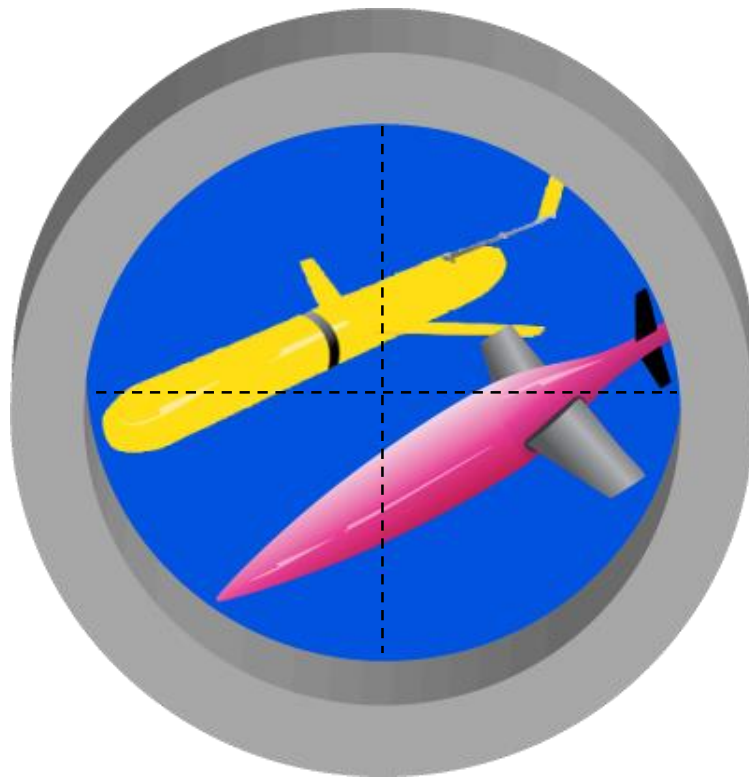**IMOS** Integrated **Marine Observing** System

AUSTRALIAN NATIONAL FACILITY FOR OCEAN GLIDERS (ANFOG)

Gliderscope **v8**

User's Manual

March 2021

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Contents

1 Introduction

Gliderscope is a standalone Win/Mac software package designed to give you the power to visualise glider data effortlessly via a convenient graphical user interface. By using the freely available *Gliderscope* software, anyone can examine NetCDF files they have downloaded, filter out bad data, interactively isolate segments of data and apply a variety of useful data graphical visualisation techniques to examine the data, e.g.

- three/four-dimensional plots of water properties,
- interpolated contour charts,
- vertical profile plots,
- water properties comparison charts (e.g. TS-diagrams)
- light attenuation coefficients charts

Gliderscope performs additional calculations for underwater sound velocity, light attenuation coefficient, 1% photic depth and local time zone to further inform you. And you can make use of a host of clever on-screen tools. For example, you can drop a 'virtual Niskin bottle' to instantly find out what the water properties are like anywhere in your cross-section; change the look of plots by dragging on sliders or swap between different cmocean colour maps to best highlight patterns of interest. Additionally, you can export any segment of data as text or NetCDF files for easy access in other applications.

Gliderscope has the ability not only to use netCDF data files from IMOS (Integrated Marine Observing System), but also from the U.S. Integrated Ocean Observing System (IOOS) and Everyone's Gliding Observatories (EGO) as well.

Useful links:

Gliderscope software download
http://imos.org.au/gliderscope.html

Gliderscope sample and tutorial data
http://imos.org.au/gliderscope.html

IMOS Ocean Gliders data download
http://imos.aodn.org.au/webportal/
http://thredds.aodn.org.au/thredds/catalog/IMOS/ANFOG/catalog.html

IOOS data download[1]
https://data.ioos.us/gliders/erddap/info/index.html

EGO data download[2]
ftp://ftp.ifremer.fr/ifremer/glider/v2/

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1 Gliderscope supports IOOS *.nc* (NetCDF-3 binary file with COARDS/CF/ACDD metadata) format.

2 Gliderscope supports EGO NetCDF format.

More information about the IMOS Ocean Gliders
http://imos.org.au/facilities/oceangliders

Feedback for *Gliderscope* software or this USERS MANUAL may be sent to the author and software creator, Dr Lai Mun Woo, at mun.woo@uwa.edu.au.

2 Installation

2.1 First Installation

- Download an appropriate installation package.

  Gliderscope is available for both Windows and Macintosh computers. Unzip the downloaded package and run it.

  During installation, you may be asked for permission to run *MCRInstaller.exe*. Select *OK* to allow this. (If the question does not appear, then manually run MCRInstaller.exe from your installation folder afterwards.) This need only be done once.

2.2 Run the Software

- Double-click on *GliderscopeV8.exe* to begin using the software (Figure 1).

Figure 1 Run Gliderscope by clicking on the desktop icon.

3 Using *Gliderscope*

To begin using *Gliderscope*, double-click on the Matlab App or *Gliderscope8.exe* to start the program.

First you will look at the entire glider track and select any segment of data of interest. As you go along, *Gliderscope* 'speaks' to you from its blue talk screen, providing you with useful guidance at every step of the way (Figure 2). Also, you can find out what every button and control does by hovering the mouse cursor over it.

3.1 Load data

3.1.1 ANFOG netCDF data file

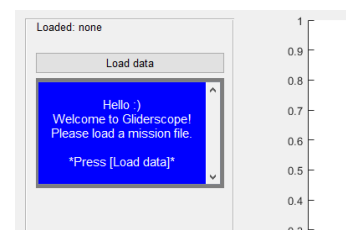- Click on **[Load data]** button (Figure 2) and select which data file you would like to access.

Figure 2 Start by pressing the [Load data] button on the main Gliderscope dashboard.

Gliderscope is able to handle .nc files from glider missions all over the world.

IMOS Ocean Gliders data download
http://imos.aodn.org.au/webportal/
http://thredds.aodn.org.au/thredds/catalog/IMOS/ANFOG/catalog.html

IOOS data download[3]
https://data.ioos.us/gliders/erddap/info/index.html

EGO data download[4]
ftp://ftp.ifremer.fr/ifremer/glider/v2/

Select the .nc format when you make your download.

Errors can occur when loading files that have not been quality controlled. Usually, this occurs when the metadata has been incorrectly recorded, e.g. in some data, the *valid_max* attribute of the TIME variable may have been set lower than the available data. But these errors can be easily collected using our freely available *NetCDFNinja* software (http://imos.org.au/netcdfninja). Simply load the file into *NetCDFNinja*, examine the attributes and edit the values where suitable. No knowledge of coding is necessary.

3.1.2 Examine glider's path

Two plots display the glider's path, from an aerial view (Figure 3) and underwater side view (Fig. 6).

Glider's horizontal path (aerial view)

- In *Gliderscope*'s right plot (Figure 3), an aerial view of the glider's journey is shown as a blue line with white arrows pointing the direction of travel. (White arrows are more obvious when you zoom in closer).
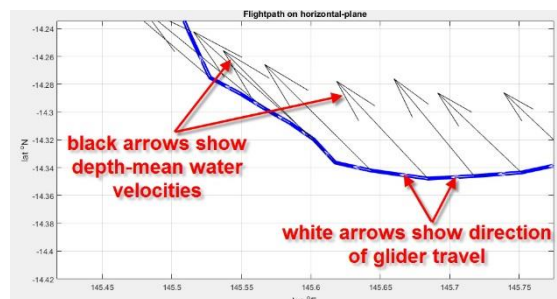

Figure 3 Aerial view of glider path.

- In addition to the glider path, you can also ○**show** or ○**hide** arrows which point the direction of average seawater flow[5].

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3 Gliderscope supports IOOS *.nc* (NetCDF-3 binary file with COARDS/CF/ACDD metadata) format.

4 Gliderscope supports EGO NetCDF format.
5 IMOS Ocean Gliders do not carry any current velocity measuring devices. Current velocities are rough estimates which the glider has derived using onboard engineering parameters and GPS (Global Positioning System) fixes each time it surfaced. These are not quality controlled.

- Press **[export loc]** if you would like to export latitude and longitude data as a text file for use in other applications.
- Press **[export vel]** if you would like to export the estimated depth mean current velocities as a text file.

The exported text files can then be used in other programs, e.g. Excel. The files are named for what the columns of data contain,

e.g.' *lat_lon_time.txt'* contains
- column 1: Latitude (*lat*)
- column 2: Longitude (*lon*)
- column 3: Time (*time*)

'ucur_vcur_lat_lon_time.txt' contains
- column 1: Eastward seawater velocity (*ucur*)
- column 2: Northward seawater velocity (*vcur*)
- column 3: Latitude (*lat*)
- column 4: Longitude (*lon*)
- column 5: Time (*time*)

(* Note: Units of measurement are as shown in Table 1.)

