7/1e

INTERNAL DOCUMENT 34

I.O.S.

USER GUIDE TO SOUTH UIST
SPECTRAL WAVE DATA

March 1976 to February 1977
and
March 1977 to March 1978

NATURAL ENVIRONMENT RESEARCH COUNCIL
INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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

(Director: Professor H. Charnock)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051-652-2396)
(Assistant Director: Dr. D. E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823-86211)
(Assistant Director: M.J. Tucker)

Marine Scientific Equipment Service
Research Vessel Base,
No. 1 Dock,
Barry,
South Glamorgan, CF6 6UZ.
(04462-77451)
(Officer-in-Charge: Dr. L.M. Skinner)

USER GUIDE TO SOUTH UIST

SPECTRAL WAVE DATA

March 1976 to February 1977

and

March 1977 to March 1978

Internal Document No 34

E G Pitt and J A Crabb
Institute of Oceanographic Sciences
Crossway
Taunton, Somerset

June 1978

CONTENTS

Section:

USER GUIDE TO SOUTH UIST SPECTRAL DATA

1. Data Collection

Measurements have been made of the variation with time of sea surface elevation at a point to the west of South Uist since 5 March 1976.

The measuring instrument, a Datawell Waverider buoy, was positioned approximately eleven miles to the south west of Benbecula at 057°18.2'N
007°38.3'W

The depth of water was approximately 42 metres.

Data from the buoy were telemetered continuously to an onshore receiving station located in the control building at the Royal Artillery Range, Hebrides, and comprising a Datawell Warep receiver interfaced to a Rapco digital data logger.

Data were recorded on a sample basis, one 1044 second sample being recorded every three hours. Each sample consisted of 2088 measurements of the wave elevation taken at 0.5 second intervals. Hereafter, a sample as just described is referred to as a (digital) wave record.

A brief history of the South Uist installation during the years March 1976 to February 1977 and March 1977 to March 1978 appears at Appendix A.

2. Preliminary processing and quality checks

Magnetic tapes from the logger were returned to the laboratory each month where they were translated and processed by a computer program designed to check for timing or tape formatting errors. In addition the program subjected each (1044 second) wave record to a number of tests to check for characteristics not normally associated with wave records of this type. The tests were based on the assumptions that a wave record should display certain simple properties consistent with the behaviour of a random process with an approximately normal distribution, and that the water surface should conform to certain well established steepness criteria.

The tests were for the following fault conditions:

(1) Test for lost data points due to format errors or telemetry failure (the latter indicated by a special signal derived from the receiver).

(2) Check for the occurrence of ten consecutive points of equal value (instrument failure test).

(3) Check for an interval between successive up-crossings of the record mean level of greater than twenty five seconds (wandering mean test).

(4) Comparison of the difference in magnitude between successive data points with a test value based on maximum probable water slope.

(5) Comparison of absolute magnitude of data points with a test value equal to four times the record standard deviation.

Actions taken by the program were:
Single lost data points, up to a maximum number of fifteen per record, identified by the first test were replaced by the average value of the two neighbouring points. Two or more adjacent lost points caused the record to be rejected.

Failure of either test (2) or (3) caused the record to be rejected.

Faulty points, up to a maximum number of five, identified by test (4), were replaced by the average value of the two neighbouring points. Two or more adjacent faulty points caused the record to be rejected.

No alterations to the record were made on failures of test (5). Six failures, up to three of which could be consecutive, were allowed before rejecting the record.

The results of these tests are recorded with each record written to the data (time history) file as a group of ten error flags, KFLAG (1-10). Note that the record was written to the data file (and subsequently processed) whether or not it was considered acceptable.

An explanation of the error flags is now given.

KFLAG (1) not used
(2) "
(3) "
(4) "
(5) record start not at correct nominal time
(6) time interval between start of current and previous records not 3 hours
(7) not used
(8) "
(9) record rejected (If set to zero the record may be assumed to be valid.)
(10) record length incorrect

The above check procedures were applied to all the records obtained during the first year of operation, and of the 2,920 records which might have been obtained during the year, 2,722 (93.2%) were finally stored on magnetic tape as valid data. In the second year 2,593 valid records were obtained. This represents 88.8% of the number which might have been obtained.

