

Wave data recording program

Gold Coast

1987 - 1994



**Queensland
Department of
Environment and
Heritage**

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Wave data recording program Gold Coast 1987-1994

Abstract

This report provides summaries of primary analyses of wave data recorded in water depths of 12 metres offshore near the Gold Coast Seaway in southern Queensland. Data was recorded using a Datawell Waverider buoy, and covers the period 20 February 1987 to 30 June 1994. The data was divided into seasonal groupings for analysis. No estimations of wave direction data have been provided.

This report has been prepared by the Coastal Management Branch, Division of Conservation, Queensland Department of Environment and Heritage on behalf of the Beach Protection Authority.

While reasonable care and attention has been taken in collecting, processing and compiling wave data in this report, the accuracy and reliability of this information is not guaranteed in any way by the Beach Protection Authority. The Authority accepts no responsibility for the use of this information in any way.

August 1994

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Other reports in this series:

- Wave data recording program, Cairns Region (Report No.W01.1) 2 May 1975 to 3 Sept. 1978
- Wave data recording program, Cairns Region (Report No.W01.2) 2 May 1975 to 11 June 1985
- Wave data recording program, Mackay Region (Report No.W02.1) 17 Sept. 1975 to 5 Nov. 1976
- Wave data recording program, Mackay Region (Report No.W02.2) 17 Sept. 1975 to 23 Aug. 1985
- Wave data recording program, Townsville Region (Report No.W03.1) 19 Nov. 1975 to 23 Feb. 1979
- Wave data recording program, Townsville Region (Report No.W03.2) 19 Nov. 1975 to 29 Dec 1987
- Wave data recording program, Sunshine Coast Region (Report No.W04.1) 5 Apr. 1974 to 5 July 1977
- Wave data recording program, Burnett Heads Region (Report No.W05.1) 5 May 1976 to 5 May 1982
- Wave data recording program, Burnett Heads Region (Report No.W05.2) 5 May 1976 to 13 Oct. 1988

- Wave data recording program, Abbot Point Region (Report No.W06.1) 6 May 1977 to 9 Aug. 1979
- Wave data recording program, Weipa Region (Report No.W07.1) 21 Dec. 1978 to 7 Apr. 1983
- Wave data recording program, Gladstone Region (Report No.W08.1) 19 Dec. 1979 to 16 May 1983
- Wave data recording program, Brisbane Region (Report No.W09.1) 30 Oct. 1976 to 30 June 1983
- Wave data recording program, Brisbane Region (Report No.W09.2) 30 Oct. 1976 to 30 June 1994
- Wave data recording program, Bowen Region (Report No.W10.1) 14 Sept. 1978 to 15 Nov. 1984
- Wave data recording program, Moreton Island Region (Report No.W11.1) 15 June 1983 to 12 Apr. 1985
- Wave data recording program, Bramston Beach Region (Report No.W12.1) 16 Dec. 1981 to 28 Oct. 1985
- Wave data recording program, Hay Point Region (Report No.W13.1) 22 Mar. 1977 to 25 May 1987
- Wave data recording program, Kirra (Report No.W15.1) 25 Aug. 1988 to 30 June 1994

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1.0 Introduction

As part of its long-term data collection program, the Beach Protection Authority has been recording wave characteristics along Queensland's coastline since 1968. This has been done using a series of wave recording stations. This report summarises the primary analyses of wave data collected at the Gold Coast station. In addition, brief details of the recording equipment, the method of handling raw data and the type of analyses used are provided.

2.0 Recording equipment

All the Beach Protection Authority's wave recording stations use the Waverider system manufactured by Datawell b.v. of the Netherlands. In this system, a waverider buoy is used to determine the sea surface fluctuations at an offshore location. Vertical acceleration of the buoy is measured by an accelerometer mounted on a stabilised platform in the buoy and twice integrated to give displacement. The instantaneous water level data are then transmitted to the shore station as a frequency modulated high frequency radio signal.

In the original configuration of the Gold Coast station, first installed on 20 February 1987, the shore station consisted of a WAREP Waverider receiver and a DIMA digitiser/recorder. The WAREP receiver controlled the timing of data recording and provided a paper chart of the water level signal. Wave data were recorded by the DIMA unit in 20-minute bursts and digitised at 0.5 second intervals (2.0Hz). The data were recorded on digital cassettes and, along with the paper charts, transferred to Brisbane office for processing.

On 1 November 1991, the wave recording system was upgraded to a personal computer-based system utilising the Datawell DIWAR Waverider receiver/digitiser. The water level data, digitised at 0.39 second intervals (2.56Hz), are recorded in bursts of 4096 points (approximately 27 minutes) and recorded on the hard disk of the PC. The proprietary software running on the PC controls the timing of data recording and processes the data in 'near real time' to provide a set of standard sea-state parameters which may be accessed remotely via the public switched telephone network. Recorded data and analysis results are downloaded daily to a central computer system in Brisbane for checking and archiving.

Further information on the operation of the Waverider buoy and the recording systems can be obtained from the sources listed in section 7 of this report.

3.0 Wave recording and analysis procedures

Over the period 20 February 1987 to 31 October 1991, wave data have generally been recorded four times a day at 0300, 0900, 1500 and 2100 hours (Australian Eastern Standard Time). During storm events the recording frequency might have been manually switched by the operator to record eight times a day. Since 1 November 1991, the PC-based recording system has recorded data at (nominally) hourly intervals.

Recorded wave data are analysed in the time domain by the zero upcrossing method and in the frequency domain by spectral analysis. Spectral analysis of the WAREP/DIMA data was performed by the autocorrelation method providing 50 lags at a spacing of 0.2 Hz. The PC-based analysis uses Fast Fourier Transform techniques to give 128 spectral estimates in bands of 0.01 Hz. The zero upcrossing analysis is equivalent in both systems.

Wave parameters resulting from this processing include the following:

S(f)	energy density spectrum
Hsig	significant wave height (time domain), the average of the highest one-third of the waves in the record
Hmax	highest individual wave in the record
Hrms	root mean square of the wave heights in the record (time domain)
Tsig	significant wave period (time domain), the average period of the highest one-third of waves in the record
Tz	average period of all zero upcrossing waves in the record (time domain)
Tpeak	wave period corresponding to the peak of the energy density spectrum
Tc	average period of all the waves in the record based on successive crests

These parameters form the basis for the summary plots and tables attached to this report.

4.0 Data losses

Data losses can be divided into two categories — losses due to equipment failure and losses during data processing due to signal corruption. Common causes of data corruption include radio interference and a spurious low frequency component in the water level signal caused by a tilting accelerometer platform in the Waverider buoy.

Analysis of data recorded by the WAREP/DIMA and the PC-based systems include some data rejection checks. In the case of the WAREP/DIMA data, the length of the record can be shortened to exclude corrupt data points. In the PC-based analysis, a small number of spurious data points can be corrected by an interpolation procedure. Otherwise the entire series is rejected.

Details of data losses for the Gold Coast wave recording station are included in Appendix 1.

5.0 Wave climate

The wave climate presented in this report is based on statistical analyses of the parameters obtained from the recorded wave data. Programs developed by the Authority provide statistical information on percentage of time occurrence and exceedance for wave heights and periods. The results of these analyses are presented in tables 1, 2 and 3 and figs. 2, 3 and 4. In addition, similar analyses are carried out on the relationships between the various wave parameters and these are presented in fig. 5.

6.0 Data presentation

No attempt has been made to interpret the recorded data for design purposes or to apply corrections for refraction, diffraction and shoaling to obtain equivalent deep water waves. Before any use is made of this data, the exact location of the buoy and the water depth in which the buoy was moored should be noted. This information is given in Appendix 1. The data presented does not include any information on wave directions. The Waverider recording system is designed to record only vertical movements of the water surface. Other means must be used to correlate wave directions and wave records.

When major meteorological events such as cyclones occurred during the recording period, these have been noted. They are summarised with the maximum wave heights recorded and other comments in Appendix 2.

For analysis, summer has been taken as the period from 1 November to 30 April of the following year. Winter covers the period 1 May to 31 October in any one year.

7.0 References

- Datawell, *Operation and service manual for the Waverider - series 6000*
Datawell, *Manual of Waverider receiver type WAREP - mark II*
Datawell, *Manual of the digital Waverider receiver type DIWAR*
Datawell, *Manual of the digital magnetic tape recorder type DIMA - mark II*
Lawson and Treloar Pty Ltd (1991), *Real time wave analysis package*
Bureau of Meteorology, *Monthly weather review*

Appendices

Appendix 1 Details of Gold Coast wave recorder installations

Details of wave recorder installation

Location: 153°26.25' East, 27°58.66' South; 0.5nm offshore, 1km north of Narrow Neck (see fig.1)
Period: 20 February 1987 to 23 July 1987
Water depth at buoy: 12 metres relative to low water datum

Location: 153°26.25' East, 27°58' South; 0.5nm offshore, 1.2km north of Narrow Neck (see fig.1)
Period: 23 July 1987 to 26 April 1988
Water depth at buoy: 12 metres relative to low water datum

Location: 153°26.48' East, 27°58' South; 0.7nm offshore, 1.2km north of Narrow Neck (see fig.1)
Period: 26 April 1988 to 10 September 1991
Water depth at buoy: 16 metres relative to low water datum

Note: These locations were calculated using radar ranging and compass bearings to prominent landmarks.

Location: 153°26.43' East, 27°58' South; 1.2nm offshore Southport Spit, 70° True Mirage Resort (see fig.1)
Period: 10 September 1991 to present
Water depth at buoy: 18 metres relative to low water datum

Note: This location was measured using GPS fixing procedures.

All water depths are accurate to ± 1 m.

Location of recording station

Gold Coast Seaway sand pumping complex

Recording

Normal recording interval: Four 20-minute records daily at 0300 hours, 0900 hours, 1500 hours and 2100 hours between 20 February 1987 and 31 October 1991.

From 1 November 1991, one-hourly samples approximately 26 minutes long have been taken giving 4096 water surface elevation figures for that period from which sea state parameters are calculated and recorded.

Number of records analysed: 28 059
Number of days in recording period 20 February 1987 to 30 June 1994: 2687
Number of days of data lost due to equipment failure and signal corruption (see 4.0 above): 511
Percentage of recordings available for analysis: 80.98%

Appendix 2 Major meteorological events

Meteorological event	Central pressure (HPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded (metres)	Maximum Hmax recorded (metres)	Tp (secs)
Low pressure system off Queensland	1012	05-03-87		2.44	4.09	7.12
High pressure system over Tasman Sea	1036	09-05-87		2.49	4.29	6.45
Low pressure system off south-east Queensland	1004	15-01-88		3.29	6.93	7.54
Low pressure system over Brisbane	1008	11-04-88		3.48	5.67	6.90
Low pressure system off Victorian Coast	1000	05-06-88		3.25	5.13	6.97
Cyclone Aivu	955	04-04-89	800 NNE	3.07	4.93	6.95
Low pressure system off south-east Queensland and high pressure system off southern central NSW	1000 and 1028	25-04-89		5.09	7.87	8.12
Low pressure system off south-east Queensland	1004	29-05-89		3.05	4.52	7.13
Low pressure system off south-east Queensland	1004	19-08-89		3.55	5.37	7.5

Meteorological event	Central pressure (HPa)	Date	Estimated position of cyclone relative to buoy (km)	Maximum Hsig recorded (metres)	Maximum Hmax recorded (metres)	Tp (secs)
Cyclone Nancy	975	01-02-90	111 E	**	**	**
High pressure system over Tasman Sea and low pressure system off central Queensland	1032 and 1008	09-06-90		3.85	7.00	8.33
Low pressure system off Brisbane	1008	07-11-90		3.73	6.02	7.30
High pressure system	1020	13-01-91		2.74	4.47	7.81
Cyclone Betsy	975	13-01-92	650 NE	2.89	5.32	10.77
Cyclone Daman	998	19-02-92	328 ESE	3.65	6.99	9.96
Cyclone Fran	980	15-03-92	340 SSE	3.11	6.01	8.92
Cyclone Roger	992	17-03-93	410 E	5.17	9.98	8.33
Cyclone Rewa	992	21-01-94	490 E	2.41	4.78	9.13

** No data available.

The highest significant wave height (Hsig) recorded was 5.17 metres on 17 March 1993 due to the passage of Cyclone Roger off the south Queensland coast.

