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Technical Report

WIND AND SEA ANALYSIS

FUNAFUTI LAGOON, TUVALU

Trip TU-86-1

by

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Prepared for:
Committee for Co-ordination of
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WIND AND SEA ANALYSIS
FUNAFUTI LAGOON, TUVALU
15 to 19 July 1985
7 to 14 February 1986

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INTRODUCTION AND BACKGROUND

This programme was undertaken as a part of the CCOP/SOPAC Work Programme CCSP/TU.3 (Baseline Studies of Inshore Areas in Tuvalu to Assist with Coastal Management) in cooperation with the South Pacific Regional Environmental Programme (SPREP). SPREP contributed some financial support to the project.

The eastern shoreline of Funafuti Lagoon was modified during WW-II, several piers were constructed, beach areas filled, and deep water access channels were excavated. In recent times the present shoreline has not accumulated sand to form the beaches as they were in former times, and the shoreline is now exposed to wave action. Several attempts to stabilize the shoreline have not achieved the desired effect.

Objectives

The following study was designed to develop baseline wind, sea, current data for the lagoon area, and in particular as they relate to the shore of the western side of Fongafale, a major cultural center in Tuvalu. These data are being developed to provide a base for the design of coastal protection facilities, planning, and storm hazard assessment. Wind and sea conditions resulting from tropical cyclones will not be included in this report, but will be considered in a later report.

Personnel Participating

The CCOP/SOPAC Staff Marine Scientist, Ralf Carter conducted the study. He received assistance from the Ministry of Commerce and Natural Resources. Individuals that participated or aided the programme included:

Tauaasa Taafaki	-	Permanent Secretary in the Ministry
Garry Wiseman	-	Planning Officer
Siniala Auenga	-	Land Officer
Elisala Pita	-	Fisheries Officer
Chris Rogers	-	New Zealand Meteorological Officer
Toapo Tapu	-	Fisheries
Vete P. Sakaio	-	PWD

METHODS AND EQUIPMENT

Nearshore currents were measured in the lagoon during both summer and winter conditions, see Figure 1 for station locations. Local wind conditions were analysed using recorded wind observations and seas were observed under typical western wind conditions for confirmation of constants employed in the wind and sea and breaker analysis. The fetch and hindcast of seas were determined and made using the method for fetch estimation given in the USArmy, B.E.B. Tech. Memo No. 132, 1962. Wind data recorded during the study period, for the time period 1978 to 1983, and 1950 to 1984 were employed in the wind analysis.

The equipment furnished by CCOP/SOPAC included the following:

Aanderaa Current Meter
Aanderaa Tide Gauge
Compass
Spar Current Meter
Measuring Tapes
Charts etc.

Equipment and facilities furnished by the Government of Tuvalu included the following:

Survey Boat and Operator
Ground Transport
Storage Facilities

PHYSICAL ENVIRONMENT

WIND

Wave heights generated by the wind over the lagoon can be hindcast from the wind records. Generally the wave calculation is made using the wind speed over water at a height of 10 metre. However, the meteorological station and anemometer is located 350 metre or more from the lagoon depending upon the direction being considered. The anemometer is located on a 23.6 metre high water (25.1 metre above msl). The correction to 10 metre high will reduce the observed wind speed about 11 percent. Also the correction for over water to over land will be an increase in speed of the same order: hence the two effects should almost cancel each other depending upon the wind direction being considered. It appears expedient: therefore, to use the unmodified data reported for westerly winds at the Met Station for analysis of waves generated within the lagoon.

The monthly wind data for Funafuti between 1 January 1950 and December 1984 a 34 year time period was collated from the New Zealand Meteorological Service records by Victoria University Staff for CCOP/SOPAC. These data were employed to develop both monthly and annual wind roses for Funafuti. Monthy values are given in Table 1, and the composite annual values are given in Table II. The values in the tables indicate the wind direction as N, E etc. followed by a number that represents the Beaufort Force number which are shown to equal the number of occurrences recorded during the 34 years of wind records. The data was complete except for two days not recorded in September 1950, one day not recorded in August in 1958, and the October 1972 cyclone "Bebe" data. Data collected from Niulakita was substituted for the "Bebe" period. Winds recorded as "variable" for 99 days were entered as calm. Winds for each direction were shown as either calm or Beaufort force 1 through 7. Eight segments or 42 to 55 degrees for N, NE. E, SE, S, SW, W, and NW were employed to characterize the winds. The daily values were the 0900 hour 10 minute constant wind speed.

A comparison of the 0900 values with 24 hour values collected for a short time period at Funafuti indicates that the maximum daily value may be 1.68 times the 0900 hour reading on the average at least for the months of February through March. The values plotted in Figures 2 and 3 are 0900 hour readings and the values plotted in Figure 4 are adjusted with the 1.68 factor for this daily difference. These data are shown in Tables III as percent occurrence. There were 13,777 entries including the 931 days classified as calm. These data are plotted as a wind rose. probability of occurrence, and recurrence period in Figures 2, 3, and 4 respectively.

FETCH

The effective fetch or length of exposed water for generating a wave In the lagoon was estimated at 6.9 nautical miles by using the method shown in US Army BEB Tech Memo No 132, 1962. The average depth of water over this fetch west of Vaiaku on Fongafale was calculated to be 16.45 fathoms. This value appears reasonable for several bearings across the lagoon. Toward the northern sector of the lagoon the effective fetch is reduced to 4.5 nautical miles along 330 degrees true. A similar reduction in effective fetch occur toward the southwest.

OBSERVATION OF WAVE PARAMETERS

On 11 February 1986 the wave conditions were monitored at Vaiaku. Wind data recorded at Met Station 643 were obtained and compared with on-site observations. Wind speed on the lagoon averaged 8.88 knots and varied between 4 and 16 knots from average bearing of 324 degrees true. The recorded wind speed varied between 280 and 360 degrees true at the airport. On the 12 February 1986 the records showed that the direction shifted to 259 degrees true and the wind averaged 9.38 knots. The wind over the lagoon varied over the same values; however, the wind at the airport would not necessarily be the same value at the same time as that over the lagoon.

During the 11th February the wind had a fetch of about 4.5 nautical miles. The depth of water in the lagoon averages about 99 ft, so the wave generated with 8 to 16 knots winds will be a deep water wave. At 1530 hours the wind was observed to be 13 knots from 320 degrees magnetic. The observed wave had a period of 2.4 seconds a height of 1 ft and an estimated wave length along the pier was 24 ft. The wave calculated using the deep water wave formula would have a period of 2.4 seconds, a significant height of 1.21 ft and a length of 29 ft. It is possible that the wind was not blowing over the entire fetch, so a lesser wave had developed that would be predicted; however, the two waves match quite well in period, a significant parameter. On the 13th February the wind was well established and beginning to shift toward a longer fetch, 6.9 nautical miles. At 0945 the wind speed was between 8 and 10 knots and shifted between 270 and 340 degrees magnetic. The observed wave had a period of 2.4 sec, a height of 1 ft, and a length of 24 ft. Using a fetch of 6.9 nautical miles and a wind speed of 9.4 knots, the average a deep water wave was calculated to the a period of 2.14 sec, a significant height of 1 ft, and a length of 23 feet. These two waves agreed quite well. Other observed waves did not agree so well with the calculated wave; however, the wind was not always constant in either speed or direction, so there could have been considerable error in the estimated value of the critical parameters. The two examples given appear to be reliable and be a check on the depth and fetch values. Other values observed were:

Wind (k)	Wave height (ft)	Period (sec)
8	<.5	1
8.5	.6	1.6
13	1.0	2.4
14	1.0	2.4
11	2.0	2.3
10	1.5	2.9

These values average 10.8 knots, 1.1 ft, and 2.1 sec. A 4.5 nautical mile fetch with 10.8 knot wind gives a deep water wave of 2.14 sec period with a 1.0 ft significant wave height and a 23 ft wave length. Where the values are averaged there appears to be a good fit even with the shoaling effects considered, $d/L = 0.2679$ and $H/H_o = 0.9323$ the wave height is within 10 percent of the predicted value. It appears safe to use the hindcast wind data and the above depth and fetch values to predict wave conditions on the lagoon using the deep water wave formula for the winds other than the hurricane conditions when the transition wave formula may apply.

WAVE CLIMATE AND PREDICTIONS

The SMB forecasting method for predicting waves in deep water and in transition depths was employed in this analysis. The equations for these calculations are given on page 3-35 and 3-46 of the 1977 edition of the U.S. Army Coastal Engineering Center "Shore Protection Manual, Volume I".

The probable barometric tide and wind setup combined or Storm Tide was calculated for 10, 20 and 50 years for the east side of Funafuti Lagoon, and it was found to be 0.63, 0.86, and 1.23 ft respectively. The average tide level or 2.8 ft was used for making this calculation.

Using the return interval estimated from the 34 years of wind data for Funafuti Lagoon and the 1.68 factor to estimate the maximum daily winds to calculate the deep water wave for a 6.9 nautical mile fetch the following recurrence intervals for the waves developed were calculated:

Recurrence (yrs)	Wind (k)	Wave (ft)	Period (sec)	Length (ft)
5	21.5	2.6	3.5	62
10	30.3	3.9	4.2	91
15	35.5	4.7	4.6	107
20	39.2	5.3	4.8	119
30	44.3	6.1	5.2	136
50	50.8	7.2	5.6	157
75	56.0	8.1	5.8	174
100	59.7	8.7	6.0	186

The winds of greater than 20 knots may produce waves in the transitional range in the lagoon: however, the characteristic5 of those waves will be quite similar to that of the deep water wave for the winds and conditions being considered, for example a transitional wave in 99 ft water produced by a 38 knot wind will be 5 ft high, have a 4.5 second period, and a 105 ft wave length. The wind data base for estimating the waves was recorded over 34 years, while this time period may be extended a few more years, it is unlikely to be reliable for much more than 50 years. The 75 and 100 year values could be in considerable error.

The wave that may develop during the hurricane would likely break upon the reef flat and would not be expected to reach the seawall with more than a fraction of the energy that it contained while in deep water. Assuming a 1:20 slope in the nearshore area then the breaking characteristics of the above wave would be:

Return period (yrs)	Breaker height (ft)	Depth (ft)
5	3.1	3.3
10	4.5	4.9
15	5.5	6.0
20	6.1	6.7
30	7.1	7.7
50	8.3	9.1

The breaker would be the spilling type unless it reached the steeper beach area where it probably be a plunging breaker.

CURRENTS

Two stations were employed to observe currents within the lagoon. Station 1 was located near the seaward of the old aircraft ramp in 5 metre depth water and Station 2 was located at the end of the main wharf in 8 meter depth water. The end of the wharf was used during February as no small craft was available at that time.

The currents observed during July were very slow as shown in Table IV. Only drogue meters would measure these weak currents. Apparently this station was located near a node in the tidal current pattern within the lagoon. There was a slight wind drift with the 5 knot wind. The dominant current was due to the seich within the lagoon. At times a current would develop and carry the drogue some 40 metre away and then return it to near the original position in about 15 minutes. The total net transport during the tidal cycle was approximately 200 metres, Figure 6.

