Seasonal climate summary southern hemisphere (summer 2002/03): El Niño begins its decline

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(Manuscript received September 2003)

Southern hemisphere circulation patterns and associated anomalies for the austral summer 2002/03 are reviewed, with emphasis given to the Pacific Basin climate indicators and Australian rainfall and temperature patterns.

Summer 2002/03 saw the beginning of the end of the El Niño which began in winter 2002. Anomalously warm sea surface temperatures in the equatorial Pacific began to retract to the central and western Pacific, with cool subsurface waters undermining warm waters in the east. Off-equatorial Rossby waves, travelling from east to west during 2002, reflected off the Indonesian – Australasian coast to form an upwelling Kelvin wave that traversed east across the equatorial Pacific.

Summer rainfall across Australia improved throughout the season, from below average rainfall in late 2002 to well above average in February 2003. Across Australia, summer temperatures were above average, making it the sixth hottest summer since 1950. Bushfires were prevalent in many states with fires burning over two million hectares of parks and forests through Victoria, New South Wales and the Australian Capital Territory.

Introduction

El Niño conditions continued during the summer of 2002/03 although there were signs of substantial weakening. Late in the season anomalous surface warming across the equatorial Pacific retracted to the central and western Pacific as a tongue of cooler surface water extended along the equator from South America, undermined by cold subsurface water extending from the western Pacific. Much of Australia experienced above average rainfall late in the season. Nationally, summer daily maximum and minimum temperatures were above average.

This summary reviews the summer 2002/03 southern hemisphere and equatorial climate patterns. Particular attention is given to the Australasian and Pacific Regions. The main sources of information for this report are the *Climate Monitoring Bulletin* (Commonwealth Bureau of Meteorology, Australia) and the *Climate Diagnostics Bulletin* (Climate Prediction Center, Washington). Information pertaining to the bushfires experienced during the summer of

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2002/03 is largely adopted from the Commonwealth Bureau of Meteorology submission to the House of Representatives Select Committee on the Recent Australian Bushfires (Submission #369). Further details regarding sources of data are given in the Appendix.

Pacific Basin climate indices

The Troup Southern Oscillation Index*

By the end of February 2003 the Southern Oscillation Index (SOI) completed 12 months of consecutive negative values, first established in March 2002 (Fawcett and Trewin 2003). This was the first 12-month period with negative SOI since May 1997 through April 1998, during the last El Niño event (Courtney 1998). The three-monthly mean SOI for the 2002/03 summer season was –6.7, with the SOI during each month being negative: –10.6 in December, –2.0 in January and –7.4 in February (Fig. 1). Overall, during the first two months of the summer season Darwin experienced above average pressures while Tahiti's pressure was near average, although Darwin had a spike of below average MSLP during mid January with the passing of an unnamed category 1 tropical cyclone. The situation was reversed during February 2003, with Tahiti's pressure dropping and Darwin's pressure becoming closer to average.

The December/January and January/February values of the Climate Diagnostics Center Multivariate El Niño-Southern Oscillation (ENSO) Index (MEI) (Wolter and Timlin 1993, 1998) were 1.223 and 0.894, with rankings of 47 and 46 respectively, out of 54 years of record. It is suggested that rankings of over 43 (i.e. the top 20 per cent) denote El Niño events. The ranking of the MEI during the summer season clearly indicates an active El Niño period, although the relative low magnitude of SOI suggests that the SOI failed, to some degree, to reflect the warm state of the ocean atmosphere system.

Fig. 1 **Southern Oscillation Index, from January 1999 to February 2003. Means and standard deviations used in the computation of the SOI are based on the period 1933-1992.**

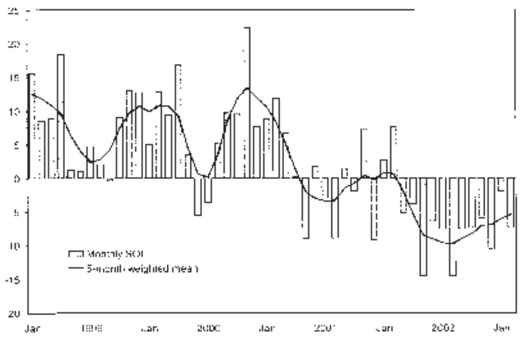
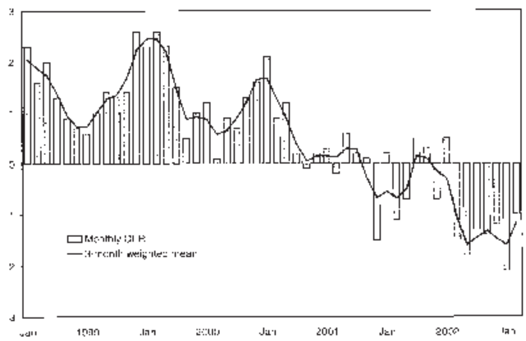


Fig. 2 **Standardised anomaly of monthly outgoing long-wave radiation averaged over the area 5ºS to 5ºN and 160ºE to 160ºW, from January 1999 to February 2003. Negative (positive) anomalies indicate enhanced (reduced) convection and rainfall in the area. Anomalies are based on the 1979-1995 base period.**



