



Help file

To navigate, click topic in index below or search (Ctrl+f).
If you do not find what you are looking for check the [FAQ](#)

1	Interface	5
1.1	Main Page	5
1.1.1	Graphics area	5
1.1.2	Pages area.....	5
1.1.3	Toolbar.....	5
1.1.4	View Menu	6
1.1.5	Tools Menu.....	6
1.1.6	Export Menu	7
1.2	Scenarios.....	7
1.3	Project setup.....	8
1.3.1	Problem creation	9
1.3.2	Properties map.....	9
1.3.3	Shape overlays	12
1.3.4	Image Overlay	13
1.3.5	Setup cross section	15
1.3.6	Set world scale	15
1.3.7	Northing, Easting & UTM zone	15
1.3.8	Grid setup.....	16
1.3.9	Source setup.....	18
1.3.10	Memory requirements	19
1.4	Frequencies and solvers page.....	19
1.5	Sources page.....	19
1.5.1	Importing multiple sources.....	20
1.5.2	Moving/line sources	21

1.5.3	Cross section	22
1.5.4	Display thresholds	22
1.6	Spectrum page	22
1.6.1	Mitigation	24
1.6.2	Copy to clipboard	24
1.6.3	Equipment page	26
1.7	Source time series page.....	27
1.7.1	Mitigation	28
1.8	Directivity	28
1.9	Water page	29
1.9.1	Speed of sound profile.....	29
1.9.2	Ocean current.....	29
1.9.3	Water properties.....	29
1.10	Seabed properties page.....	29
1.11	Marine species weightings page	30
1.12	Probes page	31
1.13	Results page.....	31
1.13.1	Exclusion zones.....	32
2	Settings and Background	33
2.1	Controlling view and display	33
2.1.1	Changing between 3D and cross section view	33
2.1.2	Controlling the 3D environment view	34
2.1.3	Display of components.....	34
2.1.4	Setting the cross-section	34
2.1.5	Measuring distances	35
2.2	Exporting	35
2.2.1	Exporting the current scene to an image file	35
2.2.2	Exclusion zone export.....	35
2.2.3	Animated exports	35
2.3	Solvers.....	36
2.3.1	Split low/high frequency solvers.....	36
2.3.2	20 log(r/r0).....	36

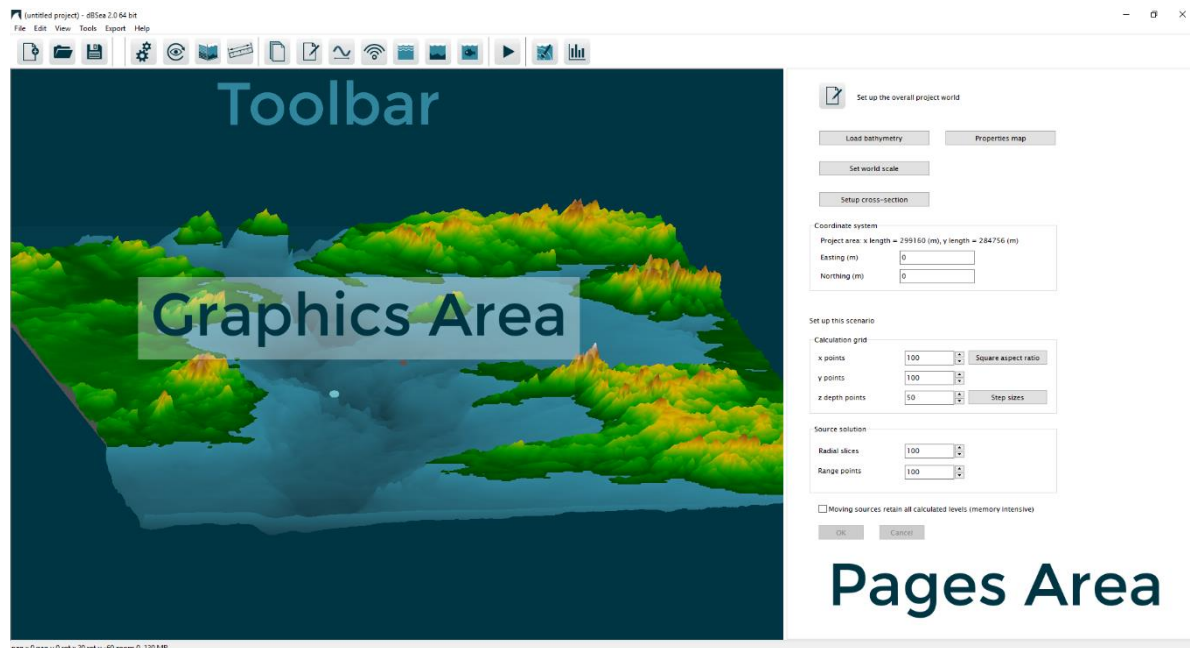
2.3.3	20 log(rd/r0) + 10 log(r/rd)	36
2.3.4	dBSeaPE - parabolic equation method	36
2.3.5	dBSeaModes - normal modes method.....	37
2.3.6	dBSeaRay - ray tracing method	37
2.3.7	Postprocessing of levels for each source	38
2.3.8	Interpolating levels from sources to the grid	38
2.4	Reading CSV files	41
2.5	Advanced solver options	43
2.5.1	General options	43
2.5.2	dBSeaPE	44
2.5.3	dBSeaRay	44
2.5.4	dBSeaModes.....	45
2.6	Preferences	45
2.6.1	Graphics.....	45
2.6.2	Graphics sizes	46
2.6.3	Multi core	46
2.6.4	Directories options	46
2.6.5	Misc. options	46
2.6.6	Exporting options	46
2.6.7	Sound levels display	46
2.7	Databases	47
2.8	CSV editor.....	48
2.8.1	Importing raster data	48
2.8.2	Importing vector data	48
2.8.3	Altering data	49
2.8.4	Selecting an export range	49
2.8.5	Exporting selected data range	49
2.8.6	Troubleshooting.....	49
2.9	CSV editor vector import	49
2.9.1	Importing vector data	49
2.9.2	Shapefile import	50
2.9.3	XYZ import	50

2.10	CSV editor troubleshooting.....	51
2.10.1	Raster import.....	51
2.10.2	Vector import.....	52
2.10.3	Shapefile import.....	52
2.10.4	XYZ import.....	52
2.11	HASP dongles and trial licenses.....	52
2.11.1	Trial licenses.....	52
2.11.2	HASP dongles.....	53
2.11.3	Demo version.....	53
2.11.4	Troubleshooting.....	53
2.12	Minimum requirements.....	54
3	References.....	56

1 INTERFACE

1.1 MAIN PAGE

The Main Page is divided into the main graphics area, the pages area on the right and the toolbar along the top.



1.1.1 Graphics area

The main graphics area shows the current project environment, either in 3D view or cross-section. Noise sources, probe locations and calculated sound levels are displayed over the project bathymetry. For information on controlling the graphics display, see Controlling view and display 2.1 p. 33

OpenGL is used to display the graphics. The OpenGL version provided by Windows 7, 8 & 10 (glu32.dll) is typically sufficient, however users who experience problems with the graphics display may benefit from obtaining updated OpenGL drivers from their graphics card vendor.

1.1.2 Pages area

Scenarios, sources, seabed, and other input properties of the current project are edited and controlled by the individual pages that show in the pages area. The relevant pages are accessed via the buttons in the toolbar.

1.1.3 Toolbar

The buttons in the toolbar control creating new projects, opening, saving, changing the view, accessing specific pages and solving the current

project. Hovering over each button shows the function of that button as tooltip text.

1.1.4 View Menu

The visibility of individual components (source, probes, bathymetry, sound levels) is controlled by checking or unchecking the items in this menu.

Cross sections can be saved, recalled and named from this menu.

The ability to grab probes and sources can be toggled on or off in this menu as well (“Can select sources/probes”).

1.1.5 Tools Menu

Load bathymetry CSV – see Reading CSV files 2.4 p. 41.

Swap heights and depths - dBSea accepts input bathymetry with depths as positive numbers and land heights as negative numbers. Many GIS tools use the reverse definition, and if this is the case with imported bathymetry, this option will reverse the imported heights and depths.

Source/Probe array tool - A useful tool for creating large arrays. It allows you to copy a source or probe to create an array easily.

Latitude/Longitude to Easting/Northing Calculator - Can help you convert decimal degrees or DMS notation to UTM coordinates. The tool will use the UTM zone of the first coordinate set as the reference for the remaining coordinates.

Remove calculated levels from .UWA file - In case you wish to strip the calculated levels from a saved file. This will greatly reduce the size of the saved file (but levels must be recalculated).

New project with specified bathymetry depth - Generates a new, flat bathymetry of the given depth, with length and width of 10,000 m.

Launch CSV Editor - This option will start the bundled CSV editor 2.8 p. 48, which is used to import and edit bathymetry files from different formats.

View dBSea Log - Lets you view the list of actions performed by dBSea, and export this. Useful for support queries.

Generate C2V file - This will generate a unique file that we use to upgrade product keys.

Preferences - Opens the Preferences (p 45) window.

1.1.6 Export Menu

Export current scene as... - An image file containing the current scene may be exported by choosing the 'Export the current scene as...' button from the Tools menu. BMP, JPG, PNG and PDF file types may be exported. If the current scene includes calculated sound levels, then the exported image will include a scale bar showing the colour scale for levels.

Export all levels/cross-section levels - Calculated sound level data may be exported in text format, with tab separated fields. The data can therefore be opened or copied directly into a spreadsheet. Data may be exported as the overall levels at each point, or the overall levels plus full spectra for each point may be written.

Export currently visible levels/bathymetry in ESRI Ascii grid format - This option will write an output file containing the currently visible sound levels or project bathymetry, in the widely supported ESRI Ascii grid format, for import into GIS packages. When exporting levels, if the solution grid dx/dy aspect ratio is close to 1, dBSea will use the standard CELLSIZE parameter. If the aspect ratio is too high, then the non-standard DX and DY parameters will be used, which may not be fully supported by all GIS software. To use a square or close to square grid aspect ratio, click on the 'Square aspect ratio' button on the Project setup 1.3 p. 8

Export exclusion zone - This can either be as an ESRI Ascii grid or as an ESRI shapefile (.shp, .shx, .dbf).

1.2 SCENARIOS

Manage scenarios



A problem may contain any number of scenarios. Scenarios allow comparison between different environmental situations, sources, mitigation, grids and solvers. Each scenario contains:

- Sources
- Grid
- Probes
- Water sound speed profile
- Seabed
- Weightings
- Solver and frequency selection

Bathymetry and the overall world dimensions are shared by all scenarios.

Use this page to manage scenarios: add, delete or duplicate scenarios with the given buttons. To make a scenario active, click in its 'Activate' column. Click in the 'Solve' column to enable and disable solving for each scenario (disabling a scenario from solving will keep any calculated results that exist for that scenario). If a scenario currently has calculated results, this is shown in the 'Levels' column.

1.3 PROJECT SETUP

Set up the overall project world



A problem consists of the following elements:

- Bathymetry
- Scenarios, containing:
 - Sources
 - Grid
 - Probes
 - Water sound speed profile
 - Sediment
 - Weighting

Bathymetry is the gridded data representing the seafloor. At each point in the grid, a depth (or if negative, a land height) is given.

Sources represent the sound sources within the problem. A problem can have any number of sources, each producing a given sound spectrum or time series.

The grid represents the entire problem area, in which sound levels are to be calculated. Points are evenly distributed in the x and y directions and sound levels are assessed at those points, by summing the contribution from each source.

Probes are used to show the sound level and spectrum at particular points in the grid, and may be thought of as hydrophones. The grid may contain one or more probes.

The water sound speed profile represents the speed of sound in the water column.

Sediment gives the fluid properties of each of the layers in the seabed: density, speed of sound and attenuation. The seabed can have any number of layers.

Weightings represent the hearing of different marine species, against which the calculated sound levels are compared, giving a weighted sound

level. The database contains both M weightings and species specific hearing thresholds. More weightings may be added to the database if desired.

1.3.1 Problem creation

dBSea initially loads with some sample bathymetry data, showing an area of the Irish sea and surrounding land. When creating a new problem, the bathymetry data is set to be all flat, at a depth of 100m. New bathymetry data may be imported from a CSV file (*Project setup-> Load bathymetry*). CSV files can be created in most spreadsheet programs, or may be created and edited using the included CSV editor (p. 48) program. Each 'pixel' is a depth in metres, separated by a semicolon. Example files may be found in the program directory. For more information on reading CSV data see Reading CSV files p. 41.

A very large amount of bathymetry data can slow down the program graphics, if this is the case then the graphical bathymetry data may be reduced (*Preferences -> Graphics -> Max bathymetry graphics data*). This reduces the amount of graphics processing required, while the underlying calculation retains the bathymetry data at full accuracy. The bathymetry layer is cached by the graphics layer, so while the first draw of new bathymetry may be slow, subsequent draws are much faster and therefore the size of imported bathymetry is seldom a problem in practice.

1.3.2 Properties map

Starting at version 2.0, dBSea allows definition of water and sediment properties at any location. Each set of properties is defined at a given location based on easting and northing.

The solvers interpolate these properties at any given point via an inverse distance weighting.

The properties map locations and names can be edited in the Properties map form in the Setup project page. Properties locations can be added, duplicated and removed. Locations are shown as coloured circles, with the current point indicated by a pulsating ring. Colours of points can be changed using the "Colour" button.

To set the properties of the points, use the relevant form i.e. "Water properties page" and "Seafloor properties page".