The highest maximum wave height (Hmax) recorded was 9.98 metres on 17 March 1993 due to the passage of Cyclone Roger off the south Queensland coast.

Meteorological information was obtained from the *Monthly Weather Review* published by the Bureau of Meteorology.

Events reported only where recorded data available and Hsig exceeds 2.0 metres.

Table 1. Wave statistics — Wave period/Wave height occurrences — All data, all directions.

Significant wave height (metres)	Peak energy wave period (seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	> 14.99	
0.00 - 0.25	*	*	*	*	*	0.08	0.04	*	0.13
0.26 - 0.50	*	2.23	6.53	14.99	30.63	21.41	4.29	1.37	81.45
0.51 - 0.75	0.13	20.08	61.17	96.23	135.75	69.91	21.45	2.62	407.34
0.76 - 1.00	*	29.40	86.93	163.30	177.47	88.35	17.19	5.69	568.33
1.01 - 1.25	*	12.64	70.40	161.28	135.10	62.53	12.62	5.44	460.00
1.26 - 1.50	*	2.38	33.52	107.77	80.32	36.62	6.21	2.62	269.46
1.51 - 1.75	*	0.63	13.73	79.52	57.40	23.25	4.47	0.56	179.57
1.76 - 2.00	*	*	4.00	38.72	34.49	13.69	2.33	0.04	93.39
2.01 - 2.25	*	*	1.01	27.85	22.38	8.96	2.54	0.50	63.25
2.26 - 2.50	*	*	0.04	7.84	18.32	5.65	0.99	0.13	32.98
2.51 - 2.75	*	*	*	5.78	10.46	5.38	0.21	0.04	21.87
2.76 - 3.00	*	*	*	2.49	11.96	5.30	0.41	*	20.15
3.01 - 3.25	*	*	*	1.08	4.28	0.87	*	0.04	6.28
3.26 - 3.50	*	*	*	0.17	3.40	1.12	0.08	*	4.78
3.51 - 3.75	*	*	*	*	2.12	0.54	0.04	*	2.71
3.76 - 4.00	*	*	*	*	0.51	0.08	*	*	0.59
4.01 - 4.25	*	*	*	*	0.77	0.56	*	*	1.33
4.26 - 4.50	*	*	*	*	1.00	0.46	*	*	1.46
4.51 - 4.75	*	*	*	*	*	0.40	*	*	0.40
4.76 - 5.00	*	*	*	*	0.25	0.29	0.07	*	0.61
5.01 - 5.25	*	*	*	*	0.25	0.50	0.02	*	0.77
5.26 - 5.50	*	*	*	*	*	0.06	*	*	0.06
5.51 - 5.75	*	*	*	*	0.25	0.02	0.06	*	0.33
5.76 - 6.00	*	*	*	*	*	*	*	*	0.00
6.01 - 6.25	*	*	*	*	*	*	*	*	0.00
6.26 - 6.50	*	*	*	*	*	*	*	*	0.00
Totals	0.13	67.35	277.44	707.03	727.12	346.07	73.04	19.06	2217.23

Values in days have been rounded to two decimal places.

Table 2. Wave statistics — Wave period/Wave height occurrences — Summer data, all directions.

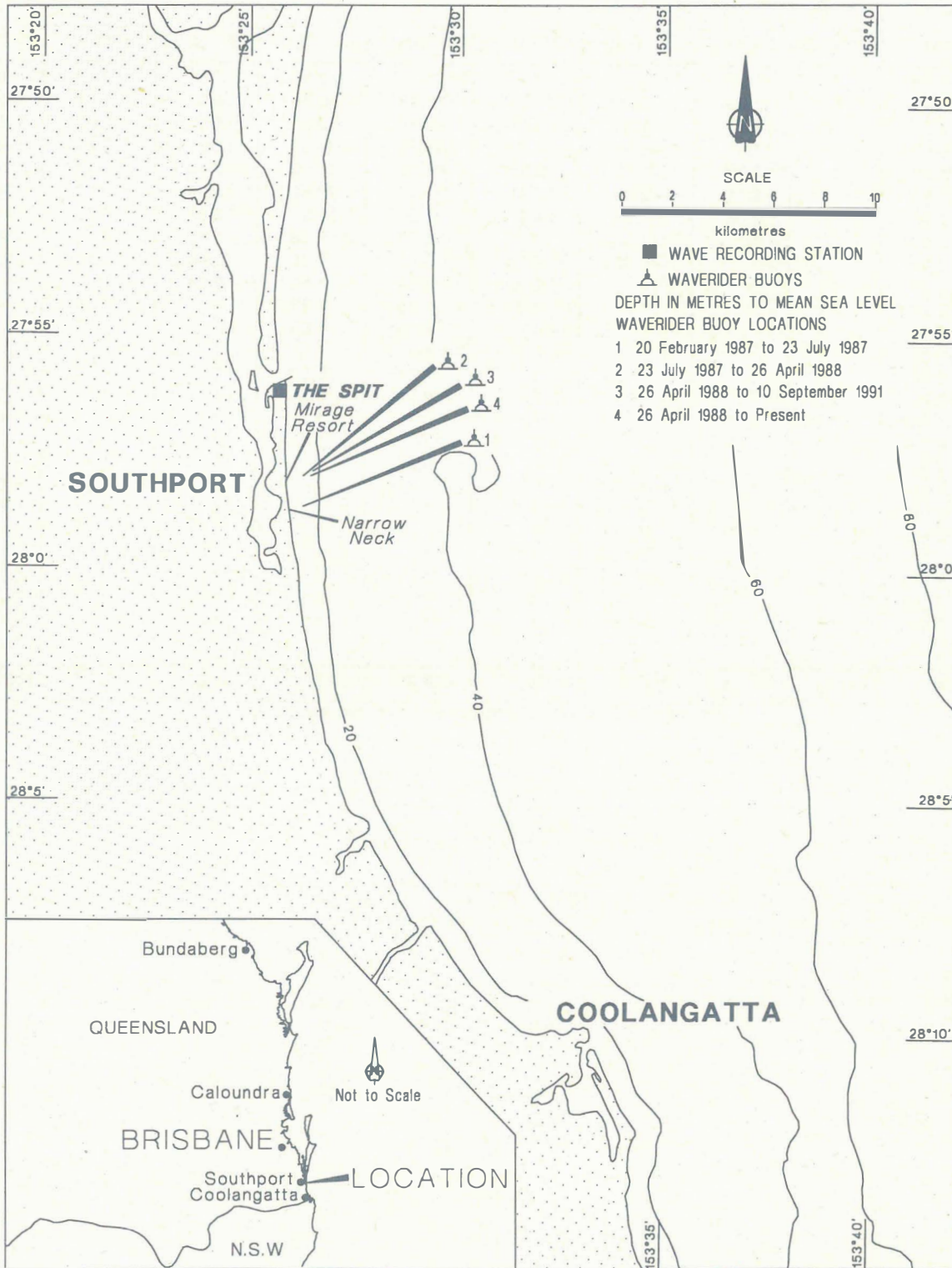
Significant wave height (metres)	Peak energy wave period (seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	>14.99	
0.00 - 0.25	*	*	*	*	*	*	*	*	0.00
0.26 - 0.50	*	*	1.89	3.23	5.48	2.08	0.10	*	12.78
0.51 - 0.75	0.08	10.57	28.56	47.17	48.35	14.10	3.12	0.33	152.28
0.76 - 1.00	*	17.80	40.27	92.98	70.55	27.48	4.68	0.48	254.25
1.01 - 1.25	*	8.85	40.10	100.03	70.61	21.12	5.17	1.27	247.14
1.26 - 1.50	*	1.27	21.24	70.59	44.22	13.81	3.17	0.46	154.75
1.51 - 1.75	*	0.54	9.26	55.39	36.85	11.35	1.62	0.04	115.06
1.76 - 2.00	*	*	2.58	25.52	24.41	8.31	0.92	*	61.73
2.01 - 2.25	*	*	0.71	19.11	17.06	6.27	2.08	*	45.22
2.26 - 2.50	*	*	0.04	5.63	14.49	4.15	0.95	0.13	25.38
2.51 - 2.75	*	*	*	3.54	9.21	4.15	0.21	0.04	17.15
2.76 - 3.00	*	*	*	1.48	7.96	3.41	0.41	*	13.26
3.01 - 3.25	*	*	*	0.46	3.04	0.87	*	0.04	4.41
3.26 - 3.50	*	*	*	0.17	1.79	0.62	0.08	*	2.67
3.51 - 3.75	*	*	*	*	1.62	0.29	0.04	*	1.95
3.76 - 4.00	*	*	*	*	0.25	0.08	*	*	0.33
4.01 - 4.25	*	*	*	*	0.77	0.56	*	*	1.33
4.26 - 4.50	*	*	*	*	0.75	0.46	*	*	1.21
4.51 - 4.75	*	*	*	*	*	0.40	*	*	0.40
4.76 - 5.00	*	*	*	*	0.25	0.29	0.07	*	0.61
5.01 - 5.25	*	*	*	*	0.25	0.50	0.02	*	0.77
5.26 - 5.50	*	*	*	*	*	0.06	*	*	0.06
5.51 - 5.75	*	*	*	*	0.25	0.02	0.06	*	0.33
5.76 - 6.00	*	*	*	*	*	*	*	*	0.00
6.01 - 6.25	*	*	*	*	*	*	*	*	0.00
6.26 - 6.50	*	*	*	*	*	*	*	*	0.00
Totals	0.08	39.02	144.66	425.29	358.16	120.39	22.71	2.79	1113.09

Values in days have been rounded to two decimal places.

Table 3. Wave statistics — Wave period/Wave height occurrences — Winter data, all directions.

Significant wave height (metres)	Peak energy wave period (seconds)								Totals
	0 - 2.99	3 - 4.99	5 - 6.99	7 - 8.99	9 - 10.99	11 - 12.99	13 - 14.99	> 14.99	
0.00 - 0.25	*	*	*	*	*	0.08	0.04	*	0.13
0.26 - 0.50	*	2.23	4.64	11.77	25.15	19.33	4.19	1.37	68.67
0.51 - 0.75	0.04	9.51	32.60	49.06	87.40	55.81	18.33	2.29	255.06
0.76 - 1.00	*	11.60	46.66	70.31	106.91	60.87	12.51	5.21	314.07
1.01 - 1.25	*	3.79	30.29	61.25	64.49	41.40	7.46	4.17	212.86
1.26 - 1.50	*	1.11	12.29	37.19	36.10	22.82	3.04	2.17	114.72
1.51 - 1.75	*	0.08	4.48	24.13	20.55	11.91	2.85	0.52	64.51
1.76 - 2.00	*	*	1.53	13.21	10.08	5.38	1.42	0.04	31.66
2.01 - 2.25	*	*	0.30	8.74	5.32	2.70	0.46	0.50	18.02
2.26 - 2.50	*	*	*	2.22	3.84	1.50	0.04	*	7.59
2.51 - 2.75	*	*	*	2.24	1.25	1.23	*	*	4.72
2.76 - 3.00	*	*	*	1.01	4.00	1.88	*	*	6.89
3.01 - 3.25	*	*	*	0.63	1.24	*	*	*	1.87
3.26 - 3.50	*	*	*	*	1.61	0.50	*	*	2.11
3.51 - 3.75	*	*	*	*	0.50	0.26	*	*	0.76
3.76 - 4.00	*	*	*	*	0.26	*	*	*	0.26
4.01 - 4.25	*	*	*	*	*	*	*	*	0.00
4.26 - 4.50	*	*	*	*	0.25	*	*	*	0.25
4.51 - 4.75	*	*	*	*	*	*	*	*	0.00
4.76 - 5.00	*	*	*	*	*	*	*	*	0.00
5.01 - 5.25	*	*	*	*	*	*	*	*	0.00
5.26 - 5.50	*	*	*	*	*	*	*	*	0.00
5.51 - 5.75	*	*	*	*	*	*	*	*	0.00
5.76 - 6.00	*	*	*	*	*	*	*	*	0.00
6.01 - 6.25	*	*	*	*	*	*	*	*	0.00
6.26 - 6.50	*	*	*	*	*	*	*	*	0.00
Totals	0.04	28.33	132.78	281.74	368.96	225.68	50.33	16.27	1104.13

Values in days have been rounded to two decimal places.



