This code is ultimately used to create a conversion factor from krill length frequencies to convert acoustic energy into density. It uses the Stochastic distorted wave born approximation (SDWBA) to calculate the target strength of Antarctic krill.

The CCAMLR Github site houses versions of the SDWBA Matlab code.

[ccamlr/SDWBA\_TS: Stochastic distorted wave born approximation (github.com)](https://github.com/ccamlr/SDWBA_TS)

This code was from the Sub-group on Acoustic Survey and Analysis Methods (SG-ASAM) of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) during a meeting in Cambridge, UK June 2010. The full process of what was done can be read about from the meeting report. This is just a part of that process. The survey area was in the Scotia Sea.

The descriptions of the steps below are adapted from the document “About the SG-ASAM-2010 archieve.docx”

**SDWBA Step**

The SDWBA model was run (100 stochastic iterations) for mean in shape and density parameters (from Table 3.2, SG-ASAM-09 report) to generate initialisation file SDWBATS\_res0 (mean parameters). The model runs were over 12 frequencies (38, 70, 120, 200, 333, 67.5, 125, 74, 82, 91, 99, 108 kHz) and a range of krill lengths from 10 to 65 mm to generate full model to run the inversion process over. The file ProcessKrillEupSDWBATS\_mlengthm.m was run. The output is in the folder ‘SDWBATS\_L1m\_’.

**Step 4 (Matlab script)**

This step uses a Matlab script (makeonefileofTS2.m) to generate a file of TS (at 38, 70, 120, 200, 333, 67.5, 125, 74, 82, 91, 99, 108 kHz) for each krill length 10 to 65 mm across all combinations of mean angle and standard deviation (T1-T9) between -45 and 45 degrees in 1 degree steps. TS\_length\_allOrients\_fin.mat is the output results.

**Step 5 (Matlab script)**

This step uses the Antarctic krill weighted length frequency distribution (from whole survey area of the CCAMLR 2000 survey) published in Siegel et al (2004) and detailed in excel file “Length density pdf used for inversion (Volker Figure 6).xls” to generate a text file (LF\_pdf\_clusters\_vweighted.txt) that is used to create multiple pdfs (across the range of mean and sd of orientation from CCAMLR\_step4run) of modelled Sv120-38 dB differences to compare with the observed (found in CCAMLR\_db\_freqs\_obs\_all.mat generated by CCAMLR\_step2run.m). The Matlab script (CCAMLR\_step5run.m) generates the file all\_db\_diffs\_calc\_Ldata\_fin.mat that contains the pdf of modelled dB differences (generated from the observed length frequency data) across the range of mean and standard orientations input in CCAMLR\_step4.

**Step 6 (Matlab script)**

The full SDWBA model was inverted in a least-squares sense to estimate the in situ distribution of orientations (mean and standard error) for all clusters weighted as per Siegel et al (2004) (Volker Figure 6). The mean and standard error of orientation was calculated using the Matlab script CCAMLR\_step6run.m which draws in CCAMLR\_db\_freqs\_obs\_all.mat from step 3 and all\_db\_diffs\_calc\_Ldata\_fin.mat from step 5 and runs a least squared analysis creating a figure that shows the best modelled dB window (2>Sv120-38>16)fit (based on the length frequency) distribution versus the observed dB window distribution. Create matlab file (CCAMLR\_orientations\_Ldata\_fin.mat) that contains T 1 to 9 as identifier of model used and column of mean and standard deviation of orientation for each run.

*From WG-EMM 11/20: The mean and standard deviation of the normal distributions of orientation for the least-squares estimate ranged from -45° to 45° and 1° to 50°, respectively, by 1° steps. Where a mean of 0° indicates krill in a horizontal position and a positive angle represents a head up position. Because the observed Sv data used in the inversion process were already averaged into 100s intervals (representing 50 pings) before calculating the orientation mean and standard deviation, the calculated standard deviation actually represents the standard error of orientations observed (SC-CAMLR-XXIX, Annex 5). This was converted to standard deviation accordingly by multiplying by the square root of the number of samples (i.e. √50). From this process the mean orientation of krill during the CCAMLR synoptic survey was estimated to be -20° with a standard deviation of 28°(N(-20°,28°)). The full SDWBA modelled TS at 38, 120 and 200 kHz, parameterised as detailed above, is given as a function of krill length in Figure 1.*

**Step 7 (Matlab script)**

This step uses a Matlab script (CCAMLR\_step7run) to generate Target Strength (T\_TS) at 38, 120, 200, 67, 70, 74, 82, 91, 99, 108, 120, 125, 120-38 and 200-120 Sv values for each krill length from 10 to 65 mm (TS\_krill\_length\_values\_alt\_fin.mat) for the derived mean and standard error of orientation.

Note: The std orientation estimated by the inversion process was the standard error. To convert to standard deviation, the angle derived in CCAMLR\_step6run is multiplied by sqrt(n) – where n is the number of pings per reset that the data were sampled from (i.e. 50). This is then used as the derived std orientation for deriving model parameters and krill length TS relationships. Creates a matlab file containing length (l) and the TS values for T1 to T9 for each of those length krill in the above 5 Sv values.

**Step 8 (Matlab script)**

This step uses a Matlab script (CCAMLR\_step8run.m) to derive Sv120-38 and Sv200-120 dB windows from the full model, where the length frequencies of krill, set to 10mm bin widths, were selected to include the range of lengths of krill that included >=95% of the krill pdf. These values were contained within the file LF\_pdf\_clusters\_10mm.csv. The dB windows were calculated as the minimum and maximum difference in dB across all the individual lengths. The script reads the csv file to set sizes then chooses min and max values of db values based on these size limits. Export file of T runs with min and max limits for 120-38 and 200-120 based on the 95% and 99% length frequency distributions. This then creates a matlab file all\_db\_windows\_10mm.mat for dB windows for all clusters for each permutation of model iteration and 95% length frequencies.

**Step 9 (Matlab script)**

This step derives Sv120-38 and Sv200-120 dB windows from the simplified model coefficients. These windows were achieved by running the script ProcessKrillEupSDWBATS.m, inputting the derived orientation and standard deviation and then using script CCAMLR\_step9run.m to determine the dB windows from the simplified coefficient. This step isn’t needs as we aren’t using the simplified SDWBA model.

**Matlab Step 10**

Conversion factors for the full model were derived by putting the krill length to TS relationship created in step 7 into the code used to calculate the conversion factors (calculate\_cf\_glider.m).

Step 10 is what you use in order to get out the conversion factors. Set the Antarctic krill length frequencies in a text file, like the “clusters123\_sizesCCAMLR\_1.txt.” It currently allows for three different length frequencies.