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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

For the measurement period, wave energy was high, dominated by three major storm events; 10-11 November, 15-16 November, 4-5 December. Directional estimates are unreliable due to movement of the EMCM although an attempt is made to recover this information, correlating mean directional estimates for wave periods of 9.1 seconds, 10.7 seconds and 12.8 seconds from the previous two data sets with hourly wind data, and applying

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SCIENCE APPLICATIONS, INC.

DRAFT

WAVE CLIMATE
GREEN HARBOR, MASSACHUSETTS

10 NOVEMBER 1983 - 14 DECEMBER 1983

CONTRIBUTION #40

March 21, 1984

DACW33-83-D-0004
Work Order 8, Task 1

DRAFT

Submitted to:

New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Submitted by:

S. Gegg
D.G. Aubrey
Woods Hole Oceanographic Institution
Woods Hole, MA 02543

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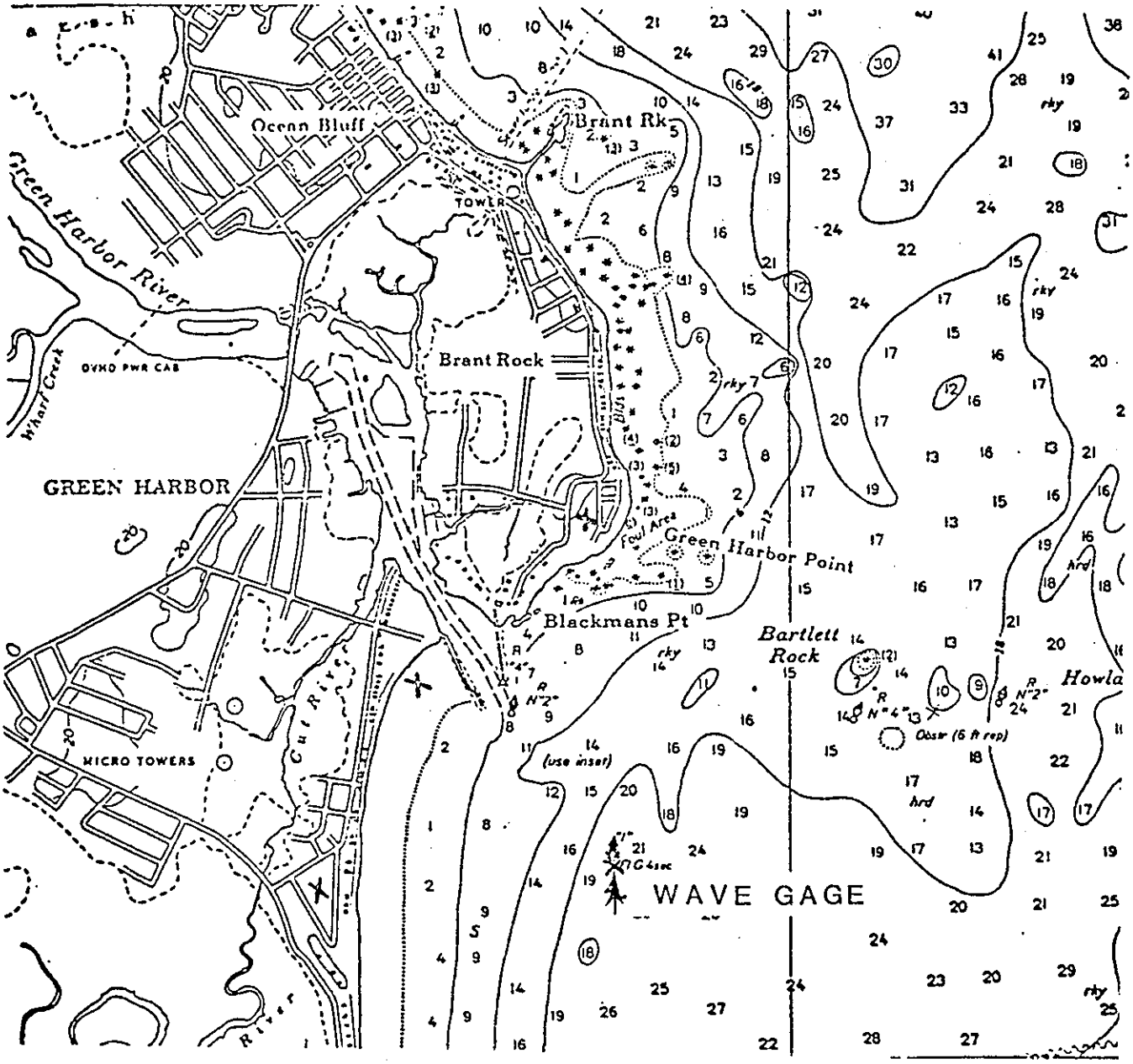
1.0 INTRODUCTION AND METHODS

The nearshore directional wave characteristics at Green Harbor, Massachusetts (Figure 1), were measured from 10 November 1983 through 14 December 1983, to monitor the coastal wave climate in Cape Cod Bay, Massachusetts. The instrument used for wave measurements was a Sea Data Corporation Directional Wave Gage Model 635-12. Its burst sampling capabilities permit measurement of waves as well as mean flows. More complete theory of operation and error analysis are contained in Aubrey (1981) and Grosskopf, Aubrey, Mattie and Mathieson (1983). For this time period, waves were sampled once every eight hours (three times a day) for seventeen minutes, acquiring a measurement of pressure and two horizontal velocity components once every half second for a total of 2048 samples per burst. Spectral estimates from these data were ensemble-averaged over 16 data subsets, yielding 32 degrees of freedom, with a frequency resolution of 0.0156 hz. Confidence intervals of 95% for these spectra with 32 degrees of freedom give an expected spectral estimate within 0.65 and 1.76 of the sample value (Table 1).

The instrument was deployed with the pressure sensor 0.17 m above the bottom, and the current meter 1.94 m above the bottom, above and slightly (<30 cm) to one side of the pressure sensor. The bottom within approximately 50 meters of the installation is flat, sandy, with medium sand grain size and widely scattered 1-2 ft. high boulders. Attempts to fluidize in a 1" I.D. pipe, and visual inspections, indicated that the sand cover is about 6"-12" deep and overlies a cobbly bottom.

The deployment was prematurely terminated on 14



X = Location of shore navigation stations.

Figure 1. Green Harbor Wave Gage Location Map.

TABLE 1

INSTRUMENT DEPLOYMENT SUMMARY

Instrument Type:	Sea Data Corporation Directional Wave Gage Model 635-12
	Green Harbor, MA (Vicinity of Buoy "1")
Deployment Date:	10 November 1983
Retrieval Date:	14 December 1983
Data Start Date:	10 November 1983
Data End Date:	14 December 1983
Burst Sample Interval:	8 hours
Burst Duration:	1024 seconds
Burst Sample Rate:	0.5 seconds
Continous Sample Rate:	7.5 minutes
Internal Averaging:	Yes
Data Quality:	Good*
Height of Pressure Sensor above Bottom:	0.17 m
Height of Current Meter above Bottom:	1.94 m

Orientation of Current Meter: 89.25^{O} TN**
(Positive X axis is towards direction from which + X flow is coming)

Daily Measurement Times:

01: 0746 E.D.T.
02: 1546 E.D.T.
03: 2346 E.D.T.

* Apart from the directional estimate problem due to EMCM movement, the overall data quality is good.

