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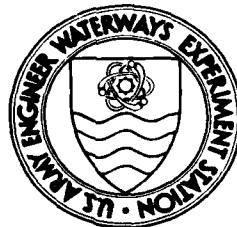
ANNUAL DATA SUMMARY FOR 1982 CERC FIELD RESEARCH FACILITY

by

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Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
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20. ABSTRACT (Continued).

➤ Summarized in this report are meteorological and oceanographic data, monthly bathymetric survey results, samples of quarterly aerial photography, and descriptions and hourly data for 16 storms that occurred during the year.

The report is the fourth in a series of annual summaries of data collected at the FRF; the first, which summarized data collected during 1977-79, was published as CERC Miscellaneous Paper 82-16; the second, which summarized data collected during 1980, was published as CERC Technical Report 84-1; and the third, which summarized data collected during 1981, was published as CERC Technical Report 85-3. These reports are available from the WES Technical Report Distribution Section, Vicksburg, Mississippi.

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PREFACE

Data and data summaries presented herein were collected during 1982 and compiled at the US Army Engineer Waterways Experiment Station (WES) Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) in Duck, N. C. This report is the fourth in a series of annual FRF data summaries carried out under CERC's Waves and Coastal Flooding Program.

The report was prepared by Mr. Herman C. Miller, oceanographer, under direct supervision of Mr. Curtis Mason, Chief, FRF Group, Engineering Development Division. Mr. Michael W. Leffler, Civil Engineering Technician, assisted with data collection and analysis; Mr. William E. Grogg, Jr., Electronics Technician, assisted with instrumentation; and Mr. Stephen C. Wheeler, Computer Specialist and Mr. C. Ray Townsend III, Amphibious Vehicle Operator, assisted with data collection.

This report was prepared under general supervision of Dr. James R. Houston, Chief, CERC; Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC; and Mr. Thomas W. Richardson, Chief, Engineering Development Division.

The National Oceanic and Atmospheric Administration/National Ocean Services maintained the tide gage and provided tide statistics for summarization. Special thanks are extended to Mr. Robert T. Battalio and Ms. Susan C. Scott who spent many hours at the computer terminals reducing the data. This report was edited by Ms. Shirley A. J. Hanshaw, Publications and Graphic Arts Division, WES.

Director of WES during the publication of this report was COL Allen F. Grum, USA; Dr. Robert W. Whalin was Technical Director.



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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
acres	0.4046873	hectares
feet	0.3048	metres
inches	2.54	centimetres
millibars	100.0	pascals

ANNUAL DATA SUMMARY FOR 1982
CERC FIELD RESEARCH FACILITY

PART I: INTRODUCTION

1. The US Army Engineer Waterways Experiment Station (WES) Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) located on 176 acres* at Duck, N. C. (Figure 1), consists of a 561-m-long research pier and accompanying office and field support buildings. The FRF is located near the middle of Currituck Spit along a 100-km unbroken stretch of shoreline extending south from Rudee Inlet, Va., to Oregon Inlet, N. C. It is bordered by the Atlantic Ocean to the east and Currituck Sound to the west. The Facility is designed to (a) provide a rigid platform from which waves, currents, water levels, and bottom elevations can be measured, especially during severe storms; (b) provide CERC with field experience and data to complement laboratory and analytical studies and numerical models; (c) provide a manned field facility for testing new instrumentation; and (d) serve as a permanent field base of operations for physical and biological studies of the site and adjacent region.

2. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The piles are embedded approximately 20 m below the ocean bottom. The pier deck is 6.1 m wide and extends from behind the dune line to about the 6-m water depth contour at a height of 7.8 m above National Geodetic Vertical Datum (NGVD). The pilings are protected against sand abrasion by concrete erosion collars and against corrosion by a cathodic system.

3. An FRF Measurements and Analysis (FRFMA) program has been established to collect basic oceanographic and meteorological data at the site, reduce and analyze these data, and publish the results.

4. This report, the fourth in a series of annual reports, summarizes the data collected during 1982. Data for 1977-79 are summarized in Miller (1982), for 1980 in Miller (1984), and for 1981 in Miller, et al. (1985). Descriptions of the instrumentation, including sensor calibration and maintenance (Part III) and data collection and analysis procedures (Part IV)

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 8.

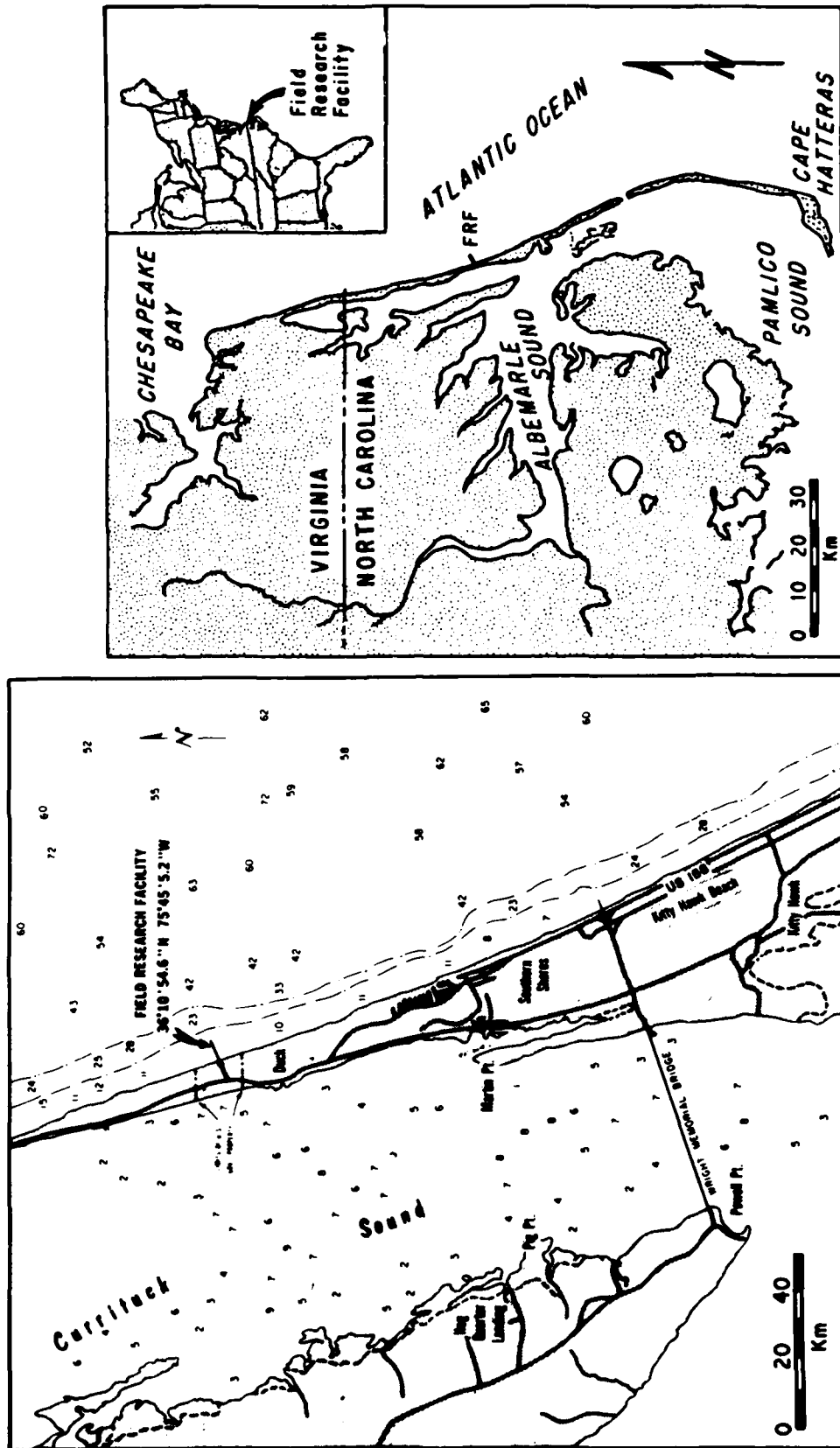


Figure 1. FRF location map

precede reporting of the data (Part V). Appendixes A-D present, respectively, the following material: Waverider buoy maintenance and calibration information, wave data, survey data, and storm data. Although this is intended as a stand-alone document, details for some procedures and instrumentation are given in the references.

5. Future annual reports will have approximately the same format. Readers' comments on the format and usefulness of the data presented are encouraged.

6. In addition to the annual reports, monthly data reports summarizing the same types of data shortly after they are collected are available from:

Chief
CERC Field Research Facility
SR Box 271
Kitty Hawk, North Carolina 27949

7. The CERC Coastal Engineering Information and Analysis Center (CEIAC) is responsible for storing and disseminating most of the data presented or alluded to in this report. All data requests should be in writing and addressed to:

Commander and Director
US Army Engineer Waterways Experiment Station
ATTN: CEIAC
PO Box 631
Vicksburg, Mississippi 39180-0631

Tidal data other than the summaries in this report should be obtained directly from:

Tide Analysis Branch
National Ocean Services
Rockville, Maryland 20850

A complete explanation of the exact data desired for specific dates or times will expedite filling any request; an explanation of how the data will be used will help CEIAC or National Ocean Services (NOS) determine if other relevant data are available. For information regarding the availability of data, contact CEIAC at (601) 634-2017. Costs for collecting, copying, and mailing will be borne by the requester.

PART II: CLIMATOLOGICAL SUMMARY

Climate

8. The FRF enjoys a typical marine climate which moderates the extremes of both summer and winter. During the warmest month, July, the daily highest temperature averages 30° C. Ocean water surface temperatures tend to be lowest in January and February, averaging less than 5° C, and highest during August and September, averaging over 20° C.

9. Precipitation is generally well distributed throughout the year, averaging 1,035 mm annually. Precipitation from midlatitude cyclones predominates in the winter, while local convection (thunderstorms) accounts for most of the summer rainfall.

10. Winds at the FRF are dominated by tropical air masses which create low to moderate warm southern breezes, arctic air masses which produce cold winds from northerly directions, and smaller scale cyclonic low pressure systems which originate either in the tropics (and move north along the coast) or inland (and move eastward offshore). The dominant wind direction changes with season, being generally from northern directions in the fall and winter and from southern directions in the spring and summer. The annual resultant wind direction is from the northwest. It is common for fall and winter storms (northeasters) to produce winds with average speeds in excess of 15 m/sec. Although the portion of the North Carolina coast in the vicinity of the FRF experiences a fairly low frequency of occurrence of direct hurricane strikes (on the average of once every 42 years), more frequent near-misses can cause high wave conditions at the FRF.

Waves

11. Wave directions at the FRF, as with winds, are seasonally distributed. Waves tend to approach most frequently from north of the pier in the fall and winter and south of the pier in the summer; whereas, annually they are evenly distributed between north and south. Storm waves, however, approach two-to-one more frequently from the north.

12. The annual mean significant wave height (measured at the seaward end of the FRF pier) is 0.9 m, with a standard deviation of 0.6 m. Wave

heights in excess of 2 m can be expected to occur 7 percent of the time or 600 hr per year.

13. Wave periods generally vary between 6 and 12 sec. The annual mean peak spectral period is 8.5 sec with a standard deviation of 2.9 sec. Wave periods tend to be longest during the fall and shortest during the summer.

Nearshore Currents

14. Surface current speed and direction at the FRF are influenced by winds, waves, and, indirectly, bottom topography. The extent of the respective influence varies daily. However, winds tend to dominate the currents at the seaward end of the pier, while waves dominate within the surf zone. The effect of the bottom topography is such that, under certain conditions (e.g., near shore-normal wave angles), rip currents develop which interrupt the general flow of the alongshore current. A trough located under the seaward half of the pier is a preferred location for such currents. Longshore currents tend to be directed southward during the fall and winter and northward during the spring and summer.

Tides and Water Levels

15. Ocean tides at the FRF occur in the usual semidiurnal pattern with a range of 1.0 m. Highest water levels generally are associated with strong and persistent onshore winds and high waves. Storm surges have resulted in a maximum 1.5-m water level (NGVD). Water levels in Currituck Sound are wind-dominated rather than tidal, being low when winds are northeasterly and high when they are southwesterly.

Bathymetry

16. Nearshore bathymetry at the FRF is characterized by regular shore-parallel contours, a moderate slope, and a single bar with a second, smaller, nearshore bar occasionally appearing. This pattern is interrupted in the immediate vicinity of the pier where a trough runs under much of the pier ending in a scour hole (with depths up to 3.0 m greater than the adjacent bottom) at the pier end.

Sediment Size

17. Across the dune and beach face, sediments are generally medium sized and moderate to well sorted. At the beach step, sizes are very coarse and moderate to poorly sorted; and offshore, the sediments are increasingly fine and well sorted.

PART III: INSTRUMENTATION

18. This section identifies the instruments used for monitoring oceanographic and meteorological conditions and briefly describes their design, operation, and location. More detailed explanations of the instruments may be found in Miller (1980). Equipment used for other types of data collection, such as the surveying system, is not generally discussed; however, references are provided in Part IV.

Wave Gages

Baylor wave staff gages

19. Two parallel cable inductance wave gages, manufactured by the Baylor Company, Houston, Tex., are mounted on the FRF pier: gage 615 (sta 6+20) and gage 625 (sta 19+00) (Figure 2). These gages are rugged and reliable; and they require little maintenance, except to keep tension on the cables and remove any material which may cause an electrical short between them. They are calibrated prior to installation by placing an electrical short between the two cables, at known distances along each, and by noting the voltage output. Electronic signal conditioning amplifiers are used to ensure that the output signals from the gages are within a 0- to 5-V range. Gage accuracy is about 1 percent, with a 0.1 percent full scale resolution. These gages are susceptible to lightning damage, but protective measures have been taken to minimize such occurrences.

Waverider buoy wave gages

20. Two Waverider buoy gages (610 and 620) were positioned offshore at 0.6 and 3 km, respectively, from the monumentation baseline (Figure 2). These gages, manufactured by the Datawell Laboratory for Instrumentation, Haarlem, The Netherlands, measure the vertical acceleration produced by the passage of a wave. The signal is doubly integrated to produce a displacement signal which is transmitted by radio to an onshore receiver. The manufacturer states that wave amplitudes are correct to within 3 percent of their actual value for wave frequencies between 0.0654 and 0.5 Hz (15- to 2-sec wave periods). However, calibration curves for buoys used at the FRF indicate that the wave heights reported in the results section of this report for wave periods less than 15 sec average about 7 percent less than actual values. For wave periods

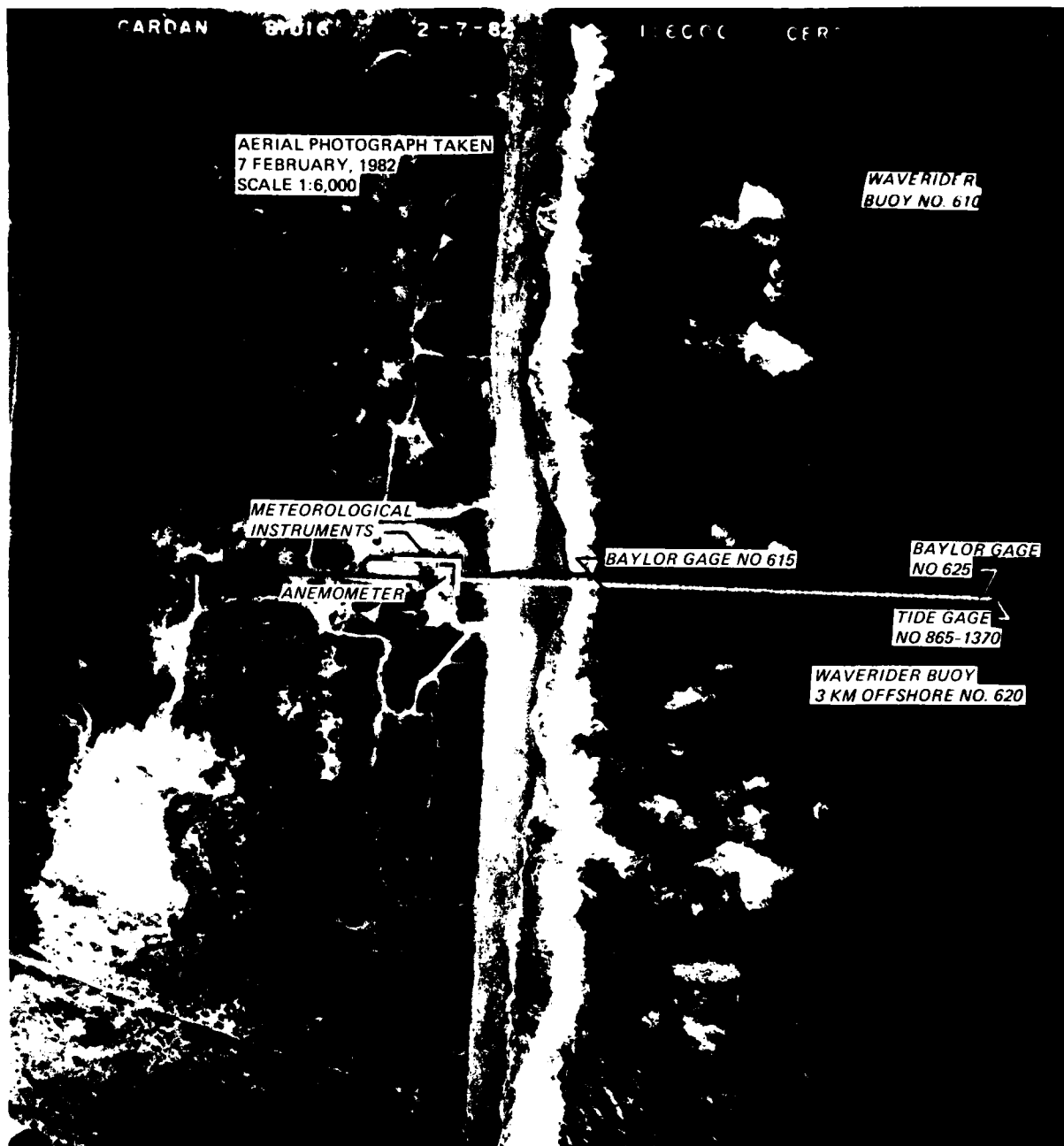


Figure 2. FRF gage locations

in excess of 15 sec, this error increases with wave period. The manufacturer specifies that the error can increase to 10 percent for wave periods in excess of 20 sec. Calibration results show errors as large as 15 percent are possible for the very long wave periods. The buoys were calibrated without the mooring system used during deployment, which may introduce additional errors

of unknown magnitude. However, a comparison of the buoy located at 0.6 km to the Baylor staff wave gage at the seaward end of the pier (approximately the same distance offshore) showed very good agreement. For most engineering applications, a 7 percent error is tolerable; however, a correction procedure is described in Appendix A which will allow the calibration error to be improved up to 4 percent.

Tide Gage

21. Water level data were obtained from a National Oceanographic and Atmospheric Administration (NOAA)/NOS control tide station (No. 865-1370), located at the seaward end of the research pier, using a digital tide gage manufactured by Leupold and Stevens, Inc., Beaverton, Oregon. The Leupold-Stevens analog-to-digital recorder is a float-activated, negator-spring, counterpoised instrument that mechanically converts the vertical motion of a float into a coded, punched paper tape record. The below-deck installation at pier sta 19+60 (Figure 2) consisted of a 30.5-cm-diam stilling well with a 2.5-cm orifice and a 21.6-cm-diam float.

22. This tide gage was checked daily for proper operation of the punch mechanism and accuracy of the time and water level information. The accuracy was determined by comparing the gage level reading to a level read from a reference electric tape gage. Once a week, a heavy metal rod was lowered down the stilling well and through the orifice to ensure free flow of water into the well. During the summer months when biological growth was most severe, divers inspected and cleaned the orifice opening as required.

23. Quarterly, a NOAA/NOS tide field group, which consisted of NOS personnel familiar with the installation and equipment, performed a tide station inspection and review. The tide gage elevation was checked using existing NOS control positions, and the equipment was checked and adjusted as needed. NOS and FRF personnel also reviewed procedures for tending the gage and handling the data. Any specific comments on the previous months of data were discussed to ensure data accuracy.

Meteorological Instruments

Anemometer

24. Prior to 30 March 1982, winds were measured using a NOAA/National Weather Service (NWS) Model F420C anemometer consisting of a cup rotor and

spread-tail wind vane located on the top of the laboratory building at an elevation of 19.1 m (Figure 2). The accuracy of the speed transmitter and indicator assemblies was 1 percent up to 100 m/sec and 2 percent over 100 m/sec. The wind direction transmitter and indicator assemblies were accurate to ± 5 deg at an air speed of 0.26 m/sec or greater.

25. The wind speed and direction were recorded on a battery-powered Esterline-Angus recorder. Problems with the recorder's clock, tape advance mechanism, and pen actuator (for indicating direction) were found, and the unit required frequent maintenance.

26. On 30 March, the system was replaced with a Skyvane Model W102P anemometer manufactured by the Weather Measure Corporation, Sacramento, Calif. Wind speed and direction were recorded continuously on an MFE Corporation, Salem, N. H., two-channel chart recorder and were incorporated into the automated data collection and analysis program using the computer. The anemometer, calibrated at the National Bureau of Standards in Gaithersburg, Md., showed an accuracy of ± 1 percent below 11 m/sec and ± 3 percent above 11 m/sec.

Microbarograph

27. A recording aneroid sensor (microbarograph), used to measure atmospheric pressure, responded to pressure changes on the order of 0.169 mb. Microbarographs manufactured by the Belfort Instrument Company, Baltimore, Md. (used before 9 April 1982), and Weathertronics Incorporated, Sacramento, Calif., were located inside the laboratory building, 9 m above NGVD.

28. The microbarograph was compared daily to an NWS aneroid barometer, and adjustments were made as necessary. Maintenance of the microbarographs consisted of inking the pens, changing the chart paper, and winding the clocks every 3 or 7 days for the instruments used before 30 March or after, respectively.

29. An electronic atmospheric pressure sensor with analog output, manufactured by Yellow Springs Instruments Company, Inc. (YSI, Inc.), Yellow Springs, Ohio, was installed in the building in late February and included in the automated data collection program. Data from this gage were compared with the microbarograph once a week to ensure proper operation of the instruments.

Air temperature thermometers--maximum/minimum

30. NWS maximum and minimum thermometers were used to determine the daily extreme air temperatures. The thermometers were housed in an NWS

instrument shelter located 43 m behind the dune (Figure 2). The shelter was designed with louvered sides, a double roof, and a slatted bottom for housing instruments requiring protection from direct sunlight (Figure 3).



Figure 3. Louvered instrument shelter (background) and rain gages (foreground)

31. The actual temperature readings at the time the thermometers were read (i.e. the present temperature) were compared to ensure accuracy of the maximum and minimum values. Maintenance consisted of periodic removal and cleaning with soap and water and lubricating the Townsend support used to hold and reset the instruments.

Rain gage

32. A 30-cm weighing rain gage manufactured by the Belfort Instrument Company, Baltimore, Md., used to measure the daily amount of precipitation, was located near the instrument shelter 46 m behind the dune (Figures 2 and 3). The manufacturer's specifications indicated that the instrument accuracy was ± 0.5 percent for precipitation amounts less than 15 cm and ± 1.0 percent for amounts above 15 cm.

33. A 15-cm-capacity "true check" clear plastic rain gage with a 0.025-cm resolution, manufactured by the Edwards Manufacturing Company, Alberta Lea, Minn., was used to monitor the performance of the weighing rain gage. This gage, located near the weighing gage (Figure 3), was checked

daily; and very few discrepancies were identified throughout the year. The weighing rain gage required little maintenance except to wind the clock and ink the pen.

PART IV: DATA COLLECTION AND ANALYSIS

Wave Data

Acquisition system

34. The primary data acquisition system was a Data General Corporation (Westboro, Mass.) NOVA-4 mini-computer located in the FRF laboratory building. The backup system consisted of a Lockheed Electronics Company, Inc. (Plainfield, N. J.), 7D FM tape recorder which was used infrequently to record data when the primary system was not operational.

Collection

35. The signals from the gages were routinely sampled four times per second for 20 min every 6 hr beginning as near as possible to 0100, 0700, 1300, and 1900 hours Eastern Standard Time (EST); these hours correspond to the time that the NWS creates daily synoptic weather maps. During storms, hourly data recordings were made. Prior to collection, each gage signal was first amplified and biased to ensure a 0- to 5-V-range. However, since the backup FM recorder operated on a maximum output of 3 V, the signal was linearly scaled by a factor of 3/5 when the backup recorder was used. The analog signals were converted to digital form prior to analysis.

36. Data were recorded on 9-track magnetic tapes having the following format: two header records of information were written, including (a) the sensor identification number; and (b) the date, time, calibration, and signal bias factors, followed by 13 records of data for each 20-min recording interval. Each data record contained 384 data values in a binary format such that each value represented the computer units corresponding to the instantaneous voltage output of the sensor. The above sequence of 15 records per file was repeated for each sensor and recording interval until the data tape was filled (600 to 700 files total per tape).

Digital analysis/ summarization procedures

37. Thompson (1977) and Harris (1974) describe the procedure used for analyzing and summarizing the digital wave data contained in this report. The procedure is based on a Finite (fast) Fourier Transform (FFT) spectral analysis of 4,096 data values (1,024-sec recordings sampled at 4 Hz) for each file processed.

38. The program computes the first five moments of the distribution of sea surface elevations. It then edits the digital data file, checking for data points out of the 0- to 5-V range and "jumps" and "spikes". A jump is defined as a data value in excess of 2.5 standard deviations from the previous data value, while a spike is a data value 5 standard deviations or more from the mean. If less than 5 jumps or spikes in a row are found, the program linearly interpolates between acceptable data and replaces the erroneous data values. If more than 5 jumps or spikes in a row or a total of 100 bad data points for the file are found, the program stops interpolation and further editing, analyzes the data, and prints a flag indicating there is a problem with the file. If the variance is less than 0.001 m^2 , the record is not analyzed. After editing, the first five moments of the distribution of sea surface elevations are again computed. A cosine bell data window was applied to increase the resolution for the energy spectrum of the file; use of the data window is discussed by Harris (1974). After application of the data window, the program computed the variance spectrum (energy spectrum) using the FFT procedure. After the data files were analyzed, the results were eliminated for files that were flagged as bad or appeared inconsistent with simultaneous observations from nearby gage sites. Frequently, the spectrum and/or distribution function of sea surface elevations were examined to determine if the data were acceptable. After the analysis results were edited, monthly summaries of wave heights and periods were generated for inclusion in summary reports.

39. Unless otherwise specified, "wave height" means the energy based parameter H_{m_0} defined as four times the standard deviation of the sea surface elevations.

40. The wave period T_p is defined as the period associated with the maximum energy in the spectrum. This is resolved by partitioning the spectrum into frequency bands of equal width and finding the band with the maximum energy density. The period reported is the reciprocal of the center frequency (e.g., $T_p = 1/\text{frequency}$), of the spectral band. Since the spectral bands are of equal frequency width, namely 0.010742 Hz (e.g., $11/1,024 \text{ sec}$), the analysis provides uniform resolution in frequency. However, the resolution in period is not uniform, since the period intervals become larger for lower frequencies. Due to the convention of reporting the period at the center of the interval, only a discrete set of period values is possible (Table 1).

Table 1
Spectral Band and Peak Period Specifications

Band Number	Upper Limit of Frequency Band, Hz	Corresponding Period, Lower Limit of Band, sec	Period Associated with Center Frequency of Band, sec	Periods Not Reported, sec
6	0.064	15.52	17	15, 16
7	0.075	13.30	14	13
8	0.086	11.64	12	
9	0.097	10.34	11	
10	0.107	9.31	10	
11	0.118	8.46	9	
12	0.129	7.76	8	
13	0.140	7.16	7	
14	0.150	6.65	7	
15	0.161	6.21	6	
16	0.172	5.82	6	
17	0.183	5.48	6	
18	0.193	5.17	5	
19	0.204	4.90	5	

The wave periods used in this report have been rounded to the nearest second before summarization. Certain period values do not occur in the results, i.e., 13, 15, and 16 sec. During October through December 1980, a different analysis program was used which utilized the same FFT analysis technique but allowed all periods to be reported. This was accomplished by searching for the band (still 11/1,024 Hz wide) with the maximum energy by letting the band occur anywhere in frequency instead of rigidly partitioning the spectrum, sometimes referred to as a "floating" frequency band search.

41. Summarizing, only a discrete set of period values is possible with the standard analysis. When the data are summarized into equal width period intervals, the results show a false absence of wave periods of 13, 15, and 16 sec. However, some of these values were reported for data between October and December 1980. Complete information about the energy contained in all frequency bands can best be obtained by inspecting the full spectrum, examples of which are included in this report for all storm wave conditions during 1982.

Water Level Data

Collection

42. The water level information was obtained from a NOS tide gage which produced a digital paper tape of instantaneous water levels sampled continuously at 6-min intervals. At the end of each month, the paper tape was removed from the recorder and mailed to NOS in Rockville, Md. for analysis.

Analysis

43. The digital paper tape records of tide heights taken every 6 min were analyzed by the Tides Analysis Branch of NOS. A Mitron interpreter created a digital magnetic computer tape from the punch paper tape, which was then processed on a Univac 732 computer. First, a listing of the instantaneous tidal height values was created for visual inspection. If errors were encountered, a computer program was used to fill in or recreate bad or missing data using correct values from the nearest NOS tide station and to account for known time lags and elevation anomalies. The data were plotted, and a new listing was generated and rechecked. When the validity of the data had been confirmed, monthly tabulations of daily highs and lows, hourly heights (instantaneous height selected on the hour), and various extreme and/or mean water level statistics were computed. The monthly or annual mean sea level (MSL) reported is the average of the hourly heights, while the mean tide level (MTL) is midway between mean high water (MHW) and mean low water (MLW).

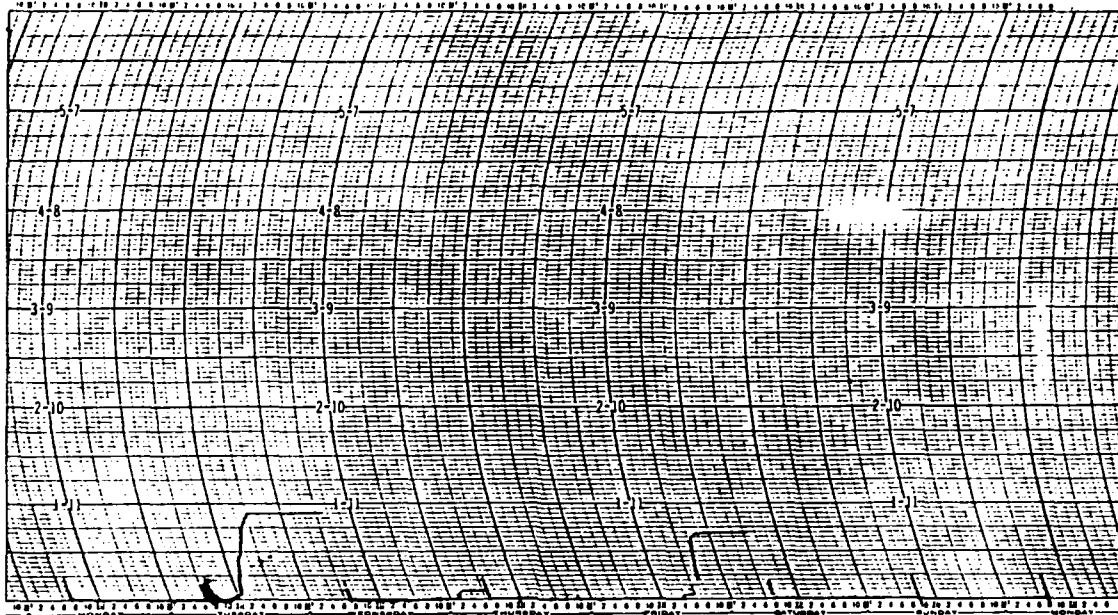
Meteorological Data

44. Each instrument used for monitoring the meteorological conditions at the FRF was read and inspected daily. For those instruments with analog chart recording capabilities, (a) the pen was zeroed (where applicable); (b) the chart time was checked and corrected; and (c) a daily reading was marked on the chart for reference, if necessary; (d) the starting and ending chart times were recorded, as necessary; and (e) new charts were installed when needed. Samples of the chart records for the microbarograph (atmospheric pressure in millibars) and rain gage (in inches) are shown in Figure 4.

45. High and low temperature values, read daily directly from the instruments, represent the extreme temperature values since the last reading.

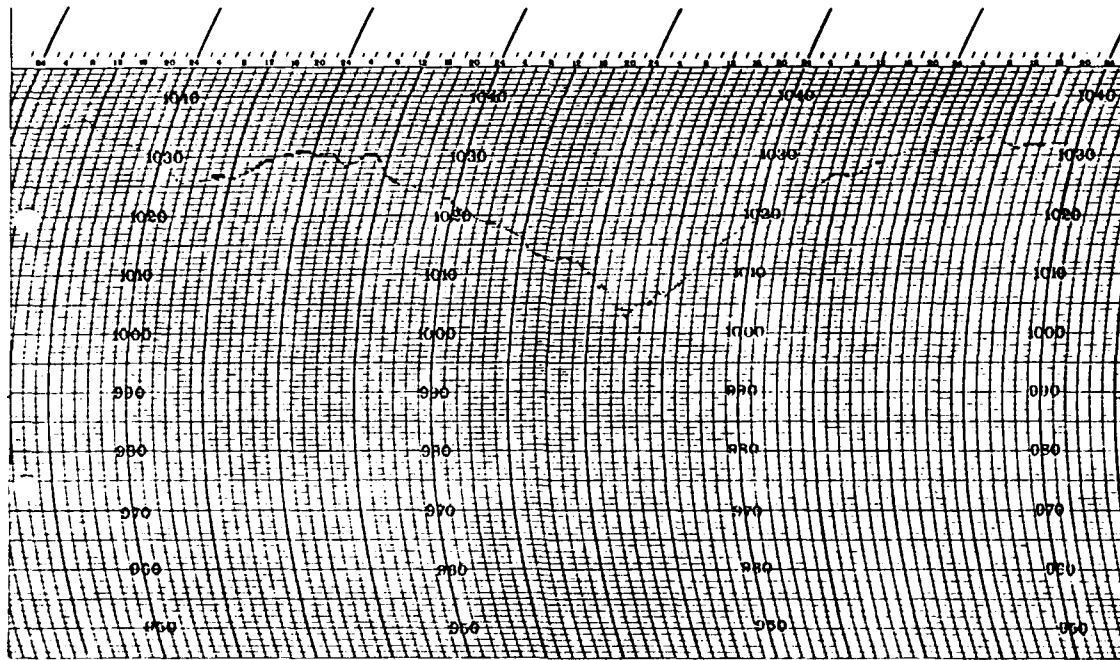
46. Atmospheric pressure values measured by the electronic instrument

CHART NO. 5-4046-B
 17 INCH DUAL TRAVERS 192 HOURS
 UNIVERSAL RAIN GAGE
 BELFORT INSTRUMENT COMPANY
 BALTIMORE, MARYLAND U.S.A.



DISCARD
 REWIND

a. Rain gage (in inches)



2771 Del Monte St., West Sacramento, California 95601
 Telephone (916) 371-5566 Telex: 377-380
 WEATHERINSTRUMENTS
 WASHINGTON, D.C. 20541

b. Microbarograph (in millibars)

Figure 4. Sample rain gage and microbarograph chart records

were collected simultaneously with wave data (routinely every 6 hr and hourly during storms).

Wind Data

Collection

47. Prior to 30 March 1982, wind speed and direction were continuously recorded on chart records. After that date, the analog signal was interfaced to the computer, and wind and wave data were collected simultaneously.

Analysis

48. The wind conditions prior to 30 March 1982 were determined by estimating the average speed and direction values from 10-min sections of the chart records four times per day. After 30 March, mean wind speed and direction were computed from 20-min digital data samples.

49. Annual, seasonal, and monthly joint probability distributions of wind speed versus direction were computed. Wind speeds were resolved into 1-m/sec intervals, while the directions were at 22.5-deg intervals, i.e., 16-point-compass-direction specifications. These distributions are presented as wind "roses". The length of the "petal" represents the frequency of wind blowing from the specified direction, and the width of the "petal" is indicative of the speed in 3-m/sec intervals. Resultant directions and speeds were also determined by vector averaging the data.

Visual Data

50. Daily visual observations were made near 0700 hours to supplement instrumented data collection. These include observations of surface current speed and direction at (a) the seaward end of the pier, (b) the midsurf position of the pier, and (c) the beach 500 m updrift of the pier. Surface currents were determined by observing the movement of dye on the water surface. Also measured were the wave approach angle at the seaward end of the pier, the breaker angle, and the breaker type nearshore.

Bathymetric and Pier Surveys

Collection

51. Profiles were obtained monthly and after storms using the Coastal Research Amphibious Buggy (CRAB), a 10.7-m-tall amphibious tripod, and a Zeiss

Elta-2 total station surveying system described by Birkemeier and Mason (1984). Each profile extended seaward from the baseline behind the dune to a water depth of about 10 m, within 0.6 km north and south of the FRF pier. Their locations are shown in Figure C1. The survey accuracy was ± 3 cm horizontally and vertically. Soundings along both sides of the FRF pier were included. The technique consisted of lowering a weighted measuring tape to the bottom and then recording the distance below the established pier deck elevation. Measurements were made midway between the pier pilings to minimize errors due to scour near the pilings.

Analysis

52. The pier, beach, nearshore, and offshore data were reduced to position (X,Y) and depth (Z) triplets relative to established monumentation and NGVD, respectively. The data were listed, and a display of the profiles (i.e. distance along the range versus elevation) were generated for visual inspection. After the data were edited, another set of routines was used to compute contour diagrams of the bottom topography and time sequences of bottom elevations at selected locations along the pier.

Sediment Data

Collection

53. Sediment data were not collected routinely at the FRF during the year. However, a sediment survey was conducted in March, and sediment samples were obtained along a shore normal profile line located 517 m south of the pier in October. Between 14 and 19 March, a graduate class from the University of Virginia, led by Professor Robert Dolan in cooperation with the FRF staff, examined the spatial variation of sediments across the littoral zone at the FRF. Sediment samples (274) were collected and analyzed from 11 of the bathymetric survey profile lines and along the pier. The samples were collected from the top of the dune to the 9-m depth contour. Onshore samples were collected by hand, and care was taken not to penetrate more than 5 cm deep. Ninety percent of the offshore samples were taken from the CRAB with a gravity release clamshell device that could recover up to 1,000 g of bottom sediment. In 10 percent of the sampling locations, the hard bottom prevented proper operation of the clamshell, so a pipe dredge sampler was dragged along the bottom.

Analysis

54. Mean sediment sizes were determined by visually estimating the size distribution of the sample by at least two analysts. Selected samples were sieved to be sure the analysts were not introducing a bias; comparisons were favorable. Size distributions presented in this report were based on sieved samples. The FRF sediment characteristics were summarized by contouring the mean grain size of the sand samples at 1/2-phi intervals.

Photographic Data

Aerial

55. Quarterly aerial photographic missions were performed using a 9-in negative format mapping aerial camera capable of black/white and color photography. All coverage was at least 60 percent overlap, with flights flown as close as possible to low tide between 1000 and 1400 hours with less than 10 percent cloud cover.

56. The photographs obtained on 7 February, 11 May, and 27 October were concentrated near the FRF (Figure 5), while those obtained on 14 July also included coverage from Cape Henry, Va., to Cape Hatteras, N. C.

Beach

57. Daily color slides of the beach were taken using a 35mm camera from the same location on the pier looking north and south. The location from which each picture was taken as well as the date, time, and a brief description of the picture were marked on the slides. An inventory is also maintained.

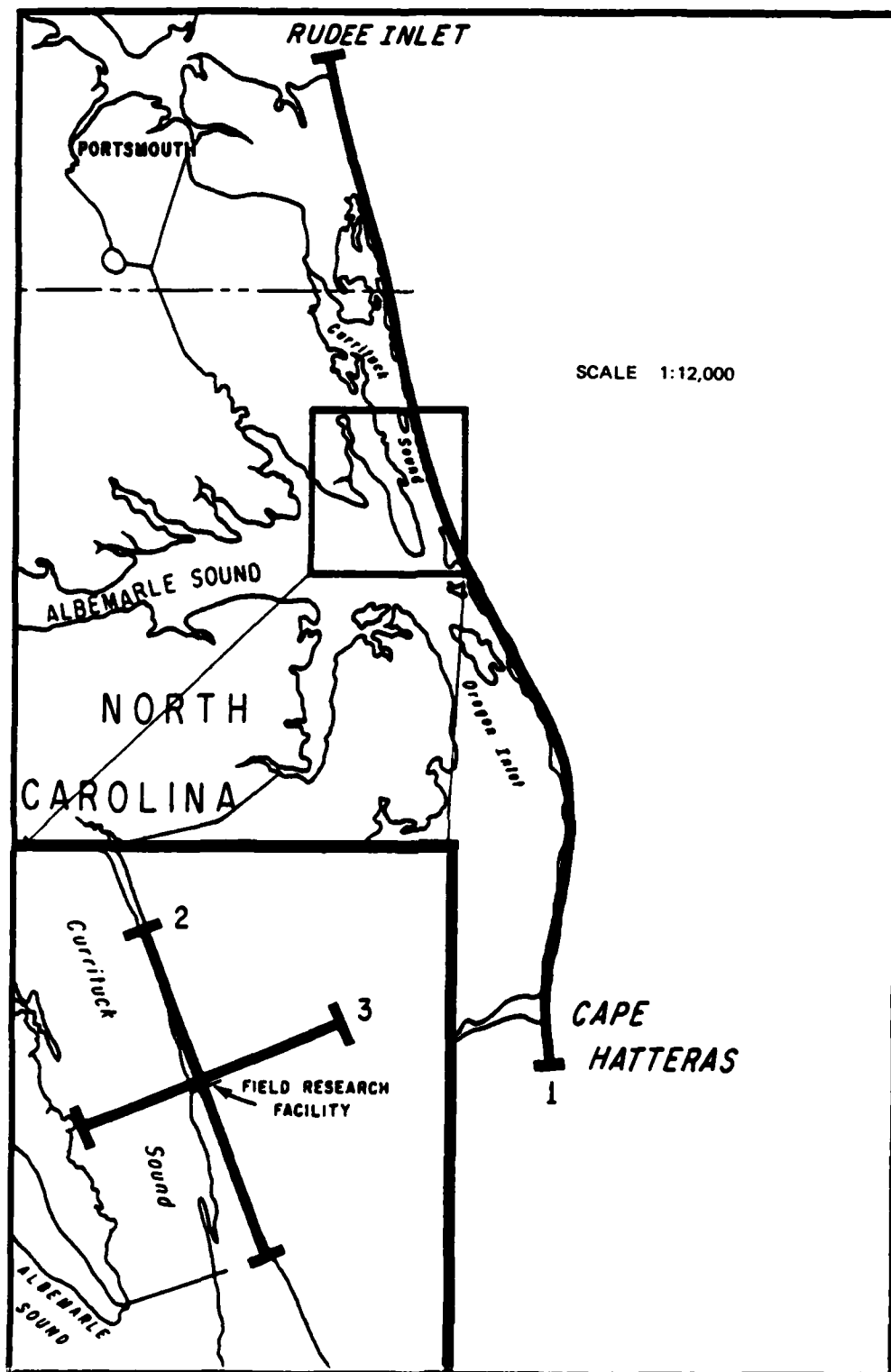


Figure 5. Quarterly aerial photography flight lines, 1981

PART V: DATA AVAILABILITY AND RESULTS

58. Table 2 is intended as a quick reference guide to show the dates for which various types of data are available. Wave gage histories which may explain major gaps in the data are provided in Appendix B.

59. This part provides results of the weather, wave, surface current, tidal, water characteristics, photographic, survey, and sediment measurements made during the year. Although this report is intended to provide basic data for analysis by users, many of the daily observations have been summarized by month, season, or year to aid in interpretation. A discussion of the data and a comparison with previous years are also presented. If individual data are needed, the user can obtain the detailed information by following the procedures described in paragraphs 6 and 7.

Meteorological Data

60. This section summarizes meteorological measurements made at the FRF in 1982. Appendix D (Storm Data) contains hourly wind speed and direction and atmospheric pressure values during storm conditions.

Air temperature

61. The marine climate at the FRF moderates the extremes of both summer and winter, as indicated by the mean monthly and annual high and low air temperatures shown in Table 3. Based on 5 years of data, the average date of the first freezing temperature is 3 December, while the average date of the last is 18 March. The 1982 annual mean high temperature was 19.8° C, and the mean low was 11.9° C, slightly warmer than in previous years.

Precipitation

62. Precipitation was reasonably well distributed throughout the year at the FRF, averaging 95 mm per month (Table 4). May through July usually tend to be high precipitation months, while September and October generally are low. However, January and February were peak precipitation months during 1982. Total precipitation for 1982 was 133 mm above the annual average, and two monthly maxima occurred.

Winds

63. Since local winds frequently control nearshore currents and wave conditions, an understanding of the wind and wave climate at any coastal

Table 3
Monthly and Annual Air Temperature Statistics
for 1982 and 1980-1981

Month	Mean High, °C		Maxima, °C	Mean Low, °C		Minima, °C
	1982	1980-1981		1982	1980-1981	
Jan	8.1	7.7	20	-1.2	0.1	-14 (1982)
Feb	10.9	6.9	22 (1982)	3.7	-0.5	-11
Mar	13.0	12.3	24	5.2	3.5	-7
Apr	16.9	20.6	30	8.6	11.3	-2 (1982)
May	24.3	23.2	35	14.8	14.3	6 (1982)
Jun	26.5	28.5	35	19.2	19.6	11
Jul	29.7	30.1	43	21.6	22.1	13
Aug	28.9	29.0	37	20.8	21.3	15
Sep	25.6	27.7	34	19.0	19.8	10 (1982)
Oct	20.8	20.6	29	13.5	12.4	4
Nov	18.0	15.5	27 (1982)	10.6	6.8	-3
Dec	15.1	11.2	25 (1982)	6.8	2.2	-12
Annual	19.8	19.2		11.9	11.0	

Table 4
Precipitation Statistics*

Month	1982	1978-1981	1978-1982	1978-1982	Extremes
	Total	Mean	Mean	Maxima		Minima
Jan	112	105	106	180	45
Feb	127	69	80	127 (1982)	46
Mar	63	85	80	137	48
Apr	131	76	87	131 (1982)	46
May	41	117	102	239	39
Jun	118	84	91	130	60
Jul	77	109	103	200	64
Aug	81	88	87	220	36
Sep	142	52	70	160	5
Oct	47	49	49	73	25
Nov	85	98	95	130	67
Dec	118	77	85	127	47
Monthly Average	95	84	86		
Annual	1,142	1,009	1,035		

* In millimetres.

location is important to most studies of hydrodynamic and sedimentary processes. In this section, wind characteristics at the FRF are discussed based on measurements made four times per day.

64. Winds at the FRF are dominated by tropical air masses which create low to moderate warm southern breezes, Arctic air masses which produce cold winds from northerly directions, and small-scale cyclonic, low pressure, systems which originate either in the tropics (and move north along the coast) or inland (and move east offshore) and are generally responsible for the strongest wind speeds. The winds at the FRF are predominantly from northeast and southwest due to the influence of these air systems.

65. Present year. Figure 6 shows the distribution of winds during 1982 as 40.6 percent blowing from north-northwest to east-northeast and 26.1 percent from south-southwest to west-southwest. The annual resultant wind speed was 0.8 m/sec with an associated north-northeasterly direction of 26 deg (Table 5).

66. The dominant wind direction changed with season, such that during January through March there was a mixture of northerly (arctic) and southerly (tropical) winds with frequent cyclones. However, northerly directions outnumbered southerly ones by two to one, while easterly and westerly directions were approximately even (Figure 7). The resultant wind speed was 1.9 m/sec, somewhat stronger than the annual resultant (Table 5). The resultant direction was 350 deg, indicating a strong northerly tendency and that western winds slightly dominated eastern wind directions. Over 15 percent of the time, the winds blew out of the north-northeast during this season. The wind speeds were not particularly strong, with 86.6 percent under 10 m/sec and only 1.5 percent exceeding 14 m/sec.

67. Low wind speeds and southerly directions during April through June are characteristic of the tropical trade winds. During this season southerly winds outnumbered northerly ones almost two to one. The resultant wind speed and direction were 0.8 m/sec and 179 deg, respectively. A distinct shift of direction occurred between April (resultant direction of 45 deg) and March (resultant direction of 196 deg). Ninety-three percent of the speeds were less than 10 m/sec.

68. July through September was very mild with all speeds 12 m/sec or less. Although the winds blew 10 percent more frequently from the south rather than from the north, they were predominantly from northeast-east

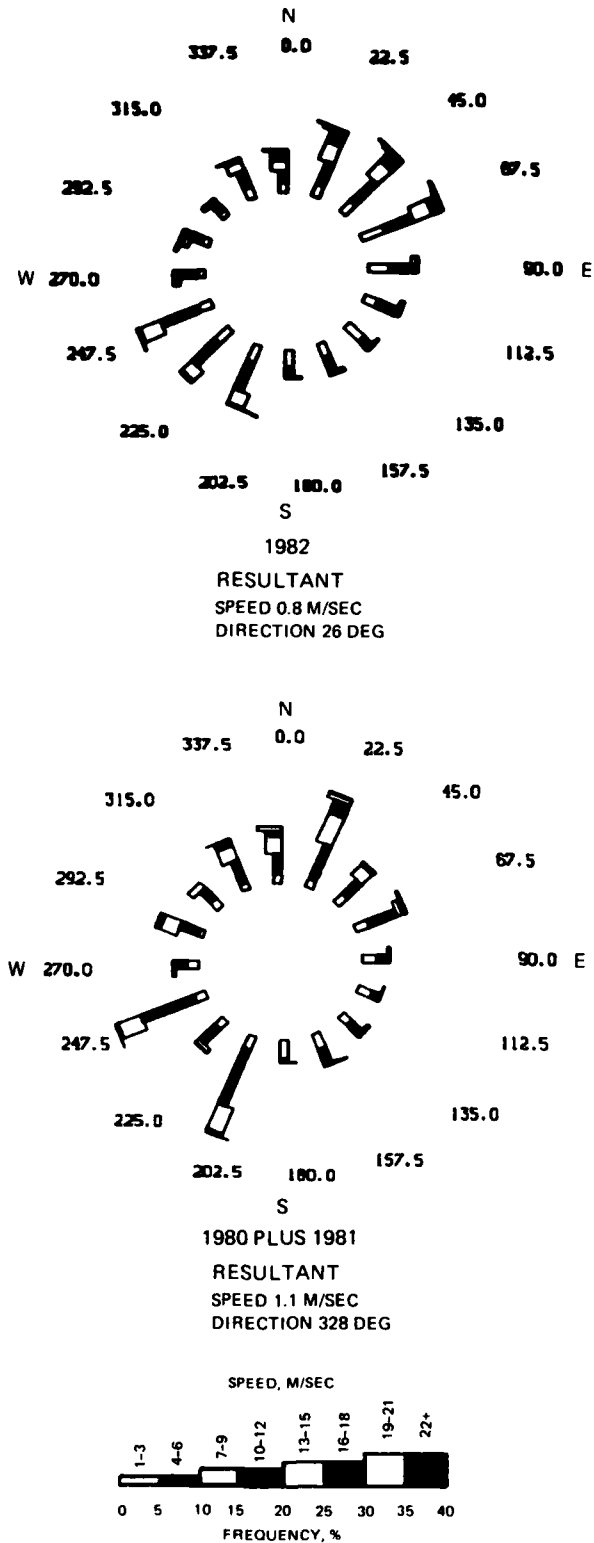


Figure 6. Comparison of annual wind roses for 1982 and 1980 plus 1981, reference true north

Table 5
FRF Resultant Wind Speed and Direction

	1982		1980-1981		1980-1982	
	Speed m/sec	Direction deg True N	Speed m/sec	Direction deg True N	Speed m/sec	Direction deg True N
<u>Annual</u>	0.8	26	1.1	328	0.9	344
<u>Seasonal</u>						
Jan-Mar	1.9	350	1.9	331	1.9	338
Apr-Jun	0.8	179	0.8	215	0.8	202
Jul-Sep	0.2	126	0.1	262	0.1	155
Oct-Dec	2.4	38	2.6	341	2.2	0
<u>Monthly</u>						
Jan	2.2	297	2.5	343	2.2	328
Feb	3.0	10	1.4	318	1.8	347
Mar	1.7	20	1.8	324	1.6	342
Apr	0.5	45	1.5	217	0.8	216
May	1.8	196	0.1	63	0.5	192
Jun	1.3	176	0.9	213	1.0	196
Jul	1.8	231	0.9	202	1.2	218
Aug	0.6	203	0.8	23	0.3	23
Sep	2.7	60	0.2	285	0.8	54
Oct	3.0	49	1.9	359	2.1	21
Nov	2.4	48	1.9	317	2.4	359
Dec	2.2	11	2.8	334	2.5	344

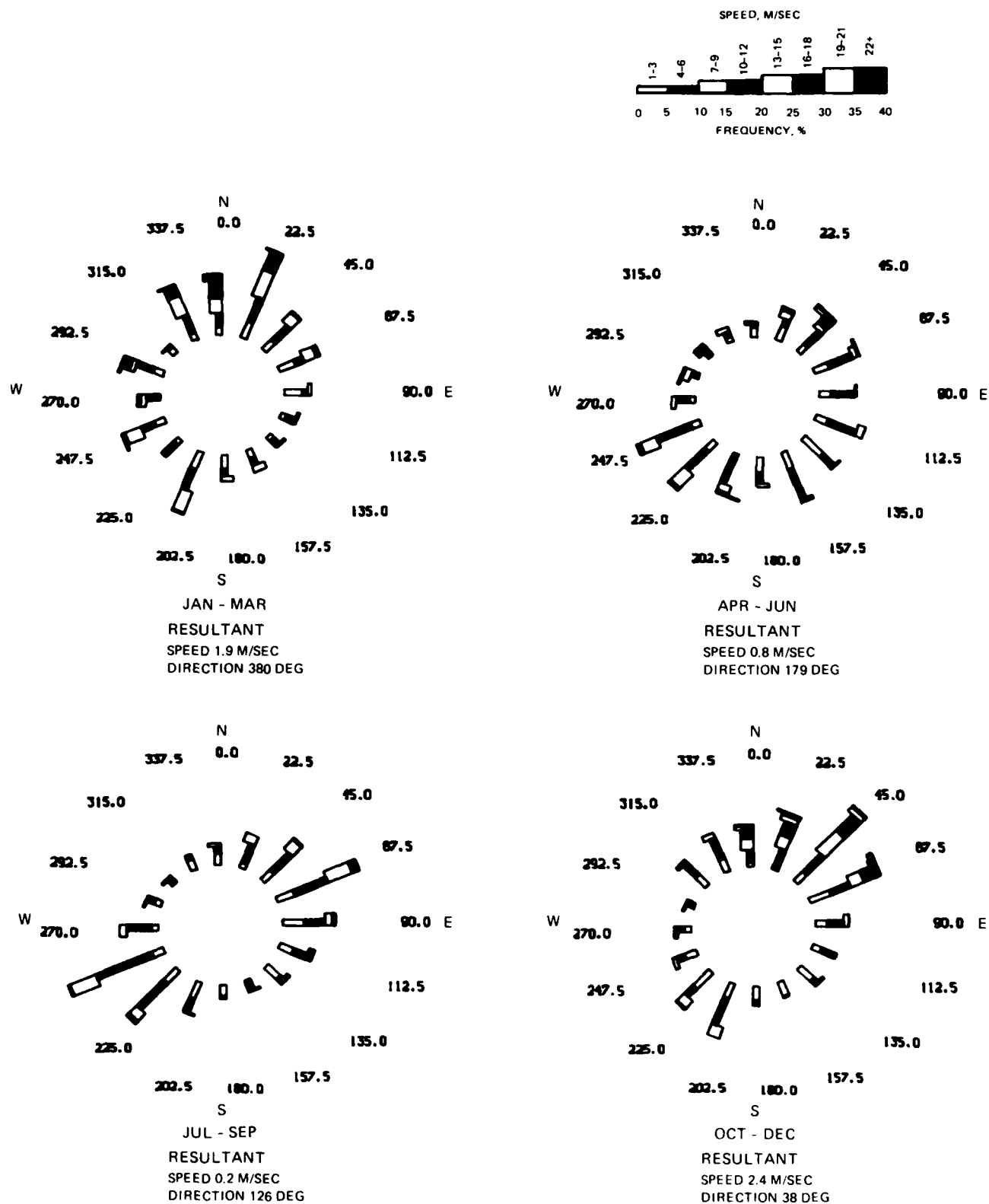


Figure 7. Seasonal wind roses for 1982, reference true north

(31 percent) and southwest-west-southwest (28 percent). The light winds and bimodal directional distribution produced a low seasonal resultant speed of 0.2 m/sec. The resultant southerly direction persisted through August when a shift back to northerly directions occurred; the seasonal resultant was 126 deg.

69. October through December brought a shift back to the northerly dominance, with percentages again two-to-one more frequent. Unlike January through March, in which easterly and westerly directions were evenly split, during this season winds were easterly more than 52 percent of the time (15 percent more often than westerly directions). The resultant speed, 2.4 m/sec, was the highest of all seasons. The resultant direction was 38 deg, reflecting the predominance of strong northeast winds.

70. The highest wind speeds occurred during October through December; 14 percent equaled or exceeded 10 m/sec. Three percent were greater than or equal to 15 m/sec, and on two occasions average speeds in excess of 22 m/sec were observed.

71. Present versus past years. The pattern of predominant wind direction rotation from northerly during the cold months (January through March and October through December) to southerly during the warm months (April through September) and strong winds from the east during October through December is consistent with that during past years at the FRF (Figures 6 and 7). However, during 1982, the winds blew far more often from the easterly directions and less often from the north through northwesterly direction than past records have shown (Table 5). The annual resultant magnitudes are comparable, while the directions show a 58 deg shift toward the east. The tendency for winds to blow more often from the easterly directions during September, October, and November 1982 is demonstrated by comparison of these data with data from September, October, and November of 1980 and 1981 combined (Table 6). The difference between the distribution of winds for 1982 and previous years was due, in part, to unseasonable westerly winds in the upper atmosphere (National Climatic Data Center 1983).

72. Combination of years--1980 through 1982. The distribution of winds for the combined 1980 through 1982 data indicates a strong northeasterly and southwesterly tendency with few northwesterly and southeasterly winds (Figure 8). Seasonal variations are large, with northern winds dominating during the fall and winter and southern winds during spring and summer (Figure 8 and Table 5).

Table 6
Comparison of Wind Directions for
1982 Versus 1980 Plus 1981*

<u>Direction</u>	<u>September</u>		<u>October</u>		<u>November</u>	
	<u>1982</u>	<u>1980 Plus 1981</u>	<u>1982</u>	<u>1980 Plus 1981</u>	<u>1982</u>	<u>1980 Plus 1981</u>
North-Northeast	4.4	13.5	6.7	19.0	9.5	9.6
Northeast	15.0	7.4	17.6	4.2	18.1	1.8
East-Northeast	26.5	11.2	13.4	5.5	14.7	4.2
East	11.5	1.9	10.9	0.4	4.3	1.8
Total	57.4	34.0	48.6	29.1	46.6	17.4

* In percentages.

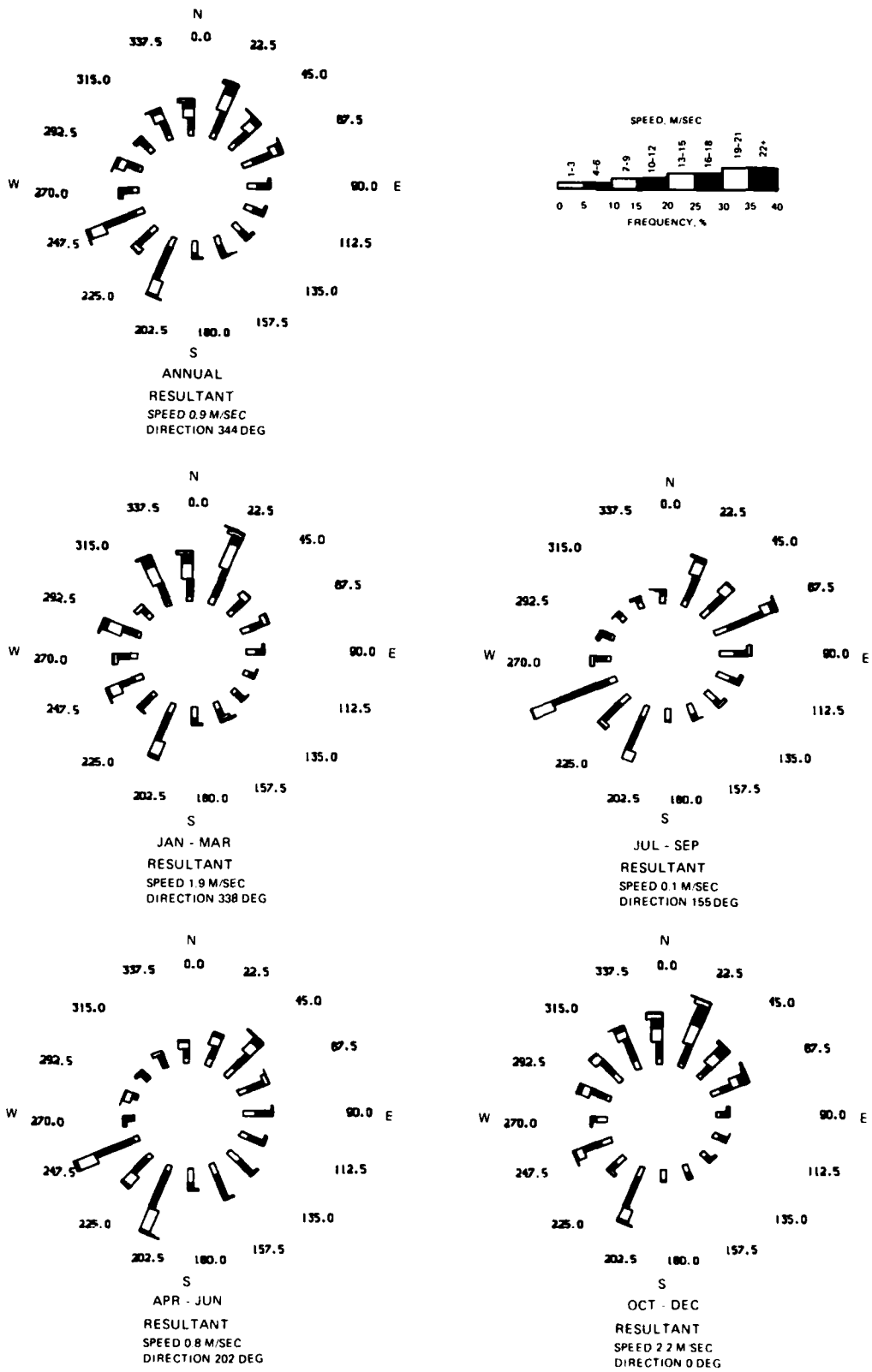


Figure 8. Annual and seasonal wind roses for 1980 through 1982

73. Less than 1 percent of the wind speeds has been observed to equal or exceed 15 m/sec, while on only one occasion during any year would the speed be expected to exceed 20 m/sec (recall the speed is an average computed over at least 10 min), as indicated in Table 7. Wind speeds are most often between 5 and 10 m/sec.

Table 7
Wind Speed Distribution* for 1980-1982

<u>Wind Speed, m/sec</u>	<u>Annual</u>	<u>Jan-Mar</u>	<u>Apr-Jun</u>	<u>Jul-Sep</u>	<u>Oct-Dec</u>
20+	0.2	0.1	0.4	0.0	0.3
15-19	0.6	0.7	0.1	0.3	1.1
10-14	7.9	9.9	4.5	2.9	13.5
5-9	49.3	52.5	52.4	47.7	44.7
0-4	42.0	36.8	42.6	49.1	40.4

Wave Data

74. This section presents summaries of the wave data collected at the FRF. A review of the wave conditions during 1982 and a comparison to previous years is followed by a discussion of the wave climate for 1980 through 1982 combined. Appendix B contains summaries for each gage which include height and period distributions, wave direction distributions, and persistence tables. A discussion of individual major storms is given in Part VI, and Appendix D contains hourly wave data for times when the heights H_{m_0} exceeded 2 m at the seaward end of the FRF pier.

Present data year

75. Spatial variation. The distribution of wave heights for buoy gage 620, located 3 km offshore, and pier end staff gage 625 were essentially the same for heights below 3 m during 1982 (Figure 9). For the few observed heights above 3 m, wave heights were larger at the gage located 3 km from shore than they were at the gage at the seaward end of the pier. Refraction, bottom friction, and the effect of depth in limiting the wave energy in a spectrum would cause the observed differences in storm wave heights. Wave statistics for staff gage 615, located at the landward end of the pier in

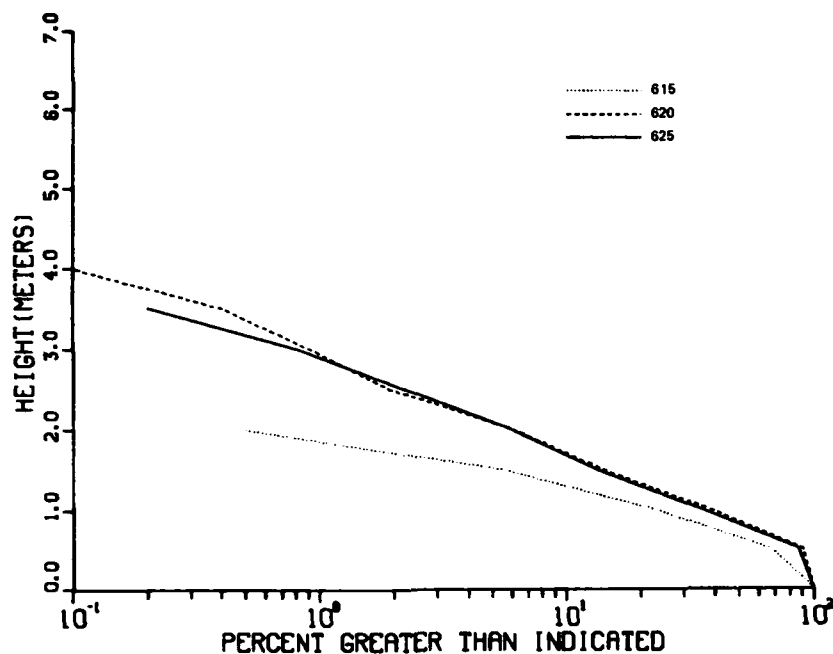


Figure 9. Annual wave height distributions for 1982

shallow water, differed from those of the other gages as can be seen in Figure 9 and Table 8. In all but the very calmest conditions, gage 615 is within the breaker zone. Consequently, these statistics represent a lower energy wave climate in which the annual mean height (0.7 m) is more than 20 percent less than at the seaward gages (0.9 m).

Table 8
Annual Wave Statistics for 1982

Gage	Depth, m	Mean H_{m_0} , m	Standard Dev, m	Mean T_p , sec	Standard Dev, sec	Maximum H_{m_0} , m	Date
620	18	0.9	0.5	8.3	2.6	4.3	25 October
625	9	0.9	0.5	8.6	2.7	3.5	25 October
615	2	0.7	0.4	7.8	3.0	2.2	25 October

76. Although the distribution of wave periods was similar for gages 620 and 625 (Figure 10), gage 615 had more wave periods less than 7 sec and fewer periods 8 sec or longer than the gages in deeper water. Wave breaking seaward of the gage again appears to affect the wave climate at this location. Gage 620 recorded more frequent 7 sec or less periods and less frequent 10 sec

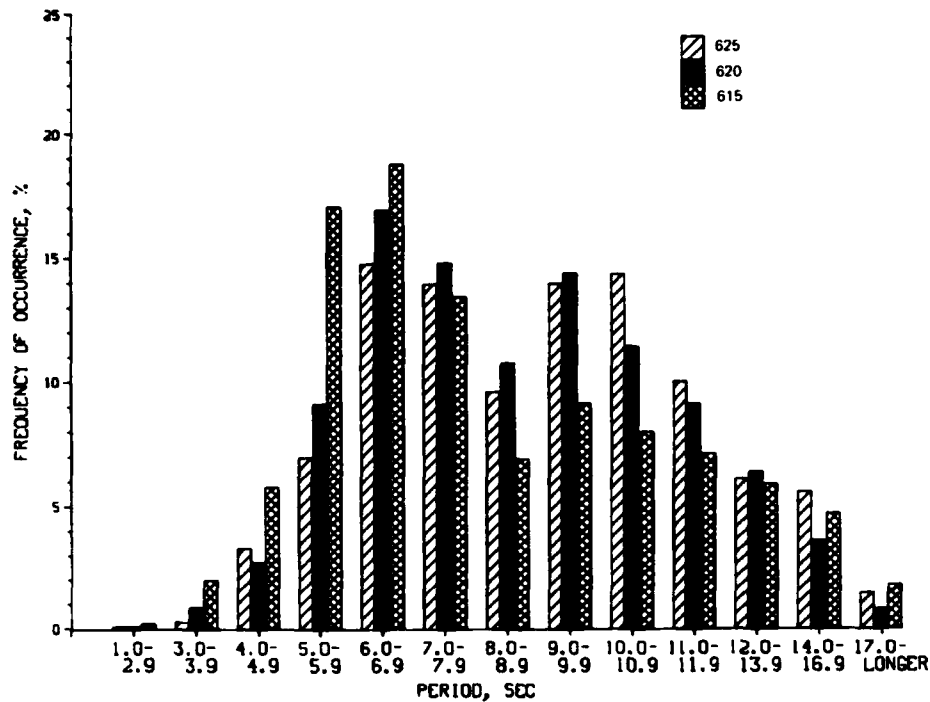


Figure 10. Annual wave period distributions for 1982

or longer periods than did gage 625. The higher percentage of short period waves at gage 620 is believed to result, in part, from the differences in fetch for winds blowing from the west. The fetch at gage 625 is only about 0.5 km, while that at gage 620 is about 3 km, sufficiently long to allow some wave growth.

77. The distribution of wave directions for the year (Figure 11) revealed that waves approached from the south side of the pier (i.e., from >70 deg) 20 percent more frequently than from the north side. However, for storm wave conditions, the distribution was three-to-two favoring waves approaching from the north side.

78. Temporal variation. The monthly and seasonal variations in wave characteristics were consistent with the wind variations (see paragraph 65). Temporal trends for gages 625 and 620 are shown in Figures 12 and 13, respectively, and are consistent with those for gage 615. Seasonal wave height distribution variations (Figure 14) were similar for all gages. Waves were highest between October and December 1982 when they could be expected to exceed 2 m 15 percent of the time (twice as often as between January and March). Wave heights were at a minimum between July and September, exceeding 2 m on only four occasions.

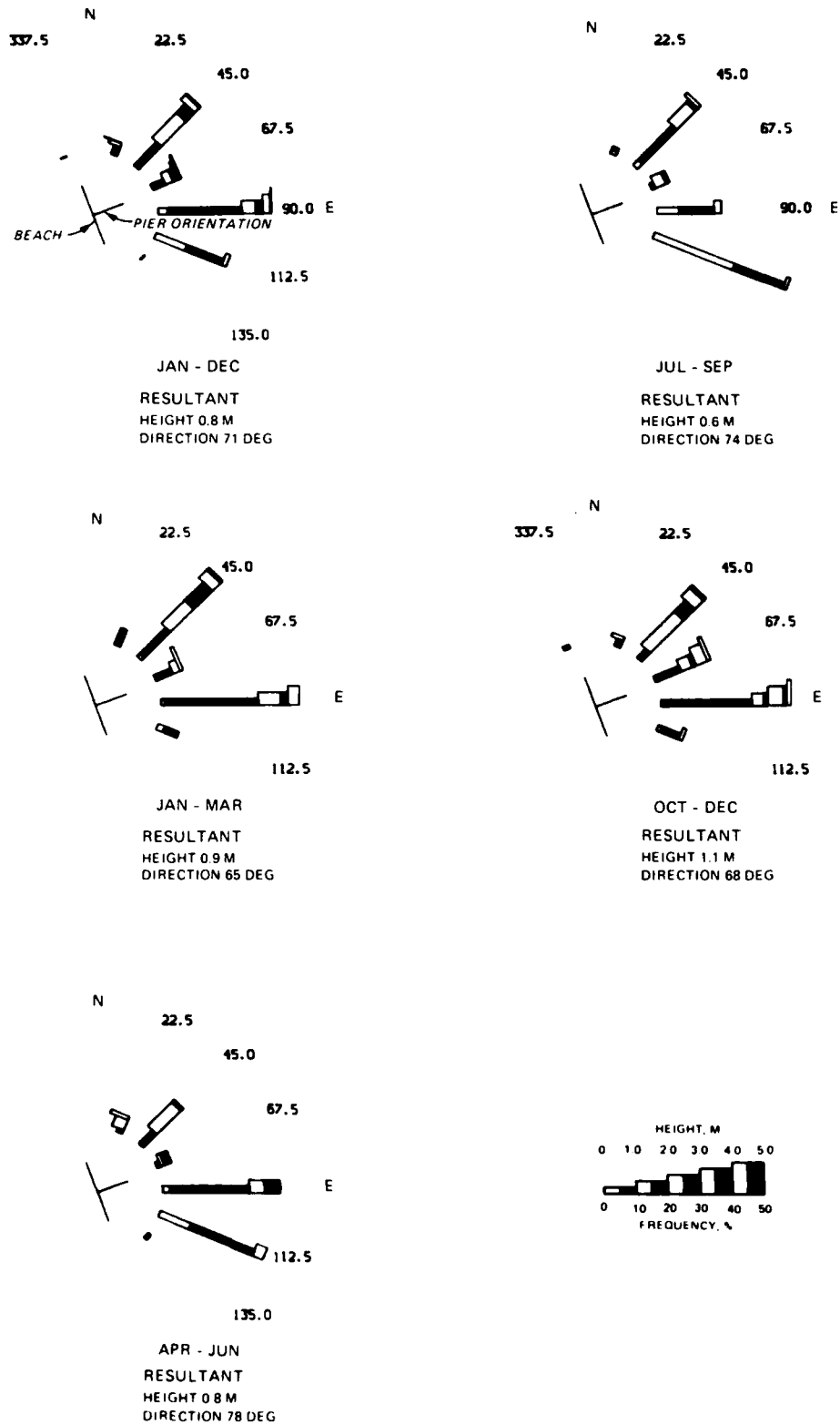
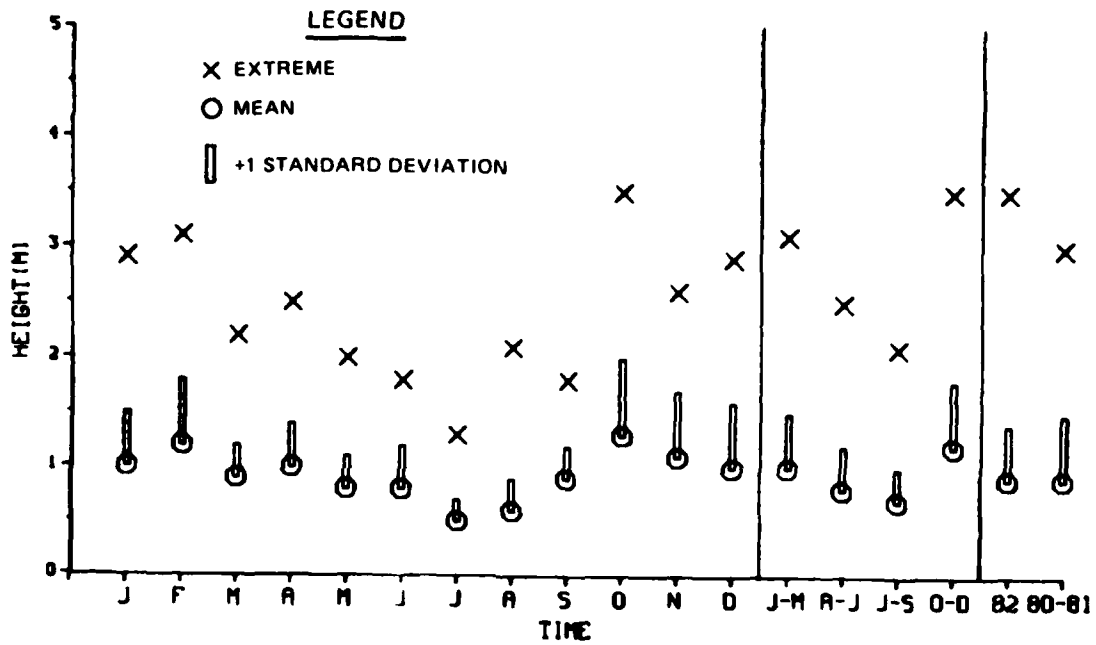
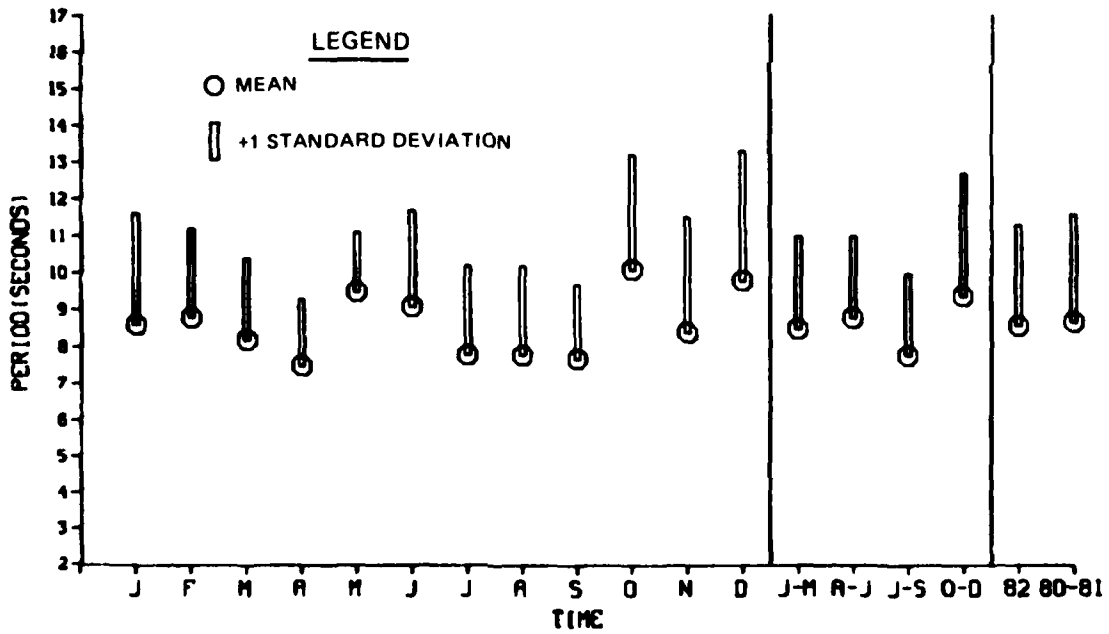


Figure 11. Annual and seasonal wave roses for 1982, reference true north

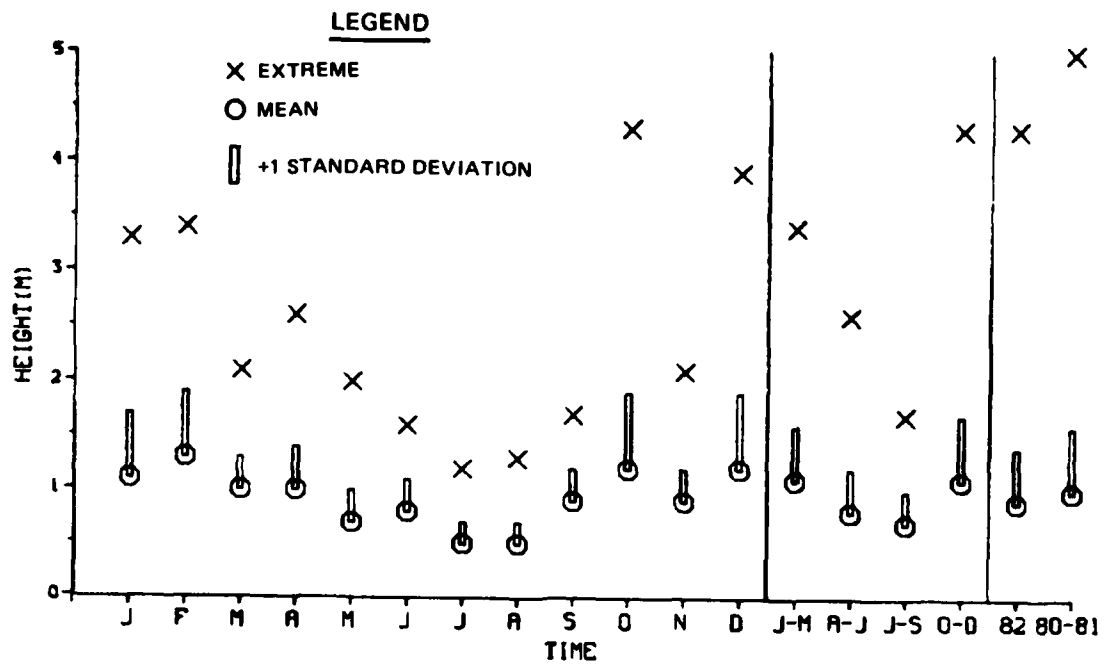


a. Wave height

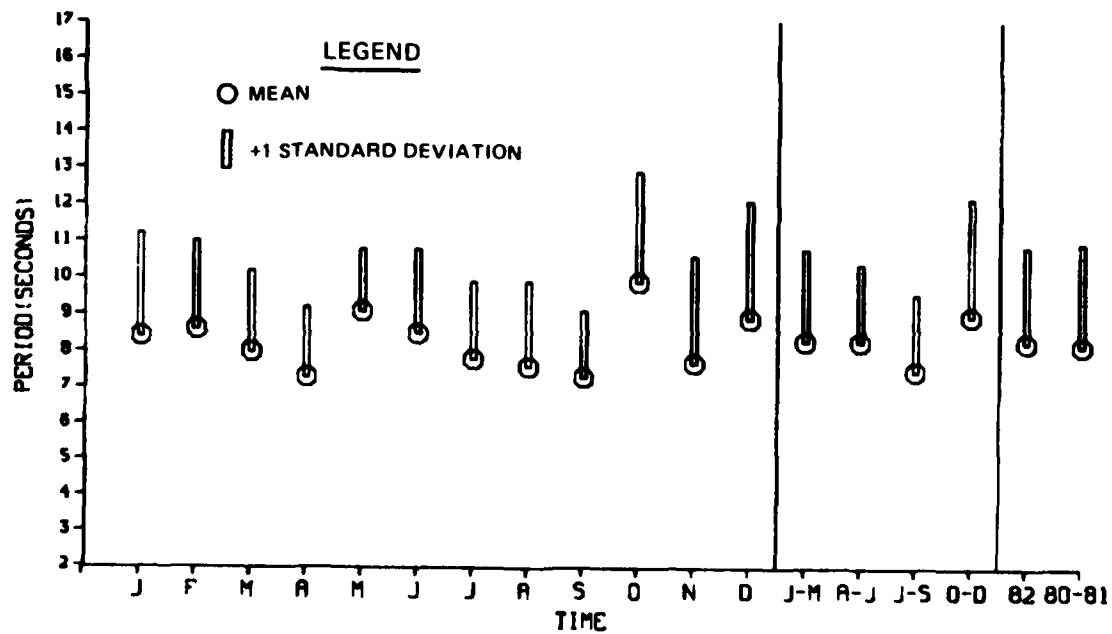


b. Wave period

Figure 12. 1982 monthly, seasonal, and annual wave statistics for gage 625



a. Wave height



b. Wave period

Figure 13. 1982 monthly, seasonal, and annual wave statistics for gage 620

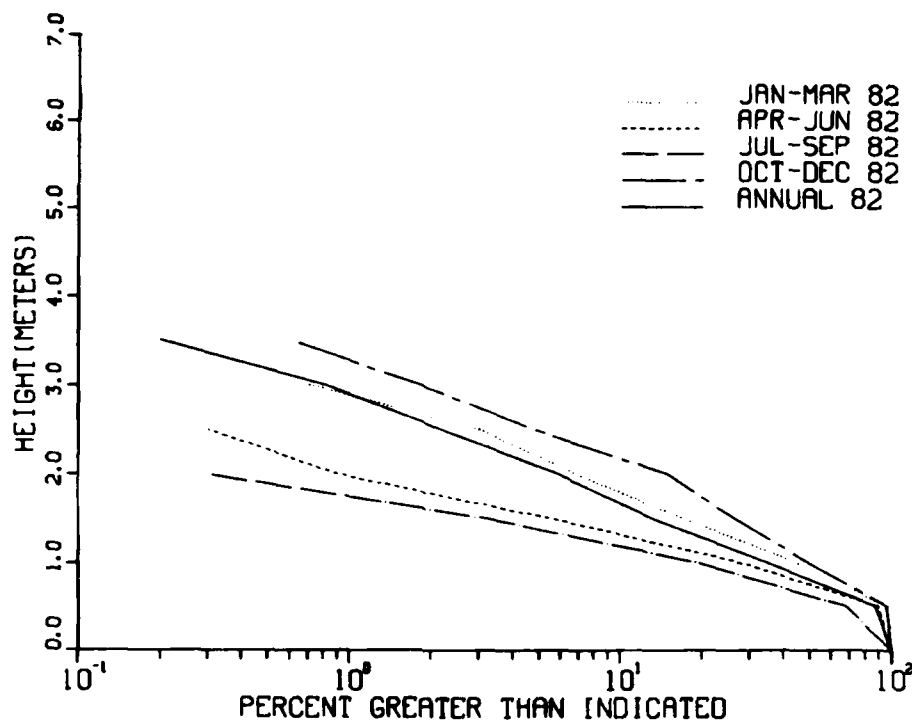


Figure 14. 1982 annual and seasonal cumulative distribution of wave height for gage 625

79. Mean seasonal wave period values (Figures 12 and 13) varied similarly to the mean wave heights; i.e., during October to December the periods were longest, and from July to September they were shortest. Trends in the variation of wave period by season are highlighted by Table 9. The exceptionally calm summer was dominated by local winds which produced wave periods predominantly shorter than 10 sec, while two storms during October resulted in a much larger number of periods 14 sec or longer.

