

Ocean Data View User's Guide

Version 4.0

Text in gray indicates features not yet implemented in the current ODV4.

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1 General Overview

Ocean Data View (ODV) is a computer program for the interactive exploration and graphical display of oceanographic and other geo-referenced profile, trajectory or time-series data. The software is available for Windows, Mac OS X, Linux, and UNIX systems. ODV data collection and view files are platform independent and can be exchanged between all supported systems. ODV lets you maintain and analyze large sets of station data on inexpensive and portable hardware. You can produce high-quality station maps, general **property-property plots** of one or more stations, **scatter plots** of selected stations, **section plots** along arbitrary cruise tracks and **property distributions on general isosurfaces**. ODV supports display of original scalar and vector data by colored dots, numerical data values or arrows. In addition, there is choice between three different gridding algorithms, providing estimates on automatically generated grids, and allowing color shading and contouring of fields along sections and on isosurfaces. A large number of **derived quantities** can be calculated on the fly. These variables may be displayed and analyzed in the same way as the basic variables stored on disk.

This version, ODV4, is based on a completely new object oriented software code and overcomes many limitations of previous ODV versions. To ensure backward compatibility, ODV4 supports existing collections and configuration files (now called views) created under previous ODV versions. All newly created collections, however, now use a new and much more general **data model** and internal **storage format**. As before, ODV4 data collections maintain platform independence and may be moved between all supported systems. Among the novel features of the new data model are more flexible metadata schemes, support for an unlimited number of collection variables, user specified data types, and custom quality flag schemes for meta- and collection variables.

1.1 Ease of Use

ODV is designed to be flexible and easy to use. Users need not know the details of the internal data storage format nor are they required to have programming experience. ODV always displays a map of available stations on the screen and facilitates navigating through the data by letting the user select stations, samples, sections and isosurfaces with the mouse. The screen layout and various other configuration settings can be modified easily, and favorite settings can be stored in view files for later use. ODV can create and manage very large data collections containing millions of stations on relatively inexpensive and portable hardware. Existing data collections can be extended easily if new data become available. With its wide range of plot types and flexible interactive controls, ODV greatly facilitates data quality control and is particularly useful for training and teaching.

1.2 Dense Data Format

The ODV data format is optimized for variable length, irregularly spaced profile, trajectory, and time-series data. It provides dense storage and allows instant access to the data of arbitrary stations, even in very large data collections. The data format is flexible

and accepts data for an unlimited number of variables. The [metadata](#) and [collection variables](#) are defined by the user at collection create time, and different ODV collection may be created to store the values of different data types, such as profiles, trajectories or time-series data. ODV maintains [quality flags](#) for all individual data values. These quality flags may be used for data quality filtering to exclude, for instance, bad or questionable data from the analysis. Numerical values and quality flags may be edited and modified. All modifications are logged in the collection's log-file, allowing unintentional changes to be reversed, if necessary.

1.3 Extensibility

ODV allows easy import of new data into collections and also allows easy export of data from a collection. Oceanographic data in the following widely used formats can directly be read into the ODV system:

- [ODV spreadsheet data](#),
- [Argo profile and trajectory data](#),
- [World Ocean Database data](#),
- [World Ocean Atlas data](#),
- [WOCE WHP data](#),
- [NODC SD2 data](#),
- [Java Ocean Atlas spreadsheet data](#).

1.4 Derived Variables

In addition to the basic measured variables stored in the data files, ODV can calculate and display a large number of [derived variables](#). Algorithms for these derived variables are either coded in the ODV software (potential temperature, potential density, dynamic height (all referenced to arbitrary levels), neutral density, Brunt-Väisälä Frequency, sound speed, oxygen saturation, etc.) or are defined in user provided macro files or expressions. The macro language is easy and general enough to allow a large number of applications. Use of [expressions](#) and [macro files](#) for new derived quantities broadens the scope of ODV considerably and allows easy experimentation with new quantities not yet established in the scientific community. ODV provides a built-in macro editor that facilitates creation and modification of ODV macros.

Any basic or derived variable may be displayed in one or more data windows. In addition, any variable can be used to define isosurfaces, such as depth horizons, isopycnals, isothermals, or isohalines. Property minimum or maximum layers like, for instance, the intermediate water salinity minimum layer, can be selected as isosurface by finding zero-values of the [vertical derivative](#) variable of these variables.

1.5 Plot Types

ODV displays data in two basic ways: (1) either by showing the original data at the data locations as colored dots of user-defined size (see Figure 1-1a), numeric values, or ar-

rows (see Figure 1-2); or (2) by projecting the original data onto equidistant or variable resolution rectangular grids and then displaying the gridded fields (see Figure 1-1b). Method 1 produces the most elementary and *honest* views of the data, instantly revealing occasional bad data values and regions of poor sampling. In contrast, method 2 produces *nicer* plots and avoids the overlapping of the colored dots that occurs with method 1, especially for large dot-sizes. It has to be noted, however, that the gridded fields of method 2 are data products and that small scale or extreme features in the data may be lost due to the gridding procedure. For both display modes, ODV allows the export of window data to ASCII files or the clipboard for subsequent use outside ODV.

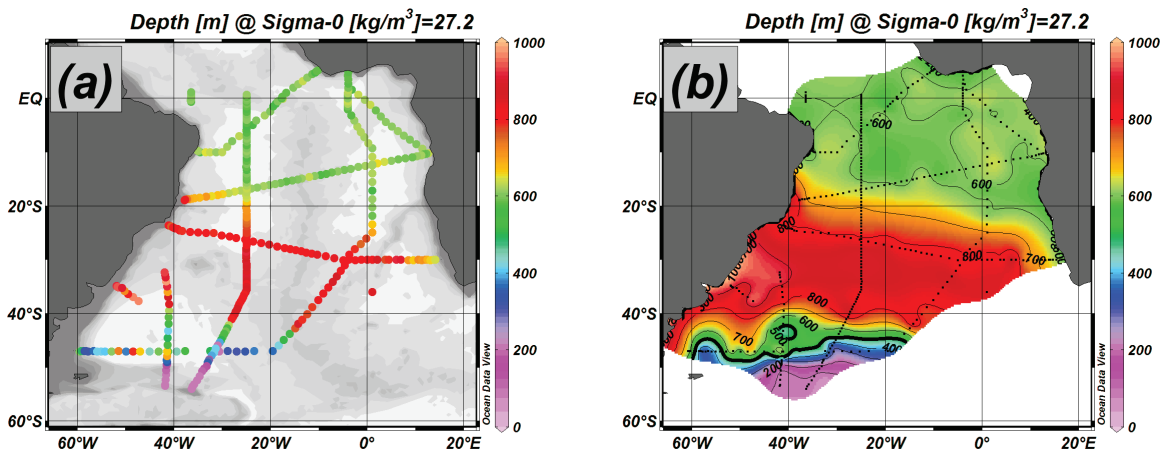


Figure 1-1: Data displayed as (a) colored dots and (b) gridded field.

In addition to scalar property fields, ODV also supports the display of vector fields for datasets providing the X and Y vector components as distinct variables (see Figure 1-2).

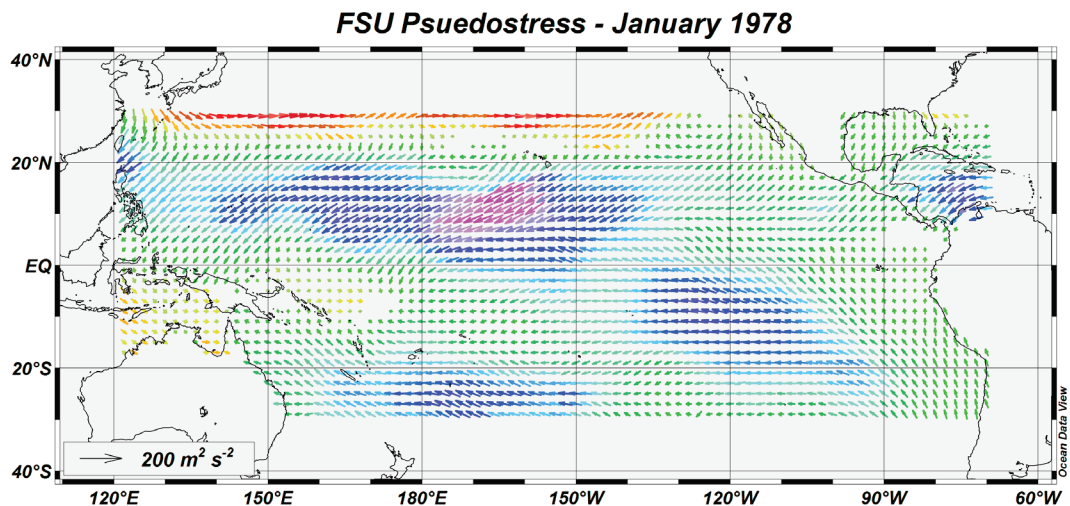


Figure 1-2: Arrow plot of historical wind field.

1.6 Window Scopes

The ODV application window always displays a map of available stations. In addition, the user may define an unlimited number of other windows for the display of the actual data. Each of these data windows can have one of the following scopes: *STATION*, *SCATTER*, *SECTION*, or *SURFACE*. Each window has its own scope, and the scopes of the different data windows may be different.

1.6.1 STATION Scope

A *STATION* scope window (see Figure 1-3) provides an X/Y plot showing only the data of stations in the map's pick list. You can add the current station to the pick list by pressing *ENTER*, or you can remove it by pressing the *Delete* button. You can edit the station pick list using the *Manage Pick List>Edit Pick List* option of the map popup menu. Among other things, this lets you adjust the graphics style for each individual picked station. As for all other data window types, *STATION* windows allow you to assign arbitrary collection variables (basic or derived) on the X and Y axis. For easy identification, picked stations are marked in the map using the same symbol and color as in the data windows. If the map has *station annotation* switched on, the picked stations positions are also labeled with the station label.

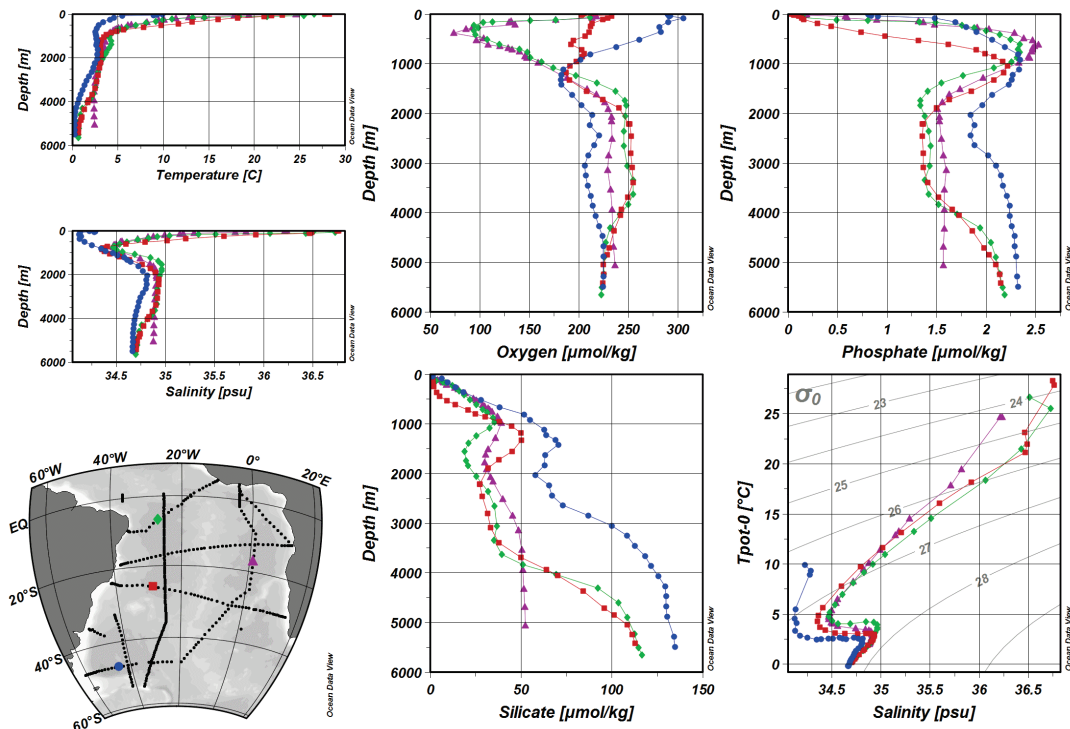


Figure 1-3: Example window layout with an orthographic map and six data windows using *STATION* scope. The pick list stations are marked in the map for easy identification.

1.6.2 SCATTER Scope

SCATTER scope windows (see Figure 1-4) display the data of all stations currently shown in the map, thereby providing overviews over potentially very large data sets. *SCATTER* windows are particularly useful for data quality control. Like for all subsequent scopes, *SCATTER* windows support a Z variable, in addition to variables on X and Y. Values of the Z variable determine the colors drawn at given X/Y data locations. Plots with Z-variables (for *SECTION* and *SURFACE* modes as well) can be displayed in two ways: (1) by placing colored dots or the actual data value at the X/Y locations (default) or (2) as continuous gridded fields, estimated on the basis of the observed data. Gridded fields can be color shaded and/or contoured.

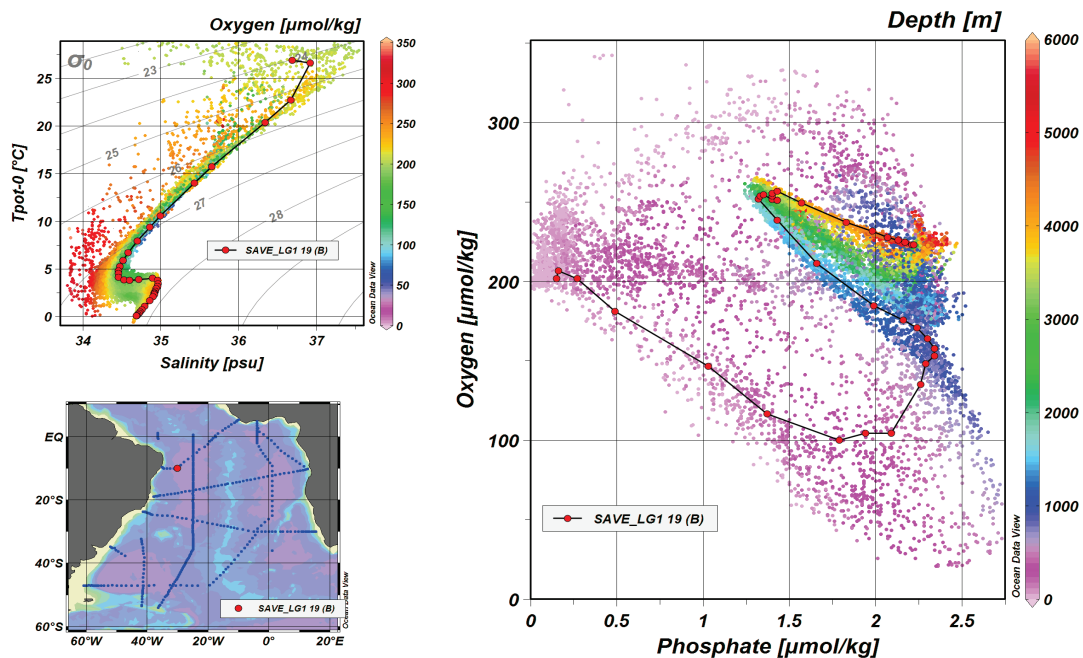


Figure 1-4: Example window layout with two data windows using *SCATTER* scope. The data of one station are highlighted using symbolset graphics objects.

1.6.3 SECTION Scope

SECTION scope windows (see Figure 1-5) display the data of all stations belonging to the section currently defined in the map, e.g., all stations inside the red section band. Sections are defined or modified using the *Manage Section* options of the map popup menu. *SECTION* windows also support Z variables and the display of original data or gridded fields. *SECTION* windows are most useful to display along-track property distributions or property/property plots for the stations of a given expedition following a given track.

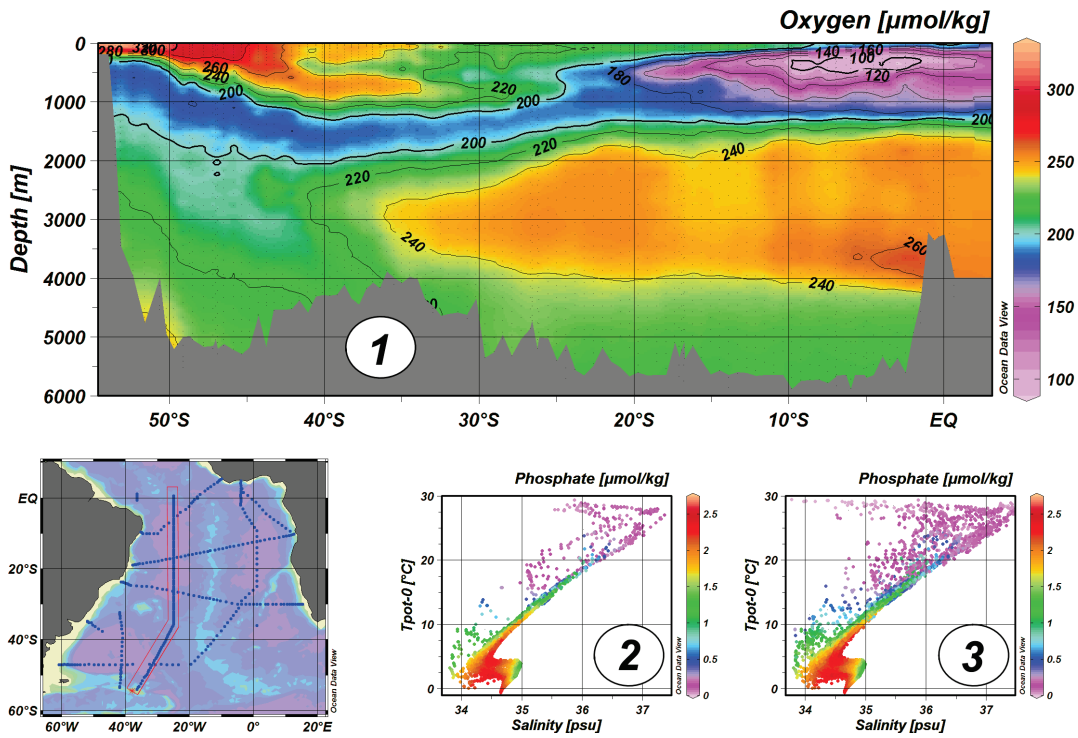


Figure 1-5: Example window layout with two data windows of scope SECTION (1 and 2) and one SCATTER data window (3). Note that the SCATTER window 3 displays all data of all stations in the map, while the SECTION windows 2 and 3 only show the data of the stations inside the section band.

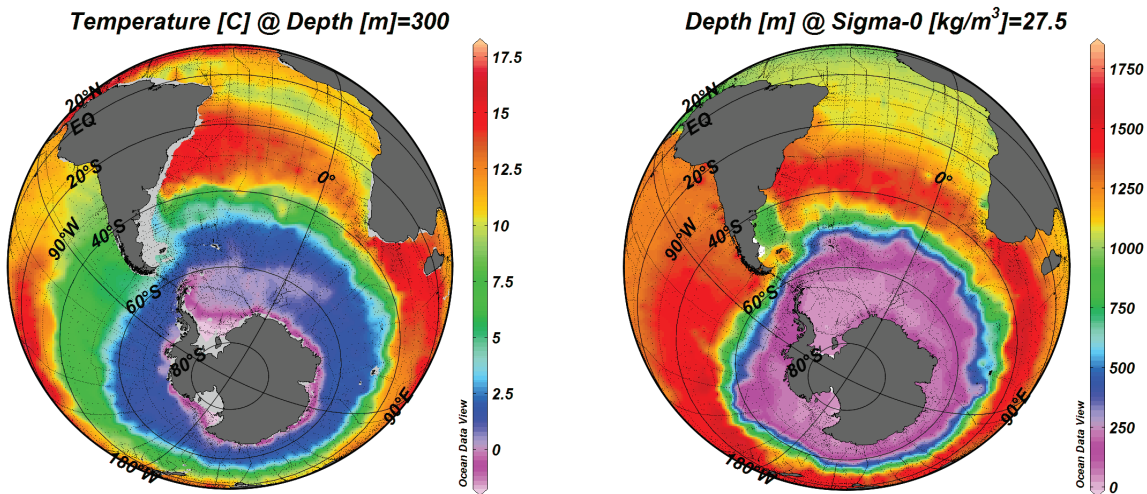


Figure 1-6: Example window layout with two data windows of scope SURFACE showing property distributions on isosurfaces.

1.6.4 SURFACE Scope

In addition to metavariables and collection variables, ODV defines a third set of variables, *isosurface variables*. Isosurface variables provide values of a given collection variable (e.g. *Temperature* or *Depth* in Figure 1-6) on specific isosurfaces. Isosurfaces are layers of constant values of another collection variable, such as, constant depth or density layers.

SURFACE scope windows show isosurface values of all stations in the map. *SURFACE* windows support X, Y and Z isosurface variables. If *Longitude* and *Latitude* isosurface variables are assigned to the X and Y axis, the window will become a map displaying the selected Z variable (see Figure 1-6). Such map data windows use the projection and layers settings of the station map. It is also possible to assign other isosurface variables to the X and Y axis of the *SURFACE* data window, resulting in general isosurface variable correlation plots, possibly colored using another isosurface variable as Z variable.

1.7 Graphics Output

Printouts of the ODV graphics canvas can easily be obtained using the *File>Print Canvas* option. As an alternative, you can also write the entire graphics canvas, individual data windows or the map to png, jpg, gif or PostScript files. These files can subsequently be included in electronic documents and web-pages. The resolution of the image files can be specified by the user and is not limited by the graphics resolution of the screen.

1.8 Data Statistics

Statistics information for the X, Y, Z data of a data window or the position and date/time metadata of the stations in the map can easily be obtained by pressing *F4* while the mouse is over the respective data window or the map. A dialog will appear showing mean, standard deviation, number of data points as well as minimal and maximal values for X, Y and Z variables separately. In addition, [histograms](#) of X, Y and Z data as well as X/Y data distribution plots can be obtained by simple button clicks. For the map you can also obtain station coverage [histograms over time or season](#).

1.9 Estimation and Averaging

ODV can be used to estimate values of any basic or derived variable at arbitrary longitude-latitude-depth points ([3D point estimation](#)). 3D point estimation is implemented as a fast weighted averaging procedure and uses the currently valid station and sample set together with user specified longitude, latitude and depth averaging length scales. The coordinates at which estimation is requested are provided in ASCII files. The points can be irregularly spaced or may form a uniform or non-uniform, rectangular or curvilinear grid. You invoke 3D point estimation from the main menu through *Tools>3D Estimation*.

For data windows with a Z variable, another method, [2D point estimation](#), can be used to estimate Z values at arbitrary X/Y points. As for 3D estimation, the X/Y coordinates are provided in ASCII files. The points can be irregularly spaced or may be on a uniform

or non-uniform, rectangular or curvilinear grid. Choose *Extras>2D Estimation* from the respective data window popup menu to invoke 2D point estimation.

A third estimation method, 1D Estimation, is available for data plots that have the **primary variable** on their X or Y-axis. For every station contained in the plot, this option allows estimation of the other variable at user-specified values for the primary variable. These user-specified coordinates have to be provided in ASCII files, one coordinate per line. The results of the estimation (one requested station after the other) are written to ODV spreadsheet format files, e.g., these files themselves can be imported easily and visualized with ODV. You can use the 1D Estimation option to obtain, for instance, standard depth (pressure) profiles of a variable stored in your collection. Choose *Extras>1D Estimation* from the respective data plot popup menu to invoke 1D Estimation.

In addition to the various point estimation methods described above, ODV can also be used to calculate averages and standard deviations for user-specified longitude/latitude/depth boxes. All currently valid samples inside a given box are used for the averaging. **Box-averaging** differs from point estimation: whereas all point estimation methods always yield a value (potentially of poor quality, if no data are found nearby), the box averaging procedure only returns results, if data values are actually found inside the box.

1.10 NetCDF Support

In addition to native data collections, ODV can also access and visualize data in **netCDF files**, widely used for platform independent storage of original data or model output. ODV requests user help for the identification of key coordinates and variables in the netCDF by means of an easy-to-use **netCDF emulation wizard**. The content of the netCDF file is then presented to the user as if the netCDF file was a native ODV collection. All ODV analysis and visualization options are available for the exploration of the data in the netCDF file. NetCDF files are platform independent and can be used on all ODV supported systems.

2 First Steps

2.1 Installing Ocean Data View

You must install ODV on your computer before you can use the software. The latest ODV installation files for Windows, Mac OS X, Linux, and UNIX systems can be downloaded from <http://odv.awi.de/en/software/download/>. Note that you have to register and use your personal login data to get access to the download pages. Detailed installation instructions are provided in *INSTALL.txt* files. Please see the [License Agreement](#) for ODV usage rules.

IMPORTANT NOTE: The ODV user directory has been moved from *odv_local* in the user's home directory in previous ODV versions to sub-directory *ODV* in the user's document directory. Private palette, macro, gazetteer, command or graphics objects files created by the user have to be manually copied to the new user directory to make them available to ODV4. The same applies to reference datasets saved with previous ODV versions. The full user directory path as well as other ODV settings can be obtained via *Help>About ODV* or *odv4>About odv4* on Mac OS X systems.

2.2 Installing Optional Packages

Complementary high resolution coastline and topography files or ready-to-use data collections are available as optional packages from <http://odv.awi.de/en/software/> and <http://odv.awi.de/en/data/>. Again, see the *INSTALL* files for installation instructions and further information.

2.3 Running Ocean Data View

Once ODV is installed on your system you can start the program in a number of ways.

On **Windows**, the installation procedure will create an ODV icon on your desktop and will automatically associate *.odv* and *.var* collection files with the ODV application. To launch ODV, you can double-click *.odv* or *.var* files, or the ODV desktop icon.

Any ODV supported file can be dragged onto the ODV icon. This will start ODV and open the dragged file in a single operation. When ODV is running, you can drag an ODV supported file onto the ODV window to open this file. Supported file types include ODV collections (*.odv* and *.var*), netCDF files (**.nc*, **cdf*), ODV spreadsheet files (*.txt*) and others.

On **Mac OS X, Linux, and UNIX** systems you can create aliases or icons for the ODV executable *odv4* or the ODV startup script file *run_odv* using methods specific to your operating system. The ODV executable *odv4* is located in the *bin_...* directory of your ODV installation (e.g., *bin_macx* on MacOS X, *bin_linux-i386* on Linux systems, etc.). Once a desktop or taskbar/dock icon is created, you start ODV by double or single-clicking on the ODV icon. On most systems you can also drag-and-drop ODV collection *.odv* and *.var* files, netCDF files or any supported data import file onto the ODV icon.

ODV can also be started from DOS boxes or terminal windows by entering the path-

name of the executable and optional arguments. On some systems a script file *run_odv* is available to start ODV from the command line. If you start ODV from the command line the following arguments are supported. Note that file and path names including spaces must be enclosed within quotation marks “ ”.

There are two ways of starting ODV from the command line:

```
odv4 file [-view view_file]
```

or

```
odv4 -x cmd_file [-q]
```

The first case opens an ODV collection (*.odv* or *.var* collection files) or netCDF *.nc* or *.cdf* file *file* and loads the view from view file *view_file*. The *-view view_file* argument is optional. If it is not provided a default view or the most recently used view is used initially. If the ODV binary directory is not in your PATH you have to specify the full pathname of the ODV executable, e.g., “c:\Program Files\Ocean Data View (mp)\bin_w32\odv4” on Windows or “/Applications/ODV/bin_macx/odv4” on Mac OS X systems. *file* has to be an absolute pathname, or a path relative to the current directory. *view_file* has to be an absolute pathname, or a path relative to the directory containing *file*.

The second case opens the ODV command file *cmd_file* and executes the commands contained in the file. If the optional argument *-q* is provided, ODV is automatically closed after all commands have been processed. *cmd_file* has to be an absolute pathname, or a path relative to the current directory.

On some platforms ODV prompts for the following *Quick Installation* information when running for the first time:

1. The full path-name of the directory that contains the *bin* directory (ODVMPHOME environment variable).
2. The full path-name of a directory on your disk which will be used by ODV during runtime to write temporary files (ODVMPTEMP environment variable). Note that you must have write permission for this directory. You can use the system tmp directory, or you can create a special directory on a local disk (e.g., */odvtmp*) for this purpose. The use of directories on network drives is not recommended because of potentially poor performance.
3. The name of your computer.
4. Your user or login name.

Press OK to finish the *Quick Installation*. Then customize ODV font and external programs settings using the *View>General Settings* dialog.

Once ODV is running, you open a data collection, netCDF file or any of the supported import data files using the *File>Open* option. A standard file open dialog will appear, and you can choose the appropriate file type and file name to be opened. If you open a supported import data file, ODV will automatically create a new collection in the directory of the selected file, import the data from the file, and open the newly created data col-

lection.

Note that after opening a collection, ODV loads the most recent view settings of the collection. These view settings may include station and sample selection filters, and, as a consequence, only a subset of the stations and data values in the collection may be shown in the map and data windows. Use *View>Station Selection Criteria* or *View>Sample Selection Criteria* to reset or modify the selection criteria.

You may load other, previously saved, view files using *View>Load View*, you may change the window layout with *View>Window Layout*, load one of the pre-defined layout templates with *View>Layout Templates>...*, or change the various settings interactively using the *View* menu options or the popup menus that appear when right-clicking the mouse while over the canvas area, the map, or one of the data windows.

2.4 Getting Help

Pressing F1 or using option *Help>User's Guide* opens the ODV User's Guide (this document). Note that a *pdf* version of the User's Guide is available on the [ODV website](#). Context sensitive help is provided by pressing the *Help* button on many ODV dialogs. This will invoke the web browser specified under *View>General Settings>Program Locations*, and the browser will jump to a particular chapter in the User's Guide. On Windows, context sensitive help works best with the *Firefox* browser. When using *Internet Explorer* it may be necessary to click into address field and to press *ENTER*. On Mac OS X and some Linux systems a running web browser may have to be closed before ODV context sensitive help will be displayed.

2.5 Application Window

The ODV4 application window consists of the following elements (see Figure 2-1):

Menu Bar: The menu bar provides access to main menus.

Canvas: The graphics canvas contains a map (always present) and an unlimited number of data windows. The canvas, the map, and the data windows may contain an unlimited number of graphics objects, such as text annotations, symbols or user-defined shapes.

Status Bar: Three panes providing (1) status information, (2) coordinates at current mouse position or a progress bar, and (3) the number of currently selected stations, the total number of stations in the collection, and the name of the current view.

Current Station Window: Metadata values and quality flags of the current station (marked in the map with a red cross).

Current Sample Window: Data values and quality flags of the current sample (marked in data windows with a red cross). Only data satisfying the current *sample selection criteria* are shown.

Isosurface Data Window: Isosurface values of the current station.

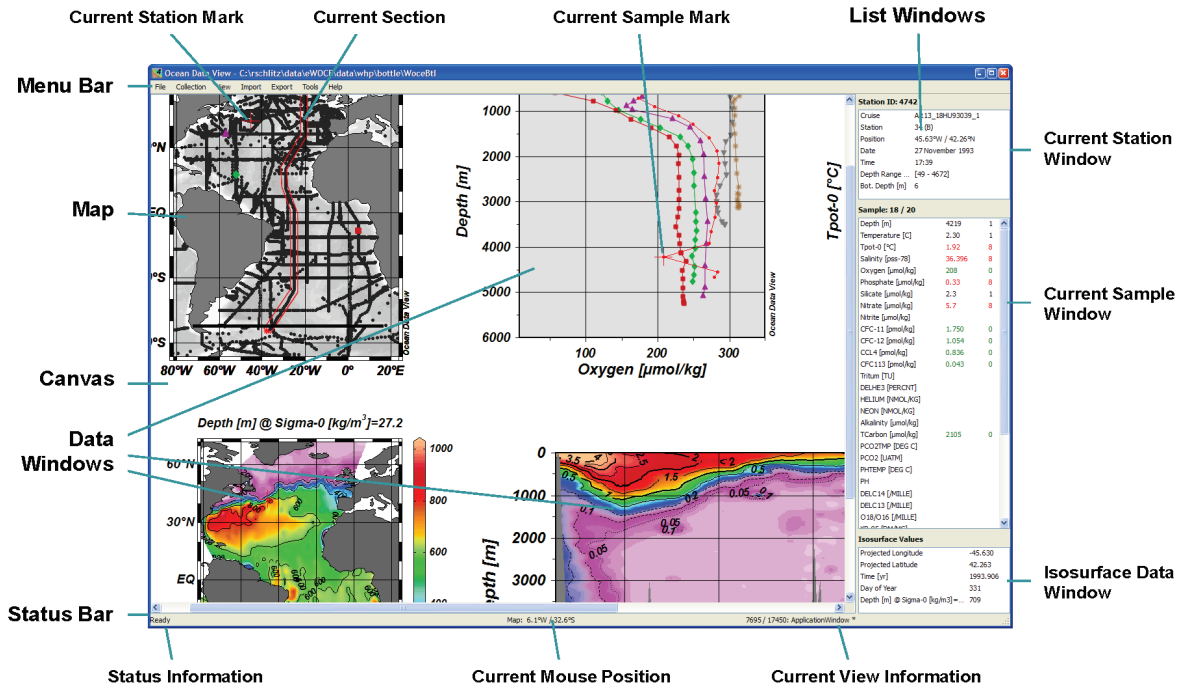


Figure 2-1: Elements of the ODV application window.

Left-clicking on station or data marks in the map or any of the data windows selects the respective station or sample. Right-clicking on most window elements brings up context menus with different, element-specific options. Resting the mouse over data listing items brings up popup windows with detailed data information.

The map displays stations that satisfy the current *station selection criteria*. It maintains a *pick station list* and may have a *section*. Data windows have one of the following *scopes*: (1) STATION, showing X/Y data of the picked stations, picked stations are marked in the map using the same marks as in the data windows; (2) SCATTER, showing X/Y/Z data of all selected stations shown in the map; (3) SECTION, showing X/Y/Z data of all stations inside the section band; and (4) SURFACE, showing isosurface X/Y/Z data of all selected stations shown in the map. The current window layout and parameter settings are collectively called a *view*. *Views* can be stored in files for later use.

Some of the ODV window elements and popup menus are described in more detail below.

2.6 Menu Bar

The main menu provides basic functionality:

File: Open or create a collection; open netCDF file; open a ODV supported data file, execute ODV commands in batch mode; print the current ODV graphics canvas; produce GIF, PNG, JPG or PostScript files of current ODV graphics canvas; exit ODV.

Collection: Copy, rename, delete collection; sort and condense data collection; delete current station or valid station subset; view collection info, inventory, and log files; add a comment to the collection log file.

View: Change [station](#) and [sample selection criteria](#); define [derived variables](#); define [isosurface variables](#); change map and data window layout; change variable labels, numeric format and display order in listing windows; load and save configuration settings, define general ODV settings.

Import: Import data into current collection (supported are various WOCE data streams, World Ocean Atlas, World Ocean Database, NODC SD2 format, ODV spreadsheet formats, two ODV list formats).

Export: Export data of currently selected stations; export window X, Y, Z data to ASCII files; export window X, Y, Z data as reference dataset.

Tools: Perform [3D estimation](#); calculate [box average values](#); find [outliers](#) and [duplicate stations](#); invoke the [macro editor](#); invoke the [palette editor](#) (Windows only).

Help: Invoke ODV help system; visit the ODV web page; send bug reports; show ODV version.

2.7 Metadata and Data Windows

The *Current Station Window* contains the metadata values and associated quality flags of the current station (marked in the map with a red cross), the *Current Sample Window* contains the data values and associated quality flags of the current sample (marked in data windows with a red cross), and the *Isosurface Data Window* contains the isosurface values of the current station. Different colors are used to display metadata and data values to instantly reveal the quality of individual values.

Right-clicking the mouse button on a list window brings up window specific popup menus letting you edit the metadata or data, or allowing modifications of variable properties. This includes changing the variable labels, the numeric format and the display order in the data values list.

