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Technical Note

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SIMBAT USER'S MANUAL

ABSTRACT This manual describes the operation and instructions for execution of the Conditional Ocean Wave Simulation Model (SIMBAT). SIMBAT is a high performance FORTRAN F77 based computer model that uses the Fast Fourier Transform (FFT) to produce ocean wave properties for ocean engineering applications. The model assumes the wave properties form a gaussian stochastic process. SIMBAT may be used to perform a conditional or unconditional simulation. A conditional simulation uses a measured or existing input time series and forces the simulated wave properties to adhere to the input time series but also follow the laws of multivariate normal probability. An unconditional simulation uses a measured or created ocean wave spectra to randomly simulate the ocean wave properties. Program features include: creation of directional ocean wave spectra; water particle kinematic stretching; conditioning time series using an input time series less than or equal to the simulation length; use of Legendre orthogonal polynomials for post creation of wave properties by program CKPOLY; and error checking. Example problems are included.

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME CALIFORNIA 93043-5003

METRIC CONVERSION FACTORS

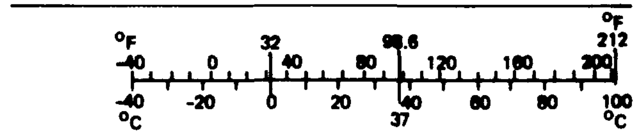
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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This manual describes the operation and instructions for execution of the Conditional Ocean Wave Simulation Model (SIMBAT). SIMBAT is a high performance FORTRAN F77 based computer model that uses the Fast Fourier Transform (FFT) to produce ocean wave properties for ocean engineering applications. The model assumes the wave properties form a gaussian stochastic process. SIMBAT may be used to perform a conditional or unconditional simulation. A conditional simulation uses a measured or existing input time series and forces the simulated wave properties to adhere to the input time series but also follow the laws of multivariate normal probability. An unconditional simulation uses a measured or created ocean wave spectra to randomly simulate the ocean wave properties. Program features include: creation of directional ocean wave spectra; water particle kinematic stretching; conditioning time series using an input time series less than or equal to the simulation length; use of Legendre orthogonal polynomials for post creation of wave properties by program CKPOLY; and error checking. Example problems are included.

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EXECUTIVE SUMMARY

OBJECTIVE

This document provides a description of the operation of the Conditional Ocean Wave Simulation Model (SIMBAT) and the instructions for use. This document is meant to be supplementary to the SIMBAT theoretical manual (Borgman et al., ca. 1991) which provides the mathematical and probability theory for the software.

INTRODUCTION

SIMBAT is a computer model that provides ocean water wave particle kinematics for the computation of wave loading on offshore structures. SIMBAT was developed to meet the requirements of analyzing the dynamic motion response of deep water semisubmersible platforms for the Offshore Tactical Aircrew Combat Training Facilities Technology Program.

SIMBAT may be used for other areas of interest besides wave loading such as input for the conditional simulation of waves in a model test basin. But the primary focus for the development of SIMBAT at the Naval Civil Engineering Laboratory is for simulation of water particle kinematics to be used in calculation of wave loading. For example, if the Morison equation (Sarpkaya and Isaacson, 1981) is used to compute the wave loads on a slender member, the water particle velocities and accelerations will be required as input for each time step and at each load point across the structure. SIMBAT will calculate this information.

SIMBAT provides the option to create either conditionally or unconditionally simulated water particle kinematics. A conditional simulation utilizes a measured ocean wave spectrum or measured time series history to "condition" the simulation to create associated water particle kinematics that adhere to the properties of the input data. This is particularly useful in the event that the user would like to impose a large measured wave profile on the structure and create the associated kinematics for that profile to determine the extreme loads on the structure. The advantage of this option is that large wave profile is certain to occur in the computer simulation where ordinarily a much longer time domain simulation would be required before an extreme wave profile would be realizable. Thus, the design engineer may utilize SIMBAT to produce the appropriate water particle kinematics for extreme wave loading in a reasonable amount of computer time.

The unconditional simulation will produce wave properties in accordance with an input ocean wave spectrum and that follow a multivariate normal probability law. The wave properties are "unconditionally" simulated randomly by an input seed number specified by the user.

Current procedures available for simulating ocean wave properties are based on time domain superposition and filtering of Guassian white noise. Substantial savings in computer simulation time and expenses can be realized if the wave properties are simulated in the frequency domain as is done in SIMBAT.

One of the major features of the simulation model is in its ability to produce wave properties over a large three-dimensional spatial region using a Legendre Polynomial fit (Hochstrasser, 1964). The wave load points on the offshore structure are calculated at each time step in an expedient manner as opposed to the standard industry method of computing the wave properties in the time domain at each load point. Orders in magnitude of computer time may be saved as a result of this method. If SIMBAT is used for this application, the design engineer would merge the SIMBAT post processor, CKPOLY, with his or her structural analysis package to read the necessary data from the SIMBAT output files and create the water particle kinematics where required.

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D - Example No. 4 -- Conditional Simulation L=N D-1

INTRODUCTION

OBJECTIVE

This document describes the operation of the Conditional Ocean Wave Simulation Model (SIMBAT) and provides instructions for its use. This document supplements the SIMBAT theoretical manual (Borgman et al., ca. 1991) which provides the mathematical and probability theory for the software.

BACKGROUND

The Naval Civil Engineering Laboratory (NCEL), under the Offshore Tactical Aircrew Combat Training Systems (OTACTS) task of the Navy Exploratory Development Program (CE2A Block - Facilities, Environmental Protection and Materials), was funded to develop technology necessary to design and construct reliable and cost effective unmanned ocean platforms for deepwater (600 to 10,000 feet) OTACTS applications (Shields et al., 1987). One of the objectives of this development task was to develop, modify, integrate, and validate computer models for simulation of deepwater moored platform motions. Investigations of various candidate platforms resulted in the semisubmersible concept being selected as the most suitable platform type, (Shields et al., 1983).

The SEASTAR (PMB Engineering, 1990) nonlinear structural finite element analysis program was selected to model the hydrodynamic loads and dynamic response of the deepwater TACTS semisubmersible/mooring system. SIMBAT was developed to meet the technical requirements for:

a. Wave force studies in random seas

b. Wave property input to the dynamic response simulation model, SEASTAR

c. Random directional seas representation for design applications

The preferred environmental data base for SEASTAR when used in design analyses consists of a number of actual ocean wave time series corresponding to major storms (i.e., 50, 75, 100 year storm) or other environmental scenarios of interest (i.e., those for fatigue analyses or operational sea states) at the sites of interest. Since these data are unavailable in most design projects, simulated ocean wave property data must be used.

Current procedures for simulating ocean wave properties are based on time domain superposition and filtering of Gaussian white noise. Substantial savings in simulation time and expenses can be realized if the discrete Fourier transform of the desired time histories of the wave properties are simulated directly in the frequency domain. The frequency domain simulation methods are ten to a hundred times faster than the time domain simulation techniques. In addition, the Fast Fourier Transform (FFT) can be used to revert the simulation to the time domain.

All simulation schemes are based on the introduction of random numbers. The engineer/ oceanographer/mathematician builds in the wave properties (design wave/wave grouping) to be preserved. If one has an actual sequence of ocean wave data and wishes to study the motion response associated with that particular sequence, available simulation procedures will not accommodate these data. Conditional simulations are necessary, with the randomness being restricted so as to produce ocean wave simulation data, conditioned on the wave having the required values. These required values may, for example, be a series of wave heights expected in a typical storm or other environmental scenario at the site. SIMBAT was developed to provide these conditioned simulations. Techniques of conditional simulation have been used in geological problems and are now applied to ocean wave applications. Conditional simulation of ocean wave properties has a wide application to Navy projects.

During the development of SIMBAT, the Legendre orthogonal polynomials (Hochstrasser, 1964) were added to SIMBAT to create three-dimensional wave properties over a large spatial region. The use of these polynomials along with the frequency domain method of creating the wave properties, was determined to provide a computationally much faster algorithm than computing the wave properties at all grid points over all time. This application utilizing Legendre polynomials is now considered one of the major benefits of SIMBAT, especially for compliant systems.

OVERVIEW OF SIMBAT MODEL AND SOFTWARE

SIMBAT is a computer model that calculates ocean wave properties, such as water particle kinematics for use in various ocean engineering applications. The model assumes the wave properties form a gaussian stochastic process. This means that all wave properties at any selected set of times and locations follow a multi-variate normal probability law. A thorough explanation of the model is provided in the SIMBAT theoretical manual (Borgman et al., ca. 1991).

The SIMBAT software can create the Ochi-Hubble, Pierson-Moskowitz, Bretschneider, JONSWAP, and Wallops spectral models or read in the user's own spectra, if desired. The waves may be directionally spread by either wrapped normal, cosine-squared, or Von Mises methods. There are options to stretch wave properties above mean water level using Rodenbusch-Forristall delta stretch, Reid-Wheeler stretch, truncation extrapolation, functional extrapolation, linear extrapolation, and gamma extrapolation.

SIMBAT has the option to perform a single simulation of wave properties at one or more locations in space using frequency domain methods directly or using the application of Legendre orthogonal polynomials. If the polynomials are used, a separate program, CKPOLY is used to create the wave properties from SIMBAT output. CKPOLY is separate to allow the user to embed the program in their structural analysis software.

For conditional simulation, the user can provide SIMBAT with a measured large wave profile, wave groups or any other wave properties that are representative of the environmental area of interest. SIMBAT will constrain the simulated wave properties to follow the measured data while also maintaining the statistical laws appropriate for ocean waves.

An example of a conditional simulation is shown in Figure 1. Here a bi-modal directional ocean spectra, containing swell and wind waves is used with a large measured storm wave. The simulation shows the large wave in the lower part of the figure that is used for simulation of extreme wave loading on an offshore structure.

The latest version of SIMBAT, Release 3.0, contains accuracy verification algorithms to compare kinematics from the different simulation methods in SIMBAT.

Finally, SIMBAT has the option to write ASCII output data files as it proceeds through the simulation so that the user may verify the integrity of the data. So if SIMBAT is executed in a multi-tasking, multi-window environment, the user can confirm the simulation is working properly on their computer throughout each level of the simulation.

GETTING STARTED

This section describes the media on which SIMBAT is delivered, computer requirements, and installation, and execution instructions.

There are four examples supplied with the software prepared for execution on the user's computer. Appendixes A through D provide a complete explanation for each example.

Though example problems are provided, the user should have an understanding of the theory behind the software as described in the SIMBAT Theoretical Manual (Borgman et al., ca. 1991) and the operation of SIMBAT as explained in the other sections of this manual.

The four example problems are meant to provide a way for the user to verify the SIMBAT program operates properly on the user's machine. They are also meant to provide some guidance in use of the software and present the underlying benefits of the SIMBAT model.

INSTALLATION AND EXECUTION

Software Distribution Media

The SIMBAT software is archived on one 1/4-inch, 60 MB cartridge tape formatted under UNIX SunOS4.0.3. "tar" format. SIMBAT source code and a reduced version of the example problems may be provided on several 5-1/4-inch or 3-1/2-inch MS-DOS formatted diskettes if required. The 1/4-inch tape version contains 60 MB of files to be loaded to the user's hard disk. The 5-1/4-inch diskette version does not contain reference output files and so the user can only verify that SIMBAT works properly by comparing output to the example output plots in the Appendixes of this manual. If the user has access to a medium performance workstation or high performance Intel 80386/80486 microprocessor based machine with 100 to 200 MB disk space available, the 1/4-inch tape version is recommended. Other types of media format may possibly be arranged by contacting the authors.

System Software and Hardware Requirements

SIMBAT and CKPOLY are FORTRAN F77 programs designed to operate on a medium performance engineering workstation, minicomputer, or high performance personal computer. A FORTRAN compiler is required. The demonstration example problems were prepared using a Sun Microsystems FORTRAN Version 1.2 compiler for Sun 4 SPARC based systems.

SIMBAT operates with the UNIX operating system or any other operating system such as MS-DOS, provided memory extenders are used and enough RAM exists.

Central Processing Unit (CPU) Requirements

SIMBAT is designed to operate on an engineering desktop workstation, minicomputer, or a high performance personal computer. The examples provided in Appendixes A through D were created using a Sun Microsystems 4/310 desktop server. This computer utilizes a scalable processor architecture (SPARC) microprocessor with performance specifications on the order of 16 million instructions per second (MIPS) and 2.6 double precision million floating point operations per second (DMFLOPS). On this computer, SIMBAT requires approximately 3 minutes to compile, and a 20-minute time history simulation takes about 5 to 10 minutes real time. Through the use of UNIX "make" command, the recompilation process is extremely fast. Theoretically, SIMBAT should execute satisfactorily on a high performance Intel 80386/80486 microprocessor based personal computer with a floating coprocessor chip that is recognized by the users FORTRAN compiler. This option has not been exercised at NCEL. If the user decides to use the Intel-based machine, the UNIX operation system or equivalent is recommended to allow full access of the computer memory and to take advantage of the multi-tasking environment.

Memory Requirements (RAM)

The minimum amount of memory required by SIMBAT depends on the length of the simulation, and the amount of wave properties to be simulated. NCEL produced the examples in Appendix A, B, C, and D using a Sun 4/310 computer with 16 MB random access memory (RAM) and 40 MB swap space. This means that SIMBAT and the graphics package MATLAB had access to 56 MB total virtual memory. Typically, SIMBAT is executed in a window based environment simultaneously with a graphics package such as MATLAB and so a significant amount of memory is required. The user should keep in mind SIMBAT does not have to have a graphics package to operate but it helps in checking the integrity of the input and output data. If a graphics package is unavailable, the SIMBAT files are in ASCII format and can be inspected. An Intel 80386/ 80486 microprocessor (or equivalent) based personal computer with 10 to 16 MB RAM operating under the UNIX operating system (or MS-DOS extender software) may be satisfactory for some of SIMBAT applications but a medium performance engineering workstation or minicomputer is recommended.

Storage Requirements (Hard Disk)

SIMBAT requires 20 MB to 100 MB of storage for typical applications. The examples in Appendixes A through D will require the user to have a storage capacity of 20 MB for Examples No. 1 and No. 2 and up to 100 MB for Examples No. 3 and No. 4. The storage requirements are set by the graphics output files and the Legendre coefficient data files. A hard disk with 200 to 300 MB of space or more is recommended so that comparisons can be made between executions. The SIMBAT source code itself is around 1 MB but output files from SIMBAT Option No. 6 and for graphics require the extra storage. If Option No. 6 is not used, output is small only on the order of 10 MB. Option No. 6 is needed when program CKPOLY is incorporated in the user's structural analysis program. Considering the low cost of storage media on today's market, the storage requirements are not considered unreasonable. The amount of savings in computation time greatly exceeds the price to be paid for storage.

Printers and Plotters

SIMBAT works best with a laser jet printer that operates with the PostScript protocol software. Screen dumps from the computer monitor to the printer are easily performed. Plotters will work fine with the appropriate graphics software. SIMBAT only provides the output data in ASCII format and does not provide the graphics drivers for the printers or plotters so in theory, any printer or plotter can accommodate the output.

Monitors

SIMBAT may be most appreciated on a large monitor (abount 17 to 19 inches in size) though any size monitor will suffice. The 17- to 19-inch monitor allows multiple windows so SIMBAT can be executed in one window while the graphics software is executed in another window. The graphics are not required to operate SIMBAT but it provides an aid in data input and output verification. SIMBAT operates on either a monochrome or color monitor.

Installation of SIMBAT and CKPOLY

The software may be obtained on either 1/4-inch 60 MB cartridge tape, 5-1/4-inch floppy diskettes, or 3-1/2-inch floppy diskettes from the authors at NCEL or the University of Wyoming. The 1/4-inch tape version is the recommended distribution media since it contains the output from example problems.

Installation of 1/4-Inch 60 MB UNIX Tape Cartridge Media

The file system structure for Example No. 1 is shown in Appendix A, Figure A-1. All four examples are structured similarly and reside on parallel branches. To unarchive the file system tree structure:

1. Check destination free disk space (60 MB is required)

2. Insert tape

3. Type: mkdir simbat

4. Type: cd simbat

5. Type: tar xvf /dev/rst0

6. Type: ls (there should be four directories for each demonstration problem)

7. Installation should be complete

Installation of 5-1/4 or 3-1/2-Inch Diskettes

Since this version only contains the source code, input files and batch files, the installation is straightforward but the tree structure must be created by hand. Type:

1. c:\(assumes "c" is destination hard drive)
2. mkdir simbat
3. cd simbat
4. mkdir case1
5. mkdir case2
6. mkdir case3
7. mkdir case4
8. mkdir source
9. copy a:*.* c:\simbat
10. copy a:\case2*.* c:\simbat\case1
11. copy a:\case2*.* c:\simbat\case2
12. copy a:\case3*.* c:\simbat\case3
13. copy a:\case4*.* c:\simbat\case4
14. copy a:\source*.* c:\simbat\source

EXECUTION OF SIMBAT AND CKPOLY

Execution for 1/4-Inch 60 MB Cartridge Tape Software

Execution of demonstration Example No. 1 is a good place to start. Figure A-1 shows the file structure for Example No. 1. The user should change directories to "case1" and read the files "INSTRUCTIONS" and "FILES." These files provide guidance to execute the example problems.

Execution for 5-1/4- or 3-1/2-Inch Floppy Diskette

The user must compile SIMBAT and CKPOLY first, utilizing FORTRAN compiler options that take advantage of hardware components such as floating point coprocessors, extended memory, and 32-bit word length. The Lahey F77L-EM/32 FORTRAN compiler may meet these requirements. The batch files and input files can then be used to execute SIMBAT. The user should refer to Appendixes A through D for details of the examples since this version does not contain the output files. The README file on the floppy disk explains how to use the files.

EXAMPLE NO. 1

This example problem demonstrates an unconditional simulation for a 5-minute time history. An Ochi-Hubble ocean wave spectra with wrapped-normal spreading is created. This spectra is used in SIMBAT to provide energy content to create wave properties, η, V_x, V_y, V_z, A_x, A_y, A_z, and P at a point located at X, Y, Z = 0, 0, - 25 feet below mean water line. Appendix A provides detailed instructions for execution.

EXAMPLE NO. 2

This example demonstrates a conditional simulation using one large measured input wave and the directional ocean wave spectra created by Example No. 1. The ocean wave is used to condition the wave properties about one wave cycle within a 5-minute simulation. Wave properties created include η, V_x, V_y, V_z, A_x, A_y, A_z located at a point in space of X, Y, Z = 10, 10, - 15 feet. Delta stretch is used for kinematics and a 5^{th} order polynomial fit is applied for generation of kinematics by CKPOLY. The user should refer to Appendix B for further details and execution instructions.

EXAMPLE NO. 3

This example demonstrates a conditional simulation using a measured input ocean wave record equal in length to the simulation. This example uses the directional ocean wave spectra from Example No. 1 to specify the wave energy. A 20-minute simulation is performed to create wave properties η, V_x, V_y, V_z, A_x, A_y, A_z, P at a point in space located at X, Y, Z = 0, 0, - 20 feet. Delta stretch is used and Legendre orthogonal polynomials coefficients are created with a 5^{th} order approximation. The user should refer to Appendix C for more indepth details and execution instructions.

EXAMPLE NO. 4

This example is similar to Example No. 3 except that the simulation is performed at a point in space X, Y, Z = 20, 20, 1 foot. This example is for 10-minute simulations and uses a 7^{th} order polynomial fit. Since the kinematics are calculated at a coordinate above the mean water line, the wave properties computed using the delta stretch will differ from those of functional extrapolation as shown in Appendix D. As the free surface elevation falls below Z = 1 foot, the program automatically sets the wave properties to zero. This can be seen in the plots of Appendix D. To execute this example, refer to Appendix D for complete instructions.

SIMBAT MODEL AND SOFTWARE

INTRODUCTION

The time series for water level elevations and kinematic properties of irregular ocean waves can be characterized either in time domain or in frequency domain. The time domain representation is very appealing intuitively. It is easy to understand and to use in computations. Unfortunately, it is very slow to calculate on a computer. It is mathematically convenient to represent irregular waves as a summation of sines and cosines. This "so called" Fourier decomposition of the irregular waves is easily expressed by listing the amplitudes of the sines and cosines as functions of the cycles per second, or frequency, of the various waves in the time series mixture.

Analysis of the waves in a Fourier decomposition can be expressed in various ways, in addition to the sine and cosine amplitude lists mentioned above. The waves can be expressed as a sum only of cosines, with each cosine having both a phase and an amplitude. In this frame of reference, the Fourier decomposition is specified by a list of cosine amplitudes and phases.

A less obvious, but more mathematically tractable, statement of the Fourier decomposition may be given in terms of complex variables. Here the irregular wave train is defined as a sum of complex amplitudes multiplied by a complex number of the form

$$\cos(2\pi ft) + i\sin(2\pi ft) = \exp(i2\pi ft) \qquad (1)$$

which is called a complex exponential. The letter "i" denotes the square root of -1.0.

The mathematical expression for this decomposition for a wave property denoted by p(x,y,z,t) is

$$p(x,y,z,t) = \sum_{m=0}^{N-1} A_m \exp(i2\pi mn/N) \qquad (2)$$

where: $n = 0,1,2 \ldots N-1$

A_m = Fourier amplitude

The major advantage of this representation is that the computation specified by Equation (2) can be calculated with great speed through an algorithm called the Fast Fourier Transform. The SIMBAT software package uses this algorithm, with suitable elaboration to incorporate sums of waves traveling different directions and the appropriate transfer functions to produce other wave properties besides the water level elevation.

The SIMBAT suite of software contains two FORTRAN F77 programs: SIMBAT and CKPOLY. SIMBAT is a menu driven program that simulates wave properties either conditionally or unconditionally depending on the options selected. A conditional simulation uses a measured or existing time series input to force the simulated wave properties to adhere to the input time series but also follow the laws of multivariate normal probability. An unconditional simulation uses a measured or created ocean spectra and randomly simulates ocean wave properties that also adhere to multivariate probability laws. CKPOLY is considered a post-processor program that is to be used as either a stand alone program or embedded in the user's own structural analysis program. CKPOLY is only required if the user requires simulation of wave properties at many locations in space at each time step.

The present version of SIMBAT and CKPOLY (Version 3) require the user to specify information in the source code PARAMETER and DATA statements. The user changes these statements to accommodate his or her application and then recompiles the program. Appendixes A through D contain example problems with some sample PARAMETER and DATA Statements. A description of the PARAMETER and DATA statements are explained thoroughly in the remaining chapters.

The user may wish to consider the use of software "make" commands. Using this command, the recompilation and linking process is reduced to include only the subroutines or object files that have been recently changed. Therefore, the new SIMBAT executable is reestablished very expeditiously.

SIMBAT OPTIONS AND FLOW OF SOFTWARE

When SIMBAT is executed, a main menu appears listing nine options (Figure 2). Option No. 1 creates or reads ocean wave spectral information and then produces the complex amplitude matrix, A_{mj}, where m is the frequency and j is the direction, for a user specified set of frequencies and directions. Option No. 1 is utilized for unconditional simulations. Option No. 2 is a preprocessor for a conditional simulation. This option can create directional spectra similar to Option No. 1. Option No. 2 is required before the user selects Options No. 3 or No. 4. Option No. 3 is selected if the user will be using an input conditioning time series where the length of the record, L, is less than the length of the simulation, N. On the other hand, Option No. 4 is selected if L = N. Once either Option No. 1 or Options No. 2 and then No. 3 or No. 4 are selected, then Options No. 5 and No. 6 are usually selected. Option No. 5 calculates time series for the desired wave properties utilizing the complex amplitude matrix, A_{mj}, created in Options No. 1, 3, and 4. Option No. 6 creates the Legendre orthogonal polynomials over a selected x, y, z spatial region and prints the coefficients to a file for use by Options No. 7 and 8, or post-processor, CKPOLY. Option No. 7 prints time series created by Options No. 5 or 6 at one point in space. Option No. 8 performs an accuracy analysis between wave properties created by frequency domain methods for linear wave theory and the method of Legendre polynomial fit. The flow of each of these options is shown in Figures 3, 4, 5, and 6.

As shown by the flow chart in Figure 4, the program returns to the basic menu after each option is completed. The user may exit from the menu or execute another option. If the user wishes to exit but keep some of the results for a later restart of the analysis, he or she can follow the prompts that appear on the screen when option number zero is executed. When the program is started up later, the screen will query the user for the file name in which the exit data was stored. This will be read in as an initial data set and the basic menu will appear for proceeding with further analysis.

The SIMBAT main program flow chart in Figure 3 shows the precedence requirements with arrows. Each option executed is assumed to have been preceded by a path of options leading down to it.

SIMBAT OPERATION AND EXECUTION

When the program is executed, a basic identifier title block appears, followed by several requests for choices and the main menu of program options. The main menu is returned to the screen after each task. The exit from the program is always made by selecting Option No. 0 from the main menu. The screen listing in this sequence of operations is shown in Figure 2.

Options No. 1, 2, and 5 are all contained in one group of computer code and will be discussed together relative to code layout. The others are each separate groups of code and will be discussed individually. Before each of these are examined, it is useful to consider the overall SIMBAT flow chart as given in Figure 4. This differs from Figure 3, which showed logical precedence and purpose, in that here flow of control in the computer code is specified. All commands are shown as originating from the basic menu. When each task is completed, the control returns to the main menu. The program is exited only from the main menu.

Options Nos. 1, 2, and 5

A flow chart for the computer code for this group of options is given in Figure 7. On entry to this option with either Option No. 1 or No. 2, the directional wave spectrum is either computed in subroutine DRSPEC, with menu requests to the user for the required parameters, or the directional spectrum matrix is read from a previously prepared file. If the user chooses to compute the directional spectrum at this point, the computer constructs the spectrum matrix (direction by frequency) as the summation of the products of a frequency spectrum and a spreading function. Each term in the sum is called a mode. There can be as many modes as desired. Each mode has its own peak frequency, dominant direction of travel, and variance, which are input by the user as queried from the menus. The peak frequency and dominant direction can be made to vary linearly with frequency.

Current spectra models available in SIMBAT Options No. 1 and No. 2 are the Ochi-Hubble, Pierson-Moskowitz, JONSWAP, Bretschneider, and Wallops. Wave spreading models supported in SIMBAT are the wrapped-normal, cosine-squared and Von-Mises. The user should refer to the section on Ocean Wave Spectra and Directional Spreading Models for details. Also, thorough explanations of each of these models are provided in the SIMBAT theoretical manual (Borgman et al., ca. 1991) and in the ocean engineering books (Chakrabarti, 1987 and Sarpkaya and Isaacson, 1981).

In the next program step for Options No. 1 or No. 2, in subroutines SIM and WAVSIM, the matrix of complex wavelet amplitudes (containing both real amplitude and phase) are computed from the directional spectrum matrix and a starting seed integer for the random number generation. A separate flow chart is given in Figure 8 for subroutine WAVSIM. WAVSIM interpolates from the directional spectrum matrix for each direction, the spectral values on a much finer increment than used in the directional spectrum table. This is controlled by the user with the time increment, DELT, the length of the time series, N, the first frequency of importance, MB (corresponding to frequency = (MB-1)*DF, where DF = 1.0/(N*DELT)), and the highest frequency of significance, ML (corresponding to frequency = (ML-1)*DF). The wavelet at each direction and frequency may be made to have deterministic amplitude consistent with the spectrum and random phase from the random numbers, or to have both a Rayleigh random amplitude and a random phase.

The complex-valued amplitude matrix produced at this point represents a conditional simulation of the frequency/direction mixture of waves represented by the directional spectrum. If the entry choice was No. 2, the program goes on to compute additional sets of values needed for subsequent conversion of the complex-valued amplitude matrix to make it into a conditional simulation. However, the program does not actually perform the conditional simulation here, but proceeds as a preprocessor.

Option No. 5 presumes that Option No. 1, or one of the option pairs, No. 2/No. 3 or No. 2/No. 4, has been previously run. Then the program, as guided by the selection of Option No. 5, proceeds to compute the time series specified by number of time series (NTS) in the parameter statements and data statements one through four. Graphical or numerical listings of the computed time series may be obtained by running Option No. 7 (the print option) subsequently.

Options No. 3 and No. 4

One or the other of these two options are used to produce a matrix of complex-valued wave amplitudes that are conditioned to agree with a pre-specified interval of wave kinematics time series provided by the user. Both of them presume that Option No. 2 (the preprocessor for this option) has previously been completed. Option No. 3 is used when the pre-specified time interval of data is a subset of the simulation time series interval, N*DELT. The other option, No. 4, is used when the pre-specified interval is of the same length as the pre-specified time interval of data to be conditioned on.

Both of the conditioning options really only force agreement with the pre-selected time interval for a band-pass filtered version of input wave kinematics. That is, the simulation process is restricted to operating only with frequencies within the interval, {(MB-1)*DF, (ML-1)*DF}. If the interval of pre-selected wave properties contain energy outside that frequency band, the simulation will be unable to include it and there will be disagreement between the time series interval being conditioned on and the conditional simulation produced. Probably the best procedure here would be to preprocess the pre-selected time interval of wave properties to eliminate all frequency content outside the specified band. This band-pass filtered version of the data being conditioned on really represents the time series that the conditional simulation is organized to agree with.

Option No. 4 generally gives better agreement with the wave properties being conditioned on than does Option No. 3. This arises because Option No. 3 uses a conjugate gradient procedure to invert the covariance matrix of the time series interval of wave properties being conditioned on. There are choices in the conjugate gradient technique controlling the iteration to an acceptable inverse which are set in subroutine CG. The user can read the comments in the source code header for that subroutine, and try other choices of error cutoff if the agreement appears not very good. If the time interval of the pre-selected wave properties is fairly small, say 20 or 30 time steps or less, the program automatically shifts to an exact matrix inversion subroutine entitled GINV (generalized inverse), which is based on a singular value decomposition.

Interestingly enough, Option No. 4, which conditions on a time interval of wave properties of the same length as the time series produced in the simulation, is more accurate because it proceeds with frequency domain techniques that operate on much smaller matrices independently at each frequency. The subroutine GINV can be used separately at each frequency with satisfactory results.

The user will have to do some experimentation to determine the best balances among all these various considerations. The conditional simulation technique in ocean wave analysis is very new and one has to develop an understanding as applications proceed. The technique is most decidedly not a "black box" software package where all contingencies are worked out and the user is protected against incomplete understanding of the background process. Rather, the technique is directed toward the intelligent user and engineer. We are all still learning about the choices and pitfalls of the methods, as additional applications are attacked. However, the effort appears worthwhile since the procedures offer ways to approach problems in ocean engineering that were not tractable before.

Option No. 3 computations are carried out within subroutine CSAMP1 as shown in Figures 9 and 10. Similarly, Option No. 4 calculations are coded into subroutine CSAMP2 as shown in Figures 11 and 12. Both subroutines give some definitions and descriptive material in their source code header. The user should examine that information, as well as the user manual discussions and the mathematical derivations in the theory report, which is a companion to this one.

Option No. 6

This option is only run after the matrix of complex-valued wave amplitudes have been computed with one of the three choices: No. 1, or Nos. 2/3, or Nos. 2/4. It provides a computer-effective way to approach the computation of wave properties at many thousands of loading points on a complex structure, without the requirement of major computer speed or memory. Once the output from Option No. 6 is obtained, the force computations can proceed on quite modest computer facilities. A 386-chip personal computer is adequate for the wave kinematics computations.

The flow charts for Option No. 6, together with flow charts for the two computational subcomponents, POLYEX and POLYEX BOX A, are given in Figures 13, 14, and 15, respectively. In combination, these produce the output of Option No. 6. In addition, the flow chart for the subsidiary program, CKPOLY, is also listed in Figure 16. CKPOLY is a short program that can be inserted into the user's own wave force analysis program to process the Option No. 6 output to produce the water level elevation, the three components of velocity and acceleration, and the dynamic pressure anomaly at the loading points in the structure under study.

Option No. 6 computer code guides the calculation of Legendre orthogonal polynomial coefficients for the representation of the sea surface elevation, the pressure anomaly, and the three components of velocity and acceleration within a rectangular box given by (X0-D1,X0+D1), (Y0-D2,Y0+D2), and (-Depth, sea surface). D1 and D2 are X and Y distances from the origin for the area over which kinematics are desired. The program uses regular Legendre expansion in the (x,y) directions in terms of the variables, u = (X-X0)/D1 and v = (Y-Y0)/D2, both of which vary from -1 to +1. A shifted Legendre expansion, in terms of w = exp(WN*Z), is used vertically. Here, w, varies from 0 to 1 as WN*Z ranges from minus infinity to zero. An additional term is introduced in shallow water to allow for the other exponential in the appropriate hyperbolic functions. The user should refer to the theory report for a discussion of how this works.

Option No. 6 code uses frequency domain procedures to compute the three-dimensional Legendre coefficients, and then, at each time step, sorts the coefficients for each wave property. The larger coefficients are stored in a way so that the post-processor CKPOLY can develop the corresponding Legendre polynomials in a computer-efficient way, and calculate the sum of the coefficients times the polynomials to get each of the wave kinematics and properties. The magnitude of the coefficients, which are kept in the list, is controlled by an integer ISMALL. ISMALL is defined as 1,000,000 times the smallest coefficient value believed to be important. Thus, if an accuracy of 0.01 is desired, ISMALL should be set to 10,000. This happens to be the current setting in SIMBAT. This is set in SIMBAT itself and so SIMBAT must be recompiled for this.

The approximation of numerical functions with orthogonal polynomials involves a certain skill in setting parameters and other values to get adequate accuracy. Option No. 6 allows polynomials of order up to six, although the higher orders should not be used without substantial care. It is easy for very high order polynomials to develop spurious oscillations that have little relation to the function being fitted. Also, there is an interplay between the radii of the horizontal rectangle, D1 and D2, the order of the polynomials used, and the cut off frequency of the directional spectrum. If an attempt is made to represent the oscillations of waves with short wave lengths in a large area, there will be many maxima and minima in every direction, and only a very high order polynomial will even have a chance of giving a reasonable approximation.

Ideally, the region, (X0-D1,X0+D1) and (Y0-D2,Y0+D2), will not contain more than three wave lengths of the shortest waves giving some significant effect on the structure. Then a polynomial order of, perhaps six or seven, should prove adequate. A number of accuracy and error-checking graphical techniques have been combined into Option No. 8 to aid in the investigation of adequacy of any particular choices of ISMALL, D1, D2, order, and cut off frequency. More procedures along this line are still being developed. There is no substitute for careful engineering judgment and prudence here. Each application will introduce new requirements and considerations. However, these same statements can be made about almost any engineering design problem. The trade off for the necessity for care and understanding lies in the reduction of many problems that were impossible to treat or required major computing facilities, to procedures that can be computed on modest computer equipment or personal computers.

Option No. 6, and its post-processor, CKPOLY, are the only parts of the SIMBAT software, which incorporate several types of stretching. The same stretching option must be specified, both in running Option No. 6 to get the Legendre coefficients and in CKPOLY to produce the wave properties. To change stretching parameters, it is necessary to repeat Option No. 6 computations. Refer to the section on Water Particle Kinematic Stretching Techniques for a discussion on use of the stretching techniques.

Option No. 7

No flow chart is shown for this since it is just an output option to print onto the file SIMBAT.OUT for various time series in the program.

Option No. 8

This is a software package of menu-driven error-checking procedures. Each is relatively simple and the user is referred to the computer code for more details.

Option No. 9

The present program is still in a testing and development phase and is inactive. Eventually, Option No. 9 will contain "help" comments on running the program. Current users are invited to keep a list of topics that might be included here when this option is made active.

OCEAN WAVE SPECTRA AND DIRECTIONAL SPREADING MODELS

Current spectra models available in SIMBAT are the Ochi-Hubble, Pierson-Moskowitz, JONSWAP, and Bretschneider, and Wallops. Wave spreading models supported in SIMBAT are the wrapped-normal, cosine-squared, and Von-Mises. Thorough explanations of each of these models are provided in the SIMBAT Theoretical Manual (Borgman et al., ca. 1991) and in the ocean engineering books (Chakrabarti, 1987 and Sarpkaya and Isaacson, 1981).

WATER PARTICLE KINEMATIC STRETCHING TECHNIQUES

A major problem with using superposition of linear wave theory for complex directional seas is that, fundamentally, linear wave theory is not supposed to be used above mean water level. Yet, that is where the wave forces on the structure are the most important. Ideally, there would be a nonlinear directional wave theory for such problems. However, linear theory is so easy to use and compute with, and appears to be amazingly robust for wave conditions deviating greatly from the assumptions embodied in the derivation of the linear theory, that various "ad hoc" adjustments have been developed that allow the linear theory to work reasonably well for computations above mean water level. These techniques may be grouped under the heading of "stretching" methods.

There are six types of stretching now incorporated into the software. These are: (1) functional extrapolation, (2) truncation, (3) linear extrapolation, (4) vertical stretching, (5) delta stretching, and (6) gamma stretching. A theoretical description of these techniques is provided in the SIMBAT Theoretical Manual (Borgman et al., ca. 1991), but a brief description is outlined here.

Stretching is basically an "ad hoc," or approximate way to adjust linear wave theory to make it do fairly well for mixed wave surface of finite amplitude. The assumptions in linear wave theory make it really only applicable for z-values between the sea floor and the mean water level. How then does one compute the velocities at the crest of a wave which is 30 feet above mean water level? The most simple approach is just to use the mathematical formulas from linear wave theory, and substitute in $z = 30.0$. This is a functional extrapolation of the wave properties far above the z-interval where they were derived and leads to a substantial overestimation at the wave crest. Another simple concept is just to take the kinematics at mean water level and apply them in a constant way to all elevations above mean water level. This is the truncation choice above. Some other suggestions that have been made are to take the value and rate of increase in the wave property at mean water level and linearly extend it on a straight line determined by that value and slope up to the free water surface. This is the linear extrapolation in the above choices.

All of these "simple" choices do not appear to do a very good job of representing the wave properties above mean water level. Of course, there may be applications that are not particularly sensitive to the above mean water behavior for which these approximations are satisfactory. However, several more elaborate stretching procedures have been studied to try to achieve a better fit to observed data. The main formulas for this are the delta stretch and a special case of the delta stretch called Reid-Wheeler stretching. The Reid-Wheeler stretch historically preceded the delta stretch and has been part of the "common knowledge" in ocean engineering for many years. This is sometimes just called the Wheeler stretch, since Wheeler used it previously in a study. However, prior to that publication, Reid (and possibly others) had also applied it in approximate engineering adjustments of linear wave theory. More recently, the parameterized family of stretch procedures, called the delta stretch, was developed by Rodenbusch-Forristall by generalizing the Reid-Wheeler stretch procedure. Linear extrapolation is also a special case of the delta stretch.

All of the stretching procedures are applied to the combined wave properties obtained by the summation of all the wavelets for all frequencies and travel directions. It is not applied to each separate component. Needless to say, all of the stretching methods have their flaws and are "band aids" on a linear theory to reduce the error for waves of finite amplitude.

The SIMBAT software allows for stretching in Option No. 6 in the production of the Legendre polynomials, in the post processor CKPOLY which converts the coefficients to time domain wave kinematics, and in Option No. 8, which compares the accuracy of the polynomial expansions and the linear wave theory for selected short time intervals. The stretching method selected within Option No. 6 of SIMBAT must be the same as that used in CKPOLY, or inconsistent results will be obtained.

Similarly, the comparisons made in the error checking Option No. 8 of SIMBAT are forced by the program to be the same as that selected in Option No. 6 in preparing the coefficients.

The full theory underlying the methods is presented in the SIMBAT Theoretical Manual (Borgman et al., ca. 1991).

COMPARISONS OF POLYNOMIAL APPROXIMATION AND LINEAR WAVE THEORY

Option No. 8 performs accuracy checking tabulations as guided by the user. For relatively short time intervals, the computations equivalent to the frequency calculations of SIMBAT are performed in the time domain, along a specified spatial line or on a specified spatial plane at each time step. The wave properties by both the direct linear wave theory and by the approximation with Legendre orthogonal polynomial are computed and tabled in files for examination or display with graphics packages.

Both the theoretical directional spectra operated on with Options No. 1 and No. 2, and the corresponding simulation spectra implied by the amplitude set produced by Option No. 1, No. 3, or No. 4 can also be stored in files for examination and comparison with graphics software. Since the simulation spectra are independent from frequency to frequency and angle to angle, it is much more "spiky" and jagged looking than the theory spectra that produced it. Each spectral line is an independent, chi-squared random variable with mean square equal to the theory directional spectra. However, the gross shape of the two can be compared, or a smoothing of the simulation similar to that used in estimating the theory spectra can be imposed to introduce greater comparability.

OUTPUT FILES FOR GRAPHICS

Currently, three types of data sets are output from SIMBAT for graphical display. These are theoretical and simulated directional spectra and related functions, both given and simulated time series, and comparison data sets along lines and over planes for kinematics from both linear wave theory and the polynomial expansion approach. Specifically, the output is formatted to be directly displayable with a software package called MATLAB. Although this software is primarily designed to operate with matrices and signal processing, it has a satisfactory exploratory graphics capability. It is also very portable, with versions available for DOS, Apple, VAX, Sun, and others. For these reasons, it was selected as the standard for patterning the graphic files. However, the files can easily be modified to other formats with an editor. MATLAB also allows the SIMBAT software to run in one window of a windows environment, while MATLAB is invoked in the other window to examine output, without terminating the SIMBAT run. This is an efficient way to interact with the computations and the output they produce.

MATLAB m-file programs have been written as adjunct programs to the SIMBAT software to facilitate the graphics display. These are provided along with SIMBAT for the user to modify specific to their needs. However, the graphics output files can easily be converted for running with other graphics packages by the user if so desired by changing the FORMAT statements in SIMBAT or using a word editor and removing extra syntax.

TYPES OF SIMULATIONS

The preparation of general simulations (which will be referred to here as unconditional simulations) or of conditional simulations in a form useful for calculations of forces on compliant structures poses special problems. If these are computed in the time domain, which allows "easy tracking" of the structure movement, the extreme slowness of the computations makes the treatment of most structures with a reasonable number of component waves (say two or three hundred) very expensive in terms of computer costs and time. If computations are performed in the frequency domain, simulation procedures are then normally based on a fixed space grid. Although the calculations on a large three-dimensional space grid can be carried out for each grid point very rapidly, the large number of grid points required to cover all positions of a moving structure also requires substantial computer time. In addition, there is a requirement for massive memory to store all the time series for all kinematics of importance at all grid points so that they are all available when a loading point on the structure requires interpolation within that grid cell.

The SIMBAT software handles this difficulty by fitting the desired wave kinematics with Legendre orthogonal polynomials (Hochstrasser, 1964) over a selected "box" of (x, y, z) spatial region. This can be done with frequency domain computations simultaneously for all time steps. The coefficients are screened for size, eliminating the smaller inconsequential coefficients, and the remaining coefficients are stored on a computer file so that the Legendre coefficients at each time step can be read and used for all space positions or loading points at that time step. Then the next set is read and used for the next time step.

The post-processor program CKPOLY is provided that can be embedded into the user's structural analysis program to quickly convert the Legendre polynomial coefficients to the desired component of velocity or acceleration, the wave water level elevation, or the dynamic pressure deviation from static mean water level pressure. Thus, the file of coefficients, together with CKPOLY, provides an easy way to transfer simulations from SIMBAT into the calculations for marine structures.

GENERAL COMMENTS

A major software package such as this one is subject to software "bugs" for some time after completion. Although every attempt has been made to check for and fix them, it is recognized that problems may arise; hopefully they will be small. Also, further graphical and numerical comparison procedures to calibrate the accuracy of the techniques are now implemented as Option No. 8 in the software. As the package is used, more knowledge of the behavior of the procedures will be gained and further improvements to the software can be introduced.

DESCRIPTION OF SOFTWARE PARAMETER AND DATA STATEMENTS

All array dimensioning and basic data governing the program are controlled by the PARAMETER and DATA statements at the beginning of the main program. Reasonably complete definitions of the parameter variables are given in comment lines within the FORTRAN code.

A few comments may help in understanding these variables.

FIRST PARAMETER STATEMENT

The first parameter statement (Figure 17) gives the length of the time series to be simulated, N, and the number of time series to be simulated, NTS. NTS must be between 1 and 8, where 8 would be Vx, Vy, Vz, Ax, Ay, Az, and P, but could all be Vx at different locations in space specified in the DATA statement. In addition, it gives various defining integers for the directional spectra on which the simulations will be based. Many meteorological wave hindcast procedures predict the wave variance in a table whose rows are the various frequencies, and whose columns are the directions of wave travel. A common size is, perhaps, 30 frequencies and 24 angles. In the parameter statement, NF gives the number of frequencies or rows in the table, and NT gives the number of angles or theta values. In the example, there are 33 frequencies and 24 angles. The frequencies do not have to be equally spaced. The list of frequencies to be used by SIMBAT is specified later in the DATA statement. The angles are taken to be equally distributed around the circle.

The actual frequencies used by SIMBAT are much more numerous than those given in the NF by NT table. The frequency increment used in the Fourier decomposition depends on N and the time increment, DELT, given in the fifth parameter statement. The frequency analysis increment is taken to be DF = 1.0/(N*DELT). This is much finer than the increments in the NF by NT table. The SIMBAT software either reads the meteorological table from user input, or computes such a table from interactive menu queries answered by the user. Then the program interpolates to the required higher resolution. The fast Fourier transform operates on a vector of values indexed to M = 1,2,3,...,N, within the computer. Thus, M = 1 corresponds to zero frequency. M = 2 corresponds to frequency DF, M = 3 corresponds to frequency 2*DF, and so forth. Ordinarily, the energetic frequencies in the directional spectra lie between frequency bounds both below and above. In SIMBAT, these bounds are taken to be (MB - 1)*DF for the lower cutoff and (ML - 1)*DF for the upper cutoff. The total number of spectral lines at increment DF is denoted by NUMM = ML - MB+1. The values of MB, ML, and NUMM are specified in the first parameter statement.

SECOND PARAMETER STATEMENT

The second parameter statement (Figure 18) defines the number, NCTS, of input time series to be conditioned on in producing the simulations.

It is assumed that these time series are over the same time interval. A second variable included in the second parameter statement for a dimension statement later is just NCTS2 = 2*NCTS. The maximum lag in the covariance function associated with the wave frequency spectrum is entered also here as MXLAG. The covariance is assumed to be zero if the lag is greater than MXLAG. This can be specified larger than the actual die-off point since it is just here for the SIMBAT Option No. 3, which has to perform part of its computations with the covariance function in the lag domain, rather than the frequency domain. The other conditioning option, No. 4, is able to do all its computations in the frequency domain, so the interesting behavior occurs that one can work with a much longer interval (i.e., the whole interval of length, N) in Option No. 4 in much faster and more accurate computations than with substantially shorter intervals in Option No. 3. A technical dimensioning constant defined as MAXX = maximum of (NUMM, MXLAG+1) is also defined here.

THIRD PARAMETER STATEMENT

Various other dimensioning constants are defined in the third parameter statement (Figure 19), mostly in terms of previously defined quantities.

FOURTH PARAMETER STATEMENT

The fourth parameter statement (Figure 20) is related to various choices that must be made concerning the order of the Legendre orthogonal polynomials that must be used to get the desired level of accuracy in the polynomial approximation of the linear wave properties. This is probably the most confusing parameter set for the user since there are no clear cut obvious choices. The values to be picked here depend on the size of the region in x, y space that is to be represented by the polynomials and the degree of smoothness of the wave surface. Many structures only respond to the longer waves and do not "see" the shorter waves. Consequently, sometimes one can ignore the high frequency waves even if they are present, and just fit the lower frequency wave portion of the variance with the polynomials. In practice, quite a bit of experimentation by the user is required before good choices can be defined. Legendre polynomials up to order 12 are available within the code. However, it is not good to just use a large value, because some polynomial representations degenerate and get worse with too high an order. Fairly good results have been obtained with orders around six or so but as demonstrated in Appendix A, only polynomial orders of 2 or 3 are necessary in some cases. However, the user will probably have to work some with the SIMBAT Option No. 8, which is specifically designed to compare direct linear theory with various choices of Legendre polynomial order for the wave spectra of interest and the rectangle of expansion in the x, y plane desired.

All the terms in the fourth parameter statement are related to the maximum polynomial order in the z direction, MORDZ, and the maximum order of the polynomials in the x, y direction, MORDXY. The other quantities are computable from these two by the formulas given in comment lines. The size of the rectangle for the expansion in the x, y plane is given to the program by the user interactively from menu queries in running Option No. 8.

FIFTH PARAMETER STATEMENT

The fifth parameter statement (Figure 21) defines the time slice for the time series, DELT, the water depth, D, the water density, RHO, and the acceleration of gravity, G. Input for G and RHO are required depending on whether the units are SI or English.

SIXTH PARAMETER STATEMENT

The sixth parameter statement defines the technical conventions of the coordinate system used. A fairly complete discussion is stated in the comment lines as shown in Figure 22.

SEVENTH PARAMETER STATEMENT

The seventh parameter statement (Figure 23) gives the resolution of comparison for Option No. 8. Wave properties are computed for linear wave theory and the polynomial approximation, either along a vertical line, along an arbitrary line, on a vertical plane, or on an arbitrarily oriented plane. These are done at a maximum number of divisions plus one of MDIVP1 along each direction in line or plane, and at a maximum number of time steps of MSTP. It is important to keep these relatively small since the time domain computations with linear wave theory are very slow. The computations with the Legendre polynomials are, however, very fast. The limit here is relative to the linear wave theory computations.

DATA STATEMENTS

The data statements (Figures 24 and 25) specify the list of frequencies to be used in the NF by NT table of directional spectra values, as well as details concerning the time series to be simulated and the time series to be conditioned on. These details include the (x, y, z) coordinates of the simulation set and the given conditioning set of time series. Note these are the same but they are not required to be the same coordinate. Also, an integer code set is given to specify the type of wave property each series is.

SUMMARY

This document provides guidance on using the SIMBAT suite of software. The software provides a fast, economical, and accurate method for computing water wave properties used in ocean engineering applications.

The examples provided in Appendixes A through D are provided in software format along with SIMBAT. We suggest the user test these examples to verify SIMBAT operates correctly on the user's machine.

This is a public domain software package. It has been developed largely in an academic environment, with major funding from the Minerals Management Service and the Naval Civil Engineering Laboratory. Many of the subroutines grew out of diverse applications funded by the EPA, various oil companies, the Army Corps of Engineers Coastal Engineering Research Center, and others in studies at the University of Wyoming, Laramie, Wyoming.

The principal author, L.E. Borgman, is responsible for the creation of SIMBAT and it is hoped the software will be beneficial and cost effective for ocean engineering applications.

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NOMENCLATURE

η free surface elevation

V_x velocity in X direction

V_y velocity in Y direction

V_z velocity in Z direction

A_x acceleration in X direction

A_y acceleration in Y direction

A_z acceleration in Z direction

P pressure

f frequency

t time

m frequency counter

j direction counter

i $\sqrt{-1}$

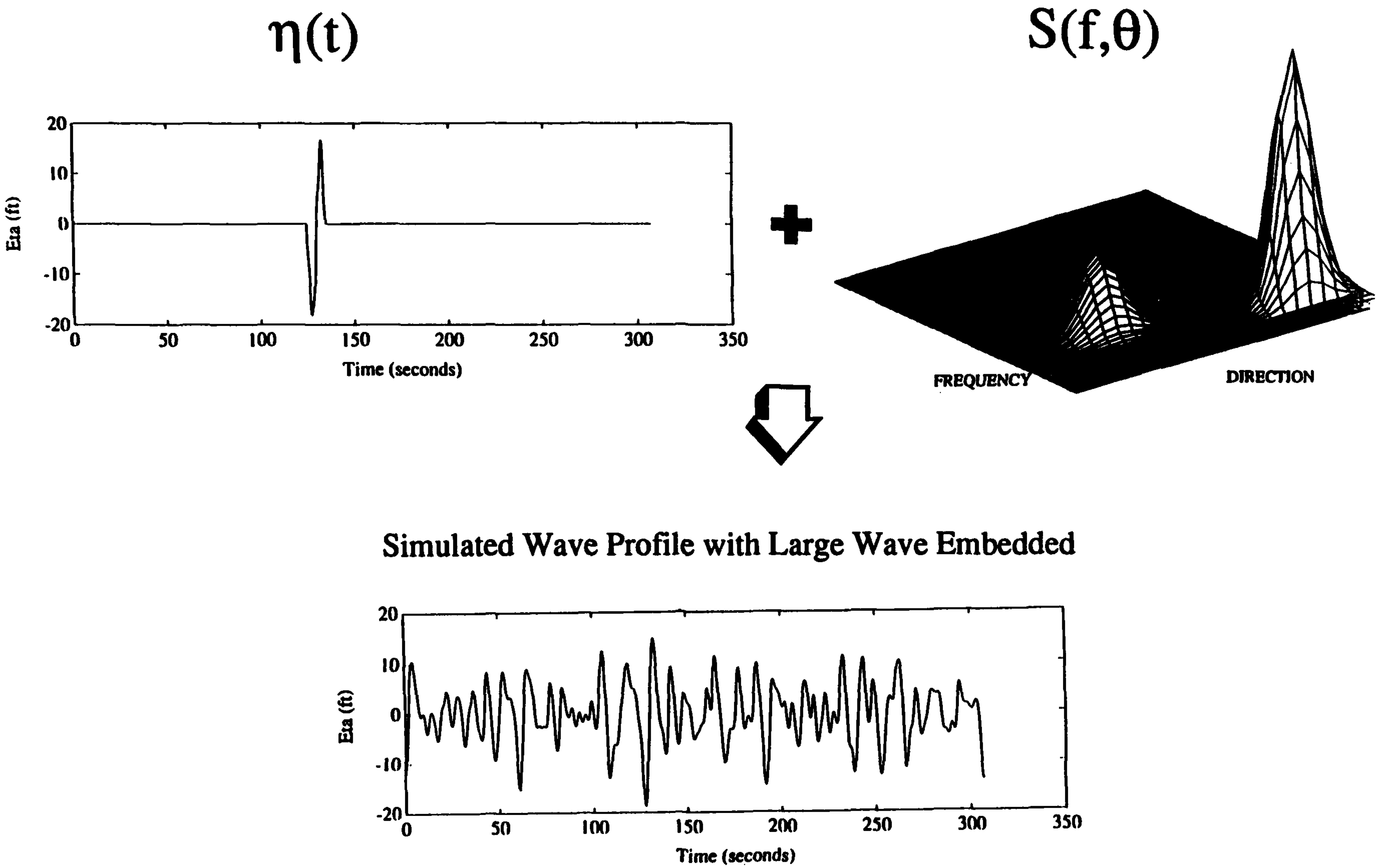

Figure 1.
Conditional simulation using one large storm wave and
and a bi-modal Ochi-Hubble directional wave spectra.

```
-------------------------------------------------------------
****************************************************** ******
 PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
 METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
  SIMULATIONS.
  (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

 PLEASE KEY RETURN TO CONTINUE
*********************************************************

DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
(Y = YES, N = NO)

***********************************************
 ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
-----------------------------------------------

***********************************************
 ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
  DOCUMENTATION FOR FUTURE REFERENCE.
--------------------------------------------------

 *************************************************
 OPTIONS ACTIVE ON THIS PROGRAM:
 0. EXIT PROGRAM
 1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
 2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
 3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
 4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
 5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
 6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
 7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
 8. ERROR CHECKING PROGRAM
 9. HELP
***********************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)

 DO YOU WANT TO SAVE THE OUTPUT FROM LAST OPTION
  Y OR N
-----------------------------------------------------------
```

Figure 2.
Initial screen listing and basic menu.