During the February survey the 8 to 10 knots of wind did result in some currents within the lagoon. The observations are given in Table V. Values observed are on the order of 3 to 4 percent of the wind speed: however, the boundary effect of the land resulted in a nearshore return current at the 2 meter depth of the current meter. Speeds were an order of magnitude greater than the weak currents during July. Net transport in February was about twice that found in July, Figure 7. In both cases a clockwise transport to the south along the shoreline was observed.

During the two study periods the currents were never strong enough to transport sand. The waves could transport sand along the shore when sand was present. The armored bottom and hard packed sand condition of the sand in the nearshore channels indicated that this sand is rather stable.

A significant amount of sand was observed around the ship wreck north of the main wharf in July, and this sand was gone in the following February. It appears that the sand had been transported southward along the shore as several exposed sandy areas that were free of periphyton were seen near the wharf. This sand would have been transported when storm sea conditions were present. The conditions during the February study could move sand in shallow water due to wave action. The tide and wind currents during the study would have little impact. The tide during the survey is shown at the end of the figures. Other physical parameters monitoring during the current study are shown in Table VI.

OLD BEACH AREA

Longtime residents of Funafuti speak of the time when a large sandy beach existed along the central lagoon area near where the Vaiakni Lagi Hotel is located. A close inspection of this area will show that near the line of large Fetau trees one can find what remains of an old buried seawall that was constructed of concrete filled 55 gal drums. This was the shoreline about the time of WW II. This old shoreline is located 30 metres shoreward of the present shoreline where Fetau and Puks trees are now growing. Apparently the area was filled by dragline and now covers the old beach area. The borrow area for this fill created the small boat channels that parallel the beach and turn seaward at intervals.

At present the water depth at the shoreline is below mllw (mean low low water) and small wind waves can erode away the sand that reaches the area so no significant beach area will develop. The shore protection used at the shoreline reflects these waves or it results in a strong backwash so sand is quickly carried away for the shore. The filling of a large volume of sand into the beach area so to extend the mllw depth 30 meters out from the present shore line and filling the nearshore area so to maintain a bottom slope of 1:20 to 1:40 depending upon the sand grain size and shape out to 3 metres or so water depth would likely re-establish a permanent beach in this area.

DISCUSSION

WIND

The length of time over which the wind data was collected, 34 years is sufficient to yield reliable wind characteristics for the area. The use of the factor of 1.68 to adjust the 0900 hour daily wind observation to indicate the maximum daily wind condition was based upon limited data, and it should be studied further. For present purpose of wave height estimation the value should be used until a better estimate is made.

The wind is from the east about 34 percent of the time as shown in figure 2. Other directions shown occur between 3 and 14 percent of the time. A calm exists about 7 percent of the time. Winds rarely exceed force 7 or 28 to 33 knots. April through October are the months when the stronger east and southeast winds dominate. During December through March stronger west and northwest winds appear.

SEAS

The largest wave that reaches the shoreline and breaks upon the seawall will be the critical design wave. As high tide during any 24 hour period is typically 6 to 7 feet (Dr. Klaus Wyrthi tide predictions for 1986) and as a 1 foot wind tide could occur concurrently with large waves, we could expect a wave that breaks in 8 feet of water (2.4 metres) to be a critical design wave on the west side of Fongafale. Wave predictions show this to be between the 30 and 50 year wave for a sloping nearshore on 1:20. steady 45 to 50 knot wind blowing across the lagoon could result in such a wave.

One would not design for a no damage condition, but would accept a modest damage to the seawall rather than commit the resources necessary for the ultimate protection. For most areas the 30 year wave condition may be acceptable. Specific site conditions would indicate when greater protection was desirable.

CURRENTS

Currents in the lagoon near Fongafale were very weak during the survey. Winds produce currents that are between 2.5 and 3.3 percent of the wind speed; hence, wind currents of 1.6 knots could be associated with a 51 knot fifty year wind. Nearshore rip current cells can develop during times of large seas. These events would likely occur only once during a lifetime. Such conditions could reshape nearshore features, but in general, they occur so infrequent as to be of little concern.

Waves appear to be more significant in sand transport on the east side of the lagoon than tide or wind driven currents.

BEACH

The old beach area along the west side of Fongafale has been filled. The present seawall is located in a depth of water where incoming waves when reflected by the seawall have retained sufficient energy to erode any sand at the seawall. In order to maintain a sandy beach it will be necessary to fill the nearshore area on a 1:20 or flatter slope out to a water depth of at least three or four metres water depth and cover the seawall with a significant amount of sand to keep the rock covered. Once this is done with sand having characteristics that result in a stable bottom on a 1:20 slope, one can expect to maintain a beach. Some modification of the various groynes and channels along the shore may also be required. Filling the channels with sand would likely be sufficient.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations reached and made in this report are based upon the data developed in this report and others cited in the references and may be revised a5 additional information is developed or located.

1. Wind data for the 34 years between 1950 and 1984 represent a significant time period, and this data should be a reliable database.

2. The use of the factor 1.68 x the wind speed observed at 0900 hours to estimate the maximum daily value appears to be satisfactory for the estimation of wave characteristics in the lagoon.

3. For routine estimation of waves in the lagoon a fetch of 6.9 nautical miles and a depth of 16.5 fathoms appears to be satisfactory.

4. The observed wave characteristics during winds up to 15 knots agree with theoretical values for the lagoon.

5. East is the dominate wind direction at Funafuti. Winds are from the East at force 2 and 3 or 4 to 10 knots about 30 percent of the time. East winds of force 4 and 5 or 11 to 21 knots occur about 10 percent of the time, and force 7 winds occur only 0.2 percent of the time. There is no wind about 7 percent of the time.

6. Winds from the North, Northeast, and Southeast have similar characteristics to each other, and each occurs about 12 percent of the time. Winds from the West, Southwest and South are less frequent and winds from the Northwest are about 7 percent of the time.

7. The 10 year wind is estimated to be 29 knots and the 100 year wind is about 58 knots.

8. The 10 year wave in the lagoon is about 4 feet in height, and the 20 year wave is 5 feet, and the 50 year wave is 7 feet in significant wave height with a period of 5.8 seconds.

9. The 30 year wave would have a significant wave height of 6 ft and a period of 5.2 seconds. It would break in 7.7 feet of water depth and have a breaker height of 7.1 ft on a 1:20 slope. This is likely the design wave for shore protection facilities.

10. Some addition work should be done for selection of the design wave for different reaches of the shoreline.

11. The wind and tidal currents along the Fongafale shoreline were not significant in sand transport during the two survey periods.

12. Waves can transport sand along the coast and did during the February survey period. As sand is limited in supply at the shoreline of the study area, and the amount of sand moved during the survey was far less than the amount that could be moved by the waves present during the survey.

13. Except during big storms, lagoon currents near Fongafale are quite weak.

14. It will be necessary to dredge a large amount of sand and reestablish the old bottom depths and slopes nearshore if a significant beach is to be developed and maintained along the lagoon side of Fongafale.

15. It is recommended that the wave data developed in this study be used to revise shore protection facilities design at Fongafale.

16. It is recommended that an estimate of Hurricane frequency and wave characteristics of waves produced by these cyclones be made as a future study.

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A] The views expressed in this report are those of the author and do not necessarily reflect those of the United Nations.

B] Mention of any firm of licensed process does not imply endorsement by the United Nations.

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Tables and Figures Follow

TABLE 1

MONTHLY WIND ROSE DATA
FOR FUNAFUTI, TUVALU

MONTH OF JANUARY

CALMS ARE 91

N1 = 20	N2 = 50	N3 = 78	N4 = 56	N5 = 13	N6 = 2	N7 = 0
NE1 = 15	NE2 = 35	NE3 = 56	NE4 = 47	NE5 = 3	NE6 = 2	NE7 = 0
E1 = 19	E2 = 30	E3 = 76	E4 = 47	E5 = 14	E6 = 1	E7 = 1
SE1 = 6	SE2 = 12	SE3 = 9	SE4 = 10	SE5 = 1	SE6 = 0	SE7 = 0
S1 = 6	S2 = 10	S3 = 7	S4 = 4	S5 = 0	S6 = 0	S7 = 0
SW1 = 12	SW2 = 7	SW3 = 20	SW4 = 6	SW5 = 2	SW6 = 1	SW7 = 0
W1 = 8	W2 = 18	W3 = 28	W4 = 30	W5 = 15	W6 = 12	W7 = 2
NW1 = 13	NW2 = 26	NW3 = 52	NW4 = 61	NW5 = 29	NW6 = 18	NW7 = 1

MONTH OF FEBRUARY

CALMS ARE 74

N1 = 30	N2 = 42	N3 = 76	N4 = 58	N5 = 19	N6 = 5	N7 = 0
NE1 = 10	NE2 = 42	NE3 = 52	NE4 = 46	NE5 = 6	NE6 = 0	NE7 = 0
E1 = 23	E2 = 39	E3 = 68	E4 = 69	E5 = 10	E6 = 2	E7 = 0
SE1 = 8	SE2 = 10	SE3 = 14	SE4 = 7	SE5 = 5	SE6 = 0	SE7 = 0
S1 = 3	S2 = 7	S3 = 12	S4 = 4	S5 = 0	S6 = 1	S7 = 0
SW1 = 4	SW2 = 5	SW3 = 6	SW4 = 5	SW5 = 2	SW6 = 0	SW7 = 0
W1 = 3	W2 = 14	W3 = 14	W4 = 26	W5 = 8	W6 = 6	W7 = 1
NW1 = 16	NW2 = 16	NW3 = 31	NW4 = 51	NW5 = 33	NW6 = 8	NW7 = 1

MONTH OF MARCH

CALMS ARE 103

N1 = 27	N2 = 43	N3 = 77	N4 = 42	N5 = 17	N6 = 5	N7 = 0
NE1 = 25	NE2 = 50	NE3 = 51	NE4 = 36	NE5 = 3	NE6 = 1	NE7 = 1
E1 = 33	E2 = 57	E3 = 107	E4 = 99	E5 = 16	E6 = 2	E7 = 0
SE1 = 7	SE2 = 16	SE3 = 23	SE4 = 18	SE5 = 2	SE6 = 1	SE7 = 0
S1 = 1	S2 = 6	S3 = 7	S4 = 5	S5 = 0	S6 = 0	S7 = 0
SW1 = 6	SW2 = 5	SW3 = 2	SW4 = 8	SW5 = 1	SW6 = 0	SW7 = 0
W1 = 1	W2 = 7	W3 = 17	W4 = 17	W5 = 4	W6 = 0	W7 = 0
NW1 = 13	NW2 = 22	NW3 = 38	NW4 = 42	NW5 = 16	NW6 = 8	NW7 = 1