Popup windows containing the full variable label and quality flag text appear automatically when resting the mouse over one of the list items.

2.8 Graphics Canvas

The canvas is the painting area of ODV and contains the station map and zero or more data windows. You can adjust the size of the canvas via *View>General Settings>Canvas*.

2.9 Popup Menus

Clicking the right mouse button (on Mac OS X system with a single-button mouse hold down the *Alt* key and click the mouse) while over the canvas, the map, a data window, a graphics object or a data list window invokes different popup menus providing element specific options. Most of the ODV functionality is available via these popup menus.

1	Redraw Canvas	F5
2	Save Canvas As	Ctrl+S
3	Print Canvas	Ctrl+P
4	Full Range (All)	Ctrl+F
5	Undo	▶
6	Add Graphics Object	▶
6	Manage Graphics Objects	
7	Window Properties	▶
8	Window Layout	Alt+W
8	Layout Templates	▶
9	Save View As	
9	Save View	
9	Load View	Shift+L

Figure 2-2: The canvas popup menu

The canvas popup menu offers the following options:

- **1**: Redraws the entire canvas and all its windows.
- **2**: Saves the entire canvas and all its windows in gif, png, jpg, or PostScript file.
- **3**: Prints the entire canvas and all its windows.
- **4**: Adjusts the axis ranges of all windows to full-scale.
- **5**: Allows undo of the most recent view changes.
- **6**: Allows adding or managing the graphics objects of the canvas.
- **7**: Changes the [properties of the map and data windows](#).
- **8**: Changes the map and data window layout and implements window layout templates.
- **9**: Saves or loads a view to or from a file.

1	Redraw Map	F5
2	Save Map As	Ctrl+S
3	Zoom	
4	Auto-Zoom In	
5	Auto-Zoom Out	
6	Full Domain	
7	Global Map	
8	Current Station by Name	
9	Current Station by ID	#
10	Station Selection Criteria	Alt+S
11	Sample Selection Criteria	Shift+S
12	Manage Pick List	▶
13	Manage Section	▶
14	Extras	▶
15	Properties	

Figure 2-3: The map popup menu

The map popup menu offers the following options:

- **1**: Redraws the map and all data windows.
- **2**: Saves the map in gif, png, jpg, or PostScript file.
- **3**: Manually zoom in or out the map domain.
- **4**: Zoom in to the point of the mouse right-click.
- **5**: Automatically zoom out.
- **6**: Chooses native map domain of the collection.
- **7**: Chooses global map domain.
- **8, 9**: Selects a new current station by name or internal number.
- **10**: Changes the [station selection criteria](#).
- **11**: Changes the [sample selection criteria](#).
- **12**: Lets manipulate the map's station pick list.
- **13**: Lets define a [section](#) and modify its properties.
- **14**: Access to the map's *Extras* menu.
- **15**: Allows modifying the [properties of the map](#).

1	Redraw Plot	F5
2	Save Plot As	Ctrl+S
3	Zoom	
4	Z-Zoom	
5	Auto-Zoom In	
6	Auto-Zoom Out	
7	Full Range	Ctrl+F
8	Set Ranges	
9	X-Variable	X
9	Y-Variable	Y
9	Z-Variable	Z
10	Extras	▶
11	Properties	

Figure 2-4: The data window popup menu

The data window popup menu offers the following options:

- **1**: Redraws the data window.
- **2**: Saves the data window in gif, png, jpg, or PostScript file.
- **3**: Manually zoom in or out the data window domain.
- **4**: Zoom into the window's color bar to modify the Z-range.
- **5**: Zoom in to the point of the mouse right-click.
- **6**: Automatically zoom out.
- **7**: Adjusts the axis ranges of this window to full-scale.
- **8**: Sets axis ranges manually.
- **9**: Selects new variables on X, Y, or Z axis.
- **10**: Access to the data window's *Extras* menu.
- **11**: Allows modifying the [properties](#) of this data window.

2.10 Status Bar

The ODV status bar displays help, status and progress information. The right-most pane of the status bar indicates the number of currently shown stations in the map, the total number of stations in the collection, and the name of the current view file. Resting the mouse over this pane brings up a popup window with more detailed information on the current state.

2.11 Current Station and Sample

ODV always points to a current station. This station is marked in the map with a red cross, and its metadata are listed in the [Current Station Window](#). You can select a new current station by clicking with the left mouse button on a station mark in the map. If you suspect more than one station at the same location, for instance, because of repeated observations at the same site, you can hold down the SHFT key while clicking on the station position. If there are indeed multiple stations at the clicked position, a list of these stations is shown, and you can select the new current station from the list.

You can also use keyboard keys to select new current stations: the right arrow key will select the next station (according to the station order in the collection), while the left arrow key will select the previous one.

Choosing option *Current Station by Name* from the map popup menu lets you specify a specific cruise label, station label and station type making the matching station the current station.

Choosing option *Current Station by ID* from the map popup menu (or simply pressing the # key while the mouse is over the map) lets you select a new current station by entering its internal ID number (not to be confused with the station label).

One of the samples of the current station is the current sample. The current sample is marked in the data windows by a red cross, and its data values as well as its quality flags are shown in the *Current Sample Window*. To select a new current sample (and possibly new current station) left-click with the mouse on any data point in any of the data windows. The down arrow key will select the next sample (in ascending order of primary variable values), while the up arrow key will select the previous one. Pressing the *PgUp* or *PgDn* keys will move the current sample forward or backward in larger steps.

2.12 Map and Data Window Drawing

The map and data windows automatically draw or redraw themselves at program start, or whenever a view is loaded or one of the many layout or display properties is modified. Data windows of scope *STATION* or *SECTION* remain empty if the list of **picked stations** is empty and no **section** is currently defined.

To add a station to the pick list either double-click on the particular station mark in the map or click on the mark to make the station the current station and then press *ENTER*. Repeat this procedure for other stations that you want to add to the pick list. The pick list can hold an unlimited number of stations. You delete a station from the pick list by making it the current station (e.g., click on one of its data points in a *STATION* window) and pressing the *Delete* button. You can edit the properties of pick list entries via the *Manage Pick List>Edit Pick List* option of the map popup menu.

To define a **section** or change section properties use options from the *Manage Section* menu of the map popup menu. Once a section is defined the along-section coordinate is available as a derived variable. This can be either *Section Longitude*, *Section Latitude*, or *Section Distance*, depending on your choice of the *Section Coordinate*. If you want to produce property distributions along the section, put the section coordinate on the X axis of the plot.

3 *ODV Collections*

ODV uses a special data format that can handle very large sets of data efficiently. This collection format is optimized for irregularly spaced, variable length data and provides dense storage and fast data access. The data model is quite general and accomodates profile, trajectory and time series data from various fields of environmental sciences, including oceanography, meteorology, glaciology and geology. In addition to observed data, ODV can also be used to analyze and visualize gridded data or numerical model output. Such data may be provided in ODV native collection format or as netCDF data-sets.

ODV4 defines a new collection data format (*ODVCF5*) that is more general than its predecessor format *ODVGENERIC* used by previous versions of ODV. *ODVCF5* overcomes many limitations of *ODVGENERIC*. In particular, there is now support for a much wider range of metadata variables, an unlimited number of collection variables and a virtually unlimited number of samples per station. For the first time *ODVCF5* now supports data quality flags for metavariables, and, for meta- and collection variables alike, the user may now adopt custom quality flag schemes from a set of the 14 most popular schemes in the oceanographic community. Collections with more than 50 variables and custom datatypes ranging from double precision (8 bytes) to single-byte integers are now possible with *ODVCF5*. Metavariables may be numeric (1 to 8 bytes per value) or of type *text* with user specified text length.

ODV4 fully supports *ODVGENERIC* collections and *.cfg* configuration files created with previous versions of ODV. When creating new collections, however, ODV4 will use the new *ODVCF5* format providing all the new features and allowing for more flexibility in the definition of meta- and collection variables.

3.1 *Data Model*

ODV can handle a very wide range of data types, such as profile data (ocean, atmosphere, lakes, marine and lacustrine sediments, ice sheets, etc.), or time series data from fixed or drifting stations in the ocean, on ice floats or on land.

The fundamental data entity handled by ODV is the *station*, representing the data of a specific sampling event at a given geographical location and date and time. ODV organizes the data of a potentially very large number of stations in ODV data collections. Users typically open a data collection and work with the station data in this collection. Collections are expandable, and new data can be appended at any time.

Stations are described by a number of *metadata* entities, including cruise and station names, space and time coordinates, and possibly a number of additional descriptive parameters. Each station contains data for one or more *samples*, and each sample can have values for two or more *variables* (collection variables). One of the collection variables, the *primary variable*, is special and serves as ordering variable for the samples of a station. The sets of meta- and collection variables are defined when the collection is created.

For each station, ODV maintains data values for all metavariables and also for all collection variables and all samples. In addition, ODV also maintains *quality flag values* associated with every individual metadata and data value. There are additional quality flags describing the overall quality of a station (*station quality flag*) and of each individual sample (*sample quality flags*). Quality flag values reflect the degree of confidence in the data and constitute an extremely valuable part of the data set.

ODV supports all widely used quality flag schemes in the oceanographic community. ODV also defines its own simple quality flag scheme that is applicable for oceanographic and most other kinds of environmental data. ODV can use data quality flag information for data filtering. Data quality flag values of collection variables can directly be worked with by means of quality flag [derived variables](#).

Individual meta- and collection variables may use different quality flag schemes. Meta-variable as well as sample data values may be missing.

Schematic summaries of station metadata and data arrays maintained by ODV are shown in Tables 3-1 and 3-2.

Table 3-1: Station metadata values v and quality flags q maintained by ODV. Metavariable values may be either text or numeric. The total number of metavariables m is unlimited.

Metavar ₁		Metavar ₂		...	Metavar _m		Station QF
v_1	q_1	v_2	q_2	...	v_m	q_m	q

Table 3-2: Station data values and quality flags maintained by ODV. Values of collection variables must be numeric, text entries are ignored. The minimum number of collection variables is two; the total number n is unlimited. The number of samples k is unlimited. One of the collection variables is defined as primary variable. Samples are sorted in ascending order of primary variable values.

	Var ₁		Var ₂		...	Var _n		Sample QF
Smpl₁	$v_{1,1}$	$q_{1,1}$	$v_{1,2}$	$q_{1,2}$		$v_{1,n}$	$q_{1,n}$	q_1
Smpl₂	$v_{2,1}$	$q_{2,1}$	$v_{2,2}$	$q_{2,2}$		$v_{2,n}$	$q_{2,n}$	q_2
.								
.								
.								
Smpl_k	$v_{k,1}$	$q_{k,1}$	$v_{k,2}$	$q_{k,2}$		$v_{k,n}$	$q_{k,n}$	q_k

3.1.1 Metavariables

ODV requires availability of some types of metadata for its basic operation. The geographic location of a station, for instance, must be known to be able to plot the station in

the station map. Date and time of observation, or the names of the station and cruise (or expedition) it belongs to are needed to fully identify the station and to be able to apply station selection filters that only allow stations of given name patterns are from specific time periods. Because of this fundamental importance, ODV defines a set of mandatory metavariables providing name, location and timing information of a given station (see Table 3-3).

Other suggested metavariables are optional, and still others may be added by the user, as necessary. Metavariable values can be either text or numeric, and the respective byte lengths can be set by the user. The value type (text or numeric) of the mandatory metavariables may not be changed, while the byte length may. As an example, the data type of the longitude and latitude metavariables may be set as 8 bytes double precision to accommodate better than cm-scale precision of station location. Metavariables with values in the ranges [0 to 255] or [-32,768 to 32,767] may be represented by 1 or 2 byte integers, respectively, to conserve storage space.

Table 3-3: Mandatory and optional ODV metavariables.

Metavariable	Recommended Label
<i>Mandatory</i>	
Cruise label (text).	<i>Cruise</i>
Station label (text).	<i>Station</i>
Station type (text).	<i>Type</i>
Date and time of observation (numeric year, month, day, hour, minute and seconds).	<i>yyyy-mm-ddThh:mm:ss.sss</i>
Longitude (numeric).	<i>Longitude [degrees_east]</i>
Latitude (numeric).	<i>Latitude [degrees_north]</i>
<i>Optional</i>	
SeaDataNet station identifier (text).	<i>LOCAL_CDI_ID</i>
SeaDataNet institution identifier (numeric).	<i>EDMO_code</i>
Bottom depth at station, or instrument depth (numeric).	<i>Bot. Depth [m]</i>
...	
Additional user defined metavariables (text or numeric).	

3.1.2 Collection Variables

The collection variables represent the parameters for which data have been obtained on the samples of the stations. The total number n of collection variables Var_i (see Table 3-2) and their particular meaning are arbitrary. All collection variables must have nu-

meric values; text values are currently not supported. One of the collection variables (the *primary variable*) is special and is used for sorting the samples in ascending order of primary variable values. Usually, the first collection variable Var_1 serves as primary variable, but any other variable can be chosen for this purpose. The primary variable is defined when the collection is created.

3.2 Example Collection Types

The ODV data model described above is flexible enough to support a wide range of different data types from various fields of geosciences and environmental research. The following examples cover some of the main applications. Other, more exotic cases not listed here may also be within the scope of the ODV data model.

3.2.1 Profile Data

This category covers a wide range of observations, including, for example, oceanographic profiles made at fixed positions or along steered or passive (current following) tracks by moored or drifting instruments, or from ships. In all these cases each individual profile should be treated as an individual station, using the metavariable and collection variable assignments from Table 4. Profile data in the atmosphere, ice sheets or sediments can be organized in similar ways, the only difference being in the choice of the primary variable (e.g., height in the atmosphere, or depth in the ice or sediment core).

Table 3-4: Recommended meta- and collection variable assignments for profile data.

Metavariables	Values
Cruise	Cruise, expedition, or instrument name
Station	Unique station identifier
Type	<i>B</i> for bottle or <i>C</i> for CTD, XBT or stations with >250 samples
yyyy-mm-ddThh:mm:ss.sss	Date and time of station (instrument at depth)
Longitude [degrees_east]	Longitude of station (instrument at depth)
Latitude [degrees_north]	Latitude of station (instrument at depth)
Bot. Depth [m]	Bottom depth of station
Unlimited number of other metavariables	Text or numeric; user defined text length or 1 to 8 byte integer or floating point numbers
Collection Variables	Comment
Depth or pressure in water column, ice core, sediment core, or soil; elevation or	To be used as primary variable

height in the atmosphere; etc.	
Unlimited number of other measured or calculated va- riables	Must be numeric; 1 to 8 byte integer or floating point numbers

3.2.2 Time Series Data

This category covers observations at a given (fixed) location that are repeated over time. Examples are measurements of currents and hydrographic parameters on moored oceanographic sensors, sea level height measurements at coastal stations or meteorological observations on land stations. In all these cases the entire time series of a given instrument or station should be treated as an individual station, using a decimal time variable as primary collection variable and the other metavariable and collection variable assignments from Table 3-5.

Table 3-5: Recommended meta- and collection variable assignments for time series data.

Metavariables	Values
Cruise	Cruise, expedition, or instrument name
Station	Unique station identifier
Type	<i>B</i> for bottle or <i>C</i> for CTD, XBT or stations with >250 samples
<i>yyyy-mm-ddThh:mm:ss.sss</i>	Deployment date and time of instrument
Longitude [degrees_east]	Deployment longitude of instrument
Latitude [degrees_north]	Deployment latitude of instrument
Bot. Depth [m]	Bottom depth at station
Unlimited number of other metavariables describing the instrument and its dep- loyment depth	Text or numeric; user defined text length or 1 to 8 byte integer or floating point numbers
Collection Variables	Comment
Continous, decimal time variable or ISO8601 dates of the form 2003-02- 17T13:57:12.3 in a single column with column label time_ISO8601 .	To be used as primary variable
Unlimited number of other measured or calculated va- riables	Must be numeric; 1 to 8 byte integer or floating point numbers

3.2.3 Trajectory Data

This category covers observations made from a moving platform (e.g., ship, drifter, float, glider, airplane, etc.) that are repeated over time. Examples are underway measurements of hydrographic parameters at a given depth made during a ship expedition and from actively moving or passively drifting Lagrangean instruments. In all these cases each individual measurement made at a given location and time should be treated as an individual station, using the depth or elevation of the measurement as primary collection variable and the other metavariable and collection variable assignments from Table 3-6. Trajectory data of this form have exactly one sample per station. The number of stations equals the number of observation along the trajectory, which is usually large.

Table 3-6: Recommended meta- and collection variable assignments for trajectory data.

Metavariables	Values
Cruise	Cruise, expedition, or instrument name
Station	Unique station identifier
Type	<i>B</i>
<i>yyyy-mm-ddThh:mm:ss.sss</i>	Date and time of the measurement
Longitude [degrees_east]	Longitude of the measurement
Latitude [degrees_north]	Latitude of the measurement
Bot. Depth [m]	Bottom depth or elevation at station
Unlimited number of other metavariables describing the individual measurement	Text or numeric; user defined text length or 1 to 8 byte integer or floating point numbers
Collection Variables	Comment
Continuous, decimal time variable	To be used as primary variable
Unlimited number of other measured or calculated variables	Must be numeric; 1 to 8 byte integer or floating point numbers

3.3 Creating Collections

You create a new *ODVCF5* collection by choosing *File>New* from the menu bar. You then select a directory in which the collection should be created and specify a name¹ for the new collection. ODV then lets you define the variables that will be stored in the collec-

¹ The following characters should not be used in collection names: \ / : * ? " < > | SPACE

tion. Collection variables can be specified in a number of ways. You may use variable names from a supported template file (.txt, .odv, .var, or an ASCII spreadsheet file with arbitrary extension), you may enter the variable labels manually, or you may use pre-defined sets of variables suitable for various published oceanographic datasets. ODV will present a dialog offering all these choices and a long list of pre-defined collection variable sets. These include variable sets for ARGO profile and trajectory data, variables for the World Ocean Database published by the U.S. NODC, variable sets for various datatypes from the World Ocean Circulation Experiment (WOCE) and various variable sets for data from the Medatlas project.

If you requested to use a template file for the variable definition a file open dialog appears, and you should navigate to and select the template file you want used. You will then be prompted with a *Metavariables* dialog (Figure 3-1) that lets you manipulate the list of metavariables and edit the properties of each of these metavariables. Note that the first eleven metavariables (up to and including *Second*) are mandatory. You may change properties of mandatory metavariables (select the variable and press *Edit*), but you may not delete or reorder them. Other metavariables may be reordered, deleted, or their properties may be edited. To add additional metavariables press *New* and define the properties of the new metavariable (see *Properties* dialog below). The total number of metavariables is unlimited.

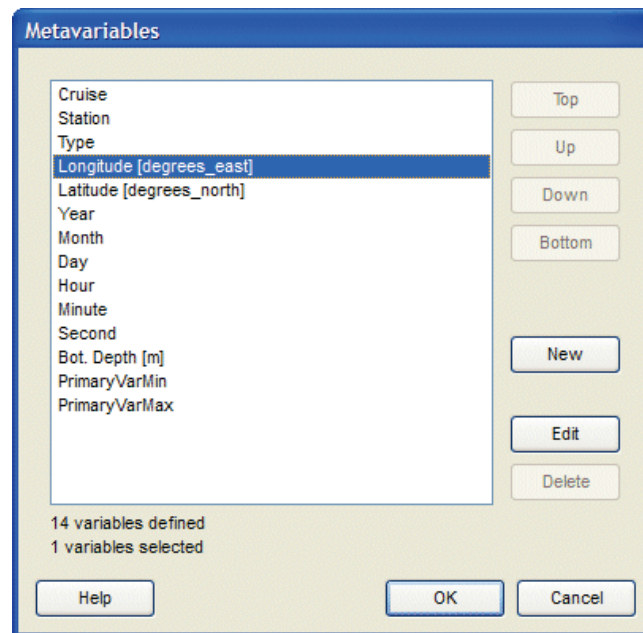


Figure 3-1: Dialog for the definition of metavariables.

If you want to inspect or modify the properties of a metavariable select it and press *Edit*. A *Properties* dialog (Figure 3-2) appears that lets you specify label and units of the variable, the number of significant digits used to display values in the current station window (if numeric), the quality flag scheme to be used for this variable, and the data

type and byte length (if text).

When entering a label or units for the metavariable you may use [formatting control sequences](#) to create subscripts, superscripts, and special symbols. Labels and units may not contain ; or TAB characters. If you need better than about 100 m precision for station positions, make sure to use datatype *DOUBLE* for longitude and latitude. Also make sure not to use datatype *TEXT* for longitude, latitude, or any of the time metavariables. For a description of the supported quality flag schemes and the mappings between the schemes see file [ODV4_QualityFlagSets.pdf](#).

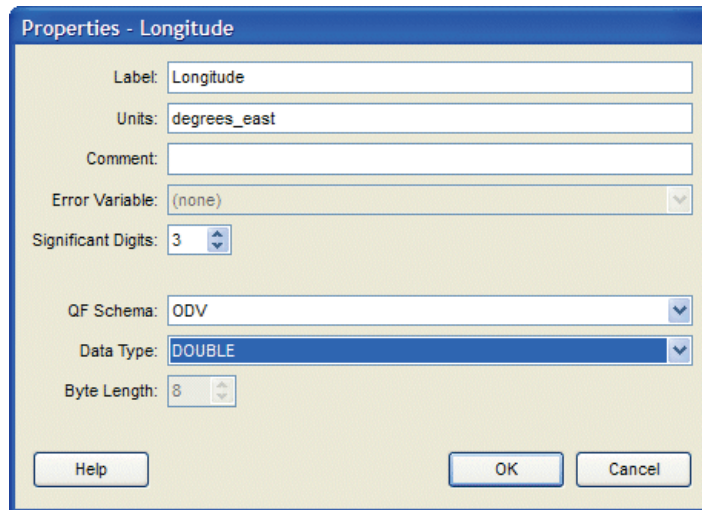


Figure 3-2: Properties dialog for meta- and collection variables.

Once the metavariables are defined, a similar dialog appears for the setup of the list of collection variables (Figure 3-3). On this dialog you may reorder or delete variables, you may add new variables, or you may edit the properties of existing variables using a dialog similar to Figure 3-2. When entering a label or units for the variable you may use [formatting control sequences](#) to create subscripts, superscripts, and special symbols. Labels and units may not contain any of the following characters: ‘;’ ‘TAB’. For a description of the supported quality flag schemes and the mappings between the schemes see file [ODV4_QualityFlagSets.pdf](#).

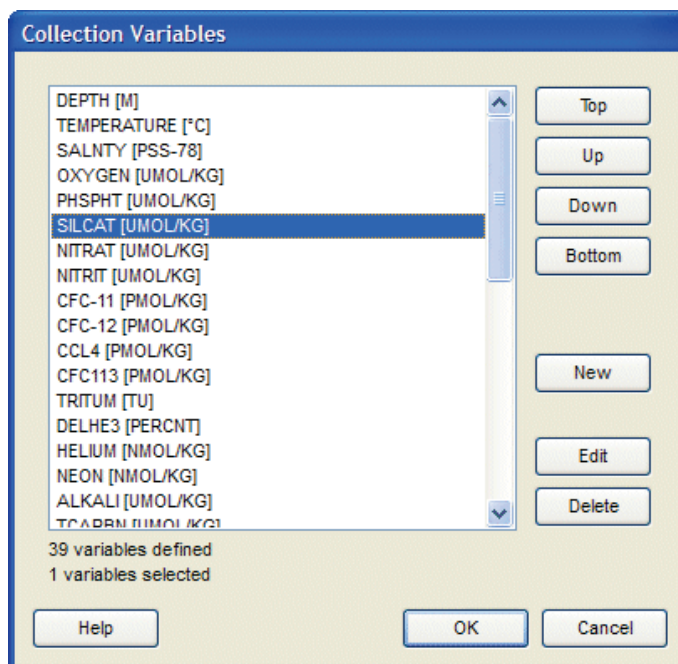


Figure 3-3: Dialog for the definition of collection variables.

As last step in the definition of new collections you have to specify the field and type of data to be stored in the collection, you have to identify the primary variable to be used to sort the samples, and you have to specify the quality flag schemes to be used for station and sample quality flags (Figure 3-4).

ODV then creates the collection and draws a global map on the canvas. Note that at this stage the collection is still empty and does not contain any station data. You must import data into the collection using options from the *Import* menu on the menu bar. Note that all dialogs that appear during collection creation contain meaningful initial settings. If you don't have special requirements you can simply press *OK* on all these dialogs to generate perfectly valid collections.

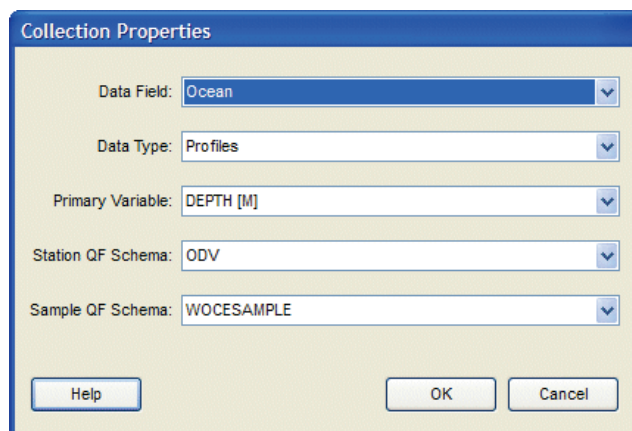


Figure 3-4: Dialog for the definition of collection properties.

3.4 Collection Files

This section provides an overview over the directory structure and the various files that make up an *ODVCF5* or *ODVGENERIC* collection, respectively. The information is provided for expert users and may be useful in case of problems or unexpected behavior. Normally, a user need not be concerned with the collection file structure.

3.4.1 ODVCF5

The information about meta- and collection variables is stored in file `<col>.odv`. This is the definition file of collection `<col>`, and this file has to be selected when opening a collection. On Windows the `.odv` filetype is associated with the ODV executable, e.g., double clicking on a `.odv` file will start ODV and open the collection. The directory containing the `.odv` file is the collection's root directory. All other files of the collection are contained in a subdirectory of the collection's root directory named `<col>.Data` (collection base directory).

The collection base directory contains the collection's metadata and data files as well as other subdirectories for specific file types, such as views and sections or graphics objects. `xview` files store view settings that define the way the user "looks" at the data in a collection. View settings include items such as map domain, station and sample selection criteria, window layout and many other parameters.

To copy or move a *ODVCF5* collection you must copy or move the `.odv` file and the `<col>.Data` directory, including all its subdirectories. ODV collection files should not be edited manually.

Table 3-7: Summary of ODVCF5 collection files. Collection names <col> may not contain / or \, and should not contain spaces for platform independence.

File	Format	Comment
Collection files		
<code><col>.odv</code>	ASCII	Defines meta- and collection variables, collection field and type. On Windows this file type is associated with the ODV executable, e.g. double-clicking on the <code>.odv</code> file will start ODV and open the collection.
Subdirectory <col>.Data		
metadata	binary	Stores the station metadata (name, position, date, etc.).
data	binary	Stores the station data and quality flags.
info	ASCII	Description of the collection (free form text format; file is optional).
inventory	binary	Collection's inventory listing by cruises.

logfile	ASCII	Collection's log file. Keeps records of data changes.
settings	ASCII	Contains settings, such as key variable identifications, name of most recently used view file, or recent import and export directories.

Table 3-8: Summary of ODVCF5 view and section files. File names <name> are arbitrary. Default location of *xview* and *sec* files is directory <col>.Data/views, but these files may also be stored in any other directory.

Extension	Format	Comment
<name>.xview	ASCII	View files storing layout, value ranges, derived and isosurface variable selections, and many other settings. The name of the collection that owns a configuration is recorded inside the <i>xview</i> file. Certain restrictions apply, if a different collection uses the <i>xview</i> file.
< name >.sec	ASCII	Stores section outlines and characteristics.

3.4.2 ODVGENERIC

The information about collection variables, station metadata and actual station data are stored in separate files (*.var*, *.hob* and *.dob*, respectively). *cfg* files store view settings that define the way the user "looks" at the data in a collection. View settings include items such as map domain, station selection criteria, window layout and many other parameters. The required *.var*, *.hob* and *.dob* files of a collection must all be located in the same directory (collection directory). *cfg* files may be stored anywhere on the disk.

ODVGENERIC collections are supported by ODV4 for reasons of backward compatibility. All new collections created by ODV4 are *ODVCF5* collections. ODV collection files should not be edited manually.

Table 3-9: Summary of ODVGENERIC collection files. Collection names <col> may not contain / or \, and should not contain spaces. All files must be located in the same directory (collection directory).

File	Format	Comment
Basic files		Must be present.
<col>.var	ASCII	Defines collection variables, stores collection name and number of stations. On Windows this file type is automatically associated with the ODV executable, e.g. double-clicking on the <i>.var</i> file starts ODV and opens the respective collection.
<col>.hob	binary	Stores the station meta-data (name, position, date, etc.).
<col>.dob	binary	Stores the actual station data and quality flags.
Info File		Optional
<col>.info	ASCII	Description of the collection (in freeform text format). ODV automati-

		cally creates an .info file containing information on dimensions and variables, when opening a netCDF file.
Auxiliary Files		Automatically created if not present
<col>.inv	ASCII	Collection inventory listing by cruises.
<col>.cid	binary	Cruise ID numbers
<col>.log	ASCII	Collection log file. Keeps records of data changes.
<col>.idv	ASCII	Lists IDs of key variables used as input for derived variables (depth, temperature, oxygen, etc.)
<col>.cfl	ASCII	Contains names of most recently used configuration file and output directory.

Table 3-10: Summary of ODVGENERIC view and section files. File names <name> are arbitrary. *cfg* and *sec* files may be located in any directory.

Extension	Format	Comment
<name>.cfg	binary	Configuration files storing layout, value ranges, derived and isosurface variable selections, and many other settings. The name of the collection that owns a configuration is recorded inside the <i>cfg</i> file. Certain restrictions apply, if a different collection uses the <i>cfg</i> file.
< name >.sec	ASCII	Stores section outlines and characteristics.

3.5 Platform Independence

Data collections and view files produced with ODV are platform independent and can be used on all supported systems (Windows, Mac OS X, Linux, and UNIX) without modification.

4 Importing Data

ODV can import new data and append the imported data to existing collections or add the data to newly created collections. Support is provided for a large variety of file formats, including many of the important oceanographic data formats as well as a wide range of column oriented spreadsheet files. Data imports can be done one file at a time, or, alternatively, by handling a potentially large number of import files in one import procedure. The import files may be selected manually via file selection dialogs or by providing a list of file names in a separate file. The *make_lst* utility is provided to facilitate the creation of import file lists on Windows (see *make_lst.README* in the *bin_w32* directory of your ODV installation). On Linux, UNIX or OS X you use the system's *ls* command to generate file lists.

4.1 ODV Spreadsheet Files

ODV can read and import data from a variety of spreadsheet-type ASCII files. If the format of the import file is **ODV generic spreadsheet format** compliant, the data import will be fully automatic and no user interaction is required. ODV generic spreadsheet files can be opened using *File>Open* or they can be dropped on the ODV window or icon. Other spreadsheet data files can also be read and imported by ODV, however, the import of these files usually requires input by the user, usually by identifying the particular columns in the import file that provide the data for meta- and data variables in the collection (e.g., longitude, latitude, date, etc.)

It is possible to import spreadsheet files with or without station metadata information and with or without column labels. ODV spreadsheet files may contain comments, and the column separation character may be TAB or semicolon ;. Missing data may be indicated by special numeric or text indicators or by empty data fields. The spreadsheet files may contain data for many stations from one or more cruises. Each station may contain an unlimited number of samples (one line per sample). The samples of a station must be in consecutive order but need not necessarily be sorted.

When reading a spreadsheet file, ODV breaks the data into stations whenever one or more of the entries for *Cruise*, *Station*, and *Type* change from one line to the next. A station break also occurs if the date changes by more than one day or the time changes by more than 12 hours, even if *Cruise*, *Station*, and *Type* remain unchanged. If *Station* information is not provided in the data file, the *Date*, *Time*, *Longitude* and *Latitude* values are checked, and a station break occurs whenever one or more of these values change. All metadata of a station, such as date, time, longitude, and latitude, are taken from the first sample line of the station in the import file.

Imported data from the file are added to the currently open data collection, or, if no collection is currently open, are added to a newly created collection.

To import data from a spreadsheet file into the currently open collection choose *Import>ODV Spreadsheet* and use the standard file-select dialog to identify the data file. Specify import options and press OK to start the data import. Spreadsheet files can also be dragged and dropped onto the ODV icon or an open ODV window.

If the file is not a generic ODV spreadsheet file, a *Spreadsheet File Properties* dialog box appears and lets you specify the column separation character and one or more missing data values. Note that multiple missing data values must be separated by one or more spaces. Fields in the import file that are empty or contain one of these values are considered missing data. You can also specify the first data line and the line containing the column labels. ODV provides reasonable defaults for all items and only a few changes should be necessary in most cases. For the *Column separator* choose the character that will give a vertical list of labels in the *Column labels* box. Press *OK* when all spreadsheet file properties are set, or press *Cancel* to abort the import.

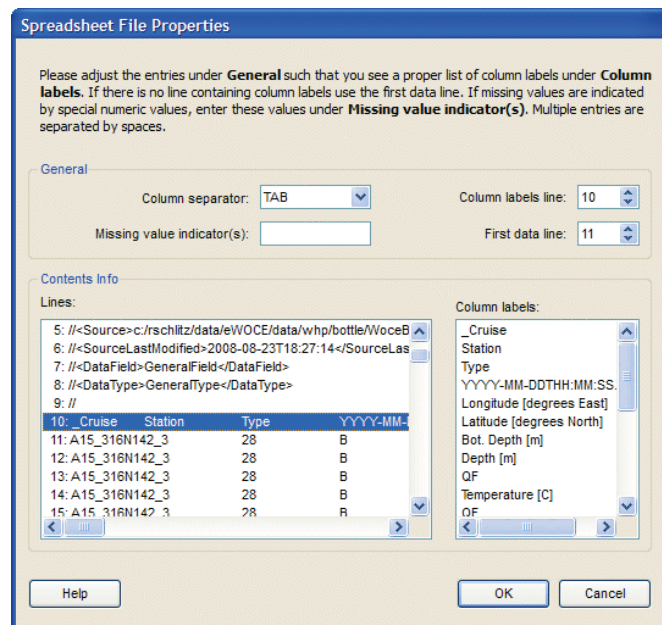


Figure 4-1: The spreadsheet file properties dialog.

If the labels for the metadata columns differ from the recommended labels defined in the *ODV generic spreadsheet format* (see below), a *Metavariable Association* dialog box appears. This dialog lets you associate input columns with the collection metavariables, or it lets you set defaults for those metavariables not provided in the input file. Already associated variables are marked by asterisks (*). See chapter *Metavariable Association Dialog* for more details.

4.2 World Ocean Database Data

You can use ODV to import original hydrographic data from the [US NODC World Ocean Database \(WOD\)](#) into existing or new data collections. ODV currently supports WOD versions 2005, 2001 and 1998, and you can use data files either from the WOD CD-ROMs or downloaded from the [WOD web site](#). To import WOD data into an existing collection, open the collection. To import into a new collection, [create the collection](#) and make sure you choose *World Ocean Database variables* when defining the collection

variables. To manually select one or more WOD data files for import into the currently open collection choose *Import>U.S. NODC Formats>World Ocean Database*. Use the standard file open dialog to select one or more WOD *.gz* data files to be imported. Choose file-type *All Files (*.*)* if you want to select WOD files that are already unzipped.

Then specify station selection criteria to be satisfied by WOD stations (simply press *OK* to import all stations falling into the current map domain), specify [import options](#) and press *OK* to start the data import. ODV will read the selected WOD data files and import all stations that satisfy the station selection criteria. The cruise labels of the imported stations consist of the WOD identifier (*WOD05*, *WOD01* or *WOD98*) followed by the two characters NODC country-code. The unique OCL profile number is used by ODV as station number. ODV recognizes and uses the NODC data quality flags found in the import files (see below). Quality flags provided by the data originators are ignored. ODV replaces invalid day information in the date of observation with the mid-month value 15.

