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Monthly anticyclonicity and cyclonicity in the Australasian region: averages for January, April, July and October

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The geographical distribution across the Australasian region of 23-year averages of monthly anticyclonicity and cyclonicity as well as monthly anticyclone and cyclone immobility times for the months January, April, July and October for the years 1965–1987 are presented in the form of maps. Differences from monthly anticyclonicity and cyclonicity in the Australasian region, as presented by Karelsky (1961) for 15 years (1946–1960), are discussed briefly. A comparison with an atmospheric climatology of the southern hemisphere on ten years of daily numerical analyses (1972–82) as presented by Le Marshall, Kelly and Karoly (1985) is presented and some synoptic-scale features of the climatology are discussed briefly.

Introduction

The method of representation of the surface circulation for long periods (months, seasons, etc.) by charts of anticyclonicity and cyclonicity was developed during 1951–1953 in connection with the problem of long-range forecasting in Australia.

Charts of seven-year averages (1946–1952) of monthly and seasonal anticyclonicity and cyclonicity and their description were published by Karelsky (1954). Charts of monthly and seasonal anticyclonicity and cyclonicity in the Australian region for 15 years (1946–1960) were published by Karelsky (1961).

Since Karelsky (1961) published his 1946–1960 climatology, satellite cloud photographs have been added to the data set available to Australian region analysts in the National Meteorological Centre. This paper presents the cyclonicity/anticyclonicity climatology for the period 1965–1987, for which satellite cloud photographs were generally available.

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Climatologies of synoptic systems such as these seem to be less common than conventional climatologies and general circulation statistics, and the complementary nature of these studies would help in providing a comprehensive picture of the earth's climate.

To the authors' knowledge similar studies have not been attempted elsewhere in the world. Information from the climate centre in Asheville, North Carolina, suggests this study is unique.

Anticyclonicity and cyclonicity

The term 'anticyclonicity' ('cyclonicity') is defined as the time in hours during which anticyclone (cyclone) centres occupy a given 5 degree square during a given period (week, month, season, etc.). Anticyclonicity (cyclonicity) was computed from the plotted locations of anticyclone (cyclone) centres at 0000 UTC and 1200 UTC, assuming a uniform speed of movement for systems that could be tracked. Single centres which were not part of a track were assigned a lifetime of six hours.

