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Seasonal climate summary southern hemisphere (autumn 1988): ending of the equatorial Pacific warm episode (1986-87) and indications of a transitional phase

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The main climate features of the southern hemisphere during the austral autumn (March, April, May 1988) are presented, emphasising conditions in the Australian region.
The end of the 1986-87 warm episode in the central and eastern equatorial Pacific was evident early in autumn. As the season progressed, the main indicators signalled the emergence of a transitional phase in the equatorial Pacific.

Introduction

In this climate summary, analyses of the southern hemisphere circulation for the austral autumn, March to May 1988 inclusive, are described with more detailed attention being given to the Australian region.

Tropical conditions corresponding to the ending of the El Niño-Southern Oscillation warm episode (1986-87) in the eastern Pacific are discussed, distinguishing some particular features of this episode. A transitional phase became apparent as sea surface temperatures in the central and eastern equatorial Pacific fell below average. There was a significant shift in tropical activity from the Pacific to the Indian Ocean, and northwest cloud bands were prominent in the Australian region.

The extratropics showed a tendency towards a three-wave pattern with marked low pressure anomalies at high latitudes in the Pacific and Indian Oceans. In the Australian region the subtropical high pressure ridge shifted northwards of its mean position and blocking activity was above average.

Data sources used in preparation of this summary are listed in the Appendix. The Australian region bounded by the equator, Antarctica, 90°E and the dateline is discussed more fully, especially the rainfall and temperature distributions.

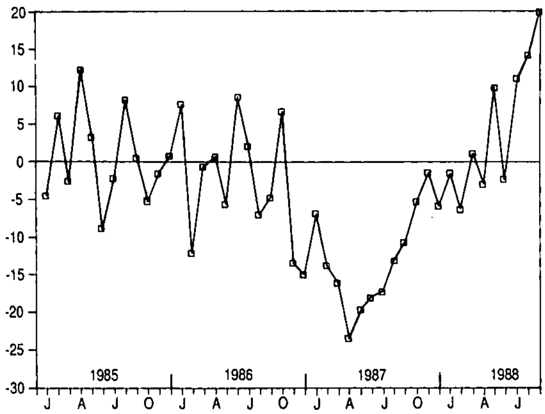
El Niño-Southern Oscillation warm episode (1986-1987)

In the late austral spring 1986, the El Niño-Southern Oscillation warm episode (1986-1987) developed. The Southern Oscillation Index (SOI)* is graphed in Fig. 1.

After reaching its lowest point in April 1987 (−22) the SOI began to rise during winter-spring 1987. It then fluctuated near zero during summer 1987-88 with the decline of the

* The SOI as used in 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 1882-1985.

Fig. 1 Southern Oscillation Index, January 1985—May 1988 inclusive.



warm episode. A rise in SOI to +10 in May (Fig. 1) was indicative of a transitional phase in the eastern equatorial Pacific.

The warm episode reached a mature phase during autumn 1987 (Gaffney and Casey 1987) and continued through winter 1987 (Gaffney 1988). Indications of a waning of the warm episode emerged in spring 1987 (Nydam 1988) before a sustained return towards normal in summer 1987-88 (Casey 1989).

Although the warm episode did not finally come to an end in terms of all main indicators until early autumn 1988, climatic conditions were generally returning to normal at the end of 1987. Hence the designation of the phenomenon as the 1986-87 Pacific warm episode was considered appropriate (see Janowiak 1988).

Evidence for the ending of the warm episode included:

(a) SOI rising to above average (Fig. 1);
(b) sea surface temperatures in the central and eastern equatorial Pacific returning to normal;
(c) lower tropospheric wind index becoming positive, showing anomalous easterlies across the equatorial Pacific;
(d) upper tropospheric wind index becoming positive, showing anomalous westerlies in the central equatorial Pacific; and
(e) convective activity around the equatorial dateline decreasing to normal.