80. Approximately 50 percent of the daily observations of wave direction indicated the primary wave train approached from the south side of the pier (i.e. >70 deg) during January to March and October to December, while 72

Table 9
Seasonal Wave Period Distributions for 1982

Season	Period, sec			
	<6	7-9	10-12	14≤
Jan-Mar	26	32	38	4
Apr-Jun	14	48	33	5
Jul-Sep	34	45	19	2
Oct-Dec	27	24	32	17

and 64 percent were from the south during the spring and summer, respectively (Figure 11). There was a stronger northerly tendency during storm conditions (i.e., 58 percent of the storm waves approached from the north).

Present versus past years

81. The wave climate during 1982 was similar to that in previous years. Annual wave height distributions for 1982 (gage 625) showed small differences in comparison to the distribution for the combined 1980 and 1981 data (Figure 15). With the exception of July to September (Figure 16), seasonal distributions were similar, also. The variation of mean monthly H_{m0} during 1982 for gage 625 versus 1980 through 1981 was inconsistent (Table 10). Individual months differed as much as 37 percent as in June. For any given month, there were large variations, year to year, in the frequency of storm waves ($H_{m0} > 2$ m). However, seasonal frequencies were consistent.

82. The distributions of wave periods for 1982 and prior years (Figure 17) were similar, with the exception of more frequent long-period waves (12 to 17 sec) between October and December 1982, primarily due to two storms in October 1982.

83. Unlike the similarity between 1982 and previous years for the wave height and period distributions, the distribution of wave direction for 1982 showed that a larger percentage of waves approached from the south. The annual resultant wave direction was about shore-normal, 8 deg southward of the 1980 plus 1981 resultant (Table 11).

All years combined

84. The 3-year data set between 1980 and 1982 provides the most reliable description of the wave climate at the FRF. Spatial differences in wave height are shown in Figure 18. Note the effect of large waves breaking seaward of the gage 615 location. For gages 620 and 625, wave height distributions are almost identical up to 2.5 m. Over 2.5 m, they differ by as much as 17 percent (i.e., 0.5 percent of the wave heights at gage 620 exceeded 3.5 m, while the corresponding height was only 3.0 m at gage 625). In deeper water, wave heights in excess of 2 m can be expected to occur 600 hr per year (7 percent of the time), and wave heights in excess of 3 m can be expected to occur at gage 625 only about 44 hr per year. Seasonal height distributions indicate that the greatest frequency of high waves occurs between October and December, while the least severe season is April to June (not July to September, as during the very mild summer of 1982).

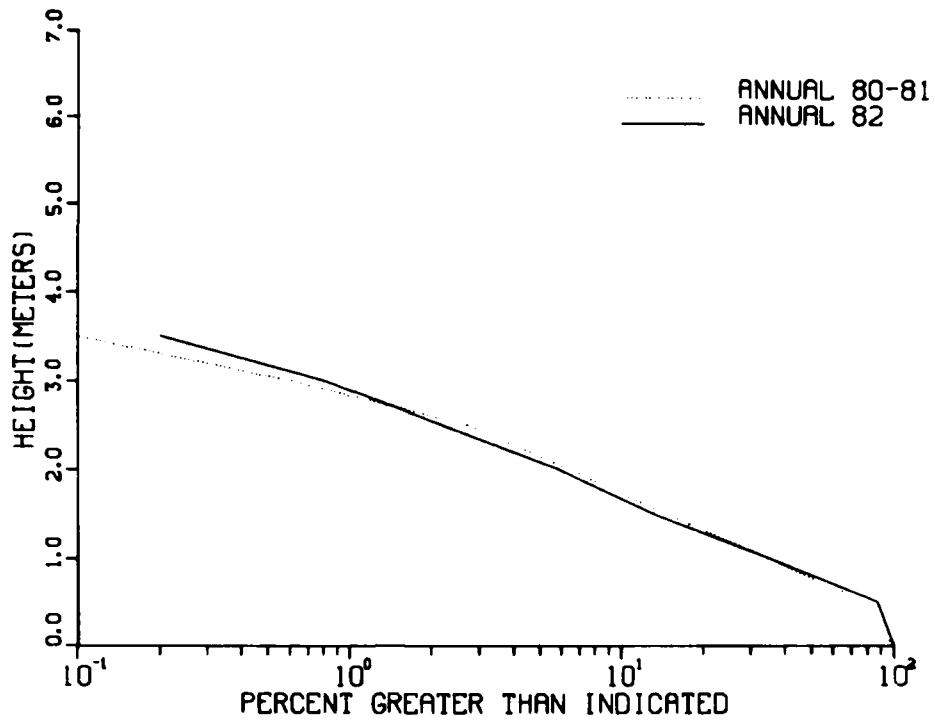


Figure 15. Comparison of annual wave height distributions for gage 625

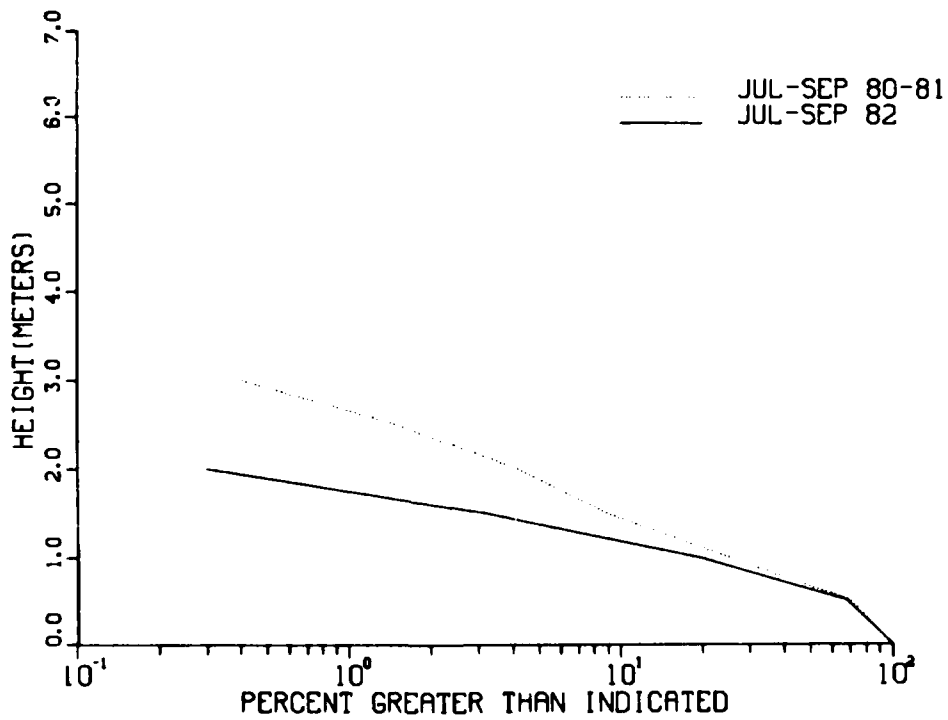


Figure 16. Comparison of July through September wave height distributions for gage 625

Table 10
Comparison of Mean Wave Height Statistics
for Gage 625

Month	1982		1980 Plus 1981	
	H_{m_o} , m	Standard Deviation, m	H_{m_o} , m	Standard Deviation, m
<u>Annual</u>				
Jan-Dec	0.9	0.5	0.9	0.6
<u>Seasonal</u>				
Jan-Mar	1.0	0.5	1.1	0.6
Apr-Jun	0.8	0.4	0.7	0.4
Jul-Sep	0.7	0.3	0.8	0.5
Oct-Dec	1.2	0.6	1.1	0.6
<u>Monthly</u>				
Jan	1.0	0.5	1.0	0.6
Feb	1.2	0.6	1.0	0.5
Mar	0.9	0.3	1.1	0.6
Apr	1.0	0.4	0.7	0.4
May	0.8	0.3	0.8	0.4
Jun	0.8	0.4	0.5	0.2
Jul	0.5	0.2	0.6	0.3
Aug	0.6	0.3	0.8	0.6
Sep	0.9	0.3	0.9	0.5
Oct	1.3	0.7	1.1	0.6
Nov	1.1	0.6	1.1	0.7
Dec	1.0	0.6	1.0	0.6

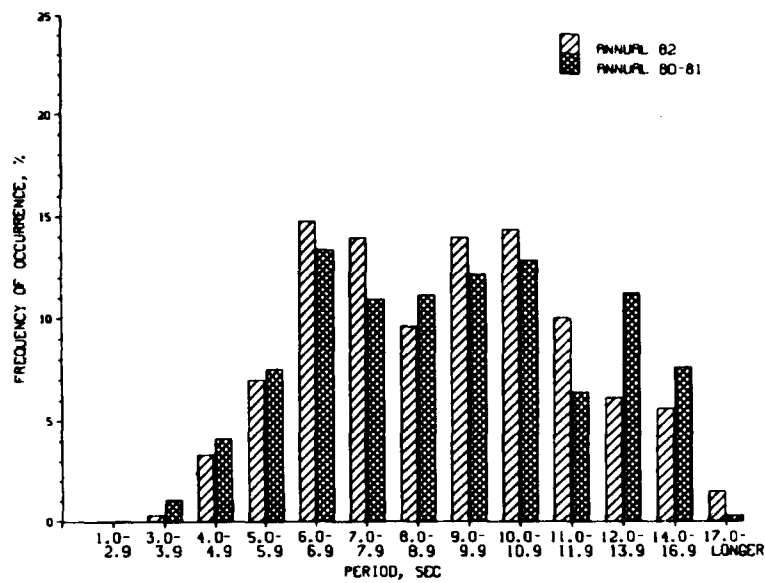


Figure 17. Comparison of annual wave period distributions for gage 625

Table 11

Resultant Wave Height and Direction at the FRF

Month	1982		1980 Plus 1981		1980-1982	
	Height, m	Direction deg True N	Height, m	Direction deg True N	Height, m	Direction deg True N
			<u>Annual</u>			
Jan-Dec	0.8	71	0.8	63	0.8	66
			<u>Seasonal</u>			
Jan-Mar	0.9	65	0.9	59	0.9	62
Apr-Jun	0.8	78	0.6	75	0.6	76
Jul-Sep	0.6	74	0.7	71	0.6	72
Oct-Dec	1.1	68	1.0	55	1.0	60
			<u>Monthly</u>			
Jan	0.8	62	0.9	42	0.8	50
Feb	1.1	60	0.9	67	1.0	64
Mar	0.8	75	0.9	64	0.9	68
Apr	0.8	73	0.6	68	0.7	70
May	0.7	79	0.7	76	0.7	77
Jun	0.7	82	0.5	81	0.6	81
Jul	0.4	82	0.5	77	0.4	79
Aug	0.5	73	0.7	69	0.6	70
Sep	0.8	70	0.8	70	0.8	70
Oct	1.2	75	1.1	56	1.1	64
Nov	1.0	67	1.1	52	1.1	57
Dec	1.0	59	0.8	60	0.9	60

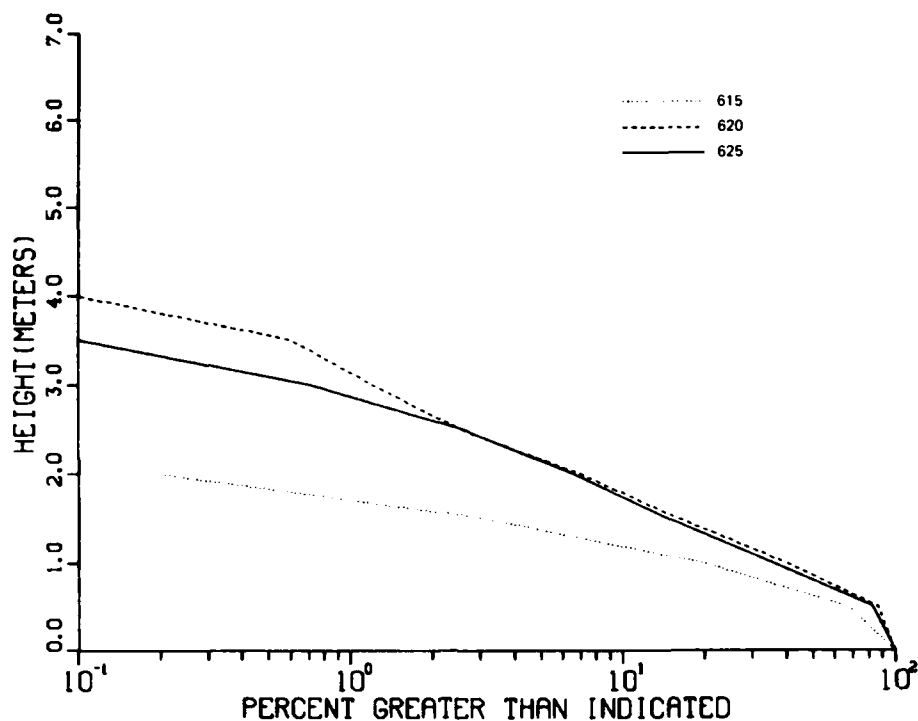


Figure 18. Wave height distributions for 1980 through 1982

85. The addition of one year of 1982 data to the 1980 and 1981 data set did not noticeably change the annual wave height distribution (Figure 19) nor the spring, fall, and winter data. The July to September distribution was lowered by only 0.1 to 0.2 percent.

86. Distribution of wave periods for the combined data set was similar for all gages (Figure 20) with most periods being between 5 and 12 sec. As with the height distribution, the addition of data for 1982 had little effect on the wave period distribution. Table 12 presents the joint distribution of wave heights and periods for gages 625 and 620 for the combined 1980-1982 data. For storm conditions when H_{m0} exceeded 2 m, there was a range of periods from 6 to 17 sec, although as the heights increased the periods tended to increase also.

87. Wave direction of approach for the combined data (Figure 21) was approximately evenly split between directions north and south of the pier axis. However, storm waves approached twice as frequently from the north than from the south.

88. Summary statistics have been presented which show that wave conditions at the FRF have a spatial and temporal variation. The cold months of

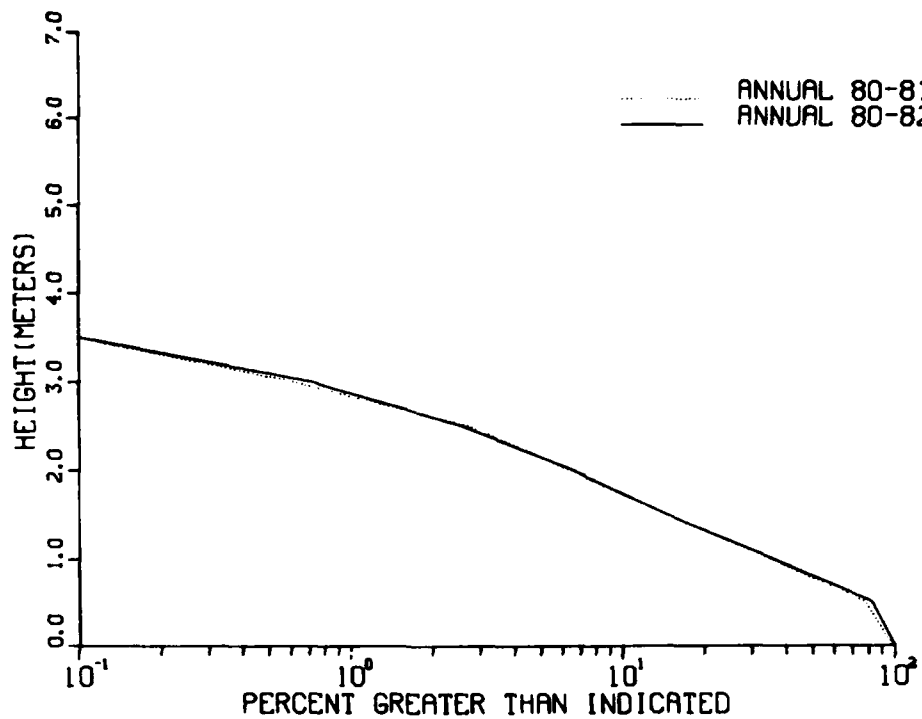


Figure 19. Comparison of long-term wave height distributions for gage 625

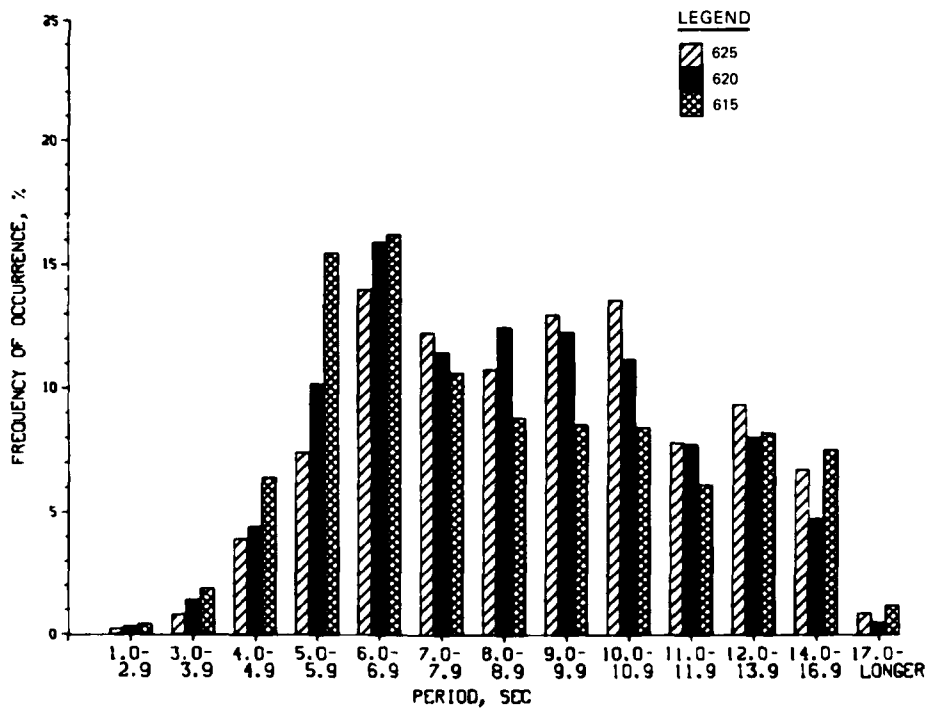


Figure 20. Annual wave period distributions for 1980-1982

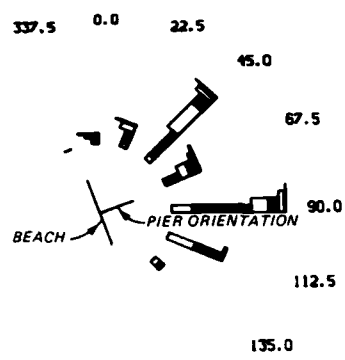
Table 12
Joint Distribution of Wave Height Versus
Period for 1980-1982

Gage 625

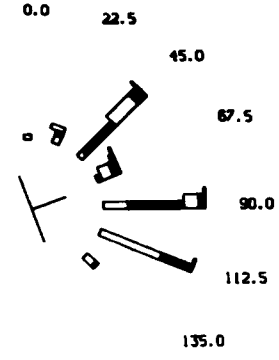
HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	2	2	3	11	20	28	33	25	10	18	17	1	170
.50 - .79	.	6	30	36	58	49	53	69	68	39	30	23	5	466
1.00 - 1.49	.	.	6	28	46	33	15	17	28	15	21	6	.	215
1.50 - 1.99	.	.	1	7	20	13	4	4	8	7	9	8	1	82
2.00 - 2.49	3	5	3	3	2	5	8	9	1	39
2.50 - 2.99	1	2	3	2	2	1	5	3	1	20
3.00 - 3.49	1	1	1	1	1	1	.	6
3.50 - 3.99	1	.	1	.	.	2
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	8	39	74	139	122	107	129	135	78	93	67	9	

Gage 620

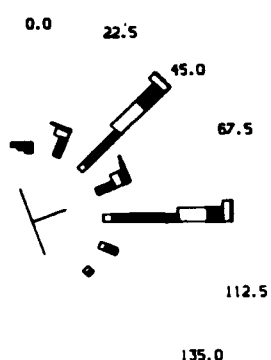
HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	1	3	7	8	13	26	29	13	5	15	8	1	130
.50 - .99	2	12	29	49	56	48	63	64	58	39	25	20	2	467
1.00 - 1.49	.	1	11	34	57	31	20	17	25	18	20	6	1	241
1.50 - 1.99	.	.	1	9	28	12	8	5	10	6	8	6	.	93
2.00 - 2.49	.	.	.	2	8	7	4	4	3	4	7	5	1	45
2.50 - 2.99	.	.	.	.	1	3	1	1	1	2	3	1	.	13
3.00 - 3.49	.	.	.	.	.	.	2	1	1	1	1	.	.	5
3.50 - 3.99	.	.	.	.	.	.	.	1	1	1	1	1	.	5
4.00 - 4.49	.	.	.	.	.	.	.	.	.	1	.	.	.	1
4.50 - 4.77	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3	14	44	101	158	114	124	122	111	77	80	47	5	



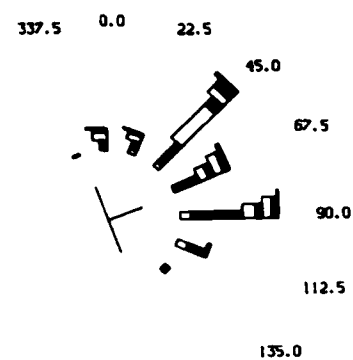
JAN - DEC
 RESULTANT
 HEIGHT 0.8 M
 DIRECTION 66 DEG



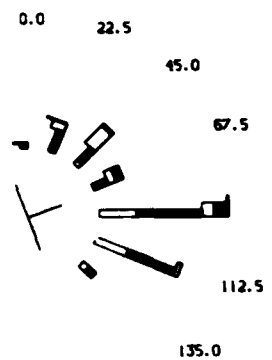
JUL - SEP
 RESULTANT
 HEIGHT 0.6 M
 DIRECTION 72 DEG



JAN - MAR
 RESULTANT
 HEIGHT 0.9 M
 DIRECTION 62 DEG



OCT - DEC
 RESULTANT
 HEIGHT 1.0 M
 DIRECTION 60 DEG



APR - JUN
 RESULTANT
 HEIGHT 0.6 M
 DIRECTION 76 DEG

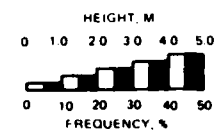


Figure 21. Annual and seasonal wave roses for 1980-1982, reference true north

January to March and October to December are times of high, generally longer, period storm waves approaching from the north. The spring and summer are characteristic of low southern seas. Annual distributions of wave height and period for 3 years of data are relatively stable. Seasonal variations are on the order of 0.5 to 1 percent, and monthly changes may be even greater.

Current Data

89. Spatial and temporal variations of longshore surface currents are discussed in this section. Surface current speed and direction at the FRF are influenced by winds, waves, and, indirectly, bottom topography. The extent of the respective influence varies daily. However, winds tend to dominate the currents at the seaward end of the pier, while the breaker angle and height dominate within the surf zone. During extreme wave conditions, the seaward end of the pier is within the breaker zone; consequently, currents measured there are strongly influenced by waves. The effect of the bottom topography is such that under certain conditions rip currents develop which interrupt the general flow of the alongshore current. The trough under the pier is a preferred location for such currents, and some were measured in excess of 1 m/sec. This report concentrates on the long-term alongshore currents, since a complete study of rip currents would require intensive measurements over a relatively short time scale.

90. Surface current measurements were made daily at about 0700 EST by timing the movement of dye patches at three locations: (a) the seaward end of the pier; (b) the midsurf zone position under the pier; and (c) along the beach 500 m updrift of the pier.

Present data year

91. Spatial variability. Since the relative influences of wind speed and direction and breaker angle on nearshore surface currents vary with location at the FRF, there is significant variability between the mean monthly and annual values for these locations (Figure 22) and the daily measurements of surface currents (Figure 23).

92. Currents at the seaward end of the pier were usually lower than those at the midsurf position (midway between the seawardmost breaker position and the beach) and consistently southward throughout the year. At the midsurf location, currents were fastest and varied from southward to northward with season as the wave angles varied (paragraph 80). Currents measured from the

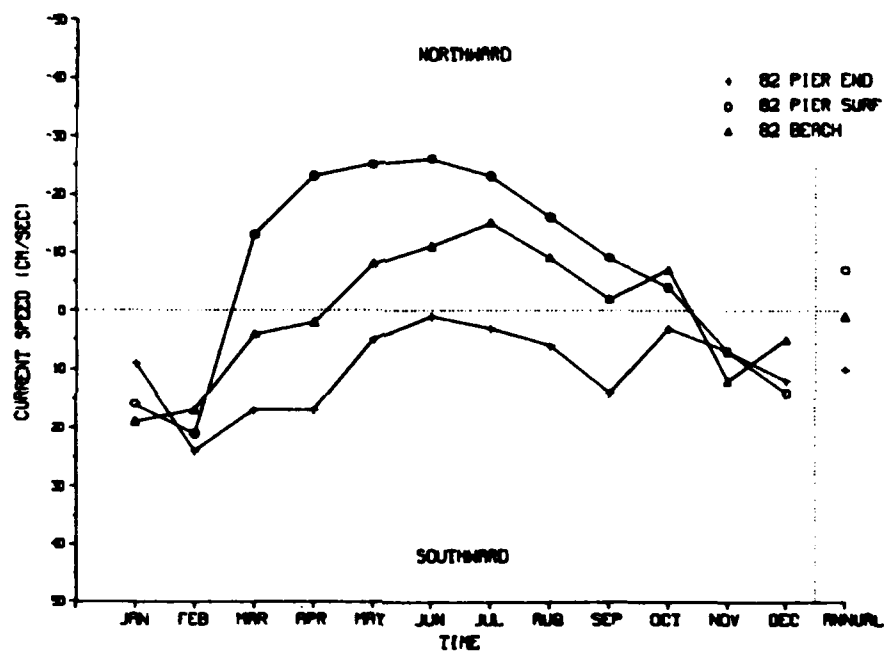
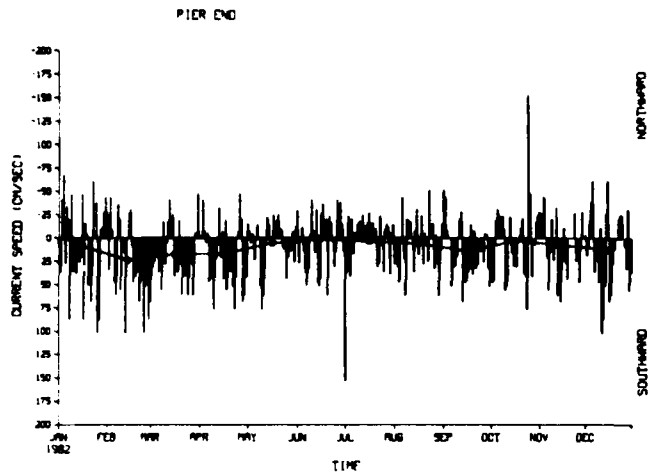
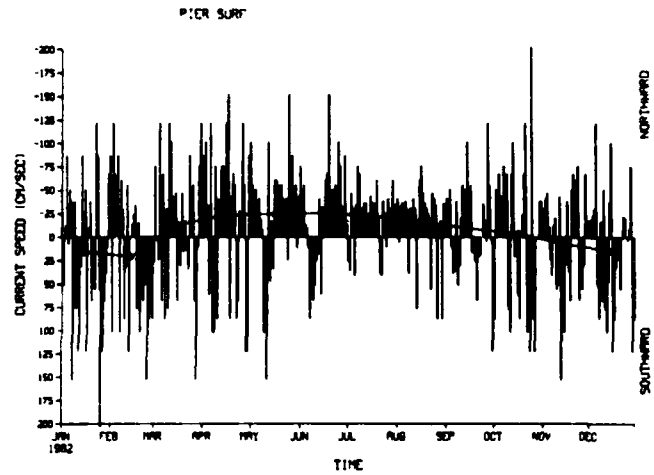


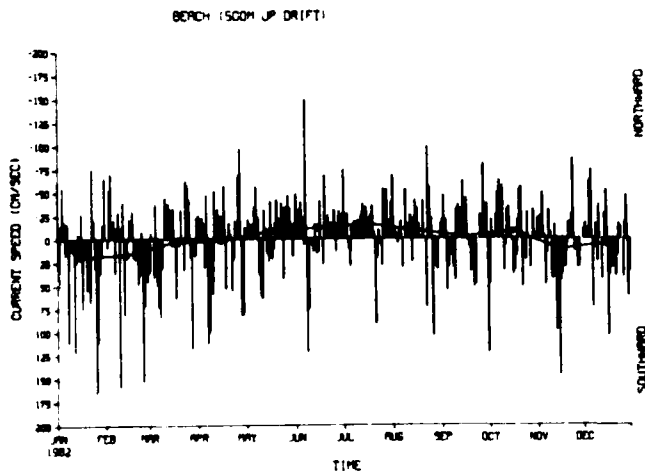
Figure 22. Mean surface currents for 1982



a. Pier end



b. Midsurf



c. Beach (500 m updrift)

Figure 23. Daily longshore surface currents at the seaward end and midsurf location of the FRF pier and 500 m updrift on the beach for 1982

beach (10 to 15 m from shore) were generally faster than those at the end of the pier but slower than those at the midsurf location; current directions at the beach agreed well with the midsurf directions. Mean annual current values (Table 13) show an approximately even distribution of northward and southward currents measured at the beach, a southward mean at the pier end, and a northward resultant at the midsurf position. Monthly mean currents tend to agree best during high wave conditions (i.e. January, February, and October through December).

Table 13
Monthly and Annual Longshore Surface
Currents at the FRE*

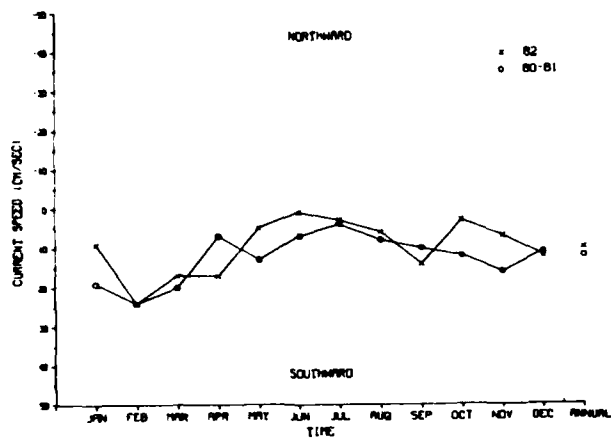
Month	Pier End, cm/sec			Pier Surf, cm/sec			Beach, cm/sec		
	1982	1980-1981	1980-1982	1982	1981	1981-1982	1982	1981	1981-1982
Jan	9	19	17	16	26	21	19	12	14
Feb	24	24	24	21	-9	6	17	6	10
Mar	17	20	19	-13	21	4	4	10	8
Apr	17	7	9	-23	-2	-13	2	-1	0
May	5	13	11	-25	7	9	-8	0	-3
Jun	1	7	6	-26	-13	-20	-11	-13	-12
Jul	3	4	4	-23	-16	-20	-15	-16	-16
Aug	6	8	8	-16	0	-8	-9	-10	-10
Sep	14	10	11	-9	-10	-10	-2	-9	-7
Oct	3	12	10	-4	25	11	-7	24	14
Nov	7	16	14	7	22	15	12	20	17
Dec	12	11	11	14	23	19	5	14	11
Annual	10	12	12	-7	6	-1	1	3	2

* + = southward; - = northward.

93. Temporal variability. Monthly mean currents in January, February, November, and December were directed southward at all locations during 1982. During the spring and summer, they were directed northward at both nearshore locations. However, frequent reversals occurred throughout the other months. This seasonality of currents was consistent with wind and wave patterns previously discussed.

1982 versus previous years

94. Longshore current speed and direction for 1982 were reasonably consistent with those of previous years at the seaward end of the pier and at the beach (Figure 24), though strong northward flow during two storms did



b. Beach (500 m updrift)

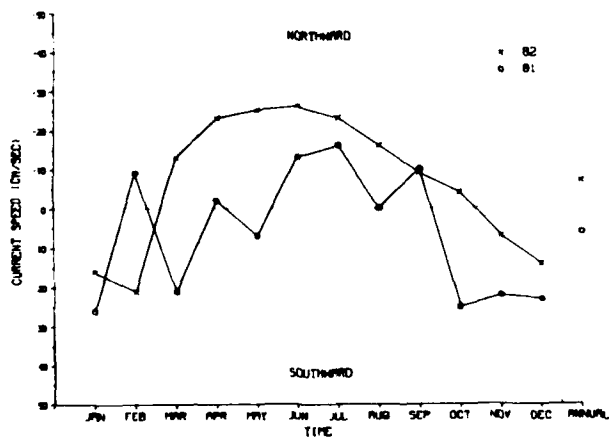
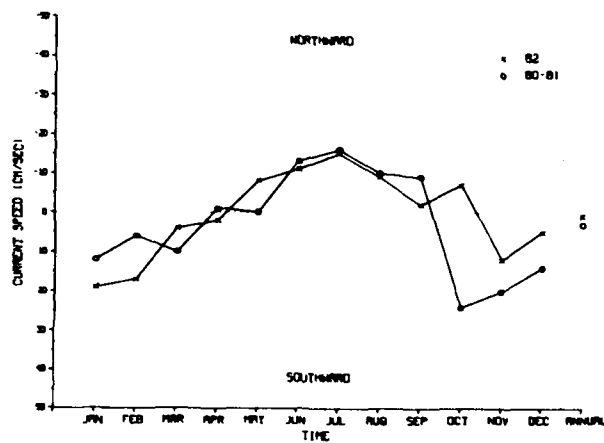


Figure 24. Comparison of surface currents at the FRF pier

cause October 1982 to show an anomalously northward predominance. The midsurf currents show large differences between 1981 (only previous year of measurement) and 1982 (Figure 24). Note that at the midsurf position, the 1981 annual mean current was 6 cm/sec southward, while during 1982 the magnitude was about the same; but the flow was directed northward.

All years combined

95. Monthly and annual mean current values for the combined years of data are presented in Figure 25. All locations show consistent temporal variation as well as spatial differences. Near zero annual means for both locations within the surf zone reflect the seasonal variations and frequent reversals due to the varying wind and wave conditions at the FRF. These contrast sharply with the strong southward predominance of the pier-end currents.

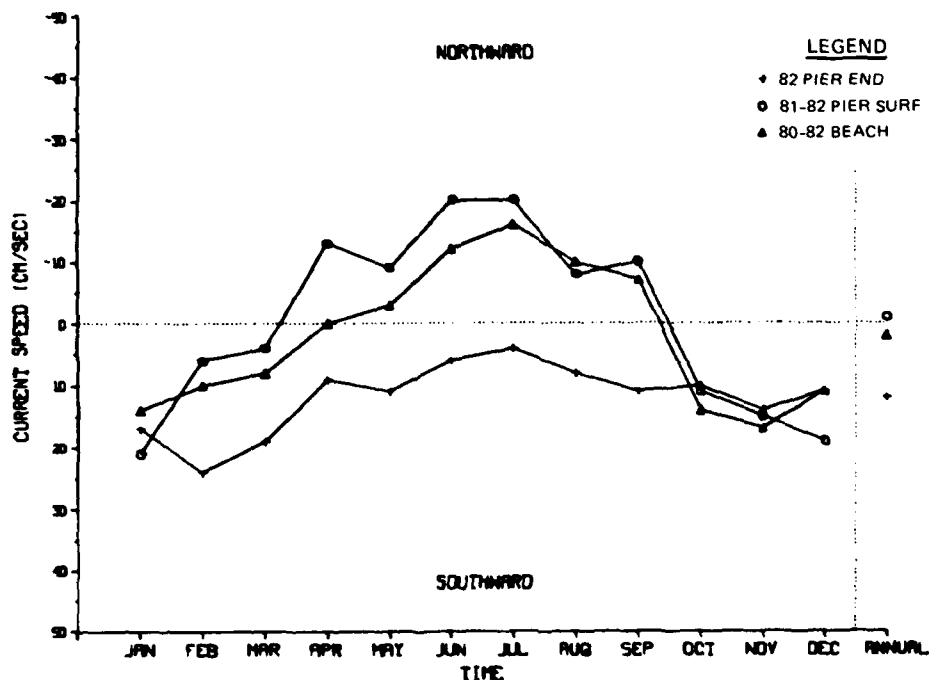


Figure 25. Mean surface currents at the FRF for 1980-1982

Tide and Water Level Data

96. Tide height values and water levels due to astronomical and meteorological forces are discussed in this section. 1982 results are followed by a comparison with previous data. All tidal heights are referenced to the local NGVD unless otherwise stated.

Present data year

97. Tides at the FRF are semidiurnal. The effect of the Moon's declination produces an average difference of 10 cm in daily high tides and 5 cm in the daily lows. The mean range during the year was 99 cm with a 4-cm difference between times near Aphelion (July), when the range was lowest, and Perihelion (January) (Table 14 and Figure 26). The monthly averages show a 3- and 6-month periodicity which in part is due to the inclination of the Sun (Coast and Geodetic Survey 1971), a long-period astronomical tidal constituent. Additionally, astronomical forces with annual periodicity, seasonal variability of the specific volume of the sea water due to temperature changes (the Steric effect), and meteorological conditions may also contribute to the observed variations.

Extreme water levels for 1982

98. Highest water levels generally occur when strong and persistent onshore winds and associated high waves produce setup of nearshore waters against the shoreline. This condition may be enhanced when the astronomical forces of the Moon and Sun are aligned (syzygy); the astronomical forces are even greater when the moon is also at Perigee (i.e. nearest the Earth). Extreme tidal heights at the FRF during 1982 were not coincident with the times of perigee-syzygean alignment that occurred on 9 January, 21 July, and 1 and 30 December. However, extremely high levels in October and December were a result of low pressure systems that produced high waves and strong onshore winds (Section VI). Strong offshore winds caused very low tides such as those of 8 February 1982 (-108 cm), the lowest of the year.

1982 versus past years

99. The distribution of daily high and low water levels and hourly tidal heights during the year were typical of those in previous years (Figure 27), except that apparently milder meteorological conditions produced fewer tidal heights in excess of 100 cm. In 1982, MHW, MLW, mean range (MR), and MTL data were consistent with those in previous years (Table 14 and Figure 26).

All years combined

100. Based on the distribution of tide heights for 1980 through 1982 (Figure 28), 1.25 percent of the time (110 hr) the tide height can be expected to exceed 90 cm. Likewise, 1.1 percent of the time (98 hr) the heights can be expected to be less than -70 cm. It can also be seen from Figure 28 that the

Table 14
Mean Tide Height Statistics for the FRF*

<u>Month</u>	<u>Mean High Water</u>	<u>Mean Tide Level</u>	<u>Mean Sea Level</u>	<u>Mean Low Water</u>	<u>Mean Range</u>	<u>Extreme High</u>	<u>Date</u>	<u>Extreme Low</u>	<u>Date</u>
Jan	45	-5	-4	-55	100	100	8	-94	11
Feb	47	-4	-3	-55	102	95	22	-108	8
Mar	55	5	5	-44	99	99	7	-89	29
Apr	46	-5	-4	-56	102	96	28	-86	24
May	56	6	7	-44	100	101	23	-76	21
Jun	68	18	19	-32	100	107	19	-62	26
Jul	55	7	7	-42	97	105	21	-66	20
Aug	58	10	11	-39	97	87	18	-72	21
Sep	67	18	19	-30	97	108	30	-57	3
Oct	78	29	29	-20	98	127	25	-54	31
Nov	58	9	9	-41	99	96	3	-76	29
Dec	62	11	12	-40	102	124	12	-82	1
1982	58	8	9	-42	99	127	25 Oct	-108	8 Feb
1979- 1981	59	8	8	-43	102	149	Nov 1981	-119	Mar 1980
1981	59	8	9	-42	101	149	13 Nov	-110	5 Apr
1980	59	8	8	-43	102	118	2 Mar	-119	16 Mar
1979	60	9	9	-43	103	121	26 Feb	-95	6 Sep

* Measurements in centimetres.

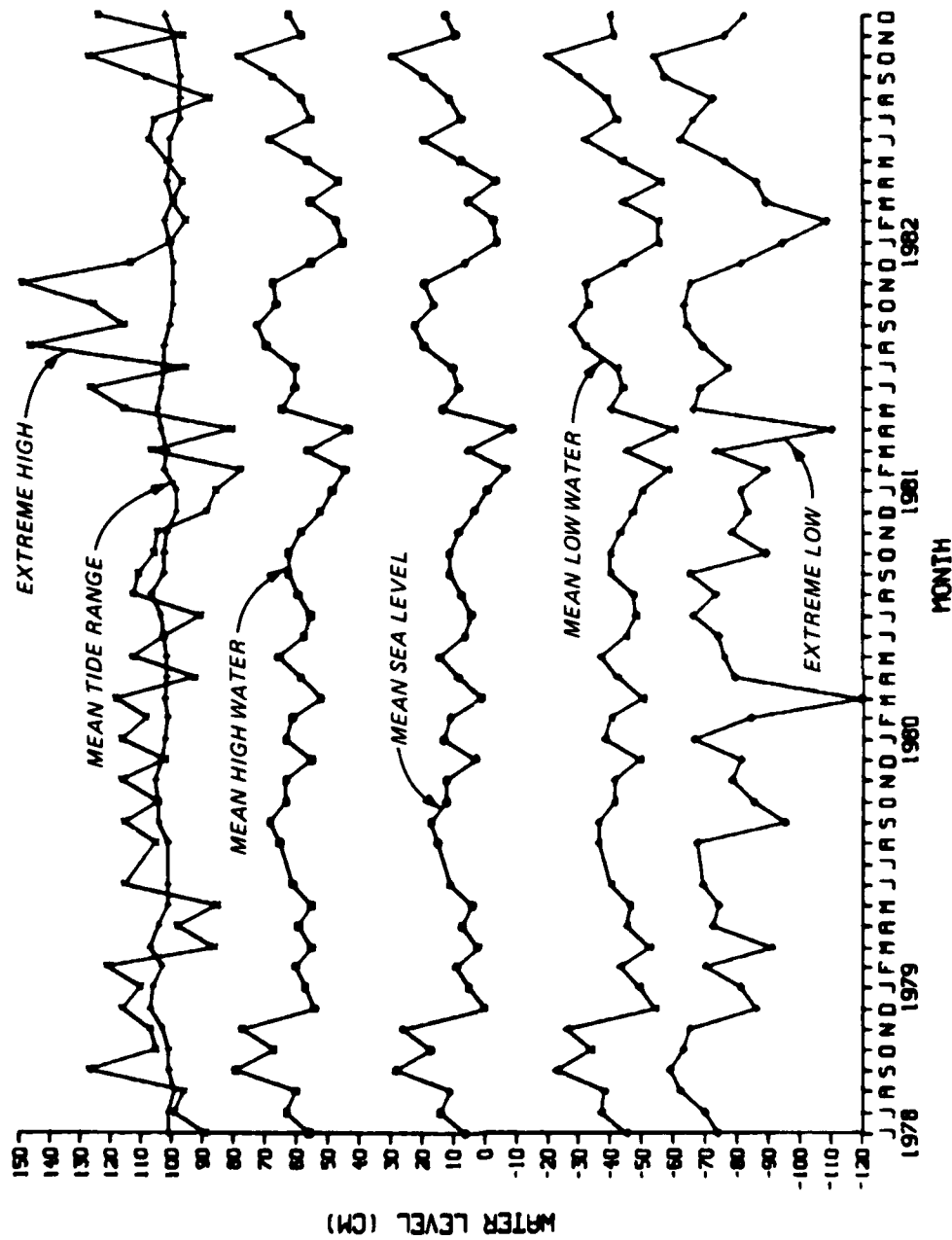


Figure 26. Mean monthly tide and water level data for 1978-1982

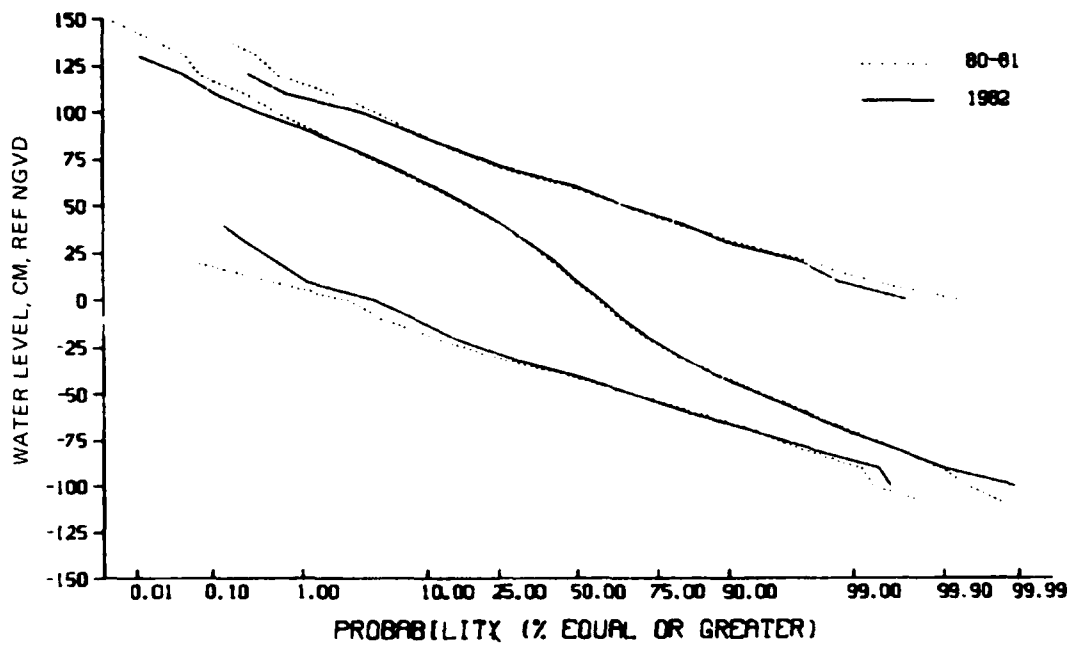


Figure 27. Comparison of hourly tide heights and mean high and low water level distributions

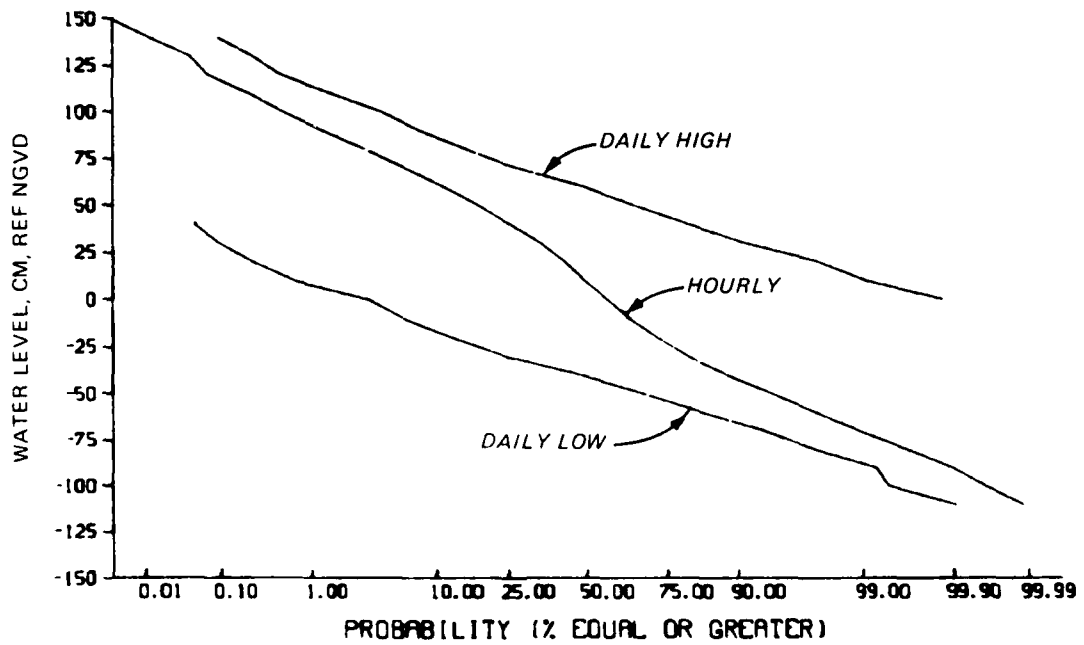


Figure 28. Distribution of hourly tide heights and mean high and low water levels for 1980-1982

daily low tide height can actually exceed NGVD 3 percent of the time or 11 days out of the year.

Water Characteristics

101. The results of daily measurements of surface water temperature, visibility, and density are presented in this section. The summaries represent single observations made near 0700 EST and, therefore, may not reflect daily average conditions since such characteristics can change rapidly within a 24-hr period. A discussion of 1982 data is followed by a comparison to that of previous years.

Water temperature

102. Present data year. Daily sea surface water temperatures at the seaward end of the FRF pier (Table 15 and Figure 29) experienced large variations in June, July, and August when frequent offshore winds blew warm surface water seaward, allowing upward and landward circulation of much colder and more turbid bottom water. Onshore winds reversed this circulation, piling up warm surface water against the shoreline, with a resulting seaward flow along the bottom.

103. From January through March (Figure 29), monthly mean water temperatures averaged less than 10°C and increased about 5°C per month from March through June. These mean values remained nearly constant and greater than 15°C from July through October. During the remaining two months of 1982, temperatures decreased at about the same rate as the spring increase, i.e., 5°C per month.

104. The annual average water temperature during the year was 14.2°C , with a standard deviation of 1.9°C . Less than 1 percent of the time (3 days) during the year the temperature exceeded 25°C (Figure 30).

105. 1982 versus previous years. Daily temperature variations were typical of those during other years. Due to a mild summer and winter, 1982, as a whole, was a moderate year in comparison to previous years; fewer occurrences of temperatures above 20°C and below 5°C were observed (Figure 30). Differences during the summer season were, in part, due to the frequent onshore winds and high wave activity during September, 1981, which tended to keep the water warm. The period during October to December 1982 was the warmest of all periods during the 3 years of data collection (Figure 31),

Table 15

Mean Sea Surface Water Characteristics

Year	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	<u>Mean Sea Surface Water Temperature, °C</u>												
1982	4.3	4.7	6.3	9.9	15.8	19.7	20.7	22.0	21.9	19.1	14.5	11.3	14.2
1981	2.8	4.0	5.7	10.4	14.9	20.1	24.0	22.9	24.0	17.5	13.0	7.5	13.9
1980	6.8	3.5	5.5	11.2	16.2	18.5	20.1	22.1	22.1	19.0	13.2	8.9	13.2
Overall	4.6	4.1	5.8	10.5	15.6	19.4	21.6	22.5	22.7	18.5	13.6	9.2	13.8
	<u>Mean Sea Surface Water Visibility, m</u>												
1982	1.4	1.5	1.8	2.2	2.6	3.7	4.6	4.4	2.2	1.6	1.0	1.0	2.4
1981	1.4	1.7	1.1	1.7	1.5	3.0	1.9	1.3	1.2	1.0	0.8	0.9	1.6
1980	1.3	1.4	1.0	2.5	2.7	3.9	4.6	3.4	2.9	1.4	1.0	0.9	2.3
Overall	1.4	1.5	1.3	2.1	2.3	3.5	3.7	3.0	2.1	1.3	0.9	0.9	2.1
	<u>Mean Sea Surface Water Density, g/cm³</u>												
1982	1.0247	1.0236	1.0221	1.0240	1.0225	1.0215	1.0221	1.0212	1.0213	1.0218	1.0231	1.0239	1.0227
1981	1.0252	1.0250	1.0254	1.0264	1.0243	1.0231	1.0215	1.0220	1.0225	1.0235	1.0241	1.0250	1.0240
Overall	1.0250	1.0243	1.0238	1.0252	1.0234	1.0223	1.0218	1.0216	1.0219	1.0227	1.0236	1.0245	1.0234

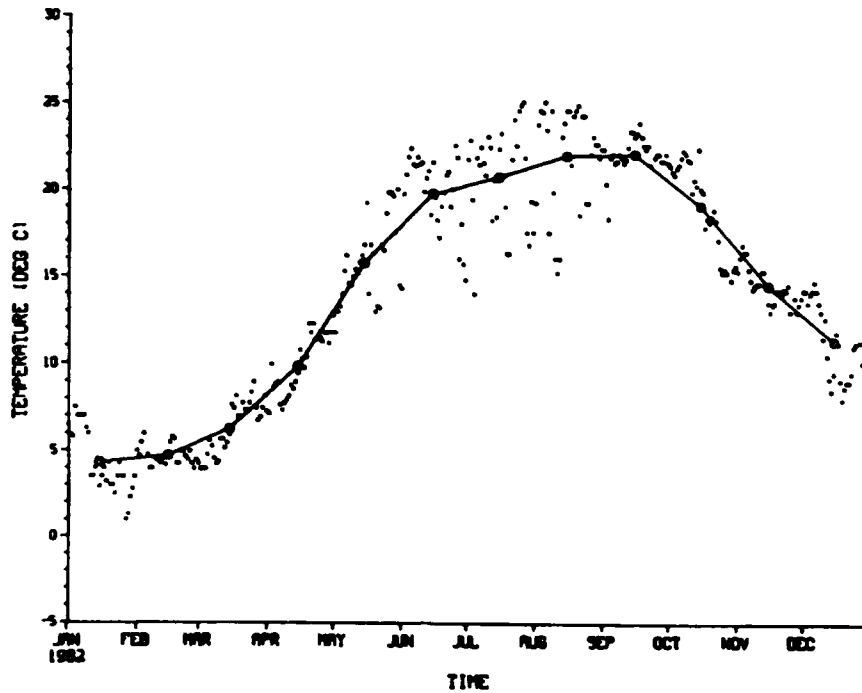


Figure 29. Daily sea surface water temperatures for 1982

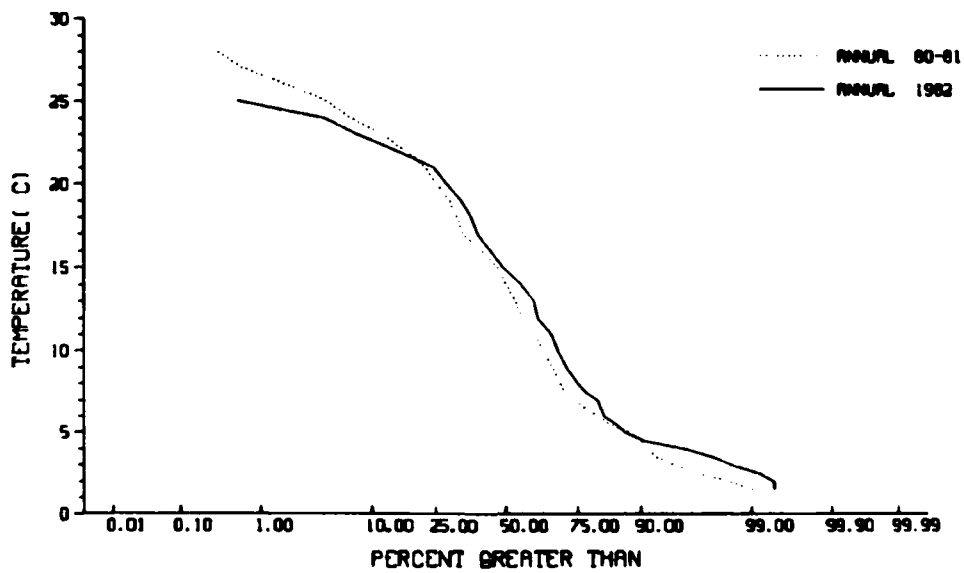


Figure 30. Comparison of annual sea surface water temperature distributions

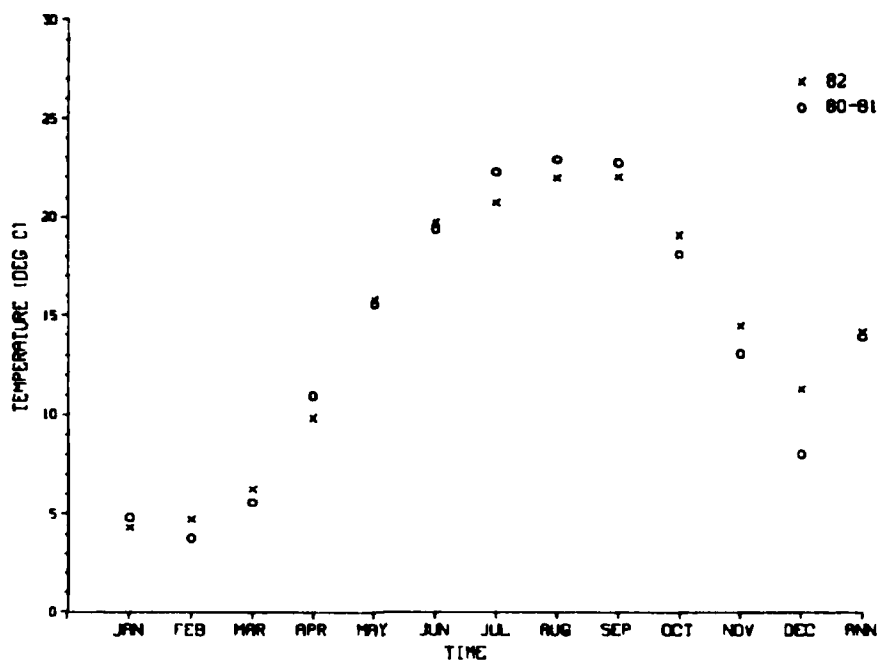


Figure 31. Mean surface water temperatures for 1980-1981 and 1982

again, at least in part, due to the higher frequency (in comparison to other years) of onshore winds during the season.

106. All years combined. Annual and seasonal temperature variations have been consistent from year to year. The addition of a third year of data made only a minor change to the annual distribution of surface temperatures.

Visibility

107. Visibility in coastal nearshore waters depends on the amount of salts, soluble organic material, detritus, living organisms, and inorganic particles in the water. These dissolved and suspended materials change the absorption and attenuation characteristics of the water, which thus vary daily and throughout the year.

108. The surface water visibility at the seaward end of the pier varies in a similar manner as the temperature (Figure 32). Since the pattern of offshore and onshore winds that produced major temperature differences also controls the visibility, the warm surface water is usually clear, while the cooler bottom water contains large concentrations of suspended matter.

109. Present data year. Daily water visibility values, measured at the seaward end of the pier using a secci disc (Figure 32), show that monthly means were the highest during July through August 1982, as were the standard deviations (Table 15) reflecting the wind-dominated processes discussed

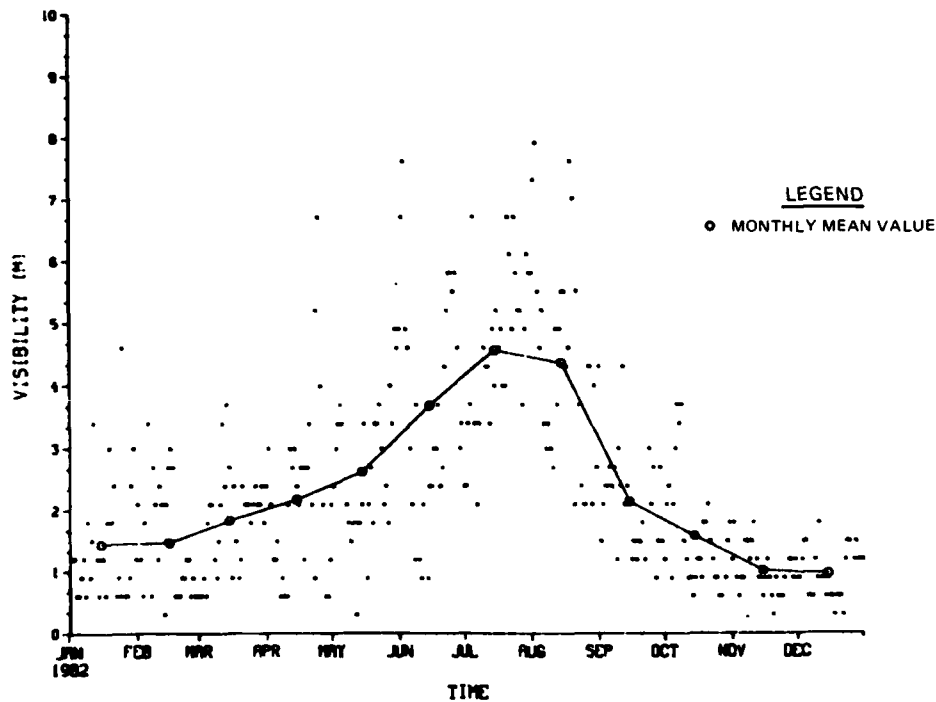


Figure 32. Daily surface water visibility for 1982

above. Between April and August the visibility occasionally was greater than 5 m, but it was generally less than 4 m. During October to December, the visibility was less than 2 m 90 percent of the time. The annual mean visibility was 2.4 m with a 1.0-m standard deviation (Table 15). Figure 33 presents the cumulative distribution of visibility measurements for the year and indicates a median visibility of only 1.5 m.

110. 1982 versus previous years. The variability of the 1982 daily sea water visibility measurements was similar to that in previous years. With the exception of July and August, monthly mean visibility values were also similar (Figure 34). The 1982 annual mean was higher than the 1980 and 1981 combined value, primarily due to the exceptionally high visibility during July and August. Figure 33 shows the distribution of daily measurements was higher in 1982 in comparison to previous years.

111. All years combined. At the FRF, over 50 percent of the time the visibility at the surface can be expected to be less than 2 m. Annual and seasonal visibility variations have been consistent from year to year. The addition of a third year of data did not change the annual distribution significantly.

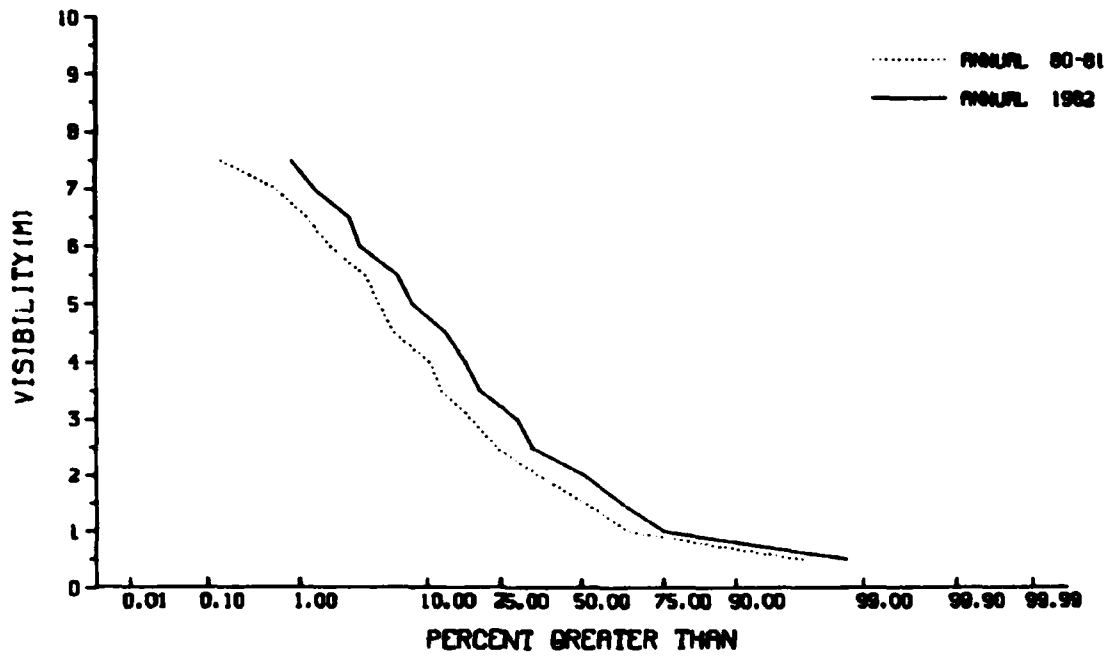


Figure 33. Comparison of annual surface water visibility distributions

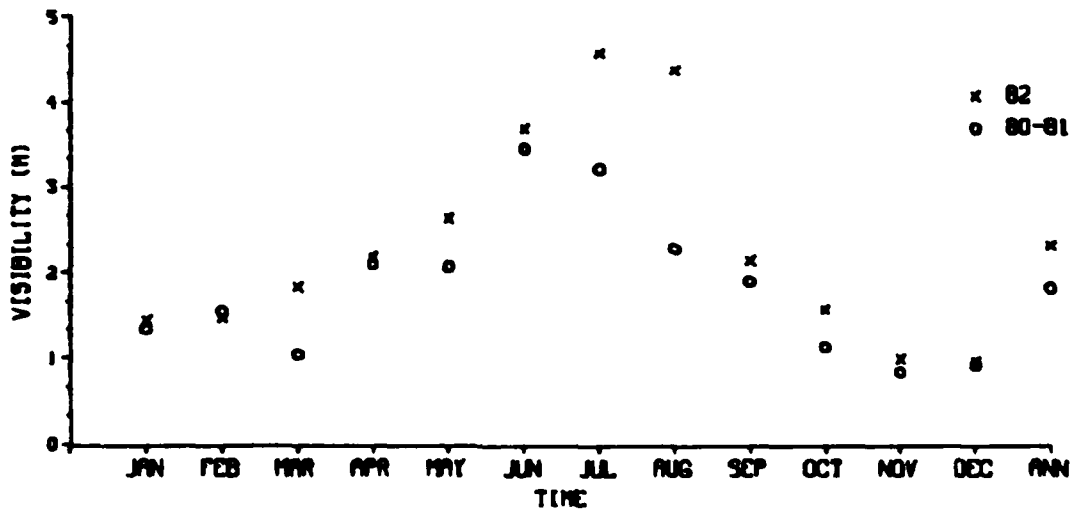


Figure 34. Mean surface water visibility for 1980-1981 and 1982

Density

112. Present data year. Daily density measurements show a large variation throughout the year (Figure 35 and Table 15). Monthly mean values (Figure 36) generally varied inversely with water temperature such that maxima occurred during the cold months--January, February, November, and December--and minima during the summer months (Table 15). The annual mean density was 1.0227 g/cm^3 with an associated standard deviation of 0.0015 g/cm^3 .

113. 1982 versus 1981. Variability in daily density values throughout 1982 was greater than that for 1981; however, the 1982 monthly and annual means (Figure 36) and distribution (Figure 37) were lower than those for 1981. This trend is reasonably consistent with a pattern of monthly mean temperature differences which indicate that 1982 temperatures were greater than those for 1981. However, during a few months this inverse relationship between temperature and density did not occur, indicating that salinity differences were probably responsible for the density variations. These may have resulted from either large-scale circulation of nearshore water masses or locally-induced salinity changes due to rainfall.

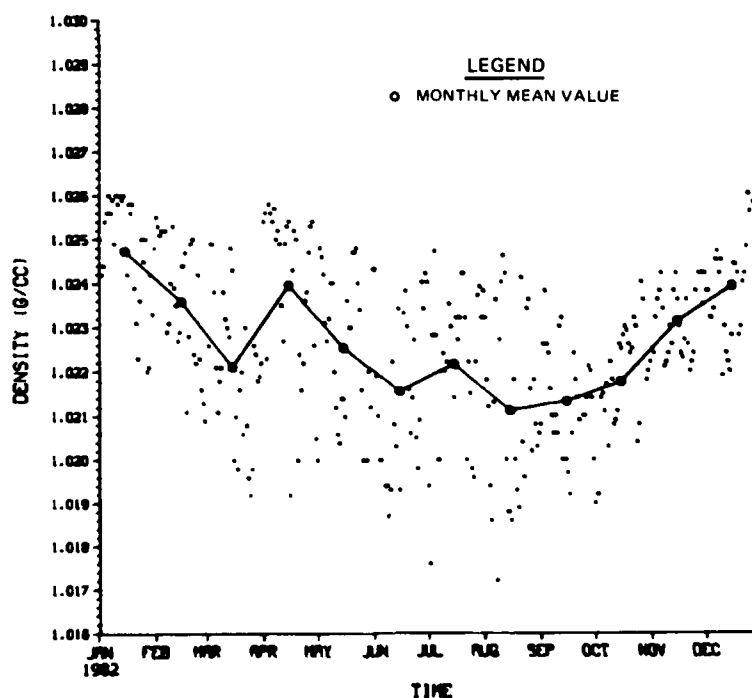


Figure 35. Daily surface water density for 1982

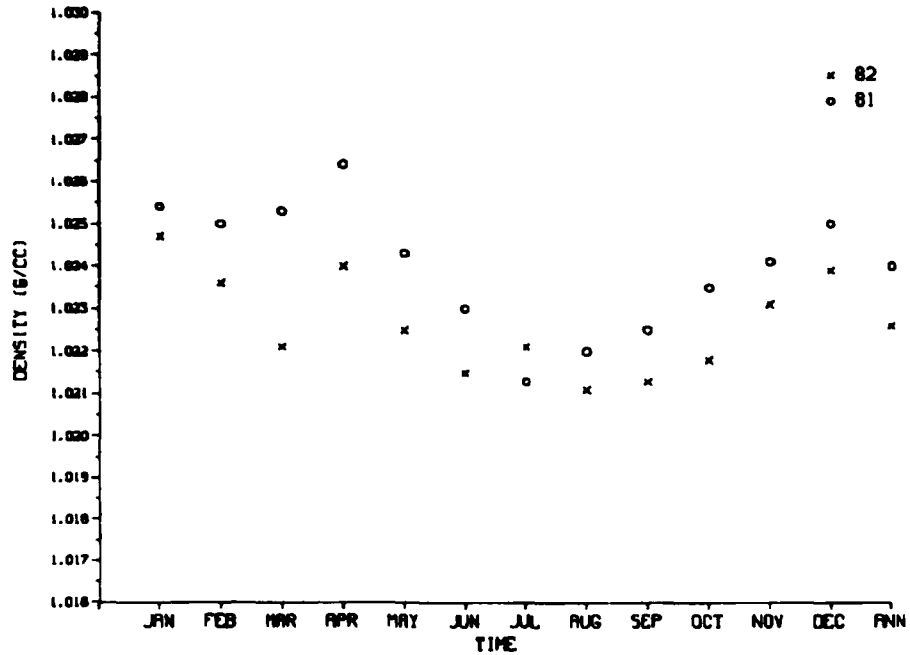


Figure 36. Comparison of mean sea surface water density for 1981 and 1982

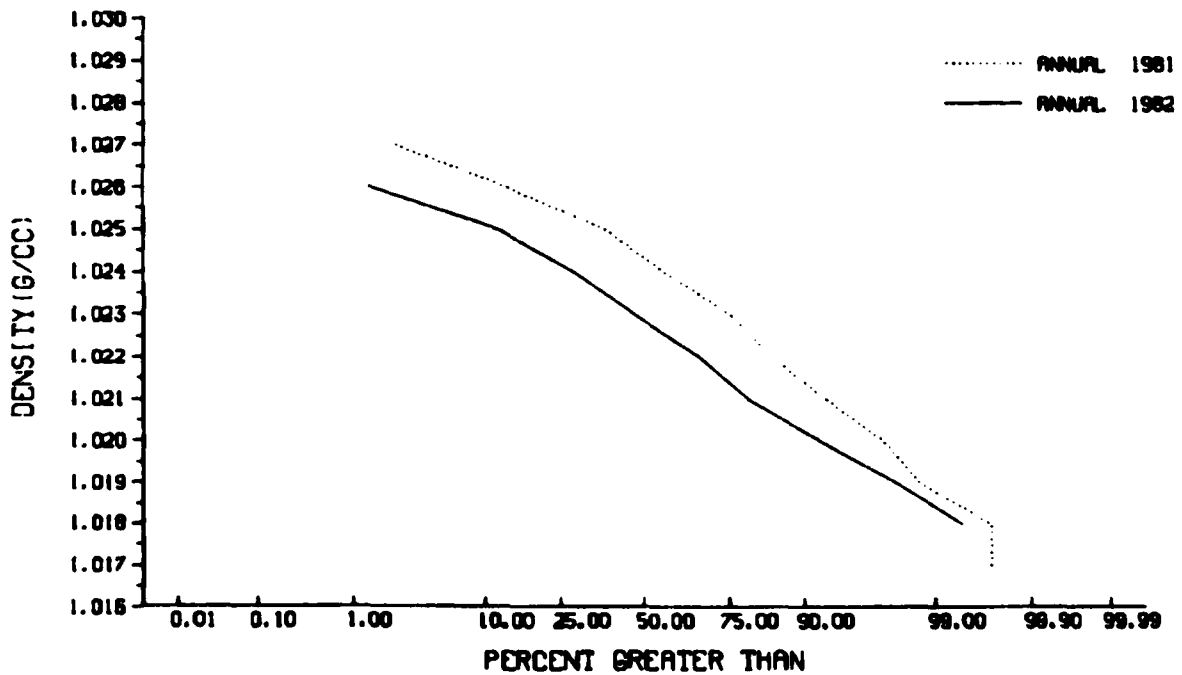


Figure 37. Comparison of annual sea surface water density distributions

Survey Data

114. Waves and currents interacting with bottom sediments produce changes in the beach and nearshore bathymetry. These changes can occur very rapidly in response to storms or slowly as a result of persistent but lower seasonal variations in wave and current conditions.

115. To document the temporal and spatial variability in bathymetry, surveys were conducted approximately monthly of an area extending 600 m north and south of the pier and approximately 950 m offshore. During March and July, 24 profile lines were surveyed. The remaining surveys consist of between 12 and 15 profiles each. These profiles were obtained using a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the CRAB, a 10.7-m-high self-powered mobile tripod on wheels (Birkemeier and Mason 1984). In addition, soundings were taken on both the north and south sides of the pier.

116. In the following sections a brief discussion of the effect of the research pier on the bathymetry precedes discussions of time-histories of bottom elevations at selected locations along the pier and contour diagrams of the bathymetry.

Pier effect

117. The research pier introduces a perturbation in bathymetry (Figure 38) in the form of a permanent trough under the pier, apparently a result of the interaction of waves and currents with the pilings. The trough deepens under the seaward end of the pier and varies in shape and depth with changing wave and current conditions. The pier's effect on shore-parallel contours occurs as far as 300 m away, and the shoreline may be affected up to 350 m from the pier (Miller, Birkemeier, and DeWall 1983).

