3.3.2 Salinity measurements

(1) Personnel

Ryosuke Makabe (NIPR)
Shintaro Takao (NIPR)
Keishi Shimada (TUMSAT)
Shinsuke Toyoda (MWJ)
Yasuhiro Arii (MWJ)
Keitaro Matsumoto (MWJ)

(2) Objective

To provide calibrations for the measurements of salinity collected from CTD and underway surface water monitoring (TSG).

(3) Parameters

The specifications of the AUTOSAL salinometer are shown as follows;

Salinometer (Model 8400B "AUTOSAL"; Guildline Instruments Ltd.)
Measurement Range : 0.005 to 42 (PSU)
Accuracy : Better than ±0.002 (PSU) over 24 hours without re-standardization
Maximum Resolution : Better than ±0.0002 (PSU) at 35 (PSU)

(4) Instruments and Methods

a. Salinity Sample Collection

Seawater samples were collected with 8 liter Niskin bottles, bucket, and TSG. The salinity sample bottle of 250ml clear glass with inner cap was used for collecting the sample water. Each bottle was rinsed 3 times with the sample water, and was filled with sample water to the bottle neck. The bottles were stored for more than 24 hours in the laboratory before the salinity measurement.

Types and numbers (n) of the samples are shown in Table 3.3.2-1.

Table 3.3.2-1 Types and numbers (n) of samples

Types	N
Samples for CTD and bucket	138
Samples for TSG	20
Total	158

b. Instruments and Method

The salinity analysis was carried out on TR/V UMITAKA-MARU during the cruise of UM-16-08 using the salinometer (Model 8400B "AUTOSAL"; Guildline Instruments Ltd.: S/N 59590) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.).

A precision digital thermometers (Model 1502A; FLUKE Corporation) were used for monitoring the bath temperature of the salinometer. A Thermo Recorder (TR-77Ui; T&D Corp.) was used for monitoring the ambient temperature of the laboratory.

The specifications of two thermometers are shown as follows;

Thermometer (Model 1502A ; FLUKE Corporation)
Measurement Range: -200 to +962 deg C
Resolution : 0.001
Accuracy : 0.006 deg C at 0 deg C

Thermo Recorder (TR-77Ui; T&D Corp.)
Measurement Range : -30 to +80 deg C
Resolution : 0.3 deg C (+10 to +40 deg C)
Limits of error ±deg C: ±0.1 deg C

The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. The ambient temperature varied from approximately 20 deg C to 24 deg C, while the bath temperature was very stable and varied within 23.990+/- 0.001 deg C on rare occasion..

The measurement for each sample was conducted with a double conductivity ratio. Data reading was started 5 seconds after filling the cell with the sample and it took about 11 seconds to determine the stable reading. Data were taken for the sixth and seventh filling of the cell after rinsing 5 times. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity with the algorithm for the practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. In the case of the double conductivity ratio of fifth filling did not satisfy the criteria above, the operator measured a ninth or tenth filling of the cell and calculated the bottle salinity above. The cell was cleaned with detergent after the measurement of the day.

(5) Results

a. Standard Seawater (SSW)

The specifications of SSW used in this cruise are shown as follows;

Batch : P159
conductivity ratio : 0.99988
salinity : 34.995
expiration date : 15th Dec 2018

Batch : P158
conductivity ratio : 0.99970
salinity : 34.988
expiration date : 25th Mar 2018

Standardization control of the salinometer S/N 59590 was set to 536 (5th Jan.), 563 (15st Jan.) at bath temperature of 24. The value of STANDBY was 5847 +/- 0001 at bath temperature of 24, and that of ZERO was 0.0-0000 +/- 0001 on rare occasion. 9 bottles of SSW were measured.

Fig.3.3.2-1 shows the time series of the double conductivity ratio of the Standard Seawater batch P159

before correction. The average of the double conductivity ratio was 1.99965 and the standard deviation was 0.00007, which is equivalent to 0.0013 in salinity.

