KESS 2006

R/V Melville, MGLN04MV

1 June 2006 - 5 July 2006

Yokohama, Japan - Yokohama, Japan

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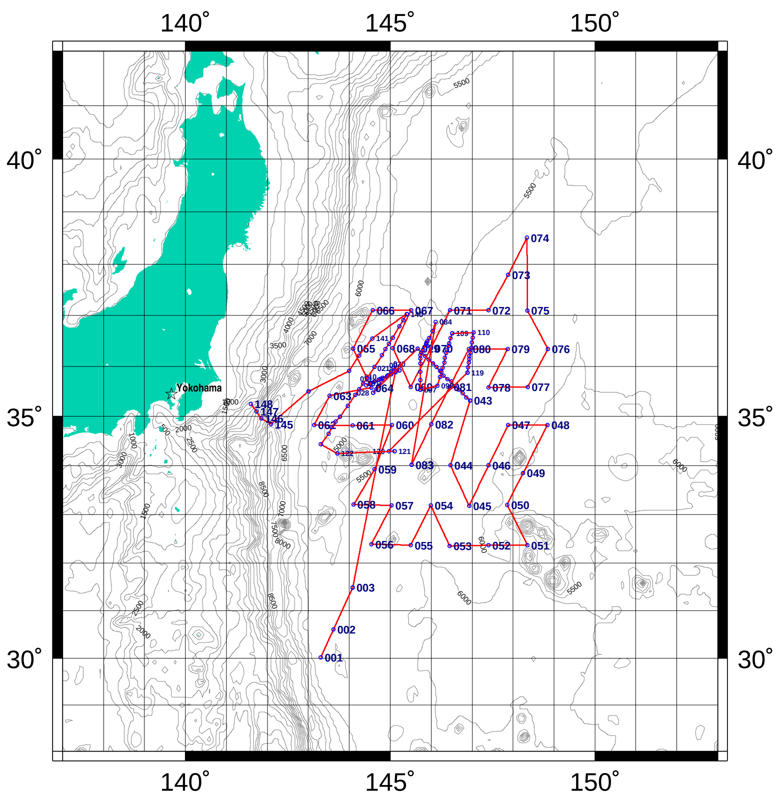

Preliminary Cruise Report
28 June 2006

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Summary

A hydrographic survey consisting of CPIES mooring recoveries, CTD/rosette and ADCP sections and drifter deployments was carried out in the Northwestern Pacific June-July 2006. The R/V Melville departed Yokohama, Japan, on 1 June 2006. A total of 45 CPIES moorings were recovered, 149 CTD stations were occupied, 5 drifters and 15 XBTs deployed from 1 June to 4 July. The cruise ended in Yokohama, Japan on 5 July, 2006.

1. Description of Measurement Techniques

CTD measurements consisted of pressure, temperature, conductivity and fluorometer sensor measurements plus salinity check samples taken from rosette bottles for conductivity sensor calibration. A total of 149 CTD casts were made, 29 of these to within 20 meters of the bottom. No major problems were encountered during the operation.

1.1. Water Sampling Package

CTD casts were performed with a package consisting of a 12-bottle rosette frame (ODF), a 12-place carousel (SBE32) and 12 10-liter bottles (ODF). Underwater electronic components consisted of a Sea-Bird Electronics SBE9*plus* CTD (ODF #381) with dual pumps, dual temperature (SBE3), dual conductivity (SBE4) an SBE35RT Digital Reversing Thermometer, a SeaTech fluorometer and a Simrad 807 altimeter.

The CTD was mounted in an SBE CTD cage attached to the center bottom of the rosette frame under the carousel. The SBE3 and SBE4 sensors and their respective pumps were mounted vertically as recommended by SBE. Pump exhausts were attached to outside corners of the cage and directed downward. The SBE35RT temperature sensor was mounted vertically and equidistant between the T1 and T2 intakes. The fluorometer was mounted horizontally to one side of the CTD cage. The altimeter was mounted on the inside of a support strut adjacent to the bottom frame ring.