Glider's vertical path (underwater side view)

- The vertical glider trajectory is displayed in *Gliderscope's* bottom plot (Figure 4),. You may choose to view this chart with data indices or dates on the x-axis.

- To zoom in, use **[switch zoom on]** and drag with mouse to zoom. If the x-axis is showing dates, it will automatically update to either show time or date where appropriate to the zoomed scale.
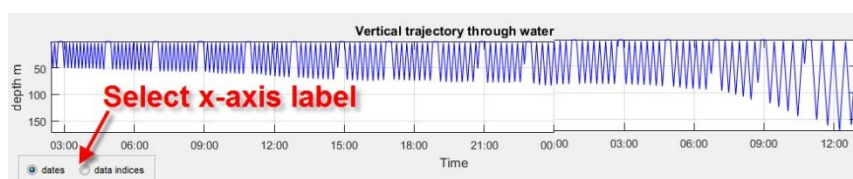

Figure 4 Gliderscope bottom plot shows the dive paths on a vertical plane.
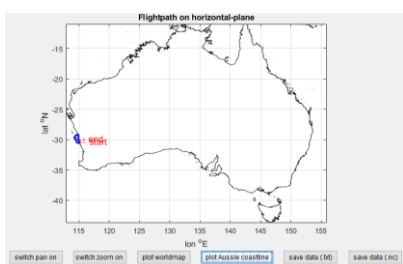
3.1.3 Plot coastline data (optional)

Figure 5 Location can be seen in relation to the Australian coastline by pressing on [plot coastline] button.

*optional: Press **[plot Aussie coastline]** button to see where the glider mission occurred in relation to the Australian coastline (Figure 5), or [**plot worldmap**] if examining overseas data from EGO or IOOS (Figure 6). Coastline data will take longer to load on first run, but subsequently, **[plot coastline]** will plot much more quickly.
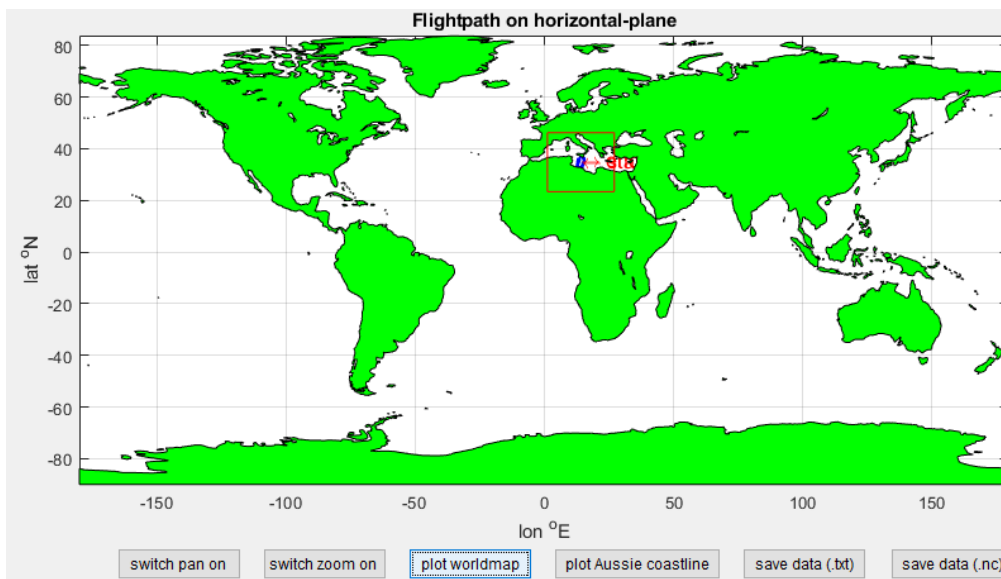
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Figure 6 Non-Australian glider mission locations can be seen in relation to the world's landmasses by pressing on the [plot worldmap] button; the red box makes your mission location easy to find on the map.

Using Pan

- Pan the picture by pressing **[switch pan on]** (Figure 6) and then click-and-drag the mouse anywhere on the map. Press the same button to toggle it off afterwards.

Using zoom

The zoom feature works in both plots.

- To enable/disable zooming, press **[switch zoom on]/ [switch zoom off]** button.

- Zoom controls -
   Zoom in: Hold the left mouse button and drag a rectangle in either plot.

   Zoom back out a bit: Hold down ALT-key (on the keyboard) and click once.

   Zoom back out all the way: Quickly double-click over the plot.

   If you have a scroll mouse, you can spin the scroll to zoom in or out fast.

   If your mouse has a right button, pressing it displays other zoom options.

*optional: pressing the yellow **[reset]** button removes the map.

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3.2 Extract data

3.2.1 Using all available data

- Press **[DONE]** button now (Figure 7) or after pressing [**reset**] to proceed with all of the data intact. Use with caution because every glider mission typically produces enormous volumes of high resolution data which may tax your computer's resources if processed all at once.
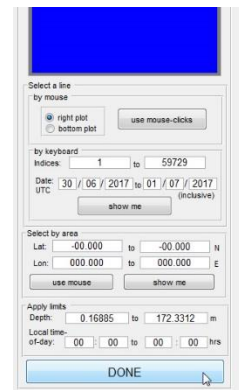
Figure 7 Use [DONE] to proceed with the data to the plotting wizard.

3.2.2 Using part of the data

If you are only interested in a segment of the data, you may isolate your data in a few easy ways.

(i) Select a line

This option is especially useful for extracting data to make an oceanographic transect line. Selection can be made by any of the following methods:

Figure 8 Control panel for line selection by mouse.

By mouse

Choose ○**right plot** or ○**bottom plot** to indicate from which display you would like to select data from.

- Press **[use mouse-clicks]** (Figure 8) button to enable the mouse.

- Using your mouse, click your desired start and end points over the chosen plot.

Although crosshairs (Figure 9) are provided to help you position your points, high precision is unnecessary, as *Gliderscope* will always find the data points closest to your mark.

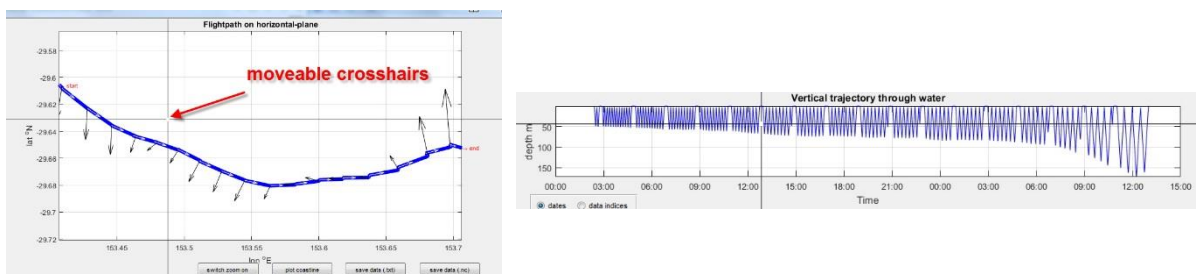You may use the **[switch zoom on]**/ **[switch zoom off]** button to zoom in for a closer look at any time.

Figure 9 Crosshairs help as your mouse-click the start and end points of your desired line segment; this can be done on either of the 2 charts.
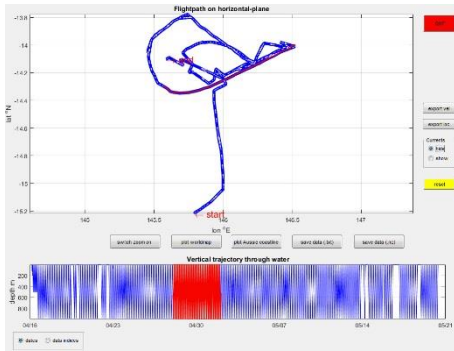
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Figure 10 User-selected segment is highlighted in red.

- Finally, your selection is highlighted in red (Figure 10), and the corresponding data indices, UTC dates and depth range are automatically updated in the control panel display.

*note: pressing **[reset]** button removes red highlighting and reinitialises everything in the control panel.

*If you re-do your mouse selection by pressing **[use mouse-clicks]** again, the existing red highlighting will also be cleared.