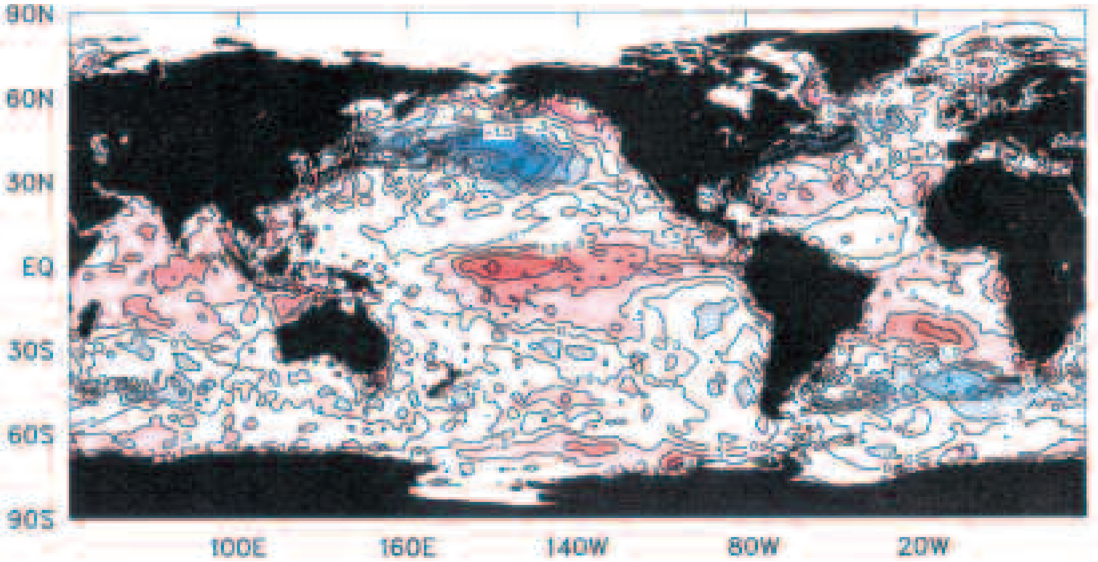
Outgoing long wave radiation

The time series of monthly standardised outgoing long wave radiation (OLR) for the period January 1999 through February 2003 is shown in Fig. 2. These data represent the amount of long-wave radiation emitted along the equatorial region 5ºS to 5ºN and 160ºE to 160ºW, a region where tropical deep convection is particularly sensitive to changes in the phase of the Southern Oscillation, and are provided by the Climate Prediction Center (CPC), Washington (CPC 2002). In this region there is generally more convection during ENSO events, resulting in reduced OLR due to increased high cloud (Wang et al. 1999). During La Niña events there is generally less convection in this region and subsequently positive OLR values.

Monthly OLR values were negative throughout the summer of 2002/03, with –1.2, –2.1 and –1.0 in December, January and February respectively, the January figure being the lowest since October 1997 (–2.5). During the summer period OLR was generally higher than average in the Australasian region, with

*The Troup Southern Oscillation Index (SOI) used in this article is ten times the standardised monthly anomaly of the difference in mean sea-level pressure between Tahiti and Darwin. The calculation is based on a sixty-year climatology (1933-1992).

Fig. 3 **Anomalies of sea-surface temperature for summer (December, January, February) 2002/03. The contour interval is 0.5°C.**



associated suppressed convective activity, and was lower than average around the equatorial central Pacific. This pattern of high OLR in the western Pacific and low OLR in the central Pacific is consistent with El Niño conditions, and has prevailed since August 2002 (Jones 2003, Watkins 2003). There was, however, an abrupt change in this pattern in mid-February 2003, where low OLR was observed over much of northern Australia and high OLR recorded in the central Pacific.

A time-longitude series of summer OLR anomalies (not shown) shows successive eastward propagating areas of enhanced and suppressed convective activity along the western equatorial Pacific, associated with active phases of the Madden-Julian Oscillation (MJO) (Wheeler and Weickmann 2001). In late December 2002 an eastward propagating area of enhanced convection (negative anomalous OLR) approached the equatorial Australian region, crossing to the north early in January 2003. This may have been in part responsible for the tropical low which brought flooding rains to the coastal area along the Northern Territory and Queensland border during early and mid-January (see below). Post analysis of this event indicates that this was an unnamed category 1 tropical cyclone. Similarly tropical cyclones *Beni*, *Fiona* and *Graham*, which affected areas of northern Australia and Christmas Island, coincided with an active MJO and a westerly wind burst during early and mid-February 2003 and provided the generally low OLR in this region as mentioned above.

Oceanic patterns

Sea-surface temperatures

Figure 3 shows summer 2002/03 SST anomalies in degrees Celsius (°C), as computed by the National Meteorological and Oceanographic Centre (NMOC). The contour interval is 0.5°C. Positive anomalies are shown in orange and red shades, while negative anomalies are shown in blue shades. Large areas of the central equatorial Pacific averaged summer SST anomalies (SSTAs) above +1°C, with an area just to the east of the date-line showing +2°C anomalies. The summer season mean anomalies of the Niño 3 and 4 regions were +0.9°C and +1.1°C respectively, a fall of 0.2°C and 0.1°C from their spring 2002 values.

The static seasonal pattern does not reflect the slow decline of the warm anomalies toward the end of the season. Pacific SSTAs generally reached a local maximum in areal extent and magnitude during November-December 2002 and began to decline during January and February 2003. Positive anomalies weakened and retracted to the central and western Pacific during February, while warm anomalies in the east were replaced by a growing tongue of cooler water extending along the equator from the west coast of South America, thus suggesting the beginning of the end of the 2002/03 El Niño. The Niño 3 and 4 indices both showed monotonic decreases: 1.4, 0.9 and 0.5 for Niño 3; 1.2, 1.1 and 1.0 for Niño 4. These figures reflect the early retraction of the warm pool from the eastern Pacific region.

In the eastern Pacific south of the equator a semi-stationary cold pool was evident as a result of upwelling in that area associated with convergence of surface winds around the Chilean coast and easterly wind anomalies further off the coast (see below). SSTs were warmer than average across most of the Indian Ocean north of around 30°S, including waters between Indonesia and Australia. Waters around southeast Australia were also anomalously warm. The anomalously cold SSTs evident around the globe between 30°S and 50°S in spring 2002 (Watkins 2003) were somewhat less evident during the summer season and contracted mostly to the waters of the South Atlantic Ocean and southern Indian Ocean.