** Original Orientation

December when divers discovered that the EMCM attachment hardware had failed, allowing the EMCM to rotate around the tripod axis approximately 30° in the horizontal to either side of its original location. When the hardware failed is not known, but inconsistent directional estimates present for most of the period indicate failure occurred following the first storm on 10-11 November 1983. This movement was not a continuous "waving" effect, as some force was required to intitiate movement and push the EMCM past various snags (cable ties, etc.) in its path. It was more of an episodic and unpredictable shift which occurred through most of the deployment. The EMCM may have been stable in one position for a length of time as long as wave energies and directions did not change drastically.

An attempt to reconstruct directional information was made by analyzing and comparing wind velocity, wave periods, and wave directions for similar events during the first and second deployments, and applying these results to similar events during the third deployment. Corrected wave directional estimates derived from this method are included in the table and are marked accordingly. No attempt was made to correct mean flow directions.

This correction was obtained by correlating the mean directional estimates for waves with periods of 9.1 seconds, 10.6 seconds and 12.8 seconds in the previous data sets with hourly wind velocity data gathered at the Otis Air National Guard weather station, Otis AFB,Cape Cod, MA. Mean directional estimates for waves of these periods were 260°TN for 9.1 second waves (direction of propagation) with standard deviations of

35^{o}, 31^{o}, and 38^{o}, respectively. The wind data for these waves correlated as well, giving a general wind pattern coming out of E/NE. Subsequently, directional estimates for waves of the same periods and/or with similar wind conditions were examined in this third deployment, and it was possible in some cases that a correction within the standard deviation of 38^{o} could be made to bring the mean directions to approximately $260\text{-}265^{o}$TN.

As in the first two reports, non-directional wave parameters discussed here are calculated from pressure data and are completely reliable. While variances as calculated from velocity and the mean flow magnitudes are unaffected by the EMCM movement, no attempt is made to generalize from these data given the nature of the EMCM movement problem. Plots included as Appendix I are only of frequency versus spectral density (no directional plots are included).

2.0 RESULTS

Over the 35 day deployment, wave energy averaged 120 cm^2 in variance (Table 2). Variance (η^2) is defined by

$$E = \rho g \langle \eta^2 \rangle$$

where E is the total energy, ρ is density of water, and g is the gravitational acceleration. Variance therefore is a direct function of the wave energy. Besides wave variance, another useful parameter representing wave energy is the significant wave height, H 1/3, where:

$$H\ 1/3 \simeq 4 \langle \eta^2 \rangle$$

This wave height is close to the wave height one would estimate

TABLE 2 - LEGEND

Analysis of the 63 day wave/tide record, measured at Green Harbor, Massachusetts with a Sea Data 635-12 Values are recorded at 8 hour intervals for the following parameters:

$\bar{h}$	= mean water depth (m)
$E_T(<\eta^2>)$	= total energy varience in wave (cm^2) This parameter is proportional to the amount of energy in the wave. Comparison values calculated from pressure and velocity are presented. Velocity calculated values are in parentheses.
$H_{1/3}$	= significant wave height (m) This parameter is derived directly from E_T. Where: $H_{1/3} \approx 4\sqrt{<\eta^2>}$
Peak F	= peak wave frequency (sec^{-1})
Peak T	= peak wave period = $\frac{1}{\text{peak wave frequency}}$
α_o	= direction of wave propagation, measured in degrees clockwise from true north
$P(\alpha_o)$	= angular spread of direction of propagation of the wave field
E_P	= energy in peak frequency variance (cm^2)
$\bar{U},\bar{V}$	= components of current velocity (m/sec); U is positive to the north, V is positive to the east
W_S	= wind speed in knots "( )" indicates max gusts
W_D	= direction from which the wind is originating in degrees ("E"indicates estimated)
S.D.	= standard deviation of indicated quantity

* Indicates corrected directional estimate. Non * values are uncorrected directional estimates, and are not reliable due to probe rotation

** Initial probe rotation occurred prior to this run.

TABLE 2. WAVE CLIMATE - GREEN HARBOR, MASSACHUSETTS - SEA DATA 635-12 10 NOV - 14 DEC 1983

DATE	TIME	$\bar{h}$ (m)	E_T (cm^2)	$H_{1/3}$ (m)	Peak F (sec^{-1})	Peak T (sec)	α_o	$P(\alpha_o)$	E_P (cm^2)	$\bar{U}$ (m/sec)	$\bar{V}$ (m/sec)	W_s	W_D
10 NOV 83 -	1546	10.15	64. (65.)	0.32	0.2344	4.3	45.	30.	15.	0.01	-0.02	05	140
10 NOV 83 -	2346	8.49	1435.(1565.)	1.52	0.1563	6.4	332.*	26.	417.	0.04	0.14	17	150
11 NOV 83 -	746	8.58	475. (521.)	0.87	0.1094	9.1	266.*	23.	156.	0.02	-0.09	10	200
11 NOV 83 -	1546	10.15	548. (502.)	0.94	0.1094	9.1	4.**	33.	142.	0.02	0.02	11	170
11 NOV 83 -	2346	7.91	164. (177.)	0.51	0.1250	8.0	282.	25.	61.	-0.01	-0.04	15	240
12 NOV 83 -	746	8.85	93. (94.)	0.39	0.1094	9.1	74.	24.	34.	-0.01	-0.06	14	260
12 NOV 83 -	1546	9.64	38. (48.)	0.25	0.0938	10.7	352.	34.	13.	-0.04	0.01	16	310
12 NOV 83 -	2346	7.75	37. (42.)	0.24	0.1094	9.1	3.	27.	7.	-0.04	-0.03	12	320
13 NOV 83 -	746	9.28	38. (47.)	0.25	0.1719	5.8	39.	27.	4.	-0.03	-0.06	13	320
13 NOV 83 -	1546	9.35	116. (115.)	0.43	0.1875	5.3	51.	20.	27.	0.01	0.05	08	030
13 NOV 83 -	2346	8.01	38. (42.)	0.25	0.2031	4.9	43.	32.	7.	-0.01	-0.04	00	000
14 NOV 83 -	746	9.79	208. (215.)	0.58	0.2500	4.0	360.	29.	55.	0.00	-0.04	08	080
14 NOV 83 -	1546	9.06	235. (249.)	0.61	0.2031	4.9	35.	22.	41.	-0.02	0.05	17	060
14 NOV 83 -	2346	8.25	188. (199.)	0.55	0.1719	5.8	37.	23.	45.	-0.01	-0.03	12	070
15 NOV 83 -	746	10.09	151. (154.)	0.49	0.2344	4.3	54.	29.	28.	-0.01	0.01	10	090
15 NOV 83 -	1546	8.63	129. (136.)	0.45	0.1563	6.4	311.	20.	18.	-0.01	0.04	08	080
15 NOV 83 -	2346	8.58	617. (613.)	0.99	0.2188	4.6	300.*	22.	151.	0.07	-0.06	17	120
16 NOV 83 -	746	10.20	2534.(2503.)	2.01	0.1563	6.4	290.*	23.	509.	0.08	-0.13	20(28)	150
16 NOV 83 -	1546	8.18	844. (849.)	1.16	0.1094	9.1	243.*	21.	342.	0.00	-0.03	14(20)	220
16 NOV 83 -	2346	8.93	373. (386.)	0.77	0.0938	10.7	301.*	26.	130.	0.00	-0.07	08	240
17 NOV 83 -	746	10.01	277. (297.)	0.67	0.0938	10.7	281.*	29.	85.	-0.01	0.01	08	250
17 NOV 83 -	1546	7.66	135. (146.)	0.46	0.1094	9.1	260.*	27.	51.	-0.02	-0.02	10	270
17 NOV 83 -	2346	9.18	79. (85.)	0.36	0.0938	10.7	49.	22.	34.	-0.02	-0.04	22(30)	280
18 NOV 83 -	746	9.77	54. (58.)	0.30	0.0938	10.7	5.	29.	20.	0.00	-0.01	14(20)	300
18 NOV 83 -	1546	7.45	44. (47.)	0.26	0.0781	12.8	343.	30.	16.	-0.02	0.00	08	290
18 NOV 83 -	2346	9.45	28. (25.)	0.21	0.0938	10.7	9.	30.	12.	0.01	-0.07	10	300
19 NOV 83 -	746	9.45	15. (18.)	0.15	0.0938	10.7	307.	33.	4.	-0.02	0.02	04	300
19 NOV 83 -	1546	7.42	12. (13.)	0.14	0.0781	12.8	330.	35.	3.	0.00	-0.04	00	000
19 NOV 83 -	2346	9.92	15. (17.)	0.16	0.0781	12.8	267.	49.	6.	-0.01	-0.03	00	000

