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THE COMPUTATIONAL SCHEME OF A NUMERIC
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J. Hodson and M. Donelan

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THE COMPUTATIONAL SCHEME OF A NUMERICAL MODEL FOR WAVE AND WIND STRESS PREDICTION

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Applied Research Division and
Hydraulics Research Division
Canada Centre for Inland Waters
Burlington, Ontario
March 1978

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FOREWORD: MANAGEMENT PERSPECTIVE

This report provides all the details for an engineer, oceanographer or limnologist to prepare a computer program which will predict the significant wave heights and the peak period of the spectrum, provided the wind velocities are known throughout the generating area. Both heights and period are forecast as a function of time and any point in the forecast area may be selected. The accuracy and stability of this program is believed to be superior to previously published methods and is recommended for adoption by all engineers or scientists requiring accurate wave climate forecasts and hindcasts.

T. M. Dick
Chief
Hydraulics Research Division
National Water Research Institute

AVANT-PROPOS: PERSPECTIVE - GESTION

Ce rapport fournit tous les détails dont ont besoin un ingénieur, un océanographe ou un limnologiste pour préparer un programme informatique qui prévoira les hauteurs significatives des vagues et la période de pointe du spectre, à condition que la vitesse du vent soit connue dans tout le secteur de formation des vagues. La hauteur et la période sont toutes deux prévues en fonction du temps et il est possible de choisir n'importe quel point du secteur de prévision. L'exactitude et la stabilité de ce programme le rendent, pense-t-on, supérieur aux méthodes publiées antérieurment et il est donc proposé à tous les ingénieurs ou chercheurs de l'adopter s'ils ont besoin de données exactes sur les prévisions et les prévisions a posteriori du mouvement des vagues.

ABSTRACT

A computer program for the time-dependent prediction of wind waves and wind stress on a two-dimensional grid has been designed using the physical basis given by Donelan (1978). At each grid point, the waves are assumed to have the JONSWAP spectrum, and therefore are described by the peak frequency, average direction and the wave age only. Wave age is the ratio of peak wave phase speed to wind speed (input), and the peak wave phase speed is uniquely related to the peak frequency. This short report is intended as an aid to users of the Wave And Wind Stress Prediction computer program. It provides an outline of the computational scheme in sufficient detail to readily permit changes, which will be required to fit the program to a different computer with perhaps different wind information. In addition, there are appendices describing the cards and wind information required as input to the computer program. A computer listing and sample output are also appended. Prospective users may obtain a Fortran deck by writing directly to the second author.

RÉSUMÉ

Un programme informatique pour la prévision, dépendant du temps, des ondes dues à l'action du vent et de l'effort du vent, sur un quadrillage à deux dimensions, a été conçu en utilisant le fondement physique fourni par Donclan (1978). À chaque point du quadrillage, les vagues sont censées avoir le spectre JONSWAP et ne sont par conséquent décrites qu'en fonction de la fréquence maximale, de la direction moyenne et de l'âge de la vague. Celui-ci correspond au rapport entre la vitesse de propagation de l'amplitude maximale et la vitesse du vent (données d'entrée), la vitesse de propagation de l'amplitude maximale n'ayant un rapport qu'avec la fréquence maximale. Ce bref rapport a pour object d'aider les utilisateurs du programme informatique de prévision de l'effort des vagues et du vent. Il fournit un exposé concis du système de calcul avec assez de détails pour permettre d'effectuer rapidement les changements qui seront nécessaires afin d'adapter le programme à un ordinateur différent et qui comprendrait peut-être d'autres renseignements sur le vent. De plus, il y a des annexes qui décrivent les cartes nécessaires et exposent les renseignements sur le vent qui sont requis comme données d'entrée au programme informatique. Un imprimé d'ordinateur et un example d'état de sortie sont également joints. Les utilisateurs éventuels peuvent obtenir un jeu de cartes Fortran en écrivant directement au second auteur.

1. INTRODUCTION

A time dependent two-dimensional numerical model for wave and wind stress prediction (given the surface wind) has been devised by Donelan (1978). The model is a finite difference solution to the local wave momentum balance equation, in which the wave spectrum is assumed to have the JONSWAP (Hasselmann et al, 1973) shape and, as such, is described by three parameters: the peak frequency f_p, the Phillips equilibrium range parameter α and the mean propagation direction θ_o. In fact, the first two parameters are linked through the wave age $g/(2\pi f_p U)$.

$$\alpha = 0.0097 \left(\frac{g}{2\pi f_p U}\right)^{-2/3} \qquad (1)$$

Effectively then, the wave spectrum, at each grid point, is defined by f_p and θ_o.

This short report is designed as an aid to users of the Wave And Wind Stress Prediction program "WAWSP". Interested users are referred to Donelan (1978) for the scientific basis of the prediction scheme. The following equations and relationships are taken from that source.

2. EQUATIONS AND RELATIONSHIPS

The <u>local momentum balance equation</u> is solved in the following form:

$$\frac{\partial M_i}{\partial t} + \frac{\partial}{\partial x_j} (\bar{v}_j M_i) = \frac{\gamma}{\rho_w g} (\tau_f)_i \qquad (2)$$

$$i = x, y$$
$$j = x, y$$

where the average group velocity $\bar{v}$ is defined in terms of the peak phase velocity C_p.

$$\bar{\vec{v}} = 0.365 \vec{C}_p \qquad \text{m/sec} \qquad (3)$$

$$C_p = \frac{g}{2\pi f_p} \qquad \text{m/sec} \qquad (4)$$

M_i and $(\tau_f')_i$ are the momentum and form drag components respectively. ρ_w is the density of water, g is the acceleration due to gravity and γ is the fraction of the form drag which acts to increase the momentum of the wave field. It is taken to be a constant,

The following relationships are used to simplify the computation. They are given in or easily derived from Donelan (1978).

$$\text{Significant Height, } H = 4\sigma \qquad \text{m} \qquad (5)$$

where σ is the r.m.s. surface deviation.

$$\sigma^2 = 0.0181 \times \alpha \times f_p^{-4} \qquad \text{m}^2 \qquad (6)$$

$$f_p = \left(0.01162 \times 0.033 \times \left(\frac{U}{g}\right)^{2/3} \times \frac{1}{|N|}\right)^{3/7} \qquad \text{secs.} \qquad (7)$$

where $|N| = \sigma^2 / C_p$.

$$\alpha = 0.033 \times \left(\frac{U}{g}\right)^{2/3} \times f_p^{2/3} \qquad (8)$$

if $\alpha < 0.006$, it is set equal to 0.006 in which case (7) becomes

$$f_p = \left(\alpha \times 0.01162 \times \frac{1}{TNT}\right)^{1/3} \qquad (9)$$

3. PROGRAM STRUCTURE

The following is a brief description of the program and the flow of information through it. The program listing and sample output are reproduced in Appendix D and a deck of cards may be obtained by writing to the second author.

Main Program	- WAWSP
Explicit Subroutines	- WAVE
	- WINDINP
	- COMBING
	- JULIAN
Implicit Subroutines	- EXFLOW
	- ZEROV
	- RTIME
Calcomp Plotter Subroutines	
	- Plot
	- Factor
	- Symbol
	- Number

3.1 Main Program

"WAWSP" reads in the depth and wind data from tape (unit 1), controls the other subroutines, plots the wind data, lists the results (unit 61) and also writes them to disk (unit 42).

The main steps are as follows:

1. Read values from the three data cards (unit 60). See Appendix A.
2. Read the lake depths from the wind data tape and set depths at all lake points to 100000 and at all shore points to -100000. See Appendix B.
3. Advance the tape to the starting wind time and read a record of wind data and the next wind time. Convert wind to m/s and direction "to" rather than "from".
4. Shrink the number of grid points, if requested. This doubles, triples or quadruples the grid spacing. Depths are averaged to decide if expanded grid square is in lake or on shore.
5. Calculate the current time and date.
6. If the current time ≥ wind time, read another record of wind data, and the next time. Convert wind to m/s and direction "to" rather than "from".

7. Produce synoptic plot of the wind if requested at this time.
8. Call S/R WAVE. For each grid point:
    - (a) on the first timestep, initialize some variables
    - (b) call S/R WINDINP to calculate the vertical flux
    - (c) calculate and plot the stress (Appendix E.1)
    - (d) calculate the horizontal flux
    - (e) calculate the new momentum components
    - (f) call S/R COMBINE to combine momentum components
    - (g) calculate the frequencies and significant heights of the waves in each wave field.
    - (h) plot the significant heights of the waves in the direction of their group velocities. See Appendix E.2.
    - (i) for the four selected stations, save information for spectral plots.
9. Print the significant wave heights for all grid points at requested times.
10. Print the results at the four stations.
11. Write the results to disk.
12. Go to step 5 until the specified number of timesteps have been performed.

Note: The time printed or plotted is correct for the wind and the stress, but the wave information corresponds to one time step later.

3.2 Subroutine Descriptions

"WAVE" is called once per time step and solves equation (2) in the following form

$$(N_i)_{t+1} = (N_i)_t + \left[\left\{ \frac{0.86\gamma}{2\rho_w g} (\tau_f)_i \right\} \mp \left\{ \frac{(\bar{v}_j N_j)_{x_j \pm \Delta x_j} - (\bar{v}_j N_j)_{x_j}}{\Delta x_j} \right\} \right] \Delta t \qquad (10)$$

$$i = x, y$$
$$j = x, y$$

Wherein the top signs are used if $\bar{v}_j$ is positive and the bottom ones if $\bar{v}_j$ is negative.

In other words the horizontal derivative term is taken "upwave" rather than centred; and where

$$N_i = 0.86\ M_i$$

Δx_j is the grid size (GRID SIZ)

The pair of equations (10) are solved twice - once for the "active wave field and once for the "fossil" wave field, where the distinction between them was made at time step t. The momentum input from the wind (the term involving τ_f in (10)) is obtained by a call to subroutine "WINDINP".

"WINDINP" returns three values of τ_η in the directions of the wind, the active wave field, and the fossil wave field. The first two are input to the active wave field; the last to the fossil wave field. They are stored as x and y components. The kinematic form stress τ_f/ρ_a is reconstituted by dividing τ_η by $0.86\ \gamma\ \rho_a/\rho_w g$. To the x and y components of this is added the kinematic skin stress $C_s|U|\vec{U}$. The skin stress coefficient C_s is taken to be a constant = 0.0007. A synoptic calcomp plot of the stress field is overlaid on the wind field (plotted by "WAWSP") at time (t). The crossed-headed arrows represent the normalized stress field. Arrow length is proportional to stress, and the dimensionless scaling factor (STRSC) referred to a full size plot (PLOTFACT=1.0) is indicated. The dimensionless scaling factor STRSC = $(\mathrm{USCALE})^2$ *CDSCALE; where USCALE is the wind speed scale and CDSCALE is a drag coefficient scale defined in a data statement in the main program. To recover the stress in dynes/cm^2, multiply the length of the stress arrow in inches by $\mathrm{STRSC} \times \rho_a \times 10^4/\mathrm{PLOTFACT}$.

At this point, the eastwards (STRESX) and northwards (STRESY) components of the kinematic stress in $(\mathrm{m/s})^2$ at the grid point (I, J) are available at time (t). These may be converted to dynamic stress by multiplying by ρ_a. Note that ρ_a is the density of air at 15°C and not a variable. The reason for this is explained in the description of the wind input (Appendix B).

At this stage, subroutine "COMBINE" is called with the two pairs of momentum components and the two wind components. If the active wave field is not within 90 degrees of the wind, this subroutine relabels the components so that those in the quadrant of the wind are the active wave field. The components in the remaining three quadrants are combined into the fossil wave field. The fossil wave field is then resolved into components, colinear with, and, perpendicular to, the active wave field. If the colinear component is parallel with the active wave field, that component only is added to it; if anti-parallel, the fossil wave field remains untouched.

The recombined values of $|N|_{t+1}$ determine θ_o and are applied to (4) and (7) or (9) to determine f_p and σ for the active and fossil wave fields separately.

For the first timestep only, certain values are initialized for each grid point at the start of WAVE. The significant heights are set to zero and the angles of the active and fossil wave fields are set equal and opposite to the wind respectively. Although this sounds paradoxical, the need for setting the angles as well arises because "WINDINP" must assume that some form drag elements (capillary waves?) are available at the start - otherwise there would be no waves generated. Thus we align the form drag elements correctly even though no gravity waves have yet been produced.

The phase velocities are calculated and stored. In fact, they could be recalculated when needed in the solution of (10). This would reduce the storage area required, but markedly increase the computation time.

Values of α, f_p and σ are saved for four selected (see Appendix A) stations for later reconstruction of the JONSWAP spectrum by another program.

When equations (10) have been solved for all the grid points in the lake, an average scalar drag coefficient C_D is calculated

$$C_D = \frac{|\tilde{\tau}|}{|\tilde{U}|^2} \qquad (11)$$

where the tilda denotes a lakewide average.

A synoptic calcomp plot of the wave fields is then produced at time (t+1). The arrows represent the active wave field and the diamond-headed arrows represent the fossil wave field. Arrow length is proportional to significant height, and the scaling factor referred to a full size plot (PLOTFACT=1.0) is indicated.

Finally, the old momentums are set equal to the new momentums, and subroutine "WAVE" returns.

Subroutine "JULIAN" simplifies the handling of input and output times by converting between Julian and Gregorian calendars (see Appendix C).

The implicit subroutines "EXFLOW", "ZEROV" and "RTIME" do not appear in the listing as they are part of the CCIW program library. They may easily be replaced by equivalents.

"EXFLOW" is called once and is the first executable statement in the main program "WAWSP". It sets all overflows and underflows to zero. Without it, the squaring of a very small number would return a large number if the doubled exponent were a larger than allowed negative exponent.

"ZEROV" simply permits the easy zeroing of arrays. The first argument is the first value to be zeroed; the second argument is the number of consecutive values to be zeroed.

"RTIME" is called at the start of each time step in the simulation. It returns the amount of CPU time left for this job in seconds. If less than 30 seconds are left, the plot tape is ended, and the job stops. Thus, all the plots are not lost, and the job does not abort.

3.3 Flow Diagram

```
        WAWSP
          ↓
call  EXFLOW
call  ZEROV
read data cards
read depths from wind data tape and find starting wind time
shrink the lake
call JULBASE
call JULIAN
for each timestep
    call RTIME
    call GREGOR
    read a record of wind data
    produce wind plot
    call WAVE  ——→  for each grid point
                        call WINDINP  ——→  calculate vertical flux
                        calculate and plot stress
                          on wind plot
                        calculate drag coefficient
                        calculate horizontal flux
                        check boundary conditions
                        calculate new momentum
                        call COMBINE  ——→  combine momentum components
                        calculate frequency and
                          significant height of waves

                    produce wave plot

                    RETURN
    print results
    write to disk

END
```

4. GRID SIZE, TIME STEP AND NUMERICAL STABILITY

The Courant condition (Donelan, 1978) limits the maximum time step Δt:

$$\Delta t \leq \frac{1}{0.365} \frac{\Delta x}{C_{MAX}} \tag{12}$$

where C_{MAX} is the maximum phase speed likely to occur in the system. This may be roughly estimated from Bretschneider's (1973) formulas or any of several wave nomograms.

Clearly, increasing the grid size by a factor n reduces the number of grid points and permits an increase in Δt (12), thereby allowing a computational reduction of order n^3. The program is designed to permit easy application of this economy if desired. A single parameter, ISHRINK, causes the effective grid size to increase by 2, 3 or 4, and the user may adjust Δt (TIMEST) according to (12) without introducing numerical instability. Tests have been carried out on Lake Ontario for the storm shown in Donelan (1978) with grid spacings of 5080, 10160, 15240 and 20320 metres and corresponding time steps of 10, 20, 30 and 40 minutes. The results are not significantly different.

The program is now set up for Lake Ontario on a 5080 metre grid spacing; so the arrays are dimensioned 60 x 23 (IGD x JGD). For a different lake, the following need to be changed:

a) dimensions of arrays: U, ISIG, CMON, ICMON, C, DEPTH

b) IGD and JGD which are set at the start of the main program. IGD and JGD are the number of grid points in the x and y directions, respectively.

d) the grid size, GRIDSIZ, which is presently set to 5080 m. It is set in a data statement in subroutine WAVE.

d) the data tape, which includes the depths, times, and x and y components of wind data (see Appendix B).

ACKNOWLEDGEMENTS

We are grateful to Dr. T. J. Simons and Ms. J. Dowell for the use of some of their computer subroutines.

