Ocean Data View HowTo

Version 5

February 3, 2024

License Agreement

Before using ODV please read the ODV license agreement.

Contents

1 Introduction

This document contains in-depth descriptions on how to perform frequently occurring tasks with ODV.

2 Collections

2.1 Adding or Deleting Meta- and Collection Variables

The sets of meta- and collection variables in a given ODV data collection are defined when the collection is created. ODV allows modifying these variable sets at any time and lets you add new variables, delete existing ones or change the properties of existing variables using the *Collection>Properties>Meta Variables* or *Collection>Properties> Data Variables* options. Before using these options you should create a zipped backup copy of the collection via *Collection > Create Snapshot*.

Note: If your collection is not of the latest format use option *Collection > Properties > Convert to ODVCF6* to convert the collection to ODVCF6 before proceeding.

You add a new variable by pressing the *New* button and specifying label, units, the number of significant digits (numeric variables only), the quality flag schema to be used for this variable, and the data type and byte length (TEXT variables only). Click *OK* to add the new variable to the end of the variable list and repeat this procedure for all new variables to be added.

You change the position of a given variables in the list by selecting that variable and clicking on the *Top*, *Up*, *Down*, *Bottom* buttons. You change the properties of an existing variable by selecting the variable and clicking on the *Edit* button. You delete an existing variable by selecting the variable and clicking on the *Delete* button. Note that mandatory meta-variables cannot be deleted.

After making the changes ODV will re-write the entire collection accommodating the new or modified variables in the new version. Please note that the new variables will not contain any data initially. You may selectively add data for the new variables and keep the data of other variables unchanged using the *Merge Data (selected variables)* import mode (see chapter 4.8 in the ODV User's Guide).

3 Station Maps

3.1 Coastlines and Bathymetry from Shapefiles

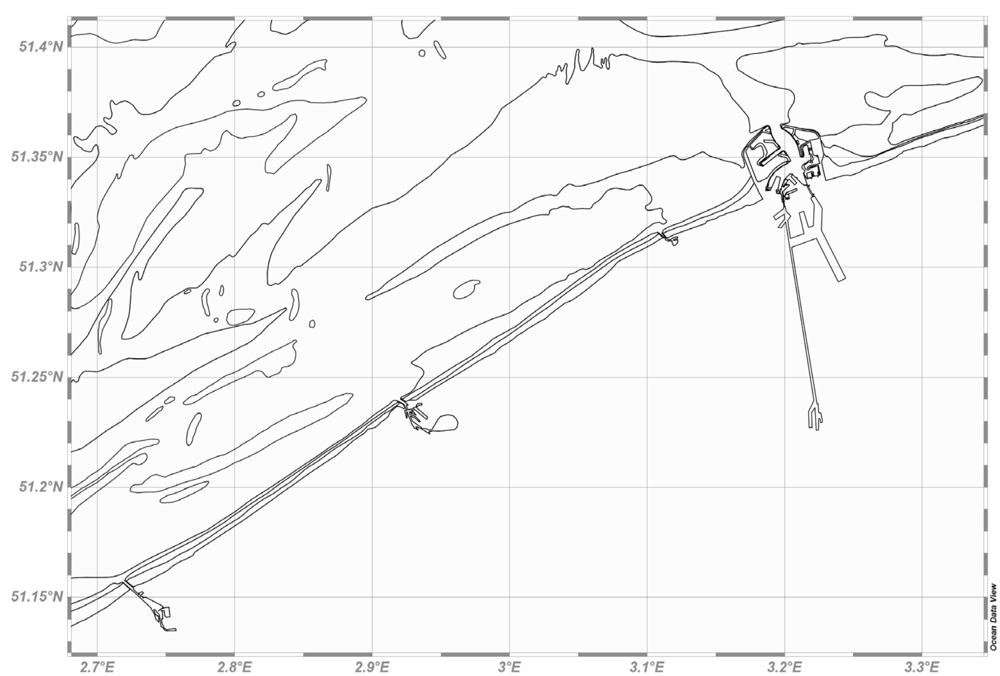
ODV comes with a moderate resolution global set of coastline and bathymetry/topography resources for use in ODV station maps. Higher resolution sets based on *ETOPO1*, *GEBCO_2014, IBCAO* and *RTOPO* can be downloaded and installed via the *View > Settings* (on Mac OS *odv > Preferences*) option. Chapter 2.12 in the User's Guide provides information on how to install these high-resolution resources.

If you require even better resolution and have coastline and bathymetry/topography data available as shapefiles you can adapt the ODV station map to use and display the features in the shapefiles.

The procedure consists of two steps: first you remove the standard ODV map resources, then you add the desired shapefiles.

