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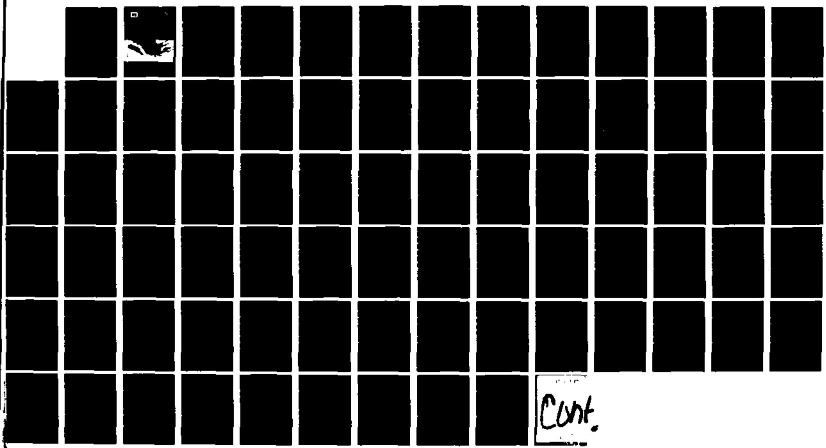

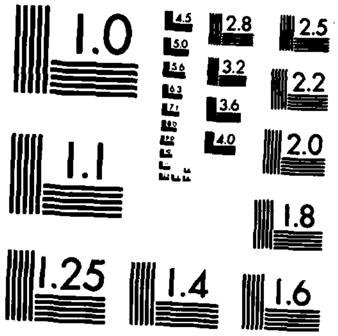

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A NUMERICAL MODEL FOR WIND-WAVE PREDICTION IN DEEP WATER

by

Donald T. Resio, Barbara A. Tracy

Hydraulics Laboratory
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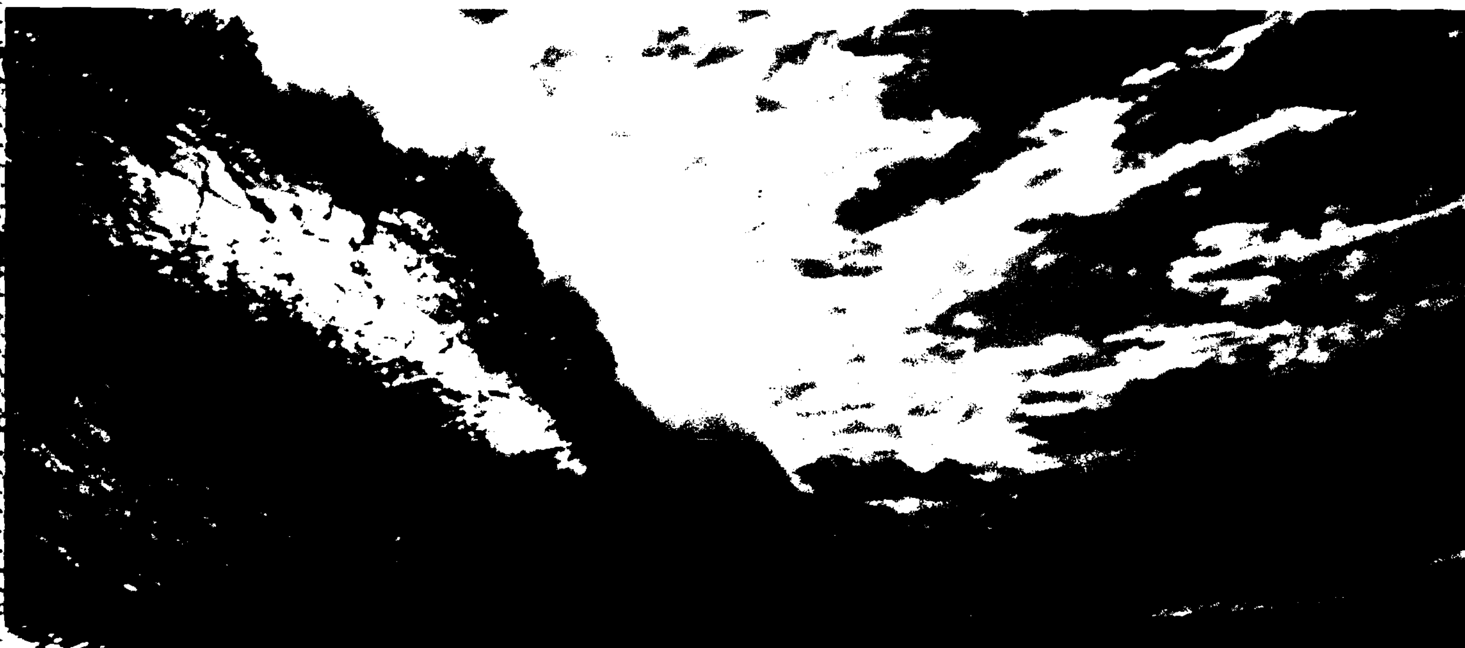
WIS Report 12
January 1983



WAVE INFORMATION STUDIES OF U. S. COASTLINES

Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

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This report contains a description and listing of a numerical wave hindcast model similar to that used to calculate 20 years of wave conditions in the Atlantic Ocean as part of the Wave Information Study. For a specified spatial grid, the model takes input time sequences of wind velocity and calculates the directional wave spectrum from which parameters such as significant wave height, frequency of peak energy density, and mean wave direction can be deduced. Instructions on how to set up the input and output for the model are given and a discussion of the model's limitations is provided.

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Preface

In late 1976, a study to produce a wave climate for U. S. coastal waters was initiated at the U. S. Army Engineer Waterways Experiment Station (WES). The Wave Information Study (WIS) was authorized by the Office, Chief of Engineers, U. S. Army, as a part of the Field Data Collection Program which is managed by the U. S. Army Coastal Engineering Research Center. The U. S. Army Engineer Division, South Atlantic, and the U. S. Army Engineer Division, New England, also authorized funds during the initial year of this study (FY 1978) to expedite execution of the Atlantic coast portion of this program.

This report, the twelfth in a series, presents a simplified version of the wave hindcast model developed to calculate the wave information. The study was conducted in the Hydraulics Laboratory under the direction of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, Dr. R. W. Whalin, Chief of the Wave Dynamics Division, and Mr. C. E. Chatham, Jr., Chief of the Wave Processes Branch. This report was prepared by Dr. D. T. Resio and Mrs. B. A. Tracy with assistance from Mr. W. D. Corson, Mrs. D. S. Ragsdale, and Mr. R. E. Jensen. Dr. C. L. Vincent provided valuable suggestions.

Commanders and Directors of WES during the conduct of the study and the preparation and publication of this report were COL John L. Cannon, CE, COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

Summary

In 1976, the U. S. Army Engineer Waterways Experiment Station began a study to produce a wave climate for U. S. coastal waters. This climatological information is produced by numerical simulation of wave growth, propagation, and decay driven by historical wind fields. It is imperative, if such an approach is to be used for applications of significant economic consequences, that the entire set of input data, all numerical techniques, and all general assumptions be thoroughly investigated and documented to determine the types and magnitudes of errors intrinsic to their use.

There are four basic steps in the calculation of waves from past meteorological data. First, pressure data must be assimilated into a pressure field that depicts all important synoptic weather features. Gradients of pressure in time and space, along with certain thermal characteristics of the planetary boundary layer, are then used to construct an estimate of a quasi-geostrophic wind speed and direction at some level where it is assumed that the frictional effects of the ocean surface on the atmosphere are negligible. Next, an analysis of the vertical variation of the wind in the planetary boundary layer is used to reduce this wind to a common 19.5-m level. Finally, these surface winds are input into a numerical wave model to simulate wave generation, propagation, and decay.

If any one of the above steps contributes significant bias (on a geographical basis, seasonally or overall), it can introduce errors into the results that are difficult or impossible to remove. Similarly, if any step contains a large random error, certain statistics (such as duration curves, extremes, and conditional probabilities) can be seriously affected. Thus, each step must be checked independently where possible. This serves to substantiate the merit of the physics and data processing techniques used in each step and hence tends to lend support to the worth of the final product more so than the performance of only wave comparisons, regardless of how extensive these comparisons may be. Indeed, if each step is shown to be physically valid, it

can be argued that the results should be as accurate in sites where there are no wave data for verification as they are in areas where large amounts of gage data are available. Additionally, if all steps are modeled correctly, factors such as direction and angular spreading, which are not generally available for comparisons, can reasonably be assumed to be at least approximately correct.

This report will discuss the numerical wave model used to generate the deepwater wave data that are contained in the Atlantic Phase I and Phase II data reports. A FORTRAN listing is included and a discussion of how to use the model is provided herein.

Contents

A NUMERICAL MODEL FOR WIND-WAVE PREDICTION IN DEEP WATER

Introduction

1. This report provides a listing and description of a simplified version of the numerical wave hindcast model used by the U. S. Army Engineer Waterways Experiment Station to develop wave climates for U. S. coastal regions. The report will outline the program architecture, time and storage requirements, and input and output parameters. Also included is a sample setup of a run with a sample of the output. It is the intent of this report to provide a sufficient description of the model to allow a person reasonably knowledgeable in numerical modeling of water waves to run the model with little difficulty. Due to the complexity of the physics of the processes modeled and the modeling techniques employed, it is not possible to develop a code that is completely foolproof; indeed, it is possible through apparently subtle misspecification of wind fields or other input parameters to create erroneous results. A description of the physics of wave growth incorporated in this model is provided by Resio (1981).

2. The model presented here is similar to the one used to hindcast 20 years of wave data in the Atlantic Ocean (Corson et al. 1981). However, the latter model was written explicitly to operate on an orthogonal grid inscribed on a sphere, and much of the code involved nonstandard FORTRAN. The present model has been modified to consider a flat earth and an attempt has been made to code the program in a manner that should run with little or no changes on most computers. Appendix B provides a discussion of the FORTRAN changes in the coding to convert the flat earth wave model into a spherical orthogonal system if large oceanic areas are to be modeled. The wave model requires a rectangular grid and wind input at each of the intersections of the grid.

3. The model is relatively simple to use. However, the user must realize that this wave model is but one of a sequence of models used to develop the wave climate. This sequence consists of programs to convert pressure fields into wind fields, wind fields into wave fields, and

wave data into statistical summaries. Considerable care has been taken to assure that all elements of the models are compatible and the models have been verified separately and together.

4. The following constraints are brought to the attention of the user:

a. Wind input. The model requires the input of a wind velocity (speed and direction) at each grid point as a function of time. The wave growth terms in the model are effectively scaled on the local wind stress based on the assumption of a neutral (0° air-sea temperature difference) atmospheric stability. The wind model that feeds wind data to the wave model accounts for both atmospheric stability and baroclinicity. The user must therefore transform observed or predicted surface wind fields to give this effective wind velocity. The procedure used in the Wave Information Study (WIS) is provided in WIS Reports 4 and 10 (in preparation). The user is specifically warned that the input of wind velocities such as those read directly from a weather map into the model without making these adjustments can lead to spurious results.

b. Grid geometry. The model was designed for water bodies of large and relatively uncomplicated geometry. The model employs a fourth order finite-difference scheme for most wave propagation. In the case of an irregular shoreline combined with a narrow body of water, most of the computation points are not fourth order points as later described, and the model may become numerically unstable. This model has only been tested for a simple geometry.

c. Input parameters. Constraints on numbers of frequencies, size of space, and time-steps must be adhered to to avoid instabilities or inadequate resolution of the energy spectrum.

d. Program modifications. The numerical procedures and approximations to the wave growth and decay processes are complex. As a result of a desire to obtain computational efficiency, certain parts of the calculations are split into various parts of the program. Such programming steps therefore make the code less penetrable to someone not intimately familiar with the program development. Consequently, great care should be taken in modifying any part of the program except the input and output portions of the model.

5. Again, it is presumed that the user of the model is basically familiar with the modeling of the growth and decay of a directional wave spectrum. Therefore, this report is written with a minimum of

explanations to this background information. The user not so familiar may need to make reference to WIS Reports 1-11.

Description of Computer Program

6. This section contains a description of the computer program and includes flow charts and notes on the dimension statements needed for the variables in the computer program. General aspects of running the program are included in this section. The sections on data input and output are self-explanatory and are necessary to run the program.

Frequency and direction

7. The model uses 20 discrete frequencies and 16 direction categories, giving 320 frequency-direction components at each spatial point. These frequencies are read in by the input file. Twenty frequencies are needed to run this program. The numerical values for these frequencies can be changed, and each Δf* (difference between frequencies) is calculated within the program. It is possible with minor modifications to change the number of frequencies considered; however, the accuracy of the wave-wave interaction source term used in this model depends on the resolution of the spectral peak. If too crude a representation is used to define the spectrum, problems arise in the estimation of these source terms. The number of direction categories cannot be changed without modifying the whole program. The part of the spectrum at frequencies higher than the highest frequency input is calculated parametrically.

Core storage

8. Core storage requirements are minimized by performing all calculations for each frequency separately. In this way, only one large matrix containing all of the two-dimensional spectral information is needed. The core storage required to load this program is described in Figure 1 in terms of the number of spatial points (water points,

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* For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix D).

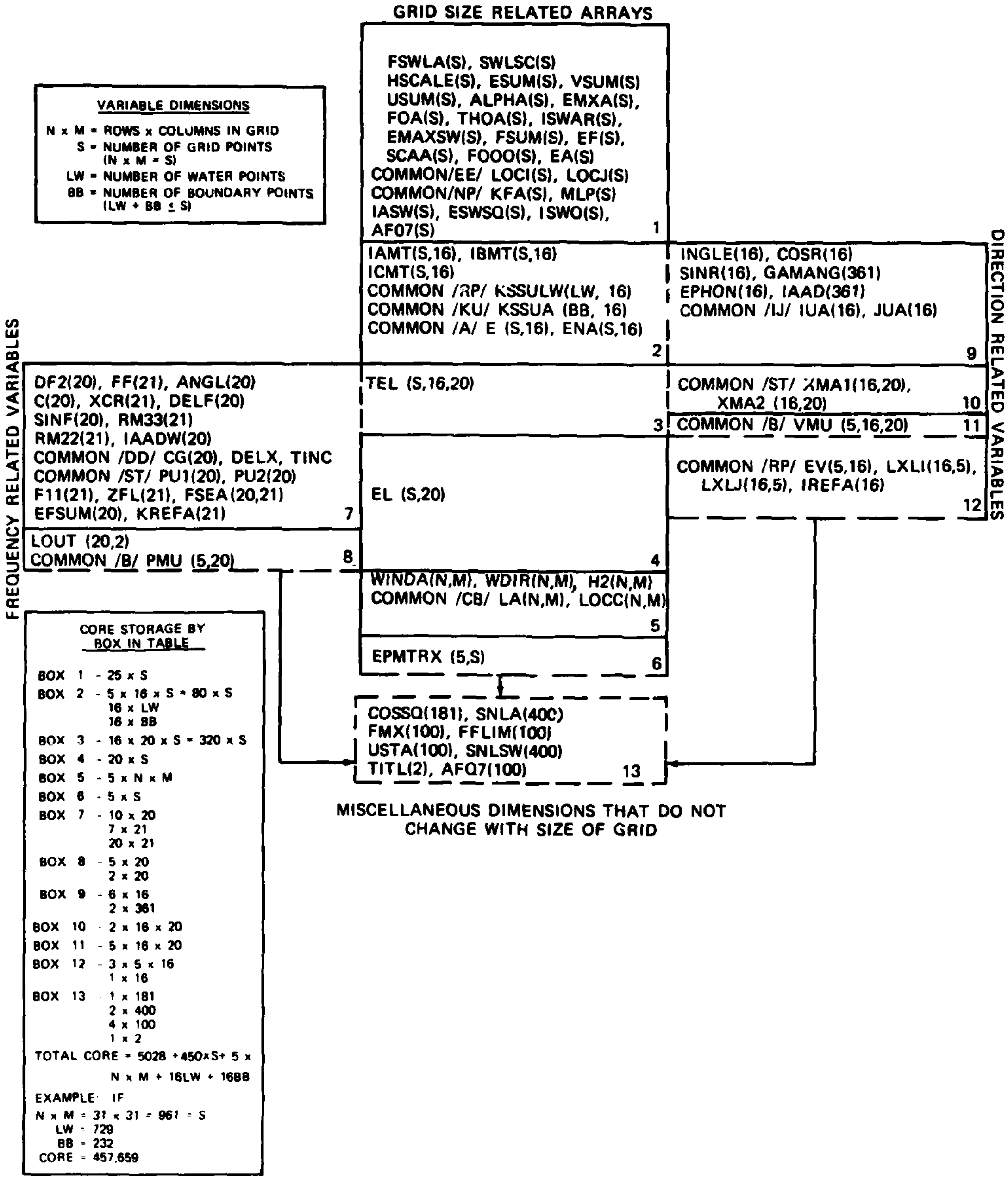

Figure 1. Description of core storage and dimension values needed for wave model program arrays. Variable dimensions (S, N, M, LW, BB) can be easily changed for different grid sizes, but a change of the numerical dimensions alters the program. The arrays are grouped by types of arrays

boundary points, and total grid points), the number of frequencies, the number of direction rays, and the wind speeds used in the calculations. The grid size related arrays are the only ones that need to be modified for a new size grid. The frequency, wind speed, and direction related variables stay constant.

9. To set up the dimension statements for a specific grid, first determine the size of the grid using

N = number of rows in grid

M = number of columns in grid

where N and M are chosen to portray an adequate resolution of the water body modeled. (N and M are numbered in the row-column convention of a matrix where (1, 1) is in the upper left-hand corner.) The number of grid points (S) is equal to N times M . Second, since this grid is a map representation of some body of water, it is necessary to determine which of the grid point intersections are land points and which are water points. Some judgment is needed to set up this grid to portray a smooth body of water. Small islands or points of land jutting out into the water may have to be assumed to be water points even though a grid intersection may actually have land under it. A sample input grid is shown in Appendix C. Third, determine the number of Lax-Wendroff water points (LW) and the number of boundary points (BB). A true Lax-Wendroff water point (fourth-order point) is defined as having two water points surrounding it in every direction. The boundary points will include the other points that are not Lax-Wendroff points. LW plus BB should be less than or equal to S . It is possible to dimension the model using only water points rather than the total number of grid points for the various source terms. This will save on the amount of core storage if the grid is very large. This report describes the method of using the S variable as the total size of the grid.