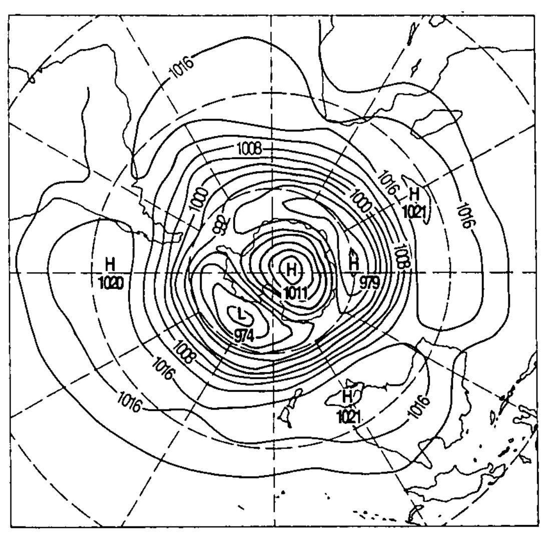
The 1986-87 warm episode had some temporal characteristics which distinguished it from previous episodes:

(a) an onset late in the austral spring (about November) of 1986—the more usual time is autumn; and
(b) a relatively long duration persisting throughout 1987, before declining in summer 1987-88 and coming to an end in early autumn 1988 (about 17 months)—the more common length is about 12 months.

Circulation features

Positive mean sea level pressure anomalies over Antarctica combined with negative anomalies in the circumpolar trough (Figs 2 and 3) to give a relatively strong polar vortex. The subtropical high pressure belt was also relatively strong.

Fig. 2 Autumn (March, April, May) mean sea level pressure analysis (hPa).



The autumn 500 hPa mean analyses showed a three-wave pattern, although four waves were prominent in March and two waves at higher latitudes in May. Major long wave troughs were evident on the mean analysis in the Indian Ocean, the central Pacific and the western Atlantic (Fig. 4). A high pressure anomaly extended south of Australia across Antarctica to the Atlantic (Fig. 5).

Fig. 3 Autumn (March, April, May) mean sea level pressure anomaly analysis (hPa).

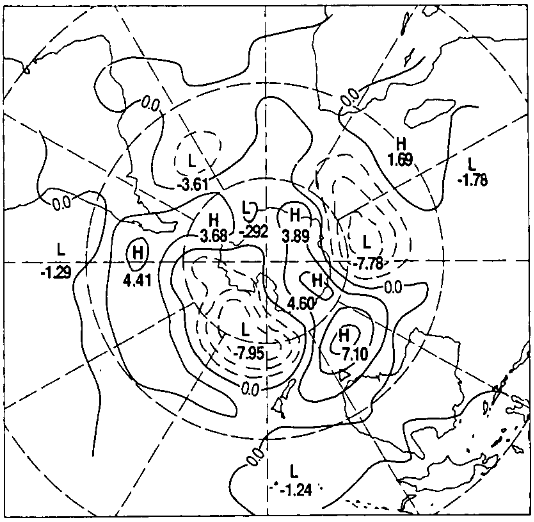
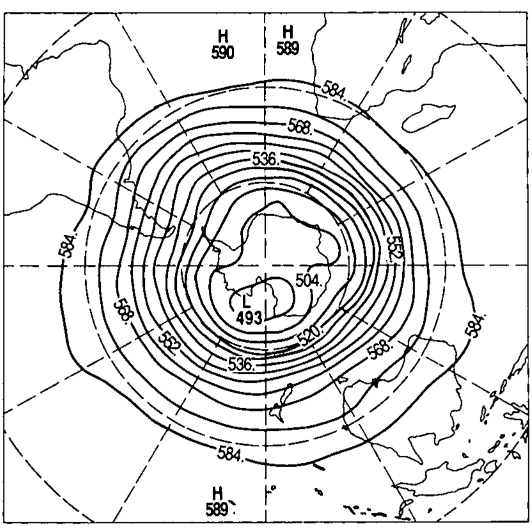
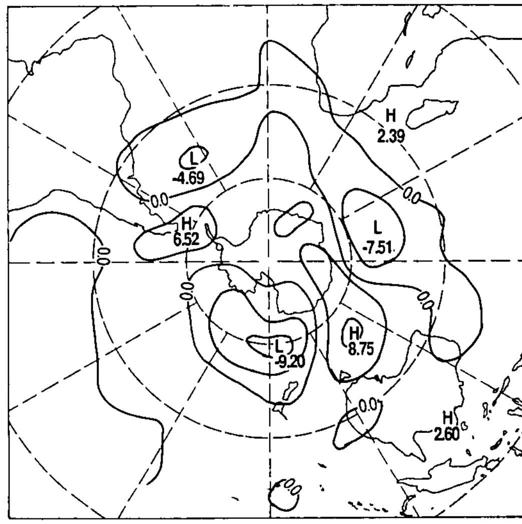


Fig. 4 Autumn (March, April, May) 500 hPa height analysis (dam).



In the Australian region the subtropical high pressure ridge was more intense than normal (Figs 2 and 3). The ridge was displaced well south of its mean position in March and then moved north of its mean position by May.

