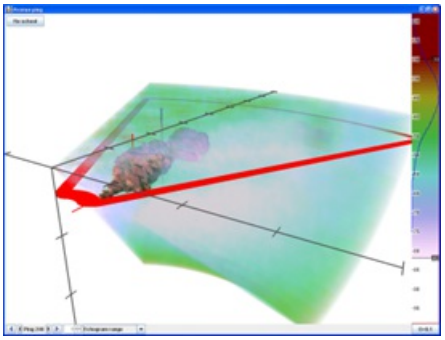


# PROMUS

## User Guide

Version 2.3.0

January 11, 2018

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- SchoolGrow3D
    - Name
    - Synopsis
    - Description
    - Parameters
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- SchoolMorphology3D
    - Name
    - Synopsis
    - Description
    - Parameters
    - Related topics
    - Related database tables
- SchoolObjectType3D
    - Name
    - Synopsis
    - Description
    - Parameters

        - Related topics
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# PROMUS

The Processing system for advanced multibeam SONAR, abbreviated PROMUS, is a plugin to LSSS. It allows for working with PROMUS data through new modules, and through new overlays to existing LSSS modules.

The documentation is organized in the following main sections:

- Working with PROMUS: A brief introduction to the main purpose and functionality of the system.
- Configuration: Description of the PROMUS configuration.
- Views: Description of the view modules for PROMUS data.
- Overlays: Description of the echogram and map overlays for PROMUS data.
- Database: Documentation of the additional database tables for PROMUS data.

# Working with PROMUS

This chapter gives a description of some of the typical tasks when working with PROMUS. For description of tasks relating to the general LSSS system, refer to "Working with LSSS"

# Proposed work flow

A main purpose of the PROMUS system is to isolate schools from the 3D sonar data. After a school has been isolated, the school is inserted into a list of isolated schools in the interpretation module, and can later be gridded and interpreted by the user. Parameters for the school are computed and a full set of computed parameters is displayed in the school data module. A subset of parameters is also displayed in the interpretation module.

The following steps can be used to scrutinize schools with PROMUS:

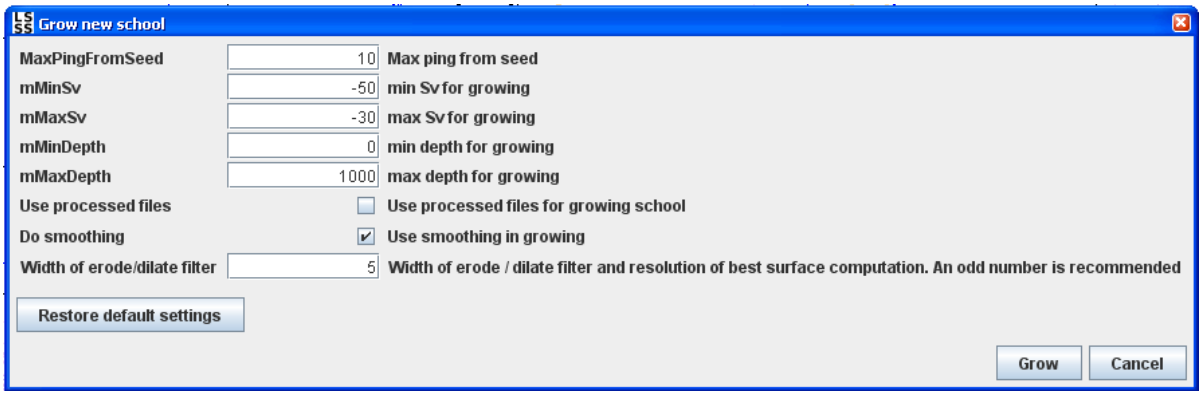
- (Optional) Perform preprocessing of the MS70 data with a preprocessing setup including school cluster module for school candidate detection.
- Position a seed point for growing a school. If school candidate detection has been performed, the seed point can be set automatically when the user clicks on candidates in the map window, or presses the and buttons in the interpretation window to cycle through school candidates.
- When a real school is found, the school data must be isolated from the rest of the ping data. See "How to grow a school" for an explanation of the growing algorithm.
- Check the outcome of the school growing. Adjust grow parameters and regrow the school if necessary.
- Assign acoustical species to the school.
- Store the result to the database. Stored schools are marked in green in the school list, map and echogram.

# How to grow a school

Schools are grown by first selecting a seed sample which the user deems to be inside the school. The seed sample is selected by positioning the slice so that it intersects the school, and then clicking at a point inside the school.

The seed sample can also be suggested by automatic school candidate detection. The school candidates from automatic school detection will be shown in the map view. Clicking a school candidate in the map view automatically sets the slice display module to a position intersecting the school candidate.

When a seed sample is selected, the coordinate of the seed sample is displayed at the bottom of the slice view. Clicking the "New School" button in the Promus interpretation module will bring up a new dialog, where the parameters used in the growing can be set:




When the user presses the grow-button, it is first tested if the seed sample passes the detection criteria. Some samples in the vicinity of the selected sample are also tested, and are used as additional seed samples in case the initially selected sample is not valid. The school is then grown by starting at each seed sample and testing whether the samples closest in space and time also passes the detection criteria. If they do, and are not already part of the school, they are added to the school. The same test is then performed for the neighbors of each of the recently added samples and the algorithm works iteratively until no more samples can be added.

The parameters are set as follows:

- MaxPingFromSeed - The max number of pings to grow in each direction.
- mMinSv - The minimum logSv for a sample to be inside the school.
- mMaxSv - The maximum logSv for a sample to be inside the school.
- mMinDepth - The minimum allowed depth for growing.
- mMaxDepth - The maximum allowed depth for growing.
- Use processed files - When enabled, use the data in the preprocessed files for growing schools.
- Use smoothing - When enabled, the grow algorithm will smooth each sample before testing the grow criteria. A smoothed sample is defined as the average of the samples directly adjacent to the sample including the sample itself.
- Width of erode/dilate filter - Width of erosion and dilation filter of the grown masks. The purpose of erosion/dilation is to eliminate small holes and small grown sample clusters. The filter width determines the minimum size of remaining holes and sample clusters. The erosion/dilation is only performed in the beam direction. A number between 1 and 9 is permitted. A filter width of 1 means that no erosion/dilation is performed. The filter width is also used as input to the calculation of the highest resolution surface.

The last used growing settings is remembered and used as default settings the next time the growing dialog is opened. The button "Restore default settings" restores the growing settings to system default settings.

When the growing is started, the school will appear in the school list in the PROMUS interpretation module, and the progress bars to the right of the school will indicate how the growing runs. When the growing finishes, the school is displayed in the PROMUS ping display module (provided the grow parameters produced a valid school), and the school bounding box will be shown in the PROMUS map overlay.

To grow another school, repeat the procedure.

# Output from LSSS-PROMUS

This chapter gives a description of data outputs from PROMUS. These include data file exports and outputs from the database.

# ReportGenerator - PROMUS extension

## Description

The report generator provides means to output data from the PROMUS extension of the database, i.e. output from the 3D part of the database. The user selects survey and at least one report from a set of pre-defined report formats. The reports are stored in the **ReportsDir** directory, which is set from the *Data files* sub-dialog in the SurveyConfiguration dialog. The actual directory **ReportsDir** are also seen in the report generator window.

### Naming of print files

Currently, the print files have simple names. See naming of print files (core LSSS) for naming of print files from core system; Example of file names are: P1.txt, P2.txt, ...

### Intended use of report formats

- PROMUS print format 1: Paper printouts and abundance estimation. Each species occupy one column.
- PROMUS print format 2: One species, sum-fan (i.e. phi) for increasing ranges.
- PROMUS print format 3: One species, sum-range of all fans (i.e. increasing vertical angles phi).
- PROMUS print format 4: One species, all fans. One species, all ranges of all fans (i.e. increasing ranges and increasing vertical angles phi).
- PROMUS print format 5: One species, all fans. One species, all ranges of all fans (i.e. increasing ranges and increasing vertical angles phi).
- PROMUS print format 10: One species, summed over all selected ESDU (possibly the whole survey). Vertical distribution of one species. Averaged over all Theta.(Phi, R varies).

### Print formats

("%s") means string, ("%d") means integer, ("%f") means floating number, (NEWLINE) means line shift. ("%4d") means 4 positions are used to print an integer, (" %4d") means a leading space before the 4 positions of an integer, ("%02d") means that 2 positions are used to print an integer, and that the first position is zero if the integer is a single digit integer.

**Promus1 print format**

**Example: Promus1_L0.0_7.0 HERR.txt**

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Wed Oct 02 13:12:07 CEST 2013, LSSS version 1.7.2-beta2
%
% PROMUS database report 01. Compact report: surface and line projected.
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2009116(This is the survey title).
% Description of survey: .
%
% OBJECT_3D[-] DATE[YYYYMMDD] TIME[hhmmssxx] FREQUENCY[Hz] PHI[deg] RANGE[m] DEPTH[m] START_L
% ... BOTTOM[m] VERTICAL_AREA_STORED[m2] UPPER_INTEGRATION_DEPTH[m] LOWER_INTEGRATION_DEPTH[m
% Note that: sV = 4*PI*1852*1852*sv, and that Phi=0 is vertically up
%
OBJ       DATE     TIME     FREQ   PHI RANGE DEPTH  START   STOP  LATITUDE  LONGITUDE BOTTOM
7     20091114 21252293      0.0   0.0   0.0   0.0    0.0    1.0 71.280861  14.993853    0.0
7     20091114 21401614  79963.5  97.5 275.0  35.9    1.0    2.0 71.280212  14.993060    0.0
7     20091114 21555434  79882.5  97.5 270.0  35.2    2.0    3.0 71.280281  14.991817    0.0
7     20091114 22114684      0.0   0.0   0.0   0.0    3.0    4.0 71.281891  14.990215    0.0
16    20091115  9172228      0.0   0.0   0.0   0.0    0.0    1.0 71.164146  14.922886    0.0
16    20091115  9403245 104051.5 127.5 360.0 219.2    1.0    2.0 71.158249  14.962493    0.0
16    20091115  9535270      0.0   0.0   0.0   0.0    2.0    3.0 71.162491  15.008532    0.0
16    20091115 10062848 108089.0 135.0 350.0 247.5    3.0    4.0 71.159363  14.991773    0.0
16    20091115 10195556      0.0   0.0   0.0   0.0    4.0    5.0 71.164558  14.989409    0.0
16    20091115 10335514      0.0   0.0   0.0   0.0    5.0    6.0 71.165886  15.000211    0.0
16    20091115 10484257      0.0   0.0   0.0   0.0    6.0    7.0 71.161232  15.009125    0.0
```

### Promus2 print format

### Example: Promus2_L7285.0_8986.996 HERR.txt

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Mon May 22 11:16:31 CEST 2017, LSSS version 2.3.0
%
% PROMUS database report 02. One species, sum-fan (i.e. phi) for increasing ranges. All lines
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2017107(Norwegian_Sea_Ecosystem_Survey_2017).
% Description of survey: The main purpose of the survey is to estimate herring abundance.
EK80 CW data were collected, as well as MS70 and SU90 data.
MS7 data were analyzed during the survey. .
%
% Date[YYYYMMDD],Time[hhmmssxx],StartLog[nmi],StopLog[nmi],Latitude[deg],Longitude[deg],DepthM
% Note that: sV = 4*PI*1852*1852*sv, and that Phi=0 is vertically up
%
20170506,19394748,7285.000,7286.000,64.22411,-0.44409,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,19461656,7286.000,7287.000,64.22348,-0.40601,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,19524656,7286.999,7287.999,64.22321,-0.36789,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,19590751,7287.999,7288.999,64.22322,-0.32982,7.500,184.081,92575.0,96275.0,-58.000,-1
20170506,20053292,7288.997,7289.997,64.22337,-0.29177,7.500,184.081,0.0,0.0,-58.000,-30.000,12
20170506,20120203,7290.000,7291.000,64.22360,-0.25344,7.500,184.081,94425.0,99975.0,-62.000,-1
20170506,20182561,7290.999,7291.999,64.22373,-0.21538,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,20244831,7292.000,7293.000,0.00000,0.00000,7.500,184.081,90725.0,98125.0,-62.000,-30
20170506,20311171,7293.000,7294.000,64.22374,-0.13904,7.500,184.081,79625.0,85175.0,-62.000,-1
20170506,20373225,7293.998,7294.998,64.22365,-0.10094,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,20435453,7294.999,7295.999,64.22365,-0.06275,7.500,184.081,0.0,0.0,-0.000,-0.000,12,1
20170506,20502117,7296.000,7297.000,64.22362,-0.02457,7.500,184.081,79625.0,109225.0,-62.000,-
20170506,22212716,7296.999,7297.999,64.22446,0.00531,7.500,184.081,79624.0,111075.0,-62.000,-1
20170506,22412214,7297.999,7298.999,64.22077,0.04168,7.500,184.081,79624.0,107375.0,-62.000,-1
20170506,22572092,7298.999,7299.999,64.21397,0.07666,7.500,184.081,79625.0,96275.0,-62.000,-30
20170506,23113383,7299.999,7300.999,64.20731,0.11179,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10
20170507,103851,7302.998,7303.998,64.18073,0.15117,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,170606,7303.997,7304.997,64.19326,0.17687,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,232221,7304.997,7305.997,64.20547,0.20265,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,294101,7305.999,7306.999,64.21774,0.22851,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,361029,7307.000,7308.000,64.22273,0.26238,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,422557,7307.999,7308.999,64.22317,0.30045,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
20170507,484173,7309.000,7310.000,64.22363,0.33861,7.500,184.081,0.0,0.0,-0.000,-0.000,12,10.0
   ......
```

### Promus3 print format

**Example: Promus3_L0.0_7.0 HERR.txt**

```
%
% PROMUS database report 03.
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2009116(This is the survey title).
% Description of survey: .
%
% (LINE 1): LineType[-] Date[YYYYMMDD] Time[hhmmssxx] StartLog[nmi] StopLog[nmi] Latitude[deg]
% (LINE 2): LineType[-] ChannelThickness[deg] NumberOfFans[-] MeanAngleOfFan[deg] MeanFrequen
1  20091114,  21252293,     0.000,     1.000,  71.28086,  14.99385,     0.000,     0.000,
2    15.000         0     0.000
1  20091114,  21401614,     0.999,     1.999,  71.28021,  14.99306,     0.000,     0.000,   78
2    15.000         7    36.319     0.000     0.000     0.000     0.000     0.000     0.000
1  20091114,  21555434,     1.997,     2.997,  71.28028,  14.99182,     0.000,     0.000,   78
2    15.000         7    23.011     0.000     0.000     0.000     0.000     0.000     0.000
1  20091114,  22114684,     3.000,     4.000,  71.28189,  14.99022,     0.000,     0.000,
2    15.000         0     0.000
1  20091115,   9172228,     0.000,     1.000,  71.16415,  14.92289,     0.000,     0.000,
2    15.000         0     0.000
1  20091115,   9403245,     0.999,     1.999,  71.15825,  14.96249,     0.000,     0.000,   9
2    15.000        10    43.221     0.000     0.000     0.000     0.000     0.000     0.000
1  20091115,   9535270,     2.000,     3.000,  71.16249,  15.00853,     0.000,     0.000,
2    15.000         0     0.000
1  20091115,  10062848,     3.000,     4.000,  71.15936,  14.99177,     0.000,     0.000,  10
2    15.000        10    60.828     0.000     0.000     0.000     0.000     0.000     0.000
1  20091115,  10195556,     3.999,     4.999,  71.16456,  14.98941,     0.000,     0.000,
2    15.000         0     0.000
1  20091115,  10335514,     4.998,     5.998,  71.16589,  15.00021,     0.000,     0.000,
2    15.000         0     0.000
1  20091115,  10484257,     6.000,     7.000,  71.16123,  15.00912,     0.000,     0.000,
2    15.000         0     0.000
```

**Promus4 print format**

**Example: Promus4_L0.0_7.0.txt**

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Wed Oct 02 13:12:07 CEST 2013, LSSS version 1.7.2-beta2
%
% PROMUS database report 04. One species, all fans.
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2009116(This is the survey title).
% Description of survey: .
%
% (LINE 1): Date[YYYYMMDD] Time[hhmmssxx] StartLog[nmi] StopLog[nmi] Latitude[deg] Longitude[
% (LINE 2): SumFanNo[-] FanAngle[deg] FanFreq[Hz] RangeThickness[m] RangeIndexMin[-] RangeInd
% (LINE 3):    FanNo[-] FanAngle[deg] FanFreq[Hz] RangeThickness[m] RangeIndexMin[-] RangeInd
% ........

