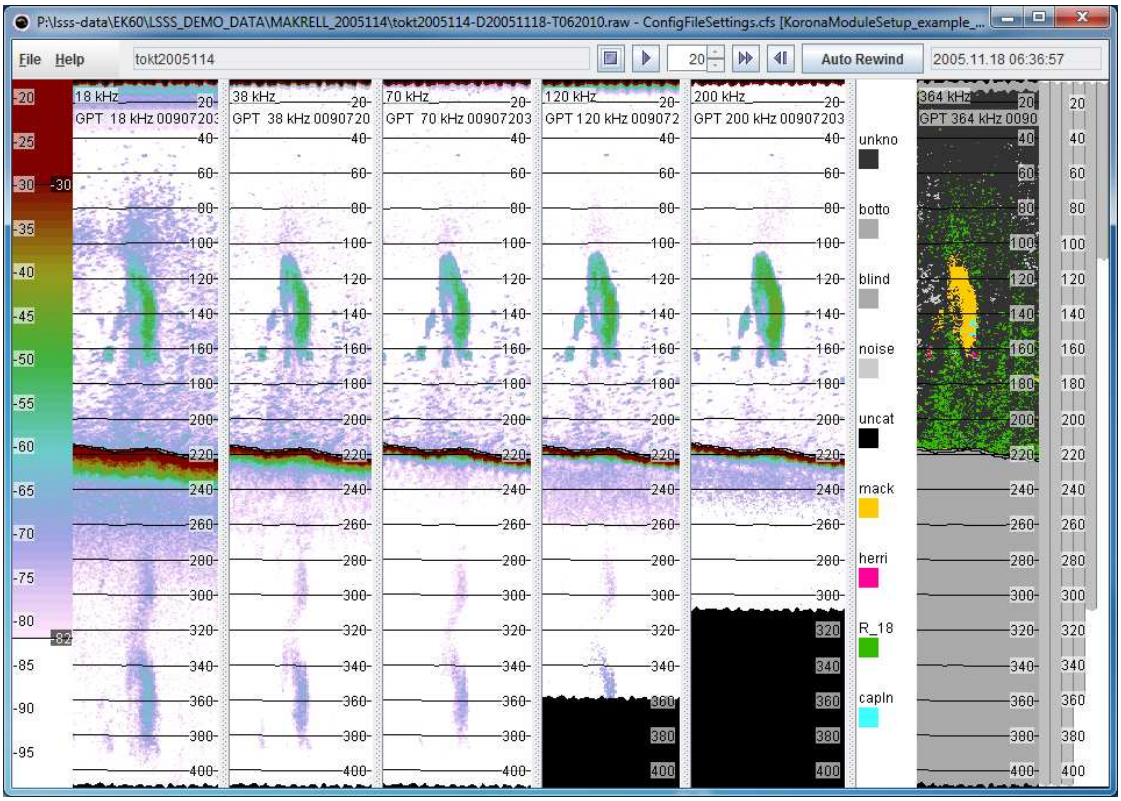


Korona

User Guide

Version 1.11.0

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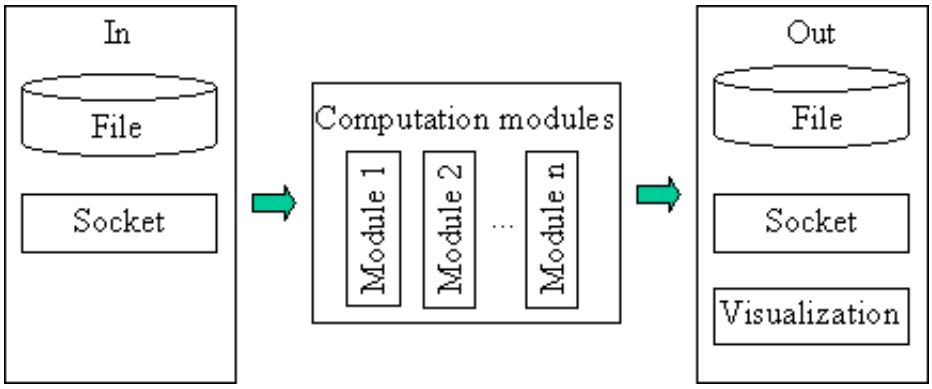
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Korona

Korona is the LSSS preprocessor, and is used for processing and visualizing data from an acoustic source. The acoustic sources may be e.g. EK60, EK500, ME70, MS70, SX90 or similar equipment.

See the getting started section for basic introduction to using the system.

Datagrams go through a sequence of processing modules as illustrated in the figure below.



Data processing in Korona.

The sequence of processing modules can be loaded from file, or configured using the module editor.

Getting started with Korona

The processing done by Korona can either be done as batch processing, using Korona relay, or interactively using Korona playbox.

Viewing a data file

1. Start Korona relay and specify the location of data files in "Source directory". A list of available data files in that directory will then appear below.
2. Select one of the files in the list by clicking on it.
3. Click the "Korona playbox" button to start Korona playbox.

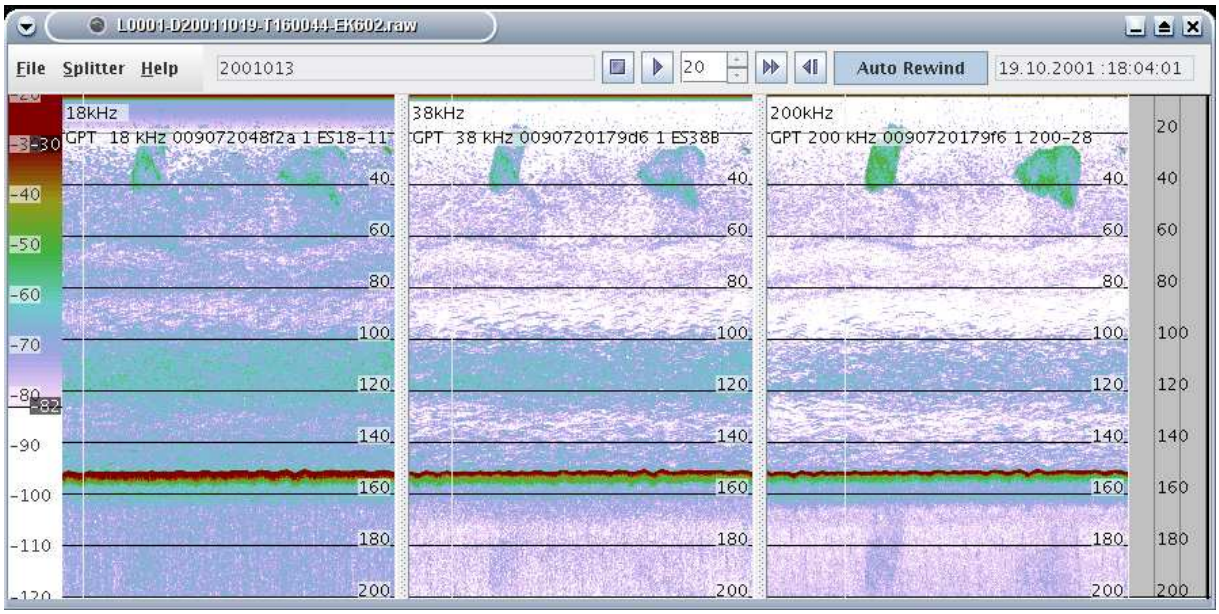
Computation modules

Computation modules are specified by the "Module configuration" file in the Config file settings.

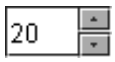
1. Click the "Edit" button for the "Config file settings" file in Korona relay.
2. Specify a "Module configuration" file by one of
   - Click the "Browse" button to select an existing file.
   - Click the "Edit" button to specify modules using the module editor.

Korona playbox

Korona playbox allows for interactively exploring the processing.



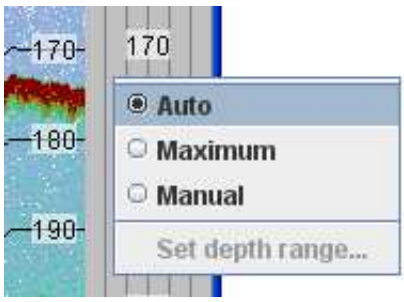
The following buttons control the viewing:

	Stop play.
	Start play.
	The play speed relative to real time.
	Play as fast as possible.
	Rewind to beginning of the data file.
	Automatically rewind when end of file is reached.

Functionality for viewing the selected data file.

Depth range menu

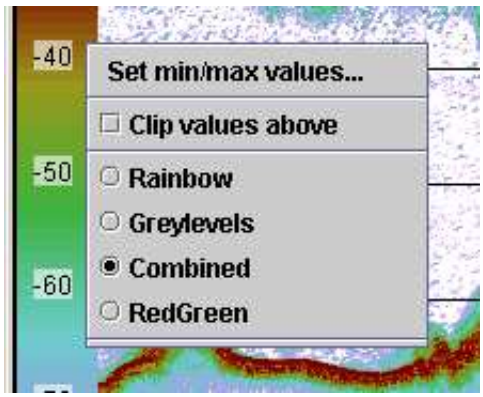
The panel on the far right shows the depth range of the data. Right-click here to access a menu with options for setting the depth range:



- *Auto:* Visible depth range is set automatically to a reasonable range based on the last 100 pings.
- *Maximum:* Visible depth range is set to the maximum (join) range during the last 100 pings.
- *Manual:* Visible depth range is user defined. Drag the two markers to change the visible range or open a dialog by selecting *Set depth range...:*

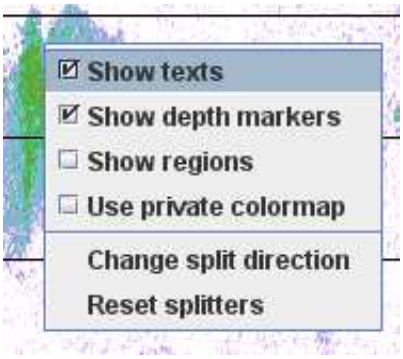
Colormap menu

The panel on the far left shows the mapping from S_v values to colors. Drag the two markers to change maximum and minimum values for the colormap. Right-click to access a menu with these options:



- *Set min/max values...:* Specify maximum and minimum values for the colormap in a separate dialog.
- *Clip values above:* Toggle on and off using white instead of the colormap's extreme color for values above the maximum value.
- *Rainbow* | *Graylevels* | *Combined* | *RedGreen:* Choose which colormap to use.

Echogram menu

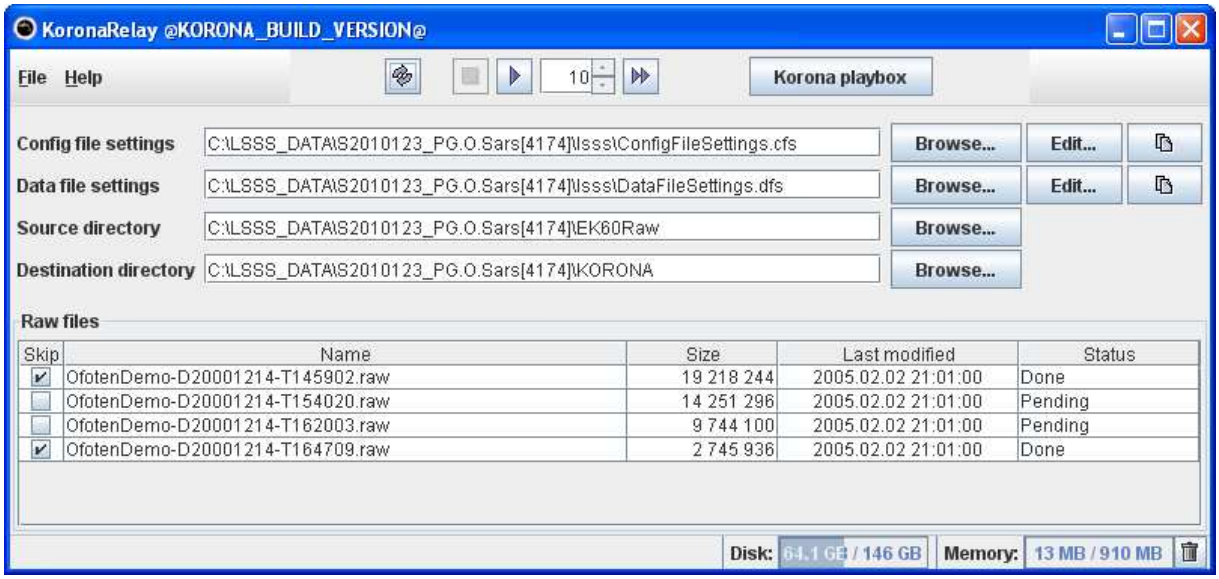


Right-click in an echogram panel to access a menu with the following options:

- *Show texts:* Toggle on and off text labels in upper left corner.
- *Show depth markers:* Toggle on and off depth labels and drawing of horizontal lines at constant depth.
- *Show region:* Toggle on and off plotting of regions detected by RegionModule.
- *Use private colormap:* Toggle on and off the use of a separate colormap panel for this echogram panel. This separate colormap panel has options to show categories.
- *Change split direction:* When a data file has more than one channel it is possible to view the channels either side by side, or stacked on top of each other. The size of each echogram panel may be adjusted by dragging the dividers with the mouse.
- *Reset split:* Sets equal distance between the splitters.

Korona relay

Korona relay is intended for batch processing. Use Korona playbox for interactive exploration.



- *Config file settings:* A file containing the paths to config files used by the processing.
- *Data file settings:* A file containing the paths to data files used by processing.
- *Source directory:* Location of files to be processed.
- *Destination directory:* Location of the processed files.

Korona batch

Korona batch is intended for scripted batch processing.

Command line options:

`--cfs`	The config file settings used by the processing.
`--dfs`	The data file settings used by the processing.
`--source`	Directory with files to be processed.
`--destination`	Directory where the processed files will be written.
`--help`	Display help information.

Example:

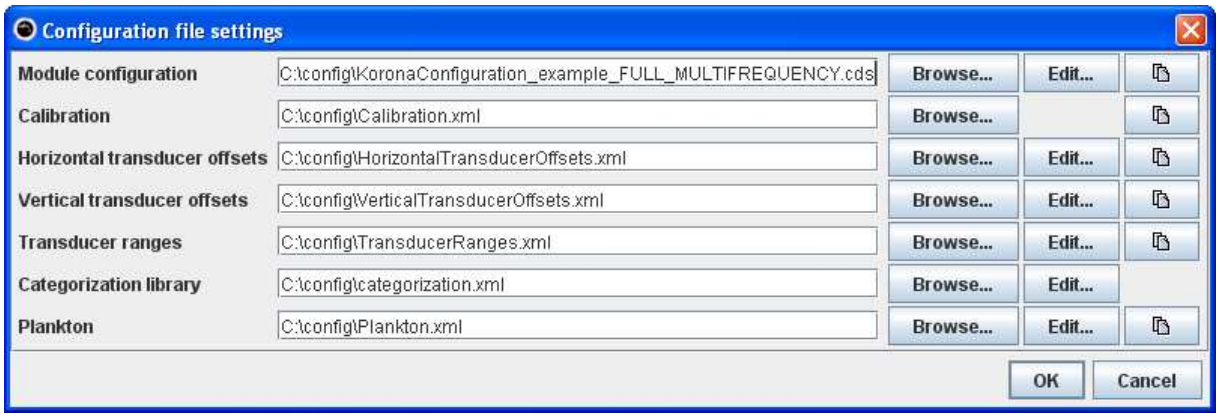
```
KoronaBatch.bat --cfs=D:\ConfigFileSettings.cfs
--source=D:\OriginalRaw --destination=D:\ProcessedRaw
```

Notes:

- The `--dfs` option can be omitted if it is not required by the processing setup.
- If file paths contain spaces then quotes are necessary, e.g. `"--source=D:\Raw files"`.

Config File Settings

The config file settings is a set of common config files used by the Korona processing modules. The paths to these files are stored in a ConfigFileSettings file, .cfs.



The files listed are:

- **Module configuration:** The modules used in the processing. Can be edited by the Module editor.
- **Horizontal transducer offsets:** The horizontal positioning of transducers relative to the 38 kHz transducer.
- **Vertical transducer offsets:** The vertical positioning of transducers relative to the 38 kHz transducer.
- **Transducer range:** The depth range of each transducer in meters.
- **Categorization:** The categorization config file. See CategorizationModule.
- **Plankton:** The plankton inversion config file. See PlanktonInversionModule.

Pressing the Edit... button will for each file bring up an editor with the contents of the config file.

Data File Settings

The data file settings is a set of common data files used be the Korona processing modules. The paths to these files are stored in a DataFileSettings file, .dfs.

The files listed are:

- **Towfish:** The top folder for towfish data. Used by TowfishModule.

Calibration

Calibration of data is done if a file named "calibration.xml" exists in the same directory as the raw data files.

Simple example

```
<?xml version="1.0" encoding="UTF-8"?>
<calibration>
   <default g="26.5" SA="64:-0.49, 128:-0.71, 256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35, 8192:-0.35"/>
   <case channel="1" kHz="18" g="22.4" SA="512:-0.59, 1024:-0.65, 2048:-0.45, 4096:-0.4,  8192:-0.35"/>
   <case channel="2" kHz="38" g="26.5" SA="256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35"/>
   <case channel="3" kHz="70" g="27.0" SA="128:-0.88, 256:-0.82,  512:-0.53,  1024:-0.39, 2048:-0.41"/>
   <case channel="4" kHz="120" g="27.0" SA="64:-0.49, 128:-0.71,  256:-0.66,  512:-0.41,  1024:-0.32"/>
   <case channel="5" kHz="200" g="27.0" SA="64:-0.66, 128:-0.76,  256:-0.38,  512:-0.32,  1024:-0.29"/>
   <case channel="6" kHz="333" g="27.0" SA="64:-0.50, 128:-0.70,  256:-0.35,  512:-0.30,  1024:-0.30"/>
</calibration>
```

If the default element is present, then it will apply to all channels without a separate case element.

At least one of the attributes ’id’ and ’channel’ must be specified. All other attributes are optional.

If an actual transducer configuration in a data file for a specified ’id’ or ’channel’ does not match all of the values specified for ’id’, ’channel’ and ’kHz’ then a warning is given and the calibration is not applied.

Attribute	Description
id	The channel id
channel	The channel number
kHz	The frequency in kHz
g	New value for gain
SA	New values of the sa correction table given as a comma separated list mapping from pulse length (in microseconds) to sa correction
abs	Absorption coefficient
sound	Sound velocity
equivalentBeamAngle	Equivalent beam angle
beamWidthAlong	Beam width alongship
beamWidthAthwart	Beam width athwartship
angleOffsetAlong	Angle offset alongship
angleOffsetAthwart	Angle offset athwartship

Example with multiple time intervals

```
<?xml version="1.0" encoding="UTF-8"?>
<calibration>
   <calibration begin="2010-01-01T12:00:00Z" end="2010-02-01T12:00:00Z">
      <case channel="1" kHz="18" g="22.4" SA="512:-0.59, 1024:-0.65, 2048:-0.45, 4096:-0.4,  8192:-0.35"/>
      <case channel="2" kHz="38" g="26.5" SA="256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35"/>
   </calibration>
   <calibration begin="2010-03-01T12:00:00Z" end="2010-04-01T12:00:00Z">
      <case channel="1" kHz="18" g="22.4" SA="512:-0.59, 1024:-0.65, 2048:-0.45, 4096:-0.4,  8192:-0.35"/>
      <case channel="2" kHz="38" g="26.5" SA="256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35"/>
   </calibration>
</calibration>
```

The calibration element can have multiple nested calibration elements specifying begin and end times. The times are specified in UTC using the format `YYYY-MM-DDThh:mm:ssZ` in accordance with ISO 8601.

If the begin time is omitted it is taken to mean since the beginning of time.
If the end time is omitted it is taken to mean to the end of time.

NB! Note that the calibration element matching the time of the CON0 datagram will be used for the entire data file. This means that even if the time of a ping matches a different calibration element, then the calibration element matching the time of CON0 datagram will be used.

NB! Note that if the time matches the interval of a nested calibration element, then *only* that element is used. Specifically, top level default and case elements and not merged with those of a nested element. In the example below, only channel 2 will be modified between 2010-01-01T12:00:00Z and 2010-02-01T12:00:00Z, as the top level default and case elements do not apply.

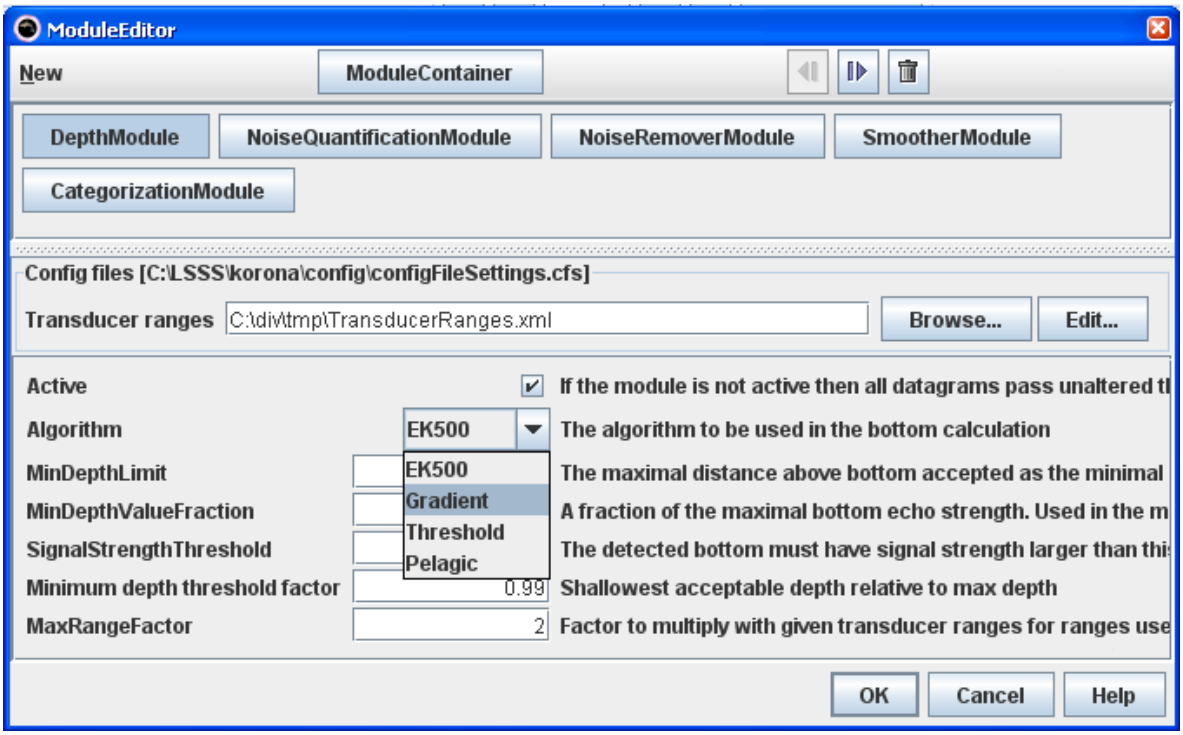
```
<?xml version="1.0" encoding="UTF-8"?>
<calibration>
   <default g="26.5" SA="64:-0.49, 128:-0.71, 256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35, 8192:-0.35"/>
   <case channel="1" kHz="18" g="22.4" SA="512:-0.59, 1024:-0.65, 2048:-0.45, 4096:-0.4,  8192:-0.35"/>
   <calibration begin="2010-01-01T12:00:00Z" end="2010-02-01T12:00:00Z">
      <case channel="2" kHz="38" g="26.5" SA="256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35"/>
   </calibration>
</calibration>
```

In fact, the above example is equivalent to

```
<?xml version="1.0" encoding="UTF-8"?>
<calibration>
   <calibration>
      <default g="26.5" SA="64:-0.49, 128:-0.71, 256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35, 8192:-0.35"/>
      <case channel="1" kHz="18" g="22.4" SA="512:-0.59, 1024:-0.65, 2048:-0.45, 4096:-0.4,  8192:-0.35"/>
   </calibration>
   <calibration begin="2010-01-01T12:00:00Z" end="2010-02-01T12:00:00Z">
      <case channel="2" kHz="38" g="26.5" SA="256:-0.58, 512:-0.77,  1024:-0.66, 2048:-0.42, 4096:-0.35"/>
   </calibration>
</calibration>
```

Module editor

The module editor is a tool for configuring the chain of computation modules, and for editing parameters of individual modules. The figure below shows the module editor with the chain of modules in the upper panel, and the parameters for the selected module in the lower panel. The order of the modules in the upper panel is left to right, top to bottom.