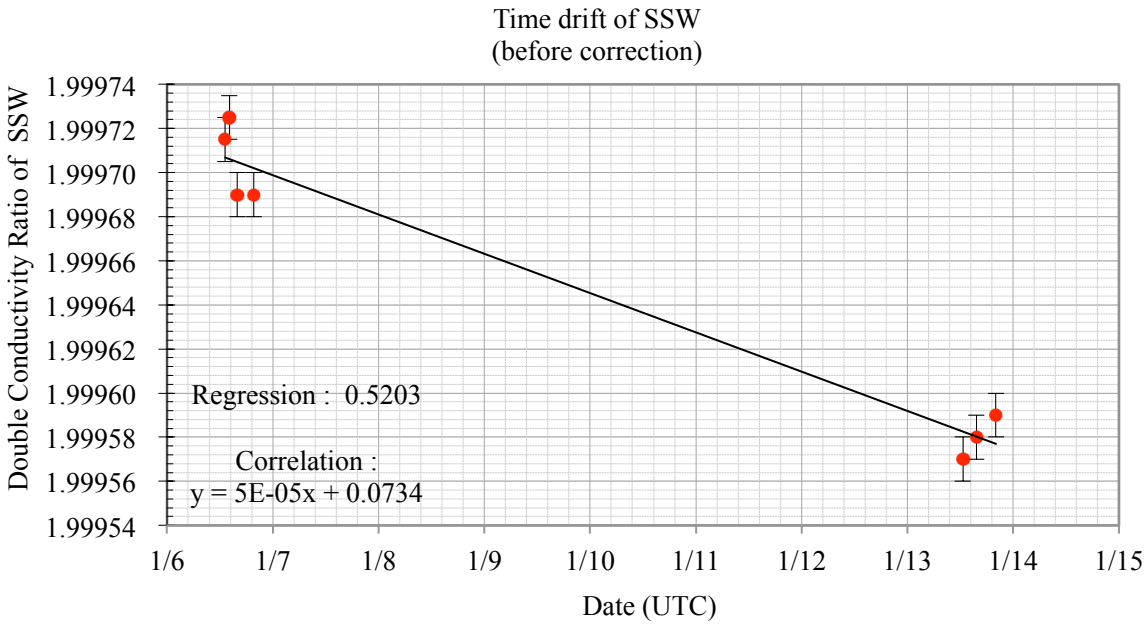

Fig. 3.3.2-1 Time series of double conductivity ratio for the Standard Seawater batch P159 (before correction)

Fig.3.3.2-2 shows the time series of the double conductivity ratio of the Standard Seawater batch P159 after correction. The average of the double conductivity ratio after correction was 1.99976 and the standard deviation was 0.000002, which is equivalent to 0.0000 in salinity.

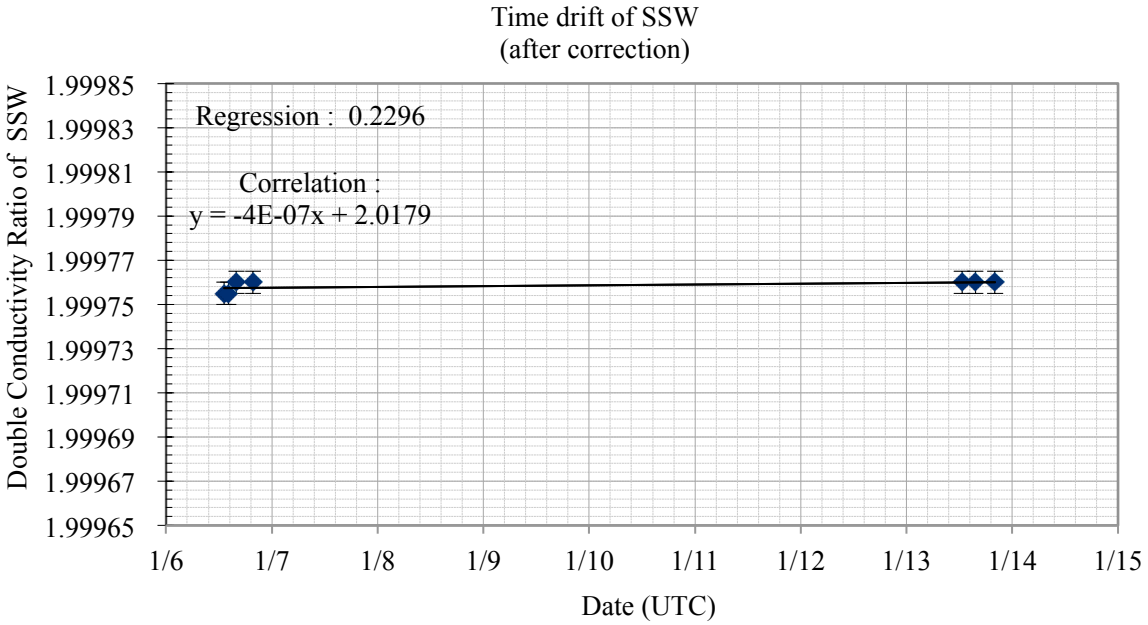

Fig. 3.3.2-2 Time series of double conductivity ratio for the Standard Seawater batch P159 (after correction)

Fig.3.3.2-3 shows the time series of the double conductivity ratio of the Standard Seawater batch P158 before correction. The average of the double conductivity ratio was 1.99941 and the standard deviation was 0.00004, which is equivalent to 0.0009 in salinity.

