

# Seasonal climate summary southern hemisphere (winter 1991): a warm Pacific episode develops

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A climate analysis is given of the southern hemisphere winter circulation, June, July and August (JJA) 1991, with more detailed treatment of the Australian region. In the equatorial Pacific, winter sea-surface temperatures (SST) were generally above average and weak low-level westerly anomalies were observed. A three-wave planetary wave pattern was evident with deep troughs in the Pacific and the eastern Indian Ocean, and a weaker trough in the south Atlantic. There was a marked variation in rainfall across Australia.

## Introduction

This seasonal summary reviews the southern hemisphere climate for winter 1991. Features reviewed include climate indices, sea-surface temperatures and tropospheric geopotential height fields. Emphasis is given to the Australian region.

The main sources of information were the Climate Monitoring Bulletins issued by the Bureau of Meteorology (Australia), and the monthly Climate Diagnostics Bulletin, Climate Analysis Center (CAC) Washington. Data sources are given in the Appendix.

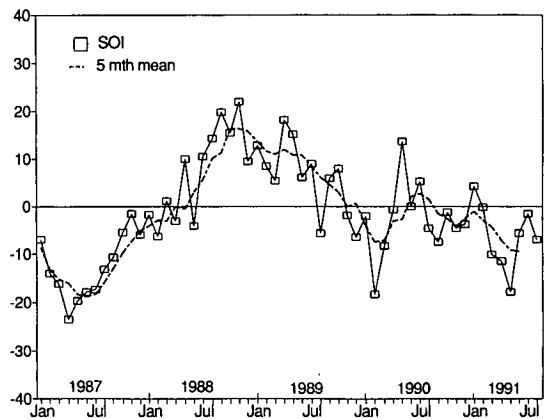
## Climate indices

The Southern Oscillation Index (SOI), negative since February 1991, fell from  $-0.2$  in February to  $-17.9$  in May. There was a sharp rise in June to  $-5.9$ . The SOI ranged between  $-1$  and  $-7$  during the remaining winter months (Fig. 1).

The relatively large change in the SOI from May to June, was due both to a change from a negative to a small positive pressure anomaly at Tahiti, and a reduction in the positive anomaly at Darwin. The persistent negative values were consistent with the development of a warm Pacific episode.

Weak westerly anomalies were observed in the low-level equatorial winds across the Pacific basin during winter. Outgoing long wave radiation was mostly near normal in the region of the dateline on the equator.

Fig. 1 Southern Oscillation Index, January 1987 to August 1991 inclusive.



Sea-surface temperatures were generally above normal throughout the central and eastern tropical Pacific, and in the tropical central Indian Ocean. An area of anomalously warm water was observed in the eastern equatorial Atlantic during the early part of winter. The distribution and movement of anomalously warm water in the tropical Pacific was consistent with the development of a warm Pacific episode.

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## Sea-surface temperatures

Satellite derived sea-surface data, as were previously included in this series of seasonal summaries, were contaminated by the stratospheric aerosol cloud associated with the eruption of the Mt Pinatubo volcano (Philippines) in June. As a result, the monthly SST anomaly charts (Fig. 2) have been adopted from the CAC Washington analyses. These are blended analyses, based on a combination of *in situ* and satellite data.

By the end of June positive SST anomalies greater than 1°C were observed in parts of the

tropical central and eastern Pacific (Fig. 2(a)). Warm anomalies were also observed in the central tropical Indian Ocean and the eastern equatorial Atlantic Ocean. In addition, a large warm anomaly developed through the eastern Pacific subsurface waters (not shown). This was accompanied by a deepening of the thermocline in the east and a shoaling in the west.

By the end of July, some cooling was observed in the surface and subsurface waters in the eastern Pacific. However warm anomalies persisted throughout the eastern and central tropical Pacific and central Indian Ocean (Fig. 2(b)). The area of

Fig. 2(a) June 1991 sea-surface temperature anomaly (°C).