By keyboard

Using the keyboard, you may further tweak your previous mouse-click selection or define a new segment altogether. This may be done by specifying the segment range by typing into textboxes for **Indices**[6] or **Date** (Fig. 12). (*Note: Having typed into the **Indices** text boxes, the **Date** will automatically be updated to correspond, and vice versa.)

Figure 11 Keyboard input boxes to define start and end points of a segment; [show me] button highlights the chosen segment in the plots.

- For a closer look at the data index numbers, you may also use the **[switch zoom on]**/ **[switch zoom off]** button and zoom into *Gliderscope*'s bottom plot.

- Press **[show me]** if you need to check where these 2 points lay geographically (Figure 11).

- The user-selected segment will then be highlighted in red (Figure 10).

*optional: pressing the yellow **[reset]** button removes highlighting and reinitialise all text boxes.

(ii) Select an area

This option is particularly useful when you want to examine data from a specific region, e.g. within a sea canyon or in an ocean eddy. You may indicate the area of interest by mouse or by keyboard.

By mouse

- Press **[use mouse]** button to enable the mouse (Figure 12).

Figure 12 Control panel for extracting data from a geographical area.

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[6] The first entry in the time series is indexed as number 1.

- Click mouse and drag a box around your area of interest (Figure 13). The shape of this box can be modified using the box handles (little squares on the sides and corners), and the whole box may be moved by placing the mouse pointer within the box and dragging.

Figure 13 Define an area of interest using the mouse; remember to double-click in the box when done.

- When done, double-click within the box.

- Data that falls within the box will be highlighted in red (Figure 14), and coordinates of the bounding box will automatically be shown in the **Lat** and **Lon** text boxes (Fig. 13).

*optional: pressing **[reset]** button (Fig. 10) removes highlighting and reinitialises all text boxes.

By keyboard

- If you prefer to define your area of interest directly by latitude/longitude coordinates, type into the **Lat** and **Lon** text boxes (Figure 12).

Figure 14 Data within a chosen space is selected, regardless of whether the data is all connected temporally.

- *optional: pressing **[show me]** (Figure 12) will highlight the data found within your chosen coordinates.

(iii) *Apply depth or time limits*

To aid your specific analyses, the chosen data may be further limited to specific depths or time. Also, the phase of the glider dive cycle may be chosen, i.e. look at data from upward profiles only. All these may be done by using the relevant text boxes and radio buttons as shown in Figure 15.

Figure 15 Control panel to further limit the data to certain depths, time of day and glider dive phase.

Specifying depth range

If you want to examine data from a particular depth range within the water column (e.g. to study surface processes, a subsurface current or dense water cascades near the seabed), you will find it useful to specify and limit the depth range. (Alternatively, you can also identify the depth range afterwards when you see how the data looks like in the plotting wizard.)

- Using your keyboard, type into the **Depth** boxes to indicate minimum and maximum depths.

- If you accidentally reverse the order of numbers in the **Depth** boxes, do not worry; *Gliderscope* will automatically sort them out.
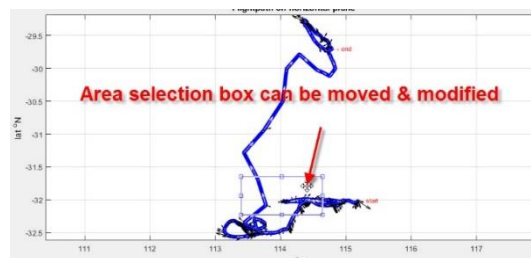
This option is especially useful if you are interested in examining processes that occur only during certain times of day, e.g. isolating data from daylight hours, we see that the fluctuating pattern of dissolved oxygen in coastal waters may be the result of photosynthetic activity (Figure 16). When the local time zone has not been recorded, *Gliderscope* automatically calculates this based on location data.

- Using your keyboard, specify the range in the **Local-time-of-day** text boxes. The local time of day may be specified,

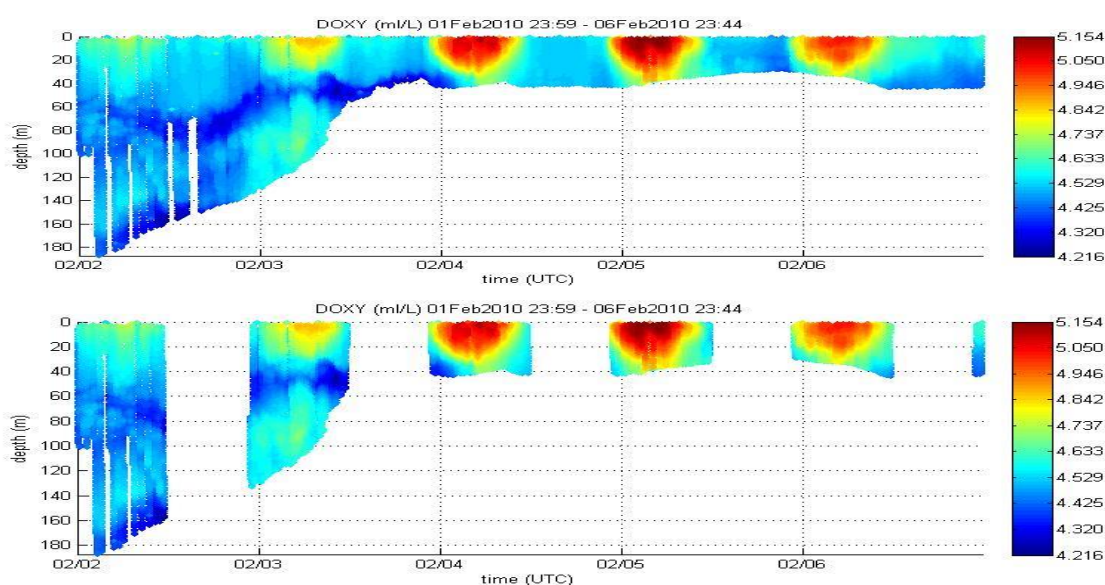 *Note: For intuitive use, Time-of-day is in standard local time, *not* UTC time.

Figure 16 (Top) A segment of data showing coastal fluctuations of dissolved oxygen concentration; (bottom) when data during daylight hours are isolated and plotted, it is seen that dissolved oxygen maxima coincides with daylight hours.

Specifying phase of dive cycle

You may not be interested in data from certain parts of the glider dive cycle, e.g. from when the glider is drifting on the sea surface. Or perhaps, you only want to see data from the ascending profile and not the descending profile. When the phase data is available in the loaded mission data file, you will be able to toggle various phases on or off (Figure 15).

Finalise your selection

Now that data has been selected, you may proceed to the next stage to visualise the data, or export the data as text files or netCDF files.

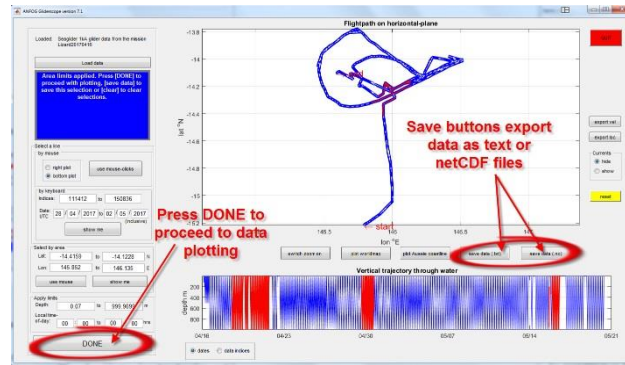- Press **[Done]** when ready to plot up your selected data (Figure 17).

Figure 17 Finalise selection and move on to plotting.

- Optional: Hit **[Save data]** to save the data as text files (.txt) or netCDF (.nc) files (Figure 17). Text files can then be used in other programs, e.g. excel. Each data type is stored in a separate column in the text file. If the user has selected a specific segment of data, only the selected segment's data will be stored. The files are named for what the columns of data contain. Units of measurement as shown in Table 1.

e.g. *'TIME_DEPTH_LAT_LON_TEMP_PSAL_CNDC.txt'* contains
- column 1: time (TIME)
- column 2: depth (DEPTH)
- column 3: latitude (*LAT*)
- column 4: longitude (*LON*)
- column 5: temperature (*TEMP*)
- column 6: salinity (*PSAL*)
- column 7: conductivity (*CNDC*)

The netCDF (.nc) files are generated such that you may read them back into *Gliderscope*. If the user has selected a specific segment of data, only the selected segment's data will be stored, with fill values used otherwise.