Charts of anticyclonic (cyclonic) immobility

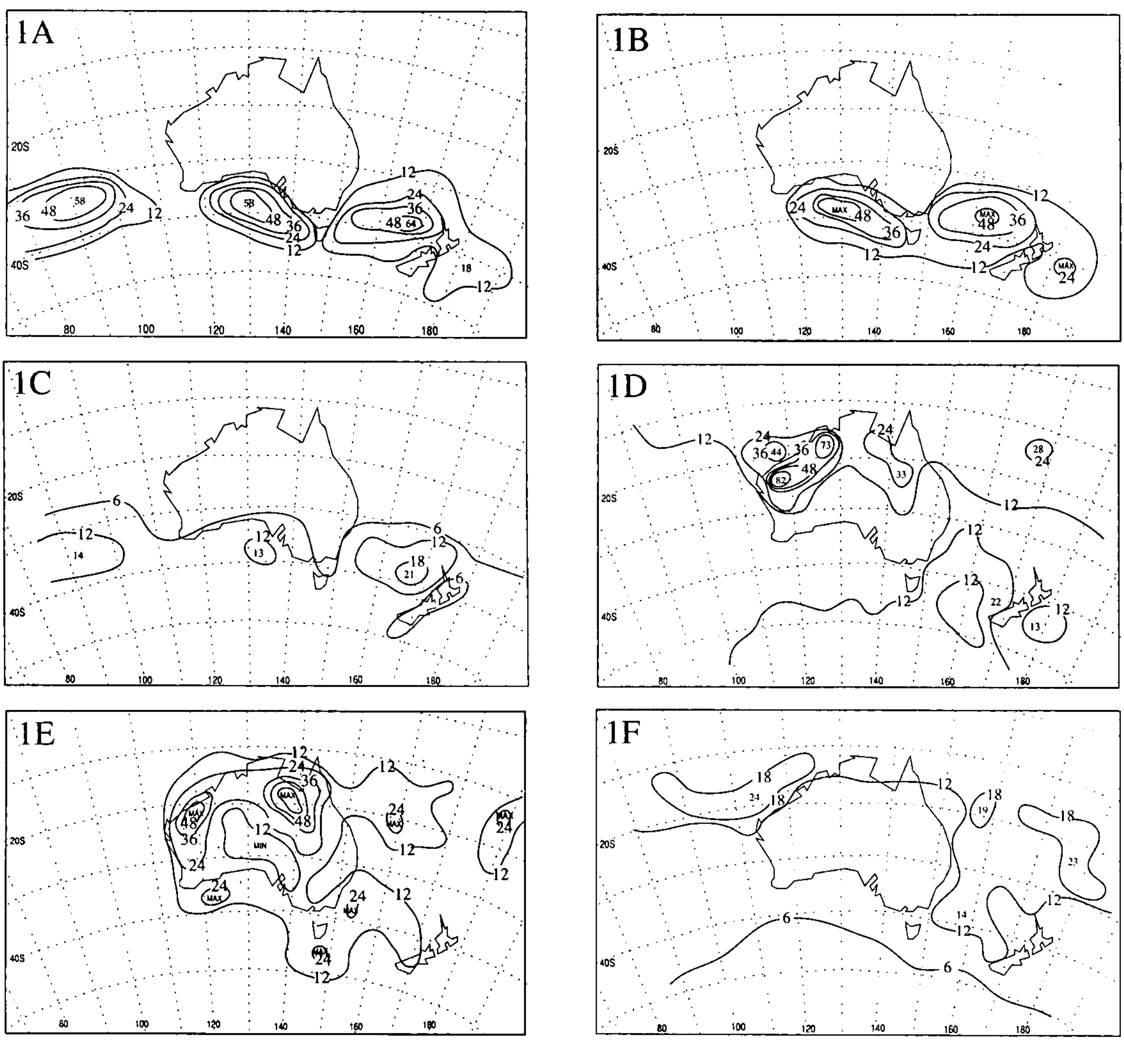
Immobility of an anticyclone (cyclone) centre is defined as the time taken by the anticyclone (cyclone) centre to traverse a 5 degree square. The average immobility of anticyclone (cyclone) centres across a 5 degree square is calculated by dividing the anticyclonicity (cyclonicity) of a 5 degree square by the number of anticyclone (cyclone) centres which have occupied that square during the same period.

Charts prepared by the National Meteorological Centre of the Bureau of Meteorology were used to obtain means of anticyclonicity (cyclonicity) and immobility for the mid-season months from 1965–1987. Figures 1(a), 2(a), 3(a) and 4(a) represent average monthly anticyclonicities, Figs 1(c), 2(c), 3(c) and 4(c) represent average monthly anticyclone immobilities, Figs 1(d), 2(d), 3(d) and 4(d) show average monthly cyclonicities, and Figs 1(f), 2(f), 3(f) and 4(f) show average monthly cyclone immobilities.

Accuracy of charts of anticyclonicity and cyclonicity

Cloud satellite photos have been available for synoptic analyses since 1965. With this increase to the data base for the Australasian region and the Indian Ocean, the accuracy of surface analyses improved greatly. Drifting buoys, deployed at

Fig. 1 January average; (A) anticyclonicity (1965–87); (B) Karelsky (1946–60) anticyclonicity — reproduced in same format as Leighton-Deslandes charts; (C) anticyclone (1965–87) immobility index; (D) cyclonicity (1965–87); (E) Karelsky (1946–60) cyclonicity - reproduced in same format as Leighton-Deslandes charts; (F) cyclone (1965–87) immobility index. Isopleths for anticyclonicity/cyclonicity are hours for each 5° square. Isopleths for immobility index are hours/system for each 5° square.