Fig. 5 Autumn (March, April, May) 500 hPa height anomaly analysis (dam).



Blocking activity in autumn, as assessed by the daily Blocking Index (BI)*, is given in Fig. 6. Blocking episodes were prominent in the Pacific during much of the season with some episodes extending to the western Atlantic. In the western Indian Ocean only a few relatively weak blocks occurred with chiefly zonal flow being maintained in that area. As noted previously, blocking in the Australian region was above average.

The Outgoing Longwave Radiation (OLR) index specifies the outgoing long wave radiation anomaly (standardised) over the area bounded by 5°N-5°S, 160°E-160°W (in tenths of W m^{-2}). In March, for the first time in more than a year, the OLR index was positive (0.8). This indicated a significant reduction in convection around the equatorial dateline and an end to the warm episode. The positive OLR index continued through autumn.

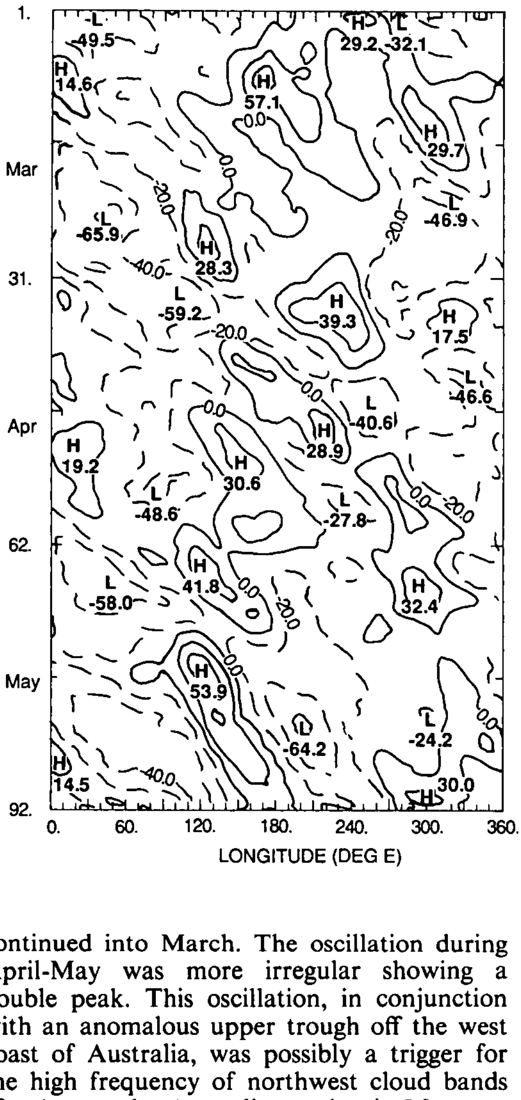
Oscillations of the 5-day mean 200 hPa velocity potential at about 40 to 50-day intervals in the vicinity of the Maritime Continent (Indonesian region) propagated eastwards during summer 1987-88 (Casey 1989) and

* The Blocking Index (BI) values shown in Fig. 6 are derived from:

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

where U is the zonal wind component ($m\ s^{-1}$) and the subscript refers to latitude.

Fig. 6 Daily blocking index: time-longitude section at 55°S. Day 1 is the first of March.



continued into March. The oscillation during April-May was more irregular showing a double peak. This oscillation, in conjunction with an anomalous upper trough off the west coast of Australia, was possibly a trigger for the high frequency of northwest cloud bands (four) over the Australian region in May.

Winds

Low-level (850 hPa) easterly wind anomalies over the equatorial Pacific with anomalous westerlies aloft (200 hPa) were indicative of a vigorous Walker circulation.

In contrast, the equatorial Indian Ocean was characterised by a reversed wind structure with anomalous westerlies at low levels and anomalous easterlies aloft.

The mid-high latitude wind anomalies at 850 hPa and 300 hPa are shown in Figs 7 and 8 respectively. At 850 hPa (Fig. 7) anomalous

Fig. 7 Autumn (March, April, May) 850 hPa wind anomalies (m s^{-1}).