1. Open the relevant collection (use *<usr>/data/MapView* to try out the procedure), right-click on the station map and choose *Properties*. Choose the *Layers* page and uncheck the *Automatic selection* and *Draw color bar* boxes. Remove the standard resources in *Ocean bathymetry*, *Coastlines, Land topography* and any other layer containing entries. Do this by selecting the layer, pressing *Compose* and removing all entries in the *Selected* list (select all and press >>). Press OK when done. An empty station map will be drawn.
2. Add one or more shapefiles using the following procedure. If you have a series of bathymetry contours start with the deepest and work your way up. To add a shapefile right-click on the station map and choose *Extras > Add Graphics Object from File > Shapefile*. Navigate to the shapefile and select the file. On the *Shapefile Object – Properties* dialog specify line and fill properties. Set the *Fill Color* to *(none)* if you are uncertain whether the file contains properly closed polygon data.

The figure below shows an example from the Zeebrugge/Oostende region.



3.2 Custom Coastlines and Bathymetry

ODV comes with a moderate resolution global set of coastline and bathymetry/topography resources for use in ODV station maps. Higher resolution sets based on *ETOPO1*, *GEBCO_2014, IBCAO* and *RTOPO* can be downloaded and installed via the *View > Settings* (on Mac OS *odv > Preferences*) option. Chapter 2.12 in the User's Guide provides information on how to install these high-resolution resources.

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 xxx*m.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.

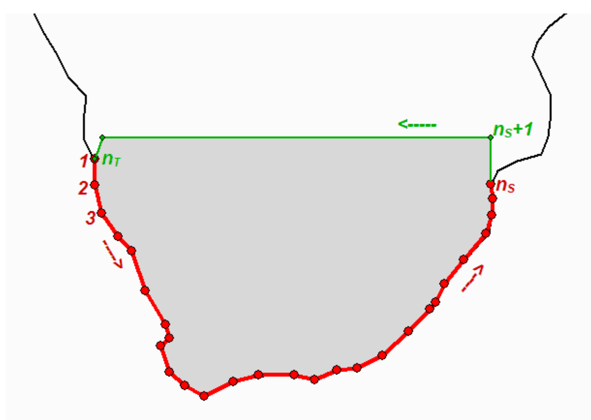


Figure 3-1: Schematic diagram of an ODV coastline/bathymetry segment.

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:

n_T n_S

lat_1 lon_1

.....

lat_{nT} lon_{nT}

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 .... 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* subdi-

rectory, 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.

- If you want the new custom series to be used by ODV in automatic series selection, you must create a text file containing information on the domain and resolution of your series. The file name must be the same as your series name, and the extension must be *.settings*. In the example above, the file name would be *GulfOf-Maine.settings*. The file must be located in the series' base directory, e.g., in c:\Program Files\Ocean Data View (mp)\coast\GulfOfMaine. The format and contents is described below.

Example .settings file: [Domain] EastLongitude = 12. NorthLatitude = 63.0 SouthLatitude = 47.5 WestLongitude = -5. [Resolution] LatitudeRes = 0.015 LongitudeRes = 0.015	Contents: Domain longitudes are decimal degrees east (negative for deg W), latitudes are decimal degrees north (negative for deg S). Domains extending across the Greenwich meridian have negative WestLongitude but positive EastLongitude. Resolution is given as decimal degrees.

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* combo-box.
- 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 the *automatic* setting 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.

3.3 Custom Gridded Bathymetry Files

Included in the ODV software distribution you find the gridded global bathymetric data of GEBCO 2014 subsampled to 6'x6' resolution (file *GEBCO_2014_6x6min_Global.nc* in directory *<install>/include*). These data are used by ODV for two purposes: (1) the section bathymetry polygon when using sections and choosing *GEBCO_2014_6x6min_Global.nc* for section bathymetry, and (2) for construction of the gridding domains and sub-domains when using DIVA gridding in maps.

Regional and global higher resolution versions of the GEBCO 2014 data as well as the ETOPO1 data are available for download and installation via the *View > Settings* (on Mac OS *odv > Preferences*) option. Chapter 2.12 in the User's Guide provides information on how to install these high-resolution resources.

If you have even higher-resolution gridded bathymetric data available for your area of interest you may create your own high-resolution bathymetry file and use this resource for section bathymetry or DIVA domain selection.

Your custom bathymetry file must be in netCDF format, have the *.nc* extension and contain elevation data on a regular longitude by latitude grid. Elevation values must be positive on land and negative in the ocean. The netCDF file must have the following structure:

```
netcdf XXXXX {
dimensions:
    lon = 3601 ;
    lat = 1801 ;
variables:
    float lon(lon) ;
        lon:long_name = "Longitude" ;
        lon:units = "degrees_east" ;
        lon:range = "-180 - 180" ;
    float lat(lat) ;
        lat:long_name = "Latitude" ;
        lat:units = "degrees_north" ;
        lat:range = "90 - -90" ;
    short Height(lat, lon) ;
        Height:long_name = "Elevation" ;
        Height:units = "m" ;
}
```

The names of dimensions and variables as well as the data types and the order of dimensions in the Height variable have to be exactly as given. Obviously the lengths of the lon and lat dimensions depend on the size of your grid, and the name of the file XXXXX is arbitrary. Note that the Height variable only stores the integer part of the elevation data. This limits the depth resolution in the file to ±1 m.

