33

ICES STATUTORY MEETING 1993



C.M.1993/C:17

# "SKAGEX ATLAS" a software package for the presentation of results of the International Experiment in Skagerrak 1990-1991.

by

Marek Ostrowski

The Institute of Oceanology PAN
Sopot ul. Powstańców Warszawy 55
Poland

## ABSTRACT

The Skagerrak International Experiment (SKAGEX) was carried out in the Skagerrak-Kattegat in the period of 1990-1991. It involved four field surveys with up to 17 vessels performing simultaneous oceanographic measurements at sea. The resulting data set covers a wide range of environmental parameters from hydrography to marine chemistry and biology. It comprises results from more than 2000 oceanographic stations with samples being taken at multiple depth levels. In order to make this huge dataset easy accessible to all scientists participating in the experiment a software package has been written that integrates functionality of a database with the presentation methods typical for oceanographic applications, such as XY charts, sections, time plots and horizontal distributions (maps).
This presentation, based on the user's manual of the "SKAGEX Atlas" demonstrates its basic features and gives examples of its use in studies on synoptic scale variability in Skagerrak and Kattegat. It indicates also in what ways the use of this software may be extended to other oceanographic datasets.

## Introduction

The international marine experiment in Skagerrak (SKAGEX) was conducted in a series of field surveys between May 1990 and May 1991. During each survey scientist from nine nations, from boards of the research vessels, were conducting an extensive programme of the *in situ* sampling that included hydrophysical, chemical as well as biological parameters. One of the main aims of SKAGEX was the recognition of the time variations of the Skagerrak-Kattegat water masses in the short, synoptic scales. In accord with that, a regular sampling programme covering carefully selected net of stations was being carried out once in every three days. There was eight main sections spanning the Danish, Swedish and Norwegian coasts, beginning from the whereabouts of the Laso Island in the East towards the western-most section extending into the North Sea domain. On all sections the vessels operated simultaneously with spacing between the stations in the range of 5 nautical miles. In addition to that, in particular during the SKAGEX I (May-June 1990), other ships not involved directly with sampling on the sections, were collecting samples at additional locations , bringing the total number of ships at sea during the most sampling-intensive days to the 17. The observations were also made in the days between the obligatory sections. The was no detailed scheme of investigation during these times; each scientific crew carried out the program according to their national agenda, still the data than collected were made available to all participating parties.

Evaluation of samples and primary processing of on-board data were worked up by the participating groups. The CTD casts reduced to one metre bins and the water bottle level data for chemistry and biology were submitted to the ICES data management group where they underwent the final quality check and were put together to form a coherent database to be released to the all member institutions. This scheme worked well and timely, so that by November 1991, only after four months after the last field survey, the diskettes containing full SKAGEX dataset with hydrographic and chemical data plus chlorophyll, with all surveys included, had been supplied to principal scientist from the member institutions.

Having the database compiled the objectives were set for scientific evaluation of the data. Whilst the most evaluation work was to be carried by separate scientific groups in their base laboratories, in several topics a close cooperation at international level continued. Among such topics were the studies on overall circulation pattern and hydrographic events taking place during SKAGEX. To a support this work the author proposed the use of an already existing custom software package, developed at IO PAS, specially designed to automate the process of the oceanographic cruise results reporting The proposition was accepted by the study group during the group meeting in November 1991. In April 1992, the first version of the package containing the SKAGEX dataset plus presentation software was ready for distribution. It was soon followed by a draft copy of an atlas showing the daily variations of the major parameter fields during SKAGEX I. It contained over 1000 maps with the horizontal distributions of temperature, salinity, density, nitrate, nitrite, silicate and phosphate at several depth levels ranging from the surface down to 200

metres. The preparation of this atlas including printing and binding was accomplished within a week.

In the following pages the user's manual for the "SKAGEX atlas" is presented. All examples in the manual relate to Skagerrak and the SKAGEX database. The software itself, though, was written with the general model of oceanographic data in mind, and may be reused for other oceanographic datasets without much additional programming effort. The basic requirement is that the data supplied must resemble a simple one-to-many relationship, with a station header information containing at least the platform/event name, the location and the time of measurement as an index, and pertaining multiple data cycles on the right hand side of the relation. The program imports such data for flat ASCII files and builds in a relational database in its own format. The author has tested this system on several datasets; one example of its use will be shown on the poster session during the ICES meeting. [Ostrowski at. all 1993]. However, the import facilities are not yet documented neither sufficiently tested for their inclusion in the next release of the SKAGEX atlas package.

**References**

Ostrowski M., Danielssen D.S., Svendsen E. "Application of the "SKAGEX Atlas" package in studies of long water mass variability along a section in Skagerrak", The poster to be displayed during the theme session "Computers in Fishery Research", the ICES Meeting 1993, Dublin

## About this version of Skagex Atlas

Version 3 of the "SKAGEX ATLAS" is based on the results from the experiment downloaded from ICES database in January 1993. The data are subdivided into the four following categories:

- SKAGEX I with 1586 stations from 18 May to 25 June 1990
- SKAGEX II with 127 stations from 10 to 17 September 1990
- SKAGEX III with 98 stations from 12 to 20 January 1991
- SKAGEX IV with 299 stations from 17 to 20 May 1991

In contrast to previous versions, there is no separation into chemical and physical datasets; all data relevant to a selected station are accessible in the same database. The field structure for each database is given below:

Depth
Temperature
Salinity
Potential temperature
Density
Potential density
Oxygen
Phosphate
Phosphorus
Silicate
Nitrate
Nitrite
Ammonia
Nitrogen
Chlorophyll A

## Installation

The package runs on PC machines with processors 80286 or higher. All programs and data take about 12 MB memory on your hard disk. The package can be executed even on small notebooks provided that there is enough conventional memory (more than 560 KB) and a numeric processor is installed.

To install the package, insert the disk labelled #3 (not #1) into floppy drive, log onto that drive and type:

```
UNPACK X:
```

where X: stands for the letter of your hard drive. The decompressing utility (UNZIP.EXE) will ask you to change installation diskettes three times more. The atlas creates a path SKX on the root directory of your hard drive. To run it one should change to this path and type the command: SKX . Always run SKX program from this directory. The atlas program uses a large portion of conventional memory during execution, and its is not safe to run it from within the memory resident utility such as Norton Commander or XTPRO. The package behaves correctly under Microsoft Windows 3.1, only when is executed in full screen mode.

