THE USE OF INDICES IN FOLLOWING THE TREND IN SURFACE SYNOPTIC PATTERNS - IN PARTICULAR, AS INDICATING THE POSSIBILITY OF THE PERSISTENCE OF A LARGE QUASI-STATIONARY TROUGH SOUTH OF AUSTRALIA

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Abstract: Indices of the westerly surface circulation from 35-50°S and 40-175°E were plotted as running five day means, as also that at the 300 mb level, over the Australian area from 115-165°E; for the latter, the mean strength of the jet stream was used as an index. Peak values of both indices were found to coincide with the occurrence of a large quasi-stationary trough south of the Continent.

1. INTRODUCTION

In the month of August 1955, over the period 10 - 18 and again, to a lesser degree, from 22 - 25, a wide, large amplitude trough persisted over the ocean south of Australia. In each case, a series of secondary lows developed about Cape Leeuwin and over the waters south of the Bight. Conditions favourable to the development of individual secondary lows, in the broad, deep southwesterly stream of those situations, has been examined by Maher (1955). These present concern is to examine the trend in the circulation of the region leading to the establishment of the deep quasi-stationary trough, with the object of finding some singularity useful to the synoptic meteorologist in recognising the situation.

2. DISCUSSION OF SITUATIONS

It is clear that the establishment of such large quasi-stationary troughs is an event affecting the general circulation of the hemisphere, only a small area of which is covered by the available routine reporting synoptic network.

The only routine chart available here, covering a range of latitude and longitude south of forty degrees, is the Southern Ocean Analysis of surface data. From this, a running five day mean geostrophic wind was extracted, by measuring pressure gradient across the zone 35-50°S, from 40-175°E. This is shown in Figure 1 (a). Despite the highly subjective nature of the Southern Ocean Analysis, the index obtained gave a surprisingly regular series of maxima and minima. These exhibit a relationship to the synoptic pressure pattern similar to that described by Rossby and Willett (1948), Namias (1947) and others, for the northern hemisphere.

By means of similar indices, Rossby and Willett were led to fit surface and upper synoptic systems to a circulation model, based on the strengthening and expansion of the polar westerly circulation. On this model, an initial strengthening in the westerly circulation starts at high latitudes. The westerly circulation then expands, the jet stream moves to lower latitudes and synoptic disturbances become progressively longer in wavelength. Finally, the jet stream in low latitudes weakens, the wavelength shortens and pronounced troughs develop, with cold cyclones forming at lower latitudes. About this time, the westerlies begin to concentrate at high latitudes again and the cycle repeats.

If the low latitude jet stream should happen to remain strong over a range of longitude across Australia, at the same time as the westerlies strengthen at high latitudes, to the south of the continent, conditions would be favourable to the formation of a large amplitude, long wavelength trough in the region, connecting the strong cyclonic zone off the Antarctic coast to southern Australia.

As a measure of jet stream strength across Australia, a five day mean of wind speed at the jet stream axis at 300 mb was taken directly from the isotach patterns, between longitudes 115°E and 165°E. This is shown in Figure 1 (b). This also gave a regular series of maxima and minima which were found, in general, out of phase with the surface index, which is in accord with the Rossby Willett model.

Over the short period considered, May to October 1955, the two indices come noticeably into phase over two periods - 24 May to 11 June and 11 August to 5 September. During these periods, both indices were above average value

from 24 May to 3 June, 11-16 August, 21-25 August, with maxima coinciding at about 30 May, 13 August, 23 August. About these periods of maximum, the surface synoptic pressure pattern was of the same type on each occasion, characterised by a large amplitude, wide trough south of the Bight and southward to Antarctic waters. Figures 2, 3 and 4 illustrate the surface situations during these periods.

Index minima occurring nearly together about 5 June, 14 July, 18 and 30 August, coincide with periods of decreased activity. Figure 5 shows the surface situation of 14 July 1955.

Several associations of the two indices are clearly associated with characteristic synoptic patterns and are here listed.

(i) Above average surface index. Above average 300 mb index. (Figures 2, 3, 4).

(a) Indian Ocean high elongated W - E but high centres weak or absent over the continent.