1  20091114,  21252293,     0.000,     1.000,  71.28086,  14.99385,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091114,  21401614,     0.999,     1.999,  71.28021,  14.99306,     0.000,     0.000,
2         0     112.5,   79963.5,    10.000        19        37    36.319     0.134     2.533
3         7      97.5    79963.5     10.000        19        37    36.319     0.134     2.533
1  20091114,  21555434,     1.997,     2.997,  71.28028,  14.99182,     0.000,     0.000,
2         0     112.5,   79882.5,    10.000        21        34    23.011     0.281     1.286
3         7      97.5    79882.5     10.000        21        34    23.011     0.281     1.286
1  20091114,  22114684,     3.000,     4.000,  71.28189,  14.99022,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091115,   9172228,     0.000,     1.000,  71.16415,  14.92289,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091115,   9403245,     0.999,     1.999,  71.15825,  14.96249,     0.000,     0.000,
2         0     112.5,  104051.5,    10.000        29        44    43.221     0.036     2.849
3         8      97.5    99369.2     10.000        29        44    17.318     0.000     0.000
3         9     112.5   104051.5     10.000        29        44    48.051     0.036     2.461
3        10     127.5   108733.8     10.000        29        44     6.573     0.000     4.190
1  20091115,   9535270,     2.000,     3.000,  71.16249,  15.00853,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091115,  10062848,     3.000,     4.000,  71.15936,  14.99177,     0.000,     0.000,
2         0     112.5,  108089.0,    10.000        32        39    60.828     1.245    43.117
3         9      97.5   106596.0     10.000        32        39    28.639     0.000     1.616
3        10     112.5   109582.0     10.000        32        39   113.056     1.245    51.990
1  20091115,  10195556,     3.999,     4.999,  71.16456,  14.98941,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091115,  10335514,     4.998,     5.998,  71.16589,  15.00021,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
1  20091115,  10484257,     6.000,     7.000,  71.16123,  15.00912,     0.000,     0.000,
2         0     112.5,       0.0,    10.000        50         0     0.000
```

**Promus5 print format**

**Example: Promus5_L7285.0_8986.996 HERR.txt**

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Mon May 22 11:06:48 CEST 2017, LSSS version 2.3.0
%
% PROMUS database report 05. One species, all fans. One species, all ranges of all fans (i.e.
% Coordinate system - vertical angle: Phi=0 point vertically upwards, FanNo * FanThickness = 
% Coordinate system - range: R = 0 is on transducer, RangeCh *
% Coordinate system - horizontal angle: Theta = 0 is in cruise direction, VerticalFanNo * Bear
% Note that: sV = 4*PI*1852*1852*sv, and that Phi=0 is vertically up
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2017107(Norwegian_Sea_Ecosystem_Survey_2017).
% Description of survey: .
%
% (LINE 1): LineType[-],ScrutinizeQuality[1,2,3],Date[YYYYMMDD],Time[hhmmssxx],Duration[1/100s
% (LINE 2): LineType[-],HorizontalSectorNo_Phi[-],VerticalAngle_Phi[deg],VerticalSectorNo_Thet

1,1,20170506,19394748,38907,7285.000,7286.000,64.22411,-0.44409,7.500,184.081,0.0,0.0,-0.000,-
1,1,20170506,19461656,38999,7286.000,7287.000,64.22348,-0.40601,7.500,184.081,0.0,0.0,-0.000,-
1,1,20170506,19524656,38094,7286.999,7287.999,64.22321,-0.36789,7.500,184.081,0.0,0.0,-0.000,-
1,1,20170506,19590751,38540,7287.999,7288.999,64.22322,-0.32982,7.500,184.081,92575.0,96275.0,
2,45,91.2,6,66.0,93191.7,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,45,91.2,7,78.0,93191.7,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,45,91.2,8,90.0,93191.7,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,45,91.2,9,102.0,93191.7,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,45,91.2,10,114.0,93191.7,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,46,93.8,6,66.0,94425.0,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,46,93.8,7,78.0,94425.0,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,46,93.8,8,90.0,94425.0,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,46,93.8,9,102.0,94425.0,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,46,93.8,10,114.0,94425.0,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,47,96.2,6,66.0,95658.3,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,47,96.2,7,78.0,95658.3,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,47,96.2,8,90.0,95658.3,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,47,96.2,9,102.0,95658.3,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
2,47,96.2,10,114.0,95658.3,10.000,17,21,0.000,0.000,0.000,0.000,0.000,0.000
1,1,20170506,20053292,38910,7288.997,7289.997,64.22337,-0.29177,7.500,184.081,0.0,0.0,-58.000,
1,1,20170506,20120203,38357,7290.000,7291.000,64.22360,-0.25344,7.500,184.081,94425.0,99975.0,
2,46,91.2,7,66.0,95118.8,10.000,19,20,0.000,0.000,0.000
2,47,93.8,7,66.0,96506.2,10.000,19,20,0.000,0.000,0.000
2,48,96.2,7,66.0,97893.8,10.000,19,20,0.000,0.000,0.000
2,49,98.8,7,66.0,99281.2,10.000,19,20,0.000,0.000,0.000
   ....
```

**Promus10 print format**

**Example: Promus10_L7285.0_8986.996 HERR.txt**

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Mon May 22 11:16:31 CEST 2017, LSSS version 2.3.0
%
% PROMUS database report 10. Vertical distribution of one species. Averaged over all Theta.(Pl
% Coordinate system - vertical angle: Phi=0 [deg] point vertically upwards. PhiIndex = FanNo.
% Coordinate system - range: R = 0 [m] is on transducer.
% Coordinate system - horizontal angle: Theta = 0 [deg] is in cruise direction.
% Note that: sV = 4*PI*1852*1852*sv, and that Phi=0 is vertically up
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2017107(Norwegian_Sea_Ecosystem_Survey_2017).
% Description of survey: The main purpose of the survey is to estimate herring abundance.
EK80 CW data were collected, as well as MS70 and SU90 data.
MS7 data were analyzed during the survey. .
%
% (LINE 1): LineType[-],ScrutinizeQuality[1,2,3],Date[YYYYMMDD],Time[hhmmssxx],Duration[1/100
% (LINE 2): LineType[-],HorizontalSectorNo_Phi[-],VerticalAngle_Phi[deg],3dB_Phi[deg],MainLob

1,1,20170506,19590751,58981795,7288.00,8550.00,64.22322,-0.32982,7.500,184.256,79624.0,111075
2,38,95.0,5.00,10.00,90.0,79624.0,10.0,5,23,3.333,0.000,0.000,0.000,0.000,0.000,0.000,0.000,0
2,39,97.5,5.00,10.00,90.0,81589.7,10.0,5,23,1.286,0.000,0.000,0.000,0.000,0.775,0.225,0.299,0
2,40,100.0,5.00,10.00,90.0,83555.4,10.0,5,23,2.273,0.000,0.000,0.000,0.370,19.370,5.823,0.539,
2,41,102.5,5.00,10.00,90.0,85521.1,10.0,5,23,3.310,0.000,0.000,0.000,24.096,19.450,3.258,0.76
2,42,105.0,5.00,10.00,90.0,87486.8,10.0,5,23,2.870,0.000,0.000,4.067,8.690,6.611,2.908,1.466,
2,43,107.5,5.00,10.00,90.0,89452.4,10.0,5,23,2.705,0.000,0.743,2.335,3.224,5.402,3.245,0.993,
2,44,110.0,5.00,10.00,90.0,91418.1,10.0,5,23,1.930,0.000,0.832,1.507,2.476,5.010,2.089,0.671,
2,45,112.5,5.00,10.00,90.0,93383.8,10.0,5,23,2.635,0.000,0.666,1.291,3.480,3.992,1.572,0.979,
2,46,115.0,5.00,10.00,90.0,95349.5,10.0,5,23,2.927,0.001,0.329,0.698,2.283,1.536,0.885,1.127,
2,47,117.5,5.00,10.00,90.0,97315.2,10.0,5,23,2.497,0.001,0.342,0.430,0.943,0.762,0.884,0.871,
2,48,120.0,5.00,10.00,90.0,99280.9,10.0,5,23,0.810,0.001,0.220,0.208,0.181,0.204,0.387,0.283,
2,49,122.5,5.00,10.00,90.0,101246.6,10.0,5,23,0.312,0.001,0.185,0.191,0.105,0.162,0.455,0.124,
2,50,125.0,5.00,10.00,90.0,103212.2,10.0,5,23,0.408,0.006,0.248,0.190,0.035,0.293,0.178,0.127,
2,51,127.5,5.00,10.00,90.0,105177.9,10.0,5,23,0.391,0.000,0.093,0.021,0.000,0.233,0.033,0.009,
2,52,130.0,5.00,10.00,90.0,107143.6,10.0,5,23,0.486,0.000,0.030,0.001,0.000,0.135,0.005,0.003,
2,53,132.5,5.00,10.00,90.0,109109.3,10.0,5,23,0.512,0.000,0.001,0.000,0.002,0.011,0.001,0.004,
2,54,135.0,5.00,10.00,90.0,111075.0,10.0,5,23,0.229,0.000,0.000,0.000,0.001,0.000,0.002,0.000,
```

**Promus11 print format**

**Example: Promus11_L7285.0_8986.996 HERR.txt**

```
% Lines starting with % are comments
% The format of and definitions in this file may change in future versions of LSSS, last chan
% Export time: Mon May 22 20:57:04 CEST 2017, LSSS version 2.3.0
%
% PROMUS database report 11. Vertical distribution of one species. Averaged over all Phi.(The
% Coordinate system - vertical angle: Phi=0 [deg] point vertically upwards, Phi=90 [deg] is h
% Coordinate system - range: R = 0 [m] is on transducer.
% Coordinate system - horizontal angle: Theta = 0 [deg] is in cruise direction, Theta=90 [deg
% Note that: sV = 4*PI*1852*1852*sv, and that Phi=0 is vertically up
% SHIP: G.O.Sars,  NATION: Norway,  SURVEY: 2017107(Norwegian_Sea_Ecosystem_Survey_2017).
% Description of survey: The main purpose of the survey is to estimate herring abundance.
EK80 CW data were collected, as well as MS70 and SU90 data.
MS70 data were analyzed during the survey.
%
% (LINE 1): LineType[-],ScrutinizeQuality[1,2,3],Date[YYYYMMDD],Time[hhmmssxx],Duration[1/100
% (LINE 2): LineType[-],VerticalSectorNo_Theta[-],HorizontalAngle_Theta[deg],RangeChannelThic

