwin for September, October and November were, respectively (anomaly in brackets), 1011.7(−0.3), 1009.9(−0.8) and 1008.7(−0.2) hPa whilst those for Tahiti were 1015.0(−0.7),

*The SOI used here is 10 times the anomaly of the monthly mean Tahiti minus Darwin mean sea level pressure difference divided by the standard deviation of that difference for the relevant month, based on the period 1882–1985.

**Fig. 1 Southern Oscillation Index for the period January 1988 to November 1989.**

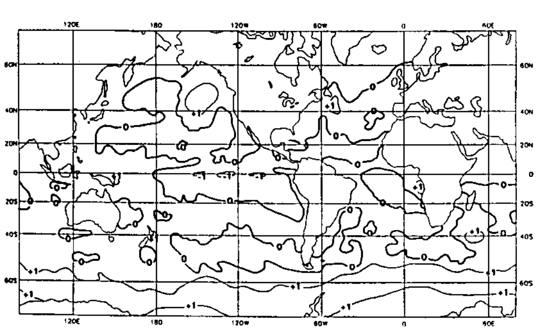



1014.0(0.4) and 1011.3(−0.5) hPa. These gave values of the SOI for September to November of 5.8, 7.8 and −1.8, respectively.

SST anomalies during spring in the equatorial Pacific changed little from the preceding winter (Gaffney 1990). In the equatorial central and eastern Pacific (Fig. 2) anomalies were generally in the range 0 to −1°C reaching −1° to −2°C at several locations on the equator. In the western equatorial Pacific and around the Australian coast, SSTs were mainly 0 to 1°C above normal. An exception was a large region adjacent to the eastern Australian coast where anomalies were in the range 0 to −1°C.

Low-level easterly winds over much of the equatorial Pacific and upper level westerlies over the central Pacific associated with the Walker Circulation were, on average, slightly stronger than normal. However, in November, for the first time since late 1987, anomalous and prolonged low-level westerlies were observed in the western equatorial Pacific. During the first few days of the month, winds briefly became westerly. Then, beginning in the middle of the month and continuing until the last week of November, 850 hPa westerly winds, at times up to 10 m/s, were observed from Indonesia eastward to near the dateline.

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



Prolonged periods of westerly wind or weakened easterlies are thought to act as a trigger to ENSO episodes (Wyrtki 1975). These wind anomalies are associated with oceanic Kelvin waves which propagate eastwards towards the South American coast. It generally takes about two months for a Kelvin wave to traverse the region from the dateline to the coast. The waves tend to depress the depth of the oceanic thermocline and increase SSTs along the South American coast.

## Extratropical circulation

**Mean sea level pressure (MSLP) and MSLP anomaly** (Figs 3 and 4). The normal three-wave pattern was evident in the MSLP pattern with troughs at mid to high latitudes having preferred locations in the central Pacific, eastern Atlantic and eastern Indian oceans. Three interesting features were present on the anomaly map. These were:

(a) a belt of negative anomaly stretching from mid-latitudes at 90°E to subtropical latitudes at 180°E;
(b) positive anomalies at mid-latitudes from about 180°E to 270°E; and
(c) A blocking dipole near New Zealand.

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

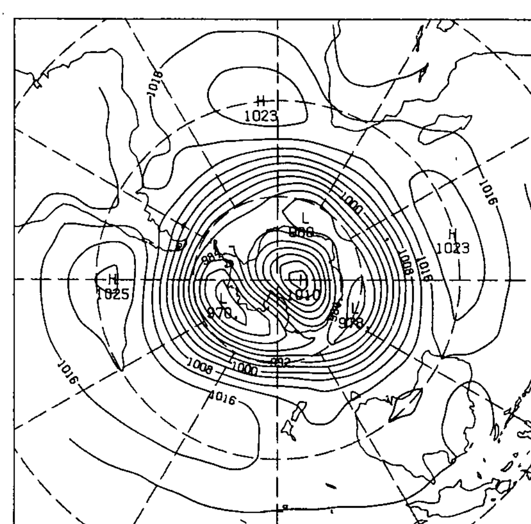
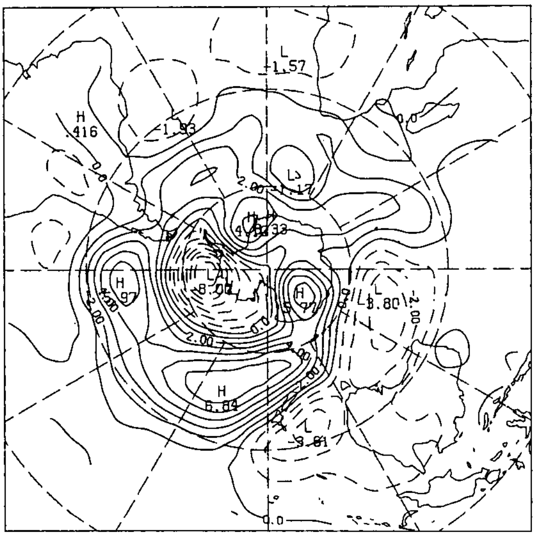
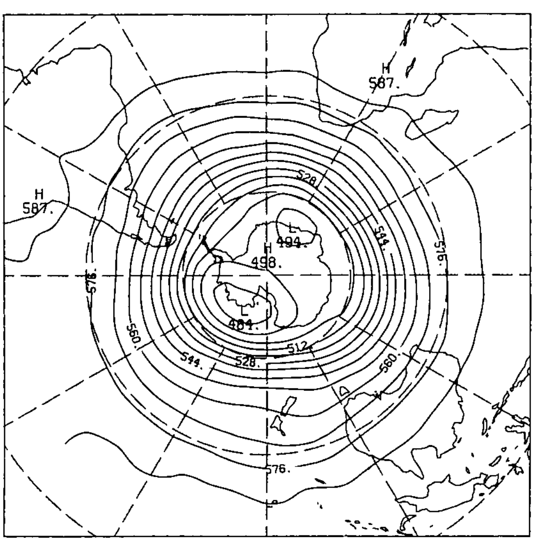