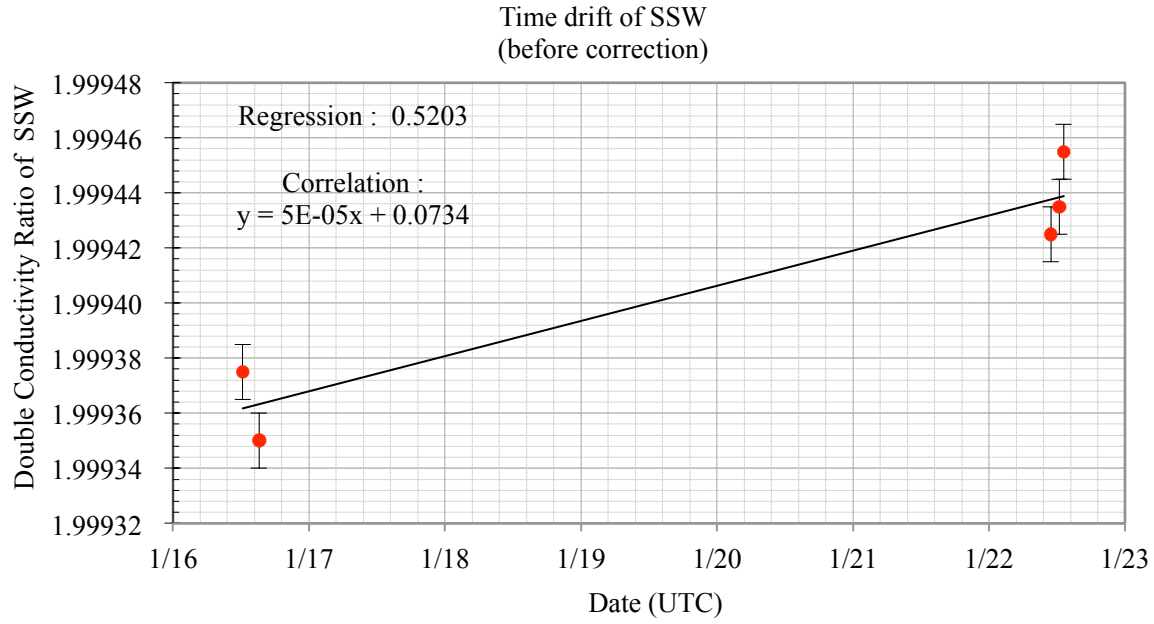

Fig. 3.3.2-1 Time series of double conductivity ratio for the Standard Seawater batch P158 (before correction)

Fig.3.3.2-4 shows the time series of the double conductivity ratio of the Standard Seawater batch P158 after correction. The average of the double conductivity ratio after correction was 1.99940 and the standard deviation was 0.00000, which is equivalent to 0.0000 in salinity.