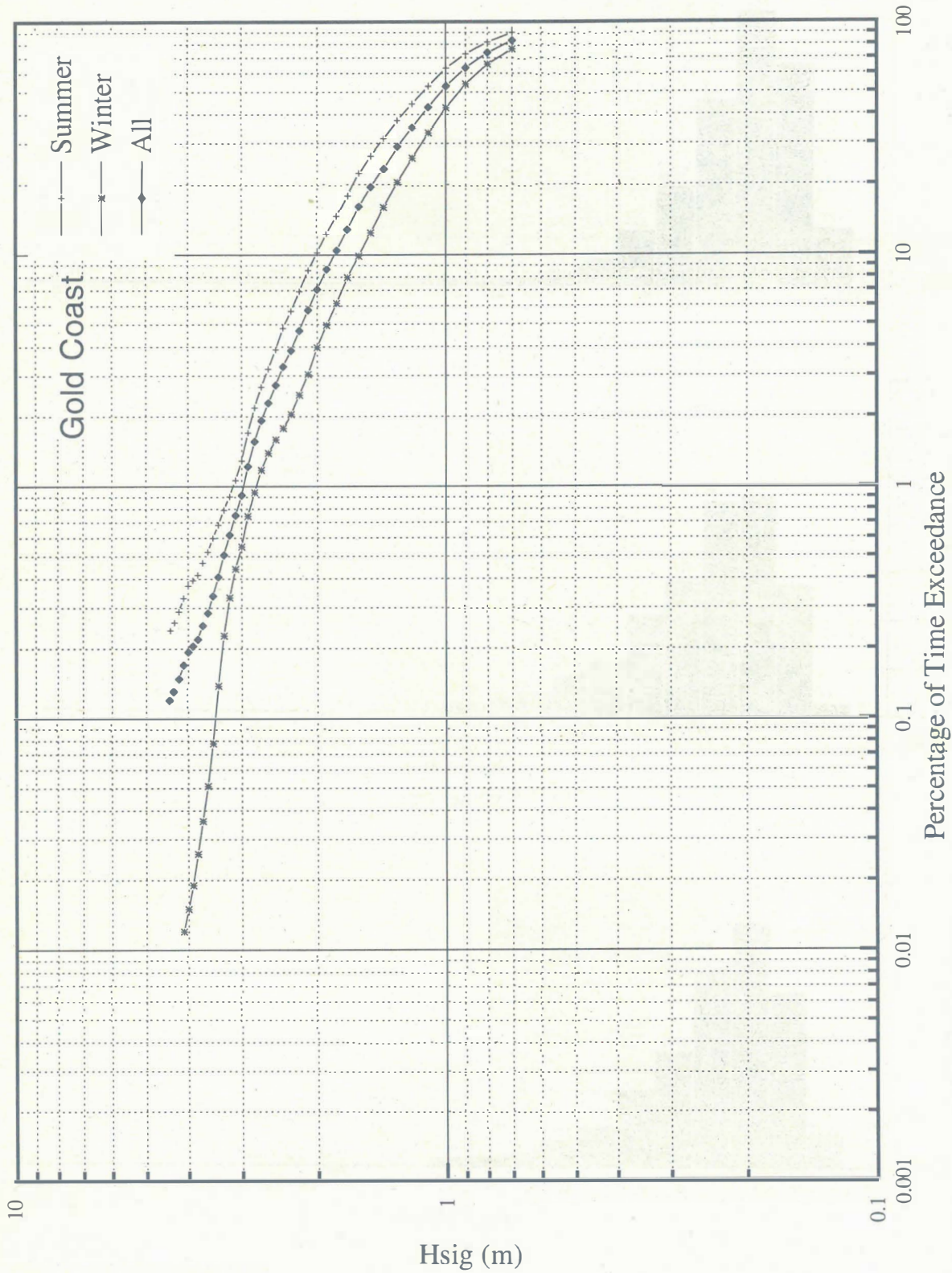
LOCALITY MAP



Beach Protection Authority Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
GOLD COAST

Figure 1

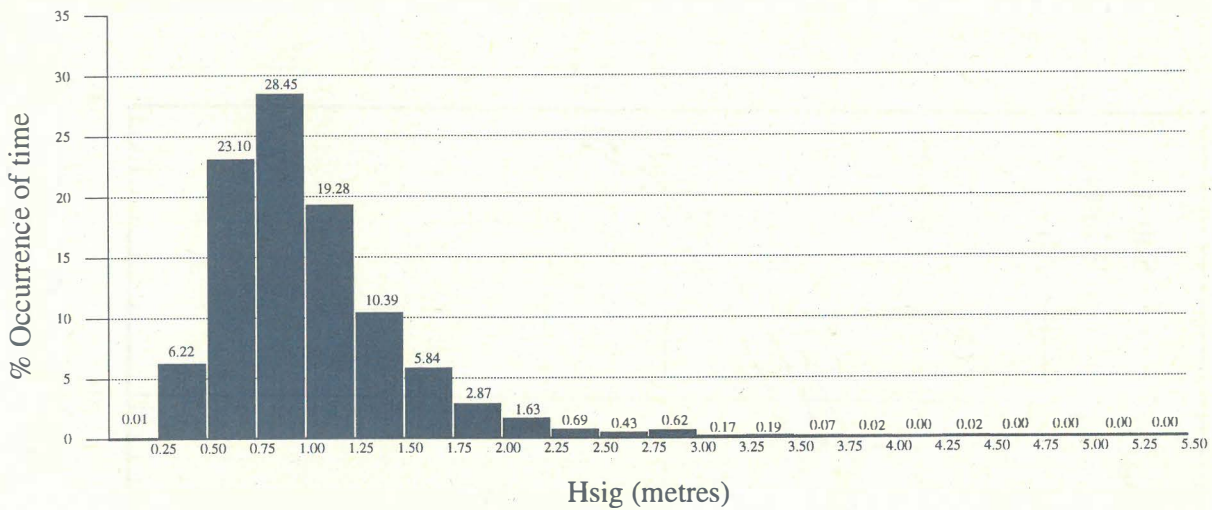


PERCENTAGE (of time) EXCEEDANCE
OF WAVE HEIGHTS (Hsig) FOR ALL WAVE PERIODS
20 February 1987 to 30 June 1994

