

Seasonal climate summary southern hemisphere (winter 1987): a season of characteristic Pacific ENSO anomaly patterns

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Analyses of the southern hemisphere circulation for the austral winter, June to August 1987 inclusive, are presented. Emphasis is given to the Australian region: an area bounded roughly by Antarctica, the equator, the dateline and 90°E.

Anomalous seasonal conditions associated with an El Niño Southern Oscillation (ENSO) episode are reviewed. Analyses for middle to high latitudes are described, noting the main planetary wave characteristics.

Notable features, characteristic of ENSO, were the enhanced convection near the equatorial dateline and the anomalous low-level westerlies continuing along the equatorial Pacific. Associated with these features were the abnormally strong subtropical upper-level westerlies on the poleward sides of a pair of upper anomalous anticyclone centres in the central equatorial Pacific.

Interactions between the tropics and higher latitudes are surveyed, particularly those connected with the ENSO episode.

Introduction

This climate summary follows sequentially the 1987 autumn summary (Gaffney and Casey 1987). The data used were derived from the archived southern hemisphere grid point analyses produced by the World Meteorological Centre, Melbourne. Data were also derived from real-time regular series in the National Climate Centre, Melbourne and issued in monthly *Climate Monitoring Bulletins*¹.

Biannual summaries of the Australian/Asian tropical area are published as a companion regular series (see e.g. Kingston *et al.* 1987), and so the tropical circulation is not discussed in detail here. More comprehensive tropical data for individual months may also be obtained from the *Darwin Tropical Diagnostic Statements*², from the *Climate Diagnostics Bulletins*³ and from the World Meteorological Organization (1987).

Overview

The El Niño Southern Oscillation (ENSO) warm episode, which apparently began in the late austral spring of 1986, continued during summer 1986-87 and into autumn 1987. In the austral winter of 1987 (June-August) some indices were indicative of a mature phase of the ENSO episode, and there were characteristic middle latitude patterns.

The Southern Oscillation Index (SOI)⁴, which was about two standard deviations below normal in autumn 1987, began to rise during winter. This upward swing in the SOI, however, was not followed at that stage by any significant sea surface temperature (SST) decrease in the central and eastern tropical Pacific to confirm the weakening in the episode.

Westerly wind anomalies persisted throughout most of the season in the lower troposphere in the

¹Obtainable from the Bureau of Meteorology, GPO Box 1289K, Melbourne 3001, Australia.

²Obtainable from the Northern Territory Regional Office, Bureau of Meteorology, PO Box 735, Darwin 5794, Australia.

³Obtainable from the Climate Analysis Center, National Weather Service, Washington DC 20233, USA.

⁴The Southern Oscillation Index (SOI), as used at the National Climate Centre, Melbourne, is 10 times the Tahiti minus Darwin monthly mean MSL pressure difference anomaly divided by the standard deviation of those differences for the relevant month over the period 1882 to 1985.

equatorial central and western Pacific. Corresponding easterly ENSO anomalies generally prevailed in upper levels associated with an anomalous anticyclonic couplet straddling the equatorial central Pacific.

Enhanced equatorial convection continued throughout the period in the vicinity of the dateline (*Climate Diagnostics Bulletin, June 1987*). The South Pacific Convergence Zone (SPCZ) was also anomalously strong and displaced appreciably eastwards of its mean position, as was the Walker circulation.

Upper-level westerly anomalies were significant at 25°S across the central Pacific. These westerlies may be related to the enhanced Hadley circulation generated by the anomalous positive SST over the tropical Pacific (El Niño). Middle to high latitude westerly anomalies were also evident over the eastern Atlantic and Indian oceans during the season.

In the southern hemisphere troposphere, a three-wave pattern predominated during most of winter with an enhanced middle to high latitude trough in the central Pacific.

Apart from a few areas, the 1986-87 ENSO episode did not appear to result in the widespread suppression of winter rainfall in eastern Australia as in the strong 1982-83 episode. Northwestern New South Wales received well above average rains for the 1987 winter season. However, record low winter rainfall in central and eastern Tasmania could be related to ENSO.

In the southwest corner of Western Australia record low winter rainfall was apparently associated with the southward displacement of the axis of the subtropical ridge.