A large area of cool SSTs is shown in the north Pacific and was possibly associated with the Pacific Decadal Oscillation (PDO), a long-lived pattern of Pacific climate variability much like ENSO, although PDO events typically last for 20-30 years (Mantua et al. 1997, Zhang et al. 1997). The PDO index (ftp.atmos.washington.edu/mantua/pnw_impacts/INDICES/PDO.latest) was positive in the period 1977 through 1998, thereafter becoming negative. Late in 2002 surface-level winds in the north Pacific became westerly, blowing off Siberia's east coast, cooling waters in the central north Pacific, and the PDO index switched to distinctly positive.

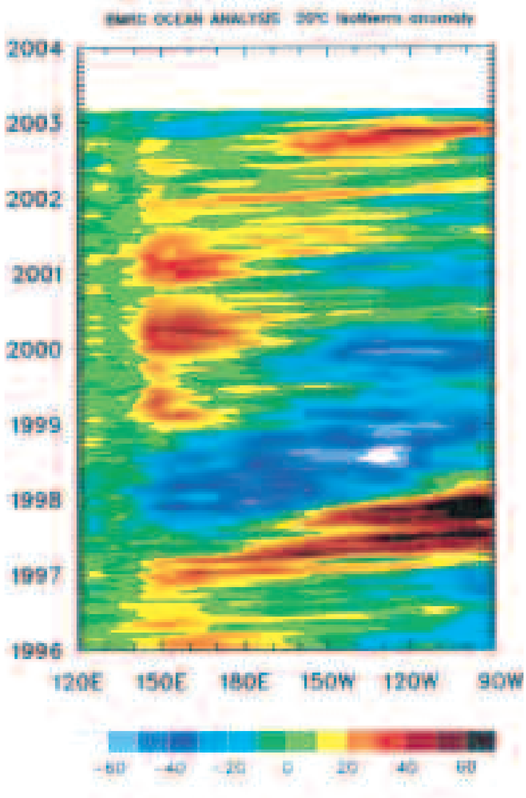
Subsurface patterns

A Hovmoller diagram of the anomaly in metres of the depth of the 20°C isotherm along the equatorial Pacific Ocean between January 1996 and February 2003, as calculated by the Bureau of Meteorology Research Centre is shown in Fig. 4. The 20°C isotherm is generally situated very close to the equatorial ocean thermocline which is the region of greatest temperature gradient. The thermocline can also be regarded as the boundary between the well-mixed upper ocean warm water and the cold deep ocean water. The depth of the thermocline, represented here as the depth of the 20°C isotherm, provides an indication of how SSTs might change in the near future. For example, La Niña events are normally preceded by a shallow thermocline in the east Pacific.

Successive Kelvin waves and associated westerly wind bursts during 2002 succeeded in creating conditions suitable for the formation of an El Niño (Fawcett and Trewin 2003, Jones 2003, Watkins 2003). During November 2002 a shallow thermocline developed in the western Pacific (Fig. 4) and during summer 2002/03 this migrated eastward across the Pacific to form a cool ocean subsurface in the eastern Pacific, suggesting that the El Niño was close to ending.

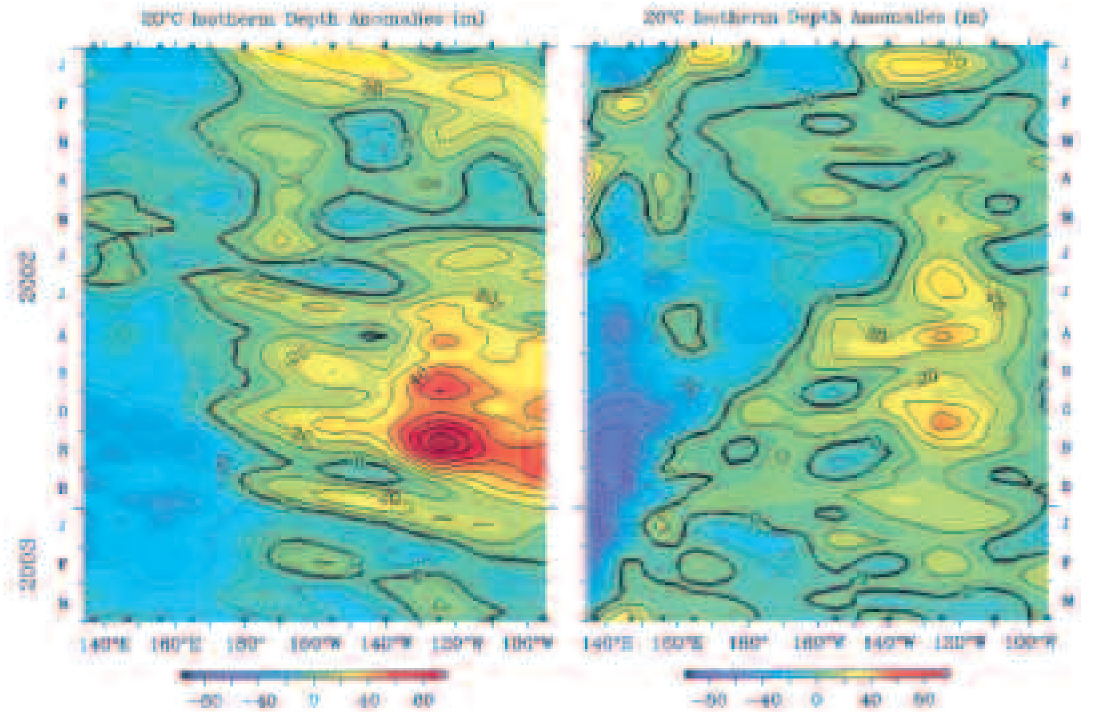
Figure 5 shows a detailed view of the equatorial 20°C isotherm depth for the Pacific region beside the

