

MamVisAD - Data Display & “Hypothesis Generation”

What you will need:

- A Windows machine capable of at least basic 3D graphics. (The machines in the Bute PC classroom should be powerful enough and already have MamVisAD available via Apps Anywhere.)
- The special version of MamVisAD that contains the datasets for this practical. A fairly up to date version will usually be available on this page:

<http://www.smru.st-andrews.ac.uk/MamVisAD/Practical/>

What can also be useful:

- A mouse
- A second screen

From this practical amongst other things you may:

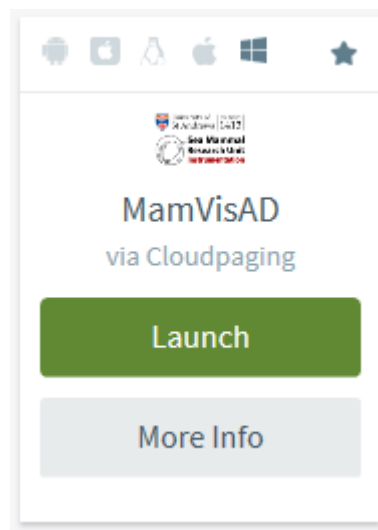
- Learn a little about MamVisAD, SMRU’s 3D visualisation package.
- Use different 3D viewpoints and linked time-depth strip charts to explore an elephant seal telemetry dataset and look for any patterns in diving behaviour that might or might be related to the underlying bathymetry.
- See how animation and a “Time Window” can help investigate possible interactions between an animal’s movements and environmental parameters which vary over time, such as Sea Ice Concentrations and Sea Surface Temperatures (SSTs).
- Investigate possible diurnal patterns in elephant seal diving behaviour.
- Gain some appreciation of the potential role of such “exploratory visualisation” techniques in “hypothesis generation”.

Step 1: Installing and launching MamVisAD

There are two ways use the special version of MamVisAD for this practical:

1) On one of the Bute Classroom PCs

The application should already be available under Apps Anywhere.



The first time you launch MamVisAD on machine this way there is a chance it may take quite a while to start up. However, any subsequent times are likely to be a bit faster.

2) On your own Windows machine

The easiest way to “install” the special version of MamVisAD is to have an unzipped copy of the “MamVisAD_Practical” folder (which contains both the program + and datasets) on your Windows Desktop.

A zipfile containing a recent version can usually be obtained from:

- this page on the MamVisAD website:

<http://www.smru.st-andrews.ac.uk/MamVisAD/Practical/ZipFileVersions/>

- USB flash drives supplied by the instructors.

Once you have the zipfile:

Extract a copy of the “MamVisAD_Practical” folder from the zipfile and save it on your Windows Desktop

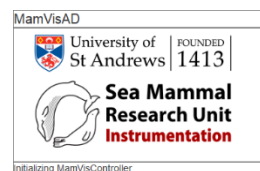
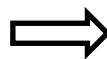
The next step is to start the MamVisAD application:

Open the “MamVisAD_Practical” folder.

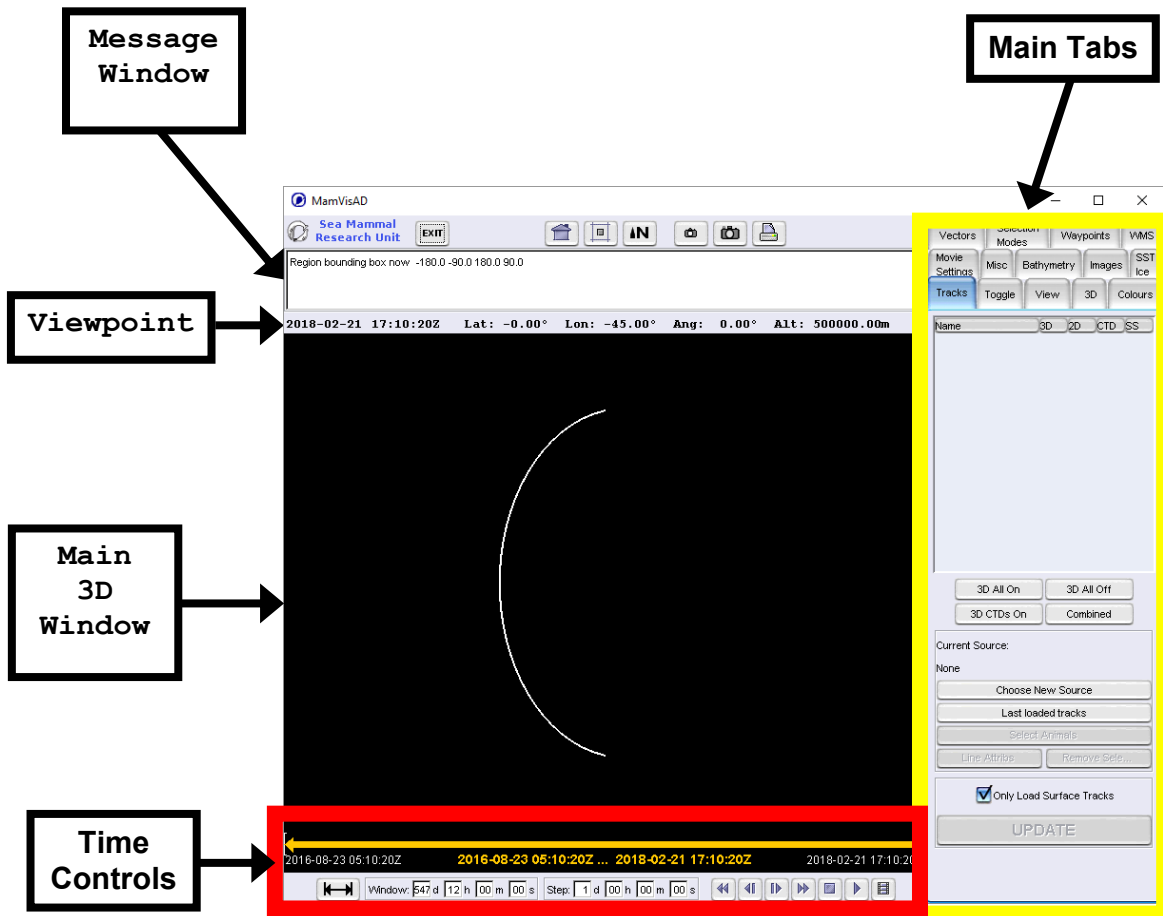
Double-click the “mamvisad_for_practical.bat” file.

A “DOS” box containing a few text messages may appear on screen, probably followed by a MamVisAD splash screen.

```
C:\WINDOWS\system32\cmd.exe
Starting 32bit MamVisAD for practical.....
MamVisAD_HOME
I:\MamVisAD_Practical
MamVisAD is making up...
I:\MamVisAD_Practical\
mamvisadDir=I:\MamVisAD_Practical
where initialed
Warning: No SMRUOracleDatabaseAdapter found
read images
[[180 @ 0.95 Degree', 'NONE'], ['BN @ 0.95 Degree': ['I:\MamVisAD_Practical\EnviroData\Imagery\land_shallow_topo_720x3601
band1.grd', '$MamVisAD_ENVIRODATA_DIR\Imagery\land_shallow_topo_720x3601_band2.grd', '$MamVisAD_ENVIRODATA_DIR\Imagery\
land_shallow_topo_720x3601_band2.grd', '$MamVisAD_ENVIRODATA_DIR\Bathy\smallIceMarbles_360.grd'], NONE: ['None
']]
read time series
[['OISST_SeaIce', 'OISST_SST', 'NONE'], {'OISST_SeaIce': ['I:\MamVisAD_Practical\EnviroData\SeaIce_SST', 'Icec-wkmean-2
000.nc', 'Icec', 'Ismask.nc', 'mask'], 'OISST_SST': ['I:\MamVisAD_Practical\EnviroData\SeaIce_SST', 'sst-wkmean-20
00.nc', 'sst', 'Ismask.nc', 'mask'], 'NONE': ['None']}]
read map
ScalarMap: Altitude-Bathymetry -> DisplayRGB
ScalarMap: Altitude-Contours -> DisplayIsoContour
ScalarMap: Altitude-Bathymetry -> DisplayIsoContour
ScalarMap: Temperature -> DisplayRGB
ScalarMap: TemperatureIso -> DisplayIsoContour
ScalarMap: Salinity -> DisplayRGB
ScalarMap: SalinityIso -> DisplayIsoContour
ScalarMap: Conductivity -> DisplayRGB
```



Either way, eventually, the main MamVisAD Window should pop-up:



Step 2: Loading in telemetry data

Datasets collected by SMRU Instrumentation tags are distributed to scientists around the world, via a secure website, as zipped MS Access databases. By default, MamVisAD looks for any such databases in its “SMRUAccessDatabases” folder.

