AD-757 982

PROCESSED WIND AND WAVE MEASUREMENTS
FROM OCEAN WEATHER STATION PAPA

C. K. Rutledge

General Dynamics

Prepared for:

Office of Naval Research

March 1973

NORPAX TECHNICAL REPORT

PROCESSED WIND AND WAVE MEASUREMENTS FROM OCEAN WEATHER STATION PAPA

Sponsored by

National Science Foundation
Office for
International Decade of Ocean Exploration

and

U.S. Navy Office of Naval Research
Ocean Science and Technology Division
Washington, D.C.

NR 083-147

C. K. Rutledge

GENERAL DYNAMICS

Electronics Division
P.O. Box 81127, San Diego, California 92138 · 714-279-7301

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
Electronics Division of General Dynamics 5001 Kearny Villa Road San Diego, California	UNCLASSIFIED
	2b. GROUP

3. REPORT TITLE

PROCESSED WIND AND WAVE MEASUREMENTS FROM OCEAN WEATHER STATION PAPA

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical report covering work performed from October 1972 to March 1973

5. AUTHOR(S) (First name, middle initial, last name)

C. K. Rutledge

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
March 1973	35	None
8a. CONTRACT OR GRANT NO N00014-70-C-0180 b. PROJECT NO c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) R-73-010 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) None	

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	U. S. Navy Office of Naval Research Code 480R

13. ABSTRACT

As part of an investigation into the environmental conditions existing in the North Pacific Ocean, observational data collected from ships occupying Ocean Weather Station PAPA were obtained from the Canadian Atmospheric Environment Service. Wind and wave data for the fall and winter months over the period 1951 through 1971 were processed. Wind speed and wave height were examined using a computer program to construct histograms displaying data distribution on a monthly basis. Data were divided into two intervals (1951 through 1961, and 1962 through 1971) to compare the two periods since there is a general belief that wind/wave severity has diminished during the past 20 years. The histograms included in the report show that maximum wind speed data and the mean wave height data as reported indicate a definite lessening in environmental severity at the location. Mean wind speed data show a similar trend, but of a much smaller extent.

DD FORM 1473
1 NOV 65

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
OCEAN WEATHER STATION PAPA PAPA NORTH PACIFIC OCEAN WIND MEASUREMENTS WAVE MEASUREMENTS WIND SPEED WAVE HEIGHT OCEANOGRAPHY METEOROLOGY CANADIAN ATMOSPHERIC ENVIRONMENT SERVICE HISTOGRAMS						

I-4

CONTENTS

ILLUSTRATIONS

TABLES

1. INTRODUCTION

A continuing investigation of the environmental conditions existing in the North Pacific Ocean, and their effects on NORPAX buoys that may be deployed in northern latitudes, is being conducted. As part of this investigation, observational data collected from ships occupying Ocean Weather Station PAPA were obtained from the Canadian Atmospheric Environment Service.

The data, extending over a 21 year period, provides a nearly continuous record of conditions at a specific location in the North Pacific, 50° N latitude and 145° W longitude. The data are the only known extensive set of consistent measurements which might be considered representative of environmental conditions in the northeastern Pacific area. Because the extremes of wind and wave conditions were of primary interest for this investigation, data from only the fall and winter months were processed to gain a better understanding of the severity of conditions which had existed, and their frequency of occurrence.

The results of this examination are considered to be of general interest to the oceanographic community. Therefore, 24 histograms of wind and wave conditions are presented in this report for general distribution.

1

2. OBSERVATION DATA FROM STATION PAPA

The entire set of oceanographic and meteorological data records for the period 1951 through 1971 was obtained from the archives of the Canadian Atmospheric Environment Service in Downsview, Ontario. The records include over 60,000 set of observations, and are in the form of a magnetic tape record equivalent to 80-column punched cards. The tape contains time-ordered observations from Ocean Weather Station PAPA in the World Meteorological Organization codes for the 1951 through 1971 period.