The rosette system was suspended from a UNOLS-standard three-conductor 0.322" electro-mechanical sea cable. The R/V Melville's forward starboard-side CTD winch was used on all casts. A single seacable termination served for the entire cruise.

The deck watch prepared the rosette 5-15 minutes prior to each cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Once stopped on station, the rosette was unstrapped from its tie down location under the starboard squirt boom. Tag lines were threaded through the rosette frame. As directed by the deck watch leader, the CTD was powered up and the data acquisition system started. The syringes were removed from the CTD sensor intake ports. The deck watch leader directed the winch operator to raise the package, the boom and rosette were extended outboard and the package quickly lowered into the water. The tag lines were removed and the package was lowered to 10 meters, by which time the sensor pumps had turned on. The winch operator was then directed to bring the package back to the surface (0 winch wireout) and to begin the descent.

29 casts (20%) were lowered to within 20 meters of the bottom, and 3 other casts were made to 3000 meters. The rest of the casts were made to 1500 meters.

During the up cast the winch operator was directed to stop the winch at each bottle trip depth. The CTD console operator waited 30 seconds before closing a bottle to insure the package wake had dissipated and the bottles were flushed, then an additional 15 seconds after bottle closure to insure that stable CTD comparison data had been acquired. Once a bottle had been closed, the winch operator was directed to haul in the package to the next bottle stop.

Salinity samples were the only bottle samples collected and were only taken to calibrate the CTD conductivity sensors. The number of samples collected varied from cast to cast.

All bottles were removed from the rosette for casts 84/1-114/01 to facilitate rapid rosette deployments in the strong Kiroshio flow.

Recovering the package at the end of the deployment was essentially the reverse of launching, with the additional use of poles and snap-hooks to attach tag lines. The rosette was secured on deck under the block for sampling. The bottles and rosette were examined before samples were taken, and anything unusual noted on the sample log.

Routine CTD maintenance included soaking the conductivity sensors in fresh water between casts to maintain sensor stability and occasionally putting dilute Triton-X solution through the conductivity sensors to eliminate any accumulating biofilms. Rosette maintenance was performed on a regular basis. O-rings were changed and lanyards repaired as necessary. Bottle maintenance was performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced as needed.

Casts 1/1-3/1 had poor T2/C2 response due to a malfunctioning pump. Cast 50/1 was aborted at 1400 meters on the down cast due to shorted winch sliprings. Cast 73/1 had poor surface T2/C2 response during the down cast which was traced to a clogged bleeder valve on the secondary pump.

1.2. Underwater Electronics Packages

CTD data were collected with a SBE9*plus* CTD (ODF #381). This instrument provided pressure, dual temperature (SBE3), dual conductivity (SBE4), fluorometer (SeaTech) and altimeter (Simrad 807) channels. CTD #381 supplied a standard Sea-Bird format data stream at a data rate of 24 frames/second.

Sea-Bird SBE32 12-place Carousel Water Sampler S/N 487	
Sea-Bird SBE9*plus* CTD	#381
Paroscientific Digiquartz Pressure Sensor	S/N 58952
Sea-Bird SBE3*plus* Temperature Sensor	S/N 03P-4213 (Primary)
Sea-Bird SBE3*plus* Temperature Sensor	S/N 03P-2059 (Secondary)
Sea-Bird SBE4C Conductivity Sensor	S/N 04-3002 (Primary)
Sea-Bird SBE4C Conductivity Sensor	S/N 04-3023 (Secondary, 1/1-80/1)
Sea-Bird SBE4C Conductivity Sensor	S/N 04-3057 (Secondary, 81/1-149/1)
SeaTech Fluorometer	S/N FLCDRTD-428
Sea-Bird SBE35RT Temperature Sensor	S/N 3528706-0035
Simrad 807 Altimeter	S/N 98110

Table 1.2.0 KESS Rosette Underwater Electronics.