Alternatively, use a [JSON file](#) to import many points in an automated fashion. Below is an example of an import:

```
[{
  "easting": 1234,
  "northing": 5.678e3,
  "name": "A name",
  "comments": "Some comments",
  "colour": "#ff0000",
  "water": {
    "temperature": 20,
    "salinity": 35,
    "velocity": 10,
    "direction": 1.2e-01,
    "name": "A name",
    "comments": "Some comments"
  },
  "ssp": {
    "cProfile": {
      "depth": [0, 10, 15, 20, 55],
      "c": [1500, 1510, 1520, 1510, 1500]
    },
    "name": "A name",
    "comments": "Some comments"
  },
  "seabed": {
    "name": "Seabed name",
    "comments": "Seabed comments",
    "isReferencedFromSeafloor": true,
    "layers": [
      {
        "depth": 0,
        "name": "A name",
        "comments": "Some comments",
        "material": {
          "c": 1700,
          "density": 1500,
          "attenuation": 0.1,
          "name": "A name",
          "comments": "Some comments"
        }
      }, {
        "depth": 10,
        "name": "A name",
        "comments": "Some comments",
        "material": {
          "c": 1820,
          "density": 1810,
          "attenuation": 0.05,
          "name": "A name",
          "comments": "Some comments"
        }
      }
    ]
  }
},
{
  "easting": 12342,
  "northing": 56782,
  "name": "A name2",
  "comments": "Some comments2",
  "colour": "#00ff00",
```

```

"water": {
  "temperature": 5,
  "salinity": 3,
  "velocity": 2.7,
  "direction": 0.2,
  "name": "A name",
  "comments": "Some comments"
},
"ssp": {
  "cProfile": {
    "depth": [0, 10],
    "c": [1500, 1530]
  },
  "name": "A name",
  "comments": "Some comments"
},
"seabed": {
  "name": "Seabed name 2",
  "comments": "Seabed comments 2",
  "isReferencedFromSeafloor": true,
  "layers": [
    {
      "depth": 0,
      "name": "A name",
      "comments": "Some comments",
      "material": {
        "c": 2510,
        "density": 2000,
        "attenuation": 0.1,
        "name": "A name",
        "comments": "Some comments"
      }
    }, {
      "depth": 20,
      "name": "A name",
      "comments": "Some comments",
      "material": {
        "c": 2400,
        "density": 2500,
        "attenuation": 0.05,
        "name": "A name",
        "comments": "Some comments"
      }
    }
  ]
}
}
]]

```

Notes on JSON files:

- Name, comments and colour fields are optional, other fields are not.
- Colour fields accept html-style colour codes.
- Numerical fields may be entered as 1234.567, 1.234e3, 987.6e-05 and other variations on scientific notation.

- The outermost list, between “[” and “]”, may be extended to include any number of entries.
- Sound speed profiles (SSPs):
 - The number of entries in “depth” and “c” must match, however different locations can have different lengths.
 - When interpolating SSPs, shorter lists have entries added as needed, via linear interpolation or nearest neighbour (when extrapolating). The scenario-wide depth list is the union of all depths entered.
 - Interpolation of sound speed within SSPs is inverse distance weighting.
 - Example:

```

"ssp": {
    "cProfile": {
        "depth": [ 0, 10, 20],
        "c": [1500, 1510, 1520]
    },
    "name": "SPP_one",
    "comments": "one SSP"
},

"ssp": {
    "cProfile": {
        "depth": [ 5, 15, 25],
        "c": [1505, 1510, 1520]
    },
    "name": "SSP_two",
    "comments": "another SSP"
},

```

SSP at midpoint between SSP_one and SSP_two is:

```

"depth": [ 0, 5, 10, 15, 20, 25],
"c": [1502.5, 1505, 1508.75, 1512.5, 1517.5, 1520],

```

- Sea bead
 - Density is in kg/m³.
 - Each entry *must* have the same number of seabed layers, and the layers *must* appear in order of increasing depth.
 - Layers of thickness ‘0’ are allowed and are achieved by setting the layer depth the same depth as the preceding layer.
 - Seabed properties, including depth of layer, are interpolated via inverse distance weighting.
- Please feel free to use the above example as a template to ensure correct syntax and field inclusion.

1.3.3 Shape overlays

From dBSea 2.0 you can import shapefiles (.shp & .shx) into dBSea. As dBSea work from northing and easting, the location of your shapefiles will be most accurate if they are using this system too. If your shapefiles are in lat/lon format, dBSea will use the UTM-zone of the centre of the

bathymetry to convert the lat/lon coordinates into northing and easting. This process may skew your shapefiles if the UTM zone does not match, or the bathymetry area is very large.

1.3.4 Image Overlay

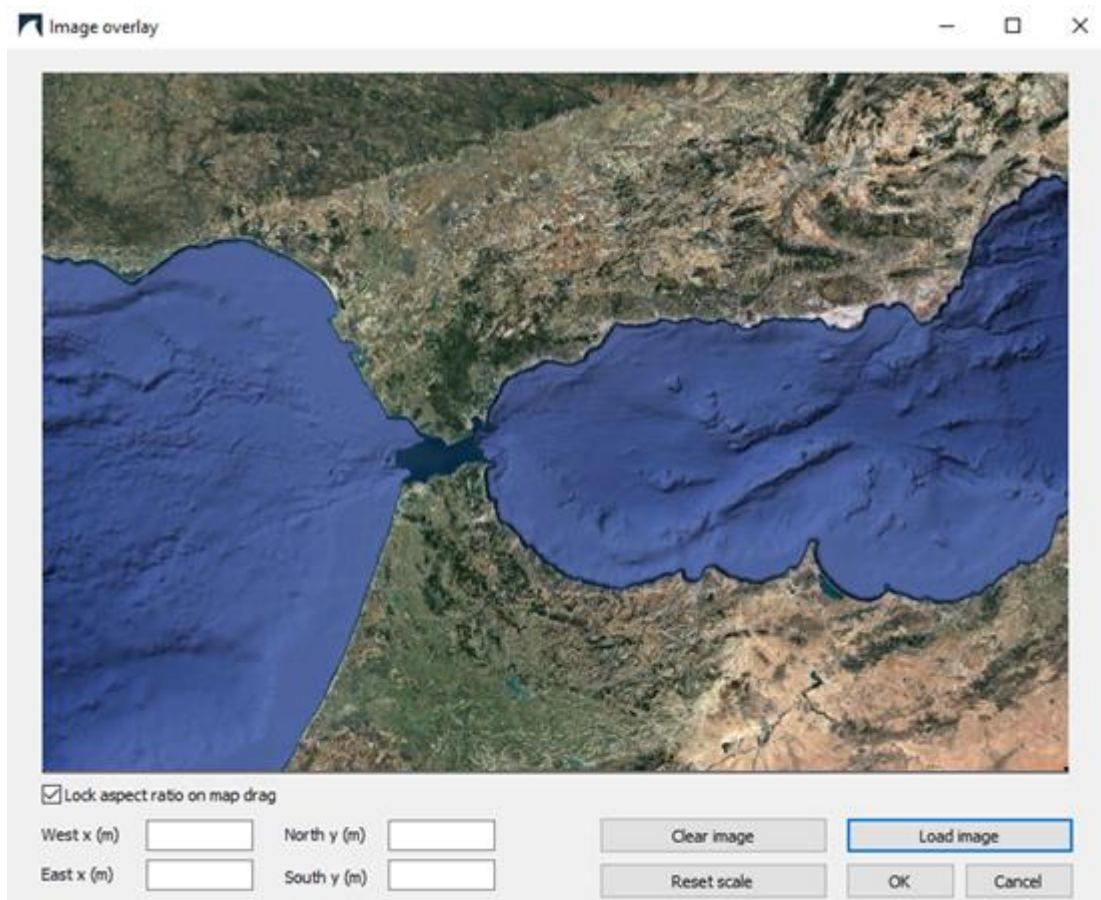
Starting in version 2.1, dBSea can import pictures as image overlays to change the appearance of the landmass included in a scenario. dBSea accepts .jpg & .jpeg, and you have the option of adding information on the image projection by adding an ESRI World File with the same name, but or ".jpw" as file extension, in the directory where the image is loaded from.

E.g. I have the following two files in my folder:

- Gibraltar.jpg (Image)
- Gibraltar.jpw (Projection information)

dBSea will look for these files and include the information when importing. If no file is found, the image is simply loaded "as is".

On the "Setup project" page find "Image overlay" to open the import form.



In this example a .jpg image of a satellite view of the Gibraltar Strait. The "Lock aspect ratio on map drag" mean that dBSea will preserve the proportions of the image as you place it on the map, disable this if your bathymetry and your image are not in the same projection.

The fields "West x (m), East x (m), North x (m) & South x (m), can be used to give the extend that the image covers.

All these values are relative to the south-west corner of the relevant UTM zone. in the above example that means:

- West x (m) is the Easting (UTM zone 30) of the most western part of the image.
- East x (m) is the Easting (UTM zone 30) of the most eastern part of the image.
- North x (m) is the Northing (UTM zone 30) of the most northern part of the image.
- South x (m) is the Northing (UTM zone 30) of the most southern part of the image.

After pressing "OK" you return to the main window in dBSea, with the image overlay.

If the image has not been cropped carefully, or no .jpw file was found, you need to fit the image by re-sizing and moving it using the five nodes. (If "Lock aspect ratio on map drag" was checked, you can't change the image proportions).



1.3.5 Setup cross section

Clicking the *Setup cross-section* button shows the current cross section location in the 3D view. The endpoints of the cross section may be dragged to the desired location. Once the location is selected, clicking the *Show cross-section* button in the main toolbar changes to cross-section view.



If you have multiple sources in your scenario, the endpoint of the cross-section can be made to jump to any source using the number 1-9 as index for the first 9 sources in your scenario.

The *cross-section* can also be specified by entering two points in the "Set up cross section -> Coordinates" menu.

1.3.6 Set world scale

Setting the world scale tells the program the overall size of the problem area. Clicking the *Set world scale* button resets the 3D view. The user then clicks on two known points in the project area, and enters the distance between them, or the absolute locations of the two given points. This scales the overall size of the project area, and if absolute positions are given, also sets the project Northing and Easting. Instead of clicking on the first point, pressing the number keys (1, 2, 3...) will set the first point to the location of the corresponding source, if one exists.

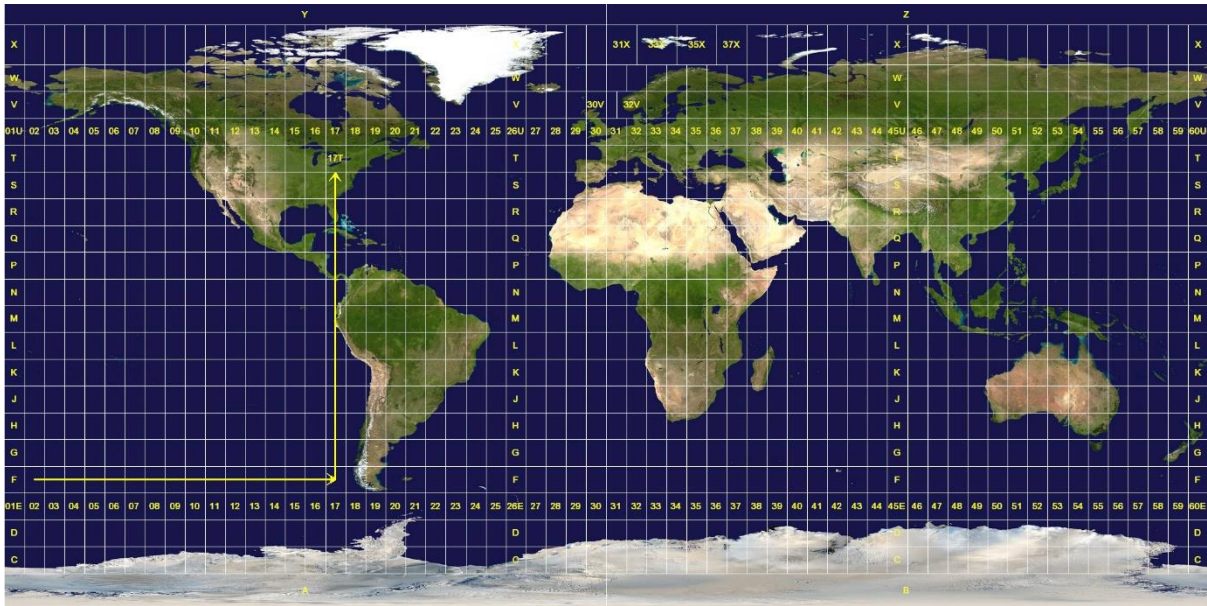
1.3.7 Northing, Easting & UTM zone

The lower left corner of the project area is initially situated at 0,0. Adding Northing and Easting changes the location of the project area. This function may be useful when matching locations given in different coordinate systems.

If the imported bathymetry was geotagged, dBSea will choose a suitable projection for the data, based on the UTM zone of the centre of the map. dBSea uses the expanded notation for UTM zones, meaning that all places have a numerical code (01-60) counting from the meridian at 180 degrees west to the meridian at 180 degrees east in 6 degree increments, and an alphabetical code based on latitude (C-X, omitting "I" and "O").

Note that some official UTM zones don't follow this grid, around Norway and Svalbard. dBSea ignores this and calculates zones as if the grid was not distorted in those areas. In addition zones A, B, Y and Z are not covered.

[See this map](#) (interactive) for UTM grid with coordinates (uses google maps/earth). Alternatively [download the ESRI shapefile](#).



1.3.8 Grid setup

On the problem setup page, the number of grid points may be altered. The grid is rectilinear (Figure 1), and the number of points may be altered in the x, y and z (depth) directions. The same z spacing is used for source solutions as for the grid.