Data collection at this site is continuing.

3. Calculation of Spectra

Each wave elevation time series was multiplied by a window function of the form $\frac{1}{2}\left(1 - \cos\frac{2\pi . t}{T}\right)$
where T is length of record analyzed and t elapsed time, and a Fast Fourier Transform performed on 2048 points of the series. The spectra thus calculated were smoothed by averaging over ten adjacent harmonics to give a final resolution of 0.0098 Hz.

The smoothed spectral estimates were multiplied by a factor to restore the energy removed in the windowing process. This factor was calculated separately for each spectrum and ensured that the variance of the record, calculated as the zeroth moment of the spectrum, was the same as that calculated from the wave elevation time series. The estimates were also adjusted to compensate for the overall frequency response of the buoy, receiving and recording systems.

Whilst this compensation process yields a frequency response which is approximately flat over the frequency range of interest, it should be noted that the natural frequency of oscillation of the accelerometer platform within the buoy is approximately 40 seconds, and this can give rise to large amplitude low frequency noise. For this reason it is recommended that the first two smoothed spectral estimates of each spectrum supplied be disregarded, and in this way it should be possible to avoid the accidental inclusion of any spurious instrumental noise. The lowest frequency for which a valid estimate of spectral density exists should therefore be regarded as 0.0444 Hz.

The moments have been calculated using the equation

$$m_n = \frac{10}{T} \sum_{i=5}^{70} f_i^n S_i$$

where the significance of i, f_i and S_i is explained in Section 4.

4. Quality of spectra

The error flags which accompany the records written to the time-history data files are carried through when the spectral analysis is done and appear in the spectral files (see Sections 1 and 5). In addition to these, three other quantities are calculated during the analysis as an aid to quality assessment. These are:

SNRL – This is a signal to noise ratio designed to detect the presence of unusually large amounts of energy at low frequencies.

$$\text{SNRL} = 10 \times \log_{10} \left\{ \frac{3}{10} \sum_{i=9}^{18} S_i \Big/ \sum_{i=3}^{5} S_i \right\}$$

SNRH – Designed to detect the presence of high frequency noise. Defined by

$$\text{SNRH} = 10 \times \log_{10} \left\{ \sum_{i=9}^{18} S_i \Big/ \sum_{i=70}^{79} S_i \right\}$$

where i is the harmonic number of the spectral estimate S_i

The frequencies and periods corresponding to the quoted values of i are shown below:

i	f_i	T_i
3	.0249	40.2
5	.0444	22.5
9	.0835	12.0
18	.1714	5.8
70	.6792	1.5
79	.7671	1.3

SCADJ 1 – Taper adjustment factor. This is the square root of the factor which has been applied to the spectrum to ensure that the zeroth moment of the spectrum is equal to the variance of the time-history. Defined by

$$\text{SCADJ 1} = \frac{\sigma}{\sqrt{m_0}}$$

(σ = standard deviation)

For a full cosine taper and for a periodic signal which is a harmonic of the record length, SCADJ 1 = 1.633.

5. Spectral data files

The data are contained in monthly files which contain formatted records with a uniform length of 96 characters. The entry in the output file corresponding to one Rapco (field) wave recording will be called an observation. Hereafter, 'record' will mean 'logical record'.

Spectral file structure

Each file contains data for one calendar month. The files are named in an ordered sequence starting with March 1976, thus:

RES 603. HEB	–	March 1976
RES 604. HEB	–	April 1976
|		|
RES 612. HEB	–	December 1976
RES 701. HEB	–	January 1977
RES 702. HEB	–	February 1977

The contents of the spectral files are set out below. However, on the standard IOS transfer tape a record containing the file name is written at the beginning of each file. This record is in addition to those detailed below.

Record 1

Date header record FORMAT (5X, 40A1, 51X)

Record 2

ISITE – Site Code – B for South Uist
INST – Instrument code – W for Waverider
FORMAT (2A1, 94X)

Record 3

ISTY – Nominal year of first observation
ITD – Nominal day number of first observation
ITH – Nominal time of first observation (Hours)
ITM – Nominal time of first observation (Minutes)
FORMAT (1X, I2, 1X, I3, 1X, 2I2, 84X)
The rest of each file consists of the observations, which are described below.

