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

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INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey GU8 5UB
(042-879-4141)

(Director: Dr. A. S. Laughton)

Bidston Observatory,
Birkenhead,
Merseyside L43 7RA
(051-653-8633)
(Assistant Director: Dr. D. E. Cartwright)

Crossway,
Taunton,
Somerset TA1 2DW
(0823-86211)
(Assistant Director: M. J. Tucker)
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Institute of Oceanographic Sciences
Crossway
Taunton
Somerset
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1. Introduction
2. Waves at the offshore buoy
3. Waves at the inshore buoy
4. Comparisons between the inshore and offshore sites
   Figures
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 $057^\circ 18' 42"$ N, $007^\circ 38' 18"$ W, apart from an interlude from March 1979 to August 1979 when it was mistakenly placed at $057^\circ 12' 12"$ N, $007^\circ 37' 18"$ 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 $57^\circ 19' 18"$ N, $007^\circ 27' 12"$ W where it remained until 16 August 1979. At that time it was moved to $057^\circ 19' 36"$ N, $007^\circ 29' 06"$ 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:

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<th>Fig.</th>
<th>Description</th>
<th>Dates</th>
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<td>March 76 - July 80</td>
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<td>Time series plots of $H_s$</td>
<td>March 76 - July 80</td>
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<td>1.30 - 1.43</td>
<td>Time series plots of $T_e$</td>
<td>March 76 - July 80</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Description</th>
<th>Dates</th>
</tr>
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<td>2.1</td>
<td>Scatter plot of $H_s$ and $T_e$. Buoy Position 1</td>
<td>August 78 - July 79</td>
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<td>2.2</td>
<td>Scatter plot of $H_s$ and $T_e$. Buoy Position 2</td>
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</tr>
<tr>
<td>2.3 - 2.9</td>
<td>Time series plots of power</td>
<td>August 78 - July 80</td>
</tr>
</tbody>
</table>
4. COMPARISONS BETWEEN THE INSHORE AND OFFSHORE SITES

These scatter plots were presented previously in WESC (80) IA 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**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>slope of regression line</td>
<td>0.270</td>
</tr>
<tr>
<td>intercept</td>
<td>2.38 kW/m</td>
</tr>
<tr>
<td>standard error of slope</td>
<td>0.0014</td>
</tr>
<tr>
<td>standard error of intercept</td>
<td>0.18</td>
</tr>
<tr>
<td>correlation coefficient</td>
<td>0.91</td>
</tr>
<tr>
<td>slope of regression line constrained to pass through (0,0)</td>
<td>0.300</td>
</tr>
</tbody>
</table>
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
148 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 WAVE RIDER - MARCH 1976 - JULY 1980

Figure 1-1
Figure 1.2

SOUTH UIST OFFSHORE WAVE RIDER

TIME SERIES OF POWER

JUN 1976

MAY 1976

APR 1976

MAR 1976
TIME SERIES OF POWER
SOUTH UIST OFFSHORE WAVERIDER

Figure 1.3
Figure 1.5
SOUTH VIET OFFSHORE WAVE RIDER
TIME SERIES OF POWER

JUN 1977

MAY 1977

APR 1977

MAR 1977
TIME SERIES OF POWER
SOUTH UIST OFFSHORE WAVERIDER

Figure 1.6
Figure 1.7
SOUTH VISIT OFFSHORE WAVE RIDER
TIME SERIES OF POWER

FEB 1978

JAN 1978

DEC 1977

NOV 1977
Figure 1.8

SOUTH UIST OFFSHORE WAVERIDER

TIME SERIES OF POWER

JUN 1978

MAR 1978
TIME SERIES OF POWER
SOUTH UIST OFFSHORE WAVE RIDER
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 WAVRIDER

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
Figure 1.18
SOUTH UIST MAR 1976 - FEB 1978
TIME SERIES OF HS

FEB 1977

JAN 1977

DEC 1976

NOV 1976
Figure 1.19

SOUTH UIST MAR 1976 - FEB 1978

TIME SERIES OF Hs

JUN 1977

Day

Mar 1977

May

Day

APR 1977

Day

Mar 1977

Day
TIME SERIES OF Hs
SOUTH UIST  MAR 1976 - FEB 1978
Figure 1.21
TIME SERIES OF Hs
SOUTH UIST OFFSHORE WAWERIDER

Figure 1.22
TIME SERIES OF $H_s$

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.24
SOUTH SHORE OFFSHORE WAVES

TIME SERIES OF Hs

JUNE 1979

MAY 1979

APR 1979
TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.26
SOUTH UIST OFFSHORE WAVE RIDER

TIME SERIES OF HS

Figure 1.27

JAN 1980

FEB 1980

NOV 1979

DEC 1979
TIME SERIES OF Hs
SOUTH UIST OFFSHORE WAVERIDER
Figure 1.28
TIME SERIES OF Hs

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.29
SOUTH VIST OFFSHORE WAEVEIDER