10. The total amount of core storage can be computed using S , N , M , LW , and BB and the equation in Figure 1. For most grids, it is easier to let LW = BB = S where $S = N \times M$. For large grids, let S = LW = BB = number of water points. The amount of core storage

is proportional to the grid size (S). Figure 1 will be discussed again in the section on model structure.

Run time

11. One of the problems with writing a generalized code is that the program cannot be designed to be optimal in terms of run time on a particular computer. Figure 2 provides a set of comparative run times on two different computers for the test run described in Appendix C.

Central Processor Time*	Name of Computer
6.2 sec	Cray Computer** at Boeing Computer Services
348.0 sec	Honeywell DPS-1 at WES

* The computer times represented here refer to the run in Appendix C which has a 9×9 grid and a grid spacing of 222.2 km. The time-step was 3,600 sec. Seventy-two time-steps were taken.

** Note that the computer listed here is a vectorizing machine. The code has been designed for a vectorizing machine and run times will increase significantly if vectorizing does not take place.

Figure 2. Comparative run time on different computers

Model structure

12. Figures 3-5 show the basic structure of the model. After an initialization section of code, the calculations are completely contained within a series of loops. Besides setting constants and precalculating various spectral shape functions and directional distributions, the initialization section of code calls the subroutine CLASSB which determines the referencing counters for all spatial points along with the propagation area (Lax-Wendroff or upstream differencing) in which they lie. CLASSB also calculates the propagation multipliers to be used in subroutine PROPR, which performs the actual propagation calculations.

13. Appendix A is a FORTRAN listing of the wave model program. Comments have been added to the program to give the user an idea what section of code corresponds to what physical process. The example in Appendix C was run on a Cray computer system. If the grid dimensions are different from the example model and core storage is minimal,

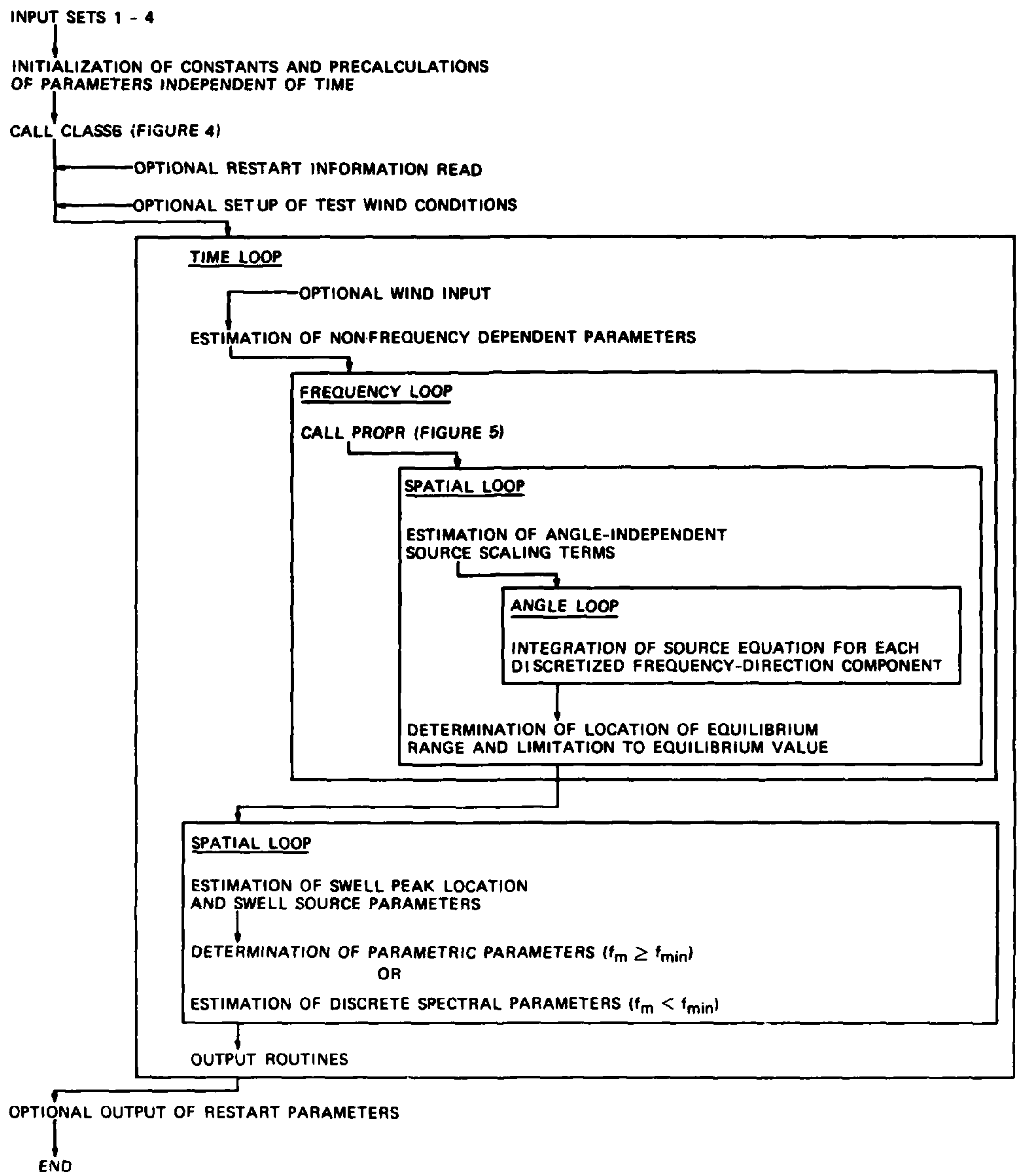

Figure 3. Fundamental structure of program

DETERMINE MAPPING INTO WATER-ONLY REFERENCING SYSTEM SEPARATING BOUNDARY POINTS AND INTERIOR POINTS INTO DIFFERENT SEQUENCES

↓

CALCULATE PROPAGATION MULTIPLIERS FOR UPSTREAM DIFFERENCING REGION

↓

CALCULATE PROPAGATION MULTIPLIERS FOR LAX-WENDROFF REGION

↓

DETERMINE LOCATION REFERENCES FOR UPSTREAM DIFFERENCE POINTS

↓

DETERMINE LOCATION REFERENCES FOR INTERIOR POINTS

Figure 4. Structure of subroutine CLASSB

PROPAGATE ENERGIES AT INTERIOR POINTS (PROPAGATION METHOD CAN BE EITHER LAX-WENDROFF OR UPSTREAM DIFFERENCING DEPENDING ON LOCATION OF FREQUENCY RELATIVE TO LOCAL SEA PEAK)

- COMPLETE PROPAGATION ALONG 8 PRIMARY AXES
- FIRST PART OF PROPAGATION ALONG 8 OFF-AXIS DIRECTIONS

↓

PROPAGATE ENERGIES AT BOUNDARY POINTS

- COMPLETE PROPAGATION ALONG 8 PRIMARY AXES
- FIRST PART OF PROPAGATION ALONG 8 OFF-AXIS DIRECTIONS

↓

PROPAGATE ENERGIES AT INTERIOR POINTS TO COMPLETE PROPAGATION FOR OFF-AXIS DIRECTIONS

↓

PROPAGATE ENERGIES AT BOUNDARY POINTS TO COMPLETE PROPAGATION FOR OFF-AXIS DIRECTIONS

↓

CHECK ON NEGATIVE ENERGY AT EACH POINT $(E(f,\theta) \geq 0)$

Figure 5. Structure of subroutine PROPR

changes need to be made in the variables S , N , M , LW , and BB (see Figure 1) to match the specific grid being considered. The FORTRAN listing in Appendix A is dimensioned large enough to accept a 31×31 grid and requires about 520K words of storage. The dimensions also need to be changed in the two subroutines (CLASSB and PROPR) to match the main program's dimensions.

14. The model can begin calculations from a cold-start condition (i.e., initialize everything to preset values) or it can begin from a warm-start condition with initial spectral and parametric values being read in from a file. An option to create such a restart file is included at the end of each run. If this code is used to calculate a long time series, it is advisable to break the series into smaller increments and run these increments sequentially using the restart capability of the model.

Input to the Model

15. The input and output for this code were kept simple to maintain generality and computer compatibility. The wave model input consists of a set of data input cards that describe the grid, options, frequencies, and initial conditions and one set of data that describes the wind in terms of time, speed, and direction. Program modifications to produce special input or output routines can be made by users with specific requirements. However, such routines, especially computer graphics, tend to vary from computer to computer. Therefore, such options have been left to the discretion of the user.

Data input

16. Data input for this model is contained on four sets of data cards (these four card sets were combined into input file INPTEST in Appendix C):

a. Card Set 1: Problem Description (1 card)

Input Parameters	Description
N	Number of rows in grid
M	Number of columns in grid

TINC*	Number of seconds per time-step
DINC	Distance between grid points in kilometres (DELX)
MSTA	Number of special output locations
IHR	Number of hours between wind inputs
NEWSTR	1 for cold start; 0 for warm start (NEWSTR should be set to 1 for test runs or for runs without restart data from previous run)
NOWRT	1 for no tape writes; 0 for output tape writes (NOWRT should be set to 1 for test runs)
NORD	1 for no tape reads; 0 for input tape reads (NORD should be set to 1 for test runs)
ZM2	Anemometer level of wind input in centimetres

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* The time-step is constrained by the stability criterion for propagation of the lowest frequency, i.e., TINC $\leq$ DELX/ $c_g(f_{min})$. DELX (the X-value of DINC) is distance between grid points and $c_g(f_{min})$ is the group velocity of the minimum frequency band that is input into the wave model.

b. Card Set 2: Discretized Frequencies (2 cards)

These two data cards contain the 20 frequencies selected for representing the wave spectrum.

c. Card Set 3: Special Output Locations (MSTA cards)

These MSTA pairs of numbers (one pair per card) are the I, J, coordinates of the special output locations desired. It should be noted here that if MSTA equals zero, no data card(s) will be read.

d. Card Set 4: Land-Sea Grid (N cards)

This final set of N data cards contains the land or water data (input by row) for the grid being used. A value ≤ 0 represents land and a value > 0 denotes water. (This input matrix of land-water points should contain a border of 1 row and 1 column of land points.)

17. Most of the above variables are self-explanatory. The number of special output locations is the number of grid intersections that are of special interest to the user. The wave information for these

points will be printed out and labeled separately.

18. The anemometer level of the wind input for this wave model is read in as an input parameter, with friction velocities used to scale various parameters inside the program. A misspecification of this input level could lead to significant biases in wave predictions. For example, if 10-m winds are assumed and the actual level of the wind field was taken at 19.5 m, calculated waves would be consistently too high.

Wind input

19. As discussed in the introduction, wind speeds coming into the wave model are transformed using the following theoretical considerations. The wind profile equation, used to obtain friction velocity from the wind velocity inside the wave model, assumes a particular drag law as well as neutral stability. The drag law used is consistent with that obtained by Garratt (1977) for velocities over 12 m/sec. Liu and Ross (1980) have shown that stability has a strong influence on wave growth. Consequently, wind speeds coming into the wave model are taken to be equivalent neutral wind velocities, i.e., those wind velocities at neutral stability which produce the same friction velocity as the actual recorded or estimated winds in a given nonneutral condition. The methods used by WIS are given in WIS Reports 4 and 10 (in preparation).

20. The form of the wind input for the program will be left to the discretion of the user. The input file ILWND in Appendix C is an example of a wind input file. The user is reminded that wind input is the primary driver of the wave model. The WIS wind data came from a wind model that took existing pressure data and converted this data to a wind field (Corson, Resio, Vincent 1980; Resio, Vincent, Corson 1982). Any extreme variations in the wind field will be reflected in unusual wave conditions. If unusual wave conditions appear as wave model output, the user is advised to check the input wind field first. The program contains an option (NORD = 1) that allows the user to enter a constant wind speed and direction for test purposes. These constants can be entered on a card immediately following card set 4 in the format specified in the program. It is suggested that the user try a test run

using constant winds before attempting a run using an input wind tape. Wind speeds are entered in knots and wind direction is in degrees. The wave model will not accept zero wind speeds but a zero in the direction category is acceptable. Wind data should be in integer format. Using the NORD = 0 option, a wind data tape can be used as input. The wind data tape needs to have a specification of date and hour in integer form. The wind speeds and directions are read in for each point of the grid at the specified time intervals. The directions of the input winds should be referenced to the direction toward which they are blowing. The direction system in the wave model is a polar co-ordinate system with 0° corresponding to east and 90° corresponding to north. A 0° direction for a wind indicates a wind blowing from west to east.

Frequency input

21. The discretized frequencies can be varied by the user. Suggested values in Hz for the 20 frequencies for oceanic conditions are: 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.20, 0.21, and 0.22. The time-step is constrained by the group velocity of the minimum frequency [$TINC \leq DELX/cg(f_{min})$] ; therefore, in situations where the grid spacing, DELX, is small and the time-steps are very small, f_{min} can be increased to create larger time-steps (less computer time). The difference between frequencies, Δf , can remain constant as shown or vary throughout the input frequency range. The frequency range must be realistic for the spectral situations being considered.

Standard Output from the Model

22. The output of the model is divided into three types. (See Appendix C for an example of the output.) The first part of the output is a listing of the input parameters such as the type of start (cold or warm), the grid size (N×M), the time increment (TINC) in seconds, and the grid spacing (DINC) in kilometres, the input frequencies, and the I and J grid location of the special output stations. The grid geometry shows the actual grid that was input and it also shows a grid

with the KSS number for each of the water points of the grid. The interior numbers beginning with one show the Lax-Wendroff (fourth order) points. The second group of numbers on this grid count the boundary water points that will be used in upstream differencing. The numbers below the grid refer to the total number of water points, the number of fourth-order points, and the number of boundary points. If a constant wind test was run for test purposes, the test parameters appear below the grids showing the input wind speed, wind direction, and the number of time-steps. The second type is the information needed at the special output locations defined in the input. This output is discussed in paragraph 23. The third type is the information at each point of the entire grid. This output is discussed in paragraph 24. The information contained in the special output prints can be obtained for every point of the grid; but if only a few sites are needed, it is necessary only to print this out for a few locations. Calculations are done using centimetre-gram-second units and numerical values are in these units unless otherwise noted.

23. The output for the special output locations is printed for each time-step. The date-time and time in hours since start of run precedes this output. Each special output location is labeled by its I and J location (matrix row-column convention) in relation to the grid. The first type of information included for the special output location includes a listing of the spectral energy by frequency and angle location. The one-dimensional energy integrated over the 16 directions is given per frequency in the column headed by Energy Density. The rest of the chart lists the energy by frequency in the direction band in which it occurs. The special output information below the chart is defined by its title and units. The total energy is the energy in the discrete frequency range and the parametric energy is the energy in the frequencies above the discrete region. The significant wave height is calculated by multiplying 0.0401 times the square root of the total energy. The rest of the values are self-explanatory. By listing no special output stations, all the special output printouts can be deleted.

24. The output for the entire spatial grid is printed in matrix form. The set of matrices is preceded by a date-time heading. The first matrix contains the significant wave height. The significant wave height in metres is displayed for all grid points at each time-step and is calculated by multiplying 0.0401 times the square root of the total energy. The data can be located by the I and J locations on the spatial grid. The next matrix contains the mean direction of the local sea and the third matrix contains the period of the local sea. The printout of significant wave height presented in Appendix C is typical of these general output matrices. Output tape writes can be added if needed by the user.

Model Characteristics

25. An example of a complete wave model run for a variable wind field is given in Appendix C. Although such a run serves to demonstrate a number of different aspects of the wave generation, propagation, and decay characteristics of the wave model, it does not provide a clear understanding of the overall model characteristics. To accomplish this, two types of idealized generation cases are presented in this section--fetch-limited wave growth and duration-limited wave growth up to a fully developed sea.

26. Figure 6 shows a comparison of the rates of growth produced by the wave model and the theoretical rates of growth from Hasselmann (1976). The wave model reproduces the observed fetch limited growth patterns quite well. Figure 7 gives the rate of growth of waves as a function of time. It is apparent from this figure that the rate of wave growth begins to be significantly altered at a nondimensional time ($\tilde{t} = gt/u$) of about 2.1×10^6. The approach to fully developed conditions is not accomplished by constraining the wave spectrum to a predetermined fully developed spectral form, but is done by limiting the scaling frequency for wave-wave interactions to a value dependent on the wind speed. Thus, a steady-state condition is never actually reached; instead, the rate of growth asymptotically approaches zero.