The CTD was outfitted with dual pumps. Primary temperature and conductivity were plumbed on one pump circuit and secondary temperature and conductivity on the other. The sensors were deployed vertically. The primary temperature and conductivity sensors (T1 #4213 and C1 #3002) were used for reported CTD temperatures and conductivities on all casts. The secondary temperature and conductivity sensors (T2 #2059 and C2 #3023 casts 1/1-80/1 and #3057 casts 81/1-149/1) were used for calibration checks.

The SBE9 CTD and the SBE35RT Digital Reversing Thermometer were both connected to the SBE32 12-place carousel providing for single-conductor sea cable operation. Two of the three sea cable conductors were connected together for signal and power, the other conductor was used for the return. Power to the SBE9 CTD, SBE32 carousel, SBE35RT and Simrad altimeter was provided through the sea cable from the SBE11*plus* deck unit in the main lab.

1.3. Navigation and Bathymetry Data Acquisition

Navigation data were acquired (at 1-second intervals) from the ship’s PCODE GPS receiver by one of the Linux workstations beginning June 1.

Swath bathymetric data from the ship’s multibeam (SeaBeam 2000) echosounder system were also acquired and processed by the R/V Melville’s underway system.

1.4. Real-Time CTD Data Acquisition System

The CTD data acquisition system consisted of an SBE-11*plus* (V2) deck unit and three networked generic PC workstations running Fedora Core Linux. Each PC workstation was configured with a color graphics display, keyboard, trackball and DVD+RW drive. One of the systems also had 8 additional RS-232 ports via a Comtrol Rocketport PCI serial controller. The systems were connected through a 100BaseTX ethernet switch, which was also connected to the Ship's network. These systems were available for real-time operational and CTD data displays, and provided for CTD and hydrographic data management and backup.

One of the workstations was used for the CTD console and was connected to the CTD deck unit via RS-232. The CTD console provided an interface and operational displays for controlling and monitoring a CTD deployment and closing bottles on the rosette.

CTD deployments were initiated by the console watch once the ship had stopped on station. The watch maintained a console operations log containing a description of each deployment, a record of every attempt to close a bottle and any pertinent comments. The deployment and acquisition software presented a short dialog instructing the operator to turn on the deck unit, examine the on screen CTD data displays and to notify the deck watch that this was accomplished.

Once the deck watch had deployed the rosette, the winch operator would begin the descent. The rosette was lowered to 10 meters, raised back to the surface then lowered. This procedure allowed the immersion-activated sensor pumps time to start and flush the sensors.

Profi ling rates were sometimes dictated by sea conditions but never exceeded 60m/minute.

The progress of the deployment and CTD data quality were monitored through interactive graphics and operational displays. Bottle trip locations were transcribed onto the console and sample logs. The sample log would later be used as an inventory of samples drawn from the bottles.

Bottles were closed on the up cast by operating an on-screen control. The winch operator was given a target wire-out for the bottle stop, proceeded to that depth and stopped. Bottles were tripped at least 30 seconds after stopping to allow the rosette wake to dissipate and the bottles to flush. The winch operator was instructed to proceed to the next bottle stop at least 10 seconds after closing a bottle to allow the SBE35R temperature sensor time to make a stable measurement.

After the last bottle was closed, the winch operator was directed to bring the rosette to the surface. Once on deck, the console watch terminated the data acquisition, turned off the deck unit and assisted with rosette sampling.

1.5. CTD Data Processing

The shipboard CTD data acquisition was the first stage in shipboard processing. The raw CTD data were converted to engineering units, filtered, response-corrected, calibrated and decimated to a more manageable 0.5 second time-series. The laboratory calibrations for pressure, temperature and conductivity were applied at this time. The 0.5 second time-series data were used for real-time graphics during deployments, and were the source for CTD pressure and temperature associated with each rosette bottle. Both the raw 24hz data and the 0.5 second time-series were stored for subsequent processing.

At the completion of a deployment a series of processing steps were performed automatically. The 0.5 second time-series data were checked for consistency, clean sensor response and calibration shifts. A 2 decibar pressure-series was then generated from the down cast. Both the 2 decibar pressure-series and 0.5 second time-series data were made available for downloading, plotting and reporting on the shipboard cruise website.

