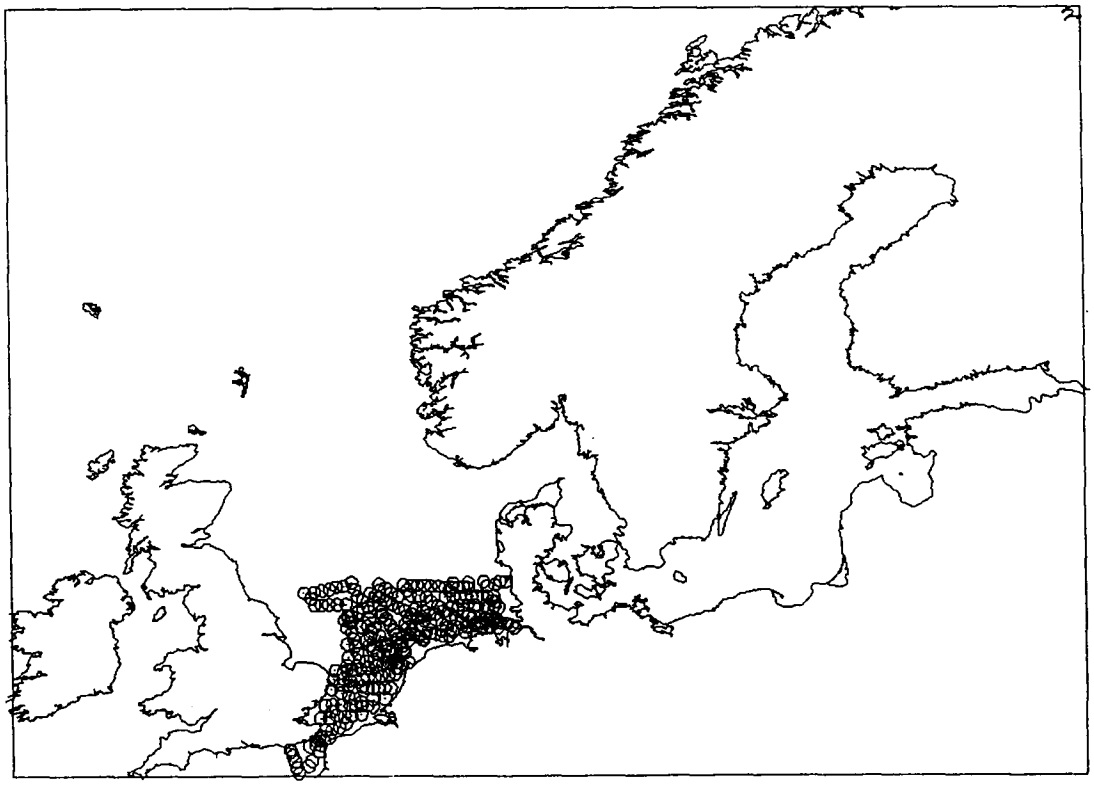
OCS Study
MMS 93-0020

OPCPLOT: Oceanographic Charting Software for the World's Seas

July 1994



MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Intergovernmental Oceanographic Commission
United Nations Educational, Scientific, and
Cultural Organization

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OPCPLOT: Oceanographic Charting Software for the World's Seas

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Author

Murray L. Brown

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ADDENDUM

The OPCPLOT user should note that OPCPLOT Version 3.1 has been superseded. The most recent version of this software and the accompanying manual are available from the Gulf of Mexico Region in digital format only.

For more information on ordering the OPCPLOT software and manual please refer to page iii of this document.

VERSION

This Manual describes the use of Version 3.1 of OPCPLOT. As new versions are released, the Minerals Management Service will inform registered users by electronic bulletin boards.

DISCLAIMER

This report has not been technically reviewed by the MMS; however, it has been approved for official Agency publication. It is a draft circulated to the oceanographic community for beta testing of the software and for comment on the manual. The contents do not necessarily reflect the views and policies of the MMS, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. It is, however, exempt from review and compliance with MMS editorial standards.

AVAILABILITY

OPCPLOT and a sampler of plottable data files can be obtained by sending a **high-density** 5" or 3" diskette to

Minerals Management Service
Gulf of Mexico OCS Region
Attn: Public Information Unit (MS 5034)
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394
Telephone Number: (504) 736-2519
1-800-200-GULF

Alternately, the program can be obtained as one component of the integrated **"OceanPC"** software system at the following address:

OceanPC Project Officer
Intergovernmental Oceanographic Commission
UNESCO
7, Place de Fontenoy
75700 Paris
France

The **OceanPC Project** is aimed at developing an integrated system of data input, quality-control, and display software for ocean station data, sponsored by the United Nations Intergovernmental Oceanographic Commission. OPCPLOT is contributed to **OceanPC** by the Minerals Management Service of the U.S. Department of the Interior.

RECOMMENDED CITATION

Brown, M. L. 1994 OPCPLOT: Oceanographic charting software for the world's seas, July 1994. OCS Report MMS 93-0020. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, La. 61 pp.

ABOUT THE COVER

This typical OPCPLOT chart shows the Baltic Sea and North Sea, using a high-resolution coastline, overlain by the station locations from a 1923 Poseidon survey. (Data courtesy of ICES.)

CONTENTS

Section I.

INTRODUCTION

The OPCPLOT program is a simple marine charting utility written in QUICKBASIC. The program uses ASCII data files in a simple, standard format called the OPCPLOT format (Appendix A), but also recognizes many other ASCII and basic-binary data formats (Appendix B) to draw charts of the ocean or to produce analytical results. The charts contain notations and symbols depicting the locations of sampling sites or cruises, as well as ocean fronts, buoy trajectories, and other useful information. Because the plottable files can be posted on electronic bulletin boards, the program offers a simple way to communicate charts of marine research activities and of ocean features important to the scientific community.

OPCPLOT grew out of an informal drifting buoy data distribution method originated by Dr. Robert E. Lee Pickett in 1989. Dr. Pickett shared buoy trajectory data with users of the GULF.MEX electronic bulletin board, as well as a simple, 70-line GWBASIC program that drew the trajectories on a map of the Gulf of Mexico. A more elaborate charting program was subsequently developed by the author, published as the GULFPLOT Program (Brown, 1991). The OPCPLOT program code (now about 5000 lines in length) extends the features of GULFPLOT to the entire globe, and introduces new capabilities.

Section II.

SYSTEM REQUIREMENTS

The following equipment and operating system are required:

An EGA or VGA monitor
DOS 5.0 (or higher)

Optional items include:

WordPerfect 5.0 (or higher)
A Hewlett-Packard 7475-series plotter

OPCPLOT and all its coastline data files are usually placed in a directory named OPCPLOT on a hard-disk. [If OPCPLOT is being used as one component of the OceanPC system, it should be located in the subdirectory OPCPLOT under the directory for OceanPC.] The directory PICTURES is required to be a subdirectory under OPCPLOT, to contain saved chart images; it is automatically created during program installation.

```
X:\ (=hard-disk volume)   -root directory
     Ocean_PC\            -optional system shell
          OPCPLOT\        -system files
               PICTURES\  -saved charts
```

Section III.

PROGRAM OVERVIEW

OPCPLOT COMMANDS: OPCPLOT is essentially an electronic sketchpad that the user operates interactively. Usually the screen image consists of a chart (either in the process of being drawn or just finished) surmounted by a command line prompt. When some commands are answered, the command line is replaced by specific questions relating to that command. Other commands cause the monitor to go blank while various text messages and additional questions scroll by. The following brief descriptions of all the OPCPLOT commands are an overview of program structure. A detailed explanation of how to use each command is contained in Section IV.

DRAW CHART: To set up the geographic dimensions of a chart and to draw it on the monitor. A menu of standard charts will be offered, but the user can add new charts by drawing one of the global charts and zooming in on a selected region. Once the answers to a few questions have been supplied, the chart will be drawn on the monitor.

ZOOM: To select a rectangular subarea from the current chart so that it can be expanded to fill the screen, or so that a new standard chart can be created.

PLOT: To select a particular data file to be drawn on a chart; the file can be in OPCPLOT's own format or in any one of about two dozen other formats. This command cannot be used until a base map has been drawn on the monitor with either the DRAW CHART command or the REPLAY command.

GRID: To draw a latitude-longitude graticule on a chart, and (optionally) to label the lines.

KEY: To display a set of chart boundaries corresponding to the various standard charts available through the DRAW CHART command.

TITLE: To write a title in a frame at the bottom of the chart.

SAVE: To save the current chart, and information about its boundaries, to disk. (The REPLAY command can subsequently be used to recall the chart to the monitor.)

REPLAY: To recall to the monitor a previously SAVED chart, and to set all computer parameters for the boundaries of that chart.

UTILITY: A set of functions that creates, manages, and augments the data files, and that turns ON or OFF certain basic functions of OPCPLOT.

MARK: A set of routines that allows the user to place labels or user-specified figures in existing files or to create new files. When a data file has been plotted, the user could, for instance, use MARK options to add more information to the same file. MARK is a powerful and flexible part of OPCPLOT that can be used to increase the readability of various files or to enhance the resulting charts for purposes of publishing.

COLOR: To fill the various land and water boundary polygons with appropriate colors, or to set the default color for data file plotting if no color is specified in the data file.

END: To exit the OPCPLOT program and return to the operating system. The user is also offered the options to

(1) re-name the Hewlett-Packard Graphics Language plotter file (named PLOTFILE.HPG) that has been created in background,

(2) re-name a file (named CONTOURS.OPC) containing the OPCPLOT formatted version of any contour line that has just been drawn from a gridded data file,

(3) rename a file (named TEMP.OPC) containing the OPCPLOT formatted version of any data file that has just been plotted, if that file was not originally in OPCPLOT standard format (i.e. the file was in one of the many other formats that OPCPLOT recognizes),

(4) or send the file PLOTFILE.HPG or any other HPGL file to an HP 7475A plotter through the computer's serial port.

OPCPLOT COORDINATE SYSTEM: In accordance with the latest Federal Information Processing Standards relating to geographic information, OPCPLOT uses latitude and longitude in "signed decimal degrees" format; for instance, -93.34478 is an acceptable longitude value. Further, the OPCPLOT globe extends (left to right) from -180 (W Longitude) to +180 (E longitude), centered on the Prime Meridian; and (top to bottom) from +90 (N Latitude) to -90 (S Latitude), centered on the equator.

Even for those data sets that may wrap over the International Date Line (where -180 W Long and +180 E Long coincide) the above conventions must be observed; e.g., a chart of the Pacific Ocean has positive longitudes on the left and negative longitudes on

the right. The internal logic of the OPCPLOT code recognizes and handles the special transformations required, and no substitutions or coordinate conversions are necessary.

OPCPLOT FORMAT AND OTHER FORMATS: The OPCPLOT program was originally written with two specific data formats in mind: the OPCPLOT "standard" files, and the OPCPLOT gridded data files (described in Appendix A). Since the publication of the earliest version of OPCPLOT (then called "GulfPlot") the program code has been revised several times to allow the use of data files from a number of more-or-less standard other oceanographic and meteorological data and analysis systems (Appendix B). Whenever the user names a file to be plotted, a listing of the allowable file formats is presented so a choice can be made.

Section IV.

COMMAND DOCUMENTATION

DATA FILE PATH: When OPCPLOT starts, the default path used by the program to locate data files is displayed. The program always uses a designated path to find various data files specified to be plotted by the user. This allows the user to enter a shorter name than the full path-and-filename protocol. The path can be changed by the use of Utility I, or by maneuvering through the subdirectory structures when the file menu appears on the screen (see PLOT Command).

MAIN COMMAND LINE: The following prompt appears at the top of the monitor:

> D-efine a chart,Z-oom,P-lot,G-rid,T-itle,S-ave,R-eplay,
> U-tility,M-ark,C-olor,E-nd

In response, the user should enter a single letter, then hit ENTER.

DRAW CHART: The user is presented with a menu of "standard charts" for which the coastlines have already been set up. The user need only enter the letter of his choice. If, however the user desires a chart that is not available from the menu, then the following alternatives are available:

> Exit DRAW CHART and use UTILITY H to create a new standard chart for the menu.
>
> DRAW a large area chart that includes the area of interest, then use the ZOOM command either to create a new standard chart or to expand the framed portion to fill the screen temporarily.