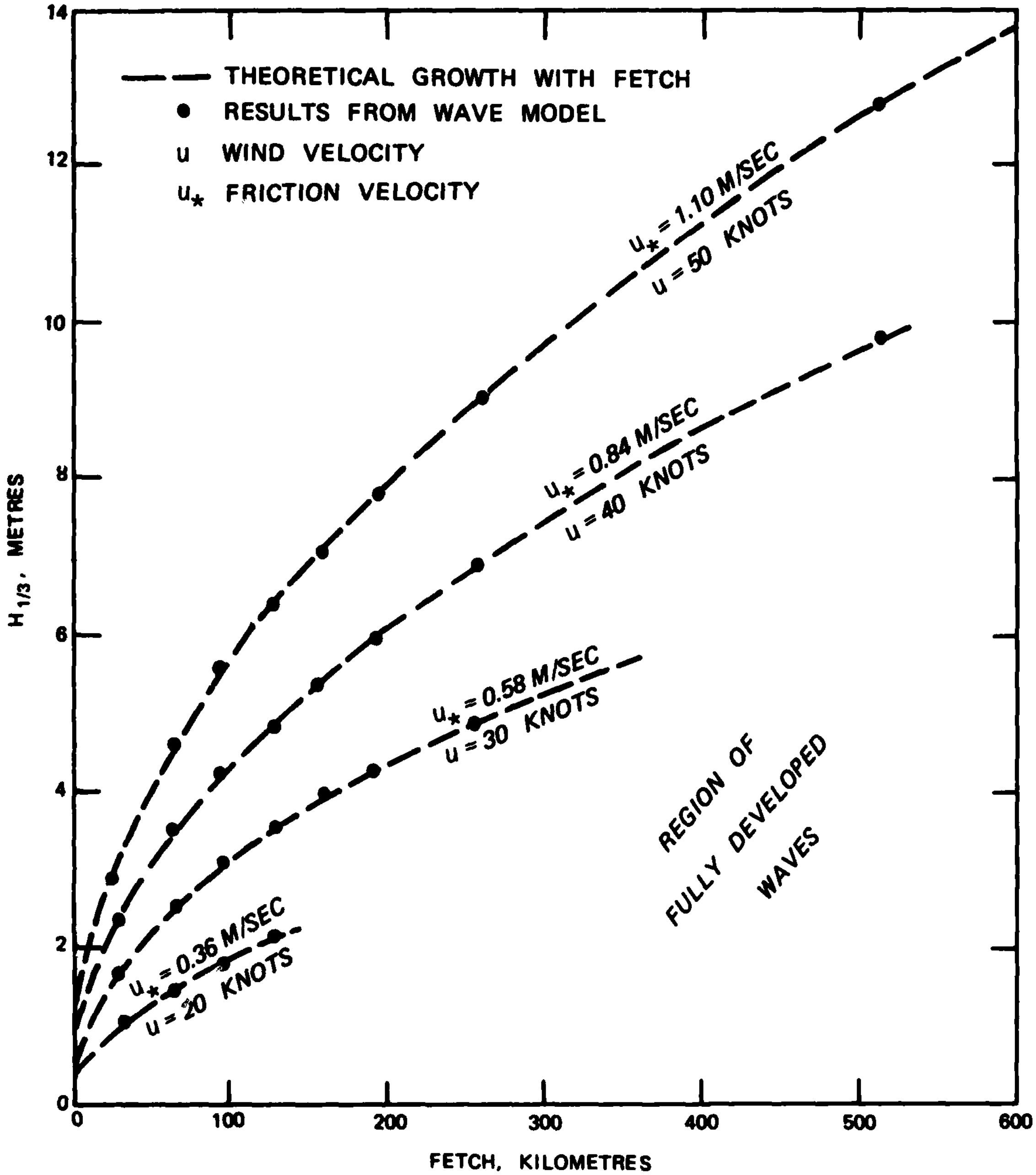

Figure 6. Comparison of the growth rates produced by the wave model to Hasselmann's (1976) theoretical growth rates

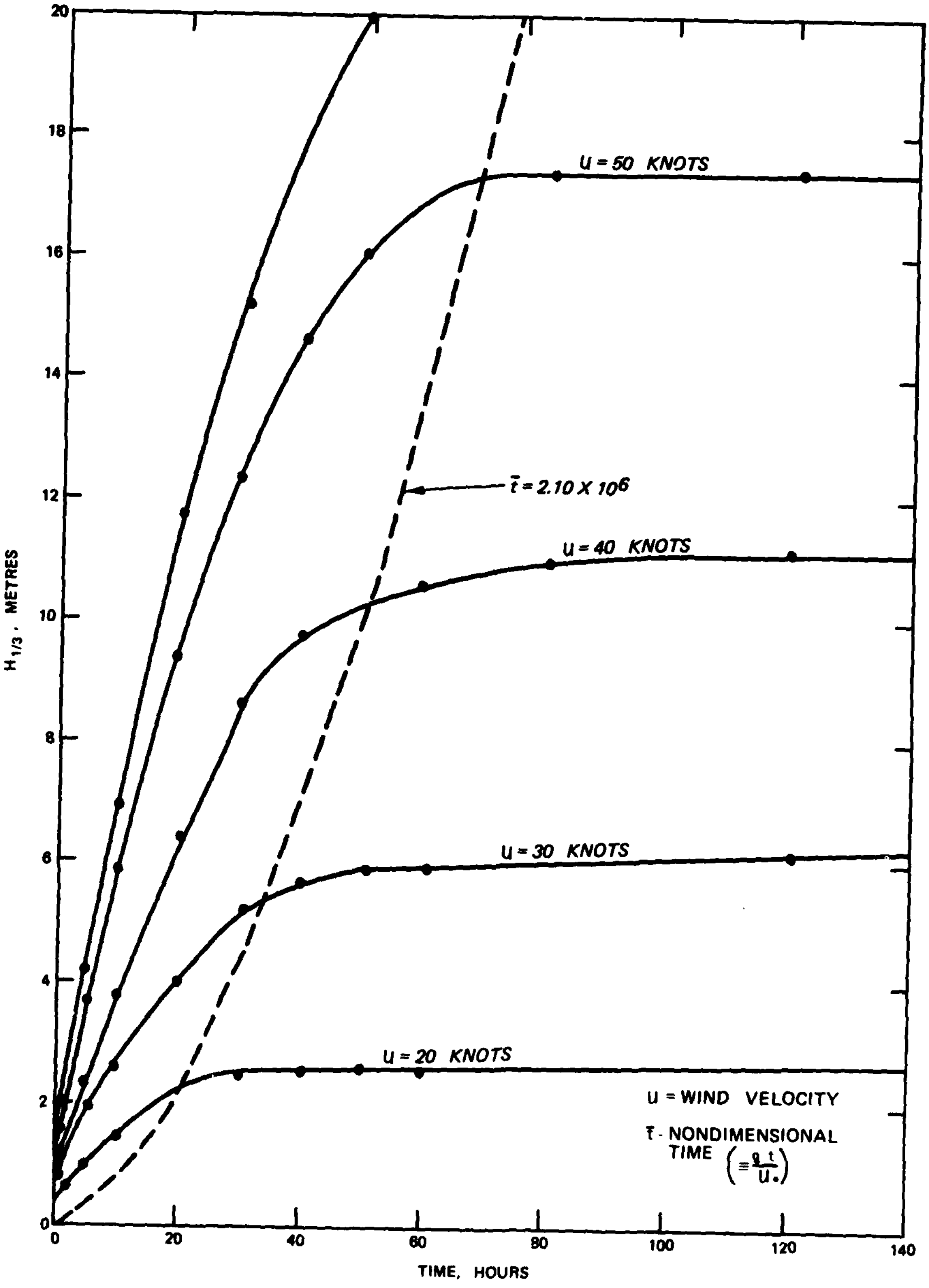

Figure 7. The rate of growth of wave height ($H_{1/3}$) as a function of time at several wind velocities

27. Three tests should be run to verify the boundary conditions and stability of the wave model. These tests consist of a fetch test (where the results can be compared with Figure 6), a time growth test (where results can be compared with Figure 7), and a test where the wind field shifts by 90 deg. Each test should be run for several different constant winds such as 20, 30, 40, and 60 knots. The fetch-limited test should be run for 30 hours, and the duration test should be run for 150 hours. The wave model has been set up with an option to run with a file containing constant winds (where each grid point has the same value of wind speed and direction). This corresponds to using a value of one for the NORD variable described in paragraph 16. The user can add the necessary logic to the program to create the fetch-limited and the wind shift conditions. These tests have been run using the FORTRAN in Appendix A. If any significant changes are made in the program, these tests need to be run again.

Discussion

28. The wave model described in this report is a state-of-the-art method of using wind data to hindcast wave heights in deep water. The model uses the equations that depict the physics of the wave interaction and growth and uses numerical procedures to evaluate the results of these equations. This model has been termed a discrete spectral model (Resio 1981) and models the spectrum by using a discrete band of frequency-direction components on the forward face of the spectrum. Other reports in the Wave Information Study deal with the confidence levels of the numerical results and compare calculated results with actual gage data (Corson and Resio 1981, Baird and Readshow 1981). The program has been written in a form that will be compatible on several different computer systems and is especially appropriate for machines that have a large core storage capacity and the potential for vectorization.

29. As stated in the introduction, this code does not contain the changes needed for a spherical orthogonal grid system. This code has been used in areas such as bays and harbors and small sections of

the ocean. Deep water is assumed throughout all calculations.

30. The validity of the wave data generated with the WIS wave model is directly related to the accuracy of the input wind data. For WIS hindcasts, every effort is made to generate representative wind fields. The procedures used to generate accurate wind fields and comparisons of hindcast and measured winds are discussed in Resio, Vincent, Corson (1982). In order to assure valid wave computations, users of the WIS wave model should verify input winds thoroughly.

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APPENDIX A: WAVE MODEL LISTING

