CH2, CANADIAN HYDROACOUSTIC DATA ANALYSIS TOOL 2 USER'S MANUAL (VERSION 2.0)

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2000

Canadian Technical Report of Fisheries and Aquatic Sciences 2332

Pêches et Océans
Fisheries and Oceans

Canada

Canadian Technical Report of
Fisheries and Aquatic Sciences

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Fisheries and Aquatic Sciences 2332

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User's Manual (version 2.0)

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Cat. No. Fs 97-6/2332E ISSN 0706-6457

Correct citation for this publication and the associated ***CH2*** software:

Simard, Y., I. McQuinn, M. Montminy, C. Lang, C. Stevens, F. Goulet, J.-P. Lapierre, J.-L. Beaulieu, J. Landry, Y. Samson and M. Gagné. 2000. ***CH2***, Canadian Hydroacoustic Data Analysis Tool 2 User's Manual (version 2.0). Can. Tech. Rep. Fish. Aquat. Sci. 2332: vii + 123 pp.

TABLE OF CONTENTS

ABSTRACT. .... **VI**

RÉSUMÉ...... .... **VII**

1. INTRODUCTION **1-1**

2. INSTALLATION **2-1**

2.1 MATERIAL 2-1
2.2 REQUIREMENTS 2-1
2.3 SOFTWARE INSTALLATION 2-1

3. GETTING STARTED **3-1**

4. OVERVIEW AND GENERAL FUNCTIONS **4-1**

4.1 DATA PROCESSING RECOMMENDATIONS 4-13

5. FILE MENU **5-1**

5.1 FILE / OPEN 5-1
5.2 FILE / CLOSE 5-2
5.3 FILE / SAVE 5-3
5.4 FILE / SAVE AS... 5-3
5.5 FILE / EXPORT POSITIONS DATA 5-3
5.6 FILE / PRINT 5-3
5.7 FILE / PRINT PREVIEW 5-4
5.8 FILE / PRINT SETUP 5-4
5.9 FILE / FILE CHECKING OPTIONS... 5-4
5.10 FILE / LIST OF RECENT FILES 5-5
5.11 FILE / EXIT 5-5

6. EDIT MENU **6-1**

6.1 EDIT / PALETTE 6-1
6.1.1 Parameter method 6-2
6.1.2 Colour table method 6-5
6.1.3 Advanced mode 6-5
6.2 EDIT / OPERATORS' LIST 6-5
6.3 EDIT / OPERATION REASON LIST 6-6
6.4 EDIT / ECHO CATEGORY LIST 6-7
6.5 EDIT / TVT(S) 6-9

7. VIEW MENU **7-1**

7.1 VIEW / TOOLBAR 7-2
7.2 VIEW / PALETTE BAR 7-2

7.3 VIEW / STATUS BAR 7-3
7.4 VIEW / DISPLAY OTHER CHANNELS… 7-3
7.5 VIEW / ECHOSOUNDER CHARACTERISTICS… 7-3
7.6 VIEW / CHANNEL CHARACTERISTICS… 7-4
7.7 VIEW / OPERATION LIST… 7-5
7.8 VIEW / PREVIOUS ZONE 7-6
7.9 VIEW / DEFAULT VIEW RANGE 7-7
7.10 VIEW / UNZOOM 7-7
7.11 VIEW / PAN VIEW 7-8
7.12 VIEW / SHOW HORIZONTAL SCALE 7-8
7.13 VIEW / SHOW VERTICAL SCALE 7-8
7.14 VIEW / SURFACE-LOCK 7-8
7.15 VIEW / BOTTOM-LOCK 7-8
7.16 VIEW / PING 7-8
7.17 VIEW / DISTANCE 7-9
7.18 VIEW / TIME 7-9
7.19 VIEW / PROPERTIES 7-9

8. TOOLS MENU 8-1

8.1 TOOLS / REGION DEFINITION GROUP 8-1
8.1.1 Tools / Rectangle and zoom 8-3
8.1.1.1 Zoom in 8-4
8.1.1.2 Classify operation 8-5
8.1.1.3 Exclude operation 8-8
8.1.1.4 New bottom detect level operation 8-8
8.1.2 Tools / Ellipse 8-10
8.1.3 Tools / Polygon 8-10
8.1.4 Tools / Below polyline 8-11
8.1.5 Tools / Above polyline 8-11
8.1.6 Tools / Whole echogram 8-11
8.1.6.1 Move bottom operation 8-13
8.1.7 Tools / Selected runs 8-13
8.1.8 Tools / Selected pings 8-13
8.2 TOOLS / MANUAL BOTTOM TOOLS 8-15
8.2.1 Tools / Bottom sample 8-16
8.2.2 Tools / Bottom line 8-16
8.3 TOOLS / CUMULATIVE DISTANCE 8-17
8.4 TOOLS / INSERT TVT(S) 8-18
8.5 TOOLS / EDIT/ADD POSITIONS VIA EXCEL 8-21
8.6 TOOLS / ECHOINTEGRATION 8-30
8.6.1 General tab 8-31
8.6.2 Channel tab 8-33
8.6.3 Step tab 8-35
8.6.4 Depth strata tab 8-39

8.6.5 Updating, saving, and loading echointegration setting parameters 8-40
8.6.6 Integration 8-41
8.7 TOOLS / OPTIONS 8-49

9. UNDO/REDO OPERATIONS 9-1

10. WINDOW MENU 10-1

10.1 WINDOW / CASCADE 10-1
10.2 WINDOW / TILE HORIZONTAL 10-1
10.3 WINDOW / TILE VERTICAL 10-1
10.4 WINDOW / ARRANGE ICONS 10-1
10.5 WINDOW / LIST OF OPEN DOCUMENTS 10-1

11. ERROR MESSAGES AND TROUBLESHOOTING 11-1

11.1 HAC FILE ERRORS 11-1
11.1.1 Signature validation 11-1
11.1.2 Edition tuple integrity 11-1
11.1.3 Ping order 11-1
11.1.4 Time synchronisation (second vs decimal) 11-1
11.1.5 Time variation (warning) 11-2
11.1.6 Pings within run limits 11-2
11.1.7 Old TVT equation used (warning) 11-2
11.2 GPS POSITION 11-2
11.2.1 X axis distance view mode 11-2
11.2.2 X axis distance view mode with the keep 1:1 aspect ratio option 11-3
11.2.3 Positions lacking 11-3
11.3 VIEWING CLASSIFIED OR EXCLUDED REGIONS 11-3
11.3.1 Alignment of mask shapes over the selected echo samples 11-3
11.3.2 Loss of the hatched region shape 11-3
11.4 CLASSIFIED OR EXCLUDED REGIONS MOVED VERTICALLY 11-4
11.5 ECHOINTEGRATION 11-4
11.5.1 Time alignment of echointegration steps 11-4
11.5.2 Echointegration by distance intervals is very long 11-4
11.5.3 Echointegration by distance intervals is not available 11-5

12. ACKNOWLEDGMENTS 12-1

13. REFERENCES 13-1

14. ANNEX 1: The *.hei echointegration ASCII file format 14-1

15. ANNEX 2: Development of TVG corrections due to the medium 15-1

16. INDEX....... 16-1

ABSTRACT

Simard, Y., I. McQuinn, M. Montminy, C. Lang, C. Stevens, F. Goulet, J.-P. Lapierre, J.-L. Beaulieu, J. Landry, Y. Samson and M. Gagné. 2000. ***CH2***, Canadian Hydroacoustic Data Analysis Tool 2 User's Manual (version 2.0). Can. Tech. Rep. Fish. Aquat. Sci. 2332: vii + 123 pp.

CH2 is the acronym for ***C***anadian ***H***ydroacoustic data analysis tool ***2***. It is a Windows 95® Multiple Document Interface (MDI) C++ application, developed by the Department of Fisheries and Oceans within the framework of the Data Analysis Tools (DAT) project of its National Hydroacoustic Program (NHP). It is dedicated to the display and processing of the standard ***HAC*** (Simard *et al.* 1997) multi-channel (multiple frequencies or beams) multi-echosounder acoustic data produced by the ***CH1*** acquisition and real-time monitoring module (Simard *et al.* 1998). Data can originate from various analog or digital echosounders (e.g., Biosonics 102 type, Simrad EK500, or EY500). ***CH2*** version 2.0 includes several editing TOOLS, to edit, eliminate, ignore, threshold, filter, or correct the raw ***HAC*** data, without erasing any original information. It also incorporates multi-channel classification tools, to partition the acoustic data into echo categories according to user decisions, and multi-channel echointegration capabilities for each echo category. The user can always track the various processing steps that have been applied to the original raw data. ***CH2*** holds full undo and redo facilities for the various operations applied to the raw data. Edited files can be saved under the standard ***HAC*** format and contain the raw data plus the parameters of the editing/classification operations. The echointegration data are exported in ASCII text files that are directly usable by common data analysis or visualisation packages such as worksheets, statistical packages, and 2-D and 3-D mapping packages.

RÉSUMÉ

Simard, Y., I. McQuinn, M. Montminy, C. Lang, C. Stevens, F. Goulet, J.-P. Lapierre, J.-L. Beaulieu, J. Landry, Y. Samson and M. Gagné. 2000. ***CH2***, Canadian Hydroacoustic Data Analysis Tool 2 User's Manual (version 2.0). Can. Tech. Rep. Fish. Aquat. Sci. 2332: vii + 123 pp.

CH2 est le sigle pour Canadian Hydroacoustic data analysis tool 2. Il s'agit d'une application Windows 95® C++ MDI ("multiple document interface"), developpée par le Ministère des Pêches et Océans dans le cadre du projet Data Analysis Tools (DAT) du Programme National en Hydroacoustique (NHP). Elle est dédiée à la visualisation et au traitement des données acoustiques multi-canaux (fréquences ou faisceaux multiples) et multi-échosondeurs de format standard ***HAC*** (Simard *et al.*, 1997), acquises par le module d'acquisition et de monitorage en temps réel ***CH1*** (Simard *et al.*, 1998). Les données peuvent provenir de divers échosondeurs analogiques ou numériques (e.g., type Biosonics 102, Simrad EK500 ou EY500). La version 2.0 de ***CH2*** comprend plusieurs fonctions d'édition, pour éditer, éliminer, ignorer, seuiller, filtrer ou corriger les données brutes ***HAC***, sans effacer aucune information originale. Elle inclut également des fonctions de classification multi-canaux, pour partitionner les données acoustiques en catégorie d'échos selon les décisions de l'usager, ainsi que des fonctions d'échointégration multi-canaux par catégorie d'échos. L'usager peut toujours retracer les divers traitements qui ont été appliqués aux données brutes. ***CH2*** incorpore des fonctions complètes pour défaire ou refaire les diverses opérations réalisées sur les données brutes originales. Les fichiers édités peuvent être sauvés sous le format standard ***HAC*** contenant les données brutes plus les paramètres des opérations d'édition ou de classification. Les données d'échointégration sont exportées dans des fichiers texte ASCII qui sont directement utilisables par les logiciels communs d'analyse ou de visualisation de données, tels les chiffriers, les logiciels statistiques, et les logiciels de cartographie et de visualisation tri-dimensionnelle.

CH2
Fisheries and Oceans Canada
Pêches et Océans Canada

PRODUCT OF
THE NATIONAL HYDROACOUSTIC PROGRAM DATA ANALYSIS TOOLS PROJECT

1. INTRODUCTION

In 1995, the Canadian Department of Fisheries and Oceans (DFO) launched a five-year priority research program to improve the use of hydroacoustics in fish stock monitoring and estimation, which is now known as the DFO National Hydroacoustic Program (NHP). One of the NHP thematic projects was dedicated to the development of data analysis tools (DAT) to collect and process the data, from the initial step of raw data acquisition up to the final production of fish species biomass estimates and maps with their confidence intervals (Figure 1-1). The first NHP-DAT product was the definition of a standard data format for multi-channel hydroacoustic data, the ***HAC*** format (Simard *et al.* 1997), which later became an international data format in fisheries acoustics (Anon. 1999). The second product was a multi-channel, multi-echosounder data acquisition tool, the ***CH1***[†] software (Simard *et al.* 1998). The third and final product of this first phase of the NHP-DAT was the second software module, ***CH2***, which is dedicated to the processing of the multi-channel raw data produced by ***CH1*** and their echointegration by channel and species.

The Version 2.0 of ***CH2*** includes most of the basic functions covered in steps 3 and 4 of the data processing line of Figure 1-1 for all data channels. Specifically for the editing step, these functions are: modification of the amplitude threshold, the acoustic calibration parameters, and GPS positions; introduction of GPS positions for files lacking such information (e.g., files digitised by ***CH1*** from archived magnetic tapes); erasing of unwanted signals (i.e., setting amplitudes to zero); labelling some areas as missing data; and filtering the data according to the duration of the signals. The classification functions are presently limited to the partitioning of the multi-channel spatial data according to user decisions based on the nature of the echoes, i.e., there are no automatic echo classification functions. The partitioning and the editing are made using several geometric tools to define regions under the various horizontal (ping sequence, time, distance) or vertical (surface or bottom locked representations) display modes. The multi-channel data can always be displayed according to the user's choice of horizontal or vertical mode and of range limit or palette and with the maximum possible zoom on the raw data. The echointegration function produces s_v (i.e., MVBS, mean volume backscattering coefficient) or s_a (area backscattering coefficient) (for definition of units, see Mac Lennan and Fernandez 2000) ASCII files for each chosen channel and echo classification category, with their corresponding metadata.

[†] "*CH*" are also the letters identifying a famous Canadian hockey team in the 1950s and 1960s, when the NHL had only 6 teams.

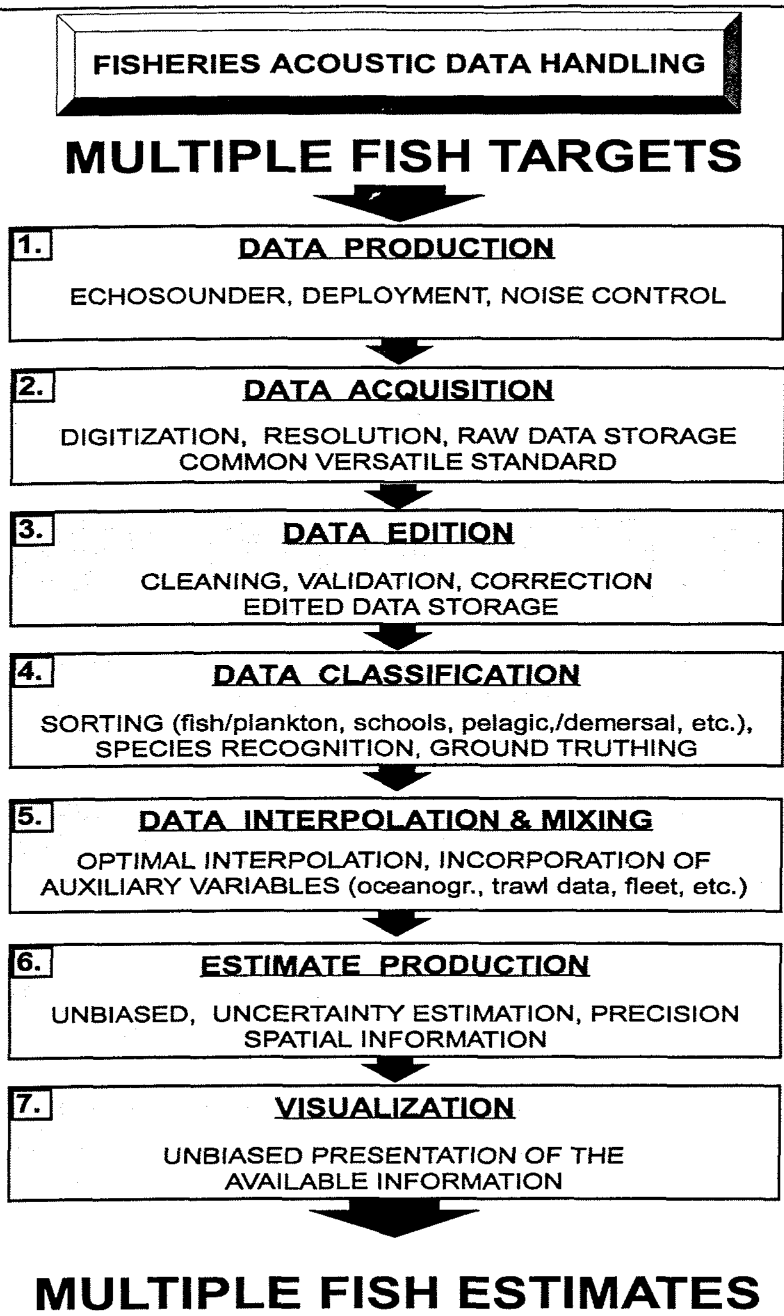


Figure 1-1. The seven data handling steps of the DAT plan.

It includes the possibility of changing the echosounder calibration parameters stored in the raw ***HAC*** file as well as the average sound speed and absorption coefficients. All the editing and classification operations are added to the raw data files as new tuples (see Simard *et al.* 1997), thus preserving the original information. All operations applied to the data are labelled by a user name, which can be used during subsequent data analysis steps. The operations can be changed or erased using the full undo/redo features of ***CH2***. The ***CH1*** and ***CH2*** tools of the NHP-DAT series define a structured way to collect, edit, classify, and store the high-resolution data produced by various echosounders, single or multi-channel, under an international standard data format, and to generate a uniform data bank that can be used for direct data comparisons and for future research in acoustics (e.g., the development of robust echo classification algorithms) or for

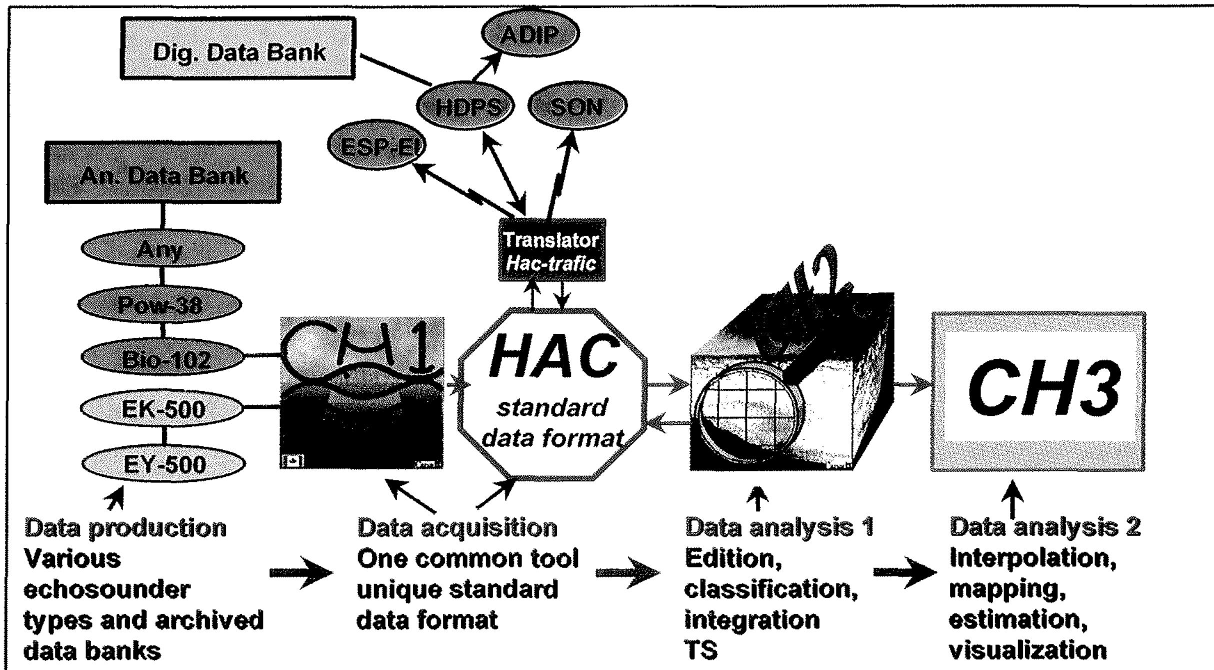


Figure 1-2. Organization of the DAT software modules and ***HAC*** standard data format.

monitoring fish stocks (e.g., historical review of abundance and vertical and horizontal distributions).

The current document is the user's manual and reference for ***CH2*** version 2.0. Much of this information is also available from the ***CH2*** on-line help. The ***HAC*** tuples or files considered by ***CH2*** are those defined by the ***HAC*** version 1.0 report (Simard *et al.* 1997) plus the edition tuples added by the NHP-DAT team between 1997 and 2000. Additional ***HAC*** tuples that may have been added by other software developers in the mean time and whose detailed definitions have not yet been provided or accepted by the ***HAC*** international committee, are simply ignored by ***CH2*** unless the basic ***HAC*** syntax rules indicating the tuple length has not been observed. Another tool of the NHP-DAT project, ***HAC-trafic*** (Figure 1-2), is designed to read, display in ASCII text, rectify or translate ****.HAC*** standard data format files to and from other former formats. ***CH3*** is presently left to the user's choice since many commercial software packages are already able to directly use the echointegration ASCII files produced by ***CH2***. These include geostatistical packages, GIS, and other 2-D or 3-D data viewing packages.

In this manual, the "/" is often used as a separator for the menu hierarchy (e.g., Edit / Echo category list, View / Properties). Capital letters are used to identify the specific ***CH2*** fields and menus, as they appear in the windows and dialog boxes, and important key words to operate ***CH2***. ***CH**** suite labels are in bold and italic. The term "group" is sometimes used to specify a group of fields or tools associated with the same function and assembled in identified portions of the dialog boxes or separated by a line in menus. The term "active" is used to identify the part of the program (e.g., a selected echogram window, a dialog box) or the data (e.g., a given ***HAC*** data channel or file) currently in use. The text is intentionally redundant for some portions that are common to different functions. This was done to provide the most direct access to the user who wants to rapidly find the complete information on the subject he is looking for. As this manual is a reference book, we did not expect the user to read the entire manual but only the sections specific to his needs. Occasionally, detailed basic information is provided, which may seem too much to acoustic experts or to other readers. This was done to provide self-contained accurate information at the right place for non-experts and for an open and complete reference to the data processing by ***CH2***, to avoid the black box syndrome.

2. INSTALLATION

This chapter lists the requirements to use ***CH2*** and gives the installation information.

2.1 Material

- One ***CH**** CD-ROM containing ***CH2*** version 2.0; ***CH1*** version 2.1.1, ***HAC-trafic*** version 1.8 and the on-line help documents and installation file; an Office97 Excel® file named HEI-format_ver1.3.xls presenting echointegration results in ASCII tab-delimited format (*.hei): the Excel® file TplPos.xlt that is linked with ***CH2*** to edit positions via Excel®, examples of data files of original ***HAC*** raw data, with or without edition and classification tuples; *.eip configuration files for recalling echointegration settings; sample colour palettes (*.pal); and ***CH1*** configuration files (*.ch1).
- The present user's manual.

2.2 Requirements

- A Pentium II PC 120 MHz or higher, a minimum of 64 Mb of RAM, a CD-ROM drive, large data storage capacity (hard disk or other fast storage devices), Windows95/98® environment, and Microsoft® Excel 97. ***CH2*** has been tested mostly with the version OSR2 of Windows95® in use in the DFO Laurentian Region between 1998-2000. The minimum video display resolution is 800 x 600 pixels, but the use of 1024 x 780 pixel or higher resolution is highly recommended. Large font display configurations is only possible with 1024 x 780 pixel or higher resolutions. It is not recommended because it affects proper display of the dialog boxes.

2.3 Software installation

As indicated in the file readme.txt of the ***CH2*** version 2.0 CD-ROM:

- Execute the Setup.exe programs located in the ***CH1*** and ***CH2*** folders of the ***CH**** version 2000 CD-ROM.
- Copy the HEI-format_ver1.3.xls file and examples of the ***CH1*** configuration files (*.ch1) and ***HAC*** data files, located in the ***CH1***\Config and ***HAC*** folders, to folders in your PC Windows 95/98® environment.

3. GETTING STARTED

This chapter is a brief tutorial for busy users wanting to rapidly explore *CH2*. This should not replace reading the following chapters, which are essential to properly operate *CH2*.

1. To start *CH2*, click the *CH2* icon. After clicking on the opening window (Figure 4-2.), the operator's list dialog box opens (Figure 4-3). Register as an operator using the Add button. Then click on the Select button to choose your name in the operators' list, and click OK.

2. Open a *HAC* file using the Open tool. This version 2.0 of *CH2* does not include the possibility of reading *HAC* files that do not conform to the standard *HAC* format version 1.0 (Simard *et al.* 1997). If the file has not been previously edited by *CH2*, *CH2* will build an index and will check for errors in the file and display messages if any are found. Then, a dialog box opens and shows the channels that the file contains. By selecting a channel in the Software channel ID box, its parameters are displayed. Select the channel(s) you want and click on the View button.

3. Pointing on a channel echogram, right-click and select Edit palette to configure a palette for the channel (as in *CH1*). Palettes are channel-specific. You can define the default palette used at channel opening with the Tools / Options menu. Repeat for the other channel echograms. Tile your channels to see them all simultaneously. The status bar displays the information at the pointer location.

4. Use the right mouse button to change the X-Z display mode for the active channel echogram, where X is the horizontal scale (in pings, time, or distance) and Z is the range in metres. You can select for surface- or bottom-locked displays and for an X-axis in ping sequence, time, or distance units. Depending on the mode you choose, you can display every ping and every sample. You can choose the Z display range using the View options. Use the Pan view to display all the data for the channel. You can define the default display preferences used at channel opening with the Tools / Options menu.

5. Use the right mouse button to increase the TVT (time-varied threshold) parameters, which set the threshold for the following pings up to the next TVT tuple. To add TVTs for the whole echogram or a portion of it, use the *CH2* Insert-TVT tool. Select the tool and point on the echogram where you want to insert a TVT. Drag if you want to insert it for a portion of the echogram. You will then be asked for the parameters for the two TVTs you want to create, first for the left limit and then for the right limit. The defaults for the right limit are the parameters of the original TVT for this portion of the echogram.

6. To zoom on the echogram, select the *CH2* Rectangle tool, and point and drag to define a rectangle on the portion of the echogram you want to zoom. Then right-click and select the

Zoom-in operation. ***CH2*** does not zoom on the displayed bitmap, as is usually done in most Windows95/98® applications. Instead, ***CH2*** rereads the data file in order to increase the data resolution in the new display zone. To go back to the previous display zone, right-click and select Previous zone.

7. To edit or classify (label) portions of the echogram, use the various ***CH2*** region tools to define regions on which you want to perform an operation. Double-click to close polygons or to end polylines. Use the Shift key to define other regions of the same type on which you want to perform the same operation. Then right-click to select the operation to perform. If you wish to perform the same operation on the same region(s) for other channels, you must first choose the option Project to other channels. For the Exclude operation, browse through the list to select the type of exclusion desired and provide the requested parameters. For the Classify operation, use the Select button to define or select a Category and an optional Reason for the classification. The newly defined items are added to the corresponding two lists (that reside on the Windows95/98® registry of the PC in use). Note that the Bad data category is used by ***CH2*** as a missing-data category and is considered as such by the echointegration algorithm. The operation is performed when you click on the OK button and the region(s) is (are) hatched using the pattern and colour that you have chosen in the Properties menu for the selected Category. If you then change the display mode (e.g., from surface-lock to bottom-lock), the region will be visible in tinted blend without the polygon to indicate that it is defined in the alternate reference mode.

8. To automatically edit the detected bottom, use one of the following region tools: Whole echogram, Selected run(s), or Selected pings. Right-click and choose the Move bottom operation to change the detected bottom range by a positive or negative offset in metres. Choose the New bottom detect level operation (also available with the Rectangle and Below polyline regions) to move the bottom to the first sample range corresponding to the defined new level (in volts or dB), starting from the transducer face, the top of the rectangle, or the polyline. Use the constraint option to limit the changes of bottom ranges to a given window half-height around the present detected bottom. To modify the bottom range manually, use the manual Bottom sample or Bottom line tools. Click to select bottom echo samples, double-click to end the polyline, and right-click to perform the operation. Note that changing the detected bottom also changes the location of the previously classified regions in the bottom-lock mode since these regions refer to the bottom.

9. To view, export, add, delete, or edit positions, use the ***CH2*** tool Edit/add positions in Excel®. This sends the positions to an Excel® worksheet (version Microsoft® Office97®) containing macros that generate graphs to check for position or time errors and that correct or filter positions. Click on the tool and the Send positions button to open Excel® (if it is not already open) and to generate the worksheet. To add a position(s), insert a line(s) and fill in the CPU-time columns (A,B,C), the GPS-time columns (E,F,G), and the position columns (J,K; negative values for western longitudes and southern latitudes). To delete positions, you can either delete the corresponding lines or use the macros. Many macros are available through buttons above the worksheet. The All-graph macro generates a series of graphs on the graph page of the worksheet to check for position errors. The Current Position macro offers some

possibilities to edit the position row on which the pointer is located. The Speed Graph macro generates a graph of vessel speed on the data page of the worksheet. You can click (slowly to allow Excel® to respond) on outlying points on that graph to directly access the Current Position macro to correct that position. If a new graph is computed, the original and edited (predicted) values are shown on the graph for comparison. Similarly, you can apply a moving average (Smooth macro) or a moving linear regression (Mobile-regression macro) to the whole time series. The original positions are updated with the predicted values using the Apply macro that copies the modifications in the ***CH2***-sensitive columns mentioned above. When the position editing is done, return to ***CH2*** and click on the Retrieve positions button of the dialog box. An Edit position operation is then performed, new position tuples are created and corresponding edited positions are tagged as edited. This operation is added to the Undo list.

10. To undo the last operation or series of operations, select the starting operation from which you want to undo the series in the ***CH2*** Undo box. The series of operations will be undone and will be added to the Redo list. The Redo box is used the same way to redo the operations in the same sequence they were originally applied. The version 2.0 of ***CH2*** does not include the possibility to undo or redo a single operation inserted in the list because of possible incompatibility with some subsequent operations in the following series.

11. To save the file with the editing/classification operations and the index generated by ***CH2***, use the File / Save as menu to create an edited ***HAC*** file. The editing/classification ***HAC*** tuples will be added to the original ***HAC*** tuples, thus preserving the original data in accordance with the NHP-DAT approach. ***CH2*** does not allow writing over the original ***HAC*** file.

12. To echointegrate one or several channels per Echo category, click on the ***CH2*** Echointegration tool. The General tab of the dialog box is for defining the output file name(s) and location, the type of echointegration results, the echo category(ies), the minimum sampled fraction of grid cell to echointegrate, and for changing the sound speed, if needed. You can edit the default root name for your *.hei file(s) and the default directory. The Channel number and the Block number will be added to the root name. Choose the type of echointegration result you want to compute, which is either the area backscattering coefficient, s_a, per depth strata (unitless, m^2 per m^2, linear, see Mac Lennan and Fernandez 2000) or the volume backscattering coefficient MVBS (s_v, linear units) per depth strata (m^2 per m^3, *ibid.*). Choose the Echo category(ies) for which you want to get the echointegration results. The displayed categories come from the list in the Windows95/98® registry of the PC and an eventual loaded *.eip file. Note that when Echo categories overlap on the echogram, the overlapping echoes are integrated in every Echo category, unless it is the Bad data category, which is handled as missing data. The Unclassified category corresponds to all echoes that have not been included in any Echo category, whether the categories were active or not. Specify the minimum fraction (in %) of the echointegration grid cell that must have been sampled to compute echointegration results. Unsampled fractions result from the bottom (or minimum sampled depth for bottom-locked depth strata) intruding into the grid cell or because portions of the grid cell have been classified as Bad data. This Minimum sampled

fraction of grid cell to echointegrate does not apply for the Whole sampled water column depth strata. Note that the regions classified with the Exclude operation have their echo values set to zero (which is different from Bad data regions). Finally, change the average sound speed used at acquisition if required.

The Channel tab of the dialog box is for selecting the channel(s) to integrate and for changing their default parameters for computing the echointegration results. All valid echointegration channels are selected by default. Uncheck the channel(s) you want to exclude from the echointegration task. Edit the channels' default parameters if needed.

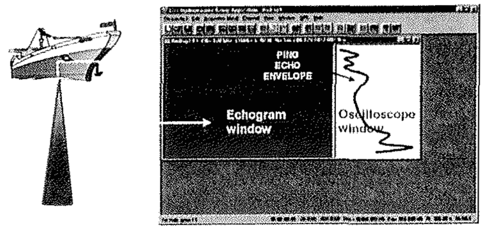
The Step tab is for defining the horizontal axis of the echointegration grid and the series of Runs to group in separate Blocks to compute the echointegration results. Define the series of Runs (if the file contains more than one Run) to concatenate into a Block for which you want to report the results in a separate *.hei file. Determine the horizontal step interval for the echointegration results in either ping, time, or distance units. If you choose the time option, you are allowed to align the steps on a given minute:second of the hour. This option is required to properly align the results for further multi-echosounder or multi-channel processing of the echointegration results. ***CH2*** automatically corrects for the drift of the PC clock relative to the GPS time, up to an offset of 30 min. The echointegration output *.hei ASCII file(s) includes Cartesian co-ordinates from a Lambert projection, which are needed for processing the echointegration data in a geostatistical framework or simply to produce non-deformed spatial plots. You must define the origin co-ordinates and the optimal domain (between the two reference latitudes) of the Lambert projection.

The Depth strata tab is for defining the series of surface- and/or bottom-locked depth strata for which you want echointegration results. The various series of depth strata are allowed to overlap. A Whole sampled water column stratum is automatically output in all *.hei files by ***CH2***. Note that the surface-locked depth strata are defined according to depth and not range. In computing echointegration results, if necessary, the stratum starting depth is automatically adjusted to the minimum sampled depth for the corresponding channel (sum of Transducer installation depth and the Surface blanking distance). The OK button copies the parameter values to the memory so that they will be displayed by the dialog box the next time it is called instead of the default values. The setting for the echointegration parameters can be saved in a file (*.eip) for recall. ***CH2*** echointegrates from the minimum sampled depth down to the detected bottom sample, and vice-versa for the bottom-locked depth strata. Bottom-lost pings are ignored unless the bottom is redefined during editing. Finally, click on the Integrate button to produce the *.hei file(s). The *.hei file format is given in the supplied HEI-format_ver1.1.xls file and in Annex 1.

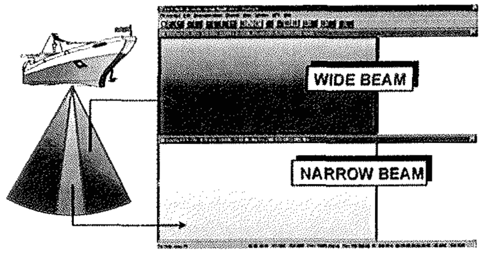
13. Consult the on-line help or subsequent chapters of this user's manual for more information.

4. OVERVIEW AND GENERAL FUNCTIONS

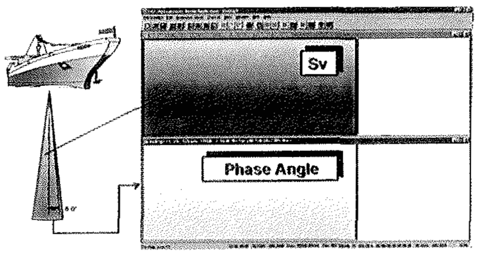
This chapter outlines the general aspects of operating ***CH2***, a Windows95/98® C++ application. ***CH2*** is an MDI (Multiple Document Interface) application, which means that the software can handle more than one ***HAC*** file at the same time. Here, a document means one of the three types of data sources handled by the ***HAC*** data acquisition software, ***CH1***, or other applications producing standard ***HAC*** version 1.0 files using the same tuple types that ***CH1*** uses. These sources are: the Biosonics-like analog echosounders, Biosonics-171 multiplexed signals played back from tapes, and the digital Simrad EK500 type. Therefore, ***CH2*** can simultaneously visualise and edit ***HAC*** files acquired from many echosounders. An echosounder can have many channels representing different frequencies, different beams, or other information (Figure 4-1.). ***CH2*** can then edit, classify, and echointegrate separately on the various channels for a given echosounder or on all channels simultaneously. The echointegration is performed per Echo category at the user's request. The present version 2.0 includes the basic facilities presented in this manual to handle the multi-channel data. Further versions should include more elaborated functions and algorithms to combine the information from the various channels, to exploit the possibilities of multi-frequency acoustics and multi- or composite-beam (dual- or split-beams) data in quantifying and qualifying the biomass and the distribution of the marine life echoing the transmitted sound.



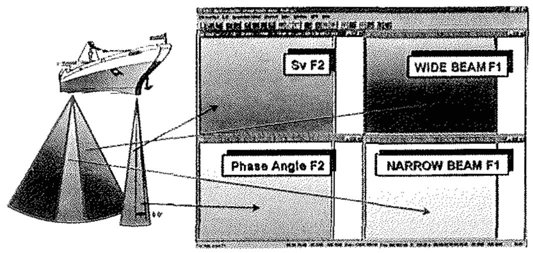
A) ***CH1***, single beam, single frequency.



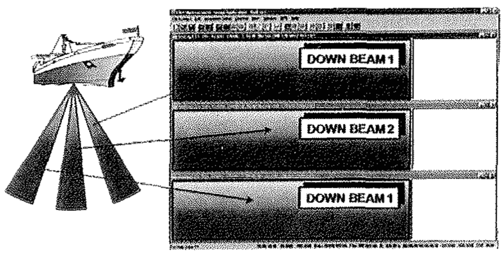
B) ***CH1***, dual-beam, single frequency.



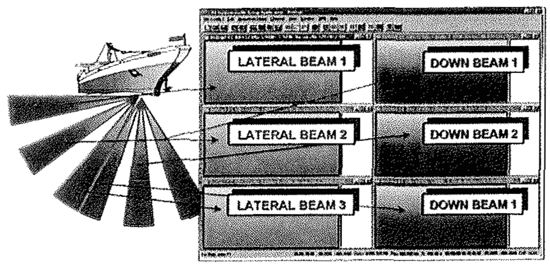
C) ***CH1***, split-beam, single frequency.



D) ***CH1***, split-beam and dual beam, two frequencies.



E) ***CH1***, three beams, any frequency.



F) ***CH1***, six beams, alternating 3 by 3, any frequency.

Figure 4-1. Examples of multi-channel, multi-echosounder configurations handled by ***CH1*** and ***CH2***.

At the start of ***CH2***, the following window with a gridded magnifying glass on a 3-D parcel of ocean (Figure 4-2.) is displayed for 10 seconds. It disappears on a click to display the Operators' list dialog box (Figure 4-3.). ***CH2*** tags all editing/classification operations performed on the data by a user's name. This attribute can be used in future examination and processing of the edited ***HAC*** files. The operators' list can be generated or edited from that dialog box, or via the Edit / Operators' list menu. This list resides on the Windows95/98® registry of the PC, in the present version of ***CH2***. As indicated, one operator must be activated to operate ***CH2***.

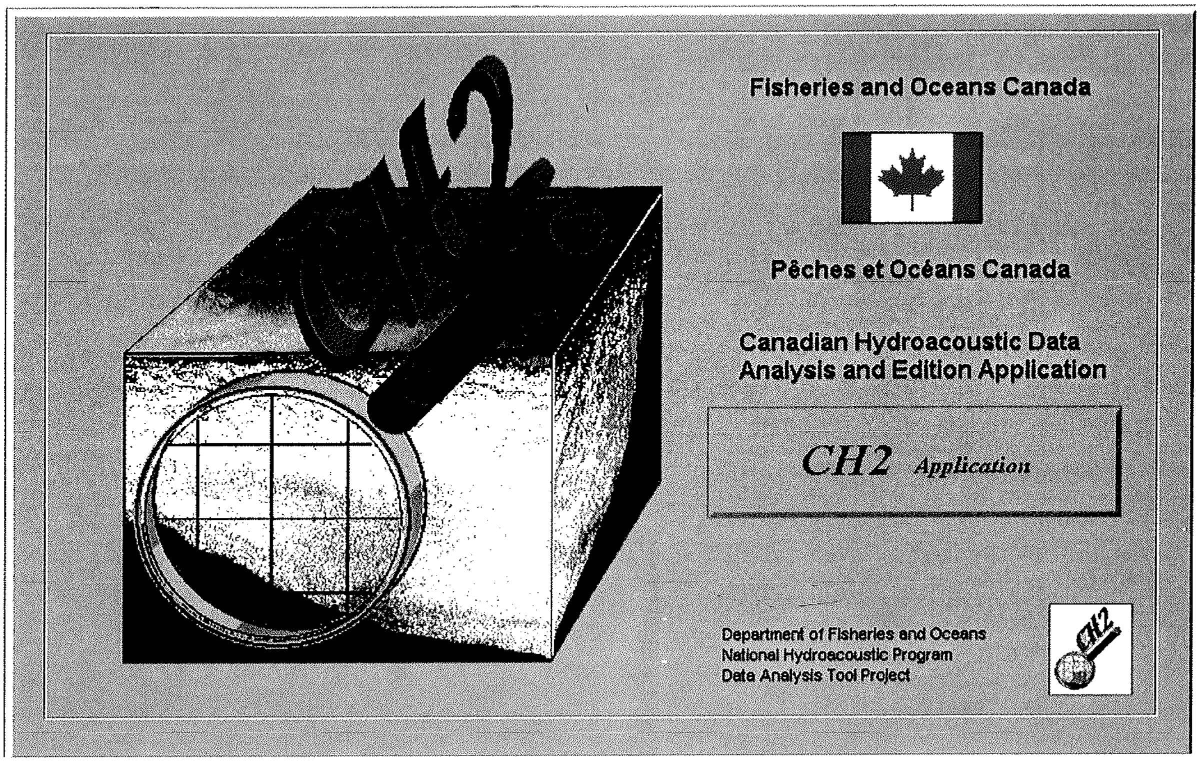


Figure 4-2. ***CH2*** opening window.

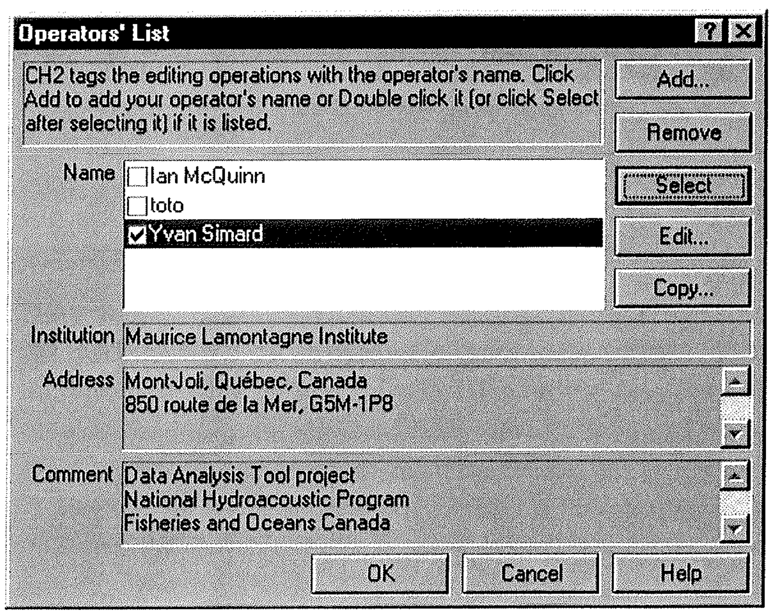


Figure 4-3. ***CH2*** operators' list dialog box.

After having defined and/or selected an operator by double-clicking on the name or by using the Select and OK buttons, the main *CH2* window opens. The various functions of the *CH2* menus are summarised in Figure 4-4. The File and Windows menus are quite standard but the other menus have specific *CH2* functions. Most of them can be accessed more rapidly by a right-click on the mouse or from the tool icons.

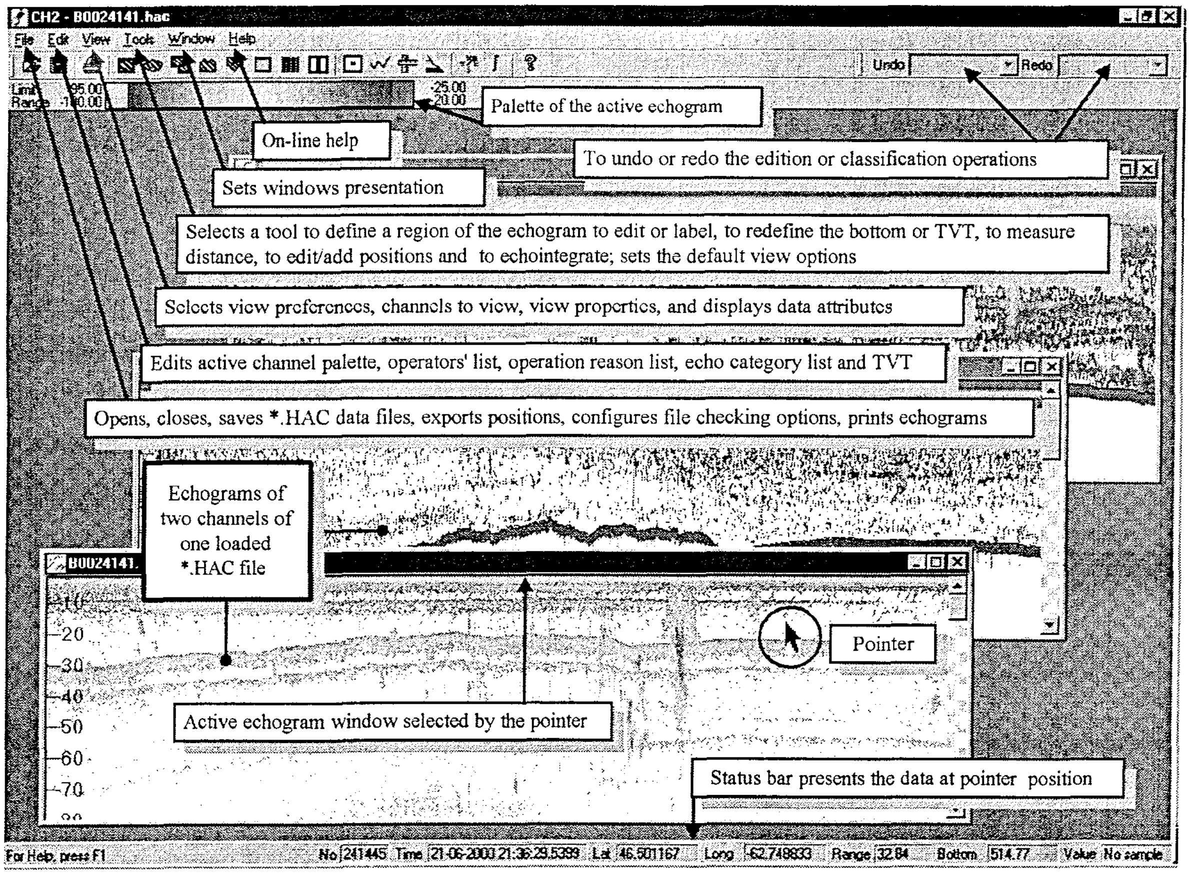


Figure 4-4. Specific functions of *CH2* menus.

Original or edited ***HAC*** file(s) are opened from the File menu. Figure 4-4 shows the *CH2* display when three channels of an EK500 ***HAC*** file are opened. The characteristics of the channel and of the echosounder can be obtained from a right-click on the mouse (Figure 4-5). Other frequently used *CH2* functions can also be accessed quickly from the mouse right button. The status bar indicates local information at the pointer position for the active echogram. Each echogram displays its specific channel data in its own units (volts, Sv, TS, etc.). Depending on the echogram window size, all pings and/or echo samples are not always visible because of the limited range of pixels displayed by the window. When a zoom is performed on one channel (using the Rectangle and zoom tool followed by a right-click selection, Figure 4-6), *CH2* does not zoom on the bitmap, as is usually done in Windows95/98® applications. *CH2* loads into the window all the new pings and echo samples that the window is now able to display for the new zoomed region (e.g., Figure 4-6). The same is true when the size of a window is changed. ***CH2*** always displays the maximum data that the window pixels allow. For large files, this sometimes requires the reading of ***HAC*** data from disk, which is not always instantaneous on slow PCs. The echograms can be tiled or cascaded from the ***CH2*** Window menu.