When the desired chart has been selected, the user is asked to specify the types of geographic features to be included in the chart, and the resolution to be used. Geographic features available in OPCPLOT include (1) coastlines and islands, (2) national and U.S. state boundaries, and (3) lakes and rivers. A fourth option allows for a "blank" chart on which the user can plot his own geographic files. OPCPLOT's coastlines are derived from the Micro World Data Bank II (MWDB2), containing 5 levels of resolution. Level 1 appears to be approximately 1-5 km in the mid latitudes; Level 5 appears to be at least 100 km.

While the coastline is drawing, which may take some time for the high-resolution file, the following prompt appears:

> "Plotting the coastline. Hit ENTER to abort."

This feature provides a shortcut in case the area being plotted is near the beginning of the coastline file, and the user does not wish to wait through much "off screen" plotting that follows.

ZOOM: This command allows the user to select and enlarge a rectangle from the already drawn chart. After selecting a rectangular area according to the same procedures described below under MARK - RECTANGLE Option, the user will see the following prompt:

"Expand subarea, Create a new OPCPLOT chart."

If the EXPAND Option is selected, then the monitor screen goes blank and the user is returned to the coastline resolution question asked during the DRAW CHART command, e.g., low, medium, or high resolution? When the user selects the desired resolution, OPCPLOT draws the selected subarea, filling the entire monitor. This use of the ZOOM command allows any part of any chart to be enlarged to become the new working chart, but the expanded image is temporary and does not become a permanent addition to the list of standard charts.

If the CREATE Option is selected, the program switches to the procedures described below under Utility H that creates a new standard chart that will subsequently appear on the DRAW CHART menu. The area enclosed by the ZOOM rectangle is automatically used to set the boundaries for the new standard chart.

PLOT: The user is asked to enter the name of a data file to be plotted. Entering a known filename (plus extension) causes the file to be selected for plotting. Entering "Q" causes the program to return to the main command line. Hitting the ENTER key causes the filemenu for the current data file path to appear. The user can move about this menu with the arrow keys to select the desired file, or can move up or down through the subdirectory structure. **Filenames that OPCPLOT recognizes not to be plottable data files will be ignored by the program.**

At this point the monitor screen temporarily clears, and a table listing all of the data file formats recognized by OPCPLOT is shown. The user must select the correct format, and indicate it by entering a single-keystroke response. (Further information about the recognized formats is contained in Appendix B.) After the file format has been selected, the drawn chart re-appears and the program now asks the following question:

"Display station labels when available (Y or N)?"

This refers to the treatment of OPCPLOT data file lines with a Z-flag of "D" or "B" (see Appendix A), which are plotted as either a small open circle or a circle with a label printed to the right, depending on the user's response to this question. This

is useful in cases where a large number of stations would cause the chart to be cluttered if all of the labels were printed out.

PLOT [A GRIDDED DATA FILE]: If the user has indicated that the file is one of the gridded formats, then the file is treated according to the type of header it has (or the lack of a header). OPCPLOT uses the CONREC contouring routine (Bourke, 1987).

NO HEADER: If there is no header, the user must supply answers to a sequence of questions about the matrix. The following prompt asks the user to input the number of columns of data there are in the input array:

"How many columns of data"

The response should correspond to the number of different longitudes found in the array. The next prompt asks the user to input similar information on the number of rows (latitudes):

"How many rows of data"

The next two prompts ask the user to enter the first longitude (X) and first latitude (Y), respectively, of the gridded array. That is to say, where should OPCPLOT begin placing the array in memory?

"First X value (-W,+E)"
"First Y value"

The next two prompts ask the user to enter the longitudinal and latitudinal distance between columns and rows, respectively.

"Distance between columns"
"Distance between rows"

There are 4 different ways that the program can begin placing the array values into memory. The next question refers to the specific structure of this grid. the user must respond by entering a 2-letter string, followed by hitting ENTER. UL indicates that the values begin being placed into memory with the first value in the upper left corner (the northwest corner of the chart), and so on. The string LL, for instance, is typical of ocean model outputs.

"Begin: UL-up/left,UR-up/right,LL-low/left,LR-low/right"

For each of the above 4 ways that the array can begin being filled, there are two ways the data can be placed into the

rows and columns. The next question asks how this filling will occur.

"Read file: R-rows then columns, C-columns then rows"

If the sequential array values begin with the same latitude values (rows) but changing longitudinal values (columns), then the response should be R. If the sequential array values begin with the same longitude values (columns), but changing latitude values (rows), then the response should be C.

"Optional factor to adjust array values (ENTER=1)"

Some arrays may contain values that, for one reason or another, have been multiplied or divided by various factors to arrive at integral values. To correct for this handling, a factor is asked for in the next question, to return the array values to their correct magnitude. If, for instance, the array values have been multiplied by 10, then the factor to enter here would be 0.1. If the array values do not need to be "adjusted," hit ENTER, and a factor of 1.0 will be entered and used.

OPCPLOT or SURFER HEADER: If the file has a header, then the program inputs the array automatically according to the information in the header.

ARRAY SIZE CHECK: OPCPLOT must check to see if the array might be too large. If the following message appears:

"Array too large by about ____ elements. Hit ENTER."

Then the user can:

Reduce the array by editing the file (for instance with LOTUS 1-2-3 or a similar spreadsheet program), or

Remove the header line (if it exists) and manually enter the answers to the questions in HEADER CHECK/NO HEADER. If the array is a C-type, the user should reduce the answer to the question about the number of rows. If the array is an R-type, the user should reduce the answer to the question about the number of columns.

This will probably not happen with a compiled version of OPCPLOT, since all available memory is available.

RANGE OF GRID VALUES: If the array is successfully input at this point, then the program will inform the user about the

range of array values encountered, with the following prompt:

"Max Z=_____; Min Z=_____; Hit ENTER."

Here Max Z and Min Z will appear as the numerical values of the largest and smallest values in the gridded data file. OPCPLOT ignores values of 9999 or -9999 (OPCPLOT blanking values), and values greater than 1E35 (SURFER blanking value) when it searches for Max Z and Min Z.

CONTOUR DRAWING: There are two basic ways to specify the contour lines to be drawn by OPCPLOT:

If the gridded file is in OPCPLOT format, then the last field in the header line specifies the contouring schema (unless it is a "Z"). This is called "auto-contouring."

If the gridded file is not in OPCPLOT format, OR if the file is in OPCPLOT format but the final field in the header line is "Z", then the program asks the user to input information about the contour lines to be drawn. This is "user-specified contouring."

AUTO-CONTOURING: Although it is impossible to provide for every possible type of dataset that the user may need to contour, an effort has been made to identify certain common sets of contour lines to be drawn in oceanographic and atmospheric data. When applicable, these can be specified by the use of a single-letter code in the OPCPLOT header line, as described in Section V.

USER-SPECIFIED CONTOURING: Because of the range of contours already displayed, and on prior knowledge of the types of contouring best suited to the data at hand, the user can select any contour (or set of contours) to be drawn.

"No of contours"

Here, the user inputs any number (up to 10) to indicate the first batch of contours to draw. Later this line will reappear so the user can draw additional contours, but the total number of contours cannot exceed 14.

"Value to contour, color code (1-15)"

Here the user is prompted for the specific contour line ("isopleth") to draw and the color to use (see Appendix C for a list of color codes). An example of a typical response would be:

22.5,5<ENTER>

where the 22.5 isopleth should be drawn in color 5 (magenta on EGA monitors). The prompt reappears until each of the requested number of contours has been specified. At this point the specified contours will be drawn. If a "stair-step" pattern appears in any contours, this is an indication that the actual gridded data values are approximately equal to the selected contours; this can be cured by selected slightly higher (or lower) values for the contour lines.

Then the following prompt appears:

"Draw more contours on this chart (Y or N)"

If the answer is Y, then the user continues to specify more contours (up to a maximum total of 14). If the answer is N, the user is returned to the COMMAND menu for more plotting.

GRID: This command causes the program to draw a latitude-longitude graticule on the chart. The user may also specify the interval between the grid lines and whether the grid lines should be labelled. (The chart must already have been drawn.)

KEY: This command causes the program to draw a set of boundary lines showing the various regional charts that are available. It is best to invoke this command while the current monitor screen contains a small-scale (large area) chart, such as the world seen from above the Western Hemisphere, in order to see several of the outlines. A letter in the southwestern corner of each polygon identifies the region in the same way as the DRAW CHART Command listing.

TITLE: When this option is chosen, the COMMAND menu disappears and a prompt appears. The title can be up to 45 characters in length, using nearly all the characters on the computer keyboard. All lowercase letters, however, will be converted by the program to uppercase. This command is useful when two or more data files with imbedded titles have been plotted, and their separate titles are overprinted at the bottom of the monitor. The title placed on the chart does not transfer to the HPGL plotter files, because the caption utility in most word-processing programs is usually a superior tool for placing titles or captions on hard-copy versions of the OPCPLOT charts.

SAVE: This is the companion command to REPLAY, above. It allows the user to save the screen image to disk.

"Picture name to save (No EXT)"

The user should enter a 1- to 8-character alphanumeric string to be used as the filename for a set of 5 files (each with a

different extension) to be saved in the OPCPLOT subdirectory. If an extension is mistakenly entered, the code deletes it. Because four of the five files are rather large (28KB each, for an EGA monitor), frequent use of SAVE can quickly load up a hard disk. For this reason, Utility D allows the user to list the SAVEd charts, so no-longer-needed images can be purged. If the user's computer is loaded with read-and-stay-resident software programs prior to using OPCPLOT, attempting to SAVE and REPLAY a chart will often give unpredictable results, since the address for the memory location where the image is to be loaded is incorrect.

REPLAY: "Pictures" of the charts drawn on the monitor screen can be saved by the use of the SAVE command. The REPLAY command is used to recall SAVEd images to the monitor. Each "picture" is actually saved in 5 files, with the filename extensions .RED, .GRN, .BLU, .INT (for intensity), and .PTR (for parameters). The .PTR file is very small, but contains essential information on the geographic limits of the chart. This means that the computer memory contains the same information, e.g., latitude and longitude ranges, that would be present if the chart had been drawn "from scratch" with the DRAW CHART command. The user can simply enter the 1- to 8-character name of the saved chart, or he can hit ENTER and a menu of SAVEd charts is provided.

It is much faster to REPLAY certain frequently used charts that have been SAVEd, than to re-draw them on the monitor with the DRAW CHART command. In addition, a utility program is included that lets the user REPLAY named sequences of SAVEd pictures in "slideshow" fashion. If the user's computer is loaded with read-and-stay-resident software programs prior to using OPCPLOT, the REPLAY command will often give unpredictable results, since the address for the memory location where the image is to be loaded is incorrect.

The only difference between creating a chart with the DRAW CHART command and REPLAY is that the HPGL plotter file being created in background does not contain any of the graphic information contained in the REPLAYed part of the chart. If a complete HPGL file is desired, then the user must go through the complete process of creating the chart with the DRAW CHART command.

THE UTILITIES OPTIONS: Whenever the user enters the UTILITIES command, the screen image is temporarily saved while the UTILITIES menu appears. The options are as follows:

> UTILITY A: Allows the user to compose an OPCPLOT file with any of the 'Z-flags' except V (for drawing vectors). Lines may also be appended to existing files. If the user makes a mistake while entering data, the data-line should be completed and then repeated correctly. Subsequent editing with any ASCII editor deletes the mistaken data-line.

"Name of file to create (no EXT)."

Enter the name of the file. The extension .DAT will automatically be added.

"Identifier (RETURN=default='D');-1 to quit."

The first field in each data line is encouraged to be an "identifier" of the source of the data, such as a station name, a vessel name, etc. If none is known, hit ENTER to use the default string of "D." If -1 is entered, the file is closed and the UTILITY menu reappears.

"Date/time as YYMMDDhhmm (RETURN=default='T')."

The second field is a date/time identifier, such as 8910082115 for 9:15 p.m. on October 8, 1989. This can be shortened to only the date if the time is unknown; or the default "T" can be used, if no date/time is known, by hitting ENTER.

"Degrees of latitude (+N,-S)"

Enter the latitude in decimal-degrees format, e.g., +31.4567 or -18.4666, if you have that value already. Alternately, if the user knows degrees+minutes+seconds of latitude, then he should enter only the whole degrees here. If the latitude is within one degree of the equator, use +0 or -0, as appropriate.