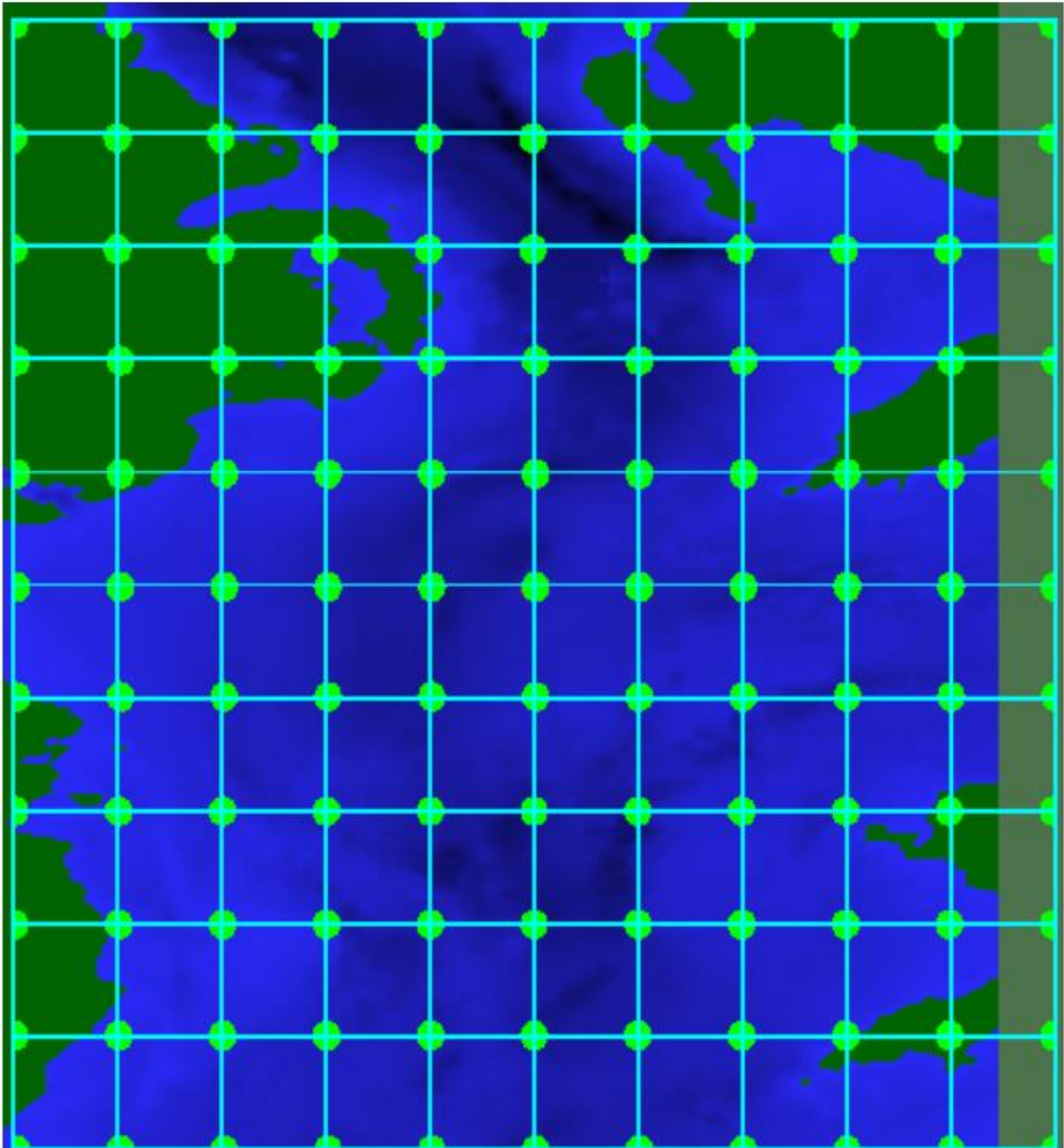


Figure 1. Example problem grid in plane view.

dBSea doesn't require that the x and y grid spacing match, however this can be an issue when exporting levels. If the x and y spacing are sufficiently close, ESRI Ascii grid exported levels will use the standard CELLSIZE parameter and effectively give square cells. If the x and y spacing differ by too large a factor, the non-standard DX and DY parameters are used for the output file. These parameters are not supported by all GIS software, so check with your GIS package as to whether this data will work. A square aspect ratio can be ensured by clicking on 'Square aspect ratio'.

Alternatively, use the button "Set to map resolution", dBSea will match the calculation grid to the resolution of the bathymetry. Remember to check that you are happy with the resolution by inspecting "Step sizes".

1.3.9 Source setup

The number of radial solution slices about each source and the evaluation range points along those slices (Figure 2) may be altered on the problem setup page.

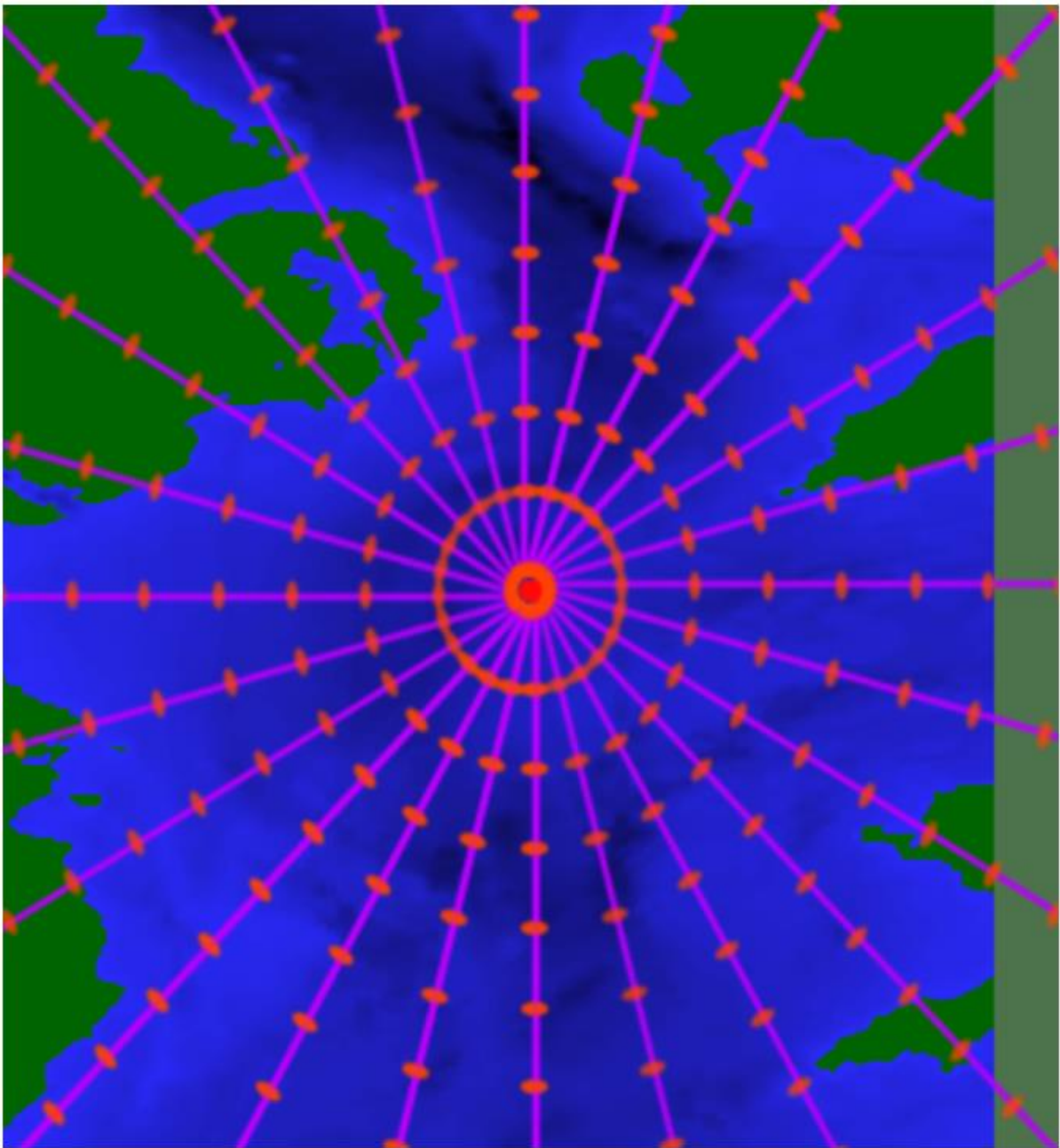


Figure 2. Example source with solution points.

If a solution only along a single direction is required, set the number of slices to 1 (in which case the solution is valid only in the positive x direction from the source, i.e. heading to the right).

1.3.10 Memory requirements

A large number of grid or source solution points can greatly increase the amount of memory required. The approximate amount of free memory needed is

$$\text{bytes} = 4 \cdot \left((x_{\text{grid size}} \cdot y_{\text{grid size}}) + (n_{\text{sources}} \cdot n_{\text{range points}} \cdot n_{\text{source position}}) \right) \cdot z_{\text{depth points}} \cdot n_{\text{frequency bands}}$$

Attempting to increase the number of points beyond available memory will be blocked by the program.

1.4 FREQUENCIES AND SOLVERS PAGE



Calculation may be at octave or third octave centre frequencies. Source equipment spectra is stored in either octave or third octave bands, depending on the original source. If calculation is in octaves and the original spectrum is in third octaves, then the 3 1/3 octave band levels are summed together to give the octave band level, e.g. the 200, 250 and 315 Hz 1/3 octave bands are summed to give the 250 Hz octave band level. If the calculation is in third octaves and the original spectrum is in octaves, the energy from the octave band is split evenly between the 3 1/3 octave bands (so each band receives the octave band level minus $10 \cdot \log_{10}(3)$, or approximately 4.77 dB).

The highest and lowest assessment- and solver split frequencies may be changed with the up and down buttons. For octave band calculations, the lowest and highest possible bands are 16 Hz and 128 kHz, for 1/3 octave band calculations the limits are 12.5 Hz to 160 kHz.

When '*Use separate solvers for low and high frequencies*' is checked, the low and high frequency solvers may be individually chosen and the solver split frequency changed.

The solver can be changed between those available. For more on the available solvers, see Solvers p. 36

1.5 SOURCES PAGE

Add, remove, edit noise sources



Multiple sound sources may be placed in the environment. A scenario may be solved in the frequency domain or the time domain, and all sources in the scenario must be solved in the same domain. A problem can contain scenarios with a combination of frequency and time domain solves.

Sources may be moved by entering coordinates in the Source page fields, or by clicking and dragging the source in the x and y directions with the mouse when in bird's eye view mode (press *Reset View* button).

If you wish to disable clicking and dragging go to *View*→*Can select probes/sources*.



The current source is selected from the dropdown menu. Sources may be added and removed with the *Add, Remove and Make copy* buttons.

The source sound level or time series are not set directly on this page. To edit the spectrum for a source, click on the 'Spectrum' button. This shows the Spectrum page form (p. 22). To edit the time series for a source, click the 'Set time series' button, which shows the

Source time series page form (p 27).

As a scenario can only contain either frequency-based or time series-based sources, changing between these types will change all sources in the current scenario.

Directivity data for the source is entered on the Directivity Page, p. 28, accessed by clicking the Directivity button.

Position data is stored with a precision of 0.1 m. This is true for all positional info, i.e. sources and probes.

The solvers will ignore sources placed on land.

To temporarily disable a source without removing it, uncheck the *Source enabled* box.

1.5.1 Importing multiple sources

The *Import CSV* button will import a list of sources from a CSV file. There are several important restrictions on the format of the input CSV file:

The data (and every row of the data) must have 4 columns. The columns are Name, x, y, z. A header row (i.e. "Name,x,y,z") is optional. Each subsequent row represents a single source. The Name field is a free text field, and the x, y and z fields must contain numbers, and will be interpreted as feet or meters, depending on the current imperial/metric units setting. It is not necessary to enclose the name field in quotation marks.

The following image shows an example that will import 3 sources, as shown in a spreadsheet.

	A	B	C	D	E
1	Name	x	y	z	
2	Source 1 name	1500	1200	10	
3	Source 2 name	6400	1900	20	
4	Source 3 name	5000	3500	30	
5					
6					
7					

Saving as a CSV file produces the following as a text file.


```
Name, x, y, z
Source 1 name, 1500, 1200, 10
Source 2 name, 6400, 1900, 20
Source 3 name, 5000, 3500, 30
```

1.5.2 Moving/line sources

A source may be stationary or moving/line. The available solvers do not calculate true line sources, instead a moving or line source is approximated by calculating the levels for a series of point sources along the desired source route. Increasing the number of intermediate points along the route increases the accuracy of the approximation, at the expense of calculation time and memory requirements.

Clicking the *Moving source* checkbox enables the *Motion* button, which shows the *Set source motion form*. On this form, add and remove waypoints by clicking in the *Add* or *Remove* column. Add as many waypoints as needed to define the source path.

The x, y and z columns give the location of each waypoint. The *Time/Speed* column contains the time taken/speed for the source as its travelling from the preceding waypoint (on the row above) to the current waypoint, and the *Points* column contains the number of points between the waypoints where sound levels should be calculated. The position of the point at position_{index} (starting from 1) between the waypoints is given by:

$$point_{position} = waypoint_x + \frac{point_{index}}{n_{points\ between\ waypoints}} \cdot (waypoint_{x+1} - waypoint_x)$$

The values in the *Time* column are in seconds. The total scenario period is taken as the greatest total time for any of the moving sources in the current scenario. Other moving sources in the scenario are inactive after their motion is finished. All stationary sources are taken to be active for the entire period (and then modified by the *Duty %* parameter in *Sound sources*→*Spectrum*).

For time domain solves, it is assumed that a single instance of the time series is short in comparison to the overall source motion, so that the source does not move while the time series is emitted.

1.5.3 Cross section

A simplified cross section for the current source can be viewed by clicking *Cross section*. If there are calculated sound levels, the levels along the current slice are shown. The current slice may be changed with the up/down buttons or by clicking on a direction in the compass rose. Clicking the *To cross section in main window* button shows the chosen cross section in the main graphics area. There are additional options to export cross sections and to alter the view of these.

1.5.4 Display thresholds

In the *Display of optional thresholds for this source* area, it is possible to show a given threshold around the current source. Entering a threshold level in the text box or choosing one of the available thresholds from the dropdown list, and pressing the *Show threshold* button, enables display of the threshold. In the main graphics area, a circle around the source shows the average distance to the threshold, and a line emanating from the source shows the maximum distance and angle to the threshold.

1.6 SPECTRUM PAGE

The spectrum and overall level of a sound source are edited on this page. A source is composed of 1 or more pieces of equipment. A maximum of 4 different types of equipment may be combined, and there may be any number of each type of equipment. To select equipment, press the '*Add Equipment*' buttons. This will bring up the

Equipment page (p 26).

Levels may be directly edited if desired. Click on the appropriate cells and enter the levels. Note that it is not possible to directly enter an overall level, only levels of individual frequency components can be entered, and the overall level is summed from these contributions.