As an alternative to manual selection of import files using the file open dialog, you can prepare an ASCII file containing the names of all the files that you want to import and then select the list file on the file open dialog. This is useful if you want to import many files from more than one directory, or, simply, if you plan to repeat the import and don't want to manually select a large number of files again. The filenames in the list file must be absolute pathnames, one filename per line. Default extension of ODV list files is *.lst*. On Windows you can use the *make_lst* utility to create import file lists (see *make_lst.README* in the *bin_w32* directory of your ODV installation). On Linux, UNIX or Mac OS X you use the system's *ls* command to generate file lists.

Once the list file is created you choose *Import>U.S. NODC Formats>World Ocean Database* and select the previously created list file. As before, you then specify station selection criteria (simply press *OK* to import all stations falling into the current map domain), specify [import options](#) and press *OK* to start the data import. ODV will read all the files listed in the list file and will import all stations satisfying the station selection criteria.

Note that ODV only imports stations falling into the current map domain. To ensure that all data from the WOD files are imported you should choose *Global Map* from the map popup menu before starting the import.

Also note that WOD data often contain a significant amount of data that have been flagged by data originators or by the U.S. NODC as being of poor or questionable quality. ODV imports and maintains the data quality information in the WOD files, and automatically maps WOD quality flags to the quality flag scheme used in the target data collection. If the target collection was created using *World Ocean Database variables*, the collection variables use the WOD quality flag scheme, and the original WOD quality flags in the import files will be maintained in the ODV collection. When viewing the data, you may want to apply data quality filters via option [View>Sample Selection Criteria](#) to exclude questionable and bad data from the analysis.

4.3 World Ocean Atlas Data

You can use ODV to import original hydrographic data directly from the distribution

CDs of the *World Ocean Atlas 1994* by choosing *Import>World Ocean Atlas 94>Single File*. Use the standard Windows file-select dialog to identify the data file (*.ol) of the WOA94 data set that you want to import. Specify station selection criteria to be satisfied by WOA94 stations (simply press *OK* to import all stations falling into the current map domain), specify import options and press *OK* to start the data import. ODV will read the selected WOA94 data file and import all stations that satisfy the station selection criteria.

You can import data from multiple WOA94 files using the same station selection criteria and import options in a single import operation. To do so, prepare an ASCII file (default extension *.lst*) containing the names of the files to be imported (full pathnames, one per line). Choose *Import>World Ocean Atlas 94>Multiple Files*, specify station selection criteria to be satisfied by WOA94 stations (simply press *OK* to import all stations falling into the current map domain), specify import options and press *OK* to start the data import. ODV will read all the files listed in the ASCII file and will import all stations that satisfy the station selection criteria.

Note that ODV only imports stations falling into the current map domain. To ensure that all data from the WOD files are imported you should choose *Global Map* from the map popup menu before starting the import.

4.4 ARGO Float Data

You can use ODV to import float profile and trajectory data from single or multiple ARGO netCDF version 2.2 or 2.1 format files into ODV float profile or trajectory data collections. ARGO files can be downloaded from the Coriolis and GODAE data centers at <http://www.coriolis.eu.org/cdc/argo.htm> and <http://www.usgodae.org/argo/argo.html>.

ARGO profile or trajectory data should be imported into data collections using the ARGO profile or trajectory variables. If you don't already have such a collection open, create one using the *File>New* option. When prompted to define the collection variables choose *ARGO profile variables* or *ARGO trajectory variables* depending on the type of data that you want to import. To initiate the data import choose *Import>ARGO Formats>Float Profiles (netCDF v2.2 or v2.1)* or *Import>ARGO Formats>Float Trajectories (netCDF v2.2 or v2.1)*. ODV then presents a standard file open dialog and lets you select one or more ARGO netCDF data files in a given directory. Alternatively, you may select an ASCII file containing the list of file names to be processed. This list file has to be prepared before you start the import. It must contain one filepath entry per line, and the file paths must be either absolute pathnames or pathnames relative to the currently open collection. The list file must have extension *.lst*. On Windows you can use the *make_lst* utility to create import file lists (see *make_lst.README* in the *bin_w32* directory of your ODV installation). On Linux, UNIX or Mac OS X you use the system's *ls* command to generate file lists.

ODV then displays the **import options dialog**. If you import into a collection created for ARGO float profile or trajectory data (see above) you may simply press *OK* to start the data import.

The variables in ARGO profile or trajectory collections include pressure, temperature, salinity and oxygen. These variables come in three versions: (1) the real-time or raw data (first group), (2) the delayed-mode or adjusted data (second group; suffix (*adj.*) in the variable label), and (3) the adjustment errors (third group; suffix (*adj. error*) in the variable label). Note that in real-time data files there are no data for groups 2 and 3.

ARGO data quality flags in the netCDF file are recognized and converted to the quality flag schemes of the target variables during import. If the target collection is an ARGO profile or trajectory collection created by ODV4 or later, no quality flag conversion occurs, and the original ARGO quality flag values are stored in the collection. For details of the quality flag mapping see the file *ODV4_QualityFlagSets.pdf*. Any Depth values in ARGO profile files are converted to pressure during import.

For ARGO profile data, the ODV station name consists of cycle number, profile direction (if available; A ascending, D descending), the data mode (R real time data, D delayed mode data, A real time data with adjusted values), and the project name (if available). The ARGO platform number is used for *Cruise*.

When importing ARGO trajectory files, ODV averages pressure, temperature, salinity and oxygen values for given float cycles (pressure > 100 dB required), and uses these average values in the collections. Only records with valid geographical position are imported.

Once imported, you may filter the data and exclude bad data from the analysis by setting appropriate quality flag selection criteria via the *View>Sample Selection Criteria* option.

4.5 WOCE Hydrographic Data

You can use ODV to import original hydrographic data in WHP exchange format into existing or new data collections. WHP exchange format data files can be found at the WHP DAC (<http://whpo.ucsd.edu/>) or on the final WOCE data release on DVD-ROM. To import the data into an existing collection, open the collection. To import into a new collection, create the collection and make sure you choose either *WOCE WHP Bottle variables* or *WOCE WHP CTD variables* when defining the variables to be stored in the collection.

To import WHP exchange format bottle data into the currently open collection choose *Import>WOCE WHP Bottle (exchange format)>Single File* from ODV's main menu. Use the standard file-selection dialog to select the WHP data set. Note that the default extension of WHP exchange files is *.csv*. If your data file has a different extension, choose file-type *All Files* in the file-selection dialog. Then specify import options and press *OK* to start the data import. ODV will read and import all stations in the data file. ODV identifies and imports the WOCE data quality flags in addition to the actual data values. These quality flags can later be used to filter the data by excluding, for instance, bad or questionable data from the analysis. You can modify the data quality filter by choosing selection criteria from the map popup menu (choose the *Sample Selection* tab).

To import CTD data into the currently open collection, choose *Import>WOCE WHP CTD*

(*exchange format*)>*Single File* from ODV's main menu and select the .zip file that contains the CTD data to be imported. Then specify vertical sub-sampling parameters or keep the default setting, which is no sub-sampling. ODV will then unpack the .zip file and import all CTD stations into the currently open collection.

You can import data from multiple WHP exchange files in a single import operation. In such a case the same import options are used for all files imported during the operation. For multi-file data import you have to prepare a ASCII file with default extension *.lst* that contains the names of the files to be imported. Use full pathnames, and specify one file name per line. Then choose either *Import>WOCE WHP Bottle (exchange format)>Multiple Files* or *Import>WOCE WHP CTD (exchange format)>Multiple Files*, specify import options and press OK to start the data import.

Note that ODV can handle up to 20,000 samples per station. CTD stations with more samples are truncated. Also note that ODV automatically converts pressure in the source files to depth in the collection. If you need pressure as a variable, you should establish the derived variable *Pressure(Depth)*.

During import, ODV maps WHP or IGOSS quality flags found in the WOCE import files to corresponding ODV quality flags. For details of the quality flag mapping see the Appendix. You may exclude *questionable* and/or *bad* data from the analysis by setting appropriate quality flag selection criteria via the *Configuration>Selection Criteria>Quality* option.

4.6 SD2 Hydrographic Data

You can use ODV to import original hydrographic data from NODC SD2 files into existing or new data collections. To import into an existing collection, open the collection. To import into a new collection, create the collection and make sure you choose *NODC SD2 variables* when defining the variables stored in the collection. To import SD2 data into the currently open collection choose *Import>NODC SD2 Format>Single File*. Use the standard file-selection dialog to identify the data file to be imported. Specify import options and press OK to start the data import.

If you want to import multiple SD2 files in one import operation, put all the SD2 files in a single directory and produce a file containing the list of SD2 file-names that you want to import (default list-file extension *.lst*; one file-name per line). Choose *Import>NODC SD2 Format>Multiple Files* and select the list-file.

4.7 Medatlas Format Data

The Medatlas format was used to create the MEDAR/Medatlas 2002 data compilation, containing water column data for the Mediterranean and Black Sea (MEDAR Group, 2002 - MEDATLAS/2002 database, Mediterranean and Black Sea database of temperature salinity and bio-chemical parameters. Climatological Atlas. IFREMER Edition (4 CDs)). The Medatlas format is also used for various types of time series data, ranging from current meters, thermistor chains, sea level gauges, meteorology buoys to sediment traps.

ODV lets you import all these diverse data types. Because variable sets for the different data types differ greatly, it is essential to ensure that the receiving data collection uses a matching set of variables. There are predefined variable sets for Medatlas bottle and CTD profile data, as well as two variable sets for time series data (one for sediment trap data and one for all other time series data). When creating new collections for Medatlas data the user should choose the appropriate variable set (see below).

Medatlas formatted data can be imported into arbitrary ODV data collections; however, manual associations of Medatlas import variables with the collection target variables are usually required. To facilitate data import and avoid manual variable associations you should create target collections using the appropriate Medatlas variables sets. To create such collections use the *File>New* option. When prompted to define the collection variables choose *Medatlas Bottle variables* for Medatlas bottle data, *Medatlas CTD variables* for Medatlas CTD, XBT or MBT data, *Medatlas Sediment Trap variables* for Medatlas sediment trap data, or *Medatlas Time Series variables* for all other Medatlas time series data (e.g., data from current meters, thermistor chains, sea level gauges, or meteorology buoys).

To initiate the data import choose *Import>Medatlas Formats>Profile Data* for bottle, CTD, XBT or MBT data or *Import>Medatlas Formats>Time Series Data* for any kind of time series data. Both import types allow selection of one or more Medatlas data files to be imported. Alternatively, you may also select a text file containing the list of file names to be processed. This list file has to be prepared before starting the import. It must contain one file entry per line, and the file names must be either absolute pathnames or pathnames relative to the currently open collection. The list file must have extension *.lst*. On Windows you can use the *make_lst* utility to create import file lists (see *make_lst.README* in the *bin_w32* directory of your ODV installation). On Linux, UNIX or Mac OS X you use the system's *ls* command to generate file lists. ODV then shows the **import options** dialog and then starts the data import.

Note that Medatlas time series and sediment trap data collections created by ODV4 or later contain a metavariable *Instrument Depth* that contains the deployment depths of the respective instruments, such as current meters, thermistors, sea level gauges, meteorology buoys or sediment traps.

Multiple variables in Medatlas profile data files of the same type but in different units are merged during import, possibly involving unit conversions and/or offset corrections.

The following merging operations are performed:

Salinity [psu] =

1 *	(PSAL PRACTICAL SALINITY P.S.U.)	+ 0
1 *	(SSAL SALINITY (PRE-1978 DEFN) P.S.U.)	- 0.004

Oxygen [ml/l] =

1 *	(DOX1 DISSOLVED OXYGEN ml/l)	+ 0
0.02297 *	(DOX2 DISSOLVED OXYGEN micromole/kg)	+ 0
0.02241 *	(DOXY DISSOLVED OXYGEN millimole/m3)	+ 0

Silicate [millimole/m3] =

1 *	(SLCA SILICATE (SiO4-Si) CONTENT millimole/m3)	+ 0
1.025 *	(SLCW SILICATE (SiO4-Si) CONTENT micromole/kg)	+ 0

Nitrate + Nitrite [millimole/m3] =

1 *	(NTRZ NITRATE + NITRITE CONTENT millimole/m3)	+ 0
1.025 *	(NTZW NITRATE + NITRITE CONTENT micromole/kg)	+ 0

Phosphate [millimole/m3] =

1 *	(PHOS PHOSPHATE (PO4-P) CONTENT millimole/m3)	+ 0
1.025 *	(PHOW PHOSPHATE (PO4-P) CONTENT micromole/kg)	+ 0

Alkalinity [millimole/m3] =

1 *	(ALKY ALKALINITY millimole/m3)	+ 0
1.025 *	(ALKW ALKALINITY micromole/kg)	+ 0

In each case the list of alias variables is traversed until a (possibly converted) value is found. Note that the density ρ of the sample at laboratory conditions is needed for the conversion from volumetric units (e.g., millimole/m³) to per unit mass units (e.g., micromole/kg)². This information, however, is not included in the Medatlas files, and an approximate conversion formula has to be applied. Using a constant density value of $\rho=1.025$ [kg/l] as above introduces errors smaller than 0.2% and seems permissible.

The GTSP quality flags in Medatlas data files are recognized and converted to the quality flag schemes of the target variables during import. If the target collection is a Medatlas profile, time-series or sediment trap collection created by ODV4 or later, no quality flag conversion occurs, and the original GTSP quality flag values are stored in the collection. For details of the quality flag mapping see the file [ODV4_QualityFlagSets.pdf](#).

4.8 Other Hydrographic Data

In addition to the specific import formats described above, ODV also supports the import of data from a variety of other formats, including Java Ocean Atlas spreadsheet format as well as the netCDF formats of most WOCE data streams. To import data in one of these formats into the currently open collection select the appropriate option from the *Import* menu. Note that for many import routes there is a choice between selecting one or more import files on file dialogs and providing a list file containing the names of the files to be imported. In all cases the user has to specify appropriate import options. During import, ODV maps data quality flags found in the import files to corresponding ODV quality flags of the meta- and collection variables. For details of the quality flag mapping see file [ODV4_QualityFlagSets.pdf](#). ODV also supports a wide variety of other spreadsheet formats, including simple three column files with XYZ data.

² Gordon, L. I., J. Joe C. Jennings, A. A. Ross, and J. M. Krest, 1993: A Suggested Protocol for Continuous Flow Automated Analysis of Seawater Nutrients (Phosphate, Nitrate, Nitrite and Silicic Acid) in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study/WHO 91-1, 55 pp (see page 48f).

4.9 Associate Metavariables Dialog

When importing data, ODV will try to automatically detect the sources in the import file for mandatory metadata, such as cruise and station names, date of observation and geographical location. If this automatic association of metavariables is not successful the *Associate Metavariables* dialog appears (see Figure 4-2), asking the user to identify the sources of metadata manually.

To define a new association select items in the *Source Variables* and *Metavariables* lists and press *Associate*. To invoke a conversion during import press *Convert* and choose one of the available conversion algorithms. To delete an existing association, select the respective variables and press *Undo*. If the import file does not contain information for a given metavariable you can specify a default value as follows: (1) select the respective metavariable; (2) press *Set Default* and (3) enter the default value. Note that the specified default settings are used for all data lines in the file. Press *OK* when done or *Cancel* to abort the import procedure. Finally specify import options and press *OK* to start the data import.

Note that associations or conversions of composite source variables, such as the ISO 8601 date and time specification *YYYY-MM-DDTHH:MM:SS.SSS* will automatically connect with multiple metavariables (e.g., Year, Month, Day, etc.).

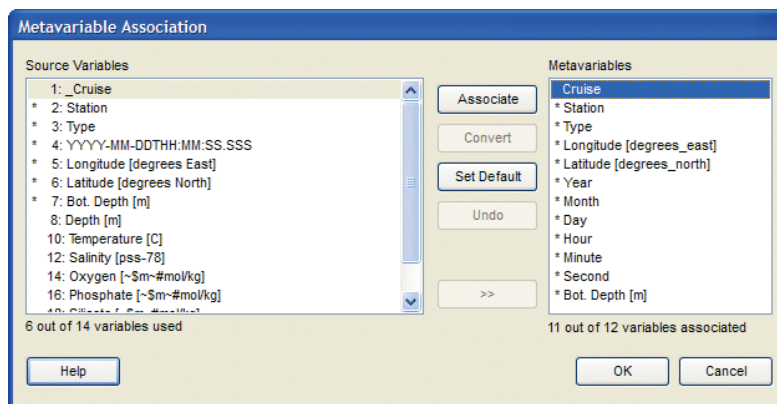


Figure 4-2: The Associate Metavariables dialog

4.10 Import Options Dialog

When importing data, ODV will present an *Import Options* dialog that lets you control the actions taken during data import (see Figure 4-3).

Import Mode

Add/Replace Station Data: Choose this option if you want to add data from the import file to the collection. If the *Check for existing stations* box is checked, ODV searches the collection for stations with the same name, date and position and (if found) asks for permission to replace the existing station in the collection with the

new version from the import file (see *Cruise Label Association* below for a description of the station search procedure).

Merge Data (selected variables): Choose this option if you want to add data for one or more variables (merge variables) and leave existing data for other variables unchanged. A *merged* value of a *merge variable* at a given sample depends on existing and new variable values according table 4-1. Note that the *Check for existing stations* box cannot be unchecked for this mode. Before adding data, ODV searches the collection for matching stations (see *Cruise Label Association* below for a description of the station search procedure) and if found, reads the original station from the collection, adds the data for the selected variables and replaces the original station with the updated version. If no matching station is found, the user is notified.

Table 4-1: Results of merging existing and imported values.

Existing value	New value	Merged value
yes	yes	Average of existing and new values
yes	no	Existing value
no	yes	New value
no	no	Missing value

Update Data (selected variables): Choose this option if you want to update data for one or more variables (update variables) and leave existing data for other variables unchanged. An "updated" value of an "update variable" at a given sample only depends on the new variable values and existing values are discarded. Note that the *Check for Existing Stations* box cannot be unchecked for this mode. Before updating data, ODV searches the collection for matching stations (see *Cruise Label Association* below for a description of the station search procedure) and if found, reads the original station from the collection, updates the data for the selected variables and replaces the original station with the updated version. If no matching station is found, the user is notified.

Cruise Label Association

When replacing or merging data, ODV first searches the target collection for an existing station matching the given station to be imported. This search is made by comparing cruise name, station name, station type, longitude, latitude and date. For a successful match, station name and station type are required to be identical. Longitudes and latitudes must agree within a 0.2° tolerance, and the dates may deviate by at most one day. For cruise names, you can establish alias names using the *Target* and *Source* combo-boxes. If, for instance, in the existing collection a set of stations is named 06MT15/3 and in the import file the same stations are named METEOR15/3 you can set up an alias name by first choosing 06MT15/3 from the Target combo-box and then typing METEOR15/3 in the source field. Exact cruise name matches are required if no aliases are defined.

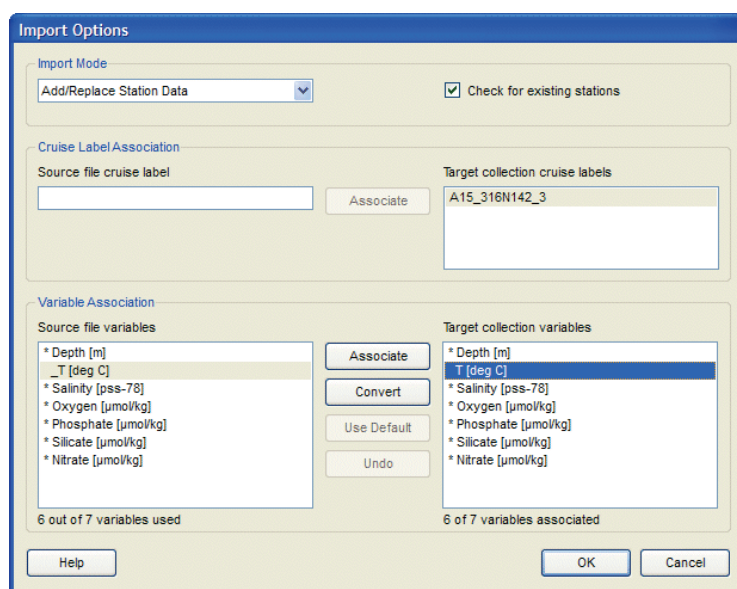


Figure 4-3: The Import Options dialog

Variable Association

Usually the number, order and meaning of variables stored in the import file differ from the number, order and meaning of variables stored in the collection. Therefore you must establish a source/target association of variables. ODV automatically associates variables with matching labels (name and units). Note that associated variables are marked with a *. You can click on such a variable to identify its associated variable.

To establish a variable association manually click on the respective source variable, then click on the target variable to be associated with the source variable and either press the *Associate* or *Convert* buttons. Use *Associate* if the data values in the import file should be imported without modification, but use *Convert* if you need to transform units during import. When using *Convert*, you can choose be-

tween predefined, commonly used transformations and you can establish your own general linear transformation formula.

For ODV Spreadsheet imports you can set default values for target variables for which no corresponding source variable is provided in the import file. This is useful, for instance, if you import longitude/latitude maps of some quantity Z from ASCII files containing three columns X, Y, Z, but not containing data for the specific surface or depth level. To set a default value for a target value, first select a the variable in the *Target Collection* list, then press the *Use Default* button and enter the desired default value for this target variable. Note that this target variables is now marked with a + sign. The specified value will be used for every sample of every station imported during this operation.

Source variables not associated with a target variable will not be imported into the collection. If you merge data into the collection, establish associations only for those variables that you want to add to the collection. Note that the primary variable of the collection must be associated in any case.

5 Exporting Data

5.1 Spreadsheet Files

You can export the data of the currently selected stations into a single ASCII ODV generic spreadsheet file by choosing *Export>ODV Spreadsheet* from ODV's menu bar. Then choose target directory and filename, select the variables to be included in the export file (default: all basic variables) and specify additional properties of the export file to be written. Note that spreadsheet files can be re-imported into ODV using the *Import>ODV Spreadsheet* option or by simply dropping the file onto the ODV icon. Note that output filenames may not contain any of the following characters “\” “/” “:”. They should not contain spaces.

5.2 ODV Collection

You can export the data of the currently selected stations into a new ODV collection by choosing *Export>ODV Collection* from ODV's main menu. Then select the variables to be included in the new collection (default: all variables) and specify destination directory and file-name using the standard file-select dialog-box. Note that valid ODV collection names may not contain spaces or any of the following characters: \ / :.

5.3 Exporting X, Y, Z Window Data

You can export the data values displayed in ODV plot windows to separate ASCII files by choosing *Export>X, Y, Z Window Data* from the ODV menu bar. Enter a descriptive text identifying the data of this export in the *ID String* field and click *OK*. ODV will create a sub-directory in the local ODV directory (normally <home>\odv_local) named *export\<ID String>*. All exported files will be written to this directory. If it already exists, ODV asks for your permission to delete all files from the directory before continuing. Note that the names of the exported files start with *win?*, where *?* represents the respective window number. The actual X, Y, Z data are found in files *win?.oai* (one data point per line; fourth column always 1).

For windows with gridded fields, ODV also exports the results of the gridding operation (files *win?.oao*). The format of the *.oao* files is as follows:

\emptyset	(ignore)
$n_x \ n_y$	(no of x and y grid-points)
... n_x X-grid values ...	(X-grid positions)
... n_y Y-grid values ...	(Y-grid positions)
... n_x*n_y gridded values ...	(estimated field, line by line starting at first Y-grid value)
... n_x*n_y gridded values ...	(estimation quality, line by line starting at first Y-grid value)

5.4 *Exporting Reference Datasets*

You can save the original data of the current plot windows in separate ASCII files and use these data later as *reference datasets* by choosing *Export>X, Y, Z Window Data as Reference* from ODV's menu bar. Enter a descriptive text identifying the reference data in the *ID String* field and click *OK*. ODV will create a sub-directory in the local ODV directory (normally <home>\odv_local) named *reference\< ID String>* and writes all files to this directory. If the directory already exists, ODV asks for your permission to delete the current contents before continuing. Reference data are used by ODV for defining difference variables.

5.5 *Exporting Isosurface Data*

You can export the isosurface data of all stations currently shown in the map by selecting *Export>Isosurface Variables* and choosing a target directory and output filename. The output file includes the metadata of the stations and is ODV generic spreadsheet format compliant.

6 Derived Variables

In addition to the basic variables stored in the collection files, ODV can calculate a large number of derived variables which (once defined) are available for analysis and use in the data plots in the same way as the basic variables. There are three types of derived variables:

- **built-in derived variables** including many commonly used parameters from physical and chemical oceanography.
- **macro files** of user defined expressions stored in files for use with arbitrary ODV collections.
- **expressions** defined by the user *on-the-fly* for the current collection only.

To define or delete derived variables choose the *Derived Variables* option from the **current sample window** popup menu or *View>Derived Variables* from the menu bar. To add a macro, choose *Macro File* from the *Choices* list; to add a user defined expression choose *Expression*. To add a built-in derived variable choose any other item in the *Choices* list.

6.1 Built-in Derived Variables

Algorithms for many physical oceanographic parameters, such as potential temperature, potential density (relative to arbitrary reference pressures), neutral density, Brunt-Väisälä Freq., and dynamic height, are built into the ODV software. In addition, various parameters of the carbon dioxide system in seawater, the saturation concentrations and partial pressures of many gases and many other variables from chemical oceanography are also available as easily selectable derived variables. Some useful mathematical expressions, such as the ratio of two arbitrary variables as well as vertical integrals and derivatives, are also available. A list of built-in derived variables is shown below. All these variables can be requested by the user, they are then calculated by ODV on-the-fly, and they can be analyzed and visualized in the same way as the basic variables stored in the collection files.

To define or delete built-in derived variables choose the *Derived Variables* option from the **current sample window** popup menu. ODV will show lists of available and already defined derived variables. To add a derived variable select an item from the *Choices* list and press *Add*. If you define a derived variable that needs additional parameters (e.g., potential temperature and potential density requiring the reference pressure) you have to provide this information on dialog boxes that appear automatically. Many derived variables also require identification of the input variable(s) needed for the calculation of the derived variable. Note that this identification of key variables has to be done only once and that the associations are remembered by ODV. Use option *Collection>Identify Key Variables* to verify and modify **key variable associations**. Note that the calculated values of derived variables may be wrong, if key variable associations are not correct.

To delete a derived variable select this variable in the *Already Defined* list box and press *Delete* or simply double-click on the item to be deleted. Note that when deleting a varia-

ble that is required as input by other derived variables, these child variables are deleted as well. To edit the parameters of a derived variable, or the expressions of ODV macros and expressions (for more information on these special derived variables see below) select the respective variable in the *Already Defined* list box and press *Edit*.

Table 6-1: List of built-in derived variables

Variable	Comment
AOU [$\mu\text{mol}/\text{kg}$]	Apparent oxygen utilization
Brunt-Väisälä Frequency [cycl/h]	EOS80
CFC-11 Saturation [%]	Warner & Weiss, Deep Sea Res., 32,1485-1497,1985
CFC-12 Saturation [%]	Warner & Weiss, Deep Sea Res., 32,1485-1497,1985
CFC-10 Saturation [%]	Bullister & Wisegarver, Deep Sea Res., 45,1285-1302,1998
CFC-113 Saturation [%]	Bu & Warner, Deep Sea Res., 42,1151-1161,1995
CH ₄ Saturation [%]	Wiesenburg & Guinasso, J. Chem. Eng. Data,24,356-,1979
CO ₂ (TCO ₂ ,TALK) [$\mu\text{mol}/\text{kg}$]	(details)
CO ₃ ²⁻ (TCO ₂ ,TALK) [$\mu\text{mol}/\text{kg}$]	(details)
Day of Month(station date)	Day of the Month derived from station date
Day of Month (time variable)	Day of the Month derived from a time variable
Day of Year(station date) [days]	Day of the Year [days] derived from station date
Day of Year(time variable) [days]	Day of the Year [days] derived from a time variable
Difference from Reference Data	(details)
Dynamic Height [dyn m]	EOS80 (any reference pressure)
fCO ₂ (TCO ₂ ,TALK) [μAtm]	(details)
Freezing Temperature [°C]	F. Millero, UNESCO Tech. Papers in the Marine Science, No. 28., 29-35, 1978
HCO ₃ ⁻ (TCO ₂ ,TALK) [$\mu\text{mol}/\text{kg}$]	(details)
Latitude	Decimal latitude derived from station latitude
Longitude	Decimal longitude derived from station longitude
Month of Year(station date)	Month of Year derived from station date
Month of Year(time variable)	Month of Year derived from a time variable
Neutral Density [kg/m^3]	Jackett & McDougall, J. Phys. Ocean., 237-263, 1997 (more)
Omega _A (TCO ₂ ,TALK)	(details)
Omega _C (TCO ₂ ,TALK)	(details)
Oxygen Saturation [%]	Weiss, Deep Sea Res., 17, 721-735, 1970
pCFC-11 [pptv]	Warner & Weiss, Deep Sea Res., 32,1485-1497,1985
pCFC-12 [pptv]	Warner & Weiss, Deep Sea Res., 32,1485-1497,1985
pCFC-10 [pptv]	Bullister & Wisegarver, Deep Sea Res., 45,1285-1302,1998
pCFC-113 [pptv]	Bu & Warner, Deep Sea Res., 42,1151-1161,1995
pCH ₄ [ppbv]	Wiesenburg & Guinasso, J. Chem. Eng. Data,24,356-,1979
pCO ₂ (TCO ₂ ,TALK) [μAtm]	(details)
pH _{tot} (TCO ₂ ,TALK)	(details)
Potential Density [kg/m^3]	EOS80 (any reference pressure)
Potential Temperature [°C]	Bryden, Deep Sea Res.,20,401-408, 1973 (any reference pressure)
Potential Vorticity [$10^{-12} \text{ m}^{-1} \text{ s}^{-1}$]	Planetary potential vorticity (derived from Brunt Vaissala Frequency $Q=f/g*N^2$)
Pressure [db]	Saunders, J. Phys. Ocean., 1981

Quality Flag	Any variable
Ratio	Any two variables
Revelle Factor(TCO ₂ ,TALK)	$(d fCO_2 / d TCO_2) / (fCO_2 / TCO_2)$. (details)
Sound Speed [m/s]	Fofonoff & Millard, Unesco Tech. Pap. in Mar. Sci., No. 44, 53 pp, 1983
Specific Heat C _p [J/(kg °C)]	F. Millero et al, J. Geoph. Res., 78, 4499-4507, 1973
Specific Volume Anomaly [mm ³ /g]	EOS80 (any reference salinity and temperature)
Time(station date&time) [yr]	Decimal time [yr] derived from station date and time
Time(time variable) [yr]	Decimal time [yr] derived from a time variable
Vertical Derivative	Any variable
Second Vertical Derivative	Any variable
Vertical Integral	Any variable
Year(station date)	Year derived from station date
Year(time variable)	Year derived from a time variable

Brunt-Väisälä Frequency

Brunt-Väisälä Frequency is calculated as follows: For a given profile, ODV first establishes a sequence of standard depths and projects the observed pressures, temperatures and salinities onto these standard depths. Then Brunt-Väisälä Frequency is calculated for every standard-depth interval and assigned to the interval mid-point. Finally the mid-point Brunt-Väisälä Frequency values are projected back to the original pressure (or depth) values of the profile. Projection of values is done using linear least-squares interpolation.

Parameters of the carbon dioxide system in sea water

The following parameters of the carbon dioxide system in sea water are provided as derived variables:

1. pH (total scale),
2. Fugacity and partial pressure of CO₂ (fCO_2 and pCO_2),
3. Concentrations of CO₃²⁻, CO₃²⁻, and HCO₃⁻,
4. Revelle, or homogeneous buffer, factor,
5. Solubility ratios $[CO_3^{2-}] \cdot [Ca^{2+}] / K_{sp}$ for calcite and aragonite, Omega_C and Omega_A.

All these quantities are calculated as functions of *in-situ* depth (or pressure), temperature, salinity, total inorganic carbon (TCO₂), total alkalinity (TALK), phosphate and silicate. If phosphate and/or silicate data are not available, concentration values of zero are assumed. ODV uses the alkalinity definition of Dickson (1981) and treats all terms except HS, S and NH₃. pH is calculated using an iterative Newton method.

The choice of equilibrium constants follows Dickson&Goyet (1994): K_1 , K_2 are from Roy et al. (1993), K_0 is from Weiss (1974), K_B is from Dickson (1990), K_S is from Dickson (1990), K_F is from Dickson&Riley (1979), K_W is from Millero (1995), K_{1p} , K_{2p} , K_{3p} and K_{Si} are from Millero (1995), and the solubility products K_{sp} of calcite and aragonite are from Mucci (1983). The pressure dependence of the equilibrium constants is from Mil-

lero (1995). Typographical errors in various publications (as summarized in Lewis&Wallace (1998)) are considered.

The carbon chemistry implementation in ODV (versions 2.1 and later) has been checked by comparing with other, independent software output, and ODV results have been found to be in very good agreement with output from the CO2SYS.EXE application of Lewis&Wallace (1998). Note that pre-2.1 ODV versions calculated "potential" pH and carbon system parameters, e.g., the values a water parcel would have if raised to the surface adiabatically. These values are different from the *in-situ* values obtained by ODV versions 2.1 and later.

DOE (U.S. Department of Energy). 1994. Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water. Version 2. ORNL/CDIAC-74. A. G. Dickson and C. Goyet (eds.), Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Lewis, E., and D. W. R. Wallace. 1998. Program Developed for CO2 System Calculations. ORNL/CDIAC-105. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.

Vertical Integral

Select the variable for which the vertical integral is to be calculated (designated A in the following; any basic or already defined derived variable can be used) and specify the starting depth z_0 for the integral (default: 0 m). For each sample of a given station, ODV will calculate the integral $A \cdot dz$ from z_0 to the respective level. The units of the integral are the units of the quantity A times the units of depth (note that ODV4 uses *m* whereas previous ODV versions used *km*). For variables with volumetric concentration units (e.g., moles per cubic meter) the calculated integral is equivalent to "standing stock per square meters". Note that by definition the value of the integral at z_0 is zero. (*Example:* To obtain the salt content in the top 500 m of the water column, select salinity as variable for the integral and use 0 as start value. Then look up the value of the vertical integral at 500 m (by interpolating between neighboring points) or in SURFACE mode define the integral at depth=500 as an isosurface variable.)

6.2 Macros

You can implement new derived variables not included in the list of built-in derived quantities provided that the value of your new derived variable for a specific sample only depends on other variable values of the same sample. In these cases you specify the input variables and the expression of the new derived quantity in a macro file. Macro files must have the extension *.mac*, they must be located in the ODV macros directory (<home>\odv_local\macros) and their format must follow the specifications given below. You can use the ODV Macro Editor (invoked by: *Tools>Invoke Macro Editor*) to facilitate macro definition. Use the example macro files distributed with ODV as sample files for your own definitions.

You activate a macro derived variable by selecting *Derived Variables* from the current sample window popup menu and choosing *Macro File* from the list of available quantities. Then select one of the macro files found in the ODV macros directory

<home>\odv_local\macros and identify the variables needed to calculate the new quantity. If one of the required variables is not available, press *Not Available* to abort setup of the macro file.

6.2.1 Macro Editor

You can create and edit Ocean Data View macro files using the *Tools>Macro Editor* option. Select an existing macro file or choose a new macro name and define the macro following the instructions below. When done press *Save As* and specify a name for the macro.

