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# WORLD OCEAN DATABASE 2013 TUTORIAL

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## National Oceanographic Data Center

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**For updates on data, documentation, and additional information about the WOD13 please refer to:**

http://www.nodc.noaa.gov/OC5/WOD/wod_updates.html

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Available at http://www.nodc.noaa.gov/OC5/WOD13/docwod13.html.

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# I. Introduction

The purpose of this informal tutorial is to introduce new users to the *World Ocean Database 2013* (WOD13), outline the WOD13 environment, and to provide step-by-step examples of: 1) how to select WOD13 online data by location (geographically sorted by World Meteorological Organization squares); 2) use programs (wodFOR.f and wodASC.f) to read and output ASCII data; and 3) decompress data files and read data using the Ocean Data View (ODV) software. For more detailed information on WOD13 see Boyer *et al*., 2013 and Johnson *et al*., 2013 available the NODC Publications webpage.

It is important to mention an alternative way of obtaining data, namely using the WOD*select*, which is not described in this tutorial.

The WOD13 data are available in the Data Sets & Products on the NODC OCL Products webpage.

Finally, this tutorial has been written for the Microsoft Windows® XP and Microsoft Windows® 7environments.

# II. Examples of Extracting and Reading WOD Data

This tutorial provides examples of several ways to use WOD13 data. Since the time-sorted selection process is similar to the geographically sorted, we provide an example of extracting geographically sorted data only.

**Geographically Sorted Data:** The geographically sorted data are organized by ten-degree latitude-longitude squares following the World Meteorological Organization (WMO) ten-degree square numbering scheme (Figure 1). This geographical location option allows the user to select data within the desired WMO square and download data at observed (O) or interpolated to standard (S) depths. Table 1 shows the standard levels and their depths. After selecting observed or standard depths, the user can select the dataset (*i.e*. instrument type) of interest (Figure 2).

**Example 1:** ***Selecting and extracting Ocean Station Data***

Select and extract the Ocean Station Data (OSD) at observed depths with geographic coordinates between the 0°-10°N and between 160°-170°W. Note the radio-buttons for selection among observed or standard depths are located above the WMO map (see Figure 1.

The region of interest is located in WMO square number 7016 (North Pacific) as shown in Figure 1. Click square 7016, or any square, to download data for a specific geographical region.

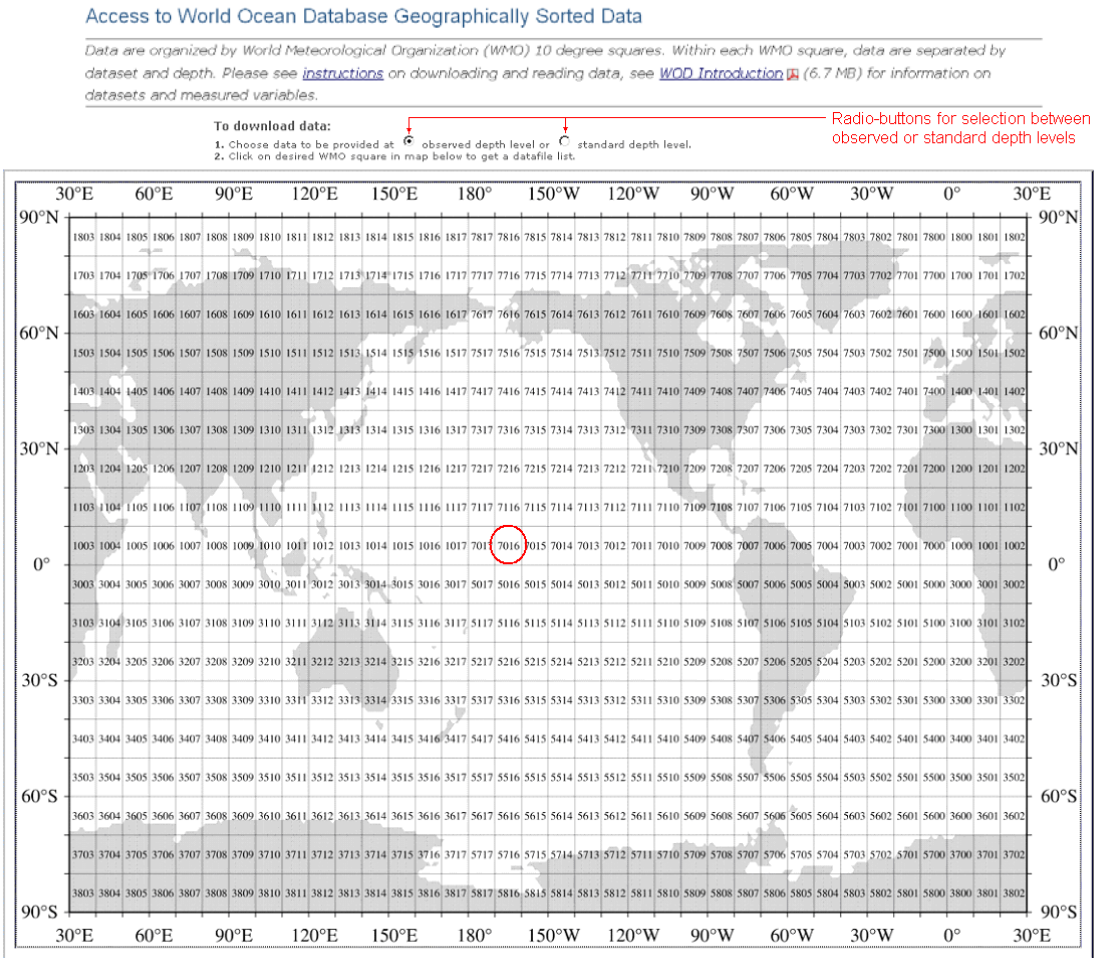



**Figure 1.** **WOD13 Geographical Selection from WMO ten-degree squares**.

Selecting data by dataset type: On the data page for each ten-degree WMO square the data are organized by dataset. The file with the desired data is OSDO7016.gz (Figure 2). The file-naming convention is as follows: OSD denotes instrument type; O denotes observed depth levels; 7016 denotes the WMO square number; filename extension .gz indicates that data file is compressed by gzip utility.

Select and save OSDO7016.gz to your work directory. You have the option of uncompressing the file or not. ODV will import the uncompressed file.

**WMO 7016 - Observed Depth Data**

Please see information on downloading and reading data

| Dataset | | File Name (size) |
|---|---|---|
| OSD | Bottle, low resolution CTD and XCTD, and plankton data | OSDO7016.gz (0.1 MB) |
| MBT | MBT, DBT, and Micro BT data | MBTO7016.gz (0.5 MB) |
| CTD | High resolution CTD data | CTDO7016.gz (2.5 MB) |
| XBT | Expendable bathythermograph data | XBTO7016.gz (8.9 MB) |
| PFL | Profiling float data | PFLO7016.gz (6.2 MB) |
| MRB | Moored buoy data | MRBO7016.gz (0.3 MB) |
| DRB | Drifting buoy data | no data in selected WMO |
| APB | Autonomous Pinniped Bathythermograph data | no data in selected WMO |
| UOR | Undulating Oceanographic Recorder data | no data in selected WMO |
| GLD | Glider data | no data in selected WMO |
| SUR | Surface data are not geographically sorted. The entire dataset is available in a single file | SURF_ALL.gz (21.6 MB) |

**Figure 2.** WOD13 Download screen of WMO square 7016 observed data.

If you have WinZip installed on your machine, the *WinZip* dialog box will appear (Figure 3) which allows decompression of OSDO7016.gz. To decompress OSDO7016.gz highlight the file, click **Extract** and select the desired location for the data file. Close the *WinZip* dialog after decompression.

