Cruise Report of the 2015 ARC01 US GEOTRACE/GO-SHIP

Release Draft 1

David Kadko

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CHAPTER

ONE

GEOTRACES HLY1502/GO-SHIP ARC01 2015 HYDROGRAPHIC PROGRAM

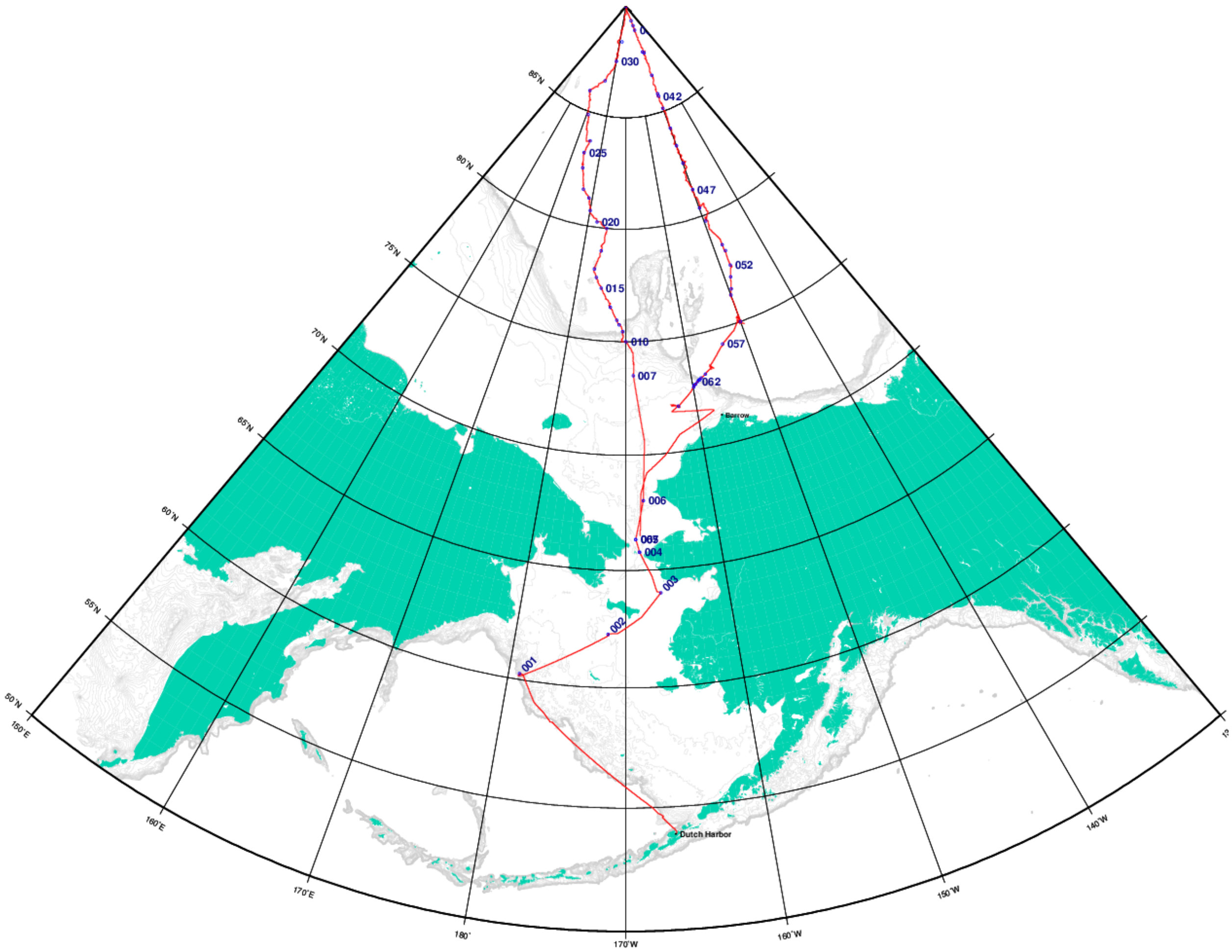

Fig. 1.1: Cruise track of HLY1502/Arc01

The US GEOTRACES and US Global Ocean Carbon and Repeat Hydrography Program performed the first Arctic collaboration cruise in the fall of 2015. The first collaboration and occupation of the repeat hydrographic line, Arc01 transect, also know as HLY1502, occurred on the United States Coast Guard Cutter Healy. The Healy, a class 4 icebreaker, departed August 9th, 2015 for the North Pole and returned October 12th, 2015 to the port of Dutch Harbor, Alaska.

This report is specific to the hydrographic aspect of the HLY1502 survey, which consisted of 66 stations, 147 casts between 3 different rosette/*CTDO* packages. The GEOTRACES rosette/CTDO package operated by *LDEO* consisted of a CTDO, 24-place rosette 12 liter GO-Flow bottles and performed 40 successful casts and 1 additional cast 048/06 that was not recorded. However, the hydrographic bottle data was preserved and reported for 048/06. The GEOTRACES package was used for stations 1-6, 8, 10, 12, 14, 19, 26, 30, 32, 38, 41, 43, 46, 48, 51-54, 56, 57, 60, 61 and 66. The second rosette/CTDO package managed and operated by both *STARC* and *SIO*/*ODF* teams, consisted of a CTDO, 12pl rosette 30 liter Bullister-style niskin bottles and performed 19 successful casts as seen in *12 Place Rosette Bottle Cross Section, 1-10 & 26*. The 12-place 30 L rosette was used for stations 1-10 and station 26. The final package was also managed and operated by *STARC* and term:*SIO*/*ODF*. This package consisted of a CTDO, *UVP*, 3 chipods, 36pl rosette, 10 liter Bullister-style niskin bottles and performed 87 successful casts as seen in *36 Place Rosette Bottle Cross Section, 11-25, 27-30 and 32* and *36 Place Rosette Bottle Cross Section, 34-38, 40-41 and 43-66*. The 36-place 10 L rosette was used for stations 11-25, 27-30, 32, 34-38, 40-41, and 43-66.