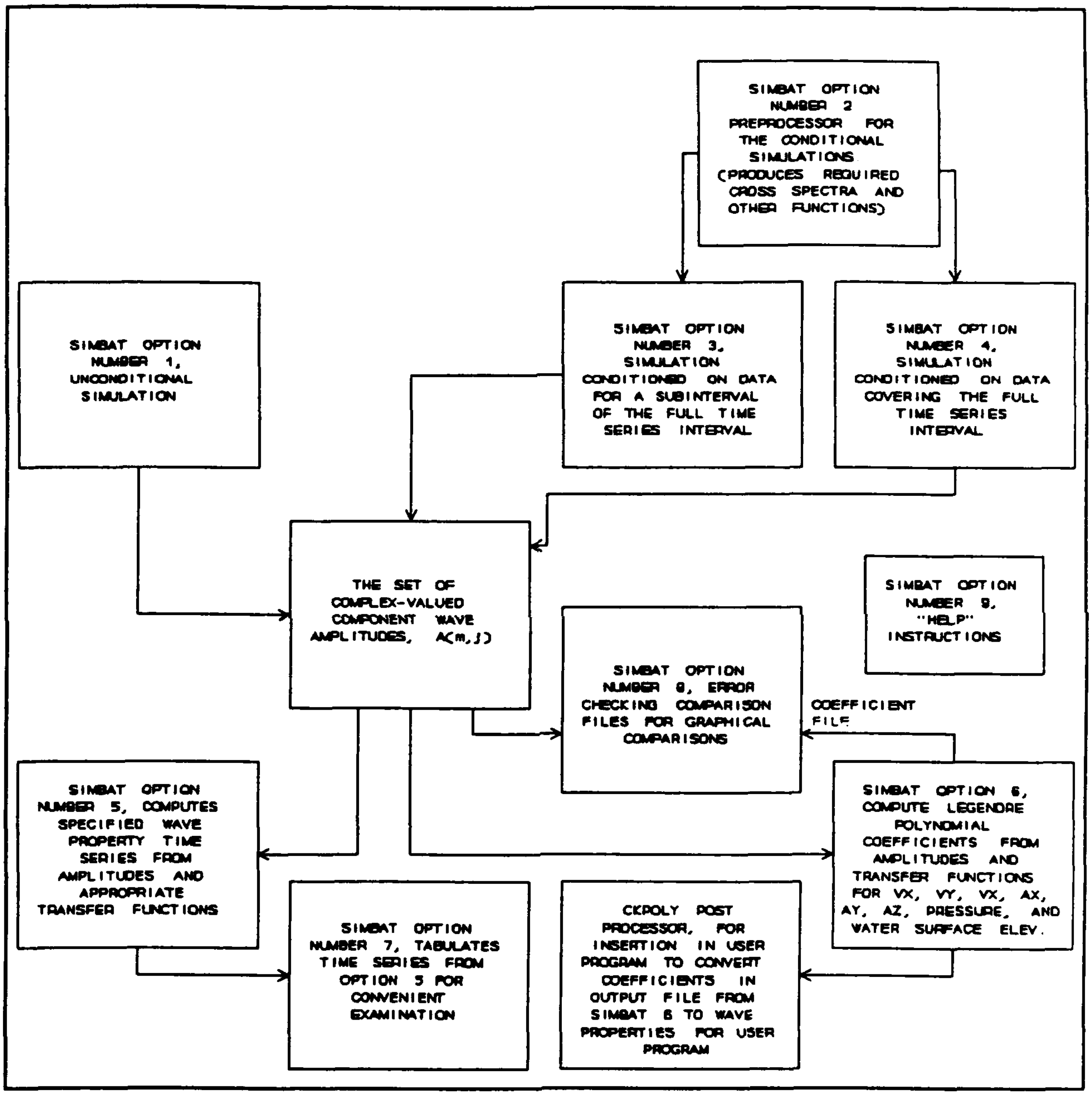

Figure 3.
General program structure.

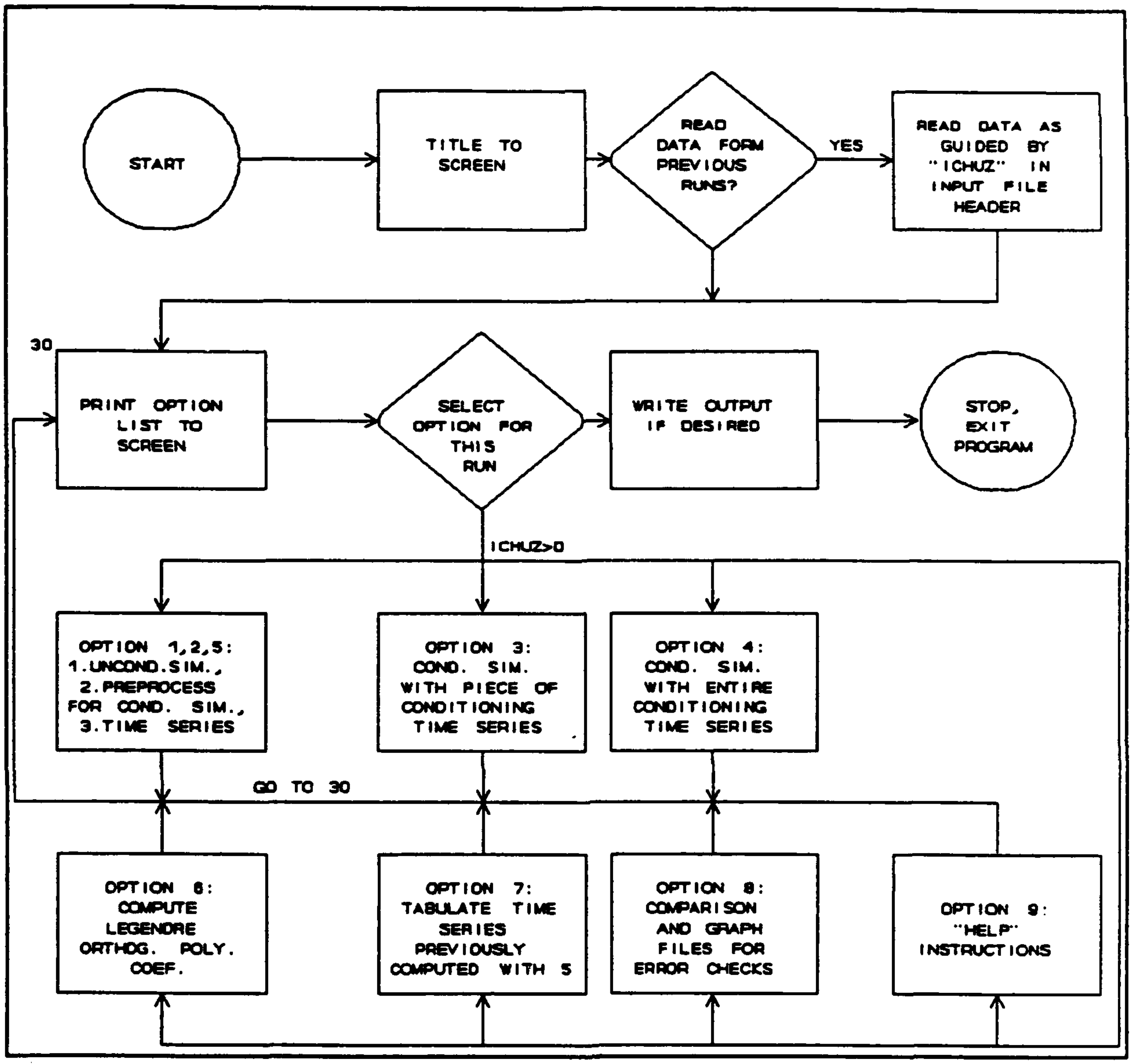

Figure 4.
Flow of control in SIMBAT.

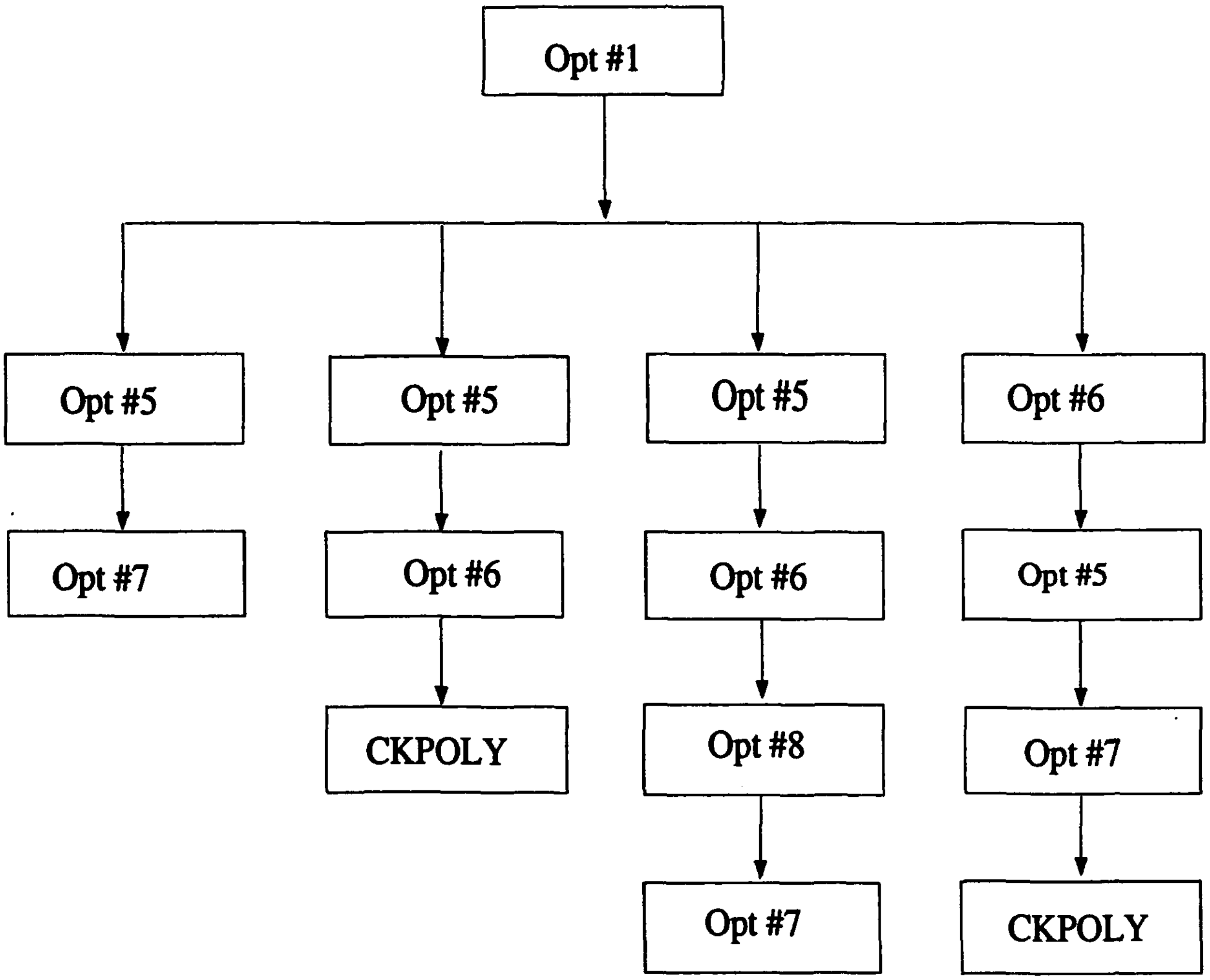

Figure 5.
Sample possible unconditional simulation options.

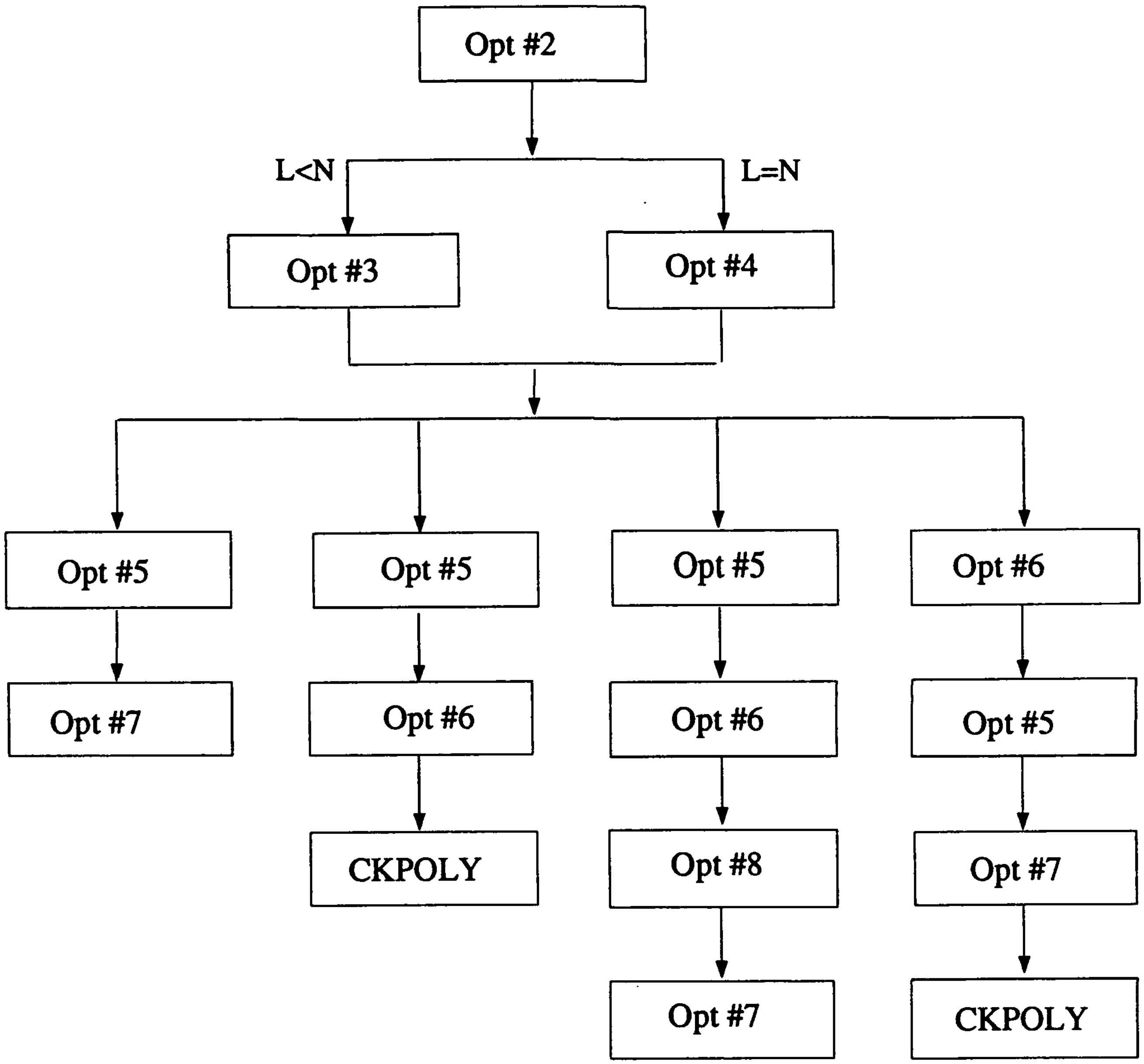

Figure 6.
Some possible conditional simulation options.

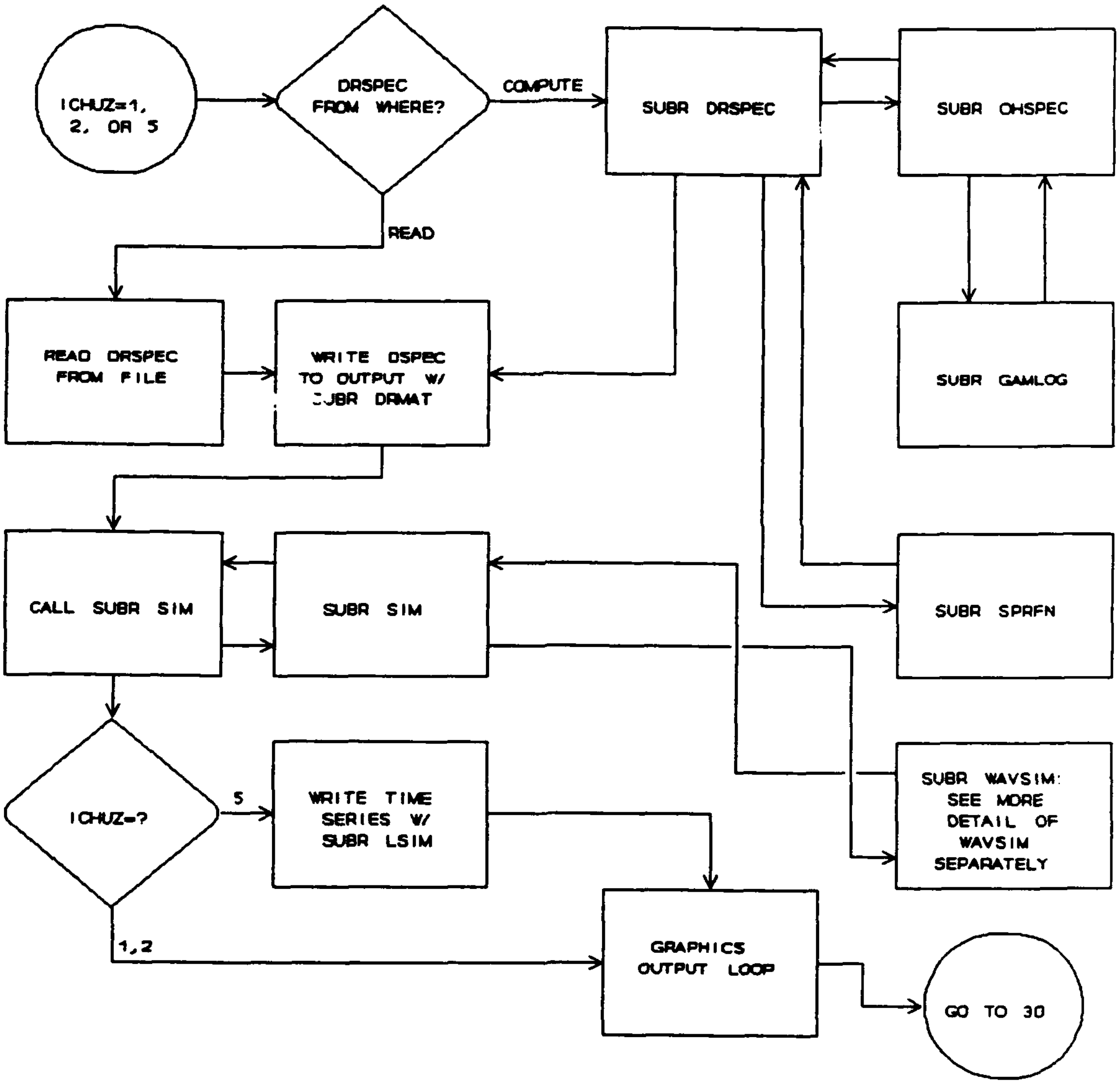

Figure 7.
Flow chart for SIMBAT Option Nos. 1, 2, and 5.

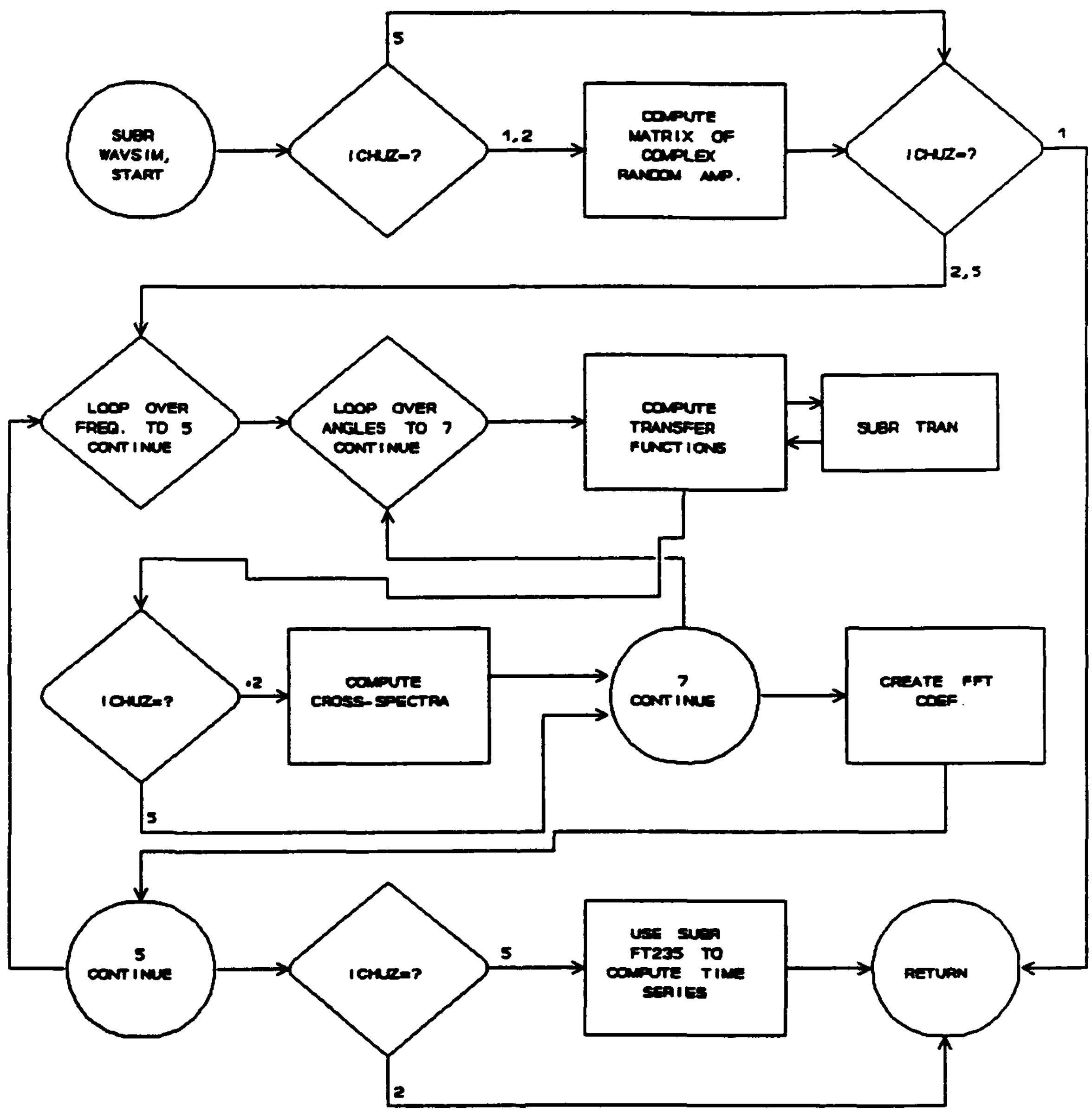

Figure 8.
Flow chart for Subroutine WAVSIM.

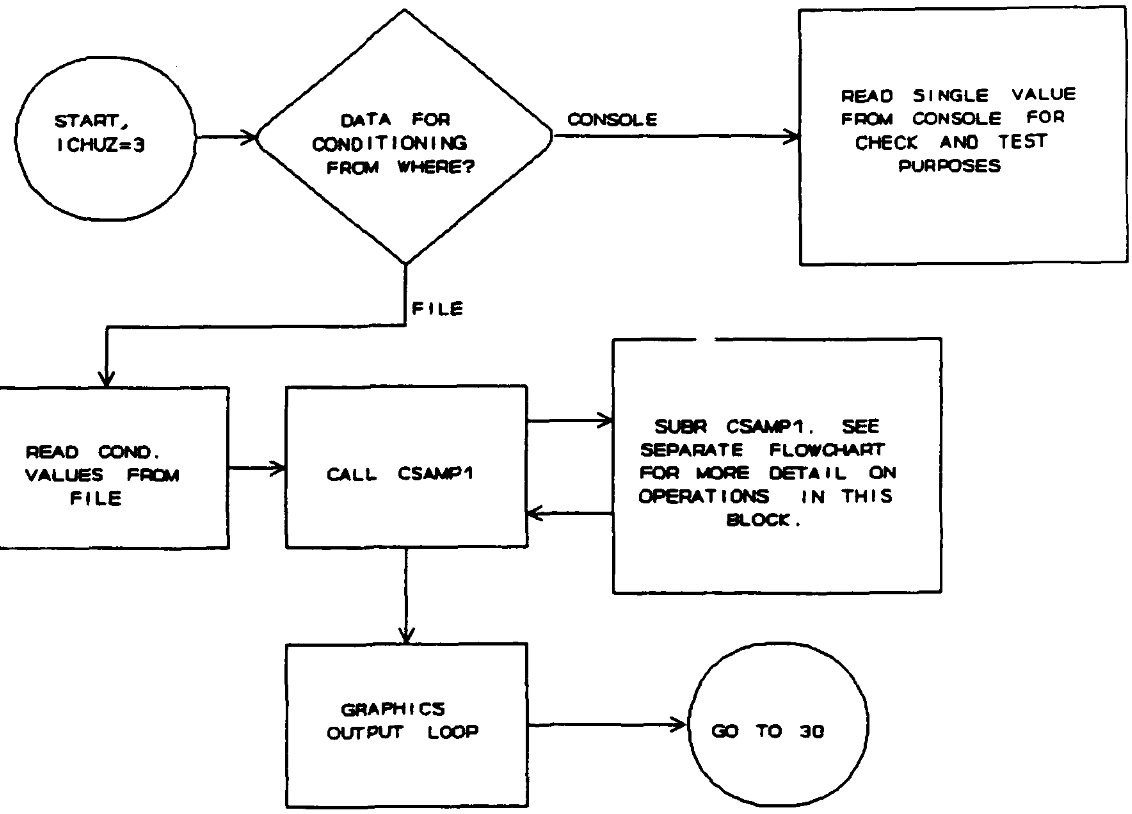

Figure 9.
Flow chart for SIMBAT Option No. 3.

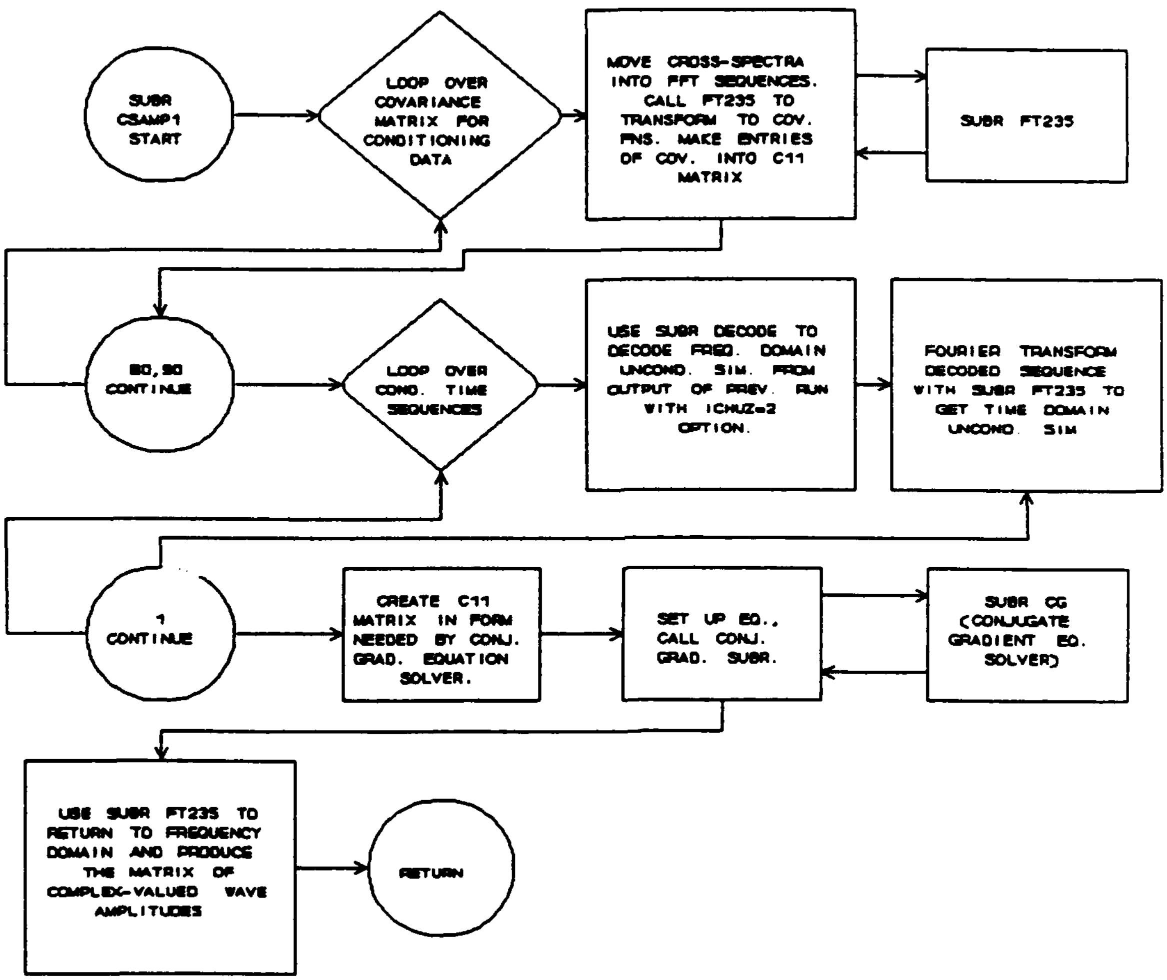

Figure 10.
Flow chart for Subroutine CSAMP1.

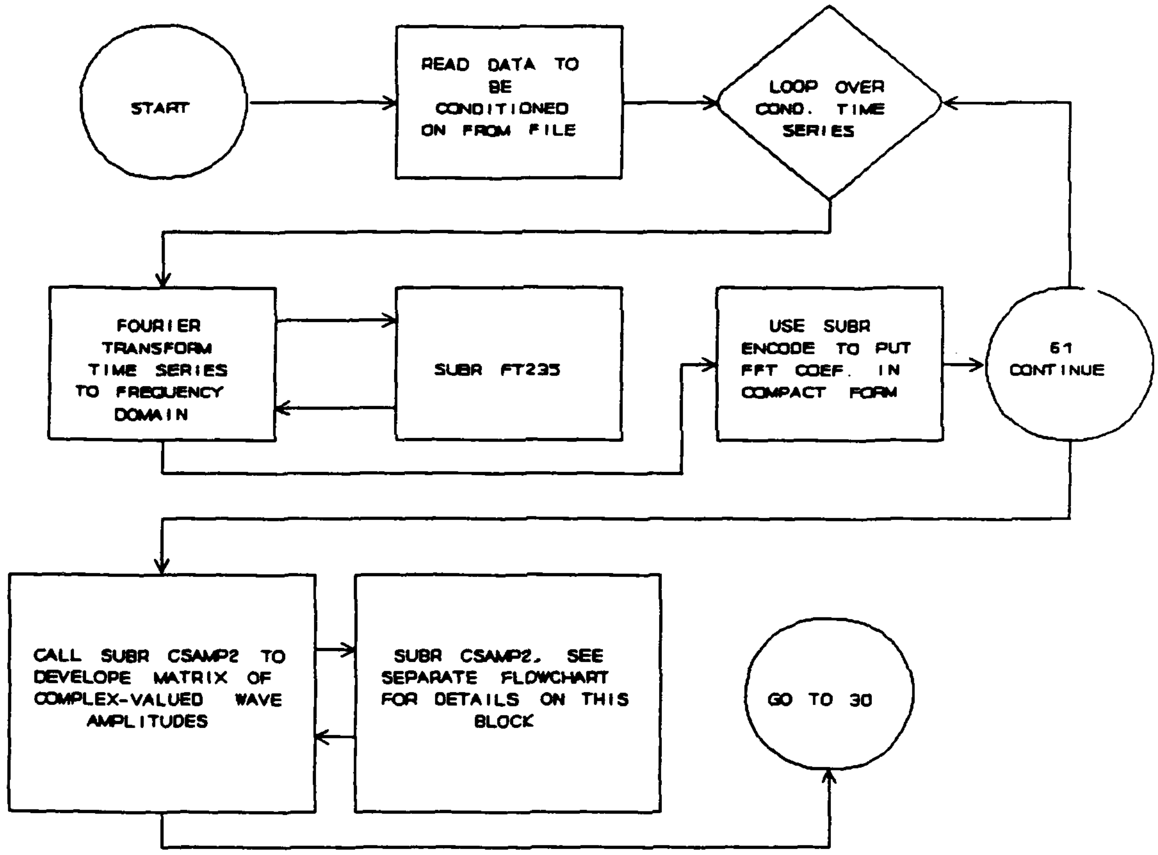

Figure 11.
Flow chart for SIMBAT Option No. 4.

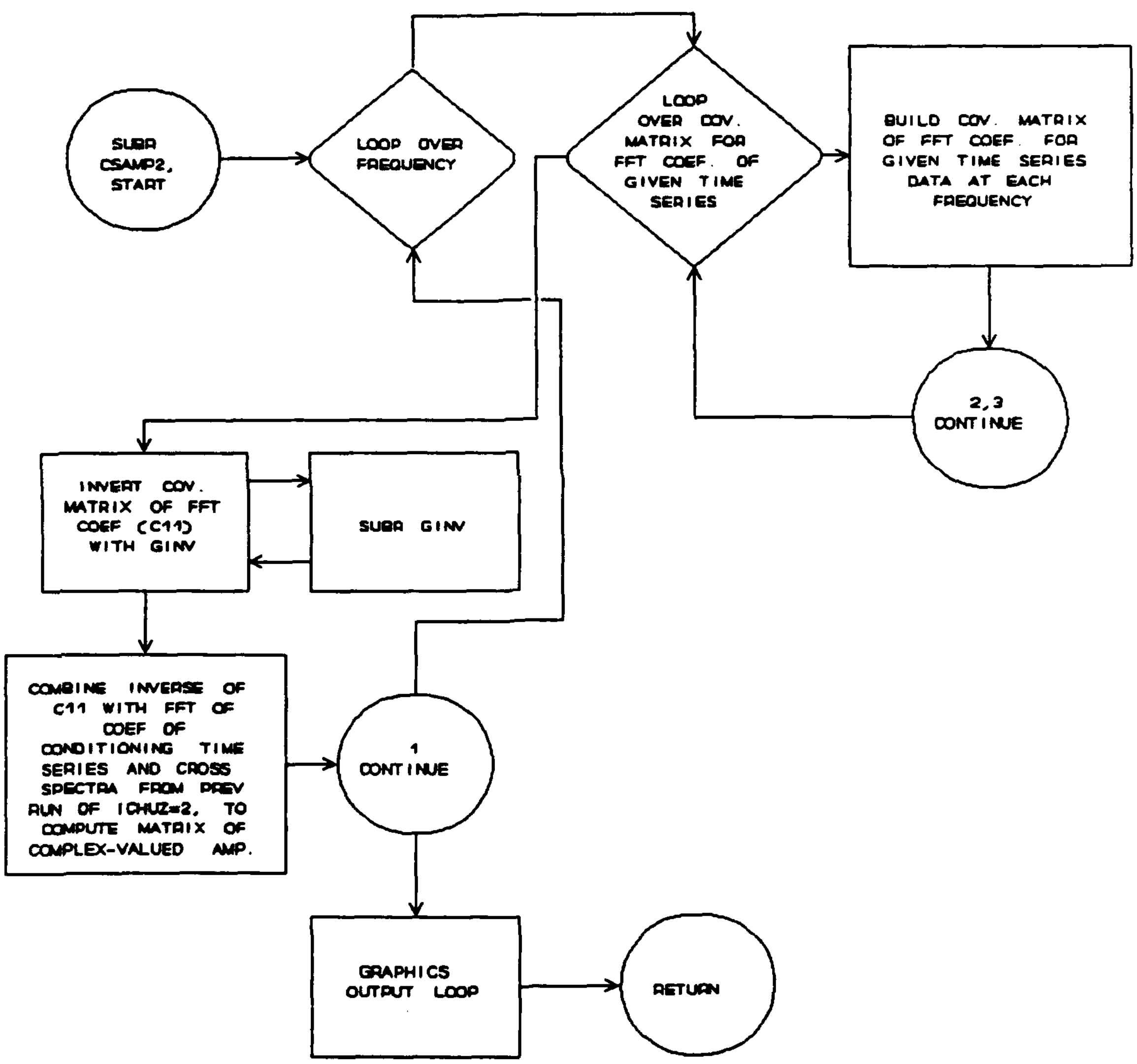

Figure 12.
Flow chart for Subroutine CSAMP2.

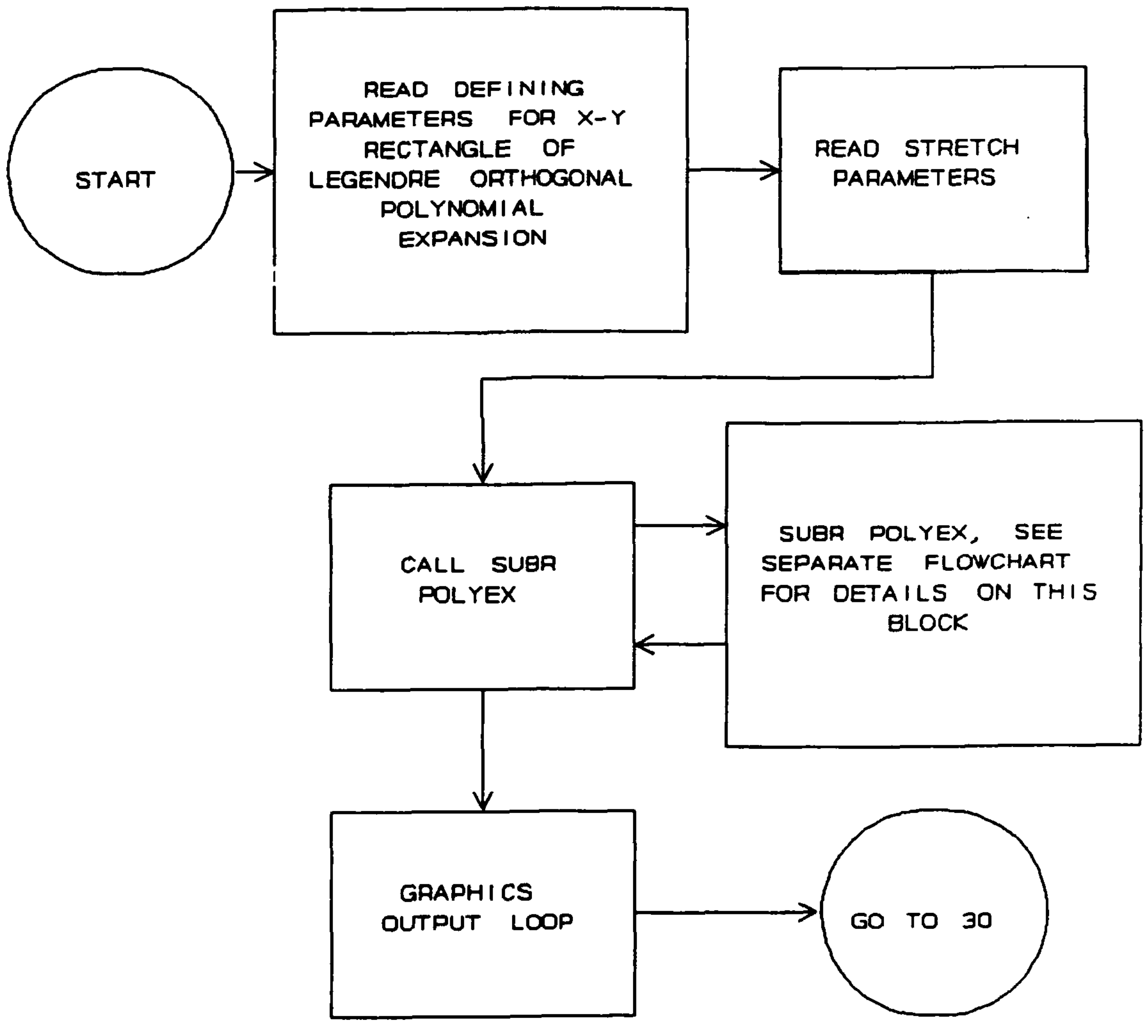

Figure 13.
Flow chart for SIMBAT Option No. 6.

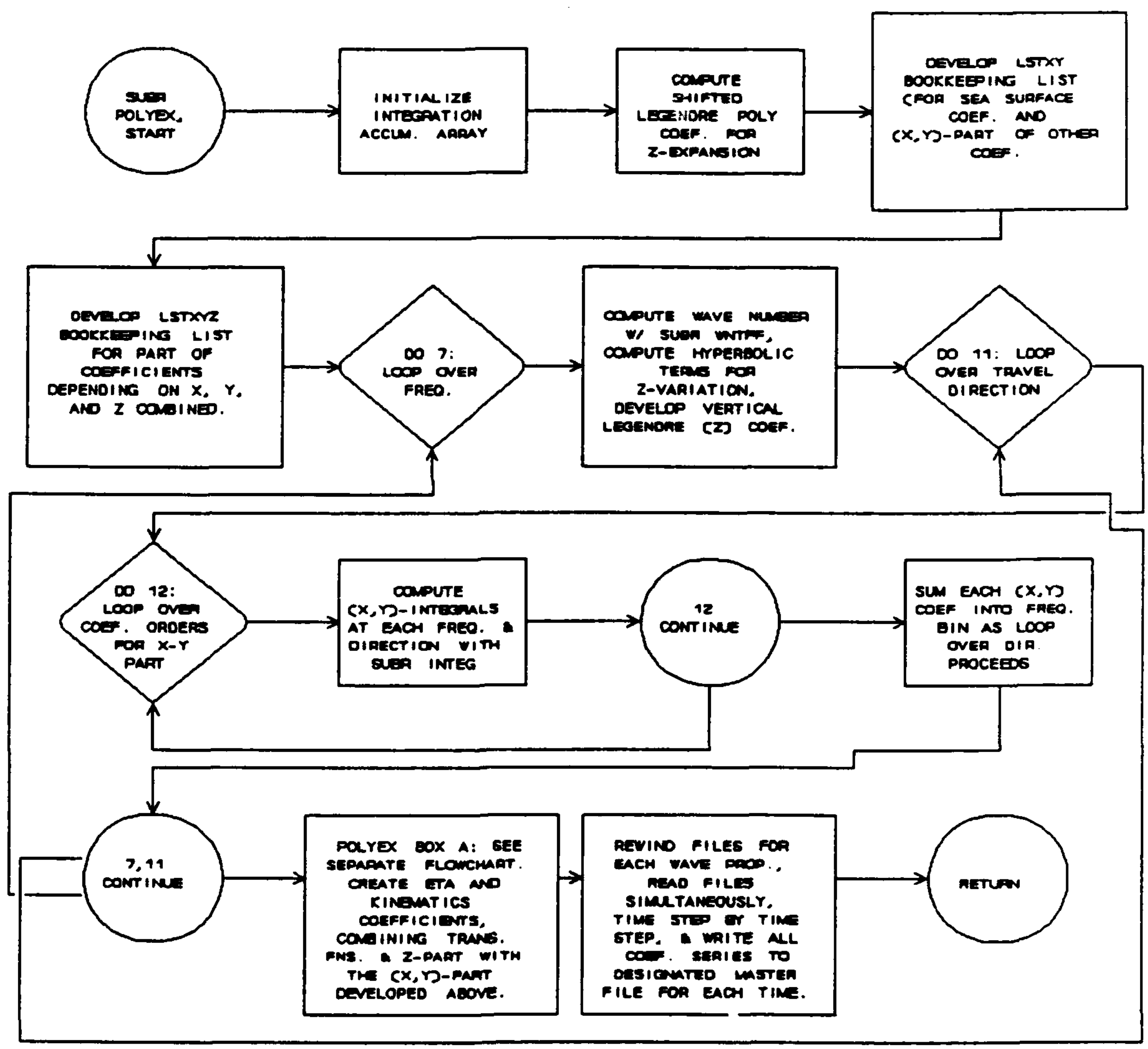

Figure 14.
Flow chart for Subroutine POLYEX in Option No. 6.

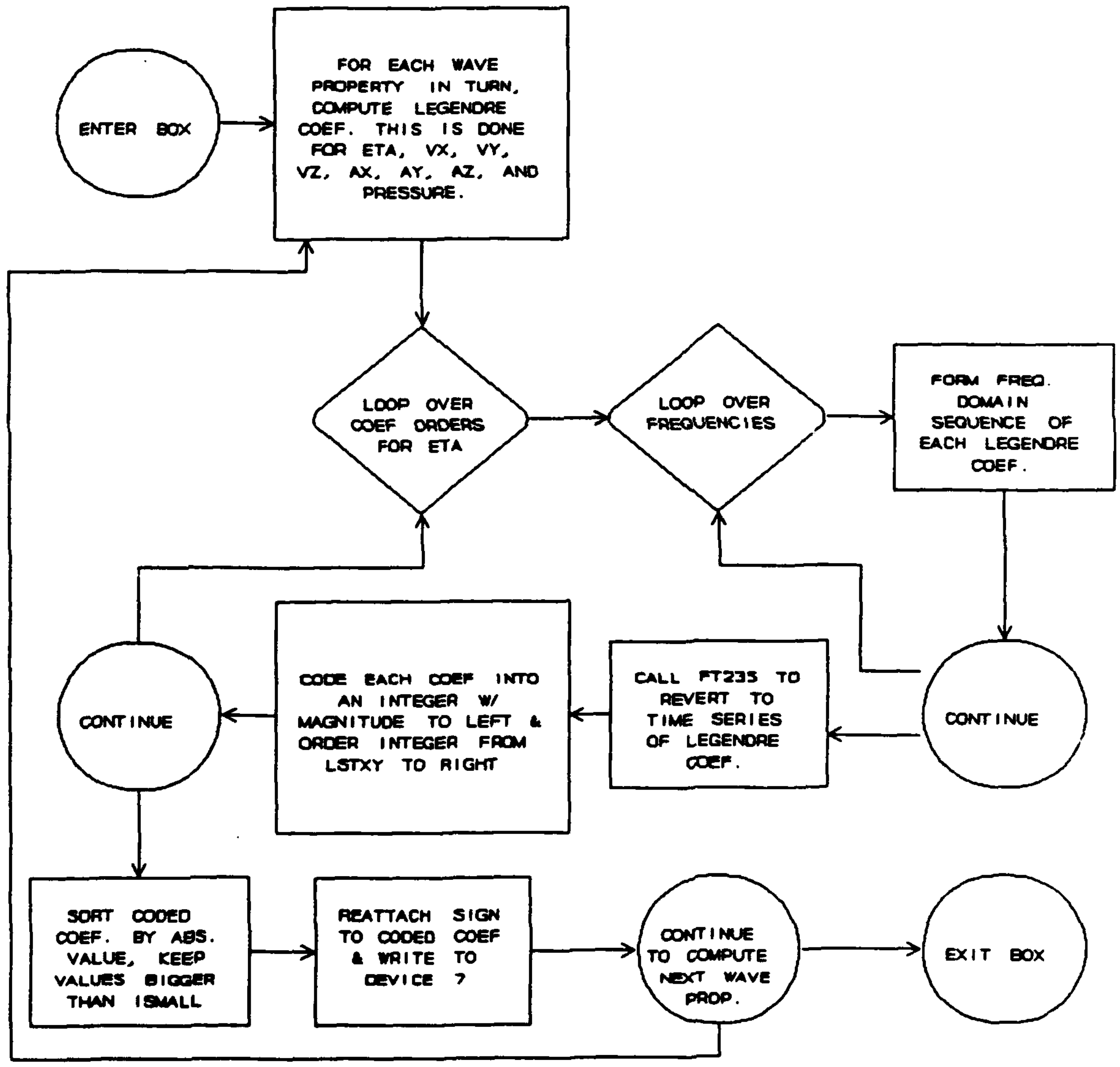

Figure 15.
Details for Box A in Subroutine POLYEX.