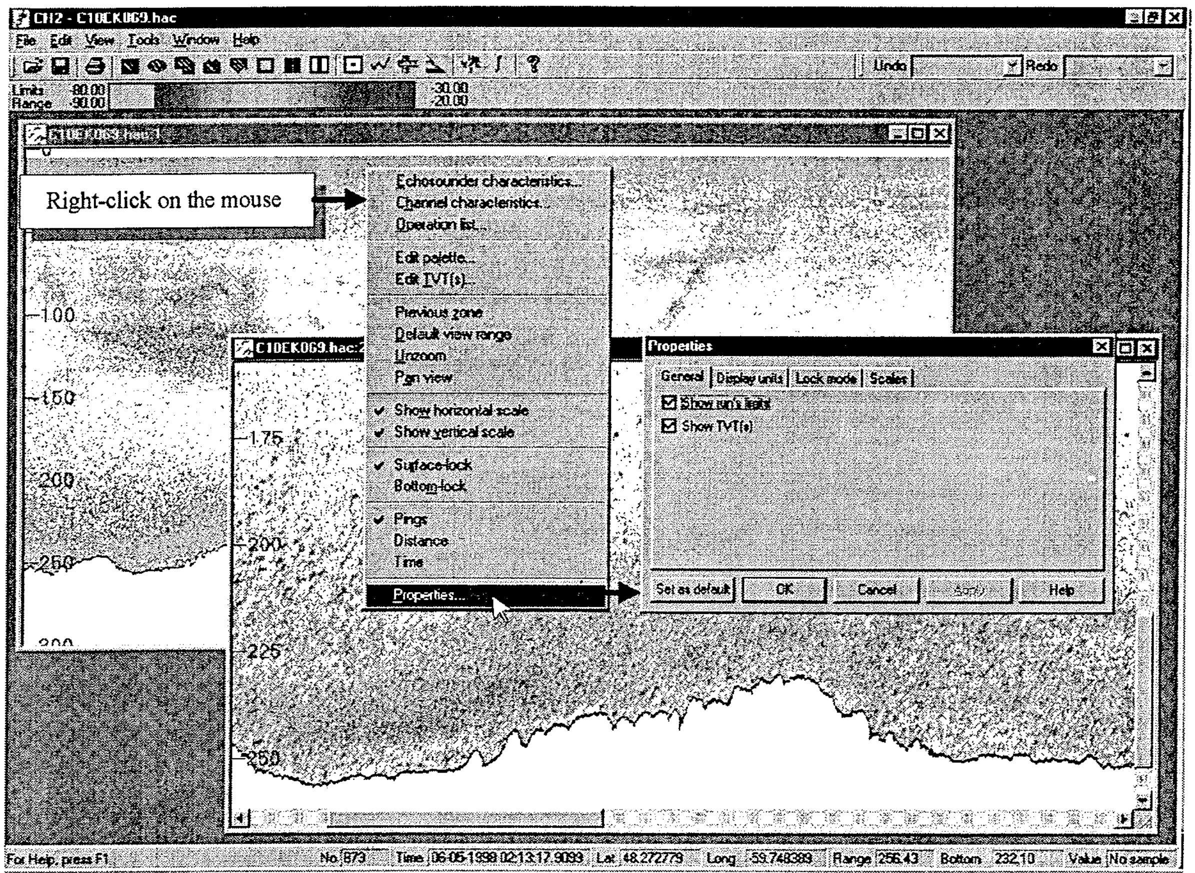


Figure 4-5. ***CH2*** functions directly accessible from a right-click on the mouse and the general visualisation preference dialog box.

The data can be visualised along three types of horizontal axes: ping sequence, time, or distance. Vertically, they can be visualised as referenced to the transducer depth, in surface-lock mode, or to the (original or edited) detected bottom, in bottom-lock mode. The user can determine a view range interval or obtain a full view of the echogram from the Pan view option of the View menu or the mouse right button short cuts. The user also defines the palette used to display the echo sample values. All these viewing characteristics are channel-specific properties that the user can change for any channel from the View / Properties menu, which can be accessed from the mouse right button (Figure 4-5), the user can define the default channel display settings used by ***CH2***. The echogram display zone that preceded the active one is always preserved in ***CH2*** memory and can be recalled by the selection of the Previous zone option from a right-click on the mouse.

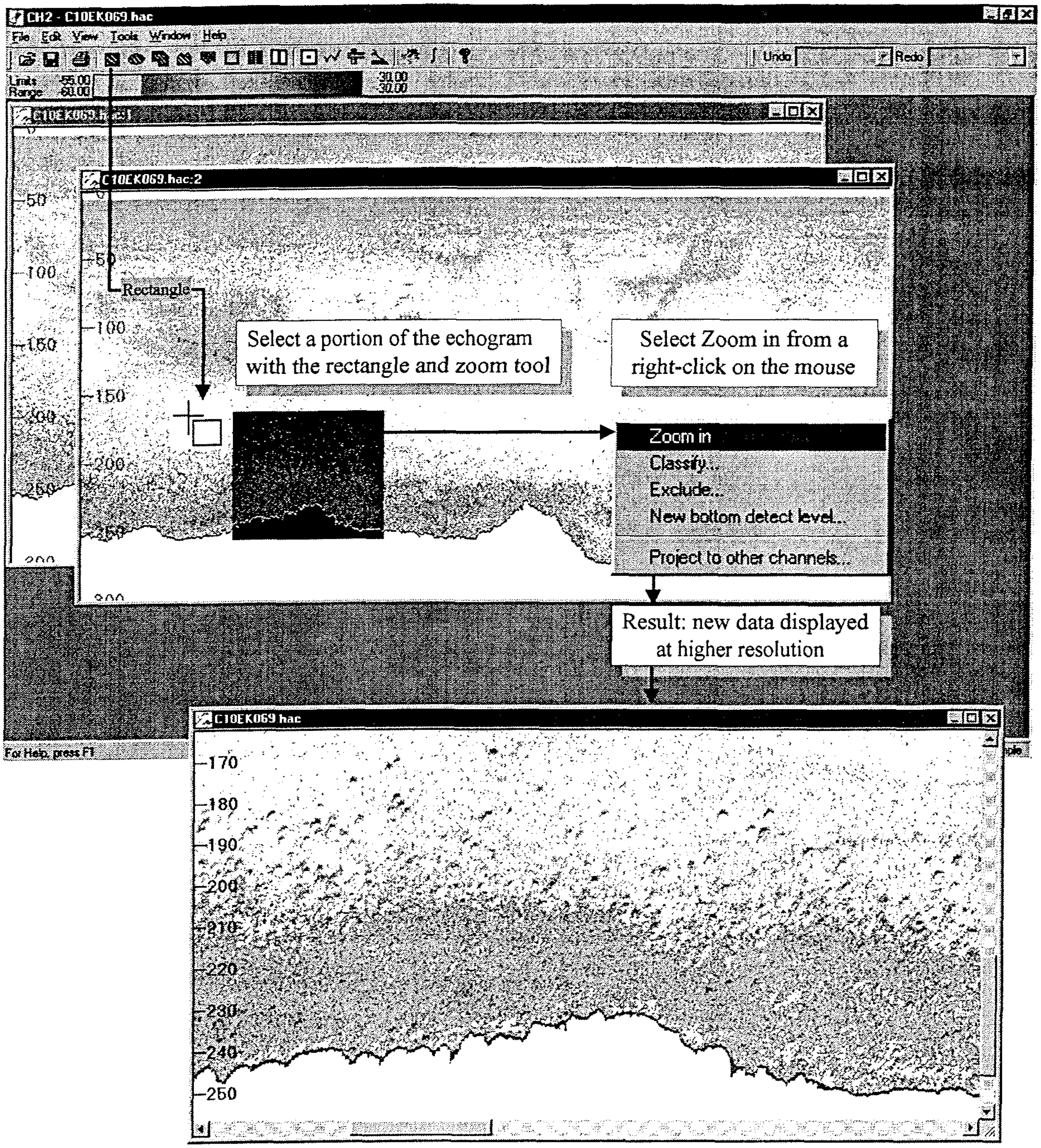


Figure 4-6. Example of a ***CH2*** zoom on the data enclosed in the selected rectangle. Note the higher resolution achieved by bringing in new data and that scroll bars have appeared on the sides of the window, indicating a zoomed echogram.

CH2 editing/classification functions can be classed into two categories. Tool tips that are displayed when the pointer is over each tool identify these functions. First, three general editing functions serve to edit/add TVT(s) or positions and to manually define the bottom with the mouse (Figure 4-7). Second, other editing/classification functions are applied to parts of the echogram(s) that are defined by several region-drawing tools. This is the basic ***CH2*** echogram editing/classification approach. First define a region, over one or many channels simultaneously, and then apply the editing/classification operation on this region using the tools. A region can be as small as a single echo sample or a single ping, or as large as the whole echogram. There are eight tools to define a region on the echogram(s) (Figure 4-7). By selecting one of these, a region is defined with the mouse and can be projected to the other channels by a right-click option, before applying the editing/classification operation from a second right-click.

Two types of operations are common to all region types (c.f. Figure 8-1). They are the classification (labelling) of the region as a particular Echo category, such as its taxonomic identification or its labelling as bad data, and the exclusion of the echo samples (values set to

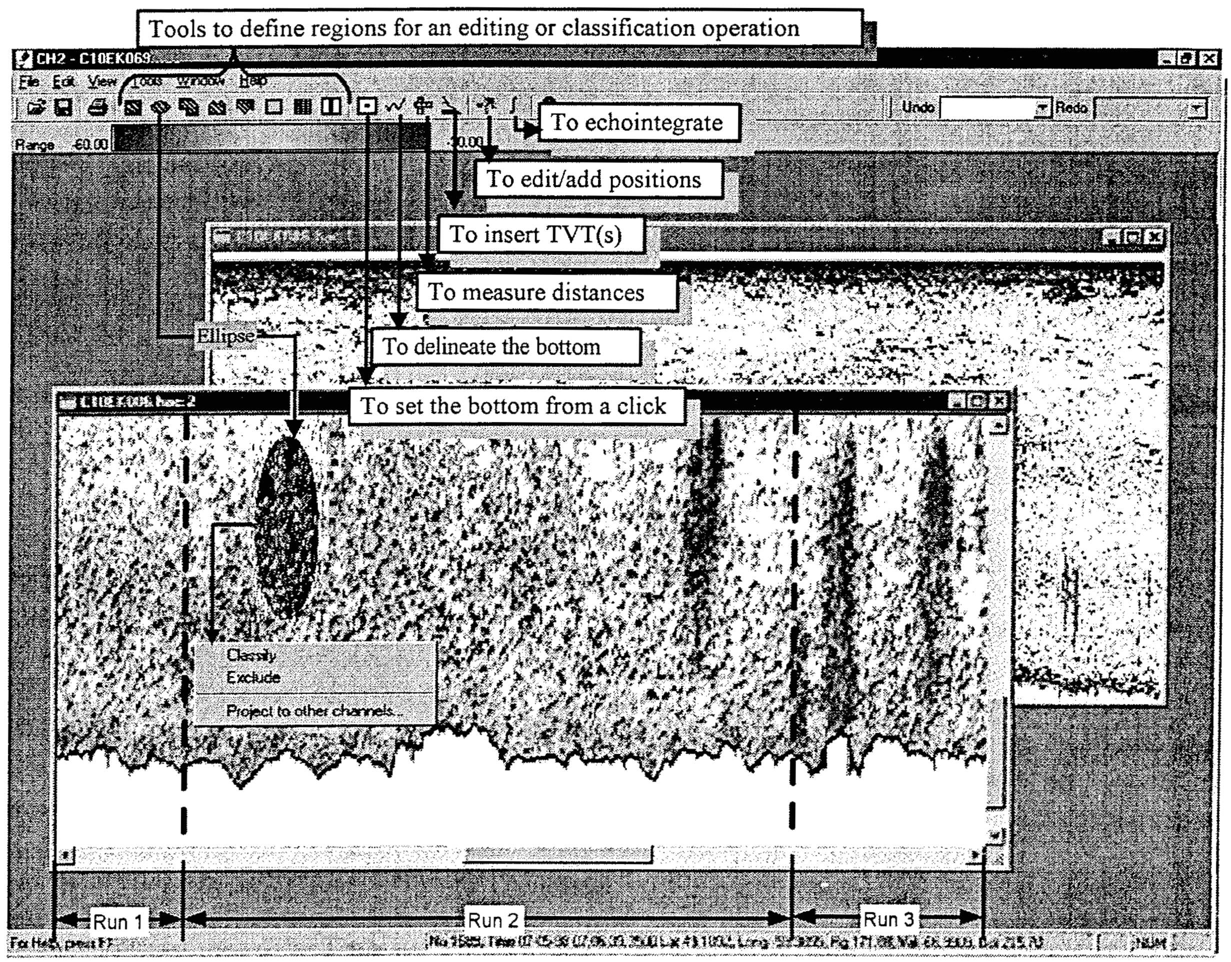


Figure 4-7. ***CH2*** editing/classification tools, distance measuring tool, and echointegration tool. Example shows the Runs portions of an echogram or a ***HAC*** file and the use of the Ellipse region tool to define a region to edit or classify.

zero) from the region. Other operations are associated with certain region types only. These are the bottom editing operations, which are exclusive to the region types Whole echogram, Selected run(s), Selected ping(s), and Below polyline, because the detected bottom is certain to be included in these region types, contrary to the other region types. Another special operation, the Zoom in, is exclusive to the Rectangle region type. The regions can be defined in either the surface-lock or the bottom-lock modes and they are tagged with the display mode in use at their creation. Their definition vertices then refer to the surface or to the detected bottom (original or edited) respectively. The selected echo samples of the edited/classified regions are painted in tinted false colour to localise them. However, the regions are visible only when the corresponding Echo category is active (see section 6.4, Edit / Echo category menu). When the display mode is the same as their creation mode, an additional mask corresponding to the region shape is added. Then, when pointing on a region shape, the pointer is changed to a cross and a magnifying glass, which indicates that the characteristics of the operation can be accessed from the mouse right button. Subsequent versions of ***CH2*** will have the additional option to edit the operation.

HAC files are edited or classified to identify unwanted data, to rectify imprecisions, namely in the bottom detection and vessel position, and to partition the echoes into distinct categories that could be used to produce separate echointegration estimates. The basic philosophy of ***CH2*** is to incorporate these operations in the ***HAC*** files while preserving the integrity of the raw data. This is done by defining new tuples of the ***HAC*** standard data format (Simard *et al.* 1997) containing the parameters of the editing/classification operations. When the user defines an operation, ***CH2*** applies the operation to the data of the selected channels of the active ***HAC*** file, and creates an edition or classification tuple in the PC memory. At the same time an operation is added to the ***CH2*** operation list and Undo list. When the ***HAC*** data file is saved, the new editing/classification tuples are appended to the original raw data to create an edited ***HAC*** data file. This way no information is removed from the original data, in accordance with the ***CH**** philosophy to acquire, archive, and preserve multi-echosounder, multi-channel acoustic data under a standard data format. The next version of ***CH2*** will have the additional option of only saving the data retained after all the operations are applied, in order to reduce the size of the ***HAC*** files and therefore the amount of data to be handled by specific applications. When an edited ***HAC*** file is loaded by ***CH2***, the editing/classification operations are applied in the same order that they were created. The data is therefore presented to the user in the same state as it was at the end of the last editing session. To see a previous editing state, the editing/classification operations can be undone using ***CH2***'s full Undo capability. Inversely the undone operations can be redone with the Redo function. The Undo / Redo functions can be used anytime while editing. The present version of ***CH2*** can undo the last operation or a selected operation with all the subsequent ones in the Operation list. It cannot undo a single operation imbedded in the Operation list, because this operation could be a prerequisite for subsequent operations in the list.

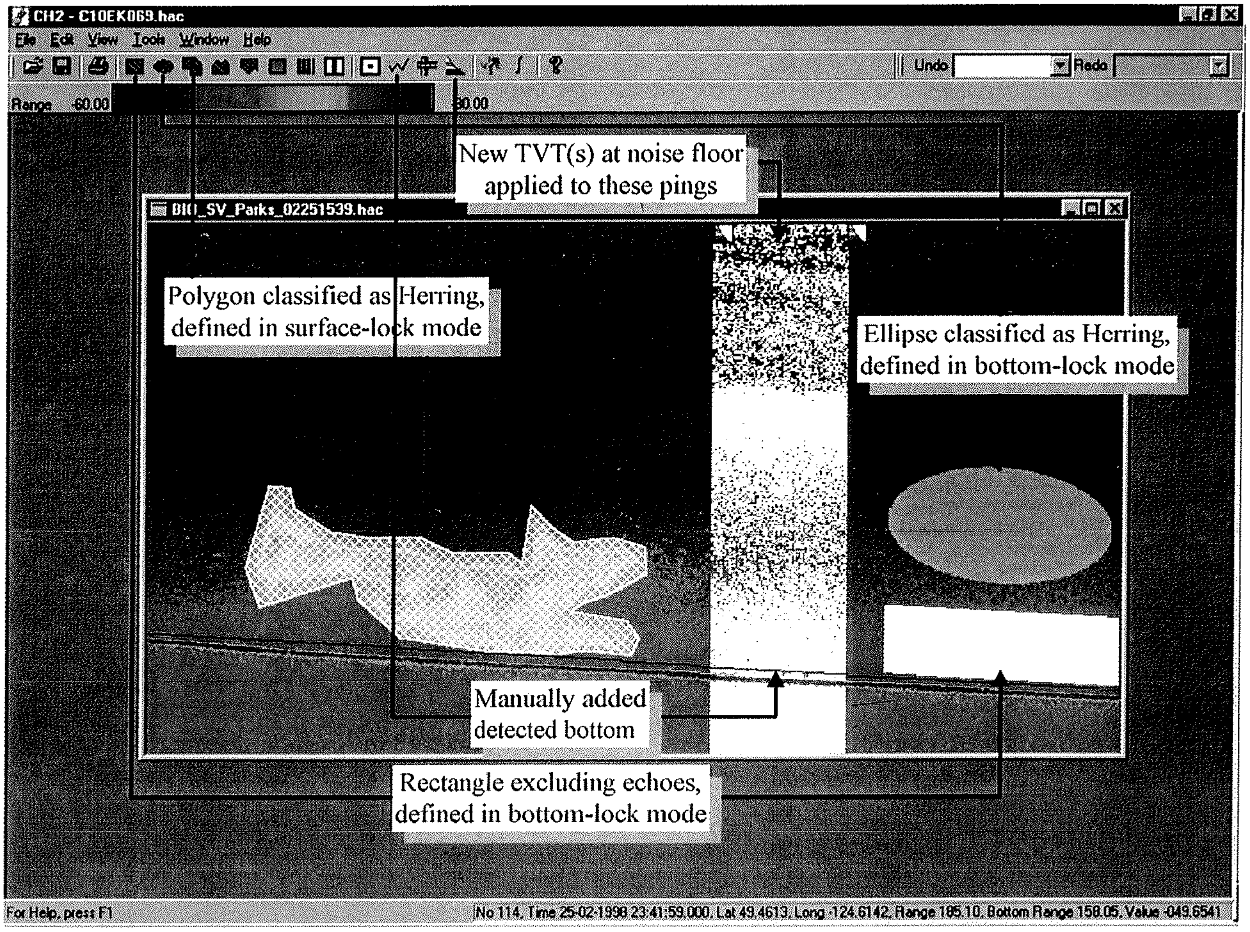


Figure 4-8. Example of editing/classifying an echogram with ***CH2*** tools and the resulting echogram display. The ***HAC*** data file is from the vertical beam of a 202 kHz IOS experimental sonar sampled without any threshold and without bottom detection. First, the bottom is added (black line above the strong bottom echo) using the Manual bottom tool. Then a herring school is delimited and classified with the Polygon region in surface-lock mode and represented with a hatched white mask. The visualisation mode was then changed to bottom-lock and the Rectangle tool was used to exclude the echo samples (values put to zero) from a region in the right part of the echogram above the bottom (the white parallelogram). The Ellipse tool was used in this visualisation mode to classify a region as herring above this excluded region. Switching back to the surface-lock mode, we see that the (deformed) elliptic herring-classified region does not wear a hatched mask, contrary to the other herring-classified region, but is only visible by the colour change of the selected echo samples. This indicates that the elliptical region was defined in bottom-lock mode and refers to the edited bottom. Similarly, the rectangle where the echo samples have been excluded is deformed in a parallelogram following the bottom slope and does not have a hatched mask. Finally, the TVT tool is used over a range of pings to threshold out the echo samples lower than the noise floor as an example of the application of this tool to only retain the significant data. Note that two TVT icons mark the location of the TVTs.

An example of the use of ***CH2*** editing/classification functions to process a ***HAC*** file containing a large herring school is presented in Figure 4-8. The data were acquired with a 202 kHz IOS experimental sonar for the vertical beam without any threshold, and then translated to the ***HAC*** standard data format. The bottom was sloping from ranges 154 to 176 m but was not detected at acquisition. To process the file, the bottom is first added using the Manual bottom

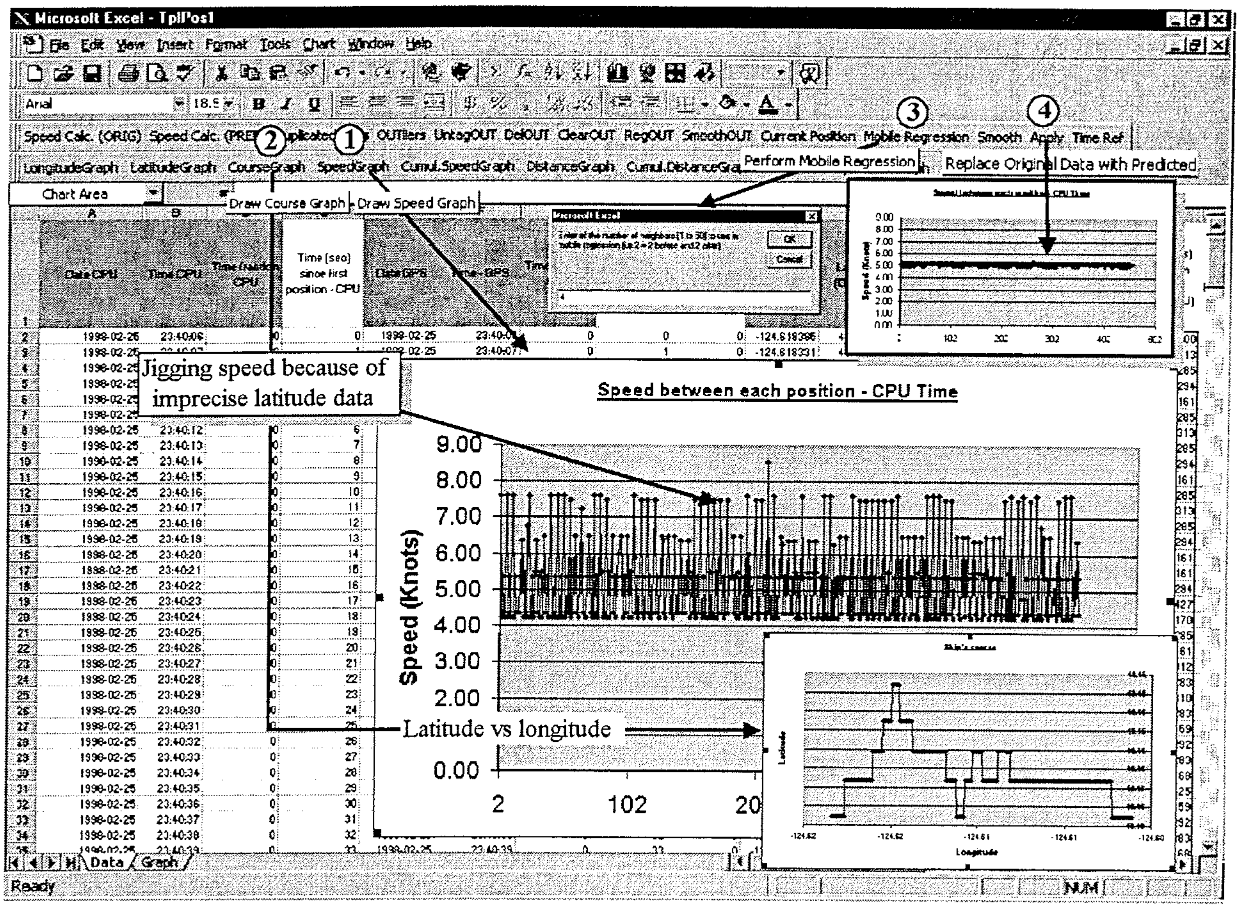


Figure 4-9. Example of editing positions with ***CH2*** via Excel. After having sent the positions to Excel using the Edit/add position via Excel tool, a speed graph is built with the SpeedGraph macro in step 1. The graph shows abnormally high frequency speed fluctuations. In step 2, the examination of other graphs (e.g. with the AllGraph macro) reveals that the latitude did not change as a monotone smooth function but as a step function. This is indicative of a lack of precision in the latitude data. To correct the positions, a mobile regression using a half-window of four neighbours is computed with the Mobile Regression macro in step 3. In step 4, the Apply macro is used to replace the original positions with the predicted positions from the mobile regression. The corrected positions are then retrieved by returning to ***CH2*** and clicking on the Retrieve positions button of the Edit/add position via Excel tool.

tool. Here it is placed 2-3 m above the probable bottom range to increase its visibility. New Edition tuples are added to define the new bottom at every ping intersected by the polyline drawn from the Manual bottom tool and none of the original data is changed. A New bottom from polyline operation is added to the Operation and Undo lists. Then the quality of the position data is inspected with the Edit/add position in Excel tool (Figure 4-9) (see section 8.5). The position data are sent to Excel and the ship speed is plotted against the position sequence number. The ship speed fluctuates abnormally, which reveals that there is imprecision in the position data. An examination of the various graphs indicates that the latitude data was imprecise, likely due to the truncation of co-ordinate decimals at acquisition. The position data thus require a correction. This is achieved by filtering the position data with a mobile linear regression on a window of nine positions. The new positions are then retrieved by ***CH2***. This adds new Position tuples and Edition tuples defining which original Position tuples were updated. Again, none of the original data is changed and a new Edit position operation is added to the Operation and Undo lists.

Once the basic space/time reference data are validated and/or corrected, the Polygon tool is used to define a region encompassing the herring school in the example of Figure 4-8. A double-click closes the polygon and the selected echo samples are indicated by inverse-video. Then the mouse right button offers three possible operations for this selected region: Classify, Exclude, or Project to other channels. The third option allows the projection of the region(s) to other channels in the file if any exist. By selecting Classify, a dialog box opens to select an Echo category from the Echo category list. New Echo categories can be added and their display properties defined. Herring is added with a white cross-hatched pattern. The hatched polygon shape is drawn over the selected echo samples, which are whitened by a blend of their displayed colour and the polygon colour. A Classification tuple is added to define the newly classified region of the echogram tagged with its Echo category attributes. A Classify [Herring] operation is added to the operation and undo lists.

The next step might be to echointegrate for herring using the Echointegration tool, and selecting only the Echo category "Herring" (see section 8.6). The results of the echointegration over the defined X by Z echointegration grid will be output in a *. hei ASCII file (format defined in Annex 1). If the user wants to simultaneously compute the echointegration results for the rest of the unclassified part of the echogram, he would also select (check box) the automatic Echo category "Unclassified" for echointegration. Similarly, if other regions of the echogram would have been classified with other Echo categories, the ***CH2*** Echointegration tool could simultaneously compute the results for each category. Moreover, it could compute the echointegration results for all Channels of the ***HAC*** data file at the same time (c.f. Figure 8-23), with or without Echointegration thresholds.

Before closing the ***HAC*** file, the editing operations can be saved using the ***CH2*** file menu. ***CH2*** does not allow overwriting an original ***HAC*** file, for security reasons. The Save as... option must be used to save an edited ***HAC*** file for the first time. The Edition, Classification, and Operator tuples are appended to the original tuples, a tuple declares the file as edited and an Index tuple is added before the new End of file tuple. Thus the original data are preserved and the new information added during the ***CH2*** editing session is attached to the file in the standard ***HAC*** format. When an edited file is loaded by ***CH2***, the operations are applied to the original data, using the parameters stored in the Edition and Classification tuples. New editing or classification operations can be added, or the old ones can be removed. If a new operator carries on the second editing session, a second Operator tuple will be added to the file. Subsequent versions of ***CH2*** will include the possibility of saving only the data resulting from the application of the operations, in the standard ***HAC*** data format.

Other commonly used ***CH2*** operations are presented in Figure 4-8. One of them excludes a region of the echogram. This is equivalent to setting the echo sample values to zero. An example of the result of this operation is given by the white parallelogram on the right part of the echogram. The entire region takes the same colour as echo samples rejected by ***CH1*** at acquisition (in this case white) because they are now below the TVT. The parallelogram results from the definition of a Rectangle region in the bottom-lock mode, which is then viewed in surface-lock mode, since it is referred to the monotonically sloping bottom. It would have been another shape if the bottom had been more complex. All regions defined in the bottom-lock mode are referred to the (original or edited) detected bottom. If the bottom is changed, the location of the region will also be changed. Another particularity of this excluded region is that it is not overlaid with a hatched polygon, contrary to the herring-classified polygon. This is because the region has been defined in the bottom lock mode and the display is in the surface-lock mode. ***CH2*** only draws the hatched shape for the regions that were defined in the same mode as the display mode. If the display mode is changed to the bottom-lock mode, the hatched rectangle corresponding to the excluded region will be visible. The same display behaviour applies to the ellipse region classified as herring in bottom-lock mode. Regions bear their display mode at their creation as an attribute.

Finally, another frequent operation is to use the TVT tool to threshold out the echo samples lower than a given level, which may be constant over all ranges or follow the TVG (see section 8.4). For example, if it is desired to output echointegration results at various threshold levels, a TVT could be added to the operation list just before echointegration. This could be repeated several times in order to compute the partial echointegration results at various cut-off densities. Here in Figure 4-8, a TVT was used over a range of pings to threshold out the echo samples lower than the TVG-shaped noise floor, thus retaining only the data of interest. Note that two TVT icons mark the location of the TVTs. By pointing on these icons, the mouse rightbutton gives access to the TVT display or editing options. Note also that TVT operations remove from ***CH2***'s memory the echo samples whose amplitudes are lower than the TVT curve. Therefore TVTs can only be edited for defining higher TVTs, since defining a lower TVT would have no effect. TVT operations are added to the operation and undo lists as with all operations. They can be undone and redone using ***CH2*** Undo and Redo functions as required.

The following chapters give details on using the various tools and their specific results. Users should keep in mind that some operations, such as bottom editing or position corrections, have important consequences on other functions (e.g., echointegration) and should be carried out first in an editing session. This version of ***CH2*** does not allow the insertion of an operation in the middle of the operation list. It is therefore recommended to read section 4.1 of this manual, which gives some recommendations for the data processing order. Use the on-line help to get precise information on how to fill out the various dialog-box fields and to properly operate ***CH2***.

4.1 Data processing recommendations

The philosophy behind ***CH2*** was to give the user the flexibility to analyse a large amount of high-resolution hydroacoustic data in a quick and user-friendly manner. This section was designed to guide users through the basic data processing steps to hopefully reduce time wasted redoing data treatment operations because essential processing steps were missed or completed out of order. It is presumed that users will develop their own procedures for data analysis, depending upon their preferences, experience, and, of course, data quality. In this section, we wish to outline the various analysis steps to be taken to produce species-by-species echointegration results from ***HAC*** hydroacoustic data files as well as the recommended order for these operations. The order of these operations will become important if one wishes to undo and redo certain operations, for instance species classifications, without losing the results of other rather time consuming procedures, such as bottom redefinition and the editing of electronic interference.

Checking Errors upon Opening a Data File:

Errors often appear in acoustic data files due to various electronic and operator mistakes or malfunctions. Often these errors will affect echointegration results and the interpretation of data by ***CH2***. It is therefore essential to correct these errors before proceeding with further data treatment and analyses. When an original ***HAC*** file is loaded, ***CH2*** checks for ***HAC*** file integrity and builds an index. It also checks for a number of known data errors when the file checking mode is activated (File / File checking options…, section 5.9). If data errors are found, a message will be displayed by ***CH2***, sometimes asking the user for a decision on subsequent steps. An ASCII log file will be created that summarises the erroneous data fields. Some of these file errors may not be significant and you may wish to ignore the error and proceed with the file opening. Others, such as errors in ping sequence or time stamp can severely impact some ***CH2*** operations, namely echointegration. Therefore, the first step of data processing is to check for and correct these errors if they occur. Some tools are available within ***CH2*** and the ***HAC-trafic*** utility application to correct most problems occurring in ***HAC*** files collected by earlier versions of ***CH1***, while this application was still in its beta phase. In addition, if the user wishes to adjust the time within a file by a fixed amount, e.g., to change the time from GMT to local time, the time can be adjusted for the entire file in ***HAC-Trafic***. This should be done before initiating any editing with ***CH2***.

Time Errors:

We have identified a number of errors in the time stamps of various tuples in ***HAC*** files collected with earlier versions of ***CH1***. These errors arose mainly from the use of an imprecise method for assigning time to certain tuples, and from not using the same method for all tuples. This has been corrected in ***CH1*** (ver. 2.1); however data files collected with earlier versions may need to be rectified. In addition, other time errors can arise if the computer clock (time, date, and time zone) was not properly set. This is easy to do on a ship given that some users prefer GMT and others local time, which is not necessarily the ship's local time, nor the office time, which is often the default time on the computer, etc. Since ***CH2*** uses the time stamp to reference various tuples, it is important to identify and correct all time errors before any other operations are performed on a ***HAC*** file.

Position Errors:

Among the most common errors are position errors, caused either by bad data communications, bad data interpretation, or by problems at the source, e.g., GPS drift, signal interference or data imprecision. These errors are easy to visualise by tracing the cruise track on a chart or graph. Position data can be exported for viewing in software of the user's choice through the File / Export Position data feature (section 5.5). However, it is recommended to use the Tools / Edit/add positions via Excel tool of ***CH2*** to visualise and edit position errors (section 8.5). Several automatic and manual tools are available in this module to identify and correct erroneous positions, although a graph of vessel speed is often the best for judging the quality of the position data. Once an erroneous position is identified, the user can choose among various options such as: (1) manually correcting the position when the error is obvious, e.g., 48 52.97 instead of 58 52.97, (2) interpolating or extrapolating what the position should have been using a running average or a running regression, or (3) simply eliminating the position.

Redefining the Detected Bottom:

When echoes of interest are distributed near the bottom, it is of utmost importance to exclude the bottom signal from data analysis. The definition of the detected bottom is often the most delicate task to be performed because one must not leave any "rocks" in the region to be integrated. However, when significant amounts of fish are found close to bottom, one must not be too conservative either, by eliminating legitimate fish biomass. There are various manual and automatic tools in ***CH2*** to redefine the bottom boundary (Tools / Manual Bottom; Tools / Selected Runs (or Pings) / Move bottom, etc. – Chapter 8). Once this has been accomplished, the user should review the bottom definition by zooming on the bottom signal and scrolling along the data file to ensure that no bottom signal is present in a zone to be integrated.

It is important to define the bottom before defining any classification regions in Bottom-lock mode. In this mode, the regions are defined in relation to the detected bottom. Therefore, if a bottom editing operation changes the detected bottom beneath a region defined in bottom-lock mode, the vertices defining the region are also changed, as are all the classified echo samples.

Changing Signal Threshold:

We may decide that the TVT was too low during data acquisition and should be raised to eliminate low level background noise or low amplitude echoes, such as plankton. In this case, the user can either edit the existing TVT (Edit / TVT, section 6.5), add a new TVT (Tools / Insert TVT..., section 8.4) to a selected region or specify an increase in the signal threshold for echointegration (Tools / Echointegration / Channels / Echointegration threshold (Sv) – section 8.6.2) to a selected region.

Noise Removal:

It is often useful to eliminate regions that are not considered interesting, such as those which contain significant external noise above threshold, e.g., from trawling activity, electronic interference, or where the system may have malfunctioned. These regions should be defined using the various region selection tools (Chapter 8) and either excluded or classified as bad data. **Note**: If a region is excluded, the value of the samples within this region will be set to 0 and will be included in the echointegration of the region. If, however, the region is classified as bad data, the samples will be excluded from the echointegration results from this region, i.e., null data.

Modification of Parameter Values:

Often a user may wish to correct various stored parameters that were used during data analysis. For example, it may be determined after the fact that certain echosounder or channel parameters were not correct during data acquisition and should be adjusted for data analysis, e.g. sound speed, transducer depth, absorption coefficient, transducer gain. Most of these sensitive parameters can be updated during echointegration (Tools / Echointegration / Channels tab, section 8.6.2).

Classification of Echoes:

At this point, we can identify and label the various regions of interest, i.e., species and species groups. Ideally, identifying the regions should be done as soon as possible after the mission, or even during the mission, when the conditions under which the data were collected are still fresh in our minds. We therefore select the various echo aggregations with the various region-drawing tools and classify these regions into species or species groups (section 8.1). It must be kept in mind that each echo category will have a separate echointegration table, therefore regions should be classified to identify species mixes and sizes that reflect the corresponding information from the trawl data. For example, regions where trawling showed concentrations of only herring could be classified as "Herring" while other regions where trawling showed a mixture of herring and cod could be classified as "Herring/Cod". ***CH2*** can therefore produce separate echointegration tables for these two classes, and separate TS and species-mix proportions can be applied to the echointegration results for biomass estimation.

5. FILE MENU

The File configuration menu offers the following commands:

Open	Opens a ***HAC*** file.
Close	Closes the active ***HAC*** file.
Save	Saves the ***HAC*** file under the current file name if it is not an original file.
Save as…	Saves the ***HAC*** file under a new file name.
Export position data	Exports position data under the *.bna or *.txt formats.
Print	Prints a copy of the active echogram.
Print preview	Previews the print output.
Print setup	Configures the printer to print the echogram.
File checking options…	Configures the options to check ***HAC*** files for errors at opening.
List of recent files	Opens a recently opened ***HAC*** file.
Exit	Closes ***CH2***.

5.1 File / Open

This dialog box is used to browse through your disks to select a previously saved ***HAC*** file that you want to process with ***CH2***. If this file is one of the last nine ***HAC*** files used by ***CH2***, select the file from the list that is displayed when you click on the File menu.

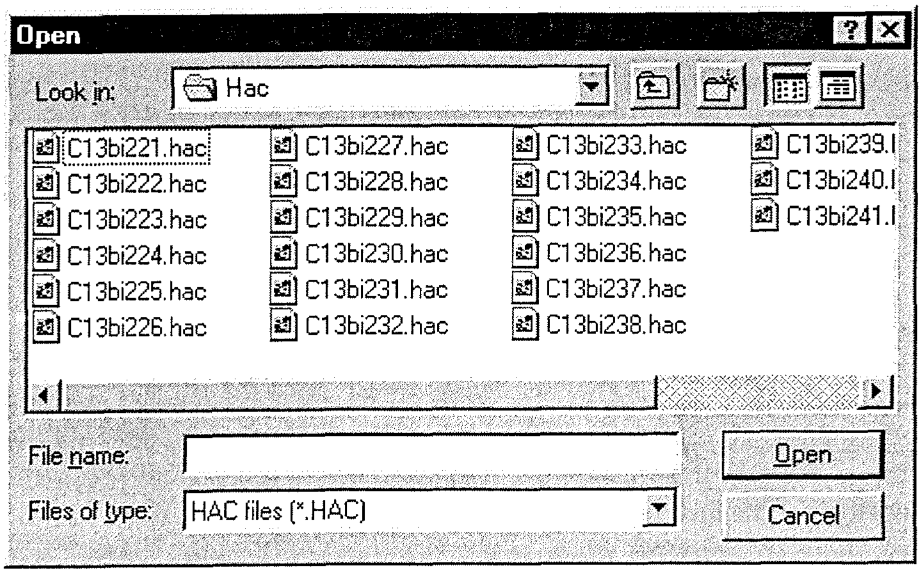


Figure 5-1. File / Open dialog box.

Once you have chosen a file, a dialog box will be displayed while the file is read and checked for errors, and an index is generated if it is not a *CH2*-edited ***HAC*** file, which already has an index. If the file contains errors or lacks certain significant data, the user is asked if he wants to continue with the opening of this file. Then a new dialog box (Figure 5-2) displays the channels the file contains, and the characteristics of the channel you select with the mouse. By default, the first channel of the list is selected. Use the Shift key to select several channels or the All channels radio button to open all channels of this ***HAC*** file. Then click on the View button to display the selected channel(s).

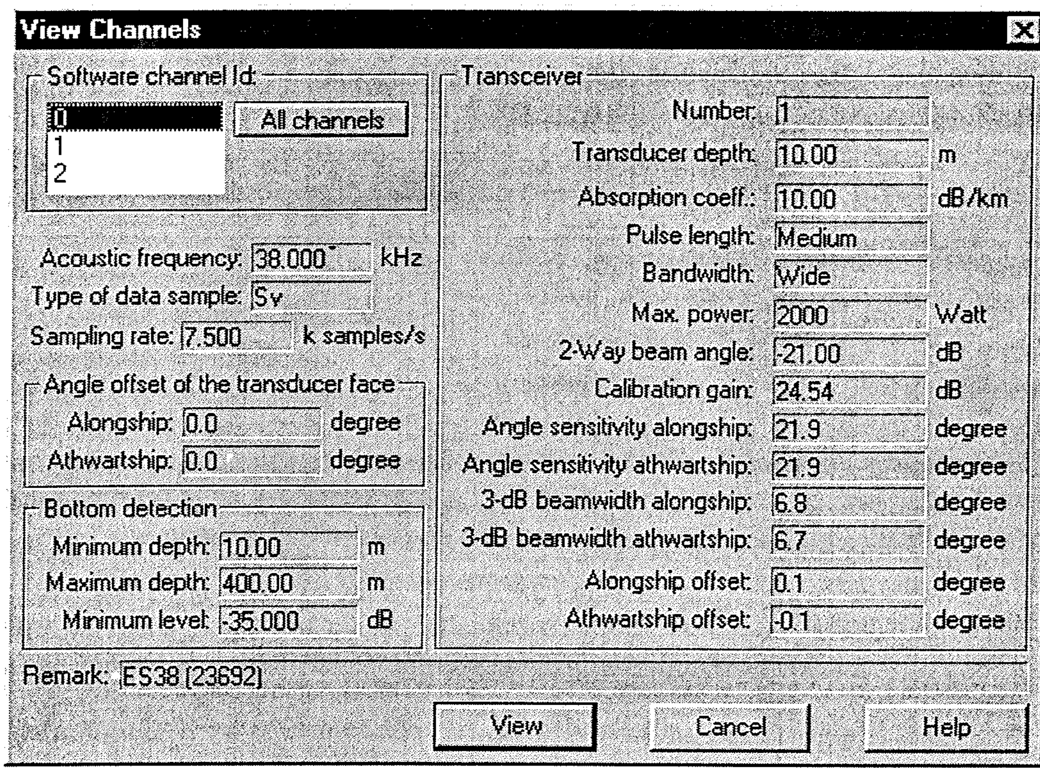


Figure 5-2. File / Open, View channels dialog box.

5.2 File / Close

This option closes the active ***HAC*** file with all its attached channel echogram windows. All the other opened ***HAC*** files will remain open, and one of them will become the ***CH2*** active ***HAC*** file. **Warning**: Your editing/classification operations for this file will be lost if you do not save them before closing the file. The usual file closing warning will remind you to do so. If you only want to close the active channel window, use the standard Windows95/98® window-closing button (X) at the right corner of the window.

5.3 File / Save

This option saves the active ***HAC*** file with your editing/classification operations. ***CH2*** does not allow overwriting the original ***HAC*** file name. Use the Save as... option if your active file is an original ***HAC*** file.

5.4 File / Save as...

This saves the active ***HAC*** file with the editing/classification operations under a new name (required) if it is an original ***HAC*** file that was edited for the first time. The same name can be used for edited ***HAC*** files.

5.5 File / Export positions data

This option (Figure 5-3) exports the GPS position data in comma separated ASCII text files (*.txt) or in Golden Software *.bna format to use directly with Surfer® or MapViewer® to plot the data locations on a map.

5.6 File / Print

This option prints the echogram bitmap view of the active channel window with an identification heading. This is a rough "quick-and-dirty" printing of the echogram. The usual Windows clipboard features can also be used advantageously to export the active echogram bitmap (Alt-Print Screen) towards various bitmap editing and printing applications such as Windows Paint® or Photoshop®.

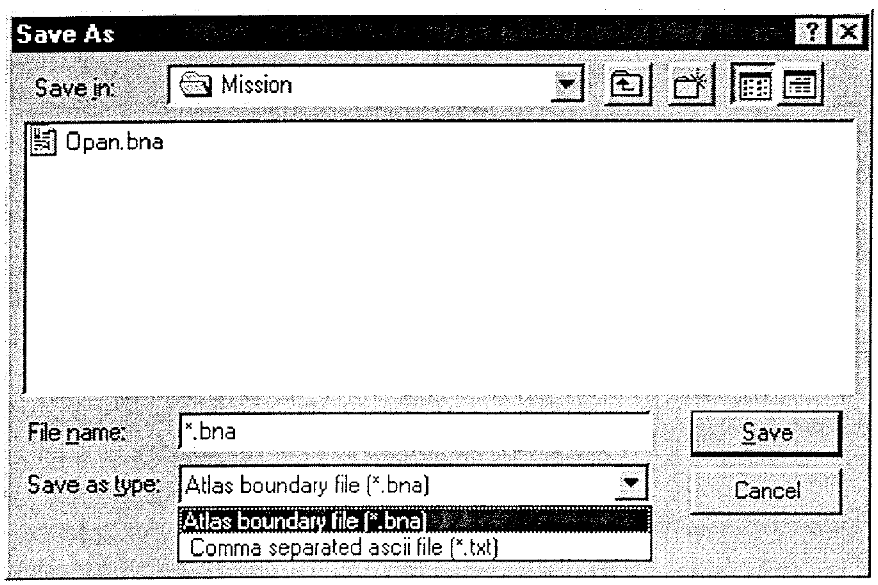


Figure 5-3. File / Export position data dialog box.

5.7 File / Print preview

This option previews the printed output of the active echogram window with the identification heading.

5.8 File / Print setup

This option configures the printer to print the bitmap of the active echogram window.

5.9 File / File checking options...

This option configures special file checking options when a ***HAC*** file is loaded. It mainly concerns old ***HAC*** data files collected during the development of the ***CH**** suite, which contain certain errors that can be corrected individually by ***CH2*** or in batch mode (several files) by the ***HAC-trafic*** utility. The same File checking options can be configured from the File menu of ***HAC-trafic*** without opening any file. Selecting this option from the ***CH2*** File menu opens the corresponding check-boxes (Figure 5-4). The File Checking Options Manager check-box activates or deactivates all the options. Seven types of known errors can be checked for by activating the check-boxes within the File Checking options dialog box. They are described in section 11 Error messages and troubleshooting. If any of the selected error types are found, a critical error message will be displayed (e.g., Figure 5-5) except for the Time Variation plugin, which will only trigger a warning. The message indicates the name of the ASCII-text log file containing information on the error and the ***HAC*** file properties. The option to correct the error is offered. The file loading will abort if the user chooses to not correct a critical error. Alternatively, the error log file and the corrected ***HAC*** file will be written to the Working directory selected in the File Checking Options dialog box. The corrected ***HAC*** file will have the same root name as the original ***HAC*** file plus the "_cor" characters (e.g., C13bi123_cor.hac).