Fig. 4 **Time-longitude section of the monthly anomalous depth of the 20°C isotherm at the equator from January 1996 to February 2003. The contour interval is 10 m.**



20°C isotherm depth along 5°N (provided by the Pacific Marine Environmental Laboratory, Seattle). Clearly seen is the westward propagating upwelling Rossby wave which, from a similar diagram along 2°N (not shown), originated from the west coast of South America in March 2002. From Fig. 5 the Rossby wave appears to arrive in the western Pacific in November 2002. Toward the end of November a reflected upwelling Kelvin wave traverses eastward along the equator causing subsurface waters in the central equatorial Pacific to cool to near or just below average values, bringing shallow thermocline anomalies to the eastern Pacific. Further MJO activity and a downwelling Kelvin wave in early to mid December failed to prolong ocean surface warming in the eastern Pacific, as November's upwelling Kelvin wave was reinforced by another in late December 2002 to early January 2003. This latter upwelling Kelvin wave may have been initiated by an easterly wind burst in late December in the western Pacific.

Fig. 5 **Time-longitude sections of the monthly anomalous depth of the 20°C isotherm at (left) the equator and (right) 5°N from January 2002 to March 2003. The contour interval is 10 m.**



Thermocline depth returned to near its normal position over much of the equatorial eastern Pacific by February 2003.

In Fig. 6, cross sections of surface to 400 metre equatorial Pacific water temperature anomalies for each month November 2002 through February 2003 show the warmer upper ocean in November being undermined by cooler water extending from the western Pacific. The tongue of cool surface water extending from the South American coast in February, as discussed above, is seen here as being part of the underlying colder water in this region. The retreat of warmer surface water to the central and western Pacific and the large underlying cold pool in the eastern Pacific lead some analysts at this stage to suggest a prospective cold event (La Niña).

Atmospheric patterns

Surface analyses

The summer 2002/03 mean sea-level pressure (MSLP) across the southern hemisphere is shown in Fig. 7, with the associated anomalies shown in Fig. 8. These anomalies are the departures from an eleven-year (1979-1989) climatology obtained from the European Centre for Medium-range Weather Forecasts (ECMWF). The MSLP analysis itself has been computed using data obtained from the Commonwealth Bureau of Meteorology's Global Assimilation and Prediction (GASP) model daily 0000 UTC analyses. The MSLP anomaly field is not shown over areas of elevated topography.

The three-wave high pressure ridge pattern evident in more recent summers (Fawcett 2002, Gamble 2003) was not as distinct during the summer of 2002/03. A broad high pressure ridge was evident in the Pacific, a narrower ridge in the southern Indian Ocean and a broad but weaker ridge in the Atlantic. The MSLP anomalies (Fig. 8) show three areas where the ridge was amplified during this season; the southern Pacific Ocean, the Tasman Sea, and to the southwest of the Great Australian Bight. The latter two are particularly interesting as their implied atmospheric flow had a distinct impact on the Australian rainfall pattern for the season, as mentioned below.

The marked deepening of the Antarctic circumpolar trough during summer 2001/02 (Gamble 2003) was not evident in summer 2002/03. There is, however, a deepening of the trough off the southwest tip of South

Fig. 6 **Four-month November 2002 to February 2003 sequence of vertical temperature anomalies at the equator for the Pacific Ocean. The contour interval is 0.5°C.**

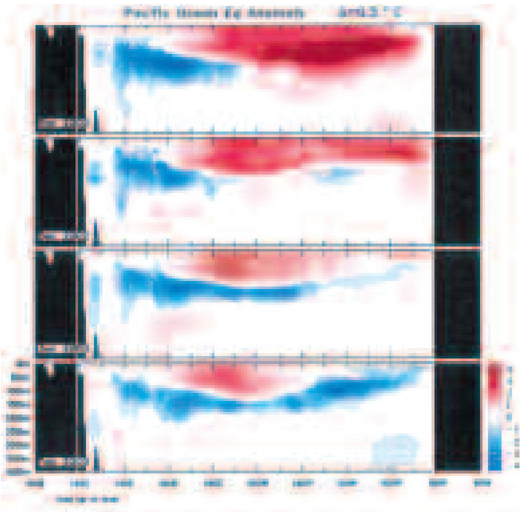
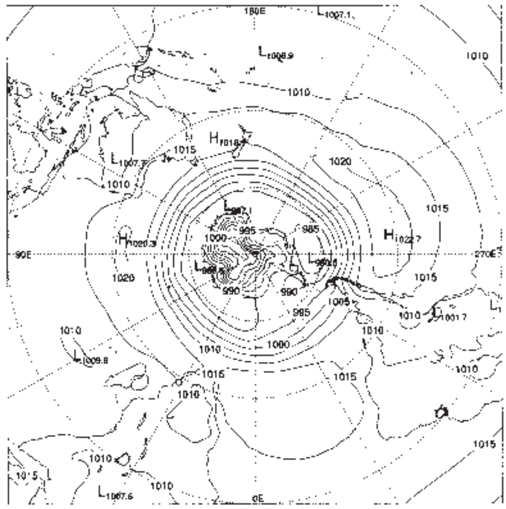


Fig. 7 **Summer 2002/03 mean sea-level pressure (hPa). The contour interval is 5 hPa, with values above 1025 hPa and below 990 hPa stippled.**



America. Simmonds and Budd (1991) suggest that around Antarctica a relationship exists between surface pressure and sea ice extent, however for the summer of 2002/03 sea ice extent was close to climatology in this region. It is possible that in this case the deepening of the surface trough had more to do with the displacement southward of the subtropical jet (see below).

In the equatorial region MSLP was particularly low in the central tropical Pacific and correspondingly high over northern Australia, which is typical of an El Niño pattern.