History of bottom elevation

118. At the Baylor wave gage locations and other selected locations along the pier, a history of the bottom elevations is useful for interpretation of the data (Figure 39). Variations of elevation under the pier are due to natural processes (such as profile changes due to bar movement) as well as scour due to the interaction of the pier piles with waves and currents. At the beginning of the year, the scour hole at the 579-m location was 8-1/2 m deep and the trough elongated to the north. A small fillet (at -1 m) formed at the landward end of the pier, near 189 m, during February. The fillet

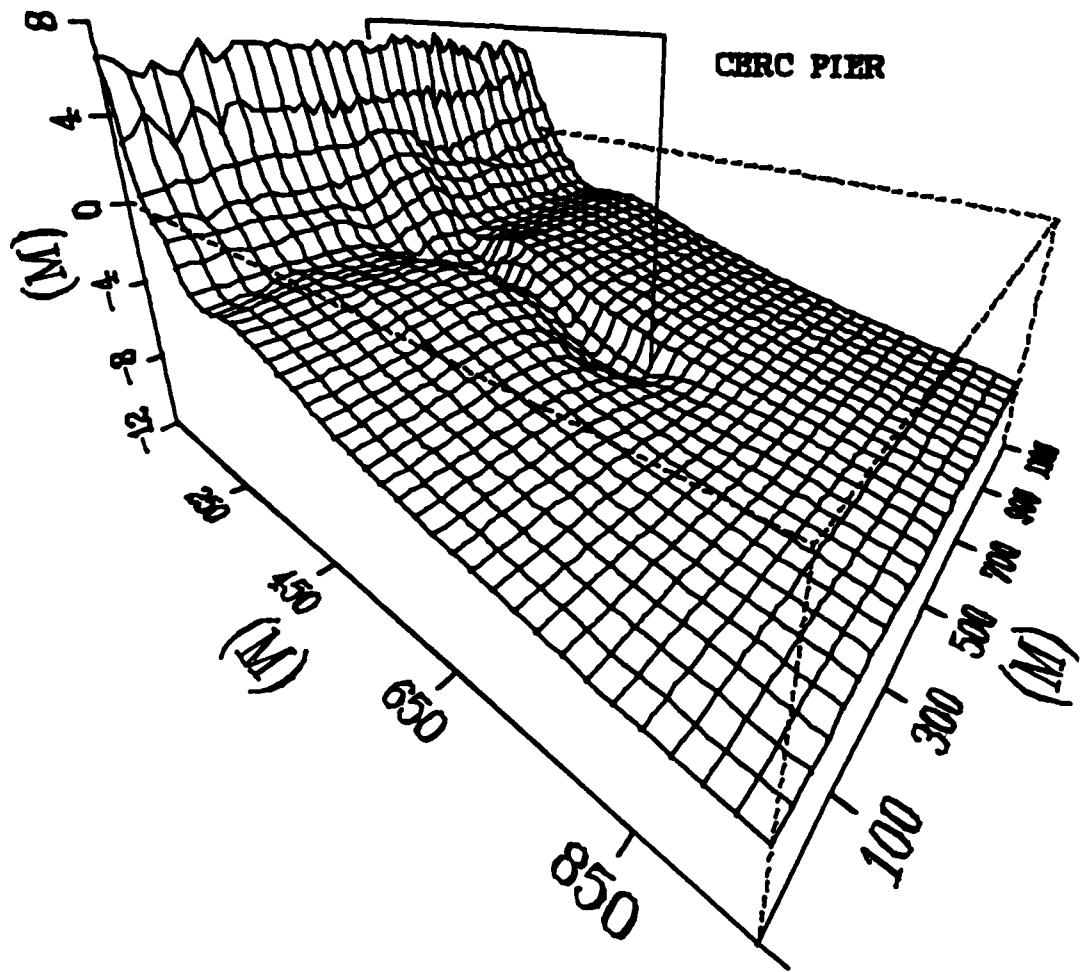
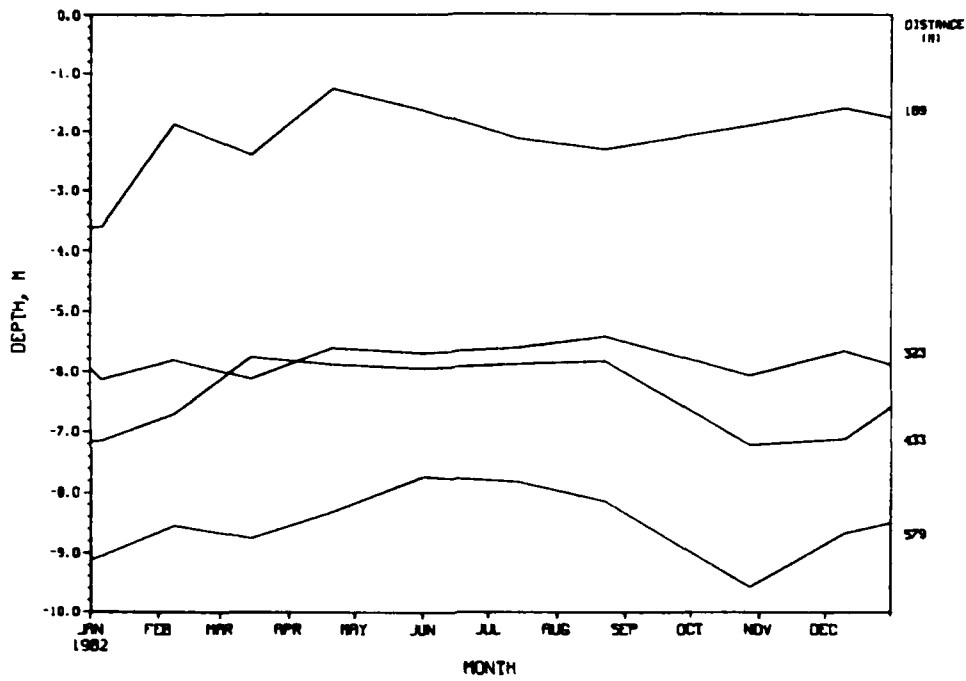
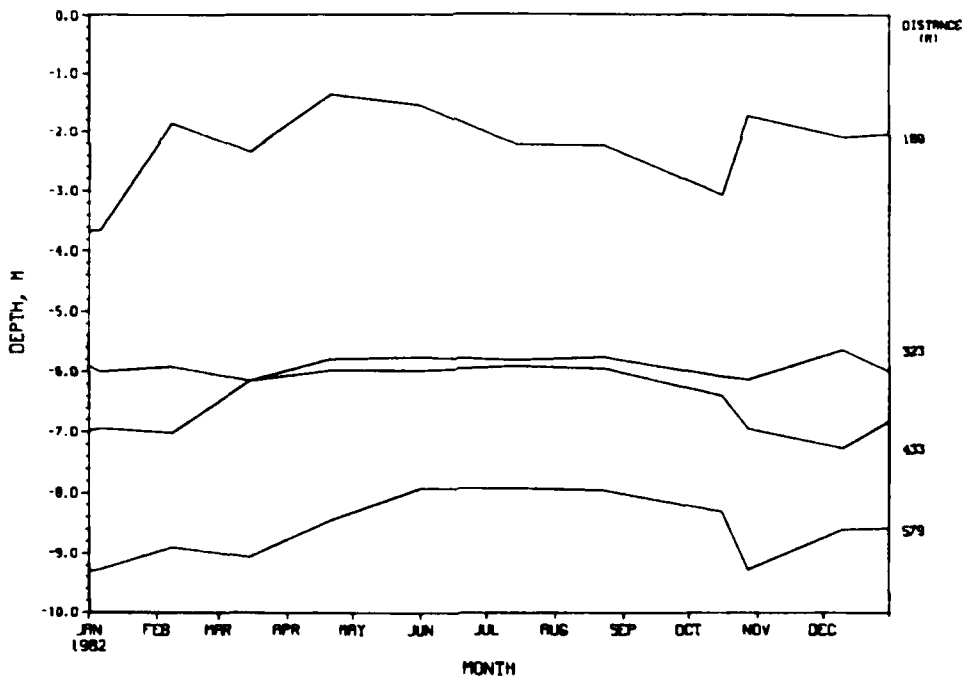


Figure 38. Permanent trough under the FRF pier
(14 July 1982)



a. North



b. South

Figure 39. Time-history of bottom elevations at selected locations along the FRF pier, Baylor gages 625 and 615, at 579 m and 189 m, respectively

became larger in April and remained through August. The trough continued to shoal through the summer and became more symmetric about the pier axis. During this time, the scour hole reached a minimum depth for the year of 7-1/2 m. Dramatic changes occurred in response to the October storms. The high waves and strong currents scoured out the trough, the scour hole depth increased to 8-1/2 m, and the fillet at the landward end of the pier was eroded away. Only minimal changes occurred during the remainder of the year.

Bathymetric surveys

119. Contour diagrams created from the data obtained during the bathymetric surveys are presented in Appendix C; characteristics of the bathymetric conditions are discussed below. Birkemeier (1984) provides a detailed discussion of the nearshore profile changes.

120. Figure 40 shows the location of the profile lines surveyed away from the pier during the monthly bathymetric surveys.

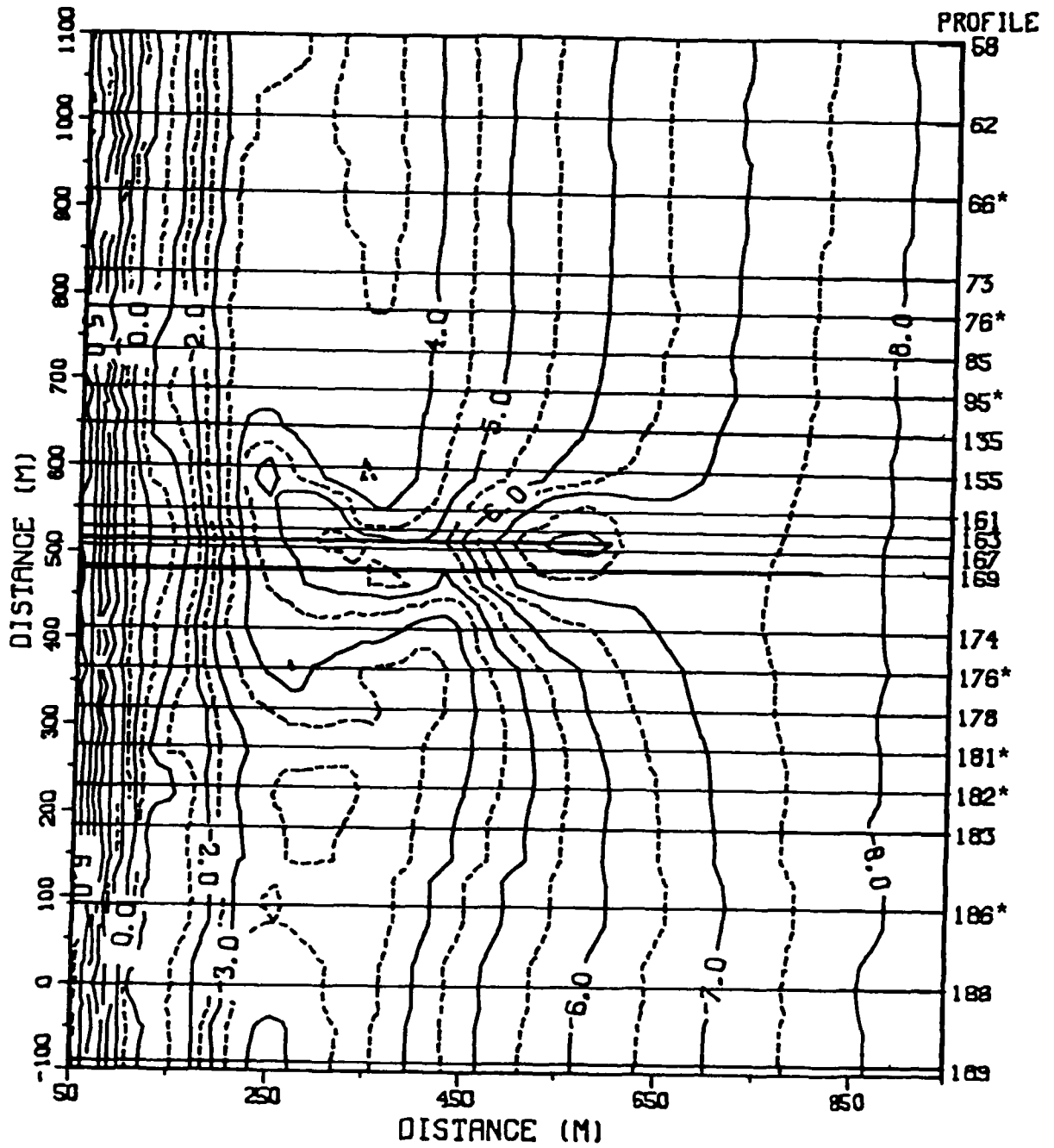
121. The bathymetric survey on 5 January (Figure 41) shows a trough under the pier extending 50 m north and 100 m south with a deeper scour hole dominating the seaward 180 m. A wide but fairly stationary storm bar (250 to 400 m) traversed the survey area interrupted only by the trough under the pier. In addition, the nearshore was dominated by a smaller but very mobile bar and trough system.

122. Little change is visible on the 9 February survey (Figure C1). The hole at the end of the pier (180 m) had filled in slightly and diminished in size. A small amount of shoaling (200 m) was also visible 350 m south of the pier.

123. Very little activity was observed in the 18 March survey (Figure C2). Some shoaling of the storm trough (250 m) was visible 150 to 400 m north of the pier, and a minor amount of deposition in the trough under the pier had taken place.

124. By 21 April (Figure C3), the scour hole at the end of the pier (180 m) had been substantially reduced in area, though the depth remained constant. The storm bar and trough (200 to 400 m) remained stable with only minor changes visible on the nearshore bar (125 m), except under the pier where a pronounced 25-m seaward migration of the bar crest had produced a prominent seaward bulge in the -1 m contour line.

125. The next survey on 2 June (Figure C4) showed the nearshore bar (175 m) had been replaced by a fairly featureless slope. The storm trough



* Quarterly.

Figure 40. Profile locations at the FRF

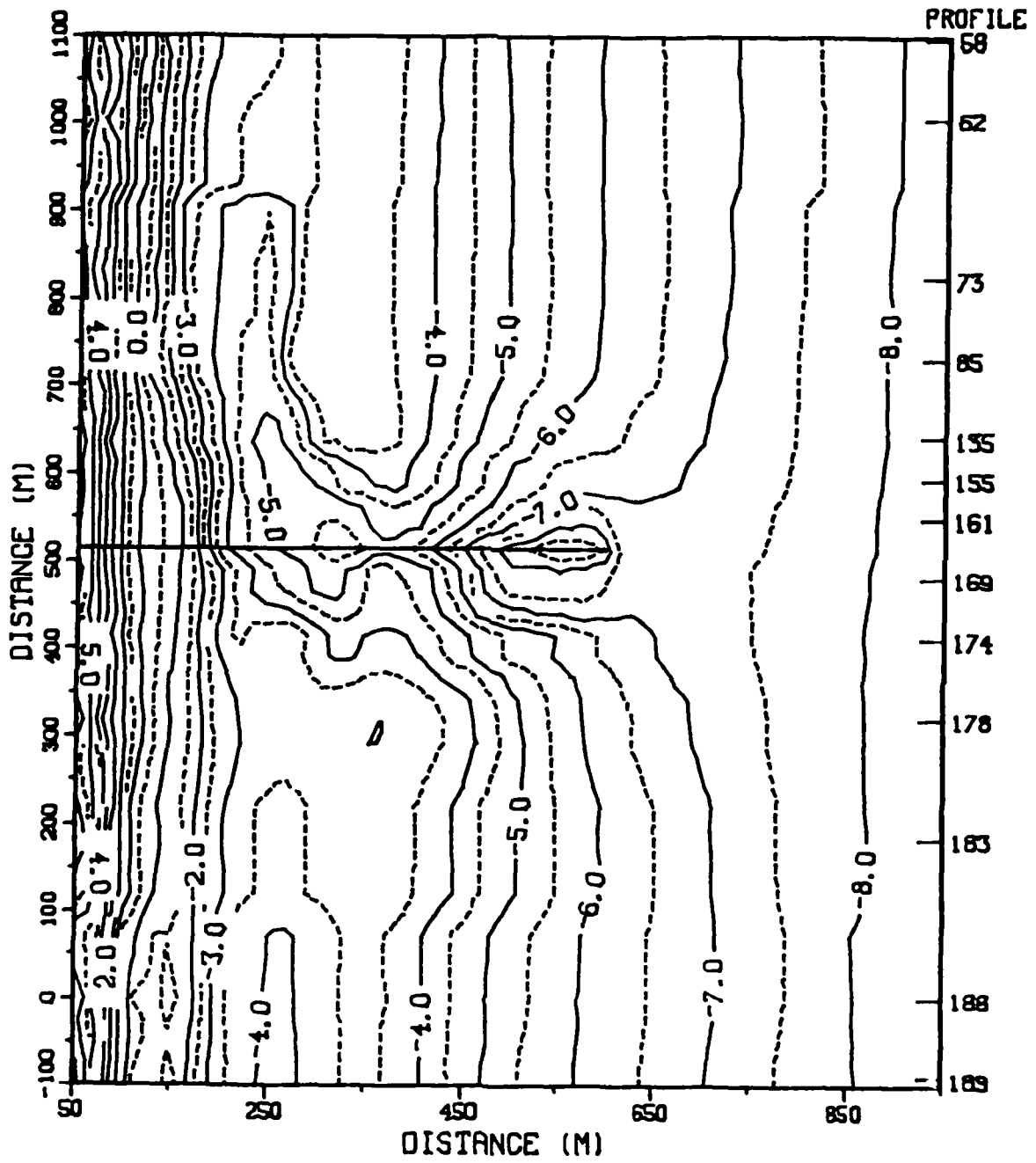


Figure 41. Contour diagram of FRF bathymetry, 5 January 1982

(250 m) widened in two areas, 375 m north and 400 m south of the pier. The trough under the pier intruded farther into the storm bar (300 m) having migrated 100 m farther south.

126. The 14 July survey (Figure C5) shows continued shoaling of the trough under the pier. The scour hole at the end of the pier had again shifted and extended seaward of the pier end. The storm bar (300 m) remained unchanged; however, the nearshore bar and trough (175 m) were completely removed.

127. Only minor changes were visible on the 24 August survey (Figure C6). These included some erosion along the beach step (150 m) and an equal amount of deposition on the foreshore slope (100 m).

128. Two poststorm bathymetric surveys were conducted during October. The first survey on 16 October (Figure 42) shows some notable aspects of the transition from summer to winter. First is the prominent nearshore bar and trough (100 to 150 m) created during this storm. This feature was built as a result of erosion (up to 1 m) at the base of the foreshore (120 m) creating the trough and a corresponding amount of deposition which built the bar (Figure 43). The trough under the pier deepened, and the scour hole at the end of the pier expanded shoreward; only slight changes were visible on the offshore bar and trough (200 to 400 m). Since the second survey on 27 October (Figure C7) followed a major storm (as compared to the 16 October survey which was also poststorm), many of the observable changes during the month are not as dramatic as they would have been had there been a prestorm survey. However, the second survey of the month shows a dramatic further deepening of the pier trough (north of the pier) and of the scour hole. Both the nearshore (100 to 500 m) and the offshore (200 to 400 m) bar systems continued to develop as their troughs deepened and deposition occurred on the bar crests. Significant amounts of accretion were also visible on most of the foreshore (50 to 150 m) extending from the toe of the dune to MSL.

129. The next survey on 6 December (Figure C8) shows a continuation of the prominent nearshore bar and trough with some deposition occurring in the trough under the pier and in the large scour hole at the end of the pier. South of the pier the storm trough (300 m) deepened significantly; however, the same did not occur north of the pier.

130. In summary, fairly minor bathymetric changes occurred from January to September; however, following a storm in mid-October and a major storm late

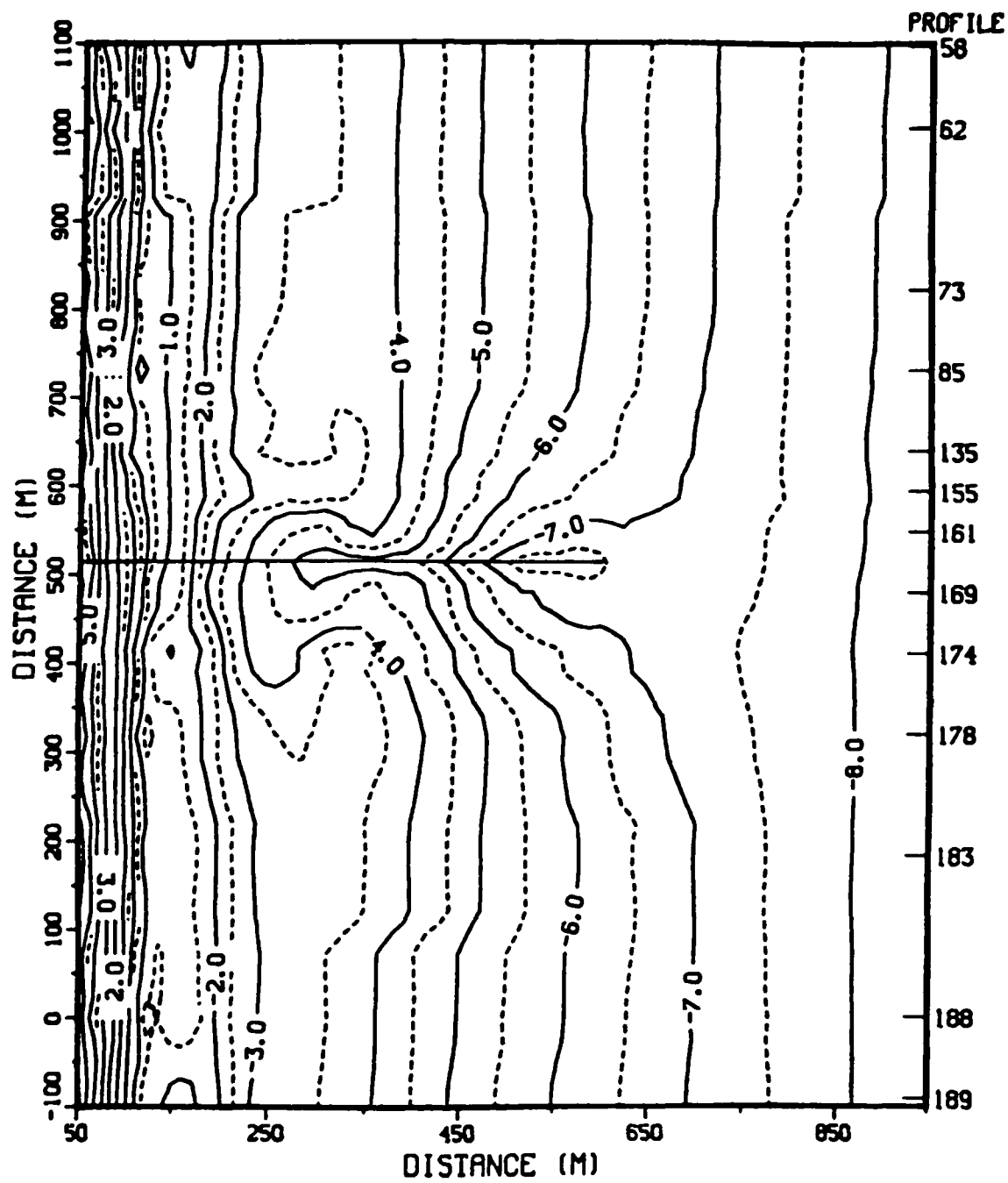


Figure 42. Contour diagram of FRF bathymetry, 16 October 1982

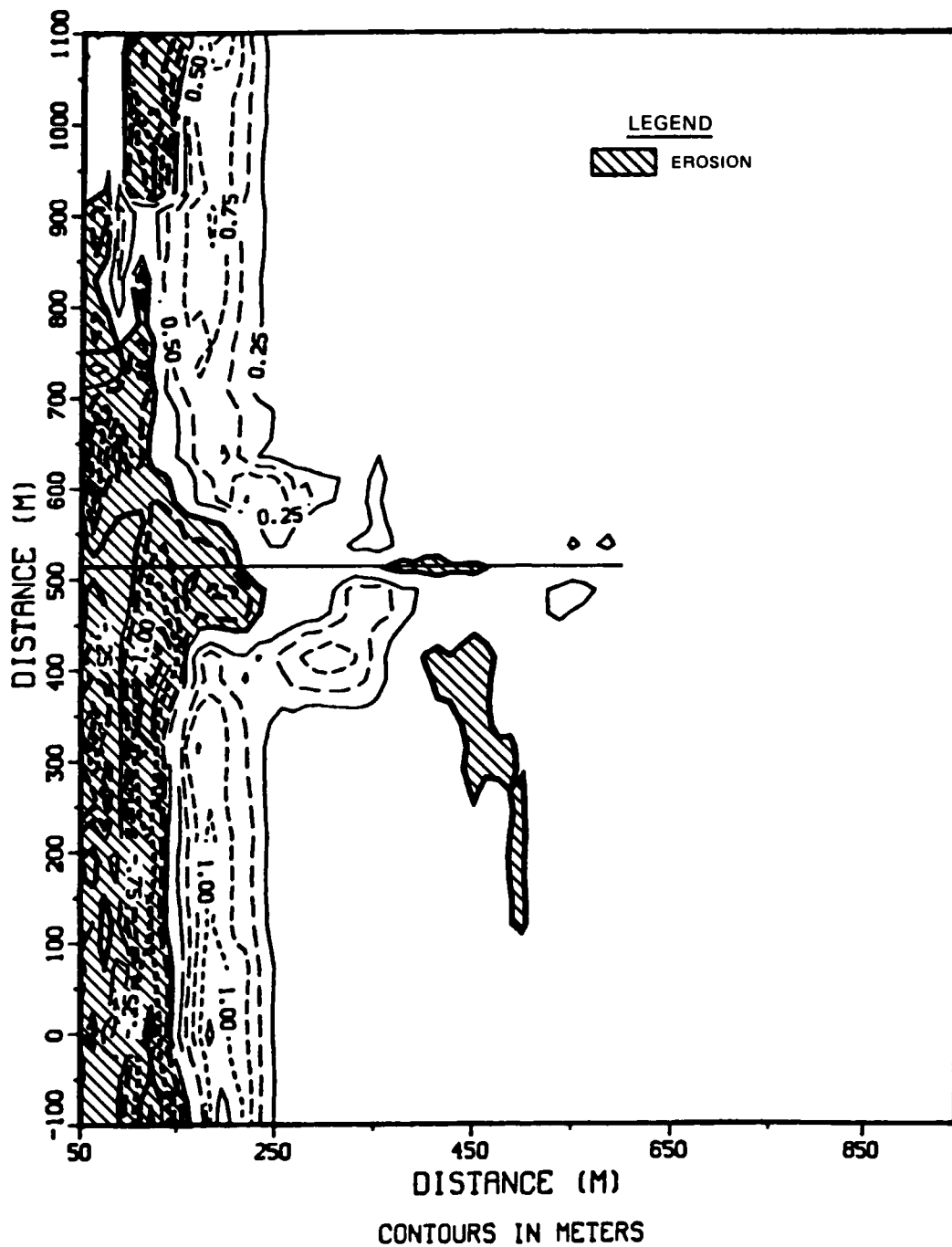


Figure 43. Changes in FRF bathymetry, 24 August-16 October 1982

in October, a rapid transition from a summer profile (small nearshore and off-shore bars and troughs) to a winter profile (sharply defined and prominent bar systems) occurred. In addition, a dramatic deepening of the trough under the pier occurred. This situation continued through the remainder of the year.

Sediment Data

131. The spatial variation of surface sediments along the beach and ocean bottom is discussed in this section. Since only two sediment surveys were performed during the year, temporal variations could not be defined. However, the effect of different wave and current conditions on the sediment characteristics (preceding each survey) is discussed. Variations of the surface sediments onshore were also observed during daily visits to the beach; there was a tendency for coarse material during the winter (high wave energy season) and fine sand during the calmer wave conditions.

Shore-normal variation

132. On 17 March and 26 October, surface sediment samples were taken along Profile 188, located 517 m south of the FRF pier. Sediment size was determined by sieving at 1/4-phi intervals. Figure 44 presents the size distributions for 17 March as a function of position on the profile. In Figure 45, size distributions are shown for some of the sediment samples taken on 26 October. Consistencies between the samples are observed when the profile is divided into the following regimes: (a) dune and beach face, (b) swash zone and beach step, (c) nearshore bar and trough, and (d) offshore bar and seaward.

133. Samples taken on the dune generally reflect aeolian (i.e. wind-blown) deposition. Therefore, the sediments are well sorted, lacking in both very fine sand (due to selective winnowing) and coarse materials. At the toe of the dune, however, mean sediment sizes vary from medium to coarse. In March, the sediment distribution was moderately well to well sorted using Folk (1974) sorting classification. In October, however, wave action placed coarser sediments on the dune toe, and fines were winnowed.

134. Sediments at the beach step were indicative of the high energy regime due to waves breaking on the beach. In both March and October, the means were coarse (1.9 to 2.4 mm) and the size distributions were moderate to poorly sorted.

135. Seaward of the crest of the nearshore bar, the mean grain size generally decreases with distance offshore, and the sediments are better sorted. However, after the October storms, the sediments on the inner bar (175 m) were coarsely skewed while being finely skewed in March. Figure 46 shows the effect of the October storms (see paragraph 128 for a description of the bathymetry changes).

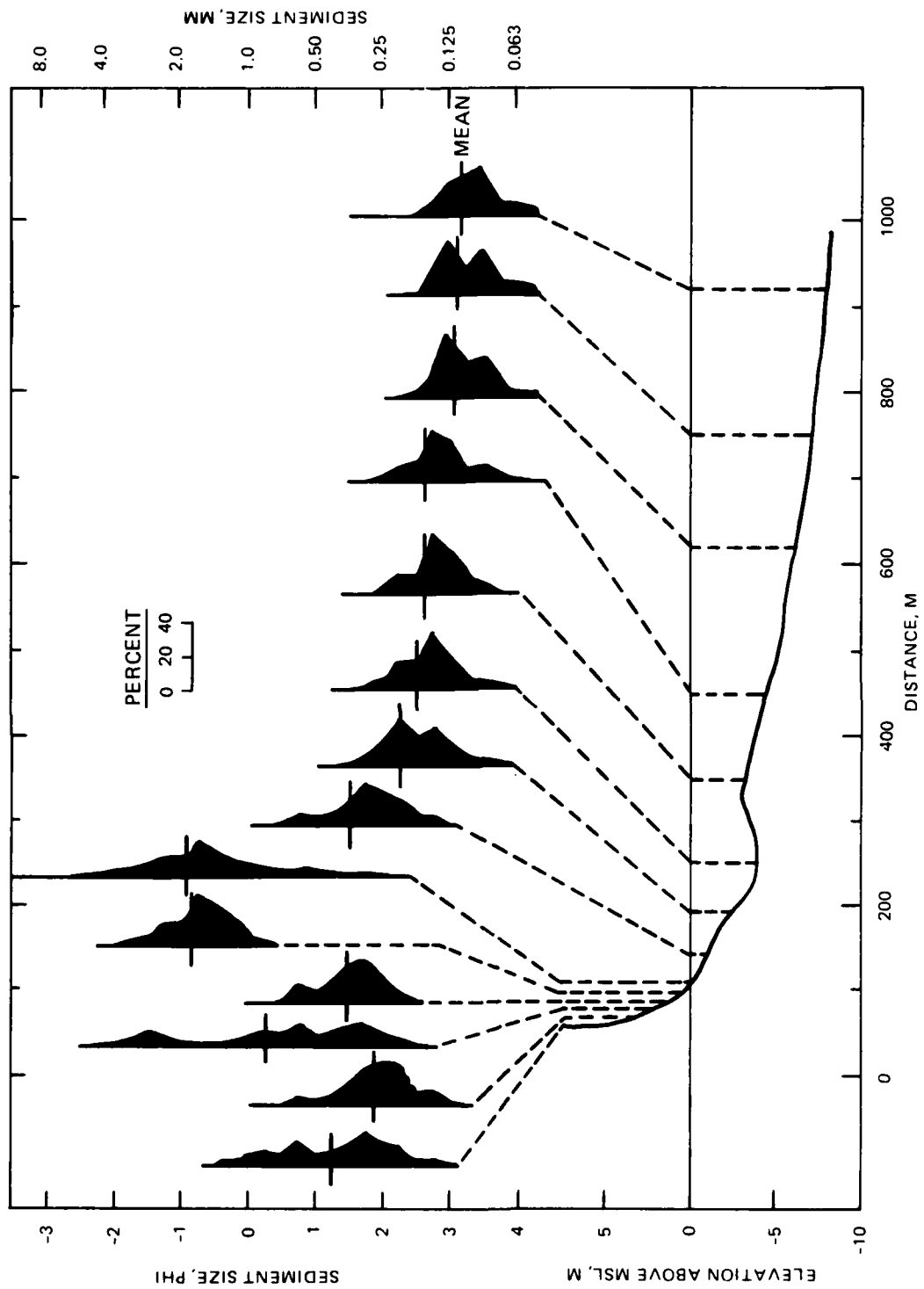


Figure 44. Sediment size distributions along profile 188, 17 March 1982

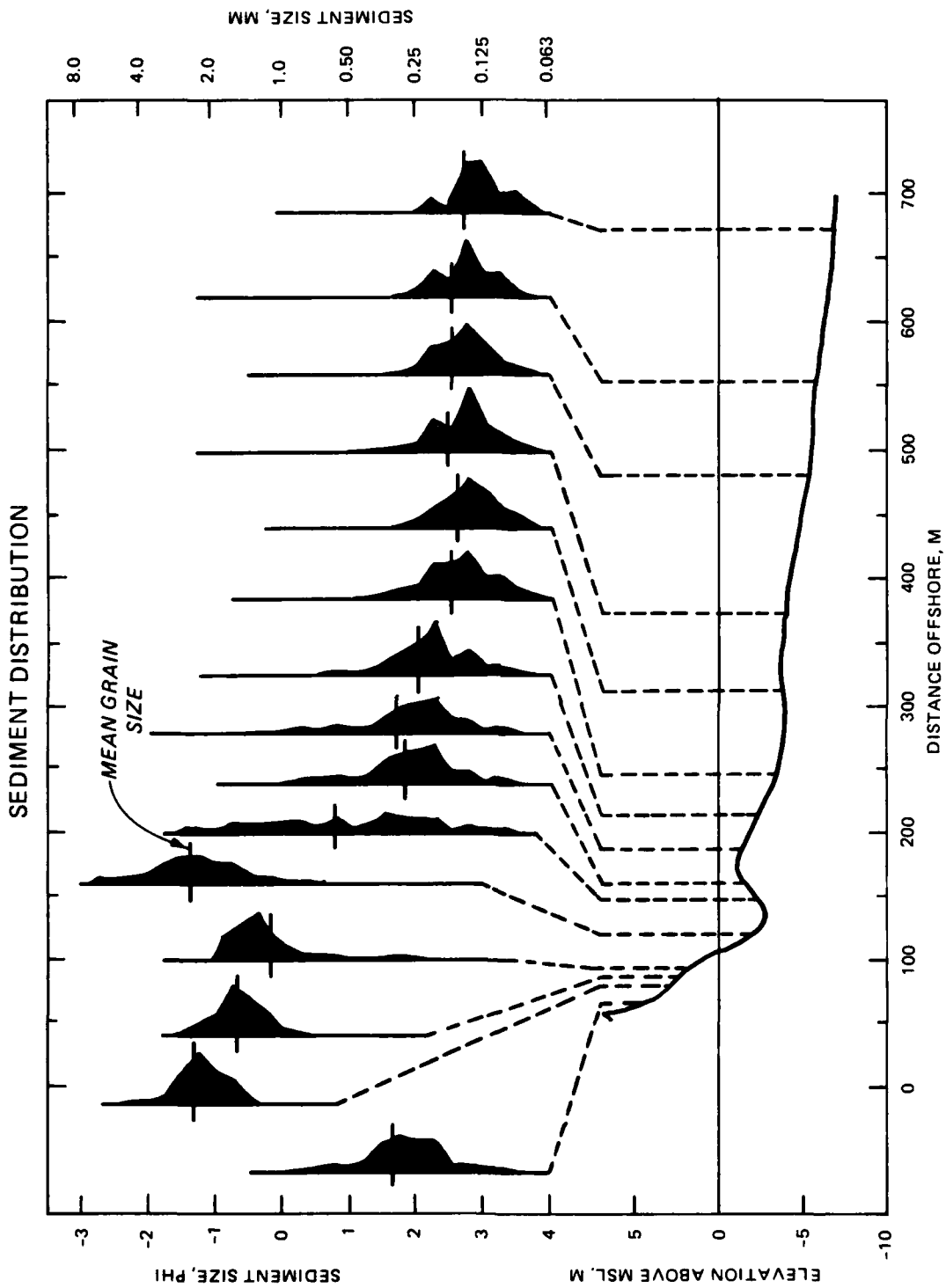
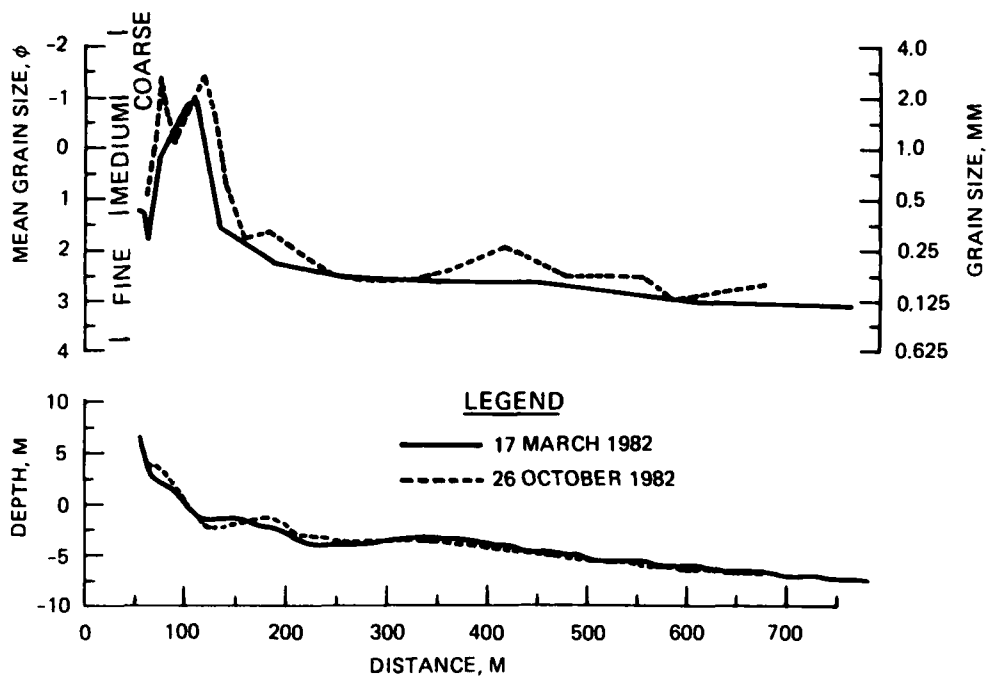
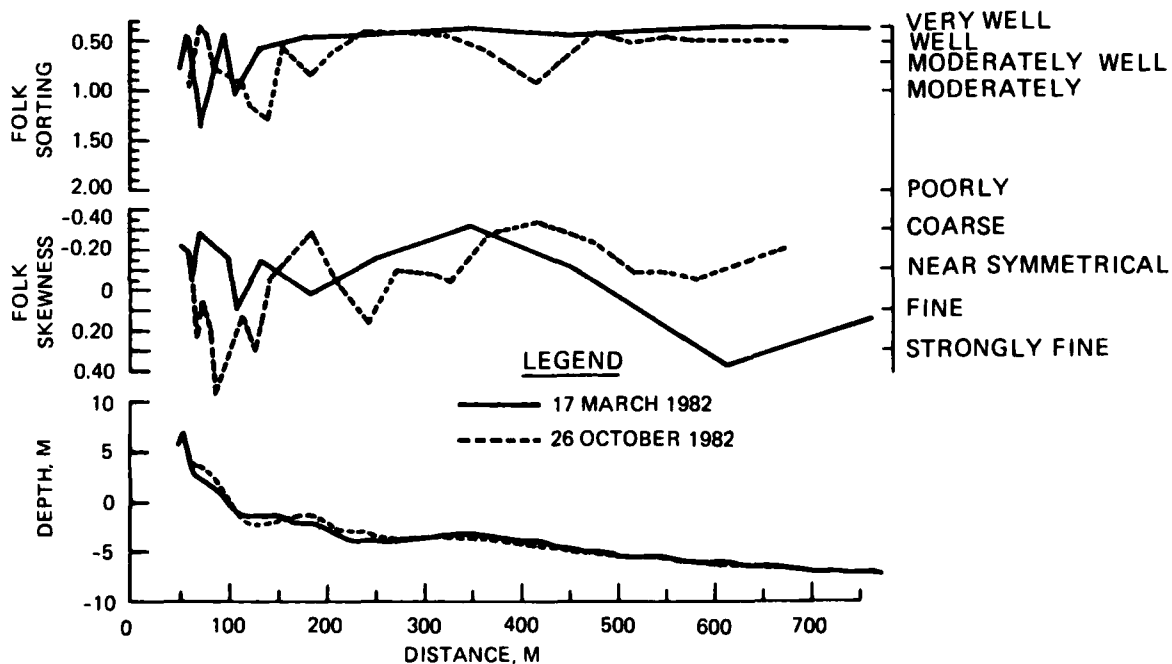


Figure 45. Sediment size distributions along profile 188, 26 October 1982



a. Mean grain size



b. Sorting and skewness characteristics of sediment distribution

Figure 46. Sediment distribution characteristics along profile 188

136. The effect of the October storms can be seen particularly well in the regime seaward of the offshore bar. Mean sediment sizes are generally more coarse, less well sorted, and coarsely skewed (Figure 46).

Alongshore variation

137. Sediment samples were obtained along the shore at different profile locations in March. Mean sediment sizes were observed to increase from north to south. Contour diagrams of the mean sediment size for the beach and offshore (Figures 47 and 48) show the alongshore and shore-normal variation of the sediment sizes described above, except under the FRF pier, where very fine, silty sands and an unusually homogeneous layer of organic mud up to 0.5 m thick filled the scour trough region.

Photographic Data

138. Two sets of photographic data were used to document nearshore and beach conditions in the vicinity of the FRF during 1982. Daily 35mm transparencies were taken of the beach from the pier looking both north and south (Figure 49). Approximately quarterly aerial photographic missions were also flown on the flight lines and dates indicated in Table 16, usually at a scale of 1:12,000. Figure 50 is a sample of this imagery obtained on 27 October 1982.

Storms

139. This section discusses the details of storms affecting the FRF. As used here, "storms" are times when the wave height parameter H_{m0} equals or exceeds 2.0 m at the seaward end of the FRF pier. Hourly data are presented in Appendix D; sample spectra from the Baylor gage at the seaward end of the pier are given in Appendix B; and pre- and/or poststorm bathymetry diagrams are given in Appendix C.

140. An unusually low number of East Coast (or Eastern Hemisphere) tropical cyclones occurred during the summer and fall seasons. Only five cyclonic storms were named (named storms have a duration of over 36 hr compared to an historical average of 10 named storms per year. Eleven named storms occurred during 1981, with four in September 1981 alone. Of the five storms during 1982, two reached hurricane strength; 1931 was the last time NWS

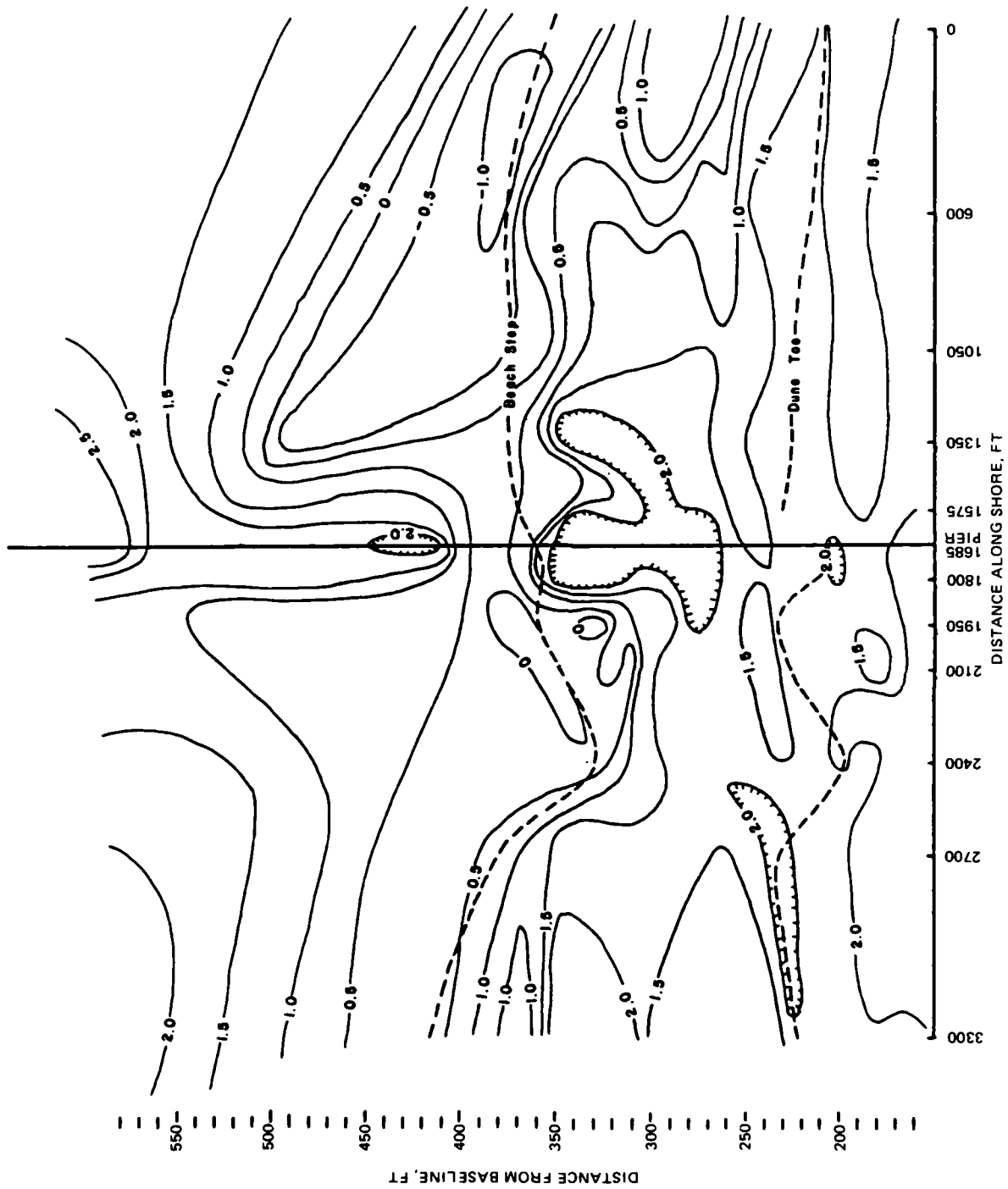


Figure 47. FRF nearshore mean sediment size distribution, 17-18 March 1982
(contour interval, 1/2 phi)

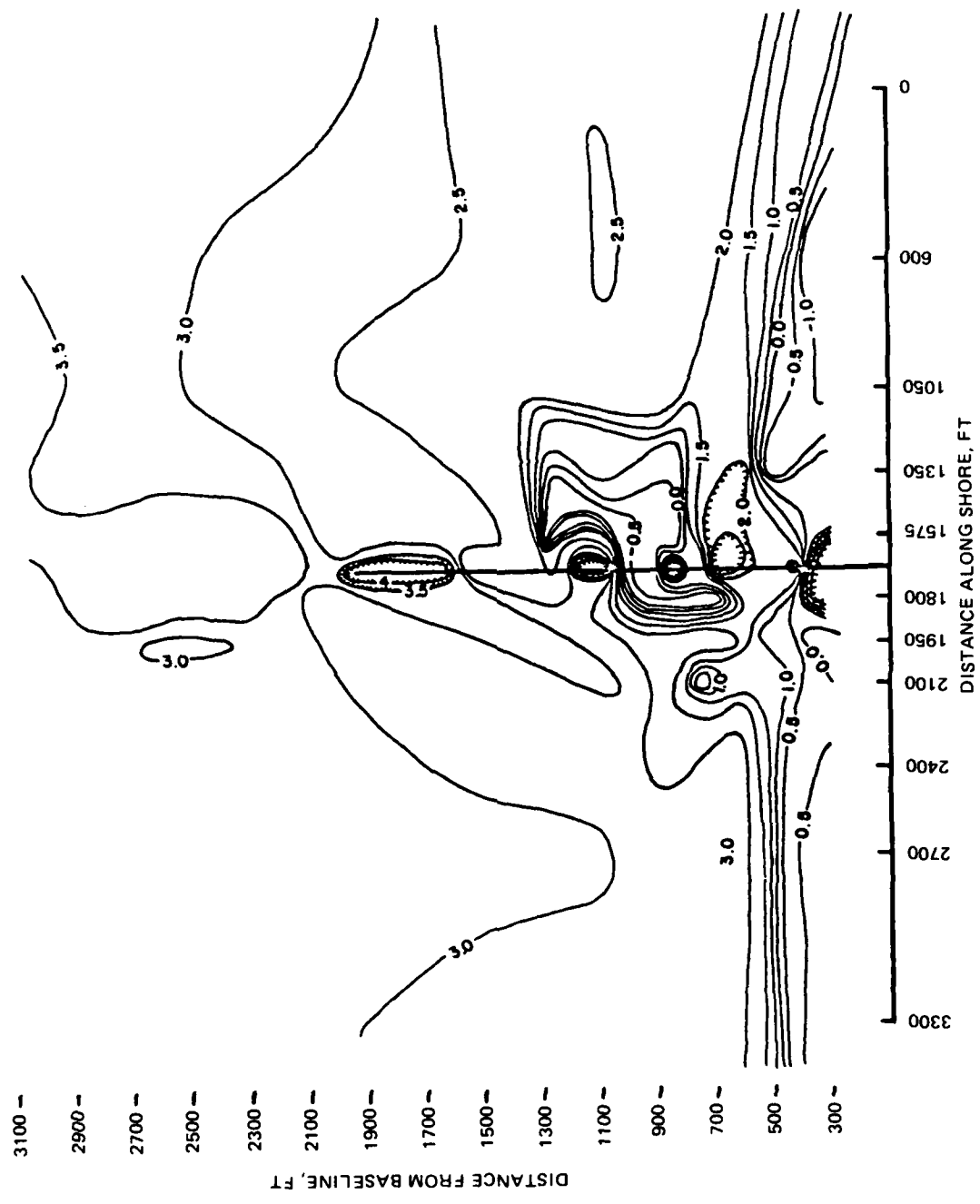
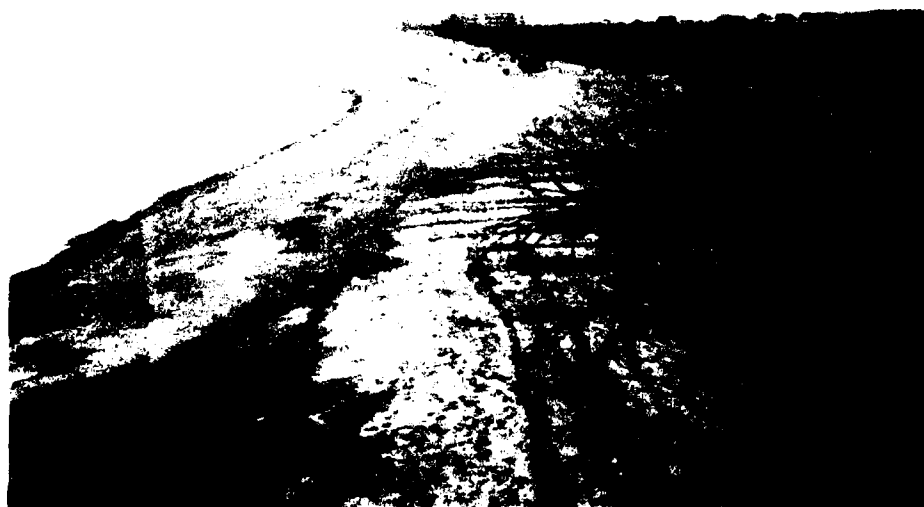


Figure 48. FRF offshore mean sediment size distribution, 17-18 March 1982
(contour interval, 1/2 phi)



a. Looking north from the pier deck



b. Looking south from the pier deck

Figure 49. Sample photographs of the FRF beach
taken 9 October 1982

Table 16
Aerial Photography Inventory for 1982

<u>Date</u>	<u>Film Type</u>	<u>Flight Lines</u>		
		<u>No. 1</u>	<u>No. 2</u>	<u>No. 3</u>
7 Feb	B/W		16 km north of FRF to 16 km south	Currituck mainland to Atlantic Ocean
11 May	Color		16 km north of FRF to 16 km south	
14 Jul	B/W	Cape Henry, Va. Cape Hatteras, N.C.		Currituck mainland to Atlantic Ocean
27 Oct	Color		16 km north of FRF to 16 km south	



Figure 50. Sample aerial photograph taken 27 October 1982

reported only two hurricanes in a season. Two of the named storms (including one hurricane) generated and dissipated in the Gulf of Mexico and consequently had no effect on the FRF. Hurricane Debby produced only slightly above average waves, and Tropical Storms Beryl and Ernesto may have been responsible for some long-period low swell evident in the data. The NOAA National Hurricane Center attributes this unusually tranquil summer and early fall to unseasonable westerly winds in the upper atmosphere which inhibited the process of tropical cyclone development.

141. The occurrence of nontropical cyclones associated with low pressure systems was responsible for most of the high wind and wave conditions at the FRF during the year. On 16 occasions, the wave heights exceeded 2 m, typical of previous years. Each storm is discussed below in terms of the date on which it occurred.

1 January 1982

142. The last storm of 1981 was responsible for the high waves at the FRF on New Year's Day. This storm traveled across the United States, moved offshore on the last day of December, and then moved north toward Newfoundland.

26-27 January 1982

143. A low pressure system originating in the central United States on the 25th moved east, arriving off Cape Hatteras, North Carolina, on the 26th before turning north and quickly moving past the FRF. Short-period waves, 6 to 7 sec, reflect the close proximity of the generating area of the storm to the FRF. At 0700 hours, the surface current speed was observed to be in excess of 2 m/sec, one of only two occasions during 1982 that such a fast current was observed. Winds of over 17 m/sec from the north and waves in excess of 2 m from north-northeast produced this strong southward current.

13 February 1982

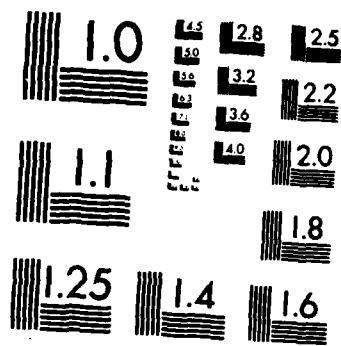
144. This cyclone formed over Florida on the 12th and moved north along the coast. Nourished by the Gulf Stream, the storm intensified. A brief period of high waves was recorded on the 13th as the storm moved rapidly past the FRF. This intense Atlantic cyclone continued traveling north leaving two disasters in its wake. One hundred seventeen deaths resulted from the sinking of a Soviet freighter and an offshore drilling rig in, reported, 15-m waves on the 14th.

17-19 February 1982

145. This low formed over Cape Hatteras on the 17th then moved east. Wave heights exceeded 3 m on the 18th.

25 February 1982

146. This storm formed over Virginia on the 21st and then moved northeastward to Newfoundland. Onshore winds resulting from the large circulation pattern of the storm dominated the meteorological conditions on the 25th. For a brief time, local winds created high waves at the FRF.



MICROCOPY RESOLUTION TEST CHART
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27 February-1 March 1982

147. A low moving north along the coast from Georgia and a high pressure system located around Maryland collided causing the low to stall and then move northeastward. Peak spectral wave periods increased from 7 sec on the 27th to 11 sec on the 1st.

16 March 1982

148. This low formed off Georgia on the 16th and moved rapidly past the FRF producing 2-m wave heights for a few hours around midday.

28 April 1982

149. This low formed in the midwest on the 24th then moved east arriving on the coast at the South Carolina-Georgia border on the 28th. The storm moved out over the Gulf Stream, and then it moved rapidly north producing high waves on the 28th.

12 May 1982

150. On 10 May, a storm developed well offshore of Virginia and moved slowly northeastward through the 12th. In addition, a frontal wave moved offshore at the North Carolina coast on the 12th. However, the long wave periods, 14 sec, measured at the FRF are indicative of swells which have traveled the long distance from the offshore generation area of the storm.

29 August 1982

151. An Arctic high pressure system formed in Canada on the 27th and moved east. Centered over Pennsylvania on the 29th, the high produced high winds and waves at the FRF.

10-13 October 1982

152. Early on the morning of 10 October, an extratropical storm moving eastward across the United States produced northeast winds having a maximum sustained speed of 13 m/sec at the FRF. Wave heights rapidly increased to 2.5 m by 1200 hours on the 10th (Figure 51). As the storm moved offshore, winds slowly abated and within 24 hr had decreased to only about 7 m/sec. However, since the storm center had moved almost due east, winds far out at sea continued to generate large waves, and heights in excess of 2 m were measured until 1300 hours on the 13th. Wave periods during the early part of the storm averaged about 7 sec, but as the storm moved offshore, a gradual shift in the peak period to higher values occurred, until by the evening of the 11th maximum energy was associated with wave periods in excess of 13 sec. This trend continued until peak periods of 17 sec were reached on the morning

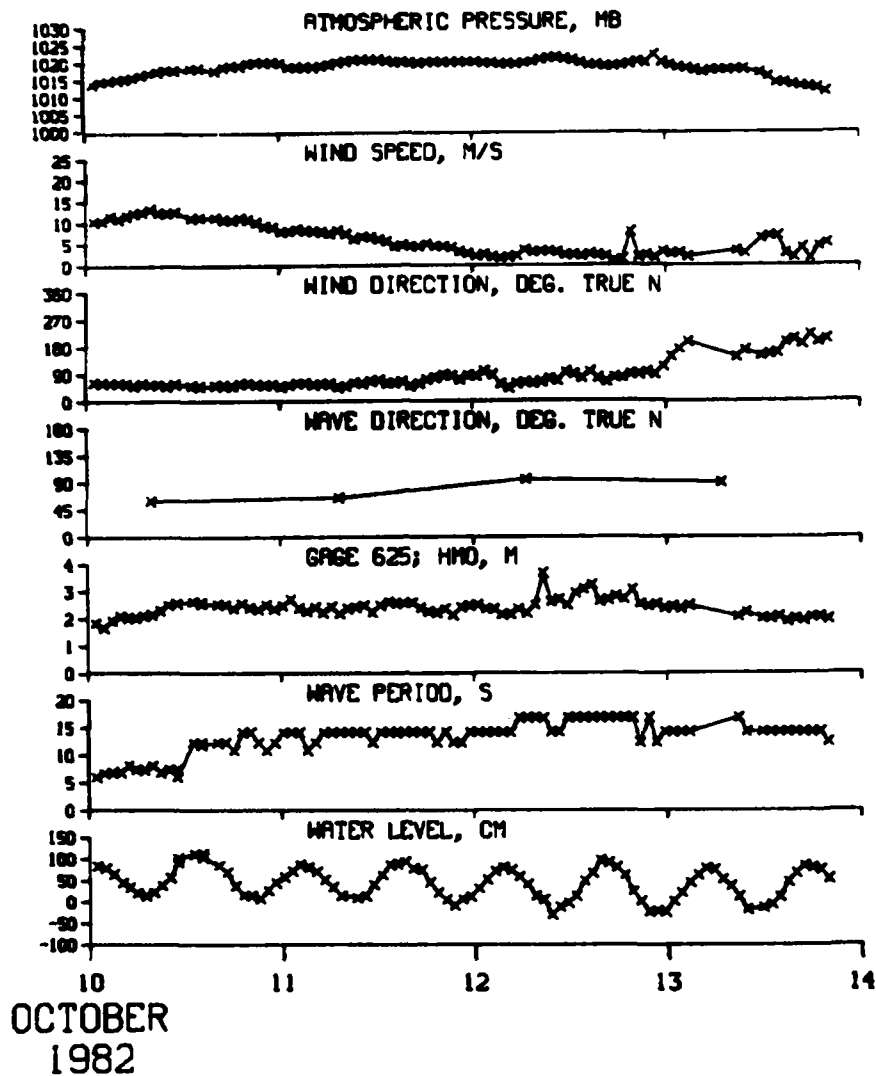


Figure 51. Storm data for 10-13 October 1982

of the 12th. Such high, long-period waves are very unusual on the east coast of the US.

153. A relatively straight beach and nearshore bar characterized the bathymetry prior to the storm. During the waning stages of the storm on the 13th, substantial offshore movement of the bar had occurred. By the 19th, the nearshore bar had moved landward to its prestorm position. Details of the storm and associated bathymetric changes are discussed by Holman and Sallenger (1984); Howd and Holman (1984); Jaffe, Sternberg, and Sallenger (1984); Mason et al. (1984); Richmond and Sallenger (1984); Sallenger et al. (1983); and Sallenger and Holman (1984).

23-25 October 1982

154. This low formed in an inverted atmospheric trough off Miami,

Florida, on the 24th. Local winds at the FRF were very strong, reaching a maximum sustained speed of 23 m/sec on the evening of the 24th. On the 25th, the low was located over Cape Hatteras, and it continued north to Maryland where it turned east and moved directly offshore for the next 2 days. Heavy rains, especially on the 25th, drenched the coast of North Carolina.

155. Wave heights exceeded 3 m for most of the 24th and 25th; wave periods increased from 6 sec on the 23rd to 14 sec on the 25th. Radar images of the wave crests obtained during the storm clearly show that the direction of wave approach changed slowly from northeast on the 24th to southeast by 0700 hours on the 25th. This shift in wave direction coincided with a similar change in wind direction as the storm moved past the FRF.

156. Longshore currents were directed southward during most of the storm, but they reversed direction at about 2200 hours on the 24th. Surface currents in excess of 2 m/sec were measured on the 25th, 200 m offshore under the pier, at the midsurf position. Waves were from the southeast with H_{m_0} in excess of 3.5 m, and winds averaging 9 m/sec from due south produced the extremely fast northwardly directed currents.

157. On the 25th, the persistent high waves and strong onshore winds produced the highest recorded water level of 1982, 127 cm.

158. Pre- and poststorm bathymetric surveys of the FRF show that although relatively little change occurred away from the pier, the trough under the pier greatly enlarged and deepened, with the depth of the scour hole at the seaward end of the FRF pier increasing to 8.5 m.

159. The storm was also responsible for severe beach erosion along the Outer Banks; several houses were lost at Kitty Hawk beach 10 km south of the FRF.

19-25 November 1982

160. An Arctic high pressure system that formed in Canada slowly drifted eastward dominating the wind patterns at the FRF. However, a succession of high pressure systems, originating in the central United States and moving off the east coast maintained onshore winds from 15 to 25 November. This storm, lasting 7 days, was the longest of the year. In general, less than 5 percent of the storms have durations exceeding 4 days.

9 December 1982

161. A high pressure system originating over West Virginia on the 7th moved east causing high waves for a short time on the 9th.

12 December 1982

162. Shortly after the passage of a cold front, a low developed off Cape Hatteras causing high waves at the FRF on the 12th.

17-19 December 1982

163. An offshore low pressure system formed off South Carolina moved slowly northeast through the 19th when it was off the FRF. Persistent onshore winds produced wave heights over 2 m for the 3 days.

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APPENDIX A: WAVERIDER BUOY MAINTENANCE AND CALIBRATION

1. This appendix presents the 1982 maintenance and calibration required for the Waverider buoy gages. Datawell recommends the Waverider buoys be cleaned and new batteries installed at least once every 9 months. The buoys were replaced on a number of occasions during the year (Table A-1 lists the operational dates of each gage used at the Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF)). Considerable biological growth occurs during the summer months when the water temperature is above 10° C. Antifoulant paint and at least one cleaning and painting during the summer reduce the fouling problem. Details of the gage installation are presented in Appendix B.

Table A1
Operational Dates for the Waverider Buoys Used at
the Field Research Facility during 1982

<u>Serial Number</u>	<u>Operational Dates</u>	<u>Calibration Dates</u>
<u>Offshore Waverider Buoy, CERC Gage 620</u>		
66966	18 Sep 1981-30 Mar 1982	7 Apr 1982
66967	30 Mar 1982-22 Nov 1982	23 Sep 1981 1 Dec 1982
66966	29 Nov 1982-29 Aug 1983	7 Apr 1982
<u>Nearshore Waverider Buoy, CERC Gage 610</u>		
66968	1 Sep 1981-29 Aug 1982	26 Aug 1981 31 Aug 1982

2. The buoys were calibrated at the National Oceanographic and Atmospheric Administration (NOAA) Engineering Support Offices, Ocean Wave Instrument Facility (Ribe 1981).* Ribe presents the following three correction factors for increasing wave measurement accuracy: (a) The Datawell-specified decrease in electronic sensitivity as a function of oscillation period, (b) a difference error based on deviations from (a) found during NOAA's calibrations, and (c) a temperature-dependent adjustment of the sensitivity due to an unknown

* References cited in the Appendixes are included in the References at the end of the main text.

chemical reaction in the conducting fluid surrounding the Waverider accelerometer. These three corrections and their application are discussed below.

Datawell-Predicted Decrease in Sensitivity Error DW

3. Waverider buoy sensitivity $/A/$ for the buoy electronics decreases with increasing period T of sinusoidal vertical motion according to Datawell as follows:

$$/A/ = \frac{1}{\left[1 + \left(\frac{T}{T_0}\right)^4\right]^{1/2}} \quad (A1)$$

where $T_0 = 30.8$ sec is a characteristic period provided by Datawell. This sensitivity decrease results in amplitude errors of less than 3 percent for oscillation (wave) periods less than 15 sec. Figures A1 to A3, which present curves for the Datawell-predicted sensitivity decrease error $(DW) = /A/ - 1$, show that the actual sensitivity does not decrease with period according to the Datawell relationship given in Equation A1.

Difference Error d

4. Difference error d is the difference between the Datawell-predicted decrease in sensitivity error DW and that found from the actual buoy calibrations. In Tables A2 through A4, DW and d are tabulated as a function of T for each buoy. Best accuracy is obtained by choosing the calibration values nearest in time to the date of the measurements.

Temperature Related Error

5. It has been determined that for some unknown number of Waveriders the sensitivity is drifting downward, possibly since manufacture, on the average of about 1 percent per year. Sensitivity loss from some unknown chemical reaction is related to increases in electrical conductivity of the conductive fluid surrounding the accelerometer. This drift is identified from calibrations over a period of time.

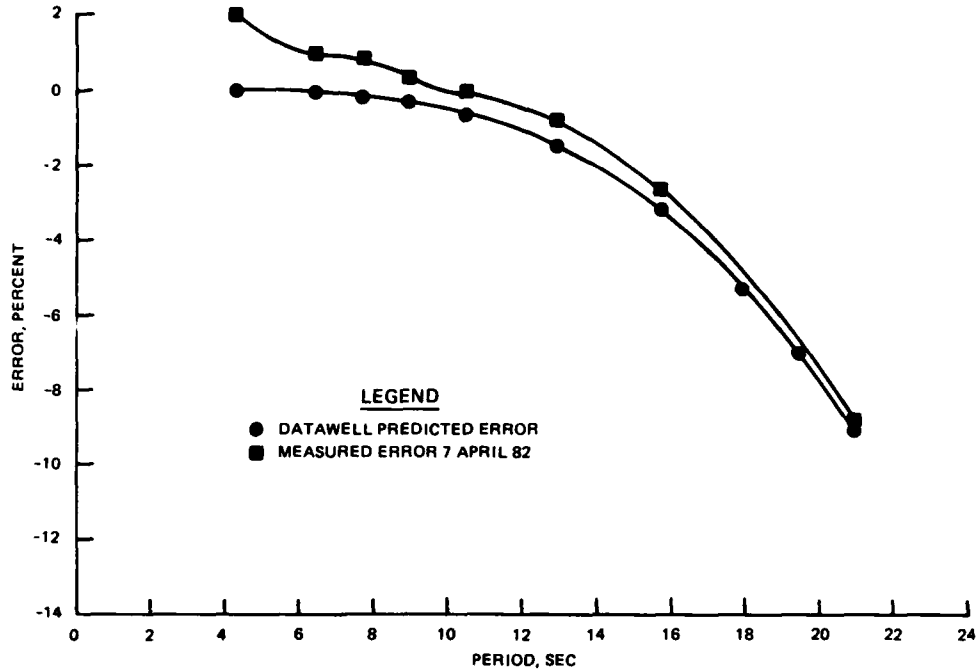


Figure A1. Waverider 66966 calibration errors as measured on 7 April 1982

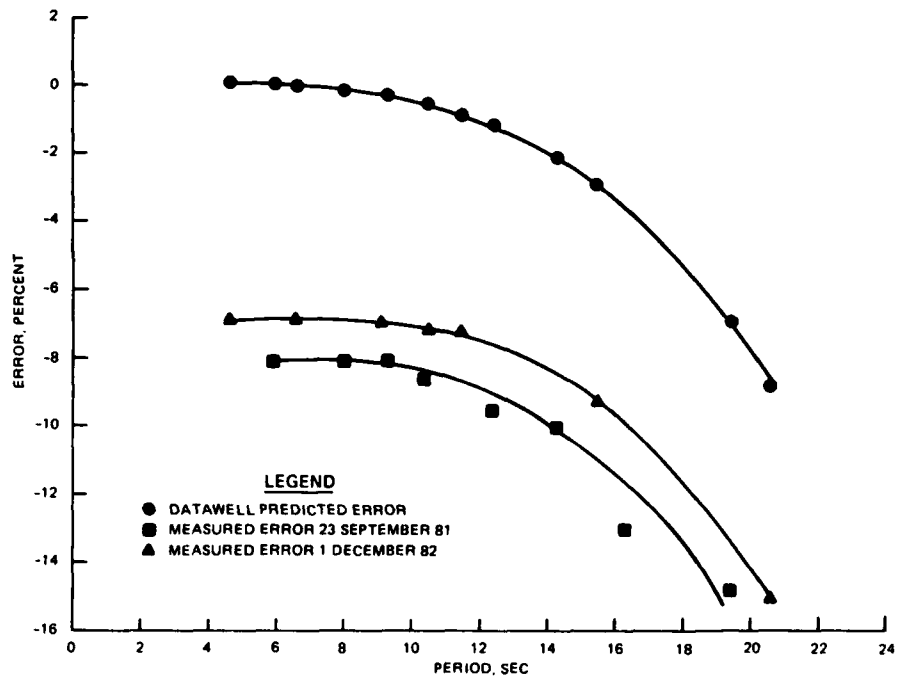


Figure A2. Waverider 66967 calibration errors as measured on 23 September 1981 and 1 December 1982

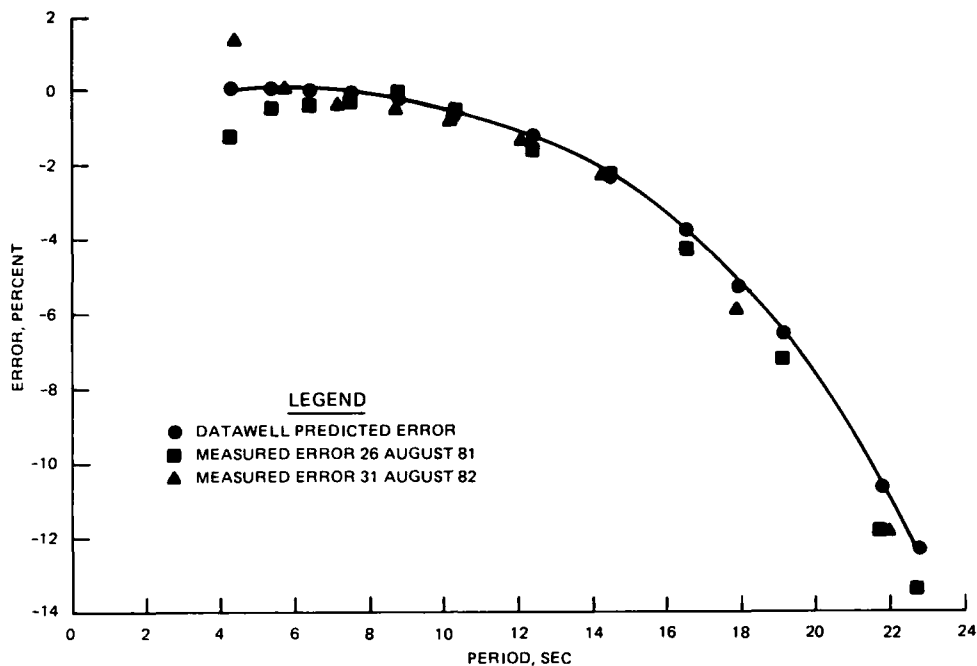


Figure A3. Waverider 66968 calibration errors as measured on 26 August 1981 and 31 August 1982

Table A2
Waverider 66966 Errors (Proportion) for
7 April 1982 Calibration

<u>Period, sec</u>	<u>Frequency, Hz</u>	<u>Difference Error d</u>	<u>Datawell-Predicted Error DW</u>
20.90	0.0478	0.0019	-0.0917
15.71	0.0637	0.0056	-0.0322
12.89	0.0776	0.0065	-0.0150
10.46	0.0956	0.0051	-0.0066
8.96	0.1116	0.0071	-0.0036
7.77	0.1287	0.0105	-0.0020
6.45	0.1550	0.0106	-0.0010
4.37	0.2288	0.0208	-0.0002
10.33	0.0968	0.0067	-0.0062

Table A3
Waverider 66967 Errors (Proportion) for
23 September 1981 and 1 December 1982

<u>Period, sec</u>	<u>Frequency, Hz</u>	<u>Difference Error d</u>	<u>Datowell-Predicted Error DW</u>
<u>23 September 1981</u>			
19.41	0.0515	-0.0786	-0.0706
16.34	0.0612	-0.0936	-0.0374
14.32	0.0698	-0.0784	-0.0226
12.47	0.0802	-0.0828	-0.0132
10.56	0.0947	-0.0801	-0.0068
10.35	0.0966	-0.0794	-0.0063
9.28	0.1078	-0.0768	-0.0041
8.03	0.1245	-0.0786	-0.0023
5.98	0.1672	-0.0802	-0.0007
<u>1 December 1982</u>			
20.64	0.0484	-0.0641	-0.0878
15.50	0.0645	-0.0632	-0.0306
11.54	0.0867	-0.0640	-0.0097
10.50	0.0952	-0.0665	-0.0067
9.15	0.1093	-0.0668	-0.0039
6.64	0.1506	-0.0688	-0.0011
4.70	0.2128	-0.0694	-0.0003

Table A4
Waverider 66968 Errors (Proportion) for Calibrations
on 26 August 1981 and 31 August 1982

<u>Period, sec</u>	<u>Frequency, Hz</u>	<u>Difference Error d</u>	<u>Datawell-Predicted Error DW</u>
<u>26 August 1981</u>			
22.80	0.0439	-0.0111	-0.1230
19.08	0.0524	-0.0062	-0.0664
16.48	0.0607	-0.0028	-0.0386
14.47	0.0691	0.0002	-0.0235
12.40	0.0806	-0.0043	-0.0129
10.40	0.0962	0.0002	-0.0064
10.26	0.0975	0.0009	-0.0061
8.81	0.1135	0.0022	-0.0033
7.57	0.1321	0.0047	-0.0018
6.45	0.1550	0.0059	-0.0010
5.40	0.1852	0.0064	-0.0005
4.33	0.2309	0.0132	-0.0002
<u>31 August 1982</u>			
21.84	0.0458	-0.0115	-0.1066
17.94	0.0557	-0.0056	-0.0530
14.34	0.0697	-0.0005	-0.0227
12.09	0.0827	-0.0025	-0.0117
10.26	0.0975	-0.0030	-0.0061
10.18	0.0982	-0.0022	-0.0059
8.69	0.1151	-0.0016	-0.0032
7.23	0.1383	-0.0006	-0.0015
5.77	0.1733	0.0006	-0.0006
4.40	0.2273	0.0133	-0.0002

6. Recently, Datawell has been working on this sensitivity-drift problem, and an improved modulator printed-circuit board has been made available for bringing calibrations within specification and for preventing further decrease in sensitivity. This modification was made for buoy 66968 and 66966 so the temperature-related error correction need not be applied. For buoy 66967, however, it is recommended that the correction be used. Datawell has provided curves for correction of the calibration based on buoy temperature when the buoy is measuring waves in the ocean. The NOAA Engineering Support Office has developed a table based on the Datawell curve which can be entered with the uncorrected difference error value d and the temperature of the

water during the time of buoy operation to determine the difference error correction (Table A5). The difference error correction is added to d to obtain the corrected difference error D . For temperatures during buoy operation greater than the buoy temperature during calibration (e.g., 22.4° C) no correction is necessary. Water temperature values may best be determined from the water characteristics section or the CERC FRF Monthly Preliminary Summaries.*

Table A5
Temperature-Dependent Sensitivity Error Adjustment

Difference d	Water Temperature, °C							
	22.4	20	18	16	14	12	10	8
0.00	0.000	0.001	0.001	0.001	0.001	0.000	-0.000	-0.002
-0.01	↓	0.007	0.008	0.009	0.010	0.011	0.011	0.011
-0.02		0.009	0.012	0.014	0.016	0.018	0.019	0.020
-0.03		0.009	0.013	0.016	0.019	0.021	0.024	0.026
-0.04		0.008	0.012	0.016	0.020	0.023	0.027	0.029
-0.05		0.006	0.011	0.016	0.020	0.024	0.028	0.037
-0.06		0.004	0.010	0.015	0.020	0.025	0.030	0.034
-0.07		0.003	0.009	0.015	0.021	0.026	0.031	0.036
-0.08		0.003	0.010	0.017	0.023	0.029	0.034	0.037
-0.09		0.006	0.013	0.019	0.026	0.032	0.038	0.043
-0.10		0.010	0.017	0.024	0.031	0.037	0.043	0.049

Application of Error Corrections

7. Since these error corrections are oscillation-period dependent, their application requires that the wave data be decomposed into amplitude or variance-spectrum coefficients for each frequency or period. A less accurate but also less complicated procedure would be to apply a single correction to the wave height H_{m0} based on the peak spectral wave period T_p and an average water temperature estimate. For correction of amplitudes or derived parameters linearly related to amplitude, a correction factor $F(T)$ can be

* These Summaries can be obtained from the FRF in Duck, N. C.

obtained from the sum of the Datawell DW and difference error D (temperature-corrected, if necessary) by

$$F(T) = \frac{1}{1 + (DW + D)} \quad (A2)$$

which can be applied by multiplying the uncorrected amplitude by F(T) for T_p . For correction of parameters related to the square of the amplitude (i.e. total energy or variance spectrum coefficients) the following should be used:

$$[F(T)]^2 = \left[\frac{1}{1 + (DW + D)} \right]^2 \quad (A3)$$

8. To apply the correction, first the difference error between the Datawell-predicted error and the error measured during calibration are determined. This difference error is then adjusted for the temperature-dependent increase in electrical conductivity before the Datawell-predicted difference error and the corrected difference error are summed. Finally, the decrease in sensitivity (based on the wave period) is computed by adding 1 to the sum.

9. To demonstrate the use of the calibration results, the Waverider buoy (620) located 3 km from shore recorded an H_{m0} of 4.3 m and T_p of 11 sec on 24 October 1982. Table A3 calibration results for 1 December 1982 (buoy 66967) give a difference error d for 11 sec of -0.0640. From Part V of the main text, Water Characteristics, the water temperature is estimated to be 15° C. Entering Table A5 with the difference error -0.06 and water temperature of 15° C, the correction is 0.0175. This is added to the uncorrected difference error d to obtain the corrected difference error D, i.e., $-0.0465 = -0.0640 + 0.0175$. The corrected difference error ($D = -0.0465$) is added to the Datawell-predicted difference error ($DW = -0.0097$) in Table A3 for $T_p = 11$ sec, $-0.0562 = -0.0465 + (-0.0097)$; and the sensitivity is computed by adding 1, or $0.9438 = 1 + (-0.0562)$.

10. This sensitivity is used to correct amplitudes and variance spectra coefficients for 11-sec period. As indicated below, the corrected amplitude = the uncorrected amplitude divided by the sensitivity, or

$$\frac{4.3 \text{ m}}{0.9438} = 4.6 \text{ m (6\% increase)}$$

and the corrected variance coefficient is

$$\frac{\text{uncorrected variance coefficient}}{(0.9438)^2}$$

11. In general, the wave statistics errors are near 5 percent for wave periods less than 12 sec (12 sec is equal to the annual mean plus 1 standard deviation wave period). Errors of this magnitude are generally tolerable for most engineering applications, although it is worthwhile to know the error bounds for some design considerations. When investigating coastal phenomena involving very long period swell of 15 sec or greater, such as surf beats and sediment accretion due to swell waves, these corrections will produce significant increases in the magnitudes of the wave parameters, and it is recommended that the corrections be used.

APPENDIX B: WAVE DATA

Wave data summaries for 1982 and climatological summaries for 1980 through 1982 are presented in this appendix. The wave data are summarized in the following forms:

- a. Gage histories. Table B1 includes information about the gages, gage installations, and major interruptions in the data collection at the Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) in Duck, N. C. Short interruptions in the operational status of the gages are not mentioned.
- b. Time-histories. A continuous display of individual wave height and peak spectral wave period values are plotted as a function of time throughout the year (Figures B1, B14, B22, and B30). So that the sequence of the data can be followed easily, solid lines connect consecutive data points for times when there are fewer than 24 hr between observations.
- c. Annual, seasonal, and monthly maxima, mean, and standard deviations of wave height and peak period. Mean 1982 wave height and standard deviation, mean peak wave period and standard deviation, and extreme wave heights are listed in Tables B2, B10, B18, and B26; 1980 through 1982 values are in Tables B6, B14, B22, and B30. Also included is the total number of observations obtained. At four observations per day, the maximum number of observations per month (based on a 30-day period) is 120.
- d. Maxima, mean, and standard deviations of wave height and peak period. The 1982 data presented in the tables described above are also graphed (Figures B2, B15, B23, and B31) for each month and the year; 1980 through 1982 data are graphed in Figures B9, B19, B27, and B35. The standard deviations are presented as vertical bars originating at the mean value and extending to the mean plus one standard deviation value. The extreme values are plotted above. No extreme period values are presented.
- e. Joint distribution functions of wave height versus peak period. Annual, seasonal, and monthly joint distribution tables are presented for 1982 in Tables B3, B4, B11, B12, B19, B20, B27, and B28. Data for 1980 through 1982 are in Tables B7, B8, B15, B16, B23, B24, B31, and B32. Each table gives the frequency (in parts per 1,000) for which the wave height and peak period were within the specified intervals; these values can be converted to percent by dividing by 10. Marginal totals are also included. The row total gives the total number of observations out of 1,000 which fell within each specified wave height interval. The column total gives the number of observations out of 1,000 which fell within each specified peak period interval.
- f. Cumulative distributions of wave height. For each gage, annual, seasonal, and monthly wave height distributions for 1982 are plotted in cumulative form in Figures B3, B4, B16, B17, B24, B25, B32, and B33; data for 1980 through 1982 are in Figures B10, B20, B28, and B36.

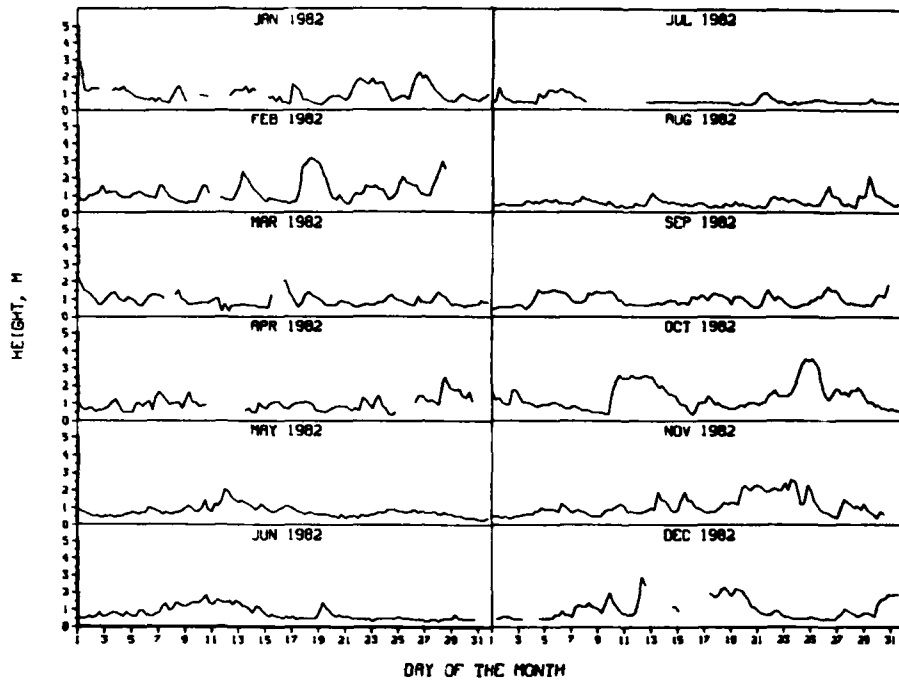
- g. Peak spectral wave period distributions. Annual, seasonal, and monthly peak wave period distribution bar charts for 1982 are presented in Figures B5, B6, B18, B26, and B34; data for 1980 through 1982 are in Figures B11, B21, B29, and B37.
- h. Persistence of wave heights. Tables B5, B13, B21, and B29 show the number of times throughout 1982 when the specified wave height was equaled or exceeded at least once during each day for the duration (consecutive days) indicated; data for 1980 through 1982 are in Tables B9, B17, B25, and B33. For example, for gage 625 (Table B5) wave heights equaled or exceeded 1.0 m 54 times for at least 1 day; 34 times for at least 2 days; 26 times for at least 3 days; 17 times for at least 4 days; etc. Therefore, on 20 occasions one would expect the height to have equaled or exceeded 1.0 m for 1 day exactly; on 8 occasions for 2 days; on 9 occasions 3 days; etc. Note that the height exceeded 1 m 54 times for 1 day or longer, while heights exceeded 0.5 m only 18 times for this same duration. This occurred because the longer durations of lower waves may be interspersed with shorter, but more frequent, intervals of higher waves. For example, the one time that wave heights exceeded 0.5 m for 109 days may represent 5 or 10 times the height exceeded 1 m.
- i. Wave roses. For gage 625 (pier-end Baylor), wave roses showing the distribution of wave height versus approach angle are presented. 1982 data are in Figures B7 and B8, while 1980 through 1982 data are in Figures B12 and B13. The angles are referenced to true North. Northerly wave angles (less than 70 deg) generally produce southward currents, while southerly wave angles (greater than 70 deg) produce northward currents.
- j. Spectra. Spectra for gage 625 (pier-end Baylor) for days when wave heights exceeded 2 m are presented in Figure B38. The plots show energy density as a function of wave frequency for all available times throughout the day.