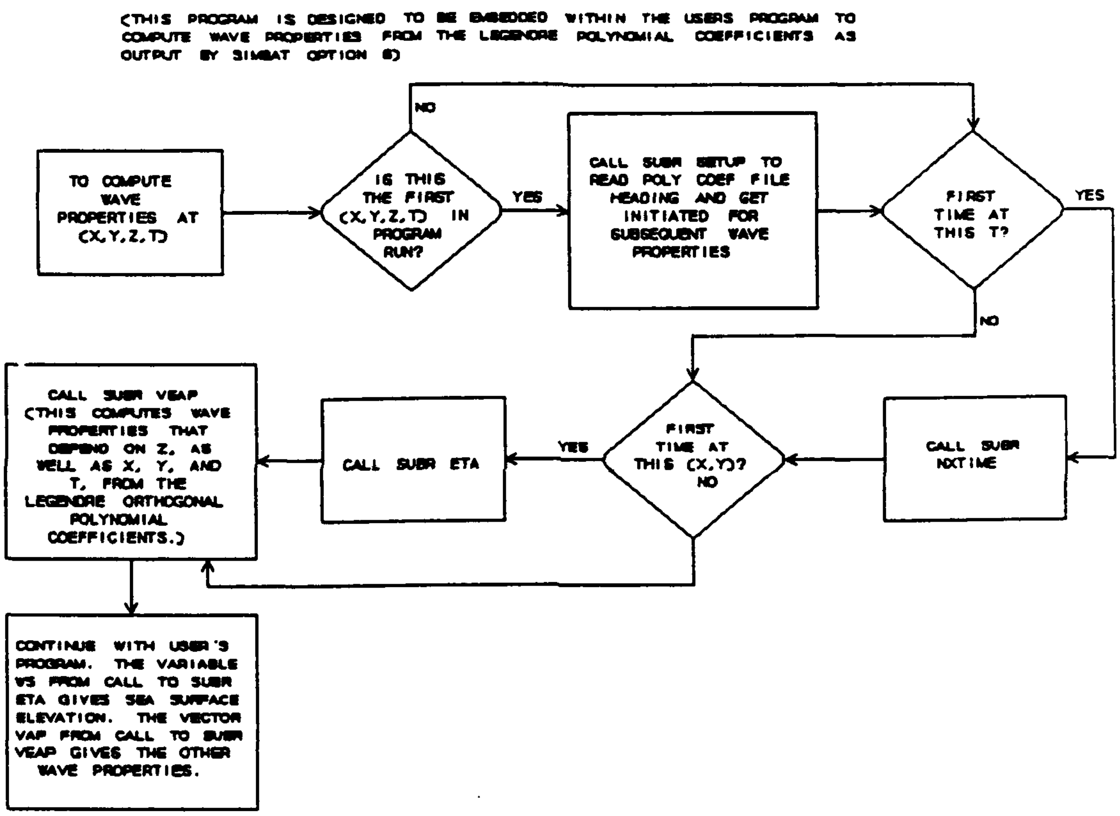

Figure 16.
Flow chart for the stand-alone kinematics program (Program CKPOLY).

```
-----------------------------------------------------------
Definitions from the comment cards in the source code:
C      N=LENGTH OF TIME SERIES
C      NF=NUMBER OF FREQUENCIES IN DSPEC. TABLE
C      NT=NUMBER OF ANGLES IN DSPEC. TABLE, ASSUMED UNIFORMLY
C             DISTRIBUTED OVER CIRCLE.
C      MB=BEGINNING M-VALUE WITH SIGNIFICANT ENERGY CONTENT
C        =(LOWER CUTOFF FREQUENCY)*N*DELT+1.0, THIS SHOULD
C             ALWAYS BE GREATER THAN OR EQUAL TO 2
C      ML=LAST M-VALUE WITH SIGNIFICANT ENERGY CONTENT
C        =(UPPER CUTOFF FREQUENCY)*N*DELT+1.0, THIS SHOULD
C             ALWAYS BE LESS THAN OR EQUAL TO N/2
C      NUMM=ML-MB+1
C      NTS=NUMBER OF TIME SERIES TO BE SIMULATED

A typical first parameter statement for the code:
      PARAMETER (N=1024,NF=33,NT=24,MB=2,ML=300,
     &NUMM=299,NTS=8)
--------------------------------------------------------
```

Figure 17.
First parameter statement.

```
Definitions from the comment cards in the source code:
C      NCTS=NUMBER OF TIME SERIES WHICH ARE THE GIVEN SET
C             FOR A CONDITIONAL SIMULATION.
C      NCTS2=NCTS*2
C      MXLAG=MAXIMUM LAG FOR COVARIANCES
C      MAXX=MAXIMUM OF NUMM AND MXLAG+1

A typical second parameter statement for the code:
      PARAMETER (NCTS=1,NCTS2=2,MXLAG=50,MAXX=299)
```

Figure 18.
Second parameter statement.

```
---------------------------------------------------------
 Definitions from the comment cards in the source code:
C      MXLEN=NCTS*MAXIMUM LENGTH IN TIME INCREMENTS OF THE
C            CONDITIONING INTERVAL,(FOR DIMENSIONING ARRAYS.)
C            (NOTE: ACTUAL LENGTH OF INTERVAL MAY BE LESS
C            THAN MXLEN.  ACTUAL LENGTH IS SPECIFIED WITH
C            LIST OF INPUT "GIVEN" DATA.)
C      NCOLUM=MXLAG+1+NCTS*(2*MXLAG+1)
C      NUMTOT=NF*NT
C      NUMTO5=INTEGER LARGER THAN NUMTOT/5

A typical third parameter statement for the code:
      PARAMETER(MXLEN=200,NCOLUM=152,NUMTOT=792,NUMTO5=159)
---------------------------------------------------------
```

Figure 19.
Third parameter statement.

```
-----------------------------------------------------------
 Definitions from the comment cards in the source code:
C     MORDXY=MAX. ORDER OF POLYNOMIALS HORIZONTALLY.
C               (NOT MORE THAN 12)
C     MORDZ=MAX. ORDER OF POLYNOMIALS VERTICALLY.
C               (NOT MORE THAN 12)
C     MXNEXY=MAXIMUM NUMBER OF COEFFICIENTS OF ORDER MORDXY
C               OR LESS HORIZONTALLY.
C           >=(MORDXY+1)*(MORDXY+2)/2
C     MXNEZ=MAXIMUM NUMBER OF COEFFICIENTS OF ORDER MORDZ OR
C               LESS VERTICALLY.
C          >=MORDZ+1
C     MAXXYZ = MAX. NUMBER OF COEFFICIENTS IN ALL 3
C               DIMENSIONS SUCH THAT ONLY HORIZ.
C               COEF. OF ORDER LESS THAN OR EQUAL TO
C               MORDXY AND ONLY VERT. COEF. OF ORDER
C               LESS THAN OR EQUAL TO MORDZ ARE USED
C               IN THE THREE DIMENSIONAL COEFFICIENTS.
C     IF MORDXY = MORDZ
C         MAXXYZ >= (MORDXY+1)*(MORDXY+2)*(MORDXY+3)/6
C     IF MORDXY > MORDZ
C         MAXXYZ >=(MORDXY+1)*(MORDXY+2)*(MORDXY+3)/6
C         -(MORDXY-MORDZ)*(MORDXY-MORDZ+1)*(MORDXY-
C         MORDZ+2)/6
C     IF MORDXY < MORDZ
C         MAXXYZ >=(MORDXY+1)*(MORDXY+2)*(MORDXY+3)/6
C                  +(MORDZ-MORDXY)*(MORDXY+1)*(MORDXY+2)/6
C     MXO5 >= MAXXYZ/5

 A typical fourth parameter statement for the code:
     PARAMETER(MXNEXY=66,MXNEZ=10,MAXXYZ=286,MXO5=58)
-----------------------------------------------------------
```

Figure 20.
Fourth parameter statement.

```
-----------------------------------------------------------
 Definitions from the comment cards in the source code:
C     DELT=TIME INCREMENT FOR TIME SERIES
C     D=DEPTH
C     G=GRAVITY
C     RHO=SEA WATER DENSITY

 A typical fifth parameter statement for the code:
      PARAMETER(DELT=0.3,D=2926.0,G=32.2,RHO=1.9875)
-----------------------------------------------------------
```

Figure 21.
Fifth parameter statement.

```
--------------------------------------------------------
 Definitions from the comment cards in the source code:
C      THETX=X-AXIS DIRECTION IN DEGREES
C      THETY=Y-AXIS DIRECTION IN DEGREES
C      BET=CONVENTION FOR DIRECTION TOWARD OR FROM
C      IGAM=Z-AXIS CONVENTION
C
C      (X,Y)=HORIZONTAL COORDINATES
C      X IS POSITIVE IN THE NAVIGATOR'S DIRECTION THETX
C            (DEGREES)
C      Y IS POSITIVE IN THE NAVIGATOR'S DIRECTION THETY
C            (DEGREES)
C      NAVIGATOR'S DIRECTIONS ARE MEASURED CLOCKWISE FROM
C            TRUE NORTH.
C
C      THETA IS THE DIRECTION TOWARD WHICH WAVES TRAVEL IF
C             BET=+1.0
C      THETA IS THE DIRECTION FROM WHICH WAVES COME IF
C             BET=-1.0
C
C      Z=VERTICAL COORDINATE
C      IGAM=1, IF Z IS MEASURED POSITIVE UPWARD FROM MWL
C      IGAM=2, IF Z IS MEASURED POSITIVE DOWNWARD FROM MWL
C      IGAM=3, IF Z IS MEASURED POSITIVE UPWARD FROM THE SEA
C                 FLOOR.

 A typical sixth parameter statement for the code:
      PARAMETER(THETX=285.0,THETY=15.0,BET=-1.0,IGAM=1)
---------------------------------------------------------
```

Figure 22.
Sixth parameter statement.

```
-----------------------------------------------------------
 Definitions from the comment cards in the source code:
C     MDIVP1=1+MAX. NUMBER OF SPACE DIVISIONS ON EITHER
C           THE X- AND/OR THE Y-AXIS IN THE ERROR CHECK
C           (ICHUZ=8)
C           OPTION FOR THE SPATIAL VECTORS AND ARRAYS.
C           ACTUAL NUMBER OF AXIS DIVISIONS (NDIV) CAN BE
C           ANY INTEGER FROM 1 TO MNDIV.
C     MSTP=MAXIMUM NUMBER OF TIME STEPS FOR THE TIME DOMAIN
C           SIMULATIONS USED IN THE ERROR CHECKING OPTION.
C           ACTUAL NUMBER OF TIME STEPS EXECUTED (NSTP) CAN
C           BE ANY INTEGER FROM 1 TO MNSTP.

 A typical seventh parameter statement for the code:
      PARAMETER(MDIVP1=21,MSTP=20)
-------------------------------------------------------------
```

Figure 23.
Seventh parameter statement.

```
------------------------------------------------------------
C   **** FIRST DATA STATEMENT ******
C      ITF(NTS)=TRANSFER FUNCTION CODE FOR EACH TIME SERIES
C        ITF:  1 = WAVE PROFILE
C              2 = SEA SURFACE SLOPE IN THE DIRECTION X
C              3 = SEA SURFACE SLOPE IN THE DIRECTION Y
C              4 = VELOCITY IN THE DIRECTION X
C              5 = VELOCITY IN THE DIRECTION Y
C              6 = VELOCITY IN THE DIRECTION Z
C              7 = ACCELERATION IN THE DIRECTION X
C              8 = ACCELERATION IN THE DIRECTION Y
C              9 = ACCELERATION IN THE DIRECTION Z
C             10 = PRESSURE FLUCTUATIONS ABOUT STATIC
C                     PRESSURE
C
C   **** SECOND DATA STATEMENT ******
C      X(NTS)=X-COORDINATE VALUE FOR EACH TIME SERIES
C
C   **** THIRD DATA STATEMENT ******
C      Y(NTS)=Y-COORDINATE VALUE FOR EACH TIME SERIES
C
C   **** FOURTH DATA STATEMENT ******
C      Z(NTS)=Z-COORDINATE VALUE FOR EACH TIME SERIES
C
C   **** FIFTH DATA STATEMENT ******
C      F(NF)=LIST OF FREQUENCIES
C
C   **** SIXTH DATA STATEMENT ******
C      ICTF(NTS)=TRANS. FUNCTION CODE FOR GIVEN TIME SERIES
C         (IN SAME CODING NUMERALS AS LISTED ABOVE FOR ITF)
C
C   **** SEVENTH DATA STATEMENT ******
C      GX(NCTS)=X-COORDINATE FOR EACH GIVEN TIME SERIES TO
C                    BE CONDITIONED ON.
C
C   **** EIGHTH DATA STATEMENT ******
C      GY(NCTS)=Y-COORDINATE FOR EACH GIVEN TIME SERIES TO
C                    BE CONDITIONED ON.
C
C   **** NINTH DATA STATEMENT ******
C      GZ(NCTS)=Z-COORDINATE FOR EACH GIVEN TIME SERIES TO
C                    BE CONDITIONED ON.
```

Figure 24.
Definitions from the comment cards in the source code.

```
Typical values for the data statements:
      DATA ITF /1,4,5,6,7,8,9,10/
      DATA X /8*0.0/
      DATA Y /8*0.0/
      DATA Z /8*0.0/
      DATA F   /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,&0.21,0.22,0.23,0.24,0.25,0.26,0.27,
     &0.28,0.29,0.30,0.31,0.32,0.33,0.34,0.35/
      DATA ICTF/1/
      DATA GX/0.0/
      DATA GY/0.0/
      DATA GZ/0.0/
----------------------------------------------------------
```

Figure 25.
Data statements.

Appendix A

EXAMPLE NO. 1 — UNCONDITIONAL SIMULATION

- ❑ N=1024 points
- ❑ Ochi-Hubble Spectra
- ❑ Wrapped Normal Spread
- ❑ Functional Extrapolation
- ❑ 2nd Order Polynomial Fit
- ❑ Compare kinematics at X,Y,Z = 0,0,-25 ft. for SIMBAT Options #5 and #6

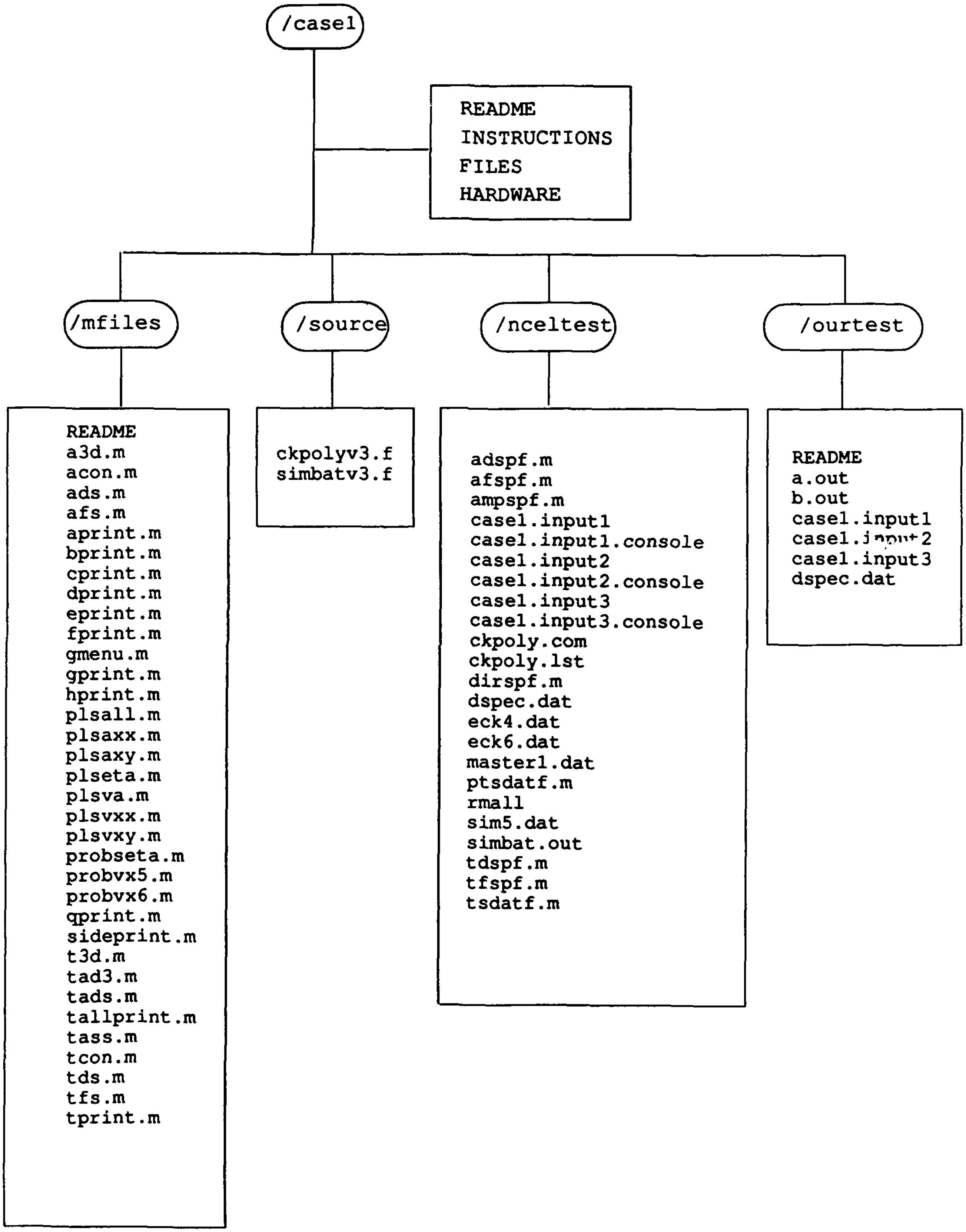

Figure A-1.
Example No. 1 directory and file structure.

```
-----------------------------------------------------------------------------
Simbat Test Case 1 Description:
-----------------------------------------------------------------------------

This example demonstrates an unconditional simulation for eight
wave properties. The wave properties Eta,Vx,Vy,Vz,Ax,Ay,Az & P
are each 1024 points in length spaced at 0.3 seconds (307.2
seconds each). The simulation creates an Ochi-Hubble directional
spectra with wrapped normal spreading using Option #1 of SIMBAT.
The wave properties are then simulated at a point in space at
X,Y,Z=0,0,-25 feet using Option #5. Next Option #6 is used to
create the Legendre orthogonal polynomials for a horizontal area
of 100 ft X 100 ft. Functional extrapolation is used to stretch
the kinematics above the mean water line. The water depth is
2,926 ft. Finally, the wave properties are compared at 0,0,-25 ft
for the Options #5 and #6.  The simulation requires about 2-5
minutes execution time on a Sun 4/310 computer.

Examination of the source code simbat.f and ckpoly.f in
subdirectory "source" show the PARAMETER and DATA statements used
for this example problem. An explanation of the values for these
statements are described in the SIMBAT USERS MANUAL and in the
source code itself and therefore will not be discussed here. The
binaries are included for this example so you should be able to
run simbat on any Sun4 SPARC based computer without having to
recompile first. If you wish to modify simbat.f or ckpoly.f, type
"f77 simbat.f" and "f77 -o b.out ckpoly.f" to recompile.

The batch files execute Simbat for the following options:

       Option 1 - Compute directional ocean spectra
       Option 5 - Create time series from frequency domain methods
       Option 6 - Create Legendre Polynomial file
       Option 8 - Create kinematic comparisons for MATLAB plots
       Option 7 - Print kinematics to output file "simbat.out"

See the file "FILES" in this directory for explanation of files
on this tape.

-----------------------------------------------------------------------------
   TO TEST EXAMPLE:
-----------------------------------------------------------------------------

    1) Go to subdirectory "ourtest" and you should see the following files:

         a.out         - simbat binary for sun4
         b.out         - ckpoly binary for sun4
         case1.input1  - input data set one for a.out
         case1.input2  - input data set two for a.out
         case1.input3  - input data for b.out

  NOTE: the two batch files case1.input1 and case1.input2 are both
```

Figure A-2.
Listing of file "INSTRUCTIONS."

required in order to compare the outputs of SIMBAT Option #5 and #6. This is because the user must exit SIMBAT in order for SIMBAT to write the output file for Option#5 that is read into CKPOLY. In a real life situation this would ordinarily not be required since the user would probably execute either Option#5 or Option#6 and the comparison would not be done. It is done in all the examples for educational purposes only.

2) To execute in batch mode, do the following where % is unix prompt and & is run in background:

```
% a.out < casel.inputl  &
        (this creates data necessary for input to b.out)

% a.out < casel.input2  &
        (this creates data necessary for input to b.out
         and all other output files)

% b.out < casel.input3  &
        (this compares frequency domain to Legendre Polynoimal
         approximation method as shown in output file: ckpoly.com)
```

3) If you would like to use matlab to plot data, copy all the files from the "mfiles" subdirectory into "ourtest" directory. Assuming you are already in the subdirectory "ourtest" type:

```
% cp ../mfiles/*.m .
```

Simbat will produce mfiles that have an "*f.m" in their name where "*" is the unix wildcard. These mfiles are data files whereas the mfiles in the "mfiles" subdirectory are matlab script files. Next:

```
a) start matlab
b) matlab> gmenu   (this will provide a menu for plotting)
c) matlab> tcon    (this will plot spectra contours)
d) matlab> tsdatf  (this reads time series output into matlab)
e) matlab> plsall  (this will plot tsdatf data)
d) pls,plvxx,plaxx,plva.... all read data from tsdatf and
   plot to screen as well.
e) matlab> prtsc or print to dump plot to printer.
f) NOTE: matlab can be used in a separate window if you run
       simbat interactively. Thus you can verify data as you
       proceed through simbat. Step 2) above is meant
       to be for a streamline batch execution of simbat.
```

HELP: Warren Bartel (805) 982-1215/1214/1217

Figure A-2. (Continued)

```
This directory contains Simbat V3.00 Test Case Example #1 Data
Files, source code and executables. This file provides a
description of each file. See INSTRUCTIONS file for additional
details.

GENERAL FILES:
--------------

INSTRUCTIONS - instructions for simulation
FILES        - this file


DIRECTORIES:
------------

mfiles   - MATLAB script files for plotting data
source   - source code
nceltest - example output data from Naval Civil Engineering Laboratory
ourtest - your execution directory


SOURCE FILES AND BINARIES:
--------------------------

simbat.f   - simbat V3.00 source code
ckpoly.f   - simbat post processor source code
a.out      - simbat binary for sun4
b.out      - ckpoly binary for sun4

INPUT BATCH FILES:
------------------

case1.input1 - input data set one for a.out
case1.input2 - input data set two for a.out
case1.input3 - input data for b.out

case1.input1.console - console listing
case1.input2.console - console listing
case1.input3.console - console listing

INPUT DATA FILES:
-----------------
none

OUTPUT FILES:
-------------

simbat.out  - text and general data. Note for this example, the kinematics
```

Figure A-3.
Listing of file "FILES."

```
              from Simbat Option #5,#7 and #6,#8 and #7 are also listed
              where Option #5 is listed first and those from Option #6
              are listed next. Simbat.out documents which is which.
masterl.dat - Legendre Polynomial data file
tsdatf.m    - time series output from frequency domain methods to be read
              by matlab.
ptsdatf.m   - time series output from Legendre Polynomials. Append this
              file to end of tsdatf.m for use in matlab.
ckpoly.com  - output from b.out that compares kinematics between frequency
              domain methods and Legendre Polynomial approximation method.
ckpoly.lst  - kinematics created from masterl.dat


EXAMPLE MATLAB "M.FILES" FOR PLOTTING OUTPUT:
-------------------------------------------
"gmenu.m" should be executed first in matlab. This
menu will list the following matlab "m-files":

gmenu.m   - matlab menu for spectra script
   tcon.m    - matlab contour plot script
   t3d.m     - matlab spectra plot script
   acon.m    - matlab simulated contour plot script
   a3d.m     - matlab 3D simulation spectra plot script
   tfs.m     - matlab point spectra script
   tds.m     - matlab directional spread script
   afs.m     - matlab simualted point spectra script
   ads.m     - matlab simulated directional spread plot script
   tads.m    - matlab direction spread plot script
   tad3.m    - matlab 3D spectra plot script
   tass.m    - matlab plot comparison script file

The next set of m.files are for plotting time series
output form data files tsdatf.m, gtsf.m, ptsdatf.m.
They do not have to be executed in any particular order
and are meant to be samples to be modified by the user.

probseta.m - matlab histogram of simulated eta
probvx5.m - matlab histogram of velocity in x direction, Opt 5
probvx6.m - matlab histogram of velocity in x direction, Opt 6
plg.m     - matlab input data plot script
pls.m     - matlab general plot script
plsall.m  - matlab general plot script
plsaxx.m  - matlab plot output acceleration data script
plsva.m   - matlab plot  output velocity & acceleration data script
plsvxx.m  - matlab plot velocity of sim5 vs sim6

Example: 1. in unix, append ptsdatf.m to end of tsdatf.m
         2. in unix, remove redundant information brought in from
            the psdatf.m file. (use vi,emacs,etc)
         3. start matlab
         2. matlab> tsdatf   (reads data into matlab)
         3. matlab> plsall   (plsall will read tsdatf.m data and
```

Figure A-3. (Continued)

```
plot data to screen)

---------------------------------------------------------------------
SEE "INSTRUCTIONS" FILE FOR SIMULATION PROCESS AND USE OF MATLAB FILES.
---------------------------------------------------------------------
```

Figure A-3. (Continued)

```
R
N
Example #1 Options #1-5-6-8-7
Unconditional Simulation , Functional Extrapolation
1
123456789
1
dspec.dat
Simbat Opt#1 Dir Spect T=16s & 9s at 285 & 105 deg.
1
1
1.5
0.0625
20.0
1
1
285.0
20.0
Y
Y
1.2
0.1111
15.0
1
1
105.0
25.0
Y
N
2
Y
5
0
0
0
0
0
0
0
0
0
Y
0
Y
sim5.dat
```

Figure A-4.
Listing of file "case1.input1."

```
R
N
Example #1 Options #1-5-6-8-7
Unconditional Simulation , Functional Extrapolation
1
123456789
1
dspec.dat
Simbat Opt#1 Dir Spect T=16s & 9s at 285 & 105 deg.
1
1
1.5
0.0625
20.0
1
1
285.0
20.0
Y
Y
1.2
0.1111
15.0
1
1
105.0
25.0
Y
N
2
Y
5
0
0
0
0
0
0
0
0
0
Y
7
1
1
1024
1
6
master1.dat
example #1
0.0
0.0
```

Figure A-5.
Listing of file "case1.input2."

```
50.0
50.0
16.7
2
2
1
master1.dat
8
1
4
2
60.0
2
1.0
9
master1.dat
-5.0
-25.0
0.0
0.0
50.0
0.0
6
master1.dat
Y
0
7
3
1
1024
1
0
```

Figure A-5. (Continued)

```
sim5.dat
master1.dat
```

Figure A-6.
Listing of file "case1.input3."

```
 ********************************************** ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 ***********************************************************
R

 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
--------------------------------------------------
Example #1 Options #1-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
---------------------------------------------------
Unconditional Simulation , Functional Extrapolation
 ***************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure A-7.
Listing of file "case1.input1 console."

```
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
1
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
0.00001
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
123456789
*************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
1
***************************************************
ENTER FILE NAME TO WHICH THE DATA IS TO BE STORED.
dspec.dat
************************************************
  ENTER A 50-CHARACTER TITLE FOR DRSPEC. MATRIX
-------------------------------------------------
Simbat Opt#1 Dir Spect T=16s & 9s at 285 & 105 deg.
  *******************************************
  PLEASE SELECT THE SPECTRAL MODEL YOU WISH TO USE.
    (1) OCHI-HUBBLE SPECTRAL DENSITY.
    (2) WALLOP (HUANG, ET. AL.) SPECTRAL DENSITY
    (3) JONSWAP SPECTRAL DENSITY (W/ GAMMA=3.3).
  ENTER THE NUMBER OF YOUR CHOICE.
  **********************************************
1
  *******************************************
  PLEASE CHOOSE A SPREADING FUNCTION MODEL.
    (1) WRAPPED NORMAL FUNCTION
    (2) GENERALIZED COSINE-SQUARED FUNCTION.
    (3) VON MISES FUNCTION.
  ENTER THE NUMBER OF YOUR CHOICE.
  **********************************************
1

  MODE NUMBER AT THIS STEP =    1
  ENTER LAMDA FOR O-H SPECTRA. NOTE: LAMDA=1.0 FOR
  P-M SPECTRA OR JONSWAP SPECTRA
1.5
  ENTER PEAK FREQUENCY FOR MODE.
```

Figure A-7. (Continued)

```
0.0625
  ENTER TOTAL VARIANCE OF MODE.
  VARIANCE DIMENSIONS DETERMINE SPECTRA DIMENSIONS
  DR.SPECT.DENSITY WILL BE IN UNITS OF
  LENGTH**2 PER (HERTZ-RADIAN)
20.0
  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT MEAN DIRECTION FOR THE SPRD. FN
    (2) LINEARLY VARYING (W/FREQ.) MEAN DIRECTION
   PLEASE ENTER YOUR CHOICE.
  ********************************************
1
  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT SPREAD PARAMETER FOR THE SPRD. FN.
    (2) LINEARLY VARYING (W/FREQ.) SPREAD PARAMETER
  PLEASE ENTER YOUR CHOICE.
  ************************************************
1
  DIMENSIONS: PRINC.DIR.CONST. IN NAV. DEGREES
  ENTER PRINCIPAL DIRECTION CONSTANT FOR MODE.
  DIMENSIONS: SPRD.PARAMETER CONST. IN NAV. DEGREES
     IF WRAPPED NORMAL USED, OTHERWISE IT IS DIMENSIONLESS
285.0
  ENTER SPREADING PARAMETER CONSTANT FOR MODE.
  SPECTRA PARAMETERS: PVEC(1), F0, VAR=        1.50000         0.06250
   NOTE: PVEC(1) IS ZERO FOR WALLOP AND JONSWAP SPECTRA
20.0
  SPREAD PARAMETERS: THET0,THET1,PAR0,PAR1=      285.00000         0.0000
    NOTE: THET1=0 IF CONSTANT DIRECTION PICKED, AND
          PAR1=0 IF CONSTANT SPRD. PARAMETER PICKED.

  ARE THESE THE VALUES WANTED? IF NOT, ENTER N=NO
    AND RE-ENTER PARAMETERS FOR THIS MODE.
    OTHERWISE ENTER Y=YES
      WHAT IS YOUR CHOICE?
Y

  MODE NUMBER AT THIS STEP =   2
  DO YOU WANT TO ENTER ANOTHER MODE?
    ENTER N=NO IF NO MORE MODES ARE TO BE ENTERED.
    OTHERWISE, ENTER Y=YES
   WHAT IS YOUR CHOICE?
Y
  ENTER LAMDA FOR O-H SPECTRA. NOTE: LAMDA=1.0 FOR
  P-M SPECTRA OR JONSWAP SPECTRA
1.2
  ENTER PEAK FREQUENCY FOR MODE.
0.1111
 ENTER TOTAL VARIANCE OF MODE.
  VARIANCE DIMENSIONS DETERMINE SPECTRA DIMENSIONS
```

Figure A-7. (Continued)

```
  DR.SPECT.DENSITY WILL BE IN UNITS OF
  LENGTH**2 PER (HERTZ-RADIAN)
15.0
  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT MEAN DIRECTION FOR THE SPRD. FN
    (2) LINEARLY VARYING (W/FREQ.) MEAN DIRECTION
   PLEASE ENTER YOUR CHOICE.
  ********************************************
1
  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT SPREAD PARAMETER FOR THE SPRD. FN.
    (2) LINEARLY VARYING (W/FREQ.) SPREAD PARAMETER
  PLEASE ENTER YOUR CHOICE.
  ************************************************
1
  DIMENSIONS: PRINC.DIR.CONST. IN NAV. DEGREES
  ENTER PRINCIPAL DIRECTION CONSTANT FOR MODE.
  DIMENSIONS: SPRD.PARAMETER CONST. IN NAV. DEGREES
     IF WRAPPED NORMAL USED, OTHERWISE IT IS DIMENSIONLESS
105.0
  ENTER SPREADING PARAMETER CONSTANT FOR MODE.
  SPECTRA PARAMETERS: PVEC(1), F0, VAR=        1.20000         0.11110
   NOTE: PVEC(1) IS ZERO FOR WALLOP AND JONSWAP SPECTRA
25.0
  SPREAD PARAMETERS: THET0,THET1,PAR0,PAR1=      105.00000          0.0000
    NOTE: THET1=0 IF CONSTANT DIRECTION PICKED, AND
          PAR1=0 IF CONSTANT SPRD. PARAMETER PICKED.

  ARE THESE THE VALUES WANTED? IF NOT, ENTER N=NO
    AND RE-ENTER PARAMETERS FOR THIS MODE.
    OTHERWISE ENTER Y=YES
      WHAT IS YOUR CHOICE?
Y

  MODE NUMBER AT THIS STEP =    3
  DO YOU WANT TO ENTER ANOTHER MODE?
    ENTER N=NO IF NO MORE MODES ARE TO BE ENTERED.
    OTHERWISE, ENTER Y=YES
   WHAT IS YOUR CHOICE?
N
************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
**************************************************
2
POINT A REACHED
POINT B REACHED
```

Figure A-7. (Continued)

```
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.9225315068865D-02
NUMBER OF DEGREES OF FREEDOM =   3974
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
  CHANNEL NUMBER:      1
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      7
```

Figure A-7. (Continued)

```
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =      2.9225315068865D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   3974
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
0
  DO YOU WANT TO SAVE THE OUTPUT FROM LAST OPTION
   Y OR N
Y
  PLEASE ENTER THE FILE NAME FOR STORAGE
sim5.dat
```

Figure A-7. (Continued)

```
************************************************ ******
 PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
 METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
  SIMULATIONS.
  (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

 PLEASE KEY RETURN TO CONTINUE
**********************************************************
R






 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
--------------------------------------------------
Example #1 Options #1-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
---------------------------------------------------
Unconditional Simulation , Functional Extrapolation
 ************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure A-8.
Listing of file "case1.input2 console."

```
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
1
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
0.00001
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
123456789
**************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
1
***************************************************
ENTER FILE NAME TO WHICH THE DATA IS TO BE STORED.
dspec.dat
************************************************
  ENTER A 50-CHARACTER TITLE FOR DRSPEC. MATRIX
--------------------------------------------------
Simbat Opt#1 Dir Spect T=16s & 9s at 285 & 105 deg.
  ******************************************
  PLEASE SELECT THE SPECTRAL MODEL YOU WISH TO USE.
    (1) OCHI-HUBBLE SPECTRAL DENSITY.
    (2) WALLOP (HUANG, ET. AL.) SPECTRAL DENSITY
    (3) JONSWAP SPECTRAL DENSITY (W/ GAMMA=3.3).
  ENTER THE NUMBER OF YOUR CHOICE.
  ************************************************
1
  ******************************************
  PLEASE CHOOSE A SPREADING FUNCTION MODEL.
    (1) WRAPPED NORMAL FUNCTION
    (2) GENERALIZED COSINE-SQUARED FUNCTION.
    (3) VON MISES FUNCTION.
  ENTER THE NUMBER OF YOUR CHOICE.
  ***********************************************
1

  MODE NUMBER AT THIS STEP =    1
  ENTER LAMDA FOR O-H SPECTRA. NOTE: LAMDA=1.0 FOR
  P-M SPECTRA OR JONSWAP SPECTRA
1.5
  ENTER PEAK FREQUENCY FOR MODE.
```

Figure A-8. (Continued)

```
0.0625
  ENTER TOTAL VARIANCE OF MODE.
20.0
  VARIANCE DIMENSIONS DETERMINE SPECTRA DIMENSIONS
  DR.SPECT.DENSITY WILL BE IN UNITS OF
  LENGTH**2 PER (HERTZ-RADIAN)

  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT MEAN DIRECTION FOR THE SPRD. FN
    (2) LINEARLY VARYING (W/FREQ.) MEAN DIRECTION
   PLEASE ENTER YOUR CHOICE.
  ********************************************
1
  *****************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT SPREAD PARAMETER FOR THE SPRD. FN.
    (2) LINEARLY VARYING (W/FREQ.) SPREAD PARAMETER
  PLEASE ENTER YOUR CHOICE.
  ***********************************************
1
  DIMENSIONS: PRINC.DIR.CONST. IN NAV. DEGREES
  ENTER PRINCIPAL DIRECTION CONSTANT FOR MODE.
  DIMENSIONS: SPRD.PARAMETER CONST. IN NAV. DEGREES
     IF WRAPPED NORMAL USED, OTHERWISE IT IS DIMENSIONLESS
285.0
  ENTER SPREADING PARAMETER CONSTANT FOR MODE.
  SPECTRA PARAMETERS: PVEC(1), F0, VAR=        1.50000          0.06250
   NOTE: PVEC(1) IS ZERO FOR WALLOP AND JONSWAP SPECTRA
20.0
  SPREAD PARAMETERS: THET0,THET1,PAR0,PAR1=      285.00000         0.0000
    NOTE: THET1=0 IF CONSTANT DIRECTION PICKED, AND
          PAR1=0 IF CONSTANT SPRD. PARAMETER PICKED.

  ARE THESE THE VALUES WANTED? IF NOT, ENTER N=NO
    AND RE-ENTER PARAMETERS FOR THIS MODE.
    OTHERWISE ENTER Y=YES
      WHAT IS YOUR CHOICE?
Y

  MODE NUMBER AT THIS STEP =    2
  DO YOU WANT TO ENTER ANOTHER MODE?
    ENTER N=NO IF NO MORE MODES ARE TO BE ENTERED.
    OTHERWISE, ENTER Y=YES
   WHAT IS YOUR CHOICE?
Y
  ENTER LAMDA FOR O-H SPECTRA. NOTE: LAMDA=1.0 FOR
  P-M SPECTRA OR JONSWAP SPECTRA
1.2
 ENTER PEAK FREQUENCY FOR MODE.
0.1111
  ENTER TOTAL VARIANCE OF MODE.
```

Figure A-8. (Continued)

```
  VARIANCE DIMENSIONS DETERMINE SPECTRA DIMENSIONS
  DR.SPECT.DENSITY WILL BE IN UNITS OF
  LENGTH**2 PER (HERTZ-RADIAN)
15.0
  ******************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT MEAN DIRECTION FOR THE SPRD. FN
    (2) LINEARLY VARYING (W/FREQ.) MEAN DIRECTION
   PLEASE ENTER YOUR CHOICE.
  *********************************************
1
  ******************************************
   CHOOSE ONE OF THE FOLLOWING:
    (1) CONSTANT SPREAD PARAMETER FOR THE SPRD. FN.
    (2) LINEARLY VARYING (W/FREQ.) SPREAD PARAMETER
  PLEASE ENTER YOUR CHOICE.
  ************************************************
1
  DIMENSIONS: PRINC.DIR.CONST. IN NAV. DEGREES
  ENTER PRINCIPAL DIRECTION CONSTANT FOR MODE.
  DIMENSIONS: SPRD.PARAMETER CONST. IN NAV. DEGREES
     IF WRAPPED NORMAL USED, OTHERWISE IT IS DIMENSIONLESS
105.0
  ENTER SPREADING PARAMETER CONSTANT FOR MODE.
  SPECTRA PARAMETERS: PVEC(1), F0, VAR=        1.20000        0.11110
   NOTE: PVEC(1) IS ZERO FOR WALLOP AND JONSWAP SPECTRA
25.0
  SPREAD PARAMETERS: THET0,THET1,PAR0,PAR1=      105.00000        0.0000
    NOTE: THET1=0 IF CONSTANT DIRECTION PICKED, AND
          PAR1=0 IF CONSTANT SPRD. PARAMETER PICKED.

  ARE THESE THE VALUES WANTED? IF NOT, ENTER N=NO
    AND RE-ENTER PARAMETERS FOR THIS MODE.
    OTHERWISE ENTER Y=YES
      WHAT IS YOUR CHOICE?

Y
  MODE NUMBER AT THIS STEP =    3
  DO YOU WANT TO ENTER ANOTHER MODE?
    ENTER N=NO IF NO MORE MODES ARE TO BE ENTERED.
    OTHERWISE, ENTER Y=YES
   WHAT IS YOUR CHOICE?
N
************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
***************************************************
2
POINT A REACHED
```

Figure A-8. (Continued)

```
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.9225315068865D-02
NUMBER OF DEGREES OF FREEDOM =    3974
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
  CHANNEL NUMBER:      1
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
```

Figure A-8. (Continued)

```
  CHANNEL NUMBER:      7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =      2.9225315068865D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   3974
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
     0. EXIT.
     1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
     2. GIVEN TIME SERIES CONDITIONED ON.
     3. TIME SERIES FROM POLYNOMIALS.
         (ICHUZ=3, 4, OR (8-SUB 6) MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
1
  ENTER TIME STEP FOR START OF LIST (I5)
1
  ENTER TIME STEP AT TERMINATION OF LIST (I5)
1024
  ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
```

Figure A-8. (Continued)

```
   0. EXIT PROGRAM
   1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
   2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
        CONDITIONAL SIMULATION
   3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
        INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
        (USES OUTPUT FROM STEP #2.)
   4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
        INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
        (USES OUTPUT FROM STEP #2.)
   5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
        STEP #1, #3, OR #4.)
   6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
        ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
        KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
6
  PLEASE ENTER A 50-CHAR. TITLE FOR THE OUTPUT.
master1.dat
  PLEASE ENTER ANY ADDITIONAL DOCUMENTATION THAT
  YOU WANT ATTACHED TO THE OUTPUT.
example #1
  PLEASE ENTER X-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER Y-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER X-RADIUS OF REGION
50.0
  PLEASE ENTER Y-RADIUS OF REGION
50.0
  PLEASE ENTER REFERENCE WAVE PERIOD.
  (NOTE: THIS SHOULD APPROXIMATELY BE THE WAVE PERIOD
  CORRESPONDING TO THE FREQUENCY AT THE PEAK OF THE
  WAVE SPECTRAL DENSITY.)
16.7
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER TO BE
  USED IN THE HORIZONTAL ORTHOGONAL POLYNOMIAL EXPANSIONS.
  THIS SHOULD NEVER BE GREATER THAN 12. FIVE OR SIX IS
  A GOOD  CHOICE.
2
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER FOR THE
  VERTICAL ORTHOGONAL POLYNOMIAL EXPANSIONS.  THIS SHOULD
  NEVER BE GREATER THAN 12. EIGHT, OR SO, IS A GOOD CHOICE.
2
  **********************************************
  STRETCHING MENU:
  0. LINEAR EXTRAPOLATION
  1. FUNCTIONAL EXTRAPOLATION
```

Figure A-8. (Continued)

```
  2. TRUNCATION EXTRAPOLATION
  3. GAMMA EXTRAPOLATION
  4. REID-WHEELER STRETCHING
  5. RODENBUSCH-FORRISTALL DELTA STRETCHING
      PLEASE ENTER YOUR CHOICE.
1
*****************************************************
  WHAT IS THE FILE NAME FOR THE MASTER FILE*
master1.dat
TVAR,STDEVI,ISTRCH,BSTR=     35.000000000000    5.9160797830996  1
    17.748239349299
JM=  1
JM=  11
JM=  21
JM=  31
JM=  41
JM=  51
JM=  61
JM=  71
JM=  81
JM=  91
JM=  101
ETA
VX
VY
VZ
AX
AY
AZ
P
M=   1
M=   101
M=   201
M=   301
M=   401
M=   501
M=   601
M=   701
M=   801
M=   901
M=   1001
STORING INTO MASTER FILE: M=    1
STORING INTO MASTER FILE: M=    101
STORING INTO MASTER FILE: M=    201
STORING INTO MASTER FILE: M=    301
STORING INTO MASTER FILE: M=    401
STORING INTO MASTER FILE: M=    501
STORING INTO MASTER FILE: M=    601
STORING INTO MASTER FILE: M=    701
STORING INTO MASTER FILE: M=    801
STORING INTO MASTER FILE: M=    901
STORING INTO MASTER FILE: M=    1001
```

Figure A-8. (Continued)

```
 ************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
8
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
1
NUMM,NT,VMULT  108  24    2.9225315068865D-02
  CHI**2 VALUE=   3952.417 CHI**2  DEGREES OF FREEDOM =        3974
  (CHI**2-MEAN CHI**2)/STDEV CHI**2 =          -0.242
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
```

Figure A-8. (Continued)

```
 1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
        THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
        ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
 2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
        LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
        LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
 3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
        LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
        LINE** GRAPHICALLY. (ANY STRETCH.)
 4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
        LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
        BY GRAPHICAL COMPARISON. (ANY STRETCH.)
 5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
        LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
        PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
 6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
        FOR SAME WAVE PROPERTIES AND LOCATIONS AS
        SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
        WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
 ***********************
 PLEASE ENTER YOUR CHOICE.
4
 WHAT WAVE PROPERTIES DO YOU WISH TO COMPARE?
 *********************************************
   YOUR CHOICES ARE:
 1. WAVE PROFILE
 2. WATER PARTICLE VELOCITY IN THE DIRECTION X
 3. WATER PARTICLE VELOCITY IN THE DIRECTION Y
 4. WATER PARTICLE VELOCITY IN THE DIRECTION Z
 5. WATER PARTICLE ACCELETATION IN THE DIRECTION X
 6. WATER PARTICLE ACCELERATION IN THE DIRECTION Y
 7. WATER PARTICLE ACCELERATION IN THE DIRECTION Z
 8. PRESSURE FLUCTUATIONS ABOUT STATIC PRESSURE
 *********************************************
      PLEASE ENTER YOUR CHOICE
2
 WHAT START TIME FOR COMPARISONS DO YOU WANT(0.0)?
60.0
 HOW MANY TIME STEPS DO YOU WANT?
    (NOT MORE THAN 20 WITH PRESENT DIMENSIONING)
2
  WHAT IS TIME INCREMENT FOR TIME STEPS (0.3)?
1.0
  HOW MANY AXIS-DIVISIONS DO YOU WANT?
     (NOT MORF THAN 20 WITH CURRENT DIMENSIONING)
9
  WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master1.dat
  WHAT Z-COORDINATE FOR TOP EDGE OF PLANE?
-5.0
  WHAT Z-COORDINATE FOR BOTTOM EDGE OF PLANE?
-25.0
```

Figure A-8. (Continued)

```
  WHAT X-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT Y-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT X-COORDINATE FOR RIGHT EDGE OF PLANE?
50.0
  WHAT Y-COORDINATE FOR RIGHT EDGE OF PLANE?
0.0
  ********** ERROR CHECK CHOICES: ************
  0.   EXIT.
  1.   CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
          THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
          ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
          LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
          LINE** GRAPHICALLY. (ANY STRETCH.)
  4.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
          BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
          PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.   COMPUTE TIME SERIES WITH ORTHOG. POLY.
          FOR SAME WAVE PROPERTIES AND LOCATIONS AS
          SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
          WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
6
 WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master1.dat
DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
  ********** ERROR CHECK CHOICES: ************
  0.   EXIT.
  1.   CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
          THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
          ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
          LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
          LINE** GRAPHICALLY. (ANY STRETCH.)
  4.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
          LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
          BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
```

Figure A-8. (Continued)

```
          LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
          PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
   6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
          FOR SAME WAVE PROPERTIES AND LOCATIONS AS
          SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
          WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
   ***********************
   PLEASE ENTER YOUR CHOICE.
 0
 **************************************************
   OPTIONS ACTIVE ON THIS PROGRAM:
   0. EXIT PROGRAM
   1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
   2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
   3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
   4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
   5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
   6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
 ************************************************
            (PLEASE KEY YOUR CHOICE AND RETURN)
 7
   SELECT SOURCE FOR TIME SERIES LIST:
      0. EXIT.
      1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
      2. GIVEN TIME SERIES CONDITIONED ON.
      3. TIME SERIES FROM POLYNOMIALS.
           (ICHUZ=3, 4, OR {8-SUB 6} MUST HAVE BEEN RUN PREVIOUSLY.)
   *******************
   (PLEASE ENTER YOUR CHOICE.)
 3
  ENTER TIME STEP FOR START OF LIST (I5)
 1
  ENTER TIME STEP AT TERMINATION OF LIST (I5)
 1024
   ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
   KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
 1
 **************************************************
   OPTIONS ACTIVE ON THIS PROGRAM:
   0. EXIT PROGRAM
   1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
```

Figure A-8. (Continued)

```
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
0
```

Figure A-8. (Continued)

```
 INPUT FILE NAME (sim5.dat) ?
sim5.dat
 INPUT MASTER FILE NAME (master1.dat) ?
master1.dat
```

Figure A-9.
Listing of file "case1.input3 console."

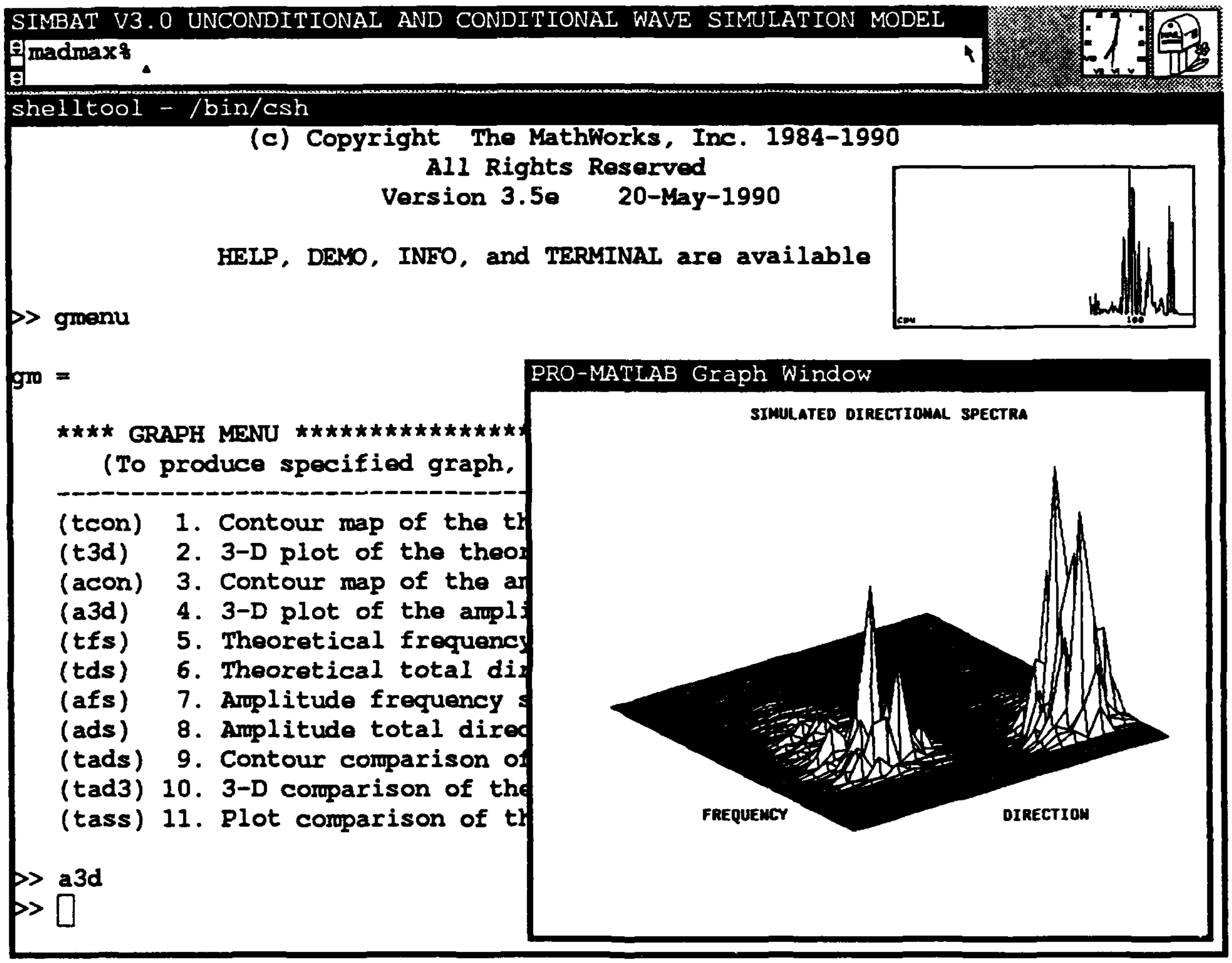

Figure A-10.
Example of computer console for execution of MATLAB
with SIMBAT plot menu file "gmenu.m."

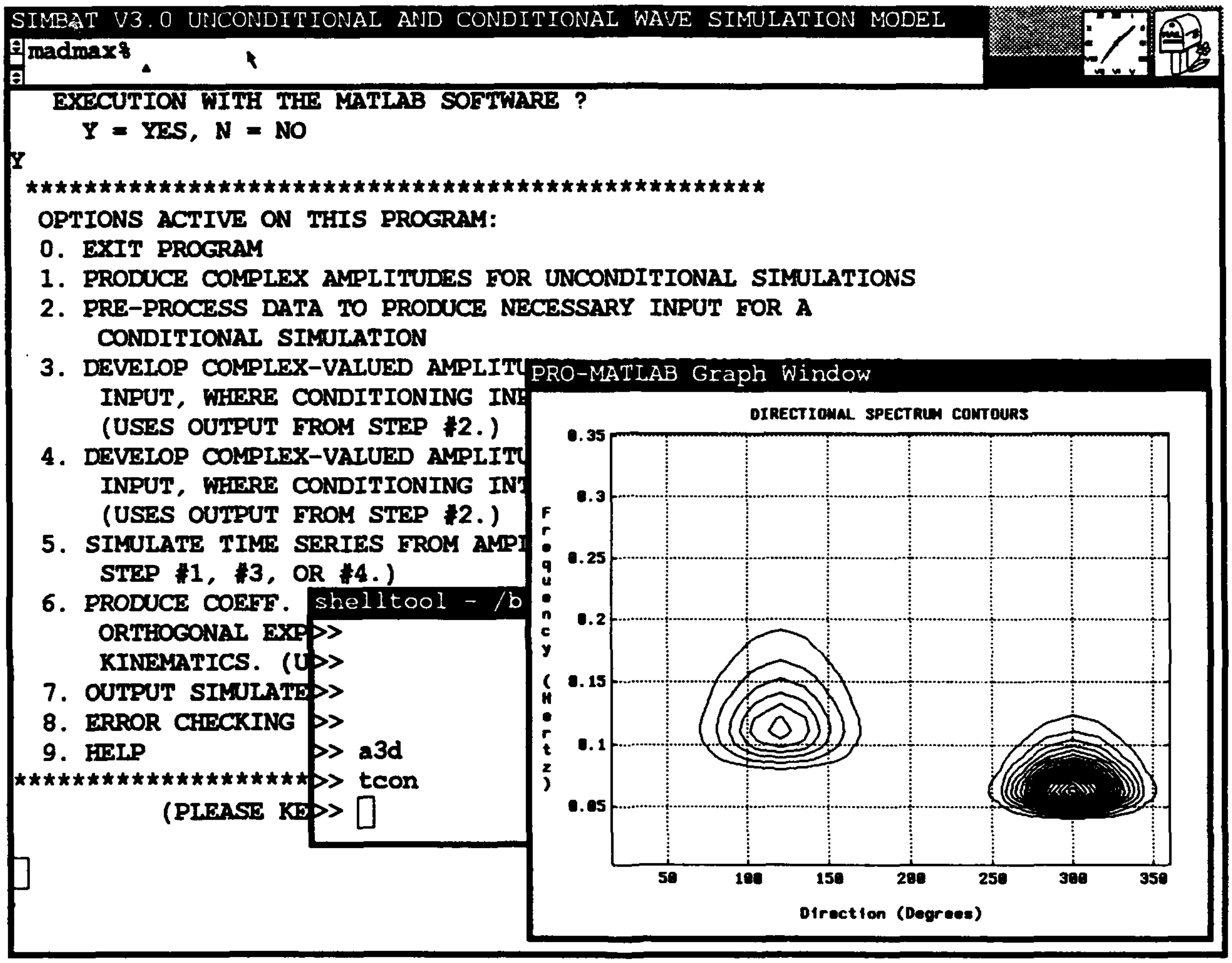

Figure A-11.
Example of computer console executing SIMBAT
interactively with MATLAB graphics in another window.

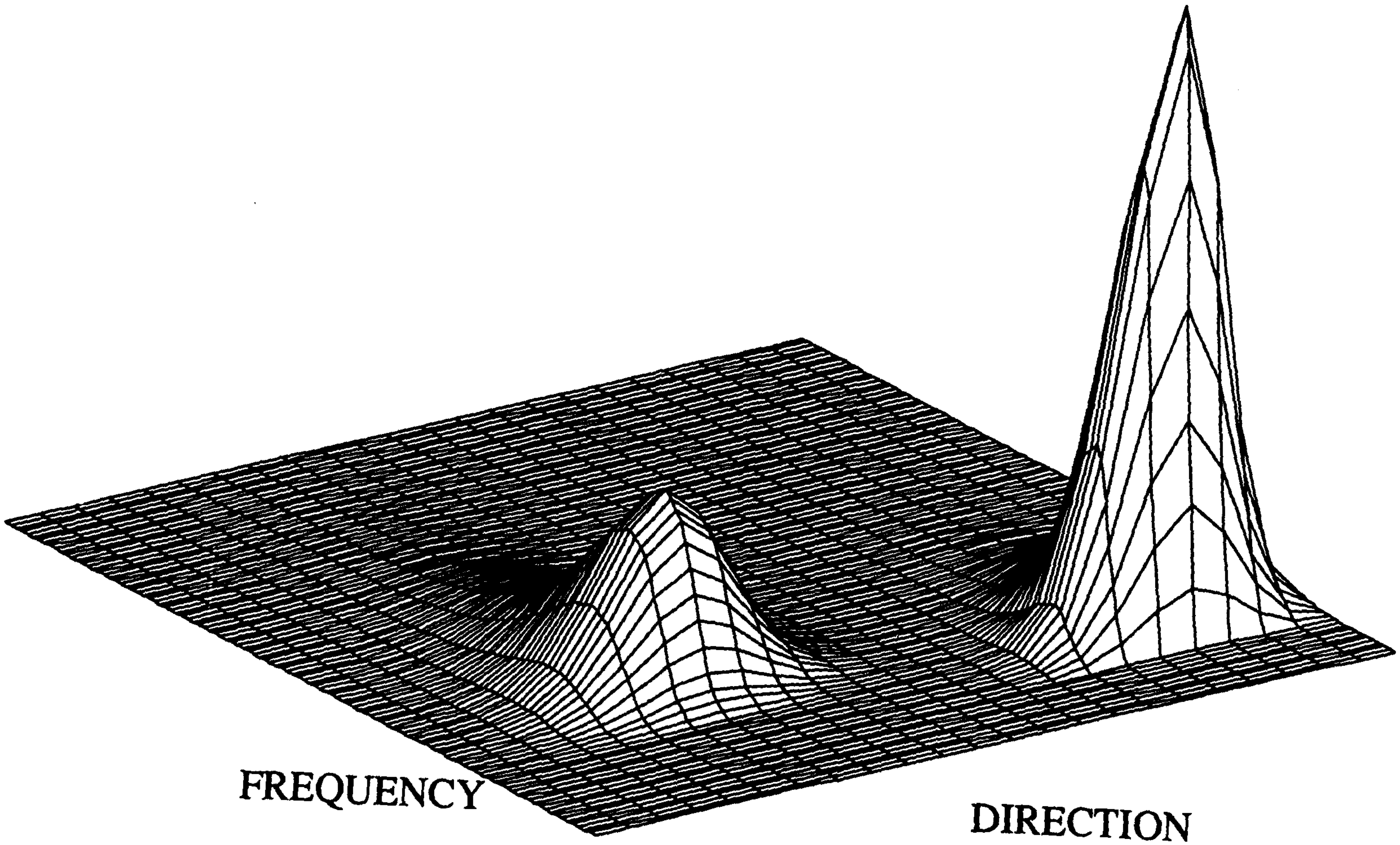

Figure A-12.
3D directional spectrum plot generated in SIMBAT and plotted with MATLAB.