Gliderscope filters out bad data so that only data that has been quality flagged as 'good', 'probably good', 'interpolated' or 'no QC performed' passes into the saved files or into the plotting stage. For non-IMOS data with limited or no QC flags, Gliderscope calculates missing variables/attributes where possible (e.g. timezone from longitudes; depths from pressure and latitude), standardises the units of measurements and applies basic quality control based on the max/min valid values and FillValues as specified in the metadata detected in the NetCDF file or on known limits. The units of measurement for every type of data in IMOS Ocean Gliders NetCDF files is as listed in Table 1. In order to examine the metadata more closely, please use *NetCDF Ninja* (http://imos.org.au/netcdfninja).

Table 1. Parameters exported in text files.

code	standard name	units
CNDC	Sea water electrical conductivity	S/m
DOX1	Mole concentration of dissolved molecular oxygen in sea water	μmol/L
DOX2	Moles of oxygen per unit mass in sea water	μmol/kg
CPHL	Mass concentration of chlorophyll in sea water	mg/m^3
PSAL	Sea water salinity	no units (previously known as psu)
TEMP	Sea water temperature	Celsius
CDOM	Concentration of coloured dissolved organic matter	ppb
VBSC	Volumetric scattering coefficient	m^{-1}sr^{-1}
BBP	Particle backscattering coefficient	m^{-1}
DENS	Sea water density	kg/m^3
SVEL	Velocity of sound through sea water	m/s
IRRADxxx	Downwelling spectral irradiance in sea water	μW/cm^{2}nm^{-1}
DEPTH	Water depth downwards from sea surface	m
LAT	Latitude	degrees north
LON	Longitude	degrees east
TIME	Time	days since 12am, Jan 1st 1950
UCUR	Eastward seawater velocity	m s^{-1}
VCUR	Northward seawater velocity	m s^{-1}
NTRA	Mole concentration of nitrate in sea water	μmol/L

3.3 Data visualisation

Gliderscope evokes a powerful plotter wizard (Figure 18) to make it very simple for you to produce a variety of useful data plots. If salinity and temperature data are available (along with the depth and location data), *Gliderscope* immediately calculates corresponding seawater densities and underwater sound velocities and makes them available to you. As before, *Gliderscope* 'speaks' to you from its blue talk screen, providing you with useful guidance at every step of the way. You may further investigate the purpose of any on-screen control by hovering your mouse cursor over it; helpful tool-tips will pop up.
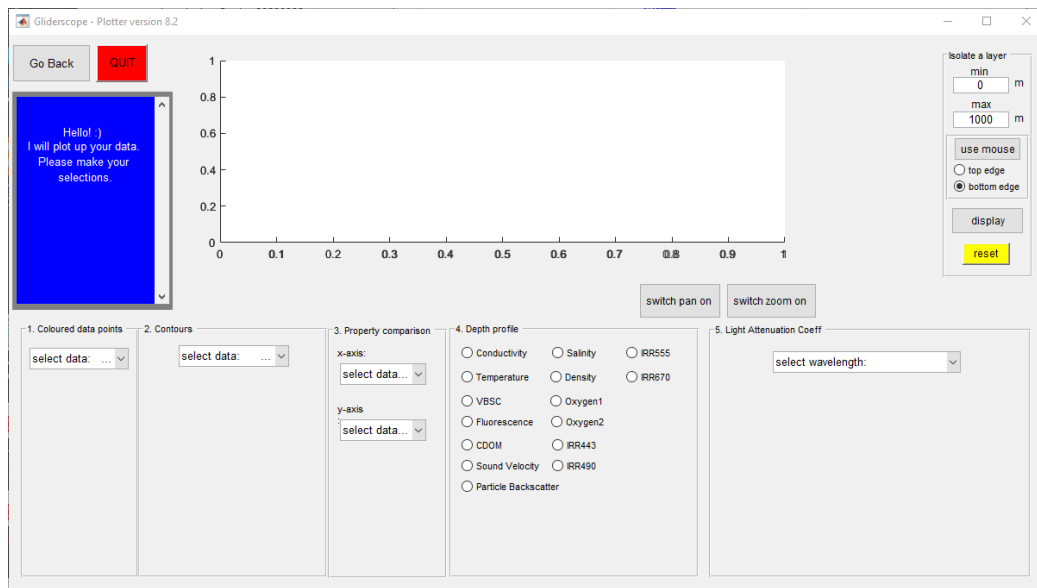

Figure 18 Gliderscope's plotter dashboard.

From each of the 5 plotting control panels of this dashboard (Figure 18), you will be able to produce the following styles of plots in a variety of cmocean colours:
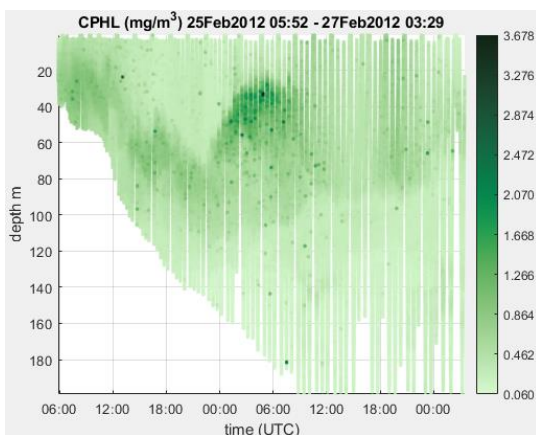
1. *Coloured data points*

Figure 19 Time-series plot of fluorescence; colour range is user-adjustable.

A user-selected selected water property data is plotted with every dot colour-coded to represent the data value recorded. You may choose to plot with depth vs time, or depth vs latitude or longitude.

- Time-series plots (Figure 19) are particularly useful when the glider performs repeated transect lines, because then it becomes obvious how the seawater's properties evolve with time. (See Section 3.3.1 for instructions to make such a plot.)

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- When plotted against location, the data are shown as colour-coded points spatially positioned in the ocean where their measurements had been taken (Figure 20). This type of plot is especially useful for analysing vertical transects of the ocean. (See Section 3.3.2 for instructions to make such plots.)
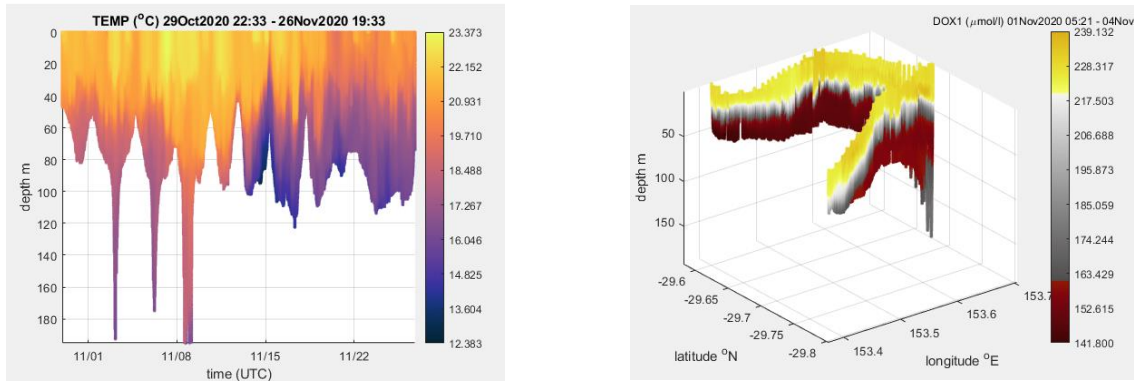

Figure 20 Temperature data plotted in two-dimensional space (left) and dissolved oxygen data in three-dimensional space (right); colour map and range of colour are user-adjustable and plots (right) can be rotated spatially using the mouse.
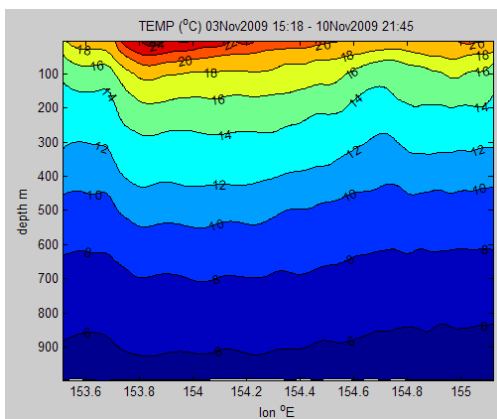

Figure 21 Contoured cross-sectional view of temperature data.

2. Contours

- Glider data across transect lines can also be displayed contoured (**Figure 21**). Because data is interpolated, the resulting plot allows you to get an overall visualisation of the general distribution and patterns of the water property.