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APPENDIX A

INPUT

A.1) THREE DATA CARDS

	Columns	Format	Name	Description	
Card 1	1 - 5	I5	ID	Identification number for this run	
	6 - 10	I5	NOSTEP	Number of steps to be performed	
	11 - 15	F5.0	TIMEST	Time interval between steps, in minutes	
	16 - 20	F5.0	USCALE	Wind scale for plotting in m/sec per inch	
	21 - 25	F5.0	SIGHTSC	Scale for plotting significant wave height in metres per inch	
	26 - 30	F5.0	PLOTFACT	Scale factor for size of plots (If PLOTFACT=1.0, 36" paper is needed)	
	31 - 33	I3	NOPLOTS	Number of plots of wind and waves	
	34 - 35	I2	ISHRINK	factor to shrink the number of grid points 1, 2, 3 or 4 only	
	36 - 40	F5.0	INTERV	Time interval between plots, in hours	
	41 - 80	10A4	IEXPL	A brief explanation of this run	
Card 2	1	1X		Blank	repeat for four stations
	2 - 5	A4	NSTAT(1)	Station name 1	
	6 - 10	I5	IST(1)	x grid coordinate of station 1	
	11 - 15	I5	JST(1)	y grid coordinate of station 1	
	16	1X		B	
	17 - 20	A4	NSTAT(2)	Station name 2	
	.	.		.	
	.	.		.	
	.	.		.	
	56 - 60	I5	JST(4)	Y grid coordinate of station 4	
Card 3	1 - 5	I5	IYEARW	Start year for wind (1900 → 1999)	

6 - 10	I5	MONTHW	Start month for wind (1 → 12)
11 - 15	I5	IDATEW	Start day for wind (1 → 31)
16 - 20	I5	IHOURW	Start hour for wind (0 → 23)
21 - 25	I5	MINW	Start minute for wind (0 → 59)
26 - 50	5I5	LISTST(I)	Start year, month, day, hour, minute for listing of results at the four stations
51 - 75	5I5	IPLOTST(I)	Start year, month, day, hour, minute for plotting

A.2) ONE DATA TAPE CONTAINING: (details in Appendix B)

depths in metres for all grid points

year, month, day, hour, and minute of wind data
x and y components of wind for all grid points

repeat until E-0-F

A.3) OUTPUT

A) listing of all variables controlling this run.
B) listing of results at the four stations at each timestep, starting at the listing start time.
C) listing of the significant wave heights at all grid points whenever a plot is produced, and starting at the listing start time.
D) plot showing wind and stress when plots are requested.
E) plot showing significant wave heights and wave directions when plots are requested.
F) a disk file containing results at the four stations at each timestep.

APPENDIX B

B.1) DEPTH AND WIND INPUT

The program is designed to accept the lake shape in the form of depths at all grid points on a 60 x 23 grid. The first record on the "wind" tape contains this depth information. As it stands, the program assumes that the waves are deep water waves, and so uses the depth information simply as an indicator of the shoreline. To simplify the locating of the shoreline on the expanded grid, the depths are all set to numbers equal in magnitude but different in sign depending on whether the grid point is on land (negative) or water (positive). The new grid points are assigned negative or positive values according as the average "depth" over a square, of side 2 x ISHRINK - 2 centred on the grid point, is negative or positive. Cautionary note: This averaging of the shoreline may assign a grid point to the lake which was originally on the shore on the basic grid. This will produce an error if the wind was computed only at the lake grid points. The error will arise in the call to "ATAN2" with the wind components in both "WAWSP" and "WAVE". Two solutions are available: compute the wind at the offending grid points - these may be determined by printing out I and J when U(1, I, J) and U(2, I, J) are both zero; or compute the wind at the grid points just inside the shore around the lake.

The wind information starts at the second record, and the time on each record is the Greenwich Mean Time corresponding to the centre of the wind record. The wind is in the form of Westward and Southward components (direction from) which are in units of cm/sec. The program assumes that the wind has been measured or adjusted to the standard meteorological height of 10 m. A further adjustment is made to the wind speed to account for the effect on the stress of varying air density. That is the wind speed is multiplied by the square root of the ratio of the air density at temperature to the air density at 15°C. For this reason, all reference to air density ρ_a above implies air density at 15°C. Of course, this introduces a slight error in the wind speed itself, but it is of less importance than the consequent stress error without it. Ideally, the wind speed and temperature should both be read in by "WAWSP" and the density correction made directly. This was not done, because it would reduce the length of wind data possible on one tape. However, it is a simple matter to adjust the program to allow a direct density correction.

For our purposes, the density of water is effectively constant and given its value at 15°C.

B.2) FORMAT OF THE WIND DATA TAPE:

The tape is written in binary mode by WRITE(i) in another program.

The following statements are used to read the tape:

```
  READ (1)  ((DEPTH (I, J), J=1, JGD), I=1, IGD)
┌[READ (1)  IYEAR, MONTH, IDATE, IHOUR, MIN
│[READ (1)  (U(1, I, J), U(2, I, J), J=1, JGD), I=1, IGD)
│
└→ repeat until E-0-F.
```

The array subscripts are used like Cartesian coordinates in referring to the position of the point on the lake, i.e. point (1, 1) is the lower right, and (1, JGD) is the upper left, (IGD, 1) is the lower right, and (IGD, JGD) is the upper right. For Lake Ontario, IGD=60 and JGD=23.

The depths are used only to indicate shorelines, so values greater than zero are points in the lake, the rest are on land.

u (1, I, J) is the west component of the wind at point (I, J) in cm/sec, and u (2, I, J) is the south component.

APPENDIX C

SUBROUTINE "JULIAN"

C.1) Author: J. Dowell, CCIW, April 1977

JULIAN - determine the number of days by which a Gregorian Calendar date occurs after a specified base date, i.e. Julian Day.

GREGOR - determine the Gregorian Calendar date which applies to a specified number of days after a base date.

JULBASE - initialize subroutines JULIAN and GREGOR by supplying the base date.

C.2) CALL JULIAN (JUL, IY, IM, ID)

Convert Georgian Calendar date to Julian Day.

JUL - returned value of Julian Day
IY - supplied Gregorian Year
IM - supplied Gregorian Month
ID - supplied Gregorian Day

Note: If day supplied is day-of-year then set month to 1

Restrictions $1900 \le$ year < 1999
$1 \le$ month ≤ 12
$1 \le$ day ≤ 999

If a limit is exceeded then an error message is printed and JUL is set to zero

```
INVALID DATE SUPPLIED TO * JULIAN *    315
```

See JULBASE to initialize a base date

C.3) CALL GREGOR (JUL, IY, IM, ID)

Convert Julian Day to Gregorian Calendar date

JUL - supplied Julian Day
IY - returned year
IM - returned month
ID - returned day

Note: There is no guarantee of accuracy outside the range $1900 \leq year \leq 1999$

See JULBASE to initialize a base date

C.4) CALL JULBASE (JUL, IY, IM, ID)

Initialize subroutines JULIAN, GREGOR to set a base date (year, month, day) corresponding to Julian Day = 1.

JUL - dummy
IY - base year
IM - base month
ID - base day

Same restrictions apply as for JULIAN.