TABLE 2. WAVE CLIMATE - GREEN HARBOR, MASSACHUSETTS - SEA DATA 635-12 10 NOV - 14 DEC 1983

DATE	TIME	$\bar{h}$ (m)	E_T (cm^2)	$H_{1/3}$ (m)	Peak F (sec^{-1})	Peak T (sec)	α_o	$P(\alpha_o)$	E_P (cm^2)	$\bar{U}$ (m/sec)	$\bar{V}$ (m/sec)	W_s	W_D
20 NOV 83 -	746	9.26	11. (14.)	0.13	0.0781	12.8	324.	30.	4.	-0.03	0.03	00	000
20 NOV 83 -	1546	7.67	15. (18.)	0.16	0.0781	12.8	26.	27.	6.	0.03	-0.06	08	170 E
20 NOV 83 -	2346	10.24	106. (116.)	0.41	0.2500	4.0	172.	28.	46.	-0.01	-0.08	10	160 E
21 NOV 83 -	746	8.82	127. (137.)	0.45	0.2188	4.6	187.	27.	31.	0.00	-0.01	06	150 E
21 NOV 83 -	1546	8.09	34. (32.)	0.23	0.1250	8.0	286.	23.	8.	0.00	-0.09	12	290
21 NOV 83 -	2346	10.15	57. (59.)	0.30	0.1406	7.1	61.	26.	12.	-0.03	-0.02	13	250
22 NOV 83 -	746	8.27	28. (30.)	0.21	0.1406	7.1	24.	24.	7.	-0.02	0.02	12	260
22 NOV 83 -	1546	8.61	26. (26.)	0.20	0.1094	9.1	6.	26.	7.	0.02	-0.08	13	310
22 NOV 83 -	2346	10.17	24. (31.)	0.20	0.1406	7.1	40.	36.	5.	-0.04	0.04	00	000
23 NOV 83 -	746	7.96	64. (70.)	0.32	0.2031	4.9	26.	26.	12.	-0.03	0.01	07	320
23 NOV 83 -	1546	9.27	132. (143.)	0.46	0.1719	5.8	24.	28.	26.	-0.01	-0.08	08	040
23 NOV 83 -	2346	9.79	75. (78.)	0.35	0.2344	4.3	37.	41.	10.	-0.03	0.07	00	000
24 NOV 83 -	746	7.76	83. (90.)	0.36	0.1250	8.0	331.	24.	27.	0.00	-0.02	08	170
24 NOV 83 -	1546	9.92	184. (184.)	0.54	0.2500	4.0	154.	23.	60.	0.03	-0.12	12	170
24 NOV 83 -	2346	9.10	80. (88.)	0.36	0.2500	4.0	113.	29.	16.	-0.02	-0.02	18	210
25 NOV 83 -	746	7.75	143. (131.)	0.48	0.2500	4.0	121.	31.	36.	0.02	-0.15	12	170
25 NOV 83 -	1546	10.30	74. (83.)	0.34	0.2188	4.6	6.	30.	12.	-0.04	-0.06	26(40)	280
25 NOV 83 -	2346	7.86	42. (48.)	0.26	0.0938	10.7	331.	31.	10.	-0.02	-0.02	18(28)	270
26 NOV 83 -	746	7.87	16. (18.)	0.16	0.0781	12.8	305.	33.	5.	0.00	-0.06	18	260
26 NOV 83 -	1546	9.99	16. (22.)	0.16	0.0781	12.8	341.	52.	6.	-0.03	-0.03	17(24)	270
26 NOV 83 -	2346	7.67	8. (9.)	0.12	0.0781	12.8	340.	36.	3.	0.00	0.00	10	280
27 NOV 83 -	746	8.52	9. (10.)	0.12	0.0781	12.8	38.	35.	2.	0.01	-0.07	10	290
27 NOV 83 -	1546	10.04	11. (13.)	0.13	0.2344	4.3	28.	47.	3.	-0.03	0.00	08	300
27 NOV 83 -	2346	7.69	17. (19.)	0.17	0.2188	4.6	25.	27.	3.	-0.03	0.01	06	320

DATE	TIME	$\bar{h}$ (m)	E_T (cm^2)	$H_{1/3}$ (m)	Peak F (sec^{-1})	Peak T (sec)	α_o	$P(\alpha_o)$	E_P (cm^2)	$\bar{U}$ (m/sec)	$\bar{V}$ (m/sec)	W_S	W_D
28 NOV 83 -	746	9.53	84. (83.)	0.37	0.2344	4.3	32.	31.	18.	0.02	-0.01	00	000
28 NOV 83 -	1546	9.83	89. (85.)	0.38	0.1875	5.3	44.	27.	18.	0.03	0.02	04	110
28 NOV 83 -	2346	7.52	269. (239.)	0.66	0.2344	4.3	285.*	33.	83.	0.04	-0.06	10(20)	150
29 NOV 83 -	746	10.16	403. (351.)	0.80	0.2188	4.6	285.*	35.	101.	0.05	-0.10	05	160
29 NOV 83 -	1546	8.93	121. (128.)	0.44	0.1250	8.0	308.	20.	37.	-0.04	0.00	10	270
29 NOV 83 -	2346	7.67	54. (51.)	0.29	0.1250	8.0	344.	21.	18.	0.00	-0.05	10	270
30 NOV 83 -	746	10.25	24. (25.)	0.20	0.1094	9.1	325.	36.	5.	-0.02	-0.04	08	250
30 NOV 83 -	1546	7.88	11. (12.)	0.13	0.1094	9.1	299.	23.	3.	-0.02	0.00	16	240
30 NOV 83 -	2346	8.31	9. (9.)	0.12	0.0938	10.7	29.	32.	2.	0.01	-0.06	12	280
1 DEC 83 -	746	10.38	7. (8.)	0.10	0.0781	12.8	1.	48.	1.	0.00	-0.02	12	280
1 DEC 83 -	1546	7.53	5. (6.)	0.09	0.1094	9.1	290.	32.	1.	-0.04	0.01	06	320
1 DEC 83 -	2346	9.09	6. (7.)	0.10	0.0625	16.0	355.	42.	1.	0.01	-0.05	04	280
2 DEC 83 -	746	10.30	8. (8.)	0.11	0.0625	16.0	351.	58.	1.	-0.01	0.06	06	290
2 DEC 83 -	1546	7.16	6. (5.)	0.09	0.0781	12.8	2.	35.	2.	-0.01	-0.01	10	270
2 DEC 83 -	2346	9.59	5. (6.)	0.09	0.0781	12.8	339.	55.	3.	-0.01	-0.02	06	260
3 DEC 83 -	746	9.62	4. (4.)	0.08	0.0781	12.8	5.	54.	2.	0.00	0.00	09	280
3 DEC 83 -	1546	7.19	9. (9.)	0.12	0.0781	12.8	346.	37.	1.	-0.02	-0.03	02	360
3 DEC 83 -	2346	10.10	36. (34.)	0.24	0.2344	4.3	19.	27.	10.	0.00	-0.03	00	000
4 DEC 83 -	746	9.22	138. (127.)	0.47	0.2500	4.0	260.*	41.	43.	-0.02	0.07	08	090
4 DEC 83 -	1546	7.86	1191. (781.)	1.38	0.1875	5.3	265.*	38.	267.	0.04	-0.03	20(27)	090 E
4 DEC 83 -	2346	10.53	2640.(2098.)	2.06	0.1094	9.1	267.*	33.	456.	0.00	0.06	18(26)	040 E
5 DEC 83 -	746	8.83	1765.(1460.)	1.68	0.0938	10.7	258.*	25.	692.	0.00	0.05	12	040
5 DEC 83 -	1546	8.26	1975.(1527.)	1.78	0.0938	10.7	259.*	31.	706.	-0.02	-0.02	10	340
5 DEC 83 -	2346	10.31	894. (707.)	1.20	0.0938	10.7	276.*	31.	325.	0.01	-0.01	06	310
6 DEC 83 -	746	8.22	393. (313.)	0.79	0.0938	10.7	279.*	26.	100.	0.01	0.03	00	000
6 DEC 803 -	1546	8.76	483. (323.)	0.88	0.2500	4.0	269.*	46.	105.	-0.01	-0.14	10	140 E
6 DEC 83 -	2346	9.93	775. (569.)	1.11	0.1719	5.8	268.*	34.	125.	-0.04	-0.10	16(24)	210 E