CTD data were routinely examined for sensor problems, calibration shifts and deployment or operational problems. The primary and secondary temperature sensors (SBE 3) were compared to each other and to the SBE35 temperature sensor. CTD conductivity sensors (SBE 4) were compared and calibrated by examining differences between CTD and check-sample conductivity values. Additional TS comparisons were made between down and up casts as well as with adjacent deployments. Vertical sections were made of the various properties derived from sensor data and checked for consistency.

Minor sea cable and slipring noise problems on this cruise did not significantly affect the CTD data, being filtered out during the data acquisition. No additional filtering was done on any of the CTD data.

The initial 10 M yo in each deployment resulting from lowering then raising the package to the surface to start the pumps was removed during the generation of the 2.0 db pressure-series.

Few CTD acquisition and processing problems were encountered during KESS 2006 . Casts 1/1-3/1 had problems with the secondary sensors that were traced to a malfunctioning secondary pump. Cast 50/1 was aborted at 1398 db on the down cast due to shorted winch sliprings. C2 developed an offset and began drifting on 81/1. It was replaced prior to 82/1. T1 and C1 exhibited response problems in the top 80 meters of the down cast on 113/1 which were traced to a clogged bleeder valve. The up cast data were used.

A total of 149 casts were made (including 1 aborted cast).

1.6. CTD Laboratory Calibration Procedures

Laboratory calibrations of the CTD pressure, temperature, conductivity and the SBE35RT Digital Reversing Thermometer sensors were performed prior to KESS. The calibration dates are listed in table 1.6.0.

Sensor	S/N	Calibration Date	Calibration Facility
Paroscientific Digiquartz Pressure	88952	15-March-06	SIO/ODF
Sea-Bird SBE3*plus* T1 Temperature	03P-4213	15-March-06	SBE
Sea-Bird SBE3*plus* T2 Temperature	03P-2059	15-March-06	SBE
Sea-Bird SBE4C C1 Conductivity	04-3002	01-March-06	SBE
Sea-Bird SBE4C C2 Conductivity	04-3023	01-March-06	SBE
Sea-Bird SBE4C C2 Conductivity	04-3057	01-March-06	SBE
Sea-Bird SBE35RT Digital Reversing Thermometer	3528706-0035	20-December-05	SIO/ODF

Table 1.6.0 KESS CTD sensor laboratory calibrations.

1.7. CTD Shipboard Calibration Procedures

CTD #381 was used for all KESS 2006 casts. The CTD was deployed with all sensors and pumps aligned vertically, as recommended by SBE. The primary temperature and conductivity sensors (T1 & C1) were used for all reported CTD data on all casts, the secondary sensors (T2 & C2) serving as calibration checks. The SBE35RT Digital Reversing Thermometer (S/N 3528706-0035) served as an independent calibration check for T1 and T2. *In-situ* salinity check samples collected during each cast were used to calibrate the conductivity sensors.

The variability of the environment that was observed on most deployments made sensor and check sample comparisons somewhat problematic. On many casts no deep check samples were collected and metrics of variability had to be inferred from sensor comparisons. The differences between primary and secondary temperatures were used as filtering criteria in these cases.

1.7.1. CTD Pressure

Pressure sensor conversion equation coefficients derived from the pre-cruise pressure calibration were applied to raw pressure data during each cast. No additional adjustments were made to the calculated pressures.

Residual pressure offsets (the difference between the first and last out-of-water pressures) were examined to check for calibration shifts. All were < 1.0db.

There was no apparent shift in pressure calibration during the cruise. This will be verified by a post-cruise laboratory pressure calibration.

1.7.2. CTD Temperature

Temperature sensor conversion equation coefficients derived from the pre-cruise temperature calibrations were applied to raw primary and secondary temperature data during each cast. Shipboard corrections to these calibrations were made during KESS 2006 .

