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NAVED - Interactive Navigation Editor Program

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CONTENTS

ABSTRACT

The Interactive Navigation Editor (NAVED) Program is a FORTRAN IV computer program presently implemented on the Hewlett-Packard 1000 series computer. It provides for the interactive editing of navigation data on a graphic display terminal. NAVED is easy to operate and is written in a modular fashion to facilitate inclusion of any desired additional editing functions.

NAVED will accept two types of navigation input data: data which describe continuous cruise tracks and data representing discrete ship positions at various times during a cruise (such as ship positions relative to known satellites). All input data (as many as eight data channels of each type) must be in Time Series Data (TSD) format.

NAVED output is corrected continuous cruise data, in TSD format, for the channel containing data from the selected System sensor and the graphic display of any or all of the cruise track data on the graphic display terminal or other plotting devices.

NAVED presently consists of a main program with 18 modules of options divided into two operating phases: start-up and editing. In the start-up phase, navigation data are entered or recalled into the program. The editing phase allows the user to plot and edit those data by selecting editing functions from a menu of options displayed on the user's terminal. These functions include plotting, editing, and program termination. The plotting functions display data within user-specified time and/or latitude and longitude bounds, and they allow the enlargement or reduction of portions of a plot.

The editing functions permit the user to make corrections to the continuous cruise track data and to display the data-collection time and latitude and longitude of specific points along a track line. Corrections include deletion of unwanted data points, replacement of segments of the System track line with segments of another continuous track line, and linear adjustment of segments of the System track line.

The program termination functions merge the corrected System track data with the original navigation input data and/or retain the navigation data for further processing.

This report contains both a technical description of the NAVED program and a manual for its use.

INTRODUCTION

The U.S. Geological Survey (USGS) conducts marine geological and geophysical investigations of the United States continental shelf, slope, and rise. The usefulness of data collected from such investigations is highly dependent upon accurate navigation data. In the past there were often long delays between collection and processing of navigation data, primarily due to the unwieldy and time-consuming nature of the existing computer processing. In response to an increased volume of navigation data and a need for quicker processing, an effort was initiated to design, develop, and implement a computer program that would provide more efficient, convenient, and effective processing of navigation data. The Interactive Navigation Editor (NAVED) system provides almost immediate processing of navigation data in an interactive display environment.

DESIGN PHILOSOPHY

The two major considerations in the design of program NAVED were the ease of operation and the ease with which additional functions or options could be included as the need arises. To ensure ease of operation, NAVED was written for use in an interactive mode with pertinent questions to the user clearly displayed on the terminal. The program relies heavily on graphic display of data, a significant time-saver in editing navigation.

To ensure easy inclusion of additional functions or options in the program, NAVED is written in FORTRAN IV and in a highly modular fashion with each editing function or option as a separate segment or module. The addition of a new function or option simply involves writing a new module for the required function and inserting the option and module names into the proper table in the program.

TECHNICAL DESCRIPTION

General

Program NAVED is written for the Hewlett-Packard 1000 computer with RTE-IVB operating system and requires the use of a Tektronix series 4014 graphics display terminal. NAVED requires 26K words of memory plus 608K words (99 tracks) of user disc for working storage. The disc is used for the storage and retrieval of navigation data under the control of Virtual Memory (VIRTL) routines (G. I. Evenden, USGS, unpub. data, 1978). Time Series Data (TSD) software (Evenden, unpub. data, 1979) is used for the initial input and the final output of navigation data. NAVED uses device-independent software for all graphics operations (Evenden, unpub. data, 1979).

Presently NAVED consists of a main program and 18 modules of options. The modules of options are divided into two operating phases: start-up and editing. The start-up phase allows navigation data to be entered into the program. The editing phase allows the user to plot and edit the navigation data.

The start-up phase is invoked automatically upon executing NAVED. There are three options available in the start-up phase: HELP, LOAD, and RESTRT. These three options are listed on the terminal, and the user is asked to type the name of the desired option. The HELP option provides information to the user on the use of any of the options available in NAVED. The LOAD option enters navigation data into the program. The RESTRT option causes NAVED to use the navigation data that was entered and saved during a previous run of NAVED.

NAVED automatically invokes the editing phase upon completion of either the LOAD option or the RESTRT option and remains in the editing phase until execution is terminated. The editing phase has 15 options, in three general categories, which are constantly displayed on the left side of the Tektronix screen in the form of a "menu" from which the user makes his selection with the cursor cross-hairs that appear on the screen.

The three general categories of editing phase options are plotting functions, editing functions, and program termination. Plotting functions include the following: SENSOR, GRID, TRACK, WINDOW, FIRSTW, NEWFW, and SVPLOT. These options control the graphic display of navigation data within user-specified time and/or latitude and longitude bounds, and the enlargement or reduction of selected portions of a plot.

The editing functions are: DELETE, LATLON, TIME, EXCHNG, and INTERP. These options permit the display of data-collection time and date or the latitude and longitude of specific points along a navigation track line, the deletion of erroneous navigation data points, and the linear adjustment of portions of a track line.

The program termination functions are MERGE and EXIT. The MERGE option merges the edited navigation data with the original navigation input data; the EXIT option saves the current edited navigation data for possible further editing in a subsequent run of program NAVED. Either of these options results in termination of NAVED execution.

For detailed descriptions of the options available in NAVED, the reader is referred to the appendix.

Basic control flow

The following description is an overall programmatic view of the NAVED program. The FORTRAN source code is available from the authors upon request.*

The main program, NAVED, provides basic control of all program operations. All modules return control to the main program for a decision as to the next module to be executed. The decision depends on whether the current module is making a normal or an error return, and/or on the integer value of the variable ISEGN that is passed to the main program in COMMON /NAVCM/.

A normal return to the main program occurs by means of a GO TO IRETRN statement in a module. In the main program the variable IRETRN is assigned the value of the address of statement number 100. Since variable IRETRN is stored in COMMON /NAVCM/ and is therefore available to both the main program and the module, this results in a transfer of control to statement number 100 in the main program. The statement immediately following statement number 100 determines the next module to be executed based on the value of ISEGN. If ISEGN is a positive integer, ISEGN+3 is the subscript in the array ISEGL (i.e., the table of option names and module names) in COMMON /NAVCM/ of the next module to be executed. Control is then passed to the requested module with an EXEC 8 call. If ISEGN is zero, control is passed to module NAV00, which is the module that displays the cursor cross-hairs on the Tektronix screen and decodes the user's selection of an option from the "menu" of editing options. If ISEGN is a negative integer, the EXIT option (i.e., module NAV50) has just been executed and NAVED terminates execution.

An error return to the main program occurs by means of a GO TO IERRTN statement in a module. In the main program the variable IERRTN in COMMON /NAVCM/ is assigned the value of the address of statement number 800. Therefore an error return results in a transfer of control to statement number 800 in the main program. If the value of ISEGN is not -1, the EXIT module will be executed. In either case, NAVED terminates execution.

By setting the value of variable ISEGN to the subscript of the ISEGL array which contains the next desired option, each module can control the choice of the next module. For example, the LOAD option (i.e., module NAV01) returns to the main program with ISEGN = MENU+1, which is the subscript in the ISEGL array of the plot initialization module NAV51. Most modules, including modules NAV03, NAV04, NAV05, and NAV06, return to the main program with ISEGN = 0. As explained above, this results in execution of module NAV00 which, in turn, enables the user to select his next option.

When main program NAVED begins execution, it performs initialization functions. Then control is passed to module NAV90 by means of an EXEC 8 call. Module NAV90 prints a "menu" of three options (HELP, LOAD, and RESTART), determines which of the three options the user has selected and sets the value of variable ISEGN accordingly, and then returns to the main program. All subsequent returns to the main program go to either statement number 100 (i.e., normal return) or statement number 800 (i.e., error return).

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APPENDIX - NAVED commands and usage

CONTENTS

ILLUSTRATIONS

[Figures are grouped at the end of the Appendix, beginning on p. 26]

I. INPUT

There are two types of input data:

1. CONTINUOUS navigation data describe and record each point along a continuous cruise track; and

2. DISCRETE data represent discrete ship positions at various times during a cruise. In most cases, the discrete data are ship positions determined from navigational satellites. These data are generally regarded as "positional truth."

Frequently, more than one navigational device will be used to record navigation data during a cruise. In this case, the device providing the most accurate navigation will be selected at data-collection time as the SYSTEM sensor. SYSTEM sensors are selected for both CONTINUOUS and DISCRETE data. All navigation data are recorded as data channels. NAVED has the capacity to process as many as eight CONTINUOUS and eight DISCRETE navigational data channels. Only DISCRETE data channels are optional input to NAVED.

All of the navigation input data must be in Time Series Data (TSD) format, a local USGS standardized object-time format useful for all types of time-series data. The data itself is preceded by a TSD header record that identifies the data channels and describes attributes of the data.

The navigation input data may be on either magnetic tape or disc. If magnetic tape is used, multiple reels may be processed by mounting subsequent reels on the same logical unit. Subsequent reels, however, must not have TSD header records.

II. OUTPUT

NAVED output is the graphic display on a Tektronix screen of any or all of the cruise navigation data and a corrected SYSTEM cruise track of CONTINUOUS data. Its secondary output, after all editing has been performed, is a new TSD-format data file, which includes the original sensor data and the corrected SYSTEM cruise track. This new file is created by selecting the MERGE option.

NAVED also enables the user to make plots on other plotting devices by allowing the user to create deferred plot files. Prior to displaying the desired plot on the screen, a deferred plot file must be requested by the user in the LOAD module, RESTRT module, or SVPLOT module. The deferred plot file is plotted at a later time by using program PDEFP on any plotting device.

It is assumed that all following commands will be executed on the Tektronix 4014 terminal and that each input entry will be followed by a carriage return unless otherwise specified.

III. EXECUTE COMMAND

To execute NAVED, the user initiates the program by typing the following command on a Tektronix terminal:

```
RU,NAVED,,list,cartridge
```

where:

list is an optional list device for error messages.
If not specified, list defaults to the user's terminal.

cartridge is the disc cartridge number of the data work files required by the program. The program requires a minimum of 99 disc tracks, i.e., a 608K word capacity.

NAVED responds by printing the following:

```
PROGRAM NAVED version
date time

HELP
LOAD
RESTRT
?
```

NAVED is then in the start-up phase of execution.

IV. START-UP PHASE

The options available in the start-up phase are HELP, LOAD, and RESTRT. The user must enter the name of one of these options, followed by a carriage return.

A. HELP option

This option prints information about usage of any of the available options. The user is prompted with:

```
HELP FOR WHAT? (6 CHARACTERS)
```

and responds by typing an option name. The screen automatically clears and the requested information is printed. The above prompt will again appear on the screen so that the user may request additional HELP information or elect to quit the HELP option by typing QUIT (Q). When the user elects to quit, the screen clears and the start-up phase menu appears again on the screen as follows:

```
HELP
LOAD
RESTRT
?
```

B. LOAD option:

This option loads the navigation data from a TSD format data file for editing. The user selects those navigation data channels he is interested in seeing plotted by entering the TSD channel numbers (fig. 1*). A maximum of 8 data channels may be selected. A maximum of 522,240 words may be stored in the work file of CONTINUOUS navigation data, and a maximum of 30,720 words may be stored in the DISCRETE data work file. The scope of data that can be loaded into a work file depends upon the frequency of the original data sampling and the number of data channels that are being read from the input. For example, if only one data channel is selected and the sampling frequency is every five minutes, an entire 20-day cruise may be loaded into the work file, but if the sampling frequency is every 20 seconds, only about one week of the cruise may be loaded. If five data channels are selected and the sampling frequency is every 20 seconds, only three days of the cruise may be loaded.

The LOAD operation requires CONTINUOUS input data. DISCRETE data is optional and is not entered until the CONTINUOUS data have been accepted.

1. CONTINUOUS input data

a. File name and channel numbers

The LOAD scenario begins with:

ENTER CONTINUOUS INPUT FILENAME:

The user must enter the input filename of the CONTINUOUS navigation data. The TSD header is displayed on the terminal and the user is then prompted with:

ENTER THE TSD CHANNEL NUMBERS TO BE STRIPPED FROM THE INPUT TAPE. MAXIMUM NUMBER OF CHANNELS THAT CAN BE STRIPPED ARE 8. THESE ARE `CONTINUOUS' POSITIONS AND SHOULD NOT INCLUDE DISCRETE `UPDATE' POSITIONS. `SYSTEM' POSITION MUST BE FIRST.

The user then enters, separated by commas, the channel numbers he is selecting from the input tape. Remember that the first channel that the user specifies must be the SYSTEM position since this is the channel that will be edited during execution of the program and will become the corrected SYSTEM track line. NAVED checks the TSD header for the selected channel numbers. If a channel number is not found, an error message is printed and the prompt is repeated. The user must then retype all his channel selections.

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*Figures are grouped at the end of the Appendix, beginning on p. 28.

b. Start and end dates

After a set of acceptable channel numbers have been entered, NAVED prints:

```
ENTER START AND END DATES TO FIND
YEAR,MONTH,DAY,HR,MIN,SEC,FSEC,YEAR,MON,...
```

(i.e. where HR is 0 to 23 hours and FSEC is fractional seconds)

The user may now enter, in the above order and separated by commas, the starting and ending data-collection time of the portion of the navigation data that the user wants loaded into NAVED for editing purposes. Omission of the starting time will start the loading of data from the beginning of the input file and omision of the ending time will cause data to be loaded until the end of file is encountered or the work file is filled.

c. Time gap

When prompted to:

```
ENTER TIME GAP IN `MINUTES´:
```

the user must enter, in minutes, the time lapse between two successive input records that is considered to be a break in a CONTINUOUS navigation cruise track. The default time gap is 15 minutes if a space is entered. The break will appear as a gap in the plotted track line and will visually indicate areas where, because of equipment malfunction or system shut-down at sea, data may be missing.

d. TSD error message

The actual loading of the CONTINUOUS navigation data now begins. If the user specified an ending date and time with which to stop the load, the message:

```
END DATE FOUND IN INPUT FILE
```

is printed when the specified date and time are encountered. Otherwise loading will continue until an end-of-file is encountered or the work file is filled. When the end-of-file is encountered, the following is printed on the screen:

```
>TSD ERR: #:year month day hour: min: sec
ARE THERE MORE DATA?  IF YES, READY INPUT DRIVE NOW.
(YES/NO):
```

The TSD ERR message signifies an end-of-file condition and informs the user of the date and time of the last input record. If the input data is on multiple reels of magnetic tape, the user may now mount the next reel on the same tape drive and continue loading by entering YES. If the user has no more input data to be loaded, he enters NO.