(b) Antarctic cyclonic activity extends northward to area south of the Bight in a wide deep trough.

(ii) Below average surface index. Below average 300 mb index. (Figure 5).

(a) Ridges tend to extend southward from the subtropic to Antarctic waters.

(b) Short wavelength synoptic pressure pattern with pronounced meridional troughs.

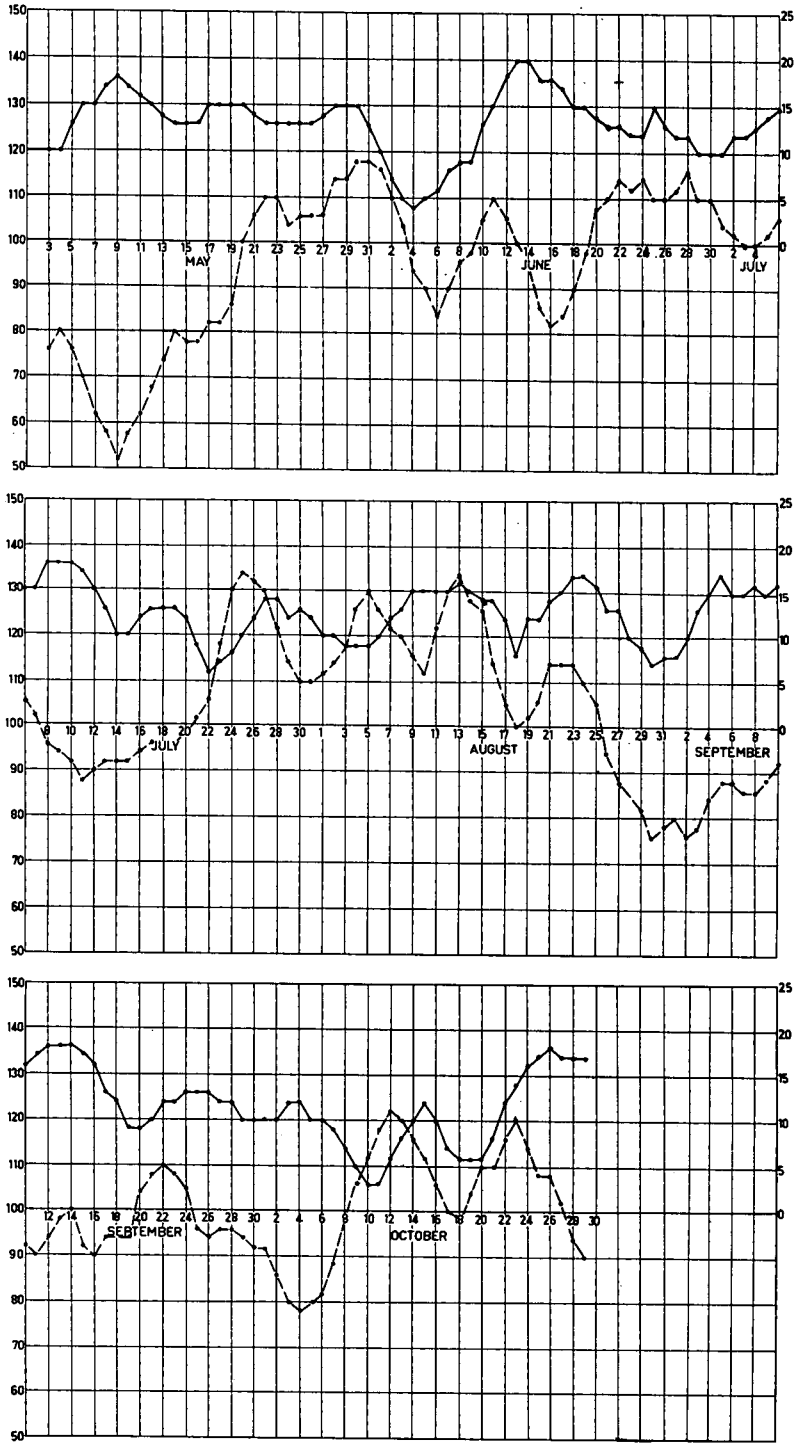
(c) Cyclonic activity in the troughs mainly confined to higher latitudes.