Over several areas of the southwest Pacific region there were severe rainfall deficiencies associated with ENSO. The Fiji area was in major

drought during the year 1987 with record low rainfall at most stations. Serious deficiencies also occurred in Vanuatu, Tonga, Samoa and the Cook Islands as well as eastern New Guinea.

The winter circulation

In the austral winter the Inter-Tropic Convergence Zone (ITCZ) normally moves northwards from near the equator and the SPCZ contracts westward and weakens in a position off the northeast coast of New Guinea. In unison the subtropical ridge and the higher latitudes systems around the southern hemisphere shift northwards. Winter 1987 showed some variations correlated with ENSO which are described in the following paragraphs.

Climate indicators

After falling to a low of -22 in April, the lowest since 1983, the SOI rose during the ensuing months to -13 in August (Table 1). The values in Table 1 are shown graphically in Fig. 1.

This rising SOI trend continued into the austral spring, signalling the decline of the 1986-87 ENSO episode.

Sea surface temperatures (SST) in the central and eastern tropical Pacific generally continued at 1-2°C above average during the austral winter, peaking in spring. In the tropical Pacific west of the dateline SSTs were slightly below average.

Westerly wind anomalies persisted throughout most of the season in the lower troposphere over the equatorial Pacific. These characteristic ENSO anomalies were related to the warm SST anomalies in the central and eastern tropical Pacific. (Rasmusson and Carpenter 1982). Corresponding easterly wind anomalies generally prevailed in the upper troposphere over the central equatorial Pacific. These winds were typically associated with an anomalous anticyclonic couplet in this area, chiefly located between 160°E and 120°W (*Climate Diagnostics Bulletin, June, July, August 1987*).

Negative outgoing long wave radiation (OLR) anomalies were indicative of enhanced convection in the equatorial Pacific near the dateline and along the SPCZ. In addition to being anomalously strong, the SPCZ was displaced eastwards of its mean position (National Oceanic and Atmospheric Administration 1985), a feature of ENSO (Rasmusson and Carpenter 1982).

Fig. 1 Southern Oscillation Index, January 1985-August 1987 inclusive.

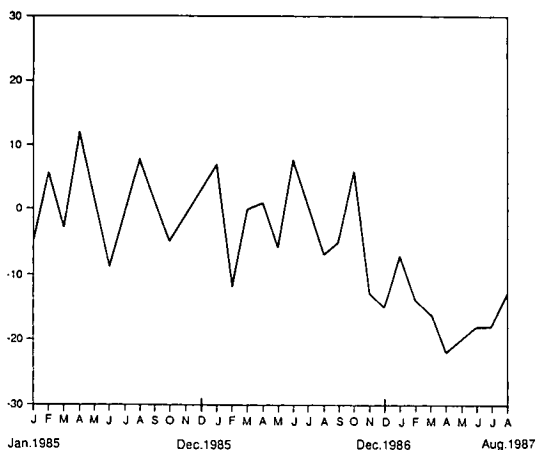


Table 1. Values of the Southern Oscillation Index (SOI) for the period January 1985 to August 1987 inclusive.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1985	-5	6	-3	12	3	-9	-2	8	0	-5	-1	1
1986	7	-12	0	1	-6	8	2	-7	-5	6	-13	-15
1987	-7	-14	-16	-22	-20	-18	-18	-13				

Surface analyses

The mean winter 1987 mean sea level pressure (MSLP) analysis showed considerable variation from normal, particularly at middle to high latitudes in the Pacific (Figs 2 and 3). Three main troughs were evident: one in the mid Pacific, one in the Atlantic and one in the Indian Ocean. The Pacific trough extended from Antarctica to the tropics and tilted northeast towards South America. The subtropical high pressure belt was generally enhanced, notably in the New Zealand region and in the southeast Pacific.

Fig. 2 Mean winter (June, July, August) mean sea level pressure analyses (hPa).