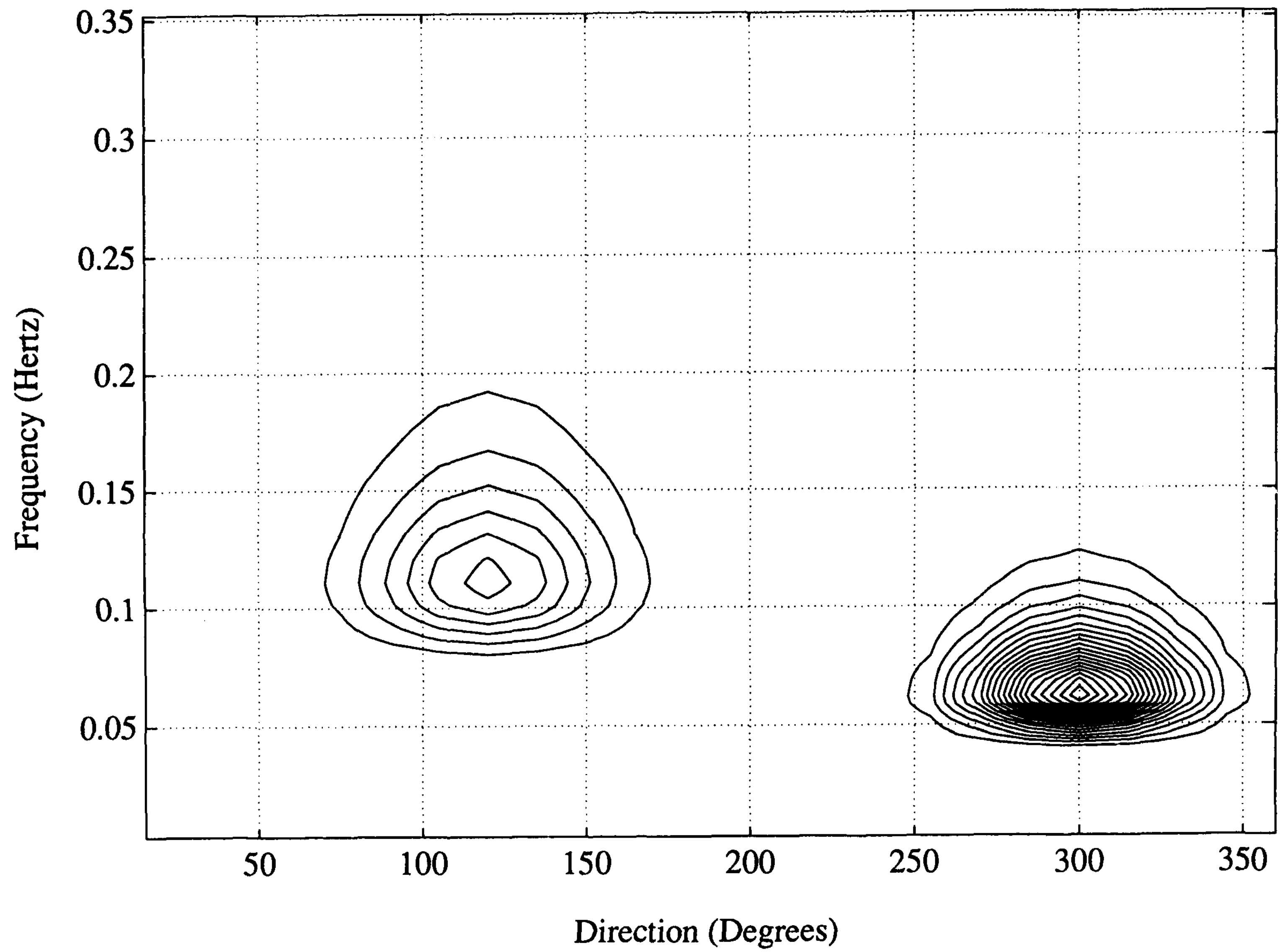

Figure A-13.
Contour plot of same 3D spectra.

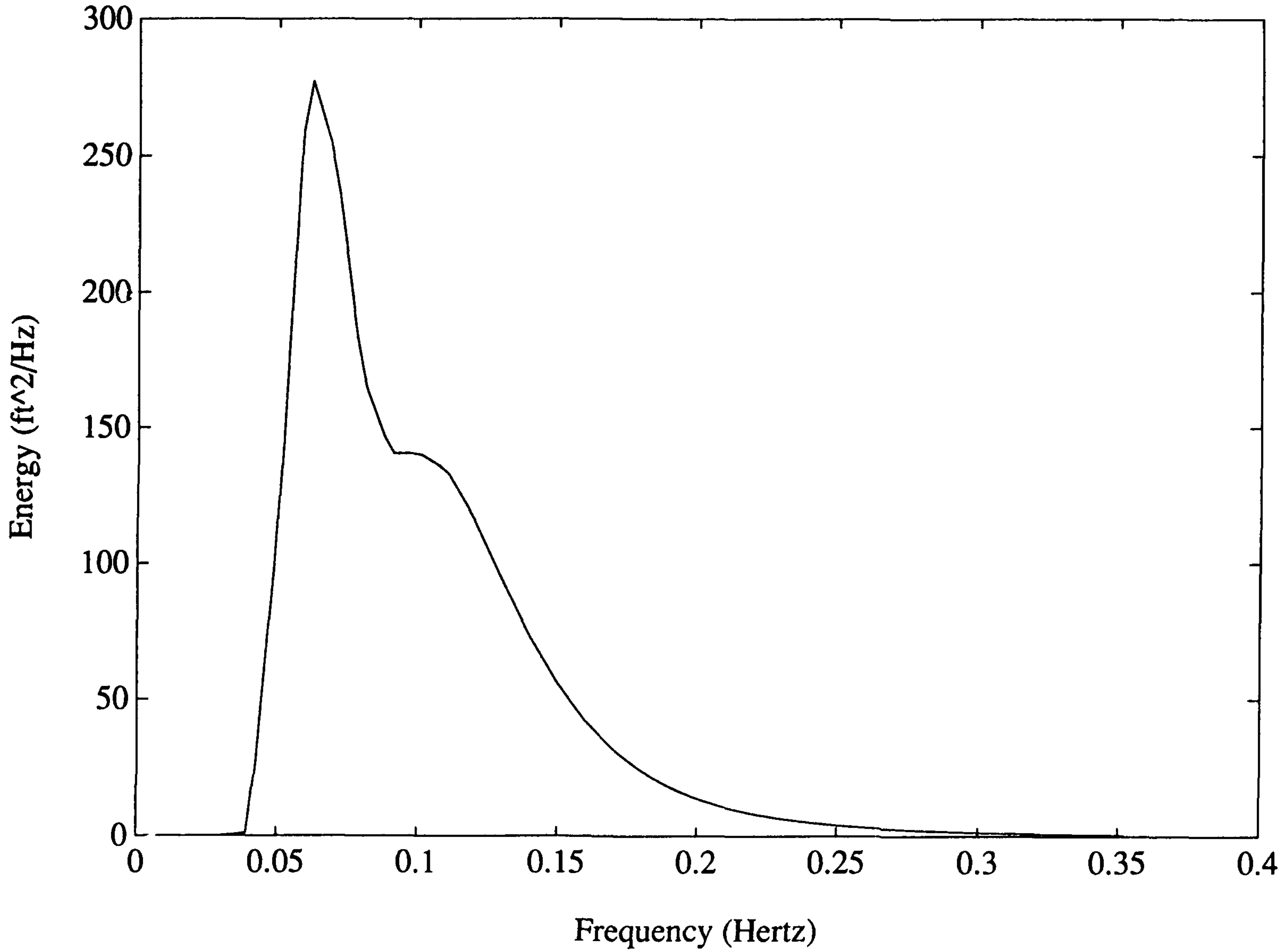

Figure A-14.
2D spectra - Ochi-Hubble.

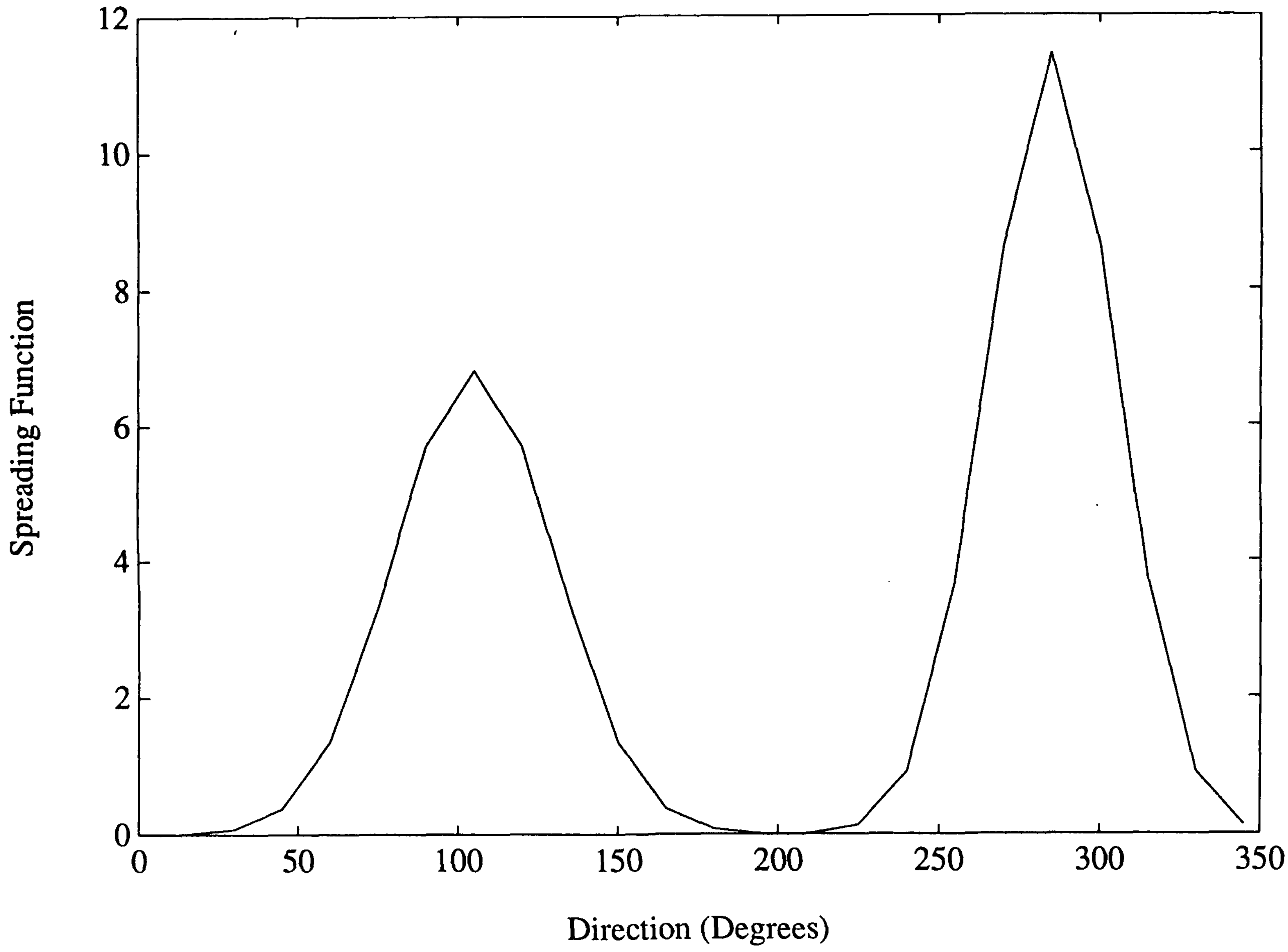

Figure A-15.
Spreading function plot - wrapped normal.

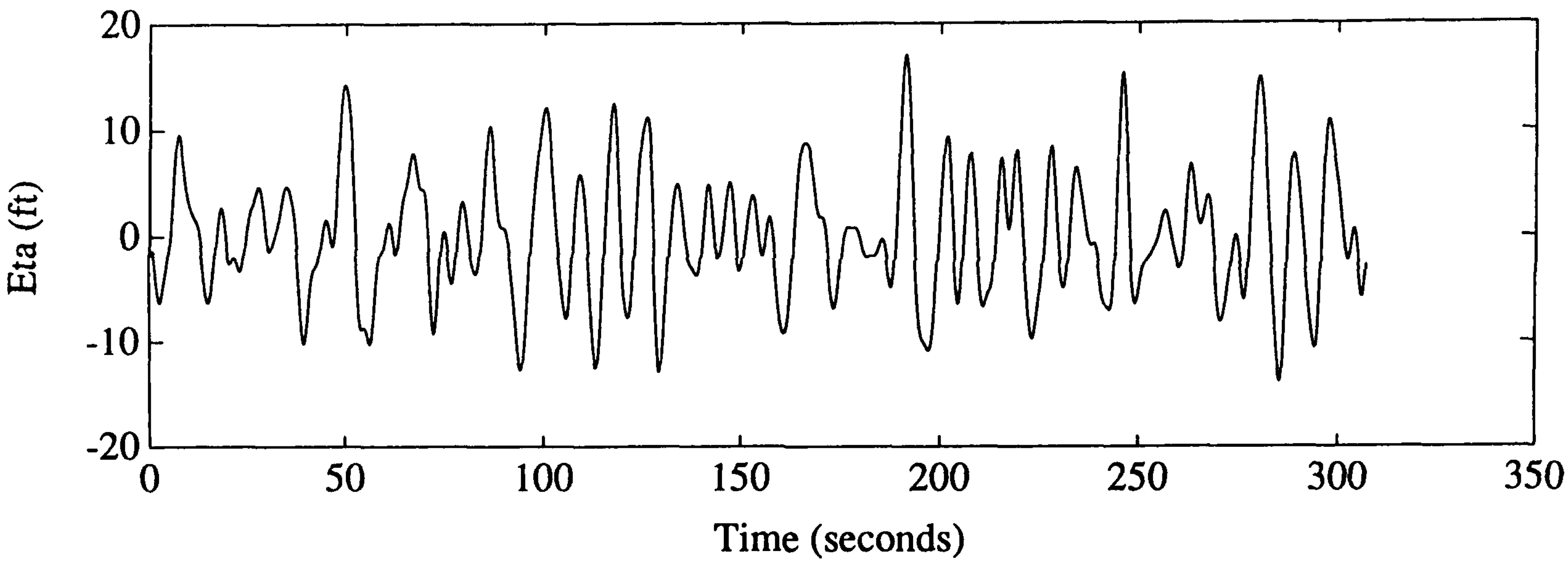

Figure A-16.
Wave (η) time history.

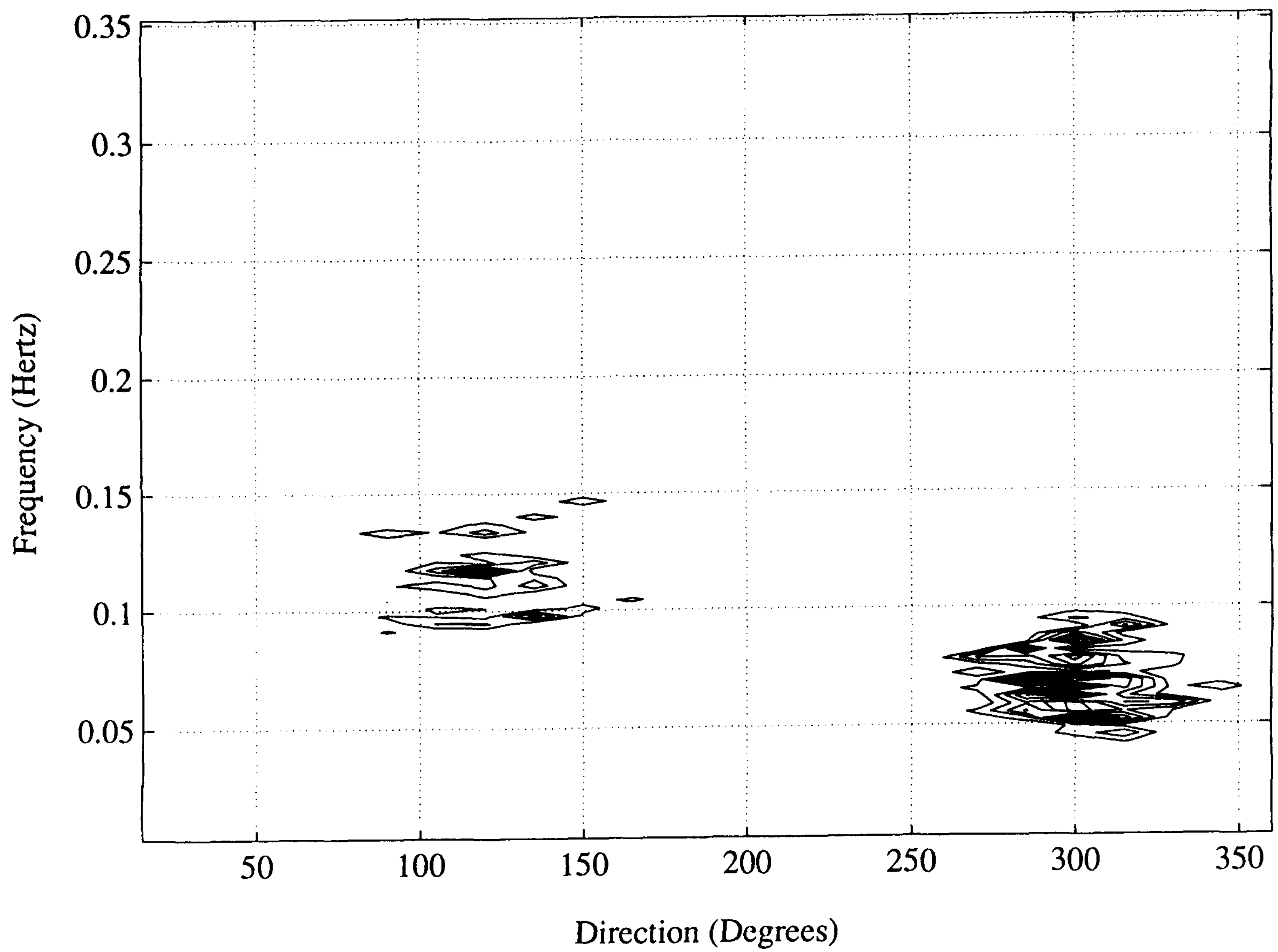

Figure A-17.
Simulated contour plot of spectra.

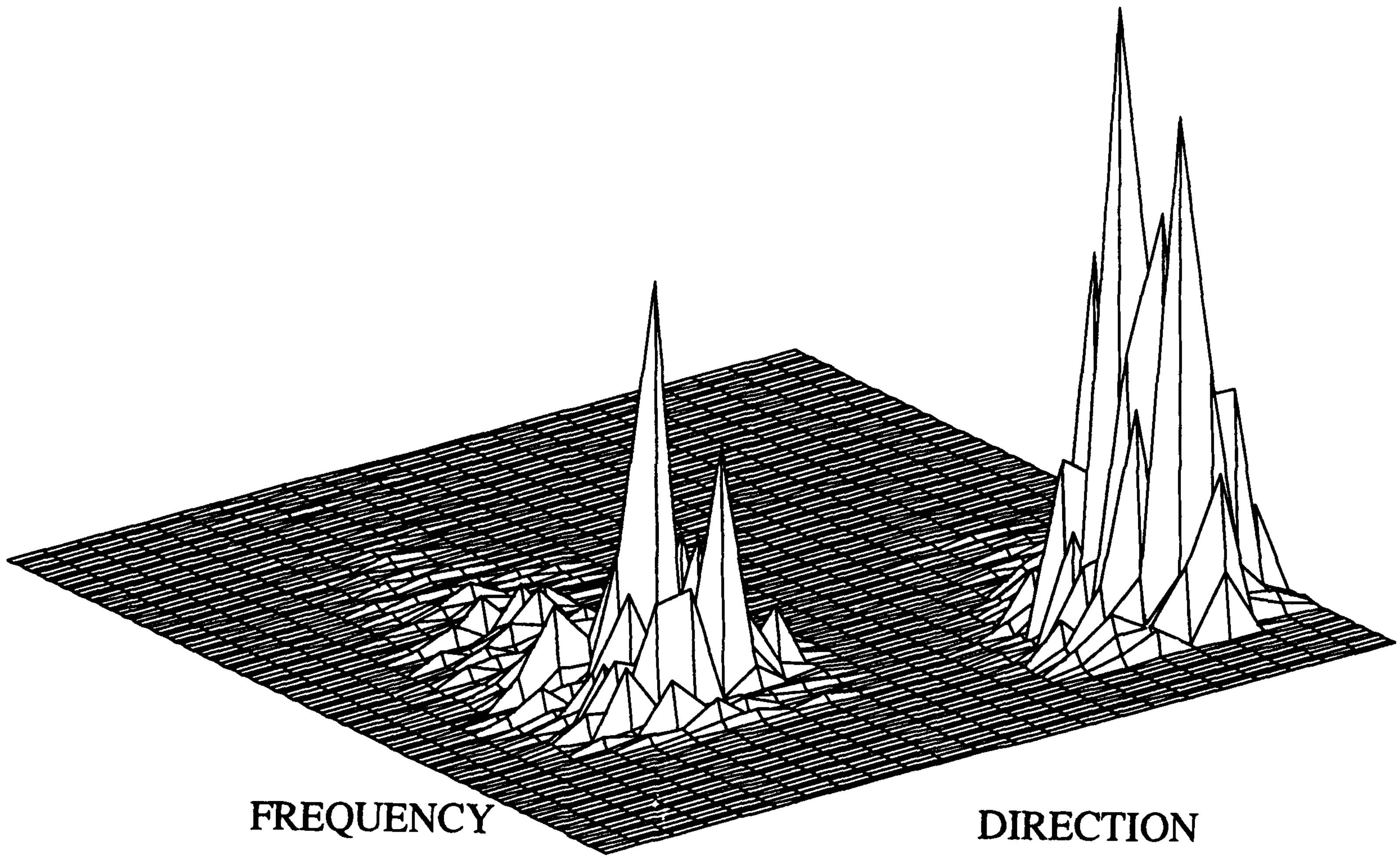

Figure A-18.
Simulated 3D spectra plot.

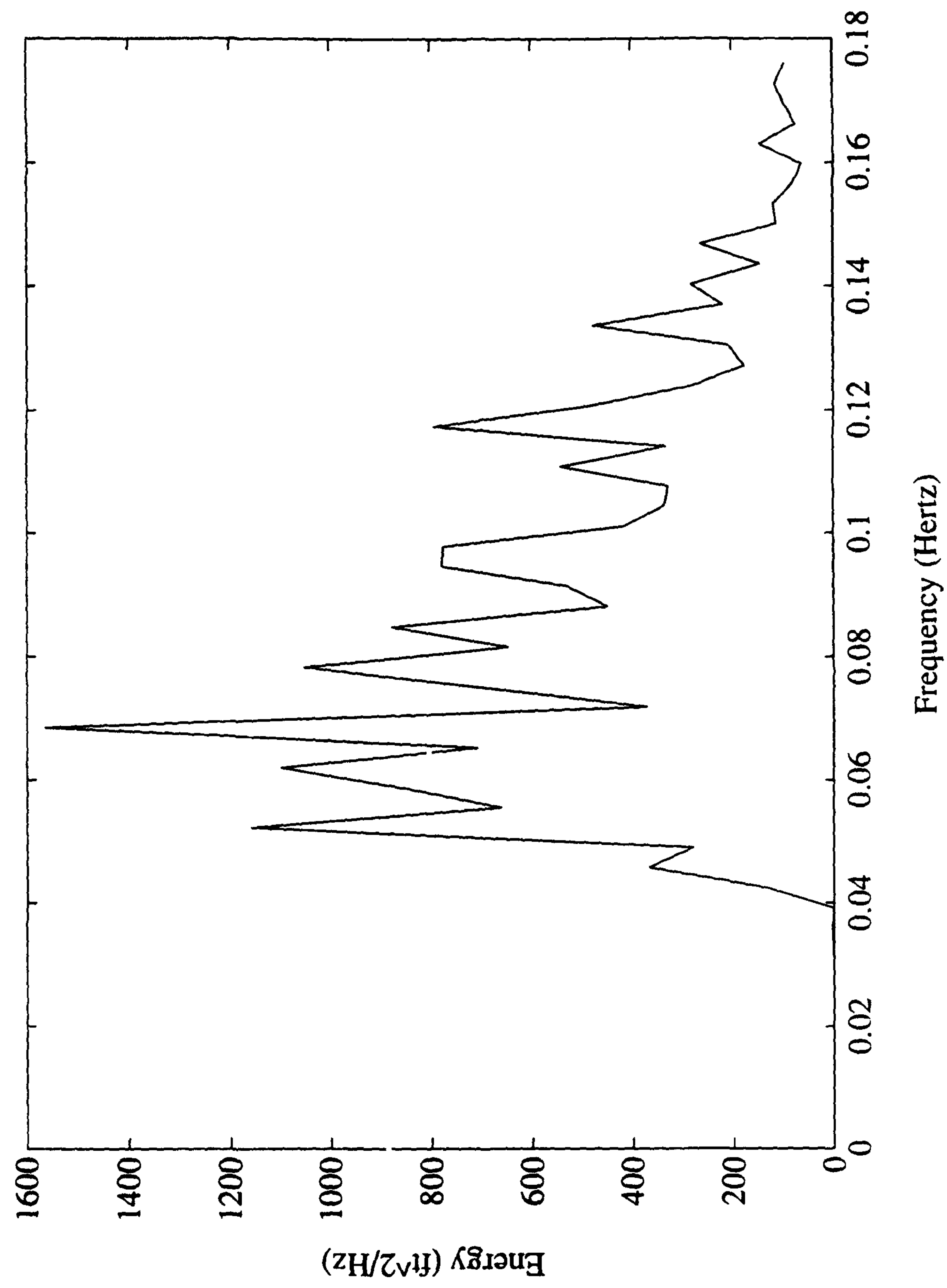

Figure A-19.
2D simulated spectra.

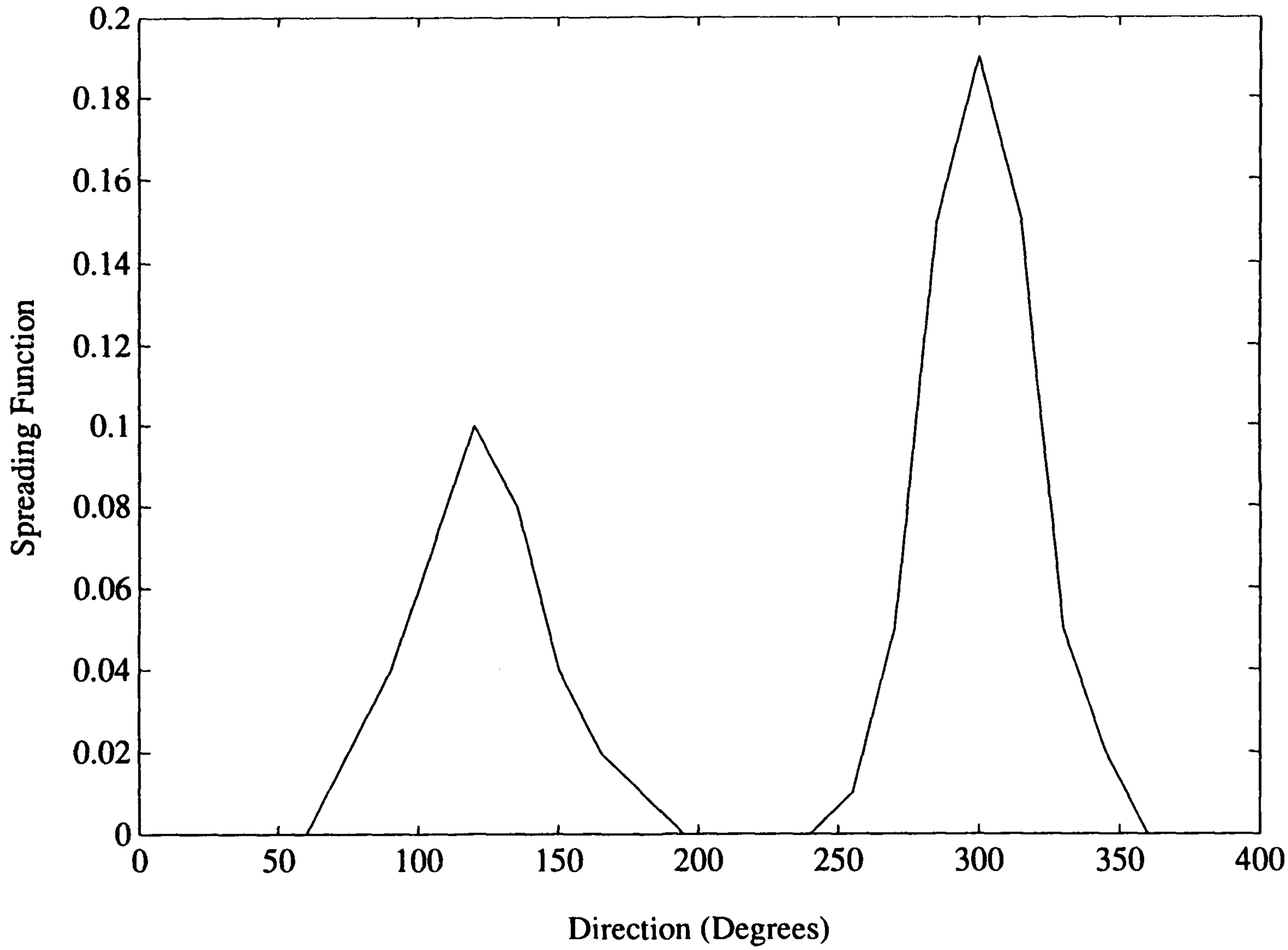

Figure A-20.
Spreading function - wrapped normal.

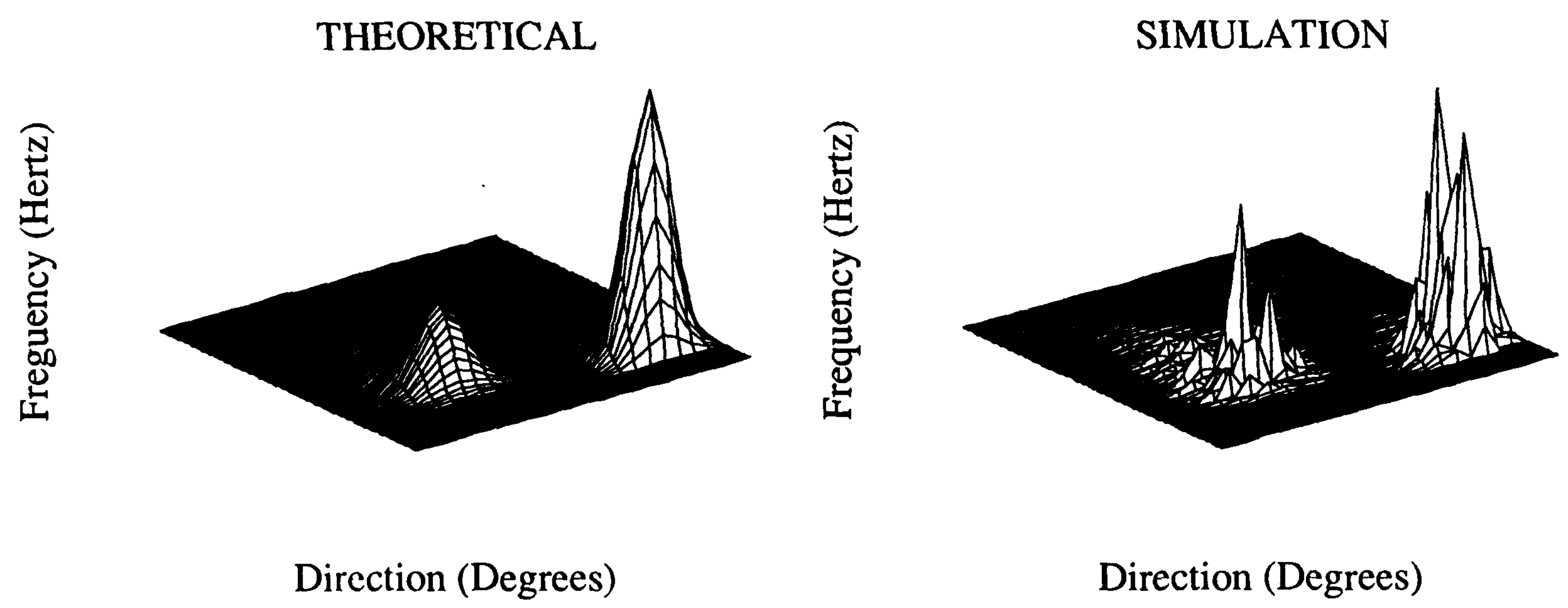

Figure A-21.
Comparison of theoretical spectra and simulated spectra.

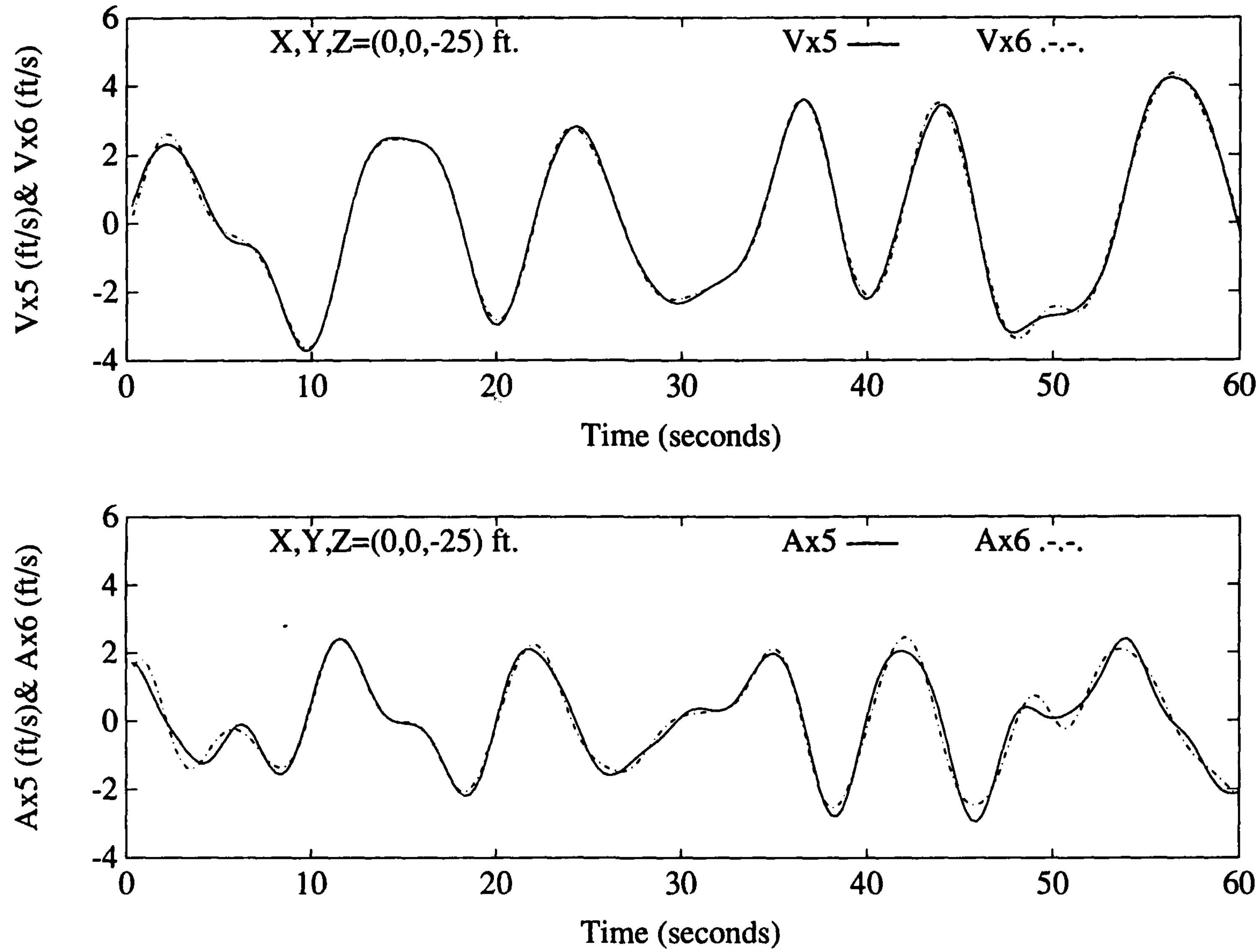

Figure A-22.
Comparison of velocity in x direction and acceleration in x direction utilizing frequency domain method and Legendre polynomial method. Note excellent fit.

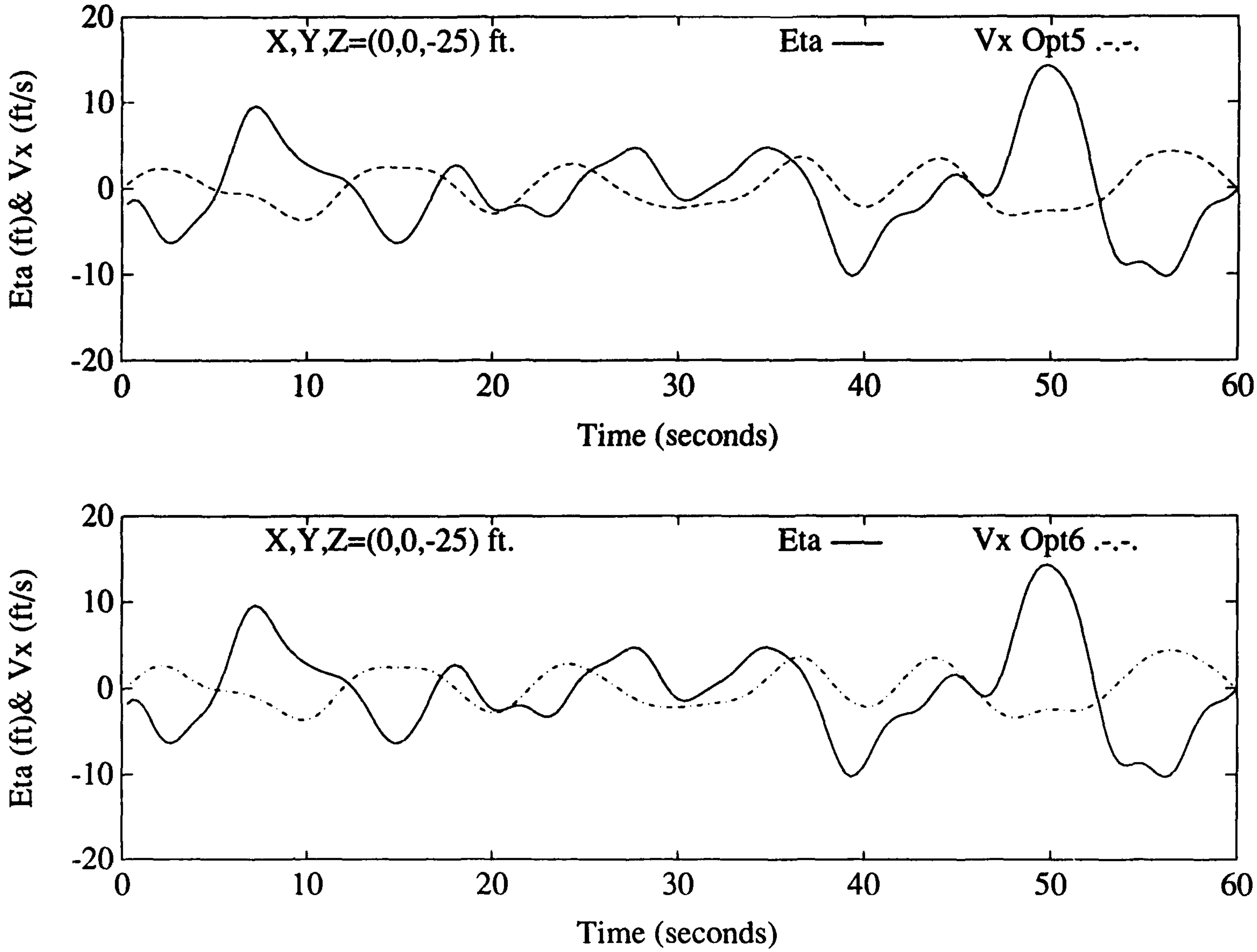

Figure A-23.
Velocity in x direction for option No. 5 and No. 6.

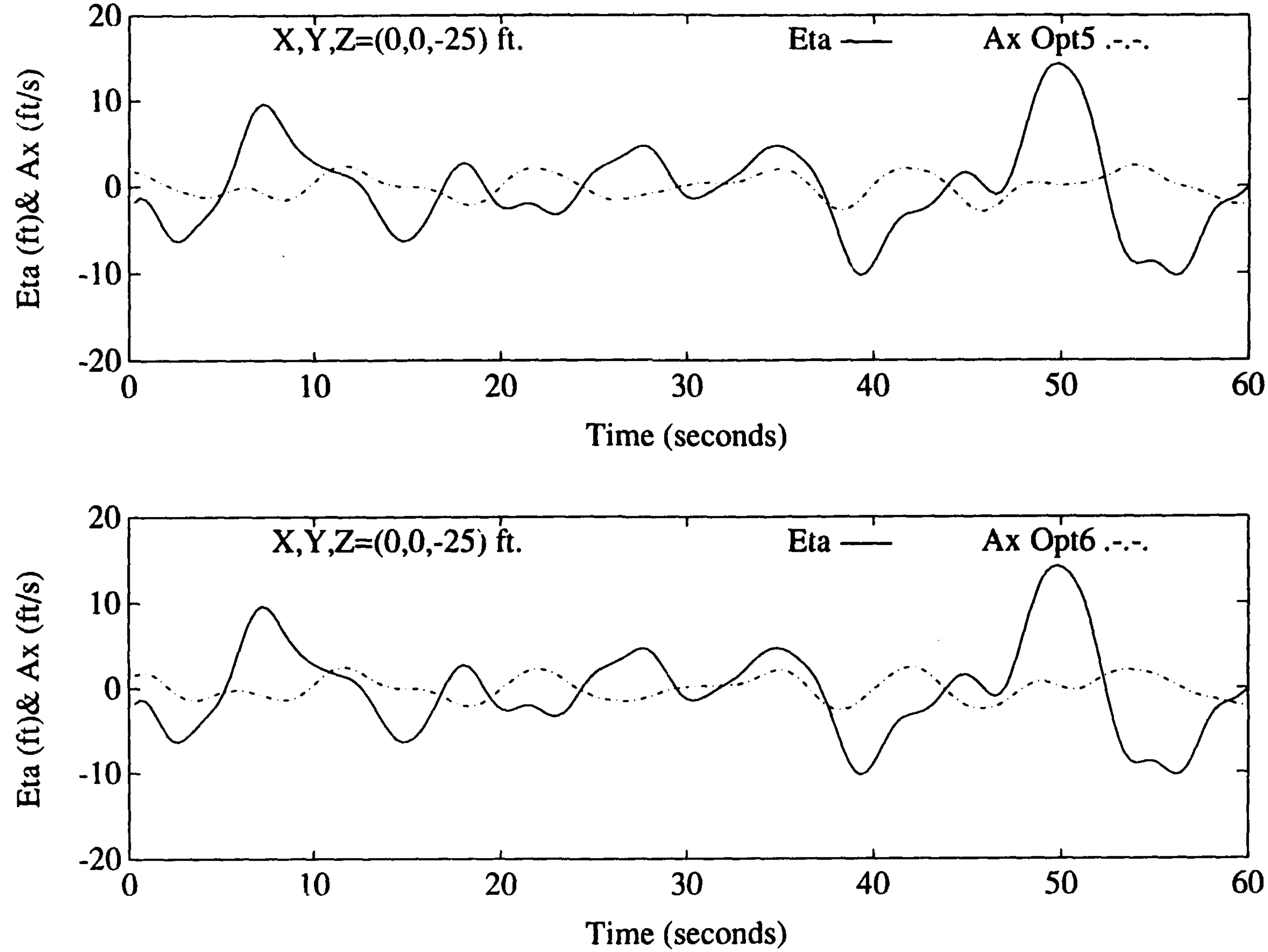

Figure A-24.
Acceleration in x direction for option No. 5 and No. 6.

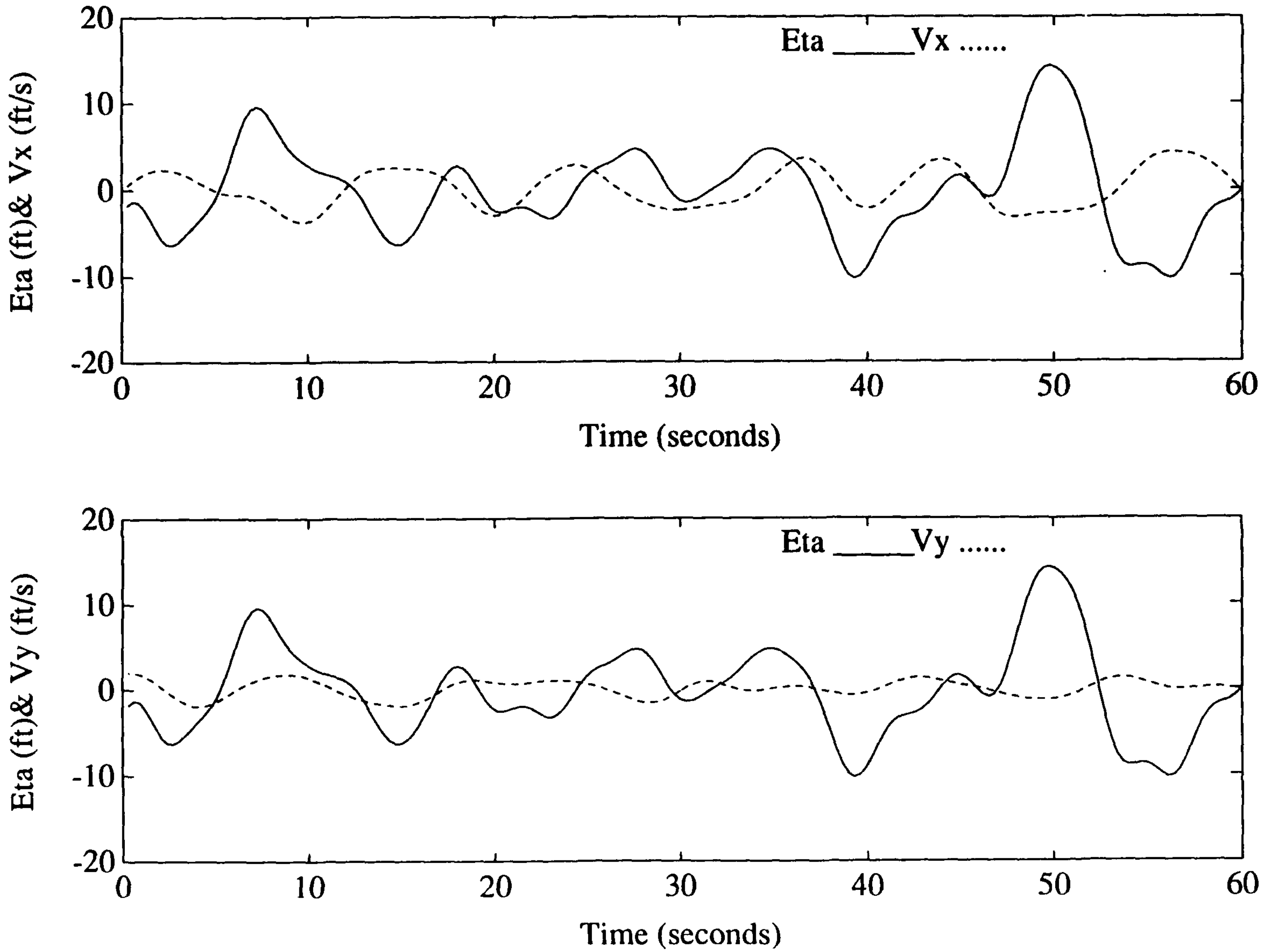

Figure A-25.
Example of η with V_x and V_y at (0,0,-25) feet.

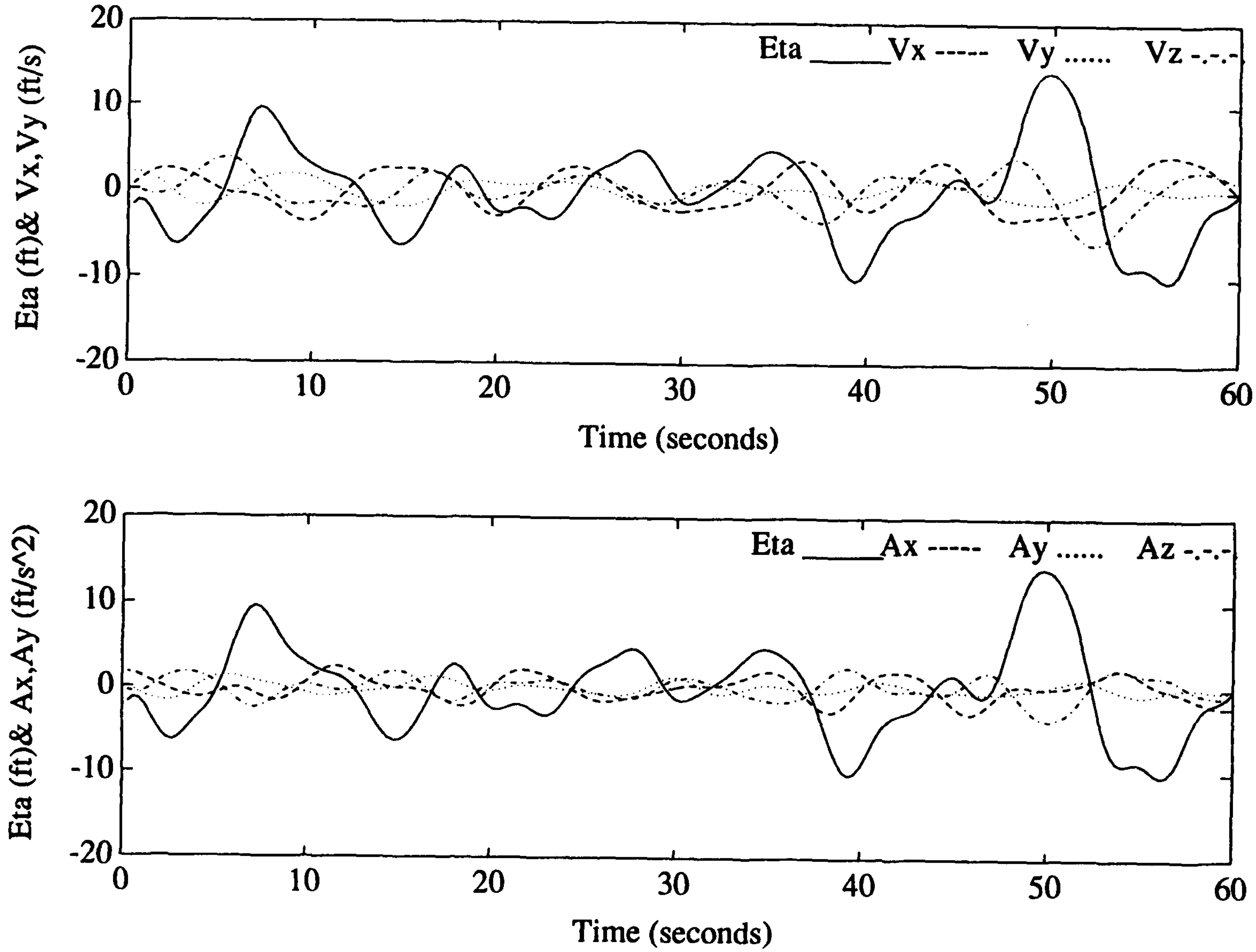

Figure A-26.
Example of η with A_x and A_y at (0,0,-25) feet.

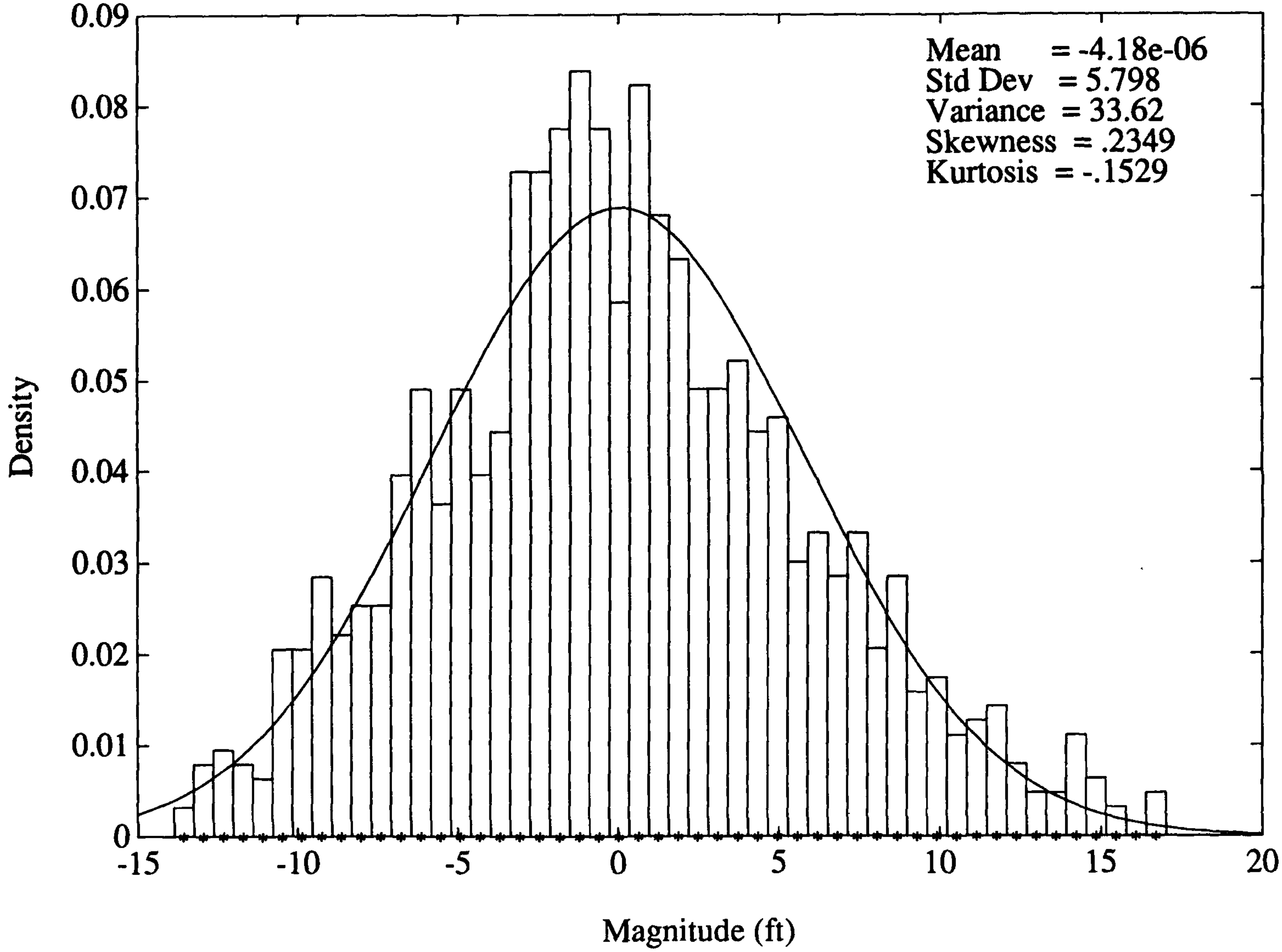

Figure A-27.
Histogram of simulated η for seed = 123456789.

