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Seasonal climate summary southern hemisphere (summer 1988–89): a peak in the cold episode in the equatorial Pacific

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The climate features of the southern hemisphere summer 1988–89 are summarised giving particular attention to the Australian region.
The cold episode in the eastern equatorial Pacific, which had been building up in the winter and spring of 1988, reached a peak about early summer and then weakened temporarily. At mid-latitudes conditions were chiefly warmer than normal, while at mid to high latitudes there was a general tendency towards more normal circulation patterns. However, blocking activity was above normal in the Tasman Sea - New Zealand region in January and February.
Southern Africa received above average summer rains, but in South America, northern Argentina was abnormally dry. Australian rainfall was chiefly average.

Introduction

This climate summary reviews the southern hemisphere circulation for the summer 1988–89 (December 1988 - February 1989 inclusive). Tropical climatic indicators and circulation features are discussed. A description of Australian rainfall is provided along with comments on temperature anomalies.

The main data sources were the Climate Monitoring Bulletin — Southern Hemisphere and the Darwin Tropical Diagnostic Statement issued monthly by the Bureau of Meteorology, Australia. Others were the monthly climate bulletins issued routinely by national weather services. Data sources are listed in the Appendix.

A cold episode, with extensive areas of the equatorial central and eastern Pacific sea-surface temperatures (SSTs) below average, was established in the austral winter 1988. This intensified in spring 1988 (Nydam 1989; Kousky 1989) and reached a peak in early summer (December 1988).

Climatic indices

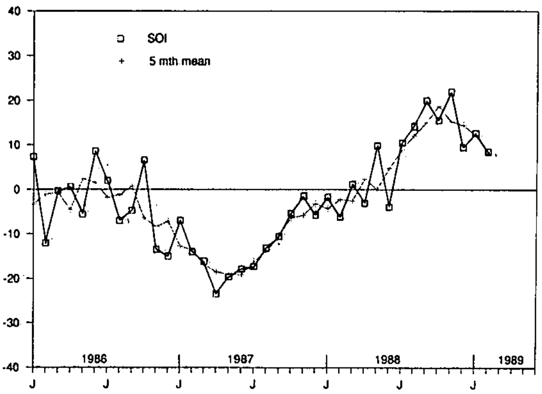
By the end of summer (February 1989) standard climatic indices for monitoring warm and cold episodes in the eastern equatorial Pacific were mainly signalling the weakening of the current cold episode. For example, the Southern Oscillation Index (SOI)* was falling, with trade winds abating.

The SOI and 5-month running mean are in Fig. 1. After reaching a peak of +20 in spring 1988 the SOI decreased during summer to about +8 at the end of February 1989.

The central and eastern equatorial Pacific sea-surface temperature indices were showing a reduction in magnitude of negative anomalies at the end of summer. This signalled a declining cold episode, particularly evident in the extreme

*The Southern Oscillation Index (SOI) used here is 10 times the Tahiti minus Darwin MSL pressure anomaly divided by the standard deviation for the month, based on the period 1882 to 1985.

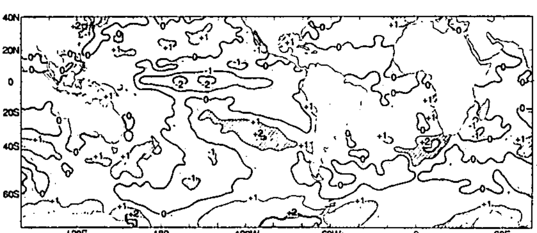
Fig. 1 Southern Oscillation Index, January 1986 to February 1989 inclusive.



eastern part of the equatorial Pacific. Summer SST anomalies are depicted in Fig. 2, and further description of SSTs is given in the next section.

Pacific 850 hPa zonal wind indices indicated that the strong anomalous trade winds were weakening, with a return towards normal conditions in the Pacific.

Fig. 2 Summer 1988–89 (December, January, February) sea-surface temperature anomaly (°C).