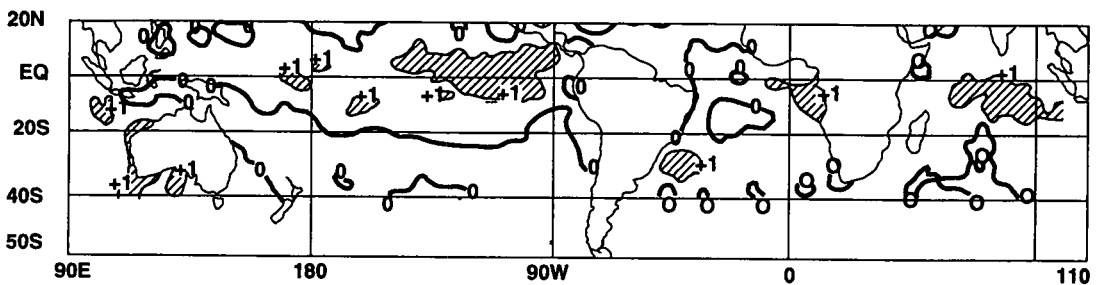


Fig. 2(b) July 1991 sea-surface temperature anomaly (°C).

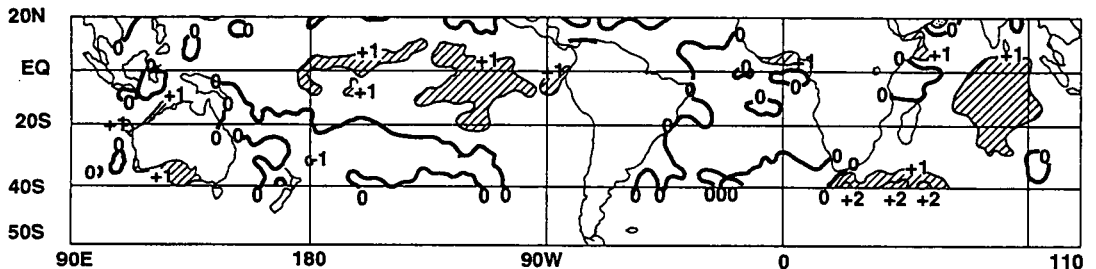
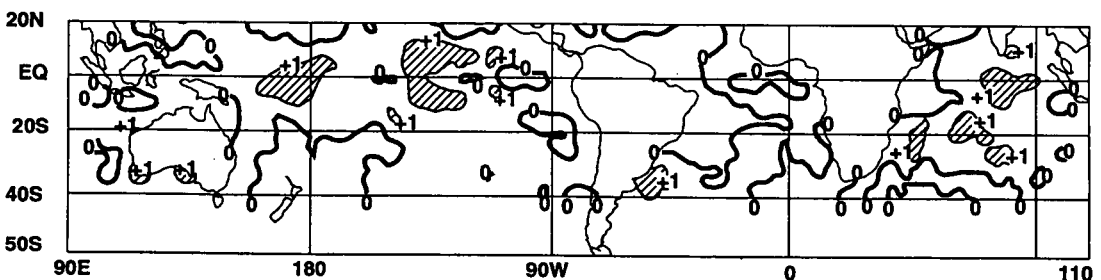


Fig. 2(c) August 1991 sea-surface temperature anomaly (°C).



warm anomalies in the eastern equatorial Atlantic decreased during July.

There was some further decrease in the spatial extent of the largest positive anomalies over the eastern equatorial Pacific during August. However, sea-surface temperatures remained anomalously warm in this region. Warm anomalies also persisted over the central Indian Ocean.

The typical El Niño signature of warm anomalies in the central/eastern equatorial Pacific surrounded by two bands of cold anomalies stretching northeastwards and southeastwards from the Philippines/Papua New Guinea area, remained stable throughout the winter.

## Surface analysis

The winter mean sea level (MSL) pressure analysis is shown in Fig. 3, with anomalies in Fig. 4. The MSL pressure analysis shows a three-wave pattern with deep troughs in the Pacific and the eastern Indian Ocean, and a weaker broad trough situated in the South Atlantic. The Pacific trough was relatively deeper, extending from the subtropical central Pacific to the Ross Sea.

- Marked features of the anomalies (Fig. 4) are:
- a deep low centre south of Tasmania;
  - a second deep low centred over Antarctica near the Weddell Sea;
  - a strong high in the mid-latitudes of the eastern Pacific Ocean, with a ridge eastward to a second weaker high east of South America; and
  - a prominent trough over the western Indian Ocean.

Fig. 3 Winter 1991 (JJA) mean sea level pressure (hPa).