MONTH OF APRIL

CALMS ARE 92

N1 = 27	N2 = 45	N3 = 49	N4 = 19	N5 = 6	N6 = 3	N7 = 0
NE1 = 13	NE2 = 35	NE3 = 27	NE4 = 16	NE5 = 5	NE6 = 0	NE7 = 1
E1 = 37	E2 = 104	E3 = 263	E4 = 93	E5 = 26	E6 = 2	E7 = 1
SE1 = 6	SE2 = 19	SE3 = 40	SE4 = 42	SE5 = 10	SE6 = 2	SE7 = 0
S1 = 7	S2 = 11	S3 = 12	S4 = 6	S5 = 1	S6 = 0	S7 = 0
SW1 = 12	SW2 = 4	SW3 = 5	SW4 = 0	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 6	W2 = 8	W3 = 6	W4 = 4	W5 = 4	W6 = 0	W7 = 0
NW1 = 7	NW2 = 23	NW3 = 26	NW4 = 12	NW5 = 8	NW6 = 1	NW7 = 0

TABLE I (Contd)

MONTH OF MAY

CALMS ARE 91

N1 = 15	N2 = 24	N3 = 28	N4 = 5	N5 = 1	N6 = 0	N7 = 0
NE1 = 14	NE2 = 28	NE3 = 38	NE4 = 13	NE5 = 4	NE6 = 0	NE7 = 0
E1 = 57	E2 = 155	E3 = 230	E4 = 153	E5 = 51	E6 = 7	E7 = 0
SE1 = 8	SE2 = 22	SE3 = 44	SE4 = 79	SE5 = 26	SE6 = 3	SE7 = 0
S1 = 9	S2 = 4	S3 = 8	S4 = 6	S5 = 1	S6 = 0	S7 = 0
SW1 = 2	SW2 = 4	SW3 = 2	SW4 = 0	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 2	W2 = 7	W3 = 5	W4 = 0	W5 = 0	W6 = 0	W7 = 0
NW1 = 3	NW2 = 13	NW3 = 6	NW4 = 5	NW5 = 2	NW6 = 0	NW7 = 0

MONTH OF JUNE

CALMS ARE 62

N1 = 15	N2 = 19	N3 = 20	N4 = 8	N5 = 0	N6 = 0	N7 = 0
NE1 = 11	NE2 = 24	NE3 = 27	NE4 = 13	NE5 = 2	NE6 = 0	NE7 = 0
E1 = 39	E2 = 117	E3 = 279	E4 = 182	E5 = 90	E6 = 13	E7 = 1
SE1 = 7	SE2 = 22	SE3 = 50	SE4 = 85	SE5 = 46	SE6 = 6	SE7 = 0
S1 = 6	S2 = 6	S3 = 9	S4 = 5	S5 = 0	S6 = 0	S7 = 0
SW1 = 4	SW2 = 0	SW3 = 3	SW4 = 0	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 0	W2 = 0	W3 = 2	W4 = 1	W5 = 0	W6 = 0	W7 = 0
NW1 = 2	NW2 = 4	NW3 = 5	NW4 = 1	NW5 = 1	NW6 = 0	NW7 = 0

MONTH OF JULY

CALMS ARE 58

N1 = 8	N2 = 14	N3 = 17	N4 = 7	N5 = 1	N6 = 0	N7 = 0
NE1 = 9	NE2 = 17	NE3 = 30	NE4 = 11	NE5 = 3	NE6 = 1	NE7 = 1
E1 = 49	E2 = 102	E3 = 357	E4 = 171	E5 = 89	E6 = 17	E7 = 2
SE1 = 4	SE2 = 16	SE3 = 46	SE4 = 107	SE5 = 68	SE6 = 22	SE7 = 1
S1 = 2	S2 = 5	S3 = 9	S4 = 6	S5 = 2	S6 = 0	S7 = 0
SW1 = 2	SW2 = 1	SW3 = 2	SW4 = 0	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 0	W2 = 2	W3 = 1	W4 = 0	W5 = 0	W6 = 0	W7 = 0
NW1 = 2	NW2 = 2	NW3 = 1	NW4 = 1	NW5 = 0	NW6 = 0	NW7 = 0

MONTH OF AUGUST

CALMS ARE 47

N1 = 3	N2 = 11	N3 = 12	N4 = 8	N5 = 0	N6 = 0	N7 = 0
NE1 = 5	NE2 = 15	NE3 = 25	NE4 = 13	NE5 = 2	NE6 = 1	NE7 = 2
E1 = 40	E2 = 146	E3 = 489	E4 = 169	E5 = 81	E6 = 15	E7 = 1
SE1 = 9	SE2 = 14	SE3 = 46	SE4 = 112	SE5 = 63	SE6 = 20	SE7 = 3
S1 = 5	S2 = 5	S3 = 8	S4 = 3	S5 = 2	S6 = 1	S7 = 0
SW1 = 2	SW2 = 1	SW3 = 1	SW4 = 1	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 2	W2 = 1	W3 = 0	W4 = 0	W5 = 0	W6 = 0	W7 = 0
NW1 = 0	NW2 = 4	NW3 = 2	NW4 = 0	NW5 = 1	NW6 = 0	NW7 = 0

TABLE I (Contd)

MONTH OF SEPTEMBER

CALMS ARE 45

N1 = 12	N2 = 17	N3 = 15	N4 = 9	N5 = 0	N6 = 0	N7 = 0
NE1 = 9	NE2 = 22	NE3 = 40	NE4 = 23	NE5 = 4	NE6 = 0	NE7 = 1
E1 = 41	E2 = 112	E3 = 297	E4 = 187	E5 = 75	E6 = 16	E7 = 2
SE1 = 9	SE2 = 15	SE3 = 59	SE4 = 93	SE5 = 47	SE6 = 14	SE7 = 0
S1 = 1	S2 = 7	S3 = 6	S4 = 14	S5 = 3	S6 = 0	S7 = 0
SW1 = 4	SW2 = 0	SW3 = 2	SW4 = 1	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 1	W2 = 0	W3 = 1	W4 = 0	W5 = 0	W6 = 0	W7 = 0
NW1 = 1	NW2 = 4	NW3 = 2	NW4 = 1	NW5 = 0	NW6 = 0	NW7 = 0

MONTH OF OCTOBER

CALMS ARE 78

N1 = 12	N2 = 34	N3 = 48	N4 = 23	N5 = 3	N6 = 1	N7 = 0
NE1 = 19	NE2 = 32	NE3 = 58	NE4 = 31	NE5 = 2	NE6 = 0	NE7 = 1
E1 = 40	E2 = 73	E3 = 214	E4 = 121	E5 = 35	E6 = 6	E7 = 2
SE1 = 14	SE2 = 18	SE3 = 52	SE4 = 63	SE5 = 23	SE6 = 1	SE7 = 0
S1 = 8	S2 = 6	S3 = 15	S4 = 6	S5 = 3	S6 = 0	S7 = 0
SW1 = 0	SW2 = 2	SW3 = 0	SW4 = 2	SW5 = 0	SW6 = 0	SW7 = 0
W1 = 4	W2 = 3	W3 = 3	W4 = 1	W5 = 0	W6 = 0	W7 = 0
NW1 = 6	NW2 = 15	NW3 = 8	NW4 = 5	NW5 = 2	NW6 = 0	NW7 = 1

MONTH OF NOVEMBER

CALMS ARE 95

N1 = 25	N2 = 42	N3 = 74	N4 = 53	N5 = 5	N6 = 3	N7 = 0
NE1 = 14	NE2 = 35	NE3 = 54	NE4 = 39	NE5 = 5	NE6 = 2	NE7 = 2
E1 = 44	E2 = 53	E3 = 121	E4 = 71	E5 = 12	E6 = 2	E7 = 0
SE1 = 14	SE2 = 17	SE3 = 44	SE4 = 42	SE5 = 17	SE6 = 1	SE7 = 0
S1 = 6	S2 = 12	S3 = 14	S4 = 3	S5 = 1	S6 = 1	S7 = 0
SW1 = 12	SW2 = 6	SW3 = 5	SW4 = 0	SW5 = 1	SW6 = 0	SW7 = 0
W1 = 3	W2 = 5	W3 = 13	W4 = 5	W5 = 0	W6 = 0	W7 = 0
NW1 = 9	NW2 = 14	NW3 = 20	NW4 = 22	NW5 = 8	NW6 = 1	NW7 = 0

MONTH OF DECEMBER

CALMS ARE 95

N1 = 28	N2 = 51	N3 = 73	N4 = 48	N5 = 16	N6 = 4	N7 = 0
NE1 = 11	NE2 = 38	NE3 = 36	NE4 = 36	NE5 = 7	NE6 = 0	NE7 = 0
E1 = 34	E2 = 48	E3 = 88	E4 = 68	E5 = 12	E6 = 1	E7 = 0
SE1 = 10	SE2 = 18	SE3 = 36	SE4 = 29	SE5 = 7	SE6 = 1	SE7 = 0
S1 = 3	S2 = 11	S3 = 19	S4 = 9	S5 = 1	S6 = 0	S7 = 0
SW1 = 6	SW2 = 3	SW3 = 8	SW4 = 8	SW5 = 2	SW6 = 2	SW7 = 0
W1 = 6	W2 = 13	W3 = 24	W4 = 26	W5 = 4	W6 = 2	W7 = 2
NW1 = 6	NW2 = 25	NW3 = 39	NW4 = 37	NW5 = 31	NW6 = 6	NW7 = 0

TABLE II

ANNUAL WIND ROSE DATA
FOR FUNAFUTI, TUVALU
1950-1984

MONTH OF FUNYEAR

CALMS ARE 931

N1 = 222	N2 = 392	N3 = 567	N4 = 336	N5 = 81	N6 = 23
NE1 = 155	NE2 = 373	NE3 = 494	NE4 = 324	NE5 = 46	NE6 = 7
E1 = 456	E2 = 1044	E3 = 2589	E4 = 1430	E5 = 511	E6 = 84
SE1 = 102	SE2 = 199	SE3 = 463	SE4 = 687	SE5 = 315	SE6 = 71
S1 = 57	S2 = 90	S3 = 126	S4 = 71	S5 = 14	S6 = 3
SW1 = 66	SW2 = 38	SW3 = 56	SW4 = 31	SW5 = 8	SW6 = 3
W1 = 36	W2 = 78	W3 = 114	W4 = 110	W5 = 35	W6 = 20
NW1 = 78	NW2 = 168	NW3 = 230	NW4 = 238	NW5 = 131	NW6 = 42

TABLE III

34 YEARS FUNAFUTI WIND DATA

The total number of observations are: 13777

DIRECTION	PERCENT DAYS AT BEAUFORT FORCE NUMBER						
	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
NORTH	1.611	2.845	4.116	2.439	0.588	0.167	0.000
NORTHEAST	1.125	2.707	3.586	2.352	0.334	0.051	0.065
EAST	3.310	7.578	18.792	10.380	3.709	0.610	0.073
SOUTHEAST	0.740	1.444	3.361	4.987	2.286	0.515	0.029
SOUTH	0.414	0.653	0.915	0.515	0.102	0.022	0.000
SOUTHWEST	0.479	0.276	0.406	0.225	0.058	0.022	0.000
WEST	0.261	0.566	0.827	0.798	0.254	0.145	0.036
NORTHWEST	0.566	1.219	1.669	1.728	0.951	0.305	0.029