Table B1

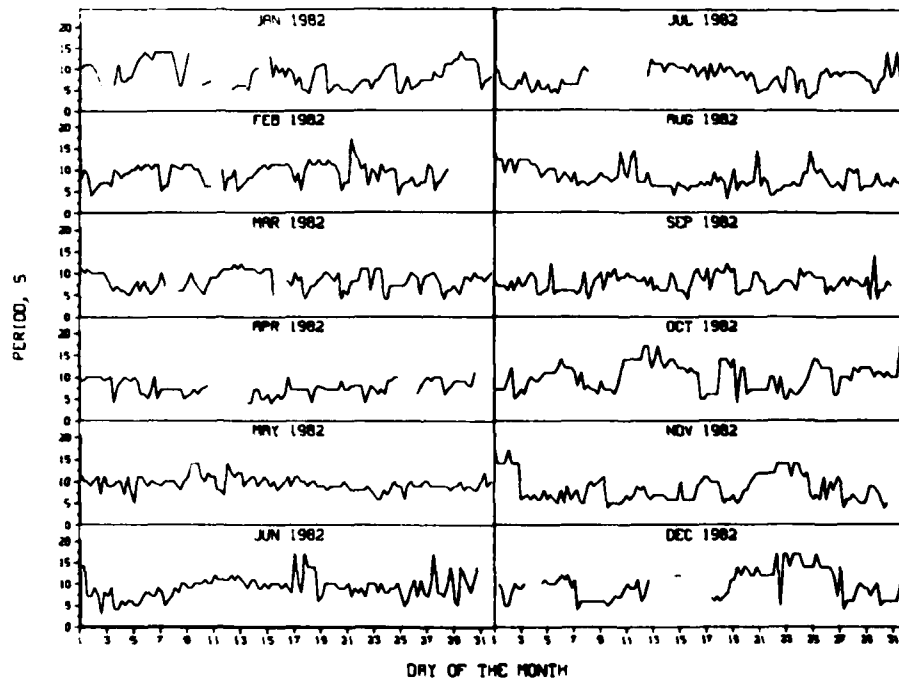
Wave Gage Histories for 1982*

<u>Type of Gage</u>	<u>Location</u>	<u>Beginning of Proper Operation</u>	<u>End of Proper Operation</u>	<u>Explanation</u>	<u>Range</u> m	<u>Depth</u> m	<u>Distance from Shore</u>
Continuous wire staff	Pier sta 19+00 (579 m ENE of coordinates given)	Nov 78		No major problems	-2.1 to 7.0	8.2	0.5 km
Accelerometer buoy	36° 11.1' N x 75° 44.4' W (2.5 km ENE of seaward end of FRF pier)	Nov 78	30 Mar 82	Replaced SM66966 with SN 66967	Continuous	18	3 km
		30 Mar 82	20 Nov 82	Mooring failed			
		29 Nov 82		Replaced with SN 66966			
Continuous wire staff	Pier sta 6+20 (189 m ENE of coordinates given)	Nov 78	28 Apr 82	Lightning damaged gage	-1.5 to 7.0 m	2.1	100 m
		7 May					
Accelerometer buoy	36° 11.1' N x 75° 44.7' W	Nov 78	26 Aug 82	Mooring failed; installation terminated	Continuous	7	0.6 km

* Pier/baseline coordinates--36° 10' 54" N x 75° 45' 50" W.



a. Wave heights



b. Wave periods

Figure B1. Time-history for gage 625

Table B2
1982 Wave Statistics for Gage 625

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	1.0	0.5	8.6	3.0	2.9	1	96
Feb	1.2	0.6	8.8	2.4	3.1	18	102
Mar	0.9	0.3	8.2	2.2	2.2	1	107
Apr	1.0	0.4	7.5	1.8	2.5	28	89
May	0.8	0.3	9.5	1.6	2.0	12	121
Jun	0.8	0.4	9.1	2.6	1.8	10	117
Jul	0.5	0.2	7.8	2.4	1.3	1	105
Aug	0.6	0.3	7.8	2.4	2.1	29	120
Sep	0.9	0.3	7.7	2.0	1.8	30	118
Oct	1.3	0.7	10.1	3.1	3.5	24	123
Nov	1.1	0.6	8.4	3.1	2.6	23	115
Dec	1.0	0.6	9.8	3.5	2.9	12	102
Jan-Mar	1.0	0.5	8.5	2.5	3.1	Feb	305
Apr-Jun	0.8	0.4	8.8	2.2	2.5	Apr	327
Jul-Sep	0.7	0.3	7.8	2.2	2.1	Aug	343
Oct-Dec	1.2	0.6	9.4	3.3	3.5	Oct	340
Annual	0.9	0.5	8.6	2.7	3.5	Oct	1,315

Table B3
1982 Annual and Seasonal Joint Distribution of Wave
Height Versus Peak Period for Gage 625

HEIGHT(METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	1	2	2	6	21	17	27	20	11	8	11	1	127
.50 - .99	.	2	24	33	63	61	56	86	81	54	21	25	11	517
1.00 - 1.49	.	.	7	30	50	33	14	22	32	21	13	3	.	225
1.50 - 1.99	.	.	.	5	23	16	3	3	6	6	9	3	.	74
2.00 - 2.49	5	6	5	.	1	5	5	9	1	37
2.50 - 2.99	2	.	1	2	1	3	3	2	14
3.00 - 3.49	1	.	.	2	2	1	.	6
3.50 - 3.99	1	.	.	1	.	2
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	3	33	70	147	139	96	139	143	100	61	56	15	

HEIGHT(METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	3	7	13	.	3	.	29
.50 - .99	.	.	30	43	33	30	62	52	85	111	36	30	3	515
1.00 - 1.49	.	.	10	39	52	56	20	23	46	33	3	.	.	282
1.50 - 1.99	.	.	.	10	36	36	7	3	7	3	3	.	.	105
2.00 - 2.49	3	16	10	.	.	10	7	.	.	39
2.50 - 2.99	3	10	3	.	.	.	23
3.00 - 3.49	7	.	.	.	7
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	40	92	124	138	102	84	155	180	49	33	3	

HEIGHT(METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	24	21	24	9	3	6	3	99
.50 - .99	.	3	15	24	43	86	89	159	135	31	.	21	6	612
1.00 - 1.49	.	.	9	18	21	24	18	34	52	37	9	6	.	228
1.50 - 1.99	3	3	6	9	3	12	12	.	.	48
2.00 - 2.49	3	.	.	.	.	.	.	3	.	6
2.50 - 2.99	3	.	.	.	.	.	.	.	3
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	3	24	42	70	125	137	223	214	89	24	36	9	

(Continued)

Table B3 (Concluded)

HEIGHT (METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	3	6	6	23	61	41	76	41	17	26	17	.	317
.50 - .99	.	6	35	35	120	87	52	73	47	20	3	6	.	484
1.00 - 1.49	.	.	6	26	50	9	17	20	20	12	6	.	.	166
1.50 - 1.99	.	.	.	9	9	12	.	.	.	.	.	.	.	30
2.00 - 2.49	3	.	.	.	.	.	.	.	.	3
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	47	76	205	169	110	169	108	49	35	23	0	

HEIGHT (METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	12	.	3	6	3	3	15	.	42
.50 - .99	.	.	15	29	53	38	24	59	62	59	47	44	32	462
1.00 - 1.49	.	.	3	35	76	47	3	12	12	6	32	6	.	232
1.50 - 1.99	.	.	.	3	44	15	.	.	15	9	21	12	.	119
2.00 - 2.49	9	9	12	.	3	12	21	32	3	101
2.50 - 2.99	6	.	.	.	.	6	12	6	30
3.00 - 3.49	3	.	.	.	6	3	.	12
3.50 - 3.99	3	.	.	3	.	6
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	18	67	182	127	42	74	101	89	136	127	41	

Table B4
1982 Monthly Joint Distribution of Wave Height
Versus Peak Period for Gage 625

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	10	10	21	21	.	10	.	72
.50 - .99	.	.	52	83	42	31	42	10	10	73	94	83	.	520
1.00 - 1.49	.	.	.	31	62	21	42	10	31	31	.	.	.	228
1.50 - 1.99	.	.	.	10	21	73	.	10	10	.	.	.	.	124
2.00 - 2.49	10	21	.	.	.	10	.	.	.	41
2.50 - 2.99	10	.	.	.	.	10
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	52	124	135	146	94	40	82	135	94	93	0	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	10	.	29	29	49	118	118	.	.	.	0
.50 - .99	.	.	.	20	39	39	10	39	69	69	10	10	10	373
1.00 - 1.49	.	.	.	20	78	39	20	.	.	.	10	.	.	334
1.50 - 1.99	29	10	.	.	.	.	.	.	167
2.00 - 2.49	10	20	10	.	.	.	49
2.50 - 2.99	10	20	20	.	.	60
3.00 - 3.49	20	.	.	.	20
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	20	69	117	136	69	98	207	227	40	10	10	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	28	112	93	121	19	.	.	.	19
.50 - .99	.	.	37	37	56	28	112	93	121	140	19	.	.	643
1.00 - 1.49	.	.	9	47	56	103	9	19	37	.	.	.	.	280
1.50 - 1.99	9	.	.	.	9	.	.	.	.	27
2.00 - 2.49	19	.	.	9	.	.	.	28
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	46	84	121	131	140	112	167	177	19	0	0	

(Continued)

(Sheet 1 of 4)

Table B4 (Continued)

HEIGHT (METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	11	11	.	.	.	.	22
.50 - .99	.	.	34	22	45	146	79	79	135	.	.	.	.	540
1.00 - 1.49	.	.	34	56	67	79	34	34	22	11	.	.	.	337
1.50 - 1.99	11	11	22	34	.	.	.	.	.	78
2.00 - 2.49	11	.	.	.	.	.	.	.	.	11
2.50 - 2.99	11	.	.	.	.	.	.	.	11
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	68	78	134	247	135	158	168	11	0	0	0	0

HEIGHT (METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	25	41	25	8	8	.	.	107
.50 - .99	.	.	.	8	25	33	107	264	165	74	.	8	.	684
1.00 - 1.49	8	17	17	50	50	17	17	.	176
1.50 - 1.99	8	17	.	.	25
2.00 - 2.49	8	.	8
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	0	8	25	41	149	322	240	140	42	33	0	0

HEIGHT (METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	26	43	9	34	17	.	17	9	155
.50 - .99	.	9	17	43	60	94	77	111	103	9	.	51	17	591
1.00 - 1.49	.	.	.	9	9	.	9	51	77	43	9	.	.	207
1.50 - 1.99	9	26	17	.	.	52
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	17	52	69	120	129	171	223	95	26	68	26	0

(Continued)

(Sheet 2 of 4)

Table B4 (Continued)

HEIGHT (METERS)	MONTH JUL													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	10	19	19	19	76	76	162	86	57	10	19	.	553
.50 - .99	.	10	48	57	57	38	29	67	29	29	.	.	.	364
1.00 - 1.49	.	.	19	19	38	10	.	.	.	.	.	.	.	86
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	20	86	95	114	124	105	229	115	86	10	19	0	

HEIGHT (METERS)	MONTH AUG													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	50	100	42	67	42	.	67	33	.	401
.50 - .99	.	8	25	42	167	125	50	33	42	17	8	8	.	525
1.00 - 1.49	.	.	.	8	25	8	.	8	.	.	.	.	.	49
1.50 - 1.99	8	8	.	.	.	.	.	.	.	16
2.00 - 2.49	8	.	.	.	.	.	.	.	.	8
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	8	25	50	258	241	92	108	84	17	75	41	0	

HEIGHT (METERS)	MONTH SEP													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	8	8	8	.	.	.	.	.	24
.50 - .99	.	.	34	8	127	93	76	119	68	17	.	8	.	550
1.00 - 1.49	.	.	.	51	85	8	51	51	59	34	17	.	.	356
1.50 - 1.99	.	.	.	25	17	25	.	.	.	.	.	.	.	67
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	34	84	229	134	135	178	127	51	17	8	0	

(Continued)

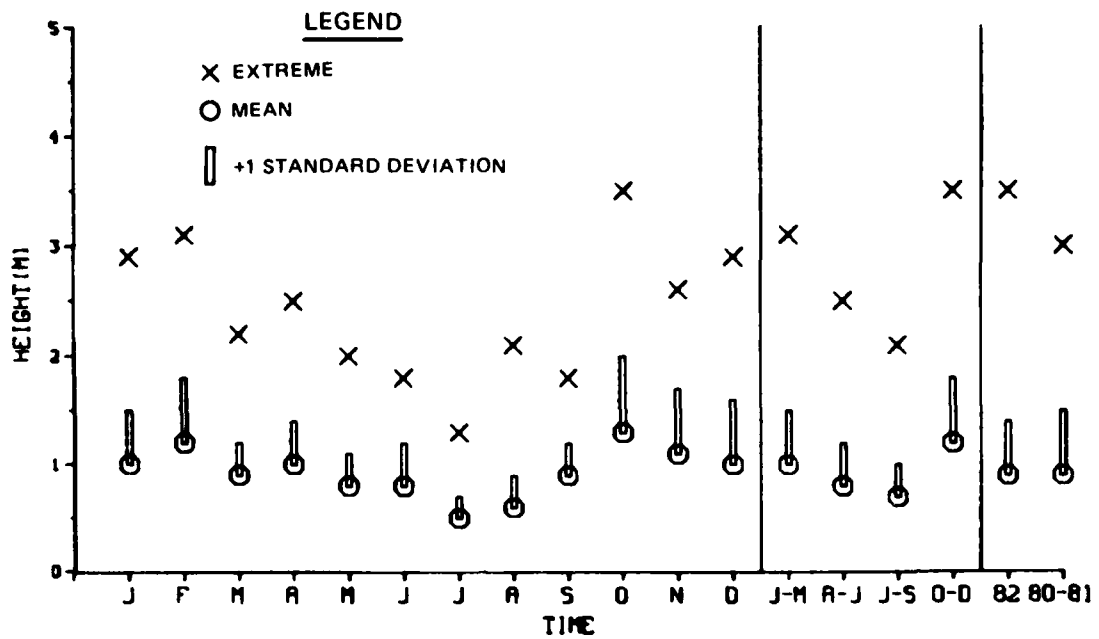
(Sheet 3 of 4)

Table B4 (Concluded)

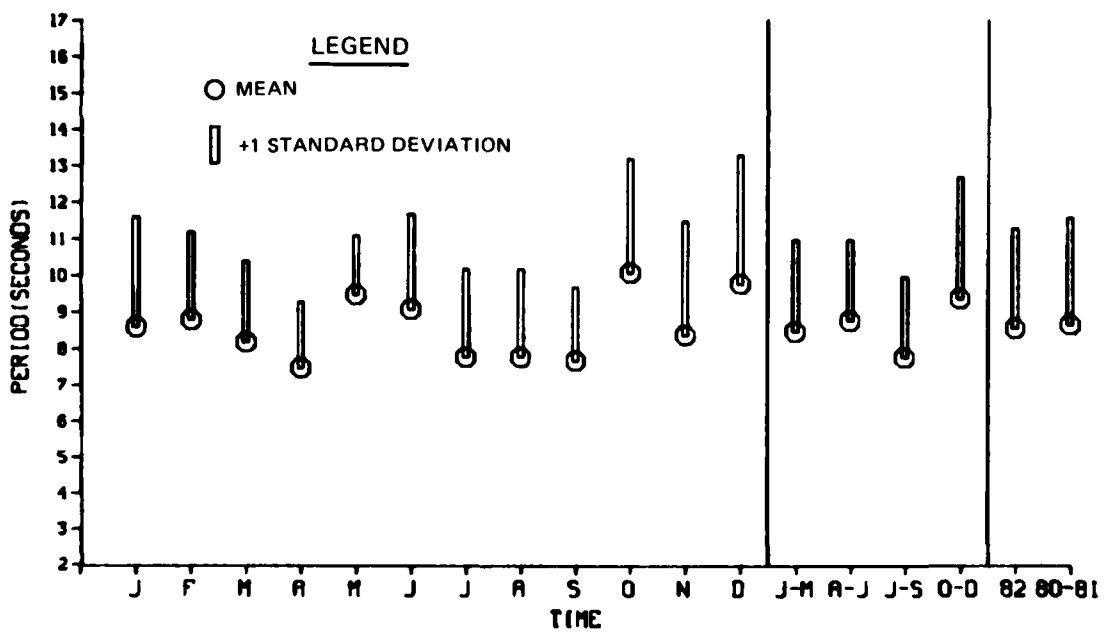
MONTH OCT														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	16	.	.	.	8	.	.	.	24
.50 - .99	.	.	8	.	24	41	16	24	49	81	73	33	16	365
1.00 - 1.49	.	.	.	33	41	81	.	16	33	8	57	8	.	277
1.50 - 1.99	.	.	.	8	41	8	.	.	33	8	33	24	.	155
2.00 - 2.49	8	.	8	.	.	.	8	41	8	73
2.50 - 2.99	8	.	.	.	.	16	16	16	56
3.00 - 3.49	8	.	.	.	16	8	.	32
3.50 - 3.99	8	.	.	.	8	.	16
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	8	41	114	154	32	40	123	105	203	138	40	

MONTH NOV														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	.	.	9	.	.	26	.	44
.50 - .99	.	.	26	61	104	61	43	61	52	43	.	26	17	494
1.00 - 1.49	.	.	.	52	113	43	9	17	.	9	9	.	.	252
1.50 - 1.99	17	17	.	.	.	.	17	.	.	51
2.00 - 2.49	9	9	17	.	9	17	43	35	.	139
2.50 - 2.99	17	.	17
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	26	113	243	139	69	78	70	69	69	104	17	

MONTH DEC														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	10	.	10	10	.	10	20	.	60
.50 - .99	.	.	10	29	29	10	10	98	88	49	69	78	69	539
1.00 - 1.49	.	.	10	20	78	10	.	.	.	.	29	10	.	157
1.50 - 1.99	78	26	.	.	10	20	10	10	.	148
2.00 - 2.49	10	20	10	.	.	20	10	20	.	90
2.50 - 2.99	10	.	.	.	.	.	.	.	10
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	20	49	195	80	20	108	108	89	128	138	69	



a. Wave heights



b. Wave periods

Figure B2. 1982 extreme, mean, and standard deviation of wave heights and periods for gage 625

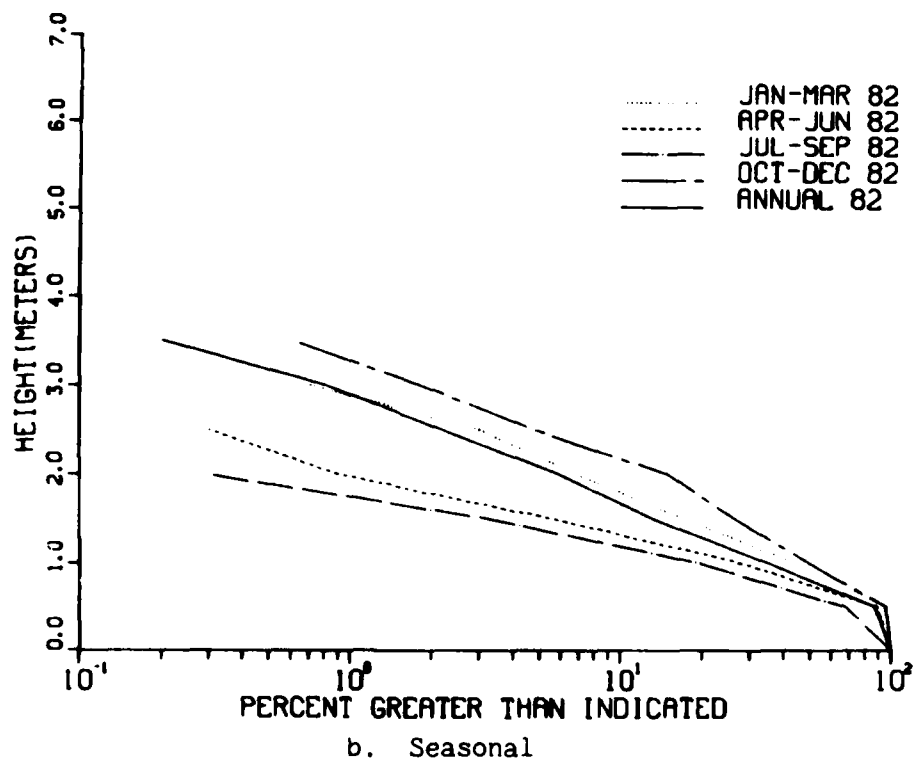
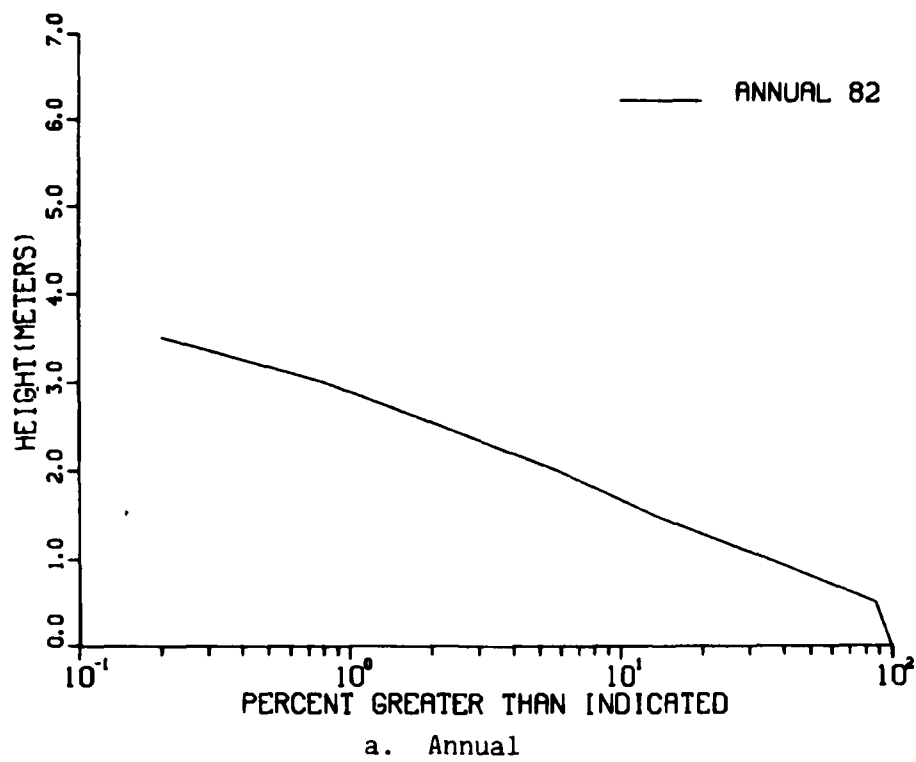


Figure B3. 1982 annual and seasonal cumulative distribution of wave height for gage 625

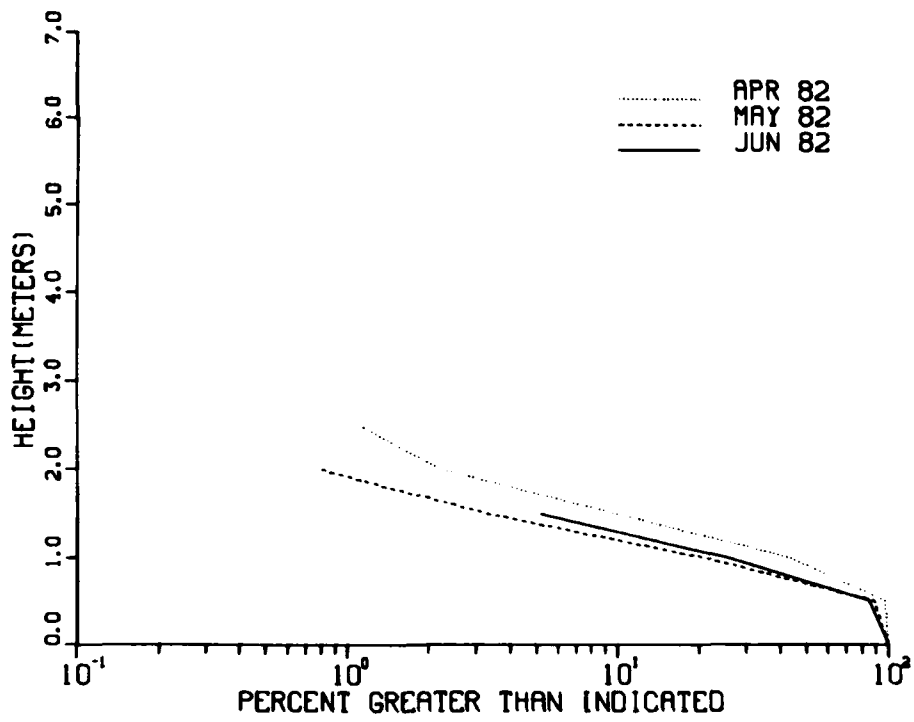
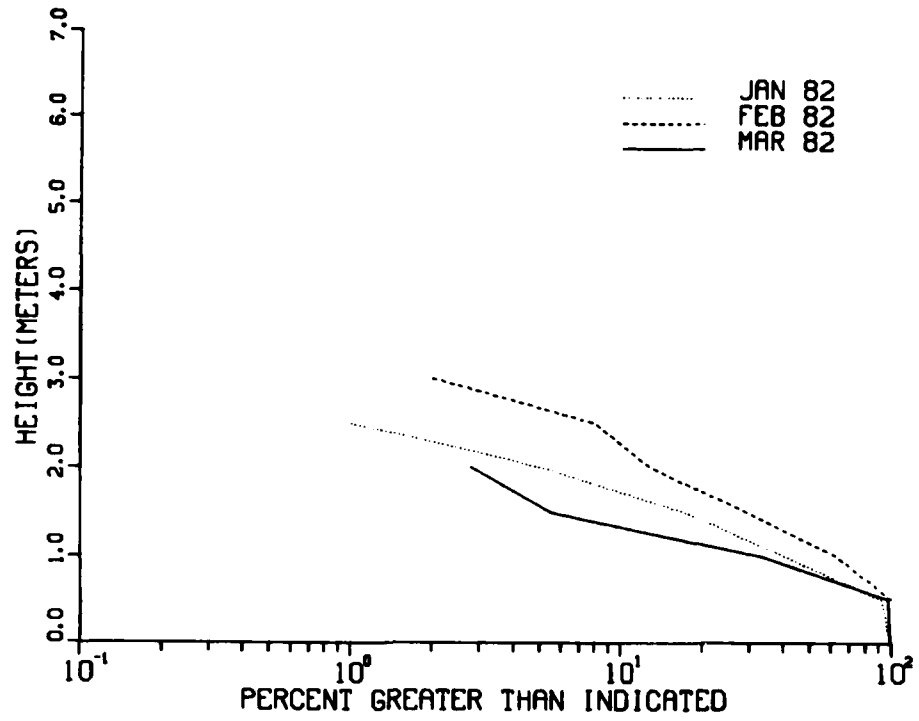


Figure B4. 1982 monthly cumulative distribution of wave height for gage 625 (Continued)

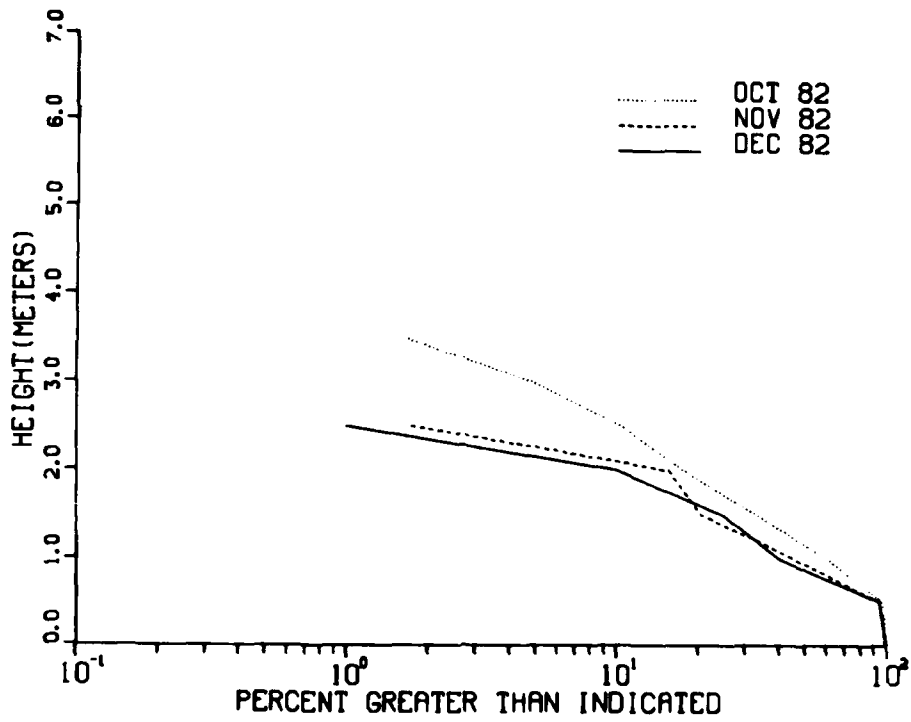
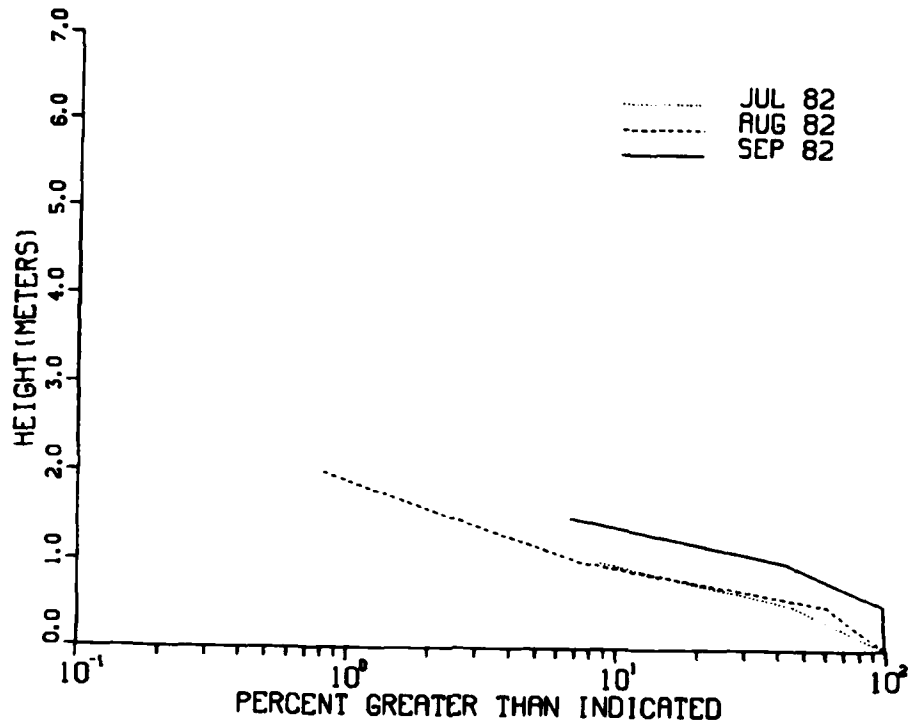


Figure B4. (Concluded)

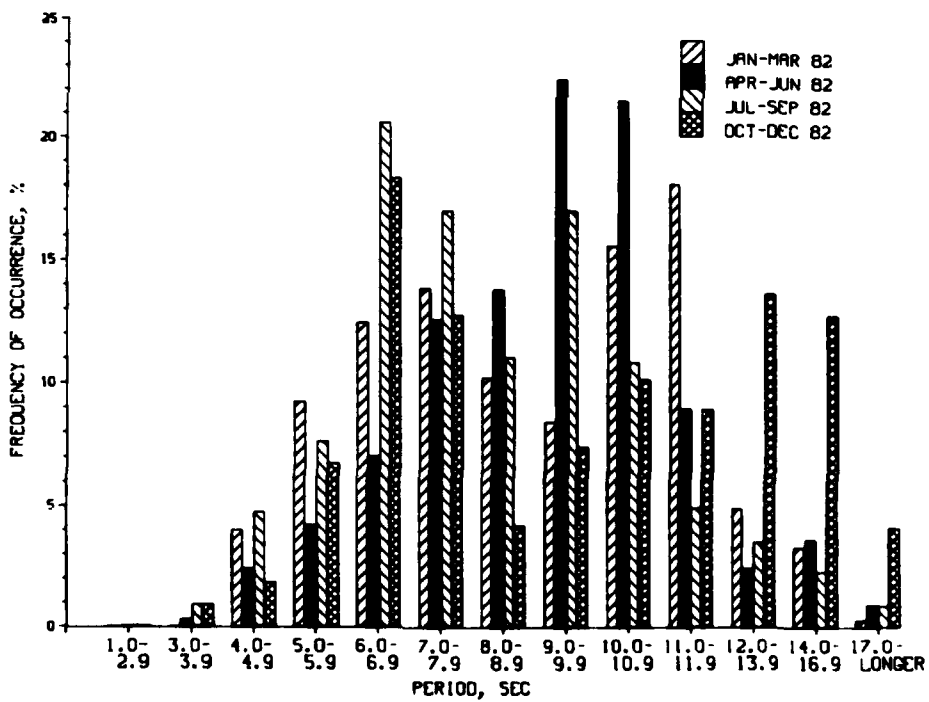
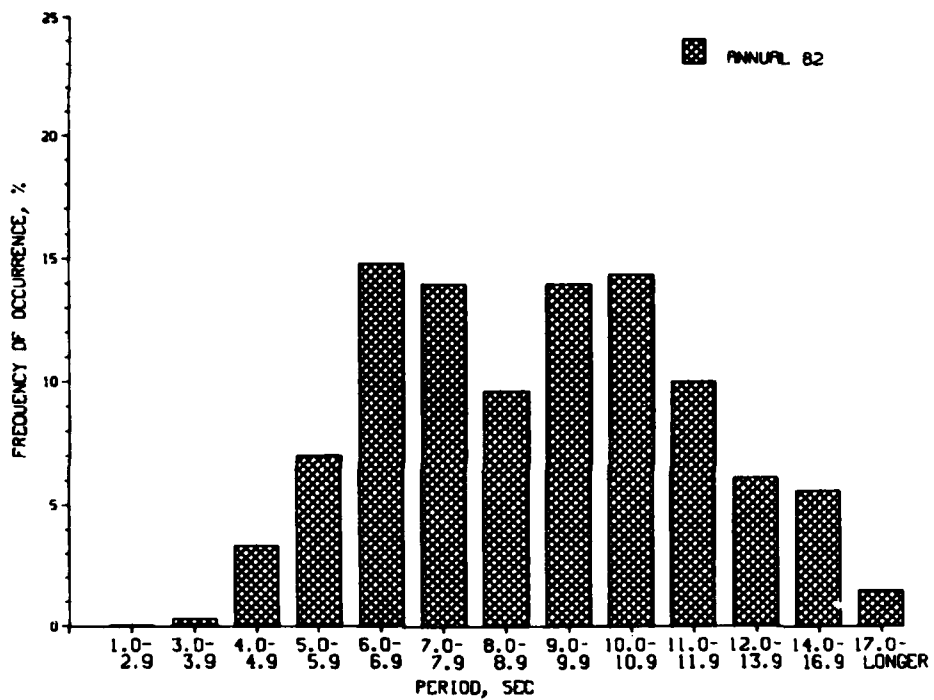


Figure B5. 1982 annual and seasonal distribution of peak spectral wave period for gage 625

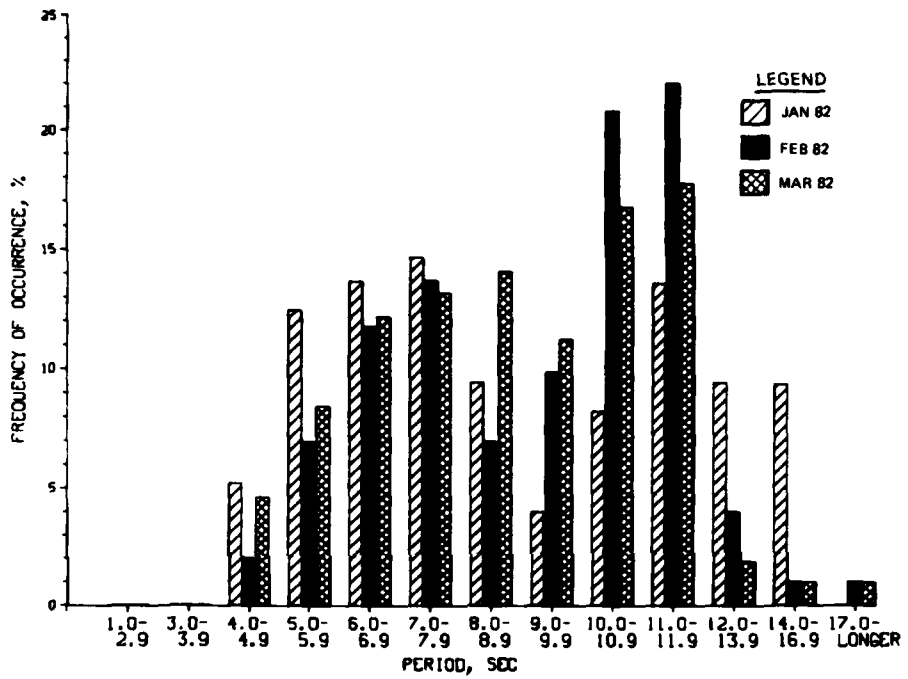


Figure B6. 1982 monthly distribution of peak spectral wave period for gage 625 (Sheet 1 of 3)

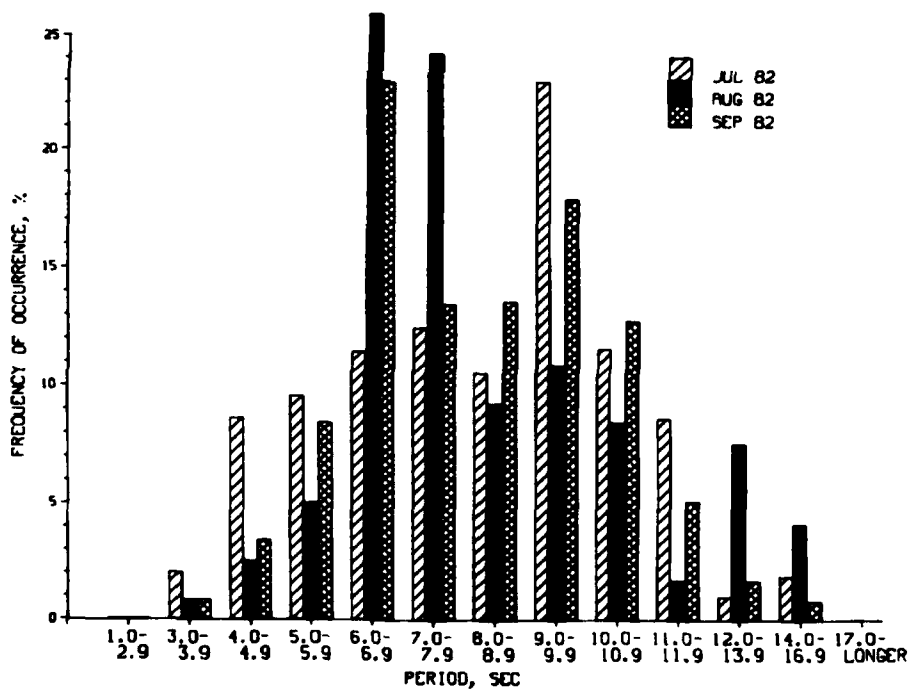
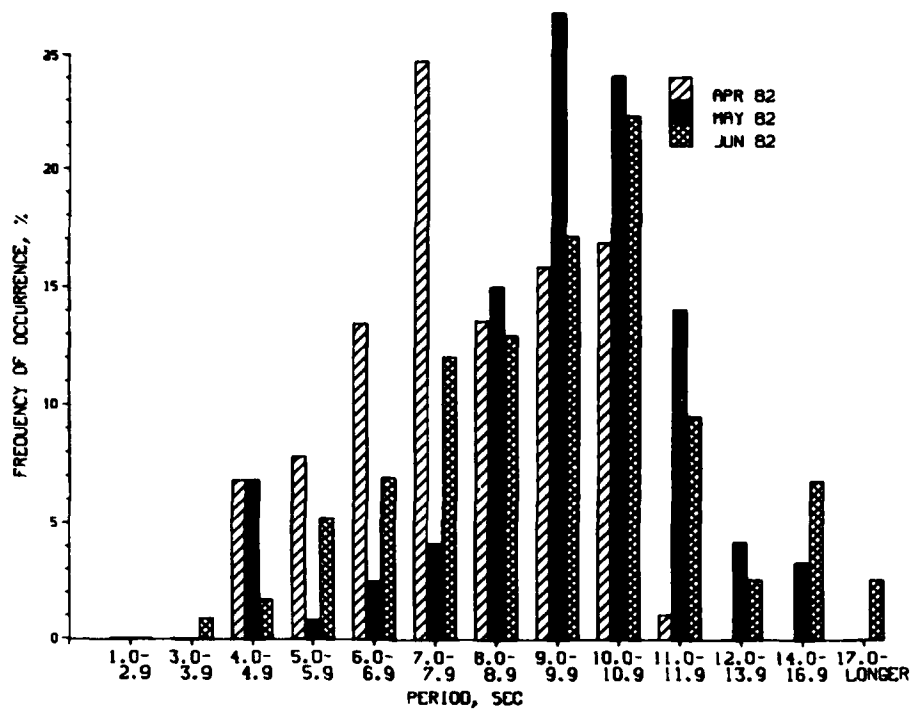


Figure B6. (Sheet 2 of 3)

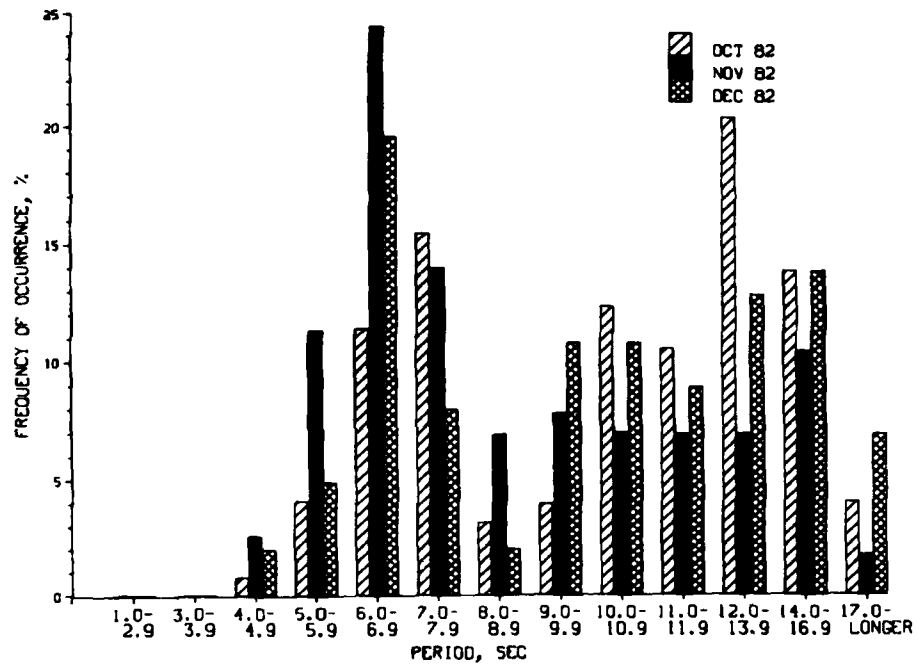


Figure B6. (Sheet 3 of 3)

Table B5
 1982 Persistence of Wave Heights for Gage 625

Height, m	Consecutive Day(s) or Longer																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	34	89	109
0.5	18	17		13		11	9			7		6			5									4	3	2	1	
1.0	54	34	26	17	11		7	6	4	2																		
1.5	36	15	10	5	4		2																					
2.0	16	7	5	2			1																					
2.5	8	3	2	1																								
3.0	2	1																										
3.5																												
4.0																												

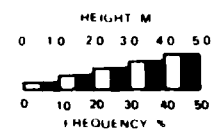
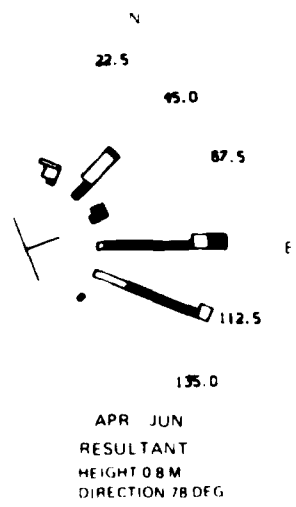
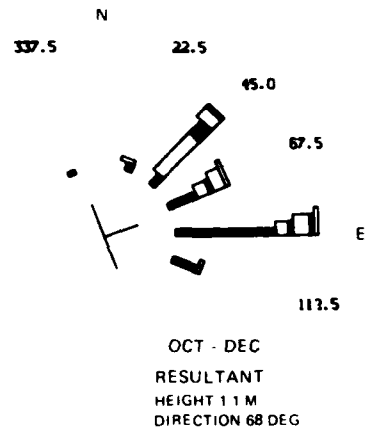
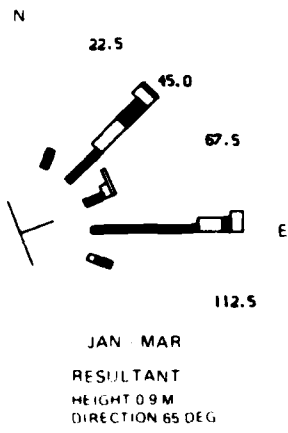
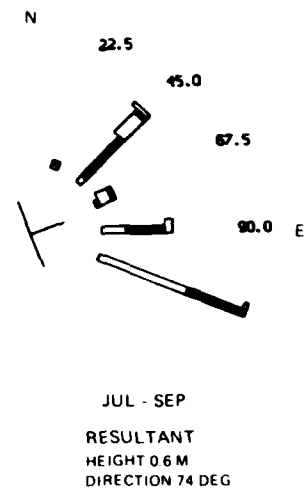
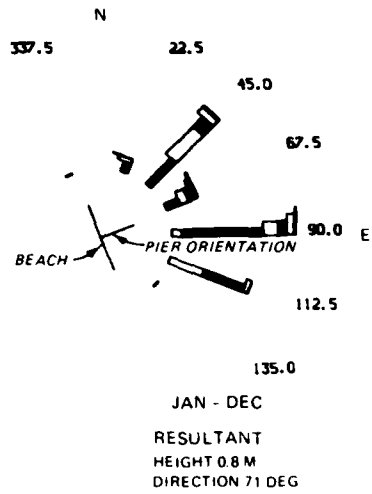


Figure B7. 1982 annual and seasonal wave roses, reference true north

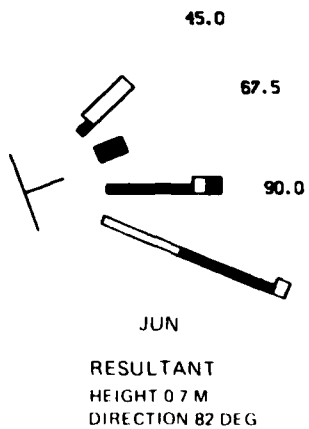
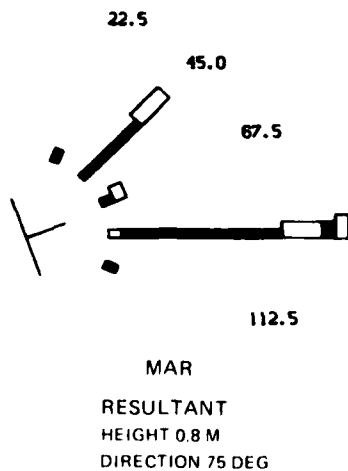
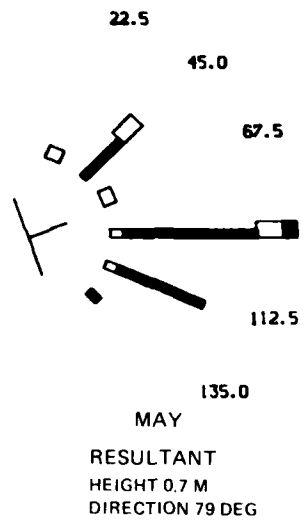
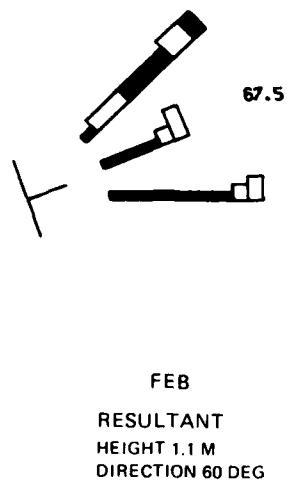
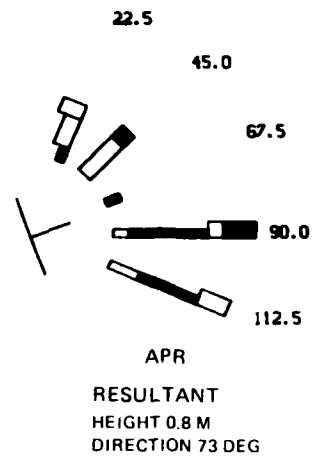
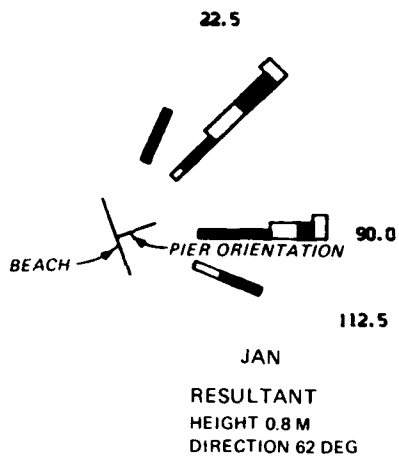
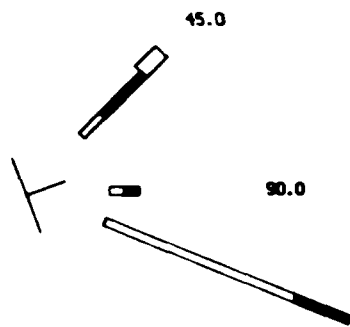
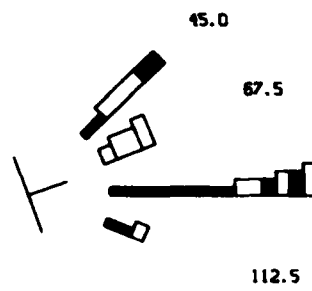


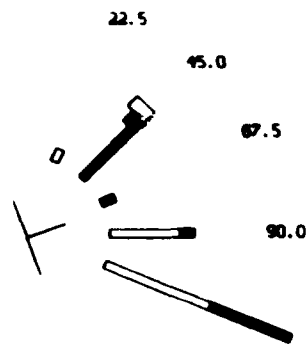
Figure B8. 1982 monthly wave roses,
reference true north (Continued)



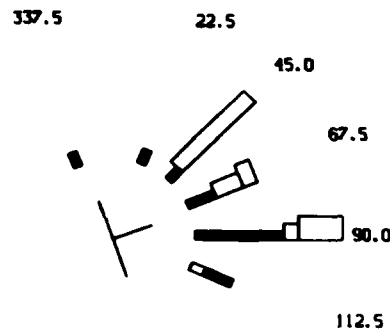
JUL
 RESULTANT
 HEIGHT 0.4 M
 DIRECTION 82 DEG



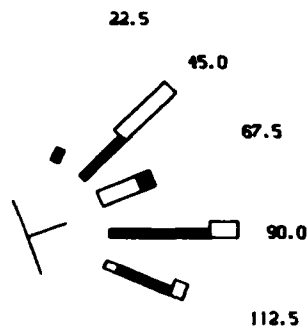
OCT
 RESULTANT
 HEIGHT 1.2 M
 DIRECTION 75 DEG



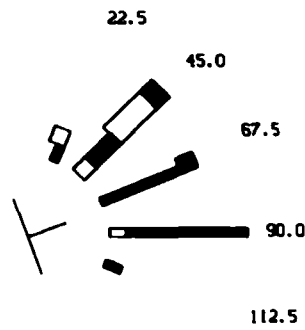
AUG
 RESULTANT
 HEIGHT 0.5 M
 DIRECTION 73 DEG



NOV
 RESULTANT
 HEIGHT 1.0 M
 DIRECTION 67 DEG



SEP
 RESULTANT
 HEIGHT 0.8 M
 DIRECTION 70 DEG



DEC
 RESULTANT
 HEIGHT 1.0 M
 DIRECTION 59 DEG

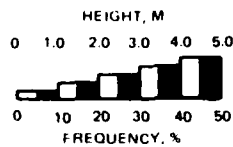
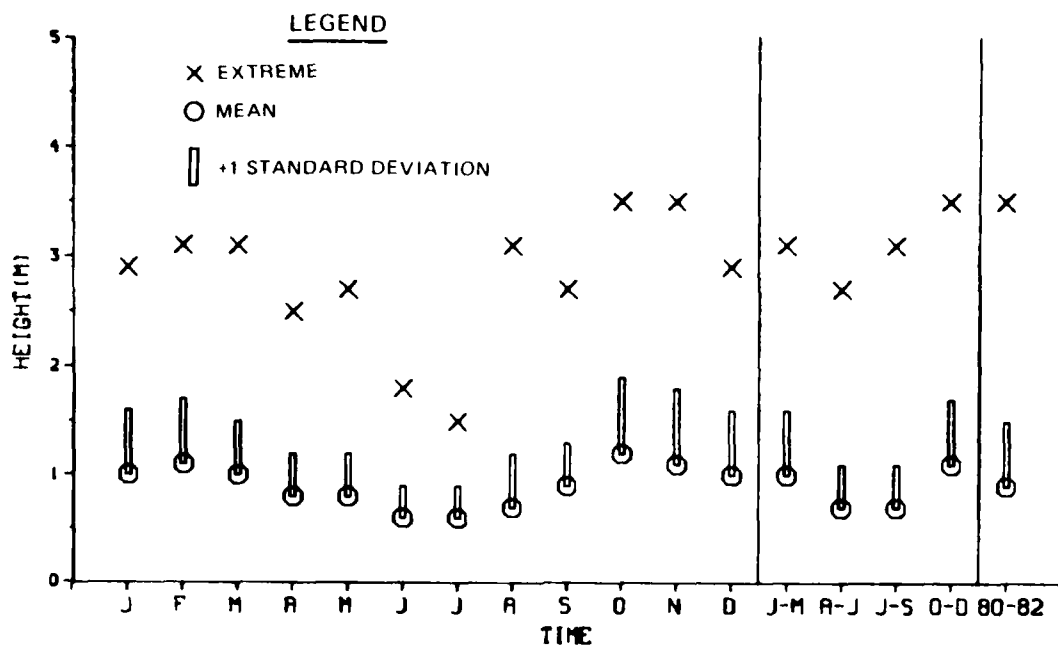


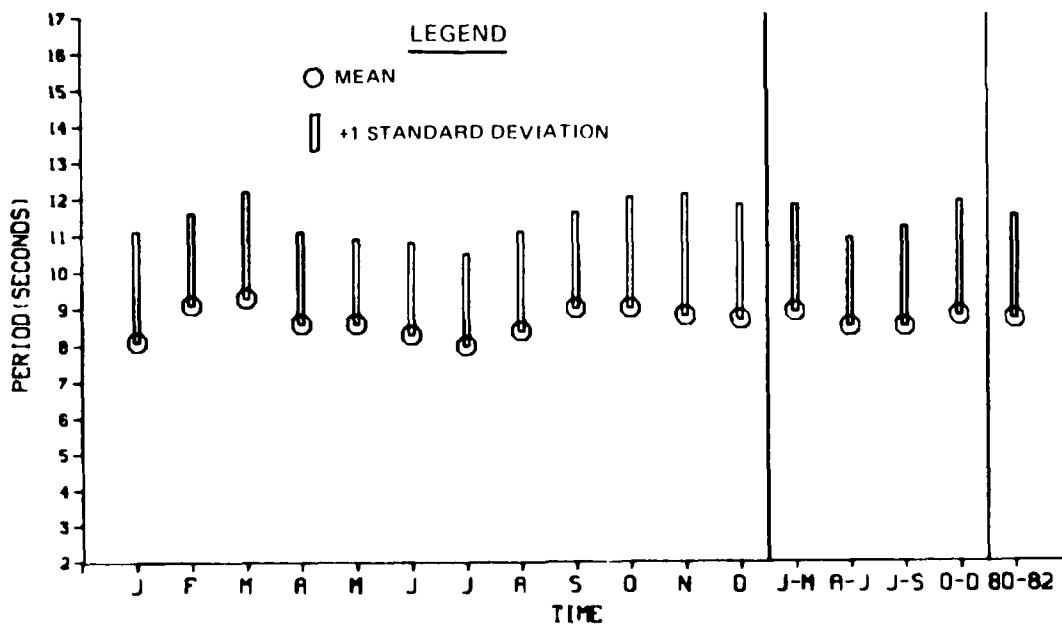
Figure B8. (Concluded)

Table B6
1980 Through 1982 Wave Statistics for Gage 625

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	1.0	0.6	8.1	3.0	2.9	1982	249
Feb	1.1	0.6	9.1	2.5	3.1	1982	258
Mar	1.0	0.5	9.3	2.9	3.1	1981	294
Apr	0.8	0.4	8.6	2.5	2.5	1982	238
May	0.8	0.4	8.6	2.3	2.7	1981	327
Jun	0.6	0.3	8.3	2.5	1.8	1982	265
Jul	0.6	0.3	8.0	2.5	1.5	1980	201
Aug	0.7	0.5	8.4	2.7	3.1	1981	275
Sep	0.9	0.4	9.0	2.6	2.7	1981	272
Oct	1.2	0.7	9.0	3.0	3.5	1980	343
Nov	1.1	0.7	8.8	3.3	3.5	1981	322
Dec	1.0	0.6	8.7	3.1	2.9	1980	277
Jan-Mar	1.0	0.6	8.9	2.9	3.1	Feb 1982 Mar 1981	801
Apr-Jun	0.7	0.4	8.5	2.4	2.7	May 1981	830
Jul-Sep	0.7	0.4	8.5	2.7	3.1	Aug 1981	748
Oct-Dec	1.1	0.6	8.8	3.1	3.5	Oct 1981 Nov 1981	942
Annual	0.9	0.6	8.7	2.8	3.5	Oct 1981 Nov 1981	3,321



a. Wave heights



b. Wave periods

Figure B9. 1980 through 1982 extreme, mean, and standard deviation of wave heights and periods for gage 625

Table B7
1980 Through 1982 Annual and Seasonal Joint Distribution
of Wave Height Versus Peak Period for Gage 625

HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	2	2	3	11	20	28	33	25	10	18	17	1	170
.50 - .99	.	6	30	36	58	49	53	69	68	39	30	23	5	466
1.00 - 1.49	.	.	6	28	46	33	15	17	28	15	21	6	.	215
1.50 - 1.99	.	.	1	7	20	13	4	4	8	7	9	8	1	82
2.00 - 2.49	3	5	3	3	2	5	8	9	1	39
2.50 - 2.99	1	2	3	2	2	1	5	3	1	20
3.00 - 3.49	1	1	1	1	1	1	.	6
3.50 - 3.99	1	.	1	.	.	2
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	8	39	74	139	122	107	129	135	78	93	67	9	

HEIGHT (METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	2	1	4	7	5	11	11	11	7	14	9	.	82
.50 - .99	.	11	25	40	41	37	47	54	67	50	45	22	1	440
1.00 - 1.49	.	.	7	34	46	36	15	17	50	17	40	7	.	269
1.50 - 1.99	.	.	.	10	24	21	6	9	17	7	11	12	1	118
2.00 - 2.49	1	7	5	5	2	5	9	19	.	53
2.50 - 2.99	1	2	1	5	2	6	6	.	23
3.00 - 3.49	1	.	.	2	.	1	.	4
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	13	33	88	119	107	87	97	152	90	125	76	2	

HEIGHT (METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	2	2	7	23	25	57	46	28	8	12	17	1	228
.50 - .99	.	6	30	34	47	59	93	113	94	30	13	20	4	543
1.00 - 1.49	.	.	5	19	23	24	20	34	19	7	2	.	.	173
1.50 - 1.99	.	.	.	4	5	1	5	6	4	8	7	.	.	40
2.00 - 2.49	1	1	.	1	1	2	1	1	1	9
2.50 - 2.99	1	.	.	1	.	.	.	.	2
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	8	37	64	99	111	175	186	162	67	40	40	6	

(Continued)

Table B8
1980 Through 1982 Monthly Joint Distribution of Wave
Height Versus Peak Period for Gage 625

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	8	4	8	16	4	20	12	32	8	12	8	.	132
.50 - .99	.	24	48	64	44	44	36	20	20	28	52	32	.	412
1.00 - 1.49	.	.	.	64	72	24	24	12	36	12	12	.	.	256
1.50 - 1.99	.	.	.	8	16	36	4	12	12	12	.	8	.	108
2.00 - 2.49	4	12	4	4	8	8	12	20	.	72
2.50 - 2.99	4	.	4	8	.	16
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	32	52	144	152	120	88	60	112	68	92	76	0	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	4	4	4	4	4	.	4	12	12	.	48
.50 - .99	.	4	4	19	31	27	47	74	93	62	43	8	4	416
1.00 - 1.49	.	.	8	16	35	39	16	31	74	31	27	8	.	285
1.50 - 1.99	.	.	.	23	39	23	12	12	31	8	8	8	.	164
2.00 - 2.49	12	4	12	.	4	8	19	.	59
2.50 - 2.99	4	8	4	12	.	.	28
3.00 - 3.49	8	.	.	.	8
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	4	12	62	109	105	83	137	206	121	110	55	4	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	7	10	17	3	10	17	7	.	74
.50 - .99	.	7	24	37	48	41	58	65	85	58	41	27	.	491
1.00 - 1.49	.	.	14	24	34	44	7	10	41	10	75	14	.	273
1.50 - 1.99	17	7	3	3	10	3	24	20	3	90
2.00 - 2.49	7	.	.	3	7	17	.	34
2.50 - 2.99	3	7	.	3	3	3	10	.	29
3.00 - 3.49	3	.	.	.	.	3	.	6
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	7	38	61	102	102	95	95	142	87	167	98	3	

(Continued)

(Sheet 1 of 4)

Table B7 (Concluded)

HEIGHT(METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	5	3	3	12	48	36	68	56	15	21	31	3	301
.50 - .99	.	4	29	32	84	71	44	64	63	29	25	20	3	468
1.00 - 1.49	.	.	3	21	44	23	15	15	16	9	12	7	.	165
1.50 - 1.99	.	.	.	7	9	7	.	3	4	1	5	4	.	40
2.00 - 2.49	1	.	.	.	.	3	9	3	.	16
2.50 - 2.99	1	1	1	.	3	.	.	6
3.00 - 3.49	1	.	1	.	.	.	2
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	35	63	150	149	96	152	140	58	75	65	6	

HEIGHT(METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	2	.	3	7	10	12	11	8	23	15	.	91
.50 - .99	.	3	33	36	63	34	31	46	50	47	35	30	12	420
1.00 - 1.49	.	.	7	37	68	46	12	17	14	14	24	7	.	246
1.50 - 1.99	.	.	2	6	38	21	4	.	6	11	13	15	1	117
2.00 - 2.49	7	8	7	5	5	8	14	14	1	69
2.50 - 2.99	2	4	6	4	2	1	11	5	2	37
3.00 - 3.49	1	1	2	1	4	2	.	11
3.50 - 3.99	2	.	2	1	.	5
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	3	44	79	181	120	71	85	92	90	126	89	16	

Table B8 (Continued)

HEIGHT(METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	4	.	4	8	21	29	21	21	8	13	25	.	154
.50 - .99	.	.	21	25	42	71	80	92	126	59	8	29	4	557
1.00 - 1.49	.	.	17	29	46	42	17	17	17	21	.	.	.	206
1.50 - 1.99	8	4	8	13	4	13	8	.	.	58
2.00 - 2.49	4	.	.	.	4	8	.	.	.	16
2.50 - 2.99	4	.	.	.	.	.	.	.	4
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	4	38	58	108	142	134	143	172	109	29	54	4	

HEIGHT(METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	3	3	15	15	52	55	28	9	18	12	.	210
.50 - .99	.	6	24	34	58	43	95	122	86	31	28	9	.	536
1.00 - 1.49	.	.	.	18	18	28	34	18	43	18	15	6	.	198
1.50 - 1.99	.	.	.	9	3	.	6	6	3	3	6	.	.	36
2.00 - 2.49	3	.	3	.	.	3	3	3	15
2.50 - 2.99	3	.	.	.	.	3
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	6	27	64	94	89	187	204	163	61	70	30	3	

HEIGHT(METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	4	4	15	45	42	87	57	34	8	4	15	4	319
.50 - .99	.	11	45	42	38	68	102	121	75	4	.	26	8	540
1.00 - 1.49	.	.	.	11	8	4	8	26	38	19	4	.	.	118
1.50 - 1.99	4	.	.	.	4	11	8	.	.	27
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	15	49	68	95	114	197	204	151	42	16	41	12	

(Continued)

(Sheet 2 of 4)

Table B8 (Continued)

HEIGHT(METERS)	MONTH JUL												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	15	10	10	10	70	80	104	65	40	15	50	.	469
.50 - .99	.	5	45	60	60	70	55	65	35	25	.	10	.	430
1.00 - 1.49	.	.	10	15	45	20	10	.	.	.	.	.	.	100
1.50 - 1.99	5	.	.	.	.	.	.	.	5
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	20	65	85	115	165	145	169	100	65	15	60	0	

HEIGHT(METERS)	MONTH AUG												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	4	.	.	25	69	33	87	84	4	33	40	.	379
.50 - .99	.	7	29	33	98	95	33	44	40	25	22	18	7	451
1.00 - 1.49	.	.	.	22	25	25	7	4	.	7	.	.	.	90
1.50 - 1.99	.	.	.	7	7	4	.	.	4	.	7	4	.	33
2.00 - 2.49	4	.	.	.	.	7	18	.	.	29
2.50 - 2.99	4	4	4	.	.	.	.	12
3.00 - 3.49	4	.	4	.	.	.	8
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	11	29	62	159	193	77	143	132	47	80	62	7	

HEIGHT(METERS)	MONTH SEP												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	11	7	22	22	7	15	7	7	98
.50 - .99	.	.	18	11	88	48	48	85	107	37	48	29	.	519
1.00 - 1.49	.	.	.	26	62	22	26	37	44	18	33	18	.	286
1.50 - 1.99	.	.	.	11	18	11	.	7	7	4	7	7	.	72
2.00 - 2.49	7	7	.	14
2.50 - 2.99	7	.	.	7
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	18	48	168	92	81	151	180	66	117	68	7	

(Continued)

(Sheet 3 of 4)

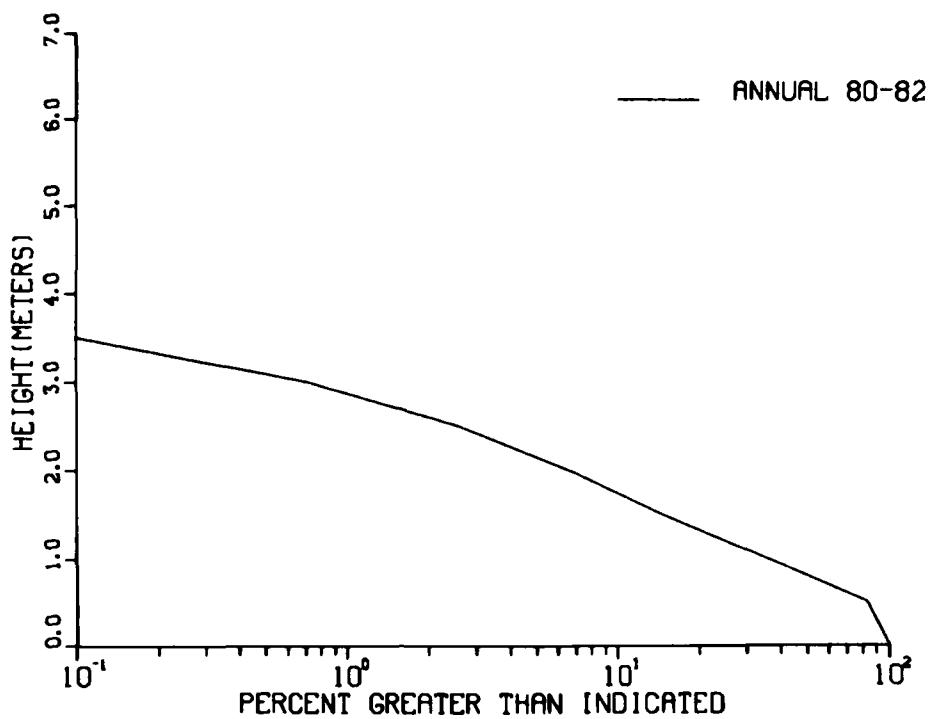
Table B8 (Concluded)

HEIGHT (METERS)	MONTH OCT													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	6	17	17	9	9	17	6	.	81
.50 - .99	.	3	20	29	47	26	35	47	61	44	47	26	6	391
1.00 - 1.49	.	.	3	35	50	41	3	17	26	20	38	6	.	239
1.50 - 1.99	.	.	6	12	38	17	6	.	12	17	17	9	.	134
2.00 - 2.49	15	12	9	9	9	6	9	15	3	87
2.50 - 2.99	6	6	12	3	3	.	9	6	6	51
3.00 - 3.49	3	.	.	.	6	3	.	12
3.50 - 3.99	6	.	.	.	.	9
4.00 - 4.49	3	.	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	3	29	76	156	108	85	93	126	96	143	74	15	

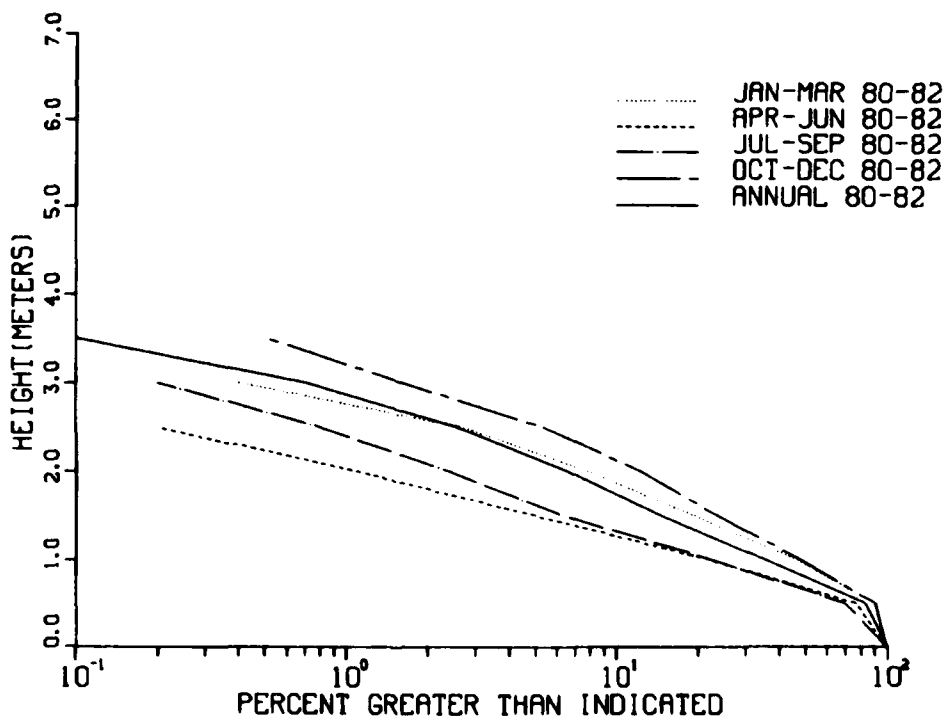
HEIGHT (METERS)	MONTH NOV													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	6	.	3	9	6	9	12	3	31	22	.	101
.50 - .99	.	6	47	43	75	50	34	31	31	56	19	31	6	429
1.00 - 1.49	.	.	9	25	87	43	16	16	.	9	16	12	.	233
1.50 - 1.99	.	.	.	3	28	25	3	.	.	3	12	31	3	108
2.00 - 2.49	3	3	9	.	3	6	22	19	.	65
2.50 - 2.99	3	6	3	.	.	12	9	.	33
3.00 - 3.49	3	6	3	6	3	.	21
3.50 - 3.99	6	.	.	6
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	6	62	71	196	133	74	62	52	80	124	127	9	

HEIGHT (METERS)	MONTH DEC													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	7	7	4	7	11	14	22	18	.	90
.50 - .99	.	.	32	36	69	25	22	61	58	40	40	32	25	440
1.00 - 1.49	.	.	11	54	69	54	18	18	14	11	18	4	.	271
1.50 - 1.99	.	.	.	4	51	22	4	.	7	11	7	4	.	110
2.00 - 2.49	4	11	4	7	4	14	11	7	.	62
2.50 - 2.99	4	.	7	4	4	11	.	.	30
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	43	94	200	123	52	100	98	94	109	65	25	

(Sheet 4 of 4)

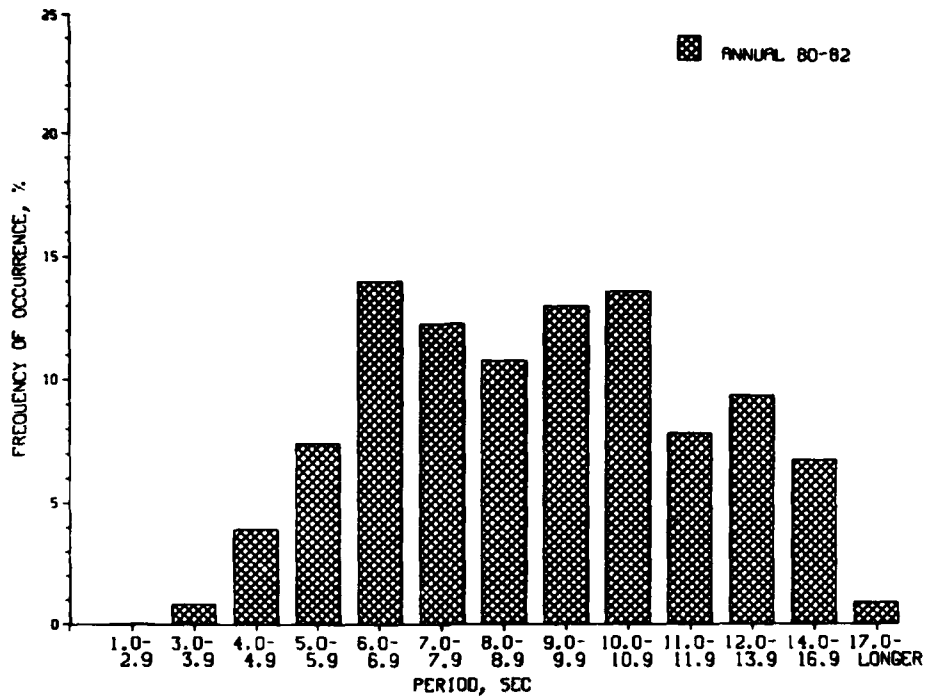


a. Annual

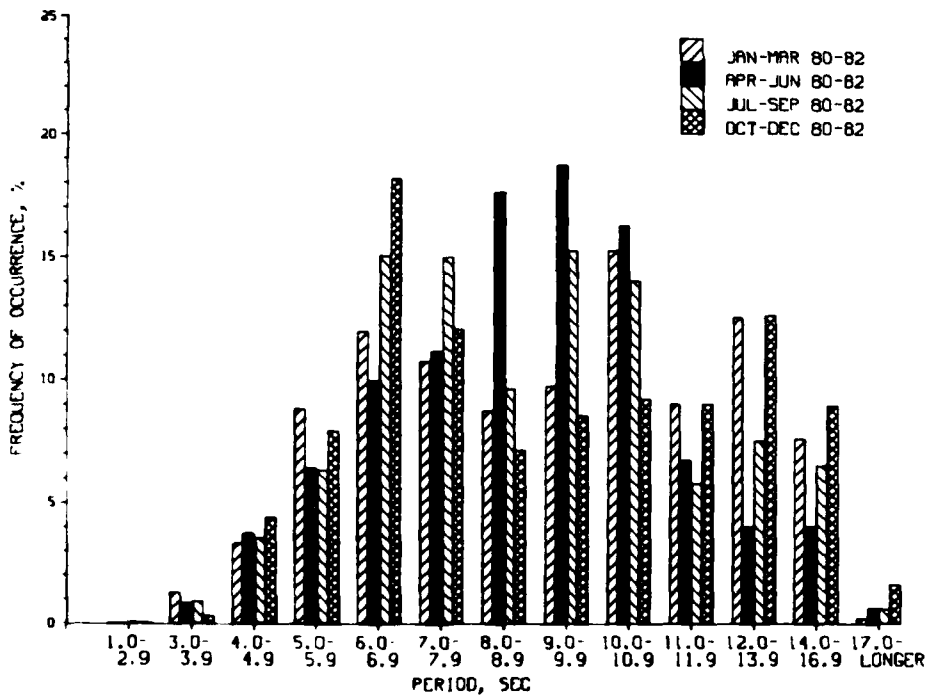


b. Seasonal

Figure B10. 1980 through 1982 annual and seasonal cumulative distribution of wave height for gage 625



a. Annual

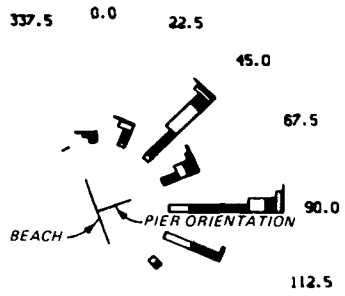


b. Seasonal

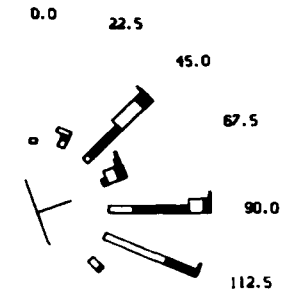
Figure B11. 1980 through 1982 annual and seasonal distribution of peak spectral wave period for gage 625

Table B9
1980 Through 1982 Persistence of Wave Heights for Gage 625

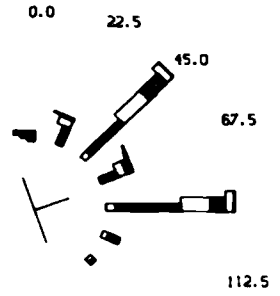
Height, m	Consecutive Day(s) or Longer																											
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>	<u>17</u>	<u>18</u>	<u>19</u>	<u>20</u>	<u>21</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	<u>34</u>		
0.5	29		25		18	14	11		8		7		6		5													4
1.0	46	31	22	15	10		9	6	5	3	2																	
1.5	31	16	9	6	5	3	1																					
2.0	16	8	5	3																								
2.5	9	4		1																								
3.0	3																											
3.5																												
4.0																												



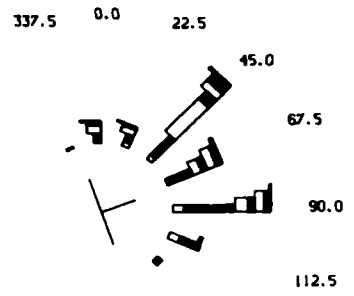
JAN - DEC
 RESULTANT
 HEIGHT 0.8 M
 DIRECTION 66 DEG



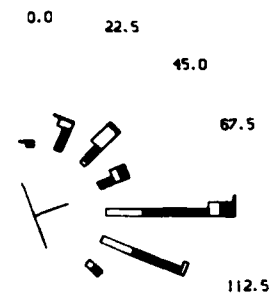
JUL - SEP
 RESULTANT
 HEIGHT 0.6 M
 DIRECTION 72 DEG



JAN - MAR
 RESULTANT
 HEIGHT 0.9 M
 DIRECTION 62 DEG



OCT - DEC
 RESULTANT
 HEIGHT 1.0 M
 DIRECTION 60 DEG



APR - JUN
 RESULTANT
 HEIGHT 0.6 M
 DIRECTION 76 DEG

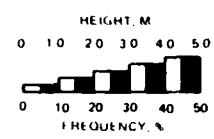
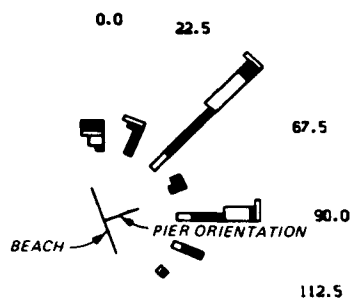
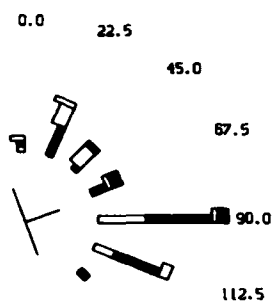


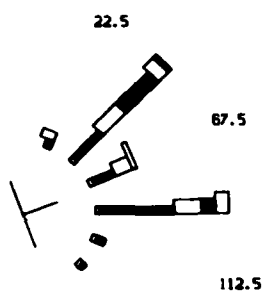
Figure B12. 1980 through 1982 annual and seasonal wave roses, reference true north



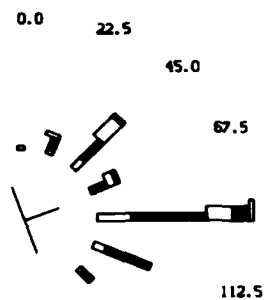
JAN
 RESULTANT
 HEIGHT 0.8 M
 DIRECTION 50 DEG