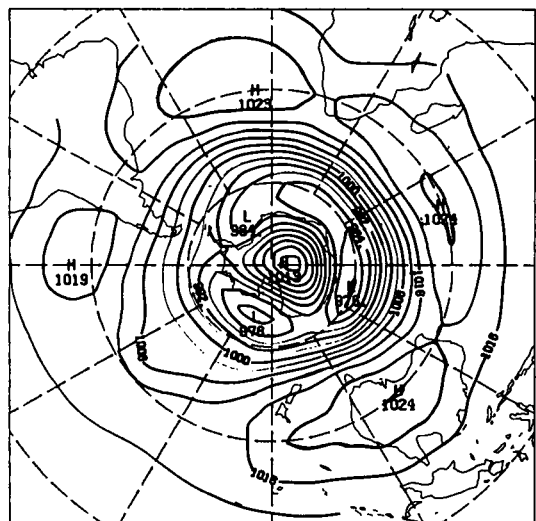
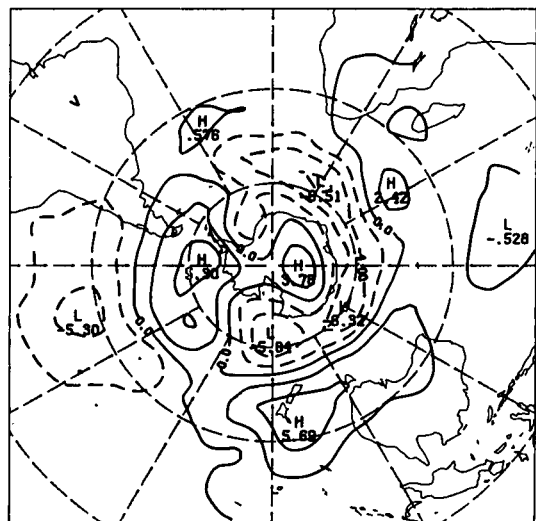


Fig. 3 Winter (June, July, August) mean sea level pressure anomaly analysis (hPa).



Upper-level analyses

At the 500 hPa level the three-wave pattern was also prominent during the season with the enhanced trough in the central Pacific extending from Antarctica to the tropics (Figs 4 and 5) similar to earlier ENSO episodes as indicated by Karoly (1986) for the 200 hPa level. The South Atlantic and eastern Indian Ocean troughs were generally confined to higher latitudes.

Blocking activity in the Pacific was strong at middle to high latitudes and showed mobility during the winter season (Fig. 6). In the South Atlantic a notable blocking event occurred in August but the Indian Ocean had zonal flow throughout most of the season.

Fig. 4 Mean winter (June, July, August) 500 hPa height analysis (dam).

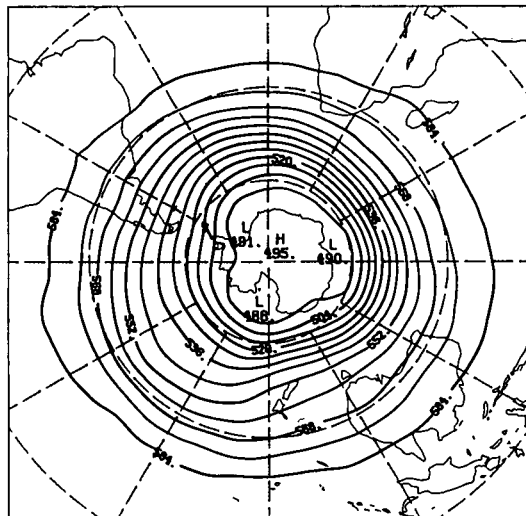
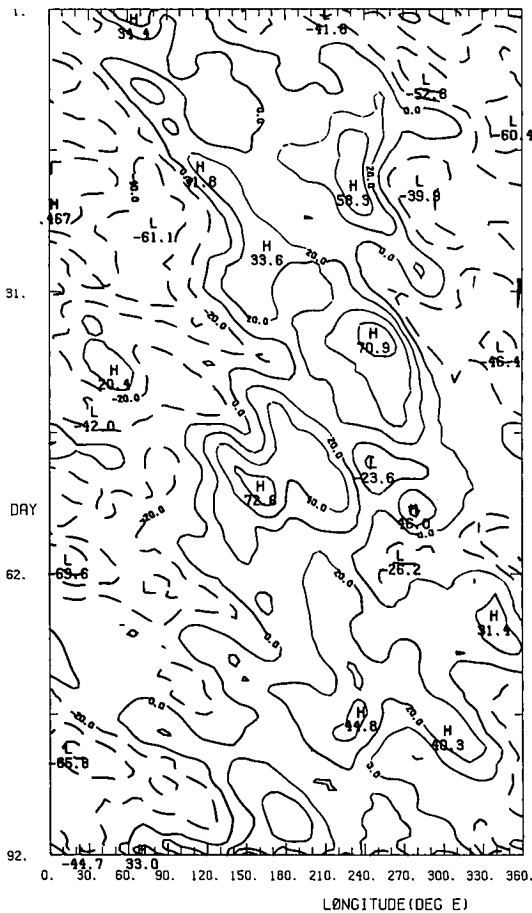


Fig. 6 Winter (June, July, August) time longitude section at 55°S of daily blocking index values. Day 1 is the first of June.



