551.515.2 (265)

N.Z. Met. S. Misc. Pub. 148

MINISTRY OF TRANSPORT

NEW ZEALAND METEOROLOGICAL SERVICE

TROPICAL STORMS AND HURRICANES IN THE SOUTHWEST PACIFIC

NOVEMBER 1939 TO APRIL 1969

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WELLINGTON, NEW ZEALAND

1976

Issued By:

THE DIRECTOR,
N.Z. METEOROLOGICAL SERVICE,
P.O. BOX 722,
WELLINGTON. 1.

1 March 1976

Acknowledgements

The author thanks colleagues for comments and advice, in particular Dr J.F. Gabites, former Director of the New Zealand Meteorological Service, and Mr G.F.A. Ward for access to his unpublished data. Information and data supplied by the Meteorological Services of Fiji, New Caledonia and French Polynesia are also gratefully acknowledged. Special thanks are due to the Cartographic Branch of the Department of Lands and Survey for drawing the charts, and the Government Printing Office.

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Contents

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PART I

INTRODUCTION

The Polynesians and others who roamed the tropical Pacific Ocean long before the arrival of Europeans could not help but know and fear the hurricanes of the South Seas. Myths and legends reflect their knowledge. But it was not all superstition: they were keen and accurate observers of nature. For example, the people of Mangaia in the Cook Islands had names for more than 30 different directions from which the wind blew - actually the names of the holes in the basket in which the winds were confined. Recognition of the series of events portending a storm is revealed by some of these names. Maoake was the name of the fairly common NE wind; a slight shift to the north and it was Maoake-anau - Maoake giving birth; on backing to about NNE it became Maoake-ta, the terrible Maoake, the violent wind of a cyclonic storm close by to the west.(26)*

Captain James Cook does not appear to have gathered any information about the tropical South Pacific cyclones, probably because most of the time he spent in the tropics was in the southern winter. It is interesting to note, however, that the friendly Tongans directed him to an anchorage at Tongatapu that is the safest in a hurricane.(27)

The European whalers, traders, and missionaries who followed Cook and the establishment of a base at Port Jackson, Sydney, shortly afterwards, soon found that the South Pacific Ocean was not free of the violent storms that had been known in the Caribbean since Columbus' day, and in the western North Pacific and Indian Oceans. The first to publish accounts were the missionaries but, not unnaturally, their accounts are couched in rather emotional language. The Rev. J. Williams, for example, described a storm at Rarotonga in December 1831.

> "..... The next day was the Sabbath, and it was one of gloom and distress. The wind blew most furiously, and the rain descended in torrents ..... Towards evening the storm increased; trees were rent, and houses began to fall ..... (Monday morning) ..... the whole island trembled to its very centre as the infuriated billows burst upon its shores ....."(65)

The log of HMS Favourite for 17 December 1842 uses more phlegmatic language but is equally vivid.

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* See numbered reference - Part V

"7.45 a.m. Mangea N.N.W. to E., one mile off shore; 1 p.m. wind E.N.E. force 7; 4 p.m. wind E.N.E. force 11; 5.30 p.m. carried away main staysail, shipped water battened down; 6.30 p.m. first gig lost, man drowned; 7 p.m. wind E.N.E. force 12, jib blew to pieces, split driver; 8 p.m. wind S.b.W. force 12 midnight wind W.S.W. force 10."(51)

The first to gather information together and to attempt to understand and explain the characteristics and behaviour of tropical storms in the South Pacific was Thomas Dobson who published his findings in 1853(36). He described 24 tropical cyclones and drew certain conclusions from his study of them. His descriptions are of considerable historical interest but naturally enough, considering the small amount of data and the lack of synoptic weather charts, his conclusions concerning the movements or tracks of the cyclones are of little value. He did, however, establish that the storms are cyclones, or "revolving storms", in which the sense of the circulation is clockwise.

It was 40 years before another consolidation of reports of South Pacific tropical storms scattered through journals and log books was published by E. Knipping in 1893(48). He extended the list to 120. Then, in 1925, the classical works of Stephen S. Visher appeared (61,62). His diligent search turned up a total of 259 tropical storms in the South Pacific: one in 1789, one in 1819, one in an unknown year, and the rest in the 94 years from 1830 to 1923. Visher attempted to estimate the average number of severe tropical cyclones occurring in the area per year. Because his records were obviously incomplete one might have expected his estimate to be on the low side but, in fact, Visher over-compensated and his estimate of more than 12 a year is probably as much as 50 per cent too high. His mistake arose from the assumption that extended gaps in the chronological lists of cyclones in particular island groups were due to failure to record or find records of cyclones. We now know that incidence is indeed sporadic: an island group may be spared violent storms for five to ten years or more and then experience two, three, or even four, in the space of one or two years.

In Visher's time and right up to World War II there was insufficient information on weather charts to permit the accurate derivation of the tracks of tropical cyclones. The situation improved immediately before and during the war as meteorological services expanded greatly to meet the needs of international aviation and military operations. By the early nineteen-fifties there was, as Hutchings believed, enough material available to allow some new conclusions to be drawn about the tropical cyclones of the area and to permit the tracks of the disturbances to be plotted with sufficient accuracy. His survey in 1953(24), contains the tracks and statistics of 43 tropical cyclones in the period 1940 to 1951 inclusive. The area covered lies between the equator and 30°S and between 150°E and 150°W. Cyclones were included in Hutching's list only if a wind of at least Beaufort force 9 was actually reported at some station or ship within the storm's circulation at some time during its life north of 30°S. This very proper objectivity had been completely lacking in earlier studies. The early investigators had perforce to rely to a large extent on unofficial

reports, newspaper accounts, and the memories of the island inhabitants. The terms used to describe the storms were many and varied; hurricanes even though it is obvious in many cases that the wind was not of hurricane force; gales or heavy gales although the possibility that the wind exceeded force 9 is not excluded; a violent storm; a stiff or hard "blow": and so on. Differences between popular usage of some of the terms to describe the strength of the wind and the official definitions of these terms still bedevil the investigator today. Unofficial estimates are almost invariably too high, and so too, regrettably, are official estimates sometimes.

Hutchings' average number of 3.6 cyclones per year is too low because a not inconsiderable number of tropical storms undoubtedly slipped through the network without any station reporting a wind of force 9. The network was still rather sparse, not only spatially but also with respect to the frequency of reporting: some stations reported only once or twice a day.

Hutchings also examined the regions of origin of the South Pacific hurricanes but his claim that the place of origin of most of the disturbances he investigated could be determined with reasonable accuracy seems a little optimistic when one considers the extremely small dimensions of many nascent tropical cyclones in relation to the spacing of the reporting stations. Nevertheless the general conclusion to be drawn from his data, that the great majority of the cyclones are born between latitudes 5 and 15 degrees south and west of longitude 180°, is probably valid. We shall need at least another ten years of satellite surveillance before this aspect of hurricane climatology can be much refined.

Finally, Hutchings drew attention to a marked difference between the tracks of tropical cyclones in the South Pacific and those of tropical cyclones in other regions. He found that only 56 per cent of the cyclones he examined moved initially westward, i.e. with a westward component of motion, from their point of origin as determined by himself, compared with 85 per cent of North Atlantic hurricanes*. While it may be that some of Hutchings' cyclones formed earlier than he thought and that initial movement in these very early stages could have been westward there is little doubt that the so-called typical track: westward, southwestward then recurving to the southeast, is far from typical of tracks in the south Pacific. (There is not really a typical or normal track in other regions either but the idea still persists in many quarters.)

Gabites (40, 41) added to Hutchings' diagrams the tracks of cyclones in the period 1952 to 1956 inclusive. He used the same criterion as Hutchings. In the 1963 series of papers Gabites discussed various aspects of tropical cyclones in the South Pacific and, in particular, gave a clear demonstration of the wide variety of track-types that occur. He found that, in the 1940-1956 period, about as many cyclones moved initially eastward as westward, and almost half failed to recurve.

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* The proportion, 85 per cent, was derived from tracks published by Tannehill (56).

Charts of the tracks of tropical cyclones in the Southwest Pacific for each of the seasons 1947/1948 through to 1961/1962 were published by Giovannelli and Robert in 1964 (13). Their terminology differs from that used by Hutchings and Gabites. The following were their respective "definitions", placed side by side for comparison.

	Hutchings and Gabites	Giovannelli and Robert
Tropical depression:	tropical disturbance: maximum wind strength force 8 or less. (Tracks not reproduced)	tropical disturbance: maximum wind strength force 8,9,10 or 11.
Tropical cyclone:	tropical disturbance: maximum wind strength force 9 or more	tropical disturbance; maximum wind strength force 12.

Giovannelli and Robert plotted the tracks of both their depressions and cyclones, and distinguished the one type from the other in the tabulations below each chart. However, Giovannelli and Robert do not say how they determined the classification. It seems probable that, at least in some cases, they must have relied on their own judgement or on the judgement of the meteorologists who had analysed the weather maps at the time of the cyclone's occurrence. Partly as a result, probably, of a difference in the method of determining the classification, and partly because a maximum wind of force 8 qualifies a disturbance for inclusion in Giovannelli and Robert's lists, their charts show tracks which do not appear in Hutchings'.

As well as tables of annual and monthly totals and of regions of origin Giovannelli and Robert presented an analysis of track-types comparable with Gabites' analysis. Their results, for the track-type analysis, were broadly similar to Gabites' but they found nearly three-fifths travelled without recurving, and slightly over three-fifths moved eastward initially or throughout their lives. The average number of tropical disturbances listed by Giovannelli and Robert was 6.3 per season, but in comparing this with Hutchings' figure the differences in procedure noted above must be borne in mind as well as the improving network of observing stations.

The Australian Bureau of Meteorology began with the 1957/58 season to publish annual reports on tropical cyclones in the Australian region (5,6....10). The classification is different again. The tropical disturbances are divided into three classes -

1. Major tropical cyclones associated with winds exceeding 33 knots (i.e. force 8 or more) and extending more than 100 miles from the centre.

2. Tropical cyclones associated with winds exceeding 33 knots but not extending more than 100 miles from the centre.

3. Minor tropical disturbances associated with wind speeds not exceeding 33 knots (i.e. force 7 or less).

Once again the classification cannot be completely objective.

In 1971 the Bureau published a survey by Coleman of tropical cyclones in the Australian region from November 1909 to June 1969(1). The area covered extends from 105°E to 165°E. It is divided into two parts: west of 135°E to east of 135°E. The data are grouped in months and decades. In general only class 1 and 2 cyclones are included but some class 3 disturbances have also been included.

The present work aims to consolidate and, by adding data up to 1969, to extend the work of Hutchings, Gabites, and Giovannelli and Robert, and, at the same time, to complement Coleman's survey. Its three principal sections are Parts II, III and IV. Part II contains a list of tropical storms and hurricanes in the Southwest Pacific in the period November 1939 to April 1969; and charts of the tracks of these storms and hurricanes. Each chart shows the tracks for one month through ten years and is, therefore, an eastward extension of the corresponding chart in Coleman. However, the charts overlap Coleman's in the west in order to give virtually complete coverage of oceanic, tropical and sub-tropical Southwest Pacific, that is from the equator to 30°S and from 150°E to 150°W. Various derived charts and statistics follow, which are discussed in Part III.

Part IV contains lists of tropical storms and hurricanes which have passed over or close to each of the several island groups in the area during the period. They can be regarded as extensions of the similar lists in Visher(61). The gap between the two sets of lists, 1923 to 1940, is partly filled by short lists of the more notable storms between 1900 and 1940.

While explanations of the tables and charts in Parts II and IV are given in the introductions to those Parts it is appropriate to discuss here the fundamental problem of the classification of tropical cyclones.

Dunn and Miller (37) have commented, "It is imperative that a classification, once agreed upon, remain relatively unchanged; otherwise the statistics of past years become less useful and extremely difficult to interpret." Unfortunately, as we have seen, workers in the Southwest Pacific have not all adopted the same classification. The present author believes that the classification should be based on the definitions adopted by the World Meteorological Organization. These are quoted below but, first, it is necessary to clarify the expression "tropical cyclone" itself. Here also the author agrees with Dunn and Miller when they strongly urge that it should be used as a generic term including tropical disturbances of all intensities.

The World Meteorological Organization classifies tropical cyclones as follows (but see the footnote on p. 6).

Tropical depression:	Winds up to 33 knots, i.e. up to Beaufort force 7.
Tropical storm - moderate:	Winds 34 to 47 knots, force 8 or 9.
- severe:	Winds 48 to 63 knots, force 10 or 11.
Hurricane (or local synonym)	Winds 64 knots and over, force 12.

In a recent publication (35) Crutcher and Quayle have adopted the same classification of tropical cyclones, using that expression in the generic sense. (Some minor differences in national practices are recognised.) But what they call the 'tropical cyclone stage' apparently excludes the 'tropical depression stage' if the point of transition from 'depression' to 'storm' is known.

The measure that determines the classification of a tropical cyclone at any particular time is the highest sustained wind speed in its circulation at that time. The expression, sustained wind speed, here refers to the average speed of the wind at a height of 10 metres above the surface over a 10 minute period. The speed of the wind exceeds the mean or sustained speed appreciably in gusts, and when press reports refer to an "100 knot cyclone" this usually means that the peak gust recorded was about 100 knots. (Unfortunately it sometimes means that the wind was estimated to have reached 100 knots; but it is impossible to estimate speeds of this order at all accurately without an anemometer.) It would, in the author's opinion, be preferable to classify tropical cyclones by reference to Beaufort scale numbers rather than wind speeds. For one thing, several different sets of equivalent wind speeds have been used over the years. Furthermore, very few of the island stations or ships in the Southwest Pacific had anemometers during the period of this survey and, although the wind strength was reported in the form of speed in knots (since 1949), many observations on land as well as at sea were made in terms of the Beaufort scale and converted to equivalent mean speeds using the agreed set of equivalents. For these reasons whenever a reported wind is mentioned in this survey it has been converted back to a Beaufort scale number unless the station is known to have had an anemometer at the time.*

During the life of a tropical cyclone the classification is likely to change, beginning as a tropical depression, probably becoming a tropical storm as it develops, and possibly a hurricane

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* The specifications of the Beaufort scale of wind force are given in Table 1 together with the ranges of equivalent mean speeds in knots that have been in force since 1946. Recent studies have indicated that, over the oceans (and this would include lowlying islets and atolls), the speeds equivalent to scale numbers above 4 are too high and a new set was recommended by W.M.O. in 1970, for research and statistical purposes only at this stage. Note also that the reporting of wind speeds in knots was introduced in 1949. Prior to that the Beaufort scale number was reported.

for a time, and then losing intensity again. This survey covers only those tropical cyclones that became tropical storms or hurricanes in terms of the above definitions at some stage during their lifetimes north of 30°S.

Unfortunately the Southwest Pacific is an area in which there are still large gaps in the observing network and the density of ships' reports is relatively low. Bearing in mind how small the area of gale force (force 8) or stronger winds may be, it is entirely possible for a tropical cyclone to slip through the network without there being any direct evidence that it was ever more than a tropical depression. For the purpose of issuing warnings during the life of a tropical cyclone it is necessary to estimate the wind strength or speeds in the circulation but, when the cyclone's centre is more than 30 or 40 km from any land station or ship, this is still a very subjective process even with the aid of satellite data. No attempt has been made in this survey, therefore, to estimate maximum sustained wind speeds or Beaufort scale numbers, or to use the estimates made by the meteorologists who analysed the maps at the time of occurrence. Instead, the principal criterion adopted was that a wind of gale force (Beaufort force 8) or stronger was reported by a land station or ship within the cyclone's circulation at some stage of its life while north of 30°S. Nevertheless a number of cyclones have been included in the catalogue even though this criterion was not fulfilled. In these cases there was other evidence, e.g. aircraft reports or satellite photographs, that strongly supported the belief that the cyclones did attain the status of tropical storms or even hurricanes.

Each track has been plotted, however, from the point at which the tropical cyclone was identified as such. In many cases, therefore, the disturbance would have been only a tropical depression for some distance along its path from the starting point. It has not been possible to indicate the points on the tracks at which the depressions became tropical storms or hurricanes. The cyclones are referred to as hurricanes only when hurricane force (force 12) winds have actually, and credibly, been reported (and sometimes when quoting from other sources).

One result of adopting the above criterion is that more tropical cyclones are included in the list from 1940 to 1951 than are given by Hutchings who excluded cyclones in which reported winds did not exceed force 8. Another result is that a number of cyclones appearing in lists in other publications have not been included in the primary lists in this work, but most are mentioned in supplementary lists under the heading, "Other possible tropical storms or hurricanes". Their tracks are not shown on the charts and they are not counted as occurrences of storms or hurricanes.

Finally, it will be noted that the "hurricane season" has been taken as November to April inclusive. True tropical cyclones do occur in other months, notably hurricane Bebe in October 1972, but they are extremely rare.

PART II

TABLES AND CHARTS

The Beaufort Scale

Table 1 gives the current specifications of the Beaufort scale of wind force together with the ranges of equivalent mean speeds in knots that have been in force throughout the main period of this survey.

Catalogue

Tables 2.1 to 2.30 inclusive contain the list of tropical storms and hurricanes that have been recorded in the area from the equator to 30°S and between 150°E and 150°W in the months of November to April inclusive, from November 1939 to April 1969.

The cyclones are numbered serially, starting from 01 in each of the three decades, in chronological order of first appearance as tropical depressions or, in some cases, as tropical storms or hurricanes when evidence of their earlier history is completely lacking or when they have entered the area from the west. The first digit of the serial number, before the point, indicates the decade, i.e. 4 indicates the nineteen forties, beginning November 1939; 5 the fifties; and 6 the sixties.

The second column gives the year and month of first appearance.

In the third column the dates, which are Greenwich dates, are those of the first and last points on the corresponding tracks. If the cyclone began in one month and finished in the next the initial letter of the second month follows the second date. For example, the entries 40 12 30-6J mean that the cyclone first appeared on 30 December 1940 and that the last point on its track was 6 January 1941.

The fourth column contains brief statements of the areas in which the cyclones are thought to have developed, the areas through which they passed together with broad indications of the directions in which they moved at various stages. The latter are given as compass points, capital letters, towards which the cyclones moved.

Descriptions of noteworthy storms and some extracts from, or summaries of, detailed reports that have been supplied by the masters of ships that have encountered hurricanes are given in Part IV. The reader is referred in column 5 of Table 2 to the relevant page or pages. Remarks on lesser storms and on cyclones on which little information is available are given in the fifth column of Table 2 itself. They sometimes include the strongest

reported wind or lowest reported pressure. The remark "west of 160°E" means that the centre of the cyclone was never east of 160°E. at least while north of 30°S. No details of these cyclones are given: The references A provide full information for the 1955/56 season and for the 1957/58 and subsequent seasons. It should be noted also that, in these cases, Coleman's tracks (1) have been adopted in the main without further examination. However the tracks of a few class 3 disturbances (see page 5) included by Coleman have been eliminated.

The references in the last column are to groups of official publications which have been used to check on the information derived from the primary sources (see Part V), and which, in some cases, have furnished additional information. The identifiers used and the groups of publications they correspond to are -

A - Australia: references 1 to 10

C - New Caledonia: references 11 to 16

F - Fiji: references 17 and 18

P - French Polynesia: references 19 to 21 (and 11)

S - Western Samoa: references 22 and 23

Z - New Zealand: reference 24.

Information concerning a particular cyclone may be found in one or more of the references in a group. Several of the publications are serial or annual: the relevant issue can be determined from the dates of the cyclone. In some the individual cyclones are identified by number (references 3 to 10 - group A, and 24 - group Z), or letter (reference 13 - group C). In Tables 2, where applicable, the relevant number or letter follows the group identifier.

As mentioned in Part I (page 7) additional, possible tropical storms or hurricanes are included in the lists, unnumbered.

Frequency Tables

Table 3.1 gives the numbers of tropical storms and hurricanes that occurred in each month of each of the thirty seasons, and the annual totals. In Table 3.2 these figures are totalled for each decade and for the whole 30 years. If a cyclone is tracked through the end of one month into the next month it is counted as being an occurrence in both months unless the first day was the last day of a month or the last day was the first day of a month: in this case it is counted only in the other month. Of course, no cyclone is counted twice in the season's total. The unnumbered, possible storms are not counted. Alongside Table 3.1 the annual totals are presented in the form of a histogram.

Tracks

The tracks of the 194 tropical storms and hurricanes are plotted on Charts 1.1 to 1.15 inclusive. They are grouped according to month and decade, except that November and December

tracks are placed on one chart for each decade. Some tracks are drawn as full lines and others as dashed lines simply to facilitate following them: there is no other significance. The dots with dates adjacent are at the positions of the centres of the cyclones at 0000GMT on those dates. The intermediate dots are at the 1200 GMT positions. In addition to the day of the month, the year and, on the November/December sets, the initial letter of the month are entered against the first 0000 GMT point of each track. If a cyclone existed for only a day or two in one month but spent most of its life in another month the whole track may be shown on the one chart appropriate to the latter month. Otherwise the track is divided between the two relevant charts. The tracks end in a number of ways:

a. At the end of the month; arrow head, noted "to Jan (etc)".

b. By crossing a boundary of the area.

c. By moving into an area in which there is insufficient data to determine subsequent history; arrow head pointing in the general direction in which it had been moving.

d. By apparently filling up or becoming absorbed in an advancing extra-tropical trough of low pressure; indicated by a fish hook-like termination of the track.

Geographical Distribution

The frequencies of tropical cyclones in 5-degree squares are plotted on Charts 2.1 to 2.3, the first for all months of all seasons, and the other two for November to January and for February to April. The figures are derived from Charts 1.1 to 1.15. Where a track crosses a boundary of a square within half a degree of a corner the cyclone has been counted as an occurrence in all four of the squares, between 10°S and 30°S, and between 150°E and 150°W, which have that corner in common.

Directions of Movement

The numbers of tracks crossing most of the five degree squares were found to be too small to warrant the presentation of direction-of-movement roses for the several months of the season: they would have no statistical significance. However a systematic trend in the frequency and geographical distribution of westward moving cyclones as the season advances was found, and this is illustrated in charts 3.1 to 3.4.

In this analysis only two classes of direction of movement have been recognised - "SE" if the point of exit of a track from a five degree square (or its terminal point) is east of its point of entry (or of its initial point): "SW" otherwise. The relative frequencies of "SE" and "SW" tracks are represented by the lengths of the arrows drawn to the SE and SW respectively. Arrows are not drawn in squares in which the number of tracks considered is less than five. The symbol ⟨ represents a track which exhibits a change of direction of movement, within the square, from one with a westward component to one with an eastward component. The number alongside is the number of tracks exhibiting this characteristic.

The symbol ⟩ represents a change of movement in the opposite sense while the symbol ∼ represents multiple changes including loops.

Types of track

The 194 tracks have been divided into four categories -

E: Direction of movement has eastward component throughout the life of the cyclone (north of 30°S)

E ⟶ W: Eastward component initially, changing north of 30°S to direction of movement with westward component

W: Direction of movement has westward component throughout the life of the cyclone (north of 30°S)

W ⟶ E: Westward component initially, changing north of 30°S to direction of movement with eastward component.

The results of this analysis are shown in Table 4. Results of similar analyses carried out by Gabites, and Giovannelli and Robert are included for comparison.

Table 1. Beaufort scale of wind.

Beaufort Number	Descriptive Term	Specifications		Equivalent Mean Velocity Ranges*	
		Land	Sea	Knots	Metres/sec
0	Calm	Calm; smoke rises vertically.	Sea like a mirror.	<1	0 - 0.2
1	Light air	Direction of wind shown by smoke drift but not by windvanes.	Ripples with the appearance of scales are formed, but without foam crests.	1- 3	0.3- 1.5
2	Light breeze	Wind felt on face; leaves rustle; ordinary vanes moved by wind.	Small wavelets, still short but more pronounced; crests have a glassy appearance and do not break.	4- 6	1.6- 3.3
3	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag.	Large wavelets; crests begin to break; foam of glassy appearance; perhaps scattered white horses.	7-10	3.4- 5.4
4	Moderate breeze	Raises dust and loose paper; small branches are moved.	Small waves, becoming longer; fairly frequent white horses.	11-16	5.5- 7.9
5	Fresh breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters.	Moderate waves, taking a more pronounced long form; many white horses are formed (change of some spray).	17-21	8.0-10.7
6	Strong breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.	Large waves begin to form; the white foam crests are more extensive everywhere (probably some spray).	22-27	10.8-13.8
7	Near gale	Whole trees in motion; inconvenience felt when walking against wind.	Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.	28-33	13.9-17.1
8	Gale	Breaks twigs off trees; generally impedes progress.	Moderately high waves of greater length; edges of crests begin to break into the spindrift; the foam is blown in well-marked streaks along the direction of the wind.	34-40	17.2-20.7
9	Strong gale	Slight structural damage occurs (chimney pots and slates removed).	High waves; dense streaks of foam along the direction the wind; crests of waves begin to topple, tumble and roll over; spray may affect visibility.	41-47	20.8-24.4
10	Storm	Seldom experienced inland; trees uprooted; considerable structural damage occurs.	Very high waves with long overhanging crests; the resulting foam, in great patches, is blown in dense white streaks along the direction of the wind; on the whole, the surface of the sea takes a white appearance; the tumbling of the sea becomes heavy and shock-like; visibility affected.	48-55	24.5-28.4
11	Violent storm	Very rarely experienced; accompanied by widespread damage.	Exceptionally high waves (small and medium-sized ships might be for a time lost to view behind the waves); the sea is completely covered with long white patches of foam lying along the direction of the wind; everywhere the edges of the wave crests are blown into froth; visibility affected.	56-63	28.5-32.6
12	Hurricane		The air is filled with foam and spray; sea completely white with driving spray; visibility very seriously affected.	64 & over	32.7 & over

* Ranges of equivalent mean wind speeds at a height of 10 metres above the surface (open flat ground if the station is on land).

Tables 2.1 to 2.30 Lists of tropical storms and hurricanes in the months November to April inclusive, from November 1939 to April 1969.
(See introductory text of part II under heading - Catalogue.)

2.1 The 1939/1940 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.01	39	12	25-29	Santa Cruz Is, SE over Viti Levu and south of Tonga.	See page 74.	F
4.02	40	2	4-17	Ellice Is, WSW through New Hebrides, north of New Caledonia then WNW to Queensland.	See page 68.	A Z27
4.03		2	14-23	Ellice Is, SW through New Hebrides over northern New Caledonia, then SSW to Lord Howe I. area	See pages 60 and 68.	A Z26
4.04		3	15-17	Coral Sea, Queensland.	West of 160°E	A
4.05		4	1- 6	South of New Guinea, Coral Sea, Queensland.	West of 160°E.	A Z32
Another possible tropical storm						
-	40	2	7- 8	French Polynesia	See page 106.	P(19)

2.2 The 1940/1941 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.06	40	12	30- 6J	North of Penrhyn I., S then SW over Suwarrow, west of Palmerston I., recurved ESE about 25°S.	See page 100.	
4.07	41	1	13-19	Northern Cook Is, SE to the Society Is.	See page 107.	P Z16
4.08		2	1- 7	Northeast of Santa Cruz Is, SW to the north of New Hebrides and New Caledonia, then S to Lord Howe I. area.	No landfall.	Z24
4.09		2	16-26	Near Samoa, WSW over Suva turning S and SE south of Loyalty Is.	See page 74.	F S Z29
4.10		2	26- 6M	West of Tokelau Is, SSE over Samoa and Niue, then ESE south of Rarotonga.	See pages 87, 90 and 95.	F S Z28
4.11		4	4- 7	West of Santo, SSE between New Hebrides and Loyalty Is.	Force 8 Tanna at 050000.	
4.12		4	25-28	Northeast of Rotuma, SSE east of Vanua Levu through Lau Group.	Force 9 Lakeba. Filled west of Tongatapu	F

2.3 The 1941/1942 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.13	41	11	24-28	West of Tokelau Is, SSE over Samoa then ESE towards Southern Cook Is.	Force 8 Samoas; strong winds Cook Is but cyclone filling.	S
4.14		12	25-27	Northeast of New Hebrides, rapidly SE over Fiji and south of Tonga.	Winds probably not in excess of force 9. Slight damage in Savusavu and Taveuni districts.	F
4.15	42	2	7- 9	North Coral Sea, Queensland.	West of 160°E.	A
4.16		2	18-24	Northwest Coral Sea, Queensland, northwest Tasman Sea.	No landfall east of Australia; filled north of Norfolk I.	A
4.17		2	16-27	Northern Cook Is, WSW then SE near Suwarrow, SW again near Palmerston I., finally SSE.	See pages 95 and 100.	Z31
4.18		2	25- 8M	Ellice Is, S then SW south of Rotuma and over southern New Hebrides and southern New Caledonia.	At Noumea - force 10 briefly and lowest pressure 981 mb.	A C Z25
4.19		4	8-13	Northwest of New Hebrides, SSE then SSW over southern New Caledonia.	No wind in excess of force 8 reported.	

2.4 The 1942/1943 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.20	42	12	27- 5J	East of Santa Cruz Is, SE over Vanua Levu and SSE through Lau Group.	See page 75.	F Z2
4.21	43	1	1-11	Willis I. area, SE through Coral Sea, north of Norfolk I.	No landfall.	A Z7
4.22		1	27-31	North Coral Sea, Queensland.	West of 160°E.	A
4.23		3	7-13	East of Niue, ESE through Southern Cook Is, then SW and SE again.	See page 96.	Z38
4.24		3	16-19	West of Northern Tonga, SW through Lau Group, recurved SE about 23°S.	No wind in excess of force 9 reported. (Two tropical depressions in New Hebrides-New Caledonia area at the same time).	Z40
Other possible tropical storms						
-	43	3	4- 8	Northwest of New Caledonia, towards Kermadec Is.		
		3	28-31	West of New Caledonia towards northern New Zealand.		

2.5 The 1943/44 season

No.	Yr	Mo	Dates	Area affected and movement	Remarks	References
4.25	43	12	15-18	East of Samoa, SE north of Palmerston I. and just north of Aitutaki and Mauke.	See page 96.	
4.26	44	1	8-12	Northwest of Fiji, erratic SE over Fiji and south of Tonga.	Reported winds not in excess of force 8 over Fiji. No damage. Marginal case.	F
4.27		1	16-20	Northeast Coral Sea, SE along east coast of New Caledonia to Kermadec Is.	See page 60.	C Z38
4.28		1	27- 2F	Southern Ellice Is, SE through Northern Tonga, north of Niue and south of Cook Is.	See pages 91 and 97.	S Z14
4.29		2	3- 6	West of New Hebrides, ESE and SE south of Fiji and Tonga.	No landfall after New Hebrides but gales in Fiji and Tongatapu.	F
4.30		3	6-10	Western Coral Sea, Tasman Sea.	West of 160°E.	A
4.31		3	15-22	Northwest of Samoa, SW passing to north and west of Fiji recurving to SSE about 24°S.	Gales in Fiji, possibly force 9 or 10 in places.	F Z41
4.32		3	24-28	North Coral Sea, Queensland.	West of 160°E.	A

2.6 The 1944/1945 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.33	45	2	2- 3	North of Willis I., Queensland and back to Coral Sea.	West of 160°E.	A
4.34		2	14-18	North of Fiji, SE through Tonga.	No winds in excess of force 8 reported.	S
4.35		3	6- 8	Queensland, South Coral Sea.	West of 160°E.	A

2.7 The 1945/1946 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.36	46	1	10-18	North of Society Is, SW through Southern Cook Is, recurved SE 25°S.	See page 97.	Z 17
4.37		1	13-20	Solomon Is, ESE north of Fiji, through Northern Tonga, then SSE close to Niue.	No damage reported.	Z9
4.38		2	24- 9M	Santa Cruz Is, WSW south of the Solomon Is and New Guinea to Queensland and south of Coral Sea.	No landfall except Queensland.	A Z23
4.39		3	17-24	North of New Hebrides, SW through Coral Sea to Queensland.	No landfall before Queensland.	A Z37
4.40		4	1- 5	North Coral Sea, northwest Tasman Sea.	West of 160°E.	A
Another possible tropical storm						
-	46	1	29- 8F	Series of tropical depressions in the New Hebrides, New Caledonia area, and to the west and south of Fiji.		F

2.8 The 1946/1947 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.41	46	12	24-30	Ellice Is, ESE south of Samoa then SSE near Niue	See page 91.	S Z6
4.42		12	31- 5J	Northwest Coral Sea, SE to southwest and south of New Caledonia.	No landfall.	A
4.43	47	1	11-14	Northwest of Rotuma, SW towards southern New Hebrides but recurved to SSE.	See page 69.	Z12
4.44		1	17-24	Santa Cruz Is, SW through Coral Sea to Queensland.	No landfall before Queensland.	A Z10
4.45		2	21-25	Banks Is, SE to south of Fiji and Tonga.	Close to Tongatapu but no damage reported.	Z22
4.46		3	9-15	South of Solomon Is, SSE through Loyalty Is, then SW to Norfolk I. area.	See page 60.	Z35
Other possible tropical storms						
-	47	1	6-10	South of Samoa, WSW to north of Fiji, then S.		F
-		1	28-31	South of Samoa, S and SE south of Niue.		S
-		2	15-22	South of Samoa, very slowly S between Niue and Palmerston I.		S
-		2	15-	West and south of Society Is, SE.	See page 107.	P(20), also (38).

