**Ocean Science
Discussions**

Interactive
Comment

Interactive comment on "Metrological traceability of oceanographic salinity measurement results" *by* S. Seitz et al.

Anonymous Referee #1

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The paper "Metrological Traceability of Oceanographic Salinity Measurements Results" by S. Seitz et al. opens the debate to the oceanographers community after the results obtained by Seitz et al. and exposed in 'Study on traceable determination of practical salinity and mass fraction of major seawater components', Accred. Qual. Assur, 15, 9-17, 2010, about the long term traceability of practical salinity calculations. It exposes also the links with absolute salinity and density measurements and the uncertainties which follow from this. It reminds the definition of absolute salinity and the different ways to approach this quantity by measurements. It reminds also the idea developed by Seitz et al. (2010) that practical Salinity is traceable to SI standards but with a degraded uncertainty compared to SSW-salinometers measurements and that stability of SSW can't be guaranteed on climatological timescales. Then, it shows how the link with SI references could be done without changing the instruments calibration procedures.

This paper is recommended for publication in Ocean Science, with, however, several corrections in section 3.

Section 2: reminds basic definition of the International vocabulary of metrology (that everybody can download from the BIPM Web site), in order to explain the processes they have started.

Section 3 : it is reminded lines 2-6, p 1311, that conductance Gsu and GsswU are measured with the same instrument and correlated by the cell constant K of the salinometer, but, in equation (5a) and (5b), this correlation doesn't appear as it might, following the recommendations of the GUM 2008. Could you explain why no cross terms appear in these expressions so that precisely, the measurement of the constant cell (at each different conductivity) is the way to realize absolute conductivity measurements as explained in the following paragraph?

I am not in accordance with the sentence which follows these equations p 1312, line 15, '... uncertainties are typically stated as standard uncertainties, i.e. related to normally distributed probability function...'. Probability functions of standards uncertainties can be rectangular, curvilinear... with different confidence levels, particularly in the case of salinometers. In order not to spread untrue ideas, could you correct this sentence?

The end of this paragraph, p 1313, lines 8-10, reminds Guildline documentation specifications: 'ratio using a Guildline 8400B salinometer is stated to be...better than +/- 0.002 at a Practical salinity of 35'. Does the +/- 0.002 is expressed as a standard or an expanded uncertainty? That might be explained. The paper 'About uncertainties in practical salinity calculation' of M. Le Menn 2009, under discussion in Ocean Science, shows that it can't be an expanded uncertainty for Portasal salinometers. Is it the same for Autosal?

p 1314, line 11, 'u(Gref), u(KKCl)/Km and u(KSSW)/Km account for sensitivity and stability of the measuring device...' : won't it be more the derivative terms in front of u(Gref), u(KKCl), u(KSSW) which account for the sensitivity and u(KKCl)/Km ,

u(KSSW)/Km ... are the respective contributions of the measuring device which take into account its stability?

Equations (6a), (6b), (6c) are true, but could be written perhaps in a more significant way: $u(G)^2 = G^2[(u(ïĄń)/ïĄń)^2 + (u(K)/K)^2]$

I don't agree with the CTD calibration procedure described after (p 1315): conductances are measured at various temperatures t but rarely at different salinities (line 6) for the simple reason that conductivity, which is the measured quantity, is strongly correlated to temperature and poorly to salinity and more, it is not very practical to have several bath with different salinities. More, (line 8-10) the conductivity calibration curves are fitted not to correlate the CTD conductance signal to the temperature and the Practical salinity as you say, but with reference conductivity values calculated by inverting Practical salinity relations, in order to linearise and correct the response curve of the conductivity sensor. Then, this paragraph might be corrected in your paper.

I don't agree also with relation (7) for two reasons :

1 - CTD Practical salinity is calculated, practically, with equations of the PSS-78 where G is not a defined variable. The first term of equation (7) can then be hardly calculated or, it needs explanations.

2 - C and t are variables strongly correlated so that C and p in a lesser way. These correlations do not appear in equation (7) as recommended by the GUM and more it lets appear that G, t and p are completely independent quantities. They are measured by independent sensors, but the results of these sensors measurements are introduced in PSS-78 relations where correlations appear. These correlations can increase or decrease the value of u(Sp).

The following paragraph doesn't reflect the exact procedure of CTD calibration for the first reason given before and several sources of errors are forgotten like the residual linearity error of the conductance sensor, the uncertainty on the reference thermome-

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ter used for the calibration. About the in situ CTD calibration, generally SCTD are compared to Ssamples. If drifts are detected, conductance sensor can be corrected by using Ssamples, the data of the pressure sensor and of a calibrated standard thermometer, by inverting PSS-78 relations.

Equation (8) doesn't reflect also the way in which uncertainties occur in CTD calibration and measurements. If calibration is made correctly, Sbath is nearly constant and measured at each temperature stage to calculate a reference conductivity, so that u(Sbath) as defined, has no real meaning. But, the temperature stability of the bath has a great importance during the stages, and that is not taken into account in your way to assess SP-cal.

CTD probes are not calibrated in S but in C, t, and p. So, u(Sfit) has no real meaning except in the case of in situ calibrations. As to u(SP), it occurs in reference conductivities calculations and not directly in the evaluation of u(SP-cal). u(SP-cal) depends also of the PSS-78 fitting uncertainty given by Perkin and Lewis (1980), and it must not be forgotten.

At the end, p 1316, line 8, Larson publication (1993) can't be found on Sea Bird web site nor in peer review literature. More, his evaluation can't be based on the GUM (1994) which is in contradiction with the goal of your paper. Then, it can't be given has a reliable reference even if his results are probably of a good quality.

Section 4 : I agree to the argument of paragraph 4.1, apart from the 0.002 (p 1318) which might be demonstrated before to give estimates of uncertainties on 5 or 50 years. More, it is probably less for SSW with S = 10 and more for S = 38.

Section 5 : p 1330, line 2, I think it miss a 'but' in the sentence: '...than Practical salinity or chlorinity, but it is nevertheless...

Section 6 : I approve the idea that density is the best quantity to measure and that it might be indicated on SSW bottles, but, p 1333, lines 25-27, this sentence is a little

bit in opposition with the ideas developed previously because conductivity sensors are enable to detect non-conducting molecules. As explained in the following paragraph, lines 28 to 12 page 1334, this proposal can be applied to SSW, but, I don't see how conductivity sensors could be properly calibrated to retrieve seawater density, so that non-conducting molecules amounts can be completely different between coastal and ocean waters for example. More, seawater conductivity is poorly correlated to density. Then, could you correct or precise this sentence, to know the way in which conductivity sensors could be used to make true density measurements, even with an SI-traceable calibration?

Interactive comment on Ocean Sci. Discuss., 7, 1303, 2010.