In general, the data are based on observations that were taken once every three hours, beginning at 0000 GMT. Wave data were often omitted during the hours from 0300 GMT to 1600 GMT (night time observations). Typically, over the period of interest, there were only half as many wave observations as there were wind observations; and wave observations during the early years were not made as regularly as they were later.

3. WIND SPEED AND WAVE HEIGHT DATA PROCESSING

The parameters of wind speed and wave height were examined using a computer program to construct histograms displaying the data distribution on a monthly basis. Because the primary interest was with environmental severity, attention was directed to the six fall/winter months (October through March). Further, the data were divided into two intervals for examination (1951 through 1961, and 1962 through 1971) in order to compare the two periods since there is a general belief that the wind/wave severity has diminished during the past 20 years.

Some specific characteristics of the data records affected construction of histograms for the wave data. During the period 1951 through 1967, wave height data had been encoded in half-meter increments by the integers 0 through 19. The maximum value was 9.5m, and there was no provision for waves of greater height. For the period 1968 and on, the code was extended to integers 0 through 99, permitting a maximum value of 49.5m. As a consequence of the earlier code limitations, it appears that values of 10m and greater were coded as if they were 9.5m. In forming histograms of the data, nine intervals 1-meter wide, and a tenth interval for all data values of 9.5m and greater, were used. For example, the first interval includes the data values of 0.0 and 0.5m, the second interval includes values of 1.0m and 1.5m, and so forth.

Coding of the wind speed data used integer values in knots, with an allowable range of 0 to 99. For these data, eight processing intervals were used, each of which spanned a 10-knot range. The first interval included all data values of 0 through 9 knots, the second included 10 knots through 19 knots, and so forth.

2

4.   HISTOGRAMS AND DATA COMPARISONS

4.1   DATA RECORDS

The histograms are shown at the end of this report.   The wind and wave pairs are
ordered by month for the period 1951 to 1961, and similarly by month for the period
1962 to 1971.   For each plot, the length of the "star" line represents the approximate
number of observations in the interval.   For example, the first interval for October
1951-1961 wind speed has a line length of 37.   This number, multiplied by the scaling
factor of 9, yields 333.   The exact number of observations (339) is listed in the corre-
sponding interval position in the frequency (FREQ) column.   To the left of this column
are listed the interval percentage (PCT) and the cumulative percentage (CUM) of the
total population.   Across the top of the histogram are listed, in order, the mean value
of the data, SIGMA, the minimum and maximum data values, and the number of
observations included in the histogram.

4.2   DATA COMPARISONS

The data permit some interesting comparisons regarding the change in conditions
during the past 20 years.   These are presented in Table 1.   The maximum wind speed
data and the mean wave height data show a definite lessening in severity.   The mean
wind speed data also show a similar trend, but to a much smaller extent.   Tc facilitate
the comparison, the mean wind speed and wave height data are plotted in Figures 1
and 2.   Seasonal trends are immediately evident in these plots.   The mean wave height
figure also reveals a surprisingly large dip for the months of January in the period
1962 to 1971.   Some of this apparent moderation is undoubtedly due to the enlarged
vertical scale.   However, examination of a listing of the January data tends to confirm
the effect.   Specifically, four extended duration intervals of data were found in the
years 1968, 1969, and 1970 for which the reported wave height was 1.5m or less.
Just under 200 observations are involved with over 90% having the value 1.0m or less.
The intervals are of 4 to 8 day duration, with wind generally in the 10 to 20 knot range.
Similar intervals are not present in the January data for the remaining years.   The
dip in mean value is also present in the 1951 to 1961 data, but to a much lesser degree.

Another way of examining the question of long term lessening in environmental severity
is to compare the two periods on the basis of the extent of high wind conditions (i.e.,
the percent of observations which equal or exceed a selected value).   Figure 3 presents
the percent of wind speed values equalling or exceeding 40 knots and 50 knots for each
of the six months.   The 40-knot curve for 1962 to 1971 has a January dip in wind level
which further confirms the dip in wave height.   Both sets of curves indicate that high
wind conditions occurred approximately twice as often in the 1951 to 1961 period than
in the 1962 to 1971 period.

