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I.O.S.

WAVES AT SOUTH UIST

Some further results of relevance to the Wave Energy Programme

R GLEASON and J A CRABB

Internal Document No. 128

April 1981

NATURAL ENVIRONMENT RESEARCH COUNCIL

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WAVES AT SOUTH UIST

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Institute of Oceanographic Sciences
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CONTENTS

1. INTRODUCTION

This document contains a selection of results from recent analyses of the South Uist wave data. It extends the results previously presented in WESC (79) DA 89.

The data on which the presentations are based cover the period March 1976 to July 1980. During this time the offshore buoy was stationed at 057° 18' 42" N, 007° 38' 18" W, apart from an interlude from March 1979 to August 1979 when it was mistakenly placed at 057° 12' 12" N, 007° 37' 18" W which is some seven nautical miles south of the correct position and in approximately the same water depth. The inshore buoy was, however, deliberately relocated during this period. This buoy was originally installed on 25 June 1978 at 57° 19' 48" N, 007° 27' 12" W where it remained until 16 August 1979. At that time it was moved to 057° 19' 36" N, 007° 29' 06" W, a position some 1.2 nautical miles further offshore. These two positions for the inshore buoy will be referred to as positions 1 and 2 respectively.

The diagrams which constitute the main body of this report are arranged in three sections as follows:

1. Waves at the offshore buoy
2. Waves at the inshore buoy
3. Comparisons between the inshore and offshore sites

2. WAVES AT THE OFFSHORE BUOY

Diagrams included under this heading are:

Fig. 1.1	Scatter plot of H_s and T_e	March 76 - July 80
Fig. 1.2 - 1.15	Time series plots of power	March 76 - July 80
Fig. 1.16 - 1.29	Time series plots of H_s	March 76 - July 80
Fig. 1.30 - 1.43	Time series plots of T_e	March 76 - July 80

Powers plotted in Figs. 1.2 to 1.15 have been calculated from the spectra using the full depth corrected expression. The figures otherwise are self explanatory.

3. WAVES AT THE INSHORE BUOY

Fig. 2.1	Scatter plot of H_s and T_e. Buoy Position 1	August 78 - July 79
Fig. 2.2	Scatter plot of H_s and T_e. Buoy Position 2	September 79 - July 80
Figs. 2.3 - 2.9	Time series plots of power	August 78 - July 80

Figs. 2.10 - 2.16	Time series plots of H_s	August 78 - July 80
Figs. 2.17 - 2.23	Time series plots of T_e	August 78 - July 80

Note that data from August 1979, the month during which the inshore buoy was relocated, have been excluded from the scatter plots.

4. COMPARISONS BETWEEN THE INSHORE AND OFFSHORE SITES

Figs. 3.1 - 3.11	Scatter plots of offshore against simultaneous inshore wave power

These scatter plots were presented previously in WESC (80) DA 114, but are included here also for completeness.

Superimposed upon each plot is the straight line which results from a reduced major axis regression analysis performed on each month's data. The change in the slope of these best fit lines following the relocation of the inshore buoy is readily apparent. There is also a hint of this change in the bimodal nature of the plot for August 1979, the month during which the buoy was moved.

In addition to these monthly comparisons, two further analyses were performed with the data divided into two groups corresponding to periods before and after the inshore buoy was moved. The purpose was to establish, more precisely than has been done so far, the comparative powers at the two sites.

For each data group a standard y on x linear regression analysis was performed with power at the offshore buoy being the independent variable and power at the inshore the dependent variable. The results are set out below.

Period August 1978 - July 1979

slope of regression line	0.270
intercept	2.38 kW/m
standard error of slope	0.004
standard error of intercept	0.18
correlation coefficient	0.91
slope of regression line constrained to pass through (0,0)	0.300

Period September 1979 - July 1980

slope of regression line	0.694	
intercept	0.66	kW/m
standard error of slope	0.006	
standard error of intercept	0.30	
correlation coefficient	0.95	
slope of regression line constrained to pass through (0,0)	0.702	

The predicted long term annual average wave power at the offshore site is 48 kW/m and these results may be used to scale this figure to form estimates of the long term annual averages at the two inshore locations.

These values are:

Inshore site 1	15.3 ± 0.4 (14.4)	kW/m
Inshore site 2	34.0 ± 0.6 (33.7)	kW/m

The bracketed values result from applying the slopes of the lines constrained to pass through (0,0).

The new values of inshore power are different from, and should be regarded as replacing, those previously presented in WESC (80) DA 114 which were calculated by an unsatisfactory method.

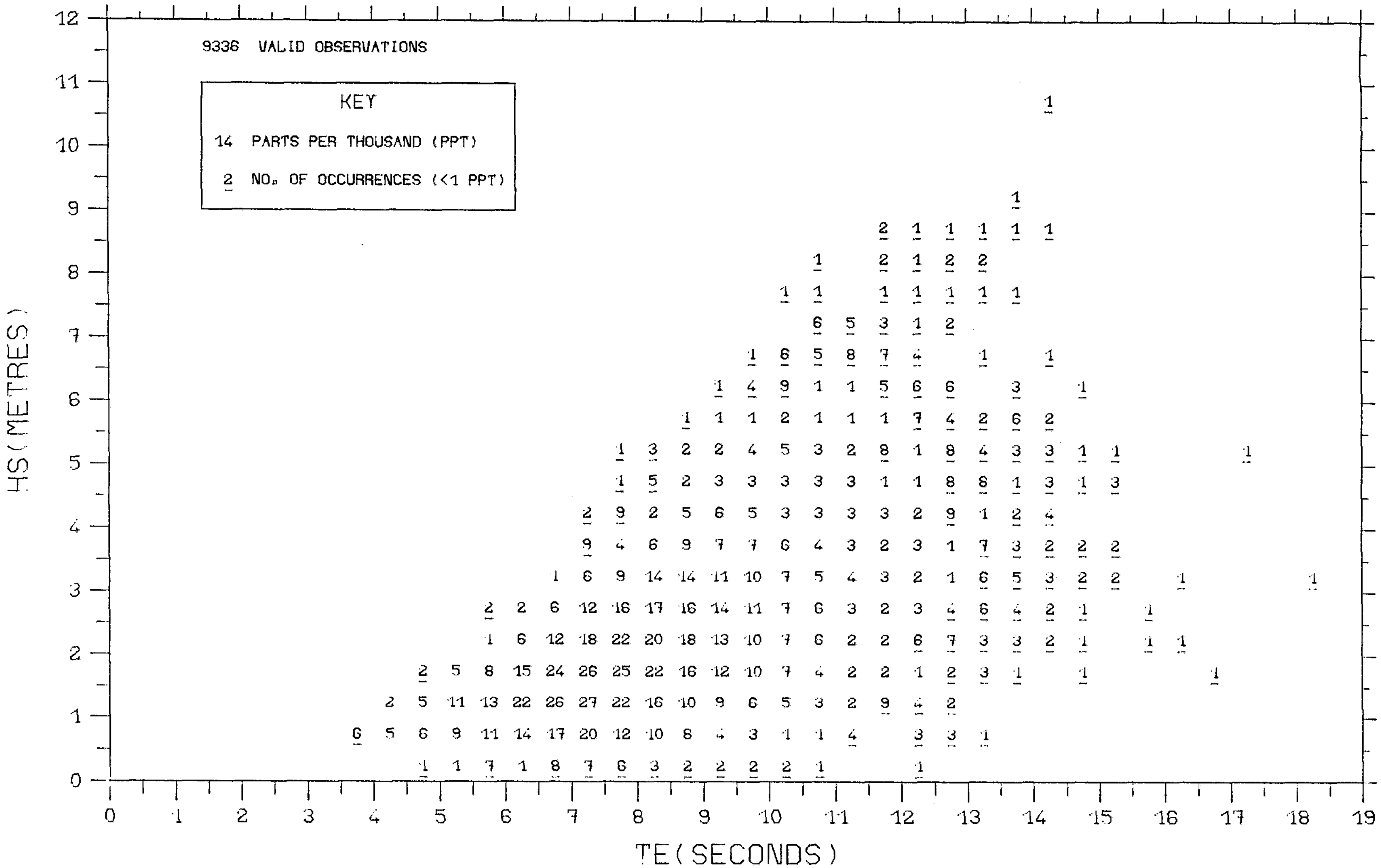
5. COMPARISONS FREQUENCY BY FREQUENCY

The comparisons presented above have been extended to show the way in which the power in each spectral frequency band varies between the two sites. The results are presented in Fig. 3.12.

For this analysis the data were again divided into two groups corresponding to periods before and after the relocation of the inshore buoy.

Each valid pair of inshore and offshore spectra were converted to energy flux (power) spectra thus allowing the power at each component frequency to be calculated. A linear regression analysis was performed on these values of inshore and offshore power at each frequency for both data groups. As expected this analysis showed significant correlations between the inshore and offshore powers at each frequency. The calculated regression lines generally gave positive intercepts; these were comparatively large at frequencies close to the spectral peak and meant that the relationship between the inshore and offshore power at these frequencies could not be adequately described by the slope of the regression line alone. A meaningful ratio relating the inshore to offshore powers was however derived by substituting into the equation to the regression line at each frequency the value of the long term average power in that band previously calculated (WESC (79) DA 89) for the offshore site, thus forming an estimate of the long term average power in that band at the inshore site. The ratio of the two average power figures was calculated and these are shown for each frequency in Fig. 3.12.

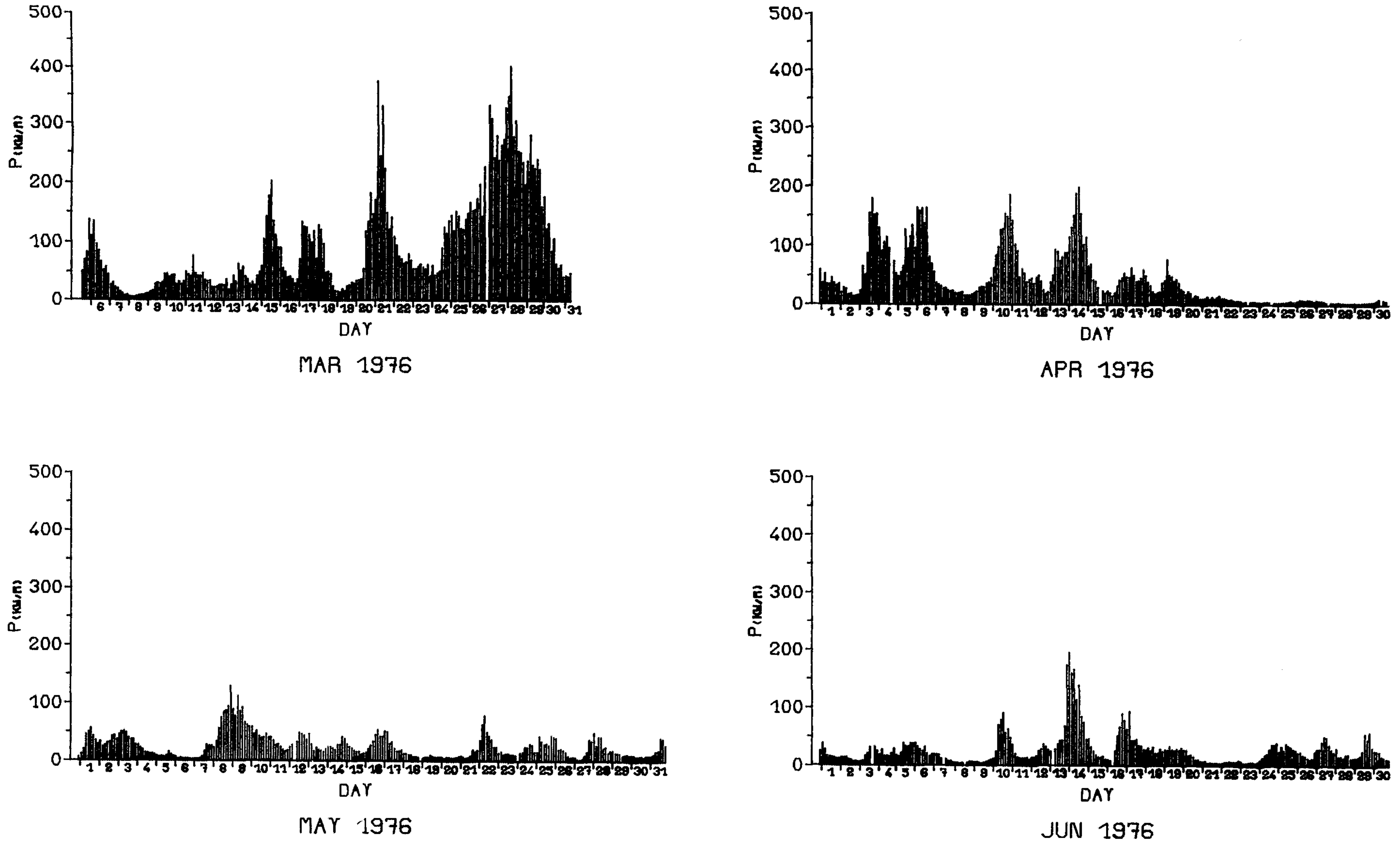
In the course of the above analysis, standard errors to the regression line slopes were not calculated. However, in a similar analysis performed by H.R.S. (WESC (81) DA 119) on data for the first inshore buoy position the standard errors of the slopes were less than 3% for frequencies below 0.2 Hz .