DATE TIME	$\bar{h}$ (m)	E_T (cm^2)	$H_{1/3}$ (m)	Peak F (sec^{-1})	Peak T (sec)	α_o	$P(\alpha_o)$	E_P (cm^2)	$\bar{U}$ (m/sec)	$\bar{V}$ (m/sec)	W_s	W_D
7 DEC 83 - 746	7.54	64. (58.)	0.32	0.1094	9.1	275.*	29.	22.	-0.04	-0.03	36(46)	250
7 DEC 83 - 1546	8.89	17. (17.)	0.16	0.0781	12.8	267.*	36.	5.	-0.04	-0.05	26(40)	260
7 DEC 83 - 2346	9.00	259. (18.)	0.18	0.0781	12.8	259.*	41.	6.	-0.04	0.00	22(32)	270
8 DEC 83 - 746	7.51	11. (10.)	0.13	0.0781	12.8	272.*	29.	4.	-0.01	-0.02	12(20)	280
8 DEC 83 - 1546	9.47	12. (12.)	0.14	0.0781	12.8	247.*	41.	5.	0.00	-0.08	14	290
8 DEC 83 - 2346	8.72	10. (11.)	0.13	0.0938	10.7	271.*	34.	3.	0.01	0.03	00	000
9 DEC 83 - 746	7.79	7. (8.)	0.11	0.0938	10.7	259.*	28.	2.	-0.03	-0.04	00	000
9 DEC 83 - 1546	9.97	7. (8.)	0.10	0.0781	12.8	235.*	48.	2.	-0.01	-0.02	06	240
9 DEC 83 - 2346	8.60	7. (6.)	0.10	0.0781	12.8	269.*	41.	2.	-0.01	-0.01	00	000
10 DEC 83 - 746	8.12	8. (8.)	0.11	0.0781	12.8	264.*	32.	2.	0.00	-0.04	04	240
10 DEC 83 - 1546	10.02	12. (13.)	0.14	0.0938	10.7	249.*	51.	3.	-0.03	-0.04	07	240
10 DEC 83 - 2346	8.24	11. (9.)	0.13	0.0938	10.7	263.*	30.	5.	-0.01	0.01	00	000
11 DEC 83 - 746	8.69	419. (368.)	0.82	0.1406	7.1	254.*	26.	98.	0.03	0.04	10	040
11 DEC 83 - 1546	10.03	345. (329.)	0.74	0.1563	6.4	250.*	22.	82.	0.01	0.02	10	070
11 DEC 83 - 2346	8.00	154. (134.)	0.50	0.1719	5.8	257.*	26.	23.	0.02	0.03	09	090
12 DEC 83 - 746	9.19	724. (467.)	1.08	0.2188	4.6	280.*	47.	211.	0.01	-0.03	12	130 E
12 DEC 83 - 1546	9.88	777. (519.)	1.11	0.2031	4.9	247.*	38.	143.	0.01	-0.06	19	120 E
12 DEC 83 - 2346	7.98	585. (392.)	0.97	0.1094	9.1	278.*	33.	166.	0.00	-0.06	14(20)	150 E
13 DEC 83 - 746	9.38	501. (352.)	0.90	0.1094	9.1	274.*	33.	155.	-0.03	-0.08	10	140 E
13 DEC 83 - 1546	9.23	201. (173.)	0.57	0.1250	8.0	32.	24.	46.	0.00	0.01	14	120 E
13 DEC 83 - 2346	7.92	126. (104.)	0.45	0.1250	8.0	35.	34.	24.	0.00	0.00	10	140 E
14 DEC 83 - 746	9.78	293. (234.)	0.68	0.0938	10.7	34.	32.	90.	-0.01	-0.01	10	190
MEAN	8.92	258. 225.	0.47		8.64							
S.D.	0.95	484. 419.	0.43		3.29							

* - Corrected Directional Estimate

visually from a random wave field.

For the period of measurement, the mean significant wave height was 0.47 m. The mean peak wave period was just over 8.5 seconds. Because the analysis was cut-off at 4.0 seconds due to depth limitations, periods less than this are not reported.

This data set is the most energetic to date with three major events and two or three minor ones recorded.

The three major events occurred on 10-11 November, 15-16 November, and 4-5 December; the latter two producing peak significant wave heights exceeding 2.0m and peak total variances exceeding 2500 cm^2 for the first time since the measurement period began in June. These data are plotted and included as Appendix I.

In conclusion, average wave energy was high, dominated by three major storm events. Directional estimates are unreliable due to movement of the EMCM although an attempt is made to recover this information, correlating mean directional estimates for wave periods of 9.1 seconds, 10.7 seconds and 12.8 seconds from the previous two data sets with hourly wind data, and applying a correction based on this correlation to data fitting the same criteria in this third data set.

Following the mounting hardware failure in December, 1983, the EMCM probe failed when exposed to cold ($<35^{o}$) water. Since the failure was intermittent, isolation of the problem took considerable effort on the part of WHOI, Sea Data, and Marsh-McBirney. Subsequently, the probe has been replaced, although the wave gage was not re-deployed until 23 February 1984 due to funding limitations.