Table 1. Comparative Wind and Wave Data

	MAX. WIND SPEED (KNOTS)		MEAN WIND SPEED (KNOTS)		MEAN WAVE HEIGHT (METERS)	
	1951-1961	1962-1971	1951-1961	1962-1971	1951-1961	1962-1971
October	71	69	22.78	23.04	3.17	2.34
November	78	64	25.03	24.59	3.60	2.57
December	75	66	25.55	24.13	3.52	2.42
January	75	61	23.66	22.56	3.31	1.95
February	62	62	23.59	21.67	3.38	2.27
March	70	60	21.20	20.73	3.22	2.08
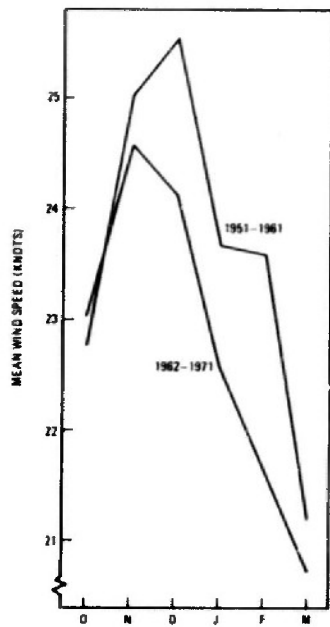
Figure 1. Wind Data
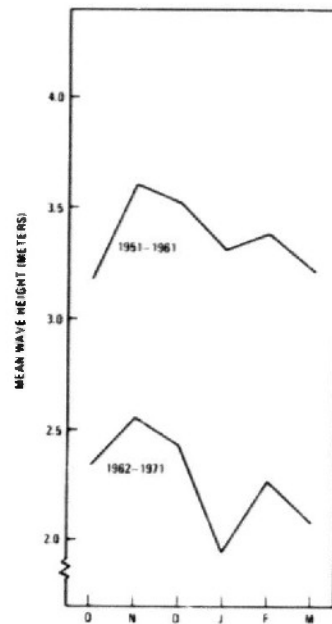
Figure 2. Wave Data
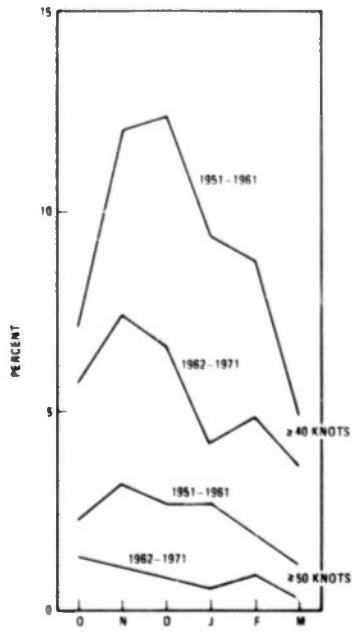
Figure 3.   Percent of Wind Speed Values Equaling or Exceeding
40 Knots and 50 Knots, Respectively

6

HISTOGRAMS

The data obtained from the computer processing of wind/
wave observations from Ocean Weather Station PAPA,
as described in the body of this report, are presented on
the following pages.

```
-------------------
VMU=   22.775 SIGMA=   11.467                              VMIN=   J.J00  VMAX=   71.000  NV=  2712

------------------------------------------------------------------------------------------------------
          PCT   CUM  FREQ.1...5...1....15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
------------------------------------------------------------------------------------------------------
  1     00-00  12.5  12.5  339 ********************************************
  2     10-10  26.0  38.5  706 ***********************************************************************
  3     20-20  32.1  70.6  869 **************************************************************************************
  4     30-30  22.5  93.0  619 ***********************************************************************
  5     40-40   4.5  97.9  131 **************
  6     50-50   1.6  99.5   44 ****
  7     60-60    .4  99.9   11 *
  8     70-70    .1 100.0    3
------------------------------------------------------------------------------------------------------
    SCALING FACTOR = 9
------------------------------------------------------------------------------------------------------
```