2.9 The 1947/1948 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.47	47	12	14-17	East of Santo, SSE and S.	No landfall; marginal.	F
4.48	48	1	21-30	Ellice Is, SW through New Hebrides and north of New Caledonia, then S to Lord Howe I. area.	See page 69.	CB Z13
4.49		1	31- 5F	East of Rotuma, SW, recurved SE west of Fiji.	See page 75.	CC F Z15
4.50		3	11-15	West of Banks Is, S then SSE over New Caledonia.	See page 60.	CE Z36
4.51		3	19-26	South of Solomon Is, SW, recurved SE about 20°S.	No landfall.	CF Z34
Other possible tropical storms						
-	48	1	9-11	East of New Hebrides, SSE.		F
-		1	13-17	Coral Sea to north of New Caledonia, then SE.		A CA
-		2	20-25	North of New Hebrides, SE then E to south of Fiji.		CD F

2.10 The 1948/1949 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
4.52	48	12	5-13	Northeast of New Hebrides, E near Rotuma, SE through Lau Group, E through Southern Tonga and ESE south of Niue.	See page 76.	CA F S Z3
4.53	49	1	10-14	Queensland, SE through Coral Sea to north of New Caledonia, then SE to Loyalty Is.	Marginal; weakened over New Caledonia.	A CB
4.54		1	17-24	East of Santa Cruz Is, SW then SE to east of New Hebrides and far to south of Fiji.	No landfall.	CC Z11
4.55		1	24-27	East of New Hebrides, W, SW and S to Loyalty Is.	No wind in excess of force 8 reported. Filled in the Loyalties.	CD
4.56		2	7-17	North Coral Sea, Queensland, north of Lord Howe I.	No landfall except Queensland.	A Z19
4.57		2	26- 2M	North Coral Sea, Queensland.	West of 160°E.	A CE Z18
4.58		3	25-29	North Coral Sea, SE then ESE west and south of New Caledonia.	No landfall but force 8 (squalls force 10) north of centre 260600.	CG
Other possible tropical storms						
-	49	2	22-23	Northwest of Fiji, SW, filled.		F
-		3	13-18	East of New Hebrides, SW over New Caledonia		CF

2.11 The 1949/1950 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.01	49	12	9-13	Coral Sea, SE then ESE to northern New Caledonia and Loyalty Is then SE and SSE.	Force 12 ship 100 km SSW of centre at 120000.	CA F Z1
5.02		12	17-21	North of Fiji, SSE to Southern Tonga, then SE.	See page 83.	CB F Z5
5.03	50	1	29- 6F	Southeast of Samoa, W then SW through Lau Group, recurved SE 22°S.	Force 8 Lakeba; no significant damage.	CD F
5.04		2	20- 1M	Northwest of Palmerston I. W between Vanua Levu and Viti Levu, then sharply SE.	See page 76.	CE F Z30
5.05		2	23-27	Western Coral Sea.	West of 160°E.	A Z20
5.06		3	6-13	East of New Hebrides, SE then SW and SE again.	No landfall.	CF F
5.07		3	28- 2A	Northwest of Rotuma, SSE over Viti Levu.	See page 76.	CG F Z39
Another possible tropical storm						
-	50	1	22-27	North of New Caledonia, SE		CC

2.12 The 1950/1951 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.08	51	1	1- 4	North of Samoa, SSE then S between Niue and Cook Is.	See page 88.	F S
5.09		2	20-28	North of New Hebrides, W then S over central New Caledonia towards Norfolk I.	See page 61.	A CA F Z21
5.10		3	11-18	Cape York area, E to 15°S, 160°E then SE, S and SW back to Australian coast,	No landfall other than Australia.	A CB F Z33
5.11		3	24- 2A	Solomon Is, SW recurved SE about 17°S.	No landfall.	A CC

2.13 The 1951/1952 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	Reference
5.12	51	12	19- 1J	West of Ellice Is, WSW through New Hebrides, turned S 17°S, 161°E.	See page 69.	CA F Z4
5.13	52	1	22-27	Northwest of Rotuma, SE over Vanua Levu, Lau Group, and north of Tongatapu.	Force 8 strongest wind reported; no significant damage.	CC F
5.14		1	23-30	Solomon Is, ESE then SE over Viti Levu.	See pages 77 and 102.	A CD F
Other possible tropical storms						
-	52	2	26-29	Western Coral Sea.	West of 160°E.	CE
-		3	3-12	Coral Sea, north of New Caledonia south of New Hebrides.		CF F
-		4	1- 6	New Hebrides, SE.		CG

2.14 The 1952/1953 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	Reference
5.15	52	12	16-20	Coral Sea, SE then S into Tasman Sea.	No landfall in tropics but see note below.	A CA
5.16	53	2	20-23	Western Coral Sea.	West of 160°E.	A
5.17		3	1- 9	Solomon Is, S, SE, ESE just to the east of the Loyalty Is.	Near hurricane force winds in the Loyalties.	CB F
5.18		3	2- 6	East of New Hebrides, S then ESE.	No landfall.	CC

Note on cyclone 5.15

The Pacific Islands Monthly, 23:6 (Jan 1953) recorded the occurrence of a "hurricane" on Nissan I., just south of 4°S and east of 154°E. Extensive damage, but no loss of life, was reported: roads blocked by trees, etc. This was said to have been in the first week in December, at least a week before the known beginnings of 5.15. However, Giovanelli and Robert trace 5.15 (their A) from just south of the Louisiade Archipelago on 15 December. Is it possible that it, in fact, had its beginnings a week before around 4°S?

2.15 The 1953/1954 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.19	54	1	4- 8	Northwest Coral Sea, SE through Coral Sea, then SW towards Lord Howe I.	No landfall.	A CA F
5.20		1	11-19	West of Samoa, W to north of Fiji curving to S and SSE by 23°S.	See page 77.	CB F
5.21		1	27-30	North of New Caledonia, then S and SW towards Lord Howe I.	No landfall.	CC F
5.22		2	13-20	Near Rotuma, WSW between Banks Is and Santo, then SW to near Brisbane.	Force 9 Luganville. Pressure 983 mb Port Patteson.	A CE F
Other possible tropical storms						
-	54	3	2- 7	Coral Sea, New Zealand		CF F
-		3	11-14	New Hebrides, Kermadec Is.		CG

2.16 The 1954/1955 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.23	54	12	20-22	Western Coral Sea.	West of 160°E.	A
5.24	55	1	2-13	Solomon Is, ESE north of New Hebrides to near Yasawa Is, then W and S.	See page 77.	A2 CA F
5.25		1	4-13	Society Is, SW south of Rarotonga.	See page 97.	CB F P
5.26		1	25-29	East of New Hebrides, ESE south of Fiji and Tonga.	Two ships east of New Hebrides force 11; one of them 982 mb. Strong winds Fiji and Tonga.	CC F
5.27		2	26- 7M	West of Rotuma, S then WSW through southern New Hebrides, New Caledonia to Queensland.	See pages 61 and 70.	A4 CD F
5.28		3	23- 6A	Solomon Is, SSW to Queensland, ESE then N to near New Caledonia, then W and S.	Force 9 or 10 reported by ships at various times and places along the track.	A CF F
Other possible tropical storms						
-	55	3	6-10	Fiji area and southward.		CE F
-		4	10-16	New Caledonia, SW then S.		CG

2.17 The 1955/1956 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.29	55	12	25- 1J	Solomon Is, SE (erratic) between Loyalty Is and New Caledonia.	Force 10 and 982 mb ship near Mare I.	A3 CA F
5.30	56	1	1- 5	Tonga, ESE then SE to south of Cook Is.	No landfall but see page 90.	CB
5.31		1	21-28	Willis I, very erratic SE then S along 160°E towards Lord Howe I.	No landfall but see ref. A.	A4 CC
5.32		1	21-24	Northwest of New Caledonia, SE then SW.	Apparently merged with 5.31.	A9 CD
5.33		1	29- 3F	Northwest of Fiji, SSE then SSW towards Norfolk I.	See page 77.	A11 CE F
5.34		2	14-18	Northwest of Willis I., Coral Sea, south Queensland.	West of 160°E.	A18
5.35		2	16-19	North of Fiji, SE through Tonga and south of Niue.	See page 91.	F
5.36		2	24- 6M	West of Fiji, W (erratic) to Loyalty Is, NW to north of New Caledonia, W to Queensland.	Heavy rain, flooding in Fiji. Area of cyclonic circulation later became immense: Willis I. to Fiji and 25 degrees of latitude.	A19 CF F
5.37		3	4- 9	New Hebrides, E to near Fiji then S.	Flooding in Fiji and some power and telephone lines down.	A21 CG F
5.38		3	12-17	Southern New Hebrides, WSW, to SSE at 27°S, 156°E.	Force 10 ship southwest of New Caledonia.	A23 CH
5.39		4	3- 7	Southeast of New Guinea, SE near Loyalty Is, then SSE.	See page 62.	A26 CI
5.40		4	6- 9	North of New Caledonia, SSE.	See page 62.	A29 CJ F
Another possible tropical storm						
-	56	3	13-17	Samoa area, SE.		

2.18 The 1956/1957 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.41	56	11	14-20	New Hebrides, SE to west of Kermadec Is.	No landfall south of 20°S.	CA F
5.42	57	1	4-10	Coral Sea, New Caledonia, then SE.	See page 62.	A CC F
5.43		2	4- 9	Samoa area, S east of Niue.	Lowest pressure at Niue 985 mb 12.20 a.m. 6th (local time) but wind not more than force 7. No damage reported.	CF F
5.44		2	4-18	Very erratic near Willis I. 4th to 11th, then E turning S west of New Caledonia.	Force 12 and 966 mb ship 400 km west of Noumea at 160600.	A CE F
5.45		2	12-13	West of Fiji.	Short life; no landfall but gales in the Yasawa Group.	
5.46		2	22- 1M	East of Rotuma, SE then SSW just east of Vanua Levu, then SE.	Force 10 or 11 ships south of Fiji; one reported 976 mb.	CG F
5.47		3	28- 1A	North of New Caledonia, SE between New Hebrides and Loyalty Is.	Force 12 and 986 mb ship south of Aneityum.	CH F
Other possible tropical storms						
-	56	12	22-24	North Queensland to south Coral Sea and south of New Caledonia.		A CB
-	57	1	11-16	New Caledonia, to south of Fiji.		A CD

2.19 The 1957/1958 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
5.48	57	12	4- 9	Tokelau Is, SW recurved SE 15°S 177°W, through Tonga near Vavau.	See page 83.	A2 CA
5.49	58	1	1- 9	Ellice Is, SE near Wallis I, then SSW through Lau Group gradually turning SSE.	See pages 78 and 105.	A3 CB F
5.50		1	17-21	South of Penrhyn I., SE then SSE through Society Is.	See page 107.	P
5.51		2	21-25	Gulf of Carpentaria (12th) to Coral Sea.	West of 160°E.	A6
5.52		3	12-17	Northwest of Rotuma, S west of Fiji.	No landfall but gale in Yasawa Group; filled southeast of New Caledonia.	A8 CC F
5.53		4	7-10	Southeast of Solomon Is, E then SE, filling over Fiji.	No wind in excess of force 9 reported.	A12 CD F
5.54		4	18-24	Coral Sea.	West of 160°E.	A14
Another possible tropical storm						
-	57	11	8-17	Ellice Is, SW then SE between Vanua Levu and Viti Levu.	Although the wind barely reached gale force in Fiji some trees and telephone lines were brought down.	A1

2.20 The 1958/1959 season

No.	Yr	Mo	Dates	Name*. Areas affected and movement	Remarks	References
5.55	58	11	28- 6D	Aurelia. Ellice Is, S near Rotuma, SSE over Viti Levu, curving E south of Tonga.	See page 78.	A1 CA F
5.56	59	1	15-21	Beatrice. Banks Is, S over New Caledonia, then WSW towards Brisbane.	See page 62.	A3 CB F Also Ref. 16
5.57		1	20-23	Charlotte. North Australia to Coral Sea.	West of 160°E.	A2 CC
5.58		1	24-28	Dorothee. South of Fiji, SW towards Norfolk I.	No landfall; doubtful if winds in excess of force 9.	A4 CD F
5.59		1	27-30	Society Is, S through Austral Is.	See page 107.	F P
5.60		2	11-16	Eulalie. South of Samoa, ESE through Southern Cook Is and south of Austral Is.	See page 98.	CG F
5.61		2	12-16	Florence. East of Willis I., erratic WSW inland near Townsville.	West of 160°E.	A5 CF
5.62		2	14-17	Gabrielle. West of Samoa, SSE to 22°S, 170°W; then SW.	Force 9 Niue 15th.	CG F
5.63		2	23- 2M	Honorine. Between Tokelau Is and Northern Cook Is, S over American Samoa and Niue, SE from 22°S, 170°W.	See pages 88 and 92.	CH F
5.64		3	7-14	Ida. Solomon Is, SW then ESE, north and east of New Caledonia, very rapidly to north of New Zealand.	See page 62.	A6 CI F

* The names, Aurelia, Charlotte, etc. that appear in Tables 2.20, 2.21 and 2.22 were bestowed on some tropical cyclones by the Meteorological Service of New Caledonia. See ref. 15. From 1964 (Table 2.25 on) names were assigned either by the Commonwealth Bureau of Meteorology, Australia or by the Meteorological Service of New Caledonia.

2.21 The 1959/1960 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.01	59	12	20-31	Amanda. Solomon Is, SE (erratic) to west of New Hebrides, E just south of Vila and south of Fiji, SE south of Tonga.	See pages 70 and 79.	A1 CA F
6.02		12	28- 4J	Brigitte. North Queensland, E north of New Caledonia and Vila, then SE towards Kermadec Is.	See page 70.	A2 CB F
6.03	60	1	15-20	Corine. South of Rotuma, E through Northern Tonga, then SSE over Niue.	See page 92.	CC F
6.04		2	28- 5M	Erika. Coral Sea, Lord Howe I.	West of 160°E.	A3 CE F
6.05		3	4- 8	Coral Sea, Queensland.	West of 160°E.	A4
6.06		3	17-23	Flora. South of Samoa, SW close to Vavau, recurved SE near 26°S, 179°W.	See page 83.	CF F
6.07		4	2-10	Gina. North Coral Sea, SE then E north of New Caledonia, SE between New Hebrides and Loyalty Is.	No landfall.	A6 CG F
Another possible tropical storm						
-	60	1	2- 4	Delilah. West of Fiji.		CD F

2.22 The 1960/1961 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.08	61	1	2- 6	Western Coral Sea.	West of 160°E.	A1
6.09		1	9-14	Barberine. South of Solomon Is, SE close to Loyalty Is.	Doubtful if storm intensity reached.	A2 CA F
6.10		1	27- 2F	Coral Sea, SSW, S, SSE, Lord Howe I.	No landfall.	A3
6.11		2	3-11	Catherine. Southwest of Santa Cruz Is, SW then SE over New Caledonia, then E and S to west of Kermadec Is	See page 64.	A4 CB
6.12		3	3- 8	Gulf of Carpentaria to Coral Sea.	West of 160°E.	A5 CC
6.13		3	12-19	Northern Cook Is, SSE then E to Society Is, then SSW.	Force 10 ships at 160000; 988 mb one of them. Possibly two storms.	CD and CE F P
6.14		3	14-19	North of Samoa, S over Western Samoa, SSW over Southern Tonga, then SE.	See page 83.	CF F
6.15		3	15-21	Isis. Southeast of Solomon Is, through Coral Sea, then S to Lord Howe I. area.	No landfall. Cyclones 6.13, 6.14 and 6.15 co-existed for several days.	A6 CG F
Another possible tropical storm						
-	61	3	3-12	Ellice Is, Samoa, Northern Cook Is.		C F

2.23 The 1961/1962 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
6.16	61	11	29- 8D	South of Solomon Is, SSE close to northern New Caledonia, towards Norfolk I.	Force 9 several ships Minor damage in northern New Caledonia.	A1 CA F
6.17		12	23-25	Western Coral Sea	West of 160°E.	A2
6.18	62	2	14-17	East of New Hebrides, SE.	No landfall.	CC F
6.19		2	14-17	Northwest of Palmerston I, ESE north of Aitutaki, then S close to Mauke and Atiu.	See page 98.	CD F
6.20		2	18-19	Southwest of Palmerston I, S then SE.	No landfall but ship reported force 10 southwest of Cook Is.	CE F
6.21		2	27- 2M	Between New Hebrides and Loyalty Is, SE then S.	No landfall.	CF F
Another possible tropical storm						
-	62	2	9-13	New Hebrides to south of Fiji.		CB F

2.24 The 1962/1963 season

No.	Yr	Mo	Dates	Areas affected and movement	Remarks	References
6.22	62	11	10-14	Loyalty Is, ESE towards Kermadec Is.	No wind in excess of force 8 reported.	C F
6.23		12	22-25	South of Samoa, SE to south of Cook Is.	No landfall but gale at Palmerston I.	C F
6.24		12	30- 1J	East of Queensland.	West of 160°E.	A2
6.25	63	1	15-18	South of Vila, SE	No significant damage in New Hebrides. No other landfall but ship reported force 9 at 161800.	C F
6.26		2	4- 6	Willis I., SSE, near Lord Howe I.	West of 160°E.	A6 C F
6.27		2	16-20	North Coral Sea, SW then SE from 20°S.	No landfall, but two ships in the Coral Sea reported force 12.	A7 C F
6.28		3	1- 6	North Coral Sea, SE between New Hebrides and Loyalty Is.	No landfall.	A8 C F
6.29		3	7-18	West of Cook Is, WNW to south of Samoa, SW through Tonga, then SE.	See pages 84, 86 and 98.	C F
6.30		4	1- 6	South Coral Sea, E south of New Caledonia.	Force 10 ships southwest of Noumea.	A13
6.31		4	20-26	Southeast of New Guinea, SE recurving to SW north of New Caledonia.	Ship in difficulties in Coral Sea (see ref. 10)	A15 C
Other possible tropical storms						
-	63	1	18-21	New Hebrides to south of Fiji.		C F
		1	29- 2F	Coral Sea, north of New Caledonia.		C F

2.25 The 1963/1964 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.32	63	11	15-25	East of Santa Cruz Is, SW recurving SE about 15°S passing to the east of New Hebrides, far south of Fiji.	See page 70.	C
6.33		12	15-23	Northeast Coral Sea, ENE through Santa Cruz Is, then SE west of Fiji, and then E near 25°S.	Early history obscure.	A1 F
6.34	64	1	27- 2F	Bertha. North of Willis I, ESE towards New Caledonia but turned S to the west of New Caledonia.	See page 65.	A2 C F
6.35		2	19-25	Edith. Northeast of New Hebrides, SW through the Group to the Loyalty Is, then sharply ESE.	See page 71.	C F
6.36		3	15-18	Gertie. Coral Sea.	West of 160°E.	A4
6.37		3	18-25	East of New Hebrides, ESE and SE to south of Fiji.	Possibly two storms. Severe flooding in Fiji.	F
6.38		3	28- 7A	Henrietta. North of Rotuma, SW through northern New Hebrides and to the north of New Caledonia, recurved SE about 20°S.	See pages 65 and 71.	A5 C F
Another possible tropical storm						
-	64	3	About 20	New Caledonia to south of Fiji.		F

2.26 The 1964/1965 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.39	64	11	20-29	Rotuma area, SE to east of Vanua Levu through Lau Group, then E between Haapai and Tongatapu, then SE again south of Niue.	See pages 79 and 84	C F
6.40		12	5- 8	Northwest of Rotuma, SE towards Tonga.	See page 79.	C F
6.41		12	18-22	Near Rotuma, S to west of Fiji.	See page 80.	C F
6.42	65	1	16-21	North Coral Sea.	West of 160°E.	A2 F
6.43		1	30- 5F	Judy. Queensland, E over Coral Sea then SE and SW to Lord Howe I. area.	Floods in Queensland, no other landfall.	A3 C F
6.44		2	4-12	Near Samoa, W and SW to pass north of Fiji, and then S to west of Fiji.	See page 80.	C F
Other possible tropical storms						
-	65	1	14-16	New Hebrides to south of Fiji.		C F
		2	18-19	Lucie. New Hebrides.		C F
		2	24-28	Olga. East of New Caledonia, Loyalty Is, SE.		C F

2.27 The 1965/1966 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.45	66	1	26- 6F	North of Fiji for several days, then E passing to the south of Samoa, ESE to the south of Palmerston I. and the Southern Cook Is.	See pages 88 and 105.	C F
6.46		1	29-31	Northwest of Palmerston I., ESE to the north of Aitutaki and Mauke, then SE to south of Austral Is.	No landfall but wind reached gale force briefly at Palmerston I. and Aitutaki.	F
6.47		2	23- 2M	Connie. Northeast Coral Sea, W and recurved SE about 15°S to pass to the west of New Caledonia.	Force 9 and 10 ships at various times. Heavy rain in north and northeast New Caledonia.	A1 C F
6.48		3	12-16	Between southern New Hebrides and Loyalty Is, SE then S towards the Kermadec Is.	No landfall.	C F
Other possible tropical storms						
-	66		About 13 Feb	East of Tokelau Is.		F
-	66	4	26-28	West of Society Is to south of Austral Is.		F P

2.28 The 1966/1967 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.49	66	11	13-19	Angela. Solomon Is area.	See page 102.	A1 F
6.50		12	2- 5	Santa Cruz Is, SE over Fiji but filling between Fiji and Tonga.	No wind in excess of force 9 reported. Relatively slight damage in Fiji to banana trees and bures.	C F
6.51	67	1	23-31	Dinah. Near Solomon Is, SW to Queensland coast, recurving SE about 24°S to Lord Howe I.	Force 10 and 979 mb ship at 261200. Torrential rain in New Caledonia although track far to the northwest.	A2 C F
6.52		2	1- 8	Agnes. East of northern New Hebrides, SE between the group and the Loyalty Is.	Gales in New Hebrides. No other landfall.	C F
6.53		2	18-22	Barbara. South of Solomon Is, S to west of New Caledonia, then SW to southern Queensland.	Force 10 ship in south Coral Sea. Heavy rain in New Caledonia.	A3 C F
6.54		3	16-19	Elaine. Willis I. to Lord Howe I. area.	West of 160°E.	A5 C
6.55		3	28- 5A	Glenda. South of Solomon Is, erratic, generally S through Coral Sea to Lord Howe I. area.	See page 102.	A6 C F
6.56		4	7-14	East of Rotuma, S over Vanua Levu and just to the east of Viti Levu, then SE.	See page 81.	C F
Another possible tropical storm						
-	67	2	23-27	New Hebrides to south of Fiji.		F

2.29 The 1967/1968 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.57	67	11	11-16	Annie. Solomon Is, SW over Louisiade Is to Willis I. where recurved ESE to pass over northern New Caledonia and Loyalty Is.	See page 103.	A1 C F
6.58		12	7-10	Southern Queensland waters.	No landfall.	A2 & 3 C
6.59		12	12-20	Ellice Is area, E south of Tokelau Is, then SE over Palmerston I. and Southern Cook Is.	See pages 98 and 106.	F
6.60	68	1	14-24	Brenda. South of Solomon Is, SW recurving SE 16°S to pass down the east coast of New Caledonia.	See page 65.	A4 C F
6.61		2	7-13	South of Samoa, SE then S over Niue.	See pages 89 and 93.	F
6.62		2	20-24	Southeast of New Caledonia, SE then SW to Norfolk I. area.	No landfall.	F
6.63		3	1- 7	Florence. North of New Caledonia SE between New Hebrides and New Caledonia, SSW towards Tasman Sea.	Force 12, 978 mb ship at 050600 (23°S).	C F
6.64		3	20-25	South of Fiji, SSW and S.	No landfall.	
6.65		4	5- 9	Gisele. South of Solomon Is, S then SSE to west of New Caledonia and east of Norfolk I.	See page 65.	A9 C F
Another possible tropical storm						
-	68	1	27-30	Coral Sea, E through New Hebrides.		F

2.30 The 1968/1969 season

No.	Yr	Mo	Dates	Name. Areas affected and movement	Remarks	References
6.66	68	12	11-15	Becky. Solomon Is, erratic SE over New Hebrides towards Kermadec Is.	See pages 71 and 103.	C F
6.67	69	1	11-17	West of Tokelau Is, erratic SSE passing just to the north of Vavau then ESE.	Pressure 982 mb Vavau at 140600. Gales in Southern Tonga.	C F
6.68		1	28- 5F	Colleen. North of New Caledonia, SSE over southern New Caledonia to Norfolk I. area.	See page 66.	A3 C F
6.69		2	12-16	Hortense. West of Rotuma, SSW then SSE between New Hebrides and Fiji.	No landfall. Force 9 ship at 141500.	C F
6.70		2	17-21	Irene. East of New Hebrides, WSW south of Vila and over northern New Caledonia, filling in Coral Sea.	See page 66.	A4 C F
6.71		2	25-28	North of Fiji, SSE through Southern Tonga.	Pressure 987 mb Nukualofa at 261800. Gales in Southern Tonga.	C F
6.72		4	26- 4M	Esther. Southeast New Guinea, SE to Loyalty Is.	No landfall; filled north of Loyalty Is.	A6 C F
Other possible tropical storms						
-	68	11	19-23	Between Niue and Palmerston I. through Southern Cook Is.		F
-	69	2	26- 2M	Solomon Is to east of New Hebrides.		C F

Table 3.1 Numbers of tropical storms and hurricanes in the months November to April inclusive - November 1939 to April 1969.

Season	Nov	Dec	Jan	Feb	Mar	Apr	Total
1939/40	-	1	-	2	1	1	5
40/41	-	1	2	3	1	2	7
41/42	1	1	-	4	1	1	7
42/43	-	1	3	-	2	-	5
43/44	-	1	3	2	3	-	8
44/45	-	-	-	2	1	-	3
45/46	-	-	2	1	2	1	5
46/47	-	1	3	1	1	-	6
47/48	-	1	1	1	2	-	5
48/49	-	1	3	2	2	-	7
1949/50	-	2	1	3	2	1	7
50/51	-	-	1	1	2	1	4
51/52	-	1	2	-	-	-	3
52/53	-	1	-	1	2	-	4
53/54	-	-	3	1	-	-	4
54/55	-	1	3	1	2	1	6
55/56	-	1	4	4	3	2	12
56/57	1	-	1	4	1	-	7
57/58	-	1	2	1	1	2	7
58/59	1	1	4	4	2	-	10
1959/60	-	2	2	1	3	1	7
60/61	-	-	3	2	4	-	8
61/62	1	2	-	4	1	-	6
62/63	1	2	1	2	2	2	10
63/64	1	1	1	2	3	1	7
64/65	1	2	2	2	-	-	6
65/66	-	-	2	2	2	-	4
66/67	1	1	2	2	2	2	8
67/68	1	2	1	2	2	1	9
68/69	-	1	2	4	-	1	7

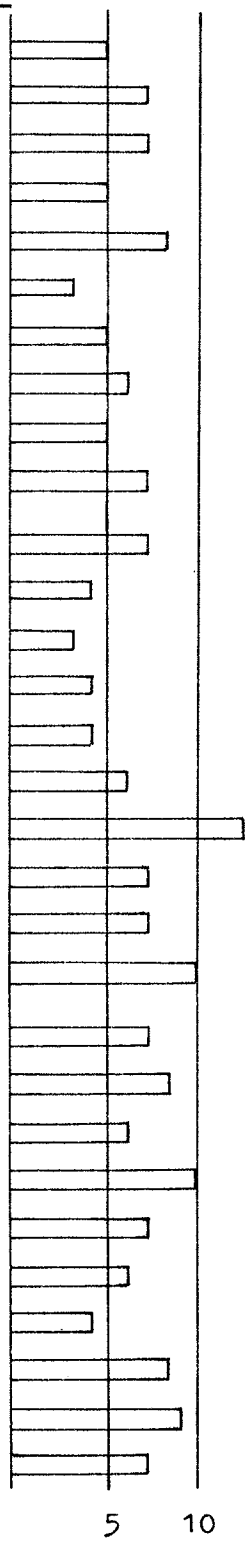


Table 3.2 Totals for the three decades and the 30 years.

Decade	Nov	Dec	Jan	Feb	Mar	Apr	Total
1939/49	1	8	17	18	16	5	58
1949/59	2	8	21	20	15	7	64
1959/69	6	13	16	23	19	8	72
30 years	9	29	54	61	50	20	194

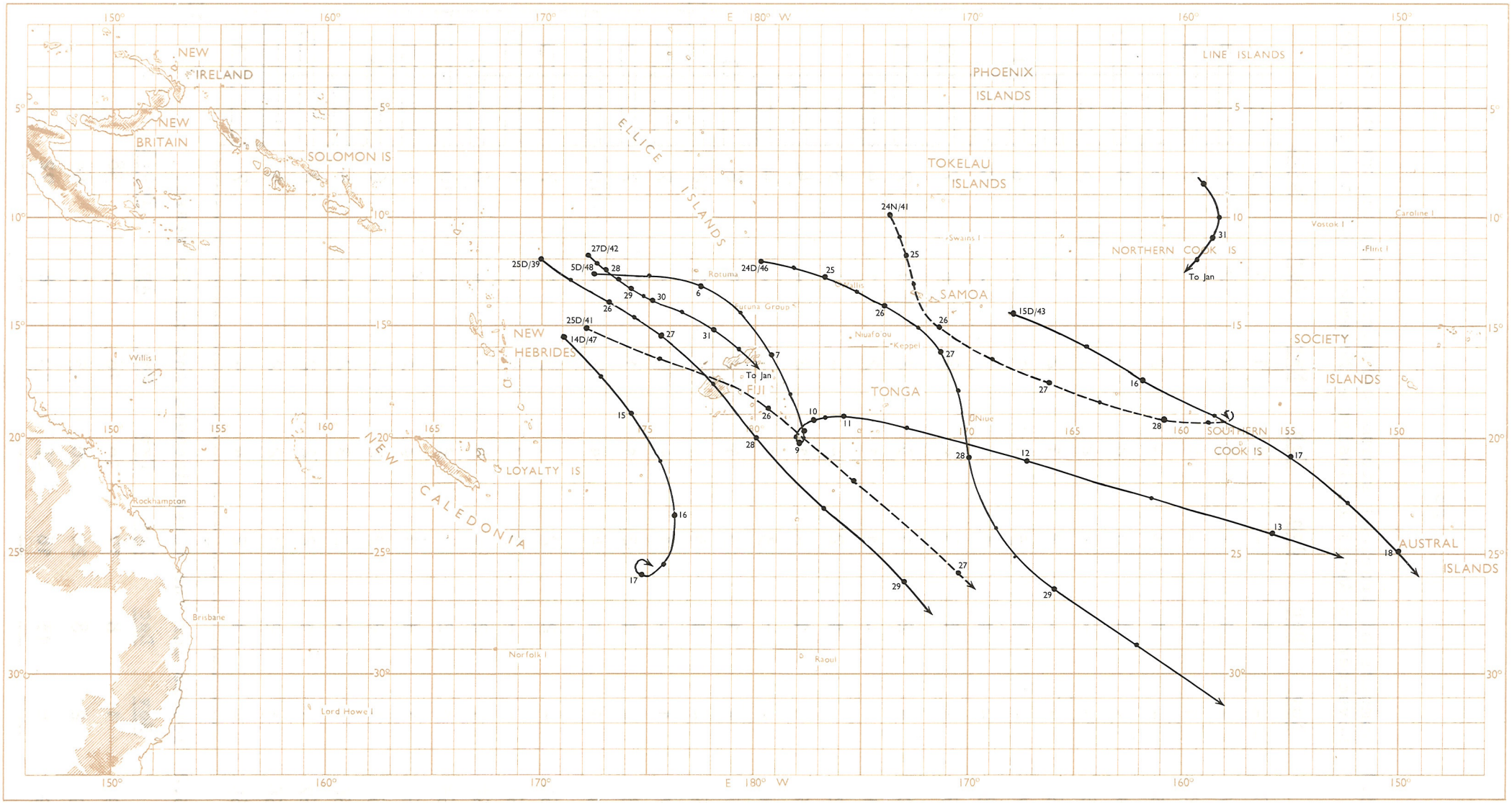


CHART 1.1 Tracks of tropical storms and hurricanes
November and December, 1939 to 1948 inclusive.

