Development of Absolute Salinity measuring tequnique

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Conductivity sensor is widely used for seawater salinity measurement around the world. Salinity measurement by conductivity assumes that composition of the dissolved material in seawater is constant around the world ocean. However, some non-ionic species (such as silicate) or river water may cause discrepancy between salinity (Practical Salinity) determined by conductivity sensor and actual salinity (Absolute Salinity): e.g. the difference is about 0.02 g/kg for deep water in the Pacific Ocean. The thermodynamic properties of seawater have been re-defined as the International Thermodynamic Equation of Seawater –2010 (TEOS-10) in 2009 after the passage of thirty years, and a simple algorithm for estimating Absolute Salinity anomaly which is difference between Absolute Salinity and Practical Salinity (Reference-Composition Salinity for more exactly) is adopted as a practical method. Absolute Salinity anomaly can be mainly represented by silicate, nitrate, total alkalinity and dissolved inorganic carbon. The simple algorithm for estimating Absolute Salinity anomaly uses silicate concentration because those properties related to Absolute Salinity anomaly change often correlatively in the ocean and relatively many data are available for silicate in the world ocean. However, the error of the simple algorithm may be large for seawater affected largely by river water such as surface water of the Arctic Ocean, and the algorithm can’ t estimate time variation of Absolute Salinity anomaly such as the increase of dissolved inorganic carbon in the ocean by anthropogenic carbon emissions since it used climatological mean field of silicate concentration. To solve this problem, a method to measure Absolute Salinity directly and precisely in the ocean is developed by using a sound velocimeter. Instead of determining salinity as a function of conductivity, temperature and pressure, it is possible to calculate Absolute Salinity as a function of sound speed, temperature and pressure with a resolution of 0.001 g/kg, but uncertainty of thus estimated Absolute Salinity is quite large (about 0.04 g/kg near the surface and 0.4 g/kg at 6000 m depths) for practical use due to error of sound velocimeter and the equation of sound speed for seawater. Therefore, the estimated Absolute Salinity need to be corrected in situ by using more precise Absolute Salinity data measured for discrete water samples by a vibrating tube densitometer with a resolution of 0.0013 g/kg. A vibrating tube densitometer is usually calibrated with a pure water measurement to agree with density calculated from the equation of state of water. However, seawater density measured by the vibrating tube densitometer may have a non-negligible error due to nonlinearity of the densitometer. Therefore, density of standard seawater is determined with a traceability to the International System of Units (SI units) based on a hydrostatic weighing method, a primary method of density measurement, and the standard seawater is used to calibrate the vibrating tube densitometer. They give the in situ measurement system of Absolute Salinity.

Keywords: Absolute Salinity, Sound speed, Density

