USER'S MANUAL

FOR THE

GLOBALLY RELOCATABLE NAVY TIDE MODEL

(PCTides)

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1.0 INTRODUCTION

The Computer Software Configuration Item (CSCI), identified as the Globally Relocatable Navy Tide/Surge Modeling System (PCTides) consists of a 2- dimensional barotropic tide/surge model, called the Global Coastal Ocean Model (PCTides GCOM2D).

GCOM2D is a two-dimensional depth-integrated shallow water model designed to characterize sea level and currents on or near continental shelves. It features a wetting and drying algorithm for simulating coastal flooding due to tides or storm surge.

2.0 APPLICATION

2.1 Description of PCTides Usage

This manual describes in detail the procedures for running the Navy Relocatable Tide/surge modeling system consisting of the 2-dimensional barotropic tide/surge model (PCTides GCOM2D) developed by the Global Environmental Modeling Systems group. The system is platform independent and may be run in the PC Windows environment driven by an interactive menu or at the command prompt under DOS mode or the UNIX operating systems. The menu provides a logical structure for the user to set up the required environment to carry out a simulation with GCOM2D in any part of the world's oceans. The model may be driven by tides and/or surface winds and pressures. Prior to running a model, the winds and pressures may be entered manually, generated using the hurricane model, or obtained from a Navy operational product such as the Navy Operational Global Atmospheric Prediction System (NOGAPS), the Distributed Atmospheric Mesoscale Prediction System (DAMPS), or the Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS). Output stations, at which time series predictions of sea level and currents are stored, may be specified. Display options allow the plotting of spatial fields or time series of sea levels and ocean currents.

This manual details the running of the system using the PC Windows interactive menu or the command prompt.   Command prompt operation is exactly the same in the PC environment as in the UNIX environment. A separate technical manual compliments this document and contains the mathematical formulation, solution procedure and code of the model as well as flow charts and descriptions of the programs and sub-programs (SDD; Hubbert et al., 2001).

2.2 Directory Structure

The directory structure for operational use of the system is as follows:

\gems\work   : working directory in which all calculations are carried out
\gems\data   : directory containing all tidal and topographical files used by

GCOM2D

\gems\gcom	: code directory containing all executable code
\gems\tctracks	: store for historical hurricane tracks
\gems\gridgen	: directory containing the grid generator files – PC only

(Note: the file "asagrid.ini" must be placed in the c:\WINNT directory under NT and Windows 2000 operating system)

UNIX note   : if running under UNIX remember to use "/" instead of "\"

These directories are transparent to the PC Windows interactive menu (gcommenu) user whereas the command prompt user should carry out all activities in the "\gems\work" directory.

2.3 Running Environment

The GCOM running environment is illustrated in the flow diagram in Figure 1 where the relationship between the components of the system and associated files can be seen.

Further understanding of the system may be obtained in the PC Windows menu where the menu procedures are also supported with help functions for all actions of choice. The help is obtained by pressing the "F1" key while the cursor is on the input box in question.

2.4 Document Organization

This manual documents the procedures for setting up and running the ocean models driven by surface winds and pressures and/or tides. Each Section illustrates the two methods of running the system by referring to the appropriate PC Windows menu option and giving the appropriate command to be entered at the command prompt.

The basic logic that underlies operation of the system through the PC Windows menu structure or the command prompt is shown in Figure 2.

3.0 LIMITATIONS AND ASSUMPTIONS

In order to successfully execute PCTides there must be at least 256 MB of RAM. The system itself requires 400 MB of disk space.

At present there is no graphics package associated with the UNIX version of PCTides.

4.0 OPERATING GUIDELINES

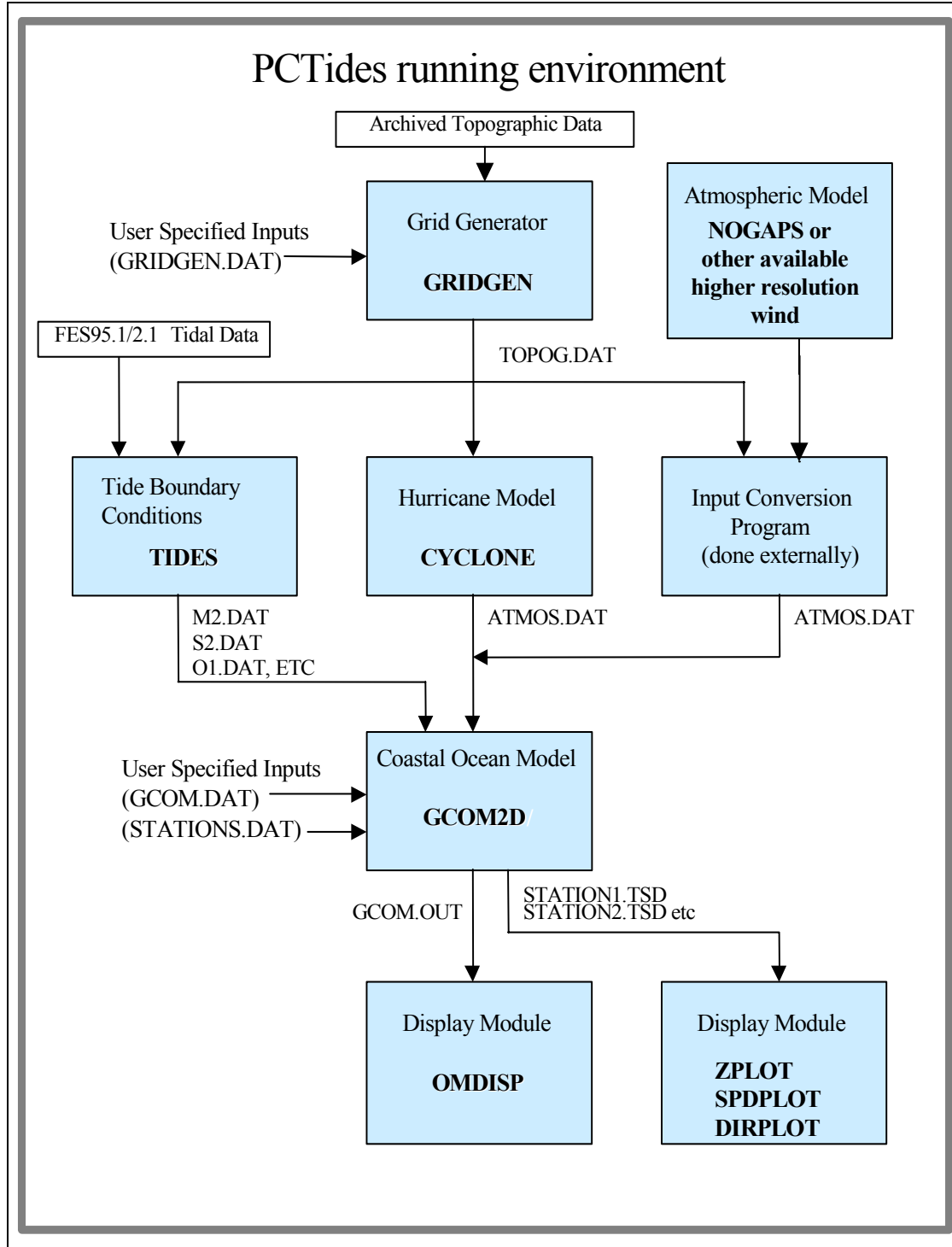This Section of the User's Manual discusses several key aspects of PCTides.
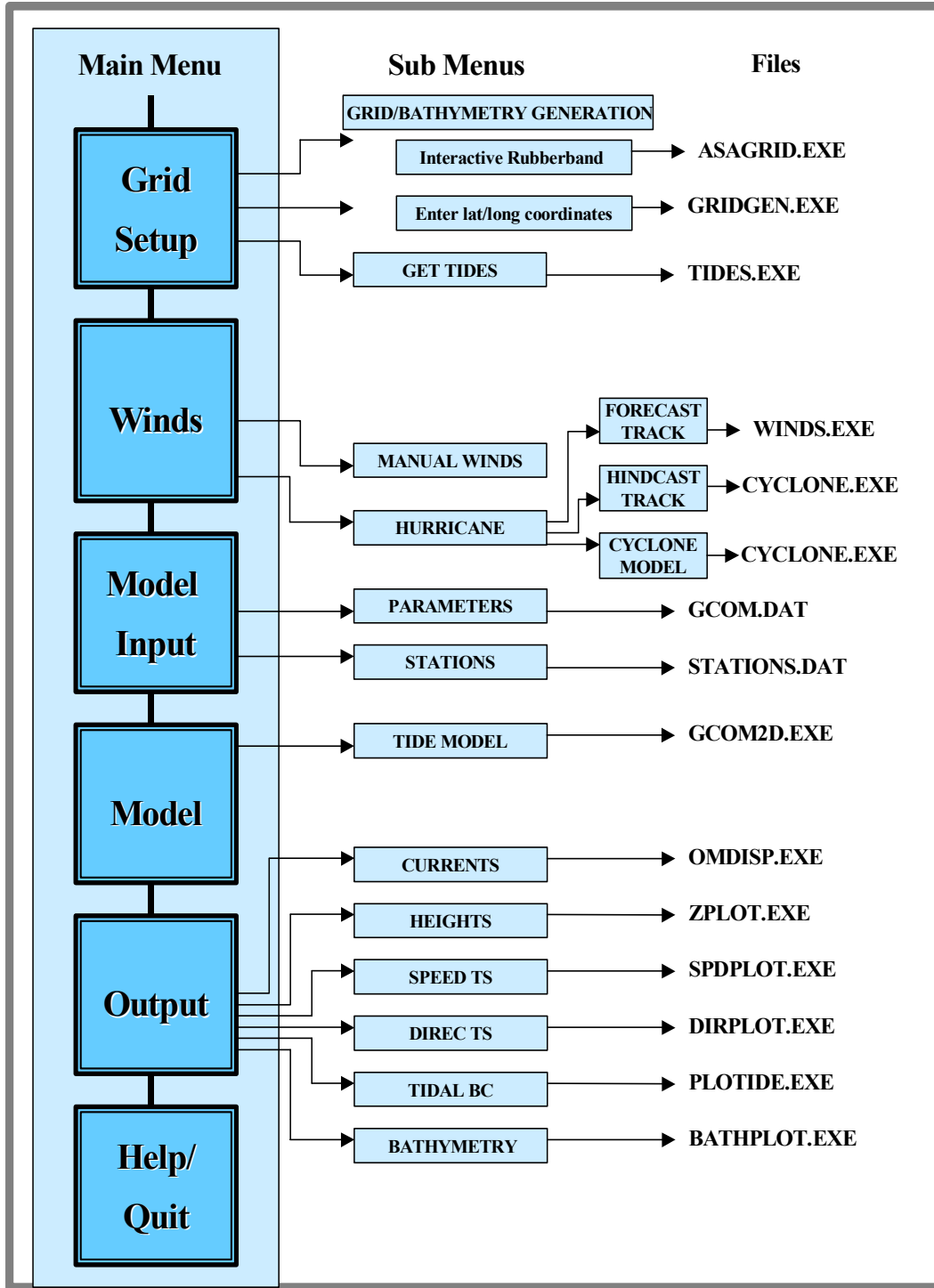

Figure 1: Flow diagram for the PCTides system.

Figure 2: Chart illustrating the PC Windows Menu and related files.

4.1 GRID SETUP

4.1.1 Grid/Bathymetry Generation

The first task is to define the model domain. This can be accomplished in two different ways either 1) by interactively rubberbanding the area or 2) by entering the latitude/longitude coordinates of the grid box. The first option (Interactive Rubberband) is described below:

Command prompt

This can be accomplished using the second option of how to generate a grid and/or bathymetry. See page 11 for further discussion.