Increasing the entry in the *Count* column multiplies the given row by that factor, this is used for multiple collocated sound sources of the same type.

The *Duty %* column specifies the percentage of time that the given equipment is active during the assessment time period.

The *Level type* box allows different level types to be selected:

$$\text{dB SL @ 1m:} \quad dB_{SL} = 20 \cdot \log_{10} \left(\frac{\sqrt{\frac{\sum_{n=1}^N p(n)^2}{N}}}{1 \cdot 10^{-6} \text{ Pa}} \right)$$

With “ p_n ” being the pressure in pascals a at sample number “ n ” and “ N ” the total number of samples.

$$\text{SWL (Lw):} \quad dB_{Lw} = 10 \cdot \log_{10} \left(\frac{W}{1 \cdot 10^{-12} \text{ W}} \right)$$

Sound power level, source power in watts relative 1 picowatt.

$$\text{SEL:} \quad SEL = dB_{SL} + 10 \cdot \log_{10}(s)$$

or

$$SEL = 10 \log_{10} \left(\frac{\int_{t_0}^t P(t)^2 dt}{(1 \cdot 10^{-6})^2 \text{ Pa}} \right)$$

With “ s ” being the duration (in seconds) of the SPL used to calculate the SEL.

Note that changing the level type will also scale the currently entered level values, so it is recommended to choose the level type before entering source level data.

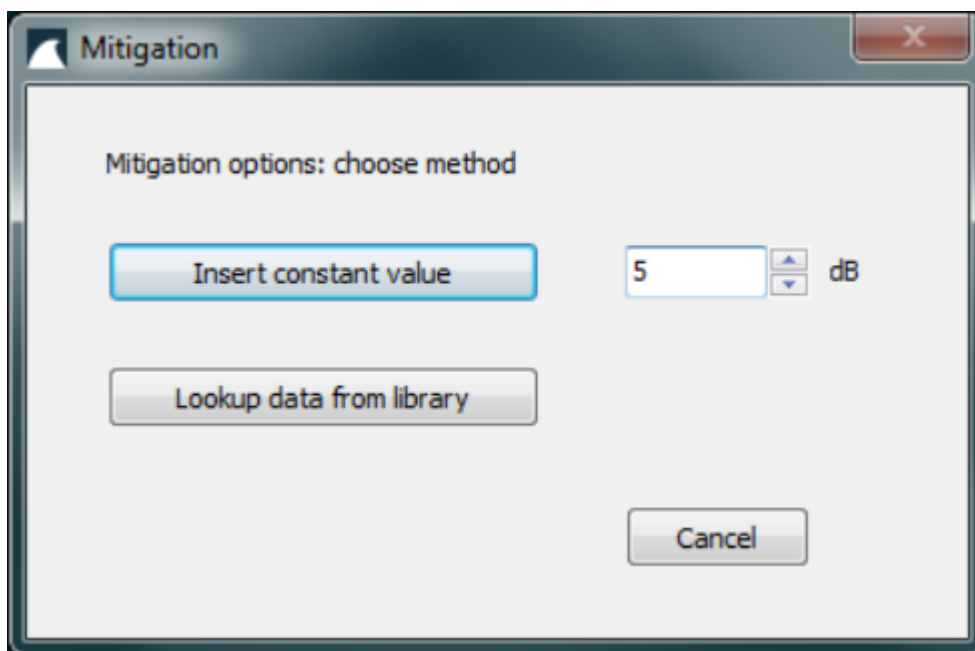
Be very careful to ensure that you enter your values under the correct unit.

The *Crest factor (dB)* is a way to incorporate impulsiveness information into the source. The Crest factor indicates the dB-level above the RMS-level of the highest peak in the signal. It is applied when assessing peak

levels (*Preferences*→*Sound level display*→*Peak sound pressure level*), and is applied to all frequency bands. If you are interested in finding peak values please consider doing a time series solve instead, as it uses the actual signal and not derived information.

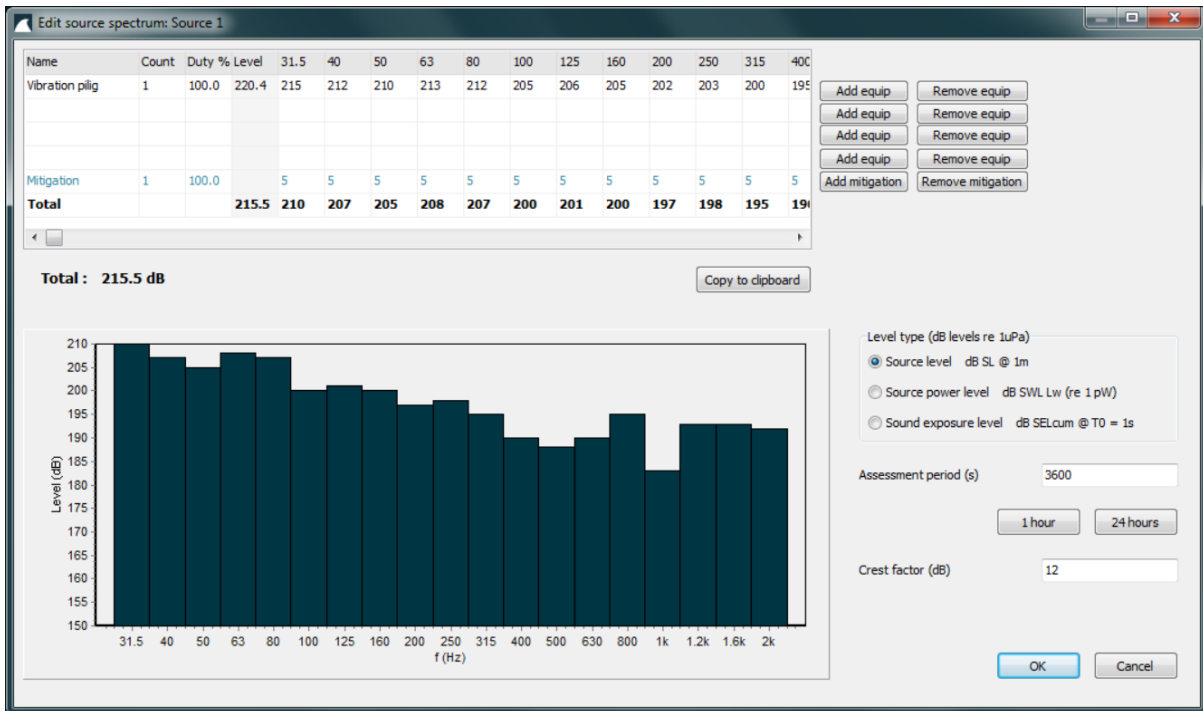
1.6.1 Mitigation

It is possible to add mitigation (attenuation, such as bubble curtains) to this source, by clicking on '*Add mitigation*'. Mitigation may be entered as a constant value across all frequencies, or by choosing mitigation spectra from the library. Positive mitigation values indicate reductions in emitted sound level.



1.6.2 Copy to clipboard

The contents of the table may be copied to the clipboard with the '*Copy to clipboard*' button.

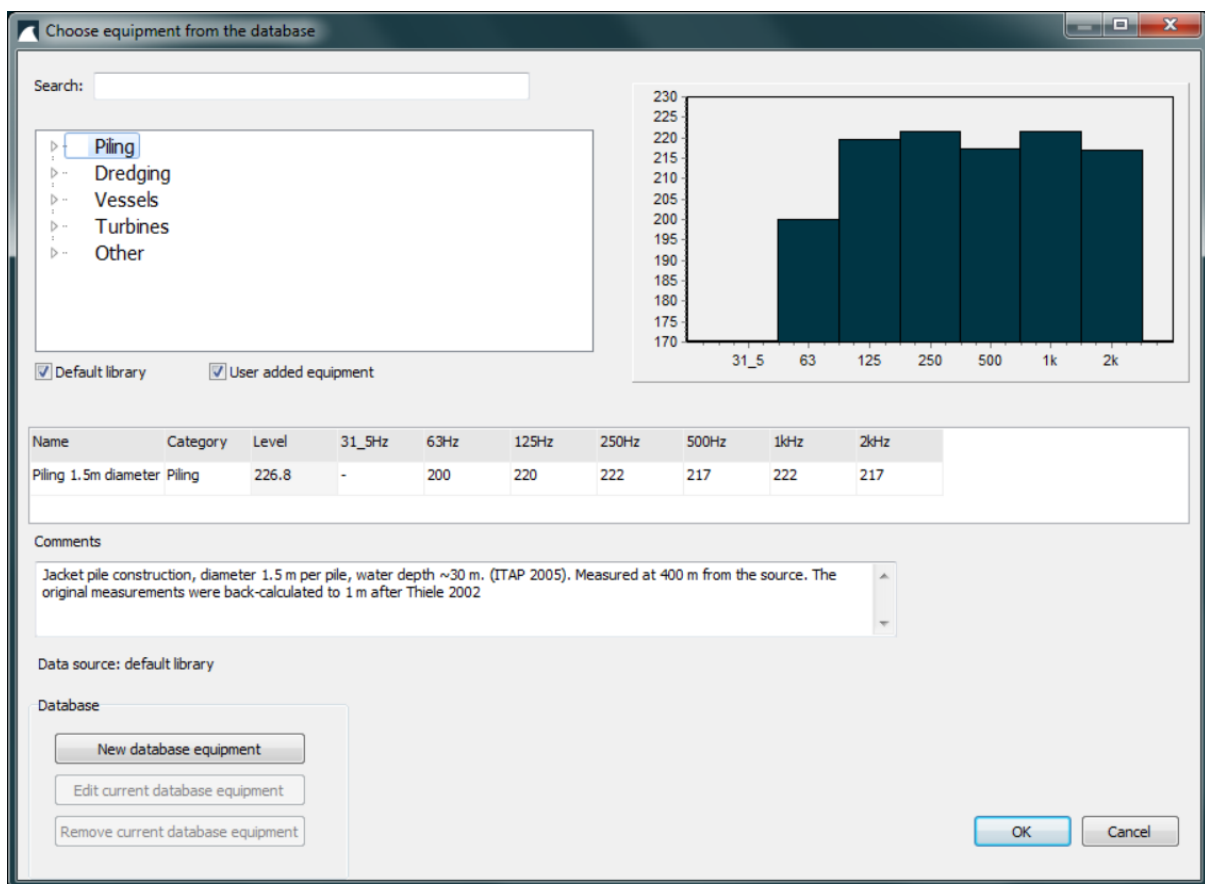


1.6.3 Equipment page

The equipment page allows selection of items of equipment from the database. The database is divided into categories such as piling, drilling etc. The list of items may be searched by typing in the search box.

The spectrum of the currently selected equipment is shown in the chart and table, along with any associated comments.

Note that data for each item may be stored in either 1/3 octave or 1 octave bandwidth, and it will be interpreted according to the current calculation bandwidth, i.e. the energy summed into 1 band, or spread out over 3 adjacent bands as appropriate.



The screenshot shows a software window titled "Choose equipment from the database". It contains a search box, a list of categories (Piling, Dredging, Vessels, Turbines, Other) with "Piling" selected. A bar chart displays the spectrum for the selected equipment, with frequency bands on the x-axis (31_5, 63, 125, 250, 500, 1k, 2k) and noise level on the y-axis (170 to 230). Below the chart is a table with columns for Name, Category, Level, and various frequency bands. The table shows data for "Piling 1.5m diameter". A comments field contains text about jacket pile construction. At the bottom, there are buttons for "New database equipment", "Edit current database equipment", "Remove current database equipment", "OK", and "Cancel".

Name	Category	Level	31_5Hz	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz
Piling 1.5m diameter	Piling	226.8	-	200	220	222	217	222	217

Comments:
Jacket pile construction, diameter 1.5 m per pile, water depth ~30 m. (ITAP 2005). Measured at 400 m from the source. The original measurements were back-calculated to 1 m after Thiele 2002

1.7 SOURCE TIME SERIES PAGE

The time series for a source are edited on this form. A source can have an overall time series representing a single event, such as the firing of an airgun. Data is imported either from a text file containing the individual samples on separate lines or a wav file.

For the text file import values should be given in Pascals, as in the example below:

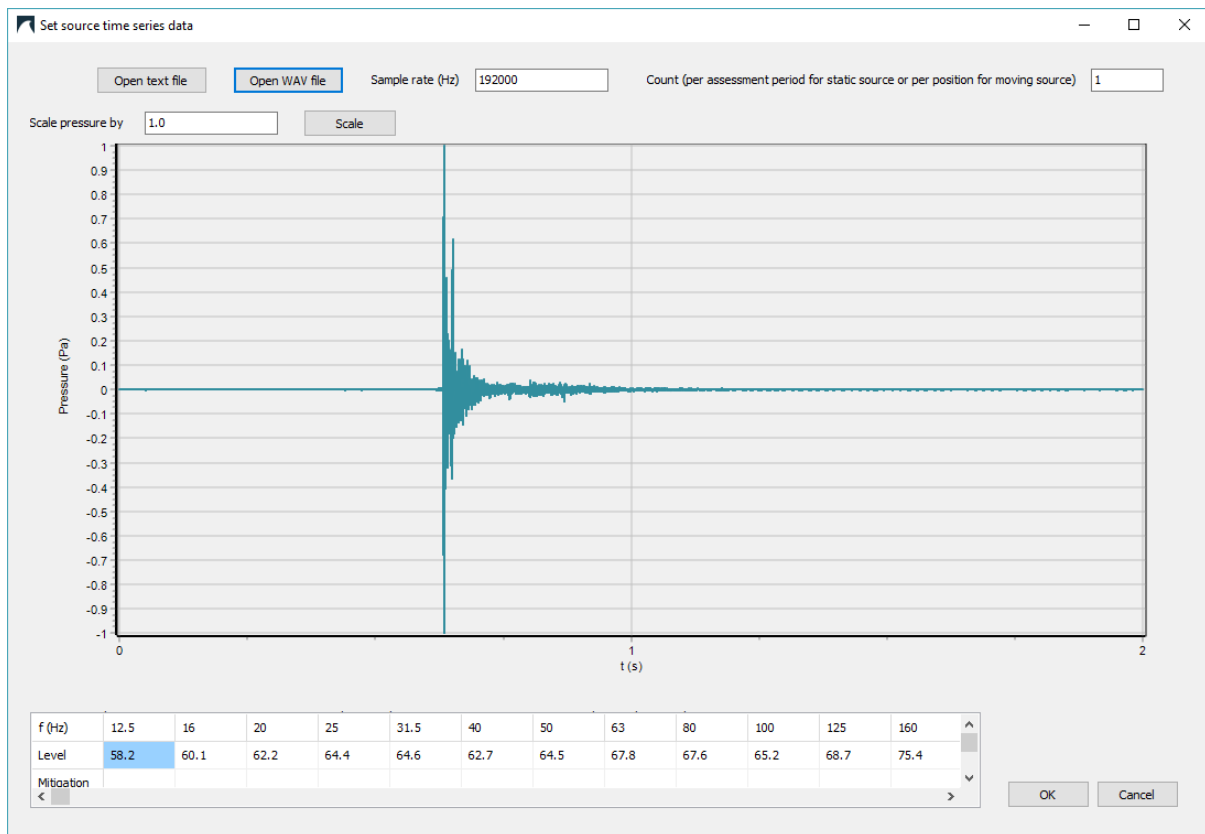
```
-16219.25685  
-53345.41704  
-87190.22469  
-113253.53917  
-128347.76087  
-130504.07825  
-120285.00891  
-99003.09385  
-70033.43854  
-37782.4307  
-6843.96387  
17906.80959  
33001.03128  
35907.37211  
25875.80862  
4218.88184  
-26157.06741  
-61314.41608  
-95815.49423  
-124410.13782
```

If you import a wav file, scale the pressure to reflect the real values (.wav files are usually scaled from -1 to 1 and thus do not contain information on the actual sound pressure).