1,1,20170506,19590751,58981795,7288.00,8550.00,64.22322,-0.32982,7.500,184.256,79624.0,111075
2,6,66.0,10.0,5,23,0.668,0.000,0.007,0.026,0.054,0.328,1.001,0.710,0.390,0.295,0.216,0.181,0.
2,7,78.0,10.0,5,23,1.836,0.000,0.100,0.207,1.635,4.298,1.286,0.362,0.642,0.492,1.464,1.224,0.
2,8,90.0,10.0,5,23,2.155,0.000,0.263,0.490,3.498,4.770,0.910,0.281,0.296,0.680,1.719,1.903,2.
2,9,102.0,10.0,5,23,1.993,0.002,0.469,1.440,4.928,4.012,0.766,0.375,0.303,1.190,2.951,1.930,1
2,10,114.0,10.0,5,23,1.158,0.000,0.132,0.716,1.960,3.421,1.814,0.445,0.287,0.405,0.529,0.439,
```

# Related topics

Database (3D extension - PROMUS);
ScatterType3D;
Report generator (core LSSS);

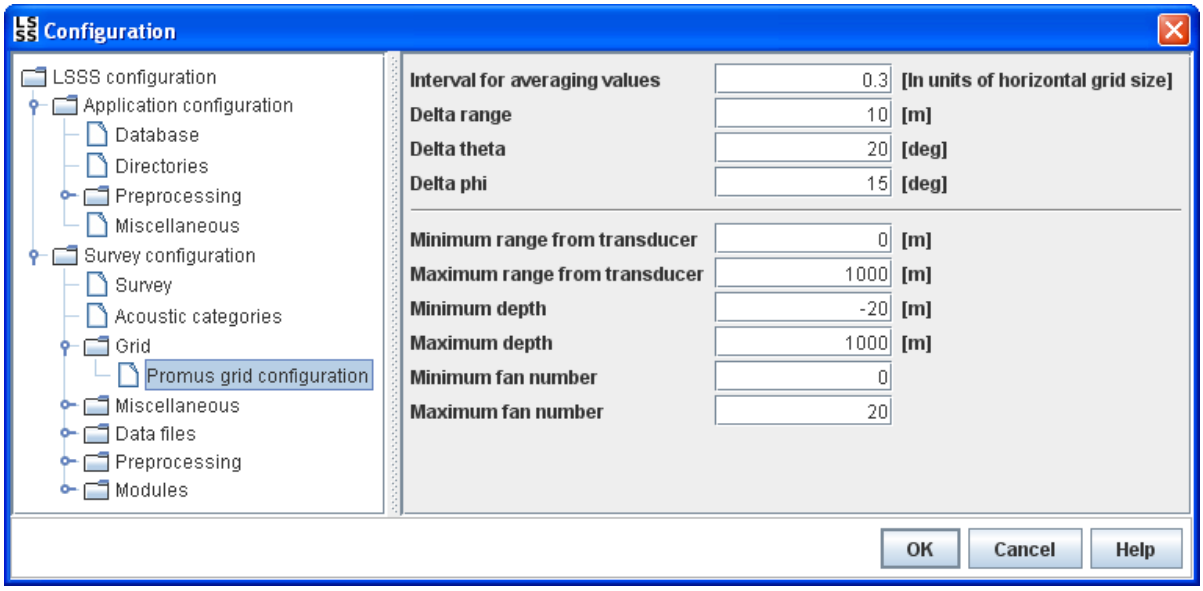
Database (core LSSS);

# Configuration

This section explains the different elements of the Promus configuration.

# Survey configuration

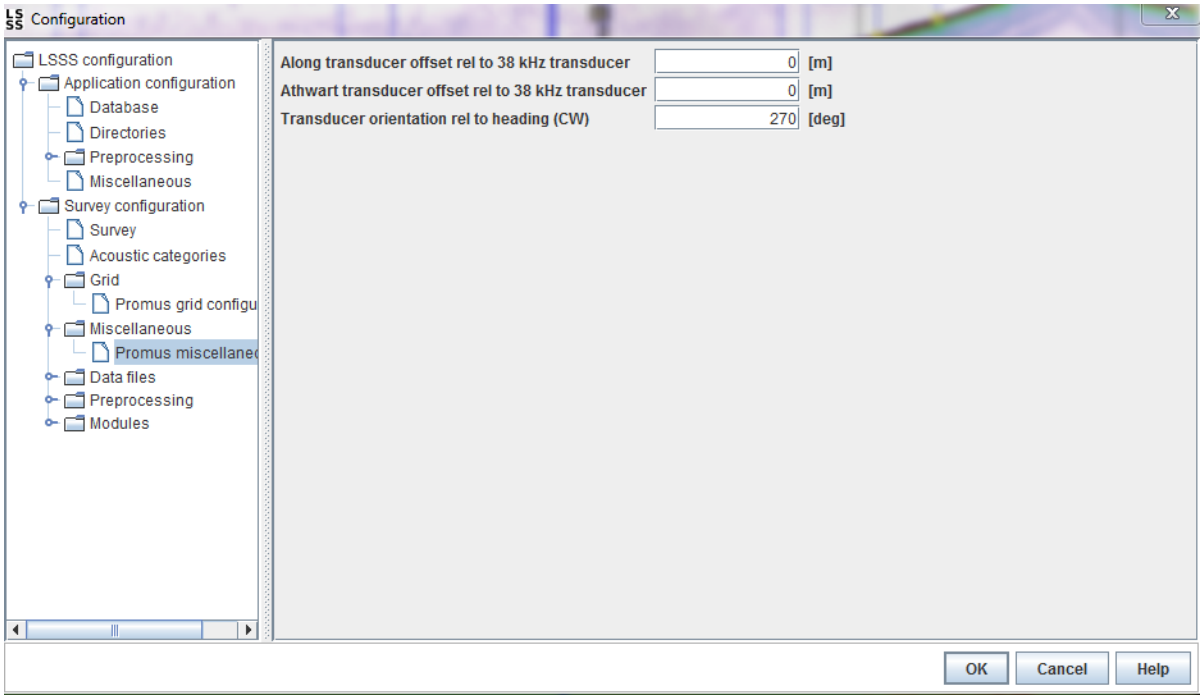
## Grid




Configuration of grid resolution. The grid is used by the Promus interpretation module. The grid if 4 dimensional with one coordinate along the survey line and 3D spherical coordinates around the transducer. The samples used for gridding can be limited by distance from transducer, depth and fan number.

- **Interval for averaging values:** Size of grid cells along the survey line.
- **Delta range [m]:** Size of grid cells radially.
- **Delta theta [deg]:** Size of grid cells in horizontal angle.
- **Delta phi [deg]:** Size of grid cells in vertical angle.
- **Minimum range from transducer [m]:** Restrict gridding to samples at minimum this distance from the transducer.
- **Maximum range from transducer [m]:** Restrict gridding to samples at maximum this distance from the transducer.
- **Minimum depth [m]:** Restrict gridding to samples at minimum this depth.
- **Maximum depth [m]:** Restrict gridding to samples at maximum this depth.
- **Minimum fan number:** Restrict gridding to samples with minimum this fan number.
- **Maximum fan number:** Restrict gridding to samples with maximum this fan number.

## Miscellaneous

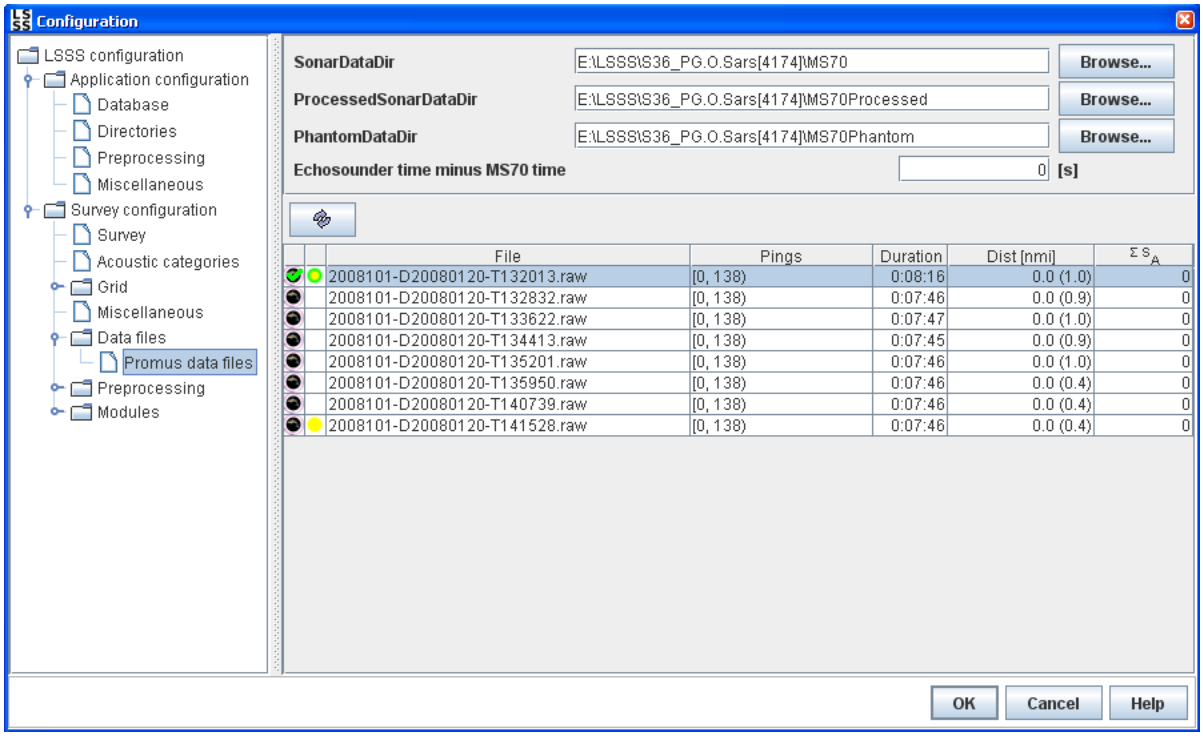



Miscellaneous configuration for Promus.

- **Along transducer offset rel to 38 kHz transducer:** The position of the MS70 transducer relative to the 38 kHz EK60 transducer in the alongship direction. The positive direction is forward.
- **Athwart transducer offset rel to 38 kHz transducer:** The position of the MS70 transducer relative to the 38 kHz EK60 transducer in the athwartship direction. The positive direction is starboard.
- **Transducer orientation rel to heading (CW):** The orientation of the MS70 transducer relative to the alongship direction. The positive direction is clockwise seen from above the ship.

See also ship coordinate system for an explanation of the coordinate system.

# Data files



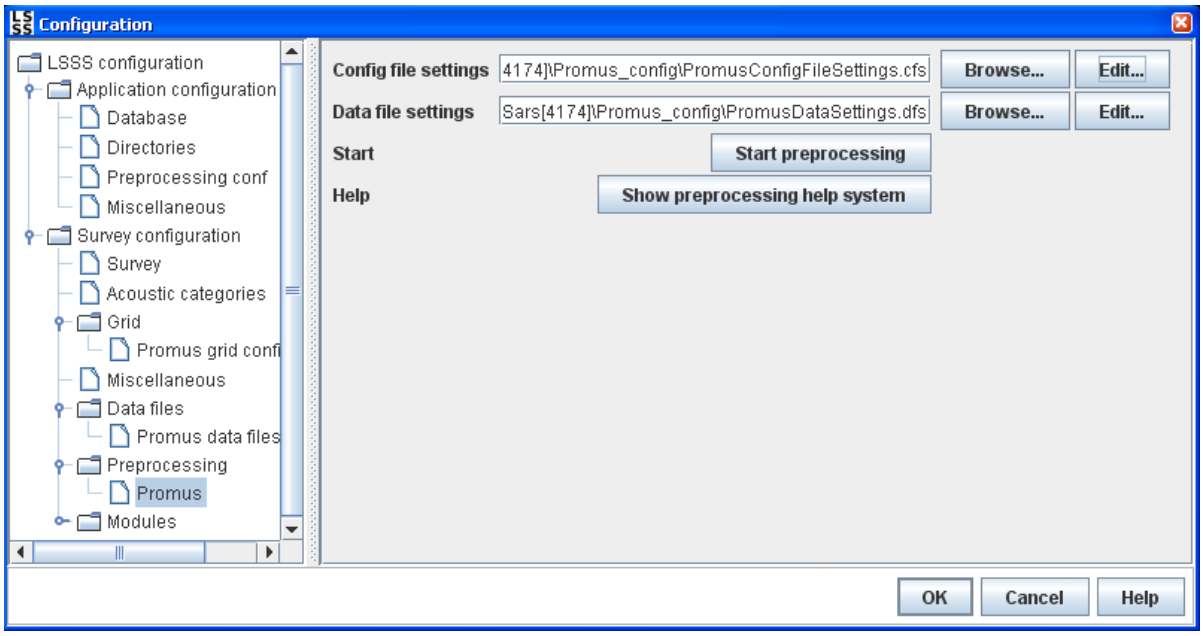

The default settings for the directories are based on settings in [Application - Directories] and the survey

number and the name of the platform configured in [Survey configuration - Survey]. When a valid data directory has been selected, the data files will appear in a list below.

The button "Create idx..." will become available if any of the MS70 data files are missing index files. Pressing this button gives the option of creating new index files based on speed and position datagrams in the EK60 files.

The setting **Echosounder time minus MS70 time** can be used if there is an offset between the recorded time on the echosounder files compared to the MS70 files. Use a positive number if the echosounder time is ahead of the sonar time.

# Preprocessing




The preprocessing program, KoronaRelay, can be started from this panel. The configuration is similar to the LSSS preprocessing.

# Views

These are the Promus views available in LSSS.

Promus ping display module
This module shows a 3D view of a ping.

Promus slice display module
This module shows a 2D slice through the current ping.

Promus interpretation module
This module shows a list of the defined schools, and has an interface for interpreting and storing the acoustic data to the database.

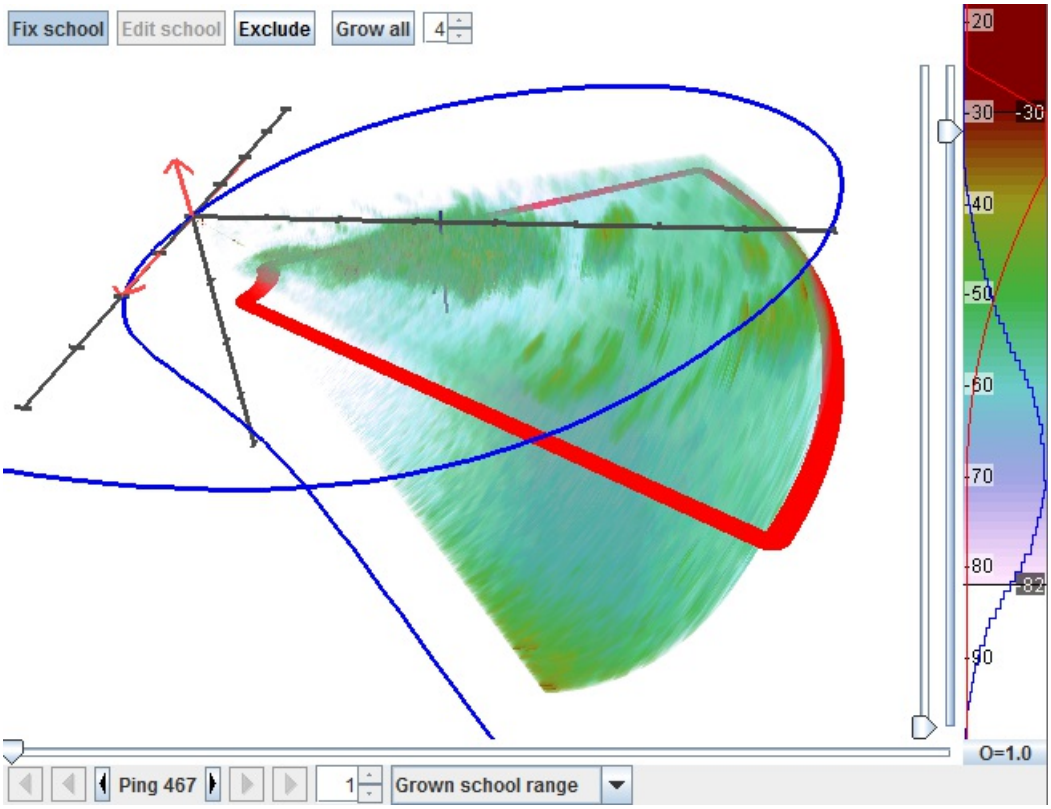
Promus school data module
This module displays the different parameters computed for the schools.

Promus phantom echogram module
This module shows an "echogram" view of the 4D Promus data. The echogram data can be produced using the Phantom module in the preprocessing system, and the input folder for the echogram data can be configured in the data file configuration.

# Promus ping

This view shows a 3D promus ping. In addition to the ping data, other information, like the coordinate system for the ping, a red plane indicating the slice shown in Promus slice display module, and a dark blue cross indicating the point selected for school growing, can be shown.

For a complete list of parameter settings for the view, see Settings below.




## Ping selector

The left and right arrows in the lower left corner of the view can be used for moving to the previous and next ping in the data set.

When a school is selected in the Promus interpretation module or in the Promus map overlay, the left and right arrows for forwards and backwards ping animation can be selected in order to automatically display all the pings within a given range. The animation speed can be adjusted by cycling through the realtime factor in the spinner directly to the right of the animation buttons. The realtime factor is the delay between consecutive ping recordings divided by the delay between pings in the animation. A number larger than 1 means that the animation is faster than realtime. The animation range can be adjusted from the combo box. Possible selections are:

- Echogram range: The animation will cycle through pings corresponding to the range visible in the echogram.
- Grown school range: The animation will cycle through ping which are members of the currently grown school.
- Entire Promus range: The animation will cycle through all available Promus pings.

The displayed ping will also be shown in the Promus slice display module, and data about the ping will be shown as per ping aspects in the Promus school data module.

## Use school mask

When a school is grown and selected, the "use school mask" (shortcut 's') setting in the general parameters determines how samples outside the detected school should be colored.

When "use school mask" is on, the samples outside the school will be transparent or gray. The intensity and transparency of the gray samples is determined by the slider at the bottom of the view.

When "use school mask" is off, the samples outside the school will be colored the same way as the school.

## Navigation

These are the controls used for navigation within the 3D-view of the ping:

- **Drag mouse (left mouse button)** - Rotate
- **Shift + drag mouse** - Translate
- **Ctrl + drag mouse vertically** - Zoom centered at the current mid-point of the view
- **Scroll wheel** - Zoom centered at the current mouse position
- **Alt + drag mouse** - Rotate in screen plane
- **Home** - Reset view to default view

When a drag has been started and the mouse button is released before the drag is stopped, the started movement (rotation/translation/zoom) will continue until the mouse is pressed inside the view.

## Fix school button

The fix button causes the current ping to be displayed relative to the fixed survey line. The survey line will also be shown. When selecting another ping, the survey line (and detected schools) will appear fixed in the display and the current ping position will move. In the "un-fix" mode, the current ping will appear fixed in the display, and the detected schools will change positions in the display when changing pings.

## Edit school button

Toggling this button when a school is selected allows for editing the grown mask for the currently displayed ping. A rectangle will be displayed, and pressing the mouse button deletes the parts of the grown mask which intersects the rectangle. The size of rectangle can be increased and decreased by pressing the + and - buttons respectively.

## Exclude button

Pressing this button excludes the current ping from further analysis. A user may want to exclude a ping due to noise or other issues which can deteriorate the abundance estimation. Pressing the button again includes the ping.

## Grow all button

When pressing this button, the system will attempt to grow the possible candidates for schools in the current ping. First all samples fulfilling the currently set grow criteria are extracted, and sorted according to how many samples will be grown in the current ping by using the sample as a seed point. Several samples may cause the same grow results, and such duplicates are removed. The N first samples in this sorted list are then used as seed points in a full growing algorithm, extracting schools spanning over several pings. N is a number between 1 and 9, and is controlled by the user from the spinner to the right of the grow all button. The result is up to N new schools. Grown schools which overlap with existing schools are automatically deleted.

## Colorbar

The colorbar to the right of the view shows the mapping between the signal strength and the colors in the ping image, measured in dB. The thresholds on the colorbar decide which samples that are included in the view.

The lower threshold is always active, while the upper threshold can be activated through the colorbar context menu (when the checkbox "Clip values above" is unchecked). Sample values that are outside the threshold range are shown in white in the echogram.

The threshold values can be set either by the colorbar context menu, or by dragging the threshold indicators in the colorbar.

The selected colorbar will also be used for setting colors in the Promus slice display module.

Different color scales can be selected in the colorbar context menu.

### Data Distribution curve

A blue curve in the colorbar indicates the relative distribution of signal strength values in the ping.

### Opacity curve

A red curve in the colorbar, called the "Opacity curve", is used for setting the opacity of the various colors (signal strength values) in the 3D ping-image.

The opacity curve can be manipulated by the mouse when mouse is close enough to the curve. The cursor will change to the  symbol or the system dependent symbol for moving up/down. Pressing the Spacebar will cycle between the two modes. In the  mode, the curve can be drawn in a freehand manner, while in the move up/down mode the whole curve can be moved uniformly.

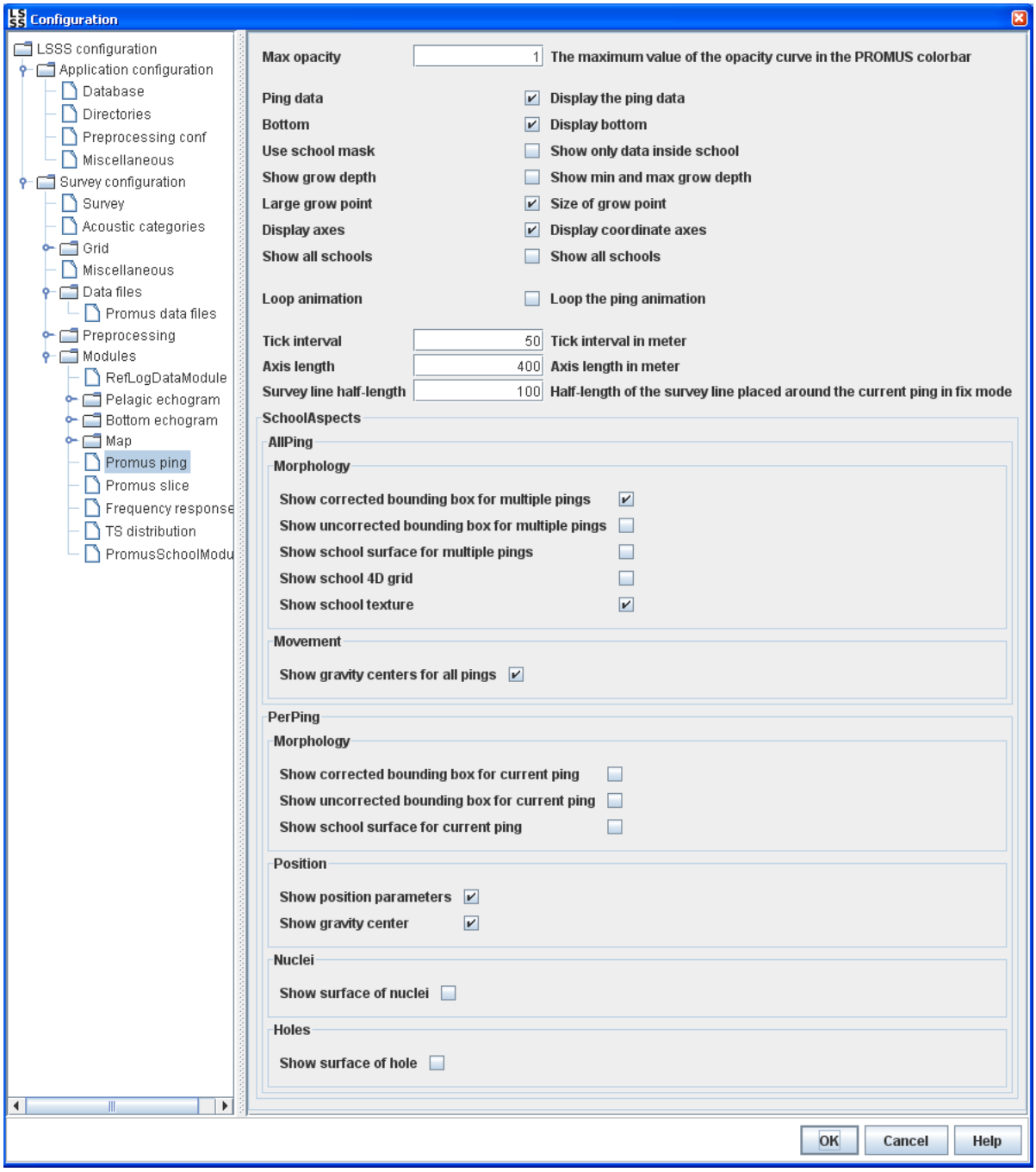
By means of parameter settings, it is possible to set the maximum opacity value to use, and the curve is scaled between 0 and this maximum value. This implies that changing the maximum value causes the curve to be rescaled to fit the new maximum value:

- When reducing the maximum value, the existing curve will be rescaled "to the right", and truncated for values greater than the new maximum.
- When increasing the maximum value, the existing curve will be rescaled "to the left".

The pushbutton below the colorbar displays the current maximum opacity value. Pressing this button will set the whole opacity curve to the maximum value.

## Settings

The module has several settings for configuring the view. These are found in the LSSS configuration window, under Survey Configuration->Modules->Promus ping.




## General parameters

- **Max opacity** - The maximum value of the opacity curve in the Promus colorbar, see opacity curve above.
- **Ping data** - If set, the ping data is displayed.
- **Bottom** - If set, and if bottom detection was run during preprocessing, display the bottom as a surface.
- **Use school mask** - Determines the coloring of the samples outside the currently selected school. Also affects Promus slice display module.
- **Show grow depth** - If set, show planes indicating minimum and maximum grow depth.
- **Large grow point**: - If set, shows a large axis cross indicating the current position of the seed point for growing schools. Otherwise the seed point is indicated with a considerably smaller axis cross.
- **Display axes** - If set, display the coordinate system axes.
- **Show all schools** - If set, show all schools, otherwise only show current school.
- **Loop animation** - If set, loop the ping animation, otherwise stop the animation when first/last ping in range has been reached.
- **Tick interval** - Sets the tick interval of the axes (in meters).

- **Axis length** - Sets the length of the axes (in meter). The z axis (depth) is half this value.
- **Survey line half-length** - Sets the half-length of the survey line placed around the current ping in "fix" mode.

## AllPing aspects

### Morphology

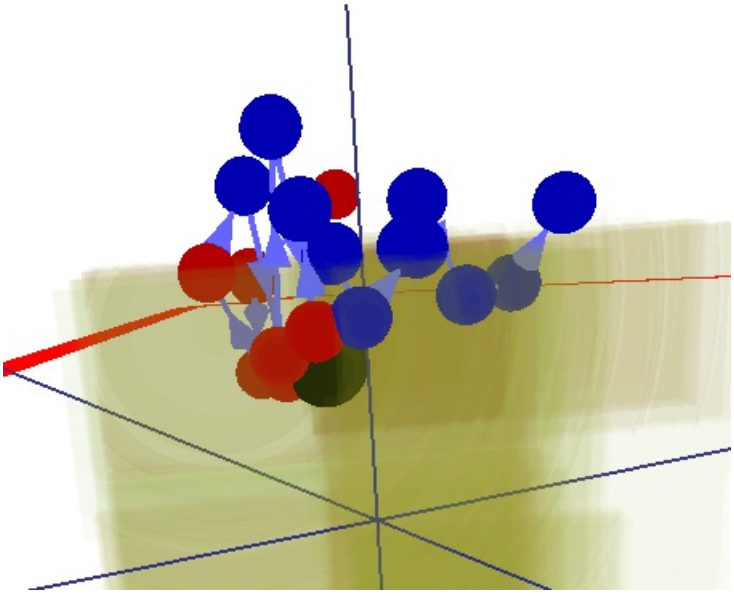
These checkboxes are used for setting which AllPing morphology parameters that shall be shown:

- **Show corrected bounding box for multiple pings** - If set, show the corrected bounding box for the whole school.
- **Show uncorrected bounding box for multiple pings** - If set, show the uncorrected bounding box for the whole school.
- **Show school surface for multiple pings** - If set, show the surfaces for all pings contained in the current school. The surface belonging to the first ping in the school is shown in green. The color is gradually changed towards red for the following pings.
- **Show school 4D grid** - If set, shows the grid used for gridding the school into a global grid.
- **Show school texture** - If set, shows the texture for the gridded school.

### Movement

The checkbox is used for setting whether AllPing movement parameters shall be shown:

- **Show gravity centers for all pings** - If set, the school's gravity centers for each ping is shown. If the school is "closed", i.e. no grown point is at the outer edge of the ping, then the center is marked with a **blue** sphere, otherwise the sphere is **red**. Light blue arrows combine the gravity centers, showing how the center moves from ping to ping. See figure below. See also checkbox for displaying PerPing gravity center.



## PerPing aspects

### Morphology

These checkboxes are used for setting which PerPing morphology parameters that shall be shown:

- **Show corrected bounding box for current ping** - If set, show the corrected bounding box for the school in the current ping.

- **Show uncorrected bounding box for current ping** - If set, show the uncorrected bounding box for the school in the current ping.
- **Show school surface for current ping** - If set, show the surface of the selected school for the current ping.

**Position**

These checkboxes are used for setting which PerPing position parameters that shall be shown:

- **Show position parameters** - If set, show the valid distance parameters for the ping as red lines.
- **Show gravity center** - If set, show the school's gravity center for the current ping, marked as a **black** sphere. See figure above.

**Nuclei**

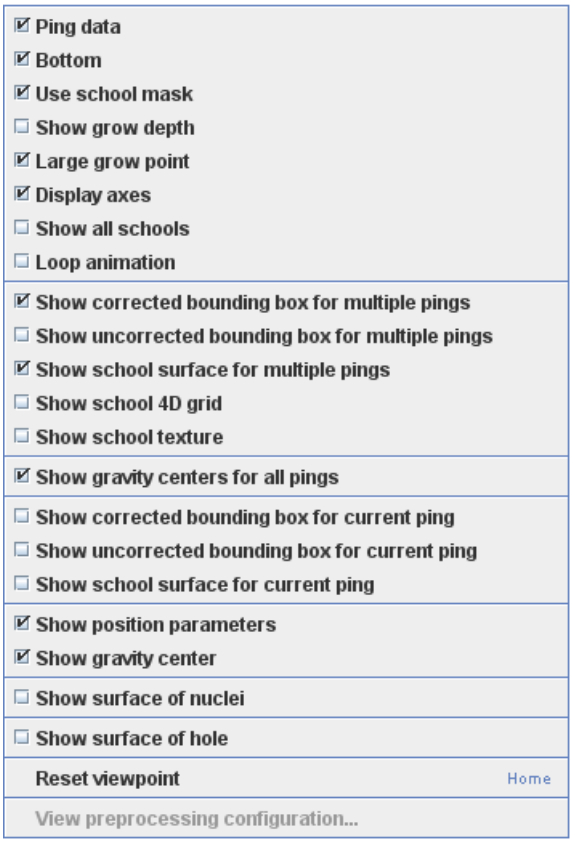
- **Show surface of nuclei** - If set, show the surface of the nuclei in the ping.

**Holes**

- **Show surface of hole** - If set, show the surface of the holes in the ping.

# Context menu

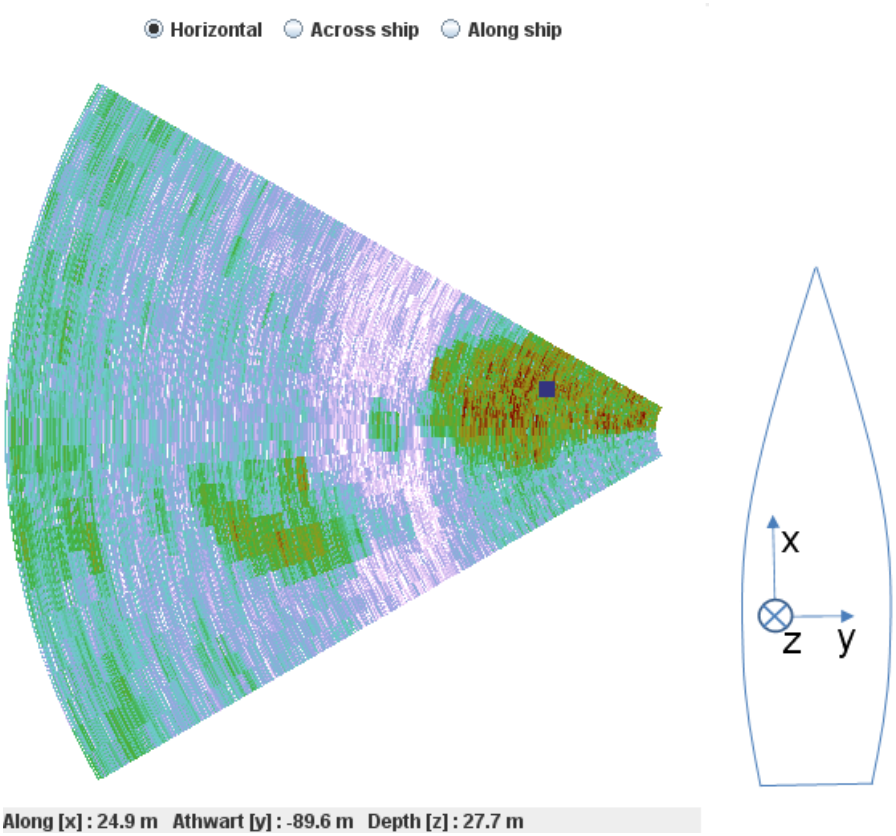
By right-clicking in the ping-view, a context menu for the view is activated. This menu gives access to all parameters that can be set with check-boxes. In addition, there is a menu entry for resetting the viewpoint (same as "Home" key), and if preprocessing has been done on the displayed data, the preprocessing configuration can be shown by selecting "View preprocessing configuration...".



# Promus slice

This view shows a 2D slice through the promus ping, and acts as the interface for growing a new school. The slice could be taken through a plane Horizontal, Across or Along the ship, set by the radio buttons in the window. The position of the plane is shown as a red plane in Promus ping display module.

By left clicking in the slice, a seed sample can be set, indicated by a dark blue square. This will also be indicated in Promus ping display module with a dark blue cross.



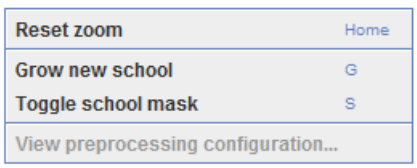

## Navigation

These are the controls used in the view

- **Left click** - Set seed sample
- **Drag mouse** - Zoom view to selected rectangle
- **Scroll wheel/arrow keys** - Move slice towards/away from user
- **Home** - Reset view to default view

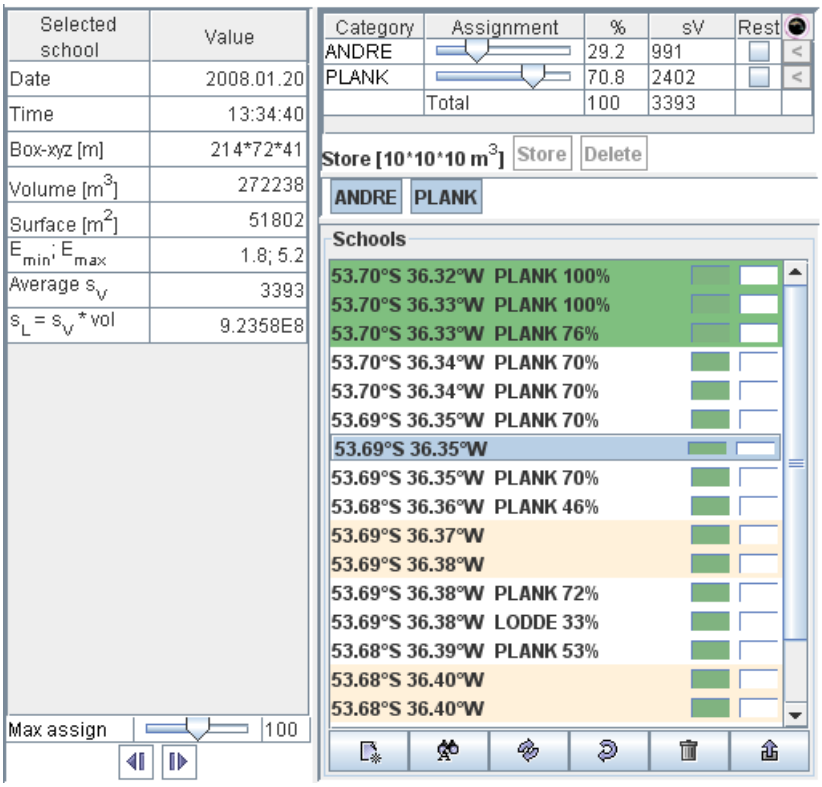
## Context menu

By right-clicking in the ping-view, a context menu for the view is activated. There is a menu entry for resetting the viewpoint (same as "Home" key). Other actions with corresponding keyboard shortcuts will also be listed here. If preprocessing has been done, the "View preprocessing configuration..." entry will be selectable and upon selection show the module setup used in the preprocessing.



# PROMUS interpretation

This view displays the defined schools together with an interpretation window for interpreting acoustic abundance for individual schools, and storing the interpretation to the database.




## Supporting information

In the left panel some supporting information for the selected school is shown. The parameters are

- Date: The date of the currently selected ping.
- Time: The time of the currently selected ping.
- Box-xyz [m]: The lengths of the sides of the corrected bounding box for the school.
- Volume [$m^3$]: The volume of the gridded school.
- Surface [$m^2$]: The surface of the gridded school.
- $E_{min}$, $E_{max}$: The corrected minimum and maximum elongation of the school.
- Average $s_V$: The average volume backscatter weighted with school volume.
- $s_L$: The average $s_V$ multiplied with the volume of the gridded school.

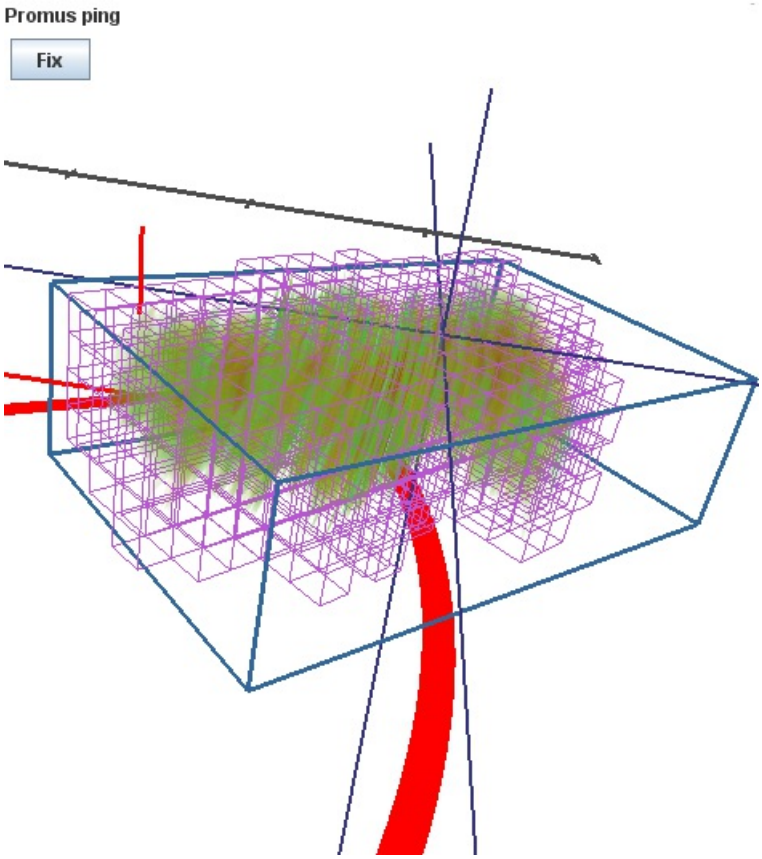
## Performing interpretation

In the interpretation window, the acoustic abundance for the various acoustic categories in the survey (as defined in Survey configuration) can be set. Percentage abundance for the categories can be set by the sliders, check the "Rest" box for a category to adjust to 100%. The interpretation is performed very similarly to the interpretation of echosounder school in the LSSS interpretation module.

The 'Store' button becomes green when an interpretation can be stored to the database. Hovering the mouse over the button shows the outlines of the storage cells in the PROMUS ping display module. The grid cells sizes are displayed in text form in front of the store button, and can be configured in the grid configuration.

Similarly, the 'Delete' button becomes red when an interpretation exists in the database. Hovering the mouse over the button shows the outlines of the cells stored in the PROMUS ping display module

The and buttons can be used to step to the previous and next school candidate (if school candidates have been detected in the PROMUS preprocessing). When selecting a school candidate, the currently selected ping will change to a reference ping of the school candidate, and the seed point in PROMUS slice display module will be moved to the center sample of the school candidate. A school candidate can also be selected from the map window. The user can accept a school candidate and convert it into a grown school which can be interpreted by pressing the new school button.




## Values stored to the database

For a full overview of the parameters stored to the database, refer to the Database chapter. Values are stored at the school level, column level and cell level. At the cell level, the most important values for abundance estimation are:

- svMean [$m^2$/m n.nmi.]: This is the mean of the samples inside a cell multiplied with a computed fill factor for the cell. The fill factor is a number between 0 and 1 depending on how large volume fraction of the cell is covered with samples.
- FrequencyMin [Hz]: The lowest frequency for the beams intersecting the cell.
- FrequencyMax [Hz]: The highest frequency for the beams intersecting the cell.
- AngleRef [rad]: The average of the angles of the beams intersecting the cell. The angle is defined as the angle of the beam with respect to a vertical vector (i.e. a vertical beam has angle 0, and a horizontal beam has angle &pi / 2).