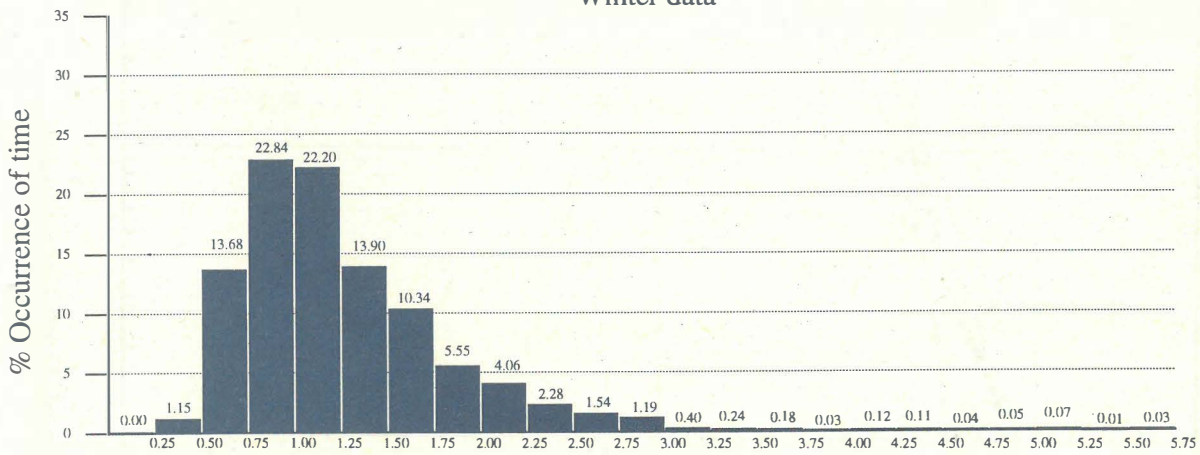


Wave Data Recording Program
GOLD COAST

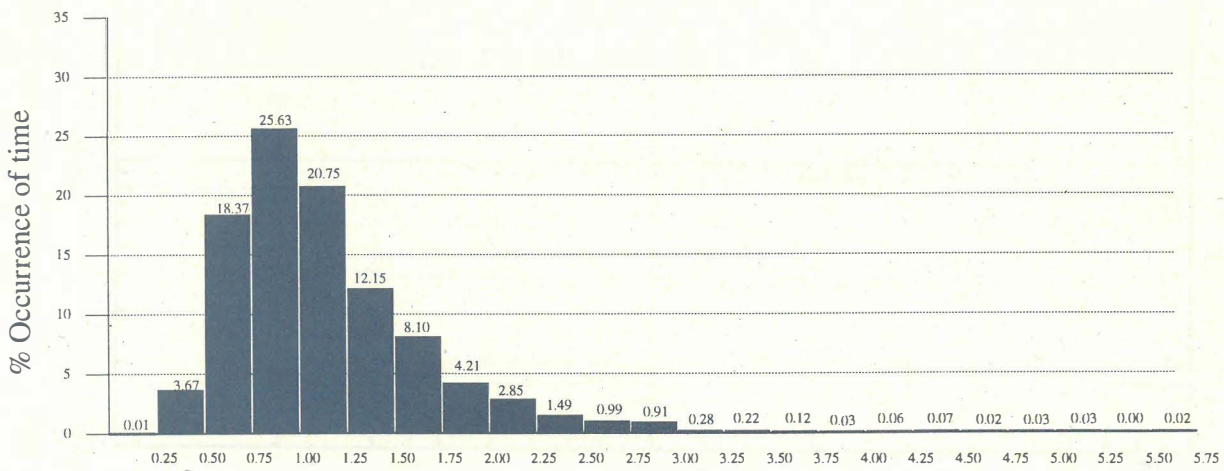
Figure 2



Hsig (metres)
Winter data



Hsig (metres)
Summer data



Hsig (metres)
All data

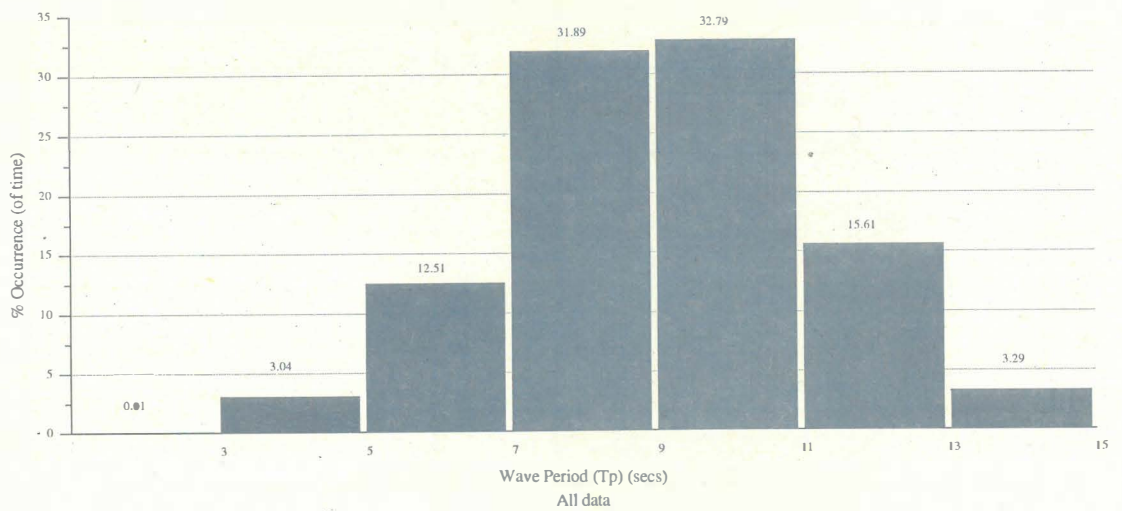
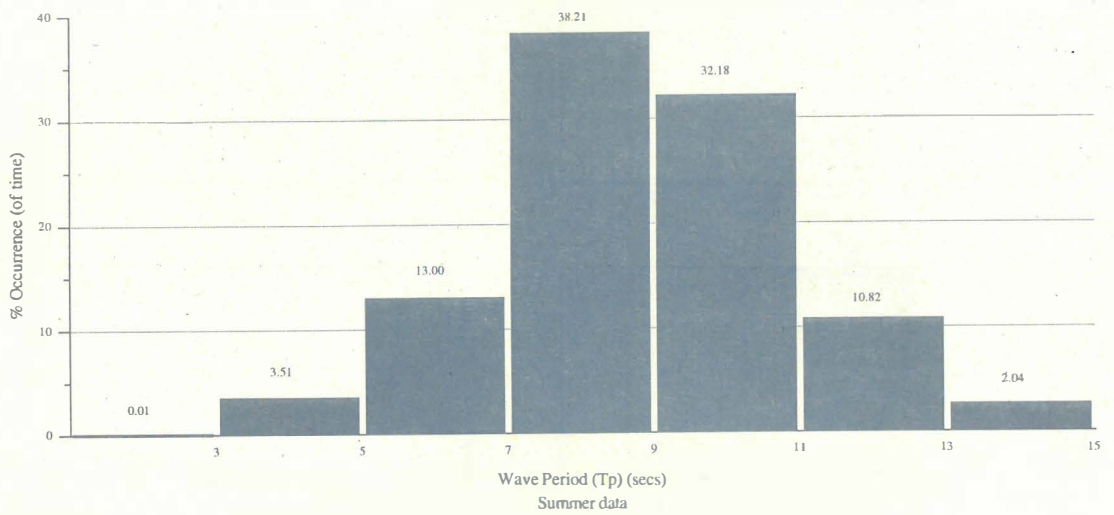
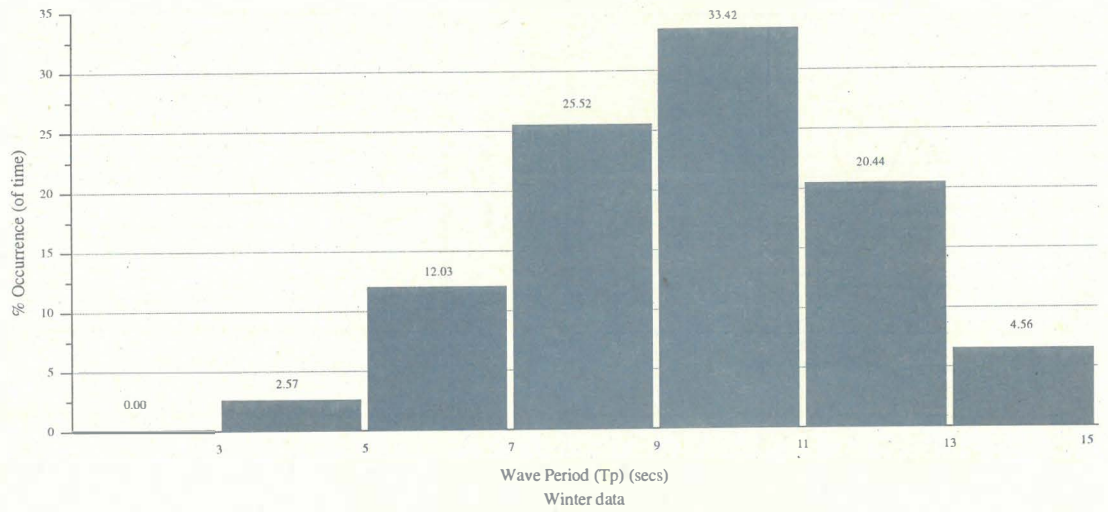
HISTOGRAM PERCENTAGE (of time)
OCCURRENCE OF WAVE HEIGHTS (Hsig)
FOR ALL WAVE PERIODS (Tp)



Beach Protection
Authority
Queensland
Queensland Department of Environment and Heritage

Wave Data Recording Program
GOLD COAST

Figure 3



HISTOGRAM PERCENTAGE (of time)
OCCURRENCE OF WAVE PERIODS (Tp)
FOR ALL WAVE HEIGHTS (Hsig)

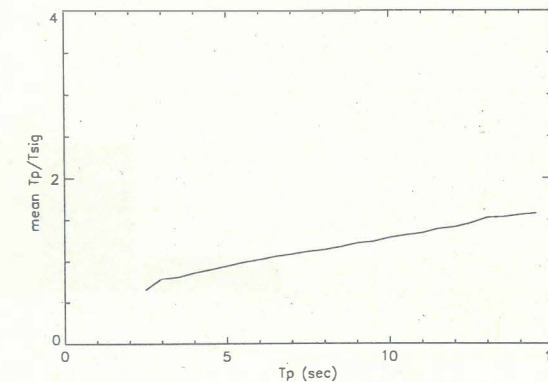
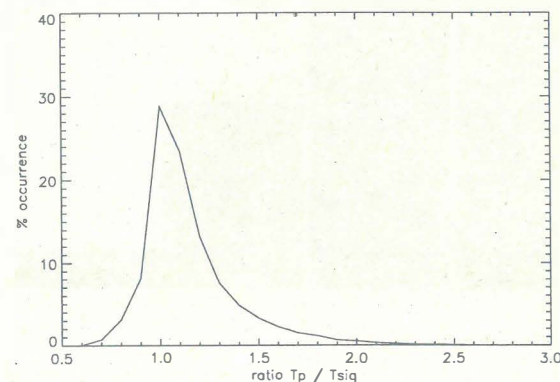
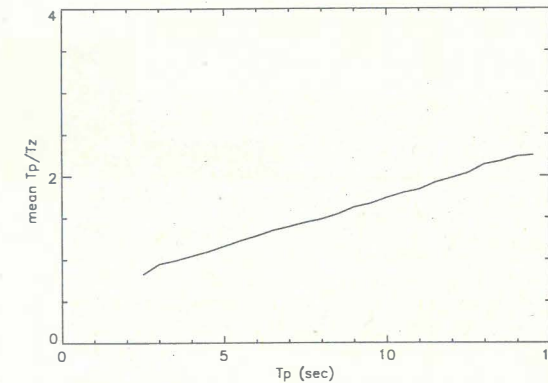
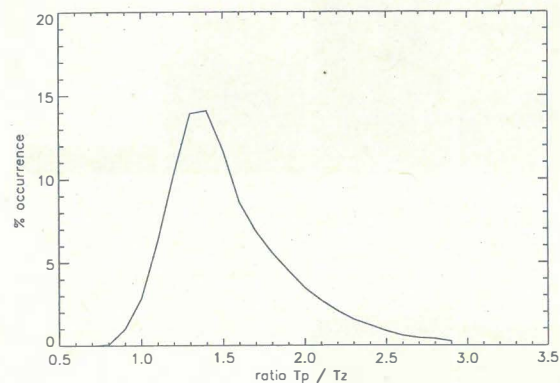
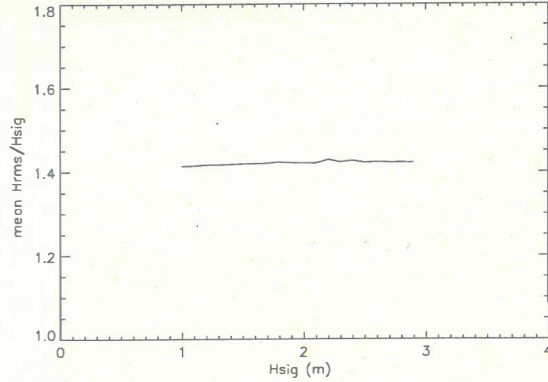
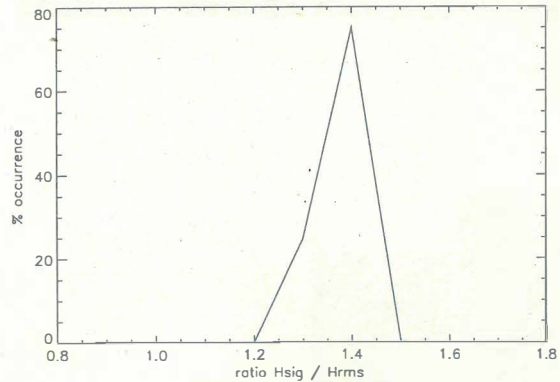
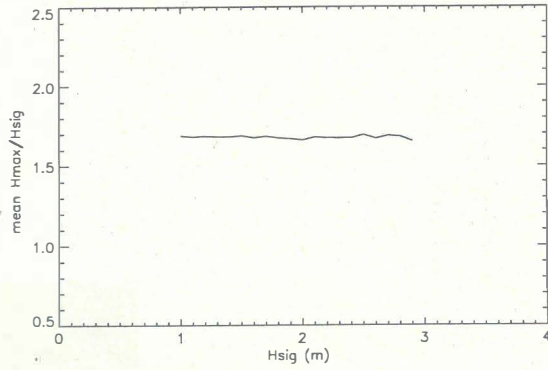
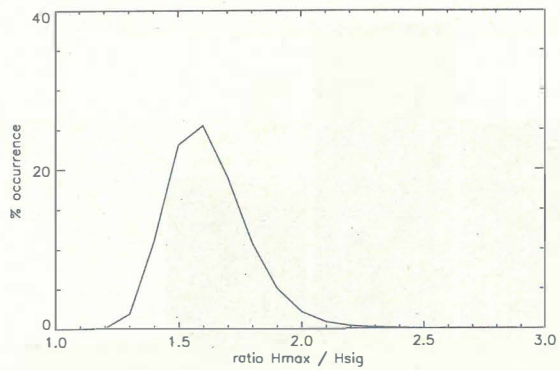


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Wave Data Recording Program
GOLD COAST