APPENDIX D

```
      PROGRAM WAWSP
C
C*******************************************************************
C
C     TIME DEPENDENT WAVE AND WIND STRESS PREDICTION IN 2 SPACE DIMENSIONS
C
C*******************************************************************
C
C           WRITTEN BY JO-ANN HODSON AND MARK DONELAN    1977/78
C
C*******************************************************************
C
C   CALCULATIONS TO PREDICT THE WAVES GENERATED ARE MADE EVERY FEW
C   MINUTES, AND THE RESULTS ARE PLOTTED AT FIXED INTERVALS, AT WHICH
C   TIMES 2 PLOTS ARE PRODUCED.  THE FIRST PLOT SHOWS WIND
C        AND STRESS, THE SECOND SHOWS THE WAVES.
C
      INTEGER C
      REAL INTERV,ICMON
      COMMON /A/ K,TIMEST,MIN10,SIGHTSC,STRSC,ID
      COMMON /G/ U(2,60,23),          ISIG(2,59,22)                       16/02/78
      COMMON /J/ ISHRINK,IPLTFL,LISTFL,ICURT(5),CD,CDWS
      COMMON /2/ CMOM(4,60,23),ICMON(4,59,22),C(4,60,23)
      COMMON /3/ SPECA(2,4),SPECF(2,4),SPECS(2,4)                          04/78
      COMMON /6/ DEPTH(60,23),IGD,JGD,NSTAT(4),IST(4),JST(4)
      DIMENSION IEXPL(10),LISTST(5),IPLOTST(5),VEL(23)
      DIMENSION CA(4),ICDA(4),W(4),IDA(4),SIG(4)
      DIMENSION IBCD1(2),IBCD2(2)
      REAL VAROUT(24)                                                   22/02/78
      EQUIVALENCE (SPECA(1,1),VAROUT(1))                                22/02/78
C
      DATA IBCD1/4H  1 ,4HIN= /
      DATA IBCD2/4H1 IN,4H =  /
      DATA PI,CDSCALE,HSS2/3.1415926535,0.002,0.00004/
C  CDSCALE IS USED TO SCALE THE WIND STRESS PLOTS.  STRESS SCALE = (WIND SCALE )
C   SQUARED TIMES CDSCALE.
C  HSS2 CONVERTS RMS WAVE HT TO SIGNIFICANT HT. FACTOR OF 0.00001  ACCOUNTS FOR
C   FACT THAT RMS VALUES ARE CARRIED AS INTEGERS TIMES 100000.
C
C  SUBROUTINE EXFLOW SETS OVERFLOWS AND UNDERFLOWS TO ZERO
C
      CALL EXFLOW
      IGD=60
      JGD=23
      IG1=IGD
      JG1=JGD
      IPLTFN = 0                                                        22/02/78
      KP = 0                                                            22/02/78
C
C  SUBROUTINE ZEROV INITIALIZES ARRAYS CMOM, C, AND U TO ZEROES.
C
      CALL ZEROV(CMOM,5520)
      CALL ZEROV(C,5520)
      CALL ZEROV(U,2760)
      CALL ZEROV(ISIG,2596)                                                04/78
      CALL ZEROV(ICMON,5192)                                               04/78
C
C     **  READ DATA CARDS  **
C
C  VARIABLES CONTROLLING THIS RUN ARE READ IN.
C  ID      - A NUMBER TO IDENTIFY THIS RUN
C  NOSTEP - THE NUMBER OF STEPS TO BE PERFORMED
C  TIMEST - THE TIME INTERVAL BETWEEN STEPS, IN MINUTES
C  USCALE - WIND SCALE M/SEC PER INCH
C  SIGHTSC- SCALE FOR SIGNIFICANT WAVE HEIGHT
C  PLOTFACT-SCALE FACTOR FOR SIZE OF PLOTTING
C  NOPLTS - NUMBER OF CALCOMP PLOTS OF WIND AND WAVES.
C  ISHRINK- FACTOR TO SHRINK THE NUMBER OF GRID POINTS
C  INTERV - HOW OFTEN PLOTS ARE PRODUCED, IN HOURS
C  IEXPL  - A BRIEF EXPLANATION OF THIS RUN
C
      READ(60,1) ID,NOSTEP,TIMEST,USCALE,SIGHTSC,PLOTFACT,NOPLTS,ISHRINK20/02/78
     1, INTERV,IEXPL                                                    20/02/78
      NOPLTN = NOPLTS                                                   20/02/78
1     FORMAT(2I5,4F5.0,I3,I2,F5.0,10A4)                                 20/02/78
C
C  READ IN THE STATION NAME AND GRID COORDINATES OF THE 4 STATIONS FOR
C  WHICH RESULTS WILL BE PRINTED AND SPECTRA PLOTTED
```

```
C
      READ(60,7) (NSTAT(I),IST(I),JST(I),I=1,4)
 7    FORMAT(4(1X,A4,2I5))
C
C  READ IN THE START TIMES FOR WIND (IE. FOR SIMULATION), LISTING
C  AND PLOTTING
C
      READ(60,11)IYEARW,MONTHW,IDATEW,IHOURW,MINW,(LISTST(I),I=1,5),
     1   (IPLOTST(J),J=1,5)
 11   FORMAT(15I5)
      WRITE(61,4) ID,IEXPL,NOSTEP,TIMEST,USCALE,SIGHTSC,PLOTFACT,
     1  ISHRINK,(NSTAT(I),IST(I),JST(I),I=1,4),IYEARW,MONTHW,IDATEW,
     2  IHOURW,MINW,(LISTST(I1),I1=1,5),TIMEST,(IPLOTST(J),J=1,5),INTERV
 4    FORMAT(1H1,*ID = *,I5,7X,10A4,
     1       /1H0,*NO. OF STEPS = *,I5,5X,*THE TIME STEP IS *,F7.1,
     1            * MINUTES*,
     1       /1H0,*WIND SCALE: 1 INCH = *,F5.1,* METRES/SECOND*,
     1       /1H0,*SIGNIFICANT HEIGHT SCALE: 1 INCH = *,F5.1,* METRES*,
     1       /1H0,*PLOT FACTOR = *,F5.3,
     1       /1H0,*LAKE SHRINK FACTOR = *,I3,
     1       /1H0,*THE FOLLOWING STATIONS ARE SINGLED OUT:*,                07/03/78
     1            4(3X,A4.3H  (,I2,1H,I2,1H)),
     1       /1H0,25X,*YR/MO/DY/HR/MN*,
     1       /1H0,*THE WIND STARTS AT      *,I4,4(1H/,I2),
     1            * AT TIME INTERVALS AS ON THE WIND DATA TAPE*,
     1       /1H0,*THE LISTING STARTS AT  *,I4,4(1H/,I2),
     1            * AT INTERVALS OF *,F5.1,* MINUTES*,
     1       /1H0,*THE PLOTTING STARTS AT *,I4,4(1H/,I2),
     1            * AT INTERVALS OF *,F5.2,* HOURS*,/)
      STRSC = USCALE**2*CDSCALE
C  CDSCALE IS USED TO SCALE THE WIND STRESS PLOTS.  STRESS SCALE = (WIND SCALE )
C   SQUARED TIMES CDSCALE.
      SIGHTSC = SIGHTSC * 100000.0
C
C     **  READ DEPTHS FROM WIND DATA TAPE AND FIND STARTING WIND TIME  **
C
C  THE DEPTHS AT EACH GRID POINT ARE READ IN AT THE START OF THE TAPE
C
      READ(1) ((DEPTH(I,J),J=1,JGD),I=1,IGD)
C
C  ADVANCE THE TAPE TO THE STARTING WIND TIME
C
 109  READ(1) IYEAR,MONTH,IDATE,IHOUR,MIN
      IF (IFEOF(1).EQ.0) GO TO 110
      WRITE(61,111)
      STOP10
 110  READ(1) ((U(1,I,J),U(2,I,J),J=1,JGD),I=1,IGD)
      IF (IYEARW.GT.IYEAR) GO TO 109
      IF (MONTHW.GT.MONTH) GO TO 109
      IF (IDATEW.GT.IDATE) GO TO 109
      IF (IHOURW.GT.IHOUR) GO TO 109
      IF (MINW.GT.MIN) GO TO 109
      IF (IYEARW.LT.IYEAR.OR.MONTHW.LT.MONTH.OR.IDATEW.LT.IDATE.OR.
     1  IHOURW.LT.IHOUR.OR.MINW.LT.MIN) WRITE(61,112) IYEAR,MONTH,
     1  IDATE,IHOUR,MIN
 112  FORMAT(1H ,*WIND DATA DOES NOT START UNTIL*,I5,4(1H/,I2))
C
C     **  SHRINK THE LAKE **
C
C  FEWER GRID POINTS ARE USED IF ISHRINK IS 2, 3, OR 4.   IE. IF ISHRINK
C  IS 2, EVERY SECOND POINT IS USED, SO THERE ARE 4 TIMES FEWER POINTS.
C  THE GRIDSIZE IS TWICE AS BIG, SO THE RESULTS ARE NOT AS ACCURATE,
C  BUT THERE ARE FEWER CALCULATIONS
C
      IF (ISHRINK.LT.2.OR.ISHRINK.GT.4) ISHRINK=1
C
C  THE SHORELINE IS DEFINED BY SETTING SHORE POINTS TO A DEPTH OF -100000.
C
      DO 51 I = 1,IGD                                                       15/02/78
      DO 61 J = 1,JGD                                                       15/02/78
      IF(DEPTH(I,J).LE.0.) DEPTH(I,J) = -100000.                            16/02/78
      IF(DEPTH(I,J).GT.0.) DEPTH(I,J) =  100000.                            15/02/78
 61   CONTINUE                                                              16/02/78
 51   CONTINUE                                                              16/02/78
      ISHRK = ISHRINK + 1                                                   16/02/78
      I = 1                                                                 16/02/78
      DO 5 IN = ISHRK,IGD,ISHRINK                                           16/02/78
      I=I+1                                                                 16/02/78
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```
      J = 1                                                             16/02/78
      DO 6 JN = ISHRK,JGD,ISHRINK                                       16/02/78
      J=J+1
      IF(ISHRINK.EQ.1) GO TO 113                                        16/02/78
      IMS = IN - ISHRINK + 1                                            16/02/78
      IMF = IN + ISHRINK - 1                                            16/02/78
      JMS = JN - ISHRINK + 1                                            16/02/78
      JMF = JN + ISHRINK - 1                                            16/02/78
      DPTSUM = 0.0                                                      16/02/78
      DO 62 IM = IMS,IMF                                                16/02/78
      DO 62 JM = JMS,JMF                                                16/02/78
      IF(IM.GT.IGD.OR.JM.GT.JGD) GO TO 63                               16/02/78
      DPTSUM = DPTSUM + DEPTH(IM,JM)                                    16/02/78
      GO TO 62                                                          16/02/78
 63   DPTSUM = DPTSUM -100000.                                          16/02/78
 62   CONTINUE                                                          16/02/78
 52   CONTINUE                                                          16/02/78
      IF(DPTSUM.LE.0.0) DPTSUM = -100000.                               16/02/78
      IF(DPTSUM.GT.0.0) DPTSUM =  100000.                               16/02/78
      DEPTH(I,J) = DPTSUM                                               16/02/78
 113  U(1,I,J)=-U(1,IN,JN)/100.
      U(2,I.J)=-U(2,IN,JN)/100.
 6    CONTINUE
 5    CONTINUE
      IF (ISHRINK.NE.1) IGD=IGD/ISHRINK+1
      IF (ISHRINK.NE.1) JGD=JGD/ISHRINK+2
      DO 200 I=1,IGD
 200  DEPTH(I,JGD)=-100000.
      DO 201 J=1,JGD
 201  DEPTH(IGD,J)=-100000.
      IF (ISHRINK.EQ.1) GO TO 204
C
C  IF THE LAKE WAS SHRUNK, THE GRID POINTS OF THE 4 STATIONS MUST BE
C  SHRUNK TOO.  CHECK THAT THE STATION IS NOT ON SHORE AFTER SHRINKING.
C
      DO 202 I=1,4
      IF (ISHRINK.NE.2) GO TO 203
      IST(I)=IST(I)-1
      JST(I)=JST(I)-1
 203  IST(I)=IST(I)/ISHRINK+1
      JST(I)=JST(I)/ISHRINK+1
 202  CONTINUE
      WRITE(61,207) ISHRINK,(NSTAT(I),IST(I),JST(I),I=1,4)
 207  FORMAT(1H ,*NEW GRID COORDINATES AFTER SHRINKING BY*,I3,* ARE:*,
     1  4(3X,A4.3H  (,I2,1H,I2,1H)))
 204  WRITE(61,1005) ((NSTAT(I),I=1,4),J=1,5)                           20/02/78
      DO 205 I=1,4                                                      20/02/78
      IC=IST(I)
      JC=JST(I)
      IF (DEPTH(IC,JC).NE.-100000.) GO TO 205
      WRITE(61,206) NSTAT(I),IC,JC
 206  FORMAT(1H0,*AFTER SHRINKING, STATION *,A4,* IS AT (*,I2,1H,,I2,
     1     *) WHICH IS A SHORE POINT*)
      STOP 206
 205  CONTINUE
C
C  INITIALIZE THE PLOT
C
      IF(NOPLTS.LT.1) GO TO 398                                         20/02/78
      CALL PLOT(0.0,0.0.-3)
      CALL FACTOR(PLOTFACT)
      SET0=IGD+7
      CALL SYMBOL(SET0,.75,.21,IEXPL,0.0,40)
C
 398  CONTINUE                                                          20/02/78
C  INITIALIZE THE JULIAN DATE ROUTINES BY SETTING THE FIRST JULIAN DAY
C  TO THE FIRST DAY OF THE CURRENT YEAR
C
      CALL JULBASE(JUL,IYEAR,1,1)
C
C  SET THE CURRENT DATE TO THE TIME THE WIND STARTS

      ICURT(1)=IYEAR
      ICURT(2)=MONTH
      ICURT(3)=IDATE
      ICURT(4)=IHOUR
      ICURT(5)=MIN
C
```

```
C     FIND THE JULIAN DATE EQUIVALENT TO THE STARTING DATE
C
         CALL JULIAN(JUL,IYEAR,MONTH,IDATE)
C
C     SINCE THE MOST RECENT WIND DATA IS USED AT EACH STEP,  THE TIME OF
C     THE NEXT DATA MUST BE KEPT
C
         READ(1) NEXTY,NEXTM,NEXTD,NEXTH,NEXTMN
C
C     RUN THE SIMULATION FOR THE SPECIFIED NUMBER OF STEPS
C
         DO 3 K=1,NOSTEP
C
C        **  FOR EACH TIMESTEP:  **
C
         IF (K.EQ.1) GO TO 114
         CALL RTIME(TLEFT)                                                  CCIW
         IF(TLEFT.LT.30.0) GO TO 399                                        CCIW
C
C     CALCULATE THE NEW CURRENT TIME
C
         ICURT(5)=ICURT(5)+TIMEST
         IF (ICURT(5).LT.60) GO TO 114
         ICURT(5)=ICURT(5)-60
         ICURT(4)=ICURT(4)+1
         IF (ICURT(4).LT.24) GO TO 114
         ICURT(4)=ICURT(4)-24
C
C     ADJUST THE CURRENT DATE
C
         JUL=JUL+1
C
C     SUBROUTINE GREGOR RETURNS THE GREGORIAN DATE CORRESPONDING TO THE
C     JULIAN DATE.
C
         CALL GREGOR(JUL,ICURT(1),ICURT(2),ICURT(3))
 114     CURTIME=ICURT(1)*100000000. + ICURT(2)*1000000. + ICURT(3)*10000.
       1         + ICURT(4)*100. + ICURT(5)
         XNEXTIM=NEXTY*100000000. + NEXTM*1000000. + NEXTD*10000.
       1         + NEXTH*100. + NEXTMN
         IF (CURTIME.LT.XNEXTIM) GO TO 115
C
C        **  READ A RECORD OF WIND DATA  **
C
         READ (1) ((U(1,I,J),U(2,I,J),J=1,JG1),I=1,IG1)
         READ (1) NEXTY,NEXTM,NEXTD,NEXTH,NEXTMN
         IF (IFEOF(1).EQ.0) GO TO 122
         WRITE(61,111)
 111     FORMAT(1H0,*END OF FILE REACHED ON WIND DATA TAPE*)
         GO TO 399                                                     23/02/78
 122     I=0
         DO 123 IN=1,IG1,ISHRINK
         I=I+1
         J=0
         DO 124 JN=1,JG1,ISHRINK
         J=J+1
         U(1,I,J)=-U(1,IN,JN)/100.
         U(2,I,J)=-U(2,IN,JN)/100.
 124     CONTINUE
 123     CONTINUE
         GO TO 114
C
C     WHEN THE STARTING TIMES FOR LISTING OR PLOTTING ARE REACHED, THE
C     LIST AND PLOT FLAGS ARE SET TO 1
C
 115     IF (LISTFL.EQ.1) GO TO 118
         DO 116 I=1,5
         IF (LISTST(I).GT.ICURT(I)) GO TO 118
         IF (LISTST(I).LT.ICURT(I)) GO TO 117
 116     CONTINUE
 117     LISTFL=1
 [illegible]8     IF (IPLTFL.EQ.1) GO TO 121
         DO 119 I=1,5
         IF (IPLOTST(I).GT.ICURT(I)) GO TO 121
         IF (IPLOTST(I).LT.ICURT(I)) GO TO 120
 119     CONTINUE
 120     IPLTFL=1
         KP=K
```

```
                                                                    22/02/78
      IPLTFN = 1
C
C     **  PRODUCE WIND PLOT   **
C
C IF MIN10 IS 0, IT IS TIME FOR A PLOT.
C
121   INTPLT=INTERV*60./TIMEST
      MIN10=MOD(KP-K,INTPLT)
      IF (KP.EQ.0) MIN10=1
C
C  IF A WIND PLOT IS TO BE PRODUCED AT THIS TIMESTEP, SET UP THE TITLES
C
      IF(NOPLTN.LT.1) IPLTFL = 0                                    20/02/78
      IF (MIN10.NE.0.OR.IPLTFL.EQ.0) GO TO 2                        20/02/78
      NOPLTN = NOPLTN - 1
      SETO = IGD + 5
      CALL PLOT(SETO,0.0,-3)
      CALL SYMBOL(2.0,1.25,.21,4HID= ,0.0,4)
      DENT=ID
      CALL NUMBER(999.,1.25,.21,DENT,0.0,-1)
      FPN=K*TIMEST/60.