Editing the `Algorithm` parameter of `DepthModule`.

A module may be

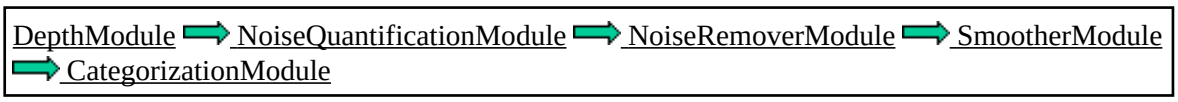
- *created* by selecting module type from the 'New' menu.
- *moved one step forward* in the processing chain by clicking .
- *moved one step backward* in the processing chain by clicking .
- *deleted* by clicking .
- *configured* by editing its parameters in the lower panel.

Categorization

- Producing categorization results
- Viewing categorization results
- Internal workings

Producing categorization results

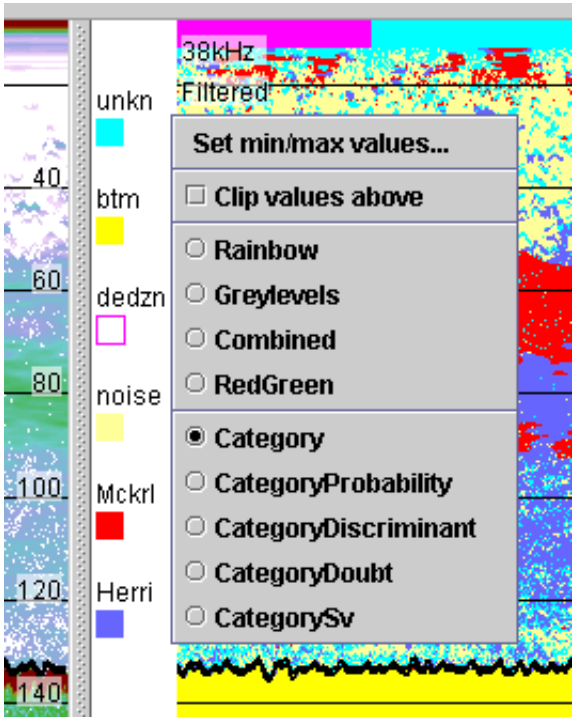
Categorization is done by CategorizationModule, which is typically used in the following setup:



Typical module configuration when doing categorization.

Viewing categorization results

Make sure categorization datagrams, Cac0Datagram and Cad0Datagram, are available and start playback. Right-click in one of the echogram panels and select 'Use private colormap'. Right-click in the separate colormap panel to access a colormap menu with the following extensions:



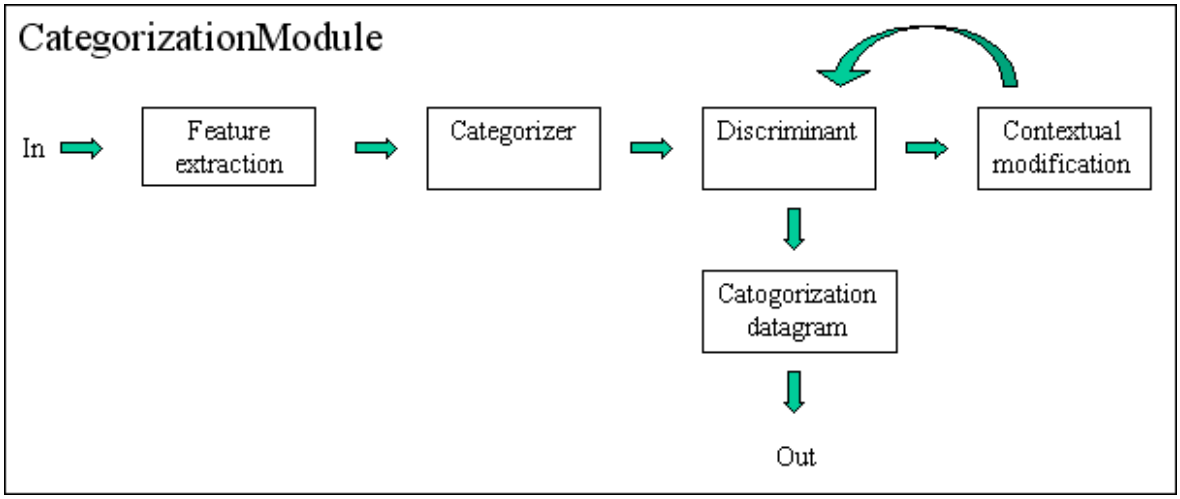
- *Category:* Each pixel is colored according to its category.
- *CategoryProbability:* Each pixel is colored according to its category with light intensity proportional to category conditional probability.
- *CategoryDiscriminant:* Each pixel is colored according to its category with light intensity proportional to discriminant value.
- *CategoryDoubt:* Each pixel is colored according to its category with light intensity proportional to the difference in discriminant value of the two best categories.
- *CategorySv:* Each pixel is colored according to its category with light intensity proportional to signal strength, S_v.

The following actions are possible:

- Left-click on a category's square in the colormap panel to toggle on and off plotting of that category. When a category is turned off, the next best category is plotted instead.
- For category colorings that modify the light intensity (the four last choices): Drag the two markers in the colormap panel.

Internal workings

The dataflow through the categorization module is depicted in the following figure:



Data flow through CategorizationModule.

Category Visualization

This is a window for visualising the defined categories in different ways.

File

Edit

View

Categorization - File

Load categorization file

Load a categorization file.

Save

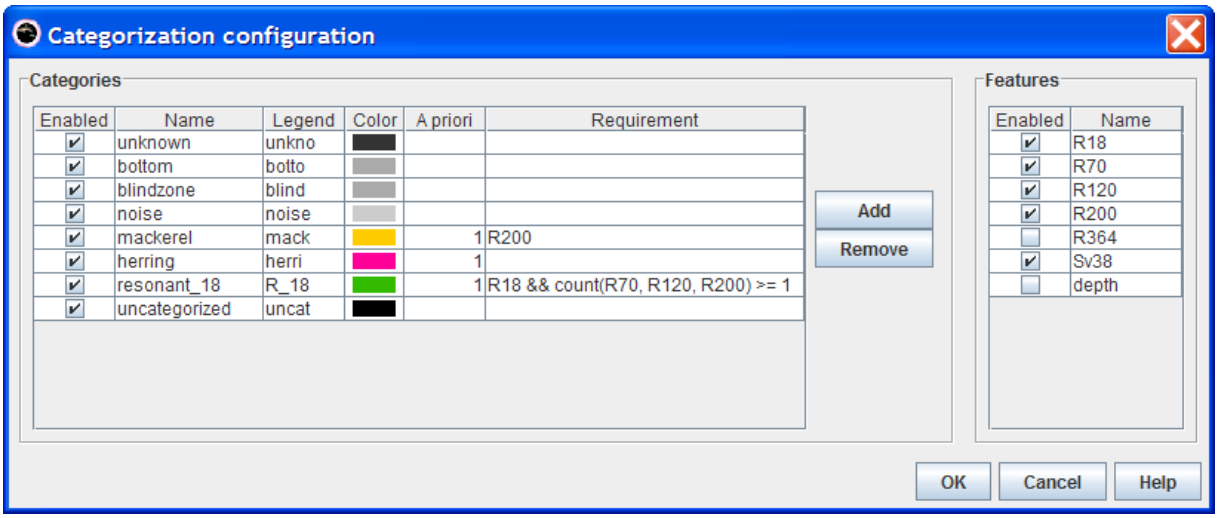
Saves the current categorization file.

Close

Closes the category visualization window.

Categorization - Edit

Categorization configuration



Here it is possible to define new categories with the **Add** button, and permanently remove categories with the **Remove** button. For each category a number of parameters can be set:

- **Enabled**: The checkboxes in the first column specifies whether the given category is enabled. Disabled categories become invisible to the user and will not be used in categorization.
- **Name**: In the second column the name for the categories can be edited. The names for the permanent categories such as noise, bottom etc. can not be edited.
- **Legend**: The third column is a shorter legend which is used in the colorbar when visualising results from categorization. The name should preferably be 5 characters or shorter.
- **Color**: By double-clicking on the color in the fourth column, the color for the category can be edited.
- **A priori**: In the fifth column the a priory probabilities for the different categories can be given.
- **Min Sv 38**: In the sixth column the a minimum Sv(38 kHz) for the different categories can be given.
- **Max Sv 38**: In the seventh column the a maximum Sv(38 kHz) for the different categories can be given.
- **Requirement**: The eight column specifies a requirement for using that category during categorization. The requirement is a Boolean expression that must evaluate to true for the category to be used.
  - If no expression is specified then the category is always used.
  - R18 evaluates to true if 18 kHz is available and false otherwise. Similarly for R70, R120, etc.
  - Boolean operators such as && and || can be used.
  - The function count(Boolean...) takes any number of Boolean parameters and returns the number of parameters with value true.

  Examples:
  - Example 1: If `R200` is specified for mackerel then 200 kHz must be available for anything to categorized as mackerel. If the transducer range for 200 kHz is set to 200 m in Config File Settings then nothing will be categorized as mackerel below 200 m.

- Example 2: `R18 && count(R70, R120, R200) >= 1` specifies that 18 kHz must be available together with at least one of 70, 120 and 200 kHz.

The features known by the system can also be enabled/disabled though the panel to the right.

Categorization parameters



Parameters used by the categorization system can be set here.

- **`OutlierFraction:`** The points that lie in the percentile given by 1 minus this number are considered outliers.
- **`ThinnedScatterSize:`** The maximum number of points in the point clouds used for visualization. The points used are drawn randomly from all existing points.

Add to category



The user can add the extracted points to a category that can be selected from a drop down list. The category that the system deems to be the best automatically appears at the top of the list, then the second best and so on. For adding points to categories, see also Misclassification matrix.

Mark

Through this you can mark points that meet some criteria. Possible criteria are:

- Classified as: marks points that will be classified as the chosen category.
- Not classified as: marks points that will NOT be classified as the chosen category.
- Outlier: marks points that are outliers relative the chosen category.
- Inlier: marks points that are inliers relative the chosen category.

Unmark

Through this you can unmark points that meet some criteria. Possible criteria are:

- Classified as: unmarks points that will be classified as the chosen category.
- Not classified as: unmarks points that will NOT be classified as the chosen category.
- Outlier: unmarks points that are outliers relative the chosen category.

- Inlier: unmarks points that are inliers relative the chosen category.

Clear marking

Clears all current markings. Shortcut key: `Escape`.

Invert marking

Inverts all current markings.

Delete marked points

Deletes the marked points. Shortcut key: `Delete`.

Delete unmarked points

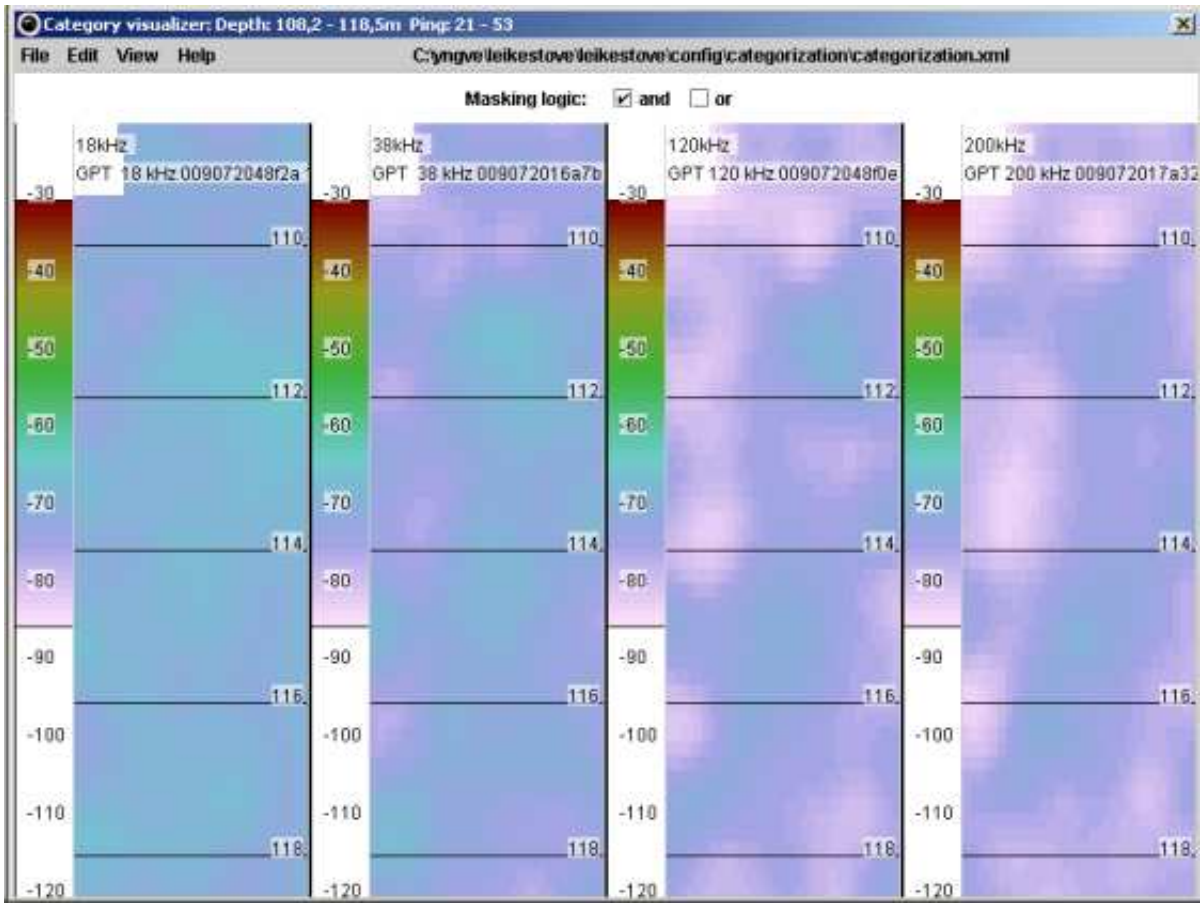
Deletes the unmarked points. Shortcut key: `Alt-Delete`.

Undo all modifications

Reads the data from file again so that all modifications before a Save are undone.

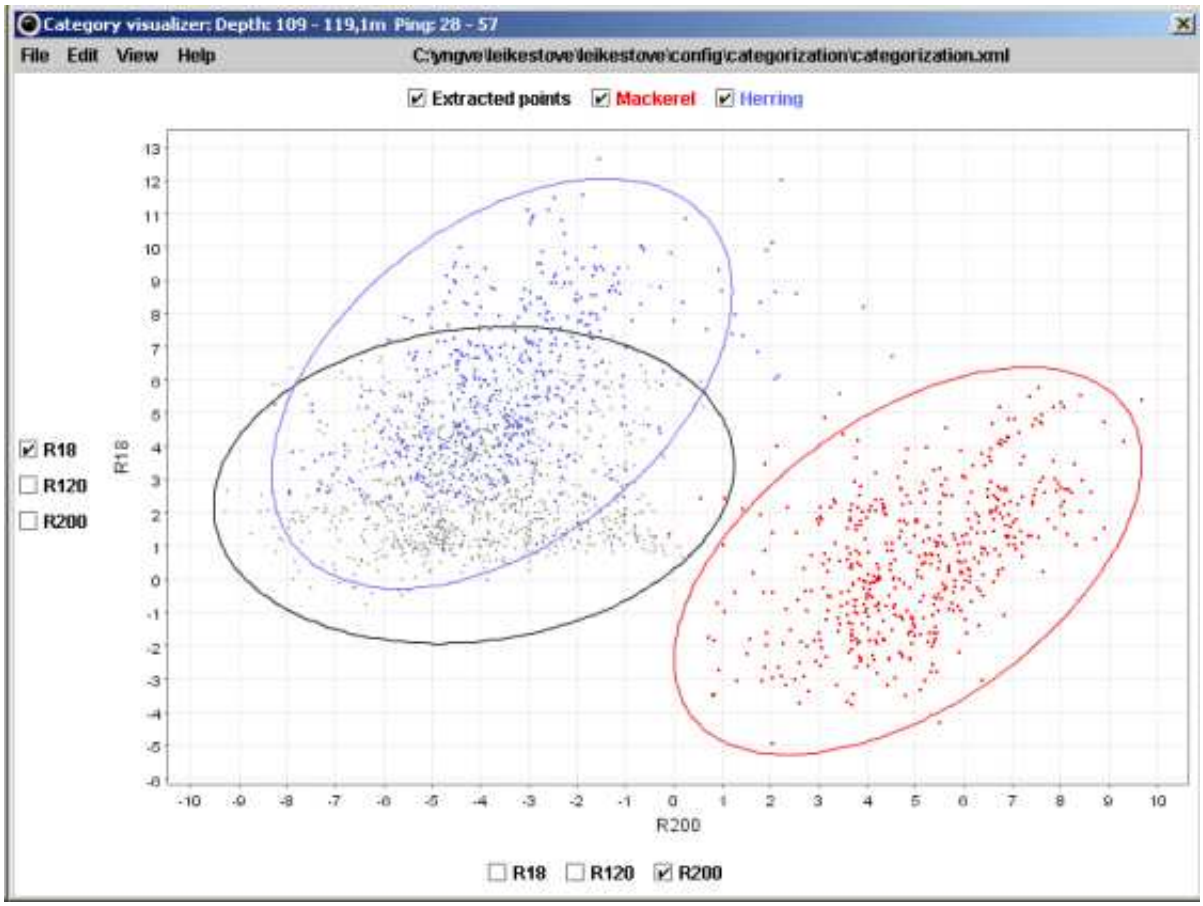
Categorization - View

Echogram



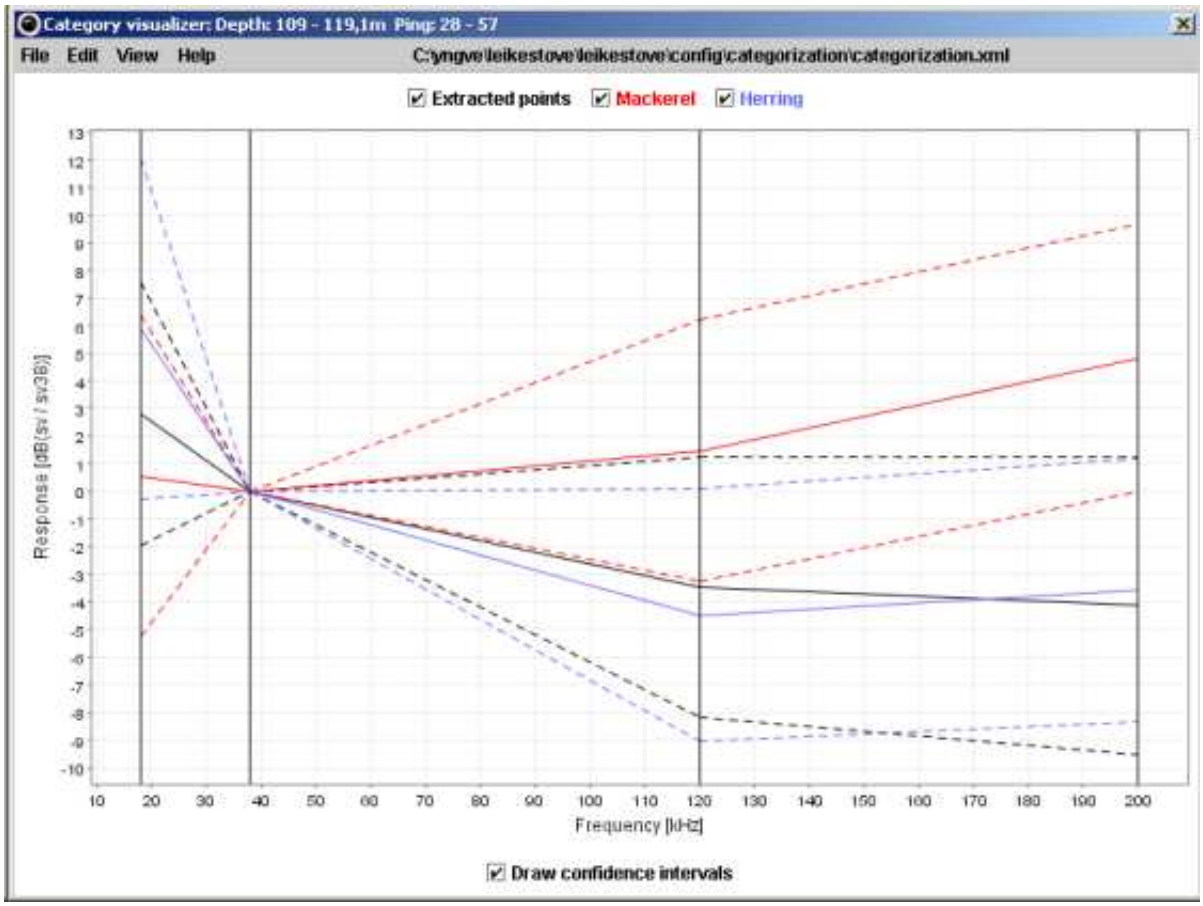
Shows the extracted rectangle with a separate colorbar for each frequency. The points will be masked/unmasked by dragging the colorbars. Points can also be masked by drawing rectangles directly in the echogram views. Holding `Ctrl` enables marking of several rectangles, and holding `Alt` unmarks the points inside the drawn rectangle.

