

## THE ASSOCIATION OF SFERIC WITH TROPICAL CYCLONES

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Abstract: Sferic activity associated with six tropical cyclones that occurred in the 1957 to 1958 tropical cyclone season has been investigated. It was found that sferic activity preceded the detection of five out of six of these cyclones and that the sferic distribution and intensity varied with the different stages of cyclone life. When a cyclone rapidly deepened there was an almost complete absence of sferic reports whereas in the last 24 hours of cyclone life sferic activity increased and was closer to the cyclone centre with the greatest sferic activity ahead of the filling cyclone. During the rest of the cyclone life, the sferics were for the most part at distances of from 300 to 400 miles from the cyclone centre with a minimum of sferic activity ahead of the cyclone.

## 1. INTRODUCTION

Sferic reports were obtained six times daily at 0248Z, 0536Z, 1106Z, 1348Z, 1918Z and 2230Z and all sferics within 400 miles of the cyclone centre were considered from the 24 hours prior to the cyclone being detected to when the cyclone filled.

An attempt was made to relate sferic activity with cyclone life which was divided into three stages, namely, the 24 hours before cyclone detection, the life of the cyclone up to 24 hours before filling and the last 24 hours of cyclone life.

Sferics were considered in relation to direction of movement of cyclone. For this purpose the area around the cyclone was divided into quadrants called front, left, rear and right. Distance from the cyclone centre was measured by the annular range lines at 100 miles, 200 miles, 300 miles and 400 miles from the cyclone centre. Thus (as shown in Fig. 1) for a cyclone at position X at time of sferic report

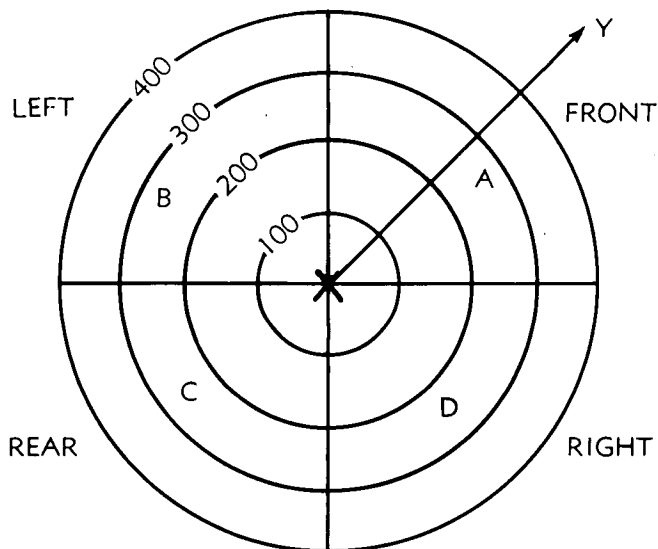


Fig. 1. Illustration of method used to locate sferics in relation to cyclone. (Range lines refer to distance in miles of sferic fix from cyclone centre.)

and movement of cyclone in next 12 hours in direction XY, then sferic reports at A,B,C,D are in front, left, rear and right quadrants at distances of 0 to 100 miles, 101 to 200 miles, 201 to 300 miles and 301 to 400 miles respectively.

## 2. BRIEF DESCRIPTIONS OF THE CYCLONES AND ASSOCIATED SFERICS FOR THE 1957 TO 1958 CYCLONE SEASON

A description of the cyclone and the associated sferics for the periods, 24 hours prior to the detection of the cyclone, from detection up to 24 hours before its filling and in the last 24 hours of its life are given below in tabular form for the 6 cyclones that occurred in the 1957 to 1958 tropical cyclone season.