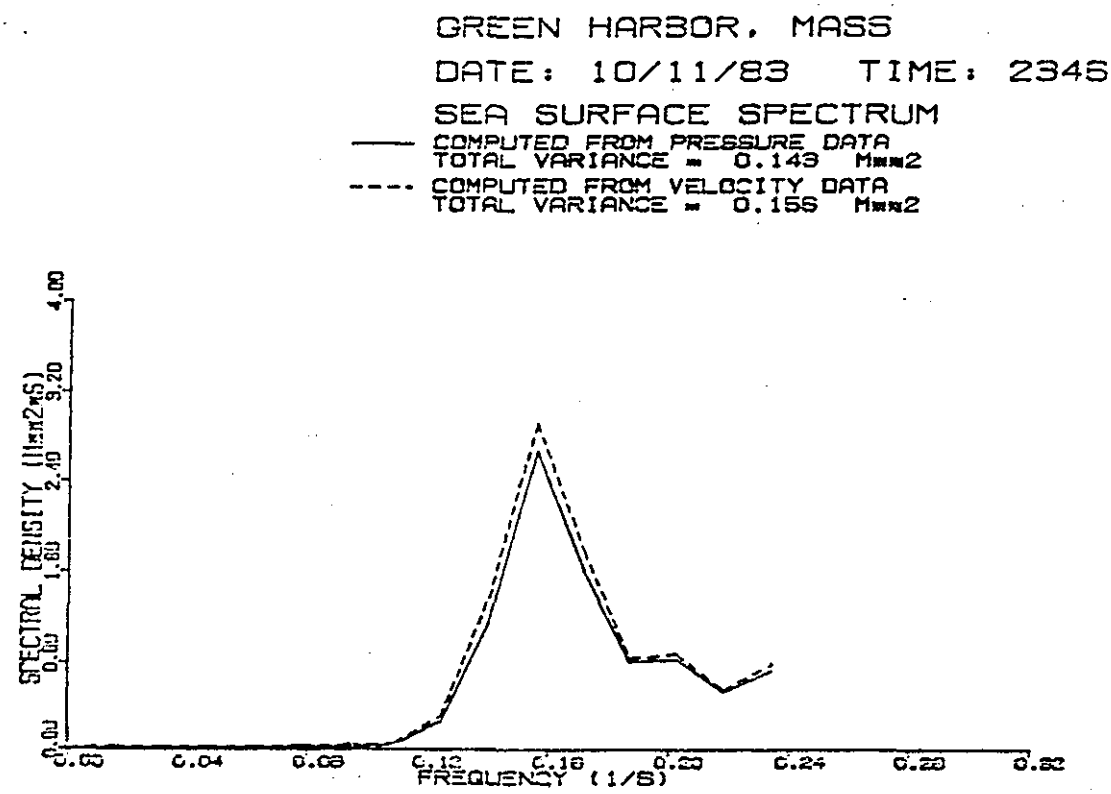
Literature Cited

Aubrey, D.G. 1981. Field Evaluation of Sea Data directional wave gage (Model 635-9). WHOI Technical Report 81-28, 52 pp.

Grosskopf, W.G.,D.G. Aubrey, M.G. Mattie and M. Mathiesen, 1983. Field intercomparison of nearshore directional wave sensors, IEEE Journal of Oceanographic Engineering.

APPENDIX I

Sea Surface Spectrum Variance Plots


GREEN HARBOR, MASS
DATE: 10/11/83 TIME: 2345
SEA SURFACE SPECTRUM
COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.143 M**2
COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.155 M**2
SPECTRAL DENSITY (M**2/S)
FREQUENCY (1/S)
DATE: 11/11/83 TIME: 745
SEA SURFACE SPECTRUM
COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.048 M**2
COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.052 M**2
SPECTRAL DENSITY (M**2/S)
FREQUENCY (1/S)

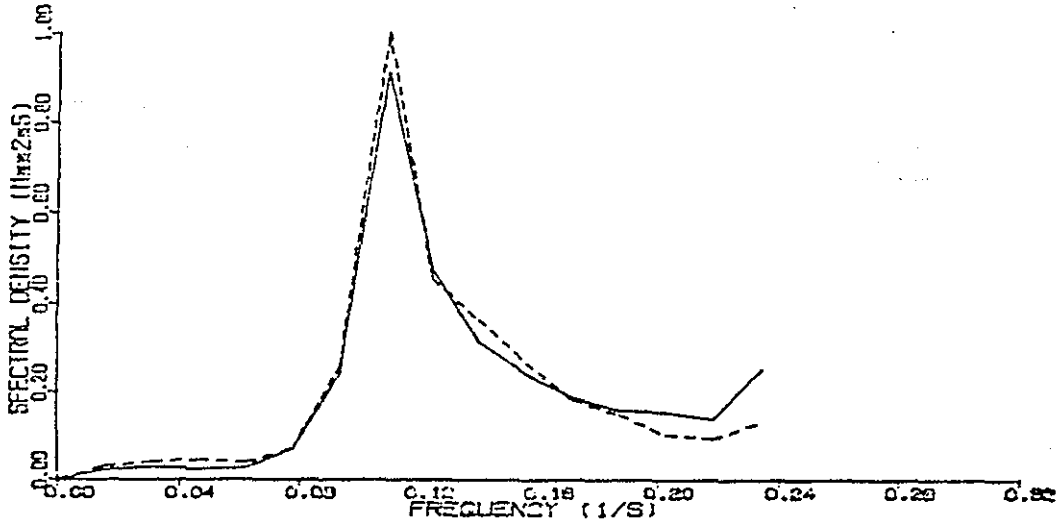
GREEN HARBOR, MASS

DATE: 11/11/83 TIME: 1546

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.055 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.050 M**2

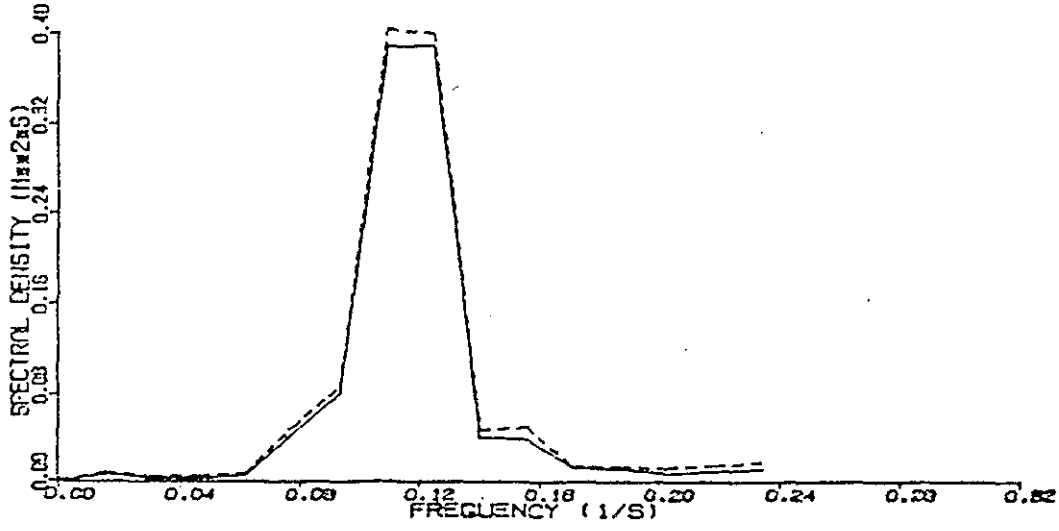


DATE: 11/11/83 TIME: 2346

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.016 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.018 M**2