The new version of the Atlas similarly to older ones requires the SURFER package (Golden Software ver. 4.0,1989). If this product is not present or not registered, the program issues the following warning:

Error during initialisation, invalid item: PRN

To register SURFER" go to [OPTIONS | DIRECTORIES] and type in its proper path.

## Basic operations and screen layout

The main screen of the atlas consists of the top menu bar from where commands are selected, and the status line at the bottom showing names of several keys used for accessing some of the commands immediately. In the centre of the screen a window is displayed with information on hydrographic stations during SKAGEX. You can zoom that window by pressing F5 , drag it around the screen, shrink or expand, and close (remove from the screen). The **WINDOWS** menu on the top bar does operations on windows, but most of these functions can be accessed faster by using so-called "hot keys". Names of hot keys are listed to the right of the appropriate command from the menu bar. For example to close a window you should press Alt-F3. To access the main menu press F10 , or hold Alt key while pressing the focused letter of an item you are going to select. To quit the program press Alt-X or go to the **SYSTEM, EXIT** menu command on the top menu bar. This version of the program is provided with the context sensitive help system which can be invoked by pressing F1. Fig. 1 shows the main program screen of the
atlas with the WINDOWS menus popped

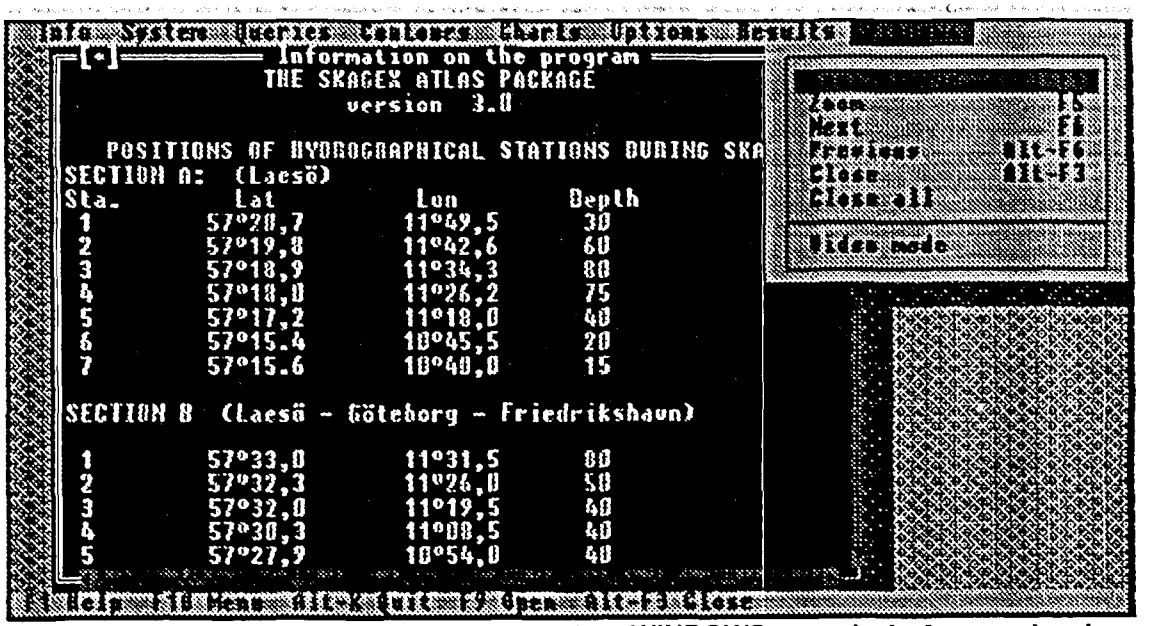

Fig.1 The main screen of Skagex atlas package showing **WINDOWS** menus in the foreground and information window in the background

Work with the atlas is subdivided into the three distinct stages:

- data selection stage

- processing stage
- presentation of results

The databases of the atlas contain almost all physical and chemical data available from the SKAGEX experiment. The access to the required portion of this dataset is possible by definition of a time span, geographical range and ship name (*data selection stage*). Selected data are then processed as horizontal distributions (maps), transects and time-depth plots (*processing stage*). In most cases results of processing are stored to files and to examine the result one needs to call the appropriate viewing or printing function after the processing (*result presentation*).

## *Data selection stage*

As the first step in an attempt to access the SKAGEX dataset, one must select the variables, time span and location for the data. For making selections the atlas provides a special **selection window**. To activate this window, you need to press Alt-F9 or select the **QUERIES, NEW INVENTORY** command from the main menu. A window will appear on the screen. (fig.2). It has its own menu bar with two menus: **SELECT** and **FILES**, a list box where you can see your selections and four buttons: **Insert**, **Modify** , **Delete** and **Open**.

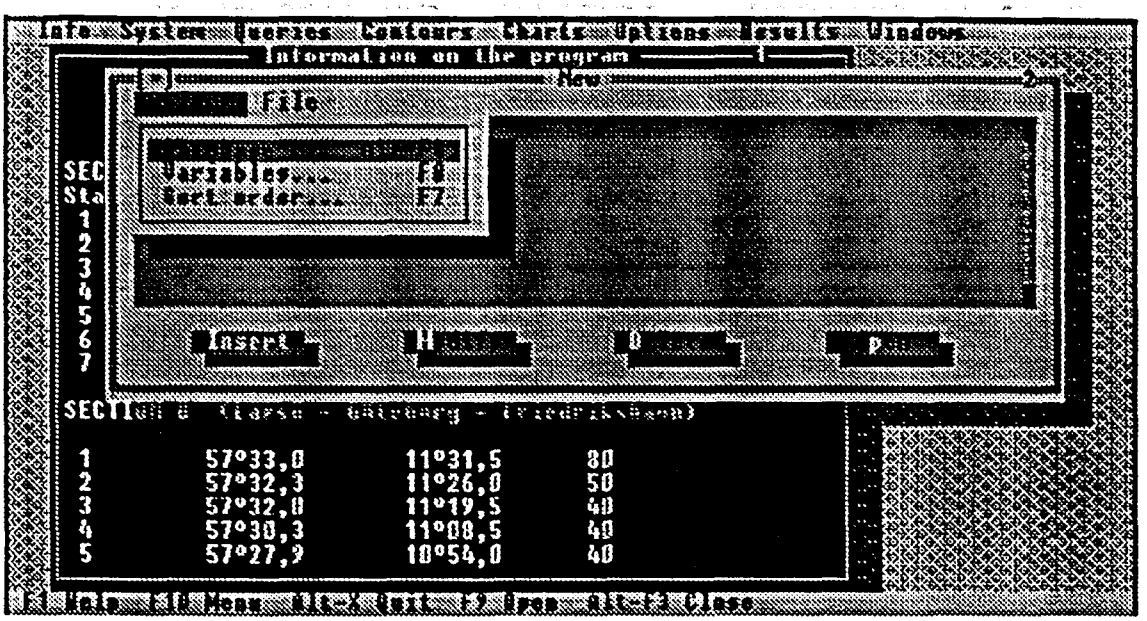


Fig.2 The selection window with **SELECT** menus in the foreground.