KEY

Beginning

24N/41 — Position of centre at 0000 G.M.T. 24 Nov 1941 (D=Dec).

Position of centre at 1200 G.M.T. (24th).

25 — Position of centre at 0000 G.M.T. 25th (Nov 1941)

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra-tropical trough.

To Jan — Track continued on next chart.

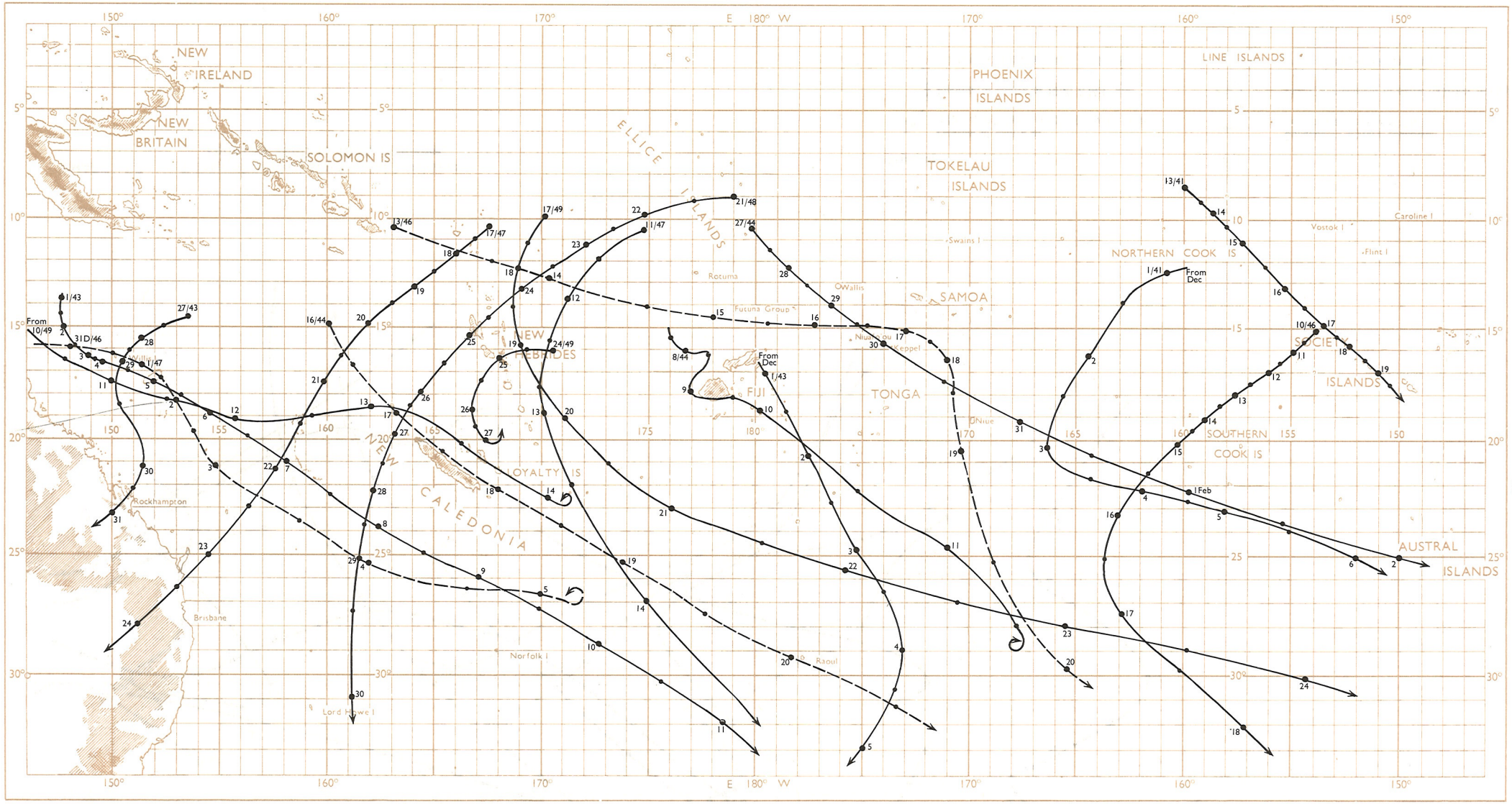


CHART 1.2 Tracks of tropical storms and hurricanes January 1940 to 1949 inclusive.

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End.

Subsequent history unknown or continues south of 30°S

Filled or absorbed in extra–tropical trough

To Feb Track continued on next chart.

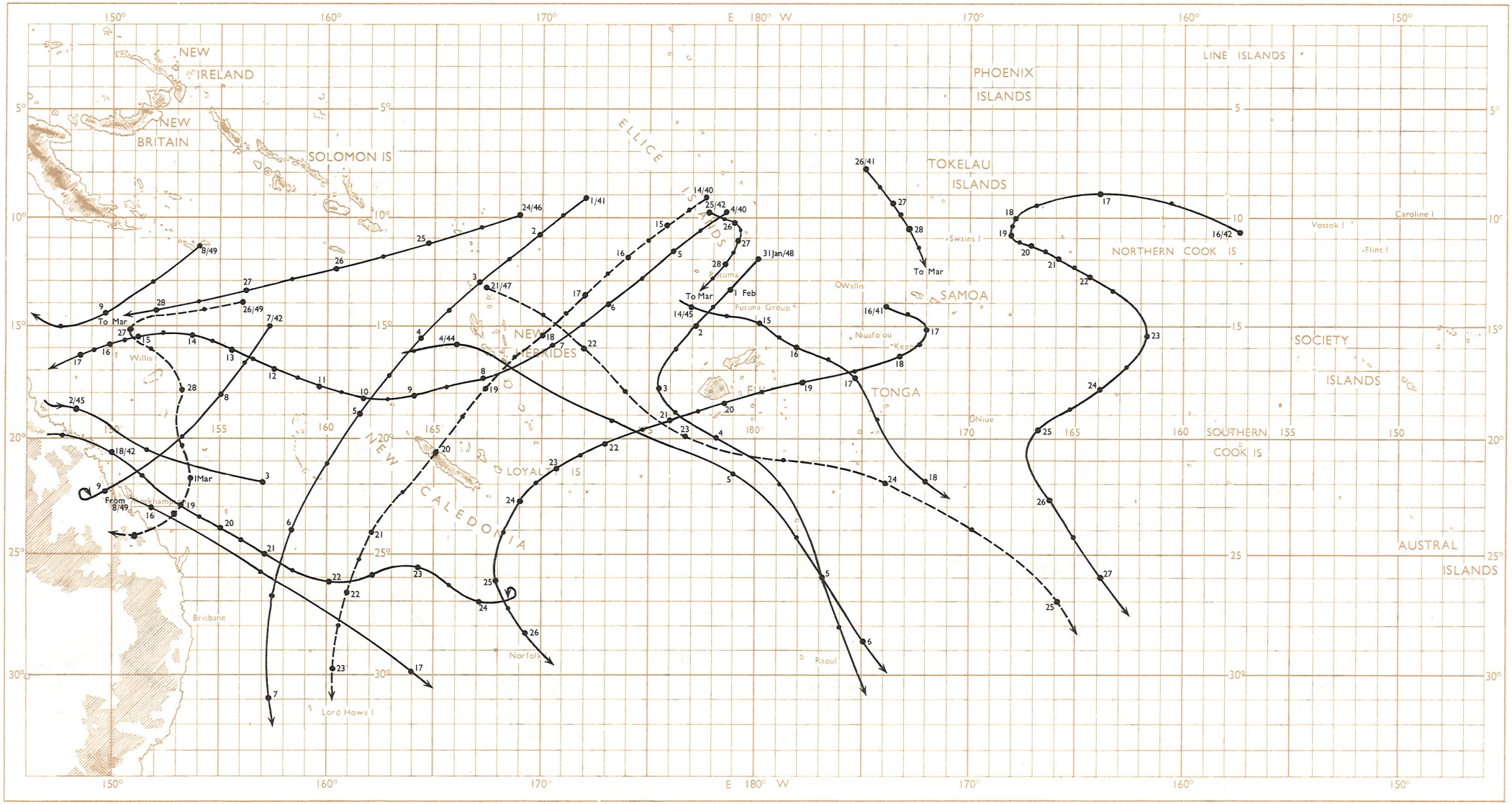


CHART 1.3 Tracks of tropical storms and hurricanes February 1940 to 1949 inclusive.

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra-tropical trough.

To Mar Track continued on next chart.

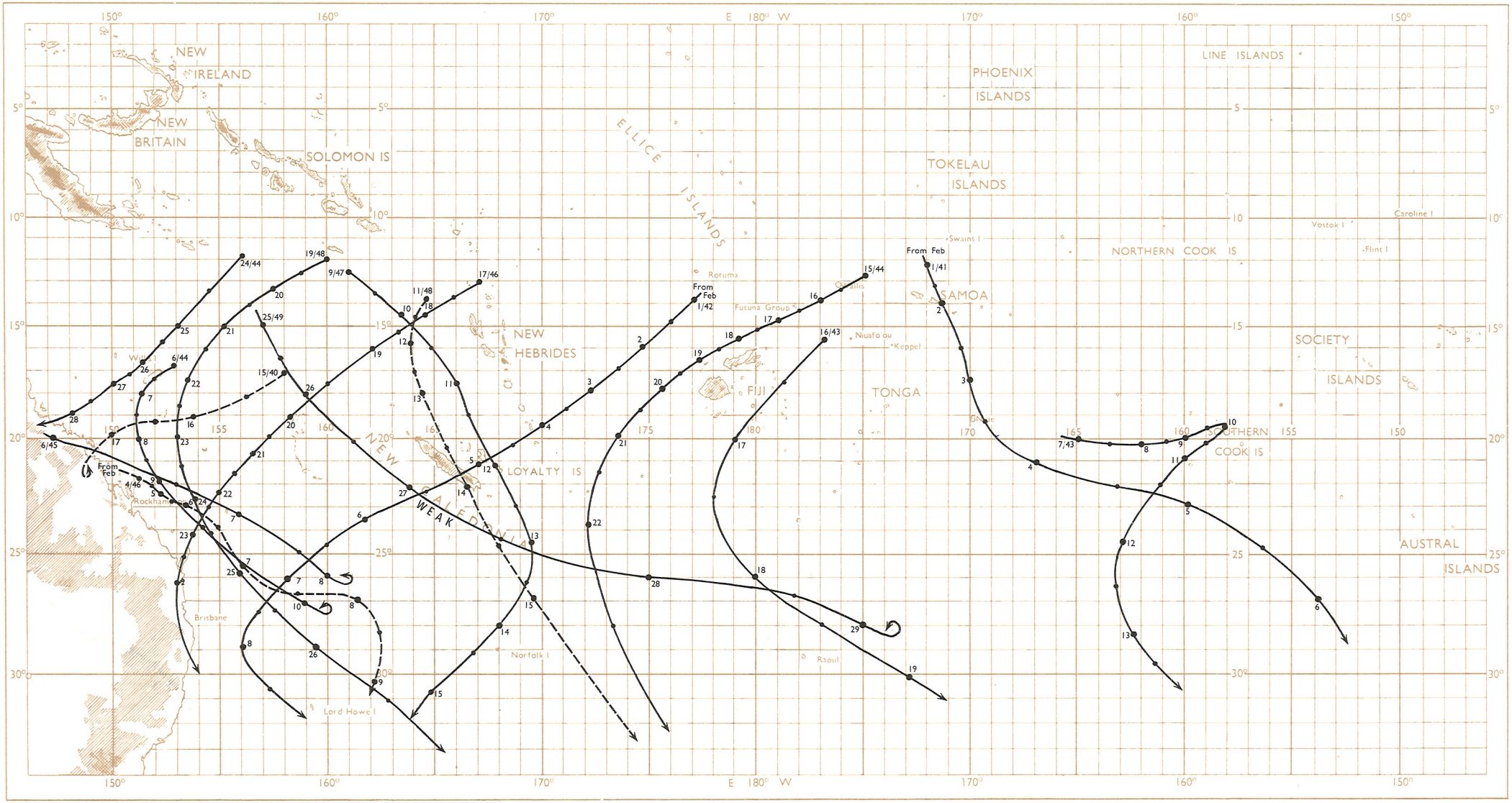


CHART 1.4 Tracks of tropical storms and hurricanes
March 1940 to 1949 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra–tropical trough.

To Apr Track continued on next chart.

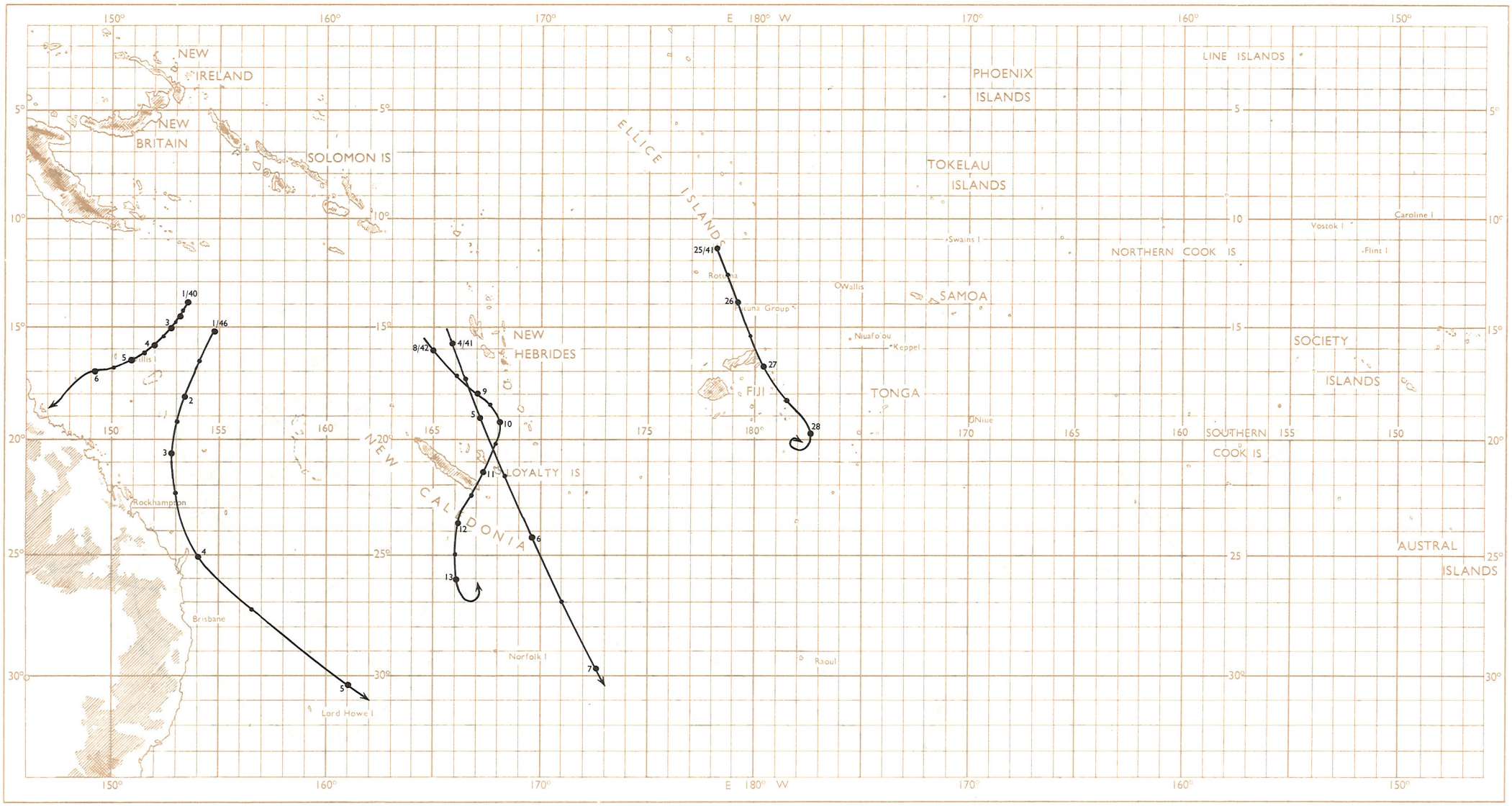


CHART 1.5 Tracks of tropical storms and hurricanes April 1940 to 1949 inclusive.

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra--tropical trough.

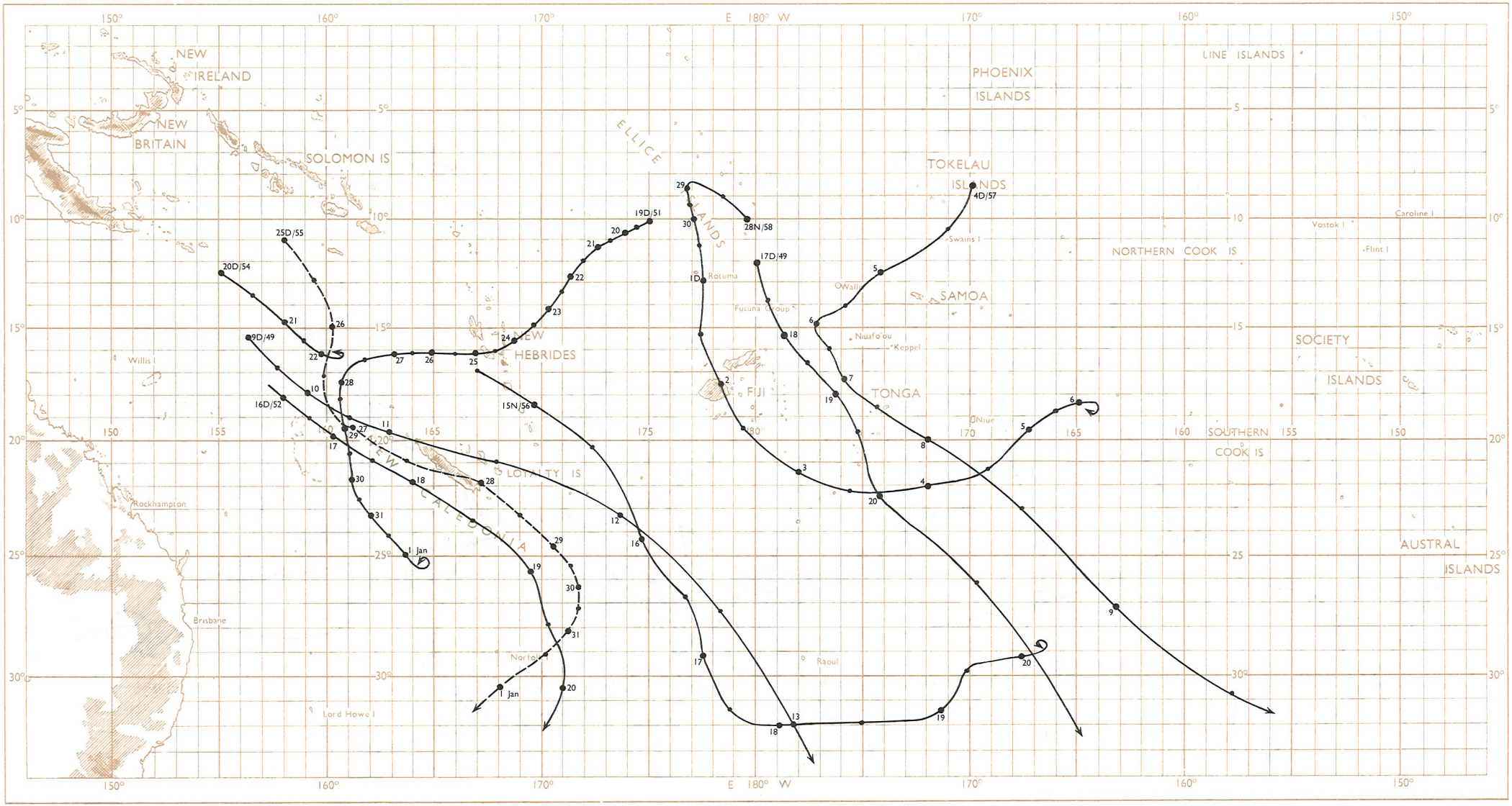


CHART 1.6 Tracks of tropical storms and hurricanes November and December, 1949 to 1958

KEY

Beginning

24N 41 — Position of centre at 0000 G.M.T. 24 Nov 1941 (D=Dec).

Position of centre at 1200 G.M.T. (24th).

25 — Position of centre at 0000 G.M.T. 25th (Nov 1941)

End

Subsequent history unknown or continues south of 30°S

Filled or absorbed in extra–tropical trough

To Jan — Track continued on next chart.

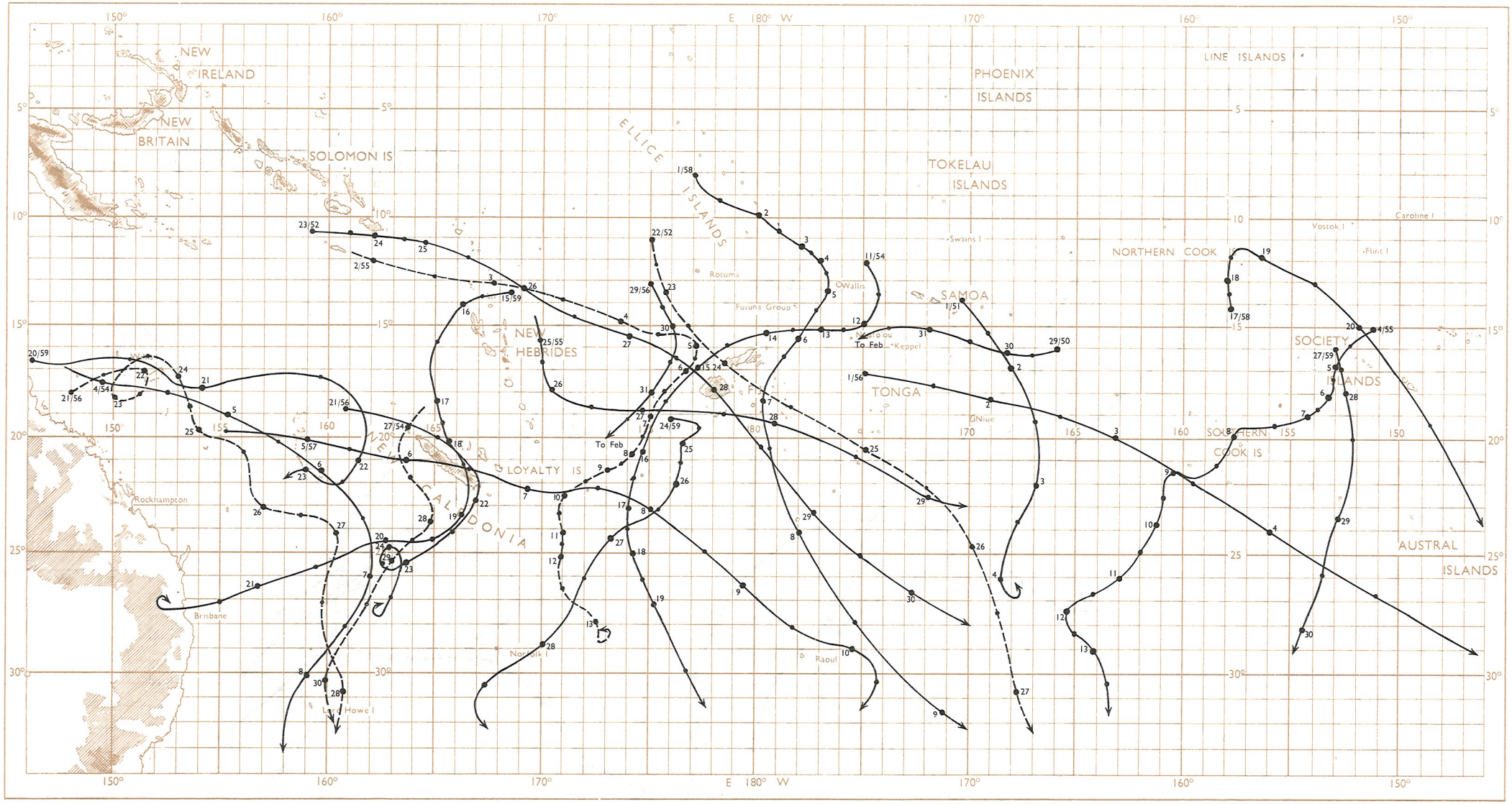


CHART 1.7 Tracks of tropical storms and hurricanes
January 1950 to 1959 inclusive

KEY

Beginning

- Position of centre at 0000 G.M.T 5th (month of chart) 1956
- Position of centre at 1200 G.M.T. 5th.
- Position of centre at 0000 G.M.T. 6th.

End

- Subsequent history unknown or continues south of 30°S.
- Filled or absorbed in extra–tropical trough.
- To Feb Track continued on next chart.

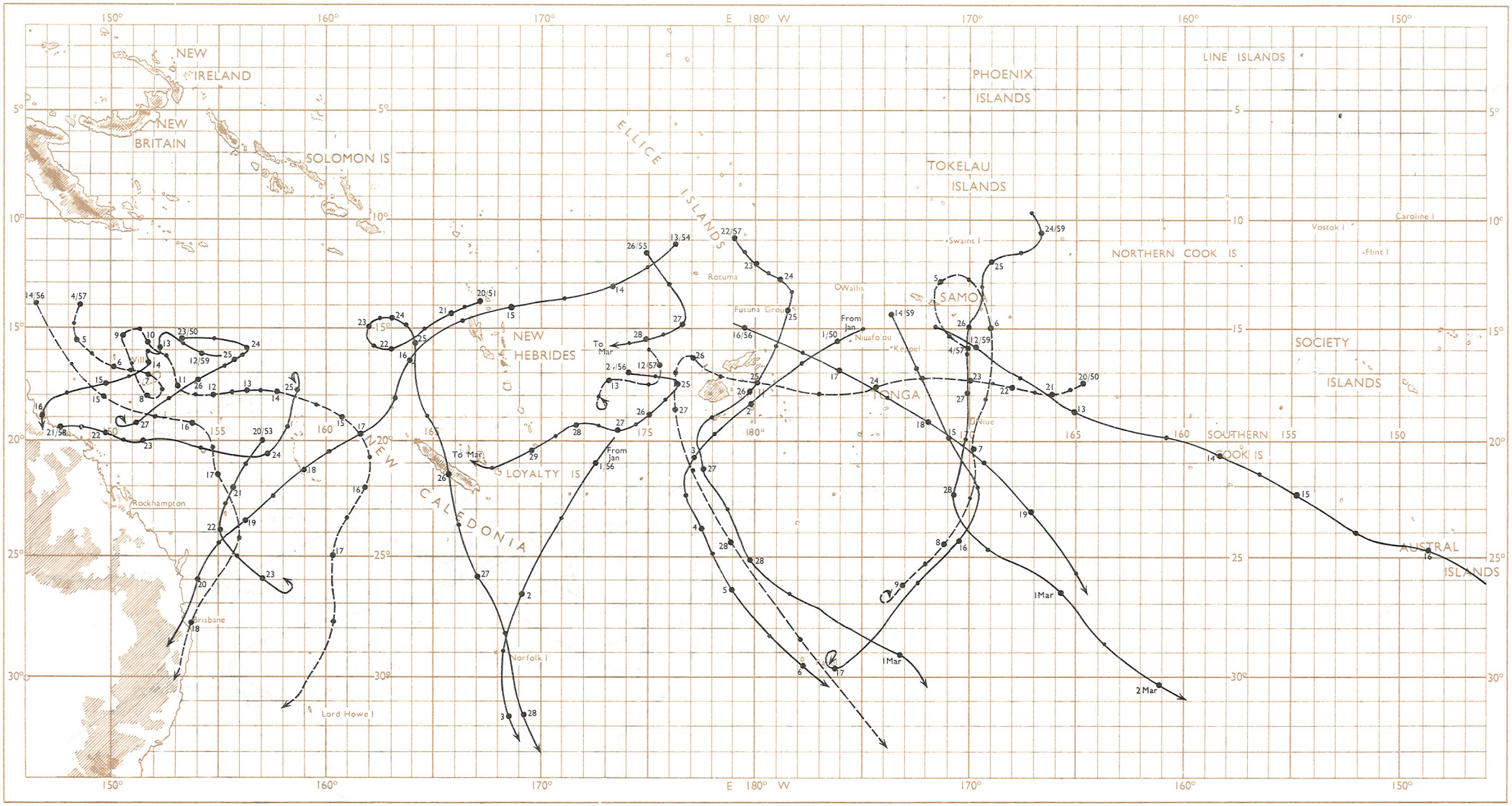


CHART 1.8 Tracks of tropical storms and hurricanes
February 1950 to 1959 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra-tropical trough.

To Mar Track continued on next chart.

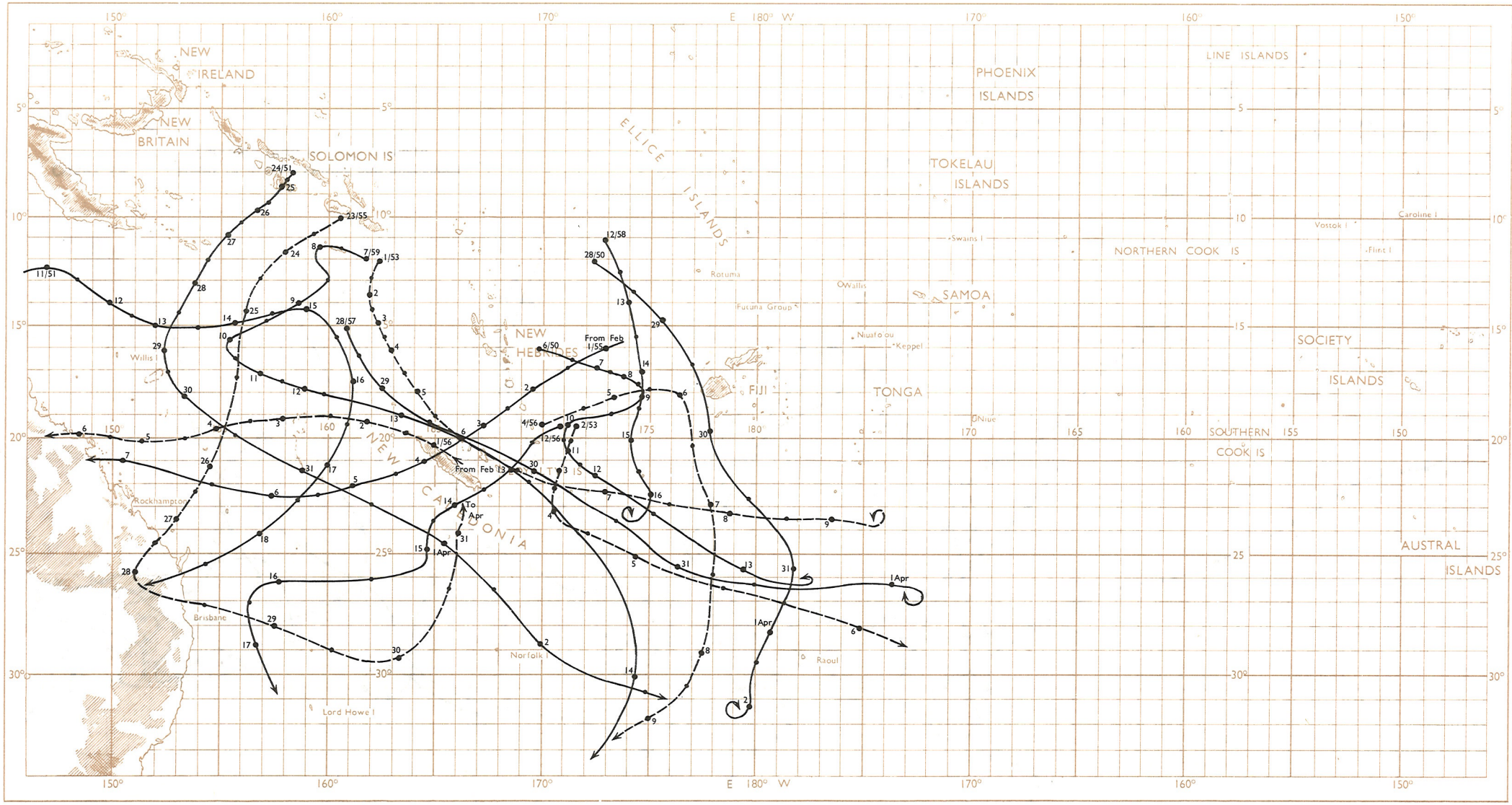


CHART 1.9 Tracks of tropical storms and hurricanes
March 1950 to 1959 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra–tropical trough.

To Apr Track continued on next chart.