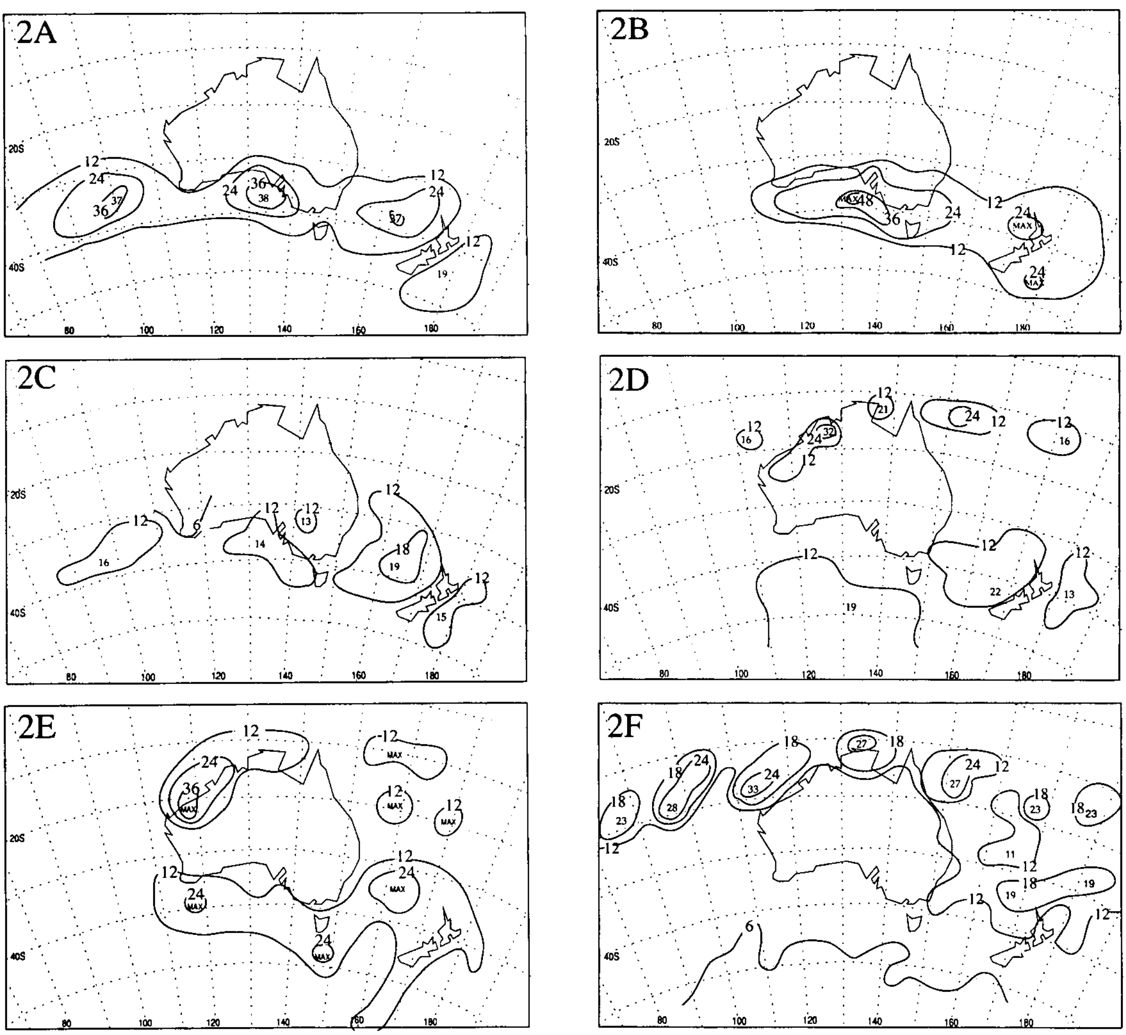


various times since 1978 at differing positions in the oceans around the southern hemisphere, have also added to the data base. The authors feel that the ability of analysts to identify centres of lows from cloud photos could affect the accuracy of charts. Wave lows forming under heavy cloud may not be obvious until the cloud displays a definite wave or hook shape. Old lows can be difficult to assess because an apparent circulation may remain visible in the cold air after the surface low has decayed. Lows situated under cloud associated with warm air advection may give no visible evidence of formation, particularly in the initial stages. Surface lows in the monsoon trough are difficult to determine. Areas showing large cloud masses of convective activity in the tropics are regarded as suspicious for surface low development and on occasion analyses persist with ephemeral centres.

Comparison between 15-year averages (1946–1960) and 23-year averages (1965–1987)

The 15-year averages (1946–1960) appear in Figs 1(b)–(e), 2(b)–(e), 3(b)–(e) and 4(b)–(e). Differences in position and values of cyclonicity maxima between 1946–60 averages and 1965–87 averages are mainly due to cloud photo interpretation. In all months cyclonicity maxima across the Southern Ocean are positioned at higher latitudes in 1965–87 than 1946–60. Most noticeable is the positioning further south of the Western Australian July maximum in 1965–87. Cloud photos showed that pressure falls across the southwest of Western Australia are mainly due to approaching cold fronts while the associated depressions are centred further south. Cyclonicity across tropical oceans was found to be differently positioned; in

Fig. 2 As for Fig. 1 for April.



1965–87 the maximum in January was found to be in a more remote region of the Coral Sea and in April the 1965–87 maxima were more clearly defined.

The heat low in the Kimberleys is absent on the 1946–60 average. During the 1950s, observations from Wyndham and Halls Creek were missing on most analyses which may have led to a low not being analysed. On some occasions when a low Wyndham pressure was plotted, no low was analysed in the Kimberleys.