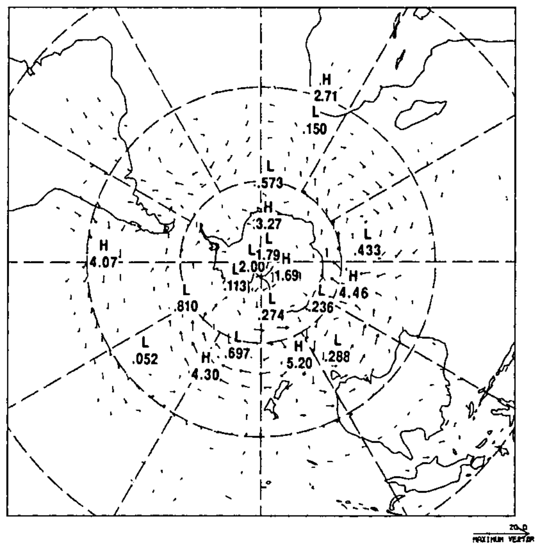
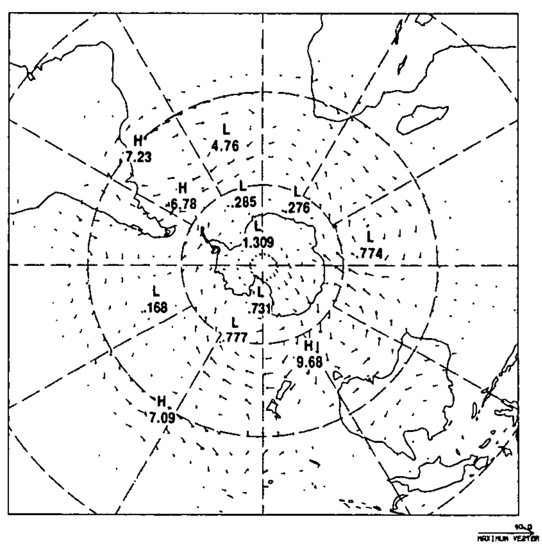


Fig. 8 Autumn (March, April, May) 300 hPa wind anomalies (m s^{-1}).



cyclonic circulations were dominant in the Indian and Pacific Oceans and to a lesser extent in the western Atlantic. An intense anticyclonic anomaly associated with blocking (Fig. 6) extended from southern Australia to Antarctica. These circulations can be directly related to the mean sea level pressure anomalies in Fig. 3. At 300 hPa (Fig. 8) similar wind anomaly patterns prevailed indicating the equivalent barotropic structure of the pressure distribution (see also Fig. 5).

Sea surface temperatures

Sea surface temperatures (SSTs) were 1°C below average in autumn across the equatorial eastern Pacific and also in an extensive area of the southeast Pacific (Fig. 9). This pattern was a significant reversal from the positive anomalies of the warm episode and was indicative of a transition phase. In the western equatorial Pacific, SSTs were above average.

Contrasting with the Pacific, in the tropical Indian Ocean and coastal areas around Australia SST anomalies were about 1°C above average in autumn.

In the tropical Atlantic, autumn SSTs were also about 1°C above average, grading to average at mid-latitudes.

Rainfall

The Australian rainfall for autumn is given in Fig. 10. Streten (1981, 1983) has suggested a correlation between positive and negative SST anomalies in the Australian region and wet and dry years respectively over the continent as a whole. The positive SST anomalies and corresponding above average autumn rainfall were generally consistent with these relationships.

The persistence of upper long wave troughs off the Western Australian coast and relatively high pressures over northern and eastern Australia provide conditions favourable to the formation of northwest cloud bands (Tapp and Barrell 1984). This pattern accorded with the marked northwest to southeast rainfall across Australia (Fig. 10) particularly in March and May. Very much above average rainfall totals (decile 10) were registered in the northwest of Western Australia, through central Australia and over much of southern Queensland, New South Wales and northern Victoria. The main very much below average area (decile 1) was in north Queensland.

Most of South America received average rainfall with an extensive area of southern Brazil and Bolivia receiving rainfall above the 70 percentile. In southern Africa rainfall was mostly average, the main exception being in the Mozambique-Zambia areas where falls were below the 30 percentile. New Zealand rainfall was chiefly below the 30 percentile.

Fig. 10 Autumn (March, April, May) rainfall in Australia—decile range values based on district averages.