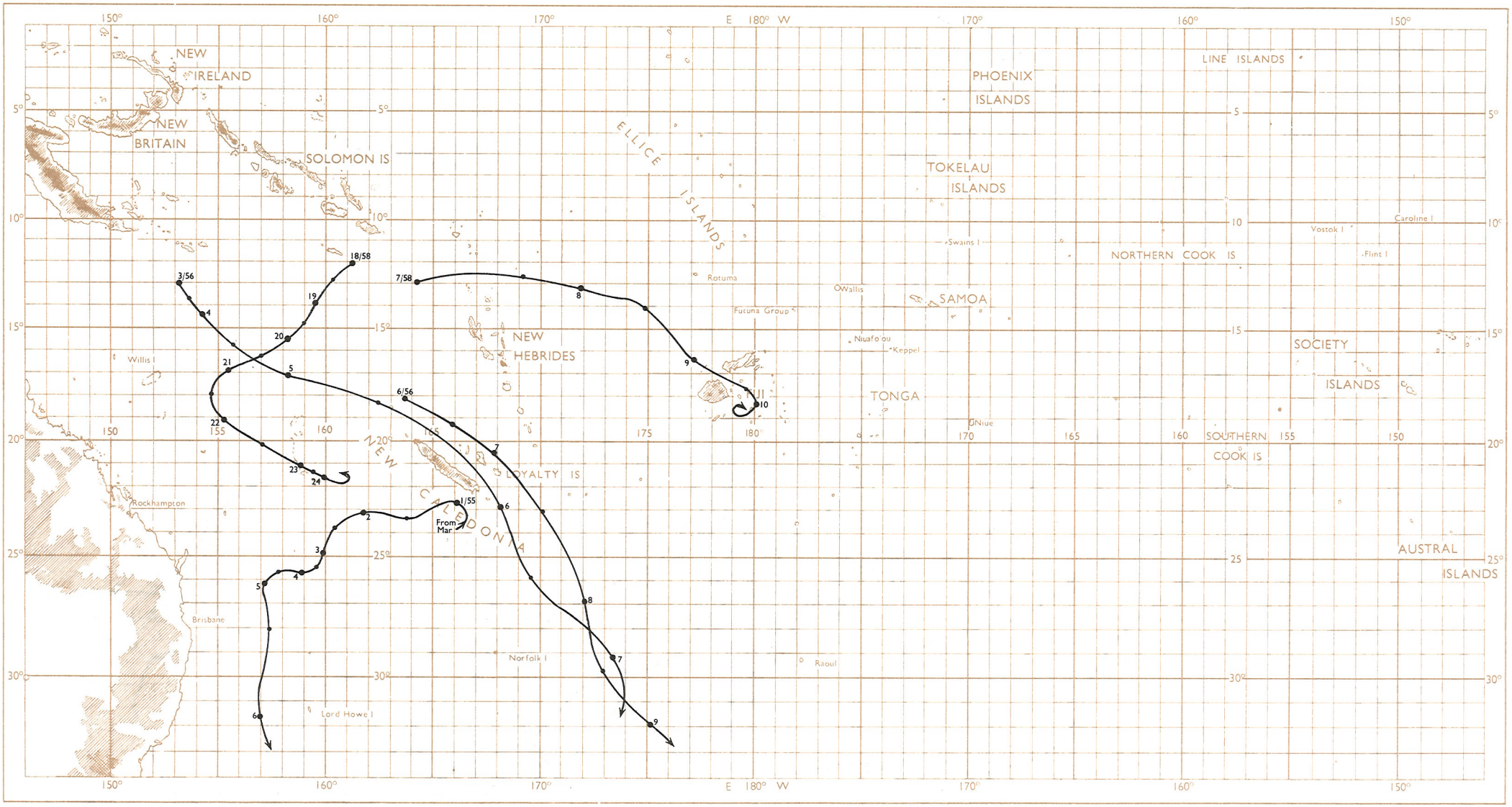


CHART 1.10 Tracks of tropical storms and hurricanes
April 1950 to 1959 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra–tropical trough.

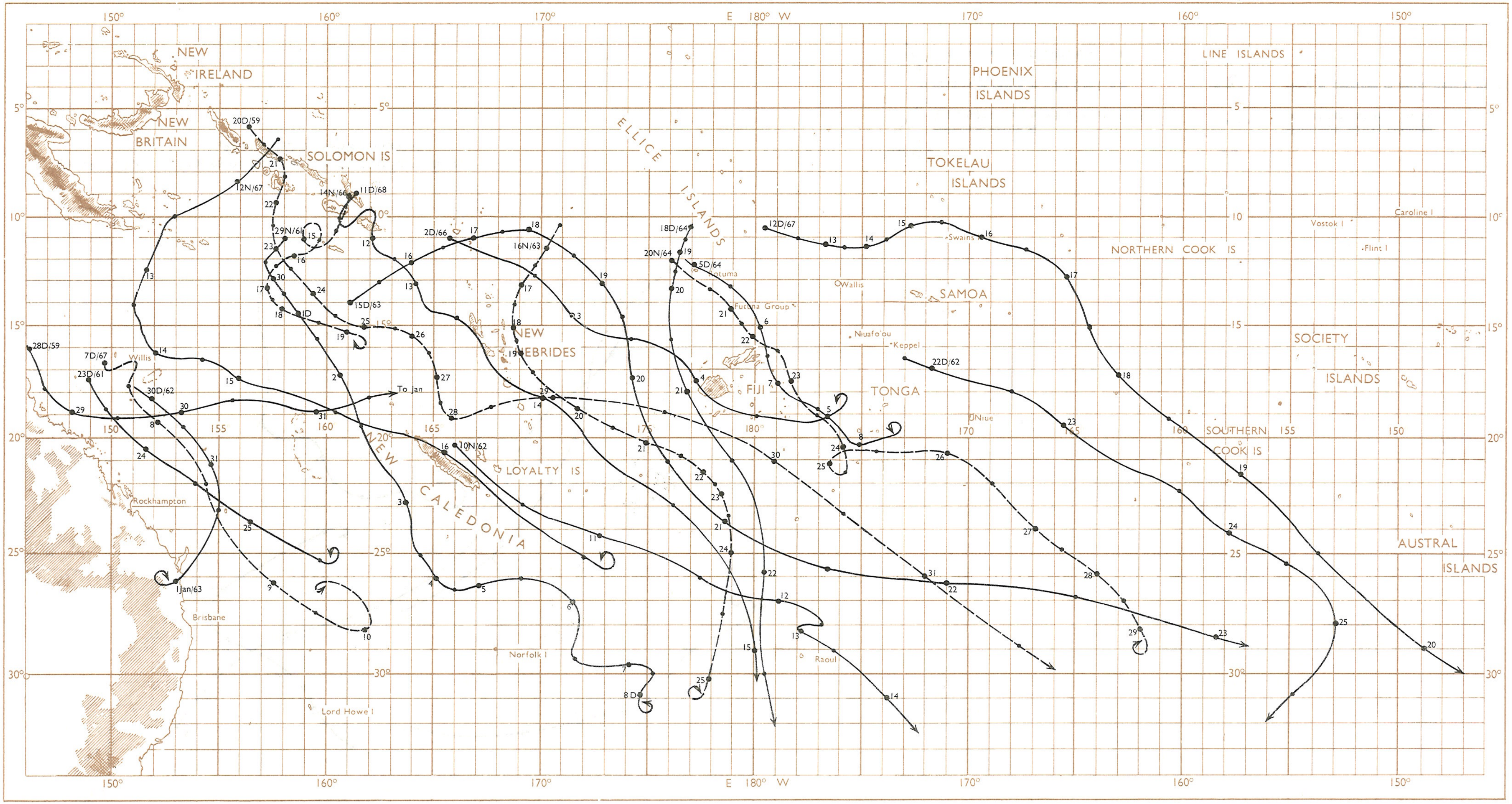


CHART 1.11 Tracks of tropical storms and hurricanes November and December, 1959 to 1968 inclusive

KEY

Beginning

24N 41 — Position of centre at 0000 G.M.T. 24 Nov 1941 (D=Dec).

Position of centre at 1200 G.M.T. (24th).

25 — Position of centre at 0000 G.M.T. 25th (Nov 1941)

End.

Subsequent history unknown or continues south of 30°S

Filled or absorbed in extra-tropical trough

To Jan — Track continued on next chart.

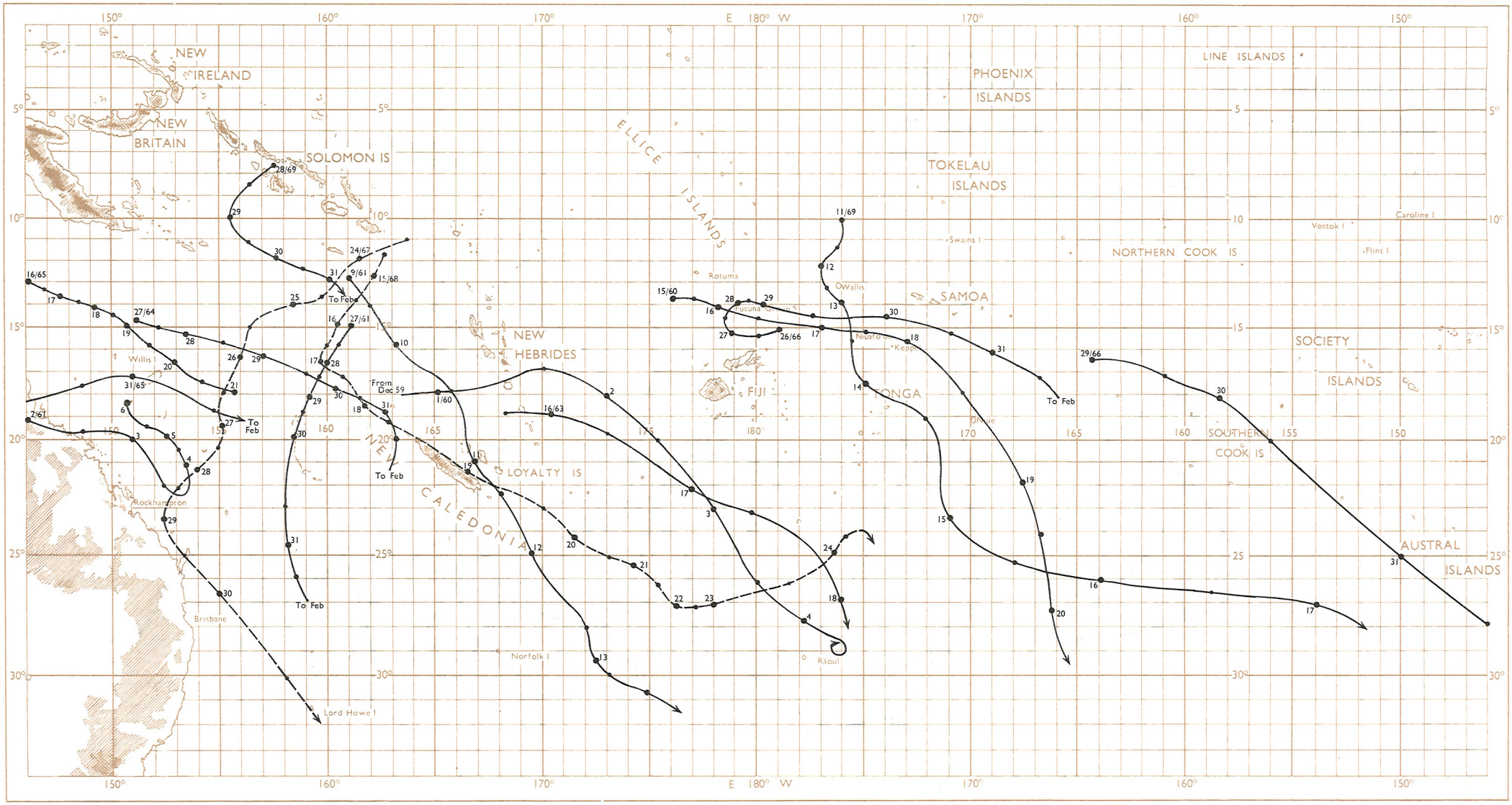


CHART 1.12 Tracks of tropical storms and hurricanes
January 1960 to 1969 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra-tropical trough.

To Feb Track continued on next chart.

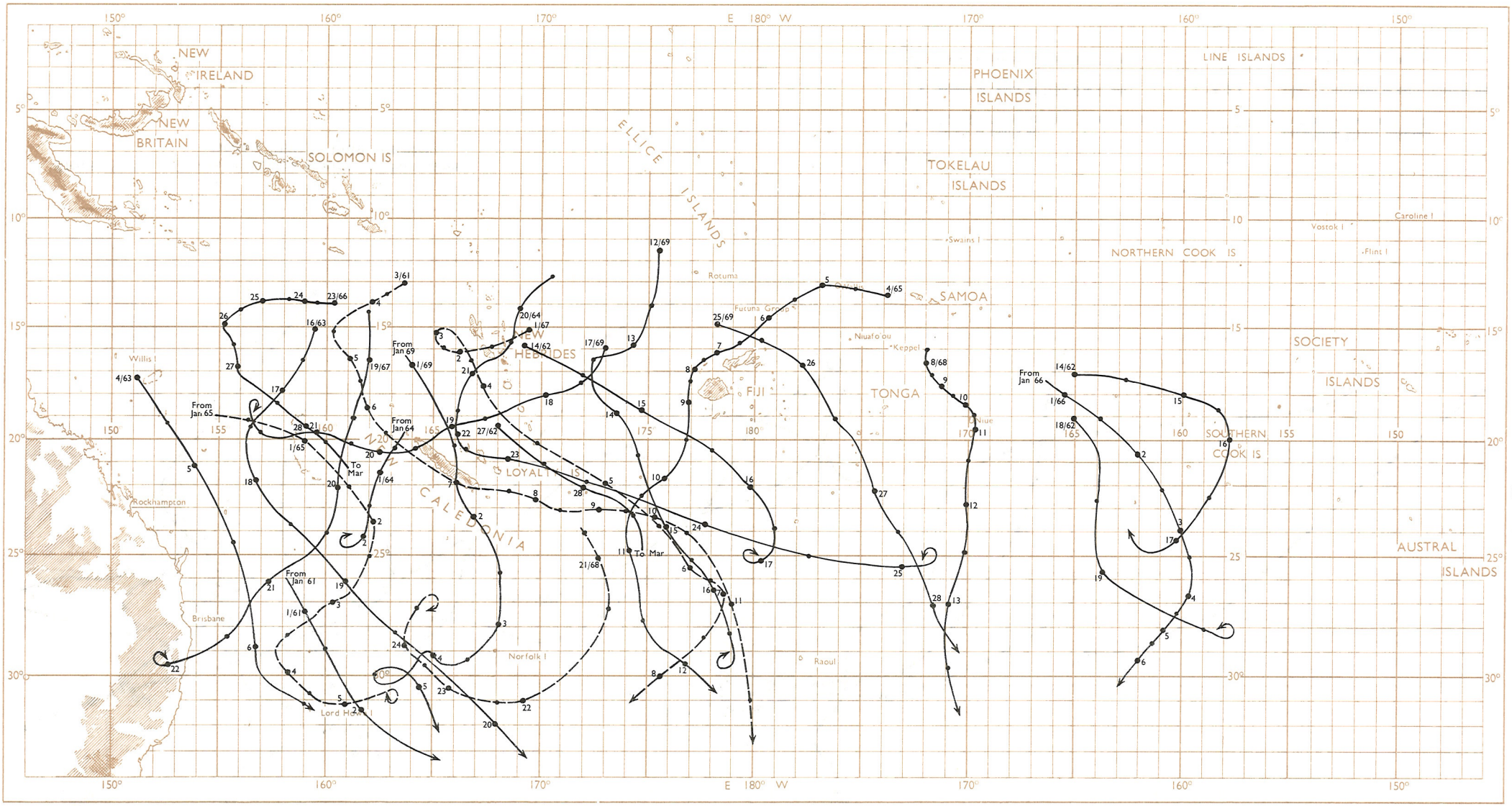


CHART 1.13 Tracks of tropical storms and hurricanes
February 1960 to 1969 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra–tropical trough.

To Mar Track continued on next chart.

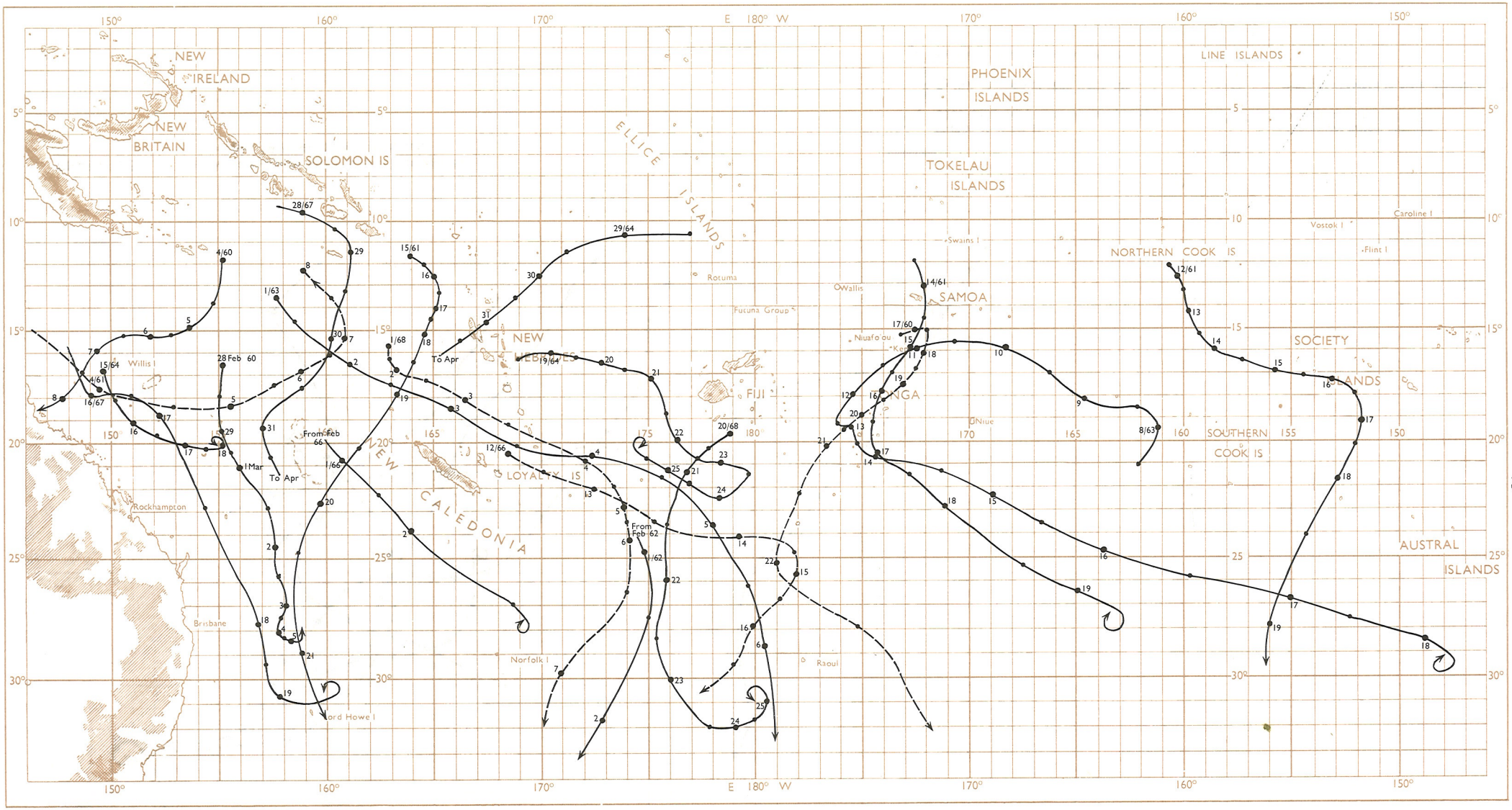


CHART 1.14 Tracks of tropical storms and hurricanes
March 1960 to 1969 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra-tropical trough.

To Apr Track continued on next chart.

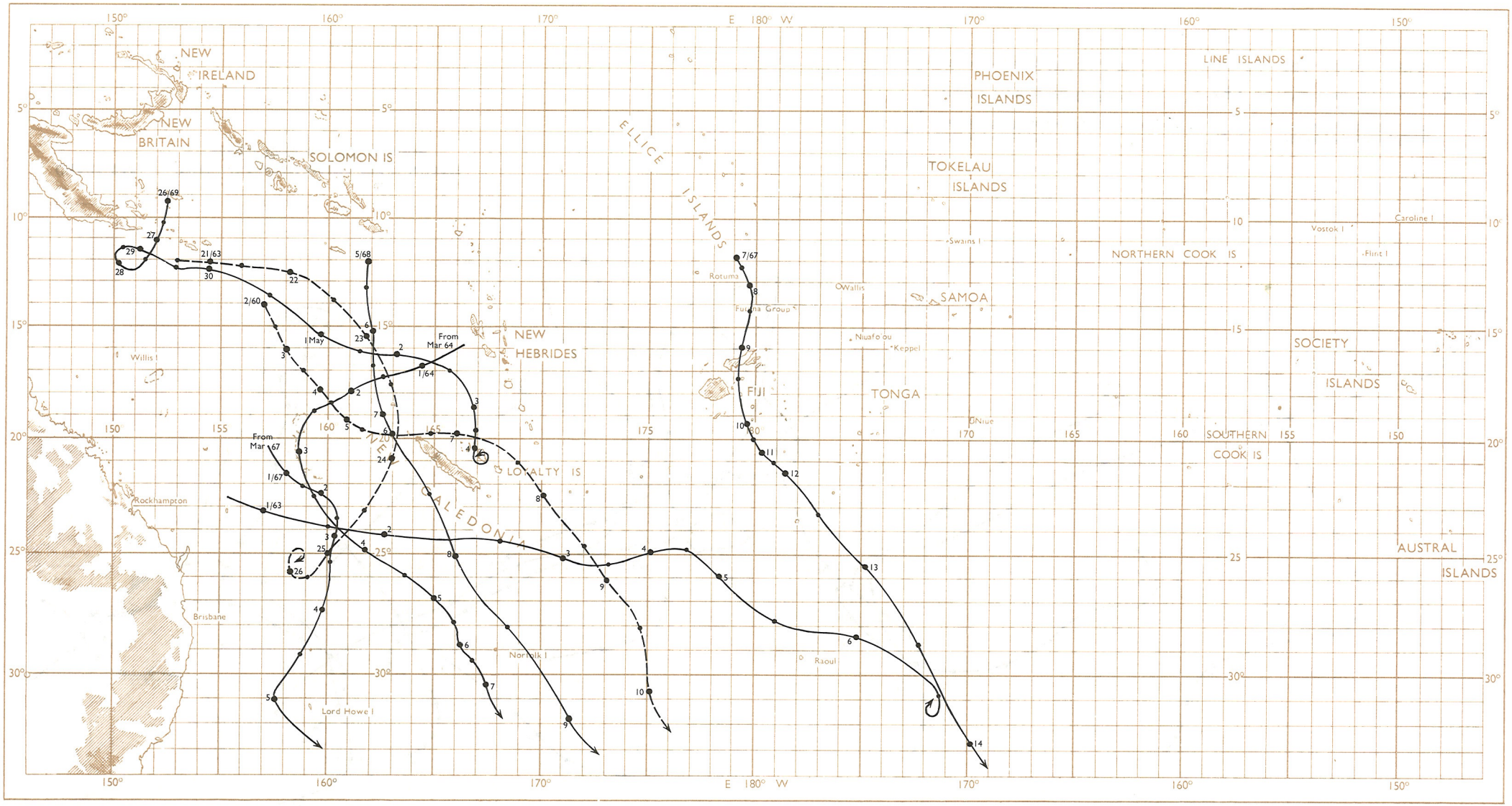


CHART 1.15 Tracks of tropical storms and hurricanes
April 1960 to 1969 inclusive

KEY

Beginning

5/56 Position of centre at 0000 G.M.T 5th (month of chart) 1956

Position of centre at 1200 G.M.T. 5th.

6 Position of centre at 0000 G.M.T. 6th.

End

Subsequent history unknown or continues south of 30°S.

Filled or absorbed in extra–tropical trough.

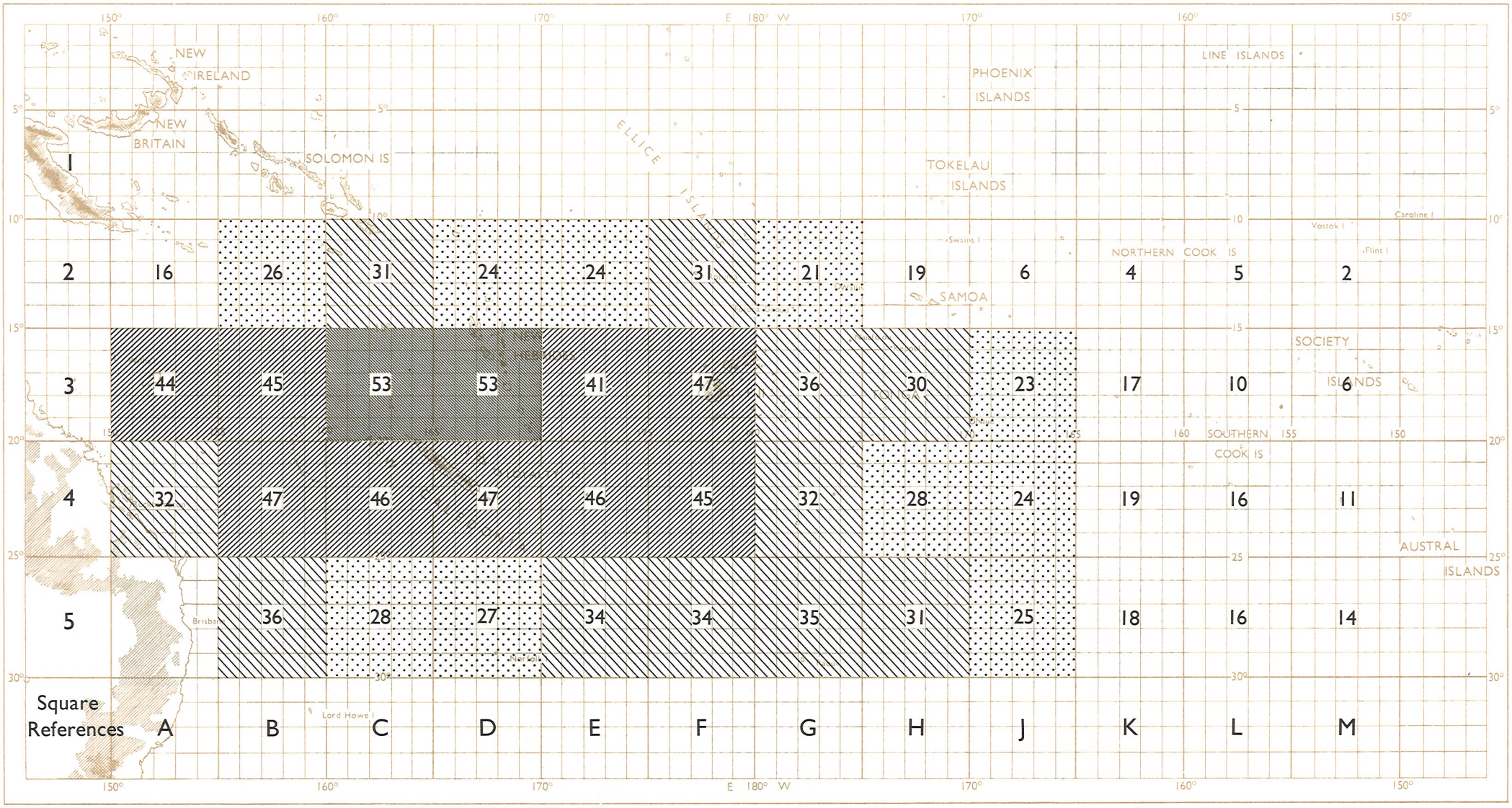


CHART 2.1 Number of cyclones that crossed each 5-degree square in the 30 "seasons" November 1939 to April 1969

KEY

25 or more | 20–24 | 15–19 | 10–14 | 1–9

per cent of all tropical storms and hurricanes in the period.

Actual numbers at centre of squares. See also text of Part II under GEOGRAPHICAL DISTRIBUTION.

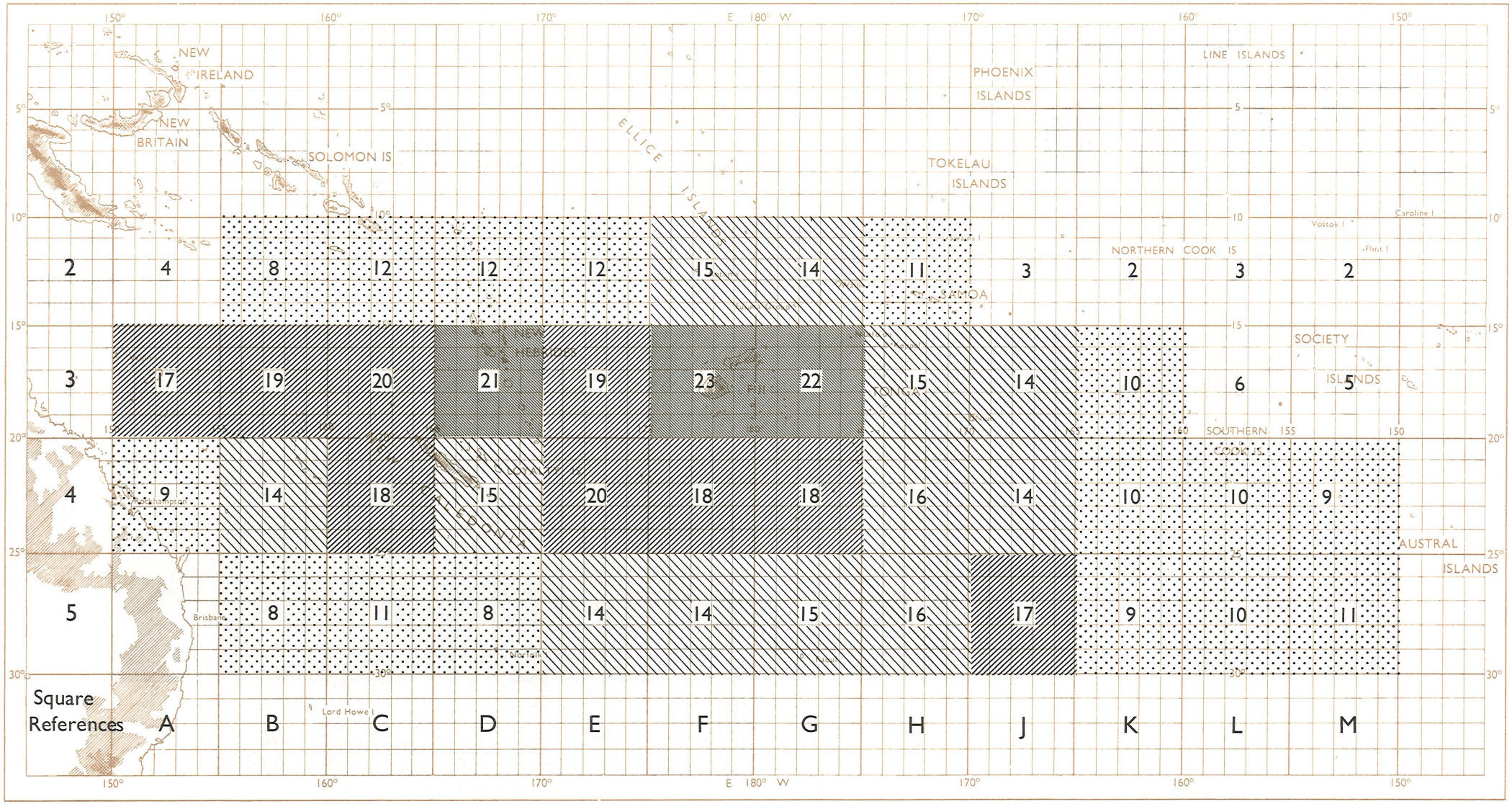


CHART 2.2 Number of cyclones that crossed each 5-degree square in the months November, December, January in the 30 "seasons"

KEY

25 or more	20–24	15–19	10–14	1–9

per cent of all tropical storms and hurricanes in the period.

Actual numbers at centre of squares. See also text of Part II under GEOGRAPHICAL DISTRIBUTION.