Once created move the custom bathymetry file to the *<install>/include* directory. You use the custom bathymetry data for the section bathymetry polygon by choosing the newly created file under *Bathymetry>File* on the *Section Properties* dialog. To use the new bathymetry file for DIVA domain selection choose the file under *DIVA Settings>Map>File* on the window's *Properties* dialog.

3.4 Custom Section Bathymetry

By default the bathymetry polygon of sections is constructed using the *Bot. Depth* metadata of the stations. Alternatively, you can also use gridded bathymetric data from the *<install>/include/GEBCO1.nc* file or your own custom bathymetry (see previous section). As a third (and preferred) option you can construct the bathymetry polygon using along-track shipboard bathymetric data and provide the bathymetry polygon as *.gob* ODV graphics object file. This method will usually result in the most detailed and accurate representation of the section bottom bathymetry and is recommended whenever shipboard bathymetric data are available.

The section bathymetry .gob file must have the following structure (see also *A7_bathymetry.gob* example file in *<install>/samples/SampleFiles.zip*):

```
%GOB1.03 graphics objects

:POLYGON
coordinates=1
clip=1
iOrder=1
isFixed=1
doSmooth=0
LineColor=16
LineType=0
LineWidth=3
FillColor=16
nPts=1187
nStrokePts=1184
12.6183     60.8
11.6183     60.8
11.5791     68.7
11.5747     69.4
11.5347     89.6
…
-36.9634    232.9
-36.9634    9500.
12.6183     9500.
12.6183     60.8
```

The first 14 lines of the file describe the graphical appearance of the polygon and its length. Then follow the X and Y coordinates of the polygon nodes, one node per line. The X values represent *Section Coordinate* values (*Section Distance [km]* or *Longitude* or *Latitude* as chosen for the section), while Y is ocean depth in meters (positive downward). [For your information, the example above uses latitudes for X.] The first *nStrokePts* nodes of the section polygon describe the bathymetry along the section; the last three nodes are needed to close the polygon.

The format of the final 3 nodes is as follows:

- Last X Huge Y
- First X Same huge Y
- First X First Y

The *Huge Y* of the closure points (9500 m in the example above) should exceed the maximum depth in the section plots. The maximum number of nodes *nPts* of the polygon is 1500. You may have to subsample the shipboard bathymetry data to stay within this limit.

Once created you use the *.gob* bathymetry file for the section bathymetry polygon by choosing the file under *Bathymetry>File* on the *Section Properties* dialog.

3.5 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 desk-top icon. On all other platforms start ODV and open the cruise track file via *File>Open* and choosing file type *Data Files (*.txt *.csv *.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).

4 Data Windows

4.1 Custom Axis Labeling

The labeling of X- and Y-axis of data windows is performed automatically by default. This includes automatic determination of labeled and unlabeled tic mark positions and the use of the variable’s label as axis title.

You may customize the frequency of labeled and unlabeled tic marks by clicking on *X-Axis Settings* or *Y-Axis Settings* buttons on the *Properties>Data* page of the window’s *Properties* dialog and specifying values for *Tic mark interval* and *Label Interval*.

You may switch off the automatic use of the variable’s label as axis title and use of a custom axis title in the following way:

(1) Right-click the mouse while being over the existing X-axis title and choose option Copy Object. Do the same for the Y-axis. This will create editable and moveable copies of the existing annotations.
(2) Uncheck the *Automatic axis titles* box on the *Properties>General* page of the window’s *Properties* dialog.
(3) Drag the annotations created during (1) to their desired positions and change the text by right-clicking on the annotation and choosing *Properties*.

4.2 Adding Station Labels to Section Windows

Station labels can be added along the top margin of section plots (see Figure below) in the following way. First export the station labels as ODV annotation objects to a *.gob* file using option *Extras > Export as Graphics Object > Section Station Labels*. If necessary then edit the *.gob* file to delete some entries in areas of dense station spacing or change the color or font size of specific entries. Finally add the labels to the section window via option *Extras>Import Graphics Object from File>GOB File*.

If the station labels overlap with the Z-variable label (*Oxygen* in the example figure below) move this label upward. Note that if the *Automatic axis titles* option on the *Properties > General* page is checked this procedure has to be repeated after every redraw of the data window. You can avoid this by creating copies of the axis labels (Ctrl-C with the mouse over the respective label), unchecking the *Automatic axis titles* option and properly placing the axis labels ones and for all.

Note that the station labels along the top margin are implemented as ODV graphics objects. You can manually change the properties of a given object by moving the mouse over it, right-clicking the mouse and choosing the *Properties* option, or simply by pressing *Alt-P* while the mouse is over the label. The easiest way to delete individual labels is to put the mouse over it and pressing the *Del* button.