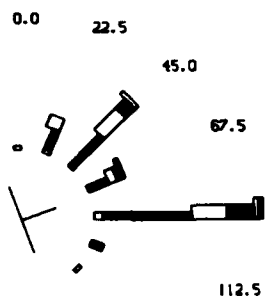
APR
 RESULTANT
 HEIGHT 0.7 M
 DIRECTION 70 DEG



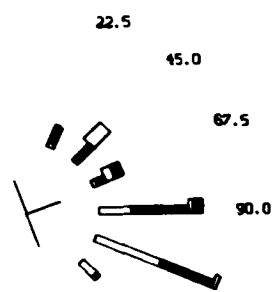
FEB
 RESULTANT
 HEIGHT 1.0 M
 DIRECTION 64 DEG



MAY
 RESULTANT
 HEIGHT 0.7 M
 DIRECTION 77 DEG



MAR
 RESULTANT
 HEIGHT 0.9 M
 DIRECTION 68 DEG



JUN
 RESULTANT
 HEIGHT 0.6 M
 DIRECTION 81 DEG

Figure B13. 1980 through 1982 monthly wave roses, reference true north (Continued)

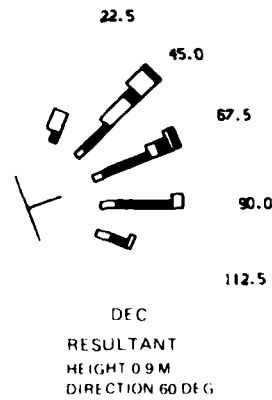
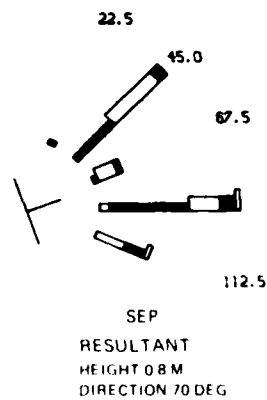
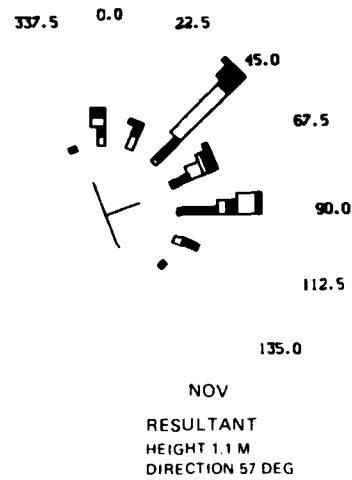
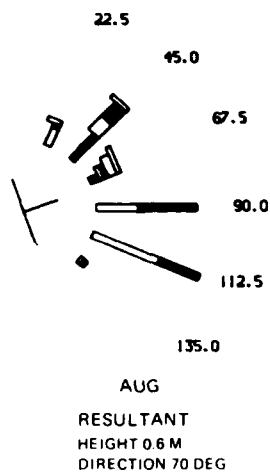
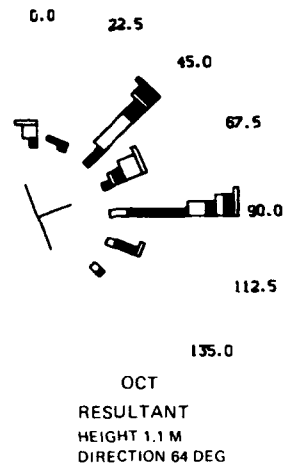
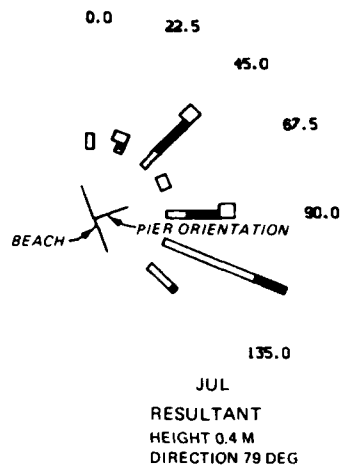
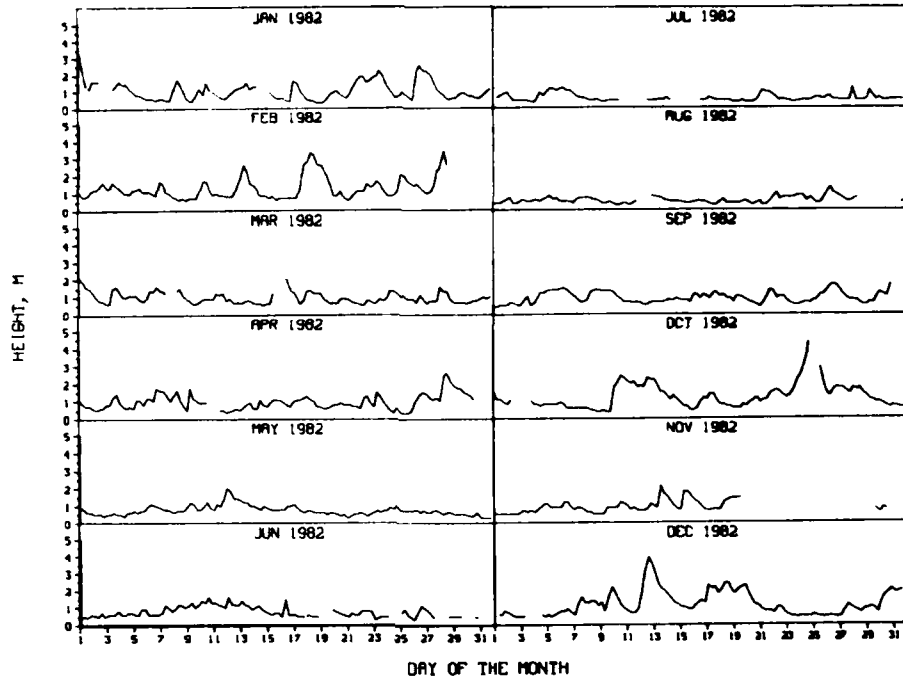
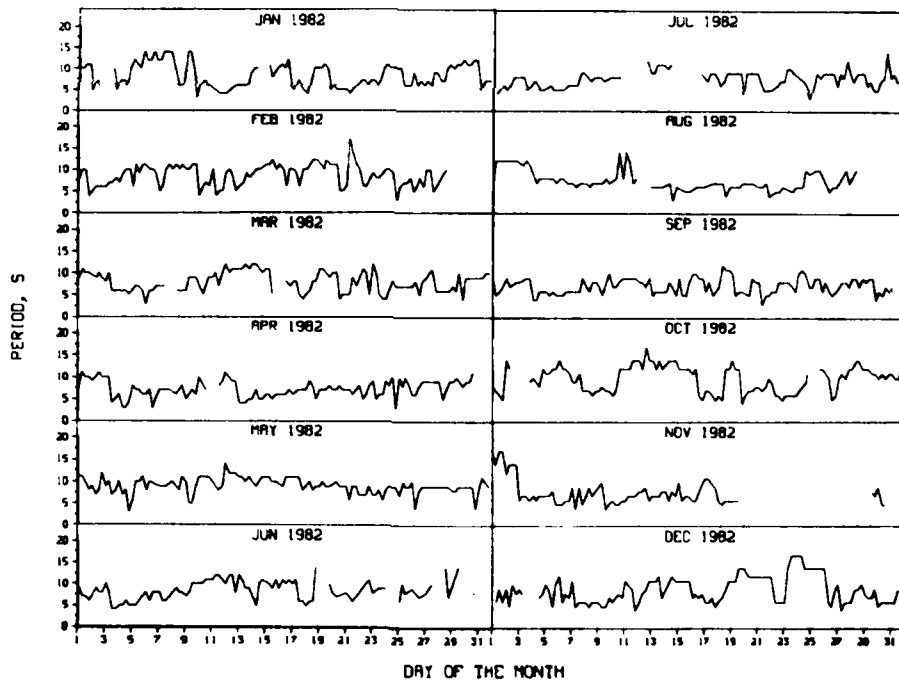


Figure B13. (Concluded)



a. Wave heights



b. Wave periods

Figure B14. Time-history for gage 620

Table B10
1982 Wave Statistics for Gage 620

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	1.1	0.6	8.4	2.8	3.3	1	112
Feb	1.3	0.6	8.6	2.4	3.4	28	110
Mar	1.0	0.3	8.0	2.2	2.1	1	115
Apr	1.0	0.4	7.3	1.9	2.6	28	111
May	0.7	0.3	9.1	1.7	2.0	12	117
Jun	0.8	0.3	8.5	2.3	1.6	10	93
Jul	0.5	0.2	7.8	2.1	1.2	6	92
Aug	0.5	0.2	7.6	2.3	1.3	26	81
Sep	0.9	0.3	7.3	1.8	1.7	26	112
Oct	1.2	0.7	9.9	3.0	4.3	24	116
Nov	0.9	0.3	7.7	2.9	2.1	13	77
Dec	1.2	0.7	8.9	3.2	3.9	12	113
Jan-Mar	1.1	0.5	8.3	2.5	3.4	Feb	337
Apr-Jun	0.8	0.4	8.3	2.1	2.6	Apr	321
Jul-Sep	0.7	0.3	7.5	2.1	1.7	Sep	285
Oct-Dec	1.1	0.6	9.0	3.2	4.3	Oct	306
Annual	0.9	0.5	8.3	2.6	4.3	Oct	1,249

Table B11

1982 Annual and Seasonal Joint Distribution of Wave
Height Versus Peak Period for Gage 620

HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	1	2	3	6	19	15	22	10	5	7	4	1	95
.50 - .99	.	6	21	43	63	71	58	89	70	52	29	20	6	528
1.00 - 1.49	.	2	4	34	60	34	24	20	24	24	14	2	.	242
1.50 - 1.99	.	.	.	8	30	12	6	4	6	4	6	4	.	80
2.00 - 2.49	.	.	.	1	9	8	2	4	2	2	5	6	1	40
2.50 - 2.99	3	1	.	2	1	2	.	.	9
3.00 - 3.49	1	1	1	1	1	.	.	5
3.50 - 3.99	2	.	1	.	.	.	3
4.00 - 4.49	1	.	.	.	1
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	27	89	168	147	107	142	115	91	64	36	8	0

HEIGHT (METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	.	.	.	12	3	3	3	.	24
.50 - .99	.	6	30	47	33	33	15	62	107	80	39	21	3	476
1.00 - 1.49	.	3	9	36	74	39	27	24	50	33	3	.	.	298
1.50 - 1.99	.	.	.	9	56	33	12	3	9	3	.	.	.	125
2.00 - 2.49	15	12	6	6	6	3	3	.	.	48
2.50 - 2.99	6	.	.	9	3	3	.	.	21
3.00 - 3.49	3	3	3	3	.	.	12
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	39	92	181	123	60	98	196	125	54	24	3	0

HEIGHT (METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	9	12	25	16	6	3	.	.	74
.50 - .99	.	12	22	34	65	81	106	140	90	50	.	9	.	609
1.00 - 1.49	.	3	3	22	31	37	28	40	25	44	22	.	.	255
1.50 - 1.99	.	.	.	6	6	6	3	9	6	6	3	.	.	45
2.00 - 2.49	.	.	.	3	.	.	.	3	.	.	.	3	.	9
2.50 - 2.99	3	.	.	.	.	.	.	.	3
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	15	25	65	105	136	149	217	137	106	28	12	0	0

(Continued)

Table B11 (Concluded)

HEIGHT(METERS)	SEASONAL JUL-SEP													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	4	7	14	18	60	53	67	14	11	25	11	.	284
.50 - .99	.	7	14	49	105	109	77	98	25	25	11	4	.	524
1.00 - 1.49	.	.	4	49	56	25	21	11	11	.	4	.	.	181
1.50 - 1.99	.	.	.	7	11	.	.	.	.	.	.	.	.	18
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	11	25	119	190	194	151	176	50	36	40	15	0	

HEIGHT(METERS)	SEASONAL OCT-DEC													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	13	.	3	.	.	.	3	3	22
.50 - .99	.	.	16	42	56	69	39	56	49	49	65	46	23	510
1.00 - 1.49	.	.	.	29	78	36	20	3	7	16	26	10	.	225
1.50 - 1.99	.	.	.	10	42	7	10	3	7	7	20	16	.	122
2.00 - 2.49	20	20	.	7	.	10	16	20	3	96
2.50 - 2.99	3	3	.	.	.	3	.	.	9
3.00 - 3.49	3	.	.	.	.	.	.	3
3.50 - 3.99	7	.	3	.	.	.	10
4.00 - 4.49	3	.	.	.	3
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	16	81	196	148	75	79	63	88	130	95	29	

Table B12
1982 Monthly Joint Distribution of Wave Height
Versus Peak Period for Gage 620

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	.	.	.	36	9	9	9	.	72
.50 - .99	.	9	45	54	36	45	9	18	80	62	62	54	.	474
1.00 - 1.49	.	.	.	27	54	18	.	18	45	36	9	.	.	207
1.50 - 1.99	.	.	.	18	80	62	.	9	.	.	.	.	.	178
2.00 - 2.49	27	18	.	.	9	.	.	.	.	54
2.50 - 2.99	9	.	.	.	.	.	.	.	9
3.00 - 3.49	9	.	.	.	.	9
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	45	99	206	152	9	45	188	107	80	63	0	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	0
.50 - .99	.	.	.	27	18	.	9	36	136	82	9	9	9	335
1.00 - 1.49	.	9	27	45	73	18	36	45	82	55	.	.	.	390
1.50 - 1.99	.	.	.	9	55	27	36	.	.	.	.	.	.	127
2.00 - 2.49	18	18	.	9	9	.	9	.	.	63
2.50 - 2.99	9	.	.	27	9	9	.	.	54
3.00 - 3.49	9	.	9	9	.	.	27
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	27	81	164	72	81	99	254	155	36	9	9	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	0
.50 - .99	.	9	43	61	43	52	26	130	104	96	43	.	.	607
1.00 - 1.49	.	.	.	35	96	78	43	9	26	9	.	.	.	296
1.50 - 1.99	35	9	.	.	17	9	.	.	.	70
2.00 - 2.49	17	9	.	.	.	.	.	26
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	43	96	174	139	86	148	147	114	43	0	0	

(Continued)

(Sheet 1 of 4)

Table B12 (Continued)

HEIGHT(METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	18	.	27	9	.	.	.	54
.50 - .99	.	27	27	45	81	108	72	54	63	18	.	.	.	495
1.00 - 1.49	.	9	9	36	72	90	27	72	.	9	.	.	.	324
1.50 - 1.99	.	.	.	18	18	18	9	27	9	.	.	.	.	99
2.00 - 2.49	.	.	.	9	.	.	.	9	.	.	.	.	.	18
2.50 - 2.99	9	.	.	.	.	.	.	.	9
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	36	36	108	171	225	126	162	99	36	0	0	0	

HEIGHT(METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	17	.	51	9	9	9	.	.	104
.50 - .99	.	9	17	.	17	60	103	282	128	77	.	.	.	693
1.00 - 1.49	.	.	.	17	.	.	17	26	34	77	17	.	.	188
1.50 - 1.99	9	.	.	9
2.00 - 2.49	9	.	9
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	17	17	26	77	120	359	171	163	35	9	0	

HEIGHT(METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	11	22	22	11	.	.	.	.	66
.50 - .99	.	.	22	65	108	75	151	65	75	54	.	32	.	647
1.00 - 1.49	.	.	.	11	22	22	43	22	43	43	54	.	.	260
1.50 - 1.99	11	22	.	.	.	33
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	22	76	130	108	216	109	140	119	54	32	0	

(Continued)

(Sheet 2 of 4)

Table B12 (Continued)

MONTH JUL														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	11	11	11	22	76	120	196	22	33	22	11	.	535
.50 - .99	.	.	11	76	65	43	33	98	11	22	.	11	.	370
1.00 - 1.49	.	.	.	43	33	22	.	.	.	.	.	.	.	98
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	11	22	130	120	141	153	294	33	55	22	22	0	

MONTH AUG														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	12	25	37	123	37	.	25	.	62	25	.	346
.50 - .99	.	12	12	25	173	210	74	12	37	25	37	.	.	617
1.00 - 1.49	.	.	.	25	12	.	.	.	.	.	.	.	.	37
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	12	24	75	222	333	111	12	62	25	99	25	0	

MONTH SEP														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	9	.	.	9	9	.	.	.	.	.	27
.50 - .99	.	9	18	45	89	89	116	161	27	27	.	.	.	581
1.00 - 1.49	.	.	9	71	107	45	54	27	27	.	9	.	.	349
1.50 - 1.99	.	.	.	18	27	.	.	.	.	.	.	.	.	45
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	27	143	223	134	179	197	54	27	9	0	0	

(Continued)

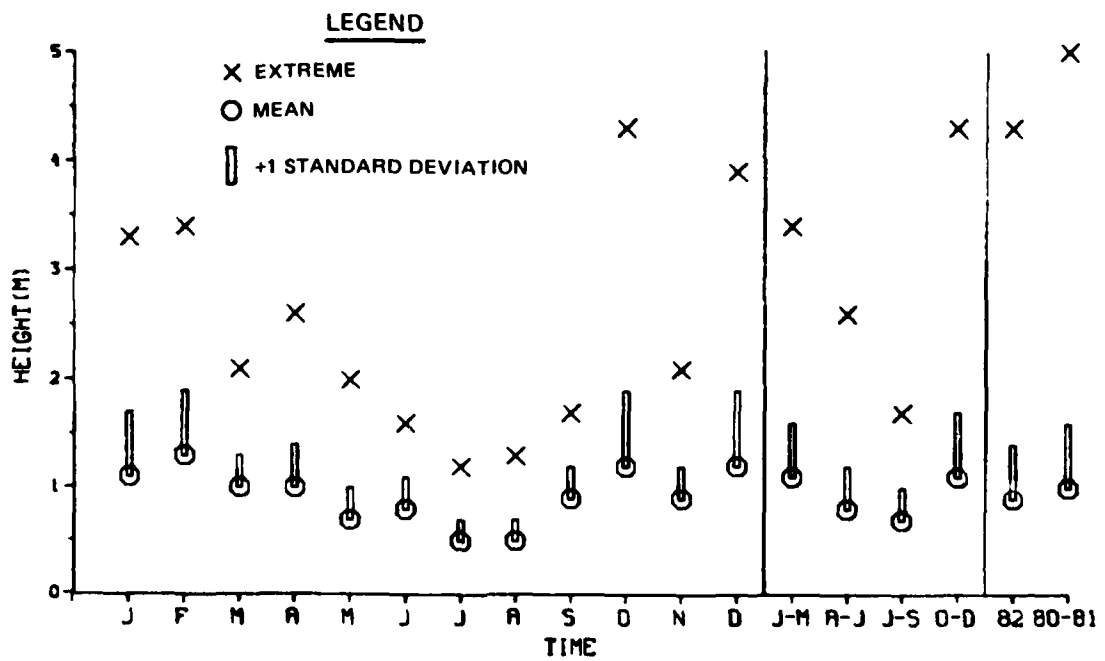
(Sheet 3 of 4)

Table B12 (Concluded)

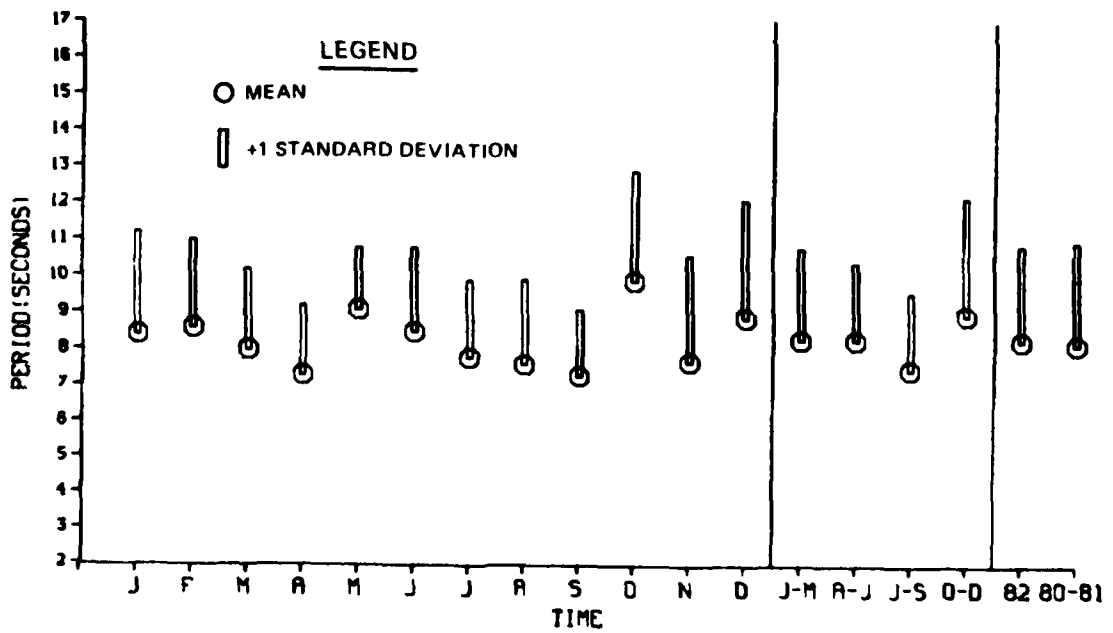
		MONTH OCT												
		PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD												
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	34	.	.	.	.	.	.	.	34
.50 - .99	.	.	9	17	34	34	26	26	43	78	121	26	9	423
1.00 - 1.49	.	.	.	26	34	43	17	9	17	17	43	26	.	232
1.50 - 1.99	.	.	.	9	43	.	9	9	17	9	43	43	.	182
2.00 - 2.49	9	9	.	.	.	.	34	26	9	87
2.50 - 2.99	9	9	.	.	.	9	.	.	27
3.00 - 3.49	0
3.50 - 3.99	9	.	.	.	.	.	9
4.00 - 4.49	9	.	.	.	9
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	9	52	120	129	61	53	77	113	250	121	18	

		MONTH NOV												
		PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD												
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	0
.50 - .99	.	.	26	91	78	169	52	78	52	26	13	52	39	676
1.00 - 1.49	.	.	.	39	143	39	13	.	.	.	.	.	.	234
1.50 - 1.99	26	26	26	.	.	.	.	.	.	78
2.00 - 2.49	13	.	.	.	.	.	.	.	13
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	26	130	247	247	91	78	52	26	13	52	39	

		MONTH DEC												
		PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD												
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	.	.	.	.	.	27
.50 - .99	.	.	18	35	62	35	44	71	53	35	44	62	27	486
1.00 - 1.49	.	.	.	27	80	27	27	.	.	27	27	.	.	215
1.50 - 1.99	.	.	.	18	53	.	.	.	.	9	9	.	.	89
2.00 - 2.49	44	35	.	18	.	27	9	27	.	160
2.50 - 2.99	0
3.00 - 3.49	9	.	.	.	.	.	.	9
3.50 - 3.99	9	.	9	.	.	.	18
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	18	80	239	97	80	107	53	107	89	98	36	

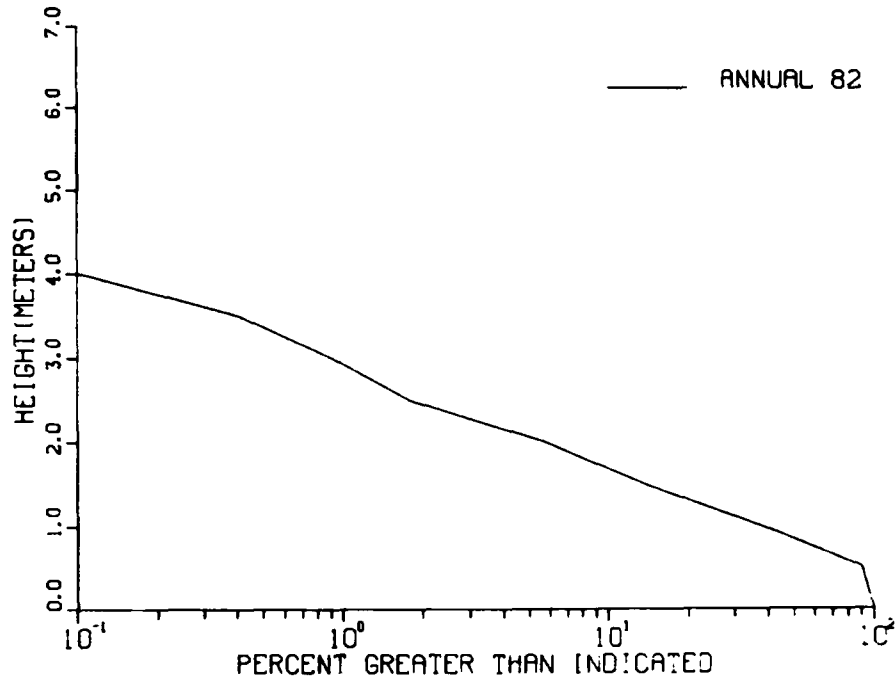


a. Wave heights

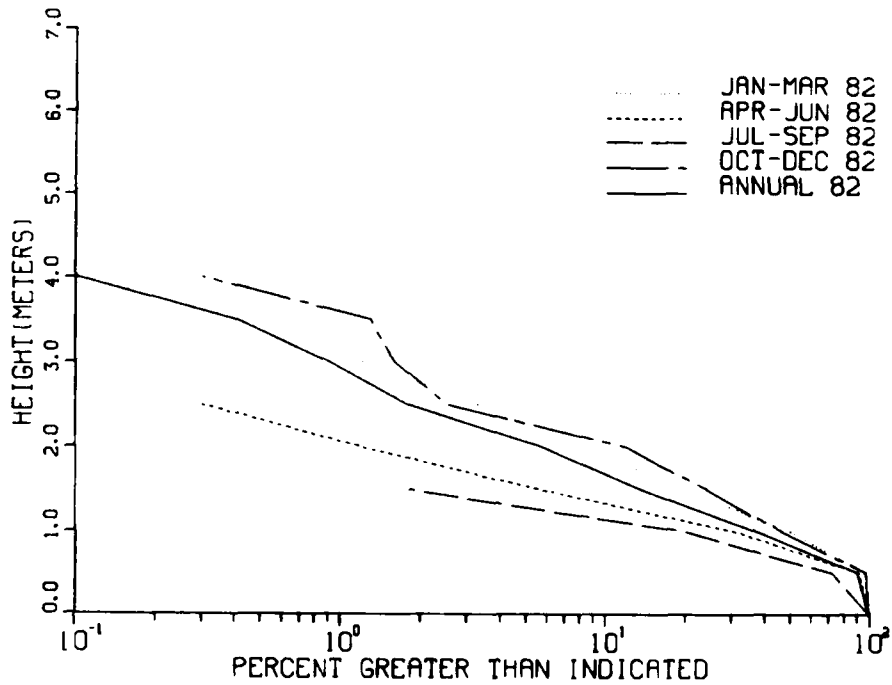


b. Wave periods

Figure B15. 1982 extreme, mean, and standard deviation of wave heights and periods for gage 620



a. Annual



b. Seasonal

Figure B16. 1982 annual and seasonal cumulative distribution of wave height for gage 620

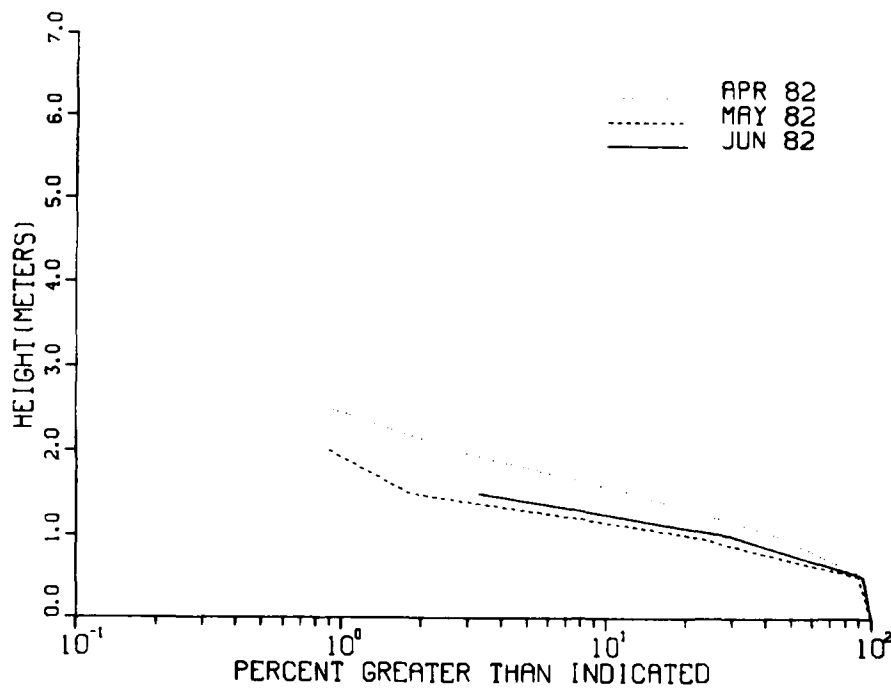
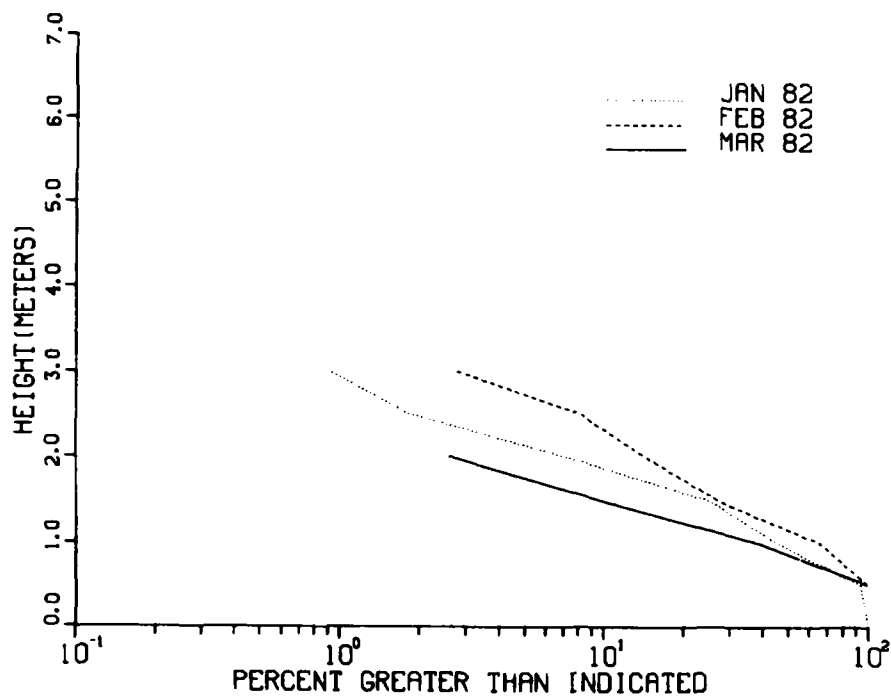


Figure B17. 1982 monthly cumulative distribution of wave height for gage 620 (Continued)

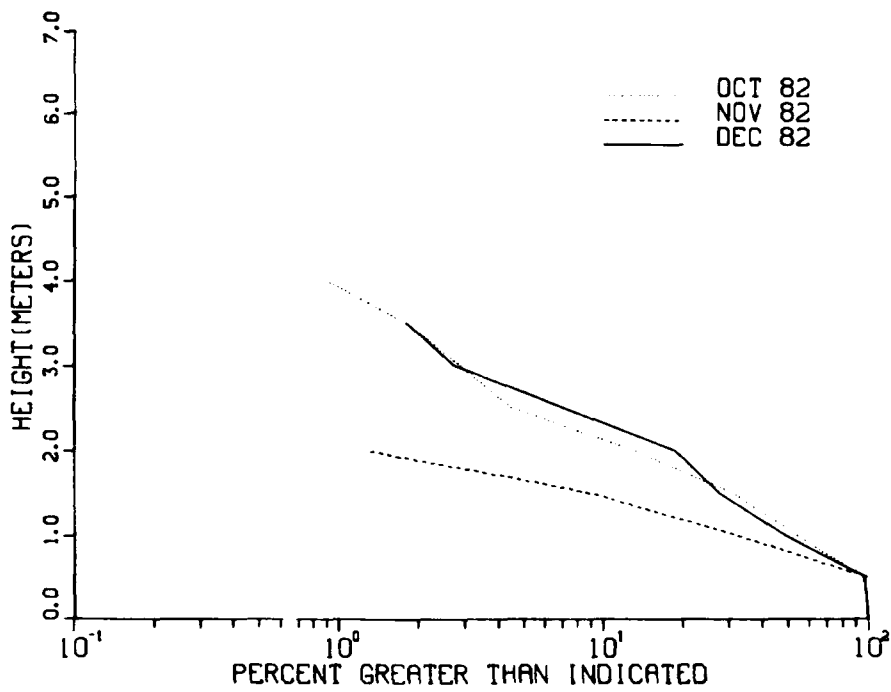
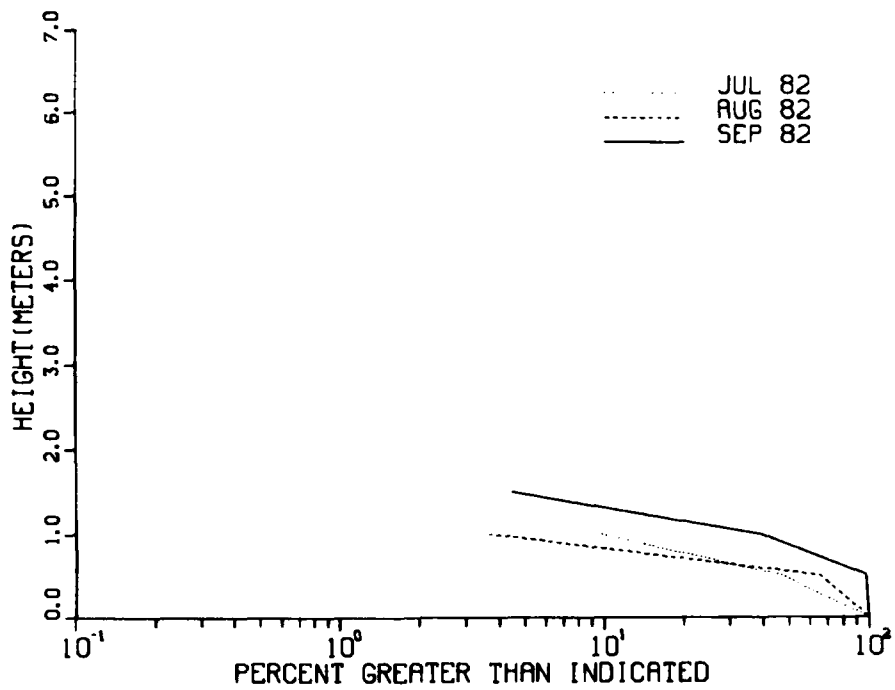
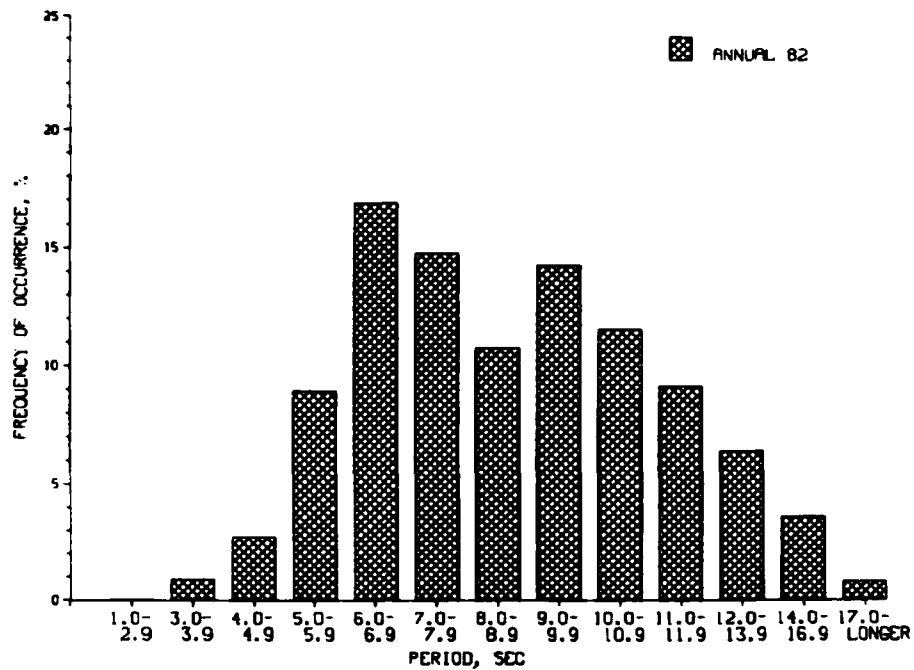
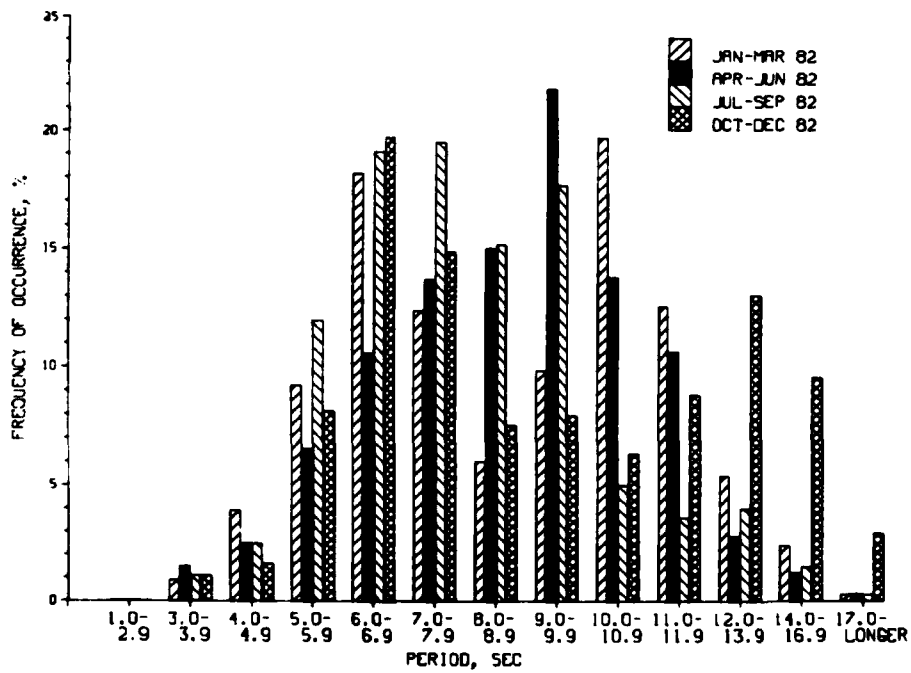


Figure B17. (Concluded)



a. Annual

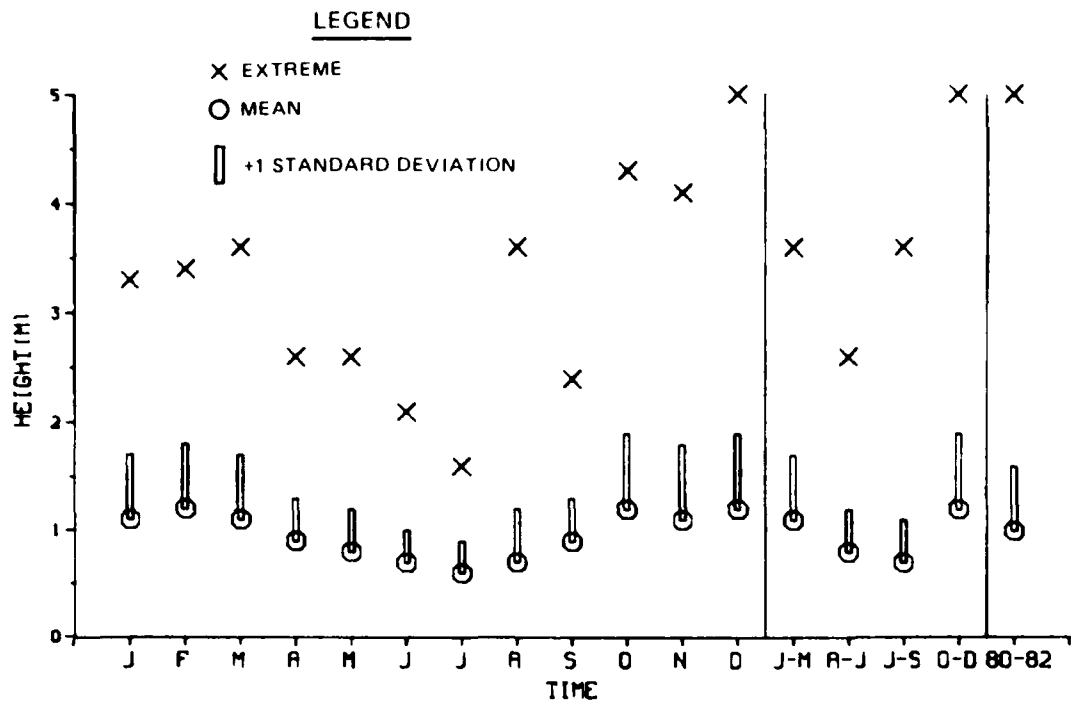


b. Seasonal

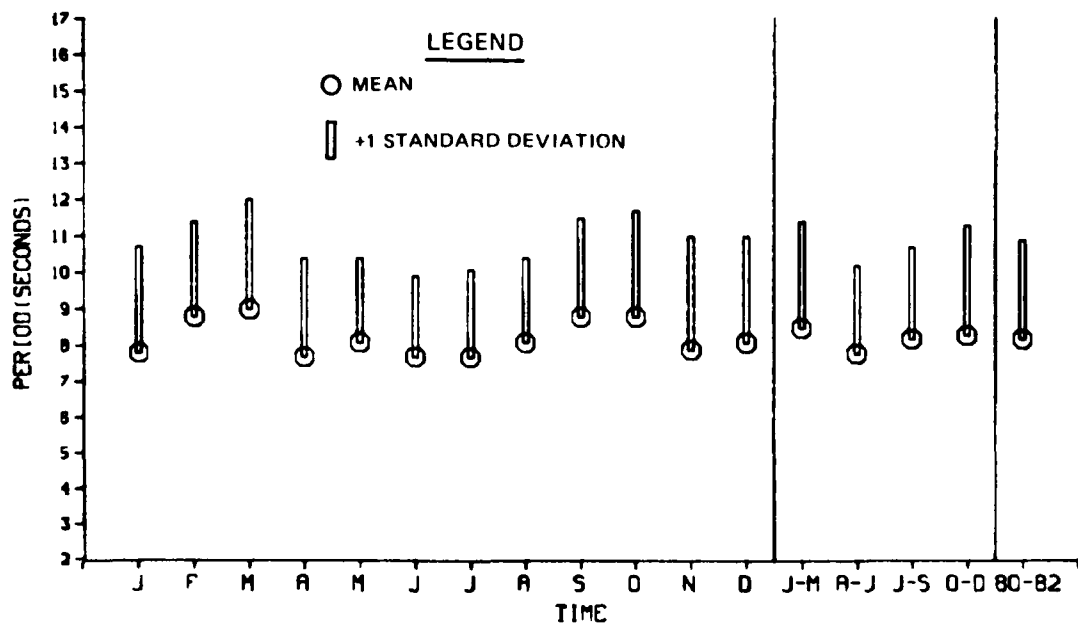
Figure B18. 1982 annual and seasonal distribution of peak spectral wave period for gage 620

Table B13
1982 Persistence of Wave Heights for Gage 620

Height, m	Consecutive Day(s) or Longer																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	32	33	35	81	114	
0.5	16	13	11	9	8	7	7					6													5	4	3	2	2	1	
1.0	51	35	26	20	17	8	6	5	3	2		1																			
1.5	41	17	8	5	2		1																								
2.0	18	8	5	2																											
2.5	8	2	1																												
3.0	5																														
3.5	2																														
4.0	1																														



a. Wave heights



b. Wave periods

Figure B19. 1980 through 1982 extreme, mean, and standard deviation of wave heights and periods for gage 620

Table B14
1980 Through 1982 Wave Statistics for Gage 620

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	1.1	0.6	7.8	2.9	3.3	1982	281
Feb	1.2	0.6	8.8	2.6	3.4	1982	262
Mar	1.1	0.6	9.0	3.0	3.6	1980	292
Apr	0.9	0.4	7.7	2.7	2.6	1982	274
May	0.8	0.4	8.1	2.3	2.6	1981	296
Jun	0.7	0.3	7.7	2.2	2.1	1981	244
Jul	0.6	0.3	7.7	2.4	1.6	1980	255
Aug	0.7	0.5	8.1	2.3	3.6	1981	234
Sep	0.9	0.4	8.8	2.7	2.4	1981	271
Oct	1.2	0.7	8.8	2.9	4.3	1982	347
Nov	1.1	0.7	7.9	3.1	4.1	1981	254
Dec	1.2	0.7	8.1	2.9	5.6	1980	329
Jan-Mar	1.1	0.6	8.5	2.9	3.6	Mar 1980	835
Apr-Jun	0.8	0.4	7.8	2.4	2.6	May 1981 Apr 1982	814
Jul-Sep	0.7	0.4	8.2	2.5	3.6	Aug 1981	760
Oct-Dec	1.2	0.7	8.3	3.0	5.6	Dec 1980	930
Annual	1.0	0.6	8.2	2.7	5.6	Dec 1980	3,339

Table B15
1980 Through 1982 Annual and Seasonal Joint Distribution
of Wave Height Versus Peak Period for Gage 620

HEIGHT(METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	1	3	7	8	13	26	29	13	5	15	8	1	130
.50 - .99	2	12	29	49	56	49	63	64	58	39	25	20	2	468
1.00 - 1.49	.	1	11	34	57	31	20	17	25	18	20	6	1	241
1.50 - 1.99	.	.	1	9	28	12	8	5	10	6	8	6	.	93
2.00 - 2.49	.	.	.	2	8	7	4	4	3	4	7	5	1	45
2.50 - 2.99	.	.	.	.	1	3	1	1	1	2	3	1	.	13
3.00 - 3.49	.	.	.	.	.	.	2	1	.	1	1	.	.	5
3.50 - 3.99	.	.	.	.	.	.	.	1	1	1	1	.	.	5
4.00 - 4.49	.	.	.	.	.	.	.	.	.	1	.	.	.	1
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3	14	44	101	158	115	124	122	111	77	80	47	5	

HEIGHT(METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	.	.	8	5	1	10	5	11	2	16	5	.	64
.50 - .99	.	12	26	46	35	26	29	48	73	37	29	20	1	382
1.00 - 1.49	.	1	17	46	61	25	23	18	49	25	37	11	.	313
1.50 - 1.99	.	.	1	12	38	20	8	11	23	4	10	12	.	139
2.00 - 2.49	.	.	.	5	13	6	6	6	8	4	10	10	1	69
2.50 - 2.99	2	.	.	5	2	8	4	.	22
3.00 - 3.49	1	2	1	1	1	.	.	6
3.50 - 3.99	2	1	.	1	.	.	4
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	1	13	44	117	152	80	78	92	171	75	112	62	2	

HEIGHT(METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	1	4	9	11	14	37	37	12	2	9	2	1	139
.50 - .99	5	15	45	64	61	65	109	87	64	33	15	17	.	580
1.00 - 1.49	.	1	16	26	29	27	26	27	26	18	10	1	.	207
1.50 - 1.99	.	.	1	6	9	6	9	5	11	4	4	.	.	55
2.00 - 2.49	.	.	.	2	1	1	1	6	.	2	1	1	.	15
2.50 - 2.99	1	.	.	.	.	.	1	.	2
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	5	17	66	107	111	114	182	162	113	59	39	22	1	

(Continued)

Table B15 (Concluded)

HEIGHT(METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	3	4	12	17	34	54	64	22	12	16	12	1	251
.50 - .99	.	9	20	43	66	64	83	80	50	45	25	20	.	505
1.00 - 1.49	.	1	3	33	49	30	18	11	8	8	13	7	1	182
1.50 - 1.99	.	.	.	5	9	4	5	1	.	5	8	1	.	38
2.00 - 2.49	1	.	1	1	.	1	4	3	.	11
2.50 - 2.99	1	.	1	.	1	.	1	.	.	4
3.00 - 3.49	1	.	.	.	1	.	.	.	2
3.50 - 3.99	1	.	.	.	.	.	1
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	13	27	93	143	133	162	158	81	72	67	43	2	

HEIGHT(METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	1	4	2	1	5	8	16	9	5	19	12	2	85
.50 - .99	4	11	25	43	62	41	37	44	46	41	29	22	8	413
1.00 - 1.49	.	.	9	32	83	41	14	13	15	18	20	4	1	250
1.50 - 1.99	.	.	.	11	53	15	10	4	6	10	10	9	.	128
2.00 - 2.49	.	.	.	.	15	18	5	4	4	8	12	8	1	75
2.50 - 2.99	.	.	.	.	1	8	1	4	.	5	2	.	.	21
3.00 - 3.49	.	.	.	.	.	.	5	2	.	1	2	1	.	11
3.50 - 3.99	.	.	.	.	.	.	.	2	3	3	1	2	.	11
4.00 - 4.49	.	.	.	.	.	.	.	.	.	2	.	1	.	3
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	5	12	38	88	215	128	80	89	83	93	96	60	12	2

Table B16
 1980 Through 1982 Monthly Joint Distribution of Wave
 Height Versus Peak Period for Gage 620

HEIGHT(METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	.	.	25	11	.	21	7	25	4	7	7	.	111
.50 - .99	.	28	36	53	39	39	11	25	50	32	28	21	.	362
1.00 - 1.49	.	.	18	60	71	25	.	7	43	18	11	.	.	253
1.50 - 1.99	.	.	4	18	60	32	7	7	28	4	.	4	.	164
2.00 - 2.49	.	.	.	4	18	11	4	.	11	11	4	14	4	81
2.50 - 2.99	4	4	.	4	4	7	7	.	30
3.00 - 3.49	4	.	.	.	.	4
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	4	28	58	160	199	111	47	46	165	73	57	53	4	

HEIGHT(METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	38	27	8	38	53	4	.	27	.	.	31
.50 - .99	.	4	4	38	57	8	46	38	88	42	34	4	4	344
1.00 - 1.49	.	4	11	38	57	8	46	38	61	42	38	8	.	351
1.50 - 1.99	.	.	.	11	42	23	19	19	19	.	8	8	.	149
2.00 - 2.49	.	.	.	11	15	8	4	15	15	.	8	8	.	84
2.50 - 2.99	4	.	.	11	4	11	.	.	30
3.00 - 3.49	4	.	4	.	.	.	12
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	8	15	98	141	51	107	129	198	92	130	28	4	

HEIGHT(METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	3	7	7	3	3	14	7	.	47
.50 - .99	.	3	38	45	38	31	38	65	82	38	24	34	.	436
1.00 - 1.49	.	.	21	38	55	41	24	10	45	17	62	24	.	337
1.50 - 1.99	.	.	.	7	14	7	.	7	21	7	21	24	.	108
2.00 - 2.49	7	.	10	3	.	.	17	7	.	44
2.50 - 2.99	7	3	.	10
3.00 - 3.49	3	3	.	.	.	.	.	6
3.50 - 3.99	7	3	.	3	.	.	13
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	3	59	90	117	82	82	102	154	65	148	99	0	

(Continued)

(Sheet 1 of 4)

Table B16 (Continued)

HEIGHT (METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	4	7	7	7	.	22	4	11	4	15	4	.	85
.50 - .99	11	15	47	58	84	73	77	51	69	44	22	36	.	587
1.00 - 1.49	.	4	18	36	40	51	11	44	11	7	.	4	.	226
1.50 - 1.99	.	.	.	11	11	15	7	11	11	4	7	.	.	77
2.00 - 2.49	.	.	.	4	.	.	.	11	.	7	.	.	.	22
2.50 - 2.99	4	.	.	.	.	.	.	.	4
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	11	23	72	116	142	143	117	121	102	66	44	44	0	

HEIGHT (METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	3	10	10	17	17	54	10	3	7	3	.	134
.50 - .99	.	17	41	47	30	54	98	135	68	34	20	.	.	544
1.00 - 1.49	.	.	17	30	27	14	41	24	47	30	10	.	.	240
1.50 - 1.99	.	.	.	7	14	3	17	.	14	.	3	.	.	58
2.00 - 2.49	.	.	.	3	3	3	.	3	.	.	3	3	.	18
2.50 - 2.99	3	.	3
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	17	61	97	84	91	173	216	139	67	43	9	0	

HEIGHT (METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	12	49	8	16	25	78	53	16	.	4	.	4	204
.50 - .99	.	.	12	90	74	70	160	70	53	20	.	16	.	618
1.00 - 1.49	.	.	12	8	20	16	25	12	16	16	20	.	.	145
1.50 - 1.99	.	.	4	.	.	.	.	4	8	8	.	.	.	24
2.00 - 2.49	4	4	.	.	.	.	.	8
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	4	12	65	106	110	111	267	143	93	44	24	16	4	

(Continued)

(Sheet 2 of 4)

Table 316 (Continued)

HEIGHT (METERS)	MONTH JUL													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	8	8	12	24	43	102	133	27	12	20	20	.	409
.50 - .99	.	16	27	67	78	51	90	71	27	8	.	24	.	459
1.00 - 1.49	.	4	4	27	39	20	16	8	.	.	.	.	.	118
1.50 - 1.99	.	.	.	4	.	.	8	.	.	.	.	.	.	12
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	28	39	110	141	114	216	212	54	20	20	44	0	

HEIGHT (METERS)	MONTH AUG													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	4	17	26	60	60	34	34	13	21	13	.	282
.50 - .99	.	4	21	38	60	103	94	60	68	43	30	9	.	530
1.00 - 1.49	.	.	.	30	30	34	4	.	.	9	.	.	.	107
1.50 - 1.99	.	.	.	4	9	4	9	.	.	4	9	.	.	39
2.00 - 2.49	4	.	.	4	4	.	.	12
2.50 - 2.99	4	.	4	.	4	.	4	.	.	16
3.00 - 3.49	4	.	.	.	4	.	.	.	8
3.50 - 3.99	4	.	.	.	.	.	4
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	4	25	89	129	205	175	98	106	77	68	22	0	

HEIGHT (METERS)	MONTH SEP													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	7	4	4	4	26	7	11	7	4	4	78
.50 - .99	.	7	11	26	59	44	66	107	55	81	44	26	.	526
1.00 - 1.49	.	.	4	41	74	37	33	22	22	15	37	18	4	307
1.50 - 1.99	.	.	.	7	18	7	.	4	.	11	15	4	.	66
2.00 - 2.49	4	.	.	4	.	.	7	7	.	22
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	7	15	81	159	92	103	163	84	118	110	59	8	

(Continued)

(Sheet 3 of 4)

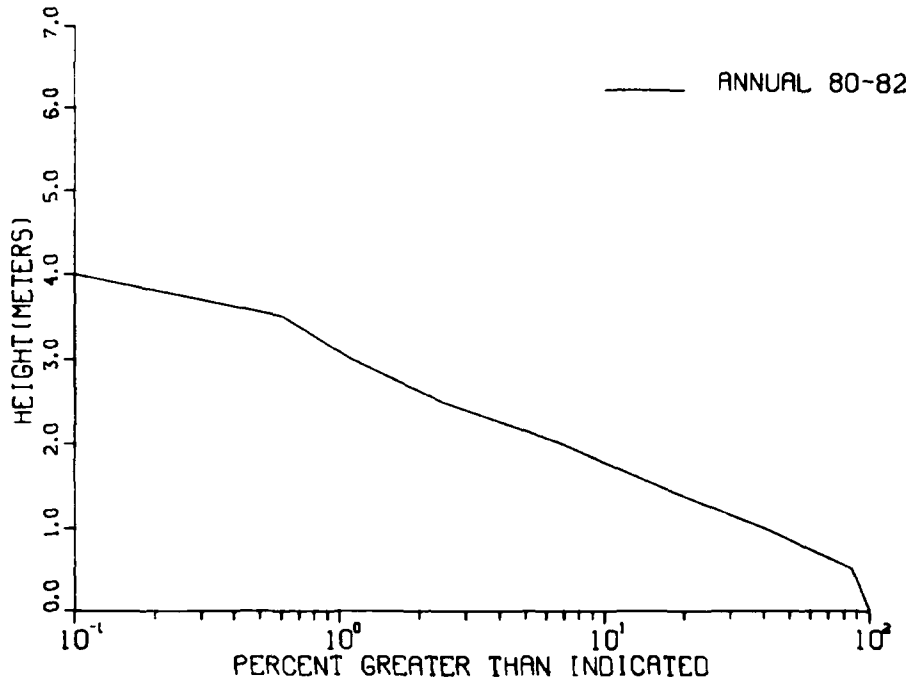
Table B16 (Concluded)

MONTH OCT														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	12	17	23	12	6	26	9	.	105
.50 - .99	.	6	12	29	43	23	43	37	49	49	55	20	3	369
1.00 - 1.49	.	.	6	46	63	29	9	17	17	26	26	9	.	248
1.50 - 1.99	.	.	.	3	61	6	6	6	12	12	20	14	.	140
2.00 - 2.49	20	23	6	3	12	6	17	9	3	99
2.50 - 2.99	3	14	3	9	.	3	3	.	.	35
3.00 - 3.49	0
3.50 - 3.99	3	.	.	.	.	.	3
4.00 - 4.49	6	.	.	.	6
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	6	18	78	190	107	84	98	102	108	147	61	6	

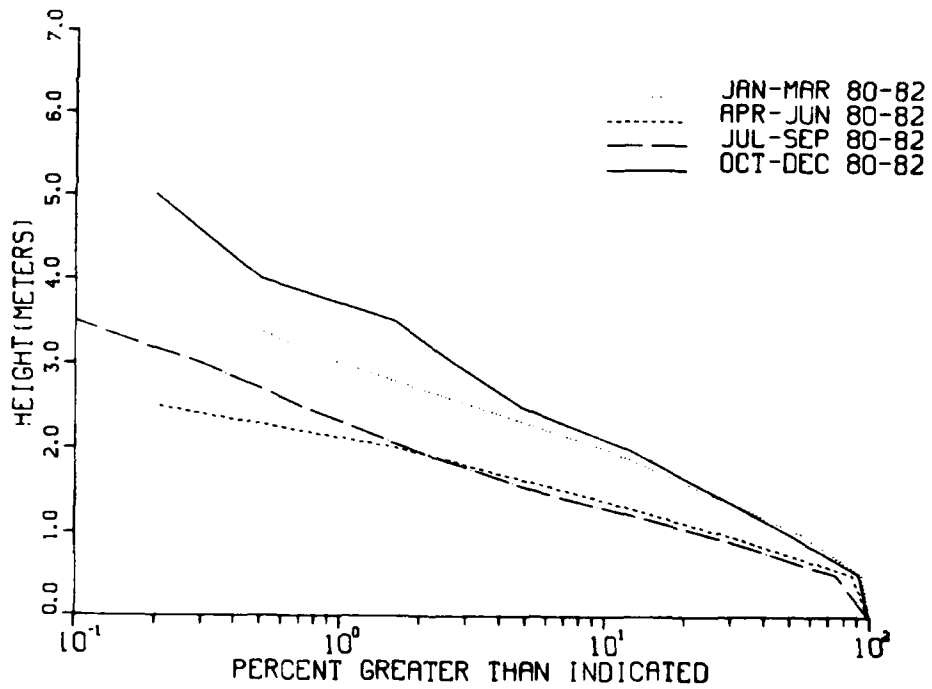
MONTH NOV														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	4	4	.	4	4	.	20	12	4	8	8	.	72
.50 - .99	8	8	59	67	67	75	35	47	39	51	8	24	12	500
1.00 - 1.49	.	.	12	24	110	28	12	8	4	12	8	4	4	226
1.50 - 1.99	.	.	.	12	28	31	12	.	.	12	.	12	.	107
2.00 - 2.49	.	.	.	.	4	8	8	.	.	8	4	4	.	36
2.50 - 2.99	.	.	.	.	.	4	4	4	.	8	4	4	.	20
3.00 - 3.49	.	.	.	.	.	.	4	4	.	4	4	4	.	16
3.50 - 3.99	.	.	.	.	.	.	.	.	12	.	4	8	.	24
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	4	.	.	4
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	12	12	75	103	213	150	71	83	67	95	40	68	16	

MONTH DEC														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	9	6	.	.	3	6	3	6	21	18	3	75
.50 - .99	6	18	12	40	79	33	30	49	49	24	18	21	9	388
1.00 - 1.49	.	.	9	24	82	64	21	12	21	15	24	.	.	272
1.50 - 1.99	.	.	.	18	64	12	12	6	6	6	6	.	.	130
2.00 - 2.49	18	21	3	9	.	9	12	9	.	81
2.50 - 2.99	3	.	.	.	6	.	.	.	9
3.00 - 3.49	12	3	.	3	3	.	.	21
3.50 - 3.99	3	.	9	.	.	.	12
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	3	3	.	6
TOTAL	6	18	30	88	243	133	81	88	79	78	87	51	12	

(Sheet 4 of 4)

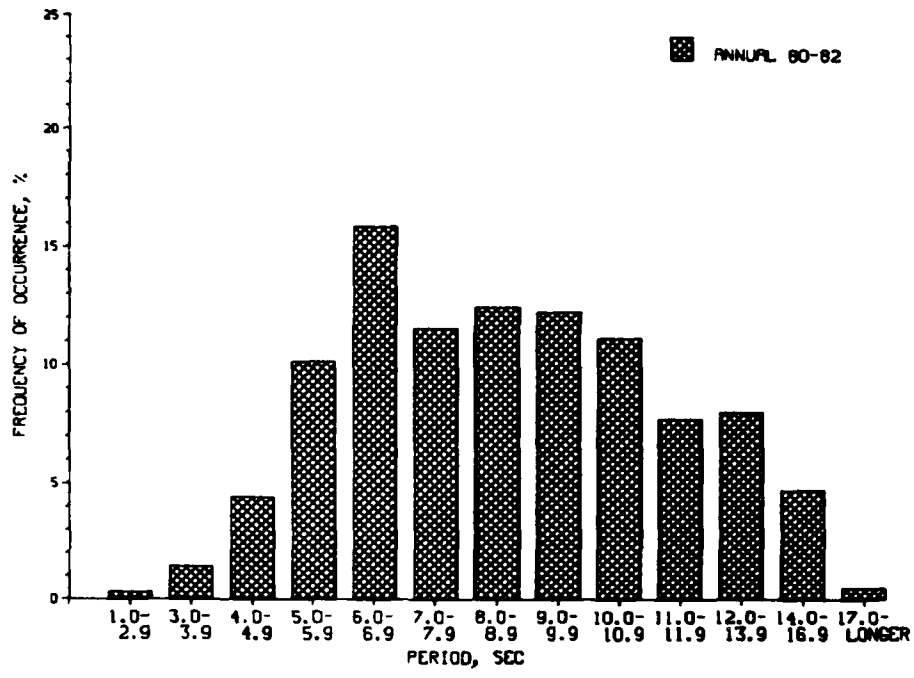


a. Annual

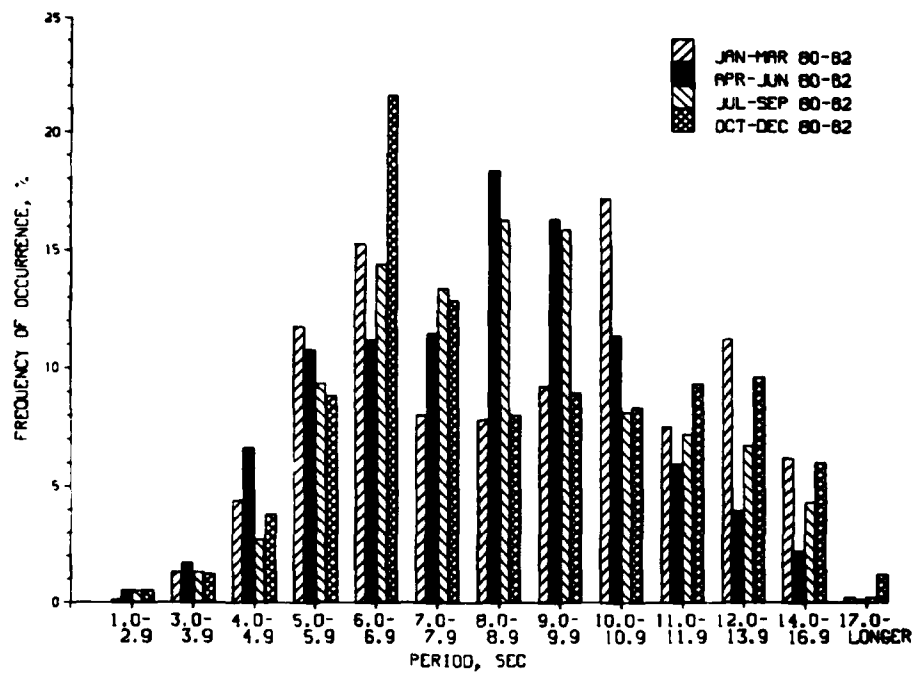


b. Seasonal

Figure B20. 1980 through 1982 annual and seasonal cumulative distribution of wave height for gage 620



a. Annual

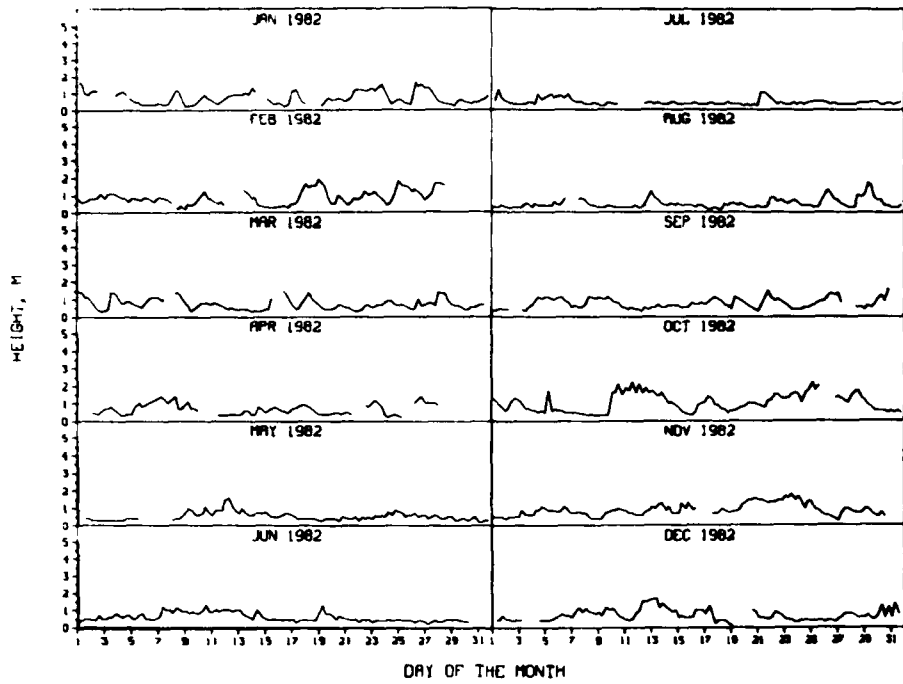


b. Seasonal

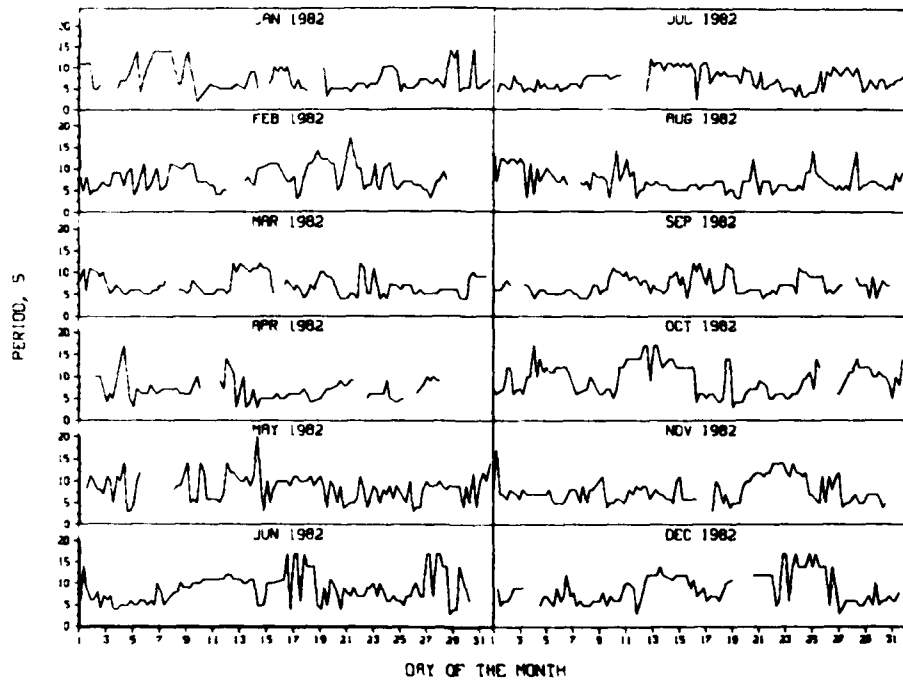
Figure B21. 1980 through 1982 annual and seasonal distribution of peak spectral wave period for gage 620

Table B17
1980 Through 1982 Persistence of Wave Heights for Gage 620

Height, m	Consecutive Day(s) or Longer																												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	29			
0.5	28	24	20	18	15	11								7	6												3		
1.0	50	33	24	17	12	9	7	5	3	2																			
1.5	37	18	10	7	5	2																							
2.0	20	9	4	3	1																								
2.5	9	4	2	1																									
3.0	5	3																											
3.5	3																												
4.0	2																												



a. Wave heights

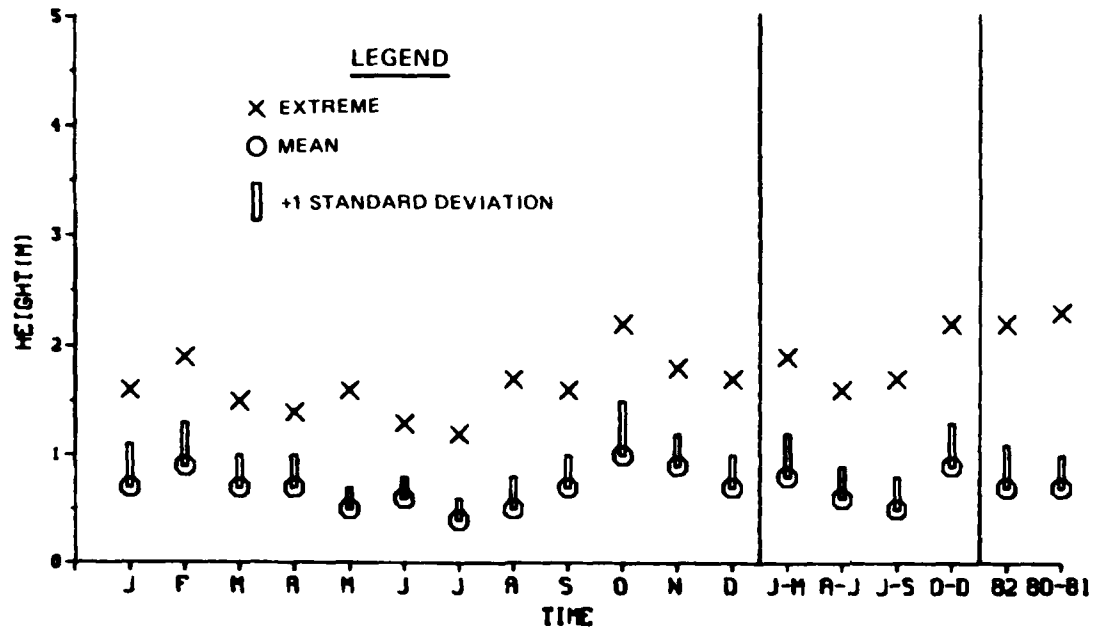


b. Wave periods

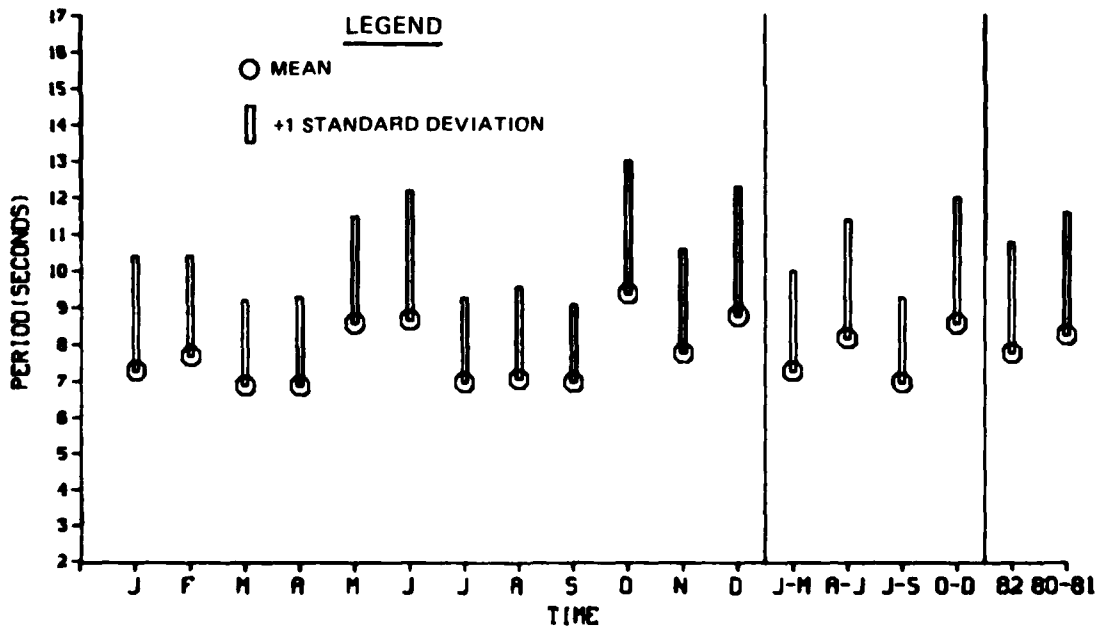
Figure B22. Time-history for gage 615

Table B18
1982 Wave Statistics for Gage 615

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	0.7	0.4	7.3	3.1	1.6	1	95
Feb	0.9	0.4	7.7	2.7	1.9	19	91
Mar	0.7	0.3	6.9	2.3	1.5	1	105
Apr	0.7	0.3	6.9	2.4	1.4	7	72
May	0.5	0.2	8.6	2.9	1.6	12	111
Jun	0.6	0.2	8.7	3.5	1.3	10	114
Jul	0.4	0.2	7.0	2.3	1.2	1	114
Aug	0.5	0.3	7.1	2.5	1.7	29	117
Sep	0.7	0.3	7.0	2.1	1.6	30	109
Oct	1.0	0.5	9.4	3.6	2.2	11	110
Nov	0.9	0.3	7.8	2.8	1.8	23	111
Dec	0.7	0.3	8.8	3.5	1.7	13	104
Jan-Mar	0.3	0.4	7.3	2.7	1.9	Feb	291
Apr-Jun	0.6	0.3	8.2	3.2	1.6	May	297
Jul-Sep	0.5	0.3	7.0	2.3	1.7	Aug	340
Oct-Dec	0.7	0.4	3.6	3.4	2.2	Oct	325
Annual	0.7	0.4	7.8	3.0	2.2	Oct	1,253



a. Wave heights



b. Wave periods

Figure B23. 1982 extreme, mean, and standard deviation of wave heights and periods for gage 615

Table B19
 1982 Annual and Seasonal Joint Distribution of Wave
 Height Versus Peak Period for Gage 615

HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL	
	PERIOD (SECONDS)														
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER		
0.00 - .49		2	10	14	42	31	41	34	41	34	28	15	26	9	327
.50 - .99		.	10	44	93	89	49	26	39	40	26	20	6	6	448
1.00 - 1.49		.	.	.	33	62	33	8	9	4	11	9	6	.	175
1.50 - 1.99		.	.	.	2	5	10	1	2	2	6	13	7	3	51
2.00 - 2.49		1	.	.	.	.	2	2	.	5
2.50 - 2.99		0
3.00 - 3.49		0
3.50 - 3.99		0
4.00 - 4.49		0
4.50 - 4.99		0
5.00 - GREATER		0
TOTAL		2	20	58	170	187	134	69	91	80	71	59	47	18	

HEIGHT (METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	3	10	41	10	7	10	24	41	34	17	31	3	234
.50 - .99	.	7	58	141	96	38	10	24	38	24	3	3	.	442
1.00 - 1.49	.	.	.	41	110	52	17	14	.	17	.	.	.	251
1.50 - 1.99	7	24	3	3	3	10	14	3	.	67
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	3	10	68	223	223	121	40	65	82	85	24	37	3	

HEIGHT (METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	17	20	44	24	44	27	61	57	27	10	34	24	389
.50 - .99	.	13	44	74	94	37	37	57	67	47	3	7	10	490
1.00 - 1.49	.	.	.	10	27	13	10	10	13	20	10	.	.	113
1.50 - 1.99	3	3	.	6
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	30	64	128	145	94	74	128	137	94	26	44	34	

(Continued)

Table B19 (Concluded)

HEIGHT (METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	18	24	71	71	85	88	62	32	41	24	12	.	531
.50 - .99	.	6	44	74	85	56	6	41	21	12	9	.	.	354
1.00 - 1.49	.	.	.	44	44	12	3	3	.	.	.	.	.	106
1.50 - 1.99	.	.	.	3	.	9	.	.	.	.	.	.	.	12
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	3	24	68	192	200	162	97	106	53	53	33	12	0	

HEIGHT (METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	9	15	22	6	15	9	9	9	28	9	131
.50 - .99	.	12	31	86	83	62	49	34	37	25	62	12	12	505
1.00 - 1.49	.	.	.	34	71	55	3	9	3	9	25	22	.	231
1.50 - 1.99	.	.	.	3	12	6	.	6	6	15	34	22	12	116
2.00 - 2.49	3	.	.	.	.	6	6	.	15
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	12	31	132	181	148	58	64	55	58	136	90	33	

Table B20
1982 Monthly Joint Distribution of Wave Height
Versus Peak Period for Gage 615

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	11	11	11	74	11	.	11	32	53	.	21	95	.	330
.50 - .99	.	.	42	158	74	32	.	21	11	11	.	11	.	360
1.00 - 1.49	.	.	.	53	116	63	11	11	.	11	.	.	.	265
1.50 - 1.99	11	11	.	.	11	21	.	.	.	54
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	11	11	53	285	212	106	22	64	75	43	21	106	0	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	11	.	22	.	.	33	55	.	.	11	132
.50 - .99	.	22	55	110	99	11	33	11	66	55	.	.	.	462
1.00 - 1.49	.	.	.	44	88	55	22	33	.	22	.	.	.	264
1.50 - 1.99	11	55	.	11	.	11	44	11	.	143
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	22	55	165	198	143	55	55	99	143	44	11	11	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	19	38	19	.	19	38	38	48	29	.	.	248
.50 - .99	.	.	76	152	114	67	.	38	38	10	10	.	.	505
1.00 - 1.49	.	.	.	29	124	38	19	.	.	19	.	.	.	229
1.50 - 1.99	10	10	.	.	.	.	.	.	20
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	95	219	257	115	48	76	76	77	39	0	0	

(Continued)

(Sheet 1 of 4)

Table B20 (Continued)

HEIGHT(METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	42	14	56	.	56	14	42	28	14	.	14	14	294
.50 - .99	.	14	42	111	181	42	42	42	28	.	.	.	.	502
1.00 - 1.49	83	42	28	28	28	.	.	.	.	209
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	56	56	167	264	140	84	112	84	14	0	14	14	0

HEIGHT(METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	18	27	54	.	9	45	108	99	54	27	18	.	459
.50 - .99	.	18	36	45	72	18	45	72	81	63	9	18	9	486
1.00 - 1.49	.	.	.	9	9	.	.	.	9	.	9	.	.	36
1.50 - 1.99	9	9	.	18
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	36	63	108	81	27	90	180	189	117	54	45	9	0

HEIGHT(METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	18	26	61	70	18	26	35	9	.	61	53	377
.50 - .99	.	9	53	79	61	53	26	53	79	61	.	.	18	492
1.00 - 1.49	.	.	.	18	9	9	9	9	9	53	18	.	.	134
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	71	123	131	132	53	88	123	123	18	61	71	0

(Continued)

(Sheet 2 of 4)

Table B20 (Continued)

HEIGHT(METERS)	MONTH JUL													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	26	53	88	79	53	184	88	79	79	9	.	.	747
.50 - .99	.	.	44	70	70	26	.	18	.	.	.	.	.	228
1.00 - 1.49	.	.	.	18	9	.	.	.	.	.	.	.	.	27
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	9	26	97	176	158	79	184	106	79	79	9	0	0	

HEIGHT(METERS)	MONTH AUG													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	26	17	103	85	137	51	85	9	26	60	34	.	633
.50 - .99	.	17	17	85	111	51	9	.	9	9	.	.	.	308
1.00 - 1.49	.	.	.	9	34	17	.	.	.	.	.	.	.	43
1.50 - 1.99	17
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	43	34	197	230	205	60	85	18	35	60	34	0	

HEIGHT(METERS)	MONTH SEP													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	18	46	64	28	9	9	18	.	.	.	192
.50 - .99	.	.	73	64	73	92	9	110	55	28	28	.	.	532
1.00 - 1.49	.	.	.	110	92	37	9	9	.	.	.	.	.	257
1.50 - 1.99	.	.	.	9	.	9	.	.	.	.	.	.	.	18
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	73	201	211	202	46	128	64	46	28	0	0	

(Continued)

(Sheet 3 of 4)