The days of calm was 6.758 percent

TABLE V

AVERAGED SURFACE CURRENT VECTORS

Station No. 2 Date: 11 FEBRUARY 1986

FILE: C:\DATA\AVR012.TXT
LINES RECORDED: 117

LINE NO.	TIME Hrs.	SPEED M/S	BEARING True	NORTHING M	NORTHING M	EASTING M	EASTING M	RANGE M	BEARING Deg
1	940	0.020	251	-8		-22			
2	1000	0.020	288	7		-23			
3	1020	0.019	271	0		-22			
4	1040	0.019	224	-17		-16			
5	1100	0.020	314	17		-18			
6	1120	0.020	298	12		-22			
7	1140	0.020	287	7		-23			
8	1200	0.020	281	5		-23			
9	1220	0.019	191	-23		-4			
10	1240	0.019	182	-23		-1			
11	1300	0.020	206	-21		-11			
12	1320	0.020	187	-24		-3			
13	1340	0.020	197	-23		-7			
14	1400	0.020	215	-20		-14			
15	1420	0.021	200	-23		-9			
16	1440	0.020	188	-24		-3			
17	1500	0.020	182	-25		-1			
18	1520	0.020	186	-24		-2			
19	1540	0.020	176	-24		2			
20	1600	0.020	184	-24		-2			
21	1620	0.020	212	-20		-13			
22	1640	0.020	199	-23		-8			
23	1700	0.020	187	-24		-3			
24	1720	0.020	209	-21		-12			
25	1740	0.020	210	-21		-12			
26	1800	0.020	196	-23		-6			
27	1820	0.021	169	-24		5			
28	1840	0.020	140	-19		16			
29	1900	0.020	160	-23		8			
30	1920	0.020	174	-24		3			
31	1940	0.021	173	-25		3			
32	2000	0.021	162	-24		8			
33	2020	0.021	169	-25		5			
34	2040	0.020	175	-24		2			
35	2100	0.021	146	-21		14			
36	2120	0.021	161	-24		8			
37	2140	0.021	150	-22		12			
38	2200	0.021	136	-18		17			
39	2220	0.020	124	-14		20			
40	2240	0.020	105	-6		24			
41	2300	0.020	77	6		23			
42	2320	0.020	142	-19		15			
43	2340	0.020	57	13		20			
44	0	0.019	62	11		20			
45	20	0.020	105	-6		24			
46	40	0.019	83	3		23			
47	100	0.018	64	9		19			
48	120	0.018	53	13		17			
49	140	0.019	110	-8		22			
50	200	0.020	109	-8		22			

TABLE V

AVERAGED SURFACE CURRENT VECTORS

Station No. 2 Date: 11 FEBRUARY 1986 FILE: C:\DATA\AVR012.TXT

LINES RECORDED: 117

LINE NO.	TIME Hrs.	SPEED M/S	BEARING True	NORTHING M	M	EASTING M	M	RANGE M	BEARING Deg
51	228	0.018	88	1		22			
52	248	0.020	118	-11		22			
53	308	0.020	115	-10		22			
54	328	0.020	144	-20		14			
55	348	0.021	147	-21		13			
56	408	0.021	155	-23		10			
57	428	0.020	177	-25		1			
58	448	0.020	84	3		24			
59	508	0.020	184	-24		-2			
60	528	0.020	197	-23		-7			
61	548	0.019	188	-23		-3			
62	608	0.020	321	19		-15			
63	628	0.020	234	-14		-20			
64	648	0.020	189	-24		-4			
65	708	0.020	242	-11		-21			
66	728	0.021	301	13		-21			
67	748	0.021	330	21		-12			
68	808	0.021	320	20		-16			
69	828	0.021	352	24		-4			
70	848	0.021	302	13		-21			
71	908	0.021	354	25		-3			
72	928	0.021	318	18		-17			
73	948	0.021	223	-18		-17			
74	1008	0.020	210	-21		-12			
75	1028	0.020	270	-0		-25			
76	1048	0.021	340	23		-9			
77	1108	0.021	341	23		-8			
78	1128	0.021	356	26		-2			
79	1148	0.022	354	27		-3			
80	1208	0.022	356	26		-2			
81	1228	0.022	356	26		-2			
82	1248	0.022	340	25		-9			
83	1308	0.022	329	23		-14			
84	1328	0.022	359	27		-1			
85	1348	0.021	344	25		-7			
86	1408	0.021	357	25		-1			
87	1428	0.022	356	26		-2			
88	1448	0.021	360	25		0			
89	1508	0.021	344	24		-7			
90	1528	0.021	343	24		-7			
91	1548	0.021	343	24		-7			
92	1608	0.021	354	25		-2			
93	1628	0.020	355	24		-2			
94	1648	0.020	348	24		-5			
95	1708	0.021	354	25		-3			
96	1728	0.020	337	23		-10			
97	1748	0.020	358	25		-1			
98	1808	0.021	319	19		-16			
99	1828	0.020	338	23		-9			
100	1848	0.020	329	21		-13			
101	1908	0.021	321	19		-16			

TABLE V

AVERAGED SURFACE CURRENT VECTORS

Station No. 2 Date: 11 FEBRUARY 1986 FILE: C:\DATA\AVR012.TXT

LINES RECORDED: 117

LINE NO.	TIME Hrs.	SPEED M/S	BEARING True	NORTHING M	NORTHING M	EASTING M	EASTING M	RANGE M	BEARING Deg
102	1928	0.021	302	13		-22			
103	1948	0.021	318	19		-17			
104	2008	0.021	271	1		-25			
105	2028	0.021	332	22		-12			
106	2048	0.021	304	14		-21			
107	2108	0.021	288	8		-24			
108	2128	0.021	306	15		-20			
109	2148	0.022	314	18		-19			
110	2208	0.021	284	6		-25			
111	2228	0.022	301	14		-23			
112	2248	0.022	340	25		-9			
113	2308	0.022	240	-13		-23			
114	2328	0.021	155	-23		11			
115	2348	0.021	262	-4		-25			
116	8	0.021	77	6		25			
117	28	0.021	233	-15	-48	-20	-423	426	263

TABLE VI

FUNAFUTI SURFACE WATER CHARACTERISTICS

Station No. 2 Date: 11 FEBRUARY 1986 FILE: C:\DATA\AVR012.TXT

Number #	Time Hrs	Temp Deg	Depth M	EC Mmhos/cm	Salinity PPT	Density Kg/CuM
1	940	29.99	2.1	57.19	34.22	1021.15
2	1000	29.99	2.1	57.19	34.22	1021.15
3	1020	29.99	2.0	57.19	34.22	1021.15
4	1040	29.99	1.9	57.19	34.22	1021.15
5	1100	29.99	1.8	57.18	34.21	1021.14
6	1120	29.99	1.7	57.15	34.19	1021.13
7	1140	30.00	1.7	57.19	34.21	1021.14
8	1200	30.01	1.6	57.19	34.20	1021.12
9	1220	30.02	1.6	57.19	34.19	1021.12
10	1240	30.04	1.6	57.19	34.18	1021.10
11	1300	30.05	1.6	57.19	34.17	1021.09
12	1320	30.06	1.6	57.18	34.16	1021.08
13	1340	30.07	1.6	57.18	34.15	1021.07
14	1400	30.10	1.6	57.19	34.14	1021.05
15	1420	30.05	1.7	57.12	34.13	1021.06
16	1440	30.02	1.8	57.10	34.13	1021.07
17	1500	30.01	1.9	57.04	34.10	1021.05
18	1520	30.01	2.0	57.04	34.10	1021.05
19	1540	30.01	2.2	57.04	34.10	1021.05
20	1600	29.99	2.3	57.04	34.11	1021.07
21	1620	30.01	2.4	57.04	34.10	1021.05
22	1640	30.01	2.5	57.04	34.10	1021.05
23	1700	30.02	2.7	57.07	34.11	1021.06
24	1720	30.02	2.8	57.07	34.12	1021.06
25	1740	30.01	2.9	57.04	34.10	1021.05
26	1800	29.99	3.0	57.04	34.11	1021.07
27	1820	29.98	3.0	57.04	34.12	1021.08
28	1840	29.97	7.3	54.53	32.45	1019.83
29	1900	29.96	3.1	57.04	34.13	1021.09
30	1920	29.96	3.1	57.04	34.13	1021.09
31	1940	29.96	3.0	57.04	34.13	1021.09
32	2000	29.95	3.0	57.00	34.12	1021.08
33	2020	29.94	2.9	56.96	34.10	1021.07
34	2040	29.94	2.8	56.96	34.10	1021.07
35	2100	29.92	2.7	56.96	34.11	1021.09
36	2120	29.91	2.5	56.96	34.12	1021.10
37	2140	29.90	2.4	56.96	34.13	1021.11
38	2200	29.90	2.3	56.95	34.12	1021.10
39	2220	29.90	2.2	56.96	34.13	1021.11
40	2240	29.88	2.1	56.89	34.09	1021.09
41	2300	29.87	1.9	56.89	34.10	1021.10
42	2320	29.87	1.8	56.89	34.10	1021.10
43	2340	29.87	1.8	56.89	34.10	1021.10
44	0	29.86	1.7	56.88	34.10	1021.11
45	20	29.85	1.6	56.89	34.11	1021.11
46	40	29.85	1.6	56.89	34.11	1021.12
47	100	29.84	1.6	56.89	34.12	1021.12
48	120	29.84	1.6	56.87	34.11	1021.11
49	140	29.84	1.6	56.81	34.07	1021.09
50	200	29.82	1.6	56.81	34.08	1021.10