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF OCTOBER

PERIOD 1951 THRU 1961

VMU= 3.169 SIGMA= 1.831   VMIN= 0.000 VMAX= 9.500 NV= 1314

           PCT   CJM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
   1   0.0-0.9 2.6   2.6   34 ********
   2   1.0-1.9 19.6 22.1 257 **
   3   2.0-2.9 24.9 47.0 327 **
   4   3.0-3.9 22.5 69.5 295 **
   5   4.0-4.9 14.3 83.8 188 **
   6   5.0-5.9 7.6 91.4 100 *************************
   7   6.0-6.9 3.3 94.7   44 ***********
   8   7.0-7.9 1.9 96.7   25 ******
   9   8.0-8.9 1.4 98.1   19 ****
  10   9.0-10. 1.9 100.0   25 ******

       SCALING FACTOR = 4

WIND SPEED HISTOGRAM FOR THE MONTH OF NOVEMBER

PERIOD   1951 THRU 1961

VMU=   25.030 SIGMA=   12.134   VMIN=   3.000 VMAX=   78.000 NV= 2622

```
                   PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
------------------------------------------------------------------------------------------------------------------------
     1     00-09   9.0   9.0   235 ********************************
     2     10-19  25.3  34.3   664 *********************************************************************************
     3     20-29  29.7  64.0   779 ****************************************************************************************************
     4     30-39  24.1  88.1   631 ******************************************************************************
     5     40-49   8.8  96.9   232 ****************************
     6     50-59   2.1  99.0    54 ******
     7     50-69    .3  99.7    20 **
     8     70-79    .3 100.0     7
------------------------------------------------------------------------------------------------------------------------
     SCALING FACTOR = 8
------------------------------------------------------------------------------------------------------------------------
```

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF NOVEMBER

PERIOD   1951 THRU 1951

```
VMU=    3.598  SIGMA=    2.033                                          VMIN=    0.000  VMAX=    9.500  NV=  1097
```

```
            PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
```

```
  1    0.0-0.9  1.5    1.5    17 *****
  2    1.0-1.9 16.0   17.5   176 ********************************************************
  3    2.0-2.9 24.8   42.4   272 ****************************************************************************************
  4    3.0-3.9 17.2   59.6   189 ***************************************************************
  5    4.0-4.9 17.4   77.0   191 ****************************************************************
  6    5.0-5.9  7.3   84.3    80 ****************************
  7    6.0-6.9  6.8   91.2    75 *************************
  8    7.0-7.9  3.6   94.7    39 *************
  9    8.0-8.9  2.9   97.6    32 ***********
 10    9.0-19.  2.4  100.0    26 *********
```

    SCALING FACTOR = 3

WIND SPEED HISTOGRAM FOR THE MONTH OF DECEMBER

PERIOD   1951 THRU 1961

VMU=   25.550 SIGMA=   11.484   VMIN=   3.300 VMAX=   75.000 NV= 2461

```
                PCT    CJM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
```

		PCT	CJM	FREQ	
1	00-09	7.6	7.5	187	************************
2	10-19	22.6	30.2	556	**
3	20-29	31.5	61.7	776	**
4	30-39	26.0	87.8	641	**
5	40-49	9.6	97.4	236	******************************
6	50-59	2.3	99.6	56	*******
7	60-69	.3	100.0	8	*
8	70-79	.0	100.0	1	