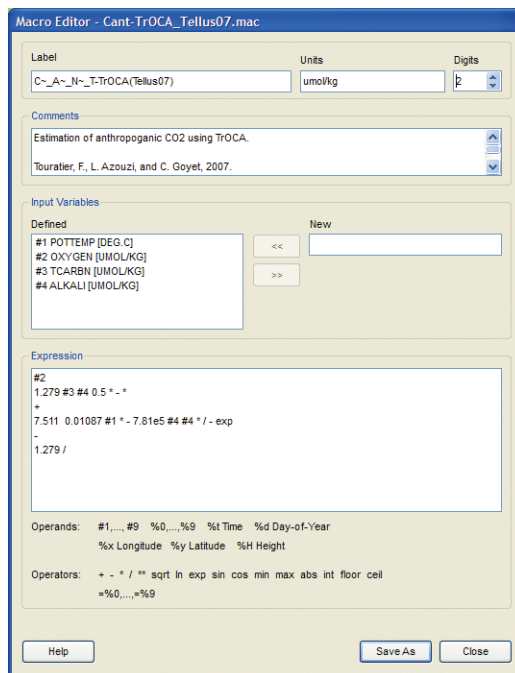


Figure 6-1: The macro editor dialog

Macro Variable

- Label:** Enter the label of the macro variable. Use [formatting control sequences](#) for greek symbols, exponents or indices.
- Units:** Enter the units of the macro variable. Use [formatting control sequences](#) for greek symbols, exponents or indices.
- Digits:** Enter the number of significant digits for the display of values in the current sample window.

Comments

Enter one or more comments lines describing the macro variable.

Input Variables

List of input variables needed for the macro variable. To add an input variable, enter its label and units into the *New* field and press the << button (note that you can use [formatting control sequences](#)). If you want to delete a defined input variable, select it in the

Defined list-box and press the >> button. The number of input variables is unlimited.

Expression

In the *Expression* field you specify the algebraic operations to be performed when the macro variable is evaluated. You can use the operators **+** **-** ***** **/** ****** for the basic arithmetic operations, **sqrt** for the square root, **min** and **max** for minimum and maximum of two operands, **ln** and **exp** for the natural logarithm and exponential, **sin** and **cos** for sine and cosine (arguments in radians), **abs** for the absolute value, and **int**, **floor**, **ceil** for integer parts of the argument, respectively. You specify the macro formula using the [Reverse Polish Notation](#), where operands precede operators. You use, terms of the form **#1**, **#2**, etc. to reference the values of the input variables.

Use the symbol **%H** for the elevation at the station position (given in meters above sea level; positive for land and negative for ocean), **%t** for the time of observation (in years since 1900 calculated from station date and time metadata; e.g., %t=84.4877 for Jun/27/1984), **%d** for the day of the year (also calculated from station date metadata), **%x** for the (east-) longitude and **%y** for the (north-) latitude, respectively. Note that the elevation variable **%H** is only available if the GEBCO1 and/or ETOPO2 optional packages are installed.

You can store intermediate results of the calculations in internal variables **%0**, **%1**, etc. using the operators **=%0**, **=%1**, etc. Stored values can be used later in the calculation by typing **%0**, **%1**, etc. Note that the **=%n** operators consume their operands, e.g., the respective value is taken off the stack. Operands and operators must be separated by one or more spaces. You may continue the definition of the macro expression on following lines, if necessary.

The evaluation of macro formulas is implemented using a simple stack-based scheme:

1. operands (constants or variable values, e.g., **#1**, **#2**, etc., **%0**, **%1**, etc., **%H**, **%t**, **%d**, **%x**, and **%y**) are added at the top of the stack as they appear,
2. operators (**+**, **-**, *****, **/**, ******, **ln**, etc.) take their operands from the top of the stack and push the result of the operation back at the top of the stack.

At the end of a successful calculation the only element remaining on the stack is the final result.

Table 6-2: Example expressions

Expression	Meaning
$135 \#1 * \#2 +$	$PO = 135 * PO_4 + O_2$ (with: PO_4 as #1 and O_2 as #2)
$\%t 80 - 17.6 / \exp \#1 *$	$c \cdot e^{(t-1980)/17.6}$ (tritium decay correction to 1980; c as #1)
$\#1 \ln$	$\ln(\#1)$ (natural logarithm)
$\#1 \ln 0.43429 *$	$\log(\#1)$ (base-10 logarithm)

$0 \#1 \max$	$\max(0,\#1)$ (maximum value)
--------------	-------------------------------

6.3 Expressions

Expression derived variables are similar to [macros](#). They can be defined and edited with the ODV macro editor and they use the same syntax and operator set. To set up an expression, select *Derived Variables* from the current sample window popup menu, choose *Expression* from the *Choices* list and press *Add*. ODV will show a dialog similar to the macro editor dialog. You should enter the label of the new variable and the corresponding units in the Label and Units fields. Then, select the input variables required by the new variable, e.g., select a variable in the *Choices* list and press <<. Finally, specify the expression to be evaluated for the new quantity. See the paragraph *Expression* under *Macro Editor* for a description of supported operators and general syntax guidelines. Press *OK* to finish the setup of the new expression.

You can edit ODV macros and expressions by using the *Derived Variables* option from the current sample window popup menu. Then select the respective variable in the *Already Defined* list box and press *Edit*. You can save an expression in an ODV macro file by pressing *Save As* on the *Edit Expression* dialog.

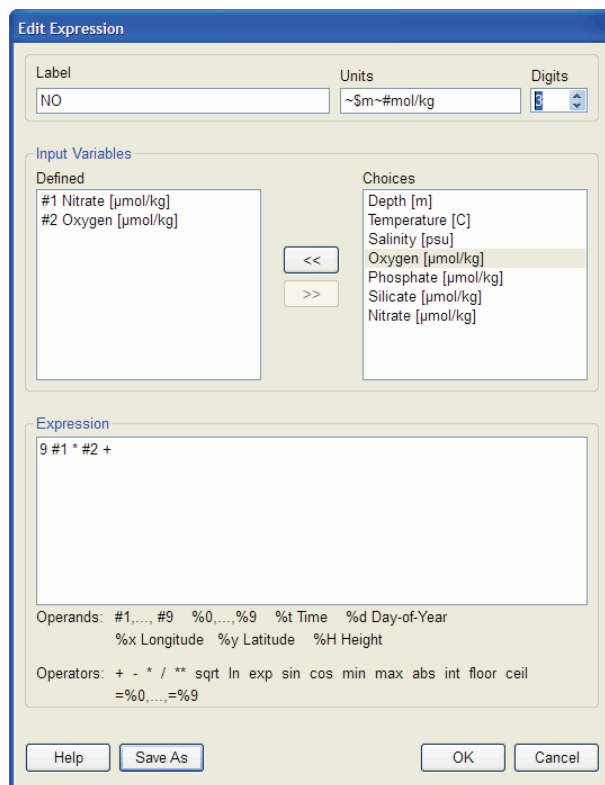


Figure 6-2: The edit expression dialog

6.4 Difference Variables

You can compare property distributions of the currently selected stations with previously saved reference data and produce difference fields by defining property differences as derived variables. Choose *View>Derived Variables* or press Alt+D and select *Difference from Reference*. Then choose the *ExportID.txt* file of the reference dataset that you want to use in one of the subdirectories of reference data directory tree. ODV will show a list of available reference data files from that directory. Select an *.oal* file that has the variable for which you want to produce the difference field as Z variable and appropriate X and Y variables (e.g., for producing longitude vs. depth sections, make sure the reference data file has longitude as X and depth as Y variable). Then identify the Z, X and Y variables in the current collection (if longitude or latitude are required, define them as derived variables prior to invoking the *Difference from Reference* option) to complete the definition of the difference variable. Note that the name of the new variable is composed of the name of the Z variable and the identification string of the reference data set. Once defined, you can use the difference variable in any data plot.

6.5 Using Patches

You can define water-mass patches by specifying polygons in the X/Y space of any data plot currently displayed on the screen. To do so, move the mouse over the data plot that you want to use for definition (e.g., theta/S plot) and click the right mouse button. From the popup menu choose *Define Patch* (note that the cursor changes to a cross-hair) and define the nodes of the patch-polygon by clicking the left mouse button at the node positions (you delete points by moving the mouse close to them and clicking the right button). Terminate definition of the polygon by pressing Enter or double-clicking the left mouse button. Note that the polygon is automatically closed by ODV. ODV then prompts you for a patch name (no extension) and writes the patch definition to a file in the collection directory.

Once you have defined one or more water-mass patches for a collection, you can use them to compose and activate the derived variable *Patches*. Choose *View>Derived Variables* and select *Patches* from the *Choices* list. You can compose the *Patches* variable by selecting one or more of the available water-mass patches (defined previously as described above) into it. Press *OK* when you are done. To evaluate the *Patches* variable for a given sample, ODV determines whether the sample is inside one of the patch-polygons selected into the variable, and (if found) assigns the number of the respective patch as *Patches* value. If the sample is outside all the selected patches, its value is set to the missing data value.

Like all other variables (basic or derived) you can use the *Patches* variable on any axis of any data window. Use it, for instance, as Z-variable along sections or for isosurface variables in order to display the spatial extent of specific water masses (see Figure 6-3).

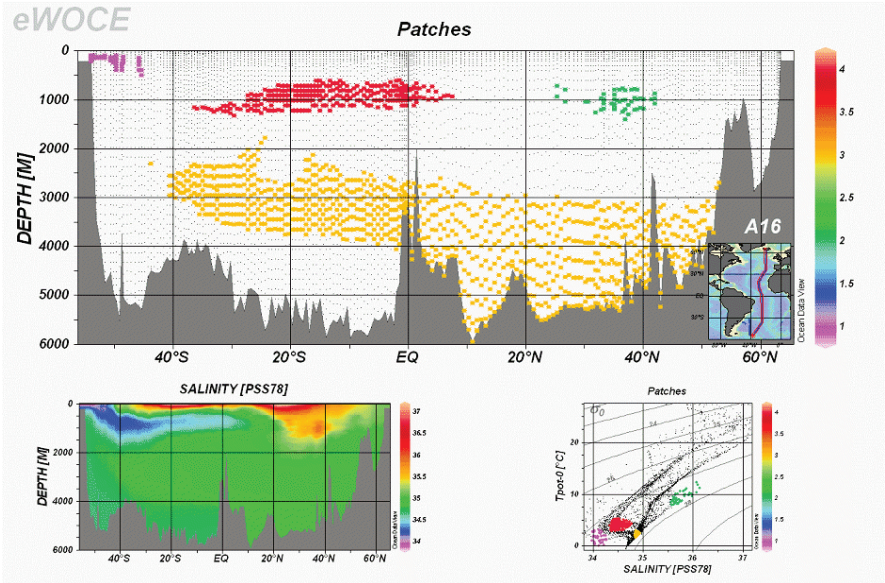


Figure 6-3: Using patches to identify the extent of water masses

7 Isosurface Variables

There is frequent scientific need to calculate and display the distribution of a variable (basic or derived) on a specific isosurface, defined by a constant value of another basic or derived variable. The concept of isosurfaces is quite general and, in the case of oceanographic water column data, includes constant depth, pressure, or density surfaces. In the case of geologic sediment core data with known down-core age estimates, isosurface variables could be used to obtain the distribution of a given variable at a constant sediment age.

Isosurface variables can be defined using *View>Isosurface Variables* or by right-clicking on the *Isosurface Data Window* and choosing *Isosurface Variables*. ODV will show the Isosurface Variables Dialog (Figure 7-1) that lets you define new isosurface variables, modify existing ones or delete some of the currently defined isosurface variables. To delete one or more existing isosurface variables select them in the *Already Defined* list and press *Delete*. To add a new isosurface variable first construct the new variable inside the *New* box and then press *Add*. Constructing an isosurface variable requires that you specify the variable that you want to display on a given surface (display variable), the variable that defines the surface (surface variable) and a numeric value for the surface variable. For first or last property distributions choose the primary variable as surface variable and enter *first* or *last* instead of a numeric value (a *f* or *l* as first character is sufficient). If you want to use derived variables, such as potential density, as display or surface variables, make sure that they are defined before you invoke the *Isosurface Variables* dialog. Note that you can define an unlimited number of isosurface variables. Isosurface variable values for the current station are shown in the *Isosurface Data Window*.

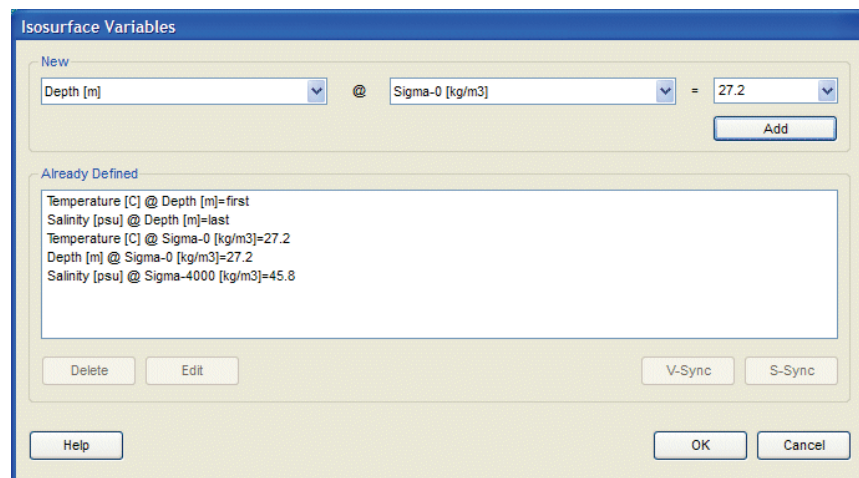


Figure 7-1: The isosurface variables dialog box

If an isosurface variable is selected in the *Already Defined* box you can synchronize all other variables to use the same surface by clicking on the *S-Sync* button (surface syn-

chronization). You can synchronize all other variables to use the same display variable by clicking on the *V-Sync* button (variable synchronization).

Note that in addition to the isosurface variables that you define explicitly, additional parameters, such as decimal time, the day-of-the-year, as well as longitude and latitude of the station are provided as automatic isosurface data.

7.1 Drawing Isosurface Variables

Once you have defined isosurface variables, you can use these variables on X, Y and Z axes of data windows with **SURFACE scope**. If plotting gridded fields on depth levels, the closest isobath will be used automatically as an overlay layer. If original data points are plotted, a gray-shaded ocean bathymetry is used as background.

8 Selection Criteria

8.1 Station Selection Criteria

While drawing the station map, ODV checks every station in the collection and determines whether it satisfies the current station selection criteria. Only stations that pass this test are considered valid. Only these stations are marked in the map and only this station subset is available for subsequent browsing and plotting.

You can modify the station selection criteria by using *Station Selection Criteria* from the **Current Station Window** popup menu or *View>Station Selection Criteria* from the main menu. Choose the category that you want to modify by clicking on the respective tab, e.g., *Name/Range*, *Date/Time*, *Domain*, or *Availability*, and modify the items of interest.

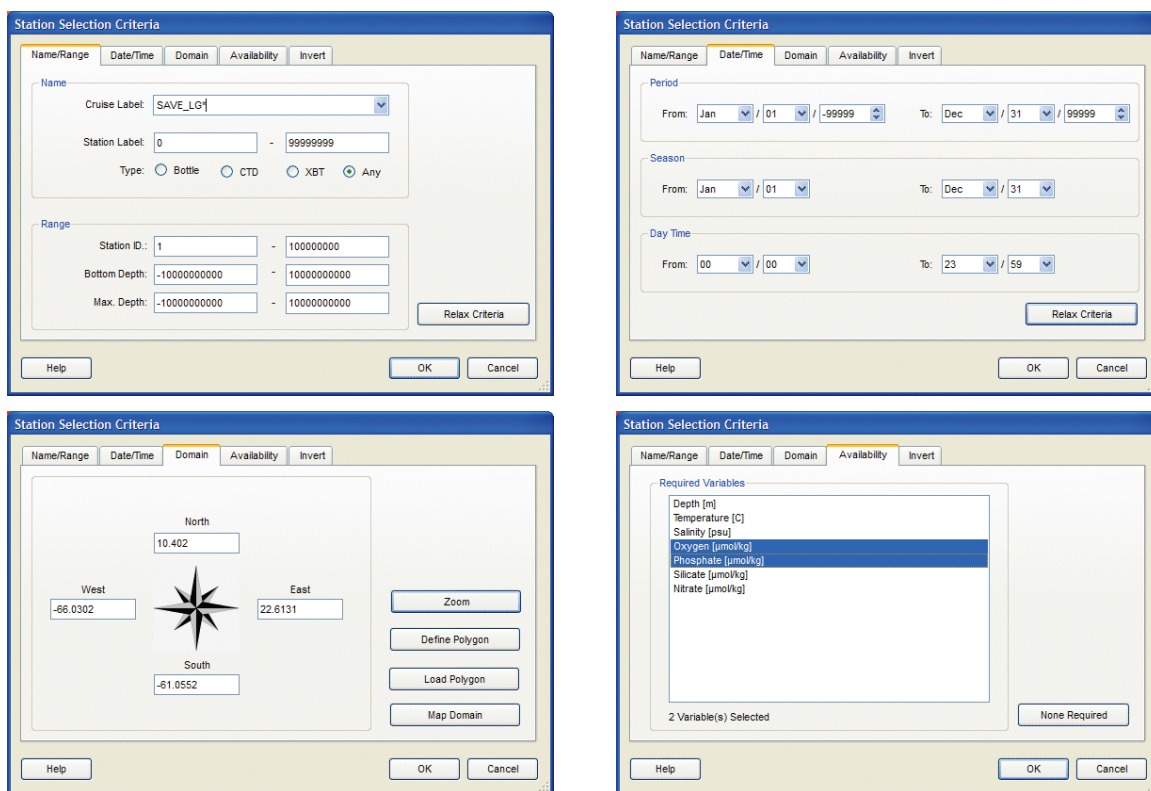


Figure 8-1: The station selection criteria pages

On the *Name/Range* tab you can select stations by cruise label, station label range, station type, range of internal ID numbers and ranges for the station bottom depths and deepest observations. For the cruise label selection you may select a specific cruise label from the list or you may specify a regular expression (wildcard pattern) in the *Cruise Label* field. In the latter case, any cruise label that matches the regular expression will be considered valid. Example regular expressions that can be used for cruise labels

are summarized in Table 8-1.

Table 8-1: Regular expression syntax for cruise labels

Character	Meaning
Arbitrary character	Any character represents itself apart from those mentioned below. <i>Example: c matches the character c.</i>
?	This matches any single character. <i>Example: SAVE_LEG? matches SAVE_LEG1, SAVE_LEG9, SAVE_LEGa, etc.</i>
*	This matches zero or more of any characters. <i>Examples: I01_* matches any label that has I01_ at the beginning; *06AQ* matches any label that has 06AQ in the middle.</i>
[...]	Sets of characters can be represented in square brackets. Within the character class, like outside, backslash has no special meaning. The dash (-) is used to indicate a range of characters; the caret (^) negates the character set if it occurs as the first character, i.e. immediately after the opening square bracket. <i>Examples: I05[EW] matches I05E and I05W; LEG[0-2] matches LEG0, LEG1, LEG2; SAVE_LEG[^3] matches all SAVE_LEG? cruises except SAVE_LEG3.</i>

The *Date/Time* tab lets you specify a valid time interval (*Period*), a valid calendar interval (*Season*), and a valid day time range (*Day Time*). A station must satisfy all three criteria to be considered valid. The *Season* and *Day Time* ranges may span consecutive years or days, e.g. [Oct/20 - Feb/03] or [21:09 - 04:15] are acceptable season and day time ranges.

In the *Domain* category you can define a rectangular subdomain of the map by specifying respective longitude/latitude values or you can press the *Zoom* button to define a rectangle by zooming. You can define a polygon as the valid domain by pressing the *Polygon* button and then entering the vertices of the polygon with the mouse. Note that the polygon is closed automatically.

In the *Availability* category you can mark one or more variables for which data must be available for a station to be considered valid.

On the *Invert* tab you can invert the station selection, e.g., all stations that do NOT satisfy the criteria will be selected if the *Invert Selection* box is checked.

Note that the selection criteria on the different pages are combined using the logical AND operator, e.g., a station is considered valid, only if it satisfies all station selection criteria. Press *OK* when you are done. ODV will rebuild the station map using the new selection criteria.

8.2 Sample Selection Criteria

A given sample of a valid station is considered valid only if it satisfies the current sam-

ple selection criteria. Only valid samples are shown in the [Current Sample Window](#) or in the different data windows.

You can modify the sample selection criteria by using *Sample Selection Criteria* from the [Current Sample Window](#) popup menu or *View>Sample Selection Criteria* from the main menu. Choose the category that you want to modify by clicking on the respective tab, e.g., *Quality* or *Range*, and modify the items of interest.

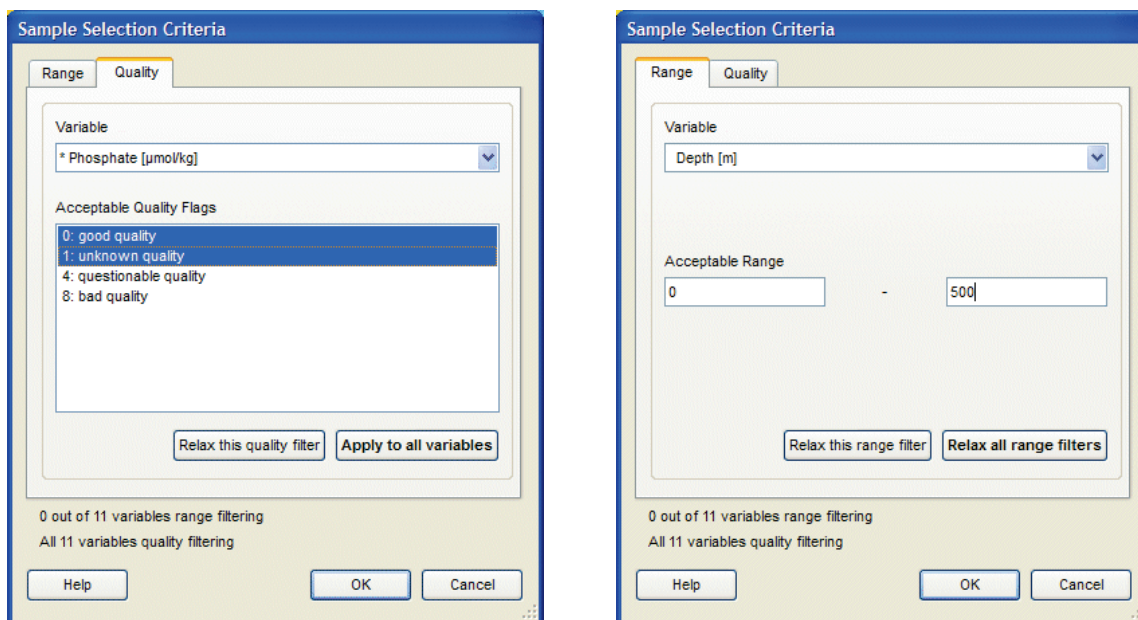


Figure 8-2: The sample selection criteria pages

On the *Quality* tab select the variable for which you want to establish a data quality filter, and then select the quality flags to be accepted. Click on *Apply to all variables* to apply the same quality filter for all variables using the same quality flag schema as the selected variable. Click on *Relax this quality filter* if you want to accept all quality flags for the selected variable. Then also click on *Apply to all variables* if you want to relax all quality filters of all variables using the same quality flag schema as the selected variable.

Use the selection criteria on the *Range* tab, if you want to see only samples that have values (for one or more variables) in specific value ranges. For instance, if you are studying the upper water column and only want to see samples between 0 and 500 m depth, choose the depth variable and enter the desired range under *Acceptable Range*. You can specify range filters for more than one variable at a time.

9 Station Map

9.1 Map Properties

The properties of the station map can be modified via the *Properties* option of the map's popup menu or via *View>Window Properties>Map*. This includes changing the map domain and projection, the appearance of ocean bathymetry, coastlines, and land topography, the style of the station dots, as well as general properties such as graphics font size or the axis labeling color and style (Figures 8-1 and 8-3).

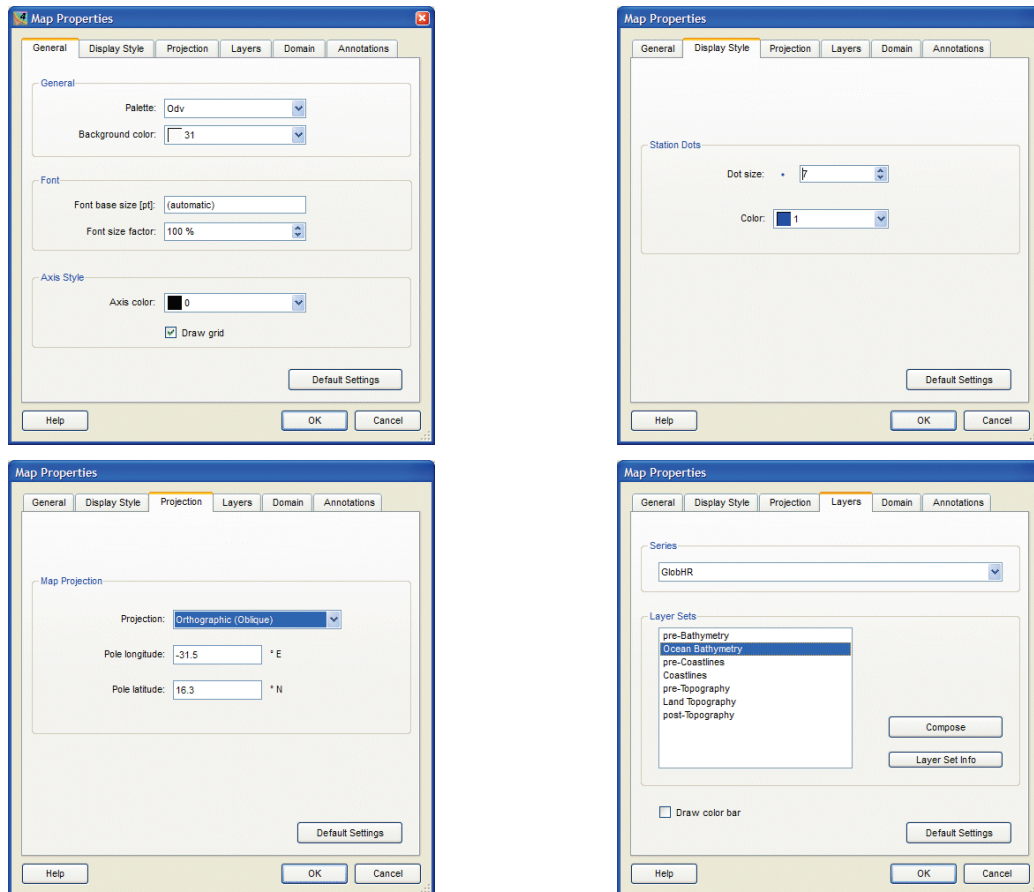


Figure 9-1: The various pages of the Map Properties dialog (part 1 of 2).

General

On the *General* page you can define the color palette used by the map, the background color of the map window, a base font size and font size factor and the color of the axis and axis annotations. Grid-lines can be switched on or off.

Display Style

On the *Display Style* page you define the color and the size of the station marks in the

map. Choosing (*automatic*) for the color will cause different colors for the different cruises in the data collection.

Projection

On the *Projection* page you choose the map projection and the longitude and latitude of the projection pole (position of the viewer). The following projections are currently available: (1) *Default Projection*, (2) *Orthographic (North Polar)*, (3) *Orthographic (Equatorial)*, (4) *Orthographic (South Polar)*, (5) *Orthographic (Oblique)*, and (6) *Mollweide*. The default projection is linear in longitude and latitude directions. The orthographic projections are hemispheric, while the default and Mollweide projections are global in extent. All projections allow zooming-in with the mouse or the definition of sub-regions using the *Domain* page of the map *Properties* dialog (see below). For the *Orthographic (Oblique)* projection you can specify an arbitrary longitude/latitude eye position (pole), from which the globe is then viewed. For the other projections the pole latitude is fixed and the user may only vary the pole longitude.

Note that for projections (2) to (6) the definition of sub-domains by zooming can be tricky. If you need accurate results, either use the *Domain* page of the map *Properties* dialog (see below) or switch to default projection temporarily, then zoom (thereby defining the sub-region) and finally switch back to the desired map projection.

Layers

On the *Layers* page you select the bathymetry/coastline/topography *Series* and specify the layers within the different *Layer Set* categories. You also switch on or off the drawing of the map's color bar by checking or unchecking the *Draw color bar* box.

A number of intermediate or high-resolution bathymetry/coastline/topography packages (*Series*) are available for ODV. Some are already installed during the ODV installation (*GlobHR*), many others may be added at any time by installing the respective **optional packages**. You may select any of the installed series by clicking into the *Series* combobox. Please note that some series are regional and that you may have to adjust the map domain to the respective series domain. Once a series is chosen, you may define the layers in the various *Layer Set* categories (see below). When the map is drawn, the layer sets (and the layers within the sets) are drawn in the given order.

To obtain information on a selected layer set (e.g., *Ocean Bathymetry*), click on the *Layer Set Info* button. To define the layers of a selected layer set, click on the *Compose* button. Note that default layers are defined for all categories; if the resulting map display suits your needs you don't have to modify any layer set.

If you pressed the *Compose* button, the layer definition dialog (Figure 8-2) appears. You add layers by selecting them in the *Available* list and pressing the << button. Layers can be removed by selecting them in the *Selected* list and pressing the >> button. Depending on the properties in the *Line* and *Fill* boxes, a given layer may be filled and/or its outline may be stroke. The default color settings are (*automatic*) in which case an appropriate color will be chosen automatically (recommended). You may override these settings and choose specific colors by clicking into the respective combobox. Choose (*none*) if

you don't want filling and/or stroking. Note that you may change the properties of a given layer in the *Selected* list by clicking on it, then modifying the settings under *Line* and *Fill*, and, finally, clicking << to implement the changes.

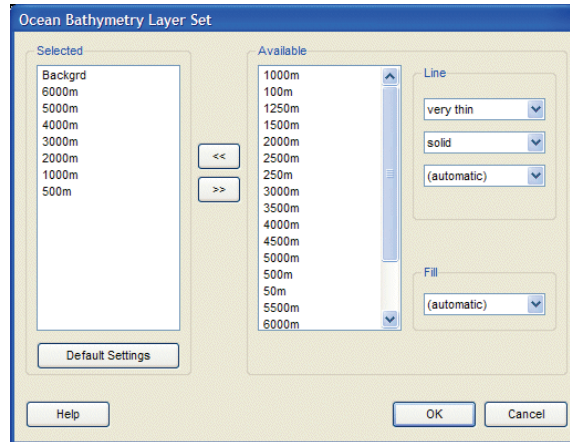


Figure 9-2: The map's layer definition dialog.

Domain

On the *Domain* page of the map's property dialog you may specify the map domain by providing east and west longitudes and south and north latitudes. You may also choose the domain spanned by the stations in the collection (native domain) by clicking on *Full Domain* or a global domain by clicking on *Global Map*.

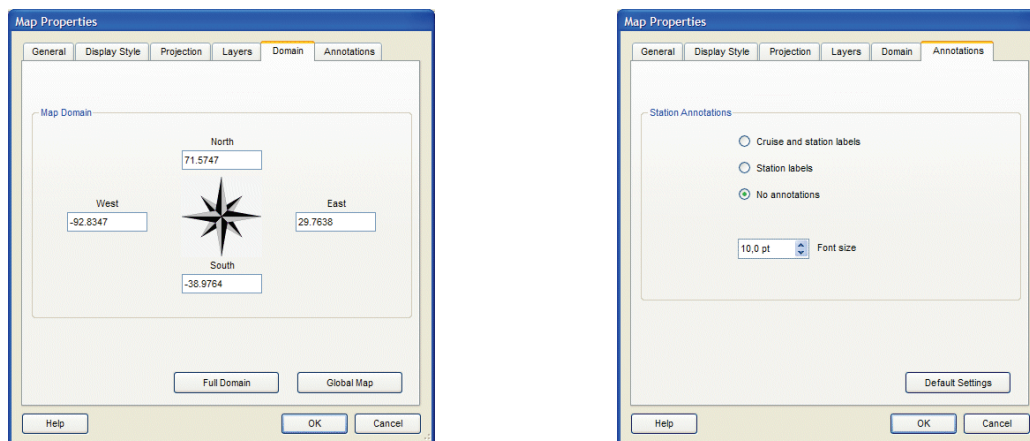


Figure 9-3: The various pages of the Map Properties dialog (part 2 of 2).

Annotations

On the *Annotations* page you may specify whether you want the picked stations (see below) annotated in the map or not. Choose *Station labels* if you want the station labels

of the picked stations drawn next to the station positions, choose *Cruise and station labels* if the annotations should also include the cruise label, or choose *No annotations* if you don't want annotations. Note that you can change the position of the annotation relative to the station position using the *Pick List Editor* (see below).

9.2 Picked Stations

The station map maintains a list of picked stations. The data of the picked stations are drawn in STATION data windows, and the picked stations are also marked in the map, using the same color and symbol as in the data windows. You can add a station to the pick list by making it the current station (for instance by left clicking on that station) and pressing *ENTER*. Double-clicking a station with the left mouse button will also add the station to the pick list. Note that the data of the newly added pick station are added to all STATION data windows and that it is also marked in map. To delete a station from the pick list make it the current station (for instance by clicking on one of its data points in one of the STATION data windows) and press the *Del* button.

You may edit the entire pick list using option *Manage Pick List>Edit Pick List* from the map popup menu. The *Pick List Editor* dialog will appear letting you edit the properties and graphical appearance of every station in the pick list. You may also change the order in the list or delete individual stations from the list, or empty the list altogether.

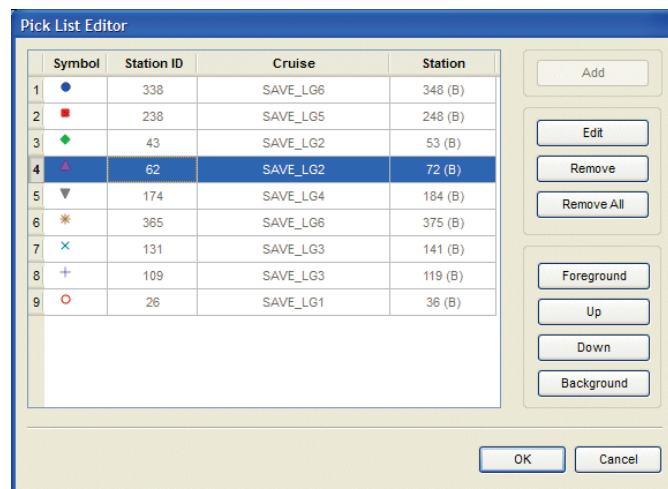


Figure 9-4: The Pick List Editor dialog.

9.3 Defining a Section

You must define a section in the station map before SECTION data windows can be plotted. To define a new section or use a previously defined section right-click on the map to invoke the map popup menu. Choose *Manage Section>Define Section* if you want to define a new section or *Manage Section>Load Section* if you want to load a previously defined one. In the latter case simply select a section file from the file open dialog (e.g.,

by double-clicking on it). If you create a new section, ODV temporarily switches to a full page map for easier definition of the section spine. Note that the mouse cursor changes to a cross hair indicating that the user is expected to enter a sequence of points defining the centerline of the section.

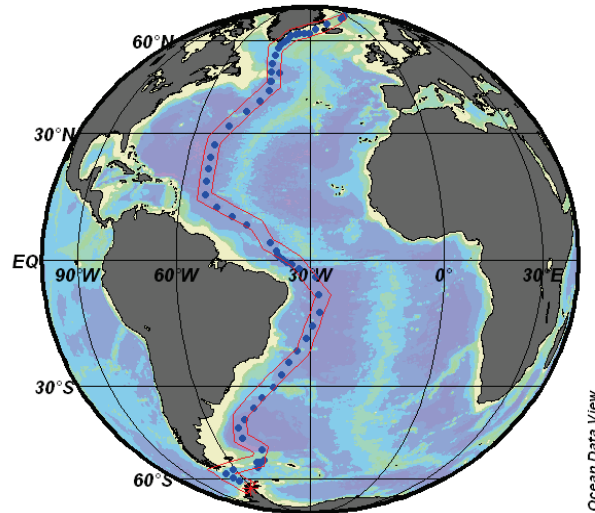


Figure 9-5: The GEOSECS western Atlantic section

You enter a point by moving the cross hair to the desired location and clicking the left mouse button. To remove a point, move the mouse close to it and click the right mouse button. To accept the set of points press *ENTER* or specify the last point with a double-click of the left mouse button. Note that you may construct rather complicated sections following arbitrary cruise tracks as shown in Figure 9-4.