Sea-surface temperatures

The sea-surface temperature anomalies for summer are shown in Fig. 2 (Brecht, National Meteorological Centre, Melbourne, personal communication). As a measure of the declining cold episode the negative SST anomalies of the previous winter–spring period in the extreme eastern equatorial Pacific became slightly positive during summer. Similarly in the central to eastern equatorial Pacific, negative departures generally decreased slightly (1°C) in magnitude from 2–3°C to 1–2°C.

In comparison with the Pacific the equatorial SST departures in the Atlantic and Indian Oceans were slightly positive (0.5°C).

At mid-latitudes around the hemisphere positive departures were general, particularly in the Indian and Pacific Oceans (1–2°C). The only exceptions were small areas of negative departures (1°C) around 50°S in the Pacific.

The Australian coastal regions were slightly positive (0–1°C), rising in the Gulf of Carpentaria (1–2°C).

Surface analyses

The summer mean sea level pressure distribution and anomalies are shown in Figs 3 and 4 respectively. Around the hemisphere the subtropical high pressure cells were generally more intense and further south than normal, except in the southwest Indian Ocean. This correlated with above average rainfall in much of southern Africa and parts of southern Australia. At high latitudes anomalies were significantly negative.

Upper air analyses

The 500 hPa analysis and anomalies given in Figs 5 and 6 exhibit a strong three-wave pattern with a marked long wave trough in the Pacific extending from Antarctica to the tropics. Long wave troughs in the Indian and Atlantic Oceans were less intense. Anomalies were chiefly positive at mid-latitudes, except in the southern Indian Ocean.

Fig. 3 Summer 1988–89 (December, January, February) mean sea level pressure (hPa).

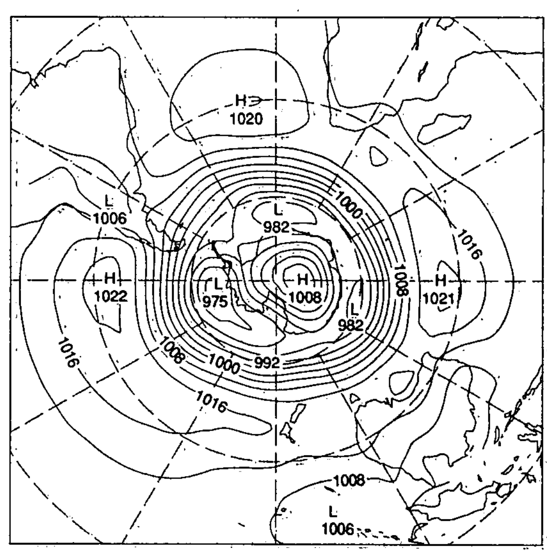
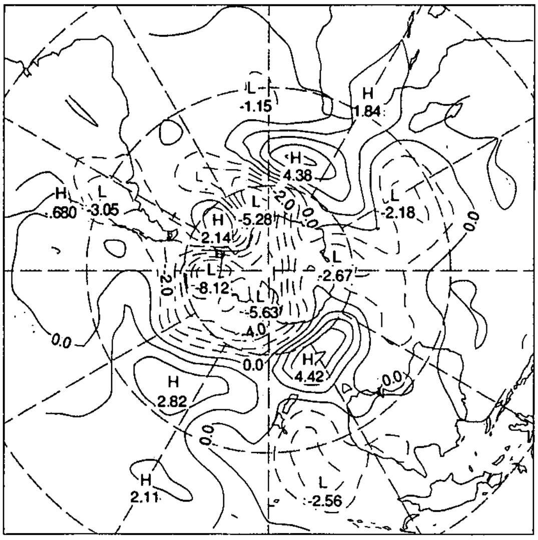


Fig. 4 Summer 1988–89 (December, January, February) mean sea level pressure anomaly (hPa).



The positive anomaly over the tip of South America (Fig. 6) could be linked to the abnormal dryness which occurred in the north of Argentina.

A similar three-wave pattern was evident at 300 hPa (Figs 7 and 8) showing the equivalent barotropic nature of the circulation. The Pacific long wave trough was also notably prominent at this level.

Fig. 5 Summer 1988–89 (December, January, February) 500 hPa mean height (dam).