SCALING FACTOR = 8

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF DECEMBER

PERIOD   1951 THRU 1961

```
-------------------

VMU=    3.522  SIGMA=    1.929                                    VMIN=    0.000  VMAX=    9.500  NV=  1621

-----------------------------------------------------------------------------------------------------------
            PCT    CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95...100
-----------------------------------------------------------------------------------------------------------
  1   0.0-0.9   1.6    1.6   16 *****
· 2   1.0-1.9  13.6   15.2  139 ***************************************************************
  3   2.0-2.9  25.0   40.2  255 ************************************************************************************************************
  4   3.0-3.9  24.0   64.2  245 *******************************************************************************************
  5   4.0-4.9  15.9   80.0  162 ************************************************************
  6   5.0-5.9   7.1   87.2   73 ***********************
  7   6.0-6.9   5.8   92.9   59 ******************
  8   7.0-7.9   2.2   95.1   22 *******
  9   8.0-8.9   1.8   96.9   18 ******
 10   9.0-19.   3.1  100.0   32 **********
-----------------------------------------------------------------------------------------------------------
    SCALING FACTOR = 3
-----------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF JANUARY

PERIOD 1951 THRU 1961

VMU=   23.663 SIGMA=   11.589   VMIN=   0.000 VMAX=   75.000 NV= 2520

==
            PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
     1   00-09 10.0 10.0   253 ****************************
     2   10-19 26.3 36.4   664 **
     3   20-29 32.9 69.3   829 **
     4   30-39 21.5 90.8   541 **
     5   40-49   6.7 97.4   168 ********************
     6   50-59   2.0 99.4   51 *****
     7   60-69   .4 99.9   11 *
     8   70-79   .1 100.0   3
==
       SCALING FACTOR = 9
==

14

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF JANUARY

PERIOD   1951 THRU 1961

```
----------------
VMU=    3.311  SIGMA=    1.936                                    VMIN=    0.000  VMAX=    9.500  NV=  1106
------------------------------------------------------------------------------------------------------------------------
              PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
------------------------------------------------------------------------------------------------------------------------
   1   0.0-0.9  1.2    1.2    13 ***
   2   1.0-1.9 19.2   20.3   212 ***************************************************
   3   2.0-2.9 28.4   48.7   314 *****************************************************************************
   4   3.0-3.9 19.5   68.3   216 ****************************************************
   5   4.0-4.9 12.0   80.3   133 ********************************
   6   5.0-5.9  6.8   87.1    75 ******************
   7   6.0-6.9  6.8   93.9    75 ******************
   8   7.0-7.9  2.1   95.9    23 *****
   9   8.0-8.9  1.9   97.8    21 *****
  10   9.0-19.  2.2  100.0    24 *****
------------------------------------------------------------------------------------------------------------------------
   SCALING FACTOR = 4
------------------------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF FEBRUARY

PERIOD   1951 THRU 1961

VMU=   23.593 SIGMA=   11.084   VMIN=   0.000 VMAX=   62.000 NV= 2478

           PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
  1   00-09   8.7   8.7   215 ****************************
  2   10-19   29.3   38.0   727 ***
  3   20-29   30.4   68.4   753 ***
  4   30-39   23.0   91.4   569 **
  5   40-49   6.9   98.2   170 **********************
  6   50-59   1.7   99.9   41 *****
  7   60-69   .1 100.0   3
  8   70-79   0.0 100.0   0

      SCALING FACTOR = 8

16

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF FEBRUARY

PERIOD   1951 THRU 1961

```
------------------

VMU=    3.384  SIGMA=    1.951                                    VMIN=    0.000  VMAX=    9.500  NV=  1234
----------------------------------------------------------------------------------------------------------
              PCT    CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----------------------------------------------------------------------------------------------------------
   1     0.0-0.9   1.6    1.6    20 *****
   2     1.0-1.9  21.2   22.9   262 ***********************************************************
   3     2.0-2.9  24.5   47.3   302 ****************************************************************************
   4     3.0-3.9  16.0   63.3   197 ************************************************
   5     4.0-4.9  13.7   77.0   169 ******************************************
   6     5.0-5.9   9.6   86.6   119 ******************************
   7     6.0-6.9   7.4   94.0    91 ***********************
   8     7.0-7.9   2.8   96.8    35 *********
   9     8.0-8.9   1.3   98.1    16 ****
  10     9.0-19.   1.9  100.0    23 *****
----------------------------------------------------------------------------------------------------------
     SCALING FACTOR = 4
----------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF MARCH

PERIOD   1951 THRU 1961

VMU=   21.214 SIGMA=   10.773   VMIN=   0.000 VMAX=   70.000 NV= 2719

          PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100

----

 1   00-09 13.2 13.2   359 **********************************
 2   10-19 31.5 44.7   857 ***
 3   20-29 32.0 76.7   869 ***
 4   30-39 18.5 95.2   503 **
 5   40-49   3.6 98.8   98 **********
 6   50-59   1.0 99.8   28 ***
 7   60-69   .1 99.9   3
 8   70-79   .1 100.0   2

     SCALING FACTOR = 9

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF MARCH

PERIOD   1951 THRU 1961