      CALL SYMBOL(2.5,28.,.21,3HT= ,0.0,3)
      CALL NUMBER(999.,28.,.21,FPN,0.0,1)
      CALL SYMBOL(999.,28.,.21,4H HRS,0.0,4)
      CALL SYMBOL(5.58,28.,.21,IBCD1,0.0,8)
      CALL NUMBER(999.,28.,.21,USCALE,0.0,-1)
      CALL SYMBOL(999.,28.,.21,4H M/S,0.0,4)
      CALL SYMBOL(6.00,29.,.21,IBCD2,0.0,8)
      CALL NUMBER(999.,29.,.21,STRSC,0.0,3)
      CALL SYMBOL(4.0,30.,.28,4HWIND,0.0,4)
2     CONTINUE
C
      DO 10 I=2,IGD
      XI=I
      DO 20 J=2,JGD
      IF (DEPTH(I,J).LT.0.0) GO TO 20
      THETA=ATAN2(U(2,I,J),U(1,I,J))
      WNDSPD=SQRT(U(2,I,J)**2+U(1,I,J)**2)
      YJ=J
      IF (MIN10.EQ.0.AND.IPLTFL.EQ.1) CALL PLOT(XI,YJ,3)
C
C  THE WIND VECTOR IS DRAWN AT EACH GRID POINT, USING THE ANGLE
C  THETA, AND WITH THE LENGTH PROPORTIONATE TO SPEED
C
      XSPD=WNDSPD/USCALE*COS(THETA)+XI
      YSPD=WNDSPD/USCALE*SIN(THETA)+YJ
      ANGLE=THETA*180./PI-90.
      IF (MIN10.EQ.0.AND.IPLTFL.EQ.1) CALL PLOT(XSPD,YSPD,2)
      IF (MIN10.EQ.0.AND.IPLTFL.EQ.1)
     1                                CALL SYMBOL(XSPD,YSPD,.14,2,ANGLE,-1)
20    CONTINUE
10    CONTINUE
C
C  S/R WAVES CALCULATES THE WAVES AT EVERY TIME STEP
C
      CALL WAVE
C
C
C
C     **  PRINT RESULTS  **
C
C  FOR THE 4 STATIONS, RESULTS OF THE SIMULATION ARE PRINTED IN THE
C  PROPER UNITS.
C
      DO 50 I=1,4
      IX=IST(I)
      IY=JST(I)
      SQ1=C(1,IX,IY)
      SQ2=C(2,IX,IY)
      SQ3=C(3,IX,IY)
      SQ4=C(4,IX,IY)
      CA(I)=SQRT(SQ1**2+SQ3**2)/(10000.*1.5597)
      ICDA(I)=0
      IF (SQ1.NE.0.0.OR.SQ3.NE.0.0) ICDA(I)=-1.0*(ATAN2(SQ3,SQ1)*
     1     57.2958-90.0)
      ICEA=0
      IF (SQ2.NE.0.0.OR.SQ4.NE.0.0) ICEA=-1.0*(ATAN2(SQ4,SQ2)
     1        *57.2958-90.0)
      CB=SQRT(SQ2**2+SQ4**2)/(10000.*1.5597)
```

```
      W(I)=SQRT(U(1,IX,IY)**2+U(2,IX,IY)**2)
      IDA(I)=-1.0*(ATAN2(U(2,IX,IY),U(1,IX,IY))*57.2958-90.0)
      SQ1=ISIG(1,IX,IY)
      SQ2=ISIG(2,IX,IY)
      IF (SQ2.GT.SQ1) CA(I)=CB
      IF (SQ2.GT.SQ1) ICDA(I)=ICEA
       SIG(I)=SQRT(SQ1**2+SQ2**2)*HSS2
      IF (ICDA(I).LT.0) ICDA(I)=360+ICDA(I)
       IF (IDA(I).LT.0) IDA(I)=360+IDA(I)
 50   CONTINUE
      IF (LISTFL.EQ.1) WRITE(61,1004) K,ICURT(4),ICURT(5),ICURT(3),
     1 ICURT(2),CD,CDWS,(SIG(I1),I1=1,4),(CA(I2),I2=1,4),(W(I3),I3=1,4),
     1 (ICDA(I4),I4=1,4),(IDA(I5),I5=1,4)
C
C     **  WRITE TO DISK  **
C
                           WRITE(42)         K,ICURT(4),ICURT(5),ICURT(3),       M13/2/78
     1 ICURT(2),CD,CDWS,(SIG(I1),I1=1,4),(CA(I2),I2=1,4),(W(I3),I3=1,4),M13/2/78
     1 (ICDA(I4),I4=1,4),(IDA(I5),I5=1,4),(VAROUT(I6),I6=1,24)            22/02/78
 1004 FORMAT(1H0,I3,I4,I2,2I4,F7.2,F7.1.2X,8F5.2,1X,4F5.1,8I5)
      IF (MIN10.NE.0) GO TO 3
      IF (LISTFL.EQ.0) GO TO 3
C
C  THE SIGNIFICANT HEIGHT OF THE WAVES AT ALL GRID POINTS ARE PRINTED
C
      WRITE(61,1002) ICURT(3),ICURT(2),ICURT(1),ICURT(4),ICURT(5)
 1002 FORMAT(1H1,* SIGNIFICANT HEIGHT OF WAVES IN METRES ON *,I2,
     1  * OF *,I2,I5,* AT *,I2,I2,* GMT*,/1H0)
C     WRITE(61,1000)
C1000 FORMAT(1HQ/1HT)
      IG=IGD-1
      JG=JGD-1
      DO 14 I=2,IG                                                        16/2/78
      DO 15 J=2,JG                                                        16/02/78
      SQ1=ISIG(1,I,J)
      SQ2=ISIG(2,I,J)
      VEL(J)=SQRT(SQ1**2+SQ2**2)*HSS2
C  HSS2 CONVERTS RMS WAVE HT TO SIGNIFICANT HT. FACTOR OF 0.00001  ACCOUNTS FOR
    FACT THAT RMS VALUES ARE CARRIED AS INTEGERS TIMES 100000.
 15   CONTINUE
      WRITE(61,1001) (VEL(JV),JV=2,JG)                                    16/02/78
 1001 FORMAT(10X,21F5.2)                                                  16/02/78
 14   CONTINUE
      WRITE(61,1005) ((NSTAT(I),I=1,4),J=1,5)
 1005 FORMAT(/1H0,*TIME  GMT DAY MTH AVG CD AVG WIND SIGNIFICANT HT.*,
     1  * (M) PERIOD OF PEAK (SEC)  WIND SPEED (M/S)    WAVE BEARING *, 16/02/78
     2  *DEG    WIND BEARING DEG*,/1H ,4HSTEP,15X,*X1000    (M/S)  *,
     3  8(A4,1X),1X,12(A4,1X),//)
 3    CONTINUE
  399 CONTINUE
      IF(NOPLTS.GT.0) CALL PLOT(15.0,0.0,999)                             20/02/78
      STOP                                                                20/02/78
      END

ASI FORTRAN DIAGNOSTIC RESULTS FOR NAWSP

  NO ERRORS

S ARE COMMON BLOCK NAMES OR NAMES NOT ASSIGNED STORAGE

  G          J
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```
      SUBROUTINE WAVE
C
C  THIS SUBROUTINE CALCULATES THE NEW WAVES FOR ONE TIMESTEP
C
      INTEGER C
      REAL ICMON
      COMMON /A/ K.TIMEST,MIN10,SIGHTSC,STRSC.ID
      COMMON /C/ WNDSPD.THETA1,THETA2,C1,C2.SIGMA(2)                    04/78
      COMMON /G/ U(2,60.23),          ISIG(2,60,22)                 16/02/78
      COMMON /J/ ISHRINK,IPLTFL,_ISTFL,ICURT(5),CD,CDWS
      COMMON /2/ CMOM(4,60,23),ICMON(4,60.22),C(4,60,23)
      COMMON /3/ SPECA(2,4),SPECF(2,4).SPECS(2,4)                       04/78
      COMMON /6/ DEPTH(60,23),IGD,JGD,NSTAT(4),IST(4),JST(4)
      DIMENSION CMON(4),VFLUX(2,2),HFLUX(2,2),CM(2),F(2),ALPHA(2)
      DIMENSION KST(4)
      DIMENSION IBCD3(4),IBCD4(2),IBCD5(4),IBCD6(2),IBCD7(2)
C
      DATA GRIDSIZ,CONST/5080..0.06152/
      DATA IBCD3/4H 4*S,4HIGMA,4H: 1 ,4HIN =/
      DATA IBCD4/4HWAVE,4HS    /
C
C  CALCULATIONS ARE DONE AT EACH GRID POINT IN THE LAKE, FOR THIS
C  TIMESTEP.
C
      NCD = 0
      CD = 0.0
      CDWS = 0.0
      PI=3.1415926535
      GRDZ=GRIDSIZ*10000.0*ISHRINK                                  27/02/78
C FACTOR (10000) ACCOUNTS FOR FACT THAT PHASE VELS ARE CARRIED AS INTEGERS
C  X 1000.
      GRDZ = GRDZ / 0.365                                           27/02/78
C  FACTOR OF 0.365 ACCOUNTS FOR DEEP WATER GROUP VEL / PH VEL RELATIONSHIP
C  (SEE PAPER).
      FAC1 = 0.0001247                                              27/02/78
C   FAC1 = AIR DENSITY (15C) / (WATER DEN. X G)
      FAC3 = 0.028                                                  27/02/78
C   FAC3 = GAMMA * 0.86                                             27/02/78
      FAC2 = FAC1 * FAC3                                            27/02/78

      COEFF=0.03300/(9.83148**(2./3.))                              MARK
      IG=IGD-1
      JG=JGD-1
      DO 5 I=2,IG
      DO 4 J=2,JG
C
C     **  FOR EACH GRID POINT:  **
C
      IF (DEPTH(I,J).LT.0.0) GO TO 4
C
C  U(L,I,J) = THE X AND Y COMPONENTS OF WIND AT (I,J)
C  THETA = ANGLE BETWEEN WIND AND X AXIS
C  F1 AND F2 = THE FREQUENCIES OF THE WAVES IN THE 2 SYSTEMS. (ONE WAVE
C             FIELD TRAVELS MORE OR LESS WITH THE WIND, THE OTHER
C             AGAINST)
C  C1 AND C2 = THE PHASE VELOCITIES OF THE WAVE FIELDS
C  PHI1 AND PHI2 = THE ANGLES BETWEEN THE PHASE VELOCITY VECTORS AND
C                  THE POSITIVE X AXIS
C  THETA1 AND THETA2 = THE ANGLES BETWEEN THE WIND VECTOR AND THE
C                      PHASE VELOCITY VECTORS
C  CMOM(M,I,J) = 1X, 2X, 1Y, AND 2Y COMPONENTS OF MOMENTUM AT (I,J)
C  C(M,I,J) = THE X AND Y COMPONENTS OF THE 2 PHASE VELOCITIES
C  ICMON(M,I,J) = THE NEW COMPONENTS OF MOMENTUM
C  ISIG(M,I,J) = SIGNIFICANT HEIGHTS STORED AS INTEGERS
C  SIGMA(M) = THE SIGNIFICANT HEIGHTS OF THE WAVES IN EACH WAVE FIELD
C  CMON(M) = THE NEW COMPONENTS OF MOMENTUM AT ONE GRID POINT
C
      WNDSPD=SQRT(U(1,I.J)**2+U(2,I,J)**2)
      THETA=ATAN2(U(2,I,J),U(1,I,J))

      SQ1  =  C(1,I,J)
      SQ2  =  C(3,I,J)
      C1   =   SQRT(SQ1**2 + SQ2**2)
      SQ1  =  C(2,I,J)
      SQ2  =  C(4,I,J)
      C2   =   SQRT(SQ1**2 + SQ2**2)
      C1 = C1 / 10000.0
      C2 = C2 / 10000.0
```

```
      PHI1=THETA
      IF (THETA.GE.PI) PHI2=THETA-PI
      IF (THETA.LT.PI) PHI2=THETA+PI
      PHI1=0.0
      PHI2=PHI1-3.1415926535
      IF (CMOM(3,I,J).NE.0.0.OR.CMOM(1,I,J).NE.0.0)
     1          PHI1=ATAN2(CMOM(3,I,J),CMOM(1,I,J))
      IF (CMOM(4,I,J).NE.0.0.OR.CMOM(2,I,J).NE.0.0)
     1          PHI2=ATAN2(CMOM(4,I,J),CMOM(2,I,J))
      THETA1=ABS(THETA-PHI1)
      THETA2=ABS(THETA-PHI2)
      SIGMA(1)=ISIG(1,I,J)/100000.
      SIGMA(2)=ISIG(2,I,J)/100000.
C
C     **  CALCULATE VERTICAL FLUX   **
C
C  THE INPUT FROM THE WIND (VERTICAL MOMENTUM FLUX) IS CALCULATED IN
C  THE DIRECTIONS OF THE THREE BASIC VECTORS U, C1, AND C2, AND THEN
C  CONVERTED TO X AND Y COMPONENTS
C
      CALL WINDINP(WI1,WI2,WI3)
C
      VFLUX(1,1)=WI1*COS(THETA)+WI2*COS(PHI1)
      VFLUX(2,1)=WI3*COS(PHI2)
      VFLUX(1,2)=WI1*SIN(THETA)+WI2*SIN(PHI1)
      VFLUX(2,2)=WI3*SIN(PHI2)
C
C     **  CALCULATE AND PLOT STRESS   **
C
C  THE STRESS IS PLOTTED WITH AN X ON THE WIND PLOT.
C
C   ADD SKIN DRAG. (COEF. = 0.0007)
C
      SKSTRS      = WNDSPD**2*0.0007
      STRESX=(VFLUX(1,1)+VFLUX(2,1))/ FAC2     + SKSTRS      * COS(THETA) MARK
      STRESY=(VFLUX(1,2)+VFLUX(2,2))/ FAC2     + SKSTRS      * SIN(THETA) MARK
      IF (MIN10.NE.0.OR.IPLTFL.EQ.0) GO TO 6
      IF (STRESX.EQ.0.0.AND.STRESY.EQ.0.0) GO TO 61
      STRANG=ATAN2(STRESY,STRESX)*180./3.1415926535-90.
      X=I
      Y=J
      X1=X+STRESX/STRSC
      X2=Y+STRESY/STRSC
      CALL PLOT(X,Y,3)
      CALL PLOT(X1,X2,2)
      CALL SYMBOL(X1,X2,.07,4,STRANG,-1)
6     CONTINUE
C
C     **  CALCULATE DRAG COEFFICIENT   **
C
C  THE DRAG COEFFICIENT, CD, AT THIS GRID POINT IS ADDED TO THE SUM
C
      CD=CD+SQRT(STRESX**2+STRESY**2)
      CDWS = CDWS + WNDSPD
      NCD=NCD+1
   61 CONTINUE
C
C  THE COMPONENTS OF HORIZONTAL MOMENTUM FLUX ARE COMPUTED USING THE
C  MOMENTUMS AND PHASE VELOCOTIES AT THE GRID POINTS AROUND (I,J)
C
C
C
C
C  FOR BOUNDARY CONDITIONS - ISH(N,S,E,W) (B,F) INDICATES THE CROSSING
C  OF A SHORE IN THESE COMPASS DIRECTIONS LOOKING BACKWARD OR FORWARD
C
      ISHNB = 1
      ISHEB = 1
      ISHSF = 1
      ISHWF = 1
      IF (J.EQ.1) GO TO 42
      DD=DEPTH(I  ,J-1)  - DEPTH(I,J)
      IF (ABS(DD).LT.50000.) GO TO 42
      IF (DD.LE.0.0) ISHNB=-1
42    IF (I.EQ.1) GO TO 45
      DD=DEPTH(I-1,J  )  - DEPTH(I,J)
      IF (ABS(DD).LT.50000.) GO TO 45
      IF (DD.LE.0.0) ISHEB=-1
45    IF (J.EQ.JGD) GO TO 48
```

```
      DD=DEPTH(I   .J+1)   - DEPTH(I,J)
      IF (ABS(DD).LT.50000.) GO TO 48
      IF (DD.GT.0.0) ISHSF=-1
   48 IF (I.EQ.IGD) GO TO 49
      DD=DEPTH(I+1,J   )   - DEPTH(I,J)
      IF (ABS(DD).LT.50000.) GO TO 49
      IF (DD.GT.0.0) ISHWF=-1
   49 CONTINUE
C
C     **  CALCULATE HORIZONTAL FLUX   **
C
C
C    X COMPONENT
C
      DO 9 M=1,2
C
C  HERE DOWN TO HERE UP                                            FEB/78
C
      CPHX = C(M,I,J)
      CPHY = C(M+2,I   ,J   )
      CPAX = C(M   ,I-1,J   )
      CPBX = C(M   ,I+1,J   )
      CPAY = C(M+2,I   ,J-1)
      CPBY = C(M+2,I   .J+1)
      IF (CPHX.GE.0.0) HFT1=CPHX* CMOM(M,I,J)-CMOM(M,I-1,J) *  CPAX
      IF (CPHX.LT.0.0) HFT1=CPBX* CMOM(M,I+1,J)-CMOM(M,I,J)  * CPHX
      IF (CPHY.LT.0.0) GO TO 93
      HFT2=CPHY* CMOM(M,I,J)-CMOM(M,I,J-1) * CPAY
C
C     **  CHECK BOUNDARY CONDITIONS   **
C
      IF(ISHNB.LT.0) HFT2 = 0.0
      GO TO 94
93    HFT2=CPBY* CMOM(M,I,J+1)-CMOM(M,I.J) * CPHY
      IF(ISHSF.LT.0) HFT2 = 0.0
   94 HFLUX(M,1) =(HFT1 + HFT2) / GRDZ
    9 CONTINUE
C
C    Y COMPONENT
C
      DO 8 N=1,2
      M = N+2
      CPHX = C(N,I,J)
      CPHY = C(N+2,I   ,J   )
      CPAX = C(N   ,I-1,J   )
      CPBX = C(N   ,I+1,J   )
      CPAY = C(N+2,I   ,J-1)
      CPBY = C(N+2,I   ,J+1)
      IF(CPHX.LT.0.0) GO TO 81
      HFT1=CPHX* CMOM(M.I,J)-CMOM(M,I-1,J) * CPAX
      IF(ISHEB.LT.0) HFT1 = 0.0
      GO TO 82
81    HFT1=CPBX* CMOM(M.I+1,J)-CMOM(M,I,J)  * CPHX
      IF(ISHWF.LT.0) HFT1 = 0.0
82    IF (CPHY.GE.0.0) HFT2=CPHY* CMOM(M,I,J)-CMOM(M,I,J-1)  * CPAY
      IF (CPHY.LT.0.0) HFT2=CPBY* CMOM(M,I,J+1)-CMOM(M,I,J)  * CPHY
      HFLUX(N,2)= (HFT1 + HFT2) / GRDZ
C
C  HERE UP TO HERE DOWN                                            FEB/78
C
    8 CONTINUE
C
C     **  CALCULATE NEW MOMENTUM   **
C
      MM=0
      DO 14 N=1,2
      DO 15 M=1,2
      MM=MM+1
C
C  THE NEW MOMENTUMS AT (I,J) ARE FOUND USING THE OLD MOMENTUMS AND
C  THE VERTICAL AND HORIZONTAL FLUXES.
C
      CMON(MM)=CMOM(MM,I,J)+(VFLUX(M,N)-HFLUX(M,N))*TIMEST*60.
15    CONTINUE
14    CONTINUE
C
C     **  COMBINE MOMENTUM COMPONENTS   **
C
```

```
C   THE MOMENTUM COMPONENTS ARE COMBINED WHEN NECESSARY, AND THE NEW
C   ANGLES FOUND
C
      CALL COMBINE(U(1,I,J),CMON)                                       27/02/78

      PHI1=0.0
      IF (CMON(3).NE.0.0.OR.CMON(1).NE.0.0) PHI1=ATAN2(CMON(3),CMON(1))
      PHI2=PHI1-3.1415926535
      IF (CMON(4).NE.0.0.OR.CMON(2).NE.0.0) PHI2=ATAN2(CMON(4),CMON(2))
      THETA1=ABS(THETA-PHI1)
      THETA2=ABS(THETA-PHI2)
      ANG=THETA1
C
C     **  CALCULATE FREQUENCY AND SIGNIFICANT HEIGHT OF WAVES  **
C
C   THE MOMENTUM, FREQUENCY, AND SIGNIFICANT HEIGHT OF THE WAVES IN EACH
C   WAVE FIELD ARE CALCULATED.
C

      DO 10 M=1,2
      IF (M.EQ.2) ANG=THETA2
      CM(M)=SQRT(CMON(M)**2+CMON(M+2)**2)
      U1=WNDSPD*COS(ANG)
      IF (U1.LE.0.0) ALPHA(M)=0.006                                     MARK
      IF (U1.LE.0.0) GO TO 11
      DEN=COEFF*U1**(2./3.)
      IF (CM(M).NE.0.0) F(M)=(0.01162*DEN/CM(M))**(3./7.)               MARK
      IF (CM(M).EQ.0.0) F(M)=0.0
      ALPHA(M)=DEN*F(M)**(2./3.)
      IF (ALPHA(M).LT.0.006) ALPHA(M)=0.006                             MARK
 11   IF (ALPHA(M).LT.0.006001.AND.CM(M).NE.0.0)                        MARK
     1 F(M) = (ALPHA(M)*.01162/CM(M))**(1./3.)                          MARK
      IF (ALPHA(M).LT.0.006001.AND.CM(M).EQ.0.0) F(M) = 0.0             MARK
      IF (F(M).NE.0.0) SIGMA(M)=SQRT(CM(M) * 1.5597 / F(M))             07/03/78
      IF (F(M).EQ.0.0) SIGMA(M)=0.0
      ISIG(M,I,J)=SIGMA(M)*100000.
      IF (F(M).EQ.0.0) F(M)=1.0E100
      ICMON(M,I,J)=CMON(M)*10000000.
      ICMON(M+2,I,J) = CMON(M+2) * 10000000.0
      CONTINUE
C   THE COMPONENTS OF THE PHASE VELOCITIES ARE CALCULATED AND STORED