When loading of the CONTINUOUS data is completed, NAVED is ready for loading the DISCRETE data, if any.

2. DISCRETE input data

a. Filename

NAVED prompts the user with:

WILL THERE BE A DISCRETE `UPDATE´ FILE (YES/NO):

The user must respond as to whether or not he has DISCRETE data to be loaded. If NO, the program skips to the summary printout (see below). If YES, the program prompts the user with:

ENTER DISCRETE INPUT FILENAME:

at which point the user enters the name of the DISCRETE data input file.

b. Channel numbers

After the TSD header is displayed on the terminal, the user is prompted with:

ENTER THE TSD CHANNEL NUMBERS TO BE STRIPPED
FROM THE DISCRETE INPUT TAPE. MAXIMUM NUMBER
OF CHANNELS IS 8.

The channel numbers he wishes stripped from the DISCRETE data file are entered, separated by commas. No more than 8 channels can be selected. If the user enters an incorrect channel number, the program will retype the above message and the user must re-enter his selection(s) correctly.

Loading of the DISCRETE navigation data now begins. If a starting and/or ending time was specified previously for loading the CONTINUOUS navigation data, the loading of the DISCRETE data will also start and end with the user-specified times. Otherwise the DISCRETE data are loaded based upon the starting and ending times of the CONTINUOUS data actually loaded previously. If an ending time was specified and found, the program will automatically go to the summary printout. If an end-of-file is encountered, the same end-of-file message and query for more data as previously described will be printed. If the user responds YES, the procedure is the same as described for CONTINUOUS data. If the user responds NO, indicating he has no more DISCRETE input data, the program proceeds with the summary printout.

3. Summary printout

A summary of the CONTINUOUS and DISCRETE data that have been loaded into the work files is printed. This summary is as follows:

```
***** WORK FILE(S) LOADED *****
START TIME: year/month/day hr:min:sec
END TIME: year/month/day hr:min:sec

***** FILE BOUNDS *****
TOP          BOTTOM          LEFT          RIGHT
deg min      deg min         deg min       deg min
```

4. Plotting information

a. Deferred-plot filename

After the summary printout is completed, the user is prompted with:

ENTER NAME OF PLOT DEFERRED FILE:

The user now has an opportunity to create a deferred plot file for later plotting on other plotters. He either rejects the opportunity by entering a space, or enters a unique filename, including disc cartridge number, for the deferred plot file. The deferred plot file always contains the plot currently displayed on the graphics screen. In order to save the current plot in the deferred file, it is necessary to close the file, prior to displaying a new plot, by selecting the SVPLOT option. (The SVPLOT option also allows the user to create a new deferred plot file.)

b. Plotter device

NAVED continues execution now by prompting the user with:

ENTER NAME OF PLOTTER DEVICE:

The user must enter the name of the Tektronix terminal he is using. If a space is entered, the default device is the Tektronix 4014 (i.e. T4014).

5. Ready for MENU request

The final prompt from the LOAD routine is:

READY FOR MENU (YES/NO):

If the user responds NO, the work files and information necessary for restarting NAVED will be saved on his disc work cartridge, and the program will terminate execution. If the user responds YES, 15 editing-phase options will be listed on the screen. NAVED is then in the editing phase of execution.

C. RESTRT option

The user requests this option, instead of the LOAD option, if he wishes to restart the program after loading his data into the work files with the LOAD option during a previous run of NAVED (fig. 2). RESTRT re-initializes all the information required by NAVED.

If the user failed to specify the disc cartridge number of the data work files in the execute command, NAVED will request the cartridge number, which the user enters followed by a carriage return.

1. Plotting information

a. Deferred-plot filename

The user will be requested to:

ENTER NAME OF PLOT DEFERRED FILE:

If he does not wish to create a deferred plot file, he enters a space. Otherwise he enters a unique filename, including disc cartridge number, for the deferred plot file.

b. Plotter device

Next the user is prompted to:

ENTER NAME OF PLOTTER DEVICE:

The user must enter the name of the Tektronix terminal he is using. If a space is entered, the default device is the Tektronix series 4014 (i.e. T4014).

2. Ready for MENU request

The final prompt from the RESTRT option is:

READY FOR MENU (YES/NO):

If the user responds NO, NAVED will terminate execution. If the user responds YES, 15 editing-phase options are listed on the screen, and NAVED is then in the editing phase of execution.

V. EDITING PHASE

The 15 editing options are: GRID, TRACK, INTERP, DELETE, LATLON, TIME, EXCHNG, WINDOW, FIRSTW, NEWFW, SENSOR, MERGE, HELP, SVPLOT, and EXIT. The list or menu of these options remains on the left side of the screen at all times (fig. 3) unless a particular option causes the screen to be cleared, in which case, the menu is printed again. The user can select any one of the 15 options by positioning the cursor cross-hairs in the box in front of the desired option and then striking any character on the keyboard. After any selected option has been completed, the menu and cursor cross-hairs will again appear on the screen to allow the user to make another selection from the menu. Prior to the reappearance of the cross-hairs, the completion of some options is indicated by "DONE" appearing on the screen below the option name.

A. HELP option

This option prints information about usage of any of the available options. The user is prompted with:

HELP FOR WHAT? (6 CHARACTERS)

The user responds by typing an option name. The screen clears and the requested information is printed. The above prompt will again appear on the screen. The user may either request information about another option or elect to quit the HELP option by typing QUIT (Q).

B. Plotting functions

The plotting options facilitate the graphic display on the Tektronix screen of user-selected navigation data channels within user-specified time and/or latitude and longitude bounds (fig.4). At least one dimension of every plot fills the plot area on the screen. Therefore, by specifying the bounds appropriately, the user can effectively enlarge or reduce a portion of a plot for more or less detailed viewing. The bounds define what is refered to as a plot window.

NAVED always defines two plot windows: the "first" or previous window and the "current" window. Initially, these two windows are identical and are determined by the bounds of the full range of the navigation input data. During execution, whenever the user requests a plot, NAVED displays only the currently selected data channels and the data that fall within the current window. The bounds of the current window may be respecified by selection of the WINDOW option, which provides a means of detailed examination of selected areas. To return to the previous window, the FIRSTW option is selected. The "first" window bounds may be changed to those of the current window by selection of the NEWFW option.

The plot that appears in figure 5 was produced by selecting the TRACK option, which plotted the currently selected data channel within the current window. The user wanted to study more closely the portion of the plot in the small rectangle and then return to this original plot. He did so by selecting the NEWFW option before requesting new current window bounds with the WINDOW option. The display of the data in the new current window by the TRACK option appears in figure 6. When ready to return to

the "first" window of figure 5, he selected the FIRSTW option followed by the TRACK option (fig. 7).

Initially all of the data channels that have been loaded into the work files are displayed whenever a plot is requested. A subset of channels to be plotted may be chosen with the SENSOR option.

The plotting functions of NAVED also permit creating and closing deferred plot files by selection of the SVPLOT option.

1. SENSOR option

This option allows the user to select which data channels are to be plotted when more than one data channel has been loaded into the work area (fig. 8 and 9). After completion of the start-up phase of NAVED, the default sensor selection is all data channels that have been loaded.

After selecting this option from the menu, the user is prompted with:

ENTER SENSOR SELECTION

The user must then enter, in any order and separated by commas, the channel numbers of the sensors he wishes plotted.

The user cannot exit from this option without selecting a sensor. If he attempts to do so, the following error message is printed on the screen:

NO SENSORS ENTERED
TRY AGAIN!

and the user is prompted again to enter his selection. If the user has entered a channel number that is not included in the work file, the following error message is printed on the terminal:

CHANNEL nnnn NOT LOADED
TRY AGAIN!

i.e., "nnnn" is the erroneous channel number. All the data channel selections must be re-entered.

When the SENSOR option is completed correctly, "DONE" appears on the screen. The cross-hairs are displayed on the terminal so the user may select another option from the menu.

2. GRID option

This option plots a rectangular boundary that indicates the maximum and minimum extents of the latitude and longitude of the navigation data within the current plot window (fig. 10). There are no questions to be answered by the user. When the plot has been completed, the menu and cursor cross-hairs are again displayed.

3. TRACK option

This option plots the rectangular boundary from the GRID option and the user-selected navigation track lines that fall within the current plot window (fig. 6). There are no questions to be answered by the user. After the plotting is completed, the menu and cross-hairs are again displayed.

4. WINDOW option

This option is used to change the time and/or latitude and longitude bounds of the current plot window. By specifying the bounds appropriately, the user can enlarge or reduce a given area of a plot. If the user specifies time bounds that are less than the full time range of the navigation data stored in the work files, he will also increase the speed with which searches of the work files are made by NAVED.

There are five suboptions available: T (user entry of time bounds), L (user entry of latitude-longitude bounds), W (cross-hairs window selection of latitude-longitude bounds), P (cross-hairs point selection of time bounds), and Q (quit). It should be noted that changing the time bounds (with the T or P suboption) of the plot window will also change the latitude-longitude bounds, but changing the latitude - longitude bounds (with the L or W suboption) will have no effect on the time bounds.

Upon selecting the WINDOW option, the user is prompted with:

```
OPTIONS: T-L-W-P-Q
```

The user selects the desired suboption by typing the appropriate character. If he types any character other than one of these five, the bell rings and the following error message appears in the lower left corner of the screen:

```
WINDOW OPTION SELECT ERROR
TRY AGAIN!
```

and the user is reprompted with the five possible suboptions.

If the user selects Q, the message "QUIT" is displayed, the program exits from the WINDOW option, and the cursor cross-hairs are displayed to allow user selection of another menu option.

Suboptions T, L, W, and P are described in detail below.

a. T suboption - User entry of time bounds

This suboption allows the user to change the time bounds of the current plot window by entering the new time bounds i.e., the desired starting and ending data-collection time (fig. 11). The user is first prompted with:

```
ENTER START TIMES
YR,MON,DAY,HR,MIN,SEC,FSEC
```

and he enters the information in the above order and separated by commas. If only the year is entered, the starting time bound defaults to that of the first record in the work file.

The next user prompt is:

```
ENTER END TIMES
YR,MON,DAY,HR,MIN,SEC,FSEC
```

The user enters, in the above order and separated by commas, the desired ending time bound. If only the year is entered, the ending time bound defaults to that of the last record in the work file.

NAVED searches the work file to find the records with data-collection times closest to the specified time bounds. If an error occurs in locating those records, or if a time bound is entered incorrectly, the message

```
WINDOW OPTION SELECT ERROR
TRY AGAIN!
```

is displayed and is followed by a request to reselect one of the WINDOW suboptions.

After the new time bounds have been established, NAVED scans the work file data records of all user-selected data channels within these time bounds to determine the maximum and minimum latitude and longitude. These maxima and minima become the new latitude and longitude bounds of the current plot window. NAVED now automatically transfers control to the TRACK option and plots a new rectangular boundary (grid) and the selected data (fig. 12).

b. L suboption - User entry of latitude-longitude bounds

This suboption allows the user to change the latitude and longitude bounds of the current plot window by entering the new latitude and longitude bounds (fig. 13). The latitude and longitude are entered as "degrees,minutes." Degrees south and west are entered as negative numbers, and both the degrees and minutes portion of the entry must have the same sign. For example, a longitude of 70°39.476'W must be entered as -70,-39.476.

The user is prompted for each entry as follows:

ENTER NORTH LATITUDE DEG & MIN

The user responds by entering the northernmost latitude desired for the plot window.

ENTER SOUTH LATITUDE DEG & MIN

The user enters the southernmost latitude desired for the plot window.

ENTER WEST LONGITUDE DEG & MIN

The user responds by entering the westernmost longitude.

ENTER EAST LONGITUDE DEG & MIN

The user must enter the easternmost longitude.

If the newly selected latitude-longitude bounds are a subset of the plotted area currently displayed on the terminal, a rectangle will be drawn around the sub-area. The user must enter YES or NO to indicate the correctness of the new latitude-longitude bounds. If he answers NO, the program requests another WINDOW suboption selection. If he answers YES, the program automatically transfers control to the TRACK option and plots a new grid and the selected data (fig. 14).

If the newly selected latitude-longitude bounds are not a subset of the plotted area currently displayed on the terminal, the program immediately transfers control to the TRACK option and plots a grid and the selected data.

c. W suboption - Cross-hairs window selection of latitude-longitude bounds

This suboption allows the user to change the latitude and longitude bounds of the current plot window by using the cursor cross-hairs to select a rectangular sub-area of the currently displayed plot (fig. 15).

When this suboption is selected, a bell rings and the user is prompted with:

SET CURSOR FOR
LOWER LEFT CORNER

The user must position the cursor cross-hairs at the lower left corner of the desired new plot window and then strike any character on the keyboard except Q to enter his selection. If the user strikes Q (for QUIT), the program will return to the WINDOW suboption selection. The bell rings again and the user is prompted with:

SET CURSOR FOR
TOP RIGHT CORNER

The cursor cross-hairs are then positioned at the upper right corner of the desired new plot window and the user strikes any character (except Q).

After the upper right corner has been defined, a rectangle outlining the newly selected plot window is displayed. When the bell rings again, the user must enter YES or NO to signify his acceptance of the new plot window. If he answers YES, the program will expand the new plot area to full scale and automatically transfer control to the TRACK option for display of the new grid and selected data (fig. 16). If he answers NO, the program will return to the beginning of the W suboption procedure.

d. P suboption - Cross-hairs point selection of time bounds

This suboption provides for changing the time bounds of the current plot window by selecting two SYSTEM track line data points to define the new bounds (fig. 17). Each SYSTEM point is selected by the user positioning the cursor cross-hairs as close as possible to the desired point and then striking any keyboard character except Q. The time value associated with the selected point becomes a time bound of the new plot window.

When the P suboption has been selected, the bell rings and the user is instructed to:

SET CURSOR AND SELECT
POINT #1

The user must make his first point selection. The selected point is circled, the bell rings, and the user is asked to:

SET CURSOR AND SELECT
POINT #2

The user makes his second point selection in the same manner. Again the selected point is circled and the bell rings. The user must now enter YES or NO to indicate whether the selected points are acceptable. If he answers NO, the program returns to the WINDOW suboption selection. If he answers YES, the program scans the work file data records of all user-selected data channels within the new time bounds to determine the new latitude and longitude bounds of the current plot window. The program then automatically transfers control to the TRACK option and plots the new rectangular boundary and the selected sensor data (fig. 18).

5. FIRSTW option

This option resets the current plot window to the "first" plot window (fig. 7). The "first" plot window is the window defined by the user's most recent selection of the NEWFW option or, if the user has not used the NEWFW option, the full range of the data loaded into the work files.