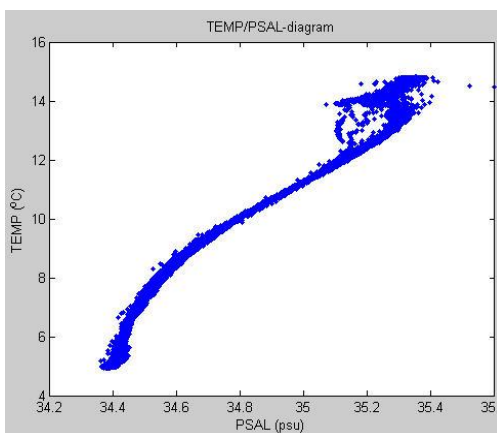 (See Section 3.3.3 for instructions to make such a plot.)

Figure 22 Temperature compared to salinity data in a T/S diagram.

3. Property comparison

- Comparison between any 2 kinds of water properties can be plotted (e.g. TS-diagram, see Fig. 23). This allows you to examine the water property signatures and identify different water masses found in the water column.

  (See Section 3.3.4 for instructions to make such a plot.)

4. Depth profile

- Data from single dives can be viewed as vertical profiles of water property (Figure 23). These plots are handy for locating the depth of thermoclines and pycnoclines, or determining the thickness of water masses, deep-chlorophyll maxima, etc.

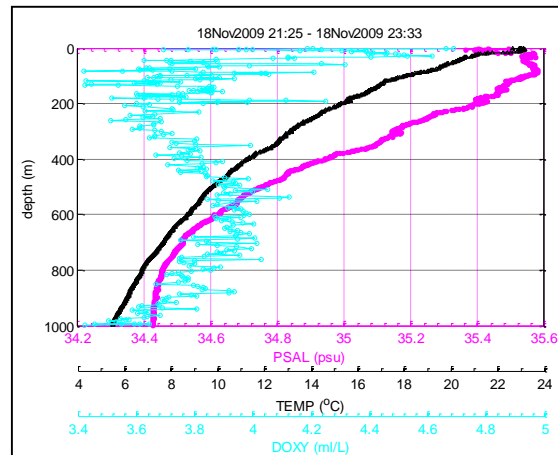(See Section 3.3.5 for instructions to make such a plot.)

Figure 23 Vertical profiles of water properties sampled in the water column.

5. Light attenuation coefficient

- *Gliderscope* has the ability to calculate light attenuation coefficients (K) from the different frequencies of downwelling spectral irradiance available in ANFOG Slocum glider data. Using this software, you can examine how K varies with time (Figure 24) or location, and also analyse how K may be affected by depth-averaged coloured dissolved organic matter (CDOM), chlorophyll (CPHL) and volumetric backscatter (VBSC). Additionally, the comparison can also be made with CDOM, CPHL and VBSC calculated to the 1% photic depth.

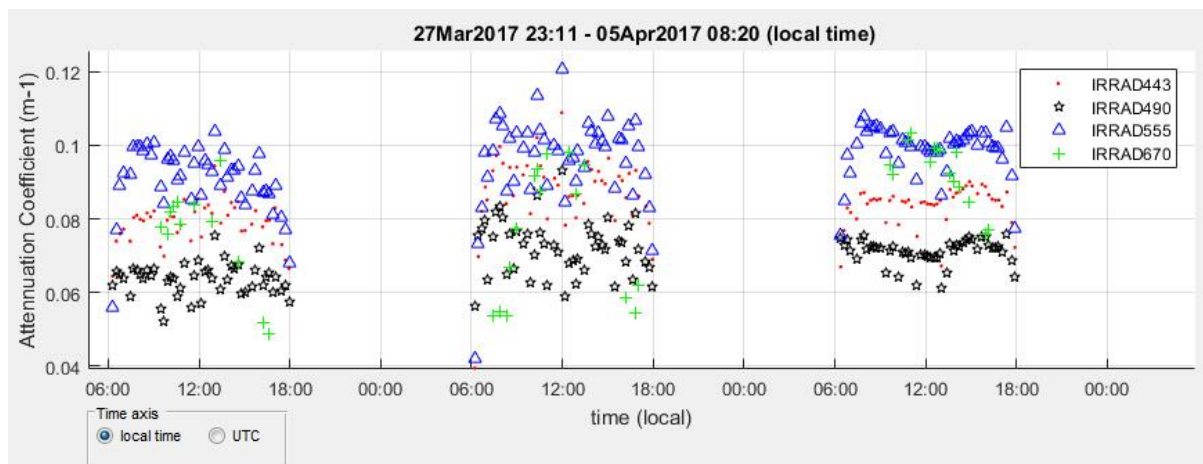(See Section 3.3.6 for instructions to make such plots.)

Figure 24 Comparisons of light attenuation coefficients of different frequencies of light over three days.

You can choose to browse the plots via *Gliderscope*'s plotter display window (Figure 18), or export them as separate figure files to be saved, edited or just placed side by side on screen for easy comparison.

Data from each plot can also be extracted and saved into text files by pressing **[save data]** at the bottom of respective control panels.

At any time, should you wish to select a different leg of the flight path or load up a different data file altogether, press **[Go Back]** (Figure 25). To end *Gliderscope*, press on the **[QUIT]** button.
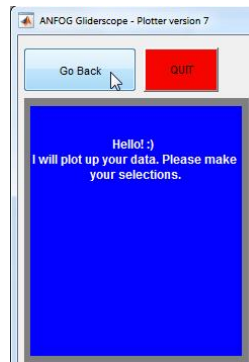

Figure 25 Go back to grab a different segment of data, or load up a different glider data file.

Detailed instructions on how to produce every kind of the aforementioned plots follow in the following sections.

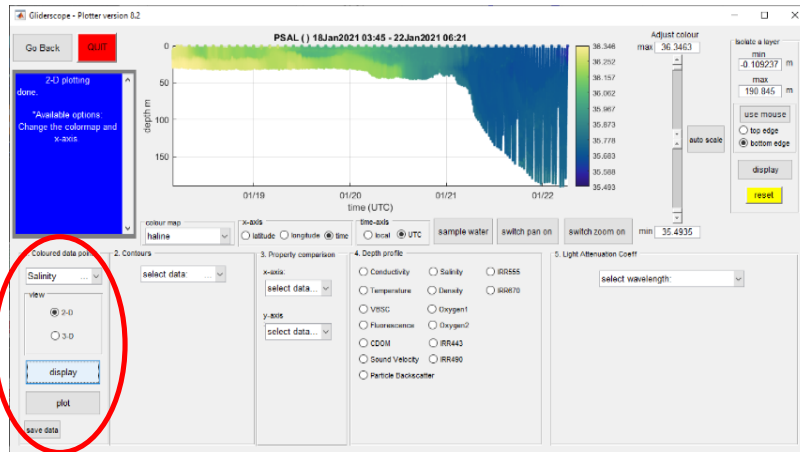## 3.3.1 Using Control Panel 1: Coloured data points

Figure 26 Coloured data points control panel and on-screen chart display area.

- Select a data type from the drop-down menu (Figure 26). This menu is populated only with data types found to be available in the glider mission (and possibly the addition of density and sound velocity data calculated by *Gliderscope*).
- You can make plots as 2 or 3 dimensional figures, by clicking on ○**2-D** or ○**3-D** radiobutton.
- Press **[display]** to view time-series plot in the control panel, or press **[plot]** to plot in a separate saveable figure.
  *Note: 3-D plots cannot be displayed. They can only be plotted separately using the **[plot]** button.
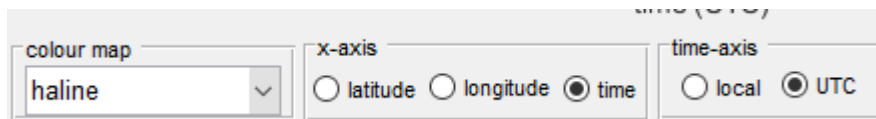

Figure 27 Control panels beneath the plot allows user to alter the colour map and x-axis.

- Colours used for the plot can be chosen from the colour map drop-down menu (Figure 27, left most).
- You can also choose to display the data with time or location on the x-axis (Figure 27, middle).
- If time is chosen for the x-axis, you can choose to have UTC time or local time, which *Gliderscope* automatically calculates based on location, if timezone data is unavailable in the datafile (Figure 27, right).