**Fig. 4 Spring (September, October, November) mean sea level pressure anomalies (hPa).**



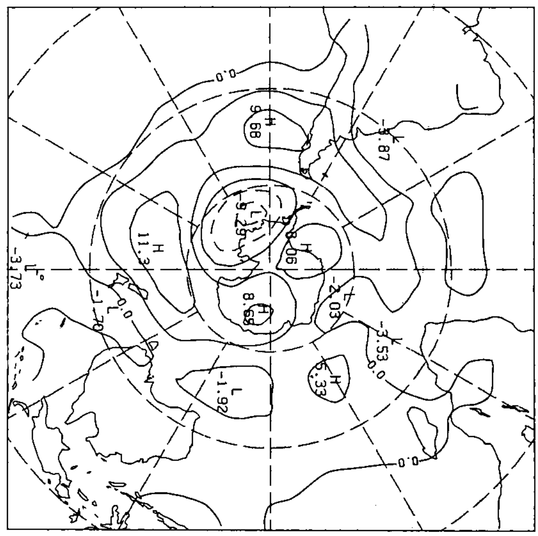
**500 hPa height** (Fig. 5). The 500 hPa height pattern showed the normal three-wave pattern and troughs in mid-latitudes were located in the central Pacific, western Atlantic and eastern Indian oceans. There was a pronounced diffluence of the westerly flow near New Zealand associated with the blocking in that region.

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



**300 hPa height anomaly** (Fig. 6). The 300 hPa height anomaly analysis was similar to the MSLP anomaly analysis with respect to the placement of regions of negative and positive anomaly and illustrates the normally equivalent barotropic nature of the southern hemisphere troposphere.

**Fig. 6 Spring (September, October, November) 300 hPa height anomalies (dam).**



**850 hPa and 300 hPa wind anomaly** (Figs 7 and 8). The main features of both the 850 hPa and 300 hPa wind anomaly analyses were:

(a) easterly anomalies at around 30°S over the central and eastern Pacific reflecting a weakened subtropical jet;
(b) northeasterly anomalies over New Zealand due to the blocking dipole in that region; and
(c) a band of westerly anomalies at 50°–60°S from the dateline to South America.

**Blocking activity**. Figure 9 is a time-longitude section of spring blocking activity over the southern hemisphere as measured by the southern hemisphere daily Blocking Index (BI). This index is defined by the following relation

$$BI = 0.5(U_{25} + U_{30} + U_{55} + U_{60} - U_{40} - U_{50} - 2U_{45})$$

where U is the 500 hPa daily mean zonal wind for 1100 and 2300 UTC and the subscript is the corresponding latitude in degrees south.

The index measures the difference in strength between the westerlies at low/high latitudes and those at mid-latitudes. The split in the mid-latitude westerlies caused by blocking activity produces positive values of the index.

Fig. 7 Spring (September, October, November) 850 hPa wind anomalies (m s$^{-1}$).