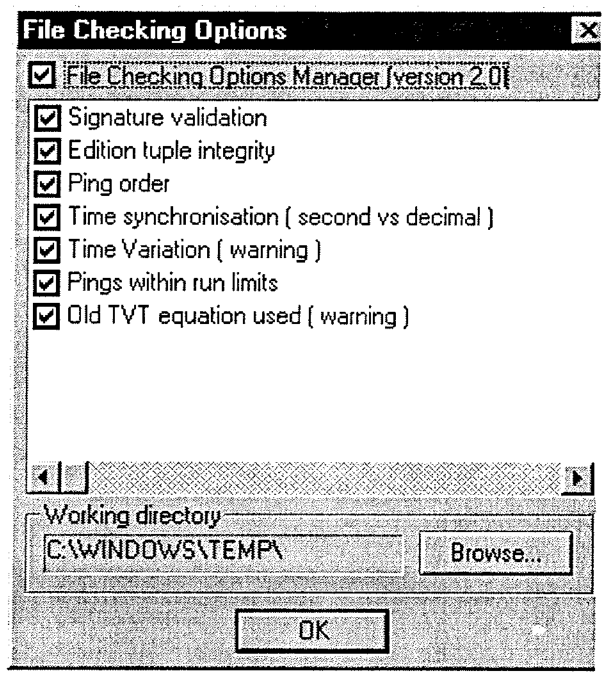


Figure 5-4. File / File checking options box.

It is recommended to deactivate the File checking options if you are not working with old ***HAC*** data files, but to activate them if ***CH2*** has difficulties opening or processing certain files. If the File checking options are deactivated, standard ***CH2*** warning messages will nevertheless be displayed if critical errors are found while the file was read. In the case of critical errors, file loading will abort.

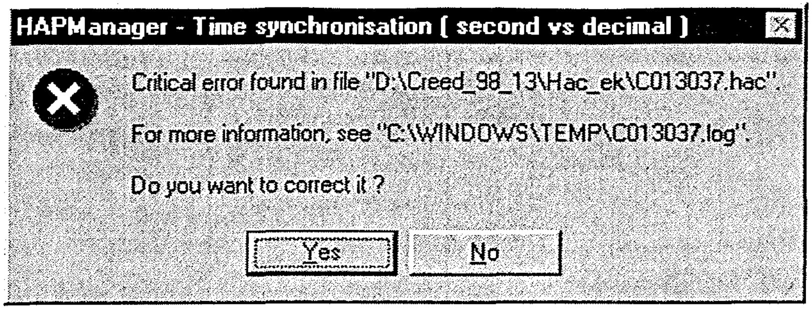


Figure 5-5. Message displayed when an error in Time synchronisation (second vs decimal) is found in a ***HAC*** file by the File / File checking options.

5.10 File / List of recent files

This is the usual direct access to the list of recent files, which can contain up to nine files. Files are removed from the list if their opening is aborted, which could result, for example, from a move or erase of the file from the directory or from a file name change.

5.11 File / Exit

This option closes ***CH2*** and all the opened ***HAC*** files. You can also exit ***CH2*** using the standard Windows95/98® window-closing button.

6. EDIT MENU

The Edit menu offers the following commands:

Palette	Edits the active channel palette.
Operators' list...	Edits the operators' list, adds or deletes operators from the list.
Operation reason list...	Edits the operation reason list, adds or deletes reasons from the list.
Echo category list...	Edits the Echo category list and their properties, and activates/deactivates the categories.
TVT(s)	Calls the Edit TVT(s) dialog box to edit the TVT(s) the file contains.

CH2 works with Operator, Operation reason, and Echo category lists that are regularly called when performing editing and classifications on ***HAC*** data. These lists reside in the Windows95/98® registry of the PC in this version of ***CH2***. They can be viewed and edited with the Edit menu. The Edit menu also serves to view and edit two properties of the active channel, the Palette and the TVT(s). These latter functions can also be accessed through the mouse right button. Double-clicking on the Palette bar is a shortcut to the Palette editor.

6.1 Edit / Palette

The Palette editor serves to define, store, and load palettes associated with channels or to define defaults for various data types. It can be accessed through a double-click on the Palette bar, the Edit / Palette menu and the right-click menu. The palette is applied over a given range of data values, determined in the Min. and Max. fields of the Palette editor dialog box (Figure 6-1). An option can be selected to mask the colours at both ends of the palette by another colour, below and above specified data-limit values, which are entered in the corresponding fields. The colours are chosen by double-clicking on the respective Above and Below buttons. The Limit colour Show button applies the given limits to the palette bar. This palette limit option is very useful to mask data values below or above specific thresholds without changing the range of values (i.e., the colour scaling) to which the active palette applies. A special colour can be assigned to the detected bottom sample through the Bottom button. The defined palette can be saved and loaded using the Save and Load buttons. The binary Palette files have the extension *.pal. ***CH2*** associates a default palette to each of the following data types: volts, Sv, TS and all others. These default palettes are configured in the Tools / Options menu (see section 8.7). The Set as default button replaces the default palette associated with the current data type with the present palette. **Warning**: The default palettes are stored in the Windows95/98® registry of the PC. Therefore, when ***CH2*** is installed on a new PC the default palettes must be reconfigured, which can be easily done by loading a previously saved *.pal palette file for each data type.

Palettes can be defined in three different ways: a parameter model, a colour gradient between two given colours, and an advanced gradient(s) mode. These three palette definition methods are detailed below.

6.1.1 Parameter method

Selecting the Parameters radio button of the Definition method group chooses this mode. In this palette definition mode, a continuous circular colour gradient from blue to green to orange to red to magenta and back to blue is generated from the combination of the three RGB primary colours (Figure 6-2). The palette is defined by three parameters: an Offset, a Span, and an Exponent parameter. The Span parameter determines the fraction of the colour cycle that is

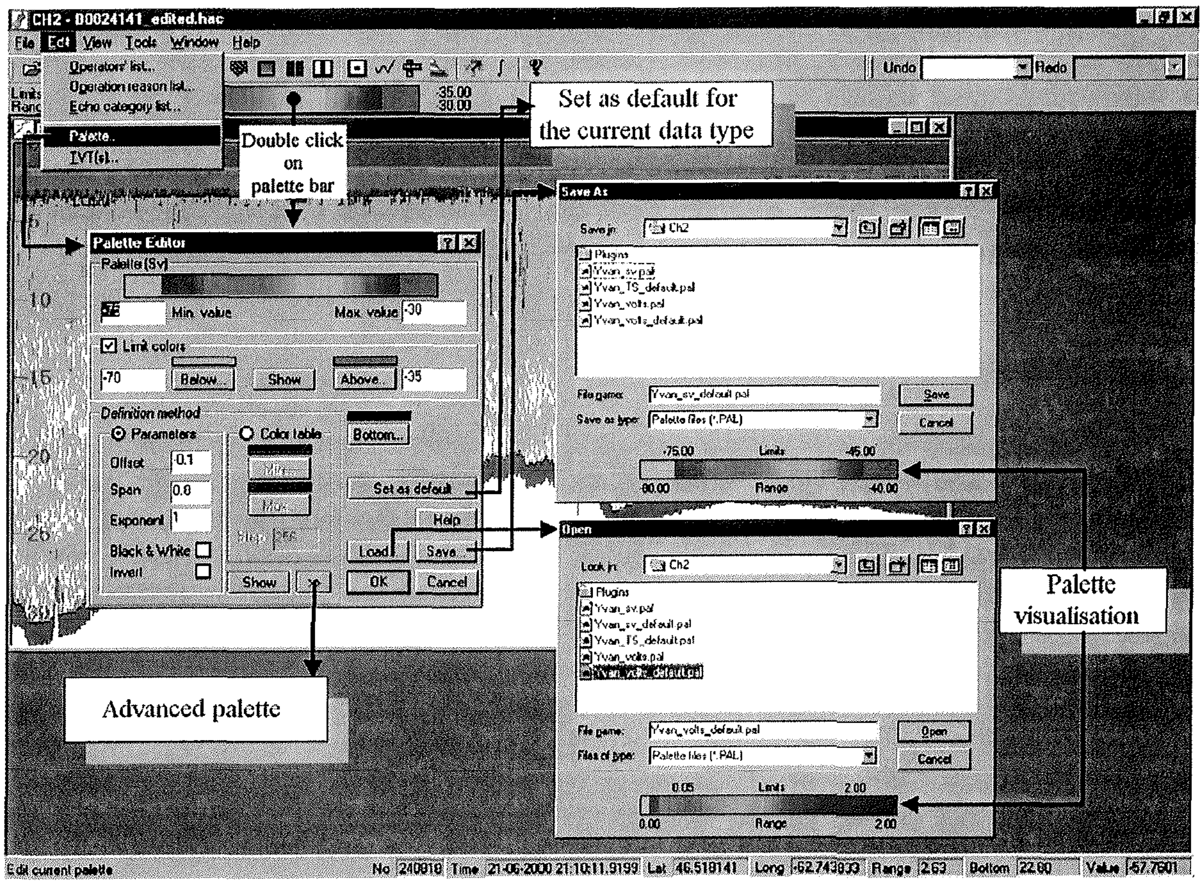


Figure 6-1. To edit the palette for the active echogram, access the Palette editor dialog box through the Edit menu, the right-click menu, or by double-clicking on the palette bar. Palettes are associated with the data type. They can be saved and recalled in ASCII *.pal files. ***HAC*** file channels are loaded with ***CH2*** default palettes, which can be determined by the user. The advanced palette is displayed in Figure 6-3.

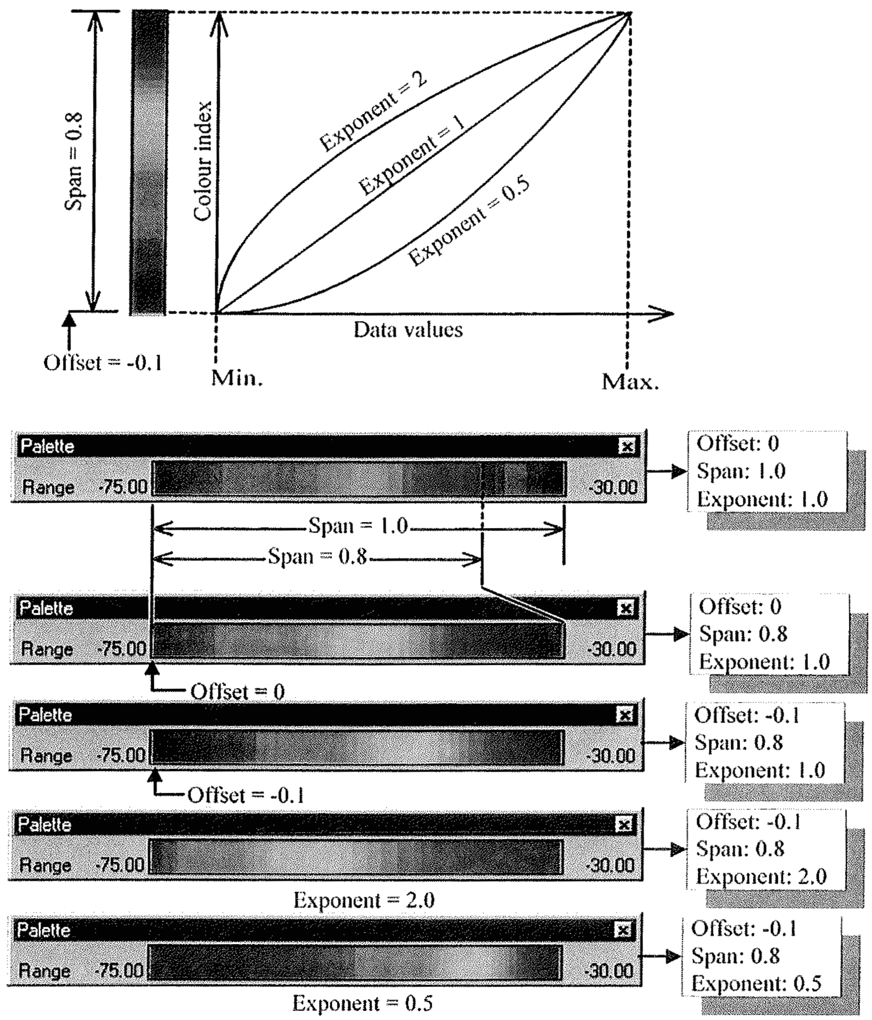


Figure 6-2. Working of the Parameter palettes and examples with different parameter settings. The full colour gradient available is displayed on the Palette bar when the Offset is 0 and the Span is 1.0 (top Palette bar). This gradient has blue at both ends, which gives a circular colour cycle. For defining a warm palette, as the one shown on the Y axis, the blue at high values is eliminated in the second Palette bar by using only 80% of the colour cycle with a Span of 0.8. The use of a negative Offset of -0.1 in the third palette brings more cold blue at low values and removes some magenta at high values, by shifting the 80% selection by -10% on the colour cycle. In the fourth palette, the selected colours (Y) are allocated to data values (X) according to a function $Y \propto X^{1/2}$, with the Exponent set to 2.0. In the fifth palette the function is $Y \propto X^{1/(0.5)}$, with the Exponent set to 0.5.

retained for the palette. Values larger than 1.0 are accepted but they will only repeat the colour cycle; for example, a value of 2 repeats the colour cycle twice, and so on. The Offset parameter determines where to start the palette in the colour cycle. For example, an offset of 0.25 will shift the beginning of the palette to 25% of the colour cycle. Negative values are allowed. They can be used to bring the blue colour of the end of the colour cycle at the palette start for generating a continuous warm palette (e.g., Figure 6-2). The Exponent parameter determines how the selected colour band will be allocated to the data values. An exponent of 1.0 gives a linear allocation; the colours are linearly attributed to the data values. Other Exponent values produce exponential allocations according to a function $Y \propto X^{(1/Exponent)}$, where Y are the colours and X are the data (see Figure 6-2). The Show button of the Definition method group displays the configured palette. The palette can be converted to a grey scale by selecting the Black & White option. The

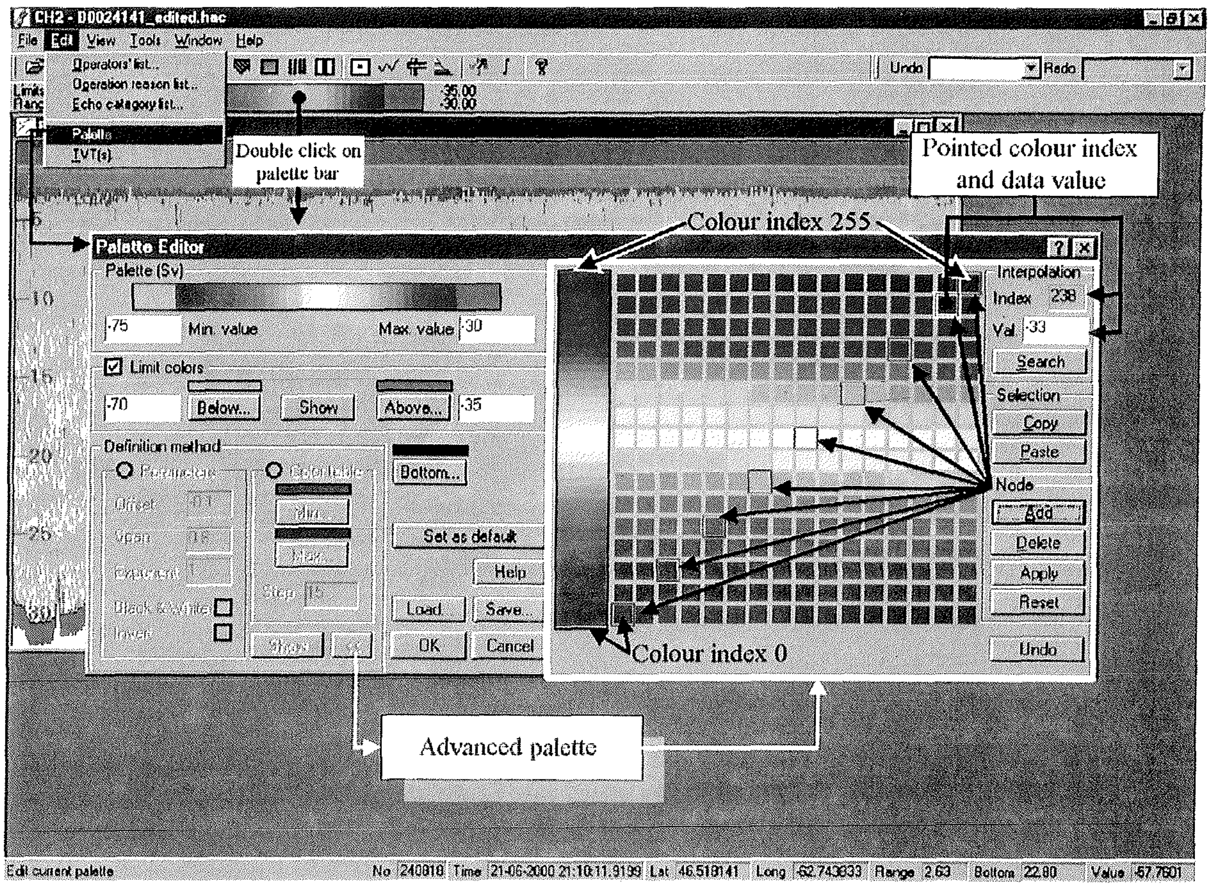


Figure 6-3. The advanced step palette is accessed from the ">>" button of the Definition method parameter group of the Palette editor dialog box. The 256 colour table is displayed. The data value corresponding to one colour cell is obtained by pointing on the cell and reading the fields in the top right corner. A search for the colour cell corresponding to a given data value can be performed with the Search button and the Val. field. Any of the 256 colours can be changed by double-clicking on it. Colours can be copied and pasted from one cell to another. Any colour cell can become a colour node (outlined in red) by selecting it, then clicking on the Node/Add button. Colours between two successive nodes are linearly interpolated. The changes made can be undone step by step with the Undo button.

Invert option inverts the palette. To view the data value assigned to each colour, click on the ">>" button of the Definition method group to open the generated 256-color table. Then point on any colour cell or on the vertical colour bar to display its data value in the upper right corner.

6.1.2 Colour table method

Selecting the Colour table radio button of the Definition method group selects this mode. A palette is then generated as a gradient between two colours that are selected from the Min. and Max. buttons. The number of steps for the palette, from 2 to 256, is given in the Step field.

6.1.3 Advanced mode

The Advanced mode is selected by clicking on the ">>" button, which adds a new panel to the dialog box (Figure 6-3). This panel contains the 256-colour table corresponding to the vertical colour scale displayed on the left, and buttons and fields used to define a custom palette. The default colour table displays the 256-colour series between the colour cell index 0 and the colour cell index 255. These two limit colour cells are called the colour "nodes" of the gradient. Colour indices are displayed in the Interpolation group fields (top right) when pointing on a colour cell of the table. The colour of any cell of the table can be changed by double-clicking on it. The Copy and Paste buttons of the Selection group are used to copy the colour of one cell to another cell (as a shortcut, simply click and drag from one cell to the other one). The data value corresponding to one colour cell is obtained by pointing on the cell and reading the Val. field in the top right-hand corner. A search for the colour cell corresponding to a given data value can be performed by typing the value in the Val. field and clicking the Search button of the Interpolation group. The colour cell found is indicated by a white contour. Any colour cell can become a colour node (outlined in red) by selecting it, then clicking on the Node/Add button. Colours between two successive nodes are linearly interpolated. The Delete button removes nodes. The Apply button recalculates the colours between the nodes, which is useful when the colour of some cells were changed. The Reset button restores the default colour table, which is a simple gradient between the colour cell index 0 and the colour cell index 255. The steps of configuring the palette are temporarily preserved in the memory and can be undone step by step with the Undo button. The configured Palette is applied by clicking on the OK button on the Palette editor dialog box.

This Advanced palette mode is useful for configuring specialised palettes, such as a change of colour at given data-value steps (e.g., 3 dB steps) or to enhance the visibility of some sub-ranges of data values that present particular interest (e.g., the TS range of one fish species).

6.2 Edit / Operators' list

All ***CH2*** editing or classification operations performed on a ***HAC*** data file are tagged with the operator's identification. Many operators can edit the same ***HAC*** data file over time. A list of operators' identifications can be set up and recalled to select a current operator at ***CH2*** opening or during the editing session. The list resides in the Windows95/98® registry of the PC.

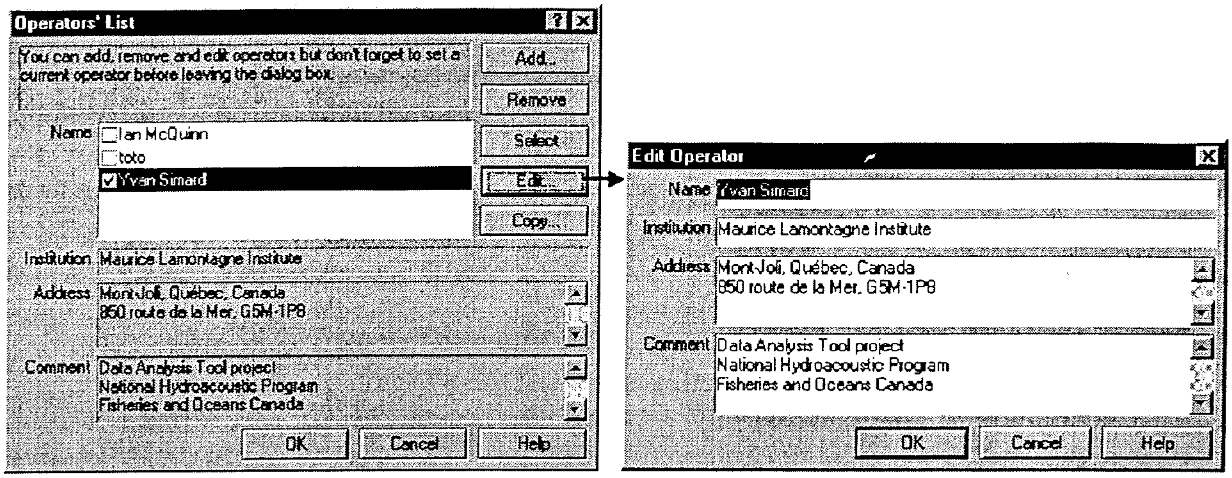


Figure 6-4. Operators' list dialog box to add or edit ***CH2*** operators' identifications.

The Edit / Operators' list menu is used to build or edit the list. This menu item opens the dialog box to define the operators' identification (Figure 6-4) and to edit the Operators' list. This dialog box can also be accessed via the specific dialog boxes of any editing or classification operation. Use the Ctrl+Enter keys to add lines in the Address or Comment boxes. To set the current operator, either double click on the name of your choice or select the name and click on the Select button and then on the OK button.

6.3 Edit / Operation reason list

A reason can be optionally attributed to every ***CH2*** editing or classification operation. Since the same reasons may be frequently recalled during an editing session, ***CH2*** offers the possibility of creating a list of common reasons that can be recalled every time the user wants to tag an editing or classification operation with a reason. The reasons are intended to be used in further data explorations by future ***CH2*** versions, for example to locate special acoustic features. The use of a list has the advantage of standardising the labelling, which will be useful in further data processing. The Edit / Operation reason list menu is used to build or edit the list. This menu item opens the dialog box to define the reasons (Figure 6.5) and to edit the list. There is no limit to the length of the text defining the reason. This dialog box can also be accessed via the specific dialog boxes of any editing or classification operation. To set a current reason, select the reason and click on the OK button.

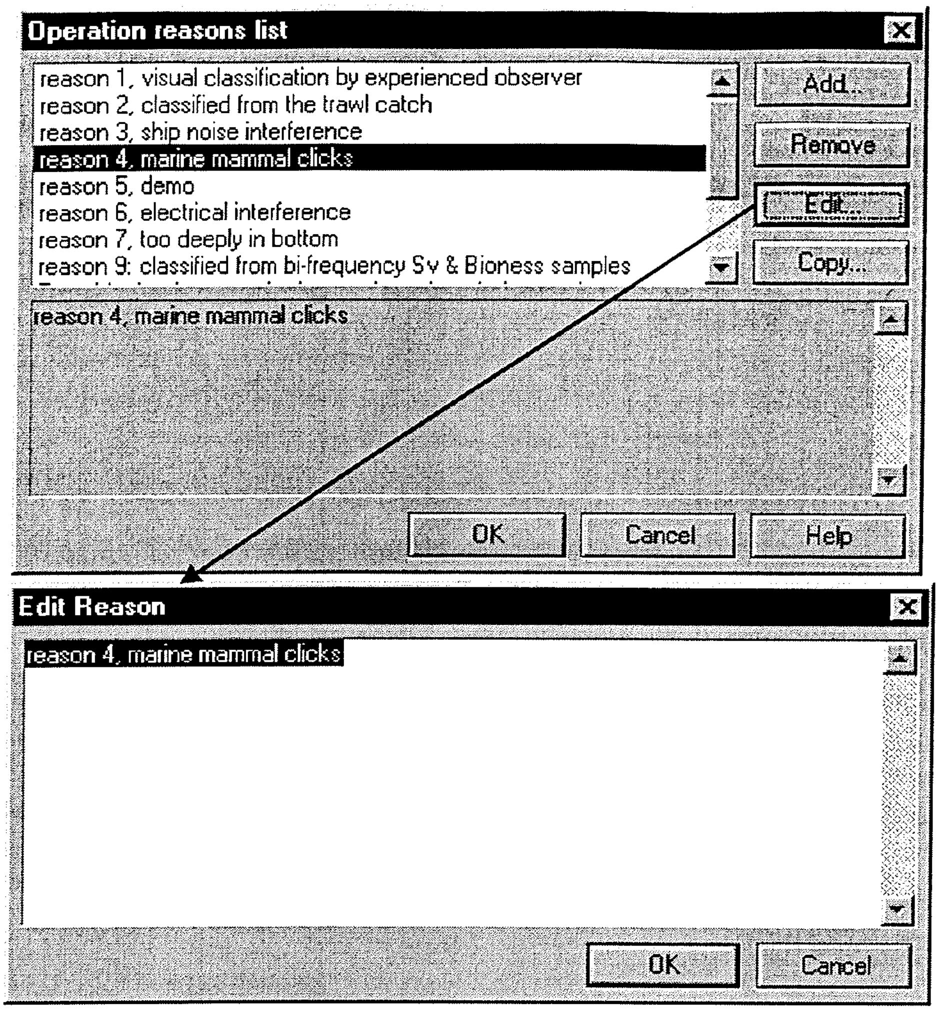


Figure 6-5. Operation reason list dialog box to add or edit reasons used to tag *CH2* editing or classification operations.

6.4 Edit / Echo category list

One important *CH2* feature is the definition of regions of the echogram(s) for performing exclusion or classifying operations on the echo samples they contain. These regions are identified by echo category names. The user determines the echo category names, except for two special categories, Bad data and Exclude, and the names are added to the Echo category list. The user also determines the display attributes of the echo-category. *CH2* computes separate echointegration results by echo category (see *CH2* Echointegration tool, Section 8.6). In this version of *CH2*, the echo categories are defined by the user, from his knowledge of the nature of the echoes, which is often derived from ground-truthing observations obtained from various gears such as trawls, nets, and cameras. Subsequent versions of *CH2* should incorporate high-level algorithms to produce objective echo classifications, such as multi-frequency algorithms and multi-channel image analysis.

As with the other lists, the Edit / Echo category list menu is used to view and edit the Echo category list, as well as to determine the display attributes of the categories. Clicking on this menu item opens the Edit / Select Category dialog box, which displays the defined categories and their active state with a check box (Figure 6-6). The Bad data and Exclude categories are always included in the list and cannot be removed. See Chapter 8 for their definitions. The other echo categories are those defined by the user. To be visible on the echogram, the echo category must be active, which is indicated by the check in the box preceding the name. Echo category display is activated through the Properties button, which accesses the category attribute dialog box. **Note**: The name of the category is case sensitive, therefore "herring" and "Herring" are considered as two different categories by ***CH2***. The colour property of the selected pattern also determines the colour of the tinted mask that will be blended with the echo sample colours defined by the echogram palette. The Echo categories can be defined for a region in both surface- or bottom-lock display modes. When the active display mode does not correspond to the display

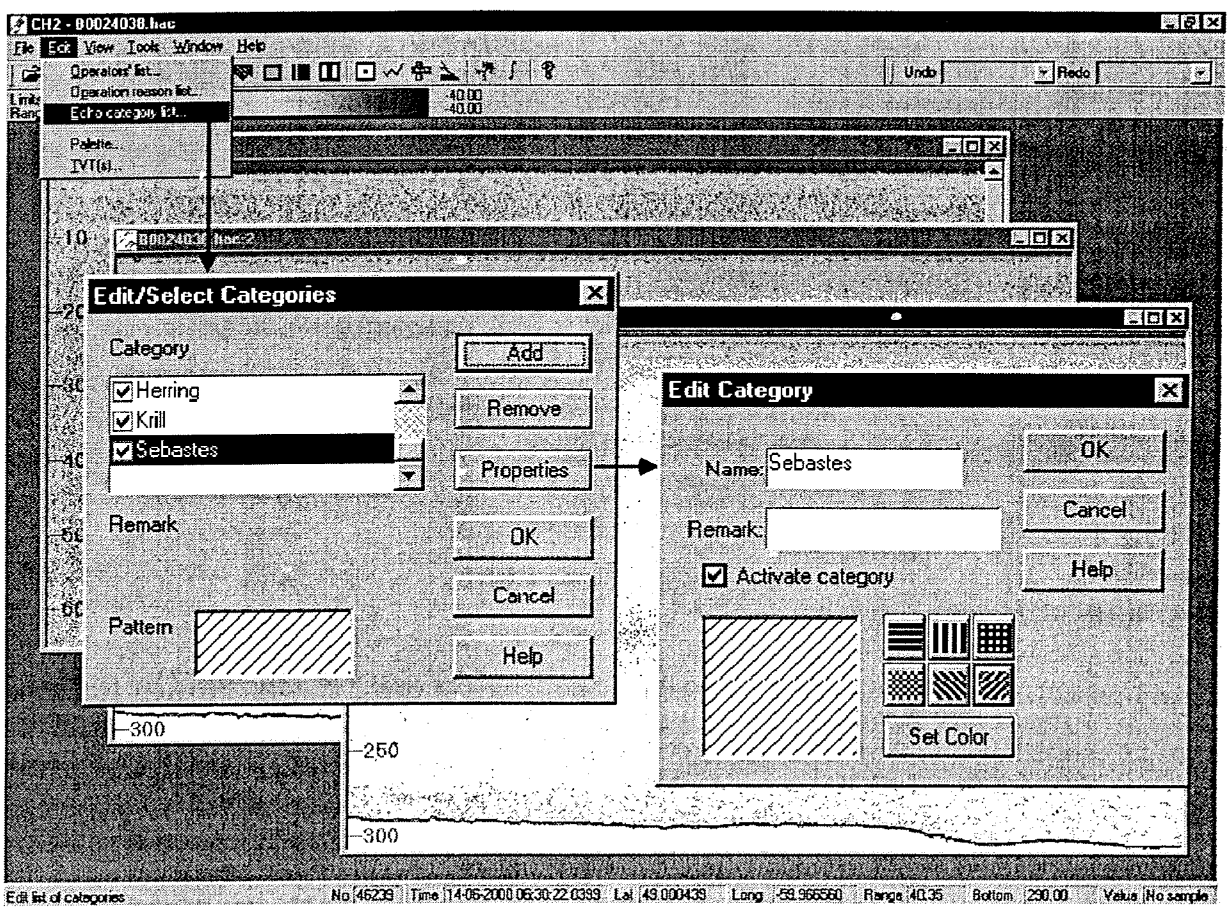


Figure 6-6. Echo Category list dialog boxes to add or edit the echo categories and their visualisation properties.

mode used when the region was defined, only the tinted mask is visible. When the mouse pointer is over an echo category region, its shape changes to a cross and a magnifying glass icon if the active display mode is the same as the one used when the region was defined. The characteristics of the operation performed on this region can then be displayed by a right click of the mouse.

6.5 Edit / TVT(s)

This menu item can also be accessed from a right click of the mouse. It serves to view and/or edit the parameters of the time-varied threshold(s) (TVT) used for the active echogram (Figure 6-7). The TVT is a threshold following the TVG law corresponding to the channel data type. The user first selects the TVT to be edited and then clicks on the View Characteristics or the Edit button to have access to its parameters. The corresponding TVT Offset (*C*) or Amplification (*A*) parameters can be changed for new values. Only values that increase the TVT for at least a portion of the total range are accepted. When the new parameter values increase the

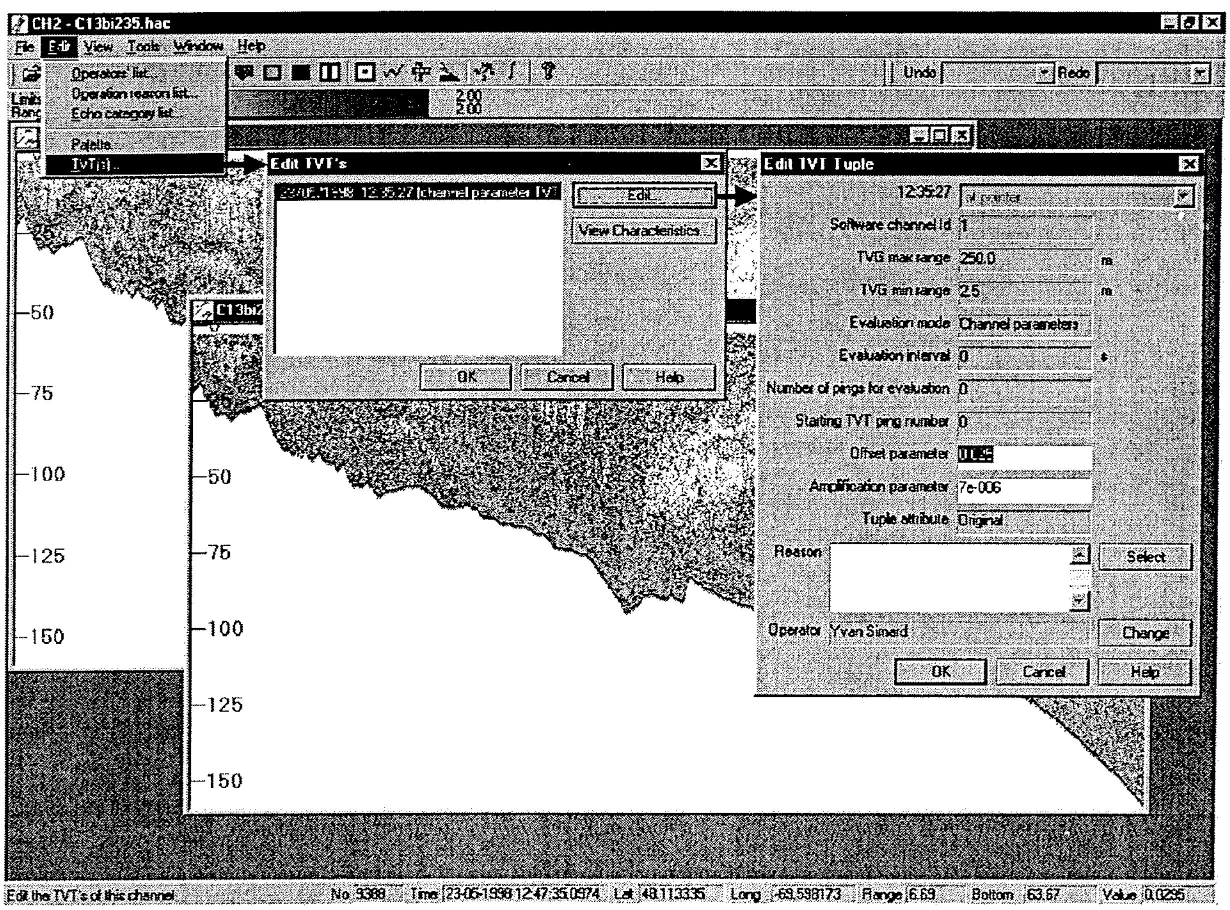


Figure 6-7. Edit TVT(s) dialog boxes to view and edit the parameters of the time-varied threshold(s) of the active echogram. Here the TVT is for a data channel in volts.

TVT for only a fraction of the total range, a warning message indicates the part of the total range where the new TVT will have no effect. The TVT equations are: $A(20\ log(R) + 2\alpha R) + C$, for a 20 log R TVG; $A(40\ log(R) + 2\alpha R) + C$, for a 40 log R TVG in dB; and $A\ R\ e^{\beta R} + C$, for a 20 log R TVG applied on data in volts. The absorption coefficients , α (in dB) and β (in nepers), are related by the equation $\beta = \alpha / 10\ log\ (e)$. A click on the OK button of the edit parameters dialog box displays the effect of the TVT changes on the echogram. If the results are unsatisfactory, the user can go back to the edit parameter dialog box by clicking on the Edit button again or use the Cancel button to undo the editing. When an editing operation is performed, it is applied to the pings affected by the TVT, which start at the TVT time location up to the next TVT encountered, if any, or to the end of the corresponding run (or the file for single-run files). This adds a TVT editing operation to the operation list of the ***HAC*** file specific to the active channel.

Single TVT editing or display can also be accessed directly from a right click on the mouse when the mouse pointer is over TVT icon and its shape is a cross and a magnifying glass icon. TVT icons are visible if this option has been selected in the View / Properties or Tools / Options menu.

7. VIEW MENU

The View menu offers the following commands:

Toolbar	Activates or deactivates the toolbar display.
Palette bar	Activates or deactivates the palette display.
Status bar	Activates or deactivates the status bar display.
Display other channels...	Opens the View channel dialog box to choose additional channels to be displayed.
Echosounder characteristics...	Displays the echosounder configuration parameters for viewing or editing.
Channel characteristics...	Displays the characteristics of the active channel.
Operation list...	Opens the View operation list dialog box to view the operation list and their characteristics.
Previous zone	Returns to the previous display zone.
Default view range	Displays the active echogram window using the default view range of the Tools / Options.
Unzoom	Displays the full view of the active channel in the echogram window, from range 0 up to the maximum detected bottom range (or height in bottom-lock mode) and from the first to the last ping, taking into account the Display every sample or Display every ping constraints of the View / Properties menu.
Pan view	Displays the full view of the active channel in the echogram window, from range 0 up to the maximum detected bottom range (or height in bottom-lock mode) and from the first to the last ping (i.e., the entire echogram), ignoring the Display every samples and Display every pings constraints View / Properties menu.
Show horizontal scale	Activates or deactivates displaying the horizontal scale.
Show vertical scale	Activates or deactivates displaying the vertical scale.
Surface-lock	Displays the active echogram window in surface-lock mode.
Bottom-lock	Displays the active echogram window in bottom-lock mode.
Ping	Displays the active echogram using the ping sequence as the X-axis units.
Distance	Displays the active echogram using the distance as the X-axis units.
Time	Displays the active echogram using the time as the X-axis units.
Properties	Opens the View properties dialog box to define the view settings for the active channel.

7.1 View / Toolbar

This option displays the ***CH2*** toolbar below the main menus presenting icons to quickly access the common ***CH2*** functions. These include all the functions available from the Tool menu plus other standard Windows® functions. By default, the Toolbar bar is visible. Click on this option to deactivate or activate it.

7.2 View / Palette bar

This option shows the palette used to display the active echogram data. The Palette bar can be moved anywhere by dragging it. The range indicated is the range of values over which the palette is applied (see Edit / Palette, section 6.1). Values below the minimum or above the maximum are displayed using the minimum and maximum colours, unless the palette also includes limit colours, which assign particular user-defined colours to values below and above the user-defined limits. By default, the Palette bar is visible. Click on this option to deactivate or activate it.

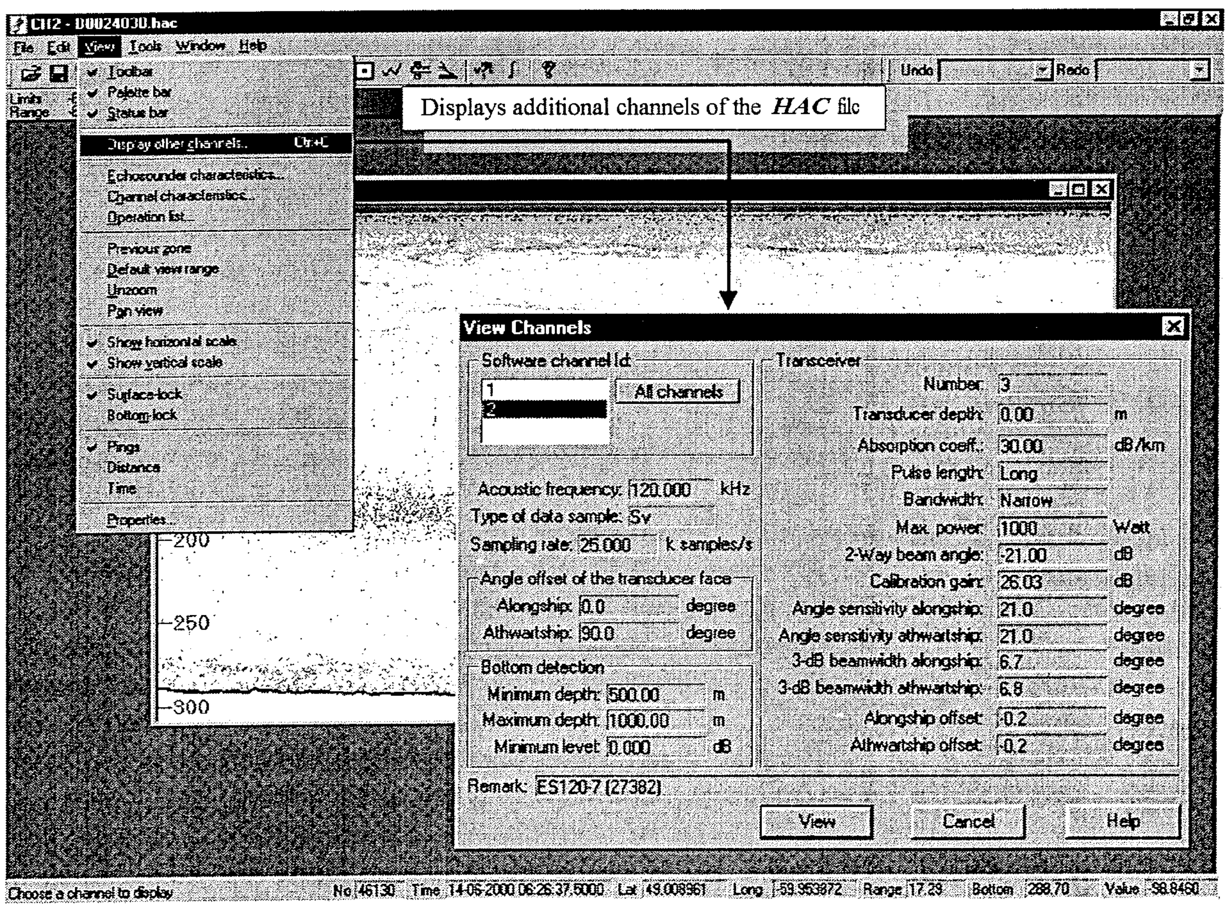


Figure 7-1. Example of the View / Display other channels to display other channels of the active ***HAC*** file. Here a 120 kHz Sv additional channel, looking horizontally, is selected and will be displayed by clicking on the View button.

7.3 View / Status bar

This option displays the *CH2* status bar at the bottom of the main *CH2* window. The objective of the selected function is displayed to the left of the status bar and the data characteristics of the active echogram at the pointer location are indicated on the right. These characteristics are, in order: the ping number, its time, the latitude and longitude (degree.decimals) if available, the range (m) from the transducer to the pointer, the range of the detected bottom (m) for that ping ("no bottom" for missed bottom), and the data value ("no sample" for samples below the TVT). By default, the Status bar is visible. Click on this option to deactivate or activate it.

7.4 View / Display other channels...

This function opens a dialog box showing the additional channels that can be displayed as echograms from the active ***HAC*** file. The characteristics of the selected channel are displayed (Figure 7-1). Select the additional channel to be opened, using the Shift or Ctrl keys to add channels to your selection, or use the All channels button to select them all. Then click on the View button to display the selected channels. The channels will be displayed using the default palette associated with the corresponding type of data (see Edit / Palette, section 6.1). Use the Window / Tile menu if you want to tile the echogram windows. Note that the EK500 split-beam phase angle channel cannot be displayed as an echogram, such viewing being of questionable interest.

7.5 View / Echosounder characteristics...

This function displays the configuration characteristics of the echosounder for the active echogram that are stored in the Echosounder tuple (Figure 7-2). For the Biosonics echosounder, the dialog box allows the editing of some fields (Figure 7-3). When an editing operation is performed, a new (edited) Echosounder tuple is created and the operation is added to the operation list. The tuple attribute is changed from "original" to "edited". This

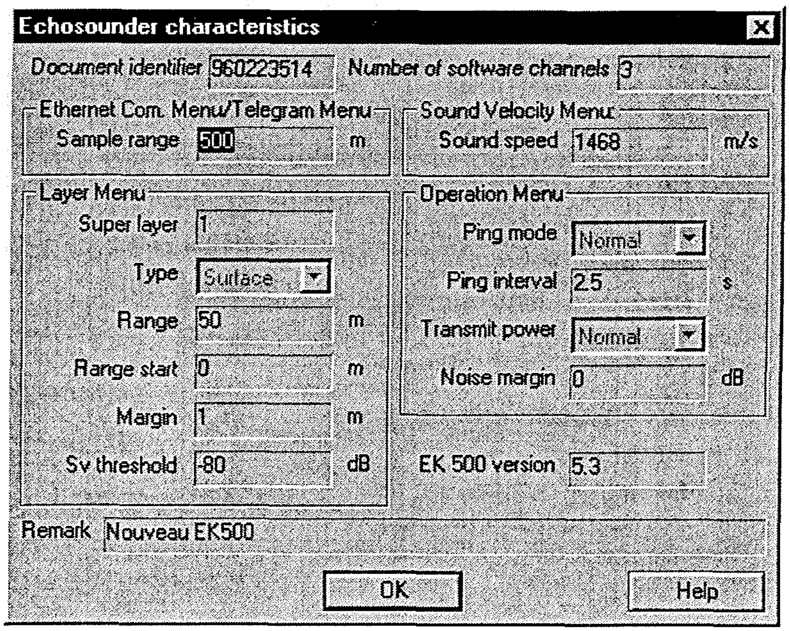


Figure 7-2. Visualisation of the echosounder configuration at acquisition for the EK500 echosounder.