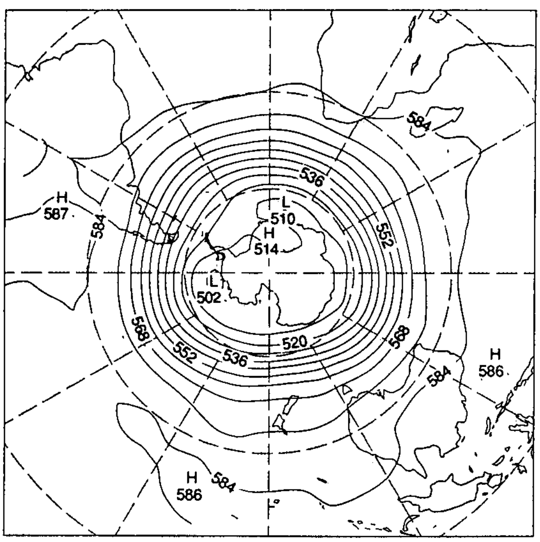


Fig. 6 Summer 1988–89 (December, January, February) 500 hPa height anomaly (dam).

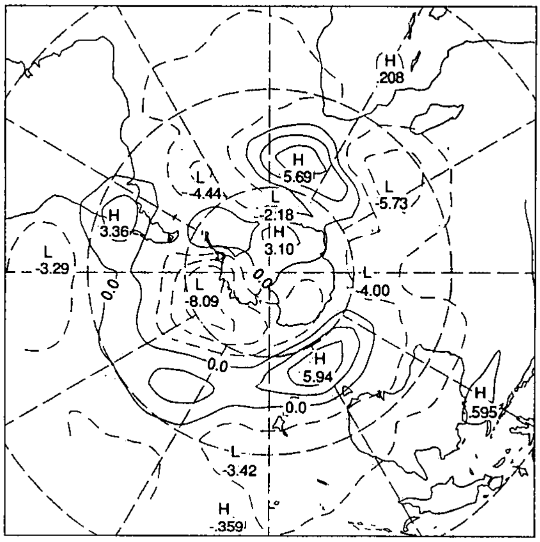
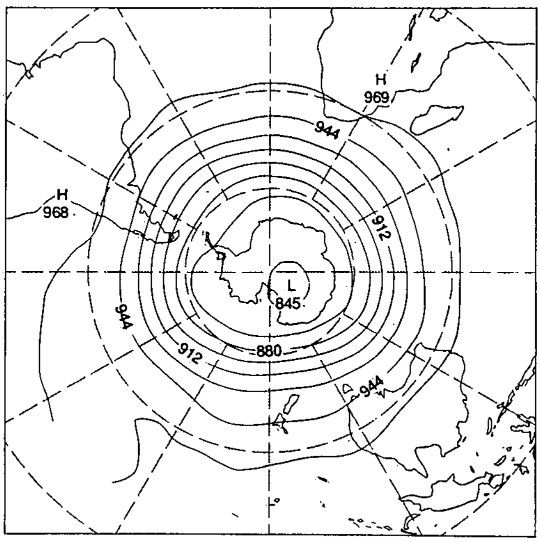


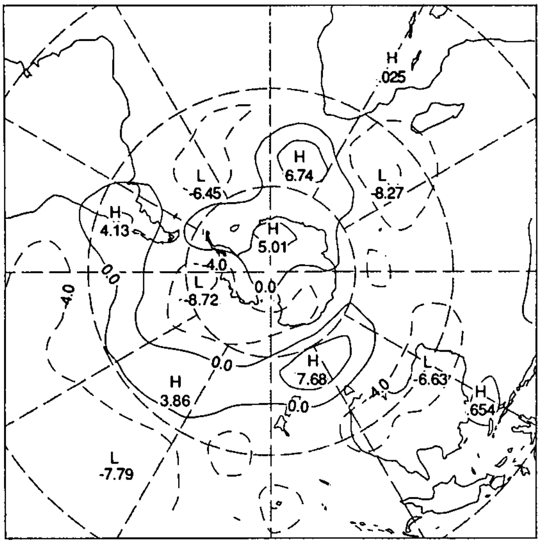
Fig. 7 Summer 1988–89 (December, January, February) 300 hPa mean height (dam).