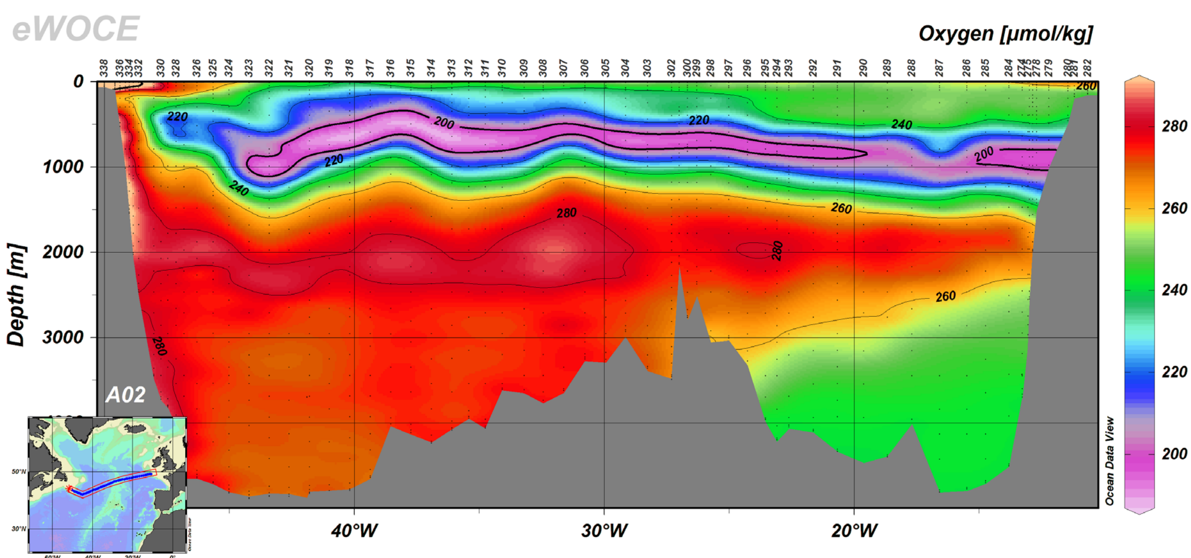


Figure 4-1: Section plot with selected station labels along the top margin.

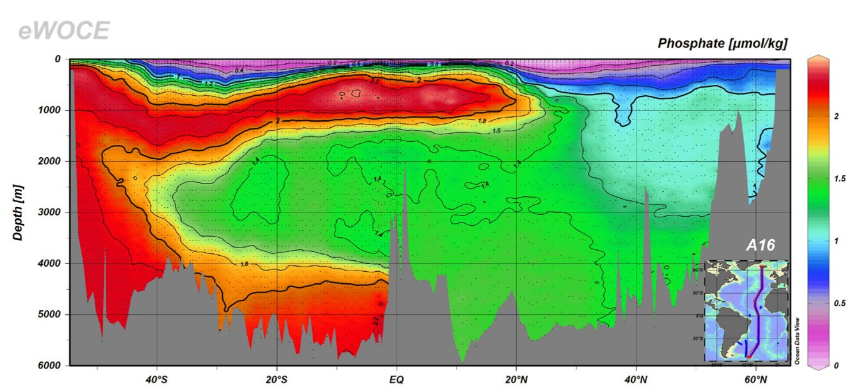
4.3 Visualizing Gridding Misfits

Gridding algorithms allow the estimation of tracer values at arbitrary (*x*, *y*) points based on data values at sampling locations (x_i, y_i), *i=1…n*. The objective is to reproduce the features in the data as realistically as possibly. However, because of errors in the data it is generally not desirable to achieve a perfect match with the data at the sampling locations, but to allow some misfits. Ideally, these misfits should show no systematic spatial patterns, the mean of the misfits should be close to zero, and the standard deviation of the misfits should be close to the error in the data. However, gridding algorithms often have problems to correctly reproduce sharp gradients or property extremes, and, in order to assess the quality of a given gridded field, it becomes necessary to view and analyze the distribution of the gridding misfits.

The easiest way to produce a plot of estimate-data misfits at the data locations is via the data window's statistics dialog (*Extras>Statistics* option or press *F4* while mouse is over the data window). Pressing the *Gridding Misfits* button will create a misfit plot similar to the one shown in the lower part of Figure 3-2 below.

ODV also allows exporting the *x, y, z* data values as well as the gridding misfits at the data locations using the *Extras > Clipboard Copy* option of the respective window context menu (obtained by right-clicking on the window). You may also simply press Ctrl-C while the mouse is over the respective window. On the *Copying to Clipboard* dialog that appears make sure to select *Export data values and gridding misfits at data positions* and check the *Export station metadata* box. ODV will then export the results to the clipboard. Open a text editor or Excel and paste the clipboard contents into it; then save the contents to an ASCII file. Choose *.txt* as file extension.

Drop the newly created *.txt* file onto the ODV icon or open a new ODV instance and use *File > Open* to open the *.txt* file. Use option *View > Layout Templates > 1 SCATTER Window* to obtain a layout with a single SCATTER window and adjust the geometry of the window to match the geometry of the original window. Assign the X and Y variables of the original window as X and Y variables of the SCATTER window, and select the *Estimated-Measured…* variable for Z. You should obtain results as shown in Figure 5-1.