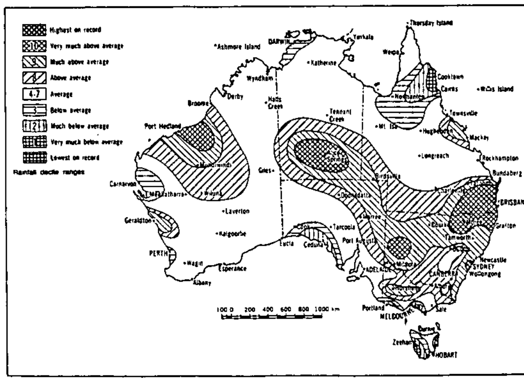
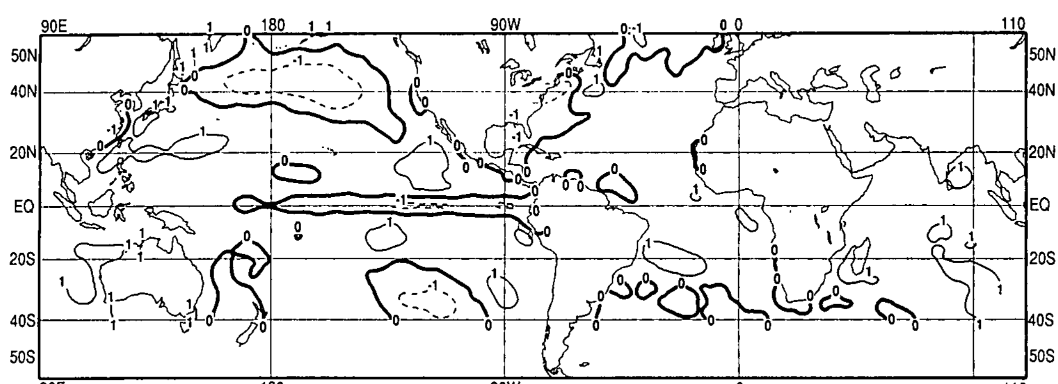


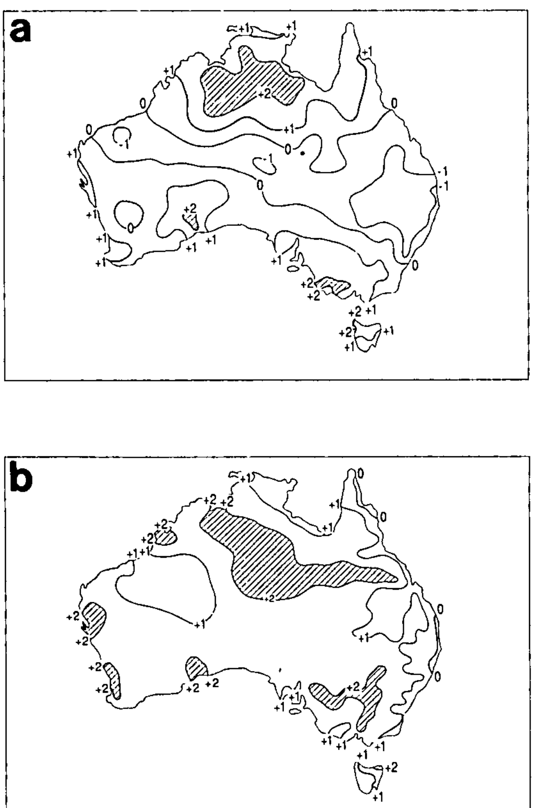
Fig. 9 Autumn (March, April, May) sea surface temperature anomalies (°C) (Source: CAC, Washington).



Temperature

Over Australia, temperatures were generally above average particularly in the north of the continent (Fig. 11). Maxima were above average in most of the continent, the main exception being a band of country extending from the northwest coast across the interior to the east coast which was about 1°C below average (Fig. 11(a)). Minima were above average throughout, with many areas being about 2°C above (Fig. 11(b)).

Fig. 11 Autumn (March, April, May) temperature anomalies for Australia (°C): (a) maximum; (b) minimum.



Around the hemisphere South American mean temperatures were greater than the 70 percentile over much of that continent. In much of southern Africa mean temperatures were also greater than the 70 percentile. In contrast, New Zealand temperatures were generally below the 30 percentile.

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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.

Appendix

Data sources used in the compilation of material for this review were:

Bureau of Meteorology. 1988. *Monthly Rainfall Review.* (March, April, May 1988 issues). Bur. Met., Australia.*

Climate Analysis Center (CAC), Climate Diagnostics Bulletin, March, April, May 1988 and seasonal analyses.†

Darwin Tropical Diagnostics Statement, March, April, May 1988.§

Monthly Report on Climate System, March, April, May 1988.¶

National Climate Centre Climate Monitoring Bulletin—Southern Hemisphere, March, April, May 1988.‖

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

Surface mean sea level pressure data archived by the National Climate Centre, Melbourne.‖

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* Obtainable from the Publications Subsection, 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 Regional Office, Bureau of Meteorology, PO Box 735, Darwin 8001, Australia.

¶ Obtainable from the Japan Meteorological Agency, 1-3-4, Ote-machi chiyoda-ku, Tokyo, Japan.

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