The following is a FORTRAN listing for the flat bed wave model. The "warm start" feature has been included in the proper place but has been entered as comment statements to allow the user to modify this for the computer system he will be using. This FORTRAN listing was used to produce the sample output included in Appendix C of this report.

```
      PROGRAM WMRWAVE
C           WMRWAVE IS A PHASE I FLAT BED WAVE MODEL
C   THIS VERSION WAS DESIGNED FOR THE WAVE MODEL REPORT (1982)
C  DIMENSIONS WILL ACCOMODATE 961 WATER POINTS ON
C  A 31X31 GRID.
      DIMENSION FSWLA(961),SWLSC(961)
         DIMENSION IPP(961)
      DIMENSION INGLE(16)
      DIMENSION LOUT(20,2),DF2(20),FF(21),ANGL(20),
     1COSR(16),SINR(16),GAMANG(361),C(20),XCR(21),
     2WINDA(31,31),WDIR(31,31),HSCALE(961),DELF(20),SINF(20)
      DIMENSION COSSQ(181),EPMTRX(5,961),SNLA(400),RM33(21),RM22(21),
     1FMX(100),FFLIM(100),USTA(100),ESUM(961),VSUM(961),USUM(961),
     2EPHON(16),ALPHA(961),EMXA(961),H2(36,36),FOA(961),THOA(961),
     3IAAD(361),IAADW(20),ISWAR(961),EMAXSW(961),FSUM(961),EF(961)
      DIMENSION SCAA(961),FOOO(961)
      DIMENSION IAMT(961,16),IBMT(961,16),ICMT(961,16)
      COMMON /DD/CG(20),DELX,TINC
      COMMON /ST/XMA1(16,20),XMA2(16,20),PU1(20),PU2(20)
      COMMON /CC/ N,M,NPLW,NPNLW,NPTS,NFREQ,NDIR,NPTSP1
      COMMON /EE/LOCI(961),LOCJ(961)
      COMMON /RP/KSSULW(729,16),EV(5,16),LXLI(16,5),LXLJ(16,5),IREFA(16)
      COMMON /KU/KSSUA(232,16)
      COMMON /IJ/ IUA(16),JUA(16)
      COMMON /NP/KFA(961),MLP(961)
      COMMON /CB/LA(31,31),LOCC(36,36)
      COMMON /B/ VMU(5,16,20),PMU(5,20)
      DIMENSION EL(961,20),TEL(961,16,20)
      COMMON /A/ E(961,16),ENA(961,16)
      DIMENSION F11(21),ZFL(21),SNLSW(400),FSEA(20,21)
      DIMENSION EA(961),TITL(2)
      DIMENSION IASW(961),ESWSQ(961),ISWO(961)
      DIMENSION EFSUM(20)
      DIMENSION AF07(961),AFQ7(100),KREFA(21)
      INTEGER WDIR,WINDA,AFQ7,AF07,WINDY
      EQUIVALENCE (NPTS,NPTOT)
      EQUIVALENCE (TINC,DELT)
C      PARAMETER PI=3.14159,NFREQ=20,NDIR=16,G=980.,TWOPI=6.28318
C      PARAMETER C1=0.1525,C2=1.47E-5,C3=0.00371,ZM2=1950.,GSQ=960400
      DATA TITL/4HCOLD,4HWARM/
      DATA PI,NFREQ,NDIR,G,TWOPI/3.14159,20,16,980.,6.28318/
      DATA C1,C2,C3,GSQ/0.1525,1.47E-5,0.00371,960400./
      DATA IUA/2*0,5*1,3*0,5*-1,0/,JUA/3*-1,3*0,5*1,3*0,2*-1/
      DATA IREFA/0,5,0,1,0,9,0,5,0,13,0,9,0,1,0,13/
C
C       N       = NUMBER OF ROWS IN GRID
C       M       = NUMBER OF COLUMNS IN GRID
C       TINC    = NUMBER OF SECONDS PER TIME STEP
C       DINC    = DISTANCE BETWEEN GRID POINTS IN KILOMETERS
C       MSTA    = NUMBER OF SPECIAL OUTPUT LOCATIONS
C       IHR     = NUMBER OF HOURS BETWEEN WIND INPUTS
C       NEWSTR  = COLD OR WARM START
C                 1 FOR COLD START (NO RE-START DATA FROM PREVIOUS RUN)
C                 0 FOR WARM START
C       NOWRT   = DETERMINES WHETHER OUTPUT TAPES ARE WRITTEN OR NOT
C                 1 FOR NO TAPE WRITES
C                 0 FOR TAPE WRITES
C       NORD    = DETERMINES WHETHER INPUT TAPES ARE READ OR NOT
```

```
C                1 FOR NO TAPE READS
C                0 FOR TAPE READS
C       ZM2    = LEVEL OF WIND INPUT ABOUT WATER SURFACE IN CENTIMETERS
C
      NFRQ = NFREQ
      NFRQ1 = NFREQ - 1
C          INITIALIZE FSWLA FOR    NGR-POINT GRID
        NGR= N*M
        DO 713 I=1,NGR
 713    FSWLA(I)=1.0
C
C       READ PROBLEM DESCRIPTION PARAMETERS
      READ 5040,N,M,TINC,DINC,MSTA,IHR,NEWSTR,NOWRT,NORD,ZM2
5040 FORMAT (2I5,F10.0,F5.1,5I5,F10.0)
      IF (NEWSTR.NE.1) NEWSTR = 2
C
C       PRINT TYPE OF START (COLD OR WARM) FOR THIS RUN
      PRINT 9090, TITL(NEWSTR),TITL(NEWSTR),TITL(NEWSTR)
9090 FORMAT(10X,3(A4,20X))
C
C       PRINT SELECTED INPUT PARAMETERS
      PRINT 2000, N,M,TINC,DINC
2000 FORMAT (/,5X,4HN = ,I3,3X,4HM = ,I3,3X,
     . 7HTINC = ,F8.0,3X,7HDINC = ,F8.0)
      NDIR2=NDIR/2
      DELX=100000.*DINC
      HR=IHR*3600.
      KTIMES=HR/TINC
      IF(KTIMES*TINC-HR.GT.0.0001) GOTO 9999
C
C       READ DISCRETIZED FREQUENCIES THAT REPRESENT WAVE SPECTRUM
      READ 220,(FF(I),I=1,10)
      READ 220,(FF(I),I=11,20)
 220 FORMAT (10F5.3)
      FF(NFREQ+1)=1.
C
C       PRINT DISCRETIZED FREQUENCIES
      PRINT 800
 800 FORMAT (/)
      PRINT 8005, (FF(I),I=1,NFREQ)
8005 FORMAT(17H +++++FREQUENCIES,10F10.5)
      IF(MSTA.LT.1) GOTO 4650
C
C       READ GRID COORDINATES FOR SPECIAL OUTPUT LOCATIONS
      PRINT 800
      DO 118 ISTA=1,MSTA
      READ 101, LOUT(ISTA,1),LOUT(ISTA,2)
101  FORMAT(40I2)
 118 CONTINUE
C
C       PRINT SPECIAL OUTPUT LOCATIONS
      PRINT 8009, ((LOUT(I,J),J=1,2),I=1,MSTA)
8009 FORMAT(20H SP OUTPUT LOCATIONS,2I10)
4650 CONTINUE
C
      PRINT 800
C       READ AND PRINT LAND-SEA GRID
C       VALUE .GT. 0 = WATER
C       VALUE .LE. 0 = LAND
```

```
C       BATHYMETRIC DATA INPUT BY ROW
      PRINT 8001
8001 FORMAT(20H +++++ GRID GEOMETRY)
      DO 1 I=1,N
      READ 101, (LA(I,J),J=1,M)
      PRINT 8003, (LA(I,J),J=1,M)
8003 FORMAT(1X,40I3)
    1 CONTINUE
C       DEFINE FREQUENCY INCREMENTS
      F1=0.5*(FF(2)-FF(1))
      DO 221 I=1,NFRQ1
      F2=(FF(I+1)-FF(I))*0.5
      DELF(I)=F1+F2
221  F1=F2
      DELF(NFREQ)=2.0*F2
      DO 8888 I=1,NFRQ1
8888 ZFL(I)=EXP(-(FF(I+1)/FF(I))**4)
C
      DO 921 ITF=1,NFRQ1
921  DF2(ITF)=(FF(ITF+1)-FF(ITF))/2.
C DEFINE NONDIMENSIONAL SHAPE FUNCTION-FORWARD FACE-LOCAL SEA SOURCE
      CON1=EXP(1.)
      DO 8849 I=1,95
      FX3=1.
8849 SNLA(I)=FX3*CON1*EXP(-(0.95/(I*0.01))**4)
      DO 8850 I=95,105
8850 SNLA(I)=1.
      DO 8860 I=106,400
8860 SNLA(I)=-(100./I)**5
C DEFINE LIMITING VALUE OF SEA PEAK FREQUENCY AS FUNCTION OF WIND SPEED
      DX33=(DELX/100.)**(-0.33)
      DO 8855 IU=1,100
      UU=IU*0.514
      F1=16.15*UU**(-0.34)*DX33
8858 V=G/(2.*TWOPI*F1)
            V=V*0.01
      D=(DELX/100. - V*DELT*0.5)**(-0.33)
      F2=16.15*UU**(-0.34)*D
      IF (ABS(F2-F1).LT.0.001) GO TO 8857
      F1=0.5*(F1+F2)
      GO TO 8858
8857 FFLIM(IU)=0.5*(F1+F2)
8855 FMX(IU)=1.76/UU
      IB=1
      DO 33 I=1,NFREQ
      II=NFREQ+1-I
      IE=3.04/FF(II)+0.5
      DO 34 J=IB,IE
      AFQ7(J)=II
 34  CONTINUE
      IB=IE+1
 33  CONTINUE
C DEFINE NONDIMENSIONAL SHAPE FUNCTION FOR FORWARD FACE OF SWELL SOURCE
      DO 8870 I=1,90
      FX3=(0.90/(I*0.01))**(-3)
8870 SNLSW(I)=FX3*CON1*EXP(-(0.90/(I*0.01))**4)
      DO 8872 I=91,100
8872 SNLSW(I)=(95.-I)*0.2
      DO 8875 I=101,400
```

```
8875 SNLSW(I)=-(100./I)**5
     AINC=TWOPI/NDIR
     RADC=TWOPI/360.
     RADDEG=360./TWOPI
     CONEM=GSQ/TWOPI**4
     CONEE=CONEM/4.
     EPRM=5.19E-11
     HEO=(FF(NFREQ)+0.5*DELF(NFREQ))**(-4)*CONEM/4.
     NF5=NFREQ-5
     ECONST=GSQ/TWOPI**4
     NF4=NF5-1
     TPRM=0.1215*TINC/G**1.33333
     EPINRM=2./PI
     SWCON=9.829E-6
     DO 11 KKF=1,NFREQ
     DO 11 I=1,NFREQ
     FSEA(I,KKF) = EXP(-(FF(KKF)/FF(I))**4)
  11 CONTINUE
     DO 12 I=1,NFREQ
  12 FSEA(I,21)=0.
     DO 651 I=1,NDIR
     INGLE(I) = (I-1) * 22.5
     ANGL(I)=(I-1)*AINC
     COSR(I)=COS(ANGL(I))
     SINR(I)=SIN(ANGL(I))
 651 CONTINUE
     DO 41 I=1,90
  41 COSSQ(I) = COS((I-1) * RADC) ** 2
     DO 43 I=91,181
  43 COSSQ(I) = 0.
     DO 42 I=1,360
     IAAD(I) = I
     IF (I.GT.180) IAAD(I)=361-I
  42 CONTINUE
     IAAD(361) = 1
C     ITDIF IS ANGLE DIFF. BETWEEN CENTRAL WAVE ANGLE AND WAVE ANGLE
     DO 60 ITH=1,360
     GAMANG(ITH)=0.
     IF(ITH.GT.80.AND.ITH.LT.280) GOTO 60
     ANG=(ITH-1)*RADC
       GAMANG(ITH)=COS(ANG)**4
       GAMANG(ITH)=GAMANG(ITH)*8./(3.*PI)
  60 CONTINUE
C     CONSTANTS FOR PHASE AND GROUP VELOCITY
     DO 29 I=1,NFREQ
     F11(I)=FF(I)**11
     EFSUM(I)=0.
     C(I)=G/TWOPI/FF(I)
     CG(I)=C(I)/2.
     XCR(I)=TINC*CG(I)
     XXD=DELX-XCR(I)/2.
     IF(XXD.LE.0.) XXD=0.05
     XD=DELX/XXD
     RM33(I)=XD**0.33
     RM22(I)=XD**0.22
     XCR(I)=XCR(I)/DELX
  29 CONTINUE
     F11(NFREQ+1)=0.
     XCR(NFREQ+1)=0.
```

```
      RM33(NFREQ+1)=1.
      RM22(NFREQ+1)=1.
      DO 70 I=1,NFREQ
 70   SINF(I)=TWOPI*GSQ/(TWOPI*FF(I))**5
C
      DO 17 IU=1,100
      VST=0.4*51.4*IU
      UST=VST
 19   Z0=C1/UST+C2*UST*UST-C3
      UST1=VST/ALOG((ZM2-Z0)/Z0)
      IF(ABS(UST1-UST).LT.0.01) GOTO 18
      UST=UST1
      GOTO 19
 18   USTA(IU)=UST1
C      PRINT 2026,IU,UST1,Z0
2026 FORMAT (1X,I5,2F12.6)
 17   CONTINUE
C
C
      CALL CLASSB
C
C      BEGIN WAVE CALCULATIONS
C
C      TEMPORARY WIND INPUT
      NUM = 1000
      IF (NORD.NE.1) GO TO 402
      READ 102, WINDY,IDIRY,NUM
 102 FORMAT (3I3)
      PRINT 103, WINDY,IDIRY,NUM
 103 FORMAT (1X,15HTEST PARAMETERS,/,
     . 5X,13HWIND SPEED = ,I3,/,
     . 5X,17HWIND DIRECTION = ,I3,/,
     . 5X,18HNUMBER OF HOURS = ,I3)
      DO 401 I=1,N
      DO 401 J=1,M
      WINDA(I,J)=WINDY
401   WDIR(I,J)=IDIRY
 402 DO 20 KSS=1,NPTSP1
      FSWLA(KSS)=1.0
      KFA(KSS)=NFREQ+1
      ESWSQ(KSS)=0.
      ISWO(KSS)=NFREQ+1
      IASW(KSS)=0
      DO 8847 NPM=1,5
8847 EPMTRX(NPM,KSS)=0.
      FOA(KSS)=0.5
      ALPHA(KSS)=0.01
      THOA(KSS)=0.
      EA(KSS)=1.0E-5
      DO 21 J=1,NFREQ
      EL(KSS,J)=0.
 21   CONTINUE
      DO 20 IA=1,16
      DO 20 ITF=1,20
      TEL(KSS,IA,ITF) = 0.
 20   CONTINUE
C
C      S T A R T   C A L C U L A T I O N S
C
```

```
      DO 1000 IHR=1,NUM
      IF(NORD .EQ. 1) GO TO 1134
      READ (1,1146,END=9999) IDP
 1146 FORMAT (I10)
      DO 1135 I=1,N
      READ(01,1140) (WINDA(I,J),J=1,M)
C********
C  1140 IS THE INPUT FORMAT FOR THE INPUT WIND FILE********
C*******
 1140 FORMAT(1X,32I3)
 1135 CONTINUE
      DO 1136 I=1,N
      READ(01,1140) (WDIR(I,J),J=1,M)
 1136 CONTINUE
 1134 CONTINUE
 9094 DO 1001 KTIME=1,KTIMES
      DO 40 KSS=1,NPTS
      ISWAR(KSS)=NFREQ+1
      ESUM(KSS)=0.
      USUM(KSS)=0.
      VSUM(KSS)=0.
      AF07(KSS)=NFREQ+1
      FSUM(KSS)=0.
      I=LOCI(KSS)
      J=LOCJ(KSS)
      IUW=WINDA(I,J)
      UST1=USTA(IUW)
      ALPHA(KSS)=HBARF(EA(KSS),UST1)
      IF(FOA(KSS).GE.FMX(IUW)) GOTO 40
      FOA(KSS)=FMX(IUW)
      KFA(KSS)=AFQ7(IUW)
   40 CONTINUE
C
C      DETERMINE WINDSPEED AND DIRECTION AT POINT X-Y
C
C*********************************************
C      PROPAGATION ROUTINE FOLLOWED BY
C      SOURCE INTEGRATION
C      LOOP STRUCTURE IS (FREQ(SPACE(DIRECTION)))
C
C************************START OF FREQUENCY LOOP ***************
C
C      DEFINE SOURCE PARAMETERS
C
      ISMIN = 20
      KMIN = 20
      DO 56 KSS=1,NPTS
      IF (ISWO(KSS).LT.ISMIN) ISMIN=ISWO(KSS)
      KFRQ=KFA(KSS)
        I=LOCI(KSS)
        J=LOCJ(KSS)
        IUW=WINDA(I,J)
        WTH=WDIR(I,J)*RADC
        IANG=WTH/AINC+1.5
        IF(IANG.GE.NDIR) IANG=1
        THO=THOA(KSS)
        IWDIR=THOA(KSS)/AINC+1.5
        IF(IWDIR.GT.16) IWDIR=1
      IF (KFRQ.LE.NFREQ) GO TO 13
```

```
      SC=0.
      FO=1.
      GO TO 14
   13 IF (KFRQ.LT.KMIN) KMIN=KFRQ
      EMU=XCR(KFRQ)
      IU=I+IUA(IWDIR)
      JU=J+JUA(IWDIR)
      KSSU=LOCC(IU,JU)
      IF(KSSU.GT.NPTOT) GOTO 8343
      EMFU=EMU/2.
      EMF=1.-EMFU
      ALP=ALPHA(KSS)*EMF+ALPHA(KSSU)*EMFU
      FO=FOA(KSS)*EMF+FOA(KSSU)*EMFU
      GOTO 8848
 8343 CONTINUE
      IF(FOA(KSS).LT.FFLIM(IUW)) FOA(KSS)=FFLIM(IUW)
      FO=FOA(KSS)*RM33(KFRQ)
      ALP=ALPHA(KSS)*RM22(KFRQ)
 8848 SC=2500.*ALP*ALP*ALP/FO**4
   14 SCAA(KSS)=SC
      FOOO(KSS)=1./FO
      TH2=(IANG-1)*AINC
      DO 56 IDIR=1,16
      IADIF=IABS(WDIR(I,J) - INGLE(IDIR)) + 1
      IAMT(KSS,IDIR) = IAAD(IADIF)
      THDIF=ABS(ANGL(IDIR)-THO)
      ITHDIF=RADDEG*THDIF+1.01
      ITHDIF=IAAD(ITHDIF)
      IBMT(KSS,IDIR)=ITHDIF
      THDIF=ABS(ANGL(IDIR)-TH2)
      ITHDIF=RADDEG*THDIF+1.01
      ITHDIF=IAAD(ITHDIF)
      ICMT(KSS,IDIR)=ITHDIF
   56 CONTINUE
      ISMIN = ISMIN - 5
      KMIN = KMIN - 5
      ITFMIN = KMIN
      IF (ISMIN.LT.ITFMIN) ITFMIN = ISMIN
      IF (ITFMIN.LT.1) ITFMIN = 1
      PRINT 8003,ITFMIN
C
C
      IF (ITFMIN.LT.2) GO TO 501
      ITFM1=ITFMIN-1
      DO 500 ITF=1,ITFM1
      DO 500 KSS=1,NPTS
      ESUM(KSS)=ESUM(KSS) + EL(KSS,ITF)*DELF(ITF)
  500 CONTINUE
  501 CONTINUE
      DO 50 JJTF=ITFMIN,NFREQ
      ITF=JJTF
      F=FF(ITF)
      F100=F*100.
      KTF=ITF-NF5
      IF(KTF.LT.1) KTF=1
      SINFF=SINF(ITF)/AINC
      DO 30 KSS=1,NPTS
      DO 30 IA=1,16
      E(KSS,IA) = TEL(KSS,IA,ITF)
```

```
 30  CONTINUE
C
C     PROPOGATE ENERGY
C
     CALL PROPR(ITF)
C
C     STRT OF SPACE LOOP.
C
     DO 57 KSS=1,NPTS
     KFRQ=KFA(KSS)
     EPI=EPMTRX(KTF,KSS)
     SC=SCAA(KSS)
     FOI=FOOO(KSS)
     IFR=FOI*F100
     SCIFR=SC*SNLA(IFR)
     SC2=-2.*SCIFR
     IF (IFR.LE.105) SC2=0.
     IFR=F100/FSWLA(KSS)
     SC=SWLSC(KSS)
     SC=SC/(EL(KSS,ITF) + 0.1)
     SCSW=SC*SNLSW(IFR)
     SUM=0.
C
C     START OF ANGLE LOOP
C
     DO 55 IDIR=1,NDIR
     IA=IAMT(KSS,IDIR)
     ITHDIF=IBMT(KSS,IDIR)
     JTHDIF=ICMT(KSS,IDIR)
     WNDSRC=SC2*GAMANG(JTHDIF)
     ESP=ENA(KSS,IDIR)+EPI*COSSQ(IA)
     SNL=SCIFR*GAMANG(ITHDIF)+SCSW*ESP
     EN=ESP+(SNL+WNDSRC)*TINC
     IF(EN.GE.0.) GOTO 120
     EN=1.0E-5
120  EPHON(IDIR)=EN
     SUM=SUM+EN
 55  CONTINUE
C
C     END OF ANGLE LOOP
C
C     NOTE SUM=ENERGY/(DELF*AINC)
C     NORMAL SINF UNITS ARE ENERGY/DELF
C
      SINFKS=ALPHA(KSS)*SINFF
      IF(SUM.LT.SINFKS) GOTO 68
     RNORM=SINFKS/SUM
     DO 58 IDIR=1,NDIR
     EPHON(IDIR)=EPHON(IDIR)*RNORM
 58  CONTINUE
     CALL DOTPRD(EPHON,COSR,XSUM)
     CALL DOTPRD(EPHON,SINR,YSUM)
     USUM(KSS)=USUM(KSS)+XSUM*DELF(ITF)
     VSUM(KSS)=VSUM(KSS)+YSUM*DELF(ITF)
     SUM=SINFKS
     EF(KSS)=SINFKS
     ESUM(KSS)=ESUM(KSS)+SUM*DELF(ITF)
     DO 69 IA=1,16
  69 TEL(KSS,IA,ITF)=EPHON(IA)
```

```
      GO TO 57
   68 DO 64 IA=1,16
      TEL(KSS,IA,ITF) = EPHON(IA)
  64  CONTINUE
      AF07(KSS) = ITF
      EF(KSS)=SUM
      ESUM(KSS)=ESUM(KSS)+SUM*DELF(ITF)
 57   CONTINUE
C
C      END OF SPACE LOOP
C
      DO 51 KSS=1,NPTS
 51   EL(KSS,ITF)=EF(KSS)
 50   CONTINUE
C
C      END OF FREQUENCY LOOP
C
      DO 66 KSS=1,NPTS
      HIGHE=HSCALE(KSS)
      I=LOCI(KSS)
      J=LOCJ(KSS)
       IPP(KSS)=NFREQ
       BENG=1.0E-5
       DO 3007 ITF=1,NFREQ
       EFF=EL(KSS,ITF)*AINC
       IF(EFF.LT.BENG) GO TO 3007
       BENG=EFF
       IPP(KSS)=ITF
3007    CONTINUE
      IU=WINDA(I,J)
      KFRQ=AF07(KSS)+1
      IMX = 2
      SMX = EL(KSS,2)
      K = KFRQ - 3
      IF (K.LT.3) GO TO 451
      DO 450 ITF = 3,K
      SEA = EL(KSS,ITF) * FSEA(ITF,KFRQ)
      SWELL = EL(KSS,ITF) - SEA
      IF (SWELL.LT.SMX) GO TO 450
      SMX = SWELL
      IMX = ITF
 450  CONTINUE
 451  ISW=IMX
      IF (ISW+3.GE.KFRQ) GO TO 22
      ESWL=EL(KSS,IMX)+EL(KSS,IMX-1)+EL(KSS,IMX+1)
      FS1=EL(KSS,IMX)*FF(IMX)
      FS2=EL(KSS,IMX-1)*FF(IMX-1)
      FS3=EL(KSS,IMX+1)*FF(IMX+1)
      FSWLA(KSS)=(FS1+FS2+FS3)/ESWL
      EMX=ESWL*0.33*AINC
      ESWSQ(KSS)=EMX*EMX*EMX
      SWLSC(KSS)=FSWLA(KSS)**11*ESWSQ(KSS)*SWCON
      EMXA(KSS)=EMX
      GOTO 24
 22   ESWSQ(KSS)=0.
      FSWLA(KSS)=1.0
      SWLSC(KSS)=0.
      ISW=NFREQ+1
 24   ISWO(KSS)=ISW
```

```
      UST1=USTA(IU)
      IF(AF07(KSS)-NFREQ.LT.0) GOTO 123
C
C      PARAMETRIC HIGH FREQUENCY
C
        ALP=ALPHA(KSS)
      T=(FOA(KSS)**(-2.33333)+TPRM*(UST1)**(1.33333))**(0.4285714)
        FOA(KSS)=1./T
        IWDIR=THOA(KSS)/AINC+1.5
      IF(IWDIR.GT.16) IWDIR=16
      IIU=I+IUA(IWDIR)
      JU=J+JUA(IWDIR)
      KSSU=LOCC(IIU,JU)
      IF(KSSU.LE.NPTS) GOTO 7740
      IF(FOA(KSS).LT.FFLIM(IU)) FOA(KSS)=FFLIM(IU)
 7740 IF(FOA(KSS).LT.FMX(IU)) FOA(KSS)=FMX(IU)
C
C      CALCULATE ENERGY INTO DISCRETE SPECTRUM FROM PARAMETRIC SOURCE
C
      EFM=FOA(KSS)**(-5) *ECONST*EPINRM*ALPHA(KSS)
      SUMH=0.
      DO 8846 NPN=2,5
      NPM=NF4+NPN
      XE=EFM*EXP(-(FF(NPM)/FOA(KSS))**(-4.))
      SUMH=SUMH+XE*DELF(NPM)
      XED=XE-EPMTRX(NPN,KSS)
      IF(XED.LT.0.) XED=0.
 8846 EPMTRX(NPN,KSS)=XED
      THOA(KSS)=WDIR(I,J)*RADC
      KFA(KSS)=NFREQ+1
      FMBAR=FOA(KSS)*UST1/G
      HSCALE(KSS)=EPRM*FMBAR**(-3.333333)*UST1**4
      HIGHE=HSCALE(KSS)
      EA(KSS)=ESUM(KSS)*AINC+HIGHE
      FSUM(KSS)=FOA(KSS)
      UST1=USTA(IU)
      ALPHA(KSS)=HBARF(EA(KSS),UST1)
      GOTO 66
  123 KFRQ=AF07(KSS)
      KFA(KSS)=KFRQ+1
      IANG=WDIR(I,J)/22.5+1.5
      IF(IANG.GT.NDIR) IANG=1
      USUM(KSS)=USUM(KSS)*AINC+HIGHE*COSR(IANG)
      VSUM(KSS)=VSUM(KSS)*AINC+HIGHE*SINR(IANG)
      ZMIN=ZFL(KFRQ)*EL(KSS,KFRQ+1)*AINC
      Z1=EL(KSS,KFRQ)*AINC-ZMIN
      Z2=ALPHA(KSS)*SINF(KFRQ)-ZMIN
      Z2=ABS(Z2)+0.1
      PC=Z1/Z2
      IF(PC.LT.0.) PC=0.
      FOA(KSS)=FF(KFRQ+1)-2.*PC*DF2(KFRQ)
      DO 9951 NPN=2,5
 9951 EPMTRX(NPN,KSS)=0.
      FSUM(KSS)=FOA(KSS)
      EA(KSS)=ESUM(KSS)*AINC+HIGHE
      USUM(KSS)=USUM(KSS)+0.000001
      X=VSUM(KSS)
      Y=USUM(KSS)
      THOA(KSS)=ATAN2(X,Y)
```

```
      IF(THOA(KSS).LT.0.) THOA(KSS)=THOA(KSS)+TWOPI
      UST1=USTA(IU)
      ALPHA(KSS)=HBARF(EA(KSS),UST1)
      HSCALE(KSS)=HEO*ALPHA(KSS)
   66 CONTINUE
      DO 6660 KSS=1,NPLW
 6660 MLP(KSS)=KFA(KSS)-4
C
C      END OF TIME STEP LOOP
C
      IF(MSTA.LT.1) GOTO 4651
        IF(KTIME.NE.1) GO TO 1001
 8100 FORMAT(1H1,20X,10HDATE-TIME=,I10)
        HOURS=IHR*(TINC*KTIMES)/3600.
  200 FORMAT(5X,35HTIME IN HOURS SINCE START OF RUN = ,F6.2,//)
      DO 217 ISTA=1,MSTA
        PRINT 8100, IDP
        PRINT 200, HOURS
      SUM=0.
      I=LOUT(ISTA,1)
      J=LOUT(ISTA,2)
      KSS=LOCC(I,J)
      PRINT 71,I,J
  71     FORMAT (3X,35HSPECIAL OUTPUT FOR GRID LOCATION
     *2HI=,I3,4H  J=,I3)
      WRITE(09,8100) IDP
      DO 8628 ITF=1,20
      WRITE(09,8629) (TEL(KSS,IA,ITF),IA=1,16)
 8628 CONTINUE
 8629 FORMAT(1X,16E8.2)
        PRINT 6000
 6000   FORMAT(42X,33HDIMENSIONAL SPECTRUM (CM**2/HZ)  )
        PRINT 6001
 6001   FORMAT (1X,19HFREQ ENERGY DENSITY,25X,19H DIRECTIONAL ENERGY)
        PRINT 6002
 6002   FORMAT(1X,4H(HZ),2X,10H(CM**2/HZ),30X,15HDIRECTION BANDS)
        PRINT 199
  199   FORMAT(19X,'0.0',4X,'22.5',3X,'45.0',3X,'67.5',3X,'90.0',
     *2X,'112.5',2X,'135.0',2X,'157.5',2X,'180.0',2X,'202.5',2X,'225.0
     *',2X,'247.5',2X,'270.0',2X,'292.5',2X,'315.0',2X,'337.5',//)
C
C      INTEGRATE TO GET ONE-DIMENSIONAL SPECTRUM
C
      WRITE(08,8100) IDP
        FSS=0.0
      DO 317 ITF=1,NFREQ
      EFS=EL(KSS,ITF)*AINC
      SUM=SUM+EFS*DELF(ITF)
        FSS=FSS+EFS*DELF(ITF)*FF(ITF)
        PRINT 73, FF(ITF),EFS,(TEL(KSS,IA,ITF),IA=1,16)
  73    FORMAT (1X,F5.3,1X,F7.0,1X,16F7.0)
      WRITE(08,76) ITF,EFS,DELF(ITF),SUM
  76  FORMAT(1X,I3,3E13.6)
  317 CONTINUE
        PPOSP=1.0/FF(IPP(KSS))
C          PPOSP= PEAK OF SPECTRUM IN DISCREET REGION
        IF(FSS.LE.0.0) FSS=1.0E-5
        TSS=SUM/FSS
C
```

```
C     PRINT ONE- AND TWO--DIMENSIONAL SPECTRUM
C
        PRINT 6004,SUM,HSCALE(KSS)
6004    FORMAT(5X,12HTOTAL ENERGY,E11.4,3H + ,E11.4,13H(PARAMETRIC) )
      SUM=SUM+HSCALE(KSS)
      UST1=USTA(WINDA(I,J))
      EBAR=GSQ*SUM/UST1**4
      HBAR=SQRT(EBAR)
      HT=4.01*SQRT(SUM)
        HTT=.01*HT
        PRINT 6005,HTT
6005    FORMAT(5X,34HSIGNIFICANT WAVE HEIGHT (METERS) =,9X,F5.1)
      HT2=HT*0.0328
        PRINT 315, HT2
 315    FORMAT (5X,32HSIGNIFICANT WAVE HEIGHT (FEET) =,11X,F5.1)
        TPER=1.0/FOA(KSS)
        PRINT 6006,TPER
6006    FORMAT(5X,34HPERIOD OF THE SEA PEAK (SECONDS) =,9X,F5.1)
        PRINT 6020,TSS
6020    FORMAT(5X,39HAVERAGE PERIOD OF ALL WAVES (SECONDS) =,4X,F5.1)
        PRINT 6017,PPOSP
6017    FORMAT(5X,35HPEAK PERIOD OF SPECTRUM (SECONDS) =,8X,F5.1)
        ITHOS=TH2*RADDEG
        PRINT 6007,ITHOS
6007    FORMAT(5X,37HMEAN DIRECTION OF THE SEA(DEGREES) = ,6X,I5)
        ITHOP=THOA(KSS)*RADDEG
        PRINT 6008,ITHOP
6008    FORMAT(5X,38HMEAN DIRECTION OF ALL WAVES (DEGREES)=,5X,I5)
        PRINT 6009,WINDA(I,J)
6009    FORMAT(5X,34HWIND SPEED AT GRID POINT(KNOTS)  =,9X,I5)
        PRINT 6010,WDIR(I,J)
6010    FORMAT(5X,43HDIRECTION OF WIND AT GRID POINT(DEGREES)=  ,I5)
      WRITE(08,365) HT,HT2
      WRITE(08,316)HBAR,EBAR
 316  FORMAT (1X,2E12.4)
 365  FORMAT(1X,2F10.2)
 217  CONTINUE
C
C     PRINT INFORMATION  FOR ENTIRE GRID
C
4651  DO 8050 I=1,N
      DO 8050 J=1,M
      H2(I,J)=0.
8050  CONTINUE
      DO 444 KSS=1,NPTS
      I=LOCI(KSS)
      J=LOCJ(KSS)
 444  H2(I,J)=0.0401*SQRT(EA(KSS))
6666     FORMAT (1H1)
      PRINT 8100, IDP
        PRINT 6011
6011  FORMAT (5X,47HSPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)    )
      DO 311 I=1,N
      PRINT 312, (H2(I,J),J=1,M)
 312  FORMAT(1X,15F6.1)
 311  CONTINUE
      DO 313 KSS=1,NPTS
      I=LOCI(KSS)
      J=LOCJ(KSS)
```

```
313  H2(I,J)=THOA(KSS)*RADDEG*0.1
        PRINT 6012
6012 FORMAT(5X,51HSPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10) )
     DO 445 I=1,N
 445 PRINT 312, (H2(I,J),J=1,M)
       PRINT 9100
9100   FORMAT(5X,33HSPATIAL GRID-PEAK PERIOD(SECONDS))
     DO 314 KSS=1,NPTS
     I=LOCI(KSS)
     J=LOCJ(KSS)
 314 H2(I,J)=1.0/FF(IPP(KSS))
     DO 446 I=1,N
 446 PRINT 312, (H2(I,J),J=1,M)
1001 CONTINUE
1000 CONTINUE
9999 STOP
     END
     SUBROUTINE CLASSB
     COMMON /DD/CG(20),DELX,TINC
     COMMON /ST/XMA1(16,20),XMA2(16,20),PU1(20),PU2(20)
     COMMON /CB/LA(31,31),LOCC(36,36)
     COMMON /CC/ N,M,NPLW,NPNLW,NPTS,NFREQ,NDIR,NPTSP1
     COMMON /EE/LOCI(961),LOCJ(961)
     COMMON /RP/KSSULW(729,16),EV(5,16),LXLI(16,5),LXLJ(16,5),
    1IREFA(16)
     COMMON /KU/ KSSUA(232,16)
     COMMON /IJ/ IUA(16),JUA(16)
     COMMON /B/ VMU(5,16,20),PMU(5,20)
     KSS=0
     NN=N-2
     MM=M-2
C     DETERMINE FULLY LAX-WENDROFF REGION
     DO 1 I=3,NN
     DO 1 J=3,MM
     LOCC(I,J)=0
     IF(LA(I,J).LE.0) GOTO 1
     IF(LA(I+1,J).LE.0) GOTO 1
     IF(LA(I+1,J+1).LE.0) GOTO 1
     IF(LA(I,J+1).LE.0) GOTO 1
     IF(LA(I-1,J+1).LE.0) GOTO 1
     IF(LA(I-1,J).LE.0) GOTO 1
     IF(LA(I-1,J-1).LE.0) GOTO 1
     IF(LA(I,J-1).LE.0) GOTO 1
     IF(LA(I+1,J-1).LE.0) GOTO 1
     IF(LA(I+2,J).LE.0) GOTO 1
     IF(LA(I+2,J+2).LE.0) GOTO 1
     IF(LA(I,J+2).LE.0) GOTO 1
     IF(LA(I-2,J+2).LE.0) GOTO 1
     IF(LA(I-2,J).LE.0) GOTO 1
     IF(LA(I-2,J-2).LE.0) GOTO 1
     IF(LA(I,J-2).LE.0) GOTO 1
     IF(LA(I+2,J-2).LE.0) GOTO 1
     KSS=KSS+1
     LOCC(I,J)=KSS
     LOCI(KSS)=I
     LOCJ(KSS)=J
   1 CONTINUE
     NPLW=KSS
C     NPLW IS THE NUMBER OF POINTS IN THE LAX-WENDROFF REGION
```

```
      NPNLW=0
      N1=N-1
      M1=M-1
      DO 2 I=2,N1
      DO 2 J=2,M1
      IF(LOCC(I,J).GE.1) GOTO 2
      IF(LA(I,J).LE.0) GOTO 2
      NPNLW=NPNLW+1
      KSS=KSS+1
      LOCC(I,J)=KSS
      LOCI(KSS)=I
      LOCJ(KSS)=J
    2 CONTINUE
C      NPNLW IS NUMBER OF BOUNDARY REGION POINTS
C      KSS NOW EQUALS TOTAL POINTS
      DO 500 I=1,N
      PRINT 501, (LOCC(I,J),J=1,M)
  501 FORMAT(1X,31I4)
  500 CONTINUE
      NPTS=KSS
      NPTSP1=NPTS+1
      PRINT 503, NPTS,NPLW,NPNLW
  503 FORMAT(5X,3I10)
      DO 3 I=1,N
      DO 3 J=1,M
      IF(LA(I,J).EQ.0) LOCC(I,J)=NPTSP1
    3 CONTINUE
C      CALCULATE AND STORE MULTIPLIERS FOR BOUNDARY REGION
      DO 40 ITF=1,NFREQ
      DIST=CG(ITF)*TINC
      D22=0.9239*DIST
      D45=0.707*DIST
      DO 4 IA=1,13,4
      XMA2(IA,ITF)=DIST/DELX
      XMA1(IA,ITF)=1.0-XMA2(IA,ITF)
 4    CONTINUE
      DO 5 IA=3,15,4
      XMA2(IA,ITF)=D45/DELX
      XMA1(IA,ITF)=1.0-XMA2(IA,ITF)
 5    CONTINUE
      DO 6 IA=2,16,2
      XMA2(IA,ITF)=D22/DELX
      XMA1(IA,ITF)=1.0-XMA2(IA,ITF)
    6 CONTINUE
      DO 7 IA=1,16
      EMU=XMA2(IA,ITF)
      EMUSQ=EMU*EMU
      EMUP=1.+EMU
      EMU2=EMU/2.
      EMUM=1.-EMU
      A=1.+3.*(1.-EMUSQ)/4.
      B=(1.-EMUSQ)/4.
      VMU(1,IA,ITF)=1.-EMUSQ*A
      VMU(2,IA,ITF)=EMU2*A*EMUP-EMU2*B*EMUM
      VMU(3,IA,ITF)=EMU2*B*EMUP
      VMU(4,IA,ITF)=EMU2*(B*EMUP-A*EMUM)
      VMU(5,IA,ITF)=B*EMU2*EMUM
    7 CONTINUE
      PU2(ITF)=0.3827*DIST/DELX
```

```
      PU1(ITF)=1.-PU2(ITF)
      EMU=PU2(ITF)
      EMUSQ=EMU*EMU
      EMUP=1.0+EMU
      EMU2=EMU/2.
      EMUM=1.-EMU
      A=1.+3.*(1.-EMUSQ)/4.
      B=(1.-EMUSQ)/4.
      PMU(1,ITF)=1.-EMUSQ*A
      PMU(2,ITF)=EMU2*A*EMUP-EMU2*B*EMUM
      PMU(3,ITF)=EMU2*B*EMUP
      PMU(4,ITF)=EMU2*(B*EMUP-A*EMUM)
      PMU(5,ITF)=B*EMU2*EMUM
   40 CONTINUE
      DO 7716 K=1,NPNLW
      KSS=K+NPLW
      I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 7716 IA=1,NDIR
      II=IA
      IU=I+IUA(II)
      JU=J+JUA(II)
      KSSUA(K,IA)=LOCC(IU,JU)
 7716 CONTINUE
      NPTSP1=NPTS+1
      DO 7717 KSS=1,NPLW
      I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 7717 IA=1,16
      IU=I+IUA(IA)
      JU=J+JUA(IA)
      KSSULW(KSS,IA)=LOCC(IU,JU)
 7717 CONTINUE
      DO 7718 K=2,5
      KK=K
      KM=1
      IF(MOD(KK,2).EQ.1) KM=2
      DO 7718 IA=1,16
      LXLI(IA,KK)=IUA(IA)*KM
      LXLJ(IA,KK)=JUA(IA)*KM
 7718 CONTINUE
      RETURN
      END
      SUBROUTINE PROPR (ITF)
      COMMON /A/ E(961,16),EN(961,16)
      COMMON /ST/XMA1(16,20),XMA2(16,20),PU1(20),PU2(20)
      COMMON /CB/LA(31,31),LOCC(36,36)
      COMMON /CC/ N,M,NPLW,NPNLW,NPTS,NFREQ,NDIR,NPTSP1
      COMMON /RP/KSSULW(729,16),EV(5,16),LXLI(16,5),LXLJ(16,5)
     .,IREFA(16)
      COMMON /B/ VMU(5,16,20),PMU(5,20)
      COMMON /EE/LOCI(961),LOCJ(961)
      COMMON /KU/KSSUA(232,16)
      COMMON /NP/KFA(961),MLP(961)
      NTOT=NPTS
      DO 1 KSS=1,NPLW
      IF (ITF.LT.MLP(KSS)) GO TO 2
      DO 4 IA=1,16
      KSSU=KSSULW(KSS,IA)
```

```
      EN(KSS,IA)=XMA1(IA,ITF)*E(KSS,IA)+XMA2(IA,ITF)*E(KSSU,IA)
4     CONTINUE
      GO TO 1
2     I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 3 IA=1,16
      EV(1,IA)=E(KSS,IA)
      DO 44 K=2,5
      LI=I+LXLI(IA,K)
      LJ=J+LXLJ(IA,K)
      KSL=LOCC(LI,LJ)
      EV(K,IA)=E(KSL,IA)
44    CONTINUE
3     CONTINUE
      DO 6 IA=1,16
      EN(KSS,IA)=EV(1,IA)*VMU(1,IA,ITF)+
     .             EV(2,IA)*VMU(2,IA,ITF)+
     .             EV(3,IA)*VMU(3,IA,ITF)+
     .             EV(4,IA)*VMU(4,IA,ITF)+
     .             EV(5,IA)*VMU(5,IA,ITF)
6     CONTINUE
1     CONTINUE
      DO 190 K=1,NPNLW
      KSS=K+NPLW
      DO 141 IA=1,16
      KSSU=KSSUA(K,IA)
      EN(KSS,IA)=XMA1(IA,ITF)*E(KSS,IA)+XMA2(IA,ITF)*E(KSSU,IA)
141   CONTINUE
190   CONTINUE
C      2ND HALF OF PROPAGATION IN LAX-WENDROFF REGION
      DO 11 KSS=1,NPLW
      IF (ITF.LE.MLP(KSS)) GO TO 12
      DO 5 IA=2,16,2
      IIA=IREFA(IA)
      KSSU=KSSULW(KSS,IIA)
      E(KSS,IA)=PU1(ITF)*EN(KSS,IA)+PU2(ITF)*EN(KSSU,IA)
5     CONTINUE
      GO TO 11
12    DO 13 IA=2,16,2
      IIA=IREFA(IA)
      EV(1,IA)=EN(KSS,IA)
      DO 14 K=2,5
      LI=I+LXLI(IIA,K)
      LJ=J+LXLJ(IIA,K)
      KSL=LOCC(LI,LJ)
      EV(K,IA)=EN(KSL,IA)
14    CONTINUE
13    CONTINUE
      DO 16 IA=2,16,2
      E(KSS,IA)=EV(1,IA)*PMU(1,ITF)
     .           +EV(2,IA)*PMU(2,ITF)
     .           +EV(3,IA)*PMU(3,ITF)
     .           +EV(4,IA)*PMU(4,ITF)
     .           +EV(5,IA)*PMU(5,ITF)
16    CONTINUE
11    CONTINUE
C      2ND HALF OF PROPAGATION IN BOUNDARY REGION
      DO 9 K=1,NPNLW
      KSS=K+NPLW
```

```
      DO 41 IA=2,16,2
      IIA=IREFA(IA)
      KSSU=KSSUA(K,IIA)
      E(KSS,IA)=PU1(ITF)*EN(KSS,IA)+PU2(ITF)*EN(KSSU,IA)
41    CONTINUE
9     CONTINUE
      DO 7 KSS=1,NTOT
      DO 7 IA=2,16,2
      EN(KSS,IA)=E(KSS,IA)
7     CONTINUE
      DO 8 IA=1,16
      DO 8 KSS=1,NTOT
      IF (EN(KSS,IA).LT.0.) EN(KSS,IA)=0.
8     CONTINUE
      RETURN
      END
      FUNCTION HBARF(E,UST)
      UST4=UST**4
      EBAR=960400.*E/UST4
      HBARF=0.044*EBAR**(-0.2)
      IF (HBARF.LT.0.008)      HBARF=0.008
      RETURN
      END
      SUBROUTINE DOTPRD (X,Y,Z)
      DIMENSION X(16), Y(16)
      Z=0.
      DO 1 I=1,16
      Z=Z+X(I)*Y(I)
    1 CONTINUE
      RETURN
        END
```