Blocking

During most of summer the major centre for blocking action was located in the Tasman Sea — New Zealand region. Blocking action, as meas-

Fig. 8 Summer 1988–89 (December, January, February) 300 hPa height anomaly (dam).



ured by the Blocking Index,* is depicted in Fig. 9. A series of blocking episodes commenced in this region around mid-December and were notably strong in January–February. Brief blocking occurred in the Indian Ocean, but the circulation pattern was chiefly zonal. In the Atlantic the circulation was zonal throughout most of the season, corresponding with a general lack of meridional anomalies in the wind pattern (Fig. 11).

Winds

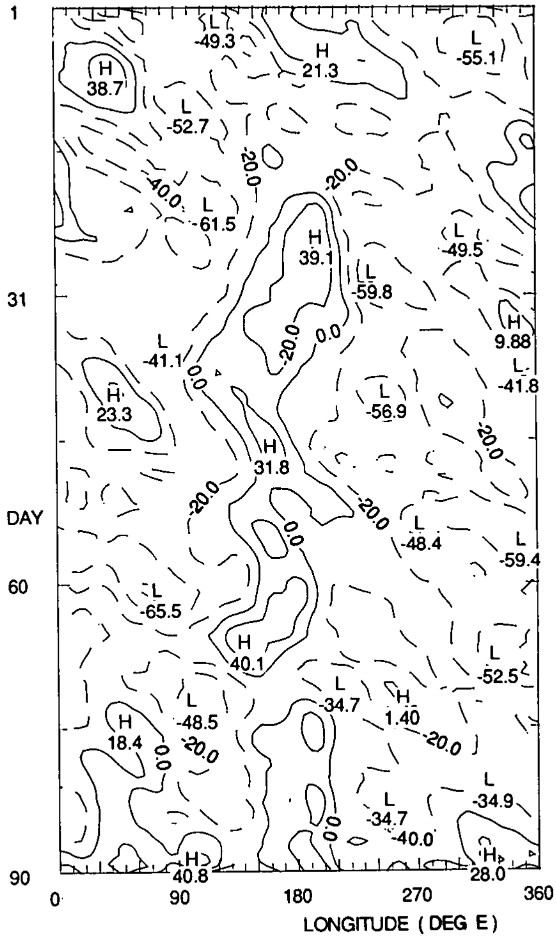
In the lower (850 hPa) and upper (300 hPa) troposphere summer winds around the hemisphere were mostly about average (Figs 10 and 11). Notable exceptions were anomalous anticyclonic circulations south of Africa and Australia at both lower and upper levels. The wind anomalies were generally consistent with the pressure–height anomalies shown in Figs 4, 6 and 8.

General climatic conditions

Well above average summer rains were received across much of southern Africa, and in some inland areas rainfall (October 1988–March 1989) was 150 per cent of normal. This rainfall could be related to relatively low height anomalies in this region (Fig. 6).

*Blocking Index (BI):
$BI = U_{27.5} + U_{57.5} - (U_{42.5} + U_{47.5})$
where U is the 500 hPa mean zonal wind and the subscript is the corresponding latitude.

Fig. 9 Summer 1988–89 (December, January, February) daily Blocking Index: time-longitude section at 55°S. Day 1 is 1 December.



At the end of 1988, very dry conditions had been occurring in northern Argentina for about six months. By the close of summer (February 1989) northern Argentina remained abnormally dry with Uruguay also becoming dry. It was unusually warm in this area with mean summer temperatures up to 5°C above normal.

Australian conditions

Rainfall

For summer as a whole much of Australia received about average rainfall (Fig. 12). However, there were significant monthly variations during the season, with December being a very wet month and January and February markedly dry.

Fig. 10 Summer 1988–89 (December, January, February) 300 hPa wind anomalies (m s^{-1}).