## Using the school list

After a new school is grown, it will show up in the list of grown schools in this module. By selecting a school from the list, the ping where the school was grown from will be shown in the PROMUS slice display module and the PROMUS ping display module, and the seed sample will be indicated.

The bounding box of the grown schools will also be shown in the PROMUS map overlay, with the same color as in the list (see below).

The school parameters of the selected school will be shown in the PROMUS school data module.

The modifiers SHIFT and CTRL can be used to select multiple schools in the list. When multiple schools are selected, the school that was selected first will be treated as the "current school" in the other views. This school is outlined with an extra border in the list.

### Color codes

The schools in the list will be shown on a different background color depending on their state:

- Moccasin if the school is grown but not yet interpreted.
- Green if the school is stored to the database.
- White if the school is interpreted, but not stored to the database.
- The color of the currently selected school depends on the 'look and feel', and has additionally an etched border.

### Dominant species for interpreted school

If a school has been interpreted, the percentage assignment for the dominant species of the school will be shown in the school list.

### Progress bars

To the right of each school are two progress-bars that indicate how each school has been processed:

- The leftmost bar indicates the progress of the school growing.
- The rightmost bar indicates the progress of the school aspect calculations.

If no processing has been done, the progress bar is white. When processing, it is golden yellow, indicating how the processing proceeds. When the processing is complete, the bar is light green.

### Group Schools

Sometimes it can be necessary to group two or more schools into one composite school. This is done by selecting the schools and right clicking the selection. This will bring up a context menu where the user can select "Group schools". The selected schools are then grouped, and new school parameters are computed for the new composite school. The school can be ungrouped again by right clicking the grouped school and selecting "Ungroup school" from the context menu. If the schools to be grouped are stored in the database, it is not possible to group the school. This is to avoid inconsistencies in the database. If the schools to be grouped are already interpreted, the composite school will inherit the interpretation of the first selected school in the group. This school is shown with an extra border in the list compared to the other selected schools.

## Tool buttons

The following buttons can be used to manipulate the school data:

- **New school** : Create a new school in the seed sample given in the PROMUS slice display module. See also the How to grow a school paragraph.
- **Regrow selected school** : Regrow the selected school. The process follows the same procedure as growing new schools as if this was a completely new school. This functionality is intended for replacing the existing school with another school with different grow parameters.
- **Grow all selected schools** : Grow the schools selected in the list.
- **Remove computed parameters:** : Remove the memory consuming parameters for the schools selected in the list. To maintain a responsive system, it may be a good idea to remove the parameters which are no longer needed. The parameters can easily be recomputed by pressing the -button. If LSSS is running out of memory, the parameters can be deleted automatically.
- **Delete selected school** : Remove the currently selected school(s). No ping data will be deleted, only the school data.
- **Export school aspects** : Export aspect data for all schools to blank-separated text files. Two files

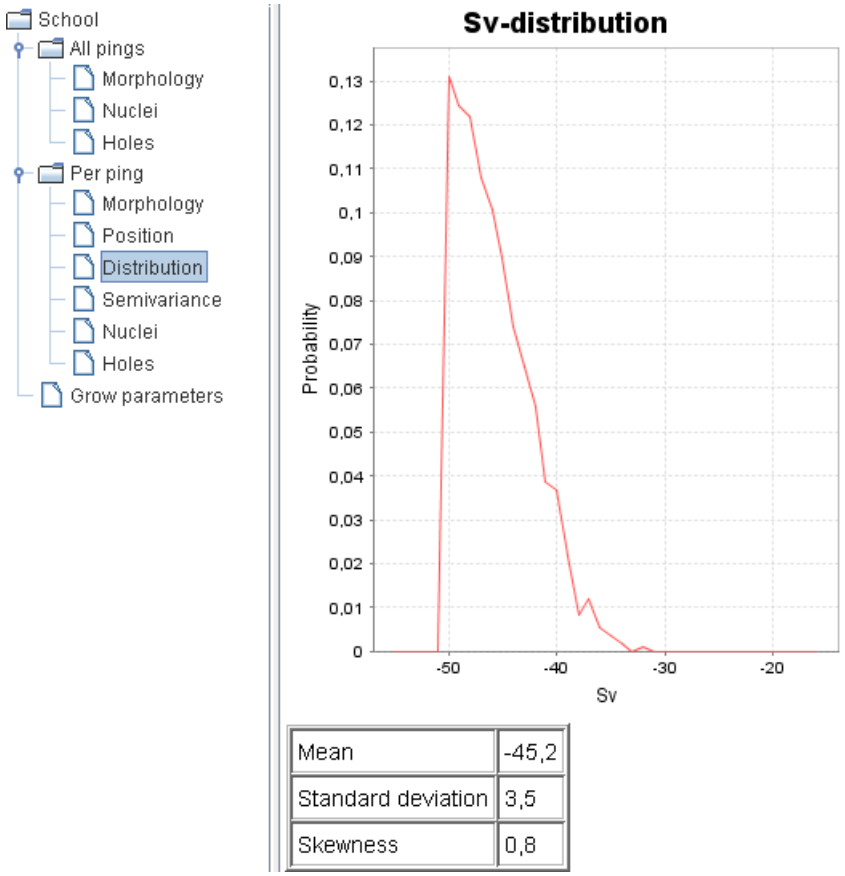
are generated, one for AllPing aspects, with one line per school, and one for PerPing aspects, with one line per ping.

# Promus school data

This module displays the different parameters computed for the school selected in the Promus interpretation module. The parameters are grouped into aspects, and the user can choose which aspect should be shown in the frame by selecting the corresponding aspect in the menu tree.

In addition to the aspects entries, the menu tree also has an entry for displaying the grow parameters for the school

An example of the Promus school data view is shown below. It consists of the menu tree and the frame for displaying the selected data, either as a graph, a table, or both.



# Aspects

The parameters for a school are divided into groups called aspects. Some of the aspects are computed for the whole grown school consisting of several pings (All ping aspects), while other aspects are computed for each ping (Per ping aspects).

## All ping aspects

These aspects are computed for the whole composite school consisting of several pings.

### Morphological aspect

The morphological aspect for the whole school are parameters describing the school shape, orientation etc. for the composite school for all the pings observing the school.

- Bounding boxes: Bounding boxes are computed based on both the sample centers and the sample corners. The box based on the sample centers is called the **corrected box**, and the box based on the sample corners is called the **uncorrected box**. The algorithm for defining the boxes is described below. The coordinate system is:
  - the x-axis in the west-east direction
  - the y-axis in the south-north direction
  - z upwards

  The following sub-parameters for the bounding boxes are displayed:
  - Rotation: The rotation of the principal axis of the box relative to the west-east(x) axis. The center point of the rotation is the arithmetic mean of the sample points (in the xy-plane, i.e. not considering the z-values).
    - The rotation is given in radians between -π and π
    - A negative rotation is clockwise, while a positive rotation is anti-clockwise.
  - Center: Center of the bounding box, relative to the geographical reference point for the school.
  - Extent: The extent of the edges of the bounding box in meters.
  - Elongation: Comparison of the horizontal extent of the school to the vertical extent.
    - Maximum elongation: The longest horizontal side of the bounding box divided by the height of the bounding box.
    - Minimum elongation: The shortest horizontal side of the bounding box divided by the height of the bounding box.
- Gridded volume:
- Grid surface:
- Geographical reference point: The sea surface at the geographical position of the transducer at the reference ping. The reference ping is the ping where the seed sample for growing the school was placed.

### Nuclei aspect

A measure of the number of nuclei in the school. The number of nuclei reported here is the total count of nuclei detected over all the pings observing the school (see Per ping nuclei aspect. The maximum and minimum relative volumes of the nuclei are also reported.

### Holes aspect

A measure of the number of holes in the school. The number of holes reported here is the total count of holes detected over all the pings observing the school (see Per ping holes aspect. The maximum and minimum relative volumes of the holes are also reported.

### Distribution aspect

The average volume backscatter for the school is computed here. Two ways of averaging the backscatter

from the pings are implemented:

- Pure average: The contribution from each ping is given equal weight.
- Volume weighted average: The contribution from each ping is weighted with the observed volume for each ping.

The average for both the linear backscatter (multiplied with 4 * PI * $1852^2$) and the logarithmic backscatter ( = 10 log ($s_V$) are computed.

### Movement aspect

A measure of how the school's gravity center has moved during observation. Only pings where the school is closed (the whole school is visible in the ping) are counted as valid observations of the gravity center position. The first and last valid observation of the gravity center is used to calculate the movement. If there are less than 2 valid observations of the gravity center, the movement cannot be measured, and the movement will be recorded as 0-velocity.

## Per ping aspects

These aspects are computed for individual pings in the school.

### Morphological aspect

The morphologic aspect says something about the school shape, size, orientation, etc. The following parameters are defined:

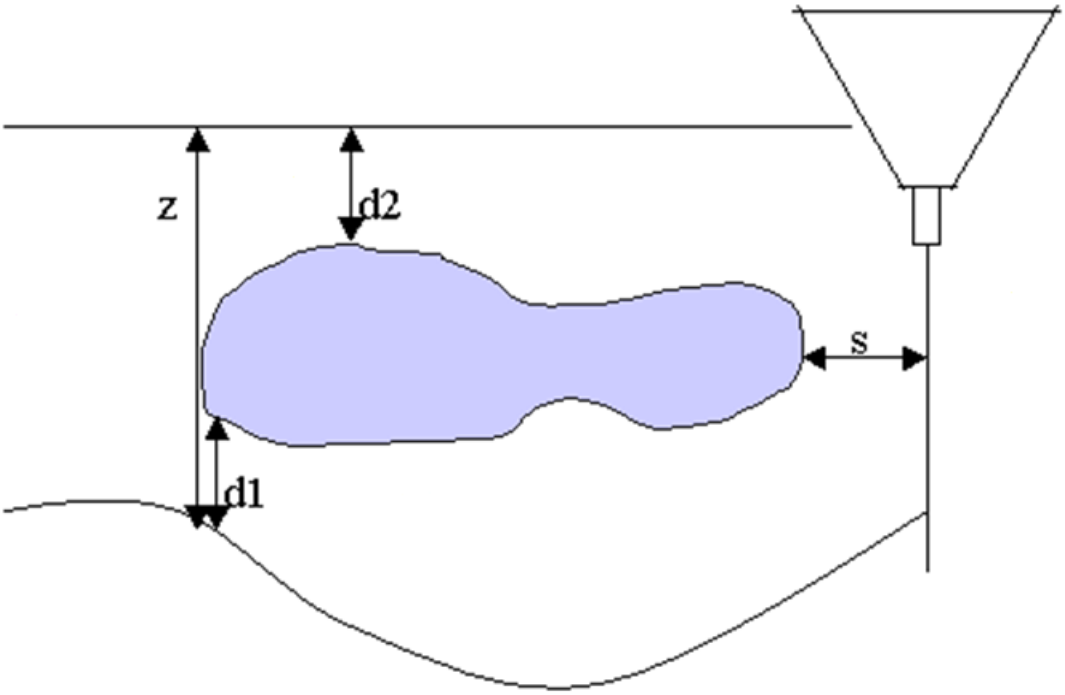
- Surface area graph: The uncorrected surface area of the school (see below) is computed for several resolutions in the beam direction, and the results are shown as a graph where the x-axis is the resolution in beam direction in meters and the y-axis is the computed surface area in $m^2$.
- Closed: True if the whole school is visible in the ping, i.e. no grown point is at the outer edge of the ping.
- Bounding boxes: Bounding boxes are computed based on both the sample centers and the sample corners. The box based on the sample centers is called the **corrected box**, and the box based on the sample corners is called the **uncorrected box**. The algorithm for defining the boxes is described below. In addition to the sub-parameters for the all ping morphological aspect, the following sub-parameters for the bounding boxes are displayed:
  - Volume: The total volume of the samples in the school.
  - Area of school (surface): The boundary of the extracted school is triangulated with the marching cubes algorithm.
  - Sphericity: Measure of how spherical the school is. Mathematically, the measure is:

    $$\psi = \frac{\pi^{\frac{1}{3}}(6V)^{\frac{2}{3}}}{S},$$

    where V is the volume of the school, and S is the surface. The value is always between 0 and 1.

### Position aspect

This aspect describes the position of the school at this ping.




The following parameters are defined:

- Distance to surface: The shortest distance from the school to the surface (The distance d2 in the picture above).
- Deepest point: The deepest point in the school.
- Bottom: The bottom depth at the position of the shortest distance from school to bottom. (The distance z in the picture above).
- Distance to bottom: The shortest distance from the school to the bottom (The distance d1 in the picture above).
- Distance to ship: The shortest distance from the school to the vertical plane passing through the ship in the ship heading direction (The distance s in the picture above).
- Gravity center: Position of the school's gravity center. The position is given relative to the geographical reference point for the school.

## Distribution aspect

The distribution aspect describes the density distribution of the volume backscatter values.

- Mean:

$$\hat{\mu}(S_V) = \frac{1}{N}\sum_{i=1}^{N} S_{Vi}$$

- Standard deviation:

$$\hat{\sigma}^2(S_V) = \frac{1}{N-1}\sum_{i=1}^{N}(S_{Vi} - \hat{\mu}(S_V))^2$$

- Skewness:

$$\hat{\gamma}(S_V) = \left(\frac{N\sqrt{(N-1)}}{(N-2)}\right)\left(\frac{\sum_{i=1}^{N}(S_{Vi} - \hat{\mu}(S_V))^3}{(\sum_{i=1}^{N}(S_{Vi} - \hat{\mu}(S_V))^2)^{\frac{3}{2}}}\right)$$

Statistics for both the linear backscatter (multiplied with 4 * PI * $1852^2$) and the logarithmic backscatter ( = 10

log ($s_V$) are computed.

### Semivariance aspect

Computes the so-called semivariance of the school samples. The semivariance is defined as:

$$\gamma(h)=\sum_{i=1}^{n(h)}\frac{(S_V(x_i+h)-S_V(x_i))^2}{n(h)}$$

The squared differences are taken in the along-beam direction for each beam, and the total sum is taken over all beams containing samples which are part of the school. The semivariance is computed for several values of the value h - the sample number difference, resulting in a curve where the semivariance is plotted against h.

### Nuclei aspect

Counts the number of nuclei in a school ping. A nucleus is defined as connected samples which have a backscatter value above a given threshold. The relative volume of the connected samples compared to the school volume in the ping must be larger than a given minimum and all the nuclei samples must be inside the school volume.

Parameters:

- Number of nuclei: The number of nuclei in the ping.
- Relative size (%): A list of the relative sizes of the nuclei detected.

### Holes aspect

Counts the number of holes in a school ping. A hole is defined as connected samples which are not part of the detected school, but are surrounded by school samples. The relative volume of the connected samples compared to the school volume in the ping must be larger than a given minimum.

Parameters:

- Number of holes: The number of holes in the ping.
- Relative size (%): A list of the relative sizes of the holes detected.

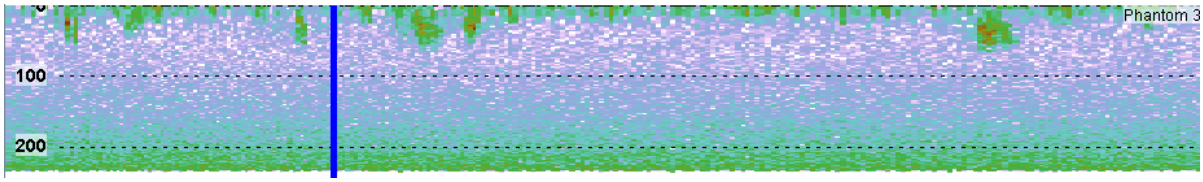
## Box fitting algorithm

The box fitting algorithm is common for the "all ping aspects" and the "per ping aspects".

- Horizontally: Project all school points in the horizontal plane. Find the (semi)-optimal rectangle which fits the data (orthogonal rectangular hull): Let X be a vector of data points (x, y). Define the matrix $A = XX^T$. A will be a symmetric positive semi-definite matrix. Perform the singular value decomposition $A = U \Sigma U^T$, where $\Sigma$ is a matrix of singular values, and the columns of U define an orthonormal basis for the 2-dimensional subspace that contains all points in X. This orthonormal basis defines the orientation of the rectangular hull, and the length of the edges is found so that all data points lie within the rectangle.
- Vertically: The deepest and shallowest points of the school define the extent of the bounding box in the vertical direction.

# Phantom echogram

This view displays phantom echograms generated from PROMUS MS70 data. The echogram data can be produced using the Phantom module in the preprocessing system, and the input folder for the echogram data can be configured in the data file configuration.




Clicking on the echogram moves the selected PROMUS ping to the ping corresponding to the mouse position.

## Overlays

As for the pelagic and bottom echograms, the phantom echograms has overlays stacked on top of it. Each overlay can be turned on or off in the configuration dialog for the echograms.

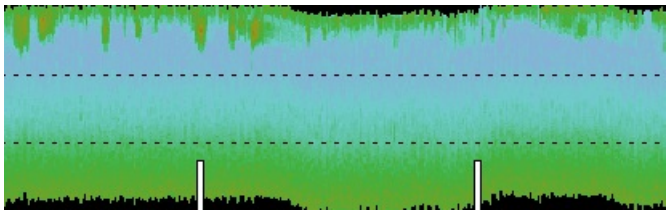
### Channel info

Shows the currently selected phantom data channel description in the top tight corner of the echogram.

### Depth markers

This overlay shows equidistant horizontal lines stretching across the echogram. The depth corresponding to each line is written to the left.

### File markers



This overlay shows white markers at the bottom of the echogram at the start of each data file, similar to the file markers in the standard echogram.

### Mouse position

This overlay shows the mouse position, similar to the standard echogram.

### Selected ping

The vertical blue line acts as a navigator for PROMUS pings. It indicates the position of the currently loaded PROMUS ping, and by dragging the line, new PROMUS pings are loaded.

The position of the selected ping is also shown in the map and on the standard echogram.

# Overlays

These are the Promus overlays added to existing LSSS views.

Promus echogram overlays
Additional overlays to the standard 2D echogram view.

Promus map overlays
Additional overlays to the standard LSSS map view.

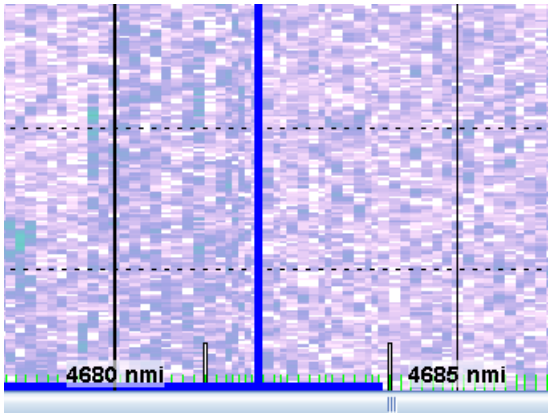
# Echogram overlays

To match the data from standard 2D echosounder with the Promus data in LSSS, some additional overlays for the 2D echogram view exists. The echogram still shows the data in DataDir, set in the Data files dialog in configuration. The additional overlays specific for Promus are explained below.

## Data marker

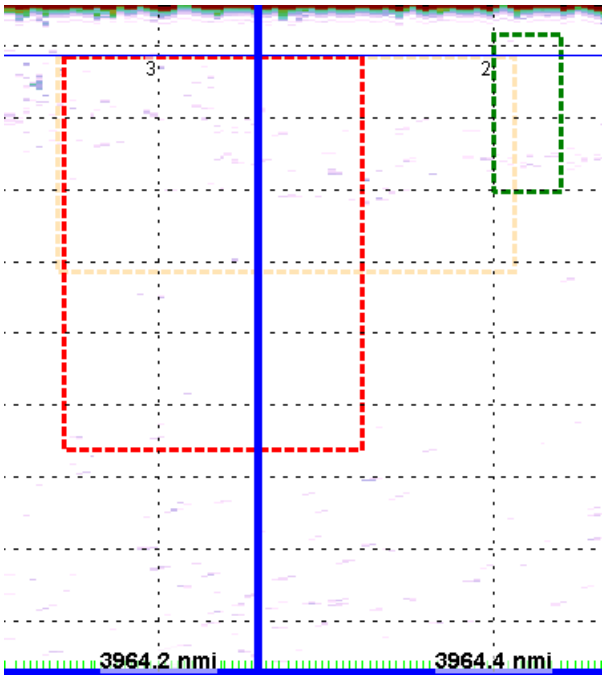
At the bottom of the echogram, a blue line indicates which section of the data corresponding Promus data exists.

## Selected ping




The vertical blue line acts as a navigator for Promus pings. It indicates the position of the currently loaded Promus ping, and by dragging the line, new Promus pings are loaded. The position of the marker is shown in the map as an orange dot, see Promus map overlays.

## School marker




This overlay shows the projected bounding boxes of identified schools (grown and ungrown schools in the

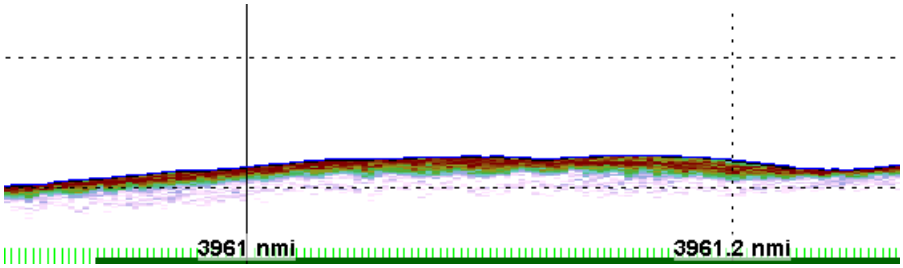
school list).

Clicking on a bounding box, selects the corresponding school as the current school, and sets the navigator line to the center ping of the school.

The bounding box will have color corresponding to their state:

- Red if the school is the selected school.
- Moccasin if the school is grown but not yet interpreted.
- Green if the school is stored to the database.
- Black if the school is interpreted, but not stored to the database.

## Database marker

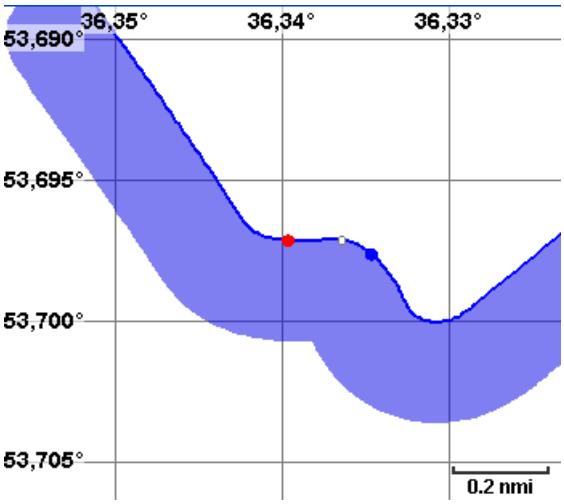



This overlay shown a green line at the bottom of the echogram, which indicates the intervals where Promus interpretation has been stored to the database.

# Map overlays

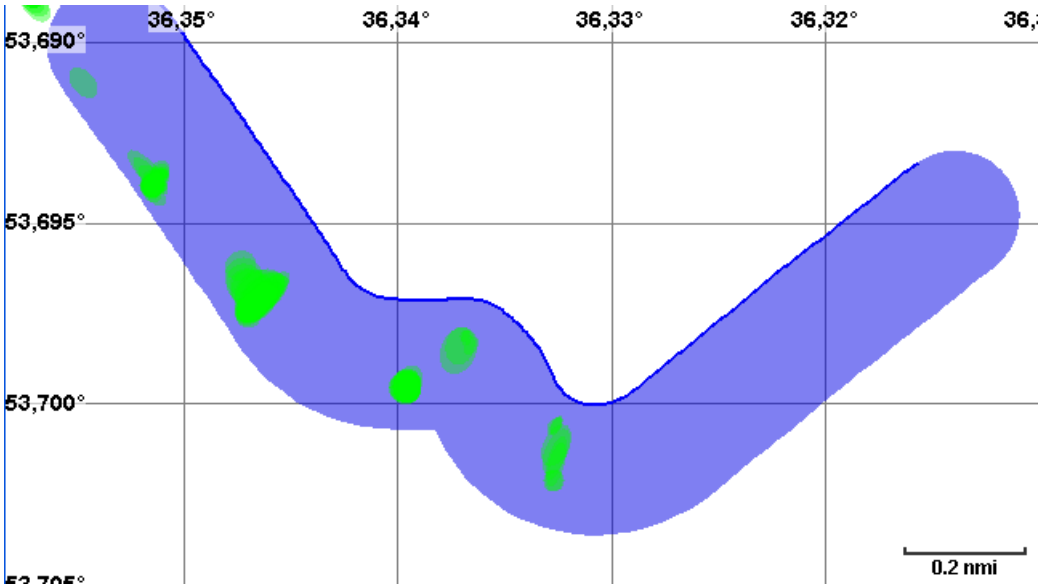
When Promus data is open, some Promus specific map overlays are shown in addition to the standard LSSS map. The additional display elements are documented below :

## Promus survey line



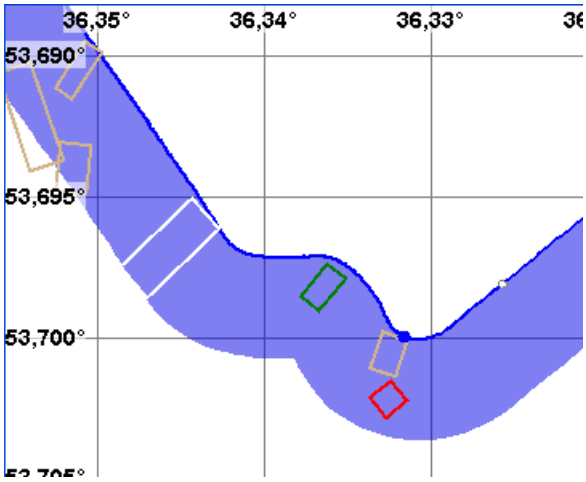

The view shows the Promus survey line, and a blue band indicating the range of the echosounder beam. If EK60 data is loaded, the EK60 survey line will be shown separately. The orange point indicates the geographical position of the current ping, also shown in the standard LSSS echogram view, see Promus echogram overlays. By left clicking on the survey line, the closest Promus ping is loaded. The red marker has the same function as always, displaying the position of the mouse pointer in the echogram.

## School candidates from preprocessing



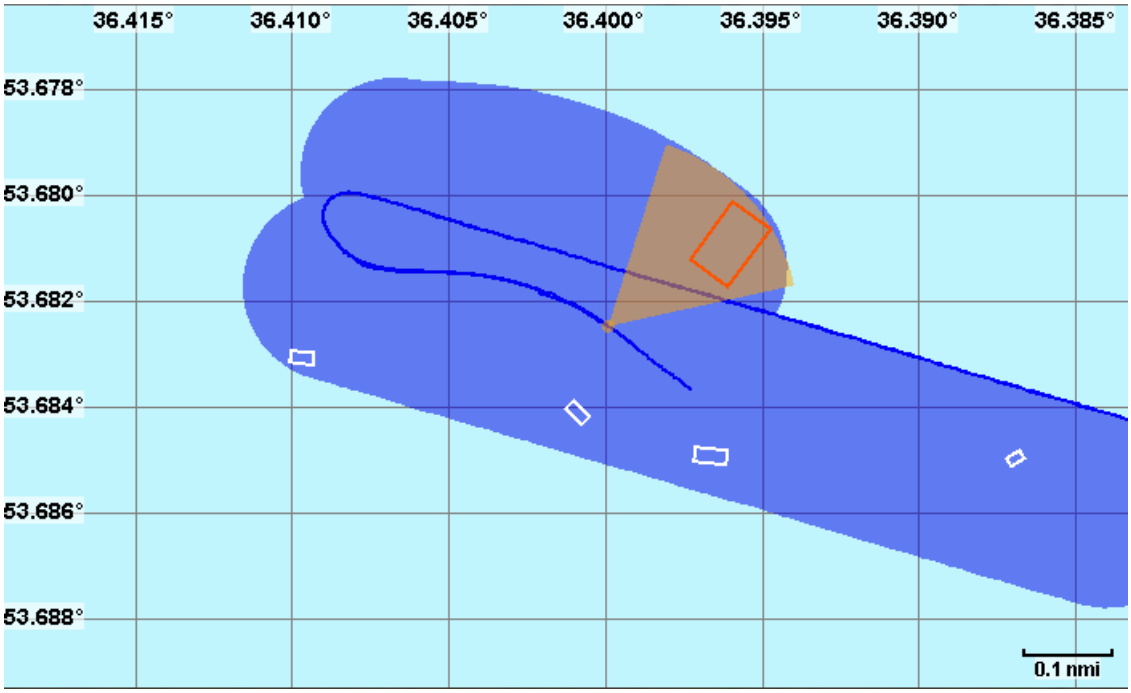

If the SchoolClusterModule is run as part of preprocessing, school candidates might have been found. These are shown as green ellipses. Each ellipse corresponds to a cluster that passed the cuts in the clustering. The extent of the ellipse shows the standard deviation of the detected cluster. By hovering the mouse over a ellipse, it is colored red, together with the clusters from neighbouring pings that it has been successfully matched to.

## School bounding boxes



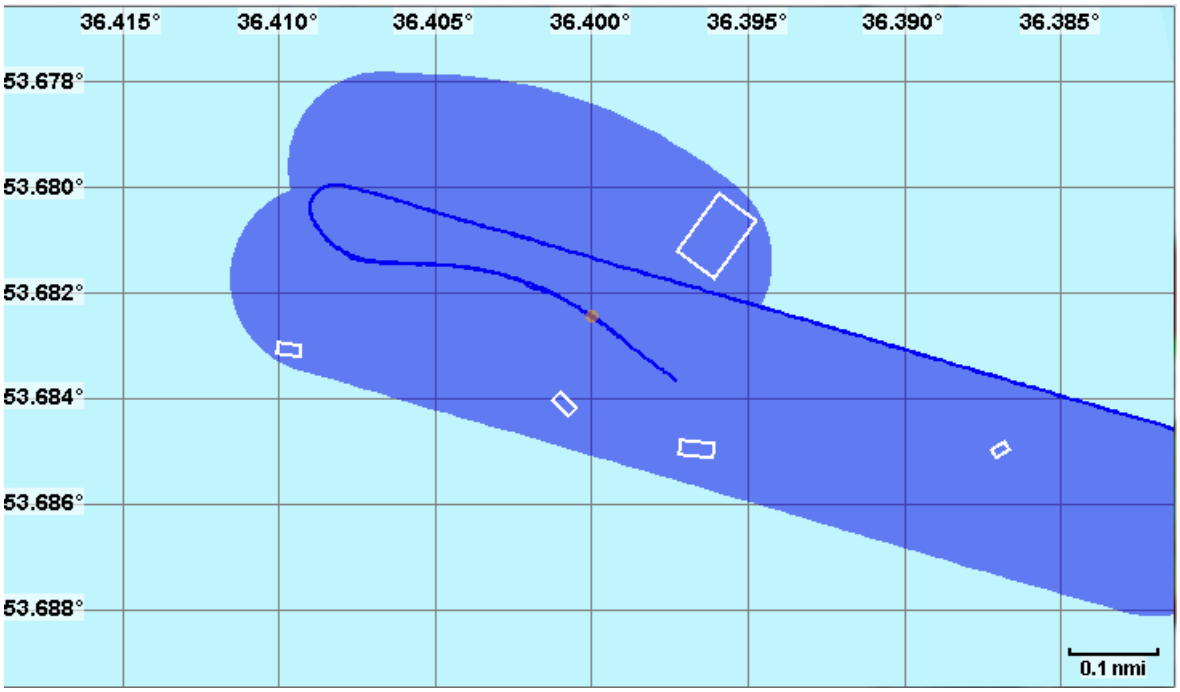

When schools have been grown, the bounding boxes for the schools are shown, with the same colors as in the Promus interpretation module school list, except that the currently selected school has a red bounding box.
Clicking a boundary box in the map has the same effect as selecting a school in the school list. As with the school list, the modifiers SHIFT and CTRL can be used to select multiple schools.
When multiple schools are selected, the "current school" is marked with a red bounding box, the others have dark red bounding boxes.

## Current ping




This overlay shows the position and extend of the currently selected ping as a semi-transparent orange fan.

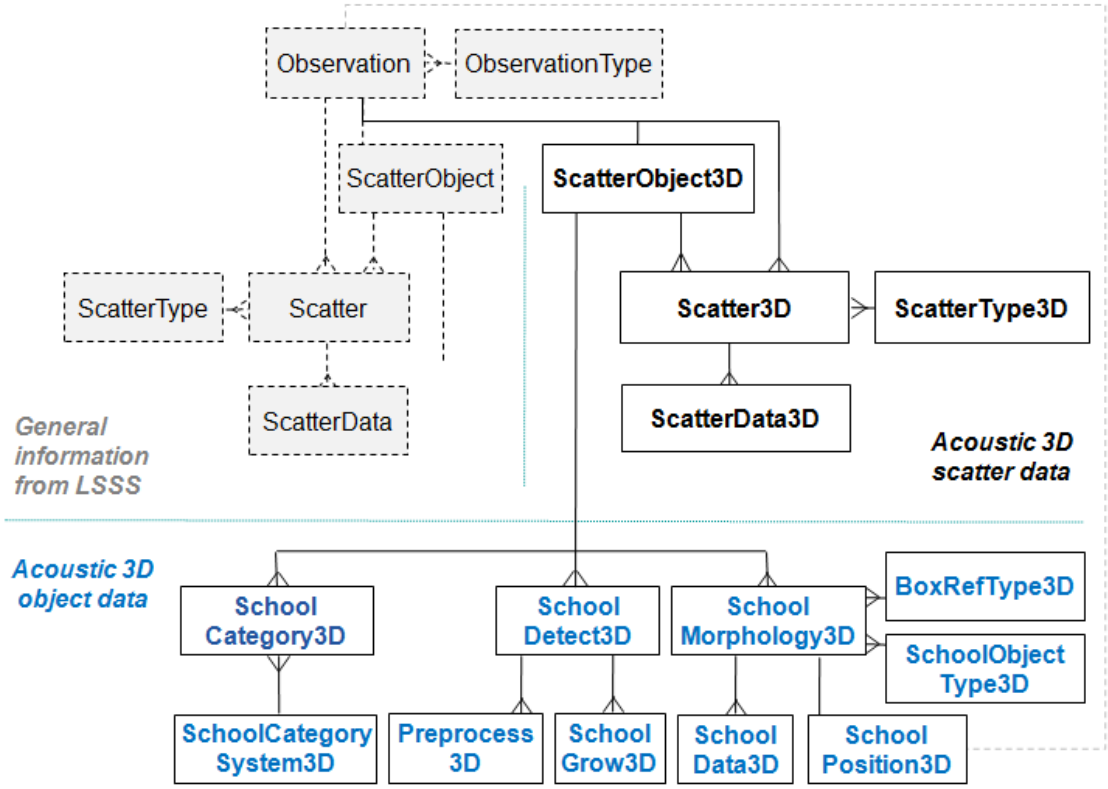
## Map position




Shows the ship position for the currently selected ping as an orange dot on the survey line.

# Database - PROMUS extension

Documentation of the additional database tables for PROMUS data. The figure below shows how the database tables relate to each other (in addition to the LSSS base database tables marked in grey).




**LSSS database tables specific to PROMUS**

The database tables specific to PROMUS data in alphabetic order are as follows:

- BoxRefType3D - Box surrounding school
- Preprocess3D - Settings used to preprocess data in 3D
- Scatter3D - Main scatter information for 3D/4D data
- ScatterData3D - Depth-channel data of acoustic 3D/4D scatter data
- ScatterObject3D - Group of scatter (e.g. entire school)
- ScatterType3D - Type of 3D/4D scatter-channels
- SchoolCategory3D - Acoustic category for 3D school object
- SchoolCategorySystem3D - Code system for school
- SchoolData3D - Data for 3D school object (in addition to Scatter)
- SchoolDetect3D - Settings used to detect school in 3D
- SchoolGrow3D - Settings used to grow school in 3D
- SchoolMorphology3D - 3D morphology of school
- SchoolObjectType3D - Type of 3D school object
- SchoolPosition3D - Position of 3D school

## Related topics

Database (core LSSS)

# BoxRefType3D

## Name

**BoxRefType3D** - Orientation of 3D storage cells of database

## Synopsis