After specifying the section spine, ODV assigns a default width for the section band and selects distance from the starting point (the first point entered) as the default along section coordinate. A dialog box appears that lets you change the default characteristics of the section. You can change the characteristics of the section at any time by choosing *Manage Section>Section Properties* from the map popup menu. Choose among *Distance*, *Longitude* and *Latitude* as along section coordinate, set the width of the section band, choose a color for the section bathymetry and specify a title for the section. For the section bathymetry you may use station bottom depths or depths from the GEBCO1 or ETOPO2 global bathymetric datasets. You may also choose to draw no section bathymetry at all. The GEBCO1 and ETOPO2 entries are available in the *Bathymetry* combobox after installing the GEBCO1 and/or ETOPO2 [optional packages](#).

You can save the current section in a file by choosing the *Manage Section>Save Section As* option. You can use saved sections later, by choosing *Manage Section>Load Section*. To undefine a section, select *Manage Section>Undefine Section*.

Note that all stations inside the section band marked in the map belong to the section. The data of all these stations are plotted in SECTION data windows.

9.4 Station Distributions

You can produce plots of the spatial and temporal distributions of the stations in the map by choosing *Extras>Statistics* from the map popup menu or by pressing *F4* while the mouse is over the map. The *Map Statistics* dialog will appear that lets you view the distributions of the currently selected stations in the map versus time or season (press buttons *Time Histogram* or *Season Histogram*, respectively). The histograms are shown in separate dialog windows (see Figure 9-6). You may save the graphics in GIF, PNG, JPG or Encapsulated PostScript files by pressing *Save As* and choosing the appropriate file type. To print the graphics press *Print*.

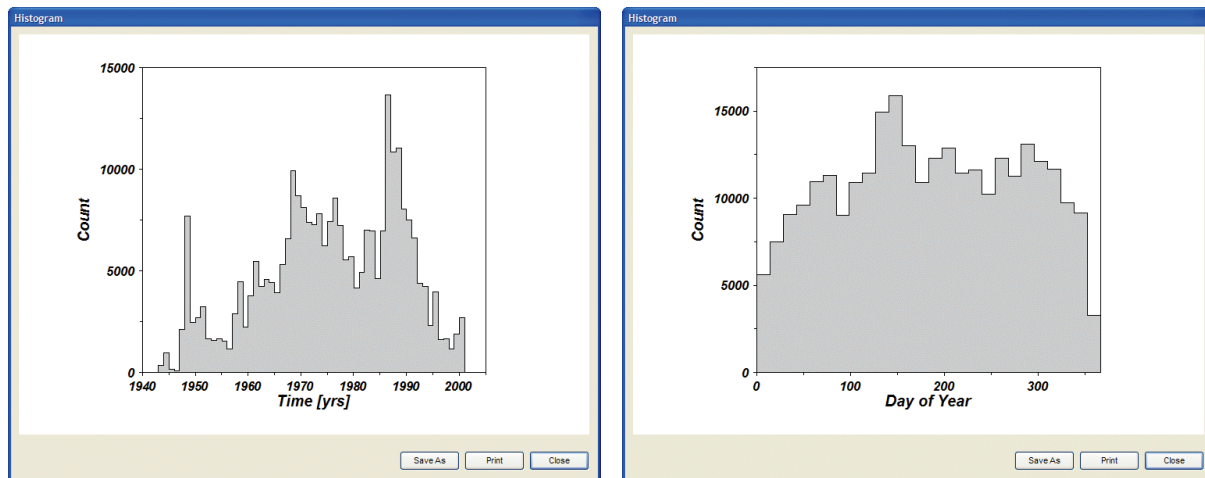


Figure 9-6: Example time and season histograms of stations in the map.

Pressing *X/Y Distribution* on the *Map Statistics* dialog produces a plot showing the data density in the entire map domain via the number of stations within small tiles. This distribution plot allows easy identification of areas of dense station coverage, especially in cases with very large numbers of stations and many repeat stations plotting at the same location in the station map. You may zoom into the map and repeat the above procedures to obtain station density information with higher spatial resolution (see Figure 9-7).

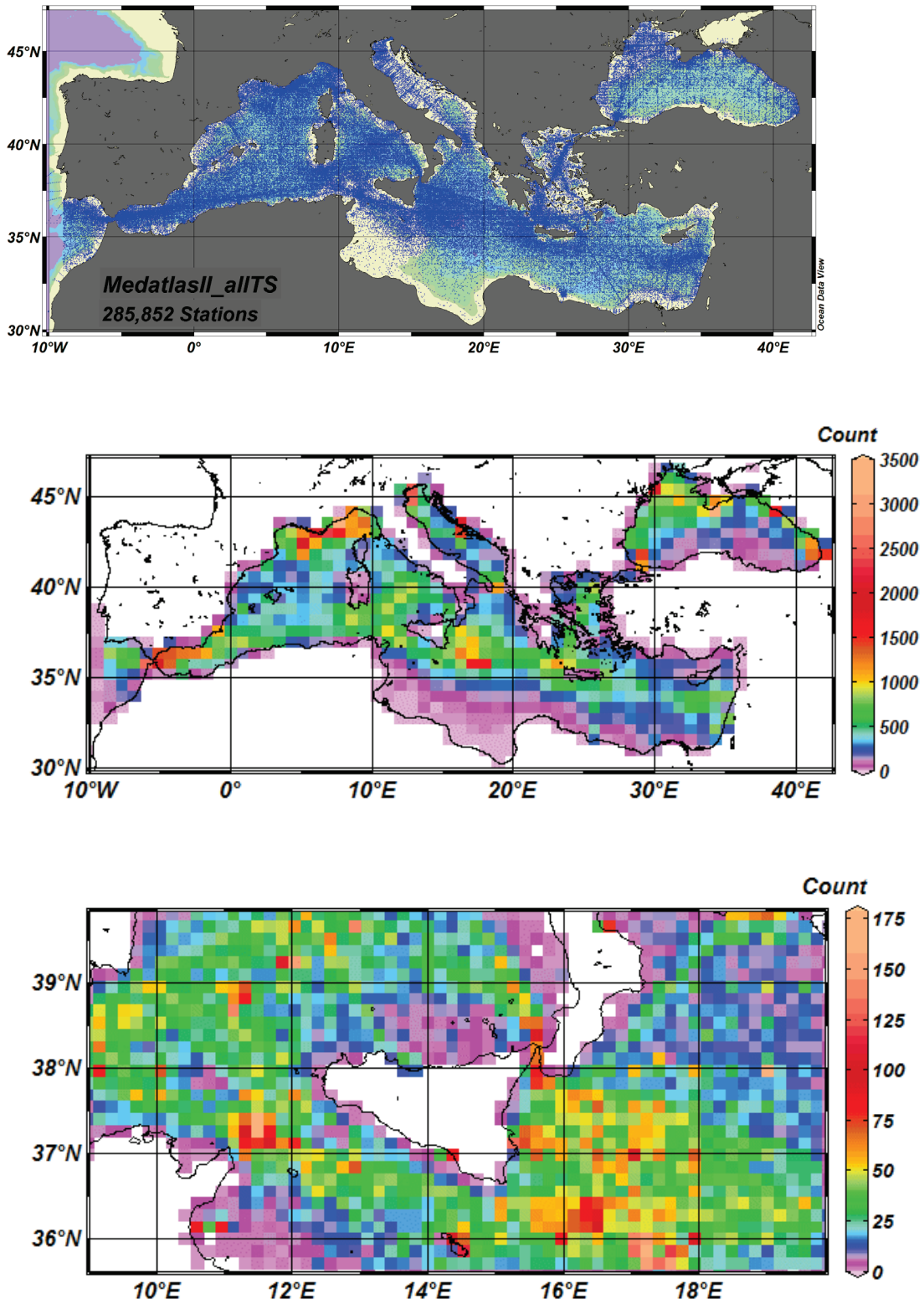


Figure 9-7: Example station map and station distribution plots with different levels of spatial resolution.

10 Data Windows

10.1 Data Window Properties

The properties of data windows may be modified by right-clicking on the respective window and choosing the *Properties* option. Alternatively, you may also use *View>Window Properties>Window x*, where *x* is the number of the window. Some of the window settings, such as value ranges or variables on the X, Y, and Z axis of the window may also be modified using the *Set Ranges* and *X-, Y-, and Z-Variable* options of the data window popup menu.

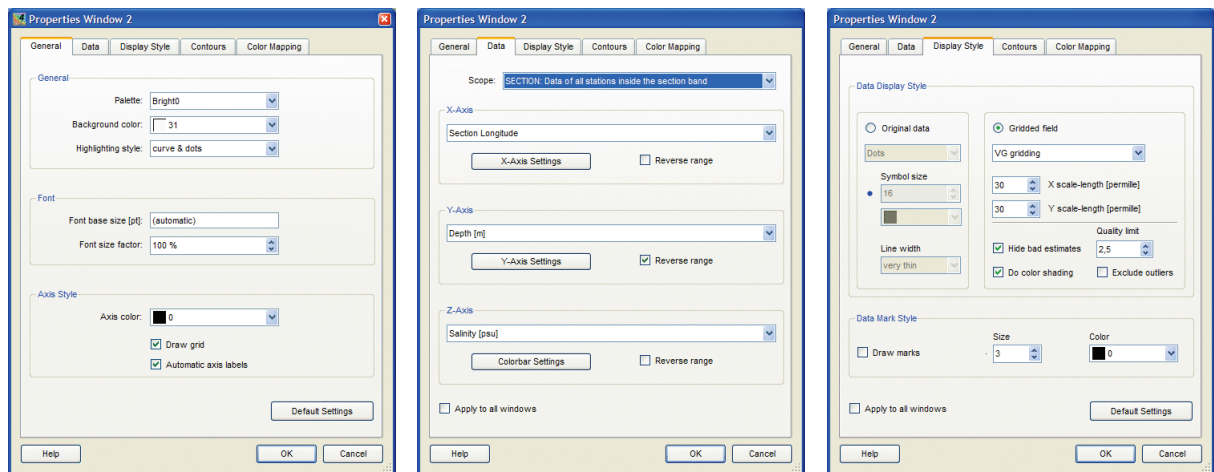


Figure 10-1: The various pages of the Data Window Properties dialog (part 1 of 2).

The data window *Properties* dialog consists of five separate pages (Figures 10-1 and 10-4).

General

On the *General* page you can define the color palette used by the data window, the background color of the data window, the highlighting style of the current station, a base font size and font size factor and the color of the axis and axis annotations. Grid-lines as well as the automatic variable labels on the axes can be switched on or off. You may customize the text on the axes by switching off the automatic axis labels and creating your own annotation [graphics objects](#).

Data

On the *Data* page you can define the [scope](#) of the data window, the variables on X, Y, and Z, as well as various axis properties. Normal axis orientation is to have increasing values from left to right for X, bottom to top for Y, and bottom to top in the colorbar for Z. You may reverse the orientation on one or more axes, for instance, to create depth in

the ocean values decreasing upward, by checking the respective *Reverse range* box.

To modify X, Y, and Z axis properties click on *X-Axis Settings*, *Y-Axis Settings*, or *Colorbar Settings*. The axis properties dialog (Figure 10-2) will appear, letting you specify the value range on the respective axis, the spacings of tic marks with or without labels and the position of the labeled axis. Choosing (*automatic*) for the tic mark spacings lets ODV determine the location and frequency of the marks automatically. The *Position* entry allows a choice of axis position (left or right; bottom or top) or lets you switch off the labeling of the respective axis altogether.

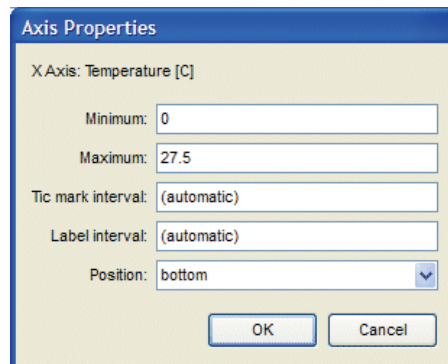


Figure 10-2: The Axis Properties dialog.

Display Style

On the *Display Style* page you can switch between the two fundamental plot types of ODV, *Original data* and *Gridded field* by clicking on the respective item.

For *Original data* you may select display types *Dots*, *Numbers*, or *Arrows* to obtain colored dots, numerical values or arrows at the measurement locations. Specify the size and color of the dots or the font size and color for the numerical values in the two fields under *Symbol size*. Note that the selected color is only honored in SECTION, SCATTER, and SURFACE data windows without a Z-variable. In data windows with Z-variable the color of the dots is determined by the Z-values. In STATION windows the different picked stations use different colors. These colors are assigned automatically, but may be modified by the user at any time. The *Line width* entry is only honored in STATION data windows.

If you choose *Arrows* the Arrow Properties dialog (Figure 10-3) will appear, letting you select the variables providing x- and y-components of the arrows, as well as an arrow scale, line width and color for the arrows. If you choose Color (*automatic*) the arrow color is determined by the value of the Z-variable at the arrow location. Make sure that a Z-variable is defined if using (*automatic*) color. To bring up the Arrow Properties dialog again and modify the arrow settings click on the *Arrows* entry under *Original data*.

Instead of showing colored dots at the sample positions you can also produce gridded property fields for any data window that has a Z-variable (property distributions along sections or on isosurfaces are examples) by clicking on *Gridded field*. Then choose one

of the available [gridding methods](#), *Quick Gridding*, *VG Gridding* and *DIVA Gridding*. Note that *DIVA Gridding* is only available if you have installed the DIVA integration [optional package](#). Then specify appropriate averaging length-scales for the X- and Y-axis, respectively. Note that length- scale values are in per mille of the full axis range and that large values result in smooth fields. You should experiment using different length-scale values until an acceptable compromise between preservation of structure in the data and smoothness is achieved. Note that gridded fields may be poor representations of the data if performed improperly.

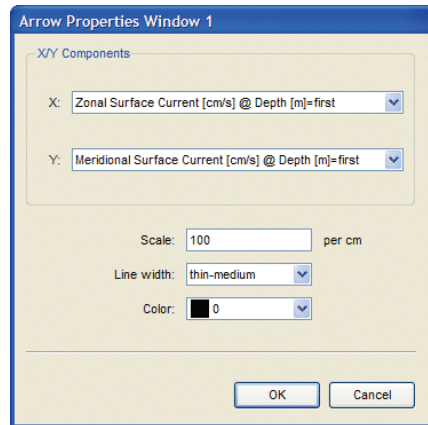


Figure 10-3: The Arrow Properties dialog.

All ODV gridding methods assign for every estimate at a given grid point (x, y) a dimensionless *quality value*. Quality values are based on the distances from the estimation point (measured in units of respective averaging scale lengths) of all data points used for the estimate. Quality values larger than about 2.5 or 3 should normally be considered as problematic, indicating that the nearest measurement is more than two length-scales away from the estimation point. You can choose to hide bad estimates with large quality values by checking the *Hide bad estimate* box and specifying an appropriate *Quality limit* value.

The gridded field is color shaded by ODV if *Do color shading* is checked. The positions of the actual data points are marked in the plot if *Draw marks* is checked and appropriate size and color are specified for the dots. Contouring (see below) and color shading of the property fields is supported for all gridding modes.

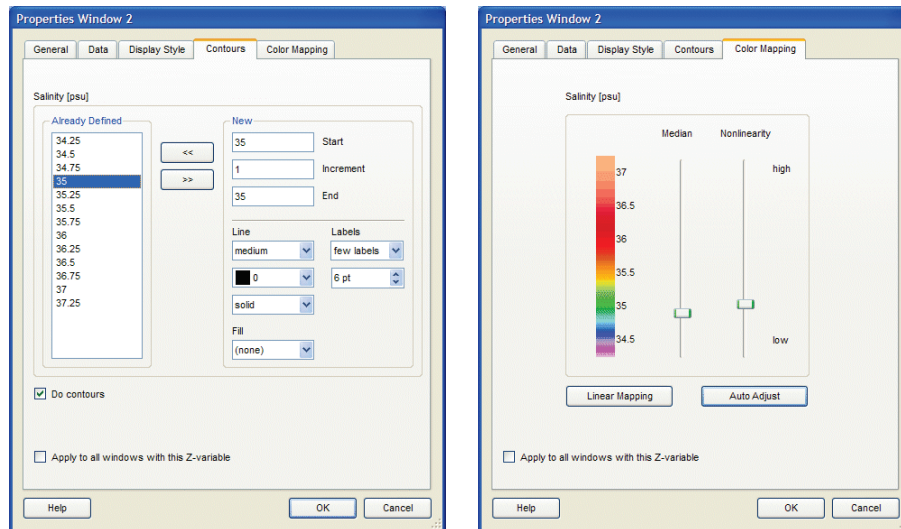


Figure 10-4: The various pages of the Data Window Properties dialog (part 2 of 2).

Contours

The *Contours* page of the data window properties page allows you to define contour lines for the plot. This page is only enabled if *Gridded field* is chosen as display style (see above). To add sets of contour lines specify *Start*, *Increment* and *End* Z-values in the *New* group. Choose appropriate line and label properties and press the << button to add the set of contour lines to the *Already Defined* list. If necessary, repeat this procedure with different *Start*, *Increment* and *End* values and possibly different line and label properties. You can modify the properties of an existing contour line by selecting it in the *Already Defined* list, modifying the properties in the *New* group and pressing the << button to implement the changes.

In addition to stroking the contour line associated with a given Z-value z you can also ask ODV to fill the region defined by Z-values larger than z using an automatic or user specified color by choosing the color under *Fill*. Figure 10-5b was produced by using (*automatic*) under *Fill* for all contour lines.

Color Mapping

The *Color Mapping* page lets you manipulate the mapping between Z-variable values and associated color. This page is only enabled for data window with a Z-variable (e.g., color sections or color distributions on isosurfaces). Press the *Auto Adjust* button to establish a possibly non-linear mapping, automatically constructed on the basis of the distribution of Z-values. Pressing the *Linear Mapping* button will restore the default, linear color mapping. You may establish customized color-mappings by moving the *Median* trackbar to the Z-value to receive the highest color-resolution and increase the non-linearity using the *Nonlinearity* trackbar.

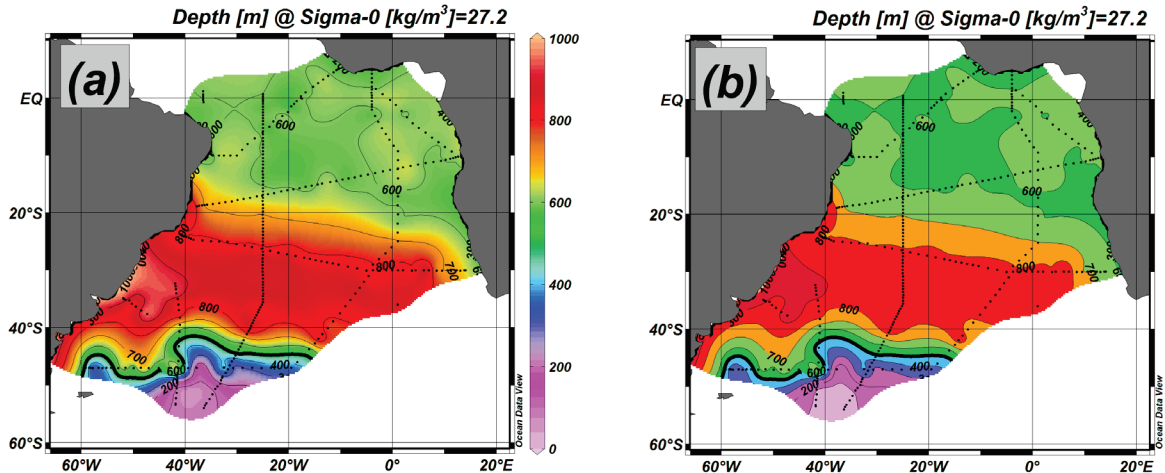


Figure 10-5: Comparison of (a) continuously shaded and (b) contour shaded fields.

10.2 Zooming and Automatic Scaling

You can change the variable ranges of any data plot by moving the mouse over this window, clicking the right mouse button to invoke the data window popup menu and choosing either *Full Range* or *Zoom*. For *Full Range*, the X- and Y-Ranges of the current window are adjusted to accommodate all plotted data values in this window. If you use *Full Range (All)* on the canvas popup menu you can auto-scale all data plots on the screen in one operation.

If you select *Zoom*, a red zoom-frame appears around the current window. To manipulate this zoom-frame move the mouse over its edges, corners or interior, press the left mouse button and drag the edges, corners or the entire frame to the desired locations. Note that the x/y coordinates of the lower/left and upper/right corners are indicated in the middle part of the status bar. To accept the current setting of the zoom-frame and adjust the variable ranges accordingly double-click the left mouse button or press *ENTER*. If you want to abort the zoom operation and keep the original variable ranges, press *ESC* or click the right mouse button.

In addition to the normal zoom procedure described in the previous paragraph there is an additional zoom method (*quick-zoom*) that may be even easier and quicker to use in many situations. While the mouse is over a data window or the map press and hold down the *Ctrl* key (on Macintosh systems use the Apple key), then press and hold down the left mouse button and move the mouse to open a zoom box. Releasing the left mouse button applies the zoom box settings to the window from which the *quick-zoom* was initiated.

10.3 Z-Zooming

All data windows with a color bar allow modifications of the Z-variable range by zooming into the color bar (Z-zooming). To invoke Z-zooming move the mouse over such a data window and click the right mouse button to bring up the data window popup

menu. Selecting *Z-Zoom* will draw a red zoom-frame around the color bar of the respective window. Manipulate and drag this zoom-frame as described above. To accept the current setting of the zoom-frame and adjust the Z-variable range accordingly, double-click the left mouse button or press *ENTER*. If you want to abort the zoom operation and keep the original Z-variable range, press *ESC* or click the right mouse button.

10.4 Changing Window Layout

The position and size of the station map as well as the number, position and size of zero or more data windows can easily be modified using *View>Window Layout* from the main menu, the *Window Layout* option of the canvas popup menu or by pressing the shortcut key *Alt-W*. ODV will outline the current layout and lets you move, resize, delete or create windows. To perform one of these operations on a window, move the mouse over this window, click the right mouse button and select the appropriate option.

If you choose *Move/Resize* a red zoom-frame appears around the respective window. You move and/or resize this zoom frame by moving the mouse over a corner, edge or the interior, press and hold down the left mouse button and move the mouse. To accept the new size and position for the window double-click the left mouse button or press *ENTER*. To abort the *Move/Resize* operation leaving the window position unchanged press *ESC*. Note that overlay windows (see below) can not be moved or resized.

You create new windows by moving the mouse over one of the existing windows, right-clicking and choosing option *Create New Window* or *Create Overlay Window*. In both cases the initial properties of the new window are derived from the existing one. If you use *Create New Window*, the new window will be placed in the middle of the ODV graphics canvas and you have to position and resize it using the *Move/Resize* option described above. If you use *Create Overlay Window*, some properties required for overlay windows will be set automatically, and the new window will be properly aligned with the existing one. You modify the properties of an existing or new window by right-clicking on this window and choosing option *Properties*. To select new variables on X-, Y- and Z-axis of the window, select the *Data* page of the *Properties* dialog and choose appropriate variables in the comboboxes of the different axes. Note that by default variable values increase to the right and upwards. If you want to reverse the direction (e.g., depth in depth profiles) check the respective *Reverse range* box. Press *OK* to accept the new properties. Note that the properties of the map or any data window may also be changed any time after leaving *Window Layout* mode (see [above](#)).

In addition to manual arrangement of map and data windows, you may also implement a predefined window layout by choosing from a wide range of layout templates (choose *Layout Templates* from the *View* menu or the canvas or window layout popup menus and select one of the templates).

To leave *Window Layout* mode and accept the new window layout, right-click the mouse and choose *Accept*. If you want to discard the modification and keep the original window layout, choose *Cancel*.

10.5 Graphics Output

Printing

Choose *Print Canvas* from the *File* or canvas popup menus to print the contents of the entire canvas.

PostScript Files

To produce Encapsulated PostScript .eps files for the entire screen or any individual data window or the map, right-click on the canvas or the respective data window or map and choose *Save Canvas As*, *Save Plot As* or *Save Map As* (alternatively, you can also press Ctrl-S while the mouse is over the canvas, data window or map), choose *PostScript (*.eps)* for the file type and specify the name and destination of the output file. ODV then presents the *PostScript Settings* dialog that lets you specify the orientation and size of the PostScript output. The resulting Encapsulated PostScript files can be printed by sending it to a PostScript printer, or it can be imported into LaTeX or Word documents, or may be opened with external graphics software, such as Adobe Illustrator or Corel Draw, for editing and processing. If you intend to include the ODV .eps output files in other documents, make sure to uncheck the *Show Collection Info* box on the *PostScript Settings* dialog.

GIF, PNG and JPG Files

You can save the entire canvas, individual data windows or the map in GIF, PNG or JPG files by choosing *Save Canvas As* from the canvas popup menu, *Save Plot As* or *Save Map As* from a data window or map popup menu and selecting the respective file type. These options can also be invoked by shortcut key-strokes: (1) pressing Ctrl-S while the mouse is over the canvas area saves the ODV graphics canvas while (2) pressing Ctrl-S with the mouse over the map or a data window will save the respective data plot. ODV will present a file save dialog that lets you choose the appropriate output file type (GIF (*.gif), PNG (*.png) or JPG (*.jpg)). Note that the default output filename is derived from the current view name. If required, you can choose any other name or destination. ODV then lets you define the resolution of the output image. Note that the maximum achievable resolution is limited by the available memory on your system.

10.6 Data Statistics

You can obtain statistics information for the data shown in a given data window by right-clicking on the window and choosing *Extras>Statistics* or by pressing *F4* while the mouse is over the window. The window's statistics page will appear (see Figure 10-6) and show mean, standard deviation, number of data points as well as minimum and maximum values for the X, Y, and (if present) Z variables of the respective window. Note that mean, standard deviation, and number of data points are based on the currently visible data only, while minimum and maximum are using all available data.

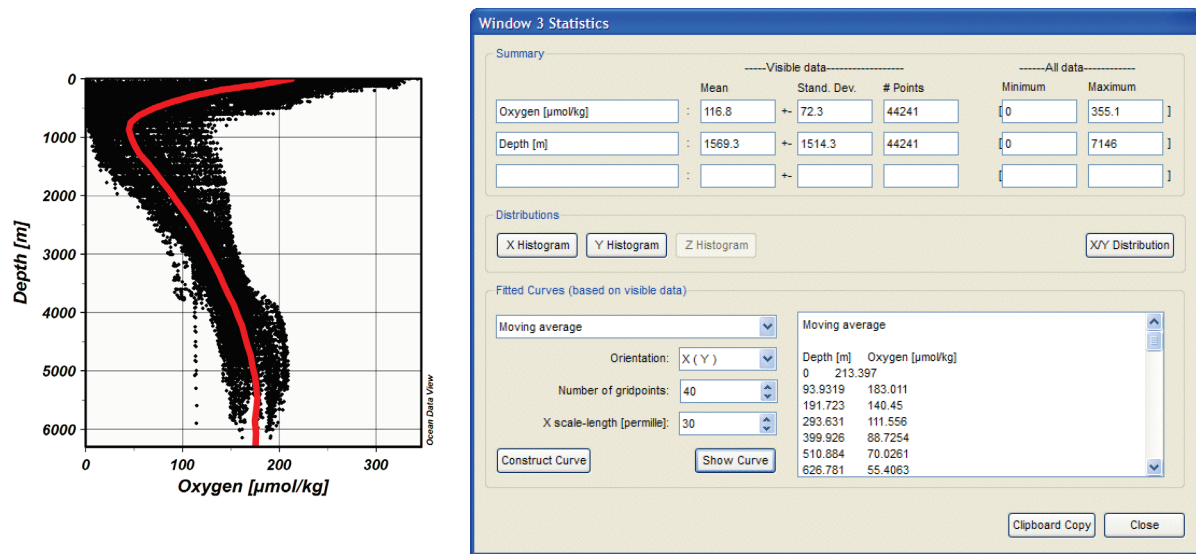


Figure 10-6: The statistics dialog box (right) for a SCATTER data window showing oxygen data from the northeast Pacific versus depth (left).

ODV will also allow you to fit three types of curves through the data: (1) least-squares lines, (2) piece-wise least-squares lines, and (3) moving average curves. You may choose one of these curve types from the top combobox of the *Fitted Curves* group. Then choose an orientation for the fit (in the example of Figure 10-6 we want oxygen as a function of depth, e.g., $X(Y)$). For curve types (2) and (3) you may also specify the number of points at which the curve will be evaluated (default 30; choose a larger value for smoother curves). For moving average curves (type 3) you may specify an averaging length scale (in permille of the axis range of the variable between parenthesis, e.g. $Y=Depth$ in Figure 10-6). Large averaging length scales will result in smooth, small values will preserve more of the structure in the data. Press *Construct Curve* to have the curve calculated and the results displayed in the box to the right. These results may be copied to the clipboard (by pressing *Clipboard Copy*) and then pasted into other documents or applications for external use.

You may also add the constructed curve to the data window by pressing *Show Curve*. Note that the curve is added as a polyline **graphics objects**, which means that you can edit or delete the object at any time using the normal graphics object's procedures.

10.7 Data Distributions

You obtain distribution histograms of the X, Y, and (if present) Z data by pressing on the respective *Histogram* button. An example histogram is shown below. Note that the histogram is based on the currently visible data only. You obtain a plots of the data distribution in X/Y space by pressing the *X/Y Distribution* button. All histogram and distribution plots may be send to the printer or they may be saved in GIF, PNG, JPG or Encapsulated PostScript files.

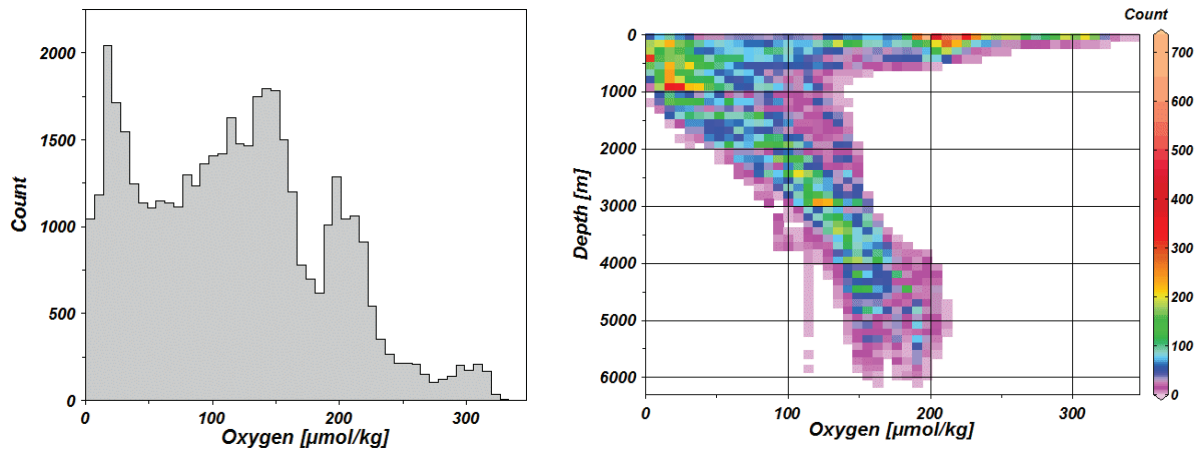


Figure 10-7: The data distribution histogram for oxygen (left) and the oxygen/depth data distribution (right) for the data from Figure 10-6.

11 Graphics Objects

You can add text annotations, symbols, lines and other geometric objects to the canvas, the map or any data window. The following graphics objects are supported: (1) text annotations, (2) straight lines, (3) rectangles and squares, (4) ellipses and circles, (5) polylines (straight-line segments or Bezier smoothed), (6) filled polygons (straight-line segments or Bezier smoothed), (7) symbols, (8) symbol sets and (9) legends. Detailed descriptions of these objects follow below.

A graphics object is owned by the canvas, the map or a specific data window on which the object was created. All graphics objects of the canvas, the map or a data window are drawn, whenever the respective parent window is drawn.

The coordinates of a graphics object are either specified in the coordinate system of the owner window or of the canvas. Canvas coordinates are in cm from the lower left corner. Using window coordinates for a graphics objects has the advantage that the objects remains at its position in the window, even if the parent window is moved or resized. However, map's using default or non-default projections may require that *Canvas* coordinates are used for graphic objects. This applies to line, polylines or polygons extending across the Greenwich meridian (any projection), or to objects to be placed outside the map area.

The initial ownership and coordinate system of an object are derived from the window, from which creation was initiated (see below). Like most other properties of a graphics object, ownership and the coordinate system may be edited and modified at any time. By default, graphics objects are clipped to the parent window. If you create objects outside the window's viewport make sure to uncheck the *Clip to window* box on the object's *Properties* dialog (see below).

Graphics objects are part of the current view and are saved in view files.

Creation

Except for legends, which are created automatically, you create and add any other graphics object by choosing *Extras>Add Graphics Object>...* ("..." represents the desired object type) from the map or data window popup menus or by choosing *Add Graphics Object>...* from the canvas popup menu. After initial creation, dialog boxes appear that let you define various properties of the object. These properties may later be changed again at any time (see *Edit* below). A graphics object is owned by the window (or canvas) from which the creation was initiated, and the coordinates of the graphics object are in the respective window coordinate system. As a consequence, all objects of a window follow automatically when the respective window is moved or resized.

Graphics objects can also be created as copies of existing objects via the *Copy Object* option of the graphics object context menu, or the *Copy* button of the graphics objects management dialog (see below). You may also import graphics objects from ODV *.gob* files, previously created by exporting existing graphics objects. Other window objects, such as bathymetry polygons in section plots, contour lines in data windows showing

gridded field, colored data dots in data windows showing original data, or the station selection polygons in the station map, may also be exported to *.gob* files. All these exported objects may later be imported and added as graphics objects to the canvas, the map or any data window.

Edit and Delete

The properties of a given object can be modified by moving the mouse over it (for symbol sets move the mouse over one of the symbols), clicking the right mouse button and choosing *Properties* from the popup menu. Some graphics objects, such as axis labels, unit arrow boxes or legends, are created and deleted automatically (automatic graphics objects). These objects may not be edited or deleted manually (automatic axis labels are switched on/off on the *General* page of the window's *Properties* dialog).

Dialog boxes (different for the different objects) appear and let you change properties easily and quickly. Graphics objects may be clipped to their parent window (check the *Clip to window* box), and they may be drawn before the data of the window are drawn (check the *Pre-data plot* box). You delete an object by moving the mouse over it, clicking the right mouse button and choosing *Delete Object*.

Dragging

If the attribute *Allow dragging* of a graphics object is set, the object can be re-positioned by simply dragging it to a different location. To drag an object, move the mouse over it, click and hold down the left mouse button and move the mouse. By default, dragging is switched on initially for all graphics objects except symbol sets, which are linked to actual data values. You can change the *Allow dragging* attribute at any time using the object's *Properties* dialog (see above).

Managing Graphics Objects

You can manage the graphics objects of the canvas, map or any data window using the respective *Extras>Manage Graphics Objects* option. This includes changing the object's properties (Edit), exporting, copying, deleting or changing the order in which the objects are drawn.

11.1 Annotations

You can add annotations by choosing (*Extras>Add Graphics Object>Annotation*) from the canvas, map or data window popup menus. A cross-hair cursor will appear, which you should move to the location where the annotation is to appear and then click the left mouse button. Note that the window from which the creation was initiated will own the respective object. When adding (or editing) annotations you may set the position, orientation (degrees, counter-clockwise), font size (pt), color and alignment parameter of the annotation text. Annotations can have a frame, and the annotation rectangle can be filled before drawing the text. You can choose different colors for all these items. In ODV annotations, you can use various [formatting control sequences](#) as well as [functions for](#)

auto-text substitution.

Like all graphics objects, you can drag an annotation to a different position by moving the mouse cursor over it, pressing and holding down the left mouse button and moving the mouse. You can edit an annotation by moving the mouse over it, clicking the right mouse button and choosing *Properties* from the popup menu. To delete an annotation (all annotations) choose *Delete Object (Delete All Objects)* from its popup menu.