The first step in the data selection is the choice of the relevant database. Make your choice by pressing Alt-F8 or Alt-e followed by D and pick the appropriate item from the list: in (fig.3) The **VARIABLE** command will show a list of variables from the selected database.
There are cases when the order of stations on inventory list has to be different from that of the database. In the databases all data are sorted by the ship name , than subsequent stations increase with time. This order may be altered, by selection of one of the options available on the **SORT ORDER** selection list. The following orderings are provided:

time
longitude
latitude

latitude than longitude
longitude than latitude
longitude than time
latitude than time
longitude then latitude than time
latitude then longitude than time

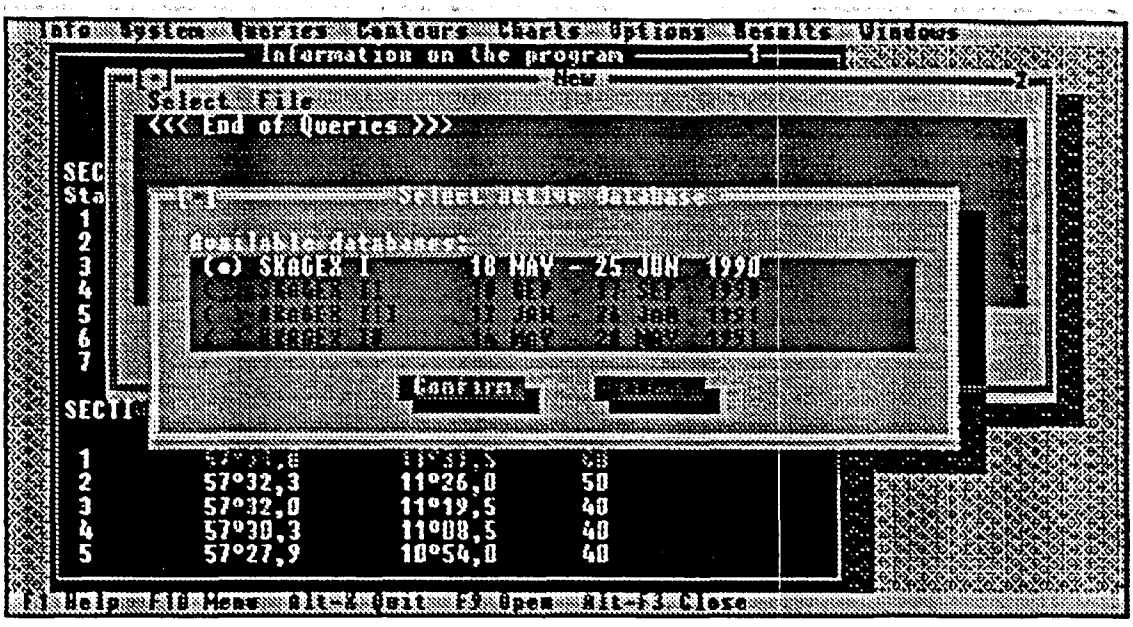


Fig 3. Selection of database from the selection window

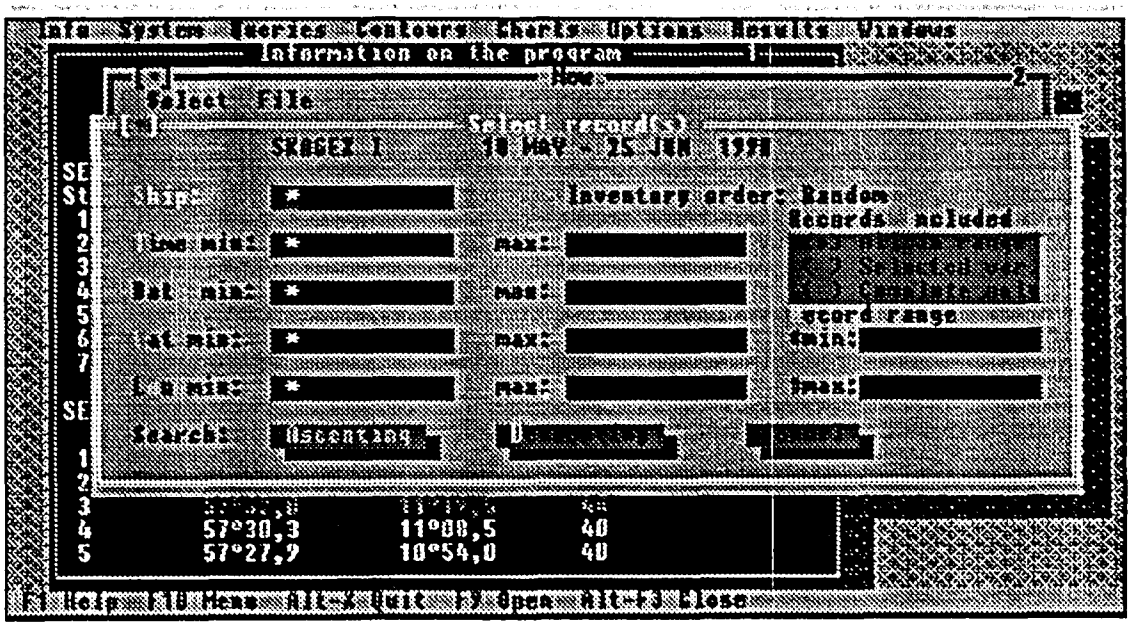


Fig.4 A dialog for selection of ship, time span and geographical range

To complete the selection, one must also specify a time span, a rectangle in geographical space, and the names of ships, which are to be included in the search. You can construct compound queries by chaining several rectangles and time periods to the one list.
Suppose that one wants to select the data collected by all participating ships on May 27 1990. By pressing I or **Insert** button. (fig.2), a new dialog window appears on screen (fig.4) The asterisk '*' in the min (minimal) field symbolises selection of all stations regardless of heir position in the time-space-ship coordinates. To specify a particular date one should alter the value in the Date min field . The date is entered in the inverse order: year first than month and day. There must be exactly three pairs of digits per entry, each pair being separated by any character symbol you wish. Thus:

900527
90 05 27
90/05/27

are all legal whereas 90052 is not. The same holds true for Time and Lon, Lat (longitude, latitude) entries. There always must be six digits denoting in the case of time: hours, minutes and seconds and in the case of geographical position: degrees, minutes and tens of a minute. The ... max fields may stay blank. By setting them one selects, a date, time of the day , longitude or latitude ranges for the selection, rather than single values. Valid ship names for this version of SKAGEX atlas are:

| | |
|---|---|
| ARGOS | HUMBOLDT |
| ATAIR | HYDROMET |
| TISELIUS | J.HJORT |
| A.VEIMAR | L.TITOV |
| DANNEVIG | OCEANIA |
| G.O.SARS | SIEDLECKI |
| THORSON | SVANIC |
| MOSBY | BRAARUD |

All must be in capital letters.