Description of cyclone.	Sferics for 24 hours prior to cyclone detection.	Sferics associated with cyclone up to 24 hours before filling.	Sferics in last 24 hours of cyclone life.
(A) Tropical depression from 11/1/58 to 16/1/58	Only 2 isolated atmospheric sources were within	Least sferics were in front quadrant. Sferic reports were isolated and	There were 3 isolated sferic fixes within 100 miles, 6 within 200 miles, 2

Description of cyclone.	Sferics for 24 hours prior to cyclone detection.	Sferics associated with cyclone up to 24 hours before filling.	Sferics in last 24 hours of cyclone life.
(A) (continued) moved from western Gulf of Carpentaria through Northern Territory to north-west coast of West Australia. The lowest central pressure was 1004 mb.	400 miles of where the cyclone was first detected.	between 100 and 400 miles from cyclone centre.	of which were of heavy activity and 11 within 400 miles. Most of these sferic reports were in rear and right quadrants.
(B) Tropical (1003 mb) depression from 13/1/58 to 17/1/58 was over eastern Coral Sea.	There were extensive sferic activity in 24 hours prior to cyclone being detected; there being 2 areas and one isolated fix within 100 miles and 2 areas, 1 line and 6 isolated fixes within 300 miles.	A decrease in sferic activity occurred. 90% of sferic reports were in the rear quadrant, of which 70% were at a distance of 301 to 400 miles from cyclone centre. There were no sferic reports in front and left side quadrants.	Sferic activity increased and greatest sferic activity was immediately in front of depression. Two lines and 2 isolated fixes were within 200 miles of cyclone position.
(C) Tropical disturbance from 12/2/58 to 23/2/58, moved from Gulf of Carpentaria to western Coral Sea and deepened to 994 mb.	An indefinite area of low pressure was over the Gulf of Carpentaria at 1700Z 10/2/58. This developed to a 1002 mb depression by 0500Z 12th. There were extensive sferics in the period 1900Z 10th to 0500Z 12th,	In the next 11 days the cyclone moved very erratically south-east, even completing a loop in its track. Only 11% of sferics were in the front quadrant whereas the left, rear and right quadrants had 37%, 33% and 19% of the reports respectively, 73% of which were from 200 to	During the 23rd the cyclone filled 6 mbs in 24 hours to reach 1008 mb. Sferic activity increased and 58% of these sferic reports were in the front quadrant.

Description of cyclone.	Sferics for 24 hours prior to cyclone detection.	Sferics associated with cyclone up to 24 hours before filling.	Sferics in last 24 hours of cyclone life.
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(C) (continued)

with an area, a line and 13 isolated fixes, and an area, a line and 26 isolated fixes, within 200 miles and 400 miles respectively of the cyclone at 0500Z 12th.	400 miles from cyclone centre. The central pressure of the cyclone decreased 6 mb in 36 hours to reach its lowest pressure of 994 mb at 2300Z 19th and during this deepening only an isolated light fix and a line of light activity were within 200 miles of cyclone centre, both of which were in the left quadrant.
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(D) For the cyclone of 31/3/58 to 3/4/58, which was first located as a 1002 mb low about 100 miles south-east of Willis Island, all sferics were of light intensity. This cyclone moved south-west deepening to 968 mb and crossed the coast at Bowen where recorded wind gusts reached 98 knots.

Only a line of sferics was detected within 200 miles, and a line and 3 isolated fixes within 300 miles.

From 0500Z 31st to 1100Z 1st the cyclone deepened to 968 mbs which is a pressure fall of 34 mb in 30 hours during which only 2 isolated fixes, both in front quadrant, were reported within 300 miles of cyclone centre.

From 1100Z 1st to 0500Z 2nd the central pressure rose 36 mb in 18 hours to a pressure of 1004 mb. An extensive outbreak of 7 isolated fixes, 3 lines and a large area of sferics occurred during this period within 200 miles. These were fairly evenly distributed around cyclone centre.