Figure 4



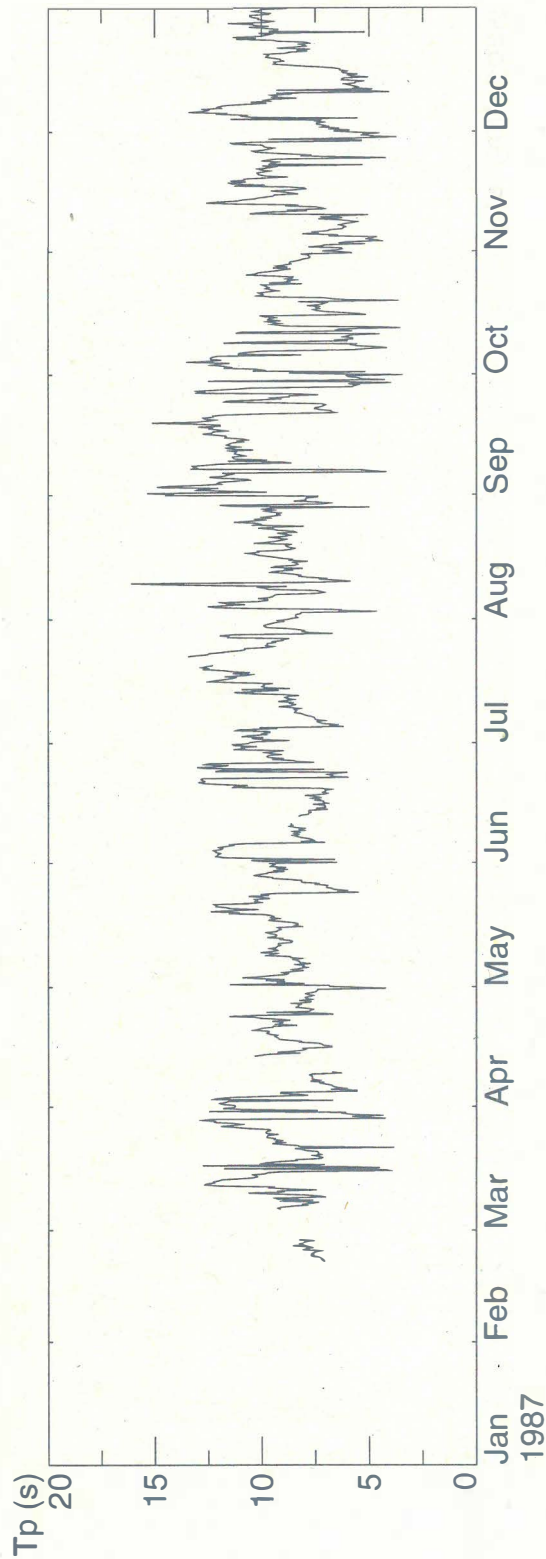
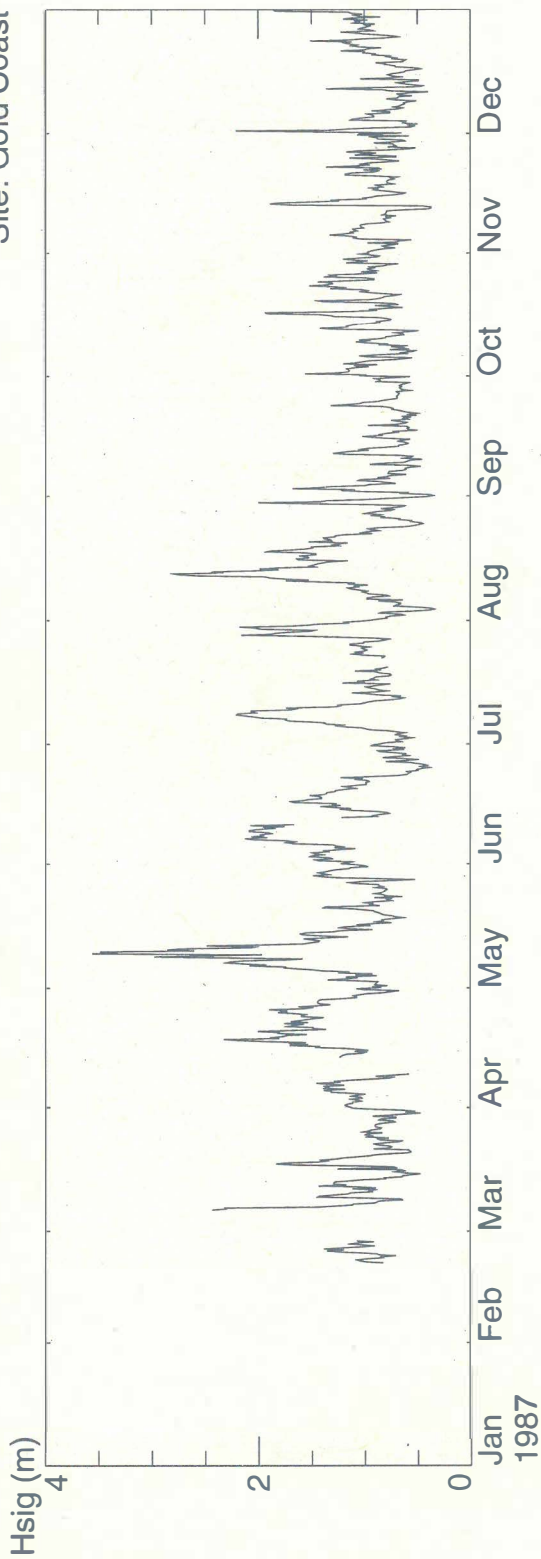
WAVE PARAMETER RELATIONSHIPS
20 February 1987 to 30 June 1994



Wave Data Recording Program
GOLD COAST

Figure 5

Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994

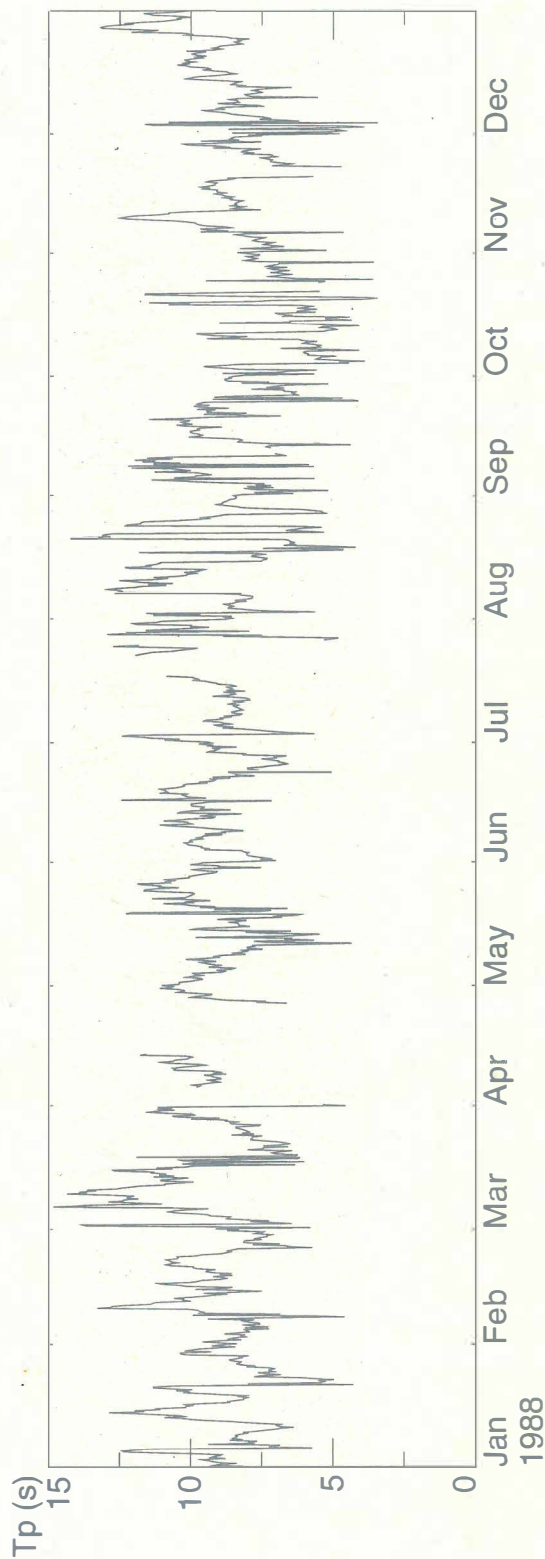
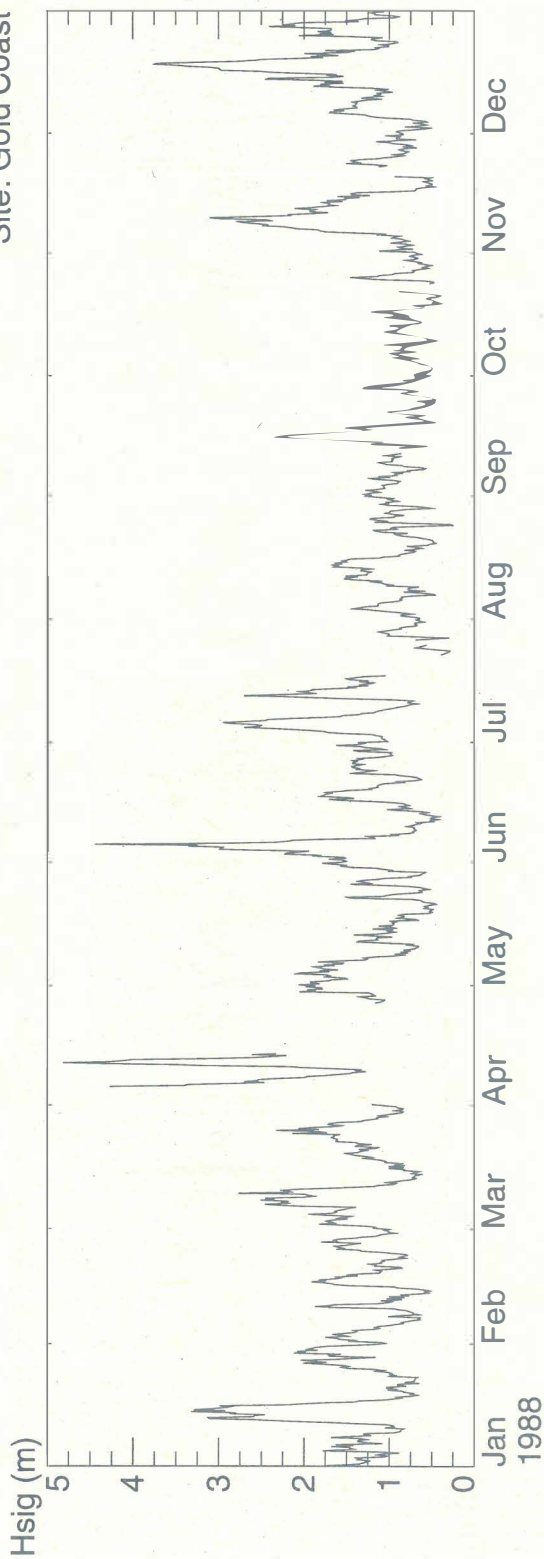