Menu

The "Generate Grid Bathymetry" menu option (Figure 3) gives the user two choices of how to create the grid bathymetry. If the user chooses the "Interactive Rubberband" option (Figure 4) option, it initiates the Applied Sciences Associates (ASA) grid selection program (Figure 5). This software allows the user to zoom in and create a new region by selecting the area for the model grid on the map using the mouse. Once the ASA grid selection program is initiated, the screen will display six drop down menus. **The user should use only the "zoom" and "gems" menu buttons** however, the following is a brief description of the options found in the other four. Under the "file" option, the "geographic location" should be set to "gems/gridgen". The base map selected should be "world.bdm" or "landpoly.bdm" to generate the global base map. Other selections will bring up specific regional base maps. The "new locations" options should not be changed. The "display" setting should show the green outlined "land" box checked, the display lat/long box checked, the "degree representation" should be set to DD MM.MM, the "vector units" should be in knots and the map projection should be set to "XY Cartesian". Other options should not be chosen. Printer options are machine dependent. Selections under the "zoom" menu are self-explanatory. The Pan to Point option allows the user to select a location and move the grid with respect to that location. Selections under the "GIS" and "Tools" menus should not be modified. The "Window" menu should not be modified and should be set at c:\gems\gridgen:gisdata". Buttons under the drop down menus should not be used, except for the circled +/- buttons that allows the user to zoom in/out without going into the drop down menu.
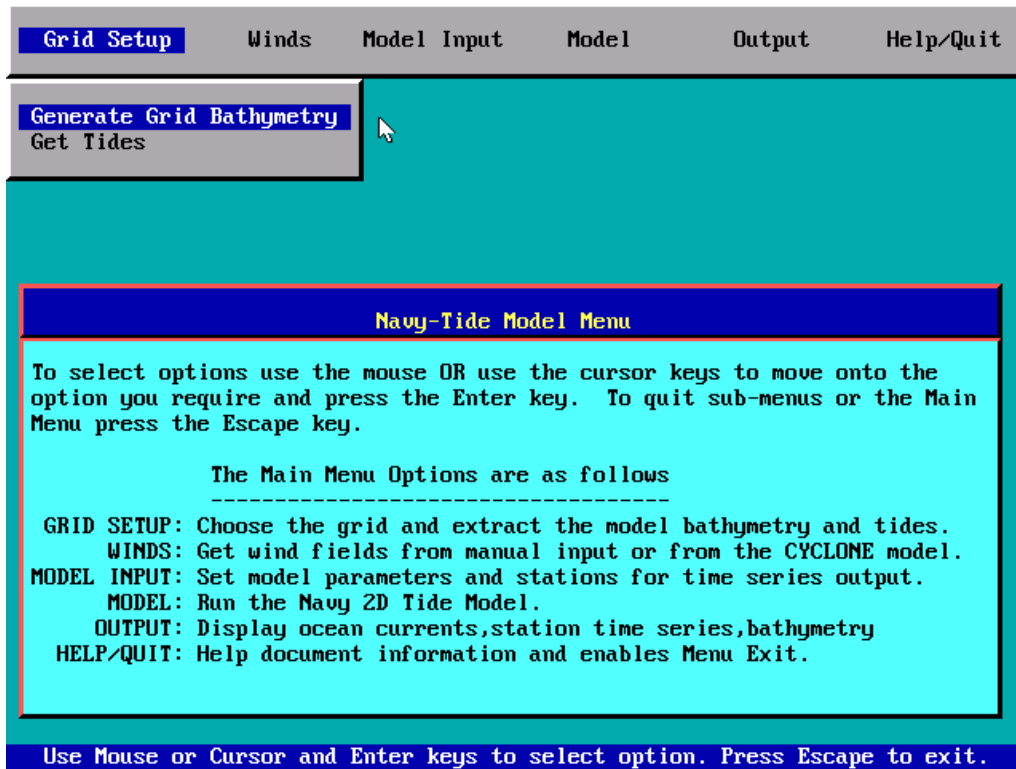
Figure 3: Grid Setup menu option.
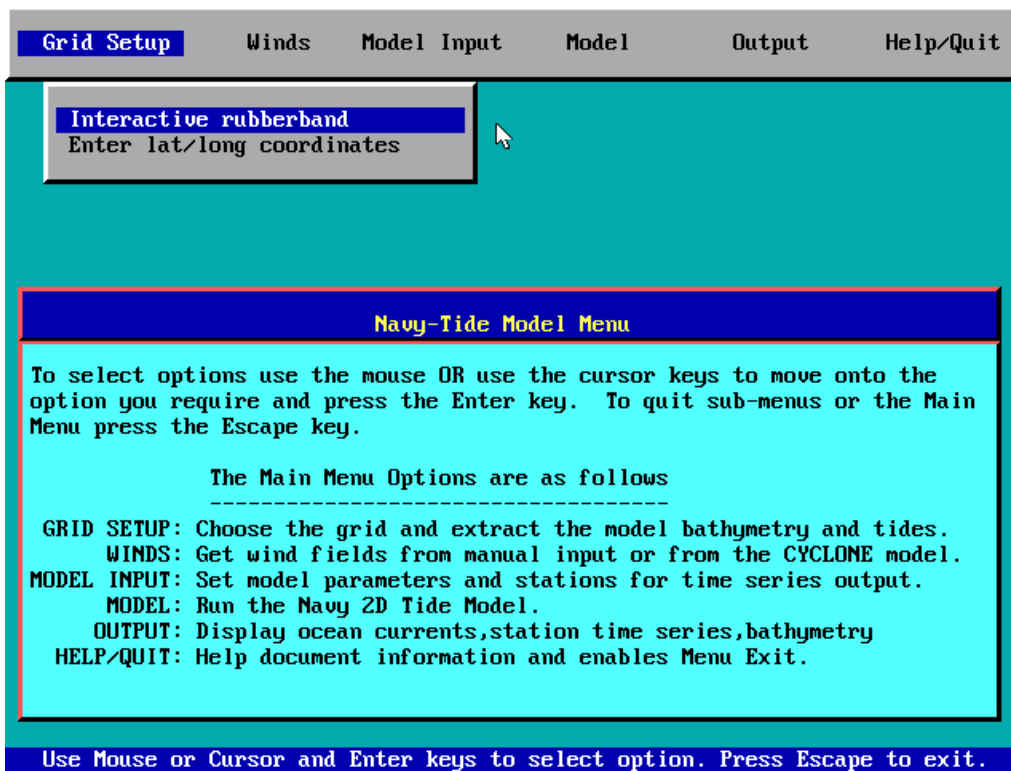
Figure 4. Interactive Rubberband option from Grid Setup Menu.
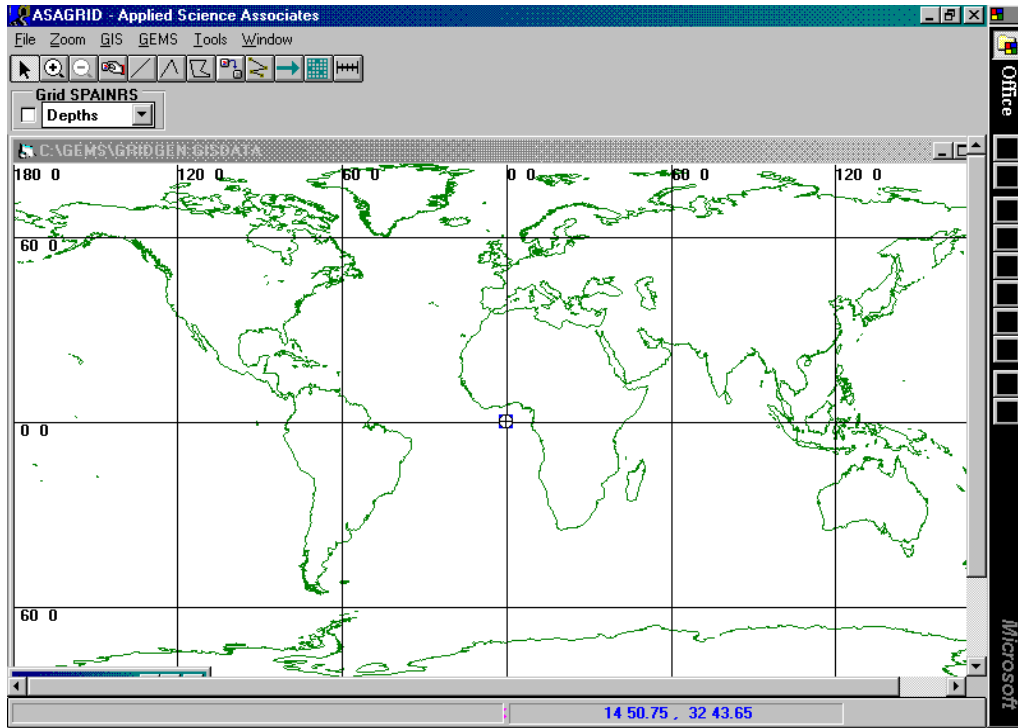
Figure 5: Grid generation global map.
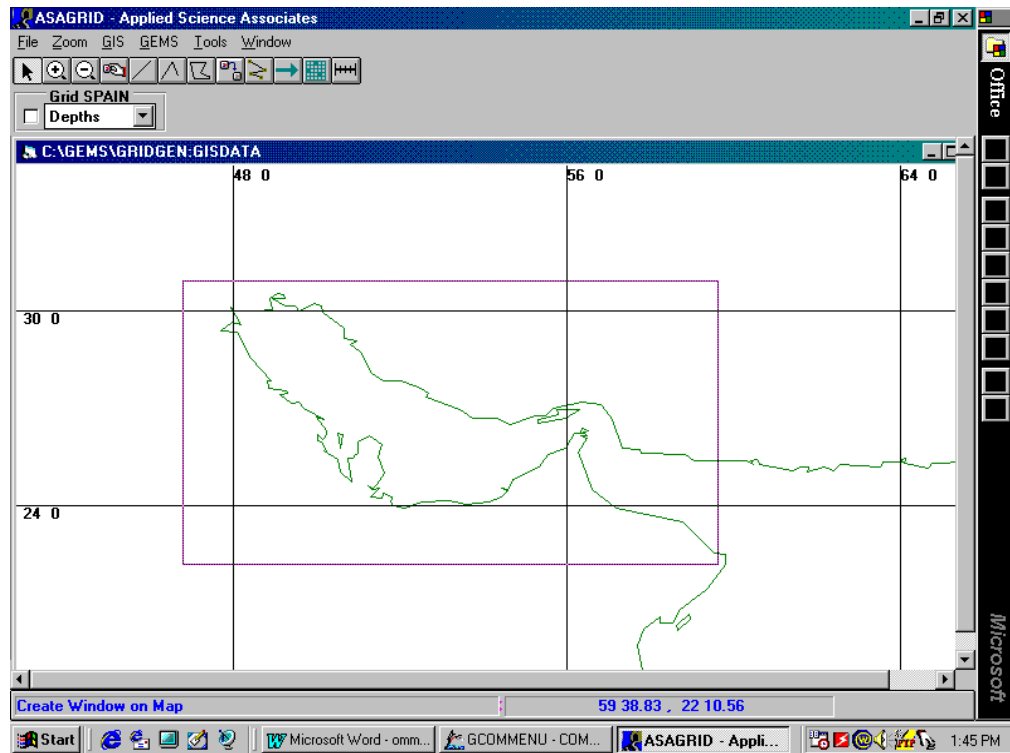
Figure 6: Zoomed map of Persian Gulf with model region selected.

To illustrate the procedure (Figure 6), a model grid for the Persian Gulf is set up. If a global map does not appear when the grid generator is brought up, click on "Zoom" and click again on "UnZoom All" and it should appear. The user then zooms in to the region of interest (click on "Zoom" and select "Create Zoom Window"). Click on "GEMS" and then click on "Create Topography Grid" to generate a new grid or on "Open Topography Grid" to access a previously generated grid. If "Create Topography Grid" is chosen, the user selects the model grid area with the mouse by holding the left button down while moving from The upper left hand corner of the proposed grid to the corner diagonally opposite (Figure 6). A panel appears (Figure 7) in which the maximum grid dimensions can be set (Note: coarse grids run faster but may give poorer results, however **do not create grids with either dimension over 200**) and a unique output file name specified for identification and storage. The global bathymetric data sets are then interrogated and the bathymetry and topography for the model grid region are displayed in an adjustable color code (Figure 8). The setting in the upper left corner labeled "GRID Filename (PGULF)" may be changed to the "cell" mode to draw the model grid squares.

On completion, the ASA grid generator writes an ASCII file to the "\gems\gridgen\depths" directory with an extension ".asc". The name of the file is the name entered by the user when setting the grid dimensions. This ASCII file contains the latitude and longitude limits of the region selected.
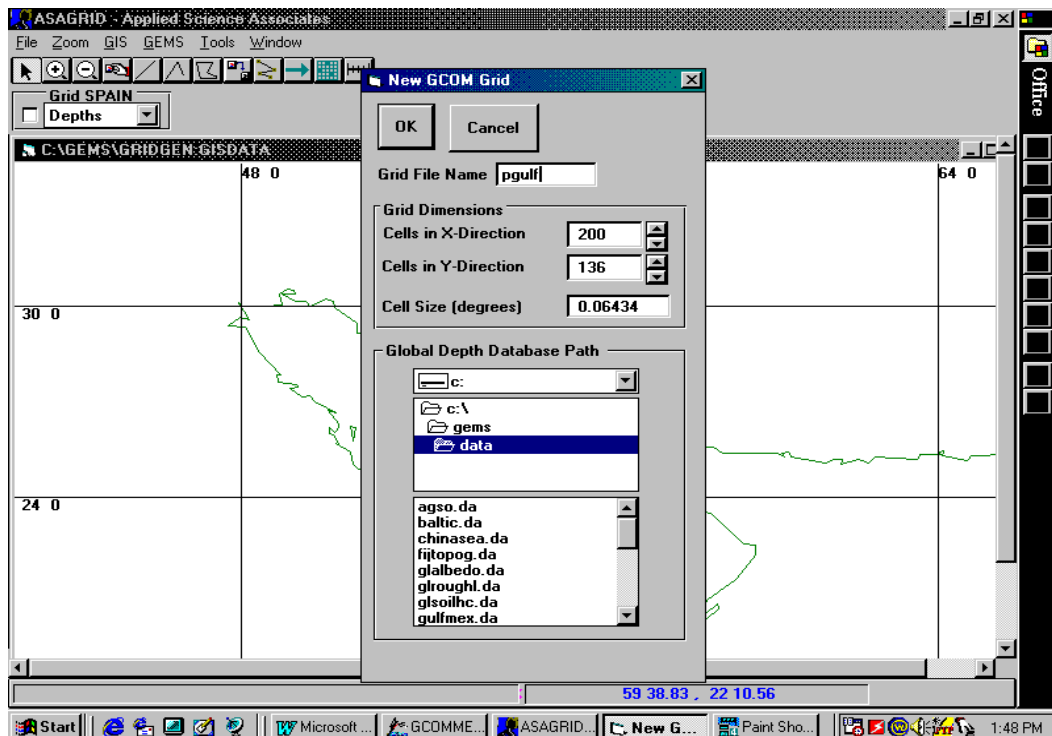
Figure 7: Panel for specifying maximum grid dimensions and grid region name.
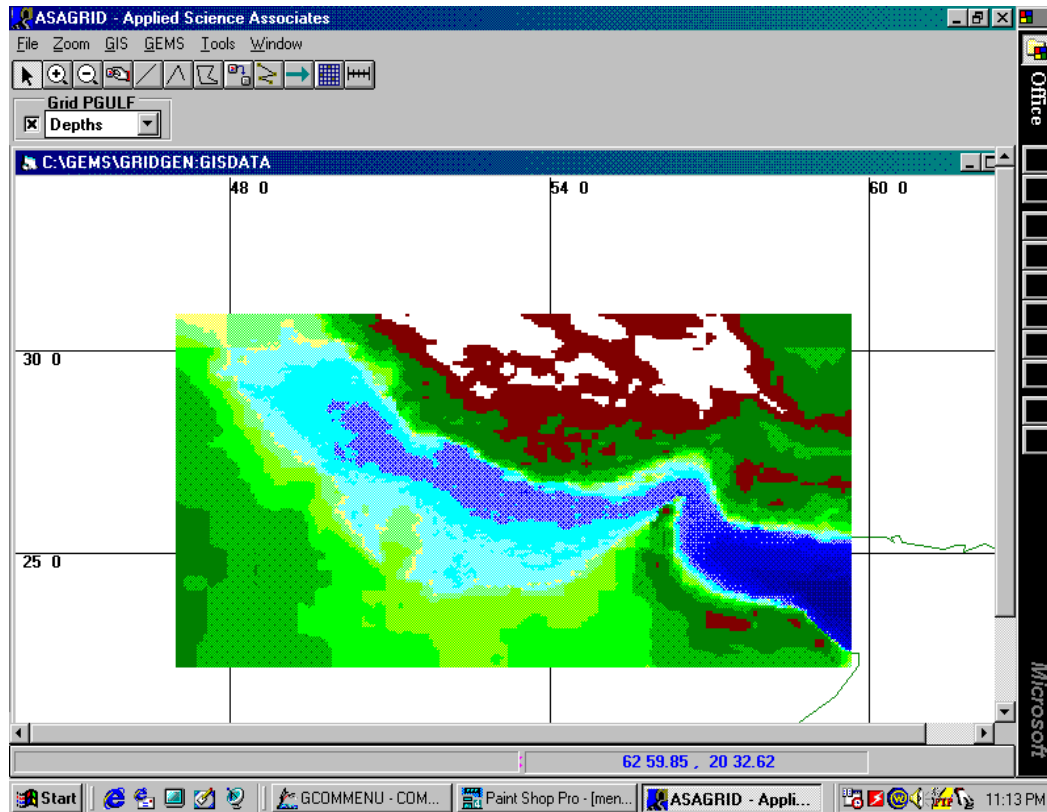
Figure 8: Color-coded bathymetry and topography for the selected region**.**

After the ".asc" file has been written, the next task is to interpolate the bathymetry to this grid. The ocean bathymetry/land topography data was generated from the NRL global 2-minute database, DBDB-2.

