THE MOVEMENT OF DEPRESSIONS OVER SOUTHERN WATERS

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INTRODUCTION

Since September, 1948, synoptic charts for 0600Z daily have been drawn covering the vast ocean area south of latitude 35°, and between longitudes 70° and 180°E. The times of inception of each routine observing station in the area concerned are shown in Figure 1. It will be readily seen that in view of the sparse network and the inherent difficulties presented by an entirely new analysis area, the construction of the charts has been a task of no mean proportion, and that no high degree of confidence can be placed in many of the analyses. The preparation of these analyses is regarded as a development project in the research section and widely differing methods of frontal analysis have been applied by different analysts. However, some degree of continuity has been observed from day to day and in any case the present work is concerned mainly with the movement of depressions, there being fairly general agreement about the locations of at least the major cyclones which are detected in the first instance in the vicinity of Marion Island.

AIMS

The primary aim of this investigation was to study the movements of depressions between Heard Island (73.5°E) and Cape Leeuwin (115°E) and their connection with troughs about the south-west corner of the continent.

METHOD AND DISCUSSION

(a) During the limited period under review (September, 1948 to November, 1949) the times have been noted of all major troughs of southern origin reaching Cape Leeuwin. The results are shown in Table I, and in a frequency curve - Figure 2. The latter approaches a normal curve with a maximum frequency at 2200Z.

(b) The longitudinal positions of "significant" (trough-producing) depressions were noted on days D, D-1, D-2, etc., D being reference day when a trough appeared at logitude 115°E in the vicinity of Leeuwin. Monthly graphs were drawn showing the movement (longitudinally) of such depressions between Heard Island and their positions when troughs appeared at 115°E.

From these graphs the times of movement of "significant" depressions between 73.5°E and 115°E were determined from the 93 troughs considered.

In Figure 3 a frequency analysis of the longitudinal positions of significant depressions at the time of the trough at 115°E is shown. It appears as a normal curve with maximum frequency between 121°E and 125°E. This result is in accordance with the usual type of NNW-SSE trough experienced in this region. High longitudinal values of this graph correspond to wave development on a front in the Bight, the major depression having moved far to the south-east. In such cases, the primary depression has been regarded as producing the trough at 115°E. Small longitudinal values on the graph correspond to the rare occasions when a trough at 115° appears ahead of a major depression to the south-west.

It is noted that about 76% of troughs at 115°E appeared during the forenoon. In deriving this percentage, the 16 troughs noted at 01Z were distributed equally between morning and afternoon, giving the result shown at the bottom of Table I.

THE MOVEMENT OF LOWS

Table II summarises the rate of movement of the "significant" depressions eastward from Heard Island (longitude 73.5°E). In Figure 4 the average daily movement in degrees of longitude for the various months is illustrated.

In the Figures 5 and 6 "modal" values of E-W speeds of depressions are shown for the various months considered. The "modal" value of the longitude of southern depressions which cause troughs at Leeuwin is 124°E, in aggreement with Figure 3. The "modal" ordinate value at 73.5°E is 3.0 days, in accordance withresults on Table II. The modal value at longitude 115°E is 0.7 days, giving a modal value of travel between 73.5°E and 115°E as 2.3 days, also in accordance with Table II. The average east-west component of travel along 55°S parallel is 25 knots, which is the same order as the actual rate of movement observed on Byers' charts for the "Southern Hemisphere Project" and those drawn in South Africa.