Description of cyclone.	Sferics for 24 hours prior to cyclone detection.	Sferics associated with cyclone up to 24 hours before filling.	Sferics in last 24 hours of cyclone life.
(E) This cyclone from 11/4/58 to 15/4/58 was first detected in the Gulf of Carpentaria. Moving southwest it deepened to a 990 mb cyclone with wind gusts to 70 knots and then filled over eastern Arnhem Land.	Four isolated fixes, 2 of which were of heavy activity, were within 100 miles, and 12 isolated fixes were within 400 miles of where cyclone was first positioned.	Only 3 isolated sferic fixes were within 400 miles of the cyclone centre during the 12 hours when the cyclone deepened 12 mb in 12 hours to a central pressure of 990 mb. For 30 hours the cyclone maintained an intensity of 990 mb and 8 isolated sferic fixes were within 400 miles of the cyclone centre, none of which were in the quadrant ahead of cyclone.	While the cyclone filled 12 mb in 24 hours, only 2 isolated sferic fixes were within 400 miles of cyclone centre.
(F) This depression from 17/4/58 to 23/4/58 was first located as a 1000 mb depression to the south of the Solomon Islands. It moved southwest and deepened to 998 mb, and then east by south-east and filled.	No sferic activity occurred prior to detection.	There were only 16 sferic reports within 400 miles of the cyclone in the 6 days that the cyclone was evident. Of these reports 62% were in the left hand quadrant.	There was no sferic activity in last 24 hours of cyclone life.

Thus some sferic activity was associated with all 6 cyclones. In 5 out of 6 cyclones, sferics were in an area where the cyclone subsequently developed and on 3 of these occasions there was a very extensive outbreak of sferics.

During the cyclone life up to 24 hours before filling, the most sferic activity was in the outer isobars of the cyclone with the least sferic activity in the direction of movement of the cyclone. There was rapid deepening in 3 cyclones with an almost complete absence of sferics in each case.

In the last 24 hours of cyclone life there was a radical change in sferic distribution. Sferic activity usually increased and was closer to cyclone centre, with the greatest sferic activity ahead of the filling cyclone. In 5 out of 6 cases sferic activity occurred when the cyclone was filling and in 4 cases the activity was very extensive.

### 3. AN ANALYSIS OF SFERICS DISTRIBUTION WITH DIFFERENT STAGES OF CYCLONE LIFE

Table 1 shows the distribution of sferic fixes with respect to the different cyclone stages for which a total of 36 days of sferic reports was considered for the 6 cyclones.

#### Distribution of Sferics

Table 1

Distance from cyclone centre.	Total sferics for 24 hours prior to detection of 6 cyclones.	Sferics for life of cyclones up to 24 hours before filling.				Sferics for last 24 hours of cyclone life.				Total sferic reports for 36 days.
		Front	Rear	Left	Right	Front	Rear	Left	Right	
0-100 miles	14	4	4	6	2	4	2	4	2	42
101-200 miles	19	2	13	12	7	6	3	3	8	73
201-300 miles	16	6	19	22	4	4	5	1	4	81
301-400 miles	22	11	31	22	18	6	2	6	2	120
Total	71	23	67	62	31	20	12	14	16	316

Average Daily Percentage Distribution of Sferics

Table 2

Distance from cyclone centre.	Sferics for 24 hours prior to cyclone detection.	Sferics for cyclone life up to 24 hours before filling.	Sferics for last 24 hours of cyclone life.	Total								
0-100 miles	7.8%	0.6%	0.6%	0.8%	0.3%	2.3%	2.2%	1.1%	2.2%	1.1%	6.6%	16.8%
101-200 miles	10.6%	0.3%	1.8%	1.7%	1.0%	4.8%	3.4%	1.7%	1.7%	4.5%	11.3%	26.6%
201-300 miles	9.0%	0.8%	2.7%	3.1%	.6%	7.2%	2.2%	2.8%	.6%	2.2%	7.8%	24.0%
301-400 miles	12.3%	1.5%	4.3%	3.1%	2.5%	11.4%	3.4%	1.1%	3.4%	1.1%	9.0%	32.7%
Total	39.7%	3.2%	9.4%	8.7%	4.4%	25.7%	11.2%	6.7%	7.9%	8.9%	34.7%	100.1%

In order to obtain a comparison of sferic activity associated with the different stages of the cyclones, the average daily percentage distribution of sferics was determined as shown in Table 2.