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Figure 6.1

Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994

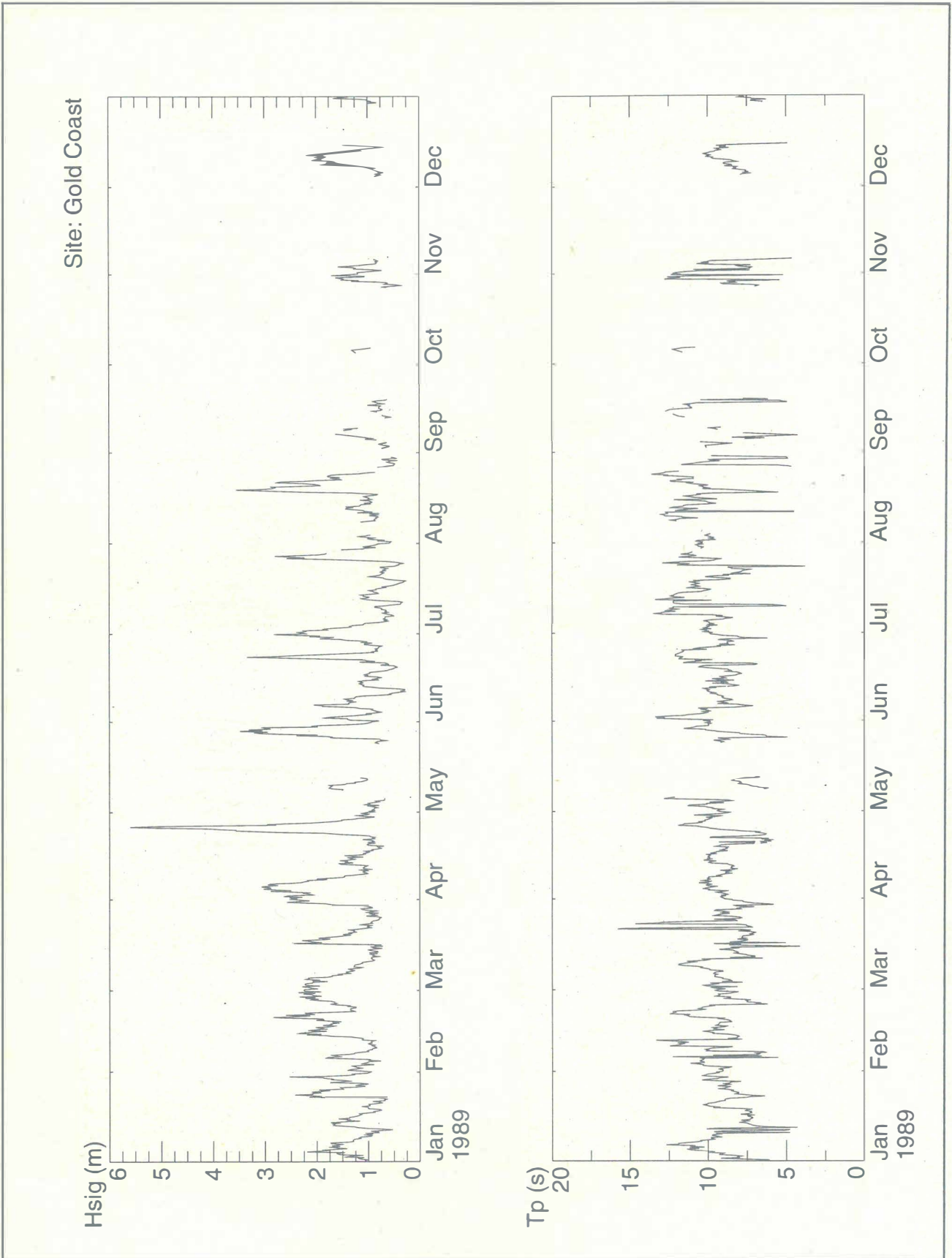


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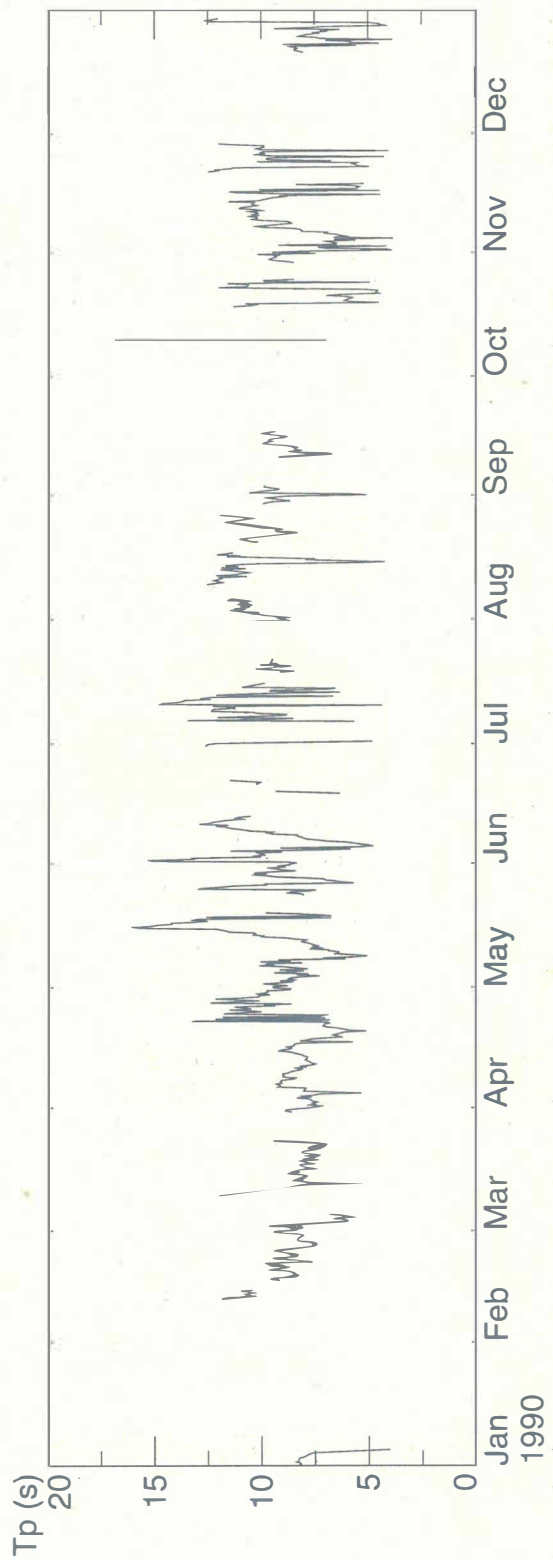
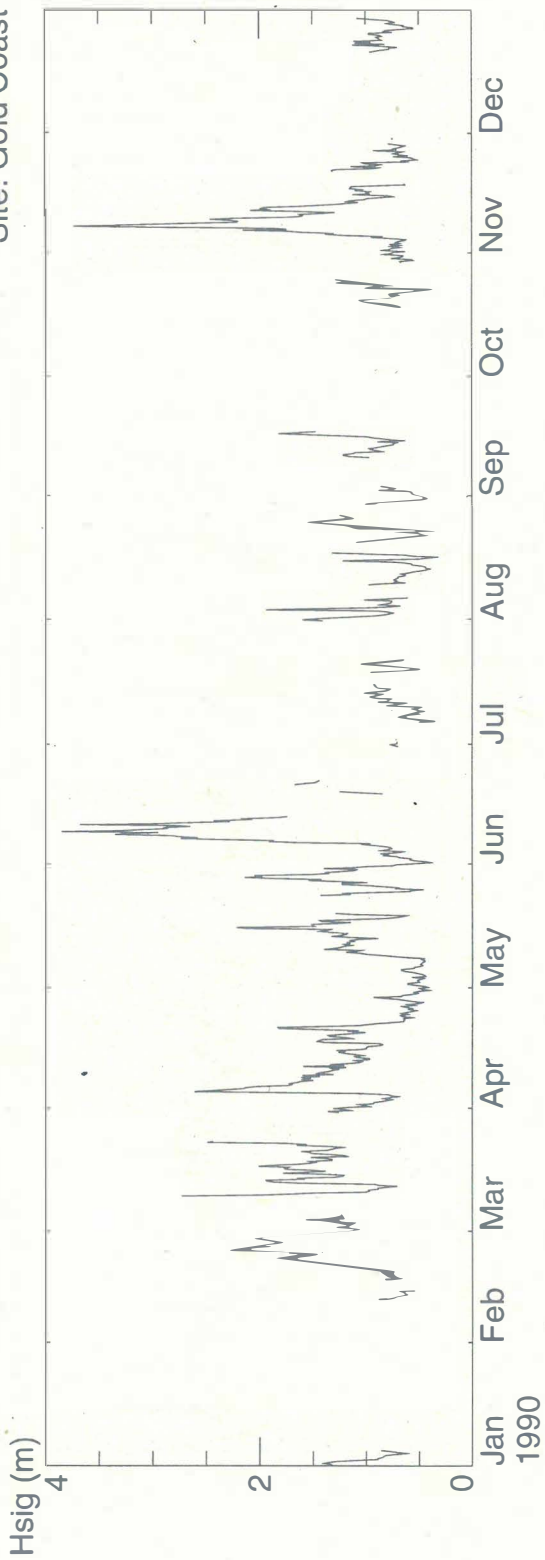
Figure 6.2



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994

 Beach Protection Authority Queensland <small>Queensland Department of Environment and Heritage</small>	Wave Data Recording Program GOLD COAST	Figure 6.3
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Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994



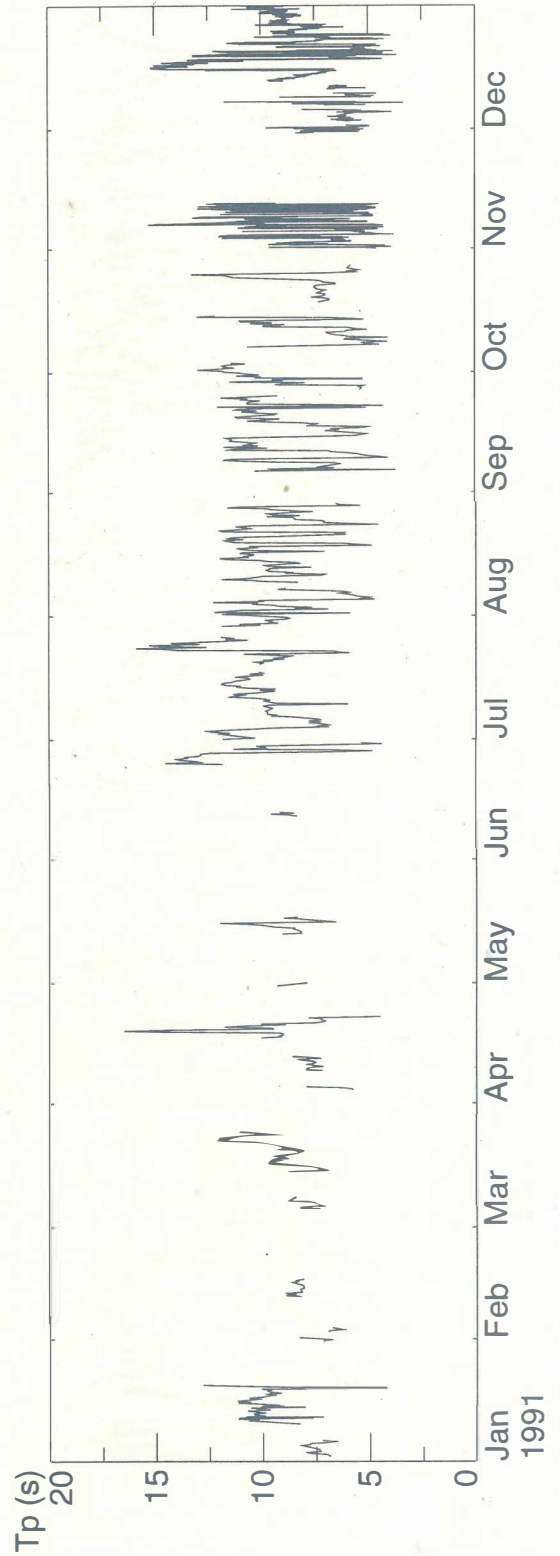
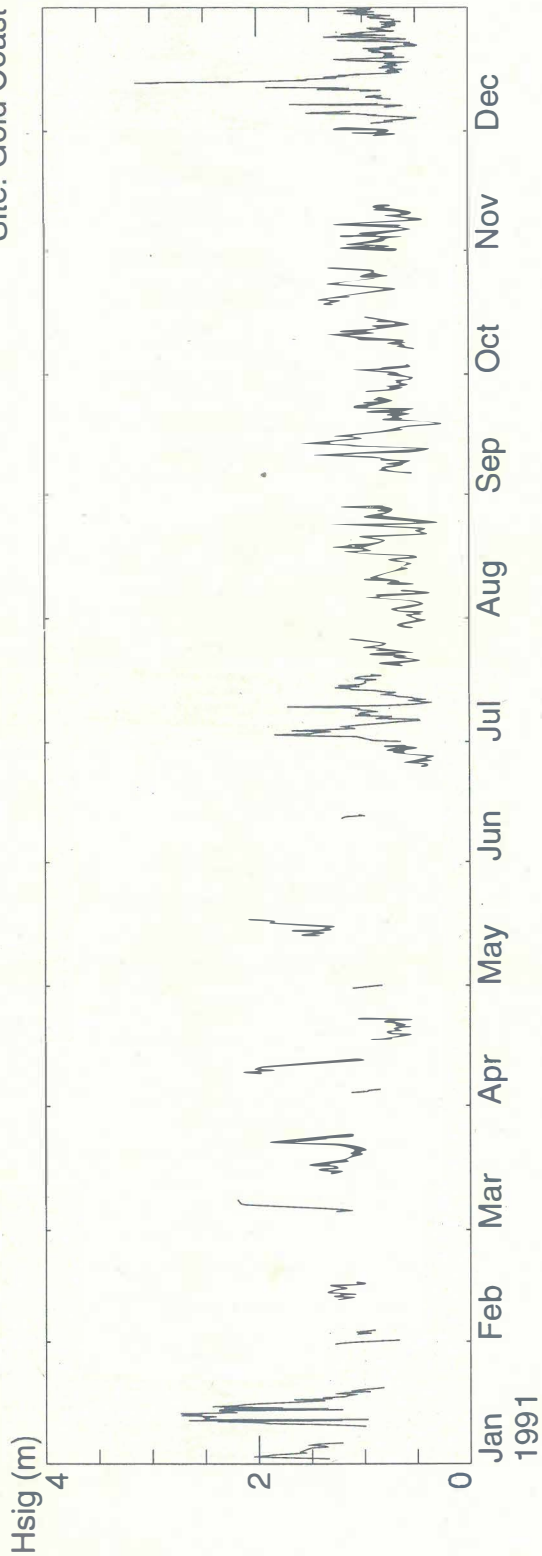
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Wave Data Recording Program
GOLD COAST