Two independent metrics of calibration accuracy were examined. The primary and secondary temperatures were compared at each rosette trip, and the SBE35RT temperatures were compared to primary and secondary temperatures at each rosette trip.

The mean of differences between T1 and T2 was < 1.2 m° C over the cruise. Comparisons between each sensor and the SBE35RT verified that the sensors were stable and had minor (< 0.7m° C) offsets relative to their initial calibrations. T2 additionally exhibited a minor secondary pressure response characterized as a -1.8e-7 ° C/db slope. The final shipboard correction to reported T1 temperature is a -0.000861562° C offset. The comparisons of primary and secondary temperatures to the SBE35RT temperatures are summarized in figures 1.7.2.0 and 1.7.2.1. The residual differences between T1 and T2 are summarized in figure 1.7.2.2.

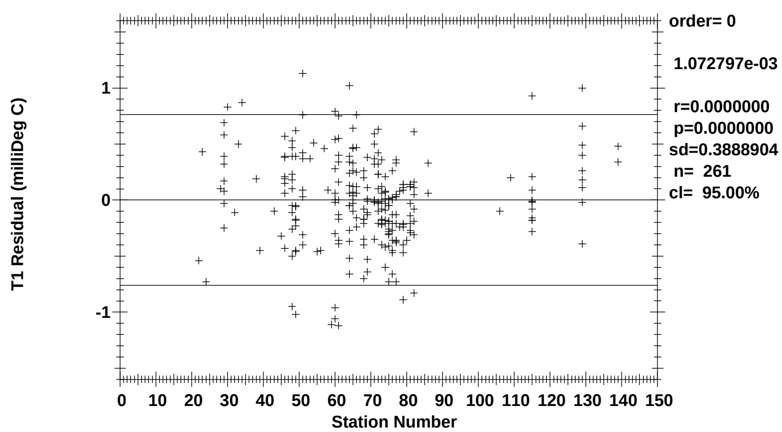

Figure 1.7.2.0 T1 and SBE35RT temperature differences by cast.

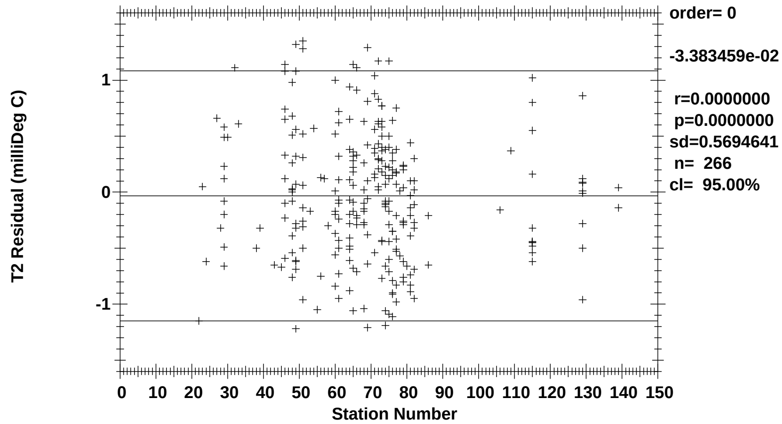

Figure 1.7.2.1 T1 and SBE35RT temperature differences by cast.

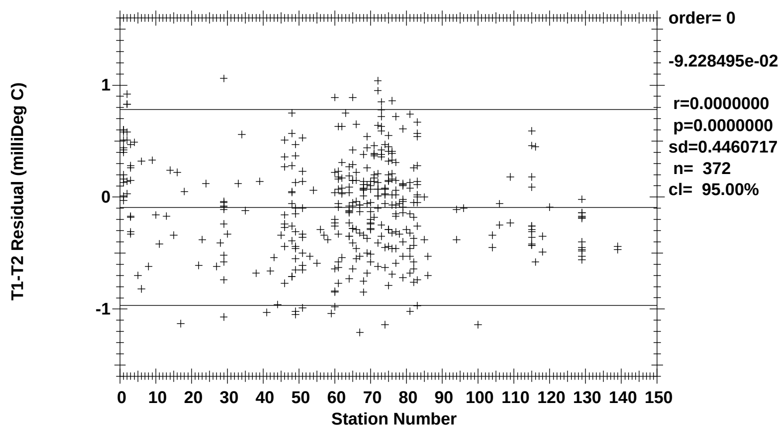

Figure 1.7.2.2 Primary and secondary temperature differences by cast.