TIME SERIES OF TE

Figure 1.30
Figure 1.31

SOUTH NIST OFFSHORE WAVE RIDER

TIME SERIES OF THE

OCT 1976

SEP 1976

AUG 1976

JUL 1976

DAY

DAY

DAY

DAY

Tumu
SOUTH VIST OFFSHORE WAVE RIDER

TIME SERIES OF TE

FEB 1977

JAN 1977

DEC 1976

NOV 1976
FIGURE 1.33

SOUTH WEST OFFSHORE WAVE RIDER

TIME SERIES OF THE

JUN 1977

MAY 1977

APR 1977

MAR 1977
Figure 1.34

South Cliff Offshore Violin

Time Series Of The

OCT 1977

SEP 1977

AUG 1977

JUL 1977
TIME SERIES OF $T_e$

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.35
TIME SERIES OF $T_e$

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.36
Figure 1.37

SOUTH UIST OFFSHORE WAVE RIDER

TIME SERIES OF T^E

OC'T 1978

SEP 1978

AUG 1978

JUL 1978
Figure 1.38

TIME SERIES OF Te
SOUTH UIST OFFSHORE WAVERIDER
SOUTH VIST OFFSHORE WAVE RIDER

TIME SERIES OF TE

FIGURE 1.59

JUNE 1979

MAY 1979

APR. 1979
TIME SERIES OF $T_E$

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.40
TIME SERIES OF T_e
SOUTH UIST OFFSHORE WAWERIDER
Figure 1.41
FIGURE 1-42

SOUTH UST OFFSHORE WAVE RIDER

TIME SERIES OF TE
TIME SERIES OF $T_E$

SOUTH UIST OFFSHORE WAVERIDER

Figure 1.43
Fig 2.1 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.

5-NOV-1980
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
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

JUL 1960
TIME SERIES OF Hs
SOUTH UIST NEARSHORE WAVERIDER

Figure 2.10
TIME SERIES OF $H_s$

SOUTH UIST NEARSHORE WAvERIDER

Figure 2.11
Figure 2.12
SOUTH VIST NEARSHORE WAVEDRIVER
TIME SERIES OF HS

JUN 1979
DAY

MAY 1979
DAY

APR 1979
DAY

MAR 1979
DAY
SOUTH UIST NEARSHORE WAVE RIDER

TIME SERIES OF HS

Figure 2.13
TIME SERIES OF Hs
SOUTH UIST NEARSHORE WAVE RIDER
Figure 2.14
TIME SERIES OF Hs
SOUTH UIST NEARSHORE WEAVERIDER

Figure 2-15
TIME SERIES OF Hs
SOUTH UIST NEARSHORE WAVE RIDER
JUL 1980

Figure 2.16
Figure 2.17

SOUTH VIST NEARSHORE WAVE RIDER

TIME SERIES OF T£

OCT 1976

SEP 1976

AUG 1976
TIME SERIES OF $T_e$

SOUTH UIST NEARSHORE WAvERIDER

Figure 2.19
Figure 2.21

SOUTH VISSL NEARSHORE WAVE RIDER

TIME SERIES OF TE

JAN 1980

FEB 1980

NOV 1979

DATE

Te (sec)

DATE

Te (sec)

DATE

Te (sec)
Figure 2.22

Figures show time series of TE nearshore waverider for March, April, May, and June 1980.
TIME SERIES OF $T_e$

SOUTH UIST NEARSHORE WAVE RIDER

Figure 2.23
SUIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

Figure 3.1
Figure 3.2

September 1978

Slope = 4.389
Intercept = 27.27
Standard Error = 2.267

October 1978

Slope = 4.656
Intercept = 24.18
Standard Error = 6.942
Figure 3.3
Figure 3.4

Slope = 2.874
Intercept = -5.19
Standard Error = 4.361

Slope = 3.519
Intercept = -4.11
Standard Error = 3.020
SUIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

Figure 3.5
SnUIST OFFSHORE/INSHORE COMPARISON
POWER KW/H

INSHORE
JULY 1979
SLOPE =2.803
INTERCEPT =-3.32
STANDARD ERROR =1.588

INSHORE
AUGUST 1979
SLOPE =1.734
INTERCEPT =-0.28
STANDARD ERROR =3.575

Figure 3.6
SUJIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

SEPTEMBER 1979

SLOPE = 1.336
INTERCEPT = 0.14
STANDARD ERROR = 3.453

OCTOBER 1979

SLOPE = 1.649
INTERCEPT = -6.36
STANDARD ERROR = 9.573

Figure 3.7
Figure 3.8

NOVEMBER 1979

SLOPE = 2.126
INTERCEPT = -27.39
STANDARD ERROR = 26.236

JANUARY 1980

SLOPE = 1.458
INTERCEPT = 2.93
STANDARD ERROR = 7.197
SUIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

FEBRUARY 1980

SLOPE = 1.512
INTERCEPT = -6.28
STANDARD ERROR = 11.018

MARCH 1980

SLOPE = 1.132
INTERCEPT = 3.88
STANDARD ERROR = 9.133

Figure 3.9
SoUIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

SLOPE = 1.508
INTERCEPT = -1.34
STANDARD ERROR = 5.446

INSHORE

APRIL 1980

SLOPE = 2.201
INTERCEPT = -2.62
STANDARD ERROR = 2.332

INSHORE

MAY 1980

Figure 3.10
SUIST OFFSHORE/INSHORE COMPARISON

POWER KW/H

JUNE 1980

SLOPE = 1.339
INTERCEPT = 0.90
STANDARD ERROR = 1.463

JULY 1980

SLOPE = 1.394
INTERCEPT = 0.32
STANDARD ERROR = 1.712

Figure 3.11
Figure 3.12

- OFF/NSH 2
- OFF/NSH 1

Inshore/Offshore power (see text)