There are no questions to be answered by the user.

6. NEWFW option

This option redefines the "first" plot window as identical to the current plot window. This allows the user to return to a display of the current plot at some time in the future, i.e., presumably after changing the current plot window with the WINDOW option (fig. 5).

There are no questions to be answered by the user. The message "DONE" is displayed when this option is completed.

7. SVPLOT option

In order to save the current plot that is in a deferred plot file, it is necessary to close the file prior to displaying a new plot. The SVPLOT option provides this capability and also the capability to create a new deferred plot file. Creating a new deferred plot file causes all subsequent plotting on the Tektronix screen to be duplicated in that file. However, it is important to note that the deferred file can only contain one plot, which is the most current plot displayed on the graphics screen. Every time a new plot is generated the contents of the deferred file are replaced by the new plot. In order to save multiple plots, multiple deferred plot files must be used.

When this option is selected, the currently open deferred plot file, if any, will be closed. The user is then requested to:

ENTER NAME OF PLOT DEFERRED FILE

If he wishes to create a new deferred plot file, he enters a unique filename, including disc cartridge number. Otherwise he must enter a space.

C. Editing functions

The editing functions permit the user to make corrections to the navigation data stored in the CONTINUOUS data work file. These functions can also be used to display the data-collection time or the latitude and longitude of specific points along a CONTINUOUS navigation track line.

1. DELETE option

This option permits the user to delete unwanted data points from any CONTINUOUS track line. When the user is prompted with:

SENSOR #

he must enter the data channel number of the track line he wishes to modify. He may choose any CONTINUOUS data channel.

The next prompt is:

SELECT POINT

The user must align the cursor cross-hairs as close to the desired point as possible and strike any keyboard character (except Q). NAVED circles the point and rings a bell. The user must then respond with YES or NO to verify the deletion request. Then the above prompt is repeated and the process is repeated until all the desired points have been deleted.

To exit from this option, the user must enter Q (for QUIT) in response to a SELECT POINT prompt. The message DONE is then printed, and the cursor cross-hairs are displayed for selection of another option from the menu.

2. LATLON option

This option will print the latitude and longitude of any selected point on a displayed CONTINUOUS track line. When the user is prompted with:

SENSOR #

he must enter a CONTINUOUS data channel number.

The user is next prompted with:

SELECT POINT

and he must position the cursor cross-hairs as close as possible to the point to be labelled. When the user types any character (except Q), the point is circled and a bell rings. The user must respond with YES or NO to verify the point selection. Then he is prompted to select another point. The procedure is repeated until the user enters Q (for QUIT) in response to the SELECT POINT prompt. The message DONE is then printed, and the cursor cross-hairs are displayed for selection of another option.

3. TIME option

This option will print the data-collection time of any selected point on a displayed CONTINUOUS track line (fig. 19). When the user is prompted with:

SENSOR #

he must enter the desired CONTINUOUS data channel number.

The next prompt is:

SELECT POINT

and the procedure is the same as for the LATLON option.

4. EXCHNG option

This option permits replacing (exchanging) segments of the SYSTEM track line with segments of the track line from any other data channel loaded into the CONTINUOUS data work file (fig. 20 and 21).

When the user is prompted with

SELECT 1ST POINT
TO BE REPLACED

he must align the cursor cross-hairs with the first point of the segment to be replaced. After typing any character (except Q), the point is circled and a bell rings. The user must respond YES or NO to verify acceptance. The next prompt is:

SELECT LAST POINT
TO BE REPLACED

The user must align the cursor cross-hairs with the end point of the segment to be replaced and then strike any character (except Q). After user verification, the next prompt is:

EXCHANGE SENSOR #

The user must enter the channel number of the navigation data to be substituted for the selected segment of the SYSTEM track line.

If the user wishes to exit from this option prior to normal completion, he may type Q (for QUIT) when the program prompts him to select a point. When this option is completed, the cursor cross-hairs are displayed so that the user may select another option from the menu.

5. INTERP option

Under this option, the user may adjust by linear interpolation a portion of the SYSTEM navigation track line (fig. 22). The first user prompt is:

SELECT 1ST POINT
TO BE MOVED

The user must select the first point of the SYSTEM track line segment to be adjusted by moving the cursor cross-hairs to the desired point and then striking any keyboard character (except Q). When the point is circled and a bell rings, the user must respond with YES or NO to verify the point selection. The next prompt is:

SELECT NEW LOCATION

The user must use the cursor cross-hairs to select the location to which the first data point will be moved. He then types any keyboard character (except Q). The verification process is then repeated.

The next user prompt is:

SELECT LAST POINT
TO BE MOVED

The user selects the last point of the SYSTEM track line segment to be adjusted by moving the cursor cross-hairs to the desired point and then striking any keyboard character (except Q). The responses are the same as they were for the previous point selections.

The final user prompt is:

SELECT NEW LOCATION

The user must use the cursor cross-hairs to select the location to which the last data point will be moved. The responses are the same as for the previous point selections.

If the user wishes to exit from this option at any time, he may type Q (for QUIT) when the program prompts him to select a point or location.

When this option is completed, the cursor cross-hairs are displayed for selection of another option. If the user wishes to display the linearly adjusted track line, the TRACK option must be selected subsequent to completion of the INTERP option (fig. 23).

D. Program termination functions

There are two options available for terminating execution of NAVED. The user should select the EXIT option if he wishes to retain the data work files in their currently-edited state so as to complete the editing process at a later time. He should select the MERGE option if he has finished editing his navigation data stored in the work files and is ready to produce a final output tape (or file).

1. MERGE option

This option merges the corrected SYSTEM data with a TSD input file of navigation data, usually the master navigation tape, to produce a new TSD output file. The corrected SYSTEM data may be included as a new data channel or may replace the data of an existing channel.

After the prompt:

```
ENTER TSD INPUT FILENAME:
```

the user must enter the name of the TSD input file to be merged. After the file has been opened, the TSD header is displayed on the terminal and the user is prompted with:

```
ENTER CHANNEL NUMBER IN INPUT FILE TO BE MERGED:
```

He must enter the number of the data channel to be replaced or added to the output file. If the channel already exists, the following prompt is displayed:

```
CHANNEL NUMBER ** FOUND ** IN INPUT DIRECTORY.
WILL OVERWRITE DATA IN INPUT FILE. OKAY? (YES/NO):
```

If the channel does not exist in the input file, the user will be prompted with:

```
CHANNEL NUMBER NOT FOUND IN INPUT FILE.
DO YOU WANT TO ADD IT TO DIRECTORY? (YES/NO):
```

Regardless of which prompt is displayed, if the user enters NO, the program will again ask for the channel number to be merged. If he enters YES, the program will proceed with the next prompt:

```
ENTER TSD OUTPUT FILENAME:
```

The user must enter the name of the TSD output file to be created.

The program then proceeds with the actual merge operation. When an end of file is found on the input file,

```
EOF FOUND ON INPUT TAPE. ARE THERE MORE DATA?
IF YES, READY DRIVE NOW. (YES/NO):
```

is displayed. If the user has multiple input reels, he must mount the next reel on the same tape drive as the first and then enter YES. (Note that only the first reel may have a TSD header.) If there is no more input data, he enters NO and the following message is displayed:

```
>>>>> MERGE COMPLETED <<<<<
```

Then execution of NAVED is terminated.

If the user wishes to suspend execution of the MERGE option, he must strike any keyboard character and wait for the following prompt to be displayed:

nn>

where nn is the logical unit number of the user's terminal. After he enters BR, followed by a carriage return, the following prompt will be displayed:

ENTER `GO', `CN,LU,FUNC' OR `QUIT':

The user enters QUIT to terminate execution of the MERGE option. He enters an appropriate CN command (as described in the Hewlett-Packard RTE-IVB Terminal Users' Manual, 1980) to perform a control operation on a magnetic tape, such as writing an end of file on an output tape. Entering GO will continue execution of the MERGE option.

2. EXIT option

This option terminates NAVED execution and saves the data work files, together with all information necessary for subsequent restarting of the program with the RESTRT option. There are no questions to be answered by the user. This option is invoked whenever any error causes NAVED to abort and also upon completion of the MERGE option.

```
RU,NAVED,,,18Ø7

 PROGRAM NAVED - VERSION MAY 198Ø
                    6/26/81   85Ø

HELP
LOAD
RESTRT
? LOAD

 ENTER CONTINUOUS INPUT FILENAME:  MTA11Ø

     -----  TSD HEADER INFORMATION  -----
 CREATION PROGRAM:  INSSPC     DATE: 198Ø/ 6/1Ø    7:17:12.Ø35
 DEFINITION FILE:  INSDEF       CARTRIDGE:    2
 NUMBER OF DATA CHANNELS:  39   DATA BLOCK SIZE:   828   LOGICAL RECORD:  138
 USER LABEL:
 R/U FAY - 19   INS -TSD NAU/MG   17 JULY '76/13:47:3Ø - 4 AUG '76/11:57

 ENTER THE TSD CHANNEL NUMBERS TO BE STRIPPED FROM THE INPUT TAPE.
 MAXIMUM NUMBER OF CHANNELS THAT CAN BE STRIPPED ARE  8.
 THESE ARE 'CONTINUOUS' POSITIONS AND SHOULD NOT INCLUDE
 DISCRETE 'UPDATE' POSITIONS.  'SYSTEM' POSITION MUST BE FIRST.
11ØØ

 ENTER START AND END DATES TO FIND
 YEAR,MONTH,DAY,HR,MIN,SEC,FSEC,YEAR,MON,...


 ENTER TIME GAP IN 'MINUTES':

 WILL THERE BE A DISCRETE 'UPDATE' FILE. (YES/NO: YES

 ENTER DISCRETE INPUT FILENAME: 11

      -----  TSD HEADER INFORMATION  -----
 CREATION PROGRAM: DISTS      DATE: 1981/ 6/26   8:44:46.Ø24
 DEFINITION FILE: INSDEF       CARTRIDGE:  2ØØ
 NUMBER OF DATA CHANNELS:   3   DATA BLOCK SIZE:  54Ø   LOGICAL RECORD:  18
 USER LABEL:
 FAY 19  INS-TSD NAVIGATION UPDATES 7/17/76/13:47 - 4/8/76/11:57

 ENTER THE TSD CHANNEL NUMBERS TO BE STRIPPED FROM THE
  DISCRETE INPUT TAPE.   MAXIMUM NUMBER OF CHANNELS ARE  8.
12ØØ,1465,1115
 >TSD ERR:'':  Ø:1976 7 2Ø 4:42:  Ø.ØØØ
 ARE THERE MORE DATA?  IF YES, READY INPUT DRIVE NOW.  (YES/NO): NO

      *****  WORK FILE(S) LOADED  *****
 START TIME: 1976/ 7/17   13:45    5Ø.ØØØ
 END TIME:   1976/ 7/25    6:55    37.ØØØ

         *****  F I L E    B O U N D S   *****
      TOP          BOTTOM           LEFT          RIGHT
  34  54.453    31   9.199    -79 -55.394    -74 -1Ø.131

 ENTER NAME OF PLOT DEFERRED FILE:
```

Figure 1. Example of LOAD option

```
RU,NAVED,,,18Ø7
 PROGRAM NAVED  VERSION OCT 1979
 12 11 79   1439
HELP
LOAD
RESTRT
?RESTRT


 ENTER NAME OF PLOT DEFERRED FILE.


 READY FOR MENU? (YES/NO): YES
```

