Response to RC4 (29 Sep 2017)

General comments

We appreciate the care taken in reviewing our work.

The impact of a densimeter zero-drift is more likely to be related to our previous publication on our substitution method and is negligible in case of regular densimeter maintenance. Therefore, in this publication, we suggest to provide such information in a reader-oriented way in the digital supplement and add a hint thereto in the method section.

Specific comments

Reviewer: Concerning the uncertainties at high pressure, the given explanations correspond to contain of the Metrologia's publication and they are clear, but the explanations on the relative density budget are less clear, so that the explanations of the paragraph 2.4. The calculation of seawater density relative to water, $\rho_{\text{mes}}^{\text{SW}} - \rho_{\text{mes}}^{\text{H}_2\text{O}}$, allows the subtraction of the linearity errors at $\rho_{\text{mes}}^{\text{SW}}$ and $\rho_{\text{mes}}^{\text{H}_2\text{O}}$, and the reduction of the errors, but if the adjustment is made with an uncertainty of 19 g m^{-3}, this uncertainty stays the same.

Authors: We are still not quite sure what exactly is being asked, therefore we give step-by-step feedback.

Reviewer: [..] but the explanations on the relative density budget are less clear, so that the explanations of the paragraph 2.4.

Authors: Are the explanations of the uncertainty budget in our previous publication referred to?

Reviewer: The calculation of seawater density relative to water, $\rho_{\text{mes}}^{\text{SW}} - \rho_{\text{mes}}^{\text{H}_2\text{O}}$, allows the subtraction of the linearity errors at $\rho_{\text{mes}}^{\text{SW}}$ and $\rho_{\text{mes}}^{\text{H}_2\text{O}}$, and the reduction of the errors, but if the adjustment is made with an uncertainty of 19 g m^{-3}, this uncertainty stays the same.

Authors: The uncertainty contribution from adjustment, more precisely that of the adjustment reference densities, to a relative density measurement on seawater with salinity 35 at 65 MPa is $\approx 9 \text{ g m}^{-3}$, which is less than 19 g m^{-3}, as the correlation coefficient has to be considered. Additionally, the uncertainty contribution of oscillating U-tube dimensions and material properties necessary for the adjustment model are considered by varying these quantities in the final adjustment equation. The uncertainty was therefore estimated conservatively. The uncertainty contributions are included in the relative density uncertainty given in the digital supplement and actually stay the same.

The uncertainty in the density–salinity relation was estimated as described in Appendix B. This suggested a maximum uncertainty of 6 g m^{-3} in the interpolation region. This is mainly a result of the very good ability to fit the data, as seen in Fig. 8 – although the relative density uncertainty is considered in the fitting process, the residuals are almost all within 6 g m^{-3}. This again may be a result of the conservative estimation of uncertainty, i.e. an overestimation of the uncertainty.

It should be noted that the positive deviation of TEOS-10 from the density–salinity relation for high pressures seen in Fig. 12 is significantly reduced, if the deviation found for atmospheric pressure is taken out.