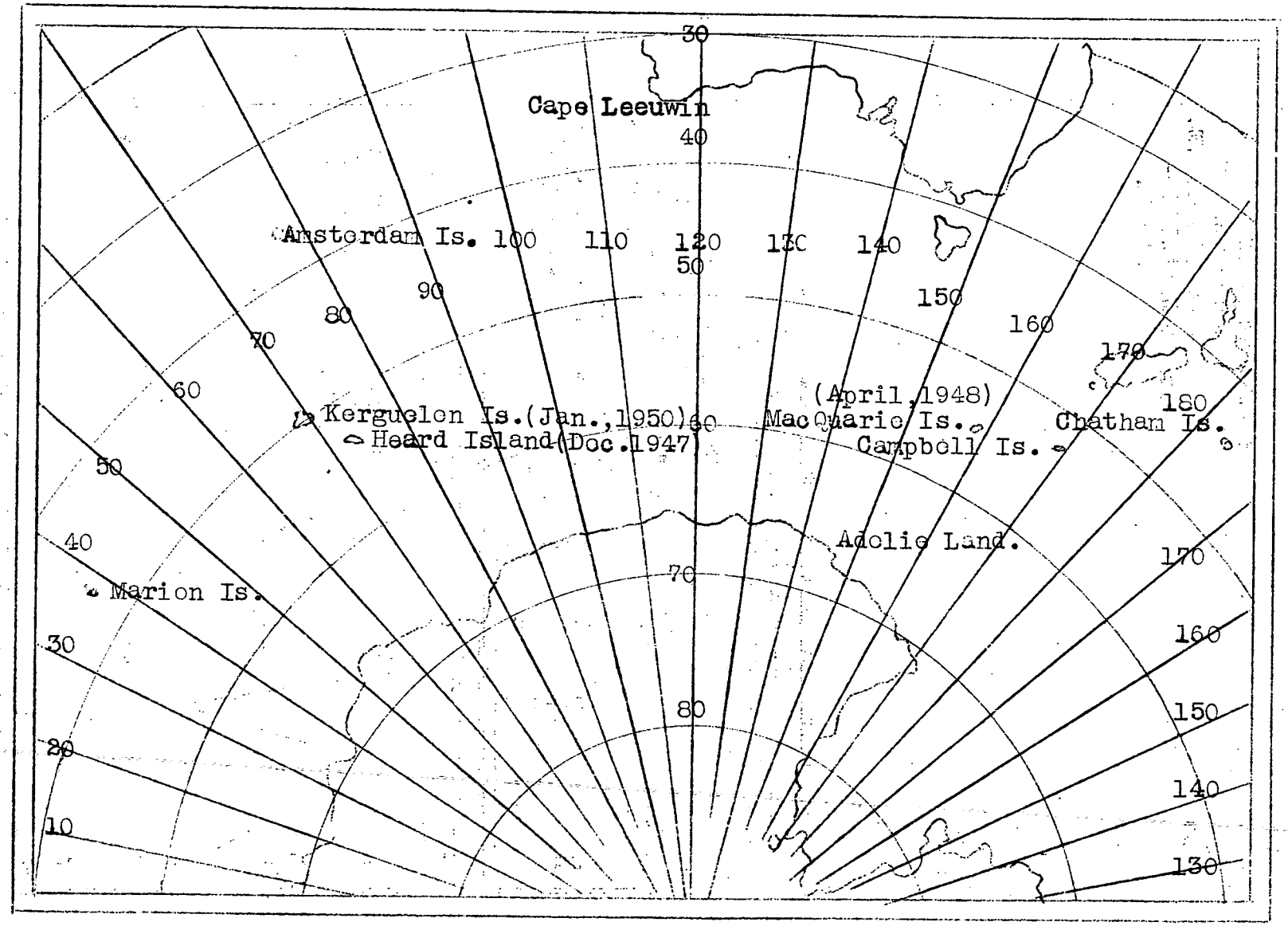
Cape Leeuwin
Amsterdam Is.
Kerguelen Is.(Jan.,1950)
Heard Island(Dec.1947)
(April,1948)
MacQuarie Is.
Campbell Is.
Chatham Is.
Adelie Land.
Marion Is.
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
10
20

Figure 1.