TABLE VI

FUNAFUTI SURFACE WATER CHARACTERISTICS

Station No. 2 Date: 11 FEBRUARY 1986 FILE: C:\DATA\AVR012.TXT

Number #	Time Hrs	Temp Deg	Depth M	EC Mmhos/cm	Salinity PPT	Density Kg/CuM
51	220	29.82	1.5	56.81	34.08	1021.11
52	240	29.81	1.7	56.79	34.07	1021.10
53	300	29.81	1.9	56.80	34.08	1021.11
54	320	29.79	1.9	56.75	34.06	1021.09
55	340	29.79	2.0	56.74	34.05	1021.09
56	400	29.78	2.1	56.74	34.06	1021.10
57	420	29.77	2.3	56.74	34.07	1021.11
58	440	29.76	2.4	56.74	34.07	1021.12
59	500	29.75	2.5	56.74	34.08	1021.13
60	520	29.75	2.6	56.74	34.08	1021.12
61	540	29.75	2.6	56.74	34.08	1021.12
62	600	29.76	2.7	56.74	34.07	1021.12
63	620	29.74	2.8	56.74	34.08	1021.13
64	640	29.74	2.9	56.74	34.09	1021.13
65	700	29.74	2.9	56.71	34.08	1021.13
66	720	29.72	2.9	56.66	34.05	1021.12
67	740	29.70	2.9	56.66	34.07	1021.13
68	800	29.71	2.9	56.66	34.06	1021.13
69	820	29.72	2.9	56.66	34.05	1021.12
70	840	29.72	2.8	56.66	34.05	1021.12
71	900	29.72	2.8	56.66	34.05	1021.12
72	920	29.72	2.7	56.66	34.05	1021.12
73	940	29.72	2.5	56.66	34.05	1021.12
74	1000	29.71	2.4	56.66	34.06	1021.12
75	1020	29.71	2.4	56.66	34.06	1021.12
76	1040	29.70	2.2	56.66	34.06	1021.13
77	1100	29.70	2.2	56.68	34.08	1021.14
78	1120	29.76	2.0	56.81	34.13	1021.16
79	1140	29.76	2.0	56.81	34.12	1021.15
80	1200	29.77	1.9	56.81	34.12	1021.15
81	1220	29.77	1.9	56.81	34.12	1021.15
82	1240	29.78	1.6	56.81	34.11	1021.14
83	1300	29.79	1.9	56.81	34.10	1021.13
84	1320	29.79	1.9	56.81	34.10	1021.13
85	1340	29.81	1.9	56.81	34.09	1021.11
86	1400	29.81	1.8	56.81	34.09	1021.11
87	1420	29.81	1.8	56.81	34.09	1021.11
88	1440	29.82	1.8	56.81	34.08	1021.11
89	1500	29.82	2.0	56.81	34.08	1021.11
90	1520	29.82	2.0	56.81	34.08	1021.10
91	1540	29.82	2.1	56.81	34.08	1021.10
92	1600	29.82	2.2	56.81	34.08	1021.11
93	1620	29.82	2.3	56.81	34.09	1021.11
94	1640	29.83	2.4	56.83	34.08	1021.10
95	1700	29.83	2.5	56.82	34.08	1021.10
96	1720	29.83	2.6	56.82	34.08	1021.10
97	1740	29.83	2.7	56.81	34.08	1021.10
98	1800	29.83	2.8	56.83	34.09	1021.10
99	1820	29.83	2.9	56.83	34.09	1021.10
100	1840	29.82	3.0	56.81	34.08	1021.11
101	1900	29.82	3.0	56.81	34.09	1021.11

TABLE VI

FUNAFUTI SURFACE WATER CHARACTERISTICS

Station No. 2 Date: 11 FEBRUARY 1986 FILE: C:\DATA\AVR012.TXT

Number #	Time Hrs	Temp Deg	Depth M	EC Mmhos/cm	Salinity PPT	Density Kg/CuM
102	1928	29.81	3.0	56.81	34.09	1021.11
103	1948	29.80	3.0	56.81	34.09	1021.12
104	2008	29.80	3.0	56.81	34.10	1021.12
105	2028	29.79	2.9	56.81	34.10	1021.13
106	2048	29.79	2.9	56.81	34.10	1021.13
107	2108	29.79	2.9	56.81	34.10	1021.13
108	2128	29.79	2.8	56.81	34.10	1021.13
109	2148	29.79	2.7	56.81	34.10	1021.13
110	2208	29.79	2.5	56.81	34.10	1021.13
111	2228	29.78	2.4	56.80	34.11	1021.14
112	2248	29.77	2.2	56.79	34.10	1021.14
113	2308	29.77	2.1	56.76	34.08	1021.12
114	2328	29.76	2.0	56.61	33.99	1021.06
115	2348	29.74	1.9	56.74	34.08	1021.13
116	8	29.74	1.8	56.74	34.09	1021.13
117	28	29.73	1.8	56.72	34.08	1021.13

End of Data Collection

TABLE IV

FONGAFALE CURRENT DATA

Station : 1 Date : 16 July 1985

TIME	DEPTH	SPEED	DEG
900	1.0	0.003	11
930	1.0	0.001	11
1000	1.0	0.003	11
1030	1.0	0.003	236
1100	1.0	0.004	236
1130	1.0	0.001	251
1200	1.0	0.005	241
1230	1.0	0.010	201
1300	1.0	0.005	251
1330	1.0	0.008	261
1400	1.0	0.009	246
1430	1.0	0.008	261
1500	1.0	0.007	241
1530	1.0	0.015	246
1600	1.0	0.017	236
1630	1.0	0.019	281
1700	1.0	0.008	281
1730	1.0	0.002	281
1800	1.0	0.002	281
1830	1.0	0.001	281
1900	1.0	0.003	281

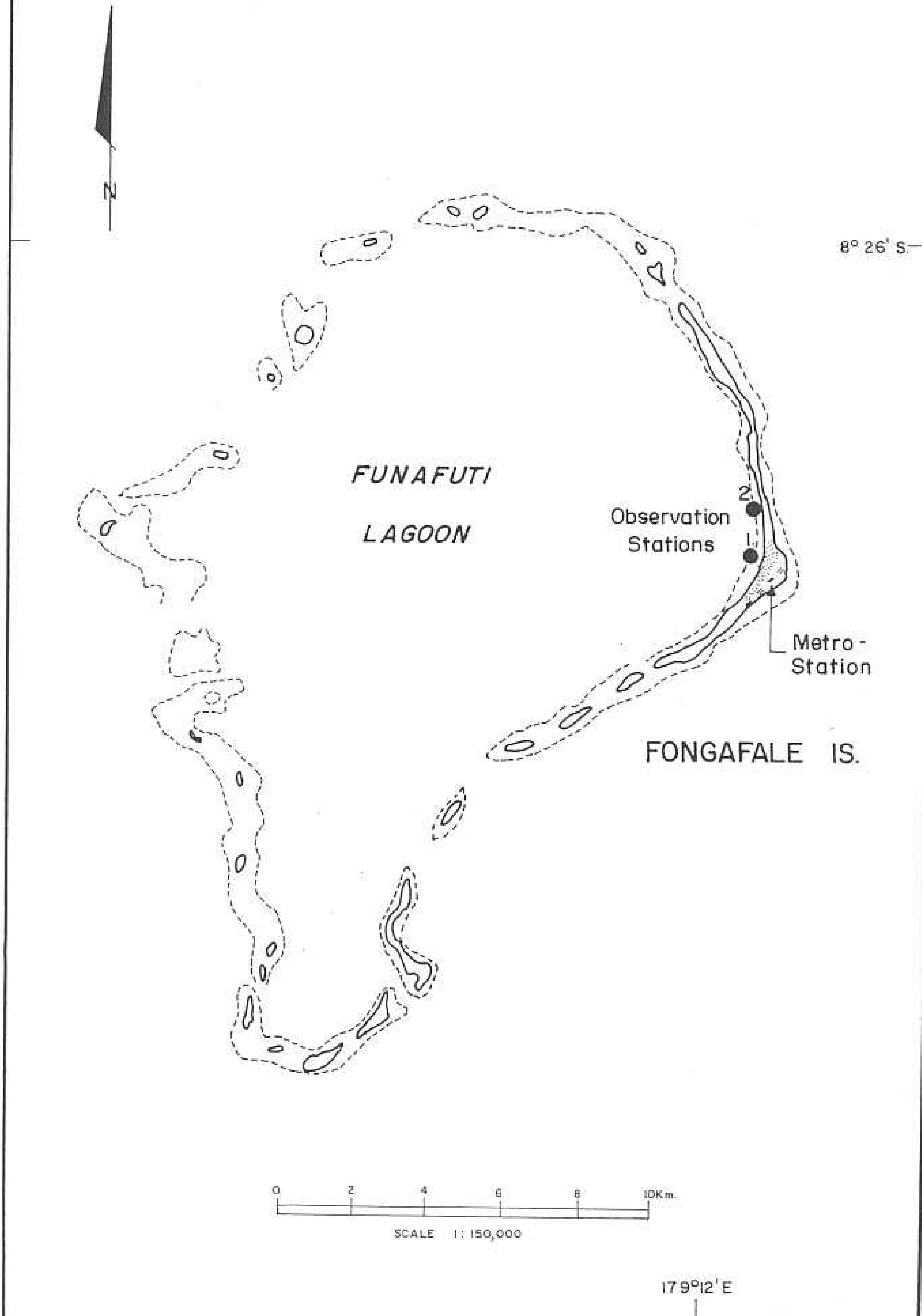
TABLE IV

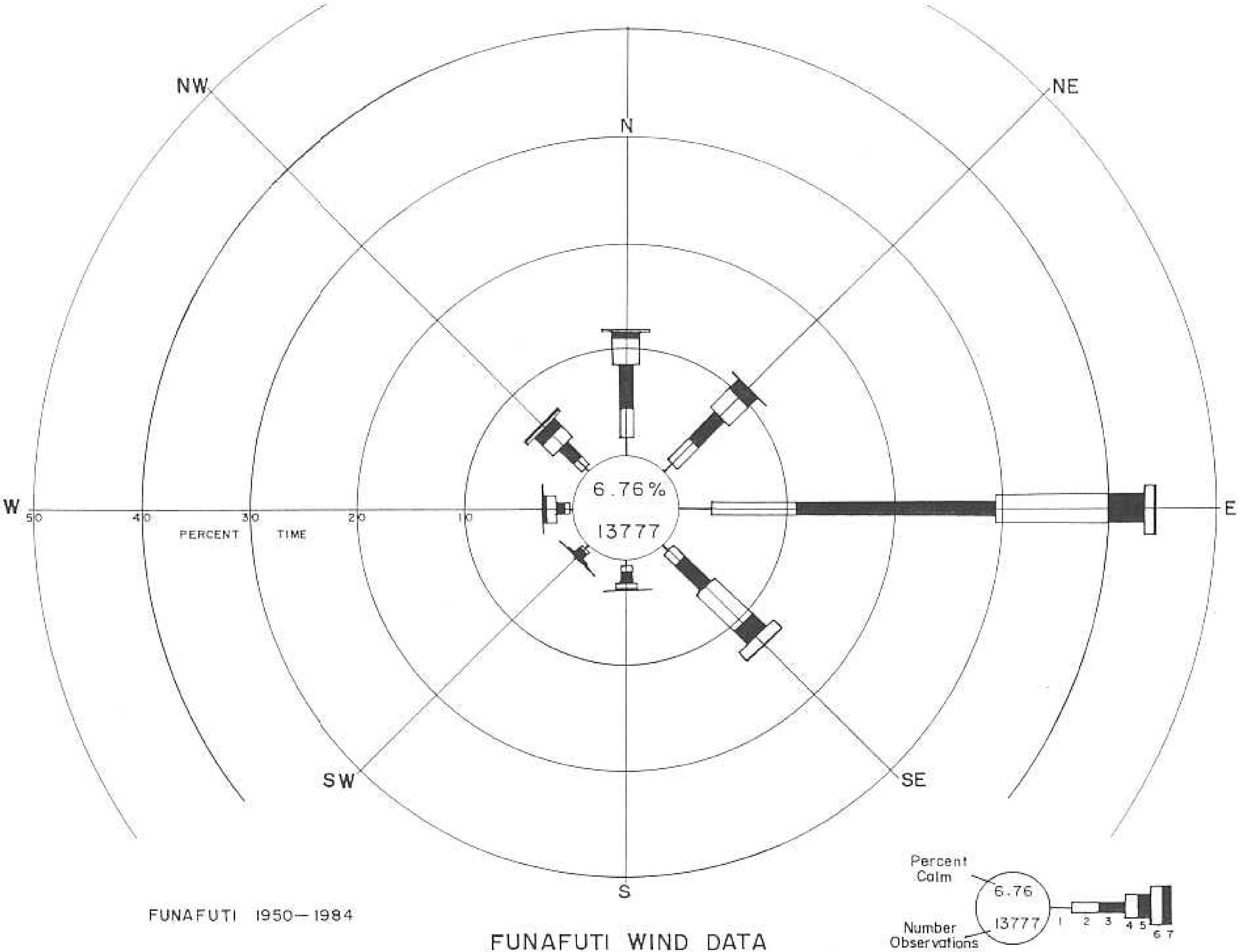
FONGAFALE CURRENT DATA

Station : 1 Date : 16 July 1985

TIME	DEPTH	SPEED	DEG
900	1.0	0.003	11
930	1.0	0.001	11
1000	1.0	0.003	11
1030	1.0	0.003	236
1100	1.0	0.004	236
1130	1.0	0.001	251
1200	1.0	0.005	241
1230	1.0	0.010	201
1300	1.0	0.005	251
1330	1.0	0.008	261
1400	1.0	0.009	246
1430	1.0	0.008	261
1500	1.0	0.007	241
1530	1.0	0.015	246
1600	1.0	0.017	236
1630	1.0	0.019	281
1700	1.0	0.008	281
1730	1.0	0.002	281
1800	1.0	0.002	281
1830	1.0	0.001	281
1900	1.0	0.003	281

FIGURE 1.