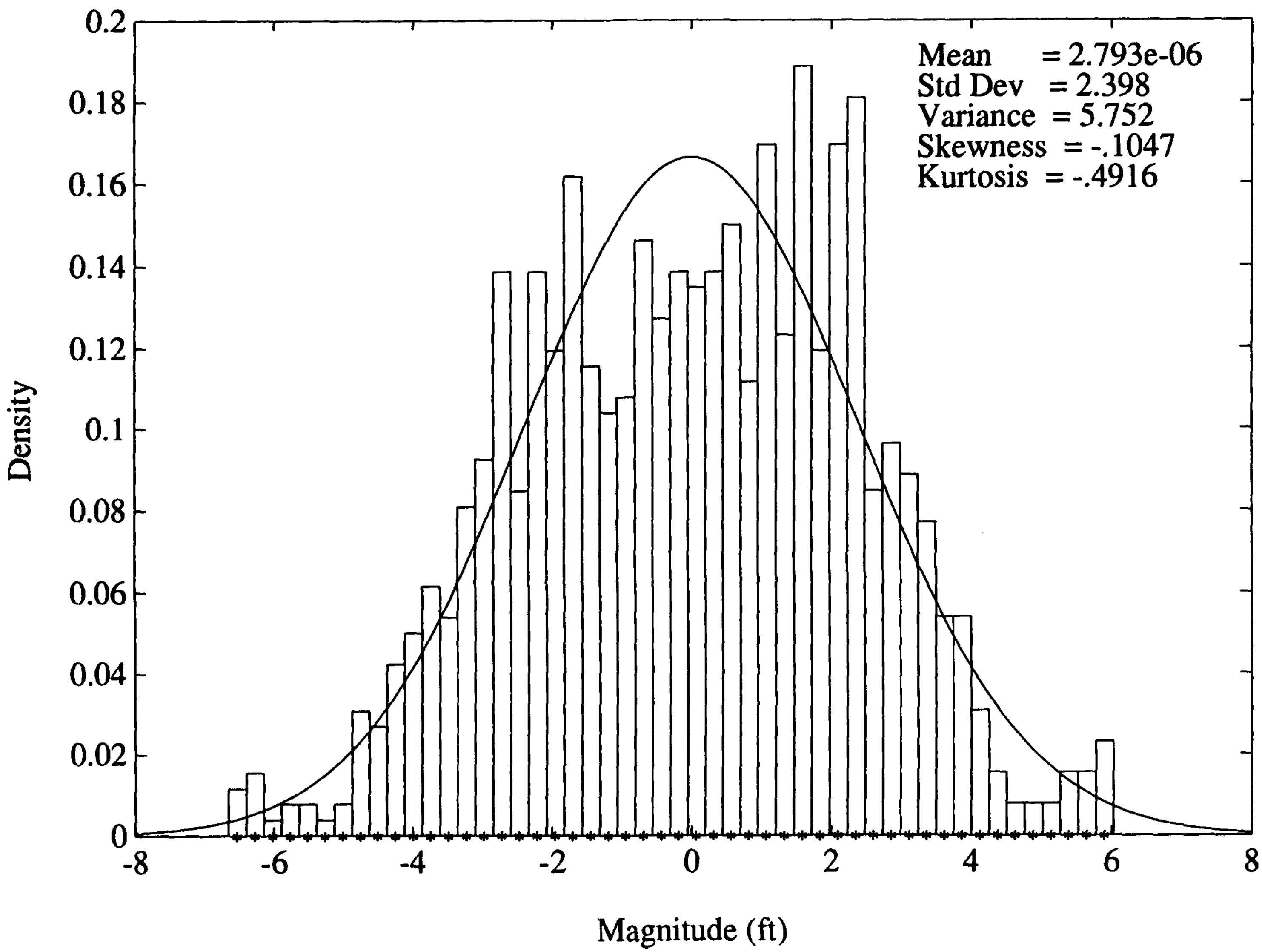

Figure A-28.
Histogram and normal probability distribution of simulated velocity in x direction for frequency domain option N = 1024 pts.

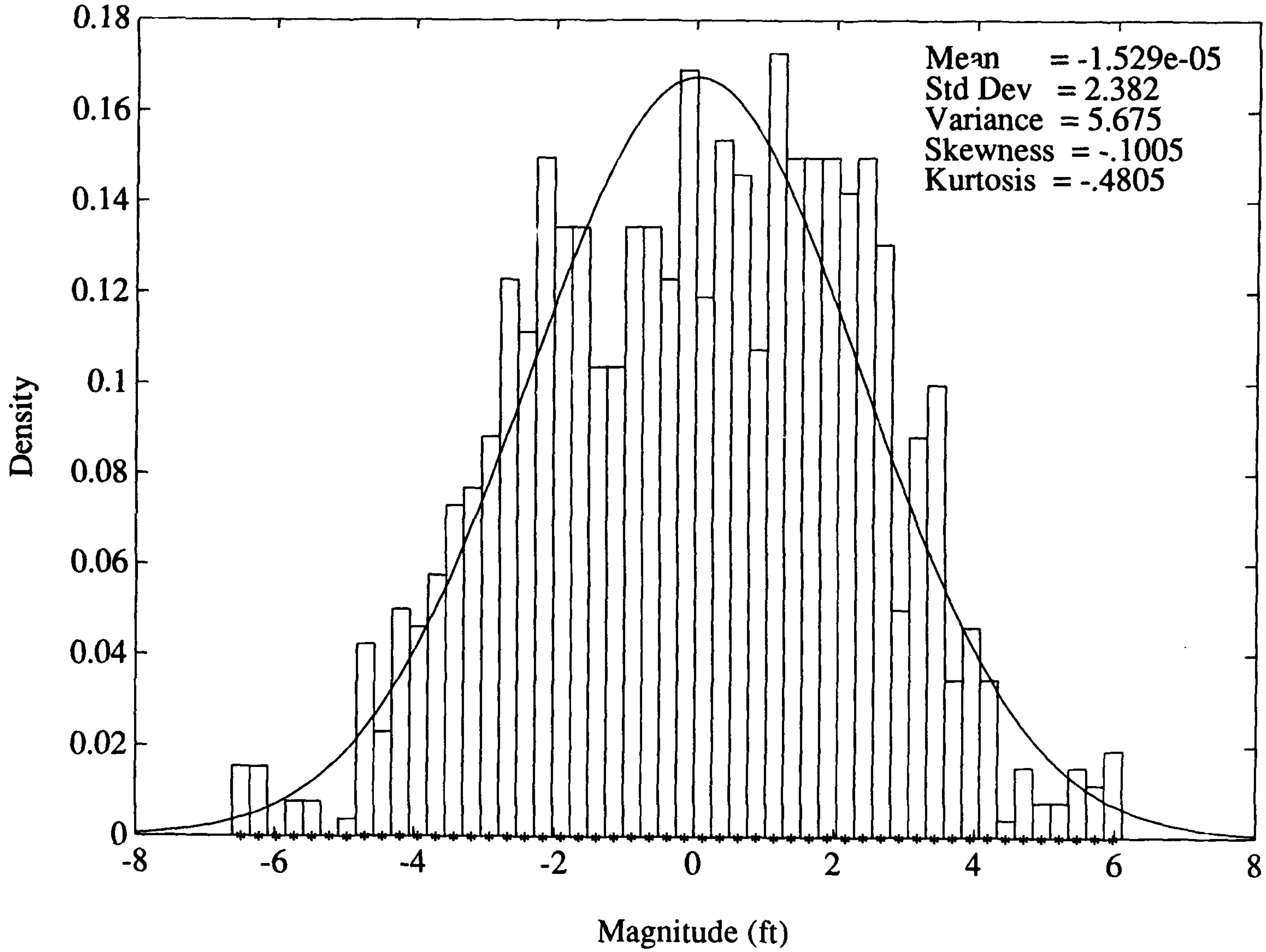

Figure A-29.
Histogram and normal probability distribution of simulated velocity in x direction for Legendre polynomial approximation method, N = 1024 pts.

Appendix B

EXAMPLE NO. 2 — CONDITIONAL SIMULATION

L<N

- N=1024 points
- Input one large wave, L=40 points
- Ochi-Hubble Spectra
- Wrapped Normal Spread
- Delta Stretch
- 5th Order Polynomial Fit
- Compare kinematics at X,Y,Z= 10,10,-15 ft. for SIMBAT Options #5 and #6

File "INSTRUCTIONS"

```
------------------------------------------------------------------------------
Simbat Test Case 2 Description:
------------------------------------------------------------------------------

This example demonstrates a conditional simulation for eight wave
properties. The wave properties Eta,Vx,Vy,Vz,Ax,Ay,Az & P are
each 1024 points in length spaced at 0.3 seconds (307.2 seconds
each). The simulation uses the Ochi-Hubble directional spectra
with wrapped normal spreading  created in Example #1. The wave
properties are conditioned by a large wave placed in the middle
of the simulation using Option #3. The wave properties are
simulated at a point in space at X,Y,Z=10,10,-15 feet using
Option #5. Next Option #6 is used to create the Legendre
orthogonal polynomials for a horizontal area of 100 ft X 100 ft.
Delta stretching is used to stretch the kinematics above the mean
water line. The water depth is 2,926 ft. Finally, the wave
properties are compared at 10,10,-15 ft for the Options #5 and
#6.  The simulation requires about 2-5 minutes execution time on
a Sun 4/310 computer.

Examination of the source code simbat.f and ckpoly.f in
subdirectory "source" show the PARAMETER and DATA statements used
for this example problem. An explanation of the values for these
statements are described in the SIMBAT USERS MANUAL and in the
source code itself and therefore will not be discussed here. The
binaries are included for this example so you should be able to
run simbat on any Sun4 SPARC based computer without having to
recompile first. If you wish to modify simbat.f or ckpoly.f, type
"f77 simbat.f" and "f77 -o b.out ckpoly.f" to recompile.

The batch files execute Simbat for the following options:

        Option 2 - Preprocess data for Conditional Simulation
        Option 3 - Perform Conditional Simulation for case L<N
        Option 5 - Create time series from frequency domain methods
        Option 6 - Create Legendre Polynomial file
        Option 8 - Create kinematic comparisons for MATLAB plots
        Option 7 - Print kinematics to output file "simbat.out"

See the file "FILES" in this directory for explanation of files
on this tape.

----------------------------------------------------------------------------
    TO TEST EXAMPLE:
----------------------------------------------------------------------------

    1) Go to subdirectory "ourtest" and you should see the following files:

         a.out         - simbat binary for sun4
         b.out         - ckpoly binary for sun4
         case2.input1  - input data set one for a.out
```

Figure B-1.
Listing of file "INSTRUCTIONS."

```
      case2.input2   - input data set two for a.out
      case2.input3   - input data for b.out
      dspec.dat      - sample input spectra
      ww383.dat      - input time series data (one wave profile)

NOTE: the two batch files case1.input1 and case1.input2 are both
        required in order to compare the outputs of SIMBAT Option #5 and #6.
        This is because the user must exit SIMBAT in order for SIMBAT to
        write the output file for Option#5 that is read into CKPOLY. In a
        real life situation this would ordinarily not be required since the
        user would probably execute either Option#5 or Option#6 and the
        comparison would not be done. It is done in all the examples for
        educational purposes only.

   2) To execute in batch mode, do the following where % is unix
      prompt and & is run in background:

      % a.out < case2.input1  &
              (this creates data necessary for input to b.out)

      % a.out < case2.input2  &
              (this creates data necessary for input to b.out
               and all other output files)

      % b.out < case2.input3  &
              (this compares frequency domain to Legendre Polynoimal
               approximation method as shown in output file: ckpoly.com)

  3) If you would like to use matlab to plot data, copy all the
     files from the "mfiles" subdirectory into "ourtest" directory:

     % cp ../mfiles/*.m .

     Simbat will produce mfiles that have an "*f.m" in their
     name where "*" is the unix wildcard. These mfiles are data
     files whereas the mfiles in the "mfiles" subdirectory are
     matlab script files. Next:

      a) start matlab
      b) matlab> gmenu   (this will provide a menu for plotting)
      c) matlab> tcon    (this will plot spectra contours)
      d) matlab> tsdatf  (this reads time series output into matlab)
      e) matlab> plsall  (this will plot tsdatf data)
      d) pls,plvxx,plaxx,plva.... all read data from tsdatf and
         plot to screen as well.
      e) matlab> prtsc or print to dump plot to printer.
      f) NOTE: matlab can be used in a separate window if you run
            simbat interactively. Thus you can verify data as you
            proceed through simbat. Step 2) above is meant
            to be for a streamline batch execution of simbat.
```

Figure B-1. (Continued)

```
FILE "FILES"

This directory contains Simbat V3.00 Test Case Example #2 Data Files,
source code and executables. This file provides a description of each
file. See INSTRUCTIONS file for additional details.

GENERAL FILES:
--------------

INSTRUCTIONS - instructions for simulation
FILES        - this file


DIRECTORIES:
------------

mfiles  - MATLAB script files for plotting data
source  - source code
nceltest - example output data from Naval Civil Engineering Laboratory
ourtest - your execution directory


SOURCE FILES AND BINARIES:
--------------------------

simbat.f  - simbat V3.00 source code
ckpoly.f  - simbat post processor source code
a.out     - simbat binary for sun4
b.out     - ckpoly binary for sun4

INPUT BATCH FILES:
------------------

case2.input1 - input data set one for a.out
case2.input2 - input data set two for a.out
case2.input3 - input data for b.out

case2.input1.console - console listing
case2.input2.console - console listing
case2.input3.console - console listing

INPUT DATA FILES:
-----------------

dspec.dat - sample input spectra (see example #1 for details)
w383a.dat - input time series data. Represents NCEL MME free surface
            elevation for 1/18/88 0429-0449.  40 data points at
            dt=0.3 seconds.   Eta was created by algebraically
            adding wavestaff data to doubly integrated heave acceleration
            data that was low passed filtered at 0.025 Hz.

OUTPUT FILES:
```

Figure B-2.
Listing of file "FILES."

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

simbat.out  - text and general data. Note for this example, the kinematics
              from Simbat Option #5,#7 and #6,#8 and #7 are also listed
              where Option #5 is listed first and those from Option #6
              are listed next. Simbat.out documents which is which.
master2.dat - Legendre Polynomial data file
tsdatf.m    - time series output from frequency domain methods to be read
              by matlab.
ptsdatf.m   - time series output from Legendre Polynomials. Append this
              file to end of tsdatf.m for use in matlab.
ckpoly.com  - output from b.out that compares kinematics between frequency
              domain methods and Legendre Polynomial approximation method.
ckpoly.lst  - kinematics created from master2.dat


EXAMPLE MATLAB "M.FILES" FOR PLOTTING OUTPUT:
--------------------------------------------
"gmenu.m" should be executed first in matlab. This
menu will list the following matlab "m-files":

gmenu.m   - matlab menu for spectra script
   tcon.m     - matlab contour plot script
   t3d.m      - matlab spectra plot script
   acon.m     - matlab simulated contour plot script
   a3d.m      - matlab 3D simulation spectra plot script
   tfs.m      - matlab point spectra script
   tds.m      - matlab directional spread script
   afs.m      - matlab simualted point spectra script
   ads.m      - matlab simulated directional spread plot script
   tads.m     - matlab direction spread plot script
   tad3.m     - matlab 3D spectra plot script
   tass.m     - matlab plot comparison script file

The next set of m.files are for plotting time series
output form data files tsdatf.m, gtsf.m, ptsdatf.m.
They do not have to be executed in any particular order
and are meant to be samples to be modified by the user.

probeta.m - matlab histogram of input eta
probseta.m - matlab histogram of simulated eta
probvx5.m - matlab histogram of velocity in x direction, Opt 5
probvx6.m - matlab histogram of velocity in x direction, Opt 6
plg.m     - matlab input data plot script
pls.m     - matlab general plot script
plsall.m  - matlab general plot script
plsaxx.m  - matlab plot output acceleration data script
plsva.m   - matlab plot  output velocity & acceleration data script
plsvxx.m  - matlab plot velocity of sim5 vs sim6

Example: 1. in unix, append ptsdatf.m to end of tsdatf.m
         2. in unix, remove redundant information brought in from
```

Figure B-2. (Continued)

```
   the psdatf.m file. (use vi,emacs,etc)
3. start matlab
2. matlab> tsdatf   (reads data into matlab)
3. matlab> plsall   (plsall will read tsdatf.m data and
                     plot data to screen)

----------------------------------------------------------------------
SEE "INSTRUCTIONS" FILE FOR SIMULATION PROCESS AND USE OF MATLAB FILES.
----------------------------------------------------------------------
```

Figure B-2. (Continued)

```
R
N
Example #2 Conditional Simulation Options #2-3-5-6-8-7
Conditional Simulation  L<N, Delta Stretch
2
464451
2
dspec.dat
1
Y
3
1
ww383.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
0
Y
sim5.dat
```

Figure B-3.
Listing of "case2.input1."

```
R
N
Example #2 Conditional Simulation Options #2-4-5-6-8-7
Conditional Simulation  L<N, Delta Stretch
2
464451
2
dspec.dat
1
Y
3
1
ww383.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
7
1
1
1024
1
6
master2.dat
example #2
0.0
0.0
50.0
50.0
16.7
5
5
5
0.3
11.382
master2.dat
8
1
4
2
60.0
2
1.0
9
```

Figure B-4.
Listing of "case2.input2."

```
master2.dat
-5.0
-25.0
0.0
0.0
50.0
0.0
6
master2.dat
Y
0
7
3
1
1024
1
0
```

Figure B-4. (Continued)

```
sim5.dat
master2.dat
```

Figure B-5.
Listing of "case2.input3."

```
 *********************************************** ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 **********************************************************
R




 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
--------------------------------------------------
Example #2 Conditional Simulation Options #2-3-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
-----------------------------------------------------
Conditional Simulation  L<N, Delta Stretch
 ***************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure B-6.
Listing of "case2.input1.console."

```
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
0.00001
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
464451
*************************************************
 ENTER IOPT:
    IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
       STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
    IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
       USER-SPECIFIED FILE
***************************************************
2
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
dspec.dat
*************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
        CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
***************************************************
1
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.9225051241239D-02
NUMBER OF DEGREES OF FREEDOM =   5184
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
 *************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
```

Figure B-6. (Continued)

```
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
       (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
       STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
       ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
       KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
3
MENU FOR OPTION #3 CONDITIONING INPUT:
  1. READ THE CONDITIONING TIME SERIES INTERVAL FROM A FILE.
  2. INPUT FROM CONSOLE A SINGLE POINT CHECK COMPUTATION.
1
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
ww383.dat
 DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
 ICZ=    1
J=  1
 ************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
       CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
       (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
       (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
       STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
       ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
       KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
  CHANNEL NUMBER:      1
```

Figure B-6. (Continued)

```
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =      2.9225051241239D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   5184
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
0
  DO YOU WANT TO SAVE THE OUTPUT FROM LAST OPTION
```

Figure B-6. (Continued)

```
   Y OR N
 Y
 PLEASE ENTER THE FILE NAME FOR STORAGE
sim5.dat
```

Figure B-6. (Continued)

```
 ************************************************ ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 **********************************************************
R







 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
***********************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
-------------------------------------------------
Example #2 Conditional Simulation  Options #2-3-5-6-8-7
***********************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
----------------------------------------------------
Conditional Simulation  L<N, Delta Stretch
 ************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure B-7.
Listing of "case2.input2.console."

```
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
         (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
0.00001
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
464451
**************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
****************************************************
2
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
dspec.dat
*************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
****************************************************
1
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.9225051241239D-02
NUMBER OF DEGREES OF FREEDOM =   5184
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
```

Figure B-7. (Continued)

```
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
       (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
       STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
       ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
       KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
3
MENU FOR OPTION #3 CONDITIONING INPUT:
  1. READ THE CONDITIONING TIME SERIES INTERVAL FROM A FILE.
  2. INPUT FROM CONSOLE A SINGLE POINT CHECK COMPUTATION.
1
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
ww383.dat
 DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
ICZ=    1
J=  1
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
       CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
       (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
       (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
       STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
       ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
       KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
  CHANNEL NUMBER:     1
```

Figure B-7. (Continued)

```
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =      2.9225051241239D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   5184
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
         (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
```

Figure B-7. (Continued)

```
      0. EXIT.
      1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
      2. GIVEN TIME SERIES CONDITIONED ON.
      3. TIME SERIES FROM POLYNOMIALS.
         (ICHUZ=3, 4, OR (8-SUB 6) MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
1
  ENTER TIME STEP FOR START OF LIST (I5)
1
  ENTER TIME STEP AT TERMINATION OF LIST (I5)
1024
  ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
6
  PLEASE ENTER A 50-CHAR. TITLE FOR THE OUTPUT.
master2.dat
 PLEASE ENTER ANY ADDITIONAL DOCUMENTATION THAT
  YOU WANT ATTACHED TO THE OUTPUT.
example #2
  PLEASE ENTER X-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER Y-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER X-RADIUS OF REGION
50.0
  PLEASE ENTER Y-RADIUS OF REGION
50.0
  PLEASE ENTER REFERENCE WAVE PERIOD.
```

Figure B-7. (Continued)

```
  (NOTE: THIS SHOULD APPROXIMATELY BE THE WAVE PERIOD
  CORRESPONDING TO THE FREQUENCY AT THE PEAK OF THE
  WAVE SPECTRAL DENSITY.)
16.7
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER TO BE
  USED IN THE HORIZONTAL ORTHOGONAL POLYNOMIAL EXPANSIONS.
  THIS SHOULD NEVER BE GREATER THAN 12. FIVE OR SIX IS
  A GOOD  CHOICE.
5
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER FOR THE
  VERTICAL ORTHOGONAL POLYNOMIAL EXPANSIONS.  THIS SHOULD
  NEVER BE GREATER THAN 12. EIGHT, OR SO, IS A GOOD CHOICE.
5
  **********************************************
  STRETCHING MENU:
  0. LINEAR EXTRAPOLATION
  1. FUNCTIONAL EXTRAPOLATION
  2. TRUNCATION EXTRAPOLATION
  3. GAMMA EXTRAPOLATION
  4. REID-WHEELER STRETCHING
  5. RODENBUSCH-FORRISTALL DELTA STRETCHING
      PLEASE ENTER YOUR CHOICE.
5
*****************************************************
 PLEASE ENTER DELTA FOR STRETCHING.
    DELTA=0.0, FOR WHEELER-STRETCH
    DELTA=1.0, FOR PURE EXTRAPOLATION
    DELTA=0.3, SUGGESTED IN RODENBUSCH-FORRISTALL
       PAPER FOR DELTA STRETCH, ALTHOUGH ANY DELTA
       BETWEEN 0 AND 1 IS PERMITTED.
0.3
PLEASE ENTER D-DELTA FOR STRETCHING.
     D-DELTA=DEPTH, FOR EXTRAPOLATION OR WHEELER-STRETCH
     D-DELTA BETWEEN ZERO AND DEPTH, FOR DELTA-STRETCH.
        (NOTE: D-DELTA=TWO TIMES STD. DEV. OF SEA SURFACE
         IS SUGGESTED IN RODENBUSCH-FORRISTALL PAPER.
         SEA SURFACE STAND. DEV.HERE =         5.91608
         DEPTH HERE=                        2926.00000
11.382
 WHAT IS THE FILE NAME FOR THE MASTER FILE*
master2.dat
TVAR,STDEVI,ISTRCH,BSTR=     35.000000000000    5.9160797830996  5
   0.30000000000000
DELTA, DDELTA=    0.30000000000000    11.382000000000
JM=  1
JM=  11
JM=  21
JM=  31
JM=  41
JM=  51
JM=  61
JM=  71
```

Figure B-7. (Continued)

```
JM=  81
JM=  91
JM=  101
ETA
VX
VY
VZ
AX
AY
AZ
P
M=   1
M=   101
M=   201
M=   301
M=   401
M=   501
M=   601
M=   701
M=   801
M=   901
M=   1001
STORING INTO MASTER FILE: M=   1
STORING INTO MASTER FILE: M=   101
STORING INTO MASTER FILE: M=   201
STORING INTO MASTER FILE: M=   301
STORING INTO MASTER FILE: M=   401
STORING INTO MASTER FILE: M=   501
STORING INTO MASTER FILE: M=   601
STORING INTO MASTER FILE: M=   701
STORING INTO MASTER FILE: M=   801
STORING INTO MASTER FILE: M=   901
STORING INTO MASTER FILE: M=   1001
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
```

Figure B-7. (Continued)

```
  9. HELP
***************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
8
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
1
NUMM,NT,VMULT  108  24    2.9225051241239D-02
  CHI**2 VALUE=   3985.477 CHI**2  DEGREES OF FREEDOM =        3974
  (CHI**2-MEAN CHI**2)/STDEV CHI**2 =           0.129
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
```

Figure B-7. (Continued)

```
  ***********************
  PLEASE ENTER YOUR CHOICE.
4
  WHAT WAVE PROPERTIES DO YOU WISH TO COMPARE?
  *********************************************
    YOUR CHOICES ARE:
  1. WAVE PROFILE
  2. WATER PARTICLE VELOCITY IN THE DIRECTION X
  3. WATER PARTICLE VELOCITY IN THE DIRECTION Y
  4. WATER PARTICLE VELOCITY IN THE DIRECTION Z
  5. WATER PARTICLE ACCELETATION IN THE DIRECTION X
  6. WATER PARTICLE ACCELERATION IN THE DIRECTION Y
  7. WATER PARTICLE ACCELERATION IN THE DIRECTION Z
  8. PRESSURE FLUCTUATIONS ABOUT STATIC PRESSURE
  *********************************************
       PLEASE ENTER YOUR CHOICE
2
 WHAT START TIME FOR COMPARISONS DO YOU WANT(0.0)?
60.0
  HOW MANY TIME STEPS DO YOU WANT?
     (NOT MORE THAN 20 WITH PRESENT DIMENSIONING)
2
  WHAT IS TIME INCREMENT FOR TIME STEPS (0.3)?
1.0
  HOW MANY AXIS-DIVISIONS DO YOU WANT?
      (NOT MORE THAN 20 WITH CURRENT DIMENSIONING)
9
  WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master2.dat
  WHAT Z-COORDINATE FOR TOP EDGE OF PLANE?
-5.0
  WHAT Z-COORDINATE FOR BOTTOM EDGE OF PLANE?
-25.0
  WHAT X-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT Y-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT X-COORDINATE FOR RIGHT EDGE OF PLANE?
50.0
  WHAT Y-COORDINATE FOR RIGHT EDGE OF PLANE?
0.0
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
```

Figure B-7. (Continued)

```
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
6
 WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master2.dat
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
0
 ************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
```

Figure B-7. (Continued)

```
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
***********************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
     0. EXIT.
     1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
     2. GIVEN TIME SERIES CONDITIONED ON.
     3. TIME SERIES FROM POLYNOMIALS.
         (ICHUZ=3, 4, OR (8-SUB 6) MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
3
  ENTER TIME STEP FOR START OF LIST (I5)
1
  ENTER TIME STEP AT TERMINATION OF LIST (I5)
1024
  ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
 *************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
***********************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
0
```

Figure B-7. (Continued)

```
 INPUT FILE NAME (sim5.dat) ?
sim5.dat
 INPUT MASTER FILE NAME (master2.dat) ?
master2.dat
```

Figure B-8.
Listing of "case2.input3.console."

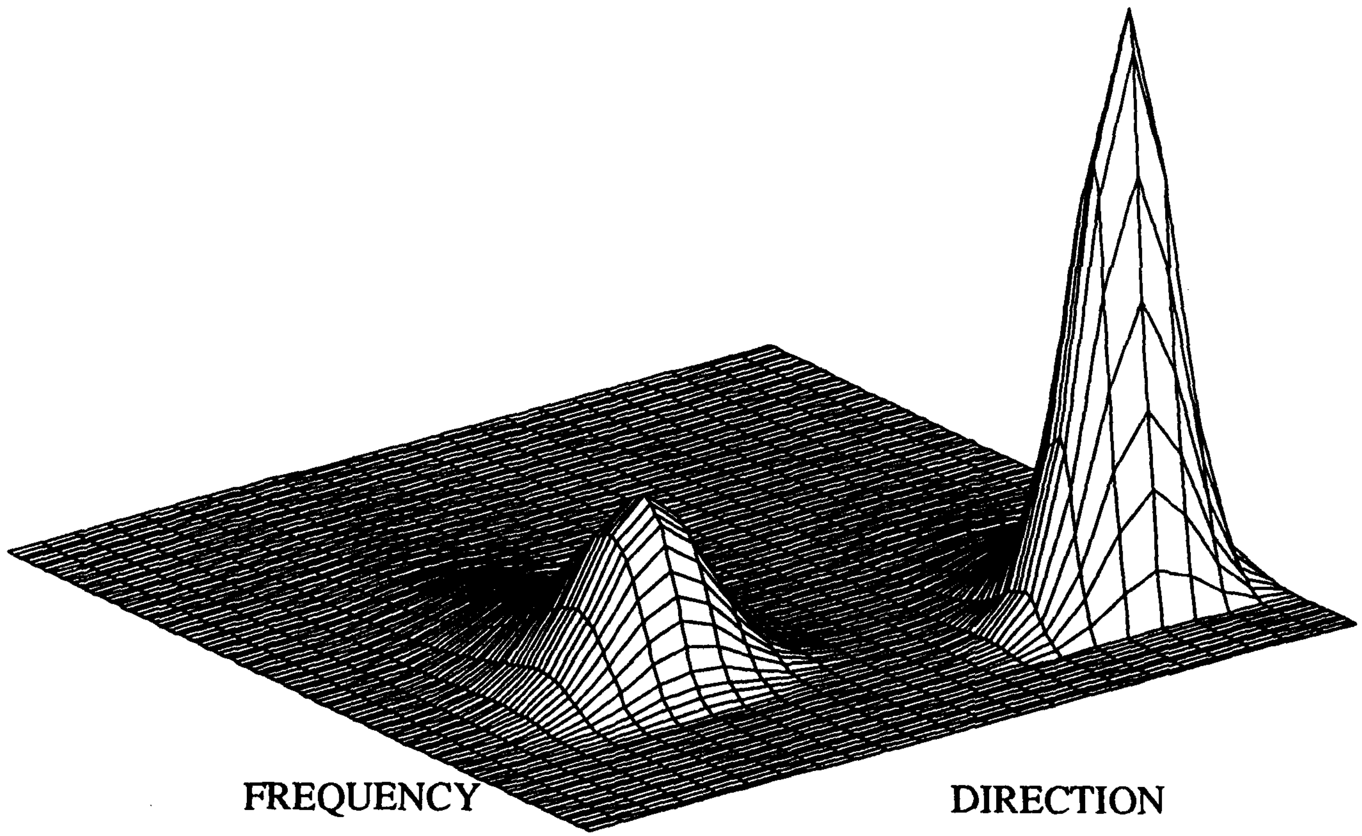

Figure B-9.
3D ocean spectra plot.

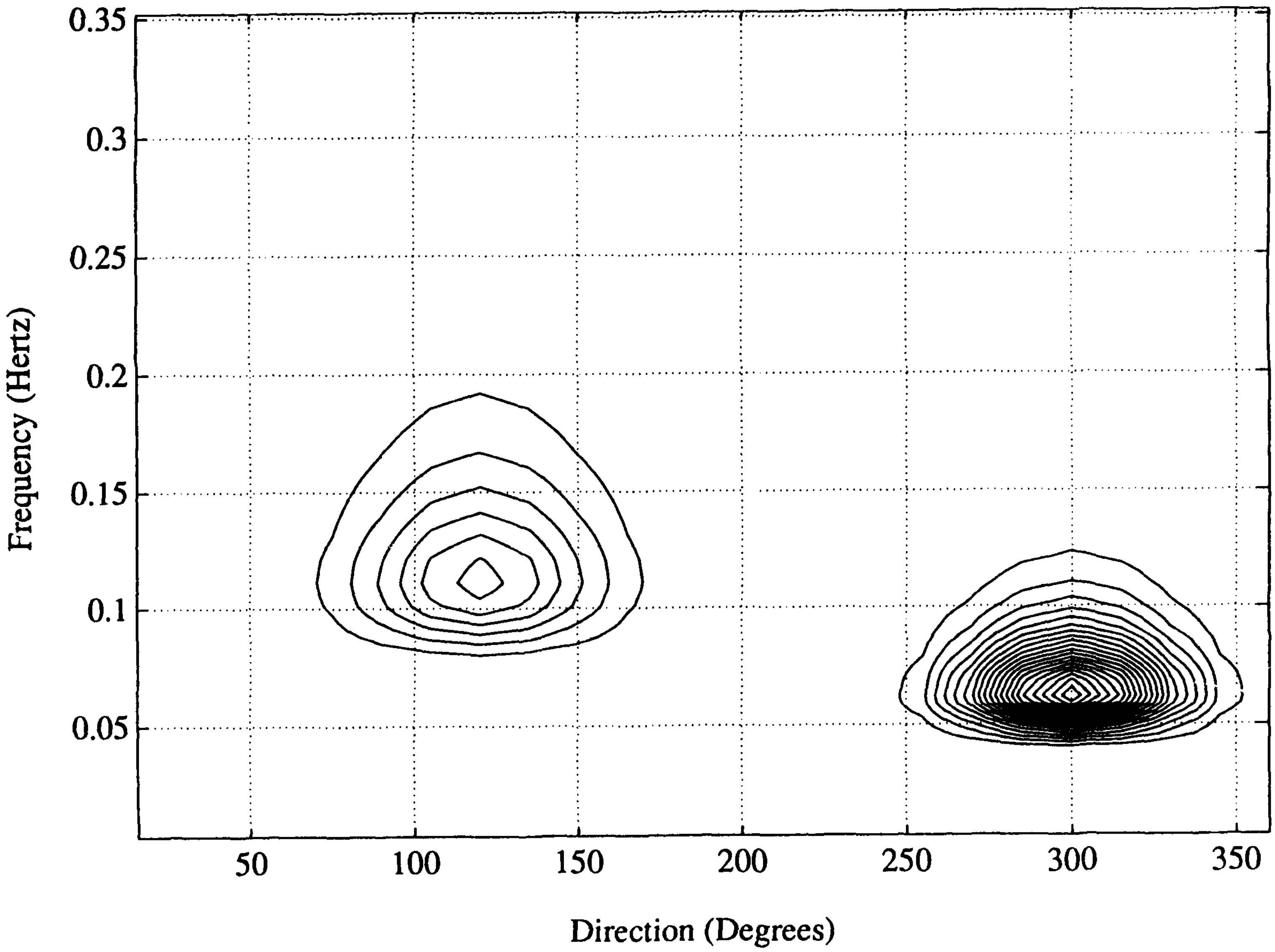

Figure B-10.
Contour plot of same 3D spectra.

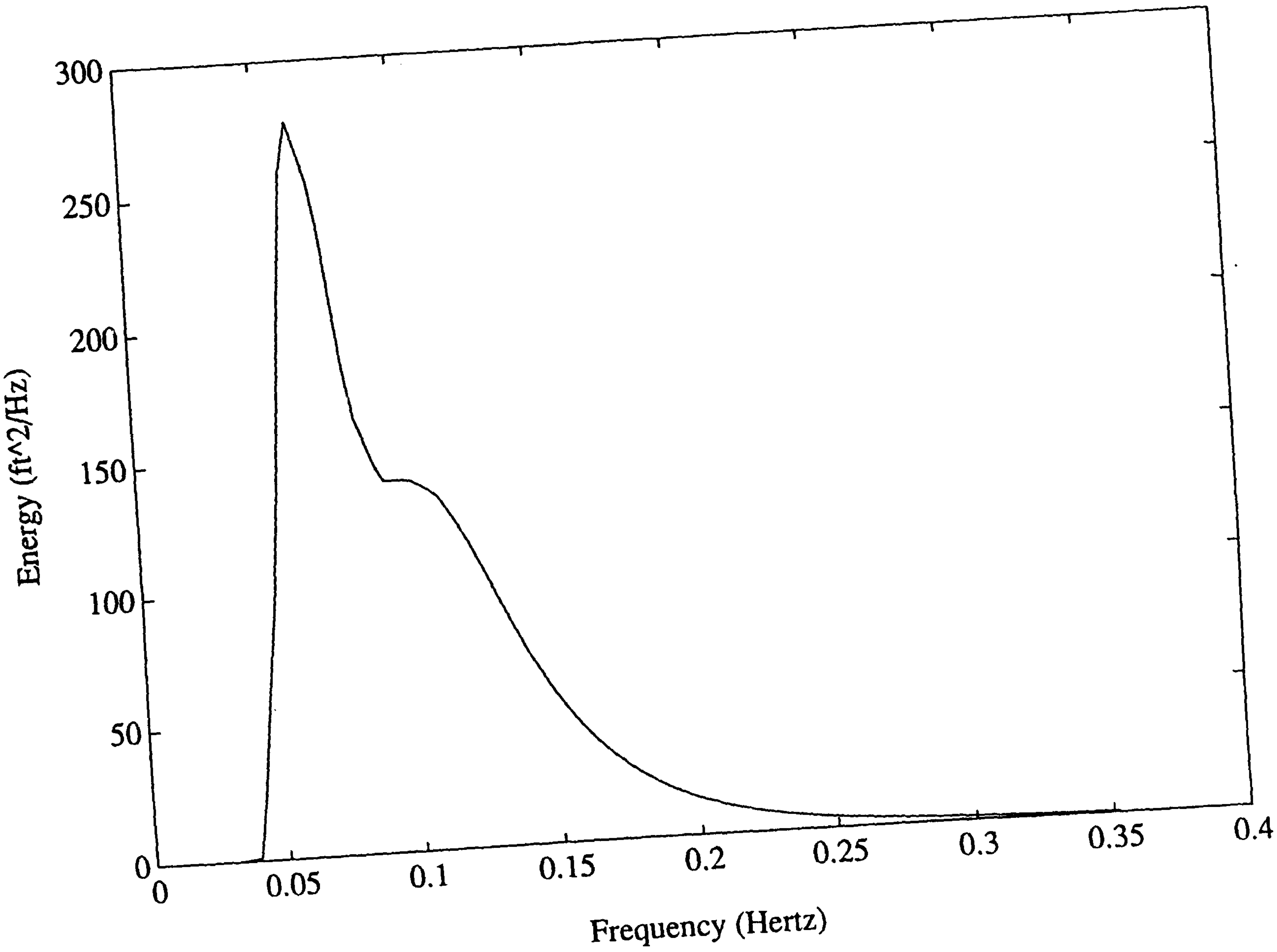

Figure B-11.
2D spectra - Ochi-Hubble.

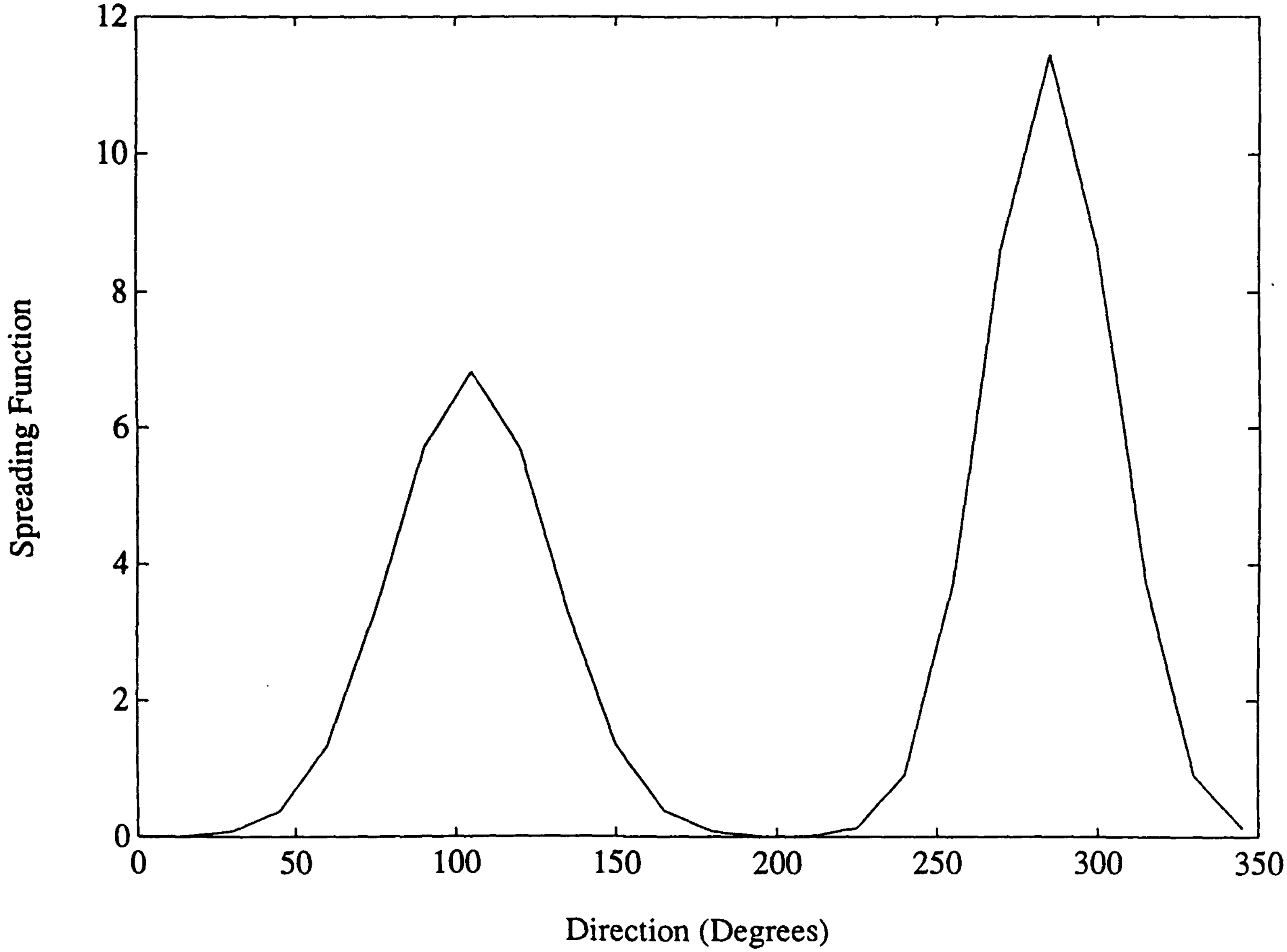

Figure B-12.
Spreading function plot - wrapped normal.

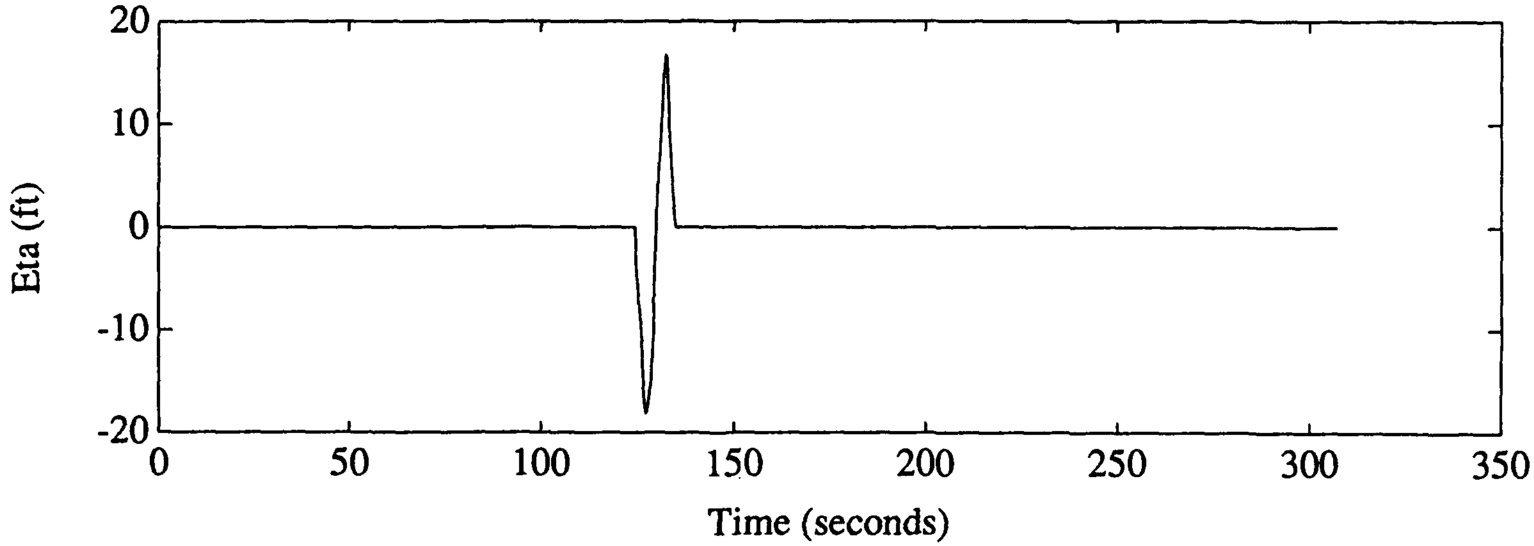

Figure B-13.
Input storm wave.

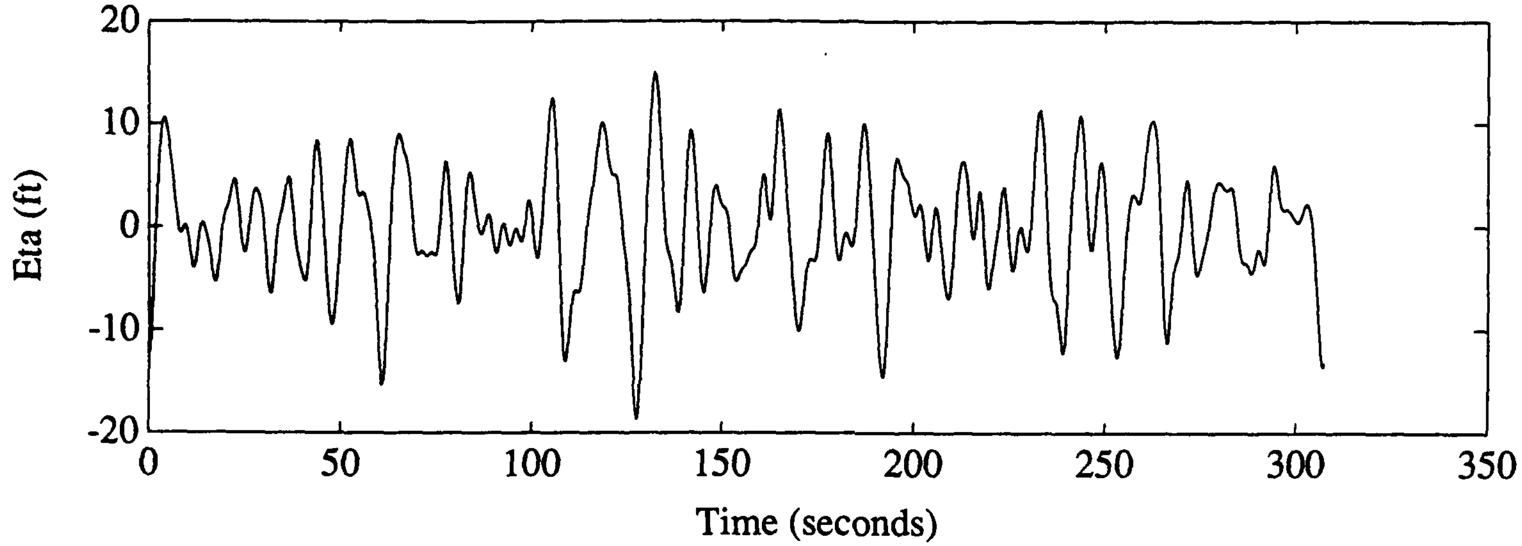

Figure B-14.
Simulated η with conditioning interval.

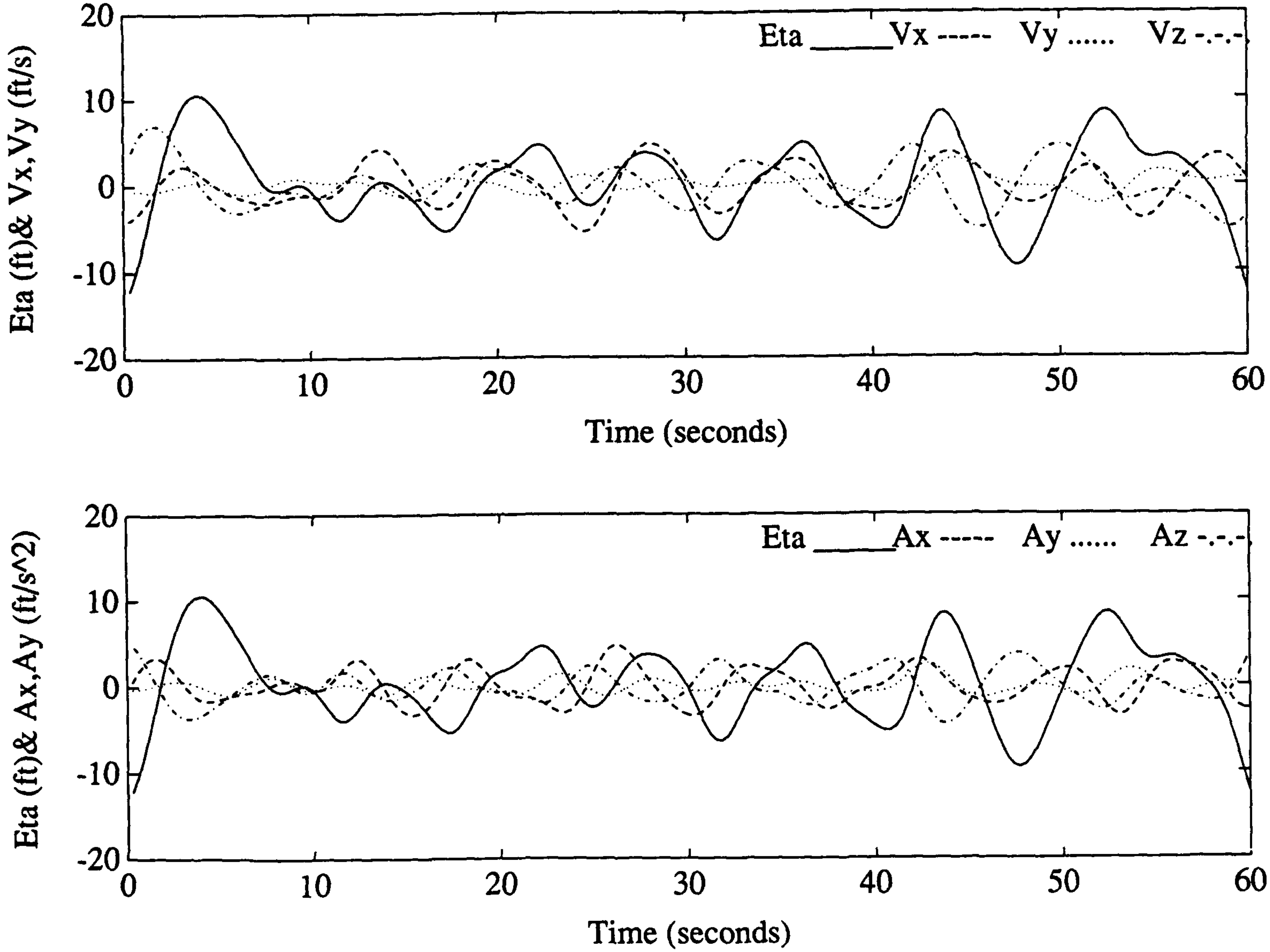

Figure B-15.
Wave properties simulated at X, Y, Z, = 10, 10-15 feet.

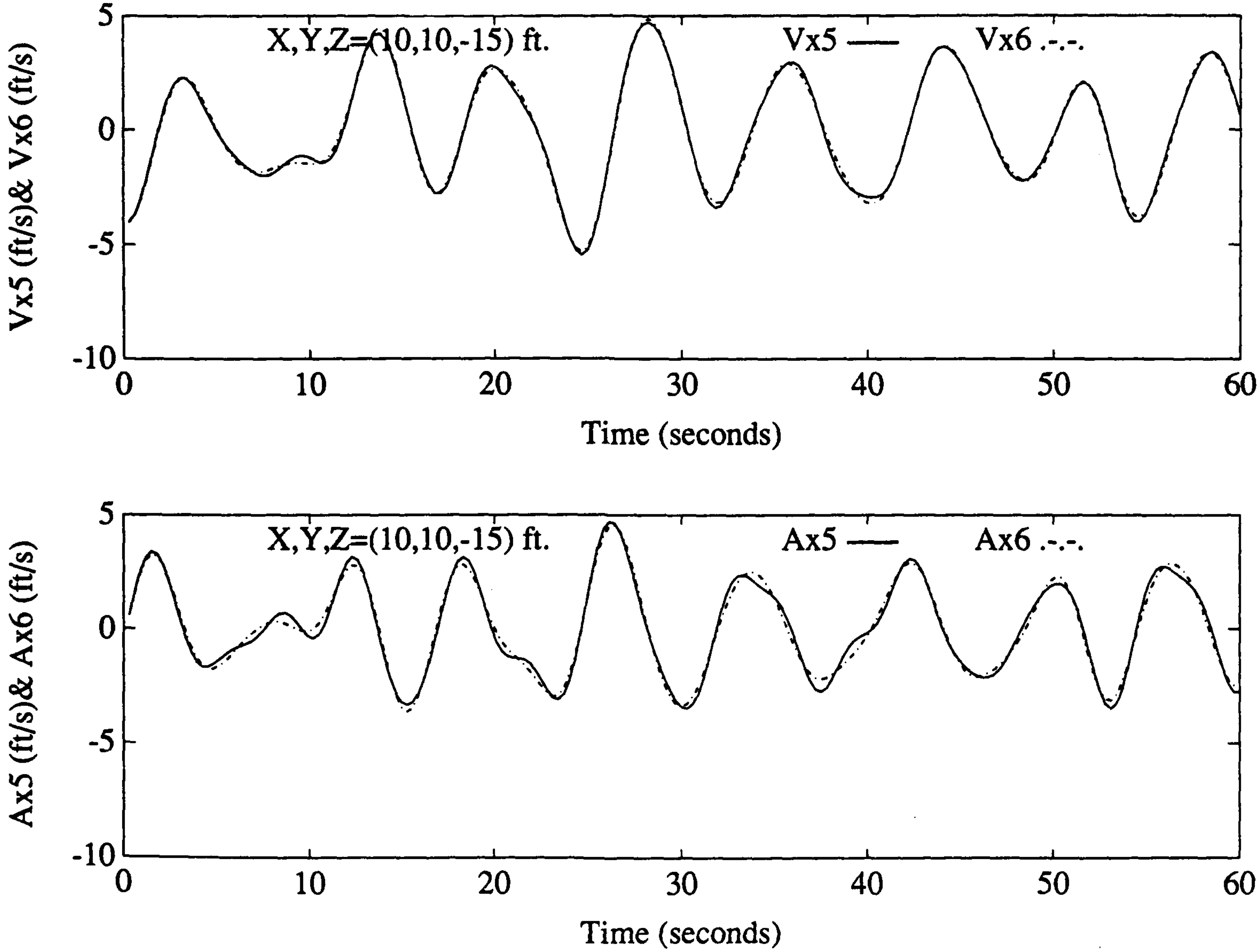

Figure B-16.
Comparison of V_x and A_x using linear wave theory and Legendre polynomials at X, Y, Z = 10, 10, - 15 ft.

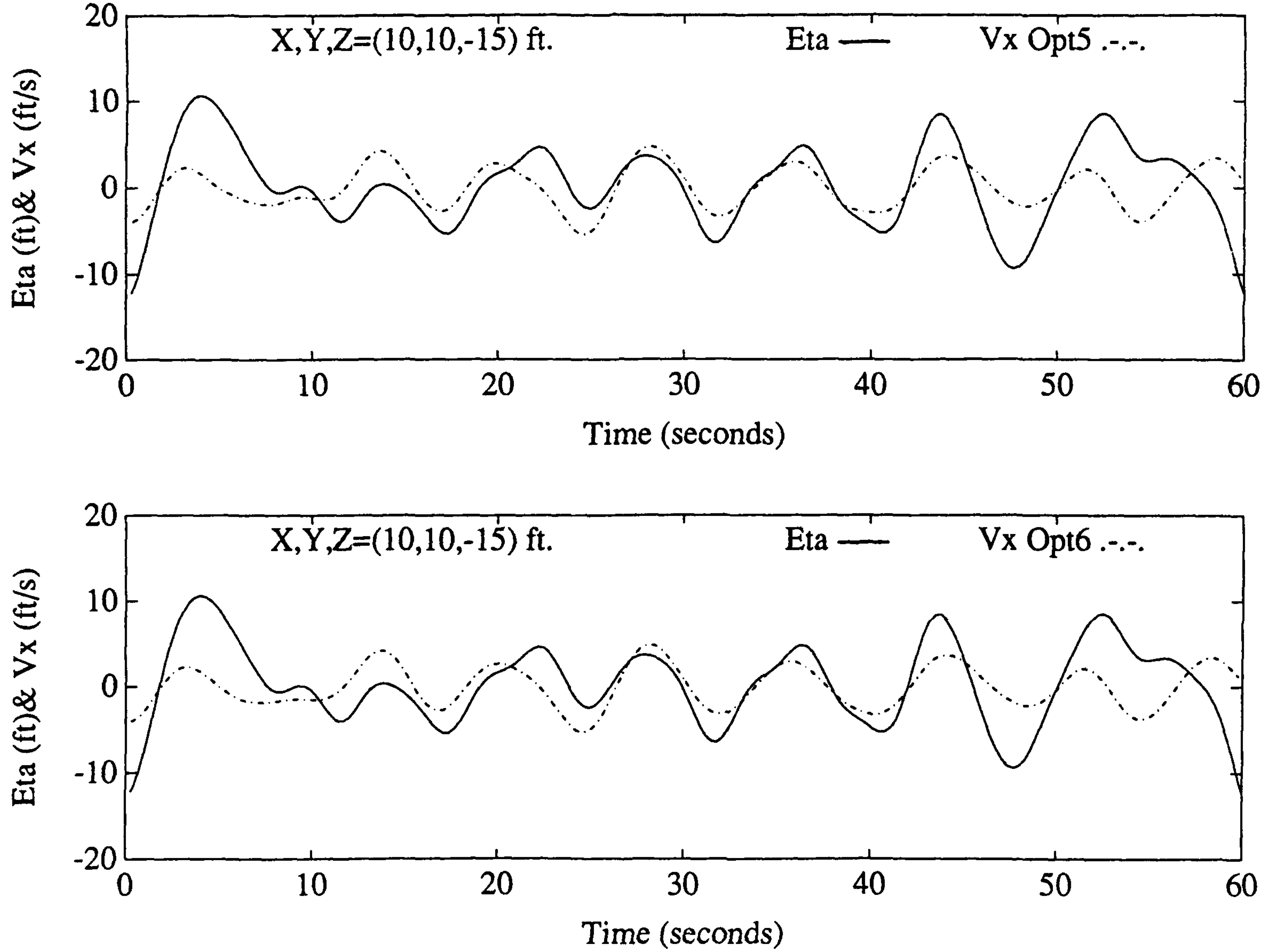

Figure B-17.
Plot of V_x on top of η for linear wave theory and Legendre polynomials.

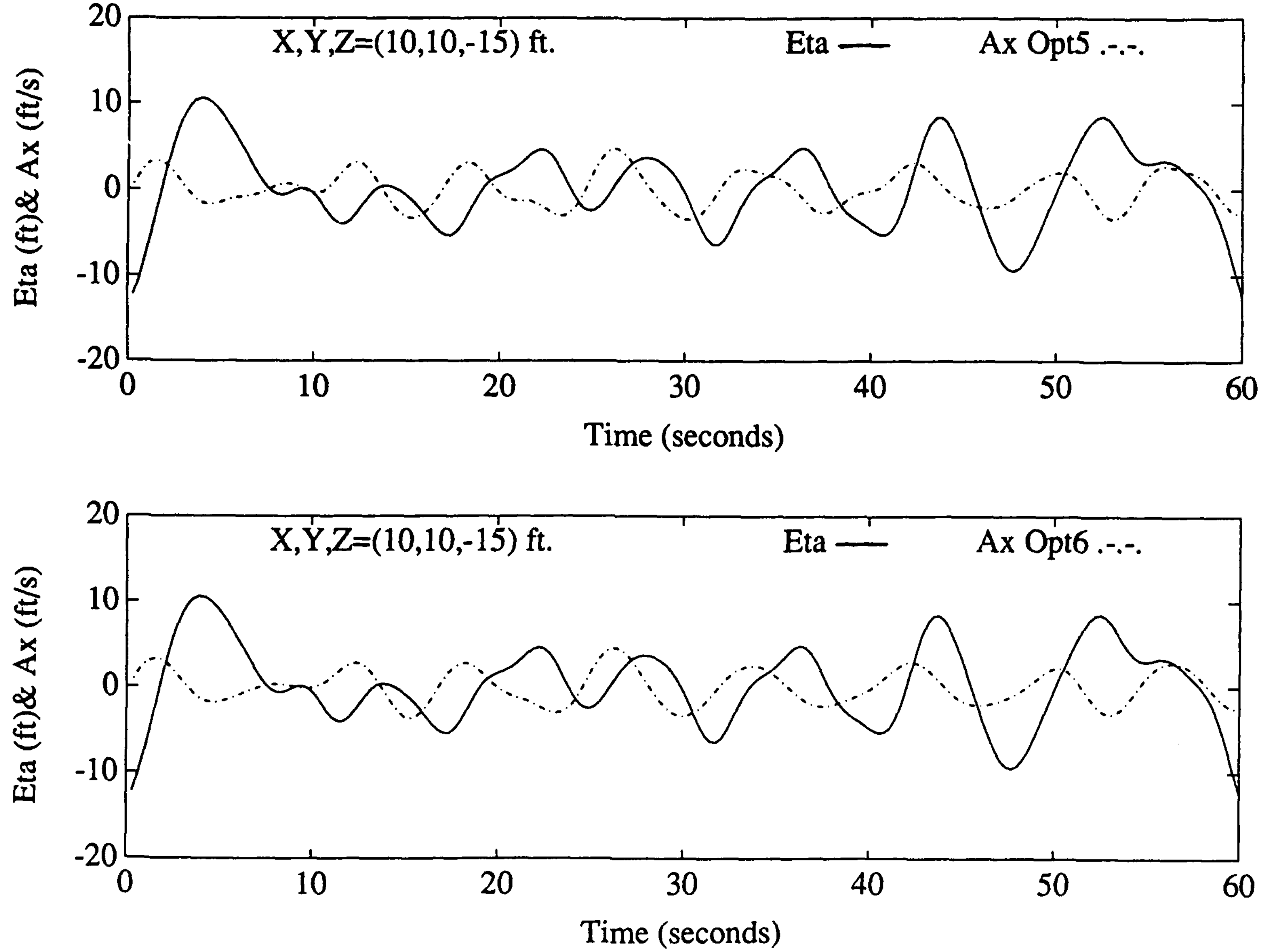

Figure B-18.
Plot of A_x with η for linear wave theory and Legendre polynomials.

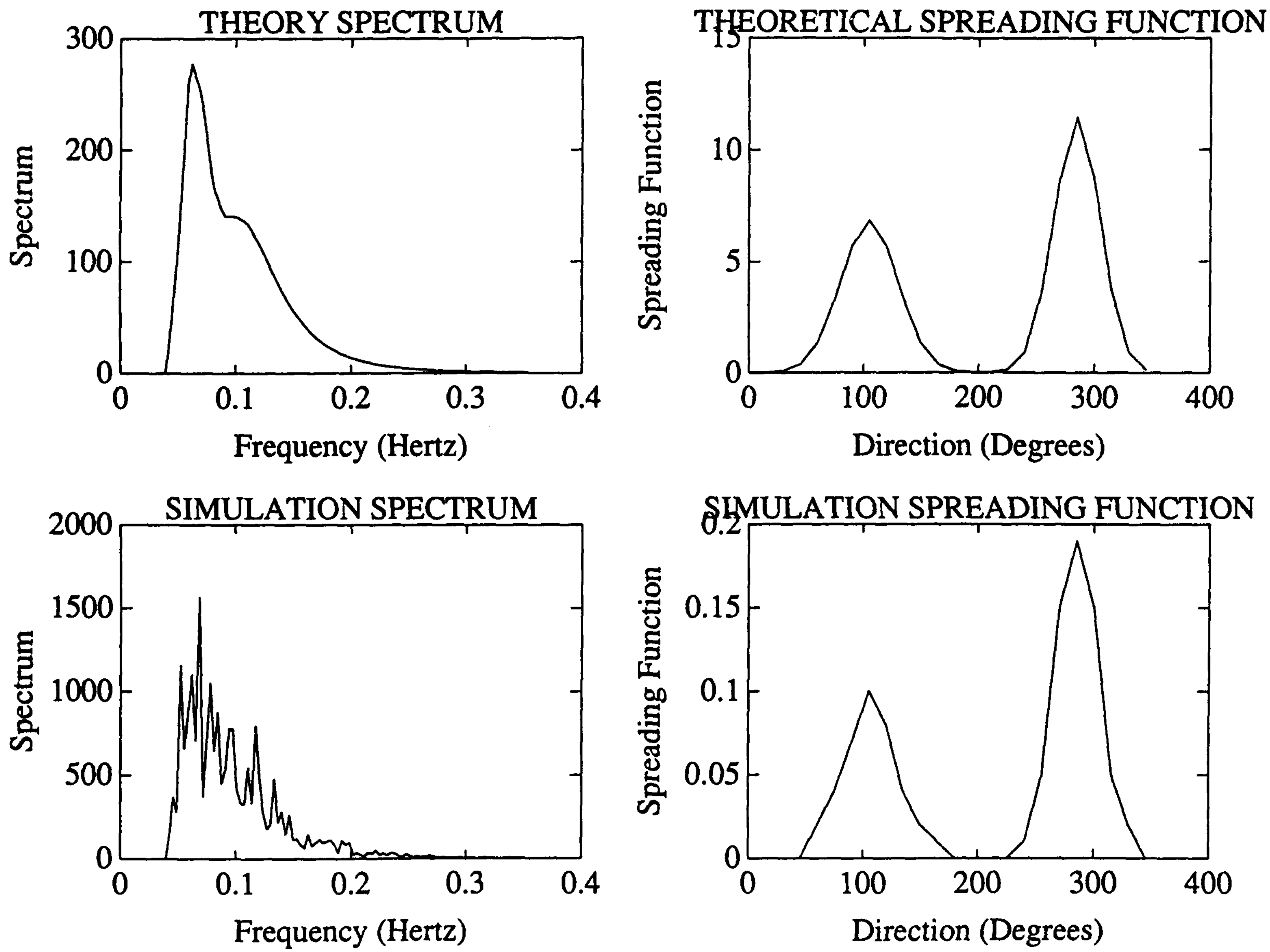

Figure B-19.
Comparison of theoretical and simulated 2D spectra and spreading function.

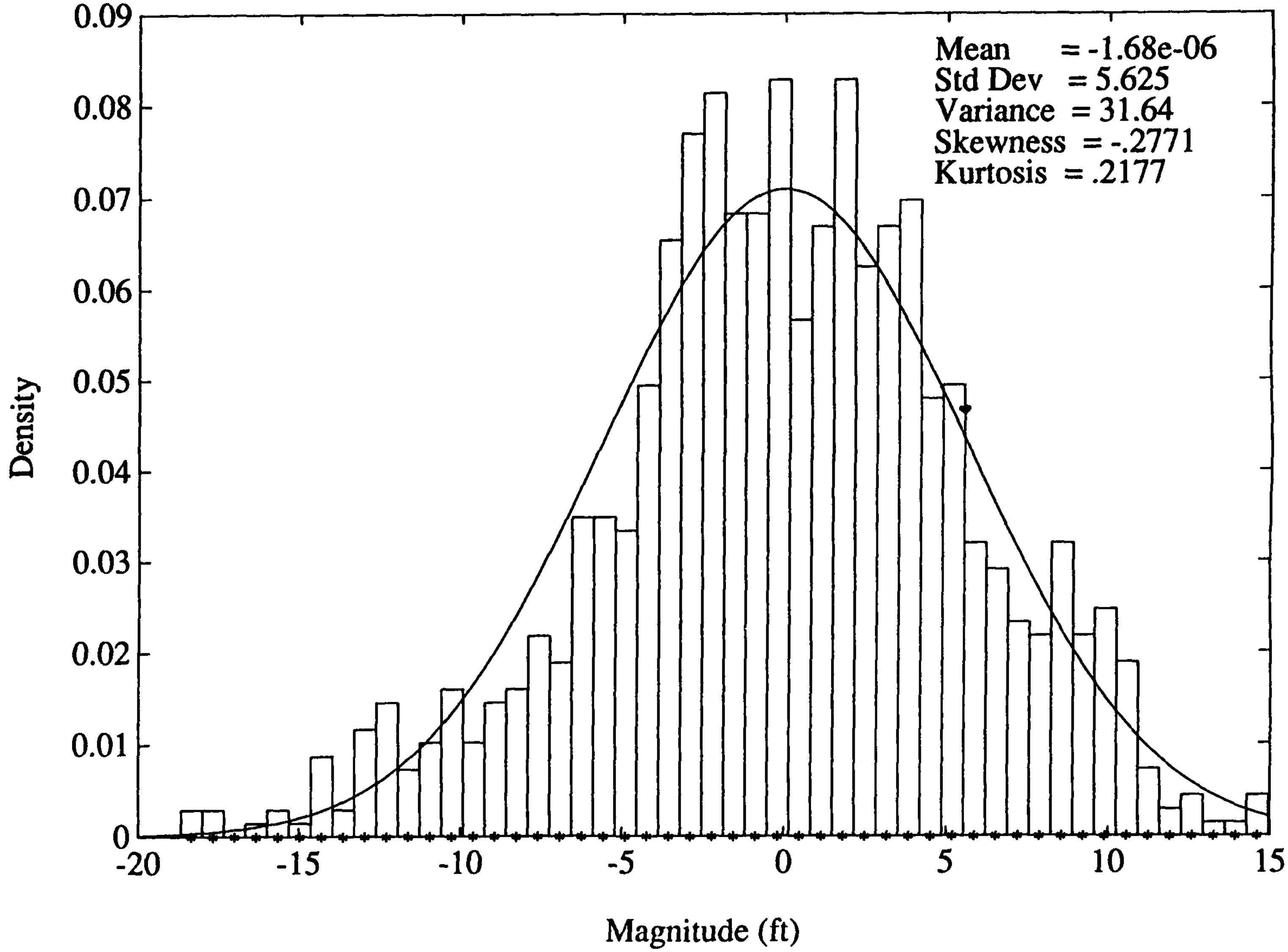

Figure B-20.
Normal distribution curve and histogram of simulated η.

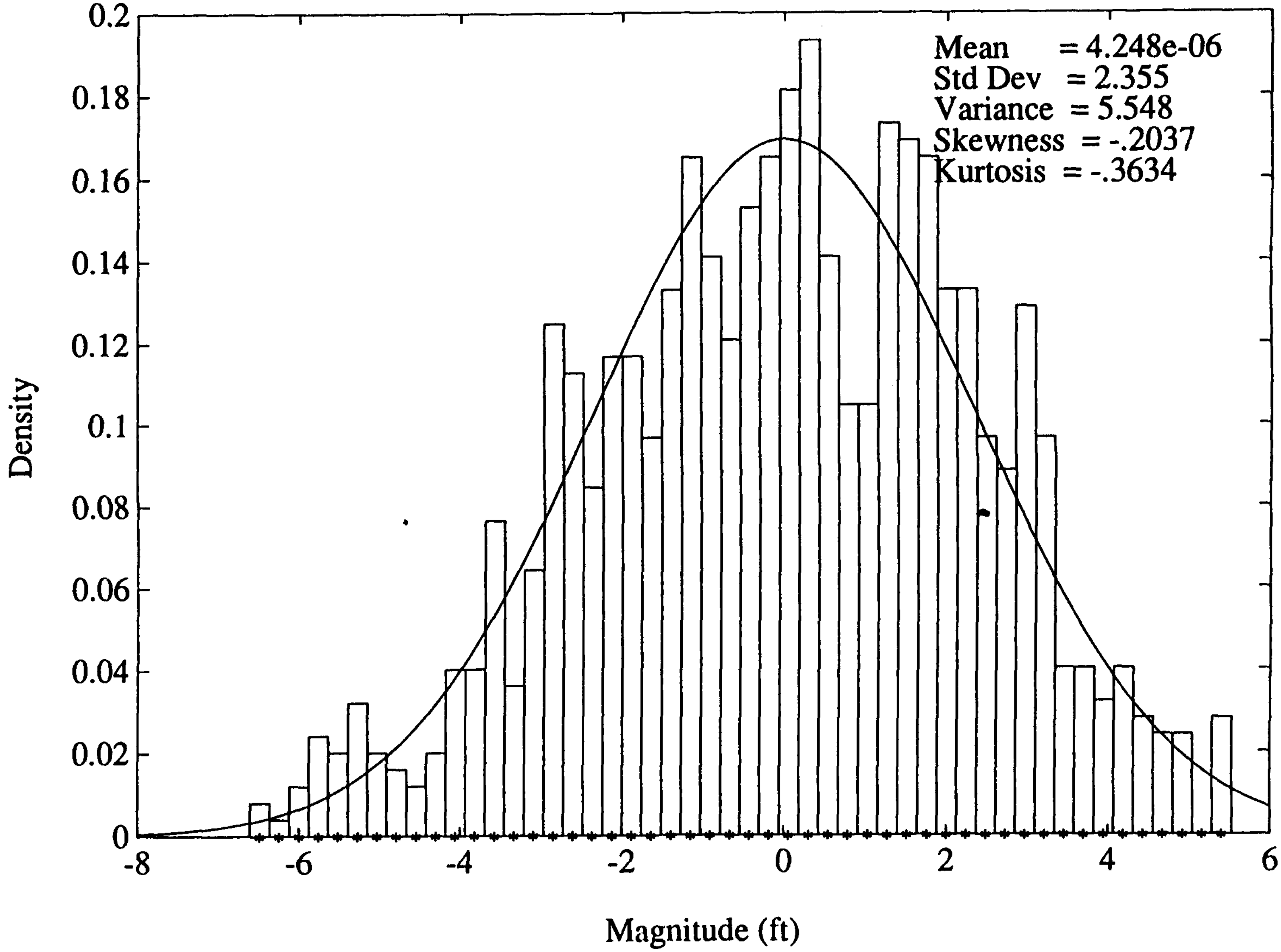

Figure B-21.
Normal distribution curve and histogram of V_x Option No. 5.

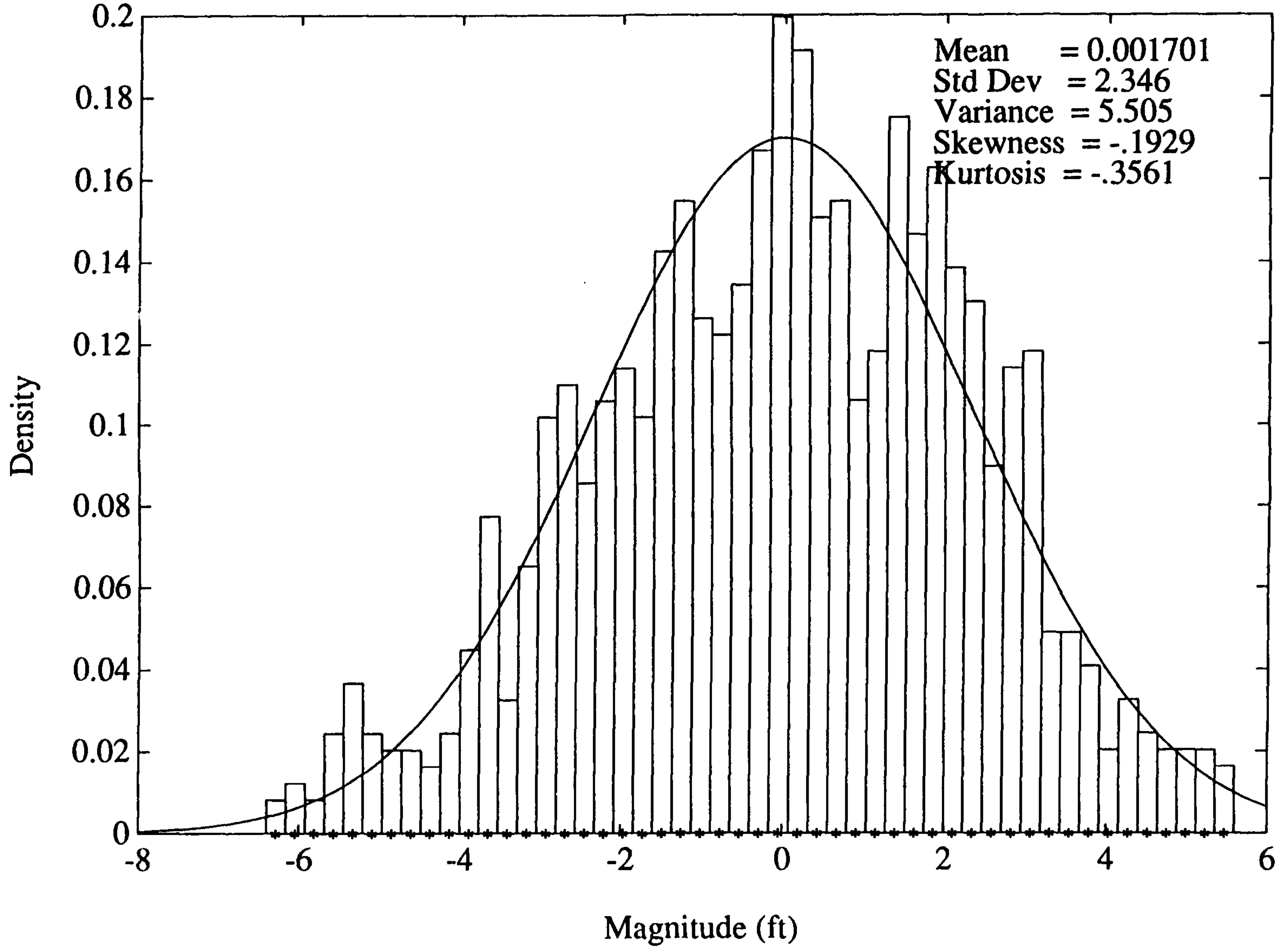

Figure B-22.
Normal distribution curve and histogram for V_x Option No. 6.

Appendix C

EXAMPLE NO. 3 — CONDITIONAL SIMULATION

L=N

- ❑ N=4096 points
- ❑ Input wave profile, L=4096 points
- ❑ Ochi-Hubble Spectra
- ❑ Wrapped Normal Spread
- ❑ Delta Stretch
- ❑ 5th Order Polynomial Fit
- ❑ Compare kinematics at X,Y,Z= 0,0,-20 ft. for SIMBAT Options #5 and #6

File "INSTRUCTIONS"