Two remaining objects from the input form are included to limit the search to oceanographic stations that meet certain conditions. The item: Query type specifies the relation of the selection to the variables If all recs condition is in effect all data sets will be included regardless of the values set in the variable box ( F8 key). On selected vars, only the stations with the checked variables present are included during the search. On Non-missing condition only those stations and selected variables are included that have no missing values embedded inside their datasets. Records condition limits the search to a chosen record range from the currently active database. When it is blank all the database content will be searched.

When selection is done return to the selection window is accomplished by clicking either the Ascending or Descending button. The first forces forward, the second backward order of the resulting inventory list. The new selection is appended to the list that occupies the central
part of the selection window. A bar running across this list shows in inverse an item currently selected. The selected item can be deleted or modified by clicking the appropriate button. (fig.3)

Pressing the Open button or 'P' letter on the keyboard terminates data selection and triggers the search for selected stations in the database.

The first and immediate result of this search is a list of oceanographic stations matching the selection. Only the stations from this list, called hereafter the inventory provide the data for subsequent processing. To avoid repetition of selection , each time the data are requested they should be saved to a file before the data search. FILES , SAVE command lets you save the selection as a file with extension *.MQR. To load that selection again press F9 or use QUERIES,OPEN command from the main menu.

## *Data processing stage*

The stations conforming to the selection condition are returned in the **inventory window** which occupies the same position on the screen as the former selection window from where the search was called. The window displays a list of selected oceanographic stations. The horizontal bar points to a record currently selected (fig.5).

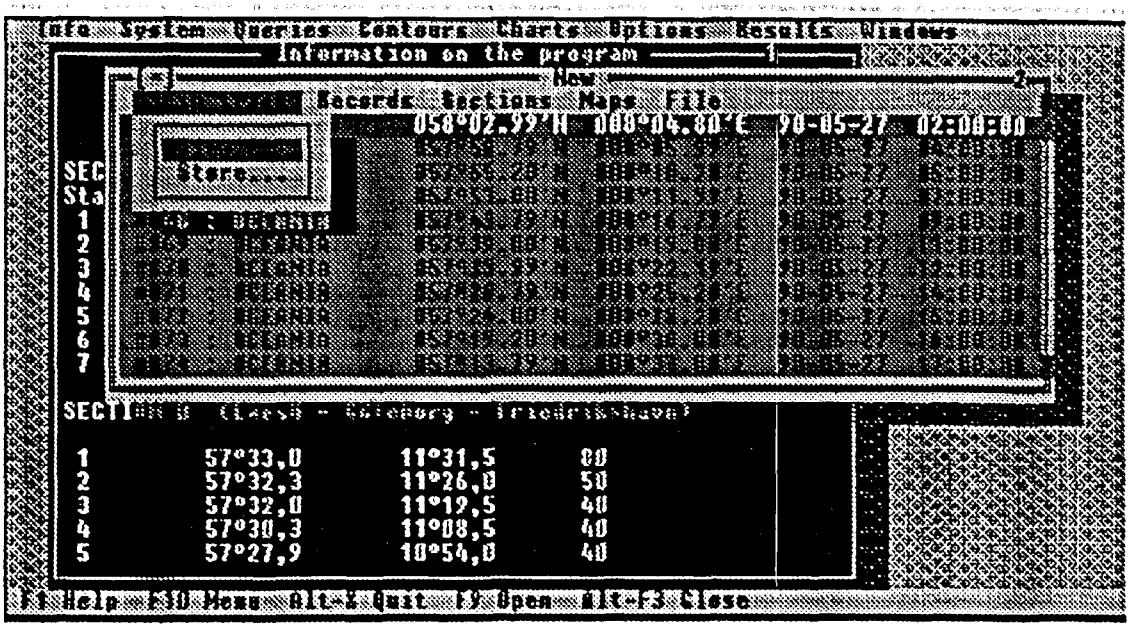


Fig 5. Inventory window with station selection for database: SKAGEX I, vessel Oceania, date 27 05 1990. with **SHIP TRACK** menus in the foreground.

All data processing operations are relevant to the displayed selection of stations. The following operations are available:

- Viewing the map of positions of all the stations included in the selection. (**SHIP TRACK** menus)
- Viewing the station 's data as numbers on the screen, (**RECORDS** menus)
- Plotting two selected variables simultaneously,(**RECORDS** menus).
- Storing station data to a file,(**RECORDS** menus)
- Making a vertical section of a variable along the path along all stations from the inventory list ,(**SECTIONS** menus)
- Creating a map at chosen depths for a selected variable, **MAP** menus)
- Storing current settings of inventory window (variable selection, plot axis choice etc.) to *.MQR file.

## SHIP TRACK *menus*

This menu displays on the map the positions of ships included in the inventory list. The picture can be stored to a file in the SURFER compatible format and used as hard copy (STORE command)

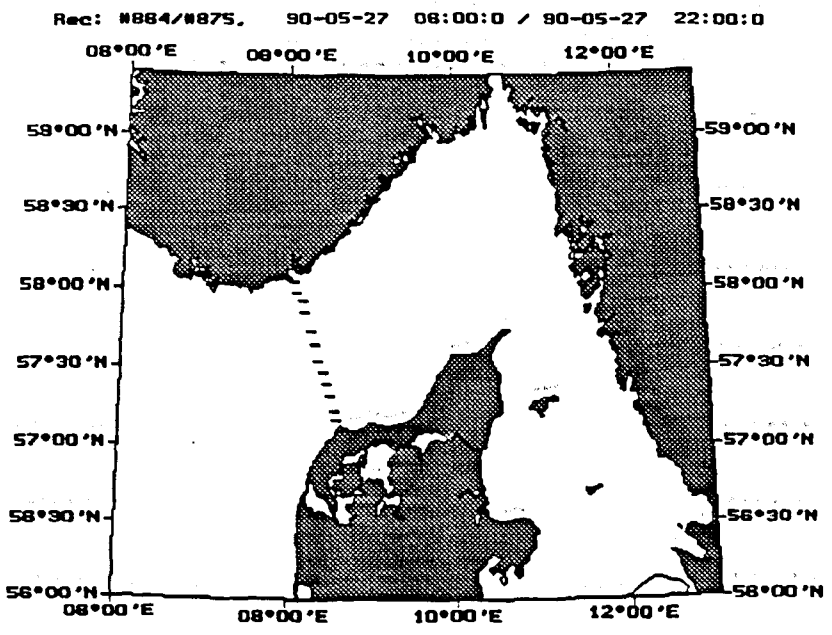


Fig.6. Ship's track of Oceania on 27.05.1990. The result of **SHIP TRACK, VIEW** command.

