Aust. Met. Mag. 43 (1994) 49–57

Seasonal climate summary southern hemisphere (winter 1992): warm Pacific episode weakens

Trevor Casey
National Climate Centre, Bureau of Meteorology, Australia

(Manuscript received December 1993; revised December 1993)

A summary of the southern hemisphere winter season climate for 1992 is presented with an emphasis on the Australian region. Warm ocean conditions in the eastern Pacific and other atmospheric circulation anomalies returned towards normal during the season, signalling a decline of the 1991–92 El Niño/Southern Oscillation warm episode.

Introduction

The season commenced with strong and persistent circulation anomalies across the Pacific region which were associated with warm ocean conditions in the eastern equatorial Pacific. Anomalous tropical convective activity in the central and eastern Pacific and a suppression of activity over Indonesia were typical signs of a mature El Niño/Southern Oscillation (ENSO) warm episode. As the season progressed, a rapid decline in sea-surface temperature (SST) in the eastern equatorial Pacific occurred with the first appearance of negative anomalies below −1°C in that region since August 1988, and there was a shift in maximum tropical convective activity towards the west. The onset of the South-East Asia/Indian monsoon was delayed, becoming established over the Indian subcontinent in mid-July, and the rainy season over the western Sahel was slow in beginning. Both of these anomalies were associated with a southward displacement of the Somali jet in June and July. By August, many of the large-scale circulation features were returning towards normal; tropical convection in the eastern and central Pacific had subsided to normal and normal convective activity re-appeared in the western Pacific. The southern hemisphere circulation planetary wave pattern, after displaying typical winter warm episode teleconnection anomalies across the south Pacific early in the season, returned to a more usual climatological wave mode in July. In the later part of the season, the major planetary wave had shown a general reorganisation and a substantial westward shift of the major anomalies in the Pacific region.

Mean sea level (MSL) pressures in the Australian region were generally above average throughout the season. Over northeastern Australia, rainfall was very much below average in the early part of the season, resulting in below average seasonal values. In the west, monthly rainfall alternated from above to below and back to above average over the season.

Corresponding author address: Mr T. Casey, National Climate Centre, Bureau of Meteorology, GPO Box 1289K, Melbourne, Vic. 3001, Australia.

Data sources

Data and information used in the preparation of this review have been obtained from a number of sources including several routine climate monitoring publications issued by national meteorological authorities. Where appropriate, material obtained from these sources has been referenced in the text by the following abbreviations: *Climate Monitoring Bulletin* (CMB), *Climate Diagnostics Bulletin* (CDB), *Weekly Climate Bulletin* (WCB), *Monthly Report on Climate System* (JMA). More complete details of these sources are contained in the appendix.

General circulation

Figure 1 shows the MSL mean pressure analysis for the three-month period June to August 1992. High pressure centres were located over Australia,

Fig. 1 Winter (June, July, August) 1992 mean sea level pressure (hPa).

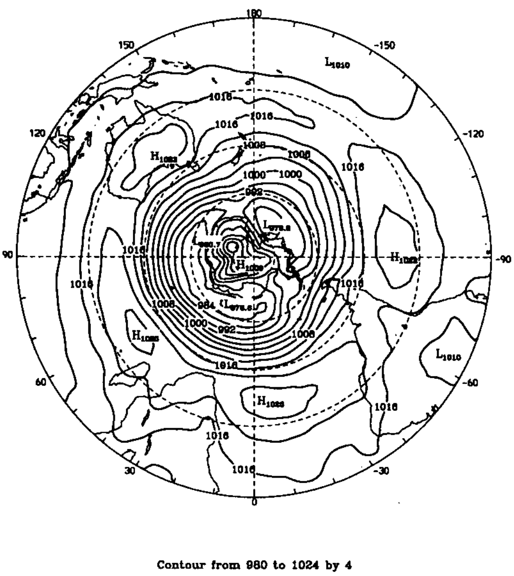
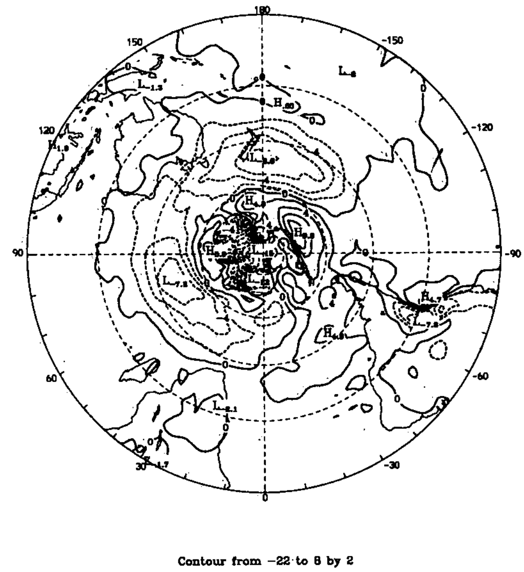