Figure 2. Example of RESTRT option

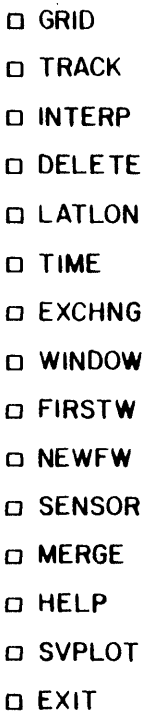

Figure 3. Editing-phase menu of options

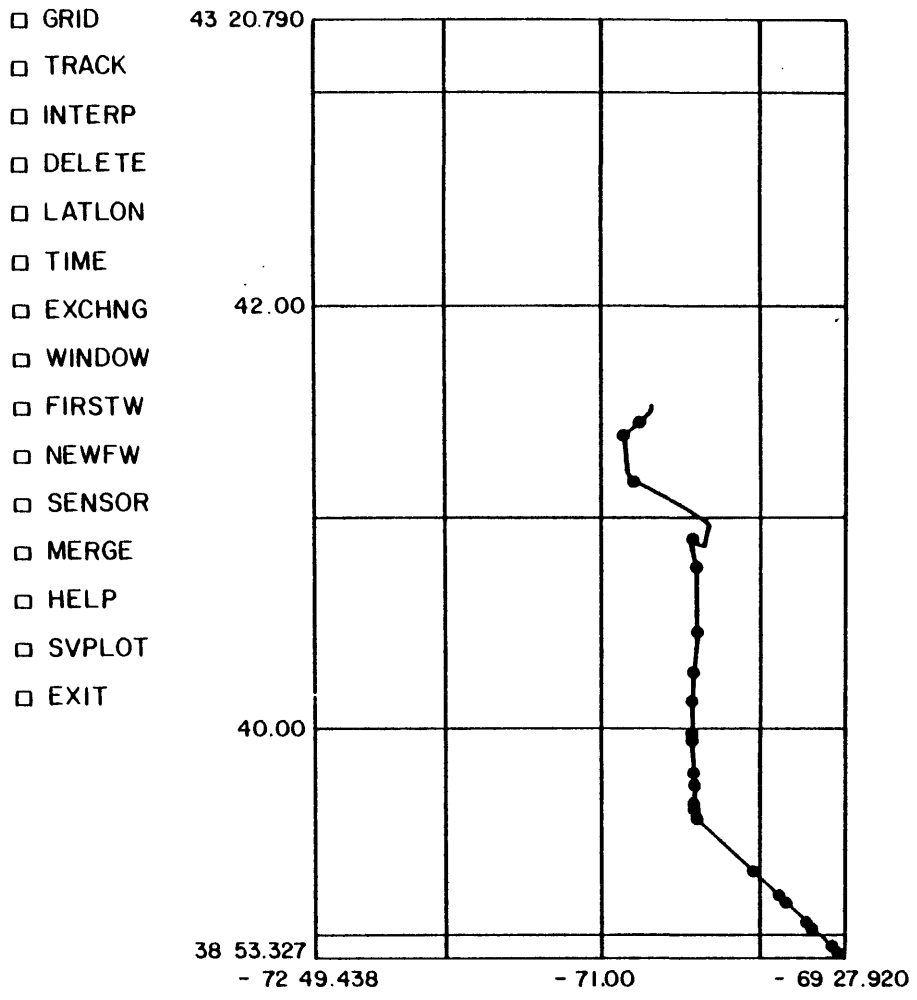

Figure 4. Sample plot

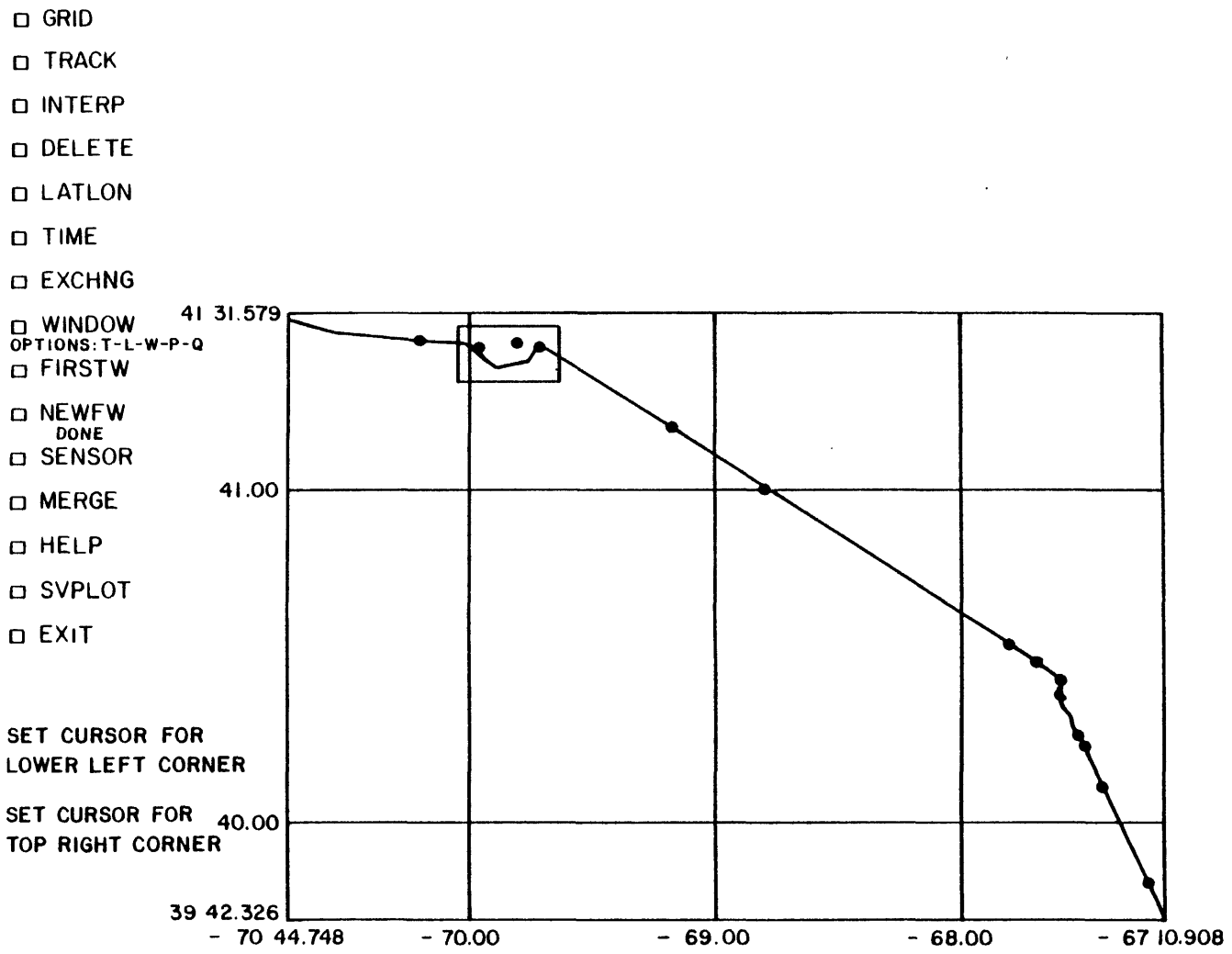

Figure 5. Selection of NEWFW option followed by selection of a new current window

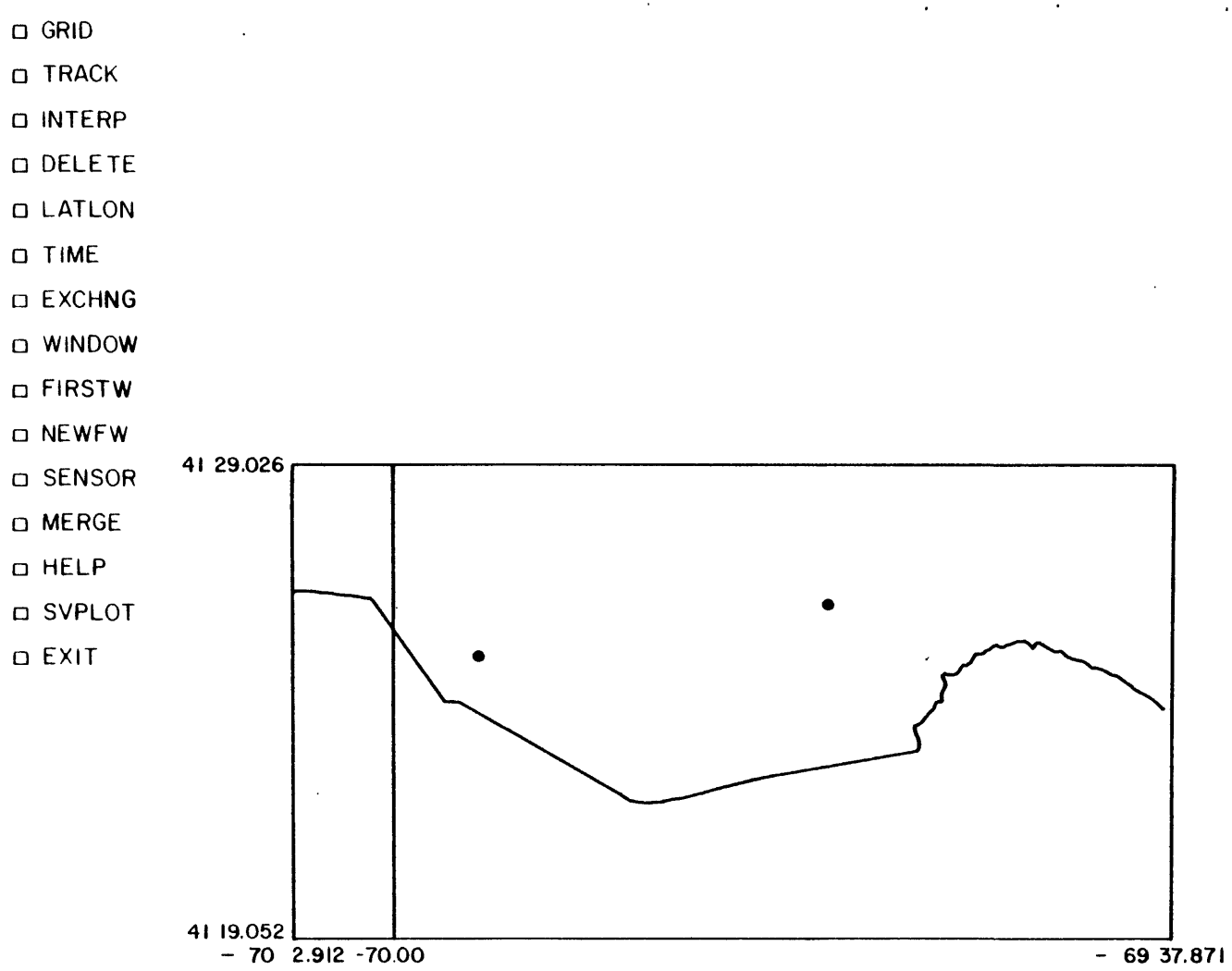

Figure 6. Display of data within current window by selection of TRACK option

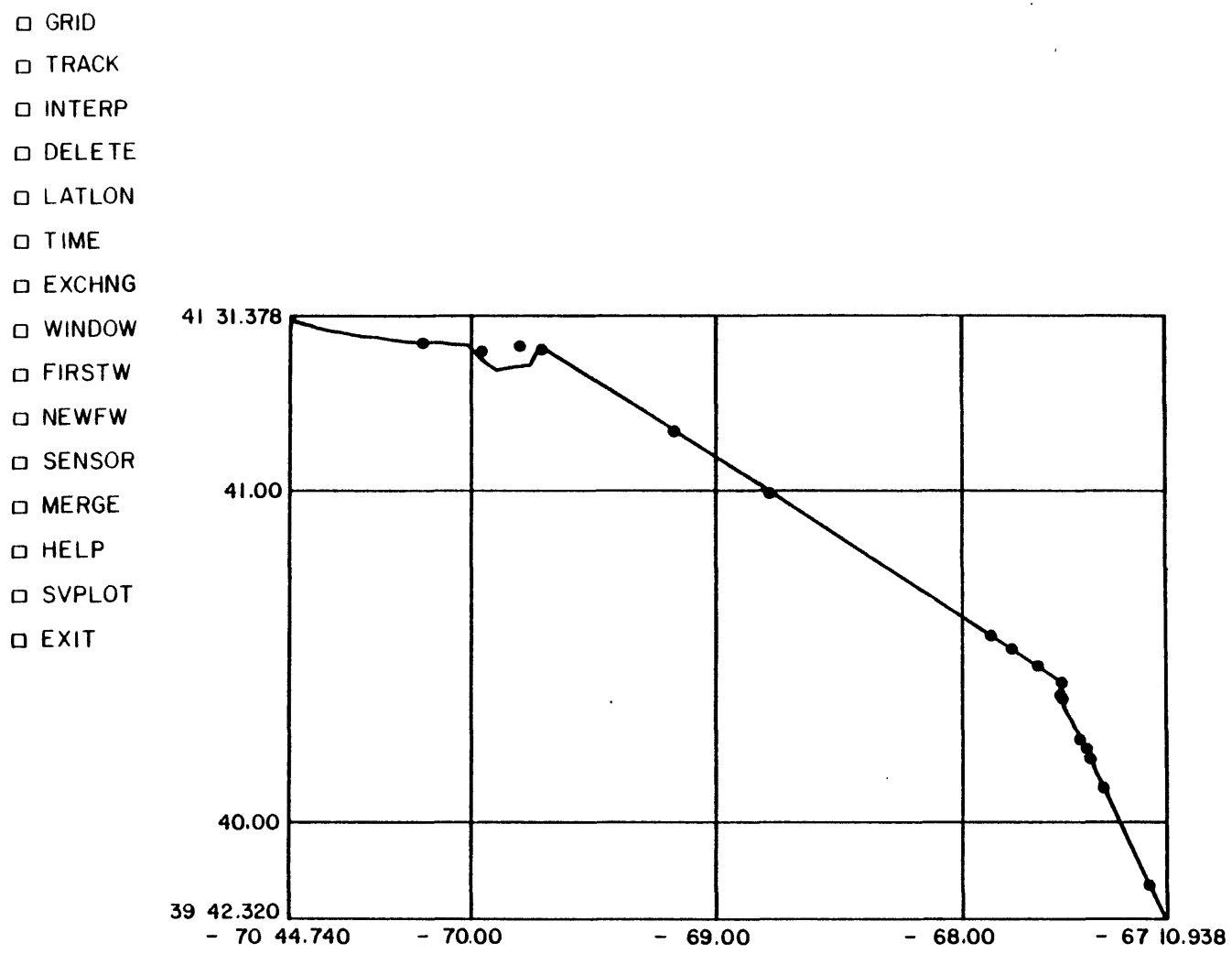

Figure 7. Return to "first" window by selection of FIRSTW option followed by TRACK option

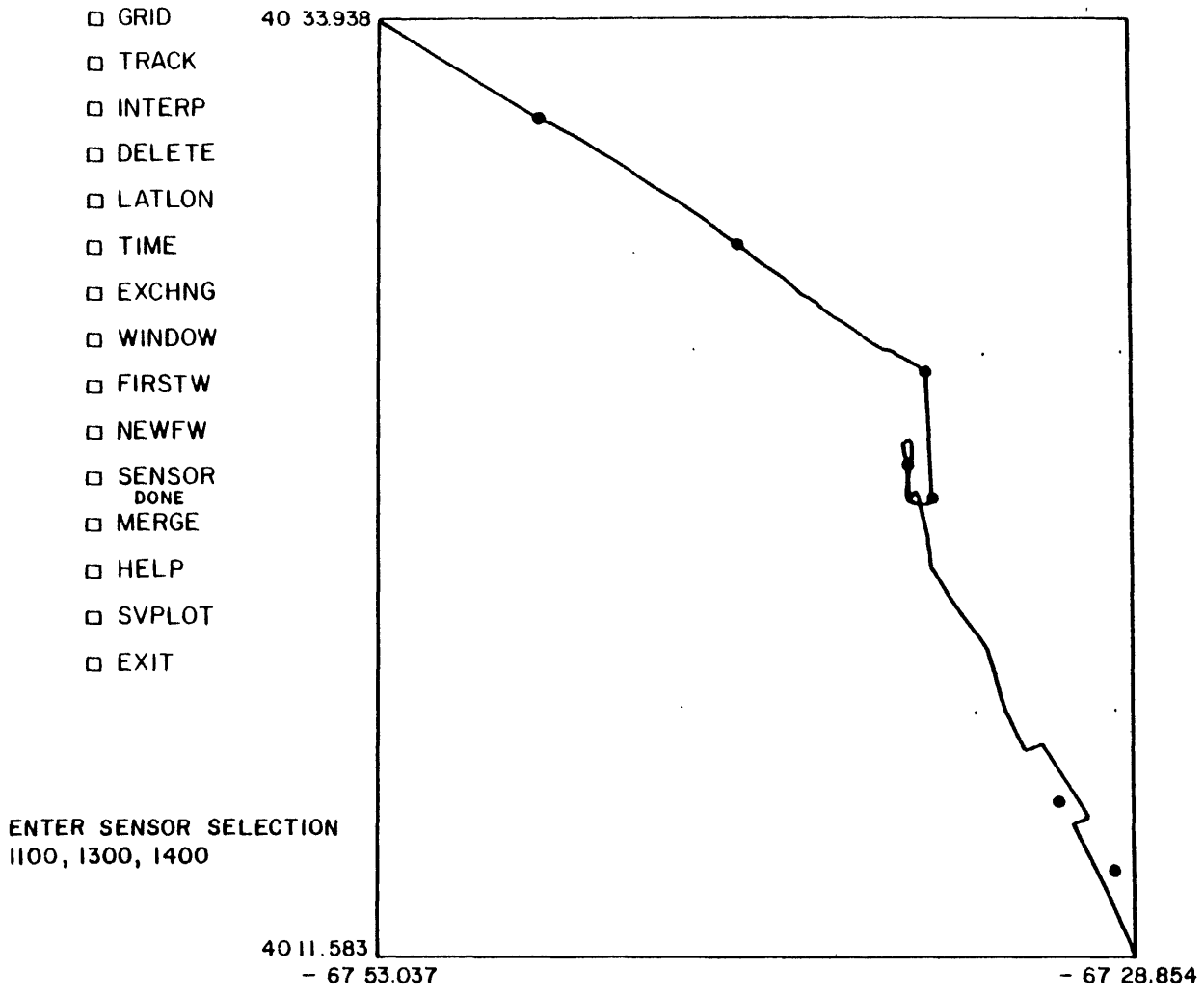

Figure 8. Selection of new sensors to be plotted (i.e., data channels 1100, 1300, and 1400)