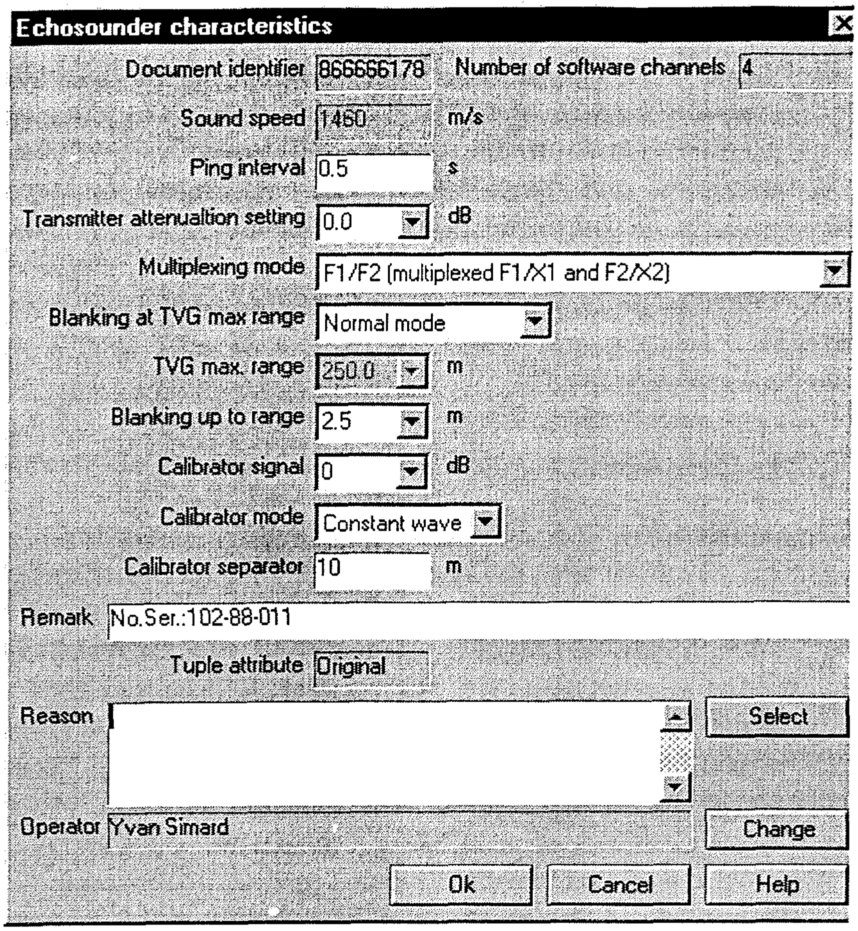


Figure 7-3. Visualisation of the echosounder configuration at acquisition for the Biosonics type of echosounder in the edit mode, showing the fields that can be edited with a white background.

function is also available from a right click on the mouse.

7.6 View / Channel characteristics...

This function displays the characteristics of the active channel at acquisition, which are stored in the Channel tuple (Figure 7-4). This function is accessed more rapidly with the mouse right button.

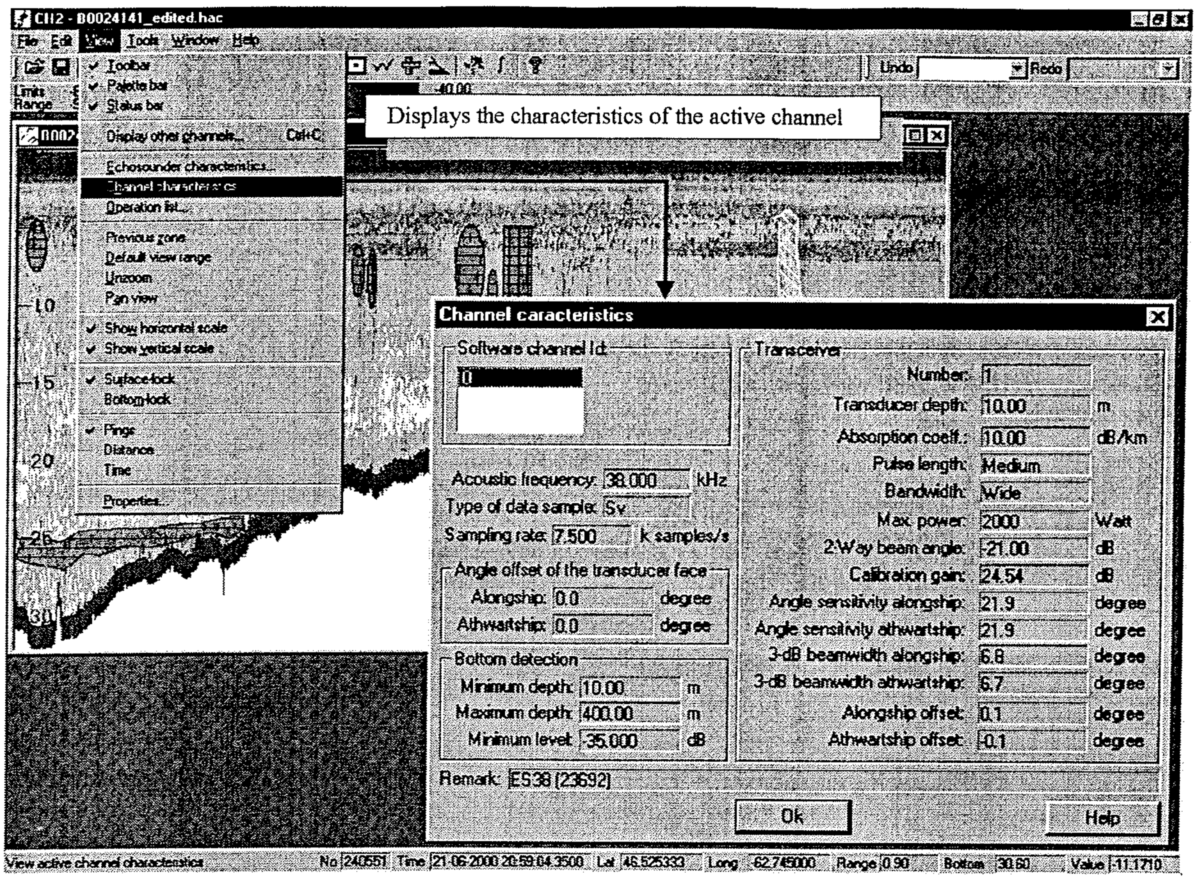


Figure 7-4. Example of the View / Channel characteristics to look at the channel properties. This option is also accessible from the mouse right button.

7.7 View / Operation list...

This function shows the list of the editing/classification operations performed on the active ***HAC*** file. The operations are presented in the order they were performed (Figure 7-5). The characteristics of the selected operation are displayed. In a future version of ***CH2***, the user will be able to edit the operation from this dialog box. To directly access a specific operation associated with a region through this dialog box, use the mouse right button when the pointer is over the region and appears as a cross and a magnifying glass.

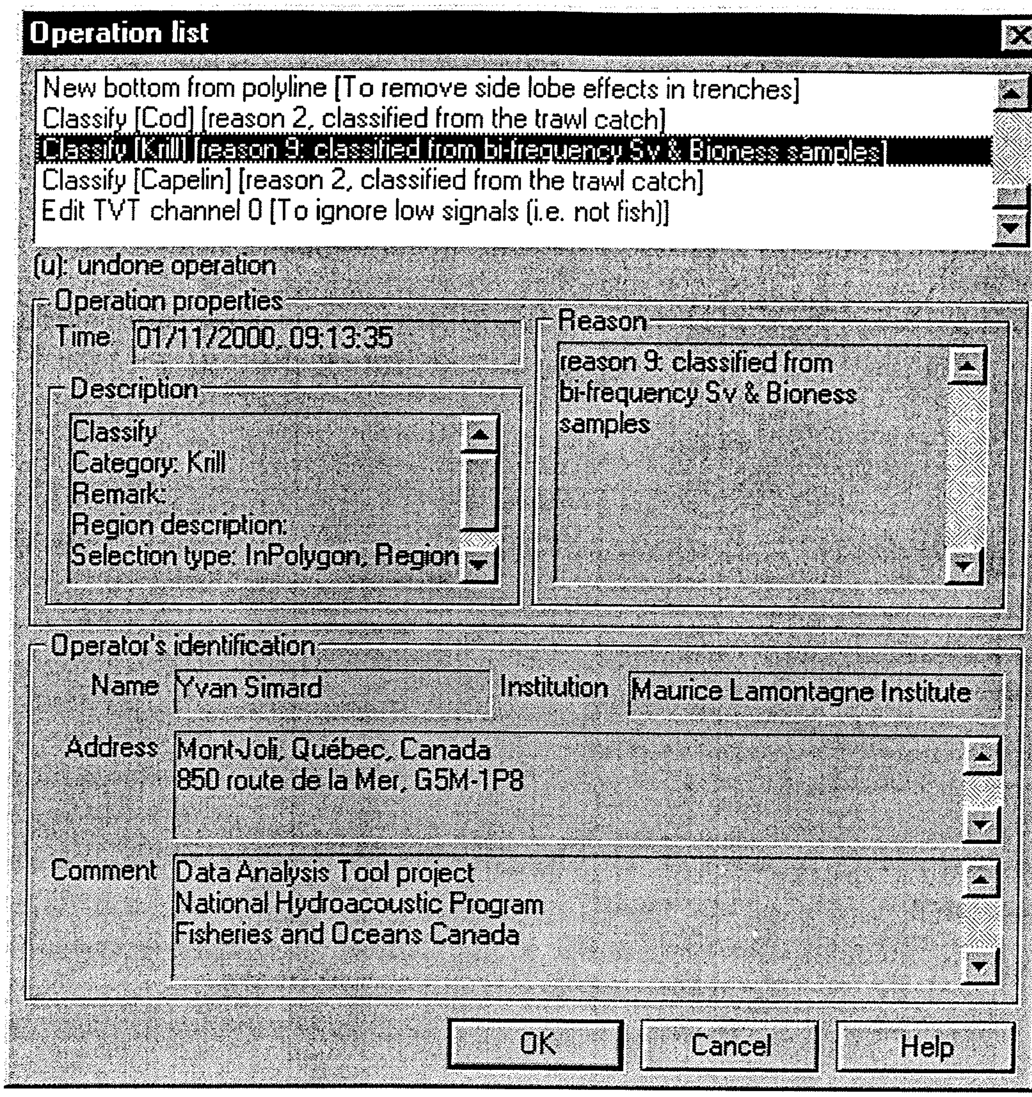


Figure 7-5. Visualisation of the Operation list and the characteristics of the selected operation through the View menu or the mouse right click.

7.8 View / Previous zone

CH2 can visualise the whole echogram for the active channel or part of it according to the display preferences chosen or the zooming state. The Previous zone function is used to rapidly bring back the previously displayed zone, which is often done while zooming on portions of the echogram. Note that *CH2* does not zoom on bitmaps but always displays all the data allowed by the window viewing properties (view options, window size, pixel resolution, etc.).

7.9 View / Default view range

This function adjusts the vertical scale of the active echogram to the default range (or height in the bottom-lock mode) specified in the Tools / Options menu. It only affects the vertical aspect of the echogram. This function is also directly available from the mouse right button.

7.10 View / Unzoom

This function displays the full view of the active channel in the echogram window, subject to the constraints in the View / Properties menu. The horizontal limits are determined by the first and last pings unless the Display every ping constraint is selected in the View / Properties menu. The maximum detected range gives the vertical range limit unless the Display every sample constraint is selected in the View / Properties menu. This function is also directly available from the mouse right button.

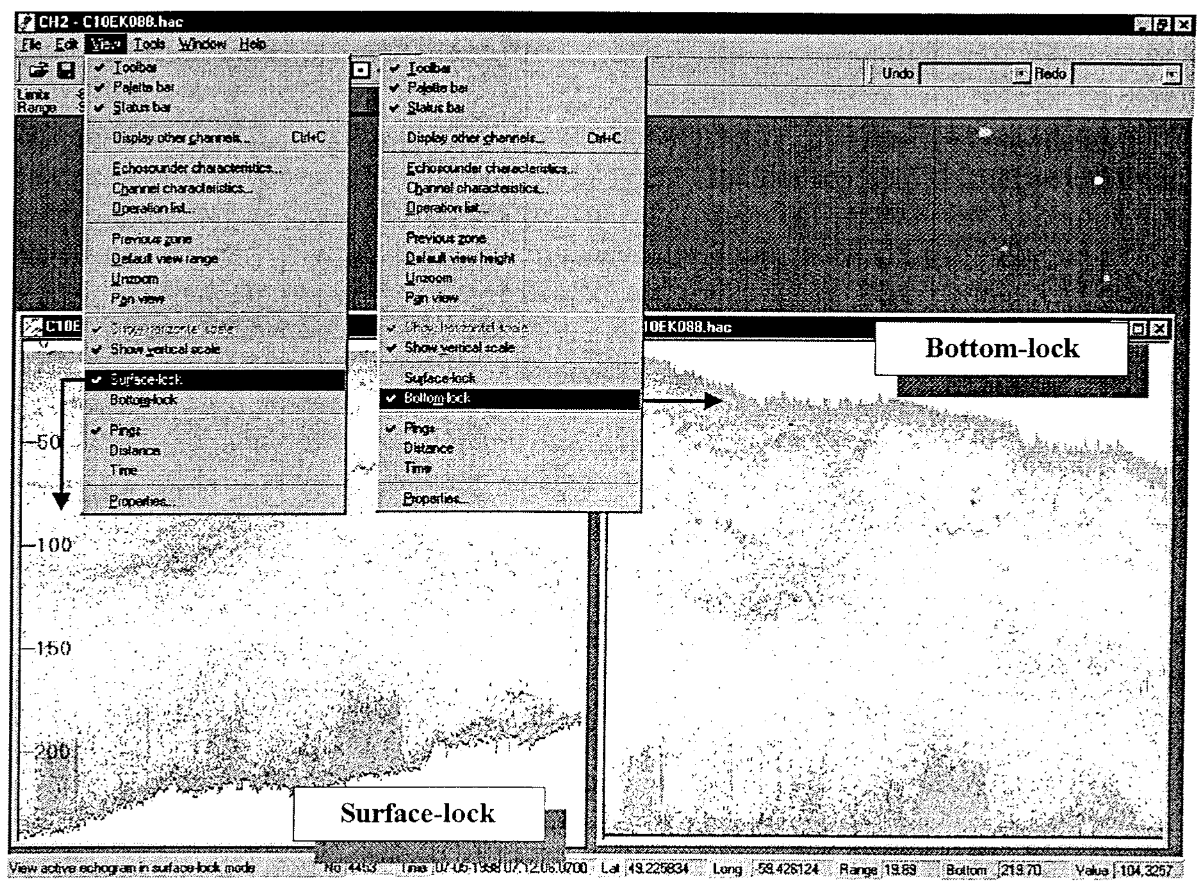


Figure 7-6. Example of the surface-lock and bottom-lock view modes.

7.11 View / Pan view

This function displays the full view of the active channel in the echogram window (i.e., the entire echogram), ignoring the Display every ping and Display every sample constraints in the View / Properties menu. The horizontal limits are determined by the first and last pings. The maximum detected range gives the vertical range limit. This function is also directly available from the mouse right button.

7.12 View / Show horizontal scale

This option is used to activate or deactivate the display of the horizontal scale on the active echogram window. The display format is set in the View / Properties or Tools / Options (see section 8.7) menus. This function is also directly available from the mouse right button.

7.13 View / Show vertical scale

This option is used to activate or deactivate the display of the vertical scale on the active echogram window. The display format is set in the View / Properties or Tools / Options (see section 8.7) menus. This function is also directly available from the mouse right button.

7.14 View / Surface-lock

This option is for displaying the echogram in surface-lock mode (i.e., the echo samples are displayed top down from range 0) (Figure 7.6). This is the ***CH2*** default display mode. Note that when a region has been edited or classified in the alternative bottom-lock display mode, the region is displayed only with a tinted mask without the hatching (see section 6.4). This function is also directly available from the mouse right button.

7.15 View / Bottom-lock

This option is for displaying the echogram in bottom-lock mode. The echo samples are displayed bottom up from the detected bottom range plus an offset, which is determined in the View / Properties menu. Note that when a region has been edited or classified in the alternative surface-lock display mode, the region is displayed only with a tinted mask without the hatching (see section 6.4). This function is also directly available from the mouse right button.

7.16 View / Ping

This option is for displaying the active echogram using the ping sequence as the X-axis units. This view property can also be set in the View / Properties menu for the active channel and in the Tools / Options menu for the ***CH2*** default setting. This function is also directly available from the mouse right button.

7.17 View / Distance

This option is for displaying the active echogram using the distance as the X-axis units. This view property can also be set in the View / Properties menu for the active channel and in the Tools / Options menu for the ***CH2*** default setting. This function is also directly available from the mouse right button.

7.18 View / Time

This option is for displaying the active echogram using the time as the X-axis units. This view property can also be set in the View / Properties menu for the active channel and in the Tools / Options menu for the ***CH2*** default setting. This function is also directly available from the mouse right button.

7.19 View / Properties

This item displays the View Properties dialog box with its four tabs to set the preferences for displaying the active echogram (Figure 7-7). It works as the Tool / Options dialog box (see section 8.7) except that the changes made to the parameters only apply to the to the active echogram unless the user updates the ***CH2*** default by clicking on the Set as default button.

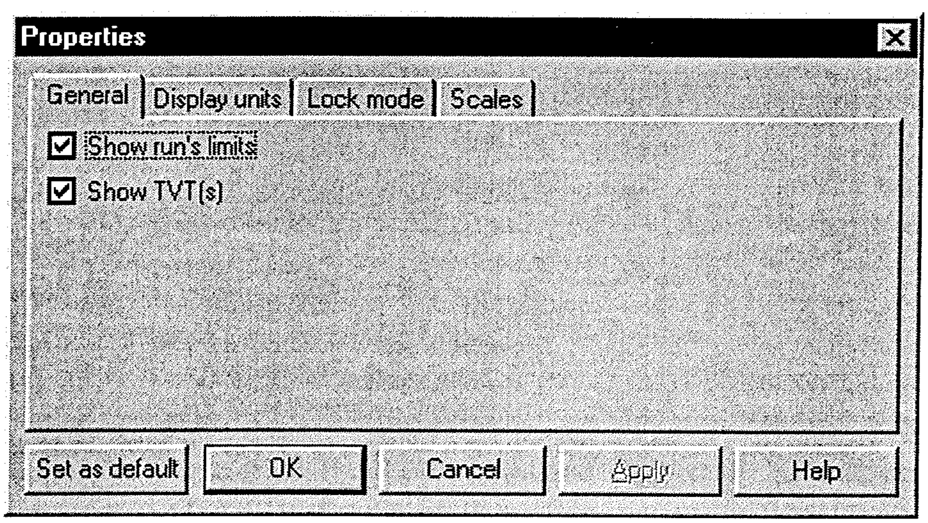


Figure 7-7. The View / Properties menu to set the preferences for displaying the active echogram.

8. TOOLS MENU

The Tools menu offers the following commands, all of which can be accessed directly through a series of icons on the tool bar.

Regions definition tools:	
Rectangle and zoom	Defines a rectangular region(s) for zooming or performing a classification/editing operation on a channel(s).
Ellipse	Defines an elliptical region(s) for performing a classification/editing operation on a channel(s).
Polygon	Idem for a polygon region(s).
Above polyline	Idem for a region(s) above a polyline(s).
Below polyline	Idem for a region(s) below a polyline(s).
Whole echogram	Idem for the whole echogram.
Selected runs	Idem for selected run(s).
Selected pings	Idem for selected ping series.
Manual bottom tools:	
Bottom samples	Manually sets the bottom-detected range by clicking on the echo sample for one or several pings.
Bottom line	Manually defines a polyline(s) that will determine the bottom-detected range.
Cumulative distance	Computes the horizontal cumulative distance (i.e., from ping to ping), between two pings selected from the line that is drawn with the mouse.
Insert TVT(s)	Adds a time varied threshold(s) to the active channel.
Edit/add positions via Excel	Edits, deletes, or adds positions to the active file via Excel®.
Echointegration	Computes s_v or s_a echointegration results by Echo category for chosen channels, blocks of runs, surface- or bottom-locked depth strata, along horizontal steps defined in ping, time or distance intervals.
Options	Sets the ***CH2*** default view options.

8.1 Tools / Region definition group

This group of tools defines regions of the echogram to edit or classify (Figure 8-1). It is at the heart of the ***CH2*** editing and classification features. Any operation performed on the data by ***CH2*** is first done on one or more XZ regions of the multichannel ***HAC*** data. A region could be the entire data set or a portion of it, which could be as small as a single echo sample. The region-definition tools serve to delineate these regions before performing an operation. Various shapes or echogram selection tools can be used to define regions as described below. It is possible to define many regions of the same type in a single operation by holding down the shift key. The common Classify or Exclude operations can be performed on all types of regions. Additional functions to modify the detected bottom range are associated with regions whose co-ordinates always include the bottom zone. The zoom on portions of the echogram is a special function associated with the rectangular region. For all region-definition tools, it is possible to project the defined region(s) to the other channels of the ***HAC*** file so that the editing/classification operation is performed on the same depth-referenced region on the additional selected channels. **Warning**: When the cursor is in the region-definition mode, the mouse displacement is confined to the part of the PC display represented by the active echogram window. If the user switches to another software application while the cursor is still in this mode, he will not be able to move the mouse on the whole display until the operation is applied or the ***CH2*** region definition mode is cancelled (by the Esc key).

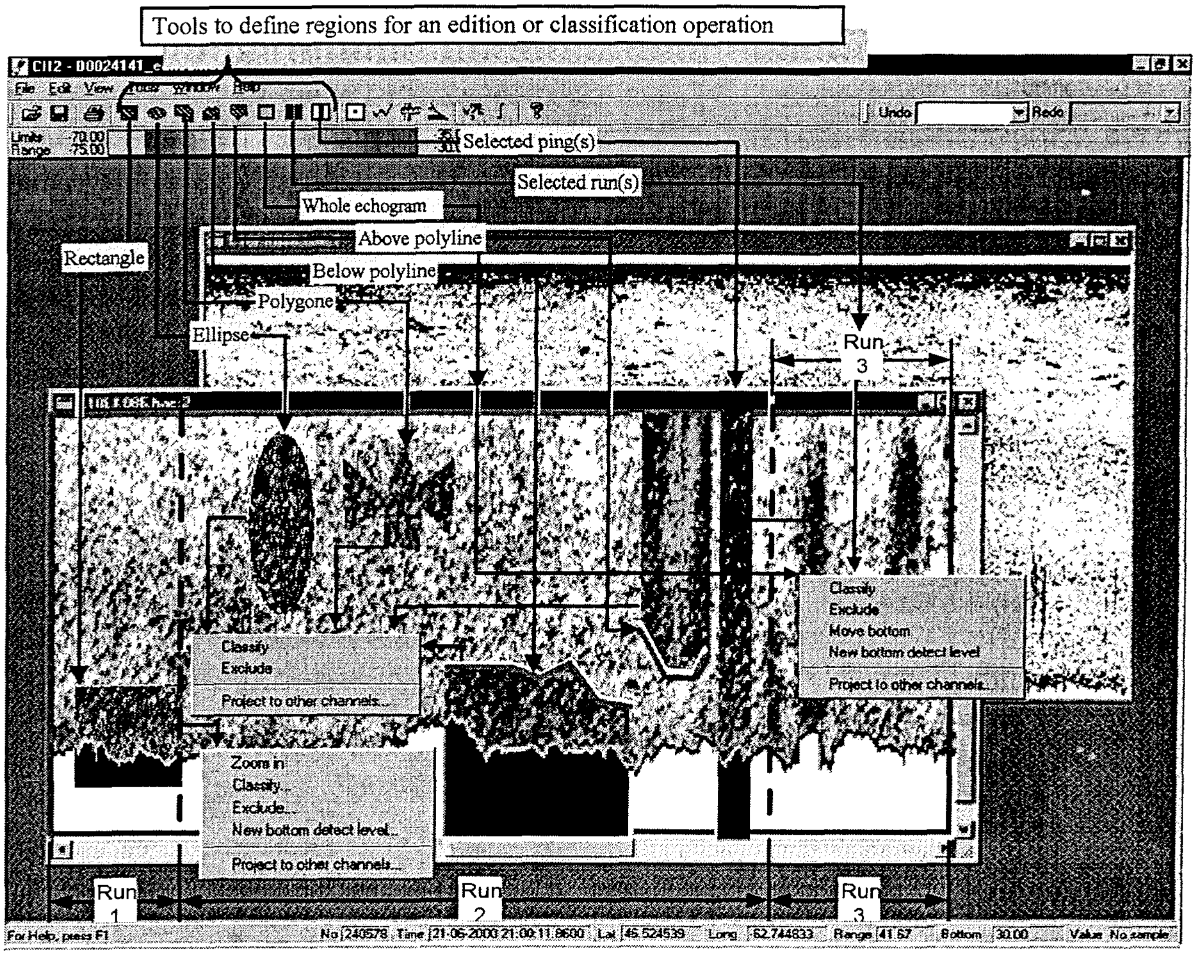


Figure 8-1. The region definition tools applied on an echogram and the right-click menus showing the edition/classification operations associated with the different types of regions. Note that all regions can be projected to additional channels before performing the operation.

Regions can be defined in surface-lock or bottom-lock view modes. The defined regions are displayed on the echogram in a way that reveals their native view mode. When the active view mode is the same as the one used when the region(s) was (were) created, the region(s) is (are) displayed with a hatched shaped plus a tinted mask over the selected samples. The mask colour is a 20% blend of the hatching colour with the colour of the samples from the echogram palette. The hatching properties for the echo categories are defined in the Echo category list (see section 6.4). By pointing on a region in its native view mode, the cursor shape changes to indicate that the characteristics of its operation can be viewed from a right click on the mouse. When the active view mode is not the same as the one used when the region(s) was (were) created, the region is only displayed with the tinted mask and the operation characteristics cannot be viewed from a right click on the mouse when the pointer is over the region. **Warning**: The regions are only visible when their specific Echo category is activated in the Echo category list.

When a region or a series of regions have been defined, possibly projected to many channels, and an editing/classification operation has been applied to them, a new tuple of the type specific to the particular operation is created and the operation is added to the Operation and Undo lists. The operation tuple contains the co-ordinates of the region(s) and channel(s) as well as the operation parameters.

8.1.1 Tools / Rectangle and zoom

To define a Rectangle region on the echogram, select this type of region from the Tools menu or click on the Rectangle tool icon of the toolbar. The pointer shape switches to a cross and a rectangle, and its displacement (including all other running applications) is confined to the active echogram window until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of one corner of the region to be defined and drag to the opposite corner of the rectangle. The selected area appears in inverse video colours. Note that to define more than one rectangle for the operation to be performed, simply hold the shift key and repeat these steps. Right click to display the menu of the operations that can be performed on the defined region. **Warning:** The selected Rectangle region includes the echo samples of the leftmost and the rightmost pings of the rectangle. Thus, the Rectangle tool can be used to select a series of samples belonging to a single ping. This is done by drawing a rectangle over the samples of interest, when the echogram is sufficiently zoomed to allow a single ping to be displayed with many pixels.

First, if the editing/classification operation has to be applied to other channels in addition to the active one, use the Project to other channels option to select the additional channels. The channel dialog box opens to display the channel characteristics and to select the channels (see View / Display other channels, section 7.4). Use the shift and/or ctrl key to select more than one channel or use the All channels button to select all additional channels.

Second, select the operation to be performed among the four possibilities: Zoom in, Classify, Exclude or New bottom detect level.

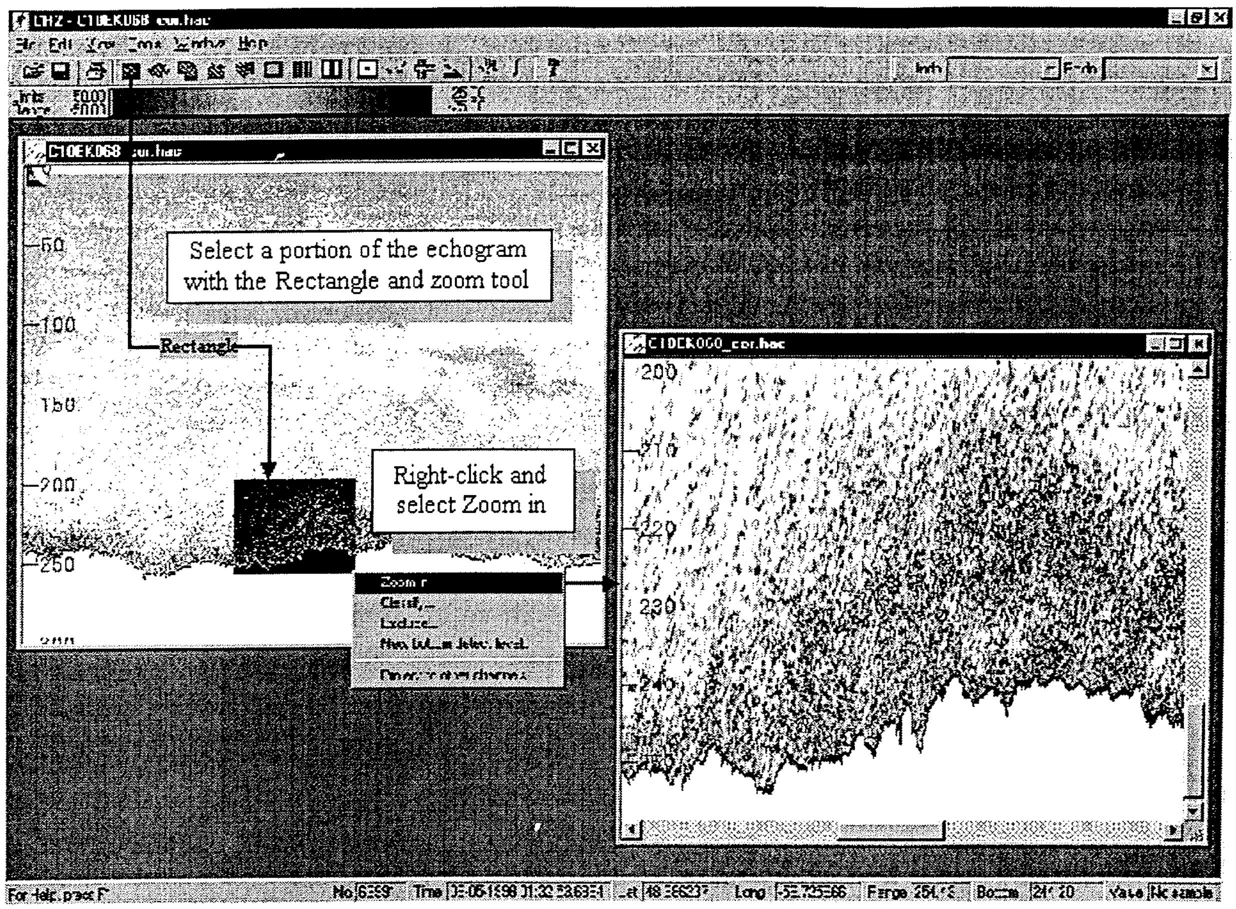


Figure 8-2. Use of the Rectangle and zoom tool to zoom on a portion of the echogram. The echogram window is changed for the one on the right. Note that ***CH2*** zoomed on the data, not on the bitmap, and loaded all new echo samples and pings that the window size allowed to display at that viewing scale. Note also that the automatic Z-scale mode was active.

8.1.1.1 Zoom in

When Zoom in is chosen, the echogram is redrawn to display only the zoomed zone in the echogram window (Figure 8-2). Scroll bars on the window border show the location of the zone relative to the echogram pan view. Unlike usual Windows95/98® applications, ***CH2*** does not zoom on the bitmap but instead loads into the window all the new pings and echo samples that the window pixels allow for the zoomed region (e.g., Figure 4-6). The same process happens when the size of an echogram window is changed. For large files this sometimes requires the reading of ***HAC*** data from disk, which is not always instantaneous on slow drives or PCs.

8.1.1.2 Classify operation

When Classify is chosen, the corresponding dialog box opens. By default, the parameters of the last Classify operation (if any) are offered (Figure 8-3). If these are satisfactory, simply click on the OK button to accept them and to classify the region(s) accordingly. Otherwise, click on the Select or Change buttons to define and/or select new ones. You can add an Echo category or a Reason or change the Operator as indicated in the respective Edit menus (Chapter 6). By clicking on the OK button, the operation is applied and the classified region is identified by a hatched shape and a tinted mask, if the display of the selected Echo category is activated (see Edit / Echo category list, section 6.4). A Classification tuple (***HAC*** tuple no. 13000) containing all the parameters of the operation is generated. The characteristics of the operation can be viewed by pointing on the classified region, which turns the pointer shape to a cross and a magnifying glass, and

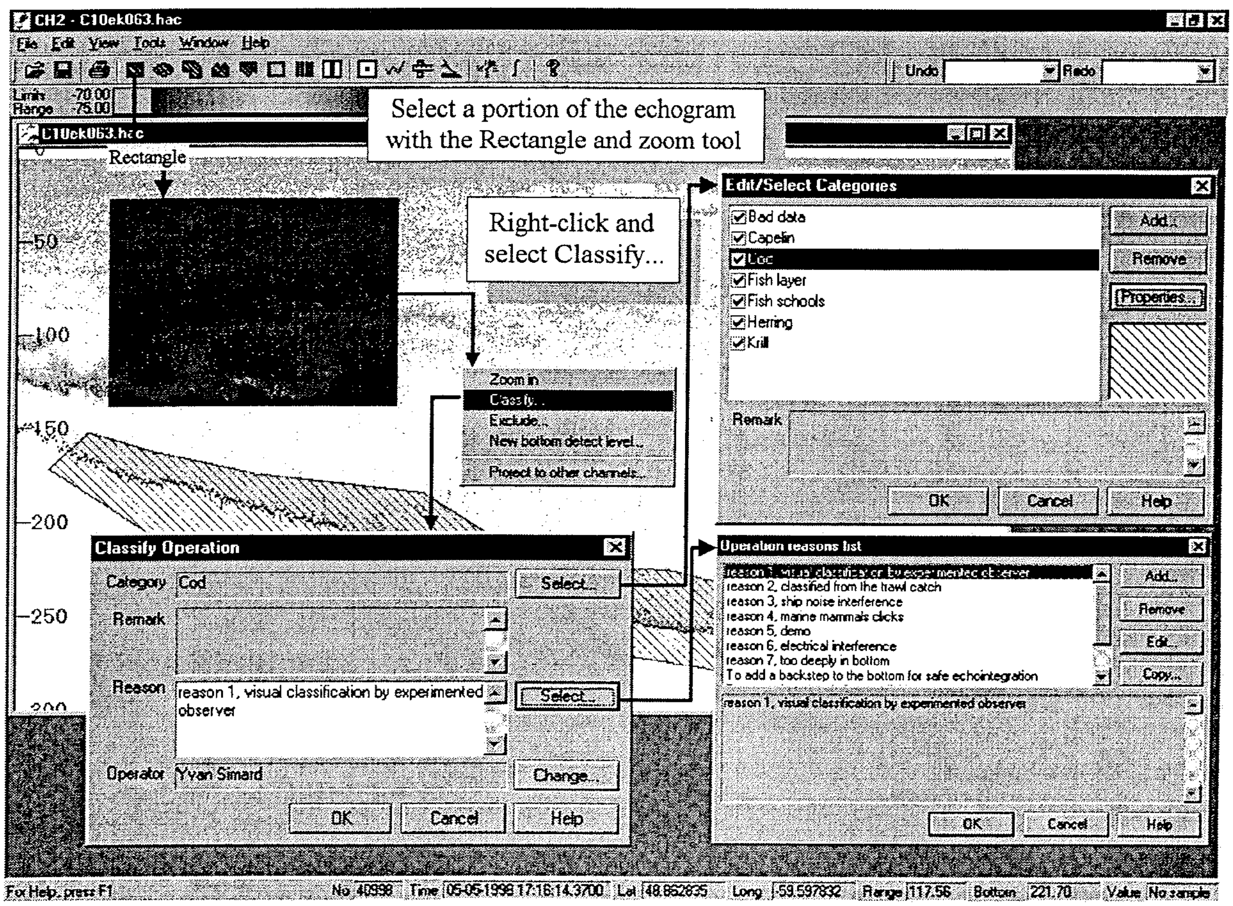


Figure 8-3. The Rectangle and zoom region definition tool applied to classify a portion of the echogram(s). The Classify dialog box offers the parameters used for the last Classify operation as default values. The buttons at the right are used to make new selections.

a right clicking the right mouse button to select the View operation characteristics (Figure 8-4).

In classifying a region, a special Echo category called Bad data can be used. **Warning:** This category should be used with caution to mark a region(s) as containing unreliable data that will be considered as unsampled in subsequent data processing, such as echointegration. These data will be handled as missing data, which will affect both the computed s_v and s_a values (see Integration, section 8.6.6).

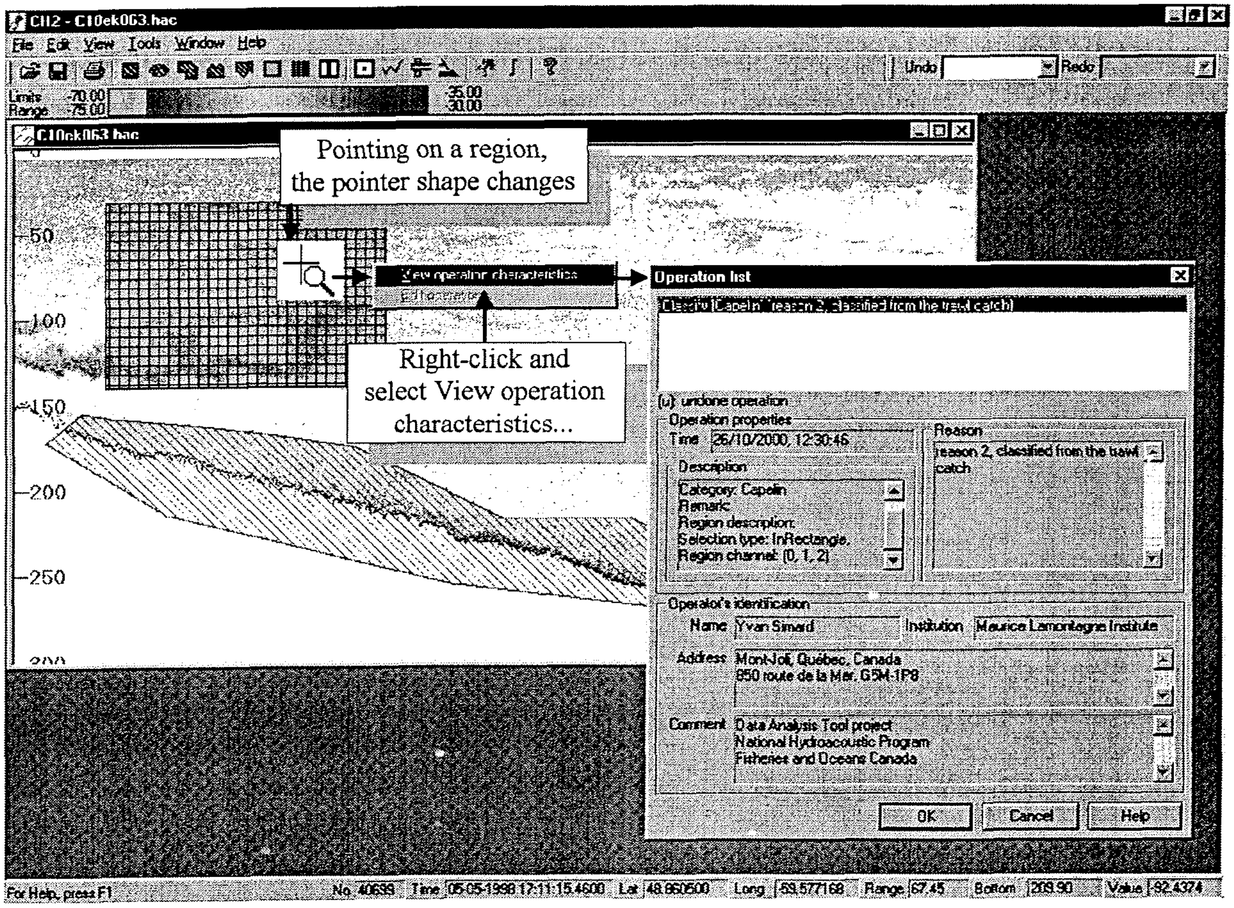


Figure 8-4. Viewing the operation characteristics applied to a region by pointing on its hatched shape and right clicking on the mouse. Note that this Classify operation has been applied here on the channels 0, 1, and 2.

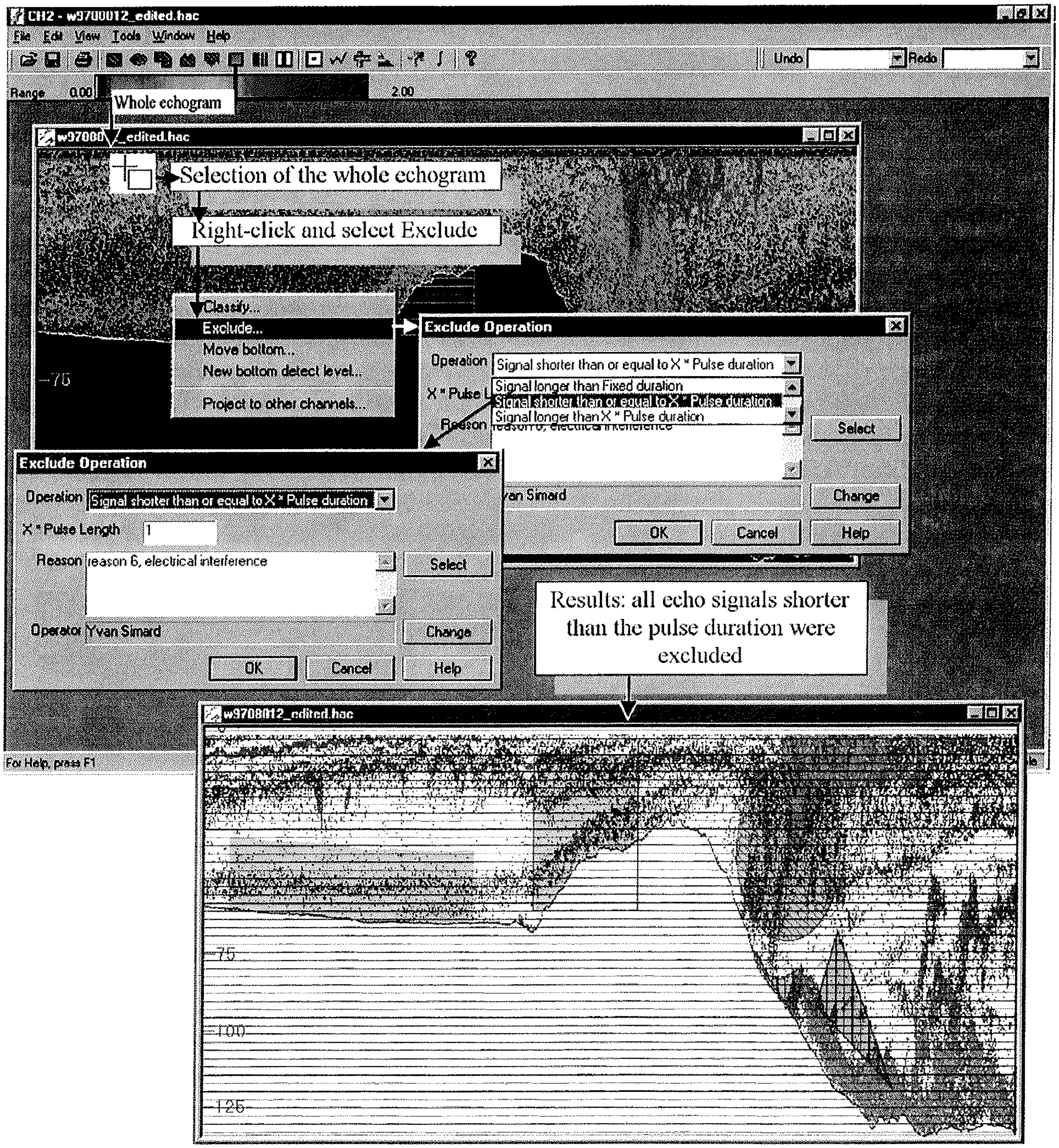


Figure 8-5. Example of the Exclude operation, excluding signals shorter than the pulse duration on a region defined as the Whole echogram, which appears in inverse video in the upper window. The result of the operation is shown on the bottom window, where all sharp electrical interference and insignificant echoes were excluded and a hatching is applied on the whole echogram to indicate the operation.

8.1.1.3 Exclude operation

When Exclude is chosen for the operation to be performed, selected echo samples can be labelled as excluded from the defined region of the echogram. From the Exclude dialog box, selecting the All signal item of the scroll box (Figure 8-5) excludes all echo samples from the region. The other options exclude the echo samples according to a selected contiguity criterion, e.g., the duration of the echo. For the EK500 echosounder the two possibilities offered are to exclude echoes shorter or longer than a given duration in ms. For the Biosonics type of analog echosounder, the time duration can also be given as a factor of the pulse duration. When the operation is applied by clicking on the OK button, a Replaced signal edition tuple (***HAC*** tuple no. 12010) containing all the operation parameters is generated. **Warning**: The excluded echo samples are simply replaced by null values for the corresponding channel. Note that in further data processing, such as echointegration, these data will be handled as such, which will affect both the computed s_v and s_a values (see Integration, section 8.6.6). For proper use of ***CH2***, it is important to distinguish between the Excluded regions (zeros) and the Bad data regions (missing data).

8.1.1.4 New bottom detect level operation

When New bottom detect level is the chosen operation, a defined echo sample level is searched for within each ping included in the region. The required dialog box parameter is the new echo sample level in the active channel units (Figure 8-6). The Bottom displacement constraint is an optional parameter that constrains the bottom displacement to a given range (m) around the present detected bottom. For those pings where the criteria are not met, the detected bottom remains unchanged unless the Assign "No Bottom" if detection criteria are not met option is checked, in which case an undetected bottom flag is assigned. The bottom search is done top down. The first echo sample greater than or equal to the new bottom detection level is accepted as the new bottom, if the previous echo sample was smaller than the new bottom detection level and the bottom displacement constraint is not exceeded. Note that this implies that the bottom cannot be found for a ping when its echo sample values in the selected region are constantly decreasing. When the operation is applied, a statistics table gives the number of pings where the detected bottom was changed or unchanged, and those flagged with no Detected bottom as well as the reason for the resulting status. On the echogram, the echo sample corresponding to the detected bottom is coloured with the bottom colour defined by the palette. When a New bottom detect level operation is applied, a corresponding edition tuple is created (***HAC*** tuple no. 12053) and contains the parameters of this operation. **Warning**: It is important for further data processing, such as echointegration, to set the bottom at the right range because the echointegration stops at the detected bottom and bottom depth strata are referred to this range. Similarly, all pings with an undetected bottom are ignored during echointegration (see Echointegration, section 8.6).