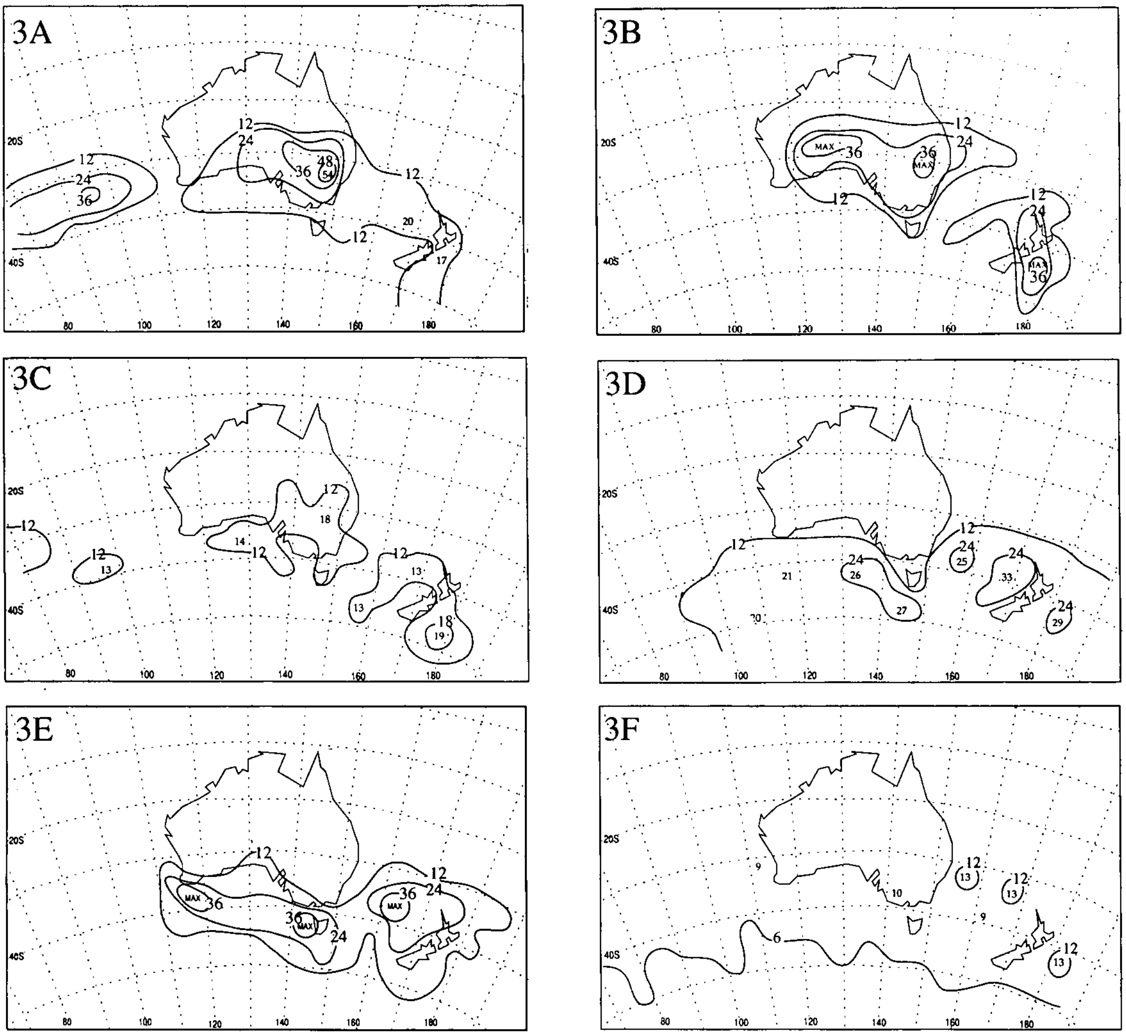
Differences between 1946–60 and 1965–87 anticyclonicity are mainly in the value of the maxima and whether the maxima areas are narrower or broader, whereas the position of the central values are generally complementary. A notable exception is the maximum in July across the western Nullarbor in 1946–60. During the 1950s, more high pressure centres were placed in ridges across the Nullarbor.

A comparison of anticyclonicity (cyclonicity) with that of Le Marshall et al. (1985)

The ten-yearly averaged hemispheric MSLP charts (1972–82) for January and July produced by Le Marshall et al. (1985) appear in Fig. 5. Climatologies of synoptic systems add detail to the understanding of the overall climatology of a region. Anticyclonicity (cyclonicity) shows how the centres of pressure systems relate to the average pressure distribution and identifies areas of fast or slow movement of the centres, thus indicating favourable regions for blocking synoptic patterns to occur.

For January, Le Marshall et al. (1985) show a broad pressure ridge from the Indian Ocean through the Bight to the Pacific Ocean. The January anticyclonicity average has a maximum in

Fig. 3 As for Fig. 1 for July.



the mean ridge through the Bight showing where anticyclones are predominant in the ridge, and the January immobility index indicates the average movement of the systems from the Indian Ocean across the Australasian region. Across north-western Australia the cyclonicity chart has two heat low centres whereas Le Marshall et al. (1985) suggest only one at the centre of lowest pressure. Across the tropics, where there is no great change in average pressure, cyclonicity defines the preferred location of low centres. In the Tasman Sea, the region favourable for cyclones could not be deduced from Le Marshall et al. (1985).

Synoptic-scale features of the climatology

Anticyclonicity or cyclonicity maxima may or may not coincide with anticyclone or cyclone immobility maxima for the same period. If they coincide the surface systems can be slow-moving crossing the anticyclonicity or cyclonicity maxima. If they do not coincide the anticyclone and cyclone immobility maxima indicate that the less common occurrences of surface systems placed outside the anticyclonicity and cyclonicity maxima can be slow moving.