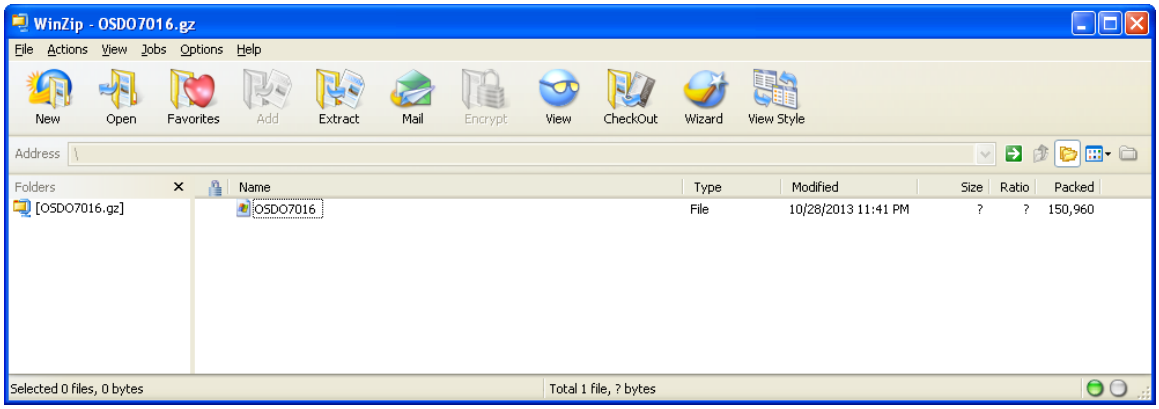



**Figure 3.** WinZip dialog box used for file extraction.

**Decompressing data:** An alternative to WinZip is gzip. This is freeware that we have provided on the **utilities** page. The **utilities** page contains utilities used for decompressing data for DOS and UNIX environments. To decompress OSDO7016.gz, use the following command: *gzip –nd OSDO7016.gz*. (Refer to the **utilities** page or the gzip web site.) The data are now ready for use.

**Example 2:** ***Using WOD programs***

The **programs** page contains sample programs written in FORTRAN and C for reading the WOD13 data.

The below FORTRAN program wodFOR.f shows how to read select WOD13 data from a file. This program is interactive in the sense that it prompts the user for the incoming file name (*e.g.*, OSDO7016) and number of stations to be displayed. The program can read data from any dataset at observed or standard depths. First, copy wodFOR.f to your working directory and make (compile) an executable or use the existing complied wodFOR.exe. It is assumed that the user is familiar with compiling FORTRAN programs (*e.g.*, UNIX environment: g77 -o <executable_file> <program_file.f>). The data should be decompressed by either WinZip, gzip, or other compression utility prior to running wodFOR.exe.

Suppose that the name of the executable is wodFOR.exe (or any other name). To execute wodFOR.exe, type: wodFOR.exe. The program prompts the user for the data file name as input. Enter the file name: **OSDO7016**. The next prompt is to enter the number of desired casts. For Example 2, since the casts are displayed on your screen, enter the number **5**. The program displays the user-selected number of casts in the OSDO7016 data file. Table 2 shows the first cast in OSDO7016.

Each dataset contains different variables. For example, OSD datasets (files) include chemical, physical, and biological variables (Table 3). The sample output from wodFOR.exe shows that the WOD13 cast number 159608 contains six variables (1=temperature, 2=salinity, 3=oxygen, 4=phosphate, 6=silicate, and 9=pH) as a function of depth (refer to Table 3 for codes). Each cast includes variable-specific and secondary header codes denoting meteorological data, originator's methods and instruments, ship and cruise name, *etc.* Refer to NODC WOD13 **codes table** page.

A note on other sample programs: Any of the FORTRAN or C programs can read WOD13 data from any dataset shown in Figure 2. The FORTRAN program wodASC.f reads the WOD13 data from a user-selected file and outputs a user-selected variable as a function of depth in either tab-separated or comma-separated format. The output from wodC.c is the same as wodFOR.f. The user can modify these programs according to specific needs.

**Example 3:** ***Reading data using Ocean Data View***

ODV is used for visualization and analysis of oceanographic data by allowing the user to generate property-property plots, maps, and sections (transects). The software can be downloaded from the ODV web site; click on software. ODV will read (import) selected WOD13 data files in both gzip compressed or decompressed format. Example 3 illustrates how to open a new collection and import single and/or multiple data files into ODV.

To use this tutorial, ODV version 4.5.7 or higher must be installed. This document is not a substitute for the ODV User's Guide. Please refer to the ODV User's Guide for more information. If you use ODV for your scientific work, you must reference it in your publication as follows:

*Schlitzer, R., Ocean Data View, http://odv.awi.de, 2013.*

Commercial use of ODV: If you plan to use Ocean Data View or any of its components for commercial applications and products, you need to obtain a software license. Please contact the address below for further information:



**Example 4:** ***Creating a new data collection and importing a file***

Example 4 walks you through creating a new data collection and importing a single WOD13 data file (**OSDO7016**) into ODV.

Opening a new data collection: Start the ODV software by double clicking the ODV icon. In the ODV menu bar, click the **File** tab to open the file menu. Click **New** to create a New_ODV_Collection in your working directory (otherwise, any existing collection can be used if available). ODV will then request a name for the new collection. Enter **demo1s** (as for "demo 1 single file", or any other meaningful file name) in the File name window. Click **Save**. This will create the collection named **demo1s.odv**.

In the "**Creating collection …**" window, (Figure 4) select "**World Ocean Database variables**" from the list of "**Definition of collection variables**" and click **OK**.

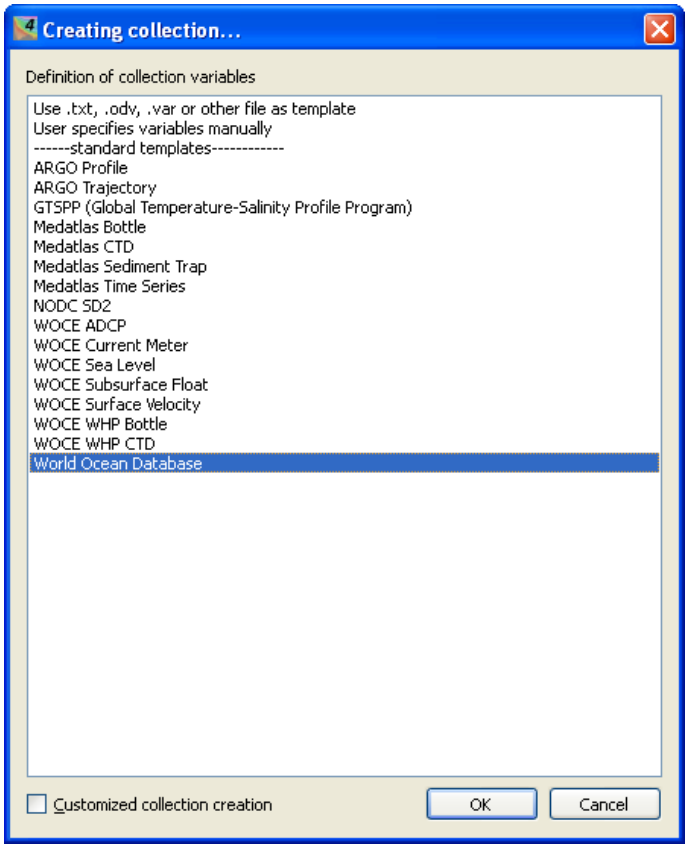



Figure 4. **Creating a new ODV collection (New_ODV_Collection.odv).**

The next window displayed is the Global Map (Figure 5). Since this is a "new" collection, just created and prior to importing data, no data are displayed in the map. Since no data have been imported yet, the ODV internal number of stations is zero, shown in the bottom of the window as **0/0: DefaultView*** circled in red.