SCATTER PLOT OF HS AND TE

SOUTH UIST OFFSHORE WAVERIDER. MARCH 1976-JULY 1980

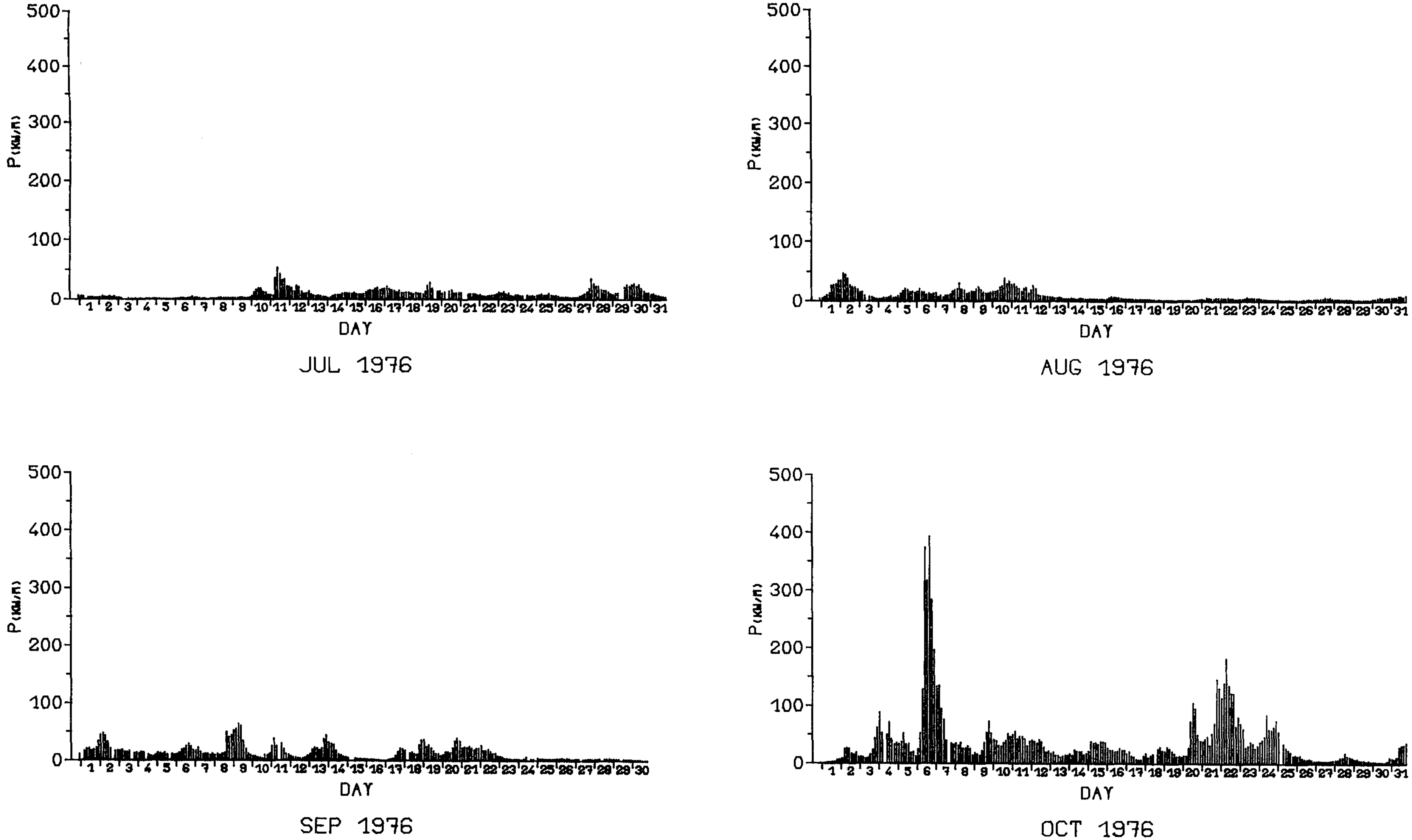
Figure 1.1



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

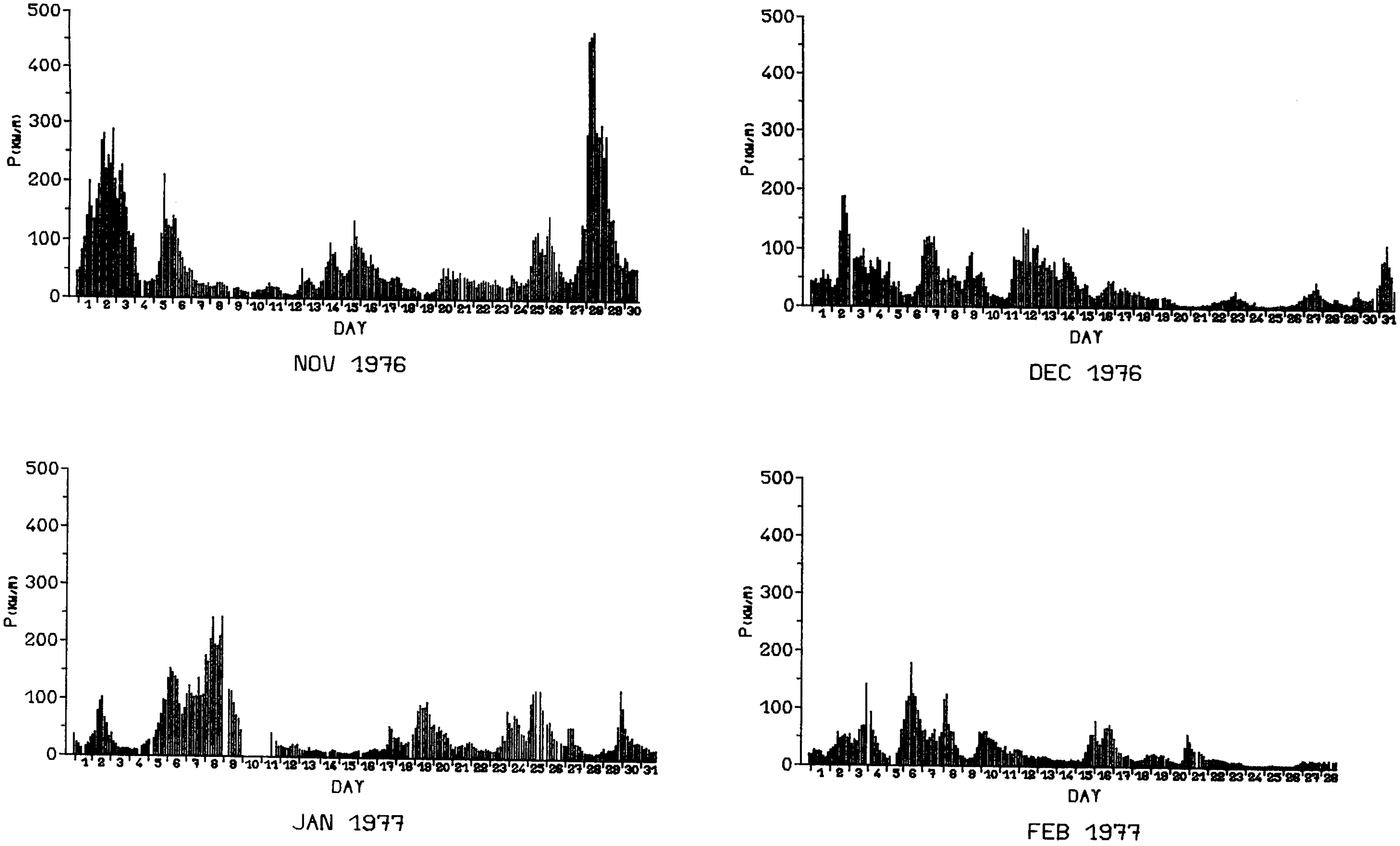
Figure 1.2



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

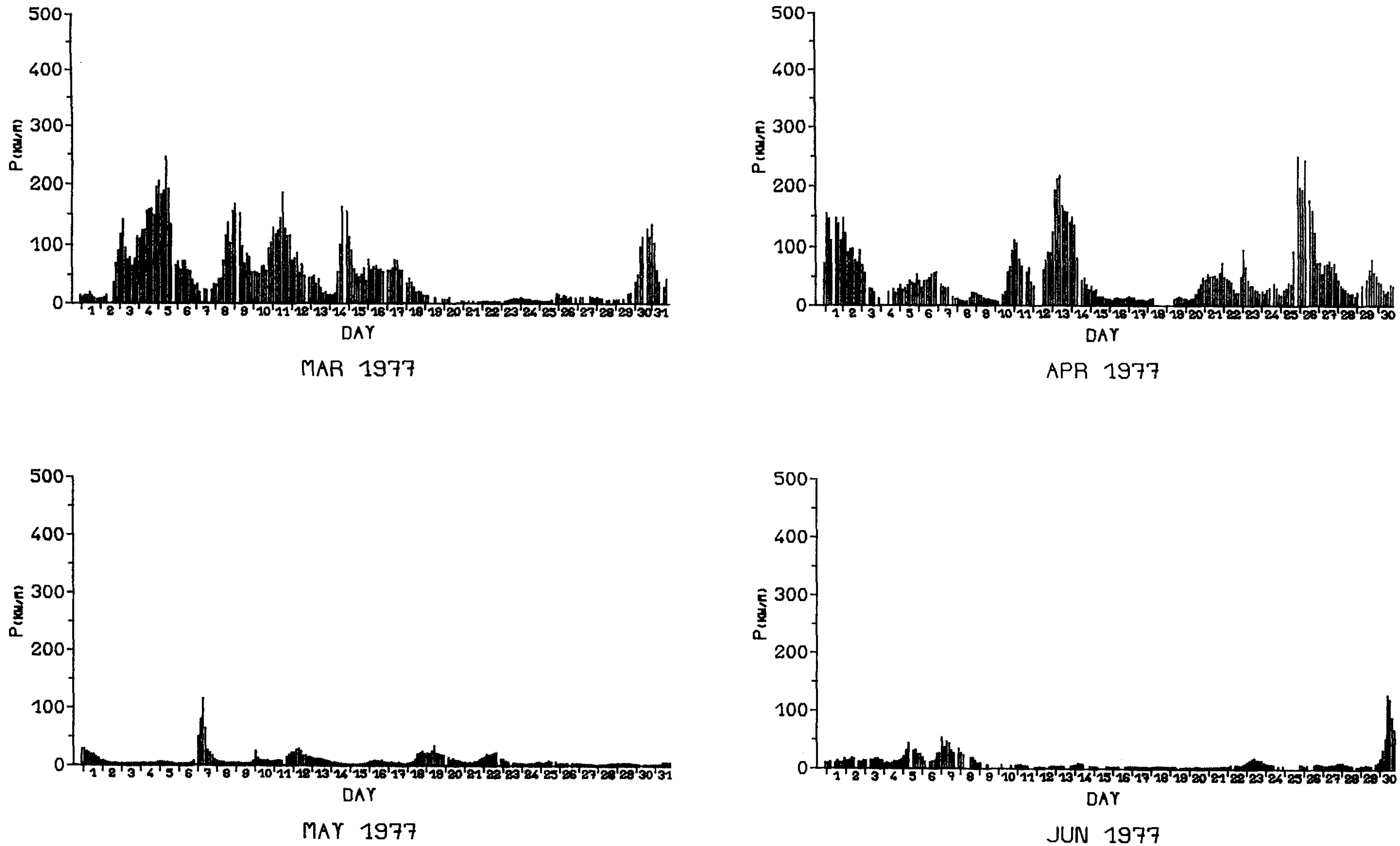
Figure 1·3



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

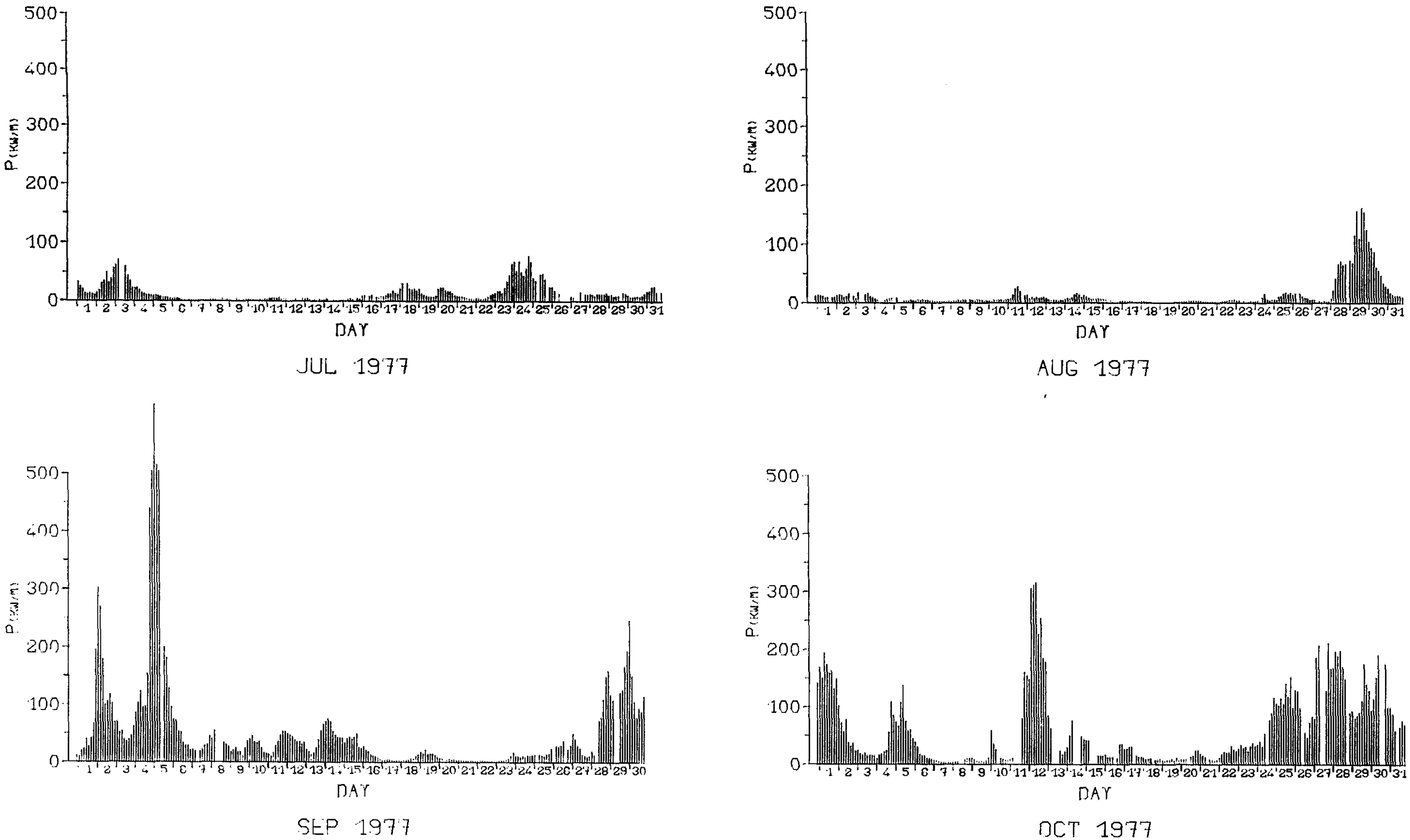
Figure 1·4



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

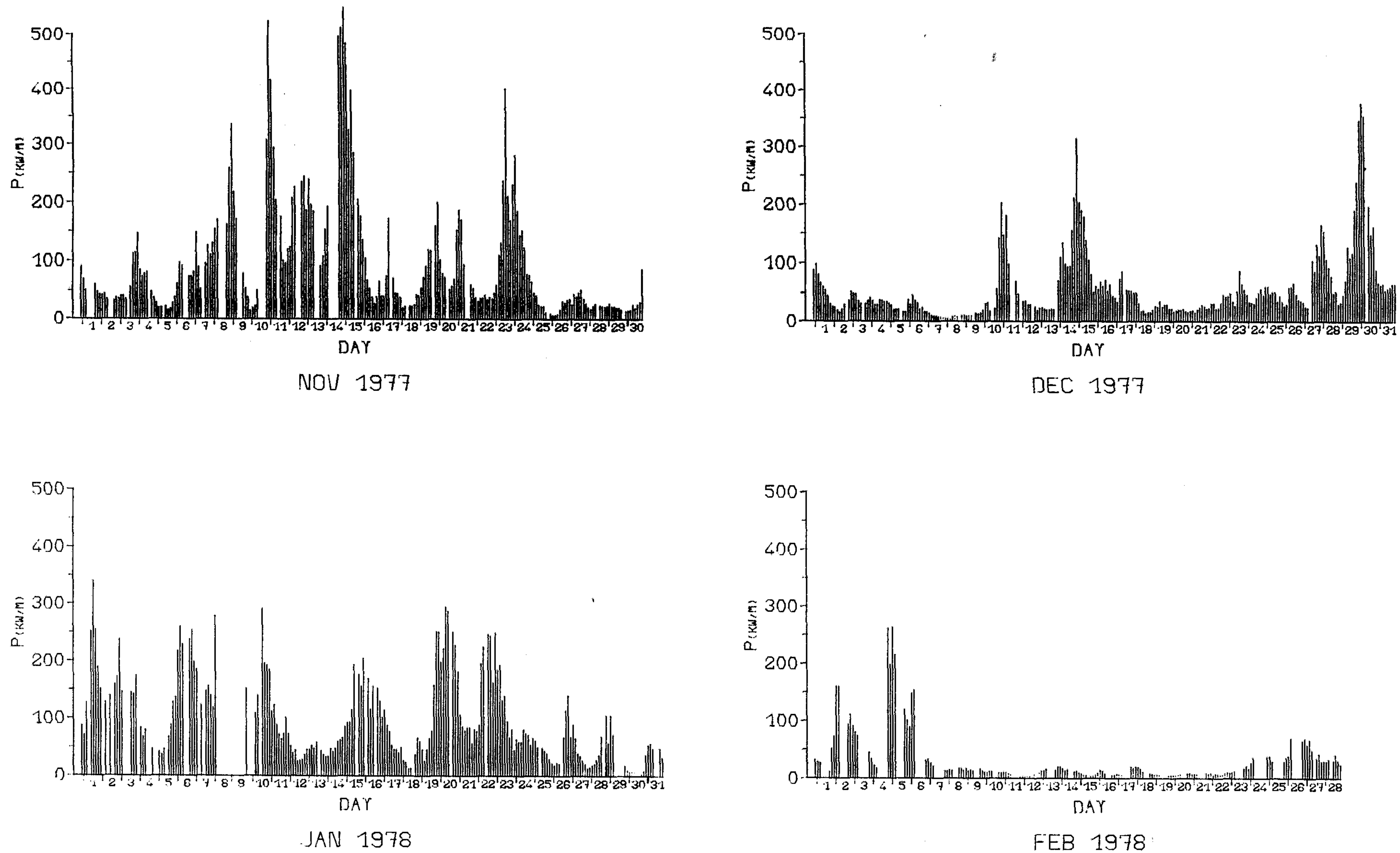
Figure 1·5



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

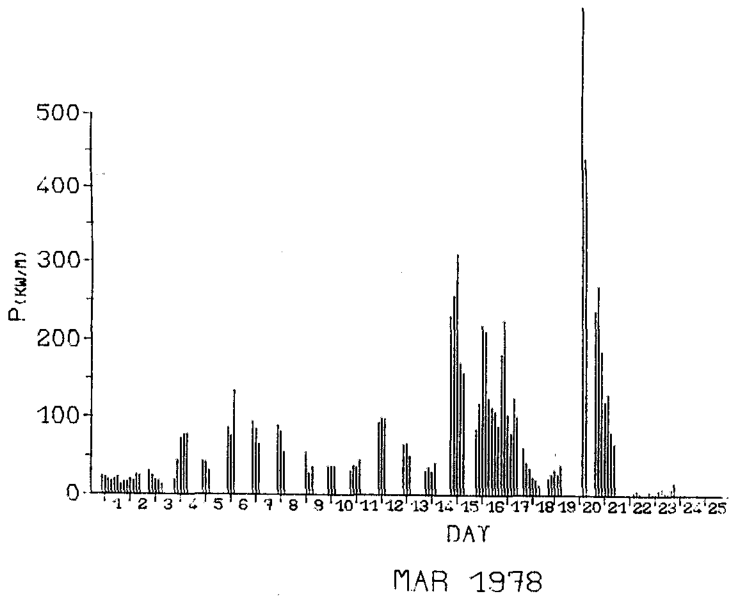
Figure 1·6

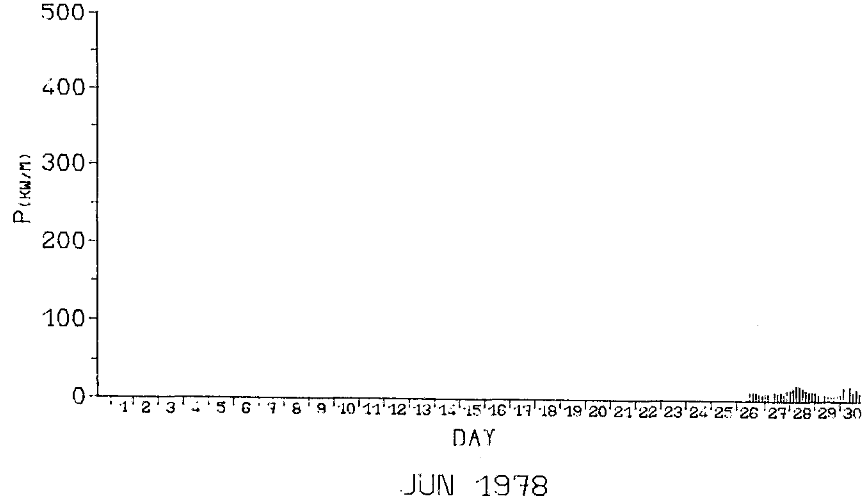


TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

Figure 1·7

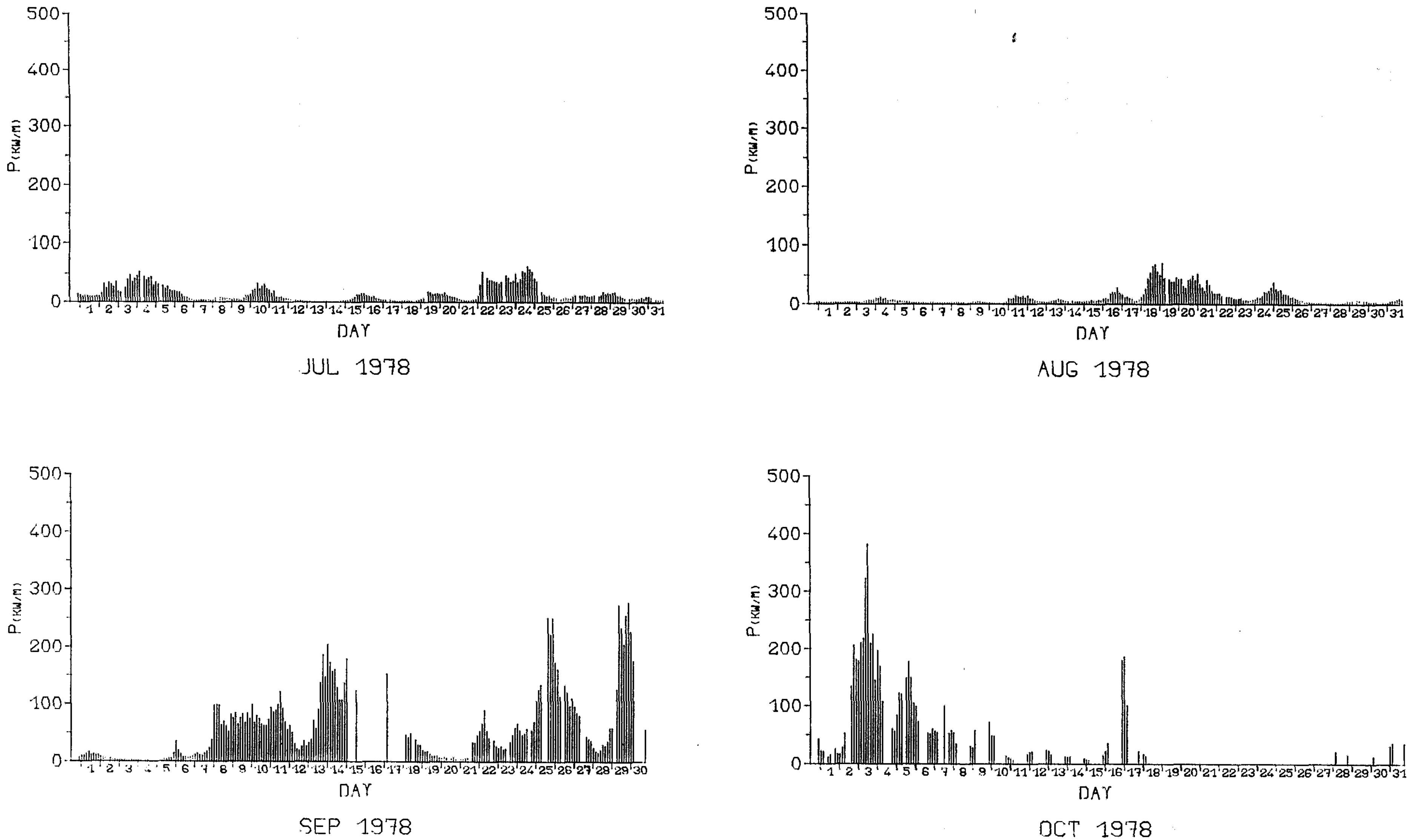




TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

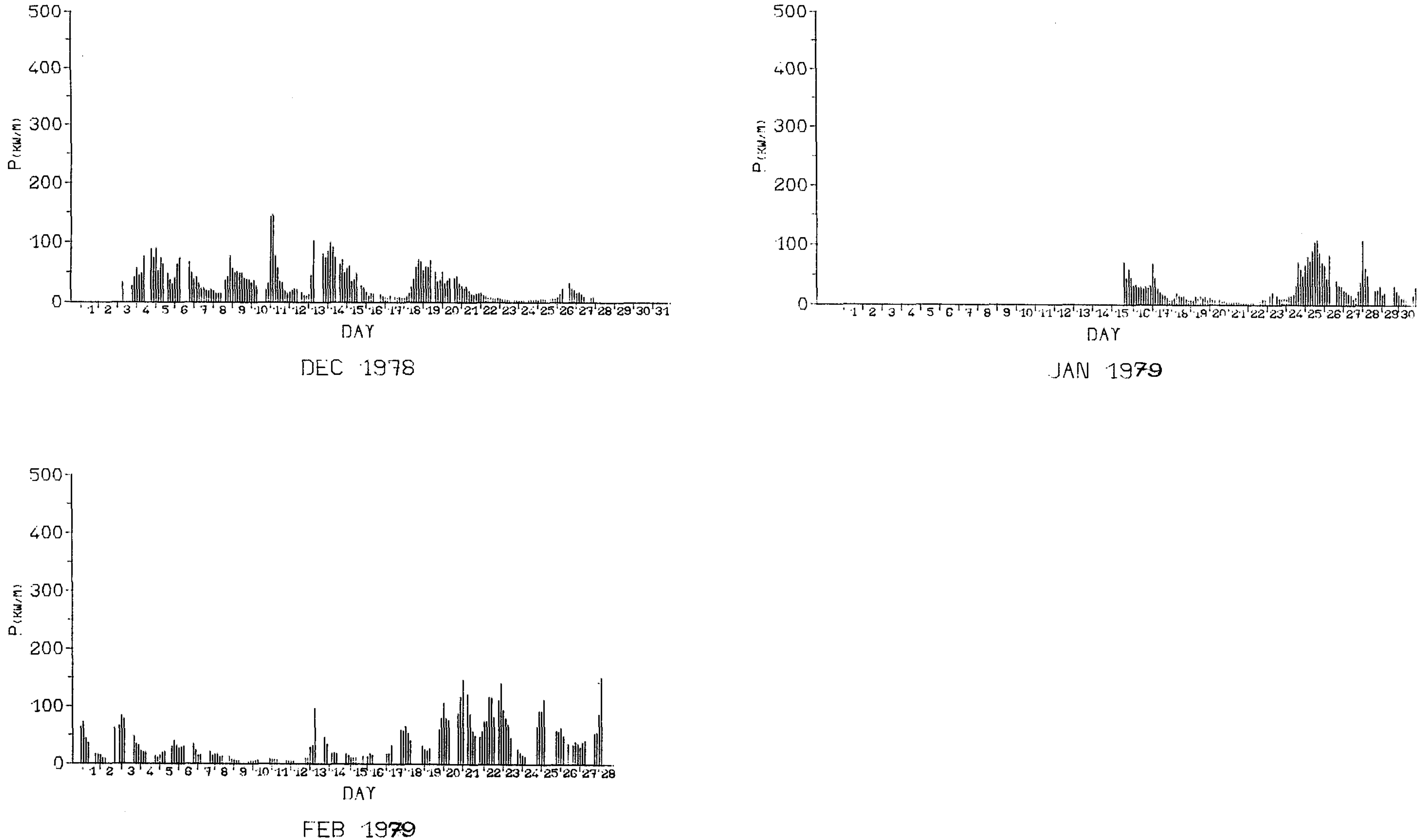
Figure 1·8



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

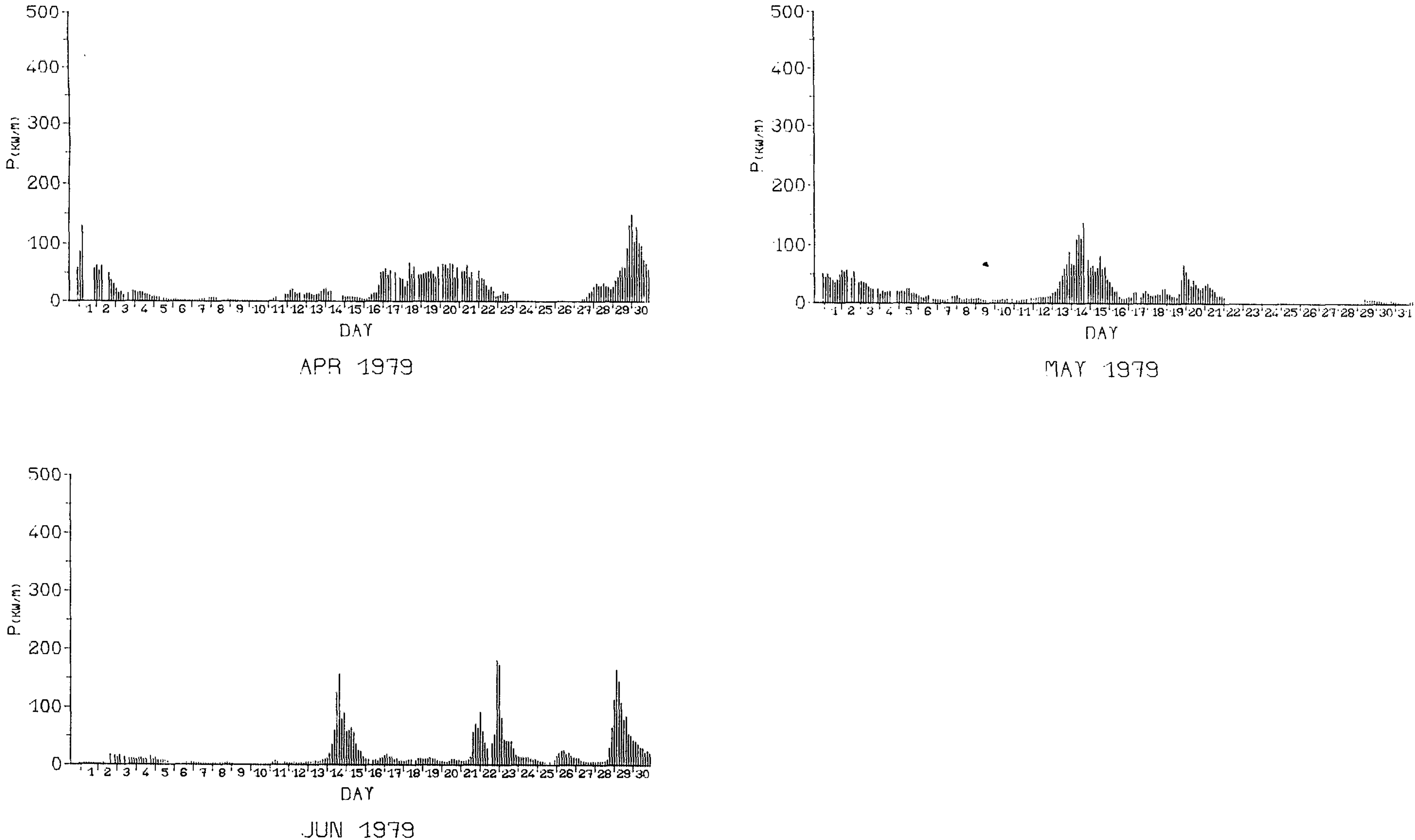
Figure 1·9



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

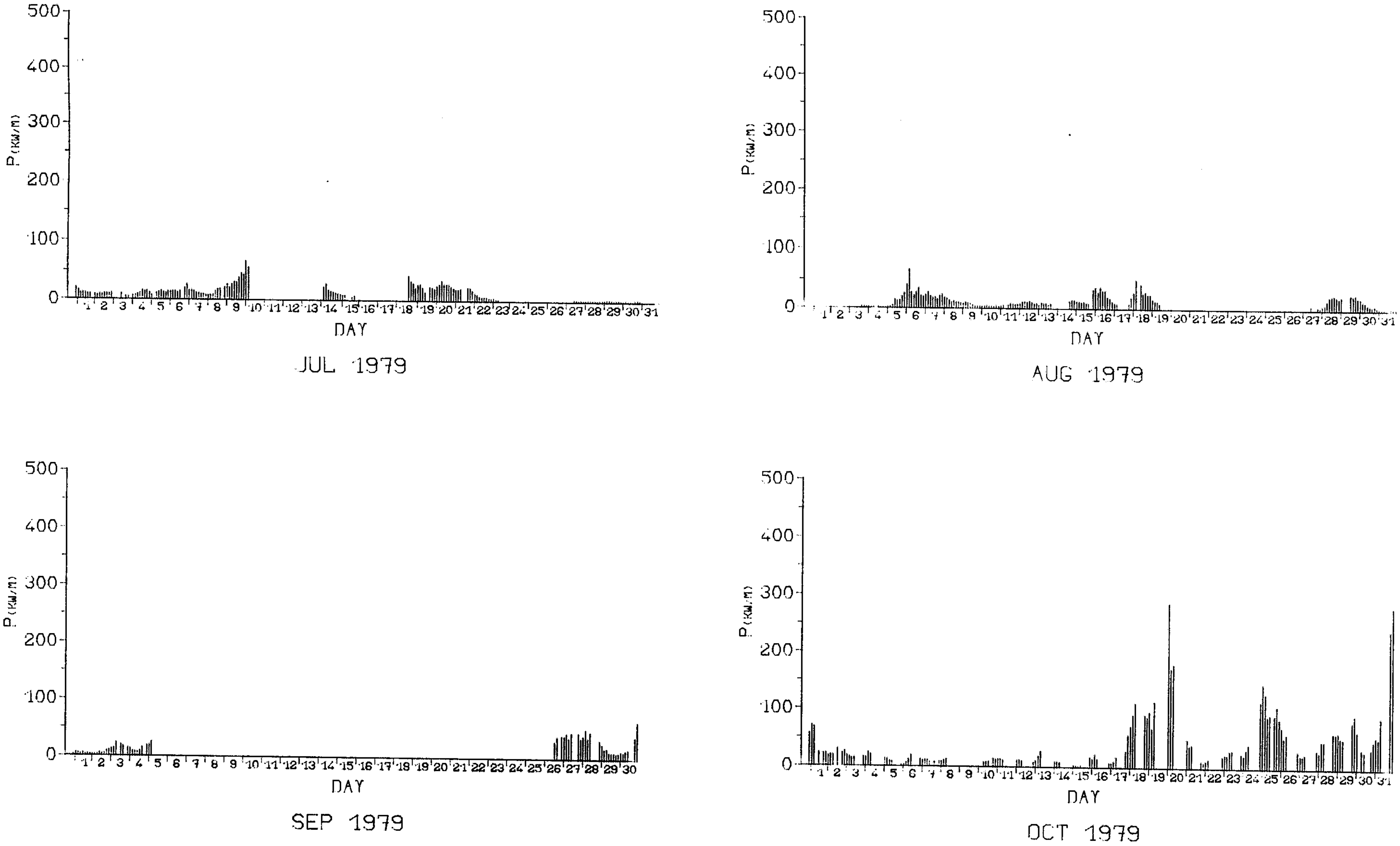
Figure 1·10



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

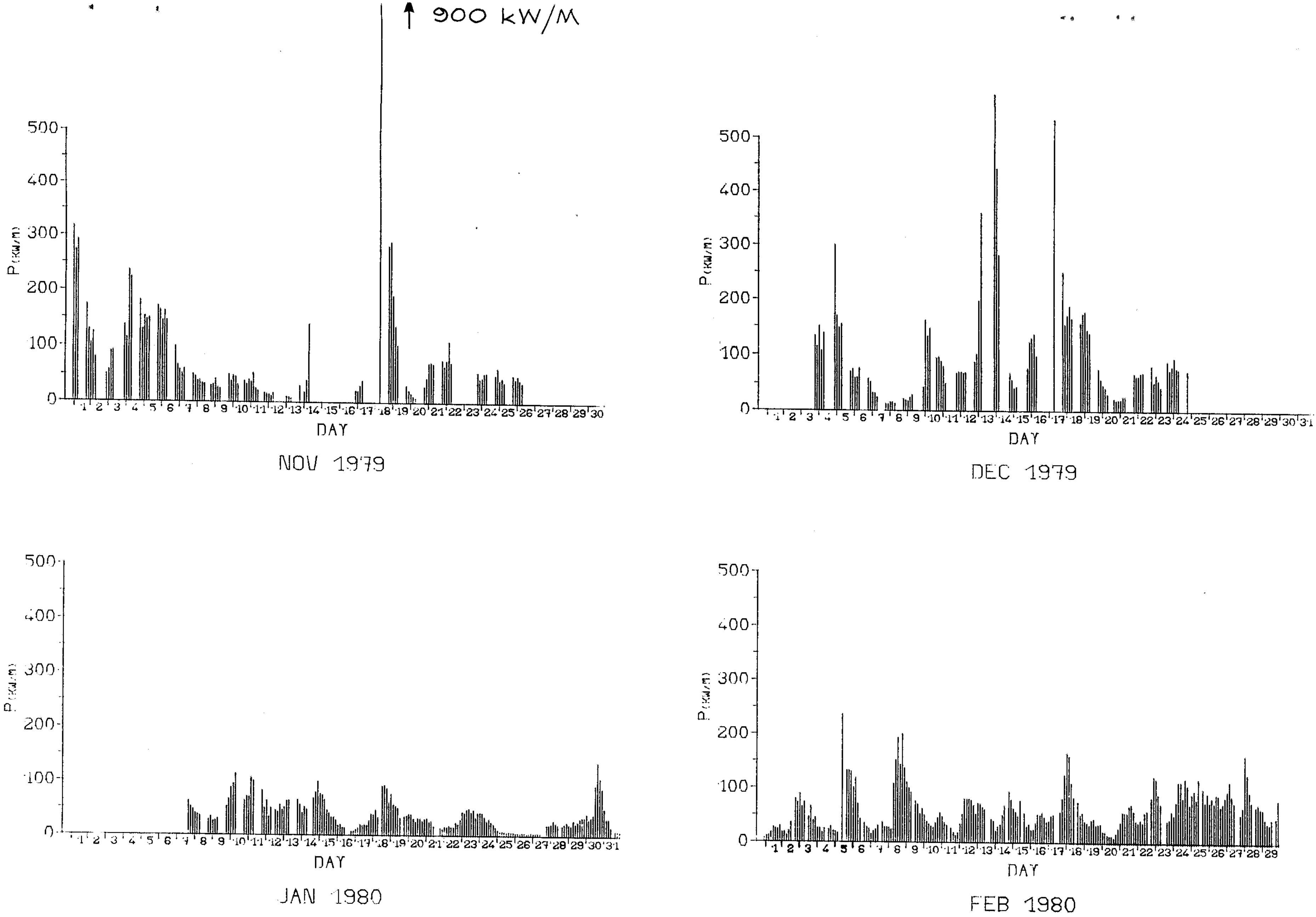
Figure 1·11



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

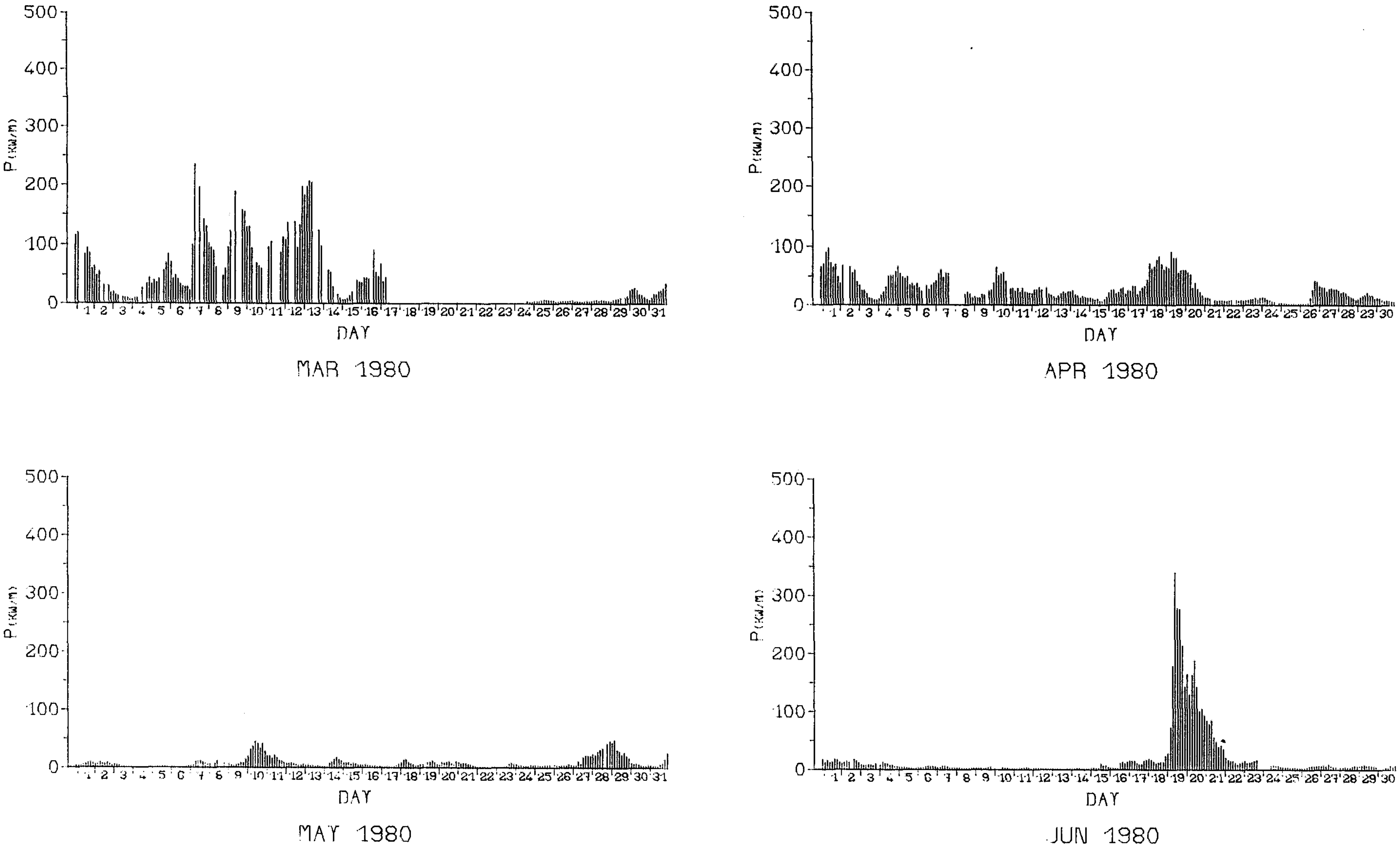
Figure 1·12



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