The sample rate value is used to filter the signal into frequency bands. The count value is used with moving sources, where it is desired to have multiple events at each calculated source position.

1.7.1 Mitigation

Mitigation is entered for each frequency band, and dBSea recalculates the band filtered time series data with these mitigation values during the solve phase. As with the source spectrum page, positive values of mitigation effect a reduction of sound level in that frequency band.



1.8 DIRECTIVITY

The source directivity is set per frequency on this form. Data may be entered directly, or imported from a text file containing each entry on a separate line. To import a text file covering a given frequency, click on the 'File' cell at the top of the column for that frequency.

-90 degrees is vertically up, 0 degrees is horizontal to the source, and +90 is vertically down. Directivity values are linearly interpolated between the given values where needed. Greyed-out rows indicate that the angle is outside the current range of starting angles set for dBSeaRay.

The directivity data is used by the dBSeaRay solver. dBSeaPE and dBSeaModes do not support source directivity.

1.9 WATER PAGE

Water properties, current and sound speed profile



1.9.1 Speed of sound profile

The vertical sound speed profile is set on this page. Some default profiles may be selected from the dropdown menu. Note that if a profile is listed as 'normalised' then the given profile will be scaled so as to extend from the water surface to the greatest depth in the current model. Profiles that are not normalised will use the depths stored with the profile.

The current profile may be modified:

- Double click on the graph to add a new control point
- Double click on an existing control point to remove it
- Click and drag to move existing control points

The profile is linearly interpolated between control points.

If you create a new point at a higher or lower speed than any existing points, it may seem like the point is created at the wrong position - this is because the graph x axis rescales if necessary when new points are added.

If multiple positions have been entered in *Setup project* → *Properties map* there will be a dropdown menu at the top right, for selecting the relevant location.

1.9.2 Ocean current

A constant ocean current may be entered in the field. The direction may be entered by clicking directly on the compass rose.

1.9.3 Water properties

The water temperature and salinity may be entered in the appropriate fields. Pre-set properties may be selected from the dropdown box. The graph shows the water absorption with frequency, in units of dB/km.

1.10 SEABED PROPERTIES PAGE

Seabed properties



The Seabed Page allows the properties of the seabed layers to be changed. The seabed may consist of any number of layers.

The currently active layer is selected in the top dropdown menu. Layers may be added with the add and remove buttons.

If multiple positions have been entered in *Setup project*→*Properties map* there will be a dropdown menu at the top right, for selecting the relevant location.

Every location must have the same number of layers!

Everything below the *Layer depths referenced from local seafloor* checkbox refers to the currently selected seabed layer. The layer may be named, and the depth where the layer starts is entered in the *Depth* text box.

A sediment type from the database may be selected via the dropdown menu. The selected properties can be modified by entering values in the text boxes.

Attenuation is given in units of dB/wavelength. The 20 log and 10 log solvers ignore the seafloor altogether.

If the *Layer depths referenced from local seafloor* checkbox is checked, then the solvers will take the layer depths as being referenced from the local seafloor at each point in the solution. If it is not checked, the layers are taken as referenced from the sea surface. So with this option it is possible to choose between seafloor layers that are horizontal throughout the entire project area, or that follow the local variations in bathymetry.

The calculation area for the dBSeaModes and dBSeaPE solvers extends lower than the water column, to a total depth of three times the depth of the water column. Any layers that fall within this are will be included in the calculation. The dBSeaRay solver does not allow rays to enter the seabed, however an effective complex reflection coefficient is calculated based on frequency, incidence angle and sediment layers. This coefficient is applied to the ray upon reflection at the seafloor.

It should be noted that the speed of sound and density of typical soft sediment layers are generally similar to those of the overlying water. Therefore the seafloor allows a large portion of incident energy to enter, in contrast to the air-water interface.

1.11 MARINE SPECIES WEIGHTINGS PAGE

Marine species weightings



This page shows the weighting curves for various species of fish and marine mammal, which may be selected from the database using the dropdown box. The '*None*' entry may also be selected, where no weighting is desired.

The currently selected weighting curve is used throughout the program to calculate weighted levels. The levels displayed in the main graphic window are weighted levels.

When exporting levels, overall weighted levels are exported, however if spectra are included, the individual frequency components within each spectrum are exported as raw unweighted levels.

1.12 PROBES PAGE

Noise level probes



Probes are used to get more control over display of predicted sounds levels, and may be thought of as hydrophones. Sound levels are calculated throughout the project area, but to see the spectrum and level at a specific point, place a probe there. A scenario can contain multiple probes.

Probes are moved by entering x and y values in the fields, or by clicking and dragging in the main graphic window. The z coordinate is connected to the current vertical levels display method Preferences -> Graphics -> Sound levels display. When this is set to '*Max from all layers projected to surface*', the level shown is the maximum from all vertical layers at that x and y location. When this is '*Single layer*', the level shown is from the given z coordinate. These controls can also be accessed directly from the Probes page by clicking the '*Show depth controls*' button.

Probes may be added and removed with the 'Add probe' and 'Remove probe' buttons. The current probe is selected with the dropdown box. The chart shows the spectrum at the current probe location (blue bars), with the current criteria overlaid (blue line). To show the variation in level with depth at the probe location, click the '*Levels vs depth*' tab.

The '*Table to clipboard*' button copies the current results showing in the results table to the clipboard, with the fields separated by tab characters. This data can be directly pasted into a spreadsheet, if the spreadsheet field delimiter is set to the tab character.

1.13 RESULTS PAGE

Overall levels and colour scale

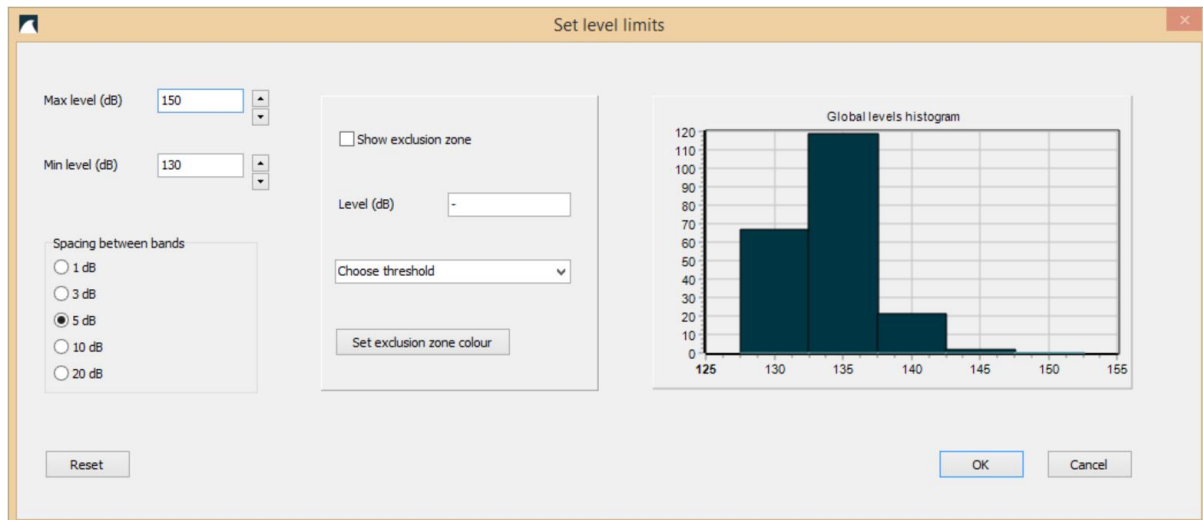


The Results Page gives control over the display of sound levels.

The current mapping of sound levels to colours is shown. Depending on whether '*Smooth result colours*' is selected under Preferences-> Graphics,

the results colours will either be displayed as solid colour bands, or will blend smoothly into one another.

To alter the limits or the spacing between colour bands, click the '*Change limits*' button. This shows the level limits dialogue.



The maximum and minimum level to show may be changed, and the spacing between adjacent bands may be set to 1, 3, 5, 10 or 20 dB.

1.13.1 Exclusion zones

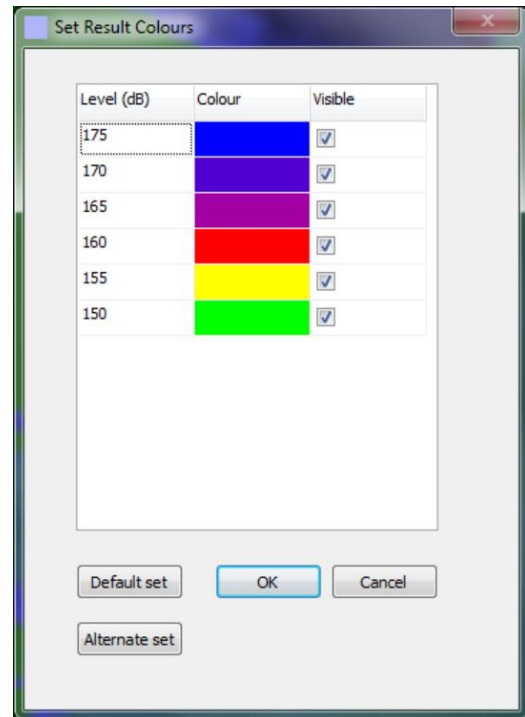
To show exclusion zones around sources, check the *Show exclusion zone* box. The exclusion level is entered in the *Level* text box, or may be chosen from the dropdown box which contains thresholds from the database.

If using predefined levels from the dropdown menu, please make sure that the variables in “Preferences” → “Sound levels display” are set to “Sound exposure level dB SELcum” and “Assessment period is set to 86400 seconds (24 hours) to comply with the assessment standards (and that your source is suitable for this). Please also make sure that you understand the background of the weightings (NOAA, 2016). Also, predefined impulsive thresholds are only available for time series sources, as they are not clearly defined in the above document. If you wish to assess a continuous sound source as impulsive set the exclusion zone manually to the desired level as per (NOAA, 2016).

The main graphics area will show all areas where the currently selected minimum level is exceeded, coloured with the chosen colour. The colour may be changed with the *Set exclusion zone colour* button. If the *Levels must decrease with distance from source* option is not selected, this may cause problems for the exclusion zone drawing algorithm, therefore it is recommended that this option is selected when exclusion zones are desired.

To change the colours for the displayed results, click the '*Change colours*' button. This shows the colour edit dialogue.

To change the colour for a particular band, click on that colour. To set a band to be not visible, uncheck the '*Visible*' box for that band.



2 SETTINGS AND BACKGROUND

2.1 CONTROLLING VIEW AND DISPLAY

2.1.1 Changing between 3D and cross section view

To change to 3D view, press the 3D toolbar button.



To change to cross section view, press the cross-section toolbar button.



To measure distances in the 3D environment, press the ruler button.



2.1.2 Controlling the 3D environment view

With the mouse in the display area, the view may be rotated, panned and zoomed with the mouse:

- To pan: Right Click, Ctrl + Right Click, Alt + Left Click
- To Rotate: Ctrl + Left Click
- To Zoom: Mouse Wheel, Ctrl + Middle Click, Shift + Left Click.

To reset to a bird's eye view, click the Reset View button. When in this bird's eye view, objects (sources and probes) may be left clicked and dragged within the environment, and scale markers are shown along the x and y axes. Once the view is rotated, objects may no longer be dragged.



When the mouse cursor is over the display area, the info bar at the bottom of the main window gives information on the current mouse location and view state (pan, rotation and zoom). In addition, when dragging objects in the view window, the current x and y location will be shown.

2.1.3 Display of components

The visual depth scaling can be changed on the options page with the Z scale slider. Land and water colours can be altered on the preferences page.

Visibility of individual components can be turned on and off via the View Menu 1.1.4 p. 6.

2.1.4 Setting the cross-section

Before the cross-section view can be shown, the cross-section position must be set. Clicking the cross-section view toolbar button or choosing *Setup cross-section* from the project setup page shows the location of the cross section, in bird's eye view. Click and drag the endpoints to move the cross-section. While in this mode, pressing the number keys (1, 2, 3...) will set the start point to the location of the corresponding source, if one exists. Clicking the cross-section view toolbar button again shows the cross-section.

In cross-section view mode, a smaller overview of the project area is shown at top right. The cross-section endpoints shown in this view may be dragged to move the location of the cross-section, which will update automatically.