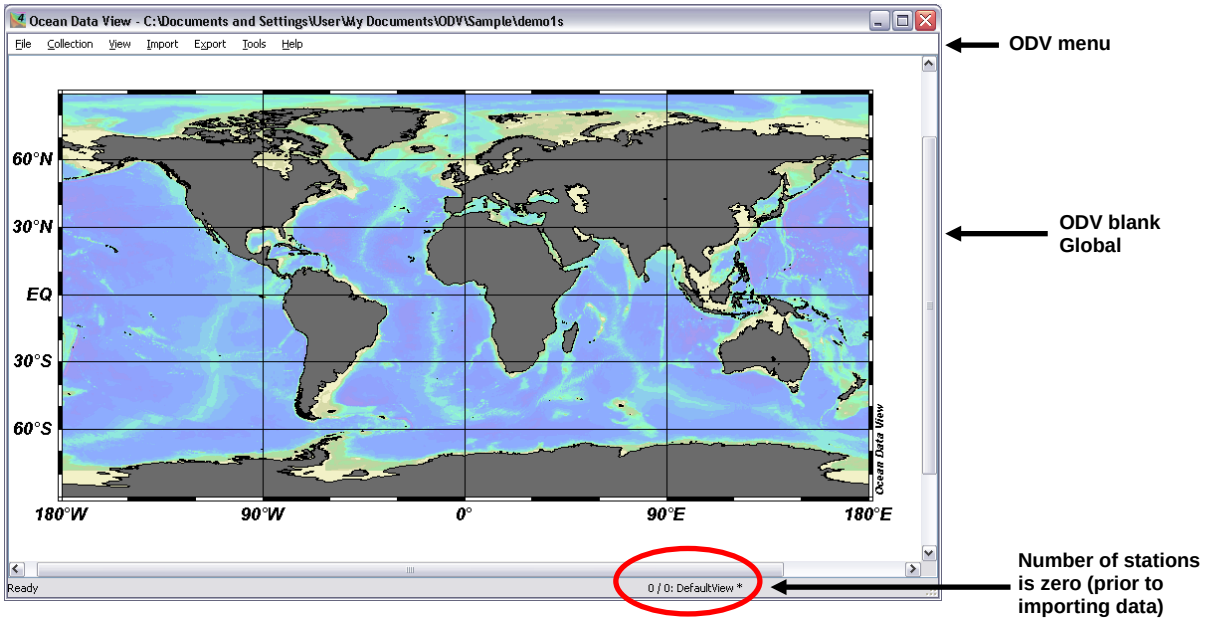



**Figure 5.** ODV screen after creating a new collection and prior to importing data**.**

Importing a single data file into the collection: The next step is to import data (OSDO7016.gz). In the ODV File Menu select **Import** > **NODC Formats** > **World Ocean Database**. In the browser window point to the folder where you have placed the OSDO7016.gz file.

Using the *Import Options* dialog box (Figure 6) you can associate the variables of the imported data with the variables already defined in the collection. Now look at the bottom portion of the box that shows window called Variable Association. All of the variables defined as the WOD13 data are preceded by asterisks. To keep this exercise simple, we will not make any changes to the *Source File* or *Target Collection*. Please refer to the ODV manual for detailed information about advanced ODV features. Highlight OSDO7016.gz so that it shows in the File name window and select **Open** to continue.

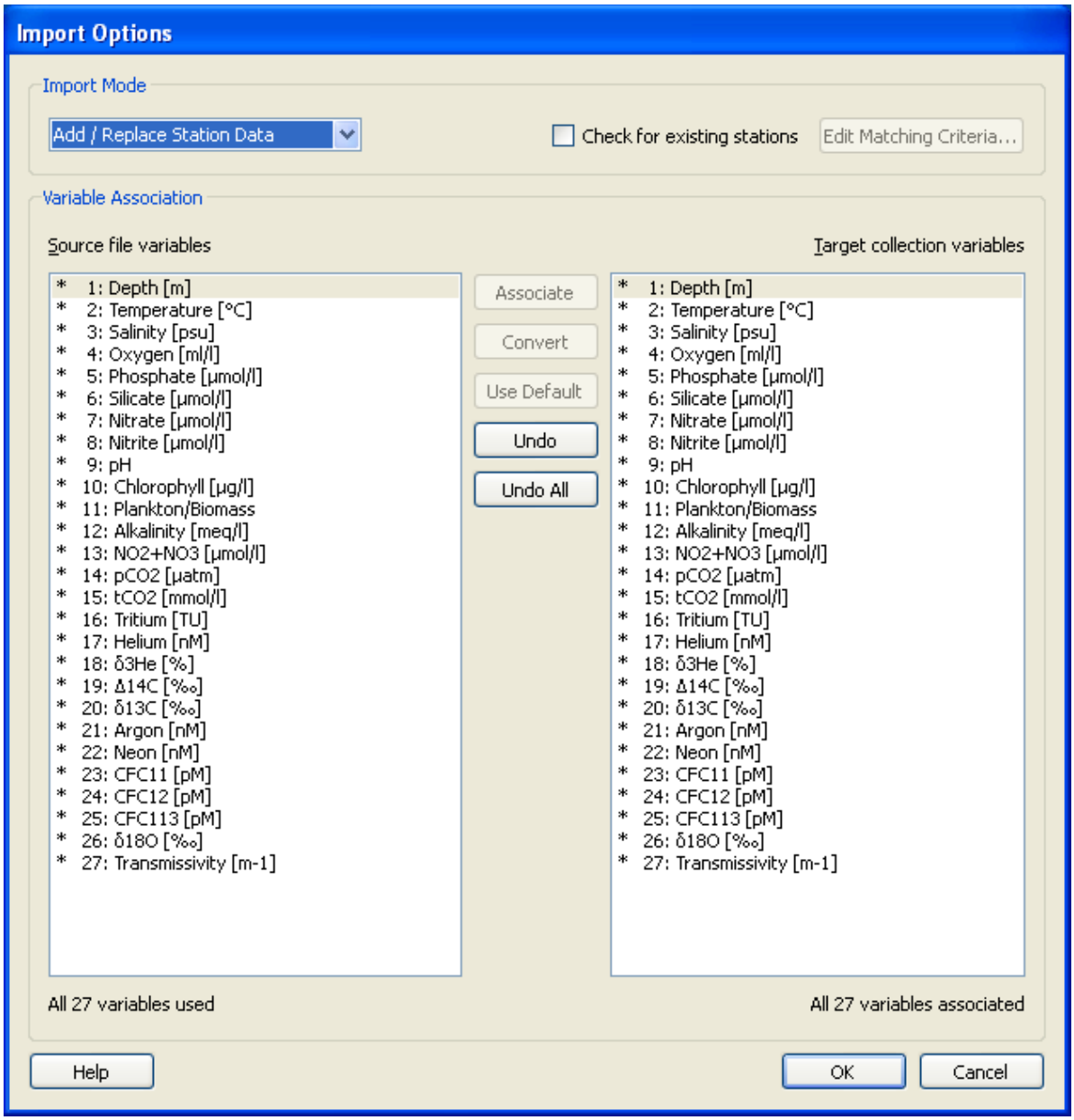



**Figure 6.** ODV Import Options**.**

A small dialog box (Figure 7) displays the total number of stations (**508 stations**) imported from OSDO7016 into the ODV Global Map. Click **OK** to continue.

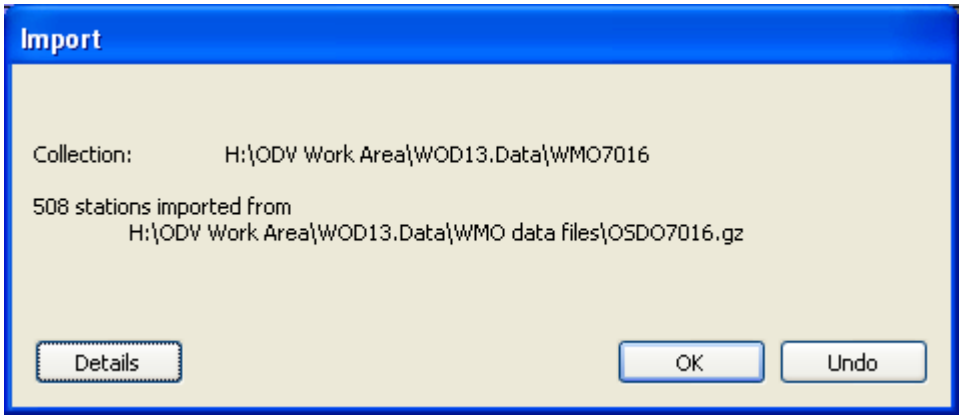



**Figure 7.** ODV Import Completion Dialog Box**.**

The next dialog box (Figure 8) allows you to improve sorting and condensing performance on the data just imported. Refer to the ODV User's Guide for detailed information on this option. To keep this exercise simply, Click **No** to continue.