Figure 6.4

Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994

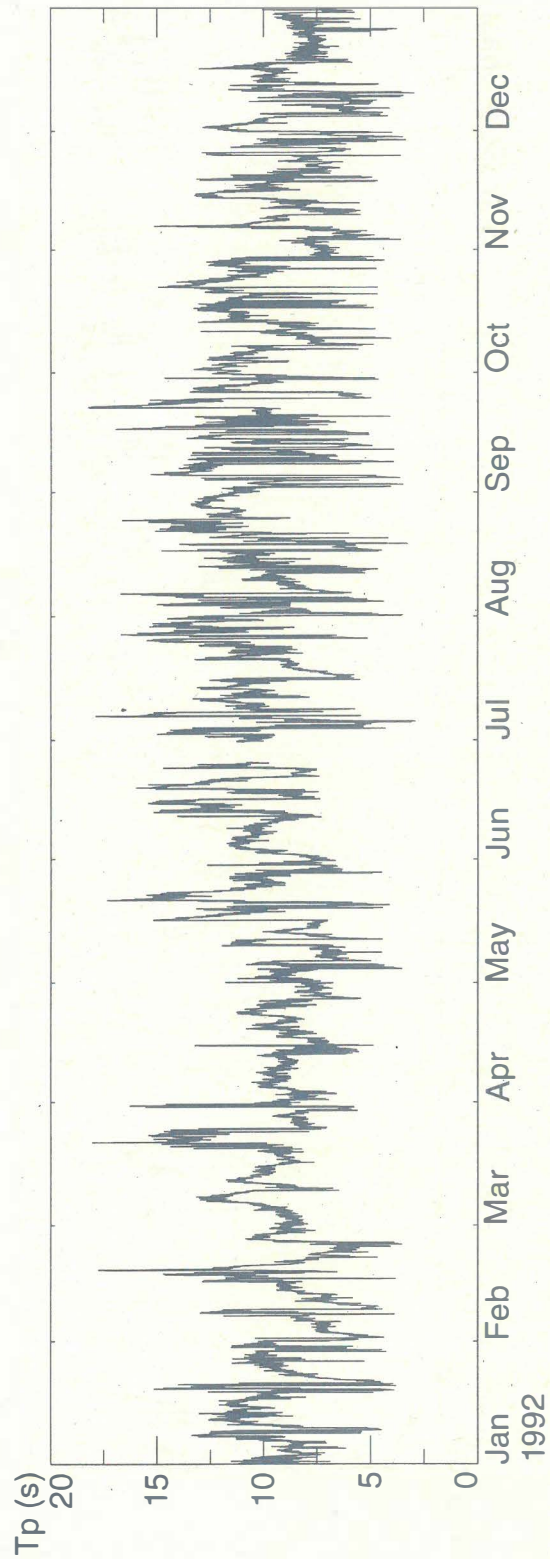
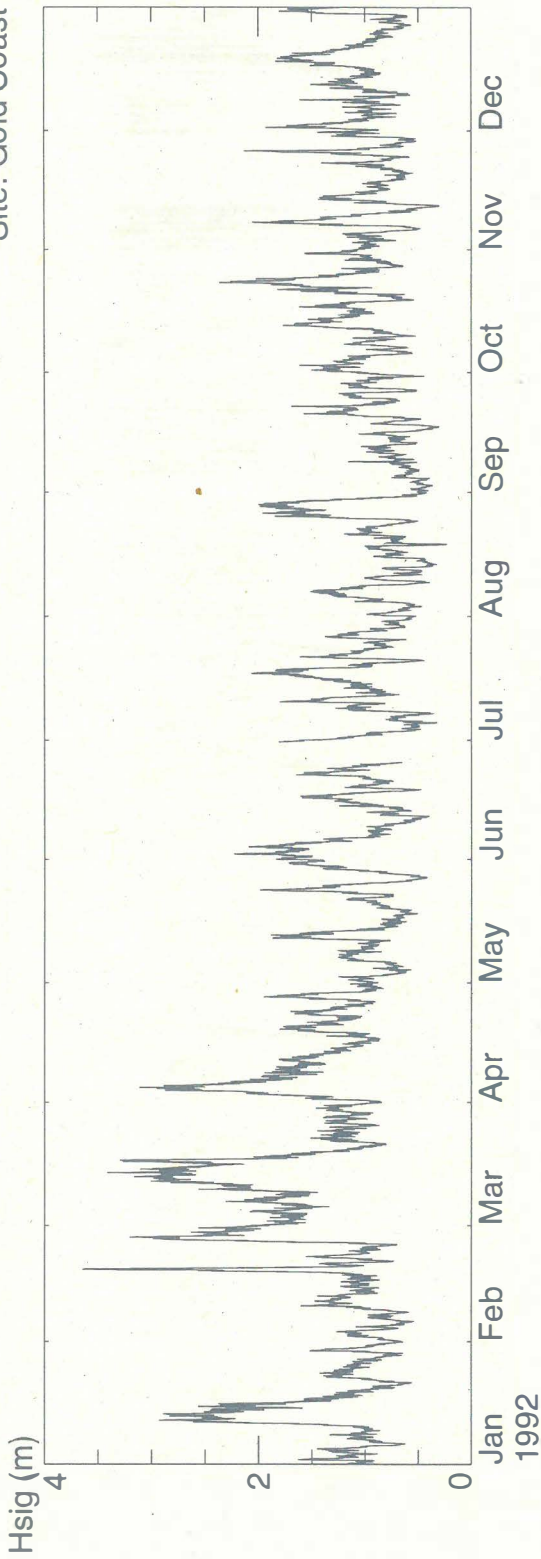


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Wave Data Recording Program
GOLD COAST

Figure 6.5

Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994



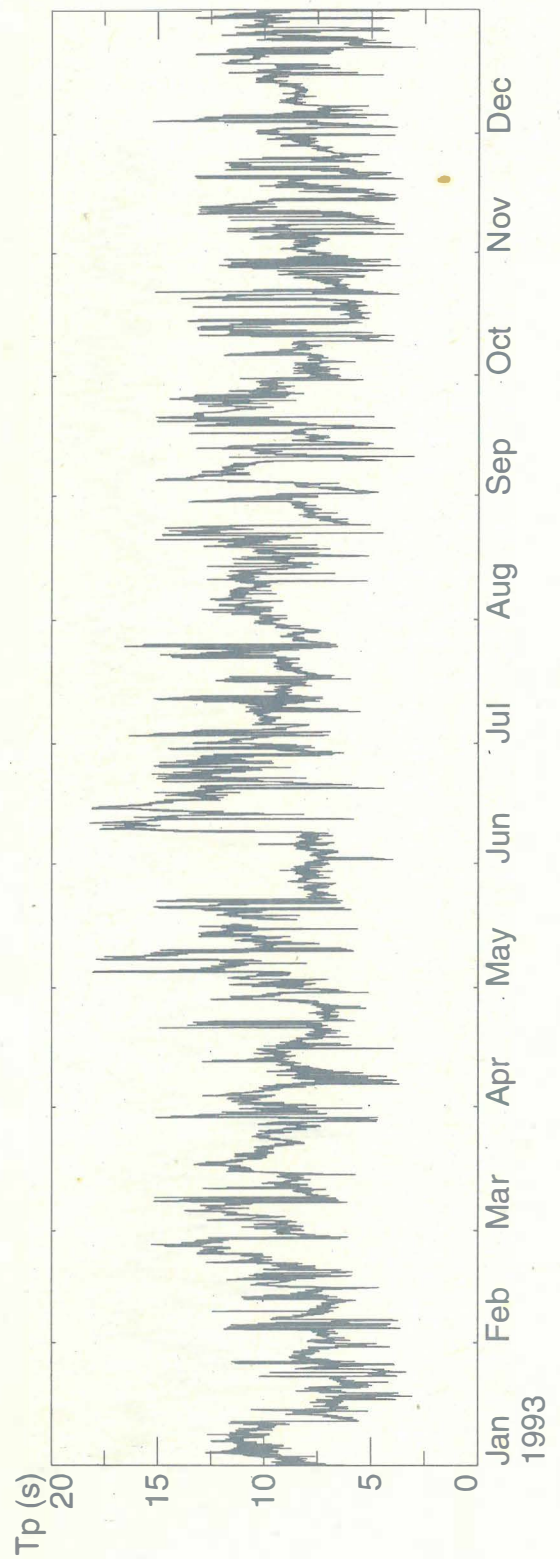
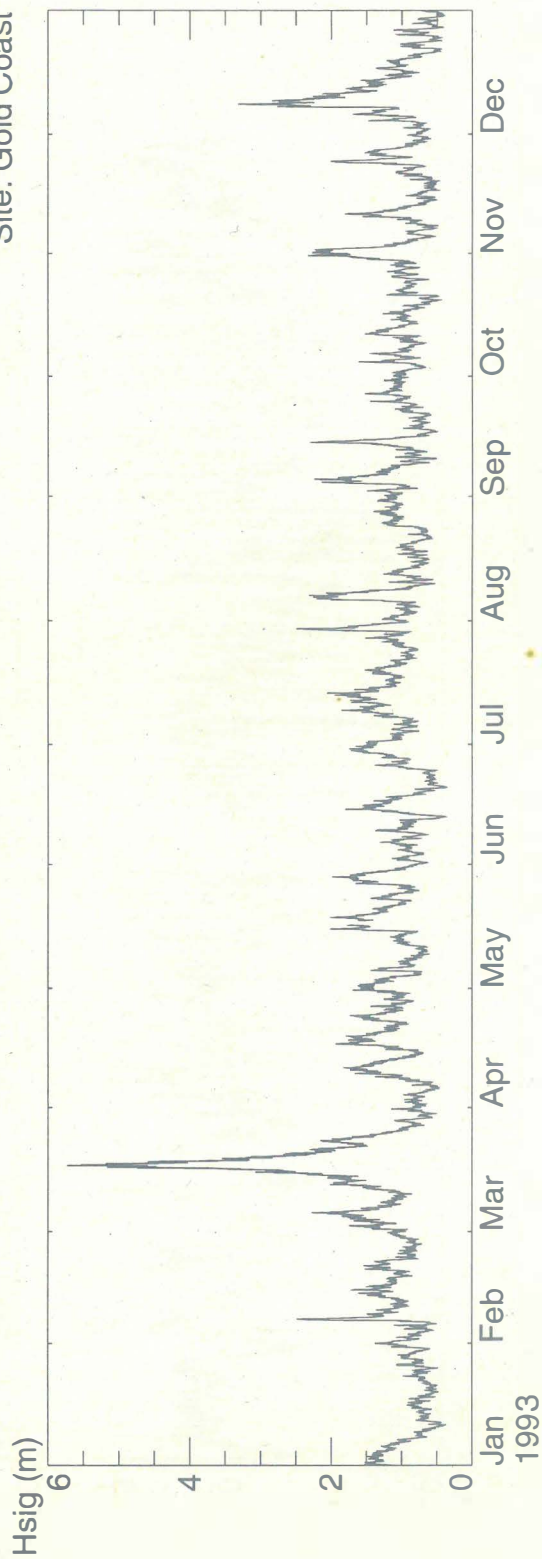
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Wave Data Recording Program
GOLD COAST