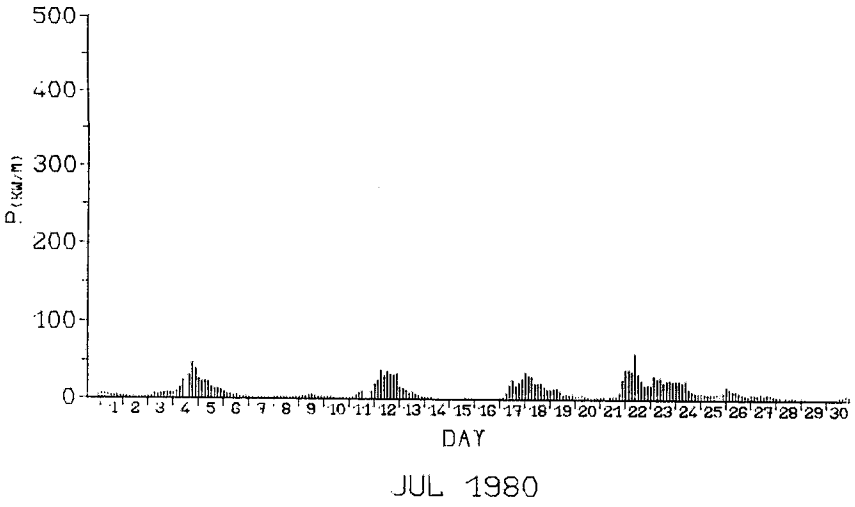
Figure 1·13



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

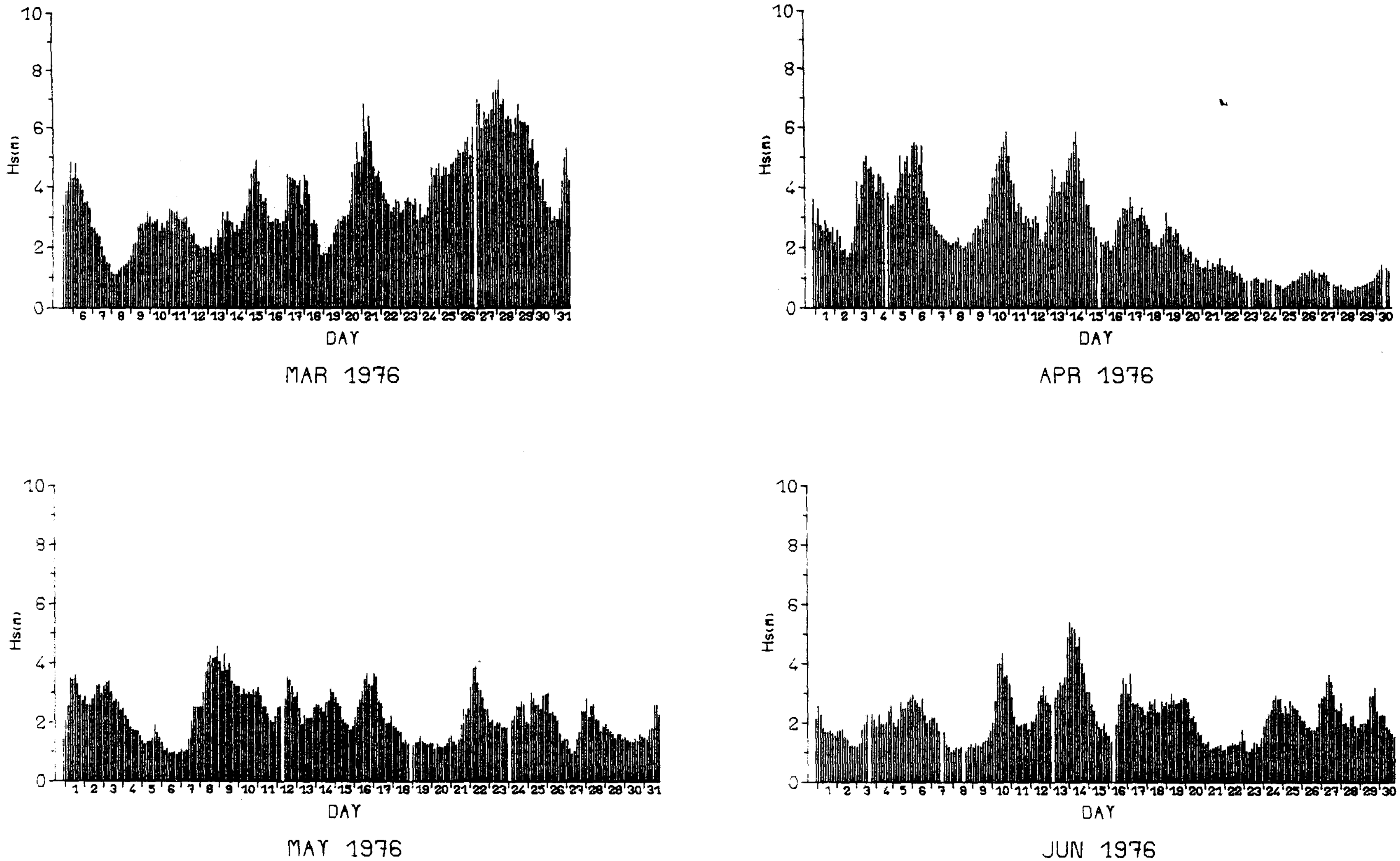
Figure 1·14



TIME SERIES OF POWER

SOUTH UIST OFFSHORE WAVERIDER

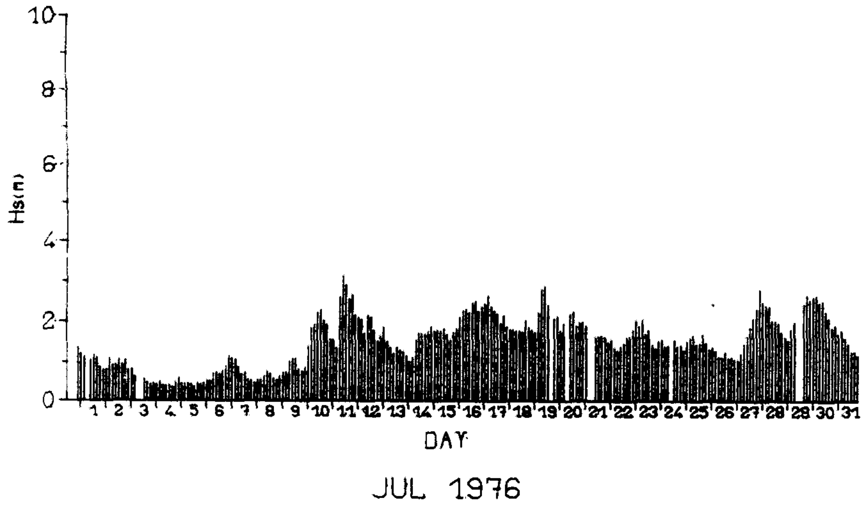
Figure 1·15

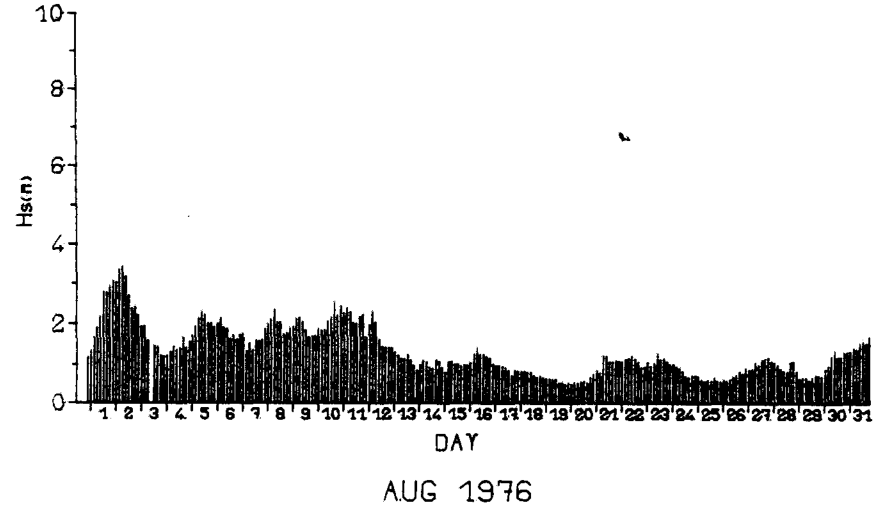


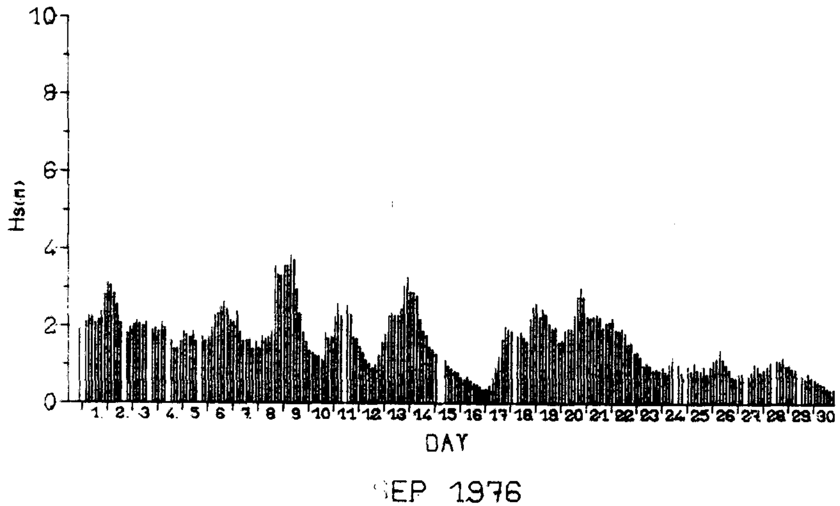
TIME SERIES OF Hs

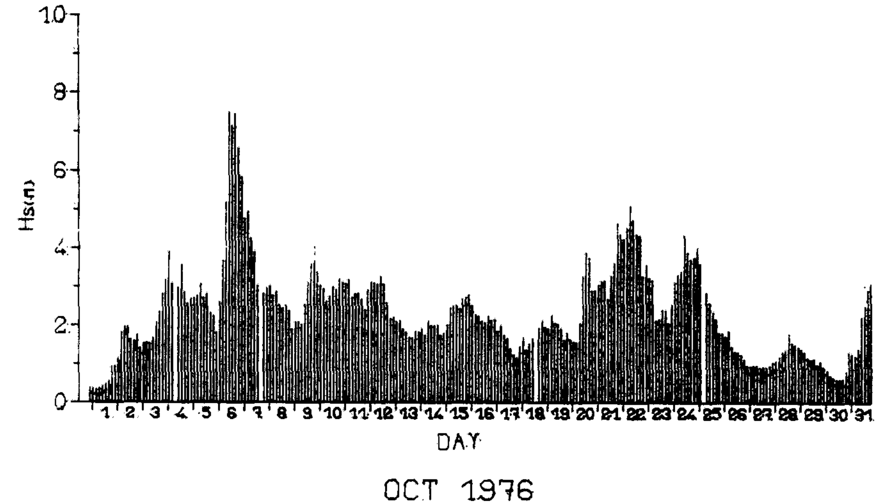
SOUTH UIST MAR 1976 - FEB 1978

Figure 1·16





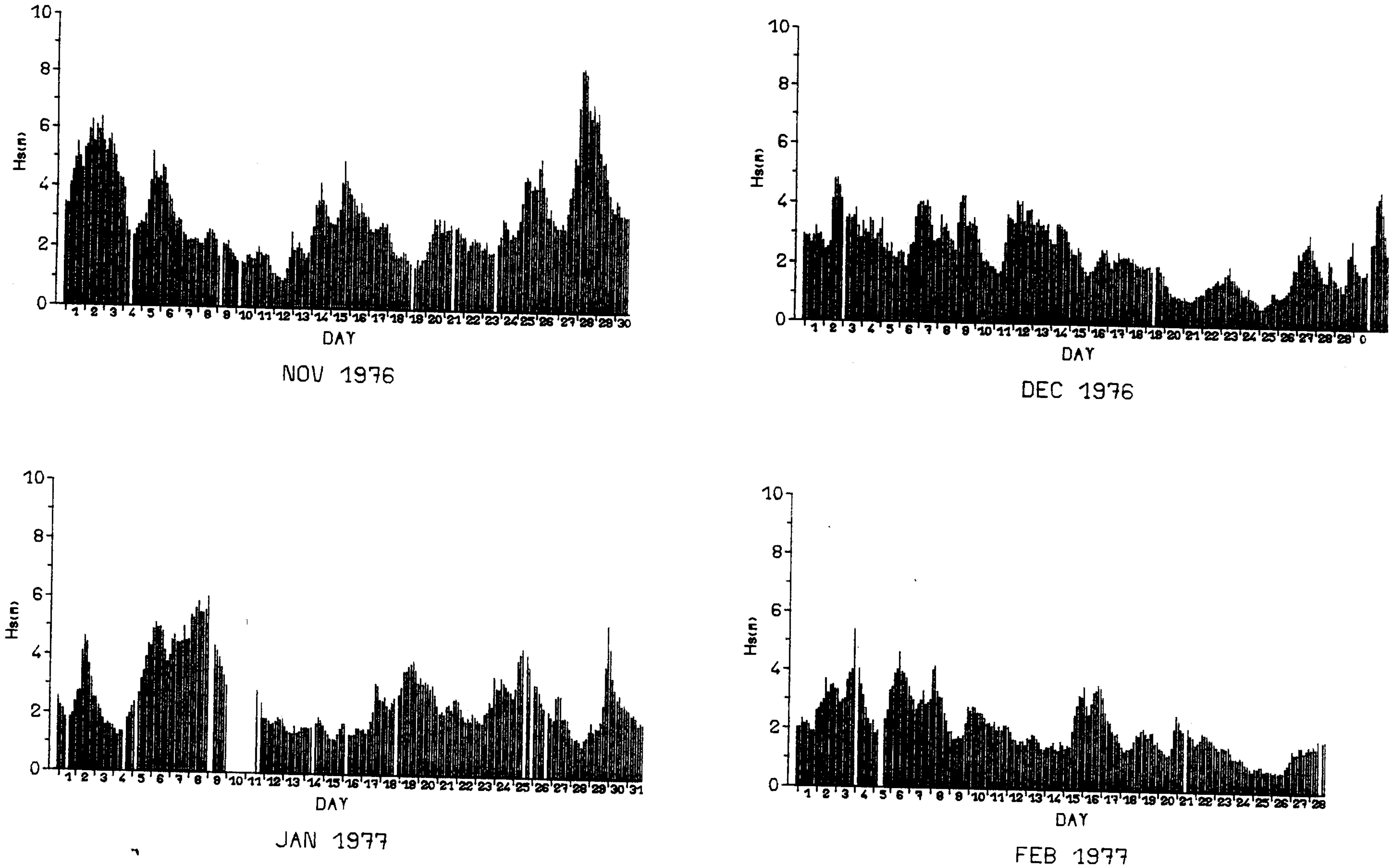




TIME SERIES OF Hs

SOUTH UIST MAR 1976 - FEB 1978

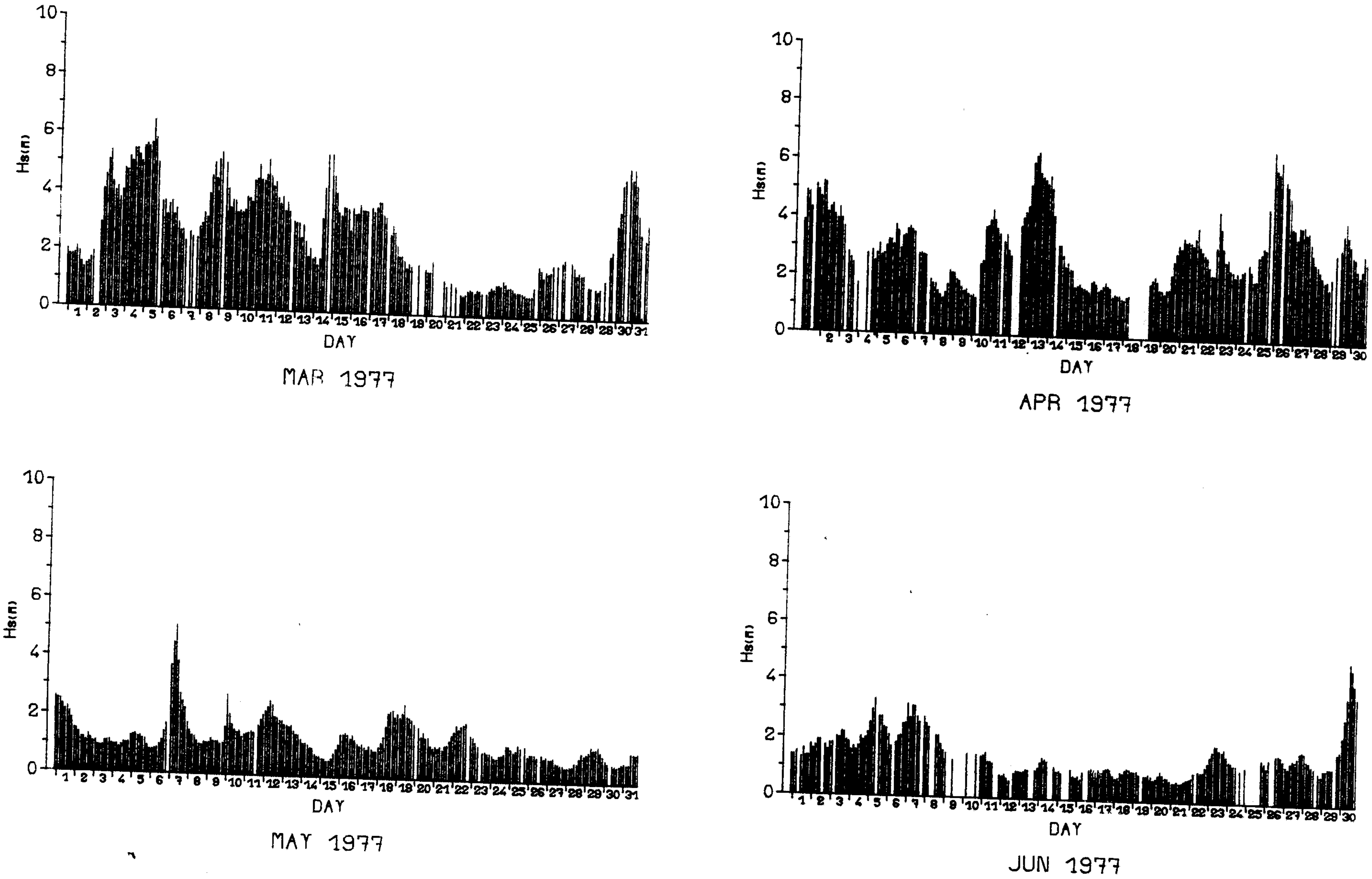
Figure 1·17



TIME SERIES OF Hs

SOUTH UIST MAR 1976 - FEB 1978

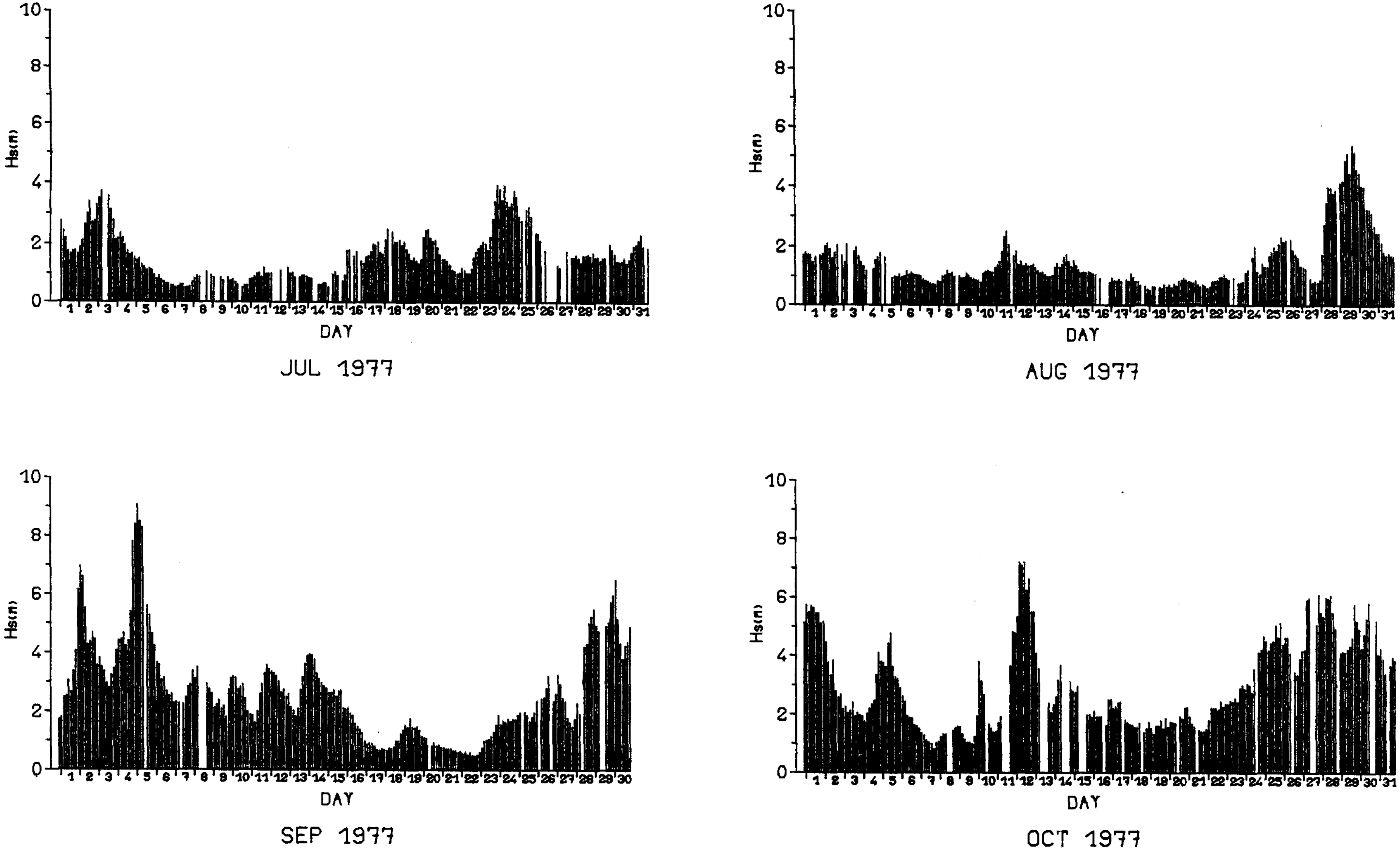
Figure 1.18



TIME SERIES OF Hs

SOUTH UIST MAR 1976 - FEB 1978

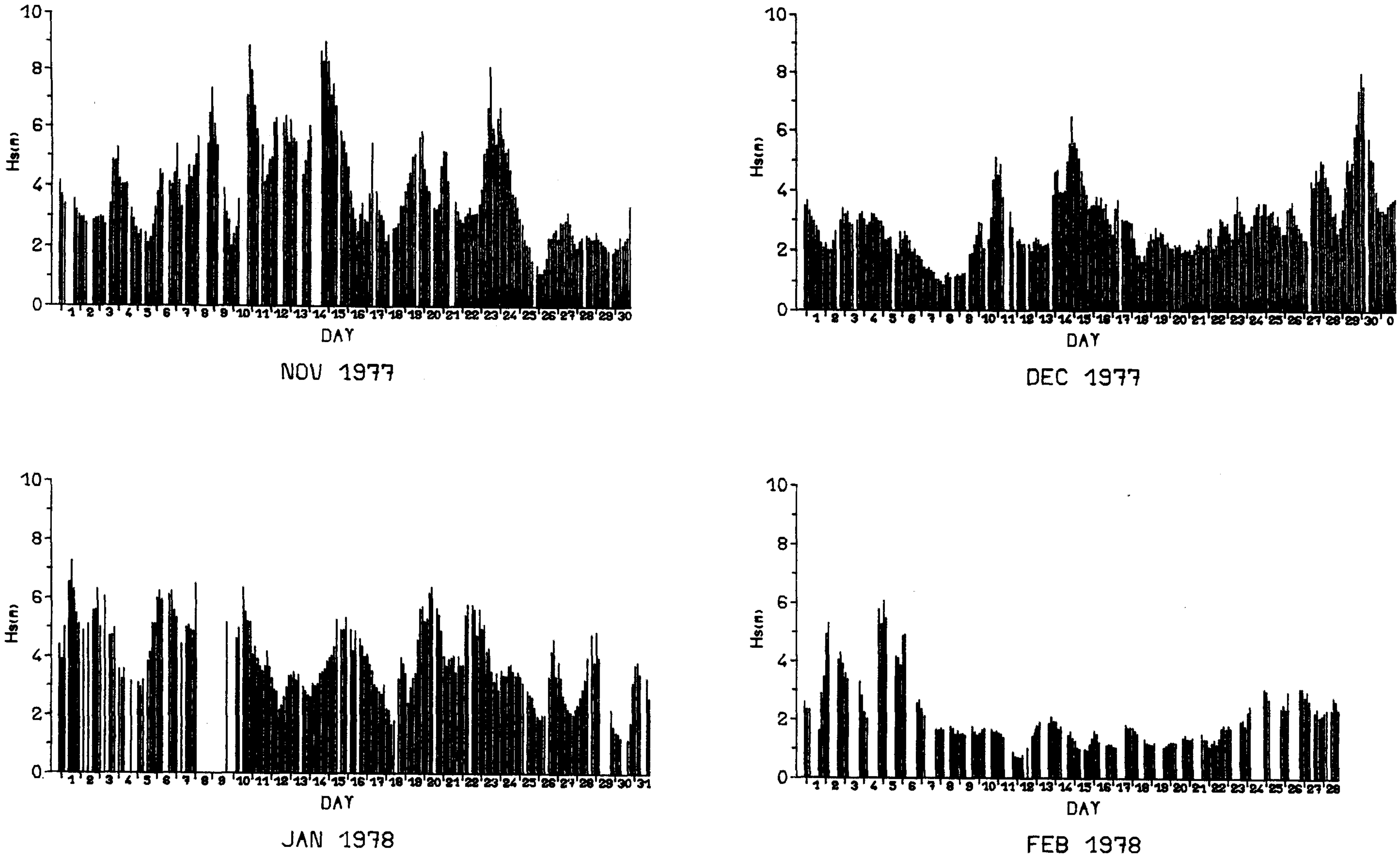
Figure 1·19



TIME SERIES OF Hs

SOUTH UIST MAR 1976 - FEB 1978

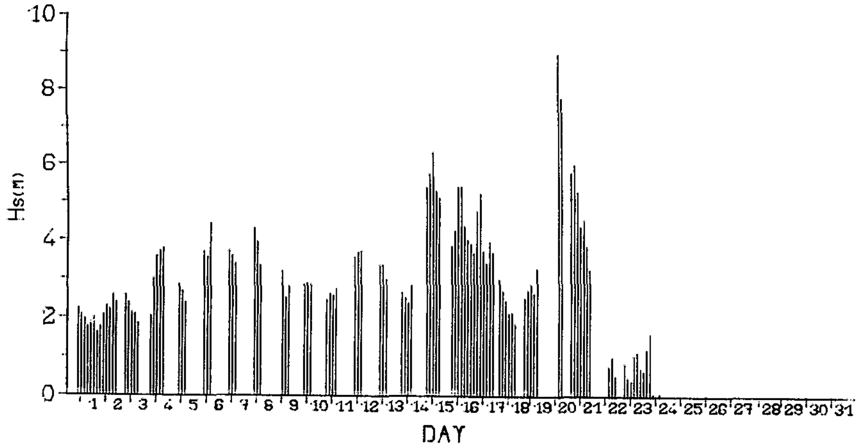
Figure 1·20



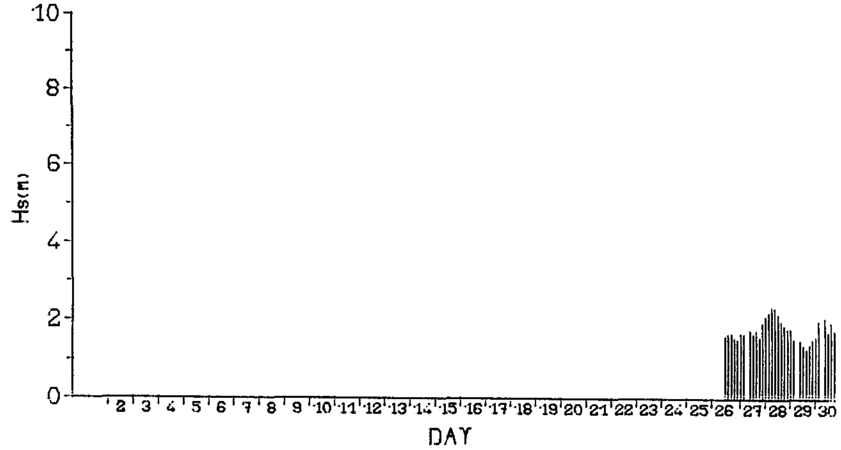
TIME SERIES OF Hs

SOUTH UIST MAR 1976 - FEB 1978

Figure 1·21



MAR 1978

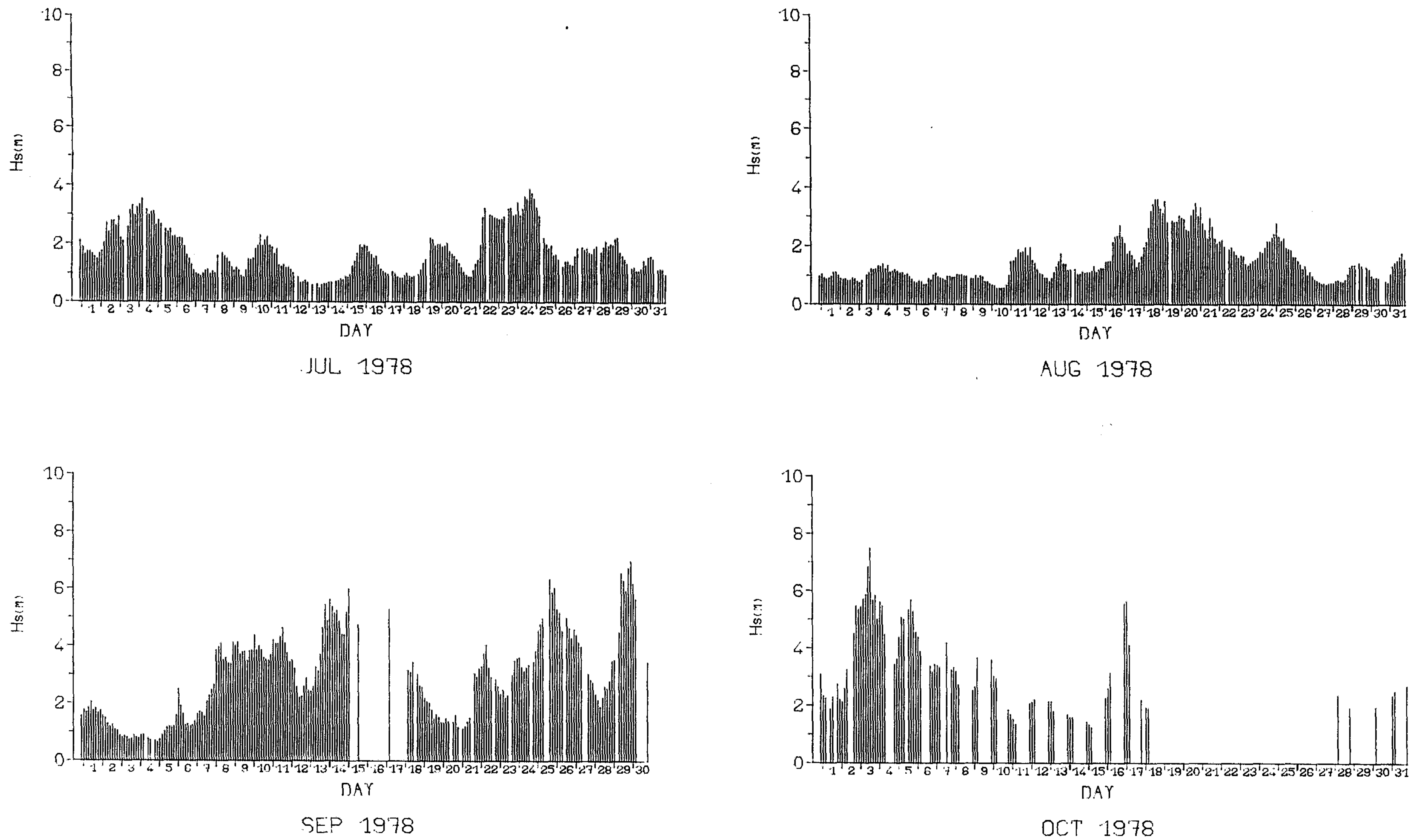


JUN 1978

TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

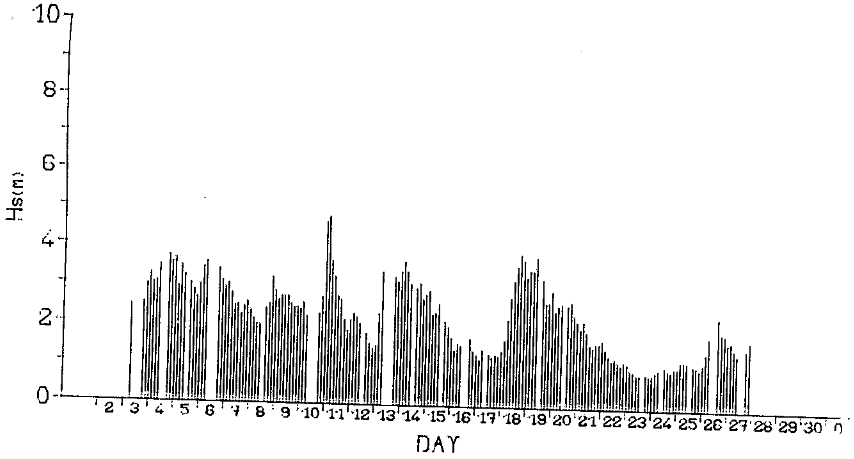
Figure 1·22



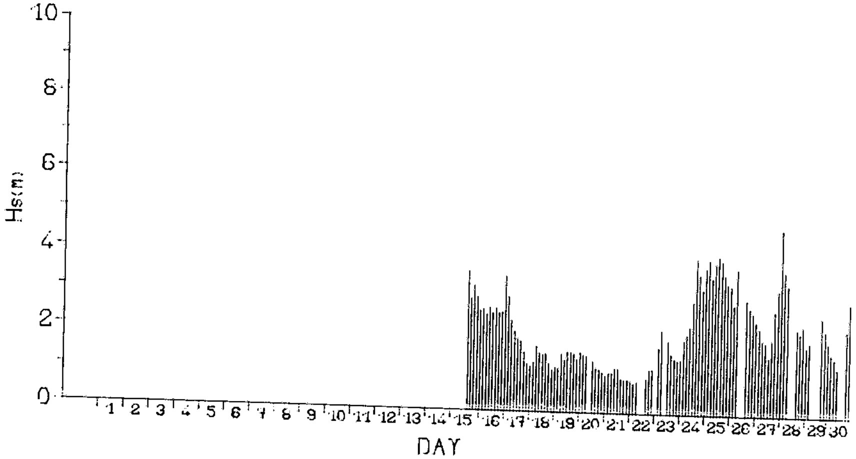
TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

Figure 1·23



DEC 1978



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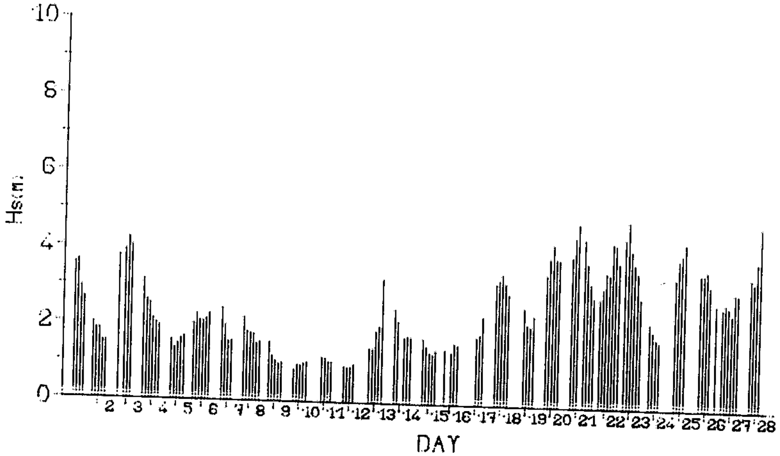
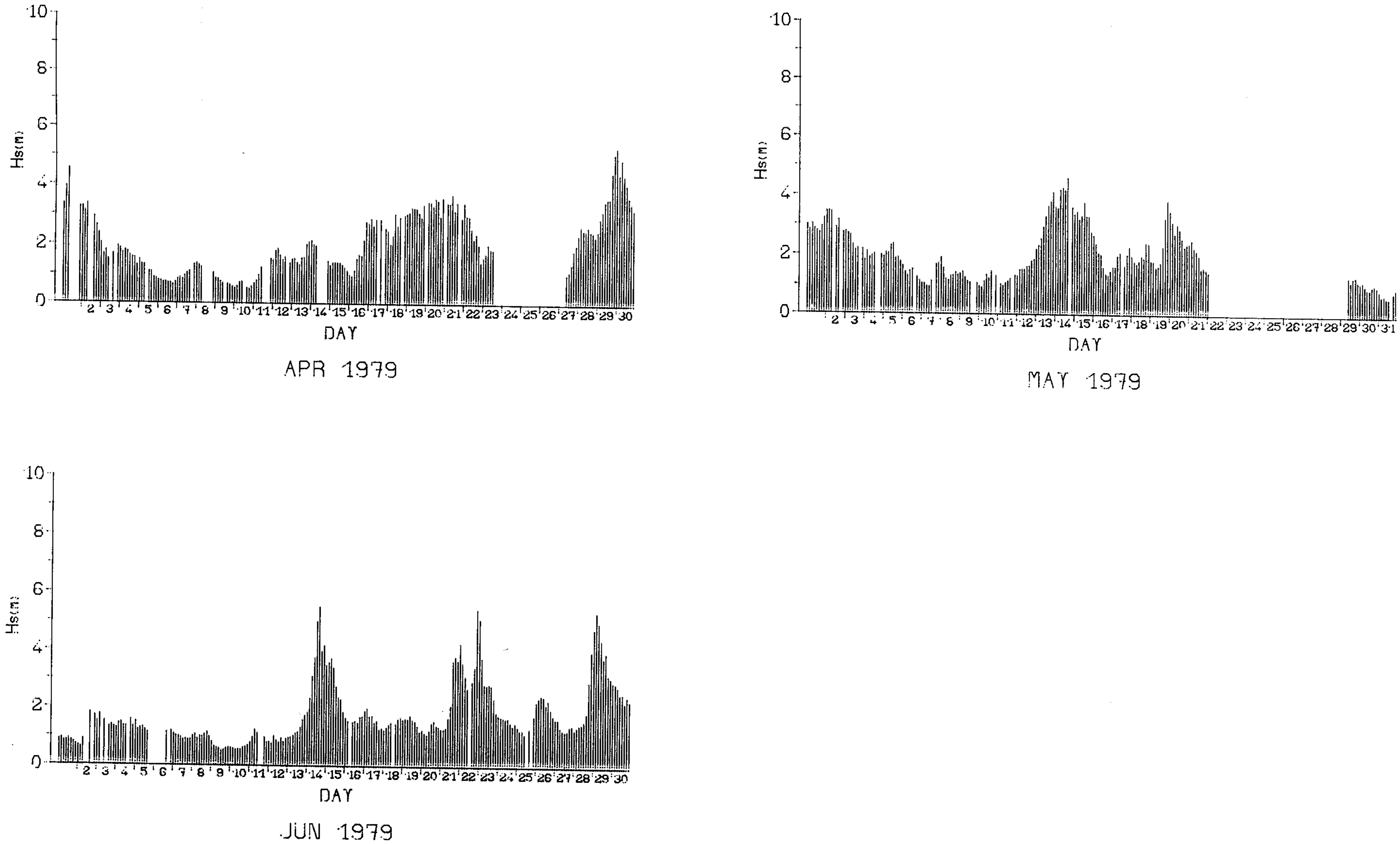