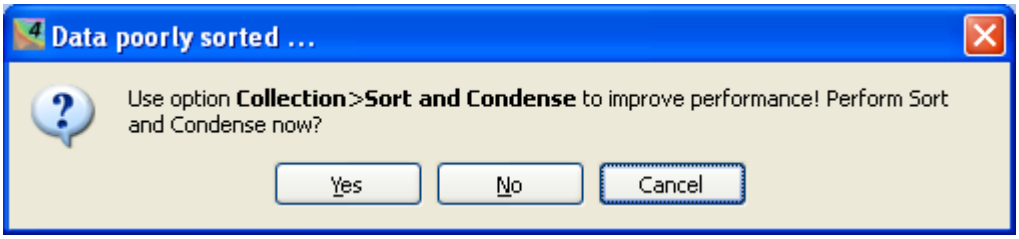
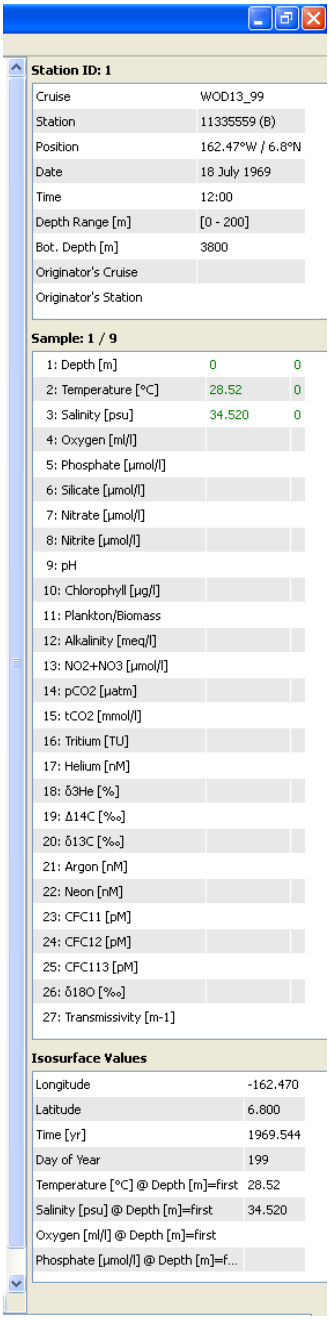



**Figure 8.** ODV Sort and Condense Dialog Box**.**

When the user selects **World Ocean Database** format, distribution of the imported data will appear in the Global Map. To the right of the Global Map, is a display of all depth-dependent variables in WOD13 (see Table 3) and their values. A zoom of the information displayed is shown in Figure 9. The station information changes accordingly, as you click a station in the distribution map. All the information corresponds to the WOD13 format unless specified otherwise. Some cast information such as profile bottom depth might not exist in all casts. Note that once a collection has been created, it is possible to import additional data files into the same collection.



**Station ID: 1**

| | |
|---|---|
| Cruise | WOD13_99 |
| Station | 11335559 (B) |
| Position | 162.47°W / 6.8°N |
| Date | 18 July 1969 |
| Time | 12:00 |
| Depth Range [m] | [0 - 200] |
| Bot. Depth [m] | 3800 |
| Originator's Cruise | |
| Originator's Station | |

**Sample: 1 / 9**

| | | |
|---|---|---|
| 1: Depth [m] | 0 | 0 |
| 2: Temperature [°C] | 28.52 | 0 |
| 3: Salinity [psu] | 34.520 | 0 |
| 4: Oxygen [ml/l] | | |
| 5: Phosphate [µmol/l] | | |
| 6: Silicate [µmol/l] | | |
| 7: Nitrate [µmol/l] | | |
| 8: Nitrite [µmol/l] | | |
| 9: pH | | |
| 10: Chlorophyll [µg/l] | | |
| 11: Plankton/Biomass | | |
| 12: Alkalinity [meq/l] | | |
| 13: NO2+NO3 [µmol/l] | | |
| 14: pCO2 [µatm] | | |
| 15: tCO2 [mmol/l] | | |
| 16: Tritium [TU] | | |
| 17: Helium [nM] | | |
| 18: δ3He [%] | | |
| 19: Δ14C [‰] | | |
| 20: δ13C [‰] | | |
| 21: Argon [nM] | | |
| 22: Neon [nM] | | |
| 23: CFC11 [pM] | | |
| 24: CFC12 [pM] | | |
| 25: CFC113 [pM] | | |
| 26: δ18O [‰] | | |
| 27: Transmissivity [m-1] | | |

**Isosurface Values**

| | |
|---|---|
| Longitude | -162.470 |
| Latitude | 6.800 |
| Time [yr] | 1969.544 |
| Day of Year | 199 |
| Temperature [°C] @ Depth [m]=first | 28.52 |
| Salinity [psu] @ Depth [m]=first | 34.520 |
| Oxygen [ml/l] @ Depth [m]=first | |
| Phosphate [µmol/l] @ Depth [m]=f... | |

**Figure 9.** WOD13 cast information and profile data as displayed by ODV**.**

**Example 5:** ***Open a new collection and import several OSD data files into ODV***

Opening a new data collection: In the ODV menu bar click the **File** tab to open the File Menu. Click **New** to create a New_ODV_Collection in your working directory (or you can open any existing collection if one is available). ODV will then request a name for the new collection under File Name. Enter demo2m (*i.e.* demo 2 multiple files; or any other file name) in the File Name box and click **Save**. This will create the collection file named demo2m.odv.

Importing multiple data files into the collection: In the ODV File Menu bar select **Import** > **U.S. NODC Formats** > **World Ocean Database**. In the browser window, select the folder where you have placed the files to import. Hold down the shift key to select all files in the folder, or hold down the control key to select certain files. Click **Open** to continue. When importing is completed, data distribution will appear on the Global Map. The **Importing ...** dialog box will show the number of imported stations. For this exercise, 13,675 stations where imported from files: OSDO7201.gz, OSDO7202.gz, and OSDO7203.gz, see dialog box shown in Figure 10.

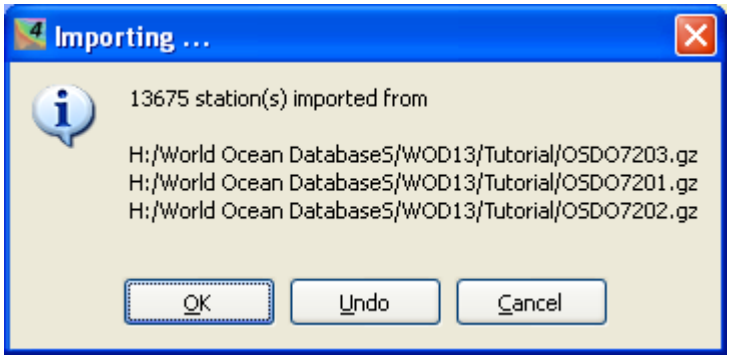



**Figure 10.** ODV Importing stations from multiple files.

Mapping of WOD variable quality flags: When a user creates a WOD collection using the WOD variables, ODV imports the original WOD quality flags and automatically maps these flags in the imported files to the ODV collection. The WOD variable quality flags are shown in Table 4. The WOD variables that received full quality control are: temperature, salinity, oxygen, phosphate, silicate, and nitrate. Other WOD variables received limited quality control such as basin data ranges for: pH, Chlorophyll, Alkalinity, Partial pressure of carbon dioxide, Dissolved Inorganic carbon, Tritium, Helium, Delta Helium-3, Delta Carbon-14, Delta Carbon-13, Argon, Neon, Chlorofluorocarbon 11, Chlorofluorocarbon 12, Chlorofluorocarbon 113, and Delta Oxygen-18.