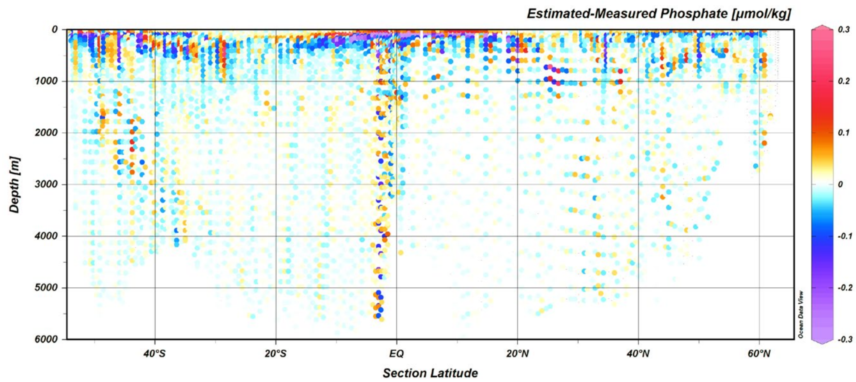


Figure 4-2: Gridded phosphate distribution (above) and estimation-minus-data differences (below).

For the example shown in the Figure below the misfits are small and random in many parts of the deep ocean. Significant and systematic misfits are found in areas of sharp gradients and just south of the equator, where data from two different cruises overlap. You can obtain further statistical information via the *Extras > Statistics* option or by pressing F4 while the mouse is over the misfit window.

4.4 Visualizing Property Differences between two Layers

Plotting the distribution of some tracer on given depth or density surfaces is a standard procedure in ODV involving the definition of appropriate isosurface variables and use of these as Z-variable of SURFACE scope data windows. Figure 4-3 below consists of two such plots showing phosphate concentrations at 10 and 250 m, respectively.

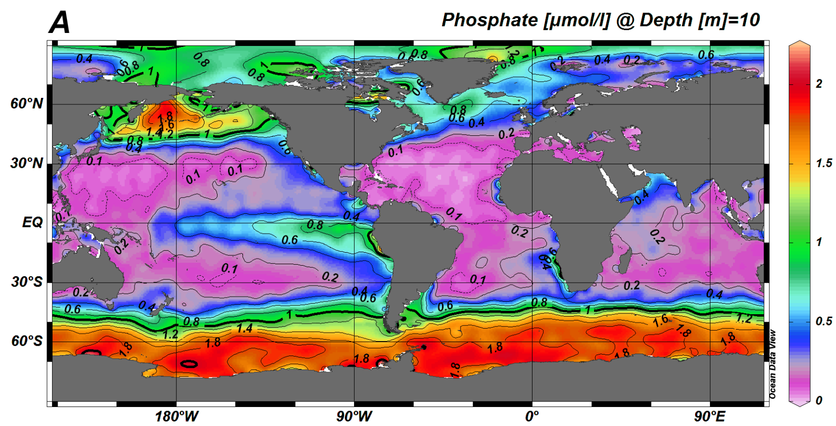
Often there is great scientific interest in the concentration difference between two such layers. Here is the procedure for creating a map of phosphate concentration differences between 250 and 10 m using the World Ocean Atlas (WOA09_Annual) collection:

1. Define isosurface variables *Phosphate [µmol/l] @ Depth [m]=10* and *Phosphate [µmol/l] @ Depth [m]=250* via option *View>Isosurface Variables*.
2. Establish a proper window layout using option *View>Layout Templates>3 SURFACE Windows*.
3. Use option *Export>X, Y, Z Window Data as Reference* to export the window data for later use with the *Difference from Reference* derived variable.
4. Define *Longitude* and *Latitude* derived variables via *View>Derived Variables*. Open the *Metadata* group under *Choices*, select *Longitude* and click *Add*, then the same for *Latitude*.
5. Still on the *Derived Variables* dialog open the *Special* group under *Choices*, select *Difference from Reference* and click *Add*. Then select the directory that received the reference data during step 3, open the *ExportID.txt* file and choose one of the win*x*

entries to be used as reference (win1 if we want to use *Phosphate [μmol/l] @ Depth [m]=10* as the reference set). Identify the *Longitude* and *Latitude* derived variables. When prompted to identify *Phosphate [μmol/l] @ Depth [m]=10* choose the *Phosphate [μmol/l]* variable.

6. Define isosurface variable *Phosphate – (Ref=<your view name>) [μmol/l] @ Depth [m]=250* and use this as Z-variable on the third data window.

This will produce the difference plot below.