FEB 1979

TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

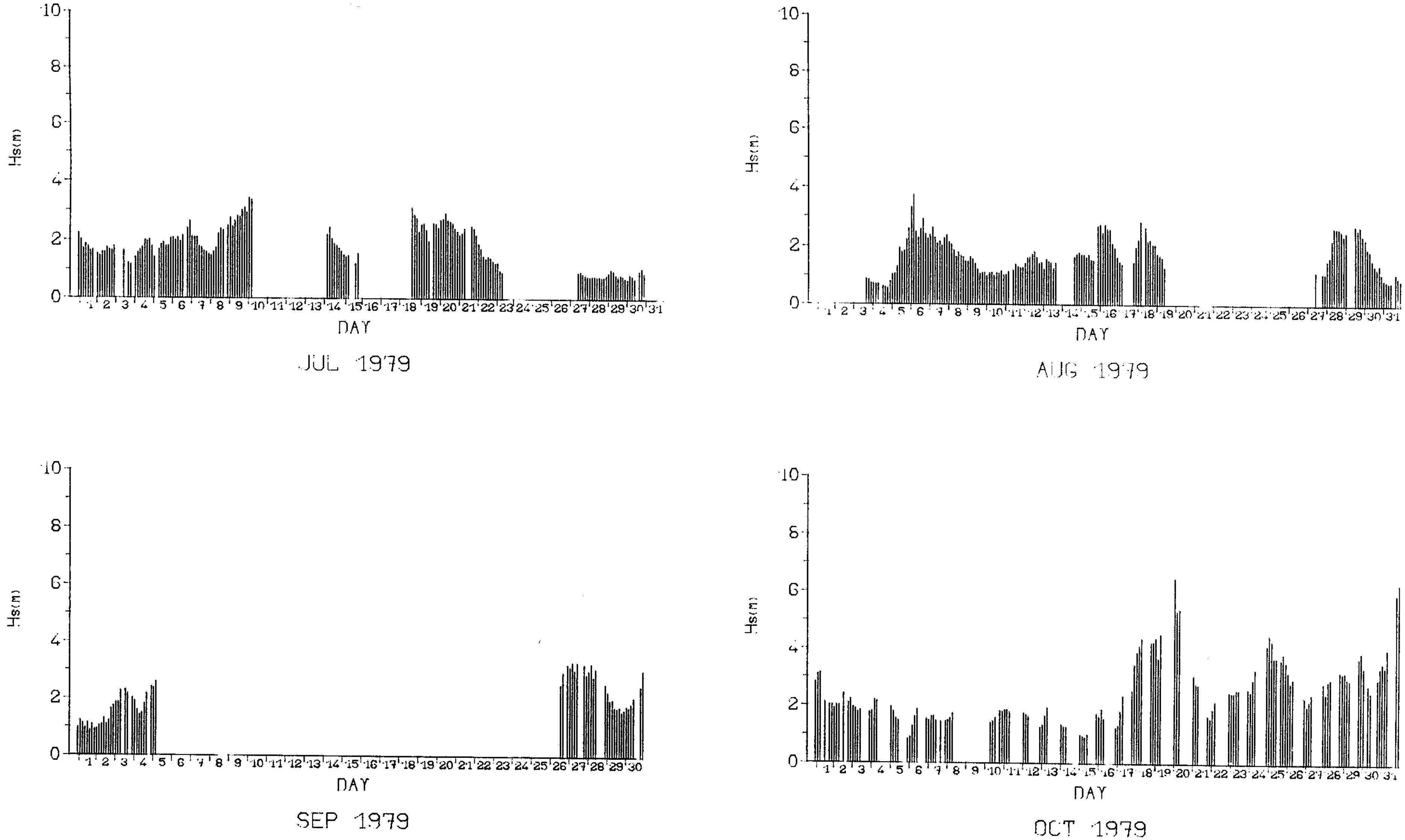
Figure 1·24



TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

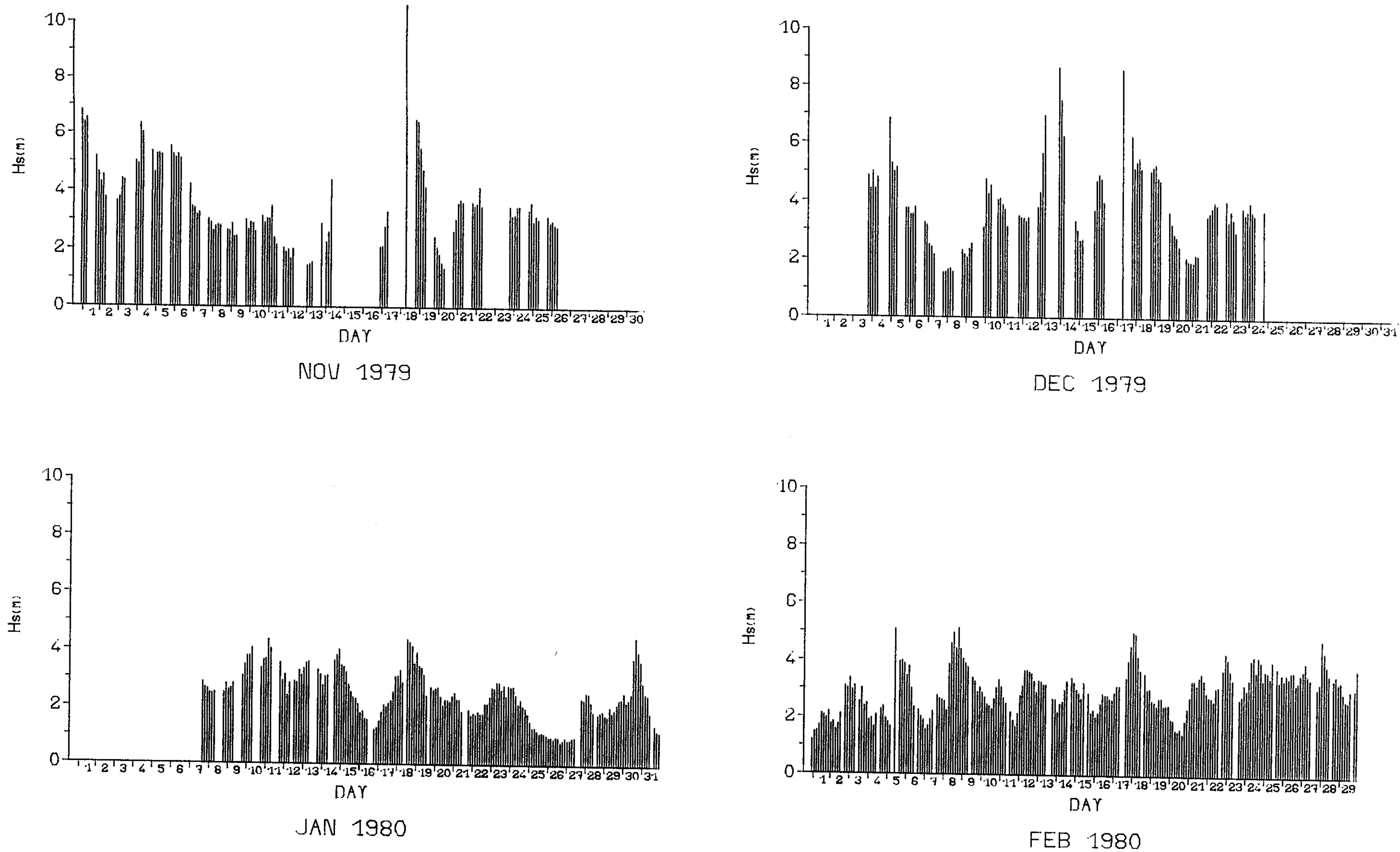
Figure 1·25



TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

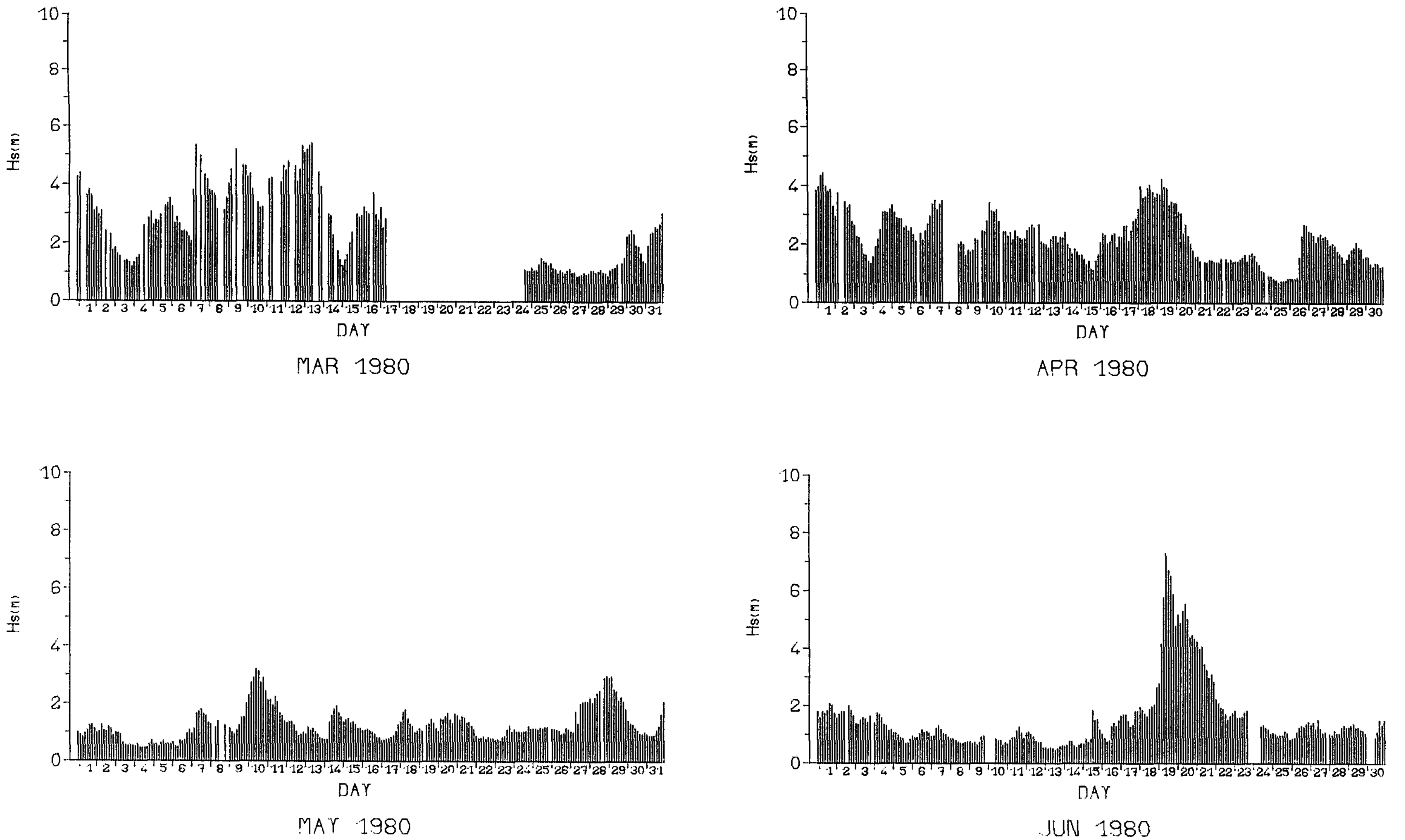
Figure 1·26



TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

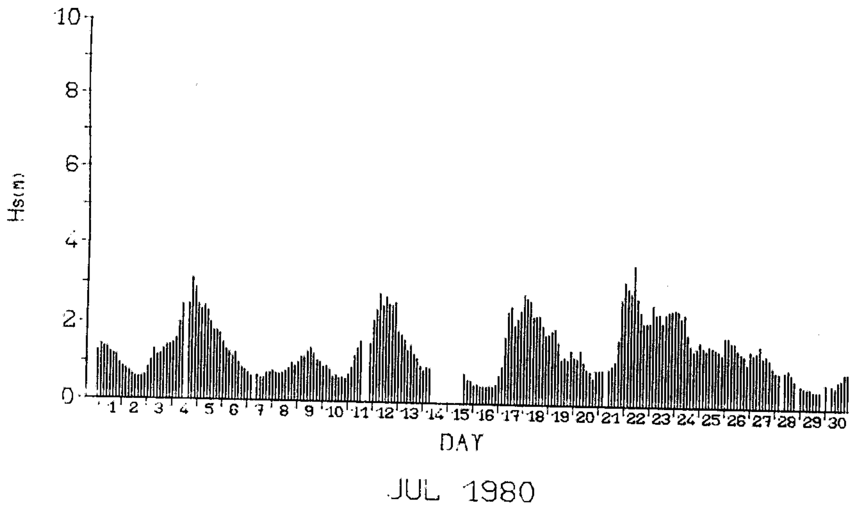
Figure 1·27



TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

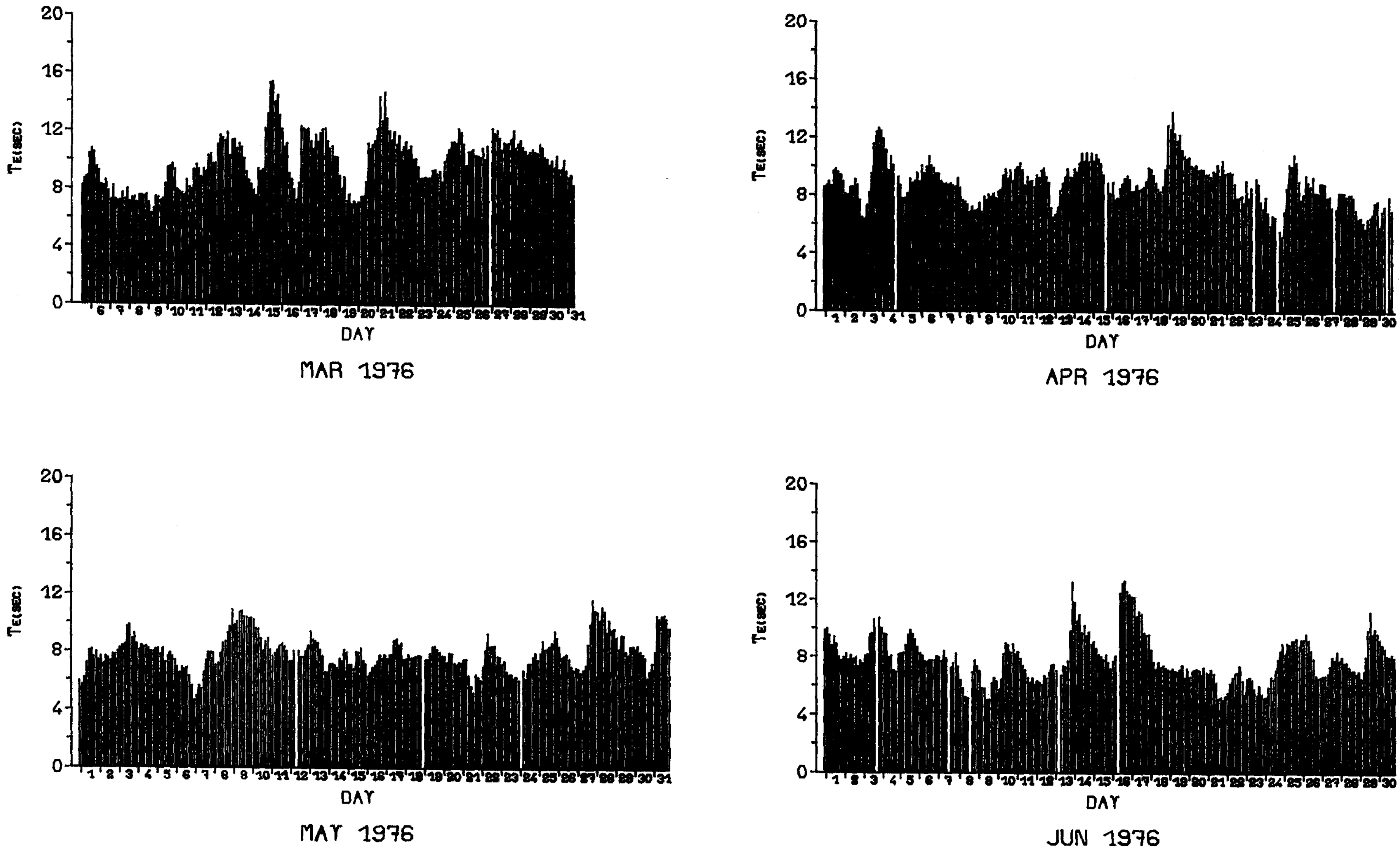
Figure 1·28



TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

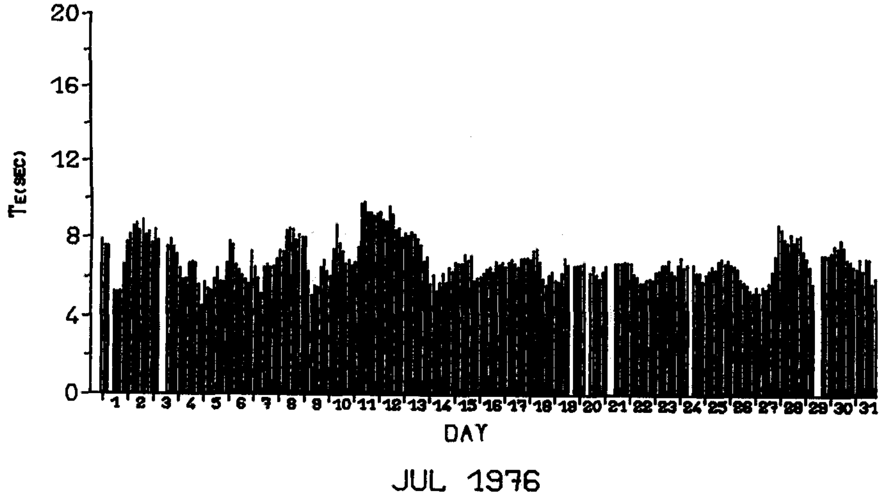
Figure 1·29

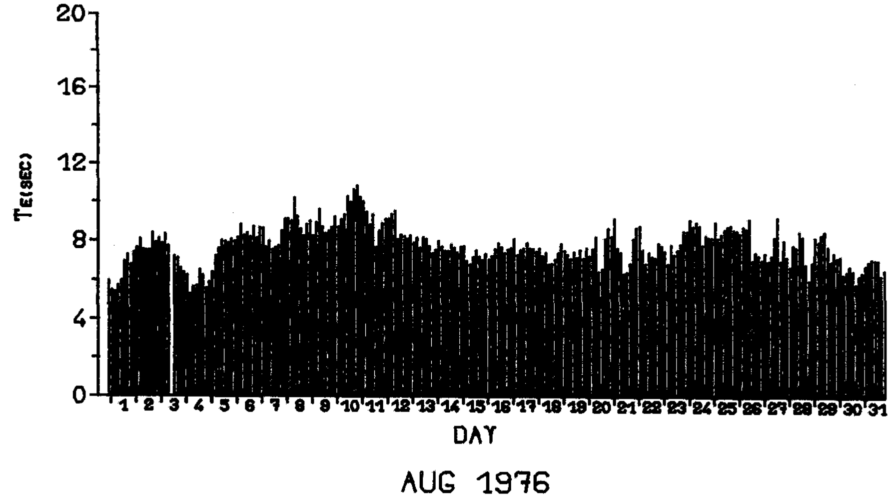


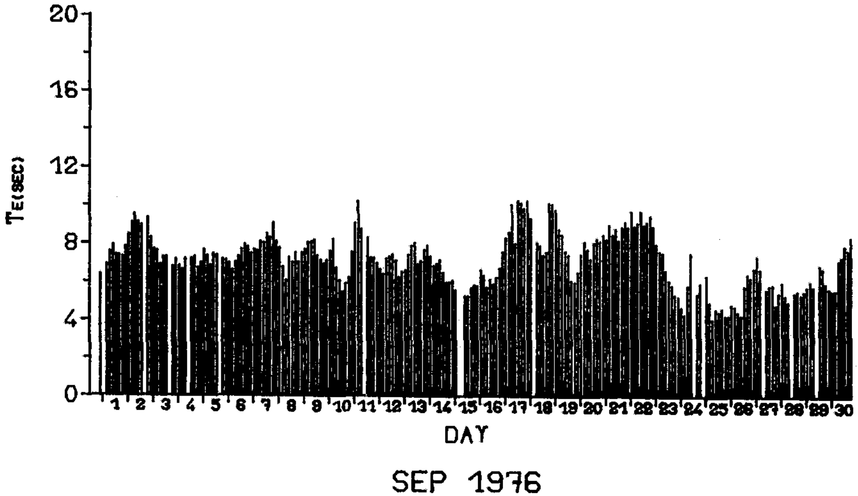
TIME SERIES OF T_E

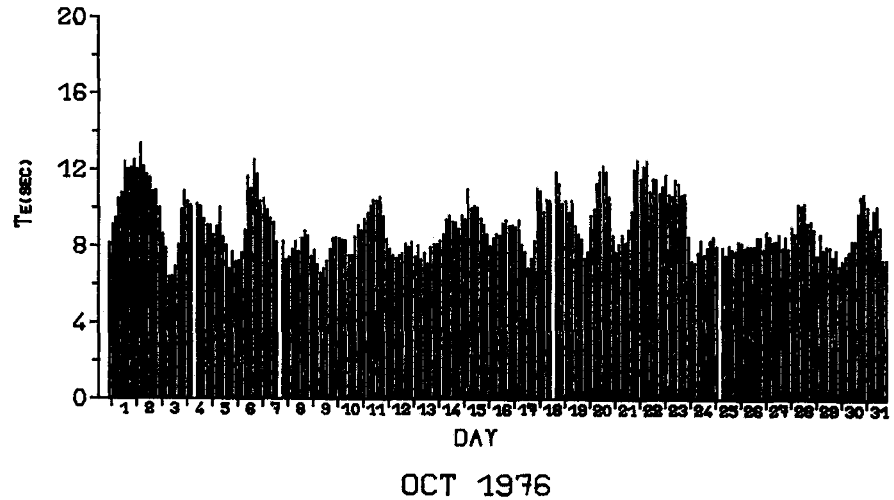
SOUTH UIST OFFSHORE WAVERIDER

Figure 1·30





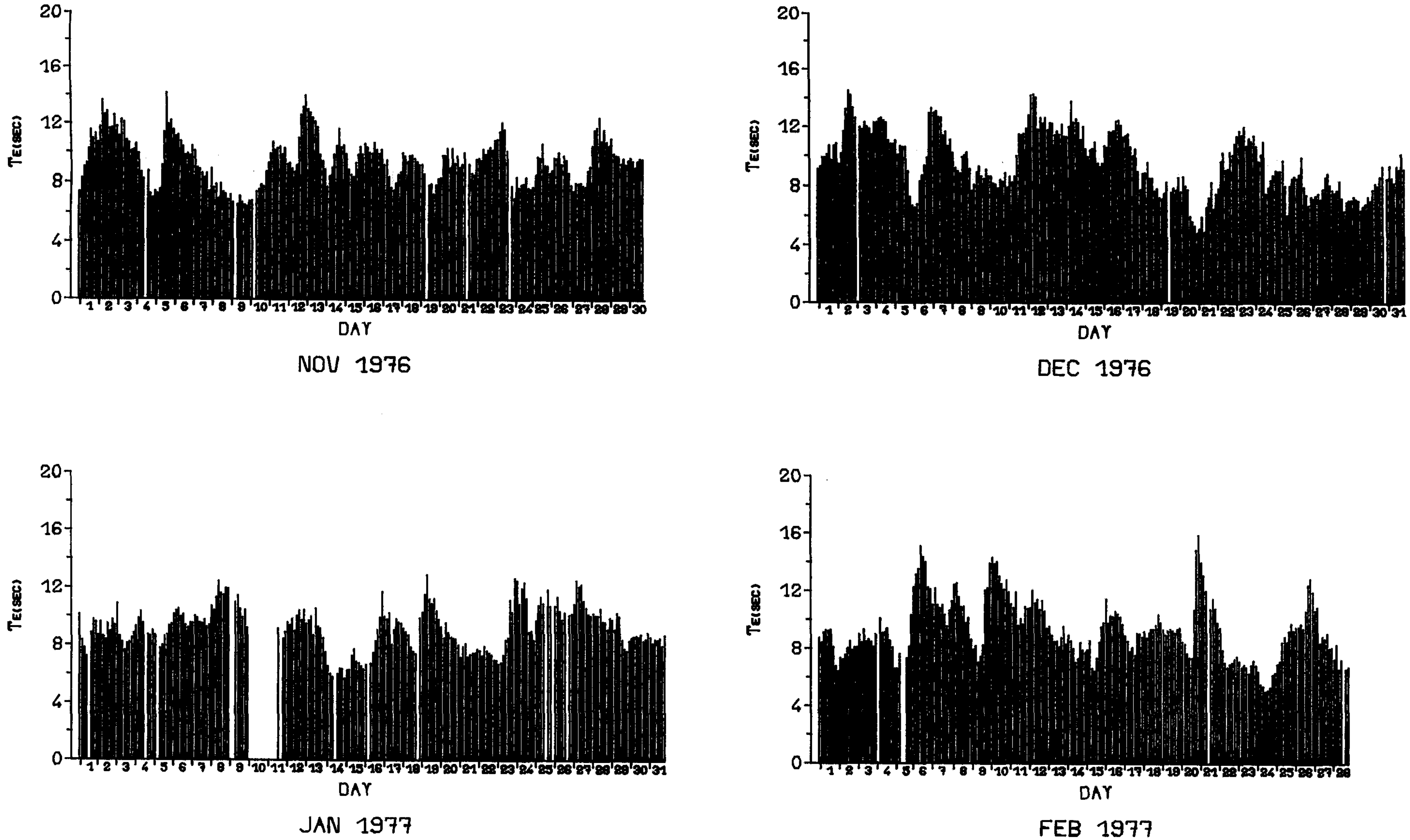




TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

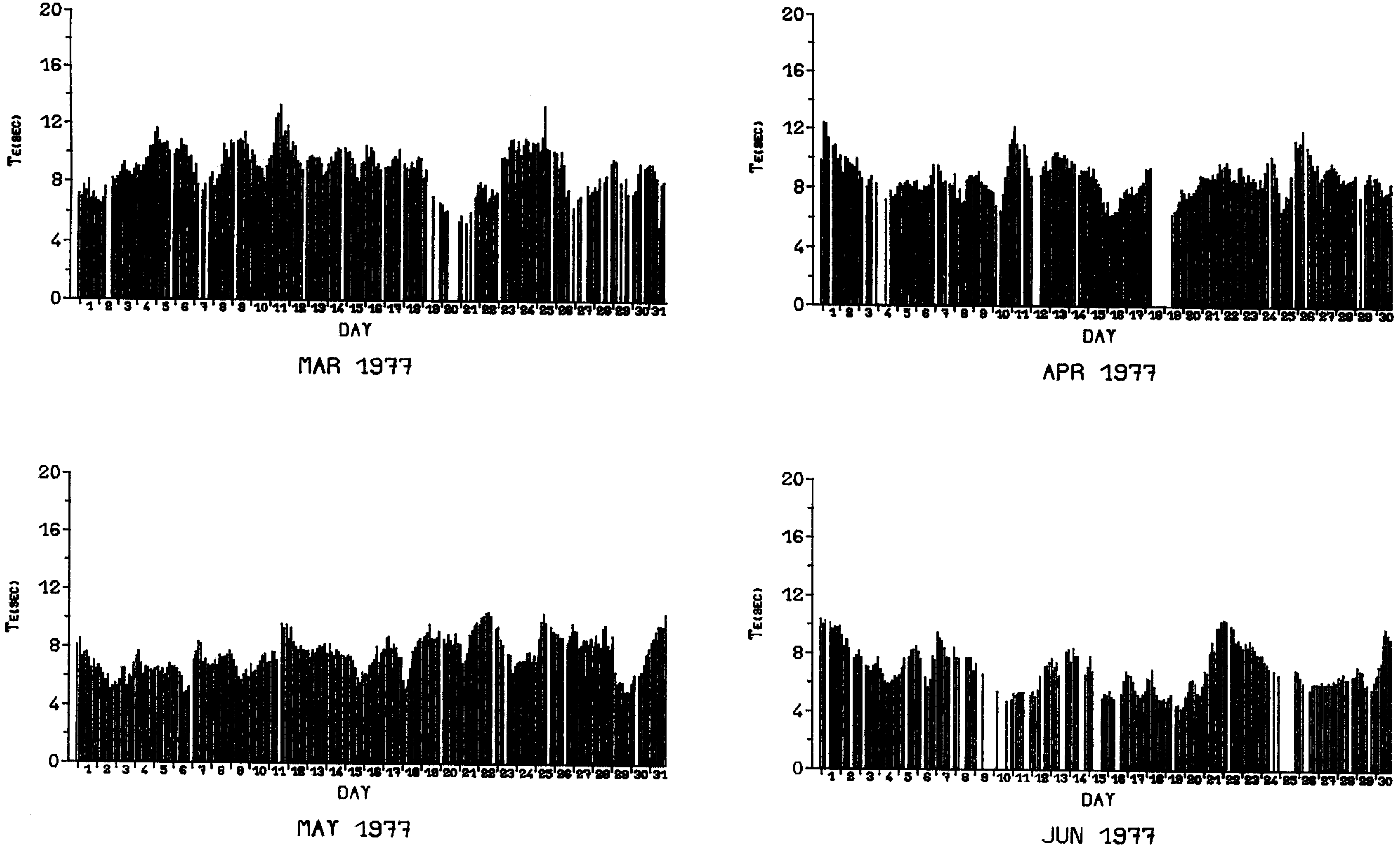
Figure 1·31



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

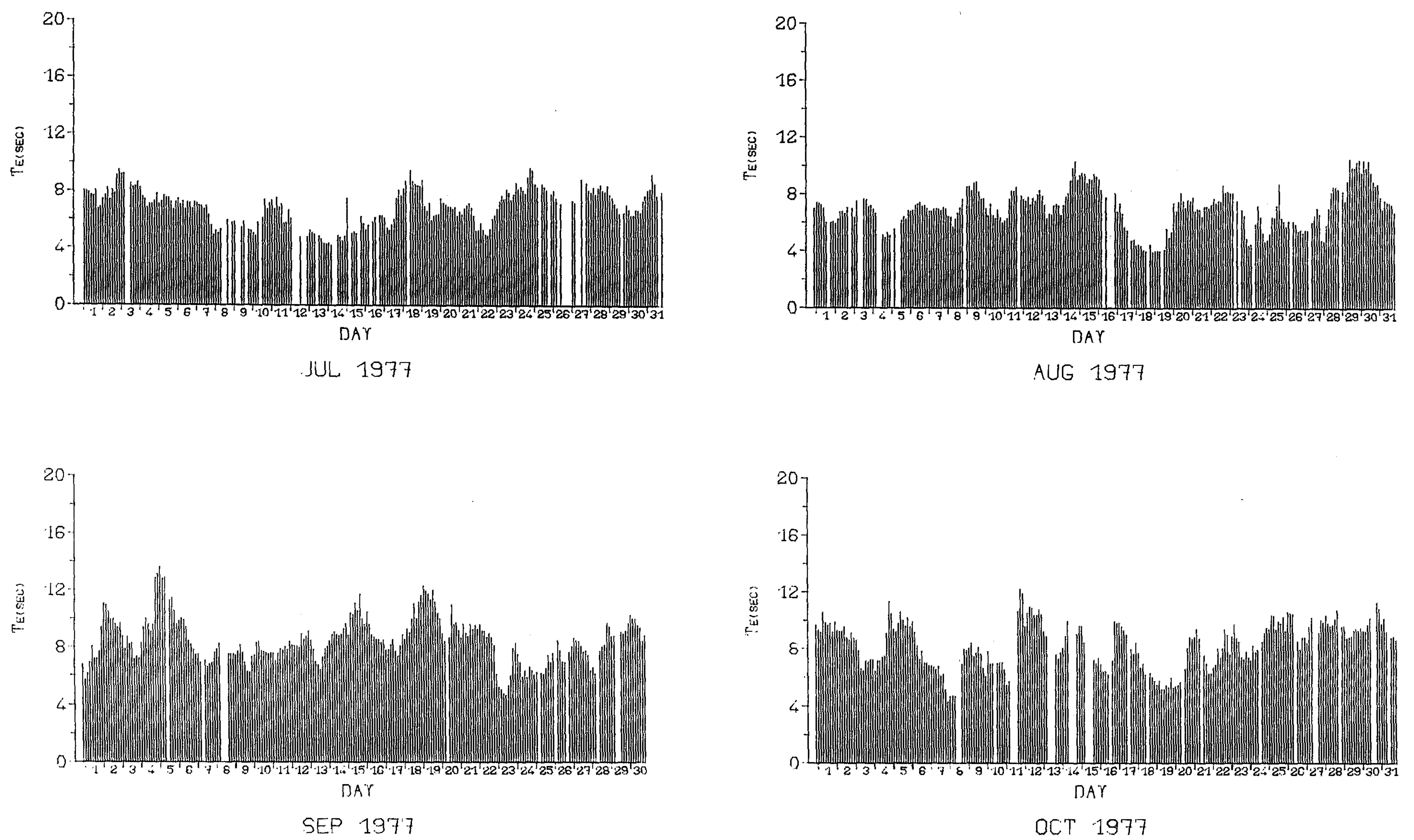
Figure 1.32



TIME SERIES OF TE

SOUTH UIST OFFSHORE WAVERIDER

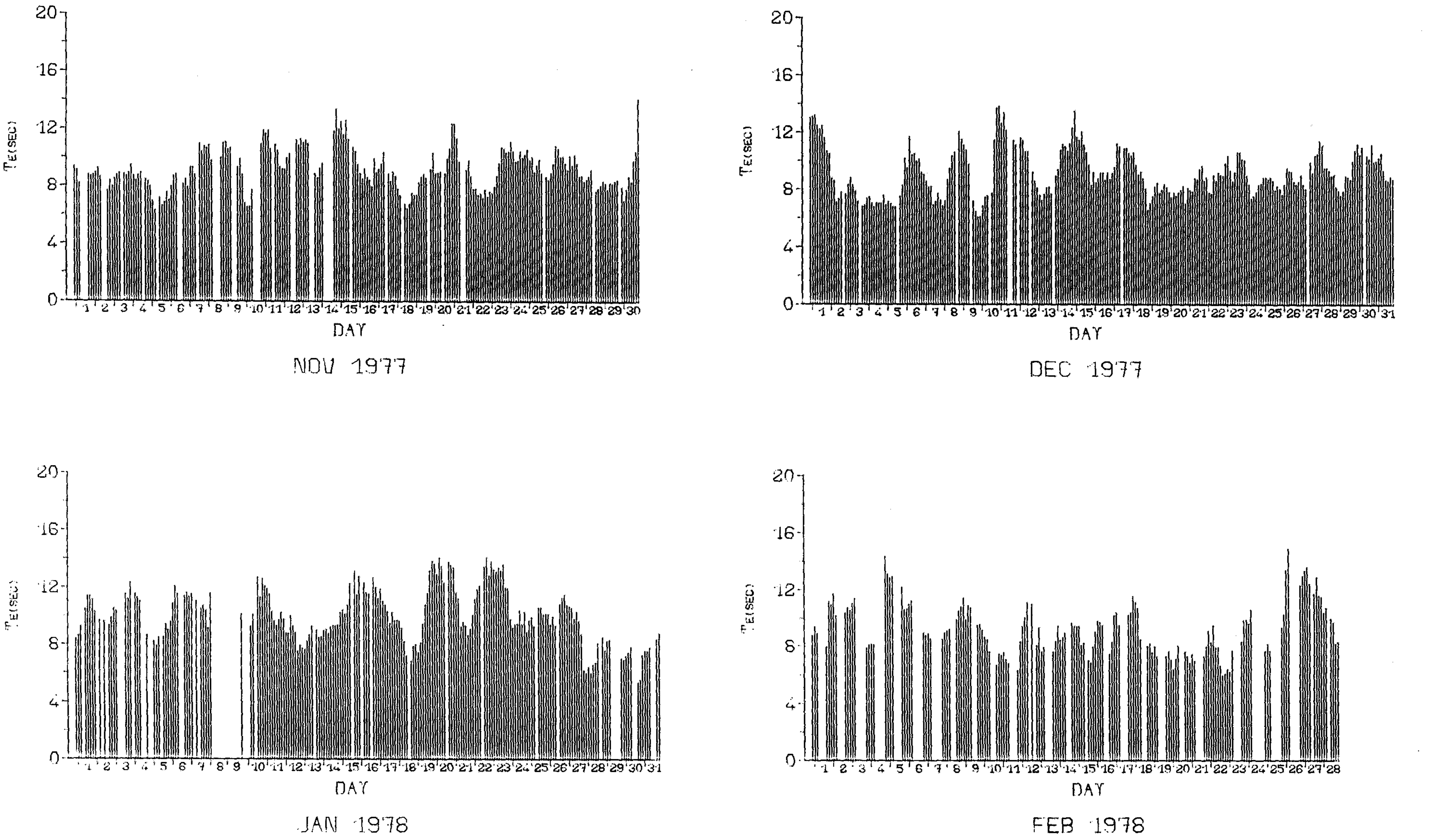
Figure 1·33



TIME SERIES OF TE

SOUTH UIST OFFSHORE WAVERIDER

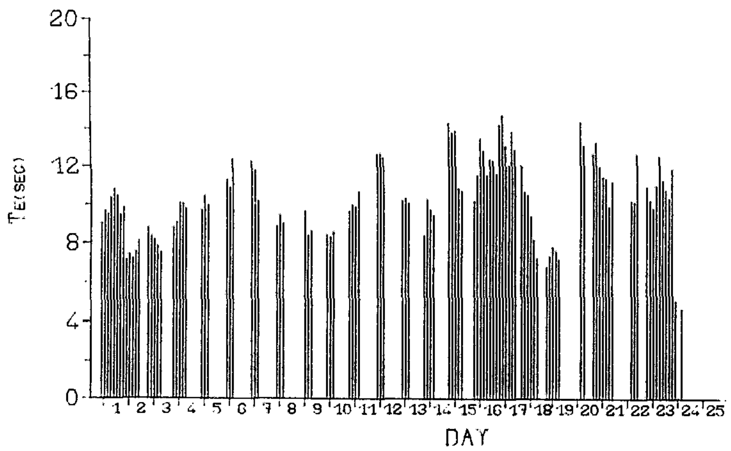
Figure 1·34



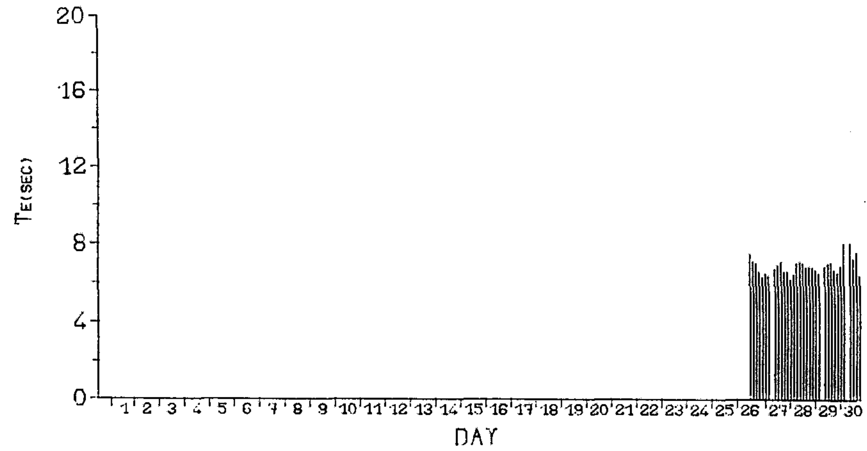
TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

Figure 1·35



MAR 1978

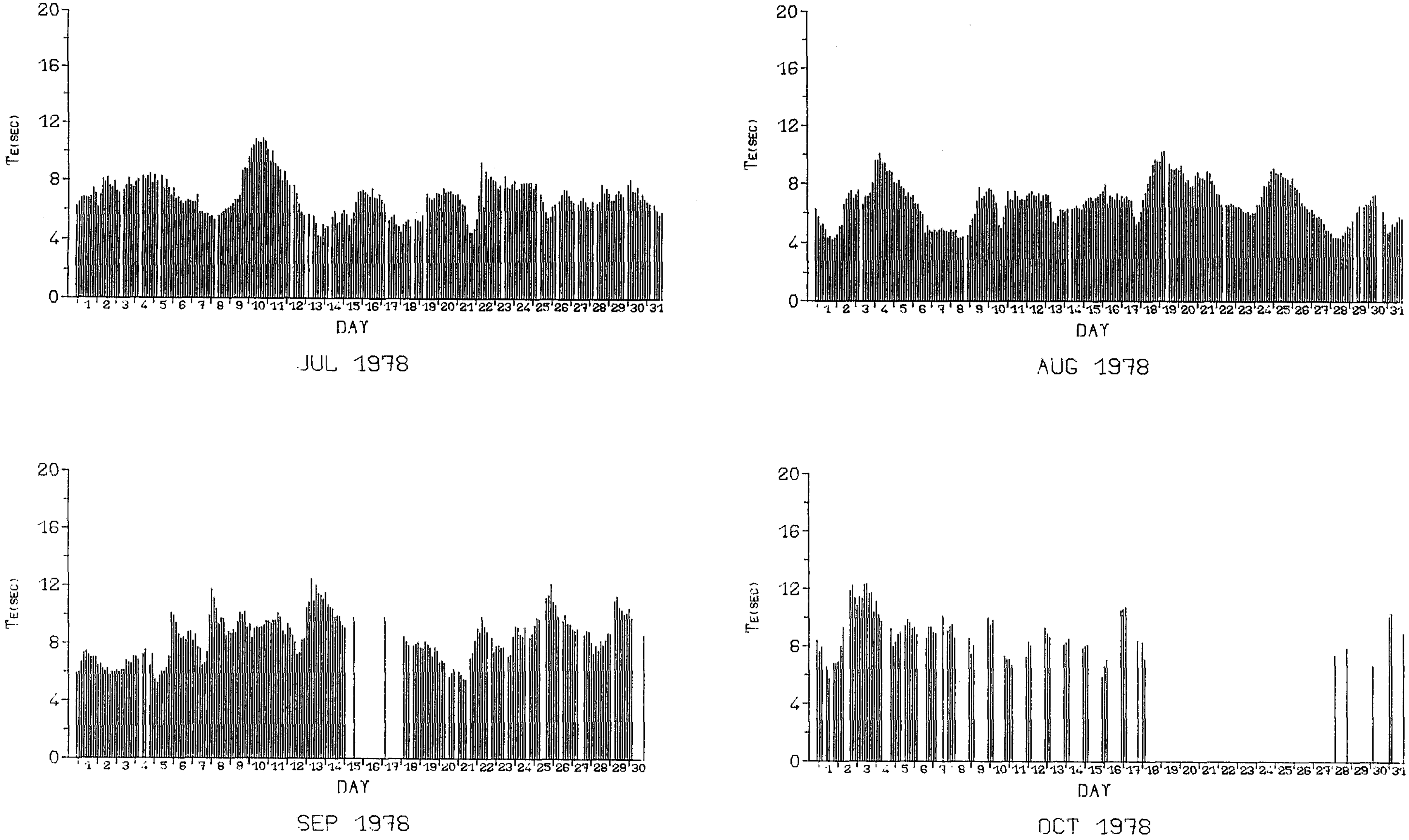


JUN 1978

TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

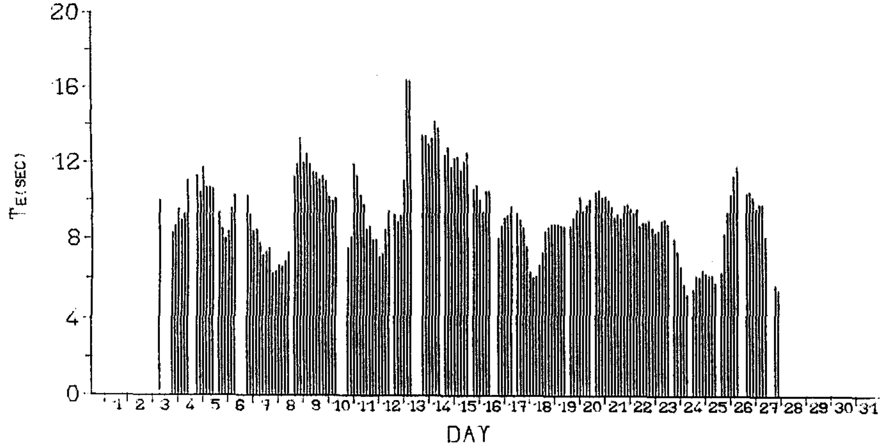
Figure 1·36



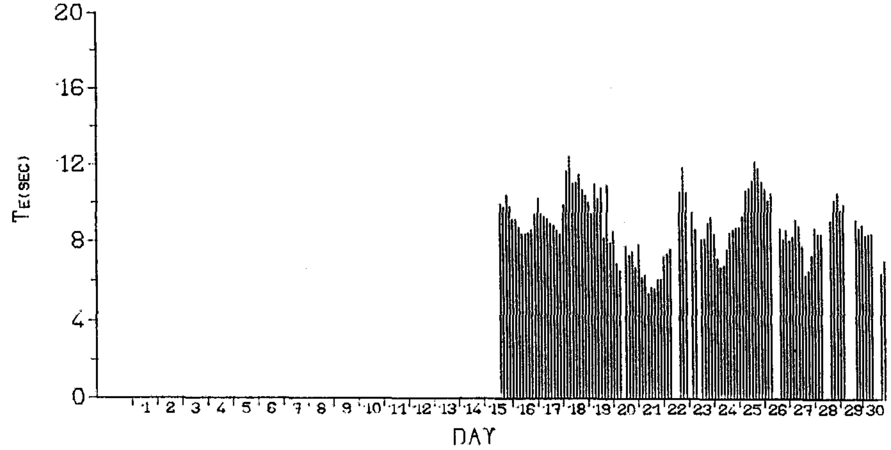
TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