File terminaton:

There is a logical end of file record which takes the place of Record 1 of the next observation after the end of the data:

ISTY (LEOF)
NDAY (LEOF)
IHR (LEOF)
MIN (LEOF)

FORMAT (5X, I2, 2X, I3, 3X, 2I2, 77X)

This record is written as all 9's to signify the end of the month, or all 8's to signify the end of the data series. If the end of the month is also the end of a series, 8's are written.

In addition, files are terminated by an IBM-compatible EOF mark on the IOS standard transfer tape.

6. Format of Observation

Each observation consists of 18 records.
Each record consists of 96 characters.
These records contain the following information:

Record 1

ISTY	Last two digits of year
NDAY	Day number
IHR	Hour
MIN	Minutes
HS	Significant wave height
TZ	Mean zero-crossing period
SNRL	Quality figure, low frequencies
SNRH	Quality figure, high frequencies
SCADJ1	Taper adjustment factor
KFLAG (1-10)	Validation flags
NREC	Record number (address) of this record with respect to the beginning of the file.

FORMAT (5X, I2, 2X, I3, 3X, 2I2, 5 (3X,F6.2), 2X, 10I1, 4X, I5, 11X)

Record 2

RM (1-7) - Moments of spectrum order -2 to +4
QP - Goda's spectral peakedness parameter

FORMAT (8E12.5)

Records 3–18

Tabulation of FREQ (I) frequency (H_Z) and

S (I) spectral density (m^2/Hz)

as 64 pairs, arranged 4 per record as follows:

```
FREQ (1)    S(1)       FREQ (17)  S(17)- - - - FREQ (49)  S(49)
FREQ (2)    S(2)       FREQ (18)  S(18)- - - - FREQ (50)  S(50)
   |          |           |          |            |          |
   |          |           |          |            |          |
FREQ (16)   S(16)      FREQ (32)  S(32)- - - - FREQ (64)  S(64)
```

This can be read using the following statement:

```
READ (n, 8ØØ)   (( FREQ (N+M-1),  S(N+M-1), M=1, 49, 16), N=1,16)
8ØØ FORMAT (4(3X, F6.4, 3X, E12.5))
```

'No data' record

If the wave recording for a particular time was not available, a 'no-data' observation is generated.

Only Record 1 appears in a 'no-data' observation, and in this all real numbers are set to 99.99, and the validation flags are set to 9.

NREC, the record address continues to increment correctly.

7. Index file structure

Index files are a separate file series which contain a subset of the information contained in the spectral files. The following records are included.

Record 1 Data header record with year and month

Record 2 Site/Instrument code

and then:

For the first year of operation (index files LST 603.HEB to LST 702.HEB), Record 1 of each observation as it appears in the spectral file.

For the second year of operation (index files LST 703.HEB to LST 803.HEB), Records 1 and 2 of each observation as they appear in the spectral file.

These files can be listed on a line printer for use as a hard-copy index.

APPENDIX A

Brief history of the South Uist installation

First year - March 1976 to February 1977

28 February 1976	Buoy 6459 moored at 57°18.2'N, 007°38.3'W in 42 metres depth
5 March 1976	First record taken at 1200 GMT
29 July 1976	Logger 401A removed, logger 401B fitted
31 July 1976	End of data series LEOF = 8
3 August 1976	Buoy 6459 recovered, buoy 6242 deployed
31 January 1977	End of data series LEOF = 8
February 1977	Occasional mean-line instability appeared in the data

Second year - March 1977 to March 1978

March 1977	Mean-line instability in the data
18 April 1977	Buoy 6242 recovered, buoy 6850 deployed. Stabiliser chain fitted in mooring
30 April 1977	End of data series LEOF = 8
10 August 1977	Buoy 6850 recovered, buoy 6459 deployed
31 August 1977	End of data series LEOF = 8
March 1978	Mean line instability in the data
24 March 1978	Buoy 6459 washed ashore on Vorran Island
31 March 1978	End of data series LEOF = 8