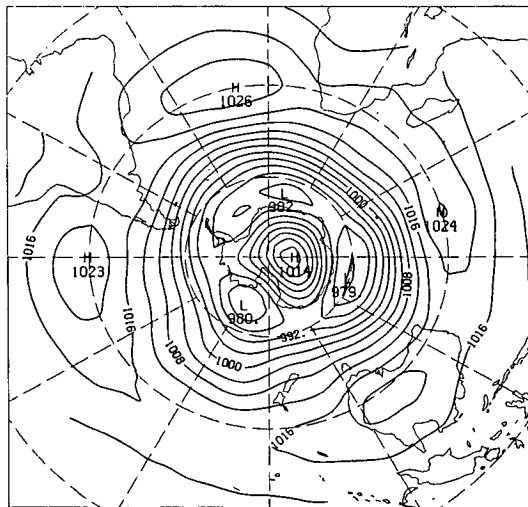
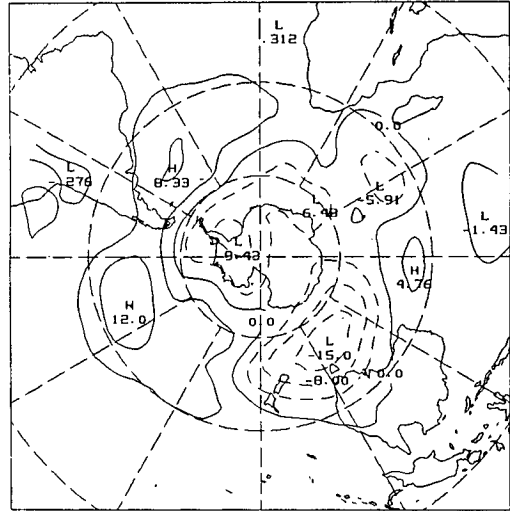


Fig. 4 Winter 1991 (JJA) mean sea level pressure anomaly (hPa).



## Upper air analysis

The 500 hPa seasonal mean analysis and anomalies are shown in Figs 5 and 6 respectively. The pattern is basically three-wave, however there appears to be a strong contribution from zonal wave number one asymmetry. Strong zonal flow is apparent in the high latitudes of the eastern Atlantic and Indian Oceans.

A similar pattern is evident at 300 hPa (Figs 7 and 8). Troughs in the Pacific and Indian Oceans were pronounced, however the flow was strongly zonal through the middle and high latitude Atlantic.

## Blocking

During winter, blocking episodes were most prominent in the Pacific (Fig. 9). Mean monthly Blocking Index\* values (not shown) indicated that blocking was above average in the eastern Pacific during most of the winter period.

Blocking activity occurred in southeastern Africa during June, and was evident in the western Pacific during the first half of July.

Significant blocking activity occurred in the central and eastern Pacific during the latter part of July and early August. Blocking was prominent in the western Indian Ocean during August.

\*Blocking Index (BI):

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





## Australian region

### Circulation and rainfall

Locations of the Australian States and Territories are shown in Fig. 12.

There was marked spatial variation in winter rainfall (Fig. 13). Much of eastern and southern Queensland and northern New South Wales experienced well below average rainfall. In contrast, a broad area extending from central Western Australia southeastward to eastern Victoria received well above average winter rainfall.

Below average rainfall over Queensland and New South Wales is consistent with a developing warm Pacific Southern Oscillation event, as evidenced by persistent negative values of the SOI and positive SST anomalies over the central and eastern tropical Pacific.