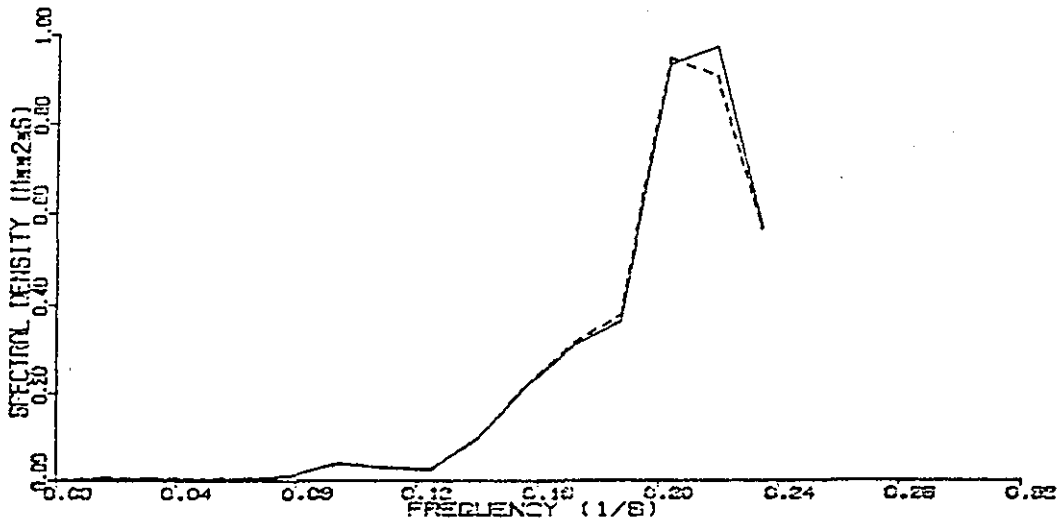
GREEN HARBOR, MASS

DATE: 15/11/83 TIME: 2346

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.052 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.051 M**2

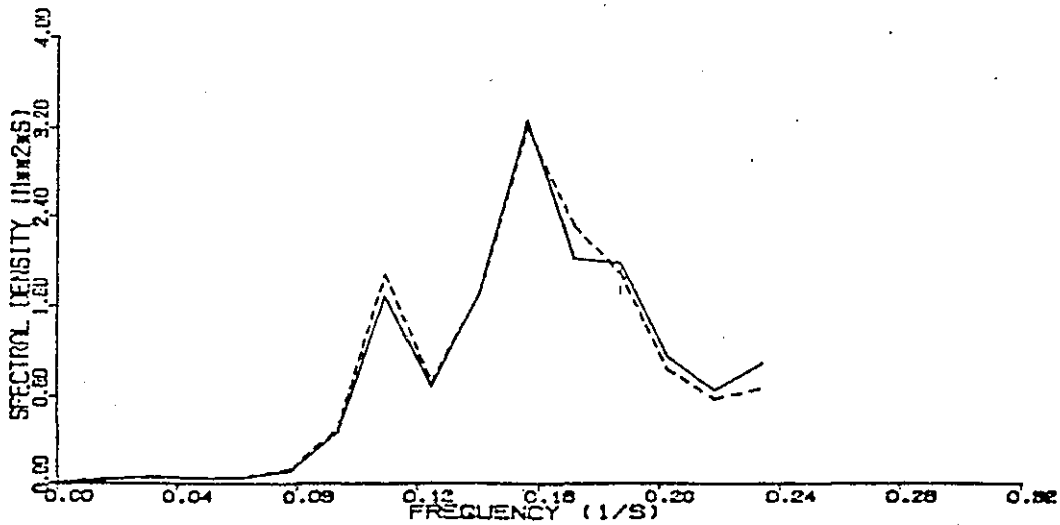


DATE: 16/11/83 TIME: 746

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.259 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.250 M**2



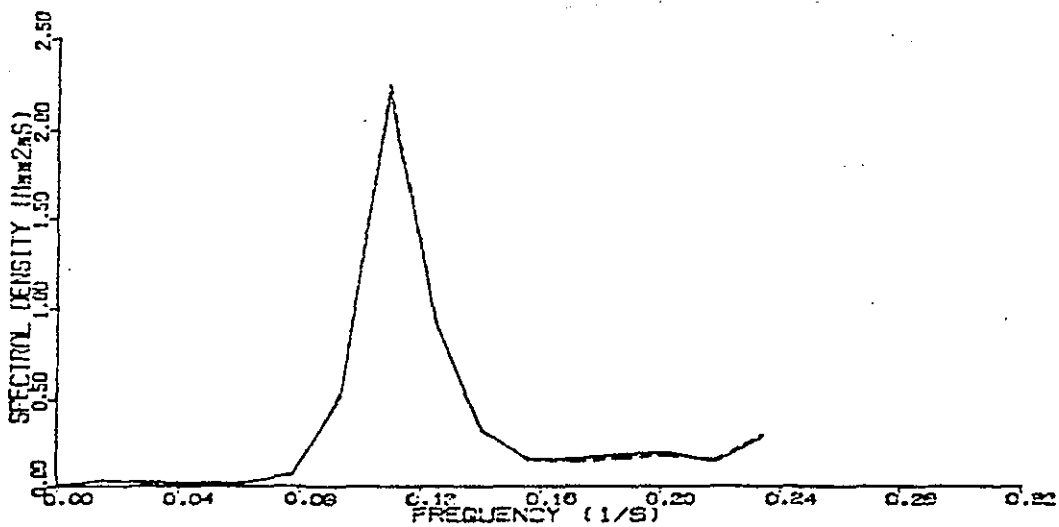
GREEN HARBOR, MASS

DATE: 16/11/83 TIME: 1546

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.094 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.085 M**2

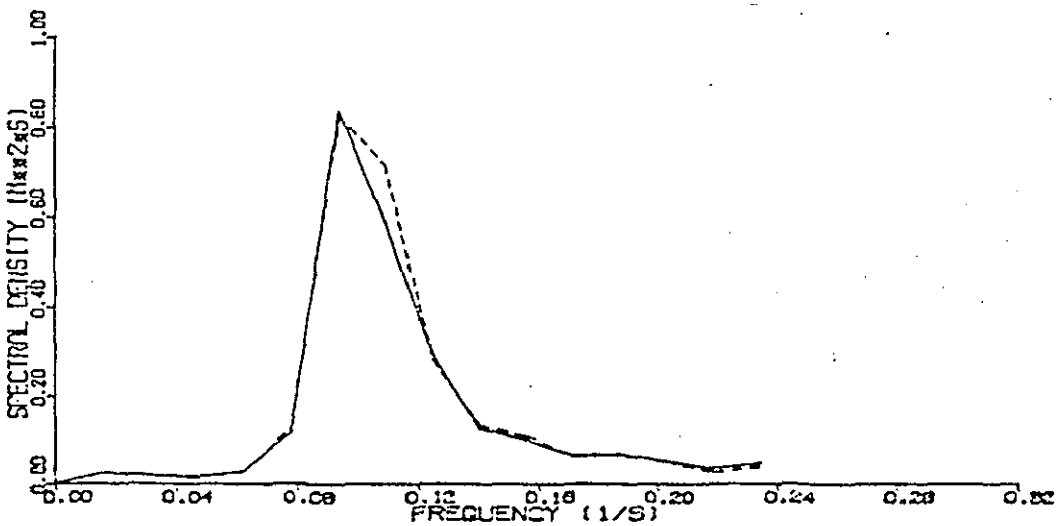


DATE: 16/11/83 TIME: 2345

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.037 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.039 M**2