```
-------------------------------------------------------------------------------
Simbat Test Case 3 Description (Delta Stretch Case):
-------------------------------------------------------------------------------

This example demonstrates a conditional simulation for eight wave
properties. The wave properties Eta,Vx,Vy,Vz,Ax,Ay,Az & P are
each 4096 points in length spaced at 0.3 seconds (1228.8 seconds
each). The simulation uses the Ochi-Hubble directional spectra
with wrapped normal spreading  created in Example #1. The wave
properties are conditioned by a wave input time series of length
equal to the whole record which corresponds to SIMBAT Option #4.
The wave properties are simulated at a point in space at
X,Y,Z=0,0,-20 feet using Option #5. Next Option #6 is used to
create the Legendre orthogonal polynomials for a horizontal area
of 100 ft X 100 ft using a polynomial order of 5.  Delta
stretching is used to stretch the kinematics above the mean water
line. The water depth is 2,926 ft. Finally, the wave properties
are compared at 0,0,-20 ft for the Options #5 and #6.  The
simulation requires about 20 minutes execution time on
a Sun 4/310 computer.

Examination of the source code simbat.f and ckpoly.f in
subdirectory "source" show the PARAMETER and DATA statements used
for this example problem. An explanation of the values for these
statements are described in the SIMBAT USERS MANUAL and in the
source code itself and therefore will not be discussed here. The
binaries are included for this example so you should be able to
run simbat on any Sun4 SPARC based computer without having to
recompile first. If you wish to modify simbat.f or ckpoly.f, type
"f77 simbat.f" and "f77 -o b.out ckpoly.f" to recompile.

The batch files execute Simbat for the following options:

          Option 2 - Preprocess data for Conditional Simulation
          Option 4 - Perform Conditional Simulation for case L=N
          Option 5 - Create time series from frequency domain methods
          Option 6 - Create Legendre Polynomial file
          Option 8 - Create kinematic comparisons for MATLAB plots
          Option 7 - Print kinematics to output file "simbat.out"

See the file "FILES" in this directory for explanation of files on this tape.

-------------------------------------------------------------------------------
    TO TEST EXAMPLE:
-------------------------------------------------------------------------------

    1) Go to subdirectory "ourtest" and you should see the following files:

        a.out          - simbat binary for sun4
        b.out          - ckpoly binary for sun4
        case3.input1   - input data set one for a.out
        case3.input2   - input data set two for a.out
```

Figure C-1.
Listing of file "INSTRUCTIONS."

```
case3.input3   - input data for b.out
dspec.dat      - sample input spectra
w383a.dat      - input time series data
```

NOTE: the two batch files case1.input1 and case1.input2 are both required in order to compare the outputs of SIMBAT Option #5 and #6. This is because the user must exit SIMBAT in order for SIMBAT to write the output file for Option#5 that is read into CKPOLY. In a real life situation this would ordinarily not be required since the user would probably execute either Option#5 or Option#6 and the comparison would not be done. It is done in all the examples for educational purposes only.

2) To execute in batch mode, do the following where % is unix prompt and & is run in background:

```
% a.out < case3.input1  &
        (this creates data necessary for input to b.out)

% a.out < case3.input2  &
        (this creates data necessary for input to b.out
         and all other output files)

% b.out < case3.input3  &
        (this compares frequency domain to Legendre Polynoimal
         approximation method as shown in output file: ckpoly.com)
```

3) If you would like to use matlab to plot data, copy all the files from the "mfiles" subdirectory into "ourtest" directory. Assuming you are already in "ourtest" subdirectory, type:

```
% cp ../mfiles/*.m .
```

Simbat will produce mfiles that have an "*f.m" in their name where "*" is the unix wildcard. These mfiles are data files whereas the mfiles in the "mfiles" subdirectory are matlab script files. Next:

a) start matlab
b) matlab> gmenu   (this will provide a menu for plotting)
c) matlab> tcon   (this will plot spectra contours)
d) matlab> tsdatf   (this reads time series output into matlab)
e) matlab> plsall   (this will plot tsdatf data)
d) pls,plvxx,plaxx,plva.... all read data from tsdatf and plot to screen as well.
e) matlab> prtsc or print to dump plot to printer.
f) NOTE: matlab can be used in a separate window if you run simbat interactively. Thus you can verify data as you proceed through simbat. Step 2) above is meant to be for a streamline batch execution of simbat.

HELP: Warren Bartel (805) 982-1215/1214/1217

Figure C-1. (Continued)

```
FILE   "FILES"

This directory contains Simbat V3.00 Test Case Example #3 Data Files,
source code and executables. This file provides a description of each
file. See INSTRUCTIONS file for additional details.

GENERAL FILES:
--------------

INSTRUCTIONS - instructions for simulation
FILES        - this file


DIRECTORIES:
------------

mfiles   - MATLAB script files for plotting data
source   - source code
nceltest - example output data from Naval Civil Engineering Laboratory
ourtest  - your execution directory


SOURCE FILES AND BINARIES:
--------------------------

simbat.f   - simbat V3.00 scurce code
ckpoly.f   - simbat post processor source code
a.out      - simbat binary for sun4
b.out      - ckpoly binary for sun4

INPUT BATCH FILES:
------------------

case3.input1 - input data set one for a.out
case3.input2 - input data set two for a.out
case3.input3 - input data for b.out

case3.input1.console - console listing
case3.input2.console - console listing
case3.input3.console - console listing

INPUT DATA FILES:
-----------------

dspec.dat - sample input spectra (see example #1)
w383a.dat - input time series data. Represents NCEL MME free surface
            elevation for 1/18/88 0429-0449.  4096 data points at
            dt=0.3 seconds = 20 minute record.  Eta was created by algebraically
            adding wavestaff data to doubly integrated heave acceleration
            data that was low passed filtered at 0.025 Hz.

OUTPUT FILES:
```

Figure C-2.
Listing of file "FILES."

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

simbat.out  - text and general data. Note for this example, the kinematics
              from Simbat Option #5,#7 and #6,#8 and #7 are also listed
              where Option #5 is listed first and those from Option #6
              are listed next. Simbat.out documents which is which.
master3.dat - Legendre Polynomial data file
tsdatf.m    - time series output from frequency domain methods to be read
              by matlab.
ptsdatf.m   - time series output from Legendre Polynomials. Append this
              file to end of tsdatf.m for use in matlab.
ckpoly.com  - output from b.out that compares kinematics between frequency
              domain methods and Legendre Polynomial approximation method.
ckpoly.lst  - kinematics created from master3.dat


EXAMPLE MATLAB "M.FILES" FOR PLOTTING OUTPUT:
--------------------------------------------
"gmenu.m" should be executed first in matlab. This
menu will list the following matlab "m-files":

gmenu.m   - matlab menu for spectra script
   tcon.m    - matlab contour plot script
   t3d.m     - matlab spectra plot script
   acon.m    - matlab simulated contour plot script
   a3d.m     - matlab 3D simulation spectra plot script
   tfs.m     - matlab point spectra script
   tds.m     - matlab directional spread script
   afs.m     - matlab simualted point spectra script
   ads.m     - matlab simulated directional spread plot script
   tads.m    - matlab direction spread plot script
   tad3.m    - matlab 3D spectra plot script
   tass.m    - matlab plot comparison script file

The next set of m.files are for plotting time series
output form data files tsdatf.m, gtsf.m, ptsdatf.m.
They do not have to be executed in any particular order
and are meant to be samples to be modified by the user.

probeta.m - matlab histogram of input eta
probseta.m - matlab histogram of simulated eta
probvx5.m - matlab histogram of velocity in x direction, Opt 5
probvx6.m - matlab histogram of velocity in x direction, Opt 6
plg.m     - matlab input data plot script
pls.m     - matlab general plot script
plsall.m  - matlab general plot script
plsaxx.m  - matlab plot output acceleration data script
plsva.m   - matlab plot  output velocity & acceleration data script
plsvxx.m  - matlab plot velocity of sim5 vs sim6

Example: 1. in unix, append ptsdatf.m to end of tsdatf.m
         2. in unix, remove redundant information brought in from
```

Figure C-2. (Continued)

```
    the psdatf.m file. (use vi,emacs,etc)
3.  start matlab
2.  matlab> tsdatf   (reads data into matlab)
3.  matlab> plsall   (plsall will read tsdatf.m data and
                      plot data to screen)

------------------------------------------------------------------------
SEE "INSTRUCTIONS" FILE FOR SIMULATION PROCESS AND USE OF MATLAB FILES.
------------------------------------------------------------------------
```

Figure C-2. (Continued)

```
R
N
Example #3  Options #2-4-5-6-8-7
Conditional Simulation  L=N, Delta Stretch
2
.00001
464451
2
dspec.dat
1
Y
4
w383a.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
0
Y
sim5.dat
```

Figure C-3.
Listing of "case3.input1."

```
R
N
Example #3 Options #2-4-5-6-8-7
Conditional Simulation  L=N, Delta Stretch
2
.00001
464451
2
dspec.dat
1
Y
4
w383a.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
7
1
1
4096
1
6
master3.dat
example #3
0.0
0.0
50.0
50.0
16.7
5
5
5
0.3
11.382
master3.dat
8
1
4
2
60.0
2
1.0
9
master3.dat
-5.0
-25.0
0.0
0.0
50.0
0.0
6
```

Figure C-4.
Listing of "case3.input2."

```
master3.dat
Y
0
7
3
1
4096
1
0
```

Figure C-4. (Continued)

```
sim5.dat
master3.dat
```

Figure C-5.
Listing of "case3.input3."

```
*********************************************** ******
 PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
 METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
  SIMULATIONS.
  (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

 PLEASE KEY RETURN TO CONTINUE
**********************************************************
R
```

```
 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
------------------------------------------------
Example #3 Options #2-4-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
---------------------------------------------------
Conditional Simulation  L=N,  Delta Stretch
 ***************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure C-6.
Listing of "case3.input1.console."

```
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
464451
**************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
***************************************************
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
dspec.dat
*************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
***************************************************
1
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     1.4610877039660D-02
NUMBER OF DEGREES OF FREEDOM =   20880
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
```

Figure C-6. (Continued)

```
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
4
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
w383a.dat
DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
  CHANNEL NUMBER:      1
 PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
```

Figure C-6. (Continued)

```
  CHANNEL NUMBER:     4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =     1.4610877039660D-02

 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   20880
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
0
  DO YOU WANT TO SAVE THE OUTPUT FROM LAST OPTION
   Y OR N
Y
 PLEASE ENTER THE FILE NAME FOR STORAGE
sim5.dat
```

Figure C-6. (Continued)

```
 *********************************************** ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 **********************************************************
R




 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
--------------------------------------------------
Example #3 Options #2-4-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
-----------------------------------------------------
Conditional Simulation  L=N, Delta Stretch
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
```

Figure C-7.
Listing of "case3.input2.console."

```
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
464451
**************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
2
****************************************************
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
dspec.dat
*************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
****************************************************
1
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     1.4610877039660D-02
NUMBER OF DEGREES OF FREEDOM =   20880
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
```

Figure C-7. (Continued)

```
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
4
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
w383a.dat
DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
 ***************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING I'.'ERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
  CHANNEL NUMBER:      1
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
```

Figure C-7. (Continued)

```
0.0
  CHANNEL NUMBER:     4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:     8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =     1.4610877039660D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   20880
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
     0. EXIT.
     1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
     2. GIVEN TIME SERIES CONDITIONED ON.
     3. TIME SERIES FROM POLYNOMIALS.
         (ICHUZ=3, 4, OR (8-SUB 6) MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
```

Figure C-7. (Continued)

```
1
 ENTER TIME STEP FOR START OF LIST (I5)
1
 ENTER TIME STEP AT TERMINATION OF LIST (I5)
4096
 ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
6
  PLEASE ENTER A 50-CHAR. TITLE FOR THE OUTPUT.
master3.dat
 PLEASE ENTER ANY ADDITIONAL DOCUMENTATION THAT
  YOU WANT ATTACHED TO THE OUTPUT.
example #3
  PLEASE ENTER X-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER Y-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER X-RADIUS OF REGION
50.0
  PLEASE ENTER Y-RADIUS OF REGION
50.0
  PLEASE ENTER REFERENCE WAVE PERIOD.
  (NOTE: THIS SHOULD APPROXIMATELY BE THE WAVE PERIOD
  CORRESPONDING TO THE FREQUENCY AT THE PEAK OF THE
  WAVE SPECTRAL DENSITY.)
16.7
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER TO BE
  USED IN THE HORIZONTAL ORTHOGONAL POLYNOMIAL EXPANSIONS.
  THIS SHOULD NEVER BE GREATER THAN 12. FIVE OR SIX IS
```

Figure C-7. (Continued)

```
  A GOOD  CHOICE.
5
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER FOR THE
  VERTICAL ORTHOGONAL POLYNOMIAL EXPANSIONS.  THIS SHOULD
  NEVER BE GREATER THAN 12. EIGHT, OR SO, IS A GOOD CHOICE.
5
  **********************************************
  STRETCHING MENU:
  0. LINEAR EXTRAPOLATION
  1. FUNCTIONAL EXTRAPOLATION
  2. TRUNCATION EXTRAPOLATION
  3. GAMMA EXTRAPOLATION
  4. REID-WHEELER STRETCHING
  5. RODENBUSCH-FORRISTALL DELTA STRETCHING
     PLEASE ENTER YOUR CHOICE.
 *****************************************************
 PLEASE ENTER DELTA FOR STRETCHING.
5
    DELTA=0.0, FOR WHEELER-STRETCH
    DELTA=1.0, FOR PURE EXTRAPOLATION
    DELTA=0.3, SUGGESTED IN RODENBUSCH-FORRISTALL
       PAPER FOR DELTA STRETCH, ALTHOUGH ANY DELTA
       BETWEEN 0 AND 1 IS PERMITTED.
 PLEASE ENTER D-DELTA FOR STRETCHING.
0.3
     D-DELTA=DEPTH, FOR EXTRAPOLATION OR WHEELER-STRETCH
     D-DELTA BETWEEN ZERO AND DEPTH, FOR DELTA-STRETCH.
        (NOTE: D-DELTA=TWO TIMES STD. DEV. OF SEA SURFACE
         IS SUGGESTED IN RODENBUSCH-FORRISTALL PAPER.
         SEA SURFACE STAND. DEV.HERE =          5.91608
         DEPTH HERE=                         2926.00000
 11.382
 WHAT IS THE FILE NAME FOR THE MASTER FILE*
master3.dat
TVAR,STDEVI,ISTRCH,BSTR=     35.000000000000     5.9160797830996  5
   0.30000000000000
DELTA, DDELTA=    0.30000000000000    11.382000000000
JM=  1
JM=  11
JM=  21
JM=  31
JM=  41
JM=  51
JM=  61
JM=  71
JM=  81
JM=  91
JM=  101
JM=  111
JM=  121
JM=  131
JM=  141
```

Figure C-7. (Continued)

```
JM=  151
JM=  161
JM=  171
JM=  181
JM=  191
JM=  201
JM=  211
JM=  221
JM=  231
JM=  241
JM=  251
JM=  261
JM=  271
JM=  281
JM=  291
JM=  301
JM=  311
JM=  321
JM=  331
JM=  341
JM=  351
JM=  361
JM=  371
JM=  381
JM=  391
JM=  401
JM=  411
JM=  421
JM=  431
ETA
VX
VY
VZ
AX
AY
AZ
P
M=    1
M=    101
M=    201
M=    301
M=    401
M=    501
M=    601
M=    701
M=    801
M=    901
M=    1001
M=    1101
M=    1201
M=    1301
M=    1401
```

Figure C-7. (Continued)

```
M=   1501
M=   1601
M=   1701
M=   1801
M=   1901
M=   2001
M=   2101
M=   2201
M=   2301
M=   2401
M=   2501
M=   2601
M=   2701
M=   2801
M=   2901
M=   3001
M=   3101
M=   3201
M=   3301
M=   3401
M=   3501
M=   3601
M=   3701
M=   3801
M=   3901
M=   4001
STORING INTO MASTER FILE: M=    1
STORING INTO MASTER FILE: M=   101
STORING INTO MASTER FILE: M=   201
STORING INTO MASTER FILE: M=   301
STORING INTO MASTER FILE: M=   401
STORING INTO MASTER FILE: M=   501
STORING INTO MASTER FILE: M=   601
STORING INTO MASTER FILE: M=   701
STORING INTO MASTER FILE: M=   801
STORING INTO MASTER FILE: M=   901
STORING INTO MASTER FILE: M=  1001
STORING INTO MASTER FILE: M=  1101
STORING INTO MASTER FILE: M=  1201
STORING INTO MASTER FILE: M=  1301
STORING INTO MASTER FILE: M=  1401
STORING INTO MASTER FILE: M=  1501
STORING INTO MASTER FILE: M=  1601
STORING INTO MASTER FILE: M=  1701
STORING INTO MASTER FILE: M=  1801
STORING INTO MASTER FILE: M=  1901
STORING INTO MASTER FILE: M=  2001
STORING INTO MASTER FILE: M=  2101
STORING INTO MASTER FILE: M=  2201
STORING INTO MASTER FILE: M=  2301
STORING INTO MASTER FILE: M=  2401
STORING INTO MASTER FILE: M=  2501
```

Figure C-7. (Continued)

```
STORING INTO MASTER FILE: M=   2601
STORING INTO MASTER FILE: M=   2701
STORING INTO MASTER FILE: M=   2801
STORING INTO MASTER FILE: M=   2901
STORING INTO MASTER FILE: M=   3001
STORING INTO MASTER FILE: M=   3101
STORING INTO MASTER FILE: M=   3201
STORING INTO MASTER FILE: M=   3301
STORING INTO MASTER FILE: M=   3401
STORING INTO MASTER FILE: M=   3501
STORING INTO MASTER FILE: M=   3601
STORING INTO MASTER FILE: M=   3701
STORING INTO MASTER FILE: M=   3801
STORING INTO MASTER FILE: M=   3901
STORING INTO MASTER FILE: M=   4001
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
8
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
```

Figure C-7. (Continued)

```
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
1
NUMM,NT,VMULT  435  24    1.4610877039660D-02
  CHI**2 VALUE=  15984.037 CHI**2  DEGREES OF FREEDOM =       15922
  (CHI**2-MEAN CHI**2)/STDEV CHI**2 =           0.348
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
4
 WHAT WAVE PROPERTIES DO YOU WISH TO COMPARE?
  ********************************************
    YOUR CHOICES ARE:
  1. WAVE PROFILE
  2. WATER PARTICLE VELOCITY IN THE DIRECTION X
  3. WATER PARTICLE VELOCITY IN THE DIRECTION Y
  4. WATER PARTICLE VELOCITY IN THE DIRECTION Z
  5. WATER PARTICLE ACCELETATION IN THE DIRECTION X
  6. WATER PARTICLE ACCELERATION IN THE DIRECTION Y
  7. WATER PARTICLE ACCELERATION IN THE DIRECTION Z
  8. PRESSURE FLUCTUATIONS ABOUT STATIC PRESSURE
  ********************************************
       PLEASE ENTER YOUR CHOICE
2
 WHAT START TIME FOR COMPARISONS DO YOU WANT(0.0)?
```

Figure C-7. (Continued)

```
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
0
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
         (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
     0. EXIT.
     1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
     2. GIVEN TIME SERIES CONDITIONED ON.
     3. TIME SERIES FROM POLYNOMIALS.
```

Figure C-7. (Continued)

```
60.0
 HOW MANY TIME STEPS DO YOU WANT?
     (NOT MORE THAN 20 WITH PRESENT DIMENSIONING)
 2
  WHAT IS TIME INCREMENT FOR TIME STEPS (0.3)?
1.0
  HOW MANY AXIS-DIVISIONS DO YOU WANT?
      (NOT MORE THAN 20 WITH CURRENT DIMENSIONING)
9
  WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master3.dat
  WHAT Z-COORDINATE FOR TOP EDGE OF PLANE?
-5.0
  WHAT Z-COORDINATE FOR BOTTOM EDGE OF PLANE?
-25.0
  WHAT X-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT Y-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT X-COORDINATE FOR RIGHT EDGE OF PLANE?
50.0
  WHAT Y-COORDINATE FOR RIGHT EDGE OF PLANE?
0.0
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
6
 WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master3.dat
DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
```

Figure C-7. (Continued)

```
          (ICHUZ=3, 4, OR (8-SUB 6) MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
3
 ENTER TIME STEP FOR START OF LIST (I5)
1
 ENTER TIME STEP AT TERMINATION OF LIST (I5)
4096
 ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
0
```

Figure C-7. (Continued)