Note that the axis labels of the data plot windows are implemented as automatic annotations. They are created automatically when the plot window is drawn and they are deleted when the respective data plot window is deleted. You may not edit or delete automatic axis labels. If you want to change an axis label permanently, you should switch off automatic axis labels (see *General* page of the window's *Properties* dialog) and create an annotation manually by choosing *Extras>Add Graphics Object>Annotation* from the canvas popup menu.

11.2 Lines and Polygons

You add straight lines, polylines and polygons to the map, data windows or the canvas by choosing (*Extras>*)*Add Graphics Object>Line, ...>Polyline* or *...>Polygon* from the map, data window or canvas popup menus. In all three cases the cursor changes to a cross hair, and you should proceed by specifying the nodes of the object. For a *Line* graphics object you must define starting- and endpoint: move the cross-hair to the start of the line and click the left mouse button, then move to the end-point and click the left button again. For *Polyline* or *Polygon* graphics objects you may define up to 1000 nodes. Note that polygons are closed automatically by ODV. If you want to delete a point, move the cross hair close to it and click the right mouse button. You end the definition of polygon or polyline points by pressing *ENTER*.

Once you have specified the nodes of the line, polyline or polygon, ODV presents a dialog box that lets you define color, width and type of the (poly)line and the fill color of the polygon (ignored for *Line* and *Polyline*; choose (*none*) as fill color to avoid filling of the polygon). Also note that lines wider than 1 pixel are always solid on many screen and printer devices. However, the requested line-type is always honored in ODV PostScript files. Polylines and polygons may be smoothed by checking the *Bezier smoothing* box.

11.3 Rectangles and Ellipses

You add rectangles (squares) and ellipses (circles) to the map, data windows or the canvas by choosing (*Extras>*)*Add Graphics Object>Rectangle*, or *...>Ellipse* from the map, data window or canvas popup menus. A red zoom rectangle will appear that represents the bounding box of the new rectangle or ellipse. The zoom rectangle can be moved and resized, then press *ENTER* to accept a setting or *ESC* to abort creation of the object. A dialog box appears that lets you define properties of the rectangle or ellipse (for details see [Lines and Polygons](#)).

11.4 Symbols

You add symbols (dots, squares, diamonds, triangles, inverted triangles, stars, crosses, pluses) to the map, data windows or the canvas by choosing (*Extras>Add Graphics Object>Symbol*) from the map, data window or canvas popup menus. A cross-hair cursor will appear, and you should move it to the location where the symbol should appear. Then click the left mouse button. The *Symbol Properties* dialog box appears and lets you set various symbol properties.

11.5 Symbol Sets and Legends

You can highlight a subset of the data points in a data window or a subset of stations in the map by assigning a symbol to the selected data points (symbol set). To create a symbol set for a data window or the map, move the mouse over this window and choose *Extras>Add Graphics Object>Symbol Set*. The *Symbol Set Selection* dialog appears and lets you select the subset of data points (select one or more cruises in the *Cruises* list, stations in the *Stations* list, and/or individual samples in the *Samples* list). Then press the << button to add the selected data points to the *Selected* list. Press *OK* once all desired points are selected. The *Symbol Set Properties* dialog appears, which lets you define the symbol and line characteristics. A symbol set can have a descriptive text (legend), which will automatically be added to the legends of the respective window (check the *Add to legends* box). Unlike other graphics objects, symbol sets cannot be dragged, because of their association with the selected data points. You can change all symbol set properties at any time by moving the mouse over any one of its symbols, clicking the right mouse button and choosing *Properties*.

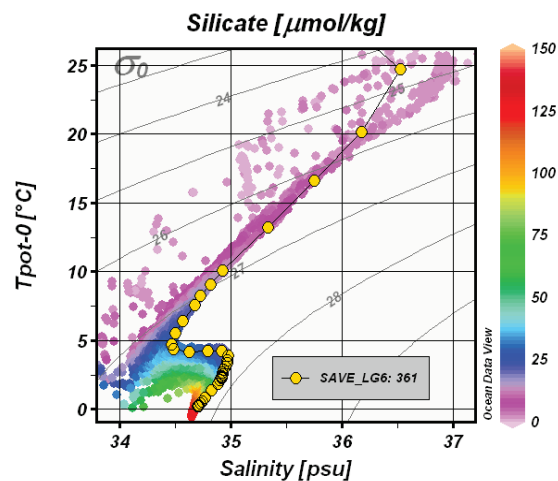


Figure 11-1: Sample SCATTER plot using symbol sets and legends to highlight the data of a particular station

If a data window or the map contains symbol sets, and the *Add to legends* option is switched on, a legend box containing the symbol and legend text of all symbol sets for this window appears automatically. Legend sets can be dragged to different locations

and their properties (the size of the legend box is modified by changing the font size for the legend text) can be modified at any time (move mouse over legend set, click right mouse button and choose *Properties*).

11.6 Managing Graphics Objects

You can obtain full lists of all graphics objects of the canvas, the map or any data window by right-clicking on the respective area and choosing *Manage Graphics Objects* or *Extras* > *Manage Graphics Objects*.

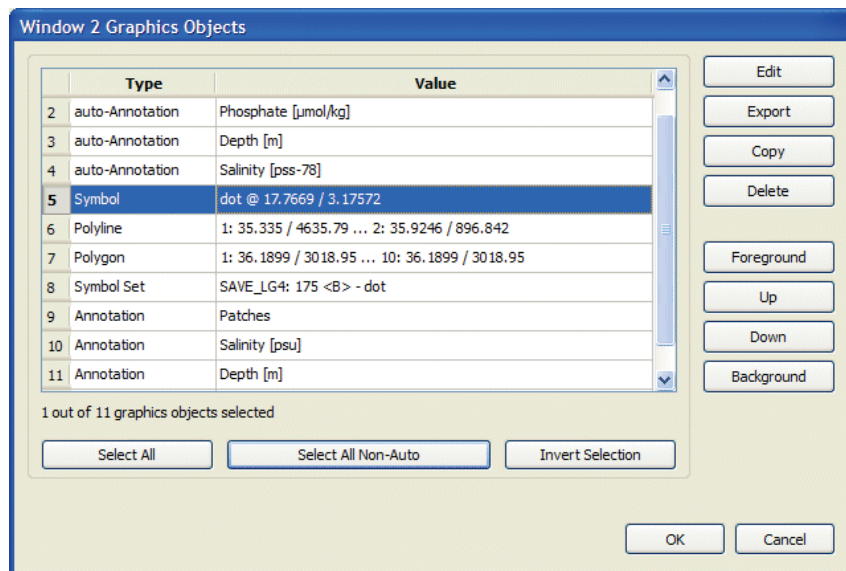


Figure 11-2: The Graphics Objects dialog.

The *Graphics Objects* dialog (Figure 11-2) appears, letting you select individual objects, sub-groups of objects, or the entire list of objects. If you have selected one or more objects you may delete all selected objects by pressing *Delete* or you may export all selected objects to a file for subsequent re-use by pressing *Export*. If you have selected just one object you may also copy the object (by pressing *Copy*) or change the properties of the object (by pressing *Edit*). You may also change the drawing order and bring the object closer to the foreground (*Foreground* or *Up*) or background (*Background* or *Down*).

12 Working with Collections

12.1 Copying, Renaming and Deleting Collections

You can create a copy of the currently open collection using *Collection>Copy*, you rename (and possibly move) the currently open collection using *Collection>Move/Rename*, and you delete the currently open collection using *Collection>Delete*. Note that view and section files associated with a deleted collection may have to be deleted manually.

12.2 Sorting and Condensing

The station search and selection algorithms of ODV work most efficiently if the stations in a collection are ordered by cruises. Therefore, it is recommended that you sort and condense your collections after importing, replacing, merging or deleting large numbers of stations. You invoke the sort and condense procedure by choosing *Collection>Sort and Condense*.

12.3 Deleting Stations

You can delete the currently selected stations from the collection by choosing *Collection>Delete Station Subset* from ODV's main menu. To delete the current station only, choose *Collection >Delete Current Station*. Note that the data space of the deleted stations in the collection disk files is not freed until you sort and condense the collection.

12.4 Key Variable Associations

Many derived variables require identification of the input variable(s) needed for the calculation of the derived variable. This identification of key variables is done during the first definition of the derived variable, and the selected variables are remembered as part of the properties of the collection. If the derived variable is requested again at a later time, the stored key variable information is used, and the user is not prompted again.

You can inspect and modify the current key variable associations using *Collection>Identify Key Variables*. The *Identify Key Variables* dialog will appear, showing lists of key variables on the left and collection variables on the right. Associated items are marked with an asterisk (*). You can click on such items in any of the lists and ODV will show the associated item in the other list. You may break the association by pressing *Undo*; pressing *Undo All* will break all association and leave all key variables undefined. You establish an association by selecting the relevant items in the two lists and pressing *Associate*. Items in the key variable list that are not included in the list of collection variables may be marked as not available by pressing the *Not Available* button. Such items are marked in the key variable list by a minus sign (-).

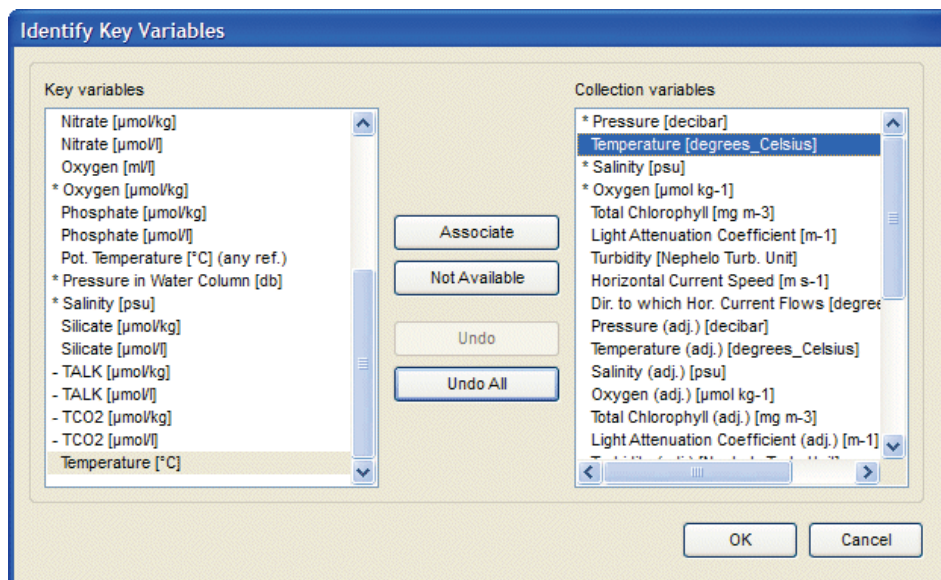


Figure 12-1: The Identify Key Variables dialog.

Important Note: Errors made in the key variable associations can lead to disastrous and sometimes hard to track errors of the values of affected derived variables. For instance, imagine the key variable *Salinity [psu]* was erroneously associated to collection variable *Oxygen [$\mu\text{mol kg}^{-1}$]*. This would cause all derived variables requiring *Salinity [psu]* as input variable, such as potential temperature, potential density, and many others, to return wrong values. You should verify the validity of key variable associations from time to time using option *Collection>Identify Key Variables*.

12.5 Good Coverage Criteria

Some ODV operations, such as the interpolation to standard depths or the calculation of various derived variables require that there are *sufficient* input data available. Calculation of dynamic height, for instance, requires full profiles of temperature and salinity data, and gaps between the data points should not be too large. Using *Collection>Good Coverage Criteria* you may specify the criteria that must be satisfied to consider the data of a given variable sufficient. These criteria are applied to any variable required for a specific operation. If one or more required variables fail the test, the respective operation is not performed.

- # Obs Number of required observations per station.
- Fraction > Percentage of samples that must contain data for a given variable.
- gap(Z).. Specifies the depth dependent tolerable gap between data points.

12.6 Browsing Collection Information

Collection Info

Every collection may have a free-text description of the data in the collection. This in-

formation is stored in the collection's info file. You may view or edit the info file of the currently open collection by choosing *Collection>Browse Info File*.

Cruise Inventory

You can view the cruise inventory table of the currently open collection by choosing *Collection>Browse Cruise Inventory*. The following information is provided for every cruise: cruise ID, number of stations, number of samples, station IDs, longitude and latitude ranges, time period, and data availability indicators for each of the basic variables. Data availability indicators are single digit numbers, with, for instance, 9 indicating that more than 90 % of the samples containing data for the particular variable.

Collection Logfile

All actions that modify the contents of a collection (creation, import of data, station deletions, editing of metadata or data, etc.) are logged in the collection's logfile. You can view the contents of the logfile by choosing *Collection>Browse Log File*.

12.7 Variable Properties

You may modify properties of meta- and collection variables by right-clicking on the current station or current sample list windows and choosing the *Properties* option. From the list of variables choose the one you want to modify and press *Edit*. On the properties dialog of the selected variable you may edit the strings for variable label, units and comment. You may also modify the number of digits used to show values in the current station or sample windows.

Note that other properties of the variable, such as data type, byte length and the quality flag schema used for the quality flags, are specified at collection creation time, and may not be changed later. If you want to change these parameters for an existing collection you have to export all data in the collection (using *Export>ODV Spreadsheet*), create a new collection using the variables from the existing *.odv* or *.var* collection, and modify the meta- or collection variable properties during creation. Then import the previously exported data using *Import>ODV Spreadsheet*.

12.8 Editing Data

You can edit the metadata as well as the actual data values and quality flags of the current station and save the modified values in the collection data files on disk.

Station Metadata

To modify the metadata of the current station, right-click on the current station list window and choose *Edit>Metadata*. The *Edit Station Metadata* dialog appears showing the metadata of the current station. You can edit an individual entry by double-clicking into the respective value field. You modify a particular quality flag by clicking on its field and then clicking the *Change Quality Flag* button and selecting the new quality flag.

Press *OK* on the *Edit Station Metadata* dialog to write the new metadata to the collection files. Press *Cancel* to discard your modifications and leave the metadata of the current station unchanged.

Note that edit operations are logged in the logfile of the collection. This file can be viewed using the *Collection>Browse Log File* option.

	Values	QF
Cruise:	6900631	1
Station:	1_DR_IFM2	1
Type:	C	1
Longitude [degrees_east]:	341.996	1
Latitude [degrees_north]:	19.990	1
Year:	2008	1
Month:	2	1
Day:	14	1
Hour:	4	1
Minute:	10	1
Second:	0.00	1
Bot. Depth [m]:		1

Figure 12-2: The *Edit Station Metadata* dialog.

Station Data

To modify the data of a given variable at the current station right-click on the particular variable in the current sample list window and select *Edit Data*. The *Edit Data* dialog appears showing the data value and quality flags of the variable for all samples of the current station. You may change data values and quality flags for the current sample (initial selection) or for a user defined sample subset. You define a sample subset in the data list by pressing the standard extended selection keys *Ctrl* and *Shift* while left-clicking the mouse. Click on *Select All* to select all samples, or press *Invert Selection* to invert the current selection.

If you have selected a single data item you can change its value by clicking on the *Change Value* and entering a new numerical value. If you have selected more than one sample in the data list, the *Change Value* button is deactivated. Pressing the *Delete Value(s)* button removes the data values of all selected samples. You should use this button with great care, as the original data values will be lost permanently. Usually, you should leave the actual data value unchanged and modify the data quality flags of the selected samples instead. This is done by clicking the *Change Quality Flag(s)* button and selecting a new quality flag from the list of available flags. Pressing *OK* saves the changes to disk, pressing *Cancel* aborts the edit session and leaves the station data in their original form.

Note that you can [filter data based on their quality flag values](#). Also that edit operations

are logged in the logfile of the collection. This file can be viewed using the *Collection>Browse Log File* option.

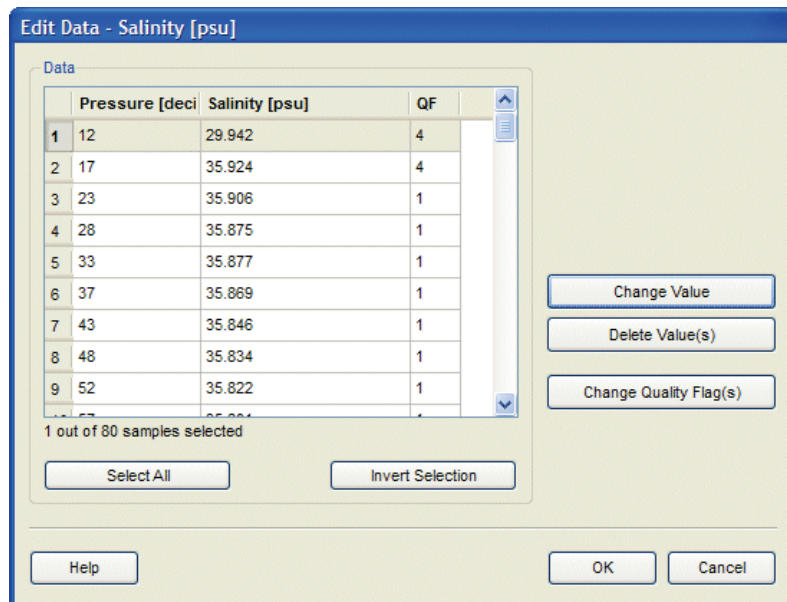


Figure 12-3: The Edit Data dialog.

13 Tools

13.1 2D Estimation

For data windows that currently use the VG Gridding gridding method you can perform estimation of Z-values at arbitrary, user-specified X-Y points by choosing the *Extras>2D Estimation* option from the respective data window popup menu. The estimated Z-values are weighted averages of nearby data points using the X and Y averaging length scales from the current VG Gridding settings. Note that the results depend on the magnitudes of the averaging length scales: large length scales result in smooth fields, whereas small scales allow maintaining small-scale features. Also note that the length-scales are specified in permille of the current X and Y ranges. Changing the axis ranges by zooming or enlarging will therefore change the absolute averaging length scales and also changes the *2D Estimation* results. Use the data plots Properties dialog to adjust the length scales until you are satisfied with the distribution displayed in the data plot. Then invoke the *Extras>2D Estimation* option.

ODV will prompt you for a file (called *input file* in the following) with the X-Y coordinates of the points for which estimation is requested. This file has to be prepared prior to invoking the *2D Estimation* option. It has to be in plain ASCII format with one X-Y coordinate pair per line, and the X and Y values must be separated by one or more spaces. The number of points (or lines) is unlimited. For each point in the input file ODV will estimate a Z-value, and will write the estimated values together with the respective X and Y coordinate to an output file. Name and location of the output file may be specified by the user. The default name is the input file name appended with *.est*, and the default location is in the same directory as the input file. Each line contains the X, Y, and Z values as well as an estimation quality indicator. A quality indicator value of 0 indicates an acceptable estimate, whereas 8 indicates a bad estimate. A Z value of *-1.e10* indicates that the X/Y point is outside the current domain.

13.2 3D Estimation

You can estimate values for a basic or derived variable at arbitrary geographical locations by choosing *Tools>3D Estimation*. ODV will prompt you for an ASCII file that contains the longitude, latitude, and depth values of the points for which Z-variable estimates are to be obtained. This 3D point definition file has to be prepared prior to invoking the *Tools>3D Estimation* option. When creating the point definition file, specify one point per line, and provide decimal longitude, latitude and depth values in this order, with one or more spaces separating the individual values. ODV will let you choose the variable for which the estimation should be performed and it lets you specify x, y, z averaging length scales used for the estimation. Note that the length scale units for longitude and latitude are in per mille of the current map ranges, whereas the unit of the depth length scale is in meters. Choosing large values for the averaging length scales will result in smooth estimates. For the *3D Estimation* all original data points from all stations currently shown in the map will be used. The weight with which a given data point influences the estimate at a specific target location is inversely proportional to the

distance between data and target points. The output file contains one line of results for every longitude, latitude and depth point specified in the input file. Each line contains six numbers x, y, z, v, d, n with the following meaning:

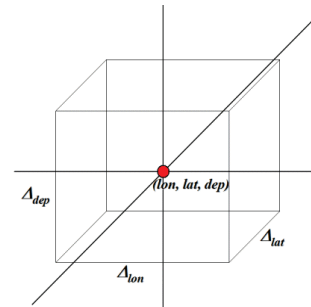
x, y, z	longitude, latitude, depth (as specified in the input file)
v	estimated value
d	normalized distance of averaged data x, y, z positions from estimation point (in units of averaging length scales)
n	number of data points used.

13.3 Box Averaging

You can use ODV to calculate averages and standard deviations for basic or derived variables in given longitude-latitude-depth boxes. Only stations currently shown in the map are considered and only stations and data points inside the requested box are actually used for the mean and standard deviation. You can specify appropriate station [selection criteria](#) prior to invoking the *Box Averaging* option, to obtain averages for different station subsets, years, months, or seasons. To invoke box averaging, choose *Tools> Box Averaging* from the main menu. ODV shows the list of basic and derived variables and lets you choose one or more variables for the averaging procedure. ODV then prompts for the ASCII box definition file containing the geometry information of the boxes for which output is to be produced. The box definition file has to be prepared prior to invoking the *Box Averaging* option.

The format of the box definition file is as follows:

- plain ASCII, one box definition per line, 6 numbers separated by (one or more) spaces,
- meaning of numbers (see figure):
 $lon\ lat\ dep$ (box center) $\Delta_{lon}\ \Delta_{lat}\ \Delta_{dep}$ (box sizes). Longitudes and latitudes are in decimal degrees, and depth is in meters.



Once you have specified a box definition file, ODV will start working. Note that while averaging, ODV will check for data outliers and will use only data within 3 standard deviations of the mean. The output will be written to the directory of the box definition file. The output file names consist of the box definition file name, the label of the variable that is processed and the extension *.est*.

The format of the *.est* output file is as follows:

- plain ASCII, one line of output per line in the box definition file, 10 values separated by TABS,
- meaning of values:
 $lon\ lat\ dep$ (same as in box definition file) $lon\ lat\ dep\ val\ \sigma\ n_u\ n_r$.

$lon\ lat\ dep\ val$ are average longitude, latitude, depth and variable values of the data

used, σ is the standard-deviation of the variable values, n_u is the number of data points used and n_r is the number of data points rejected. Note that the error of the mean, val, can be calculated as

$$\sigma_m = \sigma / \sqrt{n_u}$$

If no data point is found within a box, val is set to -1.e10; if only one data point is found, σ is set to 1.e10.

Also note that all individual data values used for a given average are exported to an ASCII file *ODVbox*.dat* in ODV's temporary files directory, where * in the file name represents the respective box number (e.g., line number in the box definition file). In the *.dat* files the meaning of values is as follows: #, lon, lat, dep, day-of-year, value, weight, used/rejected-flag. Note that *ODVbox*.dat* files are overwritten by subsequent box averaging requests. By default, *ODV*.** files in ODV's temporary files directory are automatically removed after three days. No *ODVbox*.dat* files will be written, if you request averages for 5000 or more boxes.

13.4 Finding Outliers

You can scan the currently selected stations for samples with data values outside a user specified value range by choosing *Tools>Find Outliers*. Select the variable to be scanned from the list of variables and enter the minimal and maximal accepted range values. Press *OK* to start the scan. ODV will report the number of outliers found and lets you view the list of outliers. ODV also lets you inspect and modify the data values and/or quality flags of the outlier samples.

If you check *Inspect and Edit Outliers*, ODV will visit all identified outliers and allows you to delete the respective value or to mark it as *Questionable* or *Bad*. If you press *Apply to All*, ODV applies the selected operation to all outliers, otherwise the user is prompted for an action for each individual outlier. Note that the currently edited outlier is marked in the data plots.

13.5 Finding Duplicate Stations

You can scan the currently selected station set for stations with identical or nearly identical positions and times of occupation (duplicate stations) by choosing *Tools>Find Duplicate Stations*. The list of duplicate stations is written to disk. Blank lines separate sets of duplicate stations. For each station the following information is given: (1) internal sequence number, (2) cruise label, (3) station label, (4) station type, (5) date and time, (6) longitude, (7) latitude, (8) number of samples, (9) deepest sample, (10) availability indicators for basic variables 2 to *nVar* (e.g., 7 means that between 70 and 79% of the samples contain data for a given variable). To delete a duplicate station, make it the current station using *Current Station by Number* or *Current Station by Name* from the map popup menu and then delete it using *Collection>Delete Current Station*.

14 More ...

14.1 General Settings

You can customize general ODV settings such as the graphics and text fonts, the size of the canvas, or the browser and text file viewing commands using option *View>General Settings*.

Font:

Choose a font family and various font properties and set a global font scaling factor *Size*. Increase the *Size* value, if you want larger graphics text and axis annotations, or decrease it otherwise. Note that some fonts may not be supported in ODV's PostScript output. Also note that *Graphics Font Size* adjustments may be necessary after large changes of the canvas size (see below).

The *Text Font Size* entry determines the font size used for menus, dialogs and the current station and sample list windows.

Canvas:

Adjust the width and height of the ODV graphics canvas, e.g., the white area onto which the map and data windows are drawn. Click on *Fit to screen* to establish optimal settings for the current screen. Note that it may be necessary to adjust the *Graphics Font Size* on the *Font* tab after large changes of the canvas size.

Highlighting:

Choose the color(s) to be used for highlighting the current station, current sample and data of the current station. Different colors may be chosen for the map and data windows.

Printing:

Check the *Show collection info* box to include a time-stamp as well as collection, view and user information on printouts. Adjust the position if necessary.

Program Locations:

Enter the full paths of your Web browser (needed for ODV help) and text viewer (needed for viewing text files).

System:

Enter the user's login name and the computer's host name.

14.2 Changing the Color Palette

You can change the color palette of the map or any data window by right-clicking on the window, choosing the *Properties* option and selecting one of the available palette files from the *Palette* combo box on the *General* page. ODV will redraw the map or data window using the new palette.

On Windows you can create new color palettes or modify existing palettes by means of the *PalEdt.exe* program in the ODV binaries directory (normally c:\Program

Files\Ocean Data View (mp)\bin_w32). *PalEdt.exe* can be invoked from ODV by choosing *Tools>Invoke Palette Editor*.

ODV-style color palettes define 177 colors:

- 0-15: basic colors
- 16-31: gray-scale; color 31 used as background color of ODV plot windows;
- 32-144: main palette used for color-shading;
- 145-160: colors used for map bathymetry and continents;
- 161-176 colors used for map land topography.

14.3 Animations

ODV allows lets you produce animated GIF files of the map or any data window by right-clicking on the respective window and choosing *Extras>Animation* and one of the sub-options *Metadata Time*, *Metadata Time of Year*, *Validate Variable*, or *Extras>Animation>Isosurface*. Then follow the instructions below.

(1) *Metadata Time*:

Specify a start date t_0 , the interval step dt (in days), the number of frames n to be produced and the interval type. ODV will then construct n time intervals and use the respective start and end dates for the *Date/Time>Period* station selection criteria.

Depending on the selected interval type, the start and end dates of interval i ($i=0, \dots, n-1$) are defined as follows:

Interval Type	Start of Interval i	End of Interval i
Zero Width	$t_0 + i \cdot dt$	$t_0 + i \cdot dt$
Fixed Width	$t_0 + i \cdot dt$	$t_0 + (i + 1) \cdot dt$
Fixed Start	t_0	$t_0 + (i + 1) \cdot dt$
Fixed End	$t_0 + i \cdot dt$	$t_0 + n \cdot dt$

For each such time interval, the map will be re-build, including only those stations with metadata dates in the respective time window. If the animation is for a data window, this data window will also be redrawn using data from the currently selected station set only. The current map or data window will then be added to the animation file.

(2) *Metadata Time of Year*:

Specify a start month and day t_0 , the interval step dt (in days), the number of frames n to be produced and the interval type. ODV will then construct n time intervals and use the respective start and end dates for the *Date/Time>Season* station selection criteria.

Depending on the selected interval type, the start and end dates of interval i ($i=0, \dots, n-1$) are defined as follows:

Interval Type	Start of Interval i	End of Interval i
Zero Width	$t_0 + i \cdot dt$	$t_0 + i \cdot dt$
Fixed Width	$t_0 + i \cdot dt$	$t_0 + (i + 1) \cdot dt$
Fixed Start	t_0	$t_0 + (i + 1) \cdot dt$
Fixed End	$t_0 + i \cdot dt$	$t_0 + n \cdot dt$

For each such time interval, the map will be re-build, including only those stations with metadata months and days in the respective time window. Note that data from more than one year may be used if the data collection contains stations from multiyear period. If the animation is for a data window, this data window will also be redrawn using data from the currently selected station set only. The current map or data window will then be added to the animation file.

(3) Validate Variable:

This option is available for data windows only. Select a validate variable and specify a start value v_0 , the interval step dv , the number of frames n to be produced and the interval type. ODV will then construct n intervals for the validate variable and use the respective start and end values for the *Sample Selection Criteria*>*Range* selection criteria of the chosen variable.

Depending on the selected interval type, the start and end values of interval i ($i=0, \dots, n-1$) are defined as follows:

Interval Type	Start of Interval i	End of Interval i
Zero Width	$v_0 + i \cdot dv$	$v_0 + i \cdot dv$
Fixed Width	$v_0 + i \cdot dv$	$v_0 + (i + 1) \cdot dv$
Fixed Start	v_0	$v_0 + (i + 1) \cdot dv$
Fixed End	$v_0 + i \cdot dv$	$v_0 + n \cdot dv$

For each such interval the data window will be redrawn, including only those data from the respective variable value interval. The current data window snapshot will then be added to the animation file.

(4) Isosurface :

This option is available for isosurface data windows only. Select a start value s_0 , the interval step ds , and the number of frames n to be produced. ODV will then construct n isosurface values and will re-build the data window for each such value. The current data window snapshot will then be added to the animation file.

For all animations ODV will draw an animation bar indicating the current animation interval. The animation bar is centered below the respective window.

14.4 Drag-and-Drop

On most platforms you can drag and drop ODV supported files on the ODV window or icon. Depending on the extension of the dropped file, ODV will perform the following actions:

.odv or *.var*: close current collection or netCDF file and open the dropped collection.

.nc or *.cdf*: close current collection or netCDF file and open dropped netCDF file.

.txt (ODV spreadsheet files),

.o4x (ODV list files),

.csv (WOCE WHP exchange files),

.jos (Java Ocean Atlas spreadsheet files):

import data from dropped file into currently open collection. If no collection is open when the file is dropped, ODV creates a new collection in the directory of the dropped file and imports the data into the newly created collection.

On all platforms, ODV supported file names can also be used as command line arguments. Start ODV from any terminal window by typing: `odv4 [file name[.extension]]`. Note that for file name you either use absolute pathnames or pathnames relative to the directory from which you start ODV. If you use a relative pathname, "." and ".." are not allowed. You can use command line arguments to ...

1. start ODV and open an existing collection: use the collection name for file name. If you omit an extension, the default *.odv* is used.
2. create a new collection and import data: use the name of the data file (must be one of ODV's import types, e.g., *.o4x*, *.txt*, *.csv*, *.jos*) to be imported for file name. In this case you must provide the extension. ODV will create a new collection in the directory of the import file and will import the data from the file. The collection variables are determined from information in the data file.

14.5 ODV Command Files

You can store commands for frequently used operations, such as opening a collection, loading specific view files and creating graphics or data output files in ODV command files. ODV command files can be executed at any time (batch mode) using the *File>Execute Command File* option or using the "`-x cmd_file`" command line option. The default extension of ODV command files is *.cmd*. The default location is the directory *odv_local/cmd_files* in the user's home directory. Create directory *cmd_files*, if it is not already present and place your command files in this directory.

The following commands are currently supported in ODV command files. Note that a slash "/" should be used as path separation character in all filenames appearing in ODV command files for platform independence. Once a *base directory* is defined by `set_base_directory`, all subsequent relative filenames are considered relative to *base directory*. If no *base directory* is defined and a collection or netCDF file has been opened,

relative filenames are considered relative to the collection or netCDF directory. Multiple arguments must be separated by commas “,”. The window index parameter *iw* may have the following values: -1 for the graphics canvas, 0 for the map, and positive integer integer values for data windows. Lines in ODV command files may not exceed 255 characters in length. Lines with # as first character are treated as comments and are not executed.

set_base_directory *base_directory*

Define a base directory. All subsequent file names must be either absolute pathnames or names relative to *base_directory*.

Example: `set_base_directory c:/ewoce/data`

open_collection *collection*

Open collection *collection*.

Example: `open_collection c:/ewoce/WoceBtl.var`

load_view *view_file*

Load view file *view_file*. *View_file* can be a *.xview* or *.cfg* file. `load_view` is equivalent to `load_cfg`, which is still supported for backward compatibility.

Example: `load_view c:/cfg_files/abc.xview`

set_annotation_style *ptSize, textColor, bckgrdColor, frameColor, frameWidth*

Set the style of text annotations subsequently created with `create_annotation`. *ptSize* is the font size in points, *textColor* is the color of the text, *bckgrdColor* is the background color of the text bounding box, *frameColor* is the frame color of the text bounding box, and *frameWidth* is the width of the frame around the text bounding box. All colors are specified as index values into the current color palette. Specify -1 for *bckgrdColor* and/or *frameColor* to avoid drawing of a background box or frame. Note that all arguments to `set_annotation_style` are integers. Default values are: 16, 0, -1, -1, 0, which will produce 16pt black text without box or frame.

Example: `set_annotation_style 24, 8, 7, 0, 1`

create_annotation *iw, x, y, orientation, textAlign, "text"*

Create a text annotation *text* for window *iw* at position *x, y* (window *iw* coordinates) oriented along *orientation* degrees measured counter-clockwise from positive x-axis. *textAlign* determines the alignment of the text relative to (*x, y*): center_center 0, center_top 1, center_bottom 2, right_top 3, right_bottom 4, left_top 5, left_bottom 6, right_center 7, left_center 8. Note that *iw* and *textAlign* are integers, *x, y*, and *orientation* are floats. Note that the annotation text has to be enclosed in "" characters.

Example: `create_annotation -1, 10., 8., 30., 0, "Some Text"`

export_data *data_file*

Export the data of the current station set to file *data_file* using the generic ODV spreadsheet format.

Example: `export_data c:/output/odv_data.txt`

export_graphics *iw, graphics_file, dpi*

Save graphics of window *iw* in file *graphics_file* using a resolution of *dpi* dots-per-inch. Use *graphics_file* extensions .eps, .gif, .png or .jpg for PostScript, GIF, PNG or JPEG output, respectively. Although the *dpi* argument is not used for PostScript output, it must still be provided.

Example: `export_graphics -1, c:/output/odv_graph.eps, 300`

quit

Terminate and exit ODV.

Example: `quit`

Following below is an example ODV command file that opens a collection, loads a view, adds an annotation, writes two image files of the entire canvas and of data window 1, respectively, exports the data of the currently selected stations to an ODV spreadsheet file, and finally shuts down ODV.

```
set_base_directory c:/rschlitz/data/eWOCE/data/whp/bottle
set_annotation_style 18, 0, 7, 0, 1
```

```
open_collection WoceBtl.var
```

```
load_cfg      cfgAtlanticSections/A15_OXYGEN.cfg
create_annotation 1, -13.18,65.83,0, 6, "Test"
```

```
export_graphics -1, c:/atmp/A15_OXYGEN.png, 100
export_graphics 1, c:/atmp/A15_OXYGEN_1.png, 200
export_data    c:/atmp/A15_OXYGEN.txt
```

```
quit
```

14.6 Gazetteer of Undersea Features

ODV can be used to identify undersea features like seamounts, ridges, fracture zones, troughs, basins, etc. To invoke the gazetteer option, choose *Extras>Gazetteer* from the map popup menu. The gazetteer dialog box is shown, which lets you select a specific database, lets you specify feature selection criteria as well as size and color of the gazetteer marks drawn by ODV. When you press the *Switch On* button (or *Update*, if you have modified the gazetteer settings), the information from the selected gazetteer database is loaded, and the feature positions are marked in the map. Moving the mouse close to a feature point invokes a popup window displaying the name of the feature. To switch off the gazetteer marks, invoke the gazetteer dialog box again and press the *Switch Off* button.