Menu

After the ASA grid generation is completed, close the window application by clicking on the X in the upper right corner. Click the minimized "gcommenu.exe" button on the taskbar to reopen the PCTides system. A panel (Figure 9) will appear and display previously stored model grid regions or the name of the newly created grid, any of which may be chosen for use. For this case "pergulf" is entered and after pressing "escape" the bathymetry and topography for the grid are calculated from the global direct access files by the program "gridgen" which reads the latitude and longitude limits stored in the "pergulf.asc" file.   "Gridgen" writes the bathymetry and topography to the file "topog.dat" in the "\gems\work" directory.
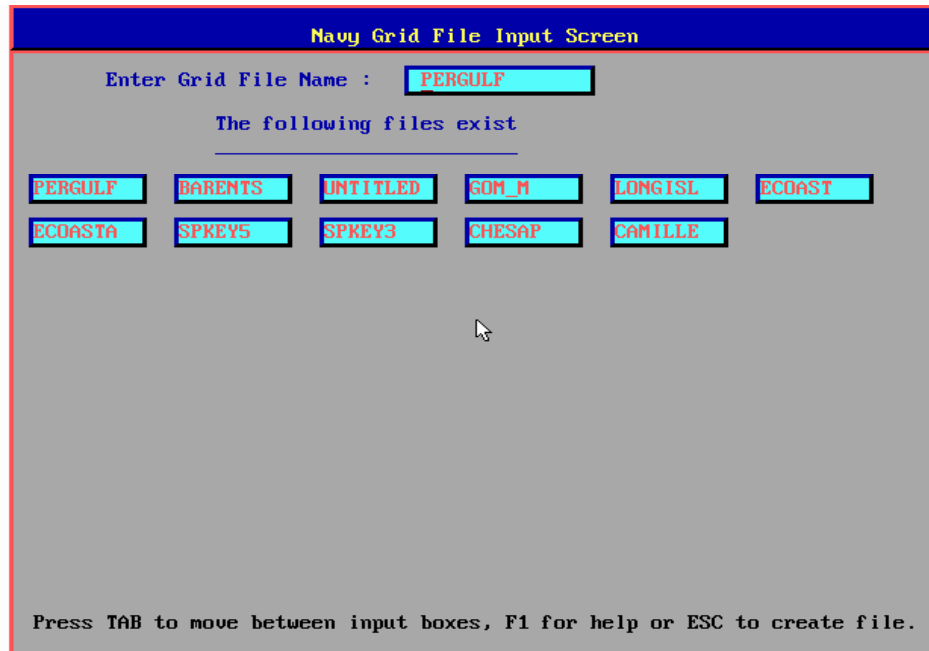
Figure 9: Selection of required model grid region.

In order to check the region and/or the bathymetry it is advisable to plot the data by returning to the main menu and selecting "Output" and then "Bathymetry" (Figure 11). The bathymetry will be plotted at a pre-selected contour interval and the topography displayed in color-coded height bands (Figure 12). If the region is not satisfactory, the user should return to the GRID SETUP option and select an adjusted region and repeat the process. If the bathymetry is poor quality for the resolution required, refer to next section for general comments.

The second option (Enter lat/long coordinates):

Command prompt

To define the model domain at the command prompt the user should edit the file "gridgen.dat", in the "\gems\work" directory structured as follows:

Line	Parameter	Typical value
1	Arbitrary Title	Persian Gulf
2	Grid Projection Flag (**do not change**)	3
3	Southern Latitude Limit	22.0000
4	Northern Latitude Limit	31.0000
5	Western Longitude Limit	46.0000
6	Eastern Longitude Limit	60.0000
7	Standard Grid Spacing (kms)	10.0

Note: Longitudes are in the range 0 to 360E. Latitudes are in the range –90S to +90N.

To generate the bathymetric grid for the model domain at the command prompt the user should run the program "gridgen" which reads the latitude and longitude limits and resolution stored in the "gridgen.dat" file. "Gridgen" calculates the bathymetry and topography from the global direct access files and writes the data to the file "topog.dat" in the "\gems\work" directory.

In order to check the region and/or the bathymetry it is advisable to plot the data by running the program "bathplot". This program plots the bathymetry at a specified contour interval and the topography displayed in color-coded height bands. If the region is not satisfactory, the user should return and select an adjusted region and repeat the process. If the bathymetry is of poor quality for the resolution required then refer to the general comments described later in this section.

Menu

The "Enter lat/long coordinates" option (Figure 4) allows the user to manually enter a starting and ending latitudes and longitudes for a grid. It also allows the user to name the grid created and enter the desired grid resolution (Figure 10). Once the user hits escape key, the grid is generated and the bathmetry is automatically interpolated to the specified grid.

Figure 10. Selection of latitude/longitude grid region, name and resolution of grid.
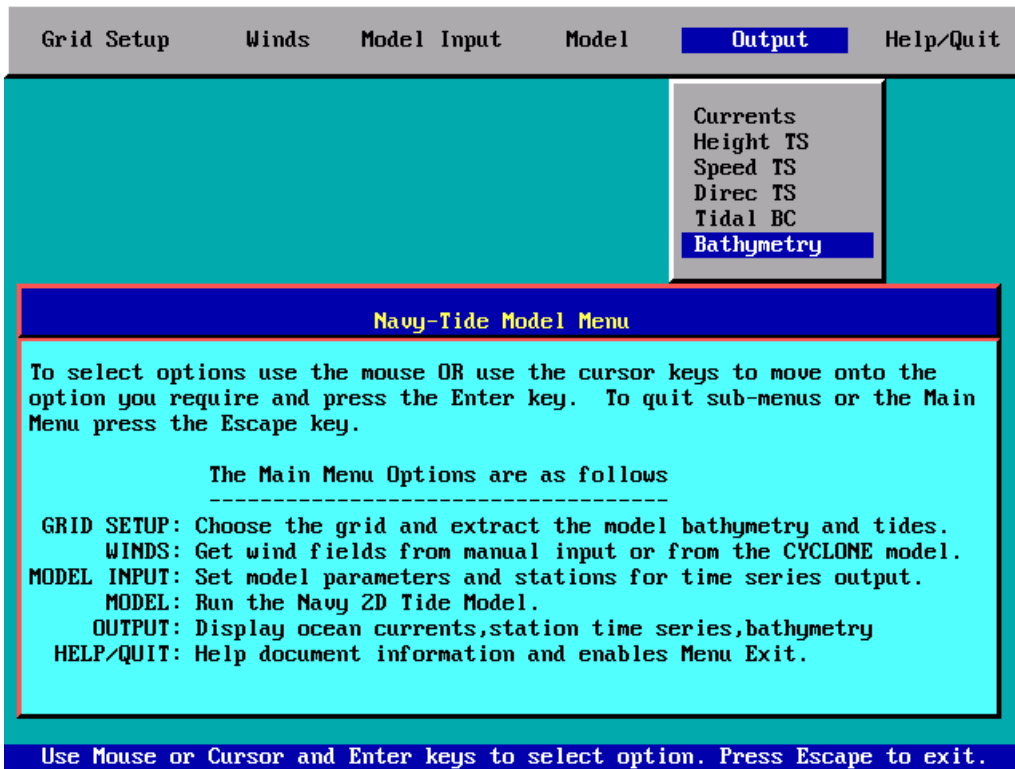
Figure 11: Selecting "Bathymetry" display.
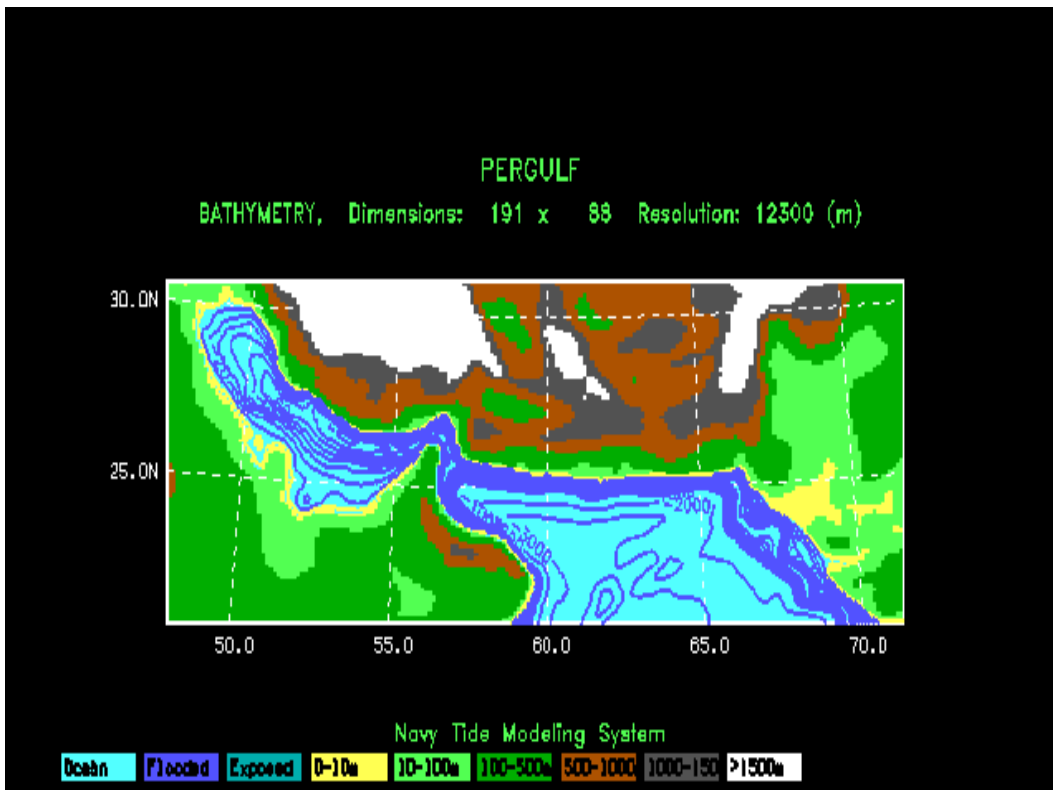
Figure 12: Bathymetry contours and topography for selected model grid.

General Comments on Grid Generation/Bathymetry

a) The following issues should be considered when selecting the model region:

  - The global tides are on a grid with a half-degree resolution and therefore open boundaries should cover several degrees to obtain reasonable boundary conditions.

  - Consult the map of global tide model amplitude and phases (Figure A1), to assure the open boundaries are located in a region where global tides exist. Examples of regions where global tides do not exist are: the Persian Gulf, the Red Sea, the Baltic Sea, and the NE Canada/US Coast.

  - It is wise to give some thought to the placement of the open boundaries. Try to establish straight open boundaries and avoid short ocean boundary segments that create ocean grid corners.

  - If possible avoid complex bathymetry on open boundaries.

  - If results are required in a bay or inlet be sure that the resolution is high enough to model the ocean dynamics of the region.

  - Consider what is important to tell the model about the bathymetry/ topography of the region. For example do not have an open boundary half way down a small bay – let the model know that it is a bay by placing the boundary on the land.

  - For best results, use grid resolution of 10 (+/-5) km.

  - When creating a grid above 70 degrees North (Arctic) and below 70 degrees South (Antarctic), use caution. Grids created in this area can be difficult to set up due to the projection distortion factor.

b) The procedure for generating the bathymetric grid is to first set up the model grid on the chosen map projection (Lambert Conformal) and then to extract the bathymetry/topography for each grid point. The latitude and longitude of the grid point is determined and then all of the direct access topography files (".da" files) are searched to find the value at that location from the highest resolution ".da" file covering that point. This procedure is repeated for each model grid point so that it is possible for values to be obtained from more than one ".da" file if the model grid spans more than one ".da" file region. If the bathymetry for the model domain appears to be poor quality it may be desirable to create a new ".da" file of higher resolution digitized data for that region. This procedure is explained in Appendix C. The existing ".da" files are summarized in the following table:

File Name	Southern	Northern	Western	Eastern	Resolution

	Limit	Limit	Limit	Limit	(minutes)
World.da	-90	90	0	360	2.0
Gulfmex.da	15	35	260	285	0.3
Wustopog.da	28	40	219	249	1.0
Pergulf.da	21	33	45	71	1.0
Chinasea.da	13	25	105	121	1.0
Baltic.da	53	61	14	26	1.0
Medsea.da	29	36	349	43	1.0
Timorsea.da	-18	-8	122	133	0.3
Oztralia.da	-46	-6	110	156	1.2
Fijtopog.da	-20	-15	176	181	0.5
Tastopog.da	-44	-39	143	150	0.5

Note: If you create a grid that crosses Greenwich and falls within the latitude of Wustopog.da and Baltic.da areas, the ASA grid generator will not correctly display the area that you created. However, the grids in these areas will be correctly created and can be viewed by selecting from the main menu the "OUTPUT" option and then "Bathymetry" option.