Fig. 2 Winter (June, July, August) 1992 mean sea level pressure anomaly (hPa).



in the southeast Pacific, South Atlantic and western Indian Oceans. The MSL pressure anomaly analysis for the season (Fig. 2) indicates that moderate to strong negative pressure anomalies extended through the middle latitudes from the Indian Ocean to the central Pacific.

The mean 300 hPa geopotential height anomaly pattern for the three months of June to August is shown in Fig. 3. The analysis shows a strong wavenumber two pattern at high latitudes with an eastward tilt to the trough and ridge axes in middle latitudes indicating a cyclonic zonal shear from middle to high latitudes. The anomaly pattern also exhibits a strong wavenumber one asymmetry in the Pacific sector, typical of warm Pacific El Niño episodes (van Loon and Shea 1987). An approximately great circle teleconnection ray-path pattern of alternating anomalies can be traced across the South Pacific from the Coral Sea to New Zealand, to the Antarctic coast at the Greenwich meridian and to a positive anomaly at high latitudes south of Australia.

Vector wind anomalies at 300 hPa (Fig. 4) show a weakened polar vortex with easterly anomalies around most of the hemisphere at high latitudes. Easterly anomalies were evident at middle latitudes in the Pacific sector, Indian Ocean and south Atlantic. One consequence of this was a cyclonic meridional shear of the zonal flow between middle and high latitudes.

Fig. 3 Winter (June, July, August) 1992 300 hPa geopotential height anomalies (dam).

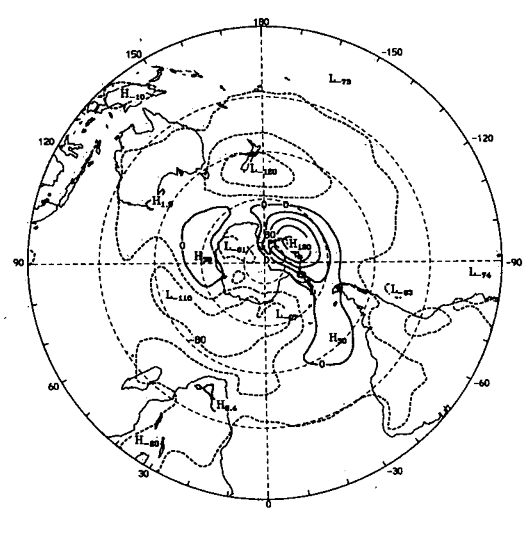
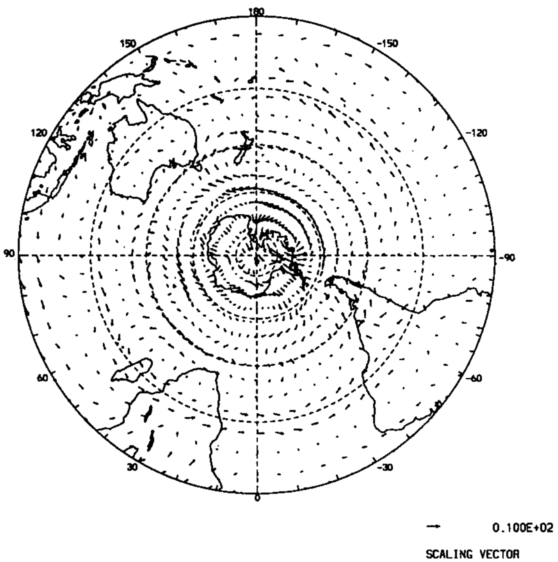


Fig. 4 Winter (June, July, August) 1992 300 hPa vector wind anomalies (m s^{-1}). Arrow length of 5 degrees latitude equal to 10 m s^{-1}.