A number of gazetteer files are provided with the ODV distribution. These include: (1) *GazetteerGEBCO.gzt* from the International Hydrographic Bureau (IHB), (2) *GazetteerBGN.gzt* from the US Defense Mapping Agency, and (3) *WHP_Sections.gzt*, which is a compilation of the sections occupied during the WOCE Hydrographic Programme. You can select feature subsets by specifying a feature type and/or feature name sub-string using the gazetteer dialog box. Note that the name and type selections are case-

insensitive. Use the gazetteer feature selection if you know the name of a feature (or part of the name) and want to identify its location (note that you might have to open the map to global extent in order to see the feature mark). Gazetteer settings are not saved in configuration files. Whenever you open a collection, the gazetteer option is switched off initially.

Gazetteer files can be edited and extended. You can also create your own, new gazetteer databases. In order to use a private gazetteer with ODV, the file must have the extension .gzt, it must be located in the ODV gazetteer directory (<home>\odv_local\gazetteers, where <home> represents your home directory) and its format must satisfy the specifications below:

The first line of the file must start with % GZT01: followed by the name of the file.

Then there are 7 lines starting with % and containing arbitrary comments.

The next line must be: Feature;Type;No;East-Longitude;North-Latitude; there has to be one blank line following.

The rest of the file contains the actual item definitions. Each feature is listed on a separate line.

The name of the feature, its type, the number of longitude/latitude points and the longitude/latitude entries are separated by semicolons ";". Longitude is specified in degrees East (0-360). The number of longitude/latitude points can be up to 1500, and the length of a line may be up to 200,000 characters.

15 Tips and Tricks

15.1 Data Quality Control with ODV

ODV facilitates quality control of multi-parameter datasets by providing a range of automatic and visual checks for easy identification and flagging of outliers and suspicious data. There is support for [automated range checks](#) of any basic variable (use option *Tools>Find Outliers (Range Check)*) as well as automatic statistical outlier checks for any data window currently applying the [VG gridding method](#) (use option *Extras>Find Outliers (Field Check)* of the data window's popup menu). In both cases, ODV generates lists of suspicious data points and allows user controlled (point by point) or automatic flagging of the identified data.

In addition to automatic quality control procedures, ODV also provides a wide range of easy-to-use visual and interactive methods for the identification and editing of outliers. For instance, you can plot all data from a given region or along a given section using data windows of SCATTER or SECTION scope, easily revealing outliers and questionable data in the entire dataset. Flagging or editing the numerical values of the spurious data is as easy as clicking on such a data point in one of the data windows and invoking the [Edit Data](#) option of the variable that you want to modify. Note that all changes made to a data collection are logged in the collection logfile. The log record includes information about the sample that was changed, the date and time of the modification, the user who made the change and the computer on which the operation was performed. You can browse the collection logfile at any time using option *Collection>Browse Log File*.

In the example below, outliers for salinity and oxygen can easily be spotted in the plots showing the data of an entire cruise. Clicking on such an outlier point selects it as current sample, which can then be edited and/or flagged. You can hide and exclude bad or questionable data from the analysis by establishing [data quality sample filters](#).

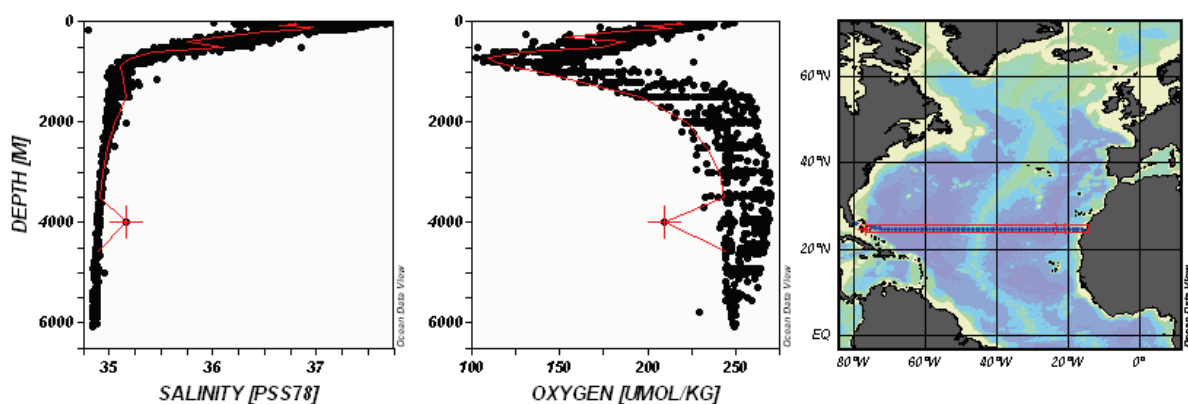


Figure 15-1: Identification of outliers for a zonal section in the North Atlantic

15.2 Visualizing Data from XYZ ASCII Files

Irregularly spaced or gridded data for some quantity Z at given X and Y coordinates are commonly provided in files using three-columns for the X , Y and Z values, respectively. Examples of such XYZ datasets are (1) maps of a given Z variable (X represents longitude, Y represents latitude), (2) vertical sections (X =along section coordinate, Y =depth) or (3) time-evolution plots (X =some geographical coordinate, Y =time or vice versa).

You can load all these XYZ files into ODV and you can analyze and display the Z data using the full suite of ODV functions. Note that the procedures described below can also be applied to data files with multiple Z variables, e.g., files with more than three columns.

Here is how to proceed if the XYZ file represents a map:

1. **Create a new collection** (choose a destination directory and collection name) with just two variables Depth [m] and Z -variable (use a descriptive label and appropriate units for the Z -variable),
2. Import the XYZ file by choosing *Import>ODV Spreadsheet* and selecting the XYZ file (note that you have to choose file-type *All Files*, if the extension of the XYZ file is not *.txt*).
3. On the *Spreadsheet File Properties* dialog specify (1) the column separation character (the items from the header line should appear on separate lines in the *Column Labels* list), (2) the line number containing XYZ labels (keep 1, if no labels are provided), and (3) the line number of the first data line,
4. On the *Metadata Variable Association* dialog associate the X -variable with Longitude [degrees_east] and the Y -variable with Latitude [degrees_north],
5. On the *Import Options* dialog associate the Z -variable (source) with the second collection variable (target). Then click on the first collection variable (target), click on Use Default and specify the default depth value (use 0, if in doubt).

ODV will import the data from the XYZ file, and lets you operate on the data in the usual way. To create a page with a map of the Z -variable create a data window with SURFACE scope. Modify the data window's properties as usual, if this is necessary.

15.3 Overlaying a Property Distribution with Contour Lines of another Property

With ODV, you can produce section or isosurface plots where the distribution of one property (color shaded and/or contoured) is overlaid with contour lines of another property. Useful applications, of this technique are, for instance, density contours on top of any property section or depth contours on isosurface or isopycnal distributions.

To produce such plots, follow these steps:

- Switch to window layout mode via *View>Window Layout*.
- Setup the window for the underlying distribution (window a : define size and position; select a Z -variable for that window (property A) using the *Properties* option).
- Create an overlay window for window a by moving the mouse over window a , click-

ing the right mouse button and selecting *Create Overlay Window*. Now select the Z-variable for the overlay window *b* (property *B*). Leave *Window Layout* mode by choosing *Accept* from the *Window Layout* context menu.

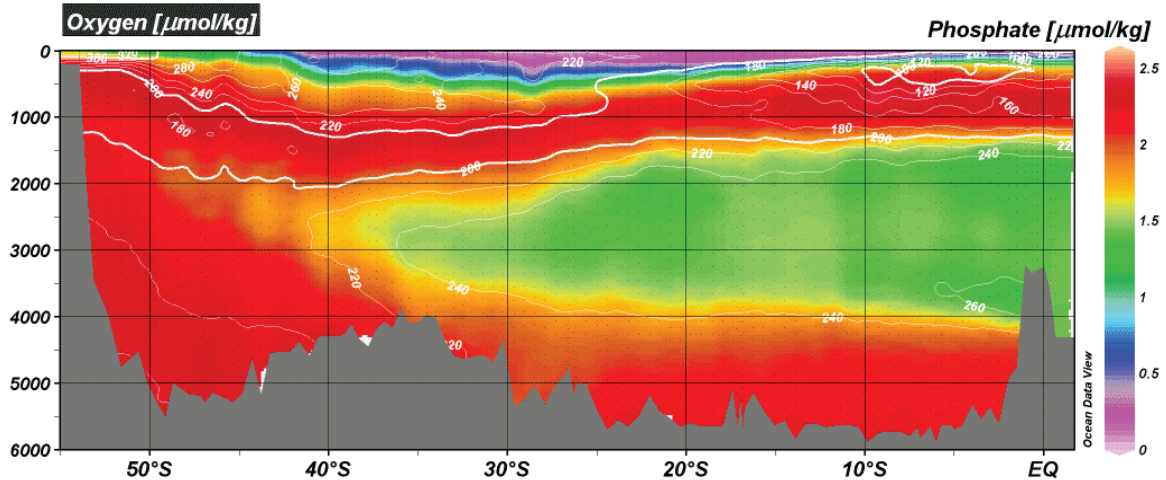


Figure 15-2: Oxygen contour lines on top of color shaded phosphate distribution

- ODV will draw a default set of white contour lines for property B on top of the color distribution of property A. You may add or delete lines or modify properties of the contour lines of B by right-clicking on the overlay window by choosing *Properties>Contours*.
- If you are satisfied, save the view for later use (*View>Save View As*).

Note that for a window entirely overlain by another window (like window *a*), the only way to access and modify its properties is via the *View>Window Properties* option from the main menu.

15.4 Pre-computing and Storing Neutral Density Values in Collections

Compared to most other derived variables, such as potential temperature, potential density, or Brunt-Väisälä Frequency, that can be calculated easily and quickly on-the-fly, the calculation of neutral density is computationally expensive. While this is not a problem for small data collections or when plotting only a small number of stations, using on-the-fly neutral density calculations with large collections and on long sections can be slow and inefficient. If you are working with large datasets and need neutral density regularly, you should consider to pre-compute neutral density and store the results in collection files on disk. You can then use the pre-computed values from the disk files. The disadvantage of pre-computing and storing these values is that they become out-of-date if any of the input data pressure (or depth), temperature and salinity changes (e.g., after data edits or calibration changes). It is the user's responsibility to re-compute the neutral density values whenever pressure (or depth), temperature or salinity data have

changed or have been added.

To create a new collection with pre-computed neutral density values for all stations or a station subset of an existing data collection follow these steps:

1. Open the existing collection and select the stations to be included in the new collection with pre-computed neutral density. If you want to process the entire collection, make sure you have a global map and the number of selected stations is identical to the number of stations in the collection (e.g., two numbers at the end of the status bar should agree).
2. Define *Neutral Density* as a derived quantity using option *View>Derived Variables*.
3. Export the station data including neutral density to a spreadsheet file, by choosing *Export>ODV Spreadsheet*. Specify a name for the new dataset (denoted as *xxx.txt* in the following) and make sure that *Neutral Density* is selected for output in the *Select Variables for Export* list.
4. Use *xxx.txt* to create a new collection by simply dragging and dropping this file on the ODV desktop icon (Windows and some other platforms) or by starting ODV from a terminal window with “*odvmp xxx.txt*” (UNIX, Linux, Mac OS X). The newly created collection *xxx* will have *Neutral Density* as one of its basic variables stored in the disk files.

15.5 Using ODV Graphics in Publications and Web Pages

ODV graphics files of the entire canvas or individual data windows can easily be included in print documents, posters or on Web pages.

To create GIF, PNG or JPG files of the entire canvas or of individual plots press Ctrl-s while the mouse is over the canvas or the respective plot window and choose GIF, PNG or JPG as output type. Then specify the desired resolution of the graphics file (default: screen resolution) and use the GIF, PNG or JPG graphics files in your web pages or in text documents. For print documents you can either produce GIF and PNG files with high resolution, or you can use ODV PostScript (.eps) output instead.

A variety of typesetting and page design software support the import of Encapsulated PostScript files (.eps) in mixed text/graphics pages (e.g., MS Word or compatibles, LaTeX, Adobe PageMaker, etc.). If you use the LaTeX typesetting system, see the file *Pssample.tex* (usually in directory *c:\Program Files\Ocean Data View (mp)\Samples*) for an example on how to include PostScript graphics in TeX documents. Note that the required *epsf* and *epsfig* style files are also included in the samples directory.

If you use Word or PageMaker or other publishing software follow these guidelines: Compose your page as usual and insert the respective ODV PostScript file at the right position. Adjust the size of the figure appropriately. When you are done composing the page you can directly print the document on a PostScript printer. If no PostScript printer is available you need to have a PostScript printer-driver and the GhostScript/GhostView package (<http://www.cs.wisc.edu/~ghost/aladdin/index.html>)

installed on your machine. In that case select the PostScript printer-driver as printer and redirect the output into a file. Open this file with GhostView and print to any printer connected to your system.

15.6 Making Cruise Maps

You can create full-page, high quality stations maps showing the currently selected stations of the open data collection using *View>Window Layout>Layout Templates>Full Screen Map*. Station maps may also be produced if you only have access to the station metadata (e.g., station positions, dates, etc.), but the actual station data are inaccessible. Here is how to proceed:

- In an empty directory on your disk create an ASCII file that contains the longitude, latitude coordinates of the stations or way-points of your track. This file should have a descriptive name (e.g., *CruiseTrack_xxx.txt*, where xxx represents the name of your cruise) and it should comply with the [generic ODV spreadsheet format specifications](#).

As first line of the file use the following header line (note that columns are TAB separated):

```
Cruise          Station Type      yyyy-mm-ddThh:mm Longitude [degrees_east]  Latitude [degrees_north]
  Bot. Depth [m]  Dummy1           Dummy2
```

Immediately following the header line, add one data line for each station or cruise track node and provide the following information for the respective station or node:

Cruise	The name of the cruise
Station	Station label or number
Type	"B"
yyyy-mm-ddThh:mm	Station date and time
Longitude [degrees_east]	Decimal longitude of station
Latitude [degrees_north]	Decimal latitude of station
Bot. Depth [m]	Bottom depth at station location or "0"
Dummy1	"0"
Dummy2	"0"

- On Windows systems drag-and-drop the prepared cruise track file on the ODV desktop icon. On all other platforms start ODV and open the cruise track file via *File>Open* and choosing file type *Data Files (*.txt *.csv *.jos *.o4x)*.
- Add new stations to the end of the cruise track file, if necessary, and drag-and-drop the updated file on the ODV desktop icon (Windows) or invoke ODV using the cruise track file name as a command line argument (all other platforms).

15.7 Preparing Custom Coastline and Bathymetry Files

ODV comes with a medium resolution global set of coastline and bathymetry files

(GlobHR). Higher resolution versions of coast/bathymetry data are available as optional packages for selected regions, such as the Arctic, Baltic, NorthSea, MeditHR and many others. If you need high-resolution coastline and bathymetry files for a region not included in the ODV distribution and if you have such high-resolution data available, here is how to produce ODV usable files.

Preparing New Files

The data for the coastline and bathymetry contours must be in separate files. Use *World.coa* as name for the coastline file. The names of the bathymetry files must follow the *xxxm.coa* scheme, where *xxx* represents the depth value of the respective contour (no white space between the depth value and the *m*; example: *1000m.coa*). For a sample *.coa* file see the *samples* directory of your ODV installation.

The latitude/longitude coordinates of the coastline or depth contour are stored in individual polygon segments (see Figure below). The first n_s nodes of a segment represent a part of the actual coastline or bathymetry contour. This part of the segment is stroked when the outline of the contour is requested. In addition, each segment can have an optional, second part which will not be stroked but is only used to properly close the segment. Segments that also contain this second part can be filled and/or stroked. The total number n_T of nodes in any segment must not exceed 1500. If a segment has no second part, the number of stroke points n_s must be equal to n_T .

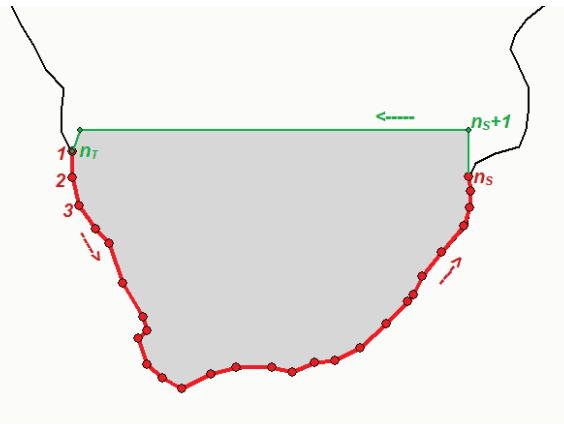


Figure 15-3: Schematic diagram of an ODV coastline/bathymetry segment.

Latitude/longitude coordinates are decimal values: longitude is in degrees East (0 – 360) and latitude is in degrees North (-90 – 90). A polygon segment in a *.coa* file is specified as follows:


```

nT nS
lat1 lon1
.....
latnT lonnT

```

where n_T is the total number of vertices for this segment and n_S is the number of "true" coast/bathymetry vertices. n_T may be larger than n_S , in which case vertices $n_S + 1 \dots n_T$ are used to close the segment (land-side closure). These extra vertices are not shown when the segment is stroked. Note that both, n_T and n_S , must be smaller than 1500. On the line following the last vertex of a segment, the next segment is started by specifying its n_T and n_S values. There is no blank line between segments. To indicate the end of the file put "0 0" in the last line of the file. *.coa* files have to be converted to binary format (*.cdt* files) before they can be used by ODV. A *.coa* to *.cdt* converter (*coa2cdt.exe*) is included in the ODV distribution package for Windows. To use the *coa2cdt* converter do the following:

1. In the directory containing the *.coa* files create a file *coa2cdt.inp* and enter the names of the *.coa* files to be processed. Put one file name per line and omit the *.coa* extension.
2. In a DOS box change to the respective directory and execute *coa2cdt.exe*. Make sure the *coa2cdt.exe* executable is in your path or in the *.coa* directory. Also make sure that the *.coa* files satisfy the *.coa* format, as described above.

The *.cdt* files created by *coa2cdt.exe* are platform-independent and can be used on all supported platforms.

Please note that if you want to fill the bathymetry and coastlines, you have to close all polygons in the *.coa* files, and the interior of the polygons must represent the areas that are shallower than the respective depth contour or coastline. If your depth contours or the coastline does not consist of closed polygons, you can still use them with ODV, however, you should select a line drawing mode and avoid filling in those cases. Use the *Display Options* menu of the map to change display settings accordingly (see *Using New Files* below).

Installing New Files

When installing the binary version of coastline-, bathymetry-, topography and overlay files follow these instructions:

- Create a new subdirectory of the ODV *coast* directory (normally: c:\Program Files\Ocean Data View (mp)\coast) and choose a descriptive name for it (e.g., GulfOfMaine). This directory is the base directory of the new file series. In the new directory create subdirectories *bathymetry*, *topography*, and *overlays*.
- Copy the coastline file (normally called *World.cdt*) into the series base directory (e.g., c:\Program Files\Ocean Data View (mp)\coast\GulfOfMaine).
- Copy all bathymetry files (e.g., 100m.cdt, 500m.cdt, etc.) into the *bathymetry*

subdirectory, all topography files into the *topography* directory and all general purpose overlay files (rivers, lakes, borders, etc.) into the *overlays* directory. If no topography and/or overlay files are available the respective directories remain empty.

Using New Files

To use the newly installed files in ODV maps do the following:

- Invoke the map *Display Options* dialog box (e.g., right-click the mouse while over the map and choose *Display Options*) and select the *Layers* tab.
- Choose the newly installed series name (e.g., *GulfOfMaine*) in the *Series* combobox.
- Compose the layer-set(s) of interest by selecting a layer-set (e.g., *Ocean Bathymetry*) and then pressing *Compose*. Select the contour files that you want to use in the *Available* list, set the desired stroke and fill properties and finally press << to add the files to the *Selected* list (note: if you forget to press << no file is added). To remove files from the *Selected* list select them and press >>.

When specifying drawing characteristics follow these rules:

- (a) If the features should be outlined by lines (stroked), choose the appropriate line-width, -type and -color or choose *none* as color, if you don't want outlines. Note that due to limitations of the operating system, on some Windows versions thick lines will always be drawn as solid lines on the screen and in GIF, PNG and JPG output files. ODV PostScript files, however, honor your selection for any line-width.
- (b) If the features should be filled choose the appropriate Fill color or *none*, if you don't want filling.

If you choose *automatic* for line and fill colors, ODV will use default colors. Note that for some layer sets *automatic* defaults to *none*. Also note that some feature files like rivers or borders should not be filled and you should explicitly set the fill color to *none*.

ODV processes the layer sets in the order as listed in the *Display Options* dialog box. For a given layer set it draws the individual layers in the order in which they appear in the *Selected* list (note that ocean bathymetry and land topography layers are sorted automatically when they are added). You should define sea-ice distributions in the *pre-Coastlines* set and lakes, rivers and borders in the *post-Topography* category.

16 NetCDF Support

16.1 NetCDF Overview

The Network Common Data Form (NetCDF) is an interface for array-oriented data storage and access, which is widely used in climate research and other fields of geosciences. Many important datasets and model output files are distributed in netCDF format.

16.1.1 NetCDF data is:

- *Self-Describing.* A netCDF file includes information about the data it contains.
- *Architecture-independent.* A netCDF file is represented in a form that can be accessed by computers with different ways of storing integers, characters, and floating-point numbers.
- *Direct-access.* A small subset of a large dataset may be accessed efficiently, without first reading through all the preceding data.
- *Appendable.* Data can be appended to a netCDF dataset along one dimension without copying the dataset or redefining its structure. The structure of a netCDF dataset can be changed, though this sometimes causes the dataset to be copied.
- *Sharable.* One writer and multiple readers may simultaneously access the same netCDF file.

16.1.2 NetCDF conventions

The netCDF data model is very general, and the structure and contents of netCDF files can vary considerably. In order to facilitate and promote the interchange and sharing of netCDF datasets, a variety of *conventions* have been defined. Two of these conventions (COARDS and GDT; see <http://www.unidata.ucar.edu/packages/netcdf/conventions.html> for detailed specifications) are widely used by climate researchers and modelers, and many datasets are available as COARDS/GDT compliant netCDF files. Examples of such datasets can be downloaded from <http://www.cdc.noaa.gov/PublicData/>, <http://ferret.wrc.noaa.gov/>, <http://ingrid.ldeo.columbia.edu/>, or <http://www.epic.noaa.gov/epic/ewb/>.

For more information on netCDF, see the netCDF web page <http://www.unidata.ucar.edu/packages/netcdf/>.

16.1.3 ODV netCDF support

ODV can read and visualize the data in a netCDF file as if it was an ODV collection. The full suite of ODV capabilities is available when working with netCDF files. Exceptions are those functions that require write permission to the netCDF file and would modify

the dataset (ODV will never write to a netCDF file). If the netCDF file follows the [COARDS and GDT netCDF conventions](#), ODV will be able to interpret a large variety of variables such as absolute and relative time formats and it can identify attributes of variables such as missing value indicators, long variable names, units and others. ODV allows subsetting of the data, often required for efficient data access in very large datasets.

16.2 Using netCDF Files

ODV can read and display data in netCDF files, widely used by researchers in different fields of geo-sciences. Based on only a few user specifications and selections, ODV accesses and interprets a given netCDF file in a way that mimics (emulates) a native ODV collection. The full suite of ODV's analysis and visualization capabilities is provided for the exploration of the data in the netCDF file. There is no need to translate and re-write the data first. Depending on the structure and contents of a netCDF file, different ODV "emulations" are possible. Settings of individual emulations are saved in view files for later use. Note that netCDF files are platform independent and the same file can be used with ODV on Windows or Solaris platforms.

(1) Opening a netCDF file

You open a netCDF file with ODV by choosing *File>Open netCDF File*. Use the standard Windows file selection dialog to identify the file that you want to open. Alternatively you can start ODV from the command line and specify a netCDF file name as a command line argument. On Windows, you can also drag a netCDF file on the ODV desktop icon. In all cases the extension of the netCDF file must be either .nc or .cdf. ODV opens the netCDF file and retrieves information on dimensions and variables contained in the file.

(2) Defining the netCDF emulation

In a sequence of steps you must now define how ODV should view (or emulate) the netCDF file. This involves selection and subsetting (if required) of coordinate axis (dimensions), association of ODV header variables with information from the netCDF file and the definition of the primary variable (first variable in an ODV collection), which determines the logical structure of a "station" (e.g., profile, sequence, etc.) and the sort-order within a station.

ODV first asks whether a new emulation is to be defined or whether a previously defined and saved emulation should be used. If you choose a previously defined emulation, no additional input is required and ODV proceeds as if it was using a native ODV collection: it draws a station map and offers the full suite of ODV analysis and display capabilities. Note that ODV will not modify an open netCDF file and treats it as a read-only dataset. As a consequence, all ODV functions that require data-write operations (data import, header and data editing, collection manipulation operations, etc.) are disabled when working with netCDF files.

(2.a) Selecting netCDF coordinates

If you define a new emulation, the first step is to select netCDF coordinates. ODV will show a list of coordinates contained in the file.

Using extended selection techniques (hold down the Ctrl or Shft keys while clicking the left mouse button) select all the coordinates that you want to use. If multiple coordinates are provided for the common coordinates X (Longitude), Y (Latitude), Z (Depth/Height), and T (Time), make sure to select only one for each direction.

For a given selection of coordinates, the set of netCDF variables that are defined on these dimensions is shown in the *Corresponding Variables* list. Make sure that the variables that you are interested in are shown in this list. Other variables in the netCDF file that depend on coordinates not selected in the *Dimensions* list are not shown as *Corresponding Variables*. These variables will remain unavailable unless you select the corresponding dimensions. To view the complete header information of the netCDF file (similar to a “ncdump -h” call) press *netCDF Info*.

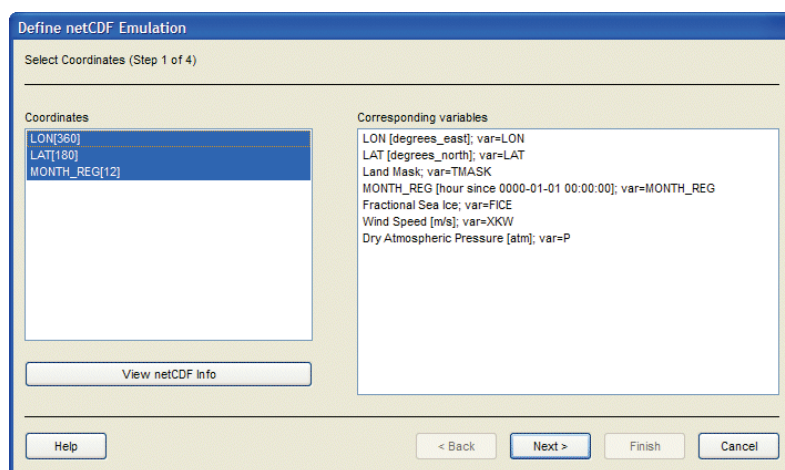


Figure 16-1: The netCDF emulation dialog (step 1 of 4)

(2.b) Specifying metadata information

Next, you must identify the netCDF variables that provide header (or meta-) information for the ODV stations: e.g., longitude (*Longitude [degrees_east]*), latitude (*Latitude [degrees_north]*), date (*mon/day/yr*), etc. This is done by establishing associations between variables from the netCDF file (*Source Variables* list) and the ODV header variables (*Target Variables* list). ODV will try to identify and associate variables automatically. Manual association of variables is only necessary for those header variables not marked by a * in the first column. Usually it is sufficient to associate *Longitude [degrees_east]*, *Latitude [degrees_north]*, and *mon/day/yr*. For header variables not associated with any netCDF variable, ODV uses default settings. You can modify the default value for a header variable (e.g., Cruise, etc.) by selecting it in the *Target Variables* list and pressing *Set Default*.

To establish a (1-to-1) association between a netCDF variable and an ODV header variable, select the netCDF variable in the *Source Variables* list and the header variable in the *Target Variables* list and press *Associate*. To establish a conversion between a

netCDF and ODV header variable (usually needed for netCDF time variables), select the two variables as above and then press *Convert*. Choose one of the available conversion options from the combo-box and press *OK*. For the *General Linear Transformation* provide a scale factor and an offset.

Many netCDF files use relative times as days or hours since a specific start date. You can exploit this information to obtain date and time of a station. To do so select the relative time in the *Source Variables* list and *mon/day/yr* in the *Target Variables* list, then press *Convert*. ODV will try to establish a conversion function automatically, or it lets you choose an appropriate conversion algorithm manually. Note that ODV assumes that the reference date is based on the Gregorian calendar. ODV *mon/day/yr* values are Gregorian dates.

Note that the metadata variables *Station* and *Type* are set automatically by ODV.

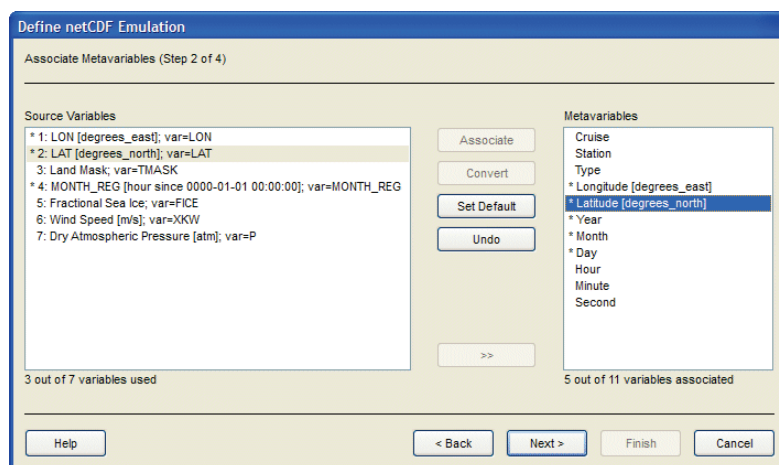


Figure 16-2: The netCDF emulation dialog (step 2 of 4)

(2.c) Selecting primary coordinate

Then you have to select the primary coordinate, which is subsequently used by ODV as first collection variable. This variable is also used as sorting variable within a station/profile/sequence. Specifying the primary coordinate is important, because this determines the logical structure of what ODV treats as a station. If, for instance, you use “Depth” or another vertical coordinate as primary coordinate, the stations will represent vertical profiles; if you use Time, the stations will represent sequences in time. If the *mon/day/yr* header variable was defined in step 2.b above, the *Use Decimal Date/Time* item is enabled and you can use a decimal time variable (units=YEARS) derived from the station header as primary coordinate (note that for time-series, the *mon/day/yr* header information refers to the start of the time series and is a constant value).

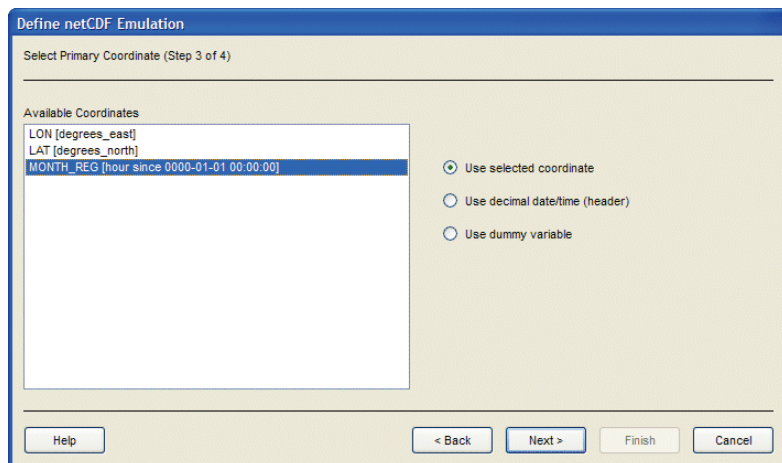


Figure 16-3: The netCDF emulation dialog (step 3 of 4)

If the data in the netCDF file represent values on horizontal surfaces (e.g., fluxes across the air-sea interface, etc.) and there is no netCDF variable that explicitly specifies the respective surface (e.g., no vertical coordinate or time variable) choose the *Use Dummy Variable* item.

(2.d) Subsetting coordinates

When working with large netCDF datasets, it is convenient to restrict data access to the domain and range of interest. You can do this by subsetting coordinate variables or by zooming into the map.

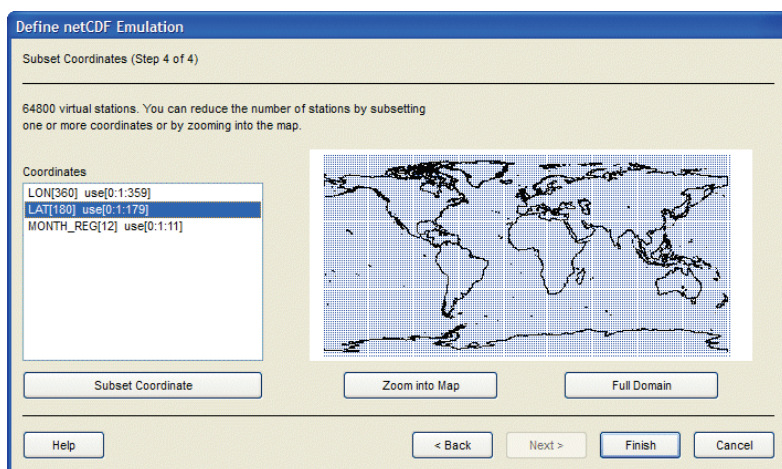


Figure 16-4: The netCDF emulation dialog (step 4 of 4)

To subset a particular coordinate select the corresponding item in the *Coordinates* list and press the *Subset Coordinate* button. ODV shows a list of the respective coordinate values and lets you specify a start index, increment, and end index for this coordinate.

Press OK to accept the new index set. Repeat this procedure for all dimensions/coordinates that you want to subset.

If longitude and latitude have been defined in step 2.b, you may visually subset these coordinates by zooming into the map. To do so, press the *Zoom into Map* button, then resize and/or move the red zoom box to the desired domain. Press the *Enter* button or double-click the left mouse to accept your choice. Press *ESC* or right-click the mouse to abort the zoom operation.

(3) Exploring the netCDF file

Once steps 2.a through 2.d are completed, ODV draws a station map and lets you explore the data in the netCDF file in the same way as if you were using a native ODV data collection. Note that ODV treats netCDF files as read-only datasets and never writes to these files. Therefore, all options that require data write access are disabled when working with netCDF files. This includes all data import operations, editing of metadata and data values, most collection manipulation operations, and others.

ODV stores netCDF emulation settings in view files and uses these settings if you open the netCDF file the next time. Should you want to establish new emulation settings please proceed as follows: Open the netCDF as usual. Then, with the netCDF file open, open the netCDF file again by choosing *File > 1*.

Also note that data access from netCDF files is somewhat slower as compared with native ODV collections. If you are using large netCDF datasets with hundred thousands of stations you may encounter slow buildup of SCATTER and/or SURFACE plots. In such cases you should subset coordinates (see above) or you should export the netCDF data to a native ODV collection using *Export>ODV Collection* and then use the newly created collection for analysis and visualization.

17 Appendix

17.1 Mouse and Keyboard Actions

Table 17-1: Mouse actions in ODV's Ready status.

Action	Object	Response
L-Click	Map	Selects the closest station as current station.
	Data Window	Selects the closest sample as current sample and the parent station as current station.
Shft L-Click	Map	Selects the closest station as current station. Allows selection from list of multiple stations at the same location.
	Data Window	Selects the closest sample as current sample. Allows selection from list of multiple samples at the same location.
L-DoubleClick	Map	Adds the closest station to the <i>pick list</i> and adds the data of this station to STATION data windows.
L-Drag	GObject	Drags the graphics object (if object allows dragging).
	Canvas, Map, Data Window	Drags the canvas (if scroll bars are present).
Ctrl L-Drag ¹⁾	Map	Quick-zooms into the map.
	Data Window	Quick-zooms into the data window.
R-Click ²⁾	Canvas, Map, Data Window, GObject, Data List Windows	Invokes element specific context menu.
Shft R-Click ³⁾	Map, Data Window	Invokes the <i>Extras</i> menu of the map or data window.

¹⁾ On Mac OS X systems hold down the *Apple* key and click-and-drag the mouse.