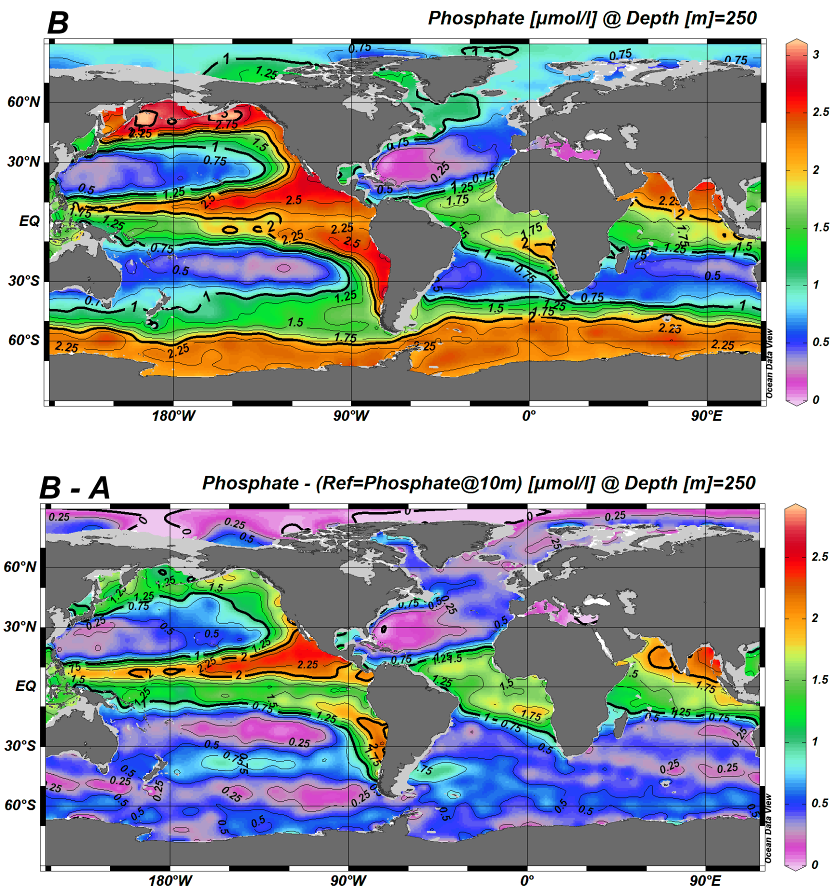


Figure 4-3: Phosphate concentrations at 10 and 250 m as well as the difference between the two layers.

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4.5 Estimating Z-Values at Arbitrary X/Y Points

Often there is a need to obtain values of the Z-variable at arbitrary X/Y positions, where no direct measurement exists. One example from marine geology is the need to obtain hydrographic or tracer data at the positions of sediment core or surface sediment samples. Another example is the need for obtaining Z-values on a regular X/Y grid when all direct measurements are irregularly distributed.

Here is the procedure to obtain values of a given variable (e.g., temperature) on a given isosurface (e.g., constant depth or constant density, etc.) at a set of sediment core locations. This procedure can easily be adapted for other use cases.

1. Prepare an ASCII file containing geographic longitudes and latitudes as spreadsheet file with two columns separated by TABs. One easy way to create such a file is to open the sediment core ODV collection (assuming such a collection exists). Then choose *Export > Window Data > Map* specify output file name and directory and press *OK* on the *Export Window Data* dialog.
2. Open the ODV collection from which you want to extract values. A good choice is *World Ocean Atlas (WOA)* that contains temperature, salinity, oxygen and nutrient data globally on 1x1 or 0.25x0.25 degree grids. Separate *WOA* ODV collections for annual, seasonal or monthly time periods are available from the ODV website https://odv.awi.de/data/ocean/. If, for instance, you want to obtain February temperatures at 75 m depth at your sediment core locations, open the monthly *WOA* collection for February.
3. Use option *View > Isosurface Variables* and define an isosurface variable for the property you want to extract, e.g., in our example *Temperature [degC] @ Depth [m] = 75*.
4. Use View > Layout Templates > 1 SURFACE Window and establish as Z variable the isosurface variable defined in step 3 above.
5. Right-click on this data window, choose *Properties > Display Style*, set *Gridded Field DIVA gridding* and adjust length scale settings if necessary.
6. Finally, right-click on the data window again, choose *Extras > 2D Estimation* and locate the positions file created under step 1.

ODV performs the requested estimation at all X/Y points in the positions file and creates an output file in the same directory that has *_est* appended to the position file‘s base name. The output file has the requested values in column 4. Columns 5 and 6 contain estimated gradients in x and y directions and can be ignored if not needed. No output is generated (field remains empty) if the gridding procedure estimate is unreliable at a given x/y point. This can happen if there is no nearby data value.

5 Overlay Windows

5.1 Contour Lines on top of a Shaded Field

It is often useful to create 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. Example images are shown in Figures 4-1 and 4-2 below.

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*, clicking 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.
- 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 satisfied, save the view for later use (*View>Save View As*).

Note that the only way to access and modify the properties of a data window entirely overlain by another window (such as window *a*), is via the main menu *View>Window Properties* option.