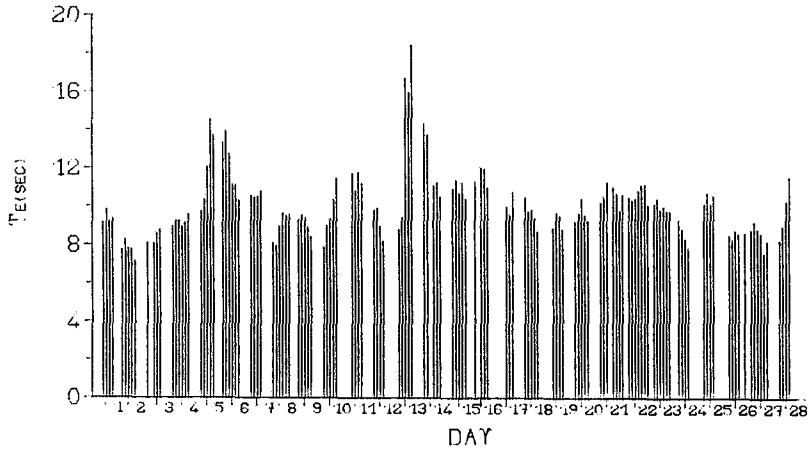
Figure 1·37



DEC 1978



JAN 1979

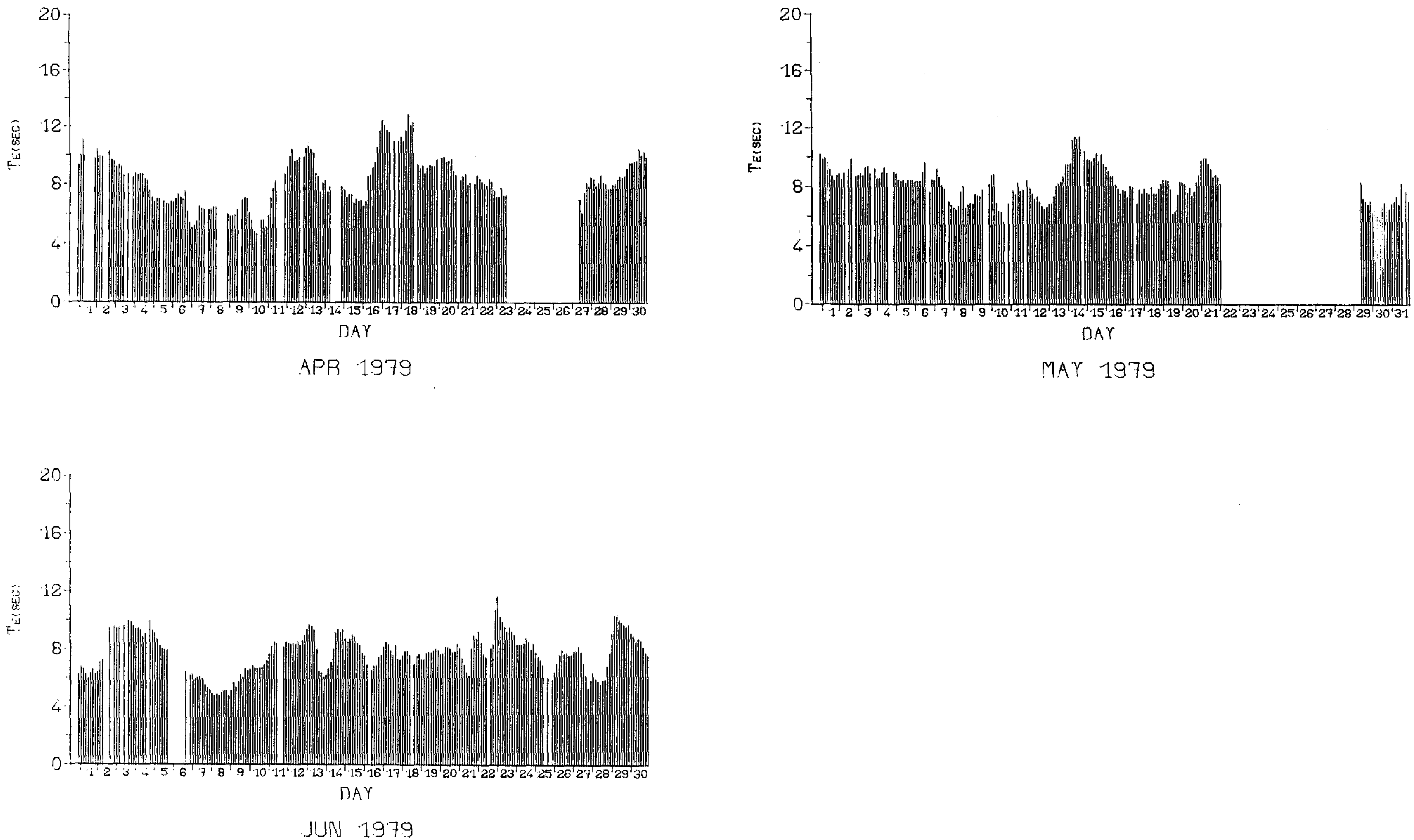


FEB 1979

TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

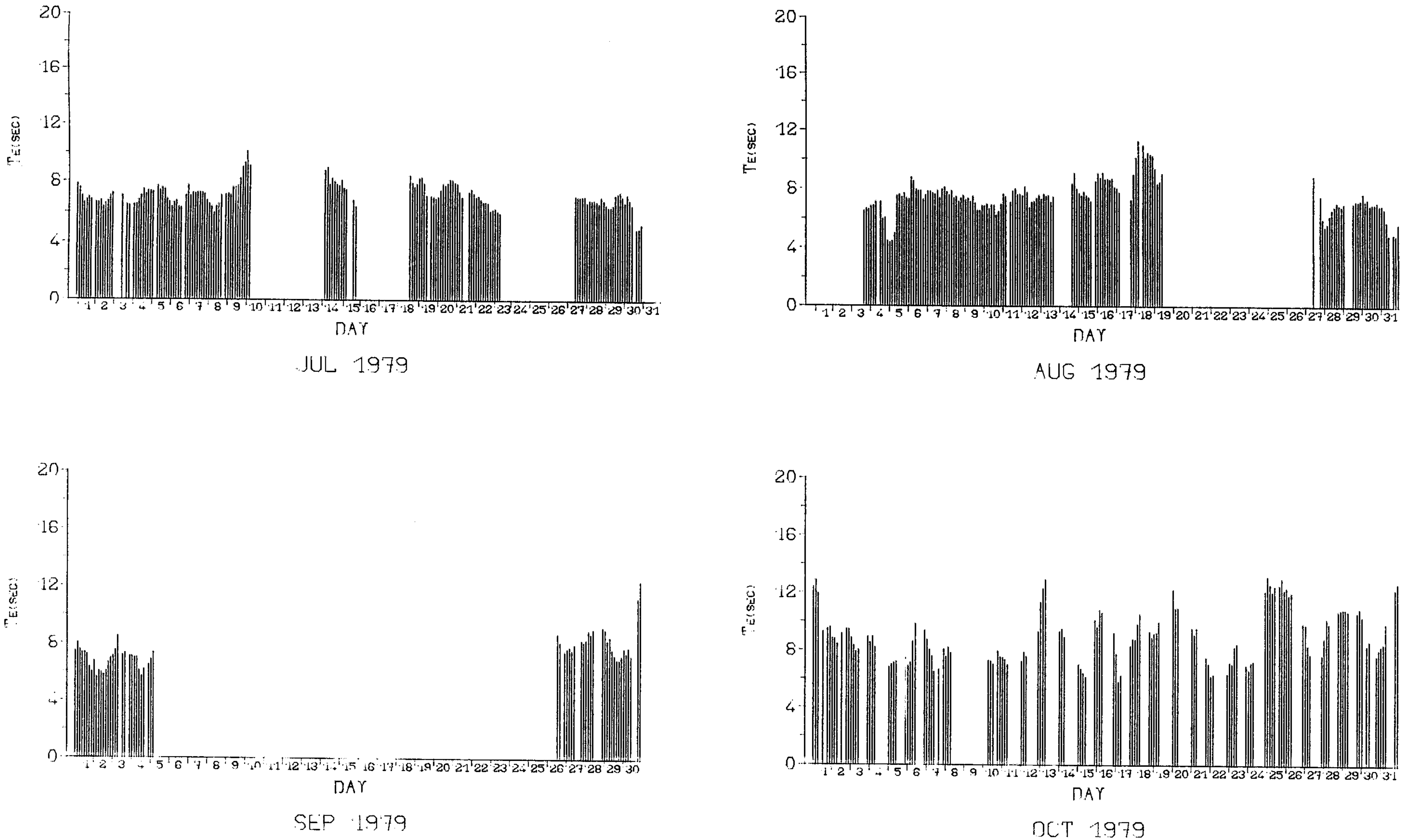
Figure 1·38



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

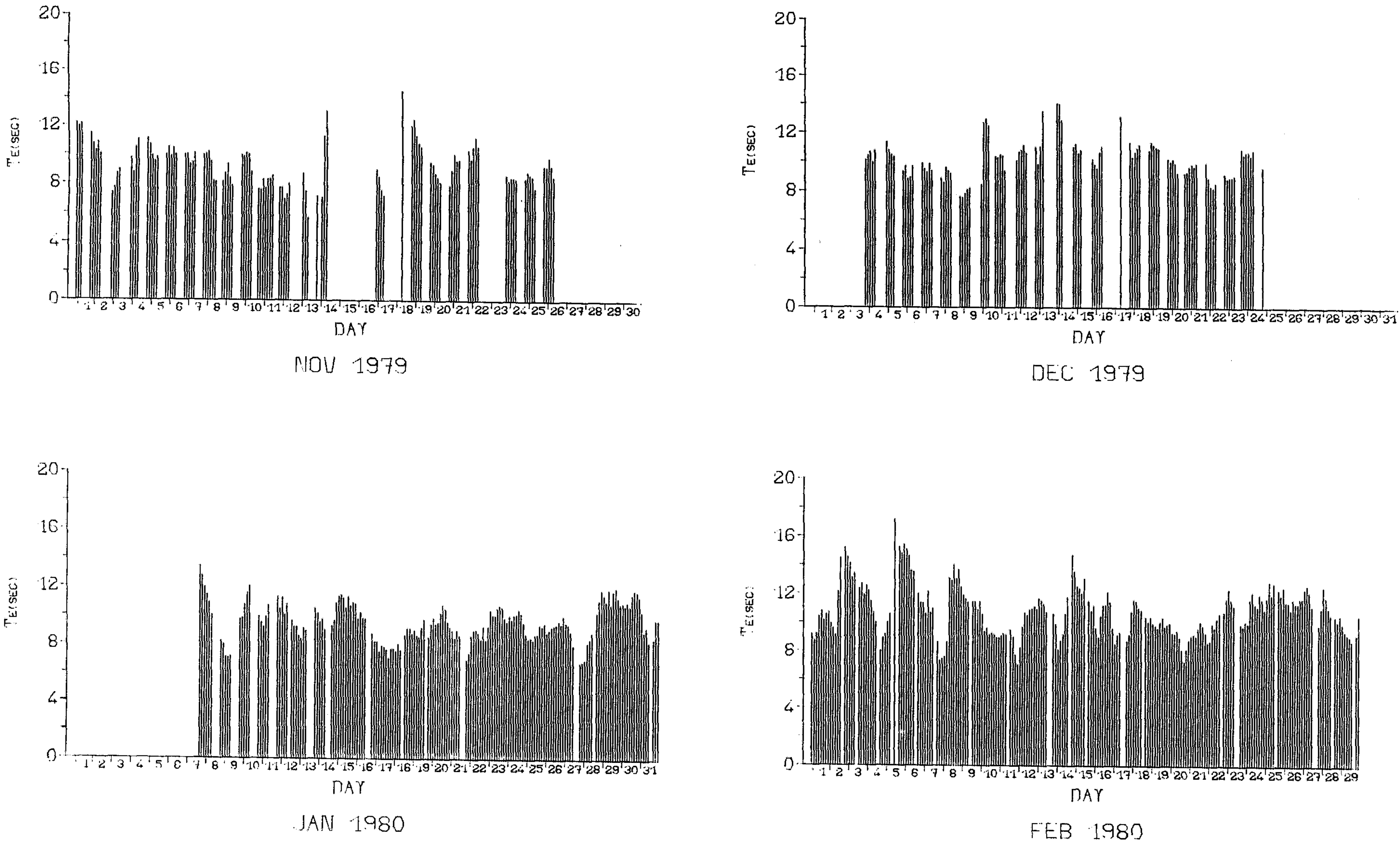
Figure 1·39



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

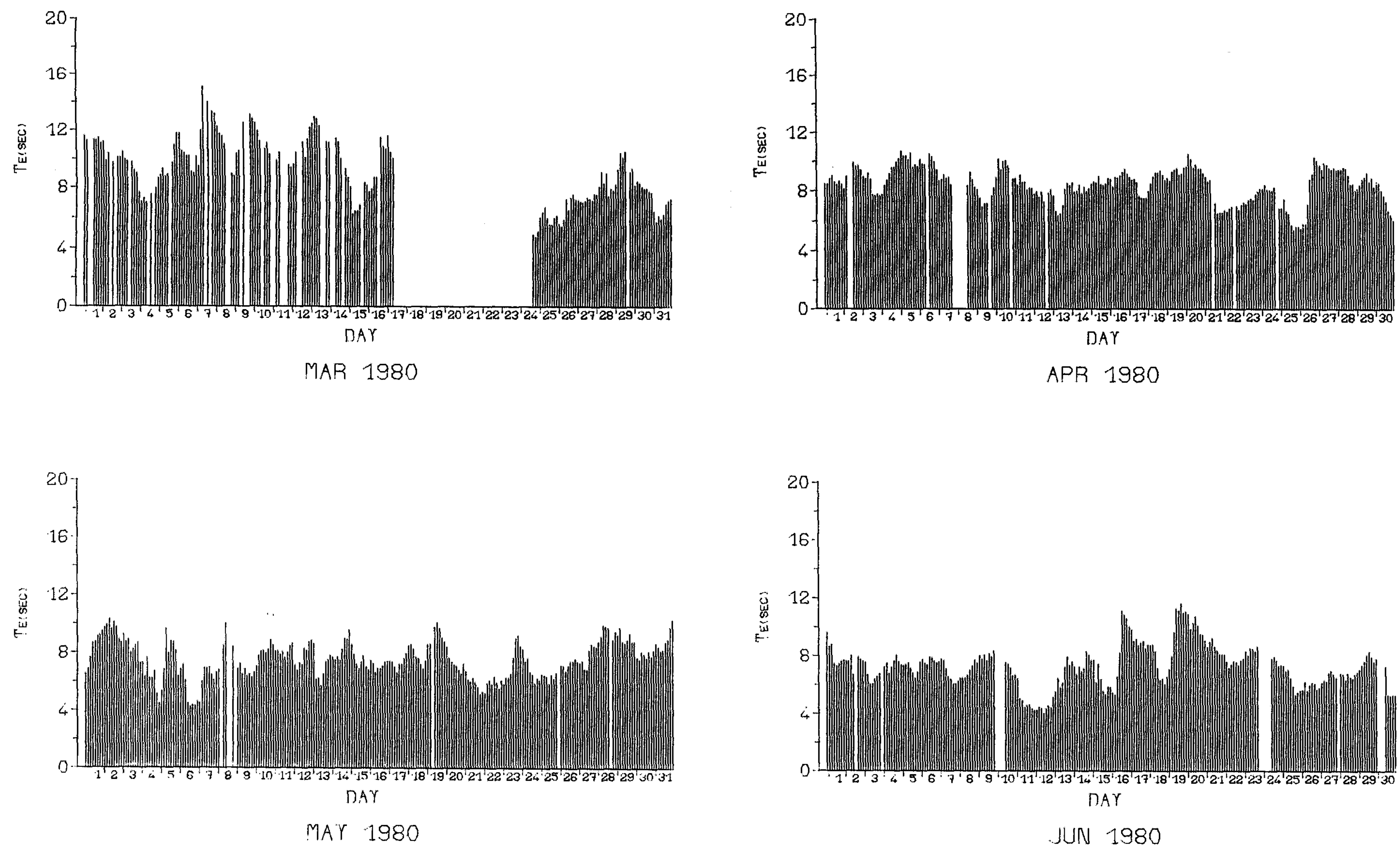
Figure 1·40



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

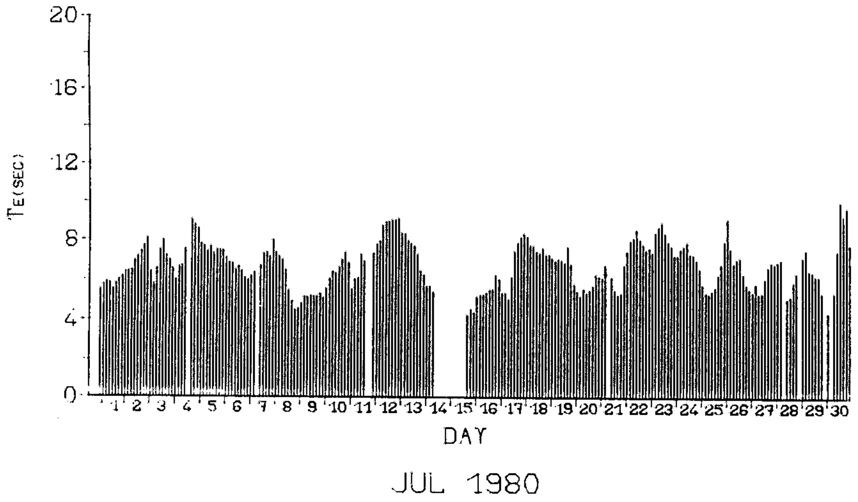
Figure 1·41



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

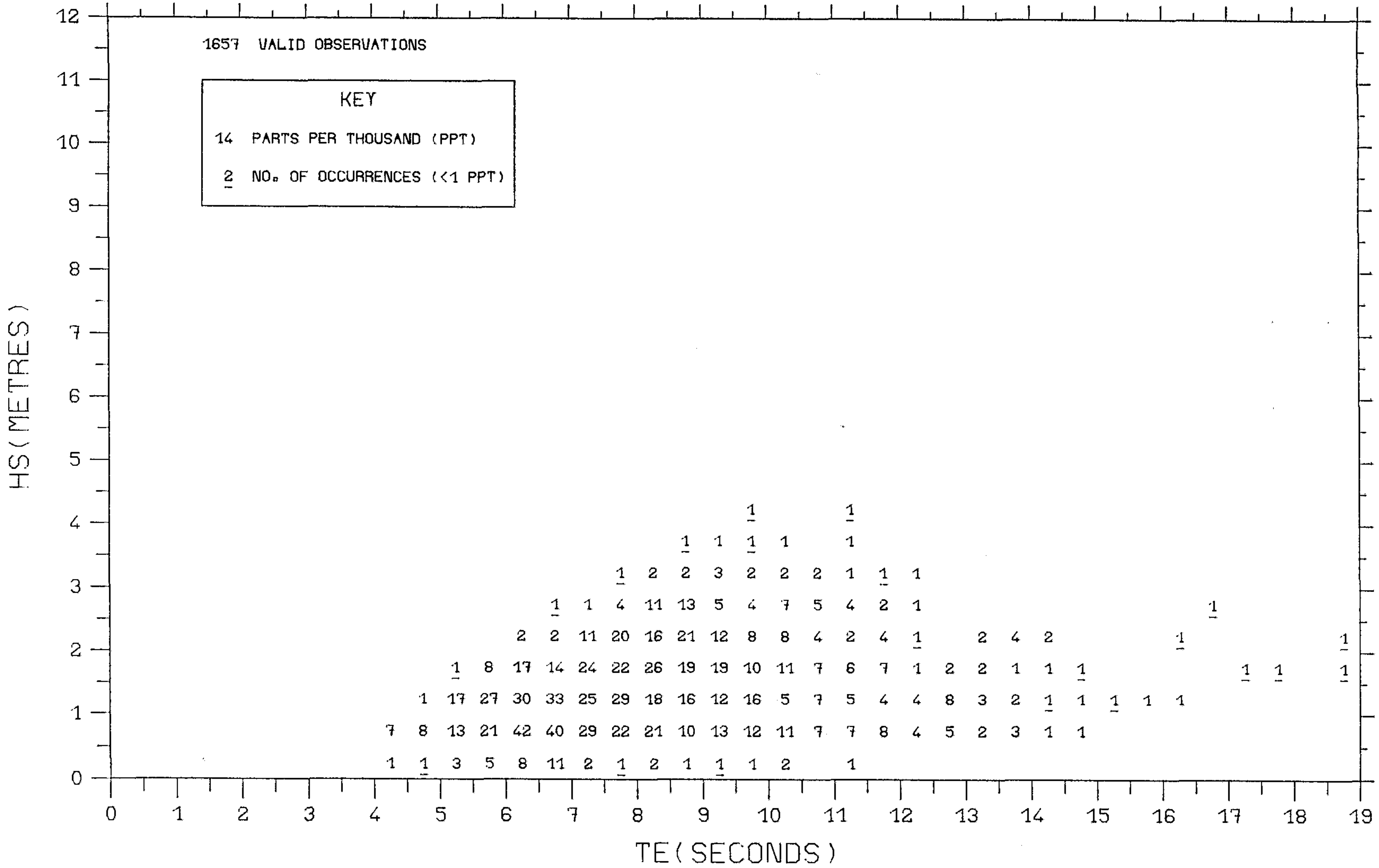
Figure 1·42



TIME SERIES OF T_E

SOUTH UIST OFFSHORE WAVERIDER

Figure 1·43

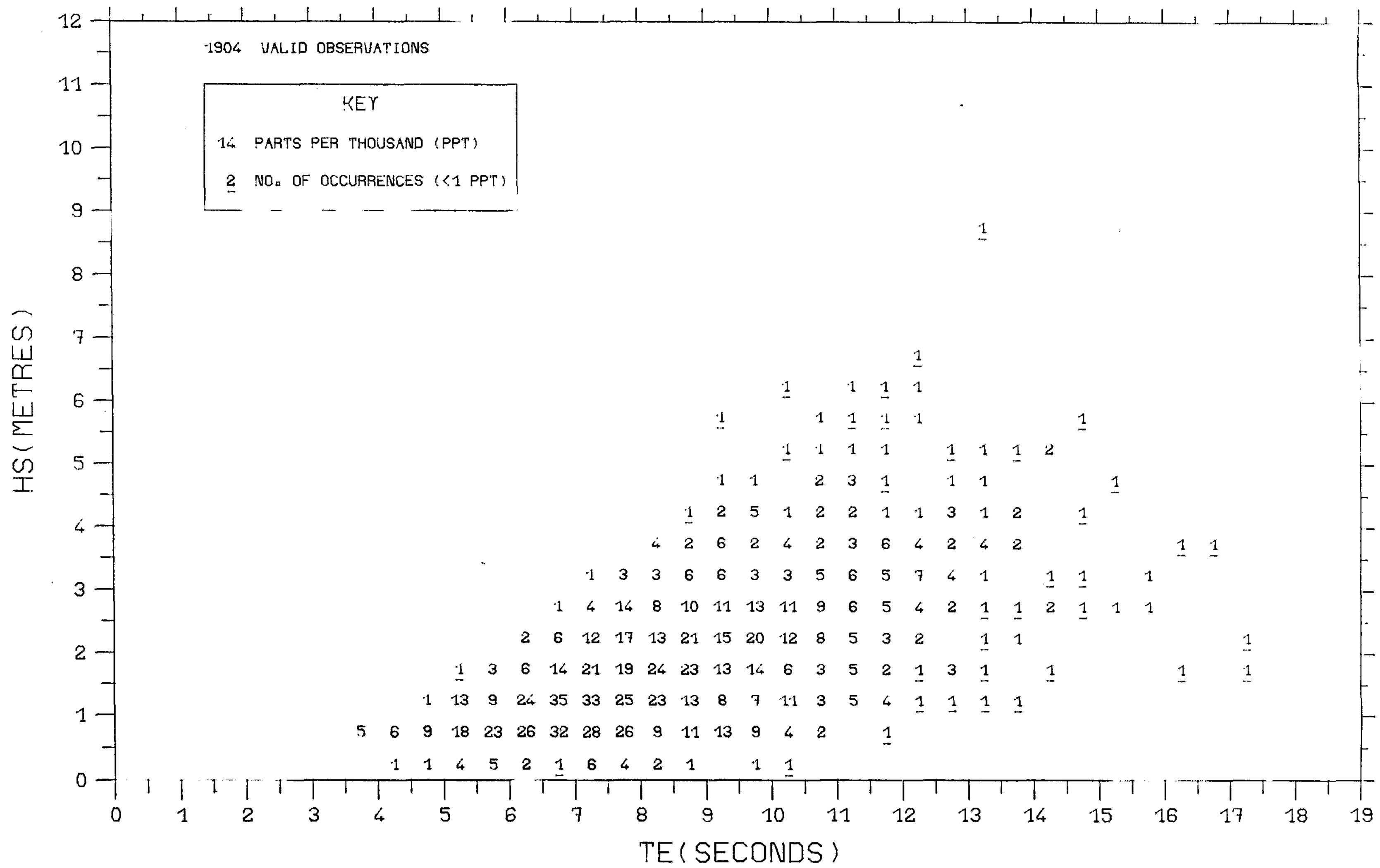


SCATTER PLOT OF HS AND TE

SOUTH UIST INSHORE 1 POSITION. AUGUST 1978-JULY 1979

CAUTION. Incomplete data set. See time series plots for details.

Figure 2·1

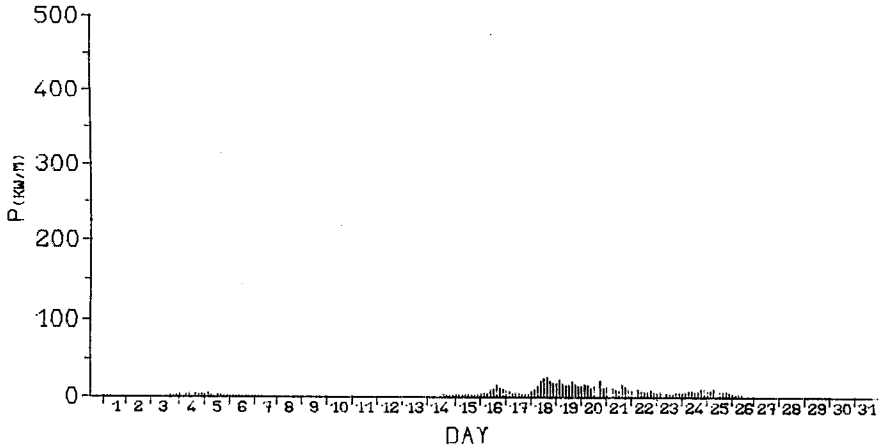


SCATTER PLOT OF HS AND TE

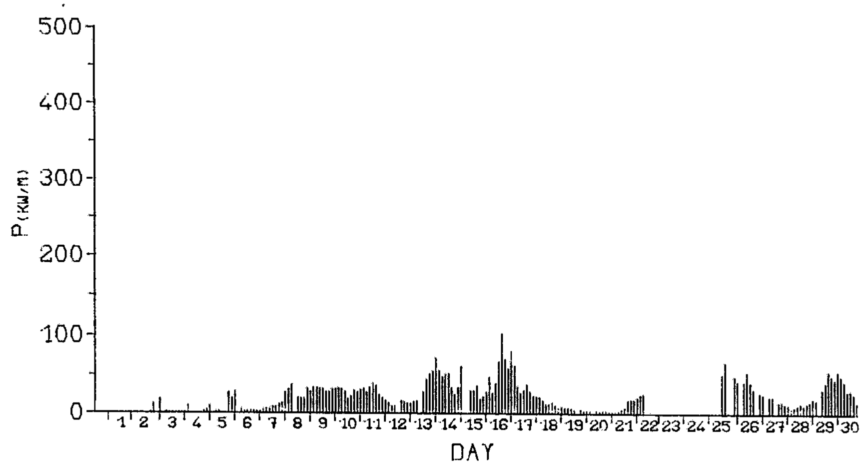
SOUTH UIST INSHORE 2 POSITION.SEPTEMBER 1979-JULY 1980

CAUTION. Incomplete data set. See time series plots for details.