4.1.2 Get Tides

Tidal boundary conditions were derived from the global tide model, Finite Element Solutions, version 95.1 (FES95.1/2.1) (Shum et al., 1997) (See Appendix A for global tidal boundary conditions). Tidal boundary conditions are derived for the model region from the global tidal files for eight constituents by determining the grid from the topography file and then writing the files:

m2.dat	2n2.dat
s2.dat	ol.dat
n2.dat	kl.dat
k2.dat	ql.dat

These files contain the amplitude and phase of the tidal constituent in time zone zero (Greenwich). The amplitude or phase can be plotted with "plotide" (PC users only). During plotting an option is given to compare with local observations (stored in the "data" directory in "tcanals.dat") both graphically (Figure 13) and with root mean square errors written to the screen and stored in the file "plotide.log". This gives the user an idea of how accurate the global tidal files are in the model region and therefore indicates the expected accuracy of the model output.
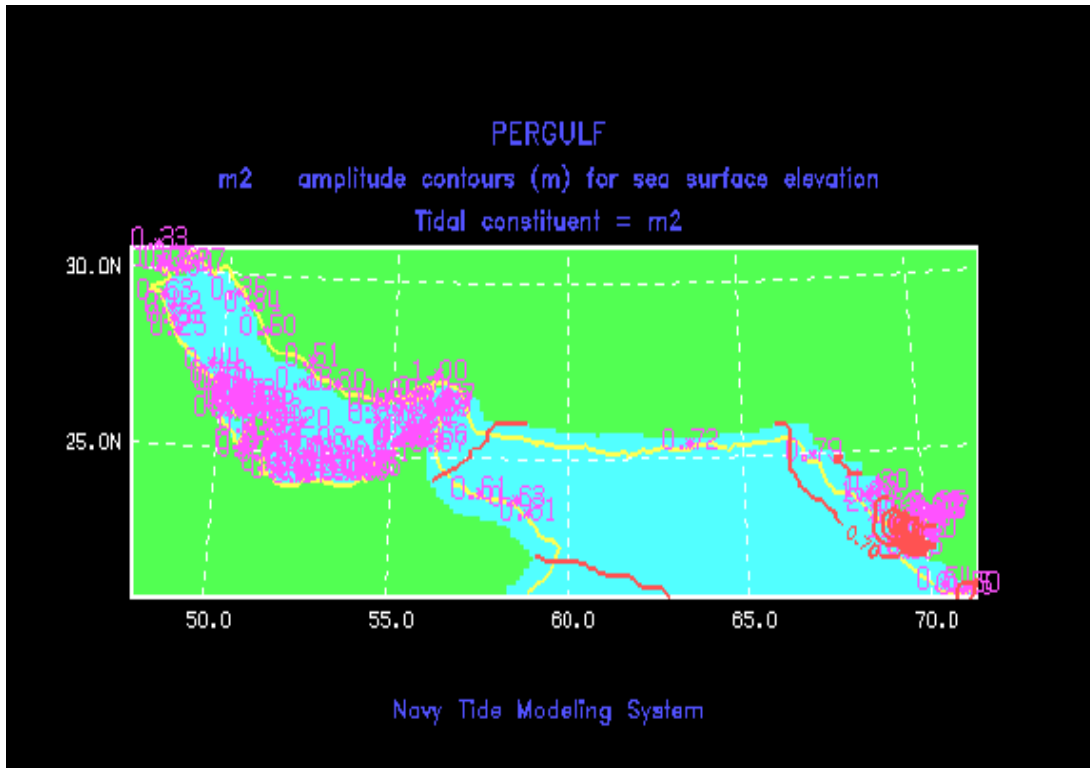
Figure 13: Amplitude contours of the M2 tide in the Persian Gulf plotted with the observed values.

Figure 13 shows the contours (meters) of the amplitude of the M2 tidal constituent derived from the global tidal database for the model region in the Persian Gulf. The observed amplitudes (meters) at tidal stations in the Persian Gulf are also plotted for comparison.

The user should notice two important things from this plot:
1. The contour lines are too short to carry labels so the user should look at the screen text or in the output file ("plotide.log") to compare the global tidal values with data.
2. There are no contours in the Western part of the grid showing that the global tidal files do not have values in the Persian Gulf and therefore it is not possible to run a model of only the Persian Gulf.

Note: The user must make sure there is global tidal data along all its open boundaries.

<u>**Command prompt**</u>
Run "tides".
For display run "plotide" (PC only).

<u>**Menu**</u>
Tidal boundary conditions are derived by selecting "Get Tides" (Figure 14). The amplitude or phase can be plotted by selecting "Output" and "Tidal BC" (Figure 15).
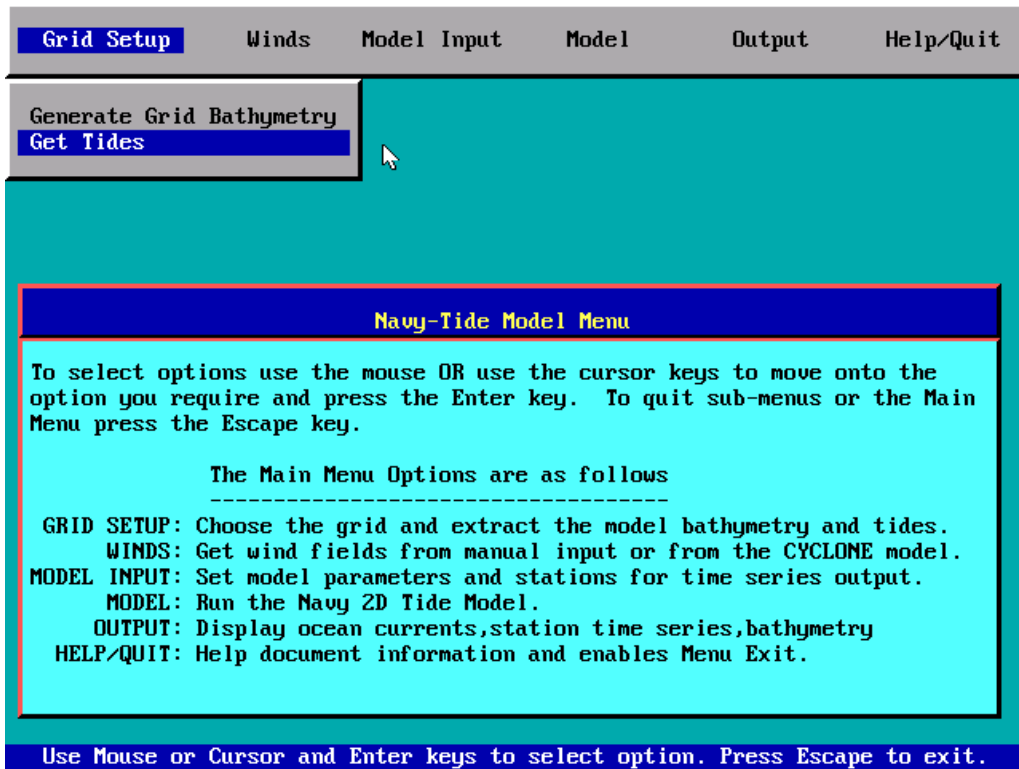
Figure 14: "Get Tides" selection.
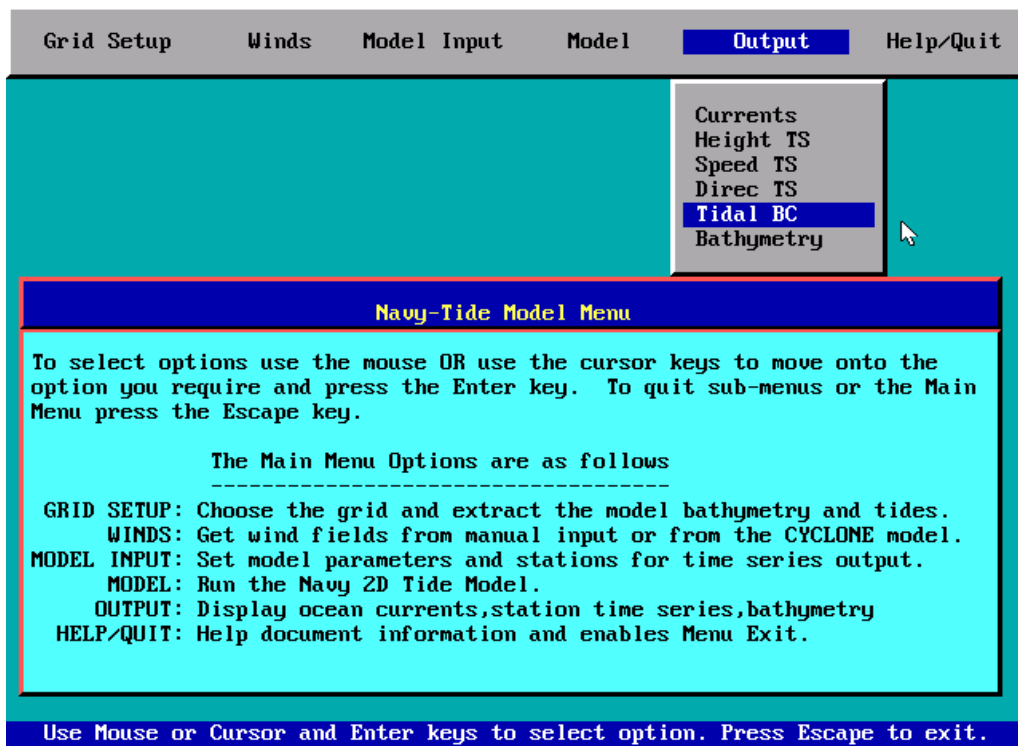
Figure 15: Selecting to plot a tidal boundary condition.

4.2 WINDS

The winds to force the ocean model may be derived from a Navy Product wind (NOGAPS, DAMPS, or COAMPS), entered manually or developed using the hurricane model.

4.2.1 Model Output Winds

The Navy Product wind file may be used to derive surface winds and atmospheric pressures to force the ocean model. These fields can be retrieved using the Navy's METCAST system. See Appendix B for a complete description of this procedure. These wind files are interpolated to the model grid and written to the binary sequential file "atmos.dat". The system looks in the "\gems\work" directory for necessary files needed.

NOTE: All of the processing of the METCAST fields is done external to the PCTides system.

4.2.2 Manual Winds

Winds may also be entered manually. This option is useful if no other winds are available or if the model is running over a small area where the user believes the local wind station observations and/or forecasts may be more accurate (or available) than model output winds. This method becomes less accurate in larger model regions for which the spatial variation of the winds is not accounted.

The user specifies the start date and hour and the local time zone and then inputs wind speeds (in knots) and directions (the direction in degrees, clockwise from true north, from which the wind is coming) at specified time intervals from the start time.

On completion these data are interpolated to the model grid and written to the "atmos.dat" file. This produces a time varying, but spatially constant, wind file.

Command prompt
Edit "winds.dat".
Run "winds".

Menu
Under "WINDS", select "Manual Winds" (Figure 16). Enter the required data in the "manual winds" panel (Figure 17).

Figure 16. "WINDS" selection.
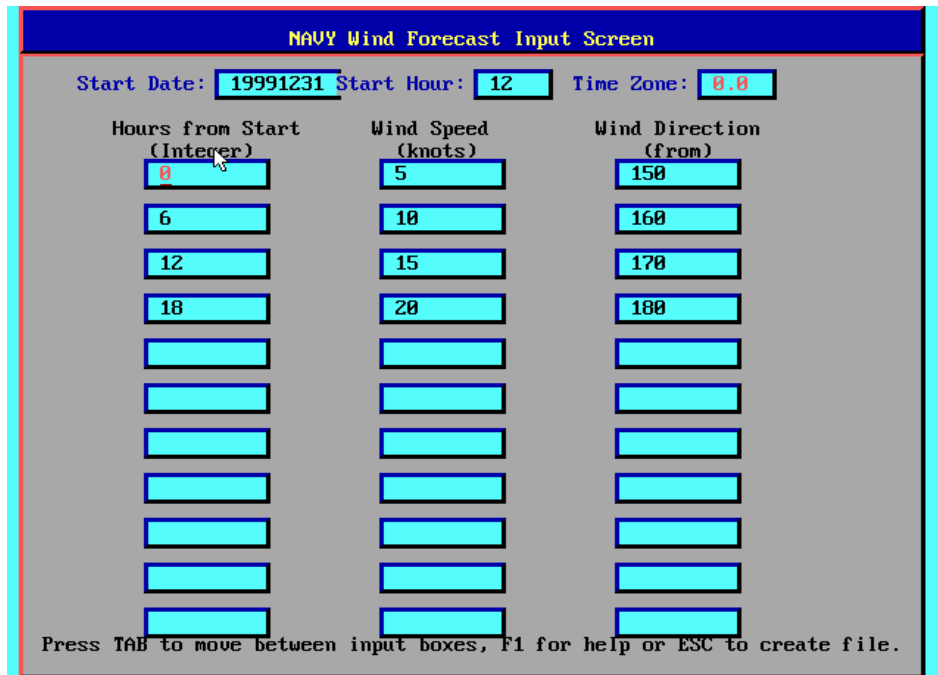
Figure 17: Manual wind entry panel.