Scatter



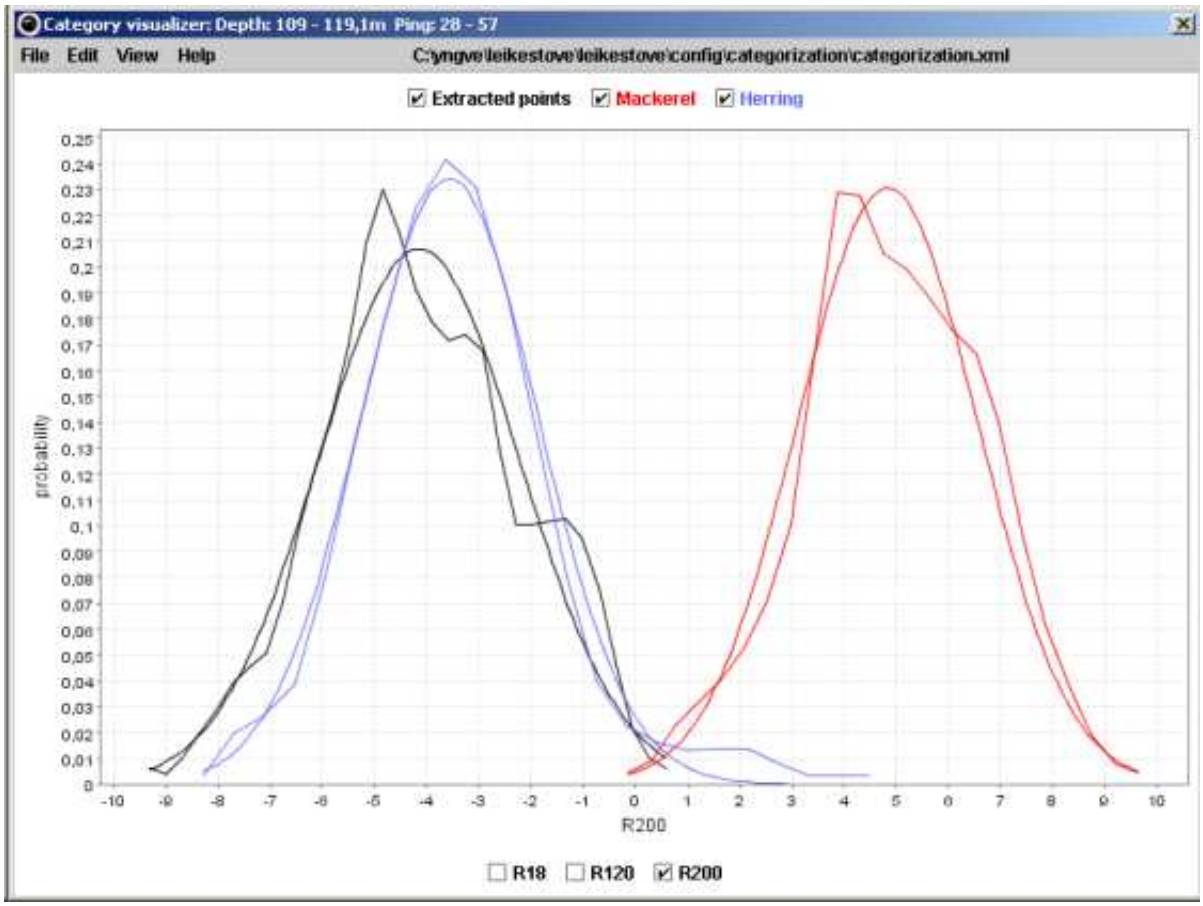
Shows a scatter plot of how the points of the categories are distributed in the feature space. A pair of feature axes can be selected by clicking the checkboxes to the left and below the plot. See also category toggles.

Frequency response



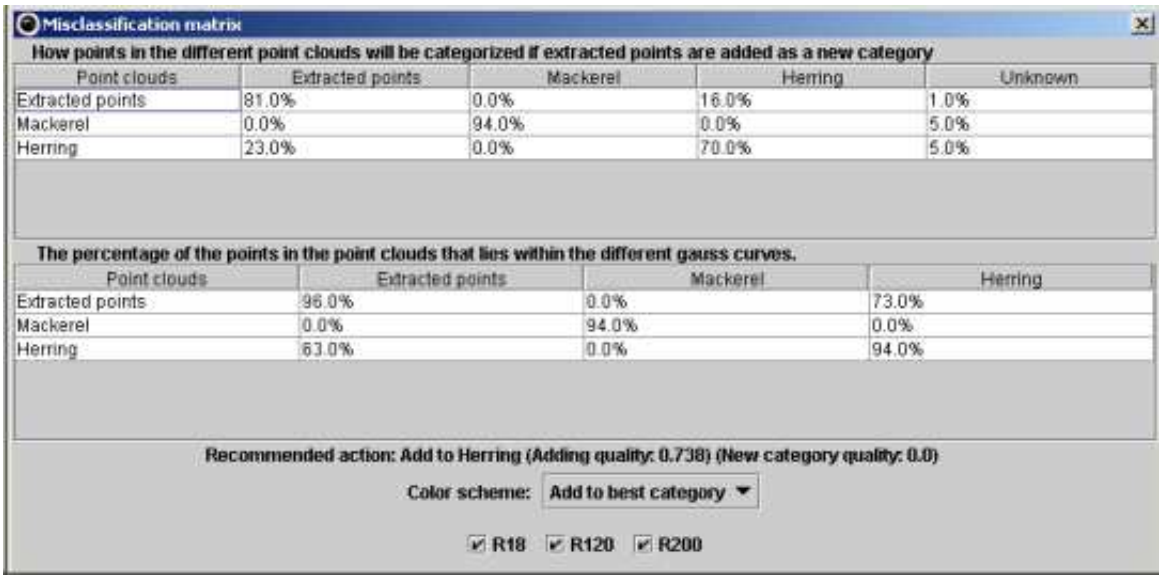
Shows the relative frequency response curves for the categories. See also category toggles.

Probabilities



Shows the probability density function for the categories for a selected feature. See also category toggles.

Misclassification matrix



The first table shows how point cloud `i`, where `i` is the row, would be categorized if the extracted points were added as a NEW category.

The second table shows the overlap between the different point clouds, i.e. the percentage of the points in category `i` that lies within the `1 - outlierFraction` contour of category `j`,where `i` is the row and `j` is the column.

This view also gives a recommendation of what can be done with the extracted points.

The user can specify different coloring schemes, depending on whether the user wishes to add the points to an existing category or create a new category. The system will then highlight the problematic values with either yellow or red color depending on the severity of the problem (yellow: somewhat severe, red: more severe).

The user can also turn on/off the enabled features (see Configuration to enable features) by clicking the toggles at the bottom of the view. The results will then be recalculated.

Rescale axes

Rescales the plot axes.

Common buttons for many views

- **Category toggles:** Positioned at the top of many views. By left clicking these toggles, the user can turn on/off the visualization of the given category. Right clicking the toggles brings up another view where it is possible to turn on/off the use of earlier saved point clouds. By right clicking the earlier point clouds, it is possible to delete them permanently.

Plankton inversion

The purpose of the plankton inversion algorithm is to fit the gathered volume backscatter coefficients for multiple frequencies to analytical plankton backscatter models. The data is fitted to each model by the non-negative least squares algorithm (Lawson & Hanson). The model with the smallest residual is selected as the best fit model if the residual is smaller than a configurable maximal residual.

Description of algorithm

Let an analytical backscatter model be given by $\sigma(\mathbf{f}, \mathbf{l})$, where **f** is a transducer frequency and **l** is a plankton size. The models used in this software and their parameters are described in Plankton inversion module

Let $[f_1, f_2, ..., f_M]$ be the frequencies used, let $\mathbf{c} = [s_{v1}, s_{v2}, ..., s_{vM}]$ be the measured backscatter for a collection of samples, and let $\mathbf{N} = [n_1, n_2, ..., n_N]$ be an abundance vector for an initial size distribution $\mathbf{b} = \mathbf{l} = [l_1, l_2, ..., l_N]$.

The system of equations to be solved can with respect to the abundance vector **N** be expressed in matrix form as
$\mathbf{A\,N = c}$,
where the elements in **A**, $A_{ij} = \sigma(f_i, l_j)$, is the backscatter computed by the plankton model for frequency number i in **c** and length number j in **b**.

Rows are added to the system:
$\mathbf{c} = [s_{v1}, s_{v2}, ..., s_{vM}, 0, ..., 0]$ (length M + N).
A is extended by a submatrix of size N×N, given by $\mathbf{I_N} \times ||\mathbf{A}|| \times \mathbf{LMfactor}$,

$$A = \overbrace{\begin{pmatrix} A_{ij} \\ I_N \, ||A|| \, LMfactor \end{pmatrix}}^{N} \Big\} M + N$$

where $\mathbf{I_N}$ is the identity matrix of size N×N, $||\mathbf{A}||$ is the norm of **A**, and **LMfactor** is the Levenberg-Marquardt factor (see Lawson & Hanson). The purpose of the Levenberg-Marquardt factor is to give a preference to the solution of smallest norm if several solutions are acceptable. It seems like a value between 1e-6 and 1e-4 gives solutions with reasonable norms without much change in residual.

The solution algorithm is described in (Lebourges 2005). In short, a non-negative least squares inversion is performed for each model with respect to the abundance vector N. After each inversion, the size vector is optimized and a new matrix A is computed based on the new size vector. New inversions are then performed until convergence is reached, or until a maximal number of iterations. After iterating over all the models, the model with the smallest residual is kept if the residual is smaller than a user configured maximal residual.

Computation of residual

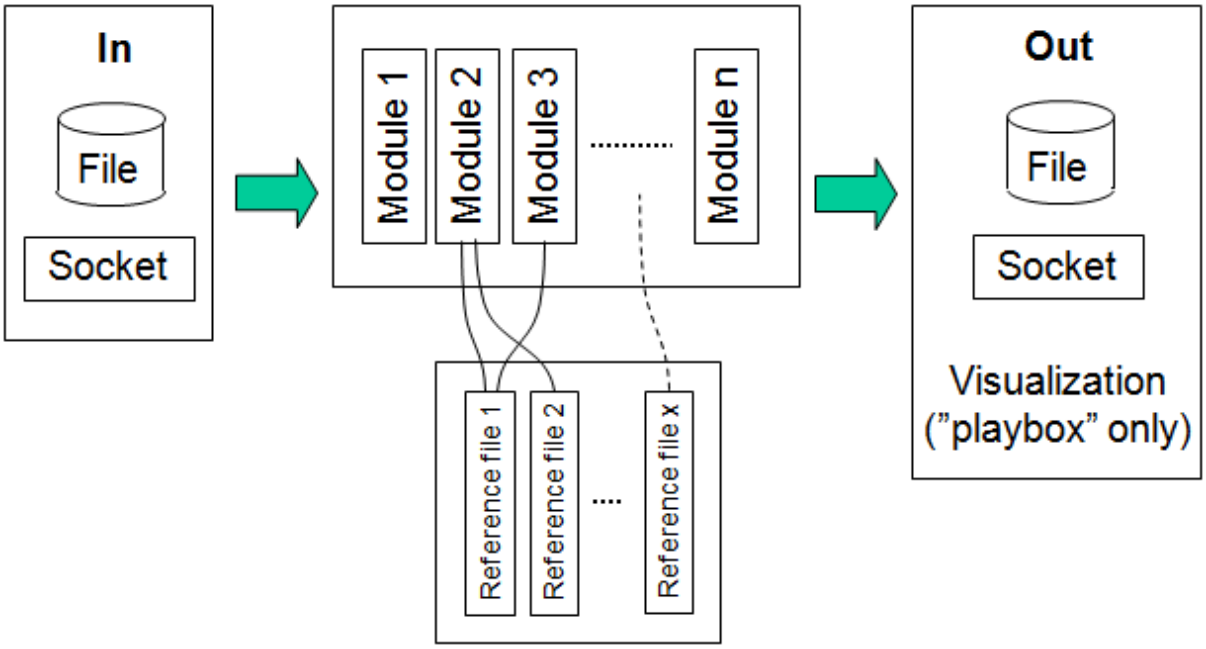
Each inversion of the system **A N = c**, gives a best fit solution vector **N'** which is an approximation for **N**. The residual is computed as || **A N' - c** || / || **c** ||, where the norm is the Euclidean norm.

Optimization of the size vector

The purpose of the optimization is to redistribute the size vector around the sizes where non-null abundance has been found. The number of sizes in the size vector is kept constant. If the number of sizes is not a multiple of non-null elements, the elements with the smallest size are divided first.

Examples using Korona

This section describes possible use cases for preprocessing in Korona. The data flows through the KORONA modules in a sequence described in the module setup, and some of the processing modules use the content of a reference file as illustrated in the figure below. Several modules may use the same reference file. *Note that the sequence of the processing modules may affect the result.* For example, noise removal (NoiseRemovalModule) need to be done after noise quantification (NoiseQuantificationModule). Further, the best data used to quantify noise is picked somewhat "below" the detected bottom (really: some time after bottom echo), so the DepthModule should be used before the NoiseQuantificationModule.



The processing modules can be grouped into 6 classes:

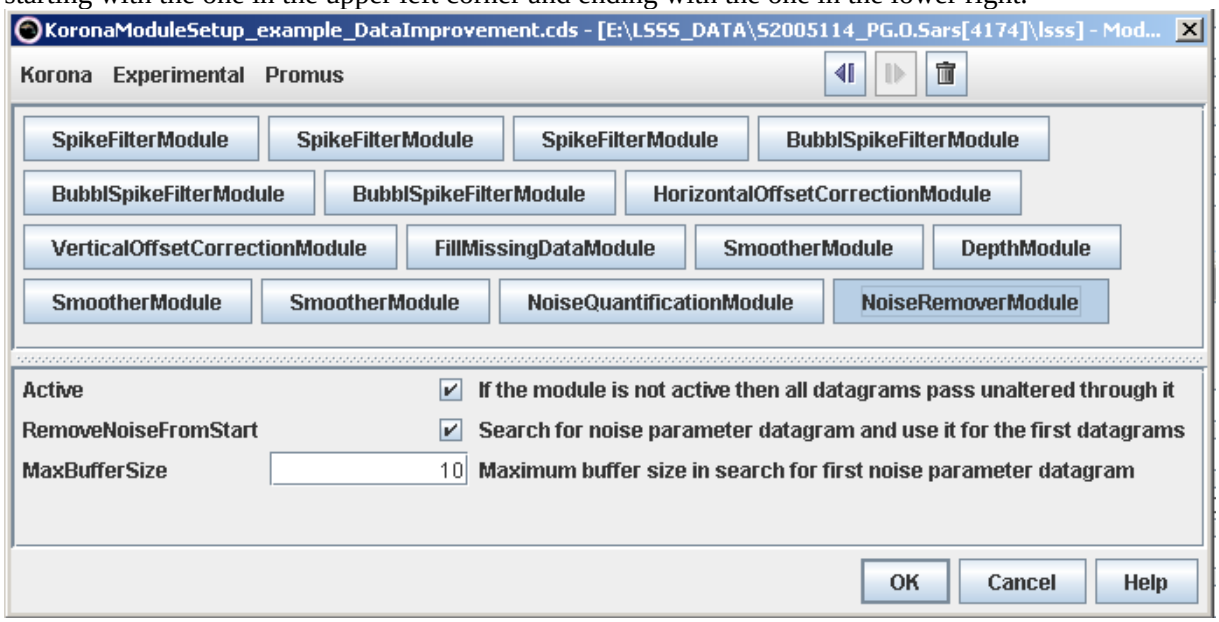
1. Data improvement modules. These manipulate data, but the data-format and file-size remain unchanged.
2. Data reduction modules. These remove or compress the data, but do not add information in form of new data-telegrams.
3. Echo-trace detection modules. These detect the extent of e.g. a school or a single-fish track, and calculate parameters that characterize the echo-trace and pass this information as new data-telegrams in the data in addition to those defined by the data-file format *.raw.
4. Identification of acoustic scattering classes by means of an acoustic feature library or by scattering models. The information is passed as new data-telegrams in the data.
5. Generation and removal of data-channels trough mathematical operators.
6. Modules for visualizing intermediate results, e.g. echogram between any two processing modules.

Examples

Example 1 - Data improvement.
Example 2 - Data reduction.
Example 3 - School detection.
Example 4 - Echo-trace detection.
Example 5 - Categorisation.
Example 6 - School categorisation.
Example 7 - Zooplankton size estimation.
Example 8 - Visualisation of intermediate results.
Example 9 - Colour scales.
Example 10 - Bottom detection.

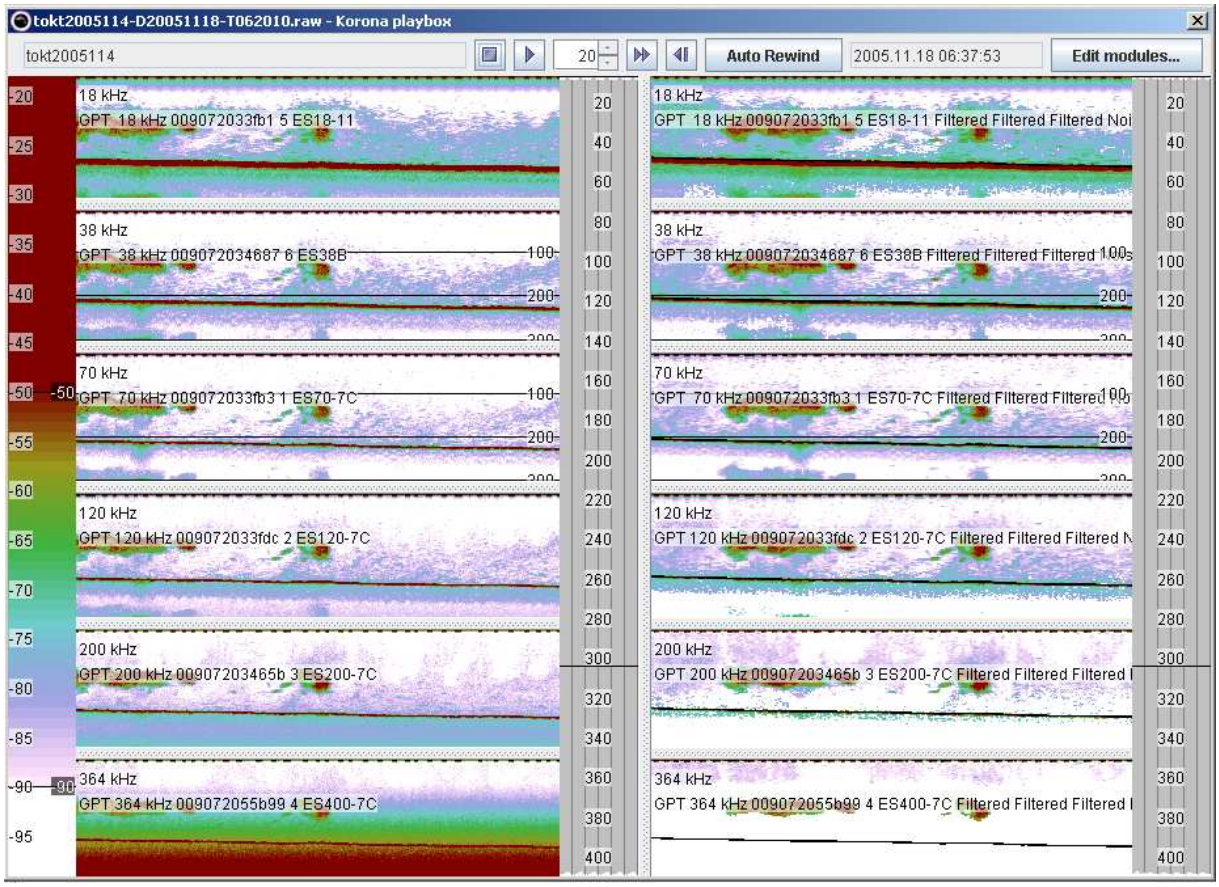
Example 1 - Data improvement through noise removal and smoothing

The module setup below shows one way to improve data. The data flows trough each of the modules starting with the one in the upper left corner and ending with the one in the lower right.



- There are three spike filters used to remove very strong values with a vertical extent, and replace those values with the median value of the surrounding measurements. The spike filters are set up to work at different depths: 10-100m, 100-250m, 250-2000m, i.e. for each depth there is only one spike-filter used. The reason why there are three different is the shape of the beam, so that spikes at shallow depths appear to be stronger.
- The three bubble-spike filters work in a similar way as the spike-filters, except that vertical regions with significantly lower values than the surroundings are replaced by the median of the surrounding values. The filters are called bubble-spike-filters because such regions often appear when there are bubbles under the ship.
- The HorizontalOffsetCorrectionModule adjusts the data at different acoustic frequencies for horizontal positioning of the transducers. The transducer position is read from a reference-file specified by HorizontalOffsetCorrectionModule
- The VerticalOffsetCorrectionModule corrects the data at different frequencies for the frequency-, and filter-dependent pulse-transmission delay. The transmission delays (i.e. the frequency-dependent vertical correction of the measurements) are read from a reference-file specified by VerticalOffsetCorrectionModule
- The FillMissingDataModule duplicate data at one frequency if data at a given time does not exist for that frequency, but do exist for other frequencies.
- The first smoother module smooths only in horizontal direction, so that the bottom-detection done by the DepthModule is better if the backscatter from the bottom varies much. The two next SmootherModule smooths data above and below the detected bottom. These smoothings are done separately to avoid losing fish that is close to the bottom. The smoothing is done below bottom because those data are used to quantify noise in the NoiseQuantificationModule, and those results are used by the NoiseQuantificationModule to remove noise.

Results are shown below: left panel is before data improvement for all 6 frequencies, right panel is after.

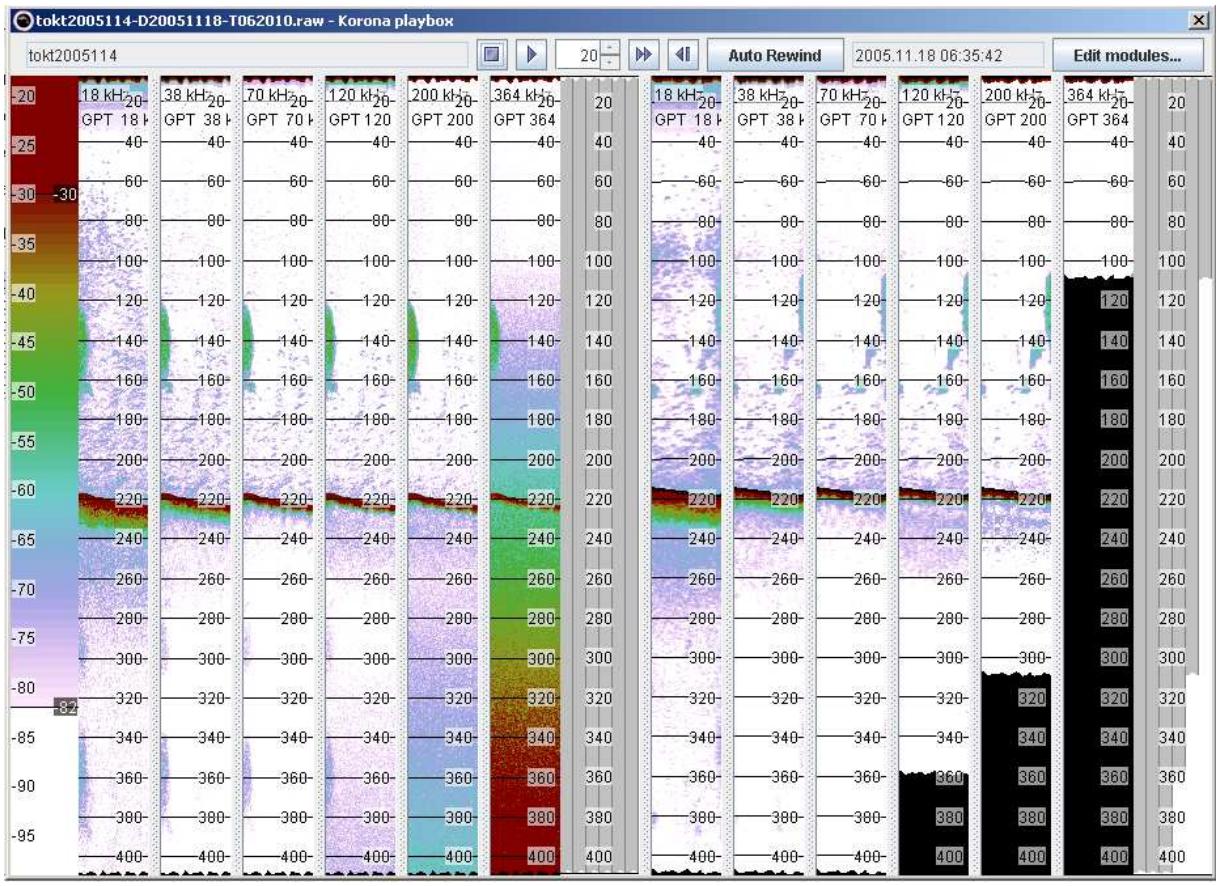


Example 2 - Data reduction

The processing setup is similar to Example 1, except that the **DataReductionModule** is inserted between the NoiseQuantificationModule and the NoiseRemovalModule. Note that the final result would be the same if the DataReductionModule was placed after the NoiseRemovalModule, but placing if before makes the processing go faster since time is not wasted in removing noise from data that is later removed.