1.7.3. CTD Conductivity

Conductivity sensor conversion equation coeffi cients were derived from the pre-cruise calibrations and applied to raw primary and secondary conductivity data during each cast. Shipboard corrections to these calibrations were made during KESS 2006 .

A single primary and two secondary conductivity sensors were used on KESS: C1 S/N 3002 was used for all casts, and was used for all reported conductivity data. C2 S/N 3023 was used on 1/1-81/1. C2 S/N 3057 was used on 82/1-149/1.

Comparisons between the primary and secondary sensors and between sensors and checksample conductivities were used to derive sensor corrections. The initial C1 and C2 calibrations were found to be consistent but 0.003 PSU high relative to both bottle salinities and CTD data collected in this area for the previous two years. The initial C2 (#3057) had response problems on 1/1-3/1 due to a malfunctioning pump. There were also response problems on 72/1-81/1 before its replacement. The second C2 drifted +0.0015mS/cm relative to C1 and bottle conductivities from 82/1 to 149/1. The residual differences between bottle conductivities and C1 are summarized in fi gure 1.7.3.0.

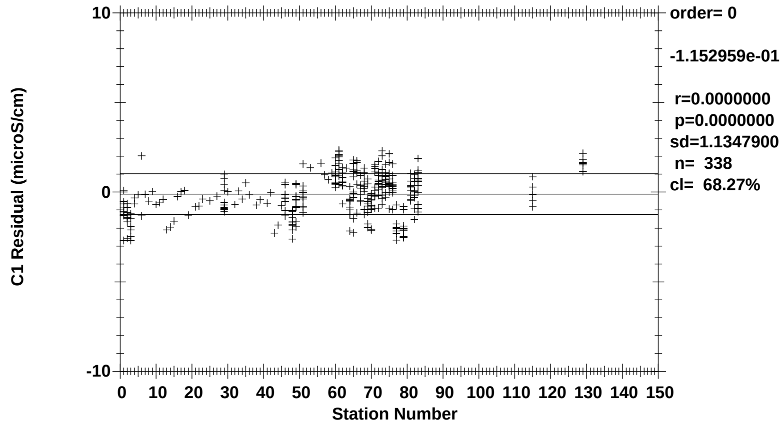

Figure 1.7.3.0 C1 conductivity residuals by cast.

The salinity residuals after applying the shipboard calibration are summarized in figures 1.7.3.1 and 1.7.3.2.

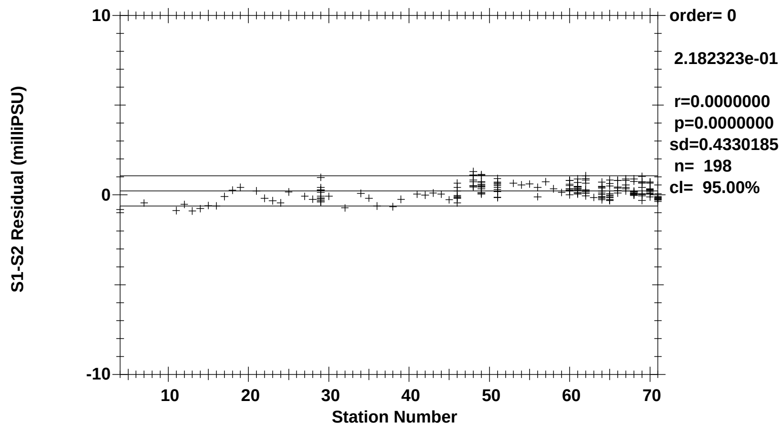

Figure 1.7.3.1 C1-C2 salinity residuals by cast, 4/1-72/1.