4.2.3 Hurricane Winds

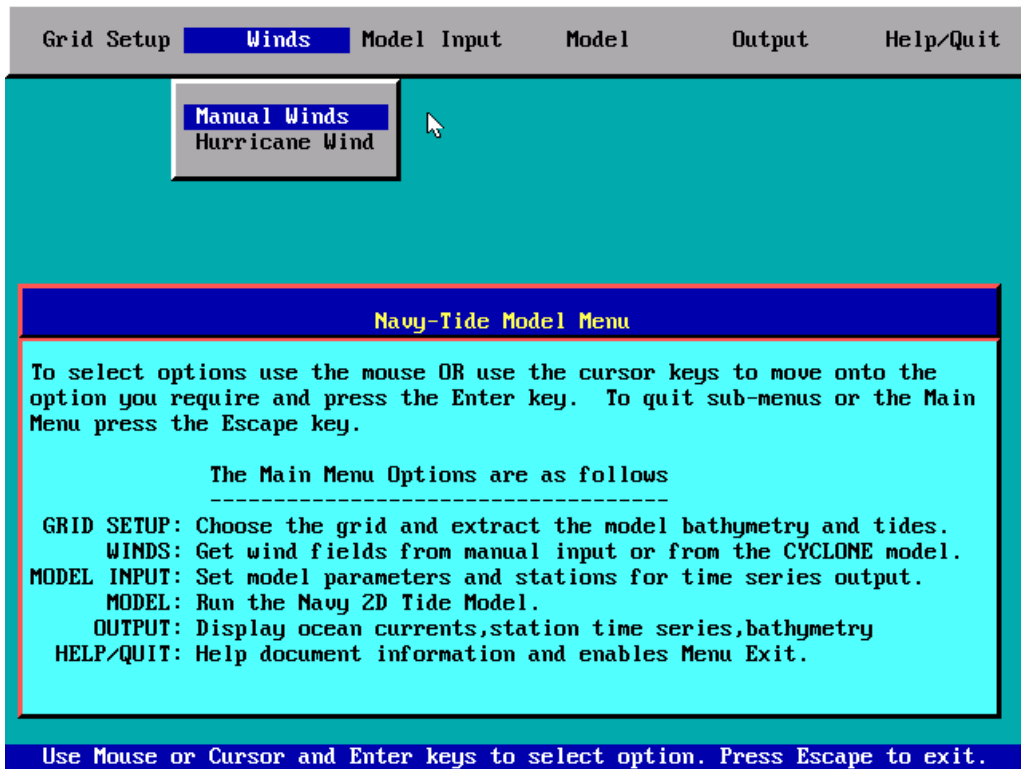A special hurricane/cyclone vortex model is available in PCTides. This model takes in track parameters and develops wind and atmospheric pressure fields. Options for entering forecast track data for real-time usage or the simulation of historical events (hindcasts) are provided.

4.2.3.1 Forecast Track

The forecast track is defined in the "cyclone.dat" file. The menu offers a more interactive method of establishing the track than can be done at the command prompt so they are described separately. The structure of this file is as follows (with sample values at end of line):

Line	Parameter	Typical Value		
1	Environmental pressure (hPa)			1005
2	Holland "b" parameter (see SDD)			1.75
3	Dummy integer parameter			0
4	Output time step (hours)			0.5
5	Dummy real parameter			0.0
6	Plot flags (wind, MSLP, dummy)	1	0	0
7	Time zone			8.0
8	Date, Time, Latitude, Longitude, Pressure, Radius of Maximum Winds	19990322 0400 -20.80 114.50 915.0 33.0		
9	repeat line 8 for each time step			

Command prompt

The user must edit the "cyclone.dat" file to set up the track data. Do not adjust "Dummy" values. The Holland "b" value of 1.75 may be used in most cases.

Menu

In the menu environment after selecting "Hurricane Wind" (Figure 16) and then selecting "Forecast track" (Figure 18), a panel appears (Figure 19) which enables the forecast track data to be entered. The track is defined by entering the required parameters concerning the initial state of the hurricane (latitude, longitude, central pressure, speed, radius of maximum winds, date and time) and then specifying its expected coastal crossing point or destination.
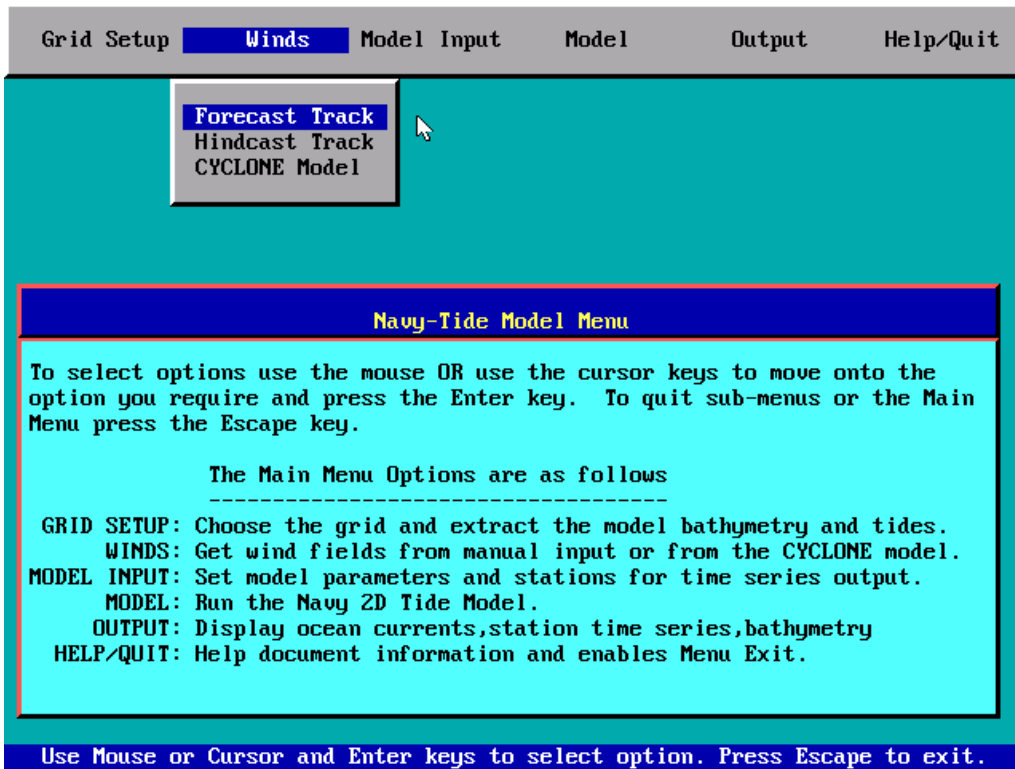
Figure 18: Forecast track menu selection.
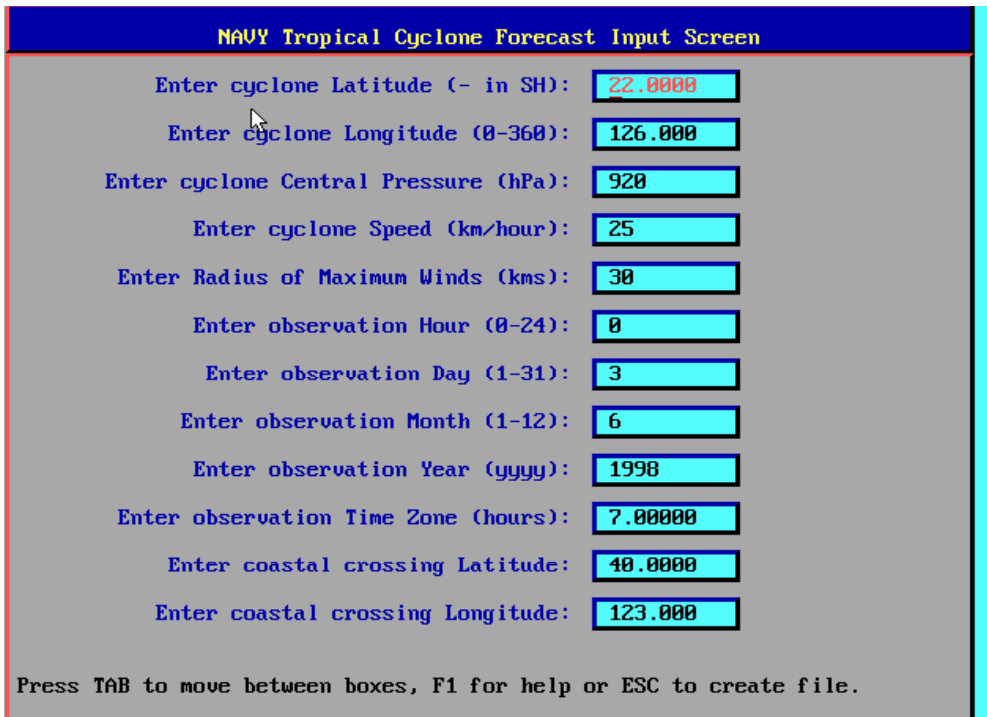
Figure 19: Entry panel for hurricane forecast data.

4.2.3.2 Hindcast Track

Historical tracks can be hindcast from stored track files by recovering the historical track file from "\gems\tctracks" where it is stored with a ".trk" extension. New historical track files can be created by copying the format of existing files and allocating an appropriate name (less than 9 characters).

Command prompt

Copy required track file from "\gems\tctracks" to "cyclone.dat" in the "\gems\work" directory.
Edit the "cyclone.dat" file to adjust the start time if required.

Menu

Select "Hurricane Wind" (Figure 16) and then "Hindcast Track" from the menu (Figure 20) and a list of stored track files will appear (Figure 21). Enter the name of the required hurricane track file. The historical storm data will then be displayed (Figure 22). The user may then adjust the start time if it is not necessary to simulate all of the hurricane track (for example if the hurricane is still well away from the coast at the beginning of the track).
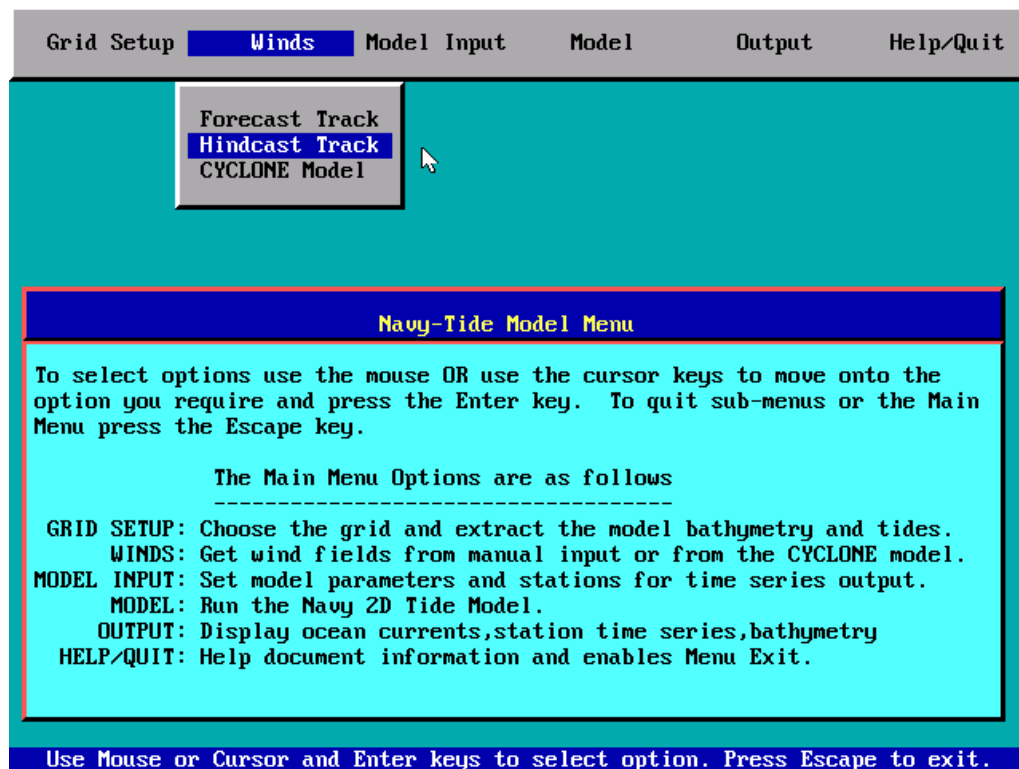
Figure 20: Hindcast track menu selection.

Figure 21: Historical storm track data selection panel.

Figure 22: Historical storm data.

4.2.4 Hurricane Model

After a forecast or hindcast track file is established, the hurricane model can be run to generate wind and pressure fields (Figure 24) on the model grid by referring to the "topog.dat" file.

Command prompt

Run "cyclone".

Menu

Select "CYCLONE Model" (Figure 23).
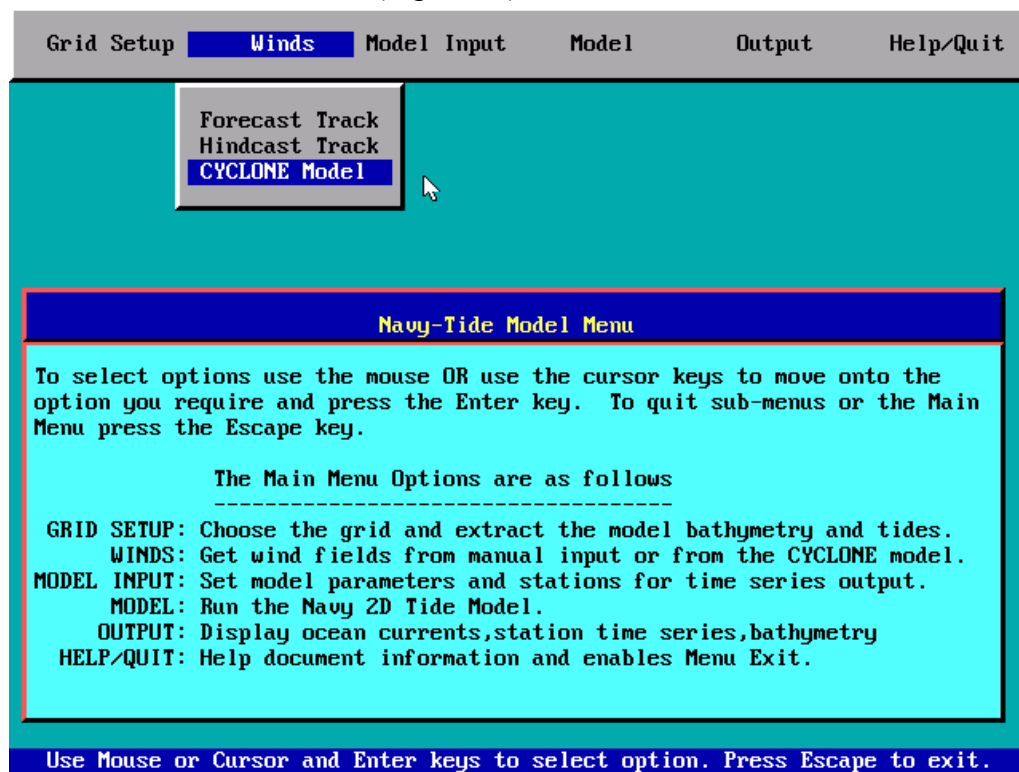
Figure 23: Cyclone Model.
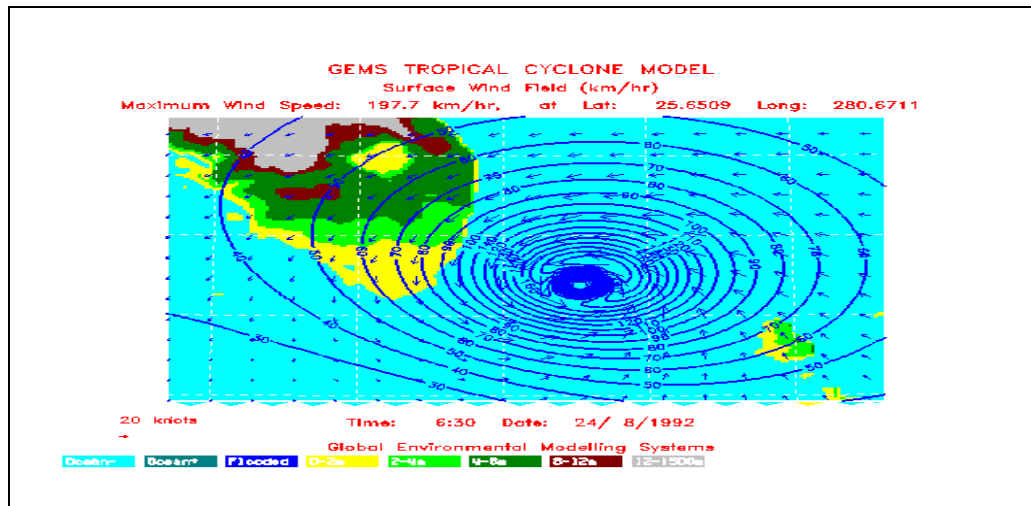
Figure 24: Hurricane model simulation (Hurricane Andrew).