(iii) Average or below average surface index. Above average 300 mb index. (Figure 6).

(a) Ridges elongated N - S through the 35-50°S zone.

(b) Short wavelength pattern with pronounced meridional troughs.

(c) Cyclonic activity in the troughs increased about southern Australia with a tendency to cold outbreaks.



(a) 5 day mean Geostrophic West Wind (Zone 35-50 degrees South, Longitude 40-175 degrees East) Scale at right.
(b) 5 day mean wind speed at jet stream axis (Longitude 115-165 degrees East) Scale at left.

Fig 1.

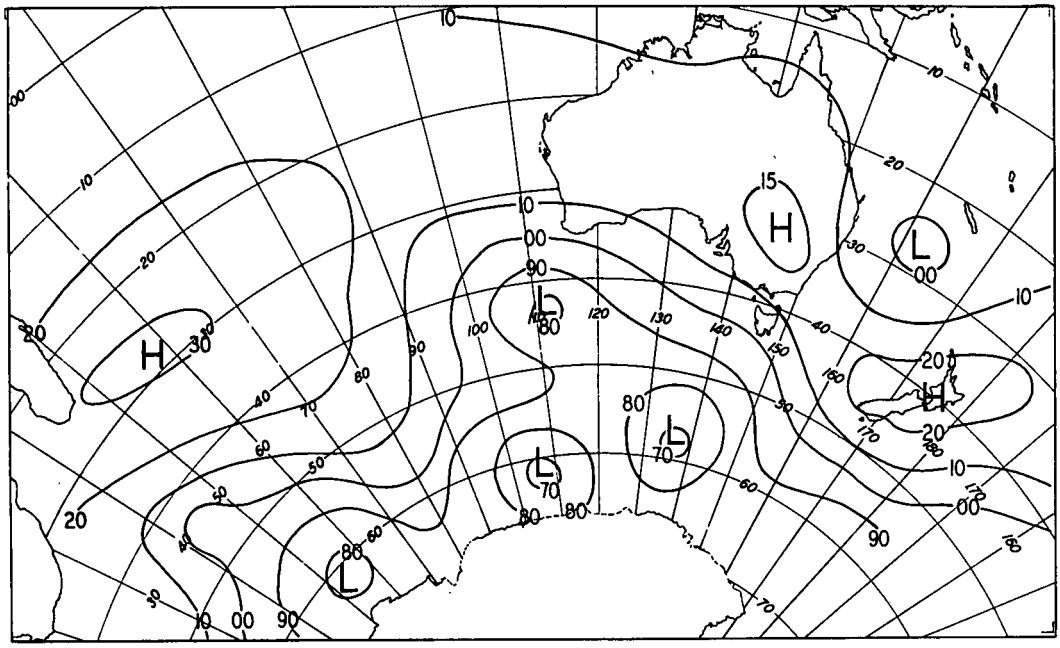


Fig 2. M.S.L. Chart for 28th. May 1955 when surface and 300mb indices above average.