Climatic anomalies

In June the southern hemisphere extratropical circulation was dominated by large and persistent height and pressure anomalies. Positive height anomalies were located over high latitudes of the Indian and South Pacific Ocean basins with accompanying negative height anomalies through much of the mid-latitude sectors of the same regions. These anomalies had been persistent since May and were typical of the South Pacific El Niño winter teleconnection response pattern (Mo and White 1985) and planetary zonal wave response to anomalous tropical convective activity in the eastern Pacific. An eastward tilting trough and convolution pattern was evident in eastern Pacific mid-latitudes (CMB, June 1992) with an associated split in the zonal flow and there were recurring formations of blocking dipoles in that region during the month. Upper troposphere westerlies in the middle latitudes of the Indian Ocean were anomalously strong and were associated with stronger than normal transient eddy kinetic energy activity in that region. The circumpolar vortex was weaker than normal, as evidenced by anomalous easterlies at high latitudes (CMB).

Large temperature and precipitation anomalies were associated with the circulation anomalies. Warm and wet conditions were experienced in west Brazil, central Argentina and eastern Ecuador. It was warm over eastern South Africa and warmer and drier than normal over Indonesia. Cooler and drier than normal conditions were experienced over the southern Tasman region between southeast Australia and New Zealand. Dry conditions continued over central and southern Queensland, extending the dry spell which had persisted through the autumn (Wright 1993).

The mean circulation pattern returned to a three-wave configuration (CMB) in July, more consistent with the climatological standing wave pattern. However, strong negative anomalies persisted at middle to high latitudes in the central Pacific, south Atlantic and central Indian Ocean. The delayed onset of the Indian monsoon in mid-July and consequent marked increase in tropical convective activity in the Bay of Bengal region was associated with a strengthening of positive height anomalies over Australia due to the advection of anticyclonic vorticity in the enhanced meridional circulation into the southern hemisphere subtropics. A positive height anomaly persisted in the central South Pacific and was associated with an anomalous split flow pattern through the eastern Pacific region. The eastern Pacific circulation anomalies were associated with alternating temperature and rainfall patterns over South America. Uruguay and southern Brazil experienced wet conditions in the early part of the month but in the second half cold air was advected over central South America producing a cold spell in Bolivia and Paraguay where temperatures were more than 5°C below average for the month. There was a slow start to the rainy season in the western Sahel but an end to the dry conditions which had been experienced in New Zealand.

A four-wave pattern became established in the mean zonal circulation in August with an accompanying two-wave pattern in the height anomalies (CMB). The negative anomaly centre which had been located at middle latitudes in the central Pacific shifted to near the dateline, although negative anomalies continued to extend through middle latitudes from the eastern Indian Ocean to South America. The other major negative anomaly was located to the south of Africa. Transient eddy activity was well above average in the southern central Pacific in association with the anomalously low heights in the region. Flow became more zonal through the mid-latitude Pacific in August, compared to July when the flow was more meridional because of the persistent trough in the central Pacific and diffluent pattern to the west of South America. The shift of strong negative height anomalies to near the dateline brought very cold and wet conditions to New Zealand in the later part of August, where snow storms caused the loss of over a million head of livestock. After a disappointing start to the rainy season, rainfall deficits began to develop in the western Sahel.

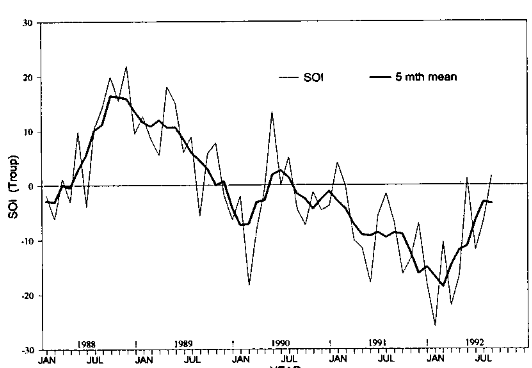
El Niño/Southern Oscillation indicators

The Southern Oscillation Index (SOI) which had fallen to around −18 (cf. standard deviation of 10)* in May showed a steady rise from near −12 in June to +1.7 in August (Fig. 5). At the western end of the indicator baseline, MSL pressures reached their highest departures from normal at Darwin during the middle part of the season, while at Tahiti, pressures rose from well below normal in June to slightly above average values in August. The changes in pressure distribution across the Indian–Pacific region can be directly attributed to the dissipation of the South Pacific teleconnection response pattern during July and the westward shift of the pressure anomaly centres which occurred in the later part of the season.