```
 INPUT FILE NAME (sim5.dat) ?
sim5.dat
 INPUT MASTER FILE NAME (master3.dat) ?
master3.dat
```

Figure C-8.
Listing of "case3.input3.console."

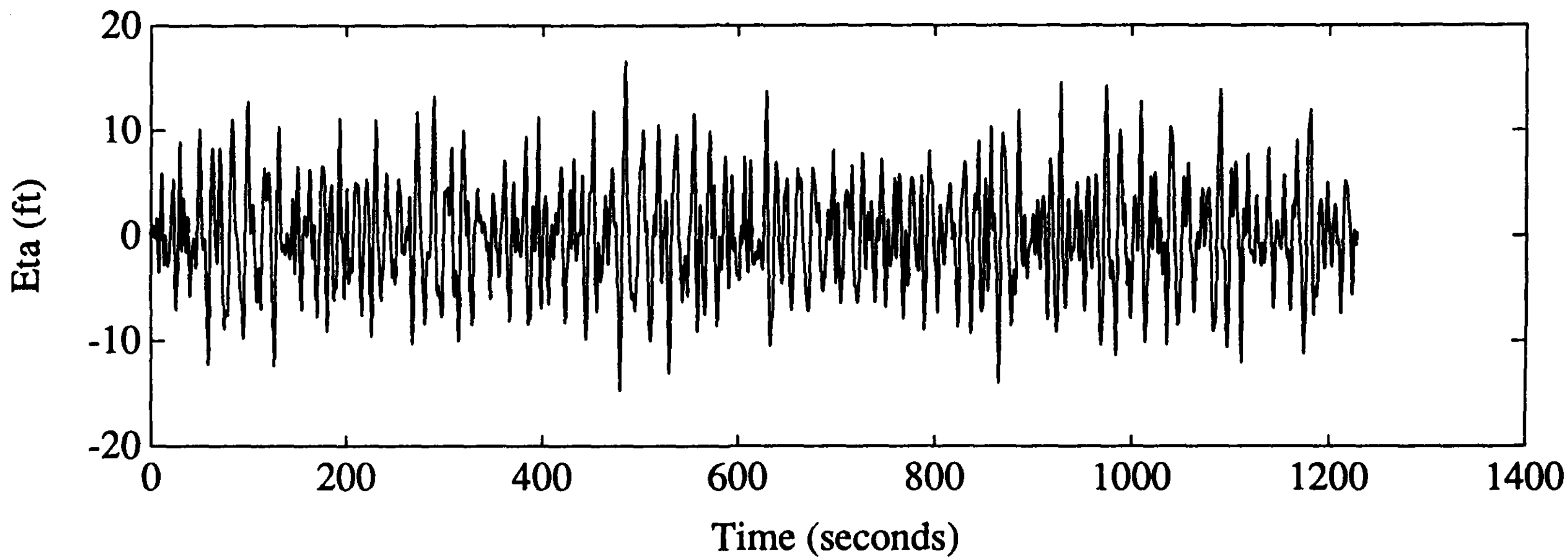

Figure C-9.
Plot of input conditioning η.

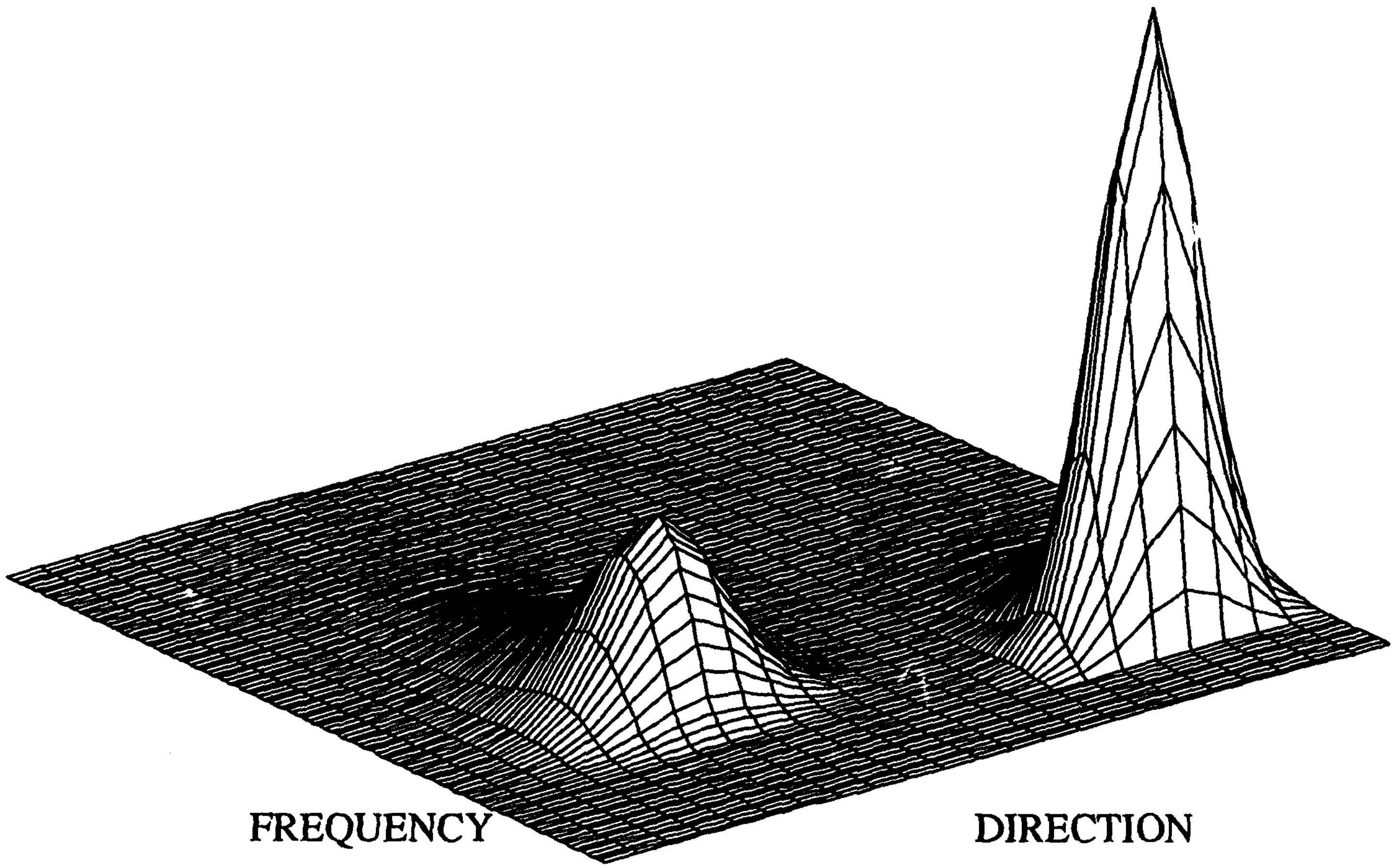

Figure C-10.
3D ocean spectra, Ochi-Hubble.

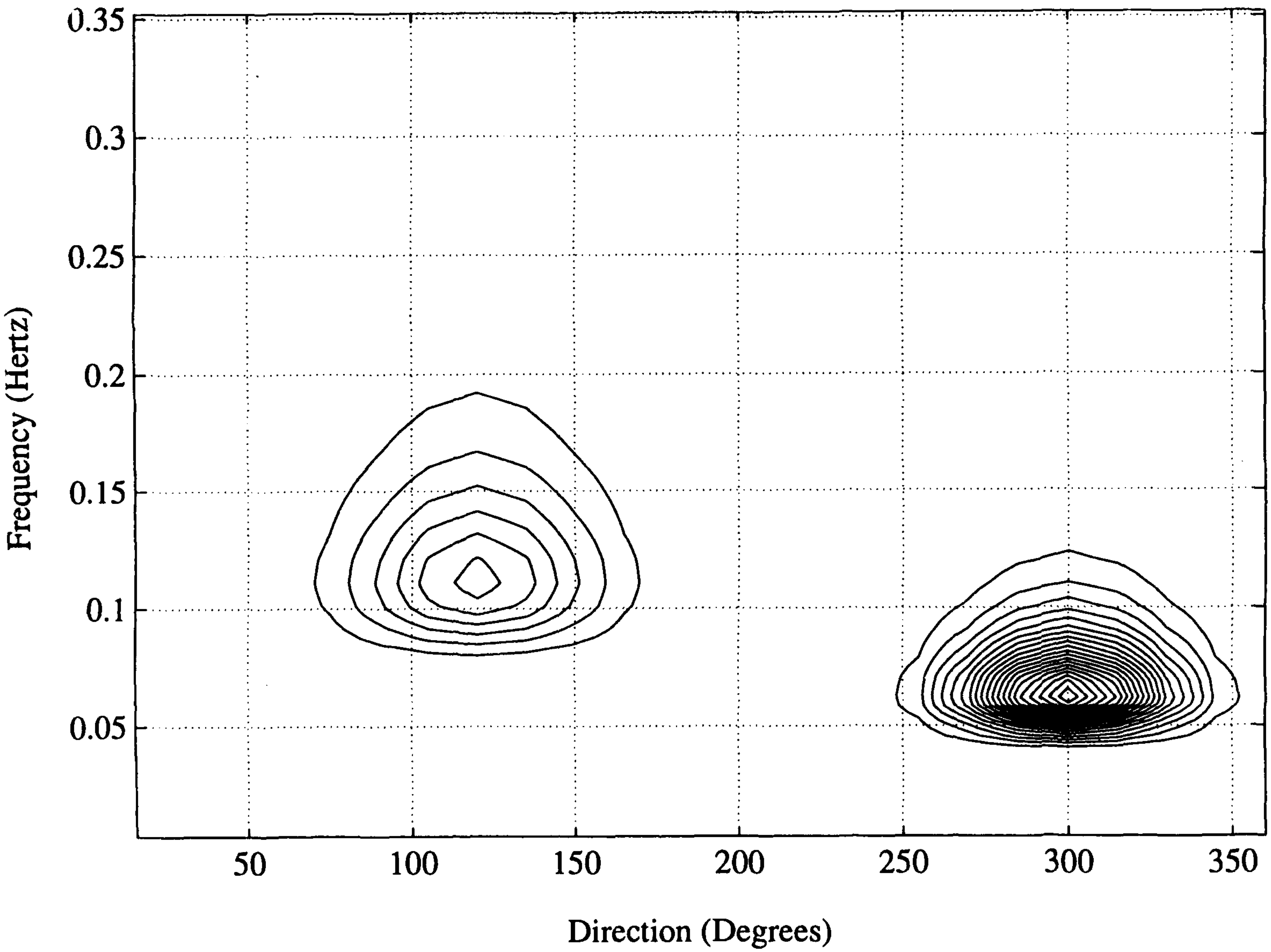

Figure C-11.
Contour plot of 3D ocean spectra.

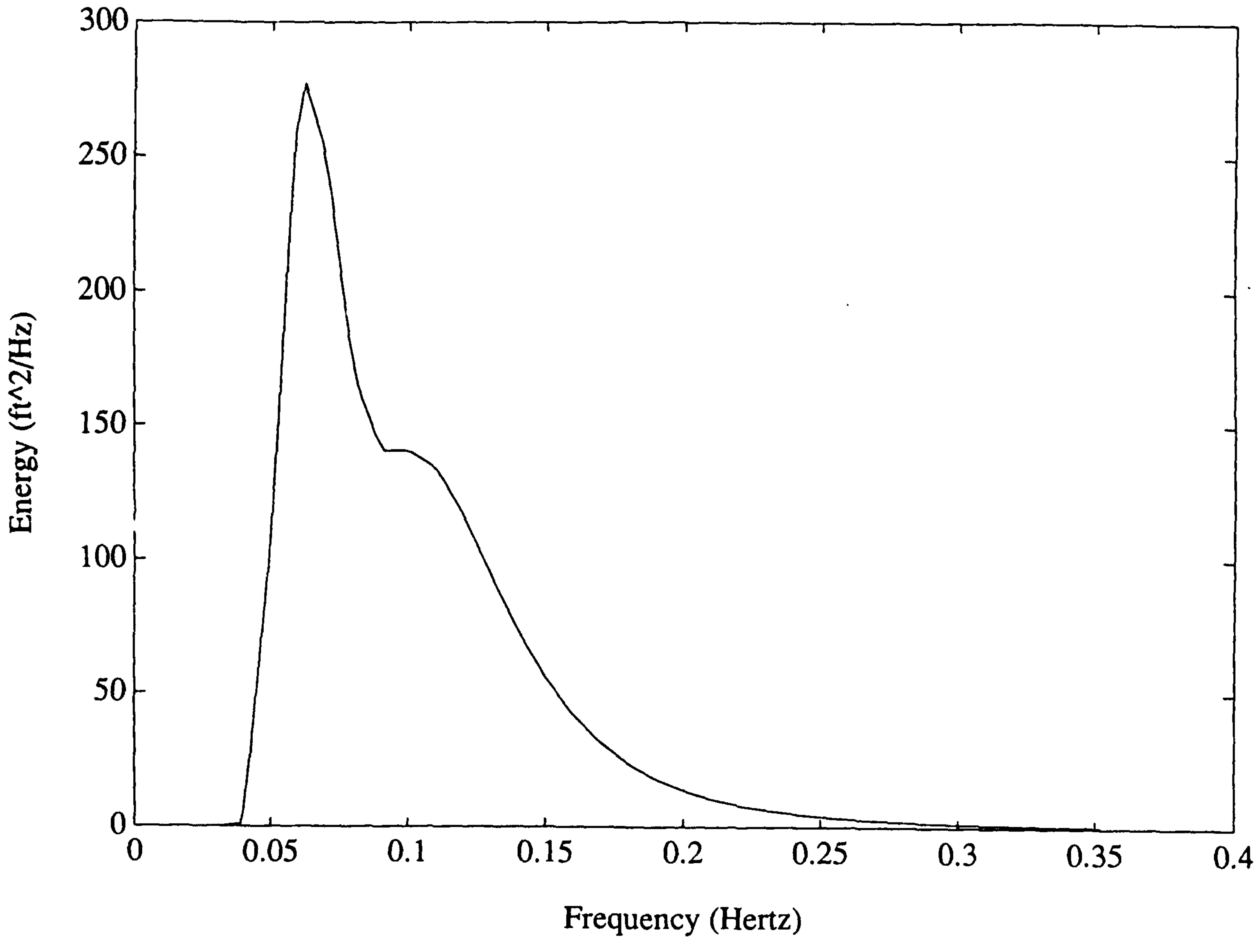

Figure C-12.
2D ocean spectra.

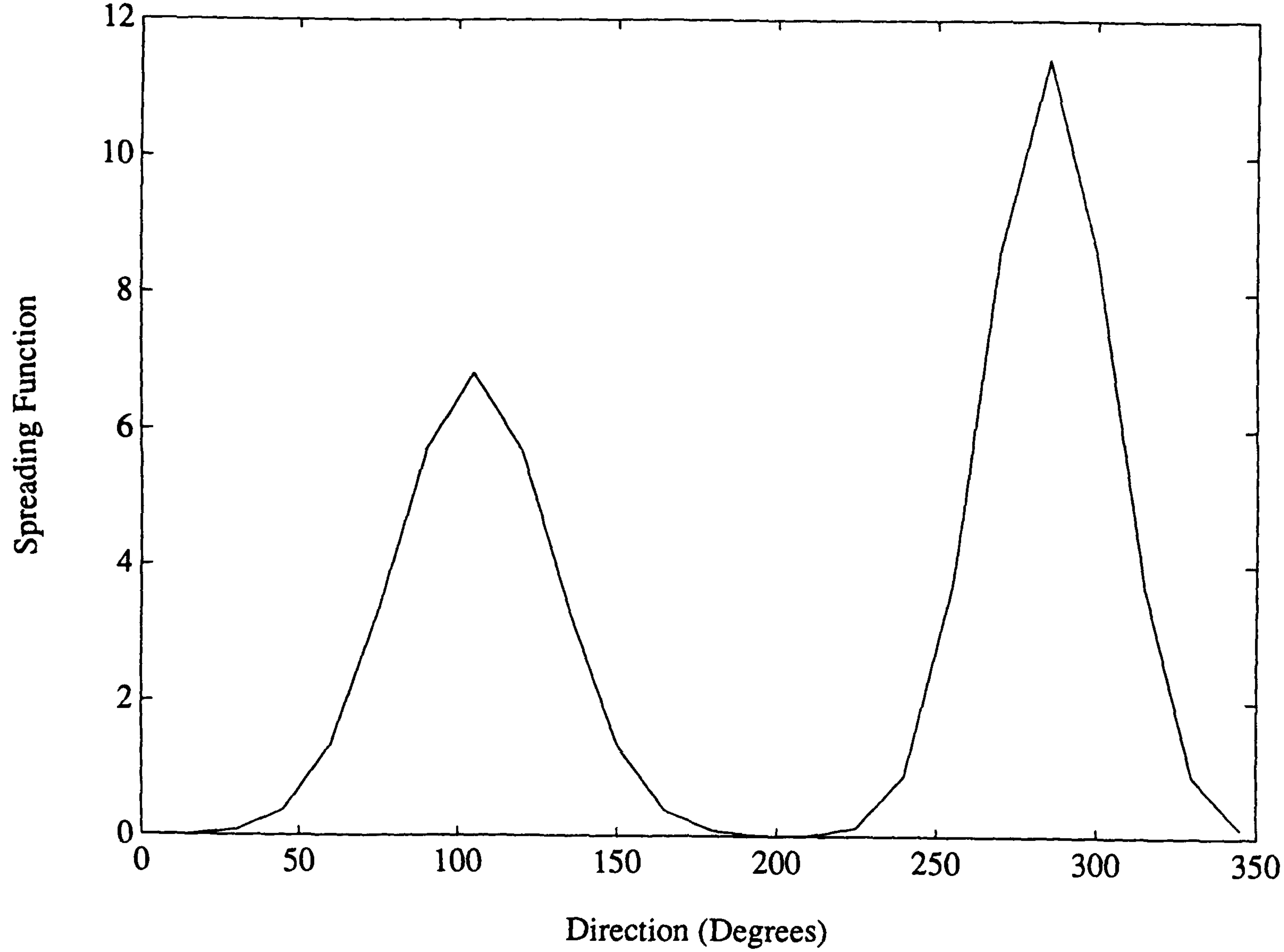

Figure C-13.
Spreading function for spectra.

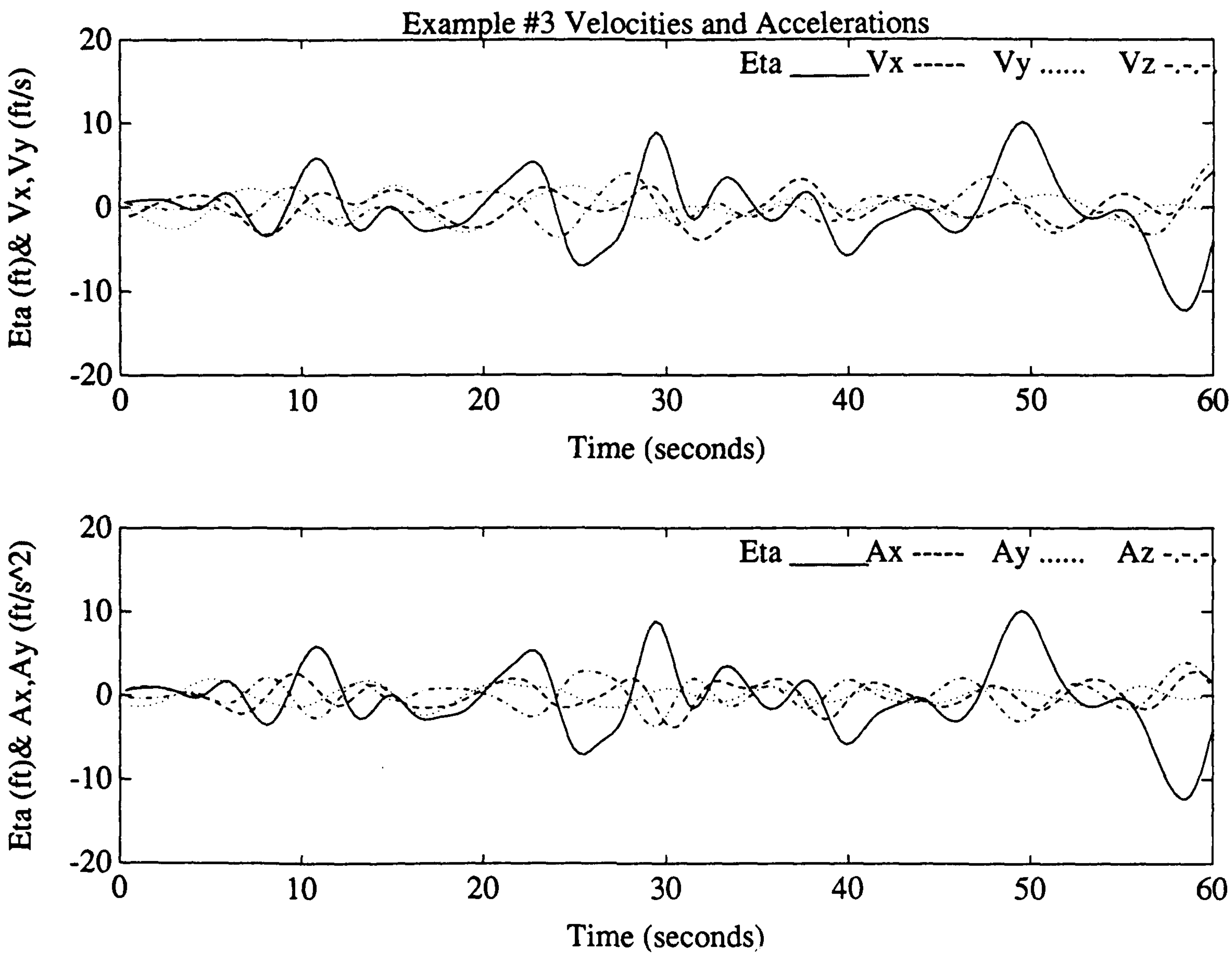

Figure C-14.
Time series plot of wave properties.

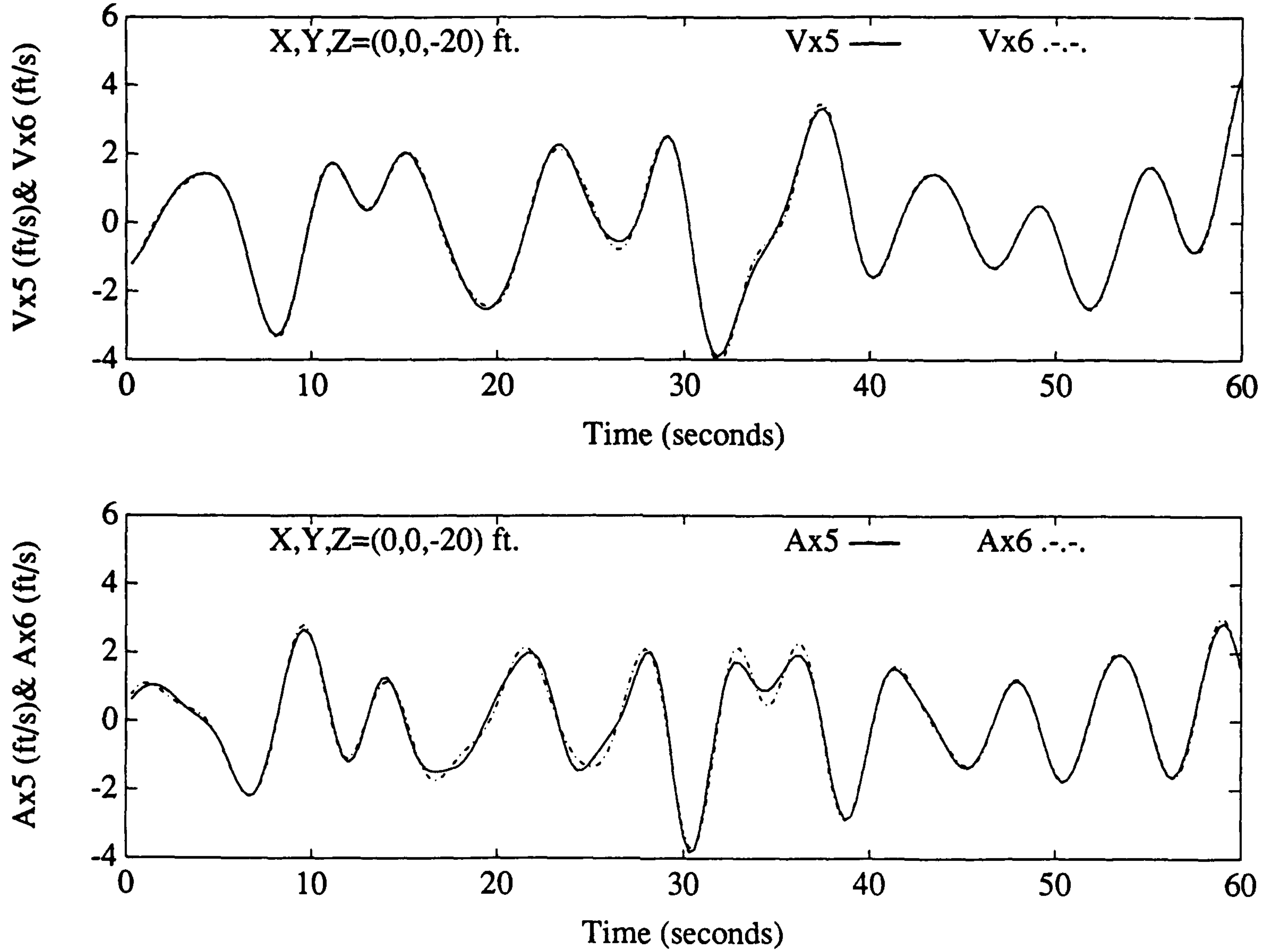

Figure C-15.
Time series plot of V_x and A_x comparing SIMBAT Option No. 5 to Option No. 6.

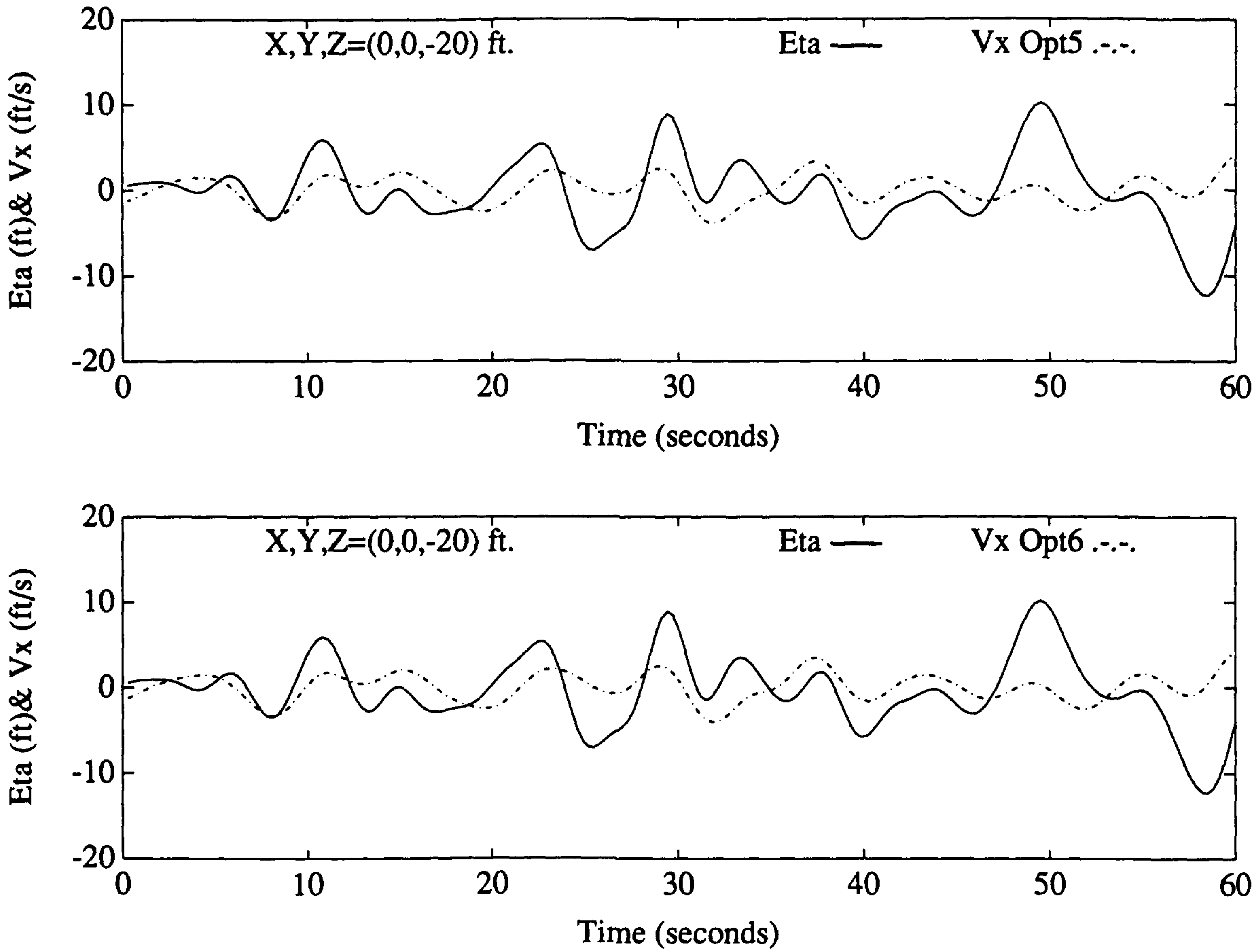

Figure C-16.
Time series plot of η with V_x Option No. 5 and Option No. 6.

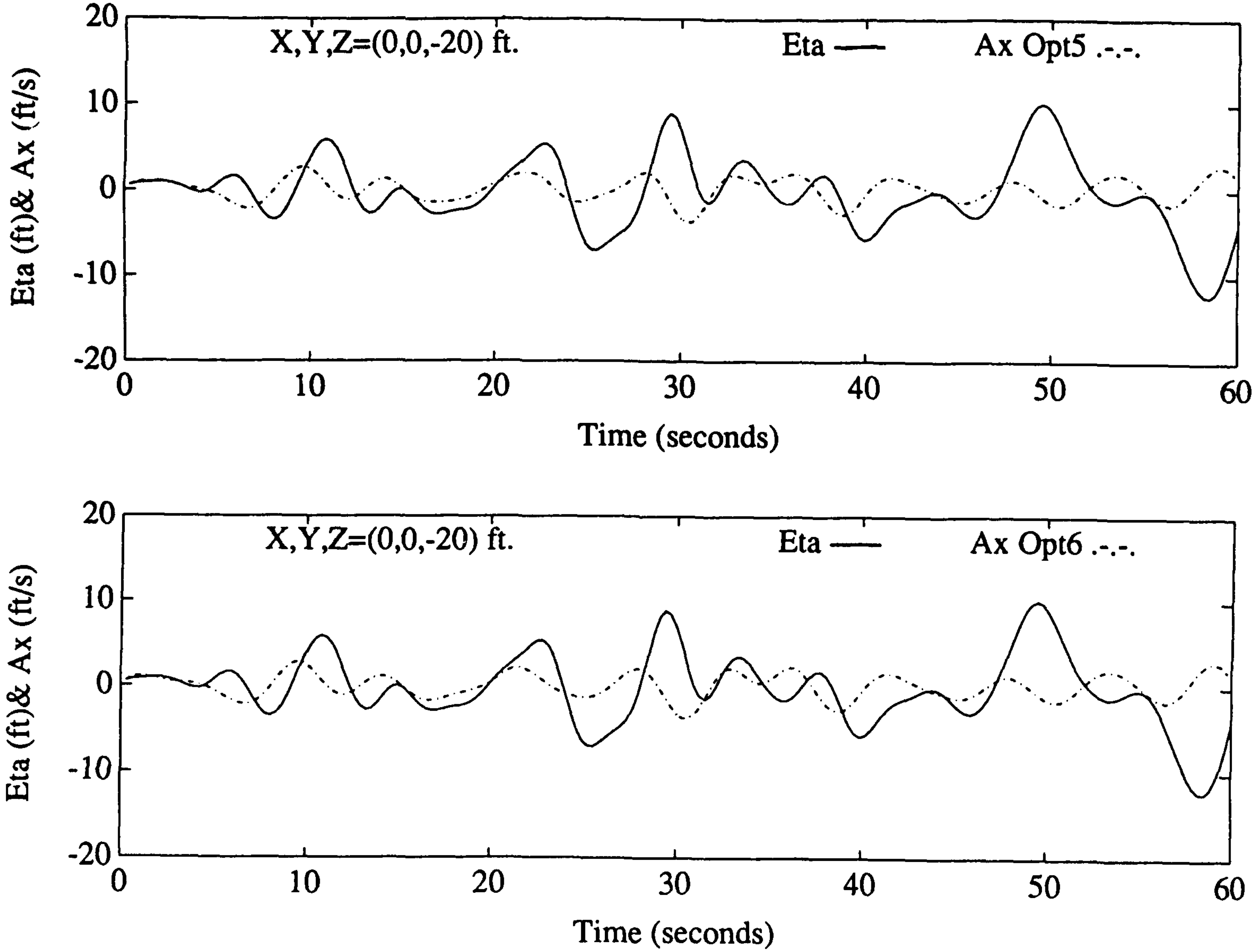

Figure C-17.
Time series plot of η with A_x Option No. 5 and Option No. 6.

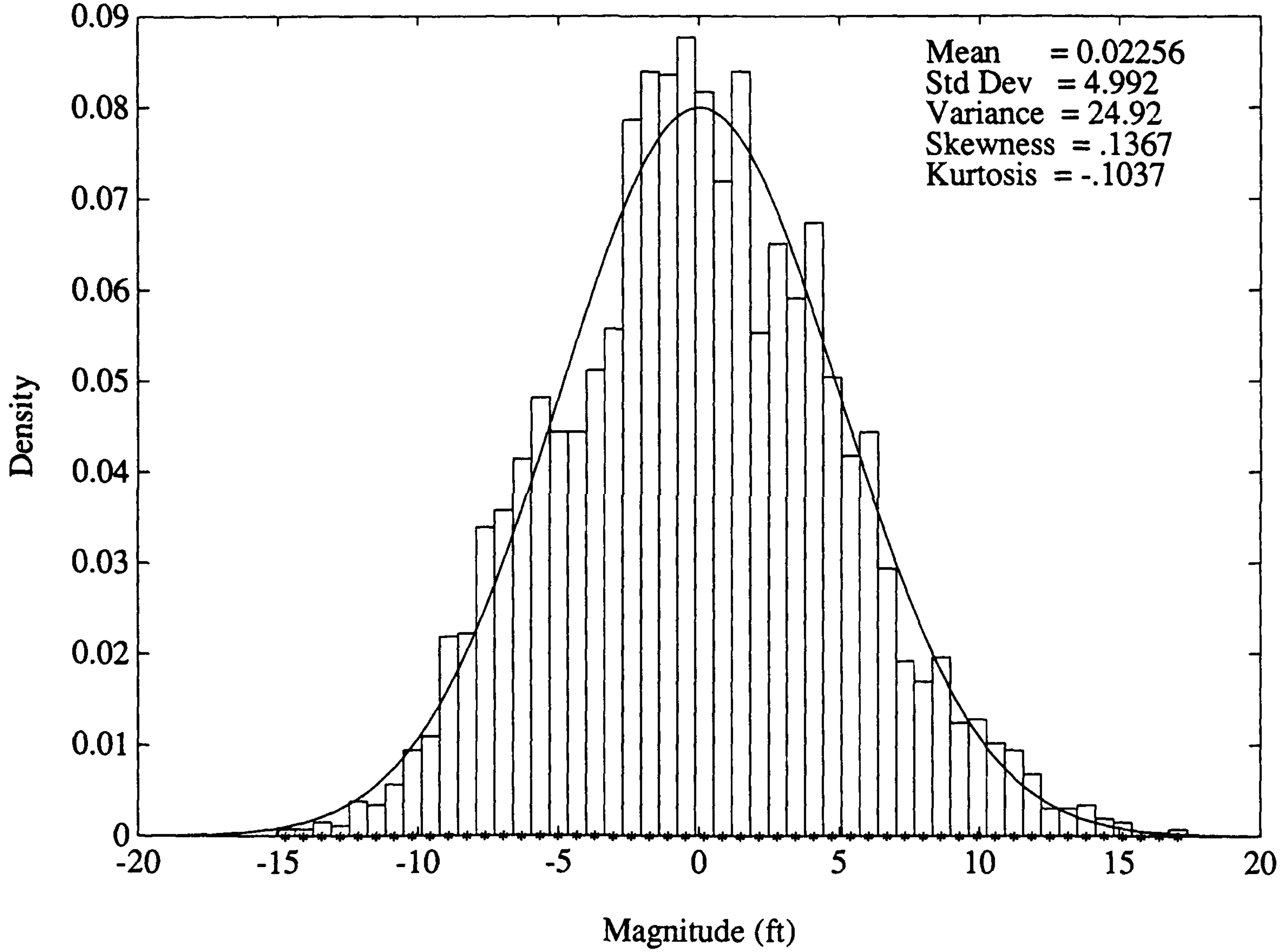

Figure C-18.
Normal distribution curve and histogram of input conditioning η.

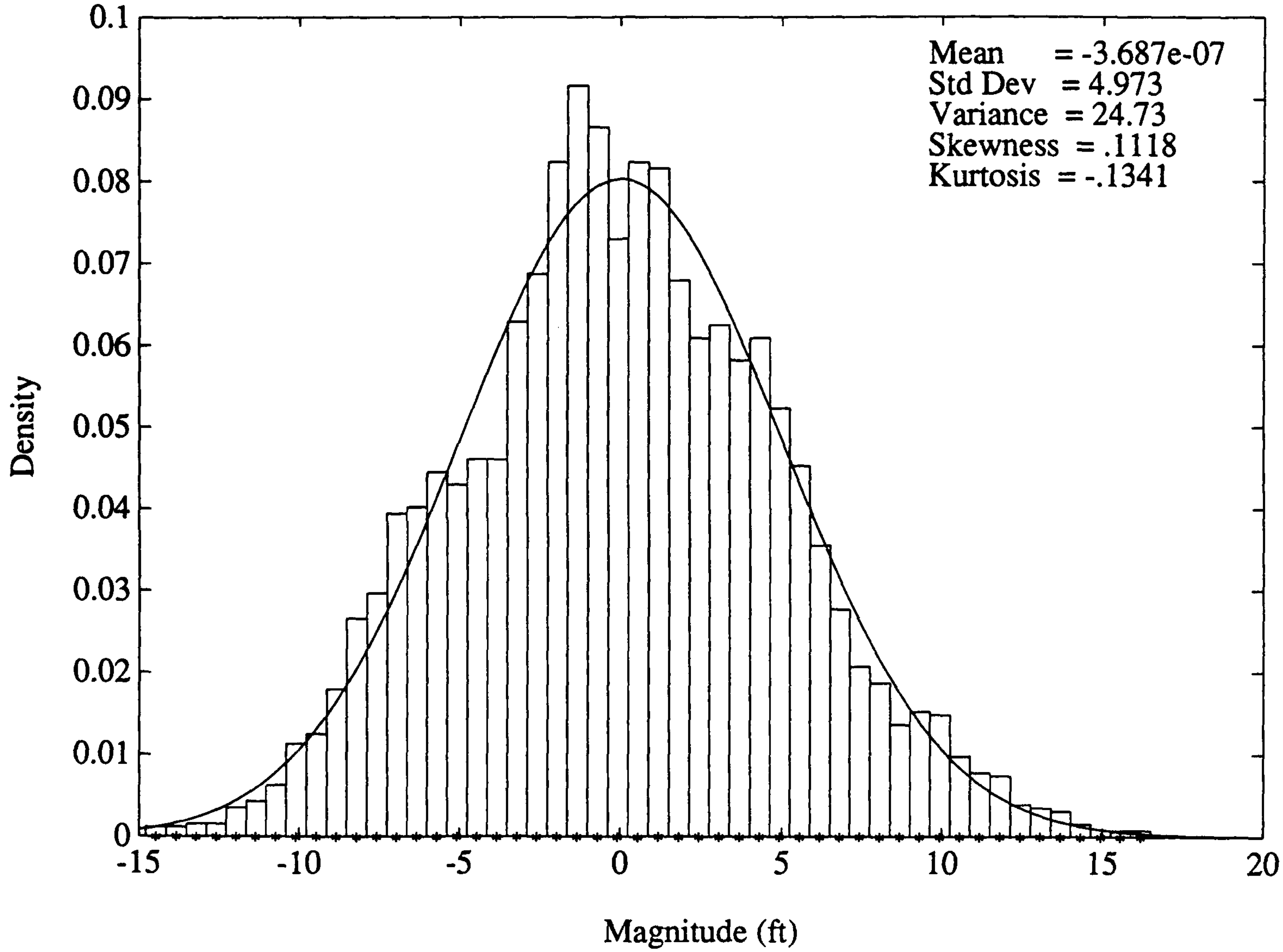

Figure C-19.
Normal distribution curve and histogram for simulated η.

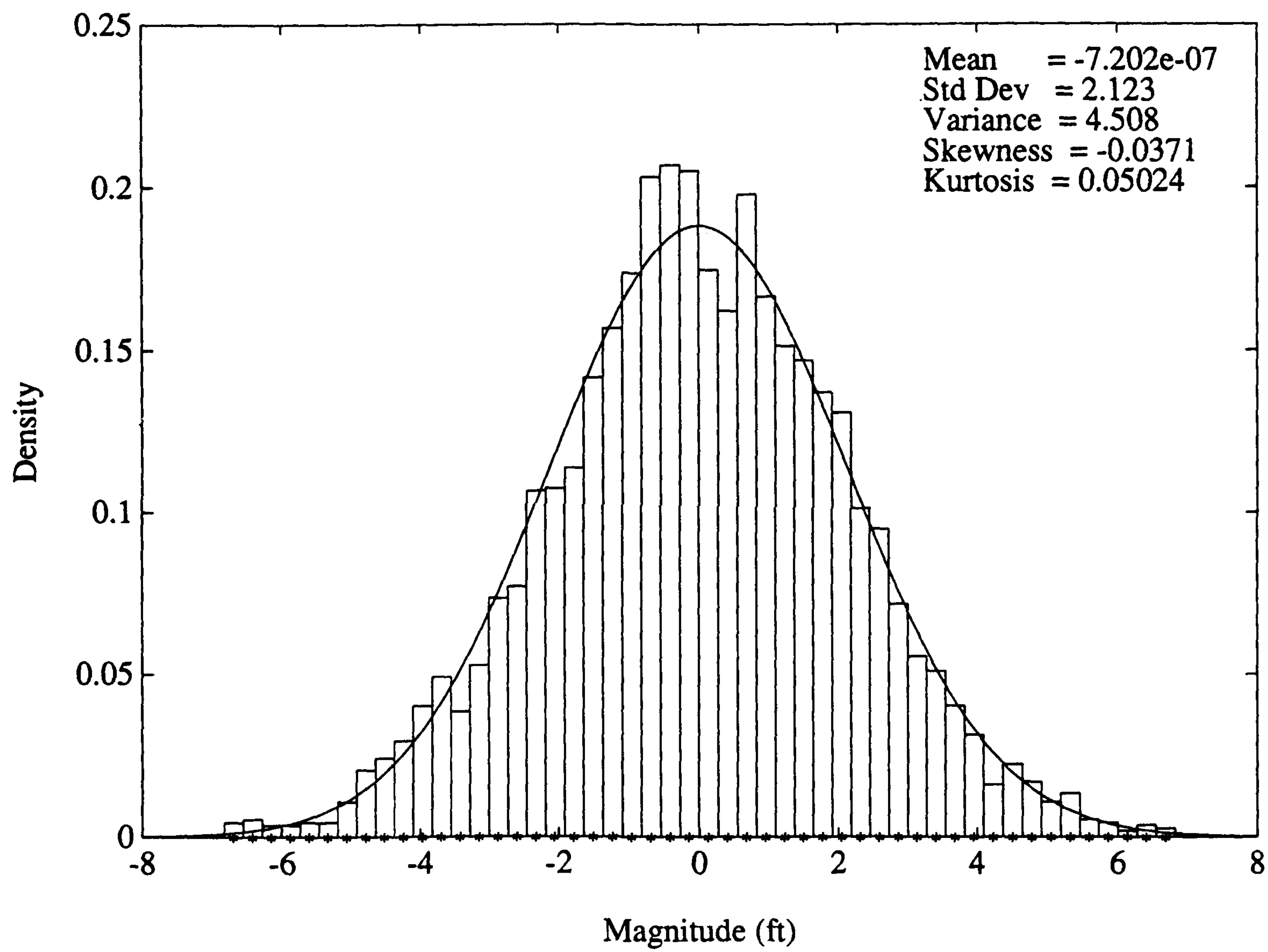

Figure C-20.
Normal distribution curve and histogram for V_x Option No. 5.

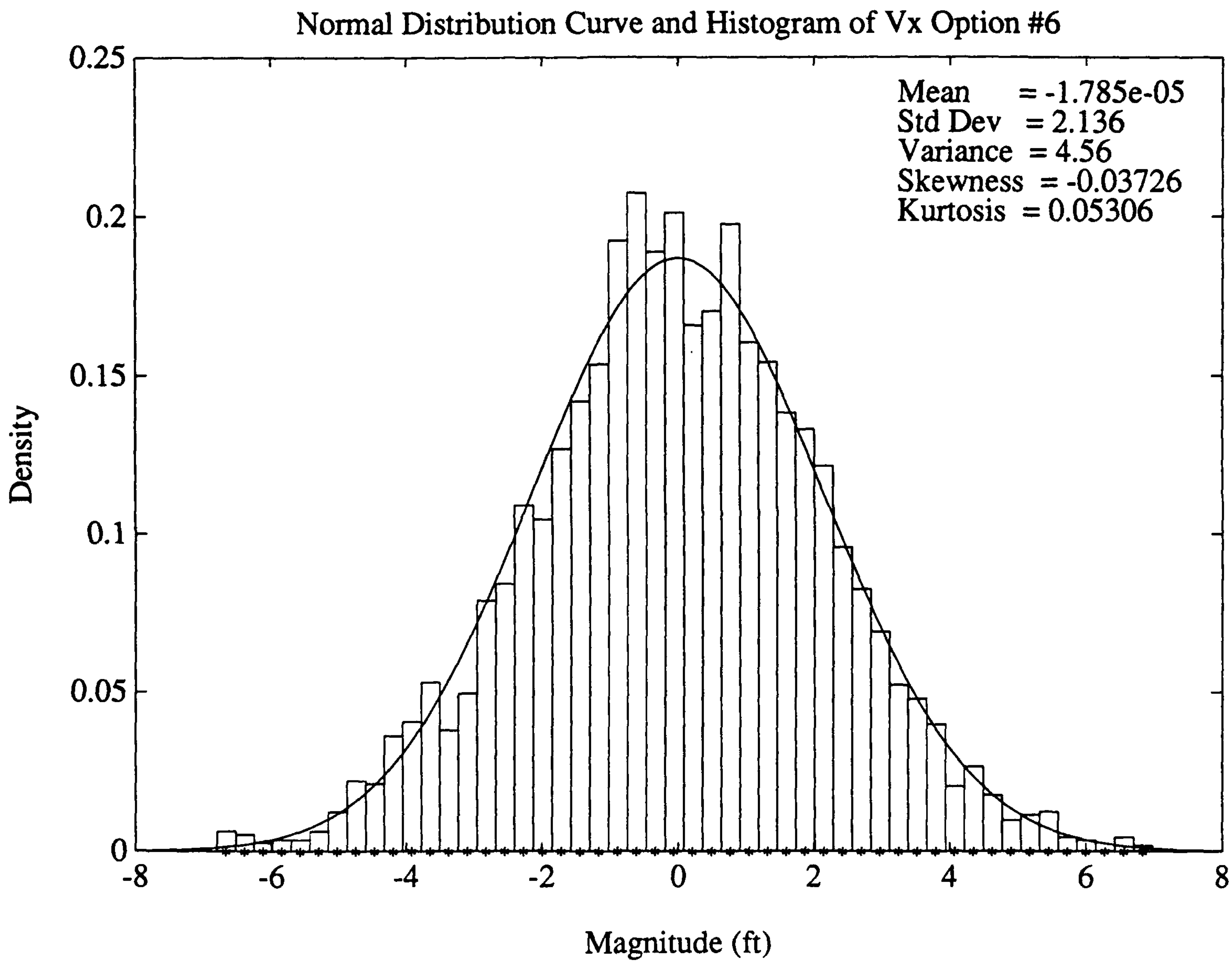

Figure C-21.
Normal distribution curve and histogram for V_x Option No. 6.

Appendix D

EXAMPLE NO. 4 — CONDITIONAL SIMULATION

L=N

- ❑ N=2048 points
- ❑ Input wave profile, L=2048 points
- ❑ Ochi-Hubble Spectra
- ❑ Wrapped Normal Spread
- ❑ Delta Stretch
- ❑ 7th Order Polynomial Fit
- ❑ Compare kinematics at X,Y,Z = 20,20,1 ft. for SIMBAT Options #5 and #6

File "INSTRUCTIONS"

```
--------------------------------------------------------------------------------
Simbat Test Case 4 Description (Delta Stretch Case):
--------------------------------------------------------------------------------

This example demonstrates a conditional simulation for eight wave
properties. The wave properties Eta,Vx,Vy,Vz,Ax,Ay,Az & P are
each 2048 points in length spaced at 0.3 seconds (614.4 seconds
each). The simulation uses the Ochi-Hubble directional spectra
with wrapped normal spreading  created in Example #1. The wave
properties are conditioned by a wave input time series of length
equal to the whole record which corresponds to SIMBAT Option #4.
The wave properties are simulated at a point in space at
X,Y,Z=20,20,1 feet using Option #5. Next Option #6 is used to
create the Legendre orthogonal polynomials for a horizontal area
of 100 ft X 100 ft using a polynomial order of 7.  Delta
stretching is used to stretch the kinematics above the mean water
line. The water depth is 2,926 ft. Finally, the wave properties
are compared at 20,20,1 ft for the Options #5 and #6.  The
simulation requires about 10 minutes execution time on a Sun
4/310 computer.

Examination of the source code simbat.f and ckpoly.f in
subdirectory "source" show the PARAMETER and DATA statements used
for this example problem. An explanation of the values for these
statements are described in the SIMBAT USERS MANUAL and in the
source code itself and therefore will not be discussed here. The
binaries are included for this example so you should be able to
run simbat on any Sun4 SPARC based computer without having to
recompile first. If you wish to modify simbat.f or ckpoly.f, type
"f77 simbat.f" and "f77 -o b.out ckpoly.f" to recompile.

The batch files execute Simbat for the following options:

          Option 2 - Preprocess data for Conditional Simulation
          Option 4 - Perform Conditional Simulation for case L=N
          Option 5 - Create time series from frequency domain methods
          Option 6 - Create Legendre Polynomial file
          Option 8 - Create kinematic comparisons for MATLAB plots
          Option 7 - Print kinematics to output file "simbat.out"

See the file "FILES" in this directory for explanation of files
on this tape.

--------------------------------------------------------------------------------
    TO TEST EXAMPLE:
--------------------------------------------------------------------------------

    1) Go to subdirectory "ourtest" and you should see the following files:

         a.out          - simbat binary for sun4
         b.out          - ckpoly binary for sun4
         case4.input1   - input data set one for a.out
```

Figure D-1.
Listing of file "INSTRUCTIONS."

```
case4.input2   - input data set two for a.out
case4.input3   - input data for b.out
dspec.dat      - sample input spectra
w383a.dat      - input time series data
```

NOTE: the two batch files case1.input1 and case1.input2 are both required in order to compare the outputs of SIMBAT Option #5 and #6. This is because the user must exit SIMBAT in order for SIMBAT to write the output file for Option#5 that is read into CKPOLY. In a real life situation this would ordinarily not be required since the user would probably execute either Option#5 or Option#6 and the comparison would not be done. It is done in all the examples for educational purposes only.

2) To execute in batch mode, do the following where % is unix prompt and & is run in background:

```
% a.out < case4.input1  &
        (this creates data necessary for input to b.out)

% a.out < case4.input2  &
        (this creates data necessary for input to b.out
         and all other output files)

% b.out < case4.input3  &
        (this compares frequency domain to Legendre Polynoimal
         approximation method as shown in output file: ckpoly.com)
```

3) If you would like to use matlab to plot data, copy all the files from the "mfiles" subdirectory into "ourtest" directory. Assuming you are already in "ourtest" subdirectory, type:

```
% cp ../mfiles/*.m .
```

Simbat will produce mfiles that have an "*f.m" in their name where "*" is the unix wildcard. These mfiles are data files whereas the mfiles in the "mfiles" subdirectory are matlab script files. Next:

```
a) start matlab
b) matlab> gmenu   (this will provide a menu for plotting)
c) matlab> tcon    (this will plot spectra contours)
d) matlab> tsdatf  (this reads time series output into matlab)
e) matlab> plsall  (this will plot tsdatf data)
d) pls,plvxx,plaxx,plva.... all read data from tsdatf and
   plot to screen as well.
e) matlab> prtsc or print to dump plot to printer.
f) NOTE: matlab can be used in a separate window if you run
      simbat interactively. Thus you can verify data as you
      proceed through simbat. Step 2) above is meant
      to be for a streamline batch execution of simbat.
```

Figure D-1. (Continued)

```
FILE "FILES"


This directory contains Simbat V3.00 Test Case Example #4 Data
Files, source code and executables. This file provides a
description of each file. See INSTRUCTIONS file for additional
details.

GENERAL FILES:
-------------

INSTRUCTIONS - instructions for simulation
FILES        - this file


DIRECTORIES:
-----------

mfiles  - MATLAB script files for plotting data
source  - source code
nceltest - example output data from Naval Civil Engineering Laboratory
ourtest - your execution directory


SOURCE FILES AND BINARIES:
-------------------------

simbat.f  - simbat V3.00 source code
ckpoly.f  - simbat post processor source code
a.out     - simbat binary for sun4
b.out     - ckpoly binary for sun4

INPUT BATCH FILES:
-----------------

case4.input1 - input data set one for a.out
case4.input2 - input data set two for a.out
case4.input3 - input data for b.out

case4.input1.console - console listing
case4.input2.console - console listing
case4.input3.console - console listing

INPUT DATA FILES:
----------------

dspec.dat - sample input spectra (see example #1)
w383a.dat - input time series data. Represents NCEL MME free surface
            elevation for 1/18/88 0429-0449.  4096 data points at
            dt=0.3 seconds = 20 minute record.  Eta was created by algebraically
            adding wavestaff data to doubly integrated heave acceleration
```

Figure D-2.
Listing of file "FILES."

```
          data that was low passed filtered at 0.025 Hz.

OUTPUT FILES:
-------------

simbat.out  - text and general data. Note for this example, the kinematics
              from Simbat Option #5,#7 and #6,#8 and #7 are also listed
              where Option #5 is listed first and those from Option #6
              are listed next. Simbat.out documents which is which.
master4.dat - Legendre Polynomial data file
tsdatf.m    - time series output from frequency domain methods to be read
              by matlab.
ptsdatf.m   - time series output from Legendre Polynomials. Append this
              file to end of tsdatf.m for use in matlab.
ckpoly.com  - output from b.out that compares kinematics between frequency
              domain methods and Legendre Polynomial approximation method.
ckpoly.lst  - kinematics created from master4.dat


EXAMPLE MATLAB "M.FILES" FOR PLOTTING OUTPUT:
---------------------------------------------
"gmenu.m" should be executed first in matlab. This
menu will list the following matlab "m-files":

gmenu.m   - matlab menu for spectra script
   tcon.m     - matlab contour plot script
   t3d.m      - matlab spectra plot script
   acon.m     - matlab simulated contour plot script
   a3d.m      - matlab 3D simulation spectra plot script
   tfs.m      - matlab point spectra script
   tds.m      - matlab directional spread script
   afs.m      - matlab simualted point spectra script
   ads.m      - matlab simulated directional spread plot script
   tads.m     - matlab direction spread plot script
   tad3.m     - matlab 3D spectra plot script
   tass.m     - matlab plot comparison script file

The next set of m.files are for plotting time series
output form data files tsdatf.m, gtsf.m, ptsdatf.m.
They do not have to be executed in any particular order
and are meant to be samples to be modified by the user.

probeta.m - matlab histogram of input eta
probseta.m - matlab histogram of simulated eta
probvx5.m - matlab histogram of velocity in x direction, Opt 5
probvx6.m - matlab histogram of velocity in x direction, Opt 6
plg.m     - matlab input data plot script
pls.m     - matlab general plot script
plsall.m  - matlab general plot script
plsaxx.m  - matlab plot output acceleration data script
plsva.m   - matlab plot  output velocity & acceleration data script
plsvxx.m  - matlab plot velocity of sim5 vs sim6
```

Figure D-2. (Continued)

```
R
N
Example #4  Options #2-4-5-6-8-7
Conditional Simulation  L=N, Delta Stretch
2
464451
2
dspec.dat
1
Y
4
w383a.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
0
Y
sim5.dat
```

Figure D-3.
Listing of "case4.input1."

```
R
N
Example #4 Options #2-4-5-6-8-7
Conditional Simulation  L=N, Delta Stretch
2
464451
2
dspec.dat
1
Y
4
w383a.dat
Y
5
0
0
0
0
0
0
0
0
0
Y
7
1
1
2048
1
6
master4.dat
example #4
0.0
0.0
50.0
50.0
16.7
7
7
5
0.3
11.382
master4.dat
8
1
4
2
60.0
2
1.0
9
master4.dat
```

Figure D-4.
Listing of "case4.input2."

```
-5.0
-25.0
0.0
0.0
50.0
0.0
6
master4.dat
Y
0
7
3
1
2048
1
0
```

Figure D-4. (Continued)

```
sim5.dat
master4.dat
```

Figure D-5.
Listing of "case4.input3."

```
 ********************************************** ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 **********************************************************
R

 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
------------------------------------------------
Example #4  Options #2-4-5-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
---------------------------------------------------
Conditional Simulation   L=N,   Delta Stretch
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
```

Figure D-6.
Listing of "case4.input1.console."

```
          (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
*************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
-------------------------------------------------
464451
**************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
2
****************************************************
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
*************************************************
dspec.dat
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
        CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
1
****************************************************
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.0660069106667D-02
NUMBER OF DEGREES OF FREEDOM =   10608
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
```

Figure D-6. (Continued)

```
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
4
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
 DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
        (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
  CHANNEL NUMBER:      1
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:      3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
```

Figure D-6. (Continued)

```
0.0
  CHANNEL NUMBER:      6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
  CHANNEL NUMBER:      8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =     2.0660069106667D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   10608
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
0
  DO YOU WANT TO SAVE THE OUTPUT FROM LAST OPTION
   Y OR N
Y
  PLEASE ENTER THE FILE NAME FOR STORAGE
sim5.dat
```

Figure D-6. (Continued)

```
 ********************************************** ******
  PROGRAM SIMULATES WAVE PROPERTIES BY FREQUENCY DOMAIN
  METHODS FOR EITHER UNCONDITIONAL OR CONDITIONAL
   SIMULATIONS.
   (WRITTEN BY LEON BORGMAN, LARAMIE, WYOMING)

  PLEASE KEY RETURN TO CONTINUE
 **********************************************************
R
```

```
 DO YOU WISH TO READ OUTPUT FROM PREVIOUS RUNS
 (Y = YES, N = NO)
N
************************************************
  ENTER A 50-CHARACTER TITLE FOR THE TIME SERIES DATA.
  --------------------------------------------------
Example #4 Options #2-4-5-6-8-7
************************************************
  ENTER A 50-CHARACTER SUMMARY OF THE TIME SERIES
   DOCUMENTATION FOR FUTURE REFERENCE.
---------------------------------------------------
Conditional Simulation   L=N,  Delta Stretch
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
```

Figure D-7.
Listing of "case4.input2.console."