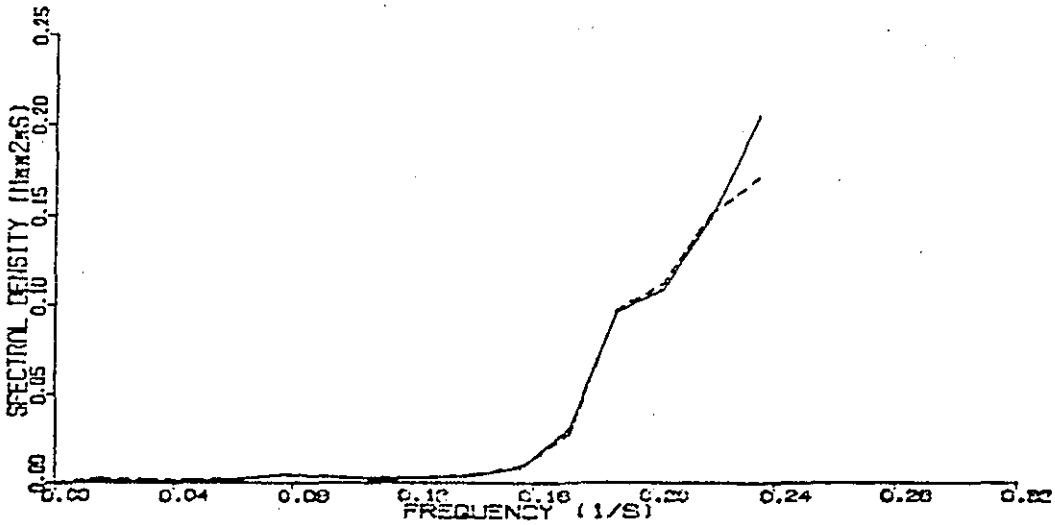
GREEN HARBOR. MASS

DATE: 4 /12/83 TIME: 746

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.014 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.013 M**2

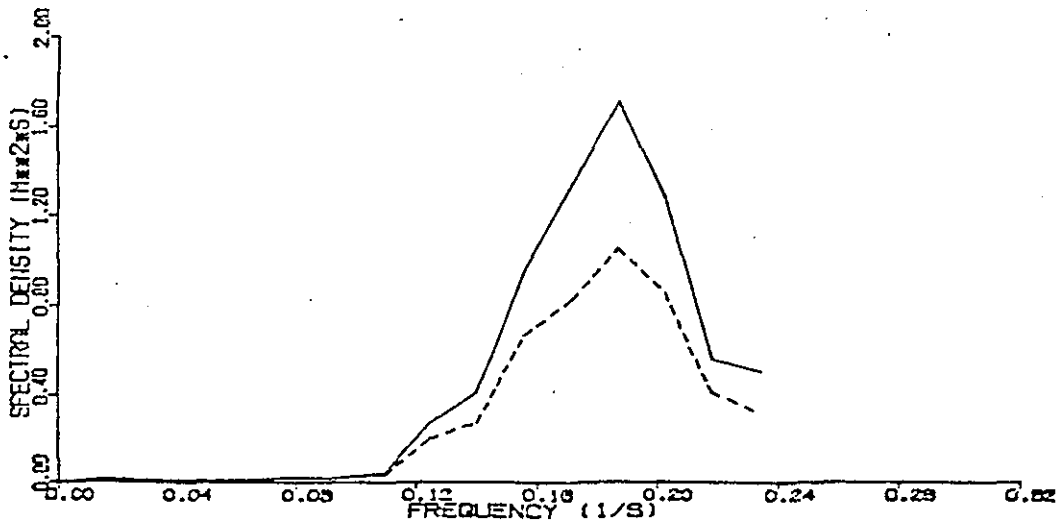


DATE: 4 /12/83 TIME: 1545

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.119 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.078 M**2



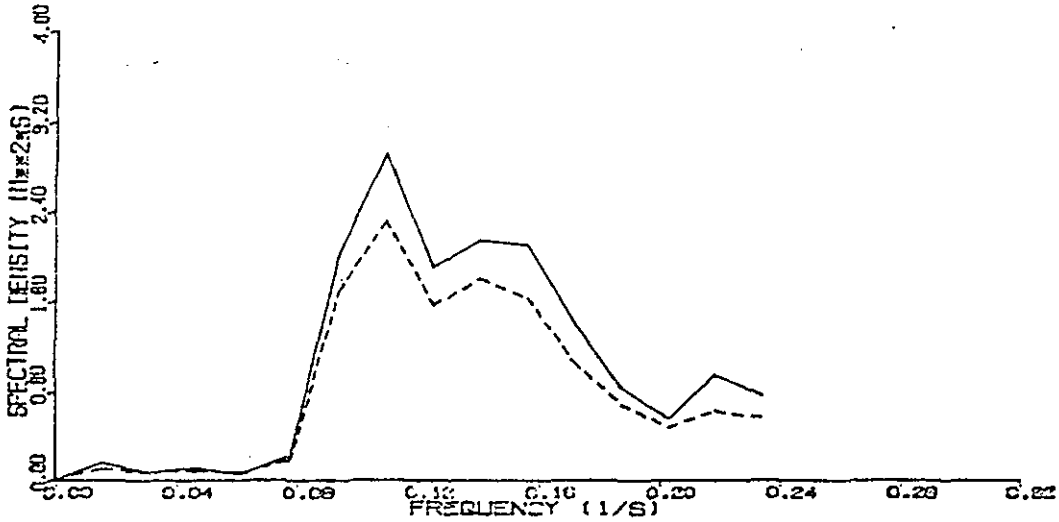
GREEN HARBOR, MASS

DATE: 4 /12/83 TIME: 2345

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.284 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.210 M**2

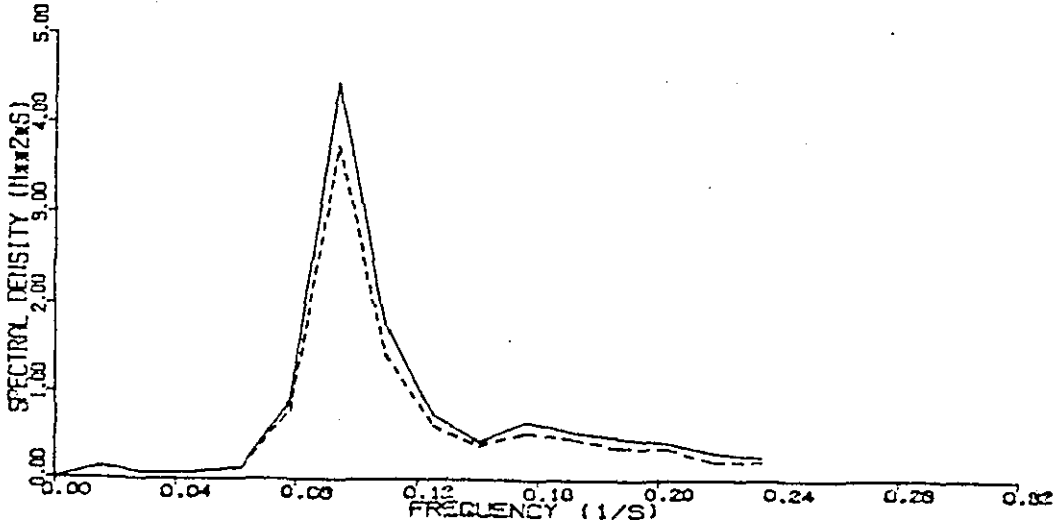


DATE: 5 /12/83 TIME: 745

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.177 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.146 M**2



