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A modified algorithm for estimating Absolute Salinity in the global ocean

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In 2010, the Intergovernmental Oceanographic Commission (IOC), International Association for the Physical Sciences of the Ocean (IAPSO) and the Scientific Committee on Oceanic Research (SCOR) adopted the new Thermodynamic Equation of Seawater – 2010 (TEOS-10). One of the substantial changes from previous practice is the use of Absolute Salinity (g/kg) instead of Practical Salinity in TEOS-10. Since there is no sensor that can precisely measure Absolute Salinity in situ, an algorithm to estimate Absolute Salinity was provided along with TEOS-10. The algorithm exploits the correlation between the Absolute Salinity anomaly (dSA) relative to the Reference-Composition Salinity and the silicate concentration, making use of the global atlas of silicate concentrations, and the correlation coefficient is a function of latitude determined for each ocean basin (McDougall et al., Ocean Sci. Discuss., 6, 215-242, 2009). However, the dSA shows latitude dependent systematic discrepancy from dSA estimated from another model which exploits more precisely the correlation between dSA and nutrient concentrations and carbonate system parameters based on mathematical investigation (Pawlowicz et al., Ocean Sci., 7, 363-387, 2011). These two models for estimating dSA were evaluated using measured dSA with an oscillation-type density meter for the North Pacific, the Bering Sea, and the Arctic Ocean. The measured dSA agreed well with the estimates of the multi-parameter model. These results suggest that the algorithm for estimating dSA used in TEOS-10 have latitude dependent systematic biases ($\sim$0.01 g/kg), probably due to systematic biases in density data used. To minimize these systematic biases, a simple relationship between dSA and silicate concentration was determined for the global ocean, regardless of latitude dependency, by combining previously used and newly obtained density data. For the surface water of the Arctic Ocean, however, dSA is related with alkalinity by the input of river waters. Therefore, a correction term for alkalinity, which was approximated by Practical Salinity, was added to the algorithm for estimating dSA for the Arctic Ocean. This modified model for estimating dSA was compared with the multi-parameter model by using high-quality water sampling data in the global ocean collected by World Ocean Circulation Experiment (WOCE), reoccupation of WOCE, and the R/V Mirai cruise in the Arctic Ocean. Standard deviation (0.0014 g/kg) of difference between the two models was considerably smaller than standard deviation (0.0026 g/kg) of difference between the model of TEOS-10 and the multi-parameter model. To establish comparability in seawater density measurements, reference material for seawater density is being developed.