Low-level easterly winds along the equator strengthened across the entire Pacific during the winter months and were close to normal strength at the end of the season. Shoaling of the thermocline and upwelling of cold water in the eastern Pacific occurred in July producing a strip of below average sea-surface temperature anomalies along the equator which extended westward towards the central Pacific in August (Figs 6 to 8). Spatially averaged SSTs over the 10 degree latitude band centred on the equator in the eastern Pacific showed significant falls over the winter months, however, a small area of warm anomalies remained on the equator near the dateline throughout the season. Subsurface temperature section analyses along the equator (CMB) indicated that below average subsurface temperatures in the western Pacific were associated with a shallower thermocline. There was some evidence in the month-to-month analyses to suggest that an ocean Kelvin wave travelling from the western Pacific produced the shoaling of the thermocline in the eastern Pacific in July.

Outgoing long wave radiation (OLR) measurements confirmed the enhanced tropical convective activity in the eastern and central Pacific in the early part of the season and the return to about normal convective activity in the western Pacific in the later part of the season. The major tropical convective activity centres as inferred from the OLR data in June and July were all located north of the equator; in the far eastern tropical Pacific, central Africa and in the region of the Indian subcontinent. Tropical convection in the eastern Pacific was still active in August, with several tropical cyclones forming in the region, but activity had returned towards the climatological average.

Fig. 5 Southern Oscillation Index (SOI) January 1988 to August 1992.



* The Southern Oscillation Index (SOI) as used here is 10 times the monthly mean Tahiti minus Darwin MSL pressure difference anomaly normalised by the standard deviation of the differences, based on the pressure records from 1882 to 1992.

Intraseasonal oscillation

An analysis of upper troposphere divergence as indicated by velocity potential at 200 hPa for the three-month period June to August is shown in Fig. 9. Centres of minimum velocity potential are representative of maximum tropical convective activity and indicate that the mean seasonal average was a maximum in the region near the Philippines, close to the climatological mean location (Hoskins et al. 1989). Monthly analyses (not shown) indicate that the maximum in convective activity shifted from just west of the Philippines in June to the Bay of Bengal region in July, and then advanced eastward and southward to just east of the Philippines in August. Intraseasonal oscillations in the amplitude of the upper troposphere velocity potential to the north of Australia, measured in the region from 5°N to 5°S and 120 to 140°E, are shown in Fig. 10. Maximum convective activity occurred in this region in mid-June, middle to late July and in mid-August. The mean period of the dominant oscillation over the season was close to thirty days.

Fig. 6 Sea-surface temperature anomaly (℃), June 1992.

