Seasonal climate summary
southern hemisphere (autumn 1995):
warm episode conditions in the
tropical Pacific weaken

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Southern hemisphere circulation patterns and anomalies for autumn (March to May) 1995 are reviewed, with emphasis given to the Pacific Basin climate indicators, and Australian rainfall and temperature patterns. Surface and subsurface temperature anomalies in the Pacific were consistent with a weakening of warm episode conditions. However, the overall pattern of positive pressure anomalies in the west of the tropical Pacific Ocean and negative anomalies to the east, which has dominated the tropical Pacific for more than five years, continued in autumn.

Introduction

A warm Pacific episode which reached a peak in early summer 1994–95 (Beard 1995) continued to weaken during autumn 1995. Heavy rainfall in northern and western Australia, and in a swath through central Australia, was associated with tropical depressions. Consistent with the cloud activity in these areas, maximum temperatures were below average. This summary reviews the southern hemisphere and equatorial climate patterns of autumn 1995, with particular attention given to the Australasian/Pacific region.

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

Pacific Basin climate indices

The Southern Oscillation Index (SOI)*

Prior to March, the SOI had remained negative for twelve consecutive months (Fig. 1). The positive March value (+2.8), associated with falling atmospheric pressure at Darwin, was followed by negative values in April (−13.5) and May (−8.2).

In April, the strongly negative SOI was mainly due to below average mean sea-level pressure (MSLP) at Tahiti, whilst the May value was attributed to both a positive MSLP anomaly at Darwin and negative MSLP anomaly at Tahiti. However, the positive trend in the five-month moving average since June 1994, was still evident (Fig. 1).

Fig. 1 Southern Oscillation Index, January 1989 to May 1995 inclusive.

*The SOI used here is ten times the monthly anomaly of the difference in mean sea-level pressure between Tahiti and Darwin, divided by the standard deviation of that difference for the relevant month, based on the period 1876–1993.
Atmospheric indices
In the early part of autumn, low-level Pacific equatorial easterly winds were stronger than normal west of the date-line and near normal in central and eastern areas. During the middle and latter parts of autumn (April to May), low-level equatorial and near-equatorial easterlies were near normal throughout the Pacific.
Figure 2, adapted from CAC (1995), shows a time series of anomalous outgoing long wave radiation (OLR). Negative anomalies imply above average cloudiness, and hence rainfall. Convective activity (inferred from OLR anomalies) was enhanced over parts of the Australian-western Pacific region in the first half of autumn, and in the Indonesian region during the early part of May. In the central tropical Pacific, convective activity was generally near normal throughout autumn.

Fig. 2 Time-longitude section of monthly outgoing long wave radiation (W m⁻²) anomalies for 5°N–5°S, March to May 1995. Contour interval is 15 W m⁻², and dashed contours indicate negative anomalies (i.e. enhanced convection and rainfall). Anomalies are departures from the 1979–1988 base period pentad means. The data are smoothed temporally by using a 3-point running average. After CAC (1995).

Oceanic indices
Sea-surface temperatures (SSTs)
Figure 3 shows autumn SST anomalies. The positive SST anomalies which dominated the tropical Pacific during 1994 and peaked in December, weakened and became more diffuse during autumn.
In the monthly SST anomaly charts (not shown), the area of positive anomalies in the equatorial Pacific near the date-line appeared to contract during autumn. The autumn anomaly pattern (Fig. 3) shows that apart from the area near the equatorial date-line, only small patches of positive anomalies greater than 1°C remained in the tropical Pacific.
Other significant features of the autumn months were the tongue of cooler water along the equator in the eastern Pacific, the warmer waters to the northwest of Australia and the cooler water to the south and east of Australia.

Fig. 3 Autumn 1995 sea-surface temperature anomaly (°C).
Subsurface patterns

Figure 4 shows the anomaly of the depth of the 20°C isotherm along the equatorial Pacific between January 1992 and May 1995. This isotherm is generally situated very close to the equatorial ocean thermocline, the region of greatest temperature gradient with depth.

In March, the depth of the thermocline was shallower than normal across the entire equatorial Pacific, with anomalies as large as at any time in the last four years. In April, the anomalies in the depth of the 20°C isotherm in the far eastern Pacific were the largest since the 1988 cool event. The largest negative anomalies during this time were between 155°W and the South American coast. There was a slight deepening of the thermocline from the date-line to 130°W in May, but negative depth anomalies persisted throughout most of the Pacific during autumn. These anomalies were of similar magnitude and duration to those that occurred during late 1993 to early 1994.

In the 150 m depth-averaged analysis (not shown), conditions near the equator were everywhere near or cooler than normal throughout autumn. In addition, a weakening in the warm anomalies to the north and south of the equator in the central-eastern Pacific was evident in April. However, these cool anomalies were flanked, immediately to the north and south, by anomalously warm water.