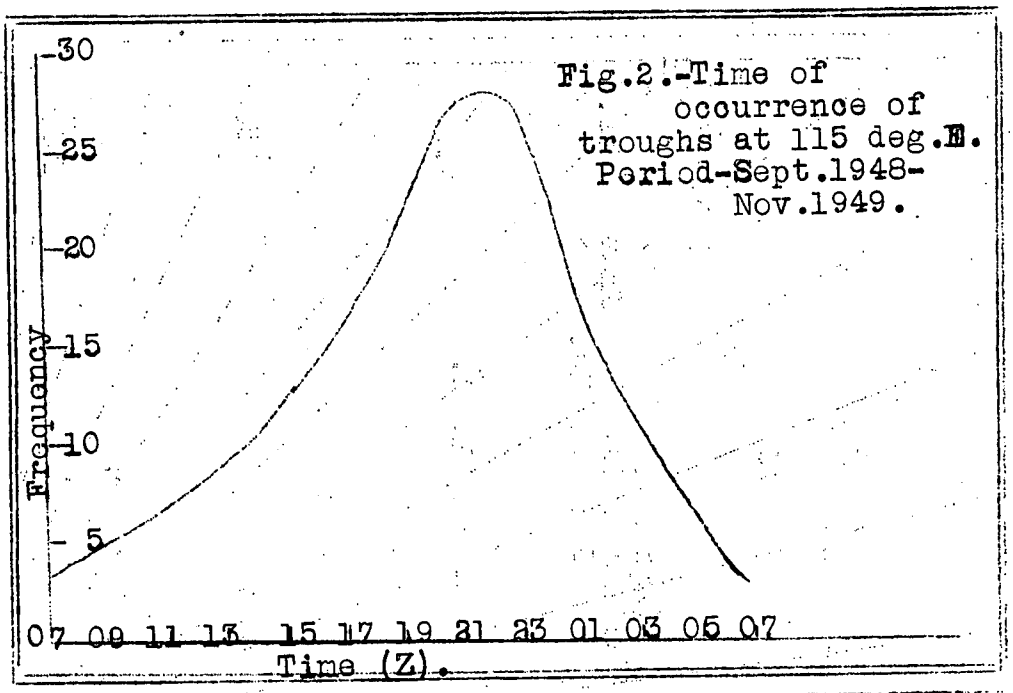

Fig.2.-Time of occurrence of troughs at 115 deg.E. Period-Sept.1948-Nov.1949.

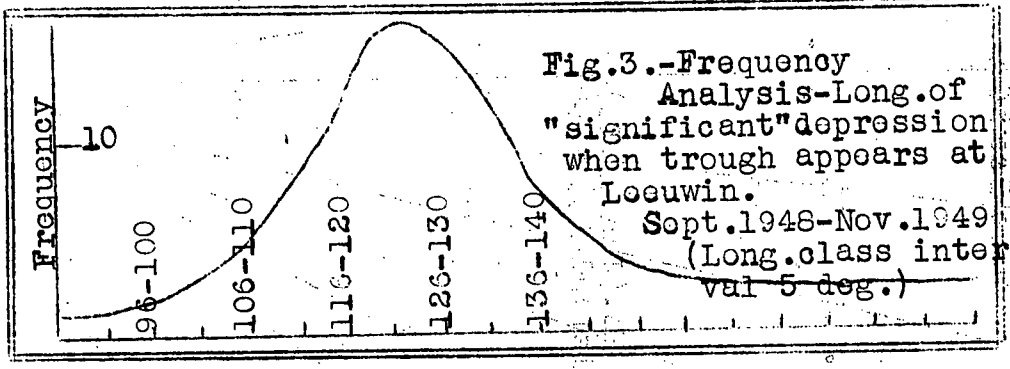

Fig.3.-Frequency Analysis-Long.of "significant"depression when trough appears at Loeuwin. Sept.1948-Nov.1949 (Long.class interval 5 deg.)