For the four months most anticyclone immobility maxima occur in or near anticyclonicity maxima. The size and nature of the immobility maxima vary with each anticyclonicity maximum, and January, April and October have the largest immobility maximum in the Tasman Sea. Most anticyclones move slowly when positioned near anticyclonicity maxima, and very slow anticyclone movement can occur in the Tasman Sea.

In January, April and October, the cyclonicity maxima in the Kimberley and Hamersley regions of Western Australia represent heat lows. These

Fig. 4 As for Fig. 1 for October.

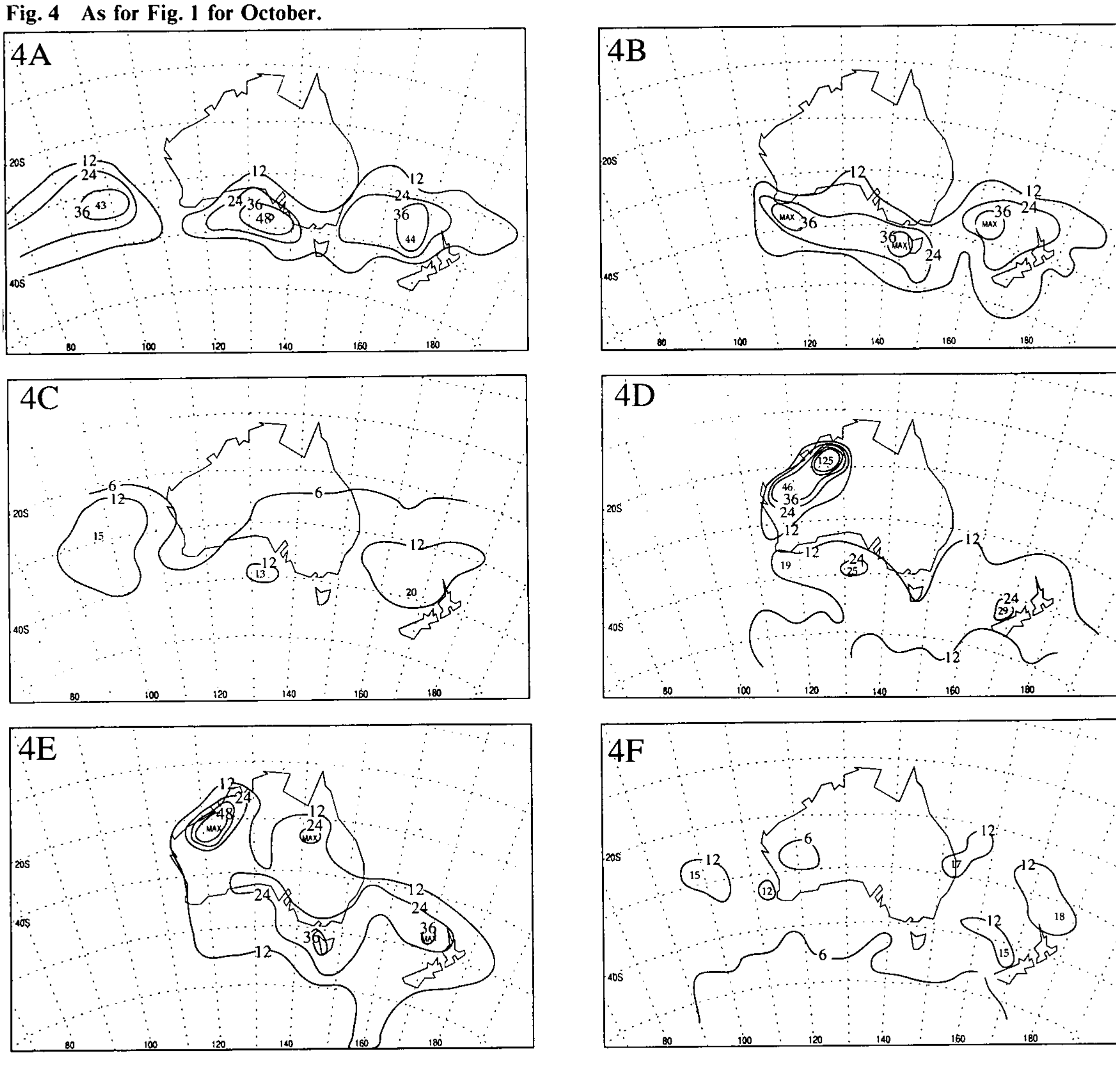
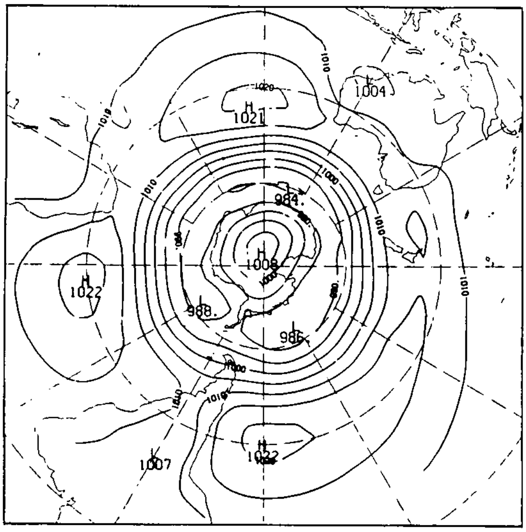
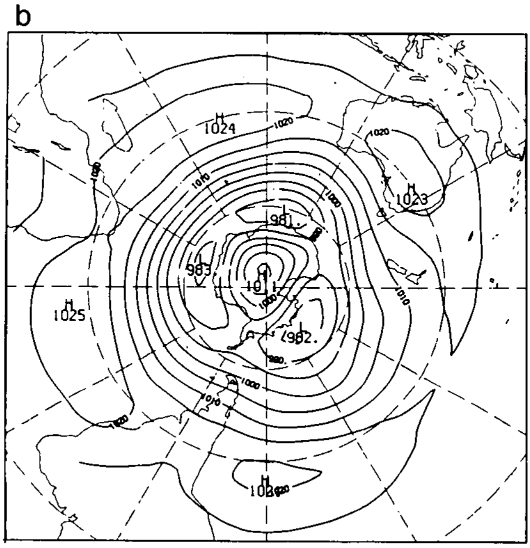