C

      C1=1.56/F(1)
      C2=1.56/F(2)
      C(1,I,J)=C1*COS(PHI1)  * 10000.0
      C(2,I,J)=C2*COS(PHI2)  * 10000.0
      C(3,I,J)=C1*SIN(PHI1)  * 10000.0
      C(4,I,J)=C2*SIN(PHI2)  * 10000.0
C
C   THE VALUES OF ALPHA,SIGMA AND FREQUENCY ARE SAVED AT THE 4 STATIONS
C   FOR WHICH SPECTRAL PLOTS ARE TO BE PRODUCED
C

      DO 71 N=1,4
      IF (I.NE.IST(N).OR.J.NE.JST(N)) GO TO 71
      DO 70 M=1,2
      SPECA(M,N)=ALPHA(M)
      SPECF(M,N)=F(M)
      SPECS(M,N)=SIGMA(M)                                               22/02/78
 70   CONTINUE
 71   CONTINUE
  4   CONTINUE
  5   CONTINUE
C
C
C     **  PRODUCE WAVE PLOT  **
C
C   AS THE TIMESTEP ENDS, THE NEW MOMENTUMS BECOME THE OLD MOMENTUMS.
C   THE AVERAGE DRAG COEFFICIENT IS CALCULATED, AND TITLES ARE SET UP
C   FOR THE WAVE PLOT.
C
C

      CDWS = CDWS / FLOAT(NCD)
      CD=(CD/FLOAT(NCD))*1000.0
      CD = CD / (CDWS**2)
      IF (MIN10.NE.0.OR.IPLTFL.EQ.0) GO TO 31
      SET0 = IGD + 5
      CALL PLOT(SET0,0.0,-3)
      CALL SYMBOL(2.0,.75,.21,3HCD=,0.0,3)
```

```
      CALL NUMBER(999.,.75,.21,CD,0.0,2)
      DENT=ID
      CALL SYMBOL(2.0,1.25,.21,4HID= ,0.0,4)
      CALL NUMBER(999.,1.25,.21,DENT,0.0,-1)
      DO 150 I=2,IG
      DO 151 J=2,JG
      IF (DEPTH(I,J).LT.0.0) GO TO 151
      INTEQ=2
      X=I
      Y=J
      PHI=0.0
      CX=ICMON(1,I,J)/10000000.
      CY=ICMON(3,I,J)/10000000.
      IF (CX.NE.0.0.OR.CY.NE.0.0) PHI=ATAN2(CY,CX)
C
C  TWO VECTORS OF LENGTH 4*SIGMA(1) IN THE DIRECTION OF C1 AND LENGTH
C  4*SIGMA(2) IN THE DIRECTION OF C2 ARE PLOTTED AT THIS GRID PT.
C
      DO 152 M=1,2
      X1=X+4.*ISIG(M,I,J)/SIGHTSC*COS(PHI)
      X2=Y+4.*ISIG(M,I,J)/SIGHTSC*SIN(PHI)
      ANGLE=PHI*180./3.1415926535-90.
      CALL PLOT(X,Y,3)
      CALL PLOT(X1,X2,2)
      IF (ISIG(M,I,J).GE.500) CALL SYMBOL(X1,X2,.14,INTEQ,ANGLE,-1)
      IF (M.EQ.2) GO TO 152
      INTEQ=5
      PHI=PHI-3.1415926535
      CX=ICMON(2,I,J)/10000000.
      CY=ICMON(4,I,J)/10000000.
      IF (CX.NE.0.0.OR.CY.NE.0.0) PHI=ATAN2(CY,CX)
152   CONTINUE
151   CONTINUE
150   CONTINUE
      FPN=K*TIMEST/60.
      CALL SYMBOL(2.5,28.,.21,3HT= ,0.0,3)
      CALL NUMBER(999.,28.,.21,FPN,0.0,1)
      CALL SYMBOL(999.,28.,.21,4H HRS,0.0,4)
      SIGSC=SIGHTSC/100000.
      CALL SYMBOL(999.,28.,.21,IBCD3,0.0,16)
      CALL NUMBER(999.,28.,.21,SIGSC,0.0,1)
      CALL SYMBOL(999.,28.,.21,2H M,0.0,2)
      CALL SYMBOL(5.0,30.,.28,IBCD4,0.0,5)
31    CONTINUE
      CALL ZEROV(CMOM,5520)
      DO 19 J=1,JG
      DO 18 I=1,IG
      IF (DEPTH(I,J).LT.0.0) GO TO 131
      DO 13 M=1,4
      CMOM(M,I,J)=       ICMON(M,I,J) /10000000.
13    CONTINUE
131   CONTINUE
18    CONTINUE
19    CONTINUE
C
C
      RETURN
      END

SI FORTRAN DIAGNOSTIC RESULTS FOR WAVE

  NO ERRORS

 ARE COMMON BLOCK NAMES OR NAMES NOT ASSIGNED STORAGE

  A              G              J
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```
N(2.3)/MASTER       INTEGER WORD SIZE = 1 , * OPTION IS   ON , 0 OPTION IS   OFF    0

      SUBROUTINE WINDINP(WI1,WI2,WI3)
C
C  THE INPUT FROM THE WIND (VERTICAL MOMENTUM FLUX) IS CALCULATED
C
      COMMON /C/ WNDSPD,THETA1,THETA2,C1,C2,SIGMA(2)                      04/78
C
C  THE IMMOBILE SURFACE DRAG COEFFICIENTS ARE CALCULATED
C
      Z=SIGMA(1)*COS(THETA1)/5.0
      IF (Z.LT.0.001) Z=0.001
      DRAG1=0.16/(ALOG(10./Z))**2
      Z=SIGMA(1)/5.0
      IF (Z.LT.0.000001) Z=0.000001
      DRAG2=0.16/(ALOG(10./Z))**2
      Z=SIGMA(2)/5.0
      IF (Z.GE.0.001) DRAG3=0.16/(ALOG(10./Z))**2
      IF (Z.LT.0.001) DRAG3=0.0
C
      FAC1 = 0.0001247                                                 27/02/78
C   FAC1 = AIR DENSITY (15C) / (WATER DEN. X G)
      FAC2 = 0.014                                                     27/02/78
C   FAC2 = 0.86 * GAMMA / 2.0
      FAC = WNDSPD * FAC1 * FAC2                                       27/02/78
C
C  THE VERTICAL MOMENTUM FLUX IS CALCULATED IN EACH OF THE 3 DIRECTIONS
C  OF THE WIND, AND THE 2 PHASE VELOCITY VECTORS.
C
      A=1.0-0.83*C1*COS(THETA1)/WNDSPD
      WI1=FAC*ABS(WNDSPD)*DRAG1*A*ABS(A)
      A=1.0-0.83*C1/(WNDSPD*COS(THETA1))
      WI2=FAC*COS(THETA1)*ABS(WNDSPD*COS(THETA1))*DRAG2*A*ABS(A)
      A=1.0-0.83*C2/(WNDSPD*COS(THETA2))
      WI3=FAC*COS(THETA2)*ABS(WNDSPD*COS(THETA2))*DRAG3*A*ABS(A)
      RETURN
      END

SI FORTRAN DIAGNOSTIC RESULTS FOR WINDINP

 NO ERRORS

 ARE COMMON BLOCK NAMES OR NAMES NOT ASSIGNED STORAGE
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```
       SUBROUTINE COMBINE(VC,CC)
       DIMENSION VC(2),CC(4)
C
C   THE 4 MOMENTUM COMPONENTS (1X,2X,1Y,2Y) MAKE UP 2 PHASE VELOCITY
C   VECTORS.  C1 MUST BE LESS THAN 90 DEG. OUT OF PHASE WITH             MARK
C   THE WIND.  IF IT IS
C   NOT, THE COMPONENTS ARE RELABELLED SO THAT IT IS IN THE QUADRANT OF  MARK
C   THE WIND.
C                                                                        MARK
       PHIV = 0.0                                                        MARK
       IF (  VC(2).NE.0.0.OR.  VC(1).NE.0.0) PHIV=ATAN2(  VC(2),  VC(1)) MARK
       PHI1 = 0.0                                                        MARK
       IF (  CC(3).NE.0.0.OR.  CC(1).NE.0.0) PHI1=ATAN2(  CC(3),  CC(1)) MARK
       DPLUS = ABS(PHI1 - PHIV)                                          MARK
       IF(DPLUS.LT.1.5708.OR.DPLUS.GT.4.7124) GO TO 5                    MARK
C
       DO 4 M=1,2
       I1=M*2-1
       I2=I1+1
       IF (VC(M).GE.0.0.AND.CC(I1).GE.0.0) GO TO 1
       IF (VC(M).LT.0.0.AND.CC(I1).LT.0.0) GO TO 1
       IF (VC(M).GE.0.0.AND.CC(I2).GE.0.0) GO TO 2
       IF (VC(M).LT.0.0.AND.CC(I2).LT.0.0) GO TO 2
       CC(I2)=CC(I2)+CC(I1)
       CC(I1)=0.0
       GO TO 4
2      TEMP=CC(I1)
       CC(I1)=CC(I2)
       CC(I2)=TEMP
     1 CONTINUE
4      CONTINUE
    5  CONTINUE                                                          MARK
C
C
C    CC(I2) IS RESOLVED INTO COMPONENTS IN THE DIRECTION OF CC(I1) AND
C    PERPENDICULAR TO IT. THE COMPONENT IN THE DIRECTION OF CC(I1) IS ADDED TO IT
C    ONLY IF THEY ARE IN THE SAME DIRECTION.
C
       PHI1 = 0.0
       IF (  CC(3).NE.0.0.OR.  CC(1).NE.0.0) PHI1=ATAN2(  CC(3),  CC(1))
       PHI2=PHI1-3.1415926535
       IF (  CC(4).NE.0.0.OR.  CC(2).NE.0.0) PHI2=ATAN2(  CC(4),  CC(2))
       PHID = PHI2 - PHI1
       CC2 = SQRT(CC(2)**2 + CC(4)**2)
       CC2IN = CC2 * COS(PHID)
       IF(CC2IN.LE.0.0) RETURN
       CC2PERP = CC2 * SIN(PHID)
       CC1 = SQRT(CC(1)**2 + CC(3)**2)
       CC1 = CC1 + CC2IN
       CC2IN = 0.0
       CC(1) = CC1 * COS(PHI1)
       CC(3) = CC1 * SIN(PHI1)
       PHIN = PHI1 + 1.5708
       CC(2) = CC2PERP * COS(PHIN)
       CC(4) = CC2PERP * SIN(PHIN)
       RETURN
       END

SI FORTRAN DIAGNOSTIC RESULTS FOR COMBINE

  NO ERRORS
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```
      SUBROUTINE JULIAN(JUL,Y,M,D)
C     BASE GREGORIAN DAY TRANSLATES AS JULIAN DAY =1
C
C*******************
C     JUL- JULIAN DAY
C     D  - DAY
C     M  - MONTH
C     Y  - YEAR
C*******************
C
C     Y... MUST BE EXPRESSED AS CENTURY PLUS YEAR WITHIN CENTURY
C          E.G.   Y=1977  NOT 77
C
C**********************************************************************
C
C
C         CONVERTS GREGORIAN CALENDAR DATES TO THE CORRESPONDING
C         JULIAN DAY NUMBERS
      INTEGER D,Y
      DATA JB/0/
      IEN=0
    5 CONTINUE
      IF(Y.GE.1999)GO TO 10
      IF(Y.LT.1900)GO TO 10
      IF(M.GT. 12)GO TO 10
      IF(M.LT.1)GO TO 10
      IF(D.GT.999)GO TO 10
      IF(D.LT.1)GO TO 10
      GO TO 20
   10 JUL=0
      WRITE(61,15)Y,M,D
   15 FORMAT(36H-INVALID DATE SUPPLIED TO *JULIAN*  ,3I5)
      RETURN
   20 CONTINUE
      RY=Y
      RM=M
      I=(M-14)/12
      RI=I
      J=1461.*(RY+4800.+RI)/4
      K=367.*(RM-2.-RI*12.)/12.
      I=(RY+4900.+RI)/100.
      RI=I
      I=3.*RI/4.
      J=D-32075+J+K-I
      IF(IEN.EQ.1)GO TO 30
      JUL=J-JB
      RETURN
C**********************************************************************
C
C
      ENTRY JULBASE
C         SUPPLIES THE BASE DATE FOR THE JULIAN DAYS BEING APPLIED
      IEN=1
      GO TO 5
   30 CONTINUE
      JB=J-1
      RETURN
C**********************************************************************
C
C
      ENTRY GREGOR
C         CONVERTS JULIAN DAY NUMBERS TO CORRESPONDING
C         GREGORIAN CALENDAR DATES
      IF(JUL.LT.1)GO TO 50
      JJ=JUL+JB
      J=JJ-1721119
      R=4.*J-1.
      Y=R/146097.
      R=R-146097.*Y
      D=R/4.
      R=4.*D+3.
      J=R/1461.
      D=((R-1461.*J)+4.)/4.
      R=5.*D-3.
      M=R/153.
      D=((R-153.*M )+5.)/5.
      Y=100*Y+J
      IF(M.GE.10)GO TO 40
```

```
      M=M+3
      RETURN
   40 M=M-9
      Y=Y+1
      RETURN
    0 D=99
      M=0
      Y=1999
      RETURN
      END

SI FORTRAN DIAGNOSTIC RESULTS FOR JULIAN

  NO ERRORS
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```
ID =     24          L.ONT. NOV.12/72. WAVE PREDICTION.
NO. OF STEPS =    150       THE TIME STEP IS     20.0 MINUTES
WIND SCALE: 1 INCH =  15.0 METRES/SECOND
SIGNIFICANT HEIGHT SCALE: 1 INCH =    1.0 METRES
PLOT FACTOR = 0.330
LAKE SHRINK FACTOR =    2
THE FOLLOWING STATIONS ARE SINGLED OUT:   STA1  (49,15)   STA2  (29,15)   STA3  ( 9, 8)   STA4  (35,13)
                                   YR/MO/DY/HR/MN
THE WIND STARTS AT      1972/11/13/ 7/ 0 AT TIME INTERVALS AS ON THE WIND DATA TAPE
THE LISTING STARTS AT  1972/11/13/ 7/ 0 AT INTERVALS OF  20.0 MINUTES
THE PLOTTING STARTS AT 1972/11/14/ 5/ 0 AT INTERVALS OF  6.00 HOURS
NEW GRID COORDINATES AFTER SHRINKING BY  2 ARE:   STA1  (25, 8)   STA2  (15, 8)   STA3  ( 5, 4)   STA4  (18, 7)

TIME  GMT DAY MTH AVG CD AVG WIND SIGNIFICANT HT. (M) PERIOD OF PEAK (SEC)  WIND SPEED (M/S)   WAVE BEARING DEG    WIND BEARING DEG
STEP               X1000   (M/S)  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4

  1   7 0  13  11   1.94    4.3   0.04 0.05 0.01 0.04 0.72 0.79 0.44 0.71  4.6  5.5  1.9  4.8   73   71   91   62   68   65   91   56
  2   720  13  11   2.22    4.3   0.08 0.10 0.02 0.08 1.01 1.13 0.56 1.02  4.6  5.4  1.9  4.7   73   70   93   59   74   67  100   51
  3   740  13  11   2.10    4.3   0.10 0.13 0.03 0.11 1.21 1.35 0.65 1.22  4.7  5.3  2.0  4.7   74   70   95   57   79   65  109   47
  4   8 0  13  11   1.98    4.3   0.13 0.16 0.03 0.13 1.37 1.52 0.72 1.38  4.8  5.2  2.1  4.8   75   70   98   55   84   71  117   43
  5   820  13  11   1.94    4.2   0.15 0.18 0.04 0.15 1.49 1.64 0.79 1.51  4.9  5.1  1.7  4.8   75   70   99   55   76   78  109   52
  6   840  13  11   1.92    4.2   0.17 0.20 0.04 0.18 1.61 1.75 0.86 1.63  5.0  5.2  1.4  5.0   75   71  100   55   69   85   93   62
  7   9 0  13  11   1.93    4.3   0.19 0.22 0.04 0.20 1.72 1.84 0.94 1.74  5.2  5.3  1.2  5.3   74   72  100   57   62   91   91   70
  8   920  13  11   1.84    4.2   0.21 0.23 0.04 0.22 1.82 1.92 0.91 1.85  5.2  5.1  1.4  5.1   73   73  100   57   68   92  100   65
  9   940  13  11   1.74    4.1   0.23 0.24 0.04 0.23 1.91 1.98 0.89 1.95  5.2  5.0  1.5  4.9   73   74  101   58   74   93  114   67
 10  10 0  13  11   1.65    4.1   0.25 0.25 0.05 0.25 1.99 2.03 0.90 2.03  5.3  4.9  2.0  4.7   73   74  102   58   79   93  124   55
 11  1020  13  11   1.54    4.0   0.27 0.26 0.05 0.26 2.07 2.15 0.94 2.10  5.2  4.5  2.1  4.5   73   75  104   59   73  105  134   65
 12  1040  13  11   1.46    4.0   0.28 0.26 0.05 0.27 2.14 2.29 0.97 2.16  5.2  4.5  2.3  4.3   73   77  108   59   66  124  143   64
 13  11 0  13  11   1.42    4.0   0.29 0.27 0.06 0.28 2.21 2.43 1.01 2.21  5.2  4.8  2.6  4.1   72   79  113   60   59  139  150   64
 14  1120  13  11   1.41    4.0   0.31 0.27 0.07 0.28 2.27 2.50 1.07 2.24  5.4  4.7  2.8  4.1   71   82  119   60   54  144  153   64
 15  1140  13  11   1.43    4.1   0.32 0.27 0.07 0.28 2.32 2.56 1.12 2.26  5.5  4.5  3.2  4.0   70   85  127   61   49  150  173   64
 16  12 0  13  11   1.45    4.3   0.34 0.27 0.08 0.29 2.37 2.53 1.16 2.28  5.8  4.5  3.6  4.0   69   87  137   61   45  156  181   65
 17  1220  13  11   1.50    4.4   0.35 0.26 0.09 0.29 2.39 2.51 1.19 2.31  6.0  4.4  4.3  3.8   68   90  147   62   50  157  185   71
 18  1240  13  11   1.58    4.6   0.36 0.25 0.11 0.29 2.42 2.47 1.29 2.34  5.2  4.3  5.1  3.8   67   93  157   62   54  158  190   75
 19  13 0  13  11   1.68    4.9   0.38 0.25 0.14 0.29 2.46 2.41 1.43 2.36  6.5  4.2  5.9  3.8   67   95  165   63   58  158  193   56
 20  1320  13  11   1.68    4.8   0.40 0.24 0.18 0.31 2.54 2.39 1.61 2.70  6.6  4.2  6.0  3.3   66   99  170   64   58  168  195  111
 21  1340  13  11   1.69    4.9   0.42 0.23 0.21 0.30 2.61 2.33 1.77 2.70  6.6  4.3  6.2  3.6   66  104  174   66   58  177  197  138
 22  14 0  13  11   1.73    5.2   0.44 0.21 0.24 0.28 2.67 2.26 1.91 2.58  6.6  4.6  6.4  4.5   65  110  177   71   58  186  195  156
 23  1420  13  11   1.77    5.2   0.45 0.20 0.27 0.26 2.73 2.20 2.02 2.42  6.5  4.7  6.3  4.6   65  117  179   90   65  187  195  168
 24  1440  13  11   1.76    5.2   0.46 0.19 0.29 0.23 2.77 1.99 2.11 2.35  6.4  4.8  6.2  4.9   65  124  160   95   72  188  193  177
 25  15 0  13  11   1.71    5.3   0.47 0.18 0.30 0.22 2.81 1.85 2.19 2.29  6.5  5.0  6.1  5.3   66  131  181  103   78  188  193  185
 26  1520  13  11   1.68    5.0   0.51 0.18 0.31 0.23 3.20 1.81 2.25 2.27  4.8  4.8  6.0  5.3   66  136  163  111   59  190  203  157
 27  1540  13  11   1.78    5.0   0.53 0.17 0.32 0.23 3.56 1.79 2.30 2.28  4.2  4.6  6.0  5.2   66  143  184  118  130  192  207  190
 28  16 0  13  11   2.09    5.3   0.49 0.17 0.33 0.24 3.22 1.78 2.33 2.20  5.0  4.4  6.0  5.2   90  147  185  126  160  193  212  192