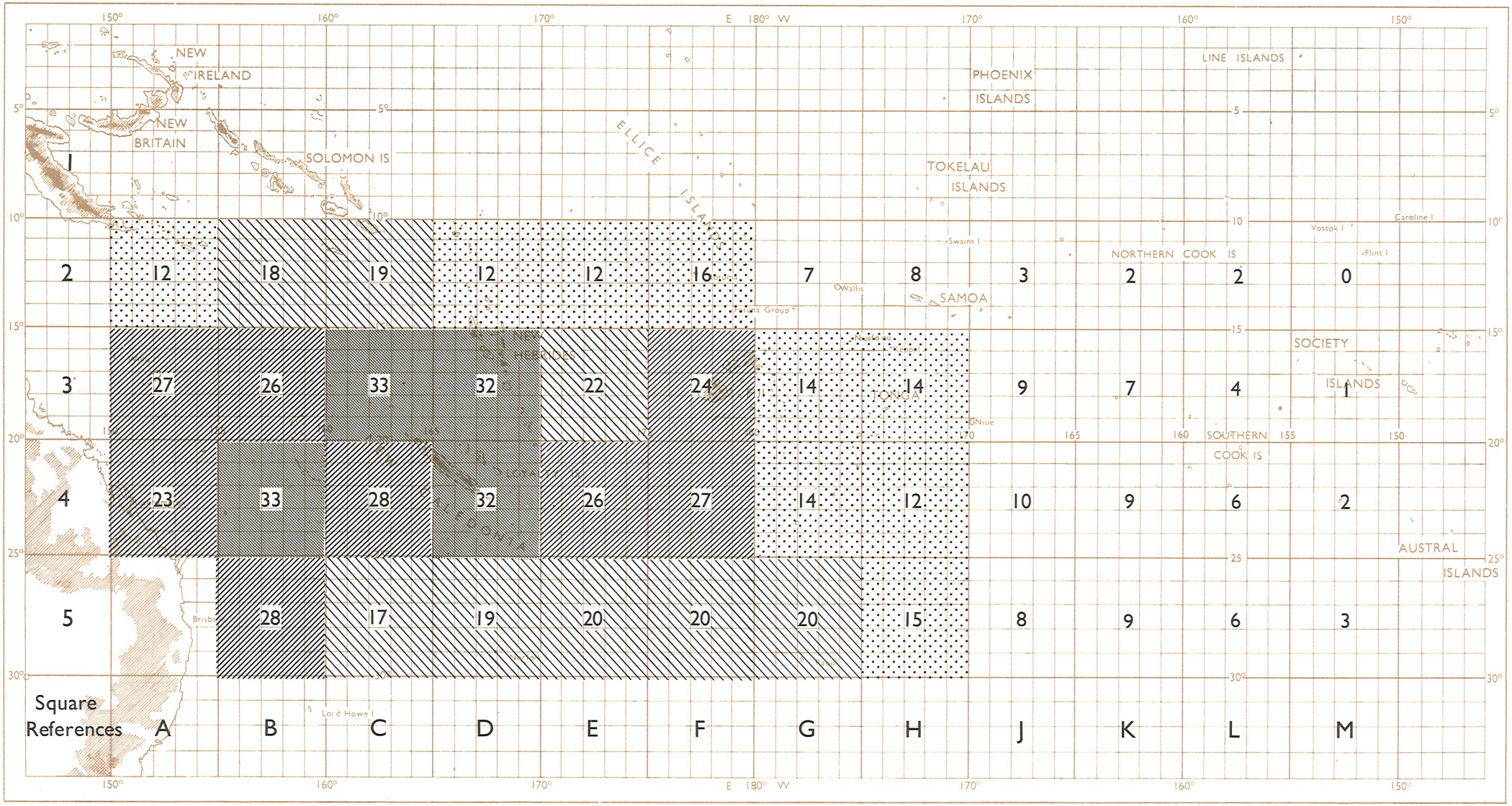


CHART 2.3 Number of cyclones that crossed each 5-degree square in the months February, March, April in the 30 " seasons"

KEY

25 or more | 20–24 | 15–19 | 10–14 | 1–9

per cent of all tropical storms and hurricanes in the period.

Actual numbers at centre of squares. See also text of Part II under GEOGRAPHICAL DISTRIBUTION.

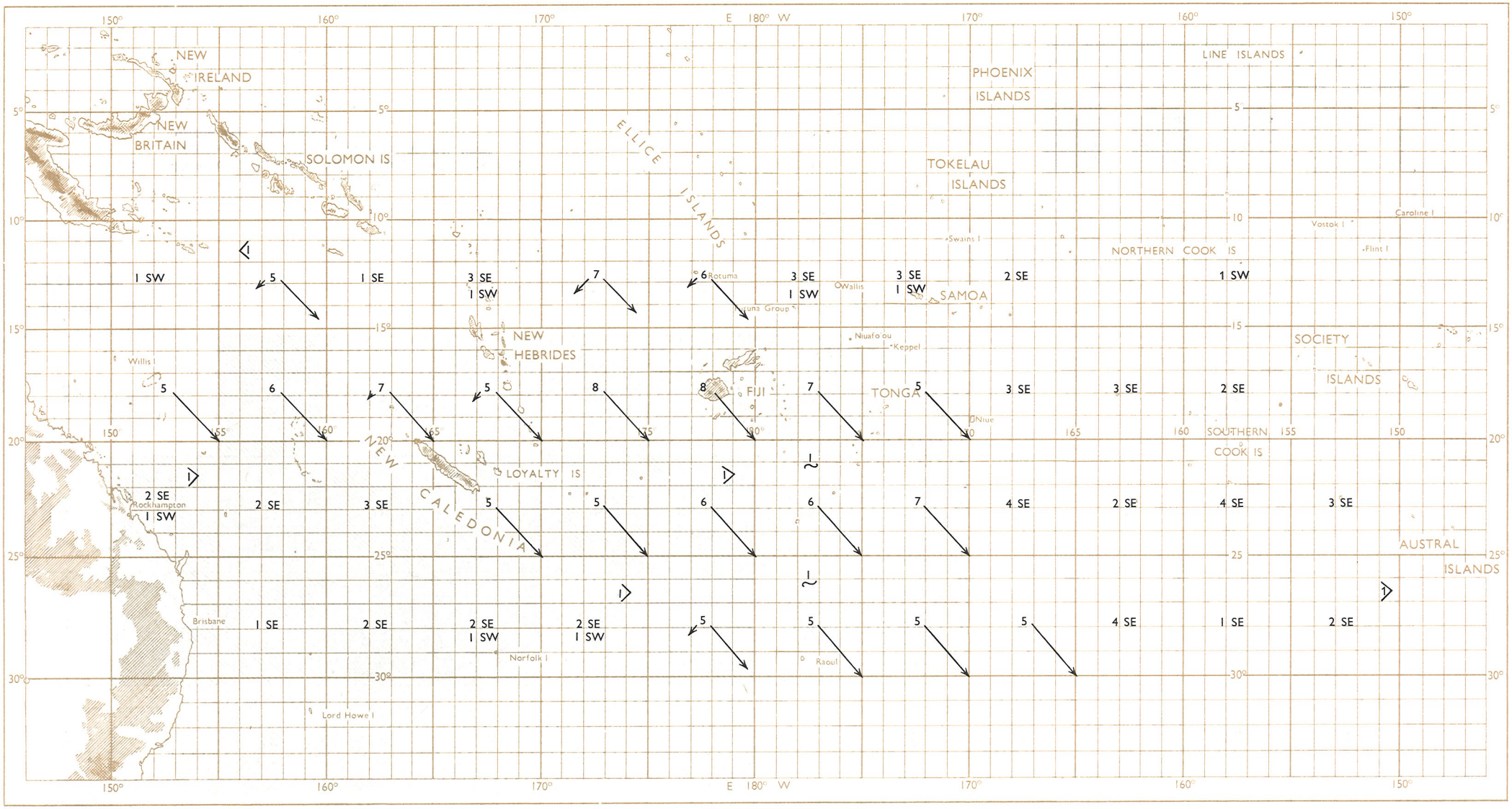
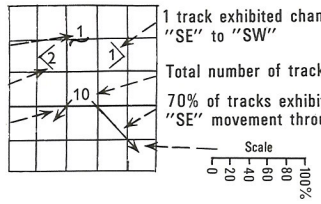


CHART 3.1. Partition of net directions of movement ("SE" and "SW") of cyclones through 5-degree squares: November and December, 1939 to 1968 inclusive.

For definitions of "SE" and "SW" see introductory text of Part II under–DIRECTIONS OF MOVEMENT.

KEY



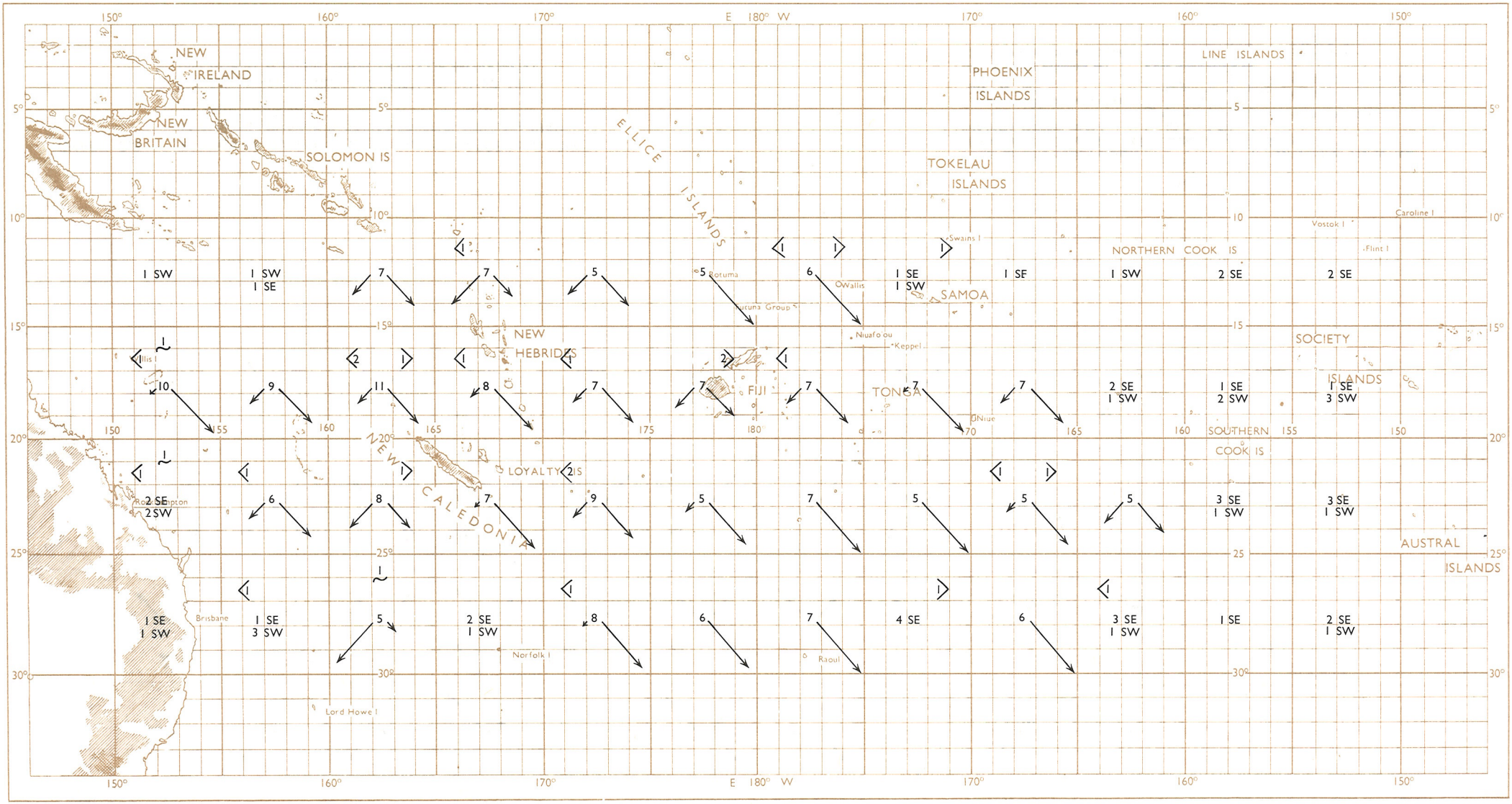


CHART 3.2 Partition of net directions of movement ("SE" and "SW") of cyclones through 5-degree squares: January 1940 to 1969 inclusive

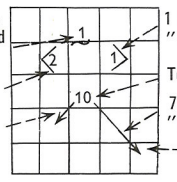
For definitions of "SE" and "SW" see introductory text of Part II under–DIRECTIONS OF MOVEMENT.

KEY

1 track exhibited multiple changes of direction ("SE" to "SW" and vice versa; includes loops)

2 tracks exhibited change from "SW" to "SE"

30% of tracks exhibited net "SW" movement through square.



1 track exhibited change from "SE" to "SW"

Total number of tracks

70% of tracks exhibited net "SE" movement through square.

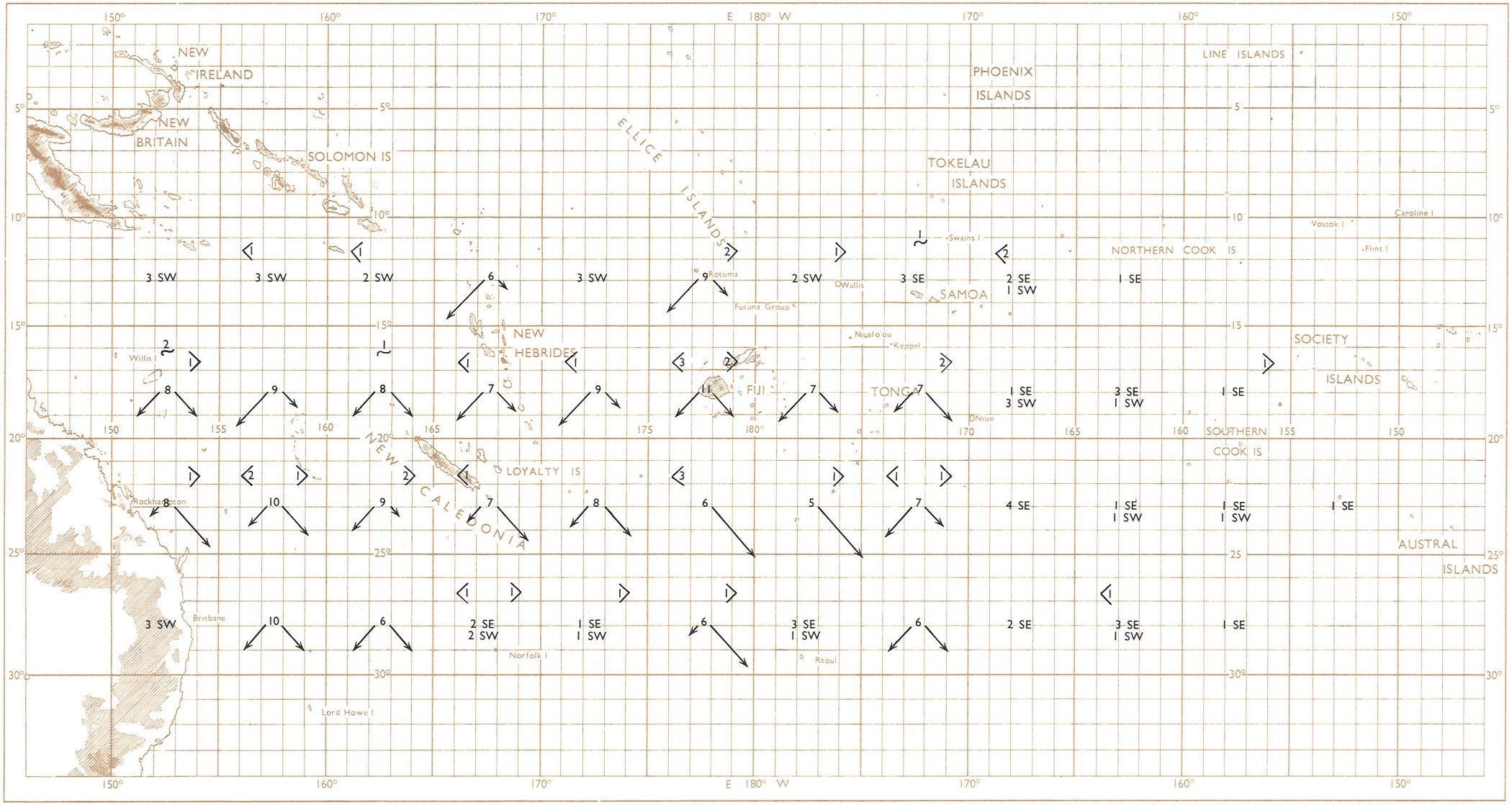
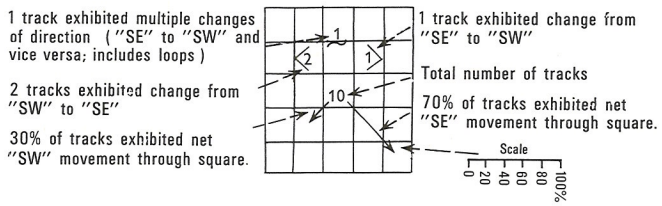


CHART 3.3 Partition of net directions of movement ("SE" and "SW") of cyclones through 5-degree squares: February 1940 to 1969 inclusive

For definitions of "SE" and "SW" see introductory text of Part II under–DIRECTIONS OF MOVEMENT.

KEY



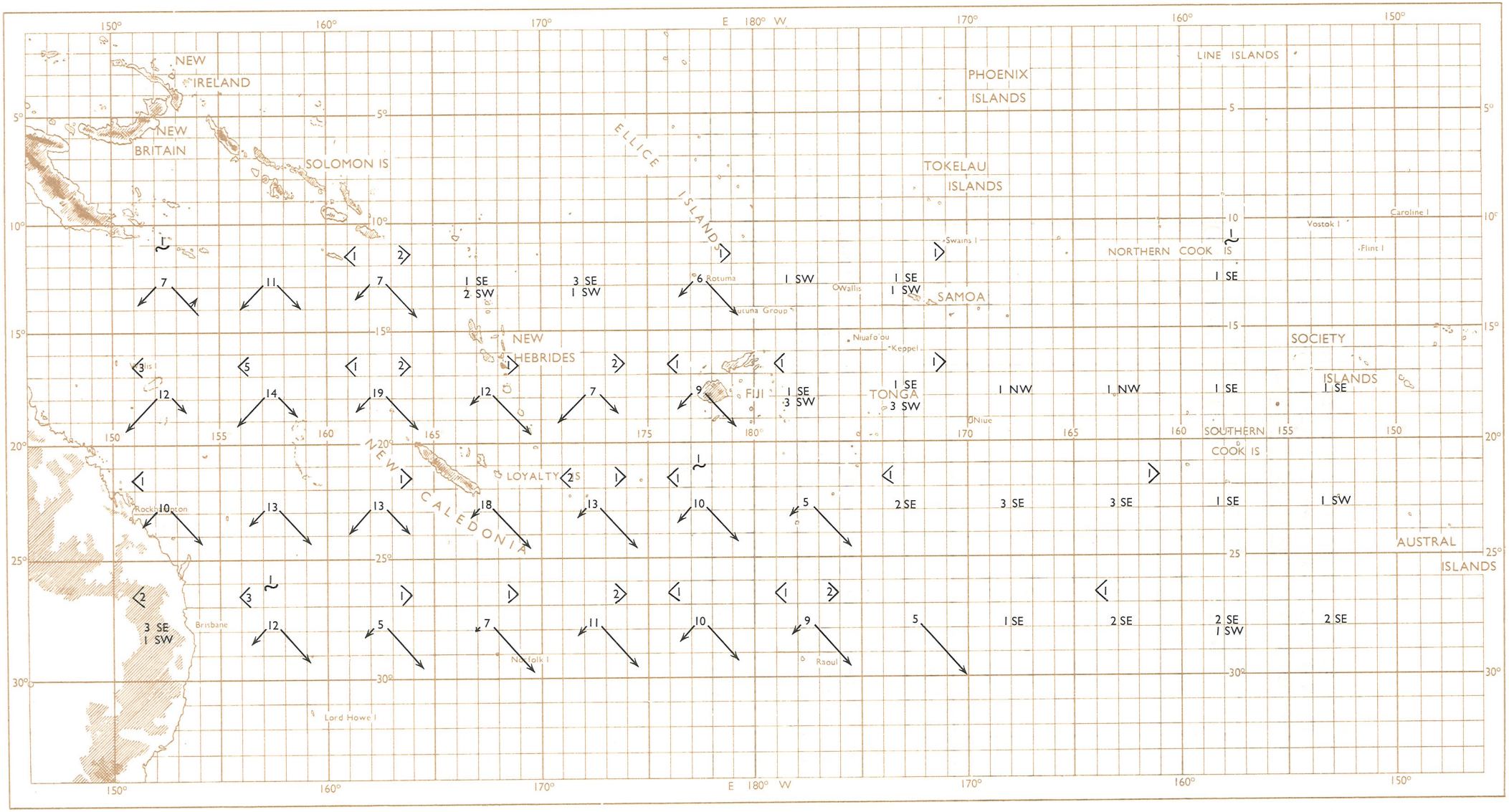


CHART 3.4 Partition of net directions of movement ("SE" and "SW") of cyclones through 5-degree squares: March and April, 1940 to 1969 inclusive

For definitions of "SE" and "SW" see introductory text of Part II under–DIRECTIONS OF MOVEMENT.

KEY

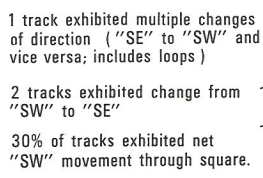


Table 4. Frequency and relative frequency of the track types: E, W, W-E and E-W (see introductory text of Part II under heading - Types of track).

Type	Kerr*		Ref. (41)	Ref. (13)
	No.	%	%	%
E	71	37	30	49
W	16	8	15	10
W-E	60	31	35	27
E-W	47	24	20	14
	194			

* The numbers and percentages in these columns are derived from Charts 1 - the period November 1939 to April 1969; 30 years or 180 months.

Ref. (41): Gabites, 1963: period 1940-1956; 17 years.

Ref. (13): Giovanelli and Robert, 1964: period 1948-1962; 15 years.

PART III

DISCUSSION OF THE DATA

Annual Frequency (Tables 3.1, 3.2)

The average number of tropical cyclones which reached at least tropical storm intensity was 6.5 per year. The averages for the three decades were 5.8 (forties), 6.4 (fifties) and 7.2 (sixties). The trend towards a higher frequency is probably accounted for by the improvement in the capability to detect the cyclones in the later years, but it is interesting to note that the greater number of storms in the third decade compared with the second is entirely due to an increase in the number of November and December storms - from 10 to 19. Of approximately 300 storms listed by Visher about 15 per cent occurred in the two months, November and December. The same proportion was found in the first two decades of the present survey but, in the third decade, the proportion was about 25 per cent. There is no obvious explanation of this increase, if it is indeed significant.

If the additional "possible" storms listed in Table 2 are included in the total the average per year becomes 7.7. Taking this into account and also the possibility that some storms may have been missed entirely in the early years, it is reasonable to assume the "true" average for the period is between 7 and 8 storms per year.

The number of storms varied considerably from year to year, from 3 to 12. The histogram alongside Table 3.1 reveals no sign of a periodic fluctuation, e.g. of a biennial oscillation. However, numbers alone are probably not an adequate measure of "activity". Each occurrence should be weighted by a suitable measure of intensity but, except in the last few years, the intensities of the majority of the cyclones are not well enough known throughout their lifetimes to warrant the attempt.

Geographical Distribution (Charts 2.1, 2.2, 2.3)

The numbers of tropical storms or hurricanes that passed through 5-degree latitude-longitude squares in the 30-year period are plotted on Chart 2.1. (See page 10 for interpretation of "passed through".) Over 25 per cent of all the storms listed passed through the square northwest of New Caledonia, and the same number, 53, through the square northeast of New Caledonia; but all squares between 15°S and 25°S from Willis Island to Fiji were not far behind. As is well known, the number of tropical storms recorded falls off rapidly to the eastward of Fiji.

The numbers of crossings are too small to reveal trends from month to month through the season that could be said to be significant. Nevertheless there is slight evidence of a trend as the season advances and this is illustrated in Charts 2.2 and 2.3

which show crossings in the months November to January inclusive and February to April inclusive, respectively. The maximum relative frequency of crossings occurs in the Fiji square (F3) in the earlier part of the season, and in the square northwest of New Caledonia (C3) and the one southwest of it (B4) in the later part of the season. The changes in individual squares are not very great but when the numbers in the two central rows of squares (west of 175°W) are compared the pattern of change is seen to be fairly consistent and appears to be significant -

	SQUARES						
	A3;4	B3;4	C3;4	D3;4	E3;4	F3;4	G3;4
Nov-Jan	17;9	19;14	20;18	21;15	19;20	23;18	22;18
Feb-Apr	27;23	26;33	33;28	32;32	22;26	24;27	14;14
Changes	+10	+7	+13	+11	+3	+1	-8
	+14	+19	+10	+17	+6	+9	-4

The change in the pattern between 25°S and 30°S is consistent with the trend north of 25°S. The maximum relative frequency of crossings occurs in the squares east of Raoul I (H5 and J5) in the early part of the season and in the square north of Lord Howe I (B5) in the later part.

Direction of movement (Charts 3.1 - 3.4)

In November and December eastward movement (i.e. direction of movement with an eastward component) was strongly dominant everywhere, from 10°S to 30°S.

While eastward movement was still dominant in January a considerable number of cyclones, especially west of 175°E, moved westward ("westward" means all directions in the western semi-circle including 180° and 360°). North of 15°S, west of 175°E, about as many cyclones moved westward as eastward, while some 20 to 30 per cent of the cyclones which crossed squares west of 180 degrees between 15°S and 25°S moved westward. South of 25°S almost all cyclones moved eastward, except for the relatively small number that passed through the squares west of Norfolk Island.

Westward components were even more in evidence in February, at all latitudes. North of 15°S, west of 175°W, almost all cyclones moved westward. Elsewhere, except in the squares south and southeast of Fiji (F4, F5, G4, G5) westward movements were about as frequent as eastward movements. In some areas, notably in the neighbourhood of the New Hebrides and the central Coral Sea (squares B3, D3, E3), westward movement was dominant.

Later in the season, in March and April, there was a return to the dominance of eastward movement except in a few areas such as the central Coral Sea. (squares A3, B3).

Types of track (Table 4)

Only 39 per cent of the cyclones moved westward initially. This figure may be compared with those found by Hutchings, 56 per cent, Gabites, 50 per cent, Giovannelli and Robert, 37 per cent, and by Tannehill for North Atlantic hurricanes, 85 per cent. It must be remembered, however, that many South Pacific cyclones develop in areas where there are no observations and their movements in the very early stages may be uncertain or unknown. Nevertheless it seems certain that the proportion of tropical cyclones which move eastward from a very early stage is much higher in the South Pacific than in the North Atlantic.

About 30 per cent of the cyclones followed the so-called typical path - west or southwest then recurving to the southeast - and about one-fifth of these recurved a second time to move westward again before leaving the area. Over 20 per cent of the tracks exhibited the opposite curvature - eastward movement then recurving to the westward.

PART IV

TROPICAL STORMS AND HURRICANES IN AND NEAR ISLAND GROUPS

Tropical storms or hurricanes whose tracks lay through or very close to an island group are listed separately for New Caledonia, New Hebrides, Fiji, Samoa, Northern Tonga, Southern Tonga, Niue, Southern Cook Islands, Northern Cook Islands, and Other Islands.

The dates quoted are the local dates on which the storm centre was within the relevant area. The complete track may be found in Charts 1 through the serial number and Tables 2.

The descriptions, "minor", "moderate", and "severe" do not refer to the absolute intensity of the storm but, rather, to the magnitude of its impact on the island group concerned. These assessments are very subjective. They are strongly influenced by the amount of publicity given to the storm, by the chance that a meteorological observing station did or did not lie directly in the path of the storm, and by the existence or not of detailed reports from the masters of ships unfortunate enough to encounter the cyclone. Publicity is, of course, influenced by the area affected: heavy damage in a large town naturally attracts more attention than the destruction of coconut and banana plantations in sparsely populated areas. Any deductions concerning the frequency of severe storms, say, must be extremely tentative.

Following each list are additional notes on some of the hurricanes. (An asterisk against the serial number indicates that such additional comments are to be found on the following pages.) The absence of detailed comment does not necessarily mean that the cyclone was not worthy of comment. It may mean only that the author has been unable to find sufficient information.

Preceding the main lists are short lists of notable storms in the first four decades of the century.

The sources of information are discussed in part V.

NEW CALEDONIA

(i) Some notable storms 1900-1939

1906 March
1910 March
1917 February
1932 February
1933 April
1934 March
1939 March

(ii) Tropical storms or hurricanes 1940-1969

1940		
20 Feb	4.03*	Moderate. Southwestward over northern New Caledonia. Also New Hebrides
1941		
5 Apr	4.11	Minor. Southsoutheast to the east of the Loyalty Islands. No reports of winds in excess of gale force.
1942		
5 Mar	4.18	Minor. Southwestward over the Loyalty Islands and southern New Caledonia. At Noumea wind briefly 50 kt and lowest pressure 981 mb. Also New Hebrides.
11 Apr	4.19	Minor. Southsouthwest over the Loyalty Islands and southern New Caledonia. No reports of winds in excess of gale force.
1944		
17-18 Jan	4.27*	Moderate. Southeastward along the east coast of New Caledonia.
1947		
12 Mar	4.46*	Severe (Mare I.) Southsoutheast over the Loyalty Islands.
1948		
27 Jan	4.48	Minor. Southwestward just to the north of mainland New Caledonia. Also New Hebrides.
13-14 Mar	4.50*	Severe. Southsoutheast over southern New Caledonia.
1949		
13-14 Jan	4.53	Minor. Eastward just to the north of New Caledonia then southeastward over the Loyalty Islands but losing intensity.
11 Dec	5.01	Minor. Rapidly eastsoutheast over northern New Caledonia and the Loyalty Islands.
1951		
26 Feb	5.09*	Severe. Southsoutheast over central New Caledonia.
1953		
6 Mar	5.17	Moderate (Loyalty Is). Southsoutheast close to the Loyalty Islands where near hurricane force winds reported.
1954		
27 Jan	5.21	Minor. Southsouthwest just to the north of New Caledonia.

1955		
4 Mar	5.27*	Moderate. Westsouthwest over central New Caledonia. Also New Hebrides.
1 Apr	5.28	Minor. Most unusual track; approached the southern tip of New Caledonia from the south then turned away to the west. Gales, gusts to over 60 kt, and heavy rain in southern New Caledonia. Also Solomon Is.
27 Dec	5.29	Minor. Southeastward over central New Caledonia and the Loyalty Islands. Heavy rain and some flooding. The lowest pressure at Tontouta was 983 mb; and a ship near Mare I. reported a wind of force 10 and a pressure of 982 mb.
1956		
21-22 Jan	5.32	Minor. Southeastward off the east coast and between the Loyalty Islands and the mainland.
1 Mar	5.36	Moderate. Westward between Lifu and Mare I. then westnorthwest to the north of New Caledonia. Flooding caused significant damage. Also Fiji and New Hebrides.
13-14 Mar	5.38	Minor. Southwestward between Mare and Walpole Is and to the south of the mainland.
6 Apr	5.39*	Moderate (Loyalty Is). Rapidly southeastward off the east coast of New Caledonia, between the Loyalty Islands and the mainland.
7 Apr	5.40*	Moderate to severe (Loyalty Is). Followed closely behind 5.39; southeastward just to the east of the Loyalty Is.
1957		
6-7 Jan	5.42*	Moderate (restricted area). Eastward over southern New Caledonia and just to the south of the Loyalty Islands.
30 Mar	5.47	Minor. Southeastward between the New Hebrides and the Loyalty Islands. Little effect on either group except on Aneityum. The oceanographic research vessel ORSUM III was caught up in the small but violent core of the cyclone.
1959		
18-19 Jan	5.56*	Severe. Southward over southern New Caledonia.

13 Mar	5.64*	Moderate (restricted areas). Southeastward to the north of New Caledonia and close to the Loyalty Islands. Also Solomon Islands.
1960		
6-7 Apr	6.07	Minor. Eastward to the north of New Caledonia then southeastward between the New Hebrides and the Loyalty Islands. Heavy rain only.
1961		
11 Jan	6.09	Minor. Southsoutheast through the Loyalty Islands but doubtful if cyclone had reached storm intensity at this time.
7 Feb	6.11*	Moderate (severe Mare I). Southeastward along west coast then eastward north of Noumea and south of Mare I.
1963		
24 Apr	6.31	Minor. Southward west of the northern tip of New Caledonia.
1964		
31 Jan/ 1 Feb	6.34*	Minor. Southward to the west of the northern tip of New Caledonia.
22-23 Feb	6.35	Minor. Southward to the northern Loyalty Islands then sharply eastsoutheast. Gales and heavy rain in the Loyalty Islands. Also New Hebrides.
1967		
16 Nov	6.57	Minor. Eastsoutheast to northern New Caledonia and along the east coast. Moving very rapidly and losing intensity. Also Solomon Islands.
1968		
19 Jan	6.60*	Severe. Southeastward along the east coast.
7 Apr	6.65*	Minor. Southsoutheast to the west of New Caledonia.
1969		
1-2 Feb	6.68*	Severe. Southward close to Uvea I., in the Loyalty Is, and to Noumea.
19-20 Feb	6.70*	Moderate. Westsouthwest over northern New Caledonia. Also New Hebrides.