Surface analyses

Figures 5 and 6 show the mean and anomalous autumn 1995 MSLP patterns respectively. Anomalies are deviations from an eleven-year (1979–1989) global climatology from the European Centre for Medium Range Weather Forecasts (ECMWF), Bracknell, England.

In the monthly analyses (not shown) a weak wave-4 pattern in March and May, and a clear wave-3 pattern in April, were evident. This is reflected in the seasonal mean and anomaly analyses which, although somewhat diffuse in the region of the Indian Ocean (Fig. 5), show a wave-3 pattern at higher latitudes (Fig. 6).

Significant features were the negative anomalies centred to the southeast of the continent, and the area of strong positive anomaly east of New Zealand (Fig. 6). The former feature was associated with wet conditions in far southeast Australia, and the latter, which was particularly strong.

Fig. 5 Autumn 1995 (March, April, May) mean sea-level pressure (hPa).
in April and May, with blocking. Higher than normal pressure was also a feature of the eastern African and Australian regions, with anomaly magnitudes generally in the range 0 to 2 hPa.

**Upper-level analyses**

Figures 7 and 8 show the mean and anomalous autumn 1995 500 hPa patterns respectively. Long wave troughs at middle to higher latitudes were located in the Tasman Sea, the eastern Pacific and western Atlantic oceans.

The anomaly pattern at 500 hPa closely resembles that at the surface, with positive anomalies east of New Zealand, a broad band of negative anomalies southeast and southwest of South America, and positive anomalies centred to the southwest and negative anomalies to the southeast of the Australian continent.

**Blocking**

Figure 9 is a time-longitude section of the daily southern hemisphere Blocking Index (BI)*, measuring the strength of the 500 hPa flow at mid-

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*The index is defined as: BI = 0.5(U^{23} + U^{30} + U^{35} + U^{40} - U^{40} - U^{23}) where U^x is the daily mean 500 hPa zonal wind at latitude x.
A peak in blocking occurred around 150°W (Tahiti's longitude) in mid-April, and frequent blocking activity occurred in the vicinity of the date-line during April and May. This is reflected in the MSLP and 500 hPa anomaly charts (Figs 6 and 8 respectively) which show strong positive anomalies in this area.

Significant blocking was also evident in the western South Atlantic Ocean in the latter half of April, and in the eastern Pacific Ocean in the last two weeks of autumn. Zonal flow (negative index values) was generally a feature over an area extending from the eastern South Atlantic Ocean to the eastern Indian Ocean.

**Winds**

Low-level (850 hPa) wind anomalies are shown in Figs 10 and 11 respectively. Low-level near-equatorial easterly anomalies extended eastward from the date-line to 120°W. Significant features were the strong anomalous anticyclonic circulation to the east of New Zealand and the strong anomalous cyclonic circulation centred to the southeast of Australia. The former feature was associated with blocking in this region, and the latter with enhanced frontal activity and heavy rainfall in far southeastern Australia.

The anomalous anticyclonic circulation to the southwest of Australia, which was associated with dryer conditions in the far southwest of the con-
Australian region

Circulation and rainfall
An active monsoon trough in early autumn resulted in heavy rainfall over much of northern Australia. During this period, most remaining areas of southwestern and eastern Australia received below average rainfall.

Tropical cyclone Chloe brought widespread heavy rainfall to northern and central areas of western Australia in April. In contrast, conditions remained dry over large areas of inland eastern Australia during this period. Towards the end of autumn, heavy rain associated with an extensive cloudband fell in a swathe through central and eastern Australia.

Figure 12 shows the rainfall deciles for the autumn period. The heaviest falls, associated with tropical cyclone activity and monsoon-related convection, occurred in western and northern areas of the continent. In far southeastern Australia, rainfall associated with frequent frontal activity resulted in above average falls. In contrast, conditions were relatively dry towards the northeast.

Temperatures
Maximum and minimum temperature anomalies for autumn 1995 are shown in Figs 13 and 14 respectively. The maximum and minimum anomaly patterns were similar, with warmer temperatures towards the northeast of the country, and colder conditions in most other southern and western areas.

Maximum temperature anomalies were particularly significant. Negative anomalies of less than −3°C, associated with extensive cloudband activity, extended in a broad band across the western part of the continent, and anomalies less than −2°C were observed over a large area of the southeast (Fig. 13). In the northeast and far southwest of the continent the warmer temperatures were associated with drier conditions.

References
Fig. 12  Autumn 1995 (March, April, May) rainfall in Australia: decile range values based on district averages and selected stations.

PRELIMINARY DISTRIBUTION OF DECIILE RANGE NUMBERS OF RAINFALL BASED ON DISTRICT AVERAGES AND SELECTED STATIONS DERIVED FROM TELEGRAPHIC REPORTS 3 months-1 March to 31 May 1995

Fig. 13  Autumn 1995 (March, April, May) maximum temperature anomalies (°C) for Australia.

Appendix

Data sources used for this review were:
National Climate Centre, Climate Monitoring Bulletin — Australia.*
Climate Analysis Center (CAC), Climate Diagnostics Bulletin."