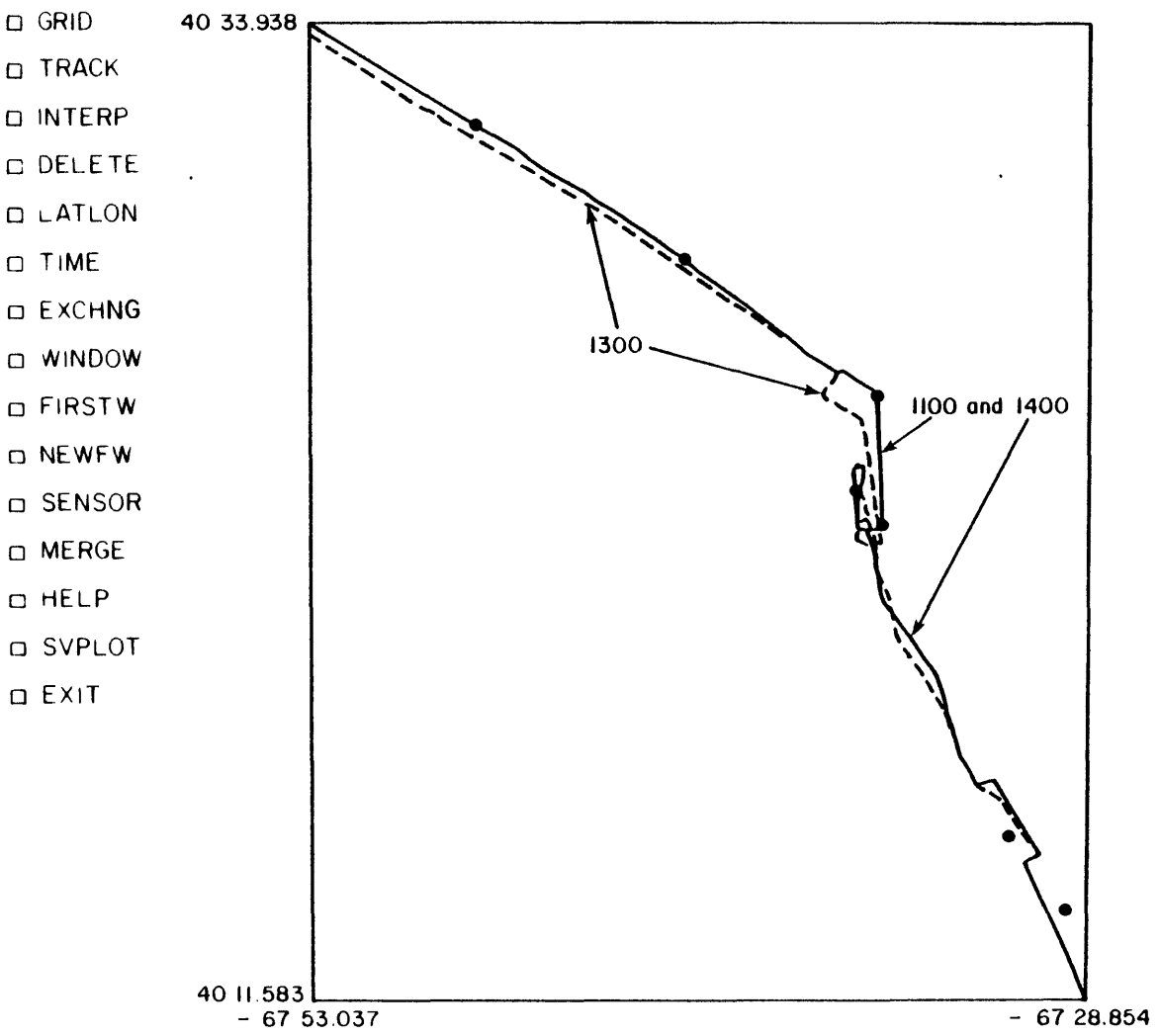

Figure 9. Display of new sensors by selection of TRACK option

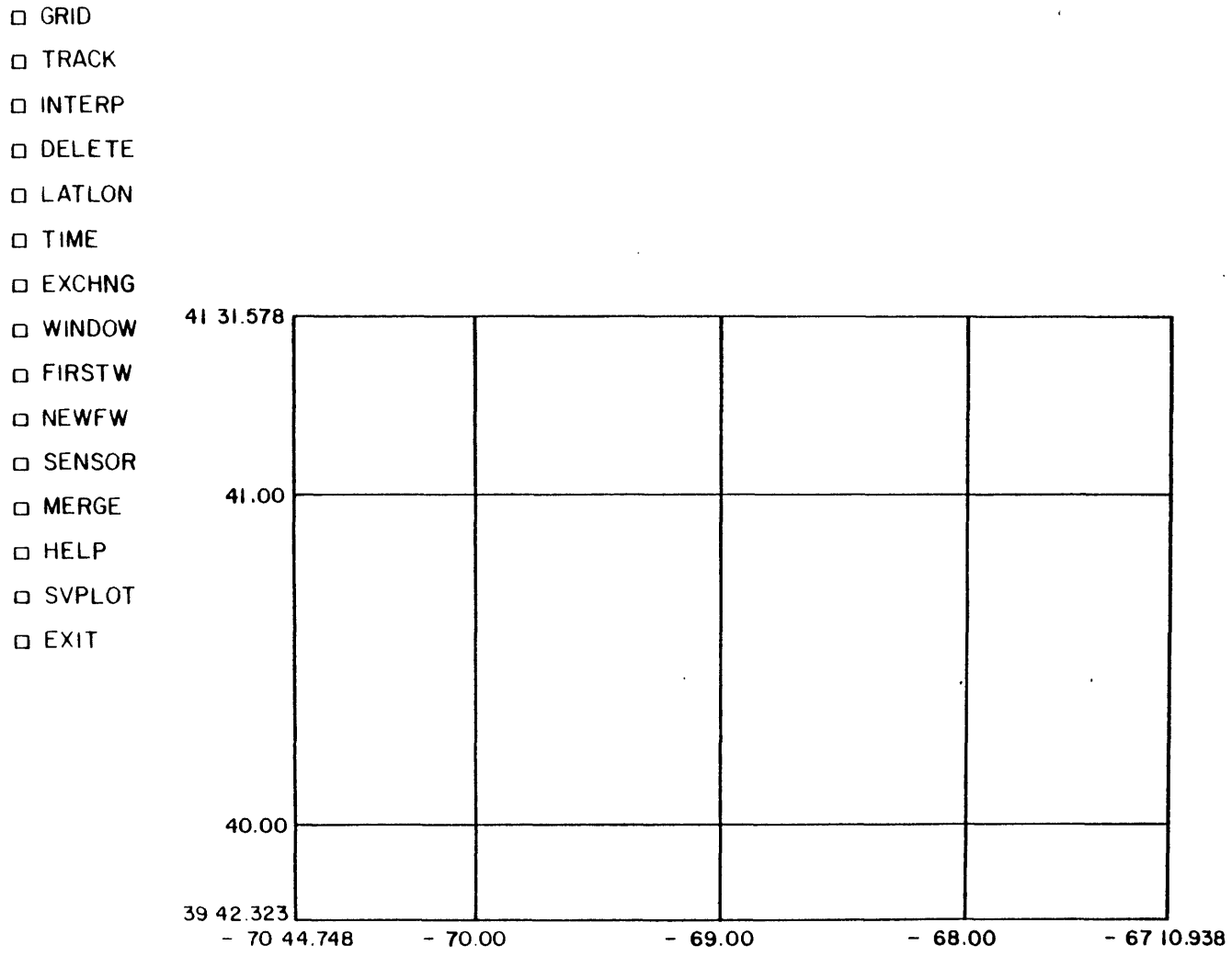

Figure 10. Example of GRID option

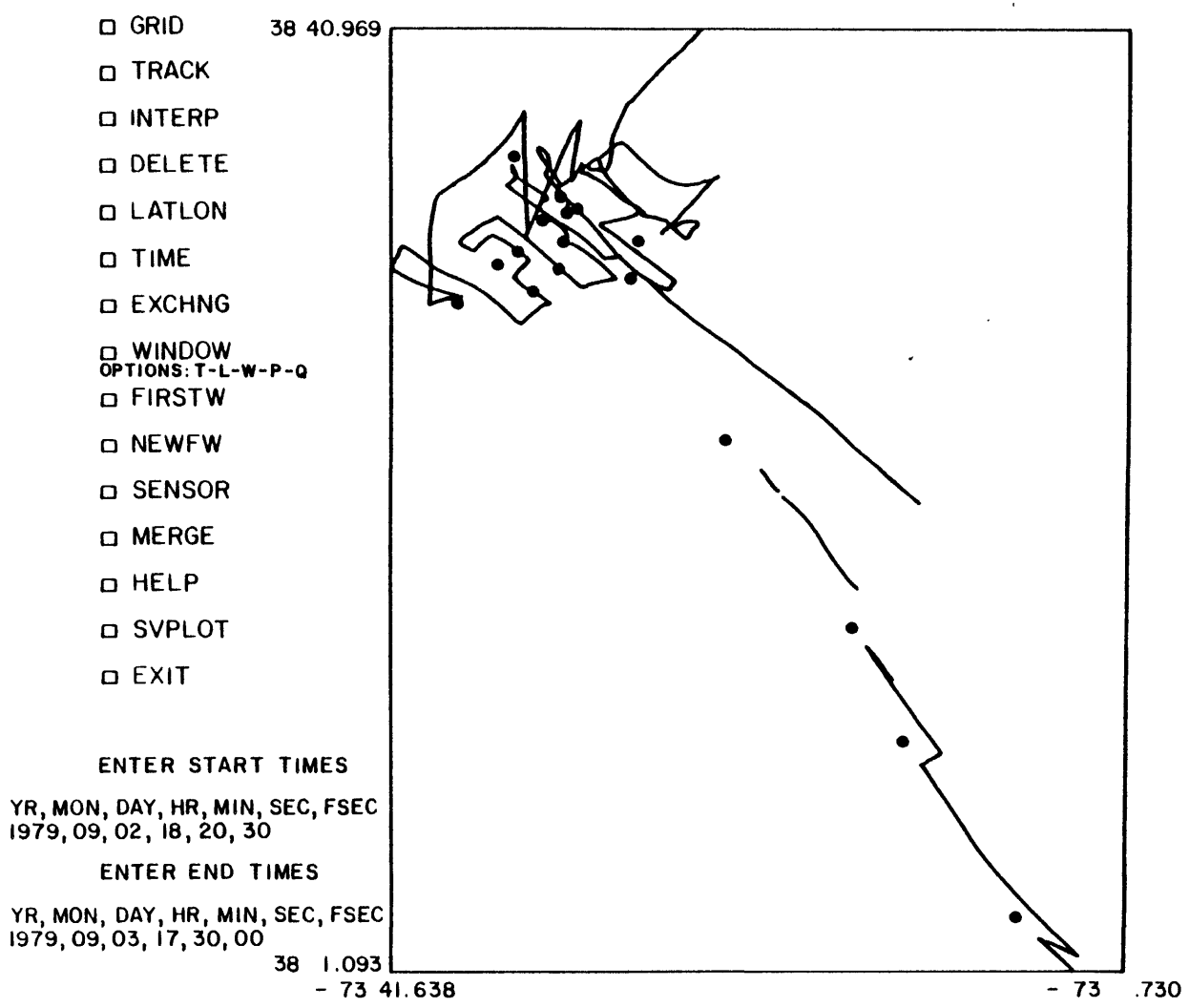

Figure 11. Example of WINDOW suboption T - before

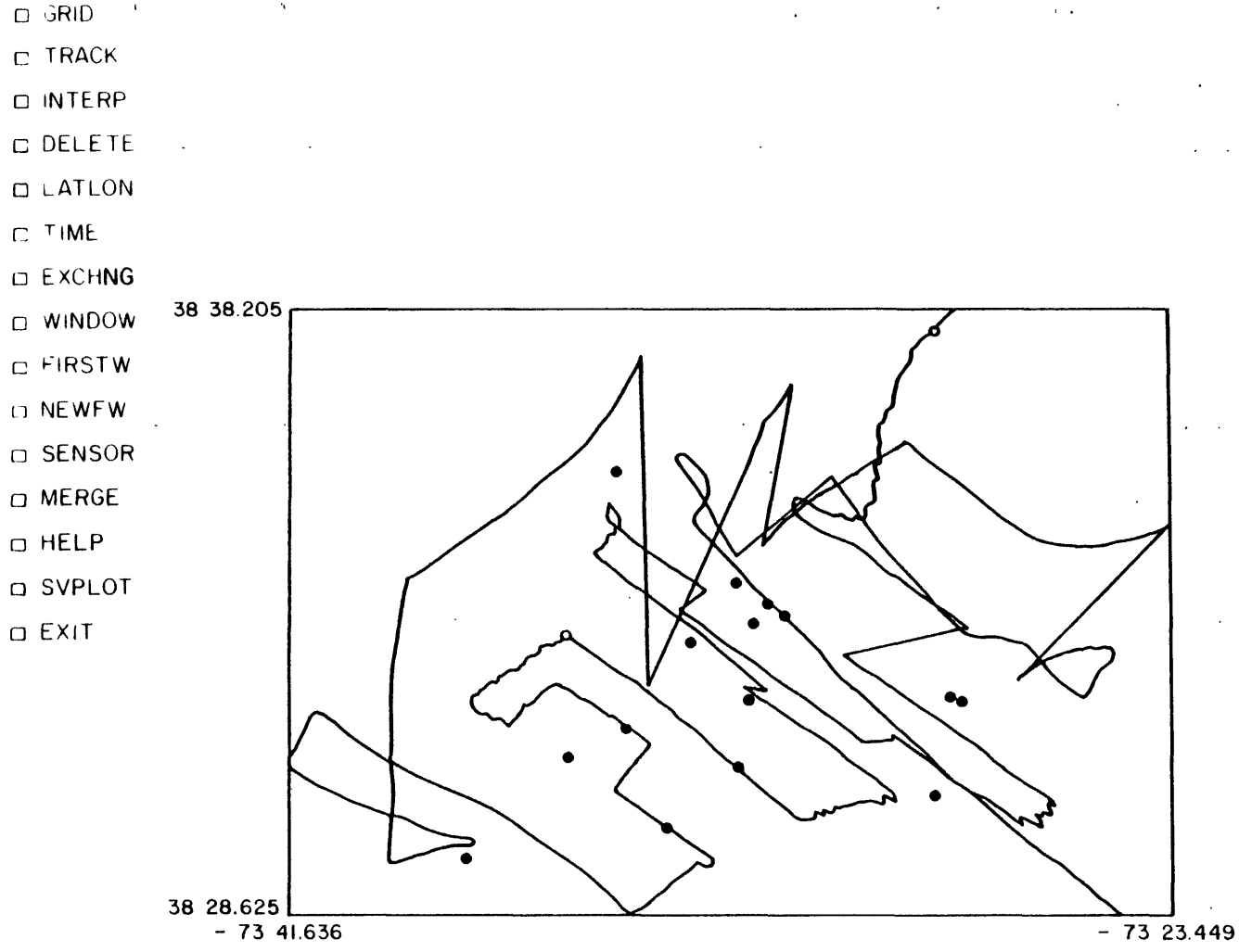

Figure 12. Example of WINDOW suboption T - after