# III. ODV Function (F) Keys

What follows are a few function keys used as shortcut keys for ODV layouts. For more detailed information on the functions keys, please refer to the ODV User's Guide.

**F1 – Opens ODV User's Guide in a browser**

**F4 – Shows data statistics of the window containing the mouse**

The dialog box for data statistics is shown in Figure 11.

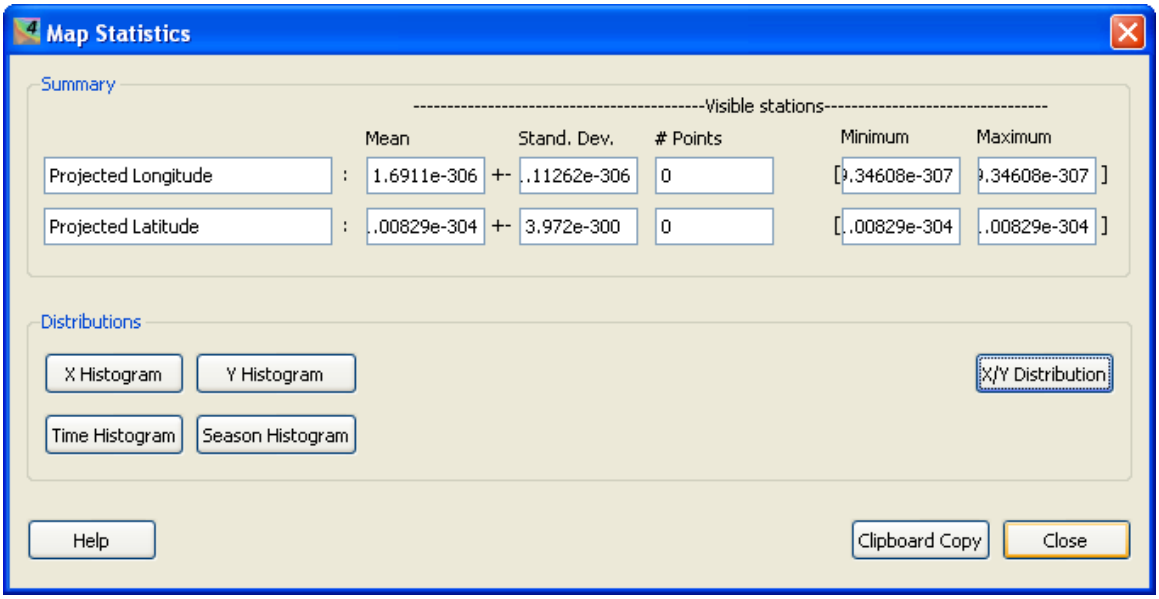



**Figure 11.** ODV Data Statistics.

**F5 – Redraws the entire canvas or the window containing the mouse**

**F8 – Switches to full-screen map layout**

The dialog box shown in Figure 12 is the ODV Glob Map in full-screen layout.

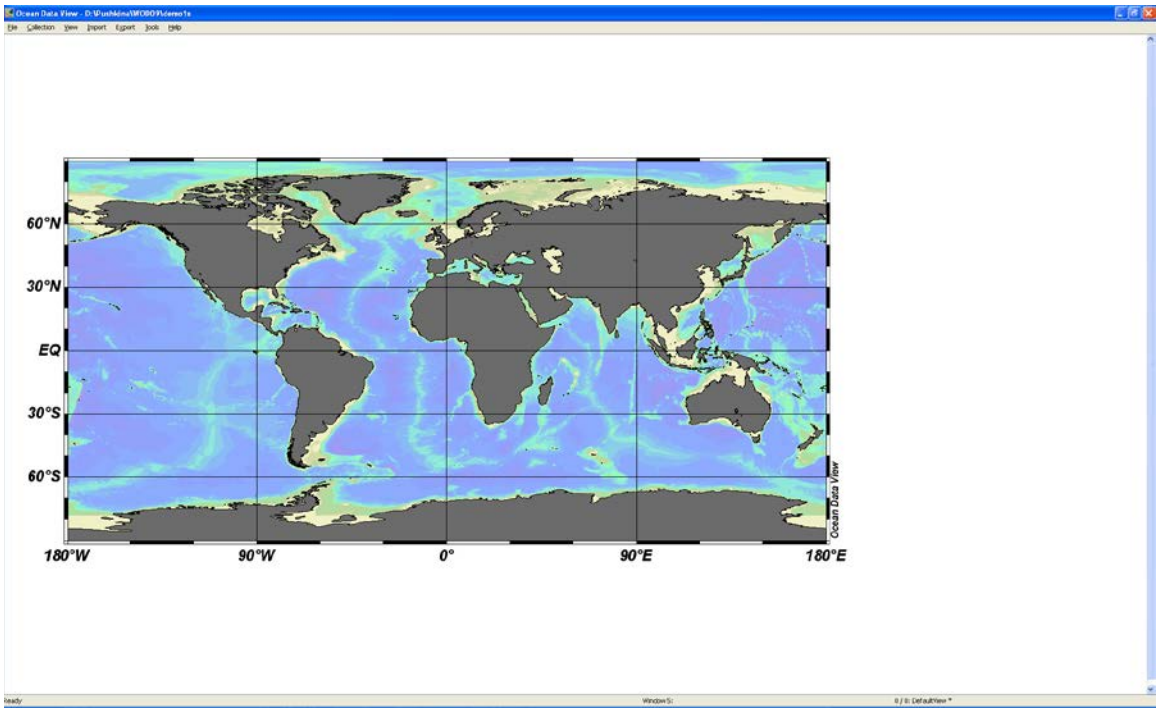



**Figure 12.** ODV full-screen layout.

## F9 – Switches to six STATION window layout

The dialog box in Figure 13 shows the six station window layout. The user can delete and/or move any desired station window from the layout.