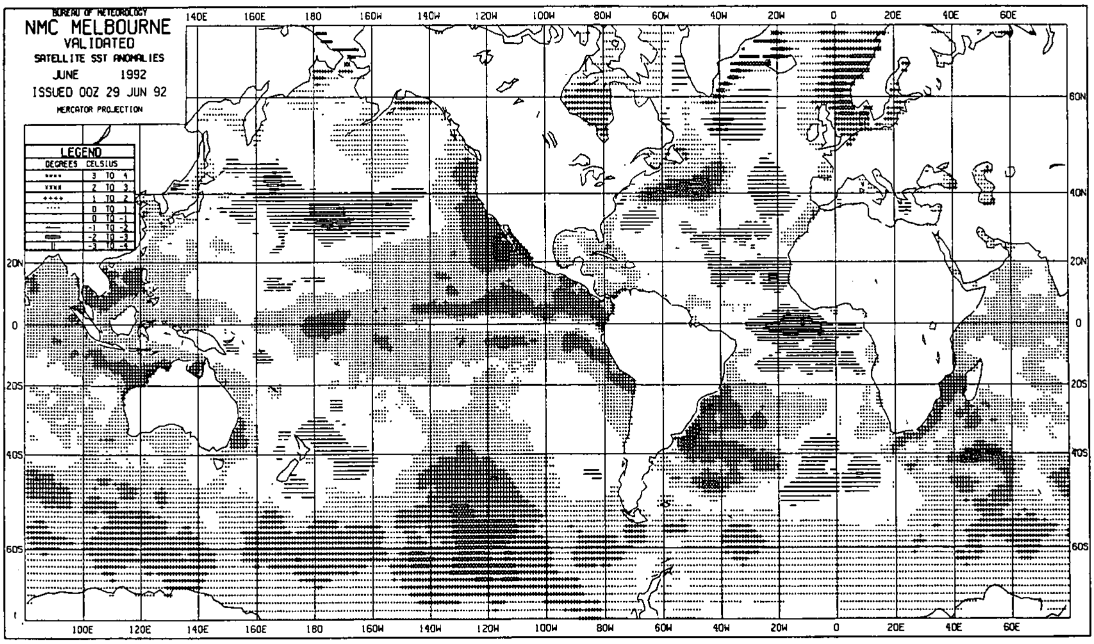


Fig. 7 Sea-surface temperature anomaly (℃), July 1992.

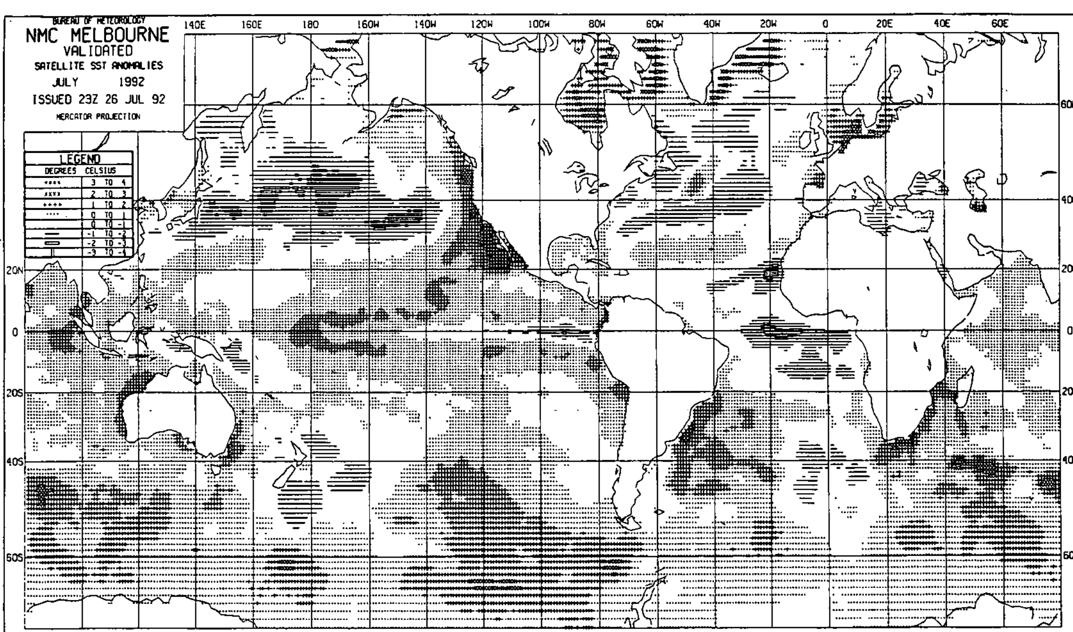


Fig. 8 Sea-surface temperature anomaly (°C), August 1992.

