Sonar Equation and the problem of scattering (Previous homework):

$$EL=SL+ 10\log_{10}(PL) - 20\log_{10}(R)- 2\alpha R + Sv + RS$$

Where:
EL-Echo level
SL-Source level
PL-Pulse length
R-range between transducer and the measurement volume.
α-sound attenuation coefficient (dB/m).
Sv-volume scattering strength (dB).
RS-Receive sensitivity.

We can re-write this equation in terms of known and unknowns, and experss it as function of concentration:

$$EL=C_1 - 2Ra^*_p[conc] + 10\log_{10}[conc]=C_2 \times counts$$

↑

S_v

Two approaches:

I. Get rid of one constant by differencing two measurements:

$$-2R\alpha^*_p\{[conc]_2-[conc]_1\}+10\log_{10}\{[conc]_2/[conc]_1\}=C_2\{counts_2-counts_1\}$$

unknowns

Set a linear algebraic problem; for each difference of two measuremenst:

$$\begin{bmatrix} A & B \end{bmatrix} \begin{bmatrix} \alpha^*_p \\ C_2 \end{bmatrix} = b$$

Where $A=2R\{[conc]_2-[conc]_1\}$, $B=\{counts_2-counts_1\}$, and $b=10\log_{10}\{[conc]_2/[conc]_1\}$.

With this approach I get α^*_p=35.3dB/m and C_2=0.38 (unlike the manufacturer's 0.43)

Two approaches:

II. Solve equation directly, nonlinarly:

$C_1 - 2R\alpha^*_p[\text{conc}] + 10\log_{10}[\text{conc}] = C_2 \times \text{counts}$

By minimizing:

$\text{sum}\{\text{Counts-} \{C_1/C_2 - 2R\alpha^*_p[\text{conc}]/C_2 + 10\log_{10}[\text{conc}]/C_2\}\}^2$

→C_2=0.39dB/count, α^*_p=35.3dB/m