"Minutes of latitude"

Enter the minutes of latitude. Use decimal-minutes format, e.g., 55.8765, if the seconds are unknown. If seconds are known, then enter only the whole minutes here.

"Seconds of latitude"

Although such precision is rarely available, you can enter the seconds of latitude here, either in whole seconds or decimal-seconds format, e.g., 14.9998.

"Degrees of longitude (+E,-W)"
"Minutes of longitude"
"Seconds of longitude"

For the above three inputs, which appear one at a time on the monitor, follow the same directions as for latitude, above. If the longitude is within one degree of the prime meridian, use +0 or -0, as appropriate.

"Enter the Z-Flag (and additional data if required)."

The fifth field in each line of an OPCPLOT data file contains the plotting instructions, identified as Z$ in the program code (hence the name Z-Flag). It consists of either a single character (the Z-Flag) or a single character plus an additional string of ASCII characters (see Appendix A). The user can enter the entire contents of the fifth field here.

After the above questions have been answered, the first line of data is written to the OPCPLOT file and the first prompt re-appears to begin entry of the second line. The user can exit from this Utility program at the conclusion of any line by entering Q<ENTER>.

UTILITY B: This utility program permanently converts files inadvertently created with incorrect longitude sign to the correct sign.

"Name and extension of existing file to convert"

Enter the name of the incorrect OPCPLOT data file. This utility will multiply all longitudes by -1 so the new file is compatible with OPCPLOT and with other software programs. As data conversion proceeds, the new data lines appear on the monitor for the user's visual inspection.

UTILITY C: Allows the user to compose an OPCPLOT file consisting entirely of vectors (signified by the Z-flag of V). Additional lines may be added to the file with Utility A, above, or the MARK command.

```
"Enter the name of the file to create (no path or
extension)"
"Identifier (ENTER = default = 'D'); enter -1 to quit"
"Date/time as YYMMDDhhmm (ENTER = default = 'T')"
"Degrees of latitude (+N,-S)"
"Minutes of latitude"
"Seconds of latitude"
"Degrees of longitude (+E,-W)"
"Minutes of longitude"
"Seconds of longitude"
```

All of the above lines are similar in meaning to the first questions under Utility A, above. In this case, however, the Z-flag and additional string will be created by the program because the format for drawing current vectors must be exact. Further, the arithmetic to get the data into the right format is tricky. This program asks simple questions and uses the responses to write the fifth data field.

Initially, the user is asked to specify which (of four) methods will be used to store the vector data:

1. U and V vectors (cm/s), where U = east/west and V = north/south

2. U and V, as above but rotated clockwise through some known angle

3. Speed (cm/s) and compass direction

4. Speed (knots) and compass direction

North is 0 or 360; East is 90; South is +180; West is 270; etc.

UTILITY D: This utility program lists the different kinds of data files or other files associated with OPCPLOT, according to match criteria entered by the user. The user is able to refine his search of the files by using * to indicate a variable-length string of any alphanumeric characters and by using ? to indicate a single variable alphanumeric character. These "wildcards" are used here exactly as they are employed with the DOS commands.

The Utility allows the user to see (1) all the subdirectories under OPCPLOT, (2) all of the files in any subdirectory under OPCPLOT, (3) a list of all the SAVEd charts that can be rapidly REPLAYed, or (4) a list of all HPGL files that can be plotted on HPGL-compatible devices.

OPTION 1: If the user selects this Option, the available subdirectories are scrolled across the monitor.

OPTION 2: If the user selects this Option, the following question appears:

"Which subdirectory; ENTER for none"

This prompt asks for the name of the subdirectory whose files will displayed. The response should be the same as the name of a subdirectory, e.g. FRONTS. If ENTER is hit, all the files within the displayed path will be listed.

"Enter the search criteria (* and ? allowed)"

This prompt allows the user to refine his search of the files by using * to indicate a variable-length string of any alphanumeric characters and by using ? to indicate a single variable alphanumeric character. These "wildcards" are used here exactly as they are employed with the DOS commands. The user enters a sequence of known and unknown alphanumeric characters,

for both the filename and the extension, followed by hitting ENTER.

For example, if the user wishes to see all files in the BUOYS directory that begin with the letter B and have a filename extension of .DAT, the following keystroke entries would be used:

```
PROMPT:    "Which subdirectory; ENTER for none"
RESPONSE:  BUOYS<ENTER>
PROMPT:    "Enter the search criteria (* and ?
           allowed)"
RESPONSE:  B*.DAT<ENTER>
```

OPTION 3: This option causes a list of all the .INT files to be scrolled across the monitor (as a surrogate for the names of all SAVEd charts).

OPTION 4: This option causes a list of all files with the extension .HPG (the metafiles containing Hewlett-Packard Graphics Language plotting instructions for the OPCPLOT charts) to be scrolled across the monitor.

UTILITY E: This utility tidies up any data file in OPCPLOT format, by lining up all the data fields in orderly columns. This is useful if the file is intended to be used as a data table in a publication.

UTILITY F: This utility allows the user to create a new file that contains portions of all other files with data in a specified data window. The option is written specifically for drifting buoy data, but may provide useful results for other data types, such as oceanographic cruise tracks. In order for this to work, all the data files must be in the same subdirectory, and their second data field must be in strict YYMMDD format.

Initially, the user is asked to input the complete data file path to reach the data files; for example

```
C:\OPCPLOT\BUOYS\<ENTER>
```

would be a valid response, indicating how the program should locate the files to be sorted. This is followed by questions concerning the range of dates to be sorted (in strict YYMMDD format), and the name of the new file to be created, containing the selected data fragments.

UTILITY G: This utility allows the user to set up sequential listings of SAVEd charts, to be shown on the monitor in rapid succession, just like a "slide show." Various sequences of charts are given separate names, so

many different slide shows can be created. For instance, a sequence of SAVEd charts showing station locations in the Gulf of Mexico, say with the name GULFPIX.SHO, could look like this:

MAMMALS
PHYSO
BIOSTATS
XBTS
XCPS
WBUOYS

The above show would contain 6 "slides" showing a variety of ocean data types. Each slide, e.g. BIOSTATS, is REPLAYed from a set of 5 files created by the SAVE command.

The following lines appear as the SLIDESHOW menu:

1 - Create A Show File.
2 - Run A Show.
3 - Quit

If one or more .SHO files have already been created, the user can proceed to Option 2. Otherwise, Option 1 must be used initially.

OPTION 1: If the user selects Option 1, then a listing of all the SAVEd charts in the OPCPLOT directory scrolls across the monitor, followed by this prompt:

"Name of .SHO file to create (No EXT)"

The user should enter a unique filename of up to 8 characters. The program will assign an extension of .SHO to the filename. This is followed by the question:

"SAVED chartname to add to file (No EXT); Q-quit"

From the list of available charts, the user can enter up to 100 names, one at a time. Names can be repeated if the chart is desired to appear more than once in the desired sequence. Hit Q to quit the selection process and close the "show file." (NOTE: The resulting .SHO file can be modified with any ASCII editor, or it can be created totally by an ASCII editor.)

OPTION 2: If the user wishes to run an existing slide show, then Option 2 should be selected. This will cause a listing of available .SHO files to scroll across the monitor, followed by this prompt:

"Show file to play"

The user should enter the name of the .SHO file without the extension, and hit ENTER. This initiates the playing of the slideshow. While the slideshow is on, the following line appears at the top right-hand side of the monitor:

"No. __ of __. Set NumLock off;PgDn=next;PgUp=previous."

On the left-hand side the sequential number of the visible chart is given along with the total number of charts in the show. The text on the right reminds the user that NumLock must be set "off" in order to use the PgDn and PgUp keys to move through the slides. PgDn moves to the next slide in sequence; PgUp moves to the previous slide.

When the end of the slide sequence is reached, the user sees the following self-explanatory prompt:

"End of file. B-back up; E-end, S-start over."

UTILITY H: This utility has three options, each of which allows the user to create new coastlines. The first option actually sets up a new "standard" chart in the OPCPLOT system (it is added to the DRAW CHART menu). The other two options create ASCII coastline files that can be used by other software programs related to OPCPLOT.

OPTION 1: This option allows the user to create a new standard chart that will appear on the DRAW CHART menu. It works by examining the current master coastline file (*.WDB) and creating an index file (*.NDX) that contains the addresses of all data segments in the master coastline file that are needed to draw the new chart. The file *.LST (with the same filename as the *.WDB file) contains a list of all the index files associated with *.WDB, called a "list file." Selecting Option 1 would cause a new *.NDX file to be created and a new line to be added to the *.LST file.

OPTION 2: This option allows the user to create a coastline file for the popular SURFER gridding and contouring program. SURFER coastline files consist of sequences of latitude-longitude pairs. Each discrete sequence is preceded by a header telling SURFER how many data pairs follow.

OPTION 3: This option allows the user to create a coastline file in the OPCPLOT data format. OPCPLOT's

own coastline files are in the binary Micro World Data Bank II format, but this option converts them to an ASCII form that can be used by the Coastwatch C COAST program to draw coastlines.

UTILITY I: This utility allows the user to change the path used by the program in searching for data files. The initial path is displayed at program startup. For convenience, nearly all command prompts in OPCPLOT that ask the user for the name of a file also display the current path. If the desired file is not in the displayed path, then the user must use Utility I to select the correct path to the file.

UTILITY J: The master coastline file supplied with OPCPLOT is named "CNSILR.WDB." It was created from the software package Micro World Data Bank II (MWDB2) (placed in the public domain by Fred Pospeschil and Antonio Riveria)(Pospeschil N.D.). MWDB2 is derived from the World Data Bank II created by the Central Intelligence Agency. The MWDB2 package contains data files for coasts, country boundaries, state boundaries, islands, lakes, and rivers, at 5 (selectable) levels of resolution. CNSILR.WDB supplied with OPCPLOT consists of all the data in MWDB2. If the OPCPLOT user wishes to use a reduced suite of geographic features, then he should obtain the MWDB2 software and create a new master coastline file containing the desired material. The new master coastline file should have a different name from CNSILR.WDB, **but the same filename extension (.WDB)**. Utility J allows the user to switch over to the new master coastline file. The program automatically switches over to the related *.LST and *.NDX files associated with the new *.WDB master coastline file.

Any number of master coastline files can be used simultaneously, and OPCPLOT keeps track of the relevant .NDX and .LST files associated with each one.

[A shortcut to using Utility J is simply to REPLAY a chart that was created with a different master coastline file. When the chart is REPLAYed, OPCPLOT automatically changes to the correct .WDB file.]

UTILITY K: Whenever OPCPLOT is drawing a data file on the monitor, it can also create an HPGL plotter file in background, named PLOTFILE.HPG. Because this I/O operation takes extra time, the default condition is to discard these plotter commands and not write information to PLOTFILE.HPG. This utility is a toggle switch that lets the user turn on or turn off the HPGL plotter file capture mode.

UTILITY L: Whenever OPCPLOT is drawing a contour line (or lines) from a gridded data file, it can also create an ASCII file in OPCPLOT format (named CONTOURS.OPC) that contains the same information as the contour line(s). Because this I/O operation takes extra time, the default condition is to discard this information and not write to CONTOURS.OPC. This utility is a toggle switch that lets the user turn on or turn off the contour line capture mode. This utility allows users to export selected contour lines in ASCII format to other software programs, or to save chosen contour lines as stand-alone files for OPCPLOT.

UTILITY M: This utility blocks the automatic typing of titles embedded in OPCPLOT data files. Embedded titles are accomplished by using -9999 for both the longitude and latitude of a label, forcing it to appear along the bottom margin of the chart. Whenever multiple data files are plotted on a single base map, the overprinting of the embedded titles would look quite messy, a situation that can be avoided with this utility.

UTILITY N: This utility allows the user to branch temporarily to DOS command level. When the user enters EXIT<Enter>, the OPCPLOT program returns.

MARK: The MARK command creates new OPCPLOT data lines that "annotate" a chart. The data lines are either placed in a new file or placed in an existing file. Subsequently, when this new or modified file is plotted, the additional lines direct OPCPLOT to do any of the following:

POINT OPTION: Place a point on the chart. The point may represent a specific location or station, or it may simply be the beginning of a line.

LINE OPTION: Draw a line on the chart from the previous point, line segment, circle, or rectangle.