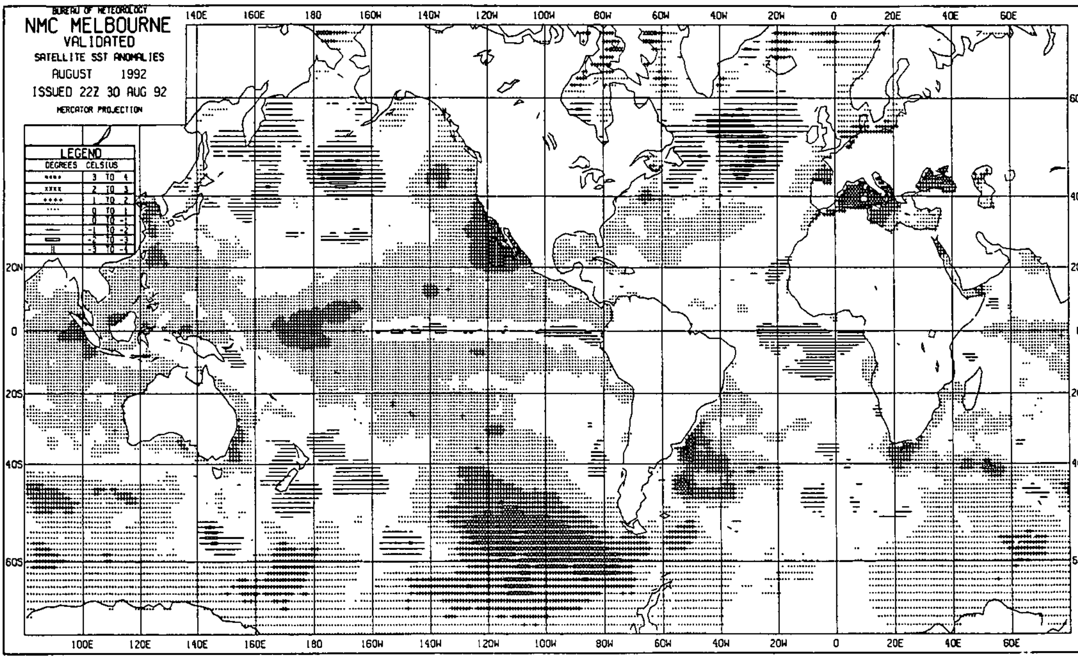


Fig. 9 Winter (June, July, August) 1992 200 hPa velocity potential ($10^{-6}s^{-1}$).

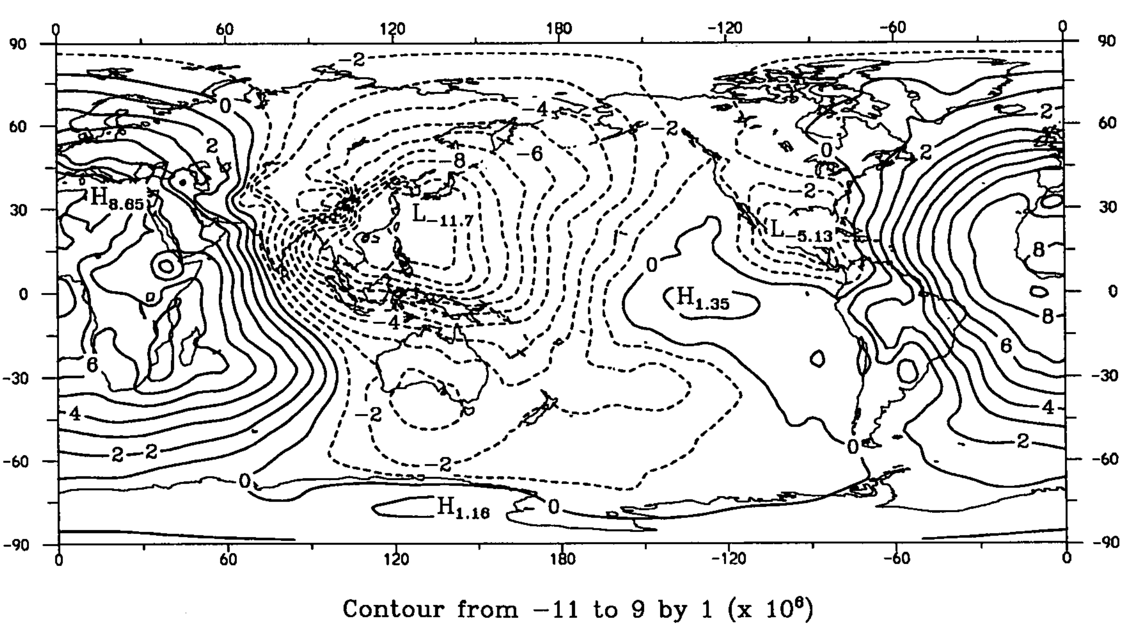
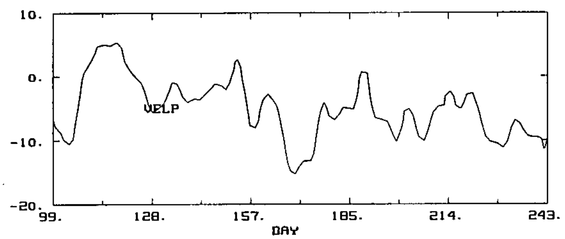


Fig. 10 Time-series plot of velocity potential 5°N to 5°S, 120 to 140°E. April to August 1992 ($10^{-6}s^{-1}$).



Australian region

Rainfall over the three months, June to August, was below average over the northeast of the country, largely as a result of deficits early in the season associated with the mature phase of the El Niño episode which had persisted since autumn. Rainfall was above average in a band extending across Western Australia from the west coast to the Bight (Fig. 11).