4.3 MODEL INPUT

Before running the ocean model the user must set parameters, which control the type of forcing and model output.

4.3.1 Parameters

These parameters must be specified for the model run. They are stored in the file "gcom.dat" which has the following structure (sample values at end of line):

Line	Parameter	Typical Value
1	wind flag (0=off, 1=on,2=hurricane,3=manual)	0
2	tide flag (0=off, 1=on, 2=on + tidal data assimilation)	2
3	nesting flag (0=off, 1=on)	0
4	screen flag (0=text, 1=vectors)	1
5	inundation flag (0=off, 1=on)	0
6	output file time interval (hours, 0=none)	12.0
7	tidal start time, time zone (hh,mm,dd,mm,yyyy,hours)	00 00 23 06 1999 19.0
8	Maximum model run time (hours)	48

4.3.1.1 Wind Flag

The wind flag allows the user to turn the winds to four different settings:

"off" (flag=0) -- using no winds

"on" (flag=1) -- using winds from METCAST

  (flag=2) -- using hurricane winds

  (flag=3) -- using manual winds

4.3.1.2 Tide Flag

Tidal forcing can be turned "off" (flag=0) or "on" (flag=1 or 2). The tidal forcing may be included with (flag=2) or without (flag=1) tidal data assimilation. If data assimilation is turned on the "tcanals.dat" file in the "\gems\data" directory is scanned for stations within the model region (the tcanals.dat file consists of the International Hydrographic Office's (IHO) tide station observations). The tidal constituent amplitude and phase at these stations are used to predict tidal heights, that are then used to nudge the model solution. The predicted tidal heights for locations nearest the output stations specified by the user (see Section 4.3.2) are written out to files with the station name and the extension ".thp". These files may be used for comparing with the model output time series.

4.3.1.3 Nesting Flag

GCOM2D may be nested inside a previous run of GCOM2D. The model will look for the output file from the previous run to nest inside, therefore it is important to make sure the two runs (coarse and fine grids) are consecutive. Nesting may be turned "on" (flag=1) or "off" (flag=0). The sequence of events for a typical nesting run is as follows:

1. Create a bathymetry grid for the coarse model domain.
2. Generate tides for the coarse domain.
3. Generate winds for the coarse domain.
4. Set the key parameters for the coarse model run (winds=on, tides=on, nesting=off, inundation=off, output file time interval=**no greater than 1 hour to pass sufficiently frequent information to the nested model**).
5. Run Tide Model (GCOM2D).
6. Create a bathymetry grid for the fine model domain within the coarse domain.
7. Generate winds for the fine domain.
8. Set the key parameters for the fine model run (winds=on, tides=on/off, nesting=on, inundation=off or on). Output file time step interval may be increased above 1 hour .
9. Run Tide Model (GCOM2D).
10. Display results.

4.3.1.4 Screen Flag

The default value for the screen flag under PC Windows is "graphics on" (flag=1) however, running under UNIX the screen flag must be set to zero to turn to "graphics off" (or text) mode. Text mode may be used on the PC if desired and the user will then only see a time series log for the first specified station on the screen as the model runs.

4.3.1.5 Inundation Flag

Normally inundation is "off" (flag=0) however for storm surge and coastal inundation modeling the flag needs to be on (flag=1). GCOM2D will run slower with the

inundation flag on as the coastline is no longer fixed and the advance (or retreat) of the ocean is being modeled each time step.

4.3.1.6 Output File Time Step

The output file time step controls how often the sea level and ocean current fields are written to the "GCOM.OUT" sequential binary file. Normally the output file time step should be chosen to suit the users display requirements. When nesting, however, the output file time step should be frequent enough to pass sufficient information to the nested model (e.g. no greater than 1 hour for tidal modeling).

4.3.1.7 Model Run Time

This option allows extra user control over the model run time. The model will run as long as the wind file has winds or until the maximum time set, whichever is earlier.

4.3.1.8 Tidal Start Time

The start time option is for cases where only tidal forcing is used. If wind forcing is used the start times are set by the wind file. The standard mode of running the tide model is with the time zone set to 0.0 or GMT. However, if required, the user may input the local time.

Command prompt
Edit "gcom.dat".

Menu
Select "Parameters" (Figure 25).
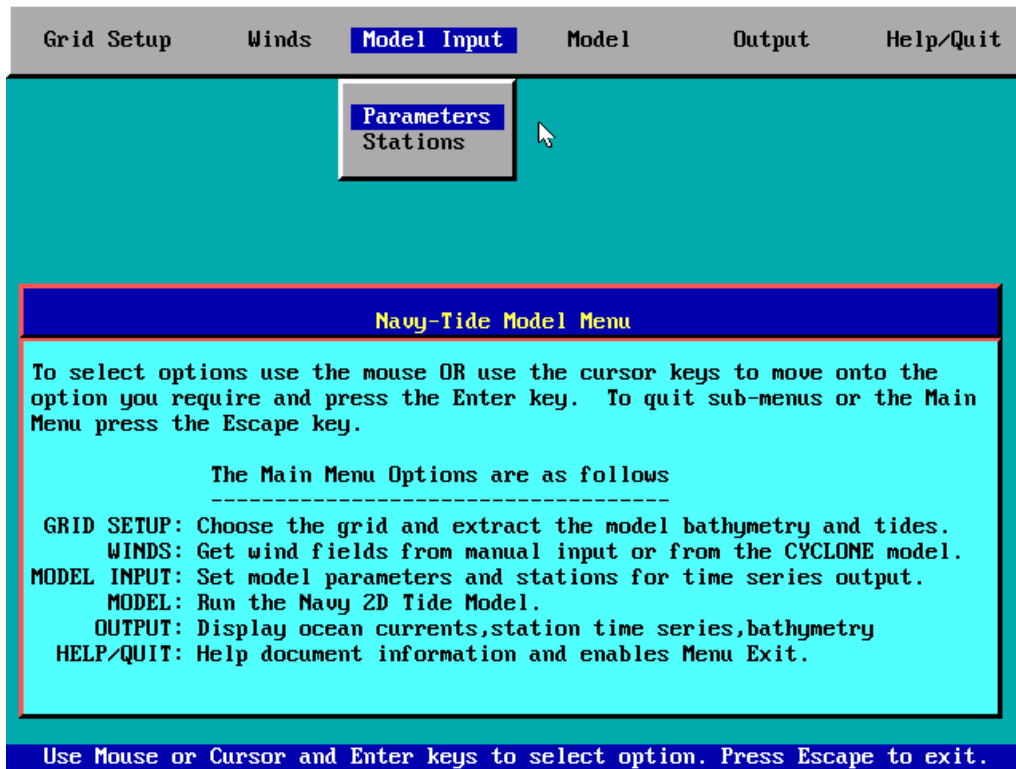Set parameters in the input panel (Figure 26).

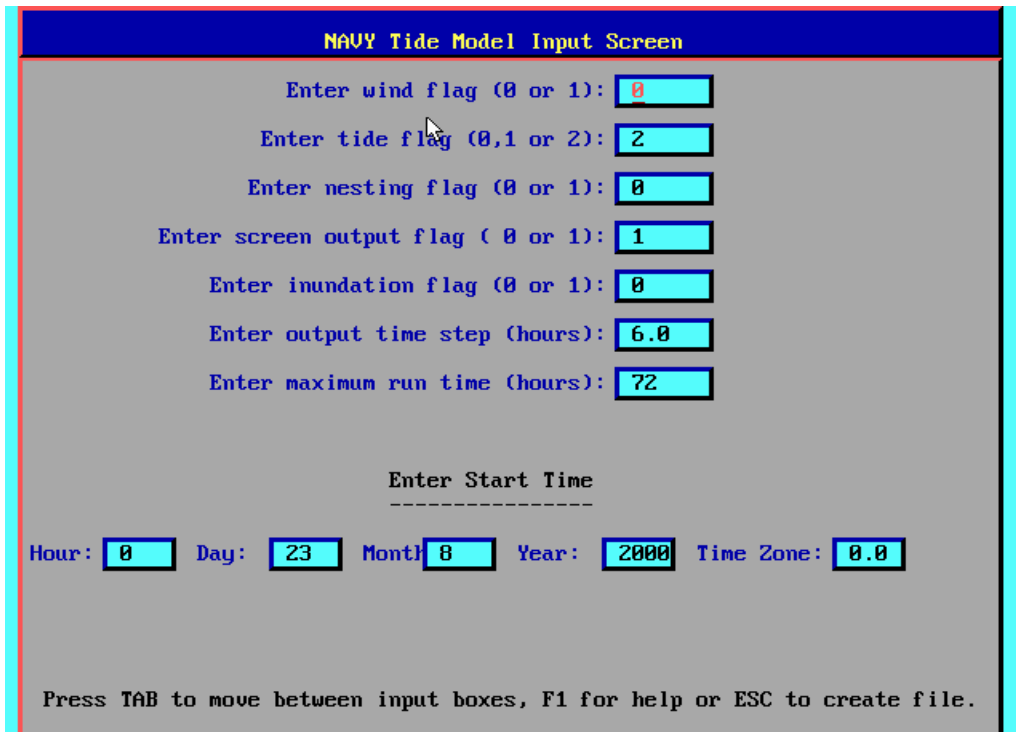**Figure 25:** Model parameter menu selection.

Figure 26: Tide Model parameter entry panel.

4.3.2 Stations

One of the features of the model is to produce time series output of sea levels and ocean currents at specified locations. The location of these "stations" must be defined before the model is run by setting up the "stations.dat" file. During the model run, time series data of sea levels, current speeds and directions are written to files with the station name and a ".tsd" extension. These files can be plotted at the end of the run for comparison with data or tidal height predictions (".thp" files).

The "stations.dat" file may have up to 12 stations defined, one per line, as latitude, longitude, and name. The user is advised to have at least one output station defined for each model run. The format for the "stations.dat" file is as follows:

Latitude (-90.0 to 90.0)	Longitude (0 to 360 E)	Station Name (max 8 characters)	Model Output Level (1 for GCOM2D)
26.17000	56.55000	Pgulf1	1
26.70000	56.28000	Pgulf2	1
24.00000	58.00000	Pgulf3	1
26.50000	53.40000	Pgulf4	1
25.67000	52.40000	Pgulf5	1
24.45000	53.37000	Pgulf6	1
27.00000	49.72000	Pgulf7	1
29.27000	50.33000	Pgulf8	1
29.83000	48.72000	Pgulf9	1

Note: The simplest way of determining the latitude/longitude location of each station is to first proceed to the main menu "Output" section and select "Bathymetry". The user should determine station latitude and longitude values that "fit" within the selected grid from this figure. (See Section 4.4 "Models" for a method to check the station locations.) The set of stations defined for a model region can be saved with an ".stn" extension in the "\gems\work" directory and recalled for later model runs.

<u>**Command prompt**</u>
Copy a ".stn" file to "stations.dat" and/or edit "stations.dat".