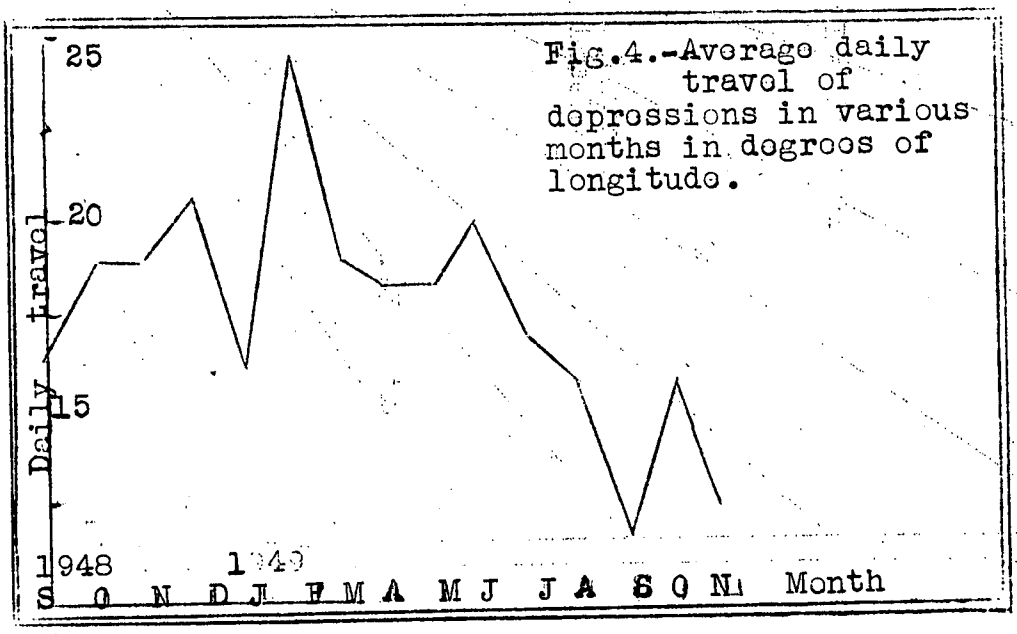

Fig.4.-Average daily travel of depressions in various months in degrees of longitude.

TROUGHS

The form of troughs about Cape Leeuwin is frequently difficult to determine, and at times no clear-out connection with other systems is evident, However, it is usually easy to determine that a major trough has passed Cape Leeuwin. In the present investigation, the actual observations at Cape Leeuwin and Albany were used in determining the trough passage at Cape Leeuwin. It was originally intended to classify troughs according to "intensity", but this idea proved fruitless, and in practice associated weather is the best criterion for trough "intensity". Trough development over 24 hours was classified according to the following scheme: 0 = no development, d = deepens, w = wave development, f = fills (results of this part of investigation to be published later).

Perusal of Table III shows that there is no one-to-one correspondence between the passage of depressions at Heard Island (73.5°E) and troughs at Leeuwin (115°E). During the time that 182 depressions passed 73.5°E, only 93 troughs appeared at Cape Leeuwin (115°E), i.e. it appears that about 50% of depressions passing 73.5° produce troughs at 115°E. When "major" troughs are considered (i.e. those with a marked cyclonic circulation, and centre below 990 mbars.), the percentage of troughs at 115°E to depressions at 73.5° rise to 70%. From the last few columns of Table III, it is clear that practically all "major" N-S troughs at 115°E are produced by "major" depressions to the south and that such depressions maintain intensity between 73.5°E and 115°E.

It must be borne in mind that there is a large "personal" element involved in the drawing and interpretation of sub-antarctic synoptic charts, and that in any case a period of many years would have to be considered before firm statistical conclusions could be reached regarding the "behaviour" of particular systems south of latitude 40°S. However, it is felt that there is value in tentative conclusions based on an analysis of results over the comparatively short period considered in the present survey.

CONCLUSIONS

(1) Depressions of southern origin passing between the longitude of Heard Island (73.5°E) and Leeuwin (115°E) have a mean west-east speed component 17 degrees per day, amounting to about 25 knots at the latitude of Heard Island.

(2) The speed of individual depressions lie between fairly wide limits - as yet no clear-cut monthly or seasonal trend emerges.

(3) Roughly 50% of all depressions passing Heard Island (73.5°E) subsequently produce troughs at Cape Leeuwin (115°E) but the percentage rises to 70% when marked depressions below 990 mbars. are considered.

(4) Practically all "major" troughs at 115°E are produced by "major" depressions to the south, and such depressions usually maintain their identity and intensity in moving between 70°E and 120°E (or more).

(5) There is a "preferred" longitudinal position of southern depressions for trough production at 115°E lying between 120° and 125°E and the longitudinal distribution of such depressions follows a normal curve.

(6) The frequency of troughs of southern origin at Cape Leeuwin (115°E) appears to follow a normal curve pattern, with a maximum on the 0900K chart.