Figure 6.6

Site: Gold Coast



DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994

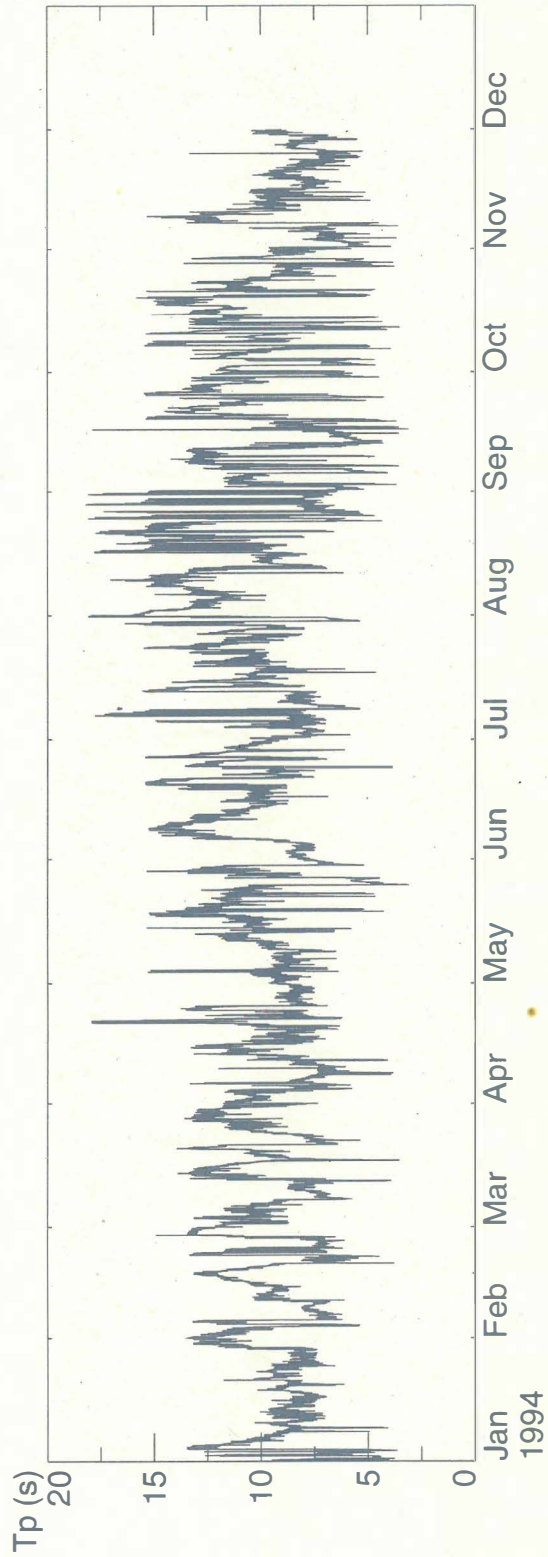
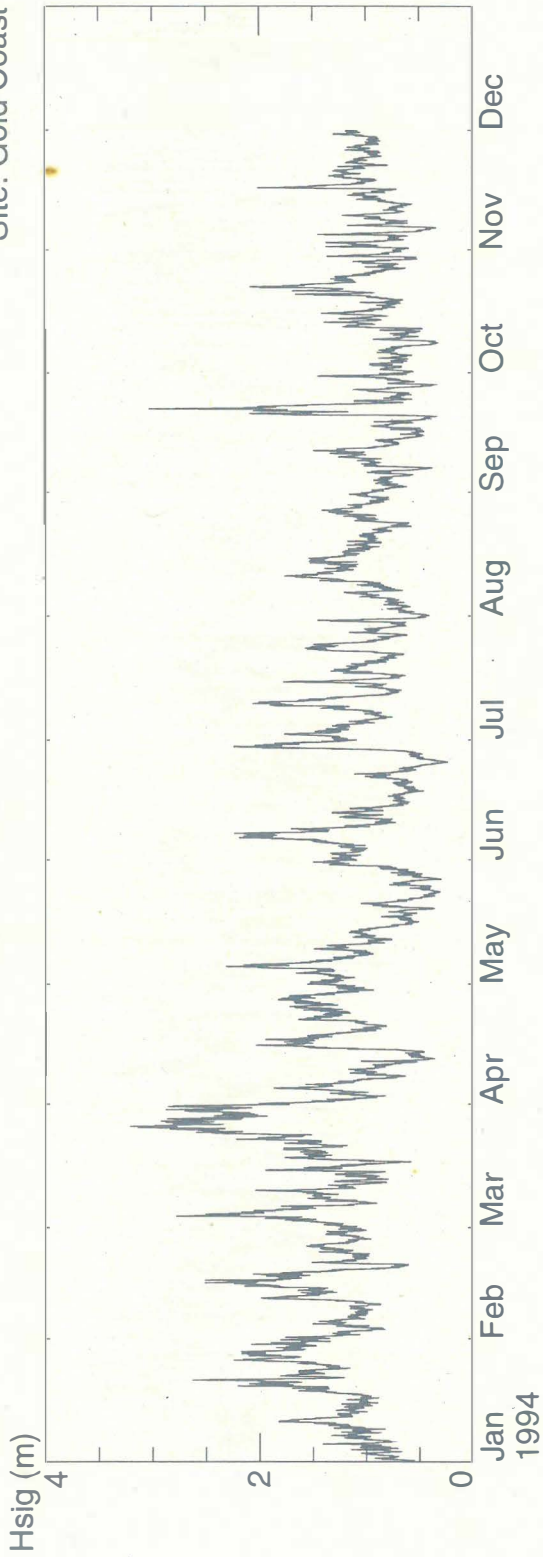


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Wave Data Recording Program
GOLD COAST

Figure 6.7

Site: Gold Coast



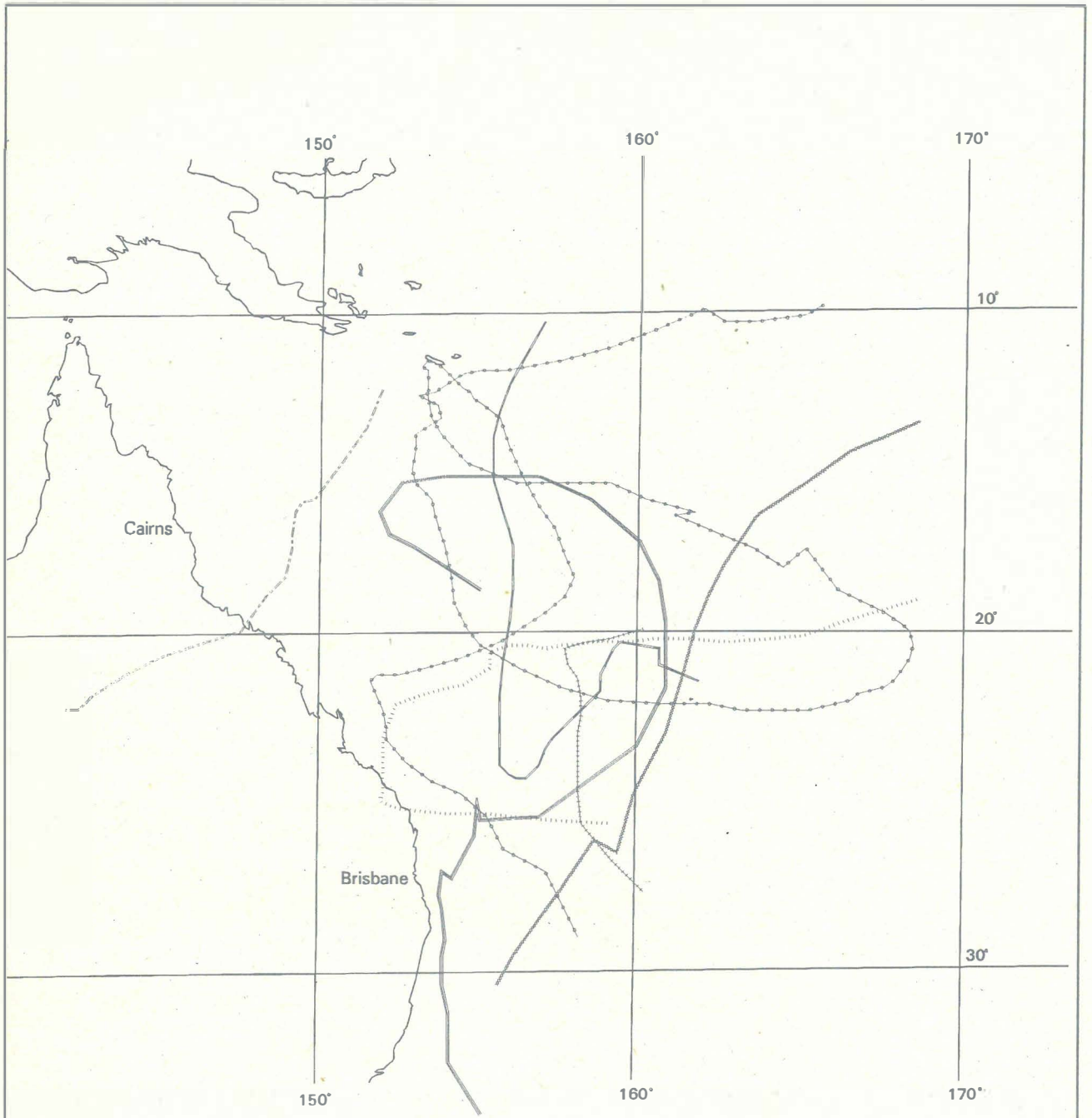
DAILY WAVE RECORDINGS
20 February 1987 to 30 June 1994



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Wave Data Recording Program
GOLD COAST

Figure 6.8



KEY TO CYCLONES

- | | | | |
|---|-------|---|-------|
|  | AIVU |  | ROGER |
|  | BETSY |  | REWA |
|  | DAMAN |  | NANCY |
|  | FRAN | | |



Cyclone Tracks



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Figure 7