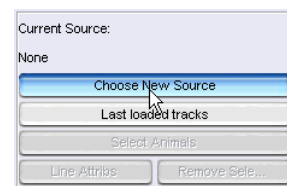
For this practical, you have been supplied with a subset of the southern elephant seal telemetry data obtained during the SEaOS project. The tracks you will be looking at are from six animals which were tagged on South Georgia during early 2004. (For more info on SEaOS see <http://biology.st-andrews.ac.uk/seaos/>)

The MS Access databases for this practical should already be in the appropriate folder. To load the data into MamVisAD just do the following:

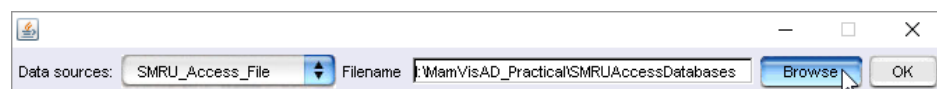
Make sure “Tracks” is the active tab.



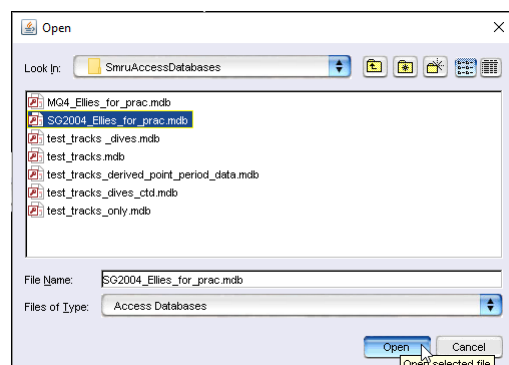
Press “Choose New Source”.



Choose “Browse” in the small window that pops up.



From the list of databases select “SG2004_Ellies_for_prac.mdb”



The small window should now show the filename you selected:

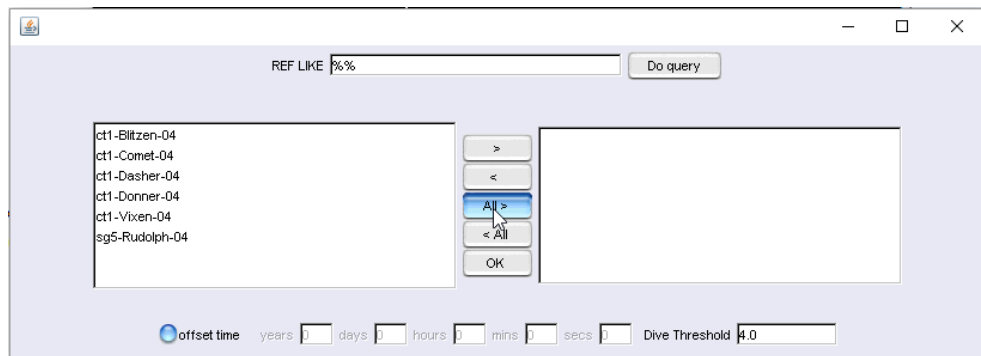
Press “OK”,



You have now specified the database from which data will eventually be read. This should be confirmed both by a line in the “Message Window” and the “Tracks” tab now showing the “Current Source” as the selected Access file.

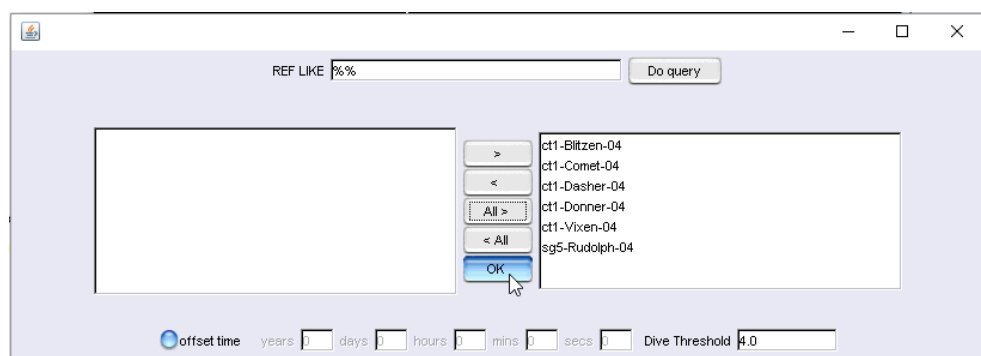
When you clicked “OK” a selection dialog should also have popped-up automatically. There are not that many animals in this database, so in this case, it is OK to load them all:

Press the “All >” button.



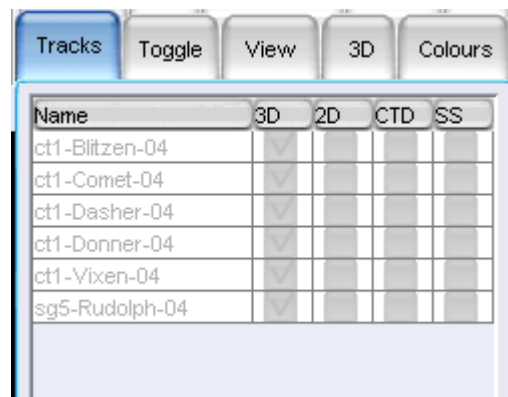
All 6 animals should move over to the right-hand panel. Next:

Hit “OK” to confirm the selection.



N.B. If the selection panel does not automatically appear or if you initially don't load the data for all the seals and wish to load any more later the selection panel can be reopened using the “Select Animals” button on the “Tracks” tab.

The “Tracks” pane should now show a greyed out list of these 6 names.



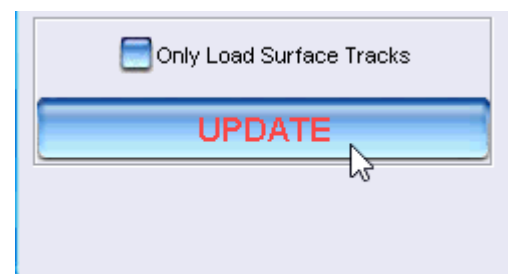
At this point, you have now chosen which animals to load in from a given database. MamVisAD’s default behaviour would now only be to load in the “surface track” for each animal, as that is a fairly quick operation (compared to loading in thousands of dives for each animal).

Importing and deciphering all the individual dive and CTD cast records for long deployments with many animals can take quite some time. It can also require a reasonable amount of computer memory. However, you will be looking at diving behaviour and maybe some CTD profile data, but for only 6 animals. In this case, it is therefore quite feasible to load in all the data at once. So:

Deselect the “Only Load Tracks” option.



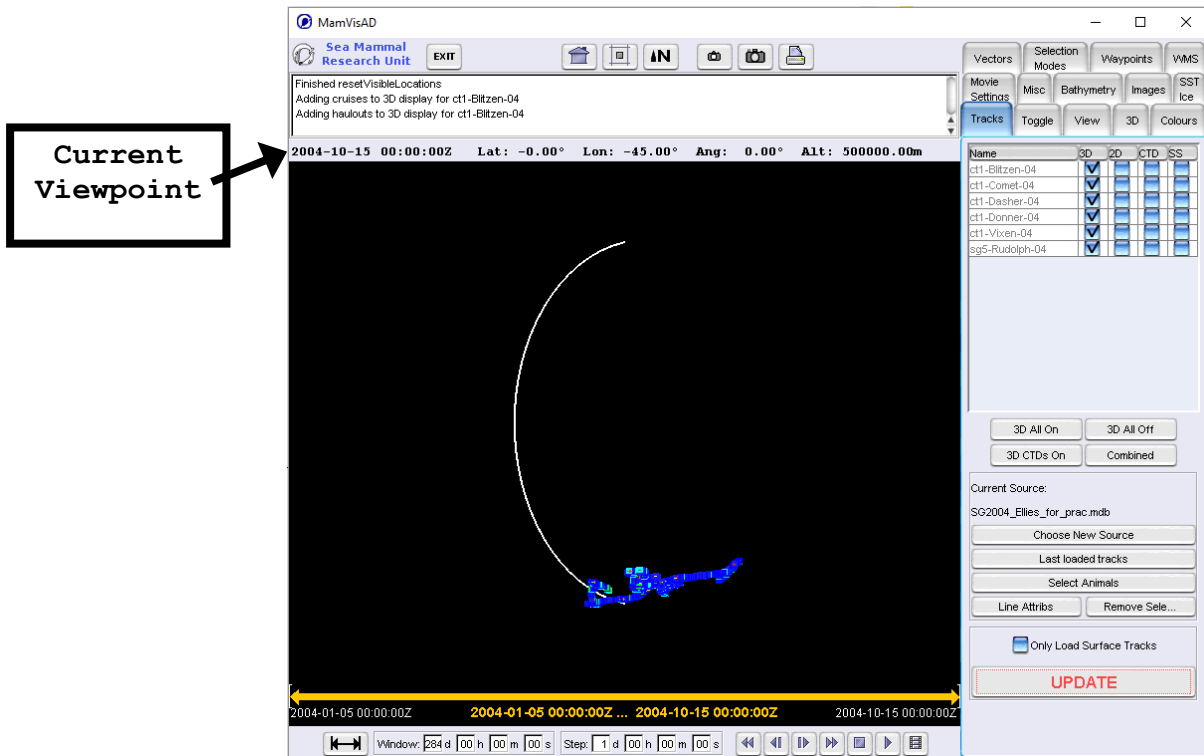
Next hit the big “Update” button.