(7) Observations and analyses extending over a period of some years are necessary before firm conclusions can be drawn regarding the behaviour and mechanisms of synoptic systems in sub-Antarctic areas. There is danger in basing conclusions on short range, tentative work.

TABLE I

TIMES (W.A.T.) OF APPEARANCE OF TROUGHS AT LEEUWIN (OR THERE

1948	0000	0300	0600	0900	1200	1500	1800	Total
September	1	3	3	2	1	-	1	11
October	-	3	1	1	2	-	1	8
November	-	-	5	1	2	-	-	8
December	3	2	1	2	-	-	1	9
1949								
January	-	1	1	-	-	-	-	2
February	1	-	1	-	-	-	-	2
March	-	1	3	1	-	-	-	5
April	-	1	1	-	1	2	1	6
May	-	-	-	-	3	-	1	4
June (16-30)	-	-	3	3	-	-	1	7
July	2	2	1	1	1	-	1	[illegible]
August	4	1	-	2	1	-	-	8
September	2	-	3	1	-	-	1	7
October	-	1	4	1	-	1	-	7
November	-	-	1	1	-	-	-	2
December	-	2	-	-	-	-	-	2
Total	13	17	28	16	11	3	8	96
%	14	18	29	17	11	3	8	100

Percentages of Troughs appearing at 115°E

Morning Hours

$17+28+16+\frac{11+13}{2}$

$= 76\%$

Afternoon Hours

$3+8+\frac{13+11}{2}$

$= 24\%$

TABLE II

MOVEMENT OF SOUTHERN DEPRESSIONS WHICH PRODUCE TROUGHS AT 115°E.

Year-Month	Heard (73.5°E) - Significant Longitude	Heard (73.5°E) - 115°E		24 hour Movement (Degrees of Longitude)
	Days	Number of Depressions	Days	
1948				
September	3.5	9	2.5	16.7
October	3.0	8	2.2	18.9
November	2.7	8	2.2	18.9
December	3.1	9	2.0	20.7
1949				
January	2.5	2	2.6	16.0
February	3.1	2	1.7	24.4
March	3.1	5	2.2	18.9
April	2.9	6	2.3	18.0
May	2.1	4	2.3	18.0
June	3.2	7	2.1	19.8
July	3.5	8	2.5	16.7
August	3.1	7	2.7	15.4
September	5.1	7	3.6	11.5
October	4.0	6	2.7	15.4
November	3.8	2	3.5	11.9
December		Insufficient data		
Means	3.3		2.45	17.0
Extreme Monthly Range	5.1-2.1		3.6-1.7	24.4-11.5
24 Hour Movement (Nautical Miles)				600 (W=E Component at 5
Speed (Knots				25 (W=E Component at 5

TABLE III

RELATIONS BETWEEN NO. OF DEPRESSIONS BETWEEN 73.5°E AND 115°E AND TROUGHS AT 115°E

Year	Month	No. of Depressions Passing			No. of troughs at 115°E	
		(A) All types	(B) Major (990mb)	(C) Trough Producers at 115°	(A) All cases	(B) Produced by Major Depr. at 115°
1948	September	10	8	8	10	10
	October	14	11	7	8	7
	November	14	11	8	8	8
	December	12	9	8	9	8
1949	January	11	9	2	2	2
	February	9	5	2	2	2
	March	15	11	5	5	5
	April	17	13	6	6	6
	May	15	13	4	4	4
*	June	9	6	7	7	7
	July	18	9	8	8	8
	August	11	6	6	8	7
	September	8	8	7	7	7
	October	9	8	6	7	6
	November	10	8	2	2	2
	December	No Charts				
	Totals	182	135	86	93	89

* 2nd Half Month only

PERCENTAGES - Troughs at Leeuwin / Depressions past Heard $\frac{93}{182} \times \frac{100}{1} = 50\%$

Troughs at Leeuwin / Major Dep. past Heard $\frac{93}{135} \times \frac{100}{1} = 70\%$

Troughs produced by Major Deps. / Total Troughs. $\frac{86}{93} \times \frac{100}{1} = 93$