<u>**Menu**</u>
Select "Stations" (Figure 27).
Select a stored stations file (Figure 28).
Edit the station data (Figure 29) and save (exit).
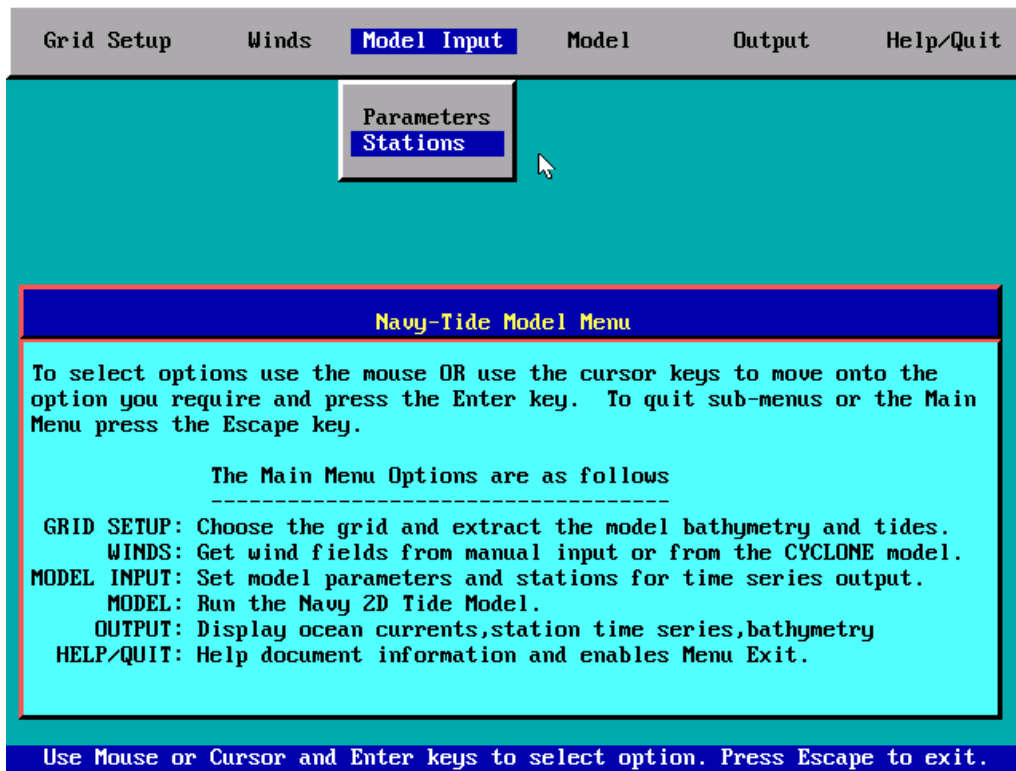
Figure 27: Model Input menu selection.
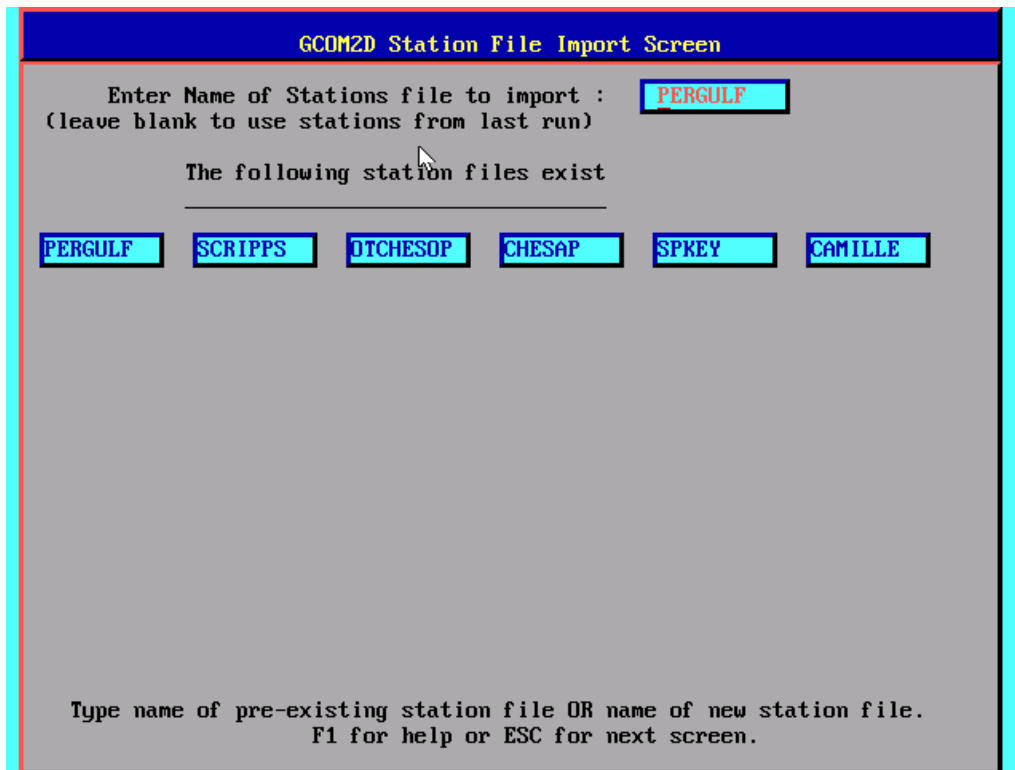
Figure 28: Stored station data selection panel.

Figure 29: Station location data (checking stored data or entering new data).

4.4 MODEL

PCTides (GCOM2D) is used to predict sea level as a result of tidal and/or hurricane forcing. GCOM2D can also simulate the inundation of coastal regions as a function of tidal ebb and flood or storm surge.

Command prompt
Run "gcom2d".

Menu
Select "Tide Model" (Figure 30).

Once the model run begins, numerical data will appear on the screen. This data will list the stations input into the station file and the depths at that location associated with the model topography. If the user selects a station that is located on land, the station location is automatically adjusted to the location of the closest water grid point. As the model runs on the screen, the new adjusted latitude/longitude position of the station is shown.
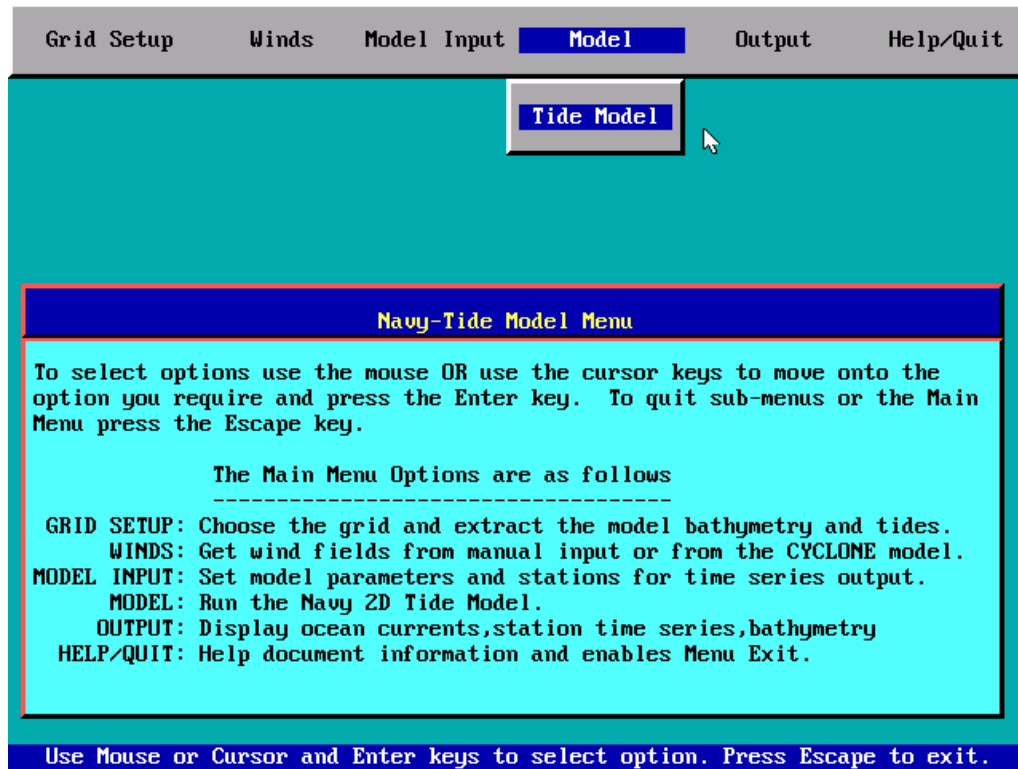
Figure 30: Tide Model selection.

4.5 MODEL OUTPUT

The PCTides system writes the model output in two forms. "Gcom.out", is created as a sequential binary file at each model output time step for each grid point. For further information on this file see section 4.6.1.   The second form of output is an ASCII file that contains tidal information for the stations previously selected. For example, for the stations selected in figure 29, nine station model output files will be written (pgulf1.tsd, pgulf2.tsd, …. pgulf9.tsd).   The ASCII file contains header information about the station, a continuous time (used in the graphics), the date (yyyymmdd), the time (hhmm), tidal height (meters), speed (m/sec) and direction (towards with 0 being north, 90 – east, 180 – south, 270 – west). A condensed form of a typical *.tsd file is listed on the following page.

```
#pgulf4
#   26.5000   53.4000    0.0    95.8           12          0
# DATA FROM THE REGIONAL OCEAN MODEL
#PLOTTIME DATE TIME   HEIGHT SPEED DIREC
     0 20000731    0  0.004  0.244 293.3
    12 20000731   12 -0.017  0.231 293.3
    24 20000731   24 -0.039  0.217 293.3
    36 20000731   36 -0.062  0.201 293.3
    48 20000731   48 -0.088  0.185 293.3
   100 20000731  100 -0.116  0.167 293.2
   112 20000731  112 -0.146  0.149 293.1
   124 20000731  124 -0.179  0.130 292.9
   136 20000731  136 -0.214  0.110 292.6
   148 20000731  148 -0.251  0.090 292.3
   200 20000731  200 -0.290  0.070 291.8
          .
          .
          .
  4636 20000801 2236  0.305  0.149 297.0
  4648 20000801 2248  0.324  0.163 296.8
  4700 20000801 2300  0.341  0.176 296.7
  4712 20000801 2312  0.355  0.187 296.6
  4724 20000801 2324  0.366  0.196 296.5
  4736 20000801 2336  0.374  0.203 296.4
  4748 20000801 2348  0.379  0.208 296.4
  4800 20000802    0  0.381  0.211 296.3
```

If data assimilation has been chosen for the model run, tidal predictions for the closest IHO tidal station to the selected model station are written to a file with the station name and the extension ".thp". The format of these files is the same as the station ".tsd" files.

Note: As stated above, the output from the PCTides model is written to files with the station name and extension ".tsd". If you make another model run using the same grid and stations, the first ".tsd" files will be overwritten. This means the user needs to move/rename the model output if consecutive runs are made.

4.6 OUTPUT DISPLAY

Various forms of display options are available for the PC user. The display code has been written for the PC and so there are no display options when running under UNIX. The display options may be run under the PC Windows Menu or at the command prompt.

4.6.1 Ocean Currents and Tidal Deviations from Sea Level

PCTides GCOM2D writes output fields to the sequential binary file "gcom.out" at each model output time step. Currents and tidal deviations from sea level contained in this file may be displayed by running "omdisp" which offers an interactive menu to set display options. The "omdisp" menu appears in both the menu and command prompt

environments and each entry parameter is supported with an "F1" help function to explain the option.

Notes:

- The user is referred to the "F1" help function in the display menu for descriptions of each parameter option.
- The vector scaling option allows the user to change the appearance of the current vectors.
- The latitude and longitude limits of the model domain are displayed and the user may choose to plot sub-regions of that area (i.e. zoomed plots).

Command prompt
Run "omdisp".

Menu
Select "Currents" (Figure 31) and set display options in the menu panel (Figure 32). Hit "Esc" key to display plots initially. Press "Enter" to scroll through the series of plots. Press "Enter" after the last plot to be returned to the menu panel (Figure 32) and then press "Esc", making sure you have not selected an output field to be plotted and the user will be returned to the main menu.
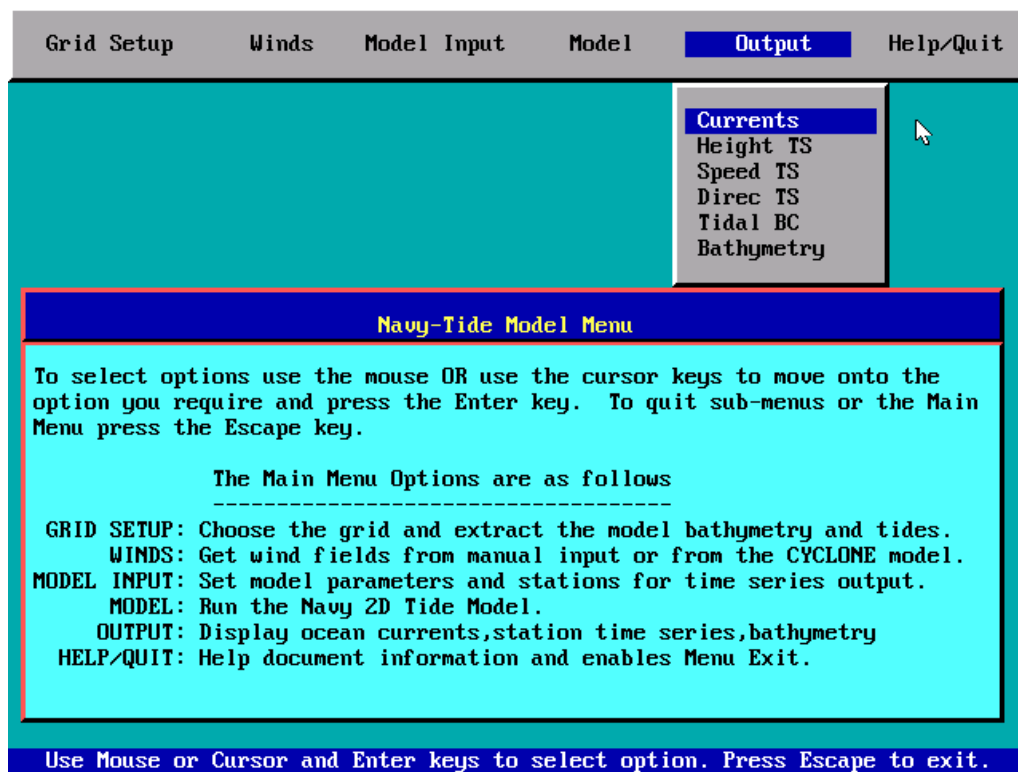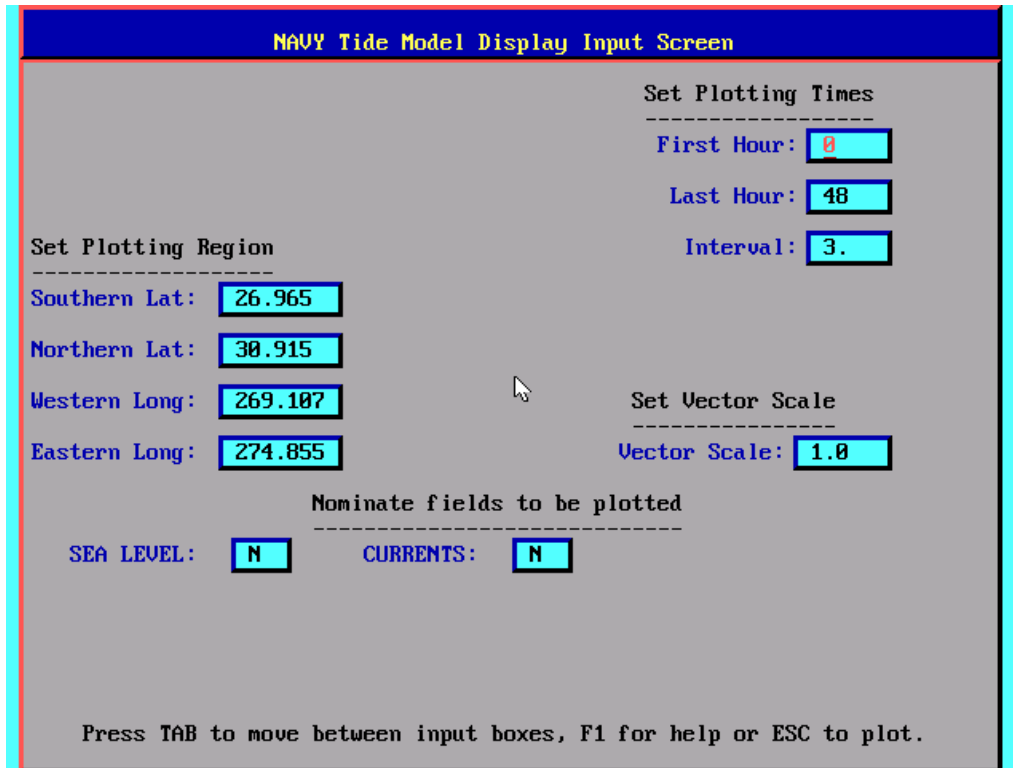

Figure 31: Output display menu selection.