From Table 2, considering sferics within 400 miles of the cyclone centre, 39.7% of sferics occurred in the 24 hours prior to cyclone detection, 25.7% up to 24 hours before cyclone filled and 34.7% in last 24 hours of cyclone life. The sferics in the 24 hours prior to cyclone detection were fairly evenly distributed up to 400 miles around where the cyclone was subsequently detected. For movement of the cyclone up to 24 hours before filling, the sferic activity was greater the greater the distance from the cyclone centre, increasing progressively from 2.3% of reports within 100 miles of the cyclone to 11.4% of reports from 301 to 400 miles. The least sferic activity was in the front quadrant where there were only 1.7% of sferic reports within 300 miles whereas in the right, rear and left quadrants there were 1.9%, 5.1% and 5.6% of sferic reports. The sferic distribution in the last 24 hours of cyclone life is exactly the reverse, as in the front, right, rear and left quadrant within 300 miles of cyclone centre there were 7.8%, 7.8%, 5.6% and 4.5% of reports respectively. The greatest sferic activity within 400 miles of cyclone centre for last 24 hours of cyclone life was in the front quadrant where there were 11.2% of reports and the least was in the rear with only 6.7%.

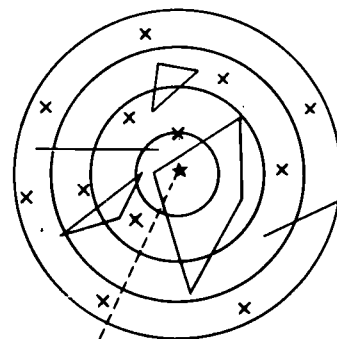
Thus sferic activity followed a definite pattern in relation to cyclone life. A schematic presentation of this is given in Fig. 2 (a), (b), (c) and (d) which show sferic activity associated with development, deepening, movement of mature cyclone and filling, respectively. The cyclone position is indicated by a star and the cyclone track by a dotted line with arrows. Range lines at distances of 100 miles, 200 miles, 300 miles and 400 miles from cyclone centre are drawn around each cyclone position.

#### 4. CONCLUSIONS

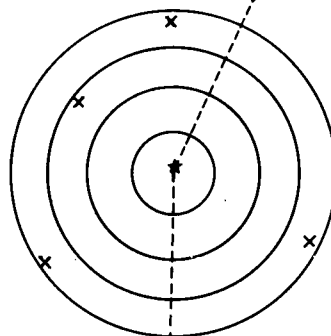
During the tropical cyclone season, a strong outbreak of sferics in an area where conditions are conducive to tropical cyclone formation will alert the forecaster to possible tropical cyclogenesis occurring in a particular area and so help in the early detection of a tropical cyclone.

Sferics also give an indication of current cyclone behaviour. When the cyclone is rapidly deepening there is a big decrease in sferic activity and the sferics are of lighter intensity. In a mature cyclone sferics are mostly in the outer isobars with the least activity ahead of the cyclone, whereas when the cyclone is decaying, sferic activity increases and is closer to the cyclone centre with the greatest sferic activity ahead of the filling cyclone.

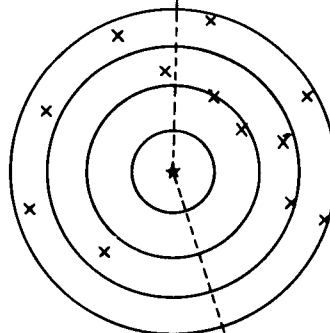
- (a) Development of cyclone. Extensive sferic activity is over area of subsequent cyclogenesis which usually occurs within 24 hours.



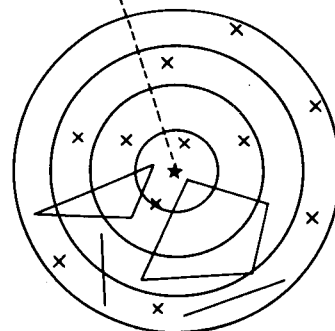
- (b) Deepening of cyclone. There is a noticeable absence of sferics during this stage.



- (c) Maturity of cyclone. This phase of cyclone life is characterised by sferics well distant from cyclone centre and chiefly to the rear and left of cyclone.



- (d) Filling of cyclone. Sferic activity increases and is closer to cyclone centre.



X is isolated sferic fix. Areas and lines of sferics are as shown.

Fig. 2. Schematic presentation of typical sferics associated with different stages of cyclone life.

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