CIRCLE OPTION: Place a small circle on the chart, and (optionally) write a label directly to the right of it. This is useful for locating stations of special interest.

LINE & CIRCLE OPTION: It is often useful, while drawing a ship cruise track, to use a single command that draws a line (from the previous position) to a position, then to draw a small circle with an optional label beside it, i.e., a combination of the previous 2 commands.

RECTANGLE OPTION: Place a rectangle of any size at any location. This useful for placing a "frame" around an area of interest, for illustrative purposes.

LABEL OPTION: Place an alphanumeric label on the chart. Lowercase letters of the alphabet are automatically converted to uppercase. The following characters can be displayed:

```
ABCDEFGHIJKLMNOPQRSTUVWXYZ
1234567890
!@#$%^&*()_+-=<>.?/\[]:;"'
```

Commas may not be used in labels, due to the manner in which the QUICKBASIC INPUT command recognizes user-supplied strings.

FILL COLOR OPTION: Paint a given polygon (drawn by a data file) with a specified color out to a specified border color.

MARKING PROCEDURE: During the use of the MARK command, the results of the user's choices will actually be drawn on the monitor. At the same time, however, OPCPLOT data lines that contain the instructions to reproduce these markings are being placed in a specific data file. The very first prompt the user will see is the following:

> "File to create or append to (EXT required)?"

The user should enter a full file name (including a subdirectory, if applicable) here. Typically, the user has just plotted an existing OPCPLOT file on a base chart, and the MARK command is now being used to place additional information on that chart. In such a case the user would enter here the name of the charted OPCPLOT file, so the new markings become a permanent addition to that file. At other times, the user may wish to create a new file that will be kept separately from the data file of interest, in which case the file name entered here would be a new one.

MARK MENU: At the top of the monitor, the user will see the following menu:

> "P-oint,L-ine,C-ircle,B-oth L&C,R-ectangle,1-A-bel,F-ill Colors, S-et color, or ESC-to main menu."

According to his intentions, the user inputs P, L, C, B, R, A, F, S, or ESC. Unless the choice is ESC, any response will cause the following prompt to appear:

> "Set NumLock off;Use ARROWS to move;ENTER accepts point:ESC to quit."

During a session with the MARK command, the user moves around the monitor screen with the use of a small blinking

dot-cursor that will initially appear at the center of the monitor. The user should use the ARROW KEYS to move the cursor to the position where the desired marking, e.g., a label, should go. Then the user hits the appropriate key from the list shown above.

While moving the cursor, the user will notice that it goes twice as far each time the same directional key is hit. If any other directional key is hit, the movements become very small again, increasing with the number of times the same direction is entered. This function allows the user to move quickly to the desired location. While the cursor moves over the monitor, the current latitude and longitude are displayed on the top line. The accuracy of these values depends on the scale of chart.

POINT(S): After the desired location has been found and the user has hit P, a small blip appears on the monitor at the location where OPCPLOT will draw a single point. The MARK menu now reappears for additional plotting.

LINE(S): A line can only be drawn if it has a beginning. The beginning can be (1) the initial location of the cursor, (2) the previous point, (3) the previous circle, or (4) the previous rectangle. If any one of these is OK, then the user can move to the desired termination of the line and hit L. If the line needs both a beginning and a termination, then the user should use P to set the beginning and then L to set the termination.

IRREGULAR POLYGONS: Free-hand drawing is possible in OPCPLOT, using combinations of P and L options. For example, the user can draw an irregular polygon by creating the following sequence of lines:

```
D,T,X,Y,P
D,T,X,Y,L
D,T,X,Y,L
.
.
.
D,T,X,Y,L
```

In the example, the first data line sets a point and the following lines cause a line to be drawn on the monitor through the indicated points. If the polygon is desired to close on itself, it is important that the last OPCPLOT data line repeat the location of the initial point. Some practice with the P and L options

is needed in order to become familiar with the proper sequence of entries to draw most figures.

CIRCLE(S): This option causes prompts identical to the L option (see below) to appear at the top of the monitor, and the user's responses will be similar. The difference, however, is that a small circle (a "station") will be drawn at the point where the cursor was placed. After the user hits C, the program prompts the user for an optional label, just as with the LABEL option (see below). If no label is desired, the user simply hits ENTER without any text, when prompted for the label text.

BOTH LINE AND CIRCLE: This option causes prompts identical to the L and C options to appear, and the user's responses will be similar. The program, however, will now draw a line from the previous point to the new point, plus a labelled circle at the new point. If no label is desired, the user simply hits ENTER without any text, when prompted for the label text.

RECTANGLE(S): If the user has located any corner of a desired rectangle, then hit R, a small blip is drawn to mark the selected location, and the following prompt appears:

> "Set NumLock off;Use ARROWS to locate SECOND CORNER."

The user now moves the cursor to the diagonally opposite corner of the rectangle, and hits R again. Another small blip appears, and rectangle will be drawn by the program. Next, the user is asked if the test frame is OK, as with the previous two options.

LABEL(S): When the location for the label has been found, the user hits A, and sees the following prompt:

> "Input text for label."

The user should enter the label, and hit ENTER. The label will immediately be written on the monitor, just to the right and slightly above the selected point, for the user's visual inspection. The following prompt will appear at the top of the monitor:

> "OK (Y or N)?"

If the label is correctly placed and spelled, the user should respond "Y", otherwise the user should respond

"N", and the program will return to the MARKing process.

FILL COLORS: This option allows the user to create data lines using the F flag, which causes polygons in data files to be filled with colors. Extreme caution should be used with this option, however, because the methods used by BASIC for filling in colors--while very straightforward--can be tricky. The user simply moves the cursor point to the center of a given polygon **marked out by a border of a single color** and hits F. Then the program asks successively for the filling color and for the border color (to be entered as EGA color codes). If the border is broken anywhere by a line or point of another color, the filling color will "leak" out, spoiling the chart. Mistakes of this sort can be fixed by answering "NO" when the program asks if you want to include the new data line in the file. The new data line created here is associated only with a specific data file, so this command option is very unlike the COLOR command (see below), which specifies colors for standard charts.

SET COLOR: This option sets the EGA color (APPENDIX C) to be used in plotting all of the above MARK Options. The color code will be permanently placed in the resulting OPCPLOT data file.

ESCAPE FROM MARK: If the user has chosen this option, the main command menu reappears at the top of the monitor, and normal PLOTting can continue. It is important to remember that during the preceding MARK session, none of the new chart annotations created with the MARK options have been placed into the PLOTFILE.HPG plotting file. If the user wants them to be placed there, they must be drawn again on the chart with the PLOT command.

COLOR: This command allows the user to place color in the polygons created on the monitor screen when a chart is drawn (or by subsequent use of the ZOOM command). Referring to Appendix C, the user finds the 15 different color codes that can be employed in EGA mode. Each time the COLOR command is used to place colors on any given chart, the information is stored in a companion file to the .NDX file, with the same filename but with a variety of different filename extensions. [These "coloring files" are further described under Auxiliary File Formats in APPENDIX B.] In this manner, whenever the particular chart is drawn the associated coloring takes place automatically. The user can continue to place new colors alongside or over the existing colors whenever the chart is drawn. Further, if the coloring

scheme becomes too complex or a mistake occurs, the user can erase all the existing color commands and begin anew.

1. The first prompt asks the user whether this usage is to place colors on the monitor screen, or to erase the existing coloring scheme, or to change the default plotting color.

2. If the response is to place colors on the monitor screen, then the user is asked to enter a digital color code, for example, 4 for the color red. Then a **small** blinking cursor appears, which the user can move with the arrow keys as in the MARK command. When the cursor is in the center of the area to be colored, the user hits ENTER and the area is colored. Due to the way in which QUICKBASIC colors the monitor screen, the coloring moves from the cursor out to the first occurrence of the color green. Green is the color used for all coastline and border drawing, so this would allow easy, error-free coloring of the polygons. Any polygon can be re-colored as many times as desired.

3. If the response is to erase the existing coloring scheme, then the entire contents of the coloring file associated with the particular chart on the monitor is deleted. The main COMMAND menu reappears.

4. If the response is to change the default plotting color, then the user enters the 1- or 2-digit EGA color code (Appendix C) and hits the ENTER key.

END: When the OPCPLOT program is exited by using the END command, the user is presented with several important options. The user will see this menu:

1: Exit program. The file PLOTFILE.HPG could be lost.
2: Rename PLOTFILE.HPG
3. Rename CONTOUR.OPC
4. Rename TEMP.OPC
5: Send PLOTFILE.HPG or any plot file to an HP 7475A plotter
6: Return to main menu. The file PLOTFILE.HPG will be lost

During the preceding OPCPLOT session, a separate file of HEWLETT-PACKARD GRAPHICS LANGUAGE (HPGL) plotting instructions can be created, always named PLOTFILE.HPG, if a "switch" in the UTILITIES menu has been turned on (see UTILITIES Option K). The HPGL file contains only those marks drawn on the monitor with the DRAW CHART, ZOOM, PLOT, and GRID commands. This file can be used to plot the same figure seen on the monitor, using an HPGL-compatible plotter or any program or device that recognizes HPGL format. Unless some measure is taken to protect or rename PLOTFILE.HPG, however, it will be overwritten the next time

OPCPLOT is run. To avoid this loss, Option 2 allows the user to rename the file. The new file name will automatically receive the extension .HPG when the name is changed.

Most geographic plotting programs do not allow the user to isolate and save the geographic coordinates of a specific contour line (drawn from a gridded data file). OPCPLOT contains a "switch" in the UTILITIES menu that causes the capture of a contour line as a separate data file in OPCPLOT standard format (see UTILITIES Option L). END Option 3 allows the user to rename this file for permanent storage.

Whenever the user plots a data file that is not in the standard OPCPLOT format (and the file is also not a gridded data file), then the program makes a temporary conversion of the file to OPCPLOT standard format before plotting. The temporary file is always named TEMP.OPC, and the user can save it permanently by the use of END Option 4, which renames it.

Option 5 allows the user to send any HPGL file to a device connected to the serial port on the back of the computer. This "plotter driver," however, is fairly simple and only works if the plotting device has a large enough buffer to hold the entire HPGL file without overflowing.

Section V.

CONTOURING WITH OPCPLOT

INTRODUCTION: If the user has environmental data in a gridded format (OPCPLOT cannot perform the required gridding), then contours of the data can be drawn. Typically, gridding programs provide the output gridfile with one or more header lines that specify certain information about the size and orientation of the grid. OPCPLOT can input a gridfile without any header, or with either of two types of headers: the SURFER format header, and a special OPCPLOT header.

DATA: With the exception of the header (if it has one), a gridded data file has no particular line format and can look like the following example:

```
1
2,3
4,5,6
7,8,9,10
11,12,13,14,15
16,17,18,19,20,21
22,23,24
25
```

The sequence of the data items (rather than the formats of the lines) is all important, because the program inserts the values into an internal matrix according to rules specified in the program. Either commas or spaces serve to separate the items in any line that is not a "header" line.

The first line (or lines) of the file may be a "header," meaning it contains special information used by OPCPLOT to insert the array values properly into computer memory.

"BLANK VALUE": OPCPLOT recognizes the value of -9999 as a "blank" for purposes of contouring, and no contour lines are drawn into a grid cell if one or more of the corners of the cell has that value. This is not quite as sophisticated as algorithms that stop the contour lines at the actual coastlines, but it does produce charts with an acceptable appearance so long as the grid cells are not very large in comparison to the general scale length of land features. OPCPLOT also recognizes the blank value used by the SURFER gridding program, 1.7E+38.

SURFER HEADER: The SURFER header lines must be formatted exactly as follows:

```
DSAA
25
0.28 5.8
```

```
49.92 54.22
5.70345 10.6197
Followed by data lines.....................
```

where "DSAA" specifies the SURFER grid format, "25" specifies the size of the grid; "0.28 5.8" specifies the minimum and maximum longitude values, respectively; "49.92 54.22" specifies the minimum and maximum latitude values, respectively; and "5.70345 10.6197" specifies the minimum and maximum values in the gridfile. [This example is for a gridfile of data from the English Channel.]