```
struct BoxReferenceType3D {
  short BoxReference;
  char  BoxReferenceName[40];
};
```

## Description

This table shows whether the storage box encapsulating the school-object has a local or global coordinate system.

## Parameters

- **BoxReference** - Box reference code: Local=0, Global=1, parallel to ship = 0, 1 = global coordinate system.
- **BoxReferenceName** - Box reference code name: "Local, parallel to ship" or "Global, north = pi/4".

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolMorphology3D;

# ObservationType - expansion of content used by PROMUS

## Description

## Parameters

- ObservationType - Unique identifier code for defined event types. Currently, the PROMUS plugin expands ObservationType with the following observation types:

  23000 = PROMUS_SCATTER_FISH_DATA = Scattered 3D fish data (intended for abundance calculations)
  29000 = PROMUS_SCATTER_OBJECT_SCHOOL = Scatter 3D object of type school

## Related topics

Database

## Database table

ObservationType;

# Preprocess3D

## Name

**Preprocess3D**

## Synopsis

```
struct Preprocess3D {
  short   Nation;
  short   Platform;
  int     Survey;
  int     PreprocessCode;
  Varchar PreprocessSettings;
};
```

## Description

Describes how the school-data was pre-processed (prior to growing the school).

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **PreprocessCode** - Connects to SchoolDetect3D database table.
- **PreprocessSettings** - Settings used to preprocess data.

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolDetect3D, SchoolGrow3D

# Scatter3D

## Name

**Scatter3D**

## Synopsis