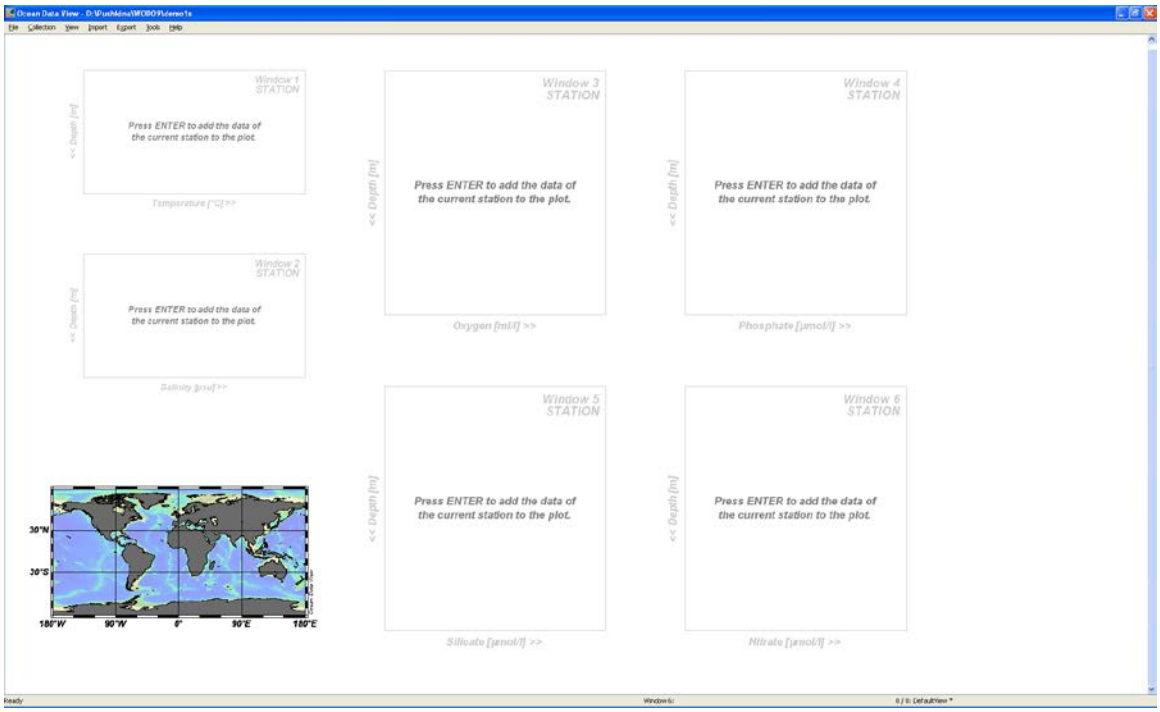



**Figure 13.** ODV six station window layout.

## F10 – Switches to two SCATTER window layout

The dialog box in Figure 14 shows salinity (top left) and temperature (right) scatter plots. Also shown in Figure 14 are the data distribution in the global map (bottom) and the cruise metadata (far right) of the dialog box.

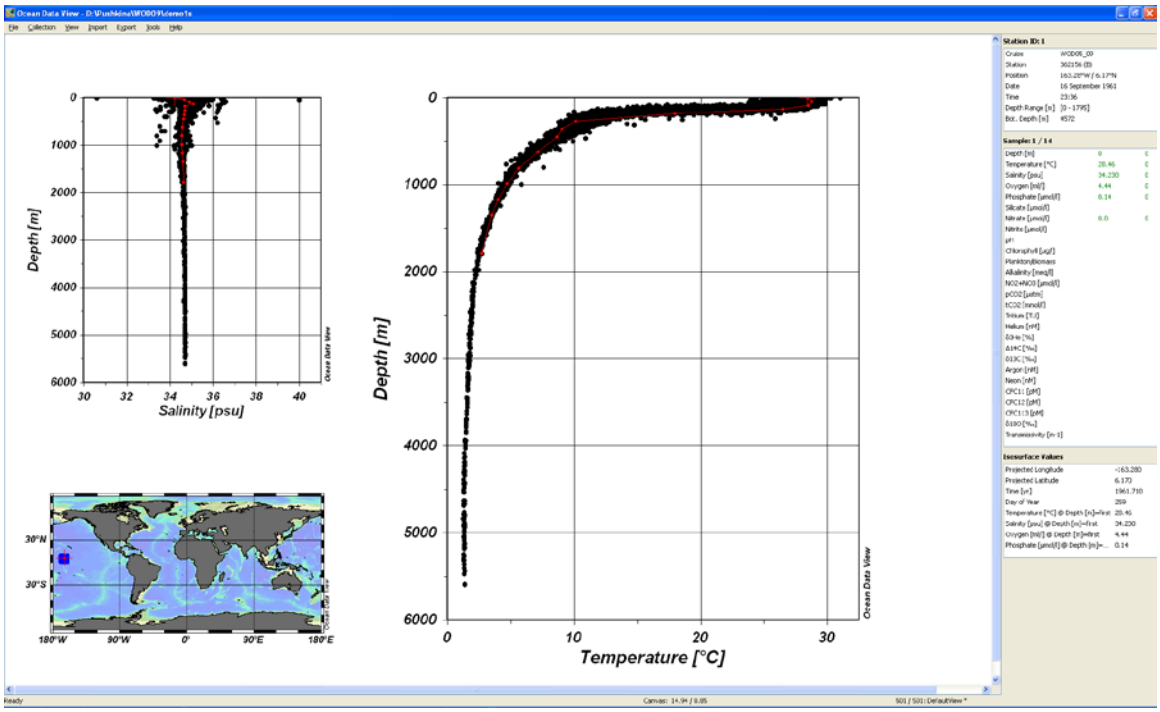



**Figure 14.** ODV salinity and temperature scatter plots.

## F11 – Switches to three SECTION window layout

The dialog box shown in Figure 15 is the layout for the three section layout. The user can delete and/or move any desired section window from the layout.

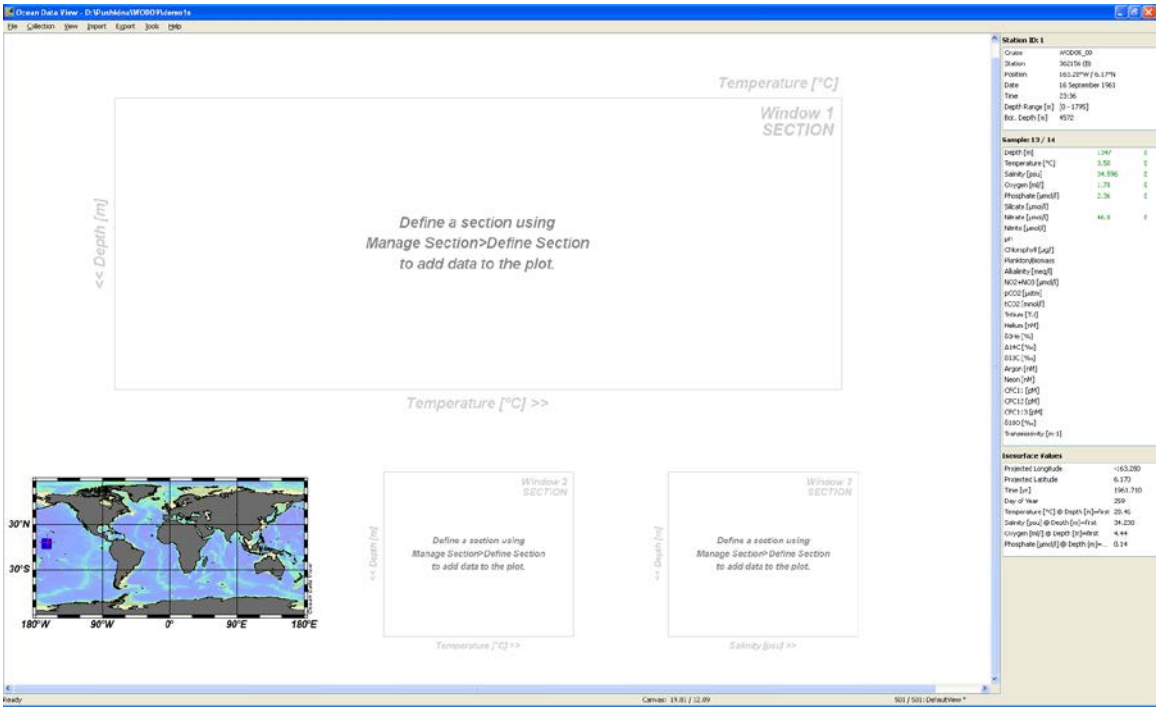



**Figure 15.** ODV three section window layout.

**F12 – Switches to one SURFACE window layout**

The dialog box in Figure 16 shows the appearance of the data in surface layout mode (right image).