2.1.5 Measuring distances

Pressing the ruler toolbar button allows the user to measure distances. Click with the mouse at the location to measure from, and the cursor will begin to show the distance from that point. While in this mode, pressing the number keys (1, 2, 3...) will set the start point to the location of the corresponding source, if one exists.

2.2 EXPORTING

2.2.1 Exporting the current scene to an image file

An image file containing the current scene may be exported by choosing the 'Export the current scene as...' button from the Export menu. BMP, JPG, PNG and PDF file types may be exported. If the current scene includes calculated sound levels, then the exported image will include a scale bar showing the colour scale for levels. The exported image can also include text and an image, which are set under *Preferences -> Exporting*.

2.2.2 Exclusion zone export

For the exclusion zone you can choose to export as either ASCII grid (.asc) or as ESRI shapefile (.shp).

2.2.3 Animated exports

If you have modelled a moving source, and ticked the "*Moving sources retain all calculated levels*" box (memory intensive) then you can use this tool to generate a .gif or .avi animation of the movement of your source. This tool does a frame by frame animation of the track, not taking movement speed into account.

2.2.4 Export to shapefile or ESRI ascii grid

A shapefile or ESRI ascii grid file is exported with current levels and geo-referenced to the selected UTM-zone.

2.3 SOLVERS

A range of calculation methods (solvers) are offered. Each given solver is applicable to certain classes of problems, and the correct method should be chosen for a given problem. A full description of the solvers is beyond the scope of this document, and the interested reader is referred to the references given below.

2.3.1 Split low/high frequency solvers

Different solvers may be chosen for the low and high frequency ranges. The crossover frequency is chosen via the Frequencies and Solvers page. A typical usage would be dBSeaModes for the low frequency range and dBSeaRay for the high. The crossover frequency is given broadly as $f = 8d/c$ where f is the frequency in (Hz), d is the average depth (m) and c is the speed of sound (m/s). Some experimentation may be required where the depth varies greatly.

Added to the solver-calculated transmission loss, is the attenuation with distance in seawater. This is insignificant at low frequencies and in the human audio range, but at high frequencies can be significant, for example attenuation is approximately 30 dB/km at 100 kHz. The attenuation with frequency is graphed on the Water page, p 29.

2.3.2 $20 \log(r/r_0)$

Transmission loss is calculated based on simple geometric spreading, i.e. an inverse square law. The calculated attenuation is spherically symmetric and frequency independent. Bathymetry is ignored, absorption is included.

2.3.3 $20 \log(rd/r_0) + 10 \log(r/rd)$

Transmission loss is calculated according to the $20 \log(r/r_0)$ inverse square law, until the distance from the source is greater than the water depth at the source. From this point, levels drop according to $10 \log(r/rd)$, i.e. an inverse law. It is considered that the reflections from the seafloor and the sea surface constrain the sound energy within the water layer, and the problem becomes essentially 2-dimensional, or similar to a vertical line source extending from the surface to the seafloor. Axially symmetric, frequency independent. Bathymetry is ignored, with the exception of the aforementioned calculation based on the water depth at the source. Absorption is included.

2.3.4 dBSeaPE - parabolic equation method

The dBSeaPE solver utilises the so-called parabolic equation, and is range-dependant, i.e. it takes variable bathymetry and water/sediment

properties into account. dBSeaPE is suitable for low frequency problems. The input to the solver is configured so that the sediment layer is extended down to 2 times the depth of the water column, with the attenuation rapidly increasing at the lowest depths. The intention is to remove energy that would be reflected from the very bottom of the sediment layer. The sea surface is a pressure-release interface.

As sharp discontinuities in density cause incorrect calculation results, the density is smoothed between water and seabed, and between seabed layers by means of a hyperbolic tangent function.

2.3.5 dBSeaModes - normal modes method

The normal modes are calculated for each water depth, based on the sediment properties and water sound speed profile. The sound field is calculated based on coupling between the calculated modes across the interfaces between different depths. The calculation is of the adiabatic, single forward scattering type. The overlying space is modelled as a vacuum. dBSeaModes is suitable where the frequency is low and/or the water depth is shallow. The sediment layer is extended down well below the depth of the water column, with the attenuation rapidly increasing at the lowest depths. In this way, there are no modes where energy is reflected from the very bottom of the sediment layer (the space underneath the bottom of the sediment is also a vacuum).

The maximum number of modes to include in the solution may be limited via the Preferences -> Advanced solver options. If the value is set to 0, the solver uses all the modes found by the eigenvalue search routine.

2.3.6 dBSeaRay - ray tracing method

The ray solver forms a solution by tracing rays from the source out into the sound field. A large number of rays leave the source covering a range of angles, and the sound level at each point in the receiving field is calculated by combining the components from each individual ray. The number of rays may be set on the Preferences -> Advanced solver options. Setting this number to 0 instructs the solver to choose the number of rays itself, however it is often the case that the number of rays chosen is higher than needed, leading to excessive computation time. It is often useful to set this number very low as a fast initial 'checking' solve, before increasing the number of rays and running a full solve which may take some time. The overlying space is modelled as a vacuum. dBSeaRay is suitable for high frequency problems.

When multiple seafloor layers are present, rays are not split and traced into the seafloor. A complex reflection coefficient is calculated which is

representative of the underlying layers, and this coefficient is applied to the ray at the point of seafloor reflection. The calculation of the reflection coefficient follows *Computational Ocean Acoustics*, Jensen et. al. Springer, 2011 (section 1.6).

dBSeaRay is used for time domain calculations. Instead of returning a transmission loss at each point in the slice, a list of ray arrivals is returned (with separate entries for each frequency). These arrivals lists can be used to calculate the effective time series at each point in the slice, which is then used to calculate peak, peak to peak, and frequency band SEL levels.

These calculation methods are extensively documented in *Computational Ocean Acoustics*, Jensen et. al. Springer, 2011.

2.3.7 Postprocessing of levels for each source

After a solve, the calculated transmission losses for each source are post-processed. These steps are optional, and can be controlled from the *Preferences -> Advanced solver options* page. The transmission loss is made to decrease monotonically with increased distance from the source (i.e. the level will decrease with distance from the source). In addition, the transmission loss is averaged radially about the source. Averaging is performed with a normalised triangular kernel of length $2 \cdot m + 1$, where m is the *Radial smoothing factor* selected on the *Preferences -> Advanced solver options* page, on the calculated transmission losses moving radially around the source, for each range distance from the source. This option is useful when dealing with results from a solver that change rapidly in the radial direction.

To disable these postprocessing steps, set *Radial smoothing factor* to 0 and uncheck *Levels must decrease with distance from source*.

Neither of these options has any effect when using the 10 log or 20 log solvers.

2.3.8 Interpolating levels from sources to the grid

For each source, sound levels are calculated in 'slices' radiating out from the source. The number of slices to calculate and the number of range points along each slice can be changed on the Project setup 1.3 p. 8. These sound levels are then interpolated onto the rectangular problem grid. Therefore, at large distances from a source, there may be a significant spacing between the calculated slices. If more detail is required in such an area, then the number of solution slices should be increased.

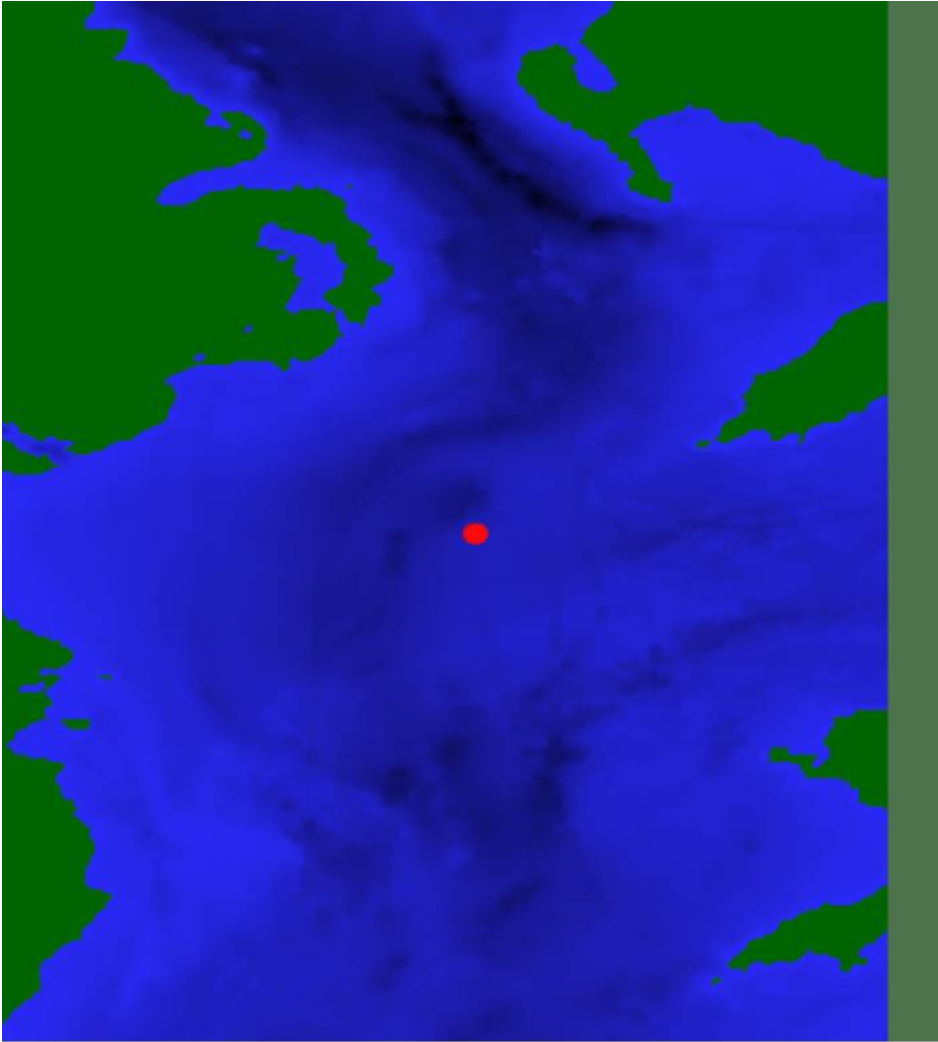


Figure 3.A single source in the problem area.

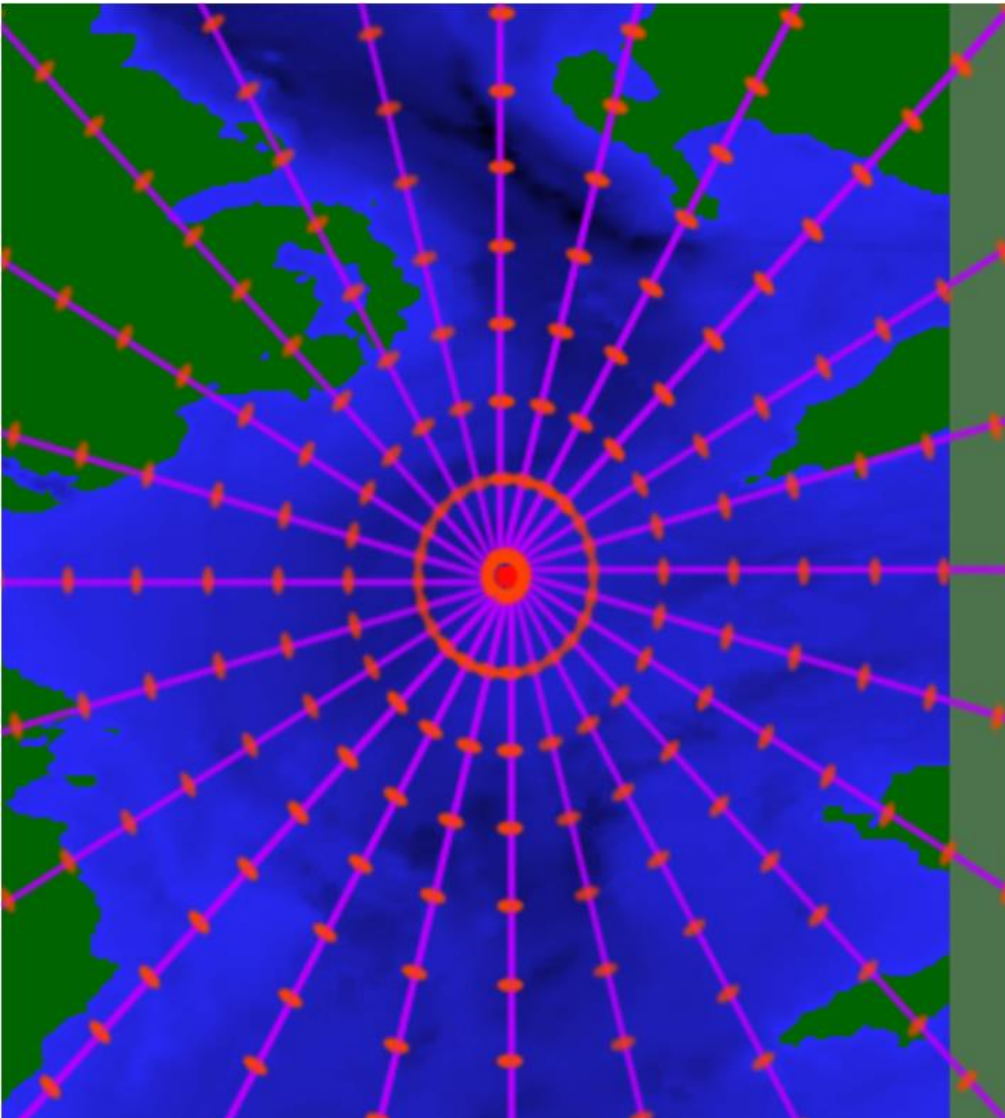


Figure 4. The slices and solution points radiating out from the source.