APPENDIX B: MODIFICATIONS FOR A SPHERICAL ORTHOGONAL GRID

1. The flat earth grid will give good results for small bodies of water; but if a large body of water is being considered, a modification to represent the grid as a section of a spherical earth is needed. The spherical orthogonal grid requires changes to be made in the dimension statements and in the main and subroutine portions of the program. A listing of the changed subroutines appears at the end of this appendix. This change will cause the core storage to increase significantly. The spherical orthogonal grid requires that the grid blocks change from the nearly square blocks at the center of the grid to rectangular blocks at the edge of the grid. Changes involve an additional array for DELY, the distance between grid points in the y-direction. The y-distances will differ depending on the J counter (J is the grid column counter) in the program. DELX will remain the same at all J values. DELY (dimensioned by the J counter) can be added to the common /DD/ block in the dimension section. In order to define DELY two new variables, JCEN and SDEG (J-center of the grid and grid spacing in degrees), must be read into the program. These values depend on the specific grid. The following loop will set up the DELY distances for each J counter.

```
      DO 659 J = 1,M
      DIF = ABS(J-JCEN)*SDEG*RADC
      DELY(J) = DELX*COS(DIF)
  659 CONTINUE
```

' ›e J grid values go over the entire grid where M is the maximum J. RADC is the conversion from degrees to radians. This loop needs to be inserted early in the main program before subroutine CLASSB is called.