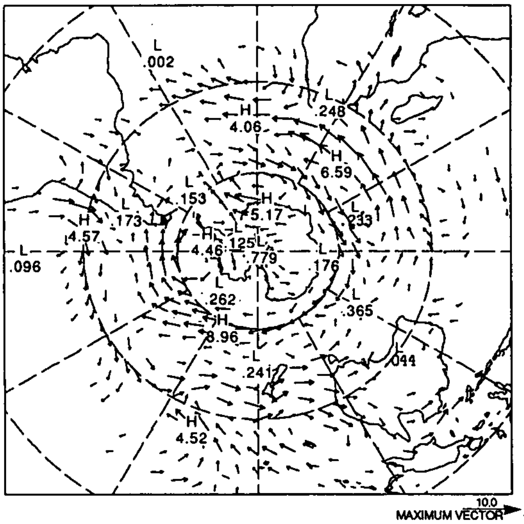
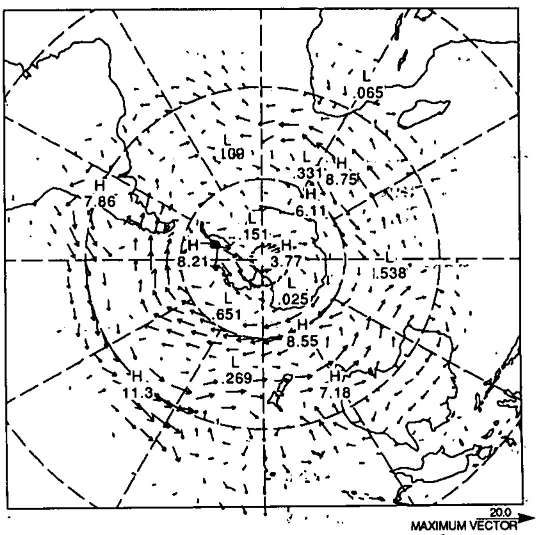


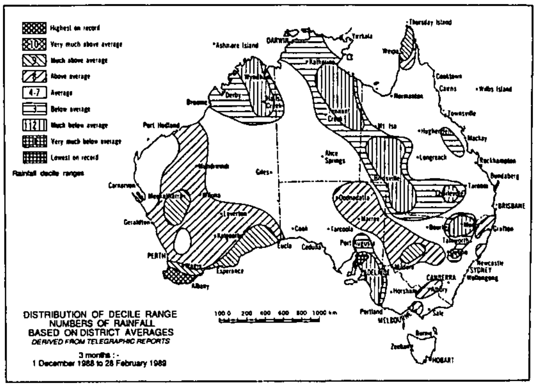
Fig. 11 Summer 1988–89 (December, January, February) 850 hPa wind anomalies (m s^{-1}).



Summer seasonal rainfall totals were below average in substantial areas extending from northwest Australia across western Queensland to the northeast of New South Wales (Fig. 12). Rainfall in the southeastern part of South Australia was also well below average for the season.

Summer rainfall was mainly controlled by the advance and retreat of the northern Australian monsoon, and related convectional activity asso-

Fig. 12 Summer 1988–89 (December, January, February) rainfall in Australia: decile range values based on district averages.



ciated with the 30 to 60-day oscillation. Characteristics of this oscillation, first identified by Madden and Julian (1972), have been investigated by a number of authors including, for example, Krishnamurti et al. (1987); aspects of convective activity in the Australian monsoon have been investigated by Keenan and Brody (1988).

In late November–early December 1988 the onset of the northern Australian monsoon was apparently triggered by an active phase of the 30 to 60-day oscillation. The monsoonal trough dipped well southwards over Australia during December, producing very much above average rains over extensive areas of the continent. Some parts received record totals for that month, particularly across the southern inland.