OPCPLOT HEADER: The OPCPLOT header lines must use commas as delimiters between the items, and the mandatory format is as follows:

```
C,R,X1,Y1,DX,DY,CORNER,TYPE,FACTOR,CONTOURS
Followed by data lines.....................
```

where C is the number of columns in the array; R is the number of rows; X1 is the first longitude value (negative in the western hemisphere); Y1 is the first latitude value; DX is the distance between columns; DY is the distance between rows; CORNER is one of 4 identifier strings to indicate where the array begins.

CORNER may be any of the following:

UL - upper left corner of the chart
UR - upper right corner of the chart
LL - lower left corner of the chart
LR - lower right corner of the chart

TYPE is one of 2 strings to indicate how the array is "filled in;" TYPE may be either of the following:

R - rows are filled in one at a time
C - columns are filled in one at a time

FACTOR is a multiplier that OPCPLOT will apply to all the array values in case the values have been increased or decreased (FACTOR = 1.0 if the array values do not need changing); and CONTOURS is a single letter that specifies a contouring protocol.

CONTOURS is a single letter directing OPCPLOT to draw contours according to the following specifications. The information in parentheses indicates the "standard" international product from which the specifications were taken (IGOSS, 1992):

If CONTOUR = "A" then the number of contours to draw = 12, the contour interval = .5, and the minimum contour

= .5. (Global monthly mean significant wave height; 0.5 to 6 m (by 0.5); United Kingdom.)

If CONTOUR = "B" then the number of contours to draw = 13, the contour interval = 1, and the minimum contour = 20. (Global mean sea surface temperature (SST); 20 to 34 C (by 1); Japan.)

If CONTOUR = "C" then the number of contours to draw = 13, the contour interval = 1, and the minimum contour = 3. (Global mean SST; 3 to 17 C (by 1); Japan.)

If CONTOUR = "D" then the number of contours to draw = 15, the contour interval = 5, and the minimum contour = 5. (Global mean SST (& other parameters); 0 to 70 C (by 5); Japan.)

If CONTOUR = "E" then the number of contours to draw = 7, the contour interval = 1, and the minimum contour = -3. (Global SST anomaly ; -3 to +3 C (by 1); Japan.)

If CONTOUR = "F" then the number of contours to draw = 12, the contour interval = .5, and the minimum contour = -2.5. (Global SST anomaly; -2.5 to +2 C (by 0.5); Japan.)

If CONTOUR = "G" then the number of contours to draw = 7, the contour interval = 5, and the minimum contour = -15. (Pacific sea level anomaly; -15 to 15 cm (by 5); USA.)

If CONTOUR = "H" then the number of contours to draw = 13, the contour interval = .25, and the minimum contour = -1.5. (Global vertically averaged temp. anomaly; -1.5 to 1.5 C (by 0.25); USA.)

If CONTOUR = "I" then the number of contours to draw = 13, the contour interval = 20, and the minimum contour = 0. (Depth of 20 C isotherm in tropical Atlantic; 0 to 240 m (by 20); USA.)

If CONTOUR = "J" then the number of contours to draw = 5, the contour interval = 1, and the minimum contour = -2. (North Sea weekly SST anomaly; -2 to + 2 C (by 1); Germany.)

If CONTOUR = "K" then the number of contours to draw = 14, the contour interval = 10, and the minimum contour = 0. (Percentages from 0 to 140 % by 10.)

If CONTOUR = "L" then the number of contours to draw = 14, the contour interval = 4, and the minimum contour = 970. (Atmospheric pressure; 970 to 1022 mbar by 4.)

If CONTOUR = "M" then the number of contours to draw = 14, the contour interval = 4, and the minimum contour = 990. (Atmospheric pressure; 990 to 942 mbar by 4.)

If CONTOUR = "Z" then the user is prompted to enter specific contour information not covered by the above "standard cases."

NO HEADER: If the gridfile does not have a header, then the user will be prompted to enter the same information that would be in an OPCPLOT header line.

EXAMPLE OF OPCPLOT HEADER: The following gridded data file has an OPCPLOT header line. The file contains gridded sea-surface temperature values (degrees centigrade) for the Gulf of Mexico:

```
13,9,-100,12.5,2.5,2.5,LL,R,.1,B
283,282,278,284,277,268,269,266,267,263,258,253,258
281,283,271,278,277,271,267,267,265,265,264,260,263
270,267,257,263,266,264,259,263,263,265,266,264,263
255,251,246,253,261,256,261,263,263,264,263,260,257
241,238,238,243,250,251,257,255,252,248,254,253,248
226,223,229,233,235,245,247,236,249,244,242,239,235
210,202,201,214,215,224,224,217,249,234,226,221,219
211,200,192,201,204,196,195,209,231,222,215,211,209
202,191,194,207,211,188,187,199,209,227,220,203,200
FNOC Sea Surface Temperature
```

In this example the temperatures have all been multiplied by 10, so the FACTOR is 0.1. Because C times R is 117 (13 X 9 = 117), all the numerical values have been read before the text line at the end, so it is ignored by the program and serves as a "comment line." Since CONTOUR is "B" the data will be contoured at intervals of 1 degree C, from 20 to 34.

CONTOUR LINES: The color coding used by OPCPLOT for the various specified contour lines is shown in Appendix C.

Section VI.

COASTLINE FILES AND "STANDARD CHARTS"

NEW STANDARD CHARTS: If the user frequently needs to work on a particular subset chart, only a few steps are needed to set up the subset area as a permanent addition to the geographic selections offered by the DRAW CHART command. These steps are given below:

Step 1: The user should select the UTILITY command, then Utility H. Then the user sets up the phrase name for the new region (that will appear on the DRAW CHART menu), the filename for the index file that contains pointers to the coastline data, and the geographic limits. The following block of text is the version of CNSILR.LST supplied with your copy of OPCPLOT:

```
World Chart Centered on the Atlantic,worldatl, 85 ,-85 , -169
,-169
World Chart Centered on the Pacific,worldatl, 85 ,-85 , -25, -25
North Atlantic Ocean,natlocn, 80 , 0 , 14 ,-90
Northwest Atlantic Ocean,nwatl, 50 , 32 ,-43 ,-80
Midwestern Atlantic & Gulf of Mexico,midwatl, 38 , 18 ,-61 ,-98
Gulf of Mexico,gmex, 31 , 18 ,-78 ,-98
Texas-Louisiana Shelf,latex, 31 , 25 ,-88 ,-98
North America & Central America,n&cen_am, 85 , 0 ,-48 ,-168.5
Southeastern Asia,seasia, 34.1018 ,-12.21557 , 177.4789 ,
89.59155
North Sea & Baltic Sea,baltic2, 72.27546 , 48.86227 , 43.73239
,-12.04227
```

In each data line, the first string is the phrase name that will appear on the monitor during use of the DRAW CHART Command; the next string is the filename (without the extension .NDX) of the index file; and the four numeric values are (in order) northern latitude, southern latitude, eastern longitude, and western longitude (of the chart).

Step 2: If the user is adding a new chart area to the DRAW CHART menu, then he should use Utility H to create the new .NDX file, and answer "Y" when the program asks if the new data line should be added to *.LST, where * is the name of current master coastline file.

After using Utility H to create any new chart regions , the user need only return to the main command menu and select the DRAW CHART command to see that new chart.

SMALL ISLANDS: If the user needs to draw charts of relatively small islands that do not already appear in the master coastline file(s), these can be obtained in the following way:

Step 1: Make or obtain a digital file of the desired island coastline(s) in geographic coordinates, then convert the file to the OPCPLOT format using the P and L flags, as appropriate (described in Appendix A), to define the line segments. Make sure that each island coastline "closes" on itself, i.e., the first point is the same as the last point. Make sure also that the color argument that follows the P or L in the fifth data field specifies the same color that the base maps use, i.e., "2" is green (for land masses), and "1" is blue for lakes and rivers.

Step 2: Plot the new data files on the appropriate regional chart.

Step 3: Use the MARK-FILL command to append additional data lines to the small island data file that will color each of the closed polygons according to the user's preferences. Remember, however, that the "border" color is green (code = 2) for land masses and blue (code = 1) for lakes and rivers.

.ADD FILES: Whenever OPCPLOT has drawn a "standard" base chart as specified by an index file (.NDX), it automatically checks to see if there is also an ADD file (*.ADD) with the same filename. An ADD file consists of a simple list of OPCPLOT data filenames (OPCPLOT standard file format; format Option A on the format menu). If it exists, then OPCPLOT will also plot all of the files named, in order to complete or augment the geographic and text features contained in the basemap. For instance, the Gulf of Mexico chart is drawn by the use of the GMEX.NDX index file, but the chart could be augmented by a GMEX.ADD file, as follows. GMEX.ADD could look like this:

```
C:\OPCPLOT\ISLANDS.DAT
B:\LABELS\ATLAS.DAT
```

This would automatically add to the Gulf of Mexico chart the file C:\OPCPLOT\ISLANDS.DAT containing the small barrier islands not contained in the master geographic file CNSILR.WDB, and the file B:\LABELS\ATLAS.DAT that contains labels for the U.S. States and countries. Notice that the full data file path must be provided if the file to be added is not in the OPCPLOT subdirectory itself.

Section VII.

HPGL FILES, PRINTERS, PLOTTERS, AND WORDPERFECT

HPGL FORMAT: While OPCPLOT is drawing charts, in the computer background a Hewlett-Packard Graphics Language (HPGL) file of plotting instructions is also being created. Here's an example of what an HPGL file looks like:

```
DF;
PT 1;
SP 1;
PS A;
SC -98 -78  18  31 ;
PU;PA -82.65318  23.66631 ;CI  0 ;PU;
PD;PA -82.76163  23.56654 ;
PD;PA -83.06278  23.56283 ;
PD;PA -83.33245  23.4791 ;
PD;PA -83.57186  23.61448 ;
PD;PA -83.70047  23.84529 ;
PD;PA -83.76448  24.31737 ;
PD;PA -83.92148  24.59374 ;
PD;PA -84.23002  24.95917 ;
PD;PA -84.37676  25.34515 ;
PD;PA -84.3631  25.66562 ;
PD;PA -84.49338  26.09335 ;
.
.
.
```

It is obvious from the above that HPGL (and other) metafiles do not closely resemble the original data. Metafiles are extremely useful, however, in that many commercial software programs recognize them; nearly all recognize HPGL. If the user has a plotter that recognizes HPGL, then either END Option No. 3 (if the device has a large buffer space) or any other program that drives the device may be used to send the metafile to the plotter.

HOW TO MAKE AN HPGL FILE: During all OPCPLOT sessions (except during the use of the MARK and REPLAY commands) anything that appears on the monitor is echoed into a file named PLOTFILE.HPG in OPCPLOT. It is this HPGL file that can be transported into a word-processing package or transmitted directly to a plotter to produce a permanent hard-copy of the chart. Here are the easiest steps to be followed to create a hard copy chart:

1. Turn on the capture feature for HPGL files (UTILITY Option K.

2. Use the DRAW CHART command to make a complete chart. Don't use the REPLAY Command, because it does not draw the individual lines needed to make the chart.

3. Use the PLOT command to draw as many data files on the chart as you need.

4. Use the END Command, then the option that sends the HPGL file to the HPGL 7475A plotter. Then you may leave OPCPLOT entirely, or you may return to the COMMAND menu for additional charting.

PRINTERS: Depending on the configuration of the user's computer, it may be possible to dump the monitor screen image to the printer using the Shift-Print Screen key combination. This is usually facilitated by inserting the DOS GRAPHICS command into AUTOEXEC.BAT file (together with certain options described in the DOS manual). The resulting printed image is usually suitable for quick report preparation or for copying onto a plastic transparency; it is not, however, of publication quality. [To make a publication-quality figure, see the discussion of WordPerfect, below.]

To eliminate the main command menu from the image before printing, the user can toggle it off by hitting the space bar. The main command menu reappears when the space bar is hit again.

PLOTTERS: The portion of OPCPLOT that operates a plotter (an option under the END Command) was provided by Dr. Larry Rouse of Louisiana State University. When the HP 7475A plotter parameters are set exactly as shown by an instruction screen, and the computer is connected to the plotter by the correct special cord, then plotfiles of any size can be successfully plotted.