You should start to see lots of messages scrolling through the Message Window. Slowly, one-by-one, the entries in “Tracks” tab for each animal will become active. Once the data for all the tracks has been loaded they will then be added to the display.

N.B. Whenever the contents of the 3D window are being updated, you may also see a little “please wait” info message in the bottom left-hand corner.

Once the data has been added to the 3D “scene”, your MamVisAD interface should look something like this



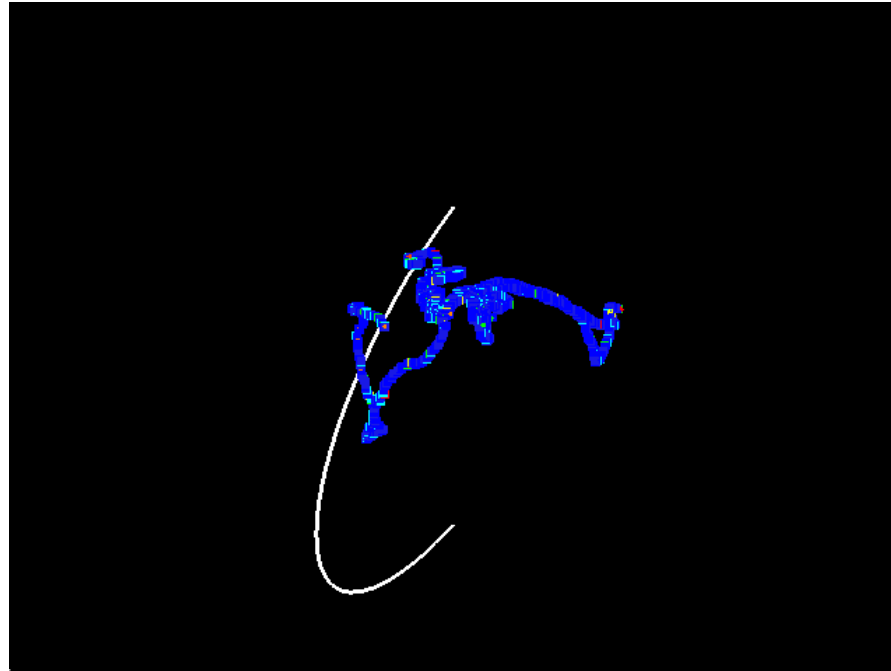
The usual default “home” viewpoint in MamVisAD is looking straight down at Lat=0.0°, Lon=0.0° – although this might have been changed in the special version supplied for this practical. If you check just above the 3D window, you should see a row of figures which give the position of the current viewpoint. South Georgia lies about 54° south. So, if the default is still at 0.0° latitude, the tracks should have appeared towards the bottom of the 3D window as shown in the figure above.

MamVisAD has an option to automatically move the viewpoint to the approximate centre of the loaded tracks. Now could be a good point to try this out:

Press the “Middle of Tracks” button.
(In a group of buttons at the top of the main window)



The items in the 3D window should appear to rotate until the tracks end up roughly in the middle of the window.



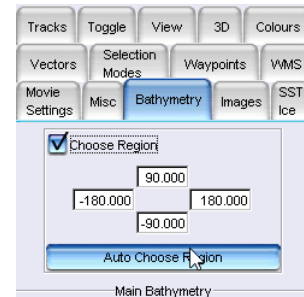
The viewpoint should now be something like -56.17°N , -33.56°E .

Step 3: Loading in bathymetry data

You can now see a representation of some telemetry tracks in the 3D window. However, without any additional data this is not particularly useful. The next step is, therefore, to add some bathymetry to the 3D scene.

Make “Bathymetry” the active tab.

Hit the “Auto Choose Region” button.



You should see the white “line”, which represents the “Region Box” (initially the whole world) change to become a recognisable “box”, which roughly surrounds the tracks. Next, you have the option of to choose which bathymetry dataset to load into this region.

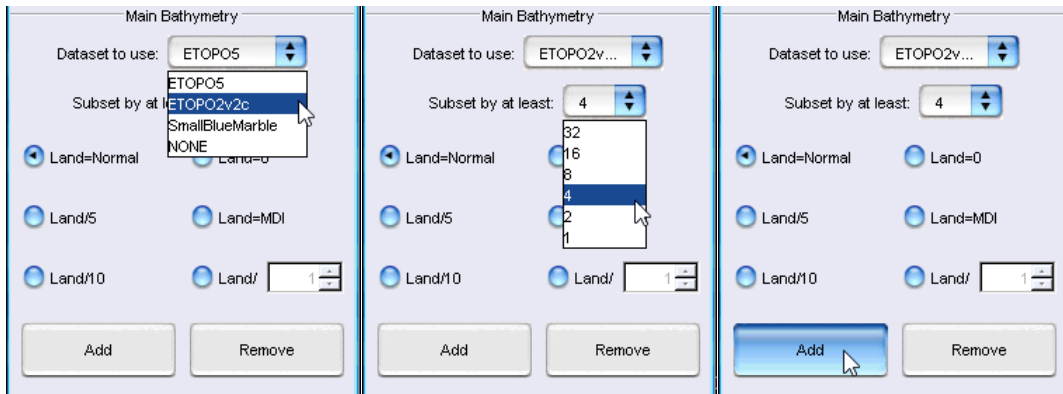
In this practical, you will be using a version of the ETOPO2 2 minute world bathymetry dataset and at least to start with subsetting it by a factor of 4.

For details on ETOPO2 see:

<http://www.ngdc.noaa.gov/mgg/fliers/O6mgg01.html>

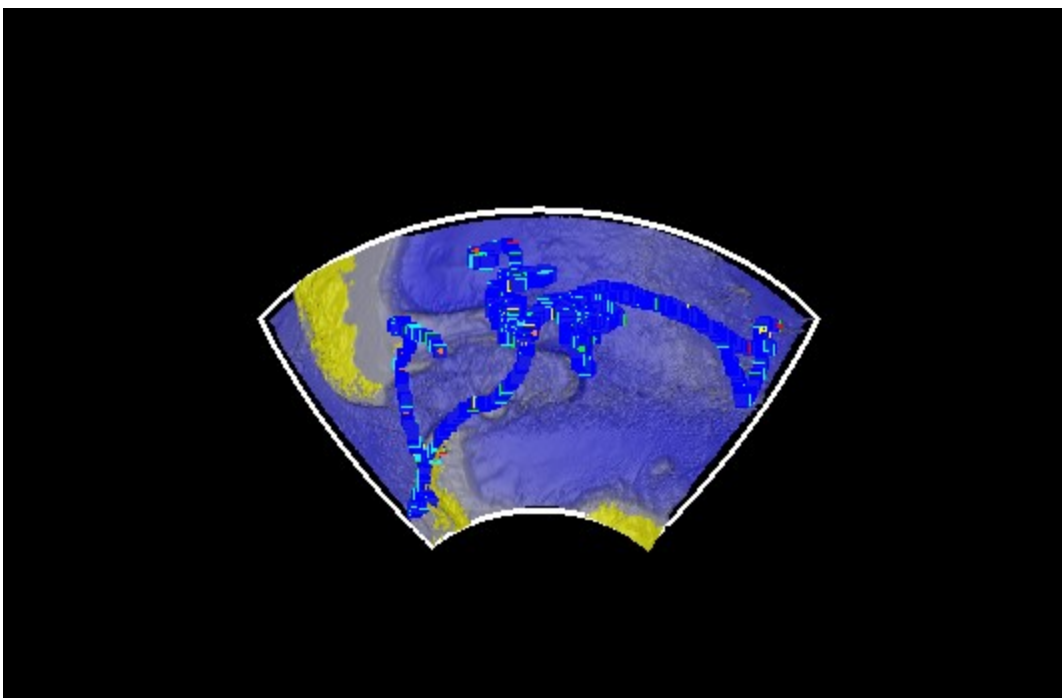
In the “Main Bathymetry” panel:

- i) Choose “ETOPO2v2c”.
- ii) Set “4” as the subset factor.
- iii) Hit the “Add” button.



There should then be another series of messages appearing in the Message Window. (Including one that shows the subset factor actually used by MamVisAD. To prevent the program from trying to load in too much data this may sometimes be larger than the chosen value.)

After a short wait the bathymetry, chopped into tiles, should start to appear in the 3D window.



Step 4: Learning to navigate within MamVisAD

Now that you have loaded in the bathymetry this may help you orientate yourself as you learn to “fly” around within the 3D window. This can be done either using just the keyboard, or the mouse + keyboard.

Read the “flying” instructions below.

Spend 5 minutes or so practising moving around in the 3D scene.