## RECORDS *menu*

The record menus provides operations on a single oceanographic station selection. The station is selected by moving a selection bar up and down the inventory list. To view data in the numeric form press the **VIEW DATA** command. The **STORE DATA** command allows you to store the data from a selected station in a text file. The command **OPTIONS, MISCELLANEOUS** from the main menu affects the output by forcing an appropriate separator between the numbers and a symbol replacing missing data values. To obtain the file in *.CSV format, compatible with popular spreadsheet packages one should select a comma as delimiter. The **VARIABLES** command selects variables for output, those unselected will not appear on the output.

**PLOT** command displays a picture containing two X-Y plots for any combination of variables accessible in the database. Selection of these variables is made through the **SELECT AXES** command. **SETUP CHART** sets options for axis orientation, line style etc. The plot can be stored in SURFER compatible format (**STORE PLOT**).

## SECTIONS *menu*

This menu provides methods for the creation of vertical section or time plot along the route or within the time span from the inventory list. The order of stations to be plotted will be the same as that of the inventory, and should be designed during the data selection stage. There is no limitation to one-ship-sections only. Time-depth diagrams are also possible, if the selection is confined to one station at different dates. Selection of the variable for transect and interpolation method is made through the **SECTIONS** menu Vertical axis is always set to depth; the horizontal axis can be either time or distance. Interpolation is done by the SURFER package and the result is written to a file. In the case of sections of the best results seem to be obtained when using the minimum curvature interpolation method. Before triggering interpolation ( **MAKE** command) one should select a variable to display ( **SELECT VARIABLE** command) and set appropriate ranges. Figure 7 shows the layout of the selection form which appears in response to the **RANGES** command:

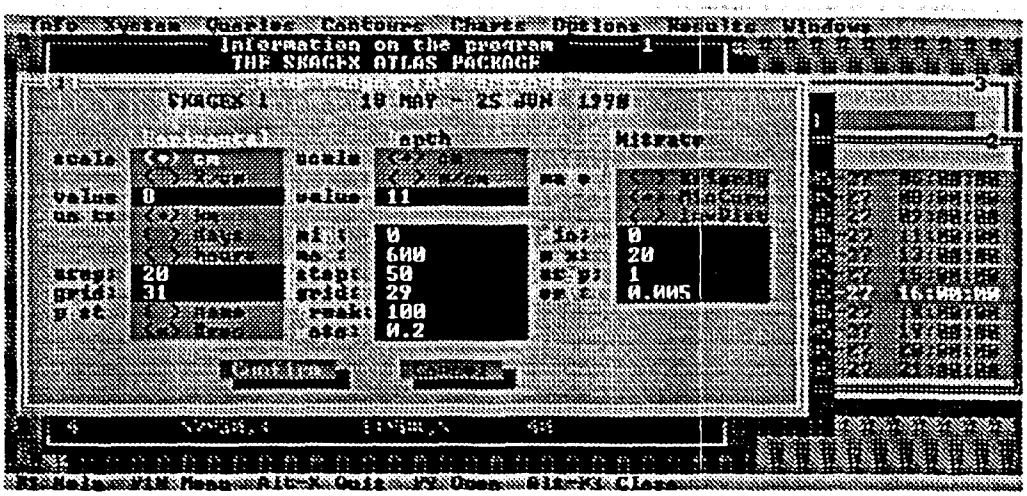


Fig 7. Transect selection form.

The form is arranged in three columns : the first for the horizontal axis, second for the vertical and the third showing selected variables. The item scale selects the size of the transect picture in centimetres or forces a constant number of kilometres per centimetre. step sets the distance between neighbouring descriptions in the selected units. On the depth axis, the units are always in meters. The grid item selects the number of grid points along the horizontal and depth axis respectively . Higher values usually produce more exact results, but calculation takes more time. The Depth column has also min and max entries for selecting the minimum and maximum depth of a transect and a break option which tells at what depth the vertical scale should change. To obtain the upper 100 meters of the water column enlarged five times, one should set break to 100 and rate to 0.2. If break is set to 0, no change in scale occurs . In the third column min, max and step items set a minimum, a maximum and a step between isolines of a selected variable correspondingly. The err (relative error) item has the meaning only when minimum curvature method is selected, otherwise it is ignored

## MAP *menus*

The **MAPS** menu provides tools and methods for the construction of horizontal distributions of environmental variables from stations present in the inventory list. The process begins with so-called "slicing" operation. The user selects via **RANGES\REFERENCES** command the reference variable, usually the depth. The database engine program from the atlas package fulfils the request by browsing all oceanographic stations inside the inventory window at the given reference level. If the requested level is not present than a value interpolated linearly from the two neighbouring layers is taken instead . When all data points are found the result is sent to SURFER to be interpolated onto an evenly spaced grid and the result of that is plotted in terms of isolines. The position of the grid on the map, its size and few other parameters necessary for the proper definition of the interpolation process are stored in the so-called region file. The file with settings adjusted for the Skagerrak region, named SKAG.REG is already prepared on the home directory of the atlas package. (Fig. 8) This file must always be assigned to inventory window before a map can be produced. (**ASSIGN REGION** command).The **MAKE** command triggers the map creation process. There are two variants of this command. **MAKE FOR ALL** produces one map for all oceanographic stations selected to the inventory window. **MAKE FOR EACH** instead makes a separate map for each line from the selection window. Suppose that during the selection stage the following lines have been entered:

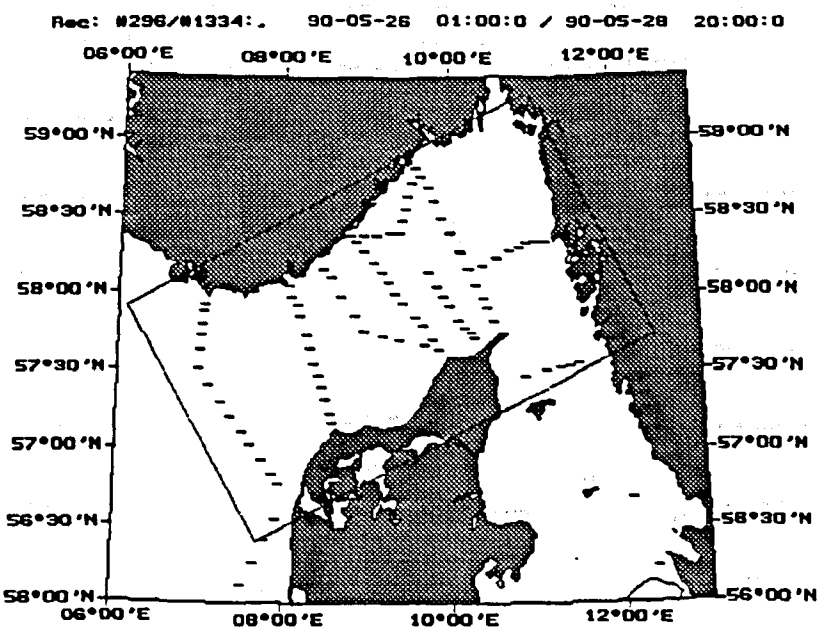


Fig.8. Ship positions of all the stations occupied in Skagerrak between 26 and 28 May 1990. The rectangle surrounding the selection limits the region in which maps will be plotted. The region shown here has been defined in the file SKAG.REG and displayed on screen using **VIEW ASSIGNED REGION** option from the **MAPS** menus.

{*;*;*;900604:900506}
{*;*;*;900607:900609}

The first line stands for selection of all vessels in the database between 4th to 6th June 1990, whereas the second between 7th and 9 June. When this query is sent to the **MAKE FOR ALL** command than only one map with averaged results from all casts from 4th to 9th June will be made. The **MAKE FOR EACH** command will create the two separate synoptic maps of both periods respectively. This command is very convenient when large number of maps to show synoptic variability is required. The query file LEGS.MQR provides the selection of stations allowing for creation of the maps covering all SKAGEX I. The maps are made in two forms: as isoline plots and colour raster maps displayable on the computer's screen. None of these are shown after the interpolation. One must use one of the commands from the **CHARTS** menus on the main menu bar to display the results on the screen or plotting device.

### **FILE** *menus*

**SAVE** and **SAVE TO** commands allow to store the current state of an inventory window into a selection file (*.MQR). Next time such a file is loaded all the assignments and setting applied to this window so far will be restored. The **GET #REC** command copies parameters of the oceanographic station pointed by the selection bar to the program clipboard from where they can be retrieved into another selection window on the screen.

## *Presentation of results*

The results of transects and maps are stored in files under names given by the user. The group of maps created via **MAPS, MAKE FOR EACH** commands are accessible through a special driver file with extension (*.LOG) . To display on the screen or to plot a single map or transect use the commands from **CHARTS** menus on the main menu bar. Each of the commands from this menu asks for the file name of an item produced during the data processing stage and starts appropriate plotting routine. The help

system invoked by pressing *F1* when **CHARTS** menus has been selected gives detailed instruction on how to use these commands.(Fig.9).

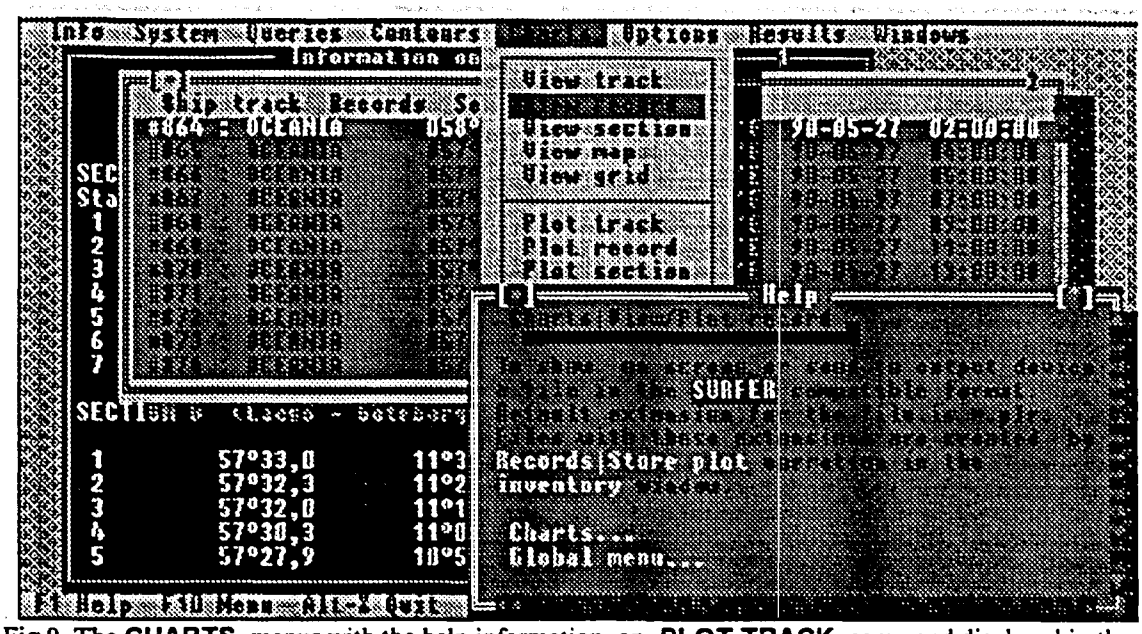


Fig 9. The **CHARTS** menus with the help information on **PLOT TRACK** command displayed in the right bottom corner

If the ship track from fig.6 was used to create a vertical section of nitrates along "Oceania" route from 27 .05.1990 and the result is stored under the name OCNO3275.PLS then to have this result displayed on the screen select **VIEW SECTION** command and pick this name from all files with the extension *.PLS (Fig.10). Fig. 11 shows the resulting plot.