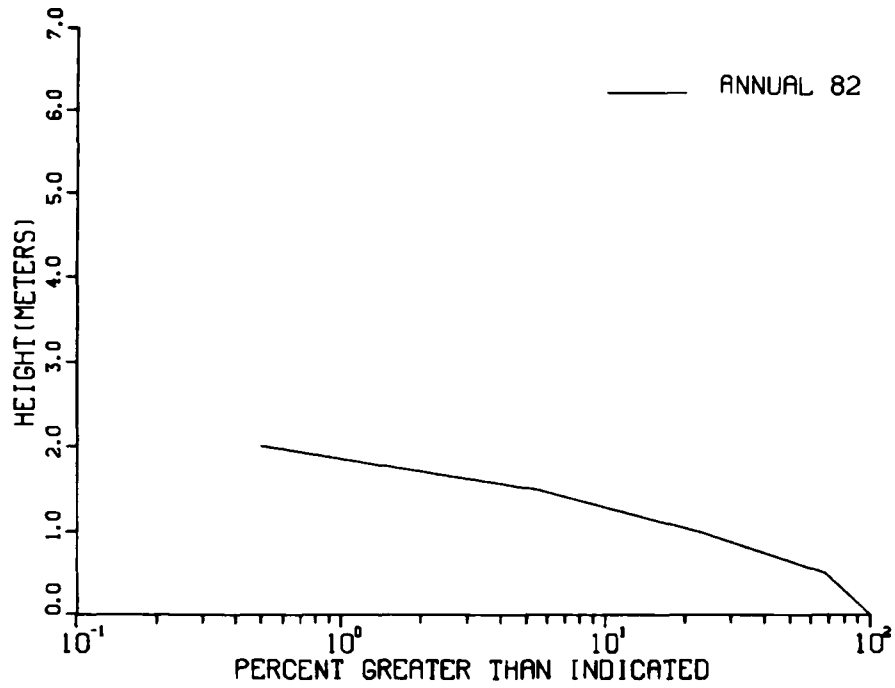
Table B20 (Concluded)

HEIGHT (METERS)	MONTH OCT													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	18	36	.	9	9	.	18	.	.	90
.50 - .99	.	9	45	27	27	9	27	9	73	27	100	36	9	398
1.00 - 1.49	.	.	.	45	82	55	.	9	.	18	18	27	.	254
1.50 - 1.99	.	.	.	9	36	18	.	9	.	18	27	45	36	207
2.00 - 2.49	9	.	.	.	.	18	18	.	45
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	45	81	163	127	27	36	91	63	181	126	45	

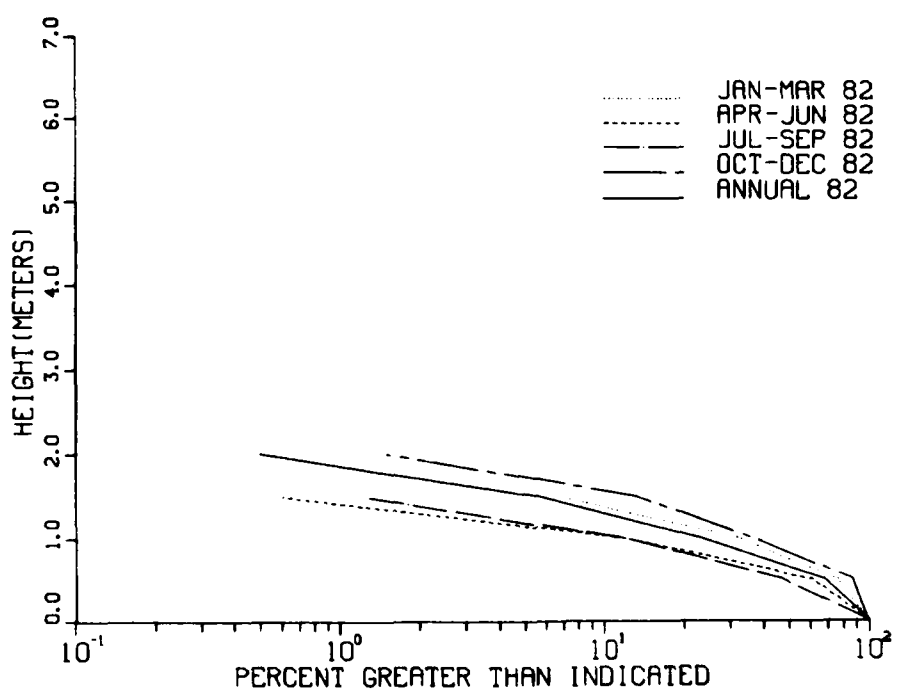
HEIGHT (METERS)	MONTH NOV													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	9	.	9	.	.	18	9	.	.	45
.50 - .99	.	9	36	144	63	135	90	45	18	27	.	.	9	576
1.00 - 1.49	.	.	.	36	81	72	9	9	9	9	27	27	.	279
1.50 - 1.99	9	27	45	18	.	99
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	36	180	153	207	108	54	36	81	81	45	9	

HEIGHT (METERS)	MONTH DEC													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	29	19	29	10	38	19	10	.	87	29	270
.50 - .99	.	19	10	87	163	38	29	48	19	19	87	.	19	538
1.00 - 1.49	.	.	.	19	48	38	.	10	.	.	29	10	.	154
1.50 - 1.99	10	.	.	29	.	.	39
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	19	10	135	230	105	39	106	38	29	145	97	48	

(Sheet 4 of 4)



a. Annual



b. Seasonal

Figure B24. 1982 annual and seasonal cumulative distribution of wave height for gage 615

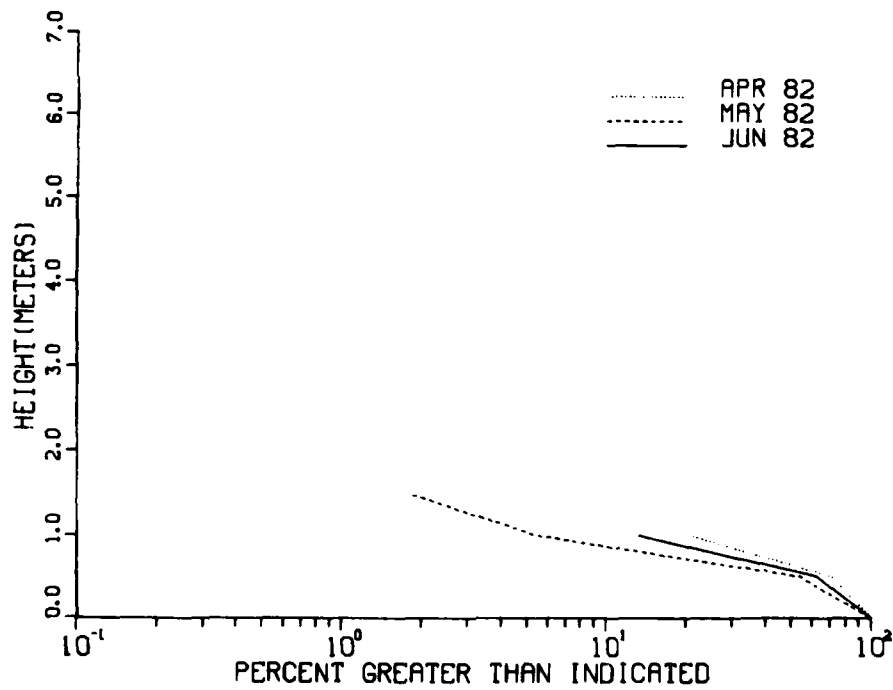
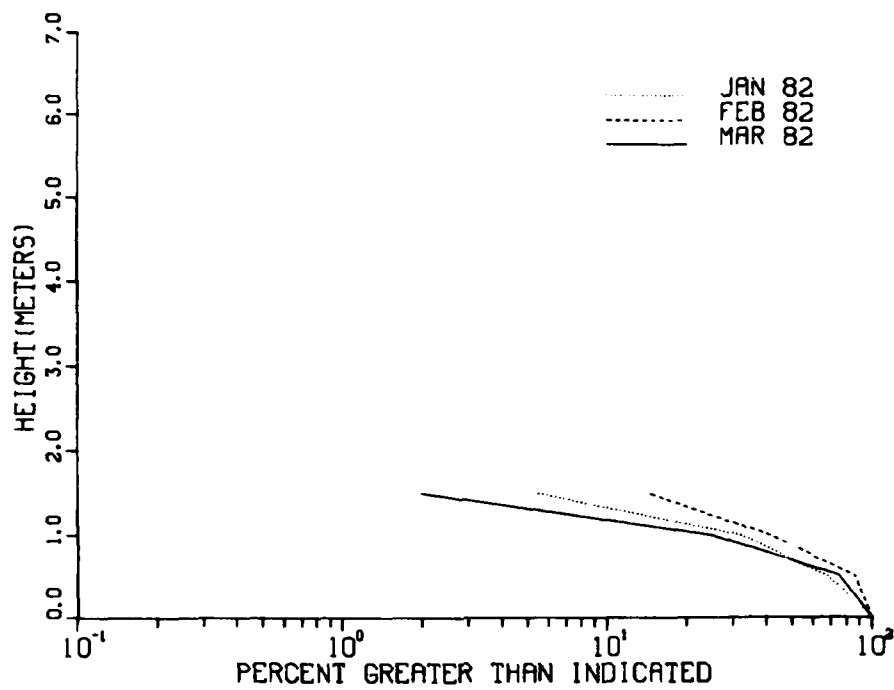


Figure B25. 1982 monthly cumulative distribution of wave height for gage 615 (Continued)

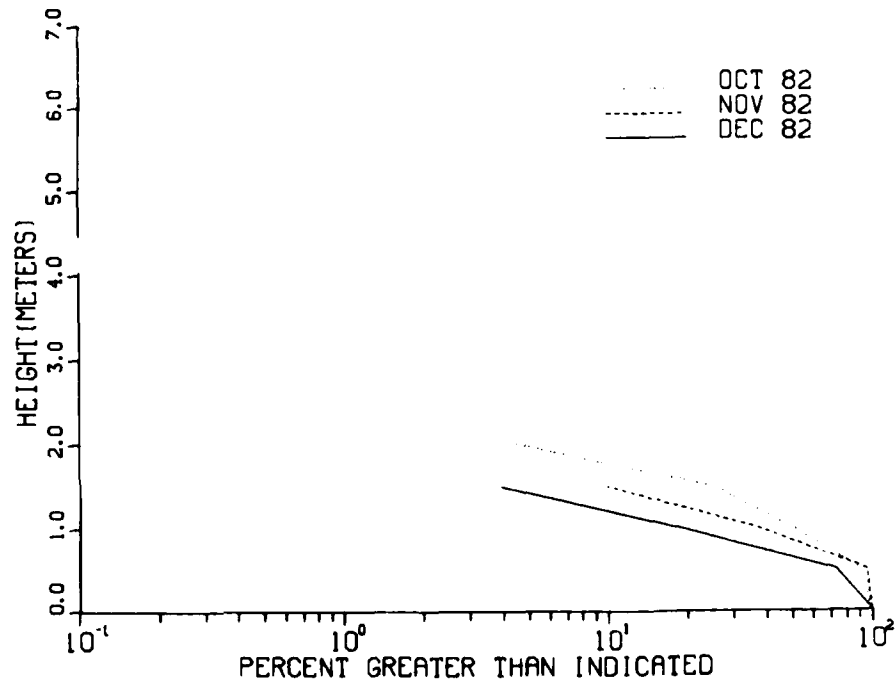
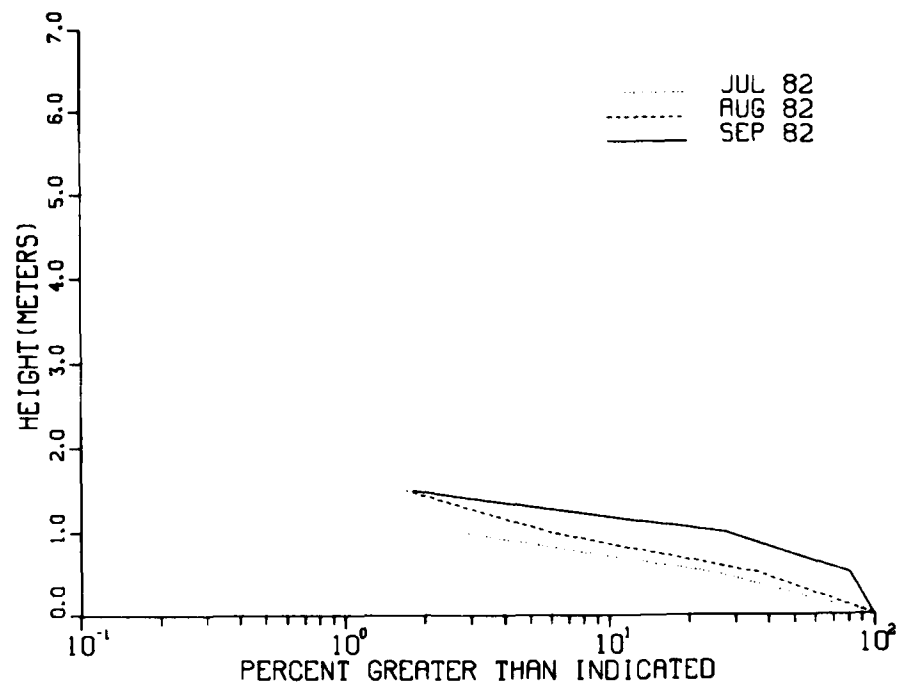
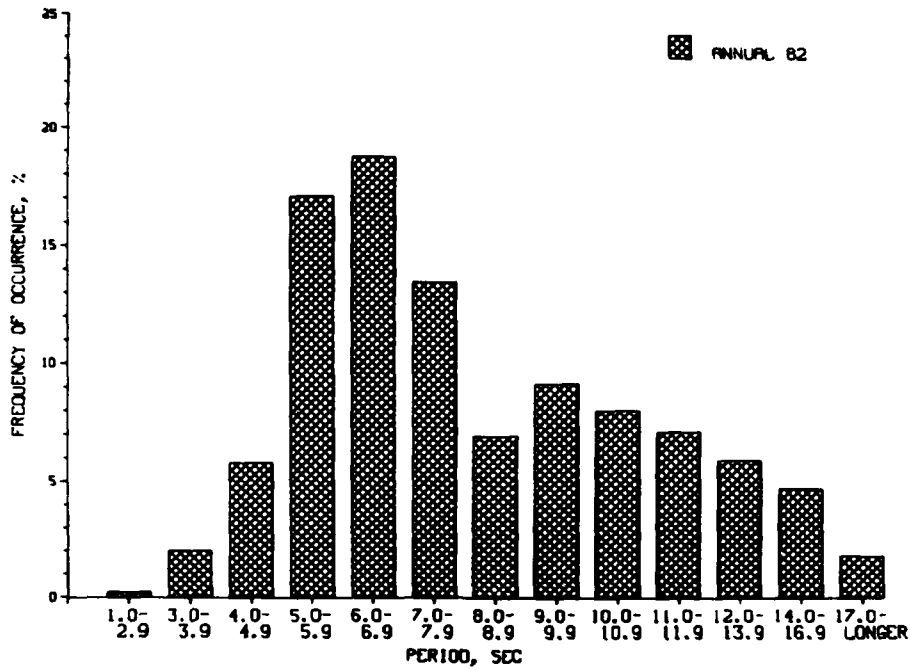
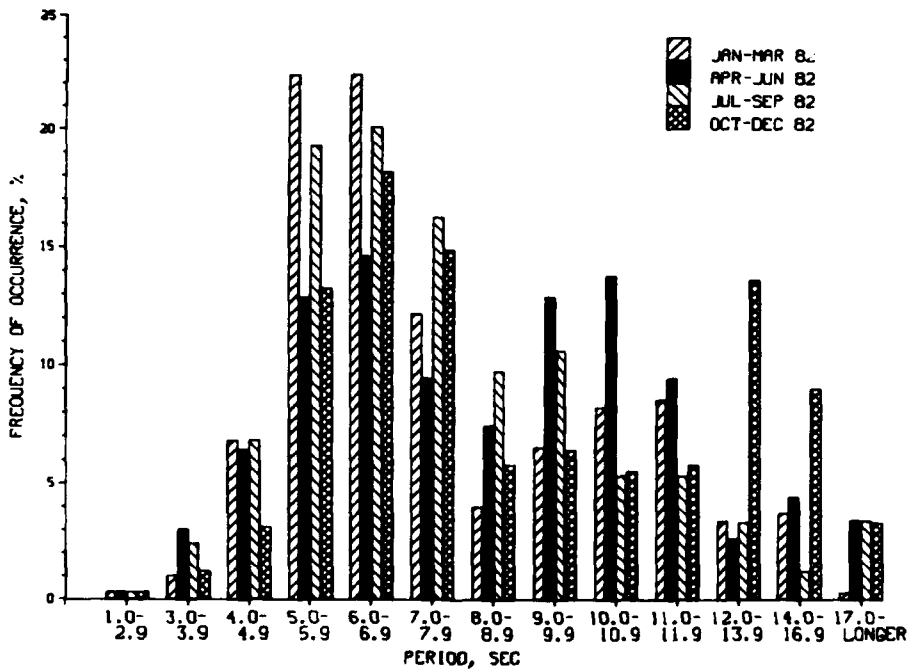


Figure B25. (Concluded)



a. Annual



b. Seasonal

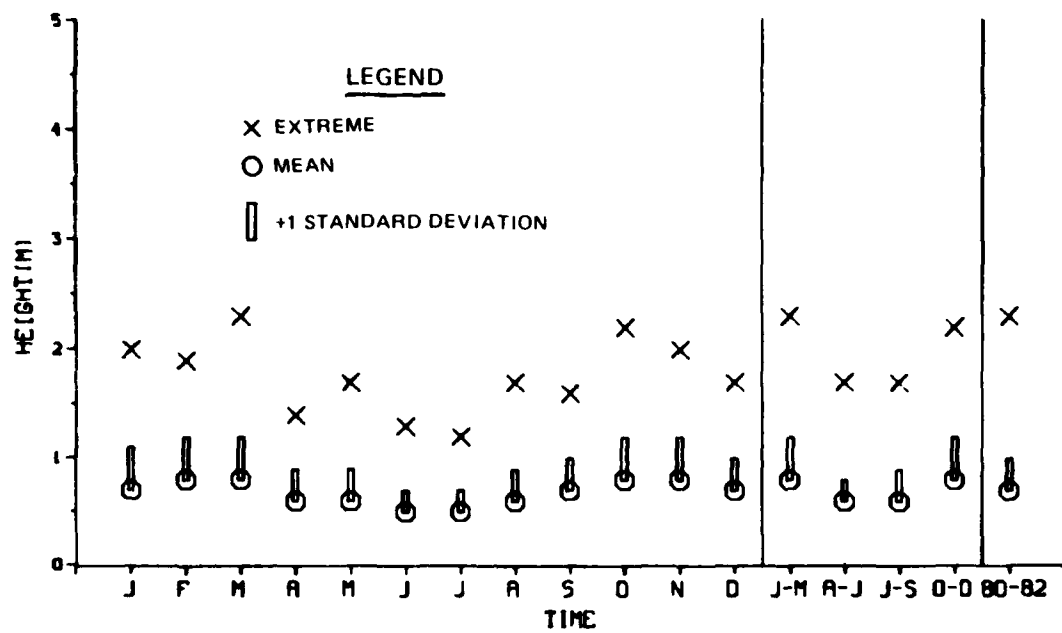
Figure B26. 1982 annual and seasonal distribution of peak spectral wave period for gage 615

Table B21
1982 Persistence of Wave Heights for Gage 615

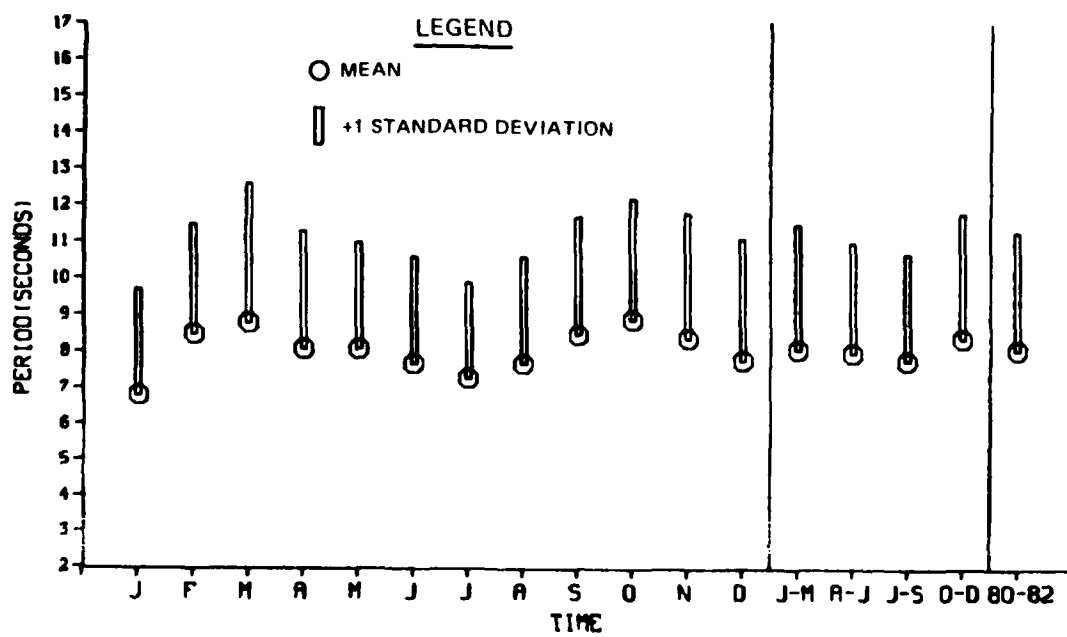
Height, m	Consecutive Day(s) or Longer																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	35	54
0.5	36	31	24	21	15	12			9	8		7							5				3			2	1
1.0	53	33	17	10	5		3		1																		
1.5	17	6	4	3	1																						
2.0	2		1																								
2.5																											
3.0																											
3.5																											
4.0																											

Table B22
1980 Through 1982 Wave Statistics for Gage 615

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	0.7	0.4	6.8	2.9	2.0	1980	221
Feb	0.8	0.4	8.5	3.0	1.9	1982	233
Mar	0.8	0.4	8.8	3.8	2.3	1980	294
Apr	0.6	0.3	8.1	3.2	1.4	1981 1982	240
May	0.6	0.3	8.1	2.9	1.7	1981	318
Jun	0.5	0.2	7.7	2.9	1.3	1981 1982	281
Jul	0.5	0.2	7.3	2.6	1.2	1982	292
Aug	0.6	0.3	7.7	2.9	1.7	1982	275
Sep	0.7	0.3	8.5	3.2	1.6	1982	247
Oct	0.8	0.4	8.9	3.3	2.2	1982	331
Nov	0.8	0.4	8.4	3.4	2.0	1981	319
Dec	0.7	0.3	7.8	3.3	1.7	1982	293
Jan-Mar	0.8	0.4	8.1	3.4	2.3	Mar 1980	748
Apr-Jun	0.6	0.2	8.0	3.0	1.7	May 1981	839
Jul-Sep	0.6	0.3	7.8	2.9	1.7	Aug 1982	814
Oct-Dec	0.8	0.4	8.4	3.4	2.2	Oct 1982	944
Annual	0.7	0.3	8.1	3.2	2.3	Mar 1980	3,344



a. Wave heights



b. Wave periods

Figure B27. 1980 through 1982 extreme, mean, and standard deviation of wave heights and periods for gage 615

Table B23

1980 Through 1982 Annual and Seasonal Joint Distribution
of Wave Height Versus Peak Period for Gage 615

HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	6	14	33	29	34	44	38	31	19	29	33	7	320
.50 - .99	1	13	47	92	82	44	36	44	24	24	29	23	3	474
1.00 - 1.49	.	.	3	28	46	24	8	9	8	13	16	13	1	169
1.50 - 1.99	.	.	.	1	4	4	.	2	1	5	7	5	1	30
2.00 - 2.49	.	.	.	.	.	.	.	.	.	.	1	1	.	2
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4	19	64	154	161	106	88	85	84	61	82	75	12	

HEIGHT (METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	5	12	39	23	17	23	13	29	16	19	27	1	228
.50 - .99	4	19	43	120	70	28	27	24	52	21	44	52	.	504
1.00 - 1.49	.	.	7	37	52	32	11	8	11	16	16	24	.	214
1.50 - 1.99	.	.	.	1	5	11	1	7	1	7	7	9	.	49
2.00 - 2.49	.	.	.	.	.	.	.	.	.	.	1	3	.	4
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	8	24	62	197	150	88	62	52	93	60	87	115	1	

HEIGHT (METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	8	12	36	29	48	63	55	33	13	31	41	12	382
.50 - .99	1	12	58	99	77	46	56	52	58	38	10	11	5	523
1.00 - 1.49	.	.	1	13	17	7	11	7	13	10	10	1	.	90
1.50 - 1.99	.	.	.	.	1	.	.	.	1	.	1	1	.	4
2.00 - 2.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	2	20	71	148	124	101	130	114	105	61	52	54	17	

(Continued)

Table B23 (Concluded)

HEIGHT(METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	2	10	25	42	45	57	79	60	47	29	32	29	7	464
.50 - .99	.	11	47	77	68	50	28	36	27	14	29	15	1	403
1.00 - 1.49	.	.	1	26	39	17	5	6	4	7	10	5	2	122
1.50 - 1.99	.	.	.	1	2	4	.	.	.	1	.	1	.	9
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	2	21	73	146	154	128	112	102	78	51	71	50	10	

HEIGHT(METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	.	10	17	19	17	13	23	17	19	34	36	7	215
.50 - .99	1	13	41	77	108	49	31	33	38	23	34	18	5	471
1.00 - 1.49	.	.	3	37	72	39	5	14	6	17	28	20	3	244
1.50 - 1.99	.	.	.	1	7	4	.	3	3	11	18	10	4	61
2.00 - 2.49	.	.	.	.	.	1	.	.	1	.	2	2	.	6
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4	13	54	132	206	110	49	73	65	70	116	86	19	

Table B24
 1980 Through 1982 Monthly Joint Distribution of Wave
 Height Versus Peak Period for Gage 625

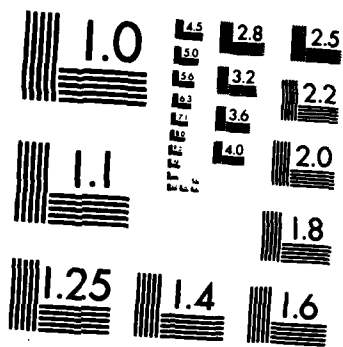
HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	14	14	14	72	45	32	36	18	27	.	18	41	.	331
.50 - .99	5	23	50	149	86	32	9	9	18	5	18	14	.	418
1.00 - 1.49	.	.	9	68	63	36	9	5	14	9	.	5	.	218
1.50 - 1.99	.	.	.	.	5	5	.	5	5	14	.	.	.	34
2.00 - 2.49	.	.	.	.	.	.	.	.	.	.	.	5	.	5
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	19	37	73	289	199	105	54	37	64	28	36	65	0	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	4	17	4	17	17	4	34	26	17	9	4	153
.50 - .99	4	13	30	107	60	21	56	39	99	43	56	52	.	580
1.00 - 1.49	.	.	.	26	43	39	13	17	9	21	17	9	.	194
1.50 - 1.99	13	26	.	9	.	4	17	4	.	73
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	4	13	34	150	120	103	86	69	142	94	107	74	4	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE (X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	3	17	31	20	7	17	17	27	20	20	31	.	210
.50 - .99	3	20	48	109	65	31	17	24	41	17	54	82	.	511
1.00 - 1.49	.	.	10	24	51	24	10	3	10	17	27	51	.	227
1.50 - 1.99	.	.	.	3	.	3	3	7	.	3	3	20	.	42
2.00 - 2.49	3	3	.	6
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	3	23	75	167	136	65	47	51	78	57	107	187	0	

(Continued)

(Sheet 1 of 4)



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table B24 (Continued)

HEIGHT (METERS)	MONTH APR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	12	8	37	33	50	46	29	17	12	37	62	8	355
.50 - .99	4	8	42	117	96	21	42	37	50	71	12	17	4	521
1.00 - 1.49	.	.	.	12	29	17	12	8	17	8	17	.	.	120
1.50 - 1.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
2.00 - 2.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	8	20	50	166	158	88	100	74	84	91	66	79	12	

HEIGHT (METERS)	MONTH MAY													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	6	19	35	9	25	60	57	47	22	53	31	6	370
.50 - .99	.	13	47	88	82	60	57	57	66	25	16	16	3	530
1.00 - 1.49	.	.	3	19	19	3	13	9	13	.	6	3	.	88
1.50 - 1.99	3	.	.	.	3	.	3	3	.	12
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	19	69	142	113	88	130	123	129	47	78	53	9	

HEIGHT (METERS)	MONTH JUN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	7	7	36	46	71	82	75	32	4	.	32	21	413
.50 - .99	.	14	85	96	57	53	68	60	57	25	.	.	7	522
1.00 - 1.49	.	.	.	7	4	4	7	4	11	21	7	.	.	65
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	21	92	139	107	128	157	139	100	50	7	32	28	

(Continued)

(Sheet 2 of 4)

Table B24 (Continued)

MONTH JUL														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	7	10	45	38	55	51	134	92	58	38	24	24	3	579
.50 - .99	.	14	55	99	65	41	48	27	14	.	3	7	.	373
1.00 - 1.49	.	.	3	17	10	7	7	.	3	.	.	.	.	47
1.50 - 1.99	0
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	7	24	103	154	130	99	189	119	75	38	27	31	3	0

MONTH AUG														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	18	18	76	51	76	73	58	44	18	40	47	7	526
.50 - .99	.	15	47	80	62	47	18	22	29	25	15	.	.	360
1.00 - 1.49	.	.	.	4	36	18	4	7	4	11	7	7	.	98
1.50 - 1.99	7	.	.	.	4	.	4	.	15
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	33	65	160	149	148	95	87	77	58	62	58	7	0

MONTH SEP														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	8	8	28	40	20	24	36	32	32	16	12	256
.50 - .99	.	4	36	49	77	65	16	61	40	16	77	40	4	485
1.00 - 1.49	.	.	.	61	77	28	4	12	4	12	24	8	8	238
1.50 - 1.99	.	.	.	4	8	4	.	.	.	.	.	.	.	16
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	4	44	122	190	137	40	97	80	60	133	64	24	0

(Continued)

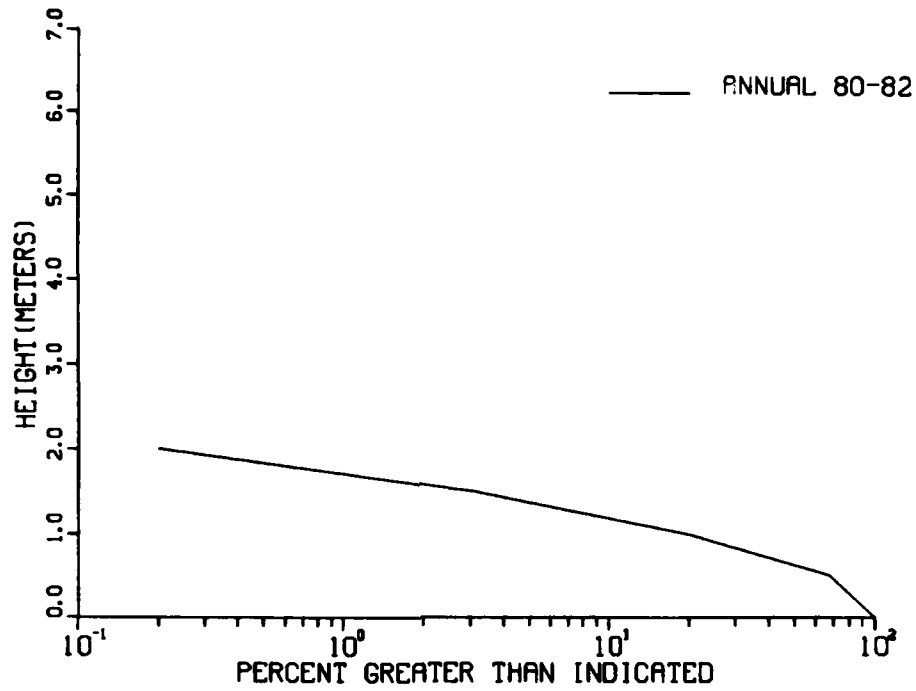
(Sheet 3 of 4)

Table B24 (Concluded)

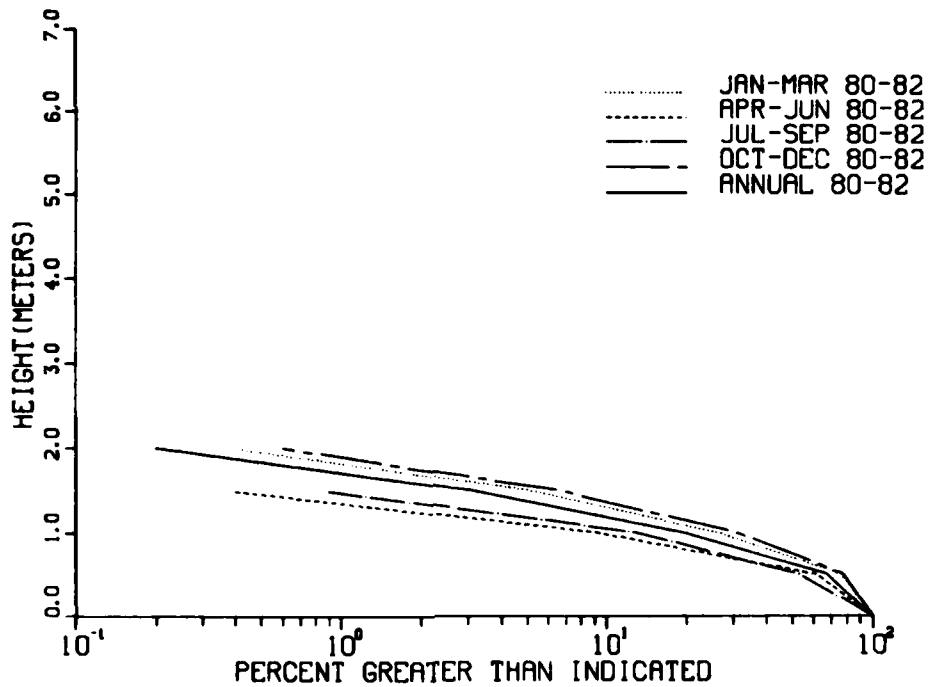
HEIGHT(METERS)	MONTH OCT													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	.	3	15	12	18	18	24	18	15	51	27	3	207
.50 - .99	.	9	18	54	73	21	27	36	73	30	54	21	6	422
1.00 - 1.49	.	.	.	48	76	54	9	18	3	30	18	9	.	265
1.50 - 1.99	.	.	.	3	18	6	.	3	3	12	15	15	12	87
2.00 - 2.49	3	.	.	.	.	6	6	.	15
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	3	9	21	120	179	102	54	81	97	87	144	78	21	

HEIGHT(METERS)	MONTH NOV													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	6	.	16	9	19	13	9	25	13	22	38	25	.	195
.50 - .99	3	6	50	100	103	85	41	31	16	22	9	28	3	497
1.00 - 1.49	.	.	.	19	56	34	6	3	6	13	41	47	9	234
1.50 - 1.99	.	.	.	.	3	6	.	3	6	13	25	13	.	69
2.00 - 2.49	.	.	.	.	.	.	.	.	3	.	.	.	.	3
2.50 - 2.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.00 - 3.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3.50 - 3.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.00 - 4.49	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4.50 - 4.99	.	.	.	.	.	.	.	.	.	.	.	.	.	0
5.00 - GREATER	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	9	6	66	128	181	138	56	62	44	70	113	113	12	

HEIGHT(METERS)	MONTH DEC													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	10	27	27	20	10	20	20	20	10	58	20	242
.50 - .99	.	24	58	78	153	41	24	31	24	17	41	3	7	501
1.00 - 1.49	.	.	10	44	85	27	.	20	10	7	24	3	.	230
1.50 - 1.99	3	.	7	14	.	.	24
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	24	78	149	265	88	34	74	54	51	89	64	27	

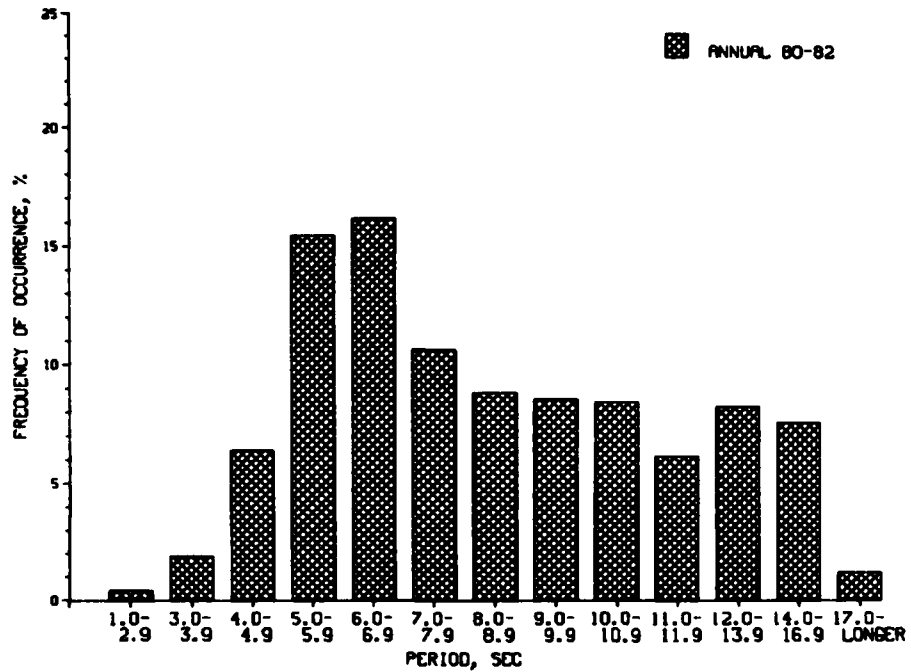


a. Annual

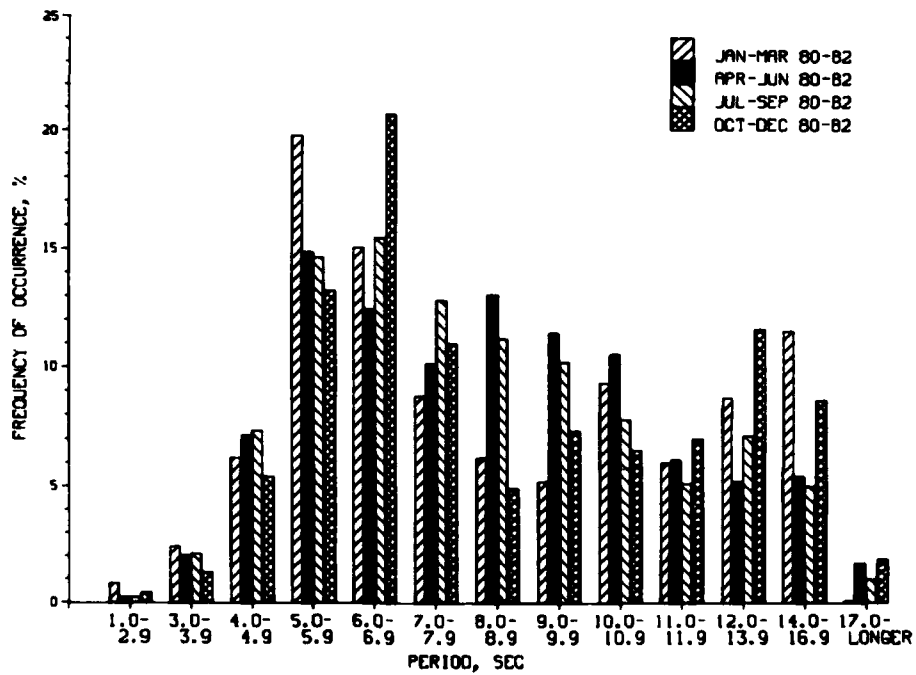


b. Seasonal

Figure B28. 1980 through 1982 annual and seasonal cumulative distribution of wave height for gage 615



a. Annual

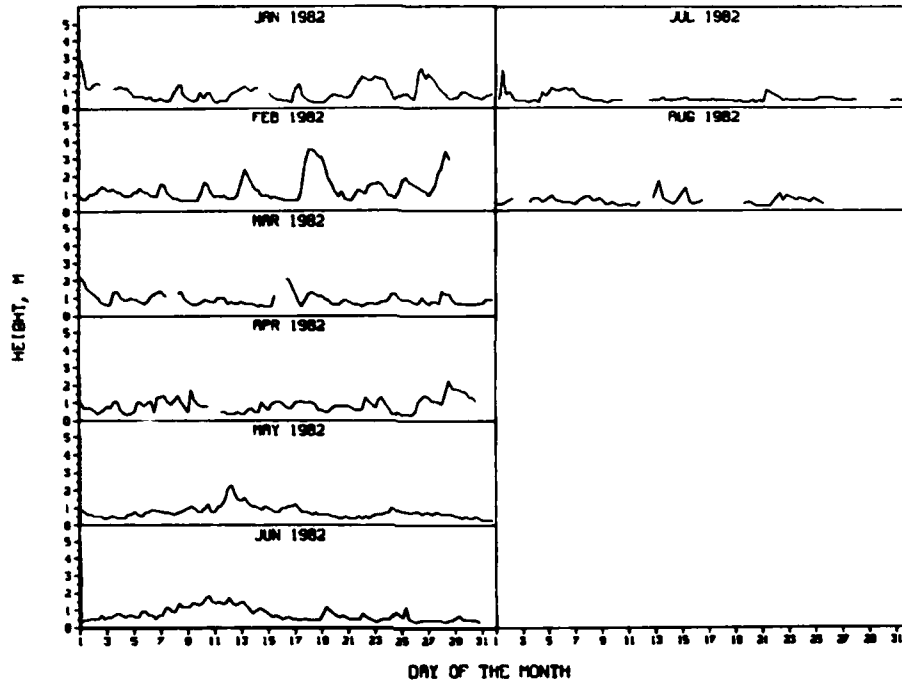


b. Seasonal

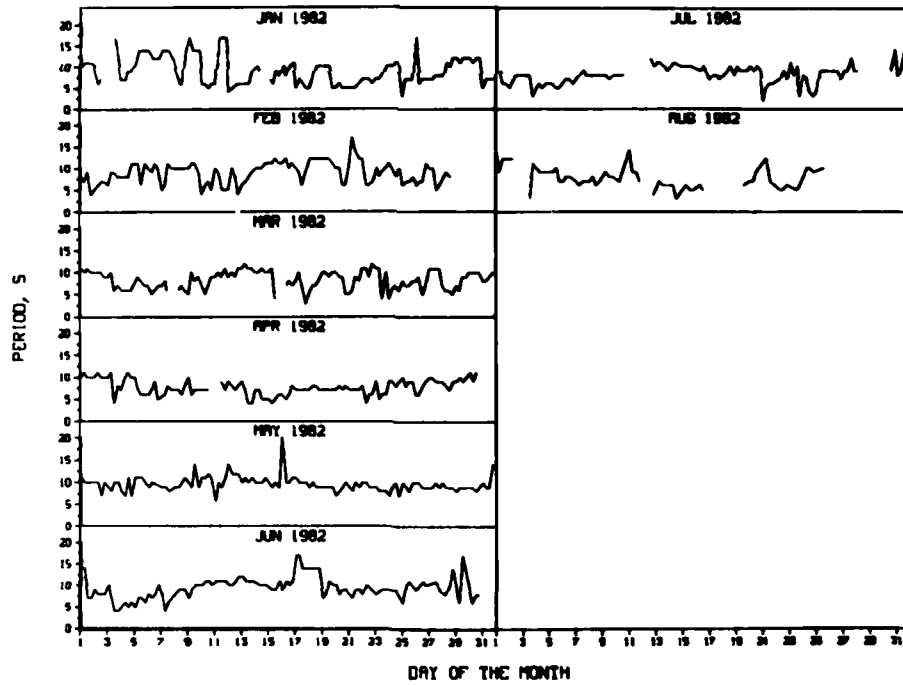
Figure B29. 1980 through 1982 annual and seasonal distribution of peak spectral wave period for gage 615

Table B25
1980 Through 1982 Persistence of Wave Heights for Gage 615

Height, m	Consecutive Day(s) or Longer																									
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>	<u>17</u>	<u>18</u>	<u>19</u>	<u>20</u>	<u>21</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	
0.5	42	35	28	23	18	14	12		9				6													
1.0	43	25	16	9	6		2																			
1.5	12	5		3	1																					
2.0	2																									
2.5																										
3.0																										
3.5																										
4.0																										



a. Wave heights

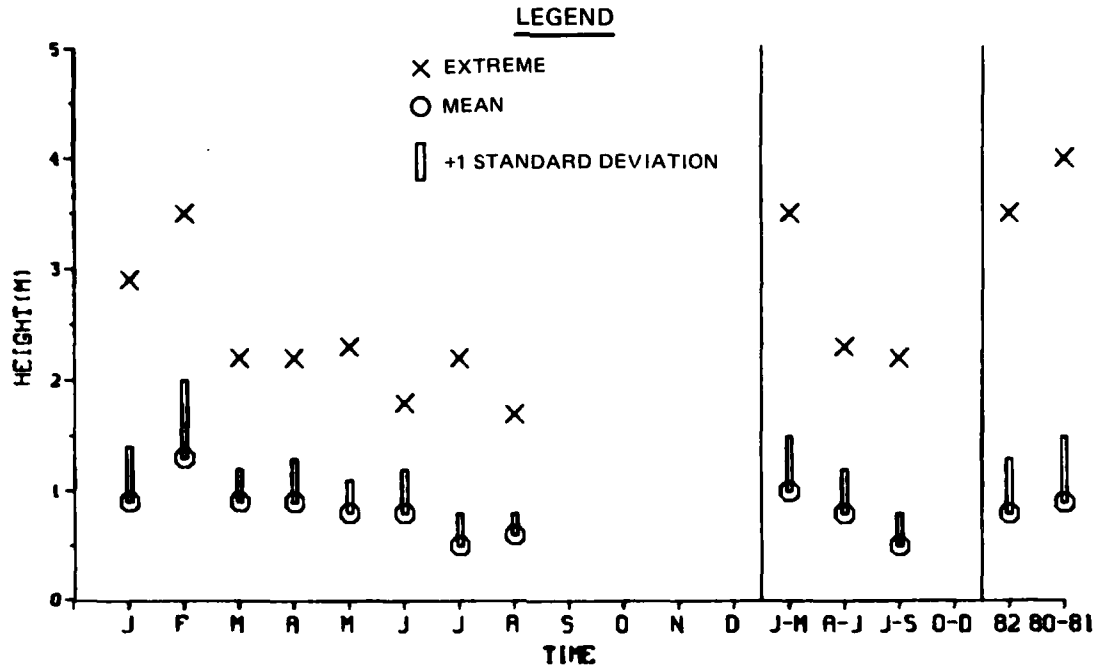


b. Wave periods

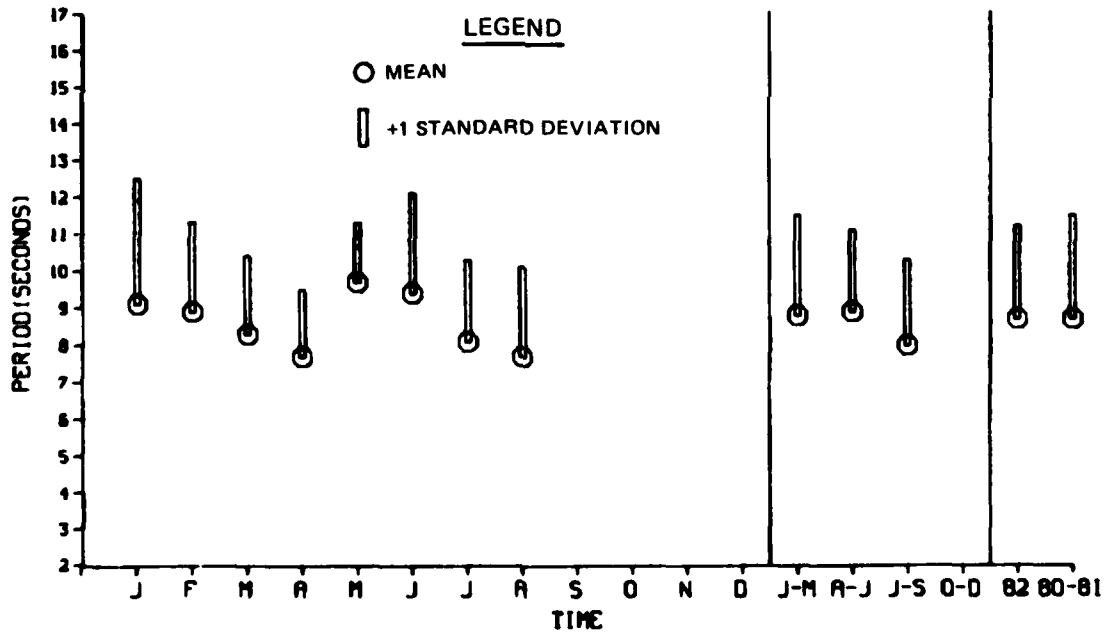
Figure B30. Time-history for gage 610

Table B26
1982 Wave Statistics for Gage 610

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	0.9	0.5	9.1	3.4	2.9	1	114
Feb	1.3	0.7	8.9	2.4	3.5	18	111
Mar	0.9	0.3	8.3	2.1	2.2	1	116
Apr	0.9	0.4	7.7	1.8	2.2	28	111
May	0.8	0.3	9.7	1.6	2.3	12	120
Jun	0.8	0.4	9.4	2.7	1.8	10	104
Jul	0.5	0.3	8.1	2.2	2.2	1	94
Aug	0.6	0.2	7.7	2.4	1.7	13	58
Jan-Mar	1.0	0.5	8.8	2.7	3.5	Feb	341
Apr-Jun	0.8	0.4	8.9	2.2	2.3	May	335
Jul-Sep	0.5	0.3	8.0	2.3	2.2	Jul	152
Annual	0.8	0.5	8.7	2.5	3.5	Feb	828



a. Wave heights



b. Wave periods

Figure B31. 1982 extreme, mean, and standard deviation of wave heights and periods for gage 610

Table B27
1982 Annual and Seasonal Joint Distribution of Wave
Height Versus Peak Period for Gage 610

HEIGHT(METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	1	2	2	4	6	14	36	43	29	11	5	17	5	175
.50 - .99	.	6	12	36	40	70	59	98	99	57	22	14	6	519
1.00 - 1.49	.	.	7	18	45	33	13	22	40	28	5	1	2	214
1.50 - 1.99	.	.	.	2	10	16	5	6	8	8	5	.	.	60
2.00 - 2.49	4	7	2	.	.	2	2	1	.	18
2.50 - 2.99	1	1	1	.	.	.	.	3
3.00 - 3.49	1	.	.	4	.	.	5
3.50 - 3.99	2	.	.	.	2
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	1	8	21	60	105	140	116	171	177	106	45	33	13	

HEIGHT(METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	3	3	3	.	3	.	12	3	.	6	9	42
.50 - .99	.	6	9	53	32	44	44	67	111	91	44	29	9	539
1.00 - 1.49	.	.	9	21	70	47	18	21	41	26	6	.	3	262
1.50 - 1.99	.	.	.	6	21	35	12	6	9	6	3	.	.	98
2.00 - 2.49	6	15	6	.	.	6	3	.	.	36
2.50 - 2.99	3	3	3	.	.	.	.	9
3.00 - 3.49	3	.	.	9	.	.	12
3.50 - 3.99	6	.	.	6
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	6	21	83	132	141	86	100	176	132	71	35	21	

HEIGHT(METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	3	12	30	51	30	12	.	24	3	165
.50 - .99	.	.	15	18	33	96	75	137	113	45	.	6	6	544
1.00 - 1.49	.	.	9	12	30	27	15	33	57	42	6	3	3	237
1.50 - 1.99	3	.	.	9	12	15	9	.	.	48
2.00 - 2.49	3	.	.	.	.	3	3	.	9
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	24	30	69	138	120	230	212	114	18	36	12	

(Continued)

Table B27 (Concluded)

HEIGHT(METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	7	13	7	13	20	53	125	125	66	26	26	26	.	507
.50 - .99	.	20	13	39	72	72	59	79	39	7	20	.	.	420
1.00 - 1.49	.	.	.	26	20	13	.	.	.	.	.	.	.	59
1.50 - 1.99	7	.	.	.	.	.	.	.	7
2.00 - 2.49	7	.	.	.	.	.	.	.	.	7
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	7	33	20	78	119	145	184	204	105	33	46	26	0	

Table B28
1982 Monthly Joint Distribution of Wave Height
Versus Peak Period for Gage 610

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	9	9	9	.	9	.	35	9	.	18	26	124
.50 - .99	.	9	.	88	53	61	18	9	44	44	96	79	18	519
1.00 - 1.49	.	.	.	18	44	35	9	35	26	26	.	.	9	202
1.50 - 1.99	26	61	18	.	9	.	.	.	.	114
2.00 - 2.49	9	18	.	.	.	9	.	.	.	36
2.50 - 2.99	9	.	.	.	.	9
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	9	115	141	175	54	44	123	88	96	97	53	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	0
.50 - .99	.	.	9	27	9	9	45	45	135	108	18	9	9	423
1.00 - 1.49	.	.	18	18	72	36	18	18	63	45	18	.	.	306
1.50 - 1.99	.	.	.	18	36	36	18	18	9	9	9	.	.	153
2.00 - 2.49	9	18	9	.	.	.	9	.	.	45
2.50 - 2.99	9	9	.	.	.	.	.	18
3.00 - 3.49	9	.	.	27	.	.	36
3.50 - 3.99	18	.	.	18
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	27	63	126	99	99	99	207	162	99	9	9	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	0
.50 - .99	.	9	17	43	34	60	69	147	155	121	17	.	.	672
1.00 - 1.49	.	.	9	26	95	69	26	9	34	9	.	.	.	277
1.50 - 1.99	9	.	.	9	9	.	.	.	27
2.00 - 2.49	9	9	.	.	9	.	.	.	27
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	26	69	129	147	104	156	198	148	17	0	0	

(Continued)

(Sheet 1 of 3)

Table B28 (Continued)

HEIGHT(METERS)	MONTH APR												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	18	27	45	27	18	.	.	.	135
.50 - .99	.	.	27	27	45	171	63	54	72	18	.	.	.	477
1.00 - 1.49	.	.	18	36	81	72	36	36	27	18	.	.	.	324
1.50 - 1.99	9	.	.	27	18	.	.	.	.	54
2.00 - 2.49	9	.	.	.	.	.	.	.	9
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	45	63	135	270	126	162	144	54	0	0	0	0

HEIGHT(METERS)	MONTH MAY												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	8	25	83	42	.	.	8	.	166
.50 - .99	8	42	67	242	192	67	.	.	.	618
1.00 - 1.49	25	75	42	8	8	8	166
1.50 - 1.99	17	17	.	.	34
2.00 - 2.49	8	8	.	16
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	0	0	8	50	92	350	309	126	33	24	8	0

HEIGHT(METERS)	MONTH JUN												TOTAL	
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	10	10	38	19	19	19	.	67	10	192
.50 - .99	.	.	19	29	48	77	96	106	67	48	.	19	19	528
1.00 - 1.49	.	.	10	.	10	10	10	38	67	67	10	.	.	222
1.50 - 1.99	19	29	10	.	.	58
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	29	29	68	97	144	163	172	163	20	86	29	0

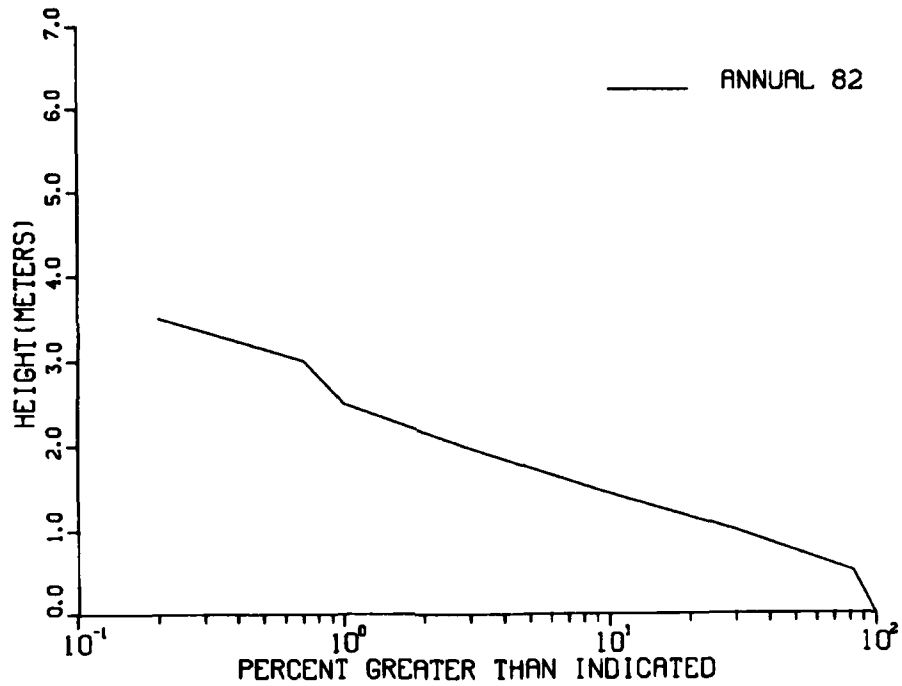
(Continued)

(Sheet 2 of 3)

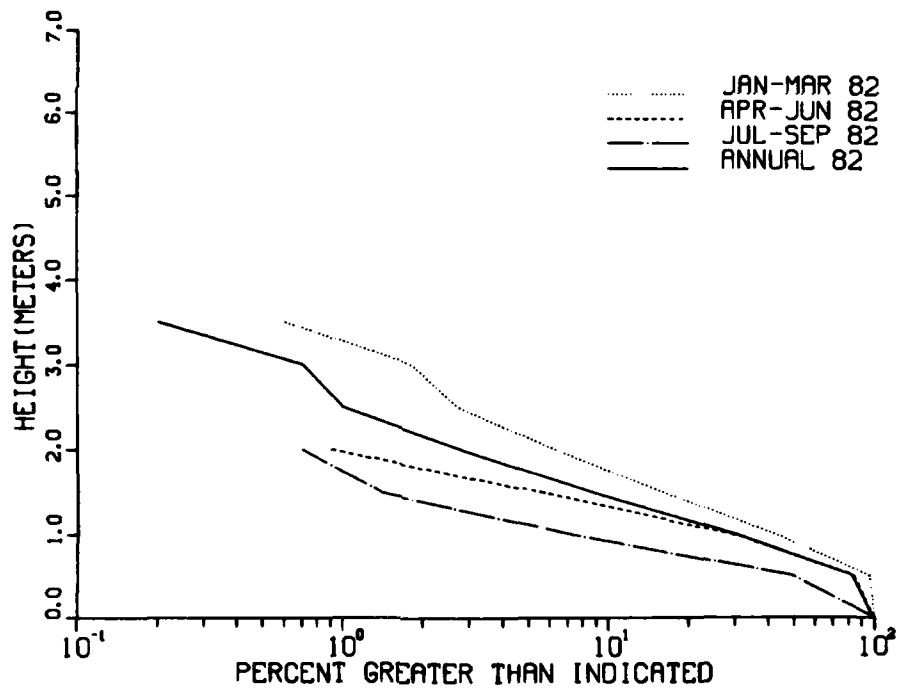
Table B28 (Concluded)

MONTH JUL														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	11	21	11	11	11	43	191	149	96	43	21	21	.	629
.50 - .99	.	11	11	21	43	32	43	85	32	.	11	.	.	289
1.00 - 1.49	.	.	.	32	21	21	.	.	.	.	.	.	.	74
1.50 - 1.99	0
2.00 - 2.49	11	.	.	.	.	.	.	.	.	11
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	11	32	22	64	86	96	234	234	128	43	32	21	0	

MONTH AUG														
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													TOTAL
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	17	34	69	17	86	17	.	34	34	.	308
.50 - .99	.	34	17	69	121	138	86	69	52	17	34	.	.	637
1.00 - 1.49	.	.	.	17	17	.	.	.	.	.	.	.	.	34
1.50 - 1.99	17	.	.	.	.	.	.	.	17
2.00 - 2.49	0
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	34	17	103	172	224	103	155	69	17	68	34	0	



a. Annual



b. Seasonal

Figure B32. 1982 annual and seasonal cumulative distribution of wave height for gage 610

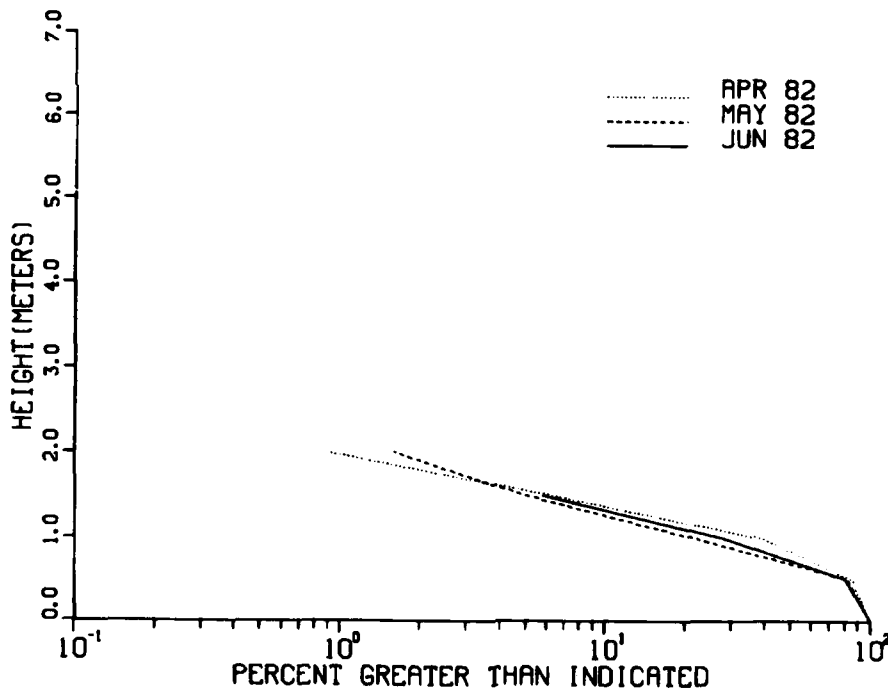
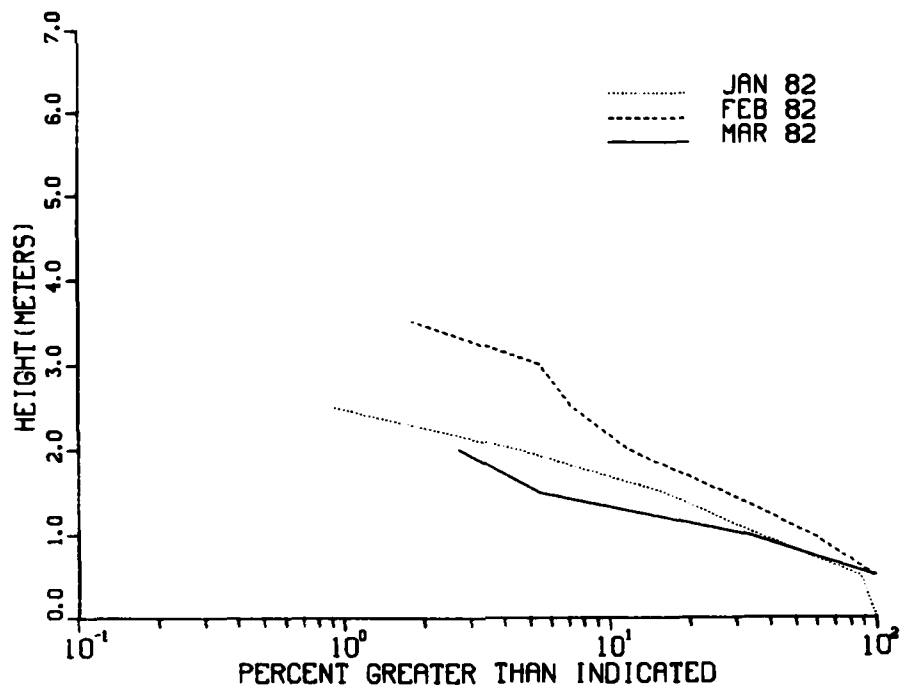


Figure B33. 1982 monthly cumulative distribution of wave height for gage 610 (Continued)

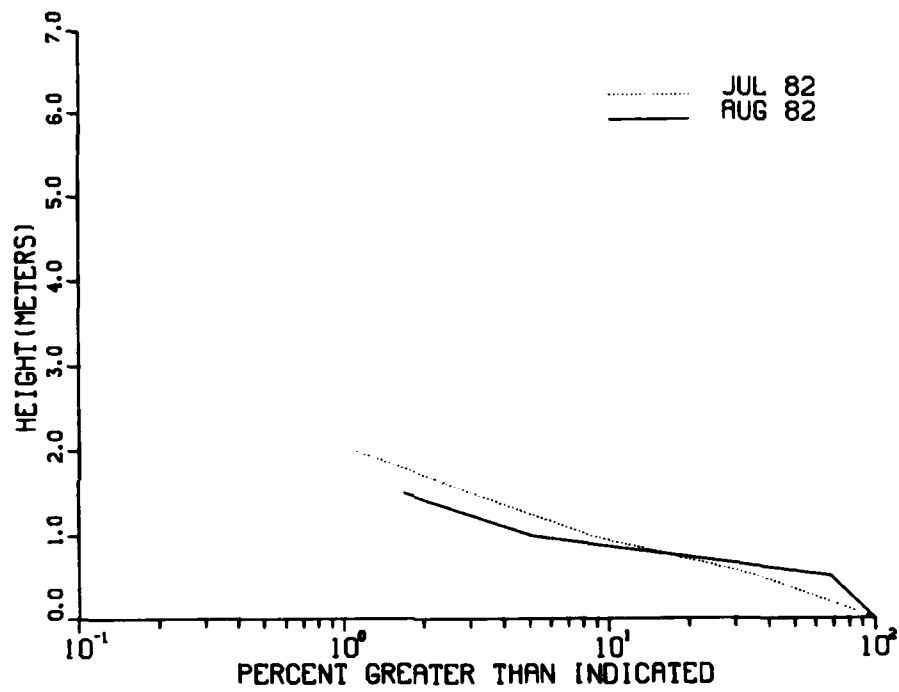
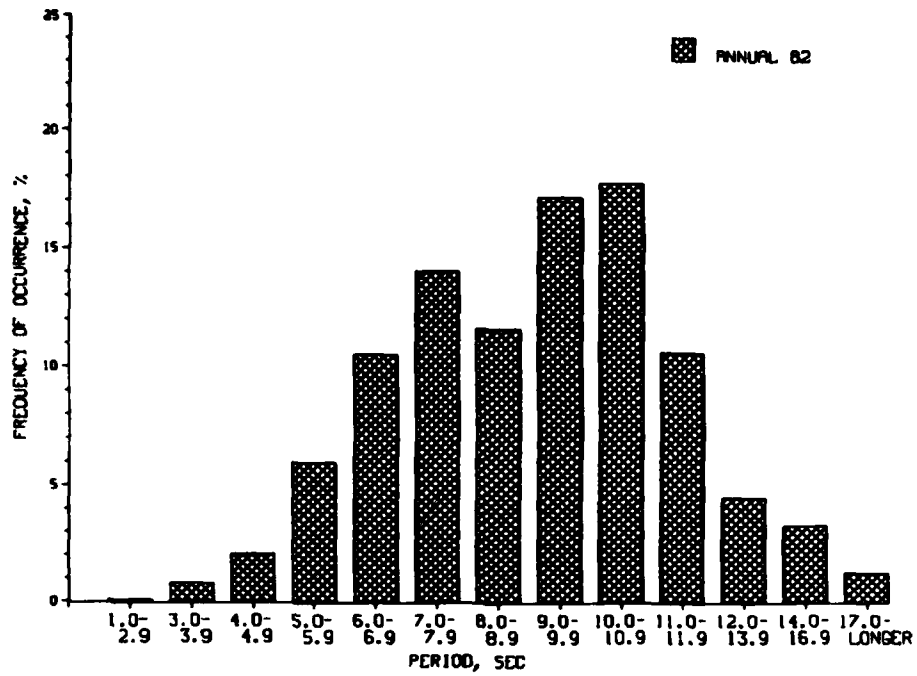
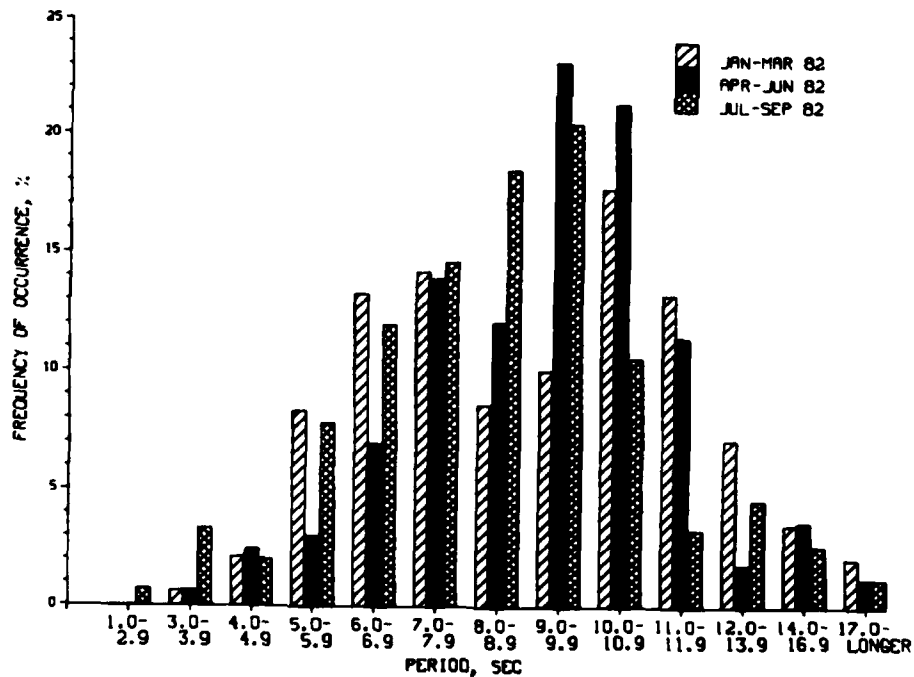


Figure B33. (Concluded)



a. Annual



b. Seasonal

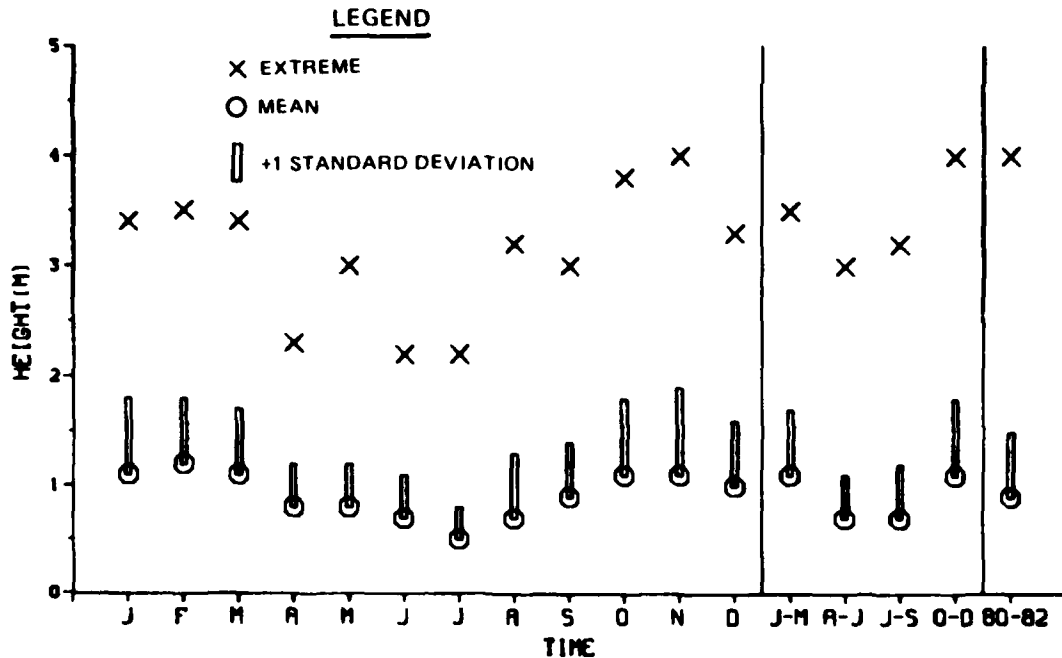
Figure B34. 1982 annual and seasonal distribution of peak spectral wave period for gage 610

Table B29
1982 Persistence of Wave Heights for Gage 610

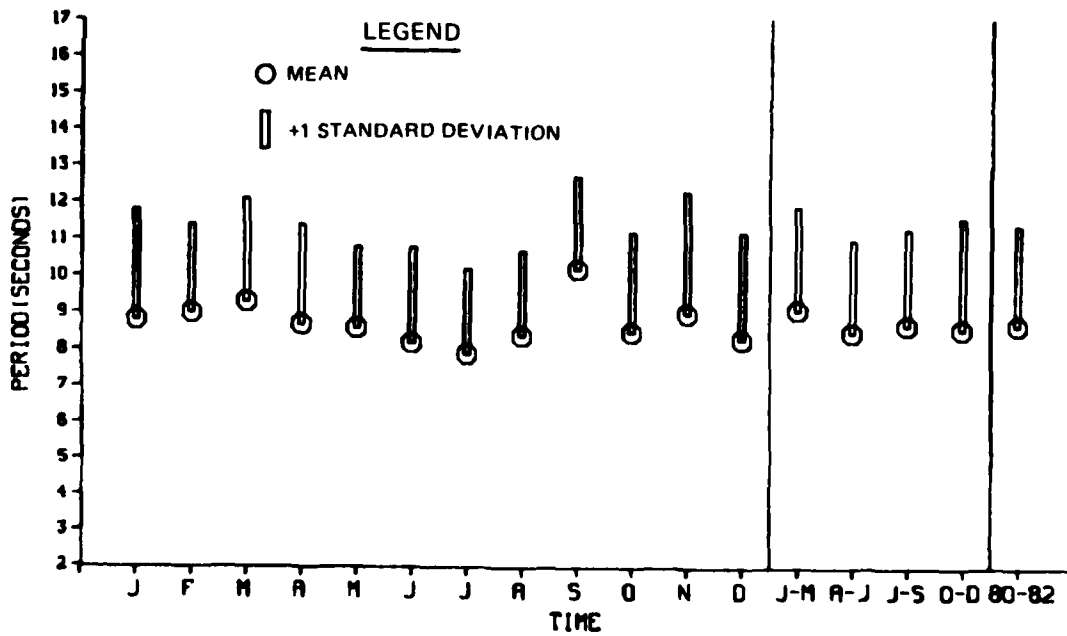
Height, m	Consecutive Day(s) or Longer																											
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	<u>15</u>	<u>16</u>	<u>17</u>	<u>18</u>	<u>19</u>	<u>20</u>	<u>21</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	<u>35</u>	<u>96</u>	
0.5	17	14	13	9	8	6	6			5							3											
1.0	34	17	12	10	8	4	3	2							1													
1.5	17	9	5	1																								
2.0	9	3	2																									
2.5	3		1																									
3.0	2	1																										
3.5	1																											
4.0																												

Table B30
1980 Through 1982 Wave Statistics for Gage 610

<u>Month</u>	<u>Mean Height, m</u>	<u>Standard Deviation Height, m</u>	<u>Mean Period sec</u>	<u>Standard Deviation Period sec</u>	<u>Extreme Height, m</u>	<u>Date</u>	<u>Number Observations</u>
Jan	1.1	0.7	8.8	3.0	3.4	1980	235
Feb	1.2	0.6	9.0	2.4	3.5	1982	181
Mar	1.1	0.6	9.3	2.8	3.4	1980	280
Apr	0.8	0.4	8.7	2.7	2.3	1980	270
May	0.8	0.4	8.6	2.2	3.0	1981	315
Jun	0.7	0.4	8.2	2.6	2.2	1981	234
Jul	0.5	0.3	7.9	2.3	2.2	1982	195
Aug	0.7	0.6	8.4	2.3	3.2	1981	173
Sep	0.9	0.5	10.2	2.5	3.0	1981	148
Oct	1.1	0.7	8.5	2.7	3.8	1980	217
Nov	1.1	0.8	9.0	3.3	4.0	1981	213
Dec	1.0	0.6	8.3	2.9	3.3	1980	207
Jan-Mar	1.1	0.6	9.1	2.8	3.5	Feb 1982	696
Apr-Jun	0.7	0.4	8.5	2.5	3.0	May 1981	819
Jul-Sep	0.7	0.5	8.7	2.6	3.2	Aug 1981	516
Oct-Dec	1.1	0.7	8.6	3.0	4.0	Nov 1981	637
Annual	0.9	0.6	8.7	2.7	4.0	Nov 1981	2,668



a. Wave heights



b. Wave periods

Figure B35. 1980 through 1982 extreme, mean, and standard deviation of wave heights and periods for Gage 610

Table B31

1980 Through 1982 Annual and Seasonal Joint Distribution
of Wave Height Versus Peak Period for Gage 610

HEIGHT (METERS)	ANNUAL PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	3	3	6	8	17	41	43	31	11	21	18	3	205
.50 - .99	1	10	23	41	45	45	60	62	67	46	25	21	2	448
1.00 - 1.49	.	.	6	20	43	28	18	15	29	18	18	6	1	202
1.50 - 1.99	.	.	1	4	15	12	6	7	9	6	10	7	.	77
2.00 - 2.49	1	8	2	2	4	6	7	5	.	35
2.50 - 2.99	2	3	2	2	3	2	2	.	16
3.00 - 3.49	1	2	.	1	4	1	.	9
3.50 - 3.99	1	1	1	1	.	4
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	1	13	33	71	112	112	131	133	143	92	88	61	6	

HEIGHT (METERS)	SEASONAL JAN-MAR PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	4	3	4	3	9	16	17	4	16	6	4	86
.50 - .99	.	10	6	40	37	37	43	47	85	50	47	26	4	432
1.00 - 1.49	.	.	10	23	56	33	13	19	39	22	37	10	1	263
1.50 - 1.99	.	.	1	4	22	23	10	10	19	9	10	13	.	121
2.00 - 2.49	.	.	.	1	3	10	4	3	7	6	7	9	.	50
2.50 - 2.99	1	3	4	4	4	3	6	.	25
3.00 - 3.49	1	3	1	.	10	1	.	16
3.50 - 3.99	3	.	.	3
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	10	21	71	122	107	83	102	172	95	133	71	9	

HEIGHT (METERS)	SEASONAL APR-JUN PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	2	4	10	13	24	51	48	33	6	18	22	1	232
.50 - .99	2	9	34	46	27	66	95	98	73	46	9	20	2	527
1.00 - 1.49	.	.	6	13	27	17	26	22	39	17	6	1	1	175
1.50 - 1.99	.	.	.	2	6	4	2	10	6	6	6	1	.	43
2.00 - 2.49	4	1	1	5	1	5	1	.	18
2.50 - 2.99	0
3.00 - 3.49	1	.	1
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	2	11	44	71	73	115	175	179	156	76	44	46	4	

(Continued)

Table B31 (Concluded)

HEIGHT (METERS)	SEASONAL JUL-SEP PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	2	10	2	10	8	31	81	103	62	23	12	27	2	373
.50 - .99	.	12	14	35	48	39	66	62	64	37	33	16	.	426
1.00 - 1.49	.	.	.	17	39	17	10	4	16	8	12	6	.	129
1.50 - 1.99	.	.	.	2	6	2	4	2	2	4	12	4	.	38
2.00 - 2.49	2	.	.	.	.	4	12	4	.	22
2.50 - 2.99	2	.	.	.	4	.	4	.	10
3.00 - 3.49	4	.	2	.	2	.	8
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	2	22	16	64	103	91	161	175	144	82	81	63	2	

HEIGHT (METERS)	SEASONAL OCT-DEC PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													TOTAL
	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	3	3	3	6	13	31	19	17	16	36	20	6	173
.50 - .99	.	11	35	39	75	30	28	31	42	47	17	20	.	375
1.00 - 1.49	.	.	8	27	52	44	20	13	16	24	17	6	.	227
1.50 - 1.99	.	.	2	8	27	20	9	3	6	6	13	13	.	107
2.00 - 2.49	17	2	5	5	13	5	6	.	53
2.50 - 2.99	2	6	9	5	3	6	6	.	.	37
3.00 - 3.49	2	2	.	5	6	.	.	15
3.50 - 3.99	3	5	.	3	.	11
4.00 - 4.49	2	.	2
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	14	48	77	162	130	101	78	92	122	100	70	6	

Table B32
1980 Through 1982 Monthly Joint Distribution of Wave
Height Versus Peak Period for Gage 610

HEIGHT (METERS)	MONTH JAN													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	9	9	9	4	21	26	38	4	9	9	13	151
.50 - .99	.	17	.	51	43	55	26	17	55	26	60	38	9	397
1.00 - 1.49	.	.	9	17	64	21	9	26	30	15	21	.	4	214
1.50 - 1.99	.	.	4	.	34	43	13	13	9	9	.	4	.	129
2.00 - 2.49	4	17	4	4	9	9	4	9	.	60
2.50 - 2.99	4	.	4	13	9	4	9	.	43
3.00 - 3.49	9	4	.	13
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	17	22	77	154	144	73	90	154	70	107	73	26	

HEIGHT (METERS)	MONTH FEB													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	6	.	.	6	.	.	.	11	28	6	.	57
.50 - .99	.	.	6	39	28	17	39	33	116	72	50	6	6	412
1.00 - 1.49	.	.	11	22	55	33	17	33	55	33	28	.	.	287
1.50 - 1.99	.	.	.	17	28	22	17	17	33	11	6	.	.	151
2.00 - 2.49	6	11	6	6	17	6	6	.	.	58
2.50 - 2.99	6	6	.	.	.	.	.	12
3.00 - 3.49	6	.	.	17	.	.	23
3.50 - 3.99	11	.	.	11
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	23	78	117	89	85	101	221	133	146	12	6	