```
struct Scatter3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  int    ObservationDate;
  int    ObservationTime;
  short  ScatterType3D;
  short  ObservationType;
  int    Duration;
  int    PingCount
  float  DistanceInterval;
  float  RangeDelta;
  float  ThetaDelta;
  float  PhiDelta;
  float  TransducerDepth;
  float  RangeMin;
  float  RangeMax;
  float  ThetaMin;
  float  ThetaMax;
  float  PhiMin;
  float  PhiMax;
  float  DepthMin;
  float  DepthMax;
  int    FrequencyMin;
  int    FrequencyMax;
  float  BottomDepthMin;
  float  BottomDepthMax;
  float  ThresholdMin;
  float  ThresholdMax;
  float  BubbleLayerThickness;
  float  BubbleCorrectionPerMeter;
  float  sV;
  float  PctSV;
  short  Quality;
  short  BottomActive;
};
```

## Description

Surface projected global grid for acoustic scatter data. The global grid is a "right-hand" coordinate-system where z increase with increasing depth.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the **Survey** database table.
- **Object3D** [-] - Object identification number for 3D objects. Here used to group scatter slices. See the Scatter database table for a thorough description of objects in 2D.
- **ObservationDate** [YYYYMMDD] (UTC). - Reference date for cell. Each line in the *Scatter3D* table is time stamped with the start of the associated sub interval, and there is a Scattered Fish Data 3D event line in the ObservationType table with a matching time stamp.
- **ObservationTime** [hhmmssxx] (UTC). - Reference time for cell. Each line in the *Scatter3D* table is

time stamped with the start of the associated sub interval, and there is a Scattered Fish Data event line in the ObservationType table with a matching time stamp.

- **ScatterType3D** [-] - Type of scatter. Connects to ScatterData3D database table. See ScatterType3D database table for description.
- **ObservationType** [-] - Connects to **Observation** database table.
- **Duration** [1/100s] - Duration of scatter grid.
- **PingCount** [#] - Number of pings for this date and time.
- **DistanceInterval** [nmi] - Distance (1 nmi = 1852 m) covered by sub interval.

COORDINATE_SYSTEM:

- **RangeDelta** [m] - Increase in range from transducer per index. (0 at transducer). See figure below.
- **ThetaDelta** [deg] - Increase in horizontal ((x,y)-plane, 0 in x-dir.)) angle per index. See figure below.
- **PhiDelta** [deg] - Increase in vertical angle per index. (0 in z-direction). See figure below.
- **TransducerDepth** [m] - Depth below surface of origin of transducer. Needed to calculate cross-sectional vertical area.

LIMITATIONS OF USED DATA: Cells that are partially filled due to the limitations in Range, Theta, Phi or Depth are stored in the database. It has to be at least 10 samples in the storage interval for the cell to be stored.

- **RangeMin** [m] - Minimum range where data is both collected and interpreted.
- **RangeMax** [m] - Maximum range where data is both collected and interpreted.
- **ThetaMin** [deg] - Minimum value of angle Theta where data is both collected and interpreted.
- **ThetaMax** [deg] - Maximum value of angle Theta where data is both collected and interpreted.
- **PhiMin** [deg] - Minimum value of angle Phi where data is both collected and interpreted.
- **PhiMax** [deg] - Maximum value of angle Phi where data is both collected and interpreted.
- **DepthMin** [m] - Minimum depth where data is both collected and interpreted. For pelagic data (ScatterType3D= scatter_pelagic_3D or school_pelagic_3D - see ScatterType3D database table for description), the sea-surface is the reference. Note that the data are collected in spherical coordinates (Range, Theta, Phi - see below), so that Depth is a measure in a converted coordinate system.
- **DepthMax** [m] - Maximum depth where data is both collected and interpreted.

MEASUREMENTS / INFORMATION:

- **FrequencyMin** [Hz] - Minimum frequency for this date and time.
- **FrequencyMax** [Hz] - Maximum frequency for this date and time.
- **BottomDepthMin** [m] - Minimum bottom depth detected by sonar.
- **BottomDepthMax** [m] - Maximum bottom depth detected by sonar.

SETTINGS:

- **ThresholdMin** [dB] - Scatter weaker than ThresholdMin are not used.
- **ThresholdMax** [dB] - Scatter stronger than ThresholdMax are not used.
- **BubbleLayerThickness** [m] - Estimated thickness of bubble layer below transducer (future use).
- **BubbleCorrectionPerMeter** [$m_{-1}$] - Factor to multiply with to correct for bubbles (future use).

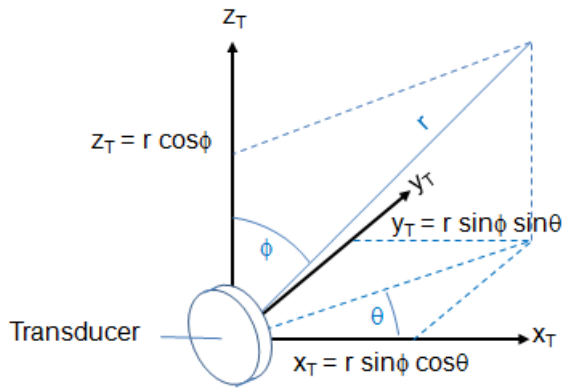
MEASUREMENTS:

- **sV** [$m^2/(m\ nmi)^2$] - $s_V$ for all cells. $s_V = 4 \times PI \times 1852^2 s_V$.
- **PctSV** [%] - % backscatter that is allocated to any acoustic category.

FLAGS:

- **Quality** [-] - Quality marking: 1, 2 or 3 where 1 is best. Refer to the Scatter database table.
- **BottomActive** {0,1} - Bottom active if BottomActive=1 (which indicate if ScatterType3D=bottom_... exists). Refer to the Scatter database table.

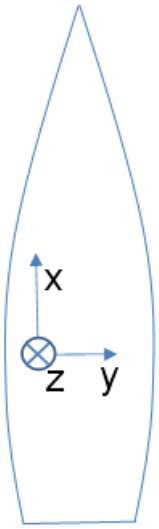
# Transducer coordinate system $x_T$, $y_T$, $z_T$




*Coordinate system used by Scatter3D and ScatterData3D*

r is the radial distance from transducer center. The vertical angle Phi varies from 90 degrees (horizontally) to 135 degrees (where 180 degrees is straight downwards from the sea surface). The angle Theta in the horizontal plane (i.e. the (x,y)-plane) varies between 60 and 120 degrees (where 0 is straight forward in the ship cruise direction). On the RV "G.O. Sars" (Norway), $x_T$ points in cruise direction (ship bow), $y_T$ in port direction and $z_T$ points upwards. Note that the coordinate ($x_T$,$y_T$,$z_T$) used here is not the same as the coordinate (x,y,z) used by the echosounder data (in the 2D database table Scatter).

## Ship coordinate system x, y, z




## Related topics

Database - PROMUS extension, Database

## Related database tables

ScatterType3D, ScatterData3D, ScatterObject3D, Observation, ObservationType, Scatter

# ScatterData3D

## Name

**ScatterData3D**

## Synopsis