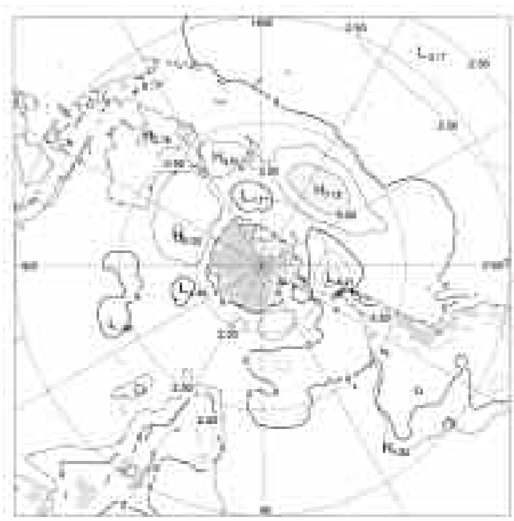
Mid-tropospheric analyses

The mean 500 hPa geopotential height patterns for summer 2002/03 are shown in Fig. 9, with anomalies shown in Fig. 10. Geopotential flow was very zonal, with a 3-4 wave trough barely evident. Anomalies at the 500 hPa level broadly reflect those of the MSLP pattern, with high anomalies in the south Pacific and just south of Australia and distinct lows south of New Zealand and southwest of South America. The anomaly pattern of 500 hPa height around Antarctica reflects the zonal flow at this level, with a distinct 3 wave pattern evident in the anomalies at higher latitudes.

Blocking

Figure 11 is a time-longitude section of the daily southern hemisphere mid-level blocking index,

Fig. 8 **Summer 2002/03 mean sea-level pressure anomaly (hPa). The contour interval is 2.5 hPa, with values above 5 hPa and below –5 hPa stippled.**



$$BI=1/2[(u_{25}+u_{30}) - (u_{40}+2u_{45}+u_{50}) + (u_{55}+u_{60})].$$

Here, u_λ indicates the 500 hPa level zonal wind com-

Fig. 9 Summer 2002/03 500 hPa geopotential height (gpm). The contour interval is 100 gpm.

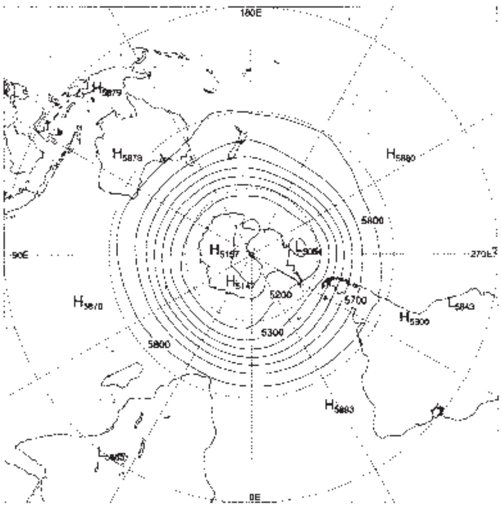
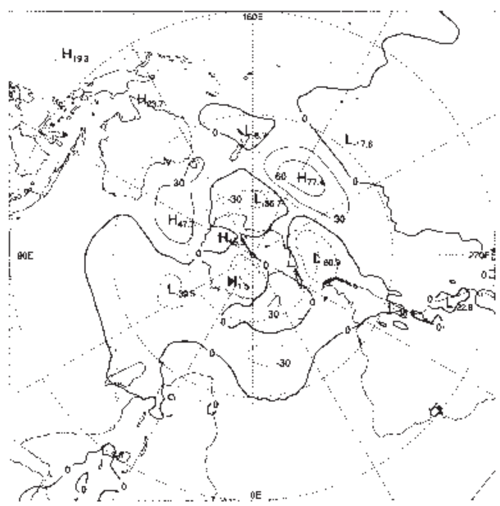
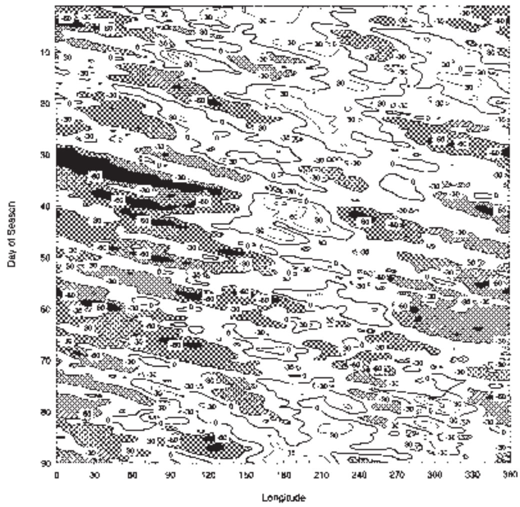


Fig. 10 Summer 2002/03 500 hPa geopotential height anomaly (gpm). The contour interval is 30 gpm, with values above 90 gpm and below –90 gpm stippled.



ponent at λ degrees of southern hemisphere latitude ranging from 0° at the equator to 90°S at the South Pole. The blocking index measures the strength of the 500 hPa flow at the mid-latitudes (40°S to 50°S) relative to that at subtropical (25°S to 30°S) and high (55°S to 60°S) latitudes.

Fig. 11 Summer 2002/03 daily blocking index: time-longitude (Hovmoller) section. The horizontal axis measures degrees of longitude east of the Greenwich meridian. Day one is 1st December 2002.



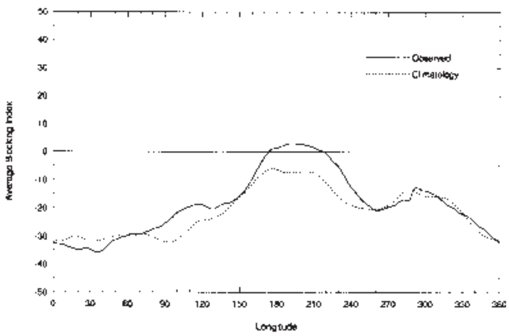
Taken across the season in the form of a seasonal mean (Fig. 12), blocking was very close to the long term seasonal mean except in the west and central Pacific region, where blocking was marginally above average, as it was to a lesser extent between 90°E and 120°E. Both of these regions experienced large positive mid-latitude MSLP anomalies.