```
------------------

VMU=    3.223  SIGMA=     1.812                                            VMIN=      3.003  VMAX=      9.500  NV =  1358

------------------------------------------------------------------------------------------------------------------------
             PCT   CUM FREQ.1...5...1u...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
------------------------------------------------------------------------------------------------------------------------
   1    0.0-0.9   3.0    3.0     41 **********
   2    1.0-1.9  18.3   21.4    249 *********************************************************
   3    2.0-2.9  27.6   49.0    375 *********************************************************************************************
   4    3.0-3.9  16.5   65.5    224 ****************************************************
   5    4.0-4.9  13.1   78.6    178 *****************************************
   6    5.0-5.9  12.7   91.3    173 ****************************************
   7    6.0-6.9   4.0   95.3     54 *************
   8    7.0-7.9   2.1   97.3     28 *******
   9    8.0-8.9   1.5   98.9     21 *****
  10    9.0-19.   1.1  100.0     15 ***
------------------------------------------------------------------------------------------------------------------------
     SCALING FACTOR = 4
------------------------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF OCTOBER

PERIOD   1962 THRU 1971

VMU=   23.036 SIGMA=   10.266   VMIN=   0.000 VMAX=   69.000 NV= 2437

                PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
  1   00-09   7.7   7.7   188 ********************
  2   10-19 30.1   37.8   734 ***
  3   20-29 36.7   74.5   894 **
  4   30-39 19.5   94.1   476 **
  5   40-49   4.7   98.7   114 *************
  6   50-59   1.1   99.8   26 **
  7   60-69   .2 100.0   5
  8   70-79   0.0 100.0   0

      SCALING FACTOR = 9

20

WAVE HEIG HISTOGRAM FOR THE MONTH OF OCTOBER

PERIOD   1962 THRU 1971

VMU=   2.339 SIGMA=   1.891   VMIN=   0.300 VMAX=   9.500 NV= 1912

		PCT	CUM	FREQ.1...5...10...15..20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
1	0.0-0.9	17.9	17.9	343 ••
2	1.0-1.9	24.0	41.9	458 ••
3	2.0-2.9	27.9	69.8	533 •••
4	3.0-3.9	12.6	82.3	240 •••••••••••••••••••••••••••••••••••••••
5	4.0-4.9	7.7	90.1	148 •••••••••••••••••••••••••
6	5.0-5.9	3.3	93.4	64 •••••••••••
7	6.0-6.9	3.2	96.7	62 •••••••••••
8	7.0-7.9	1.6	98.2	30 •••••
9	8.0-8.9	.5	98.7	10 •
10	9.0-19.	1.3	100.0	24 ••••

SCALING FACTOR = 6

WIND SPEED HISTOGRAM FOR THE MONTH OF NOVEMBER

PERIOD   1962 THRU 1971

```
------------------
VMU=    24.589  SIGMA=     9.863                                    VMIN=    0.000  VMAX=    64.000  NV=  2375
-----------------------------------------------------------------------------------------------------------------
             PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
-----------------------------------------------------------------------------------------------------------------
  1   00-09   5.8   5.8   138 ****************
  2   10-19  25.9  31.7   615 ***********************************************************************
  3   20-29  36.6  68.3   870 *****************************************************************************************************
  4   30-39  24.5  92.8   581 *****************************************************************
  5   40-49   6.1  98.9   145 *****************
  6   50-59   1.0  99.9    24 **
  7   60-69    .1 100.0     2
  8   70-79   0.0 100.0     0
-----------------------------------------------------------------------------------------------------------------
     SCALING FACTOR = 9
-----------------------------------------------------------------------------------------------------------------
```