- Zoom in close enough to look at a few tracks/dives.
- Find a viewpoint showing Rudolph crossing a shelf edge.
- Try out some of the navigation buttons in the “View” tab,

3D Window Navigation

N.B. Click inside the 3D Window to make sure that it is active!

1) Moving/ "Spinning the Globe"

To move the viewpoint to a different longitude and/or latitude:

Either:

Hold down left mouse button and then drag within the 3D window.

Or:

Use the four "arrow" keys.

2) Zooming/"Up and Down" (+SHIFT key)

To change the altitude of the viewpoint (i.e. move towards or away from the centre of the Earth):

Either:

Hold down Shift key + left mouse button and drag up and down.

Or:

Hold down the Shift key then use the up and down "arrow" keys.

3) Changing the view direction/"Looking Around" (+CONTROL key)

To look up or down (i.e. change the pitch: down= -90° , ahead= 0° , up= 90°):

Either:

Hold down Control key + left mouse button and drag up and down.

Or:

Hold down the Control key then use the up and down "arrow" keys.

To look in different directions (i.e. change the bearing: North= 0°):

Either:

Hold down Control key + left mouse button and drag left and right.

Or:

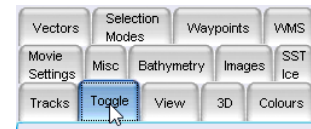
Hold down the Control key then use the left and right "arrow" keys.

N.B. Ctrl+"R" key on keyboard = "Reset to default viewpoint".

Step 5: Toggling items on and off

SRDLs record many types of data. This potentially leads to the 3D scene becoming “cluttered”, with representations of one type of data obscuring the “view” of other types of data. It is, therefore, useful to be able to choose which types of data should be displayed. This is the role of the “Toggle” tab. Try out some of the options (you may want to return to the “Middle of tracks” view first):

Make “Toggle” the active tab.

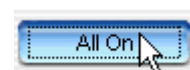


Try “Toggling” a couple of the options off and on to see what happens. (“Locations” and “Bathymetry” should have clearly visible effects. Many of the others will not, as no data of the appropriate type is currently loaded.)

The coloured squares that depict the locations along the tracks are very useful when the view is zoomed in close enough to see the individual points. In this case, the points are filtered ARGOS locations, with the colour representing the location quality (class 3 = red, class 2 = yellow, etc.). This provides a visual cue as to the uncertainty associated with each point.

However, when zoomed further out, there are so many points that they tend to “hide” the lines linking them (representing a simple straight line model of each animal’s actual path). Therefore make sure all the other options are toggled back to on, and then turn off just the locations:

Press the “All On” button.



Toggle off the locations.



Click “Middle of Tracks”.



You should now be able to clearly identify the individual tracks in the 3D Window.

Step 6: Using the “Time Controls”

So far you have looked a little at the 3-Dimensional nature of the tracks and dives. The “Time Controls” at the bottom of the MamVisAD window allow temporal aspects of such datasets to be investigated.



MamVisAD uses the concept of a “Time Window”. This allows the telemetry data visible in the 3D scene to be restricted to just the locations, dives, CTD casts, etc. which were recorded during a certain period of time.

When a set of tracks are loaded this “Time Window” is set to be the period that runs from the earliest “on date” of any of the tags through to the time of the most recent data received from any of the animals. This should mean that all of the locations (and dives assuming they were loaded) from all of the tags will be displayed in the 3D window.

For the 6 animals in this dataset, the location times range from 2004-01-05 00:00Z through to 2004-10-07 21:43:35Z. These dates are reflected in the limits of the time range shown on the left- and right-hand sides of the “Time Controls” panel. **(N.B. Note that SRDL and MamVisAD times are all expressed in UTC / Greenwich Mean Time.)**

The limits of the currently visible “Time Window” are displayed in the middle the Time Controls panel. When the whole dataset is visible, these limits will be the same as the overall time range of the telemetry dataset (i.e. the default “Time Window” - as shown above).

One way to change the “Time Window” is by using the “Time Slider”. This is the yellow horizontal line with an arrowhead at each end. The individual yellow arrowheads or the line itself can all be dragged to adjust the limits of the “Time Window”. To see how this works, try restricting the visible telemetry data just to that from the beginning of May 2004 onwards. To do this;

Move the mouse so that the point of the cursor lies over the left-hand yellow arrowhead.



Depress the left mouse button and then drag the arrow-head to the right until the lower bound of the time window shows 2004-05-01. Then release the mouse button. (Don't worry about the hours and minutes).

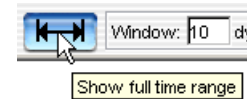


The portions of the tracks visible in the main window should change to reflect the new, shorter, Time Window. If you like try experimenting with the time slider a little more. When you have finished, you should reset the “Time Window” to show all the data.

Step 7: Animating the data

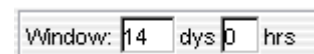
Now let's try to animate these tracks.

Click the "Show full time range" button



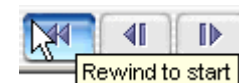
Another way to adjust the Time Window is to manually set the values in the "Window" and "Step" sections of the "Time Controls" panel. Try this out (you may have hit return after typing the new values):

Set the Window to 14 days 0 hours.



The VCR style controls provide several additional options. Try to "rewind" to the beginning of the deployment and then stepping forward and backward:

Press the "Rewind to start" button.



Next, click the "Forward" button a few times.



You might also like try "playing" the tracks as a rather jerky animation. You can use the "Stop" button to end potentially long animations. (N.B. it sometimes takes quite a while before pressing that button actual has an effect, so you may find playing has been set to stop automatically after 20 frames.) It may also be worth trying out a few different values for the "Time Step".

Use the time controls to investigate the paths of these elephant seals. Note the variety of different types of routes taken by just 6 animals. Consider what information this might be providing about the foraging strategies of this species.

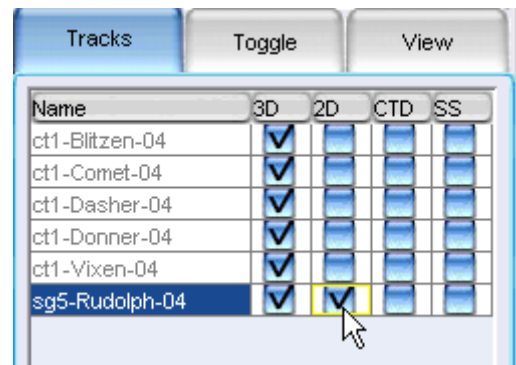
Step 8: The “Strip Chart” Window

The 3D window and the Time Controls are useful for examining animal movements. However, sometimes it can be hard to examine some aspects of diving behaviour. For instance, an animal might be almost be diving “on the spot”. In such cases, a time-depth view of the dives can be more informative.

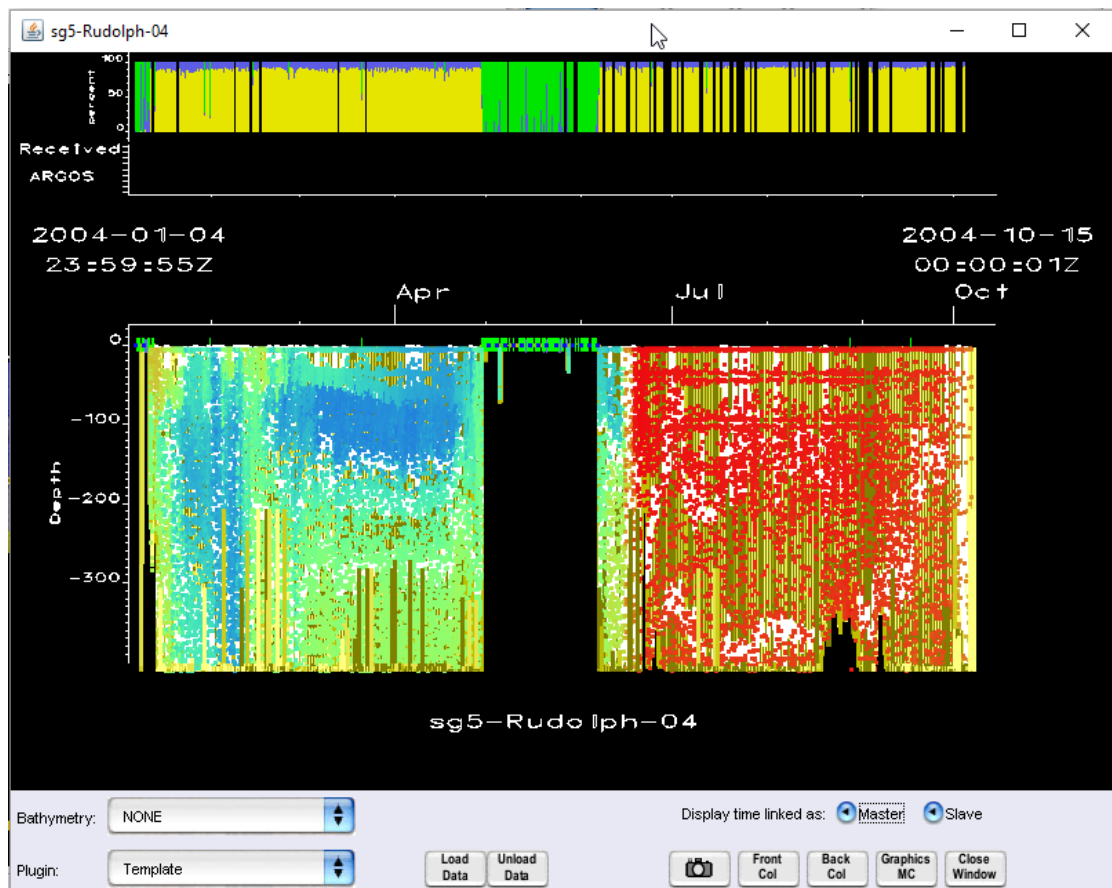
MamVisAD not only provides such a strip chart, but this is linked to the 3D window. This makes it easier to relate things such as dive “shape” to the location of the animal. To see this in action open the strip chart for “Rudolph”:

Make “Tracks” the active tab.