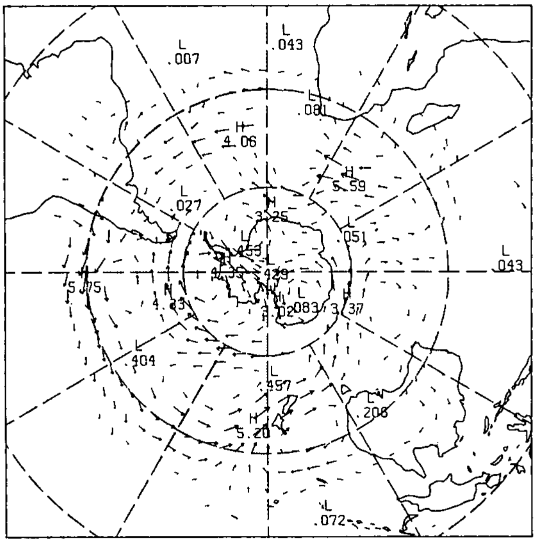
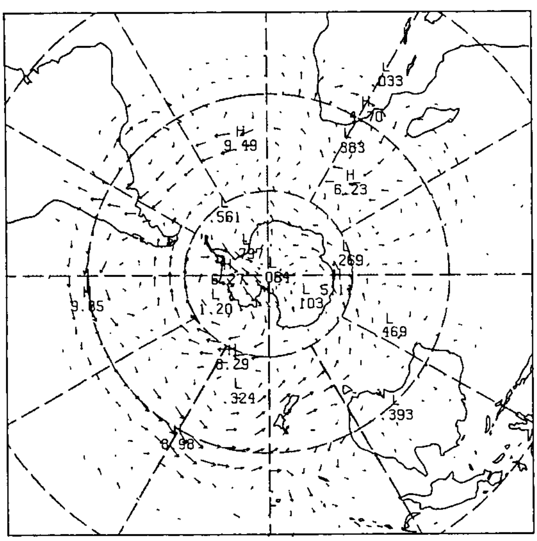


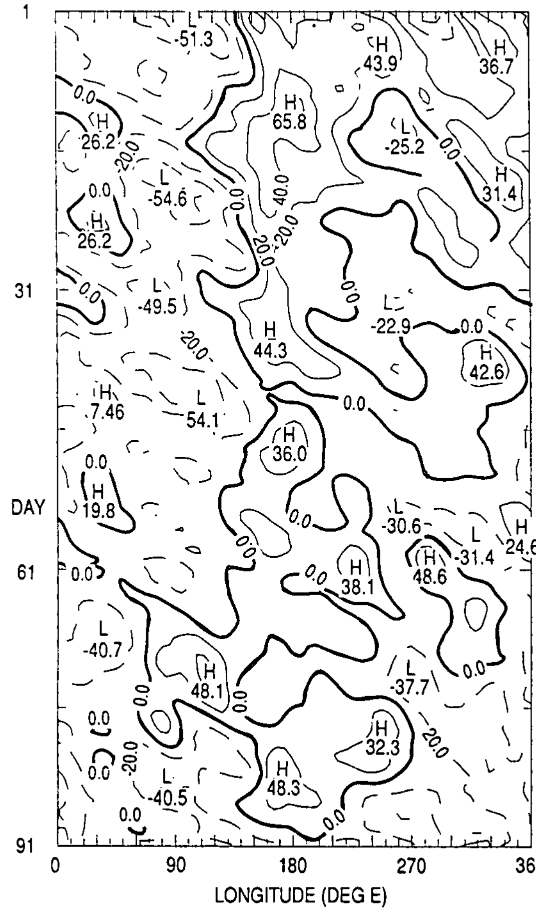
Fig. 8 Spring (September, October, November) 300 hPa wind anomalies (m s$^{-1}$).



Significant features of Fig. 9 are the strong blocking activity in the western South Pacific (155–200°E) for most of the season, and relatively zonal flow at mid-latitudes in the Indian ocean (45–110°E) during September and October.

Throughout the year, blocking in the southern hemisphere occurs predominantly in the Tasman Sea region. There is evidence (Coughlan 1985) that this may be related to the heat source over the maritime continent and/or to the longitudinal

Fig. 9 Time-longitude section of the southern hemisphere daily Blocking Index. Day 1 is 1 September 1989.




gradient in SSTs (directed towards New Zealand) which is generally present at mid-latitudes to the south of Australia.

## Australian rainfall

Rainfall during the season (Fig. 10) was below normal over most of Western Australia and much of the Northern Territory, South Australia and New South Wales. A large region comprising the northwestern half of Queensland and adjacent northeastern South Australia received above average accumulations.