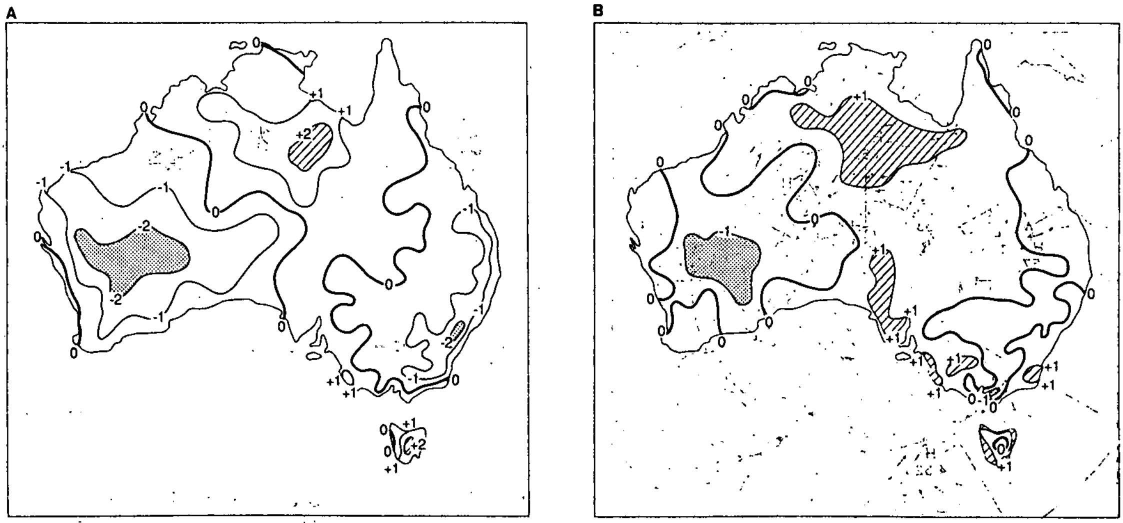
In early January 1989 the monsoon trough weakened and retreated northwards, resulting in a break period in monsoonal rains. January rainfall was very much below average over extensive areas of Australia with northern parts of South Australia recording lowest ever monthly totals. Towards the end of January the next active phase of the 30 to 60-day oscillation became evident, although convective activity associated with this phase was mainly confined to parts of the northern coast.

In February, the monsoon trough generally remained to the north of Australia and the next active phase did not occur until early March. Rainfall in February, over an extensive area stretching from the north coast across the interior to the south coast, was very much below average. South Australia was again markedly dry with lowest ever February totals in most of the State.

Temperatures

Mean maximum temperatures for summer over Australia were 1–2°C below average in the southwest and southeast (Fig. 13(a)). In contrast,

Fig. 13. Summer 1988–89 (December, January, February) temperature anomalies (°C) for Australia: (a) maximum, (b) minimum.



maxima were 1–2°C above average in the central north of the continent and extending southwards through South Australia to Tasmania. Mean minimum temperatures (Fig. 13(b)) generally followed a similar pattern as for the maxima, however departures from average were small, being chiefly less than 1°C. Broadly these temperature distributions could be related to the rainfall (Fig. 12) with below average temperatures corresponding to above average rainfall and vice versa.

References

Keenan, T.D. and Brody, L.R. 1988. Synoptic scale modulation of convection during the Australian summer monsoon. *Mon. Weath. Rev.*, *116*, 71–85.

Kousky, V.E. 1989. Seasonal climate summary. The global climate for September-November 1988: high Southern Oscillation Index and cold episode characteristics continued. *Jnl climate*, *2*, 173–92.

Krishnamurti, T.N., Oosterhof, D.K. and Mehra, A.V. 1987. Air-sea interaction on the time scale of 30 to 50 days. *J. Atmos. Sci.*, *45*, 1304–22.

Madden, R.A. and Julian, P.R. 1972. Description of global-scale circulation cells in the tropics with a 40-50 day period. *J. Atmos. Sci.*, *29*, 1109–23.

Nydam, P.G. 1989. Seasonal climate summary southern hemisphere (spring 1988): the cold episode in the central-eastern tropical Pacific intensifies. *Aust. Met. Mag.*, *37*, 185–91.

Appendix

Data sources used for this review were:

Climate Analysis Center (CAC), Climate Diagnostics Bulletin, December 1988, January and February 1989 and seasonal analyses.*

Darwin Tropical Diagnostic Statement, December 1988, January and February 1989.†

Monthly report on Climate System, December 1988, January and February 1989.§

National Climate Centre (NCC) Climate Monitoring Bulletin — Southern Hemisphere, December 1988, January and February 1989.‡

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

Obtainable from:

*Climate Analysis Center, National Weather Service, Washington D.C. 20233, USA.

†Regional Office, Bureau of Meteorology, PO Box 735, Darwin 0801, Australia.

§Japan Meteorological Agency, 1-3-4, Ote-machi chiyoda-ku, Tokyo, Japan.

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