Several blocking events impacted on the Australian region during the season. The slow passage of a low pressure system across southeastern Australia during late December/early January, aided by a stationary high pressure ridge stretching down Australia's east coast and across the Tasman Sea, brought much needed rain to southern and eastern Australia. Similarly, a slow moving ridge developed in the Great Australian Bight in mid-February and extended into the Tasman Sea, cradling a southward moving complex low pressure system. The low pressure system brought substantial rainfall to much of mainland Australia but the blocking high pressure ridge constrained the rainfall to north of Tasmania (see below).

Winds

Low-level (850 hPa) and upper-level (200 hPa) wind anomalies for summer 2002/03 are shown in Figs 13 and 14 respectively. Low-level wind anomalies are consistent with the anomalous MSLP.

Fig. 12 Mean southern hemisphere blocking index for summer 2002/03 (solid line). The dashed line shows the corresponding long-term average. The horizontal axis shows degrees east of the Greenwich meridian.



A weak anticyclonic circulation pattern was evident in the anomaly pattern of low-level winds in the Tasman Sea and is consistent with the blocking index for that region. Anomalous northerlies over Australia corresponded to anomalously high temperatures in central and southern Australia during summer.

Enhanced trade winds in the central Pacific reflect the strengthened gradient between the south Pacific high pressure ridge and the anomalous low pressure region in the central equatorial Pacific. This is consistent with the decline of high SST anomalies in the eastern Pacific and is a contrast to low-level winds during enhanced El Niño conditions (Mullen 1998; Walland 1998). Convergence of low-level winds near the coast of Chile combined with anomalous easterly winds in the southeast Pacific are responsible for upwelling and an associated cold pool of SST in that region.

There was no distinct El Niño pattern in the mean summer upper-level wind anomalies, although the wave train in the upper-level winds, as seen in the previous two seasons (Jones 2003, Watkins 2003), was present but weak. Strong upper-level easterly wind anomalies over the equatorial Pacific, typically associated with El Niño and a weak Walker circulation (Mullen 1998; Walland 1998) were not evident, although they were in the December 2002 anomalies (not shown). Also seen in the upper-level winds is the southward displacement of the subtropical jet over the south Pacific. The right exit of this jet was placed just to the west of the southern tip of South America and is a probable cause of the anomalous low surface pressure in that region.

Australian region

Rainfall

Figure 15 shows the summer rainfall totals for Australia, while Fig. 16 shows the summer rainfall

Fig. 13 Summer 2002/03 850 hPa vector wind anomalies with contours of vector magnitude overlaid. The contour interval is 5 m s^{-1}, with values above 5 m s^{-1} stippled.

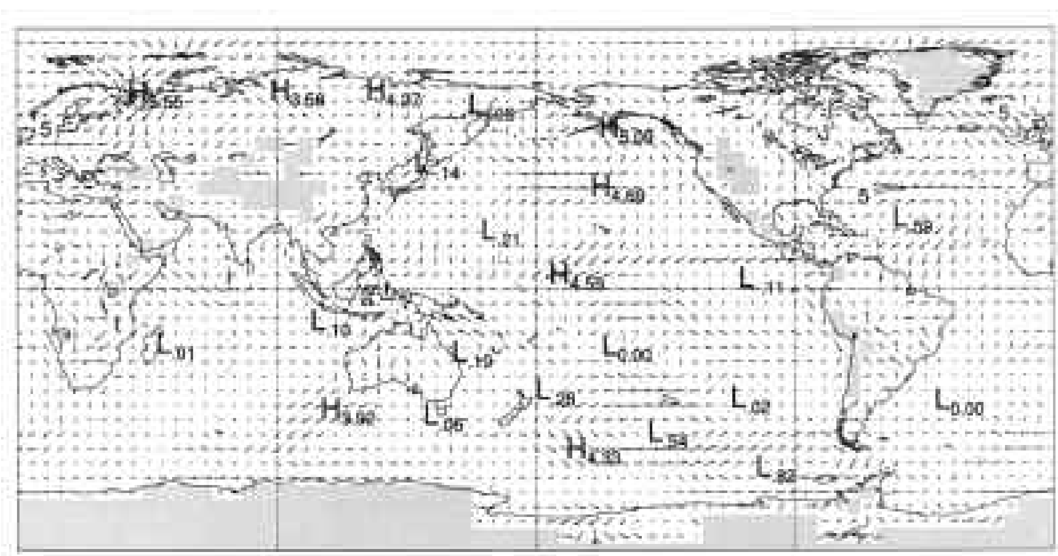


Fig. 14 **Summer 2002/03 200 hPa vector wind anomalies with contours of vector magnitude overlaid. The contour interval is 5 m s^{-1}, with values above 5 m s^{-1} stippled.**