HEIGHT (METERS)	MONTH MAR													TOTAL
	PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD													
	PERIOD (SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	4	.	4	18	11	.	14	4	.	55
.50 - .99	.	11	11	32	39	36	61	82	89	57	36	29	.	483
1.00 - 1.49	.	.	11	29	50	43	14	4	36	21	57	25	.	290
1.50 - 1.99	.	.	.	7	7	7	4	4	18	7	21	29	.	97
2.00 - 2.49	.	.	.	4	.	4	4	.	.	4	11	14	.	41
2.50 - 2.99	4	4	4	.	4	4	7	.	23
3.00 - 3.49	4	4	4	.	7	.	.	19
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	11	22	65	100	90	95	116	158	93	150	108	0	

(Continued)

(Sheet 1 of 4)

Table B32 (Continued)

MONTH APR
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD

HEIGHT(METERS)	PERIOD(SECONDS)												TOTAL	
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9		17.0- LONGER
0.00 - .49	.	4	.	4	11	22	41	30	30	7	37	26	.	212
.50 - .99	7	7	26	26	30	104	56	56	81	81	7	48	.	529
1.00 - 1.49	.	.	11	22	44	33	26	22	19	7	7	.	.	191
1.50 - 1.99	4	11	4	15	7	.	4	4	.	49
2.00 - 2.49	4	.	.	4	4	7	.	.	19
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	7	11	37	52	89	174	127	123	141	99	62	78	0	

MONTH MAY
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD

HEIGHT(METERS)	PERIOD(SECONDS)												TOTAL	
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9		17.0- LONGER
0.00 - .49	.	.	3	3	6	22	54	67	38	3	10	13	.	219
.50 - .99	.	.	35	35	22	48	73	133	92	35	16	3	.	492
1.00 - 1.49	.	.	3	16	29	13	35	22	63	16	6	3	3	209
1.50 - 1.99	.	.	.	6	13	.	3	13	3	6	6	.	.	50
2.00 - 2.49	6	3	.	6	.	6	3	.	24
2.50 - 2.99	0
3.00 - 3.49	3	.	3
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	41	60	70	89	168	235	202	60	44	25	3	

MONTH JUN
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD

HEIGHT(METERS)	PERIOD(SECONDS)												TOTAL	
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9		17.0- LONGER
0.00 - .49	.	4	9	26	26	30	60	43	30	9	9	30	4	280
.50 - .99	.	21	43	85	30	47	171	98	38	21	.	9	9	572
1.00 - 1.49	.	.	4	.	4	4	13	21	30	30	4	.	.	110
1.50 - 1.99	9	13	9	.	.	31
2.00 - 2.49	4	4	.	.	.	.	8
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	25	56	111	60	81	244	166	111	73	22	39	13	

(Continued)

(Sheet 2 of 4)

Table B32 (Continued)

MONTH JUL														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	5	26	5	10	5	41	159	144	92	21	10	36	.	554
.50 - .99	.	21	21	36	46	26	87	77	15	.	5	.	.	334
1.00 - 1.49	.	.	.	26	41	15	15	5	.	.	.	.	.	107
1.50 - 1.99	0
2.00 - 2.49	5	.	.	.	.	.	.	.	.	5
2.50 - 2.99	0
3.00 - 3.49	0
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	5	47	26	72	97	82	261	226	112	21	15	36	0	

MONTH AUG														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	.	.	17	17	40	52	110	46	23	12	17	.	334
.50 - .99	.	12	17	52	64	64	75	64	69	46	12	6	.	481
1.00 - 1.49	.	.	.	12	40	17	.	.	6	6	.	.	.	81
1.50 - 1.99	6	6	6	.	.	.	12	6	.	36
2.00 - 2.49	12	17	6	.	35
2.50 - 2.99	6	.	.	.	12	.	.	.	18
3.00 - 3.49	12	.	6	.	.	.	18
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	12	17	81	127	133	133	186	121	105	53	35	0	

MONTH SEP														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	7	14	41	41	27	14	27	7	178
.50 - .99	.	.	.	14	34	27	27	41	122	74	95	47	.	481
1.00 - 1.49	.	.	.	14	34	20	14	7	41	20	41	20	.	211
1.50 - 1.99	.	.	.	7	14	.	7	7	7	14	27	7	.	90
2.00 - 2.49	20	7	.	27
2.50 - 2.99	14	.	14
3.00 - 3.49	7	.	7
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	0	0	35	82	54	62	96	211	135	197	129	7	

(Continued)

(Sheet 3 of 4)

Table B32 (Concluded)

MONTH OCT														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	14	60	28	28	14	23	18	.	185
.50 - .99	.	9	23	51	74	14	32	32	69	51	23	23	.	401
1.00 - 1.49	.	.	9	23	51	9	28	5	14	14	23	.	.	176
1.50 - 1.99	.	.	.	5	28	18	14	5	5	14	5	.	.	94
2.00 - 2.49	46	.	14	9	14	5	.	.	88
2.50 - 2.99	5	14	14	9	5	.	9	.	.	56
3.00 - 3.49	0
3.50 - 3.99	5	.	.	.	5
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	9	32	79	158	115	148	93	130	112	88	41	0	

MONTH NOV														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	.	9	9	9	5	9	33	19	14	5	38	19	.	169
.50 - .99	.	9	47	28	66	28	28	19	23	47	14	38	.	347
1.00 - 1.49	.	.	.	23	47	56	14	5	9	23	19	19	.	215
1.50 - 1.99	.	.	5	5	23	28	14	5	.	5	23	38	.	146
2.00 - 2.49	5	.	.	9	9	19	.	42
2.50 - 2.99	5	9	.	.	5	9	.	.	28
3.00 - 3.49	9	9	.	.	18
3.50 - 3.99	9	9	.	9	.	27
4.00 - 4.49	5	.	5
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	18	61	65	141	126	103	48	55	112	121	147	0	

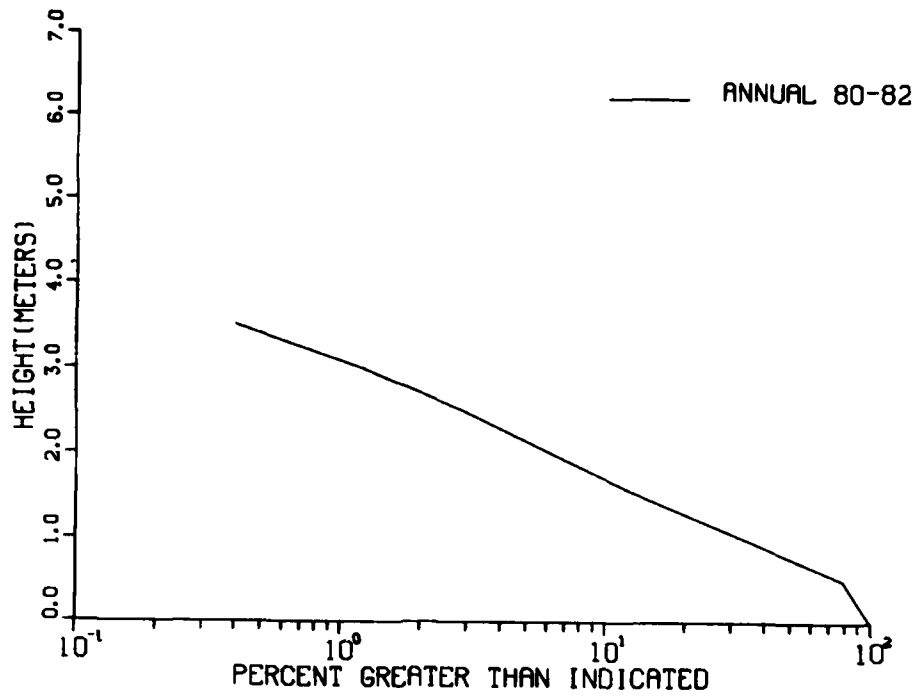
MONTH DEC														TOTAL
PERCENT OCCURRENCE(X10) OF HEIGHT AND PERIOD														
HEIGHT(METERS)	PERIOD(SECONDS)													
	1.0- 2.9	3.0- 3.9	4.0- 4.9	5.0- 5.9	6.0- 6.9	7.0- 7.9	8.0- 8.9	9.0- 9.9	10.0- 10.9	11.0- 11.9	12.0- 13.9	14.0- 16.9	17.0- LONGER	
0.00 - .49	14	14	.	10	10	29	48	24	19	168
.50 - .99	.	14	34	39	87	48	24	43	34	43	14	.	.	380
1.00 - 1.49	.	.	14	34	58	68	19	29	24	34	10	.	.	290
1.50 - 1.99	.	.	.	14	29	14	.	.	14	.	10	.	.	81
2.00 - 2.49	5	.	.	5	14	.	.	.	24
2.50 - 2.99	5	5	5	14	.	.	.	29
3.00 - 3.49	5	5	.	5	10	.	.	25
3.50 - 3.99	0
4.00 - 4.49	0
4.50 - 4.99	0
5.00 - GREATER	0
TOTAL	0	14	48	87	188	149	53	92	92	139	92	24	19	

(Sheet 4 of 4)

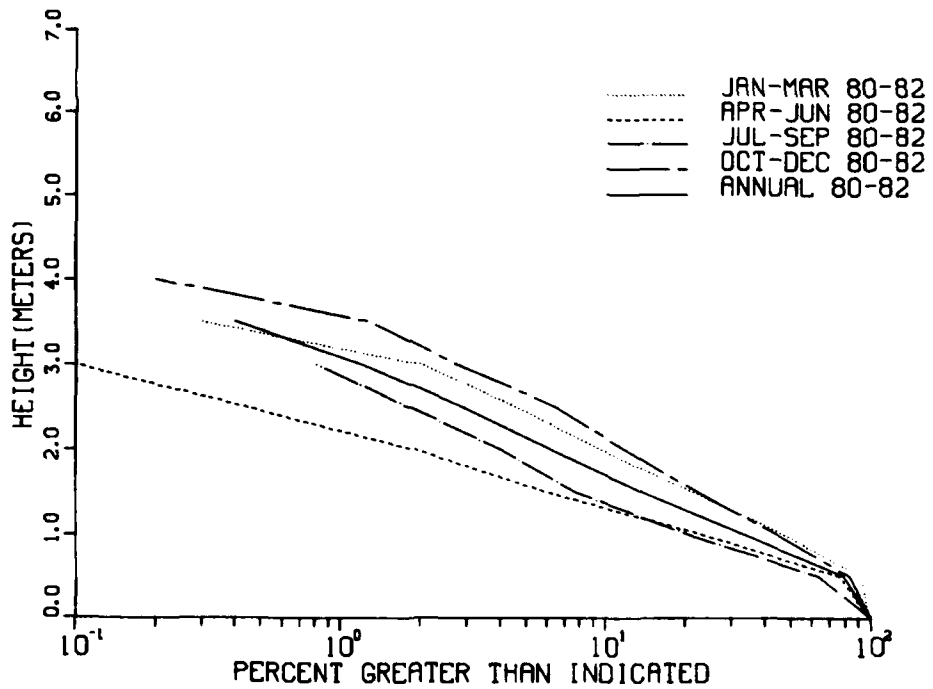
Table B33

1980 Through 1982 Persistence of Wave Heights for Gage 610

Height, m	Consecutive Day(s) or Longer																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	35	
0.5	29	25	22	18	12	10	9	8	7	6	5	4	3	2	1												3
1.0	38	24	15	14	9	8	4																				
1.5	23	10	8	5	3	1																					
2.0	14	7	4	3	2																						
2.5	7	5	2	1																							
3.0	4	2	1																								
3.5	1																										
4.0																											

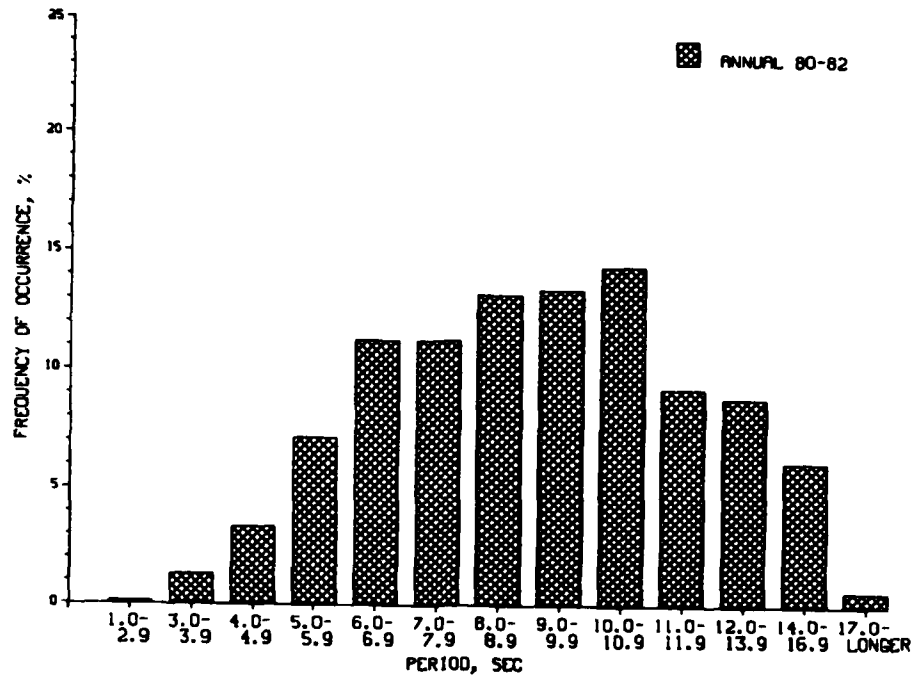


a. Annual

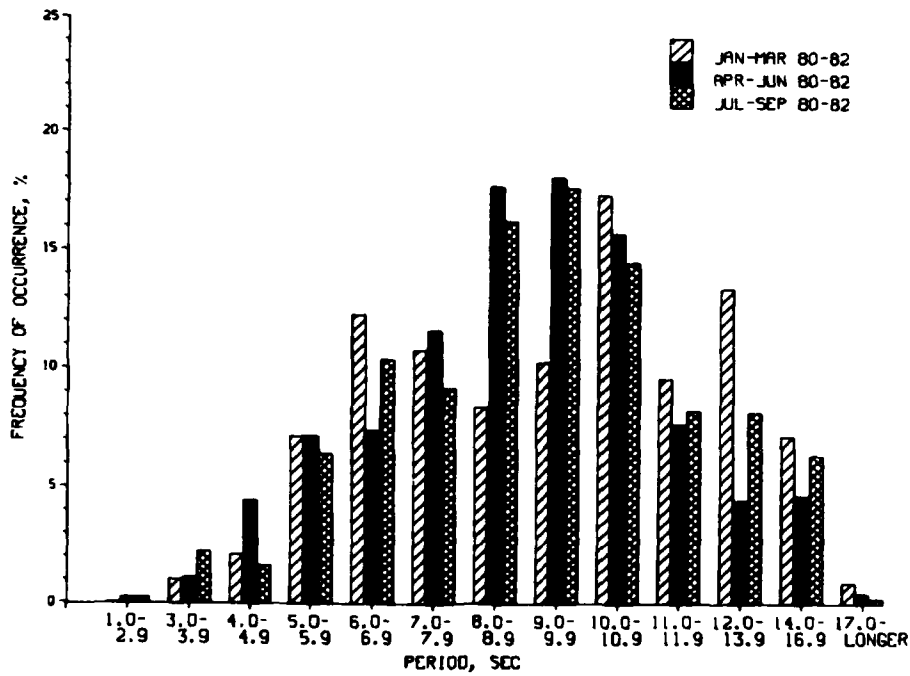


b. Seasonal

Figure B36. 1980 through 1982 annual and seasonal cumulative distribution of wave height for gage 610



a. Annual



b. Seasonal

Figure B37. 1980 through 1982 annual and seasonal distribution of peak spectral wave period for gage 610

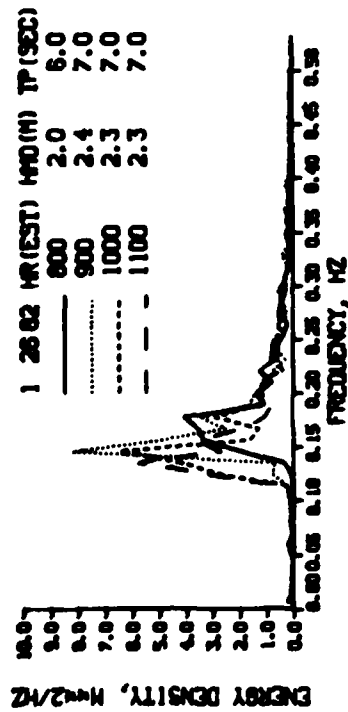
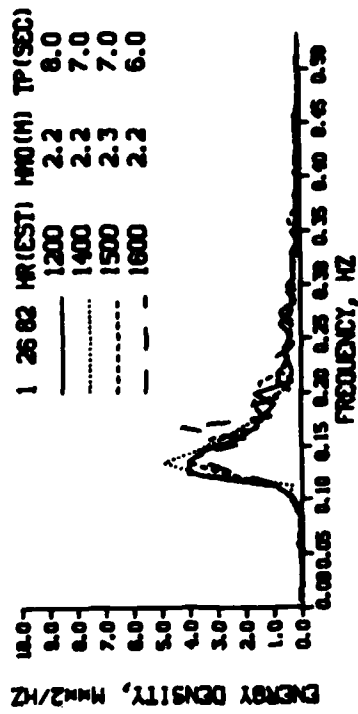
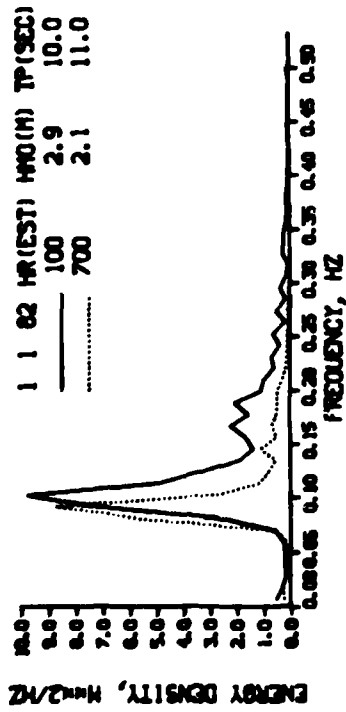


Figure B38. Spectra for 1982 storms, gage 625 (Sheet 1 of 21)

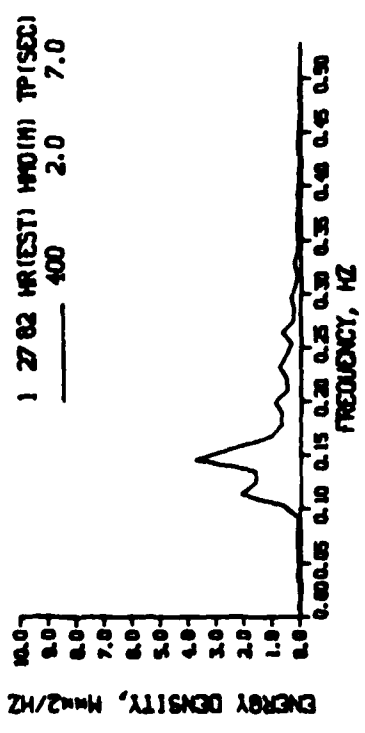
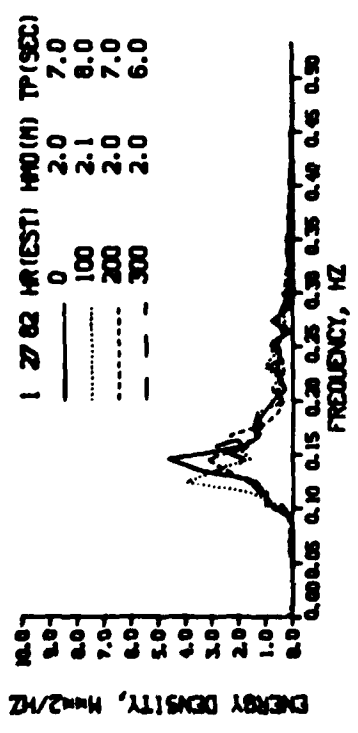
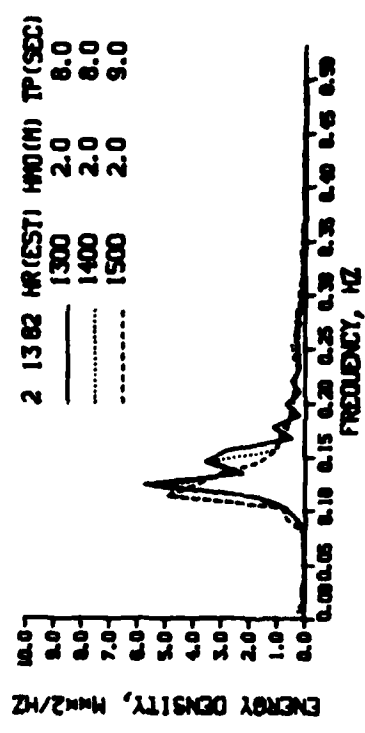
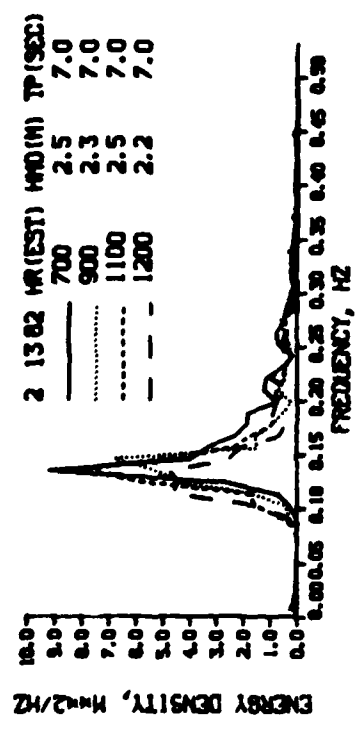


Figure B38. (Sheet 2 of 21)

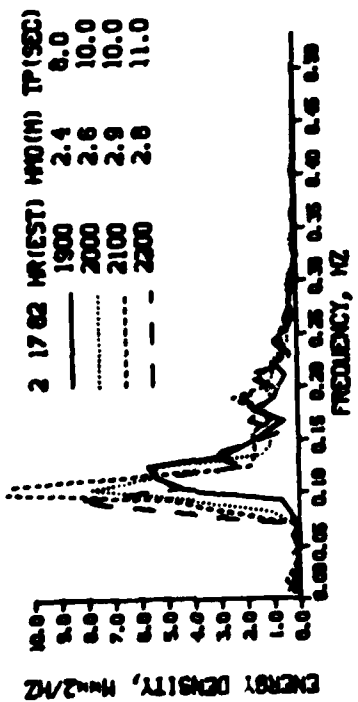
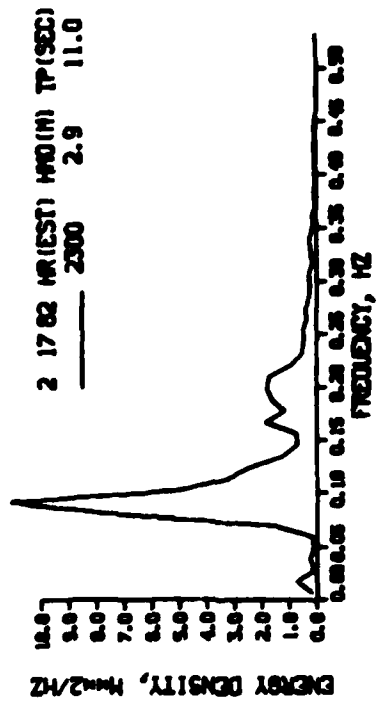


Figure B38. (Sheet 3 of 21)

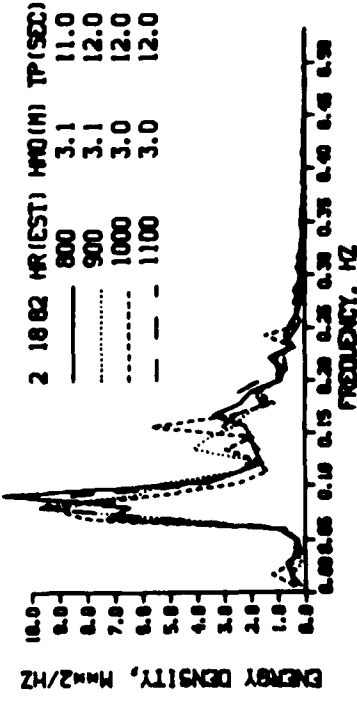
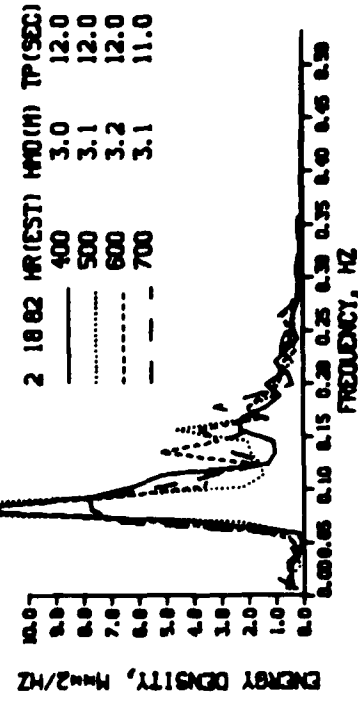
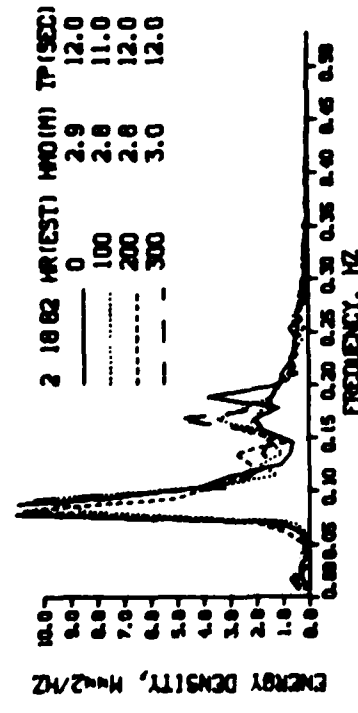
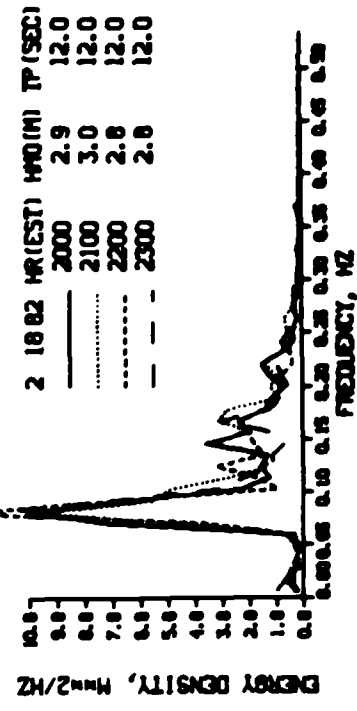
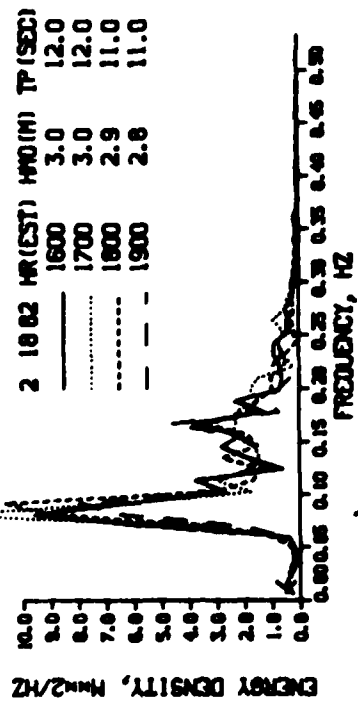
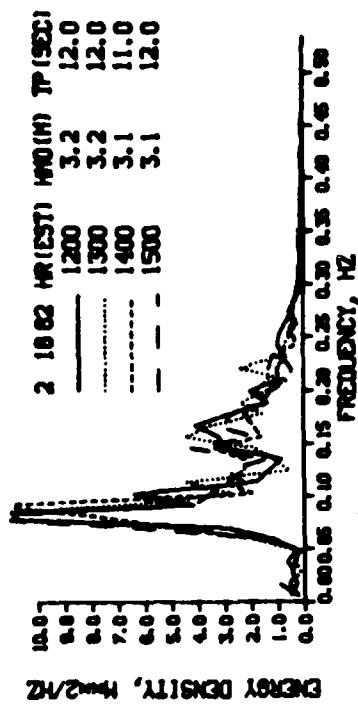


Figure B38. (Sheet 4 of 21)

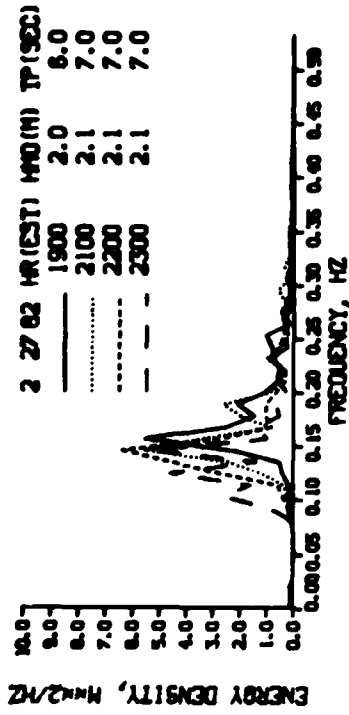
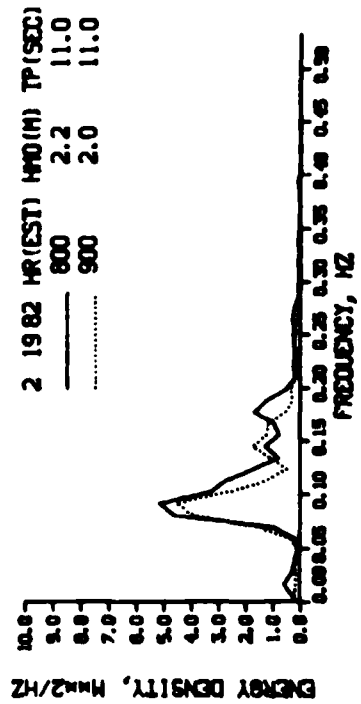
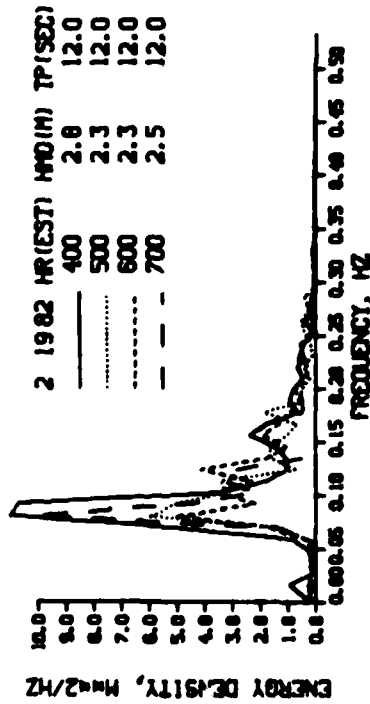
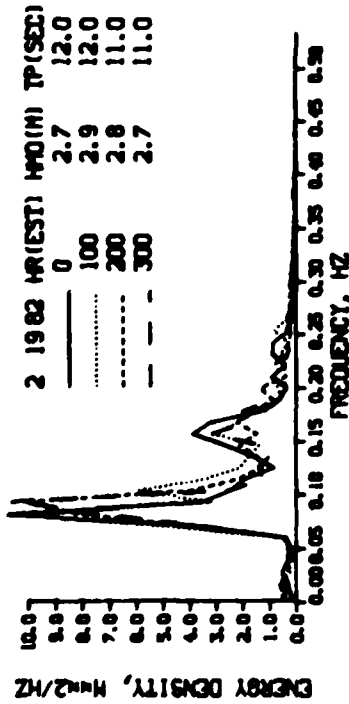


Figure B38. (Sheet 5 of 21)

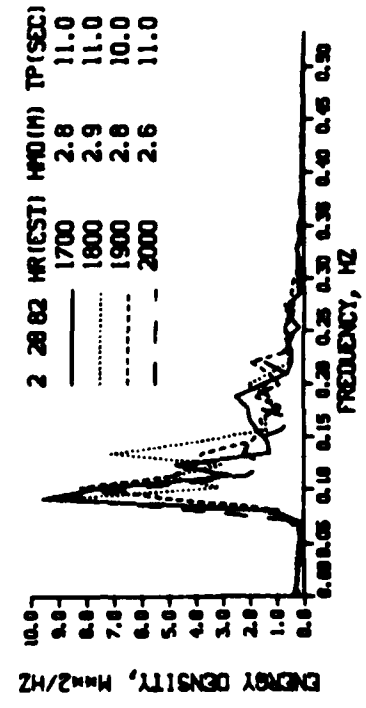
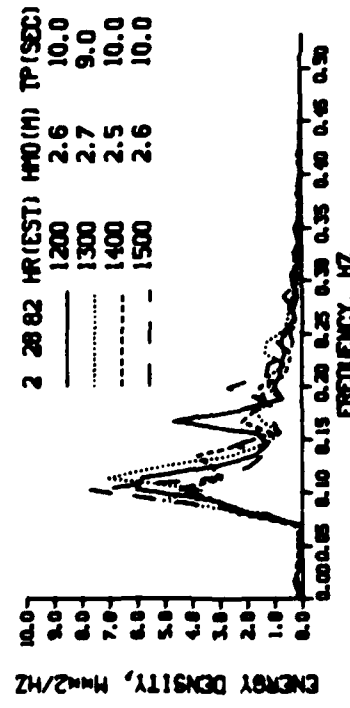
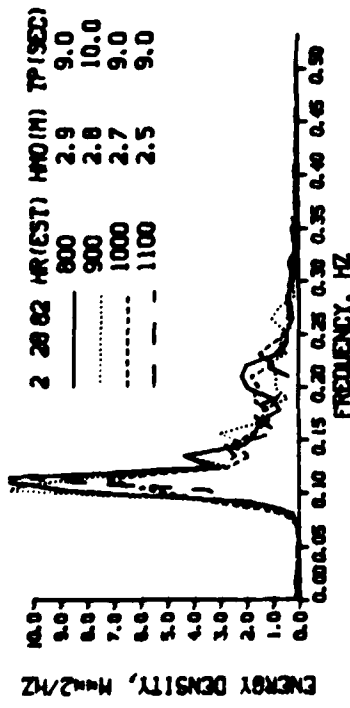
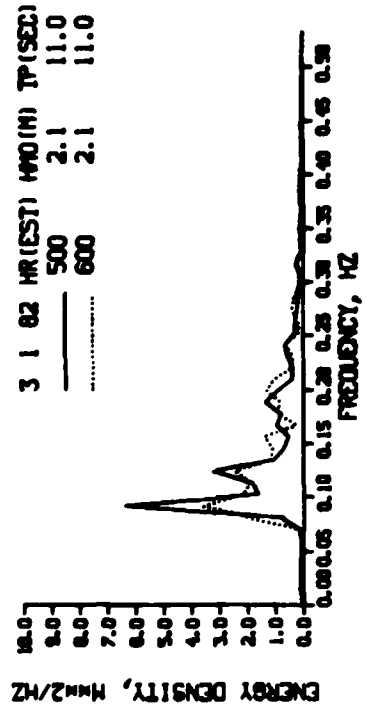
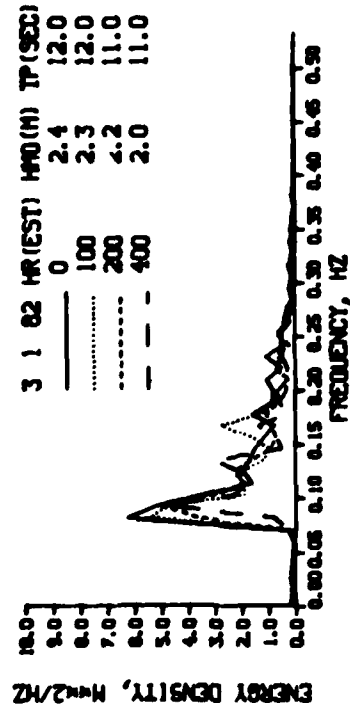
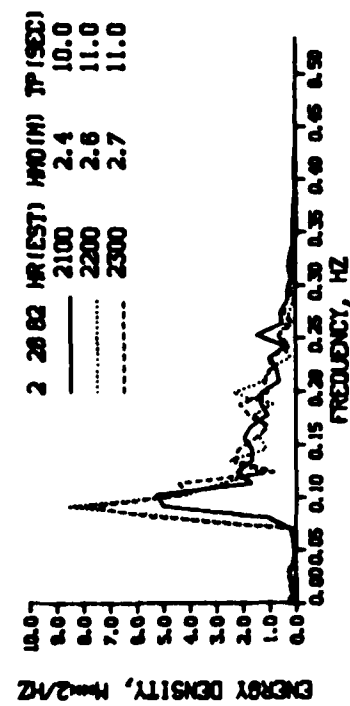


Figure B38. (Sheet 6 of 21)

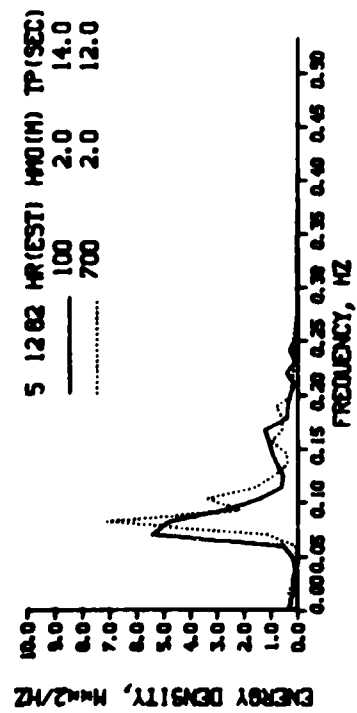
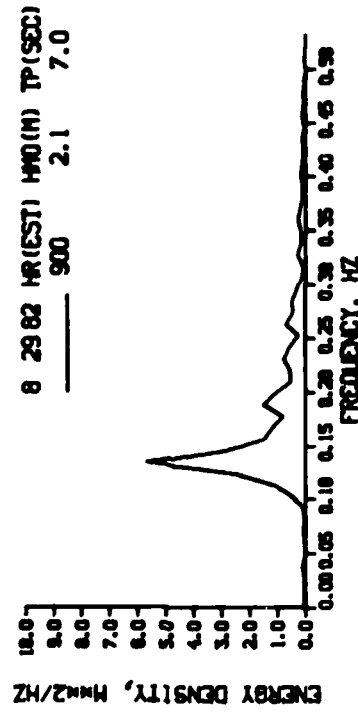
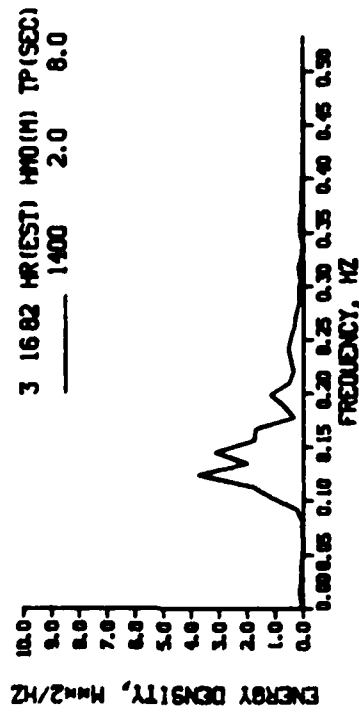
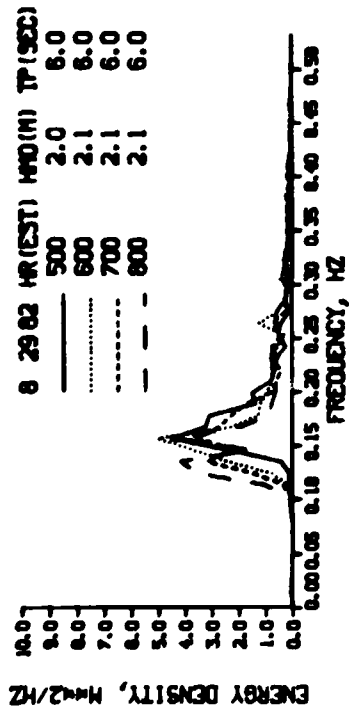
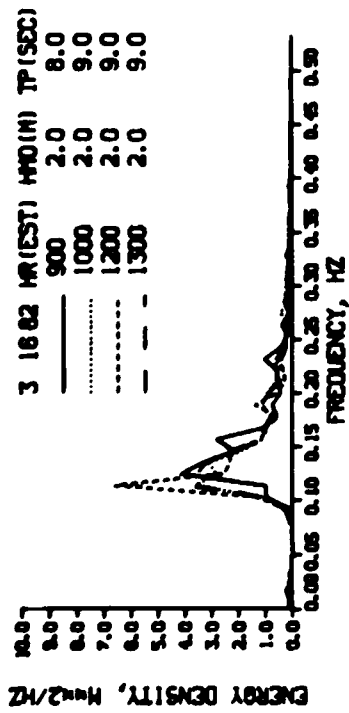


Figure B38. (Sheet 7 of 21)

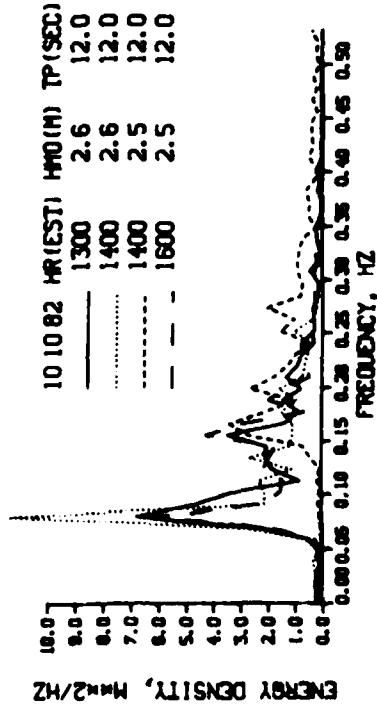
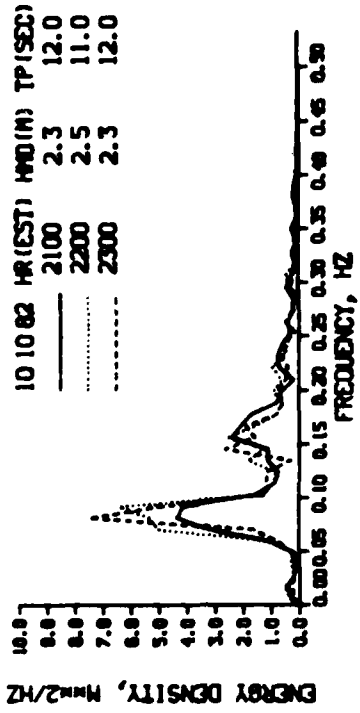
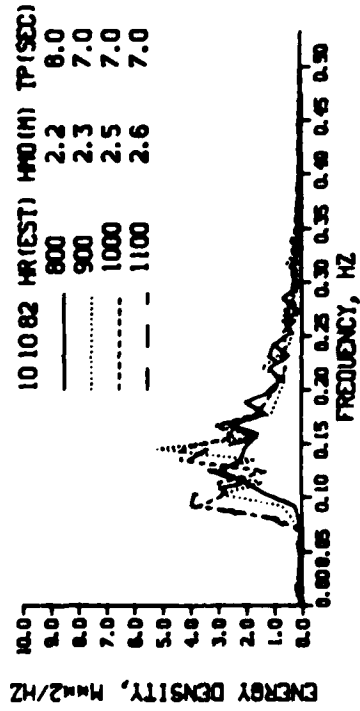
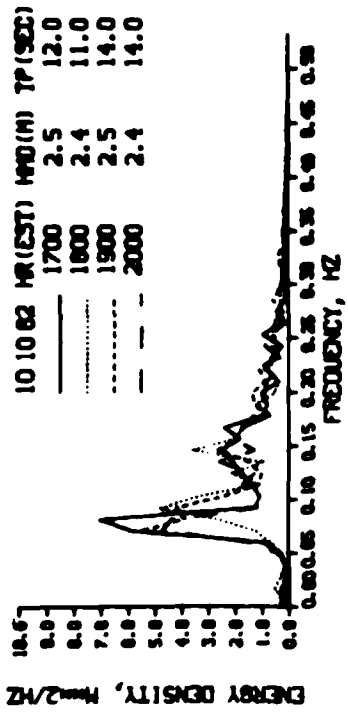
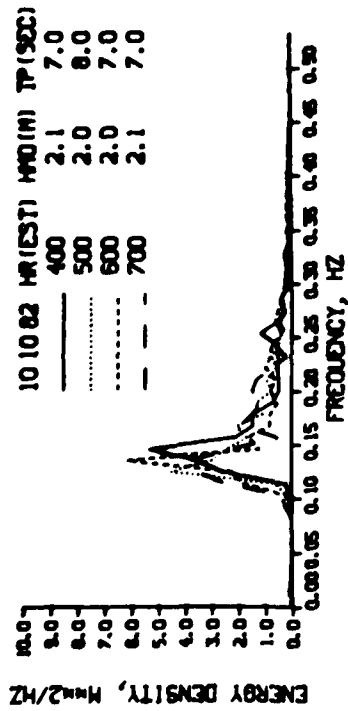


Figure B38. (Sheet 8 of 21)

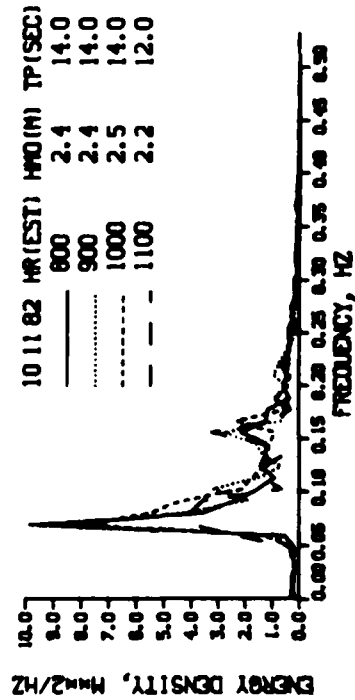
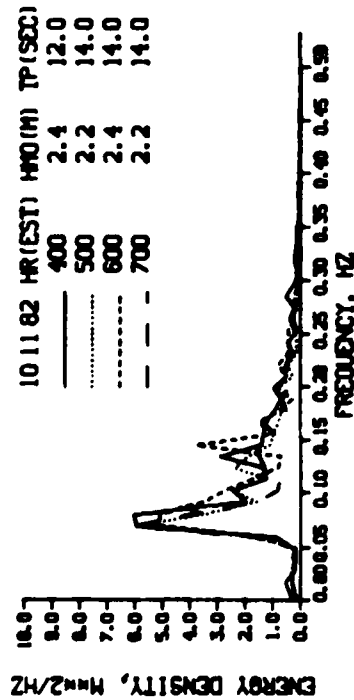
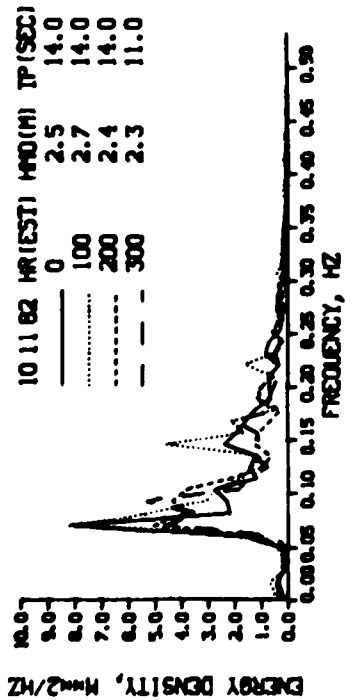
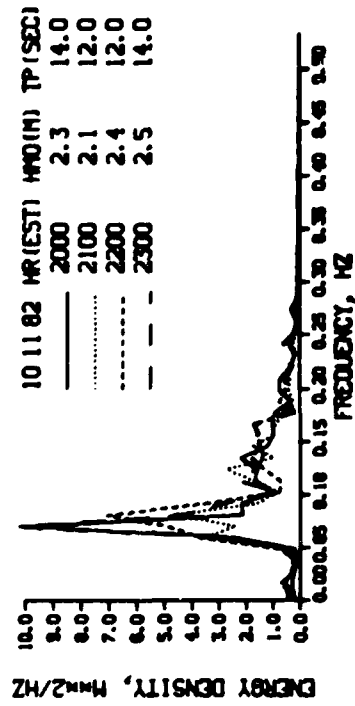
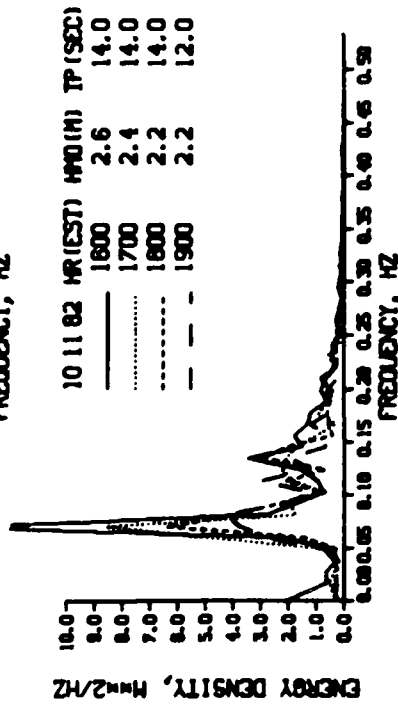
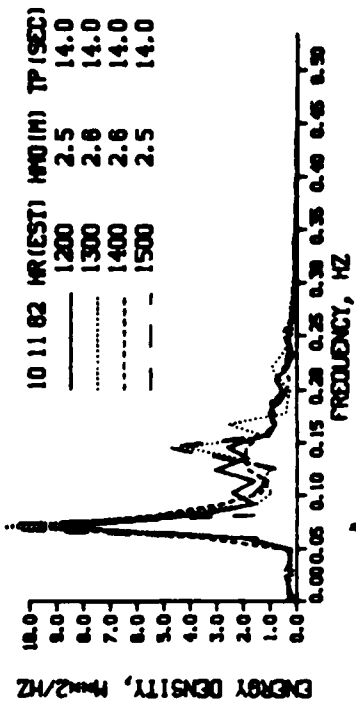


Figure B38. (Sheet 9 of 21)

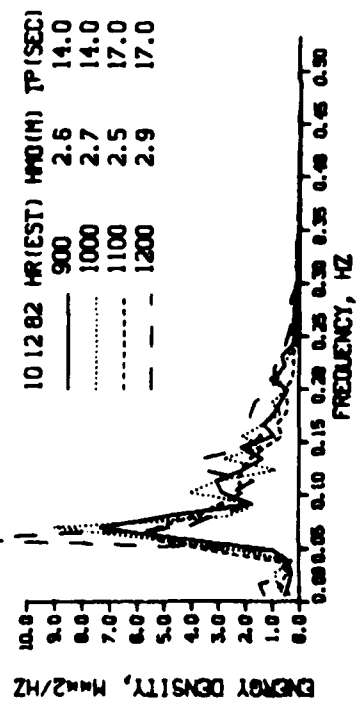
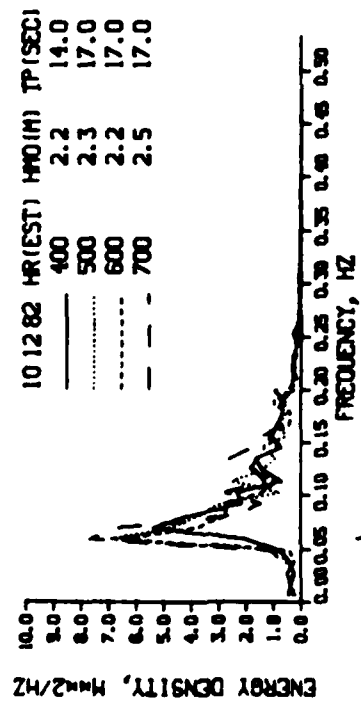
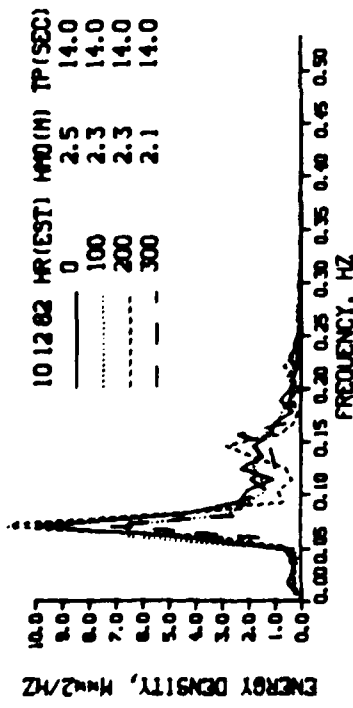
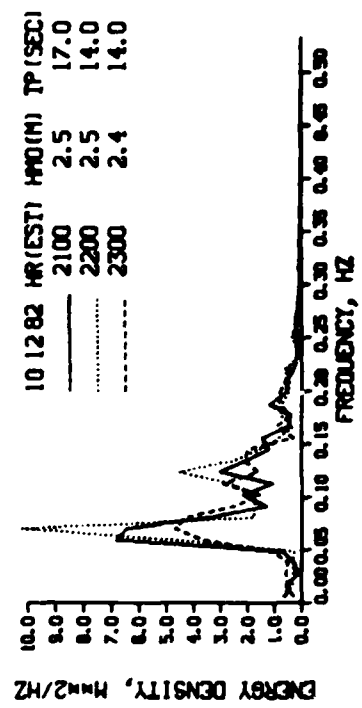
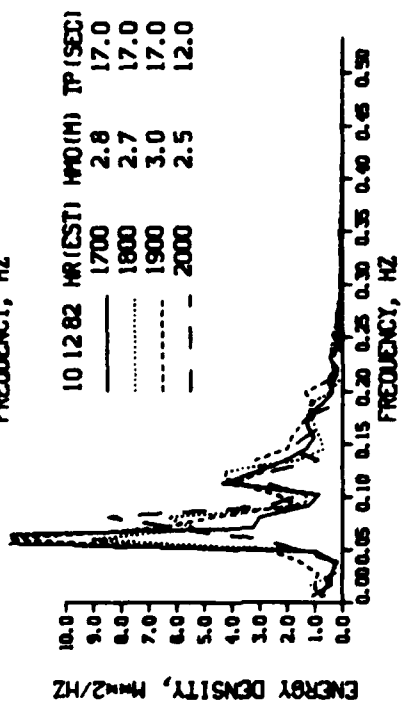
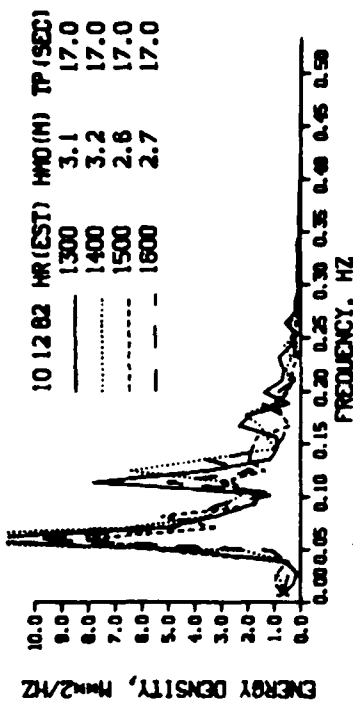


Figure B38. (Sheet 10 of 21)

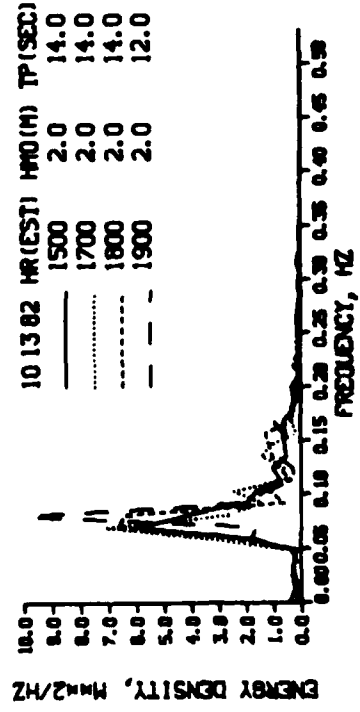
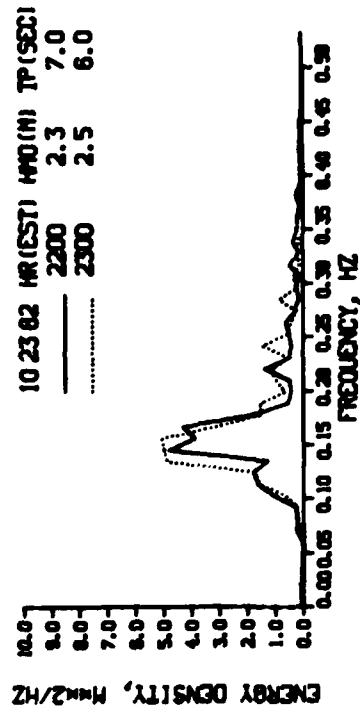
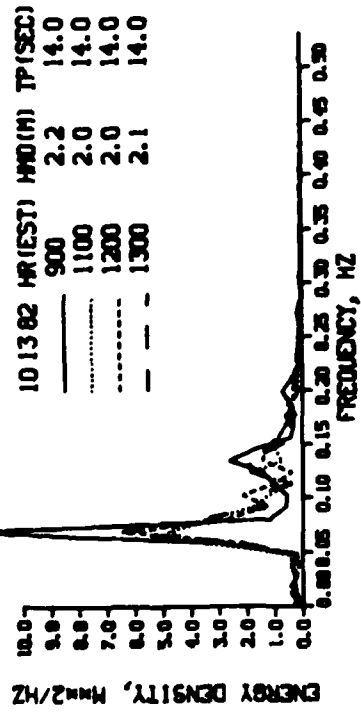
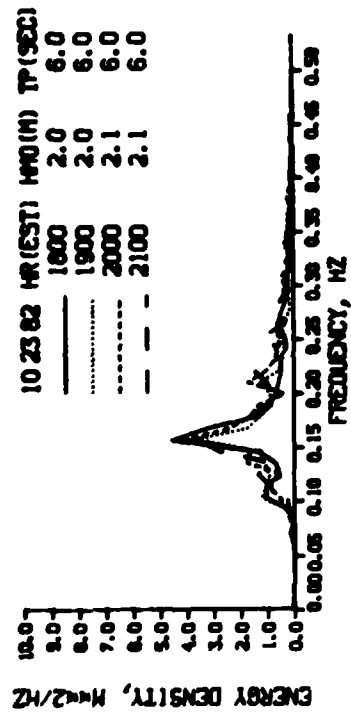
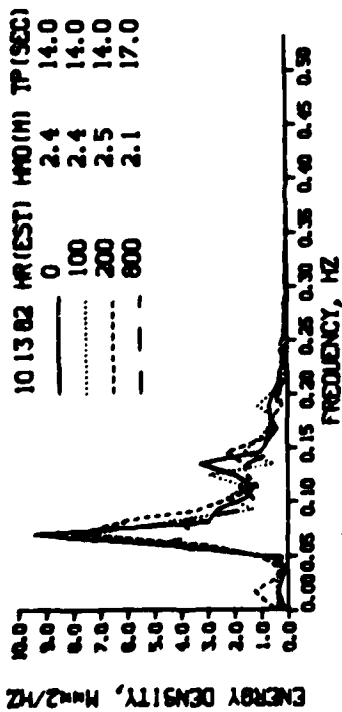


Figure B38. (Sheet 11 of 21)

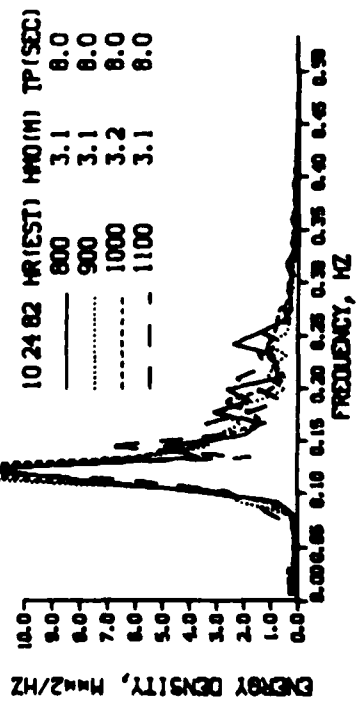
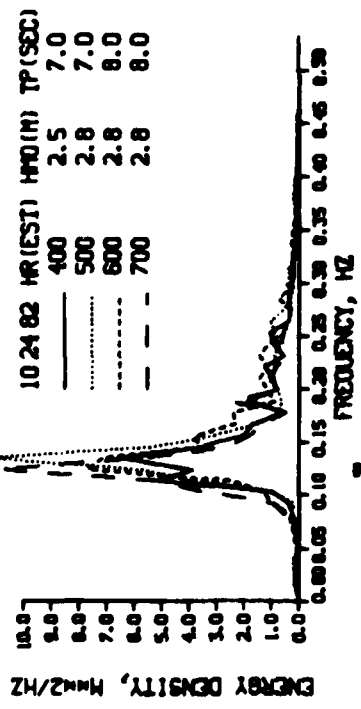
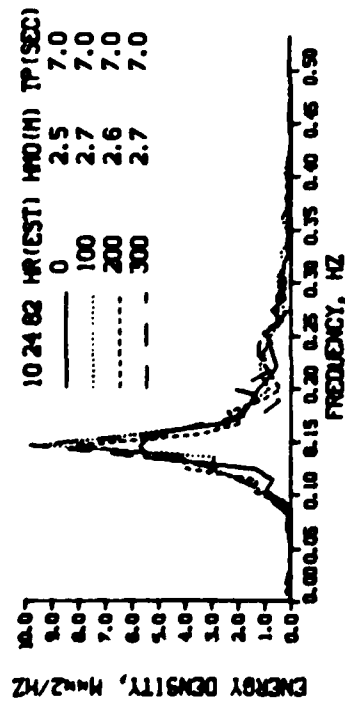
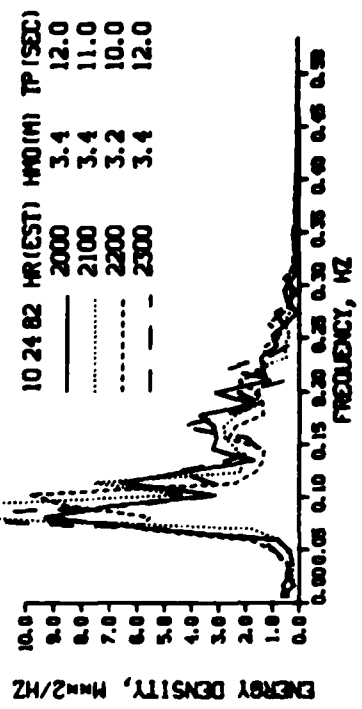
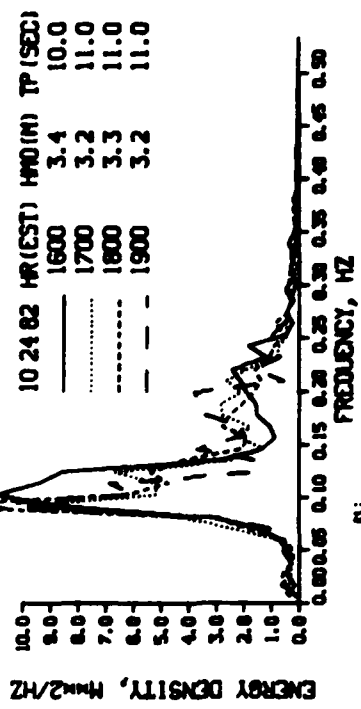
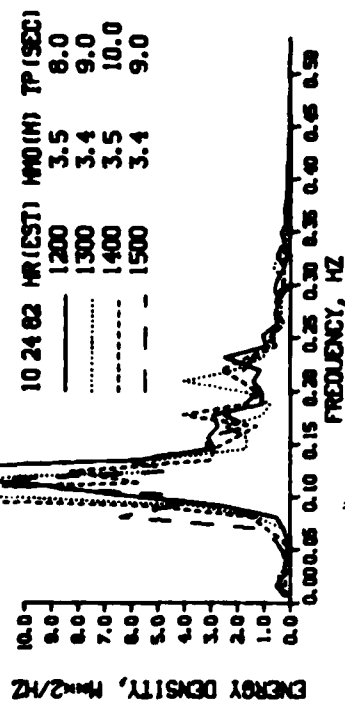


Figure B38. (Sheet 12 of 21)

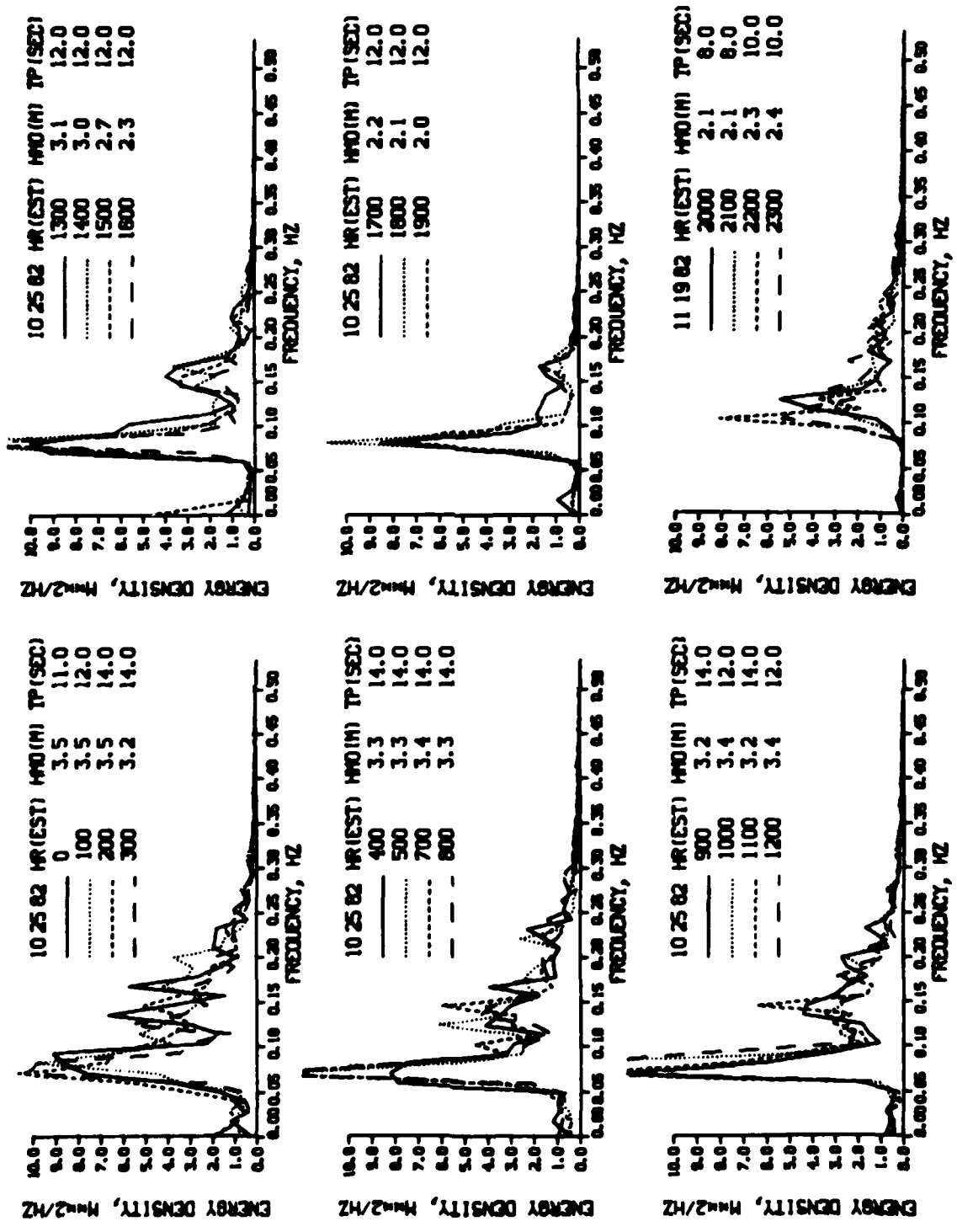


Figure B38. (Sheet 13 of 21)

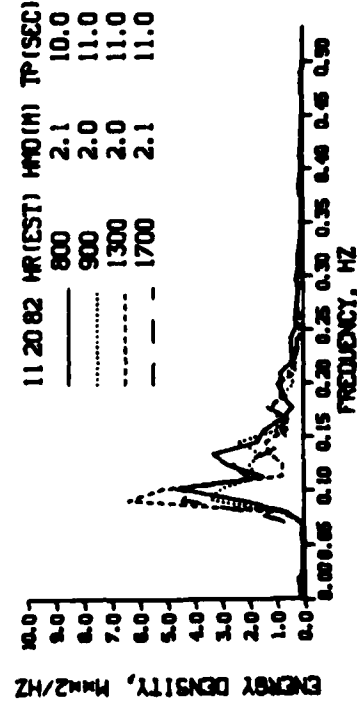
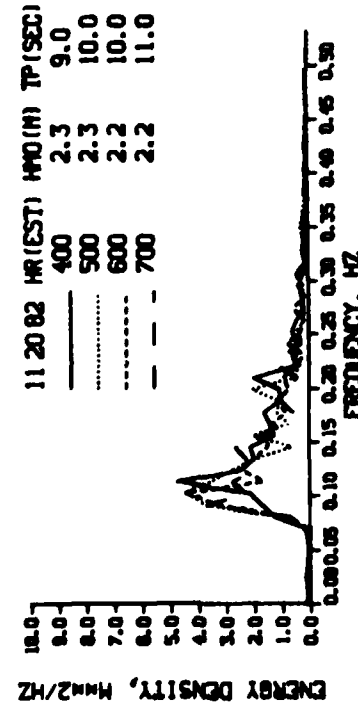
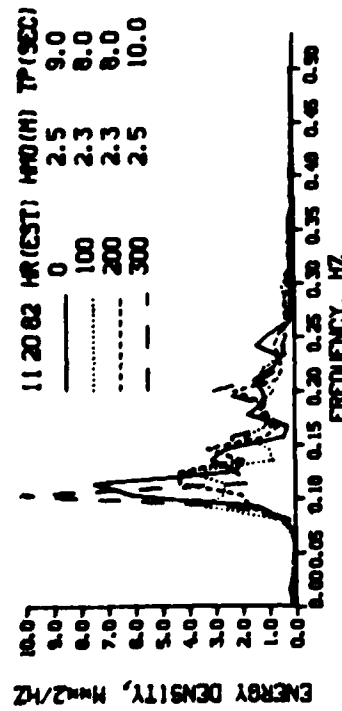
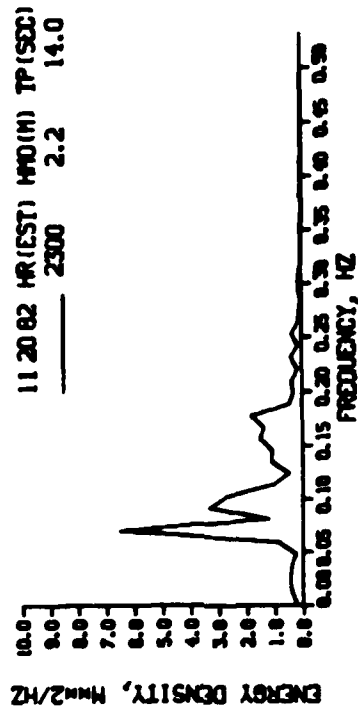
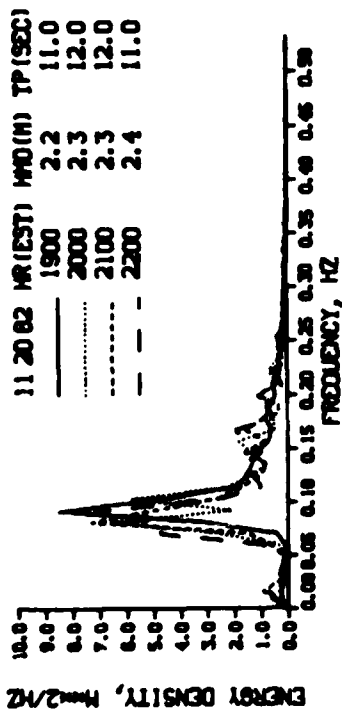


Figure B38. (Sheet 14 of 21)

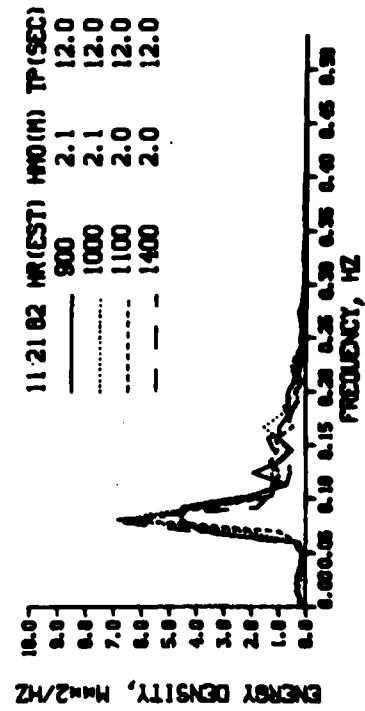
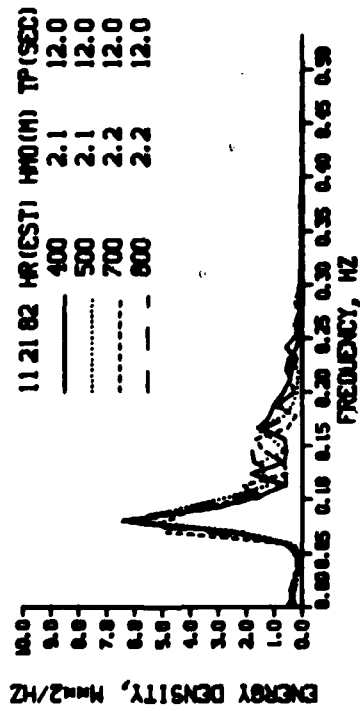
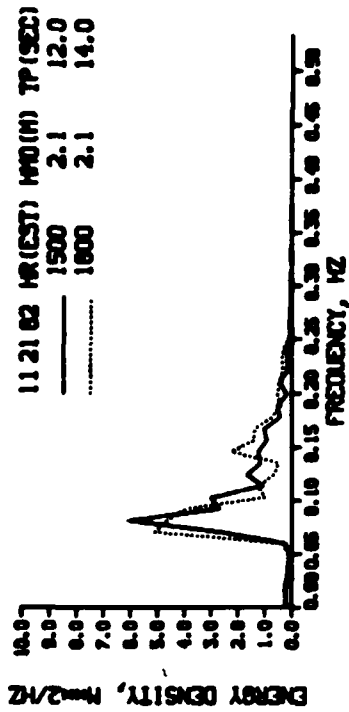
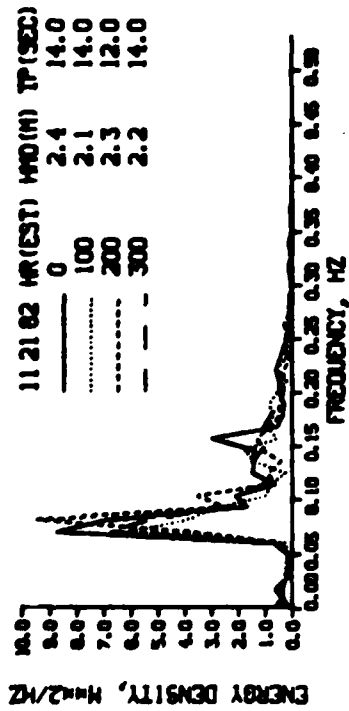


Figure B38. (Sheet 15 of 21)

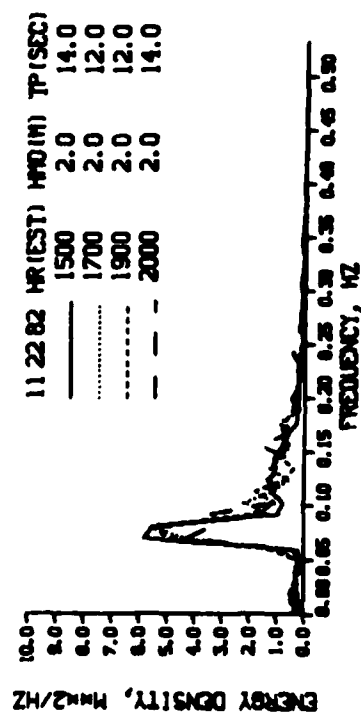
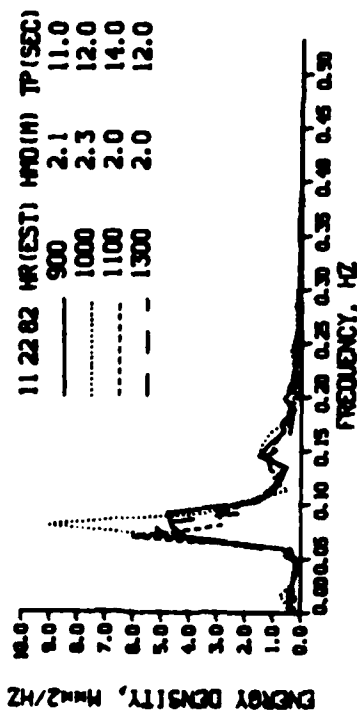
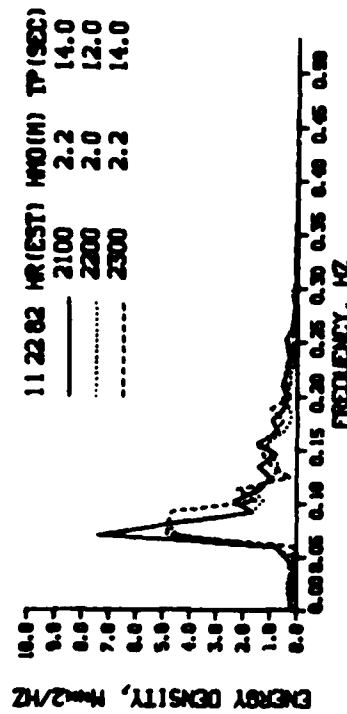
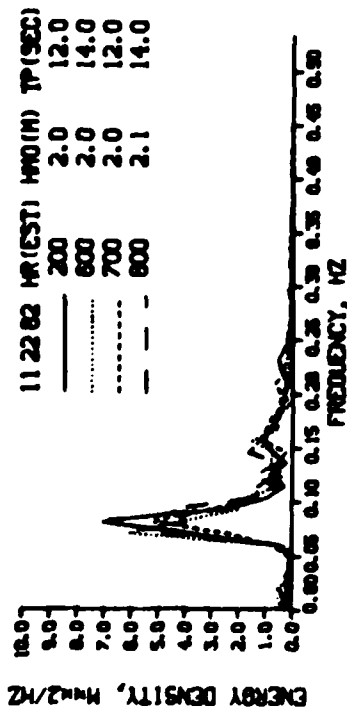


Figure B38. (Sheet 16 of 21)

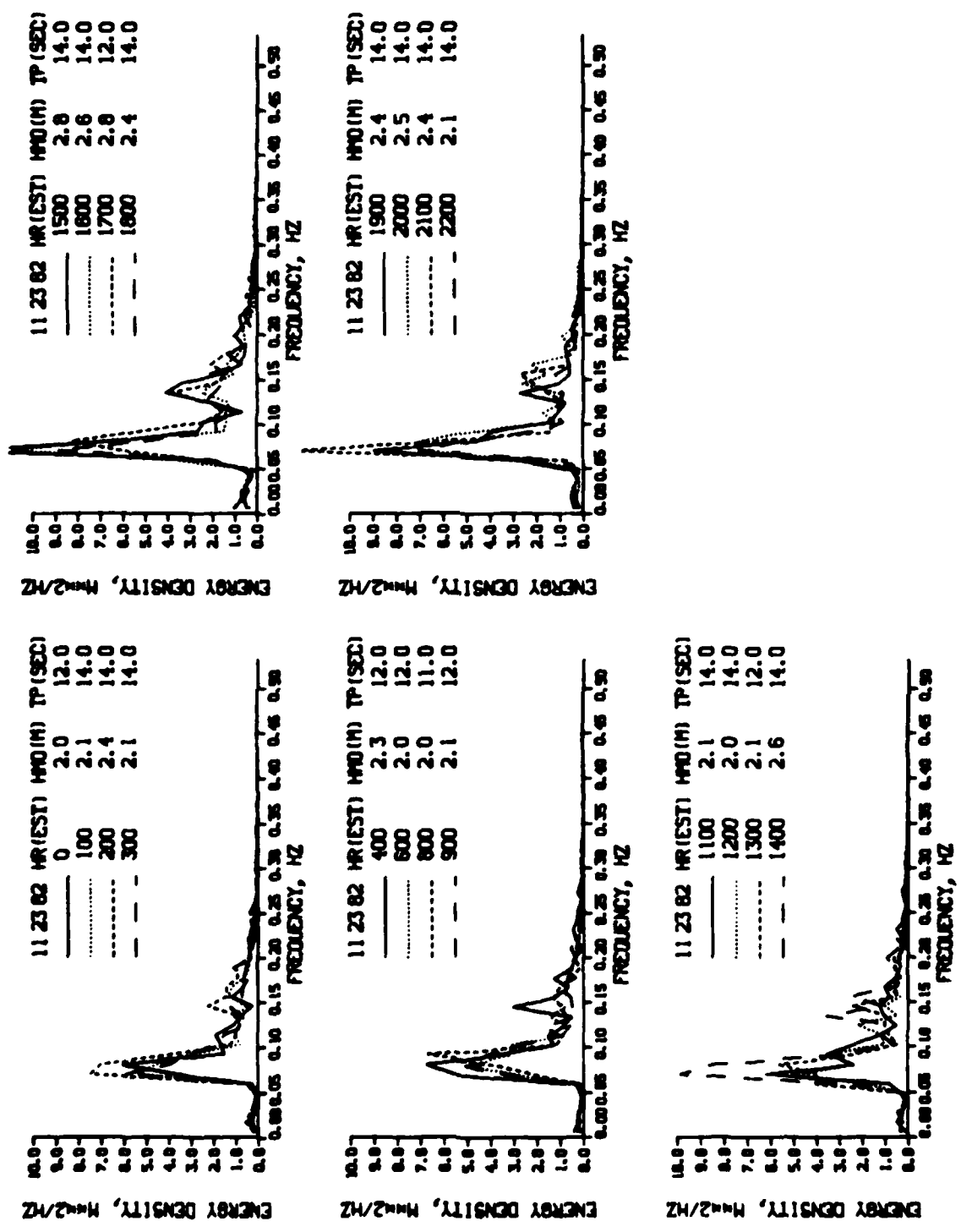


Figure B38. (Sheet 17 of 21)