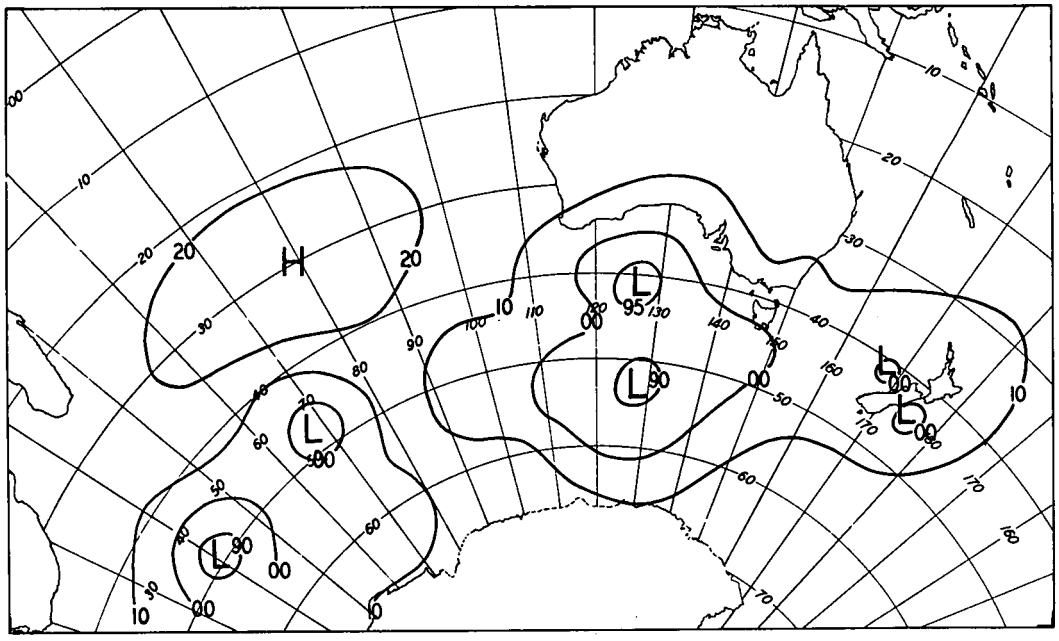


Fig 3. M.S.L. Chart for 14th. August 1955 when above average surface index and high 300mb index.

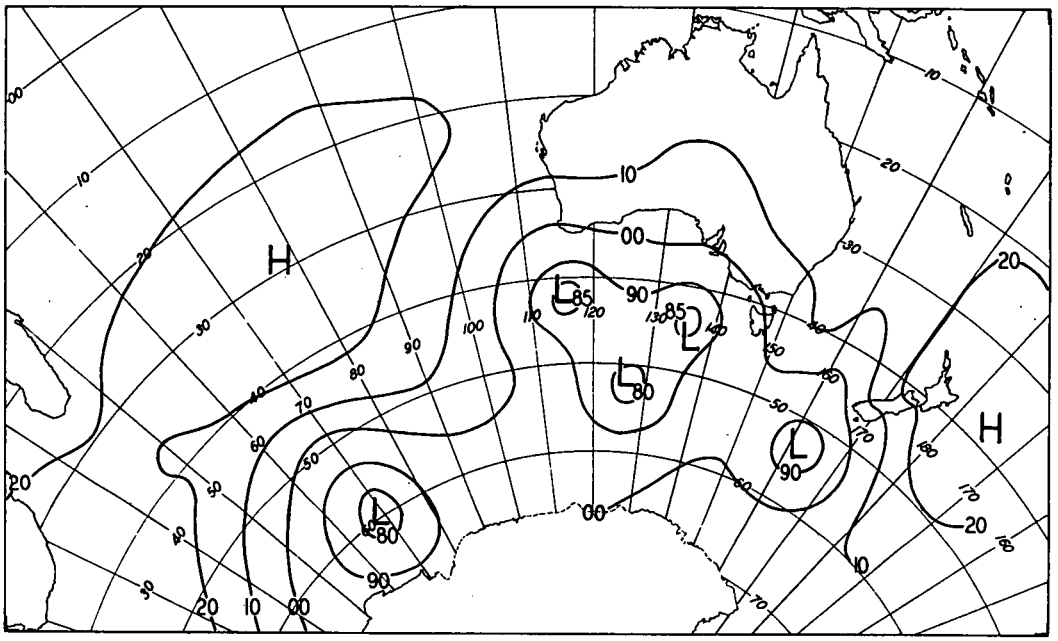


Fig 4. M.S.L. Chart for 22nd August 1955 when high surface index and above average 300mb index.