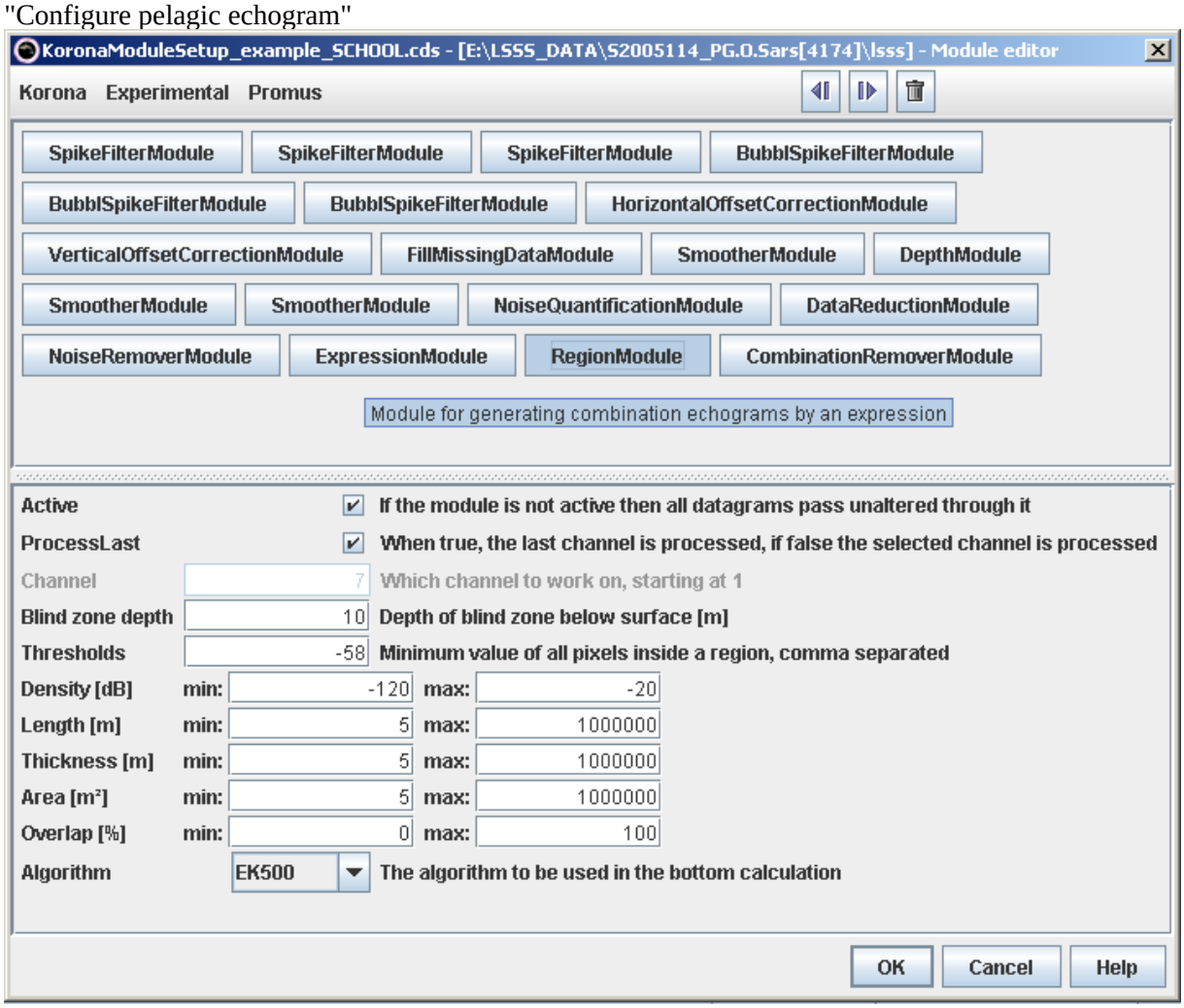


Results are shown below: left panel is original data for all 6 frequencies, right panel is after data improvement and data reduction. Black colour means that there is no data.

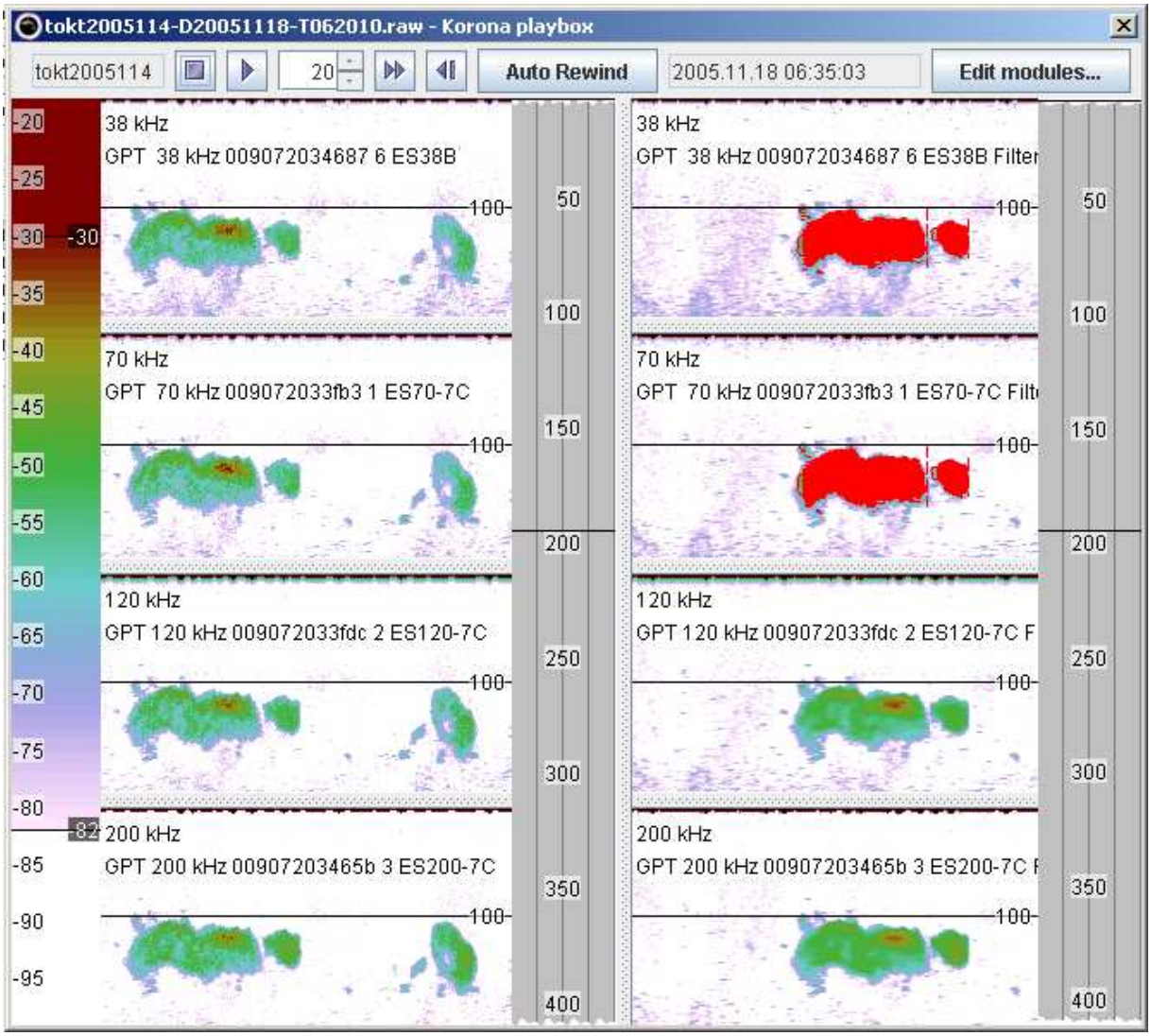

tokt2005114-D20051118-T062010.raw - Korona playbox
tokt2005114
20
Auto Rewind
2005.11.18 06:35:42
Edit modules...
18 kHz GPT 18 k
38 kHz GPT 38 k
70 kHz GPT 70 k
120 kHz GPT 120
200 kHz GPT 200
364 kHz GPT 364

Example 3 - School detection

School detection is done by means of the RegionModule, and is typically done on a combined-frequency channel after data improvement (see modules before RegionModule, and Example 1) as shown in the figure below. Further, there is no need to keep the synthetic data-channel when the school is detected, so in the example that channel is removed. The RegionModule add a new data-telegram. The results of the school-detection is visualised in KORONA by setting "Show regions", and in LSSS by checking the "Preprocessed regions" from the "Overlay menu". The "Overlay menu" is started e.g. by clicking the right-mouse-button in the Pelagic echogram and select "Configure pelagic echogram"



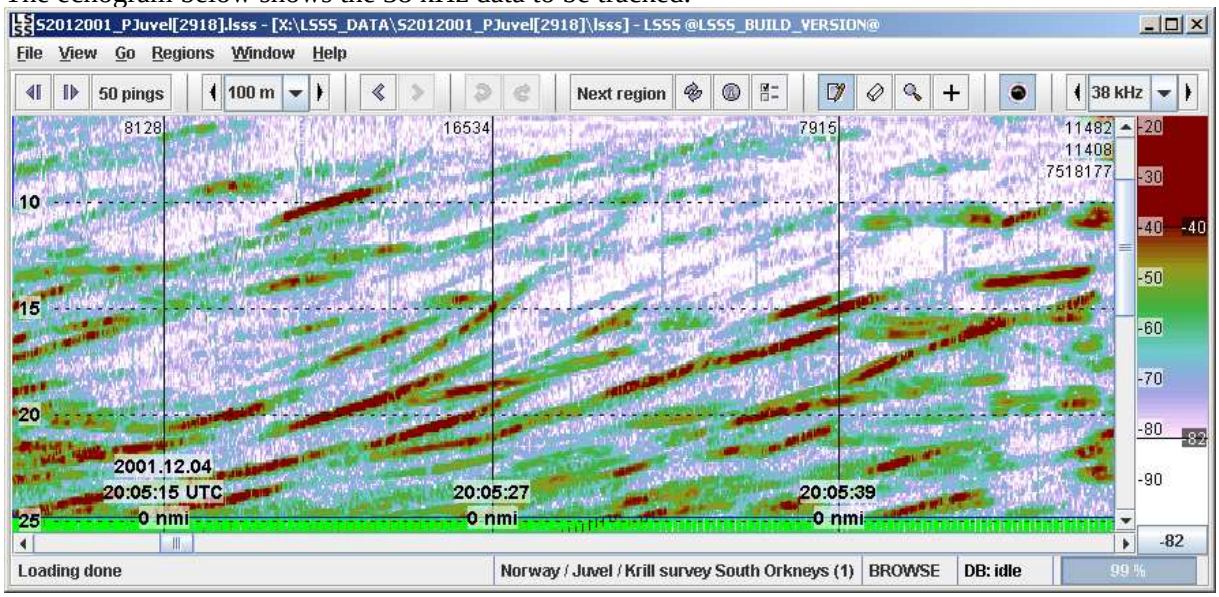
The figure below show detected schools. The left panel shows the 4 frequencies 38, 70, 120 and 200 kHz, and the right panel shows the same frequencies preprocessed, and with the detected schools shown in the 18 and 38 kHz echogram.


tokt2005114-D20051118-T062010.raw - Korona playbox
tokt2005114
20
Auto Rewind
2005.11.18 06:35:03
Edit modules...
38 kHz
GPT 38 kHz 009072034687 6 ES38B
38 kHz
GPT 38 kHz 009072034687 6 ES38B Filter
70 kHz
GPT 70 kHz 009072033fb3 1 ES70-7C
70 kHz
GPT 70 kHz 009072033fb3 1 ES70-7C Filt
120 kHz
GPT 120 kHz 009072033fdc 2 ES120-7C
120 kHz
GPT 120 kHz 009072033fdc 2 ES120-7C F
200 kHz
GPT 200 kHz 00907203465b 3 ES200-7C
200 kHz
GPT 200 kHz 00907203465b 3 ES200-7C F
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-30
-82
100
50
100
150
200
250
300
350
400

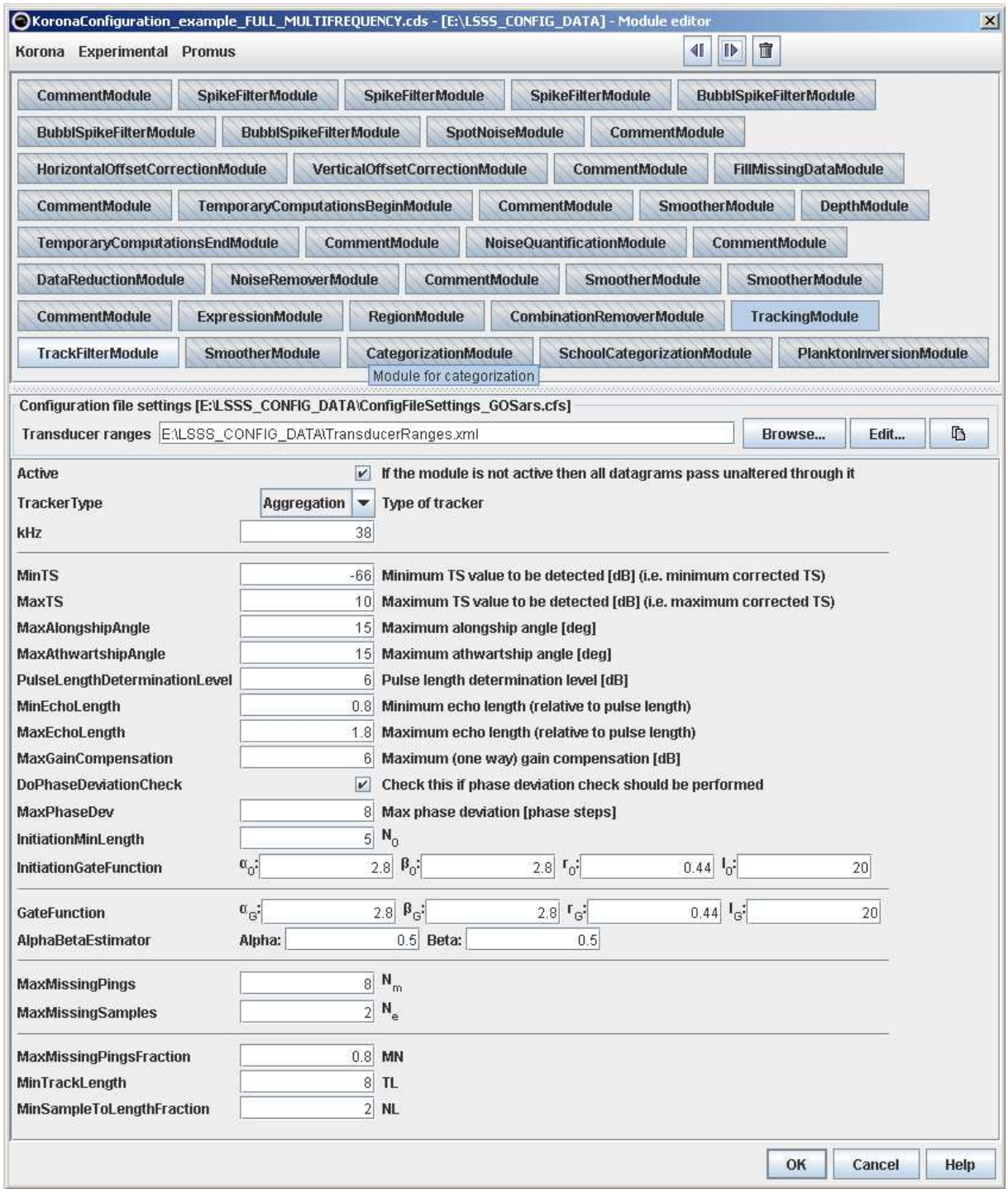
Example 4 - Echo trace detection

The tracks will be marked. The acoustic tracking module is based on the publication: *Nils Olav Handegard, Ruben Patel and Vidar Hjellvik (2005). "Tracking individual fish from a moving platform using a split-beam transducer", J. Acoust. Soc. Am., Vol 118(4), pp 2210-2223.*

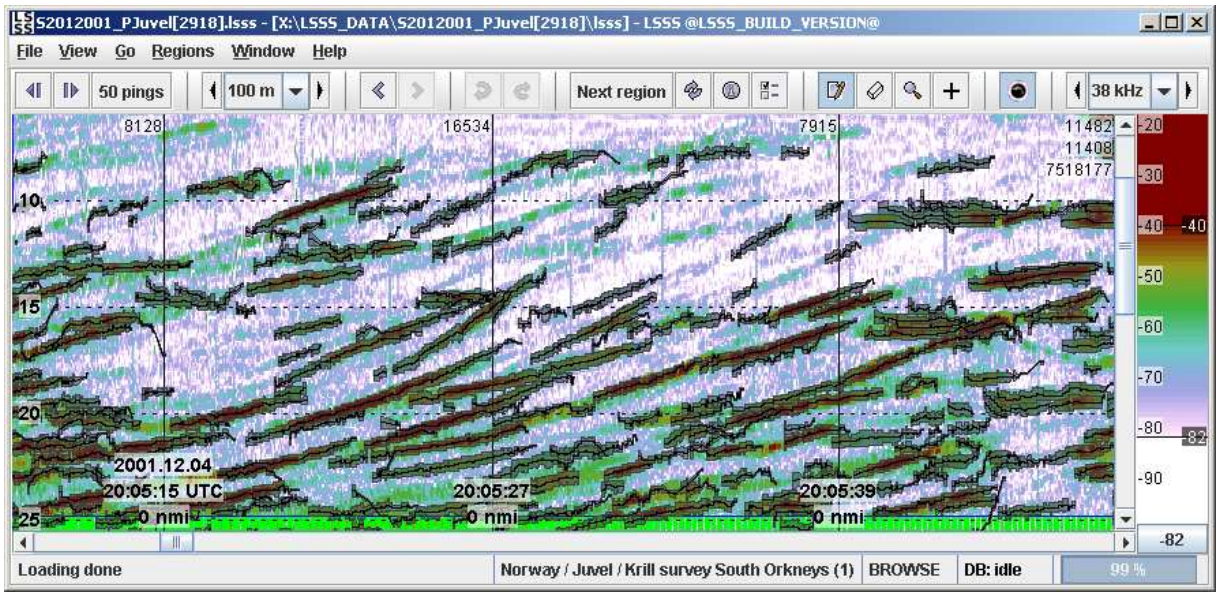
The echogram below shows the 38 kHz data to be tracked.



The figure below shows the module setup, e.g. the limitations put onto the tracking algorithm.

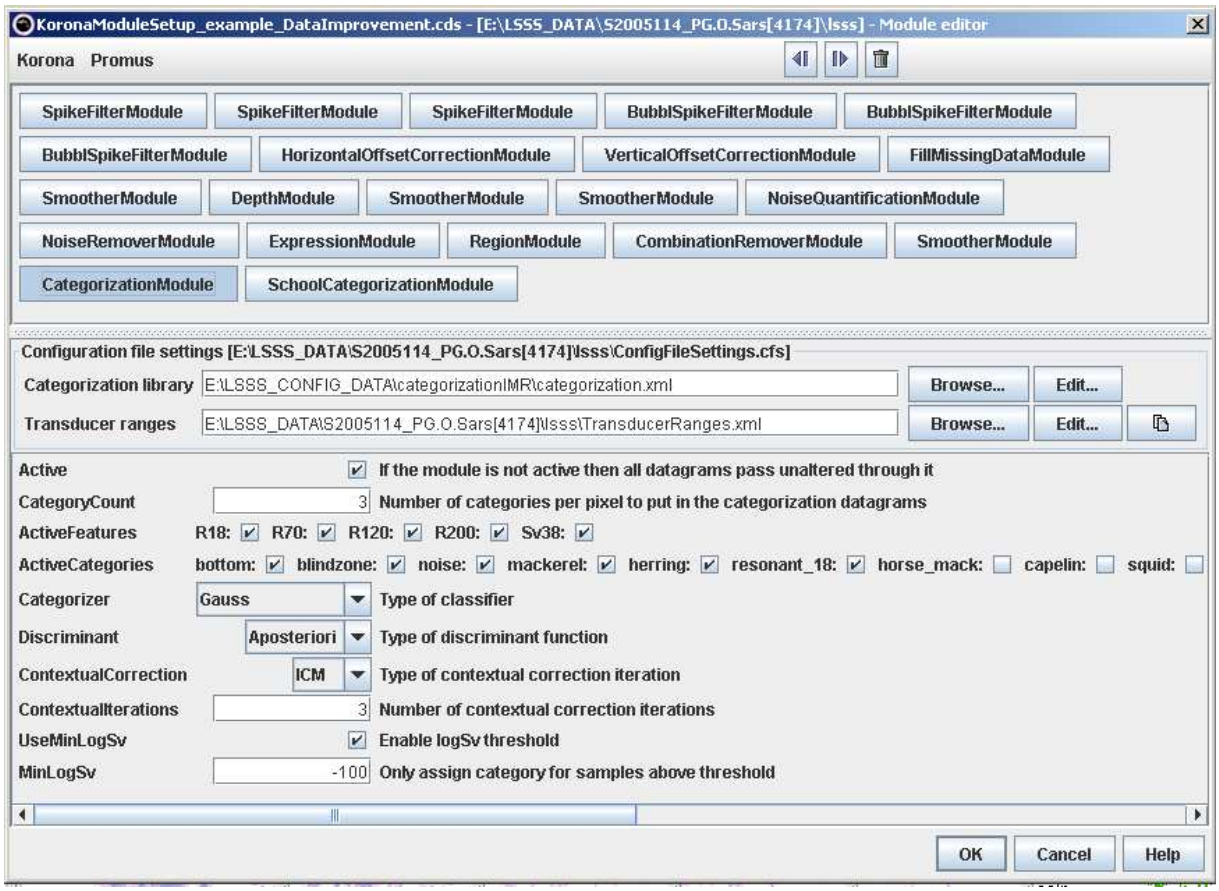


The echogram below shows the result of the tracking (marked in grey).