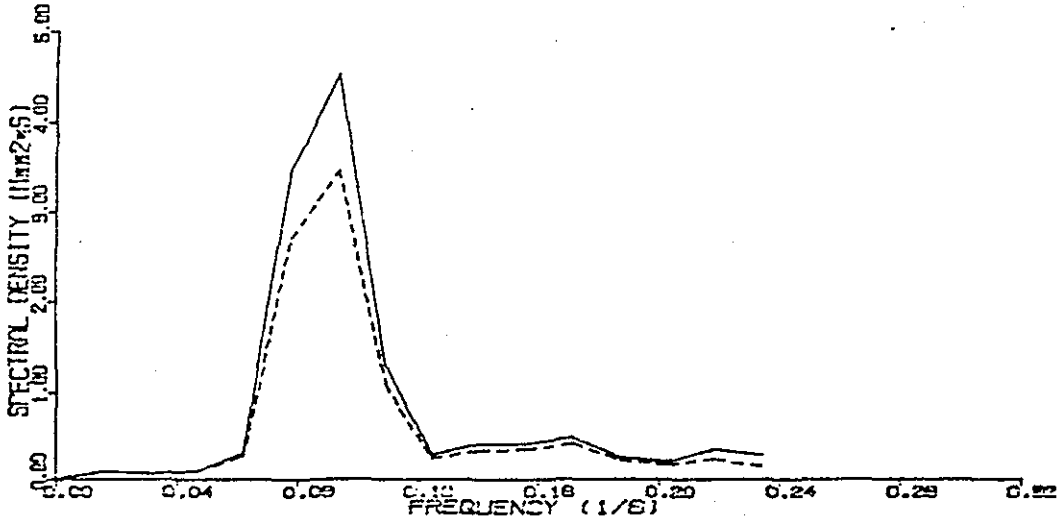
GREEN HARBOR, MASS

DATE: 5 /12/83 TIME: 1546

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.198 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.159 M**2

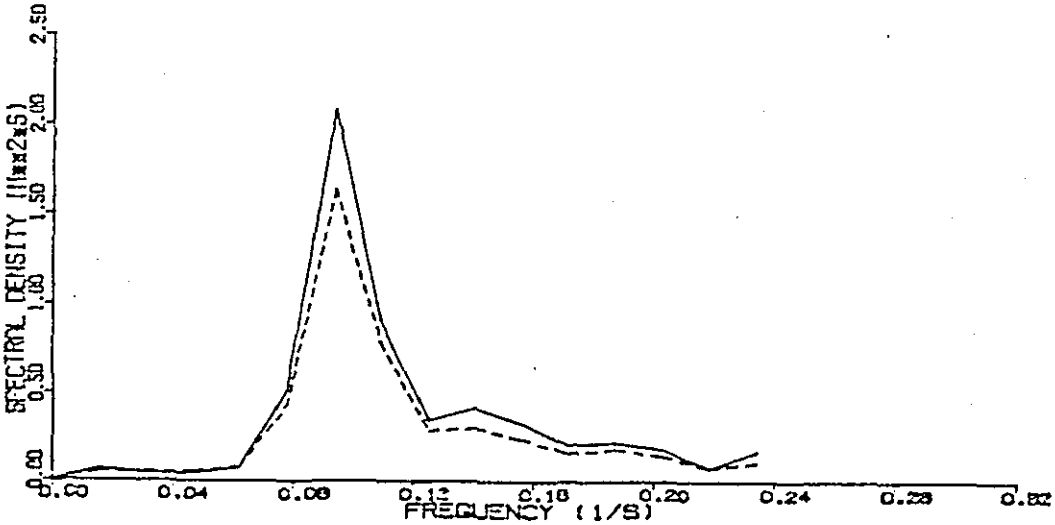


DATE: 5 /12/83 TIME: 2345

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.089 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.071 M**2



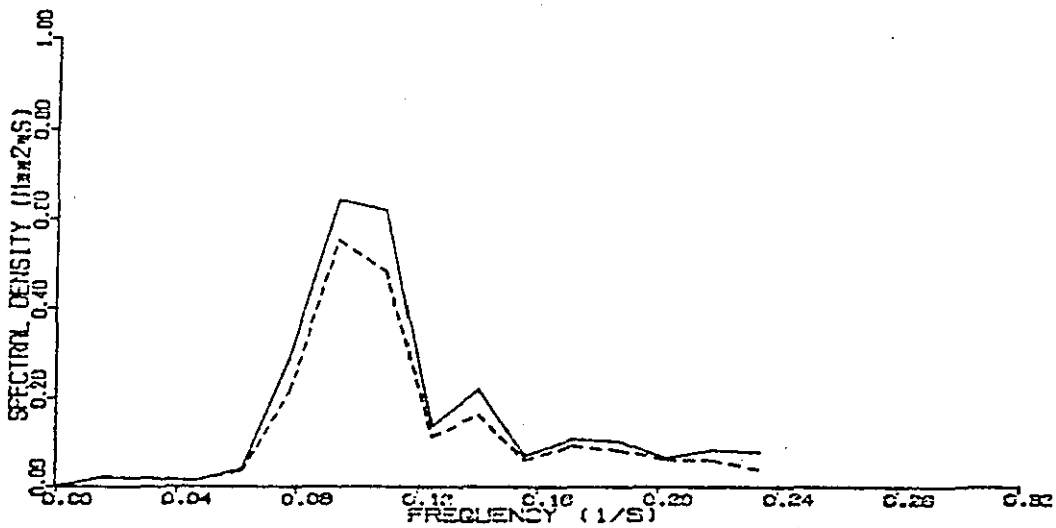
GREEN HARBOR, MASS

DATE: 6 /12/83 TIME: 746

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.039 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.031 M**2

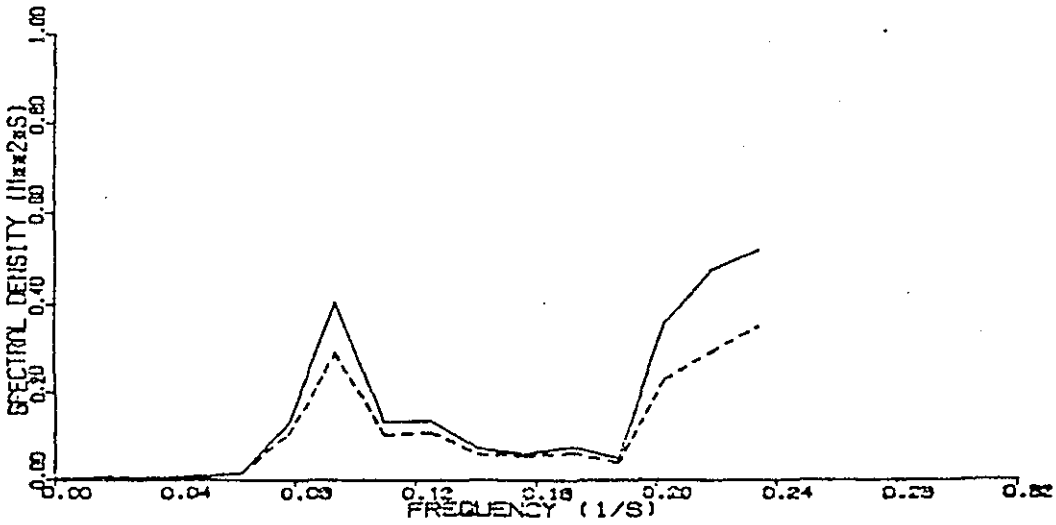


DATE: 6 /12/83 TIME: 1546

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.048 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.032 M**2



GREEN HARBOR. MASS

DATE: 6 /12/83 TIME: 2345

SEA SURFACE SPECTRUM

—— COMPUTED FROM PRESSURE DATA
TOTAL VARIANCE = 0.070 M**2

---- COMPUTED FROM VELOCITY DATA
TOTAL VARIANCE = 0.067 M**2