Figure 32: Ocean model horizontal fields display menu.

4.6.2 Sea level height time series

When the user specifies stations in the menu or edits the "stations.dat" file the model produces time series output at those locations and writes to a file with the station name and an extension of ".tsd". If data assimilation has been chosen for the model run then the tidal predictions for the closest IHO tidal station to the selected model station are written to a file with the station name and the extension ".thp". Both these file types may then be plotted in the following manner. The output plot from a height field is saved (if chosen during the menu option only) under \gems\work\gifs\height as a gif file. The naming convention of these saved files is {station name.tsd or station name.thp} {date}.hgt.gif.

Command prompt

Run "zplot" and specify the input file.

Menu

Select "Height TS" (Figure 31) and specify the input file. Station#.tsd is the output time series at the model station location while Station#.thp is the time series of the closest IHO point. Note these two may not be at the same location. Also note that the color scheme for several time series is as follows for the first six time series plotted on the same screen: Green, Red, Blue, Pink, Yellow, Purple.

Note: The time series, tidal boundary conditions and bathymetry plots require interactive input from the user. Unless a specific plot is needed (such as overlaying

two time series), the user should hit "enter" until the plot appears on the screen. To return to the menu, the user should hit "enter" once again.

4.6.3 Current Speed and Direction Time Series

As described in Section 4.6.2 the time series of current speeds and directions are part of the ".tsd" files and may be plotted in the following manner. The output plot from a both the direction and speed fields are saved (if chosen during the menu option only) under \gems\work\gifs\direction and \gems\work\gifs\speed as a gif file.   The naming convention of these saved files is {station name.tsd or station name.thp}{date}.dir.gif for the direction plots and {station name.tsd or station name.thp}{date}.spd.gif for the speed plots.

Command prompt
Run "spdplot" or "dirplot" and specify the input station.

Menu
Select "Speed TS" or "Direc TS" (Figure 31) and specify the input station.

4.6.4 Tidal Amplitudes and Phases

The tidal forcing from the global tidal files may be plotted as described in Section 4.1.2 in the following manner.

Command prompt
Run "plotide" and specify the tidal constituent file (m2.dat, o1.dat etc. as defined in Section 4.1.2).

Menu
Select "Tidal BC" (Figure 31) and specify the tidal constituent file (m2.dat, o1.dat etc. as defined in Section 4.1.2).

4.6.5 Bathymetry

A two-dimensional contour plot of the model bathymetry and color-coded topography may be obtained with the program "bathplot". This program reads the "topog.dat" file and allows the user to set the minimum plotting contour (meters). The color coding of the topography is defined on the bottom of the plot. This program may be run in the following manner.

Command prompt
Run "bathplot".

Menu
Select "Bathymetry" (Figure 31).

5.0 FUNCTIONAL DESCRIPTION

For a discussion of the functional description see the accompanying Software Design Description (SDD) manual (Hubbert et al., 2001).

6.0 TECHNICAL REFERENCES

6.1 Software Documentation Guidelines

Oceanographic and Atmospheric Master Library Summary. Naval Oceanographic Office, System Integration Department. OAML-SUM-21F. April, 1998.

Software Documentation Standards for Environmental System Product Development. Naval Oceanographic Office, System Integration Department. OAML-SDS-59A. January, 1999.

6.2 PCTides Software Release

Hubbert, G. D., R. H. Preller, P. G. Posey and S. N. Carroll, "Software Design Description for the Globally Relocatable Navy Tides/Atmosphere Modeling System (PCTides)," NRL/MR/7322—01-8266, Naval Research Laboratory, Stennis Space Center, MS, 2001.

Preller, R.H., P.G. Posey, S.N. Carroll and L.B. Orst, "Software Requirements Specification for the Globally Relocatable Navy Tide/Atmosphere Modeling System (PCTides)", NRL/MR/7322—01-8265, Naval Research Laboratory, Stennis Space Center, MS, 2001.

Posey, P.G., R.H. Preller, G.M. Dawson and S.N. Carroll, "Software Test Description for the Globally Relocatable Navy Tide/Atmospheric Modeling System (PCTides)", NRL/MR/7320—02-8618, Naval Research Laboratory, Stennis, Space Center, MS, 2002.

6.3 General Technical Documentation

Shum, C.K., Woodworth, P.L., Andersen, O.B., Egbert G.D., Francis, O., King, C., Klosko, S.M., Le Provost, C., Li, X., Molines, J.M., Parke, M.E., Ray, R.D., Schlax, M.G., Stammer, D., Tierney, C.C., Vincent, P., and Wunsch, C.I., (1997) Accuracy Assessment of Recent Ocean Tide Models. *J. Geophys. Res.*, **102** (11): 25173-25194.

7.0 NOTES

7.1 Acronyms

ASA	Applied Sciences Associates
ASCII	American Standard Code for Information Interchange
COAMPS	Coupled Ocean Atmosphere Mesoscale Prediction System
CSCI	Computer Software Configuration Item
CSC	Computer Software Component
DAMPS	Distributed Atmospheric Mesoscale Prediction System
FES	Finite Element Solution
GCOM2D	Coastal Ocean Model 2-D
GEMS	Global Environmental Modeling Systems
GMT	Generic Mapping Tool
IHO	International Hydrographic Office
NOGAPS	Navy Operational Global Atmospheric Prediction System
NRL	Naval Research Laboratory
OAML	Oceanographic and Atmospheric Master Library
PC	Personal Computer
PSI	Planning Systems Incorporated
SDD	Software Design Description
SRS	Software Requirements Specification
SSC	Stennis Space Center
STD	Software Test Description
UNIX	Workstation Operating System

APPENDIX A – GLOBAL TIDAL BOUNDARY CONDITIONS

A description of The Finite Element Solutions 95 versions 1 and 2.1 (FES95.1/2.1) are documented in a paper by Shum et al., (1997) describing this model and several other global tide models. The FES95.1/2.1 model differs from the earlier FES94.1 model by assimilating tidal solutions derived from TOPEX/POSEIDON (T/P) altimetry data. The difference between FES95.1/2.1 is that in FES95.1 only the M_2 and S_2 constituents have been corrected while in FES95.2.1 N_2, K_1 and O_1 have also been corrected.

Figure A1 shows the global Coamplitude and Phase of the M2 Tidal component from the FES95.1/2.1 model.
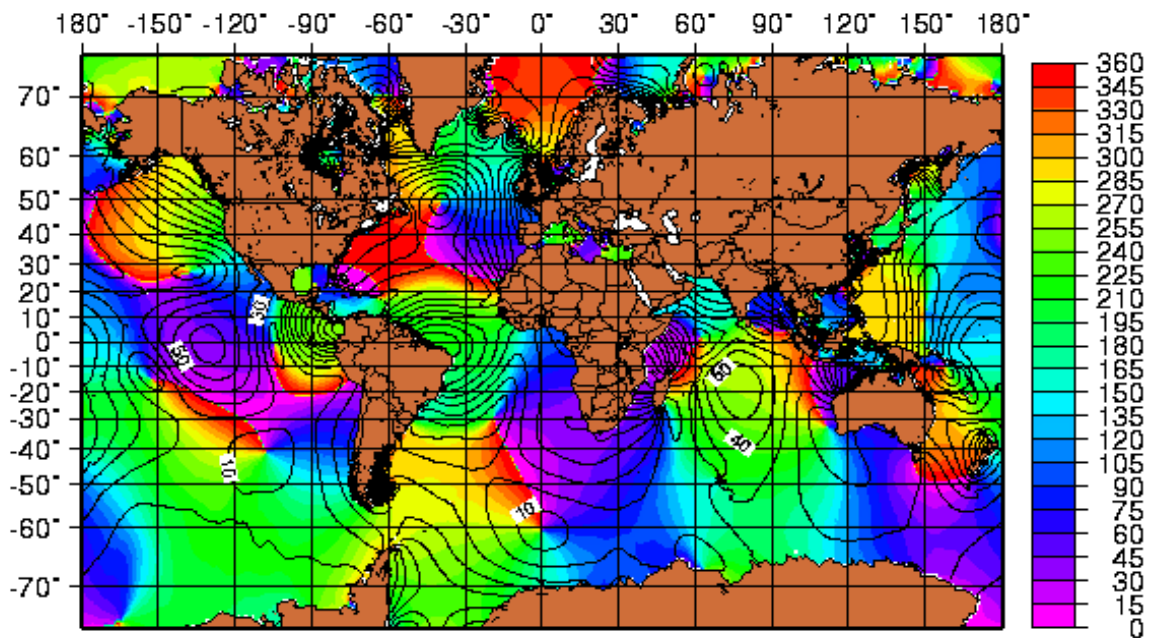

Figure A1: M_2 Coamplitude and Phase Tidal Component.

APPENDIX B – METCAST ATMOSPHERIC FORCING

Since April 2001, PCTides has been using atmospheric forcing available through METCAST. METCAST is officially supported and distributed by Fleet Numerical Meteorology and Oceanography Center (FNMOC) in Monterey, California. Through METCAST, a user can retrieve the atmospheric forcing required by PCTides (surface air pressure and 10-meter wind forcing).   A user can retrieve this atmospheric forcing from either the Navy Operational Global Atmospheric System (NOGAPS) or any the various Coupled Ocean and Atmospheric Prediction Systems (COAMPS). NOGAPS forecasts are produced with a resolution of 1 degree while the COAMPS forecasts are produced with a higher resolution of 0.2 degrees.

In order to run using the METCAST fields, you must first have the METCAST software loaded on your NT machine.   Installation and data retrieval are very easy and well documented. The user will need to "schedule" the necessary atmospheric forcing.

After a successful retrieval of data, the pre-selected METCAST fields have been retrieved and will be stored on the local disk drive under c:\jmvwin\noddsfls.

Before running the preprocessor, the user will need to make sure that the appropriate model grid has been selected through the PCTides menu. This has to be done first so that the atmospheric fields can be interpolated to the correct grid. To begin the preprocessor phase, click the preprocessor icon that was set up during the installation of the system. The preprocessor icon will run a job that asks the user to select the appropriate atmospheric forcing needed for the model run.   The user will select from a list that includes NOGAPS, COAMPS Central America, COAMPS Eastern Pacific, COAMPS Europe, COAMPS Western Pacific, COAMPS Southwest Asia or COMAPS Western Atlantic.

After the preprocessor finishes, the model (Tide Model or GCOM2D) is ready to run.

Note: The user must remember to set the winds parameter to (winds=1) from the PCTides menu in order to user the winds.

APPENDIX C – INPUT HIGH RESOLUTION BATHYMETRY FILE

To input a high resolution bathymetry data set into PCTides, the file must be in the following format:

      Read (unit_number,100)elong1,elong2,alat1,alat2,n,m,deltax,title
100 format(1x,4f20.10,1x,2i5,1x,f20.10,1x,a20)
      Read(unit_number,102)(depth(I,j),I=1,nx),j=1,ny)
102 format(1x,7f10.2)

where:

elong1 is the stating longitude (W)   N
elong2 is the ending longitude (E)   W   E
alat1 is the starting latitude (S)   S
alat2 is the ending latitude (N)
n is the number of points in the longitude direction
m is the number of points in the latitude direction
deltax is the distance in degrees between grid points
   NOTE: Deltax must be the same in both the x and y direction.
 title is the name of the grid. Limit to 20 characters
depth is the bathymetry array of depths in meters.

The longitudes can be input as either 0. to 360. degrees E or –180.0 W to 180.0 E. NOTE: If you cross Greenwich please use the –180. W to 180. E orientation. Bathymetry values must be negative (ie..ocean depths negative and land heights positive). If you don't have topography values (land), then the interpolation program will use the 2 minute DBDB2 values for topography. Maximum number of grids points is (3500,3500).

To add a high resolution file to the PCTides system follow the directions below. For this example we'll use a high resolution bathymetry call Bights (Gulf of Mexico) data.

   1.   Copy your formatted file (see above) into the c:\gems\data directory.
        DOS: copy bight.dat   c:\gems\data\bight.dat
        UNIX: cp   bight.dat   ~/gems/data/bight.dat

   2.   From c:\gems\data   run the hires.bat script
        This script will ask you to input the name of your ASCII file
        Enter bight.dat
        Then it will ask you to input the name of the direct access filename
        Enter bight.da

   3.   PCTides is ready to use the newly created direct access file. Create a grid in the
        area includes your new high resolution and the interpolator will use this new file
        to generate a PCTides grid.