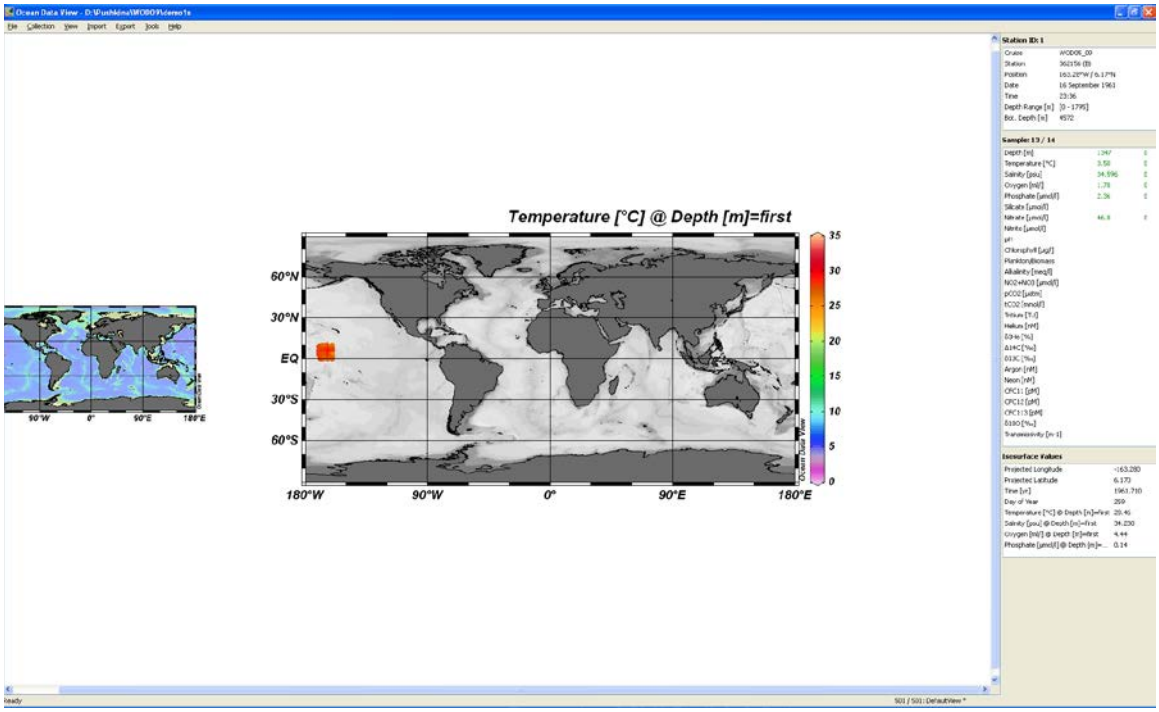



**Figure 16.** ODV surface window layout.

# IV. Reporting Data Problems, Suggestions and Comments about WOD13

If any errors are found in WOD13, please contact the Ocean Climate Laboratory (OCL) at OCL.help@noaa.gov and the problems will be corrected. Comments or suggestions for improving WOD13 would be greatly appreciated. Updates to programs and changes to WOD13 will be posted on the National Oceanographic Data Center/OCL web site.

# V. References

Boyer, T. P., J. I. Antonov , O. K. Baranova, C. Coleman, H. E. Garcia, A. Grodsky, D. R. Johnson, R. A. Locarnini, A. V. Mishonov, T. D. O'Brien, C. R. Paver, J. R. Reagan, D. Seidov, I. V. Smolyar, M. M. Zweng, 2013, *World Ocean Database 2013*. S. Levitus, Ed., A. Mishonov Technical Editor, NOAA Atlas NESDIS 72.

Johnson, D.R., T.P. Boyer, H.E. Garcia, R.A. Locarnini, O.K. Baranova, and M.M. Zweng, 2013. *World Ocean Database 2013 User's Manual*. Sydney Levitus, Ed.; Alexey Mishonov, Technical Ed.; NODC Internal Report 22, NOAA Printing Office, Silver Spring, MD, 172 pp. Available at http://www.nodc.noaa.gov/OC5/WOD13/.

Schlitzer, R., 2013. Ocean Data View, http://odv.awi.de, 2013.

**Table 1. Standard levels and their depths.**

| Depth | Level # | Depth | Level # | Depth | Level # | Depth | Level # |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 475 | 36 | 2400 | 71 | 5900 | 106 |
| 5 | 2 | 500 | 37 | 2500 | 72 | 6000 | 107 |
| 10 | 3 | 550 | 38 | 2600 | 73 | 6100 | 108 |
| 15 | 4 | 600 | 39 | 2700 | 74 | 6200 | 109 |
| 20 | 5 | 650 | 40 | 2800 | 75 | 6300 | 110 |
| 25 | 6 | 700 | 41 | 2900 | 76 | 6400 | 111 |
| 30 | 7 | 750 | 42 | 3000 | 77 | 6500 | 112 |
| 35 | 8 | 800 | 43 | 3100 | 78 | 6600 | 113 |
| 40 | 9 | 850 | 44 | 3200 | 79 | 6700 | 114 |
| 45 | 10 | 900 | 45 | 3300 | 80 | 6800 | 115 |
| 50 | 11 | 950 | 46 | 3400 | 81 | 6900 | 116 |
| 55 | 12 | 1000 | 47 | 3500 | 82 | 7000 | 117 |
| 60 | 13 | 1050 | 48 | 3600 | 83 | 7100 | 118 |
| 65 | 14 | 1100 | 49 | 3700 | 84 | 7200 | 119 |
| 70 | 15 | 1150 | 50 | 3800 | 85 | 7300 | 120 |
| 75 | 16 | 1200 | 51 | 3900 | 86 | 7400 | 121 |
| 80 | 17 | 1250 | 52 | 4000 | 87 | 7500 | 122 |
| 85 | 18 | 1300 | 53 | 4100 | 88 | 7600 | 123 |
| 90 | 19 | 1350 | 54 | 4200 | 89 | 7700 | 124 |
| 95 | 20 | 1400 | 55 | 4300 | 90 | 7800 | 125 |
| 100 | 21 | 1450 | 56 | 4400 | 91 | 7900 | 126 |
| 125 | 22 | 1500 | 57 | 4500 | 92 | 8000 | 127 |
| 150 | 23 | 1550 | 58 | 4600 | 93 | 8100 | 128 |
| 175 | 24 | 1600 | 59 | 4700 | 94 | 8200 | 129 |
| 200 | 25 | 1650 | 60 | 4800 | 95 | 8300 | 130 |
| 225 | 26 | 1700 | 61 | 4900 | 96 | 8400 | 131 |
| 250 | 27 | 1750 | 62 | 5000 | 97 | 8500 | 132 |
| 275 | 28 | 1800 | 63 | 5100 | 98 | 8600 | 133 |
| 300 | 29 | 1850 | 64 | 5200 | 99 | 8700 | 134 |
| 325 | 30 | 1900 | 65 | 5300 | 100 | 8800 | 135 |
| 350 | 31 | 1950 | 66 | 5400 | 101 | 8900 | 136 |
| 375 | 32 | 2000 | 67 | 5500 | 102 | 9000 | 137 |
| 400 | 33 | 2100 | 68 | 5600 | 103 | | |
| 425 | 34 | 2200 | 69 | 5700 | 104 | | |
| 450 | 35 | 2300 | 70 | 5800 | 105 | | |