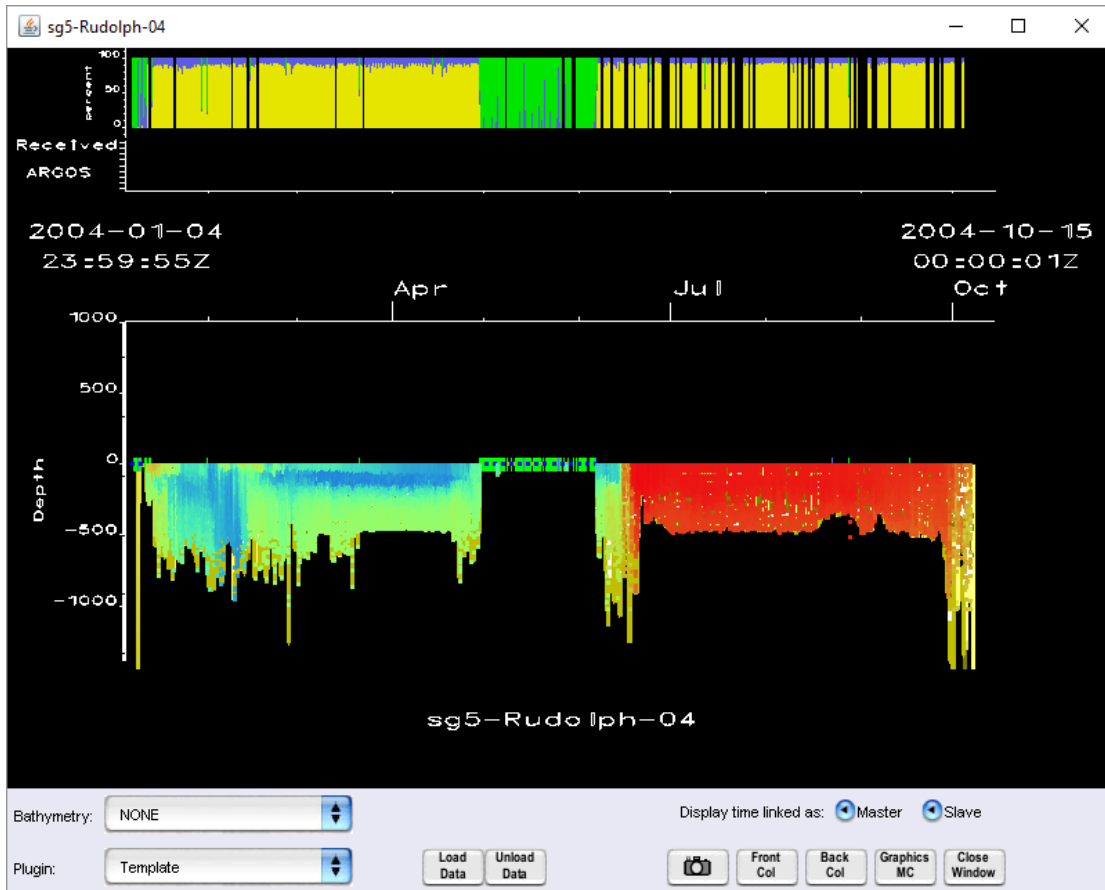
Click the box for “Rudolph” under the “2D” column.



A new strip chart window should then appear,

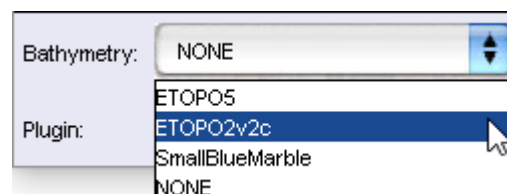


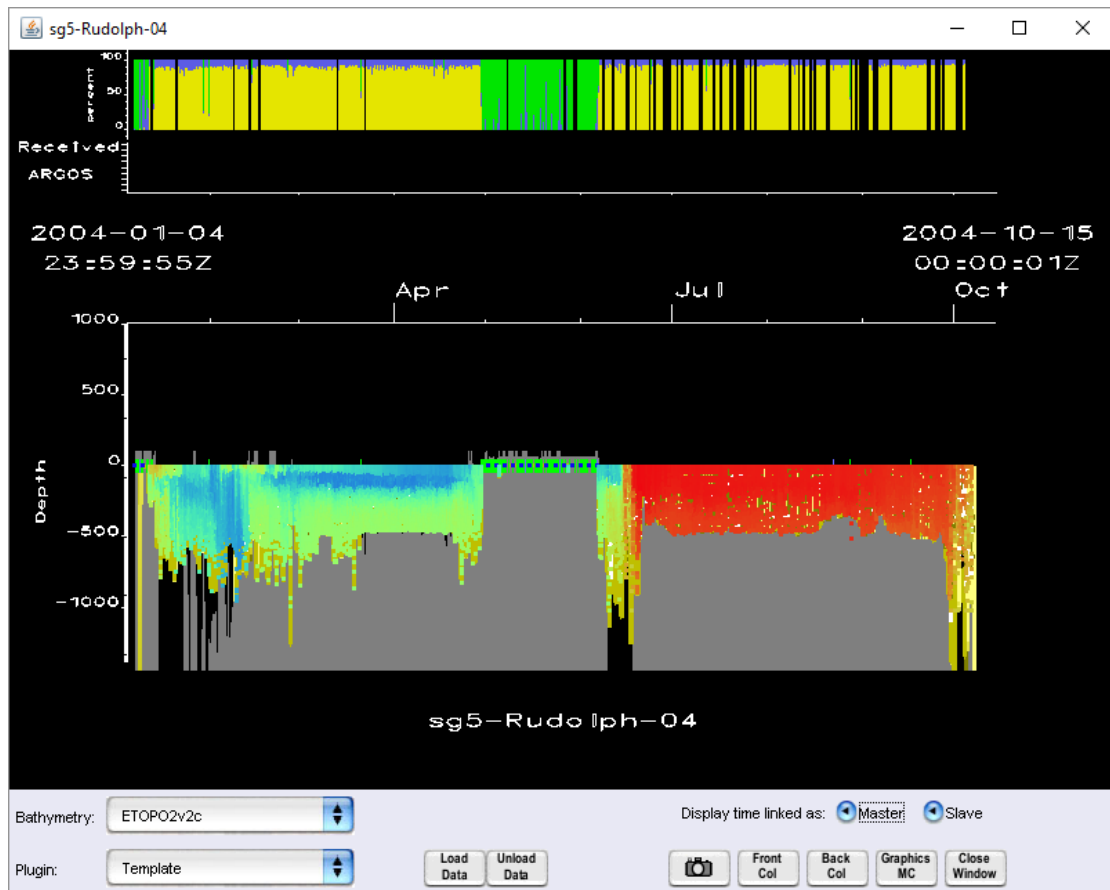
In this case, the default depth range is not large enough to include the bottoms of most of the dives. To adjust this, click somewhere inside the time and depth axes and then keep pressing Shift+Down to increase the range of depths shown.



The bottom of this window is a time-depth graph showing the dive profiles, some temperature data. You can add some bathymetry by selecting a dataset using the pull-down menu.

Try choosing "ETOPO2v2c" and then wait a few seconds while MamVisAD is "busy" adding this bathymetric data to the display.





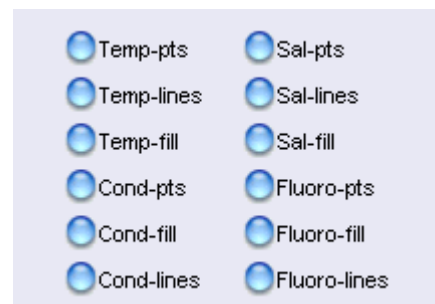
It will be easier to get a proper view of the dives if the temperature data is toggled the off. Do this by:

Making "Toggle" the active tab.