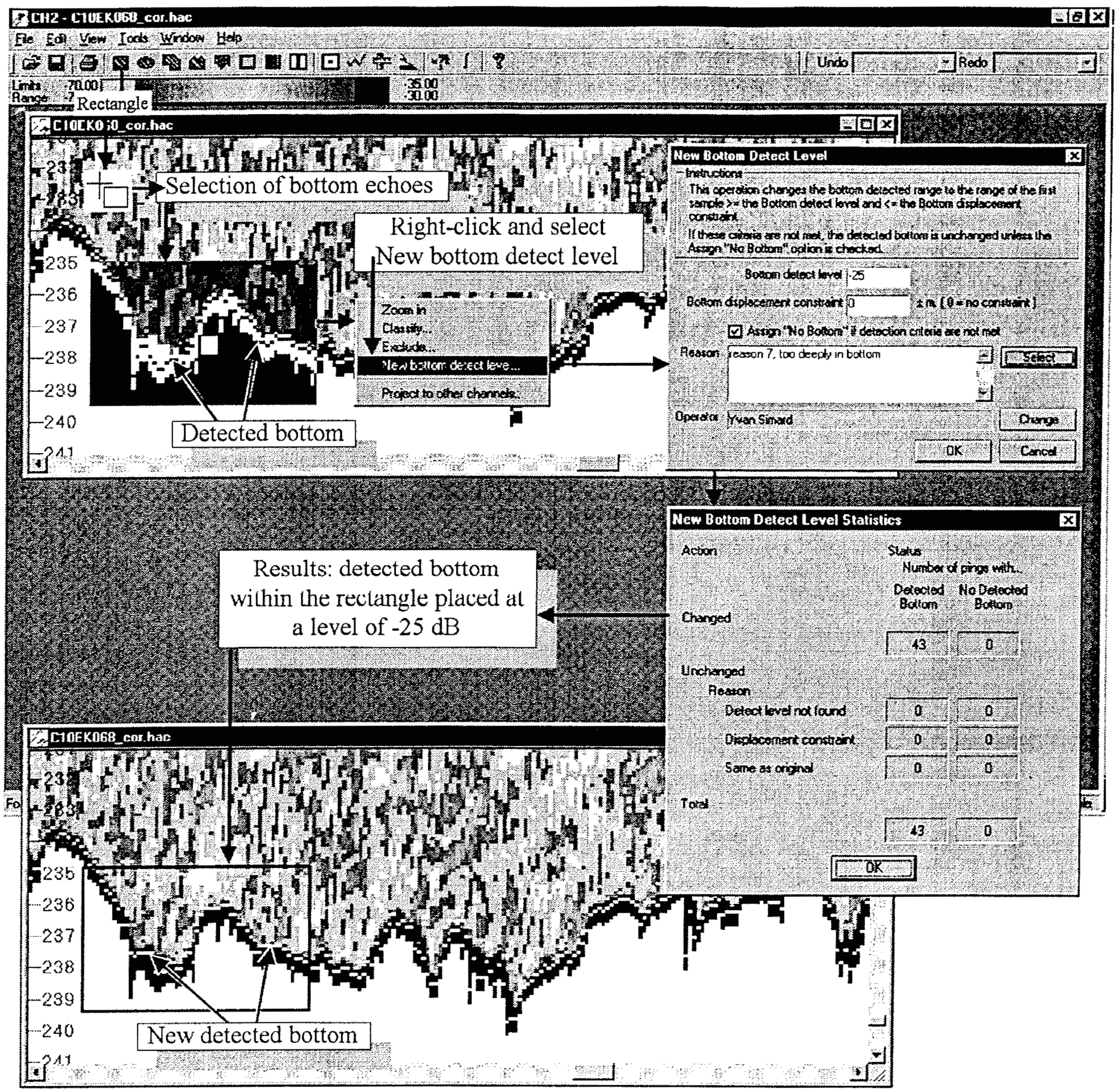


Figure 8-6. Example of the New bottom detect level operation with the Rectangle region. Here the bottom detection level within the rectangle is changed to -25 dB, which moved the detected bottom closer to the interface in the rectangle. If this level is not found, the bottom is labelled as undetected since this option was selected. The statistics table indicates that the new -25 dB level changed the detected bottom for 44 of the 56 pings of the rectangle, 11 pings had no changes and 1 ping was tagged with no detected bottom.

8.1.2 Tools / Ellipse

To define an Ellipse region on the echogram (e.g., Figure 8-1), select this type of region from the Tools menu or click on the Ellipse tool icon of the toolbar. The pointer shape switches to a cross and a circle, and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of one corner of the virtual rectangle enclosing the ellipse to be defined and drag to the opposite corner of the rectangle. The selected area appears in inverse video colours. To define more than one ellipse region for the operation to be performed, simply hold the shift key and repeat the last steps. Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that the operations available with the Ellipse region are limited to Classify and Exclude. To properly superimpose the hatched ellipse shape with the ellipse mask over the selected samples, the echogram view mode must be in time, not in pings or distance.

8.1.3 Tools / Polygon

To define a Polygon region on the echogram (e.g., Figure 8-1), select this type of region from the Tools menu or click on the Polygon tool icon of the toolbar. The pointer shape switches to a cross and a polygon and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of one vertex (the point of intersection of two sides) of the polygon to be defined and click to set the vertex. Repeat for the other vertices and double click to close the polygon. The selected area appears in inverse video colours. Note that to define more than one polygon region for the operation to be performed, simply hold the shift key and repeat the last steps. Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that the operations available with the Polygon region are limited to Classify and Exclude. Crossing the polygon segments is allowed when defining the region, which creates strange polygonal shapes with holes. This non-standard procedure is at the user's risk. When the hatched shape is drawn, the polygon vertices are placed in the middle of the selected echo sample image, even if the mouse clicked elsewhere on the echo sample. This is visible only during large zooms on the echogram, when the echo samples are represented by many pixels. The selected echo samples of a polygon region are all enclosed samples. This includes: 1) the echo samples belonging to the pings intersected by a polygon edge (the ping intersection line is the virtual line marking the beginning of the ping) and 2) those from vertical polygon edges (i.e., consecutive vertices on the same ping). **Warning:** *CH2* does not allow the drawing of a polygon in which all vertices are within a single ping. Use the Rectangle and zoom tool (see section 8.1.1) to select a series of echo samples from a single ping.

8.1.4 Tools / Below polyline

To define a region below a polyline on the echogram (e.g., Figure 8-1), select this type of region from the Tools menu or click on the Below polyline tool icon of the toolbar. The pointer shape switches to a cross and a polygon whose upper boundary is a polyline; its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of the first point of the polyline to be defined and click to set the point. Repeat for the other vertices and double click to end the polyline. Convex and concave polylines, including returns to already-selected pings, are possible. Crossing defined polyline segments is allowed when drawing the polyline, which can create strange polygonal shapes with holes. This non-standard procedure is at the user's risk. The selected area appears in inverse video colours. It is defined as a polygon drawn below the polyline down to a very large range. The region includes the leftmost and the rightmost pings of the polyline. Note that to define more than one polyline for the operation to be performed, simply hold the shift key and repeat the last steps. Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that the search for a New bottom detect level is limited to ranges below the polyline. The selected echo samples of a Below polyline region are all samples below the polyline, taking into account the above-mentioned concave and convex possibilities. This includes: 1) the echo samples belonging to the pings intersected by a polyline edge (the ping intersection line is the virtual line marking the beginning of the ping) and 2) those from vertical polygon edges (i.e., consecutive vertices on the same ping).

8.1.5 Tools / Above polyline

To define a region above a polyline on the echogram (e.g., Figure 8-1), select this type of region from the Tools menu or click on the Above polyline tool icon of the toolbar. The pointer shape switches to a cross and a polygon whose lower boundary is a polyline; its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of the first point of the polyline to define and click to set the point. Repeat for the other vertices and double click to end the polyline. This region type works as a mirror of the Below polyline region (refer to section 8.1.4), except that the New bottom detect level operation is not available with this type of region.

8.1.6 Tools / Whole echogram

To define a region as the whole echogram (e.g., Figures 8-1 and 8-6), select this type of region from the Tools menu or click on the Whole echogram tool icon of the toolbar. The whole echogram appears in inverse video colours. The pointer shape switches to a cross and a rectangle, and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that a new Move bottom operation is available. The Move bottom operation is detailed in section 8.1.6.1. The search for a New bottom detect level is not limited to a range interval.

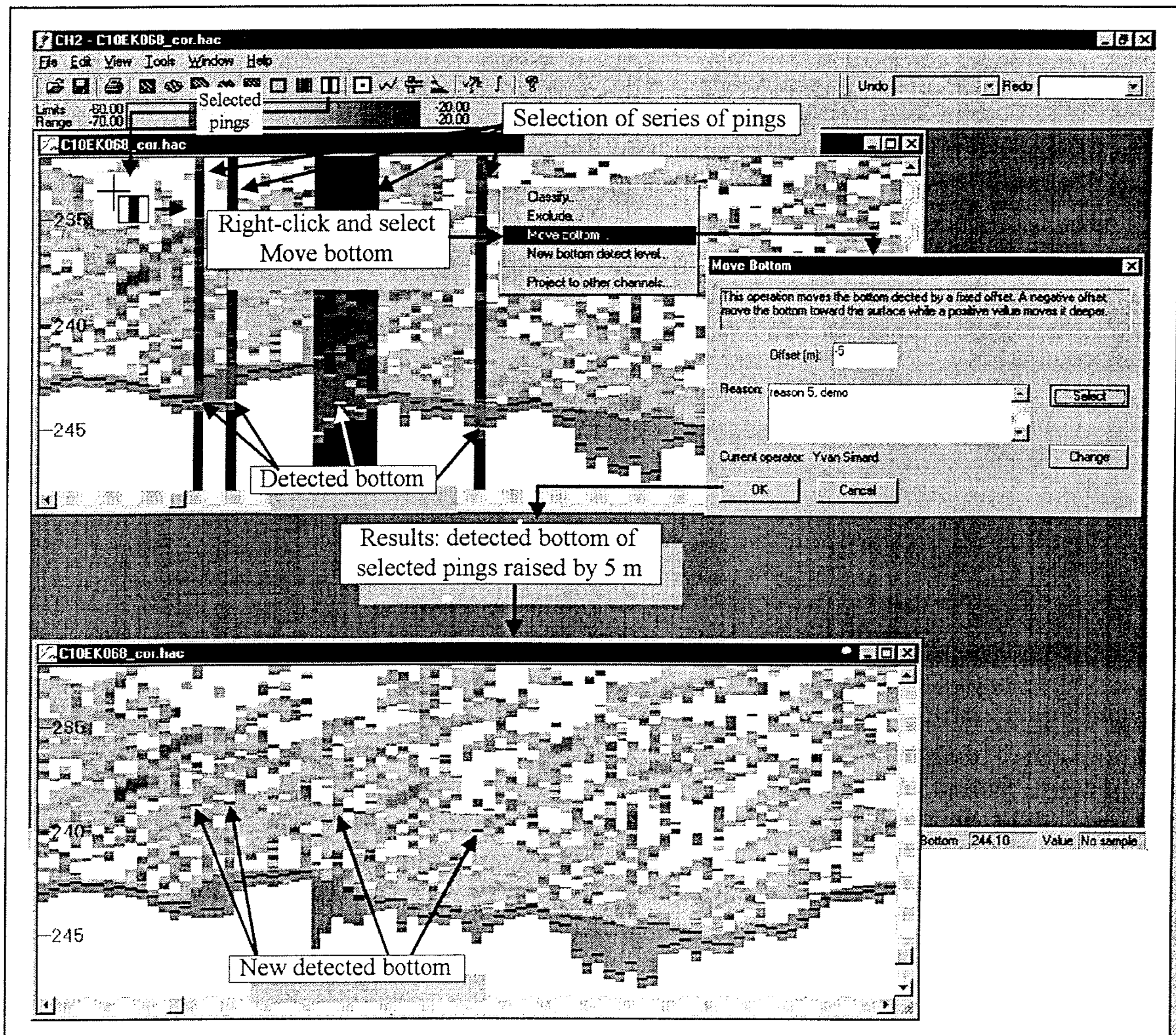


Figure 8-7. Example of the Move bottom operation with the Selected pings region tool. The detected bottom is raised by an offset of 5 m for each selected ping.

8.1.6.1 Move bottom operation

When the Move bottom operation is selected, the corresponding dialog box opens to give the offset (m) to move the detected bottom from its present range (Figure 8-7). Positive values deepen the detected bottom and negative values do the opposite. The usual option of typing a reason for the operation or selecting one from the Reason list via the Select button is offered as is the possibility of changing the current operator that will be attached to the operation. By clicking on the OK button, the detected bottom is moved and the echo sample corresponding to its new range is set to the active palette bottom colour. When a Move bottom detect level operation is applied, a corresponding edition tuple is created (***HAC*** tuple no. 12051) and contains the parameters of this operation. **Warning**: It is important for further data processing, such as echointegration, to set the bottom at the right range because the echointegration stops at the detected bottom and bottom depth strata are referred to this range (see Echointegration, section 8.6). This Move bottom operation is often used to slightly offset the bottom to insure that no bottom echoes will be included in the echointegration.

8.1.7 Tools / Selected runs

To define a region for a single run or a series of runs on the echogram of the ***HAC*** data channel, select this type of region from the Tools menu or click on the Selected runs tool icon of the toolbar. The pointer shape switches to a cross plus hatched rectangle; its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. To select a run, click on the echogram anywhere in the desired run. The selected run(s) appears in inverse video colours. To define more than one run for the operation to be performed, simply hold the shift key and repeat the selection for other runs. Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that the Move bottom operation is available. The Move bottom operation is detailed in section 8.1.6.1. The search for a New bottom detect level is not limited to a range interval.

8.1.8 Tools / Selected pings

To define a region for a single ping, or a series of pings on the echogram, select this type of region from the Tools menu or click on the Selected runs tool icon of the toolbar. The pointer shape switches to a cross and a bar in a rectangle, and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. To select a ping, simply click on it. To select a series of pings, click on the first ping of the series and drag to the last one. The selected ping(s) appears in inverse video colours. To define more than one ping or series of pings for the operation to be performed, simply hold the shift key and repeat the selection steps (e.g., Figure 8-7). Right click to display the menu of the operations that can be performed on the defined region.

This tool works like the Rectangle tool (see Rectangle and zoom tool, section 8.1.1) except that the Move bottom operation is available. The Move bottom operation is detailed in section 8.1.6.1. The search for a New bottom detect level is not limited to a range interval. **Warning**: A highly zoomed view or the Display every ping option of the View / Properties menu (see section 7.19) is needed to view all pings on the echogram window. In a series of pings, all pings between the first and the last of the series are parts of the selected region, even if some of them are not displayed on the echogram.

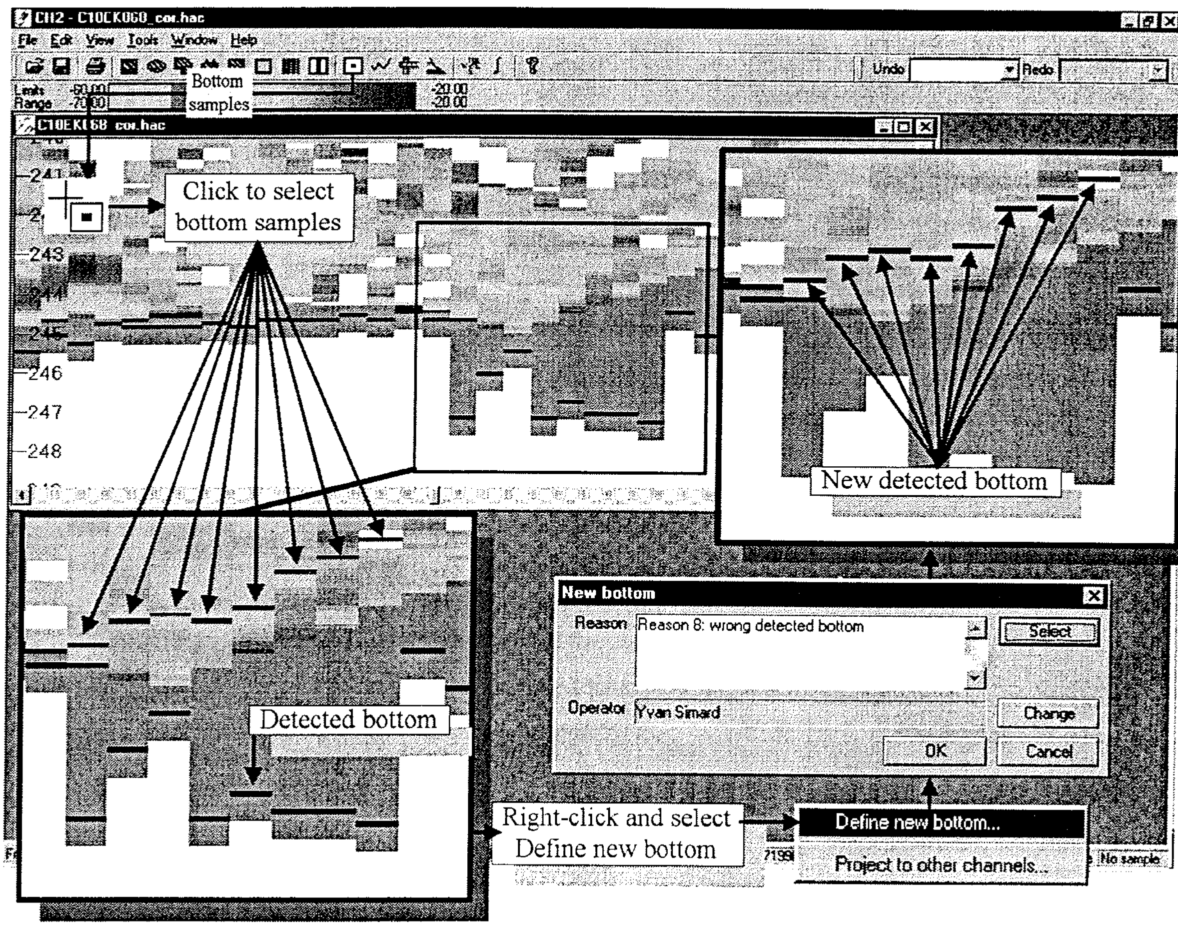


Figure 8-8. Example of the Bottom sample tool to set the bottom manually. Once the tool is selected, a click on the echogram selects the bottom sample for the corresponding ping. The selected echo sample is indicated in inverse video colour. This is repeated for the other pings of interest. The operation is then applied by selecting the Define new bottom from the right-click menu and the detected bottom is moved to the selected range for each ping chosen.

8.2 Tools / Manual bottom tools

CH2 has two tools to set the detected bottom manually. The Bottom sample tool fixes the bottom at the range given by the mouse click for selected ping(s). The Bottom line tool sets the bottom by drawing a polyline on the echogram.

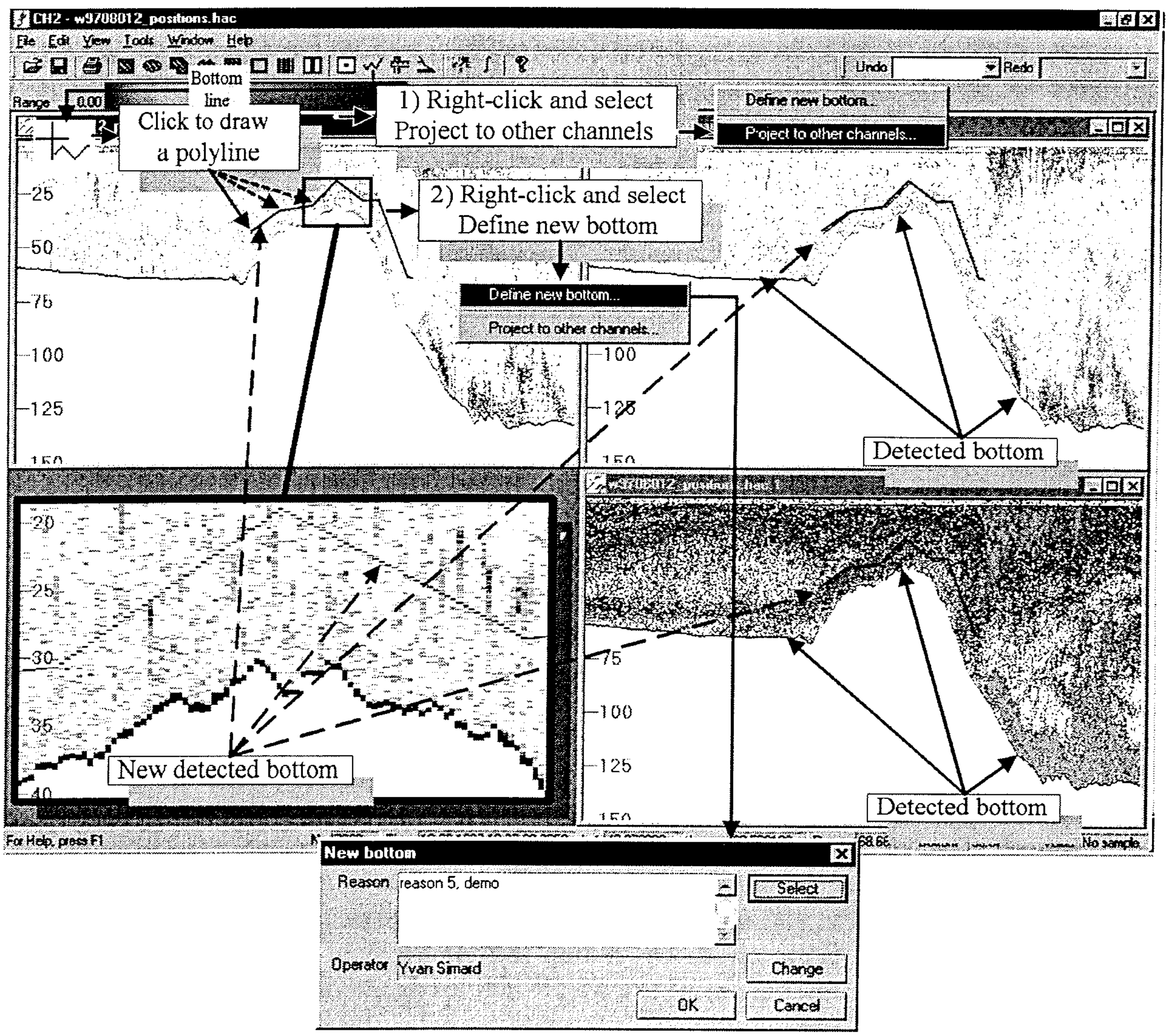


Figure 8-9. Example of the Bottom line tool to set the bottom manually. Once the tool is selected, a series of clicks on the echogram draws a polyline defining the replacement of the detected bottom for all pings intersected by the polyline. The polyline is ended by a double click. The operation is then applied by selecting the Define new bottom from the right-click menu and the detected bottom is moved to the polyline. Here the operation was previously projected to all other channels using the Project to other channels option first.

8.2.1 Tools / Bottom sample

To manually set the detected bottom of individual pings with a mouse click, select the Bottom samples tool from the Tools menu or click on its icon from the toolbar (Figure 8-8). The pointer shape switches to a cross and a horizontal bar in the middle of a rectangle; its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. To select an echo sample of a ping, simply click on it. This can be done for all pings of interest. To change the selected echo sample of a ping, simply click on a new one. The selected sample(s) appears in inverse video colours. Right click to access the Define new bottom operation and the Project to other channel option. The New bottom dialog box allows the inscription of a reason for the operation and to change the operator's name. The operation is applied by clicking on the OK button and the detected bottom is set to the selected echo sample(s) for the chosen ping(s). When a New bottom operation is applied, a corresponding edition tuple is created (***HAC*** tuple no. 12050) that contains the parameters of this operation. This Manual bottom operation is identified as New bottom from polyline in the Operation list as the next operation (section 8.2.2), the polyline(s) here being limited to the width of a ping. **Warning**: It is important for further data processing, such as echointegration, to set the bottom at the right range because the echointegration stops at the detected bottom and bottom depth strata are referred to this range (see Echointegration, section 8.6).

8.2.2 Tools / Bottom line

To manually set the detected bottom for a series of pings, from a polyline drawn by the mouse, select the Bottom line from the Tools menu or click on its icon from the toolbar (Figure 8-9). The pointer shape switches to a cross and a polyline, and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Move the cross on the echogram to the location of the first point of the polyline to define and click to set the point. Repeat for the other vertices and double click to end the polyline. Note that the Polyline is not valid when it intersects a ping more than once. To define other polylines for simultaneously performing the operation over other ping series, simply hold the shift key and repeat the drawing steps. Right click to access the Define new bottom operation and the Project to other channel option. The New bottom dialog box allows the inscription of a reason for the operation and to change the operator's name. The operation is applied by clicking on the OK button and the detected bottom is set to the selected echo sample(s) for the chosen ping(s). When a New bottom operation is applied, a corresponding edition tuple is created (***HAC*** tuple no. 12050) that contains the parameters of this operation. This Manual bottom operation is identified as New bottom from polyline in the Operation list as the previous operation (section 8.2.1) with the Bottom samples tool. **Warning**: It is important for further data processing, such as echointegration, to set the bottom at the right range because the echointegration stops at the detected bottom and bottom depth strata are referred to this range (see Echointegration, section 8.6).

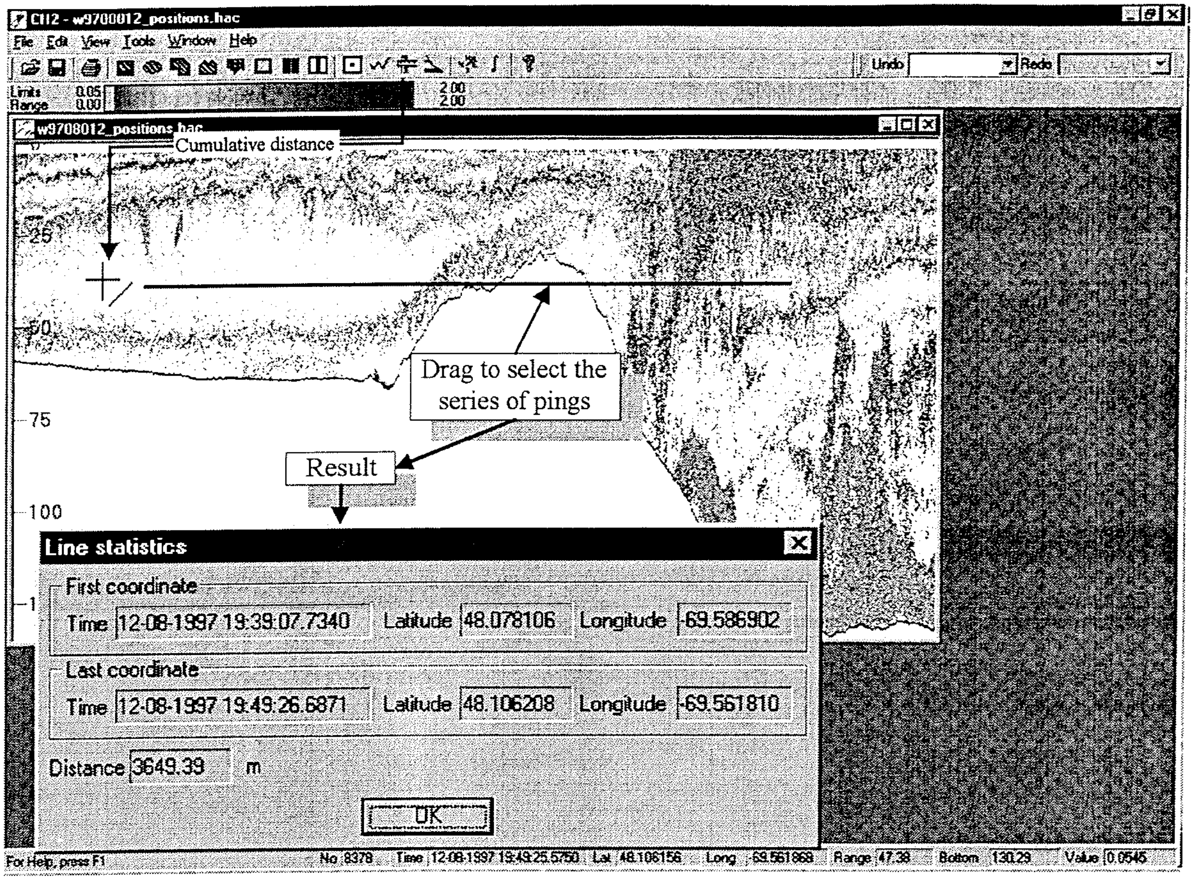


Figure 8-10. Example of measuring the cumulative (i.e., sailed) horizontal distance between a series of pings with the Cumulative distance tool. Select the tool and click on the first ping and hold to the last ping of the series. At the release of the mouse button, the time and co-ordinates of the two pings as well as the cumulative distance (m) between them are given.

8.3 Tools / Cumulative distance

To get an estimate of the cumulative (i.e., sailed) horizontal distance between two pings, select the Cumulative distance from the Tools menu or click on its icon from the toolbar (Figure 8-10). The pointer shape switches to a cross and a line, and its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. Click on the first ping of the series and hold the mouse button by moving the pointer to the last ping. A horizontal line is displayed to indicate the series of pings being selected. At the release of the mouse button, the time and co-ordinates of the first and last pings of the series as well as the cumulative distance (m) between them are given. **Warning**: The measured distance will be longer than the actual (shortest) distance between the two pings if the sailing route was not a straight line.

8.4 Tools / Insert TVT(s)

To insert a TVT or a set of two TVTs for the active channel, select the Insert TVT tool from the Tools menu or click on its icon from the toolbar (Figure 8-11). The pointer shape switches to a cross and a curve in a rectangle; its displacement is confined to the active echogram window (including all other running applications) until the operation is completed or cancelled by the Esc key. The TVT is a threshold following the TVG law corresponding to the channel data type. ***HAC*** data files recorded with ***CH1*** have at least one TVT inserted at the beginning of each run (or the file for single run files) for each relevant data channel. A TVT applies to the series of pings starting at the TVT time location up to the next TVT encountered, if any, or to the end of the run (or the file for single run files).

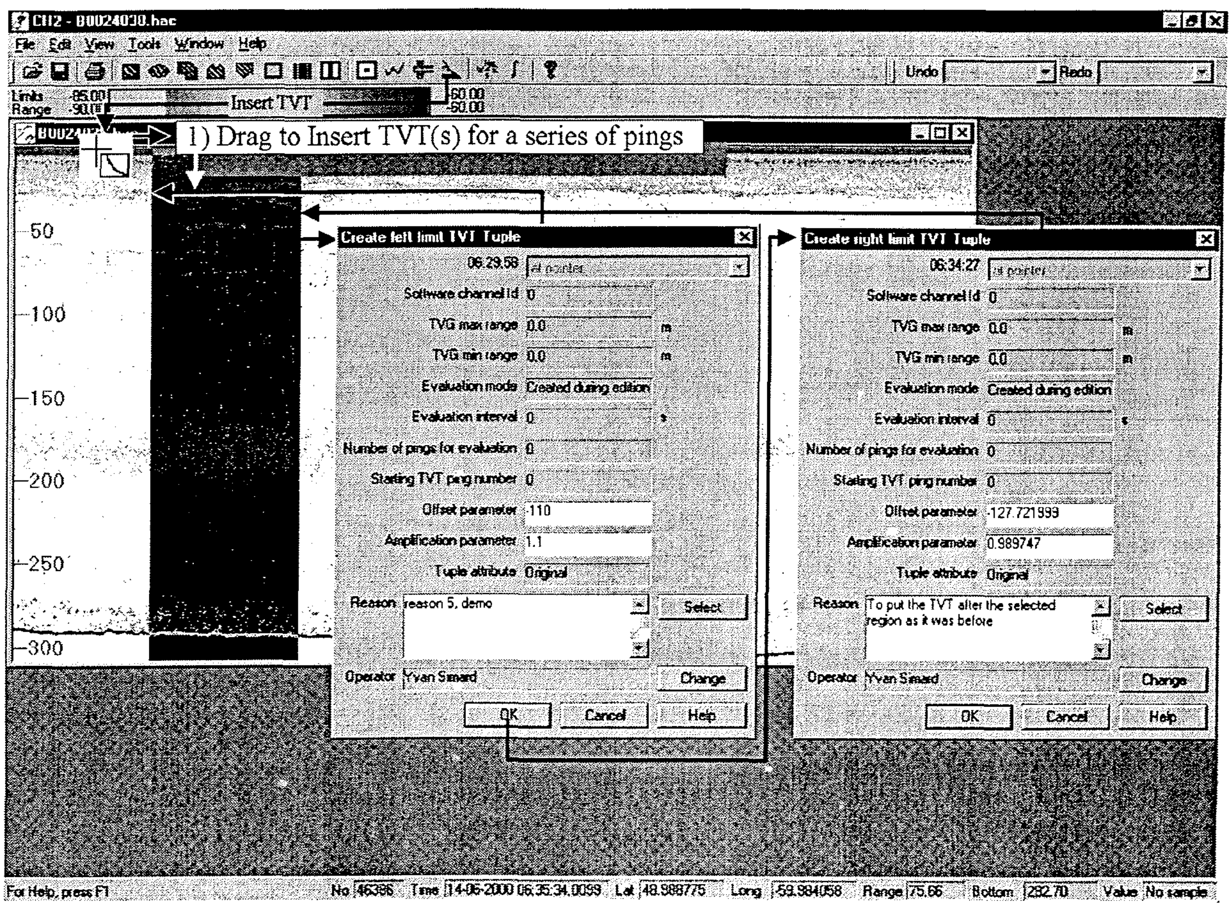


Figure 8-11. Example of inserting a set of two TVTs over a series of pings with the Insert TVT tool. First, select the tool, then click on the first ping and drag to the last ping of the series. At the release of the mouse button, the Create left limit TVT tuple dialog box opens to define the TVT parameters to apply to the series of pings. The OK button then opens the Create right limit TVT tuple dialog box. By accepting the default parameters for the right limit, the Insert TVT operation only effects the selected pings. Results are shown in the next figure.

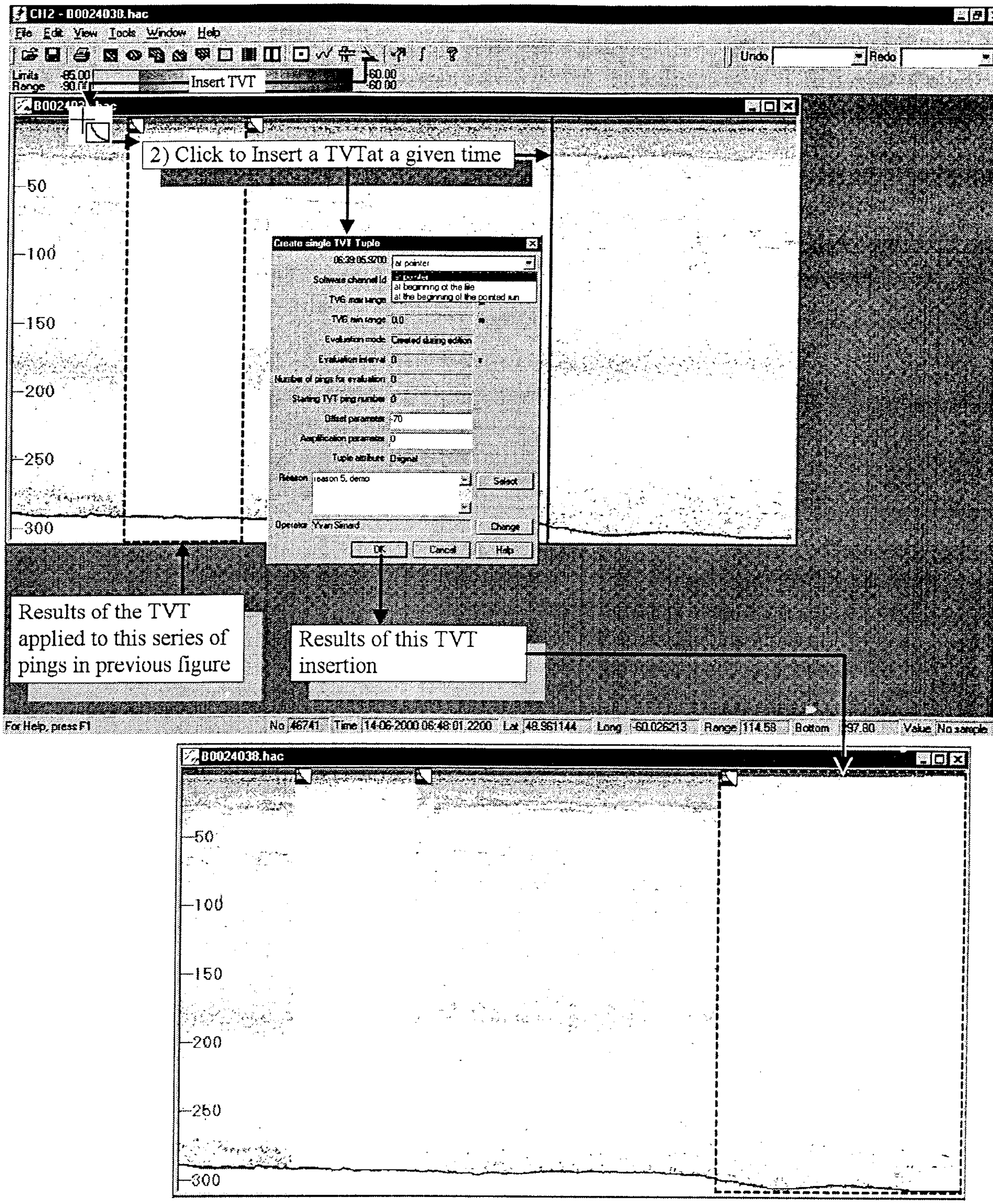


Figure 8-12. Example of inserting a TVT affecting all following pings, up to the next TVT or to the end of run or file (for single run files) with the Insert TVT tool. Select the tool and click on the echogram at the desired time location for insertion (which can be changed for two other alternatives) and give the TVT parameters, then click on the OK button.

To insert a set of two TVTs at the beginning and at the end of the series, drag over a series of pings (Figure 8-11). The selected pings are displayed in inverse video and the Create left limit TVT tuple dialog opens with the existing parameter values when the mouse button is released. Edit the TVT Offset (*C*) and Amplification parameters (*A*), an optional reason for the operation, and change the operator's name as required. Clicking on the OK button then opens the Create right limit TVT tuple dialog box. The parameters corresponding to the TVT presently applied at this ping are displayed as default values for the TVT at the end of the selected ping series. By accepting them, the insert TVT operation only affects the selected pings of the series. A click on the OK button applies the TVT operation and its effect is displayed on the echogram.

To insert a TVT from a given time up to the next TVT or the end of run or of file for single run files, first click on the echogram (Figure 8-12). At the release of the mouse button, the Create single TVT tuple dialog box opens. The Time scroll box first offers three alternatives for the time from which the TVT will be applied: the time at the beginning of the file, at the beginning of the run, or from the position at the pointer. Fill in the fields as above and insert the TVT by clicking on the OK button.

If the results are unsatisfactory, the TVT operation can be undone by the ***CH2*** Undo operation function (see Chapter 9). Each inserted TVT adds a General threshold tuple (***HAC*** tuple no. 10100) to the ***HAC*** file.

Warning: Only values that increase the present TVT will have an effect on the data. The TVT equations are: $A(20\ log(R) + 2\alpha R) + C$, for a 20 log R TVG; $A(40\ log(R) + 2\alpha R) + C$, for a 40 log R TVG; and $A\ R\ e^{\beta R} + C$, for a 20 log R TVG applied on data in volts. The absorption coefficients, α (in dB) and β (in nepers), are related by the equation $\beta = \alpha / 10\ log\ (e)$.

Warning: Since TVTs have an effect on the subsequent data processing steps, such as echointegration (see section 8.6), they should be used with caution. If the purpose is only to see the effects of range-constant thresholds on echointegration results, ***CH2***'s Echointegration threshold parameter (see Echointegration / Channel tab, section 8.6.2) should be used instead of the Insert TVT tool. Similarly, if the purpose is only to visualise data above given thresholds, the limits option of the Palette is recommended (see Edit / Palette menu, section 6.1). Note that the Insert TVT tool does not offer the possibility of being projected to other channels, because TVTs are specific to the data type and to the noise level of the channel.

8.5 Tools / Edit/add positions via Excel

This tool is for processing position data via an Excel® worksheet (version Microsoft® Office97®). It is a multi-purpose tool that can be used to view, export, add, check, edit, or delete positions associated with the current ***HAC*** data file. Accurate and precise positions are important for many ***CH2*** operations, namely visualisation in distance mode, measuring distances, and definiting echointegration step limits. Errors in positions originating from poor GPS performance

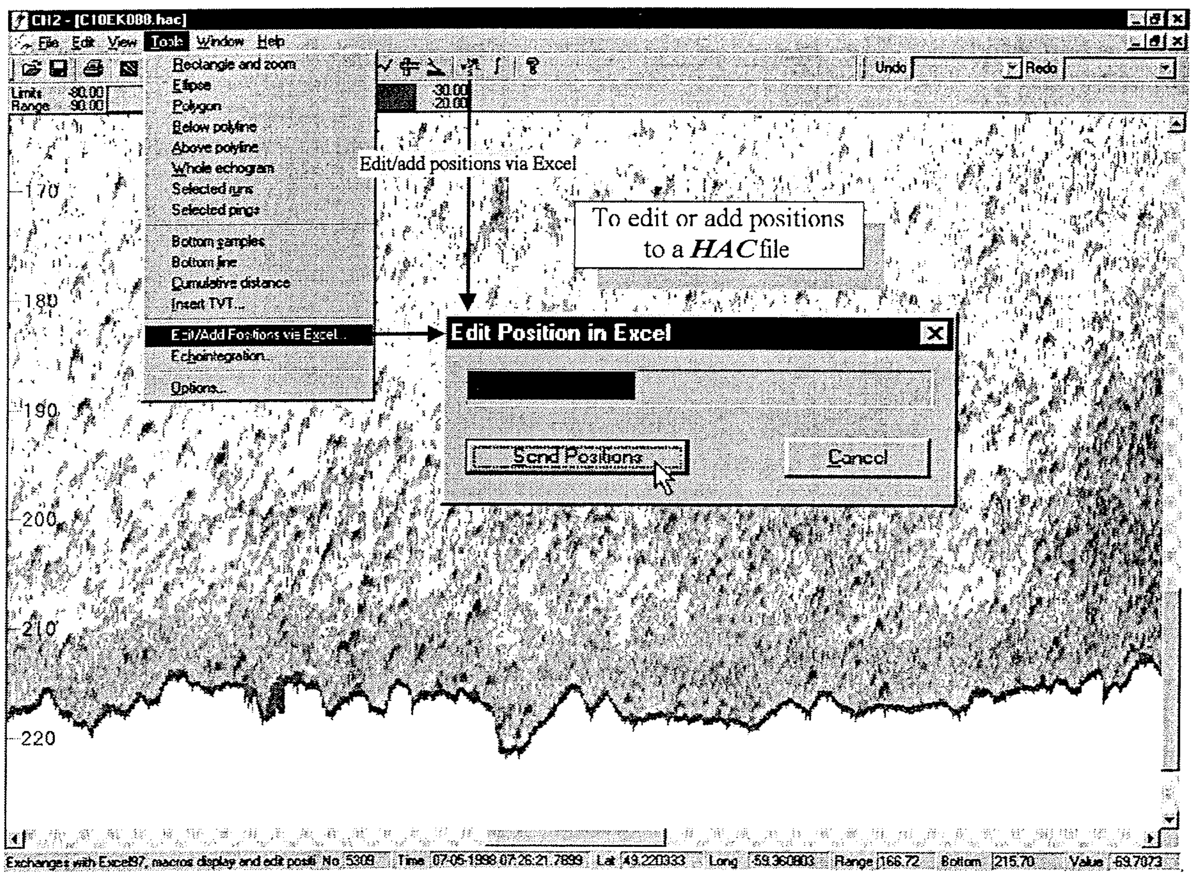


Figure 8-13. Edit/add positions via Excel tool: Sending positions to Excel.

or bad GPS settings, or the absence of positions in some ***HAC*** files (e.g., generated by ***CH1*** from archived data on magnetic tapes) can strongly impede, or inhibit, the application of these operations. Position data can be used by auxiliary software to plot the ship's track. This Edit/add positions via Excel tool was designed to provide an adaptable means of allowing ***CH2*** users to process position data.

First, before clicking on the Edit/add positions in Excel tool, make sure that Excel® is closed, or does not have active worksheets if it is open, to allow ***CH2*** to establish a clean link with Excel®. Clicking on the tool opens the send position box (Figure 8-13). The Send positions function does the following: it opens Excel®, if it is not already open, it loads the TplPos.xlt Excel template that contains Visual Basic macros to view and edit positions, and, if the ***HAC*** data file contains position tuples, it fills the worksheet with the ***HAC*** file position data that are within the boundaries of the Run time limits given by the Start of run and End of run tuples. This may take some time if the file contains many positions. A progress bar monitors the data transfer (Figure 8-13). Then the user's view is focused on the Excel spreadsheet, where several new columns are computed from the position and time data. When this is done, the user can use the macros to check and edit the position data or to bring in new positions with the usual Excel® functions. Note that the Excel / Window / split option is active, which divides the worksheet at line 17.

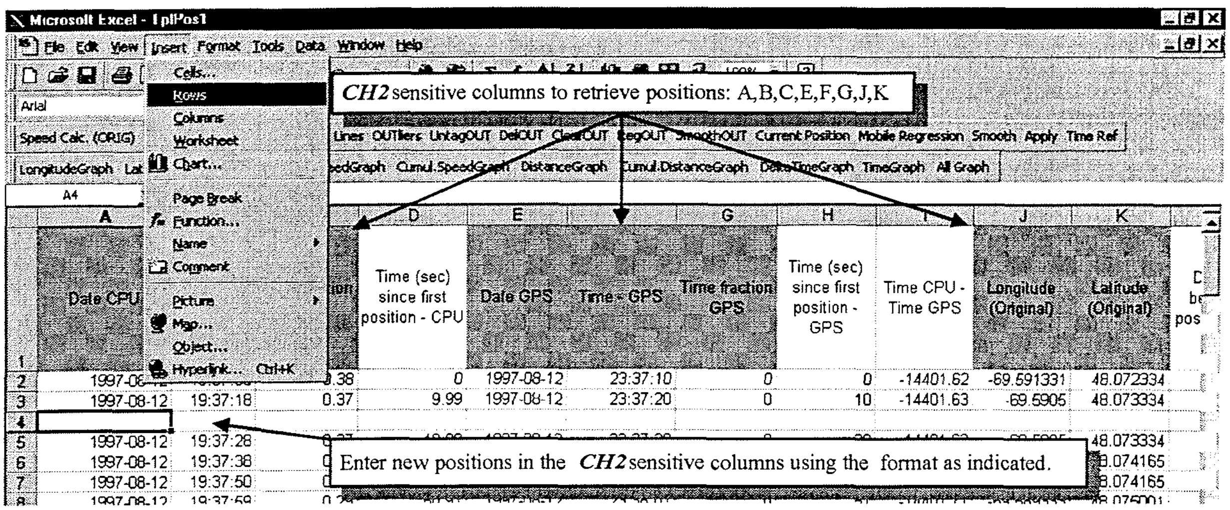


Figure 8-14. Edit/add positions via Excel tool: Adding new positions.

To add positions, simply insert new lines (if necessary) and type (or paste) the new position information in the eight ***CH2*** sensitive columns, indicated with a blue background on the headings (Figure 8-14). CPU-time information is in columns A, B, and C, the GPS-time in columns E, F, and G, and the position in columns J and K. The date format is yyyy-mm-dd and the time is hh:mm:ss. For the spatial co-ordinates, negative values are used for western longitudes and southern latitudes. Note that ***CH2*** requires more than two positions in a ***HAC*** file for the following echointegration functions: to echointegrate along a grid where the steps are defined in distance intervals, to compute the step distance intervals in all echointegration modes, and to correct for the PC clock offset in computing and reporting the echointegration results (see section 8.6.3).

Many macros are available through the various buttons above the Excel worksheet. The upper row of macros is to perform editing operations (Figure 8-15), while the lower row is to build a series of graphs to check for errors in the position series (Figure 8-16). An editing session generally starts by an inspection of the data, i.e., by plotting a few graphs with the macros, such as the longitude, latitude, course or speed graph, to see the evolution of these variables in over time. These graphs will be generated in the upper window split of the worksheet Data page, one at a time. To see all the graphs simultaneously, an All Graph macro can be used to generate them on the worksheet Graph page (e.g., Figure 8-16). When the inspection of the graphs reveals anomalies, such as outliers, duplicate positions, stepping courses or noisy positions, the macros are used to edit the erroneous positions.