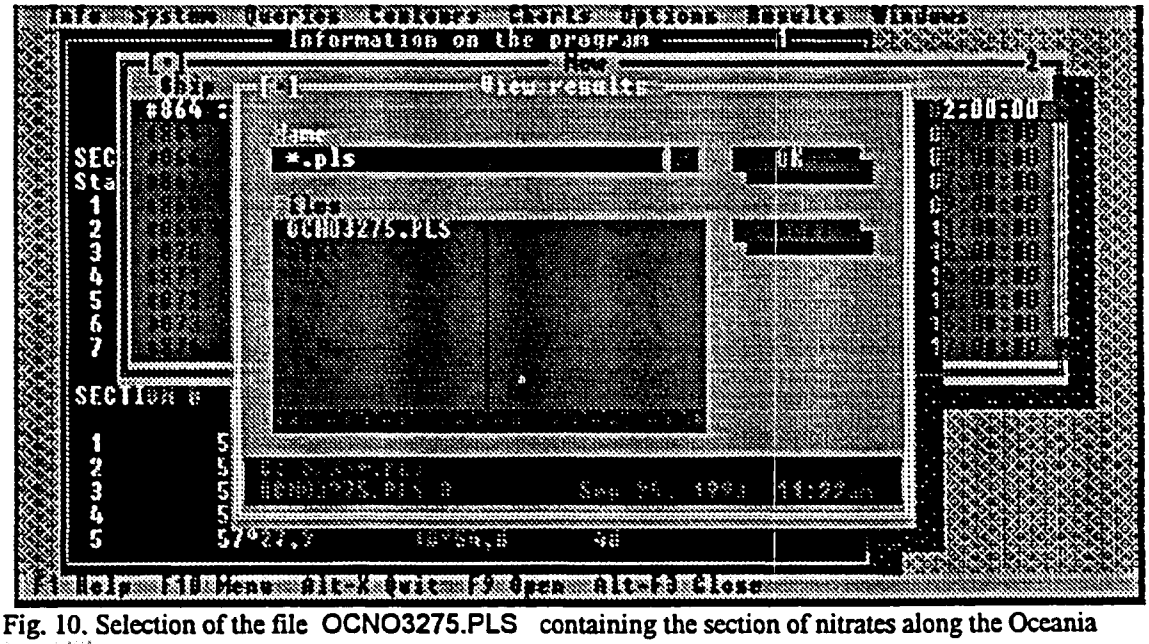


Fig. 10. Selection of the file OCNO3275.PLS containing the section of nitrates along the Oceania route on 27.05.1990.

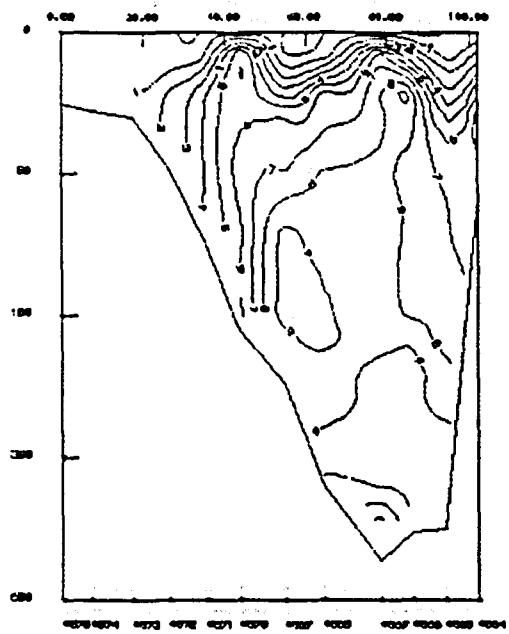

Fig. 11. Distribution of nutrients along the r/v Oceania route on 27.05.1993. The plot was retrieved from the file OCNO3275.PLS using **VIEW SECTIONS** command from the **CHARTS** menus

The maps created through the **MAKE FOR EACH** command cannot be found on the current directory. Instead the program creates a subdirectory with the user given name and a special driver file with the extension *.LGT. All maps resulting from this command are put to that directory being given numeral file names increasing with the order of their creation i.e. 001.PLM, 002.PLM, ... . To view such a collection on the computer screen, give the name of the proper driver file in **VIEW DISTRIBUTIONS** dialog accessible from **RESULTS** menus on the main menu bar. (Fig.12).

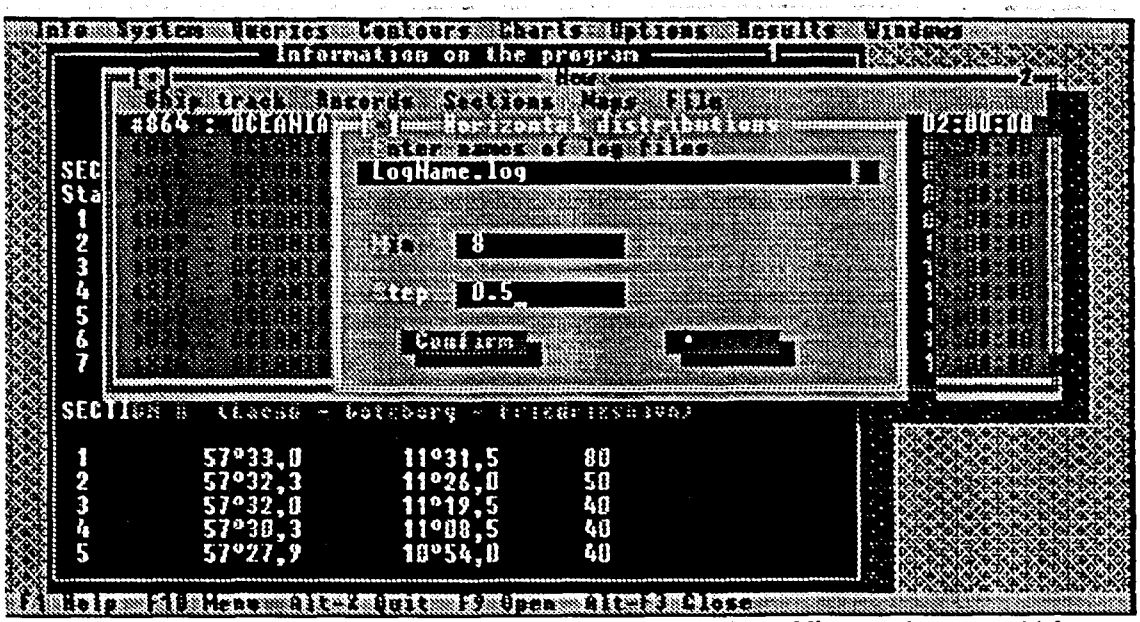


Fig.12 The dialog box for displaying the collection of maps. The item Min sets the value which will be displayed with lowest value on the colour scale and Step sets the threshold value before color changes.