```
struct ScatterData3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  int    ObservationDate;
  int    ObservationTime;
  short  ScatterType3D;
  int    RangeIndex;
  int    ThetaIndex;
  int    PhiIndex;
  int    AcousticCategory;
  int    Frequency;
  float  SV;
};
```

## Description

Acoustic measurements of cells. The average acoustic backscatter estimate, **SV**, is computed as follows:

- For this cell a theoretical number, *Count*, of samples belonging to the cell is computed based on the definition of the cells in Promus grid configuration.
- For each ping (index k) a sample average of the interpreted samples belonging to this cell is computed $\mathbf{SV}_k$ = *(sum of interpreted samples) / Count*
- For the configured averaging intervals an accumulated value is computed using a weighting by the "distance" since the last ping. For distance weights $w_k$, we get $\mathbf{SV} = \sum w_k * \boldsymbol{SV}_k / \sum w_k$ The unit of the distance is the unit of the horizontal grid defined in LSSS grid configuration

Cells where one or more of the indices are zero are average-cells. For example a cell with *RangeIndex = 0*, *ThetaIndex = 2* and *PhiIndex = 5*, is computed as the average over all cells with *ThetaIndex = 2* and *PhiIndex = 5*. The number *Count* is used as the weighting of the cells.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the **Survey** database table.
- **Object3D** [-] - 3D-object identification number. For description of similar 2D-objects, refer to the Scatter database table.
- **ScatterType3D** [-] - Connects to Scatter3D database table. See ScatterType3D database table for description.
- **ObservationDate** [YYYYMMDD] (UTC). - Connects to the Scatter3D database table where each appurtenant field has the same value.
- **ObservationTime** [hhmmssxx] (UTC). - Connects to the Scatter3D database table where each appurtenant field has the same value.
- **RangeIndex** [#] - Index count in radial direction (range) from transducer center. See table **Scatter3D**.
- **ThetaIndex>** [#] - Index count for Theta angle. See table **Scatter3D**.
- **PhiIndex** [#] - Index count for Phi angle. See table **Scatter3D**.
- **AcousticCategory** [-] - Acoustic category. See table *AcousticCategory*.

- **Frequency** [Hz] - Frequency for beam.
- **SV** [$m^2/m\ nmi^2$] - Scrutinized $s_V$ of volume. $s_V = 4 * PI * 1852^2 * s_v$.

## Related topics

Database - PROMUS extension, Database

## Related database tables

Scatter3D, ScatterData

# ScatterObject3D

## Name

**ScatterObject3D**

## Synopsis