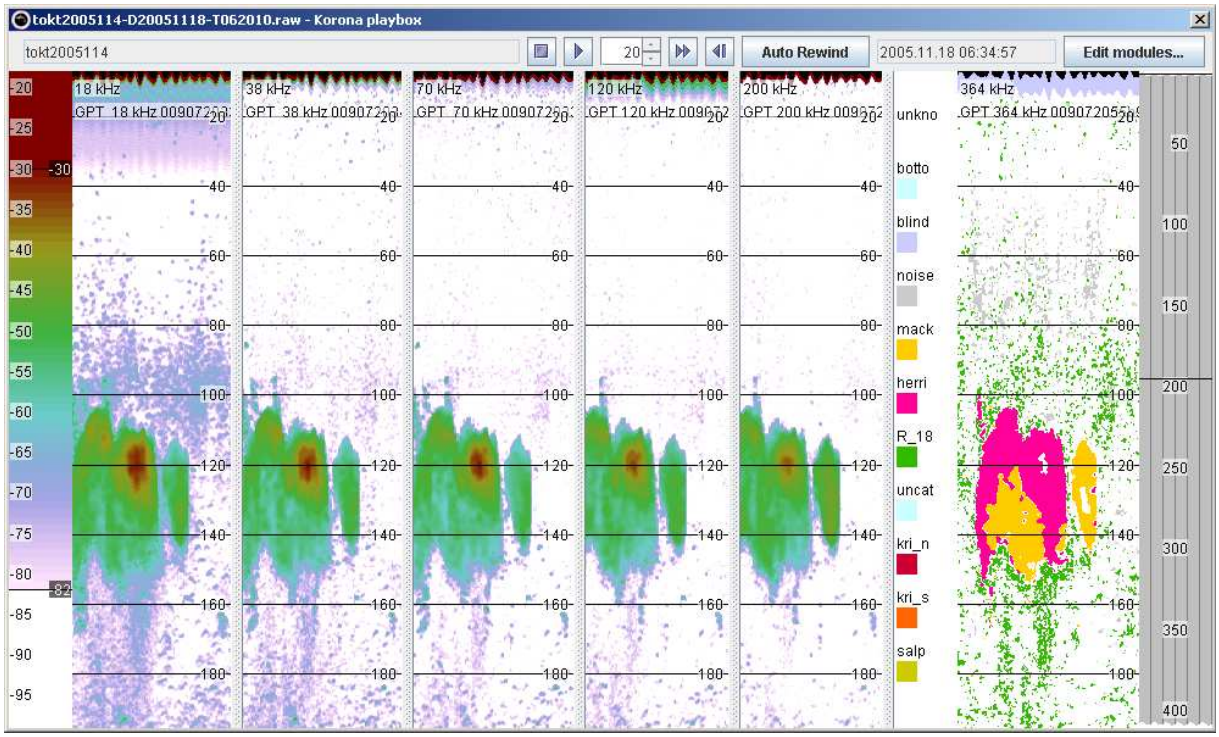

S2012001_PJuvel[2918].lsss - [X:\LSSS_DATA\S2012001_PJuvel[2918]\lsss] - LSSS @LSSS_BUILD_VERSION@
File View Go Regions Window Help
50 pings
100 m
Next region
38 kHz
8128
16534
7915
11482
11408
7518177
10
15
20
25
2001.12.04
20:05:15 UTC
20:05:27
20:05:39
0 nmi
0 nmi
0 nmi
-20
-30
-40
-40
-50
-60
-70
-80
-82
-90
-82
Loading done
Norway / Juvel / Krill survey South Orkneys (1)
BROWSE
DB: idle
99 %

Example 5 - Categorisation (pixel categorisation)

The acoustic categories may be a single species (e.g. Atlantic mackerel), a group of species (e.g. swimbladdered fish) and sometimes even a subset of a species (different year-classes of sandeel). The figure below shows an example of a module setup used to identify acoustic categories. The CategorisationModule is placed after the data improvement modules, and is showed in a somewhat darker grey colour than the other modules.



The figure below shows the result of the acoustic categorisation. The CategorisationModule add a new data-telegram, ane the results are visualised in KORONA by setting the colour-scale (Use private colourmap) "Categories".



References

- Korneliussen, R. J., and Ona, E. 2002. An operational system for processing and visualizing multi-frequency acoustic data. â ICES Journal of Marine Science, 159: 293â313.
- Korneliussen, R. J., and Ona, E. 2003. Synthetic echograms generated from the relative frequency response. â ICES Journal of Marine Science, 60: 636â640.
- Korneliussen, R. J., Heggelund, Y., Eliassen, I. K., and Johansen, G. O. 2009. Acoustic species identification of schooling fish. â ICES Journal of Marine Science, 66: 1111â1118.
- Pedersen, G., and Korneliussen, R. J. 2009. The relative frequency response derived from individually separated targets of northeast Arctic cod (Gadus morhua), saithe (Pollachius virens), and Norway pout (Trisopterus esmarkii). â ICES Journal of Marine Science, 66: 1149â1154.
- Korneliussen, R. J. 2010. The acoustic identification of Atlantic mackerel. â ICES Journal of Marine Science, 67: 1749â1758.

Example 6 - School categorisation

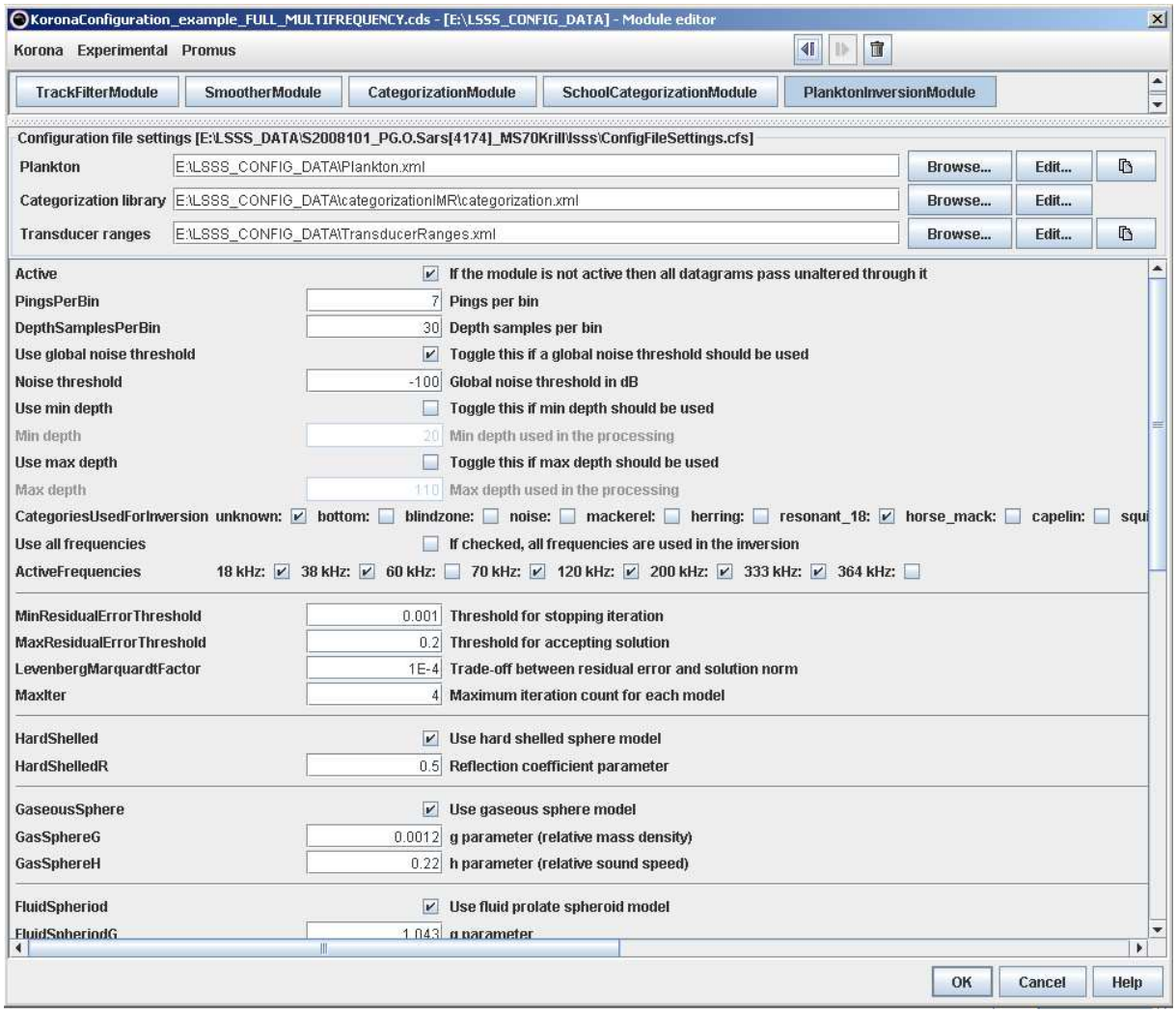
The identification of acoustic categories is improved if the variance is reduced, e.g. by assuming that a school contains one species only. The school categorisation module splits schools into segments, and compare those to investigate if the school is likely to contain one or several species. The **SchoolCategorisationModule** has to be used after the CategorisationModule as shown in the first figure of Example 5. The results are similar, except that whole schools receive the same acoustic category.

References

- Korneliussen, R. J., Heggelund, Y., Eliassen, I. K., and Johansen, G. O. 2009. Acoustic species identification of schooling fish. â ICES Journal of Marine Science, 66: 1111â1118.

Example 7 - Zooplankton size estimation

Acoustic scattering models are used to calculate size of different zooplankton groups. This is done by means of data improvement (optional) followed by acoustic categorisation (Example 5) and inversion by means of the PlanktonInversionModule. The figure below show which of the acoustic categories output from the CategorisationModule that is used in this example. The results of the inversion are sizes of the zooplankton specimens, and these sizes for the active region may be visualized in the Plankton window.


KoronaConfiguration_example_FULL_MULTIFREQUENCY.cds - [E:\LSSS_CONFIG_DATA] - Module editor
Korona Experimental Promus
TrackFilterModule SmootherModule CategorizationModule SchoolCategorizationModule PlanktonInversionModule
Configuration file settings [E:\LSSS_DATA\S2008101_PG.O.Sars[4174]_MS70Krill\lsss\ConfigFileSettings.cfs]
Plankton E:\LSSS_CONFIG_DATA\Plankton.xml Browse... Edit...
Categorization library E:\LSSS_CONFIG_DATA\categorizationIMR\categorization.xml Browse... Edit...
Transducer ranges E:\LSSS_CONFIG_DATA\TransducerRanges.xml Browse... Edit...
Active If the module is not active then all datagrams pass unaltered through it
PingsPerBin 7 Pings per bin
DepthSamplesPerBin 30 Depth samples per bin
Use global noise threshold Toggle this if a global noise threshold should be used
Noise threshold -100 Global noise threshold in dB
Use min depth Toggle this if min depth should be used
Min depth 20 Min depth used in the processing
Use max depth Toggle this if max depth should be used
Max depth 110 Max depth used in the processing
CategoriesUsedForInversion unknown: bottom: blindzone: noise: mackerel: herring: resonant_18: horse_mack: capelin:
Use all frequencies If checked, all frequencies are used in the inversion
ActiveFrequencies 18 kHz: 38 kHz: 60 kHz: 70 kHz: 120 kHz: 200 kHz: 333 kHz: 364 kHz:
MinResidualErrorThreshold 0.001 Threshold for stopping iteration
MaxResidualErrorThreshold 0.2 Threshold for accepting solution
LevenbergMarquardtFactor 1E-4 Trade-off between residual error and solution norm
MaxIter 4 Maximum iteration count for each model
HardShelled Use hard shelled sphere model
HardShelledR 0.5 Reflection coefficient parameter
GaseousSphere Use gaseous sphere model
GasSphereG 0.0012 g parameter (relative mass density)
GasSphereH 0.22 h parameter (relative sound speed)
FluidSpheriod Use fluid prolate spheroid model
FluidSpheriodG 1.043 g parameter
OK Cancel Help

Example 8 - Visualisation of intermediate results

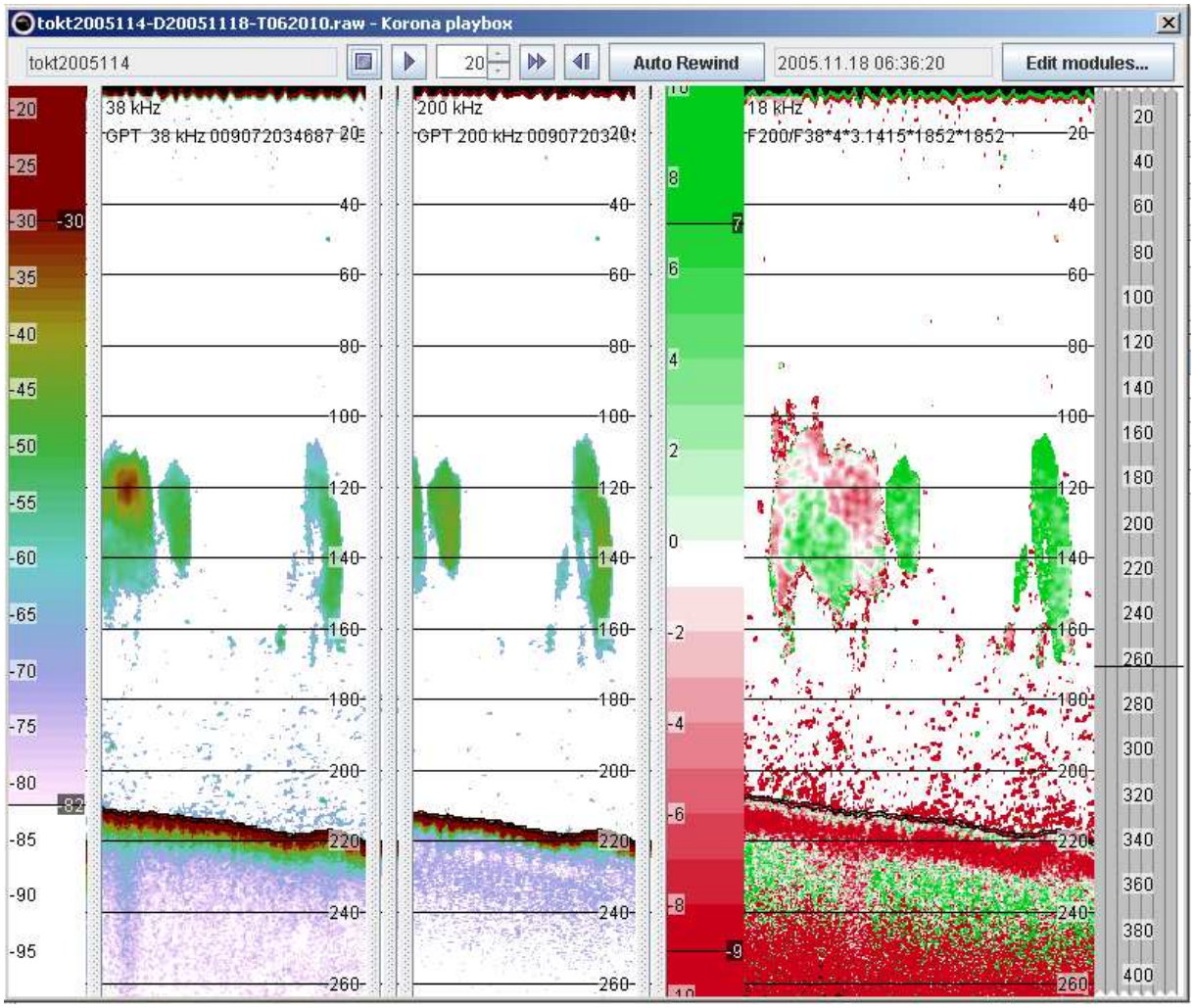
This section describes how intermediate results may be displayed in KORONA and KoronaRelay. This functionality is typically used during the creation of new KORONA module setups. One FishViewDisplayModule is inserted prior to the modules to be investigated, and another FishViewDisplayModule is placed after.



The FishViewDisplayModule is used also in Example 1, Example 2, Example 3.

Example 9 - Use of the red-green colour scale

This section describes how the red-green colour-scale may be used to compare backscatter at two frequencies. The module setup is expanded from Example 3 (school detection): A **ThresholdModule** is inserted at the end to remove all data at all frequencies weaker than -70 dB, and then an **ExpressionModule**. The ExpressionModule generates a new synthetic data-channel: F200/F38*(4*3.1415*1852*1852). F200 is the 200 kHz data-channel and F38 is the 38 kHz data-channel. The somewhat strange looking constant $4*PI*1852^2$ is because all colour-scales expect to read power-values and then convert those to s_v, so the factor is needed to make the resulting echogram symmetric around 0 dB. By applying the red-green colour-scale, and setting the limits between -10 (dB) and 10 (dB), the result below appears. The left panel is 38 kHz data, the middle is 200 kHz, and the right is the combined channel with the red-green colour-scale used. In the example below, herring (that has swimbladder) appear in red colour and Atlantic mackerel (no swimbladder) in green.

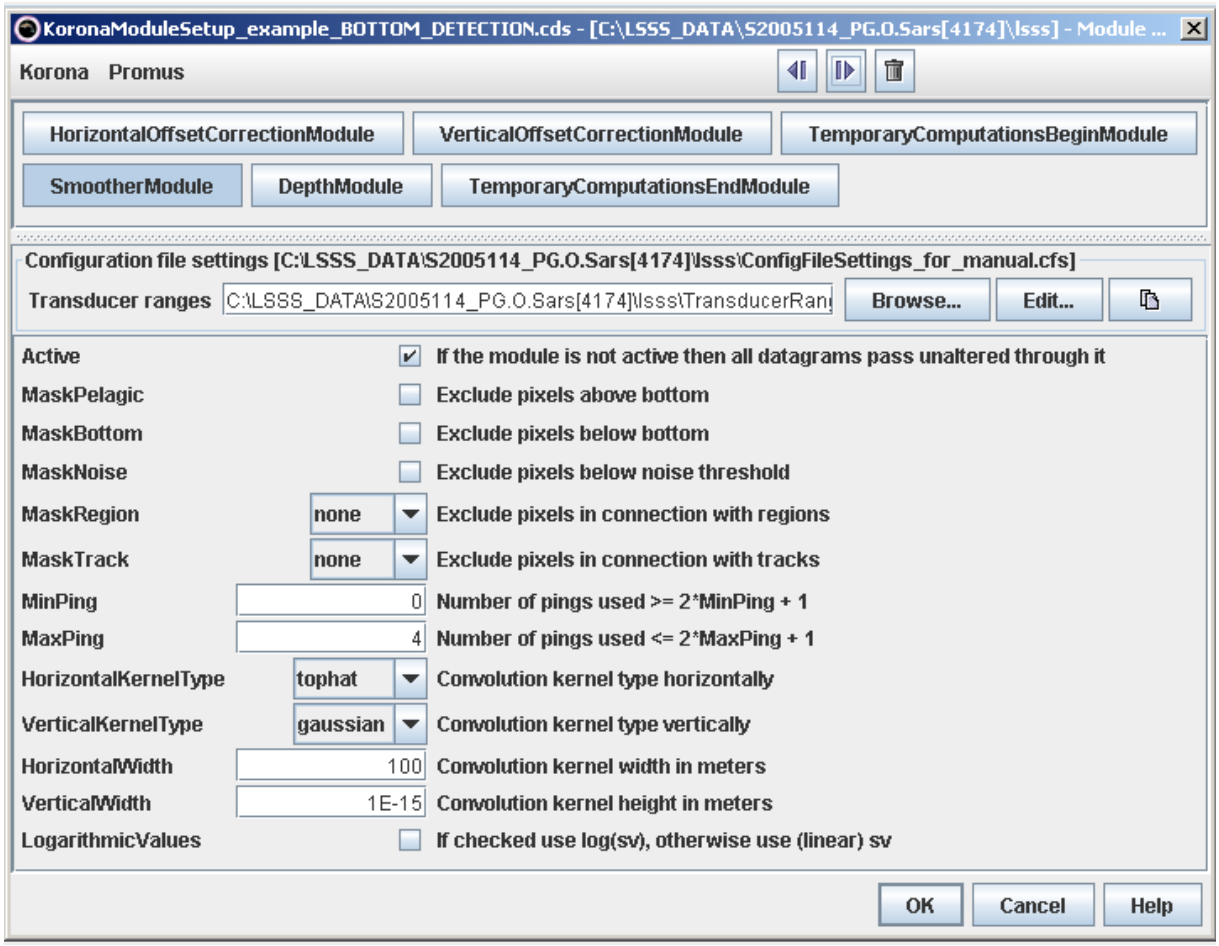

tokt2005114-D20051118-T062010.raw - Korona playbox
tokt2005114
20
Auto Rewind
2005.11.18 06:36:20
Edit modules...
38 kHz
GPT 38 kHz 009072034687
200 kHz
GPT 200 kHz 009072032
18 kHz
F200/F38*4*3.1415*1852*1852

Example 10 - Bottom detection by means of temporary calculations

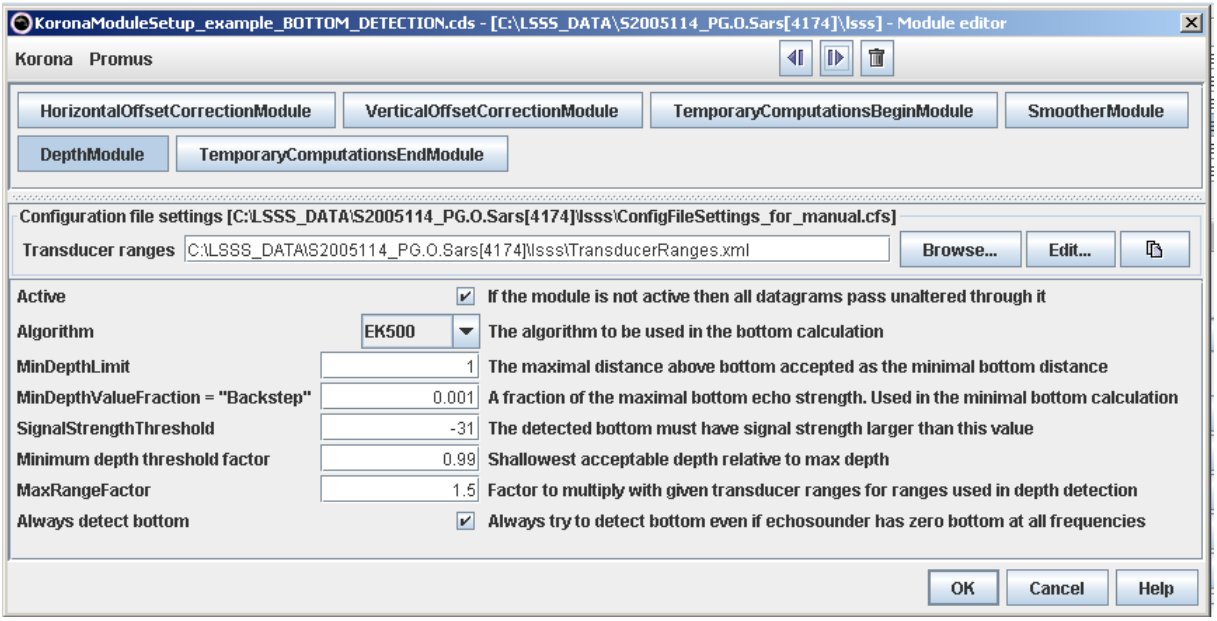
The common bottom detection in KORONA use the same algorithm as Simrad EK500 and Simrad EK60. However, the settings used by the algorithm may be different. How well a particular bottom detection setup works depends on the bottom, i.e. a setup that works well in Norwegian waters may not work as well in Icelandic waters. The use of temporary calculations may solve or at least reduce this problem. All calculations between temporary calculations are rejected, but new datagrams (e.g. bottom datagram) are kept. The following KORONA module setup usually solves the challenge of possibly using the improper settings to the bottom algorithm, and may work unless the bottom depth changes very rapidly:

- Mark start of temporary calculations
- Do heavy horizontal smoothing
- Detect bottom
- Mark stop temporary calculations

The module setup of the smoother module and depth module in the KORONA module setup is shown below:

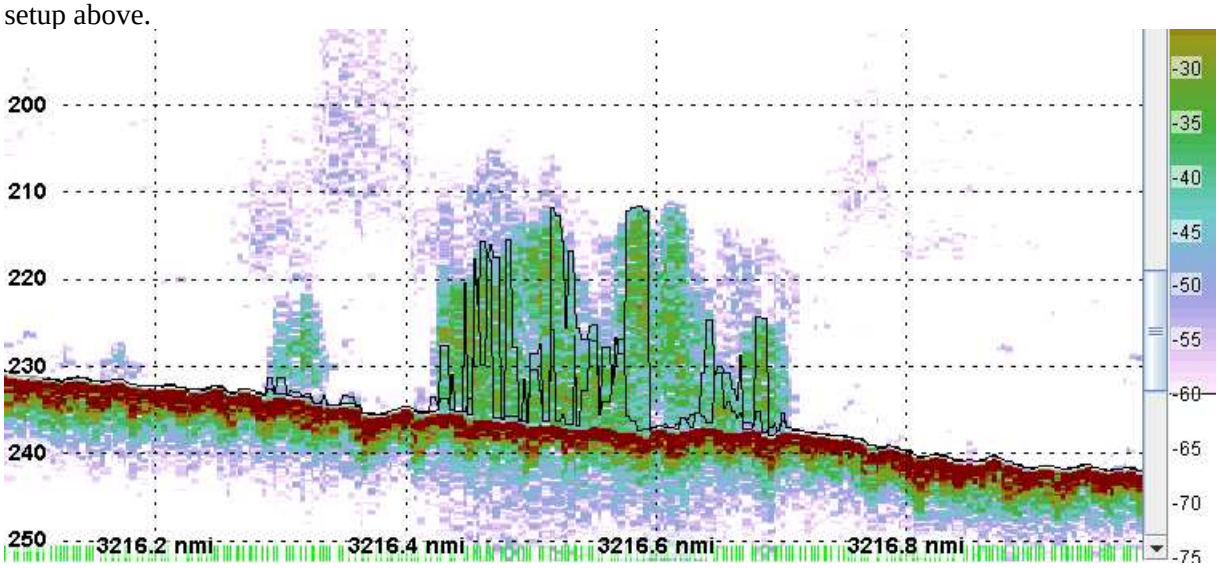


Settings in the smoother module

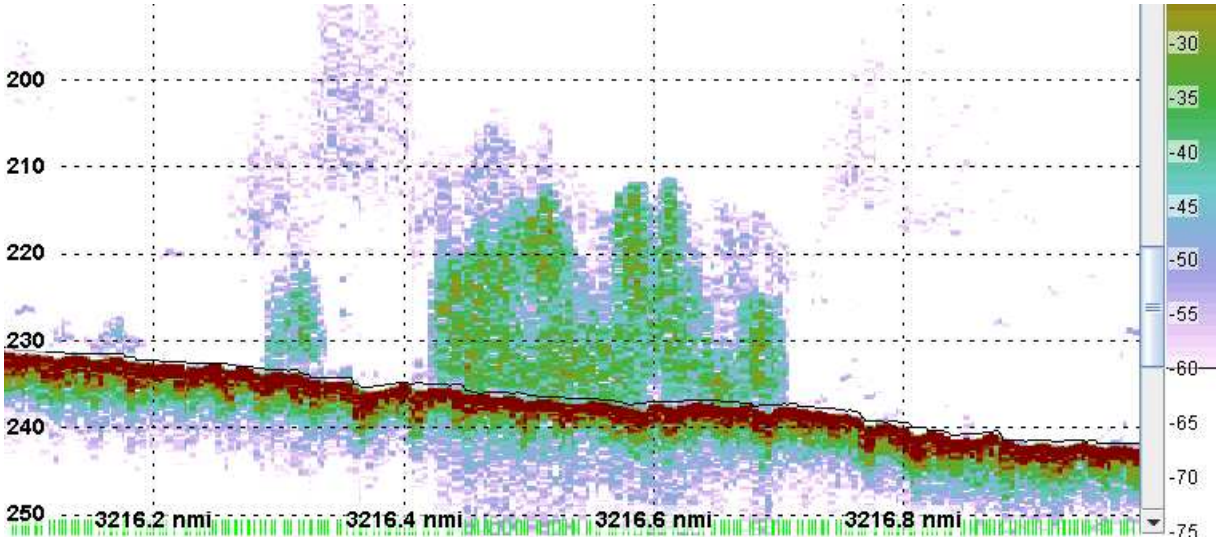


Settings in the depth module

The figures below shows bottom detection from EK60 (38 kHz) and from KORONA using the module setup above.



Bottom detection from EK60 at 38 kHz



Bottom detection from KORONA

Modules

AngleDeletionModule
BubbleSpikeFilterModule
CategorizationModule
CdsViewerModule
ChannelDataRemovalModule
CombinationModule
CombinationRemoverModule
CommentModule
DataReductionModule
DepthModule
DilateModule
DownsamplingModule
EdgeDetectionModule
EmptyPingRemovalModule
ErodeLowValuesModule
ErodeModule
ExpressionModule
FillMissingDataModule
Filter3X3Module
HorizontalOffsetCorrectionModule
IsolationModule
MedianModule
NoiseQuantificationModule
NoiseRemoverModule
NoiseVisualizationModule
PingCollapsingModule
PingThinningModule
PlanktonInversionModule
PluginModule
RegionFilteringModule
RegionModule
RemoveBottomModule
RemoveSingleChannelModule
RescaleModule
SchoolCategorizationModule
SmootherModule
SpikeFilterModule
SpotNoiseModule
TemporaryComputationsBeginModule
TemporaryComputationsEndModule
ThresholdModule
TimeIntervalModule
TowfishModule
TraceBorderModule
TrackingModule
VerticalOffsetCorrectionModule
WriterModule

CategorizationModule

Module for categorization. See references for description of original methods.

Requirements

- Depth datagrams, Dep0Datagram, see DepthModule, if category *bottom* is active.
- Noise datagrams, Nqp0Datagram, see NoiseQuantificationModule, if category *noise* is active.
- Smoothing, see SmootherModule, is recommended.

New datagrams

- One initial categorization configuration datagram, Cac0Datagram.
- Subsequently one categorization datagram, Cad0Datagram, for each ping.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`CategoryCount:`** Number of categories per pixel to put in the categorization datagrams.
  Allowed values: `CategoryCount` >= 1
- **`ActiveFeatures:`** Which features to use. Only enabled features can be set to active.
- **`ActiveCategories:`** Which categories to use. Only enabled categories can be set to active.
- **`BlindZoneDepth:`** Depth of surface dead zone.
  Allowed values: `BlindZoneDepth` >= 0.0
- **`Categorizer:`** Type of classifier.
  Allowed values: `{ Gauss, Nearest neighbor, Combined }`
- **`Discriminant:`** Type of discriminant function.
  Allowed values: `{ Aposteriori, Cost }`
- **`ContextualCorrection:`** Type of contextual correction iteration.
  Allowed values: `{ None, ICM }`
- **`ContextualIterations:`** Number of contextual correction iterations.
  Allowed values: `ContextualIterations` >= 0

References

- Korneliussen, R. J., and Ona, E. 2002. An operational system for processing and visualizing multi-frequency acoustic data. â ICES Journal of Marine Science, 159: 293â313.
- Korneliussen, R. J., and Ona, E. 2003. Synthetic echograms generated from the relative frequency response. â ICES Journal of Marine Science, 60: 636â640.
- Korneliussen, R. J., Heggelund, Y., Eliassen, I. K., and Johansen, G. O. 2009. Acoustic species identification of schooling fish. â ICES Journal of Marine Science, 66: 1111â1118.
- Pedersen, G., and Korneliussen, R. J. 2009. The relative frequency response derived from individually separated targets of northeast Arctic cod (Gadus morhua), saithe (Pollachius virens), and Norway pout (Trisopterus esmarkii). â ICES Journal of Marine Science, 66: 1149â1154.
- Korneliussen, R. J. 2010. The acoustic identification of Atlantic mackerel. â ICES Journal of Marine Science, 67: 1749â1758.

IsolationModule

Isolates one category by zeroing out all pixels of different categories.

Requirements

- Categorization datagrams, Cac0Datagram and Cad0Datagram, see CategorizationModule.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Category:`** The category to isolate.

SchoolCategorizationModule

Module for performing categorization of whole schools.

Requirements

- Region border datagrams, RegionBorderDatagram, see RegionModule.
- Region info datagrams, RegionInfoDatagram, see RegionModule.
- Categorization module, see CategorizationModule, must be before this module in the module setup.

New datagrams

- A school categorization datagram, Cas0Datagram, for each detected region which has not been classified as multi-species. If the module has been unable to determine whether the region is single- or multi-species, the region is classified as uncategorized.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Horizontal cell size:`** Cell size in number of pings.
- **`Vertical cell size:`** Cell size in number of samples.
- **`Upper sample offset:`** Number of samples excluded at top of region.
- **`Lower sample offset:`** Number of samples excluded at bottom of region.
- **`Horizontal offset:`** Number of pings excluded at the left and right edges of region.
- **`Secondary category fraction:`** Fraction of cells in region that can be allowed to be different from dominant category.
- **`School categorization distribution:`** Distribution to use when categorizing whole schools.
  Allowed values: `{ CELL, SCHOOL }`
- **`Fill factor for cells:`** The fill factor of cells must be above this value for cells to be used in the analysis of schools.
- **`Minimum fraction categorized cells:`** The fraction of categorized cells has to be above this factor for the school to be categorized.

References

- Korneliussen, R. J., Heggelund, Y., Eliassen, I. K., and Johansen, G. O. 2009. Acoustic species identification of schooling fish. â ICES Journal of Marine Science, 66: 1111â1118.

SmootherModule

Performs smoothing by convolution.

Requirements

- Depth datagrams, Dep0Datagram, see DepthModule, if parameter `MaskBottom` is selected.
- Noise datagrams, Nqp0Datagram, see NoiseQuantificationModule, if parameter `MaskNoise` is selected.
- Region border datagrams, RegionBorderDatagram, see RegionModule, if parameter `MaskRegion` is selected.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`OnlyLastChannel:`** If selected only the last channel is processed, otherwise all channels are processed.
- **`MaskPelagic:`** Exclude samples above bottom.
- **`MaskBottom:`** Exclude samples below bottom.
- **`MaskNoise:`** Exclude samples below noise threshold.
- **`MaskRegion:`** Exclude samples in connection with regions.
  Allowed values: `{ none, inside, outside }`
- **`MaskTrack:`** Exclude samples in connection with tracks.
  Allowed values: `{ none, inside, outside }`
- **`MinPing:`** Number of pings used â¥ 2*MinPing + 1.
  Allowed values: `MinPing` â¥ 0
- **`MaxPing:`** Number of pings used â¤ 2*MaxPing + 1.
  Allowed values: `MaxPing` â¥ 0
- **`HorizontalKernelType:`** Convolution kernel type horizontally.
  Allowed values: `{ gaussian, tophat }`
- **`VerticalKernelType:`** Convolution kernel type vertically.
  Allowed values: `{ gaussian, tophat }`
- **`HorizontalWidth:`** Convolution kernel width in meters.
  Allowed values: `HorizontalWidth` > 0.0
- **`VerticalWidth:`** Convolution kernel height in meters.
  Allowed values: `VerticalWidth` > 0.0
- **`LogarithmicValues:`** If checked use log(sv), otherwise use (linear) sv.

AngleDeletionModule

Deletes angles from Raw0Datagrams.

ChannelDataRemovalModule

Removes data on selected channels. The channels themselves are not removed.

Parameters

- Active: If the module is not active then all datagrams pass unaltered through it.
- Channels: Comma separated list of channels number to remove.
- Frequencies: Comma separated list of kHz to remove.

CombinationRemoverModule

This module removes the last channel. It can be used to remove the channel created by the CombinationModule. For instance if creating certain datagrams requires changing the pingdata and one wants the original channels to stay unaltered one can make a copy of the channel one wants to alter, manipulate the copy, add datagrams into the stream based on the copy and then remove the copy using this module. That is how the RegionModule works.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

DataReductionModule

Removes data above and below selected ranges.

Parameters

- Active: If the module is not active then all datagrams pass unaltered through it.
- BlindZone: Remove data above the blind zone configured in Transducer ranges file.
- MinRange: Remove data above this range.
- MinDepth: Remove data above this depth.
- TransducerRange: Remove data below the range configured in Transducer ranges file.
- MaxRange: Remove data below this range.
- MaxDepth: Remove data below this depth.

DownsamplingModule

This is a module for reducing vertical resolution by downsampling. Sv is downsampled by averaging. Angles are downsampled by using the angles of the center sample in the downsample interval.

Parameters

- Active: If the module is not active then all datagrams pass unaltered through it.
- Downsampling: The method to find the downsampling factor.
- DownsamplingFactor: If `Downsampling = FACTOR` then this is the downsampling factor.
- DownsamplingSampleSize: If `Downsampling = SAMPLE_SIZE` then the downsampling factor calculated to give approximately this sample size.

EmptyPingRemovalModule

Removes pings with no sample datagrams.

Parameters

- Active: If the module is not active then all datagrams pass unaltered through it.

PingThinningModule

Removes pings.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Initial skip:`** The number of pings to skip initially.
- **`Periodical skip:`** The number of pings to skip between each included ping.

RemoveSingleChannelModule

Removes a specified channels.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`ChannelNumber:`** Channel number to remove. Refers to echosounder channel numbering.

DilateModule

A dilation filter.
Each pixel gets the value of the max value of its neighbors. Size of neighborhood vertically is defined by setting `VertResolution` , if 1 it is a 3*3 neighborhood with the current pixel in the middle of it. In general a 3* (2*`VertResolution`+1) neighborhood. The module buffers up one timestep thereby delaying the stream by one timestep.
Informally the filter has the effect of growing all objects by adding pixels around the object edges.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`VertResolution:`** Vertical resolution of filter(integer).

EdgeDetectionModule

Detects edges by using sobel horizontal and vertical filter. Filter can be prolonged vertically by setting mVertRes. Value if gradient is 0 is -120, and increases linearly with strength of edge. Value is multiplied with scaleFactor.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`ScaleFactor:`** Scale of filter.
- **`VertResolution:`** Vertical resolution of filter(integer).

ErodeLowValuesModule

This is a module for eroding low values. All samples close to another sample with a value lower or equal than a given threshold are set to a predefined value. A sample is close to another if they are on the same or neighbouring pings and their vertical distance is less than a configured distance in meters.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`Threshold:`** The threshold for determining low values.
- **`Replacement value:`** The value to set to samples that are close to samples with value below the threshold.
- **`Vertical extent:`** The vertical distance that low values are eroded.

ErodeModule

An erode filter.
Each pixel gets the value of the min value of its neighbors. Size of neighborhood vertically is defined by setting `VertResolution`, if set to 1 it is a 3*3 neighborhood with the current pixel in the middle of it.
In general it is a 3*(2*`VertResolution`+1) neighborhood.
Informally the filter has the effect of shrinking all objects by removing all the pixels around the edges.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`VertResolution:`** Vertical resolution of filter(integer).

FillMissingDataModule

Creates missing pingdata. Timesteps with missing raw0Datagrams/pings will after passing through this module have same values on the missing raw0datagrams as the previous timestep had.
This module is used in front of other modules that don’t handle missing pings in the middle of a stream.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

Filter3X3Module

Class implementing a 3*3 filter. Either choose a filter from the dropdownmenu or specify one manually by setting all 3*3 values.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`FilterType:`** Specifies what filter to use
  Allowed values: `{ User defined, /*smooth1*/{{1,2,1},{2,1,2},{1,2,1}}, /*smooth2*/{{1,1,1},{1,1,1},{1,1,1}}, /*lowpass*/{{1,2,1},{2,4,2},{1,2,1}}, /*sharpen*/{{-1,-1,-1},{-1,9,-1},{-1,-1,-1}}, /*Laplacian edge (Deltasquared)*/{{1,-2,1},{-2,4,-2},{1,-2,1}}, ... }`
- **`00:`** matrix value.
- **`01:`** matrix value.
- **`02:`** matrix value.
- **`10:`** matrix value.
- **`11:`** matrix value.
- **`12:`** matrix value.
- **`20:`** matrix value.
- **`21:`** matrix value.
- **`22:`** matrix value.

MedianModule

Sets pixelvalue to median of its 8 neighbors and itself. Has the effect of removing spikes and of smoothing the data whilst preserving edges.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.

PingCollapsingModule

Collapses sequential pinging.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

RemoveBottomModule

Removes bottomdata.

Presumes that DepthModule is positioned before this module
Sets all pixels in the interval `[endDepth-Above,endDepth+Below]` to value `PixelValue` where `endDepth` is the bottomDepth detected by the depthmodule and `maxdepth` is maximum depth of ping. If one wants the interval to include start and/or end of range set `Above` and/or `Below` to very high values.

If `AutomaticDepthRange` is toggled off, `endDepth` can be specified manually. `StartDepth` has no meaning in this module.

Requirements

Depth datagrams, Dep0Datagram must be computed, see DepthModule.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`Above:`** Remove this many pixels above bottom.
  Allowed values: `Above` >= 0
- **`Below:`** Remove to this many pixels below bottom.
  Allowed values: `Below` >= 0
- **`PixelValue:`** Value to set pixels to.

ThresholdModule

Masks out values in specific range. This module sets all values >= mThreshold to value mAboveThreshold or does not change them if mAboveSame is true
similarly it sets all values < mThreshold to value mBelowThreshold or does not change them if mBelowSame is true

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`Threshold:`** Threshold value.
- **`Cut below:`** If true all samples with values < threshold will become ’Value below’. Otherwise, the sample values will remain the same.
- **`Cut above:`** If true all samples with values ≥ threshold will become ’Value above’. Otherwise, the sample values will remain the same.
- **`Value below:`** Value to set to samples with value < threshold. The value is given in log(sv) with unit dB.
- **`AboveVal:`** Value to set to samples with value ≥ threshold. The value is given in log(sv) with unit dB.

WriterModule

Writes to a .cmr file for loading into EK60.

New datagrams

- One initial module configuration datagram, Cds0Datagram, is written to the file.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`FileName:`** Output file relative to the directory deduced from the input file.

BubbleSpikeFilterModule

This filter works in a similar way as the SpikeFilterModule, except that is it is looking for vertical structures that are significant weaker than the surroundings (in opposition to the SpikeFilterModule that looks for vertical structures that are stronger). A module for removal of narrow vertical spikes in the echogram, typically caused by bubble-clouds that blocks the sound below the ship. The module works on a per sample basis in essentially the same way as the SpikeFilterModule, and compares each sample to surrounding samples in a user defined *search window* of dimension 3 pings X (2***WindowMedianSearchHeight** + 1) samples, and to a user defined *search column* in the current ping of height 2***VerticalMedianSearchHeight** + 1, also centered on the current sample.
Two medians are calculated by the filter for each sample: The median of the search window, and the median of the samples in the search column. The value of the current sample is then compared against these medians in the following way:

If the center sample is greater than search window median + **TotalDelta**, and maximum one of the horizontal neighbours of the current sample is less than the search column median + **VerticalDelta**, the current sample is replaced by the search window median value.

Parameters

- **Active:** If the module is not active then all datagrams pass unaltered through it.
- **TotalDelta:** Require center sample less than (window median - TotalDelta) to consider sample part of a spike. Given in log(sv).
- **VerticalDelta:** Require maximum one of horizontal neighbours to center sample to be < (column median + VerticalDelta). Given in log(sv).
- **VerticalMedianSearch** The ping column median is performed on a column of range 2*VerticalMedianSearch + 1 in the current ping, centered on the current sample.
- **WindowMedianSearchHeight** The search window median is performed in a window of dimension 3 pings X (2*WindowMedianSearchHeight + 1) centered on the current sample.
- **Debug:** Replace spikes by 0 instead of median.

NoiseQuantificationModule

Produces noise quantification datagrams.

Requirements

- Depth datagrams, Dep0Datagram, see DepthModule.

New datagrams

- Noise quantification datagrams, Nqp0Datagram.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Smooth:`** Type of smoothing.
  Allowed values: `{ none, running averager, averager }`
- **`SmoothInterval:`** Number of samples to smooth vertically before making histogram.
  Allowed values: `SmoothInterval` >= 0
- **`Mask:`** Type of masking.
  Allowed values: `{ none, dynamic }`
- **`MinimumQuality:`** Minimum quality of histogram data. The quality for each ping is set based on where the data for the histogram is picked, and then the mean quality for all data used is calculated:
  Quality = 100. Data between first and second bottom echo are used.
  Quality = 50. Data below a certain (frequency-dependent) range from the transducer, but above the first bottom echo are used.
  Quality = 0. All data are used.
  Allowed values: 0.0 <= `MinimumQuality` <= 100.0
- **`ThresholdMasking:`** Masks values above a threshold and reflections below bottom.
- **`Threshold:`** The threshold to use for threshold masking.
- **`Histogram:`** Type of histogram.
  Allowed values: `{ geometric, linear, constant }`
- **`UseTimeStepBuffer:`** Try to center noise parameters.
- **`TimeStepBufferMaxSize:`** Maximum number of time steps in buffer.
- **`HistogramInitializationCellCount:`** Number of cells in the histograms at initialization.
  Allowed values: `HistogramInitializationCellCount` >= 1
- **`HistogramMaximumCellCount:`** Maximum number of cells in the histograms.
  Allowed values: `HistogramMaximumCellCount` >= 1
- **`HistogramInitializationSampleCount:`** Minimum count of noise samples at initialization of the histograms.
  Allowed values: `HistogramInitializationSampleCount` >= 1
- **`HistogramMinimumSampleCount:`** Minimum number of noise samples in the histograms.
  Allowed values: `HistogramMinimumSampleCount` >= 1
- **`HistogramSmooth:`** Whether or not to smooth the probability distribution.
- **`HistogramSmoothFactor:`** Diffusion time step = HistogramSmoothFactor * dx^2.
  Allowed values: `HistogramSmoothFactor` > 0.0

References

- Korneliussen, R. J. 2000. Measurement and removal of echo integration noise. ICES Journal of Marine Science, 57: 1204â1217.