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Figure 28 Controls for adjusting the colour-scale for cross-sectional plots.
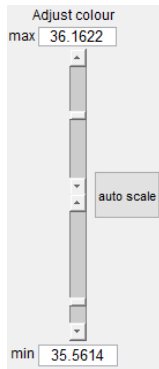
- When the chart has been plotted, the range of the colours can be adjusted by

  (i) moving the sliders up and down and then pressing **[display]** or **[plot]** (Figure 28), or
  (ii) by manually typing numbers into the **max** and **min** text-boxes, and then pressing **[display]** or **[plot]**.
  (iii) Alternatively, if you have made changes to the colourscale, pressing **[auto scale]** will once again optimise your colour scale.
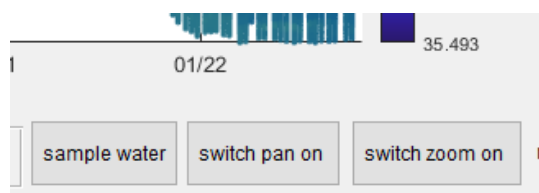

Figure 29 Useful buttons to use when examining the on-screen chart and data it contains.

Looking at the cross-sectional display, you may identify a layer of water that is of particular interest (e.g. a surface layer or a subsurface water mass).

- You can use the zoom button for a closer look.

  (i) Press the **[switch zoom on]** button (Figure 29), and then click and drag the mouse to indicate a box within the chart display to zoom into.
  (ii) Double-click to return to the original view if required.
  (iii) Press the zoom button again **[switch zoom off]** to end zooming.

- You can pan to view more of the chart, beyond the zoomed area.

  (i) Press the **[switch pan on]** button (Figure 29), and then click and drag the mouse to move the charted area around.
  (ii) Press the pan button again **[switch pan off]** to end panning.

- You can drop a virtual Niskin bottle into the chart to sample all the water properties in that bucket of seawater.

(i) Press the **[sample water]** button.
(ii) Draw a box anywhere in the chart using the mouse.
(iii) Read on the blue talk screen (Figure 30), the list of ranges of all the water properties on the water found within the box you drew.
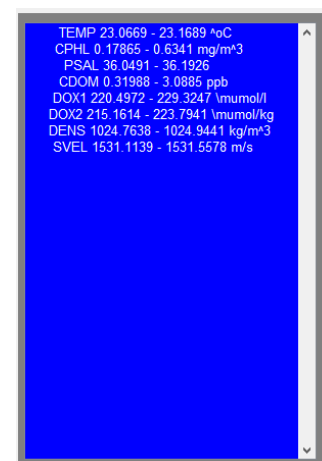

Figure 30 Talk screen displays the list of the ranges of all water properties of the water found in the 'virtual Niskin bottle'.

Isolate a layer

Although you can also isolate the depth levels from the Gliderscope main control panel, it is useful to be able to actually see the data visually as you select the depths. This can now be done.
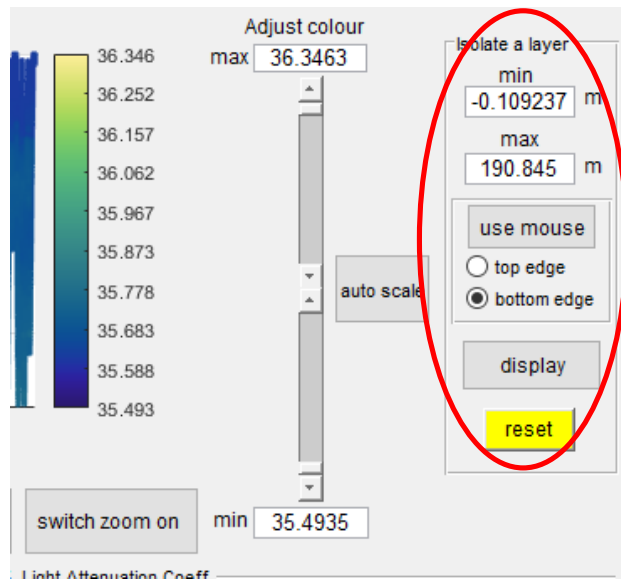

Figure 31 Controls for selecting a layer of water.

The depth limits of a specific layer can be specified using either keyboard or mouse (Figure 31):

By Keyboard:

- type into the *min depth* and *max depth* text boxes (Figure 31).
- press the **[display]** button
- press **[auto scale]** to automatically optimised the colour range of the display.

By mouse:

Figure 32 Controls for using the mouse to indicate the layer of interest.

- Select either ○**select top** or ○**select bottom** radiobutton (Figure 32) to indicate whether you now want to specify the upper or lower depth limit respectively.
- Press **[use mouse]**
- Position the mouse over the display chart and click at where the level should be. A red line will appear.
- Repeat until the red lines define your chosen layer accurately (Fig. 33). The depth range will also automatically be updated in the text boxes.
- Press the **[display] or [plot]** button
- press **[auto colour scale]** to automatically optimise the colour range of the display.

(* Hint: Take note of the depths automatically shown in the text boxes if you would like to use these values again, e.g. when doing a T-S plot later to visualise the water property signature of this specific water body.)

For example, if surface coastal water circulation is the focus of your study, you may choose to isolate the topmost ~200m of water using a mouse, as shown in Figure 33.
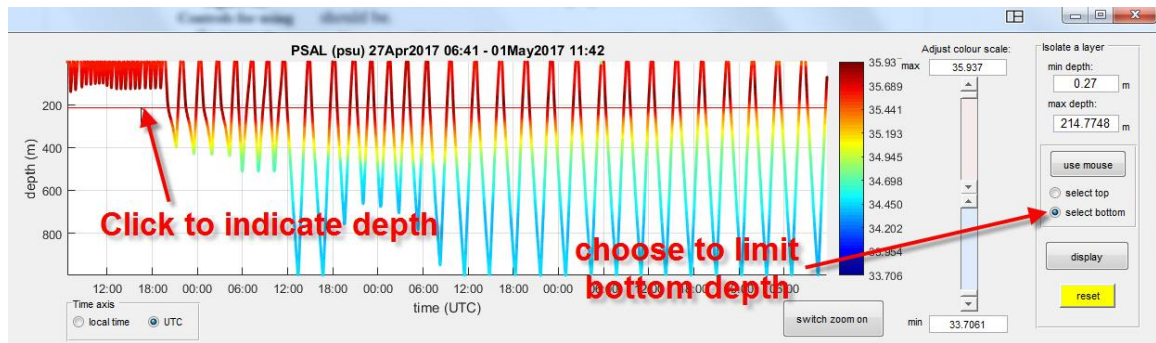

Figure 33 User-selected red line limits the salinity data to depths of 200m.

Subsequently, fine-tuning the colour scale (by using the slider, colour scale text boxes or the **[auto colour scale]** button) and pressing **[display]** or **[plot]** produces a display which shows more clearly the salinity patterns seen in the surface layer (Figure 34).
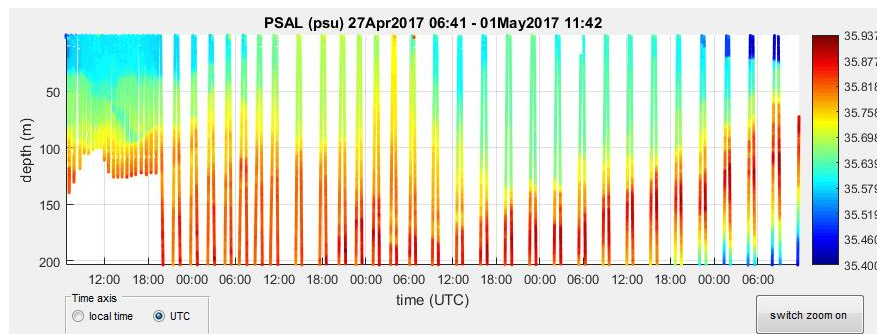

Figure 34 Salinity patterns in the surface waters clearly shown after surface waters have been isolated.

- To clear off your user-defined depths and colour scale values, simply press on the yellow **[reset]** button.

- Optional: If you require a copy of the data illustrated in your plot, press the **[save data]** (Figure 35).

Each saved file contains 3 columns of numbers. The file name reflects which control panel produced it, as well as what data each column contains,

> e.g. '*chart1_DENS_time_depth.txt*' contains
> - column 1: Density (*DENS*)
> - column 2: Time (*time*)
> - column 3: Depth (*depth*)

(* Note: Units of measurement are as shown in Table 1.)