N
8° 26' S.
FUNAFUTI
LAGOON
2
Observation
Stations
1
Metro-
Station
FONGAFALE IS.
0
2
4
6
8
10Km.
SCALE 1: 150,000
179°12'E



FUNAFUTI 1950—1984

FUNAFUTI WIND DATA

Figure 2.

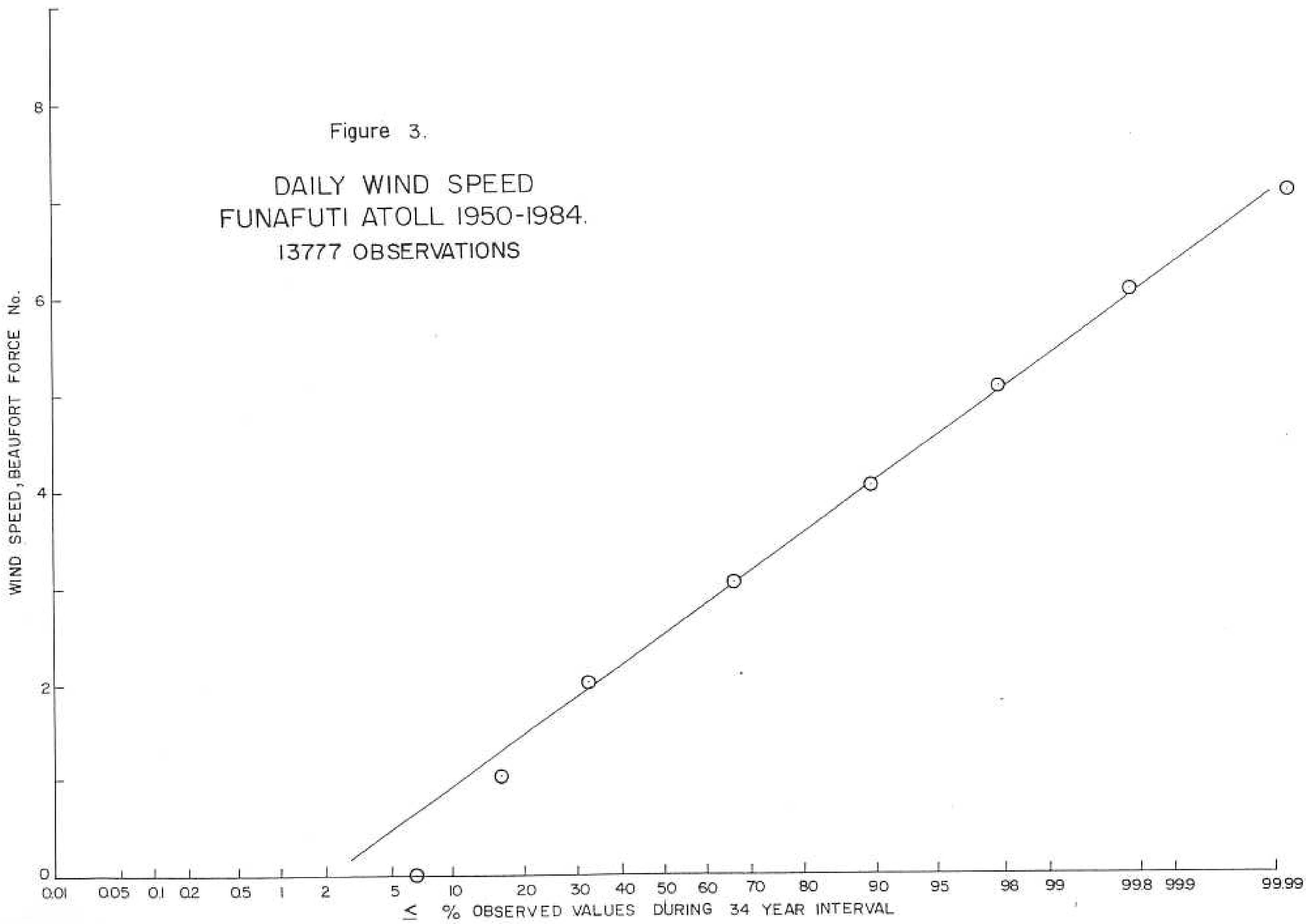


Figure 3.

DAILY WIND SPEED
FUNAFUTI ATOLL 1950-1984.
13777 OBSERVATIONS

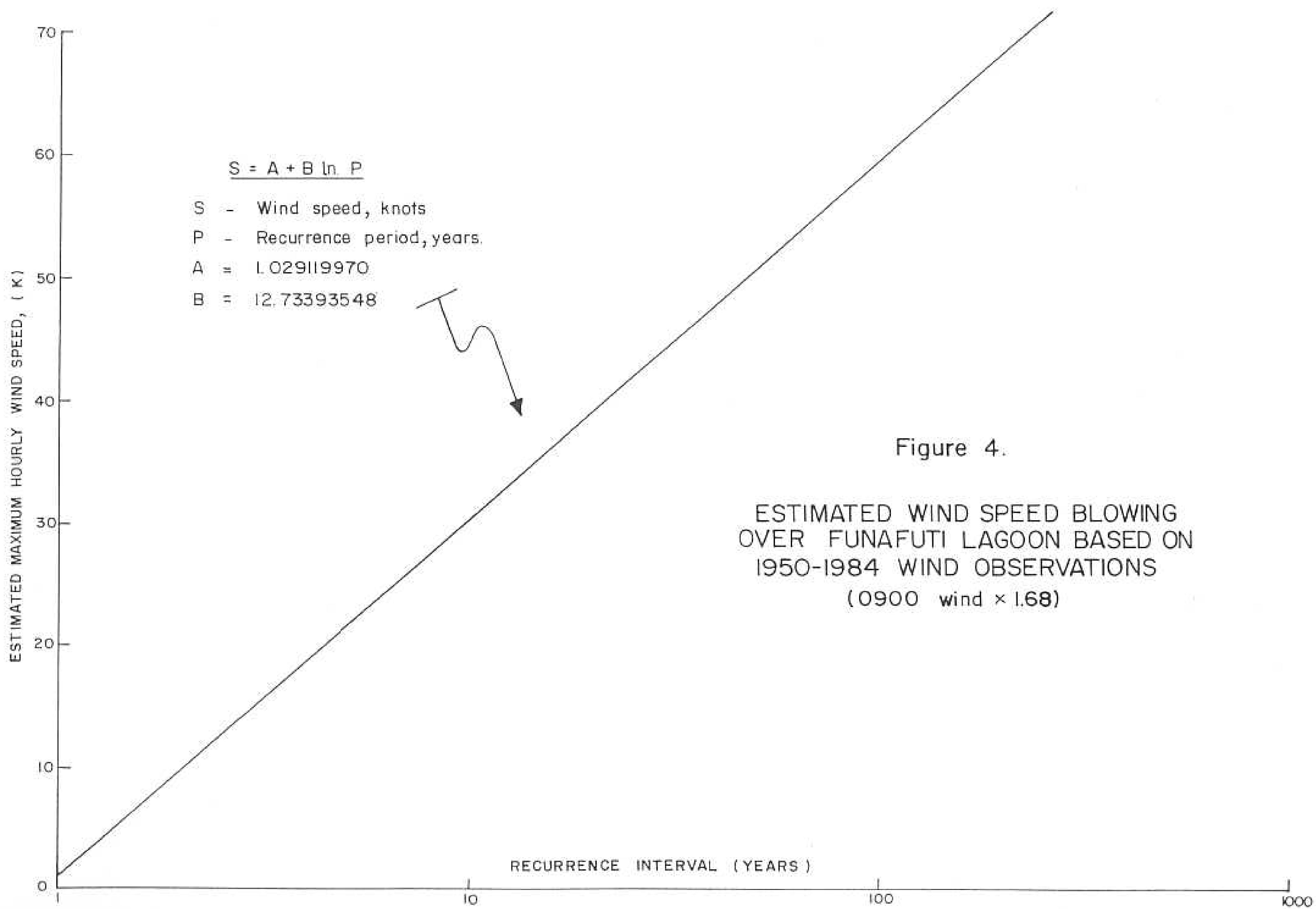


Figure 4.

ESTIMATED WIND SPEED BLOWING OVER FUNAFUTI LAGOON BASED ON 1950-1984 WIND OBSERVATIONS (0900 wind × 1.68)