Australian conditions

Rainfall

Winter rainfall was well above average over a large area of inland southeastern Australia, along the north Queensland coast, and in northeast parts of the Northern Territory (Fig. 7). Below average falls were experienced in parts of Victoria, coastal areas of the Bight, and an area of the Western Australian coast from Northwest Cape to the southwest. Very much below average winter rain occurred in the far southwest of Western Australia and in central and eastern parts of Tasmania. Lowest on record winter rains were recorded in parts of the southwest corner of Western Australia, in Tasmania and on King Island in Bass Strait.

The 1986-87 ENSO episode did not cause general deficiencies in eastern Australian winter rainfall patterns. A marked exception was the central and eastern area of Tasmania where there were severe winter deficiencies. For that area

deficiencies for the seven months ending August 1987 were approaching a record.

Monthly rainfall in eastern Australia in relation to ENSO signals was chiefly variable in time and space. In June very much above average monthly totals occurred in western Queensland and extended to western New South Wales due to heavy rains, mostly about the third week of the month. A return to drier (ENSO) conditions came in July when New South Wales and southern Queensland were well below average. In August most of New South Wales and southern areas of Queensland received notably above average rains, largely around the third week of the month.

Temperatures

Temperatures over Australia in winter were mainly about average (Fig. 8). Mean maxima were 1°C above average towards the west coast of Western Australia and 1°C below average in western parts of South Australia (Fig. 8(a)). Mean minima were above average (1°C) in most of Queensland and in western areas of Western Australia (Fig. 8(b)).

There were notable monthly temperature variations. June mean maximum temperatures were slightly above average over much of the continent due to northerly wind components; minimum temperatures were markedly above average in the eastern half (+3°C) and parts of the west, generally in areas that experienced above average rains and cloudiness. July maximum temperatures were above average over much of Western Australia; minimum temperatures were appreciably below average in most of eastern Australia (-2°C) as a result of mostly clearer skies. Maximum temperatures in August were above average in the west and below average in most of the east due to air flow associated with the anomalous high pressure over the southwest of the continent; minima were above average (+2°C) towards east coastal areas resulting from above average cloud coverage.

Concluding remarks

Seasonal movements mostly occurred on schedule, although the ENSO episode in the Pacific exerted a significant influence on the general circulation patterns. Anomalous ENSO convective activity was observed near the equatorial dateline and in the SPCZ which had been displaced east of normal with corresponding eastward displacement of the Walker circulation. The enhanced convection generated an anomalously strong southern hemisphere Hadley cell east of its normal position. Consequently, anomalous subsidence extending eastwards over the Coral Sea areas was evidently responsible for the serious rainfall deficiencies from New Guinea southeast across the Solomons and severe drought in Fiji.

Fig. 7 Winter (June, July, August) decile range values of Australian rainfall based on district averages.