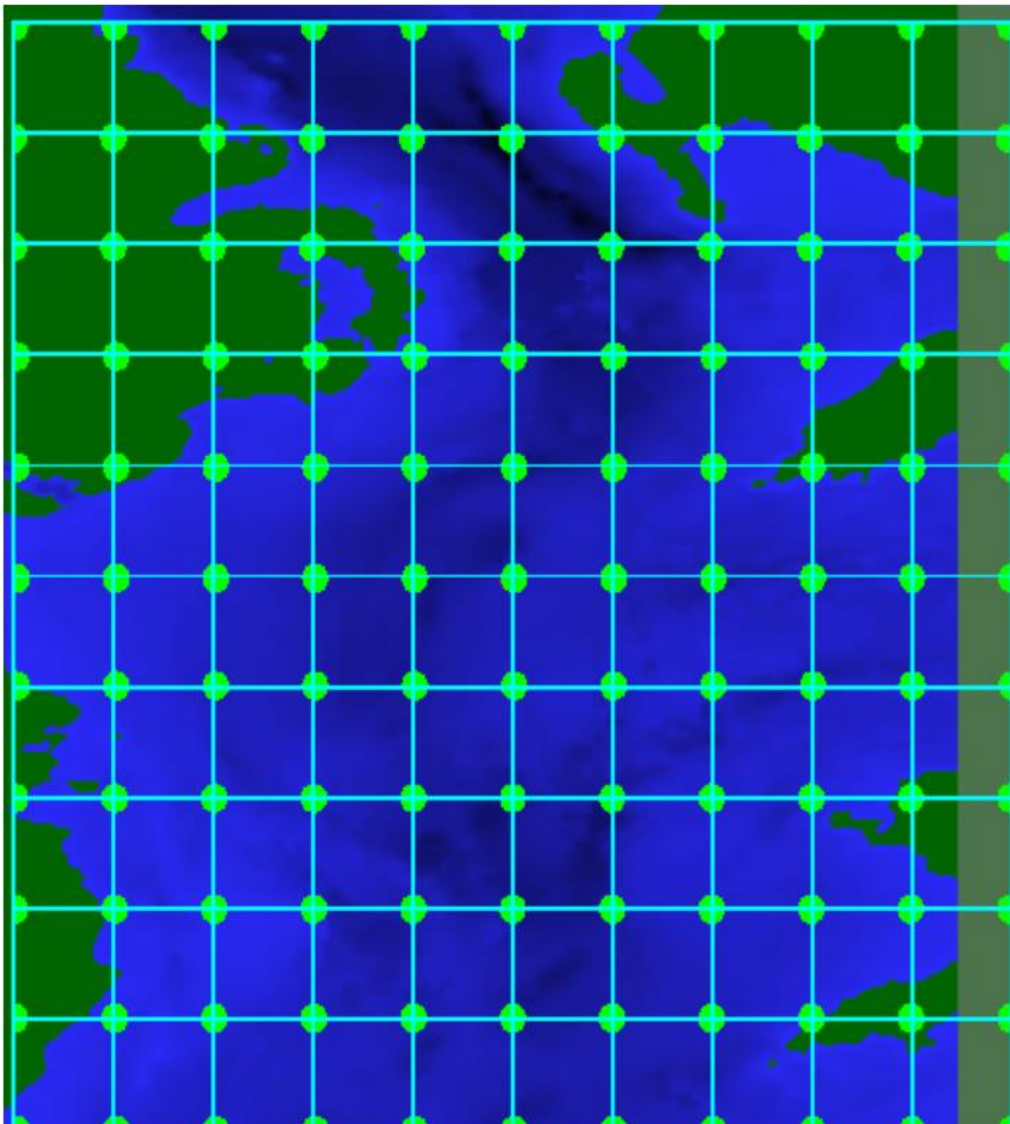


Figure 5. Example problem grid.

The overall sound levels are interpolated (and summed over all active noise sources) to the rectangular problem grid.

2.4 READING CSV FILES

Bathymetry data is read into the program from comma separated value (CSV) files. CSV files can be created in Excel or other similar programs. Each 'pixel' is simply a depth in metres, separated by a semicolon or comma. Example files may be found in the program directory. As CSV is not a standardised format however, there are several problems that may occur, depending on the specific file format.

Upon loading a CSV file, the program will ask whether the values are

separated by commas or semicolons. It will also take a guess as to which is the correct one. The CSV files created by different programs use slightly different standards (and can also depend on locale settings, for example MS Excel will use the current locale settings to choose delimiters and decimal separators). For users from countries where numbers are written 123,45 rather than 123.45 this can cause confusion, as a comma is used as a decimal separator rather than a value delimiter. To ensure correct import of data, use a decimal point as the decimal separator.

Furthermore, some programs will place quote marks around each field, giving .."123.45";"45.6";"42"... which is currently not supported for import.

Another problem may be caused by end of line characters - the text characters used to denote the end of a line differ between operating systems. Therefore care should be taken with files created on non-Windows machines (Apple, Linux, FreeBSD etc).

Please note that many files with the .csv extension are in fact .xyz files or some variation thereof. CSVEditor expects .csv files to contain gridded height/depth data, representing a raster. A common file format is 3 columns of text data, representing x,y, and depth (sometimes in another order) points. Such files should be opened using the '*Import vector file*' dialog.

It is a requirement that there are the exact same number of fields (i.e. delimiters) on each line of the file. (Note that this is not a requirement for ESRI ascii grid files, in that format the end of a row is found by using the *ncols* parameter in the ESRI ascii header).

If a particular file is causing problems, this can often be fixed by opening the file in a spreadsheet program such as Excel or LibreOffice Calc and re-saving as a CSV file.

Very large CSV files can easily exceed the maximum size allowable in spreadsheet programs. Large files can be edited with text editors such as Emacs, Vim or Notepad++.

CSV Editor is included, which allows simple editing of CSV data and conversion of shapefile or xyz formats. For more information see CSV editor 2.8 p. 48.

2.5 ADVANCED SOLVER OPTIONS

The *Advanced* tab in the preferences form allows more detailed control of solver behaviour.

(Extensive documentation of all types of solvers is available in (Jensen, et al., 2011).)

2.5.1 General options

Autosave:

Save the active project file after each solve if the project has a save file.

Remove levels below seafloor:

dBSeaModes and dBSeaPE calculate levels in the seafloor as part of a solve. By default dBSea ignores these levels.

Levels must decrease with distance from the source:

The solver output is often more detailed than required. This option ensures that sound levels will decrease monotonically with distance away from each source, which is often useful where conservative design is required. This can be applied and removed without recalculating levels in the scenario.

Stop marching solution upon reaching land:

Whenever land is encountered the solver will stop the propagation calculation. This is useful for limiting computational load when next to a large landmass, but is not suitable when many small islands are present.

Frequency oversampling:

dBSea can solve for multiple evenly spaced frequencies in each frequency band. For example, if the band centre is 1 kHz, the oversampling 5, and the bandwidth is 1 octave, dBSea will solve at 757.9, 870.6, 1000, 1148.7 and 1319.5 Hz, and then average the results to give the level for that band. This option is useful for modelling broadband noise sources and/or fast changing environments. Increases computation time.

Radial smoothing factor and exclusion zone radial smoothing factor:

The solver output is often more detailed than required. dBSea smooths results or exclusion zones radially around each source, with a triangular kernel of length $2 \times \text{factor} + 1$. Set the factor to 0 for no smoothing.

2.5.2 Maximum attenuation layer thickness, in wavelengths

For dBSeaPE and dBSeaModes the sediment is set to attenuate sound so that no sound is reflected from deep in the sediment. The user can set the

depth at which maximum attenuation occurs, relative to the wavelengths in the scenario.

2.5.3 dBSeaPE

Depth and range oversampling:

The output from dBSeaPE is calculated at the range points and depth points grid. These oversampling factors control the size of the oversampled calculation grid that dBSeaPE uses internally. Increasing these factors increases the accuracy of the calculated levels, at the cost of increased solve time and memory requirements.

dBSea currently uses dBSeaModes to generate a starting field. This approach can fail, in which case dBSeaPE uses Greene's starter (Jensen, et al., 2011), a simpler (but less accurate) method of generating a starting field.

Number of Padé terms:

Specify a number of Padé terms to use. A higher number will increase accuracy of the prediction, but also decrease solving speed. If "0", dBSea will use "Greene's approximation" (Greene, 1984)

Setting the number of Padé terms at 5 is thought to be sufficient for most scenarios (Collins, 1991). Note that using just *one* Padé term is inferior to using Greene's approximation.

If the modal starter fails to find any modes, dBSea will let you know:

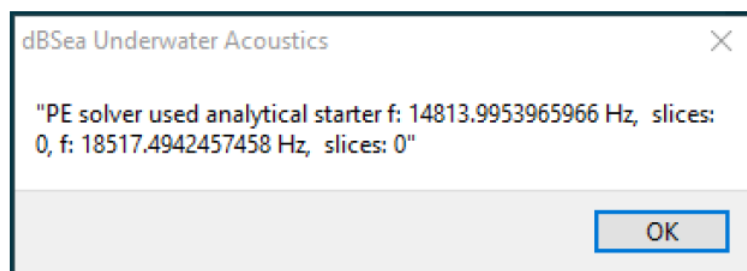


Figure 6. An example of the PE solver not finding any modes for the starting fields. Here provoked by using very high frequencies (for the PE solver).

2.5.4 dBSeaRay

Calculate volume attenuation at each step:

dBSeaRay can calculate the accumulated attenuation in water for each ray at every step. With this option turned off, the average of the source and receiver depths is used. The volume attenuation is typically negligible except for at high frequencies.

Runge-Kutta method:

The solvers rely on a smooth sound speed profile. dBsea uses the Runge-

Kutta method to extrapolate from the provided sound speed profile if it is likely to cause errors in the calculation. You can force dBSea to use either 2nd or 4th order Runge-Kutta method if you wish.

Number of rays, start and end angles:

dBSea splits the sound leaving the source into N evenly spaced rays between the start and end angle. 0 degrees is horizontal from the source, -90 degrees is up and +90 degrees is down. Default number of rays is 1000.

Max number of reflections from seafloor:

After this number of reflections, the ray is terminated. In shallow water scenarios this number should be high (>1000).

Initial step size (m):

Size of the first step in metres. The next step sizes depend on solver grid resolution and ray path.

2.5.5 dBSeaModes

Max number of modes:

Enter a value other than zero to limit the number of modes to search for. Setting zero lets dBSeaModes use all modes found by the eigenvalue search routine.

Oversampling:

For more accurate results you can choose to oversample both with range and depth.

2.6 PREFERENCES

The Preferences page gives access to options relating to data display and calculation.



2.6.1 Graphics

Immediately update results graphics - if ticked dBSea will update the graphics layer *as you are changing properties*. This can lead to performance issues on slower computers.

Max bathymetry graphics data - This determined the maximum amount of data held in your graphics memory. It does not affect the resolution of the actual calculation, only how much is displayed.

Two drawing tweaks are available: **Smooth result colours** and **Draw levels with triangle algorithm**. Use either to change the way results are represented.

By default, probes are not included in exported images. To enable exporting of probes, uncheck the '*Hide probes on image export*' box.

Levels display: Three methods are available for display of calculated levels. With the default **Max from all depths projected to surface** option, for each x and y location, the maximum sound level at any depth is found. This is then displayed at the water surface. With the **Single depth** option, data from a single depth is displayed at the correct depth. The display depth may be changed with the **Display solution depth #** buttons. **All depths** can be selected, and by adjusting opacity in *Preferences* → *Graphics sizes*.

The colours for display of various objects (land, water, background) can be changed here.

2.6.2 Graphics sizes

Immediately update results graphics - if ticked dBSea will update the graphics layer *as you are changing properties*. This can lead to performance issues on slower computers.

Sliders control an array of display options.

2.6.3 Multi core

dBSea will by default use all available cores on your computer. If you wish to work alongside a running solve, consider limiting the number of cores that dBSea will use.

2.6.4 Directories options

The default save directory and the temporary working directory may be changed here.

2.6.5 Misc. options

The units may be changed between metric and imperial. A name for the project may be entered here.

2.6.6 Exporting options

An image and text may be chosen to include in exported image files. The delimiter for CSV export may also be chosen (for ESRI Ascii export, the delimiter is always the space character (ASCII 32)).

2.6.7 Sound levels display

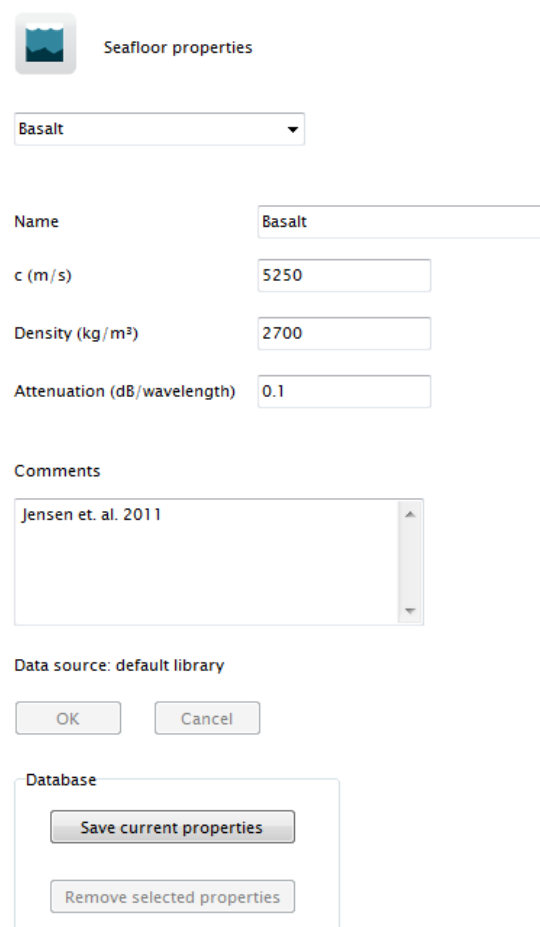
The type of sound levels to display may be chosen on this tab. The options 'dB SELcum' and 'dBpeak' may be used for assessment against the criteria

defined in "Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing", (NOAA, 2016).

For converting between the available sound level types, an effective assessment period is set on this tab. This time period is used when converting between, for example, input sound sources given as SL, and output levels as dB SELcum. Continuous sound sources (created via the 'Spectrum' button) are active throughout the entire assessment period, unless modified by the 'Count' and/or 'Duty %' parameters.