NoiseRemoverModule

Removes noise based on parameters in noise quantification datagrams.

Requirements

- Noise quantification datagrams, Nqp0Datagram, see NoiseQuantificationModule.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`RemoveNoiseFromStart:`** Search for noise parameter datagram and use it for the first datagrams.
- **`MaxBufferSize:`** Maximum buffer size in search for first noise parameter datagram. Allowed values: `MaxBufferSize` >= 0

NoiseVisualizationModule

Visualizes noise parameters in a separate window.

Requirements

- Noise quantification datagrams, Nqp0Datagram, see NoiseQuantificationModule.
- Noise removing, see NoiseRemoverModule, should be done *after* noise visualization, since the median of equidistant samples is plotted.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`UpdatePeriod:`** Number of pings between each graph update.
  Allowed values: `UpdatePeriod` >= 1
- **`TimeSeriesLength:`** Number of pings in the graphs.
  Allowed values: `TimeSeriesLength` >= 1
- **`HistogramSpan:`** Upper limit of plotted histogram domain in multiples of N_H.
  Allowed values: `HistogramSpan` > 0.0
- **`MedianSampleCount:`** Number of equidistant samples used for finding median noise.
  Allowed values: `MedianSampleCount` >= 0

SpikeFilterModule

A module for removal of narrow vertical spikes in the echogram, typically caused by instrumentation on the ship. The module works on a per sample basis, and compares each sample to surrounding samples in a user defined *search window* of dimension 3 pings X (2***WindowMedianSearchHeight** + 1) samples, and to a user defined *search column* in the current ping of height 2***VerticalMedianSearchHeight** + 1, also centered on the current sample.
Two medians are calculated by the filter for each sample: The median of the search window, and the median of the samples in the search column. The value of the current sample is then compared against these medians in the following way:

If the center sample is greater than search window median + **TotalDelta**, and maximum one of the horizontal neighbours of the current sample is greater than the search column median - **VerticalDelta**, the current sample is replaced by the search window median value.

Parameters

- **Active:** If the module is not active then all datagrams pass unaltered through it.
- **TotalDelta:** Require center sample > (window median + TotalDelta) to consider sample part of a spike. Given in log(sv).
- **VerticalDelta:** Require maximum one of horizontal neighbours to center sample to be > (column median - VerticalDelta). Given in log(sv).
- **VerticalMedianSearch** The ping column median is performed on a column of range 2*VerticalMedianSearch + 1 in the current ping, centered on the current sample.
- **WindowMedianSearchHeight** The search window median is performed in a window of dimension 3 pings X (2*WindowMedianSearchHeight + 1) centered on the current sample.
- **Debug:** Replace spikes by 0 instead of median.

SpotNoiseModule

A module for removal of spot-noise in the echogram. The module works on a per sample basis, and compares each sample to surrounding samples in a user defined *search window* of dimension 3 pings X 5 samples
The 80% percentile value (=testValue) is calculated by the filter for each sample. The value of the current sample is then compared against this testValue + **`Delta`**, and is replace by the median of the 3 x 5 search window.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Delta:`** Require sample > (window 75% percentile + Delta) to consider sample as being spot-noise. Given in $\log(s_v)$.
- **`Debug:`** Replace spikes by 0 instead of median.

HorizontalOffsetCorrectionModule

Module for horizontal offset correction.

The offsets used can the adjusted in the offset editor.

Only the value in the field AlongCorrection is used in this module.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

VerticalOffsetCorrectionModule

Module for vertical offset correction.

The offsets used can the adjusted in the offset editor.

Only the values specified in the fields DepthCorrection and PulseDelayDepthCorrection are used in this module.

Module for vertical offset correction.

Parameters

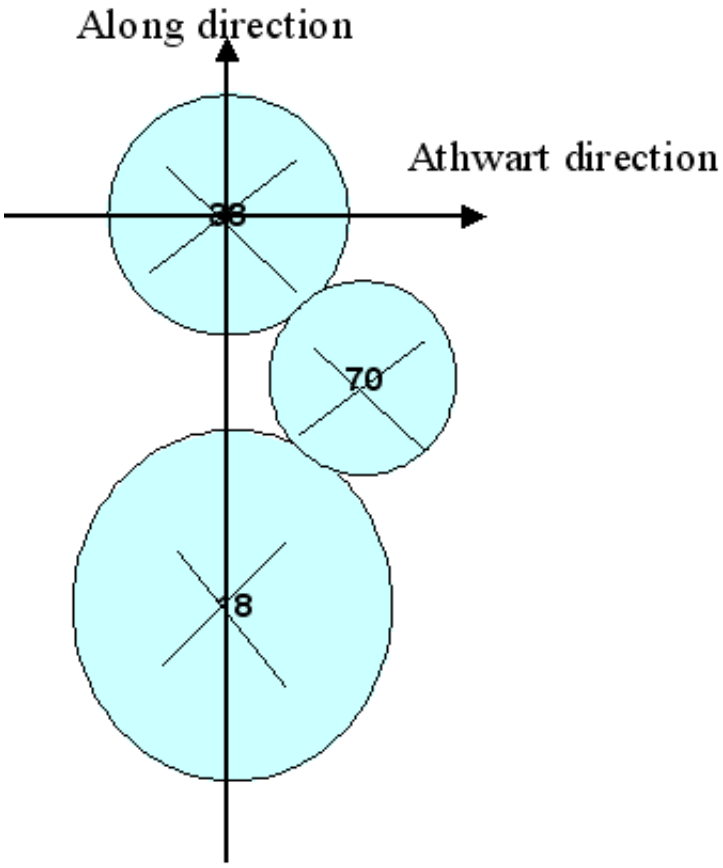
- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

Transducer offsets

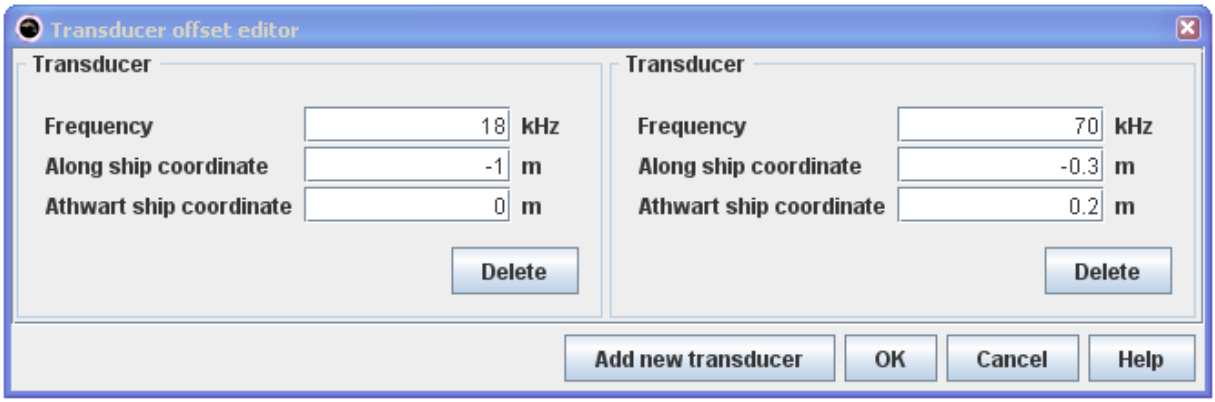
Here it is possible to specify transducer offsets to be used by the modules HorizontalOffsetCorrectionModule and VerticalOffsetCorrectionModule.

The picture below shows a transducer configuration seen from above, and the coordinate system used. The positive z (depth) axis is inwards in the figure. Here the 18 kHz transducer has a negative along ship coordinate compared to the 38 kHz transducer, so a negative number should be inserted into the along ship coordinate below for 18 kHz (if 38 kHz is selected as origin). The transducer selected as origin should have zero offsets. The 70 kHz has a positive athwart ship coordinate and a negative along ship coordinate compared to 38 kHz, so a positive number should be inserted into to athwart ship coordinate for 70 kHz, and a negative number for along ship coordinate.

The vertical offset is divided into two components. The depth coordinate component is offset due to the physical placement. A positive value means that the transducer is placed deeper than the reference depth. Note that this position can also be set in the Simrad logging software, so the offset here is considered an additional offset. The other component, PulseDelayDepthCorrection, is the offset due to pulse delay. A positive value for PulseDelayDepthCorrection is equivalent to an offset due to deeper placement of the transducer compared to the reference depth.



The transducer offsets are given with respect to one of the transducers, usually the 38 kHz transducer, and are specified in the window shown below. All values are in meters.



To add offset corrections to a new transducer, press "Add new transducer". Press delete to remove the corrections for a transducer.

Pressing OK will save the offsets.

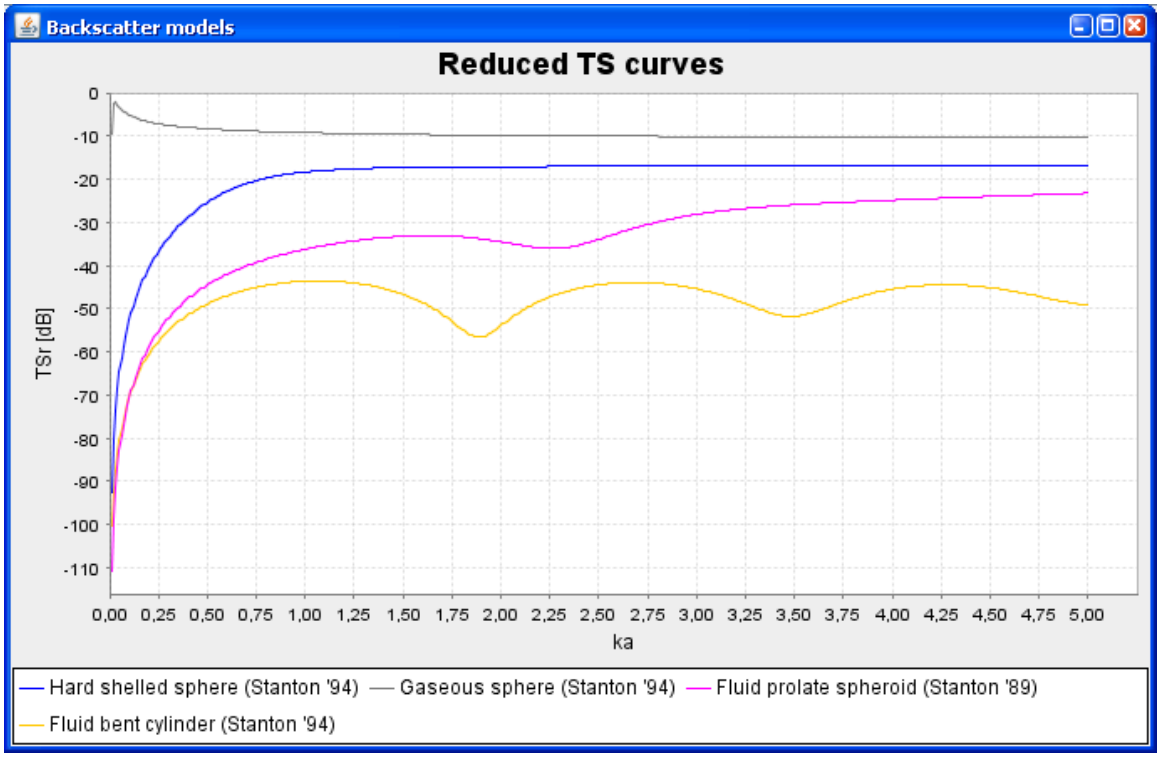
PlanktonInversionModule

Produces plankton inversion datagrams. For more about the algorithm see plankton inversion chapter. For more about the implemented plankton models, see plankton models.

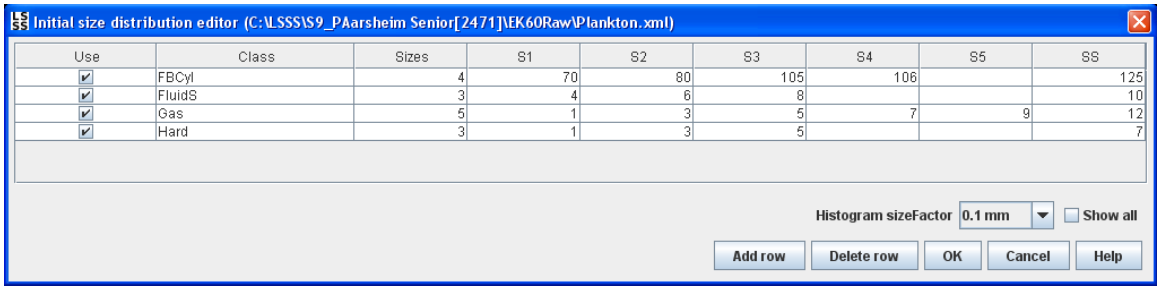
Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`PingsPerBin:`** The number of pings per bin.
- **`DepthSamplesPerBin:`** The number of samples per bin.
- **`Use global noise threshold:`** Toggle this if the global noise threshold should be enabled. Using the global noise threshold means that the sample values for all enabled frequencies should be above the given threshold value for the sample to be used in inversion.
- **`Noise threshold:`** The global noise threshold. See above.
- **`CategoriesUsedForInversion:`** Here the user can toggle which categories (see CategorizationModule) should be used as input to plankton inversion.
- **`ActiveFrequencies:`** The user can toggle which frequencies should be used in the inversion. The effect on the domain of backscatter models can be seen in the backscatter curve plot.
- **`MinResidualErrorThreshold:`** The minimal residual error. The inversion iterations for a model stops if the residual is below this value.
  Allowed values: `MinResidualErrorThreshold` >= 0.0
- **`MaxResidualErrorThreshold:`** The maximal residual error. The plankton sample is set to no category if the residual for the best-fit model is higher than this number.
  Allowed values: `MaxResidualErrorThreshold` >= 0.0
- **`LevenbergMarquardtFactor:`** The Levenberg-Marquardt factor. Used in during the inversion to give preference to solution with the smallest norm. A higher value means that a small norm is more important than a small residual. Suggested value between 1e-6 and 1e-4.
  Allowed values: `LevenbergMarquardtFactor` >= 0.0
- **`MaxIter:`** The maximum number of iterations for each model inversion.
  Allowed values: `MaxIter` >= 1
- **`HardShelled:`** Toggle on if the hard shelled sphere model (Stanton 1994) is to be used in the inversion.
- **`HardShelledR:`** Reflection coefficient.
- **`GaseousSphere:`** Toggle on if the gaseous sphere model (Stanton 1994) is to be used in the inversion.
- **`GasSphereG:`** Relative density.
- **`GasSphereH:`** Relative sound speed.
- **`FluidSpheriod:`** Toggle on if the fluid prolate spheriod model (Stanton 1989) is to be used in the inversion.
- **`FluidSpheriodG:`** Relative density.
- **`FluidSpheriodH:`** Relative sound speed.
- **`FluidSpheriodBeta:`** Length to width ratio.
- **`FluidBent:`** Toggle on if the fluid bent cylinder model (Stanton 1994) is to be used in the inversion.
- **`FluidBentR:`** Reflection coefficient.
- **`FluidBentS:`** Standard deviation of length.
- **`FluidBentBeta:`** Length to width ratio.

- **`SDWBA:`** Toggle on if the SDWBA model (Conti 2006) is to be used in the inversion.
- **`SDWBA coefficients:`** Select which set of SDWBA coefficients should be used (defined in Conti 2006)
- **`BackscatterCurves:`** Opens a view of the backscatter curves with the current configuration of the models. The unused part of the backscatter curves will be drawn with a thinner line width than the parts that can be used given the set of frequencies and the given initial size distributions of the individuals belonging to the models.



- **`Editor:`** Opens an editor for the initial size distribution for the models:



This dialog lets the user specify an initial size distribution for the various models used in the plankton inversion.

Each row defines an initial size distribution histogram for a given class [FBCyl, FluidS, Gas, Hard]. The species column is used for entering a catch. By clicking "Show all", it is possible to specify a start/stop date/time/depth for each distribution, defining a window of validity in terms of time and depth.

The number of bins in the histogram is given in the "size" column. Entering a higher/lower number here will dynamically alter the number of columns in the table to match the number of bins in the histogram. The SX gives the lower edge of each histogram bin, while SS gives the upper edge of the last bin. NX gives the contents of each bin. If a divider is entered that is inconsistent with the previous/next divider, the user is asked if the surrounding inconsistent dividers should be automatically adjusted. The dividers will be adjusted with one unit with respect to the entered divider.

The initial size factor in the combo box gives the scaling factor for the histogram bin edges.

Additional initial size distributions can be specified by pressing "Add row". Distributions are deleted by selecting a row and pressing "Delete row".

Pressing OK saves the setting to the XML file indicated in the window header.

Implemented plankton models

There are five plankton models implemented in the PlanktonInversionModule.

FluidBentCylinder

This models the backscattering of a fluid bent cylinder, taken from Stanton 1994.

The model has three configurable parameters:

- Reflection coefficient
- Relative standard deviation of length - std dev/L
- Length to width ratio

The bend of the cylinder is not a parameter, as the average echo is independent of the curvature when the distribution of orientations is sufficiently broad.

Bio volume

$V = L * \pi * r^2$
where L is the length of the cylinder and r is the radius.

FluidProlateSpheroid

This models the backscattering of a prolate spheroid filled with a fluid, taken from Stanton 1989.

The model has three configurable parameters:

- g - density body material/density surrounding fluid
- h - compressional speed of sound in body material/compressional speed of sound in surrounding fluid
- beta - Length to width ratio.

Bio volume

$V = \pi /6 * L * d * d$
where L and d the diameters of the sphere.

GaseousSphere

This models the backscattering of a gas filled sphere, taken from Stanton 1989.

The model has two parameters

- g - density body material/density surrounding fluid
- h - compressional speed of sound in body material/compressional speed of sound in surrounding fluid

BioVolume

$V = \pi /6 * L^3$
where L is the diameter of the sphere.

HardShelledSphere

This models the backscattering of a hard shelled sphere, taken from Stanton 1989.

The model has one parameter

- R - The reflection factor.

Bio volume

$V = \pi /6 * L^3$
where L is the diameter of the sphere.

SDWBA

This models the backscattering of a reference size krill, using a parametrization of the Stochastic Distorted Wave Born Approximation (SDWBA), taken from Conti 2006.

The model takes one parameter.

- SDWBA coeff set - The parametrization of the SDWBA is given in terms of the distribution of krill orientations N(theta, sigma), where theta is the mean krill orientation, and sigma is the standard deviation of the distribution of orientations. Coefficients for the distributions presented in the paper above are provided in this implementation.

Bio volume

$V = V_0 * (L/L_0)^3$
where V_0 is the volume of the reference krill, L is the length and L_0 is the length of the reference krill.

RegionFilteringModule

Filters away regionInfoDatagrams that fall outside of the ranges specified in the module so that they are not visualised with a horizontal line, the module also has options for printing the data in the regionInfoDatagram. The module does not actually remove the regionInfoDatagrams that are outside the ranges, it only sets a flag in the datagram to false. The visualiser does not show regionInfoDatagrams that have this flag set to false. Originally all regionInfoDatagrams created by the RegionModule have their flags set to true.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Thresholds:`** What threshold datagram to filter.
- **`Density:`** Density range of region; This range is compared with the average echostrength for the region (Integrated echostrength in whole region / Pixels in region).
- **`Length:`** Minimum length of region in meters.
- **`Thickness:`** Minimum thickness of region in meters.
- **`Area:`** Area of region in square meter.
- **`Overlap:`** Overlap of distribution with values outside region.
- **`PrintInfo:`** Prints out info about the regionEnd datagram.
- **`PrintHistogram:`** Prints out histogram for region.

RegionModule

For a specified channel this module detects regions with pixelstrength higher than a certain threshold and creates datagrams describing them.
See TraceBorderModule for more info.

New datagrams

RegionInfoDatagram and RegionBorderDatagram.

RegionInfoDatagrams are created when the end of a region is reached and the region values are within the legal intervals specified in the module. RegionBorderDatagrams are created so that they describe the borders of all regions with values higher than the specified threshold independent of the regions values. However the RegionBorderDatagrams contain a boolean flag which is set to true if it would be the case that if the region ended at that datagram a RegionInfoDatagram would be created, and set to false otherwise. This is visualised by filling the regionBorderDatagrams that have the flag on, and only outlining the regionBorderDatagrams with the flag off. RegionInfoDatagrams are visualised by a horizontal line starting at the highest depth of the region to the lowest depth of the region.

This module encapsulates a module setup that looks like this:
FillMissingDataModule -> DepthModule-> CombinationModule -> RemoveBottomModule -> MedianModule*3 -> ErodeModule -> DilateModule -> TraceBorderModule * #thresholds -> CombinationRemoverModule
The setup is loaded from cfgSchool.xml

The threshold value is set in the Thresholds parameter. If one wants to detect several thresholds then separate them with comma. The TraceBorderModule is instantiated as many times as there are thresholds, this is invisible for the user.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`ProcessLast:`** If selected, the last channel will be used for region detection. The Channel setting is in this case ignored.
- **`Channel:`** What channel module will work on.
- **`Blind zone depth:`** Depth of blind zone below surface [m].
- **`Thresholds:`** Minimum value of all pixels inside a region, comma separated [dB].
- **`Density:`** Density range of region; This range is compared with the average echostrength for the region (Integrated echostrength in whole region / Pixels in region).
- **`Length:`** Minimum length of region in meters must be in this range.
- **`Thickness:`** Minimum thickness of region in meters must be in this range.
- **`Area:`** Area of region in square meter.
- **`Overlap:`** Overlap of distribution with values outside region.

TraceBorderModule

Detects regions with special properties and creates datagrams describing them.

New datagrams

RegionInfoDatagram and RegionBorderDatagram.
Using this module alone won't work, it will disable itself automatically after writing a warning, use the RegionModule instead.

A region is defined as a closed, connected area where all values are equal to or above a certain threshold, all values outside the region are below this threshold. A region is allowed to have holes in it. An inner boundary(border) of a region is the set of pixels within the region that have one or more neighbors outside the region.

The TraceBorderModule finds regions by tracing their inner boundaries with respect to a threshold value. For each region different values for the region are calculated (RegionInfoDatagram). 'Interesting' regions can be separated from 'uninteresting' regions by means of the region values. RegionInfoDatagrams are only created if the region values are within the range specified in the module.

Requirements

This module requires modules in front of it in this order where XX means any module:

FillMissingDataModule -> XX -> DepthModule-> RemoveBottomModule -> XX -> (maybe some smoothing, a quick solution is 3* MedianModule) -> ErodeModule -> DilateModule -> TraceBorderModule*REP}

If REP > 1, the thresholds of the TraceBorderModules must be in increasing order.