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF NOVEMBER

PERIOD   1962 THRU 1971

VMU=	2.566	SIGMA=	2.057				VMIN=	3.000	VMAX=	12.000	NV=	1877

```
                    PCT   CUM FREQ.1...5...10...15...2J...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
-----------------------------------------------------------------------------------------------------------------------------------
    1    0.0-0.9 17.6  17.6   331 ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
    2    1.0-1.9 20.8  38.4   390 ••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
    3    2.0-2.9 23.8  62.2   446 •••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
    4    3.0-3.9 16.0  78.2   300 •••••••••••••••••••••••••••••••••••••••••••••••••••••••••••
    5    4.0-4.9  9.2  87.3   172 ••••••••••••••••••••••••••••••••••
    6    5.0-5.0  3.6  90.9    67 •••••••••••••
    7    6.0-6.0  4.7  95.6    89 •••••••••••••••••
    8    7.0-7.9  1.5  97.1    28 •••••
    9    8.0-8.9  1.2  98.3    23 ••••
   10    9.0-19.  1.7 100.0    31 ••••••
-----------------------------------------------------------------------------------------------------------------------------------
    SCALING FACTOR = 5
-----------------------------------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF DECEMBER

PERIOD   1962 THRU 1971

VMU=   24.127 SIGMA=   10.135   VMIN=   0.000 VMAX=   66.000 NV= 2434

              PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
  1   00-09   6.2   6.2   152 ****************
  2   10-19 27.9 34.1   678 **
  3   20-29 35.4 69.5   862 ***
  4   30-39 23.9 93.4   582 ***
  5   40-49   5.8 99.2   141 ***************
  6   50-59   .6 99.8   14 *
  7   60-69   .2 100.0   5
  8   70-79   0.0 100.0   0

     SCALING FACTOR = 9

PERIOD   1962 THRU 1971

VMU=   2.424 SIGMA=   2.079   VMIN=   0.000 VMAX=   11.500 NV= 1898

		PCT	CUM	FREQ	.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
1	0.0-0.9	21.2	21.2	402	**
2	1.0-1.9	21.1	42.3	401	***
3	2.0-2.9	23.4	65.7	444	**
4	3.0-3.9	12.3	78.0	234	**
5	4.0-4.9	9.4	87.4	178	***********************************
6	5.0-5.9	4.6	92.0	87	*****************
7	6.0-6.9	4.0	96.0	76	***************
8	7.0-7.9	1.4	97.4	27	*****
9	8.0-8.9	1.1	98.5	21	****
10	9.0-10.	1.5	100.0	28	*****

SCALING FACTOR = 5

WIND SPEED HISTOGRAM FOR THE MONTH OF JANUARY

PERIOD   1962 THRU 1971

| VMU= | 22.558 | SIGMA= | 9.474 | | VMIN= | 0.000 | VMAX= | 61.000 | NV= | 2367 |

		PCT	CUM	FREQ	.1...5...1v...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
1	00-09	7.2	7.2	171	*******************
2	10-19	31.7	38.9	750	**
3	20-29	37.2	76.1	881	***
4	30-39	19.9	96.0	471	**
5	40-49	3.5	99.5	83	**********
6	50-59	.4	99.9	9	*
7	60-69	.1	100.0	2	
8	70-79	0.0	100.0	0	

SCALING FACTOR = 9

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF JANUARY

PERIOD   1962 THRU 1971

VMU=   1.951 SIGMA=   1.589   VMIN=   0.001 VMAX=   9.500 NV= 1795

              PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
----
   1   0.0-0.9 21.0   21.0   377 ***
   2   1.0-1.9 29.5   50.5   529 **
   3   2.0-2.9 25.3   75.8   454 ***
   4   3.0-3.9 11.9   87.6   213 ***********************************
   5   4.0-4.9   7.1   94.8   128 *********************
   6   5.0-5.9   2.0   96.8   36 ******
   7   6.0-6.9   1.9   98.7   35 *****
   8   7.0-7.9   .7   99.4   12 **
   9   8.0-8.9   .2   99.6   3
  10   9.0-10.   .4 100.0   8 *

      SCALING FACTOR = 6

27

WIND SPEED HISTOGRAM FOR THE MONTH OF FEBRUARY

PERIOD   1962 THRU 1971

VMU=   21.669 SIGMA=   10.534   VMIN=   0.000 VMAX=   62.000 NV= 2255

		PCT	CUM	FREQ	.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
1	00-09	12.7	12.7	286	******************************
2	10-19	30.8	43.6	694	***
3	20-29	32.7	76.2	735	***
4	30-39	18.8	95.1	424	**
5	40-49	4.1	99.2	93	***********
6	50-59	.8	100.0	17	**
7	60-69	.0	100.0	1	
8	70-79	0.0	100.0	0	

SCALING FACTOR = 8

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF FEBRUARY

PERIOD   1962 THRU 1971