2.7 DATABASES

Information on acoustical sources, mitigation, material properties, criteria and sound speed profiles is contained within two databases. The program ships with a default database, containing the default data provided by dBSea Ltd. A second database is created on the user's computer (in the temporary directory, which by default is located at C:\Users\\AppData\Local\dBSea Ltd\userLib.db), and the user may add and remove data freely in this database. Each of the tabs where the database is used allow the user to add or remove data, as shown in this example from the seafloor tab:



Clicking the 'Save current properties' button will create an entry in the user database with the current name, with the given properties. Clicking 'Remove selected properties' will remove the given entry (note that this button is only enabled when the current entry is from the user database).

Entries from both databases are shown together in the dropdown menu.

The user database may be backed up by making a copy of the userLib.db file. To restore this backup, simply copy the backed up file to its original location.

Should the user database become corrupted, or to permanently clear all user entries and start again, delete (or rename) this file and restart the program, a new empty user database will be created.

2.8 CSV EDITOR

CSV Editor is used to prepare input topography data for use in dBSea. It can read input data in a variety of formats, and produces correctly formatted CSV data (CSV editor p 48) ready to be accepted by dBSea.

GIS data comes in a wide variety of different formats, each specific to a particular use. CSV Editor attempts to interpret input data and prepare it for use by dBSea. However, due to the large number of possible input formats, it is not always possible to correctly interpret the input. It is recommended that if the user has access to specialised GIS software, to make use of that software to produce comma separated raster output with a suitably chosen grid size, ready for use by the main program. ESRI/ArcGIS ascii grid is a suitable and widely supported file format that CSV Editor is able to read. Data imported in ascii grid format has the added advantage that northing, easting and scaling data is included, and will be passed on to dBSea, removing the need to separately set those values within dBSea.

CSV Editor is able to import vector data from .shp (ESRI shapefile) and .xyz formats. Raster data is generated from the imported vectors via a Delaunay triangulation.

CSV Editor also allows the direct editing of depth data, by selection of an area and raising or lowering the terrain as necessary.

2.8.1 Importing raster data

Choose a data file to open with the '*Open raster file*' button. The entire file is not read initially, instead sample data from the file will be displayed in the fields to the right. If the data is not correctly interpreted, then use the '*Delimiter*', '*Header rows to ignore*' and '*Reverse direction*' options until the data is correctly recognised. Then click the '*Parse raster file*' button to display the data graphically. Heights/depths of exactly 0 are considered to be land.

2.8.2 Importing vector data

CSVEditor is able to import and convert vector data in .shp (ESRI shapefile) or .xyz (text xyz points) formats. See CSV editor vector import p 49 for more information.

2.8.3 Altering data

Large files may be reduced in size with the *Tools*→*Save reduced version of current file* option. A higher decimating number reduces the size of the output file, as each output data point is the average of $m \times m$ input data points, where m is the decimation factor.

Left clicking and dragging in the data image area selects a rectangular subset of the data (shown with an orange selection box) to edit. To select a non-rectangular area, click individual points forming a polygon in the image area. Double-click to confirm the selection. With an area selected, the bathymetry within that area may be raised or lowered with the '*Alter selected terrain heights*' buttons. Any changes may be removed with the '*Reset*' button. Changes to the terrain are reflected in the data image area. Moving the mouse over the image area shows the current depth at the cursor location.

2.8.4 Selecting an export range

The yellow selection rectangle shows the area of bathymetry that will be exported. To alter the export range, either enter values in the '*Use data subset*' boxes, or right click and drag in the image area.

2.8.5 Exporting selected data range

Clicking '*Export current selection*' writes out the selected data to a file which may then be opened in dBSea.

2.8.6 Troubleshooting

See CSV editor troubleshooting 2.10 p. 51.

2.9 CSV EDITOR VECTOR IMPORT

CSV Editor is able to import vector data from .shp (ESRI shapefile) and .xyz formats. Raster data is generated from the imported vectors via a Delaunay triangulation.

2.9.1 Importing vector data

Open the vector import form with the '*Import vector file*' button. On this form, a desired output file size can be chosen by setting the '*Target x or y length*' field. The input data will be triangulated to a grid with a maximum side length of the given value. The file to open is chosen, either a .shp (ESRI shapefile) or a .xyz (text xyz points) file.

Data import and triangulation may take some time, depending on the desired output file size and the number of input points. The current limit for total number of rows is approximately 2 million, although the exact limit may vary depending on the details of the triangulation.

2.9.2 Shapefile import

The shapefile format specifies many files that can be part of a 'shapefile', CSV requires two of these: a .SHP file containing the shapes/contours themselves, and a .DBF database file containing information about the shapes. The z height/depth data for each shape/contour is read from one of the fields in the database file, and all the points in that shape are given that height. A dialog will show upon selecting an import file, asking which field contains the height/depth data. The .SHP and .DBF must have the same name (excluding extension) and be located in the same directory.

2.9.3 XYZ import

XYZ is a commonly used format, despite not being well defined. CSVEditor allows some variations on the basic format. When opening an XYZ file, a form shows, asking whether:

- Data is arranged in 3 columns, giving X location, Y location, and depth/height. Alternatively, columns may be ordered z, x, y.
- Header rows at the start of the file may be ignored. Click in the 'Ignore' column to choose rows to ignore.

All data is in metres.

An example file viewed in a spreadsheet program:

	A	B	C	D	E	F
1	177735.6	3962665.6	10			
2	183451.5	3966812.8	10			
3	185753.1	3973534.8	10			
4	189985.2	3976379.1	20			
5	196423.4	3978692.5	20			
6	201309.2	3975803.0	10			
7	202698.6	3970608.1	10			
8	208852.5	3967241.9	20			
9	215732.6	3965459.4	5			
10	222774.2	3966739.5	2			
11	229552.8	3970631.8	30			
12	233849.5	3976403.0	30			
13	237135.2	3982131.4	30			
14	239784.5	3988041.9	30			
15	243230.6	3993309.5	30			
16	247758.4	3998085.1	30			
17	254049.5	4001724.6	0			
18	260014.1	4006071.2	0			
19	265537.2	4010151.4	0			
20	272709.0	4012576.0	0			

Column A is the X location, column B the Y location, and column C the Z location.

The same file in a text editor:

```
177735.6,3962665.6,10
183451.5,3966812.8,10
185753.1,3973534.8,10
189985.2,3976379.1,20
196423.4,3978692.5,20
201309.2,3975803.0,10
202698.6,3970608.1,10
208852.5,3967241.9,20
215732.6,3965459.4,5
222774.2,3966739.5,2
229552.8,3970631.8,30
233849.5,3976403.0,30
237135.2,3982131.4,30
239784.5,3988041.9,30
243230.6,3993309.5,30
247758.4,3998085.1,30
254049.5,4001724.6,0
260014.1,4006071.2,0
265537.2,4010151.4,0
272222.0,4013336.0,0
```

Fields may be delimited by comma or tab characters (ASCII code 09). Line endings should be Windows-style (ASCII 13, ASCII 10).

2.10 CSV EDITOR TROUBLESHOOTING

CSV Editor attempts to cope with some of the common variations on input GIS files. However, there are many reasons why an input file will not correctly parse. Here are some guidelines for input data.

2.10.1 Raster import

Raster data must follow an exact grid, that is there must be an equal number of columns in each row of the data. Each 'cell' is interpreted as one pixel of depth data, and easting is considered to increase going along a row of data. Cells must be equally spaced.

Many files with the extensions CSV, TXT, ASC, XYZ etc. in fact contain vector data and in those cases it is appropriate to use the XYZ vector import tool. If an input file has 3 columns of text data, it is very likely a vector XYZ file rather than a raster. There are also raster gridded XYZ files

(where the given points are located on a regular grid), however CSV Editor also imports these using the XYZ vector import tool.

ESRI Ascii grid files commonly (but not exclusively) use the .ASC extension. There are several variations on the file header data, such as offering different X and Y cell sizes (using the DX and DY parameters in place of CELLSIZE), or using latitude/longitude coordinates in place of easting and northing given in metres. CSV Editor will attempt to interpret the input file, but not all header variations are known and some manual editing may be necessary. The delimiter for ESCI Ascii grid files is the space character (ASCII code 32).

2.10.2 Vector import

Whether the input file is .shp or .xyz, the quality of the generated raster will depend on the spacing of the input points. Best results are achieved where the given points are spread relatively evenly over the project area, and there are no large areas where no points are found. Areas at the edge of the map where there are no points will be shown in grey and will not contribute to any calculations. Increasing the size of the output raster gives greater resolution, at the expense of more calculation time, and the added detail may not be warranted by the quality of the input data.

2.10.3 Shapefile import

Both a .SHP and .DBF file are required. The input shapes are interpreted as contours, and the height/depth of each contour is read from one of the numerical fields in the .DBF file. Input shapes where the height/depth data is given by the z point coordinate are not currently supported.

2.10.4 XYZ import

There are several different ways of expressing XYZ data, and XYZ files may also use a variety of extensions. CSV Editor requires data to be comma or tab separated, in three columns, showing x, y and z coordinates as shown in CSV editor vector import 2.9 p. 49. Alternatively, the columns may be ordered z, x, y. Ignore any non-numerical header rows by clicking in the 'Ignore' column. The distribution of the given points in space is not important beyond the guidelines given above, so gridded XYZ files will import as well as partially gridded files and files with unstructured/unordered point spacing.

2.11 HASP DONGLES AND TRIAL LICENSES

2.11.1 Trial licenses

Your distributor can provide you with a dBSea trial license. If dBSea opens without a valid HASP dongle connected, it will request a trial license file.



Choose the file, and dBSea will import the license and will be available in trial mode until the trial period is over, or a valid HASP dongle is connected.

Trial mode allows full use of dBSea, however export of levels or bathymetry is disabled. In addition, exported images will have an overlaid watermark.

Projects created and saved in the trial version of dBSea can be opened in the full version, so if you start working on a project and then decide to purchase the full version, your work will carry over.

2.11.2 HASP dongles

The full version of dBSea is secured using Sentinel HASP licensing. Your HASP dongle will be sent to you by your distributor when you purchase dBSea. The first time you insert the dongle, it will install the required drivers which may take some time. If the driver install fails, drivers may be downloaded from [Safenet \(External link\)](#). Once the drivers are installed, your HASP dongle will be ready to use whenever inserted.

To use dBSea on a different computer, simply install dBSea and insert the HASP dongle as before.

2.11.3 Demo version

If neither a HASP dongle or a trial license is found, dBSea will open in demo mode. In this mode, import and export functions are disabled, as are opening and saving of projects. Other functions are activated, so you will be able to explore the program, work on and solve problems using the default bathymetry.

2.11.4 Troubleshooting

Occasionally, there can be problems with installation of a trial license or using the HASP dongle. In most cases, these can be solved by uninstalling and reinstalling dBSea. If dBSea will not open after this step, please contact your distributor, quoting any error messages displayed including the error code (e.g. "1160: License file could not be decoded").

For network keys sometimes manual specification of IP addresses is necessary:

The network Hasp Key can be situated on a computer outside the subnet range of the local client machines accessing the HASP Key. However, the IP address of the remote computer with the HASP key must be manually entered on the client machines using the HASP License Manager as follows:

1. On each of the client machines, type `http://localhost:1947` in the address bar of web browser, e.g. Internet Explorer, Chrome or Mozilla, on the local machine that is to access to the HASP key located on a different subnet. This starts the Hasp License Manager interface.
2. Click the Configuration tab on the left-hand side menu.
3. Select the “Access to Remote License Managers” tab across the top of the window.
4. Click the box next to “Aggressive Search for Remote Licenses”.
5. In the clear window next to “Remote Licence Search Parameters” type in IP address of the server that holds the Hasp key and press the Submit button.
6. Click the “Sentinel Keys” button on the left-hand side menu and wait for the remote Hasp key to appear in the list of keys.
7. It may take some time but the remote Hasp key should be found within 2 minutes.
8. Once the Hasp key appears in the list, you will be able to run dBSea.
9. You only have to do this setup once as the settings are stored in the HASP License Manager on the local machine when the browser is closed.

If this search fails, it's likely you do not have access to the computer with the HASP key. To confirm this open a “Command Prompt” (press `Win+R`, type “cmd” and hit “enter”). Type either “ping” *or* “tracert” followed by a space and the IP address of the machine with the key. If the above does not return either “reply” or “trace complete”, your machine is not connected to the requested IP. A firewall, faulty network setup, or hardware issues (are all cables connected?) could be the cause.

2.12 MINIMUM REQUIREMENTS

dBSea is available for Windows 7, 8 and 10. A computer that runs Windows 7 is capable of running dBSea. However, dBSea is both graphics and processor intensive, and so in general it is recommended to run dBSea on a machine with a fast processor and a graphics card. dBSea takes around 35 MB hard drive space, however the project files created are typically far larger than this.

dBSea may be run from a networked location if desired. Performance should not be significantly affected by network latency, for most tasks.



The required database files are stored locally on the user's machine (under {Users}/{Username}/Appdata/Local/dBSea Ltd) so database access is not affected by the network.

dBSea is 64 bits. If a 32 bit version is required, contact your distributor. The dBSea solvers run single threaded, and future versions are planned which will take advantage of the multiple cores available on modern machines.

dBSea will run in linux with wine, but you'll need to configure wine to use the native version of usp10.dll before the built-in version (can be set up in wine configuration menu). The HASP key is known to not be recognised in Linux, we do not have a solution for that at present.

3 REFERENCES

Collins, M., 1991. Higher-order parabolic approximations for accurate and stable elastic parabolic. *J. Acoust. Soc. Am.*, Volume 89, pp. 1050-1057.

Greene, R., 1984. The rational approximation to the acoustic wave equation with bottominteraction. *J. Acoust. Soc. Am.*, Volume 76, pp. 1764-1773.

Jensen, F., Kuperman, W., Porter, M. & Schmidt, H., 2011. *Computational Ocean Acoustics*. 2nd ed. s.l.:Springer.

NOAA, 2016. *Guidance for Assesing the Effects of Anthropogenic Sound on Marine Mammal Hearing*, s.l.: National Oceanic and Atmospheric Administration.