WORDPERFECT 5.0: Once a chart has been created with OPCPLOT, the user can exit OPCPLOT and use WordPerfect to print the chart. The chart can also be incorporated into an existing text document as a figure. Because WordPerfect also usually places a border around the figure, the user should cancel this automatic function by preceding the figure with setup steps that eliminate the border. This is accomplished by the following keystrokes:

Keystroke	WordPerfect Command Equivalent
Alt-F9	Graphics
1	Figure
4	Options
1	Border type
1, etc.	No border

Now, the HPGL plot file can be imported into WordPerfect. The following sequence of keystrokes is required:

Keystroke	WordPerfect Command Equivalent
Alt-F9	Graphics
1	Figure
1	Create
1	Filename
<path+filename+.HPG>	Specify the complete path and filename of the HPGL file
8	Edit[1]

When the graphics figure has been imported into WordPerfect, then all the procedures in the WordPerfect manual apply, e.g., size, orientation, placement, etc. The finished figure can be saved as a WordPerfect document.

[1]For WordPerfect 5.1, the Edit command is item 9.

Section VIII.

BUGS, NEW VERSIONS, AND E-MAIL

There will certainly be problems in the OPCPLOT code, because it is still an evolving program. Please report any problems or fixes to the author at the title page address.

The most common problem in creating new data files will be the failure to observe the required 5-field format, with commas as delimiters. Users often forget to edit out "header" and "footer" lines inserted in electronic mail messages by the commercial service company, and these will also cause problems. Commas imbedded in comment lines (in addition to the required 4 commas at the end of the comment line) will cause serious problems.

OPCPLOT was written, in part, to provide a charting capability within the GULF.MEX electronic bulletin board, sponsored by the Minerals Management Service, on SCIENCENET (also often called OMNET). GULF.MEX was set up in conjunction with the "Texas-Louisiana Shelf Physical Oceanography Program" (LATEX Study), scheduled to be performed during the 1992-1995 timeframe. Full utilization of OPCPLOT is intended during LATEX, as well as the creation of additional data types as needs and opportunities are identified. Subsequent versions of OPCPLOT will be announced on the GULF.MEX and OCEAN bulletin boards on SCIENCENET.

ACKNOWLEDGMENTS

The OPCPLOT Program code was necessitated by the enthusiastic attitudes of so many marine scientists working in the Gulf of Mexico. There simply were so many interesting data to share, and such an obvious benefit from finding a way to combine them in a common presentation format, that its development was inevitable. The author gratefully acknowledges the following help:

Dr. Robert E. Lee Pickett for sending me one day a diskette of buoy data containing a small program that gave me the whole idea; Dr. Paul Bourke for permission to use the CONREC algorithm used for contouring; Mr. Robert Hughes for providing the code lines that save and replay EGA screen images; Dr. Tony Sturges, Dr. George Forristall, Mr. Ken Schaudt, Dr. Geoff Patton, Dr. David Johnson, Dr. Walter Johnson, and especially Mr. Joe Perryman for review comments and discussions; Drs. Doug McLain and Larry Rouse for algorithm contributions; and, finally, the author gives special thanks to Dr. Harry Dooley for providing comments and assistance during the job of integrating OPCPLOT with OceanPC.

My bosses at the Minerals Management Service, Drs. Rick Defenbaugh and Jim Kendall, have been supportive and patient, even when this project moved beyond the Gulf of Mexico, the official limits of our office's responsibility.

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Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside
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Dr. Harry Dooley
International Council for the Exploration of the Seas
Palaegade 2-4
1261 Copenhagen K
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Dr. Dieter Kohnke
Bundesamt fur Seeschiffahrt und Hydrographie
Postfach 30 12 20
D-20305 Hamburg
GERMANY
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Bidston Observatory, Birkenhead
Merseyside. L43 7RA United Kingdom
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Fred Pospeschil
3108 Jackson St.
Bellevue, NE 68005
U.S.A.
Telephone 402-291-0795

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APPENDIX A
THE OPCPLOT FILE FORMAT

BACKGROUND: In 1990, the Minerals Management Service Gulf of Mexico OCS Region published and widely circulated the first version of a computer software program called "GULFPLOT." The program, written in BASIC (specifically GWBASIC), is a simple "electronic notepad" that draws charts of the Gulf of Mexico and overlays them with plots of near-real-time data displays, ocean fronts, station locations, and other features of interest to marine scientists. It is based on an earlier program informally distributed in 1989 by Dr. Bob Pickett of (then) NOARL that draws drifting buoy trajectories. This successor program, OPCPLOT, is intended as a management tool to assist in the rapid, cost-effective dissemination of information about oceanographic research and ocean conditions anywhere in the world. The data files used by OPCPLOT to draw the requisite charts can be disseminated via electronic mail, as ASCII files, or sent through the mails on diskettes.

BASIC STRUCTURE: Each OPCPLOT data file consists of a variable number of ASCII lines, each containing five fields. Although there is some flexibility, the usual order of the fields is as follows:

First Field: Platform or station I.D.
Second Field: Date and/or time.
Third Field: The longitude.
Fourth Field: The latitude.
Fifth Field: Plotting instructions/data.

These fields must be delimited by commas, for example:

```
RV Pelican,910612, -82.0156  ,24.4468   ,P
RV Pelican,910613, -82.21236 ,24.433827 ,L
RV Pelican,910614, -82.38555 ,24.333091 ,L
RV Pelican,910615, -82.79521 ,24.578802 ,L
RV Pelican,910616, -83.09259 ,24.331513 ,L
```

DETAILED FORMAT INSTRUCTIONS:

FIELD DESCRIPTORS: The first field is provided for a string that identifies the source of the data, such as a "station number" or a vessel call sign.

The second field is provided for date/time information, preferably in YYMMDDhhmm format.

The third field is the longitude of a location to be plotted, in decimal-degrees format. Longitudes in the western hemisphere are given as negative numbers.

The fourth field is the latitude, in decimal-degrees format. Latitudes in the southern hemisphere are given as negative numbers.

The fifth field is an ASCII string (called Z$ in the program) that contains directions to the program and (sometimes) data. The very first position in the string is a "flag" that tells OPCPLOT what to draw on the screen, as follows:

POINT	P	
LINE	L	
CIRCLE, fixed radius, small label, horizontal right	D	
CIRCLE, fixed radius, no label	C	
LINE-TO-CIRCLE, fixed radius, optional small label, horizontal right	B	
CIRCLE, variable radius, no label	G	
COLOR, set	K	xx
COLOR, fill polygon	F	xx yy
LABEL, small, horizontal right	S	xxxxxxxxxxxxxxxxxxxx
LABEL, medium, horizontal right	M	xxxxxxxxxxxxxxxxxxxx
LABEL, large, horizontal right	H	xxxxxxxxxxxxxxxxxxxx
LABEL, small, vertical down	A	xxxxxxxxxxxxxxxxxxxx
LABEL, medium, vertical down	E	xxxxxxxxxxxxxxxxxxxx
LABEL, large, vertical down	J	xxxxxxxxxxxxxxxxxxxx
VECTOR	V	xxxxxxxxxxxxxxxxxxxx
XBT DATA, subsurface thermal data from the International Global Ocean Services System (IGOSS)	X	xxxxxxxxxxxxxxxxxxxx
SALINITY DATA, as X, but surface salinity	Y	xxxxxxxxxxxxxxxxxxxx

These flags are further described below, in alphabetical order:

A Directs the program to draw a vertical/down label in small size uppercase letters. The label consists of the string of ASCII characters that follows an intervening space, for example

```
D,T,-90.3,25.6,A THIS IS A LABEL
```

The program writes the string "THIS IS A LABEL" as a vertical downward label beginning at longitude -90.3 and latitude 25.6. All alphabet characters, numbers, and punctuation marks appearing on the standard keyboard are supported (except ~ and ').

B Is a combination of L and D, below. The B-flag directs the program to draw a line (L-flag) from the last point to the new point designated by the

data line, then to draw a small circle with an optional label next to it (D-flag). The label text is taken from the first field in the data line, usually station information. [A common error in creating OPCPLOT files is to begin a file with the B flag. Because no previous point has been defined (to draw the line from), this can lead to unpredictable results. A labelled "station" at the beginning of an OPCPLOT file should be specified with the "D" flag.]

C Directs the drawing of a circle with a diameter of about 1/6 inch.

D Is a combination of C, above, and S, below. The D-flag directs the program to place a small circle at the indicated position and to write a label in small letters immediately to the right of the circle. The text of the label is taken from the first field in the data line, usually oceanographic station information.

E Directs the program to draw a vertical/down label in medium size uppercase letters.

F Directs the program to fill a surrounding polygon with color. The flag is followed by 2 numeric arguments that specify the colors to be used:

The EGA color code for the color to be used in the filling (see Appendix C), and

The EGA color code that defines the edge of the area to be filled.

The 2 arguments occupy, respectively, the 3-4 and 6-7 positions after the "F", for example:

```
D,T,-90.1234,27.9876,F  1  2
```

This data line would color a polygon with blue (code = 1) out to a green (code = 2) border. The F-flag is used in files created by the MARK Command, and it can be used to fill a polygon of any border color with any other color.

G Directs the drawing of a circle whose diameter is variable. The unit radius is 1 degree of longitude on the drawn chart. This usage is illustrated by the following data fragment from a 1989 overpass of Geosat over the Gulf of Mexico, where the variable radius is given by the argument

after the G. The radius is related to the altimeter-derived, real-time sea surface height (vs. a selected mean surface):

```
890724-191,890611,-87.96  ,22.416,G .275
890724-191,890612,-87.988 ,22.468,G .231
890724-191,890613,-88.01  ,22.524,G -.012
```

In this example, the G would have directed OPCPLOT to use the value following the Z-flag as the variable circle radius for plotting.

H Directs the program to write a label on the monitor in large-sized uppercase letters.

J Directs the program to draw a vertical/down label in large size uppercase letters.

K Sets the plotting color according to the 16-color EGA pallette (Appendix C). Because no physical location is associated with this flag, the longitude and latitude are both given as -9999, e.g.,

```
D,T,-9999,-9999,K 4
```

sets the plotting color to red (code=4). There can be any number of color commands in a plottable file, a single color command at the beginning of the file, or no color command at all. When the color is not specified, then the OPCPLOT default plotting color is used, bright yellow (code = 14), but this can be changed by the COLOR Command.

L Directs the drawing of (or continuation of) a line. The above file example would begin a line at the point indicated by the first data line in the file ("P" flag), and continue drawing until the end of the file. New lines can be started by using the "P" flag at any point in the file. [A common error in creating OPCPLOT files is to begin a file with the L flag. Because no previous point has been defined, this can lead to unpredictable results.]

M Directs the program to write a label on the monitor in medium-sized uppercase letters.

P Directs OPCPLOT to draw a single point.

S Directs the program to write a label on the monitor in small-sized uppercase letters.

V Directs the program to draw a vector arrow on the monitor that represents current velocity. The format for the entire line is as follows:

D,T,X,Y,V AAAA BBBB CCCC DDD EEE FFF

where AAAA = U in cm/s, BBBB = V in cm/s, CCCC = clockwise offset angle in degrees if U was not true east, DDD = scalar speed in cm/s, EEE = speed in knots, and FFF = true direction in degrees. Leave blanks for missing data. The data may be entered in any one (but only one) of the following combinations:

AAAA and BBBB (and CCCC if applicable)
DDD and FFF
EEE and FFF

According to the data supplied, the program selects the proper logic for drawing the vector arrows. The vector drawn is corrected for monitor distortion, and it is scaled to equal 50 cm/s for each degree of longitude.

X Directs the program to display information extracted from IGOSS BATHY/TESAC messages from ships-of-opportunity. (See the discussion of IGOSS files, below.) The flag X directs the program to draw circles on the monitor scaled to represent the depth of the 20-degree isotherm, given by temperature data in the ASCII string that follows. The following data line illustrates the use of this flag:

```
IRCS  DATETIME  LONG   LAT X<SST<<26<<23<<20<<15<<<9<<<5<<<2DEEP<DPT,,,
A3BE  ,90050804,-143.20, 31.88,X18.7 - - - 153 364 - - 459 7.3
```

The first line is a "comment line" (see below) to explain the sequence of the data that follows. In the second line the International Radio Call Sign (IRCS) of the reporting vessel is A3BE, and the date is given in YYMMDDHH format. The X is immediately followed by the sea surface temperature (SST), then successively by the following: depths of 26-degree, 23-degree, 20-degree, 15-degree, 9-degree, 5-degree, and 2-degree isotherms; then the total depth (DEEP) and the bottom temperature (DPT). The isotherms were selected for their importance in identifying specific water masses worldwide.