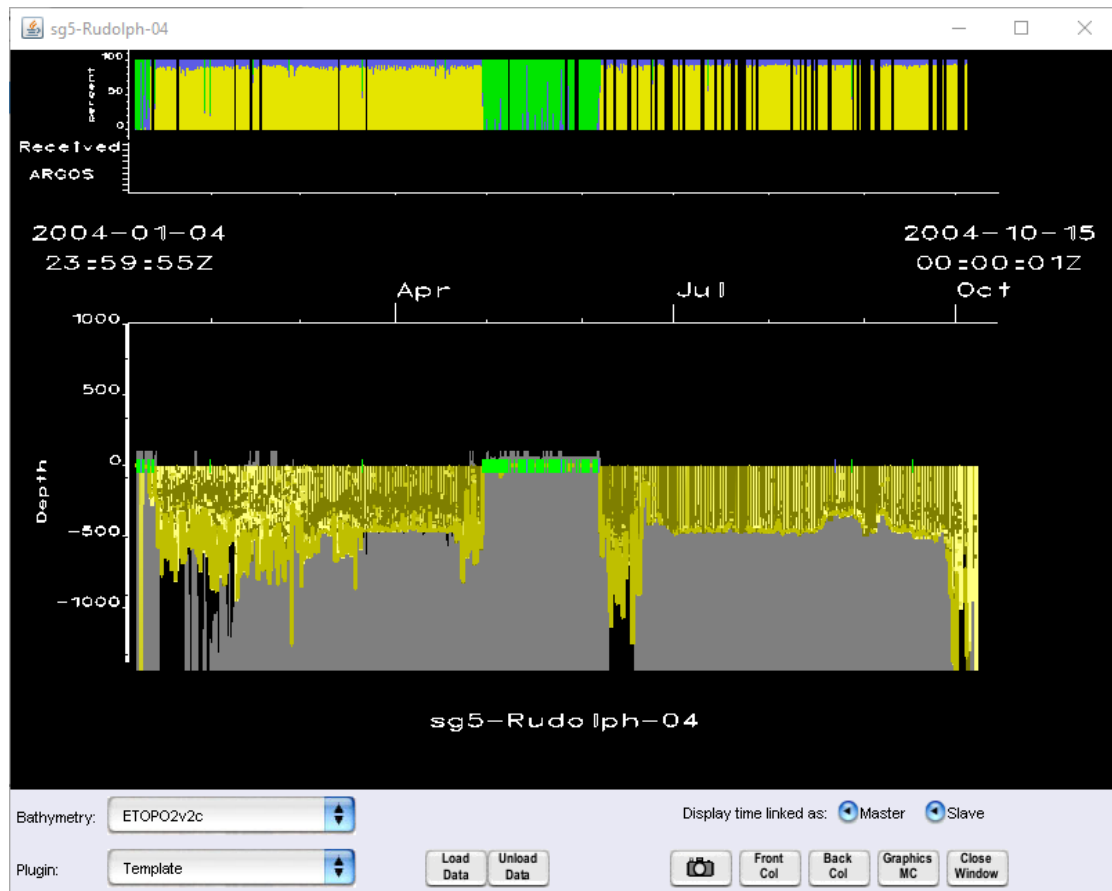


Pressing the "CTD Off" button.

That should have the effect of deselecting all the "Temp", "Cond", "Sal" and "Fluro" elements.



The dive profiles should now be more clearly visible in the strip chart window.



This time-depth window allows a similar form of “navigation” to that used in the 3D window.

Read the instructions below.

Try out these different controls for a couple of minutes.

Zoom in to see various individual dives from along the track.

Do any dives seem to fit any of the “classic” types (e.g. “U”, “V”, etc.)?

Strip chart Window Navigation

N.B. Clicking on the main graph makes it become interactive!

1) Moving the graph

To move the centre of the viewpoint to a different time and/or depth
Either:

Hold down left mouse button and then drag within the 2D axes.

Or:

Click inside the axes and then use the four “arrow” keys.

2) Stretching the axes (+SHIFT key)

The two axes can be stretched independently using the keyboard:

- Click inside the axes.
- Hold down the Shift key.
- The up and down “arrow” keys will then stretch the vertical axis.

Similarly, the left and right-hand “arrow” keys can also be used stretch the horizontal time axis.

3) Zooming into a given rectangle.

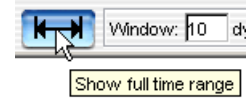
To zoom into a given rectangular section of the plot:

- Hold down the Shift Key.
- Move the mouse to a corner of the region you wish to zoom into,
- Hold down the right-hand mouse button.
- Drag the mouse to define a rectangle.
- Release the right-hand mouse button to perform the zoom.

N.B. Ctrl+“R” on keyboard = “Reset to default full time range view”

The strip chart window offers options as to whether it should act as a “master” display, a “slave” display or both (likely to be the default). These control how changes in the main “Time Window” are linked to changes in the time range of the time axis in the plot. Try this:

Click the main “Show full time range” button.



Change the width of the Time Window to some shorter period.
(Either use the Time Slider or set the “Width” manually)

If you see the time axis in the strip chart adjust to match the same period as the Time Window then the strip chart is acting as a “slave”. Change the Time Window a few times to see the effect, maybe see if you can pick periods when Rudolph crosses the edges of the continental shelves.

To see if the linking also works the other way around try this:

Click somewhere inside the time-depth plot.

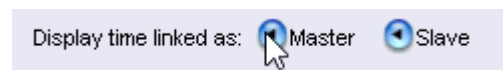
Hit Ctrl+ the”R” key on keyboard. (“Reset default stripchart view”)

The strip chart should “reset” to include the whole time range for the data from the tag which it is displaying, but the depth range might need a little adjustment. If this window is set as a “master”, the main Time Window will also change.

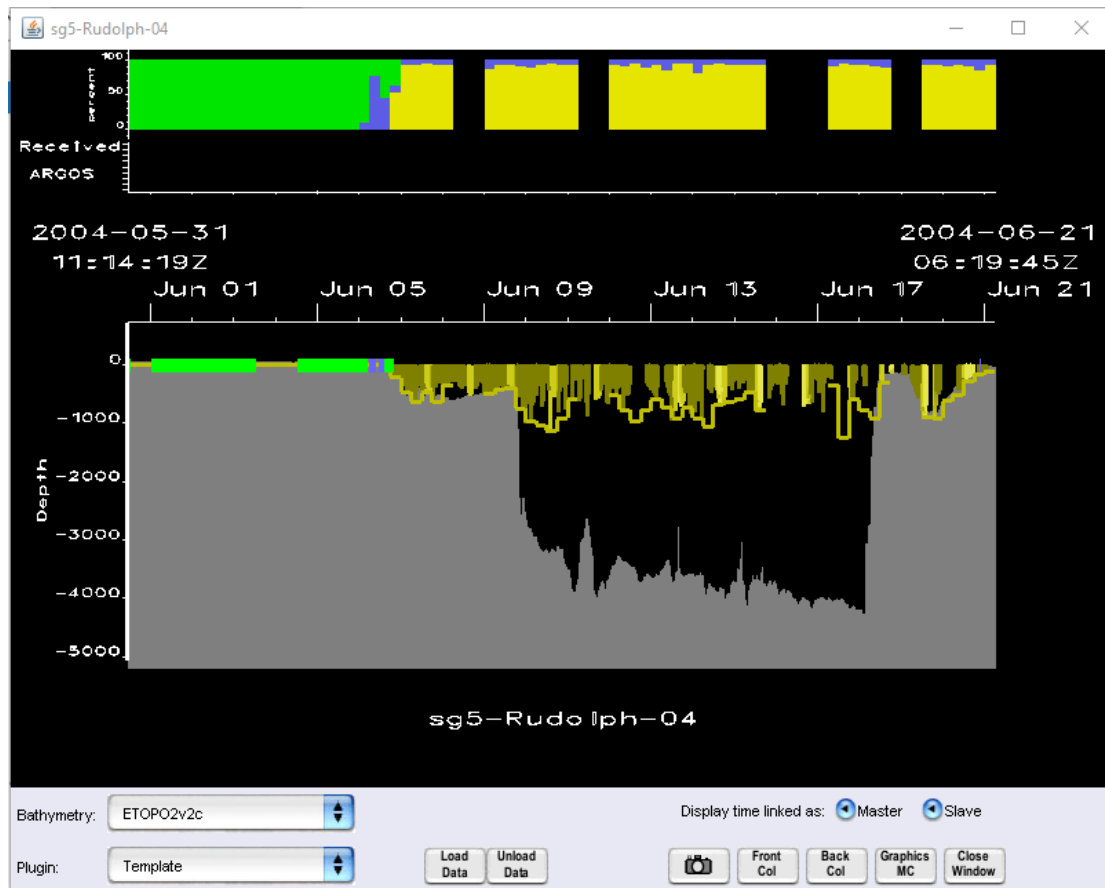
If you like, experiment a little with toggling “master” and “slave” off and on and then changing time ranges again.