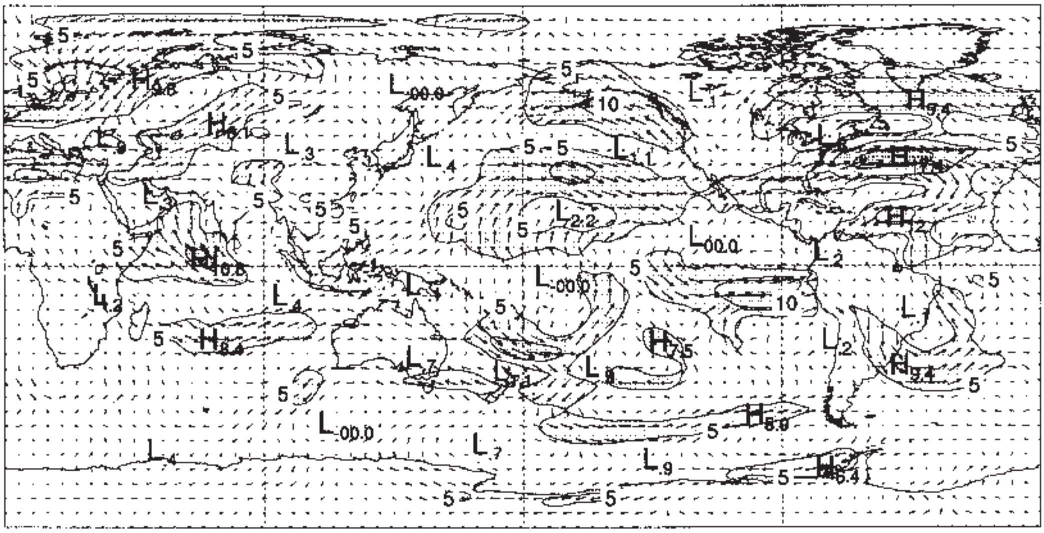


Fig. 15 **Summer 2002/03 rainfall totals for Australia (mm).**

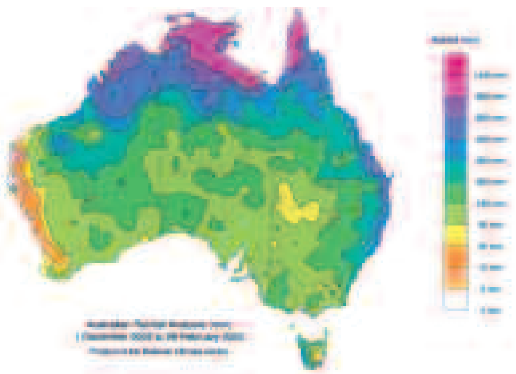
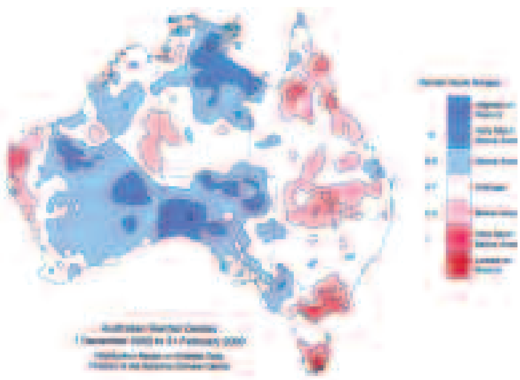


Fig. 16 **Summer 2002/03 rainfall deciles for Australia: decile range values based on grid-point values over the summers 1900/01 to 2002/03.**



deciles, where the deciles are calculated with respect to gridded rainfall data for all summers from 1900/01 to 2002/03.

Australian-averaged summer 2002/03 rainfall was slightly above median (decile 6), with above average falls in parts of South Australia, Western Australia and the Northern Territory. Below average falls were recorded over coastal Western Australia, Tasmania, eastern and central Victoria and parts of Queensland.

The total seasonal rainfall, however, masks the considerable temporal variability. All states except Western Australia received below average rainfall during December. Nationwide rainfall in January 2003 was close to average, although decile one in New South Wales, the fourth driest January on record for that state since 1890. February 2003 was particularly wet across most of Australia, setting a recent trend for February rainfall: the last four Februaries (2000, 2001, 2002 and 2003) have had rainfall in the top 13 of over 110 years of records. Tasmania's February rainfall proved the exception, with it being the lowest since 1991 and the ninth lowest on record. February 2003 marked the end of a very dry 11-month period across Australia, with much of Australia receiving decile 3 or below during this period (Table 1).

During December Western Australia received above average rainfall late in the month associated with the blocking event mentioned above. Western Australia was the only state to have any observation stations report record December rainfall, while each of Queensland, Tasmania and the Northern Territory

Table 1 March 2002 to February 2003 monthly rainfall deciles for each Australian State and the Northern Territory and nationally: decile range values based on grid-point values over months in 1900 to 2003.

YEAR	MONTH	NSW	NT	QLD	SA	TAS	VIC	WA	AUS
2003	2	8	9	8	10	1	7	7	9
2003	1	1	9	2	6	5	2	7	5
2002	12	4	1	2	5	2	4	7	2
2002	11	2	7	1	7	2	4	9	4
2002	10	1	1	1	1	8	2	2	1
2002	9	4	6	2	2	10	4	3	3
2002	8	2	1	9	1	6	2	2	3
2002	7	1	2	1	3	9	2	2	1
2002	6	2	1	5	3	10	5	2	2
2002	5	3	3	2	4	2	3	2	2
2002	4	3	4	2	5	1	5	4	2
2002	3	5	1	2	1	2	4	3	1

had stations that recorded their lowest December rainfall on record.

During January there was a high rainfall gradient over Queensland which was reflected in the fact that several northern observation stations recorded highest January rainfall totals while over 70 stations from the southeast of the state recorded their lowest January rainfall totals. Many stations in the Northern Territory also recorded above average January rainfall with Redbank Mine recording a new Northern Territory record for the most rain in any month (1252.1mm, 249 in just one day). Above average rainfall in northern Australia was as a result of a low pressure system, post-analysed as a category 1 tropical cyclone, which developed in the Arafura Sea early in the month.

In the tropics, February rainfall was dominated by the effects of tropical cyclones *Beni* and *Graham*, and to a lesser extent tropical cyclone *Fiona*. Remnants of these events, combined with blocking systems in the Tasman Sea were responsible for above average February rainfall in most southern Australian states. During February several stations in Queensland, New South Wales and the Northern Territory recorded record daily rainfall figures for any month. Tasmania's below average rainfall in February was primarily due to the formation of a blocking system which was initially in the Great Australian Bight and moved slowly to the Tasman Sea.