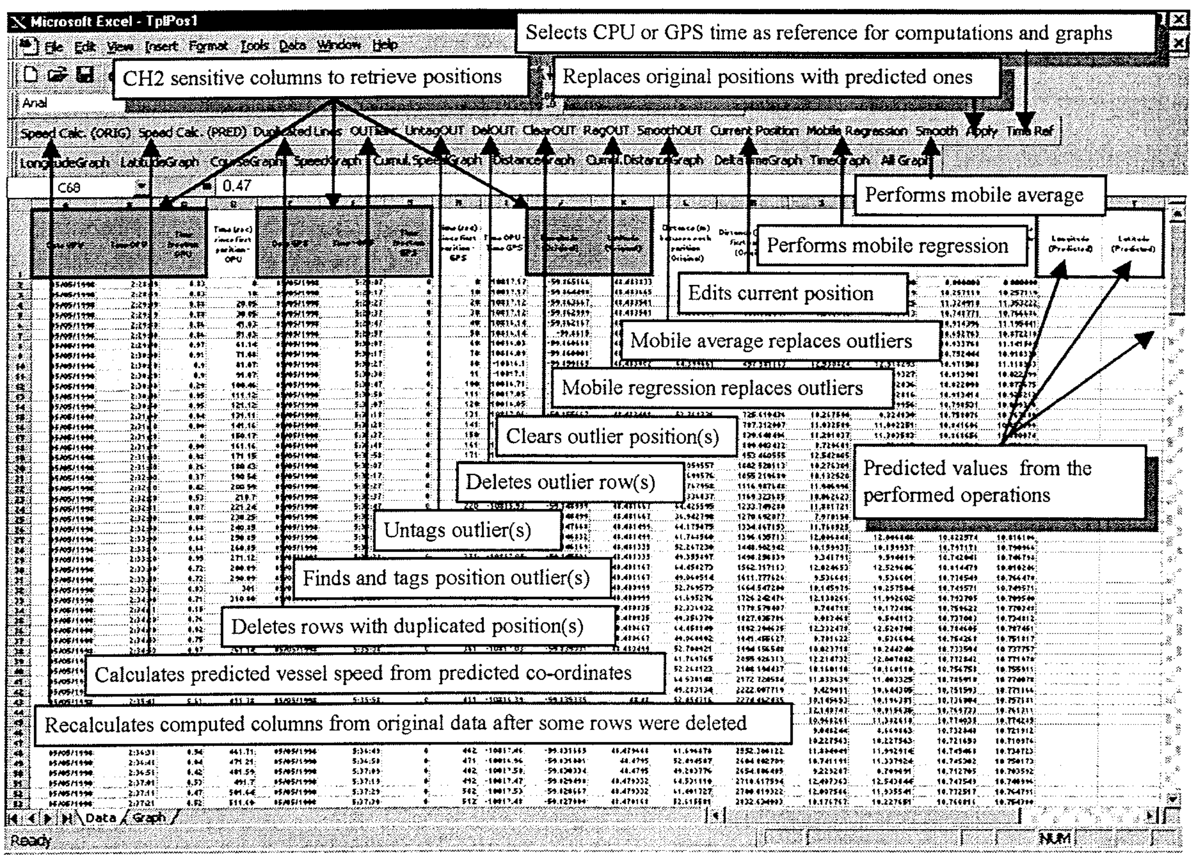


Figure 8-15. Edit/add positions via Excel tool: Edition macros and worksheet organisation.

Some editing macros, such as the various outliers' macros, must be applied in order. It is recommended to start by removing duplicate positions if the file contains any. The Duplicated Lines macro is called to remove all rows in which the CPU and GPS times and position co-ordinates are repeated from the preceding row.

Positions can be deleted by deleting the selected rows with the Excel Edit menu or by using the macros. When rows are deleted, the computed columns, such as the distance or the

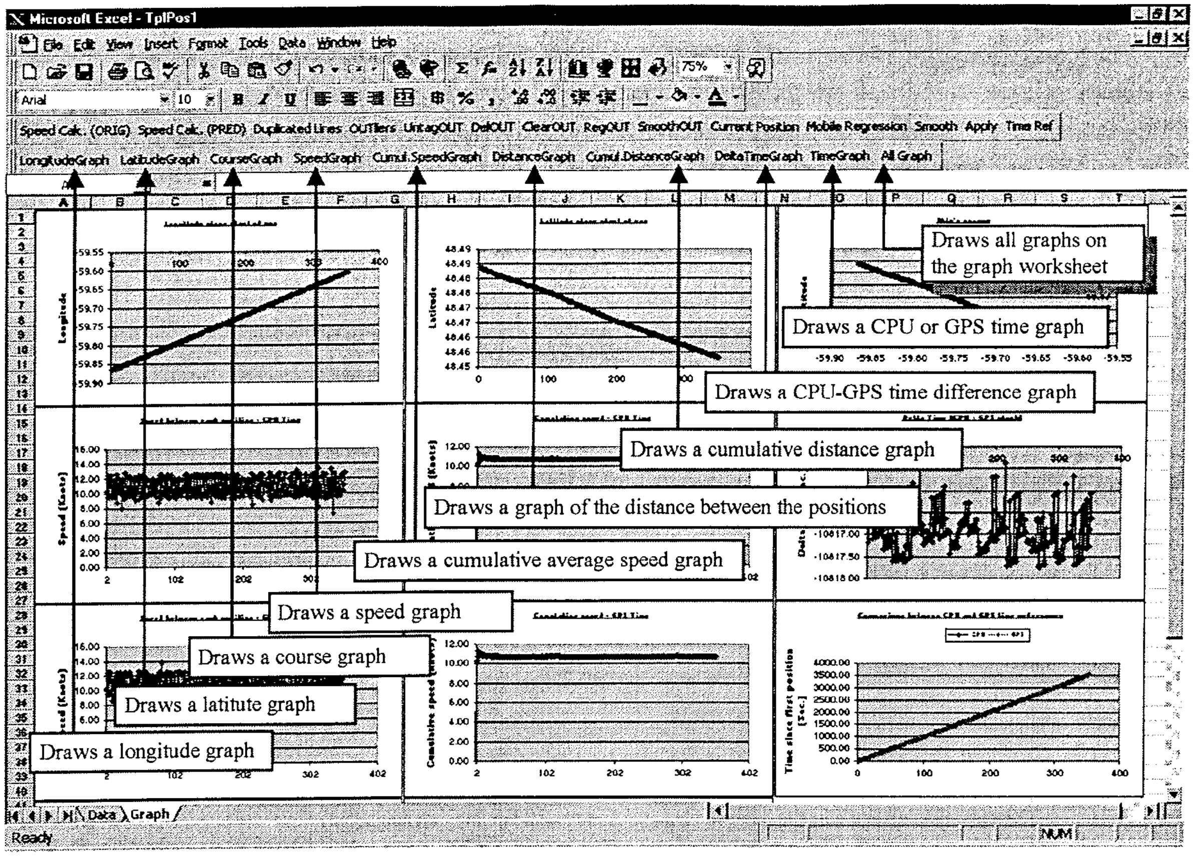


Figure 8-16. Edit/add positions via Excel tool: Graph macros and all graph worksheet page.

speed between positions, must be updated before computing new graphs. This is done using the Speed Calc. (ORIG) and Speed Calc. (PRED) macros.

The Current Position macro offers three possibilities to edit the position co-ordinates on which the pointer is located. The position co-ordinate(s) can be either deleted, which will delete the row, or estimated using an average on a symmetric window of neighbouring positions (Figure 8-17) or a linear regression on a given range of positions (Figure 8-18). The estimation can be done on both latitude and longitude at the same time or on only one of the co-ordinates. It can be done using either the GPS time or the CPU time as the reference for the interpolation, as determined by the Time Ref macro (Figure 8-19). The predicted co-ordinate(s) replace(s) the measured ones only when the Apply macro is called, which is usually done after all erroneous positions are estimated. The predicted co-ordinates can be used to compute predicted speeds from the Speed Calc. (PRED) macro. Any new graph that is plotted when predicted values are present in the various predicted columns (columns X, Y, Z, AF to AJ) will include both data series, the observed (blue) and the predicted data (magenta). The computation of new predicted values will then update the predicted data series.

The Current Position macro can be called directly by pointing on a given position on the graph displayed on the worksheet data page. First select the graph data series by pointing on the plot. When the data series is selected, you can see in a ToolTip the data corresponding to the pointer position. By clicking on this point the co-ordinates of the corresponding position are selected and the Current Position macro is called to edit the position. This is an easy way to find and edit outliers in the series. The graph is automatically updated when the position is changed, using the Apply macro.

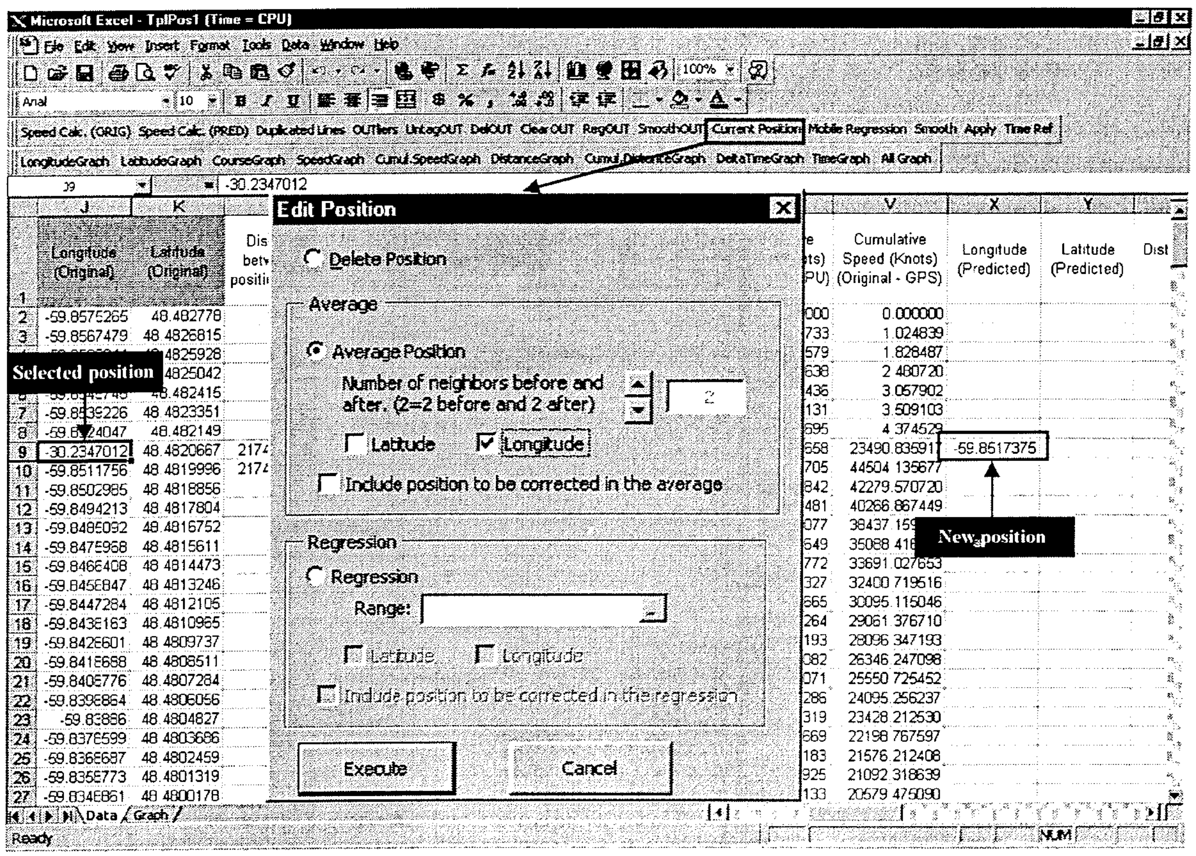


Figure 8-17. Edit/add positions via Excel tool: Current Position macro, editing a position longitude using a moving average on two neighbours before and after the selected position.

The Smooth macro and the Mobile regression macro work similarly to the Current Position macro, but on the whole data series instead of a single position. The Smooth macro performs a mobile average using the given window width while the Mobile regression macro computes predicted values from a regression using the time reference selected from the Time Ref macro (Figure 8-19). This latter method may be preferable when the positions were recorded at irregular time intervals or when gaps occurred in the time series. At both ends of the data series, the positions corresponding to the half width of the mobile window are estimated from linear extrapolation from the first or last complete window. The graph macros can be used to examine the predicted values compared to the original data. The Apply macro replaces the original co-ordinates with the predicted ones.

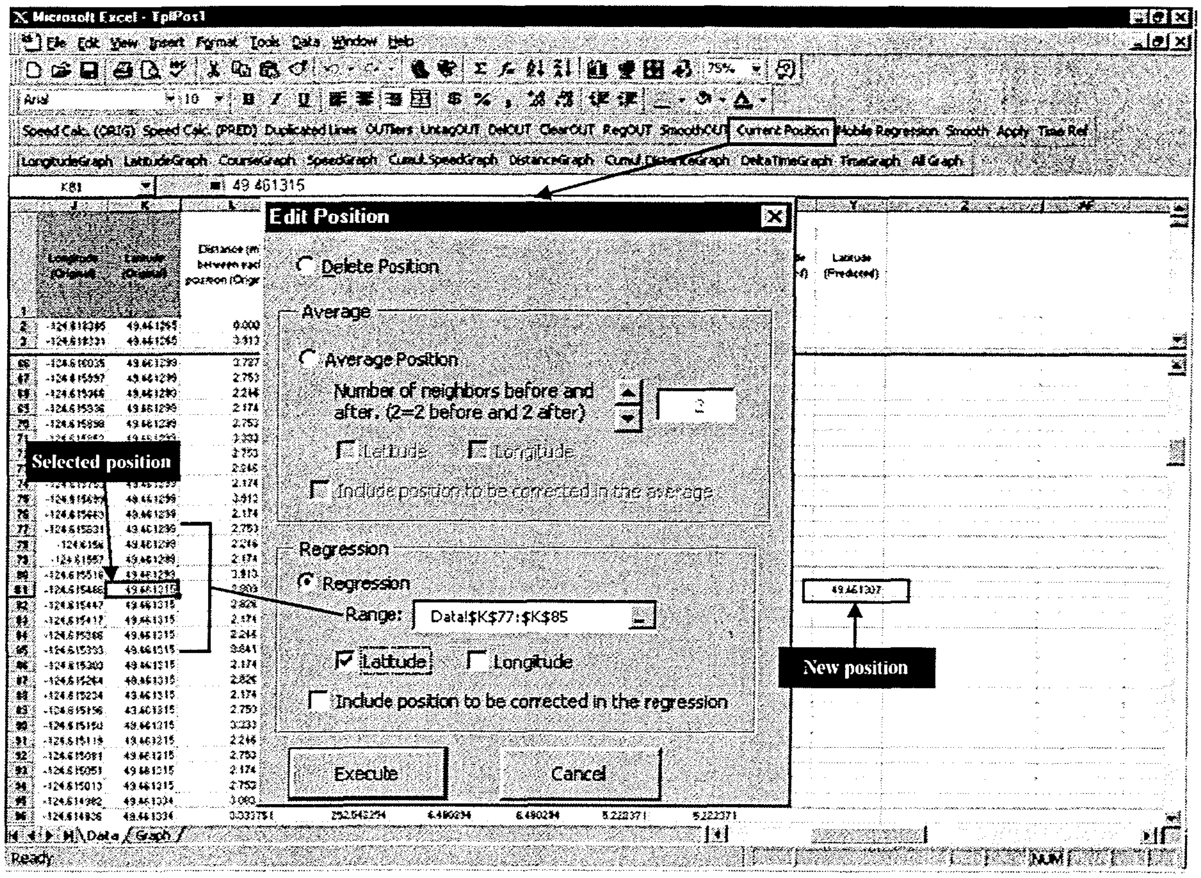


Figure 8-18. Edit/add positions via Excel tool: Current Position macro, editing a position latitude using a regression on a window of four neighbours before and after the selected position.

The outlier macros are specialised tools for locating and editing ouliers. The OUTliers macro detects the co-ordinates that exceed a given number of standard deviations from the mean (Figure 8-21). The corresponding rows are tagged with a yellow background. The UntagOUT macro untags the outlier rows. The DelOUT macro deletes the outlier positions and updates the computed columns. The RegOUT and the SmoothOUT macros work like the similar functions of the Current Position macro described above. The ClearOUT macro clears the cell co-ordinates of the outlier positions. This is a prerequisite step before using the Mobile regression or the Smooth macros for filtering the whole position time series. One must take care not to define a mobile window that is smaller than the data gaps created by the ClearOUT macro. The Apply macro finalises the outlier editing.

When the position editing or addition is done, activate ***CH2*** from the Windows menu bar and click on the Retrieve-positions button of the dialog box to upload the positions into the ***HAC*** file. If no editing was done, click on cancel to close Excel and return to the ***CH2*** menus. Data from all rows are then checked with the original Position tuples for position editing changes, additions, or deletions. If necessary, new Position tuples are added and an Edition tuple defining which original Position tuples were edited is created. Following the ***CH2*** approach, none of the original data is changed. A new Edit position operation is added to the Operation and Undo lists.

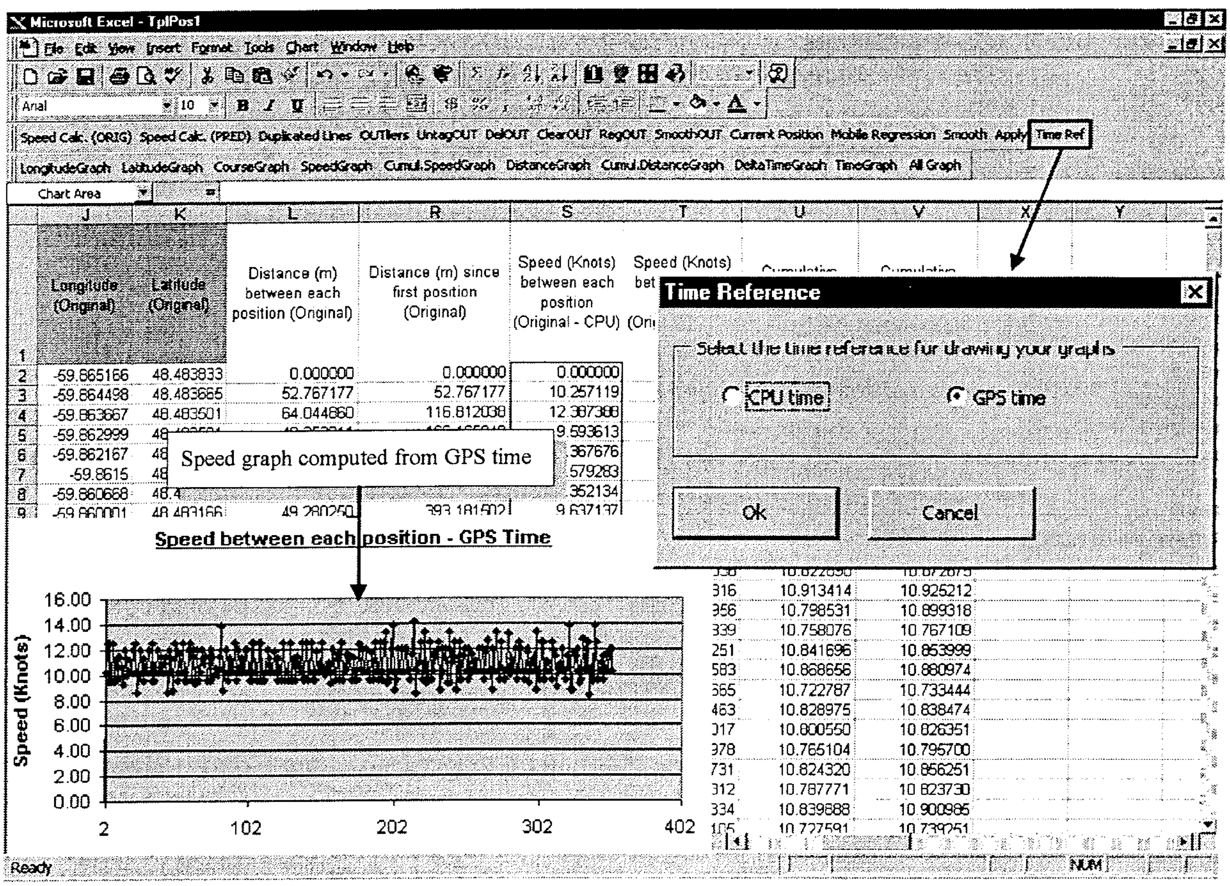


Figure 8-19. Edit/add positions via Excel tool: Time Ref macro used to determine the time reference to produce the graphs and to estimate the corrected values with the edition macros. The example is of a speed graph, indicating noisy position data, which is computed using the GPS time as reference.

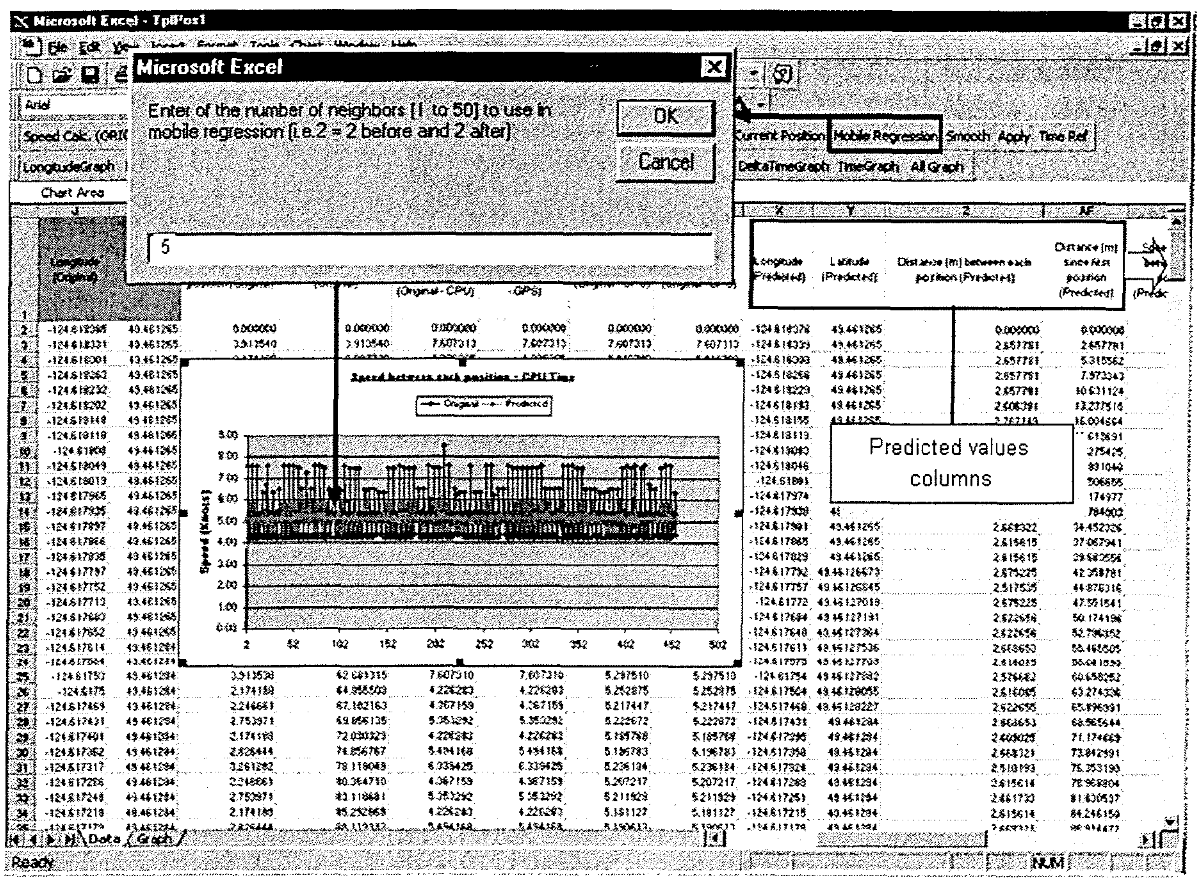


Figure 8-20. Edit/add positions via Excel tool: Mobile Regression macro, using a half window of five neighbour positions to predict the new position and to fill out the predicted value columns. The speed graph plots both the original and the predicted values.

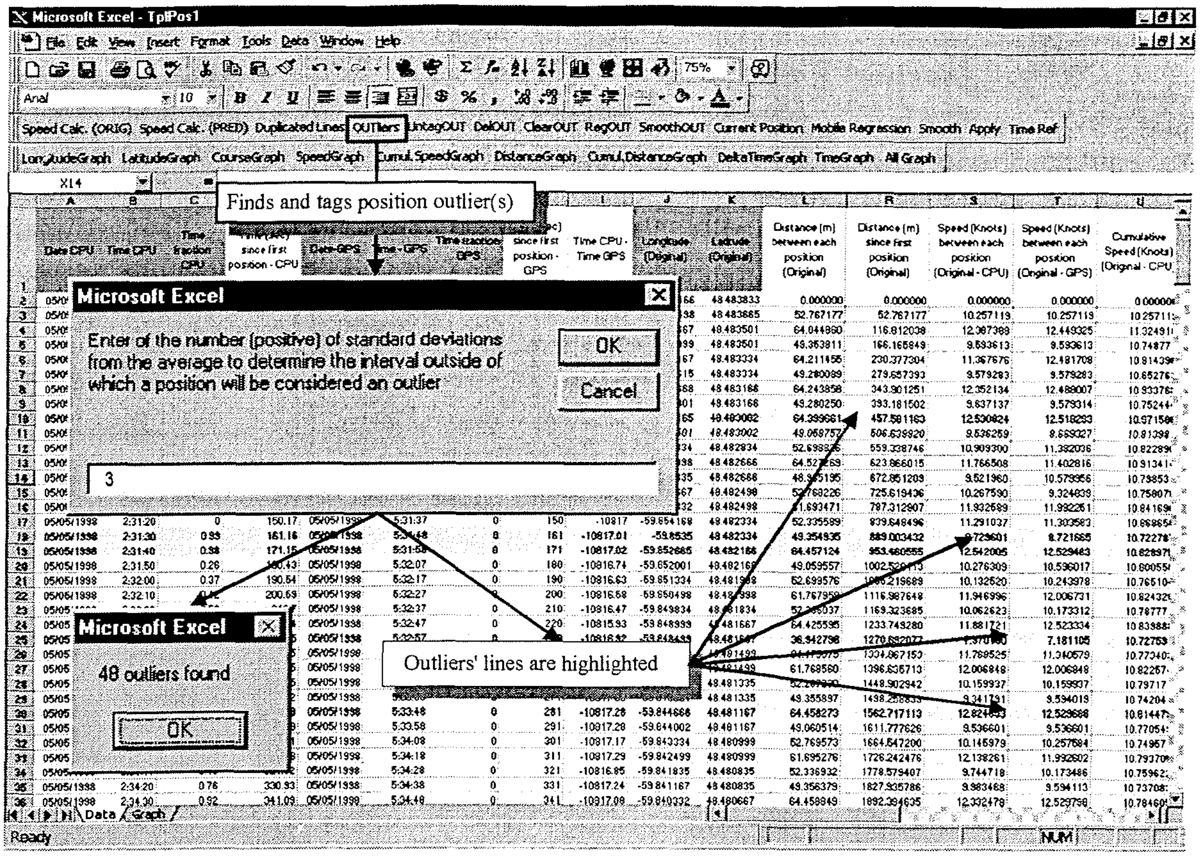


Figure 8-21. Edit/add positions via Excel tool: Find and tag outliers macro.

8.6 Tools / Echointegration

This tool is for computing the mean backscattering volume coefficient (s_v) or the area backscattering coefficient (s_a) per Echo category for one or many channels over horizontal and vertical integration grids. The horizontal echointegration steps can be defined in number of pings, time, or distance intervals. Unlimited bottom- and surface-locked vertical depth strata series can be created and they are allowed to overlap. Clicking on the Echointegration tool opens a four-tab dialog box, which presents the parameters of the echointegration setup (Figure 8-22).

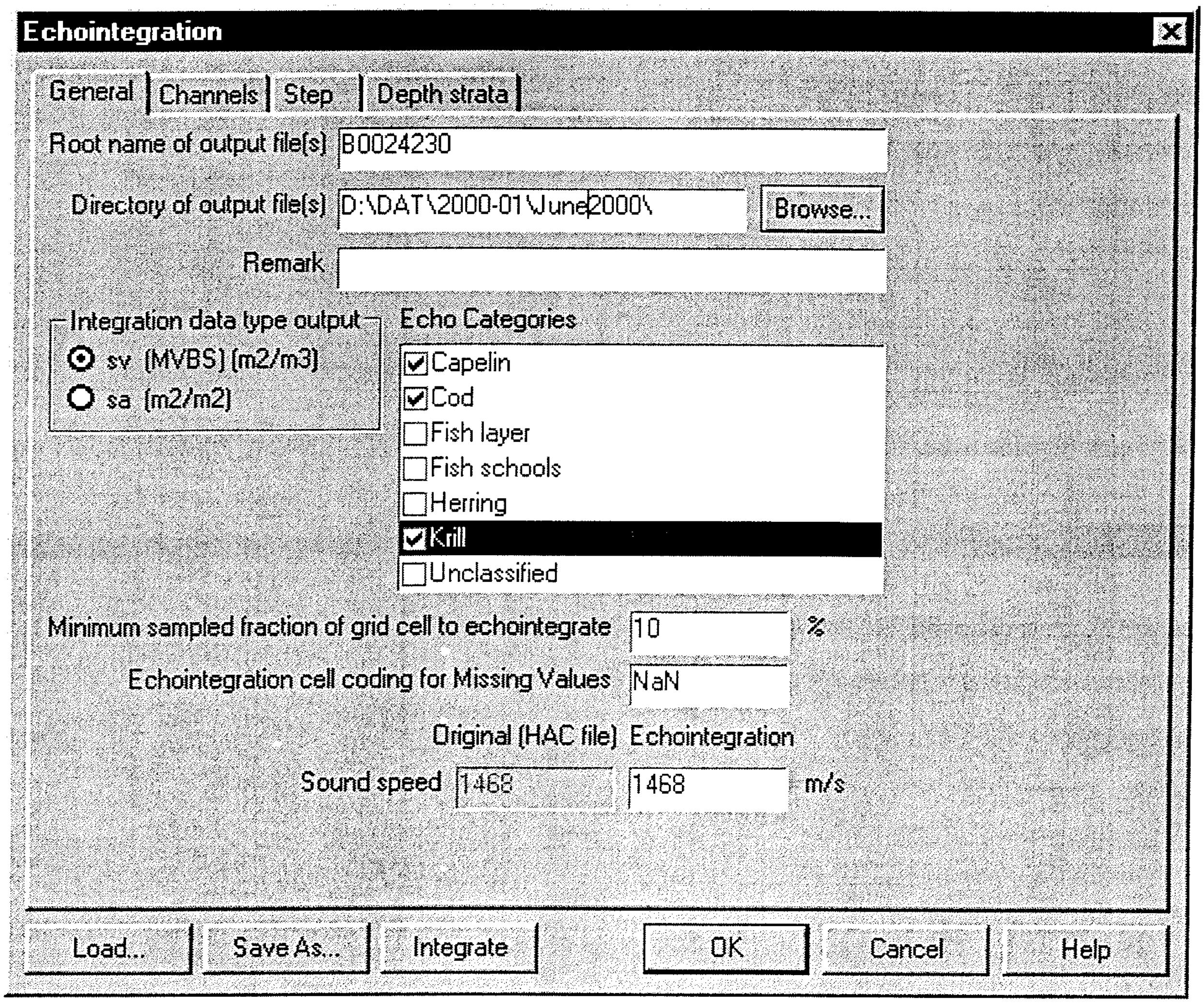


Figure 8-22. Echointegration dialog box, General tab.

8.6.1 General tab

The first tab is used to define the echointegration output file name(s) and location, the type of echointegration data, the echo categories, and to change the average sound speed of the medium if required. ***CH2*** can generate several echointegration files in a single process (Figure 8-23), one file for each combination of channel and block of runs (see section 8.6.3). First, choose a root name for the ***h***ydroacoustic ***e***cho***i***ntegration (**.hei*) output file(s). By default, the root is the active ***HAC*** file name. ***CH2*** adds the channel number (e.g., c0) and the block number (e.g., b1) to the root name, and the file extension (.hei). The list of the related files of the echointegration process is given in the *.hei header. Type the directory name where you want to save the *.hei

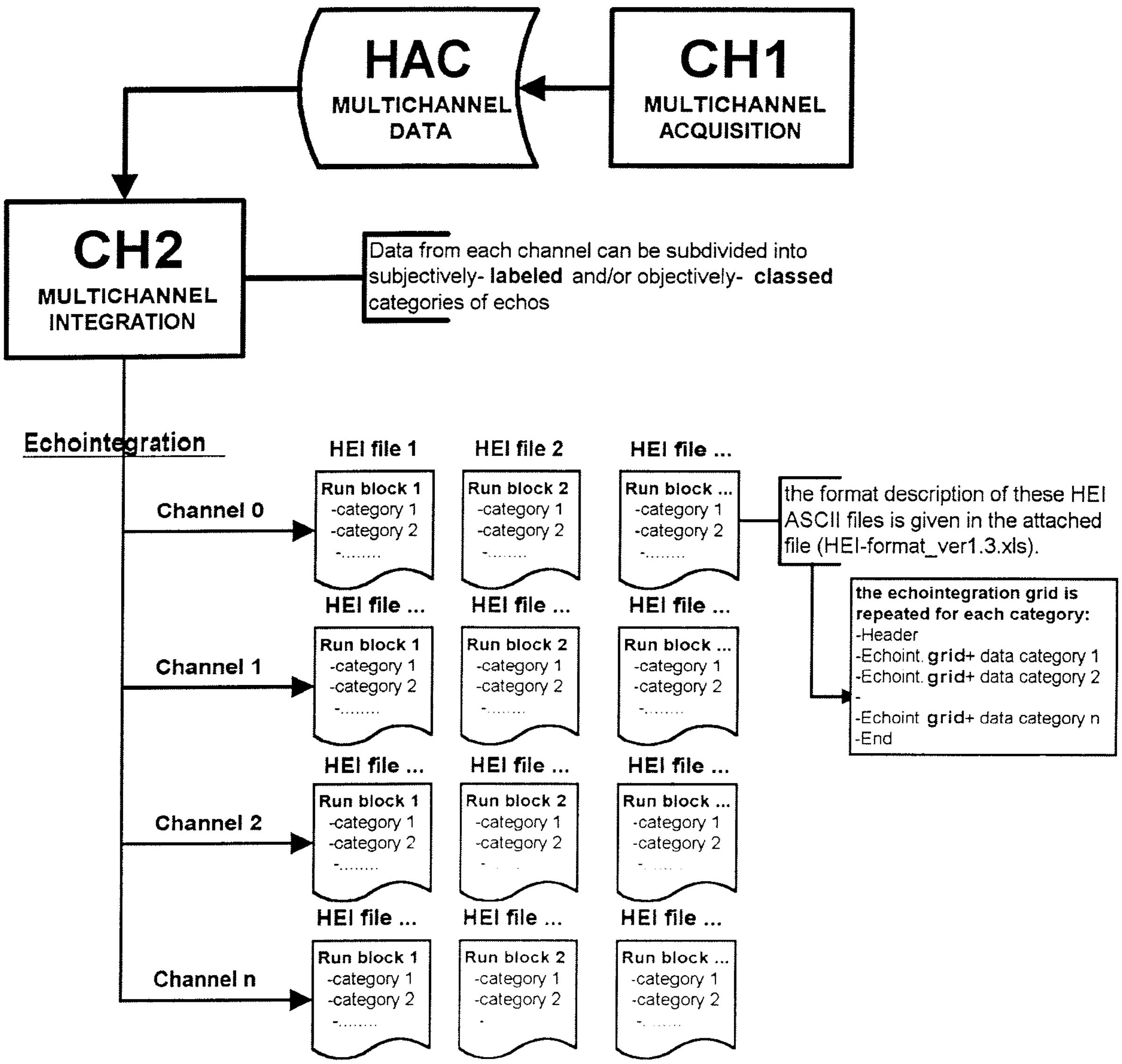


Figure 8-23. Structure of *.hei echointegration files output by *CH2*.

file(s) or choose it with the "..." button. The default is the directory of the active ***HAC*** file. If this field is blank, the Windows default directory (the last one you have used) will be used. The next field is used to save a remark that will appear in the *.hei file header for this echointegration process.

The Integration data type radio buttons serve to choose the type of data output you want to compute over the integration grid. Two choices are available: the mean volume backscattering coefficient s_v (MVBS, m^2 per m^3, linear units, see Mac Lennan and Fernandez 2000) or the mean area backscattering coefficient s_a (m^2 per m^2, linear units, *ibid.*). The choice you make is stored in the *.hei file header(s).

The Echo Categories combo box presents a list of echo categories you can select for computing echointegration results. Each category is presented separately in the *.hei file (Figure 8-23, Annex 1). The number of categories and their respective name(s) is (are) given in the *.hei file header (Annex 1). The displayed categories in the Echo category field come from a combination of the Echo category list (see Edit / Echo category list menu, section 6.4), except for the special Bad data and Exclude categories, and the loaded echointegration parameter (*.eip) file (section 8.6.5). The Echo category list is stored in the Windows95/98® registry of the PC in the present version of ***CH2***. The Unclassified Echo category is automatically added to the displayed categories. This category corresponds to all echoes that have not been included in any Echo category, whether the categories are active or not. Check the echo categories for which you want to get separate echointegration results. Note that the categories loaded from an *.eip file are already checked. Uncheck them if you do not want to include them in the integration. Note also that when checked echo categories overlap on the echogram, the overlapping echoes are integrated in each category, unless it is the Bad data category. This category is handled as missing data by ***CH2***. The portions of the echogram tagged as Bad data (e.g., Figures 8-31 and 8-32) are simply ignored by the echointegration algorithm as if they had not been sampled. The Exclude category has a different meaning and is handled differently. The signals excluded in the echogram regions for which an Exclude operation has been performed are considered to be zero (i.e., below the value of the TVT) by the echointegration algorithm. For example, performing an Exclude operation for all signals smaller than the pulse length on the whole echogram is equivalent to setting all those excluded samples to zero for the echointegration function. **Warning**: It is important to clearly understand the differences between the two special echo categories, Bad data and Exclude, in the computation of the echointegration results.

The Minimum sampled fraction of grid cell to echointegrate field quantifies the minimum stratum fraction of the echointegration grid cell that must have been sampled to compute an echointegration value. By default, the fraction is set to 10%. The user can change it by typing another value, including zero, in which case no minimum is considered. This ***CH2*** option prevents spurious echointegration results in certain cells of the echointegration grid, for example cells that were poorly sampled, such as a surface-locked depth strata in which the bottom is intruding close to its starting depth or depth strata for which a large proportion has been declared missing by a Bad data classification. Note that ***CH2*** does not take this Minimum sampled fraction into account in computing the echointegration results of the automatic Whole water column depth strata of all *.hei files. The objective here is to produce the best estimate with all the information available over the whole sampled water column depth strata, for which the Minimum sampled fraction to echointegrate is rarely relevant. In the *.hei files, the echointegration results for the grid cells where the Minimum sampled fraction is not satisfied are set to the code given in the Echointegration cell coding for Missing Value field. ***CH2*** uses "NaN" (for **N**ot **a** **N**umber) by default for coding echointegration missing values.

The next field is the sound speed to use for echointegration. The sound speed recorded in the ***HAC*** data file is the default. ***CH2*** allows the user to change it for the echointegration process by typing a new value in the editable Echointegration field. The present version of ***CH2*** uses a constant sound speed to compute the range from the transducer. Subsequent versions will include an option to use a profile instead of an average for the sound speed and the absorption coefficient. The sound speed is involved in many parts of the echointegration process. It is used to determine the echo sample depth, the detected bottom depth, the TVG correction, the echointegration constant and the Fernandez and Simmonds' (1996) correction when selected. The effect of the sound speed in correcting the TVG and the echointegration constant is detailed in the Integration section (8.6.6) and Annex 2.

8.6.2 Channel tab

This tab is to choose the channel(s) to integrate for the echo categories selected in the general tab, to accept or modify their default values for echointegration, and to determine an optional echointegration threshold (Figure 8-24). The Channel to integrate combo box presents a list of the ***HAC*** data channel(s) that can be used for computing echointegration results. Only 20 log R volts or S_v channels are available for echointegration. All channels are selected by default. Uncheck the ones not wanted for computation of echointegration results. The values of the parameters corresponding to the active channel in the combo box are displayed in the series of fields of the dialog box. The parameters displayed depend on the type of echosounder used. The parameters differ between the analog Biosonics type and the EK500. Refer to the ***CH1*** manual (Simard *et al.* 1998) or the ***HAC*** format description (Simard *et al.* 1997) for the parameter definitions. The ***HAC*** data file default values are displayed in the grey fields of the Original (***HAC*** file) column. If necessary, use the editable fields of the Echointegration column to change these values for echointegration. If the echosounder is an analog Biosonics type, the Beam pattern factor (BPF) and Directivity index (DI) fields are displayed. Those two fields work together according to the following equation: $BPF = -10^{DI/10}$. ***CH2*** uses the linear-scale beam pattern factor parameter. If you only know the alternative directivity index parameter in dB and you want to change its value, enter the new value in the corresponding editable field and the Beam pattern field will be changed automatically. The conversion can also be done in the other direction (BPF to DI). If the data came from an EK500 echosounder, two additional fields are given for applying a range-dependent correction necessary to offset a systematic error introduced during the calibration of older versions (≤ ver. 5.2) of the EK500 (Fernandez and Simmonds, 1996) (see section 8.6.6). The two parameters of the correction are the EK500 Receiver delay (milliseconds) (t_{del} of Fernandes and Simmonds 1996) and the EK500 Measured range to sphere at calibration (metres) (r_m of Fernandes and Simmonds 1996). The EK500 measured range to the sphere differed from the true range to the sphere (r_{sph}) because of the receiver delay. Enter the values of these two parameters in the corresponding fields, if necessary. The next two parameters

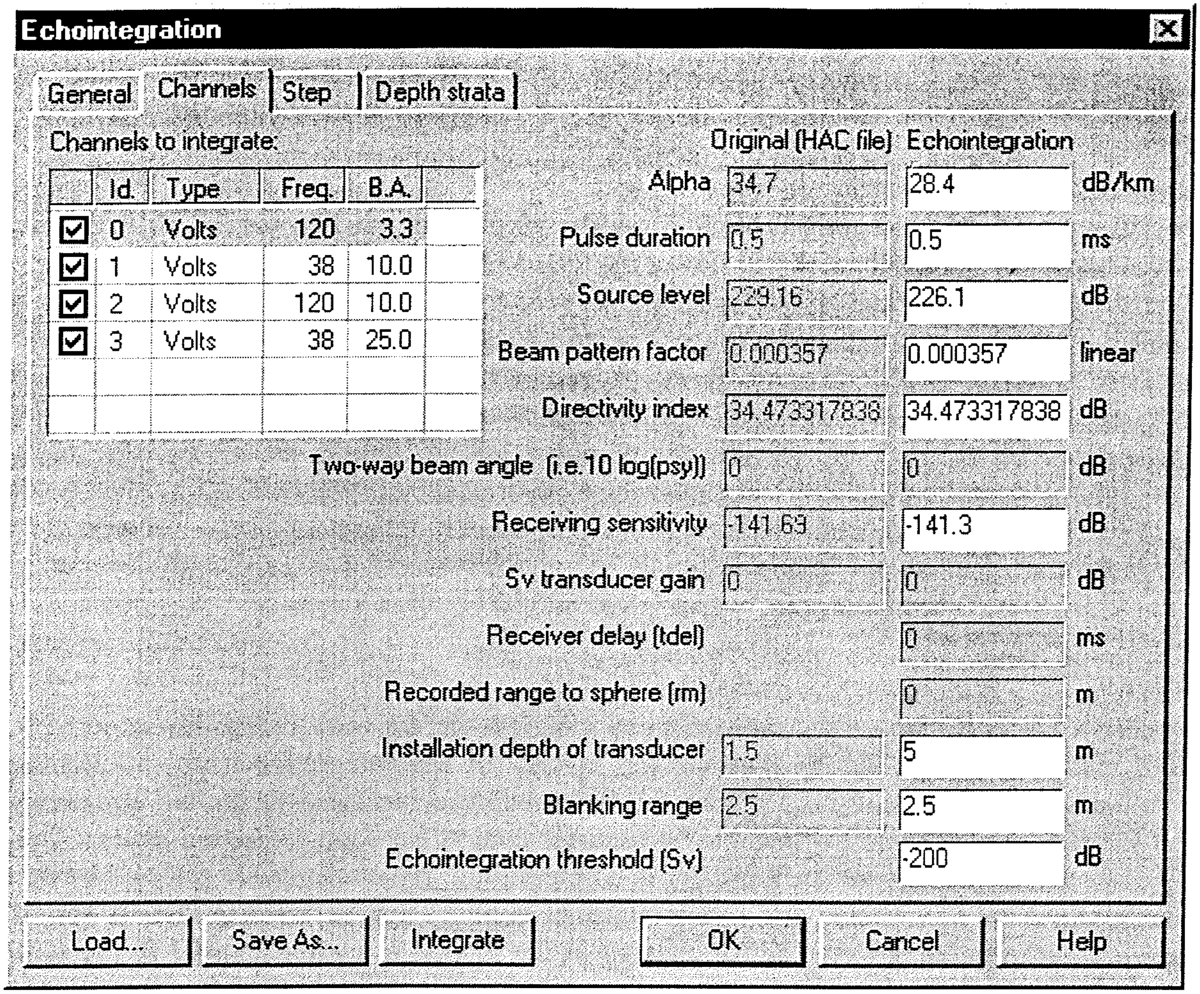


Figure 8-24. Echointegration dialog box, Channels tab.

are the Installation depth of the transducer and the Blanking range. The default value for the blanking range comes from the echosounder tuple of the ***HAC*** file for the analog Biosonics type of echosounder. For EK500 data, the default value is set to zero because the blanking range used in the ***CH1*** Channel menu is not presently saved in the ***HAC*** file. The sum of the Installation depth of the transducer and the Blanking range give the Minimum sampled depth, within which no echointegration can be performed, for both surface-locked or bottom-locked depth strata (see sections 8.6.4 and 8.6.6, Figures 8-31 and 8-32). The last parameter is the Echointegration threshold (S_v in dB), which sets a threshold for including any echo sample in computing the echointegration results. By default no Echointegration threshold is used in ***CH2*** by setting this parameter to an extremely low value (-200 dB).