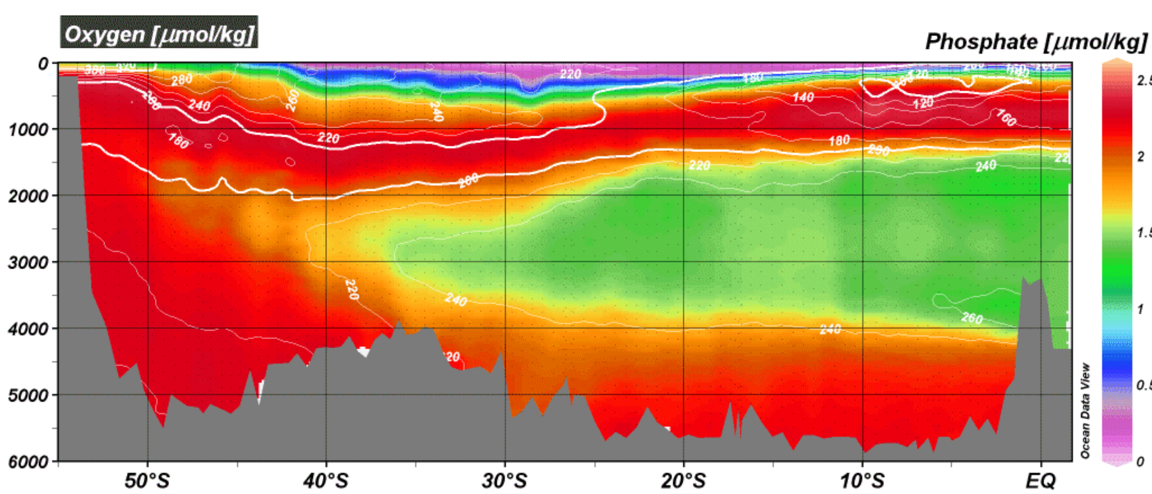

Figure 5-1: Section plot showing oxygen contour lines on top of color shaded phosphate distribution

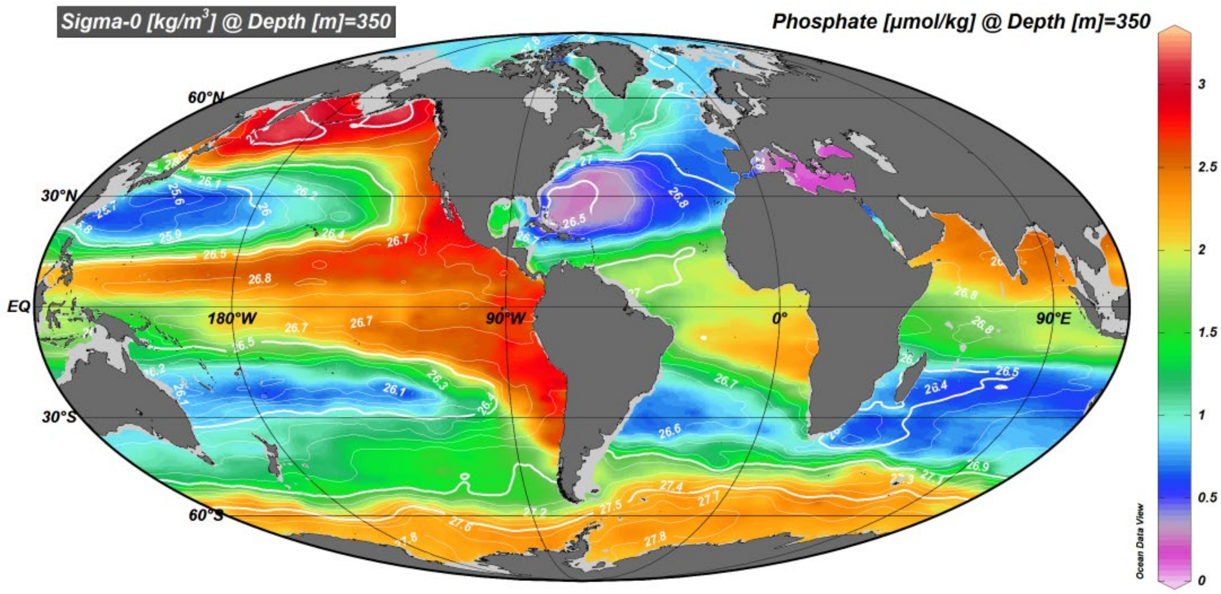

Figure 5-2: Map showing isopycnals on top of color shaded phosphate distribution.

5.2 Arrows on top of a Shaded Field

It is often useful to create maps where the distribution of one property (color shaded and/or contoured) is overlaid with arrows of another vector property, such as ocean current velocities or atmospheric winds (see Figure 4-3 below).