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29	1620	13	11	2.52	5.1	0.42	0.17	0.33	0.25	3.10	1.73	2.35	2.22	4.5	4.5	5.9	5.1	92	151	186	132	171	192	213	135
30	1640	13	11	2.23	5.0	0.37	0.17	0.33	0.25	2.36	1.71	2.36	2.23	4.2	4.5	5.7	5.0	94	154	188	139	184	190	215	203
31	17 0	13	11	2.00	5.0	0.29	0.17	0.33	0.26	2.59	1.70	2.36	2.24	4.1	4.5	5.6	5.0	90	157	189	145	197	198	217	208
32	1720	13	11	1.88	4.8	0.26	0.18	0.32	0.26	2.41	1.72	2.34	2.17	4.0	4.5	5.7	4.7	89	160	190	149	200	192	215	206
33	1740	13	11	1.81	4.7	0.23	0.18	0.32	0.26	2.21	1.74	2.33	2.15	3.9	4.6	5.8	4.4	89	163	192	152	203	195	220	204
34	18 0	13	11	1.75	4.5	0.21	0.18	0.32	0.27	2.00	1.76	2.32	2.13	3.8	4.7	5.9	4.1	89	166	193	154	206	200	221	202
35	1820	13	11	1.67	4.5	0.19	0.19	0.32	0.26	1.80	1.78	2.29	2.11	3.8	4.4	6.1	4.0	89	168	195	156	204	199	219	200
36	1840	13	11	1.62	4.5	0.18	0.19	0.33	0.26	1.53	1.80	2.28	2.08	3.7	4.1	6.3	3.9	182	170	196	158	201	197	216	199
37	19 0	13	11	1.60	4.5	0.17	0.18	0.34	0.26	1.57	1.81	2.30	2.06	3.7	3.8	6.5	3.8	181	171	197	159	198	195	214	197
38	1920	13	11	1.58	4.5	0.17	0.18	0.35	0.26	1.61	1.80	2.36	2.03	3.9	3.7	6.4	3.9	181	172	198	161	203	199	217	195
39	1940	13	11	1.55	4.6	0.16	0.18	0.36	0.25	1.64	1.80	2.41	2.01	4.1	3.7	6.3	4.1	181	173	199	162	207	202	221	199
40	20 0	13	11	1.51	4.7	0.17	0.18	0.36	0.25	1.58	1.79	2.44	1.99	4.3	3.6	5.2	4.3	182	174	200	164	211	205	224	200
41	2020	13	11	1.44	4.6	0.18	0.17	0.36	0.25	1.70	1.75	2.48	2.03	4.5	3.7	5.9	4.2	183	176	201	166	211	206	226	205
42	2040	13	11	1.39	4.6	0.18	0.17	0.36	0.25	1.73	1.72	2.50	2.06	4.7	3.7	5.6	4.1	184	177	201	166	212	207	227	210
43	21 0	13	11	1.39	4.6	0.19	0.16	0.35	0.25	1.76	1.70	2.51	2.08	5.0	3.8	5.3	4.1	186	178	202	170	212	208	229	215
44	2120	13	11	1.35	4.6	0.20	0.15	0.35	0.25	1.87	1.67	2.46	2.07	4.8	3.9	5.5	4.0	188	180	203	172	222	206	231	215
45	2140	13	11	1.34	4.5	0.21	0.16	0.34	0.25	1.95	1.66	2.43	2.05	4.8	3.8	5.7	4.0	190	181	204	173	232	203	233	216
46	22 0	13	11	1.35	4.6	0.22	0.16	0.34	0.24	2.03	1.65	2.40	2.04	4.9	3.8	5.9	3.9	194	182	205	174	242	201	235	217
47	2220	13	11	1.37	4.6	0.22	0.16	0.34	0.24	1.95	1.64	2.37	2.05	4.9	4.0	6.0	3.9	195	183	206	176	232	204	231	221
48	2240	13	11	1.45	4.7	0.22	0.16	0.34	0.24	1.91	1.65	2.35	2.06	5.0	4.2	6.2	3.8	197	184	208	178	221	207	223	225
49	23 0	13	11	1.55	4.9	0.23	0.17	0.35	0.24	1.91	1.66	2.35	2.07	5.3	4.4	6.4	3.8	198	186	208	179	212	209	225	223
50	2320	13	11	1.57	4.9	0.24	0.17	0.36	0.24	1.98	1.68	2.36	2.07	5.3	4.5	6.7	3.8	199	188	209	181	216	213	224	232
51	2340	13	11	1.58	5.0	0.26	0.18	0.37	0.24	2.04	1.71	2.39	2.07	5.3	4.7	7.1	3.8	200	190	210	183	219	217	224	235
52	0 0	14	11	1.61	5.1	0.26	0.19	0.39	0.24	2.09	1.74	2.44	2.08	5.3	4.9	7.5	3.8	201	193	211	185	223	221	223	236
53	20	14	11	1.72	5.6	0.28	0.20	0.41	0.23	2.08	1.76	2.51	2.06	6.3	5.8	7.7	4.1	203	197	212	189	229	232	225	243
54	40	14	11	1.85	6.2	0.30	0.21	0.43	0.24	2.13	1.80	2.58	2.04	7.4	6.8	8.0	4.4	206	204	214	191	233	240	235	247
55	1 0	14	11	1.98	6.8	0.34	0.24	0.46	0.24	2.22	1.87	2.65	2.02	8.4	8.0	8.5	4.7	210	212	216	195	236	246	241	250
56	120	14	11	2.08	7.7	0.39	0.29	0.48	0.25	2.36	2.01	2.71	1.87	9.5	8.9	8.7	5.8	214	220	218	200	238	250	233	247
57	140	14	11	2.23	8.6	0.46	0.35	0.52	0.27	2.54	2.19	2.78	1.86	10.6	9.9	9.0	6.9	218	226	219	206	240	253	236	244
58	2 0	14	11	2.39	9.5	0.55	0.42	0.55	0.31	2.76	2.40	2.87	1.95	11.7	10.8	9.3	8.0	222	231	220	212	242	255	234	242
59	220	14	11	2.55	10.0	0.64	0.50	0.59	0.36	3.00	2.62	2.96	2.10	11.7	11.2	9.6	9.1	223	234	222	215	234	251	235	235
60	240	14	11	2.68	10.6	0.73	0.59	0.62	0.44	3.22	2.84	3.05	2.32	11.8	11.5	9.9	10.3	224	236	223	217	227	247	237	229
61	3 0	14	11	2.60	11.3	0.82	0.67	0.66	0.54	3.43	3.04	3.14	2.59	12.2	12.1	10.2	11.7	223	237	224	218	219	243	239	225
62	320	14	11	2.73	11.6	0.90	0.74	0.70	0.62	3.63	3.24	3.24	2.89	12.3	12.2	10.6	11.7	224	238	226	221	225	247	247	235
63	340	14	11	2.66	12.0	0.98	0.81	0.74	0.70	3.81	3.41	3.34	3.13	12.5	12.4	11.2	12.1	224	239	229	224	232	250	254	244
64	4 0	14	11	2.63	12.6	1.08	0.87	0.78	0.79	3.97	3.55	3.43	3.34	12.8	12.7	12.0	12.8	225	240	232	228	237	254	251	253
65	420	14	11	2.66	12.7	1.13	0.93	0.83	0.88	4.12	3.69	3.51	3.54	12.9	12.8	12.4	13.0	226	241	235	231	238	255	251	254
66	440	14	11	2.69	12.9	1.19	0.98	0.90	0.96	4.25	3.81	3.64	3.72	12.9	12.9	12.8	13.1	227	242	237	234	239	257	260	255
67	5 0	14	11	2.71	13.1	1.25	1.03	0.97	1.03	4.37	3.91	3.79	3.87	13.0	13.0	13.2	13.3	228	243	239	236	240	259	259	256

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SIGNIFICANT HEIGHT OF WAVES IN METRES ON 14 OF 11 1972 AT  5 0 GMT

          1.05 0.91 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          1.07 1.05 0.92 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.97 1.05 1.01 0.85 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.84 0.97 0.97 0.83 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.66 0.90 0.95 0.95 0.84 0.00 0.00 0.00 0.00 0.00 0.00
          0.00 0.89 0.96 0.93 0.96 0.81 0.00 0.00 0.00 0.00 0.00
          0.00 0.95 1.04 1.07 1.01 0.92 0.75 0.00 0.00 0.00 0.00
          0.00 0.99 1.11 1.11 1.05 0.95 0.78 0.00 0.00 0.00 0.00
          0.00 0.86 1.15 1.15 1.13 1.03 0.84 0.00 0.00 0.00 0.00
          0.00 0.00 1.17 1.21 1.21 1.13 0.93 0.00 0.00 0.00 0.00
          0.00 0.00 1.19 1.23 1.24 1.19 1.02 0.00 0.00 0.00 0.00
          0.00 0.00 1.19 1.21 1.22 1.20 1.13 0.94 0.00 0.00 0.00
          0.00 0.00 1.18 1.19 1.17 1.14 1.09 0.92 0.00 0.00 0.00
          0.00 0.00 1.14 1.13 1.11 1.07 1.03 0.88 0.00 0.00 0.00
          0.00 0.00 1.11 1.10 1.07 1.02 0.97 0.83 0.00 0.00 0.00
          0.00 1.11 1.12 1.11 1.08 1.01 0.91 0.77 0.00 0.00 0.00
          0.00 1.11 1.12 1.12 1.11 1.03 0.90 0.73 0.00 0.00 0.00
          0.88 1.12 1.13 1.14 1.12 1.03 0.87 0.61 0.00 0.00 0.00
          0.00 1.16 1.16 1.17 1.14 1.04 0.83 0.00 0.00 0.00 0.00
          0.00 1.20 1.21 1.22 1.18 1.07 0.85 0.00 0.00 0.00 0.00
          0.00 1.24 1.26 1.27 1.23 1.13 0.90 0.00 0.00 0.00 0.00
          0.00 1.25 1.29 1.31 1.26 1.21 1.01 0.00 0.00 0.00 0.00
          0.00 1.19 1.29 1.33 1.32 1.30 1.24 1.12 0.89 0.00 0.00
          0.00 0.97 1.21 1.31 1.31 1.29 1.25 1.15 0.93 0.00 0.00
          0.00 0.00 1.00 1.23 1.28 1.26 1.23 1.15 1.01 0.78 0.00
          0.00 0.00 0.00 1.21 1.20 1.19 1.16 1.09 0.92 0.64 0.00
          0.00 0.00 0.00 1.05 1.06 1.06 1.05 1.00 0.78 0.00 0.00
          0.00 0.00 0.00 0.83 0.80 0.81 0.82 0.67 0.64 0.00 0.00
          0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.64 0.00 0.00 0.00

TIME  GMT DAY MTH AVG CD AVG WIND SIGNIFICANT HT. (M) PERIOD OF PEAK (SEC)  WIND SPEED (M/S)    WAVE BEARING DEG    WIND BEARING DEG
STEP               X1000   (M/S)  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4

 68   520  14  11   2.69   13.1   1.30 1.08 1.06 1.10 4.46 4.00 3.97 4.01 13.0 13.4 13.7 13.4  229  244  241  238  235  259  251  257
 69   540  14  11   2.67   13.2   1.34 1.14 1.16 1.15 4.54 4.09 4.14 4.13 13.1 13.7 14.2 13.4  230  245  243  240  229  256  252  256
 70   6 0  14  11   2.66   13.4   1.39 1.20 1.25 1.20 4.61 4.20 4.31 4.23 13.4 14.1 14.7 13.5  230  246  244  241  224  258  254  259
 71   620  14  11   2.65   13.4   1.42 1.26 1.35 1.25 4.70 4.32 4.48 4.32 13.1 14.1 15.0 13.6  230  247  246  243  234  257  254  253
 72   640  14  11   2.65   13.6   1.45 1.31 1.44 1.29 4.77 4.42 4.64 4.40 13.2 14.1 15.2 13.7  231  248  247  244  244  256  254  262
 73   7 0  14  11   2.67   13.9   1.47 1.36 1.53 1.32 4.81 4.51 4.75 4.46 13.7 14.2 15.4 13.9  233  248  248  245  253  256  254  264
 74   720  14  11   2.70   13.9   1.49 1.40 1.61 1.35 4.82 4.58 4.94 4.48 13.9 14.3 15.2 13.8  234  249  249  246  251  256  250  255
 75   740  14  11   2.75   14.1   1.51 1.44 1.68 1.37 4.83 4.65 5.07 4.51 14.0 14.5 15.0 14.0  235  250  250  246  248  257  257  247
 76   8 0  14  11   2.80   14.4   1.54 1.48 1.74 1.40 4.86 4.71 5.18 4.55 14.3 14.7 14.9 14.5  236  251  250  245  246  258  253  239
 77   820  14  11   2.78   14.4   1.58 1.51 1.81 1.43 4.92 4.81 5.29 4.62 14.5 14.4 15.1 14.4  237  252  250  245  247  253  257  242
 78   840  14  11   2.75   14.4   1.62 1.54 1.89 1.46 4.98 4.88 5.41 4.69 14.7 14.2 15.4 14.3  238  253  251  245  249  269  251  246
 79   9 0  14  11   2.73   14.5   1.66 1.55 1.98 1.49 5.04 4.94 5.56 4.74 15.0 14.2 15.7 14.2  239  254  251  245  251  275  254  250
 80   920  14  11   2.72   14.4   1.70 1.56 2.07 1.51 5.13 4.92 5.72 4.77 14.5 14.3 15.6 14.4  240  255  251  245  239  272  264  244
 81   940  14  11   2.72   14.6   1.73 1.58 2.15 1.53 5.20 4.93 5.84 4.81 14.6 14.5 15.5 14.6  240  256  252  245  227  267  253  240
 82  10 0  14  11   2.74   14.9   1.76 1.61 2.19 1.56 5.27 4.96 5.92 4.85 15.4 14.8 15.4 14.9  239  257  252  244  216  264  253  235
 83  1020  14  11   2.72   14.7   1.78 1.64 2.23 1.58 5.28 5.03 5.99 4.90 14.7 14.6 15.5 14.8  239  257  252  244  226  266  264  236
 84  1040  14  11   2.70   14.6   1.79 1.67 2.29 1.61 5.28 5.08 6.08 4.94 14.6 14.5 15.5 14.7  239  257  253  244  237  258  255  242
 85  11 0  14  11   2.69   14.7   1.81 1.68 2.36 1.63 5.30 5.12 6.20 4.99 15.0 14.3 15.5 14.7  240  258  253  244  247  259  257  245
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SIGNIFICANT HEIGHT OF WAVES IN METRES ON 14 OF 11 1972 AT 11 0 GMT

      2.20 2.41 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
      1.92 2.57 2.06 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
      1.32 2.61 2.29 1.81 0.00 0.00 0.00 0.00 0.00 0.00 0.00
      1.13 2.56 2.36 1.97 0.00 0.00 0.00 0.00 0.00 0.00 0.00
      0.32 2.55 2.42 2.13 1.89 0.00 0.00 0.00 0.00 0.00 0.00
      0.00 2.34 2.47 2.25 2.06 1.77 0.00 0.00 0.00 0.00 0.00
      0.00 2.22 2.45 2.30 2.11 1.90 1.51 0.00 0.00 0.00 0.00
      0.00 1.94 2.44 2.30 2.13 1.92 1.54 0.00 0.00 0.00 0.00
      0.00 1.49 2.40 2.23 2.15 1.96 1.60 0.00 0.00 0.00 0.00
      0.00 0.00 2.33 2.25 2.14 1.99 1.67 0.00 0.00 0.00 0.00
      0.00 0.00 2.26 2.13 2.06 1.96 1.75 0.00 0.00 0.00 0.00
      0.00 0.00 2.21 2.10 1.99 1.89 1.83 1.58 0.00 0.00 0.00
      0.00 0.00 2.17 2.04 1.90 1.80 1.76 1.57 0.00 0.00 0.00
      0.00 0.00 2.15 2.02 1.85 1.71 1.68 1.52 0.00 0.00 0.00
      0.00 0.00 2.16 2.03 1.84 1.66 1.57 1.43 0.00 0.00 0.00
      0.00 2.27 2.19 2.06 1.87 1.63 1.47 1.31 0.00 0.00 0.00
      0.00 2.28 2.20 2.08 1.99 1.63 1.39 1.15 0.00 0.00 0.00
      1.57 2.29 2.21 2.09 1.91 1.65 1.32 0.87 0.00 0.00 0.00
      0.00 2.29 2.24 2.13 1.96 1.70 1.29 0.00 0.00 0.00 0.00
      0.00 2.24 2.23 2.15 2.02 1.78 1.34 0.00 0.00 0.00 0.00
      0.00 2.15 2.20 2.18 2.07 1.87 1.45 0.00 0.00 0.00 0.00
      0.00 1.99 2.12 2.15 2.08 1.94 1.62 0.00 0.00 0.00 0.00
      0.00 1.72 1.95 2.03 2.05 1.98 1.87 1.68 1.30 0.00 0.00
      0.00 1.30 1.72 1.95 1.93 1.89 1.81 1.66 1.33 0.00 0.00
      0.00 0.00 1.32 1.73 1.78 1.75 1.70 1.60 1.36 1.01 0.00
      0.00 0.00 0.00 1.59 1.56 1.57 1.55 1.47 1.21 0.80 0.00
      0.00 0.00 0.00 1.33 1.33 1.33 1.34 1.31 1.01 0.00 0.00
      0.00 0.00 0.00 0.93 0.98 0.58 1.02 1.11 0.80 0.00 0.00
      0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.80 0.00 0.00 0.00

TIME  GMT DAY MTH AVG CD AVG WIND SIGNIFICANT HT. (M) PERIOD OF PEAK (SEC)  WIND SPEED (M/S)    WAVE BEARING DEG    WIND BEARING DEG
STEP                X1000   (M/S)  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4

 86  1120  14  11   2.68    14.8   1.83 1.68 2.43 1.66 5.33 5.12 6.32 5.04  14.9 14.6 15.3 14.7  240  258  253  244  244  273  257  252
 87  1140  14  11   2.68    14.9   1.84 1.70 2.47 1.68 5.36 5.13 6.41 5.09  14.9 15.0 15.1 15.0  241  259  253  245  241  276  257  259
 88  12 0  14  11   2.70    15.1   1.86 1.72 2.48 1.71 5.38 5.16 6.43 5.14  14.9 15.3 14.9 15.5  241  259  254  246  238  273  257  265
 89  1220  14  11   2.74    15.1   1.87 1.74 2.48 1.73 5.38 5.17 6.41 5.16  15.2 15.6 15.2 15.1  241  260  254  246  239  274  258  257
 90  1240  14  11   2.81    15.3   1.89 1.78 2.51 1.75 5.39 5.19 6.44 5.16  15.5 15.9 15.6 15.1  241  260  254  246  240  271  259  248
 91  13 0  14  11   2.87    15.5   1.91 1.81 2.57 1.76 5.41 5.21 6.51 5.18  15.8 16.3 15.9 15.4  241  260  254  246  240  256  271  253
 92  1320  14  11   2.88    15.6   1.94 1.85 2.64 1.78 5.46 5.27 6.57 5.20  15.9 16.4 15.9 15.5  241  260  254  246  238  265  251  242
 93  1340  14  11   2.88    15.7   1.97 1.88 2.68 1.80 5.50 5.31 6.60 5.22  16.1 16.5 16.2 15.6  241  260  253  245  236  257  253  243
 94  14 0  14  11   2.90    15.8   2.00 1.90 2.69 1.81 5.54 5.35 6.57 5.25  16.3 16.6 16.8 15.7  241  260  253  246  233  267  245  245
 95  1420  14  11   2.92    16.0   2.03 1.92 2.70 1.84 5.58 5.37 6.59 5.25  16.5 16.9 16.7 16.1  240  260  252  246  233  257  245  247
 96  1440  14  11   2.97    16.3   2.07 1.95 2.72 1.87 5.61 5.40 6.63 5.28  16.7 17.2 16.6 16.6  240  260  252  246  232  267  252  248
 97  15 0  14  11   3.02    16.5   2.10 1.99 2.75 1.91 5.66 5.44 6.67 5.33  17.0 17.5 16.6 17.1  240  260  253  246  231  268  255  250
 98  1520  14  11   3.01    16.5   2.13 2.02 2.77 1.96 5.71 5.51 6.71 5.41  16.8 17.1 16.4 17.0  240  260  253  247  237  261  252  243
 99  1540  14  11   3.00    16.5   2.16 2.04 2.79 2.00 5.75 5.55 6.75 5.47  16.8 16.9 16.3 16.9  240  260  254  247  243  250  247  246
100  16 0  14  11   2.99    16.6   2.18 2.05 2.82 2.03 5.79 5.59 6.82 5.53  16.9 16.8 16.3 16.9  241  259  254  247  249  250  243  244
101  1620  14  11   2.98    16.5   2.20 2.05 2.86 2.05 5.82 5.58 6.87 5.59  16.9 16.6 16.3 16.7  241  259  255  246  245  258  243  240
102  1640  14  11   2.96    16.5   2.22 2.04 2.93 2.07 5.85 5.57 6.95 5.64  16.9 16.7 16.4 16.5  241  260  256  246  241  265  253  237