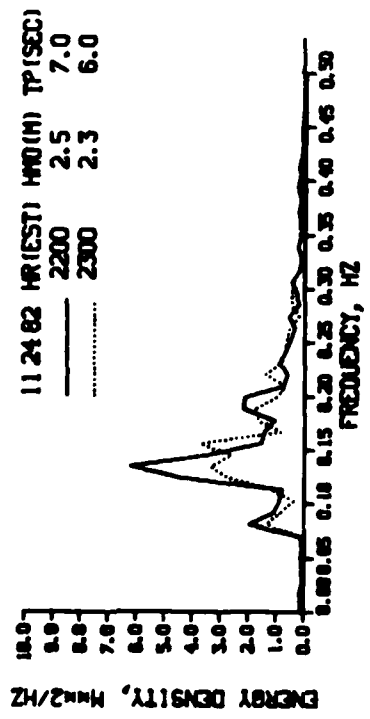
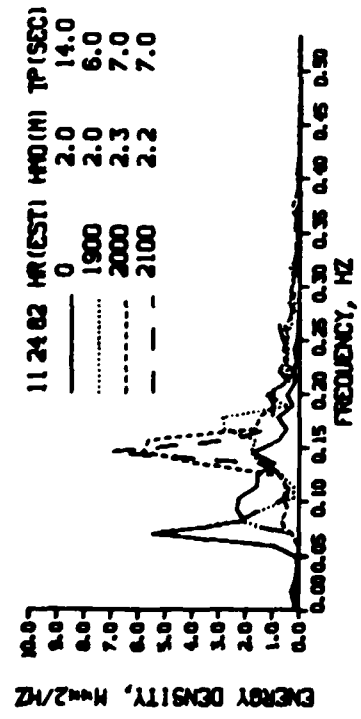
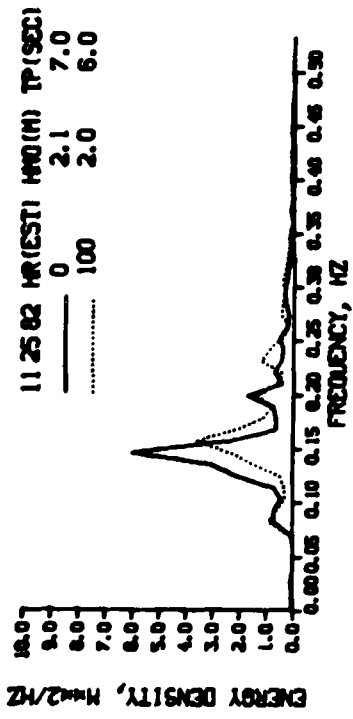


Figure B38. (Sheet 18 of 21)

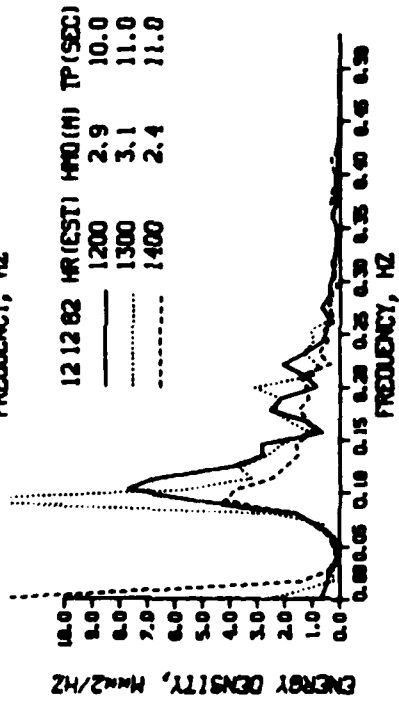
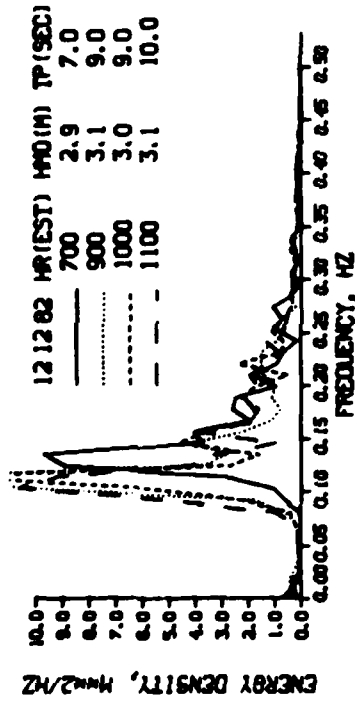
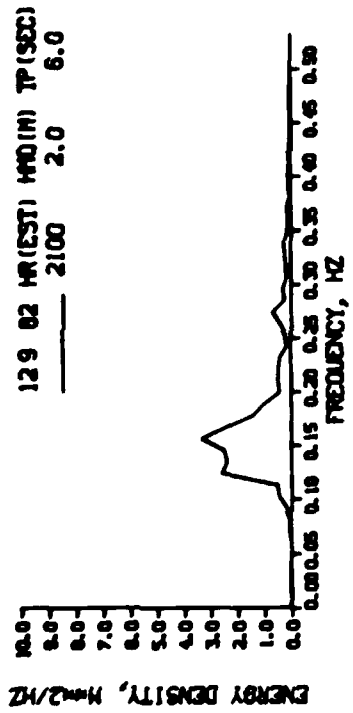
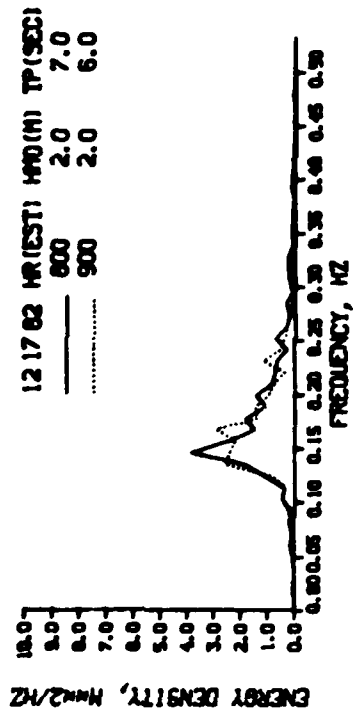


Figure B38. (Sheet 19 of 21)

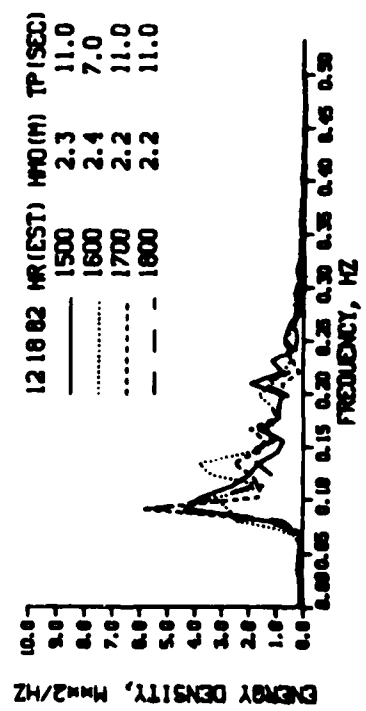
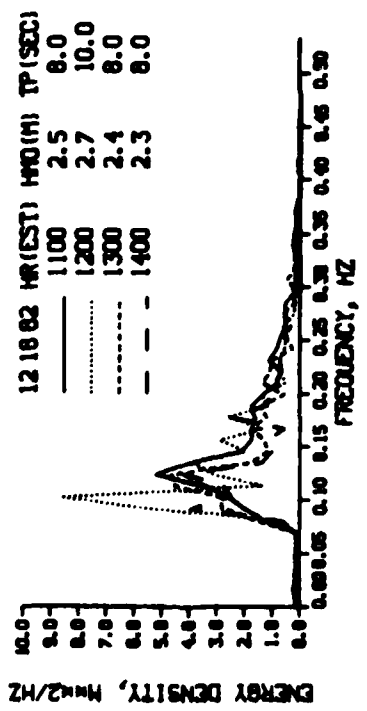
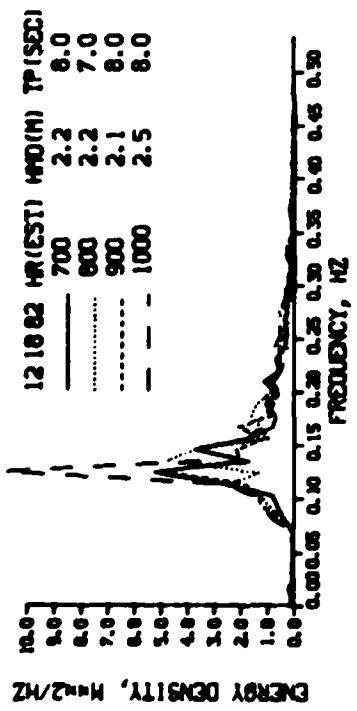
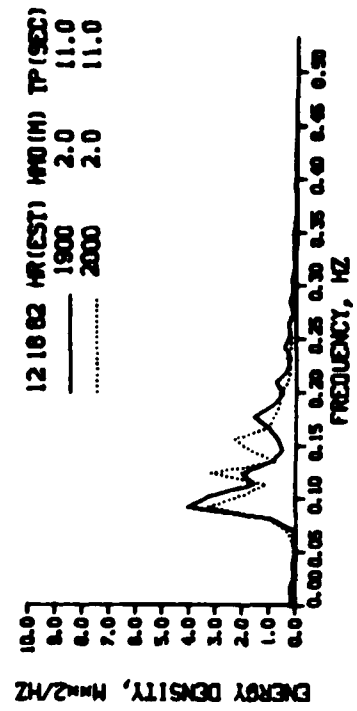


Figure B38. (Sheet 20 of 21)

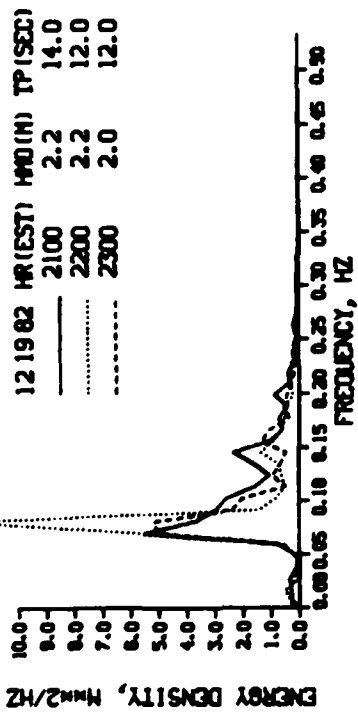
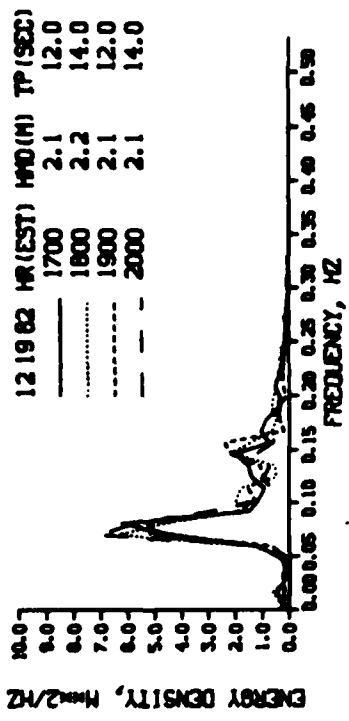
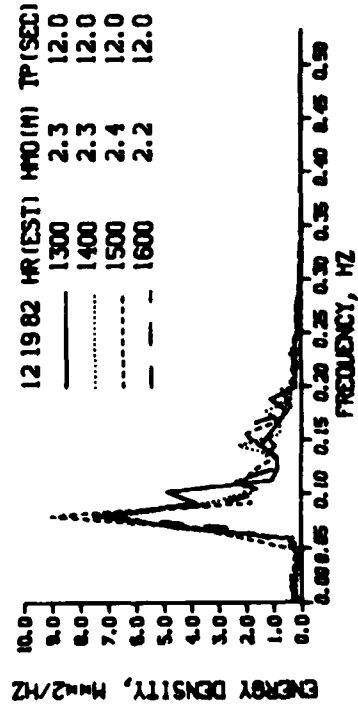
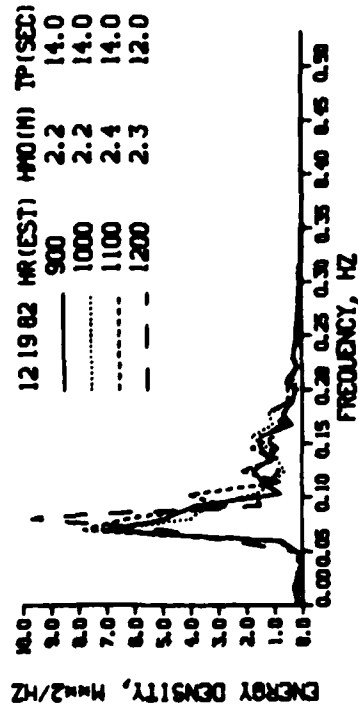
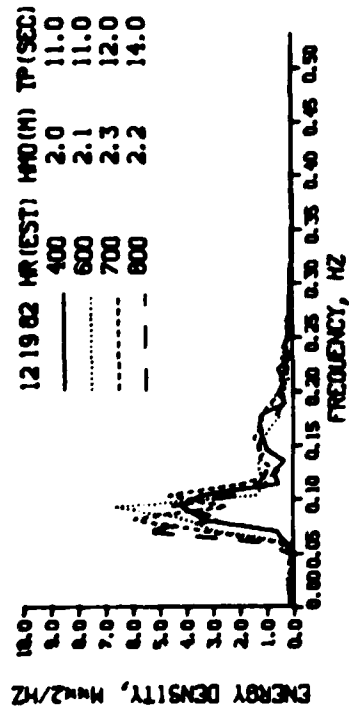


Figure B38. (Sheet 21 of 21)

APPENDIX C: SURVEY DATA

Contour diagrams constructed from the bathymetric survey data are presented in this appendix. The profile lines surveyed are identified on each diagram. Contours are in half meters referenced to National Geodetic Vertical Datum. The distance offshore is referenced to the Field Research Facility (FRF) monumentation baseline behind the dune.

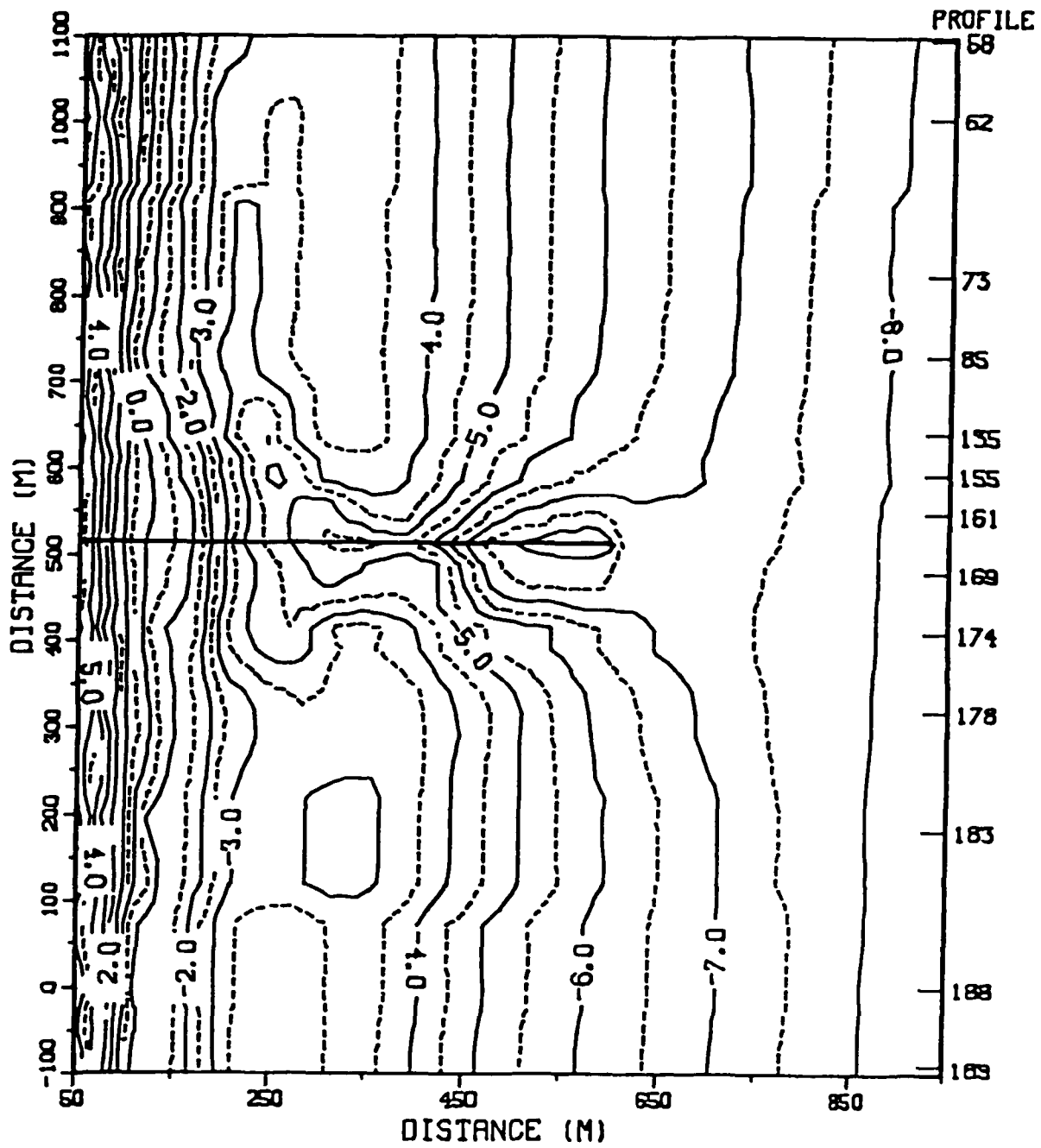


Figure C1. FRF bathymetry, 9 February 1982
(contours in metres)

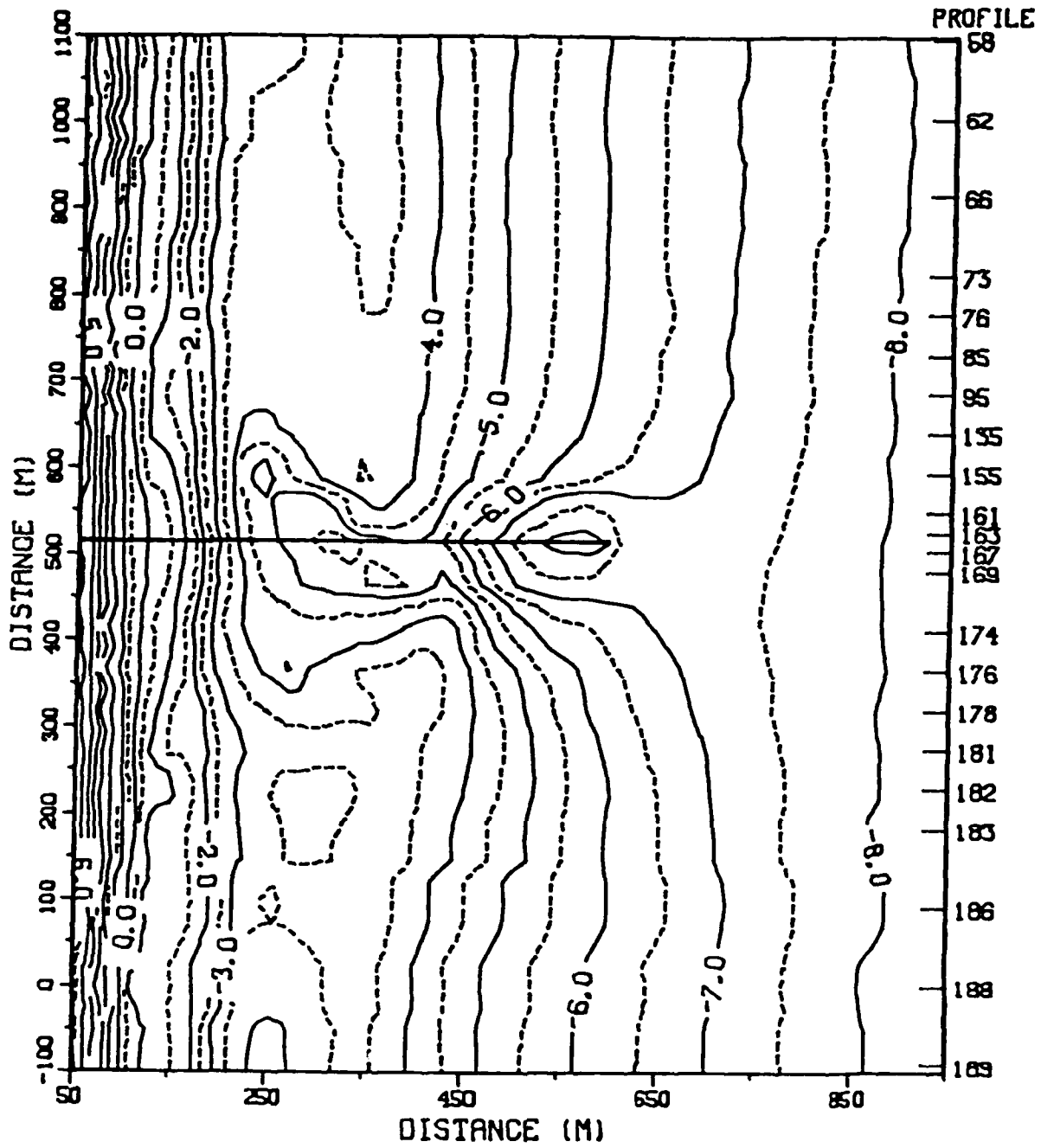


Figure C2. FRF bathymetry, 18 March 1982
(contours in metres)

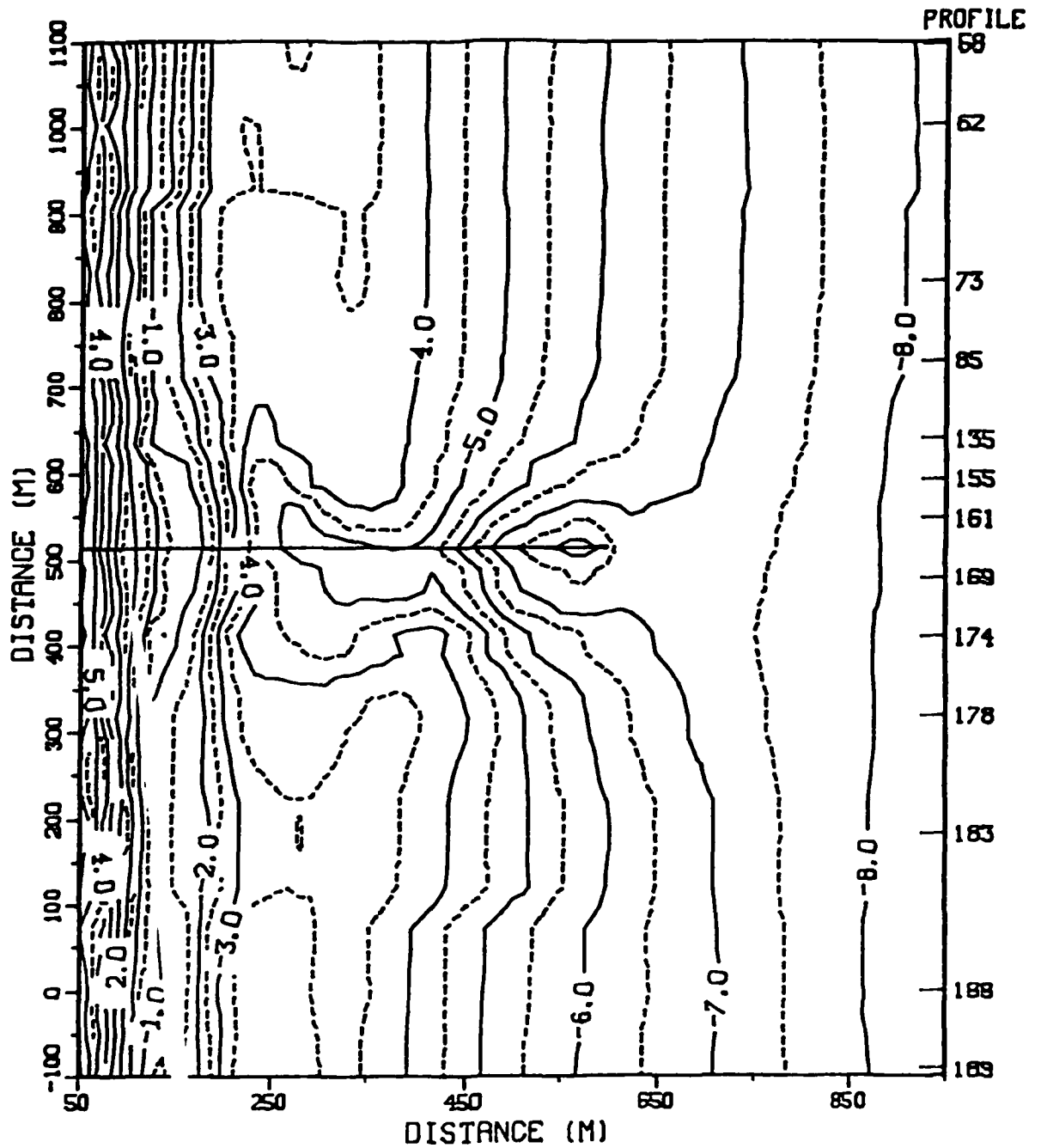


Figure C3. FRF bathymetry, 21 April 1982
(contours in metres)

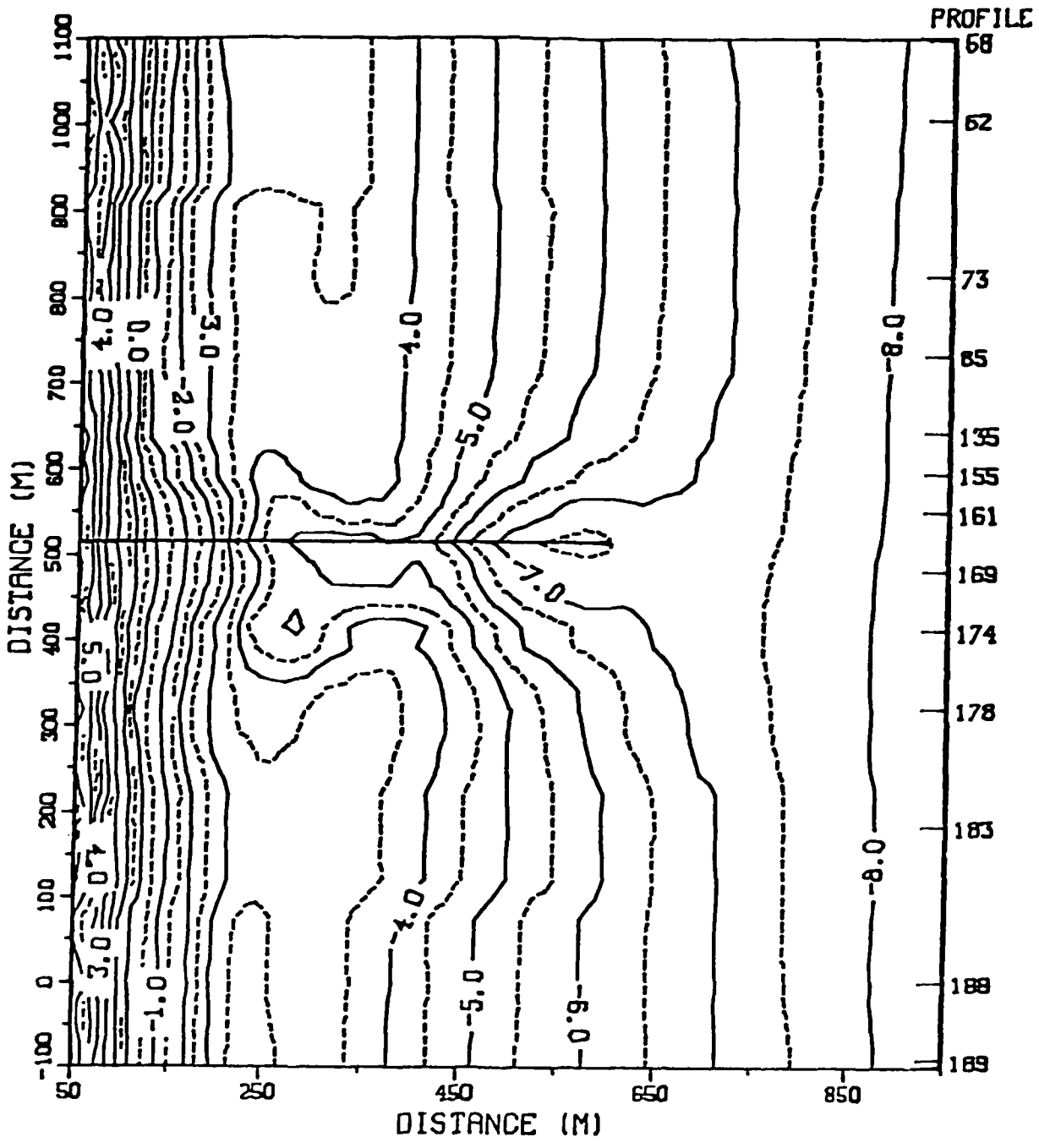


Figure C4. FRF bathymetry, 2 June 1982
(contours in metres)

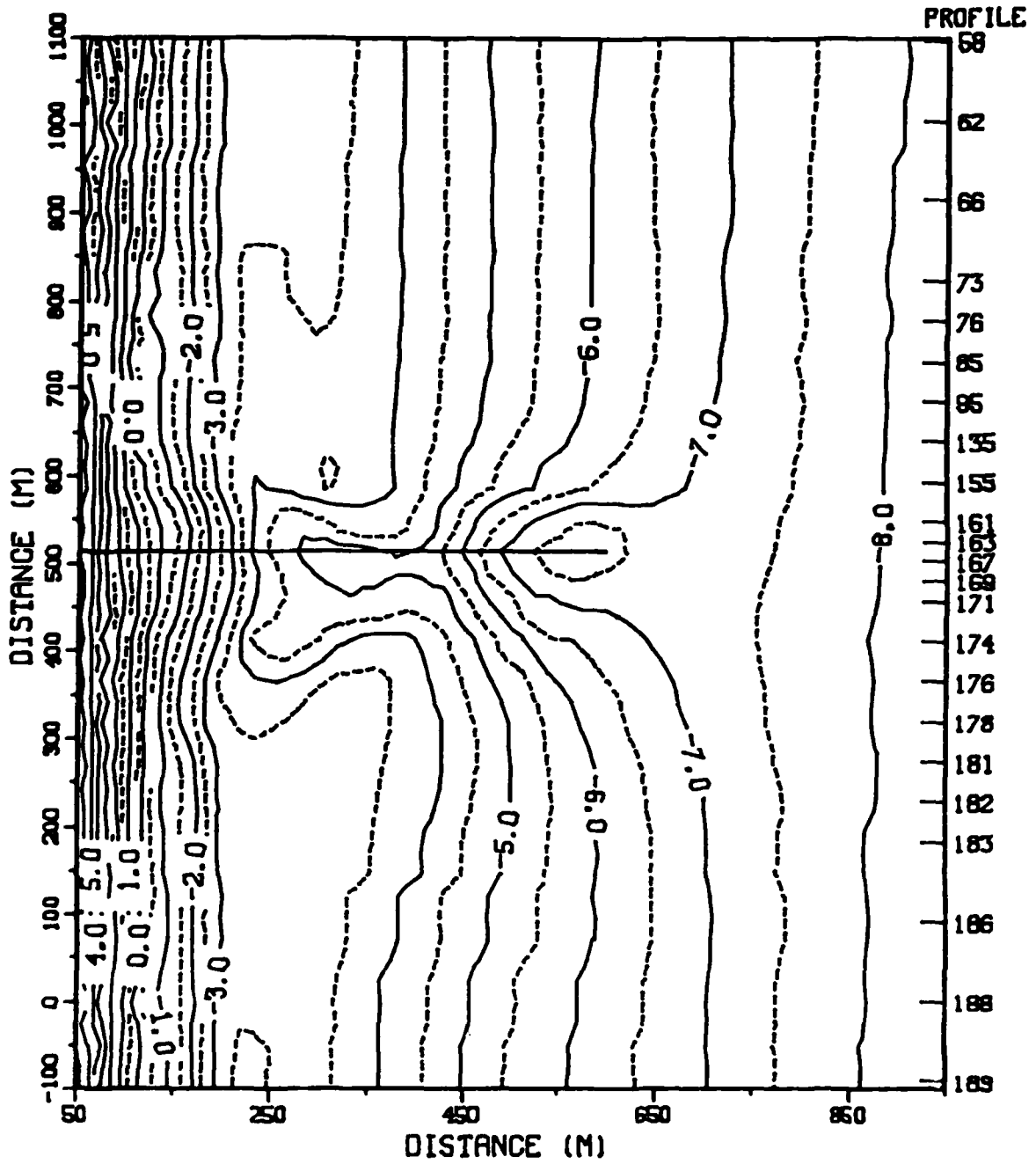


Figure C5. FRF bathymetry, 14 July 1982
(contours in metres)

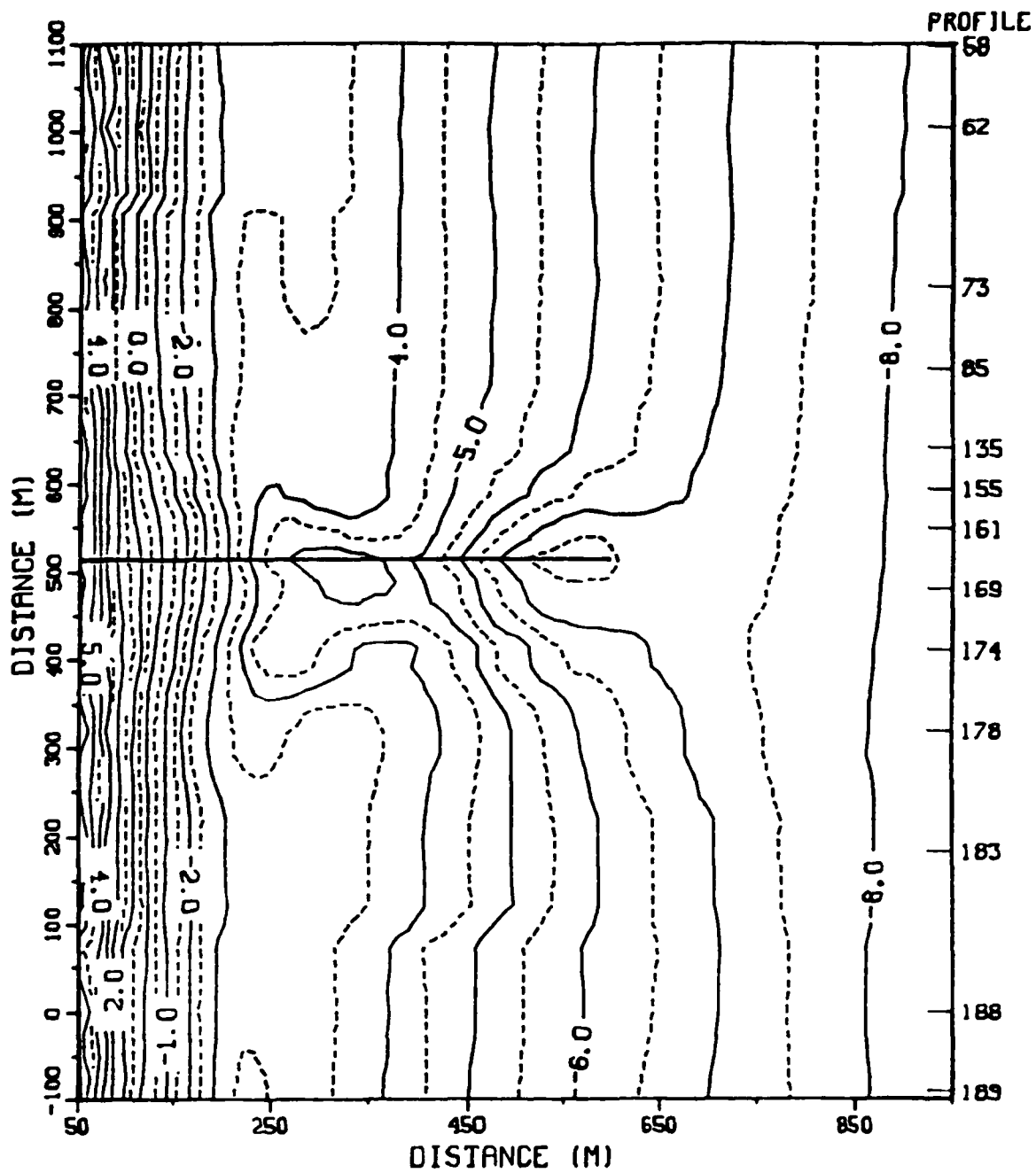


Figure C6. FRF bathymetry, 24 August 1982
(contours in metres)

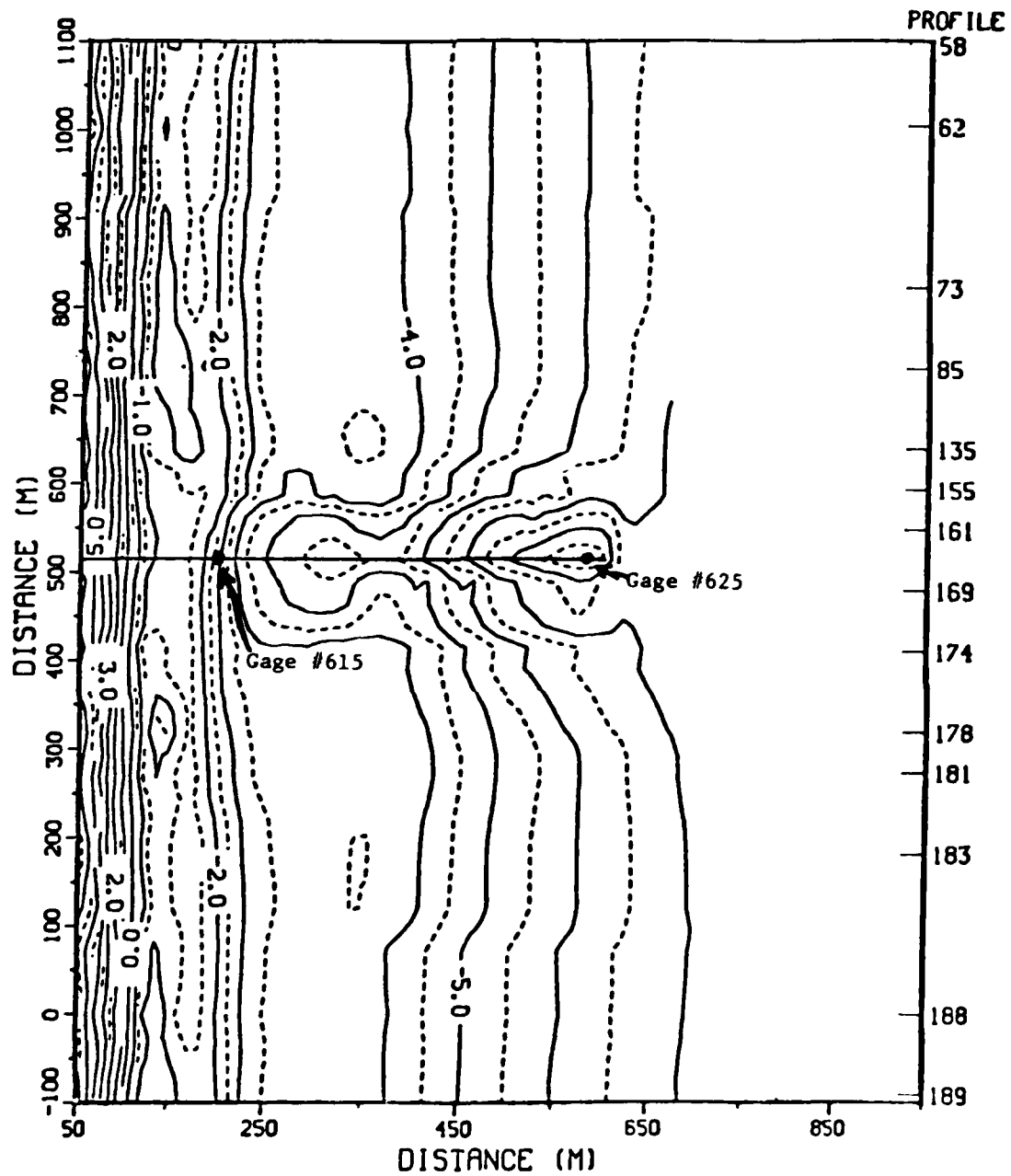


Figure C7. FRF bathymetry, 27 October 1982
(contours in metres)

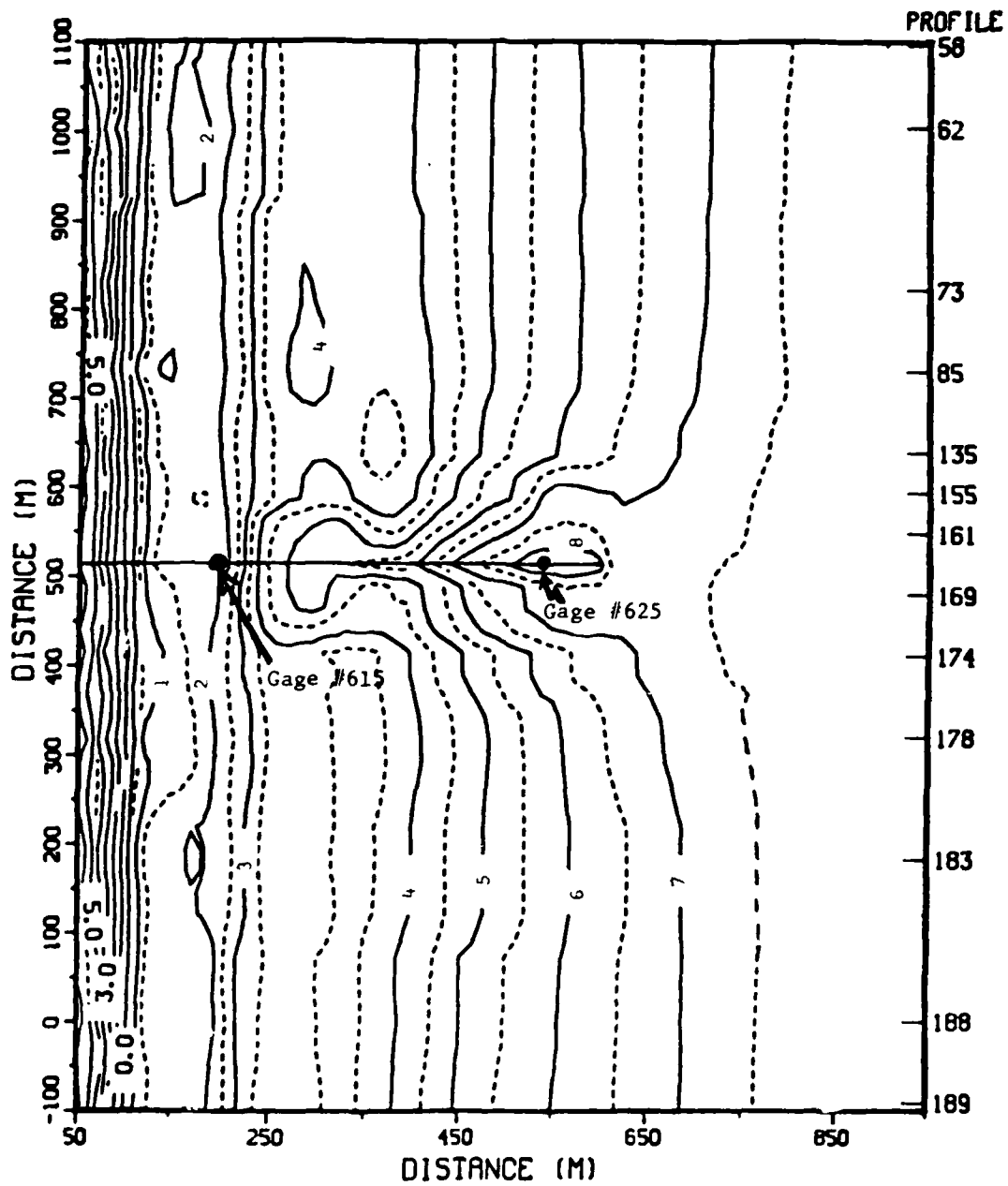
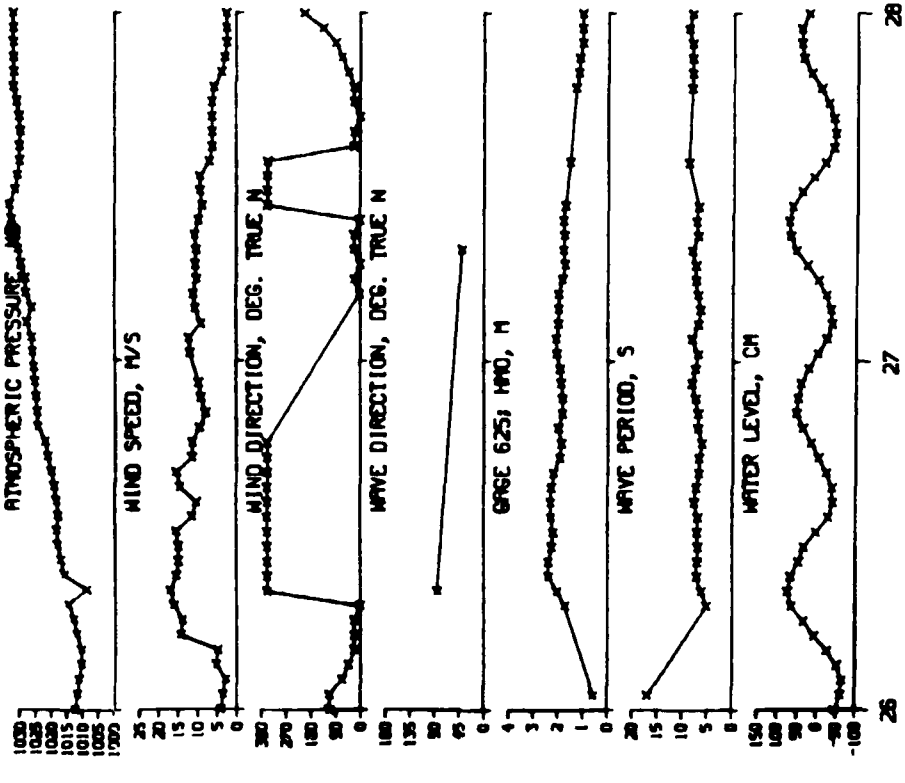


Figure C8. FRF bathymetry, 6 December 1982
(contours in metres)

APPENDIX D: STORM DATA

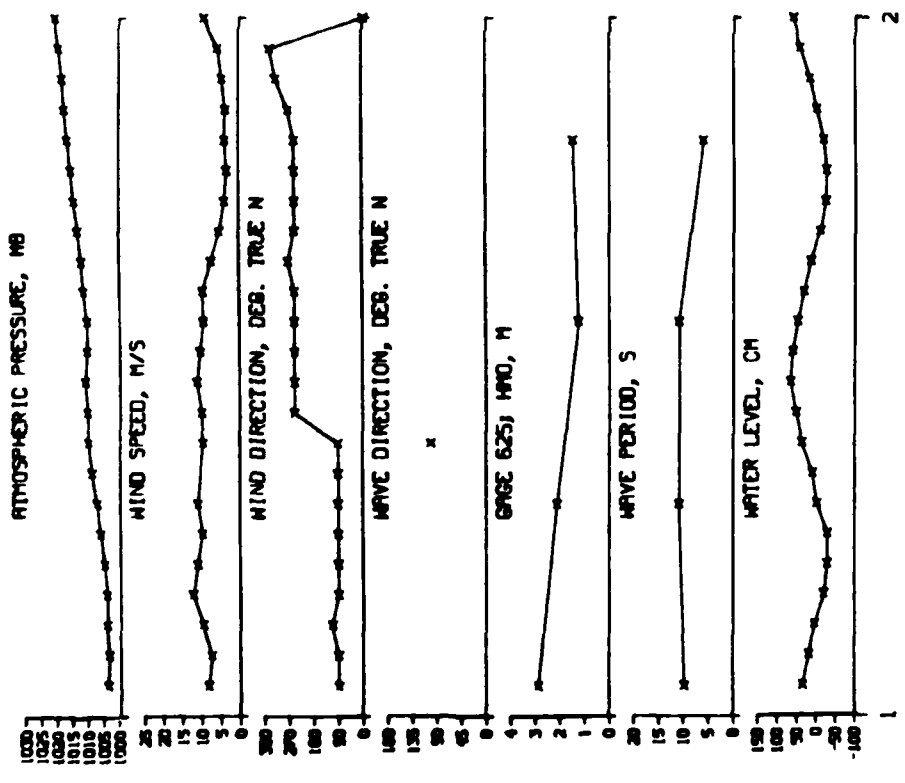
During times when the wave height H_{m_0} exceeded 2 m at the seaward end of the Field Research Facility (FRF) pier, data were collected hourly. The available data for the 16 storms during the year are presented in this appendix.

- a. Atmospheric pressure. Reported in millibars, these data are useful for documenting the type of storm, the passage of fronts, and the intensity of the atmospheric pressure system.
- b. Wind speed. Local winds are generally responsible for the wave conditions at the FRF. Wind speed is reported in metres per second.
- c. Wind direction. Referenced to true (star) north, the wind direction indicates the direction from which the winds are blowing, e.g., winds blowing from west to east are referred to as west winds.
- d. Wave direction. Referenced to true north, the wave direction measurements are taken at the seaward end of the FRF pier. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg imply the waves were coming from the south side of the pier.
- e. Gage 625, wave height. The wave height, measured in metres, was that obtained from the Baylor staff wave gage located at the seaward end of the FRF pier.
- f. Wave period. The peak spectral wave period (in seconds) from gage 625 is reported.
- g. Water levels. Reported in centimetres and referenced to the local National Geodetic Vertical Datum (NGVD), the water levels were obtained from National Ocean Services (NOS) primary tide sta 865-1370 at the seaward end of the FRF pier.



JANUARY
1982

Figure D1. Storm data for
1 January 1982



JANUARY
1982

Figure D2. Storm data for
26-27 January 1982

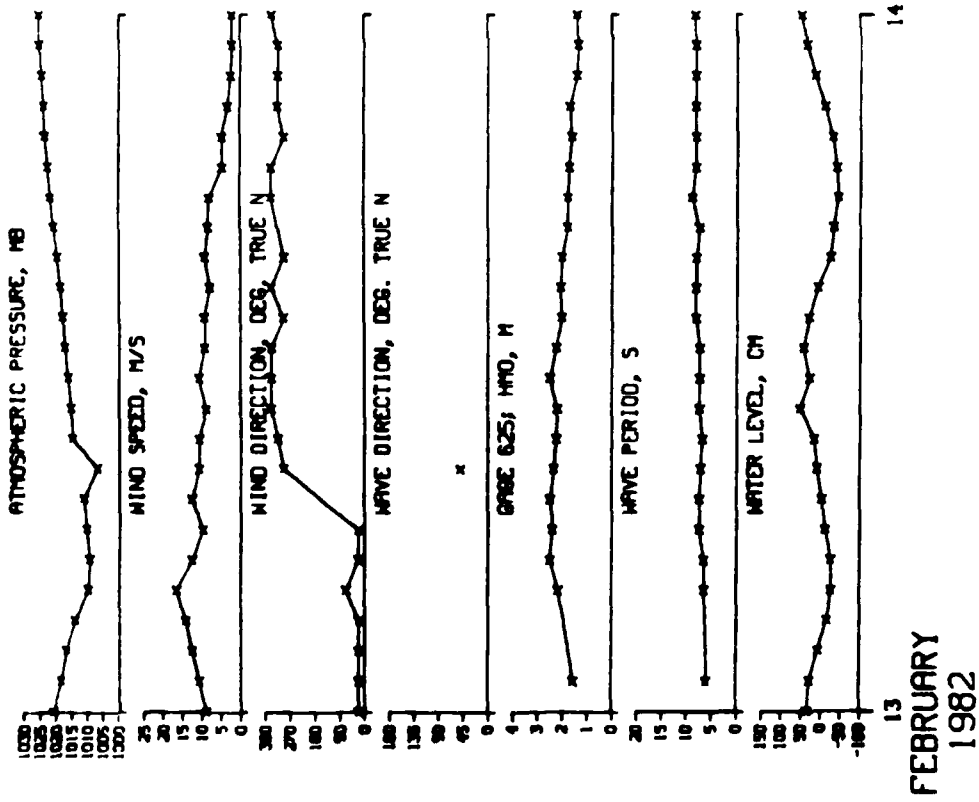


Figure D3. Storm data for
13 February 1982

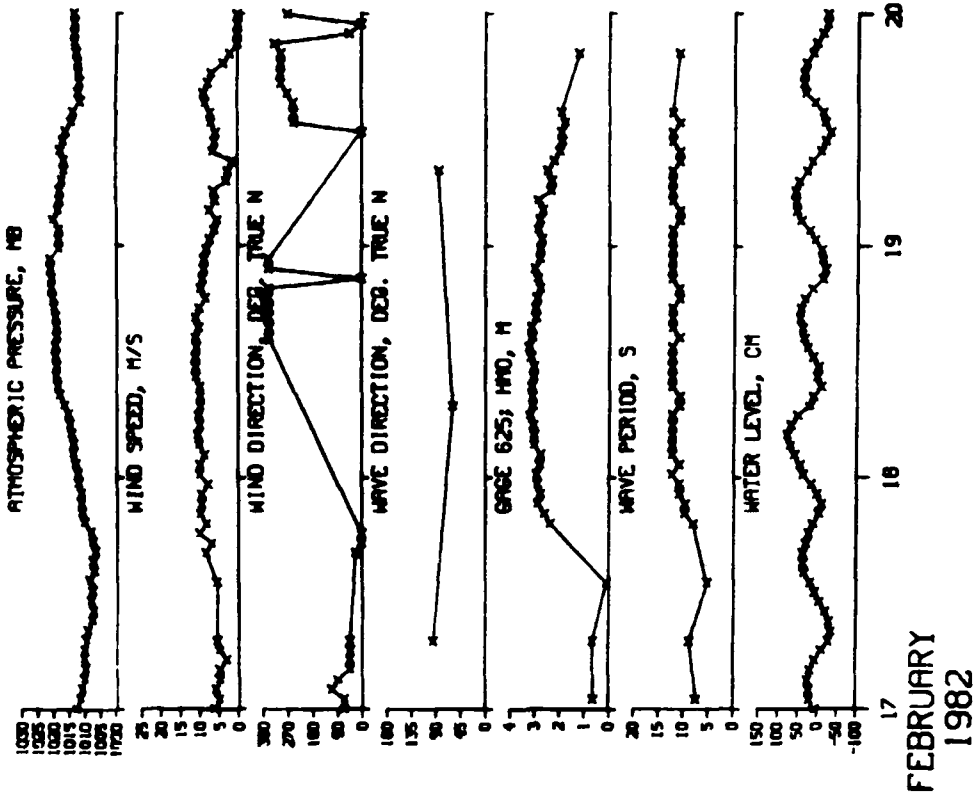


Figure D4. Storm data for
17-19 February 1982

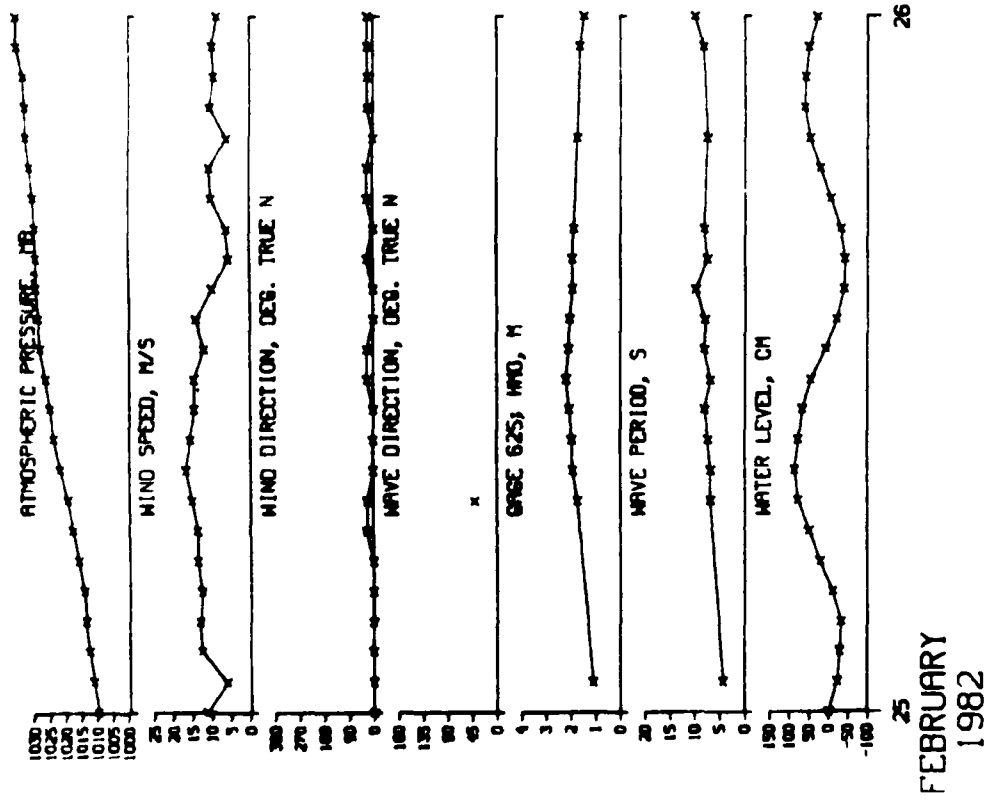


Figure D5. Storm data for 25 February 1982

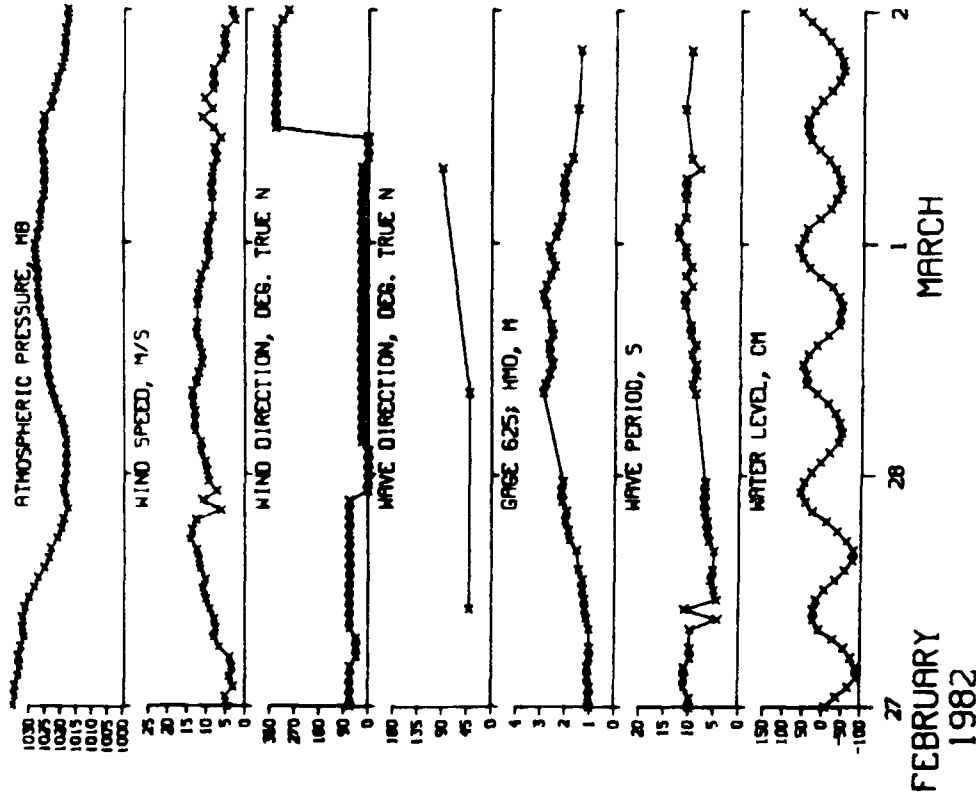
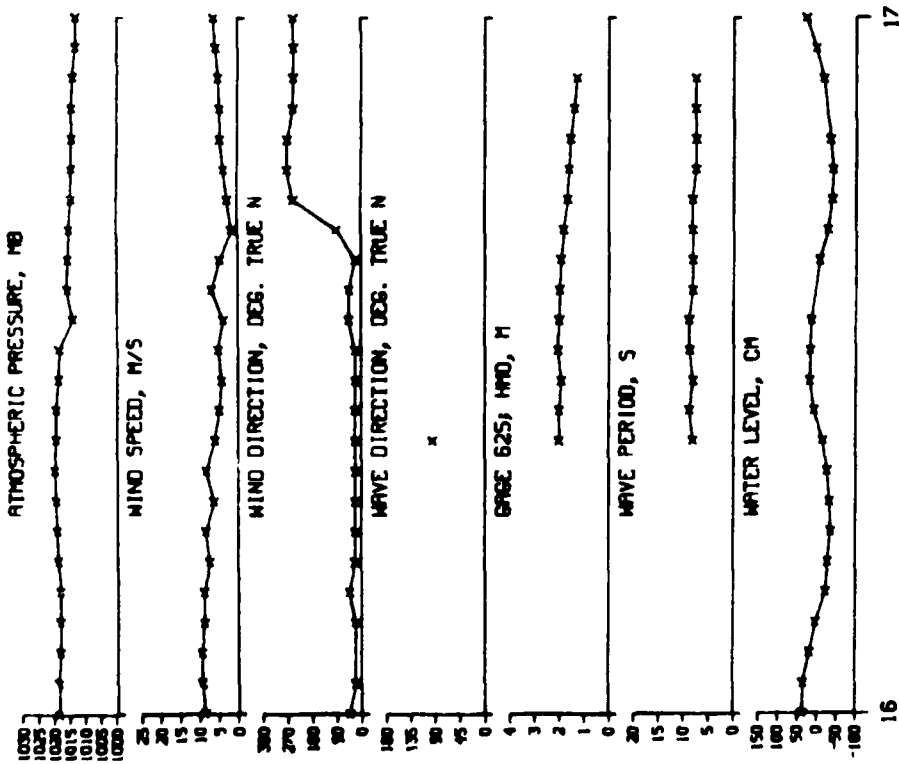
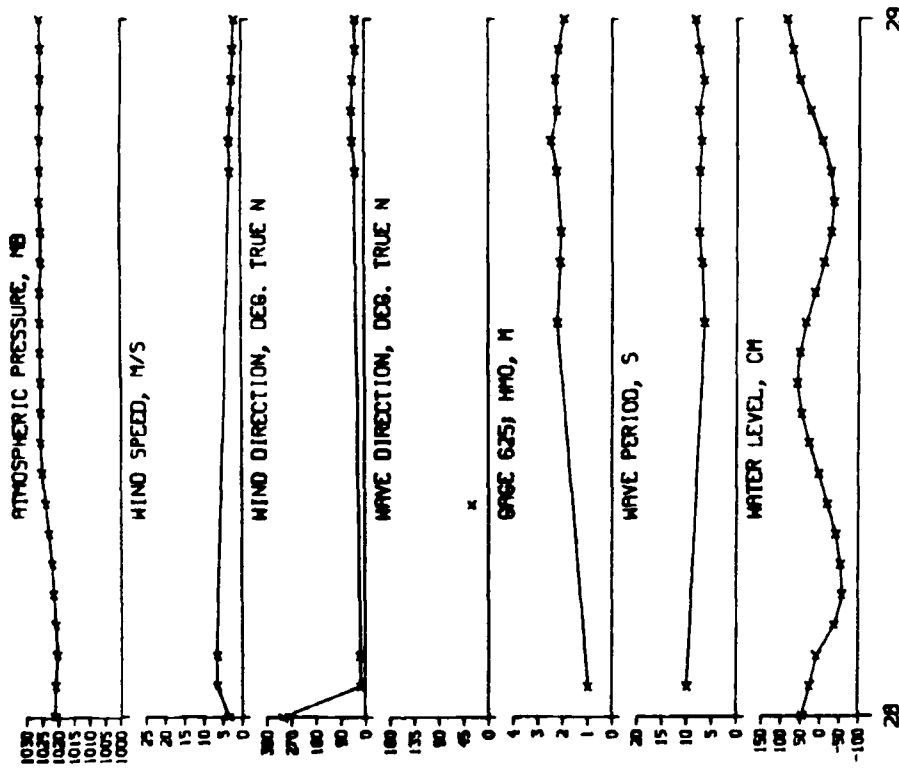


Figure D6. Storm data for 27 February through 1 March 1982



16
MARCH
1982

Figure D7. Storm data for
16 March 1982



28
APRIL
1982

Figure D8. Storm data for
28 April 1982

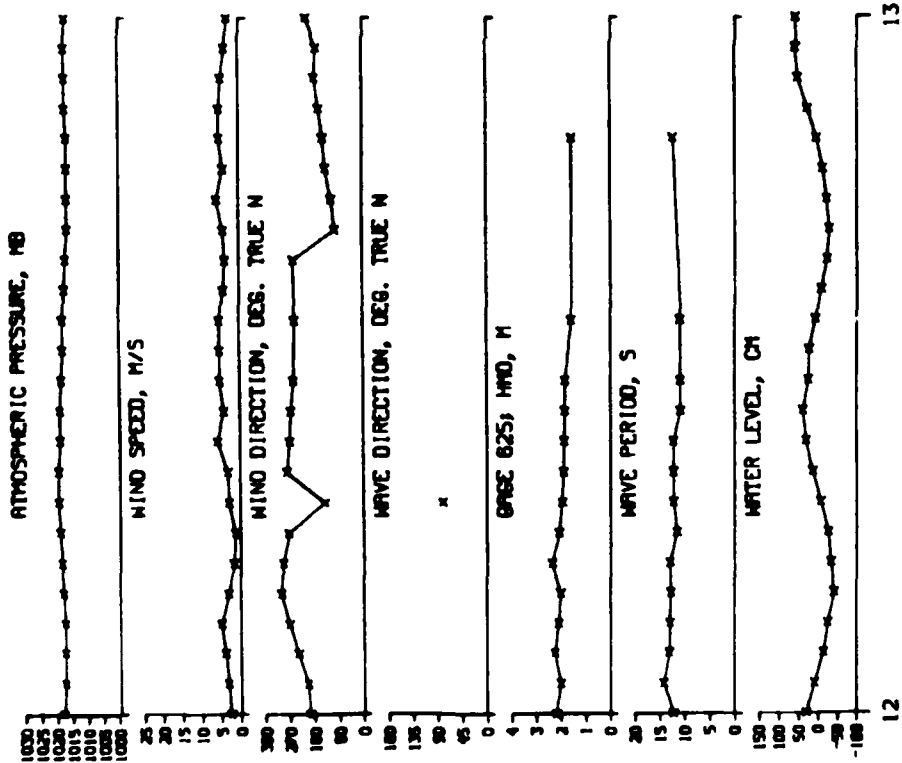


Figure D9. Storm data for
12 May 1982

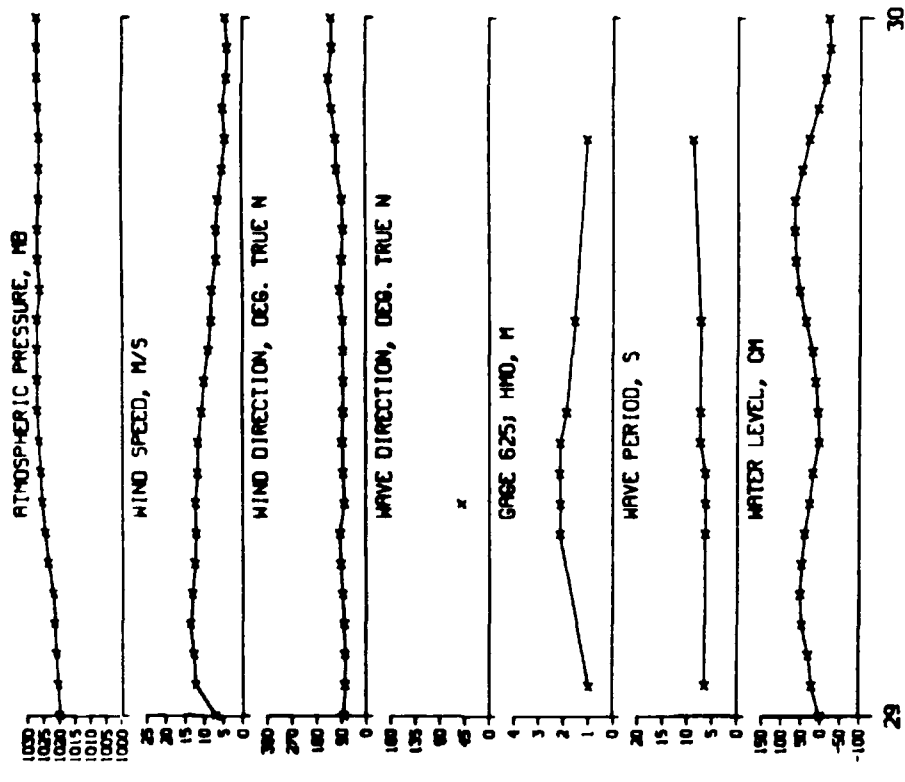


Figure D10. Storm data for
29 August 1982

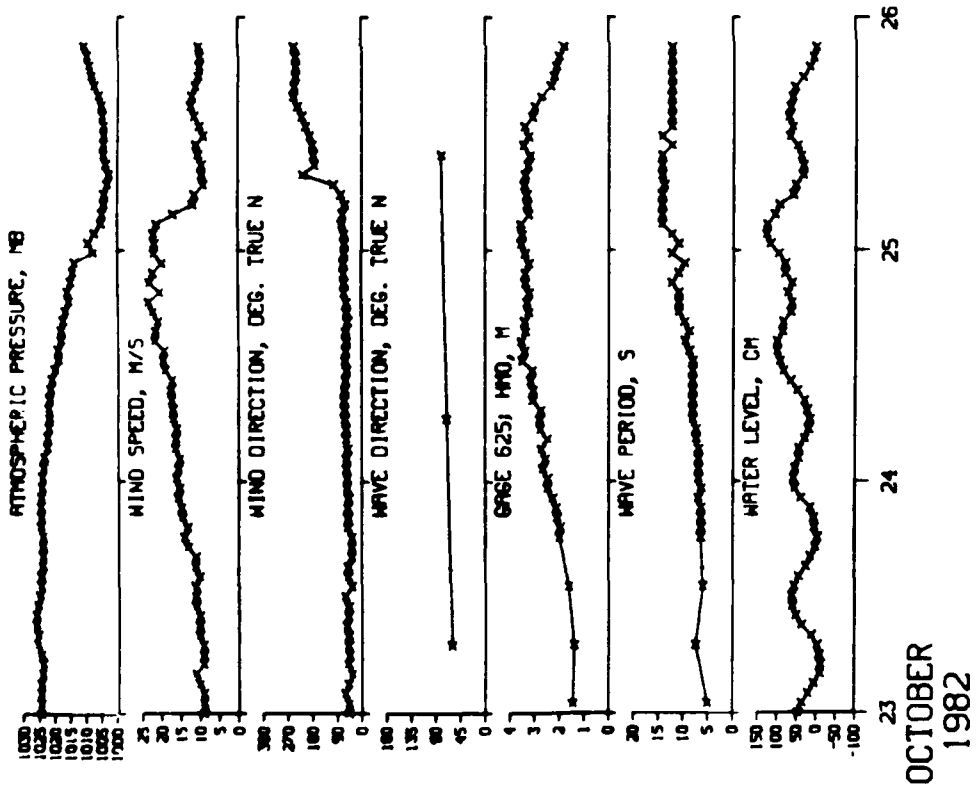


Figure D11. Storm data for 23-25 October 1982

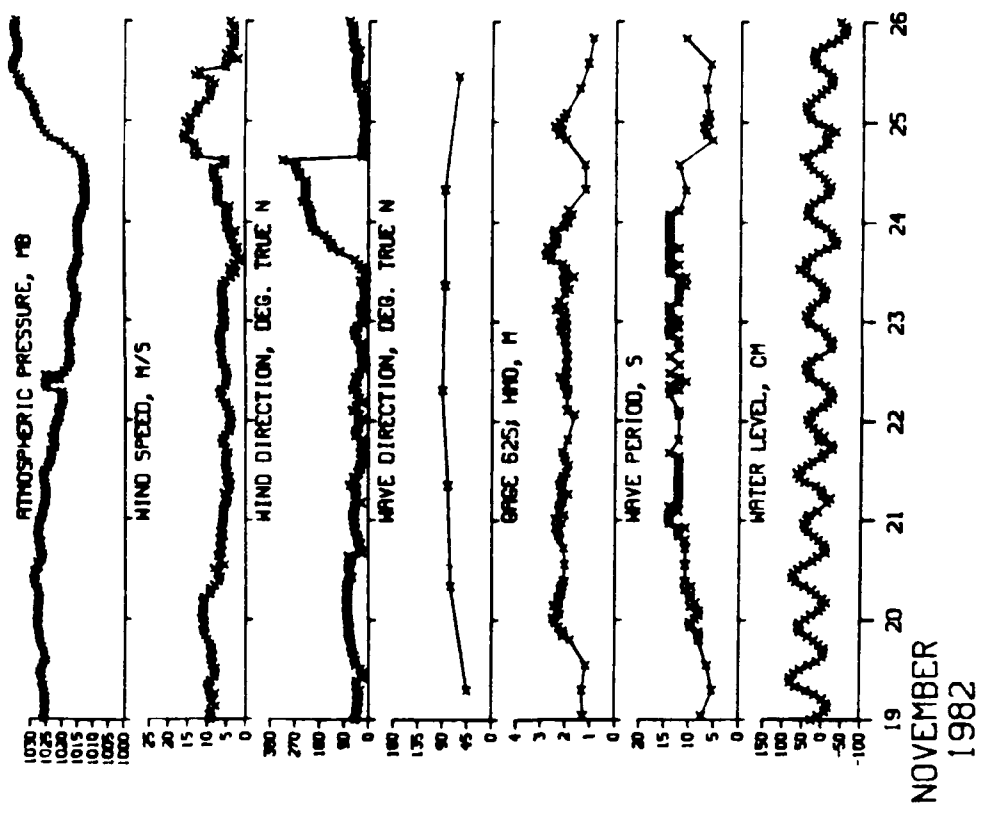
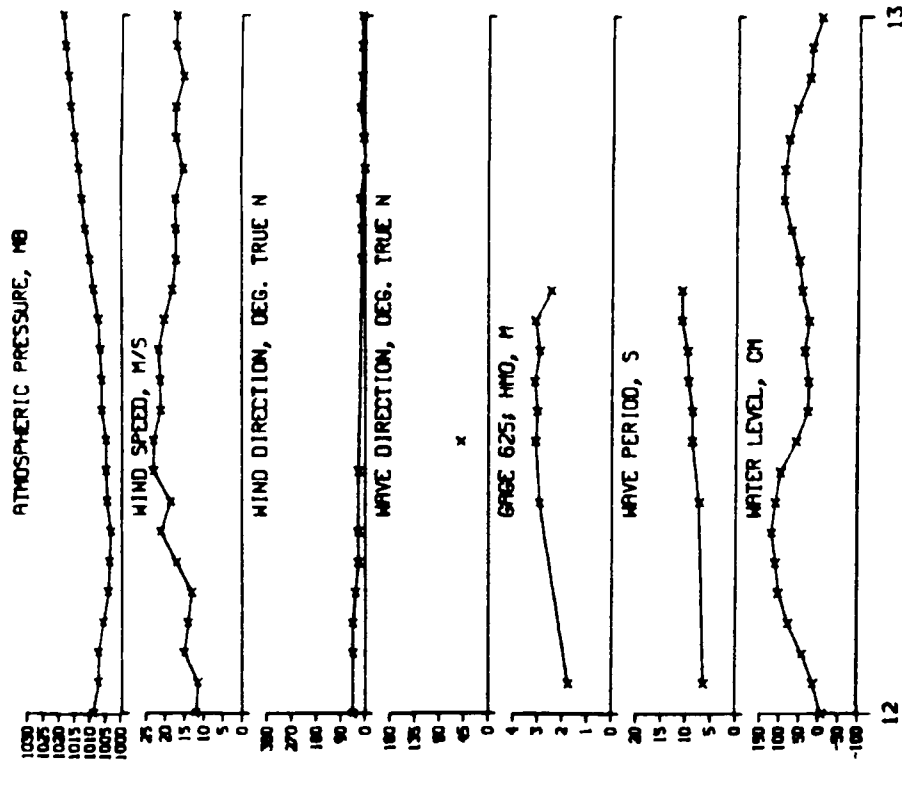
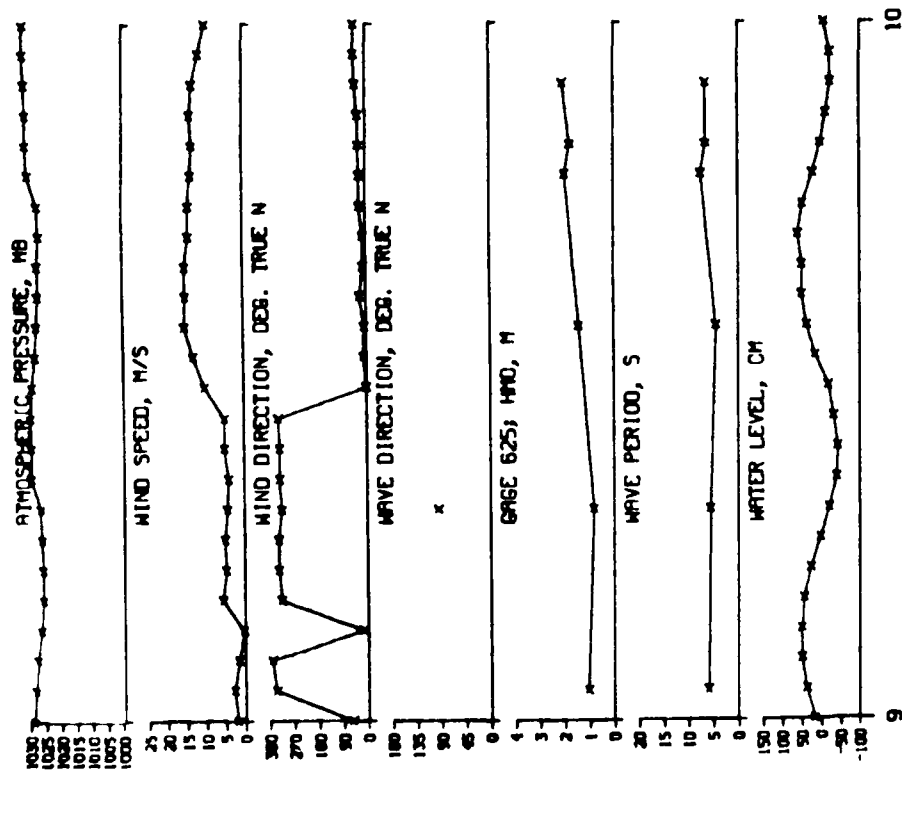


Figure D12. Storm data for 19-25 November 1982



9
DECEMBER
1982

Figure D13. Storm data for
9 December 1982



12
DECEMBER
1982

Figure D14. Storm data for
12 December 1982

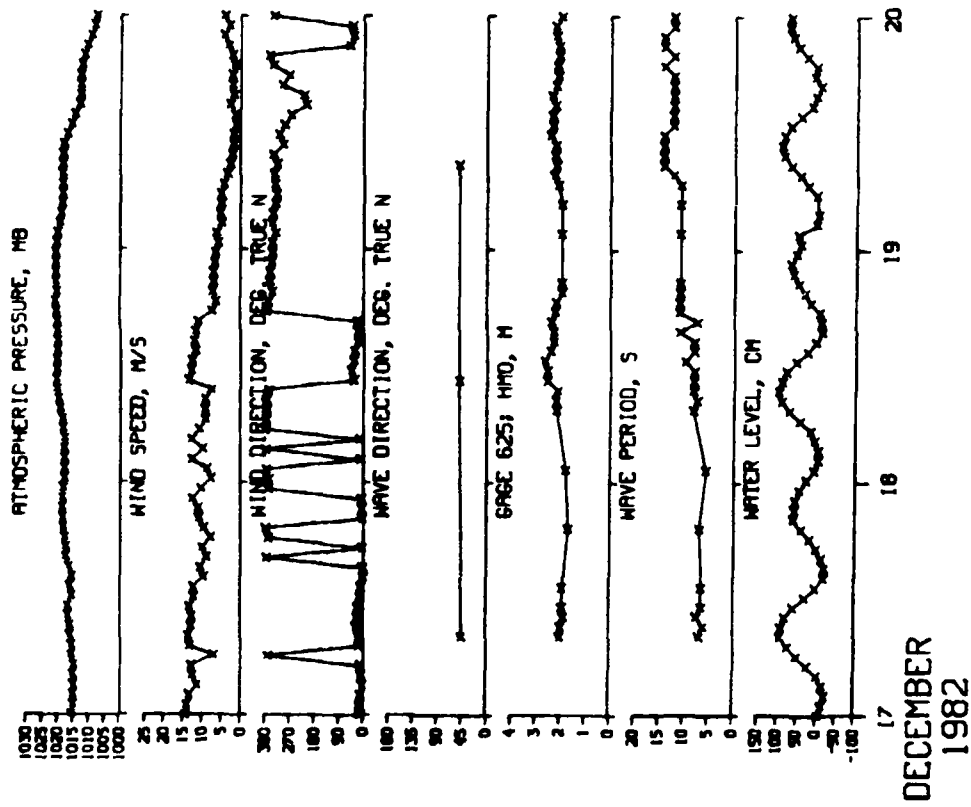


Figure D15. Storm data for
17-19 December 1982

END

DTIC

10-86