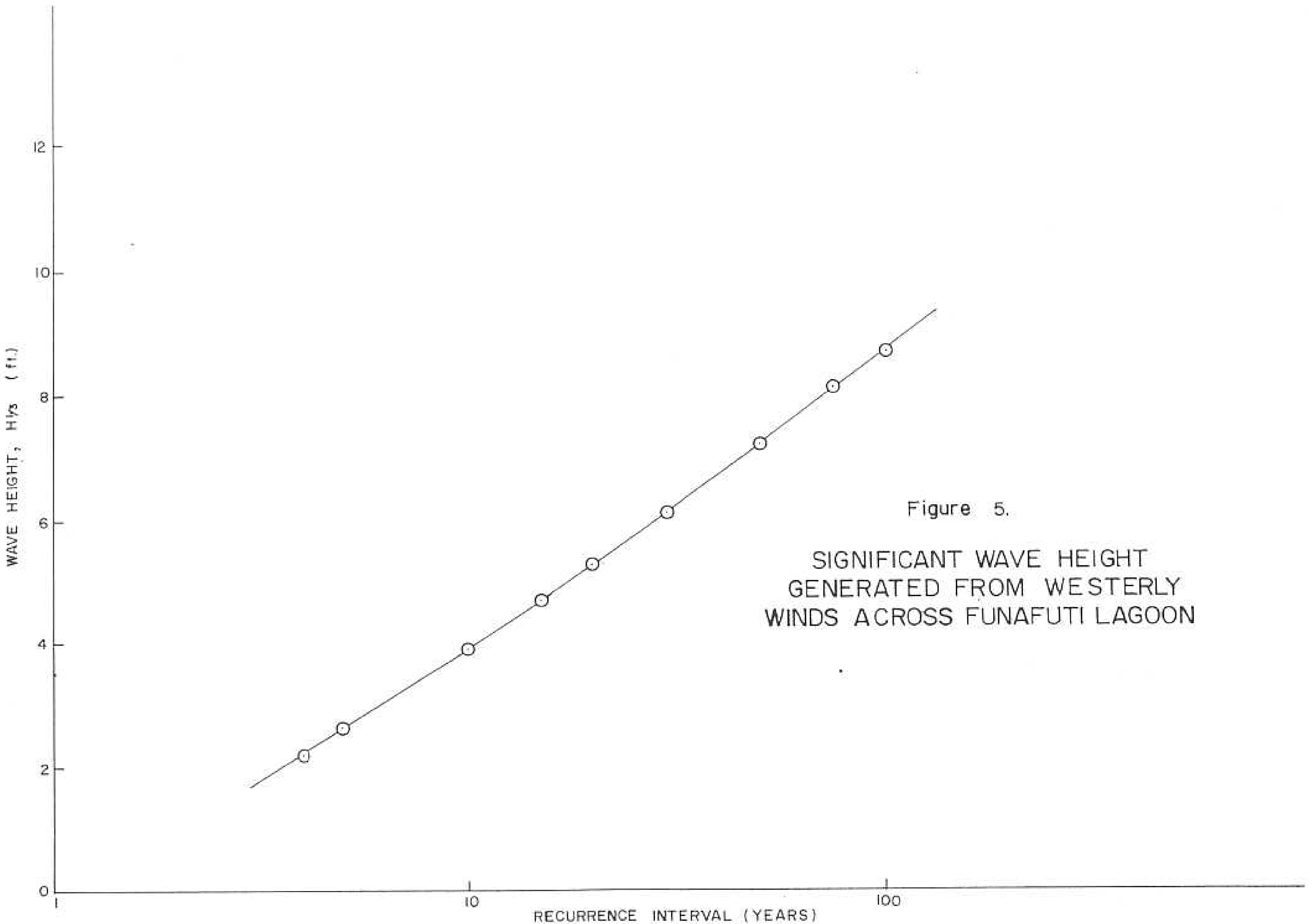


Figure 5.

SIGNIFICANT WAVE HEIGHT GENERATED FROM WESTERLY WINDS ACROSS FUNAFUTI LAGOON

FIGURE 6

CURRENT IN FUNATUTI LAGOON
VAIAKU, STATION 1
16 JULY 1985
W = .2

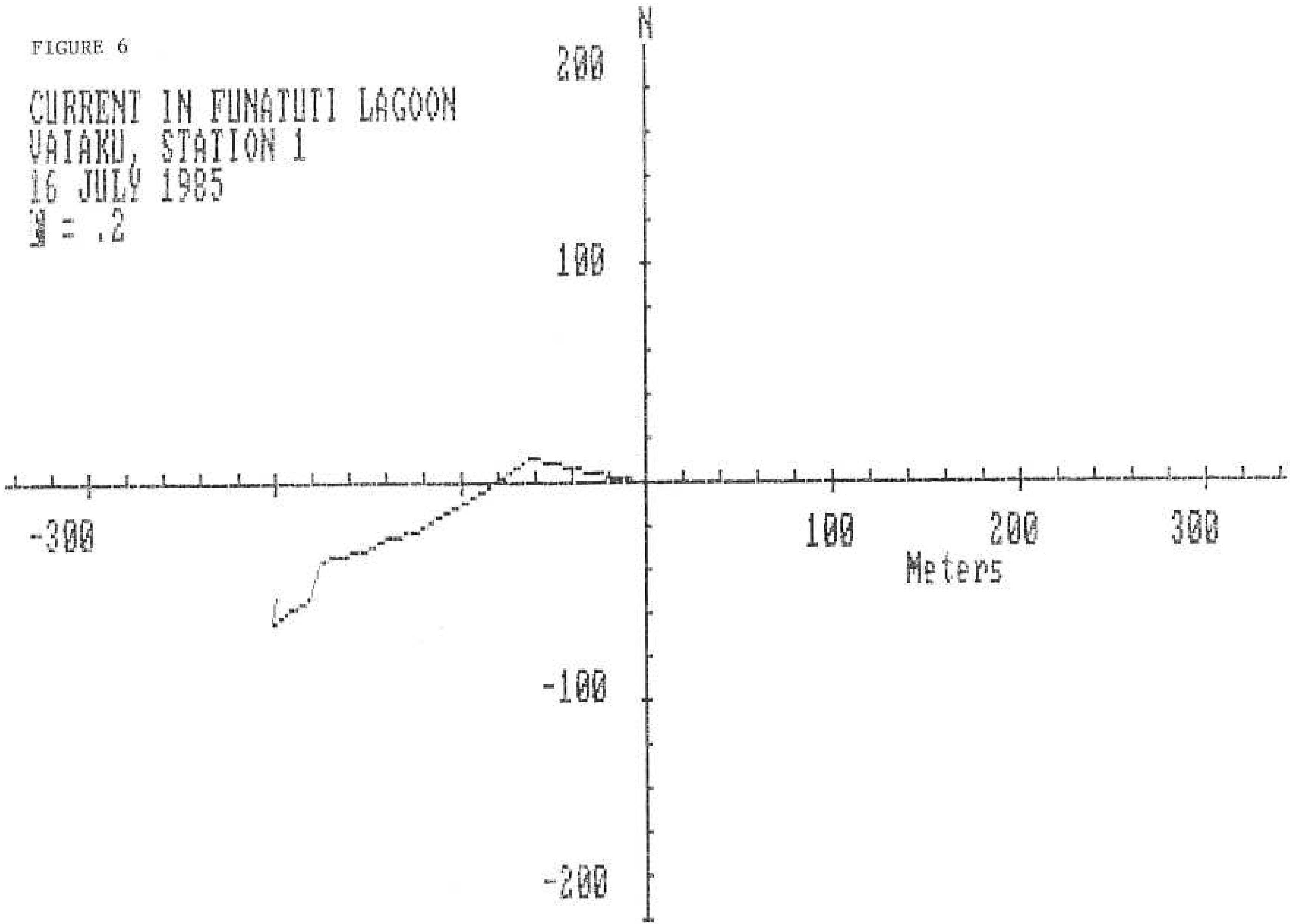
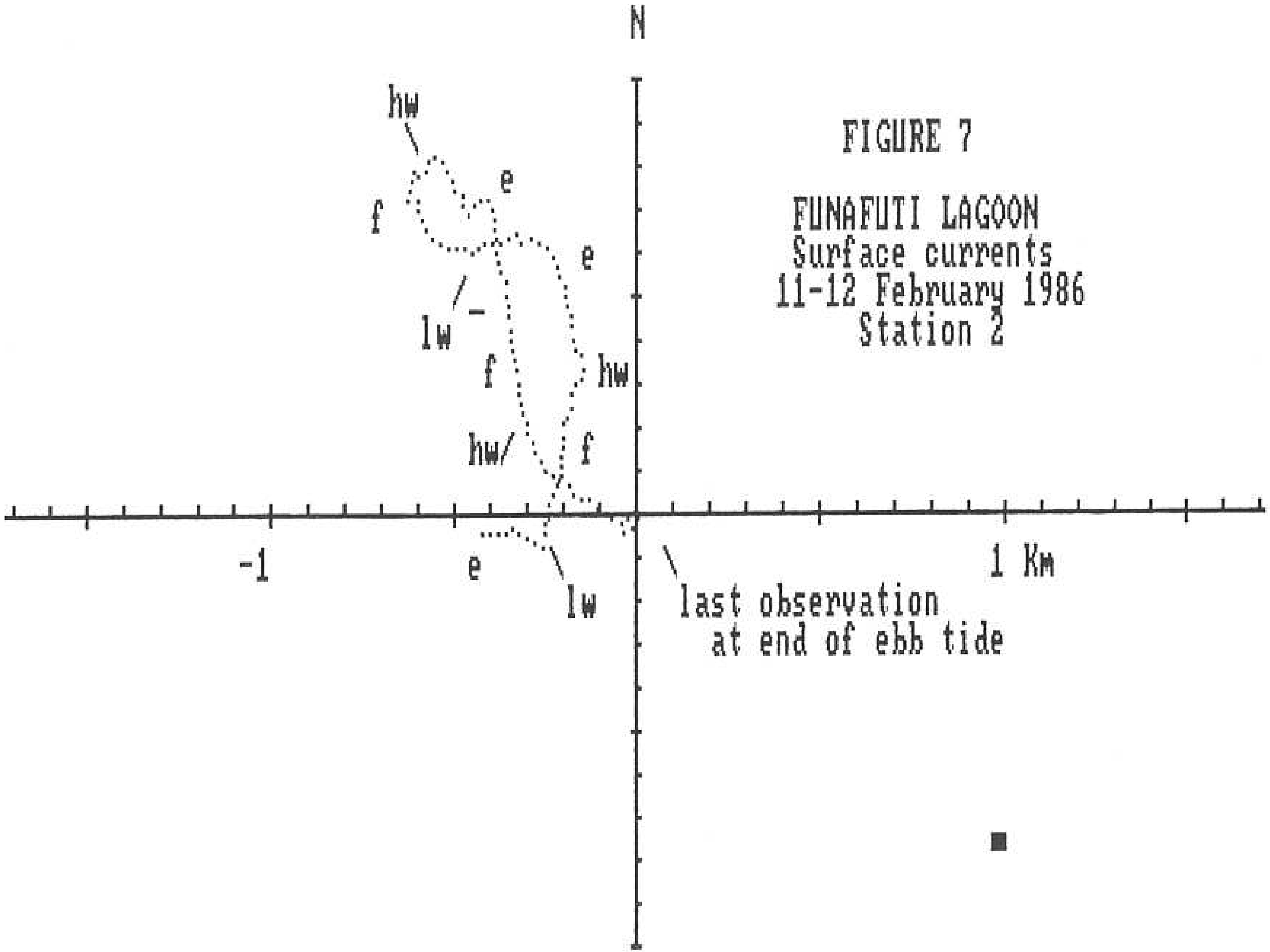