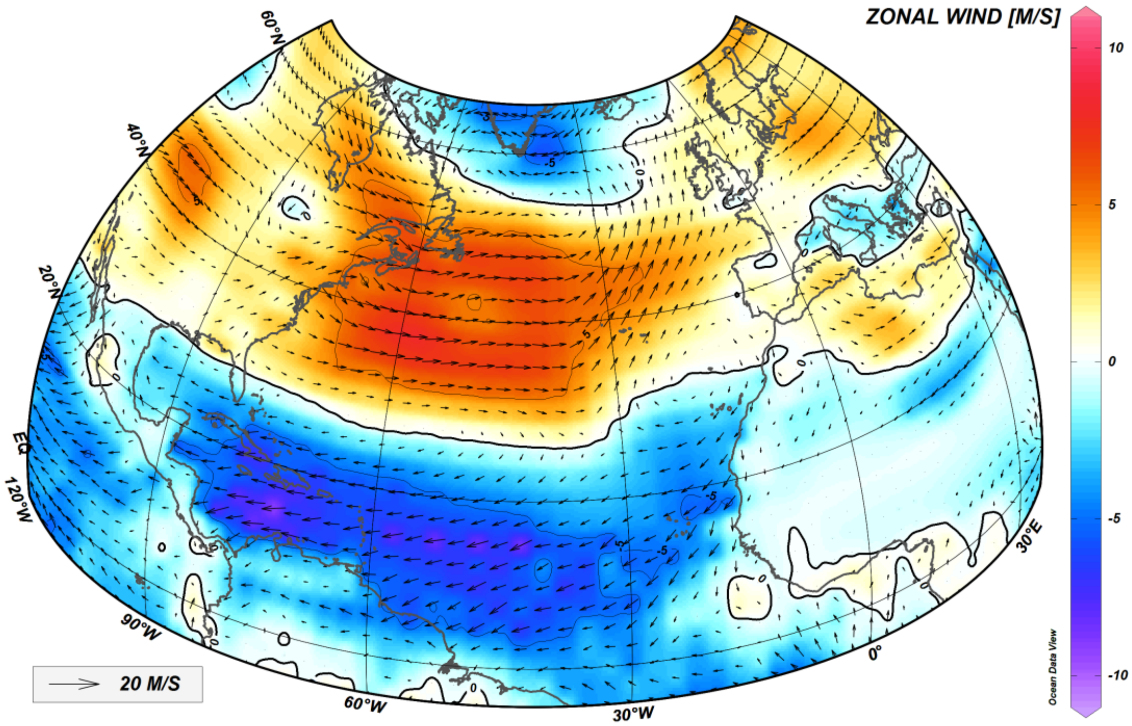

Figure 5-3: Map showing wind arrows on top of color shaded distribution.

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*), specify the display style, and possibly create some contour lines using the *Properties* option).
- Create an overlay window for window *a* by moving the mouse over window *a*, clicking the right mouse button and selecting *Create Overlay Window*. Now select a Z-variable for the overlay window *b* (property *B*) that could be used for automatically coloring the arrows.
- Edit the properties of the newly created overlay window by right-clicking on the window and choosing the *Properties* option (shortcut: Alt-P with the mouse over the window). On the *Display Style* page click on *Original data*, then on the combo box just below, and choose *Arrows*. Under X/Y Components choose the variables for the X and Y arrow components, and then specify a scale, line width and color. Choosing *(automatic)* will automatically set the arrow colors on the basis of the Z variable of the overlay window (property *B*). If you want all arrows having the same color, choose this color from the *Color* combo box.
- Leave *Window Layout* mode by choosing *Accept* from the *Window Layout* context menu.
- ODV will draw the arrows of the overlay window on top of the color distribution of

property A.

- If satisfied, save the view for later use (*View>Save View As*).

Note that the only way to access and modify the properties of a data window entirely overlain by another window (such as window *a*), is via the main menu *View>Window Properties* option.

6 Data Quality Control

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.

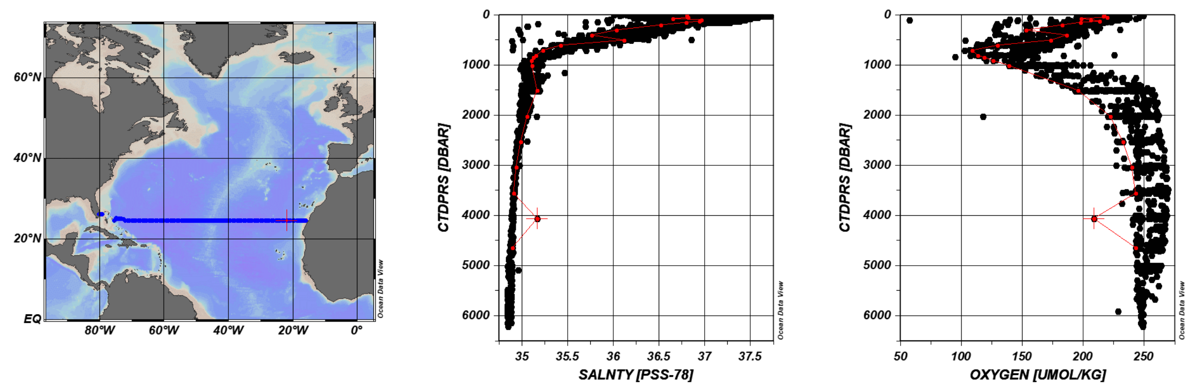

Figure 6-1: Identification of outliers for a zonal section in the North Atlantic

7 Importing XYZ Data

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 col-

lection 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.

8 Pre-computing Neutral Density

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). The newly created collection *xxx* will have *Neutral Density* as one of its basic variables stored in the disk files.

9 Using ODV Graphics

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, JPG or TIFF 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, JPG or TIFF as output type. Then specify the desired resolution of the saved image and use the GIF, PNG, JPG or TIFF graphics files in your web pages or in text documents. For print documents you can either produce raster image files with high resolution, or you can use ODV PostScript (.eps) output instead.

A number of typesetting and page design software applications 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.