```
  9. HELP
***************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
2
  ENTER SPECTRAL-LINE CUTOFF FRACTION. (NOTE: A
   SMALL VALUE IS GOOD. ONLY THOSE LINES GIVING VARIANCE
   CONTRIBUTION GREATER THAN OR EQUAL TO (CUTOFF*LARGEST
   SPECTRAL LINE) ARE KEPT
***************************************************
  ENTER SEED INTEGER FOR RANDOM NUMBER GENERATOR, I10
---------------------------------------------------
464451
***************************************************
 ENTER IOPT:
     IOPT=1 INDICATES DSPEC MATRIX IS COMPUTED AND THEN
        STORED FOR FUTURE USE IN A USER-SPECIFIED FILE.
     IOPT=2 INDICATES DSPEC MATRIX IS READ FROM A
        USER-SPECIFIED FILE
*****************************************************
2
ENTER FILE NAME FROM WHERE THE DATA IS TO BE READ.
dspec.dat
***************************************************
  AMPLITUDE RANDOMNESS MENU
  1. RANDOM PHASE, BUT WAVE AMPLITUDE DETERMINISTIC AND
         CONSTRAINED TO BE EQUAL TO  2.0*SQRT(S(F,THETA))
  2. RANDOM PHASE AND RANDOM AMPLITUDE
    PLEASE ENTER YOUR CHOICE
*****************************************************
1
POINT B REACHED
POINT C REACHED
POINT D REACHED
VMULT AFTER CALL TO SIM AND RETURN =     2.0660069106667D-02
NUMBER OF DEGREES OF FREEDOM =   10608
  DO YOU WANT GRAPHICS OUTPUT OF SPECTRA FOR
   EXECUTION WITH THE MATLAB SOFTWARE ?
     Y = YES, N = NO
Y
 ****************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
```

Figure D-7. (Continued)

```
      STEP #1, #3, OR #4.)
   6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
4
THE GIVEN TIME SERIES IS TO BE READ FROM WHAT FILE?
 DO YOU WISH TO OUTPUT GIVEN TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
5
  ENTER NOISE TO SIGNAL RATIO, AS RATIO OF NOISE
    STANDARD DEVIATION TO SIGNAL STANDARD DEVIATION
0.0
 CHANNEL NUMBER:     1
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:     2
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
CHANNEL NUMBER:     3
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:     4
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
```

Figure D-7. (Continued)

```
 CHANNEL NUMBER:      5
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:      6
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:      7
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
 CHANNEL NUMBER:      8
  PLEASE ENTER MEAN VALUE DESIRED FOR THIS CHANNEL
0.0
VMULT AFTER CALL TO SIM AND RETURN =     2.0660069106667D-02
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
NUMBER OF DEGREES OF FREEDOM =   10608
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
     CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
     (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
     INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
     (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
     STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
     ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
     KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
7
  SELECT SOURCE FOR TIME SERIES LIST:
     0. EXIT.
     1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
     2. GIVEN TIME SERIES CONDITIONED ON.
     3. TIME SERIES FROM POLYNOMIALS.
         (ICHUZ=3, 4, OR {8-SUB 6} MUST HAVE BEEN RUN PREVIOUSLY.)
  *******************
  (PLEASE ENTER YOUR CHOICE.)
 1
 ENTER TIME STEP FOR START OF LIST (I5)
1
 ENTER TIME STEP AT TERMINATION OF LIST (I5)
```

Figure D-7. (Continued)

```
2048
  ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
  KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
1
**************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
6
  PLEASE ENTER A 50-CHAR. TITLE FOR THE OUTPUT.
master4.dat
 PLEASE ENTER ANY ADDITIONAL DOCUMENTATION THAT
 YOU WANT ATTACHED TO THE OUTPUT.
example #4
  PLEASE ENTER X-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER Y-VALUE AT CENTER OF REGION
0.0
  PLEASE ENTER X-RADIUS OF REGION
50.0
  PLEASE ENTER Y-RADIUS OF REGION
50.0
  PLEASE ENTER REFERENCE WAVE PERIOD.
  (NOTE: THIS SHOULD APPROXIMATELY BE THE WAVE PERIOD
  CORRESPONDING TO THE FREQUENCY AT THE PEAK OF THE
  WAVE SPECTRAL DENSITY.)
16.7
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER TO BE
  USED IN THE HORIZONTAL ORTHOGONAL POLYNOMIAL EXPANSIONS.
  THIS SHOULD NEVER BE GREATER THAN 12. FIVE OR SIX IS
  A GOOD  CHOICE.
7
  PLEASE ENTER THE MAXIMUM POLYNOMIAL ORDER FOR THE
  VERTICAL ORTHOGONAL POLYNOMIAL EXPANSIONS.  THIS SHOULD
```

Figure D-7. (Continued)

```
  NEVER BE GREATER THAN 12. EIGHT, OR SO, IS A GOOD CHOICE.
7
  **********************************************
  STRETCHING MENU:
  0. LINEAR EXTRAPOLATION
  1. FUNCTIONAL EXTRAPOLATION
  2. TRUNCATION EXTRAPOLATION
  3. GAMMA EXTRAPOLATION
  4. REID-WHEELER STRETCHING
  5. RODENBUSCH-FORRISTALL DELTA STRETCHING
      PLEASE ENTER YOUR CHOICE.
 *****************************************************
5
 PLEASE ENTER DELTA FOR STRETCHING.
    DELTA=0.0, FOR WHEELER-STRETCH
    DELTA=1.0, FOR PURE EXTRAPOLATION
    DELTA=0.3, SUGGESTED IN RODENBUSCH-FORRISTALL
       PAPER FOR DELTA STRETCH, ALTHOUGH ANY DELTA
       BETWEEN 0 AND 1 IS PERMITTED.
0.3
PLEASE ENTER D-DELTA FOR STRETCHING.
     D-DELTA=DEPTH, FOR EXTRAPOLATION OR WHEELER-STRETCH
     D-DELTA BETWEEN ZERO AND DEPTH, FOR DELTA-STRETCH.
        (NOTE: D-DELTA=TWO TIMES STD. DEV. OF SEA SURFACE
         IS SUGGESTED IN RODENBUSCH-FORRISTALL PAPER.
         SEA SURFACE STAND. DEV.HERE =          5.91608
         DEPTH HERE=                         2926.00000
11.382
  WHAT IS THE FILE NAME FOR THE MASTER FILE*
TVAR,STDEVI,ISTRCH,BSTR=     35.000000000000    5.9160797830996  5
   0.30000000000000
DELTA, DDELTA=    0.30000000000000    11.382000000000
JM=  1
JM=  11
JM=  21
JM=  31
JM=  41
JM=  51
JM=  61
JM=  71
JM=  81
JM=  91
JM=  101
JM=  111
JM=  121
JM=  131
JM=  141
JM=  151
JM=  161
JM=  171
JM=  181
JM=  191
```

Figure D-7. (Continued)

```
JM=  201
JM=  211
JM=  221
ETA
VX
VY
VZ
AX
AY
AZ
P
M=   1
M=   101
M=   201
M=   301
M=   401
M=   501
M=   601
M=   701
M=   801
M=   901
M=   1001
M=   1101
M=   1201
M=   1301
M=   1401
M=   1501
M=   1601
M=   1701
M=   1801
M=   1901
M=   2001
STORING INTO MASTER FILE: M=    1
STORING INTO MASTER FILE: M=    101
STORING INTO MASTER FILE: M=    201
STORING INTO MASTER FILE: M=    301
STORING INTO MASTER FILE: M=    401
STORING INTO MASTER FILE: M=    501
STORING INTO MASTER FILE: M=    601
STORING INTO MASTER FILE: M=    701
STORING INTO MASTER FILE: M=    801
STORING INTO MASTER FILE: M=    901
STORING INTO MASTER FILE: M=    1001
STORING INTO MASTER FILE: M=    1101
STORING INTO MASTER FILE: M=    1201
STORING INTO MASTER FILE: M=    1301
STORING INTO MASTER FILE: M=    1401
STORING INTO MASTER FILE: M=    1501
STORING INTO MASTER FILE: M=    1601
STORING INTO MASTER FILE: M=    1701
STORING INTO MASTER FILE: M=    1801
STORING INTO MASTER FILE: M=    1901
```

Figure D-7. (Continued)

```
STORING INTO MASTER FILE: M=   2001
 **************************************************
  OPTIONS ACTIVE ON THIS PROGRAM:
  0. EXIT PROGRAM
  1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
8
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
1
NUMM,NT,VMULT  221  24    2.0660069106667D-02
  CHI**2 VALUE=   8085.204 CHI**2  DEGREES OF FREEDOM =        8028
  (CHI**2-MEAN CHI**2)/STDEV CHI**2 =             0.451
  ********** ERROR CHECK CHOICES: ************
```

Figure D-7. (Continued)

```
   0.   EXIT.
   1.   CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
           THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
           ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
   2.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
           LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
           LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
   3.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
           LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
           LINE** GRAPHICALLY. (ANY STRETCH.)
   4.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
           LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
           BY GRAPHICAL COMPARISON. (ANY STRETCH.)
   5.   CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
           LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
           PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
   6.   COMPUTE TIME SERIES WITH ORTHOG. POLY.
           FOR SAME WAVE PROPERTIES AND LOCATIONS AS
           SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
           WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
4
  WHAT WAVE PROPERTIES DO YOU WISH TO COMPARE?
  *********************************************
    YOUR CHOICES ARE:
  1. WAVE PROFILE
  2. WATER PARTICLE VELOCITY IN THE DIRECTION X
  3. WATER PARTICLE VELOCITY IN THE DIRECTION Y
  4. WATER PARTICLE VELOCITY IN THE DIRECTION Z
  5. WATER PARTICLE ACCELETATION IN THE DIRECTION X
  6. WATER PARTICLE ACCELERATION IN THE DIRECTION Y
  7. WATER PARTICLE ACCELERATION IN THE DIRECTION Z
  8. PRESSURE FLUCTUATIONS ABOUT STATIC PRESSURE
  *********************************************
       PLEASE ENTER YOUR CHOICE
2
 WHAT START TIME FOR COMPARISONS DO YOU WANT(0.0)?
60.0
  HOW MANY TIME STEPS DO YOU WANT?
     (NOT MORE THAN 20 WITH PRESENT DIMENSIONING)
2
 WHAT IS TIME INCREMENT FOR TIME STEPS (0.3)?
  HOW MANY AXIS-DIVISIONS DO YOU WANT?
      (NOT MORE THAN 20 WITH CURRENT DIMENSIONING)
1.0
  WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master4.dat
 WHAT Z-COORDINATE FOR TOP EDGE OF PLANE?
-5.0
  WHAT Z-COORDINATE FOR BOTTOM EDGE OF PLANE?
-25.0
```

Figure D-7. (Continued)

```
  WHAT X-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT Y-COORDINATE FOR LEFT EDGE OF PLANE?
0.0
  WHAT X-COORDINATE FOR RIGHT EDGE OF PLANE?
50.0
  WHAT Y-COORDINATE FOR RIGHT EDGE OF PLANE?
0.0
  ********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
         PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
         FOR SAME WAVE PROPERTIES AND LOCATIONS AS
         SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
         WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
  ***********************
  PLEASE ENTER YOUR CHOICE.
6
  WHAT IS THE NAME OF THE FILE OF LEGENDRE COEF.?
master4.dat
 DO YOU WISH TO OUTPUT SIM. TIME SERIES FOR GRAPHICAL COMPARISONS?
   ENTER Y=YES OR N=NO
Y
********** ERROR CHECK CHOICES: ************
  0.  EXIT.
  1.  CHECK **CHI-SQUARED VALUE** FOR DIFFERENCE BETWEEN
         THEORETICAL DIR. SPECTRA AND SIM. AMPLITUDES.
         ICHUZ=1 OR 2 SHOULD HAVE BEEN PREVIOUSLY RUN.
  2.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG A **VERTICAL STRAIGHT
         LINE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  3.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ALONG AN **ARBITRARY STRAIGHT
         LINE** GRAPHICALLY. (ANY STRETCH.)
  4.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
         LEGENDRE APPROX. ON A **VERTICAL RECTANGLE**
         BY GRAPHICAL COMPARISON. (ANY STRETCH.)
  5.  CHECK DIFFERENCES BETWEEN LINEAR WAVE THEORY AND
```

Figure D-7. (Continued)

```
          LEGENDRE APPROX. ON AN **ARBITRARY RECTANGULAR
          PLANE** BY GRAPHICAL COMPARISON. (ANY STRETCH.)
   6.  COMPUTE TIME SERIES WITH ORTHOG. POLY.
          FOR SAME WAVE PROPERTIES AND LOCATIONS AS
          SPECIFIED IN PARAMETER STATEMENT, FOR COMPARISON
          WITH OUTPUT FROM OPTION #5. (STRETCH #1 ONLY.)
   ***********************
   PLEASE ENTER YOUR CHOICE.
 0
   **************************************************
   OPTIONS ACTIVE ON THIS PROGRAM:
   0. EXIT PROGRAM
   1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
   2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
      CONDITIONAL SIMULATION
   3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
      (USES OUTPUT FROM STEP #2.)
   4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
      INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
      (USES OUTPUT FROM STEP #2.)
   5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
      STEP #1, #3, OR #4.)
   6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
      ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
      KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
   7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
   8. ERROR CHECKING PROGRAM
   9. HELP
 ************************************************
         (PLEASE KEY YOUR CHOICE AND RETURN)
 7
   SELECT SOURCE FOR TIME SERIES LIST:
      0. EXIT.
      1. TIME SERIES FROM ICHUZ=5 SIMULATIONS.
      2. GIVEN TIME SERIES CONDITIONED ON.
      3. TIME SERIES FROM POLYNOMIALS.
          (ICHUZ=3, 4, OR {8-SUB 6} MUST HAVE BEEN RUN PREVIOUSLY.)
   *******************
   (PLEASE ENTER YOUR CHOICE.)
 3
   ENTER TIME STEP FOR START OF LIST (I5)
 1
  ENTER TIME STEP AT TERMINATION OF LIST (I5)
 2048
   ENTER 0 IF GRAPHICAL OUTPUT IS DESIRED
   KEY 1 IF NUMERICAL LIST OF TIME SERIES IS WANTED
 1
  **************************************************
   OPTIONS ACTIVE ON THIS PROGRAM:
   0. EXIT PROGRAM
   1. PRODUCE COMPLEX AMPLITUDES FOR UNCONDITIONAL SIMULATIONS
```

Figure D-7. (Continued)

```
  2. PRE-PROCESS DATA TO PRODUCE NECESSARY INPUT FOR A
       CONDITIONAL SIMULATION
  3. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INPUT IS LESS THAN N.
       (USES OUTPUT FROM STEP #2.)
  4. DEVELOP COMPLEX-VALUED AMPLITUDES, CONDITIONED ON GIVEN
       INPUT, WHERE CONDITIONING INTERVAL EQUALS N.
       (USES OUTPUT FROM STEP #2.)
  5. SIMULATE TIME SERIES FROM AMPLITUDES (USES OUTPUT FROM
       STEP #1, #3, OR #4.)
  6. PRODUCE COEFF. FOR A TIME-STEP-BY-TIME-STEP X-Y-Z
       ORTHOGONAL EXPANSION OF SEA SURFACE AND WATER PARTICLE
       KINEMATICS. (USES OUTPUT FROM STEPS #1, #3 OR #4.)
  7. OUTPUT SIMULATED OR GIVEN (CONDITIONING) TIME SERIES
  8. ERROR CHECKING PROGRAM
  9. HELP
************************************************
          (PLEASE KEY YOUR CHOICE AND RETURN)
0
```

Figure D-7. (Continued)

```
 INPUT FILE NAME (sim5.dat) ?
sim5.dat
 INPUT MASTER FILE NAME (master4.dat) ?
master4.dat
```

Figure D-8.
Listing of "case4.input3.console."

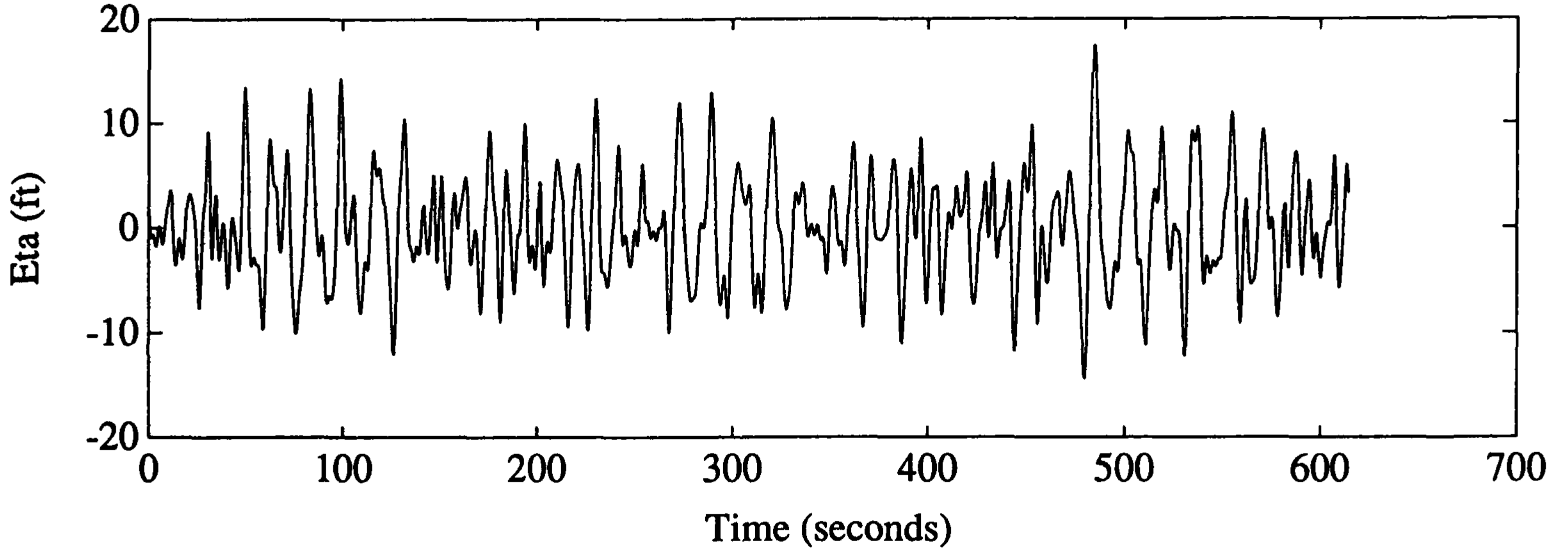

Figure D-9.
Input conditioning η.

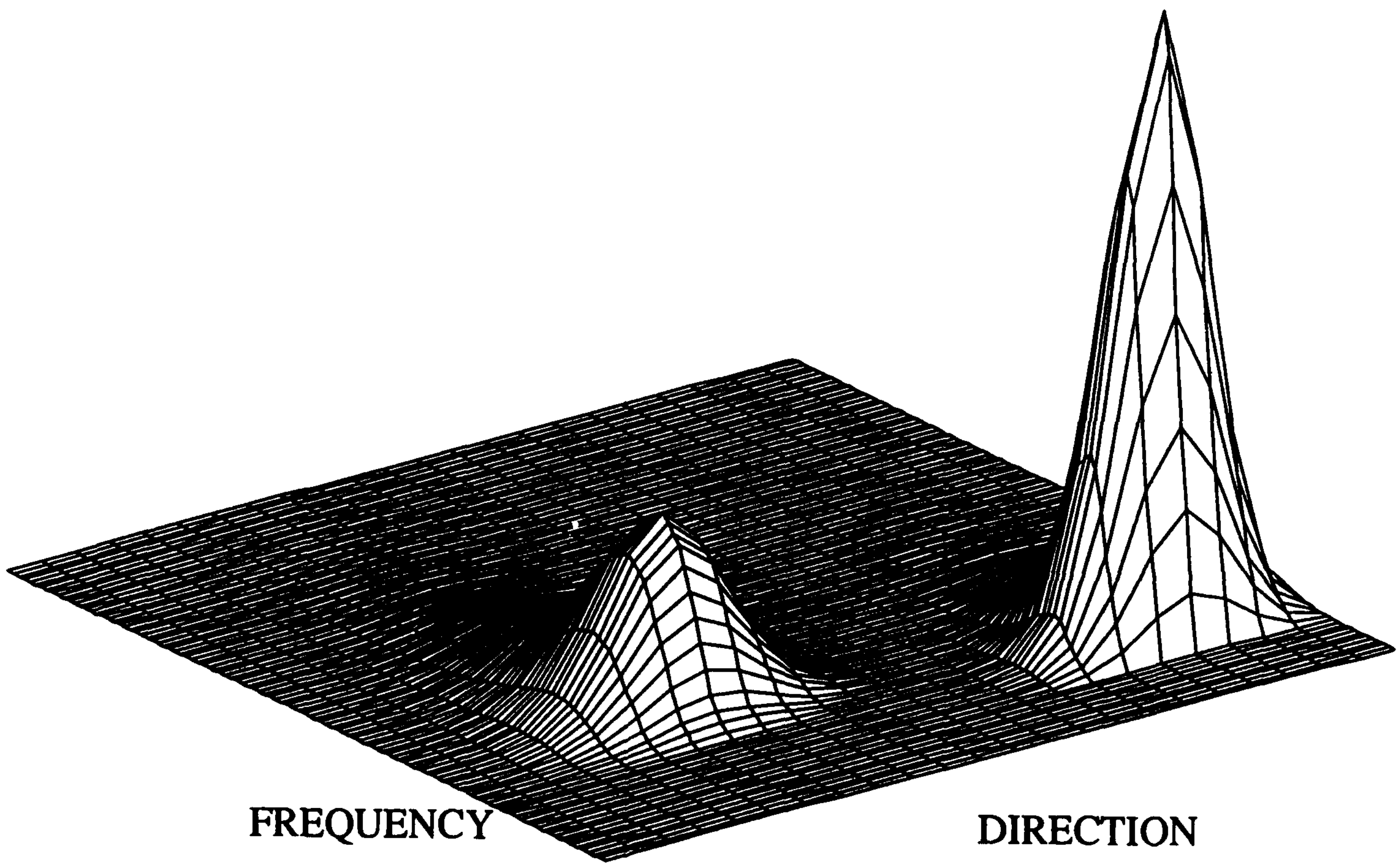

Figure D-10.
3D ocean spectra.

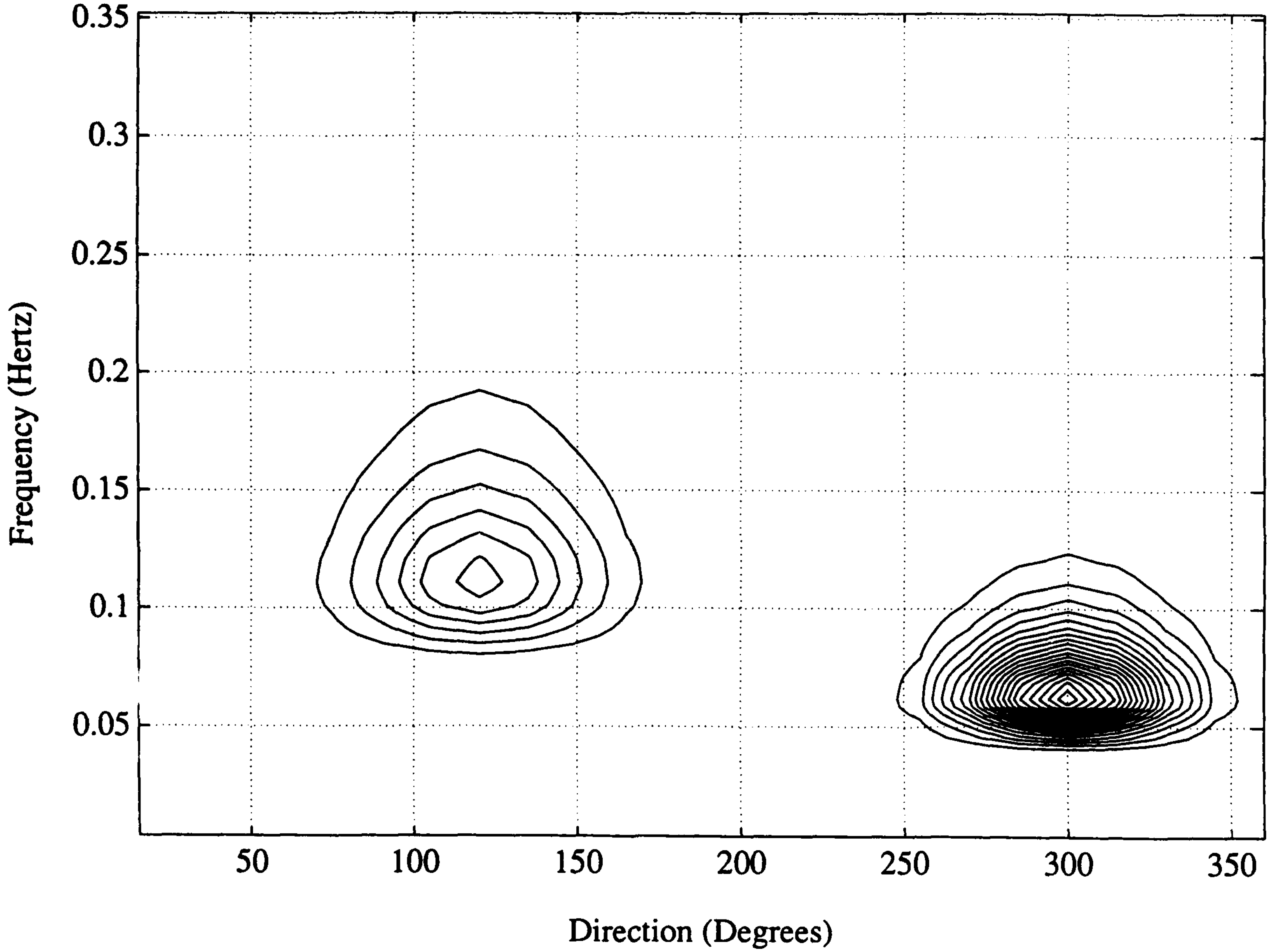

Figure D-11.
Contour plot of ocean spectra.

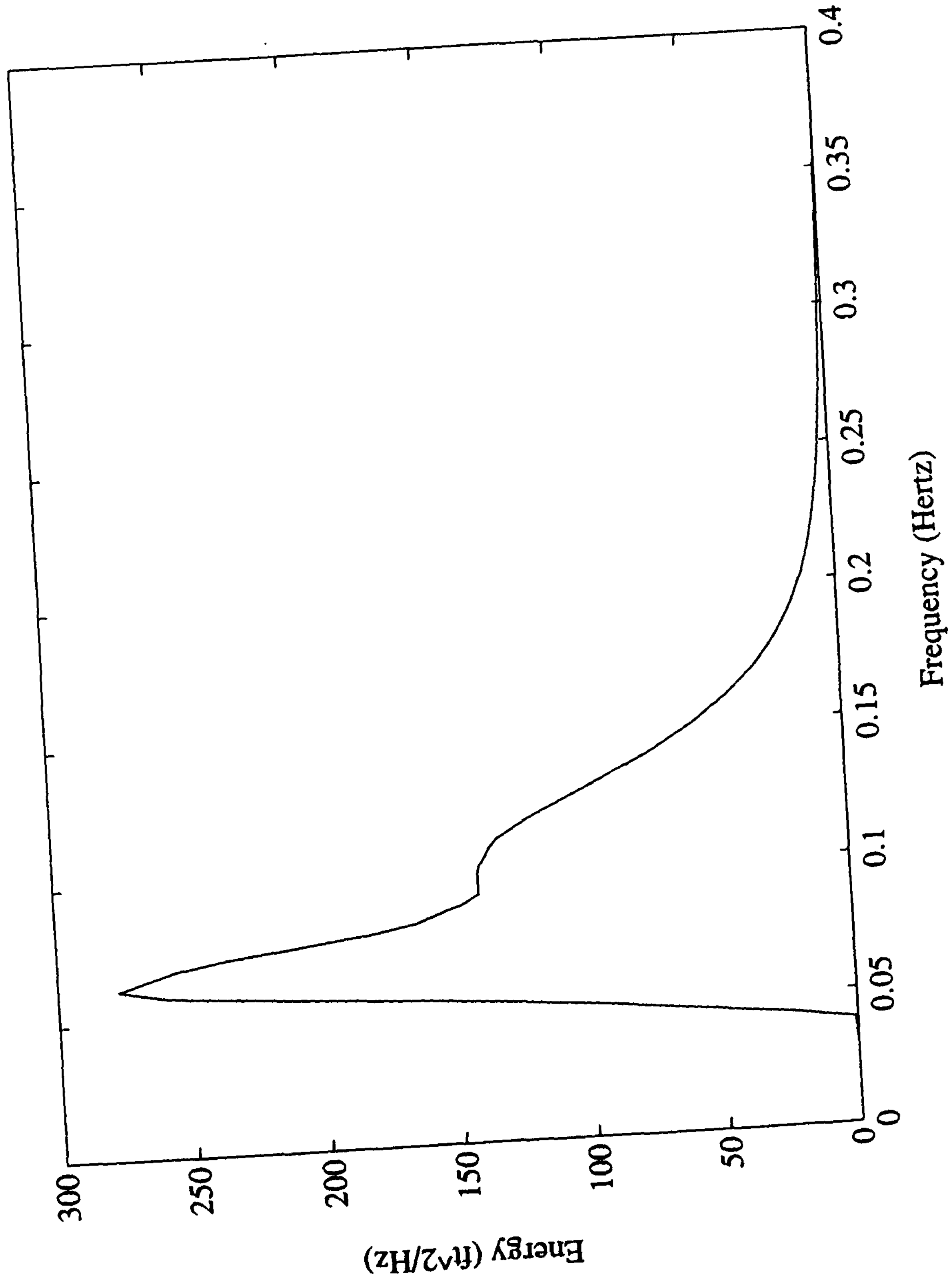

Figure D-12.
2D ocean spectra.

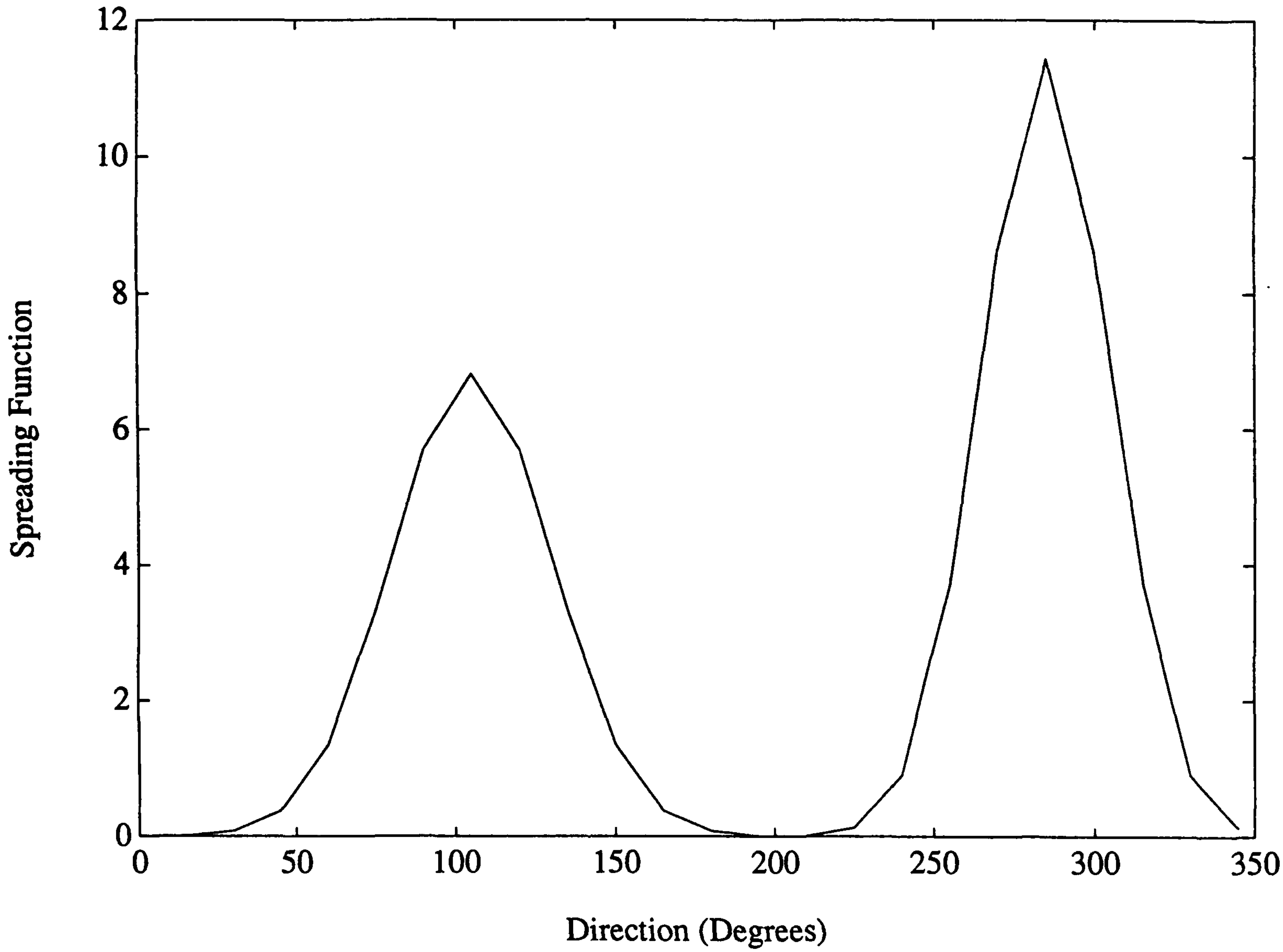

Figure D-13.
Spectra spreading function.

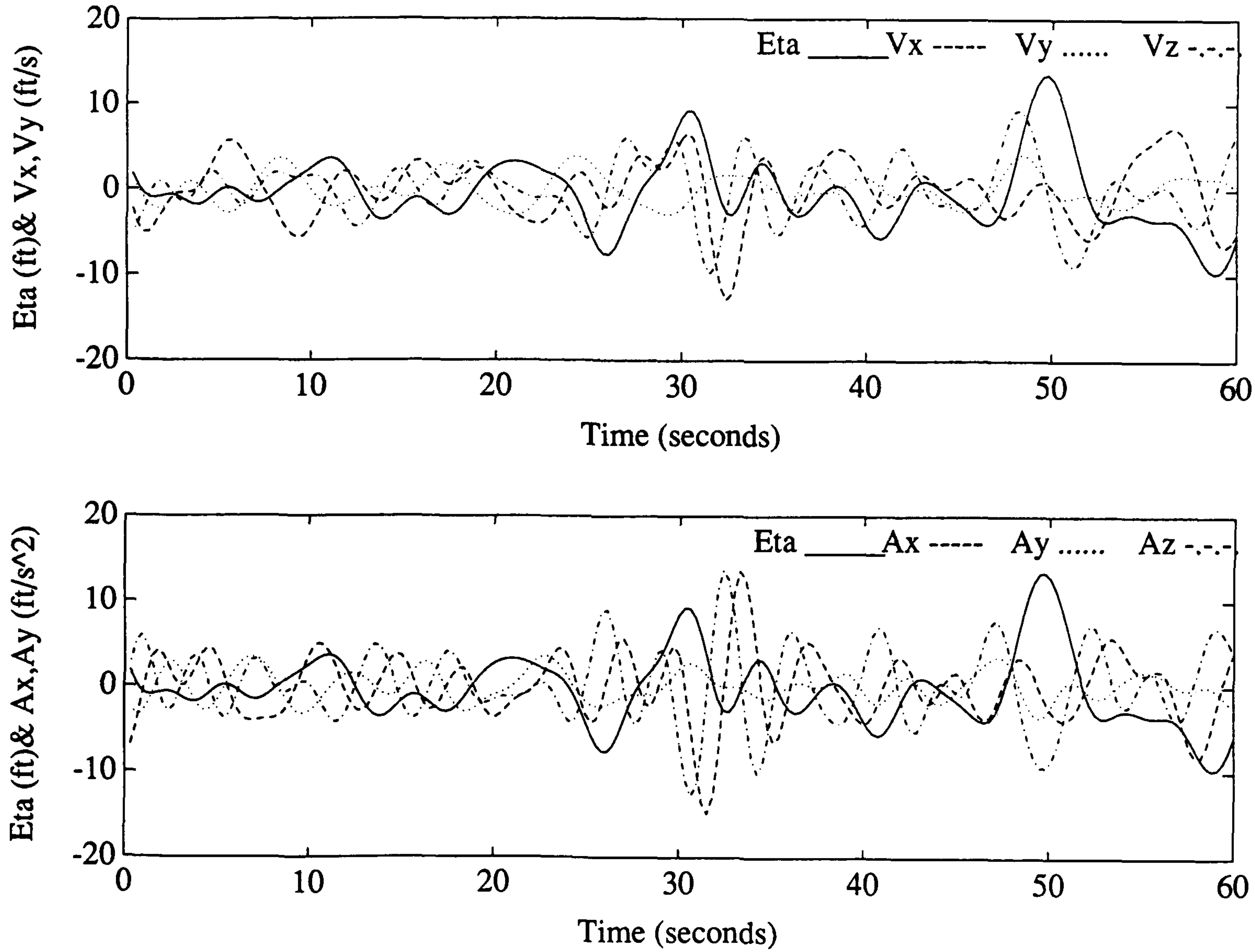

Figure D-14.
Time series plot of wave properties.

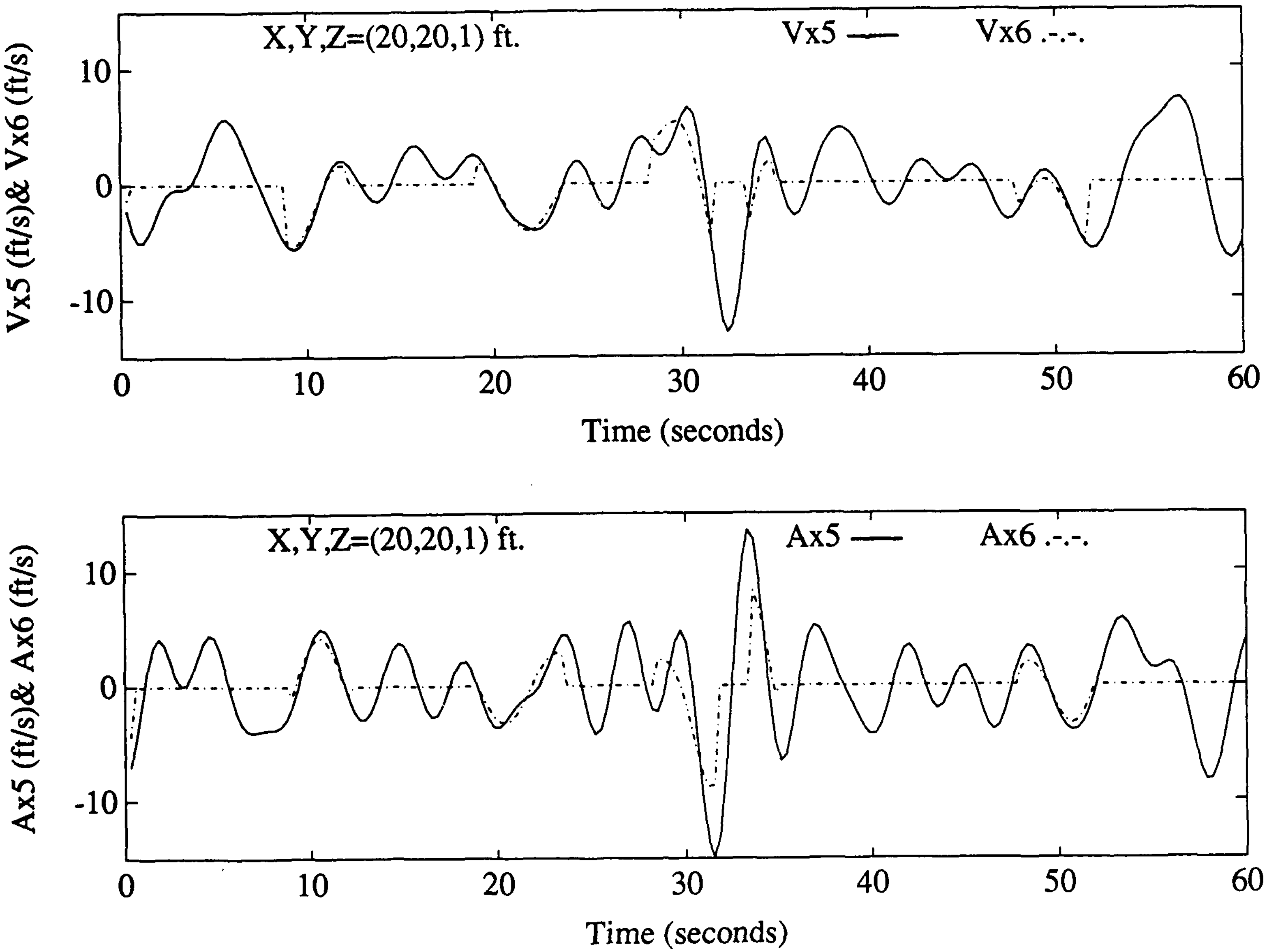

Figure D-15.
Comparison of V_x Option No. 5 and V_x Option No. 6 and A_x Option No. 5 and A_x Option No. 6. Option No. 6 V_x and A_x drop to zero as η passes Z = 1 ft elevation.

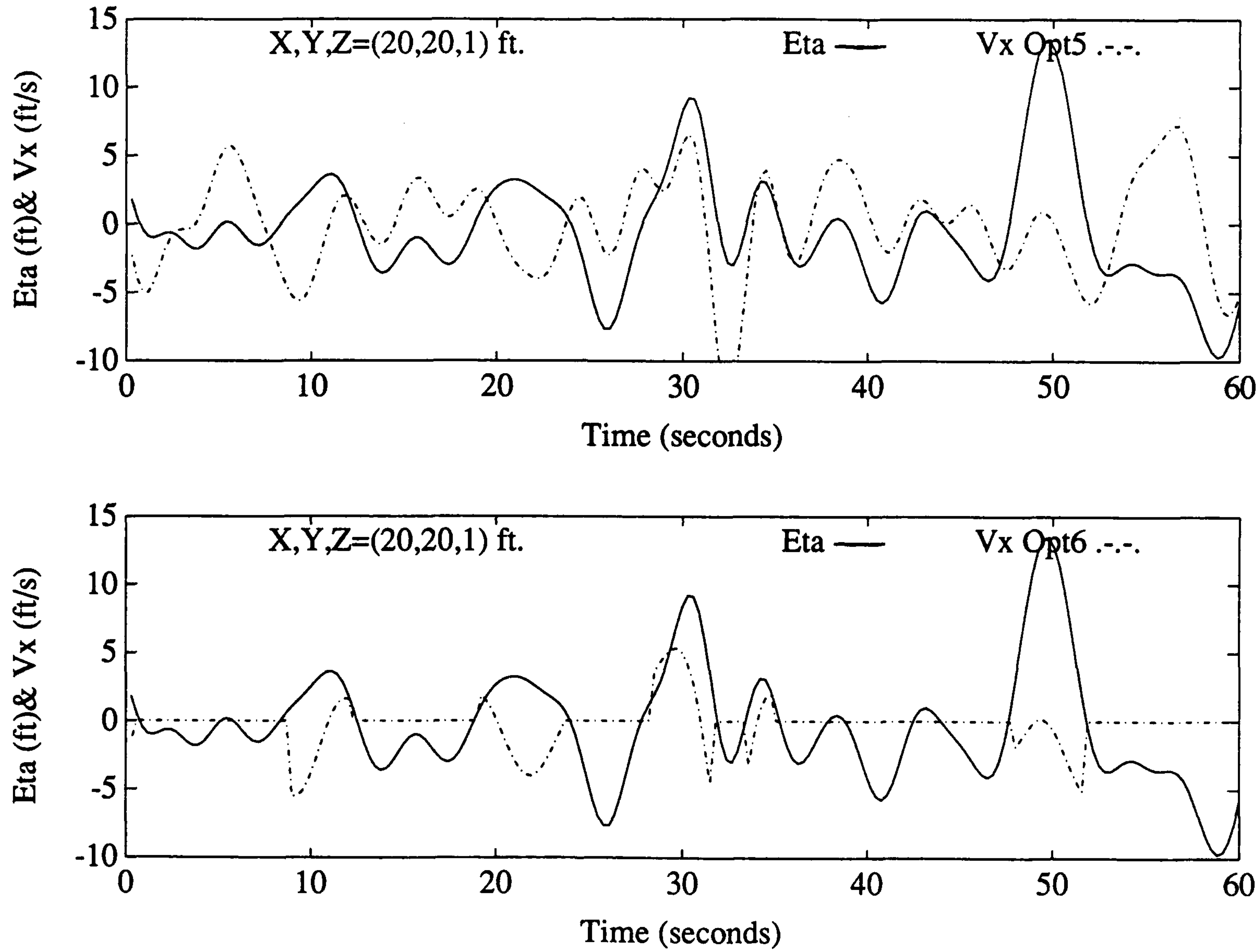

Figure D-16.
V_x Option No. 5 and No. 6 plotted with η.

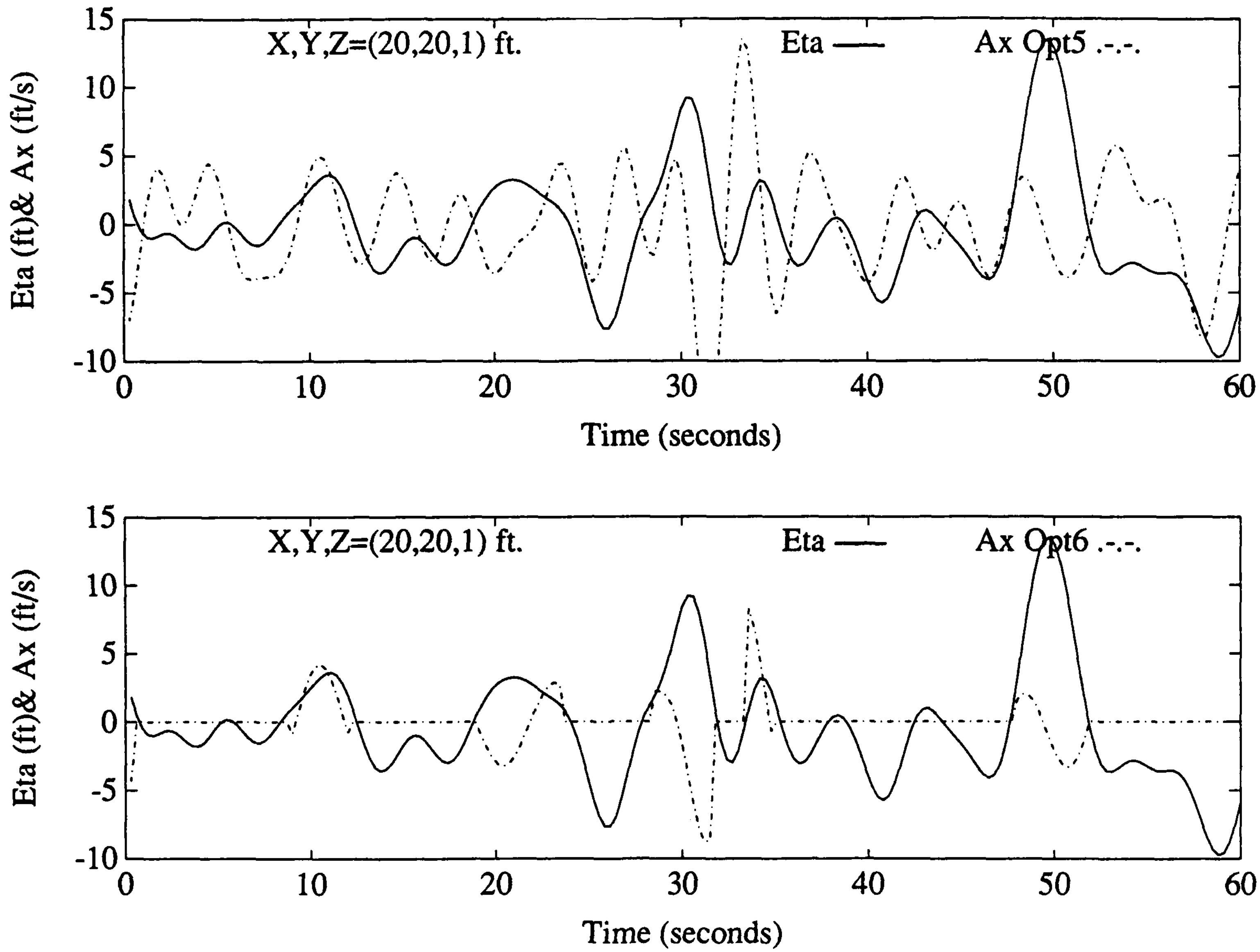

Figure D-17.
A_x Option No. 5 and No. 6 plotted with η.

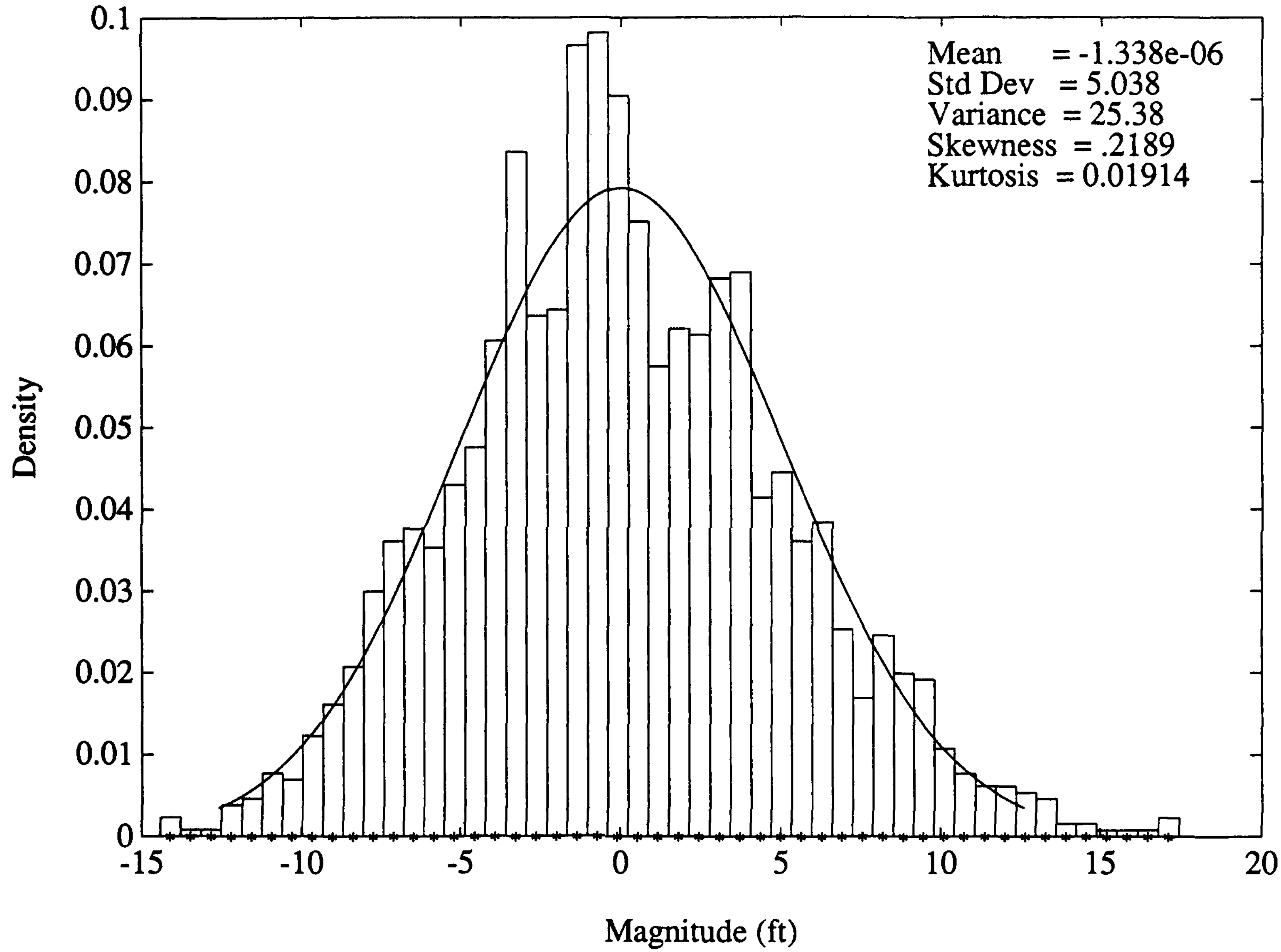

Figure D-18.
Normal distribution curve and histogram of simulated η.

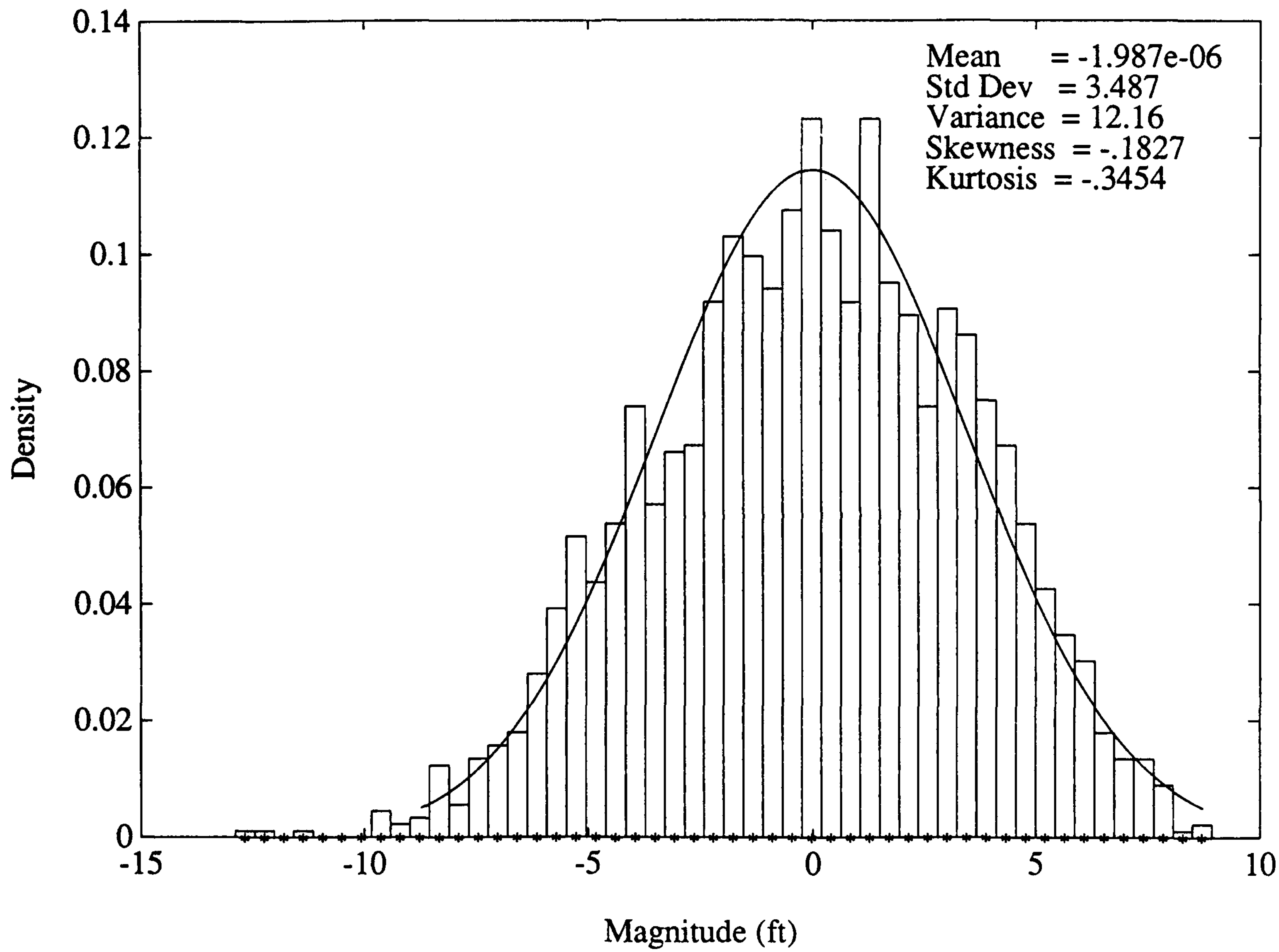

Figure D-19.
Normal distribution curve and histogram of V_x Option No. 5.

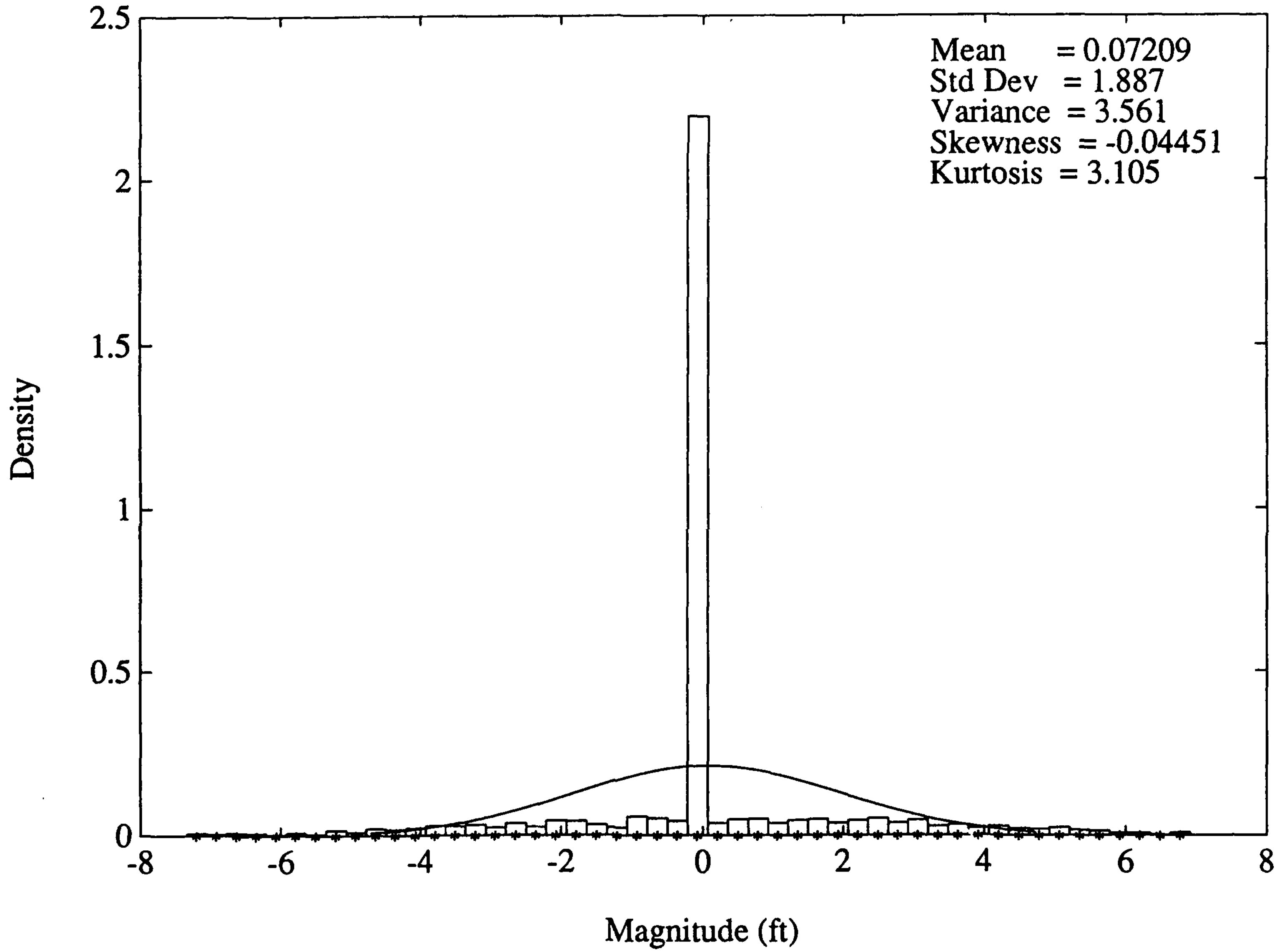

Figure D-20.
Normal distribution curve and histogram of V_x Option No. 6.

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NAVPGSCOL / CODE 68 (C.S. WU), MONTEREY, CA; E. THORNTON, MONTEREY, CA
NAVSHIPYD / CODE 202.5 LIB, BREMERTON, WA
NAVSTA / DESIGN SEC, BROOKLYN, NY
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