NOTES

4.03 February 1940

The second of the two cyclones that devastated a number of small islands in central New Hebrides continued on its southwestward course to pass over central New Caledonia on 20 February. It caused a considerable amount of damage in the north and especially in the Canala district on the east coast where several plantations were ruined. Many houses were damaged and telephone lines brought down. Floods in the north destroyed bridges and washed out roads. Rainfall was over 200 mm in many places.

4.27 January 1944

This cyclone originated in the Coral Sea northwest of New Caledonia and ran southeastward along the length of the island between mid-morning on 17 January and midday on the 18th. At Noumea the wind reached 54 kt (gusts 74 kt) and the lowest pressure was 983 mb.

While in no way comparable with the disastrous hurricane of April 1933 this one caused a considerable amount of havoc in and around Noumea. Low-lying army camps in the area were flooded and hundreds of tents were blown down. In the town itself falling trees damaged many properties. A cutter was lost along with three of the people on board.

4.46 March 1947

A tropical cyclone which developed south of the Solomon Is on 9 March moved southeastward then southsoutheast to pass just to the east of the Loyalty Is on 12 March. It passed almost directly over Mare I. shortly after midday and was reported to have been the worst experienced on that island "within living memory". Schools, churches, houses and plantations were all damaged in varying degree. More than half the island's coconut trees were uprooted and no harvest of coconuts or any other crops could be expected that year.

Neighbouring islands were not greatly affected and Noumea itself had only strong winds and torrential rain.

4.50 March 1948

The storm which developed west of the Banks Is on 11 March and moved southsoutheast to pass over southern New Caledonia on 14 March was probably the worst to strike Noumea since 1933. The wind at Noumea reached gale force from the East in the morning and, backing through North to West as the centre passed close by, reached its peak in the early afternoon. The maximum gust speed was almost 90 kt.

Damage was extensive and of the usual sort. In Noumea eight houses were demolished and the roofs were ripped off

many others. It was estimated that over 3000 sheets of iron would be needed to effect repairs. Three 12-metre naval patrol boats were sunk in the harbour and the radio installations at Tontouta were demolished. One woman lost her life.

Crops suffered heavily in the ensuing floods. (Heavy rain in the preceding two months had already caused a considerable amount of damage.)

5.09 February 1951

A tropical cyclone was first detected in the vicinity of the Banks Is on 20 February. During the next two days it moved slowly southwest and then hovered for three days about 500 km north of New Caledonia, possibly executing a loop as shown by the plotted track. On the 25th it began to move southsoutheast at about 15 kt and, on the 26th, crossed the east coast of New Caledonia not far north of Houailou, and the west coast between Bouloupari and Tontouta. While in the vicinity of New Caledonia winds were generally 55 to 60 kt within 200 km of the centre with gusts up to 90 kt recorded at Tontouta and 78 kt at Noumea. The lowest pressure recorded was 961 mb at Koumac.

The unusual behaviour of the cyclone north of New Caledonia resulted in the 7750 ton freighter "Tantara", en route from Brisbane to San Francisco, being caught in the core of the hurricane on 23 February some 500 km northwest of Santo. Early on the 24th the vessel was hove to and was battered by hurricane force winds and tremendous seas for three whole days. The ship's log shows a succession of entries such as, "Mountainous seas, rolling and labouring heavily; shipping water aft. ..... No. 2 and 4 lifeboats stove in. ..... Poop deck awning carried away. ..... Rolling heavily, labouring, pounding ...." and so on. When the ship's position could at last be determined she was south of the Loyalty Is, over 1000 km off course. She could very easily have been wrecked on one of the islands.

Wind damage in plantations along the hurricane's path over New Caledonia was considerable. In Noumea itself several barges and a cutter sank; telegraph and power lines were brought down; and a number of houses were slightly damaged. Floods and high seas were responsible, as usual, for much of the general destruction.

In the New Hebrides some damage, presumably caused by big seas, was reported. Malekula suffered most; several people were believed to have been drowned.

5.27 March 1955

This cyclone which had passed through the New Hebrides on 2 March (see page 69) continued to the westsouthwest over central New Caledonia on 4 March. The lowest pressure recorded was 976 mb at Koumac. On the east coast of New

Caledonia the coffee plantations which promised a good harvest were badly affected. Two small vessels, one on Lifu I., were destroyed but no lives were lost. In Noumea itself, where the maximum gust speed was 70 kt the water supply was damaged but property generally escaped lightly.

5.39/ 5.40 April 1956

Two storms moved southeastward to the east of New Caledonia in quick succession on 6 and 7 April. The first passed over the Belep Is where the copra crop was badly damaged, and then between New Caledonia and the Loyalty Is. The second moved through the Loyalty Is: a ship near Lifu I. reported a wind of force 10 and Mare I. reported a pressure of 988 mb. Telephone lines were blown down and there were heavy losses of fruit and copra. Floods occurred in the southern half of the mainland.

5.42 January 1957

The storm which developed in the Coral Sea on 4 January crossed central New Caledonia from west to east on the night of the 6th. Although a maximum gust speed of about 80 kt was recorded at Noumea damage there was less than expected because of the storm's rather rapid movement. However, rain fell steadily for 48 hours from 5 January and crops and roads in country areas suffered considerably.

5.56 January 1959: Beatrice

Beatrice developed north of the New Hebrides on 15 January, moved west, southwest, and then south to approach the northern end of New Caledonia on the 18th. It then moved along the east coast of the island and crossed its southern tip on the morning of the 19th. Force 11 winds were reported by stations in the Loyalty Islands and New Caledonia and full hurricane force was reported by a ship about 220 km south of Noumea on the 19th. The lowest pressure recorded was 939 mb at Poindimie on the east coast (16).

The cyclone caused serious damage in many parts of New Caledonia. In the east the wind was the chief agent of destruction, coffee and coconut plantations suffering heavy losses. The western side of the island was less affected but crops were damaged by flood waters. In compensation for losses sustained during this storm and the lesser storm of 13 March (No. 5.64, Ida) nearly $90,000 was paid out from agricultural insurance funds.

5.64 March 1959: Ida

Hurricane Ida was born south of the Solomons about 7 March. It moved slowly southwest to about 16°S 156°E at which point it recurved sharply to the eastsoutheast on 10 March. At 1700 hours 12 March a ship about 550 km northwest of New Caledonia reported a force 9 wind and a pressure of 987 mb. Twenty-four hours later the hurricane

was centred 100 to 150 km northeast of Koumac which reported a force 9 wind and pressure of 981 mb. Ida was now moving very rapidly, over 30 knots, and passed between Mare I. in the Loyalty Group and Aneityum in the New Hebrides in the late evening of 13 March. Here the m.v. "Tulagi" was caught up in the hurricane and her captain, Brett Hilder, has provided a very detailed and vivid report on the encounter (2), and some extracts from it are given here. Times quoted are ship's local time which was 11 hours ahead of G.M.T. The ship carried an aneroid barometer reading in inches and requiring a correction of 0.066 in. at 29.50 in. In the following extract barometer readings have been converted to millibars and the correction applied (assumed constant).

> "At 8 p.m. the glass was down to 973 mb, the lowest I had ever seen in a hurricane, and as the wind force was now exceeding gale force, I dashed off a weather report to Noumea in plain language. By the time I was writing "Wind 030 degrees" I had to put "hurricane force".

At this point the vessel was hove to at the estimated position 20° 20'S, 168°33'E, about 120 km NNW of Mare I. and a similar distance W of Aneityum. At 9 p.m.,

> "The glass was still falling, but that was no longer of much importance compared with the fact that the ship's head could no longer be kept into the wind; the bow was now about 45° off the wind, and we were heading NNW. I called for full speed and for the next half hour or so tried to get the bow back into the wind by frequent use of full rudder, but with less and less success as the wind and sea increased and increased. By now the ship's head was about west, and as the wind had backed to about north, we were broadside-on to the hurricane. This was most alarming, and the ship was rolling so violently that the boats were straining their chocks, the deck cargo was breaking adrift, the gangways were being struck by heavy seas, and the spray and rain were driving horizontally. The whistle lanyard, rigged straight down the funnel to the deck for use when the electric control failed, now took the force of the wind and blew a steady blast on the whistle to the dismay of us all.
>
> The bridge and wheelhouse were awash, as well as most of the passenger and crew accommodation, and we were being shot from side to side and badly bruised and shaken. The radar cabinet in the wheel-house broke from the deck with a loud crack, but was held in place by superhuman efforts until it was shored into position by timbers; it had to be switched off and the power disconnected to save us from electrocution. My last glimpse of the screen showed bands

of heavy rain like a spiral nebula, lying along the isobars, and about 20 miles to the westward were two horns in a semicircle possibly indicating the actual core of the storm. The rain bands extended about 30 miles to north and south of us, and might have made a good photograph, but the violent motion of the ship would have wrecked any attempts to rig the tripod to hold a camera, as well as preventing any steady time-exposure.

For the first time in my life I was in a ship which could not be brought up into the wind, though I had been in six hurricanes before. As it was too dangerous to remain broadside-on, we turned hard-a-port and came slowly around to South, with the wind astern. I reduced speed to slow, but we still appeared to be making speed down wind at an alarming rate. The time was about 9.30 p.m.

We had not been running down wind for long when the wind fell away to a calm, the stars appeared overhead, and we had obviously reached the eye of the storm. The glass read 949 mb and the temperature was 77°F, but the bulb was hardly "Dry". We had taken some heavy seas over the stern ..."

As the wind picked up from the opposite quarter Captain Hilder steered 080° true with the wind right astern.

" At 8 a.m. on the 14th we were off the SE corner of Aneityum, and were able to steer about NNE. The wind had dropped to a breeze but the swell was still rather mountainous, on our port quarter. By noon we were able to shape a course for Vila and resume full speed, having been a total of 16 hours in various forms of being "hove-to", out of control, and running before the storm. .....".

Although the hurricane's track was within 80 km of the Loyalty Islands damage was relatively light except on Lifu I. where coconut trees and dwellings were severely battered. The west coasts of the southern islands of the New Hebrides were affected by the storm surge.

On 14 March the hurricane moved at an extremely high speed, over 40 knots, and, north of New Zealand, recurved to the southwest and into the Tasman Sea. It caused considerable wind and flood damage in Northland.

6.11 <u>February 1961</u>

This cyclone developed southwest of the Santa Cruz Is on 3 February, moved southwestward, then swung to the southeast to pass over southern New Caledonia and just to the south of the Loyalty Is on 7 February. The eye of the storm passed over Noumea about 1330 hours.

Several stations in New Caledonia reported force 9 or force 10 during the day, and there was one report (unconfirmed) of a force 12 wind from Uvea in the Loyalty Is.

In Noumea damage was confined to a number of uprooted trees and a few lost roofs but in the countryside there were substantial losses of food crops. The Nickel Company lost about 2000 sheets of iron and fibro-cement. The greatest destruction appears to have occurred on Mare I. where the coffee plantations were severely damaged. Five fishermen from Mare I were caught in a small boat and managed to cling to a speck of coral for nearly six days before they were rescued.

6.34 January 1964: Bertha

Although Bertha was only about 100 km from the northern tip of New Caledonia on 31 January damaging winds were not experienced there. However, heavy rain fell in the north and on the east coast, bringing on this occasion welcome relief from a prolonged drought. A ship reported hurricane force winds and a pressure of 977 mb at 16°S, 159.5°E early on 30 January.

6.38 April 1964: Henrietta

This storm which passed through Santo on 31 March is not included in the New Caledonia list because it passed rather far to the north of the country. Nevertheless it brought much needed rain to most of New Caledonia, and beaches were battered for several days by high winds and seas as Henrietta swung southeastward after passing to the north of New Caledonia. Norfolk I. received a battering on the night of 6 April.

6.60 January 1968: Brenda

Brenda developed southwest of the Santa Cruz Islands on 14 January, moved southwestward and recurved to the southeast about 17°S. On the 19th the storm moved right down the east coast of New Caledonia. Some native huts and older houses were wrecked and roofing iron was blown away. Telephone communication with the interior was interrupted for several days. Coconut, banana and coffee plantations were badly damaged. The losses sustained by the agricultural sector of the economy were put at over $500,000.

6.65 April 1968: Gisele

Gisele was not a noteworthy storm during its tropical existence but became extremely violent after leaving the tropics. In moving southsoutheast close to the east coast of New Zealand it became for many parts of the country the worst storm on record. Wellington experienced full hurricane force winds for several hours on the morning of 10 April and will never forget the day the 9000 ton inter-island steamer "Wahine" foundered in the harbour entrance with the loss of 57 lives.

6.68 February 1969: Colleen

Colleen developed in the vicinity of the Solomon Islands during the period 27 to 29 January and moved southeastward during the next few days. On 2 February it passed over Uvea in the Loyalty Islands and very close to Noumea at about 0400 hours. The wind at Noumea rose to force 10 (50 to 55 kt) with gusts to 85 kt and the pressure minimum was 962 mb. In Noumea roofs were torn off houses, roads were blocked by landslides, and water and electricity supplies were cut. Agricultural losses were particularly heavy in the north of the Territory and on Uvea. The total was estimated at nearly $750,000. Rain was very heavy in two small areas: over 500 mm northwest of Hienghene and up to 700 mm north of Noumea.

6.70 February 1969: Irene

Irene developed northwest of Fiji on 17 February and moved WSW through the New Hebrides, between Efate and Erromanga, then close to the northern tip of New Caledonia where force 10 winds were reported. The strong wind belt was very narrow but torrential rain led to flooding throughout New Caledonia.

NEW HEBRIDES

(i) Some notable storms 1900-1939:

1903	March
1907	April
1910	March (Tanna only)
1916	January
1922	February
1928	February
1932	February
	April
1933	April
1936	January

(ii) Tropical storms or hurricanes 1940-1969

1940 8 Feb	4.02*	Severe (restricted area). Southwestward through central New Hebrides
18-19 Feb	4.03*	Severe (restricted area). Southwestward over central New Hebrides. Also New Caledonia.
1941 3 Feb	4.08	Minor (probably). Southwestward through the Banks Islands.
1942 4 Mar	4.18	Unknown. Southwestward over southern New Hebrides. Also New Caledonia.

1944 4 Feb	4.29	Unknown. Very rapidly southeastward through central New Hebrides.
1947 13 Jan	4.43*	Minor. Southwestward towards the New Hebrides but turned southward just east of the southern islands.
1948 24-25 Jan	4.48*	Moderate. Southwestward through northern New Hebrides. Also New Caledonia.
1949 19-20 Jan	4.54	Minor. Southwestward towards the New Hebrides but recurved to the southeast east of the group. Probably not closer than 100 km to any island of the group.
25 Jan	4.55	Minor. Southwestward through central New Hebrides. Short life. No reports of winds in excess of gale force.
1951 24-25 Dec	5.12*	Severe. Southwestward through central New Hebrides.
1954 15 Feb	5.22	Minor. Westsouthwest through Banks Islands. Gales in Santo; Port Patteson reported pressure of 983 mb.
1955 3 Jan	5.24	Minor (probably). Eastsoutheast through the Banks Islands. Also Fiji.
2 Mar	5.27*	Minor to moderate. Westsouthwest through southern New Hebrides. Also New Caledonia.
1956 29 Feb	5.36	Minor (probably). Westsouthwest passing just to the south of the New Hebrides. Also Fiji and New Caledonia.
1959 29 Dec	6.01*	Severe. Eastward near Vila. Also Solomon Is and Fiji.
1960 1 Jan	6.02*	Minor. Eastward through central New Hebrides.
1963 16 Jan	6.25	Minor. Eastward through southern part of group in developing stage. No significant damage.

1963		
3-4 Mar	6.28	Minor. Southeastward between New Hebrides and Loyalty Islands. Passed not far to the south of Aneityum. No damage reported.
18-19 Nov	6.32*	Moderate. Southwestward towards New Hebrides but recurved to the southeast east of the group.
1964		
21 Feb	6.35*	Minor. Southwestward through northern New Hebrides. Also New Caledonia.
31 Mar	6.38*	Moderate to severe. Southwestward through northern New Hebrides.
1967		
1-5 Feb	6.52	Minor. Westward through northern New Hebrides; hovered for 36 hours before moving southeastward to pass close to Aneityum.
1968		
4 Mar	6.63	Minor. Southeastward to south of the group, close to Aneityum which, along with Tanna, sustained some damage.
14 Dec	6.66*	Moderate. Southeastward (rather erratic) through central New Hebrides. Also Solomon Islands.
1969		
18 Feb	6.70	Minor. Westsouthwest through southern New Hebrides. Also New Caledonia.

NOTES

4.02/ 4.03 February 1940

Within the space of 12 days two hurricanes swept through the centre of the New Hebrides. Both came from the north-east having developed to the west of the Ellice Islands. The belt of destructive hurricane force winds appears to have been very narrow in both cases. On 8 February several small islands just north of Efate, including Mataso, Nguna and Lelepa, bore the brunt of the storm. As many as 10 Mission churches and many island houses were destroyed. All citrus and breadfruit trees on these islands and a large proportion of the coconut trees were uprooted.

The second hurricane went through the Group about 50 km further north, this time devastating the islands of Tongoa and Emai just south of Epi. A trader on Tongoa described the storm vividly. The experience was so shattering that he thought it must be the worst in Pacific history. It was certainly the worst in that particular area since 1932.

The trader's store was shattered in the first onslaught, and then, after the passage of the eye of the storm in the early hours of the 19th, the wind returned with even greater violence and his home collapsed. His barometer indicated a fall of about 40 mb in nine hours (the actual readings quoted are improbable). Devastation on Tongoa was almost complete.

4.43 January 1947

This cyclone was first detected northwest of Rotuma on 11 January. It headed towards the New Hebrides but fortunately began to recurve and missed the northern islands but passed within 50 km of Tanna and Aneityum, now moving southsoutheast.

Strong winds and heavy rain were all that the southern New Hebrides had to endure, and no significant damage has been reported. But, about 150 km southsoutheast of Aneityum, the 10,000 ton S.S. "Waitomo" came very close to the centre of the hurricane. Early on the 14th, just after midnight, the ship's log recorded the wind as SSE force 10 to 11 - torrential rain, visibility 200 m, pressure 966 mb, vessel shipping heavy spray, and rolling and pitching violently. The tarpaulin on No. 5 hatch was ripped, drums and cases on deck and in the holds broke loose, the two lifeboats on the starboard side were badly damaged, and two crew members needed medical attention in Lautoka for minor injuries received during the buffeting.

4.48 January 1948

Like the hurricanes of February 1940 this cyclone began in the neighbourhood of the Ellice Islands and moved southwestward. This one, however, went through the New Hebrides somewhat further north. The chief target was the island of Obe, east of Santo, which was struck on the afternoon of 24 January. The storm also did considerable damage in Santo itself, where many of the old army huts left by the U.S. Army were damaged, and in Malekula. A considerable number of mango and other trees were blown down.

5.12 December 1951

The first cyclone of this season developed west of the Ellice Is about 19 December and moved rather slowly southwest. On the 25th it passed through the New Hebrides between Luganville and Vila. Although the distance between them is only about 280 km neither place experienced worse than gale force winds. But on Epi and Ambrim the hurricane destroyed all villages and plantations in its path. Malekula also suffered. More than 100 people were killed, half of them in a landslide on Epi. Six small vessels were sunk and three others disappeared. At least 15,000 coconut trees on Epi and Malekula were destroyed and the loss to the copra trade was put at over $150,000. Damage to Mission

and plantation buildings on Ambrim was estimated as $100,000. A major cause of general damage was flooding resulting from streams being blocked by fallen trees.

5.27 March 1955

Towards the end of February a tropical cyclone developed northwest of Rotuma. Initially it moved to the southsoutheast but soon turned westward and later to the westsouthwest. It passed through the southern islands of the New Hebrides on 2 March. Force 11 winds were reported and, at one station, pressure below 975 mb. The storm continued over New Caledonia and across the Coral Sea to the Queensland coast which it reached on 7 March.

There is little information concerning damage in the New Hebrides but, at Vila where the wind did not reach hurricane force, there was considerable damage to coconut plantations and some rainwater damage. A garage at the meteorological station was destroyed and an observation tower was rendered unsafe.

6.01 December 1959

The cyclone which had been moving slowly southsoutheast towards New Caledonia suddenly changed direction to eastnortheast, accelerated, and in the early hours of 29 December passed just to the south of Vila where the barometer fell to 975 mb and NW to W winds of hurricane force blew for two or three hours. Damage was reported from most of the southern islands of the New Hebrides, from Epi to Aneityum, but no lives were lost. The southern part of Efate was the most severely affected, and, in Vila, the cost of repairing and replacing Condominium property, including schools and a hospital, was expected to be about $A250,000, while the total was thought to be of the order of $A1,000,000. Copra production in the southern islands of the group was expected to be halved in 1960. (In fact, 24,000 tonnes of copra were exported from the Condominium in 1960, compared with 35,000 tonnes in 1959.)

6.02 January 1960

A second hurricane passed through the New Hebrides on the evening of 1 January 1960. It came from the Coral Sea, moving eastward to the north of New Caledonia, passed to the north of Efate, and then moved to the southeast well to the south of Fiji. Although the wind at Vila was estimated as force 10 for a time it did not, here or elsewhere in the islands, cause serious additional damage.

6.32 November 1963

Like No. 4.43 (January 1947) this storm moved towards the northern islands from the northeast but recurved gradually to the southeastward keeping just clear of the Group. Nevertheless, it was close enough through 18 and 19 November to cause a considerable amount of damage on the

eastern side of Pentecost, the south of Malekula, Epi, Efate and Tanna. The little island of Tongoa was once again one of the storm's chief victims: one village on the eastern side was completely destroyed and less than half of the houses in the others were left standing.

Forari, the site of a manganese mine on the eastern side of Efate, also suffered heavily with damage to wharves and tug boats, by wave action, estimated at $150,000.

The usual damage to coconut trees was expected to reduce copra production significantly for several years.

6.35 February 1964: Edith

Edith moved southwestward through northern New Hebrides on 21 February with gales and torrential rain. The storm then moved southward to the Loyalty Islands where, again, nothing worse than gales and heavy rain were reported. From the Loyalties Edith moved rapidly eastsoutheast and filled southeast of Tonga. A ship near the centre on 24 February reported force 10 winds and a pressure of 988 mb.

6.38 March-April 1964: Henrietta

Moving southwestward through the northern islands of the New Hebrides on 31 March Henrietta caused extensive damage to houses, schools and other buildings in the Banks Islands and in Santo which was said to have had its worst spell of bad weather for several years. Some small vessels loaded with copra from the outer islands had to jettison their cargoes.

6.66 December 1968: Becky

Becky developed north of the Solomons and moved over the islands on a rather erratic course on the 11th and 12th December. It then moved southeast passing through the New Hebrides on the 14th, between Malekula and Efate. Considerable damage resulted particularly in Lamap (Malekula) and in the Shepherd Islands, south of Epi.

From the New Hebrides Becky moved very rapidly southeastward, at more than 35 kt, and passed very close to the ship "Waimate" which reported an estimated wind speed of 90 kt and pressure of 971 mb at 1200 GMT 14 December.

FIJI

(i) Some notable storms 1900-1939:

1901 March
1904 January
1910 March
1912 January
1919 February/March (2)
1929 December
1931 February/March (2)

(ii) Tropical storms or hurricanes 1939-1969

1939		
28 Dec	4.01*	Minor. Southeastward over western Viti Levu.
1941		
20 Feb	4.09*	Severe. Westsouthwest over eastern Viti Levu. Also N. Tonga and Samoa.
27 Apr	4.12	Moderate. Southsoutheast, east of Vanua Levu and through Lau Group. Said to have been more intense, over a very limited area, than the major February storm (4.09).
26 Dec	4.14	Minor. Southeastward between Vanua Levu and Viti Levu, southern Lau. Slight damage in the Savusavu district and Taveuni. Also Southern Tonga.
1943		
1 Jan	4.20*	Moderate. Southsoutheast over eastern Vanua Levu and Lau Group.
17 Mar	4.24	Minor. Southwestward and through Lau Group.
1944		
8-10 Jan	4.26	Minor. Erratic, passing to west and south of Viti Levu and through southern Lau. No damage reported. Also Southern Tonga.
18-19 Mar	4.31	Minor. Westsouthwest, north and west of the Group. Gales but no damage reported.
1948		
3-4 Feb	4.49*	Moderate. Southwestward north of the Group; recurved to southeast west of Viti Levu.
7-8 Dec	4.52*	Moderate to severe. Southsoutheast east of Vanua Levu and through Lau Group. Also Southern Tonga and Niue.
1950		
2 Feb	5.03	Minor. Southwestward through northern Lau Group. Gales but no significant damage. Also Samoa and Northern Tonga.
25-27 Feb	5.04*	Moderate. Westward between Vanua Levu and Viti Levu, then southward.
30 Mar	5.07*	Moderate. Southward over Viti Levu.
1952		
24 Jan	5.13	Minor. Southeastward over Vanua Levu and Lau Group. Gales but no significant damage reported. Also Southern Tonga
28 Jan	5.14*	Severe. Southeastward over Viti Levu, near Suva.

1954		
15 Jan	5.20*	Minor. Southwestward to the north and west of Fiji. Also Northern Tonga.
1955		
5-6 Jan	5.24*	Moderate. (Yasawas mainly). Southsouthwest, west of Fiji. Also New Hebrides.
27-28 Jan	5.26	Minor. Eastward south of Viti Levu. Appears to have lost intensity; strong winds only in southern Fiji. Also Southern Tonga.
1956		
30-31 Jan	5.33*	Minor. Southward west of Fiji.
16 Feb	5.35	Minor. North of Fiji in developing stage, moving eastsoutheast. Also Southern Tonga and Niue.
25 Feb	5.36	Minor. Eastward towards Viti Levu but turned a away to the southwest. Heavy rain and flooding. Also New Hebrides and New Caledonia.
6 Mar	5.37	Minor to moderate. Eastnortheast towards Viti Levu but turned away to the south. Slight wind damage but further serious flooding.
1957		
26 Feb	5.46	Minor. Southwestward through Koro Sea. Gales in eastern Vanua Levu and Lau Group. No significant damage reported. Also other Islands (Wallis and Futuna).
1958		
7 Jan	5.49*	Moderate to severe. Southward through Lau Group. Also other islands (Ellice and Wallis and Futuna).
9 Apr	5.53	Minor. Southeastward over Yasawas where force 9 to 10 winds, but appeared to fill over Fiji.
2-3 Dec	5.55*	Severe. Southeastward over central Viti Levu.
1959		
30 Dec	6.01*	Moderate. Eastsoutheast, south of Fiji. Also New Hebrides.
1964		
22-23 Nov	6.39*	Minor. Southeastward east of Vanua Levu and through northern Lau. Also Southern Tonga.
6-7 Dec	6.40*	Minor. Southeastward over Rotuma, east of Vanua Levu and through northern Lau.
21 Dec	6.41*	Moderate to severe. Southward just west of Viti Levu.

1965		
6-9 Feb	6.44*	Severe. Southwestward north of Vanua Levu and then southward west of Viti Levu. Also other Islands (Wallis and Futuna).
1966		
26-27 Jan	6.45	Minor. North of Fiji in developing stage. Also Southern Cook Islands, Samoa and other Islands (Wallis and Futuna).
4-5 Dec	6.50	Minor. Southeastward over Viti Levu and southern Lau. Appeared to be losing intensity. Relatively slight damage to banana trees and bures.
1967		
9-10 Apr	6.56*	Severe (in restricted area). Southward over Vanua Levu and just east of Viti Levu.
1969		
25-26 Feb	6.71	Minor. North of Fiji in developing stage; moved southeastward. No damage reported. Also Southern Tonga.

Notes

4.01 December 1939

The first tropical storm of the period under survey developed in the vicinity of the Santa Cruz Islands on or before 25 December, and moved southeast to pass over the western portion of Viti Levu in the early hours of 28 December. Only minor damage was reported. At Suva, on the fringe of the storm, the lowest pressure was 992 mb at about 0400 hours, and the maximum gust speed recorded shortly before 0400 hours was barely 60 kt.

4.09 February 1941

This hurricane is classed as one of the worst to strike Fiji in its recorded history. This distinction is due in part to the fact that it passed almost directly over the capital city, Suva, although there is no doubt that it was a severe storm. It had its beginnings in the middle of February near Samoa and, on the 18th, was near Keppel Island where the pressure fell to 984 mb but the wind strength did not exceed force 7. From Northern Tonga the cyclone moved westsouthwest at a speed of just over 10 kt to pass south of Levuka and a very short distance north of Suva during the late morning and early afternoon of the 20th. The lowest pressure of 965 mb occurred at Suva shortly after 1 p.m. An anemometer at Suva Point recorded full hurricane force wind for at least an hour from about 1145. The limit of the anemometer's range was 97 kt and one or two gusts reached this mark. The actual peak gust speed was probably not over 100 kt.

The scene in Suva after the storm had passed was typical. Fallen trees festooned with telephone and power lines littered the streets and sheets of roofing iron lay everywhere. However, although many buildings, houses and garages were damaged, only a few were completely demolished. In the harbour, and also at Taveuni, Levuka and other anchorages in the area, many small craft were lost or heavily damaged. Three ocean-going vessels at Suva dragged their anchors and ran aground but were later floated off without serious damage.

The cyclone's path took it through the principal banana producing areas of the islands and many of the plantations suffered heavy losses. Trees bearing fruit were smashed and young trees coming on destroyed. Flooding, particularly of the Navua River, added to the destruction. And on the Tailevu coast the storm surge caused much damage.

At least six people died: drowned, electrocuted or struck by a falling tree or flying debris.

4.20 December 1942 - January 1943

Like the storm of December 1939 (4.01) this hurricane developed near the Santa Cruz Islands and moved southeast over Fiji, but this time over the eastern extremities of Vanua Levu and the Lau Group. The path of destruction lay through Udu Point, Rabi, Qamea, Laucala I., the north end of Taveuni and through the Lau Group to Ogea. Coconut trees were brought down in their thousands and it was expected that it would take three years for many of the plantations to recover. The Labasa and Savusavu districts escaped serious wind damage but experienced floods in places.

4.49 February 1948

This hurricane was first detected south of Niulakita on 31 January. It moved southwest to a position 150 km or more west of Lautoka on 3 February and then recurved to the southeast to pass about 100 km south of Kadavu on 4 February.

There were gales and torrential rain in Viti Levu where all rivers were in high flood. Fruit and cane crops suffered moderate damage.

The auxiliary ketch "Tiare Tapore" on a voyage from Penrhyn Island to Suva spent several hazardous days in the Koro Sea and in the Kadavu area buffeted by the hurricane's winds and sea. As the ketch approached Suva on 2 February visibility was very poor in heavy rain and the Captain wisely decided to stand off from the land. Unfortunately as the hurricane swung round Viti Levu wind and sea drove the vessel into its path south of Kadavu. A note in the log reads, "It seems a miracle that a ship can live in a wind and sea like this." At 1600 hours that day, the 4th, the ship's barometer (unchecked) read 959 mb. The vessel did survive and made Suva two days later. She had lost a forestaysail and a mainsail, and two of her crew were injured when the

ship was hit by a particularly heavy sea.

4.52 December 1948

A hurricane was detected between Banks Islands and Rotuma on 5 December and passed close to the latter on 6 December when the wind reached force 9 for several hours, and the pressure fell to about 970 mb. Turning then to the southeast it passed close to the eastern extremity of Vanua Levu and through the Lau Group on the 7th. From the 8th to the 10th it hovered west of Tonga and then moved rapidly eastward near Haapai and south of Niue.

Rotuma. The island's foodcrops and coconut trees suffered severely; and the Government station and other buildings were badly damaged.

Fiji. It was estimated that 40 to 75 per cent of the 1949 copra crop would be lost in eastern Vanua Levu, Taveuni, Rabi and the Lau islands. The storm devastated food crops and badly damaged many buildings. An eye witness on Naitauba described a scene of desolation the next morning, "...Heavy wood and iron copra-drying trays had been hurled against other buildings, garage doors wrenched off, all buildings flooded, native houses obliterated and ruin everywhere." She claimed it was the worst storm on that particular island since 1912.