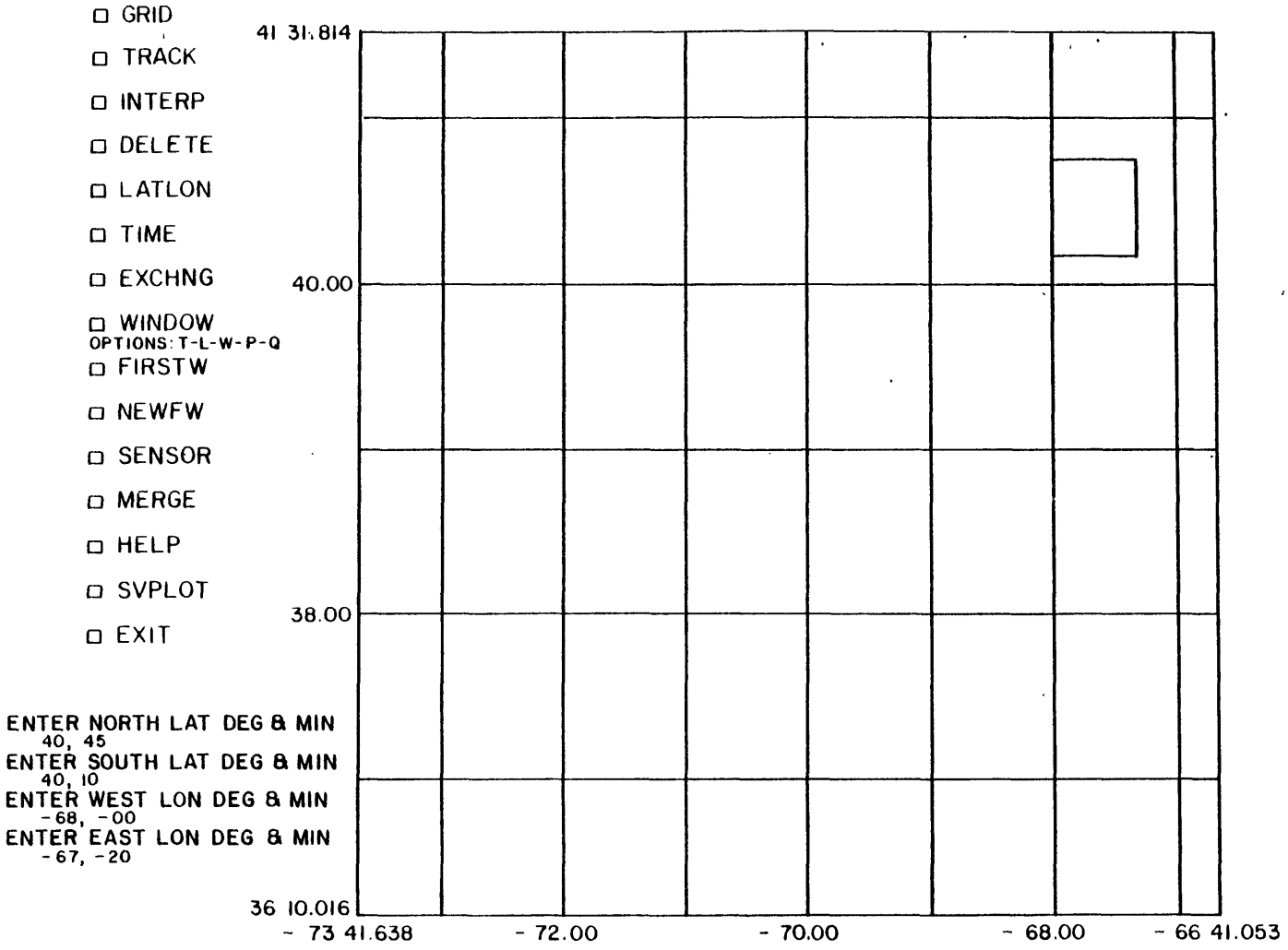

Figure 13. Example of WINDOW suboption L - before

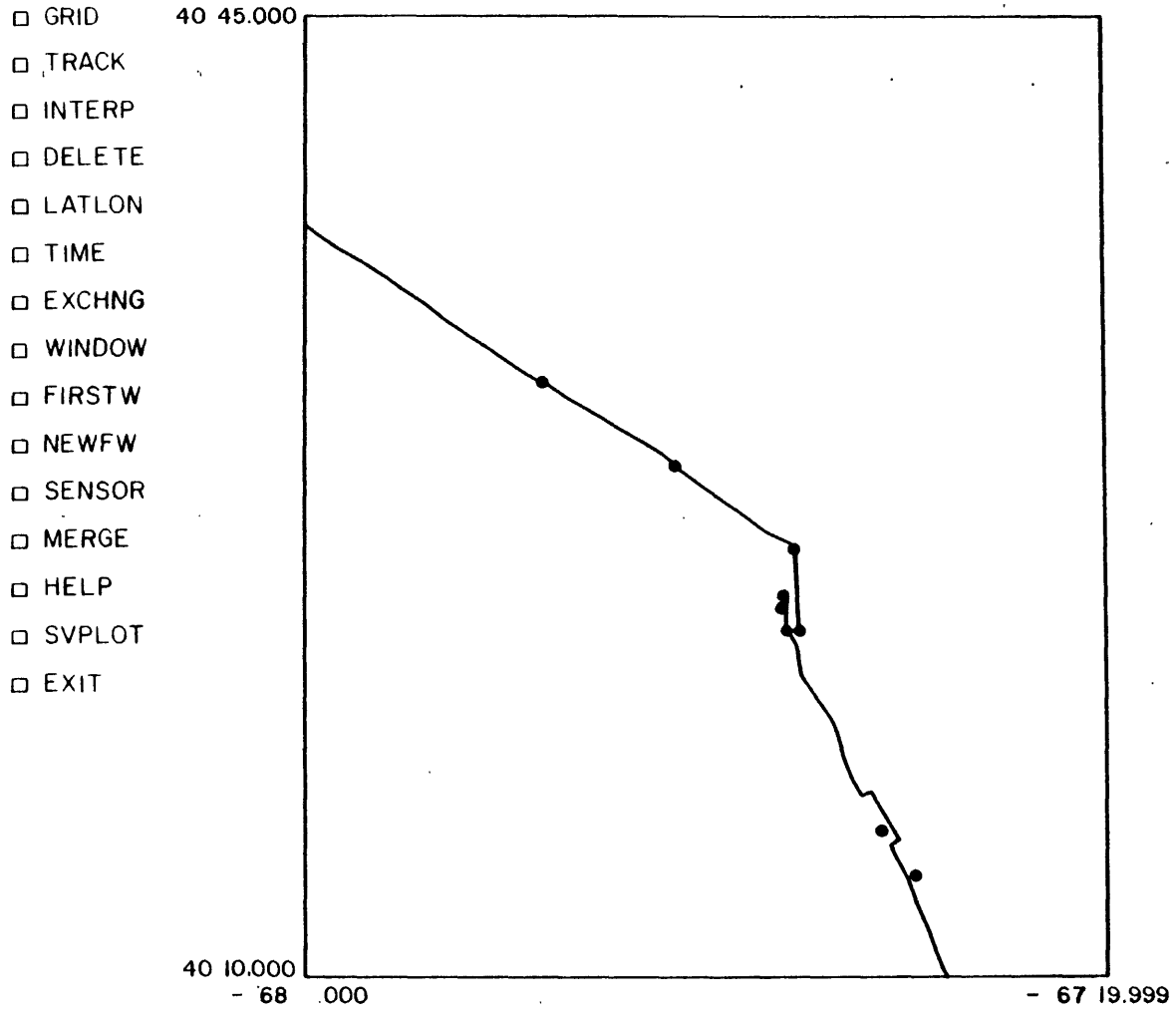

Figure 14. Example of WINDOW suboption L - after

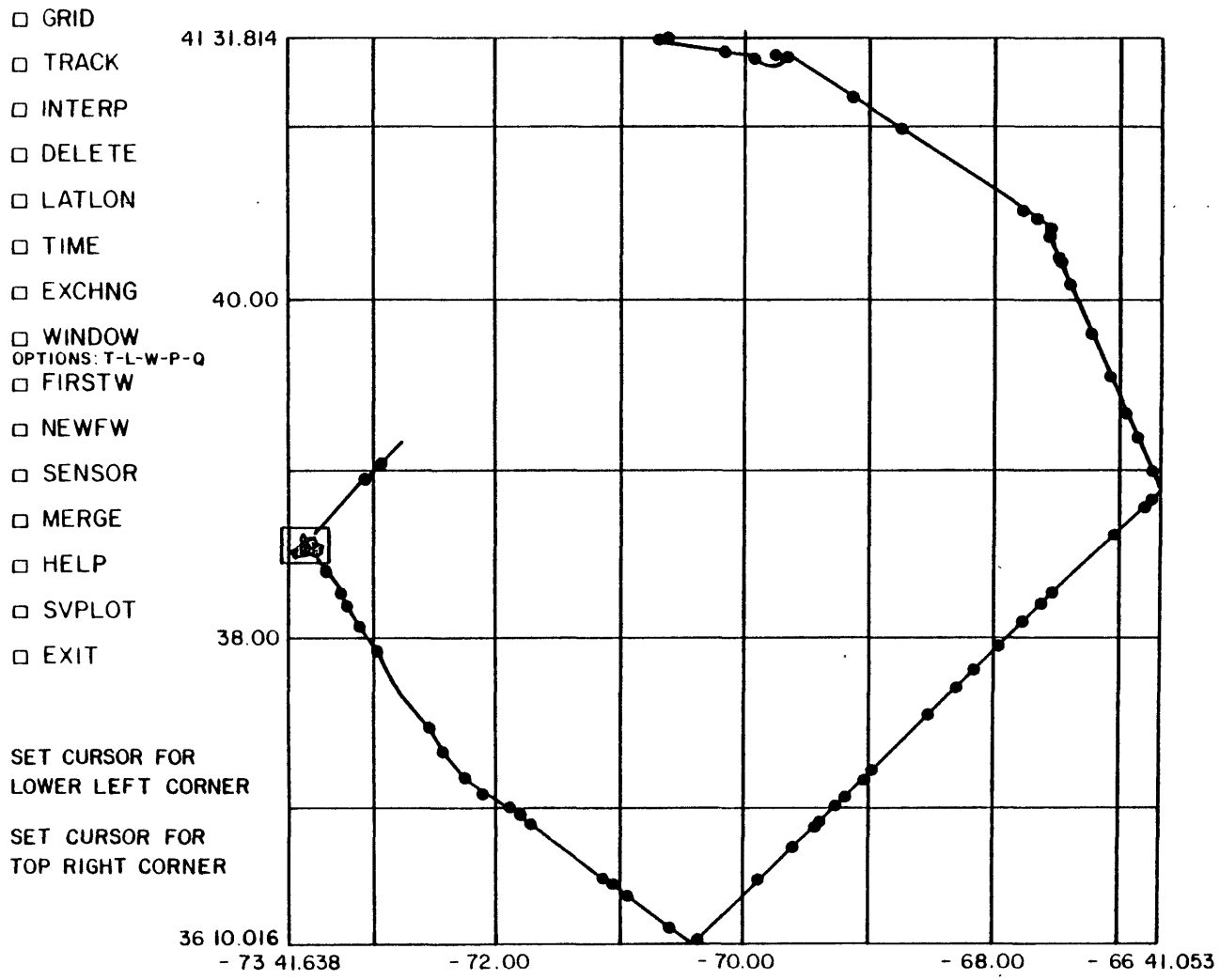

Figure 15. Example of WINDOW suboption W - before

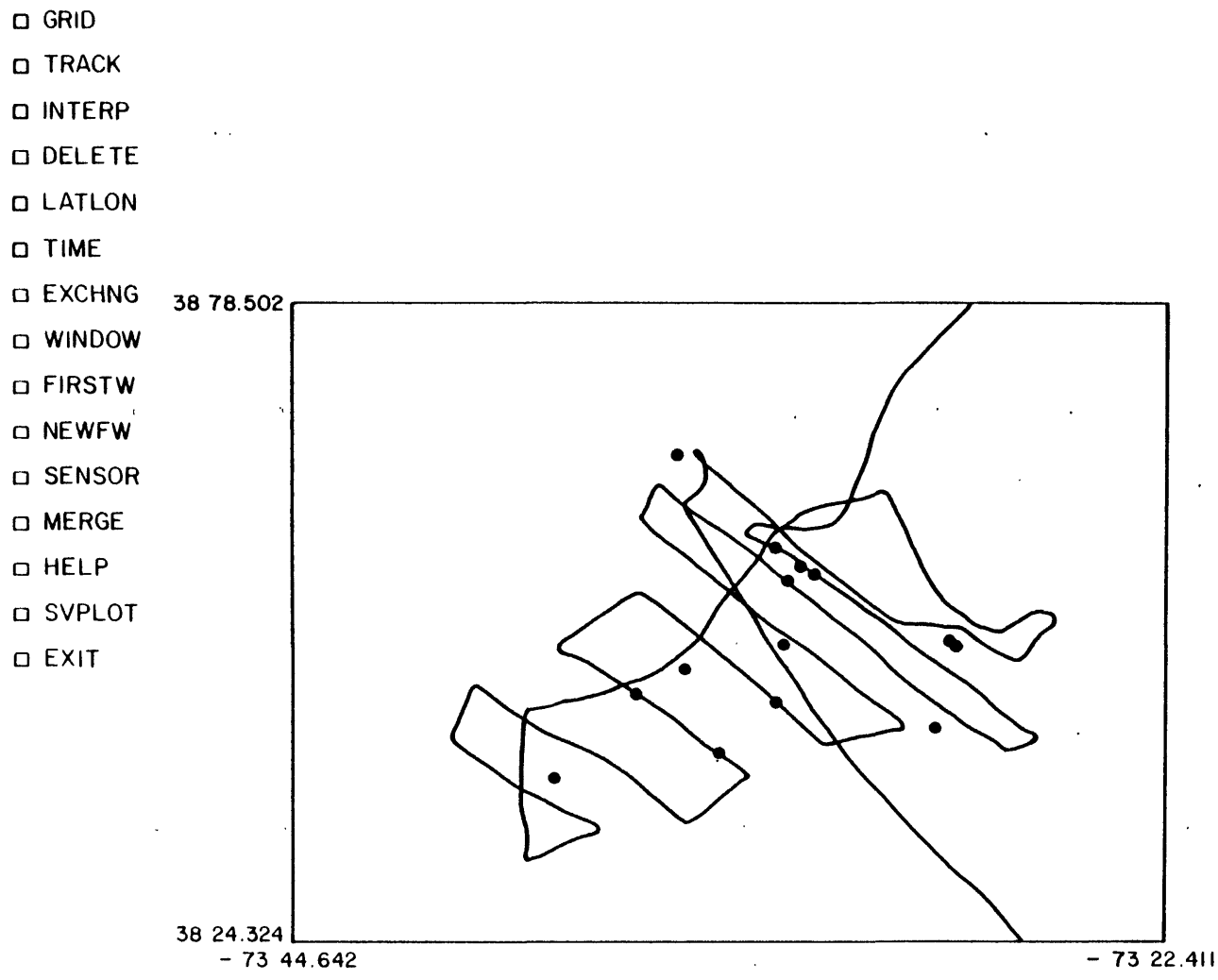