Seasonal mean daytime maximum temperatures (Fig. 12) were close to normal with only slight excesses in the northwest and slightly below average conditions in the southern western interior. Mean minimum temperatures averaged over the season were above normal over the northwest of the continent, but generally close to average over the remainder (Fig. 13).

In June, a four-wave hemispheric zonal circulation pattern was evident in the early part of the month which evolved into a more progressive five-wave pattern during the middle part. A blocking dipole developed in the southern Tasman Sea in the last week. A northwest cloudband development and a cut-off low produced rain over the west of the country in the first half and the remainder of the monthly falls were largely due to weak trough and frontal activity over the southern coastal region. Very much below average rainfall was received in the northeast where serious rainfall deficits in southern and central Queensland reached 15-month durations (CMB). Daytime maximum temperatures were above average over the northwest as a result of northwesterly wind anomalies advecting tropical maritime air from the Indian Ocean and minimum temperatures

Fig. 11 Winter (June, July, August) 1992 Australian rainfall. Decile range values based on district averages.

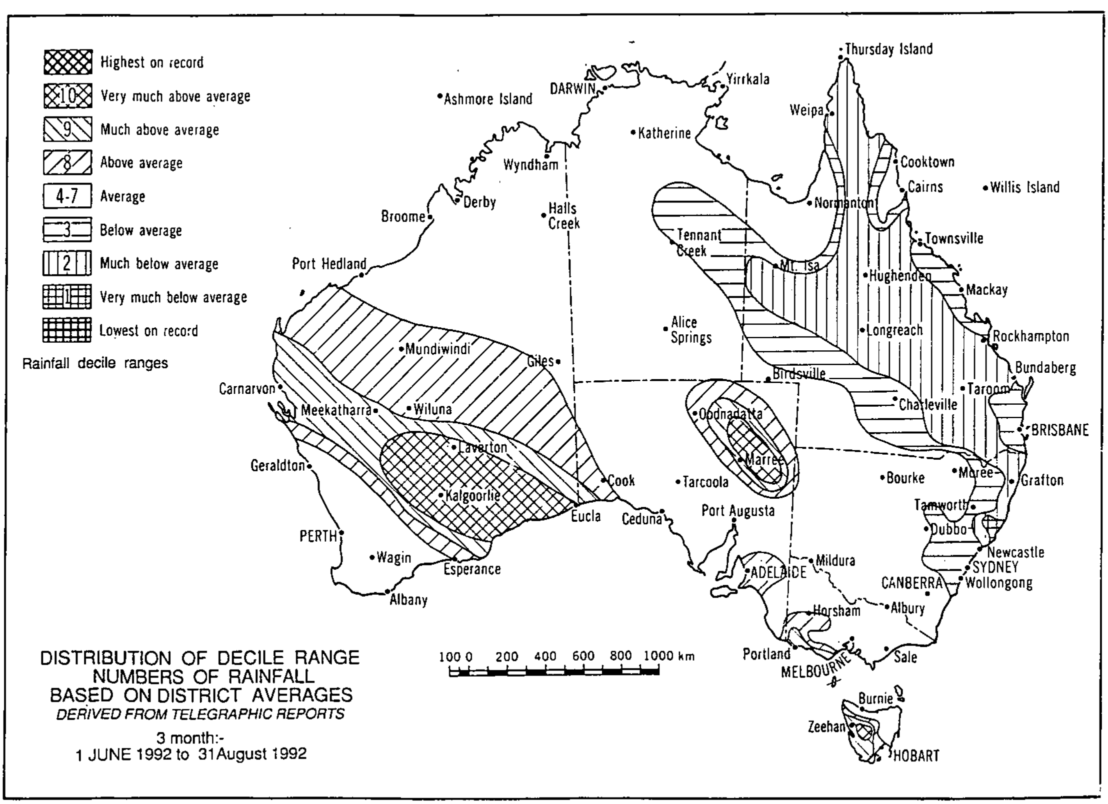


Fig. 12 Winter (June, July, August) 1992 maximum temperature anomalies (°C). Australia.