```
------------------

VMU=    2.271  SIGMA=     1.815                                          VMIN=     J.J00  VMAX=    12.000  NV=  1813

------------------------------------------------------------------------------------------------------------------
              PCT    CJM FREO.1...5...1...15...20...25...30...35...40...45...5J...55...60...65...70...75...80...85...90...95..100
------------------------------------------------------------------------------------------------------------------
     1    C.C-C.C  19.7   19.7   357 **************************************************************************
     2    1.C-1.C  22.2   41.9   403 *******************************************************************************
     3    2.0-2.C  26.0   67.9   471 ***********************************************************************************
     4    3.C-3.9  15.3   83.2   277 *****************************************************
     5    4.C-4.C   9.0   92.2   164 *********************************
     6    5.C-5.C   2.8   95.0    50 **********
     7    6.C-6.C   2.8   97.7    50 **********
     8    7.C-7.9    .9   98.7    17 ***
     9    8.C-8.9    .4   99.1     7 *
    10    9.C-1C.    .9  100.u    17 ***
------------------------------------------------------------------------------------------------------------------
     SCALING FACTOR = 5
------------------------------------------------------------------------------------------------------------------
```

WIND SPEED HISTOGRAM FOR THE MONTH OF MARCH

PERIOD   1962 THRU 1971

```
------------------

VMU=   20.727 SIGMA=    9.748                                      VMIN=    0.000  VMAX=   60.000  NV=  2481
**************************************************************************************************************
              PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
**************************************************************************************************************
    1    00-09  11.7  11.7  291 *********************************
    2    10-19  37.6  49.4  934 ****************************************************************************************************************
    3    20-29  30.5  79.3  756 *****************************************************************************************
    4    30-39  17.0  96.8  421 **************************************************
    5    40-49   2.9  99.8   73 *******
    6    50-59    .2 100.0    5
    7    60-69    .0 100.0    1
    8    70-79   0.0 100.0    0
**************************************************************************************************************
      SCALING FACTOR =10
**************************************************************************************************************
```

WAVE HEIGHT HISTOGRAM FOR THE MONTH OF MARCH

PERIOD 1962 THRU 1971

| VMU= | 2.083 | SIGMA= | 1.734 | | | VMIN= | 0.000 | VMAX= | 10.500 | NV= | 1913 |

```
                    PCT   CUM FREQ.1...5...10...15...20...25...30...35...40...45...50...55...60...65...70...75...80...85...90...95..100
 1    0.0-0.9  19.5  19.5   373 ********************************************************************
 2    1.0-1.9  30.4  49.9   582 *********************************************************************************************************
 3    2.0-2.9  23.9  73.8   457 ***********************************************************************************
 4    3.0-3.9  11.4  85.2   218 ***************************************
 5    4.0-4.9   7.3  92.5   139 *************************
 6    5.0-5.9   2.9  95.4    56 *********
 7    6.0-6.9   2.5  97.9    47 ********
 8    7.0-7.9   1.5  99.3    28 ****
 9    8.0-8.9    .1  99.4     1
10    9.0-10.    .6 100.0    12 **
```

SCALING FACTOR = 6