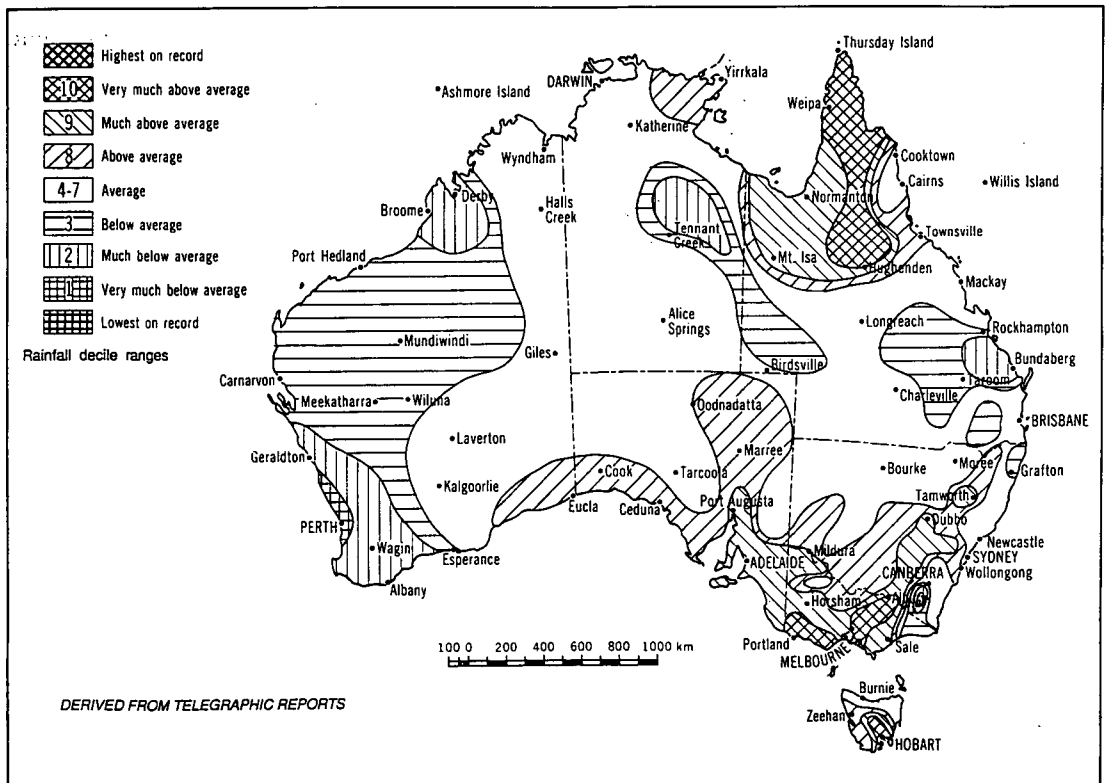
Enhanced cut-off low development and frequent frontal activity over central and southeastern Australia, which resulted in above average rainfall in these areas, can be linked to the strong negative height anomaly in the Southern Ocean (Figs 6 and 8).

### Temperatures

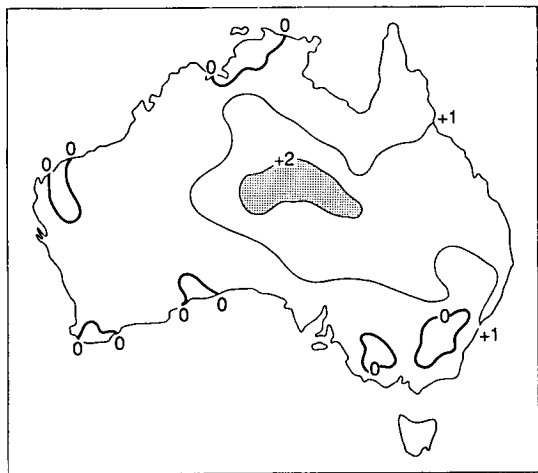
Winter maximum temperatures were mostly above normal. Positive departures in excess of 1°C extended from southern Queensland westward over the central part of the continent (Fig. 14(a)).

Similarly, minimum temperature anomalies for winter were mostly positive. Parts of the southeastern continent and a large area of central Australia showed positive departures of 2°C (Fig. 14(b)).

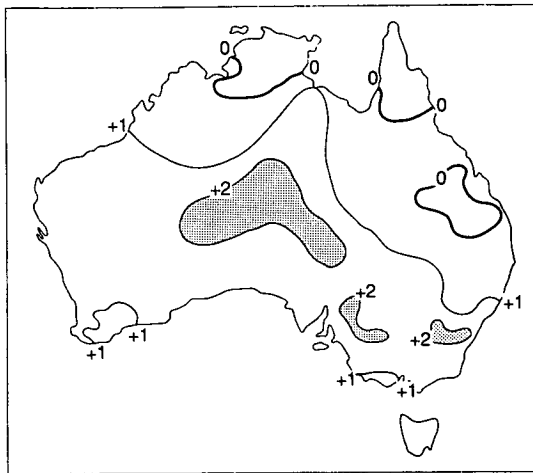
Fig. 13 Winter 1991 (JJA) rainfall in Australia: decile range values based on district averages.



**Fig. 14(a) Winter 1991 (JJA) maximum temperature anomalies (°C) for Australia.**



**Fig. 14(b) Winter 1991 (JJA) minimum temperature anomalies (°C) for Australia.**



## Appendix

Data sources used for this review were:  
Climate Analysis Center Diagnostics Bulletin.\*  
Darwin Tropical Diagnostic Statement.†  
National Climate Centre – Climate Monitoring  
Bulletin – Southern Hemisphere.‡

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.

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