²⁾ On Mac OS X systems with a single-button mouse hold down the *Alt* key while clicking the mouse to simulate a right mouse button click.

³⁾ On Mac OS X systems with a single-button mouse hold down the *Alt* and *Shft* keys while clicking the mouse to simulate a *Shft* right mouse button click.

Table 17-2: Key press actions in ODV's Ready status.

Key	Response
Enter	Adds the current station to the <i>pick list</i> and adds the data of this station to STATION data windows (if any).
Del	Removes the current station from the <i>pick list</i> and removes the data of this station from STATION data windows (if any).
#	Allows selection of a new current station using internal sequence numbers.
→	Selects the next station as current station.
←	Selects the previous station as current station.
HOME	Selects the first sample as current sample.
↓	Selects the next sample as current sample.
↑	Selects the previous sample as current sample.
END	Selects the last sample as current sample.
PgDn	Steps down (forward) the current sample.
PgUp	Steps up (backward) the current sample.
F1	Shows the ODV help document.
F4	Shows the data statistics of the window containing the mouse.
F5	Redraws the entire canvas or the window containing the mouse.
Ctrl-C ¹⁾	Copies the data of the window containing the mouse to the clipboard.
Ctrl-F ¹⁾	Adjusts the X, Y, Z ranges of the window containing the mouse (or of all data windows) to full range.
Ctrl-P ¹⁾	Prints the entire graphics canvas.
Ctrl-S ¹⁾	Saves the window containing the mouse (or the entire canvas) to an image file (gif, png, jpg).
Alt-D	Allows to define derived variables.
Alt-S	Allows to change the station selection criteria.
Alt-W	Allows to change the window layout.
Shft-L	Loads view settings from a file.
Shft-S	Allows to modify the sample selection criteria (range and quality filters).
ESC	Aborts the current operation (if supported by operation).

¹⁾ On Mac OS X systems hold down the *Apple* key while pressing the other key.

Table 17-3: Mouse and key press actions in Zoom or Z-Zoom modes.

Action	Object	Response
L-Drag	Boundaries and corners of zoom rectangle	Resizes the zoom rectangle.
L-DbbleClick or ENTER	anywhere	Accepts current settings and terminates zooming.
R-Click ¹⁾ or ESC	anywhere	Discards changes and aborts zooming.

¹⁾ On Mac OS X systems with a single-button mouse hold down the *Alt* key while clicking the mouse to simulate a right mouse button click.

Table 17-4: Mouse and key press actions in GetPoints modes.

Action	Object	Response
L-Click	Canvas, Map, Data Window	Add current point to list.
R-Click ¹⁾	Canvas, Map, Data Window	Remove closest point from list.
ENTER	anywhere	Accept current settings and terminate <i>GetPoints</i> mode.
ESC	anywhere	Abort <i>GetPoints</i> mode.

¹⁾ On Mac OS X systems with a single-button mouse hold down the *Alt* key while clicking the mouse to simulate a right mouse button click.

17.2 Quality Flag Schemes

ODV supports most quality flag schemes widely used in the oceanographic community. Any of these schemes can be used to encode the quality flags of a given meta- or collection variable. See Table 17-5 and file *ODV4_QualityFlagSets.pdf* for summaries of supported schemes, lists of quality flag codes and their meaning as well as code mappings between the schemes.

Table 17-5: Quality flag schemes supported by ODV. For full lists of quality flag values and value mappings between the different schemes see file *ODV4_QualityFlagSets.pdf*.

SchemaID	Comment
ARGO	ARGO quality codes. Reference: Argo data management, User's manual, Version 2.1, http://www.usgodae.org/argo/argo-dm-user-manual.pdf
BODC	BODC quality codes. Reference: http://www.bodc.ac.uk/data/codes_and_formats/request_format/
ESEAS	European Sea Level Service quality codes. Reference: www.e seas.org/e seas-ri/deliverables/d1.2/ESEAS_QC_29032005.doc
GTSP	GTSP quality codes. Reference: http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Databases/OCEAN/GTSPcodes_e.htm
ODV	ODV generic quality flags. Reference: ODV User's Guide, http://odv.awi.de/en/documentation/
QARTOD	Qartod quality flags. Reference: http://dmac.ocean.us/dacsc/docs/apr2005_post_mtg/QARTODI_II.ppt
PANGAEA	PANGAEA generic quality flags. Reference: http://wiki.pangaea.de/wiki/Quality_flag
SEADATANET	SeaDataNet quality codes. Reference: http://vocab.ndg.nerc.ac.uk/term/L201/1/
SMHI	Swedish Meteorological and Hydrographic Institute quality codes.
WOCEBOTTLE	WOCE bottle value quality codes. Reference: http://odf.ucsd.edu/joa/userguide/docs/woceigossqualitycodes.html
WOCECTD	WOCE CTD value quality codes. Reference: http://odf.ucsd.edu/joa/userguide/docs/woceigossqualitycodes.html
WOCESAMPLE	WOCE WHP quality flags for the water bottle itself. Reference: http://odf.ucsd.edu/joa/userguide/docs/woceigossqualitycodes.html
WOD	World Ocean Database individual observed level quality codes. Reference:

	ftp://ftp.nodc.noaa.gov/pub/WOD05/DOC/wod05_tutorial.pdf
WODSTATION	World Ocean Database entire station quality flags. Reference: ftp://ftp.nodc.noaa.gov/pub/WOD05/DOC/wod05_tutorial.pdf

17.3 Generic ODV Spreadsheet Format

The ODV generic spreadsheet format is the recommended format for exchange of data between data producers and data users. The generic spreadsheet format allows automatic import of data into ODV collections, not requiring any user interaction. ODV also uses the generic spreadsheet format when exporting data from collections, and the exported datasets may easily be re-imported into the same or a different collection, possibly after editing and modifying the data in the file. Exporting data from the open collection into a generic spreadsheet file is done via the *Export>ODV Spreadsheet* option.

ODV generic spreadsheet files use the ASCII encoding, and the preferred file extension is *.txt*. Station metadata and data are provided in separate columns, where metadata and data columns can be in arbitrary order. Every metadata and data column may have an optional quality flag column. A quality flag column may appear anywhere after the metadata or data column it belongs to. Quality flag values may be in any one of the supported quality flag schemes (see Table 17-5). The total number of columns in the file is unlimited. All non-comment lines (see below) in the file must have the same number of columns. Individual columns are separated by TAB or semicolon ; .

Typically, ODV spreadsheet files hold the data of many stations from many cruises. The number of lines in a file, as well as the length of individual lines are unlimited. There are three types of lines in ODV generic spreadsheet files: (1) comment lines, (2) the column labels line, and (3) data lines.

17.3.1 Comment Lines

Comment lines start with two slashes // as first two characters of the line and may contain arbitrary text in free format. Comment lines may, in principle, appear anywhere in the file, most commonly, however, they are placed at the beginning of the file and contain descriptions of the data, information about the originator or definitions of the variables included in the file. Comment lines are optional.

Comment lines may be used to carry structured information that may be exploited by ODV or other software. Examples are the *//SDN_parameter_mapping* block employed by the SeaDataNet project, and containing references to variable definitions in official parameter dictionaries, or the *//<attribute_name>* lines defined by ODV, containing values for given attribute names. The currently defined attribute names are summarized in Table 15-6. Structured comment lines may only appear before the column labels line or the first data line.

Table 17-6: Summary of comment line attributes names supported by ODV.

Attribute Name	Possible Values
File information	
Creator	Free text specifying the creator of the file. <i>Example:</i> <code>//<Creator>rschlitz@GSYSP168</Creator></code>
CreateTime	Time of file creation in ISO 8601 extended format. <i>Example:</i> <code>//<CreateTime>2008-05-16T09:53:45.2</CreateTime></code>
Software	Software used to create the file. <i>Example:</i> <code>//<Software>Ocean Data View - Version 4.0.0</Software></code>
Source	Absolute path of source collection. <i>Example:</i> <code>//<Source>C:/rschlitz/data/eWOCE/data/whp/bottle/WoceBtl</Source></code>
SourceLast-Modified	Last modified time of source collection in ISO 8601 extended format. <i>Example:</i> <code>//<SourceLastModified>2003-11-11T19:53:45.2</SourceLastModified></code>
Version	Version of the file. <i>Example:</i> <code>//<Version>ODV Spreadsheet V4.0</Version></code>
Data information	
DataField	GeneralField, Ocean, Atmosphere, Land, IceSheet, Sealce, Sediment <i>Example:</i> <code>//<DataField>Ocean</DataField></code>
DataType	GeneralType, Profiles, TimeSeries, Trajectories <i>Example:</i> <code>//<DataType>Profiles</DataType></code>

17.3.2 Column Labels

There has to be exactly one line containing the labels of the columns. This column labels line must always be present, it must appear before any data line and it must be the first non-comment line in the file.

ODV generic spreadsheet files must provide columns for all mandatory metavariables (see Table 3-3), and the following labels must be used exactly as given as column labels: *Cruise*, *Station*, *Type*, one of the [supported date/time formats](#), *Longitude [degrees_east]*, *Latitude [degrees_north]*, *Bot. Depth [m]*. The recommended date/time format is ISO 8601, which combines date and time as `yyyy-mm-ddThh:mm:ss.sss` in a single column. The labels *Lon (°E)* and *Lat (°N)* for longitude and latitude are still supported for back-

ward compatibility.

Metadata labels may have extensions of the form *:METAVAR:<valueType>:<valueBytes>* to indicate that the column represents a metavariable of a given value type and byte-length. *valueType* may be one of the following: BYTE, SHORT, INTEGER, FLOAT, DOUBLE, or TEXT. *valueBytes* is only needed for *valueType*=TEXT and represents the maximum number of characters to be stored in this field (default: 21Bytes). Note that one of the characters is used for string termination and is not available for actual metadata text, e.g., a TEXT field of 21 bytes can store a maximum of 20 characters of metadata text.

Examples: Longitude [degrees_east]:METAVAR:DOUBLE
 Citation:METAVAR:TEXT:81
 DOI:METAVAR:TEXT:81

Data variable labels should include unit specifications enclosed in brackets [], e. g., Depth [m]. Exactly one column label may have the *:PRIMARYVAR* extension to indicate that this column is the primary variable.

Example: Depth [m]:PRIMARYVAR

Quality flag column labels must comply with the following naming conventions to enable automatic identification of the meta- or collection variable they belong to, as well as of the particular quality flag scheme used.

ODV generic spreadsheet quality flag labels may be specified in one of the following forms:

- QV<Text>:<SchemaID>:<columnLabel>
- QV<Text>:<SchemaID>:STATION
- QV<Text>:<SchemaID>:SAMPLE
- QF

<Text> is an arbitrary and optional string, <SchemaID> is one of the supported quality flag schema identifier (see Table 17-5) and <columnLabel> is the column label of the variable to which the quality flag column belongs. The <Text>, <SchemaID> and <columnLabel> parts of the quality flag label are optional. If the <SchemaID> item is missing, it is assumed that the quality flag values are ODV generic quality flags. If the <columnLabel> part is missing, it is assumed that the quality flags belong to the variable preceding the quality flag column. Note that if the <Text> item is present, it may not contain the ':' separation character. Also note that <Text> is not evaluated or used by ODV. This item is only included to allow unique column labels for applications that require this feature (e.g., QV1, QV2, etc.).

In addition to quality flag values for individual data values, ODV also supports entire station quality flags describing general quality aspects of the entire station (single flag for a given station; e.g., WOCE entire station flags), as well as sample quality flags that may be used to indicate problems with the sampling device, possibly affecting the quality of all measurements made on that sample (one flag for every sample). Entire station and sample quality flags are indicated with the words STATION or SAMPLE in the *<columnLabel>* part of the column label.

Note that the QV syntax of quality flag labels is not recognized by ODV versions 3 or earlier. If ODV generic spreadsheets file needs to be compatible with these earlier software versions, you must use QF as the label of quality flag columns. In such cases, it is assumed that the quality flag values are ODV generic flags and that they belong to the variable preceding the quality flag column.

IMPORTANT NOTE: Column labels must not contain the column separation character of the spreadsheet file.

Table 17-7: Example quality flag column labels

Quality Flag Label	Comment
QV or QF	ODV generic quality flags for the variable in the preceding column.
QV:SEADATANET	SeaDataNet quality flags for the variable in the preceding column.
QV:ARGO:Nitrate [umol/kg]	ARGO quality flags for <i>Nitrate [umol/kg]</i> .
QV:ODV:Nitrate [umol/kg] or QV::Nitrate [umol/kg]	ODV generic quality flags for <i>Nitrate [umol/kg]</i> .
QV:WOCESAMPLE:SAMPLE	WOCESAMPLE sampler quality flags.
QV:WODSTATION:STATION	WODSTATION entire station quality flags.
QV::STATION	ODV generic quality flags for entire station.

17.3.3 Data Lines

Every non-comment line following the column labels line is considered a data line. All data lines must have the same number of columns as the column labels line. Each data line contains metadata and data for one sample. All samples of a given station must be in consecutive order but need not be sorted. Missing values may be indicated by an empty field, the value *-1.e10*, or by a text indicator, such as *na* (not available) or *NaN* (not a number).

Cruise and station labels are limited to the length of the *Cruise* and *Station* metavariables (default: 20 characters). The use of numbers for station labels will enable en-

hanced internal sorting and selection functionality and is recommended.

Station *Type* is a single character string. You should use B for stations with less than about 250 samples (e.g., bottle data) and C for stations with more than about 250 samples (e.g., CTD, XBT, etc.). Specifying * for *Type* lets ODV make the choice. If *Bot. Depth* values are not available, you should leave this field empty.

The station metadata must be provided on the first line of a given station. The metadata fields on the remaining lines of the station may remain empty to reduce file size (compact spreadsheet format). An ODV generic spreadsheet file usually stores the data of many stations from many cruises. The metadata and data of the first sample of the next station follow immediately after the last sample of the previous station. There are no separator lines between stations.

17.4 Supported Date and Time Formats in ODV Spreadsheet Files

ODV supports the single column ISO 8601 date/time format. This is the recommended date/time format for ODV import and export files. In addition, ODV also supports a wide range of other date and time formats to allow easy import of data provided in one of the many custom file formats, commonly used in the scientific community. This includes many date and time specifications that differ in the order of the day, month, year values, and cases with day, month, year, hour and minute data in individual columns.

Use of the column labels in Table 17-8 is strongly recommended (lower, upper or mixed case) as this allows automatic date/time identification by ODV. The default date/time format in ODV spreadsheet output files is ISO 8601.

Table 17-8: Supported date formats (column labels may be upper, lower or mixed case)

Column label	Comment
yyyy-mm-dd hh:mm or yyyy-mm-ddThh:mm	ISO 8601. Recommended ODV date/time format. Combines date and time in a single column. <i>Examples: 2006-02-23 10:23 or 2006-02-23T10:23 for Feb/23/2006 10:23h.</i>
mon/day/yr or mm/dd/yyyy	Date in one column. Time provided separately. <i>Example: 02/23/2006 for Feb/23/2006.</i>
dd/mm/yyyy	Date in one column. Time provided separately. <i>Example: 23/02/2006 for Feb/23/2006.</i>
yyyy/mm/dd	Date in one column. Time provided separately. <i>Example: 2006/02/23 for Feb/23/2006.</i>

mmddyyyy	Date in one column. Time provided separately. <i>Example: 02232006</i> for Feb/23/2006.
ddmmyyyy	Date in one column. Time provided separately. <i>Example: 23022006</i> for Feb/23/2006.
yyyymmdd	Date in one column. Time provided separately. <i>Example: 20060223 10:23</i> for Feb/23/2006 10:23h.
year month day	Date information in individual columns (any order). Time provided separately. <i>Example: 2006 02 23</i> for Feb/23/2006.

Table 17-9: Supported time formats (column labels may be upper, lower or mixed case)

Column label	Comment
hh:mm	Time in one column. Date provided separately. <i>Example: 10:23</i> for 10:23h.
hhmm	Time in one column. Date provided separately. <i>Example: 1023</i> for 10:23h.
hour minute	Time information in individual columns (any order). Date provided separately. <i>Example: 10 23</i> for 10:23h.

17.5 Control Sequences and Functions in Annotations

Table 17-10: Formatting control sequences in ODV annotations.

Control Sequence	Action
~\$	Switches to Symbol font (Greek symbols)
~#	Switches to normal text font
~%	Produces per mille character (‰)
~^	Next character drawn as superscript
~_	Next character drawn as subscript.

Example: “~\$~#CO~_2 [~\$m~#mol/kg]” will produce ΣCO_2 [$\mu\text{mol}/\text{kg}$].

ΑΒΧΔΕΦΓΗΙΘΚΛΜΝΟΠΘΡΣΤΥΖΩΞΨΖ
 ΑΒCDEFGHIJKLMNOPQRSTUVWXYZ
 αβχδεφγηιφκλμνοπθρστυπωξψζ
 abcdefghijklmnopqrstuvwxyz

Figure 17-1: Greek symbols and Latin equivalents

Table 17-11: Available auto-functions in ODV annotations.

Function	Substituted Text
=date()	Current date
=time()	Current time
=user()	User and host name
=collection()	Full path of current collection
=view()	Full path of current view file
=section()	Full path of current section file

17.6 Gridding Methods

ODV lets the user project irregularly spaced original data onto equi- or non-equidistant rectangular grids (for contouring and graphical display or output of gridded values) using one of three available methods: *Quick Gridding*, *VG Gridding*, and *DIVA Gridding*. The first two methods are built into ODV; *DIVA Gridding* is available once the respective [optional package](#) has been installed.

Quick Gridding is a weighted averaging algorithm optimized for speed that calculates estimates at all grid nodes requiring only one loop over the available data. *Quick Gridding* should only be used in cases when the other algorithms are too slow, e.g., in cases with millions of data points. *VG Gridding* uses a more sophisticated weighted averaging algorithm and yields good results in cases with good and homogeneous data coverage. *VG Gridding* is the default gridding method. *DIVA Gridding* is the most advanced gridding method available in ODV. It is computationally more expensive than the other methods, but should always be used when preparing final graphs for publications or web-pages.

17.6.1 VG Gridding Algorithm

In contrast to *Quick Gridding*, for which an equidistant, rectangular grid is used, ODV constructs and uses a variable resolution, rectangular grid if *VG Gridding* is requested. In this case, grid-spacing along the X and Y directions varies according to data density. High resolution (small grid-spacing) is provided in regions with high data density, whereas in areas of sparse sampling a coarser grid with reduced resolution is used. For hydrographic sections, this typically yields high spatial resolution in the upper water column and in boundary current regions, where data coverage is good, and a coarser resolution grid in open ocean regions and the deep sea, where data typically are sparser.

After construction of the grid, property estimates $c_e = \sum_i \alpha_i \cdot d_i / \sum_i \alpha_i$ are calculated at every grid point (+) using a simple weighted-averaging scheme. For efficiency reasons, only data values d_i from a small neighborhood of the grid-point are considered for summation (see figure above). The weights α_i decrease exponentially with increasing distance between data and grid-point: $\alpha_i = e^{-r}$, with $r = (\Delta x / L_x)^2 + (\Delta y / L_y)^2$ and separate averaging length-scales L_x and L_y in X and Y directions, respectively. Averaging length-scales vary over the domain, and are

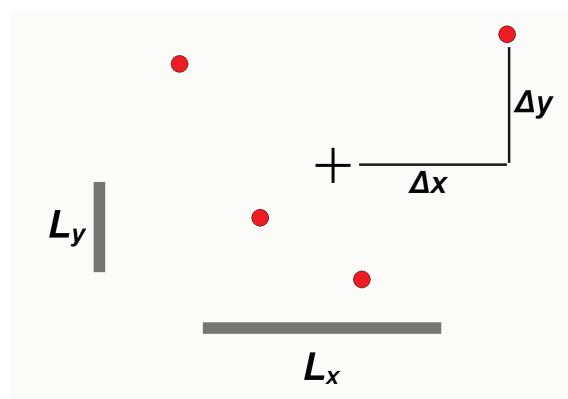


Figure 17-2: Weighted averaging of data values (red symbols) at a grid node (+). See text for details.

proportional to local grid-spacing. Thus, small averaging length-scales are used in areas with small grid-spacing (high grid resolution, e.g., in the upper water column or in boundary current regions, etc.), whereas in regions with large grid-spacing, large averaging length-scales are applied automatically. This approach of spatially varying length-scales allows resolving small-scale features in areas of dense data coverage and at the same time provides smooth and stable fields in other regions with sparse data coverage. The user-provided length-scales L_{x0} and L_{y0} on the *Display Options* dialog are measured in per-mille of the respective axis range and are representative for the area of poorest data coverage (coarsest grid). The ODV implementation of the weighted averaging algorithm is highly optimized for speed to allow field estimations within a few seconds, even for fields with thousands of data points.

Once estimates have been obtained for all grid points, the field is passed to shading and contouring routines for display on the screen or a printer.

17.6.2 DIVA Gridding Integration

DIVA is a gridding software developed at the University of Liege (<http://modb.oce.ulg.ac.be/projects/1/diva>) that offers a number of advantages over the weighted averaging methods built into ODV. DIVA allows analyzing and interpolating data in an optimal way, comparable to optimal interpolation OI. Unlike OI it also takes into account coastlines and bathymetry features to structure and subdivide the domain on which estimation is performed. Calculations are highly optimized and performed on a finite element mesh adapted to the specific gridding domains.

DIVA tools to generate the finite element mesh, optimize the parameters of the analysis and calculate the gridded field can be integrated into ODV by [installing the optional package `odvmpOP_DIVA<diva-version>_integration`](#). Once this package is installed, a new option *DIVA Gridding* is available on the *Display Options* dialog of data windows with a Z-variable. You activate DIVA gridding by choosing this option and specifying appropriate X and Y correlation length scales. ODV creates all necessary files for the operation of DIVA automatically (in directory `odv_local/diva/work` in your home directory), runs the DIVA mesh generation and field estimation steps, and reads the DIVA output for graphical display of the field by ODV. As for the other gridding algorithms, you can control the smoothness of the estimated field by adjusting the X- and Y- length scales. Note that the scale length values are in per mille of the respective axis range and that large values result in smooth fields.

DIVA gridding generally produces better results than *Quick Gridding* or *VG Gridding* in cases of sparse and heterogeneous data coverage (see Figure above) and in cases where sub-regions with quite different property values are separated by land masses, ridges or other bathymetric barriers (see Figure below). Whereas the weighted averaging schemes used for *Quick Gridding* or *VG Gridding* wrongly transmit information across

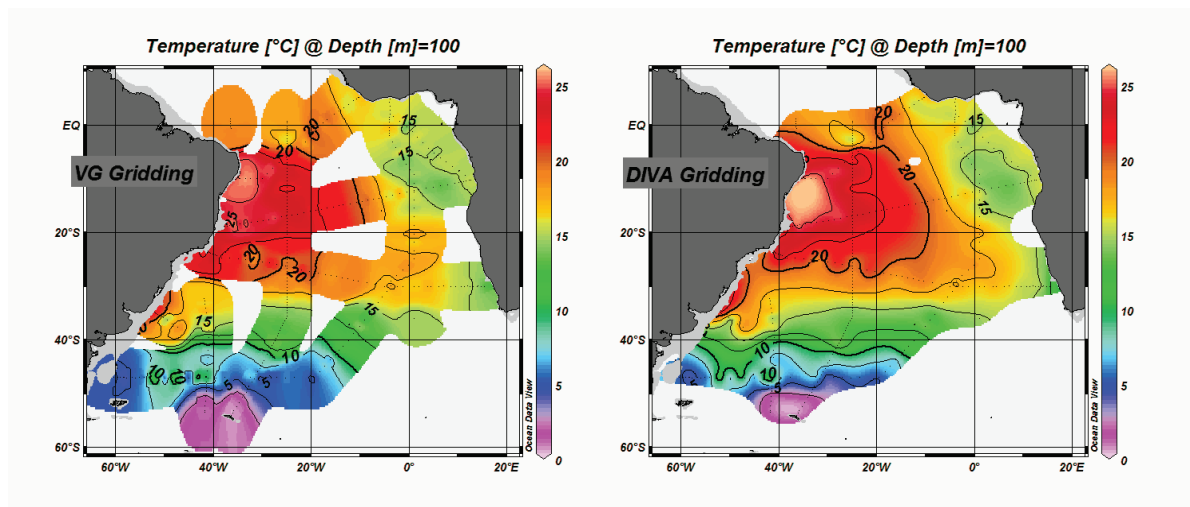


Figure 17-3: Comparison of VG and DIVA gridding methods for a field with inhomogeneous data coverage.

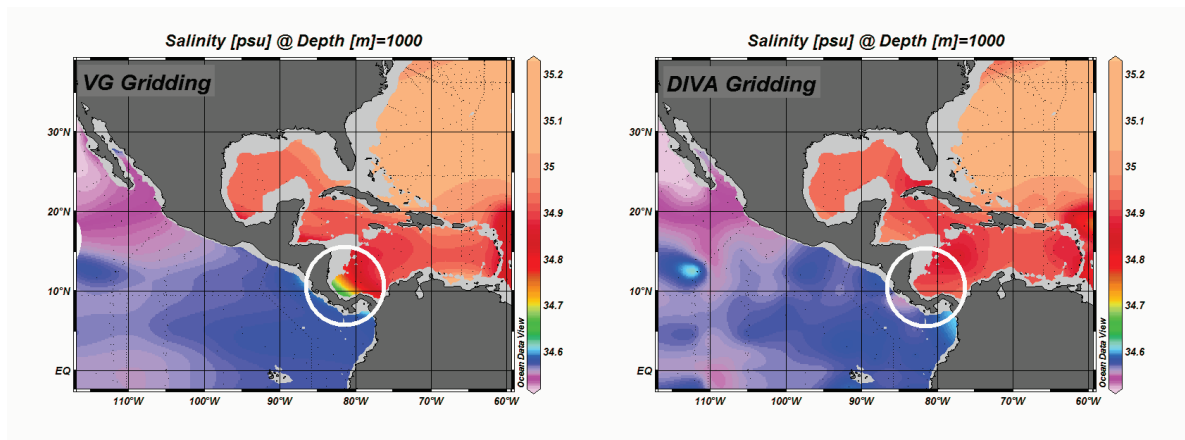


Figure 17-4: Comparison of VG and DIVA gridding methods for separated ocean basins. Note the influence of Pacific values in the Caribbean in the VG gridding case.

the barriers, this does not happen with *DIVA gridding*. *DIVA* execution times are somewhat larger than for the other gridding methods; nevertheless, you should always consider using *DIVA gridding* for publication-quality figures.

System requirements and troubleshooting: For successful operation of the *DIVA* package you need a computer with at least 1GB of RAM. If you run *DIVA* and the plot window remains white, please close other applications and try again.

17.7 o4x Exchange Format

The o4x exchange format is supported for backward compatibility; it is no longer recommended as data exchange format. New users should use the generic spreadsheet format instead.

ODV .o4x exchange files contain information on the type of the data, the number and labels of variables, the actual data values and the data quality flags in a single ASCII file with extension .o4x. Typically, .o4x files contain three sections: (1) a (possibly missing) *comment section* consisting of an arbitrary number of free-format lines of at most 200 characters each (this part may be missing), (2) a *variables section* that describes the type of the data and the number and labels of variables in the file, and (3) the *data section* that contains the actual data values and data quality flags. Data quality flags may be missing; if they appear they must be single digit ODV quality flags. For a sample .o4x file see the *samples* directory of your ODV installation.

The .o4x variables section begins with the keyword ODV4.0 Listing and should be formatted as shown in the sample below. Any records before the ODV4.0 Listing line are treated as comments and will be added to the collection .info file during import.

Sample .o4x variables section

(Note that the "....+" lines at the top and bottom only serve as rulers and are not part of the file.)

```

....+....1....+....2....+....3....+....4....+....5....+....6....
ODV4.0 Listing
  File Name: import4.o4x
    Type: HYD
    Nstat: 12
  Variables: 8

Depth [m]                                6.0
Temperature [°C]                          8.2
Salinity [psu]                             8.3
Oxygen [~$m~#mol/kg]                       6.0
Phosphate [~$m~#mol/kg]                    8.2
Silicate [~$m~#mol/kg]                     8.1
Nitrate [~$m~#mol/kg]                      7.1
Nitrite [~$m~#mol/kg]                      6.1
....+....1....+....2....+....3....+....4....+....5....+....6....

```

One empty line separates the variables section of the data file from the header line of the first station (see file import4.o4x in the ODV samples directory for an example). Station header lines must start with a # in column 1. The following items are: (1) *cruise-label* of the station (cols. [3:22], format a20); (2) *station-label* ([24:43], a20); (3) *station-type* (either B, C or X for bottle, CTD or XBT data; [45:45], a1); (4) *date* mm/dd/yyyy ([47:66], i2,1x,i2,1x,i4); (5) *east longitude* (decimal; [58:64], f7.3); (6) *north latitude* (decimal; [66:72], f7.3); (7) *bottom depth* ([m]; [74:78], i5); (8) *depth of deepest observation* ([m]; [80:84], i5); (9) *number of depths sampled* ([85:89], i5); (10) *number of va-*

riables for which data are provided in the file ([91:93], i3). In the example file, the station 06MT18/558 is of type "Bottle", it contains 14 observed depths and data for 8 variables at these observed depths are to follow. These variables have to be identified by specifying their numbers (as defined in the variables section at the beginning of the file) on the second header line (e.g., 1 represents Depth and, for instance, 6 represents Silicate). Note that as the only format restriction, the variable numbers on the second header line have to be separated by at least one blank.

For each observed depth (14 in the example file) one line of data has to follow. Each of these lines must contain a data and quality flag value for every variable specified on the second header line in that order. Missing values have to be set to -1.000E+10 in the data file. Note that data and quality flag values have to be separated by at least one space. Quality flags are single digit integers with the following meaning: 0=Good, 1=Unknown, 4=Questionable, 8=Bad. Immediately after the last data line of a given station follows the first header line (starting with the #) of the next station to be imported or the end-of-file if the station is the last to be read.

Once the .o4x file has been created, start ODV and open or create the collection that is to receive the new data. Then choose *ODV4.x Listing* from the *Import* menu. Select the ASCII data file created above as data import file. Specify import options and press OK to start the data import. ODV will then read the import file and add/merge the stations to the collection. Note that you can also drag-and-drop .o4x files onto ODV.

17.8 o3x Exchange Format

The o3x exchange format is supported for backward compatibility; it is no longer recommended as data exchange format. New users should use the generic spreadsheet format instead.

Sample .var File

```

.....1.....2.....3.....4.....5.....6.....
ODV4.0
Collection: SAVE
      Type: HYD
      Nstat: 0
      Variables: 7

Depth [m]                                     6.0
Temperature [°C]                               8.2
Salinity [psu]                                 8.3
Oxygen [~$m~#mol/kg]                          6.0
Phosphate [~$m~#mol/kg]                       8.2
Silicate [~$m~#mol/kg]                        8.1
Nitrate [~$m~#mol/kg]                         7.1
.....1.....2.....3.....4.....5.....6.....

```

To import data using the .o3x exchange format you have to provide two ASCII files, one containing the actual data for all the stations that you want to import (default extension is .o3x) and one (small) file that describes the variables included in the data file (exten-

sion must be .var). For a sample .o3x file see the *samples* directory of your ODV installation.

Note that the “...+.” lines at the top and bottom only serve as rulers and are not part of the .var file. Also note that the .var file has the same format as ODV4.x collection definition files but that the information needed for the data import is confined to entries concerning the variables. In line 5 of the file starting in column 13 you have to specify the number of variables included in the data file to be imported. Then, after one blank line you have to provide variable label and numeric format for all the variables on separate lines. The numeric format has the appearance ll.d (ll is the total length in characters and d is the number of decimal figures) and starts in column 61.

Sample .o3x header lines

```

.....+.....1.....+.....2.....+.....3.....+.....4.....+.....5.....+.....6.....+.....7...
# REID_ET          212 B  6/21/1967 243.167 -28.233 3400 3310 34 7
   1    2    3    4    5    6    7

```

The data for all the stations to be imported have to be provided in a single ASCII file (default extension .o3x). This file has to meet the following format specification (note that the ruler at the top is not part of the file):

The file must begin with the header line of the first station to be imported. Station header lines must start with a # in column 1. The following items are: (1) cruise-label of the station (cols. [3:12], format a10); (2) station-label ([14:23], a10); (3) station-type (either B, C or X for bottle, CTD or XBT data; [25:25], a1); (4) date mm/dd/yyyy ([27:36], i2,1x,i2,1x,i4); (5) east longitude (decimal; [38:44], f7.3); (6) north latitude (decimal; [46:52], f7.3); (7) bottom depth ([m]; [54:58], i5); (8) depth of deepest observation ([m]; [60:64], i5); (9) number of depths sampled ([66:69], i4); (10) number of variables for which data are provided in the file ([71:73], i3). In the example above, the station REID_ET/212 is of type “Bottle”, it contains 34 observed depths and data for 7 variables at these observed depths are to follow. These variables have to be identified by specifying their numbers as defined in the .var file on the second header line (e.g., 1 represents Depth and, for instance, 6 represents Silicate). Note that as the only format restriction, the variable numbers on the second header line have to be separated by at least one blank.

For each observed depth (34 in the example above) one line of data has to follow. Each of these lines must contain a numerical value for every variable specified on the second header line in that order. Missing values have to be set to -1.000E+10 in the data file. Immediately after the last data line of a given station follows the first header line (starting with the #) of the next station to be imported or the end-of-file if the station is the last to be read.

Once the .var and .o3x files have been created, run ODV and open or create the collection that is to receive the new data. Then choose ODV3.0 Listing from the Import menu. Select the ASCII data file created above as data import file and identify the variables to be imported by selecting the import .var file as the data source. Specify import options

and press OK to start the data import. ODV will then read the import file and add/merge the stations to the collection. Note that the data quality flags are set to Unknown if you import data using ODV3.0 exchange format.

17.9 ODV Directory Structure

The default installation directory for ODV is *c:\Program Files\Ocean Data View (mp)* on Windows, */Applications/ODV* on Mac OS X and */usr/local/odvmp* for Linux and UNIX (indicated as *<install>* below; for Mac OS X, Linux and UNIX replace \ by / in the following). The installation directory contains various subdirectories for specific purposes. Installation files that may be modified by the user, such as macro files, palette files or sample data collections, are installed in subdirectory *ODV* under the user's document directory (indicated as *<user>* below).

Following below is a list of directories used by ODV:

<install>\bin_w32 on Windows platforms, ...or...
<install>\bin_macx on Mac OS X platforms, ...or...
<install>\bin_linux-i386 on Linux i386 platforms, ...or...
<install>\bin_solaris-sparc on SUN Solaris Sparc platforms, ...or...
<install>\bin_irix6.5_mips on SGI Irix platforms, ...or...
<install>\bin_aix-powerpc on IBM AIX powerpc platforms:
ODV executable, tools, and PostScript preamble file.

<install>\coast\GlobHR:
High-resolution coastline and topography files for the whole globe.

<install>\doc4:
ODV html help files (pdf version available from ODV web page).

<install>\include:
Default directory for ODV include files (e.g., ETOPO2 global topography available as optional package). Note that there are several sub-directories containing other files of a given type.

<install>\include\atmhist:
Concentration histories of various atmospheric trace gases.

<install>\samples:
Directory for ODV sample files. Use these files as templates for data import or macro files.

<user>\cmd_files:
ODV command files (.cmd).

<user>\data:
Base directory for ODV data collections. While ODV data collections may, in principle, reside anywhere on a read-write (hard-disk, memory stick, etc.) or read-only (DVD, CD-ROM, etc.) storage medium, it is recommended to maintain all your collections under this directory. Every collection should be stored in its own sub-directory.

<user>\diva:
DIVA working directory (only present if [DIVA](#) is installed).

<user>\export:

Base directory for datasets exported via *Export>X, Y, Z Window Data*.

<user>\gazetteers:

ODV gazetteer database files.

<user>\macros:

ODV macro files (.mac).

<user>\palettes:

ODV palette files (.pal).

<user>\reference:

Base directory for reference datasets exported via *Export>X, Y, Z Window Data as Reference*.