103  17 0  14  11   2.95    16.5   2.24 2.04 3.02 2.08 5.87 5.56 7.06 5.57  17.0 17.2 16.6 16.5  241  260  256  246  237  275  256  233
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SIGNIFICANT HEIGHT OF WAVES IN METRES ON 14 OF 11 1972 AT 17 0 GMT

         2.10 2.74 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
         1.53 2.99 2.58 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
         1.35 3.02 2.90 2.35 0.00 0.00 0.00 0.00 0.00 0.00 0.00
         1.26 3.02 3.02 2.59 0.00 0.00 0.00 0.00 0.00 0.00 0.00
         1.10 3.02 3.09 2.85 2.51 0.00 0.00 0.00 0.00 0.00 0.00
         0.00 2.95 3.09 2.90 2.74 2.42 0.00 0.00 0.00 0.00 0.00
         0.00 2.70 3.07 2.93 2.75 2.58 2.16 0.00 0.00 0.00 0.00
         0.00 2.37 3.03 2.89 2.73 2.58 2.21 0.00 0.00 0.00 0.00
         0.00 1.90 2.97 2.84 2.70 2.57 2.27 0.00 0.00 0.00 0.00
         0.00 0.00 2.93 2.80 2.67 2.54 2.32 0.00 0.00 0.00 0.00
         0.00 0.00 2.92 2.75 2.59 2.46 2.34 0.00 0.00 0.00 0.00
         0.00 0.00 2.91 2.71 2.50 2.35 2.34 2.30 0.00 0.00 0.00
         0.00 0.00 2.92 2.63 2.42 2.23 2.20 2.21 0.00 0.00 0.00
         0.00 0.00 2.92 2.63 2.36 2.13 2.04 2.04 0.00 0.00 0.00
         0.00 0.00 2.93 2.70 2.39 2.06 1.85 1.75 0.00 0.00 0.00
         0.00 2.06 2.95 2.75 2.45 2.05 1.67 1.28 0.00 0.00 0.00
         0.00 3.02 2.95 2.73 2.51 2.08 1.50 0.97 0.00 0.00 0.00
         1.53 2.96 2.92 2.77 2.51 2.12 1.59 0.52 0.00 0.00 0.00
         0.00 2.90 2.89 2.77 2.54 2.18 1.63 0.00 0.00 0.00 0.00
         0.00 2.79 2.84 2.77 2.59 2.27 1.71 0.00 0.00 0.00 0.00
         0.00 2.63 2.75 2.75 2.62 2.37 1.84 0.00 0.00 0.00 0.00
         0.00 2.40 2.62 2.69 2.61 2.45 2.05 0.00 0.00 0.00 0.00
         0.00 2.05 2.41 2.57 2.54 2.47 2.33 2.07 1.59 0.00 0.00
         0.00 1.53 2.09 2.41 2.39 2.35 2.24 2.03 1.62 0.00 0.00
         0.00 0.00 1.59 2.21 2.20 2.18 2.11 1.95 1.66 1.23 0.00
         0.00 0.00 0.00 1.96 1.96 1.95 1.91 1.79 1.47 0.97 0.00
         0.00 0.00 0.00 1.63 1.64 1.64 1.64 1.60 1.23 0.00 0.00
         0.00 0.00 0.00 1.17 1.18 1.19 1.23 1.35 0.97 0.00 0.00
         0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.97 0.00 0.00 0.00

TIME  GMT DAY MTH AVG CD  AVG WIND SIGNIFICANT HT. (M) PERIOD OF PEAK (SEC) WIND SPEED (M/S)    WAVE BEARING DEG   WIND BEARING DEG
STEP                X1000   (M/S)  STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4

104  1720  14  11  2.93   16.6    2.28 2.02 3.12 2.09 5.93 5.51 7.18 5.66 16.7 17.2 16.7 16.9 241  261  256  245  231  271  253  233
105  1740  14  11  2.92   16.7    2.26 2.00 3.19 2.12 5.97 5.46 7.27 5.68 16.6 17.4 16.7 17.4 240  260  256  244  224  266  250  232
106  18 0  14  11  2.94   16.9    2.25 1.97 3.23 2.17 5.99 5.39 7.32 5.73 16.7 17.7 16.8 17.9 239  260  255  243  217  262  252  231
107  1820  14  11  2.95   17.0    2.23 1.94 3.24 2.23 5.94 5.33 7.36 5.80 16.9 17.7 16.6 18.0 238  258  256  243  217  260  250  233
108  1840  14  11  2.96   17.0    2.23 1.89 3.23 2.28 5.91 5.25 7.36 5.86 17.1 17.8 16.4 18.2 237  257  255  242  217  258  253  235
109  19 0  14  11  3.01   17.1    2.23 1.84 3.19 2.32 5.89 5.16 7.33 5.90 17.3 17.9 16.2 18.4 236  254  255  241  218  255  255  237
110  1920  14  11  2.98   16.9    2.23 1.79 3.17 2.35 5.88 5.08 7.29 5.95 16.9 17.7 16.2 18.1 236  252  254  241  223  254  255  243
111  1940  14  11  2.93   16.8    2.23 1.74 3.16 2.36 5.88 5.00 7.27 5.99 16.7 17.6 16.2 18.0 235  249  254  242  228  252  252  245
112  20 0  14  11  2.90   16.8    2.23 1.69 3.15 2.36 5.88 4.93 7.26 6.00 16.7 17.5 16.3 18.2 235  246  253  242  234  250  245  255
113  2020  14  11  2.89   16.7    2.24 1.67 3.15 2.34 5.87 4.89 7.30 5.98 16.9 17.4 15.1 17.5 234  244  253  243  231  249  243  245
114  2040  14  11  2.92   16.7    2.25 1.65 3.14 2.29 5.86 4.88 7.31 5.94 17.2 17.2 16.2 17.1 234  241  252  243  229  249  235  242
115  21 0  14  11  2.93   16.8    2.26 1.66 3.13 2.25 5.87 4.90 7.32 5.89 17.5 17.1 16.5 16.9 234  240  251  243  227  245  223  236
116  2120  14  11  2.66   16.5    2.27 1.67 3.11 2.20 5.96 4.92 7.25 5.81 17.0 16.9 16.6 16.8 233  242  251  243  216  245  232  243
117  2140  14  11  2.77   16.3    2.28 1.69 3.10 2.16 6.00 4.96 7.20 5.75 17.2 16.8 16.7 16.9 231  243  251  244  206  242  236  254
118  22 0  14  11  2.73   16.3    2.24 1.70 3.12 2.13 6.01 4.98 7.19 5.70 18.0 16.8 16.9 17.2 229  244  250  244  195  240  233  256
119  2220  14  11  2.79   16.3    2.18 1.70 3.15 2.10 5.83 4.99 7.27 5.63 17.2 16.7 16.6 17.3 228  245  250  245  206  246  237  251
120  2240  14  11  2.93   16.6    2.16 1.71 3.17 2.08 5.72 5.00 7.33 5.57 17.4 16.8 16.4 17.6 228  246  250  245  221  252  235  246
121  23 0  14  11  3.08   17.0    2.16 1.74 3.18 2.07 5.68 5.04 7.38 5.53 18.4 17.2 16.2 18.0 228  248  250  245  233  256  232  241
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SIGNIFICANT HEIGHT OF WAVES IN METRES ON 14 OF 11 1972 AT 23 0 GMT

              2.47 2.80 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
              2.10 3.19 2.67 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
              1.21 3.29 3.07 2.47 0.00 0.00 0.00 0.00 0.00 0.00 0.00
              1.09 3.21 3.18 2.75 0.00 0.00 0.00 0.00 0.00 0.00 0.00
              0.95 3.14 3.22 3.05 2.64 0.00 0.00 0.00 0.00 0.00 0.00
              0.00 3.03 3.21 3.09 2.92 2.45 0.00 0.00 0.00 0.00 0.00
              0.00 2.87 3.24 3.12 2.93 2.61 1.98 0.00 0.00 0.00 0.00
              0.00 2.54 3.27 3.10 2.89 2.56 1.93 0.00 0.00 0.00 0.00
              0.00 1.93 3.29 3.09 2.85 2.49 1.95 0.00 0.00 0.00 0.00
              0.00 0.00 3.30 3.00 2.82 2.41 1.76 0.00 0.00 0.00 0.00
              0.00 0.00 3.31 3.08 2.78 2.34 1.69 0.00 0.00 0.00 0.00
              0.00 0.00 3.31 3.05 2.72 2.29 1.68 1.05 0.00 0.00 0.00
              0.00 0.00 3.29 3.01 2.67 2.26 1.67 0.35 0.00 0.00 0.00
              0.00 0.00 3.24 2.35 2.61 2.23 1.74 0.30 0.00 0.00 0.00
              0.00 0.00 3.19 2.93 2.53 2.18 1.71 1.14 0.00 0.00 0.00
              0.00 3.31 3.16 2.92 2.58 2.12 1.71 1.43 0.00 0.00 0.00
              0.00 3.27 3.10 2.98 2.55 2.07 1.67 1.45 0.00 0.00 0.00
              2.13 3.12 3.01 2.91 2.46 2.03 1.55 1.08 0.00 0.00 0.00
              0.00 3.01 2.95 2.75 2.45 2.03 1.48 0.00 0.00 0.00 0.00
              0.00 2.89 2.68 2.75 2.46 2.08 1.51 0.00 0.00 0.00 0.00
              0.00 2.74 2.81 2.75 2.55 2.21 1.64 0.00 0.00 0.00 0.00
              0.00 2.53 2.71 2.73 2.61 2.36 1.87 0.00 0.00 0.00 0.00
              0.00 2.22 2.54 2.65 2.59 2.46 2.23 1.90 1.40 0.00 0.00
              0.00 1.71 2.25 2.43 2.45 2.35 2.18 1.90 1.45 0.00 0.00
              0.00 0.00 1.76 2.27 2.25 2.19 2.06 1.84 1.54 1.14 0.00
              0.00 0.00 0.00 2.30 2.00 1.96 1.87 1.69 1.38 0.95 0.00
              0.00 0.00 0.00 1.68 1.68 1.67 1.63 1.50 1.15 0.00 0.00
              0.00 0.00 0.00 1.24 1.25 1.26 1.27 1.29 0.95 0.00 0.00
              0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.95 0.00 0.00 0.00

TIME  GMT DAY MTH AVG CD  AVG WIND SIGNIFICANT HT. (M)  PERIOD OF PEAK (SEC)  WIND SPEED (M/S)    WAVE BEARING DEG    WIND BEARING DEG
STEP              X1000    (M/S)   STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4  STA1 STA2 STA3 STA4

 122  2320  14  11  3.07    16.8   2.22 1.76 3.19 2.07  5.74 5.09 7.44 5.56  18.3 16.7 15.9 17.6  228  249  249  244   227  254  226  239
 123  2340  14  11  3.02    15.7   2.26 1.76 3.18 2.07  5.91 5.12 7.49 5.57  18.5 16.3 15.7 17.3  228  250  249  244   221  249  224  239
 124   0 0  15  11  2.99    16.7   2.31 1.75 3.16 2.06  5.88 5.13 7.52 5.58  18.9 16.1 15.6 17.0  227  250  249  243   215  244  220  237
 125   020  15  11  2.90    16.3   2.34 1.73 3.13 2.05  5.96 5.15 7.51 5.56  17.8 15.3 15.2 17.0  227  250  249  243   225  238  221  236
 126   040  15  11  2.80    16.0   2.35 1.70 3.09 2.04  6.02 5.16 7.50 5.55  17.3 14.7 14.7 16.9  228  249  248  242   236  232  221  235
 127   1 0  15  11  2.74    15.9   2.34 1.66 3.05 2.03  6.05 5.17 7.47 5.54  17.5 14.3 14.2 16.9  229  249  243  242   247  225  222  234
 128   120  15  11  2.65    15.4   2.32 1.62 3.00 2.02  6.00 5.06 7.44 5.56  17.0 13.8 13.7 16.2  229  249  245  241   238  233  223  243
 129   140  15  11  2.58    15.1   2.30 1.60 2.97 2.00  5.96 5.00 7.43 5.57  16.9 13.7 13.2 15.9  229  249  247  242   225  242  224  253
 130   2 0  15  11  2.53    14.9   2.29 1.60 2.93 1.98  5.94 4.99 7.41 5.58  17.2 13.8 12.7 16.1  229  250  247  242   220  250  226  252
 131   220  15  11  2.53    14.6   2.28 1.62 2.89 1.95  5.92 5.07 7.47 5.53  17.2 13.4 12.3 15.5  229  251  246  242   222  247  213  251
 132   240  15  11  2.55    14.5   2.27 1.64 2.81 1.92  5.89 5.14 7.47 5.47  17.2 13.0 12.3 15.2  229  251  245  241   223  244  209  244
 133   3 0  15  11  2.60    14.4   2.26 1.65 2.73 1.89  5.86 5.19 7.47 5.42  17.2 12.6 12.5 15.3  229  251  244  240   225  240  201  235
 134   320  15  11  2.44    14.0   2.25 1.64 2.59 1.87  5.95 5.19 7.14 5.39  16.4 12.5 12.3 15.1  229  251  243  239   215  236  205  234
 135   340  15  11  2.29    13.7   2.21 1.62 2.47 1.83  5.99 5.17 6.85 5.35  16.1 12.4 12.1 14.8  228  251  242  238   205  235  211  234
 136   4 0  15  11  2.19    13.6   2.17 1.59 2.36 1.80  6.00 5.14 6.61 5.31  16.3 12.4 12.1 14.6  227  250  242  233   195  232  217  233
 137   420  15  11  2.16    13.4   2.10 1.56 2.31 1.77  5.37 5.09 6.59 5.27  15.8 12.3 11.7 14.4  226  250  241  237   197  229  214  231
 138   440  15  11  2.16    13.2   2.02 1.52 2.27 1.73  5.74 5.04 6.60 5.22  15.3 12.3 11.3 14.2  225  249  241  236   200  225  211  228
 139   5 0  15  11  2.16    13.1   1.96 1.49 2.24 1.70  5.63 4.98 6.61 5.17  14.9 12.3 11.0 14.1  224  247  240  235   203  223  208  225
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 SIGNIFICANT HEIGHT OF WAVES IN METRES ON 15 OF 11 1972 AT  5 0 GMT

             2.24 2.04 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
             2.11 2.36 1.78 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
             1.93 2.45 2.09 1.44 0.00 0.00 0.00 0.00 0.00 0.00 0.00
             1.60 2.49 2.24 1.69 0.00 0.00 0.00 0.00 0.00 0.00 0.00
             0.70 2.51 2.37 1.38 1.44 0.00 0.00 0.00 0.00 0.00 0.00
             0.00 2.45 2.41 2.03 1.59 1.19 0.00 0.00 0.00 0.00 0.00
             0.00 2.30 2.42 2.12 1.78 1.38 0.88 0.00 0.00 0.00 0.00
             0.00 2.04 2.41 2.14 1.64 1.47 0.98 0.00 0.00 0.00 0.00
             0.00 1.58 2.39 2.16 1.90 1.58 1.12 0.00 0.00 0.00 0.00
             0.00 0.00 2.36 2.17 1.95 1.67 1.27 0.00 0.00 0.00 0.00
             0.00 0.00 2.38 2.19 1.97 1.73 1.42 0.00 0.00 0.00 0.00
             0.00 0.00 2.40 2.19 1.97 1.75 1.55 1.41 0.00 0.00 0.00
             0.00 0.00 2.43 2.21 1.96 1.74 1.53 1.33 0.00 0.00 0.00
             0.00 0.00 2.46 2.24 1.99 1.73 1.49 1.25 0.00 0.00 0.00
             0.00 0.00 2.51 2.23 2.02 1.72 1.44 1.17 0.00 0.00 0.00
             0.00 2.76 2.56 2.32 2.04 1.71 1.40 1.09 0.00 0.00 0.00
             0.00 2.81 2.62 2.37 2.06 1.70 1.32 0.96 0.00 0.00 0.00
             2.02 2.85 2.66 2.43 2.10 1.70 1.24 0.74 0.00 0.00 0.00
             0.00 2.99 2.74 2.51 2.18 1.75 1.19 0.00 0.00 0.00 0.00
             0.00 2.85 2.77 2.58 2.28 1.86 1.27 0.00 0.00 0.00 0.00
             0.00 2.74 2.75 2.62 2.37 1.99 1.41 0.00 0.00 0.00 0.00
             0.00 2.54 2.65 2.61 2.43 2.15 1.65 0.00 0.00 0.00 0.00
             0.00 2.21 2.46 2.51 2.41 2.25 2.02 1.66 1.18 0.00 0.00
             0.00 1.67 2.15 2.34 2.26 2.15 1.96 1.67 1.23 0.00 0.00
             0.00 0.00 1.66 2.11 2.06 1.98 1.84 1.53 1.33 0.94 0.00
             0.00 0.00 0.00 1.83 1.81 1.76 1.66 1.47 1.17 0.78 0.00
             0.00 0.00 0.00 1.51 1.51 1.49 1.43 1.23 0.94 0.00 0.00
             0.00 0.00 0.00 1.03 1.10 1.10 1.11 1.10 0.78 0.00 0.00
             0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.78 0.00 0.00 0.00

 TIME  GMT DAY MTH AVG CD  AVG WIND  SIGNIFICANT HT. (M) PERIOD OF PEAK (SEC)  WIND SPEED (M/S)   WAVE BEARING DEG   WIND BEARING DEG
 STEP               X1000    (M/S)   STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4 STA1 STA2 STA3 STA4

 140   520  15  11   2.09    12.8    1.90 1.45 2.19 1.66 5.56 4.95 6.58 5.14 14.6 11.9 10.9 13.7  223  246  240  234  201  220  205  222
 141   540  15  11   2.03    12.5    1.84 1.41 2.13 1.61 5.48 4.91 6.52 5.09 14.3 11.6 10.8 13.3  222  245  239  233  199  217  203  215
 142   6 0  15  11   1.97    12.3    1.78 1.37 2.07 1.57 5.41 4.86 6.45 5.03 14.0 11.4 10.7 13.0  221  243  239  232  197  214  200  216
 143   620  15  11   1.97    12.1    1.72 1.32 2.00 1.52 5.27 4.78 6.35 4.94 13.6 11.2 10.8 12.9  220  242  239  232  203  212  195  215
 144   640  15  11   1.99    12.0    1.66 1.28 1.93 1.47 5.16 4.70 6.24 4.87 13.3 11.0 10.9 12.7  219  241  238  231  210  211  195  214
 145   7 0  15  11   2.02    11.9    1.62 1.24 1.87 1.43 5.08 4.62 6.13 4.79 13.3 10.9 11.0 12.6  215  239  237  230  217  210  193  214
 146   720  15  11   1.96    11.6    1.59 1.20 1.78 1.39 5.04 4.57 5.80 4.72 13.0 10.3 10.8 12.3  218  238  237  229  213  209  204  214
 147   740  15  11   1.92    11.4    1.56 1.16 1.72 1.34 4.99 4.52 5.56 4.66 12.9  9.8 10.9 11.9  217  237  237  229  209  208  214  214
 148   8 0  15  11   1.91    11.3    1.52 1.11 1.69 1.30 4.95 4.46 5.40 4.59 12.7  9.3 11.3 11.5  216  236  237  228  205  208  224  214
 149   820  15  11   1.88    11.1    1.49 1.06 1.69 1.26 4.91 4.32 5.47 4.51 12.6  9.3 10.9 11.5  215  235  237  227  202  207  215  212
 150   840  15  11   1.85    10.9    1.46 1.01 1.68 1.22 4.87 4.20 5.52 4.45 12.4  9.2 10.6 11.4  214  234  236  226  196  207  213  209

    STOP
```