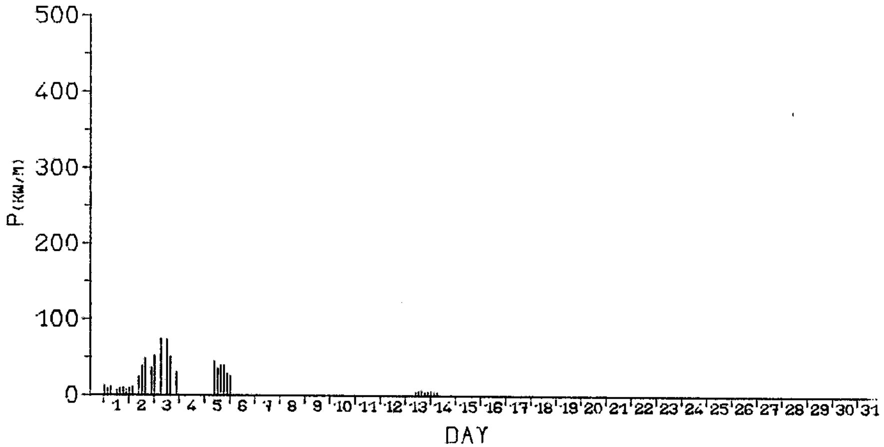
Figure 2·2



AUG 1978



SEP 1978

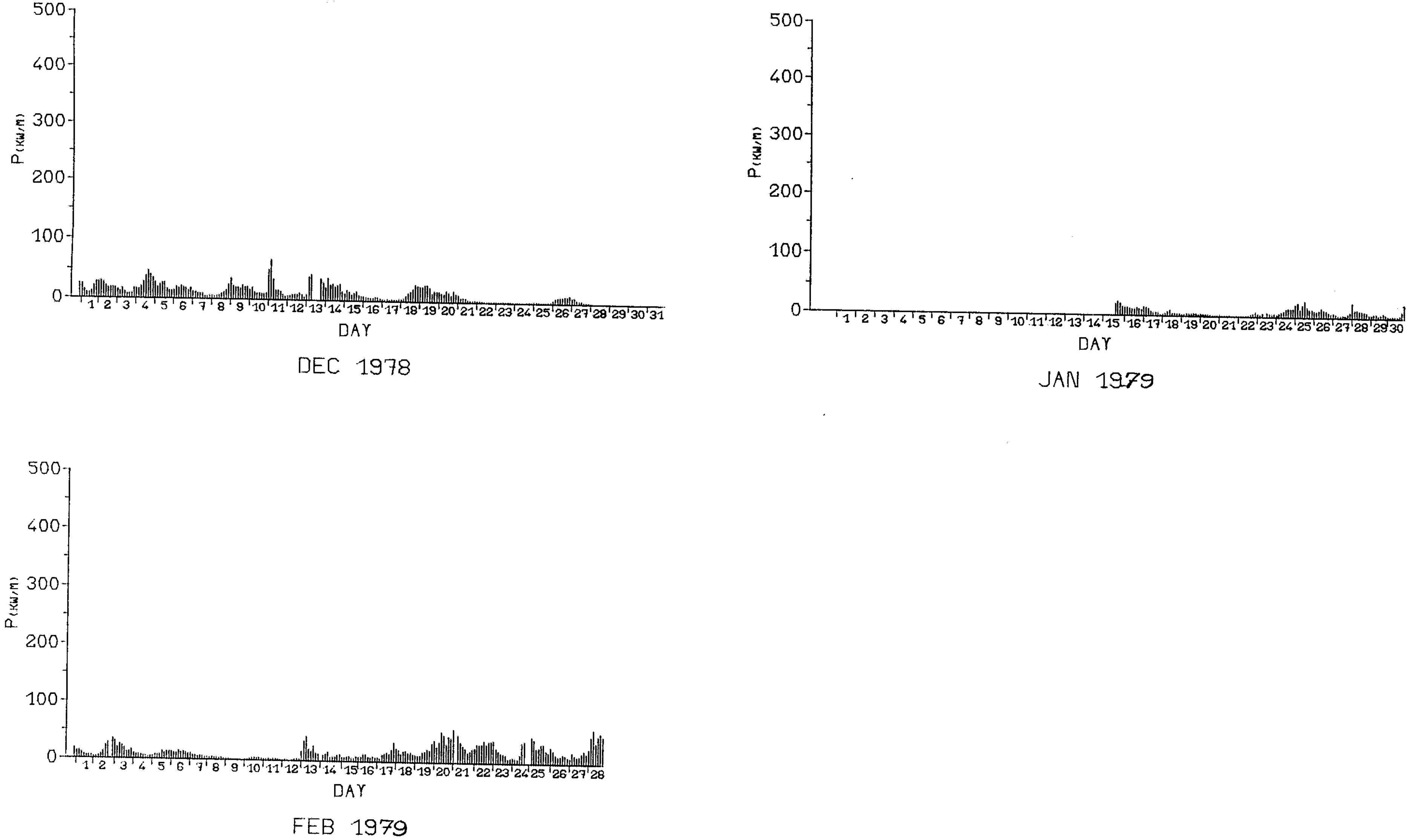


OCT 1978

TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

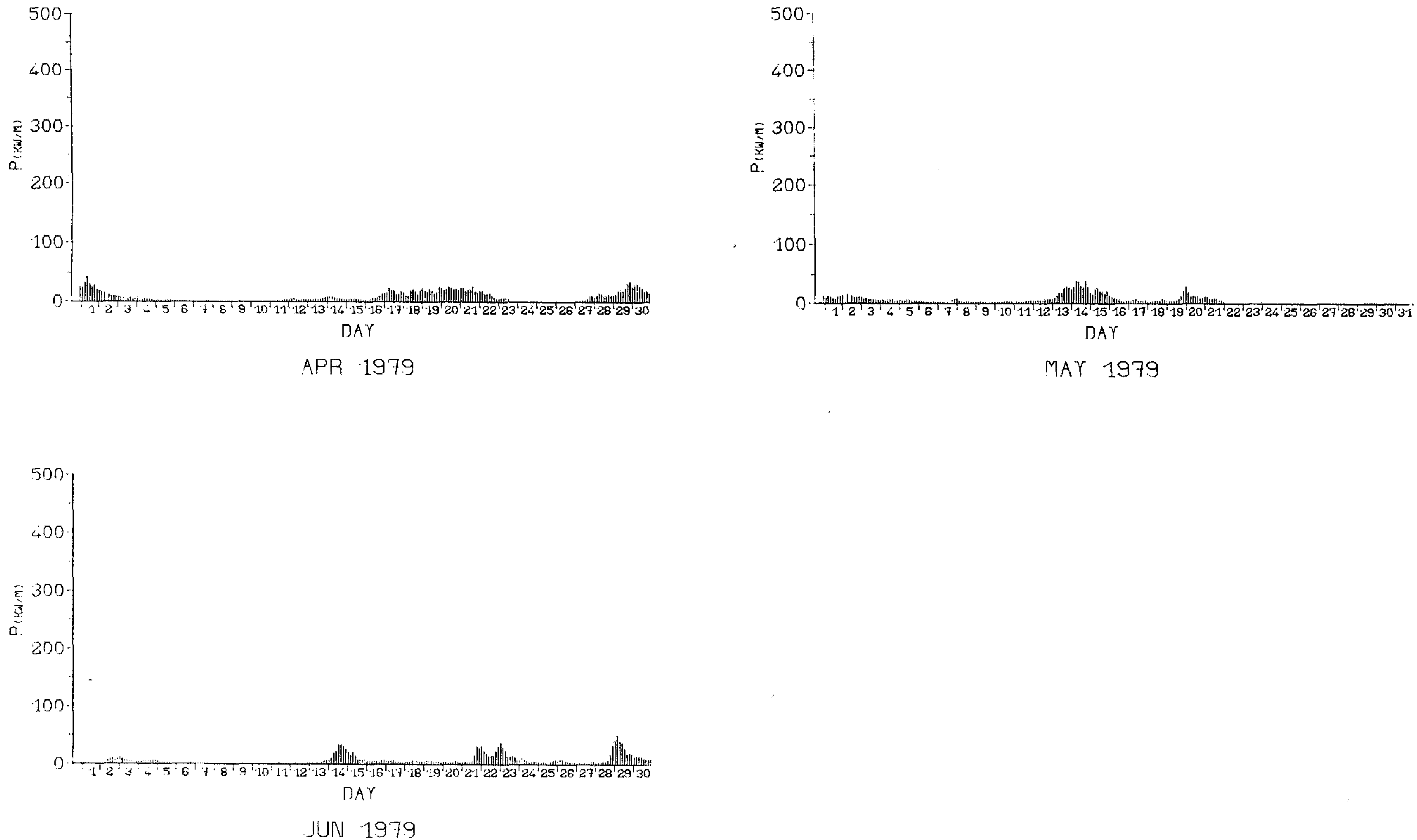
Figure 2·3



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

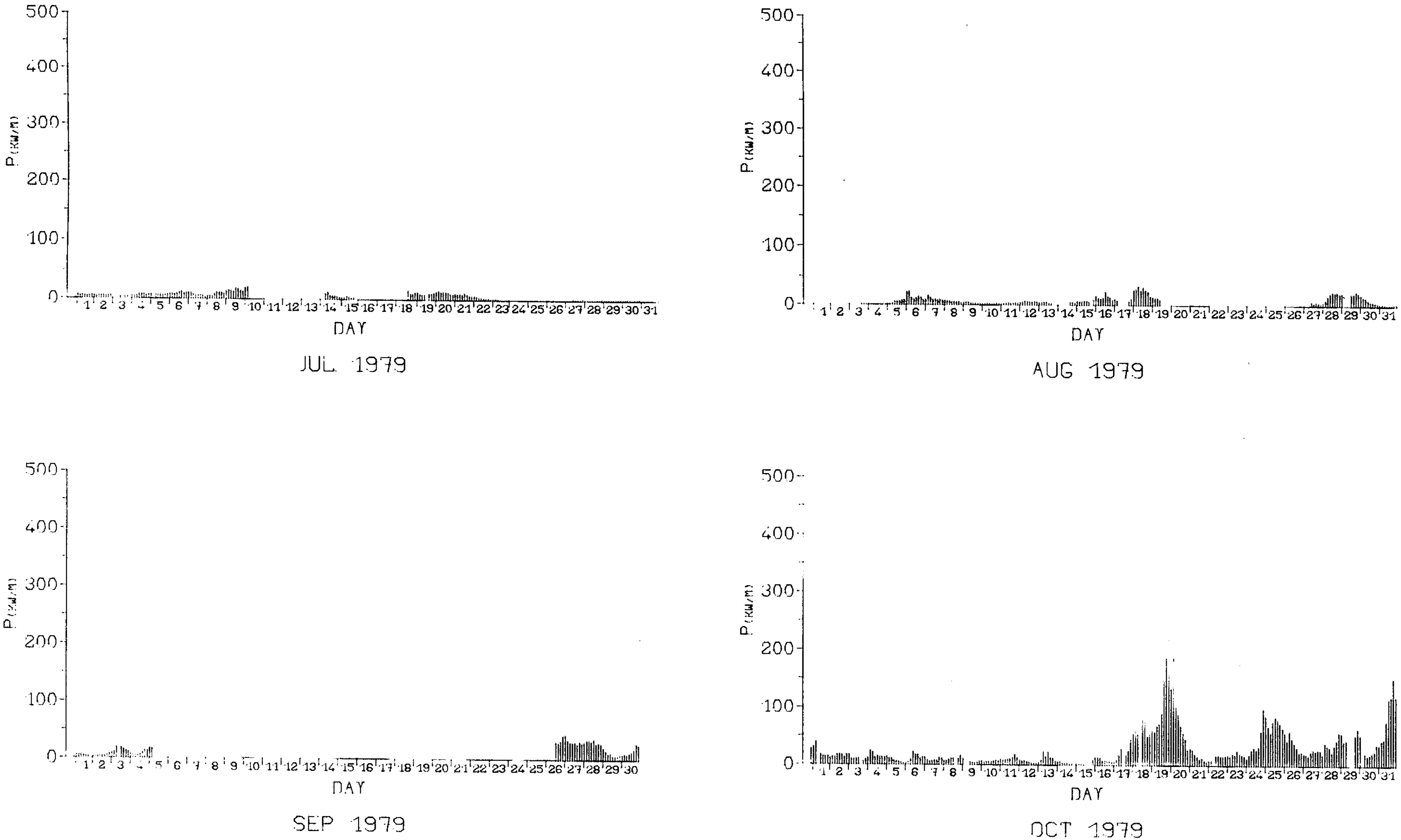
Figure 2.4



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

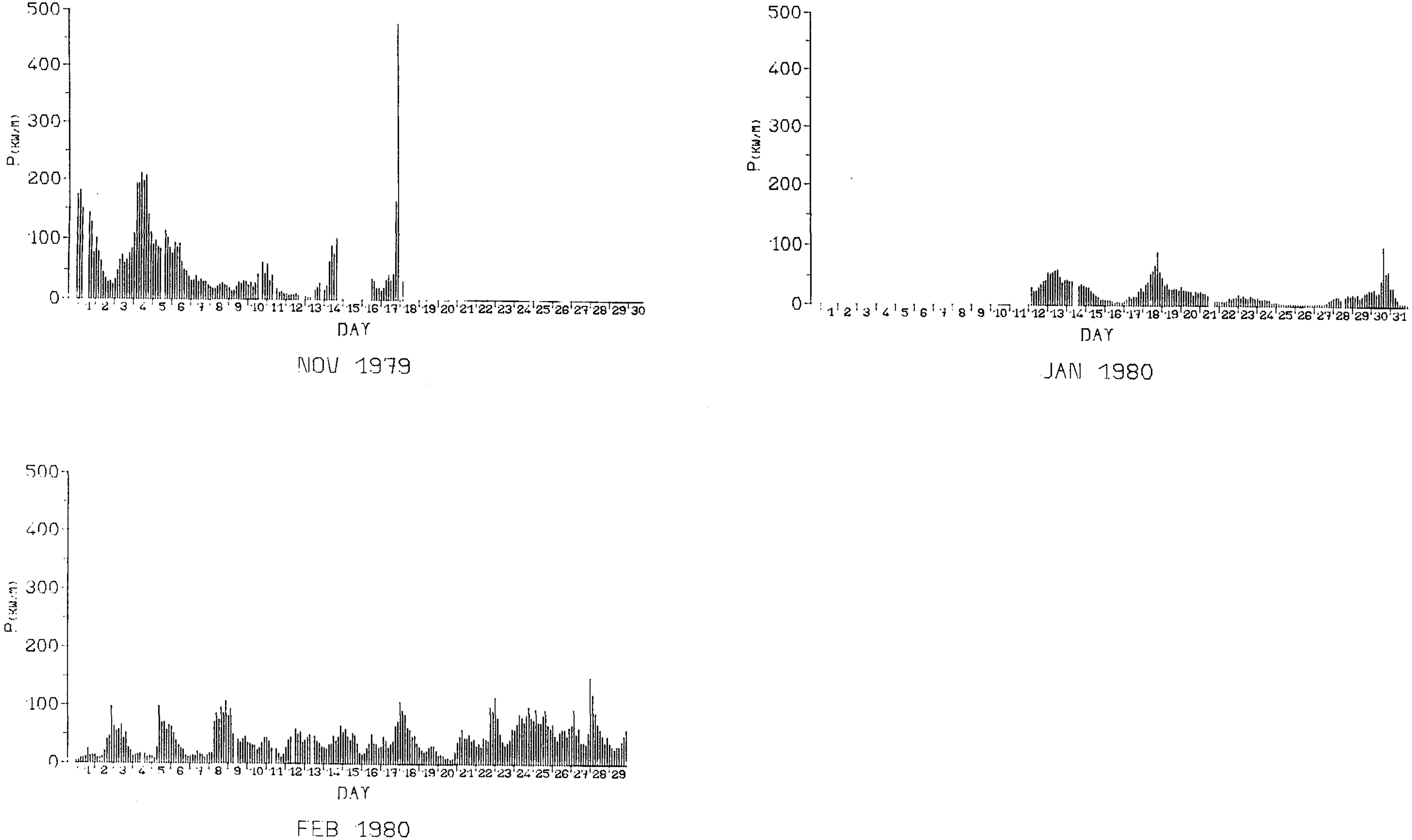
Figure 2·5



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

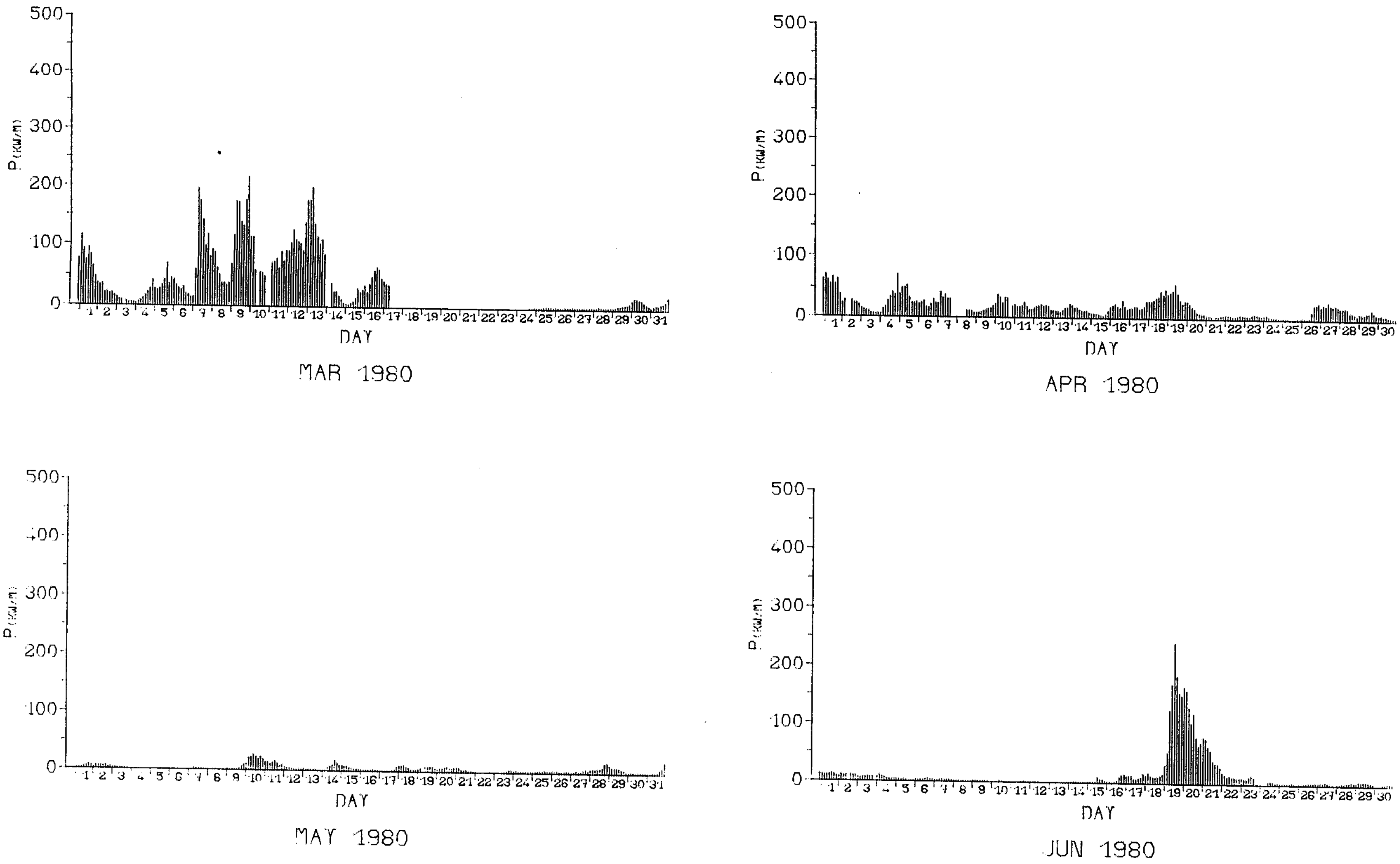
Figure 2·6



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

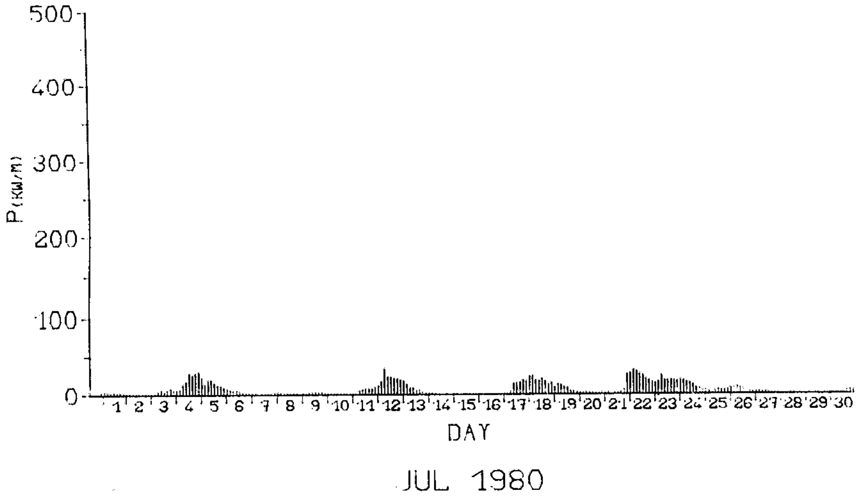
Figure 2·7



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

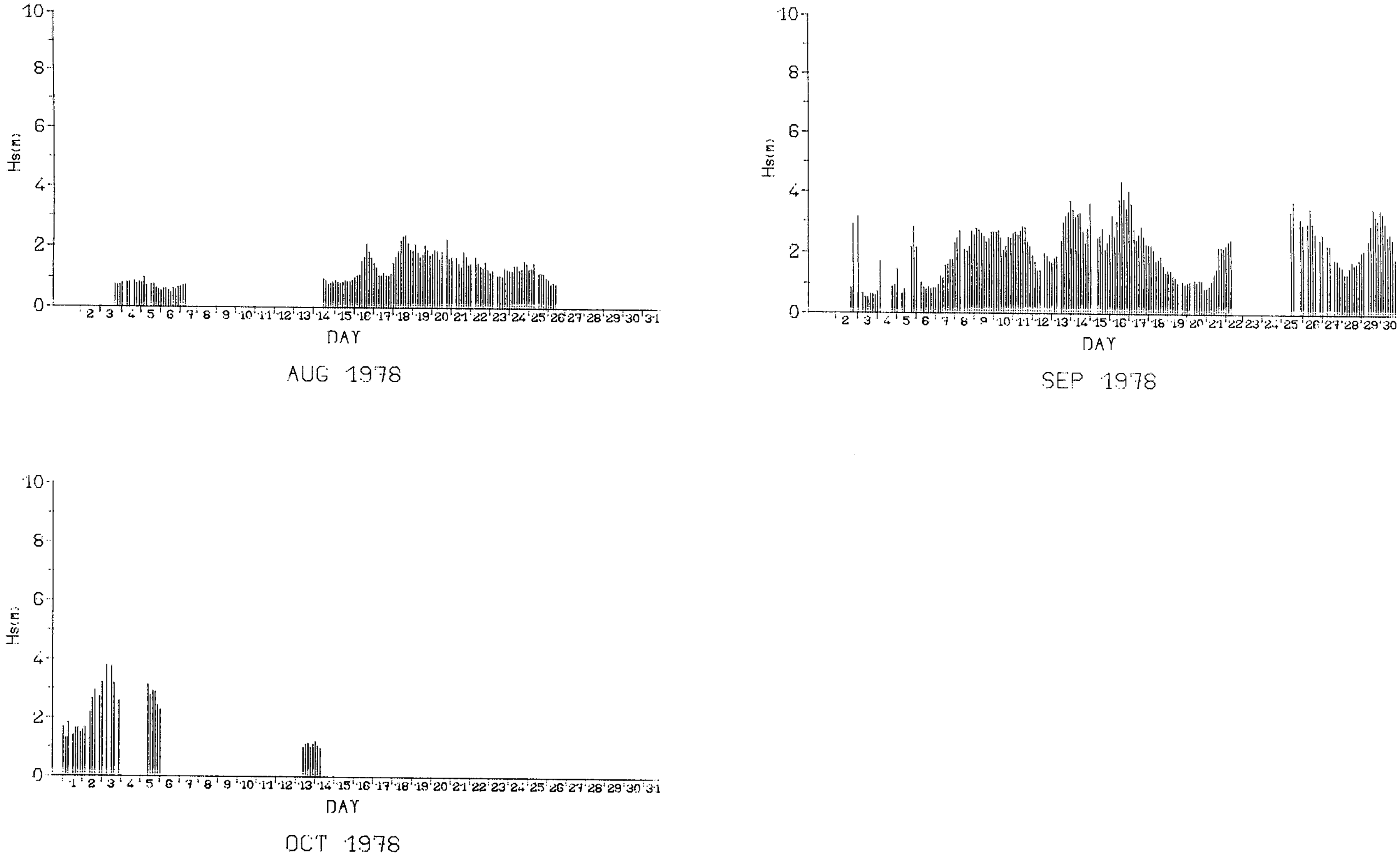
Figure 2·8



TIME SERIES OF POWER

SOUTH UIST NEARSHORE WAVERIDER

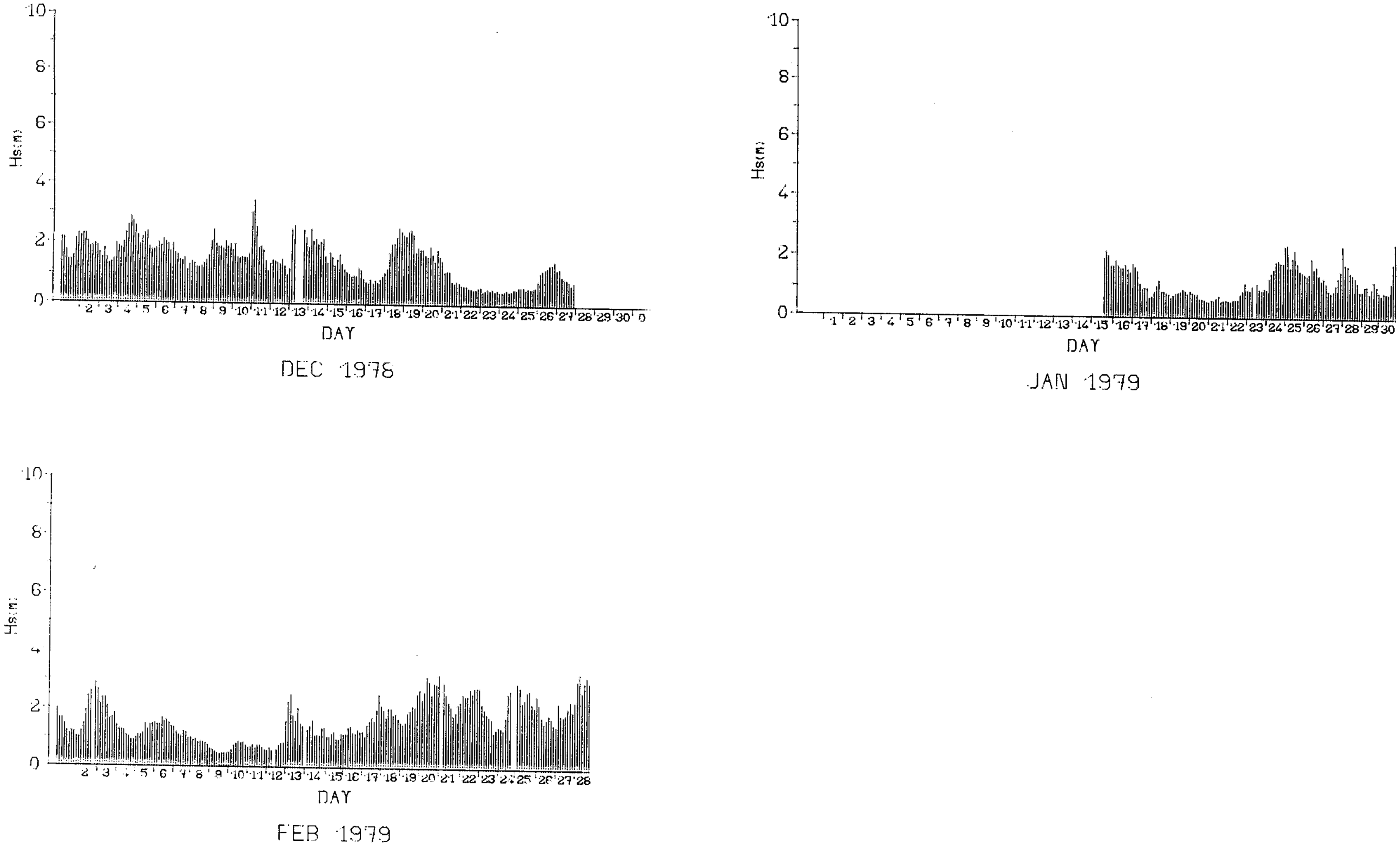
Figure 2·9



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

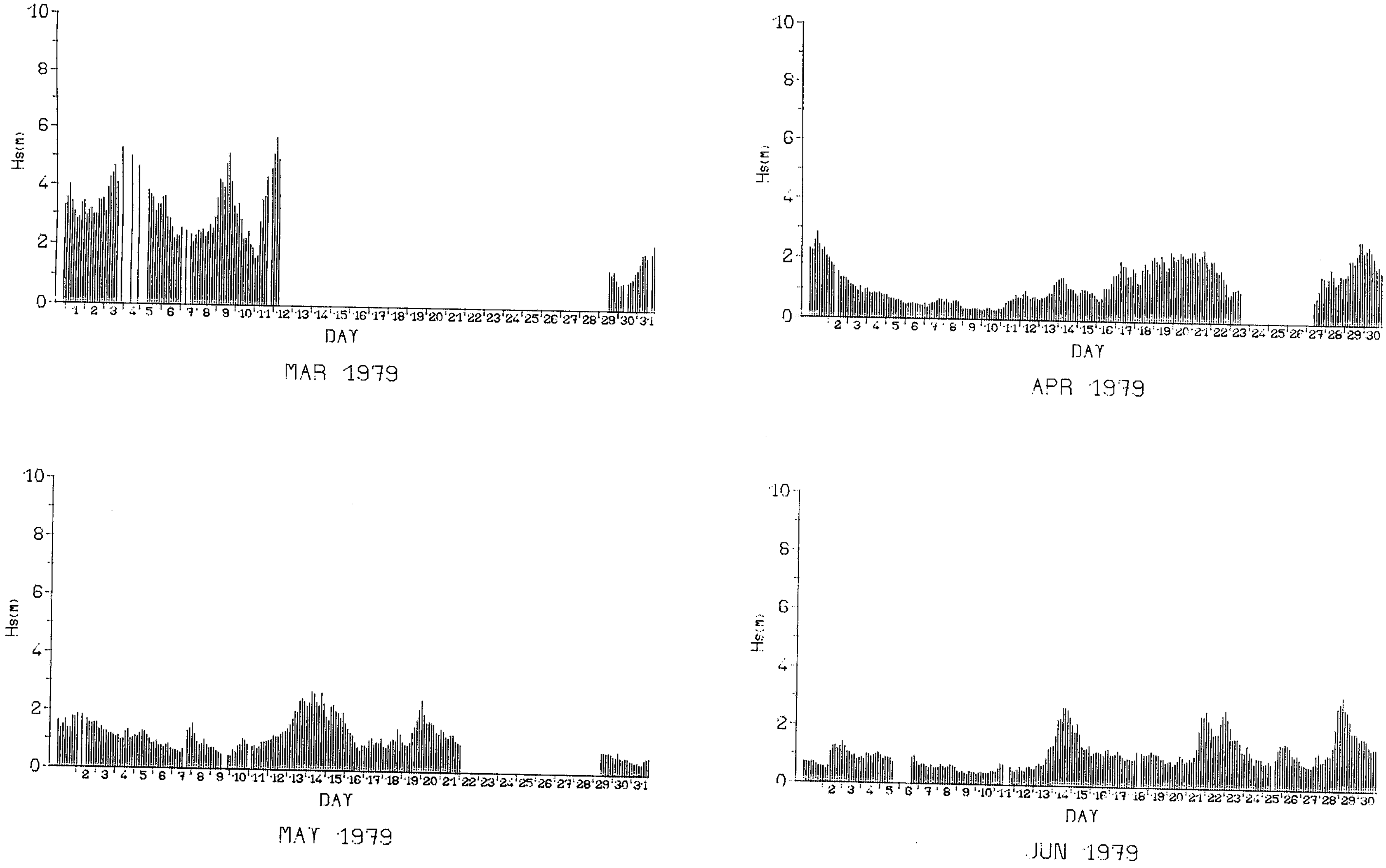
Figure 2·10



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

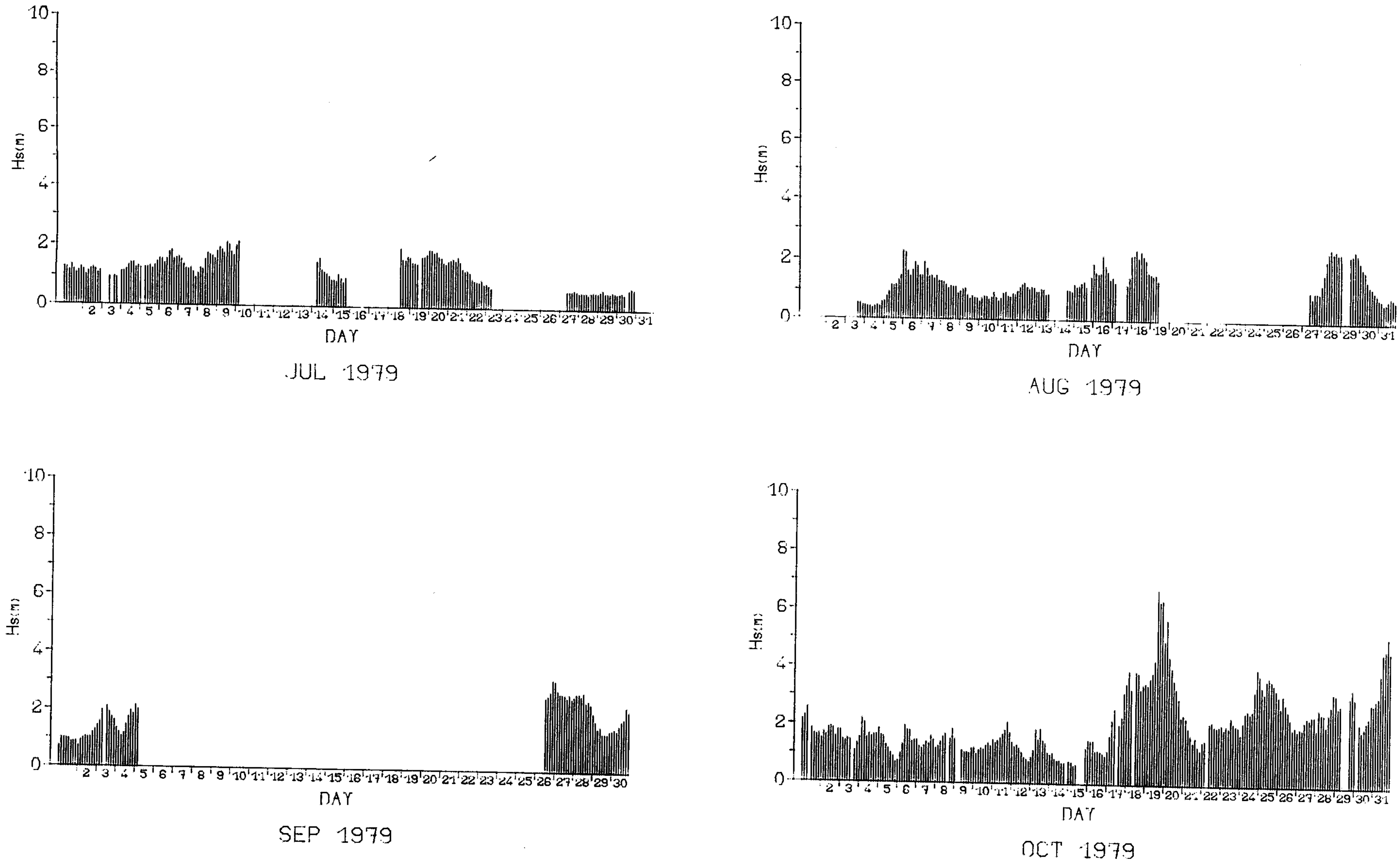
Figure 2·11



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

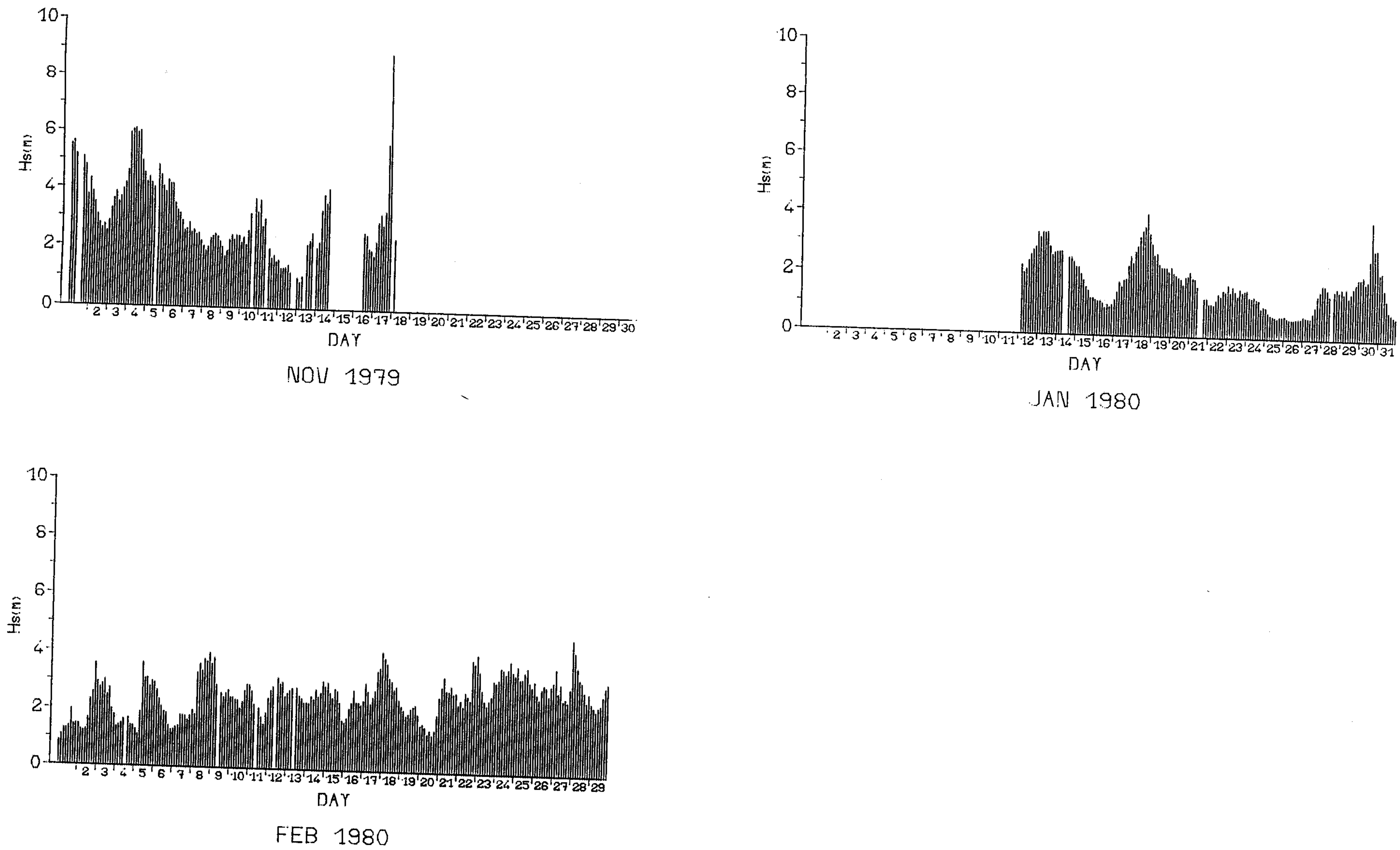
Figure 2·12



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

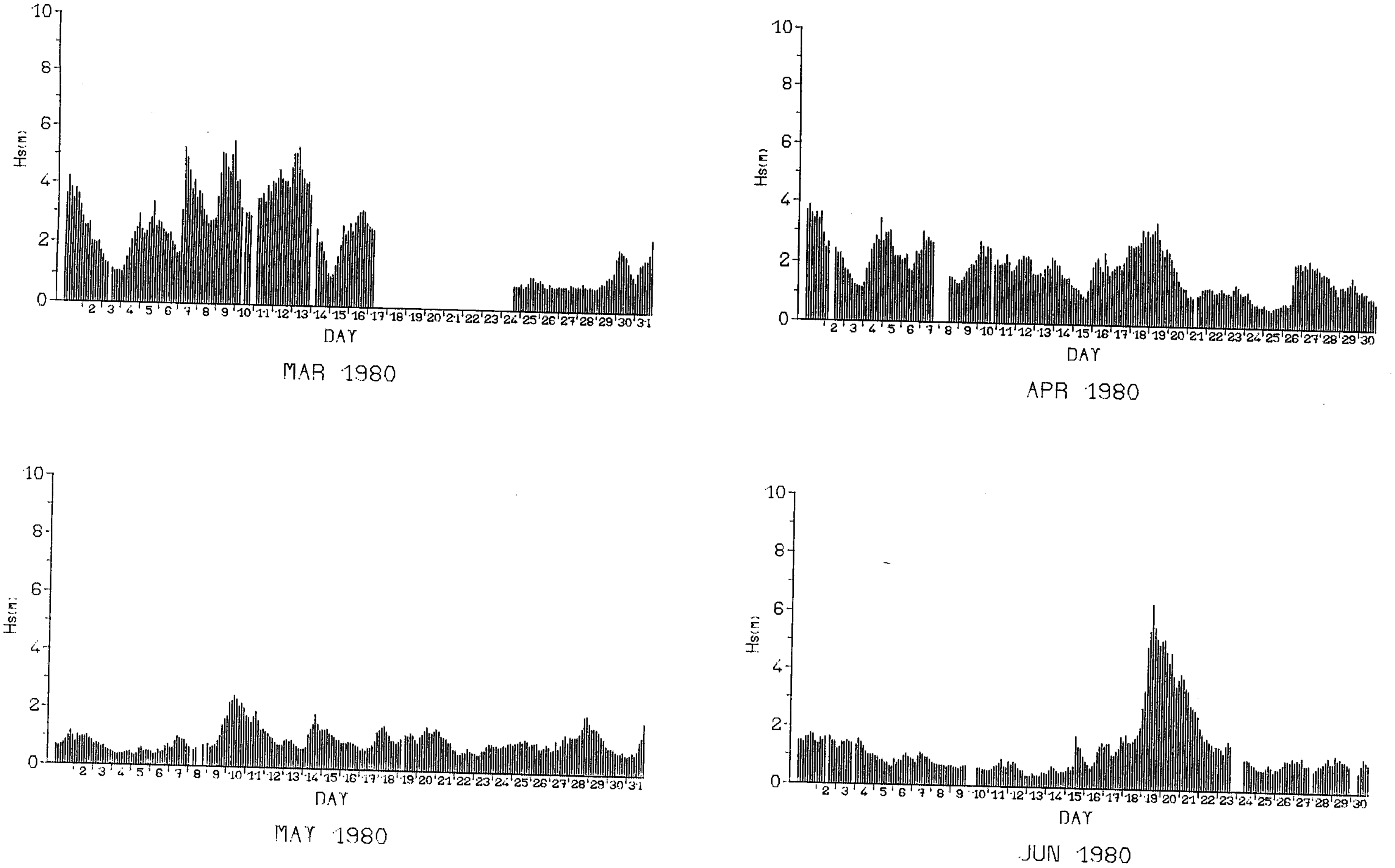
Figure 2·13



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

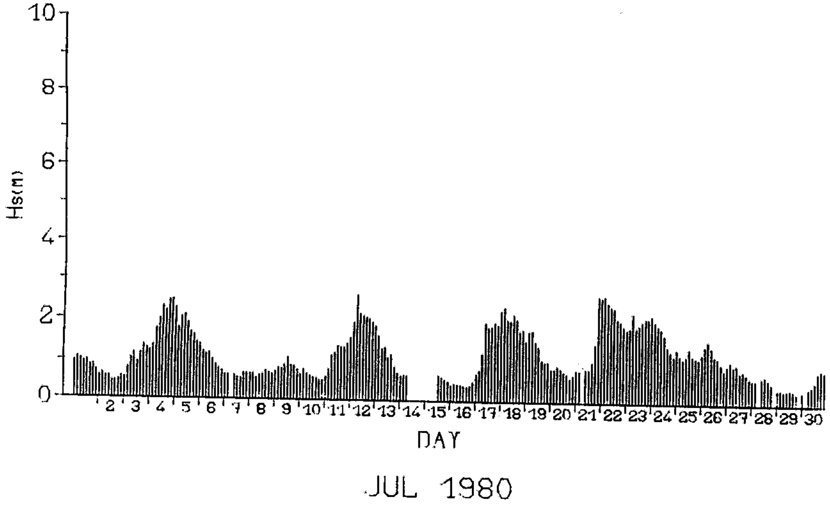
Figure 2·14



TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

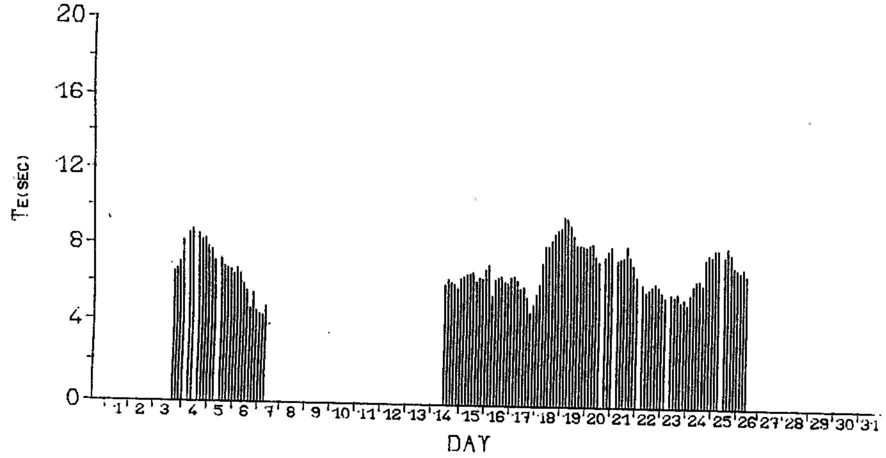
Figure 2-15



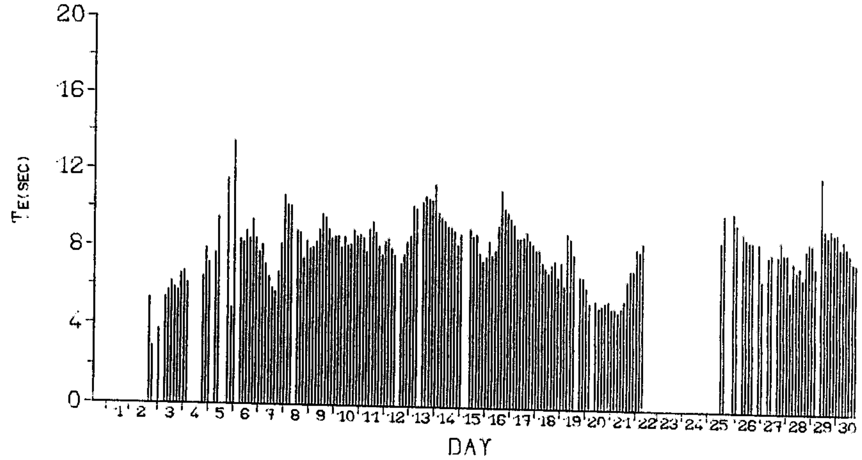
TIME SERIES OF Hs

SOUTH UIST NEARSHORE WAVERIDER

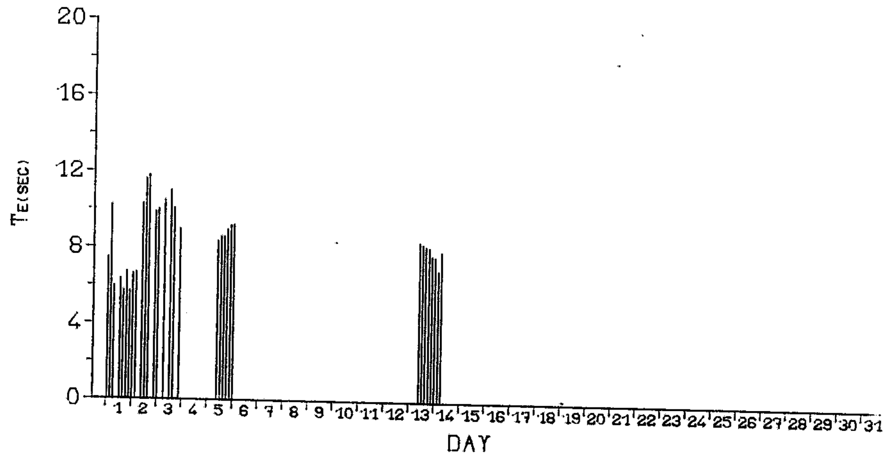
Figure 2·16



AUG 1978



SEP 1978

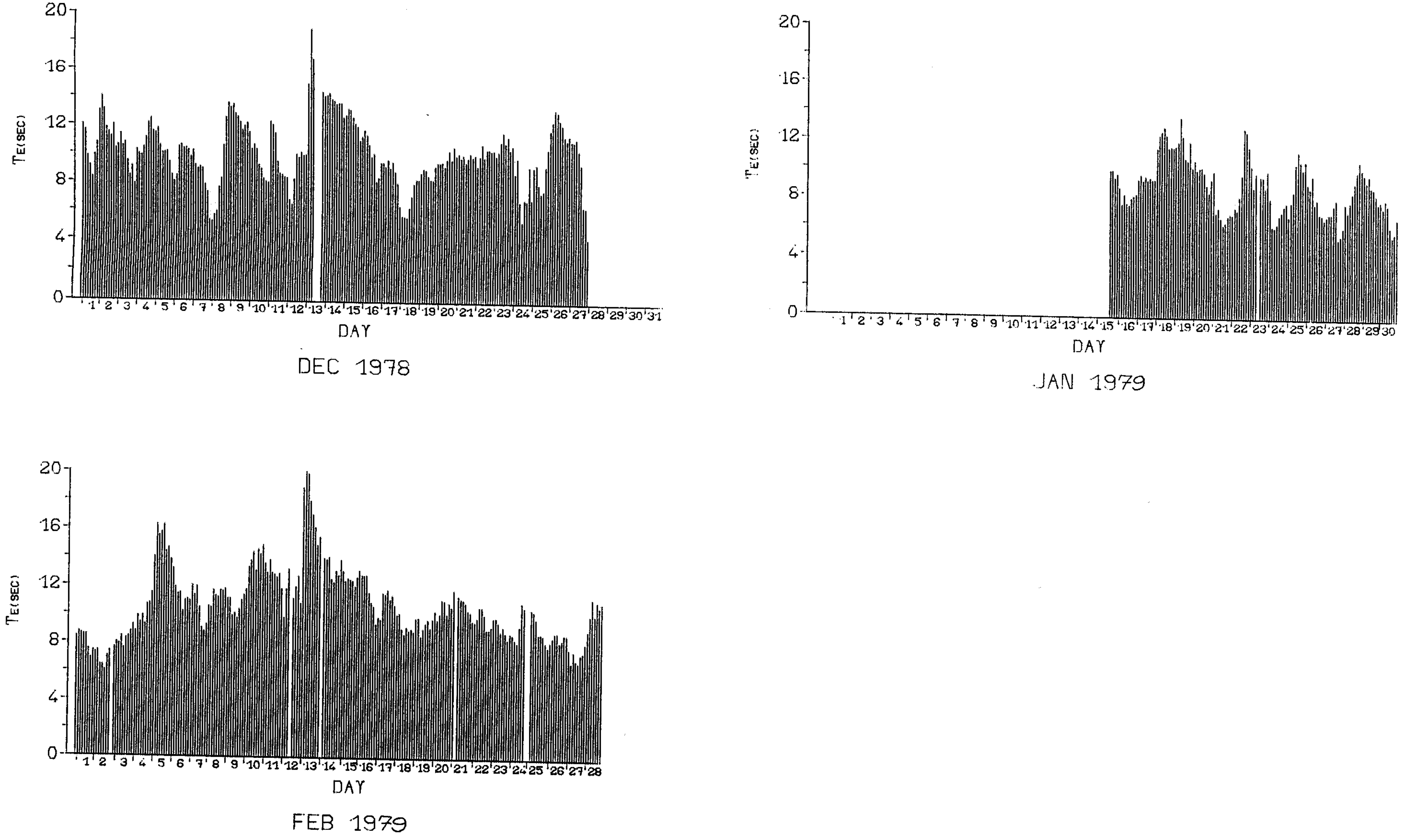


OCT 1978

TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

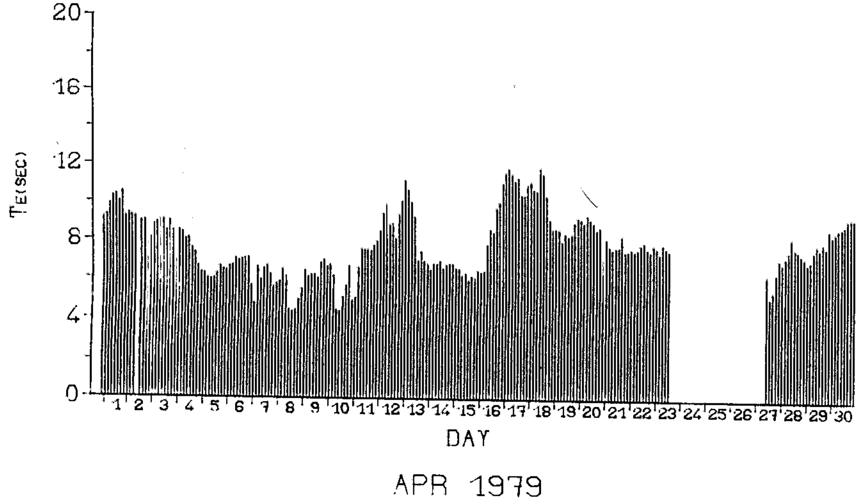
Figure 2.17

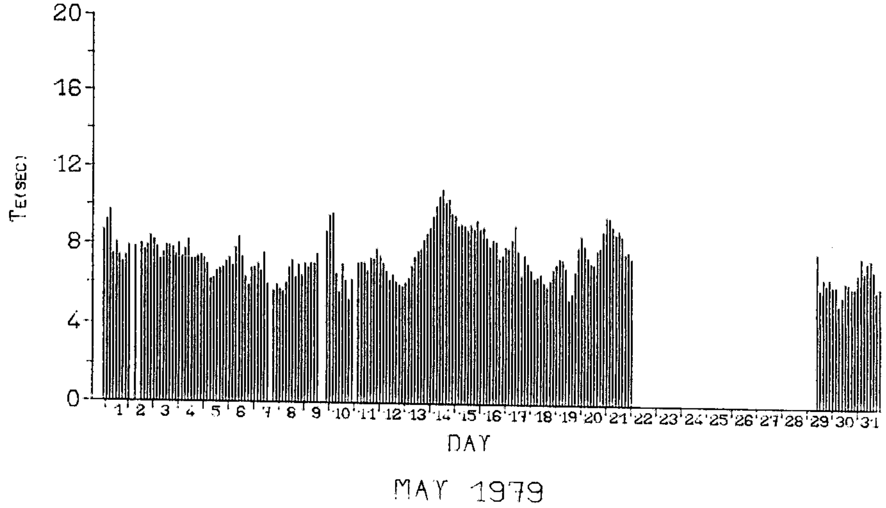


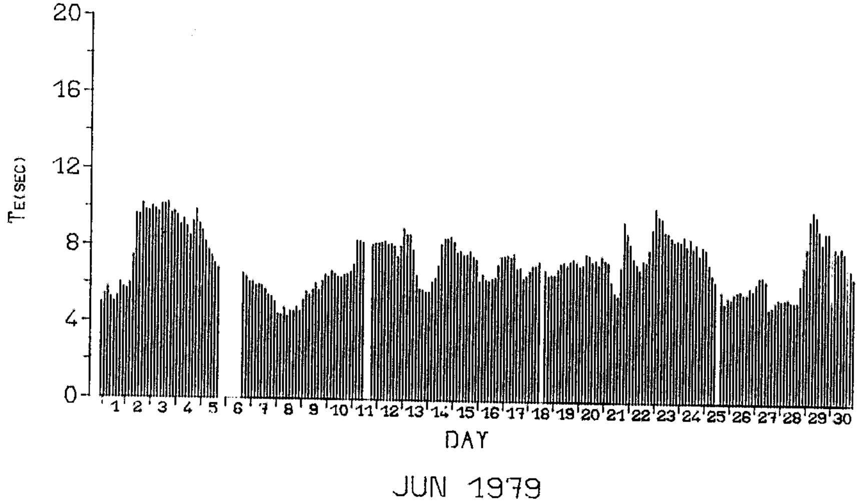
TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