COMMENT LINES: Alternately, the entire line can be any text string (without imbedded commas) followed by four commas, in which case the program ignores the line. This allows users to insert explanatory information. The following data line is a comment line:

These data were supplied by the NRL Loop Group.,,,,

IMBEDDED CHART TITLES: When a data line contains a longitude of 9999 (or -9999) the program recognizes this to be the left-hand margin of any chart. Similarly, a latitude of 9999 is recognized as the bottom margin. Using these two values and either the S or M flags, the user can insert a chart title in the data file. No matter what user-defined limits are employed, the title will always appear left justified along the bottom border. Agency or source credits can be added to charts in this way, for example,

D,T,-9999,9999,M NRL OCT 15 1990

would provide a title for a frontal analysis provided by the NRL Loop Group.

FILENAMES: Using the above flags, many different types of charts can be drawn with OPCPLOT. To identify common charts to be posted on the GULF.MEX bulletin board, a file-naming convention will often be used. The 3-letter extension of the filename is usually .DAT, but this is not mandatory. Some file names already in use are listed below:

CRUISES: The path of a survey cruise of interest. The filename begins with the letter "C" followed by a two-letter vessel identifier, two numbers denoting the year, and two numbers denoting the sequential cruise number in that year, e.g., "CGY9006.DAT." Further refinement will be developed under the LATEX Program. The file draws lines, points, and/or circles as appropriate to provide a simple, pragmatic chart of the cruise. Header lines should be provided to identify the scientific program, the chief scientist, and other pertinent information.

FRONTS: The reported alignments of any of a number of ocean fronts. The filename begins with the letter "F," followed by the date of the analysis in YYMMDD format, followed by a single character designating the origin of the analysis, as follows. In the Gulf of Mexico region, the following "originator" codes have been used:

A	Naval Oceanographic Office, NSTL Miss.
C	NOAA/Ocean Products Center, Rockville, Maryland
F	National Marine Fisheries Service/Stennis Center
L	Louisiana State University, Coastal Studies Inst.
N	NRL, NSTL Miss. ("Loop Group")

R Roffer's Ocean Fishing Forecast Service, Miami
V Special charts created by LSU from satellite visual channels

The file draws a series of lines (as needed) corresponding to the fronts identified, e.g., "F900227A.DAT." Labels may be added (see MARK Command).

CHART OF XBT DATA FROM IGOSS SHIPS-OF-OPPORTUNITY: The Integrated Global Ocean Services System is the international oceanographic equivalent of the WMO-GTS, in that it supports transmission of public domain ocean data. The Oceans Applications Group of NOAA in Monterey has agreed to post monthly OPCPLOT files on electronic bulletin boards of all IGOSS XBT (X-flag format) data in the Gulf and northwestern Atlantic areas. The filename begins with "IGOS" followed by the month, designated in YYMM format, e.g. "IGOS9001.DAT".

DRIFTING BUOYS: The trajectories of drifting buoys, often tracked by System ARGOS. The filename begins with "B," followed by the 5-digit ARGOS identifier, e.g., "B11328".

APPENDIX B
OTHER FILE FORMATS

DATA FILE FORMATS: OPCPLOT was originally written with a view toward creating a single standard ASCII file format that could easily be used to create ocean charts by other software programs. Although some success has been achieved through the use of the OPCPLOT format alone, it became obvious that the program would be more valuable if it could "recognize" and plot standard products in other programs. Since early 1992, the author has collected a number of these formats, and OPCPLOT can now plot them if they are properly identified by the user. The list of formats is presented to the user each time a new data file is to be plotted on a chart. Given below is a brief synopsis of the different formats now recognized by OPCPLOT.

OPCPLOT
- Standard.....A
- GRIDDED.....B

SURFER Gridded.....C
Sea Ice Edge.....D
NRL Drifting Buoy .....E
ICES Standard Profile.....F
TOGA CD ROM
- UK Ship Obs.....H
- UK BathyTesac I
- Pseudo Wind Stress....J
- Gridded Scalar.....K
- Drifting Buoys.....L

BODC Mooring Inventory.....N
GLOSS Station Handbook.....O
Luyten-Stommel Atlas.....P
Rhines ATLAST.....Q
GRIDDED Fields
- No Header.....R
- OPCPLOT Header.....B
- SURFER Header.....C
- TOGA CD Scalar.....K

NODC CD-ROM's
- NODC-2 & 3.....T
- NODC-20.....U

JJXX Message.....V
C&GS Bulletin Board
- Sediments.....W
- Wrecks/Obstructions...X
- Tide Gauges.....Y
- Nautical Charts.....Z

A description of each format follows:

OPCPLOT

Standard.....A

This is the "standard" data file format for which OPCPLOT was designed. It is described in detail in Appendix A.

Gridded.....B

This format is the "standard" gridded data file (with or without a special OPCPLOT header line) described in Section V.

SURFER Gridded.....C

This format is the ASCII output from SURFER, a popular gridding and contouring software package widely used by oceanographers.

Sea Ice Edge.....D

This format is used by the U.S. Navy/National Oceanic and Atmospheric Administration Joint Ice Center to post Arctic and Antarctic ice front charts on Sciencenet. An explanation of the file format precedes every file, as posted.

NRL Drifting Buoy.....E

This format has been discontinued.

ICES Standard.....F

This format is both the archive format for the very large hydrographic dataset of the International Council for the Exploration of the Seas (ICES) and the principal data format for the OceanPC software package. It is well described by Dooley (1991). The data include position and time information, hydrographic parameters, and nutrients. When OPCPLOT is presented with an ICES file, the program allows the user to plot the locations of the sample stations. A set of questions is presented that allows the user to display (a) all samples, (b) all sample locations within a given depth interval, (c) all samples for a given parameter, e.g., phosphate, or (d) any combination of (b) and (c).

FSU Pseudo Wind Stress...G

Dr. James O'Brien's group at Florida State University produces monthly mean pseudo wind stress vectors for the Pacific and Indian Oceans as part of the Tropical Oceans-Global Atmosphere (TOGA) Program (Legler and O'Brien 1988). The files consists of an I x J matrix of U vectors followed sequentially by

an I x J matrix of V vectors. OPCPLOT combines the vector components and draws a small vector arrow at each grid point in the domain.

TOGA CD ROM

The recent proliferation of compact disks containing oceanographic and atmospheric datasets allows the general user to access enormous quantities of information, and to synthesize his own information with global- to regional-scale analyses. The "TOGA CD ROM" (Halpern et al 1990) for 1985-1986 contains several file formats that can be plotted by OPCPLOT.

UK Ship Obs.....H

This file format is used for meteorological observations by ships-of-opportunity globally. OPCPLOT can plot the positions of the observations.

IFREMER BathyTesac..I

This file format is used for oceanographic observations by ships underway. OPCPLOT can plot the locations of the observations. The ship call sign (the 4-letter sequence seen near the beginning of each data group) can be plotted on the chart if the label-plotting option is exercised.

Pseudo Wind Stress..J

The FSU pseudo wind stress vectors described above are also archived on the TOGA-CD, along with a similar product from ORSTOM in France for the Atlantic Ocean. These products are not, however, presented in the same format as the original FSU product.

Gridded Scalars.....K

Also on the TOGA-CD are gridded sea surface temperature charts for the globe (padded with a value of "1.80" for all gridpoints on land).

OPCPLOT contours the above data file, using the contouring flag of "Z", which requires the user to specify the contours to be drawn.

Drifting buoys.....L

Also on the TOGA-CD are trajectory data from WOCE and TOGA drifting buoys, in individual files identified by the buoys' WMO numbers.

BODC Mooring Inventory...N

The British Oceanographic Data Center has produced a digital database of current meter mooring locations (BODC N.D.). The software program provides screen graphics (or ASCII output files) displaying the locations of data, selected according to the user's criteria.

GLOSS Station Handbook...O

The Permanent Mean Sea Level Service has developed a digital catalog of all the Global Sea Level Observing System (GLOSS) sites (PMSLS N.D.).

Using these files, OPCPLOT merely plots the station locations. (The GLOSS catalog does not have a graphics capability, so OPCPLOT is the only means at present to plot the output.)

Luyten-Stommel Atlas.....P

The first widely circulated "community shareware" program to display ocean station data was the Luyten & Stommel atlas (Luyten & Stommel 1988). Its function, as quoted from the manual: "Data [is read from a] random access file whose records are 18 bytes long, corresponding to 9 integers as specified by

FIELD#2,2 AS STN$,2 AS LAT$,2 AS LON$,2 AS DT$,2 AS P$,2 AS T$,2 AS S$,2 AS O$,2 AS R$

"The variables are station number, latitude, longitude, date, pressure, temperature, salinity, dissolved oxygen, and sigma-theta, respectively. To be stored as integers, the following conversions must be made:

```
LAT=INT(100*LAT):LON=INT(100*LON):DT=100*YR+MN
T=INT(1000*T):S=INT(1000*(S-15)):O=INT(100*O)
R=INT(1000*R)"
```

OPCPLOT merely plots the locations of the stations contained in the atlas data files.

Rhines ATLAST.....Q

Extending the work of Luyten & Stommel, Rhines has published a far more flexible ATLAST (Rhines 1991) that recognizes the file format of Luyten & Stommel and 3 other formats, which are essentially larger versions (i.e., more variables) of the Luyten and Stommel format. OPCPLOT recognizes all 4 formats contained in the Rhines ATLAST, but usage is limited to merely plotting the station locations. The extreme versatility of the two atlases described above cannot be described here, nor does OPCPLOT attempt to duplicate any of their graphical capabilities. This

compatibility is provided merely to allow the user to intercompare the locations of various files he may be analyzing.

GRIDDED Fields

No Header.....R

This format was described in Section V.

OPC-Plot Header.....B

This format was described in Section V.

SURFER Header.....C

This format was described in Section V.

TOGA CD Scalar.....K

This format was described above, in this Appendix.

NODC CD-ROM's

NODC-2 & 3: Global Salinity and Temperature Profiles.....T

When the NODC released CD-ROM's 2 & 3 containing salinity/temperature data, they devised an abbreviated form of the SD2 format, used only on these CD's. OPCPLOT recognizes this format and plots the locations of the data stations.

NODC-20: "SD2" Format...U

This format is used by the U.S. National Oceanographic Data Center (NODC) to hold its major archive of "Nansen cast" data, including station header information, salinity, temperature, and nutrients. OPCPLOT simply plots the locations of the stations in the file. No example is included with OPCPLOT, but the format is well described in the NODC Users Guide (NODC 1992).

JJXX Message.....V

This format is used in the Global Telecommunications System to transmit expendable bathythermograph data taken by ships-of-opportunity.

When the file is specified as being in the JJXX format, OPCPLOT will offer the user the opportunity to see the temperature-depth data graphed as profiles in Cartesian (T vs. D) coordinates. The code for this graphing is provided by Dr. Doug McLain of NOAA-COAP in Monterey, California. The profiles can be viewed one at a time, in order to identify any possible quality control

problems with the data. After the profiles are displayed, OPCPLOT continues with station plotting in the usual fashion. The "station labels" displayed in both treatments of the JJXX data are actually the sequential numbers of the XBT stations within the data file, useful for subsequent editing.

C&GS Bulletin Board

A recent, and very welcome, development in the U.S. is the availability of electronic bulletin boards operated by a number of agencies, offering immediate access to digital data. The Coast and Geodetic Survey (of NOAA) operates a bulletin board at (301) 713-4573 (or 4574) that offers files of data related to marine charting. The following types of files can be downloaded from the board (in *.ZIP compressed form), uncompressed, and then plotted directly with OPCPLOT.

Sediments.....W

Files of sediment sample sites (from NOAA's 1,000,000+ data set) can be plotted.

Wrecks/Obstructions..X

These files contain the locations of known wrecks and unknown obstructions in U.S. coastal waters. Where known, the vessel name is given.

Tide Gauges.....Y

These files contain the locations and official identification numbers of coastal tide gauges in the U.S.

Nautical Charts.....Z

The C&GS Bulletin Board also serves as an excellent source of information about the availability and coverage of nautical charts. Given any unique geographic location (in geocoordinates), the Board can supply a listing of all NOAA charts that cover that location. The resulting file can be plotted by OPCPLOT as a set of overlapping rectangles. In some areas, the great number of rectangles may be difficult to read, but the user can ZOOM in on progressively smaller portions of the area to read the identification numbers of the charts.