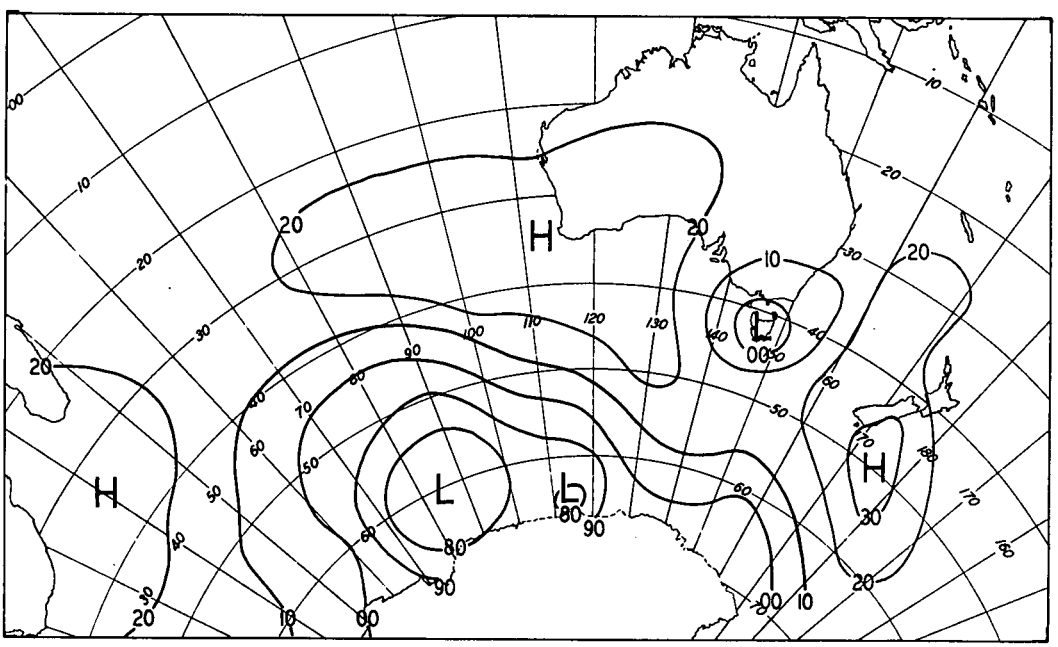


Fig 5. M.S.L. Chart for 14th. July 1955 when below average surface and 300mb indices.

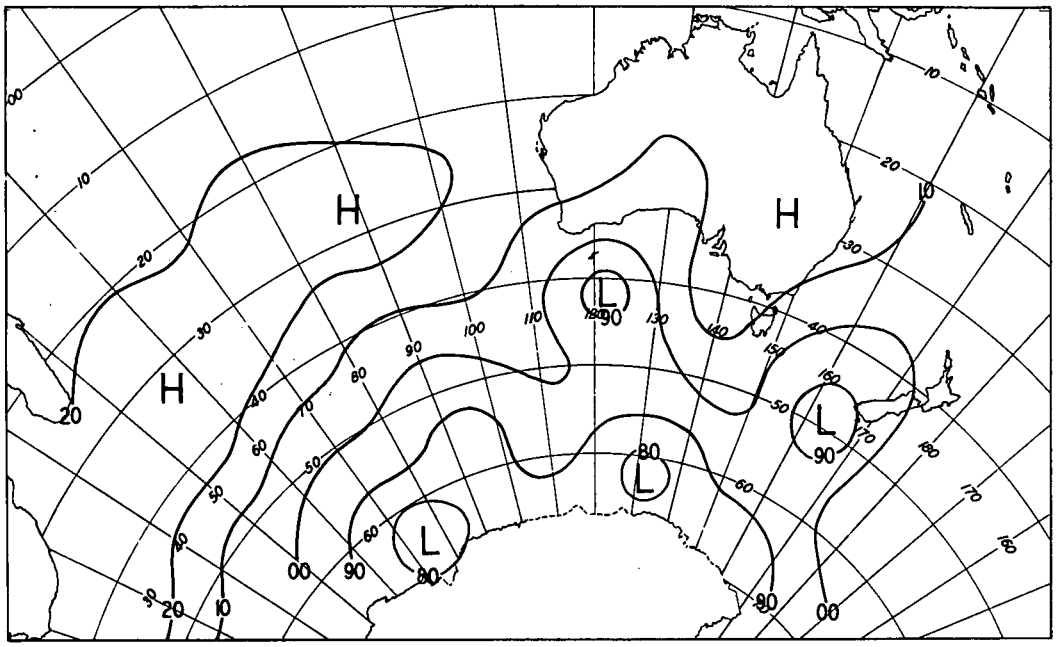


Fig 6. M.S.L. Chart for 31st May 1955 when average surface index and high 300mb. index.