Figure 16. Example of WINDOW suboption W - after

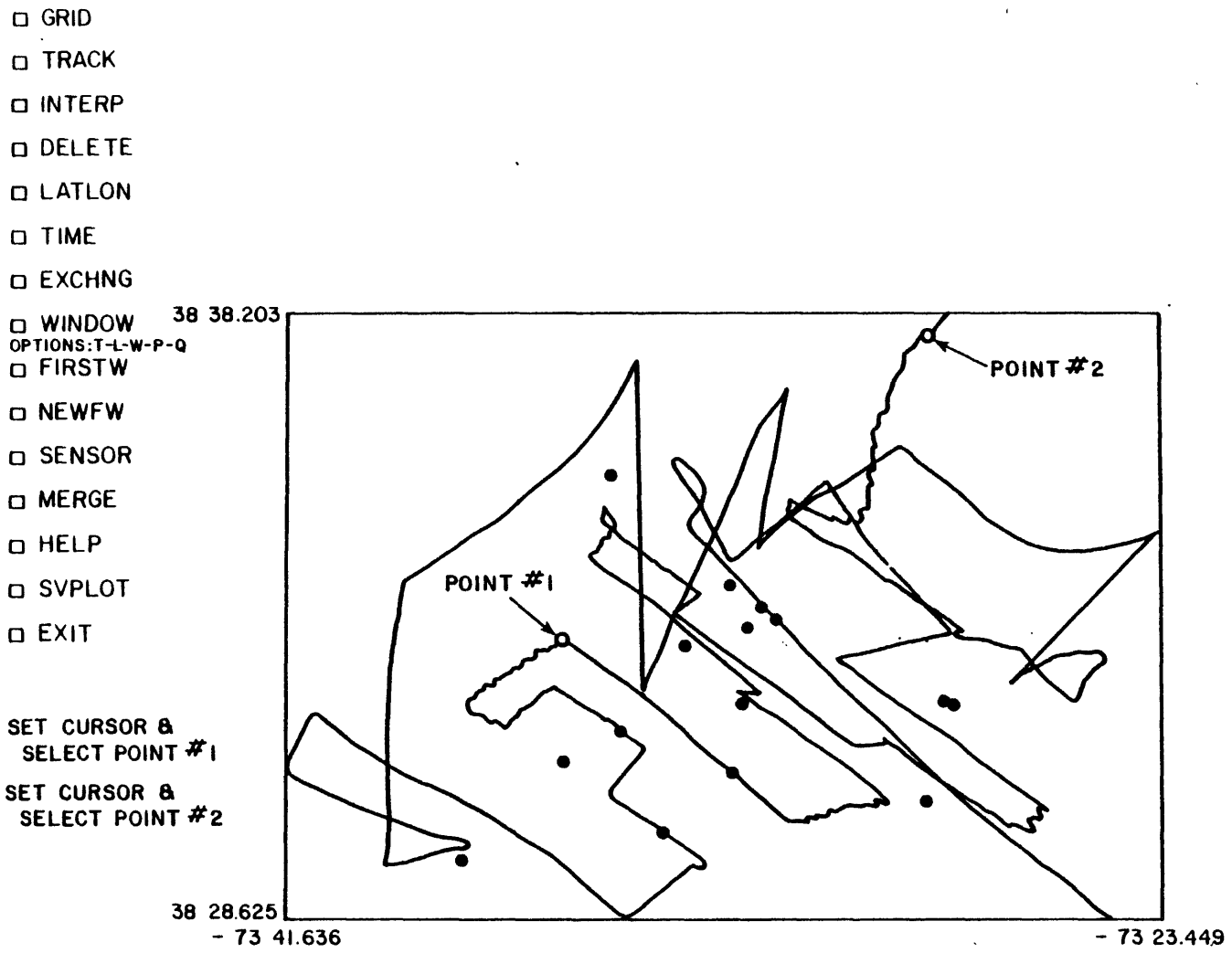

Figure 17. Example of WINDOW suboption P - before

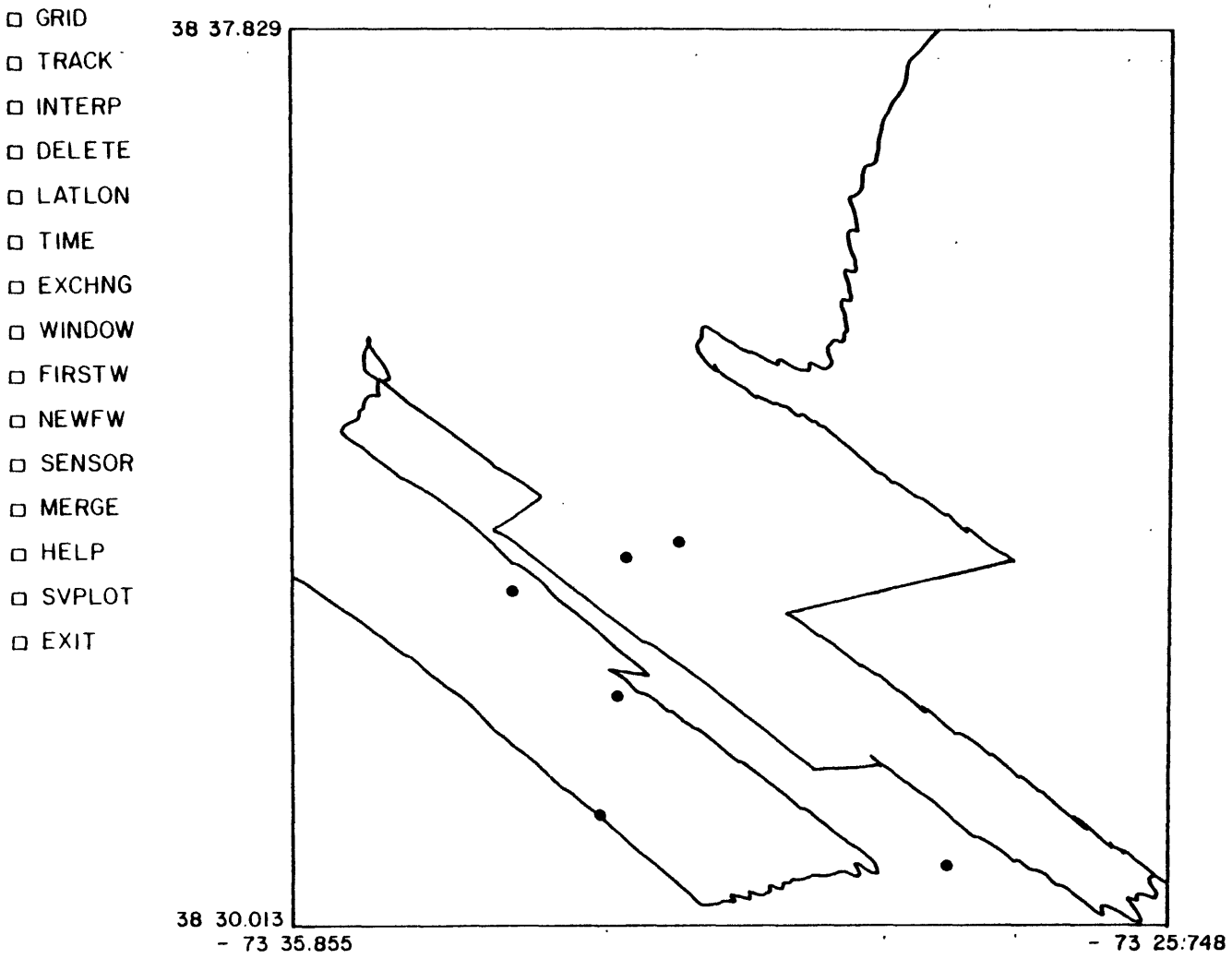

Figure 18. Example of WINDOW suboption P - after

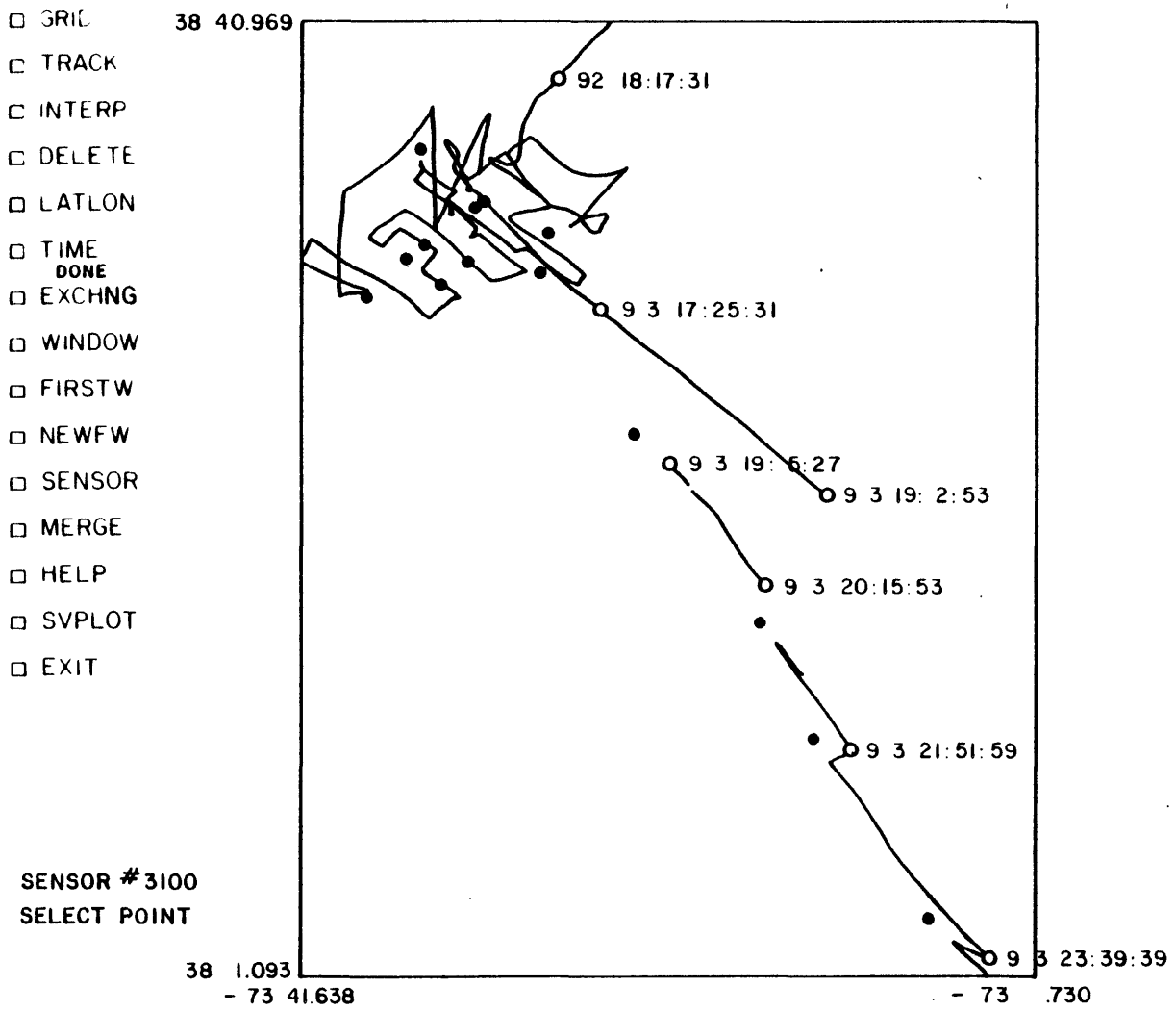

Figure 19. Example of TIME option

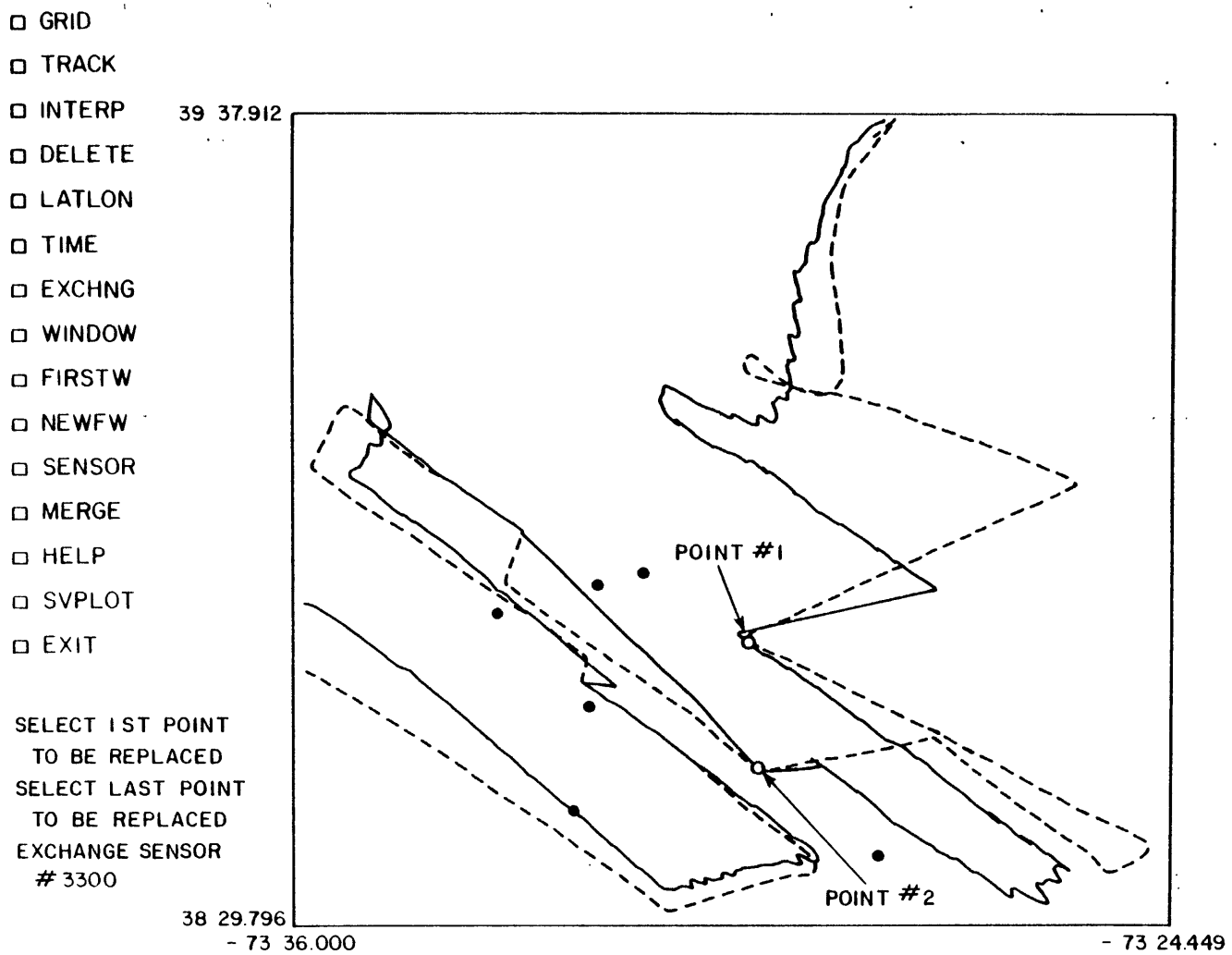