5.04 February 1950

About 20 February a tropical cyclone developed northwest of Palmerston I and moved westward, slowly at first and then more rapidly as it intensified. On 25 February it passed through the Lau Group and between Vanua Levu and Viti Levu. On the 26th it turned sharply southward, passed to the west of Viti Levu and then southsoutheast towards the Kermadec Islands.

Although not a very severe storm - the maximum wind gust at Nadi was 70kt - it brought a number of trees down and damaged Fijian houses. Many small, local vessels were in trouble and one launch with five people on board was lost. As the storm approached its turning point near the Yasawa Is its rate of movement slowed down and the prolonged heavy rain resulted in floods in Viti Levu and the Labasa district.

5.07 March 1950

The storm developed east of the Santa Cruz Islands on 28 March and moved rapidly southsoutheast over western Viti Levu and just west of Kadavu on the 30th. The highest sustained wind speed recorded at Nadi Airport was 50 knots for a short period about 0430 hours, and the peak gust was 84 knots. The lowest pressure was 973 mb. Damage was relatively light: some airport buildings and hotels in the vicinity suffered damage to roofs and windows. A number of native bures were destroyed; tops of coconut trees were blown off; and some sugar cane was lost.

Later in the day force 9 winds were reported from Kadavu, where there was some damage. At Vunisea the Police Station was almost flattened.

5.14 January 1952

A tropical cyclone developed south of the Solomon Is on or before 23 January 1952, moved eastward and gradually turned to the southeast to pass over the Yasawa Is and Viti Levu on the 28th. Laucala Bay, Suva, was in the eye of the hurricane about midday. About half an hour before, the anemometer recorded a sustained wind of 70 knots and a peak gust of 115 knots when the anemometer was blown down. The barometric pressure minimum at Laucala Bay was 958 mb. At least 23 people lost their lives and over 800 were treated for injuries in the Suva Hospital. Damage to property and crops was extensive and severe. The destruction at Tavua - 172 wooden and iron dwellings destroyed or badly damaged and over 700 bures destroyed - was typical of that experienced in many villages in Viti Levu. The Colonial Sugar Refinery's mill at Penang was badly smashed and the island's banana crop was wiped out. One unofficial estimate of the total of the losses sustained was over $2,000,000.

This hurricane was described in the Fiji Times as "the worst disaster of its kind in Fiji's modern history". It certainly ranks among the five most destructive Fijian hurricanes of this century. The other four occurred in 1910, 1931, 1941, and 1972.

5.20 January 1954

The hurricane passed close to the Yasawa Is on 15 January. Yasawa-i-rara reported a force 10 wind for a time. A number of fishermen in the area were reported missing. Otherwise the hurricane, according to one report, caused only "normal storm damage", most of it from flooding in Viti Levu.

5.24 January 1955

This storm developed south of the Solomon Is and moved eastsoutheast to the north of the New Hebrides on 3 January. North of the Yasawas it became almost stationary for more than 12 hours on 6 January. It then turned on to a southwest course and moved away from Fiji. Hurricane force winds were reported from Yasawa-i-rara and force 9 winds from the Lautoka area. Damage was, relatively, on a small scale. The ship "Waitomo" reported force 12 winds and 12-metre waves about 250 km southwest of Viti Levu on 7 January.

The storm continued to move slowly southwest and then south, filling northeast of Norfolk I. about 13 January without further landfall.

5.33 January 1956

The storm developed west of Rotuma on 29 January and

moved initially southsoutheast towards Fiji but turned off to the southwest 80 to 160 km west of the Yasawas. Early on the 31st the wind reached gale force in northwest Viti Levu and force 9 in the Yasawas. However, heavy rain and floods blocked roads and disrupted communication in the west, particularly in the Ba district. Two boys were drowned.

Late on 2 February the cyclone passed close to Norfolk I. where the pressure fell to 980 mb.

5.49 January 1958

A developing tropical cyclone moved southeast through the Ellice Islands on 1 and 2 January and, very slowly, towards Wallis I. On the morning of 5 January near-hurricane force winds were reported from Wallis I. where the storm caused considerable damage to trees and houses. The hurricane then turned to the southwest and passed through the Lau Group on 7 January leaving a trail of destruction through the northern and central islands of the Group. Eastern Vanua Levu and Taveuni were less seriously affected, but all telephone lines were blown down in Taveuni, Buca Bay and along the Savusavu coast; the Taveuni coastal road and a new sea wall at Waiyevo were badly damaged. The peak of the storm occurred in the northern Lau Islands in the early hours of the morning. At midday the hurricane was near Matuku where, as in the islands to the north, many houses, and coconut and breadfruit trees were blown down. The wind was reported as full hurricane force at Matuku at this time, and a number of ships near the cyclone's track reported force 12 winds. The "Armagh", hove to some 80 km east of the centre, reported waves up to 22 metres.

It was expected that the islands most affected would be without local food supplies for at least six months. It was probably Fiji's worst storm since the hurricane of January 1952.

5.55 December 1958 : Aurelia

Aurelia developed in the vicinity of the Ellice Is during the last days of November and then moved south over Rotuma which reported force 10 winds and pressures of 997 mb at 1100 hours 1 December. The storm continued to move southward and began to change its course to southsoutheast. At 0900 on the 2nd it was just east of the northern end of the Yasawa Group and, by midday, it had crossed the northern coast of Viti Levu near Rakiraki. The eye of the storm passed over Suva between 1500 and 1600 hours. At Laucala Bay the wind reached a sustained speed of 55 kt about 1400 hours with the highest gust recorded being 84 kt. Aurelia, now moving southeast, passed during the night to the west of Matuku where force 12 winds were reported. At Ono-i-Lau on the morning of 3 December the wind reached hurricane force as the storm passed to the west and south. The change in direction of movement continued until, south of Tonga, Aurelia was moving eastward. South of Niue it turned to the northeast, on 5 December, and began to fill.

Although not nearly as destructive as the 1952 hurricane Aurelia caused a considerable amount of damage, particularly to the banana crops in the Nausori area. Houses were damaged in the Yasawas, Ra and Beqa, and communications were disrupted all over Viti Levu. Heavy rain, particularly on the north coast of Viti Levu, led to flooding. The sugar mill at Penang was flooded and water rose to 60-100 cm in a number of houses in the Nausori area.

6.01 December 1959

A cyclone which had been moving slowly southsoutheast towards New Caledonia suddenly moved eastnortheast, passed through the New Hebrides on the 29th (see page 69) and then moved rapidly eastward and later southeastward to pass to the south of Fiji and Tonga on 30 December. The only report of hurricane force winds came from Ono-i-lau where the pressure fell to about 984 mb. However, high seas coupled with high tides caused some damage along the south coast of Viti Levu and inundated a number of villages in Kadavu and in islands of the southern Lau Group.

In the early hours of 30 December what was apparently a tornado swept through the village of Yako, about 25 km southwest of Nadi Airport. The swathe of destruction was typical of the phenomenon. One man was killed and several others injured.

The liner "Monterey" ran into the storm approaching Kadavu on a voyage from Auckland. With engines half-speed ahead she could make no headway against wind and sea, and was hove to for four hours.

6.39 November 1964

This tropical cyclone was first detected near Rotuma on 19 November and its position was fixed by an aircraft of the R.N.Z.A.F. on 20 November. The storm travelled southeastward passing close to the eastern tip of Vanua Levu, without serious effects, on 22 November and east of the Lau Group next day. West of Nukualofa the cyclone appeared to execute a loop and then moved eastward between Tongatabu and Haapai. Finally, south of Niue, it turned away to the southeast. Minor damage to coconut trees and Fijian houses was reported from Katafaga and Oneata Islands in the Lau Group.

6.40 December 1964

Rotuma. A small tropical cyclone followed a somewhat similar track to 6.39 but apparently filled before reaching Tonga. This storm with a very narrow ring of hurricane force winds passed very close to Rotuma, just to the east, on 5 December causing serious damage. Scores of houses and other buildings, including some concrete and wooden buildings with iron roofs, were heavily damaged. Over

1000 coconut trees were uprooted, and fruit trees and other crops were severely battered. The storm reached its peak between 1400 and 1500 hours when the wind was reported to be force 11. The lowest pressure was 989 mb.

Fiji. A few fruit trees were blown down in the Udu Point area and some ccconut trees and seedling palms were uprooted on Katafaga I. in the Lau Group.

6.41 December 1964

The third tropical cyclone of the season also developed north of Rotuma about 18 December. Its centre was located by a reconnaissance aircraft about 130 km southwest of Rotuma on 20 December. It moved southsouthwest at first but gradually turned on to a southsoutheast track as it passed about 130 km to the west of Fiji. Yasawa-i-rara reported the wind as force 11 early on the morning of 21 December, and a cruise ship near Vuda Point recorded force 12. At Nadi the sustained wind speed reached 45 kt with gusts to 65 and one to 83. The area of gale force winds was quite extensive east of the track; at Vunikodi, nearly 450 km from the centre of the cyclone, crops in the village were badly damaged and guttering and a sheet of roofing iron were blown off one building. Fruit trees also suffered in the Suva area and falling branches broke telephone and power lines. Yasawa-i-rara reported moderate damage to crops and fruit trees. Although wind damage in western Viti Levu was not severe an uprooted tree fell across a house in a village near Nadi and killed two children. Torrential rain brought rivers up and roads and villages were flooded, communications disrupted, and cash and food crops damaged. The lowest pressure reported, by a ship north of Fiji, was 985 mb.

6.44 February 1965

The hurricane of February 1965 was probably the worst to afflict Fiji since the 1952 hurricane. Wind damage was not severe except in the Yasawa Group, Taveuni and the northwest of Vanua Levu, but the very slow movement of the storm in the vicinity of Fiji meant prolonged heavy rain and widespread floods which in some areas eclipsed the record floods of March of the previous year.

The cyclone developed near Samoa and moved westward as it intensified. Gales were reported from Wallis and Futuna Islands as it passed close by and a ship near Futuna reported hurricane force winds early on 6 February (Fiji time). At this stage the storm was moving southwest and, later on the 6th, was centred north of Udu Point. From there it moved very slowly towards the Yasawas during the next 48 hours. It then turned southward and remained close to the west coast of Viti Levu for another 24 hours before accelerating away from Fiji on the 9th.

Hurricane or near-hurricane force winds blew in the

Yasawas for nearly 40 hours. Thousands of coconut trees were blown down or severely damaged, breadfruit trees destroyed, houses flattened and food crops ruined. Driving sea spray blackened and killed vegetation not stripped away by the wind. It was estimated that copra production for the year would be halved, a loss of some $75,000, and that the coconut plantations would take 5 or more years to recover fully. The loss of copra production from the much larger plantations of Taveuni was put at over $500,000.

On the main islands very severe flooding caused heavy stock and crop losses and claimed the lives of 11 people. Another, a young girl, was killed by a landslide in the Nausori Highlands.

6.56 April 1967

On 7 April a cyclone developed northeast of Rotuma and moved south to cross Vanua Levu on 9 April. It continued southward to the east of Suva next morning and then began to swing to the southeast passing close to Matuku and to the west of Ono-i-lau on the 11th. The pressure fell below 980 mb at Matuku and force 11 winds were reported from Ono-i-lau. The belt of hurricane or near-hurricane force winds appears to have been not more than 30 km wide. Houses and food crops in this belt suffered considerable damage but the total amount was not too great.

SOUTHERN TONGA

(i) Some notable storms 1900-1939

1912	January
1913	February
1915	March
1932	March
1935	March
1937	February

(ii) Tropical storms or hurricanes 1940-1969

1941			
26-27	Dec	4.14	Minor. Southeastward to the south of Tongatapu - about 100 km distant. No winds in excess of gale force reported. Also Fiji.
1944			
10-11	Jan	4.26	Minor. Southeastward to the south of Tongatapu - about 100 km distant. No winds in excess of gale force reported, and no damage. Also Fiji.
1945			
17-18	Feb	4.34	Southeastward between Vavau and Haapai Groups but appears to have caused little or no damage.

1947 24 Feb	4.45	Minor. Rapidly eastward just to the south of Tongatapu. No winds in excess of gale force reported and no reports of significant damage.
1948 11 Dec	4.52	Minor. After lying almost stationary for three days east of the Lau Is the cyclone moved rapidly eastward between the Vavau and Haapai Groups. It appeared to have lost intensity at this stage. Also Fiji and Niue.
1949 20 Dec	5.02*	Moderate. Southsoutheast between Haapai and Tongatapu.
1952 25 Jan	5.13	Minor. Rapidly southeastward between Haapai and Tongatapu. No wind in excess of force 8 reported, but pressure fell to 985 mb at Nukualofa at 1600 hours on the 25th. Also Fiji.
1955 28-29 Jan	5.26	Minor. Rapidly southeastward just north of Tongatapu. Strong winds for a brief period but no damage reported. Also Fiji.
1956 17-18 Feb	5.35	Minor. Southeastward, north of Vavau. Gales for a time but no significant damage reported. Also Fiji and Niue.
1957 7-8 Dec	5.48*	Moderate. Southeastward just to the south of Vavau. Also other Islands (Wallis I.)
1960 19-20 Mar	6.06*	Moderate. Southwestward, to the north of Vavau.
1961 16-17 Mar	6.14*	Severe. Southward close to Vavau and Haapai Groups and to the east of Tongatapu. Also Samoa and Northern Tonga.
1963 12-14 Mar	6.29*	Moderate (severe in Nomuka Group). Southeastward between Haapai and Tongatapu. Also Cook Islands and Northern Tonga.
1964 24-25 Nov	6.39*	Moderate. Almost stationary west of Tongatapu for 24 hours then rapidly eastward between Haapai and Tongatapu. Also Fiji.

1969 14 Jan	6.67	Minor. Southeastward, north of Vavau. Gales reported, and Vavau registered a pressure of 982 mb at 1900 hours on the 14th. Also other Islands (Wallis I.) and Northern Tonga.
27 Feb	6.71	Minor. Rapidly southeastward between Haapai and Tongatapu. Pressure at Nukualofa 987 mb at 0700 hours on the 27th, and gales were reported from the southern islands. Also Fiji.

Notes

5.02 December 1949

This rather weak storm developed north of Fiji on 17 December, moved southsoutheast to the east of the Lau Group, and to the north and east of Tongatapu. It then moved rapidly southeast. At Nukualofa, the only reporting station close to the cyclone's track, the wind did not rise above gale force. Heavy rain, however, fell in Southern Tonga: Haapai recorded 163 mm in 24 hours, Vavau 82 mm in 6 hours, and Nukualofa 167 mm in 24 hours. Although not a severe storm about 20 percent of the banana crop was heavily damaged, there was minor damage to coconut trees, and some telephone lines were brought down. A launch belonging to a mission station on Vavau was destroyed.

When the cyclone was near 28°S a ship some 50 km from the centre reported a force 10 wind and a pressure of 974 mb.

5.48 December 1957

A tropical cyclone which developed in the vicinity of the Tokelau Is on 4 December moved southwest to the west of the northern islands of Tonga and then turned to the southeast. It passed close to Vavau late on 7 December. Although there was no report of wind in excess of force 8 banana crops were flattened and many breadfruit trees uprooted in Vavau.

6.06 March 1960

The storm was detected south of Samoa on 17 March. It moved southward and later southwestward to pass to the east of Keppel and to the west of Vavau. The strongest wind reported was force 11 at Vavau at 0300 hours on the 19th. A new Tongan vessel, "Teiko", with 22 people on board was lost in the area about this time, presumably but not certainly through running into the hurricane.

6.14 March 1961

The tropical cyclone was first detected north of Samoa and on 14 March was located west of Apia by a reconnaissance aircraft of the R.N.Z.A.F. The storm then moved southsouthwest, about 100 km east of Keppel, and passed over

Vavau late on the morning of 16 March. The last observation at Vavau just before the meteorological station was wrecked gave the wind as E force 11 and the pressure 966 mb. The hurricane was centred some 15 to 25 km east of Ha'apai at 0300 hours on the 17th and then turned away to the southeast. The wind at the meteorological station reached hurricane force about 2300 hours on the 16th but then decreased gradually although the pressure continued to fall to a minimum of about 950 mb at 0400 hours.

The hurricane, which was by far the most severe in Tonga in the period of this survey, left between 8000 and 9000 people homeless in the Vavau and Ha'apai Groups, with some fifty percent of houses and buildings demolished or badly damaged. Damage was estimated to be close to $500,000. The banana crops were completely wiped out and coconut trees were stripped or uprooted. A news item in September 1963 recorded the first shipments of copra from Tonga since the hurricane of 1961. Two people lost their lives in Neiafu (Vavau).

6.29 March 1963

This cyclone followed a rather unusual track. It developed west of the Southern Cook Islands on 4 March (Greenwich date) and moved towards the westnorthwest during the next three days. It passed close to Palmerston I. in the early hours of the 8th. Between 10 and 11 March, when positions southeast and southwest of American Samoa were fixed by reconnaissance aircraft, the storm changed course to the southwest and passed about 160 km southeast of Keppel. Early on 13 March the centre of the hurricane lay between the Haapai Group and the m.v. "Matua" some 130 km west of Haapai. The vessel was hove to in hurricane force winds and tremendous seas. The Captain, who said it was the worst storm he had encountered estimated that some waves were as high as 12 metres. The starboard wing of the bridge was wrecked and many other deck fittings were badly damaged. From about midday on 13 March the storm was nearly stationary for 12 hours and then headed eastsoutheast passing between Haapai and Tongatapu.

On the principal islands of the Haapai Group and Tongatapu damage was moderate but on the small islands south of Haapai nearly all buildings, including two churches, were blown down, and all plant life and crops were destroyed.

6.39 November 1964

See note on cyclone no. 6.39 under Fiji on page 79. Minor damage to coconut trees and houses was reported from the Haapai, Nomuka and Tongatapu Groups in Tonga. In Haapai 100 metres of a new 1.5 metre high concrete and rock breastwork was demolished by high seas. The strongest wind reported was force 10 at Nukualofa on 24 November.

NORTHERN TONGA

(i) Some notable storms 1900-1939:

1909	April
1930	December
1936	February

(ii) Tropical storms or hurricanes 1940-1969:

1941 18 Feb	4.09	Minor. See note on cyclone no. 4.09 under FIJI on page 73. Although a pressure of 984 mb was reported from Keppel I. the wind barely reached gale force. Also Samoa.
1944 30 Jan	4.28	Southeastward between Niuafoou and Keppel I. Both islands experienced gale force winds, force 9 at Niuafoou. Also Niue, the Southern Cook Islands, and other Islands (Wallis I.).
1946 16-17 Jan	4.37	Minor. Although this cyclone was traced by Hutchings from the Solomon Is eastward to the north of Fiji and Northern Tonga it remained a tropical depression until it turned southward towards Niue on 18 January. Also Niue.
1950 31 Jan-1 Feb	5.03	Westward about 100 km to the north of Keppel I. on 31 January and close to Niuafoou on 1 February. Strong winds (force 6) reported from Keppel; no information from Niuafoou. Also Fiji and Samoa.
1954 12 Jan	5.20	Westward about 50 km to the north of Niuafoou. No information available. Also Fiji.
1959 14 Feb	5.62	Minor. Southsoutheast to the east of Keppel I. At that stage it was still only a tropical depression and had little effect on Keppel I.
1960 17-18 Jan	6.03	Eastward north of Niuafoou on the night of 17 January and near Keppel I. the next morning. The latter reported a wind of force 10 and pressure 987 mb at 0700 hours. Also Niue.
1961 15 Mar	6.14	See note on cyclone no. 6.14 under SOUTHERN TONGA on page 82. Although there was a strong S wind at Keppel I. it did not reach gale force.

1963		
11 Mar	6.29*	Moderate. Westsouthwest about 100 km southeast of Keppel I. Also Southern Cook Islands and Southern Tonga.
1969		
13-14 Jan	6.67	Southward (erratic), close to Niuafoou during the night of the 13th. Also Southern Tonga and other Islands (Wallis I.).

Note

6.29 March 1963

The hurricane developed west of the Southern Cook Islands on 8 March (Greenwich date) and moved towards the westnorthwest during the next three days. Between 10 and 11 March when positions southeast and southwest of American Samoa were fixed by reconnaissance aircraft, the storm changed course to the southwest. At the time of the second reconnaissance, about 1300 hours (local time) on the 11th the centre was estimated to be about 100 km southeast of Keppel I. Some six hours later it was almost due south of the island and the wind there was W force 8. However as the storm moved away the wind at Keppel I. increased to force 9, and finally force 10 (from WNW) was reported for about four hours early on the morning of the 12th. Houses, the wharf and plant life suffered moderate damage.

SAMOA

(i) Some notable storms 1900-1939:

1903 February (mainly American Samoa)
1915 January (mainly American Samoa)
1926 January
1936 January
1939 January (exceptional rainfall)

(ii) Tropical storms or hurricanes 1940-1969

1941		
16 Feb	4.09	Minor. Strong westerly winds and heavy rain, lowest pressure at Apia 996 mb, but no damage reported. Also Northern Tonga and Fiji (see note on cyclone no. 4.09 under FIJI on page 73).
1 Mar	4.10*	Minor to moderate. Southsoutheast over Upolu. Also Niue and Southern Cook Islands.
25 Nov	4.13	Minor. Southsoutheast to the west of Upolu. The lowest pressure recorded at Apia was 991 mb but the wind did not exceed gale force and there were no reports of damage. Also Southern Cook Islands.

1946 25 Dec	4.41	Minor. Eastsoutheast between Western Samoa and Northern Tonga. The wind at Apia reached gale force for only about half an hour, with peak gust 46 kt and lowest pressure 998 mb, but over 45 mm of rain fell in one hour. Also Niue and other Islands (Wallis I.)
1950 30 Jan	5.03	Minor. Westward, passing to the south of the Group without any significant effect. Also Fiji and Northern Tonga.
31 Dec	5.08*	Minor to moderate. Developed north of Samoa and moved southsoutheast to pass to the east of Tutuila.
1957 4 Feb	5.43	Minor. Developed southeast of Samoa on the 3rd, moved northwestward over Western Samoa, then turned in a loop to pass southward to the east of Tutuila on the 5th. It appears to have been developing slowly during this period and strong winds were not reported from the Group. Also Niue.
1959 25 Feb	5.63*	Severe (Manu'a I.) Southward, close to Manu'a I. in American Samoa. Also Niue.
1961 13 Mar	6.14	Minor. Southward over Western Samoa. Gales caused losses of banana crops in some parts of Western Samoa. Also Northern and Southern Tonga. (See note on cyclone no. 6.14 under SOUTHERN TONGA on page 82.)
1966 29 Jan	6.45*	Severe. Eastward, just to the south of Western Samoa on 29 January and Tutuila that night. Also Fiji, Other Islands (Wallis, Futuna and Tokelau Is), and Southern Cook Islands.
1968 10 Feb	6.61*	Severe. A hurricane developed south of Samoa on 7 February and moved southward over Niue on the 10th. At this time when the centre was nearly 600 km south of Samoa a secondary disturbance or violent squall struck Western Samoa. Also Niue.

Notes

4.10 March 1941

The cyclone developed west of the Tokelau Is about 26

February and moved southsoutheast to pass over Upolu on 1 March. Gale force winds were recorded at Apia for a period of about five hours, with the peak gust 55 kt and lowest pressure 991 mb. After the centre had moved to the south the NW gales caused considerable damage to exposed plantations on the north side of Upolu.

5.08 December 1950

The early history of this cyclone is not known. It was first detected north of Samoa on 31 December and, on that day, it moved southsoutheast, apparently to the east of Tutuila. At Apia the wind reached gale force for less than 30 minutes and the peak gust was only 45 kt but the wind damaged some houses and other buildings, and crops in the Fa'asaleleaga and Aleipata districts.

5.63 February 1959

This storm developed between Tokelau and Northern Cook Islands on 23 February. It moved in a rather erratic fashion towards Western Samoa but turned southward on the 25th to pass over the Manu'a Is, east of Tutuila. Every house in the three main villages of the islands was destroyed. All crops were badly damaged and the banana plantations almost completely demolished.

6.45 January 1966

A shallow tropical depression lay to the northeast of Samoa on 23 January and, in the days following as the cyclone developed, it moved westsouthwest towards Fiji. It remained in the area north of Vanua Levu from 26 to 28 January (GMT) and then moved eastward towards Samoa over Futuna, intensifying and accelerating. At 0100 hours 29 January (Samoan time, i.e. 1200 29th G.M.T.) the storm was centred about 100 km southwest of Wallis I. In the next 24 hours it continued to move eastward passing just to the south of Samoa. The maximum sustained wind recorded at Mulinu'u, near Apia, was 60 kt with a peak gust of 82 kt about 2000 hours on the 29th. The lowest pressure recorded was 987 mb about the same time. Full hurricane force winds were probably experienced in other parts of the islands. A survey of the damage in Western Samoa, compiled in the Prime Minister's Department, led to the following conclusions:

1. The banana industry had been temporarily wiped out.

2. Copra production in 1966 could be down by as much as 50 percent and cocoa production would also be considerable reduced.

3. Breadfruit production would be nil for approximately 6 months and from then on less than half the normal supply would be available for at least 5 years.

On the basis of these findings it was estimated that

total exports for 1966 could be 40 percent lower than in 1965, and the Treasury estimated that revenue would be reduced by more than $200,000 in 1966. The cost of repairing or replacing Government buildings, including village schools, was put at $65,000. Unofficial estimates of the total losses, private and Government, were put as high as $6,000,000 but this is probably on the high side. Ten people were killed, mostly by falling trees.

The hurricane moved on to ravage Tutuila where the peak gust speed is reported to have been over 100 kt. The destruction was similar to that caused in Western Samoa. A Korean fishing vessel foundered early on 31 January trying to get out of Pago Pago harbour: twenty of her crew were drowned. Three Koreans were lost from another vessel, and two Samoans were killed by falling trees.

An indication of the damage caused is given by the fact that President Johnson authorized the provision of aid funds amounting to more than $US1,700,000.

6.61 February 1968

By the time this hurricane reached Niue the area affected by the storm's cyclonic circulation had become very large - radius of 500 to 600 km. Samoa was within this area and the wind was WNW 20 to 25 kt. In the early hours of 10 February a small but vicious secondary cyclone or line squall swept over Western Samoa causing serious damage for the second time in just over two years. At the peak of the storm, between 0530 and 0645 hours, the wind speed at Mulinu'u, Apia, rose to 55 to 60 kt with top gust to 78 kt. The lowest pressure was 992 mb.

Losses were comparable with those suffered in the 1966 hurricane. The banana crop was the most seriously affected with approximately 70 percent of mature and bearing stems lost. Recovery was expected after six months. Damage to cocoa trees was expected to reduce production in 1968 by about 30 percent. Coconut trees were not so seriously affected. Damage to Govenment property, including schools and hospitals, and roads, bridges and power and telephone lines, etc. was put at nearly $200,000.

NIUE

(i) Some notable storms 1905-1939:

1915	January
1920	January
1929	January
1930	November and December (2)

(ii) Tropical storms and hurricanes 1940-1969:

1941		
2 Mar	4.10*	Moderate to severe. Southsoutheast just east of Niue. Also Samoa and Southern Cook Is.

1944		
30 Jan	4.28*	Moderate. Southeastward to the north of Niue. Also Northern Tonga, Southern Cook Islands, and other Islands (Wallis and Futuna).
1946		
18 Jan	4.37	Minor. Southward west of Niue. Wind briefly force 9 from WNW about midday. No damage reported. Also Northern Tonga.
26 Dec	4.41*	Moderate. Southward west of Niue. Also Samoa and other Islands (Wallis and Futuna).
1948		
11 Dec	4.52	Minor. Eastsoutheast at least 100 km to the south of Niue. Strong gale and rough seas reported but no significant damage. Also Fiji and Southern Tonga.
1956		
1 Jan	5.30	Minor. Eastsoutheast about 100 km to the north of Niue. Tremendous seas washed away fill recently deposited in preparation for extension of the wharf. Also Southern Cook Islands.
17 Feb	5.35*	Minor. Southeastward south of Niue. Also Fiji and Southern Tonga.
1957		
6 Feb	5.43	Minor. Southward just to the east of Niue. Lowest pressure 985 mb at 0200 hours but wind did not exceed force 7. No damage reported. Also Samoa.
1959		
26 Feb	5.63*	Severe. Southward just to the west of Niue. Also Samoa.
1960		
18 Jan	6.03*	Severe. Southsoutheast directly over Niue. Also Northern Tonga.
1968		
9-10 Feb	6.61*	Severe. Southward over Niue. Also Samoa.

Notes

4.10 March 1941

A tropical cyclone which had developed northwest of the Tokelau Is late in February moved southsoutheast over Samoa (see page 86) and passed just to the east of Niue during the night of 2 March. The lowest pressure recorded at Niue was 970 mb about midnight.

A few houses and other buildings were wrecked and many seriously damaged. A new Government school and a Mission school lost their roofs, as did scores of other buildings and dwellings. The banana and coconut plantations were stripped of virtually all fruit and foliage. No lives were lost.

The hurricane turned to eastsoutheast shortly after passing Niue and moved towards Rarotonga (see page 95).

4.28 January 1944

This cyclone developed in the southern Ellice Is about 27 January (Greenwich date) and moved eastsoutheast with increasing speed, to pass about 100 km to the north of Niue on the morning of 30 January (local date).

The meteorological record notes gales from midnight to midday on the 30th. The lowest pressure reached is not known but the reading at 0630 hours was 991 mb. About 255 mm of rain fell in 48 hours. 30 and 31st.

There was little damage to property and no loss of life, but banana and coconut trees suffered considerable damage. It was expected that exports of bananas would be reduced for several months.

The cyclone subsequently passed close to Rarotonga (see page 97).

4.41 December 1946

This storm also developed south of the Ellice Is and passed close to Western Samoa on Christmas Day (see page 89). It then moved southsoutheast, passing to the west of Niue on the morning of the 27th.

The meteorological record notes NE to N winds, force 10 from 0300-0600 hours on the 27th, and force 11 to 0800 hours gradually easing thereafter as the wind backed to W. The lowest pressure was 990 mb at 0430 hours. The Administration's Annual Report refers to it as a severe storm with hurricane force winds and very high seas, but of short duration. Some buildings were damaged, particularly on the north side of the island. Banana and coconut trees were extensively damaged but other food crops were not greatly affected.

5.35 February 1956

From north of Fiji, where the cyclone developed on 16 February, it moved fairly rapidly southeast through Tonga, north of Haapai and about 100 km southwest of Niue. Although this was not one of Niue's major storms the wind was force 9 for several hours on the 17th. The Administration's Annual Report referred to two severe storms accompanied by tremendous seas (the other was 5.30). It also stated that because of a severe storm in February 1956 the banana plants

suffered severe damage and exports would probably be small until later in the year.

5.63 February 1959

The storm developed between the Tokelau and Northern Cook Is on 12 February. It moved in a rather erratic fashion towards Samoa but turned southward well to the east of Pago Pago, and passed directly over Niue between 1400 and 1700 hours on Thursday, 26 February. The wind at Niue was in excess of gale force for more than 36 hours, from late on the 25th to early on the 27th, and reached full hurricane force in the afternoon of the 26th. A sustained wind speed of more than 100 kt was recorded at the peak of the storm before the anemometer blew down.

The hurricane was described in the Administration's Annual Report as the worst on record. Whole villages in the west were completely devastated and all others severely damaged. The Administration block at Alofi was destroyed and many other buildings, including schools and churches, were damaged beyond repair. The hospital buildings, nurses' home, and the wharf and store sheds were extensively damaged. Road transport and communications were disrupted for a week. The banana crop, and also pawpaws, were wiped out. Coconut trees were uprooted all over the island and other food crops were severely damaged. There was an immediate shortage of food and exports virtually ceased for many months. Fortunately no lives were lost.

An appeal was launched for funds, $20,000, to replace the 440 Niuean houses that were destroyed or damaged beyond repair. One estimate put the total damage and losses at $1,500,000.

After passing over Niue the storm continued to move southward for about 350 km and then turned to the southeast. At midday 1 March (G.M.T.) a ship reported full hurricane force winds and that the eye of the storm had passed over it near 16°S, 166°W.

6.03 January 1960

This hurricane was traced from near Rotuma to north of Keppel I. where the wind reached force 10 on the morning of 17 January. From Keppel I. it turned to the south-southeast and passed over Niue on the morning of 18 January. Between 0200 and 0300 hours the wind blew at hurricane force from the northeast (anemometer pen jammed at 90 kt). There was then a lull for about one hour after which the wind blew again from the south. During the passage of the eye the barograph pen went off the chart at about 950 mb. Rainfall in seven hours from midnight was 175 mm.

The island had not yet recovered from what was probably its worst hurricane on record. That there

should be another almost as bad less than a year later was a crushing blow. After the storm there were only 134 Niuean houses left standing in the 13 villages and there were 4000 homeless people. The people were faced with having to build 900 houses which it was expected would take at least two years.

