

Interactive comment on “About uncertainties in practical salinity calculations” by M. Le Menn

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Comment 1: I understand the meaning of your comment, but the measure made by the salinometer cell is, in a physical point of view, a conductivity measurement. The salinometer measures the resistance of the seawater between two electrodes and knowing the cell constant, it is performed as a conductivity value. In my mind, equations (1) and (2) describe really the conductivities measured respectively with the standard water and with the sample. Equation (4) gives the conductivity ratio (which is said to be measured) displayed by the salinometer and used to calculate the salinity. Then if you agree with this explanation, and if you think that the text of the publication is not enough detailed, I can add this explanation.

Comment 2: conductivity is strongly dependent on temperature. This is why, in situ conductivity sensors need to be corrected of the thermal mass effect. According to

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R. W. Schmitt et al. (2005), molecular diffusion of heat is 100 times faster than the diffusion of salt. Heat flux decrease viscosity of seawater and lead to higher mobility of ions which is measured as conductivity variations. This is why it is admitted (see R.G. Lueck, 1990) that electrical conductivity is dominated by temperature to about or at least 80 %. This can be proven by calculating the correlation coefficient (r) of conductivity with the corresponding temperature values for a given salinity.

Schmitt R. W., Millard R. C., Toole J. M., Wellwood W. D., 'A double-diffusive interface tank for dynamic-response studies', J. of Marine Res., 63, 263-289, 2005. Lueck R. G., 'Thermal inertia of conductivity cells: theory', J. of Atm. and Ocea. Tech., 7, 741-755, 1990.

Conductivity ratios are much less sensible to temperature. This is why salinometers are based on this principle, but the thermal stability of the cell must be well controlled between the adjustment of the cell conductivity ratio with standard seawater and the measures of seawater samples. The first part of these explanations and references can be added to the article if you hope it.

Comment 3: it is true that my formulation of the paragraph on uk15 assessment let foresee doubts about the results of Bacon et al. (2007) and on the value I have choose to assess uK15. I am confident in this value, this is why I have chose it, but I am enable to say where is the truth because the proofs given in the two publications are consistent, and I prefer to inform the readers of the existence of this publication. Then, I propose to modify the text in this way:

'uk15 has been estimated by S. Bacon et al., 2007. According to this paper, the expanded uncertainty of the standard seawater conductivity ratio has been found to be 1×10^{-5} with a coverage factor of 2 at the time of manufacture. This value includes the uncertainty due to the KCl quality used to prepare the reference conductivity according to S. Bacon et al.. In 2005, Kawano et al. had demonstrated in a publication (Kawano et al., 2005) that a default of quality could include an uncertainty of 0.001 on the value

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of the standard salinity S . As Bacon's publication is more recent and as this publication has not been refuted at this time, we will retain this value to estimate u_{k15} . The way in which this uncertainty has been calculated, leads to choose a Normal pdf to assess u_{k15} and then: $u_{k15} = 5 \times 10^{-6}$.

Comment 4: Seitz (2008) explanations on the exact meaning of 'long-term variations' are unclear, and might have been more explained, that's true. I don't think that the 'aging' and the lifetime of the SSW bottles have been assessed by the Euromet project, but more the impossibility by primary metrology laboratories to warrant the attachment of conductivity measurements to well known metrological standards to better than a few 0.01 in salinity. It doesn't prejudge of the long term variations of the SSW quality but of the impossibility to prove it in absolute. Taking into account the importance of this project, I can't forget to speak of it in a publication about uncertainties on practical salinity, but I accept to modify the formulation of this paragraph. Following the modification of 'comment 3', I'll write:

'It must be noted that the value 1×10^{-5} has been recently analysed by members of the Euromet project 918 (Seitz et al., 2008). According to Seitz et al., this uncertainty value quantifies the current capability of the standard seawater manufacturer to replicate the conductivity of the KCl solutions on the short term. This work doesn't quantify the effects of 'aging' and the lifetime of the standard seawater bottles and no value is given to quantify the long term variations (on several years or decades) in the production of KCl solutions. It fixes more, the limits of metrological standards in terms of long term traceability of the salinity, which is not taken into account in the usual use of salinometers. Then, in this assessment, we will consider only the results of S. Bacon et al.. The numerical results for $u_{c(Rt)}$ and U_S are given in tables 1 and 2.'

Comment 5: OK, will be corrected.

Comment 6: OK, the sentence will be replaced by: 'C(35, 15, 0) is a constant to which several values have been attributed'.

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Comment 7: The French LNE uses the same equipment and procedure that the other national standard agencies, but the LNE is used to present its results with a security margin to be sure to include all the possible cases of error. 1.2 mK is generally sufficient for industrial applications. Oceanography is nearly the only domain where this uncertainty can't be acceptable. I have explained this situation to a responsible of the temperature laboratory and she explained me that, since the end of 2009, the LNE temperature laboratory has a new organisation and this uncertainty will be reviewed for the scientific applications, but at this time, no new value has been given. The NIST gives the same level of uncertainty that the NPL but I don't know the uncertainty given by the German DKD laboratory. BIPM international inter-comparisons give generally standard deviations in the order or less than 0.1 mK for the primary Gallium melting points cells, but calibration of the secondary cells must include more the uncertainties of the standard thermometer used to fix their reference temperature by comparison. Then, to conclude, NPL and NIST are perhaps too much confident in their results and the LNE is not enough.

Comment 8: OK, will be corrected: ' $R_t = R/(R_1 \times R_P)$ ' instead of ' $R_t = R/R_1/R_P$ '.

Comment 9: OK.

Comment 10: OK, the 3D histogram will be replaced by the 2D histogram which is in the pdf attached file.

Interactive comment on Ocean Sci. Discuss., 6, 2461, 2009.

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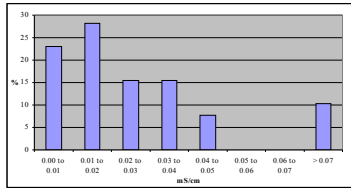


Fig. 1.

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