FIGURE 7

FUNAFUTI LAGOON
Surface currents
11-12 February 1986
Station 2



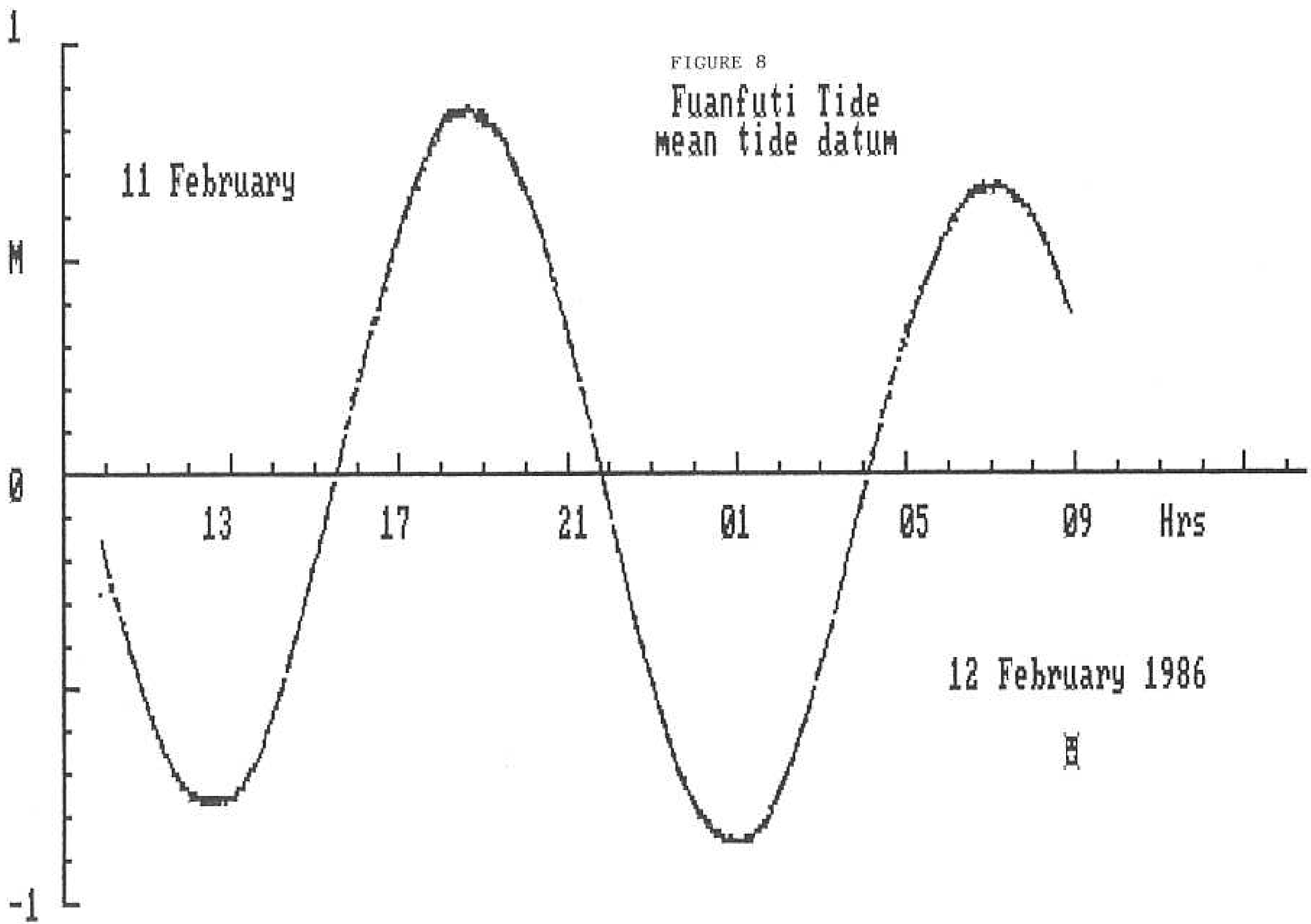


FIGURE 8
Fuanfuti Tide
mean tide datum
11 February
12 February 1986
1
M
0
-1
13
17
21
01
05
09
Hrs

FIGURE 9

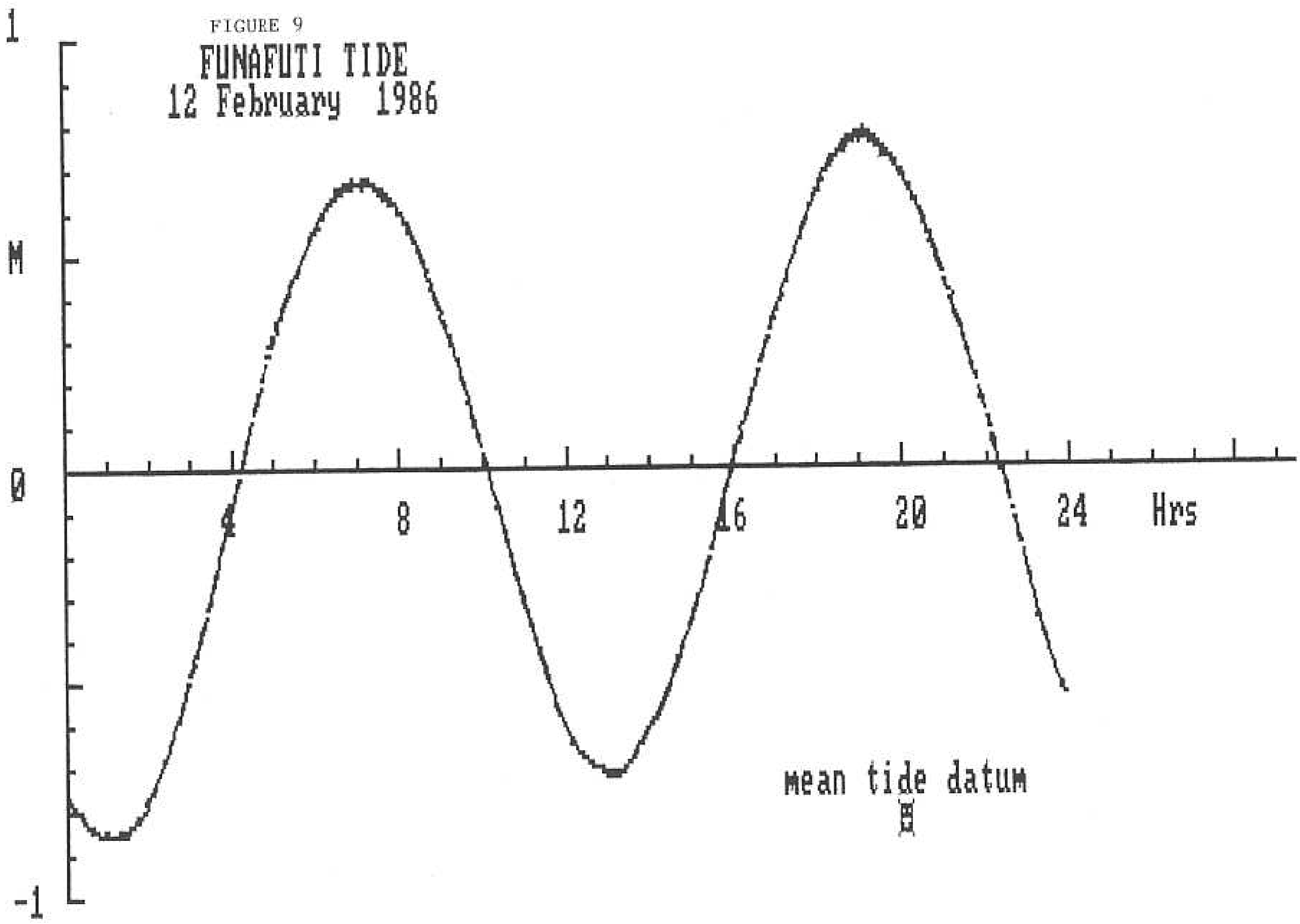
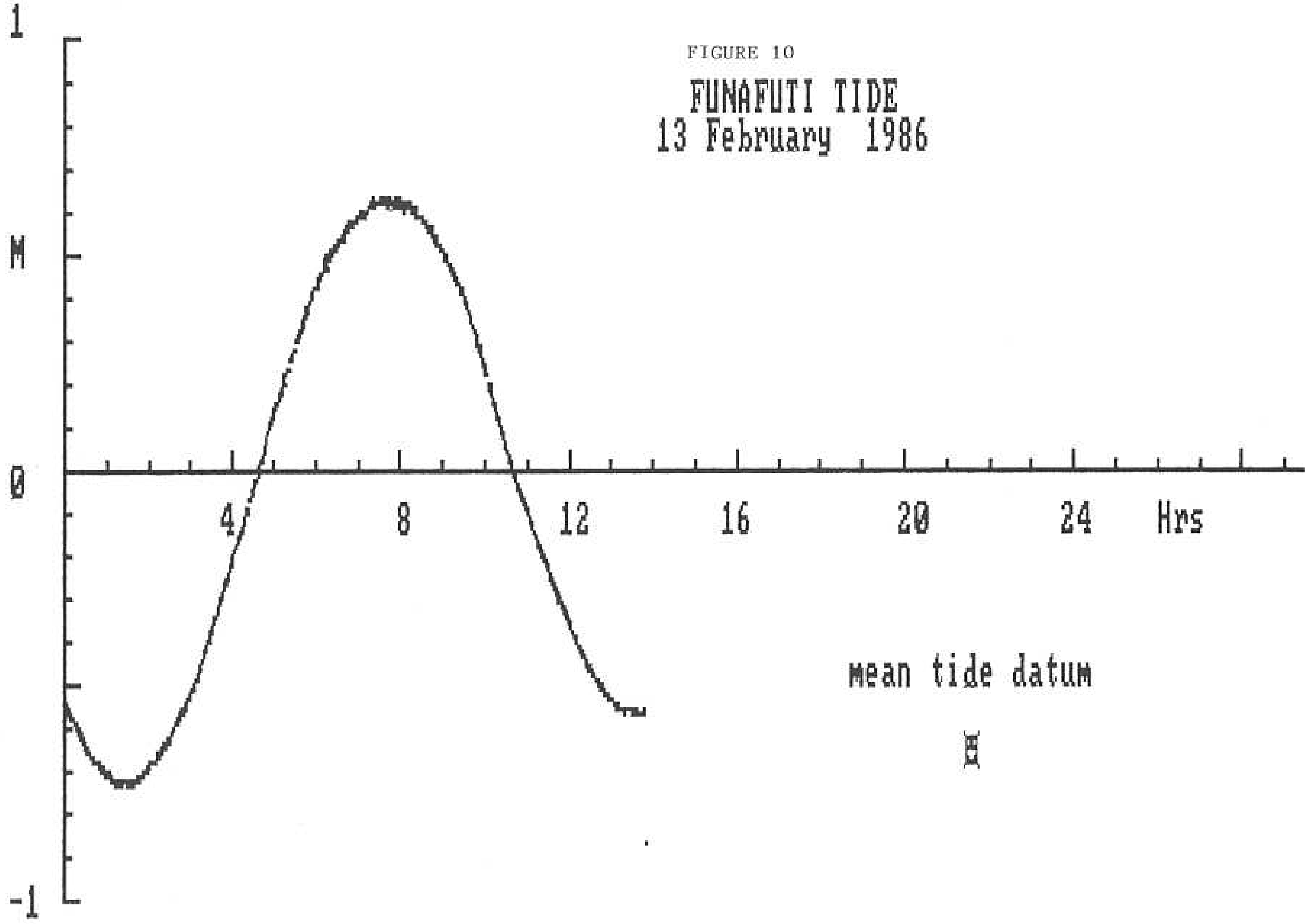

FUNAFUTI TIDE
12 February 1986
1
M
0
-1
4
8
12
16
20
24
Hrs
mean tide datum

FIGURE 10



FUNAFUTI TIDE
13 February 1986
1
M
0
-1
4
8
12
16
20
24
Hrs
mean tide datum