8.6.3 Step tab

This tab is used to define the horizontal axis of the echointegration grid and the series of runs to be grouped into separate blocks (e.g., Figures 8-25 and 8-26) for the computation of the echointegration results. The Echointegration block field is used to group the Runs of the ***HAC*** file (if it contains more than one Run) into series or Blocks (Figure 8-26) for which echointegration results will be computed and separate *.hei files created. ***CH2*** generates one *.hei file per Block and Channel combination (Figure 8-23). The block number is indicated in the *.hei file header as well as the total number of Blocks and their associated file names that are involved in the whole echointegration process (see Annex 1). By default, the Echointegration

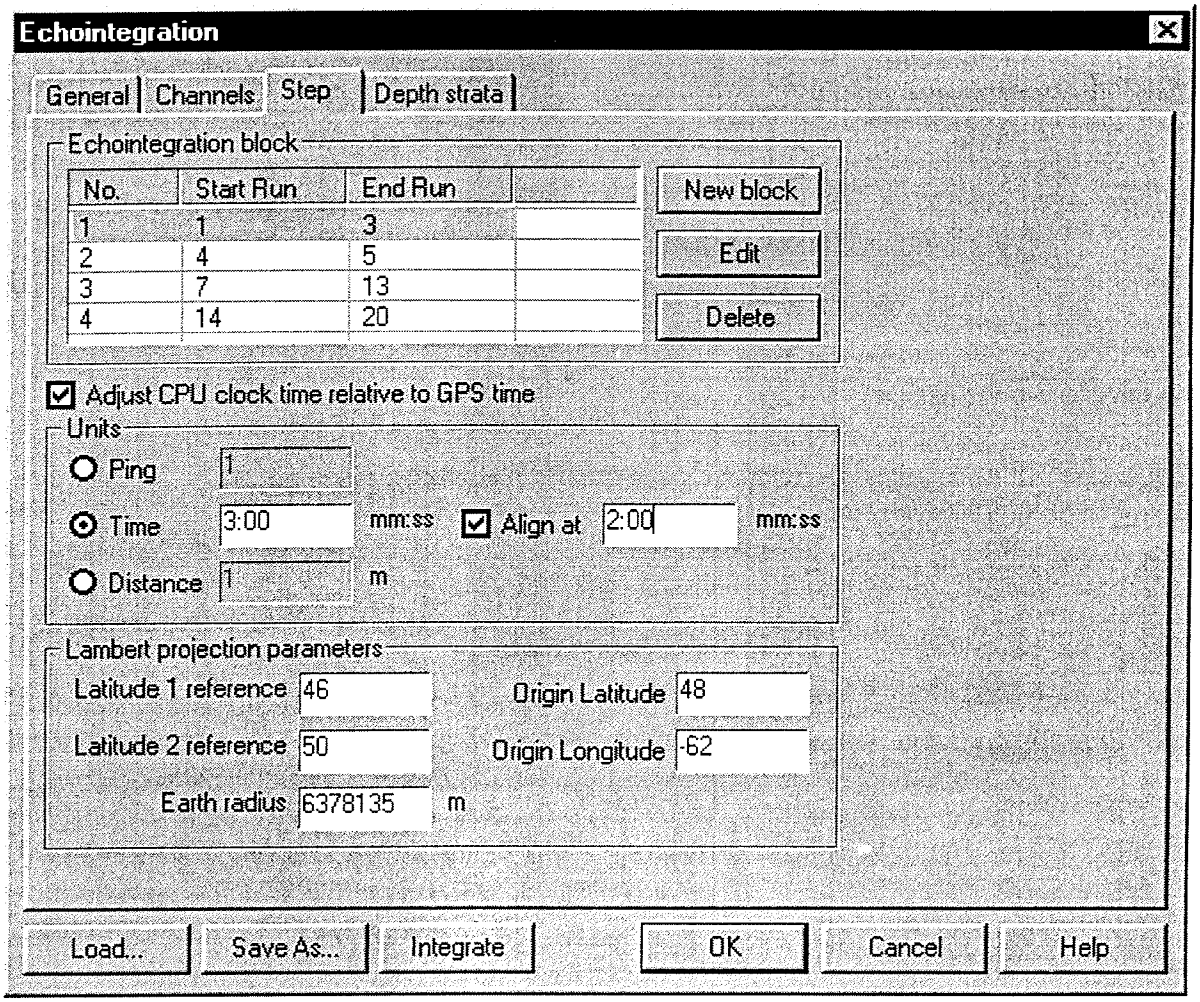


Figure 8-25. Echointegration dialog box, Step tab.

block field contains a single Block grouping all the Runs of the ***HAC*** file. The loading of an *.eip file (see section 8.6.6) does not update that default configuration because different files generally contain different numbers of Runs. Use the New block, Edit, and Delete buttons to define your echointegration blocks if the ***HAC*** file contains more than one Run. Note that the Block of runs setting is saved in the echointegration parameter *.eip file, even though it is not applied at loading.

A check-box is then presented to adjust the CPU clock time relative to GPS time from the times fields of the Position tuples of the ***HAC*** file. **Warning**: By default, this option is checked. ***CH2*** automatically corrects for the most frequent offset of the PC clock relative to the GPS time,

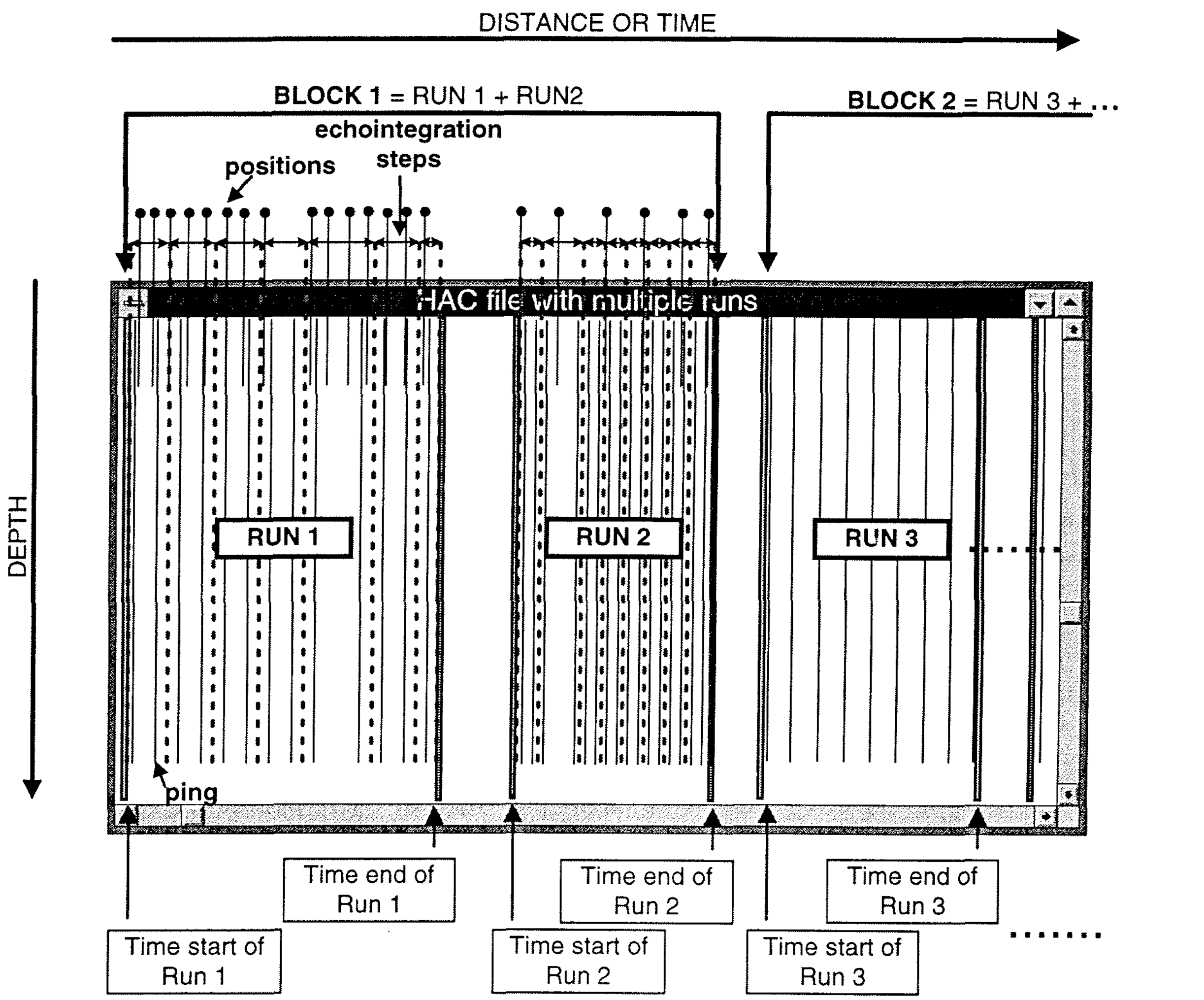


Figure 8-26. Time/space structure of multiple-Run ***HAC*** files and echointegration Blocks. Echointegration steps are defined by ping number. Note that the step limit sequence is bounded by the Run limits (i.e., no run-overlapping step) and that the step widths vary when some pings are missing.

up to an offset of 30 min, unless this CPU time synchronisation option is unchecked. The Time offset of PC clock is computed from the most frequent PC clock time difference with GMT (in seconds) in all Position tuples of the ***HAC*** file, which is robust to outliers that could result from GPS bad data. The offset is the modulo 1800 of this time difference (i.e., in Excel® formulation: MOD(most frequent PC time difference with GMT, 1800)). Therefore, if the CPU clock was not accurately adjusted at data acquisition, the times indicated for the echointegration steps in the *.hei file(s) are not the times you get by pointing on the echogram, but the corrected time. This is needed to properly align the echointegration results for further processing of the data, such as when they were collected by different PCs or to synchronise the results with other types of data recorded at the same time. The computed CPU time offset is reported in the Time offset of PC

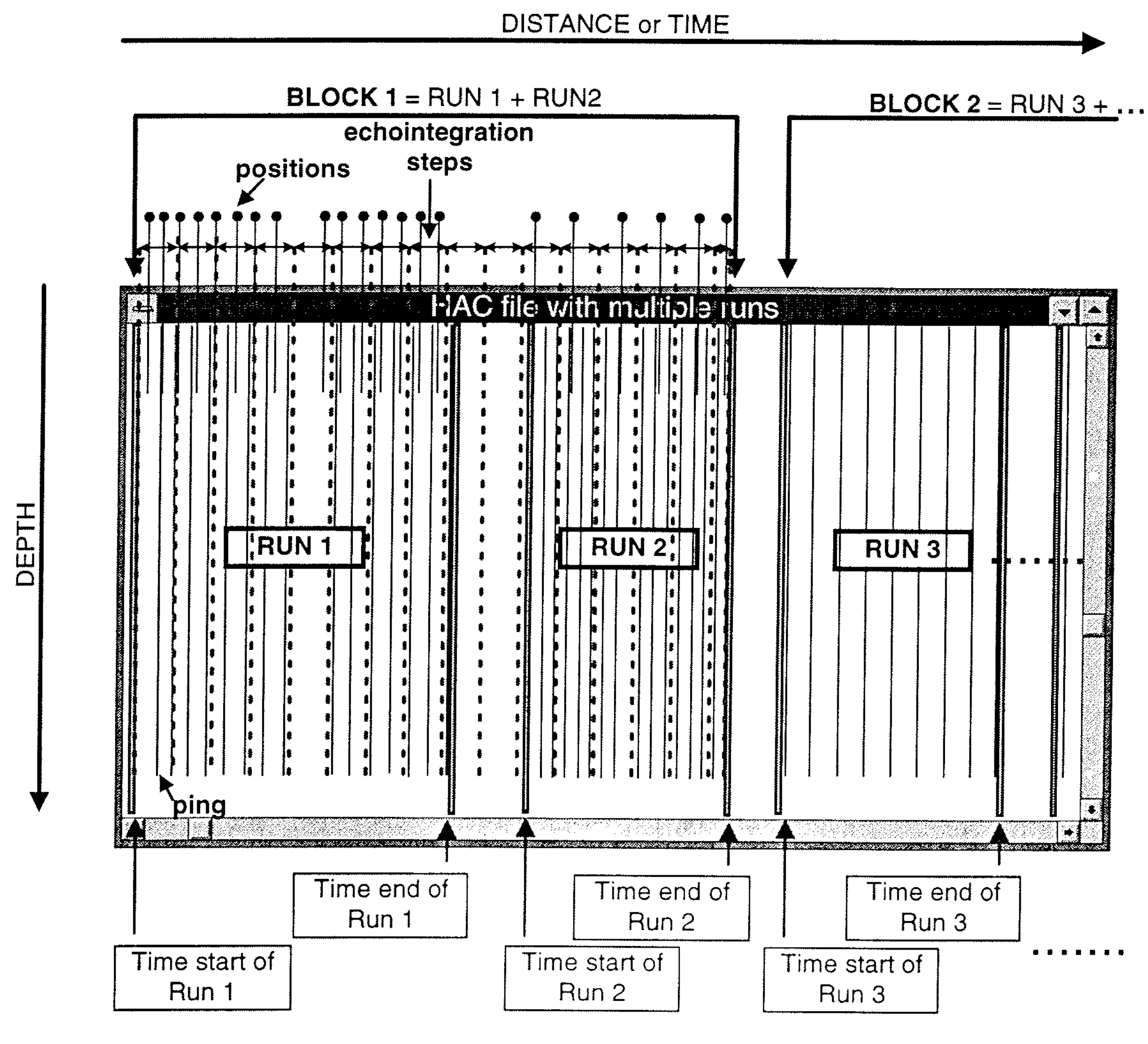


Figure 8-27. Time/space structure of multiple-Run *HAC* files, and echointegration blocks. Echointegration steps are defined in time or distance intervals. Note that steps can overlap two Runs and that both intra-Run and inter-Run empty steps can occur.

clock field of the *.hei file. Note that if the ***HAC*** file has less than two GPS positions, the time correction will not be applied.

The next group of fields serve to determine the echointegration steps in either ping, time, or distance intervals. If the active ***HAC*** file contains less than two GPS positions; the distance mode is not available; the Missing Value code will be reported for all columns of the *.hei file(s) in which the positions are involved (latitude, longitude, x-Lambert, y-Lambert, step distance, cumulative distance, sailing speed, step-distance weighted s_v or s_a results summary for the whole block). Use the radio buttons in the Units sub-group to make the choice, then give the corresponding interval in the field box. Time intervals can be given in minutes and seconds, which must be separated by colons. If there are no colons, ***CH2*** reads the interval as seconds. The distance interval is given in metres (resolution 0.1 metre). If you choose to integrate in time intervals, an additional option becomes available in the adjacent check-box. Check this box if you want to align your time steps on a given minute:second of the hour. By default, this option is not checked. This option is required to properly align multi-echosounder or multi-channel echointegration results. For multiple-Run echointegration Blocks, the echointegration step series continue in between the Runs (see Figure 8-27) when they are defined in time or distance intervals. This is not the case when the steps are defined by number of pings, in which case a new step is starting at every Run (see Figure 8-26).

The last group of the step tab of the Echointegration dialog box is for defining the parameters of a Cartesian co-ordinate system for calculating the starting co-ordinates of your echointegration steps produced in the *.hei file(s), if the active ***HAC*** file has more than two positions. Cartesian co-ordinates are needed for processing the echointegration data in a geostatistical framework or simply to produce non-deformed spatial plots of the echointegration results. These Cartesian co-ordinates (metres by default) are computed from a Lambert projection. The user must define, in the appropriate fields at the bottom of this dialog box: the origin co-ordinates and the optimal domain (between the two reference latitudes) for that Lambert projection. Use negatives for western longitudes and southern latitudes. The default earth radius (m) is given. If you choose to express the earth radius in other units (e.g., km), the Cartesian co-ordinates and the distances in the *.hei files will be expressed in these new units. **Warning**: This change of units will also change the sailing speed units, which will be undefined, i.e., not knots (see section 8.6.5). Note also that the *.hei file will report the Missing Value code if the Cartesian co-ordinates cannot be computed because the ***HAC*** file does not contain more than two GPS positions.

8.6.4 Depth strata tab

The last tab of the Echointegration dialog box is used to define the vertical axis of the echointegration grid, with depth strata (or layers) referenced from the surface or the bottom (Figure 8-30). The two boxes and their associated buttons serve to define the series of surface- and bottom-locked depth strata (see Figures 8-28 and 8-29) for which echointegration results are to be computed. To create a depth strata series, click on the New series button to open the dialog box to define the depth strata limits (Figure 8-28). **Warning:** The surface depth strata are defined in the **depth** domaine (i.e., distance from the surface) and not as range from the transducer. This depth reference is necessary to allow the comparing or merging of multi-channel echointegration results coming from ***HAC*** data acquired from transducers deployed at different depths. First determine the start and end depths for the depth strata series. Then the user chooses either the number of depth strata he wants to have over that depth range or the stratum thickness. The Update button computes the alternative field. The maximum resolution allowed for the depth strata limits is 1 mm. Click on the OK button to return to the main dialog box. Repeat these steps to add other depth strata series. The various series of depth strata can overlap. For example, you can define a first series of ten 10-m depth strata from 0 to 100-m in the water column, followed by a series of four 25-m depth strata over the same 0 to 100-m depth range. A Whole water column stratum is automatically included by ***CH2*** in all *.hei files to compute echointegration results for every selected Echo category over the whole sampled water column, from the Minimum sampled depth down to the bottom. The user does not have to define this stratum. **Warning**: The start depth of any depth strata within which the Minimum sampled depth (see section 8.6.2) for the corresponding channel(s) is located will be the Minimum sampled depth in the *.hei file(s). The echointegration start depth then becomes the sum of the Installation depth of the transducer and the Blanking range. These latter parameters are channel specific and therefore

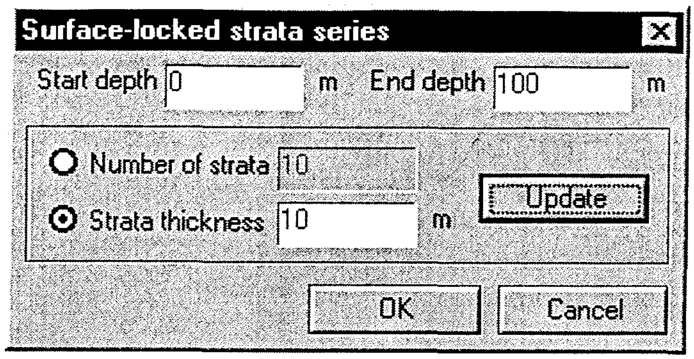


Figure 8-28. Surface-locked strata definition dialog box.

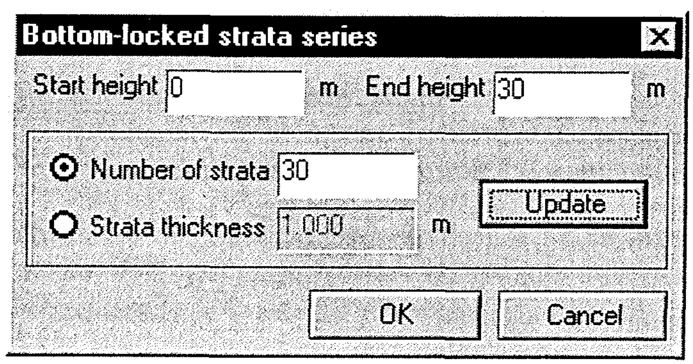


Figure 8-29. Bottom-locked strata definition dialog box.

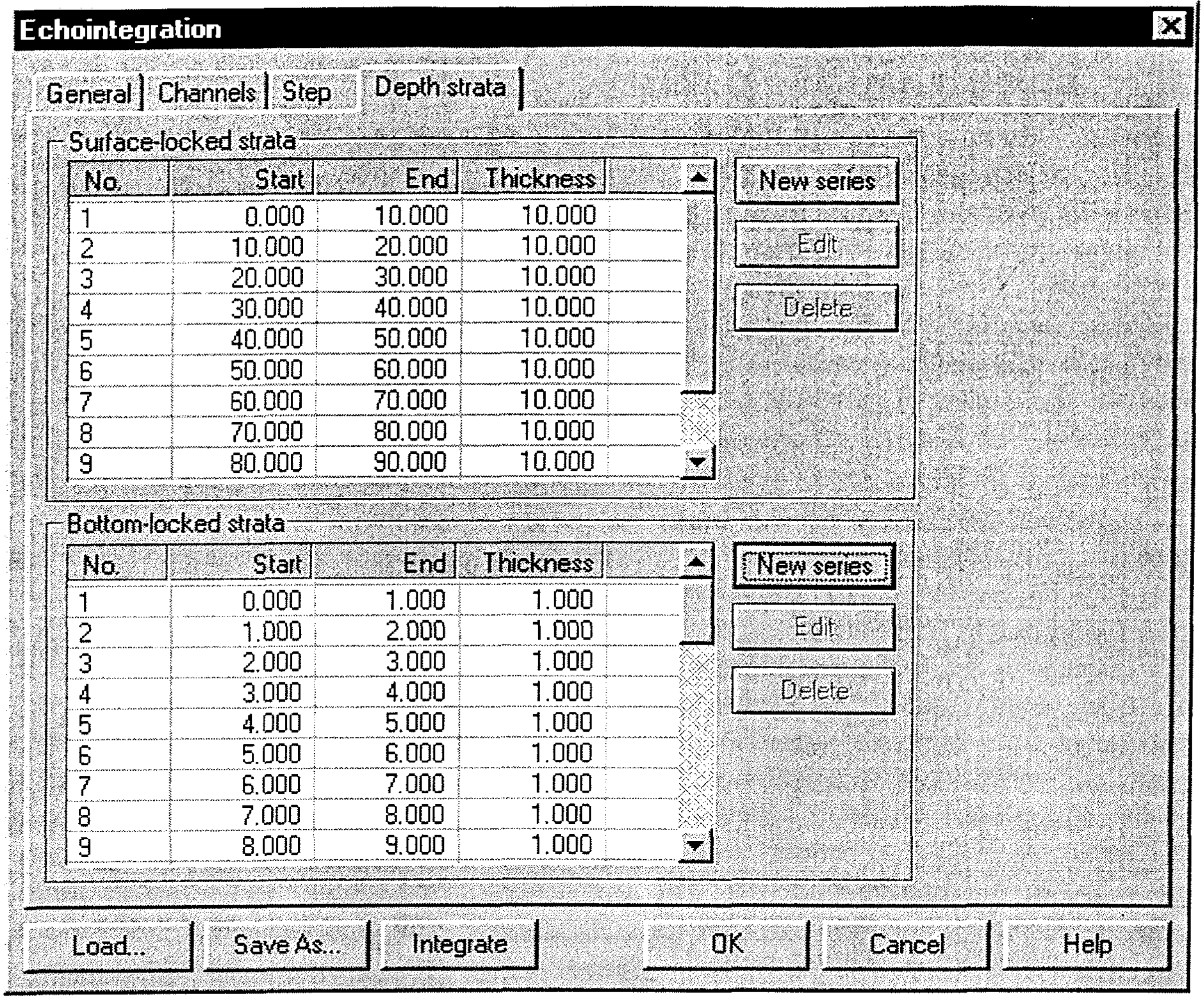


Figure 8-30. Echointegration dialog box, Depth strata tab.

can vary among channels. Similarly, the definition of the bottom-locked depth strata series is made by clicking on the corresponding New series button. The depth strata limits are given in height (altitude) above the bottom. The echointegration stops at the Minimum sampled depth.

8.6.5 Updating, saving, and loading echointegration setting parameters

The OK button at the bottom of the Echointegration dialog box updates the fields of the four tabs of the dialog box, so that the updated values will be recalled by ***CH2*** the next time the Echointegration tool is called up. The Save As button and the Integrate button defined below also have the effect of updating the echointegration setting parameters. **Warning**: If one quits the Echointegration dialog box by clicking on the Cancel button or the standard Windows closing X at the top right of the dialog box the changes made to the fields will not be saved and the default setting parameter values will be used the next time Echointegration tool is called up.

If the user wants to re-use the echointegration parameter settings frequently, he can save them in an *e*cho*i*ntegration *p*arameter **.eip* file using the Save As button. This ASCII file can be edited with a text editor. The Load button loads the parameter settings in the Echointegration dialog box. Note that these *.eip files vary with echosounder type, as they require specific parameters. The user should not forget to edit the parameter settings he wants to change before integrating, notably the output *.hei file name if you do not want to use the default ***HAC*** file name as the *.hei root name. Note that the setting of the echointegration Block(s) is saved in the *.eip file, but it is not applied at loading because the number of runs usually varies from file to file. The default Block setting is one Block containing all the runs of the active ***HAC*** file.

When an *.eip file is loaded, the Echo categories it contains are added to the list displayed in the first tab of the Echointegration dialog box, if these categories are not already listed (from the active categories in the Echo category list), and their check box is checked, i.e., active. If the *.eip file contains categories that are not included in ***CH2*** Echo category list, these categories are added to the ***CH2*** list. **Warning**: ***CH2*** checks for the similarity in the character string of the Echo category names of the *.eip file and the Echo category list. In this case, the comparison is not case sensitive (i.e., "Herring" is the same as "herring") as opposed to the creation of Echo categories (see section 6.4). Special attention should be paid to the spelling of Echo category names, which could result in duplicated Echo categories (e.g., "caplin" and "capelin" would be two different categories for ***CH2***).

8.6.6 Integration

Finally, click on the Integrate button to echointegrate and produce the *.hei file(s). A progress box will appear to monitor the creation of each *.hei file of the echointegration process. Many *.hei files may be generated during echointegration, one for every combination of channel and echointegration Block (see Figure 8-23). These *.hei echointegration files are tab-delimited ASCII text files that can be opened directly by worksheet applications such as Excel® or other packages. The *.hei file format is given in the HEI-format_ver1.3.xls Excel file supplied with ***CH2*** (see Annex 1). The *.hei files contain a long metadata header that describes the echointegration parameter and grid settings, followed by the echointegration results for each echo category that was selected in the General tab of the echointegration dialog box.

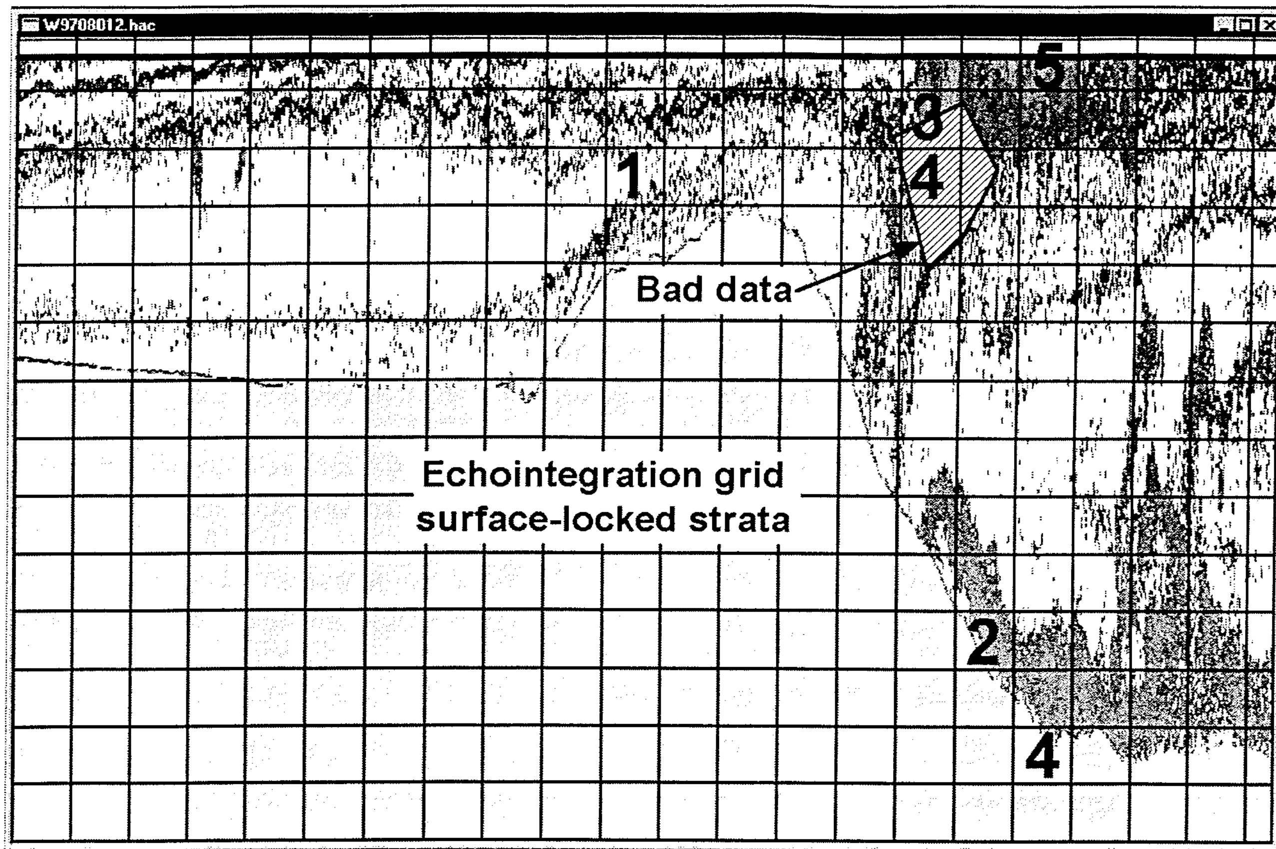


Figure 8-31. Echointegration grid with surface-locked depth strata. The strata limits are given in depth from the surface, not in range from the transducer. The blanking range at the top is added to the transducer installation depth to set the minimum sampled depth, indicated by the horizontal bold line limiting the start depth of the upper stratum. All the other strata limits are still referred to the starting depth of the strata series, not to the minimum sampled depth. The minimum sampled depth can be set at any other depth by changing the Blanking range and/or the Installation depth of transducer in the Channel tab of the Echointegration dialog box. Any echo sample shallower than the minimum sampled depth is ignored (i.e., non existent) for the echointegration. Grid cell #1 is a normal pelagic cell, entirely sampled. Grid cell #2 is a bottom cell, partially sampled because the bottom is intruding. Grid cell #3 is a partially sampled pelagic cell because a portion that contains bad data is considered unsampled. The two grid cells #4 have a very small sampled fraction, which may be considered below the Minimum sampled fraction to echointegrate. Grid cell #5 is partially sampled because it is in a stratum where the start depth is defined by the minimum sampled depth. This minimum sampled depth could be set to another depth in the Channel tab. All strata shallower than this depth will be considered unsampled for echointegration.

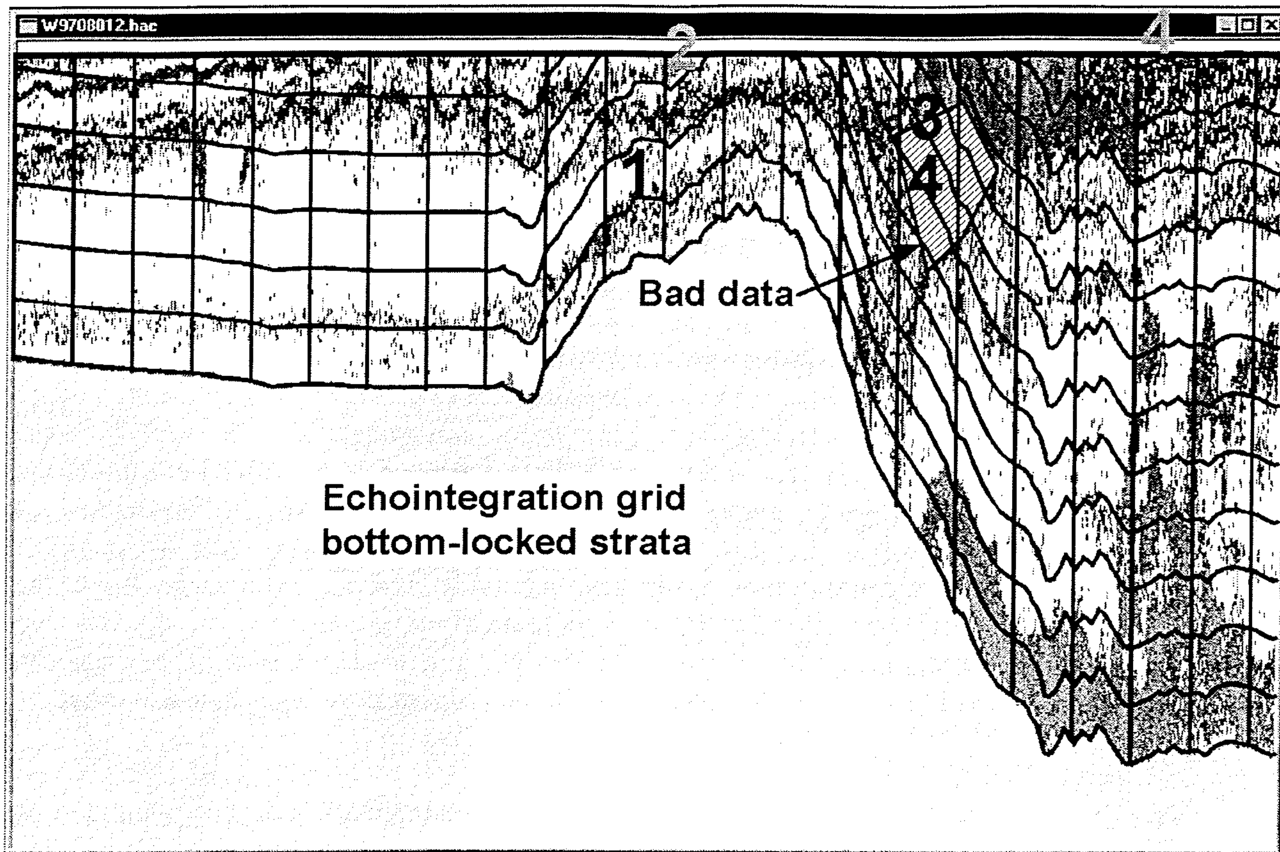


Figure 8-32. Echointegration grid with bottom-locked depth strata. Strata limits are referred to the detected (or edited) bottom depth. Note the blanking range at the top, which is added to the transducer installation depth to set the minimum sampled depth indicated by the horizontal bold line limiting the upper bottom-locked strata for echointegration. This minimum sampled depth can be set at any other depth by changing the Blanking range or the Installation depth of transducer in the Channel tab of the Echointegration dialog box. Any echo sample and strata shallower than the minimum sampled depth is ignored (i.e., non existent) for echointegration. Grid cell #1 is a normal pelagic cell, entirely sampled. Grid cell #2 is a partially sampled surface cell because the minimum sampled depth is intruding. Grid cell #3 is a partially sampled pelagic cell because a portion that contains bad data is considered unsampled. The two grid cells #4 have a very small sampled fraction, which may be considered below the Minimum sampled fraction to echointegrate.

For surface depth strata, the echointegration is computed from the minimum sampled depth down to the strata end depth or to the Detected bottom sample for the depth strata touching the bottom (see Figure 8-31). For bottom-locked depth strata, the echointegration is performed up to the strata end heights or to the minimum sampled depth for the depth strata that contains this depth (see Figure 8-32). For both types of depth strata, the echo sample corresponding to the start limit is included in the stratum and the echo sample corresponding to the end limit is excluded. In a depth strata series, the end sample is the same as the start sample of the next depth strata in the series, and is therefore counted only once. The Detected bottom sample is never included and the Minimum sampled depth sample is always included. The echointegration results are set to the Missing Value code in the *.hei files for all bottom-locked depth strata shallower than the minimum sampled depth and surface-locked depth strata deeper than the bottom. Empty depth strata resulting from the classification of an area as Bad data (e.g., Figure 8-31) are also set to Missing Value code. Bottom-lost pings are ignored for echointegration. To include these bottom-lost pings in the integration, add a detected bottom with one of the ***CH2*** bottom editing tools. Entire steps can sometimes be empty, if they were classified as Bad data, are located in between two runs (e.g., Figure 8-27), or if the detected bottom is below the minimum sampled depth. In such cases all depth strata of the given ping are set to Missing Value code. When the step interval is in pings and the integration Block(s) contain(s) more than one run, the last step of each run is closed by the last pings of the given run and a new step begins at the next run (Figure 8-26). Therefore, in ping interval mode, steps do not overlap from one run to the other.

The echointegration results for each cell of the echointegration grid are computed as follows. If the echo sample units of the ***HAC*** data file are volts, as it is generally the case for the 20 log R TVG detected signal of the analog type of echosounders, voltages (V_{TVG}) are first converted to volume backscattering coefficient s_v (m^2 per m^3, linear units). Often, this backscattering intensity index is also named MVBS (mean volume backscattering strength) in fisheries acoustics literature. When the unit of the echo sample is the volume backscattering strength, S_v in dB re $1m^{-1}$, the volume backscattering coefficient, s_v, is obtained from the conversion: $s_v = 10^{S_v/10}$. The equations for the grid cell are:

$$s_v\,(grid\,cell) = \frac{1}{n} \sum_{n_{\det}} V_{TVG}^2 \bullet A$$

or

$$s_v\,(grid\,cell) = \frac{1}{n} \sum_{n_{\det}} s_v$$

where n_{det} is the number of detected echo samples whose voltage exceeds the value of the time varied threshold at the given range and n is the maximum number of echo samples that could be sampled in the grid cell. The fraction of the cell that cannot be sampled because the bottom (or minimum sampled depth) is intruding into the cell, or because a part of the cell has been tagged as bad data, is excluded from the computation of n. The constant A is the calibration constant (also named echointegration constant). It is computed from the equation:

$$A = \frac{1}{(\pi\ \tau\ c_0\ 10^{SL/10}\ 10^{RS/10}\ BPF)}$$

Its parameters (in SI units) are: the pulse duration, τ (s); the sound speed at range 0, c_0 (m s^{-1}); the source level, SL (dB re 1 µPa @ 1 m); the receiving sensitivity, RS (dB re 1 V); and the beam pattern factor, BPF (unitless). For the EK500, the s_v is expressed differently since Simrad used the formulation of the radar equation instead of the sonar equation used in acoustics.

$$s_v = \frac{1}{n} \sum_{n_{ir}} \frac{P_r\ 32\pi^2}{P_t\ G_0^{\ 2}\ \lambda^2\ c_0\ \tau\ \psi} \bullet G_{TVG}$$

where P_r and P_t are respectively the received and the transmitted power; G_0 is the one-way fixed gain, whose dB equivalent is the S_v transducer gain ($10\ log_{10}\ G$); λ is the sound wavelength (m); ψ is the equivalent beam angle in steradians, called the two-way beam angle (in dB: $10\ log_{10}\ \psi$); and G_{TVG} is the 20 log R TVG. For circular transducers $\psi = BPF \bullet 2\ \pi$, approximately (Urick 1983). The total two-way gain (G^2) in dB is $20\ log_{10}\ G$.

The above calibration parameters come from the Channel and Echosounder tuples of the ***HAC*** data files, unless they were changed in the General and/or the Channel tabs of the echointegration dialog box (sections 8.6.1 and 8.6.2). In that case the range of the echo samples and of the detected bottom is updated using the new sound speed, and the time-varied gain (G_{TVG}) is corrected for the change in sound speed and the absorption coefficient. For the Biosonics type analog echosounder, the constant A is computed using the new parameters when the echo samples are in volts. When the echo samples are in S_v units, a correction is applied. The equations are:

for the Biosonics type analog echosounder:

$$s_{v2} = V_{TVG1}^2 \bullet \frac{G_{TVG2}}{G_{TVG1}} \bullet A_2 \text{, for echo samples in volts}$$

$$s_{v2} = s_{v1} \bullet \frac{G_{TVG2}}{G_{TVG1}} \bullet \frac{A_2}{A_1} \text{, for echo samples in } S_v$$

for the EK500 echosounder:

$$s_{v2} = s_{v1} \bullet \frac{c_{01}}{c_{02}} \bullet \frac{G_{TVG2}}{G_{TVG1}} \bullet \frac{G_1^2}{G_2^2} \bullet \frac{\psi_1}{\psi_2},$$

where the indices 1 and 2 are, respectively, for logging at acquisition and processing for echointegration. The range-dependent G_{TVG} correction, ΔG_{TVGr2}, adjusting the TVG to the characteristics of the propagation medium is given by:

$$\Delta G_{TVG\,r2} = \frac{G_{TVG2_{r2}}}{G_{TVG1_{r1}}} = \frac{c_2^2}{c_1^2} \bullet e^{2(b_2 r_2 - b_1 r_1)}, \text{ (c.f. development in Annex 2)}$$

$$\text{where } r_2 = r_1 \frac{c_2}{c_1}$$

where b is the absorption coefficient in nepers m^{-1}, computed from the absorption coefficient α in dB km^{-1} of the ***HAC*** Channel tuple ($b = (\alpha / 1000) / 10 \log_{10} e$).

The correction related to changes of source level, pulse duration, sound speed at range 0, receiving sensitivity, and beam pattern is not range dependent and is given by:

for the Biosonics type analog echosounder:

$$s_{v2} = s_{v1} \bullet \frac{A_2}{A_1}$$

$$s_{v2} = s_{v1} \bullet \frac{\dfrac{1}{(\pi\, \tau_2\, c_{0_2}\, 10^{SL_2/10}\, 10^{RS_2/10}\, BPF_2)}}{\dfrac{1}{(\pi\, \tau_1\, c_{0_1}\, 10^{SL_1/10}\, 10^{RS_1/10}\, BPF_1)}}$$

$$s_{v2} = s_{v1} \bullet \frac{(\tau_1\, c_{0_1}\, 10^{SL_1/10}\, 10^{RS_1/10}\, BPF_1)}{(\tau_2\, c_{0_2}\, 10^{SL_2/10}\, 10^{RS_2/10}\, BPF_2)}$$

$$s_{v2} = s_{v1} \bullet \frac{\tau_1}{\tau_2} \bullet \frac{c_{0_1}}{c_{0_2}} \bullet \frac{BPF_1}{BPF_2} \bullet 10^{(SL_1 - SL_2 + RS_1 - RS_2)/10}$$

for the EK500 echosounder:

$$s_{v2} = s_{v1} \bullet \frac{c_{0_1}}{c_{0_2}} \bullet \frac{G_1^2}{G_2^2} \bullet \frac{\psi_1}{\psi_2}$$

$$s_{v2} = s_{v1} \bullet \frac{c_{0_1} \bullet (10^{Sv\,transducer\,gain_1/10})^2 \bullet 10^{two-way\,beam\,angle_1/10}}{c_{0_2} \bullet (10^{Sv\,transducer\,gain_2/10})^2 \bullet 10^{two-way\,beam\,angle_2/10}}$$

$$s_{v2} = s_{v1} \bullet \frac{c_{0_1} \bullet 10^{Sv\,transducer\,gain_1/5} \bullet 10^{two-way\,beam\,angle_1/10}}{c_{0_2} \bullet 10^{Sv\,transducer\,gain_2/5} \bullet 10^{two-way\,beam\,angle_2/10}}$$

$$s_{v2} = s_{v1} \bullet \frac{c_{0_1}}{c_{0_2}} \bullet 10^{((Sv\,transducer\,gain_1 - Sv\,transducer\,gain_2)/5)+((two-way\,beam\,angle_1 - two-way\,beam\,angle_2)/10)}$$

where the *SL*, *RS*, S_v *transducer gain* and the *two-way beam angle* are in dB. As mentioned in section 8.1, in this version of ***CH2***, the medium is assumed homogeneous and the sound speed is the same at all ranges (i.e., $c_0 = c$). For the EK500, there is no correction of the pulse duration since it is not applicable. The EK500 computes the S_v using the right pulse duration corresponding to the nominal pulse lengths chosen by the user at acquisition. In the case of Biosonics-type analog echosounders, the pulse duration is indicated by the user at acquisition with ***CH1*** and could be changed later to compute the right s_v if the value stored in the ***HAC*** data file was wrong.

In the case of the EK500, an additional correction could be applied to s_{v1} to take into account a systematic error occurring during calibration in early versions (≤ ver. 5.2) of the EK500 (Fernandez and Simmonds, 1996). This error relates to an inaccurate estimation of the range to the target, because the receiver delay was ignored, and to an improper TVG start time over the pulse length. The range-dependent correction factor from equation 8 of Fernandez and Simmonds (1996), $C_{rdstd\,r}$, is called correction for receiver delay and TVG start time delay. The equations are:

$$s_{v2} = s_{v1} \bullet C_{rdstd\,r}$$

$$\text{where } C_{rdstd\,r} = \left(\frac{r_m \bullet (1 + \frac{\Delta r_g}{r_{sph}})}{r_{sph} \bullet (1 + \frac{\Delta r_g}{r_2})} \right)^2,$$

$$\text{where: } r_{sph} = r_m - \frac{(c_{cal} \bullet t_{del})}{2}$$

$$\Delta r_g = \frac{(c_{cal} \bullet t_g)}{2}, \text{ where } t_g = t_{del} + \frac{\tau}{2}$$

The above equation is a simplification of Fernandez and Simmonds' (1996) equation 8, which retains only the significant range terms. In Fernandez and Simmonds' (1996) notation, r_m (m) is the range measured on the EK500 to the calibration sphere, r_{sph} (m) is the actual range to the calibration sphere, and t_{del} (s) is the receiver delay. c_{cal} is the sound speed at calibration, which is assumed to be equal to c_0 in this version of ***CH2***. The pulse duration (τ) used by ***CH2*** for computing the Fernandez and Simmonds' (1996) correction is the one corresponding to the "medium" nominal pulse length recommended by Simrad for the EK500 calibration. These pulse durations vary with frequency as follows: 12 kHz, 3.0 ms; 18 kHz, 2.0 ms; 27 kHz, 1.5 ms; 38 kHz, 1.0 ms; 49 kHz, 1.0 ms; 120 kHz, 0.3 ms; 200 kHz, 0.2 ms.

The area backscattering coefficient s_a (unitless, m^2 m^{-2}) for each cell of the echointegration grid is obtained from s_v and the mean sampled height, $\bar{h}_s$ (m), for that cell. This $\bar{h}_s$ differs from the depth strata thickness in the grid cells where a fraction of the depth strata has not been sampled, either because the bottom or the minimum sampled depth is intruding into the strata. The general equation is:

$$s_{a\,(grid\,cell)} = \bar{h}_{s\,(grid\,cell)} \bullet s_{v\,(grid\,cell)}$$

When a grid cell has not been sampled or the sampled fraction is less than the minimum sampled fraction of the grid cell to be echointegrated, then the s_v or s_a for this cell is assigned the Missing Value code.

Besides the s_a or s_v results of each echointegration grid cell and Echo category, the *.hei file reports the number of pings, the starting co-ordinates, the starting drift-corrected PC time, and the linear distance covered for each echointegration step (see section 8.6.3). The geographic co-ordinates are interpolated from the GPS positions and ping times, or the start or end of run times, of the original or edited tuples of the ***HAC*** file. The linear distance covered during the steps is the distance computed from the two limit points of the step. Note that this is not the cumulative distance resulting from the sum of the inter-ping distances plus the remaining segments up to the step limits. This latter distance would generally be in error, due to the summation of proportionally large errors in distance estimates between successive GPS positions recorded at relatively short time-space intervals. The starting Cartesian co-ordinates and the linear step distances are given in metres although, as mentioned in section 8.6.3, they would be in other units if the earth radius of the Lambert projection was given in other units. This change of units would also affect the computed sailing speed (see below). The linear step distance (m) is then divided by the time interval of the step (s) and the result is divided by 0.5148 m s^{-1} knots to get an estimate of the average sailing speed in knots for the step. The average bottom depth of the step is computed from the original or edited detected bottom range of the pings of the step, corrected for the eventual change in sound speed.

An additional line of results follows the report of the echointegration step results for each Echo category (see Annex 1, description of the *.hei format). This line either terminates or summarises the column results for the whole echointegration Block of runs and gives, in order, the end time and spatial co-ordinates, the total number of pings, and the linear distance between the start and end limits of the Block. This distance can be compared with the cumulated distance obtained by summing the linear step distances (the adjacent field). **Warning**: Steps with no pings are ignored. In the case of multiple-run Blocks integrated in ping interval mode, the cumulated distance does not include the gaps between the runs (see Figure 8-26). Except for these cases, the step-cumulated distance should be longer than the linear distance for the Block, especially if the ship's course significantly deviated from a straight line. The step-cumulated distance is used with the next column field, the total time of the whole Block, to compute the mean sailing speed over the Block. The average bottom depth for the Block that follows is simply the average of the mean depths of the non-empty steps. Then the average s_v or s_a for the whole Block for each depth strata and the whole water column are computed from the step s_v or s_a weighted by the step distance. Since most echointegration processes are carried out to produce estimates over specific areas or volumes, the distance is the most relevant weighting variable. Subsequent versions of ***CH2*** should allow the users to choose the weighting variable (ping, time, or distance). If the ***HAC*** file has less than two positions, the average s_v or s_a for the Whole block will not be computed and the Missing Value code will be reported. A Missing Value will also be reported in the Whole block line for any depth strata where a Missing Value was reported for all steps.