Parameters

- **`Active:`** If the module is not active, all datagrams pass unaltered through it.
- **`LogarithmicValues:`** Use log(sv) or sv.
- **`ShowDetails:`** Shows more detailed settings (OnlyLast,AutomaticDepthRange,StartDepth,EndDepth).
- **`OnlyLast:`** When true, only last channel is processed, if false all channels are processed.
- **`AutomaticDepthRange:`** If true and DepthModule is used then the range goes to the detected seabed, if true and DepthModule is not used the range goes to max depth of the ping.
- **`StartDepth:`** Start depth in meter for filter.
- **`EndDepth:`** End depth in meter for filter.
- **`Channel:`** What channel module will work on.

'Satisfaction values':

- **`Density:`** Density range of region; This range is compared with the average echostrength for the region (Integrated echostrength in whole region / Pixels in region).
- **`Length:`** Minimum length of region in meters.

- **`Thickness:`** Minimum thickness of region in meters.
- **`Area:`** Area of region in square meter.
- **`Overlap:`** Overlap of distribution with values outside region.
- **`Threshold:`** Minimum value of all pixels inside a region.

TowfishModule

Merges towfish data with main echosounder data.

For each ping in the input data, the module searches for a corresponding ping in the towfish data. For a corresponding towfish ping to be found, the following criteria must be met:

- A towfish data file folder must be specified
- There must exist towfish meta data, and the time of the input ping must correspond to meta data for that time. The meta data must be on one of the formats specified in meta data file format section
- There must exist towfish raw data for the towfish corresponding to the input ping time

If a towfish ping is found, the data from the towfish ping is merged with the input data.

The module attempts to use the data for cable length and depth of the towfish (from the meta-data) to find a matching towfish ping for a given input ping. To do this, there must be a relationship between the cable length *L* and the towfish depth, *D* on one hand and the distance behind the ship on the other hand. Two types of functions are available:

- Pythagoras: The distance behind the ship is given as $sqrt(L^2 - D^2)$
- Straight down: The distance behind the ship is *0*

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Time to add to the towfish echosounder data:`** If there is a known time offset between the towfish echosounder data and the towfish meta-data and the ship mounted echosounder data, the offset can be entered here.
- **`Distance behind function:`** The relationship between the cable length and towfish depth on the one side and the distance behind the ship on the other side.

Meta data file format

Currently three types of towfish meta can be read by the towfish module. The expected format is decided by the name of the directory where the metadata file is found. The directory should be a subdirectory to the Towfish directory. The formats and the metadata directory name are explained below.

Telegram based data

Metadata directory name: Consys-metadata. In this format the meta data comes as telegrams in a flat text file. Each line in the file starts with the time and date in the following format:
`dd.MM.yyyy,HH:mm:ss`
The relevant telegrams are:

- Pressure: `Pressure = 110.300 dB Temperature = 10.2 dgr C`, where pressure is in decibars and temperature is in degrees Celsius
- Cable length: `L=102.9m S=13.4m/m`, where L is cable length [meters] and S is winch speed [meters/minute]

- Ship vessel log: `$EKDEA,D2,19360507,1823.9,6,1,0,*5c`, where the third parameter is the time/data and the fourth parameter is the vessel log in nmi

Line based data

In this format each line is a complete set of parameters for the towfish. The first line should be headers giving the name of the columns. For all following lines, each line starts with the time and date, and contains vessel log and depth. All numbers use . as decimal character. There are currently two variants of line based data available based on metadata files from two different tow-bodies (MUST and MESSOR).
Metadata directory name: Messor-metadata. The relevant columns of MESSOR separated by tab are:

- Column 0 - Date and time: format `ddMMyyyyHHmmss`
- Column tag "EK_Log-Dist" - Vessel log: The vessel log in nmi
- Column tag "CTD_Depth(m)" - towfish depth: The depth of the towfish in meters

Metadata directory name: Must-metadata. The relevant columns of MUST separated by " , " (space-comma-space) are:

- Column 0 - Date and time: format `yyyyMMddHHmmssSS`
- Column tag "ShipER60VesselLog" - Vessel log: The vessel log in nmi
- Column tag "CTDDepth" - towfish depth: The depth of the towfish in meters

TrackingModule

Tracks single targets. Tracking is done on a single frequency.

- Frequency [kHz]: The frequency on which to do tracking.

Target candidates

Target candidates are identified to continue tracks or start new tracks.

SED

In this case the target candidates are found using single echo detections with the following parameters:

- MinTS: Minimum TS value to be detected [dB]
- MaxTS: Maximum TS value to be detected [dB]
- MaxAlongshipAngle: Maximum alongship angle [deg]
- MaxAthwartshipAngle: Maximum athwartship angle [deg]
- PulseLengthDeterminationLevel: Pulse length determination level [dB]
- MinEchoLength: Minimum echo length (relative to pulse length)
- MaxEchoLength: Maximum echo length (relative to pulse length)
- MaxGainCompensation: Maximum (one way) gain compensation [dB]
- DoPhaseDeviationCheck: Check this if phase deviation check should be performed
- MaxPhaseDevSteps: Max phase deviation [phase steps]

Aggregation

In this case all samples satisfying the following criteria are used as target candidates:

- MinTS: Minimum corrected TS for target candidates.
- MaxTS: Maximum corrected TS for target candidates.
- MaxAlongshipAngle: Maximum alongship angle [deg]
- MaxAthwartshipAngle: Maximum athwartship angle [deg]
- MaxDirectivityCorrection: Maximum directivity correction [dB]

Gating and data association

The difference between prediction from track *i* and sample *j* is calculated for all predictions and samples at ping *k*:

$$\varepsilon_{ijk} = y_{jk} - \&\#7929;_{jk}$$

where $y_{jk} = [\ \alpha\ \beta\ r\ TS\ ]$, α = alongship angle, β = athwartship angle, r = range, TS = target strength.

The gate distance is then defined as

$$d_{ijk} = \varepsilon_{ijk}\, G\, \varepsilon_{ijk}^{T}$$

where

$$G = \begin{bmatrix} \alpha_G^2 & 0 & 0 & 0 \\ 0 & \beta_G^2 & 0 & 0 \\ 0 & 0 & r_G^2 & 0 \\ 0 & 0 & 0 & I_G^2 \end{bmatrix}^{-1}$$

A sample is inside the gate if $d_{ijk} \leq 1$.

Termination

A track is terminated based on the following parameters:

- N_m: Maximum number of missing pings in a row.
- N_e: Maximum number of missing samples in a single ping.

Acceptance

When a track is terminated accepted or rejected based on a set of acceptance criteria. A track is marked as accepted if it satisfies all the following acceptance criteria:

- MN: Maximum acceptable ratio of missing pings to track length.
- TL: Minimum acceptable track length.
- NL: Minimum acceptable ratio of total number of samples to track length.

References

Nils Olav Handegard (2007). "Observing individual fish behavior in fish aggregations: Tracking in dense aggregations", J. Acoust. Soc. Am, Vol 122(1), 177-187

Nils Olav Handegard, Ruben Patel and Vidar Hjellvik (2005). "Tracking individual fish from a moving platform using a split-beam transducer", J. Acoust. Soc. Am., Vol 118(4), pp 2210-2223

New datagrams

Tbr0Datagram, Tnf0Datagram, Ttc0Datagram.

CdsViewerModule

For viewing the module configuration stored in a processed file. Each time a Cds0Datagram is encountered, a ModuleEditor window appears displaying its configuration. Edits in this ModuleEditor have no effects.

Requirements

- Module configuration datagram, Cds0Datagram.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.

CombinationModule

Module for generating combination echograms.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`FirstOperandKhz:`** Frequency of the first operand.
  Allowed values: `FirstOperandKhz` >= 0
- **`SecondOperandKhz:`** Frequency of the second operand.
  Allowed values: `SecondOperandKhz` >= 0
- **`FirstOperandChannel:`** Channel of the first operand (used if `FirstOperandKhz` = 0).
  Allowed values: `FirstOperandChannel` >= 1
- **`SecondOperandChannel:`** Channel of the second operand (used if `SecondOperandKhz` = 0).
  Allowed values: `SecondOperandChannel` >= 1
- **`LogarithmicOperands:`** If checked use log(sv), otherwise use (linear) sv.
- **`Operation:`** Specifies how the operands are combined.
  Allowed values: `{ -, +, *, /, mean, harmonic mean, min, max, zero, copy1stOperand }`

CommentModule

This module can be used for writing a comment about the module configuration.

DepthModule

Bottom depth detection module. The depth datagrams that may accompany the raw data files are used to detect the case that no bottom can be found. If the accompanied depth datagrams exist and have detected zero-depth for all channels, this is used as an indication that there is no detectable bottom. In this case the depth is set to the maximum range of the ping.

New datagrams

Depth datagrams, Dep0Datagram.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Algorithm:`** Specifies the algorithm to be used in the bottom calculation.
  Allowed values: `{ EK500, Gradient, Threshold }`
- **`MinDepthLimit:`** Specifies the maximal distance above bottom accepted as the minimal bottom distance.
- **`MinDepthValueFraction:`** For the minimal bottom calculation. The module backsteps from the depth maximal bottom echo strength, until the echo strength is less than this fraction of the maximal bottom echo strength.
- **`SignalStrengthThreshold:`** The detected bottom must have signal strength larger than this value.
- **`Minimum bottom depth:`** The detected bottom must be minimum this value.
- **`Maximum bottom depth:`** The detected bottom must be maximum this value.

ExpressionModule

Creates a new channel defined as an expression of the existing channels.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Expression:`** An expression of the (linear) s_v values. Use C1, C2, ..., or F18, F38, ...
  If multiple expressions are specified then the first expression with all variables available is used.
  All functions in java.lang.Math are available.
  Examples:
  C1
  (C1 + C2) / 2
  C1 / C5 + F70 - C4
  C6 * log10(C2) / pow(C3, F364)

PluginModule

Uses the Korona API for module computations. The parameter Implementation implements the ModuleComputation interface, and is compiled and used directly by Korona. This provides a simple way to getting started and experimenting with the API.

Details about the Korona API can be found in the Javadoc.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`Description:`** A description of what the implementation does.
- **`Example:`** Example implementations.
- **`Implementation:`** An implementation of the ModuleComputation interface.

RescaleModule

Rescales some channels to fit into the logarithmic Sv range.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`RescaleChannels:`** Which channels to rescale.
  Allowed values: `{ all, half, last, none }`
- **`DesiredMinimum:`** Desired minimum.
- **`DesiredMaximum:`** Desired maximum.
- **`MinMaxFraction:`** Discard this fraction of lower and upper values when deciding the rescaling.
  Allowed values: 0.0 <= `MinMaxFraction` <= 1.0
- **`InitializationDatagramCount:`** Number of datagrams from each channel used to determine rescaling factors.
  Allowed values: `InitializationDatagramCount` >= 1
- **`InitializationMaxDatagramCount:`** Maximum number of datagrams to buffer up when finding rescaling factors.
  Allowed values: `InitializationMaxDatagramCount` >= 1

TemporaryComputationsBeginModule

This module marks the start of temporary computations. For each ping, copies of the Raw0Datagrams are made. Subsequent changes to Raw0Datagrams are reverted by a TemporaryComputationsEndModule. New datagrams, however, from for example seabed detection, region detection or categorization, are kept.

TemporaryComputationsEndModule

This module marks the end of temporary computations. Changes made to Raw0Datagrams since a previous TemporaryComputationsBeginModule are reverted. New datagrams, however, from for example seabed detection, region detection or categorization, are kept.

TimeIntervalModule

Module for processing only the datagrams in a specified time interval. The start and end dates are in the same format as is displayed in the upper right in the Korona main window. The empty string implies no restriction.

Parameters

- **`Active:`** If the module is not active then all datagrams pass unaltered through it.
- **`StartDateString:`** The start date and time in UTC (`dd.MM.yyyy HH:mm:ss`). The empty string implies no restriction.
- **`EndDateString:`** The end date and time in UTC (`dd.MM.yyyy HH:mm:ss`). The empty string implies no restriction.

Datagrams

Bot0Datagram
Cac0Datagram
Cad0Datagram
Cas0Datagram
Cds0Datagram
Con0Datagram
Dep0Datagram
Idx0Datagram
Nme0Datagram
Nqp0Datagram
Pic0Datagram
Pid0Datagram
Raw0Datagram
RegionBorderDatagram
RegionInfoDatagram
RegionTableOfContentsDatagram
Tbr0Datagram
Tnf0Datagram
Ttc0Datagram
UnknownDatagram

Bot0Datagram

The ER60 bottom datagram.

Occurrences

- In the bot file.

Creator

- ER60.

Contents

- Bottom depth.

Cac0Datagram

Categorization configuration datagram. Identifies all categories referred to later by categorization datagrams, Cad0Datagram.

Occurrences

- Once only, after Con0Datagram and before the first Raw0Datagram.

Creator

- CategorizationModule.

Contents

- **`NumberOfCategories:`** The number of categories.
- **`Categories:`** A list of properties for each category:
  - **`CategoryName:`** The name of a category.
  - **`CategoryLegend:`** The legend (short name) of a category.
  - **`CategoryNumber:`** The number of a category.
  - **`CategoryColor:`** The color (24 bit rgb) of a category.

Cad0Datagram

Categorization datagram that contains categorization data for each pixel in each ping. Refers to categories identified in the initial categorization configuration datagram, Cac0Datagram.

Occurrences

- Once per ping.

Creator

- CategorizationModule.

Contents

- **`NCategories:`** The number of categories included for each pixel.
- **`Count:`** The number of pixels, which is the same as the Raw0Datagram for the reference channel.
- **`SampleDistance:`** Vertical distance [m] between pixels.
- **`FirstDepth:`** Depth [m] of the first pixel.
- **`Categories:`** Array of category numbers that loops over all included categories and all pixels. The innermost loop is over the `Count` pixels. If a pixel has fewer than `NCategories` categories, the unknown category is used for remaining entries.
- **`Discriminants:`** Array of discriminant values. Same ordering as for `Categories`.
- **`Probabilities:`** Array of probabilities. Same ordering as for `Categories`.

Cas0Datagram

Result of school categorization. Refers to categories identified in the initial categorization configuration datagram, Cac0Datagram. The datagram keeps a reference to the RegionInfoDatagram it was created from.

Occurrences

- Once per region which has not been identified as multi-species.

Creator

- SchoolCategorizationModule.

Contents

- **`NCategories:`** The number of categories included for each region.
- **`RegionID:`** The id of the corresponding the RegionInfoDatagram.
- **`Categories:`** Array of category numbers that loops over all included categories.
- **`Discriminants:`** Array of discriminant values. Same ordering as for `Categories`.
- **`Probabilities:`** Array of probabilities. Same ordering as for `Categories`.

Cds0Datagram

Datagram for module configuration. Contains complete description of the module configuration used when processing the file which this datagram is read from.

Occurrences

- Once only, after Con0Datagram and before the first Raw0Datagram.

Creator

- WriterModule.

Contents

- **`ModuleConfiguration:`** Module configuration as XML.

Con0Datagram

The EK60 echo sounder configuration datagram.

Occurrences

- Initially, as the first datagram.

Creator

- EK60.

Contents

- Echo sounder configuration.

Dep0Datagram

Datagram for depth data.

Occurrences

- Once per ping.

Creator

- DepthModule.

Contents

- **`Depth:`** The detected bottom depth.
- **`MinimumDepth:`** The minimum bottom depth, see DepthModule.

Idx0Datagram

The ER60 index datagram.

Occurrences

- In the index file.

Creator

- ER60.

Contents

- Ping number, vessel distance, latitude, longitude, file offset.

Nme0Datagram

NMEA datagram.

Occurrences

- Unspecified.

Creator

- EK60.

Contents

- Positioning data.

Nqp0Datagram

Datagram for Noise Quantification Parameters. Contains parameters that quantify the noise level for a channel.

Occurrences

- Once per ping.

Creator

- NoiseQuantificationModule.

Contents

- **`Channel:`** The channel to which this datagram corresponds.
- **`Average:`** Average noise level, N_E.
- **`UpperLimit:`** Upper limit for noise values, N_H.
- **`Quality:`** The quality of the noise parameters, ranging from 0 to 100.

Pic0Datagram

Plankton inversion configuration datagram. Defines all plankton categories to be referred to later in the plankton inversion datagrams Pid0Datagram.

Occurrences

- Once only, after Con0Datagram and before the first Raw0Datagram.

Contents

```
Pic0Datagram // "PIC"=Plankton Inversion Configuration
{
   int numberOfCategories;
   PlanktonCategory[] planktonCategories;
}
PlanktonCategory
{
   string name;
   string legend;
   byte number;
   unsigned byte red;
   unsigned byte green;
   unsigned byte blue;
}
```

Pid0Datagram

Plankton inversion datagram that contains plankton category and associated length distribution of the plankton.

Occurrences

- Once per ping.

Contents

```
Pid0Datagram // "PID"=Plankton Inversion Datagram
{
   int count; // The number of inverted samples.
   float sampleDistance; // The distance between the samples [m].
   float firstDepth; // The depth of the first sample [m].
   int numberOfSamples; // The number of stored planktonSamples objects.
   PlanktonSample[] planktonSamples;
}
PlanktonSample
{
   int startSampleNumber; // The first sample number in the original RAW datagram this plankton sample is valid for.
   int numberOfPlanktonDatas; //The number of plankton datas for this sample.
   PlanktonData[] planktonDatas; // Should be numberOfPlanktonDatas of these.
}
PlanktonData
{
   byte planktonNumber;
   float fraction; // The fraction of the s A  this data unit represents.
   float residual; // The computed residual from the inversion algorithm.
   int numberOfBinsInLengthDistribution;
   LengthDistribution lengthDistribution; // Only present if numberOfBinsInLengthDistribution > 0.
}
LengthDistribution
{
   float[] binDividerPositions; // Should be numberOfBins + 1 of these.
   float[] abundanceForBins; // Should be numberOfBins of these.
}
```

Raw0Datagram

The EK60 echo sounder sample datagram.

Occurrences

- Once per ping per channel.

Creator

- EK60.

Contents

- Sample data.

RegionBorderDatagram

Datagram for regionborder data.
This datagram describes where the regions start and stop for one ping thereby describing a vertical slice of a region. It contains a list of `BorderInfo` objects describing all regions cross-sections with this ping.

Occurrences

- Irregularly: from none per ping to as many per ping as there have been TraceBorderModules in front of the stream.

Creator

- TraceBorderModule, also RegionModule since it contains one or more TraceBorderModules.

Contents

- **`Channel:`** On what channel this regionslice was detected.
- **`Threshold:`** The threshold for the regionslice.
- **`BorderSize:`** Number of regionslices (twice the number of borders) for this ping.
- **`BorderInfo:`** A list of `BorderInfo` objects, each being a description of a region's cross-section with this ping, the objects are in increasing order with respect to start and end values: if BorderInfo a is before BorderInfo b then a.mEnd < b.mStart.

`BorderInfo` object

Describes a region's position in a ping in terms of its start index and end index, also contains its id and its 'average pixelvalue': (sum of Sv values in region so far) / (sum of pixels in region so far).

Contents

- **`mID:`** Id of the region cross section, is guaranteed to be unique among all currently open regions within one program session.
- **`mStart:`** Start index of the region, the region cross section is [mStart,mEnd].
- **`mEnd:`** End index of the region, the region cross section is [mStart,mEnd].
- **`mProbability:`** (sum of Sv values in region so far) / (sum of pixels in region so far), i.e. the average strength of a pixel in the region up till now.

Comments

- Start and end values within one RegionBorderDatagram will never overlap each other.
- If there are multiple RegionBorderDatagrams in a ping (created by multiple TraceBorderModules) and all were traced on the same channel then the regionslices for higher thresholds will be contained inside regionslices for lower thresholds.
- Any interval from any two datagrams on same channel and ping will either be completely disjoint, equal or one will be contained inside the other, they will never 'partially overlap'.

RegionInfoDatagram

Datagram for region data. This datagram describes different properties of a region and comes at the end of the region.

Occurrences

- Irregularly: Pings can have none, one or many of this datagram.

Creator

- TraceBorderModule, also RegionModule since it contains one or more TraceBorderModules.

Contents

- **`Channel:`** On what channel the region was detected.
- **`Threshold:`** The threshold for the region.
- **`IDs:`** Ids of all borders in the region.
- **`Area:`** Area of region in square meter.
- **`PixelArea:`** Area of region in pixels.
- **`SumLogSv:`** Sum of LogSv parameter in the area.
- **`LogMeanSv:`** Korona of Mean Sv in the area.
- **`Sa:`** Sa of region.
- **`Perimeter:`** Perimeter of region in meter.
- **`Length:`** Length of region in meter.
- **`MaxHeight:`** Maximum height of region in meter.
- **`Rect:`** A rectangle tightly surrounding the region, in pixels.
- **`MeanRegion:`** Mean LogSv values just on the inside of the region.
- **`StdDevRegion:`** Standard deviation for region values.
- **`MeanOutOfRegion:`** Mean LogSv values just on the outside of the region.
- **`StdDevOutOfRegion:`** Standard deviation for values just outside region.
- **`Crossing:`** Crosspoint (between the mean values) of the two distributions.
- **`Overlap:`** Percent overlap between the gauss curves of the two distributions.
- **`Histogram:`** A histogram over the values inside the region.
- **`HistogramStartValue:`** Min pixelvalue in region, values of the first bin are in [HistogramStartValue,HistogramStartValue+HistogramStep).
- **`HistogramEndValue:`** Max pixelvalue in region, values of the last bin are in [HistogramEndValue,HistogramEndValue+HistogramStep).
- **`HistogramMaxIndex:`** Last index of the Histogram array.
- **`HistogramStep:`** Binsize (stepsize between the bins in the histogram).
- **`Trace of region:`** Consists of a list of points giving the regions outer trace. First the number of points is given followed by the first points x value, the first points y value, and so on for each point. Later the datagram might contain the regions inside the outer region to be subtracted from the outer region so to represent holes in the outer region. The last value of this datagram specifies the number of such regions it describes and is currently 0 as default.

Comments

- Stepsize of histogram can be set in the code by changing `Region.Statistics.Histogram.mHistStep`.
- The values MeanOutOfRegion,StdDevOutOfRegion,Crossing and Overlap requires knowledge of the area just around the detected region to be calculated.

Here is a description of how these values are sampled:

- The band around the region for which out-of-region values are sampled from starts `Region.OUTREGIONJUMP` meters out in y direction from the border of the region and is `Region.BANDTHICKNESS` meters thick in y direction.
- If thickness of regionslice is less than `BANDTHICKNESS`, no sampling will occur because the region is too thin.

RegionTableOfContentsDatagram

Datagram with references to RegionInfoDatagrams.

Occurrences

- In the last ping of a file. Possibly more than one.

Creator

- TraceBorderModule, also RegionModule since it contains one or more TraceBorderModules.

Contents

- A list of times in NTDate format that point to pings containing RegionInfoDatagrams.

Comments

- The same time may be repeated if it refers to a ping with more than one RegionInfoDatagram.

Tbr0Datagram

Tracking info per ping.

Creator

- TrackingModule.

Tnf0Datagram

Tracking info per track.

Creator

- TrackingModule.

Ttc0Datagram

Tracking table of contents.

Creator

- TrackingModule.

UnknownDatagram

Class for unknown datagrams. All datagrams not recognized by the system are represented by this datagram.

References

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