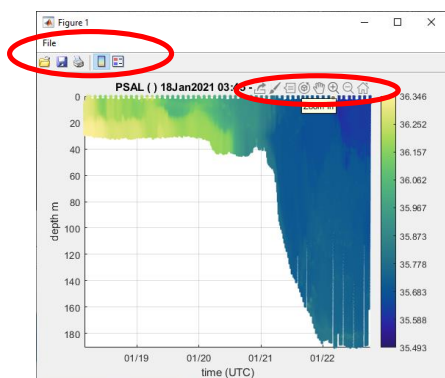**Figure 35 The save data button saves the data used in the plot.**

Figure 36 The chart menu and toolbar allows user to do various things to the chart; click on the menu items or roll the mouse over icons to find out what each does.

- If plotted separately, use the chart's toolbar to save, print or remove the colorbar in the chart (Figure 36). Further tools for zoom, rotation, export as a picture, etc. become available on the top right corner when you hover the mouse over the chart. A helpful description for each toolbar button appears as you roll your mouse over it.
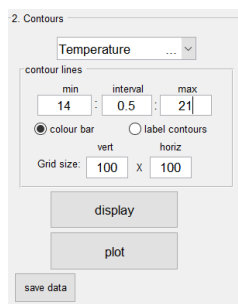
3.3.2 Using Control Panel 2: Contours

Figure 37 Contoured cross-section control.

- Select a data type from the drop-down menu (Figure 37). This menu is populated only with data types found to be available in the glider mission (and possibly the addition of density and sound velocity data calculated by *Gliderscope*).

- Contour values can be user-defined. Just alter the values in the text boxes (Figure 37) by typing into them.

- Use radio buttons (Figure 37) to control whether a colour bar and/or contour labels are used.

- Grid size used for interpolations for the contours can be adjusted by typing into the relevant grid size boxes (Figure 37).

- Press **[display]** to produce the plot in the display area, or press **[plot]** to plot in a separate figure. The figure can be kept for comparison with other figures that you plot subsequently, or saved for further editing later.

- If plotted separately with **[plot]**, use the chart's toolbar (Figure 36) to save, print or remove the colorbar in the chart. Further tools for zoom, export as a picture, etc. become available on the top right corner when you hover the mouse over the chart. A helpful description for each toolbar button appears as you roll your mouse over it.

Looking at the cross-sectional display, you may identify something of particular interest (e.g. a surface layer or a subsurface water mass).

- You may zoom into the display chart for a closer look (Figure 38):
  - i) To zoom in, press the **[switch zoom on]** button, and then click and drag the mouse to indicate a box within the chart display to zoom into.
  - ii) Double-click to return to the original view if required.
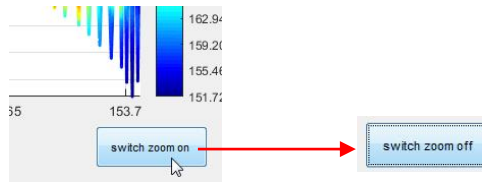 - iii) Press the zoom button again **[switch zoom off]** to end zooming.

Figure 38 Zoom toggle button switches from 'switch zoom on' to 'switch zoom off'.

- You can pan to view more of the chart, beyond the zoomed area.

    (iii)   Press the **[switch pan on]** button (Figure 29), and then click and drag the mouse to move the charted area around.
    (iv)   Press the pan button again **[switch pan off]** to end panning.

- You can drop a virtual Niskin bottle into the chart to sample all the water properties in that bucket of seawater.

(iv)   Press the **[sample water]** button (Figure 29).
(v)   Draw a box anywhere in the chart using the mouse.
(vi)   Read on the blue talk screen (Figure 30), the list of ranges of all the water properties on the water found within the box you drew.

- Depth can be limited by mouse or keyboard. This has been described in detail in 3.3.1.

- Optional: Press **[save data]** if saving the plotted data to a text file is required.

    The plotted data is then saved in a three text files for every data type that is selected,

    e.g.   - '*1chart2_interpTEMP.txt*' contains an *n* x *m* matrix of interpolated temperature data.
            - '*1chart2_lon.txt*' contains longitudinal positions for each data point in the above file.
            - '*1chart2_depth.txt*' contains depth positions for each data point.

    Because all avalaible data can now be saved at once using the **-***all available data-* selection, the text files begin with a number to group each data type into a set of three (data file together with its related lat/lon file and depth files).

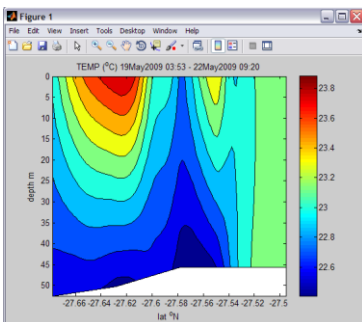   The units of measurement for each type of data is as listed in Table 1.

The white section beneath the contour plot indicates the limit of glider data, not bathymetry (Figure 39).

Note that in contour plots, data interpolation is performed between sampled points. As such, the user is cautioned when interpreting the contour chart. It is suggested that users also plot the data using colour-coded data points, so they may better conceptualise where the real sampling positions lay.

Figure 39 Temperature (^{0}C) contour plot.

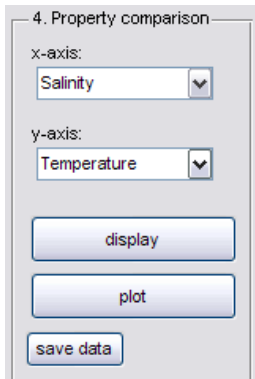### 3.3.3 Using Control Panel 3: Property Comparison

Figure 40 Property comparison control panel.

- Select your required data types for each of the x- and y- axes from the respective drop-down menus. These menus are populated only with data types found to be available in the glider mission (and possibly the addition of density and sound velocity data calculated by *Gliderscope*).

- Press **[display]** to produce the plot in the display area, or press **[plot]** to plot in a separate saveable figure (Figure 40).

If plotted separately with **[plot]**, use the chart's toolbar (Figure 36) to save, print or remove the colorbar in the chart. Further tools for zoom, export as a picture, etc. become available on the top right corner when you hover the mouse over the chart. A helpful description for each toolbar button appears as you roll your mouse over it.

** Hint: This type of chart will provide clearer patterns if smaller segments of data (e.g. from a specified depth range or area) are examined.

- Optional: Use **[save data]** if saving the plotted data to a text file is required (Figure 40).

The selected data are then saved in a text file with 2 columns of numbers, one for each axis plotted. The file is named for what the columns of data contain,

e.g. '*chart3_PSAL_TEMP.txt*' contains
- column 1: Salinity (*PSAL*)
- column 2: Temperature (*TEMP*)
(The units of measurement for each type of data is as listed in Table 1.)

- It may also be useful to limit the depth to isolate a body of water and examine its water property signature.

For example, seeing that there is a layer of subsurface high salinity water between the depths of 40m-80m (Figure 41a), you may introduce this depth limit by typing into the 'isolate a layer' text boxes Figure 41b) and pressing the **[display]** button to view the TS-diagram for this layer alone (Figure 41c).
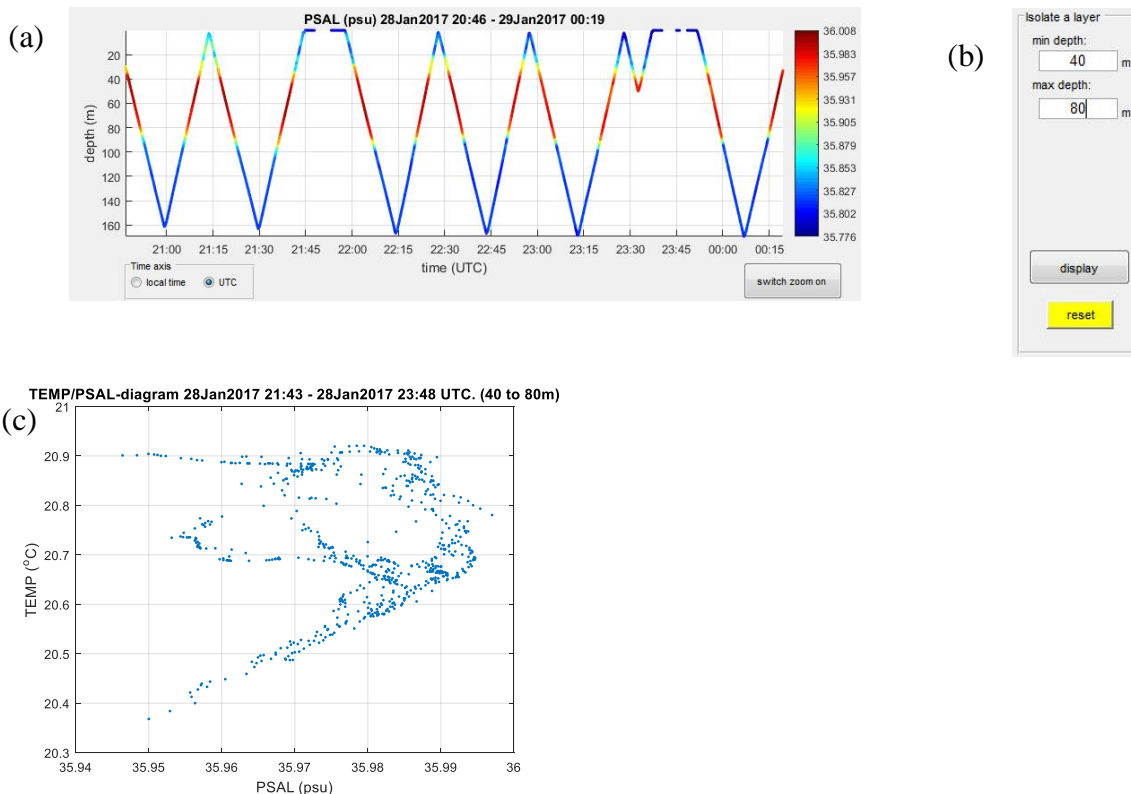
(a)