Next, you are going use the strip chart acting as a “master” to help examine Rudolph’s diving behaviour during a particular period:

Check “Master” is on.



Then “navigate” in the time-depth plot so that the visible period is from sometime in the first week through to the third week of June.



Look at the Time Controls and the main 3D window. They should both also now be displaying the same period from the middle of June. The time-depth plot clearly indicates that Rudolph crossed some deep water during this period. The 3D window makes it easy to see that this is when Rudolph was crossing the Drake Passage northwards from Antarctica towards South America. This is a simple example of the power of linking two different types of display.

Use the different features of MamVisAD which you have learnt about to see if you can now find any possible differences in dive shapes between the periods Rudolph spent in deeper water and those during which he was on the continental shelves. This should be much simpler now that you are using both the 3D window and the strip chart together.

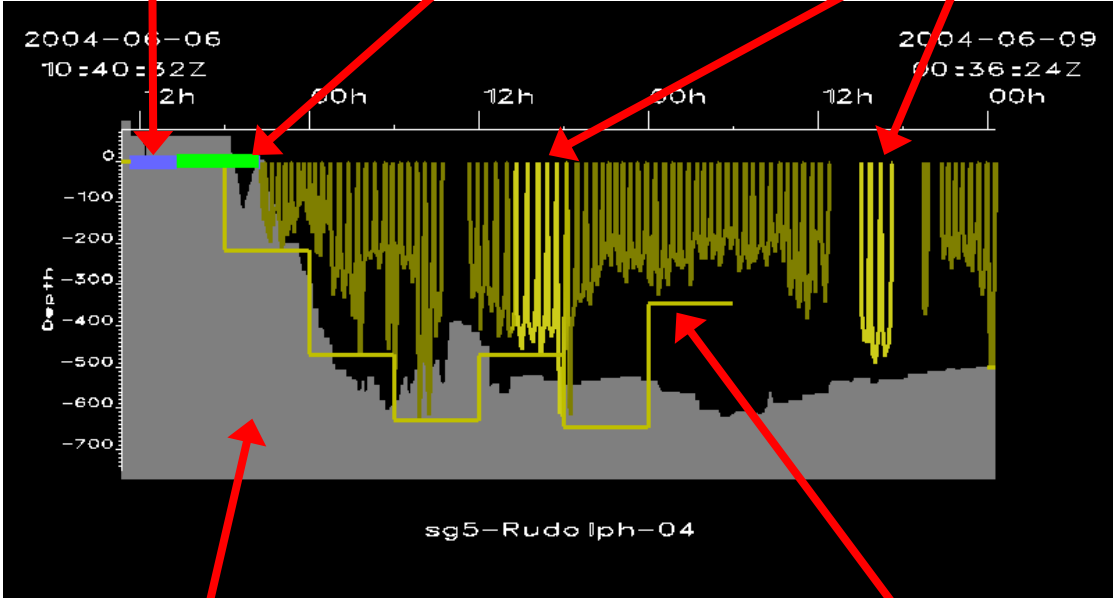
Can you find any possible diurnal patterns in the diving? The dives are coloured to help you - from darkest when near local midnight through to bright yellow around local noon. You may also want to examine the behaviour of a few other seals in addition to Rudolph.

(N.B. To close a strip chart go to the "Tracks" tab and untick the appropriate "2D" box".)

Blue = Cruise

Green = Haulout

Bright yellow = near local noon



Grey = Bathymetry

Deepest dives in each 6 hour summary period

If you have extra time.....

Step 9: Loading in Sea Ice Fields

One factor that may influence the behaviour of elephant seals is the extent of the sea ice that surrounds Antarctica for much of the year. MamVisAD offers an option to display a sea ice dataset. Before you go on to try out this feature it is probably best to reset a few things:

Close any open strip charts.

Reset the Time Window show the full time range.

Set the viewpoint in the 3D window to be looking at the "Middle of the tracks" again.

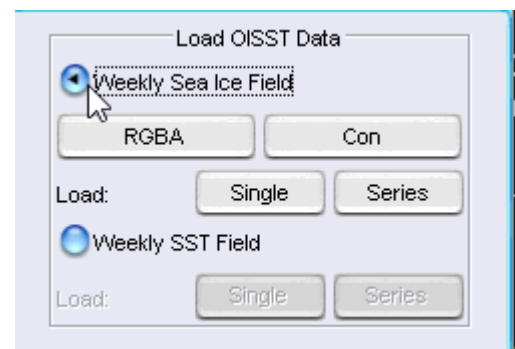
Make sure the "Region Box" is still set to include all the tracks.
(If not go to "Bathymetry" tab and "auto-choose" the region again)

Now you are ready to load in a time series of sea ice concentrations.
(N.B. you may also need to download or unzip the OISST data files)

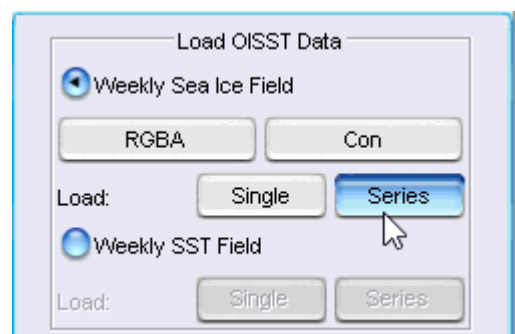
Make "SST/Ice" the active tab.



Tick the "Weekly Sea Ice" radio box.



Click the "Series" button to start loading data for the current Time Window.

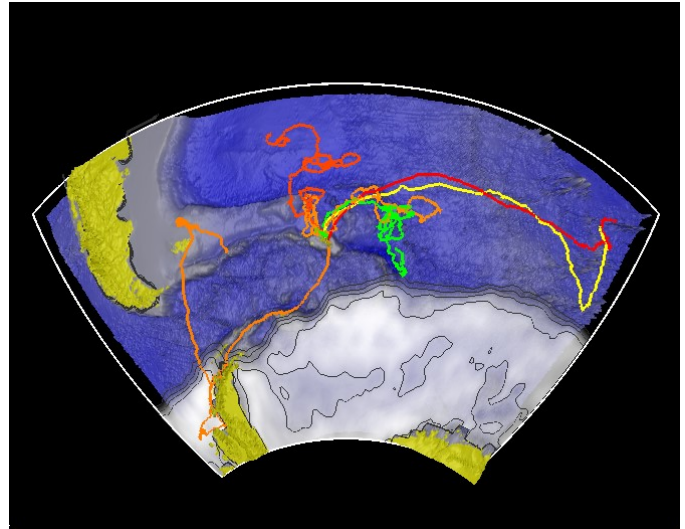


The loading process might take some time. In the Message Window, you should though get to see information about each week's field being read in.

```
Getting field for 2004-10-03 00:00:00Z
Getting field for 2004-10-10 00:00:00Z
Read all fields
```

Eventually, you should see some "sea ice" appear in the 3D window.

This ice will be the relevant 2D field for the "current time" (i.e. the "end" of the current Time Window).



From such a static view it is not possible to see how close any of the seals ever really came to the ice edge, Rudolph's track clearly crosses the ice in the display, but at that time his actual location is far further north.

Animating the tracks and the ice together might provide a clearer indication of whether any of these animals visited the ice at any point.

Set the Width of the Time Window to 7 days.

Set the Time Step to 3 days 12 hours.

"Rewind to the Start".

Either hit the "Play" button or step forward one time step at a time.

Does this "animation" show whether any of the seals may ever have interacted with the ice edge?

Step 10: Loading in CTD data and SSTs

Other environmental parameters relating to water masses, such as the temperature and salinity, might also be useful in helping to explain some elephant seal behaviour. SRDL tags record spot measurements of water temperature (some even performing “CTD casts”), while techniques such as satellite remote sensing can be used to measure values, such as the Sea Surface Temperature (SST), over large regions.

There is, therefore, some potential to identify, even just by visualising some of these “observed” datasets, when animals might be crossing features such as ocean fronts.

Before taking a look at some of these datasets, once again it is best to reset a few things first:

Close any open strip charts.

Reset the Time Window show the full time range.

Set the viewpoint in the 3D window to be looking at the “Middle of tracks” again.

Make sure the “Region Box” is still set to include all the tracks. (If not go to “Bathymetry” tab and “auto-choose” the region again)

Go to the “Toggle” tab and hit “All On”.

Now to show the “CTD” data for three animals

Go to the “Tracks” tab.

Tick the “CTD” radio box for Comet, Blitzen and Rudolph.

Hit the big “Update” button,

This should load in two sets of CTD data (Comet and Blitzen) and one set of just temperatures (Rudolph). If you like, zoom in to see the “ribbons”. You are going to look at the temperatures. The locations, dives and the salinities are likely just being a distraction, So:

Go to the “Toggle” tab.

Turn off:

“Locations”, “DiveProfs”, “Sal-pts”, “Sal-lines” and “Sal-fill”.

Next load in the SST fields:

Make “SST/Ice” the active tab.