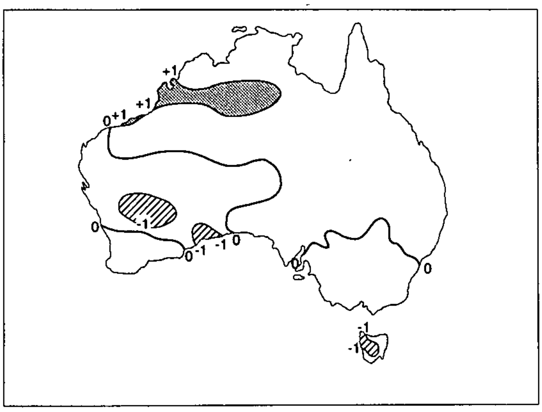
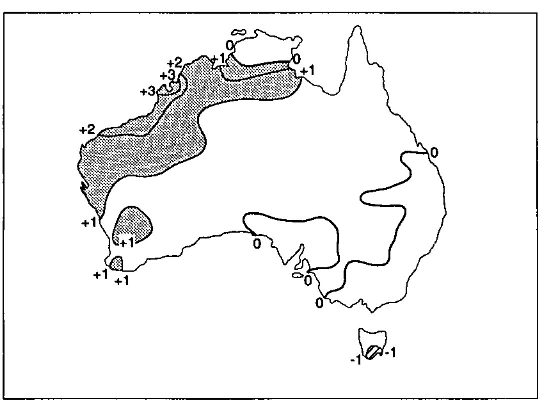


Fig. 13 Winter (June, July, August) 1992 minimum temperature anomalies (°C). Australia.



were also well above average in the west as a result of the generally increased cloudiness.

A stronger than average subtropical ridge developed over the southern part of the continent in July. After a four-wave zonal circulation pattern in the first part of the month, a more complex shorter wavelength pattern became established and a blocking dipole developed over the Tasman Sea in the second week of July. Below average rain was received in the west as a result of the stronger subtropical ridge, and conditions remained dry over central southern Queensland. Maximum temperatures were above average in the northwest and Western Australia interior due to long trajectory easterly anomalies advected over the hotter continental interior. Monthly minimum temperatures were also correspondingly warm along the northwest coastal region and southwest corner.

A split in the zonal flow occurred over Western Australia early in August, but generally there was much stronger zonal flow through the southern part of the continent and a tendency for troughing to occur in the Bight region. Rainfall totals over Western Australia and in southern regions of the continent were above average. Maximum temperatures were well below average in the south and interior of Western Australia, but slightly above average over the tropical north. Minimum temperatures were generally close to normal but slightly warmer over the north.

Summary

Winter season (June, July, August) 1992 in the southern hemisphere was characterised by a decline in circulation and climatic anomalies which had been associated with the mature phase of an El Niño/Southern Oscillation warm episode in the preceding autumn season. Notable climatic anomalies during the season were the outbreak of cold air over central South America in the second half of July and the heavy snowfalls over New Zealand in the last part of August. There was a slow and below average start to the rainy season in the western Sahel and the Indian monsoon was late in arriving. Rainfall deficits continued over northeastern Australia.

References

Hoskins, B.J., Hsu, H.H., James, I.N., Masutani, M., Sardeshmukh, P.D. and White, G.H. 1989. *Diagnostics of the Global Atmospheric circulation*. Based on ECMWF analyses 1979–1989, WMO, Geneva. 217 pp.

Mo, K.C. and White, G.H. 1985. Teleconnections in the Southern Hemisphere. *Mon. Weath. Rev., 113*, 22–37.

van Loon, H. and Shea, D.J. 1987. The Southern Oscillation. Part IV: Associations with the trades and with the trough in the westerlies of the South Pacific ocean. *Mon. Weath. Rev., 113*, 2063–74.

Wright, W.J. 1993. Seasonal climate summary southern hemisphere (autumn 1992): signs of a weakening ENSO event. *Aust. Met. Mag.*, 191–8.

Appendix

Sources of data from routine climate monitoring publications and addresses where these can be obtained are:

Climate Monitoring Bulletin — Southern Hemisphere, June, July, August 1992. National Climate Centre, Bureau of Meteorology, GPO Box 1289K, Melbourne 3001, Australia.

Climate Diagnostics Bulletin, June, July, August 1992. Climate Analysis Center, National Weather Service, Washington D.C. 20233, USA.

Monthly Report on Climate System, June, July, August 1992. Japan Meteorological Agency, 1–3–4, Ote-machi chiyoda-ku, Tokyo, Japan.

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