8.7 Tools / Options

This menu sets the default options for ***CH2***, specifically the view preferences in the present ***CH2*** version. When an ***HAC*** data channel is opened, the echogram is displayed with its specific

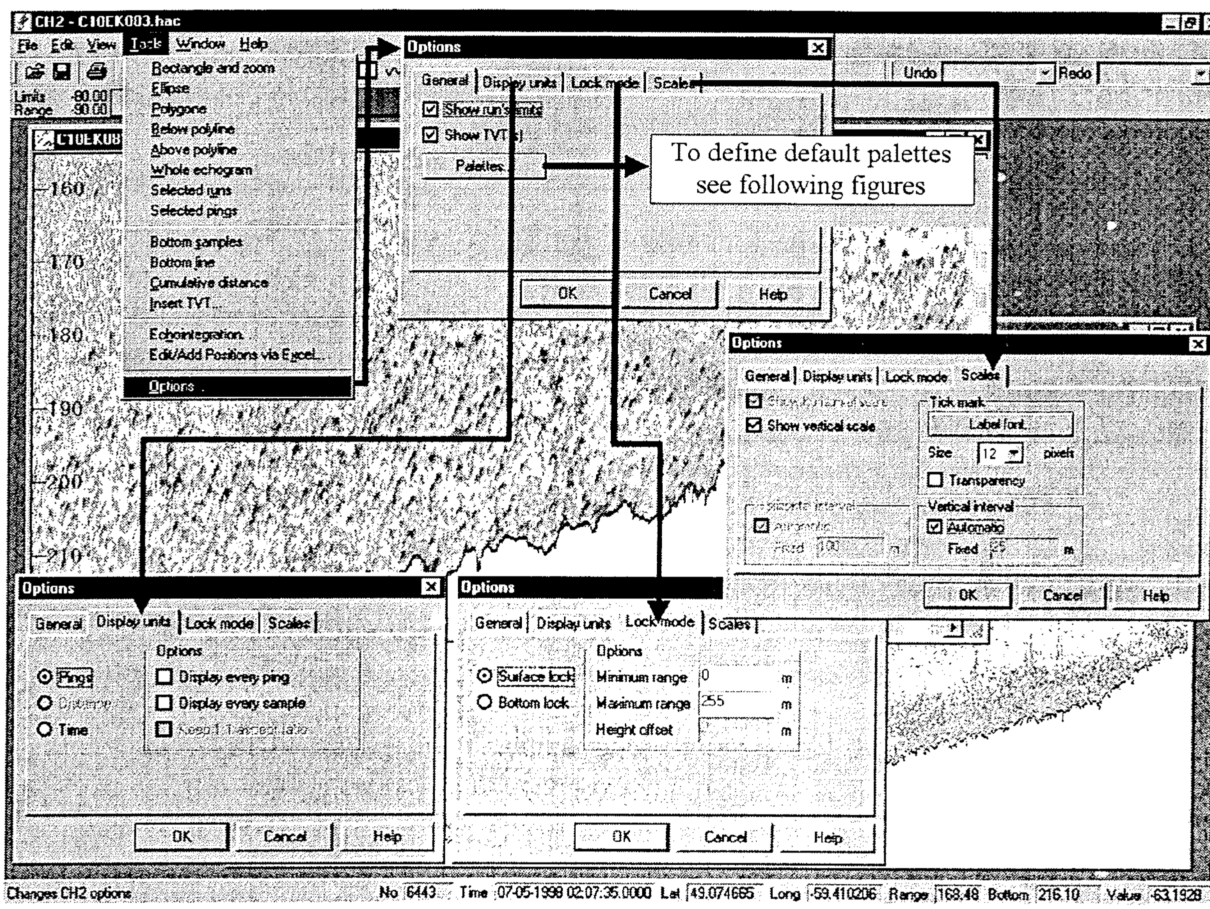


Figure 8-33. Tools/Options menu to set the echogram default view options.

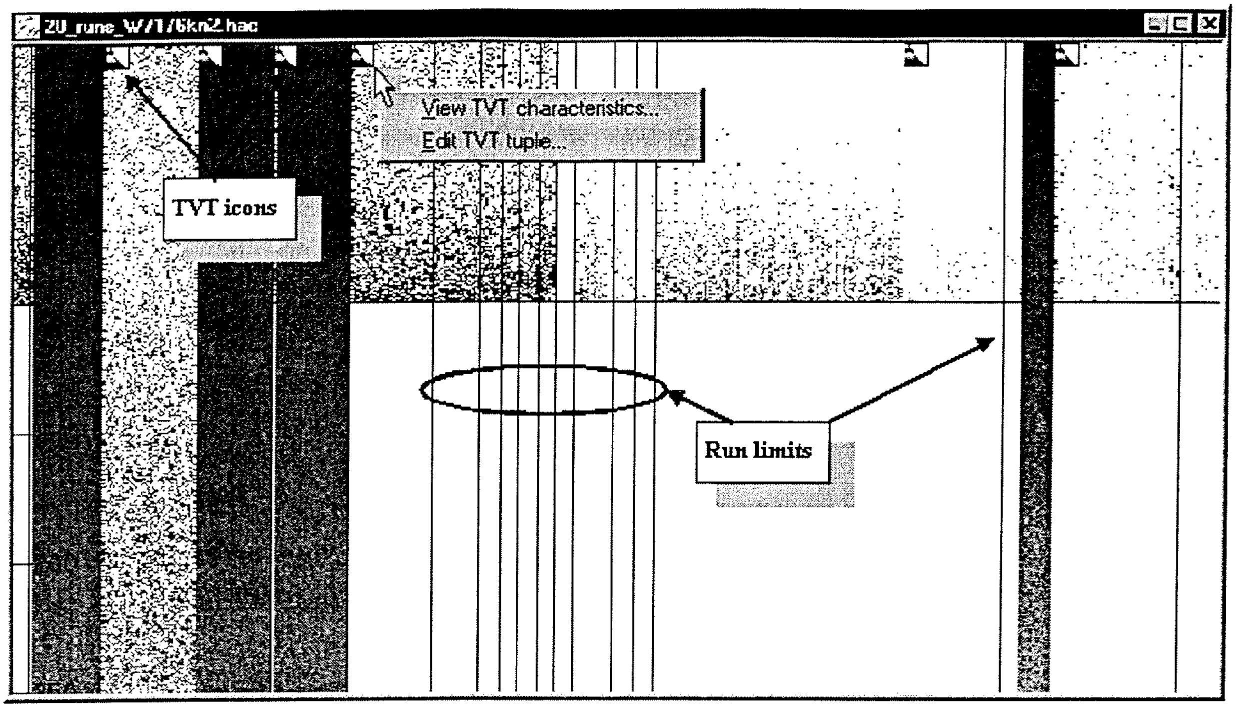


Figure 8-34. Echogram with 20 runs with the Show TVT and the Show run's limits options activated. Note that the TVT editing or visualisation can be accessed by a right click on the mouse when pointing on a TVT icon.

default view options, defined in the four tabs of the Tools / Options dialog box (Figure 8-33). The View / Properties menu (section 7-19) must be used to change the view option for the active echogram only. The General tab has two check-boxes offering the options to show the Run limits with a vertical black line and to display an icon where the TVTs are inserted (except the initial TVT at the beginning of the echogram) (Figure 8-34). The Palettes button accesses the dialog box showing the default palettes used by ***CH2*** to display the echo samples in volts, S_v, or TS (dB), depending on the data channel (Figure 8-35). The Auxiliary palette is used to display all other data channels. Note that palettes are echogram properties and can be changed at any time from the Edit / Palette menu (see section 6.1). Palettes can be stored in *.pal binary files and can be recalled using the Load button of the palette dialog box (Figure 8-35). The Default palettes can be edited from the Edit button, which calls the Palette editor dialog box (Figure 8-35, see section 6.1).

The Tool / Options second tab parameters define the echogram X-axis default units and some display constraints. The echograms can be displayed with the ping sequence, time, or distance as the X-axis units. When Pings is selected, the user has the possibility to add two constraints to the viewing preferences: to display every ping and every echo sample. This is to insure that all pings and echo samples will be visible when scrolling through the echogram, not only those that the window size and pixel resolution allow to view. The Display every ping option is useful when checking the detected bottom depth. When Distance is selected, the additional option forcing the X- and Z-axes to the same scale is offered (keep 1:1 aspect ratio) , which is useful for accurately visualising the shape of fish school vertical cross-sections. **Warning**: For this option works properly, the position data must be exempt of noise and the sailing speed must be a smooth function.

The Tool / Options third tab parameters set the Z-axis default view mode (surface-lock or bottom-lock), the default view range or height above bottom according to the selected mode, and the height offset. Radio buttons set the default view mode to surface-lock or bottom-lock. A check-box then activates or deactivates a user-defined Default view range or height. In the unchecked case, the echograms are opened with the full view range or height. The values entered in the Minimum and Maximum range (or height) fields define the Default view range or height, which can be recalled through the View / Default view range menu or mouse right button (see section 7-9). When these two filed are put to zero, the Default view range or height becomes the full view range or height. When the Default view range or height check box is checked, all echograms are opened with the Default view range or height defined by the Minimum and Maximum range (or height) fields. In the bottom-lock mode, an optional Height offset can be set for distancing the detected bottom from the echogram window bottom, for greater visibility of the bottom zone. When the Default view range or height check-box is not activated, the echograms are automatically displayed down to the maximum detected range (or up to the maximum height above bottom) unless the constraint to Display every sample is selected in the Display units tab.

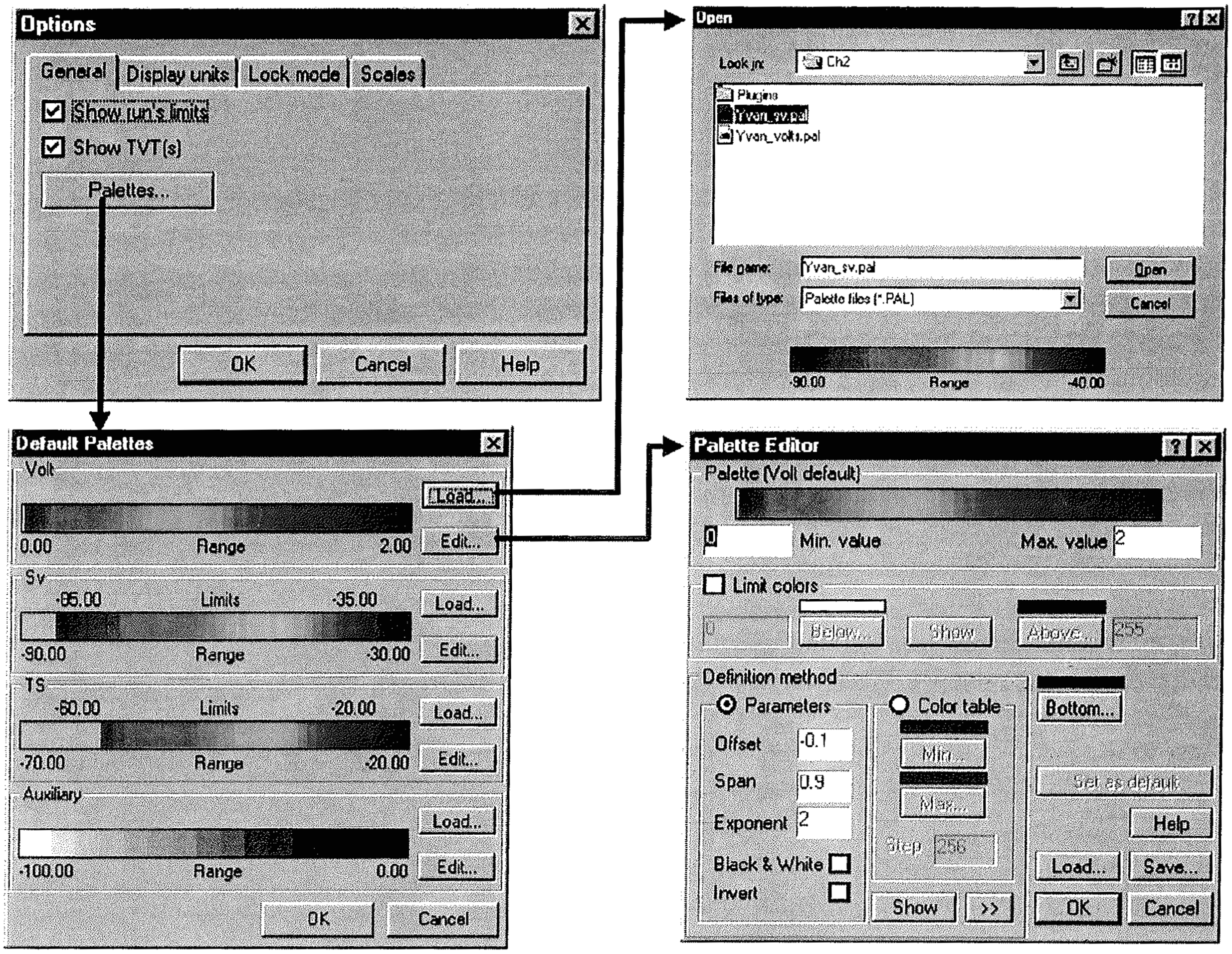


Figure 8-35. Tools / Options / General tab Palette button to set the default palettes associated to the various channel data types.

The Tools / Options last tab check-boxes activate or deactivate the horizontal and vertical scale display by default on the echograms. The other parameters configure the display format. The vertical tick interval is determined automatically by ***CH2*** as a fraction of the visualised range interval, which is the recommended operation mode. However, the user can set the tick interval to a preferred constant value. The tick mark size can be selected from the scroll box. If he chooses the All option, continuous lines will be drawn on the echogram instead of a tick. The font and colour properties of the tick label are determined from the Label font button. The chosen scale options become the ***CH2*** default scale options by a click on the Set as default button. This dialog box is also accessible from the Tools / Options menu.

9. UNDO/REDO OPERATIONS

Undo scroll box	To undo a series of editing/classification operations starting from the selected operation from the scroll list.
Redo scroll box	To redo a series of editing/classification ending with a selected operation in the scroll list.

The Undo and Redo operation functions are two of the main ***CH2*** attributes for effective hydroacoustic data editing. All the editing/classification operations done during an editing session or previously saved in an edited ***HAC*** file can be undone. Therefore, if the user has to

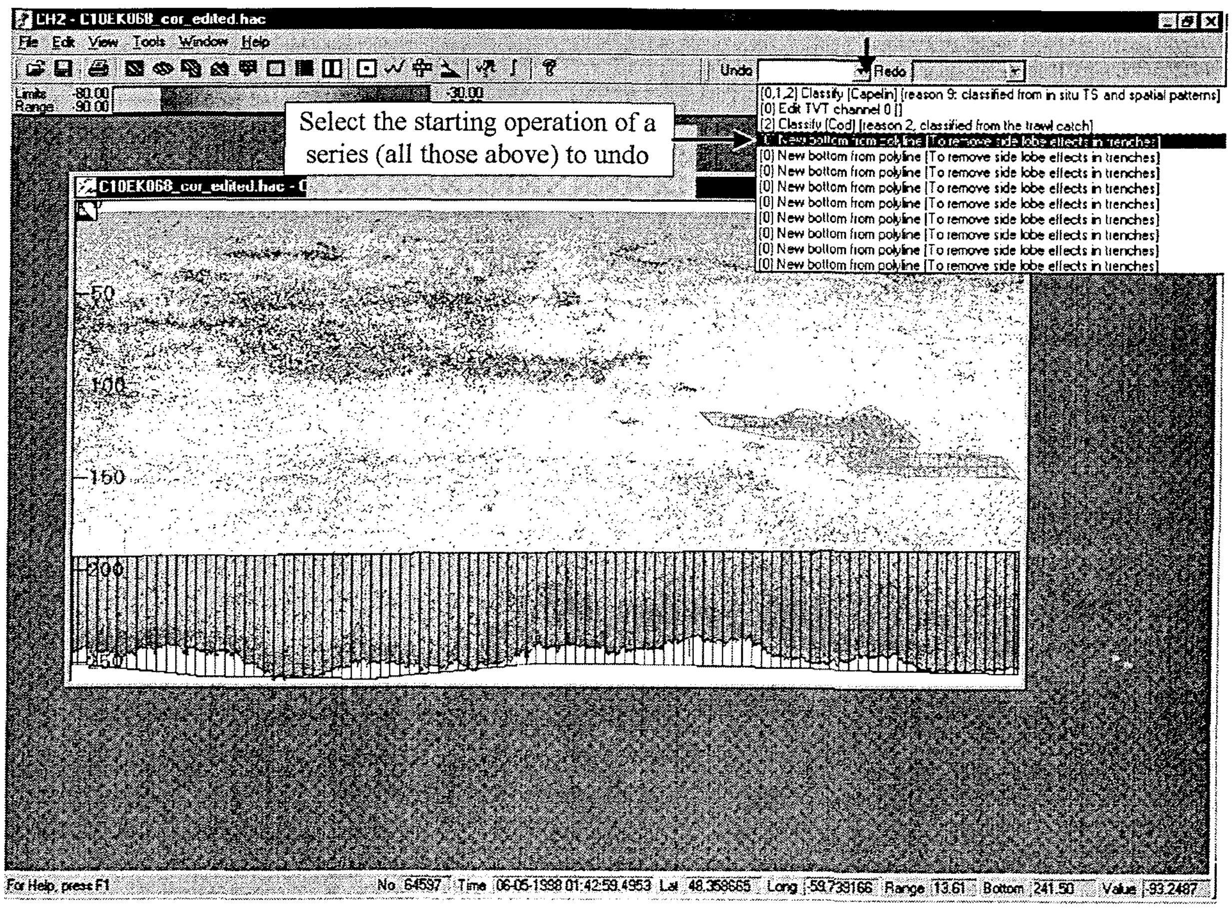


Figure 9-1. Example of the Undo function. The Undo scroll box lists all operations the ***HAC*** file contains. By selecting an operation from that list and releasing the mouse button, the operation is undone with all other subsequent operations. Here the two Classify operations, the Edit TVT and the Move bottom operations will be undone. The undone operations are placed in the Redo list.

modify the data processing for any reason, he can go back to any file editing state by using the Undo function. The Undo and Redo operation functions provide a convenient tool for exploring the effects of various editing operations. Since all the editing/classification operations are applied in sequence, some of them may require prerequisite operations to be applied before they themselves are applied. Inversely, the application of some operations can prevent the application of other subsequent operations. For example, a Classify operation on a region for which an Exclude all signals operation has been performed has no interest. Because of these linking conditions, this version of ***CH2*** can only undo or redo the operations in the sequence they were initially performed. Subsequent versions should allow certain selected operations to be undone independently from within the Undo list.

To undo the last operation or the last series of operations, scroll the Undo list and select the starting operation of the series and release the mouse button (Figure 9-1). The Undo list is

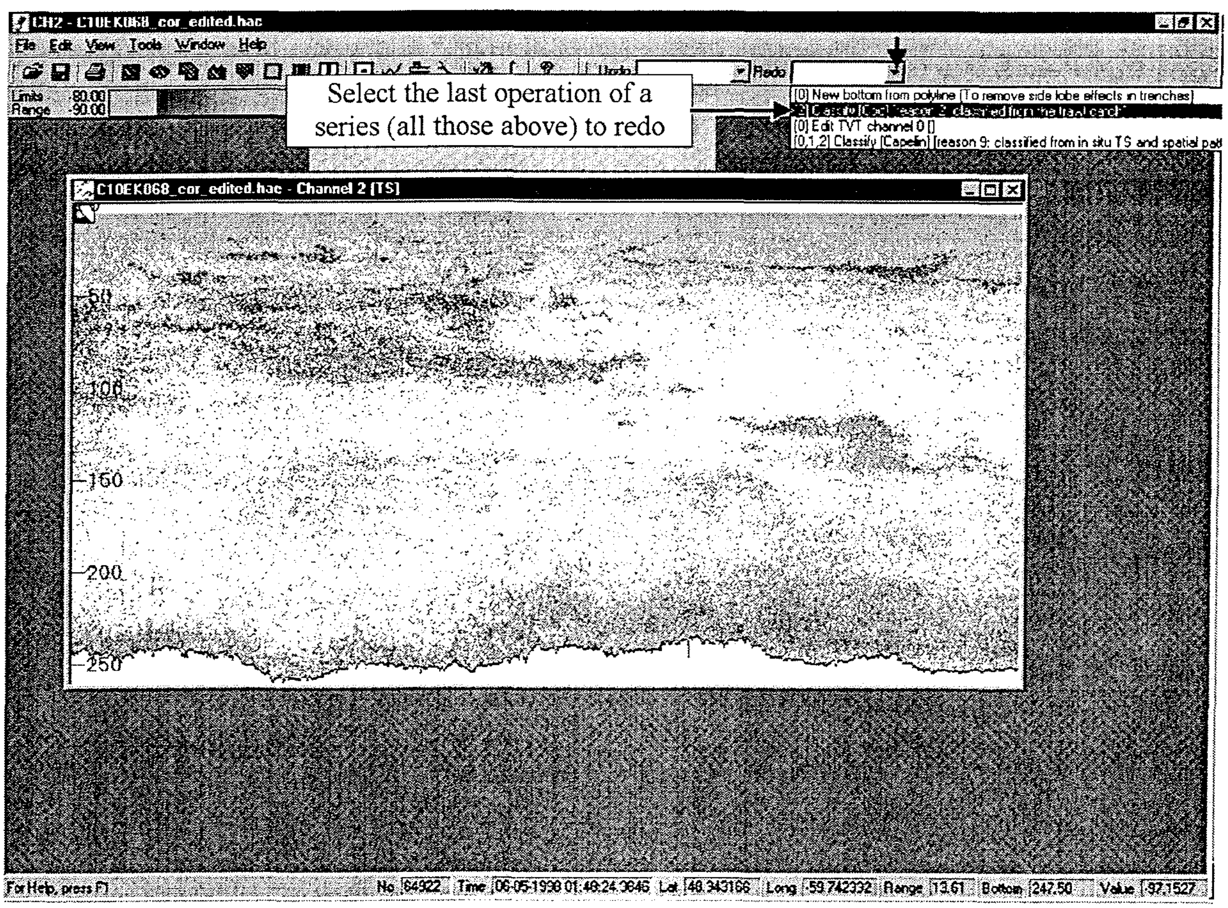


Figure 9-2. Example of the Redo function. The Redo scroll box lists the undone operations that can be redone. By selecting an operation from that list and releasing the mouse button, the operation is redone with all other preceding operations. Here the Classify (Cod) and the Move bottom operations will be undone. The undone operations are placed in the Redo list.

presented in the inverse order from which they were done, the last applied operations being at the top of the list. The channel numbers to which the operation applies is indicated in the brackets before the operation name. All undone operations will be placed in the Redo operation list, in the sequence that they were initially created in. They will remain there until a new operation is applied, which will create a new applied operation sequence. This breaks the possibility to redo the undone operations, because of the above-mentioned linking conditions. The Redo operation list is thus erased when a new editing/classification operation is applied to the file.

To redo an undone operations from the Redo list, scroll the list, select the last operation of the series to redo and release the mouse button (Figure 9-2). The Redo list presents the operations in the sequence they were done in, the first applied operations being at the top of the list.

When ***CH2*** saves an edited ***HAC*** file, only the tuples of the operations in the Undo list are appended to the file, the undone operations of the Redo list being ignored and erased from the list.

10. WINDOW MENU

10.1 Window / Cascade

Overlays the channel windows.

10.2 Window / Tile horizontal

Tiles the channel windows horizontally.

10.3 Window / Tile vertical

Tiles the channel windows vertically.

10.4 Window / Arrange icons

Arranges the icons of the minimized channel windows.

10.5 Window / List of open documents

Lists the open ***HAC*** channel windows. The active one is marked.

11. ERROR MESSAGES AND TROUBLESHOOTING

11.1 *HAC* file errors

The seven error checks of the File / File checking options menu (see section 5.9) are described below. All these errors can be corrected by ***CH2***, when a ***HAC*** file is opened and the File checking options manager and the respective error check-boxes are activated, or by the ***HAC-trafic*** File / File checking options / Fix utility. The correction results in the creation of a file-root-name.log file and a new ***HAC*** file with the "_cor" characters added to the original root name. These files are stored in the Working directory chosen in the File checking option dialog box.

11.1.1 Signature validation

The Signature validation plugin checks for the presence of the ***HAC*** signature tuple and verifies the validity of its structure. If this test fails, the file is not a ***HAC*** file and its opening aborts after the message "Invalid HAC file: ..." is displayed.

11.1.2 Edition tuple integrity

The Edition tuple integrity plugin verifies the structural integrity of the other tuples in the file A specific error was produced in the Edition Tuple when the tuple-size field was incorrectly calculated by earlier versions of ***CH2*** (before ver. 1.5). This plugin recalculates this field and replaces it in the Edition tuple.

11.1.3 Ping order

The Ping order plugin checks for the continuous increase of the ping number within the file. The ping numbering could be out of ascending order in certain files created by ***CH1*** (previous to ver. 2.0) when the ping number reached 66536 (16 bits) and the following ping number was set to 0. The plugin corrects this error by renumbering the pings, starting from the first ping of the file.

11.1.4 Time synchronisation (second vs decimal)

The Time synchronisation (second vs decimal) plugin checks for the synchronisation of the seconds and the decimal fractions among ping tuples in EK500 ***HAC*** files. This error was produced by ***CH1*** (previous to ver. 2.0) because the CPU time (hh:mm:ss) saved in the ping tuples was determined from the computer clock, and the fraction of a second was determined from the EK500 ping telegram. Since these clocks were rarely synchronised, this sometimes produced a non-monotonic increase in the ping time stamp, especially if the ping rate was not a multiple of 1 second. The plugin corrects the error by reassigning the CPU time in each ping tuple according to the synchronised time interval between each ping. Since ver. 2.0 of ***CH1***, the ping CPU time (hh:mm:ss.dd) is determined entirely by the computer clock.

11.1.5 Time variation (warning)

The Time variation (warning) plugin checks for variations of more than 10% from the most frequent ping interval in the file and issues a warning. This may reveal an error in the file or the use of a variable ping rate at acquisition (e.g., EK500 option for maximum ping rate according to bottom depth).

11.1.6 Pings within run limits

The Pings within run limits plugin checks for the presence of pings outside of the Run limits indicated by the Start of run and End of run tuples of the ***HAC*** file. This error occurred because ***CH1*** (previous to ver 2.0) was using two different methods for determining the CPU time for the Ping tuple and the Start of Run and End of Run tuples. The plugin corrects the error by reassigning the Start of Run and/or End of Run tuple CPU time to the value of the time of the first and/or last ping in the run, respectively, and the End of File tuple to the value of the last ping in the file. Since ver. 2.0 of ***CH1***, the same method is used for determining CPU time for all tuples.

11.1.7 Old TVT equation used (warning)

The Old TVT equation used (warning) plugin checks whether a previous (erroneous) equation was used by ***CH1*** for the estimation of the TVT offset and amplification parameters in the EK500 ***HAC*** files. If the old parameters are found, the parameters of the present TVT equation are estimated if the user accepts to correct this error (recommended), and the old TVT parameters are replaced in the TVT tuple, whose attribute field is coded as edited.

11.2 GPS position

11.2.1 X axis distance view mode

Trouble: The echogram displays very broad pings when the X axis view mode is in distance.

This occurs when some positions are in error. Correct the erroneous positions with the Edit/add positions via Excel tool to correct this data problem.

11.2.2 X axis distance view mode with the keep 1:1 aspect ratio option

Trouble: The pings displayed on the echogram have highly variable widths.

This results from noisy position data that were acquired with a high rate. The variable ping width reflects the position data error. Correct the positions by smoothing them to get a reasonable sailing speed with the Edit/add positions via Excel tool, before using this keep 1:1 aspect ratio option or the X axis distance view mode.

11.2.3 Positions lacking

Trouble: The echogram displays variable long pings when the X axis view mode is in distance.
X axis distance view mode is not available nor is the echointegration option along distance steps.

These options cannot be used when positions are lacking. Use the Edit/add positions via Excel tool to add positions that ***CH2*** can use to compute distances.

11.3 Viewing classified or excluded regions

11.3.1 Alignment of mask shapes over the selected echo samples

Trouble: The colour-masked classified echo samples or the excluded echo samples do not correspond exactly to the mask shape superimposed on the classified or excluded region.

If your echogram display mode is not Time, this could result from irregularities in the ping intervals in this region or gaps in the ping time series. Change the display mode for Time in the View / Properties or Tools / Options menus to show the exact location of the classified region. Note that ***CH2*** computes the polygons and selects the echo samples in the time domain.

11.3.2 Loss of the hatched region shape

Trouble: The hatching of classified regions has disappeared and access to the characteristics of the operations for this region from the right mouse button is not available.

The hatched shapes of classified or excluded regions are only visible in the display mode in which they were defined, either relative to the surface (surface-lock mode) or relative to the bottom (bottom-lock mode) . Change to the alternate display mode if you want to see the hatched shape and have access to the characteristics of the operations for this region from the right mouse button.

12. ACKNOWLEDGMENTS

We wish to thank colleagues from the Department of Fisheries and Oceans who contributed to the improvement of this software by their comments and assistance, or as beta testers. We are grateful to Martin Castonguay, Diane Lavoie, and Laure Devine for revision of this manual. Anne-Marie Cabana helped with the preparation of figures and word processing. This work was funded by the National Hydroacoustic Program of the Canadian Department of Fisheries and Oceans.

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14. ANNEX 1: The *.hei echointegration ASCII file format

Table 1. Description of the *.hei ver 1.3 ASCII file ***CH2*** outputs for the echointegration results.

Part of the file	Tag	Field description		Data example	Field description	Data example	Comments
	Signature	**HEI file signature**		*HEI*			HEI = Hydroacoustic EchoIntegration
	HEI version	**HEI-Data format version**		*1.3*			Fisheries & Oceans Canada, National Hydroacoustic Program
GENERAL HEADER	Original source file	**Original raw data source file**		*creed_98_13_001.hac*			***HAC*** file format
	Edited source file	**Edited file used for integration**		*creed_98_13_001e01.hac*			***HAC*** file format
	Integration software	**Integration software**		*CH2*			Fisheries & Oceans Canada, National Hydroacoustic Program
	Software version	**Version (of software)**		*2.0*			Version of November 2000.
	Remark	**Remark**		*any comment*			From the ***CH2*** echointegration dialog box
	Related HEI files	**Additional HEI files corresponding to the other channels and/or run blocks of the source file, simultaneously echointegrated with the present one**		*cr_98_13_c1_b2.hei* *cr_98_13_c1_b3.hei* *cr_98_13_c1_b4.hei ...*			
	Echosounder type	**Echosounder type**		*Biosonics 102*			*NB: for the EK500, some of the next lines of this *.*hei* file will contain information
	Sound speed		**Sound speed of the (original or edited) Channel tuple (m/s)**	1460	**Sound speed used for echointegration (m/s)**	1473	"
	Alpha		**Alpha of the (original or edited) Channel tuple (dB/km)**	34.7	**Alpha used for echointegration (dB/km)**	26.2	"
	Alpha & SS profile				**Ascii file of alpha & sound speed profile used for echointegration (dB/km)**	alpha-ssp03.prn	This is a feature not implemented in Ver. 2.0 of ***CH2***, but could be implemented in the future versions
	STD profile				**Ascii file of temperature and salinity profile used to compute alpha & sound speed profile used for echointegration (dB/km)**	T_S_p.prn	"
	Min. sampled fraction of grid cell to echointegrate			10			Minimum fraction (%) of the grid cell that must have been sampled for computing the s_v or s_a. When the bottom or the minimum sampled depth is intruding in the cell or the "bad data" category occupies a large proportion of it, the sampled fraction could become too low to compute a reliable estimate for this cell. In such a case, when the sampled fraction is lower than the given percentage, the s_v or s_a will not be estimated for this cell and a Missing Value code will indicate a missing value.

Table 1. Continued.

Part of the file	Tag	Field description		Data example	Field description	Data example	Comments
	Echointegration cell coding for Missing Values			-9999.99			Code used by ***CH2*** to report echointegration missing values for echointegration cells below the detected bottom, cells above the minimum sampled depth, cells with bad data, or cells where the sampled fraction was lower than the Min. sampled fraction of grid cell to echointegrate. By default ***CH2*** uses the Missing Value code "NaN" (for Not a Number).
	Channel no.	Channel	no.	*01*			NB: there is only one channel per ****.hei*** echointegration file. Multichannel echointegration results in many echointegration files.
	Frequency		freq. (kHz)	*120*			
	Pulse duration3		pulse duration of the (original or edited) Channel tuple (ms)	*0.5*	Pulse duration used for echointegration (ms)	*0.5*	Here the user has the possibility to integrate using parameters that are different from those of the (original or edited) tuples of the ***HAC*** file.
	Source level		SL of the (original or edited) Echosounder tuple (dB)	*221.5*	SL used for echointegration (dB)	*225.0*	"
	Beam pattern factor		Beam pattern factor (Bav^2 or BPF) of the (original or edited) Channel tuple Value of B square (linear): 10 log (1/beam pattern factor). Approximation for a circular transducer of active diameter d: Bav^2 or BPF= $(\lambda / \pi d)^2$	*.0035*	Beam pattern factor (Bav^2 or BPF) of the (original or edited) Channel tuple Value of B square (linear): 10 log(1/beam pattern factor). Approximation for a circular transducer of active diameter d: Bav^2 or BPF= $(\lambda / \pi d)^2$	*.0035*	"
	Directivity index		Directivity index (DI) corresponding to the beam pattern factor of the (original or edited) Channel tuple (10 log (1/beam pattern factor). Approximation for a circular transducer of active diameter d: DI=10 log $(\pi d / \lambda)^2$	*24.56*	Directivity index (DI) corresponding to the beam pattern factor of the (original or edited) Channel tuple (10 log (1/beam pattern factor). Approximation for a circular transducer of active diameter d: DI=10 log $(\pi d / \lambda)^2$	*24.56*	"
	Two-way beam angle		Two-way beam angle (i.e., 10 log ψ) of the (original or edited) Channel tuple in dB for the EK500	-26.7	Two-way beam angle (i.e., 10 log ψ) of the (original or edited) Channel tuple in dB for the EK500	-26.7	"
	3-dB beamwidth alongship		3-dB beam width alongship of the (original or edited) Channel tuple (degree)	3.3		3.3	

Table 1. Continued.

Part of the file	Tag	Field description		Data example	Field description	Data example	Comments
	3-dB beamwidth athwartship		3-dB beam width athwartship of the (original or edited) Channel tuple (degree)	3.3		3.3	
	Receiving sensitivity		VR of the (original or edited) Channel tuple (dB)	-143.2	VR used for echointegration (dB)	-145.7	"
	Sv transducer gain		Sv transducer gain of the (original or edited) Channel tuple for the EK500	26.5	Sv transducer gain used for echointegration for the EK500	27.4	"
	Receiver delay				Receiver delay (ms)	0.39	Optional field. This delay in ms is to correct for improper receiver delays used in the EK500 versions lower than version 5.3 during calibration with a standard sphere. (Tdel of Fernandes and Simmonds 1996, ICES CM 1996/B:17.)
	Recorded range to sphere				Recorded depth to sphere (m)	10	Optional field related to the previous one. Range recorded during the calibration with a standard sphere to use to compute the correction.. (rm of Fernandes and Simmonds 1996, ICES CM 1996/B:17.)
	Receiver bandwidth		Receiver bandwidth used during acquisition (kHz)	5			"
	Installation depth of transducer		Transducer installation depth of the (original or edited) Channel tuple (m)	6	Transducer installation depth used for echointegration (m)	4.5	This field is giving the offset between the depth and the range. It is used at many places in *CH1* and *CH2*.
	Blanking range		The range (m) from the transducer for which the data were either not output by the echosounder or not acquired by *CH1*, as indicated in the Echosounder tuple (only for the Biosonics 102 analog echosounder type)	2.5	The range (m) from the transducer for which the data were not recorded by *CH1* and/or ignored by *CH2* for echointegration as given in the dialog box	10	The sum of this field + the installation depth gives the minimum sampled depth, where the echointegration can start.
	Echointegration Sv threshold				Echointegration threshold (S_v in dB)	-60	All echo samples below this threshold are handled as having a null backscattering coefficient. By default *CH2* does not use any echointegration threshold by setting this field to an extremely low level (-200 dB).
SPACE-TIME INFORMATION ON THE INTEGRATION GRID	Time difference between PC clock and GMT	Average time difference in seconds between the PC clock and GMT as computed from GMT and CPU times of the Position tuples :		12600			This field gives the average time offset of the PC clock relative to the universal time (GMT). If the PC clock was set to the local time, this time offset gives local time lag relative to the univeral time.

Table 1. Continued.

Part of the file	Tag	Field description		Data example	Field description	Data example	Comments
	Time offset of PC clock	Time offset of the PC clock as estimated from GMT and CPU times of the Position tuple (s) :		183			If the lag between CPU and GMT times of the Position tuples is not zero or a multiple of 30 min (1800 s), the PC clock was not properly set at acquisition or drifted since its last setting. ***CH2*** will correct for this error (here 183 s) for determining the time of the horizontal echointegration steps. The lag used by ***CH2*** is the average lag for the whole file computed over all Position tuples.
	Synchronization time	Synchronization time of the hour for the horizontal integration step (s)		240			This field is required if one wants to synchronize (or align) the horizontal echointegration steps of this file with another file (for example, acquired by another echosounder on the same ship or another ship). Here all steps will be synchronized for the 0:04 min of the hour (by default there is no synchronisation, i.e., the integration steps start at the beginning of each Block of run, a run being a continuous acquisition segment of a ***HAC*** file)
	Lambert latitude 1 reference	Latitude 1 reference for Lambert projection:		48.0			References for Lambert projection.
	Lambert latitude 2 reference	Latitude 2 reference for Lambert projection:		46.0			"
	Lambert origin latitude	Origin latitude of Lambert projection system:		45.5			"
	Lambert origin longitude	Origin longitude of Lambert projection system:		-70.0			"
	Lambert earth radius	Earth radius at equator in m:		6378135			The units of this variable set the units of the Lambert projection system, we have chosen metres in *CH2*.
	NSL (No. of surface-locked depth strata)	No. of surface-locked depth strata:		12			Variable name: NSL
			Surface-locked depth strata no.	**Start depth (m)**	**end depth (m)**		Any depth strata can be defined, even overlapping depth strata. N.B. The depth strata are defined according to their depth not their range.
	Whole sampled water column		**surface depth strata 1 (= whole sampled water column)**	Na	Na		N.B. Users want this first depth strata always represents the integration over the whole sampled water column.
			Surface depth strata 2				
			surface depth strata ...	"	"		
			surface depth strata NSL	"	"		

Table 1. Continued.

Part of the file	Tag	Field description		Data example	Field description	Data example	Comments
	NBL (No. of bottom-locked depth strata)	No. of bottom-locked depth strata		25			Variable name: NBL
			Bottom-locked depth strata no.	**Start altitude (m)**	**end altitude (m)**		Altitude = distance from the bottom
			bottom depth strata 1	"	"		Any depth strata can be defined, even overlapping depth strata.
			Bottom depth strata 2				
			bottom depth strata ...	"	"		
			bottom depth strata NSL	"	"		
	Integration data type	Type of echointegration data		s_v (MVBS) (m^2/m^3) or s_a (m^2/m2)			MVBS or s_v, is the mean volume backscattering coefficient, the linear value of S_v (the volume backscattering strength in dB re 1 m^2), of the echointegration cell (i.e., a measure of density per cubic metre in m^2/m^3); s_a is the area backscattering coefficient, the integration of s_v over the integration cell height (i.e., a measure of density per square metre in m^2/m^3).
	NEIB (No. of echointegration blocks)	No. of echointegration blocks generated during this echointegration operation on the HAC data file		3			Variable name: NEIB. A block is a series of r time series of pings) used for reporting the ech over a given transect line. For example if a 7-r contains 2 transect lines, each one having 3 ru transect of one run, one can choose to chop th blocks: a first block containing the 3 runs of tr second block containing the inter-transect run, block containing the 3 runs of transect 2. The defined in the echointegration dialog box of C
ECHOINTEGRATION BLOCK no.	Block no.	Echointegration block no. of this HEI echointegration file		block no. 1			The blocks will be defined in the echointegration dialog box of ***CH2***.
	Step unit and value	Time		10:00			Type of units used to define the boundaries of the echointegration steps (time, pings or distance) and its value.
	NEIS (No. of echointegration steps)	No. of horizontal integration steps		1742			Variable name: NEIS
	NC (No. of echo categories)	No. of Echo category		3	**List of Echo category in order**	-capelin schools -herring schools -unclassified echoes	Variable name: NC. Here an **Echo category** is either a result of an objective classification or a subjective labeling of echoes by a user (e.g., capelin, plankton) from ***CH2***. The **echo categories** are listed in the order they appear in the following echointegration result tables.

Table 1. Continued.

Part of the file	Tag	Field description:		Data example	Field description	Data example	(Comments)						
		Echo category 1		**category name** **ex.: capelin schools**									
		start of each step for that block		date(aaaa/mm/dd) (corrected PC time)	hh (corrected PC time)	mm (corrected PC time)	ss (corrected PC time)	latitude (deg.decimal)	longitude (deg.decimal)	x lambert (m)	y lambert (m)	No. of pings during that step	Linear distance covered during that step (m)
	1		step1	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	2		step2	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	...		...	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	NEIS		step NEIS	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	Whole block		Whole block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	▪	(end-start)

Cumulative linear distance of steps from start of integration (m)	Time interval of that step (s)	sailing speed (knts)	Average bottom depth (m)	Echointegration MVBS or 'sa' data (NEIS lines by (NSL+NBL) columns):	Horizontal step	surface locked depth strata 1 (= whole sampled water column)	surface locked depth strata 2	...	surface locked depth strata NSL	bottom locked depth strata 1	bottom locked depth strata 1	....	bottom locked depth strata NBL
▪	▪	▪	▪		step 1	▪				▪			
▪	▪	▪	▪		step 2	▪				▪			
▪	▪	▪	▪		...	▪				▪			
▪	▪	▪	▪		step NEIS	▪				▪			
▪	end-start	Whole block = cumul. Dist / cumul. Time	▪		all steps distance-weighted average	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings

Part of the file	Tag	Field description:		Data example	Field description	Data example	(Comments)						
		Echo category 2		category name ex.: herring schools									
		start of each step for that block		date(aaaa/mm/dd) (corrected PC time)	hh (corrected PC time)	mm (corrected PC time)	ss (corrected PC time)	latitude (deg.decimal)	longitude (deg.decimal)	x lambert (m)	y lambert (m)	No. of pings during that step	Linear distance covered during that step (m)
	1		step1	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	2		step2	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	...		...	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	NEIS		step NEIS	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪
	Whole block		Whole block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	▪	(end-start)

Table 1. End.

Cumulative linear distance of steps from start of integration (m)	Time interval of that step (s)	sailing speed (knts)	Average bottom depth (m)	Echointegration MVBS or 'sa' data (NEIS lines by (NSL+NBL) columns):	Horizontal step	surface locked depth strata 1 (= whole sampled water column)	surface locked depth strata 2	...	surface locked depth strata NSL	bottom locked depth strata 1	bottom locked depth strata 1	....	bottom locked depth strata NBL
·	·	·	·		step 1	·				·			
·	·	·	·		step 2	·				·			
·	·	·	·		...	·				·			
·	·	·	·		step NEIS	·				·			
·	end-start	whole block= cumul. Dist/ cumul. Time	·		all steps distance-weighted average	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings

Part of the file	Tag	Field description:		Data example	Field description	Data example	(Comments)						
		Echo category NC		category name ex.: unclassified									
		start of each step for that block		date(aaaa/mm/dd) (corrected PC time)	hh (corrected PC time)	mm (corrected PC time)	ss (corrected PC time)	latitude (deg.decimal)	longitude (deg.decimal)	x lambert (m)	y lambert (m)	No. of pings during that step	Linear distance covered during that step (m)
	1		step1	·	·	·	·	·	·	·	·	·	·
	2		step2	·	·	·	·	·	·	·	·	·	·
			...	·	·	·	·	·	·	·	·	·	·
	NEIS		step NEIS	·	·	·	·	·	·	·	·	·	·
	Whole block		Whole block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	end of block	·	(end-start)

Cumulative linear distance of steps from start of integration (m)	Time interval of that step (s)	sailing speed (knts)	Average bottom depth (m)	Echointegration MVBS or 'sa' data (NEIS lines by (NSL+NBL) columns):	Horizontal step	surface locked depth strata 1 (= whole sampled water column)	surface locked depth strata 2	...	surface locked depth strata NSL	bottom locked depth strata 1	bottom locked depth strata 1	....	bottom locked depth strata NBL
·	·	·	·		step 1	·				·			
·	·	·	·		step 2	·				·			
·	·	·	·		...	·				·			
·	·	·	·		step NEIS	·				·			
·	end-start	whole block= cumul. Dist/ cumul. Time	·		all steps distance-weighted average	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings > 0	average weighted by the step distances with no. of pings

15. ANNEX 2: Development of TVG corrections due to the medium

The s_v correction of echo samples due to the effect of changes of sound speed and absorption coefficient on the TVG is:

$$s_{v2} = s_{v1} \bullet \frac{G_{TVG2}}{G_{TVG1}} , \qquad (1)$$

where indices 1 and 2 correspond to the values at acquisition and for echointegration, respectively. The scattering volume index, s_{v1}, is related to the voltage at acquisition (V_{TVG1}) through the relationship:

$$s_{v1} = V_{TVG1}^2 \bullet A_1 , \qquad (2)$$

where A is the calibration (or echointegration) constant. In this equation, the voltage at acquisition (V_{TVG1}) is considered to have been compensated for the spreading of the sound wave by an accurate 20 log r TVG, except for the sound speed and absorption effect. The V_{TVG1}^2 is related to the raw voltage (V_1) and the 20 log r TVG by the equation:

$$V_{TVG1}^2 = \left(V_1 \bullet k\, r_1\, e^{b_1 r_1}\right)^2 , \qquad (3)$$

where k is a constant, r_1 is the range and b_1 is the absorption coefficient in nepers m^{-1} and $\left(k\, r_1\, e^{b_1 r_1}\right)^2$ is G_{TVG1}. Ignoring the constant A (even if it involves the sound speed at range 0), only considering the TVG correction, and combining equations 1, 2, and 3, yields:

$$s_{v2} = s_{v1} \bullet \frac{\left(k\, r_2\, e^{b_2 r_2}\right)^2}{\left(k\, r_1\, e^{b_1 r_1}\right)^2}$$

$$s_{v2} = s_{v1} \bullet \frac{k^2\, r_2^2\, e^{2 b_2 r_2}}{k^2\, r_1^2\, e^{2 b_1 r_1}}$$

$$s_{v2} = s_{v1} \bullet \frac{r_2^2\, e^{2 b_2 r_2}}{r_1^2\, e^{2 b_1 r_1}}$$

since $r_2 = r_1 \bullet \frac{c_2}{c_1}$, $\quad s_{v2} = s_{v1} \bullet \frac{\left(r_1 \frac{c_2}{c_1}\right)^2 e^{2 b_2 r_2}}{r_1^2\, e^{2 b_1 r_1}} = s_{v1} \bullet \frac{r_1^2 \frac{c_2^2}{c_1^2} e^{2 b_2 r_2}}{r_1^2\, e^{2 b_1 r_1}} = s_{v1} \bullet \frac{\frac{c_2^2}{c_1^2} e^{2 b_2 r_2}}{e^{2 b_1 r_1}}$

$$s_{v2} = s_{v1} \bullet \frac{c_2^2}{c_1^2} e^{2 b_2 r_2}\, e^{-2 b_1 r_1} = s_{v1} \bullet \frac{c_2^2}{c_1^2} e^{2(b_2 r_2 - b_1 r_1)}$$