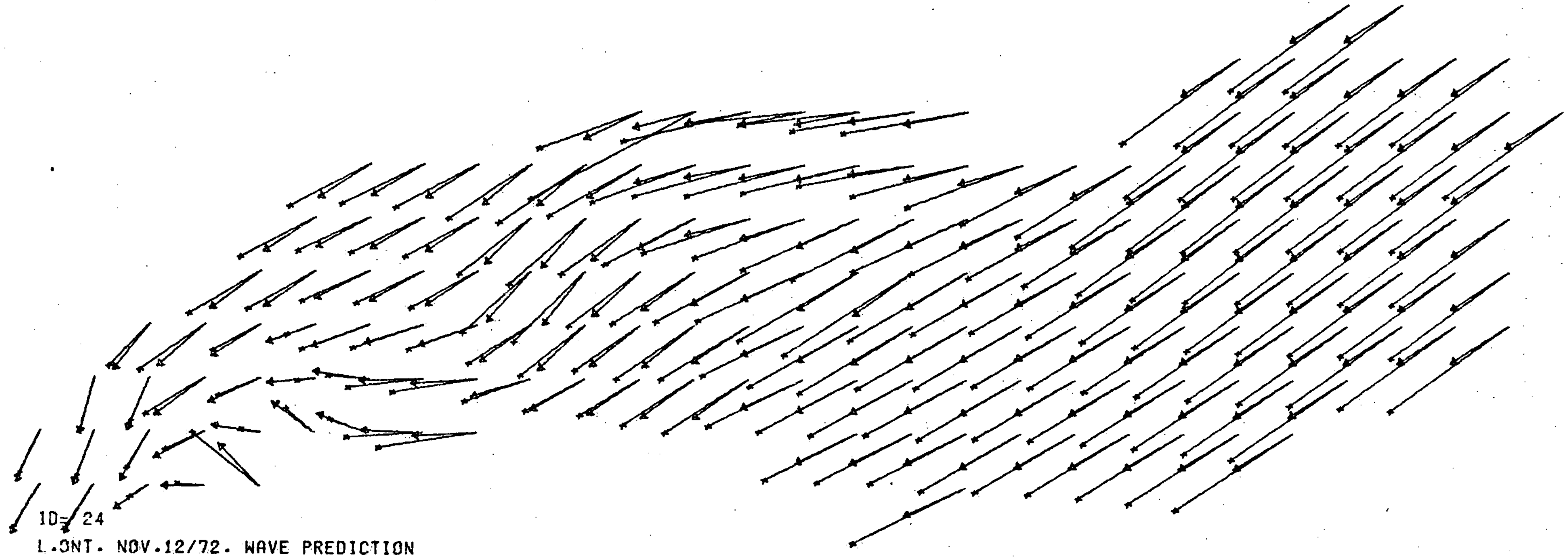
APPENDIX E.1

WIND

1 IN = 0.450

T= 40.3 HRS

1 IN= 15 M/S

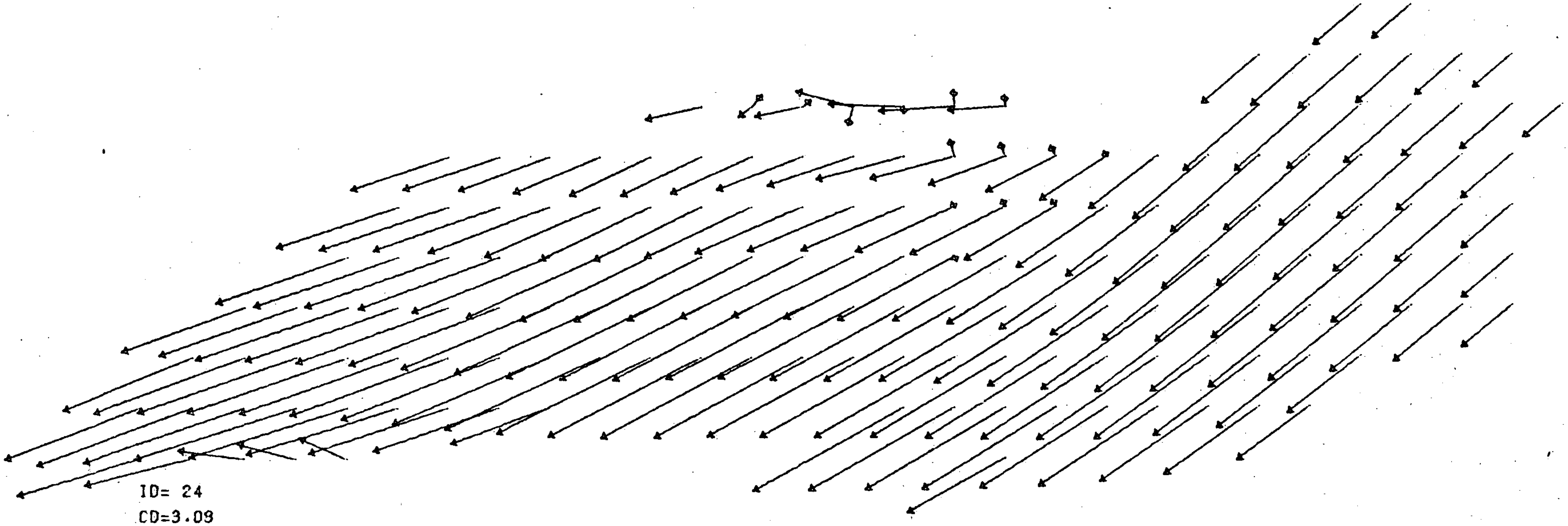


ID= 24

L.ONT. NOV.12/72. WAVE PREDICTION

WAVES

T= 40.3 HRS 4*SIGMA: 1 IN =1.0 M



APPENDIX E.2

10039

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