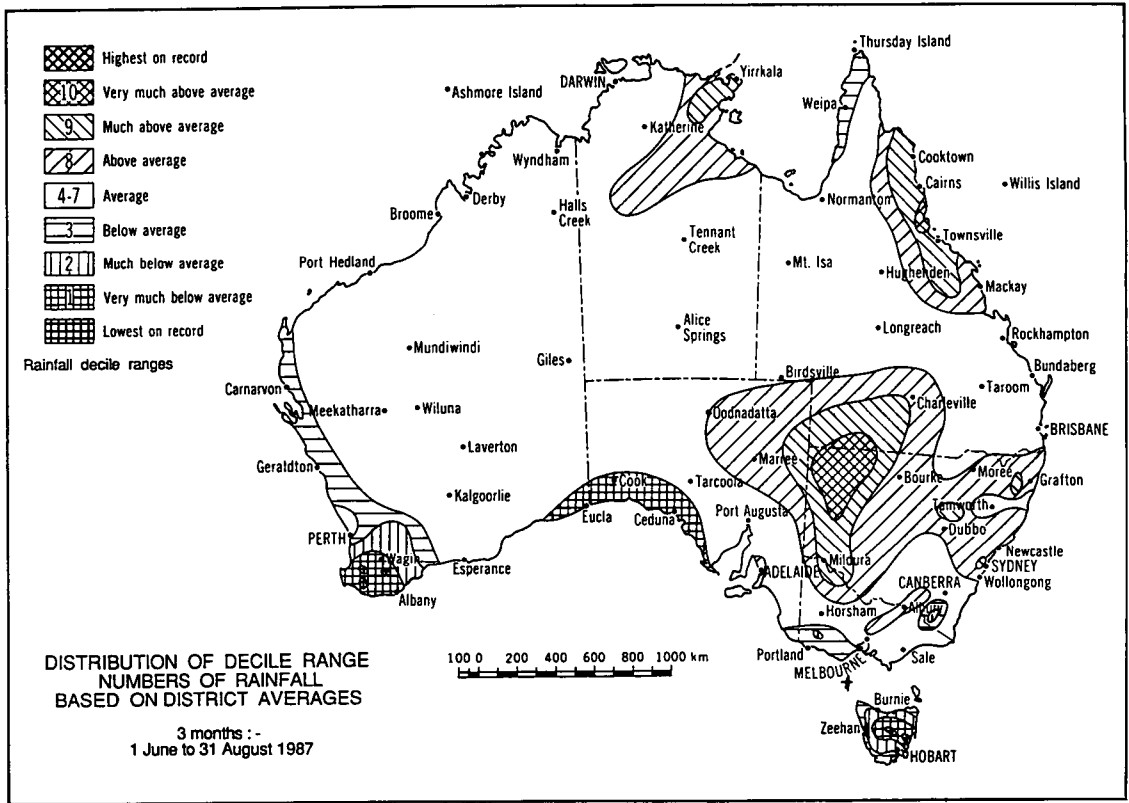
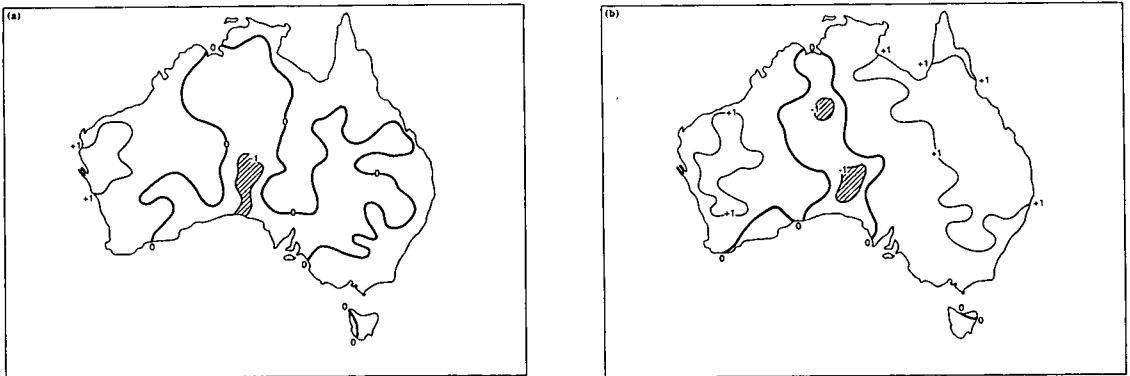


Fig. 8 Winter (June, July, August) temperature anomalies for Australia (a) maximum (b) minimum (°C).



At middle to high latitudes in the South Pacific the enhanced upper long-wave trough and strong anomalous blocking action at high latitudes in the extreme southeast Pacific may be associated with the strong Hadley cell.

The anomalously strong upper-level westerlies across the central Pacific at subtropical latitudes

could be related to the ENSO-induced upper anticyclonic couplet straddling the equator.

In comparison with the South Pacific, the circulation patterns over the Indian Ocean were chiefly zonal. The South Atlantic circulations were also mainly zonal in June and July but blocking was prominent in August.

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