**Table 2. Sample data output (Cast No. 159608) from the OSDO7016 using wodFOR.f**

The output shows six variables as a function of depth; quality flags; and secondary header codes. Letters “f” and “o” denote
WOD13 and originator’s quality flags, respectively; numbers in parenthesis indicate significant digits; “VarFlag” indicates whole
profile quality flag; missing values are denoted as -999.990.

```
Input File Name:

 Enter number of casts to view (0=view entire file)
 ------------------------------------------------------------
 Output from ASCII file, cast# 159608
 ------------------------------------------------------------

 CC  cruise Latitude Longitude YYYY MM DD    Time    Cast  #levels
 77    1232   8.670  -169.470  1947 12 20   22.00   159608     13

 Number of variables in this cast:  6

 Originators Cruise Code: 77470418

    z  fo    1       fo   2       fo   3       fo   4       fo   6       fo   9       fo

   0.0 00   27.500 (4) 00   34.270 (4) 00    4.830 (3) 00    0.290 (2) 00    5.000 (1) 00    8.130 (3) 00
  24.0 00   27.510 (4) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00 -999.990 (0) 00
  48.0 00   27.490 (4) 00   34.350 (4) 00    4.810 (3) 00    0.260 (2) 00    6.000 (1) 00    8.140 (3) 00
  72.0 00   26.330 (4) 00   35.010 (4) 00    4.430 (3) 00    0.420 (2) 00    9.000 (1) 00    8.110 (3) 00
  96.0 00   21.160 (4) 00   34.880 (4) 00    3.810 (3) 00    0.650 (2) 00    9.000 (1) 00    8.050 (3) 00
 144.0 00   13.990 (4) 00   34.560 (4) 00    2.780 (3) 00    1.550 (3) 00   21.000 (2) 00    7.910 (3) 00
 194.0 00   11.100 (4) 00   34.650 (4) 00    0.750 (2) 00    2.520 (3) 00   32.000 (2) 00    7.730 (3) 00
 293.0 00    9.720 (3) 00   34.700 (4) 00    0.570 (2) 00    2.520 (3) 00   41.000 (2) 00    7.710 (3) 00
 392.0 00    8.960 (3) 00   34.660 (4) 00    0.540 (2) 00    2.810 (3) 00   49.000 (2) 00    7.660 (3) 00
 491.0 00    8.140 (3) 00   34.620 (4) 00    0.630 (2) 00    2.900 (3) 00   56.000 (2) 00    7.670 (3) 00
 587.0 00    6.310 (3) 00   34.560 (4) 00    0.450 (2) 00    3.120 (3) 00   68.000 (2) 00    7.640 (3) 00
 779.0 00    5.460 (3) 00   34.560 (4) 00    0.960 (2) 00    3.040 (3) 00   86.000 (2) 00    7.630 (3) 00
 971.0 00    4.590 (3) 00   34.580 (4) 00    1.470 (3) 00    3.060 (3) 00   98.000 (2) 00    7.710 (3) 00

VarFlag:            0           4           0           3           3           0
 Secondary header #  1      126. (3)
 Secondary header #  3     6185. (4)
 Secondary header #  7      130. (3)
 Secondary header # 10     5450. (4)
 Secondary header # 18        3. (1)
 Secondary header # 19        9. (1)
 Secondary header # 21        4. (1)
 Secondary header # 29        7. (1)
 Secondary header # 99  2006124. (7)
```

**Table 3. Depth-dependent variables in WOD13.**

| Code | Parameter (nominal abbreviations) | WOD13 standard unit or scale (nominal abbreviation) | Dataset(s) where variable(s) is/are stored |
|---|---|---|---|
| 1 | Temperature | Degrees Celsius (°C) | OSD, CTD, MBT, XBT, SUR, APB, MRB, PFL, UOR, DRB, GLD |
| 2 | Salinity | Dimensionless (unitless) | OSD,CTD, SUR, MRB, PFL, UOR, DRB, GLD |
| 3 | Oxygen [$O_2$] | Milliliter per liter (ml $l^{-1}$) | OSD, CTD, PFL, UOR |
| 4 | Phosphate [$HPO_4^{-2}$] | Micromole per liter (µM) | OSD |
| 6 | Silicate [$Si(OH)_4$] | Micromole per liter (µM) | OSD |
| 8 | Nitrate [$NO_3^-$] and Nitrate+Nitrite | Micromole per liter (µM) | OSD |
| 9 | pH | Dimensionless | OSD, SUR |
| 11 | Total Chlorophyll [Chl] unless specified | Microgram per liter (µg $l^{-1}$) | OSD, CTD, SUR, UOR |
| 17 | Alkalinity [TALK] unless specified | Milliequivalent per liter (meq $l^{-1}$) | OSD, SUR |
| 20 | Partial pressure of carbon dioxide [$pCO_2$] | Microatmosphere (µatm) | OSD, SUR |
| 21 | Dissolved Inorganic carbon [DIC] | Millimole per liter (mM) | OSD |
| 24 | Transmissivity (BAC)[1] | Per meter ($m^{-1}$) | CTD |
| 25 | Pressure | Decibar | OSD, CTD, UOR, GLD, PFL |
| 26 | Air temperature | Degree Celsius (°C) | SUR |
| 27 | $CO_2$warming | Degree Celsius (°C) | SUR |
| 28 | $xCO_2$atmosphere | Parts per million (ppm) | SUR |
| 29 | Air pressure | Millibar (mbar) | SUR |
| 30 | Latitude[3] | Degrees | SUR, APB, UOR |
| 31 | Longitude[3] | Degrees | SUR, APB, UOR |
| 32 | Julian year-day[2,3] | Day | SUR, APB, UOR |
| 33 | Tritium [$^3H$] | Tritium Unit (TU) | OSD |
| 34 | Helium [He] | Nanomol per liter (nM) | OSD |
| 35 | Delta Helium-3 [$\Delta^3He$] | Percent (%) | OSD |
| 36 | Delta Carbon-14 [$\Delta^{14}C$] | Per mille (‰) | OSD |
| 37 | Delta Carbon-13 [$\Delta^{13}C$] | Per mille (‰) | OSD |
| 38 | Argon [Ar] | Nanomol per liter (nM) | OSD |
| 39 | Neon [Ne] | Nanomol per liter (nM) | OSD |
| 40 | Chlorofluorocarbon 11 (CFC 11) | Picomole per liter (pM) | OSD |
| 41 | Chlorofluorocarbon 12 (CFC 12) | Picomole per liter (pM) | OSD |
| 42 | Chlorofluorocarbon 113 (CFC113) | Picomole per liter (pM) | OSD |
| 43 | Delta Oxygen-18 [$\Delta^{18}O$] | Per mille (‰) | OSD |

[1] Beam Attenuation Coefficient
[2] Julian year-day is the decimal day for the year in which the observations were made (see Section I. F7)
[3] Codes: 30, 31, and 32 (latitude, longitude, and Julian year-day respectively) are not depth-dependent variables and are not in WOD*select*.

**Table 4. Definition of WOD13 Quality Flags**

| | |
|---|---|
| **(1) FLAGS FOR ENTIRE CAST (AS A FUNCTION OF VARIABLE)** | |
| 0 | accepted cast |
| 1 | failed annual standard deviation check |
| 2 | two or more density inversions ( Levitus, 1982 criteria ) |
| 3 | flagged cruise |
| 4 | failed seasonal standard deviation check |
| 5 | failed monthly standard deviation check |
| 6 | failed annual and seasonal standard deviation check |
| 7 | bullseye from standard level data or failed annual and monthly standard deviation check |
| 8 | failed seasonal and monthly standard deviation check |
| 9 | failed annual, seasonal and monthly standard deviation check |
| **(2) FLAGS ON INDIVIDUAL OBSERVATIONS** | |
| **(a) Depth Flags** | |
| 0 | accepted value |
| 1 | duplicates or inversions in recorded depth ( same or less than previous depth ) |
| 2 | density inversion |
| **(b) Observed Level Flags** | |
| 0 | accepted value |
| 1 | range outlier ( outside of broad range check ) |
| 2 | failed inversion check |
| 3 | failed gradient check |
| 4 | observed level “bullseye” flag and zero gradient check |
| 5 | combined gradient and inversion checks |
| 6 | failed range and inversion checks |
| 7 | failed range and gradient checks |
| 8 | failed range and questionable data checks |
| 9 | failed range and combined gradient and inversion checks |
| **(c) Standard Level Flags** | |
| 0 | accepted value |
| 1 | bullseye marker |
| 2 | density inversion |
| 3 | failed annual standard deviation check |
| 4 | failed seasonal standard deviation check |
| 5 | failed monthly standard deviation check |
| 6 | failed annual and seasonal standard deviation check |
| 7 | failed annual and monthly standard deviation check |
| 8 | failed seasonal and monthly standard deviation check |
| 9 | failed annual, seasonal and monthly standard deviation check |
| **(d) Biological data flags (applied only to Comparable Biological Value - CBV Taxa code 27)** | |
| 0 | accepted value |
| 1 | range outlier ( outside of broad range check ) |
| 2 | questionable value (“bullseye flag” ) |
| 3 | group was not reviewed |
| 4 | failed annual standard deviation check |