2. Other dimension changes in the common block statements include the variables, XMA1, XMA2, PU1, PU2, VMU, and PMU. All these variables need to have a dimension added so each of them will allow different values at each different J counter. These variables will now be three- and four-dimensional variables and core storage will increase by a factor of the maximum value of J times the initial storage value for

these variables. These variables are used in the two large subroutines, CLASSB and PROPR.

3. The subroutine CLASSB sets up the constants that are used in the propagation routine. These constants need to be changed to fit the varying block size needed by the spherical orthogonal changes. The DO loops referring to statement numbers 4, 5, and 6 calculate the distance values of the block in the various directions. These loops correspond to IA = 1(0°), IA = 2(22.5°), IA = 3(45°), and so on up to IA = 16 (337.5°).

4. The DO 4 loop calculates the distances for 0°, 90°, 180°, and 270°. Change DELX to DELY(J). If an IF statement

```
IF (IA.EQ.1.OR.9) DELY(J) = DELX
```

is added after the DO 4, DELX will be used instead of DELY for the 0° and 180° distance increment. A second DO 4 index

```
DO 4 J = 1,M
```

needs to be added to the loop to calculate all the different DELY(J) values. Obviously, XMA2 and XMA1 need to have a J dimension added.

5. The DO loop corresponding to the 5 statement number in CLASSB calculates the propagation constants in the IA = 3(45°), IA = 7(135°), IA = 11(225°), and IA = 15(315°). DELX needs to be changed to DELY(J). Again, XMA2 and XMA1 need to be dimensioned by J and a

```
DO 5 J = 1,M
```

needs to be added at the beginning of the loop to index all the J values.

6. The DO 6 loop calculates the 22.5°, 67.5°, 112.5°, 157.5°, 202.5°, 247.5°, 292.5°, and 337.5° propagation constants. DELX needs to be changed to DELY(J). An IF statement needs to be added in the loop:

```
IF (IA.EQ.2.OR.8.OR.10.OR.16) DELY(J) = DELX
```

As before, XMA2 and XMA1 need to be dimensioned by J and

```
DO 6 J = 1,M
```

needs to be added at the beginning of the loop to index all the J values.

7. The DO 7 loop calculates values for the VMU variable. This loop needs to have a

```
DO 7 J = 1,M
```

added to index the various J values. All the VMU variables need to be indexed and dimensioned by J.

8. A loop needs to be added for the calculation of the PU2 and PU1 variables. These variables involve the second component (the other component was calculated previously) of the propagation constant for the 22.5° and 67.5° angle rays. A suggestion for this loop is

```
     DO 40 J=1,M
     DO 40 IA=2,16,2
     IF (IA.EQ.4.OR.6.OR.12.OR.14) DELY(J)=DELX
     PU2 (IA,J,ITF)=0.3827*DIST/DELY(J)
     PU1 (IA,J,ITF)=1-PU2 (IA,J,ITF)
     EMU=PU2 (IA,J,ITF)
     EMUSQ=EMU*EMU
     EMUP=1.0+EMU
     EMU2=EMU/2.
     EMUM=1.-EMU
     A=1.+3.*(1.-EMUSQ)/4.
     B=(1.-EMUSQ)/4.
     PMU(1,IA,J,ITF)=1.-EMUSQ*A
     PMU(2,IA,J,ITF)=EMU2*A*EMUP-EMU2*B*EMUM
     PMU(3,IA,J,ITF)=-EMU2*B*EMUP
     PMU(4,IA,J,ITF)=EMU2*(B*EMUP-A*EMUM)
     PMU(5,IA,J,ITF)=B*EMU2*EMUM
40   CONTINUE
```

The dimensioning changes of the PMU variables are also shown in the above loop.

9. The changes in the propagation subroutine PROPR are relatively easy. The variables just discussed in CLASSB need to be redimensioned in PROPR. The J dimension for the grid point (KSS point) needs to be known to utilize the correct propagation constants. JKSS=LOCJ(KSS) gives the needed J dimension and needs to be inserted in the various loops to assure that the proper propagation constants are being used.

10. A listing of the two subroutines that have been modified for the spherical orthogonal grid follows. Note that the loop discussed in paragraph 1 must be included in the main program and the dimension

statements in the main program must correspond to the dimension statements in the subroutines. The main program must also receive SDEG and JCEN as described in paragraph 1 as input.

```
      SUBROUTINE CLASSB
      COMMON /DD/CG(20),DELX,TINC,DELY(31)
      COMMON /ST/XMA1(16,31,20),XMA2(16,31,20),PU1(16,31,20),
     1         PU2(16,31,20)
      COMMON /CB/LA(31,31),LOCC(36,36)
      COMMON /CC/ N,M,NPLW,NPNLW,NPTS,NFREQ,NDIR,NPTSP1
      COMMON /EE/LOCI(961),LOCJ(961)
      COMMON /RP/KSSULW(729,16),EV(5,16),LXLI(16,5),LXLJ(16,5),
     1IREFA(16)
      COMMON /KU/ KSSUA(232,16)
      COMMON /IJ/ IUA(16),JUA(16)
      COMMON /B/ VMU(5,16,31,20),PMU(5,16,31,20)
      KSS=0
      NN=N-2
      MM=M-2
C      DETERMINE FULLY LAX-WENDROFF REGION
      DO 1 I=3,NN
      DO 1 J=3,MM
      LOCC(I,J)=0
      IF(LA(I,J).LE.0) GOTO 1
      IF(LA(I+1,J).LE.0) GOTO 1
      IF(LA(I+1,J+1).LE.0) GOTO 1
      IF(LA(I,J+1).LE.0) GOTO 1
      IF(LA(I-1,J+1).LE.0) GOTO 1
      IF(LA(I-1,J).LE.0) GOTO 1
      IF(LA(I-1,J-1).LE.0) GOTO 1
      IF(LA(I,J-1).LE.0) GOTO 1
      IF(LA(I+1,J-1).LE.0) GOTO 1
      IF(LA(I+2,J).LE.0) GOTO 1
      IF(LA(I+2,J+2).LE.0) GOTO 1
      IF(LA(I,J+2).LE.0) GOTO 1
      IF(LA(I-2,J+2).LE.0) GOTO 1
      IF(LA(I-2,J).LE.0) GOTO 1
      IF(LA(I-2,J-2).LE.0) GOTO 1
      IF(LA(I,J-2).LE.0) GOTO 1
      IF(LA(I+2,J-2).LE.0) GOTO 1
      KSS=KSS+1
      LOCC(I,J)=KSS
      LOCI(KSS)=I
      LOCJ(KSS)=J
    1 CONTINUE
      NPLW=KSS
C      NPLW IS THE NUMBER OF POINTS IN THE LAX-WENDROFF REGION
      NPNLW=0
      N1=N-1
      M1=M-1
      DO 2 I=2,N1
      DO 2 J=2,M1
      IF(LOCC(I,J).GE.1) GOTO 2
      IF(LA(I,J).LE.0) GOTO 2
      NPNLW=NPNLW+1
      KSS=KSS+1
      LOCC(I,J)=KSS
      LOCI(KSS)=I
      LOCJ(KSS)=J
    2 CONTINUE
C      NPNLW IS NUMBER OF BOUNDARY REGION POINTS
C      KSS NOW EQUALS TOTAL POINTS
```

```
      DO 500 I=1,N
      PRINT 501, (LOCC(I,J),J=1,M)
  501 FORMAT(1X,31I4)
  500 CONTINUE
      NPTS=KSS
      NPTSP1=NPTS+1
      PRINT 503, NPTS,NPLW,NPNLW
  503 FORMAT(5X,3I10)
      DO 3 I=1,N
      DO 3 J=1,M
      IF(LA(I,J).LE.0) LOCC(I,J)=NPTSP1
    3 CONTINUE
C      CALCULATE AND STORE MULTIPLIERS FOR BOUNDARY REGION
      DO 40 ITF=1,NFREQ
      DIST=CG(ITF)*TINC
      D22=0.9239*DIST
      D45=0.707*DIST
        DO 4 J=1,M
      DO 4 IA=1,13,4
        IF (IA.EQ.1.OR.9) DELY(J)=DELX
      XMA2(IA,J,ITF)=DIST/DELY(J)
      XMA1(IA,J,ITF)=1.0-XMA2(IA,J,ITF)
4     CONTINUE
        DO 5 J=1,M
      DO 5 IA=3,15,4
      XMA2(IA,J,ITF)=D45/DELY(J)
      XMA1(IA,J,ITF)=1.0-XMA2(IA,J,ITF)
5     CONTINUE
        DO 6 J=1,M
      DO 6 IA=2,16,2
        IF(IA.EQ.2.OR.8.OR.10.OR.16) DELY(J)=DELX
      XMA2(IA,J,ITF)=D22/DELY(J)
      XMA1(IA,J,ITF)=1.0-XMA2(IA,J,ITF)
    6 CONTINUE
       DO 7 J=1,M
      DO 7 IA=1,16
      EMU=XMA2(IA,J,ITF)
      EMUSQ=EMU*EMU
      EMUP=1.+EMU
      EMU2=EMU/2.
      EMUM=1.-EMU
      A=1.+3.*(1.-EMUSQ)/4.
      B=(1.-EMUSQ)/4.
      VMU(1,IA,J,ITF)=1.-EMUSQ*A
      VMU(2,IA,J,ITF)=EMU2*A*EMUP-EMU2*B*EMUM
      VMU(3,IA,J,ITF)=-EMU2*B*EMUP
      VMU(4,IA,J,ITF)=EMU2*(B*EMUP-A*EMUM)
      VMU(5,IA,J,ITF)=B*EMU2*EMUM
    7 CONTINUE
        DO 40 J=1,M
          DO 40 IA=2,16,2
        IF(IA.EQ.4.OR.6.OR.12.OR.14) DELY(J)=DELX
      PU2(IA,J,ITF)=0.3827*DIST/DELY(J)
      PU1(IA,J,ITF)=1.-PU2(IA,J,ITF)
      EMU=PU2(IA,J,ITF)
      EMUSQ=EMU*EMU
      EMUP=1.0+EMU
      EMU2=EMU/2.
      EMUM=1.-EMU
```

```
      A=1.+3.*(1.-EMUSQ)/4.
      B=(1.-EMUSQ)/4.
      PMU(1,IA,J,ITF)=1.-EMUSQ*A
      PMU(2,IA,J,ITF)=EMU2*A*EMUP-EMU2*B*EMUM
      PMU(3,IA,J,ITF)=-EMU2*B*EMUP
      PMU(4,IA,J,ITF)=EMU2*(B*EMUP-A*EMUM)
      PMU(5,IA,J,ITF)=B*EMU2*EMUM
   40 CONTINUE
      DO 7716 K=1,NPNLW
      KSS=K+NPLW
      I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 7716 IA=1,NDIR
      II=IA
      IU=I+IUA(II)
      JU=J+JUA(II)
      KSSUA(K,IA)=LOCC(IU,JU)
 7716 CONTINUE
      NPTSP1=NPTS+1
      DO 7717 KSS=1,NPLW
      I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 7717 IA=1,16
      IU=I+IUA(IA)
      JU=J+JUA(IA)
      KSSULW(KSS,IA)=LOCC(IU,JU)
 7717 CONTINUE
      DO 7718 K=2,5
      KK=K
      KM=1
      IF(MOD(KK,2).EQ.1) KM=2
      DO 7718 IA=1,16
      LXLI(IA,KK)=IUA(IA)*KM
      LXLJ(IA,KK)=JUA(IA)*KM
 7718 CONTINUE
      RETURN
      END
      SUBROUTINE PROPR (ITF)
      COMMON /A/ E(961,16),EN(961,16)
      COMMON /ST/XMA1(16,31,20),XMA2(16,31,20),PU1(16,31,20),
     1         PU2(16,31,20)
      COMMON /CB/LA(31,31),LOCC(36,36)
      COMMON /CC/ N,M,NPLW,NPNLW,NPTS,NFREQ,NDIR,NPTSP1
      COMMON /RP/KSSULW(729,16),EV(5,16),LXLI(16,5),LXLJ(16,5)
     .,IREFA(16)
      COMMON /B/ VMU(5,16,31,20),PMU(5,16,31,20)
      COMMON /EE/LOCI(961),LOCJ(961)
      COMMON /KU/KSSUA(232,16)
      COMMON /NP/KFA(962),MLP(961)
      NTOT=NPTS
      DO 1 KSS=1,NPLW
         JKSS=LOCJ(KSS)
      IF (ITF.LT.MLP(KSS)) GO TO 2
      DO 4 IA=1,16
      KSSU=KSSULW(KSS,IA)
      EN(KSS,IA)=XMA1(IA,JKSS,ITF)*E(KSS,IA)+XMA2(IA,JKSS,ITF)*E(KSSU
     1      ,IA)
 4    CONTINUE
      GO TO 1
```

```
2     I=LOCI(KSS)
      J=LOCJ(KSS)
      DO 3 IA=1,16
      EV(1,IA)=E(KSS,IA)
      DO 44 K=2,5
      LI=I+LXLI(IA,K)
      LJ=J+LXLJ(IA,K)
      KSL=LOCC(LI,LJ)
      EV(K,IA)=E(KSL,IA)
44    CONTINUE
3     CONTINUE
      DO 6 IA=1,16
      EN(KSS,IA)=EV(1,IA)*VMU(1,IA,JKSS,ITF)+
     .             EV(2,IA)*VMU(2,IA,JKSS,ITF)+
     .             EV(3,IA)*VMU(3,IA,JKSS,ITF)+
     .             EV(4,IA)*VMU(4,IA,JKSS,ITF)+
     .             EV(5,IA)*VMU(5,IA,JKSS,ITF)
6     CONTINUE
1     CONTINUE
      DO 190 K=1,NPNLW
      KSS=K+NPLW
        JKSS=LOCJ(KSS)
      DO 141 IA=1,16
      KSSU=KSSUA(K,IA)
      EN(KSS,IA)=XMA1(IA,JKSS,ITF)*E(KSS,IA)+XMA2(IA,JKSS,ITF)*E(KSSU
     1     ,IA)
141   CONTINUE
190   CONTINUE
C      2ND HALF OF PROPAGATION IN LAX-WENDROFF REGION
      DO 11 KSS=1,NPLW
        JKSS=LOCJ(KSS)
      IF (ITF.LE.MLP(KSS)) GO TO 12
      DO 5 IA=2,16,2
      IIA=IREFA(IA)
      KSSU=KSSULW(KSS,IIA)
      E(KSS,IA)=PU1(IA,JKSS,ITF)*EN(KSS,IA)+PU2(IA,JKSS,ITF)*EN(KSSU
     1     ,IA)
5     CONTINUE
      GO TO 11
12    DO 13 IA=2,16,2
      IIA=IREFA(IA)
      EV(1,IA)=EN(KSS,IA)
      DO 14 K=2,5
      LI=I+LXLI(IIA,K)
      LJ=J+LXLJ(IIA,K)
      KSL=LOCC(LI,LJ)
      EV(K,IA)=EN(KSL,IA)
14    CONTINUE
13    CONTINUE
      DO 16 IA=2,16,2
      E(KSS,IA)=EV(1,IA)*PMU(1,IA,JKSS,ITF)
     .           +EV(2,IA)*PMU(2,IA,JKSS,ITF)
     .           +EV(3,IA)*PMU(3,IA,JKSS,ITF)
     .           +EV(4,IA)*PMU(4,IA,JKSS,ITF)
     .           +EV(5,IA)*PMU(5,IA,JKSS,ITF)
16    CONTINUE
11    CONTINUE
C      2ND HALF OF PROPAGATION IN BOUNDARY REGION
      DO 9 K=1,NPNLW
```

```
      KSS=K+NPLW
         JKSS=LOCJ(KSS)
      DO 41 IA=2,16,2
      IIA=IREFA(IA)
      KSSU=KSSUA(K,IIA)
      E(KSS,IA)=PU1(IA,JKSS,ITF)*EN(KSS,IA)+PU2(IA,JKSS,ITF)*EN(KSSU
     1     ,IA)
41    CONTINUE
9     CONTINUE
999       CONTINUE
      DO 7 KSS=1,NTOT
      DO 7 IA=2,16,2
      EN(KSS,IA)=E(KSS,IA)
7     CONTINUE
      DO 8 IA=1,16
      DO 8 KSS=1,NTOT
      IF (EN(KSS,IA).LT.0.) EN(KSS,IA)=0.
8     CONTINUE
      RETURN
      END
      FUNCTION HBARF(E,UST)
      UST4=UST**4
      EBAR=960400.*E/UST4
      HBARF=0.044*EBAR**(-0.2)
      IF (HBARF.LT.0.008)      HBARF=0.008
      RETURN
      END
      SUBROUTINE DOTPRD (X,Y,Z)
      DIMENSION X(16), Y(16)
      Z=0.
      DO 1 I=1,16
      Z=Z+X(I)*Y(I)
    1 CONTINUE
      RETURN
        END
```

APPENDIX C: SAMPLE WAVE MODEL RUN

1. A sample flat-bed wave model run using the FORTRAN listing in Appendix A for one day is included. The input consists of a file calle INPTEST and the wind file, ILWND. The INPTEST file contains all the grid information and the parameters and constants needed to run the wave model. The ILWND file contains the wind speeds and directions needed to drive the wave model.

2. The output included in this report contains the printout of the information discussed in the section on standard output from the model. Note that the input file has 1-hr time-steps (TINC=3600.) and has wind input every 3 hr. Stability criteria require that 1-hr time-steps are the largest that can be used with this input setup. The output prints do not print the hourly data--the data are printed every 3 hr to match the input wind data.

3. File INPTEST describes a 9×9 grid with a grid spacing of 222 km. TINC is 3600 sec (1 hr). The frequency range is valid for oceanic conditions. One special output station at I=5,J=8 is included.