All of the Administration's buildings, schools and houses were damaged, mostly by water, and all village schools were structurally damaged. It was estimated that repairs, where possible, to Administration buildings, schools, village water supplies and the wharf would cost $32,000. Immediate expenditure on clearing debris, village sanitation and the erection of temporary shelters was $9000.

Cash export crops, bananas and copra, were set back again some 12 to 18 months, a very serious blow as prices were high at the time. The only bright notes were that no lives were lost and that damage to food crops was not as severe as in the more prolonged 1959 hurricane.

6.61 February 1968

A tropical cyclone developed south of Samoa on 7 February (local date) and moved slowly southeastward towards Niue. It passed over Niue, or a few kilometres to the east, in the early hours of 10 February. Hurricane force winds blew over the island from near midnight to about 0700 hours, first from the east and then from the south. The lowest pressure was below 950 mb about 0200 hours.

Although apparently not quite as devastating as the 1959 and 1960 hurricanes the export crops were again seriously affected. Some 12 percent of coconut trees were destroyed, mainly medium-age bearing trees. In addition many of the better bearing trees were badly damaged in the tops. It was expected that copra exports would virtually cease for two years. Bananas were also affected and there would be no exports for over a year. Many lime trees were also destroyed.

Damage to Government and private buildings and facilities was put at over $33,000.

At about the time the hurricane was over Niue a vicious "secondary" storm on the periphery of the main cyclone's extensive circulation struck Western Samoa (see page 89).

SOUTHERN COOK ISLANDS

(i) Some notable storms 1905-1939:

1905 January
1914 January
1926 March

1931 February
1935 February

(ii) Tropical storms and hurricanes 1940-1969:

1941		
4 Mar	4.10*	Moderate. Eastsoutheast, south of Rarotonga. Also Samoa and Niue.
27 Nov	4.13	Minor. Eastward south of Aitutaki. Strong winds only in the northern islands of the lower group. Cyclone apparently filling. Also Samoa.
1942		
23 Feb	4.17*	Severe (Palmerston I. only). Southwestward north and west of Palmerston I. Also Northern Cook Islands.
1943		
9-11 Mar	4.23*	Severe. History obscure: see notes below.
15-16 Dec	4.25*	Moderate. Eastsoutheast north of Aitutaki.
1944		
31 Jan	4.28*	Severe (Mangaia), moderate (elsewhere). Eastsoutheast south of Rarotonga. Also Northern Tonga, Niue, and other Islands (Wallis and Futuna).
1946		
13-14 Jan	4.36*	Moderate. Southwestward between Aitutaki and Rarotonga. Also other Islands (French Polynesia).
1955		
7-8 Jan	5.25*	Minor. Southwestward (erratic) south of Rarotonga. Also other Islands (French Polynesia).
1956		
2-3 Jan	5.30	Minor. Very rapidly southeastward south of Rarotonga. Although the wind was reported to have reached force 10 for a time the Administration's annual report made no reference to any damage. Also Niue.
1959		
13 Feb	5.60*	Moderate. Eastsoutheast between Aitutaki and Rarotonga.
1962		
14-15 Feb	6.19*	Minor to moderate. Eastnortheast north of Palmerston I. and Aitutaki then southsouthwest east of Rarotonga.
1963		
8 Mar	6.29*	Moderate to severe (Palmerston I. only). Westnorthwest south of Palmerston I. Also Northern Tonga and Southern Tonga.

1963		
28-29 Jan	6.46	Minor. Eastsoutheast north of Palmerston I., Aitutaki and Mauke. Wind reached gale force briefly at Palmerston I. and Aitutaki. No damage reported.
31 Jan	6.45	Moderate (Palmerston I. only). Southeastward to the southwest of Palmerston I. during the night of 31 January - 1 February. The wind was reported as force 11 for over six hours. Also Fiji, Samoa and other Islands (Wallis and Futuna).
1967		
17-18 Dec	6.59*	Severe. Southeastward close to Palmerston I. and just north of Rarotonga. Also Northern Cook Islands.

Notes

4.10 March 1941

The hurricane which had moved over Samoa and Niue on 1 March and during the night of 2 March, respectively, (see pages 86 and 90) veered to the eastsoutheast and passed to the south of Palmerston I. on 3 March and Rarotonga and Mangaia on 4 March. Its centre was probably not closer to those islands than 200 km.

The meteorological record from Rarotonga notes that the wind increased on the 4th to full gale force (force 9?) and that the sea was very high with a big swell. The wind moved through north to west at gale force, lessening as it changed to southwest. The pressure did not fall below 1000 mb. The Mangaia record notes that conditions were squally with mountainous seas. Palmerston I reported a gale from the northnorthwest and heavy seas on the 3rd. Even as far away from the centre of the cyclone as Aitutaki high winds and heavy seas were reported.

Although the wind was not strong enough to damage buildings and houses to any great extent the banana crop suffered considerably and shipments in the next season were expected to be greatly reduced. It was also estimated that there would be approximately 10,000 fewer cases of citrus fruits available for export than had been expected.

Some structural damage was caused by seas sweeping over the foreshore at Arorangi: some kikau houses and school out-buildings were demolished. On Mangaia the landings at Oneroa and Atuakoro were damaged.

4.17 February 1942

Starting near Penrhyn I. on 15 February this cyclone followed an unusual zig-zag track through the Northern

Cook Is (see page 100) and passed to the northwest of Palmerston I. on a southwest course, on 23 February.

The wind was reported to have reached force 10 at Palmerston I. on the night of the 22nd and to have increased to hurricane force by midday on the 23rd. Tremendous seas swept across the island, washed away many houses and damaged the radio station.

4.23 March 1943

The early history of this cyclone is obscure. Hutchings traced it from east of the New Hebrides, through Fiji and close to Niue. While there were some signs of a feeble depression about 5 March in Fiji there is certainly no indication that there was a cyclone anywhere near Niue in the period. It is remotely possible that it developed between the Northern Cook Is and Samoa but there is little evidence in support of this. It seems likely, indeed, that the cyclone developed not far west of the Southern Cook Is in about latitude 20° South. From about 6 March the developing storm moved slowly eastward between Aitutaki and Rarotonga. On the 9th it was centred about midway between Aitutaki and Mauke. It then moved sharply back southwestward towards Rarotonga. From about 0100 hours the wind at Rarotonga was force 9, with frequent squalls up to force 10, until 1100 hours. Shortly after this the cyclone centre moved to the west of Rarotonga and the wind shifted from E to N, still gale force but abating gradually.

The prolonged period of high winds culminating in the gales of the 10th caused a great deal of havoc in Rarotonga. Many native dwellings were demolished as was the old Royal Hall theatre. Numerous houses and buildings lost their roofs. Crop losses, bananas, oranges, coconuts and breadfruit ranged from 60 to 90 per cent or more. Most of the 90,000 banana shoots planted out in the previous 12 months were lost.

The toll was not much lighter on Atiu, Mitiaro and Mauke. On Atiu, for example, it was estimated that of the expected 27,000 cases of oranges only 9000 would now be available for export. Damage on Aitutaki and Mangaia was relatively light.

4.25 December 1943

The tropical cyclone developed east of Samoa on 14 December (local date) and moved southeast to pass to the north of Aitutaki during the evening of the 15th and Mauke on the early morning of the 16th.

The lowest pressure at Aitutaki was 984 mb but the wind did not exceed force 9.

Winds and sea caused moderate damage to houses, trees and crops in Aitutaki and Atiu but on Manuae, Mitiaro and Mauke losses were heavy. The first report from Mitiaro said, ".... Our food is in a sorry state. Bananas have blown down, taro and kumera patches are flooded, breadfruit, oranges and mango blown down. The island is ruined. There will be a great famine again on the island ..... Please assist." Rarotonga and Mangaia escaped.

4.28 January 1944

The third storm to hit the Southern Cook Is in the space of 12 months originated near the Ellice Islands and moved eastsoutheast through Northern Tonga, north of Niue, and south of Rarotonga and Mauke. It passed within about 50 to 100 km of the latter in the middle of the afternoon of 31 January.

The wind at Rarotonga did not exceed force 9 but at Mangaia was reported to be of hurricane force about 1500 hours.

On Rarotonga bananas, breadfruit, citrus and other crops were damaged but there was little structural damage caused by the wind. High seas, however, at Arorangi wrecked or heavily damaged 15 to 20 houses, caused road washouts, and destroyed two bridges.

On Mangaia many houses were blown down or rendered uninhabitable; the cottage hospital, many school rooms, and the district cargo and packing sheds were destroyed. The orange and food crops were badly damaged.

4.36 January 1946

This storm approached the Islands from the northeast passing to the east of Aitutaki and to the west of Rarotonga during 13 and 14 January.

The wind reached force 10 in squalls at Rarotonga and was reported to have reached force 12, for about half an hour, at Aitutaki. The lowest pressure recorded at both places was 980 mb.

Structural damage was relatively light but food crops and export citrus crops were again seriously affected. The northern islands of the group, particularly Mitiaro, suffered most.

5.25 January 1955

Although this storm from the northeast passed close to Mauke and not far south of Rarotonga on 7 and 8 January, there is no evidence that winds in excess of force 9 were experienced. However, heavy seas damaged at least one ship at Rarotonga. Rarotonga also had over 80 mm of rain in 13 hours.

5.60 February 1959

Giovanelli and Robert traced the cyclone called Eulalie from the Tokelau Is while the Pacific Islands Monthly stated that it originated in the Northern Cook Islands. At any rate it was well established on 11 February south of Samoa. From there it moved eastsoutheast to the south of Palmerston I. and through the Southern Cook Is south of Aitutaki and Mauke.

Although the wind does not appear to have exceeded force 9 on any of the islands mentioned the storm did a considerable amount of damage. The chief destroying agent was the sea. At Palmerston I heavy seas damaged boat sheds, copra driers and other buildings; wind and sea between them brought down about 500 coconut trees and destroyed or badly damaged 1000 breadfruit trees. At Aitutaki the storm was the worst for some years but damage was mainly confined to launches, canoes and whaleboats, and some roofs ripped off houses. At Atiu it was described as the worst since 1936 (probably 1935): damage included the destruction of the cargo boat launching ramps.

6.19 February 1962

A tropical cyclone formed northwest of Palmerston I. on 13 February and moved eastward to the north of Aitutaki where there was a gale on the 14th. The storm then moved southward through the eastern islands of the Group. Hurricane or near-hurricane force winds in the middle hours of the 15th caused considerable damage to houses and citrus plantations on Mauke and Atiu. The storm was, however, described as "mild" in the Annual Report of the Cook Islands Administration. It passed well to the east of Rarotonga.

6.29 March 1963 (Palmerston I. only)

This cyclone followed a rather unusual track (see page 84). It developed west of the Southern Cook Islands on 7 March and moved towards the westnorthwest during the next three days. It passed close to Palmerston I. in the early hours of the 8th. Winds of near hurricane force destroyed a number of native houses and severely damaged coconut trees and all other plant life.

6.59 December 1967

A tropical cyclone which developed east of the Ellice Is moved slowly eastward towards the Northern Cook Islands, turned southeastward on 16 December and passed to the north of Palmerston I. on the afternoon of the 17th. During that night it moved quite rapidly between Aitutaki and Rarotonga and by midday on the 18th was between Mauke and Mangaia.

On Palmerston I. several lighters and boatsheds were wrecked; and the high winds and heavy seas that pounded Aitutaki left boulders strewn across the road.

At Avarua in Rarotonga the storm demolished the agriculture building at Avarua wharf, two cinemas, the Union Steam Ship Company's office, two bakeries and the airport building, and badly damaged the Rarotonga Hotel, many houses and bridges, and brought down power and telephone lines. Subsequent flooding added to the havoc. Fortunately the cyclone was now moving fairly rapidly but it caused further damage in Mangaia as it passed close by.

Palmerston I., Aitutaki and Mauke all reported estimated winds of hurricane force at the peak of the storm but judging by the amount of damage reported it seems likely that the wind did not exceed force 9 or 10. The strongest measured wind speed at Rarotonga (10 minute average) was 42 kt with a peak gust speed of 81 kt. These winds were from the south when the centre of the storm was northeast of Rarotonga. Extreme turbulence induced by the range of hills behind Avarua undoubtedly contributed much to the extent of the damage. The "Mariposa" and another vessel rode out the storm north of its track in hurricane force winds. The two ships and Rarotonga all recorded lowest pressure below 975 mb.

NORTHERN COOK ISLANDS

(i) Some notable storms 1905-1939:

1905 March
1914 January (damage caused by huge seas rather than wind)

(ii) Tropical storms and hurricanes 1940-1969:

1940 29-31 Dec	4.06*	Southward to the west of Penrhyn, then southwestward passing almost directly over Suwarrow.
1941 13 Jan	4.07	Southeastward between Penrhyn I. and Rakahanga towards the Society Is. Appears to have been in an early developing stage while in the vicinity of the Northern Cook Islands. No report of winds in excess of force 4. Also other Islands (French Polynesia).
1942 19-21 Feb	4.17*	West of Pukapuka and Nassau, moved east-southeast passing close to Suwarrow. Also Southern Cook Islands.

1967 16 Dec	6.59*	Southeastwards 100 to 150 km southwest of Pukapuka and Nassau. Also Southern Cook Islands.

Notes

4.06 December 1940

This cyclone must have developed west or northwest of Penrhyn Island on 28 or early 29 December. Moving southward it passed very close to the Island: the lowest pressure was 971 mb at 1600 hours on the 29th. The wind reached gale force from NNW about midday that day and backed to W as the centre passed. The wind was still force 8 the next morning. The record does not indicate the strength of the wind during the afternoon and night of the 29th but it appears that it did not exceed force 9.

On a mere atoll such as Penrhyn, prolonged gales or strong gales together with the high seas generated are quite enough to do extensive damage. As it is the only tropical cyclone in an advanced stage of development known by the author to have come close to Penrhyn I. (Visher records none) it is worth quoting from the meteorological observer's report. ".... (the cyclone destroyed) one-third of Omuka village and two-thirds of Te Tautua village. Both wind and sea. The sea just about washing over our island. A lot of fine breadfruit trees were turned over .... Many coconut trees fell in clusters showing so many directions of falling that it looked as though some whirlwind had caused their queer looking fall. Such fallings were observed at several islets which made it look as if half a dozen water spouts had had a go at us .....". Fortunately there was no loss of life.

By coincidence, the Cook Islands' schooner "Tiare Taporo" which usually laid up for the hurricane season at Papeete was sent this year to Penrhyn I. instead. She was "welcomed" by the "most severe blow for 45 years" (?). However her crew was able to render assistance to the islanders.

The cyclone turned southwestward and passed over Suwarrow during the night of the 31st. At 0900 the wind was S force 7 and heavy rain had just begun. Twenty-four hours later the wind was NNW force 7 but, in between, the record notes that the wind reached force 11 at 1800 hours on the 31st and full hurricane force at 2200 hours. Details of damage are not available but the meteorological record notes that "rain gauge was washed away during hurricane."

4.17 February 1942

The early history of this storm is obscure. Hutchings

puts its beginnings near Penrhyn I. on 16 February, and this could be correct, but evidence of its subsequent movement westward is inconclusive. At any rate it was centred west of Pukapuka and Nassau by the 17th. From this time the storm deepened steadily and moved slowly southeastward passing about 100 km south of Pukapuka and 60 km south of Nassau. The wind was reported to have reached force 10 at Pukapuka during the night of the night of the 19th. The sea reached the taro beds, and houses were damaged. At Nassau the wind was force 9 by 0900 hours on the 20th when the radio mast and aerial were blown down. The storm reached its peak at midnight. Again the sea was the chief destroying agent: all buildings near the landing, including the copra shed and its contents, together with canoes and surf boats were swept away. Stocks of oil, kerosene and petrol were scattered through the bush. A great many trees, nearly all houses, a store, the radio shed, and the station kitchen were blown down.

The hurricane next passed close to Suwarrow on the night of the 21st. It is recorded that a party of visitors to the island lashed themselves to "the tops of some tamanu trees, which were one of the few things left on Anchorage Islet, the sea sweeping right over the atoll and the tops of the seas being some 8 metres above normal high water .... I had a grandstand seat to watch the tremendous power of the sea as it washed automobile-sized boulders over the land and saw conditions which either raise the level of an islet or completely wash it out to reef level." (64)

By this time the cyclonic circulation had become quite extensive in area and gales were experienced at Manahiki and Rakahanga over 400 km northwest of the centre.

The storm went on to Palmerston I. (See page 95).

6.59 December 1967

A developing tropical cyclone was located by satellite east of the Ellice Is on 12 December. It moved slowly eastward for several days passing close to Swains I. and south of the Tokelau Is on the 14th. It then began to move to the eastsoutheast and later the southeast passing about 80 to 100 km southwest of Pukapuka and Nassau. The gales destroyed or badly damaged many coconut, breadfruit and pawpaw trees on the islands. The storm went on to the Southern Cook Islands. (See page 98).

OTHER ISLANDS

Solomon Islands

Lack of information, particularly during and immediately

following the war years precludes any possibility of dealing fully with hurricanes in the Solomon Is. The following is an incomplete list for the last two of the three decades.

1951		
24-25 Mar	5.11	No details.
1952		
23-24 Jan	5.14	The cyclone which was to become one of the worst to strike Fiji in the period, developed south of the Solomon Is on or before 23 January 1952. On the night of the 23rd through to the next morning the southeastern Solomon Islands were battered by what the Pacific Islands Monthly called a young hurricane. Trees and power and telephone lines were brought down and many roofs were damaged. Most of the damage, however, was caused by tremendous seas. The last of Honiara's three wartime jettys was battered to pieces. Mission buildings and a pontoon jetty at Tulagi were demolished, and many coastal villages on San Christoval and Ysabel were inundated.
1955		
23 Mar	5.28	No details.
1959		
7-8 Mar	5.64	South of the main islands of the Solomons Group; probably in developing stage.
20-22 Dec	6.01	Wind force 9 at Choiseul Bay at 0400 hours on the 22nd. No other details.
1966		
14 Nov	6.49	Angela was a small but vicious tropical cyclone which moved southwestward over Malaita and Guadalcanal on 14 November. Its subsequent history is obscure but it apparently filled over tropical waters about 15°S. On the two islands thousands were left homeless when their homes were destroyed. There was extensive damage to coconut and cocoa trees and many village market gardens were destroyed. Three people lost their lives. For a full account see reference 10.
1966		
28 Mar	6.55	Glenda was the second cyclone of the season to affect the Solomons. On 28 March when the centre was more than 100 km to the south the manager of a coconut plantation on Russell Island estimated that wind gusts were reaching more than 75 kt. Two hundred and fifty hectares of the plantation

were completely destroyed, including 125 ha of new plantings. The cyclone then caused widespread damage in Guadalcanal and San Cristoval, mostly through the action of the sea. The wharves at Honiara were damaged and a nearby fishing village was flattened.

From the Solomons area Glenda moved southward through the Coral Sea and claimed the lives of six men in two separate marine accidents. (For details see reference 10.)

1967
11-12 Nov 6.57

Annie. Wind, flood and sea caused widespread and heavy damage in the Solomon Is, especially in the more western islands of the group. The Louisiade Archipelago and the Milne Bay area of Papua were also lashed by the storm. More than a dozen people lost their lives. Full details are given in reference A.

In addition the following remark in an article on Ontong Java in the "Pacific Islands Monthly" November 1972, probably relates to Annie.

> "Breadfruit was never apparently very important, and practically all of the bearing trees destroyed by the 1967 cyclone have not been replaced ....."

The significance of this lies in the fact that Ontong Java is a large atoll lying at 5° to 5.5°S (159.5°E). While the centre of the cyclone was probably somewhat further south at the time of the destruction it was certainly well developed at a fairly low latitude.

1968
11-12 Dec 6.66

Becky. Widespread damage was caused by an early cyclone for the third year in succession. This time the central islands, particularly Malaita, and also San Cristoval suffered most. At Auki (Malaita) it was reported that gust speeds reached 72 kt. The roof was blown off the Government store and the market housing destroyed at Kira-Kira. Seven school buildings were destroyed on Ugi I., and flooding in parts of Malaita left 200 people homeless. One woman was killed and other people injured.

Ellice Islands

Hurricane Bebe which devastated Funafuti in October 1972 was

said to have been quite exceptional and that nothing like it had occurred since 1891. It is true that a direct hit on one of the atolls and islets of the Group is extremely rare (in October especially) but it does not follow that tropical cyclones in an advanced stage of development are particularly rare in the area. Bebe's dimensions when it struck Funafuti were very small indeed and such a hurricane could easily have slipped between islets without being detected (at least before the satellite era). There is, in fact, one definite report of a hurricane in the area in the period of this survey, and another unconfirmed report that, "In 1957 a hurricane passed on a southsouthwest course through the central Ellice, recurving west of Rotuma, and causing widespread damage throughout the group". (63)

The track described closely resembles the track of the "possible" storm listed at the foot of Table 1.19.

The only other hurricane in the period, 1940-1969, known to have had a serious effect on any of the Ellice Islands occurred in 1958:

1958		
2 Jan	5.49	Between 0600 amd 0900 hours on 2 January the wind at Funafuti changed from E to WNW and increased from force 5 to force 8. By 1200 hours the wind was reported to be full hurricane force from W, and maintained that strength for more than 6 hours. There was no anemometer then and the estimated strength was probably a little high but it must have been close to hurricane force. Damage to houses, the government station and the hospital area was considerable; coconut and breadfruit trees were levelled up to 200 metres in from the lagoon side of the island; and the jetty was damaged.

Wallis Island and the Futuna Group

The following is the list of cyclones in the period of this survey whose tracks lay close to one or both of these island groups. Little information is available about most of them.

1944		
29 Jan	4.28	Southeast between the two Groups.
15-17 Mar	4.31	Westsouthwest close to both Groups.
1946		
25 Dec	4.41	Eastsoutheast close to Wallis I.
1957		
25 Feb	5.46	Southsouthwest close to the Futuna Group.
5 Dec	5.48	Southwestward to the south of Wallis Is recurved south of Futuna.

1958		
5 Jan	5.49	Southward near Wallis I. where wind in excess of 40 kt was reported.
1965		
5-6 Feb	6.44	Westward then southwestward very close to both Groups. Heavy damage to houses and food crops reported.
1966		
29-30 Jan	6.45	Eastward close to the Futuna Group and 100 km or more south of Wallis I. Considerable damage was caused by near-hurricane force winds on Futuna and Alofi during the evening of the 29th. One report described it as "a night of terror". Wallis I. was affected mostly by the storm surge which reached its west coast.
1969		
12-13 Jan	6.67	Southward near Wallis I.

Tokelau Islands

As in the Ellice and Northern Cook Islands fully developed hurricanes in close proximity to any of the atolls of the Tokelau Group are extremely rare. However, because they are atolls high seas or gale force winds, or both, generated by hurricanes some hundreds of kilometres away have occasionally swept the islets with destructive effect. In this century, prior to 1940, three such visitations have been recorded:

- in January 1914 (see page 99) when huge seas demolished the church and most of the houses on Atafu, and levelled many coconut trees to the ground (29,53);
- in December 1925 when the copra crop was badly damaged by heavy gales (23,53,58);
- in January 1936 when Fakaofo reported a wind of force 8 from NE on the 14th followed by W force 9 on the 15th (22,53)

In the period 1940 to 1969 the following cyclones affected the Tokelau Islands:

1941		
26 (or 27) Feb	4.10	See page 90. NW gale at Atafu.
1957		
3 Dec	5.48	See pages 82 and 104.
1966		
29-30 Jan	6.45	See page 88. Although the centre of the hurricane which ravaged Samoa was never closer to the Tokelau Islands than about 600 km tremendous seas destroyed or badly damaged nearly 50 houses on

Nukunono and Fakaofo, wrecked copra sheds and stores, and almost completely demolished the protective stone wall which had been built round the principal motu of Fakaofo. At Nukunono waves continually swept right over the inhabited motu for seven hours, but the villagers made a hazardous journey across the lagoon in a long boat to the safety of a more sheltered motu.

Coconut and breadfruit trees were badly affected by strong salt-laden winds.

1967
14-15 Dec 6.59 — See page 101. W to NW wind reached force 10 at Nukunono.

French Polynesia

Tropical cyclones are rare in French Polynesia. However, as Alt says, " .... the information provided by meteorological satellites seems now to indicate that the frequency of cyclones is perhaps greater than was previously thought, for these storms, whose geographical extent is small, may affect none of the islands (in the area through which they pass). ..... Cyclones affecting French Polynesia either originate far away, generally in the zone extending from New Caledonia to Samoa, in which case they are already well developed and generally pass to the south of the territory, or form north or northwest of the Tuamotu archipelago; in the latter case they are violent and may affect many islands." (25) Alt listed only six major tropical cyclones in 100 years - none in the period covered by this survey. Tessier (57) recorded 12 since 1870 - three in the period of our survey. There is, indeed, no record of barometric pressure below 990 mb or of any meteorological station having reported a wind of hurricane force in the period 1940 to 1969. The lowest pressure recorded on land appears to have been 976 mb at Napuka during the 1905 cyclone. The lowest pressure recorded at Papeete was 981 mb during the 1906 hurricane, but the schooner "Papeete" which was in the path of the same hurricane west of Anaa, some 400 km east of Tahiti, recorded 953 mb (57). The author does not know if the barometer was afterwards checked.

(i) Some notable storms 1900-1939:

1903 January
1905 March
1906 February
1926 January

(ii) Tropical cyclones 1940-1969 (excluding those that may have affected the Austral Islands).

1940
7-8 Feb - Classed by the present author as a "possible tropical storm". According to Giovannelli (19) it developed in the vicinity of the Leeward Islands (Iles Sous-le-Vent) and moved southeastwards to the south of Tahiti. Winds of gale force were experienced at Uturoa and Makatea.

1941		
17-18 Jan	4.07*	Southeastward through the Leeward Islands.
1947		
15 Feb	-	Classed as a "possible tropical storm". Southeastward south of Society Islands. At Papeete a gale which lasted less than one hour, with gusts to about 50 kt, caused minor damage (20,38).
1955		
3-6 Jan	5.25	Southsouthwest between the Leeward Is and Tahiti, then southwestward towards the Southern Cook Is. Rainfall at Papeete on 6 January was 273 mm - a record 24-hour rainfall for January.
1958		
19 Jan	5.50	Southsoutheast, east of Tahiti towards Rapa I. Heavy swell and high tide caused considerable damage on northwest coasts of islands of the Tuamotu archipelago, and also in the Society Is.
1959		
26-27 Jan	5.59*	Southward west of Bora Bora.
1961		
14-15 Mar	6.13	Eastward south of Mopelia then southward. Strong winds (near gale) at Mopelia. Ships in the vicinity of the Society Is reported force 10 winds.

Notes

4.07 January 1941

This cyclone developed in the vicinity of the Northern Cook Is between 12 and 14 January, moved steadily southeastward as it intensified, and passed over or very close to Raiatea and Bora Bora during the night of 17-18 January. Early in the afternoon of the 17th the wind (estimated) was force 11 at Raiatea and force 12 at Bora Bora. Wind and sea caused extensive damage to coconut and other crops, and to houses and buildings of all types. The village of Vaitape on Bora Bora was in ruins. At Utaroa (Raiatea) one death resulted from a tree falling on a house. Papeete was also buffeted by winds gusting to nearly 60 kt but damage was relatively light.

5.59 January 1959

On 26 January this storm moved southward through the Leeward Is west of Bora Bora. Winds of at least gale force, high seas, and heavy rain were experienced by most of the islands of the group. At Bora Bora, during the morning of the 27th when the cyclone lay to the southwest and was

intensifying rapidly, the wind reached hurricane force with gusts to almost 100 kt. Wind and sea caused severe damage at Bora Bora. Raiatea, Huahine and Moorea also suffered but to a lesser extent. In Tahiti the sea, up to 1 m above its normal level, and swell damaged the coast road, and flooded quays and neighbouring streets in Papeete.

PART V

NOTE ON SOURCES
REFERENCES AND SELECT BIBLIOGRAPHY

Primary

The information in Tables 2 and the tracks on Charts 1, except for those which lie entirely west of 160°E, have been derived from the weather maps and records of the New Zealand Meteorological Service and official reports in the Service's files.

The tracks of cyclones which lie entirely west of 160°E were taken in the main from Coleman (1) without further examination, but see page 9.

Secondary

(a) Secondary sources, mainly official meteorological publications, that have been used to check the data and which, in some cases, have furnished additional information, are listed below in six groups identified by capital letters. The group identification letters appear in the last column of Tables 2 indicating that information concerning the referenced cyclone will be found in one or more of the publications listed under the letter or letters.

A. Australia

1. Coleman, F., 1971: Frequencies, tracks and intensities of tropical cyclones in the Australian region November 1909 to June 1969. Bureau of Meteorology, Melbourne, Australia.

2. Hilder, B., 1959: Report on an intense hurricane. Aust.Met.Mag., 25: 81-85.

1954/55 season

3. Bath, A.T., 1955: A study of the 1954/55 season tropical cyclones and forecasting methods employed. Report of Tropical Cyclone Conference held at the Divisional Meteorological Office, Brisbane, Queensland, 13 to 16 September 1955.

1955/56 season

4. Newman, B.W., A.R. Martin and W.R. Wilkie, 1956: The occurrence of tropical depressions and cyclones in the Australian region during the summer, 1955-6. Proceedings of the Tropical Cyclone Symposium, Brisbane, December 1956.

1957/58 to 1961/62 season

5. Newman, B.W. and A.T. Bath , 1959: Occurrence of Tropical depressions and cyclones in the northeast Australian region during the season 1957-58. Aust.Met.Mag., 24 : 35-64.

6. Staff of the Divisional Office, Brisbane, 1959: Occurrence of tropical depressions and cyclones in the northeastern Australian region during the season 1958-1959. Aust.Met.Mag., 26: 50-75.

7. Whittingham, H.E., 1960: Tropical cyclones in the north-eastern Australian region - 1959/60 season. Aust.Met.Mag., 30: 1-38.

8. Staff of Divisional Office, Brisbane, 1961: Tropical cyclones in the northeastern Australiam region - 1960/61 season. Aust.Met.Mag., 35: 15-47.

9. ____, 1962: Tropical cyclones in the northeastern Australian region, 1961-62 season. Aust.Met. Mag., 38: 43-60.

1962/63 season to 1968/69 season

10. Meteorological Summary (annual); Bureau of Meteorology, Melbourne, Australia : Tropical cyclones in the northeastern and northwestern Australian regions for the ..... season. (Or similar title)

C. New Caledonia

11. Annales des Services Meteorologiques de la France d'Outre-Mer 2e Volume (annual series) Paris. (This publication contains summaries for both New Caledonia and French Polynesia and is therefore included in Group P also.)

12. Giovannelli, J., 1952: Les cyclones tropicaux en Nouvelle-Caledonie au cours d'un siecle (1852-1951). Service Meteorologique, Noumea.

13. Giovannelli, J. and J. Robert, 1964: Quelques aspects des depressions et cyclones tropicaux dans le Pacifique Sud-ouest. Monographies de la Meteorologie Nationale, 33. Paris.

14. Giraud, J. and D. Rignot, 1971: Climatologie de la Nouvelle-Caledonie. Monographies de la Meteorologie Nationale, 82. Paris.

15. Resume (annual) climatologique de l'annee ..... en Nouvelle-Caledonie et dependances. Service de la Meteorologie, Noumea. (Title: Caracteres climatologiques etc. prior to 1965).

16. Robert, J., 1959: Etude meteorologique de cyclone BEATRICE 15 au 22 janvier 1959. Service Meteorologique, Noumea.

F. Fiji

17. Nasmyth, G.B., 1940: Annual Report for the year 1939. Colony of Fiji.

18. Annual Meteorological Summary: stations in Fiji, Tonga, New Hebrides and Western Pacific High Commission Territories - years 1947 to 1969 inclusive. New Zealand Meteorological Service (prepared at the Meteorological Office, Laucala Bay, Suva, Fiji).

P. French Polynesia

19. Giovannelli, J., 1940: Les cyclones en Oceanie Francaise. Bulletin de la Societe des Etudes Oceaniennes, 68. Papeete.

20. Resume (annual) des Observations en Surface, annee ..... (Or - Resume des Observations en Surface et en Altitude; or - Resume des Observations faites en .....). Service Meteorologique, Papeete, Tahiti.

21. Service Meteorologiques de la Polynesie Francaise, 1965: Climatologie de l'Ile de Tahiti. Monographies de la Meteorologie Nationale, 44. Paris.

Also ref. no. 11 in Group C.

S. Western Samoa - Apia Observatory

22. Annual Reports (as its Annual Report 1930-1947; its Magnetic and Meteorological Results 1948-1951).

23. Monthly Meteorological Summaries 1925-1969.

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