Figure 11 shows the expected spring district average rainfall calculated from the average SOI for spring, using linear regression. The data used to establish the linear relationship were monthly district average rainfall and SOI values for the

**Fig. 10 Spring (September, October, November) rainfall: decile range values based on district averages.**

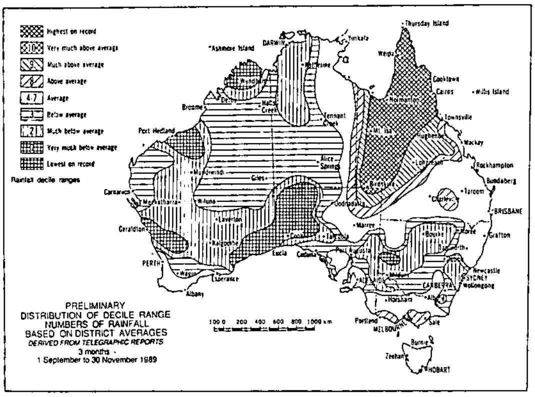
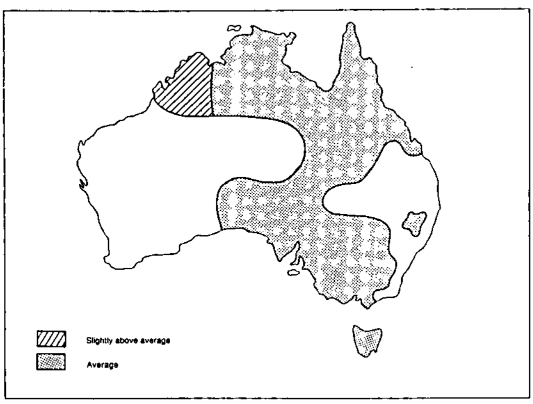



**Fig. 11 Spring (September, October, November) rainfall expected from the observed spring Southern Oscillation Index.**




period 1959 to 1988 inclusive, archived by the National Climate Centre, Australia. Only rainfall for districts where the long-term correlation coefficient exceeded 0.35 are shown.

During spring 1989, values of the SOI (Fig. 1) were small and fluctuated about zero. During periods when there is a weak Southern Oscillation signal, as was the case in spring 1989, there can be a wide variation between the actual seasonal rainfall and rainfall accounted for by the SOI.

The expected rainfall in Fig. 11 is generally average and occupies an area covering much of the eastern half of Australia. In reality, less than one quarter of the area of expected rainfall had average rainfall. The western half of the area was below average, as was most of New South Wales. The area in Queensland received above average rainfall.

## Australian temperatures

Maximum and minimum temperature anomalies (Figs 12 and 13, respectively) were generally in the range −1 to +1°C. The overall area of positive anomaly for both maximum and minimum temperature was at least twice as great as that for negative anomalies. This may have been related to the predominance of positive SST anomalies around the Australian coastline (Fig. 2). Areas of negative anomaly for maximum and minimum temperature tended to occur in eastern Australia and may be explained by the large region of negative SST anomaly adjacent to the eastern Australian coast.

**Fig. 12 Spring (September, October, November) maximum temperature anomalies (°C).**

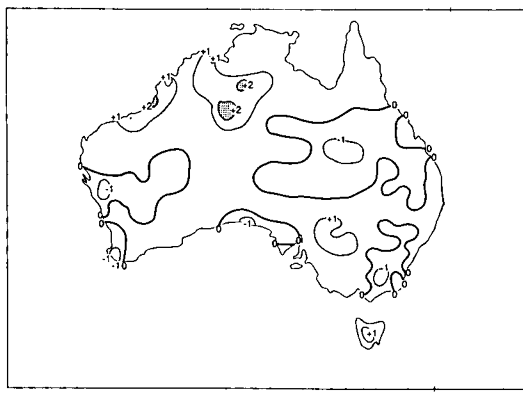
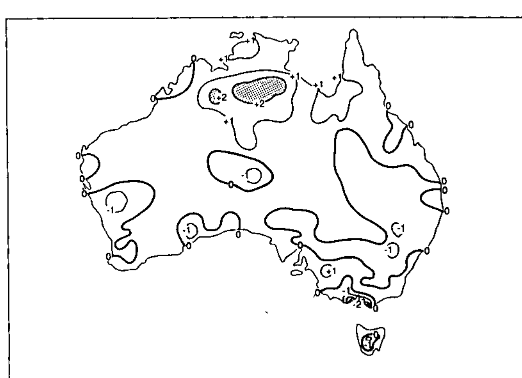


**Fig. 13 Spring (September, October, November) minimum temperature anomalies (°C).**



## References

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## Appendix

### Further information on data sources

Data sources used for this review were:

Bureau of Meteorology. 1989. Monthly Rainfall Review. (November 1989 issue.) Bur. Met., Australia.*

Climate Analysis Center Climate Diagnostics Bulletins, January 1988, January, September, October and November 1989.†

National Climate Centre Climate Monitoring Bulletins — Southern Hemisphere, September, October and November 1989.§

Southern Hemisphere grid-point analysis data archived by the World Meteorological Centre, Melbourne.§

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*Obtainable from the Bureau of Meteorology, GPO Box 1289K, Melbourne 3001, Australia.

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

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