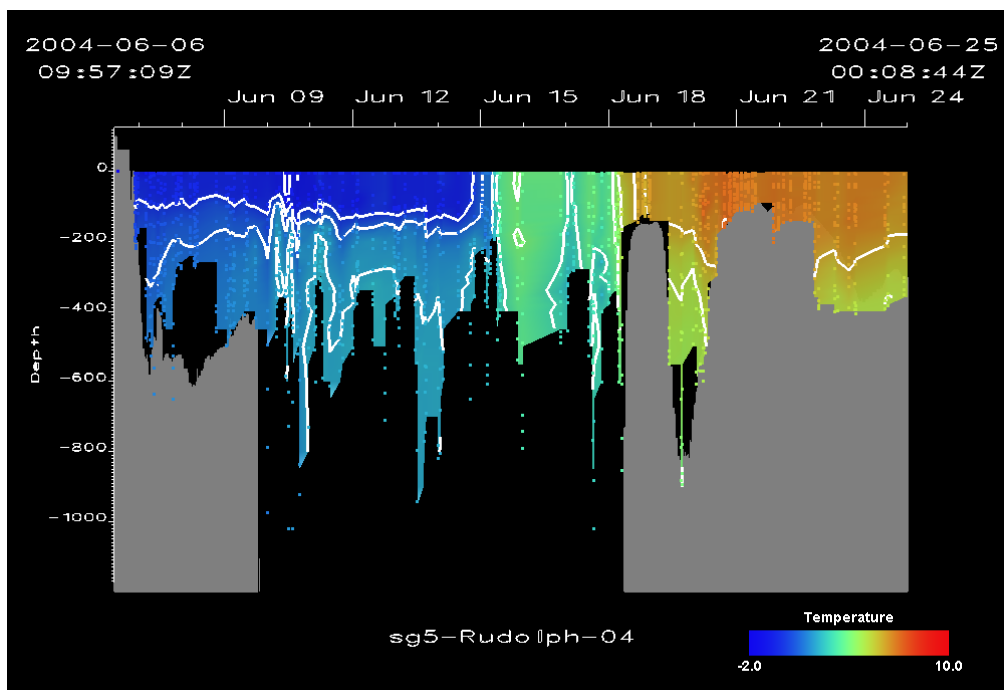
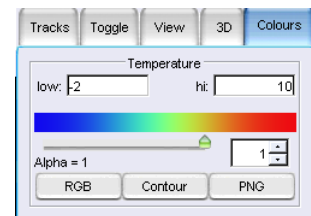
If the Sea Ice radio box is still ticked, untick it.

Tick the “Weekly SST” radio box.

Click the SST “Series” button to start loading the data.

By this stage of the practical, you have already learnt about many of MamVisAD’s features including 3D navigation, the time controls and linked strip charts. Now, use these and any others you may find, to explore the two types of temperature datasets that you have just loaded. Can you find any cases whether any of these seals appear to cross from one water mass into another?

For example, you could try setting the temperature and time ranges to come up with something like this representation of the data collected by Rudolph’s tag.



Step 11: Investigating diurnal diving behaviour

A relatively late addition to MamVisAD's features was the colouring of dive profiles based on the time of day. The brightest yellow dives should be around local noon the darkest near midnight. This should help in investigating any possible diurnal patterns in recorded diving behaviour.

Did you find any possible diurnal patterns in Rudolph's diving? You may also want to examine the behaviour of a few of the other SEaOS seals.

If you still have time, another potentially interesting dataset to look at is provided in the "MQ4_Ellies_for_prac.mdb" Access database. This contains data from elephant seals tagged with SMRU SRDLs in late 2000 on Macquarie Island. A good animal for you to start looking at would be the one that was named "Billie".

Probably best to restart MamVisAD.

Follow the same procedure as you used earlier in the practical for loading data (N.B. remember you will want tracks and dives). This time load the data for "Billie" from this database:

MQ4_Ellies_for_prac.mdb

Once Billie is loaded "Autochoose" the region and load some bathymetry data in the 3D view (maybe the ETOPO2v2c dataset).

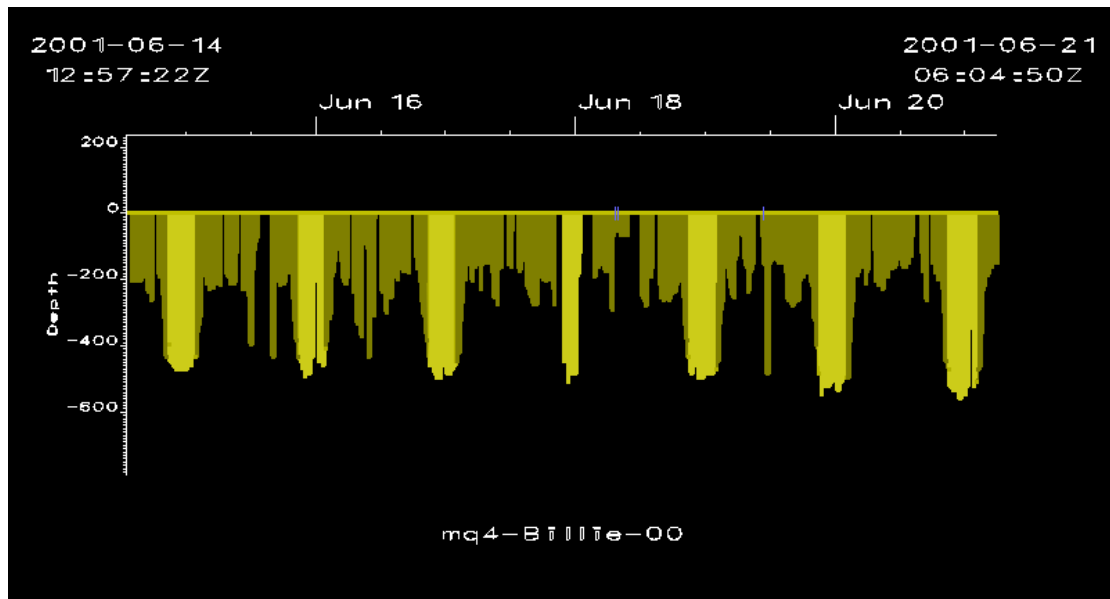
In the "Tracks" tab tick "2D" to bring up the strip chart.

Select "ETOPO2v2c" as the bathymetry for the strip chart. (N.B. remember it might take a few seconds to load)

Begin to use the two views together to investigate any possible diurnal and geographic patterns in the animal's diving behaviour.

Some dates you might want to look at could include around:

17th January, 1st June, 18th June, 17th July & 25th August



For example, what sort of diving behaviour is shown here? Can you find any other occurrences of this and/or identify any other different patterns using MamVisAD? If so, then think about the “biology” that might lie behind them. Then, if you have time, load in data from some other animals to see if that seems to support any of your “hypotheses”.

Some further reading / references

Fedak, MA, Lovell, P & McConnell, BJ 1996,
'MAMVIS: A marine mammal behaviour visualization system ', JOURNAL OF VISUALIZATION AND COMPUTER ANIMATION, vol 7, no. 3, pp. 141-147.

Fedak, M, Lovell, P, McConnell, B & Hunter, C 2000,
'Methods for overcoming the constraints of long range telemetry of biological information from animals: getting more useful data from small packages. ', American Zoologist, vol 40, pp. 1013-1013.

Biuw, M, McConnell, BJ, Bradshaw, C, Burton, H & Fedak, MA 2003,
'Blubber and buoyancy: Monitoring the body condition of free-ranging seals using simple dive characteristics ', Journal of Experimental Biology, vol 206, no. 19, pp. 3405-3423.

Biuw, M, Boehme, L, Guinet, C, Hindell, M, Costa, D, Charrassin, J, Roquet, F, Bailleul, F, Meredith, M, Thorpe, S, Tremblay, Y, McConnell, B, Park, Y, Rintoul, S, Bindoff, N, Goebel, M, Crocker, D, Lovell, P, Nicholson, J, Monks, F & Fedak, MA 2007,
'Variations in behavior and condition of a Southern Ocean top predator in relation to in situ oceanographic conditions ', Proceedings of the National Academy of Sciences of the United States of America, vol 104, no. 34, pp. 13705-13710.

Boehme, L, Thorpe, SE, Biuw, M, Fedak, MA & Meredith, MP 2008,
'Monitoring Drake Passage with elephant seals: Frontal structures and snapshots of transport ', Limnology and Oceanography, vol 53, no. 5, pp. 2350-2360.

Websites:

MamVisAD:

<http://www.smru.st-andrews.ac.uk/MamVisAD/>

SMRU Instrumentation:

<http://www.smru.st-andrews.ac.uk/Instrumentation/>

SEaOS:

<http://biology.st-andrews.ac.uk/seaos/>

MEOP:

<http://www.meop.info/>

Census of Marine Life:

<http://www.coml.org/>

Jython:

<http://www.jython.org/>

VisAD:

<http://www.ssec.wisc.edu/~billh/visad.html>

Java:

<http://www.java.com/>