4. File ILWND is the input wind file. The 72050100 is the date-time which means May 1, 1972, at 00 hours. The matrix directly below the date-time is the wind speed in knots and below this is the direction matrix (in degrees) that corresponds to the wind speeds.

5. The next file is the output data from the model. The prints have been labeled to make this information self-explanatory; but if any questions should arise, see the section on standard output from the model on page 16.

File INPTEST

```
    9    9      3600. 222.    1    3    1    1    0     1950.
  .03  .04  .05  .06  .07  .08  .09  .10  .11  .12
  .13  .14  .15  .16  .17  .18  .19  .20  .21  .22
 5 8
-1-1-1-1-1-1-1-1-1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1 1 1 1 1 1 1 1 1-1
-1-1-1-1-1-1-1-1-1-1
```

File ILWND

```
 72050100
 18 21 20 16 10  8 10  8  8
 18 20 20 16 10  8  8  8  1
 20 21 20 16 14  8  8 10  1
 16 21 21 18 14 10  8 12  1
 12 21 20 18 14 10 10 14  1
 14 21 18 16 14 12 10 12  1
 12 16 18 16 12 12 12 12  1
  6 14 16 18 14 14 14 12  1
 12 12 14 14 12 10 12 16  1
155146137143142167203250250
153143134141140165201248248
145133126134149168200225225
137125129128142164204232232
122105122131139165195231231
104107119125137178204232232
 50103123132140177197232232
147119127135164188185218218
332100124130154180188207207
 72050103
 15 21 22 18 10  8 10  9  9
 15 20 21 17 11  8  8  8  1
 16 19 20 17 14  8  8 10  1
 13 18 20 18 13 10  8 12  1
 11 17 19 18 13  9  9 14  1
 11 15 18 15 13 11 10 13  1
 11 12 17 14 11 11 11 12  1
  7 12 15 15 13 12 13 11  1
 10 11 13 13 11 10 11 15  1
123139134143142169205254254
121136131141140167203252252
 76122122131147170200229229
212119125122141165202237237
 37 97118125141165193234234
 20105108120138177204234234
337104111129141175201235235
197112121137165188190224224
316103131136158182194212212
 72050106
 12 21 25 20 10  8 10 10 10
 12 20 23 18 12  8  8  8  1
 12 16 20 18 14  8  8 10  1
 10 14 20 18 12 10  8 12  1
 10 12 18 18 12  8  8 14  1
  8  8 18 14 12 10 10 14  1
 10  8 16 12 10 10 10 12  1
  8 10 14 12 12 10 12 10  1
  8 10 12 12 10 10 10 14  1
 92132131142142171205257257
 90129128140140169203255255
  71101181281461711982 31231
285113122116141166199240240
312 90114119142164190234234
296104 98115139175203233233
263105100126141174203235235
245105115138165186194227227
299106139141161182198215215
 72050109
```

```
 14 17 21 19 11  9 11 11 11
 13 15 20 17 12  9  9  9  1
 13 13 16 17 13  9  8 10  1
 10 10 15 16 11  9  8 10  1
 10  9 14 16 11  8  8 12  1
 10  8 13 13 11 10 10 12  1
 12  7 12 12 10  9  9 10  1
 10  8 11 12 12 10 10  8  1
  9  8 10 12 11 10 10 12  1
 65115125133135178210249249
 63113122131132176208247247
  1 73111121146181204233233
313 49120113145173202240240
307179118124151172191232232
287179106122143183201226226
256173119132143179200225225
246171138141166187192215215
274167155144161179194206206
 72050112
 16 12 18 18 12 10 12 12 12
 14 10 16 16 12 10 10 10  1
 14 10 12 16 12 10  8 10  1
 10  6 10 14 10  8  8  8  1
 10  6 10 14 10  8  8 10  1
 12  8  8 12 10 10 10 10  1
 14  6  8 12 10  8  8  8  1
 12  6  8 12 12 10  8  6  1
 10  6  8 12 12 10 10 10  1
 38 99119123127185212240240
 36 96116121125183210238238
355 36103115146189207234234
338345118110150180204238238
301269123130160179191228228
277254115129147189197216216
247241139138145185196212212
246238161143166186188201201
247228171147161176189195195
 72050115
 19 13 14 15  9  7 10 10 10
 15 11 13 14  9  7  8  9  1
 14  9  8 14 11  8  7 10  1
 10  7  6 11 10  8  8  9  1
  7  8  7 11  9  7  9 12  1
  8  8  6 10 10  9 10 12  1
 11  7  7 10  9  8  9 10  1
 12 10  9 11 12 10  9  8  1
 10  9  9 11 12 10 11 11  1
 46 75112134132182216254254
 44 73110132129179214252252
 15 29113126150185214231231
  73291561201471772122 34234
328270137136149183203229229
271268178136144194208223223
229245186145146189209220220
228228190151167191204215215
231225188158160183204207207
 72050118
 21 14 10 12  6  4  8  8  8
 16 12 10 12  6  4  6  8  1
```

```
 14  8  4 12 10  6  6 10  1
 10  8  2  8 10  8  8 10  1
  4 10  4  8  8  6 10 14  1
  4  8  4  8 10  8 10 14  1
  8  8  6  8  8  8 10 12  1
 12 14 10 10 12 10 10 10  1
 10 12 10 10 12 10 12 12  1
 54 52106144136178218267267
 52 49103142134176216265265
 35 22122138155179218227227
353111195131145174219228228
354269151143138184213228228
263280242143140197218227227
210248231151146192221225225
208216218158168194219227227
213221203168159188217217217
 72050121
 24 16  8 10  7  5  6  6  6
 18 13  8 10  7  5  5  6  1
 14  7  4  9  9  6  5  8  1
 10  6  2  7 10  8  7 10  1
  4  7  4  7  9  6  8 14  1
  4  6  5  8 10  8  9 13  1
  7  7  7  9  9  9 10 12  1
  9 12 10 12 13 11 11 10  1
  8 12  9 11 13 11 12 12  1
 59 53 87127125153204274274
 57 50 84125122151202272272
 41 39 92130146154208224224
 42320192138139161211228228
 71255172148130166206230230
226257226144134184217234234
197236222150142181215233233
196217216154165187211230230
209224204163156182209217217
 72050200
 27 18  6  8  8  6  4  4  4
 20 14  6  8  8  6  4  4  1
 14  6  4  6  8  6  4  6  1
 10  4  2  6 10  8  6 10  1
  4  4  4  6 10  6  6 14  1
  4  4  6  8 10  8  8 12  1
  6  6  8 10 10 10 10 12  1
  6 10 10 14 14 12 12 10  1
  6 12  8 12 14 12 12 12  1
 64 54 68109113128188280280
 62 51 65107111126186278278
 47 55 61122137129195219219
 49327188146133147202226226
148239194154121148198230230
188232208146128169214238238
183222211149137168208238238
183216213150162179201230230
203226203157152174200214214
```

Wave Model Output

```
        COLD                        COLD                        COLD

    N =    9   M =    9   TINC =    3600.   DINC =     222.

+++++FREQUENCIES   0.03000   0.04000   0.05000   0.06000   0.07000   0.08000   0.09000   0.10000   0.11000   0.12000
+++++FREQUENCIES   0.13000   0.14000   0.15000   0.16000   0.17000   0.18000   0.19000   0.20000   0.21000   0.22000

SF OUTPUT LOCATIONS         5         8

+++++ GRID GEOMETRY
 -1 -1 -1 -1 -1 -1 -1 -1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1  1  1  1  1  1  1  1 -1
 -1 -1 -1 -1 -1 -1 -1 -1 -1
    0   0   0   0   0   0   0   0   0
    0  10  11  12  13  14  15  16   0
    0  17  18  19  20  21  22  23   0
    0  24  25   1   2   3  26  27   0
    0  28  29   4   5   6  30  31   0
    0  32  33   7   8   9  34  35   0
    0  36  37  38  39  40  41  42   0
    0  43  44  45  46  47  48  49   0
    0   0   0   0   0   0   0   0   0
           49          9        40
 15
```

DATE-TIME= 72050100
TIME IN HOURS SINCE START OF RUN = 3.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)
DIRECTIONAL ENERGY
DIRECTION BANDS

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.170	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.180	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.190	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.200	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.210	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.220	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

TOTAL ENERGY 0.0000E+00 + 0.8004E+02(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.4
SIGNIFICANT WAVE HEIGHT (FEET) = 1.2
PERIOD OF THE SEA PEAK (SECONDS) = 2.5
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 0.0
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 225
MEAN DIRECTION OF ALL WAVES (DEGREES)= 231
WIND SPEED AT GRID POINT(KNOTS) = 14
DIRECTION OF WIND AT GRID POINT(DEGREES)= 231

DATE-TIME= 72050100

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.0
0.0	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.0
0.0	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.0
0.0	0.5	0.5	0.4	0.4	0.3	0.3	0.4	0.0
0.0	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.0
0.0	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.0
0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	14.3	13.4	14.1	14.0	16.5	20.1	24.8	0.0
0.0	13.3	12.6	13.4	14.9	16.8	20.0	22.5	0.0
0.0	12.5	12.9	12.8	14.2	16.4	20.4	23.2	0.0
0.0	10.5	12.2	13.1	13.9	16.5	19.5	23.1	0.0
0.0	10.7	11.9	12.5	13.7	17.8	20.4	23.2	0.0
0.0	10.3	12.3	13.2	14.0	17.7	19.7	23.2	0.0
0.0	11.9	12.7	13.5	16.4	18.8	18.5	21.8	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	5.9	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

10
10

DATE-TIME= 72050103
TIME IN HOURS SINCE START OF RUN = 6.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
		DIRECTIONAL ENERGY DIRECTION BANDS															
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.170	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.180	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.190	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.200	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.210	4.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	2.	2.	1.	1.	0.	0.
0.220	11.	0.	0.	0.	0.	0.	0.	0.	0.	2.	5.	7.	7.	5.	2.	0.	0.

TOTAL ENERGY 0.1567E+00 + 0.2370E+03(PARAMETRIC)

SIGNIFICANT WAVE HEIGHT (METERS) =	0.6
SIGNIFICANT WAVE HEIGHT (FEET) =	2.0
PERIOD OF THE SEA PEAK (SECONDS) =	3.4
AVERAGE PERIOD OF ALL WAVES (SECONDS) =	4.6
PEAK PERIOD OF SPECTRUM (SECONDS) =	4.5
MEAN DIRECTION OF THE SEA(DEGREES) =	225
MEAN DIRECTION OF ALL WAVES (DEGREES)=	234
WIND SPEED AT GRID POINT(KNOTS) =	14
DIRECTION OF WIND AT GRID POINT(DEGREES)=	234

DATE-TIME= 72050103

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.0	1.0	0.7	0.5	0.3	0.3	0.3	0.0
0.0	1.0	1.0	0.7	0.6	0.3	0.3	0.4	0.0
0.0	0.9	1.0	0.8	0.6	0.4	0.3	0.5	0.0
0.0	0.9	0.9	0.8	0.6	0.3	0.3	0.6	0.0
0.0	0.8	0.8	0.7	0.6	0.5	0.4	0.5	0.0
0.0	0.6	0.8	0.7	0.5	0.5	0.5	0.5	0.0
0.0	0.6	0.7	0.7	0.6	0.6	0.6	0.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	13.6	13.1	14.1	14.0	16.7	20.3	25.2	0.0
0.0	12.2	12.2	13.1	14.7	17.0	20.0	22.9	0.0
0.0	11.9	12.5	12.2	14.1	16.5	20.2	23.7	0.0
0.0	9.7	11.8	12.5	14.1	16.5	19.3	23.4	0.0
0.0	10.5	10.8	12.0	13.8	17.7	20.4	23.4	0.0
0.0	10.4	11.1	12.9	14.1	17.5	20.1	23.5	0.0
0.0	11.2	12.1	13.7	16.5	18.8	19.0	22.4	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

15
15
12

DATE-TIME= 72050106
TIME IN HOURS SINCE START OF RUN = 9.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)
DIRECTIONAL ENERGY
DIRECTION BANDS

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.170	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.180	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.190	88.	0.	0.	0.	0.	0.	0.	0.	3.	19.	40.	55.	53.	37.	16.	1.	0.
0.200	205.	0.	0.	0.	0.	0.	0.	0.	7.	45.	93.	128.	123.	86.	36.	3.	0.
0.210	396.	0.	0.	0.	0.	0.	0.	0.	13.	87.	180.	247.	238.	166.	71.	6.	0.
0.220	668.	0.	0.	0.	0.	0.	0.	0.	21.	147.	303.	417.	402.	280.	119.	10.	0.

TOTAL ENERGY 0.1356E+02 + 0.4360E+03(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.9
SIGNIFICANT WAVE HEIGHT (FEET) = 2.8
PERIOD OF THE SEA PEAK (SECONDS) = 4.1
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 4.7
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 225
MEAN DIRECTION OF ALL WAVES (DEGREES)= 234
WIND SPEED AT GRID POINT(KNOTS) = 14
DIRECTION OF WIND AT GRID POINT(DEGREES)= 234

DATE-TIME= 72050106

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.4	1.6	1.1	0.6	0.3	0.3	0.3	0.0
0.0	1.4	1.4	1.1	0.9	0.3	0.3	0.4	0.0
0.0	1.0	1.5	1.2	0.6	0.4	0.3	0.6	0.0
0.0	0.8	1.3	1.2	0.6	0.3	0.3	0.9	0.0
0.0	0.5	1.2	0.9	0.6	0.4	0.4	0.8	0.0
0.0	0.3	1.1	0.7	0.4	0.4	0.4	0.6	0.0
0.0	0.4	0.9	0.7	0.6	0.4	0.6	0.4	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	12.9	12.8	14.0	14.0	16.9	20.3	25.5	0.0
0.0	11.0	11.8	12.8	14.6	17.1	19.8	23.1	0.0
0.0	11.3	12.2	11.6	14.1	16.6	19.9	24.0	0.0
0.0	9.0	11.4	11.9	14.2	16.4	19.0	23.4	0.0
0.0	10.4	9.8	11.5	13.9	17.5	20.3	23.3	0.0
0.0	10.5	10.0	12.6	14.1	17.4	20.3	23.5	0.0
0.0	10.5	11.5	13.8	16.5	18.6	19.4	22.7	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.3	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

13
12
11

DATE-TIME= 72050109
TIME IN HOURS SINCE START OF RUN = 12.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
		DIRECTIONAL ENERGY DIRECTION BANDS															
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	0.	0.	0.	0.
0.170	8.	0.	0.	0.	0.	0.	0.	0.	0.	1.	4.	6.	6.	3.	1.	0.	0.
0.180	22.	0.	0.	0.	0.	0.	0.	0.	0.	2.	10.	18.	17.	8.	1.	0.	0.
0.190	521.	0.	0.	0.	0.	0.	0.	0.	17.	111.	237.	345.	317.	211.	81.	6.	0.
0.200	1046.	0.	0.	0.	0.	0.	0.	0.	33.	221.	476.	694.	640.	425.	163.	13.	0.
0.210	1768.	0.	0.	0.	0.	0.	0.	0.	56.	374.	803.	1168.	1081.	721.	278.	22.	0.
0.220	2718.	0.	0.	0.	0.	0.	0.	0.	85.	571.	1232.	1795.	1667.	1111.	426.	33.	0.

TOTAL ENERGY 0.6084E+02 + 0.2355E+03(PARAMETRIC)

SIGNIFICANT WAVE HEIGHT (METERS) =	0.7
SIGNIFICANT WAVE HEIGHT (FEET) =	2.3
PERIOD OF THE SEA PEAK (SECONDS) =	3.5
AVERAGE PERIOD OF ALL WAVES (SECONDS) =	4.7
PEAK PERIOD OF SPECTRUM (SECONDS) =	4.5
MEAN DIRECTION OF THE SEA(DEGREES) =	225
MEAN DIRECTION OF ALL WAVES (DEGREES)=	232
WIND SPEED AT GRID POINT(KNOTS) =	12
DIRECTION OF WIND AT GRID POINT(DEGREES)=	232

DATE-TIME= 72050109

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.4	1.7	1.6	0.6	0.3	0.3	0.3	0.0
0.0	1.3	1.4	1.6	0.8	0.3	0.3	0.4	0.0
0.0	0.8	1.4	1.6	0.5	0.3	0.3	0.4	0.0
0.0	0.6	1.3	1.6	0.5	0.3	0.3	0.7	0.0
0.0	0.4	1.6	0.8	0.5	0.4	0.4	0.7	0.0
0.0	0.2	1.3	0.7	0.4	0.3	0.3	0.4	0.0
0.0	0.3	0.6	0.7	0.6	0.4	0.5	0.3	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	11.7	11.8	13.5	13.2	17.6	20.8	24.7	0.0
0.0	7.9	11.4	11.4	14.6	18.1	20.4	23.3	0.0
0.0	4.9	11.4	11.3	14.5	17.3	20.2	24.0	0.0
0.0	17.9	11.3	13.3	15.1	17.2	19.1	23.2	0.0
0.0	17.9	11.1	12.2	14.3	18.3	20.1	22.6	0.0
0.0	17.3	11.2	13.2	14.3	17.9	20.0	22.5	0.0
0.0	17.1	13.8	14.1	16.6	18.7	19.2	21.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.0	5.0	4.8	4.5	4.5	4.5	4.5	0.0
0.0	4.8	5.0	4.8	4.5	4.5	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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12

DATE-TIME= 72050112
TIME IN HOURS SINCE START OF RUN = 15.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)
DIRECTIONAL ENERGY
DIRECTION BANDS

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.
0.170	6.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	5.	4.	2.	0.	0.	0.
0.180	18.	0.	0.	0.	0.	0.	0.	0.	0.	2.	8.	15.	13.	6.	1.	0.	0.
0.190	426.	0.	0.	0.	0.	0.	0.	0.	14.	92.	185.	302.	248.	175.	63.	6.	0.
0.200	876.	0.	0.	0.	0.	0.	0.	0.	28.	187.	380.	618.	513.	361.	131.	11.	0.
0.210	1517.	0.	0.	0.	0.	0.	0.	0.	49.	323.	659.	1061.	892.	629.	230.	20.	0.
0.220	2391.	0.	0.	0.	0.	0.	0.	0.	77.	505.	1040.	1663.	1416.	995.	363.	30.	0.