(b)

(c)

Figure 41 (a) Subsurface layer of raised salinity water seen in time-series data, (b) depth limits of the high-salinity water are entered into the text boxes, (c) TS-diagram shows the TS-signature of the layer of water.

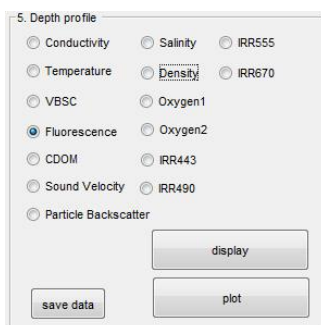## 3.3.4 Using Control Panel 4: Depth-profile

Figure 42 Depth-profile control panel.

• Select your required data types by clicking on the radio buttons (Figure 42). Radio buttons will appear according to which data types are available in the segment of data you have selected in the Gliderscope mean control panel.

• Press **[display]** to produce the plot in the display area (this option is only available for single data type selection), or press **[plot]** to plot in a separate saveable figure (Figure 43). If plotted separately, use the chart's toolbar to save, print or edit the chart. A helpful description for each toolbar button appears as you roll your mouse over it.

• You may zoom into the display chart for a closer look:
   i) To zoom in, press the **[switch zoom on]** button and then on the chart - click and drag the mouse to indicate a box to zoom into.
   ii) Double-click to return to the original view if required.
   iii) Press the zoom button again **[switch zoom off]** to end zooming.

• Depth can also be limited using the mouse or keyboard, as previously described in detail (section 3.3.1).
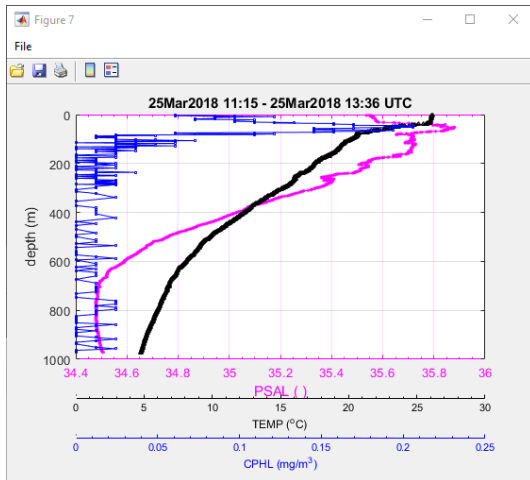
25

Figure 43 Depth profiles taken from a single dive.

Optional: Use **[save data]** if saving the plotted data to text files is required.

The selected data are then saved into text files with 2 columns of numbers, one for each axis plotted. The file is named for what the columns of data contain,

e.g. '*chart4_TEMP_depth.txt*' contains
- column 1: Temperature (*TEMP*)
- column 2: Depth (*depth*)

The units of measurement for each type of data is as listed in Table 1.

(** Hint: This plotting method is best used with data from a single profile.)

3.3.5 Using Control Panel 5: Light attenuation

Gliderscope makes the calculations to enable examination of light attenuation if the necessary data are available.
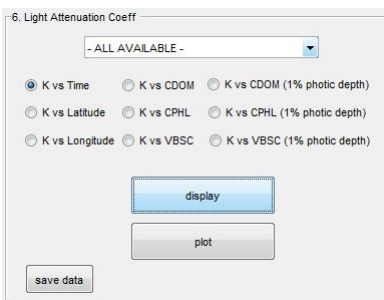

Figure 44 Light attenuation coefficient control panel.

- Select your required data types by clicking on the radio buttons (Figure 44). A light attenuation coefficient (K) is calculated for each profile made in daylight, using:

$$ln\, E_o - ln\, E = Kz$$

Where
E_o = irradiance measured at the shallowest available position
E = irradiance measured at depth z
z = depth

CDOM, CPHL and VBSC are depth averaged either for the whole profile depth or from the surface down to 1% photic depth (d), which is calculated as:

$$d = \frac{ln\, E_o - ln(E_o * 0.01)}{K} = \frac{ln\, 100}{K}$$

- Press **[display]** to produce the plot in the display area or press **[plot]** to produce a separate saveable figure (Figure 45). Having the plot in a separate figure window is also handy because then these plots can be used to compare with other plots you might want to generate on the display area.

- For K vs Time plots, it is often useful to be able to look at the data in terms of local standard time rather than UTC, so you see when daytime/night time are (Figure 45). To do this, use the radio buttons (○**local time** / ○**UTC**) in the **Time axis** panel (Fig. 57).
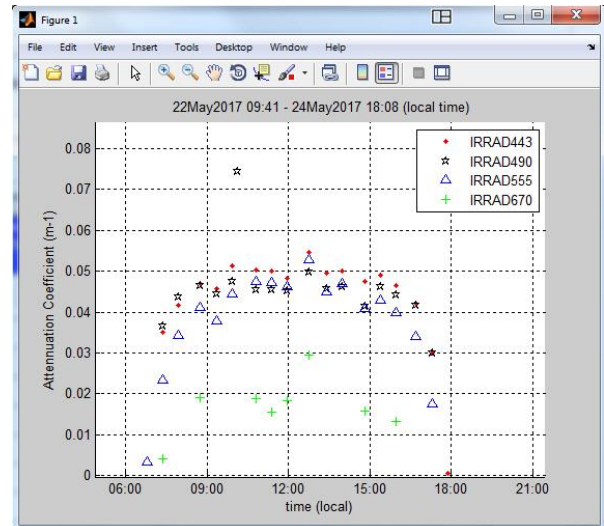

Figure 45 Light attenuation coefficients calculated at four frequencies of light; the local time axis indicating these occurred between 7am and 6pm.
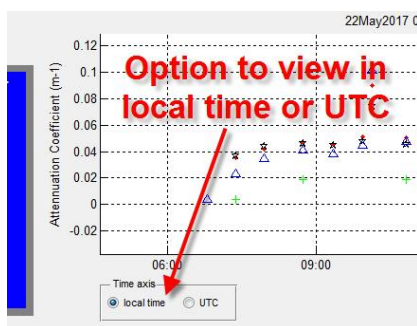

Figure 46 Controls to switch between UTC and local time view on the x-axis.

- If plotted separately, use the chart's toolbar to save, print or edit the chart. A helpful description for each toolbar button appears as you roll your mouse over it.

- You may zoom into the display chart for a closer look:
    i)   To zoom in, press the **[switch zoom on]** button, and then click and drag the mouse to indicate a box within the chart display to zoom into.
    ii)   Double-click to return to the original view if required.
    iii)   Press the zoom button again **[switch zoom off]** to end zooming.

- Optional: Use **[save data]** if saving the plotted data to text files is required (Fig. 55).

The selected data are then saved into text files with 2 columns of numbers, one for each axis plotted. The file is named for what the columns of data contain,

e.g. '*chart5_K(IRRAD443)_CPHL.txt*' contains
        - column 1: Light attenuation coefficient of light at 443nm (*K*)
        - column 2: Depth-averaged chlorophyll (*CPHL*)

The units of measurement for each type of data is as listed in Table 1.

3.4 Finish

When you have finished plotting and examining your data, you may:

- Press the **[go back]** button (Figure 47) to select another leg of the mission or load a different data file altogether; or

- Finally press the red **[QUIT]** button to end the *Gliderscope* program.

Figure 47 Control buttons to leave the plotter.