Figure 20. Example of EXCHNG option - before

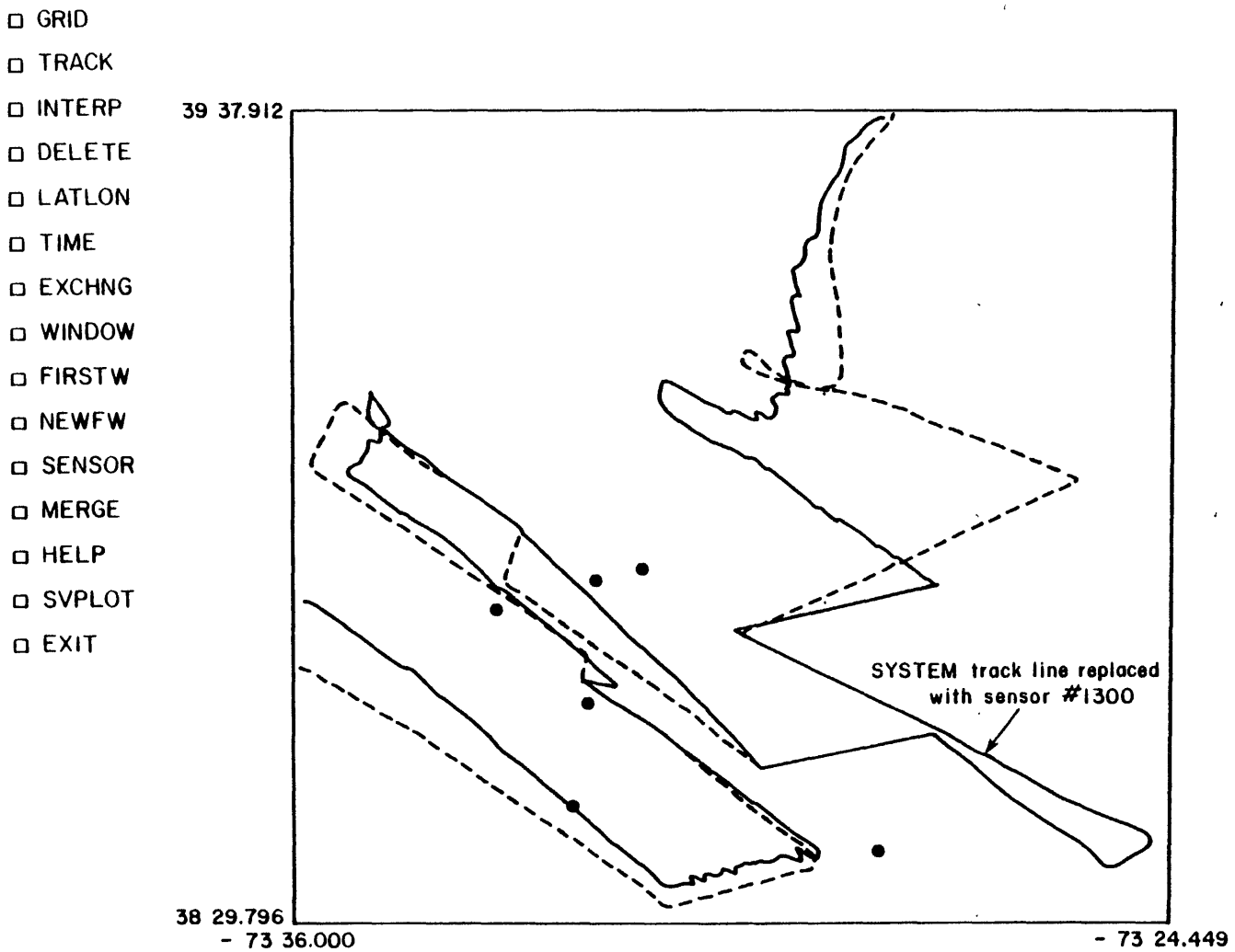

Figure 21. Example of EXCHNG option - after

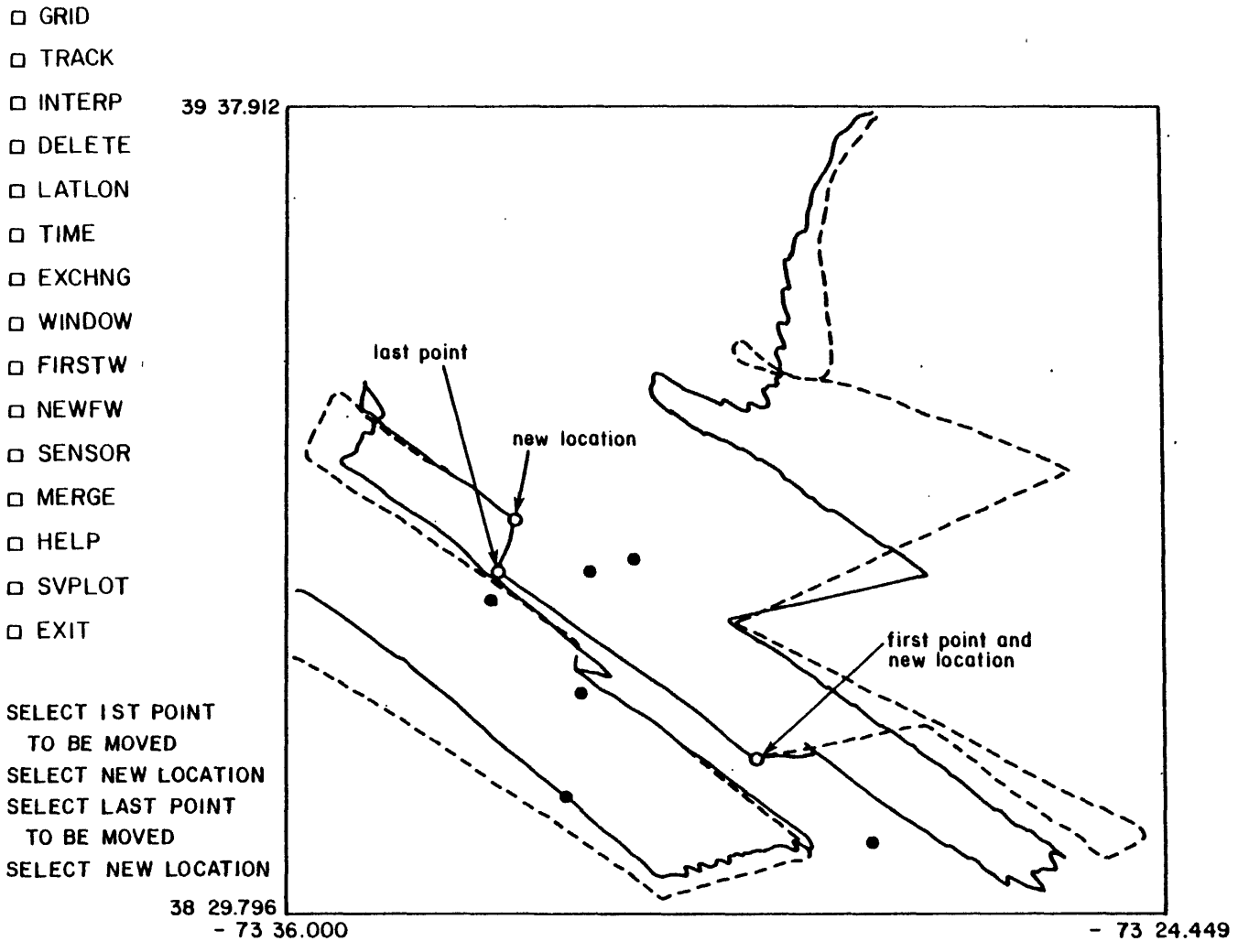

Figure 22. Example of INTERP option - before

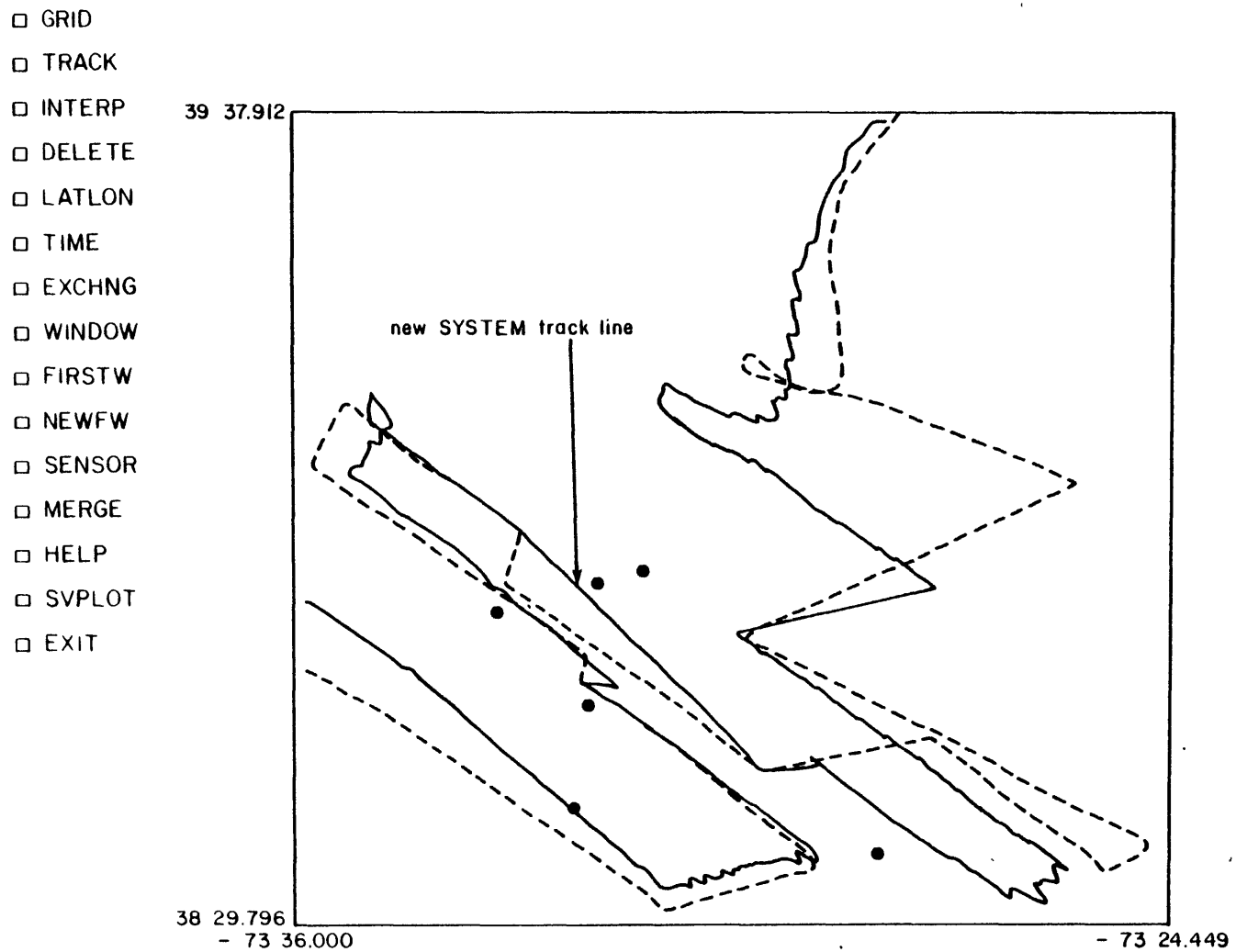

Figure 23. Example of INTERP option after TRACK option is selected