Figure 2.18



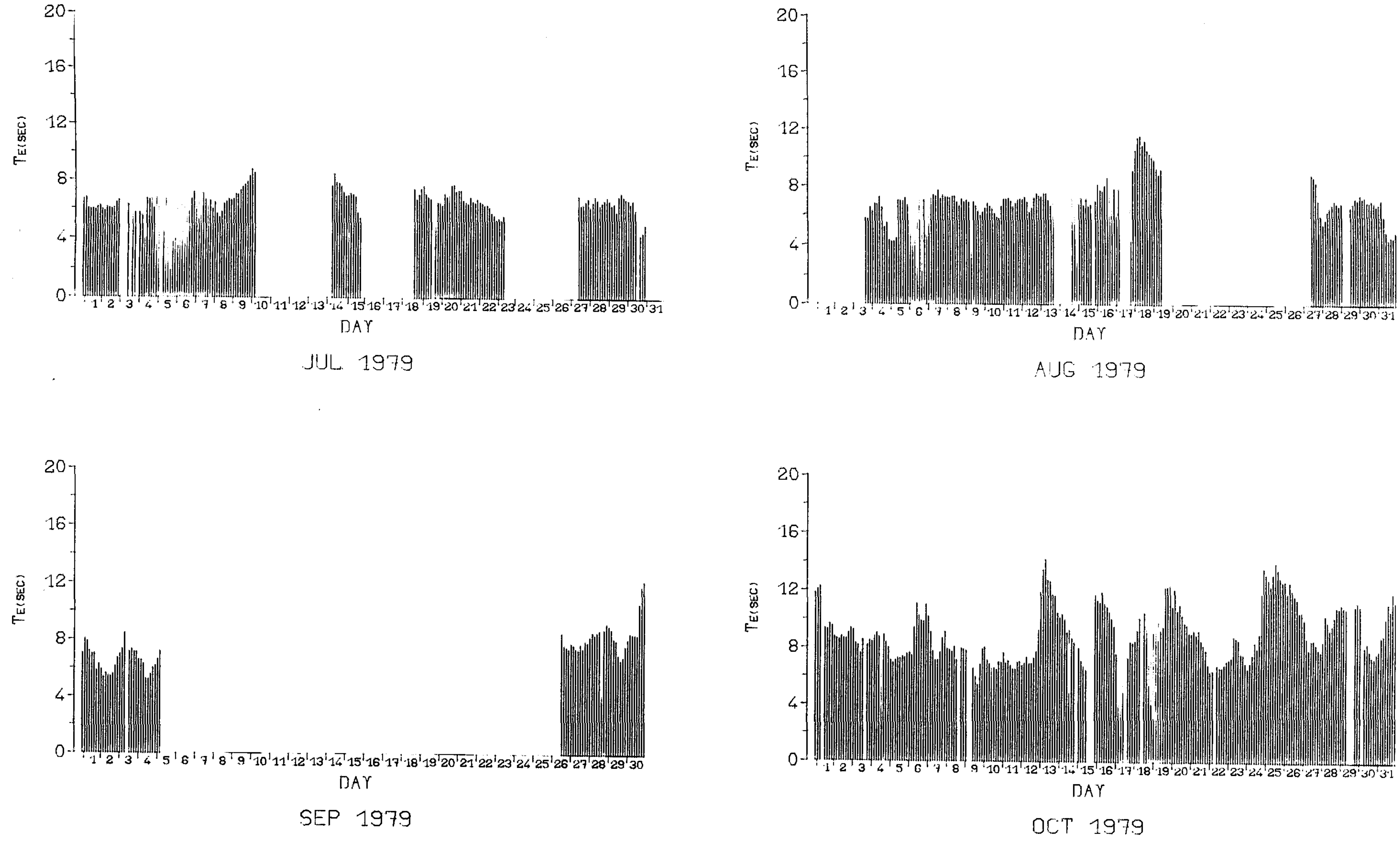




TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

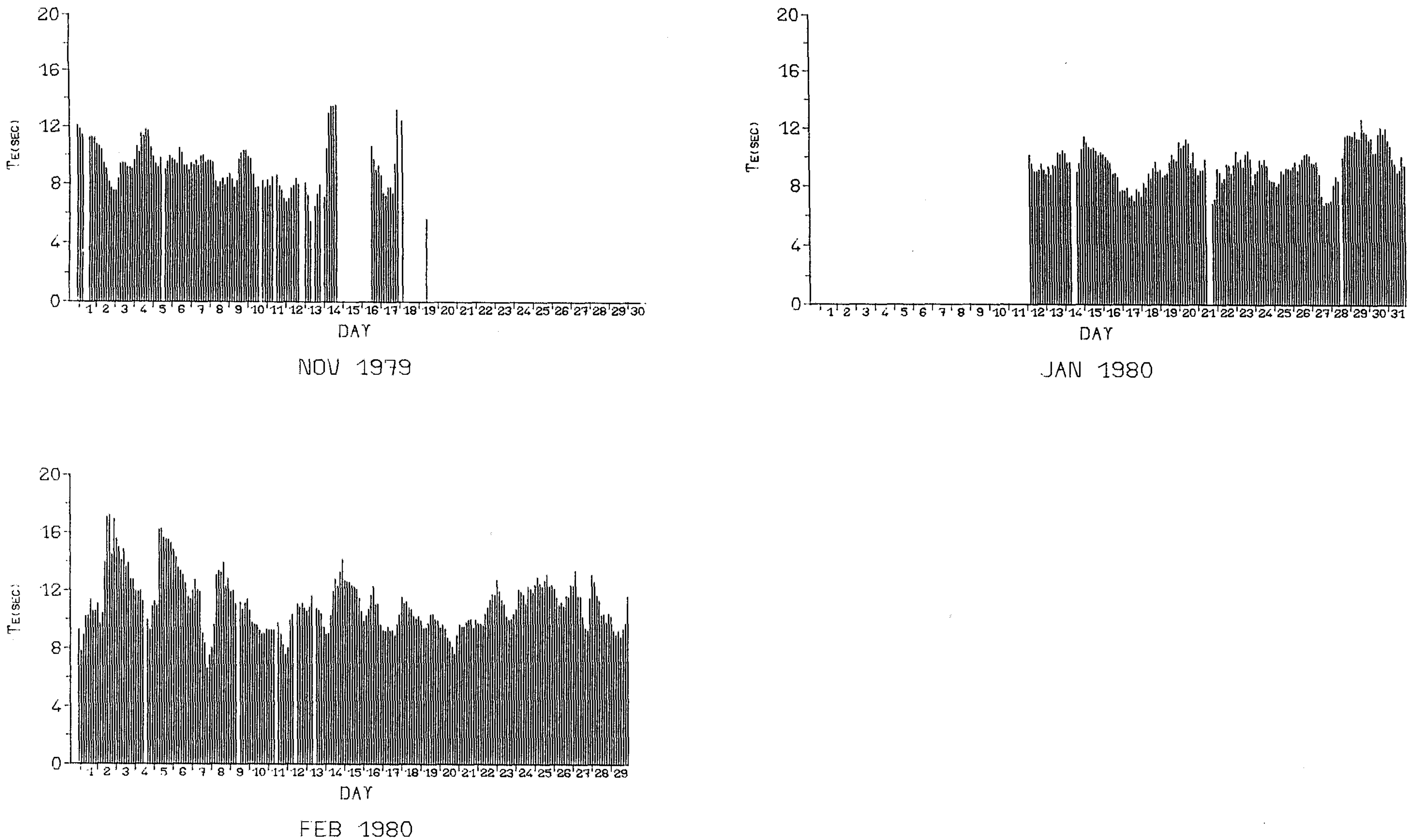
Figure 2.19



TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

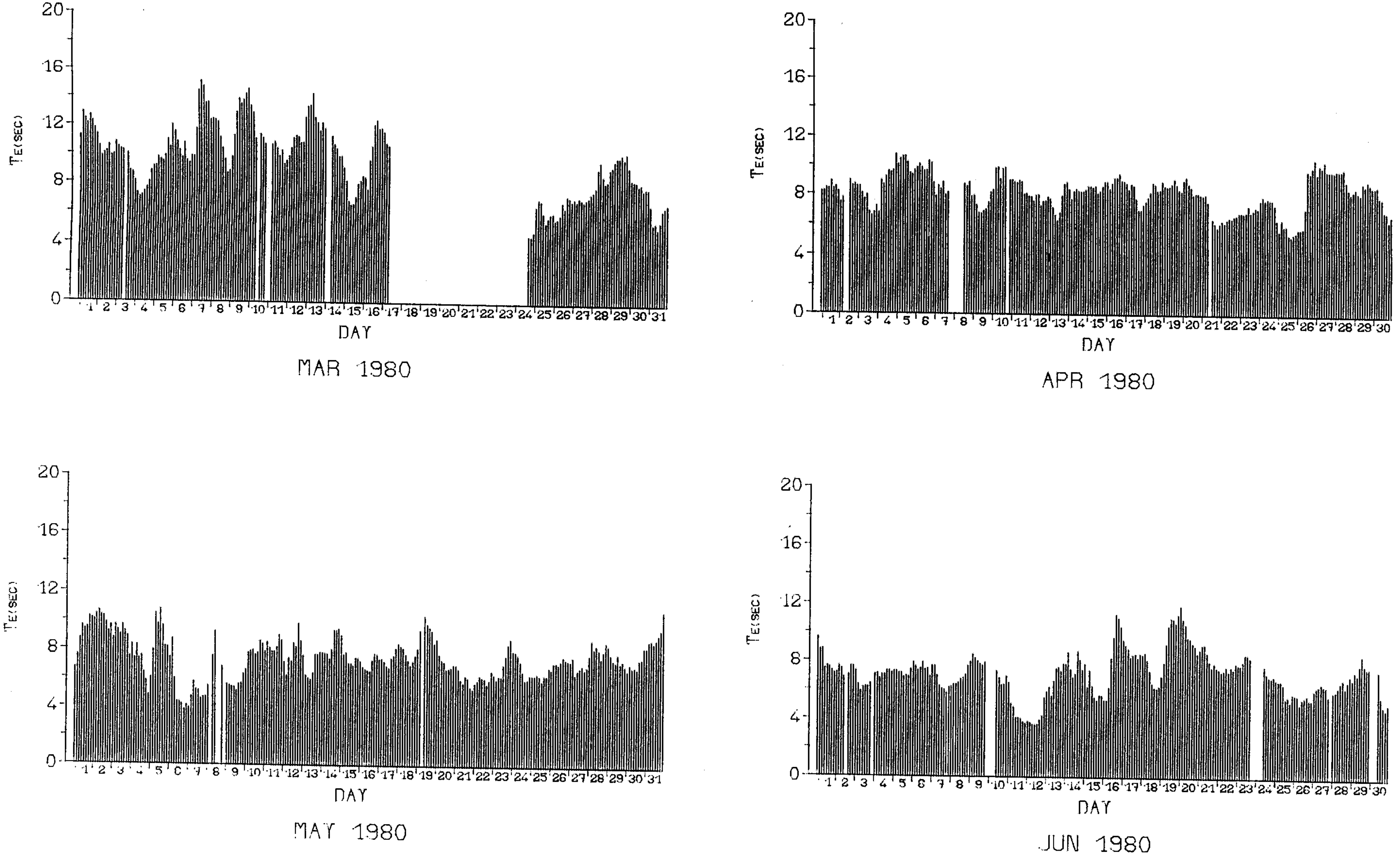
Figure 2·20



TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

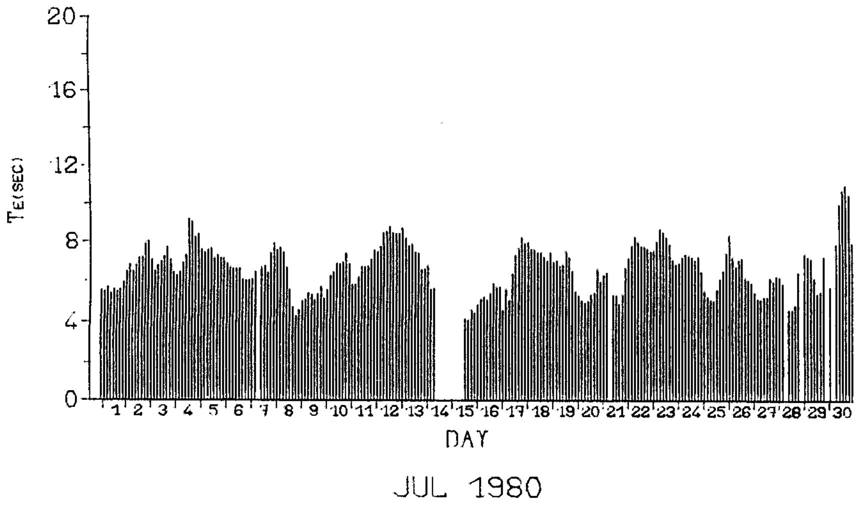
Figure 2·21



TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

Figure 2.22



TIME SERIES OF T_E

SOUTH UIST NEARSHORE WAVERIDER

Figure 2·23

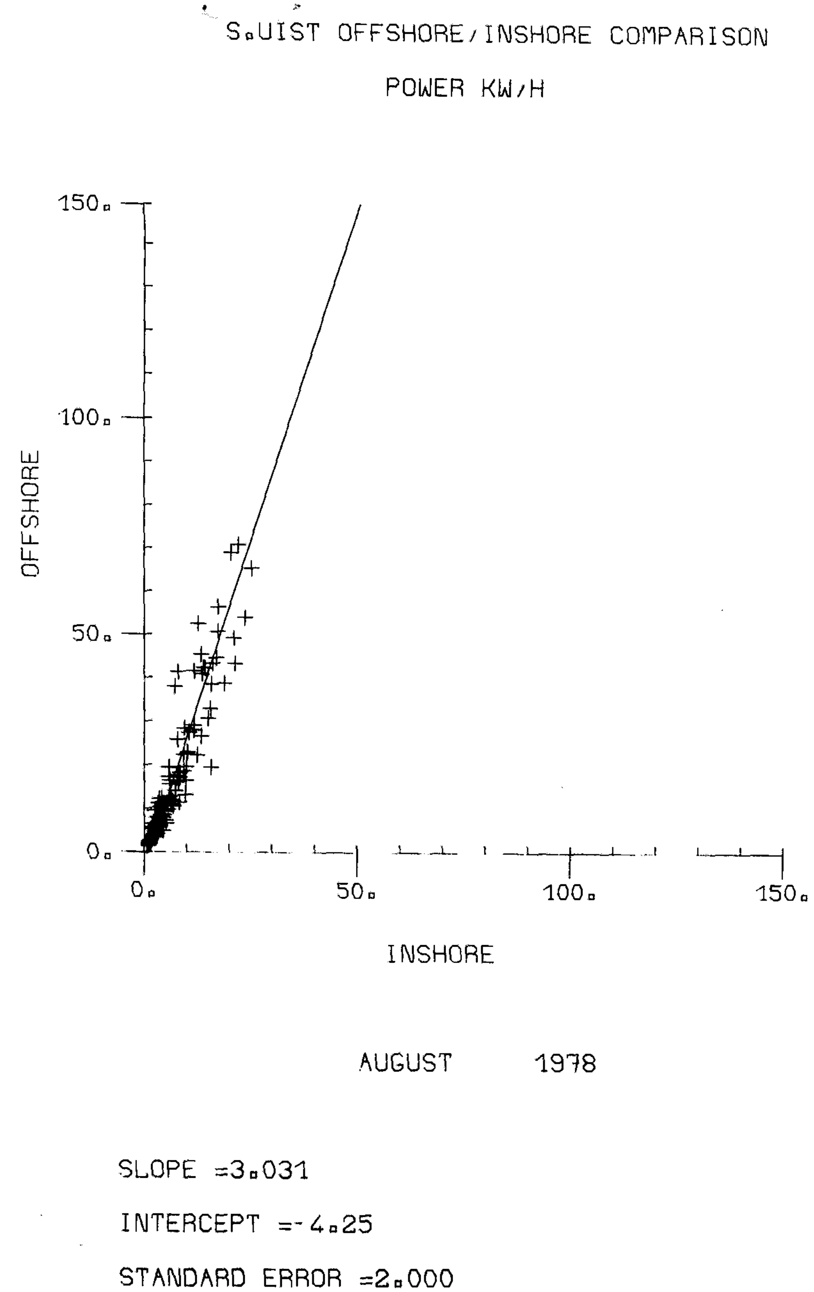
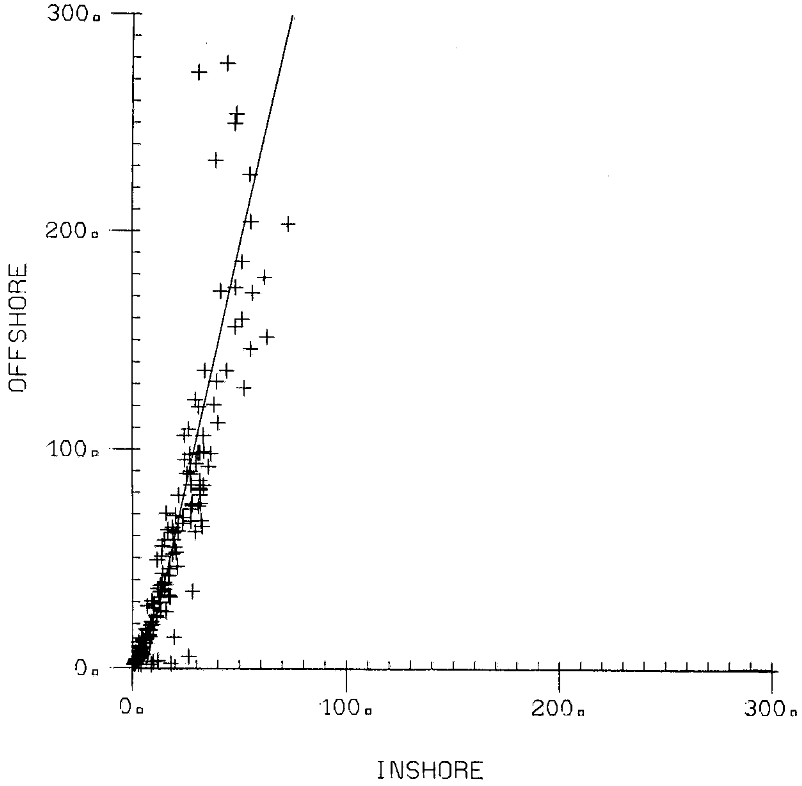

S.UIST OFFSHORE/INSHORE COMPARISON
POWER KW/H
150.
100.
50.
0.
OFFSHORE
0.
50.
100.
150.
INSHORE
AUGUST 1978
SLOPE =3.031
INTERCEPT =-4.25
STANDARD ERROR =2.000

Figure 3·1

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



SEPTEMBER 1978

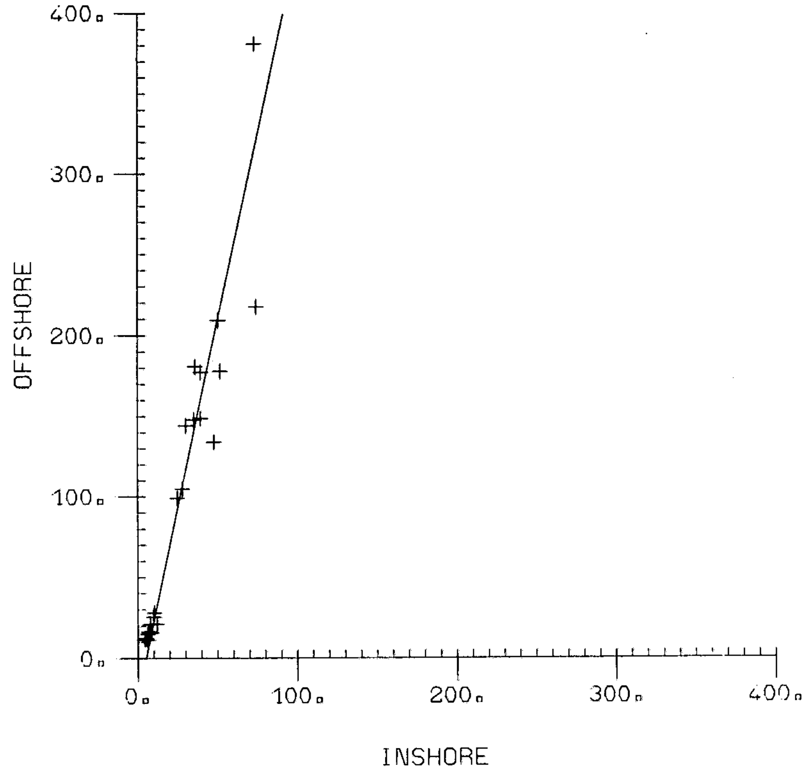
SLOPE =4.389

INTERCEPT =-27.27

STANDARD ERROR =7.267

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



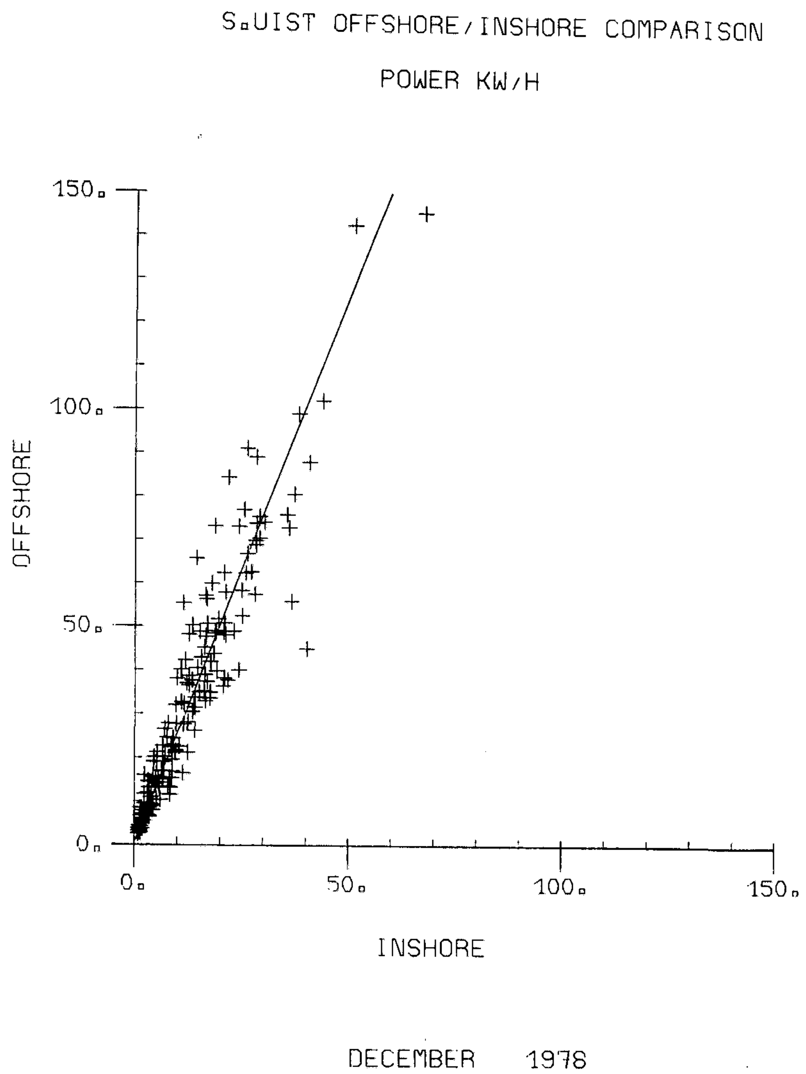
OCTOBER 1978

SLOPE =4.656

INTERCEPT =-24.18

STANDARD ERROR =6.942

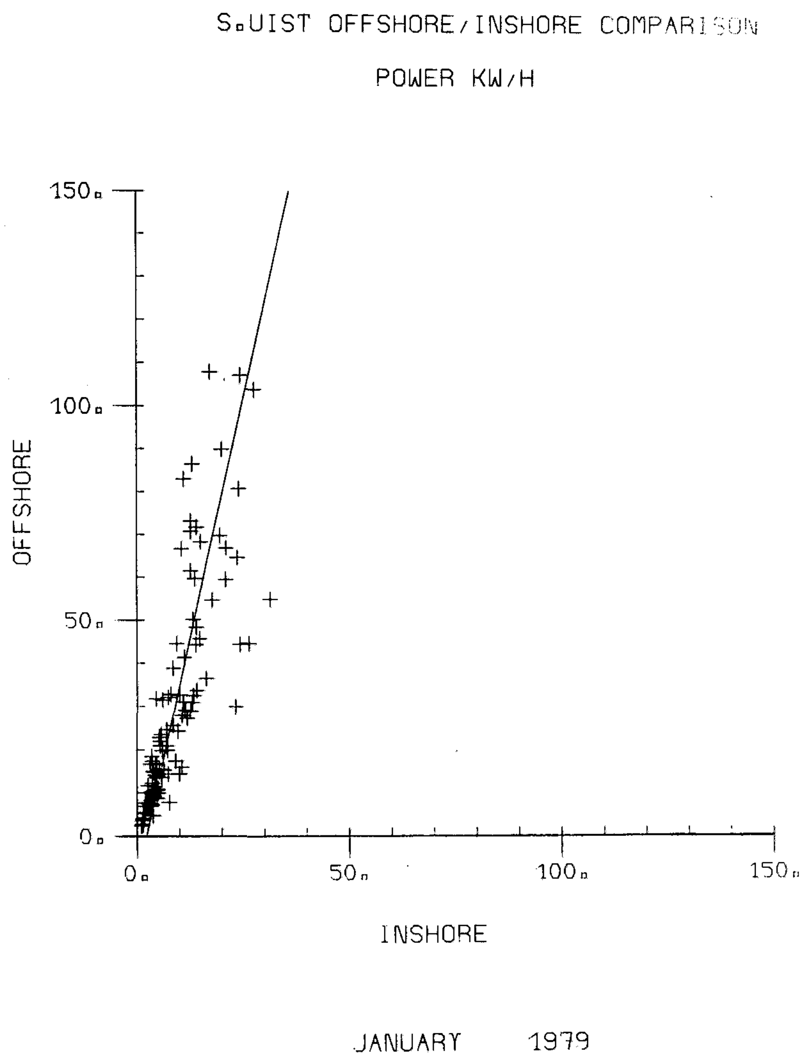
Figure 3.2



SLOPE =2.508

INTERCEPT =0.48

STANDARD ERROR =3.682

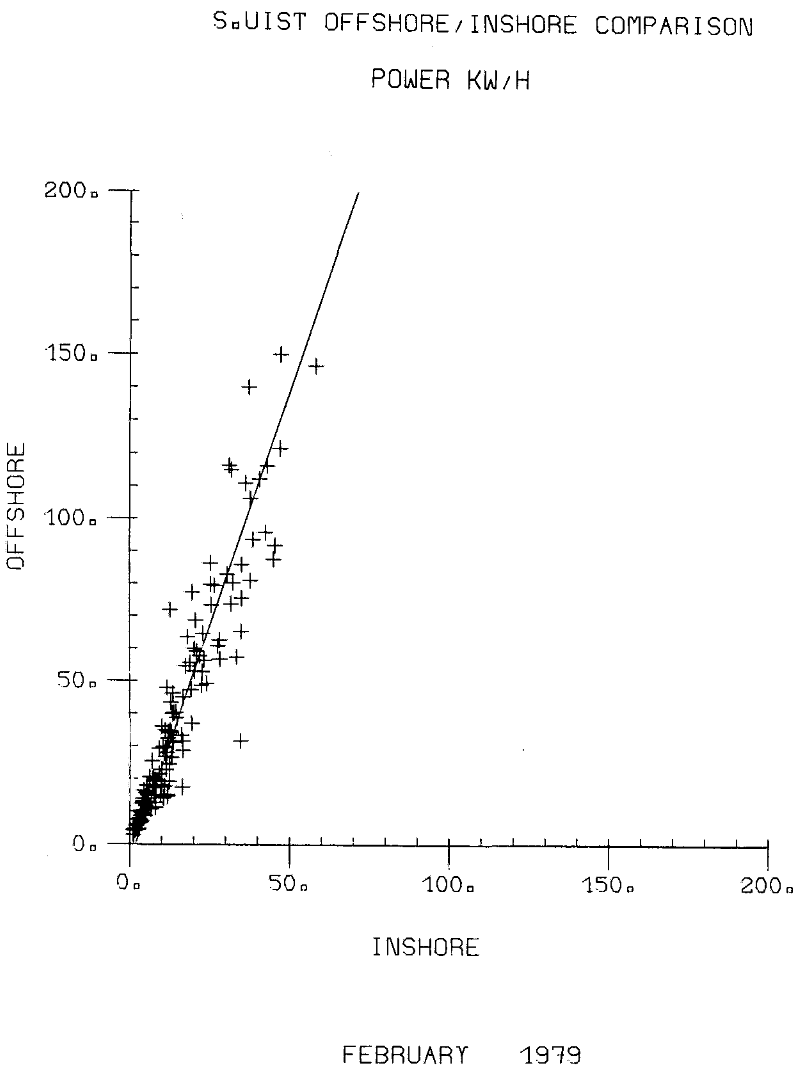


SLOPE =4.452

INTERCEPT =-9.93

STANDARD ERROR =3.829

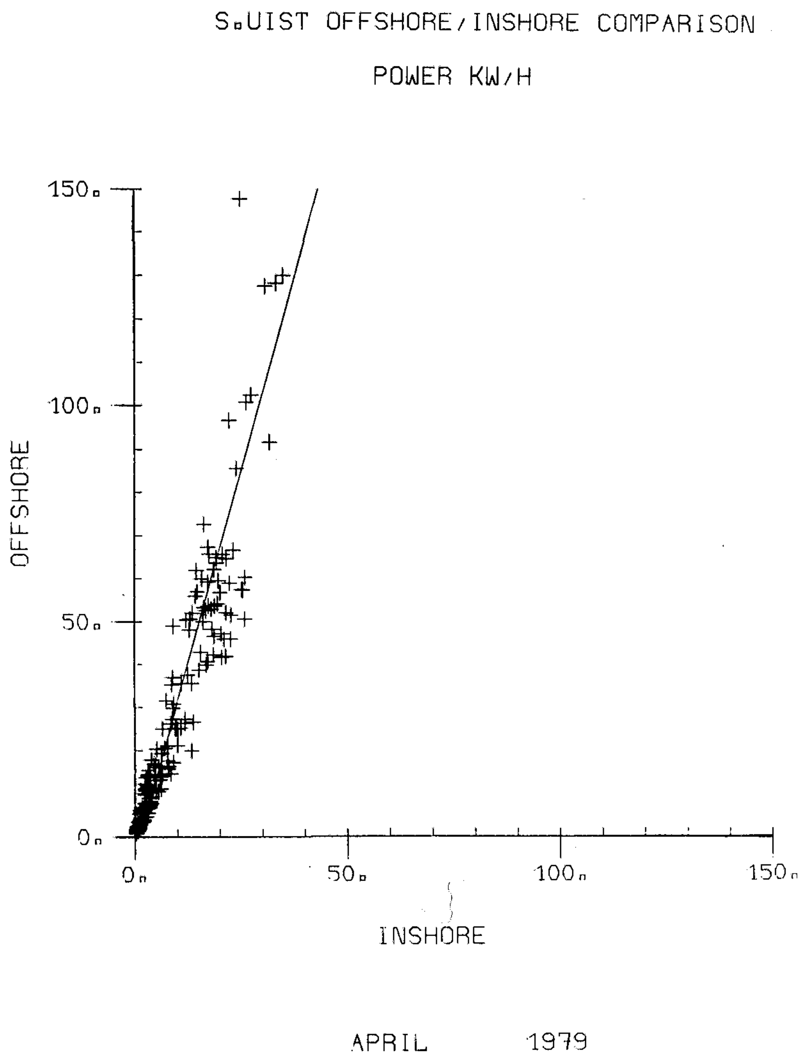
Figure 3·3



SLOPE =2.874

INTERCEPT =-5.19

STANDARD ERROR =4.347

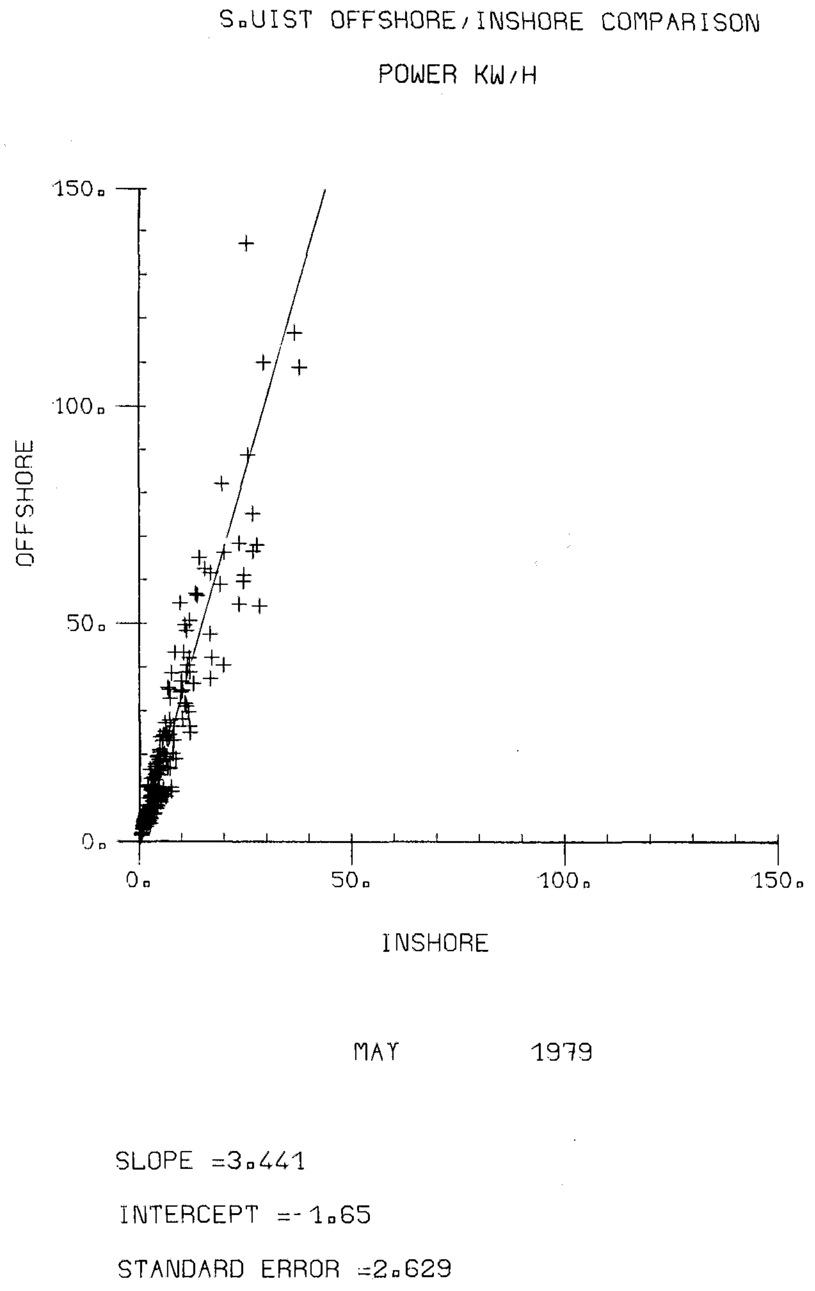


SLOPE =3.579

INTERCEPT =-4.77

STANDARD ERROR =3.020

Figure 3·4


S.UIST OFFSHORE/INSHORE COMPARISON
POWER KW/H
OFFSHORE
150.
100.
50.
0.
50.
100.
150.
INSHORE
MAY 1979
SLOPE =3.441
INTERCEPT =-1.65
STANDARD ERROR =2.629