```
struct ScatterObject3D {
   short Nation;
   short Platform;
   int   Survey;
   int   Object3D;
   int   ObservationDate;
   int   ObservationTime;
   int   ObservationType
   int   Duration;
};
```

## Description

Grouping of scatter objects. One object may be observed in different ways (=different ObservationType).

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **Object3D** [-] - 3D-object identification number. For description of similar 2D-objects, refer to the Scatter database table.
- **ObservationDate** [YYYYMMDD] (UTC). - Each line in the *Scatter3D* table is time stamped with the start of the associated sub interval, and there is a Scattered Fish Data event line in the ObservationType table with a matching time stamp.
- **ObservationTime** [hhmmssxx] (UTC). - Each line in the *Scatter3D* table is time stamped with the start of the associated sub interval, and there is a Scattered Fish Data event line in the ObservationType table with a matching time stamp.
- **ObservationType** [-] - Refer to the ObservationType database table. //todo Here: ObservationType = SCHOOL_OBJECT_3D
- **Duration** [1/100 s] - Duration in 1/100 seconds, current sequence (Duplicated)

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolCategory3D, SchoolDetect3D, SchoolMorphology3D, Observation

# ScatterType3D

## Name

**ScatterType3D**

## Synopsis

```
struct ScatterType3D {
  short ScatterType3D;
  char  ScatterType3DName[40];
};
```

## Description

Scatter channel type. This table contains a mapping between a scatter type code and the scatter type name for 3D data. Currently (2012), only one scatter channel type is used, but the content will be expanded when new modules are added to LSSS.

## Parameters

- **ScatterType3D** [-] - Scatter type code
- **ScatterType3DName** [-] - Name of scatter type. scatter_pelagic_3D=1000 means scatter channels referred to the sea-surface.

## Related topics

Database - PROMUS extension, Database

## Related database tables

Scatter3D

# SchoolCategory3D

## Name

**SchoolCategory3D**

## Synopsis

```
struct SchoolCategory3D {
  short Nation;
  short Platform;
  int   Survey;
  int   Object3D;
  short CategorySystem;
  int   SchoolCategory3D;
  float Pct;
};
```

## Description

How a school-object was interpreted (frequency dependent). This table is tight connected to how LSSS or other post-processing systems work.

## Parameters

- **Nation** [-] - Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the **Survey** database table.
- **Object3D** [-] - 3D-object identification number. For description of similar 2D-objects, refer to the Scatter database table.
- **CategorySystem** [-] - Identification code for categorisation system.
- **SchoolCategory3D** [-] - Code for category in the used CategoryType system.
- **Pct** [-] - Percentage of SchoolCategory3D. For category system 1="AcousticCategory", Pct is percentage sVV = sVmean * Volume. Refer to the SchoolData3D database table.

## Related topics

Database - PROMUS extension, Database

## Related database tables

ScatterObject3D, SchoolCategorySystem3D

# SchoolCategorySystem3D

## Name

**SchoolCategorySystem3D**

## Synopsis

```
struct SchoolCategorySystem3D {
  short   CategorySystem;
  String  CategorySystemName;
  String  CategorySystemDescription;
};

1 = AcousticCategory // Acoustic category interpreted
2 = KORONA_Category  // KORONA_Category suggested by KORONA
3 = PROMUS_Category
4 = MOVIES_Category  // Category (0 ? 15) similar to MOVIES
```

## Description

Name and description of system for describing acoustic categories.

## Parameters

- **CategorySystem** [-] - Identification code for categorisation system. Connects to SchoolCategory3D database table.
- **CategorySystemName** [-] - Name of coding system (LSSS, KORONA, ...)
- **CategorySystemDescription** [-] - Description of Category system (i.e. coding system)

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolCategory3D

# SchoolData3D

## Name

**SchoolData3D**

## Synopsis

```
struct SchoolData3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  short  SchoolObjectType3D;
  int    FrequencyRef;
  int    Sequence;
  int    ObservationDate;
  int    ObservationTime;
  int    FrequencyMin;
  int    FrequencyMax;
  double sVMean;
  double sVSdev;
  double sVV;
};
```

## Description

Multifrequency acoustic measurements on school-object. Depending on SchoolObjectType3D the acoustic values are based on corrected or uncorrected schools.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **Object3D** [-] - 3D-object identification number. For description of similar 2D-objects, refer to the Scatter database table.
- **SchoolObjectType3D** [-] - School calculation type code. See ScatterType3D database table. Example: 10=SchoolAsDetectedUncorrected, 11=SchoolAsDetectedCorrected.
- **FrequencyRef** [Hz] - Reference frequency
- **Sequence** [-] - Running sequence for measurements.
- **ObservationDate** [YYYYMMDD] (UTC). - Connects to the ScatterObject3D database table where each appurtenant field has the same value.
- **ObservationTime** [hhmmssxx] (UTC). - Connects to the ScatterObject3D database table where each appurtenant field has the same value.
- **FrequencyMin** [Hz] - Minimum acoustic frequency contributing to column.
- **FrequencyMax** [Hz] - Maximum acoustic frequency contributing to column.
- **sVMean** [$m^2$/n.mi.$^2$m] - Mean of sV measurements. If SchoolObjectType3D indicates a corrected value, e.g. SchoolAsDetectedCorrected=11=SchoolAsDetectedCorrected: $sVMean_{corrected}$ = sVMean * A / $A_{corrected}$ * $10^{(dSv_{corrected}/10)}$. This parameter ($s_V$, volume backscattering coefficient, Nautical Volume Scattering Coefficient) contains the integrated echo level for a particular sub-interval/channel/active-acoustic-category triplet. The parameter has dimension square meter per square nautical mile per meter. The value is allocated to one acoustic category. Note that $s_V$ = 4 pi 1852 $^2s_v$.
- **sVSdev** [$m^3$/n.mi.$^2$] - Standard deviation of mean sV measurements. // [ (sV_mean - sV_i) / (n-1) ] ** 0.5

- **sVV** [$m^4/n.mi.^2$] - Acoustic abundance of school: $s_V V$, where V is school volume.

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolMorphology3D

# SchoolDetect3D

## Name

**SchoolDetect3D**

## Synopsis

```
struct SchoolDetect3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  int    SchoolGrowCode;
  int    PreprocessCode;
  double DetectionThresholdMin;
  double DetectionThresholdMax;
  short  ManuallyCorrected;
};
```

## Description

Describes how the school-data was pre-processed and the settings used to grow school, and finally if the grown school is used as is, or if the grown school is manually corrected.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **Object3D** [-] - Object identification number for 3D objects. Here used to group scatter slices. See the Scatter database table for a thorough description of objects in 2D.
- **SchoolGrowCode** - Connects to SchoolGrow3D database table.
- **PreprocessCode** - Connects to Preprocess3D database table.
- **DetectionThresholdMin** [dB] - Minimum threshold for school extent detection.
- **DetectionThresholdMax** [dB] - Maximum threshold for school extent detection.
- **ManuallyCorrected** - False if automatically detected school, true else.

## Related topics

Database - PROMUS extension, Database

## Related database tables

ScatterObject3D, SchoolGrow3D, Preprocess3D

# SchoolGrow3D

## Name

**SchoolDetect3D**

## Synopsis

```
struct SchoolGrow3D {
  short   Nation;
  short   Platform;
  int     Survey;
  int     SchoolGrowCode;
  Varchar SchoolGrowSettings;
};
```

## Description

Describes how the school-data was grown.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **SchoolGrowCode** - Connects to SchoolDetect3D database table.
- **SchoolGrowSettings** - Settings used by postprocessor to grow school.

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolDetect3D, Preprocess3D

# SchoolMorphology3D

## Name

**SchoolMorphology3D** - Frequency independent measurements on school-object

## Synopsis

```
struct SchoolMorphology3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  short  SchoolObjectType3D;
  int    Sequence;
  int    ObservationDate;
  int    ObservationTime;
  int    BoxReference;
  float  BoxOrientation;
  float  BoxDepth;
  float  BoxThickness;
  float  BoxLength;
  float  BoxWidth;
  float  BoxLatitude;
  float  BoxLongitude;
  float  BoxDistanceToVessel;
  float  MaxThickness;
  float  MaxLength;
  float  MaxWidth;
  float  Surface;
  float  Volume;
  float  Roughness3D;
  float  Sphericity;
  float  ElongationMin;
  float  ElongationMax;
  short  Quality;
  short  SchoolCovered;
  float  DistanceToBottom;
  float  DistanceToSurface;
  float  BottomDepth;
  int    NmbAcousticCategories;
  short  NmbHoles;
  short  NmbKernels;
};
```

## Description

This table shows whether the storage box encapsulating the school-object has a local or global coordinate system.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the **Survey** database table.
- **Object3D** [-] - Object identification number for 3D object. See ScatterObject3D and refer to the database table Scatter for description of 2D objects.
- **SchoolObjectType3D** [-] - School calculation type code. See ScatterType3D database table.
- **Sequence** [-] - Running sequence for measurements.
- **SeqObsDate** [YYYYMMDD] (UTC). - Connects to the ScatterObject3D database table where each appurtenant field has the same value.

- **SeqObsTime** [hhmmssxx] (UTC). - Connects to the ScatterObject3D database table where each appurtenant field has the same value.
- **BoxReference** [-] - Global grid: 1, local grid: 0 (parallel to ship). See BoxRefType3D table.
- **BoxOrientation** [rad] - Horizontal box orientation relative to reference.
- **BoxDepth** [m] - Top of box.
- **BoxThickness** [m] - Thickness of box covering school.
- **BoxLength** [m] - Length of box covering school.
- **BoxWidth** [m] - Width of box covering school.
- **BoxLatitude** [deg] - Latitude of box centre
- **BoxLongitude** [deg] - Longitude of box centre
- **BoxDistanceToVessel** [m] - Distance from box to measuring platform (ship).
- **MaxThickness** [m] - Largest thickness of school.
- **MaxLength** [m] - Largest length of school.
- **MaxWidth** [m] - Largest width of school.
- **Surface** [$m^2$] - The boundary of the extracted school is triangulated with the marching cubes algorithm.
- **Volume** [$m^3$] - The total volume of the samples in the school.
- **Roughness3D** [-] - //To be defined
- **Sphericity** [-] - Measure of how spherical the school is. Mathematically, the measure is:

  $$\psi = \frac{\pi^{\frac{1}{3}}(6V)^{\frac{2}{3}}}{S},$$

  where V is the volume of the school, and S is the surface. The value is always between 0 and 1.
- **ElongationMin** [-] - MIN(Length,Width)/Thickness
- **ElongationMax** [-] - MAX(Length,Width)/Thickness
- **Quality** [-] - {1, 2, 3} Quality of calculations where 1 is best.
- **SchoolCovered** [-] - {0, 1} 1=TRUE if school is covered by one (=current) ping, 0=FALSE if not.
- **DistanceToBottom** [m] - Minimum distance from lower part of school to bottom (i.e. where school is closest to bottom).
- **DistanceToSurface** [m] - Minimum distance from upper part of school to surface (i.e. where school is closest to bottom).
- **BottomDepth** [m] - Bottom depth below the point where the school is closest to the bottom.
- **NmbAcousticCategories** [#] - Number of acoustic categories within this school-object.
- **NmbHoles** [#] - Number of holes within this school-object.
- **NmbKernels** [#] - Number of kernels within this school-object.

## Related topics

LSSS Database; PROMUS Database

## Related database tables

ScatterObject3D, BoxRefType3D, SchoolObjectType3D, SchoolData3D, SchoolPosition3D

# SchoolObjectType3D

## Name

**SchoolObjectType3D**

## Synopsis

```
struct SchoolObjectType3D {
  short  SchoolObjectType3D;
  String SchoolObjectType3DName;.
  String SchoolObjectType3DDescription;
};

  Currently, the following choices are suggested for type and type name:
  10  = School as detected, uncorrected
  11  = School as detected, corrected
  40  = School kernel, uncorrected
  41  = School kernel, corrected
  100 = Echogram slice
```

## Description

This table contains code, name and description of school object type 3D.

## Parameters

- **SchoolObjectType3D** [-] - School calculation type code.
- **SchoolObjectType3DName** [-] - Name of school calculation type.
- **SchoolObjectType3DDescription** [-] - Description of school object type.

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolMorphology3D

# SchoolPosition3D

## Name

**SchoolPosition3D**

## Synopsis

```
struct SchoolPosition3D {
  short  Nation;
  short  Platform;
  int    Survey;
  int    Object3D;
  short  SchoolObjectType3D;
  int    Sequence;
  int    ObservationDate;
  int    ObservationTime;
  double SchoolLatitude;
  double SchoolLongitude;
  double SchoolDepth;
  double DistanceToVessel;
};
```

## Description

Position of object-centre. One entry for each observation.

## Parameters

- **Nation** - [-] Unique nation identification code. Refer to the Nation database table.
- **Platform** [-] - Unique platform (vessel) identification code. Refer to the Platform database table.
- **Survey** [-] - Unique survey identification code. See the *Survey* database table.
- **Object3D** [-] - Object identification number for 3D object. Refer to the Scatter database table for description od 2D objects.
- **SchoolObjectType3D** [-] - Code for 3D school object type. See ScatterType3D database table for description of types.
- **Sequence** [-] - Running sequence for measurements. Connects to SchoolMorphology3D database table.
- **ObservationDate** [YYYYMMDD] (UTC). - Connects to **Platform** (e.g. ship) position in **Observation** database table where each appurtenant field has the same value.
- **ObservationTime** [hhmmssxx] (UTC). - Connects to **Platform** (e.g. ship) position in **Observation** database table where each appurtenant field has the same value.
- **SchoolLatitude** [deg] - Latitude of school reference point (see below). (*NB! NOT position of measuring platform*).
- **SchoolLongitude** [deg] - Longitude of school reference point (see below).
- **SchoolDepth** [m] - Depth of school reference point. The school reference point is the school centre of gravity.
- **DistanceToVessel** [m] - Distance from vessel reference point (transducer) to school reference point (see above).

## Related topics

Database - PROMUS extension, Database

## Related database tables

SchoolMorphology3D

# Keyboard shortcuts

This is a summary of keyboard shortcuts in Promus. Some of the keystrokes can be seen in menus and tool tips.

## Promus ping

| Keystroke | Description |
|---|---|
| Home | Reset viewpoint |
| e | Exclude/include ping |
| g | Grow new school |
| s | Toggle school mask on/off |

## Promus slice

| Keystroke | Description |
|---|---|
| Home | Reset zoom |
| Arrow up | Navigate slice away from user |
| Arrow down | Navigate slice towards user |
| g | Grow new school |
| s | Toggle school mask on/off |
| x | Set slice in alongship mode |
| y | Set slice in athwartship mode |
| z | Set slice in horizontal mode |