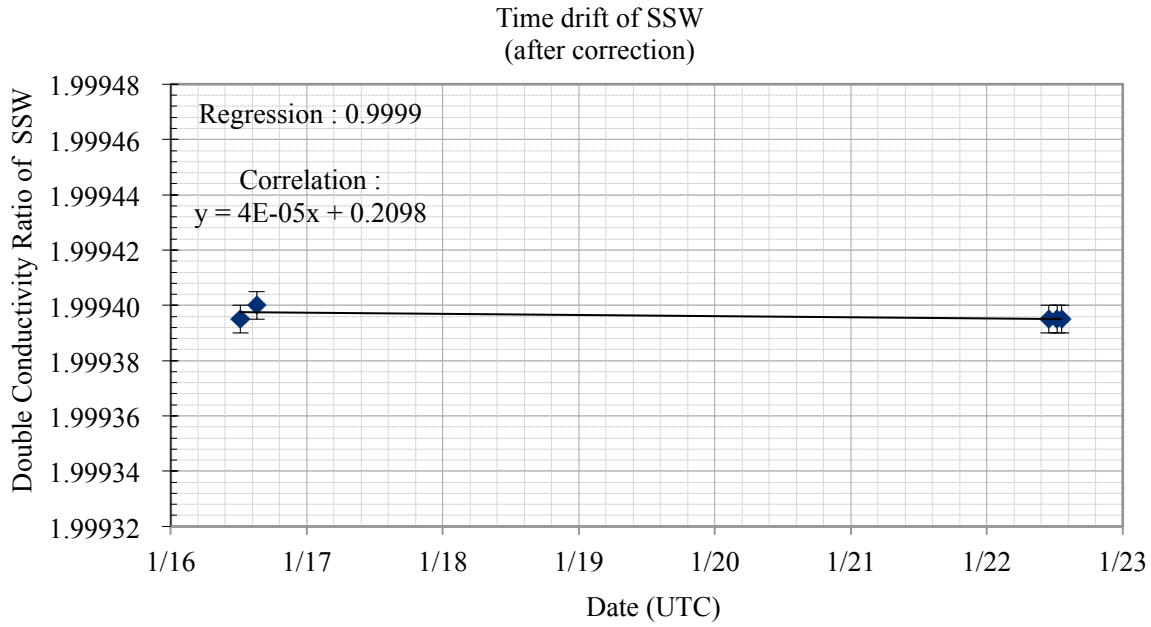

Fig. 3.3.2-4 Time series of double conductivity ratio for the Standard Seawater batch P158 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from sea water filtered and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured between every about 6 or 10 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

The precision of this method was estimated by using 19 pairs of replicate samples taken from the same Niskin bottle.

Fig.3.3.2-5 shows the histogram of the absolute difference between each pair of replicate samples. The average and the standard deviation of absolute difference among 19 pairs were 0.00046 and 0.00047 in salinity, respectively.

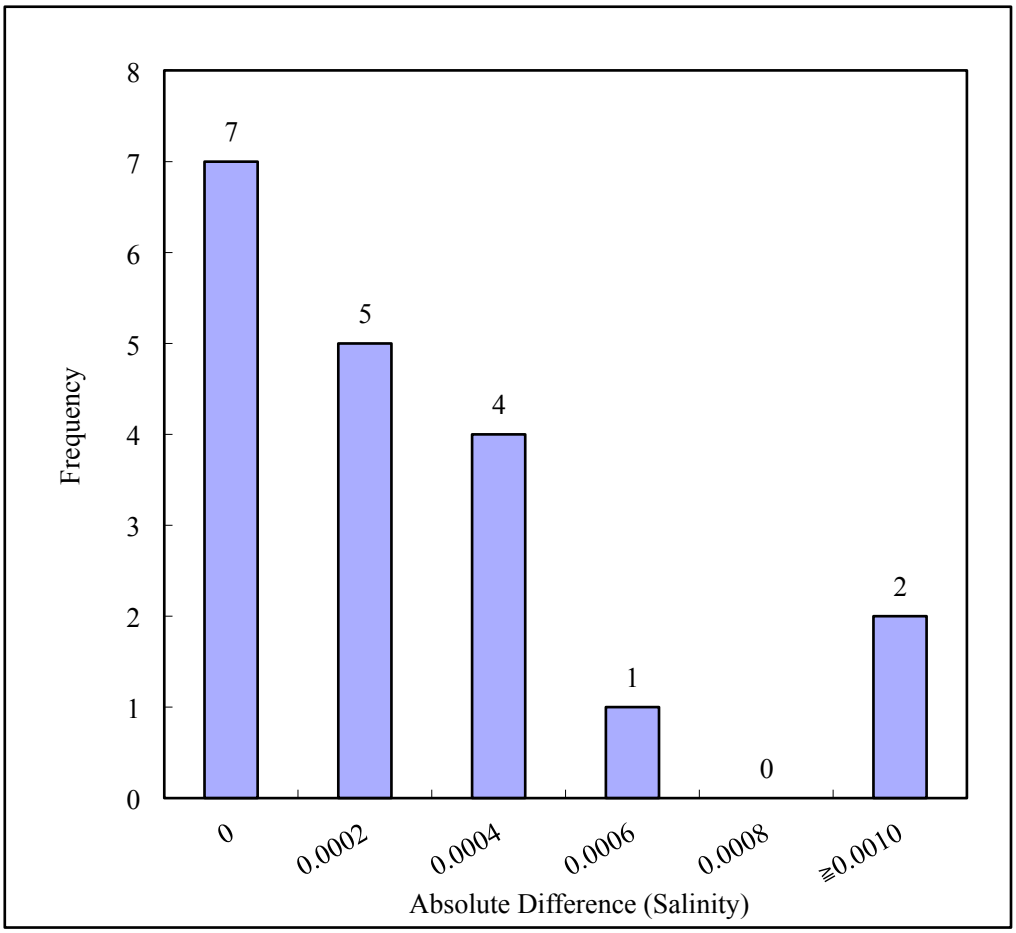

Fig. 3.3.2-5 Histogram of the Absolute Difference between Replicate Samples

d. Data Correction for Samples

All data were corrected according to the result of the offset correction for SSW.

(6) Data archives

a. Data set

All data will be quality checked again after this cruise and all data flag will be revised.

b. Citation

・UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981