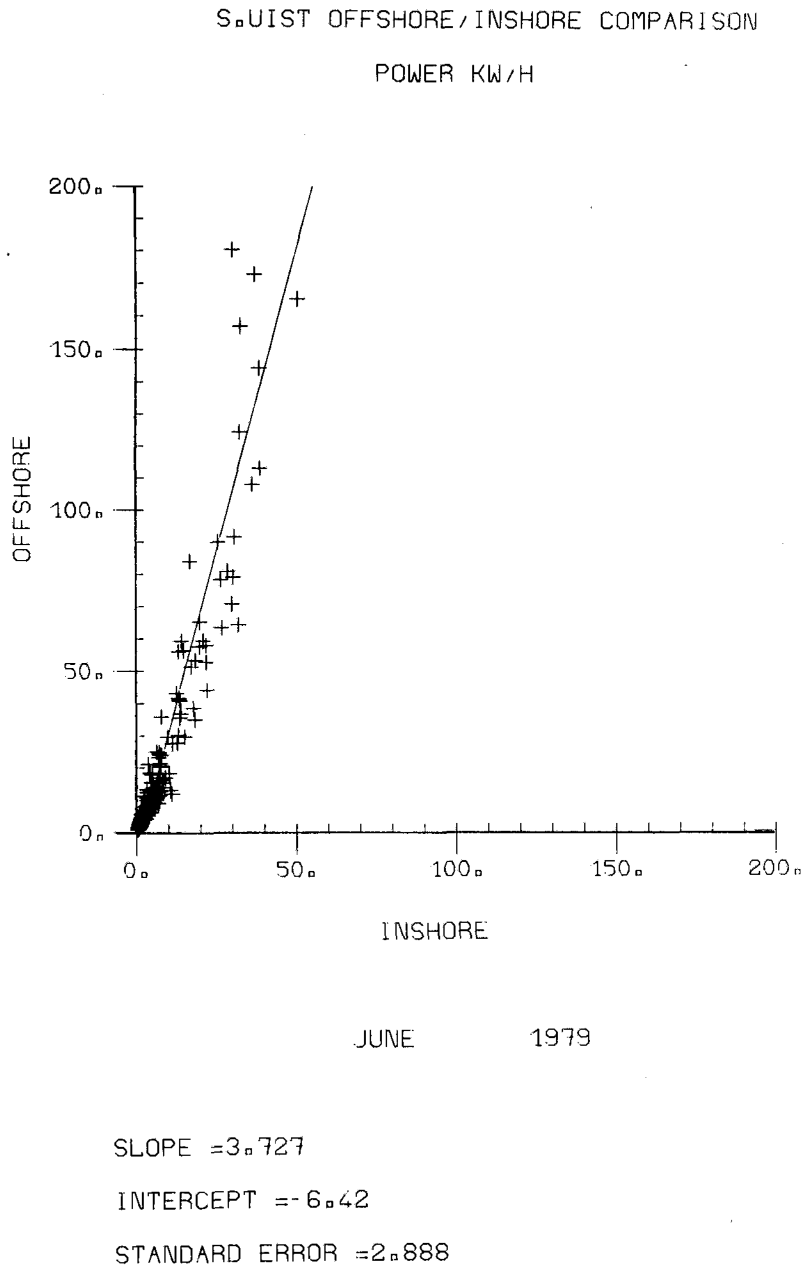
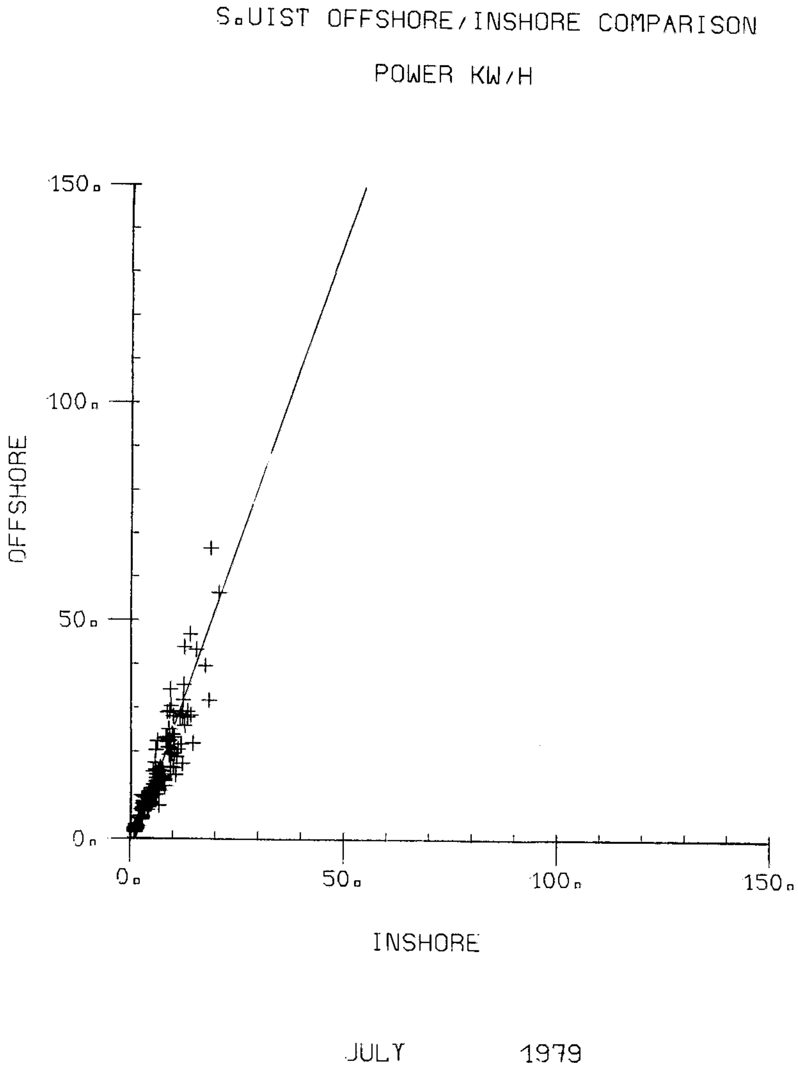

S.UIST OFFSHORE/INSHORE COMPARISON
POWER KW/H
OFFSHORE
200.
150.
100.
50.
0.
50.
100.
150.
200.
INSHORE
JUNE 1979
SLOPE =3.727
INTERCEPT =-6.42
STANDARD ERROR =2.888

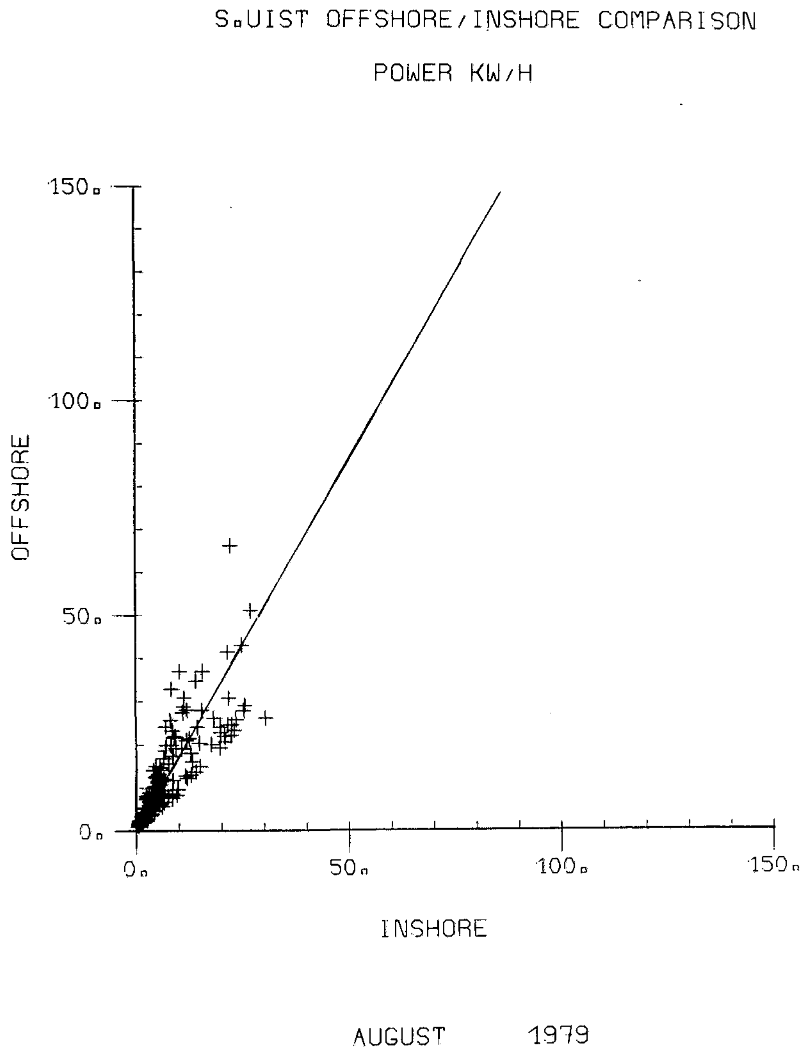
Figure 3·5



SLOPE =2.803

INTERCEPT =-3.32

STANDARD ERROR =1.588



SLOPE =1.734

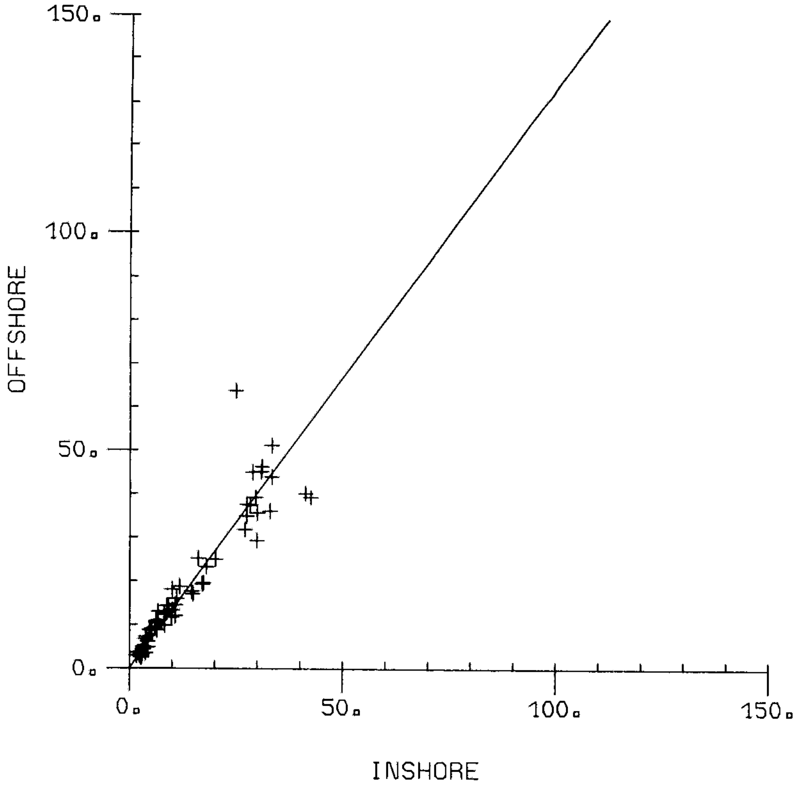
INTERCEPT =-0.28

STANDARD ERROR =3.575

Figure 3·6

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



SEPTEMBER 1979

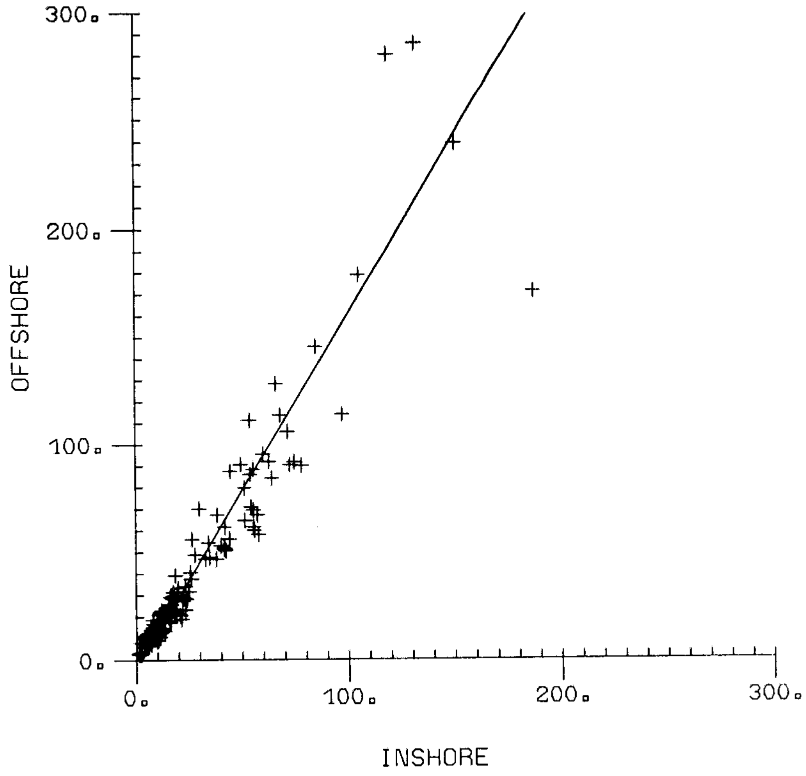
SLOPE =1.336

INTERCEPT =0.14

STANDARD ERROR =3.453

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



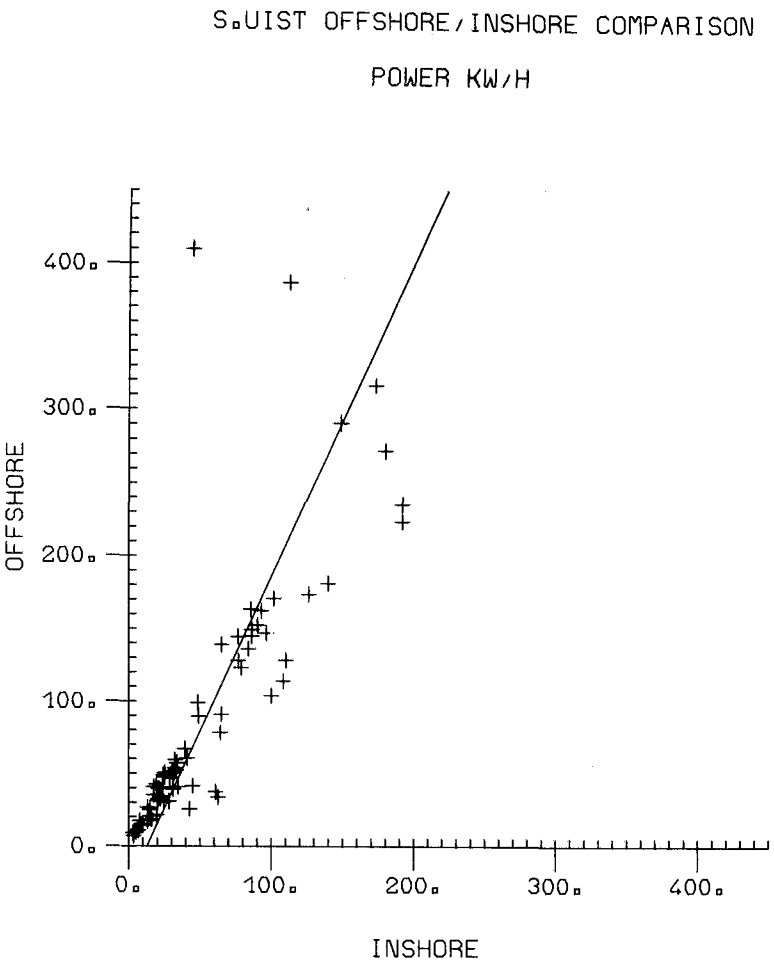
OCTOBER 1979

SLOPE =1.649

INTERCEPT =-4.36

STANDARD ERROR =9.573

Figure 3·7

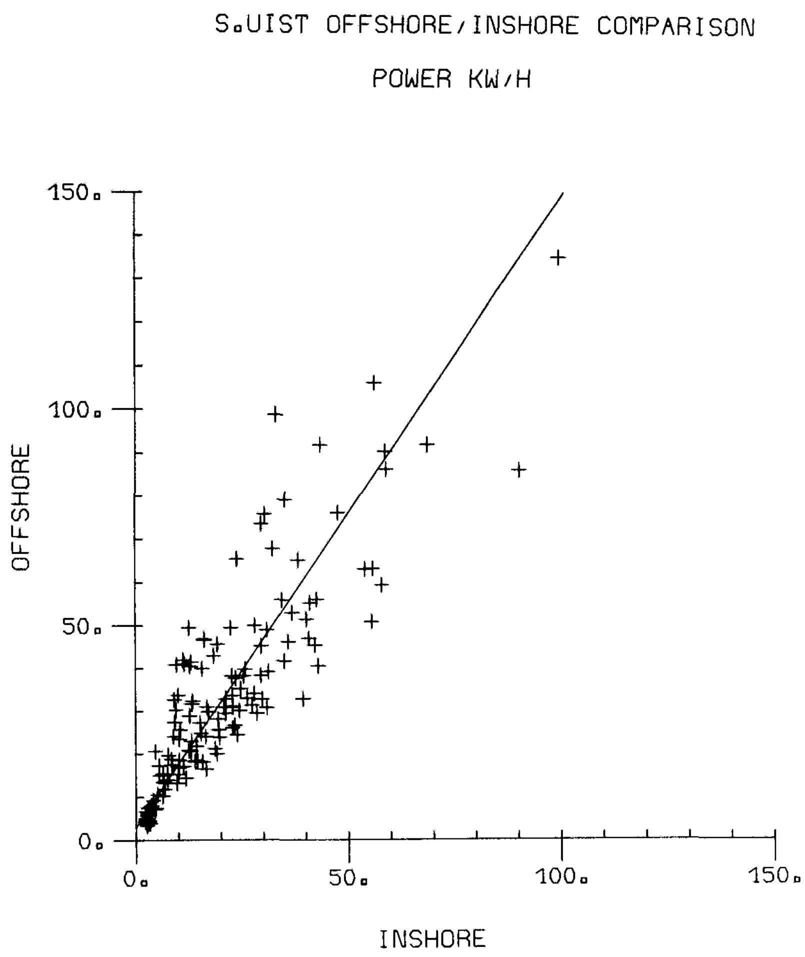


NOVEMBER 1979

SLOPE =2.126

INTERCEPT =-27.39

STANDARD ERROR =26.236



JANUARY 1980

SLOPE =1.458

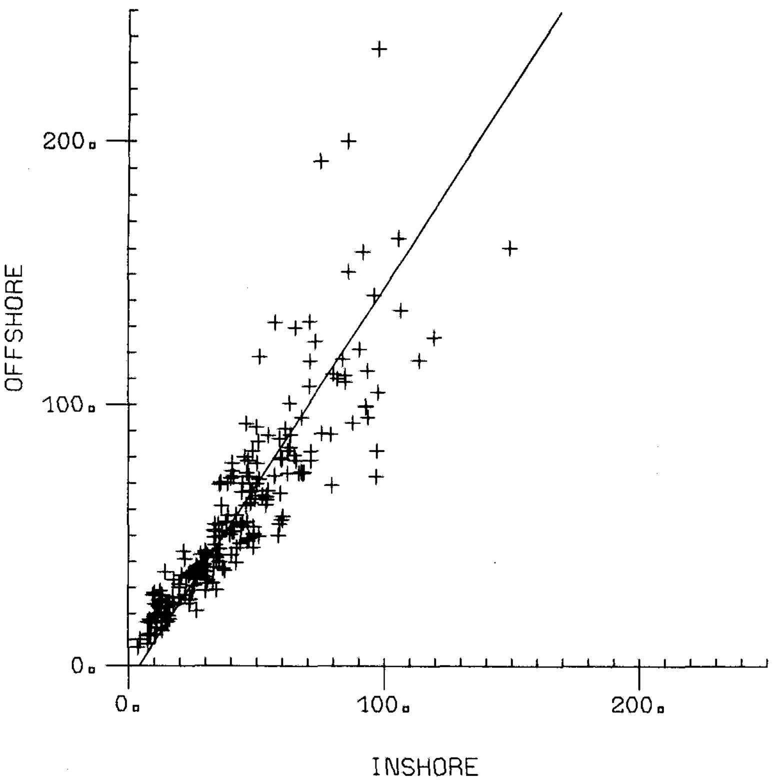
INTERCEPT =2.93

STANDARD ERROR =7.197

Figure 3.8

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



FEBRUARY 1980

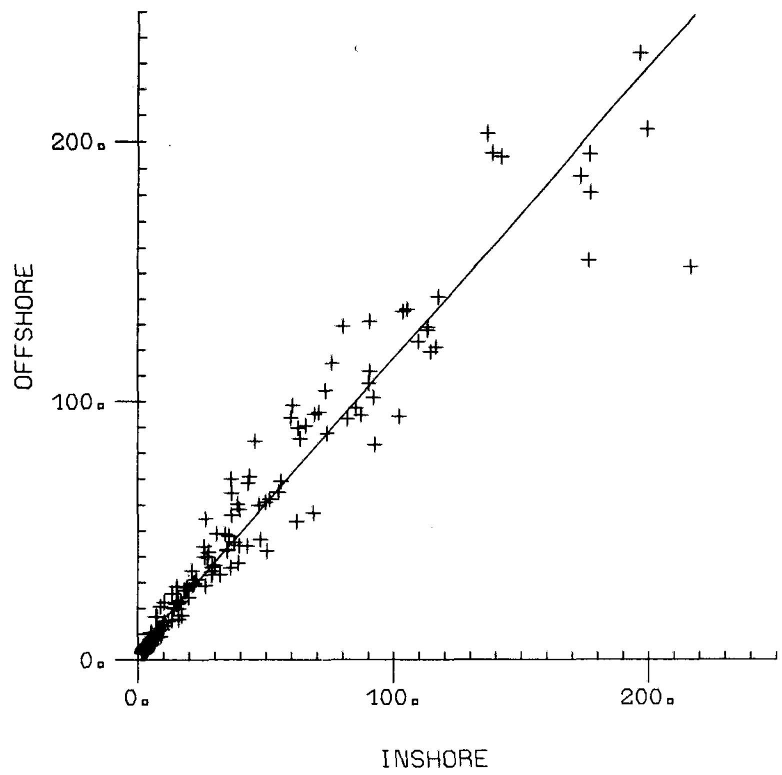
SLOPE =1.512

INTERCEPT =-6.28

STANDARD ERROR =11.018

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



MARCH 1980

SLOPE =1.132

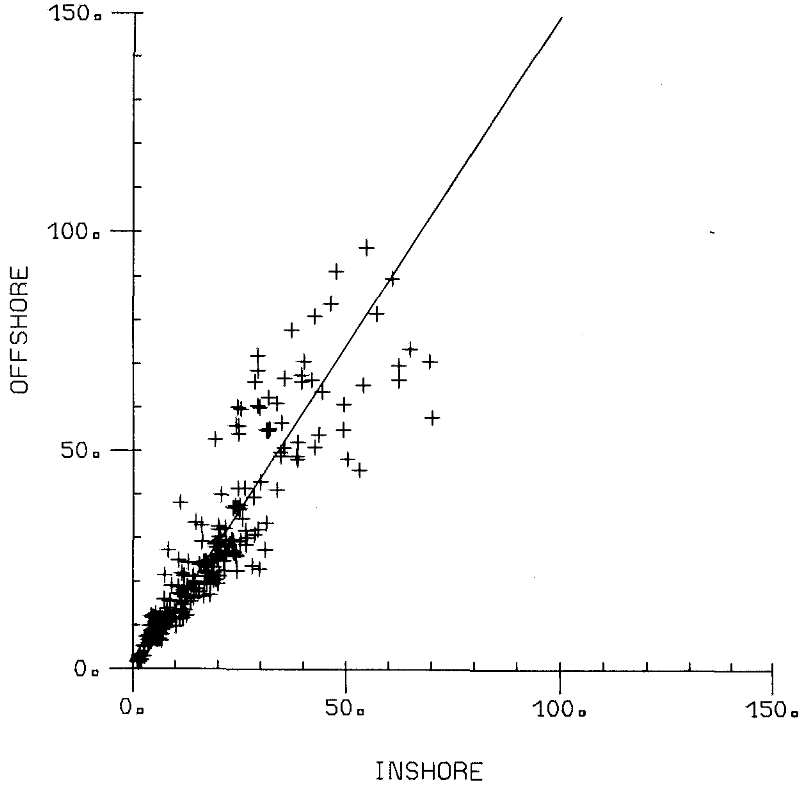
INTERCEPT =3.88

STANDARD ERROR =9.133

Figure 3·9

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



APRIL 1980

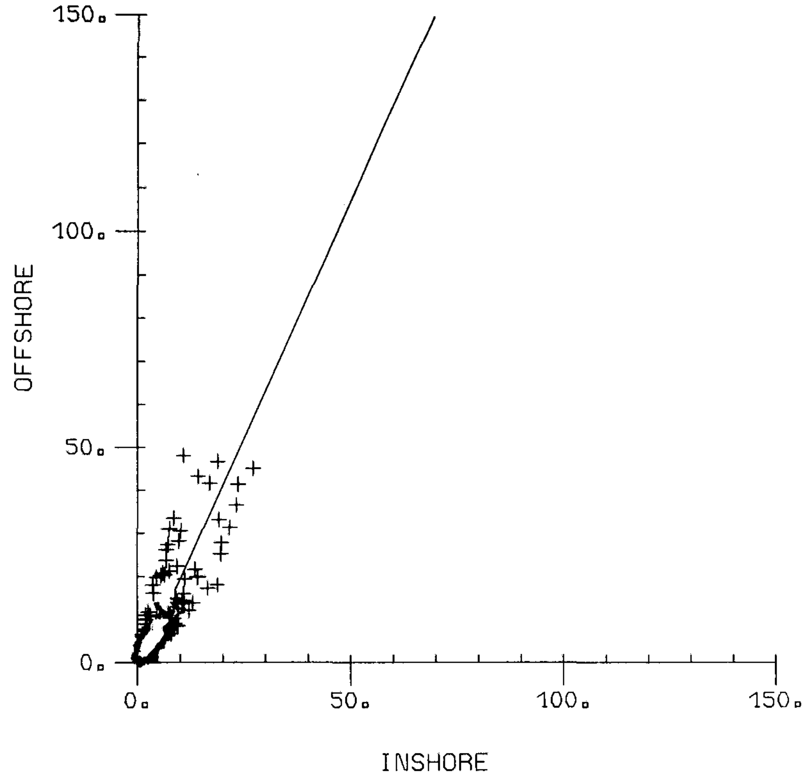
SLOPE =1.508

INTERCEPT =-1.34

STANDARD ERROR =5.446

S.UIST OFFSHORE/INSHORE COMPARISON

POWER KW/H



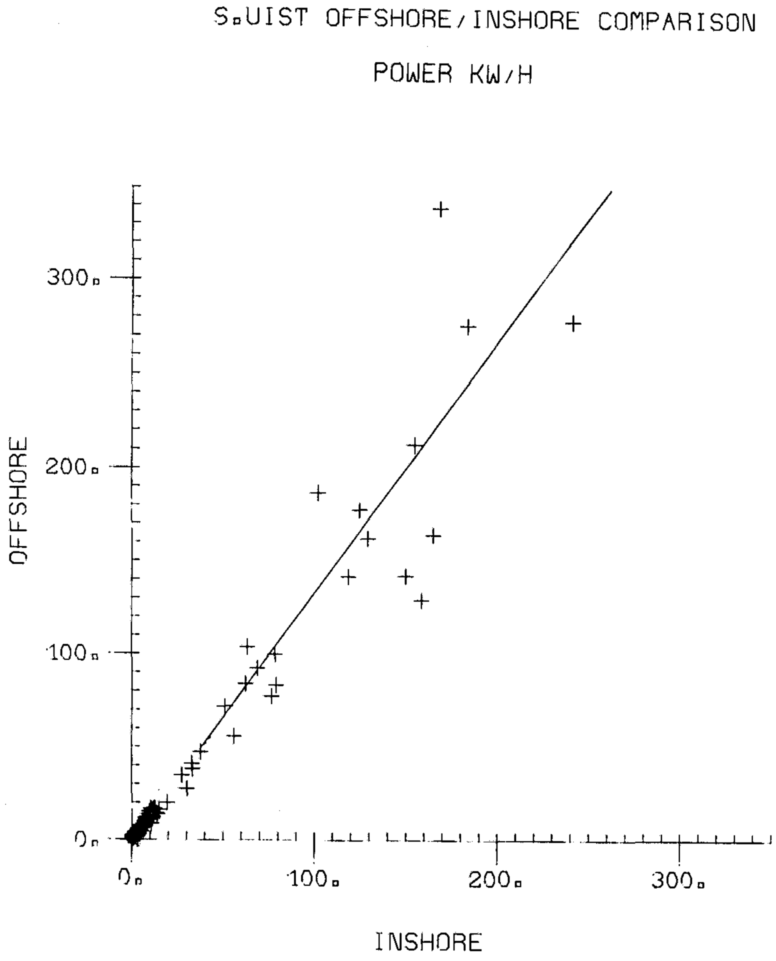
MAY 1980

SLOPE =2.201

INTERCEPT =-2.62

STANDARD ERROR =2.332

Figure 3.10

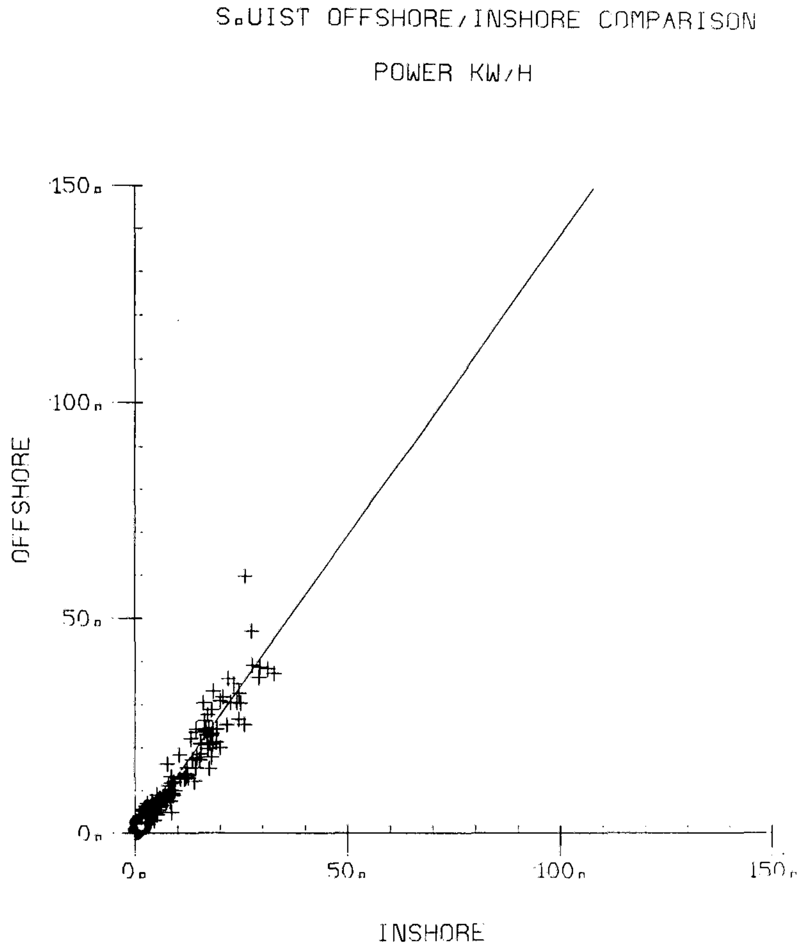


JUNE 1980

SLOPE =1.339

INTERCEPT =-0.90

STANDARD ERROR =7.443



JULY 1980

SLOPE =1.394

INTERCEPT =-0.32

STANDARD ERROR =1.772

Figure 3.11

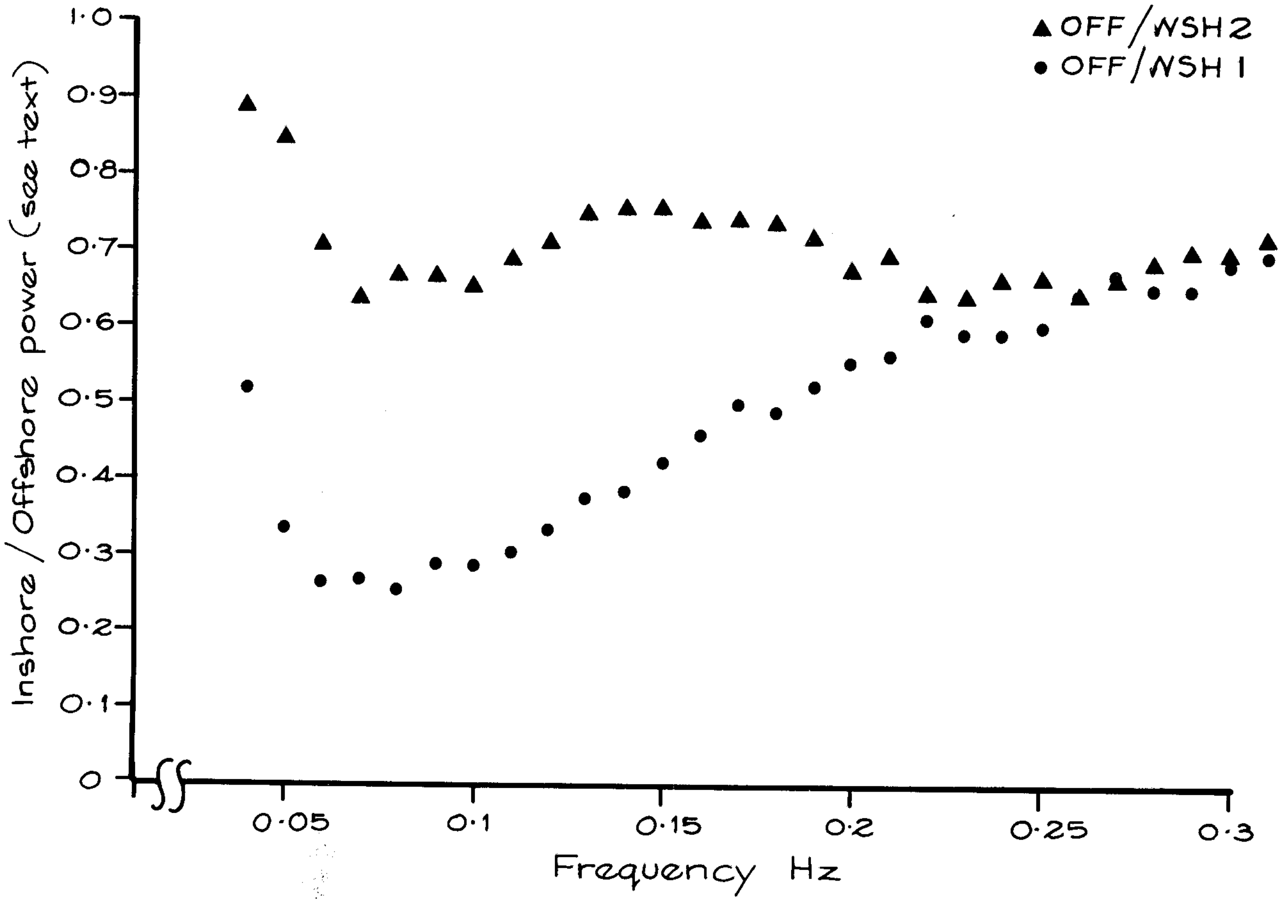

OFF/WSH 2
OFF/WSH 1
Inshore / Offshore power (see text)
1·0
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
0
0·05
0·1
0·15
0·2
0·25
0·3
Frequency Hz

Figure 3·12