Fig. 5 **Ten-year monthly mean Australian southern hemisphere climatology mean sea level pressure (MSLP) for (a) January and (b) July. From Le Marshall et al. (1985).**

a



b



regions do not have any associated immobility maxima. Weak shallow lows drawn over the northwest of Australia fluctuate with the time of day, being more common at 1200 UTC than 0000 UTC, hence high immobility figures do not appear there as the lows appear as separate systems each day. In January and April, cyclonicity maxima with non-coincident cyclone immobility maxima occur across tropical oceans due to the slow movement of tropical cyclones and depressions. The immobility maxima across the tropics for April are possibly a result of analyses persisting with ephemeral centres in the monsoon trough largely on the basis of satellite interpretation. The authors feel a more dense network of surface pressure observations would be needed to confirm such a pattern of cyclone immobility centres. The four months have cyclonicity maxima and cyclone immobility maxima in the Tasman Sea, indicating slow-moving lows in this region are common. The Tasman Sea also favours slow-moving anticyclones, suggesting that in the Australasian region this area is most favoured for blocking patterns. Across the Southern Ocean in all months the cyclone immobility maxima are low, suggesting rapid movement of systems.

Conclusion

Anticyclonicity (cyclonicity) averages add to conventional climatologies by showing regions of slow and rapid movement of surface centres and potential blocking areas and, as such, can be used as a guide for forecasting. The averages could be useful for verifying the realism of numerical weather prediction or global models, and the basic figures being on a five-degree grid could be used as a data base in models. Anomalies can be calculated for ongoing current months and these would help in defining severe weather occurrences or any climate change.

Acknowledgments

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