TOTAL ENERGY 0.5235E+02 + 0.1134E+03(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.5
SIGNIFICANT WAVE HEIGHT (FEET) = 1.7
PERIOD OF THE SEA PEAK (SECONDS) = 2.9
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 4.7
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 202
MEAN DIRECTION OF ALL WAVES (DEGREES)= 228
WIND SPEED AT GRID POINT(KNOTS) = 10
DIRECTION OF WIND AT GRID POINT(DEGREES)= 228

DATE-TIME= 7205011[illegible]

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.4	1.8	1.5	0.6	0.4	0.4	0.4	0.0
0.0	1.3	1.4	1.6	0.7	0.4	0.3	0.4	0.0
0.0	0.7	1.4	1.4	0.5	0.3	0.3	0.3	0.0
0.0	0.5	1.3	1.4	0.5	0.3	0.3	0.5	0.0
0.0	0.5	1.1	0.7	0.5	0.4	0.4	0.5	0.0
0.0	0.2	0.7	0.7	0.4	0.3	0.3	0.3	0.0
0.0	0.2	0.4	0.7	0.6	0.4	0.3	0.2	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	10.3	11.6	12.0	12.5	18.3	21.0	23.8	0.0
0.0	6.3	11.4	11.4	14.6	18.9	20.7	23.4	0.0
0.0	34.5	11.4	11.3	15.0	18.0	20.4	23.8	0.0
0.0	26.9	11.3	13.1	16.0	17.9	19.1	22.8	0.0
0.0	25.4	11.1	12.9	14.7	18.9	19.7	21.6	0.0
0.0	24.1	13.9	13.8	14.5	18.5	19.6	21.2	0.0
0.0	23.8	16.1	14.3	16.6	18.6	18.8	20.1	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.0	5.6	5.3	4.5	4.5	4.5	4.5	0.0
0.0	4.9	5.3	5.3	4.5	4.5	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

12
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15

DATE-TIME= 72050115
TIME IN HOURS SINCE START OF RUN = 18.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
		DIRECTIONAL ENERGY DIRECTION BANDS															
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.
0.170	5.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.	5.	3.	2.	0.	0.	0.
0.180	14.	0.	0.	0.	0.	0.	0.	0.	0.	1.	6.	13.	10.	5.	1.	0.	0.
0.190	344.	0.	0.	0.	0.	0.	0.	0.	11.	75.	141.	262.	190.	143.	49.	5.	0.
0.200	717.	0.	0.	0.	0.	0.	0.	0.	23.	153.	296.	539.	401.	300.	103.	10.	0.
0.210	1257.	0.	0.	0.	0.	0.	0.	0.	41.	268.	520.	932.	709.	530.	184.	17.	0.
0.220	2004.	0.	0.	0.	0.	0.	0.	0.	65.	423.	831.	1469.	1143.	850.	295.	27.	0.

TOTAL ENERGY 0.4342E+02 + 0.1670E+03(PARAMETRIC)

SIGNIFICANT WAVE HEIGHT (METERS) =	0.6
SIGNIFICANT WAVE HEIGHT (FEET) =	1.9
PERIOD OF THE SEA PEAK (SECONDS) =	3.2
AVERAGE PERIOD OF ALL WAVES (SECONDS) =	4.7
PEAK PERIOD OF SPECTRUM (SECONDS) =	4.5
MEAN DIRECTION OF THE SEA(DEGREES) =	225
MEAN DIRECTION OF ALL WAVES (DEGREES)=	229
WIND SPEED AT GRID POINT(KNOTS) =	12
DIRECTION OF WIND AT GRID POINT(DEGREES)=	229

DATE-TIME= 72050115

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.1	1.7	1.5	0.4	0.2	0.3	0.3	0.0
0.0	0.9	1.4	1.5	0.6	0.3	0.2	0.4	0.0
0.0	0.7	1.3	1.4	0.5	0.3	0.3	0.3	0.0
0.0	0.6	1.2	1.3	0.4	0.2	0.3	0.6	0.0
0.0	0.5	0.8	0.6	0.5	0.3	0.4	0.6	0.0
0.0	0.3	0.6	0.5	0.4	0.3	0.3	0.4	0.0
0.0	0.3	0.4	0.6	0.6	0.4	0.4	0.2	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	7.3	11.7	13.1	12.9	17.9	21.4	25.2	0.0
0.0	2.9	11.4	12.6	15.0	18.5	21.4	23.1	0.0
0.0	32.9	14.6	11.3	14.7	17.7	21.2	23.4	0.0
0.0	27.0	13.2	13.2	14.9	18.3	20.3	22.9	0.0
0.0	26.8	17.8	13.6	14.4	19.4	20.8	22.3	0.0
0.0	24.5	18.6	14.5	14.6	18.9	20.9	22.0	0.0
0.0	22.8	19.0	15.1	16.7	19.1	20.4	21.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.0	5.6	5.3	4.5	4.5	4.5	4.5	0.0
0.0	4.8	5.3	5.3	4.5	4.5	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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DATE-TIME= 72050118
TIME IN HOURS SINCE START OF RUN = 21.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
		DIMENSIONAL SPECTRUM (CM**2/HZ) DIRECTIONAL ENERGY DIRECTION BANDS															
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.
0.170	4.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	4.	2.	1.	0.	0.	0.
0.180	11.	0.	0.	0.	0.	0.	0.	0.	0.	1.	4.	11.	7.	4.	1.	0.	0.
0.190	285.	0.	0.	0.	0.	0.	0.	0.	10.	62.	111.	230.	150.	120.	38.	4.	0.
0.200	609.	0.	0.	0.	0.	0.	0.	0.	21.	132.	241.	484.	326.	257.	83.	9.	0.
0.210	1099.	0.	0.	0.	0.	0.	0.	0.	38.	238.	438.	853.	595.	466.	153.	15.	0.
0.220	1800.	0.	0.	0.	0.	0.	0.	0.	63.	388.	724.	1374.	990.	768.	254.	24.	0.

TOTAL ENERGY 0.3809E+02 + 0.3267E+03(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.8
SIGNIFICANT WAVE HEIGHT (FEET) = 2.5
PERIOD OF THE SEA PEAK (SECONDS) = 3.7
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 4.7
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 225
MEAN DIRECTION OF ALL WAVES (DEGREES)= 223
WIND SPEED AT GRID POINT(KNOTS = 14
DIRECTION OF WIND AT GRID POINT(DEGREES)= 223

DATE-TIME= 72050118

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.2	1.6	1.5	0.3	0.1	0.2	0.3	0.0
0.0	0.9	1.0	1.5	0.5	0.2	0.2	0.4	0.0
0.0	0.7	1.3	1.0	0.5	0.3	0.3	0.4	0.0
0.0	0.6	0.8	0.9	0.3	0.2	0.4	0.8	0.0
0.0	0.5	0.7	0.5	0.5	0.3	0.5	0.8	0.0
0.0	0.3	0.5	0.4	0.3	0.3	0.4	0.5	0.0
0.0	0.5	0.5	0.5	0.6	0.4	0.4	0.4	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	4.9	11.5	13.0	13.4	17.6	21.6	26.5	0.0
0.0	2.2	12.2	12.7	15.5	17.9	21.8	22.7	0.0
0.0	31.1	19.3	13.1	14.5	17.4	21.9	22.8	0.0
0.0	26.9	15.1	14.3	13.8	18.4	21.3	22.8	0.0
0.0	28.0	24.2	14.3	14.0	19.7	21.8	22.7	0.0
0.0	24.8	23.1	15.1	14.6	19.2	22.1	22.5	0.0
0.0	21.6	21.8	15.8	16.8	19.4	21.9	22.7	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.0	5.6	5.3	4.5	5.0	4.5	4.5	0.0
0.0	5.0	5.3	5.3	4.5	5.0	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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DATE-TIME= 72050121
TIME IN HOURS SINCE START OF RUN = 24.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	DIRECTIONAL ENERGY DIRECTION BANDS 0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	1.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.
0.170	3.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	2.	1.	0.	0.	0.
0.180	9.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	10.	5.	3.	0.	0.	0.
0.190	500.	0.	0.	0.	0.	0.	0.	0.	24.	124.	220.	372.	268.	196.	65.	5.	0.
0.200	1040.	0.	0.	0.	0.	0.	0.	0.	50.	257.	457.	768.	562.	409.	135.	9.	0.
0.210	1839.	0.	0.	0.	0.	0.	0.	0.	89.	453.	809.	1345.	1000.	729.	243.	16.	0.
0.220	2927.	0.	0.	0.	0.	0.	0.	0.	140.	714.	1286.	2124.	1604.	1169.	390.	26.	0.

TOTAL ENERGY 0.6319E+02 + 0.4391E+03(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.9
SIGNIFICANT WAVE HEIGHT (FEET) = 2.9
PERIOD OF THE SEA PEAK (SECONDS) = 4.1
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 4.7
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 225
MEAN DIRECTION OF ALL WAVES (DEGREES)= 230
WIND SPEED AT GRID POINT(KNOTS) = 14
DIRECTION OF WIND AT GRID POINT(DEGREES)= 230

```
                  DATE-TIME=  72050121
 SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   1.2   1.3   1.2   0.3   0.1   0.1   0.2   0.0
0.0   0.9   1.0   1.1   0.5   0.2   0.1   0.3   0.0
0.0   0.7   0.9   0.9   0.5   0.3   0.2   0.4   0.0
0.0   0.6   0.8   0.9   0.4   0.2   0.3   0.9   0.0
0.0   0.4   0.7   0.4   0.5   0.3   0.4   0.8   0.0
0.0   0.3   0.5   0.4   0.3   0.3   0.4   0.6   0.0
0.0   0.6   0.5   0.6   0.7   0.5   0.5   0.4   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
 SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   5.0   8.4  12.5  12.2  15.1  20.2  27.2   0.0
0.0   3.9   9.2  13.0  14.6  15.4  20.8  22.4   0.0
0.0  32.0  19.2  13.8  13.9  16.1  21.1  22.8   0.0
0.0  25.5  17.2  14.8  13.0  16.6  20.6  23.0   0.0
0.0  25.7  22.6  14.4  13.4  18.4  21.7  23.4   0.0
0.0  23.6  22.2  15.0  14.2  18.1  21.5  23.3   0.0
0.0  21.7  21.6  15.4  16.5  18.7  21.1  23.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
 SPATIAL GRID-PEAK PERIOD(SECONDS)
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   5.0   5.3   5.3   4.5   5.0   5.0   4.5   0.0
0.0   5.0   5.3   5.3   4.5   5.0   4.5   4.5   0.0
0.0   4.5   5.0   5.0   4.5   4.5   4.5   4.5   0.0
0.0   4.5   4.8   5.0   4.5   4.5   4.5   4.5   0.0
0.0   4.5   4.8   4.5   4.5   4.5   4.5   4.5   0.0
0.0   4.5   4.5   4.5   4.5   4.5   4.5   4.5   0.0
0.0   4.5   4.5   4.5   4.5   4.5   4.5   4.5   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
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DATE-TIME= 72050200
TIME IN HOURS SINCE START OF RUN = 27.00

SPECIAL OUTPUT FOR GRID LOCATION I= 5 J= 8

DIMENSIONAL SPECTRUM (CM**2/HZ)

FREQ (HZ)	ENERGY DENSITY (CM**2/HZ)	DIRECTIONAL ENERGY DIRECTION BANDS 0.0	22.5	45.0	67.5	90.0	112.5	135.0	157.5	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5
0.030	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.040	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.050	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.060	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.070	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.080	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.090	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.110	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.130	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.140	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.160	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.170	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	3.	1.	1.	0.	0.	0.
0.180	7.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.	8.	4.	3.	0.	0.	0.
0.190	712.	0.	0.	0.	0.	0.	0.	0.	36.	182.	319.	521.	382.	275.	92.	5.	0.
0.200	1455.	0.	0.	0.	1.	0.	0.	0.	74.	371.	650.	1060.	784.	565.	189.	11.	0.
0.210	2533.	0.	0.	0.	1.	0.	0.	0.	129.	643.	1132.	1834.	1371.	989.	332.	19.	0.
0.220	3954.	0.	0.	0.	1.	0.	0.	0.	200.	997.	1764.	2850.	2151.	1555.	522.	30.	0.

TOTAL ENERGY 0.8665E+02 + 0.4391E+03(PARAMETRIC)
SIGNIFICANT WAVE HEIGHT (METERS) = 0.9
SIGNIFICANT WAVE HEIGHT (FEET) = 3.0
PERIOD OF THE SEA PEAK (SECONDS) = 4.1
AVERAGE PERIOD OF ALL WAVES (SECONDS) = 4.7
PEAK PERIOD OF SPECTRUM (SECONDS) = 4.5
MEAN DIRECTION OF THE SEA(DEGREES) = 225
MEAN DIRECTION OF ALL WAVES (DEGREES)= 230
WIND SPEED AT GRID POINT(KNOTS) = 14
DIRECTION OF WIND AT GRID POINT(DEGREES)= 230

DATE-TIME= 72050200

SPATIAL GRID-SIGNIFICANT WAVE HEIGHT(METERS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.3	1.2	1.1	0.3	0.2	0.1	0.1	0.0
0.0	0.9	1.0	1.0	0.4	0.2	0.1	0.2	0.0
0.0	0.6	0.9	0.9	0.5	0.3	0.2	0.4	0.0
0.0	0.5	0.8	0.8	0.4	0.2	0.2	0.9	0.0
0.0	0.4	0.6	0.4	0.5	0.3	0.3	0.7	0.0
0.0	0.3	0.5	0.5	0.4	0.4	0.4	0.6	0.0
0.0	0.5	0.5	0.8	0.8	0.6	0.6	0.4	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-MEAN DIRECTION OF SPECTRUM(DEGREES/10)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.1	6.5	10.7	11.1	12.6	18.6	27.8	0.0
0.0	5.5	6.1	12.2	13.7	12.9	19.5	21.9	0.0
0.0	32.7	18.8	14.6	13.3	14.7	20.2	22.6	0.0
0.0	23.9	19.4	15.4	12.1	14.8	19.8	23.0	0.0
0.0	23.2	20.8	14.6	12.8	16.9	21.4	23.8	0.0
0.0	22.2	21.1	14.9	13.7	16.8	20.8	23.8	0.0
0.0	21.6	21.3	15.0	16.2	17.9	20.1	23.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SPATIAL GRID-PEAK PERIOD(SECONDS)

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	5.0	5.6	5.3	4.5	5.0	5.0	4.5	0.0
0.0	5.0	5.3	5.3	4.5	5.0	4.5	4.5	0.0
0.0	4.5	5.0	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	5.0	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.8	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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APPENDIX D: NOTATION

BB	Boundary point in grid
c_g	Group velocity
DELX	Grid spacing in wave model (x-direction)
DELY	Spacing between grid points in the longitudinal direction (only when using a spherical orthogonal grid)
E	Energy associated with wave
$\bar{E}$	Average nondimensional energy at a specific point
f_f	Frequency of wave
f_m	Frequency of spectral peak
f_{min}	Minimum frequency that is input into wave model
g	Gravitational acceleration (980 cm/sec^2)
$H_{1/3}$	Significant wave height
$\bar{H}$	Average wave height associated with $\bar{E}$
J	Latitude counter
JCEN	Latitude counter of center of grid
LW	Lax-Wendroff water point in grid
M	Number of columns in grid
N	Number of rows in grid
S	Number of grid points
SDEG	Grid spacing in degrees
SUM	One-dimensional energy
t	Time
$\bar{t}$	Nondimensional time
TINC	Time increment in wave model
u	Wind speed
u_*	Friction velocity
Δf	Difference between two separate frequencies
θ	Direction of wave

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Resio, Donald R.
A numerical model for wind-wave prediction in deep water / by Donald T. Resio, Barbara A. Tracy (Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. : available from NTIS, 1983.
73 p. in various pagings : ill. ; 27 cm. -- (WIS report ; 12)
Cover title.
"January 1983."
"Prepared for Office, Chief of Engineers, U.S. Army."
"Wave Information Studies of U.S. Coastlines."
Bibliography: p. 23-24.

1. Atlantic coast (United States). 2. Numerical analysis. 3. Ocean waves. 4. Wind waves. I. Tracy, Barbara A. II. United States. Army. Corps of Engineers. Office of the Chief of Engineers. III. Wave Information

Resio, Donald T.
A numerical model for wind-wave prediction : ... 1983.
(Card 2)

Studies of U.S. Coastlines. IV. U.S. Army Engineer Waterways Experiment Station. Hydraulics Laboratory. V. Title VI. Series: WIS report (U.S. Army Engineer Waterways Experiment Station) ; 12.
TA7.W349 no.12

AD-A125 985 A NUMERICAL MODEL FOR WIND-WAVE PREDICTION IN DEEP WATER(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRAULICS LAB D T RESIO ET AL. JAN 83 2/2

UNCLASSIFIED WIS-12 F/G 8/3 NL

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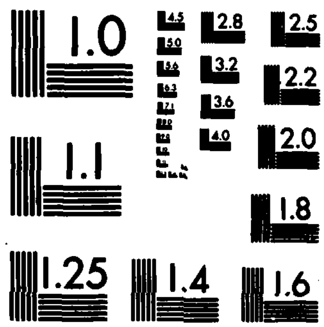

MICROCOPY RESOLUTION TEST CHART
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DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF

WESCW-P

11 March 1985

Errata Sheet

No. 1

A NUMERICAL MODEL FOR WIND-WAVE
PREDICTION IN DEEP WATER

WIS Report 12

January 1983

1. Page A6, after line 38 (402 DO 20 KSS=1,NPTSP1), add:

   SCAA (KSS)=0.0
   SWLSC (KSS)=0.0

2. Page A10, after line 18 (DO 66 KSS=1,NPTS), delete:

   HIGHE=HSCALE(KSS)

3. Page A11, after line 39 (123 KFRQ=AF07(KSS), add:

   HIGHE=HSCALE(KSS)

4. Page A15, line 26 (IF(LA(I,J).EQ.0) LOCC(I,J)=NPTSP1), change:

   .EQ. to .LE.

5. Page A15, line 55, change VMU(3,IA,ITF)=EMU2*B*EMUP to:

   VMU(3,IA,ITF)=-EMU2*B*EMUP

6. Page A16, line 11, change PMU(3,ITF)=EMU2*B*EMUP to:

   PMU(3,ITF)=-EMU2*B*EMUP

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