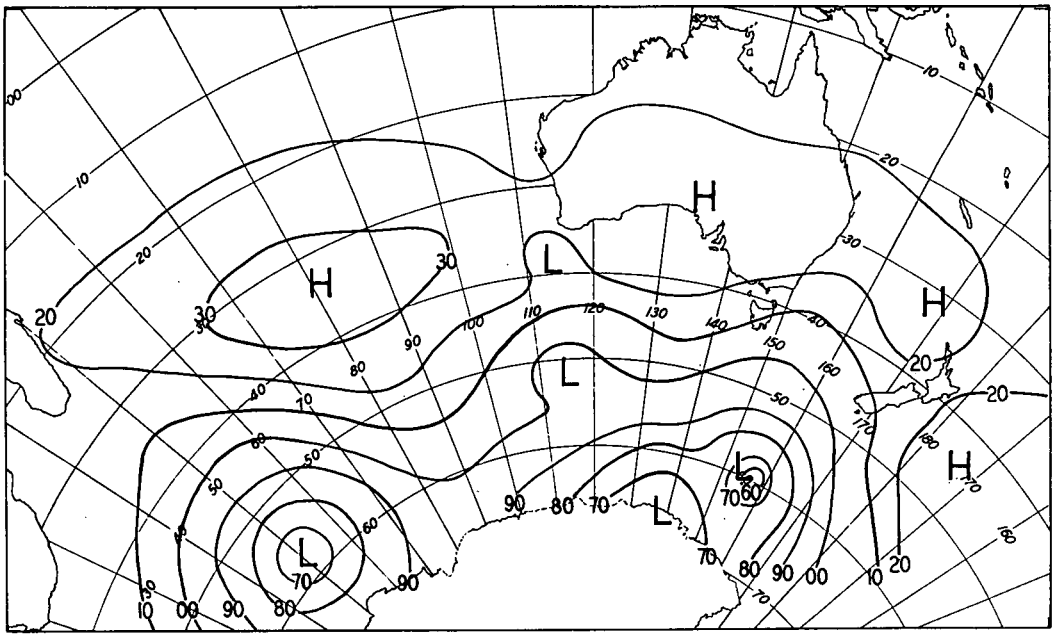


Fig 7. M.S.L. Chart for 10th. July 1955 when high surface index and below average 300mb index.

(iv) Above average surface index. Below average 300 mb index. (Figure 7).

(a) Strong westerlies through the 35-50°S zone.

(b) Ridges to the north elongated W - E with centres at about 35-40°S, i.e. troughs far apart.

(c) Cyclonic activity about southern Australia generally weak.

(d) Main cyclonic activity well south over Antarctic waters.

3. CONCLUSION

The combination of indices is found to be useful in summarising the characteristics of the immediate past and present synoptic patterns but for forecasting purposes, its usefulness depends on the maintenance of trend in the indices. This is rather variable. Over the short period considered, in the case of the surface index, persistence of value either above or below average, ranged from 2 to 26 days, average 9 days and for the 300 mb index, 4 to 28 days, average 13 days. In each case, short periods occurred when the index was close to average value. In other words, periods of high or low index persisted longer, the further the value of the index away from the average.

The surface index for the 35-50°S zone reflects quite well, changes in the general wavelength of the synoptic pressure pattern, while the 300 mb index reflects the activity in the troughs in the Australian region. When the two are in phase and above average value; a high latitude trough, coming into position south of a trough over southern Australia, leads to intensification. The two troughs reinforce one another, producing the long wavelength, large amplitude trough which is likely to remain quasi-stationary for several days, with surface secondary lows developing in it.

Regions favourable for the appearance of these secondaries in the trough are clearly depicted in the examination of the surface circulation of the Australian region by Karelsky (1956).

References:

Karelsky, S.	1956	Bur. of Met., Met Study No. 8.
Maher, J.V.	1955	Bur. of Met., Aust. Met. Mag. No. 9, p. 14.
Namias, J.	1947	J. Met. 4, p. 122.
Namias, J. and Clapp, P.F.	1944	J. Met. 1, p. 57.
Riehl, H. et al	1954	Am. Met. Soc. Met. Monog. 2, No. 7.
Rossby, C.G. and Willett, H.C.	1948	Science 108, p. 643.