NOAA Ocean Product Center

Ocean Feature Analyses in OTH-Gold Format

Both the NOAA OPC and the operational oceanographic facility (in Bay St. Louis, Mississippi) of the Naval Oceanographic Office use the "over the horizon targeting-gold" (OTH-Gold) format to create digital charts of ocean fronts and ice edges. Due to its complexity, the OTH-G format is not illustrated here.

AUXILIARY FILE FORMATS

The following files are not "data files," because they cannot be displayed with the PLOT command of OPCPLOT. However, they are important files that the program uses to create charts during normal operations, i.e., when using the DRAW CHART command and Utility H.

MASTER COASTLINE FILE (*.WDB)

BASIC Binary format. The file CNSILR.WDB supplied with OPCPLOT contains the complete dataset from the Micro-World Data Bank II, consisting of land masses, political boundaries, lakes and rivers. This file is the "mother file" from which all coastline files are derived. Portions of this file are plotted by the DRAW CHART Command, using the information in the index files (see below) as pointers. The format of this file is given by the following BASIC specification:

```
FIELD #1, 2 AS CODE$, 2 AS LAT$, 2 AS LON$
```

where CODE$ is either a 4-digit number indicating the beginning of a line segment, or a single digit number indicating the level of resolution ranging from 5 [=low resolution] to 1 [=high resolution]. LAT$ and LON$ are the latitude and longitude, respectively, in decimal-degrees format, multiplied by 60. CNSILR.WDB, the master coastline file supplied with OPCPLOT, was created by using the Micro World Data Bank II software (Popeschil and Riveria n.d.). Users of OPCPLOT can make their own, new master coastline file, containing a smaller subset of the data available in WDBII. Option J in the Utilities menu allows the user to switch over to the new system.

LIST FILE (*.LST)

Each master coastline file (*.WDB) has an associated list file (*.LST) that contains information about all the different charts that the user ordinarily draws ("standard charts"). The *.LST file contains a single line describing each chart. This is the contents of CNSILR.LST, supplied with your copy of OPCPLOT:

```
World Chart Centered on the Atlantic,worldatl, 85 ,-85 , -169
,-169
World Chart Centered on the Pacific,worldatl, 85 ,-85 , -25, -25
North Atlantic Ocean,natlocn, 80 , 0 , 14 ,-90
Northwest Atlantic Ocean,nwatl, 50 , 32 ,-43 ,-80
Midwestern Atlantic & Gulf of Mexico,midwatl, 38 , 18 ,-61 ,-98
Gulf of Mexico,gmex, 31 , 18 ,-78 ,-98
Texas-Louisiana Shelf,latex, 31 , 25 ,-88 ,-98
North America & Central America,n&cen_am, 85 , 0 ,-48 ,-168.5
Southeastern Asia,seasia, 34.1018 ,-12.21557 , 177.4789 ,
89.59155
North Sea & Baltic Sea,baltic2, 72.27546 , 48.86227 , 43.73239
,-12.04227
```

There are 10 standard charts currently associated with CNSILR.WDB, using 9 different .NDX files (2 charts use the same .NDX file, WORLDATL.NDX).

INDEX FILES (*.NDX)

These are ASCII files containing "pointers" to the data segments in the master coastline file (*.WDB) used in plotting a specific chart. For instance, in the above list file the sixth line refers to an .NDX file named GMEX.NDX. Here is that file, responsible for plotting the Gulf of Mexico chart:

```
 49568
 49912
 50045
 50132
 50662
 50722
 50752
 51123
 57091
 57331
 57569
 57650
 57675
.
.  (Lines deleted for brevity)
.
 106792
 106851
 107042
 107083
 107116
 107142
 107172
 111089
 148203
 173665
```

```
173753
174608
175506
```

This example shows that there are many segments of CNSILR.WDB that are required to draw the chart named "Gulf of Mexico." The first data segment begins at data point number 49568 in the master coastline file, and so on.

COLOR FILES (*.C1, *.CP5, *.L3, etc.)

Each .NDX file has associated files containing information about how to color the charts after they have been has been drawn on the monitor. The coloring files are created by the individual OPCPLOT users each time they use the COLOR Command, and OPCPLOT automatically gives them filename extensions that indicate what geographic features are included. "C" indicates landmasses; "P" indicates political boundaries; and "L" indicates lakes and rivers. This is followed by a numeric digit to indicate the resolution level (1 through 5).

A coloring file can be created all at once, or gradually over a number of sessions; OPCPLOT used the coloring files to color the charts automatically. If a mistake in coloring has been made, the user can place a new color over the old one, or erase the entire coloring file and begin anew, using the COLOR Command. This is the author's coloring file for the Gulf of Mexico (GMEX.C1, where C1 = land masses, high resolution) using blue (code = 1) for water and brown (code = 6) for land:

```
-88.0000, 24.5000, 1
-88.0156, 20.9581, 6
-80.0970, 22.3593, 6
-82.7574, 21.6587, 6
-78.1565, 18.2725, 6
-78.1252, 24.7335, 6
-78.5008, 26.6407, 6
-90.1440, 30.1826, 1
-94.9014, 29.5988, 1
-97.5305, 21.5808, 1
-97.4366, 21.6198, 6
-80.6917, 28.5090, 1
-82.4914, 25.5509, 1
-80.7283, 25.5509, 6
-89.8965, 29.5116, 6
```

Some care should be taken with these coloring files, because files with extensions of "C" or "P" or "CP" expect to be filling within green borders (the color used for land masses). Coloring files with extensions of "L" expect to be filling within blue borders (the color used for lakes and rivers).

APPENDIX C
COLOR CODING IN OPCPLOT

Coloring of standard charts can be accomplished by the use of the COLOR command immediately after the chart has been drawn or ZOOMed. The program stores the specified color scheme in files with the extension .FLL corresponding to each standard chart, and duplicates the coloring every time the same chart is redrawn.

Coloring of data files can be accomplished by the use of the MARK-FILL COLORS option. Great care must be taken with this option, since the BASIC method for "painting" colors follows rigid rules that require some practice.

Color codes "hard-wired" into the program:

EGA:	0	Black
	1	Blue
	2	Green
	3	Cyan
	4	Red
	5	Magenta
	6	Brown
	7	White
	8	Gray
	9	Light Blue
	10	Light Green
	11	Light Cyan
	12	Light Red
	13	Light Magenta
	14	Yellow
	15	High-intensity White

VGA: Same as EGA (screen mode 9)

Color codes used by the contouring procedure CONREC:

	BLUE	GREEN	CYAN	RED	MAGENTA	BROW	WHITE	GRAY	LT BLUE	LT GREEN	LT CYAN	LT RED	LT MAGENTA	YELLOW	HI WHITE
A:	.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6			
B:	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
C:	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
D:	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70
E:	-3	-2	-1	0	1	2	3								
F:	-2.5	-2	-1.5	-1	-.5	0	.5	1	1.5	2					
G:	-15	-10	-5	0	5	10	15								
H:	-1.5	-1.25	-1	-.75	-.5	-.25	0	.25	.5	.75	1	1.25	1.5		
I:	0	20	40	60	80	100	120	140	160	180	200	220	240		
J:	-2	-1	0	1	2										
L:	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140
M:	970	974	978	982	986	990	994	998	1002	1006	1010	1014	1018	1022	
N:	990	994	998	1002	1006	1010	1014	1018	1022	1026	1030	1034	1038	1042	

Z: (No specified codes; the user is prompted to supply contour values and color codes)

The letter codes to the left of each row indicate the contouring specification described in the text (see CONTOURING WITH OPCPLOT, above).

APPENDIX D
CONTENTS OF THE OPCPLOT DISKETTE

To install OPCPLOT on your computer, copy the contents of the OPCPLOT diskette to a selected directory. The author recommends C:\OPCPLOT, but the drive and the directory name are entirely up to the user.

After installation, you'll find the following files in OPCPLOT:

OPCPLOT.EXE - The executable code

CNSILR.WDB - The master coastline file, containing data from the Micro World Data Bank II

CNSILR.LST - The list file that contains information about each of the index files (see below)

*.NDX - Index files for segments of data in CNSILR.WDB that need to be plotted in any specific chart.

GMEX.C1 - The file that directs proper coloring of the chart of the Gulf of Mexico (DRAW CHART menu, selection A). This file is provided as an example of the results of using the COLOR command; other files will automatically be generated by the program when the COLOR command is employed.

You will also find a selection of **data files** in various formats, as follows:

OPCPLOT:

Standard format:

F9208091.DAT - Ocean frontal analysis for the Gulf of Mexico for August 9, 1992 (Nan Walker, Louisiana State University).

IGOS9204.DAT - XBT data from the IGOSS data stream for the Gulf of Mexico for the month of April 1992 (Doug McLain, NOAA-COAP, Monterey, California).

Gridded:

LCWATER.GRD - Gridded file showing the relative presence of the Loop Current in the Gulf of Mexico, including an OPCPLOT header that allows automatic contouring (SAIC, 1989).

SURFER Gridded:

ICES.GRD - Gridded file showing sea surface temperatures (for an unidentified month) in the English Channel, with "blanking values" (1.7E38) to indicate land (Dr. Harry Dooley, ICES, Copenhagen).

Sea Ice Edge:

I920724.SIE - Chart for July 24, 1992 (Joint Navy-NOAA Ice Center, Washington, DC).

ICES Standard:

GY3536.ICE - Poseidon survey of the southernmost North Sea (Dr. Harry Dooley, ICES, Copenhagen).

FSU Pseudo Wind Stress:

PACJAN92.PSV - Modeled wind field for the Pacific Ocean, January 1992 (Dr. Jim O'Brien, TOGA Program & Florida State University). [Different format from the TOGA-CD ROM, below, where the same results are also found.]

TOGA CD ROM:

UK Ship Obs:

METOB-EX.UKM - Short extract from file containing all shipboard meteorological observations for 1986 (Halpern et al 1990).

IFREMER BathyTesac:

EXAMPLE.XBT - Short extract from file containing all XBT's for January 1985 (Halpern et al 1990).

Pseudo Wind Stress:

ATLJAN85.PSV - Modeled wind field for the Atlantic Ocean, January 1985 (Halpern et al 1990). [For the Pacific and Indian Oceans, different format from the original FSU products, above.]

Gridded Scalar:

JAN85SST.GRD - Global gridded sea surface temperature values for January 1985 (Halpern et al 1990).

Drifting Buoy:

[No example at present.]

BODC Mooring Inventory:

EXAMPLE.CMI - Short extract from the complete inventory of stations, showing only "German" stations (BODC n.d.).

GLOSS Station Handbook:

TEST.GLO - Short extract from the complete inventory of stations, showing stations in the northwestern Indian Ocean area (PSML n.d.).

Luyten-Stommel Atlas:

See Rhines ATLAST below, where the single example provided plots in exactly the same manner.

Rhines ATLAST:

First Format and Second Format: No example provided

Third Format:

NP87KOR3.DAT - "1987 R/V Korolev" according to notes in the Program manual (Rhines 1991).

Fourth Format: No example provided

GRIDDED Fields:

No Header:

No example available.

OPC-Header:

See LCWATER.GRD, described above.

SURFER Header:

See ICES2.GRD, described above.

TOGA CD Scalar:

See JAN85SST.GRD, described above.

NODC Ocean Station (SD2):

[No example at present.]

JJXX Message:

JJXX.DAT - XBT messages taken in the Gulf of Mexico during one phase of the LATEX Program.

C&GS Bulletin Board:

Sediments:

N2NOAA1.TXT - Sediment sample sites offshore Tampa, Florida.

Wrecks/Obstructions:

N2NOS1.TXT - Wrecks and obstructions near the mouth of the Mississippi River.

Tide Gauges:

N2TIDE1.TXT - Tide gauges along the Florida coast.

Nautical Charts:

N2CHRT1.TXT - Charts that include New Orleans, LA (approximately 30N 90W).

NOAA Ocean Product Center

Ocean Feature Analysis in OTH-GOLD Format:

1_N_OFA.OTH - Ocean Feature analysis of the northwestern Atlantic Ocean on February 18, 1994.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.