Temperatures

Figures 17 and 18 show the maximum and minimum temperature anomalies for summer 2002/03, respectively. The anomalies have been calculated with respect to the 1961-1990 period.

Summer maximum temperatures were above average over most of Australia, the exception being much of central Northern Territory, coastal Western Australia and some of the southern coast of Victoria. Several areas of New South Wales and neighbouring areas recorded anomaly peaks of up to +3°C. Averaged over the continent the 2002/03 summer was the sixth hottest in the post-1950 record at 0.69°C above the 1961-1990 average, and the fourth hottest in New South Wales (+1.66°C above average).

The expansive negative anomaly of summer maximum temperature over the Northern Territory was largely the result of the unnamed tropical cyclone which developed in the Arafura Sea in early January and brought colder than average conditions during that month, breaking several daily and monthly observation station records. Areas of summertime positive temperature anomalies in New South Wales and southern Queensland were primarily the result of high temperatures recorded in January, again as a result of the unnamed tropical cyclone forcing tropical air further south.

Several long-term maximum temperature records were broken through the summer, with Hobart recording its highest ever mean January temperature (25.0°C) in 120 years of data, and Richmond in Queensland recorded its highest ever mean February temperature (25.1°C) in 109 years of data.

The summer minimum temperature anomaly had a similar magnitude and pattern to that of the maximum anomaly, with the majority of Australia above the long-term mean. Averaged over Australia, the summer of 2002/03 mean minimum temperature was Australia's fourth hottest in the post-1950 period (0.68°C above the 1961-1990 average), a strong contrast to the previous summer which was the sixth coolest. Above average minimum temperatures were widespread in New South Wales and southern Queensland during January, primarily as a result of the unnamed tropical cyclone in the Arafura Sea. February saw large areas of inland and southeast Australia having positive minimum temperature anomalies, reflecting the widespread cloud and associated rainfall over these areas through that month.

The end of December 2002 marked the end of Australia's hottest ever post-1910 year, with the nationally averaged maximum temperature recorded at +1.20°C above the yearly average (based on 1961-1990 period). The year also saw the greatest ever diurnal range at +1.17°C above the mean. To put these figures into perspective, both the maximum temperature record and the diurnal range record were more than 2.5 standard deviations above the mean obtained from over 90 years of data.

Fig. 17 Summer 2002/03 maximum temperature anomalies for Australia based on a 1961-1990 mean (°C).

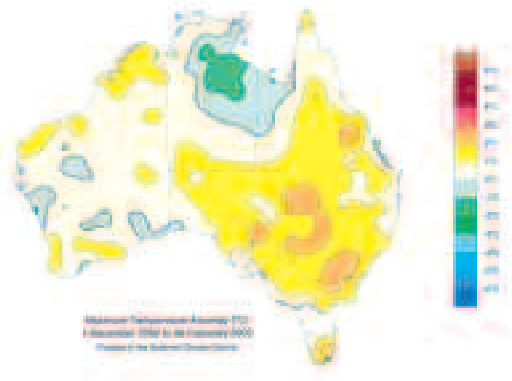
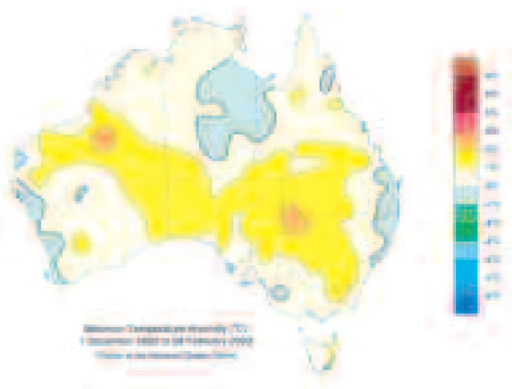


Fig. 18 Summer 2002/03 minimum temperature anomalies for Australia based on a 1961-1990 mean (°C).



Bushfires

During 2002 Australia experienced one of its worst droughts with widespread low rainfall and record high temperatures combining to produce climate conditions suitable for an early curing of fuels across most of eastern Australia. The broad climate conditions are shared by other severe fire seasons experienced in southeast Australia, including the seasons of 1938/39 and 1982/83, though the high temperatures in the lead-up to this latest fire season appear to be unprecedented.

Through the summer of 2002/03 much of southern Australia reported bushfires, although the Australian Capital Territory (ACT), New South Wales and Victoria were the areas most affected. By the end of February 2003 New South Wales had experienced a record 151 days of bushfire emergency, with fires burning 1.5 million hectares. Similarly, summer bushfires in Victoria burnt around 1.1 million hectares of parks and forests. In the ACT, fires that were started by lightning on the 8th of January reached Canberra on the 18th causing loss of life and such damage to property that placed it, in insurance terms, as the most expensive fire in Australia's history (Insurance Disaster Response Organisation).

A significant contributor to the long period for which the 2003 bushfires remained active was the absence of any significant rain for several weeks after the fires first ignited. Most of the fire affected region did not receive substantial rainfall* after 2 January until 21 or 22 February, a period of approximately 50 days.

Other major contributors to severe conditions leading up to and during the fire season were high temperature and evaporation. Over the August-January period, most of the region experienced average daily maximum temperatures 2 to 3°C above average, making it the warmest such period on record in many parts. Evaporation across the fire affected regions was generally well above average in 2002/03. Evaporation over the 10 months from April 2002 to January 2003 was 5 to 20 per cent above average at the locations where data were available.

Acknowledgment

The author would like to thank Grant Beard and Dr Robert Fawcett for providing useful comments on an earlier draft of the manuscript.

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Appendix

Data sources used for this review were:

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