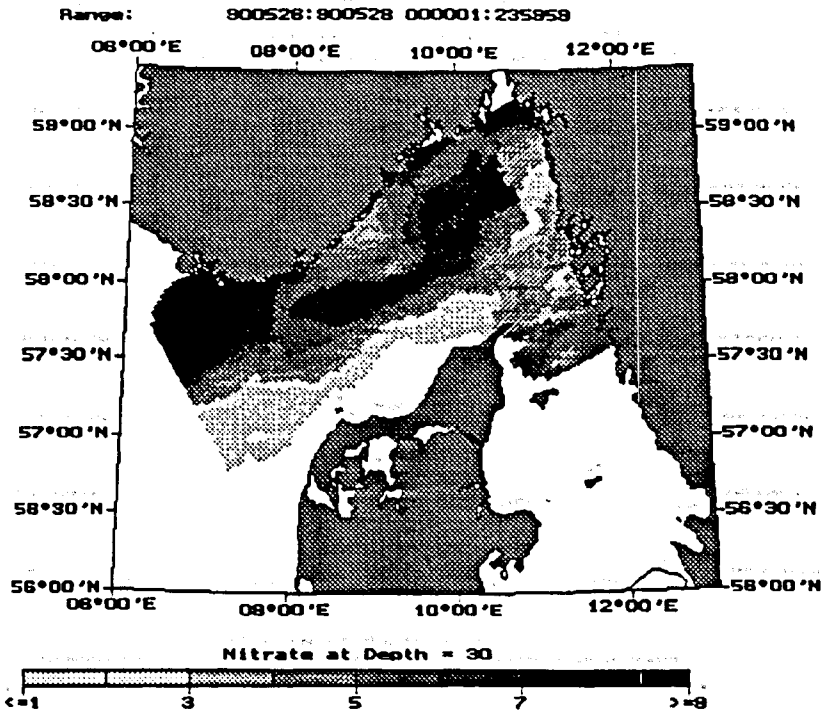


Fig. 13. Distribution of nitrates interpolated from all datasets available between 26 and 28.05.1990

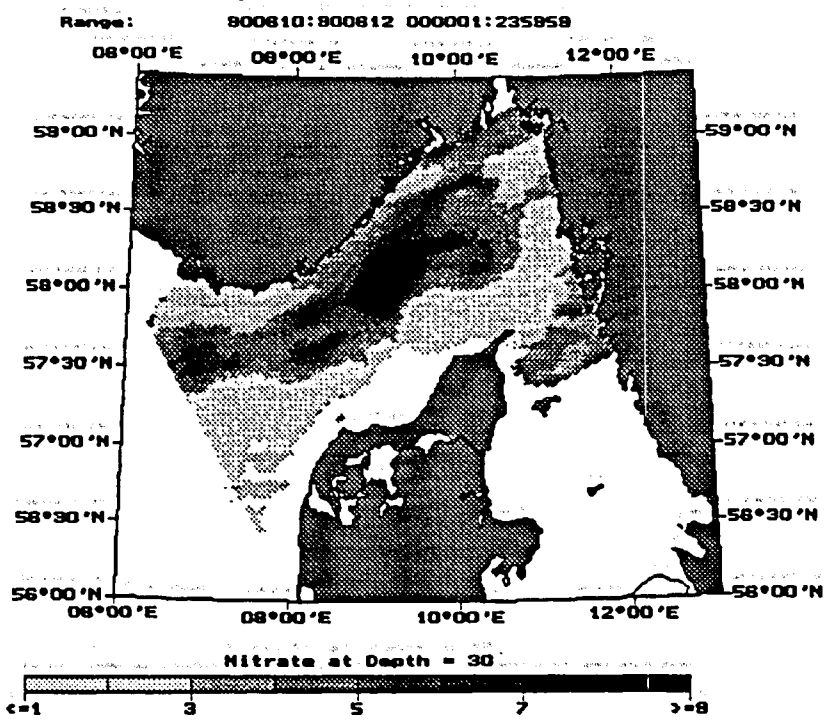


Fig. 14. Distribution of nitrates interpolated from all datasets available between 10 and 12.06.1990

The program will than show in colours the horizontal distribution of interpolated parameter on top of the contour map of Skagerrak.
Pressing the space bar moves to a new distribution. Fig. 13 and 14 show a sample distributions of nitrates at the depth of 30 meters obtained when a driver file NO3-30.LGT is used in the dialog box from fig. 14.

## Windows management

### *Windows*

Most of what you see and do in the program manager happens in a window. A window is a screen area that you can open, close, move, resize, and overlap. You can have up to nine windows open in the program manager, but only one window can be active at any time. The active window is the one that you're currently working in. Any command from the local menu bar you choose or text you type generally applies only to the active window.(If you have the same query open in several windows, the action will apply to the file everywhere that it's open.)
You can spot the active window easily: It's the one with the double-lined border around it. The active window always has a close box in the upper corner. If your windows are overlapping, the active window is always the one on "top" of all the others (the front most one).There are several types of windows, but most of them have these things in common:

- a title bar
- a close box
- a window number (1 to 9)

The *close box* of a window is the box in the upper left corner. Click this box to quickly close the window. (Or choose **WINDOW , CLOSE** or press Alt-F3.) The *title bar*, the topmost horizontal bar of a window, contains the name of the window and the window number. You can drag the title bar to move the window around. The *zoom box* of a window appears in the upper right corner of a data window. If the icon in that corner is an up arrow, you can click the arrow to enlarge the window to the largest size possible. If the icon is a doubleheaded arrow, the window is already at its maximum size. In that case, clicking it returns the window to its previous size. To zoom a data window from the keyboard, choose **WINDOW , ZOOM**, or press **F5**. Data windows also return to the unzoomed state following each call to the database engine, or graphic routines. A *window number* is displayed in the upper right border. You can make a window active (and thereby bring it to the top of the heap) by pressing Alt in combination with the window number. For example, if selection window LEGS.MQR window is #5 but has got buried under the other windows, Alt-5 brings it to the front. *Scroll bars* are horizontal or vertical bars that are visible on the bottom and right sides of an active data window. You use these bars with a mouse to scroll the contents of the window. Click the arrow at either end to scroll one line at a time. (Keep the mouse button pressed to scroll continuously.) You can click the shaded area to either side of the scroll box to scroll a page at a time. Finally, you can drag the scroll box to any spot on the bar to quickly move to a spot in the window relative to the position of the scroll box.
You can drag any corner to make a window larger or smaller. To resize using the keyboard, choose **SIZE,MOVE** from the **WINDOW Ctrl-F5**.