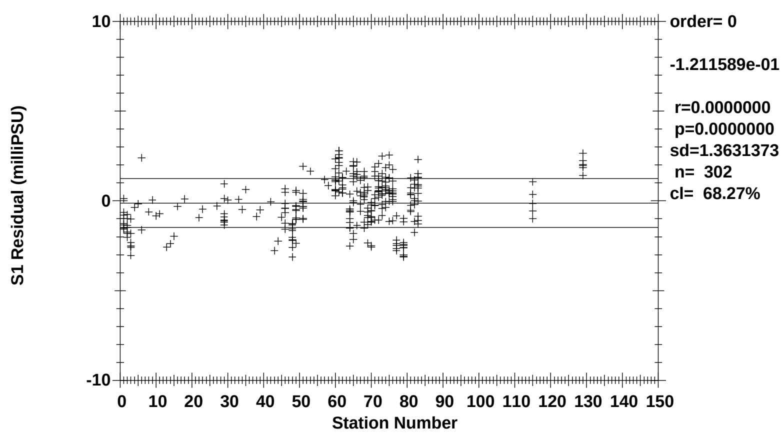

Figure 1.7.3.1 C1 salinity residuals by cast.

Figure 1.7.3.1 represents an estimate of the salinity accuracy of CTD #381. The 95% confidence limit is ±0.0015 PSU, in agreement with the generally accepted limit of repeatability for bottle salinities (±0.002PSU).

1.8. Bottle Data Processing

Water samples collected and properties analyzed shipboard were managed centrally in a relational database (PostgreSQL-8.0.8) run on one of the Linux workstations. A web service (OpenAcs-5.2.2 and AOLServer-4.0.10) front-end provided ship-wide access to CTD and water sample data. Web-based facilities included on-demand arbitrary property-property plots and vertical sections as well as data uploads and downloads.

The Sample Log (and any diagnostic comments) was entered into the database once sampling was completed. Quality flags associated with sampled properties were set to indicate that the property had been sampled, and sample container identifications were noted where applicable.

Various consistency checks and detailed examination of the data continued throughout the cruise.

1.9. Salinity Analysis

Equipment and Techniques

A single Guildline Autosal Model 8400A salinometer (S/N 48-266) located in the forward analytical lab was used for all salinity measurements. The salinometer was modified by ODF to contain an interface for computer-aided measurement. The water bath temperature was set and maintained at a value near the laboratory air temperature. It was set to 24° C for the entire leg.

Salinity analyses were performed after the samples had equilibrated to laboratory temperature, usually within 10-12 hours after collection. The salinometer was standardized for each group of samples in a run using at least one fresh vial of standard seawater per group. The control computer aided the analyst with functions such as changing, flushing, and reading a sample.

Sampling and Data Processing

Salinity samples were drawn into 200 ml Kimax high-alumina borosilicate bottles, which were rinsed three times with the sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Prior to collecting each sample, inserts were inspected for proper fit and loose inserts were replaced to insure an airtight seal. The sample draw time and equilibration time were logged for each cast. Laboratory temperatures were logged at the beginning and end of each run.

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference between the initial vial of standard water and one run at the end as an unknown was applied as a linear correction to the data to account for any drift. The data were incorporated into the cruise database. 402 salinity measurements were made.

Laboratory Temperature

The air temperature in the analytical laboratory varied from 21.2 to 24.8° C, during the cruise. The temperature change during any single run of samples was less than ±1.4° C.

Standards

Approximately 52 vials of IAPSO Standard Seawater were used, from 3 different batches: P144 (1/1-34/1), P145 (35/1-77/1) and P146 (83/1-129/1).

The estimated accuracy of bottle salinities run at sea is usually better than ±0.002 PSU relative to the particular standard seawater batch used.

References

UNES81.
UNESCO, “Background papers and supporting data on the Practical Salinity Scale, 1978,” UNESCO Technical Papers in Marine Science, No. 37, p. 144 (1981).