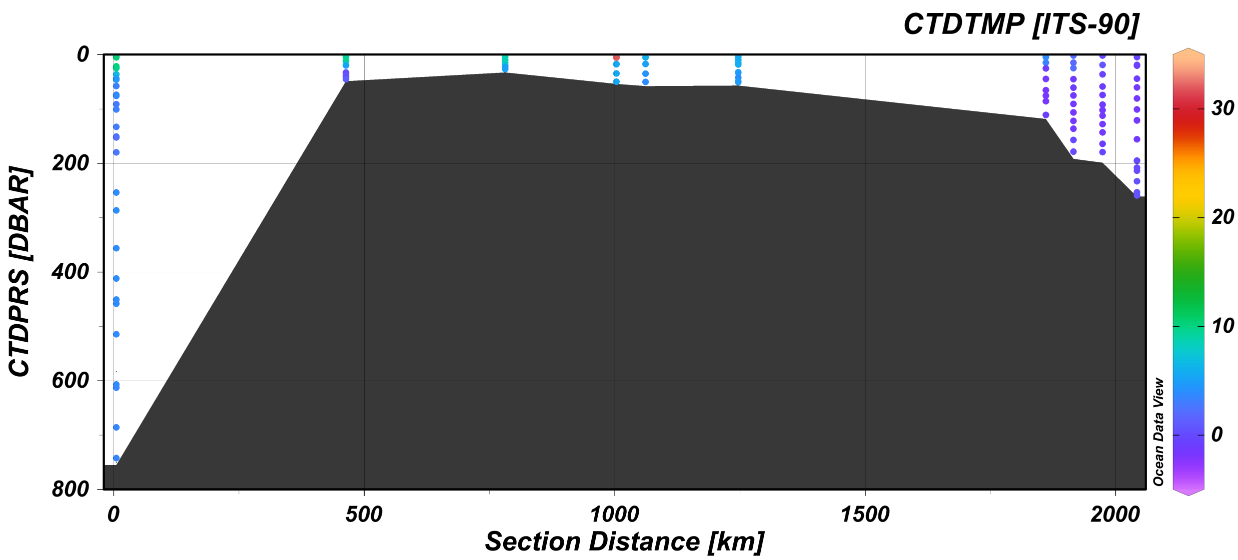

Fig. 1.2: 12 Place Rosette Bottle Cross Section, 1-10 & 26

Station 26 is not featured in the *12 Place Rosette Bottle Cross Section, 1-10 & 26* image.

CTDO data and water samples were collected on each CTDO, rosette cast. The following tables outline analysis performed from data collected on each rosette and the responsible parties involved.

1.1 LDEO Operated 24 Place Rosette Analysis & Science Teams

The following table outlines data collected and analyzed from the LDEO operated 24-place 12 liter rosette, the supporting institutions and principal investigators.

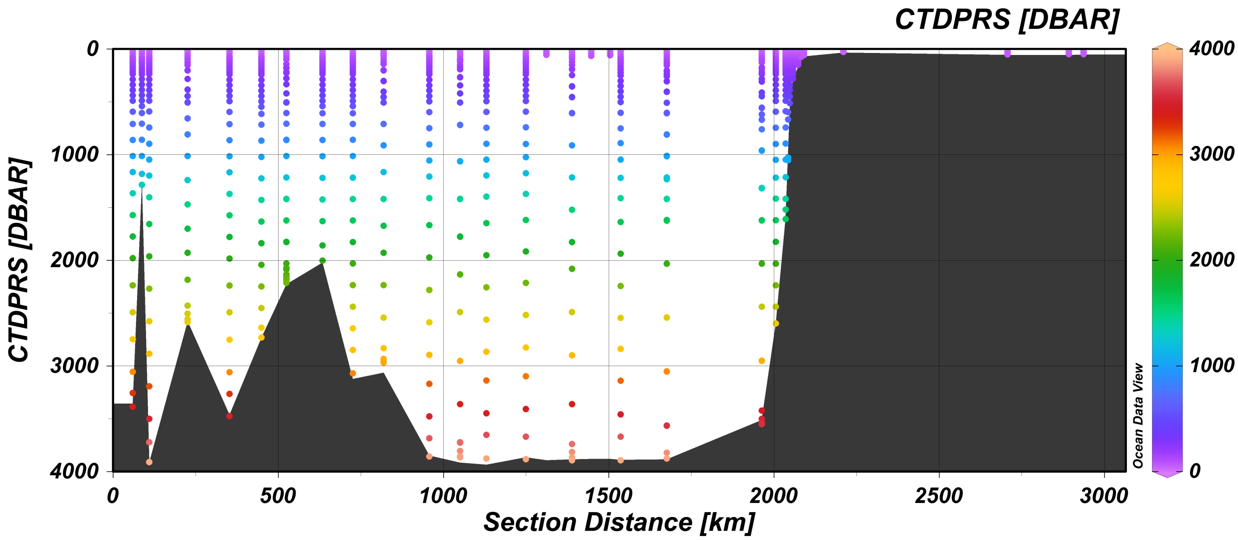

Fig. 1.3: 36 Place Rosette Bottle Cross Section, 11-25, 27-30 and 32

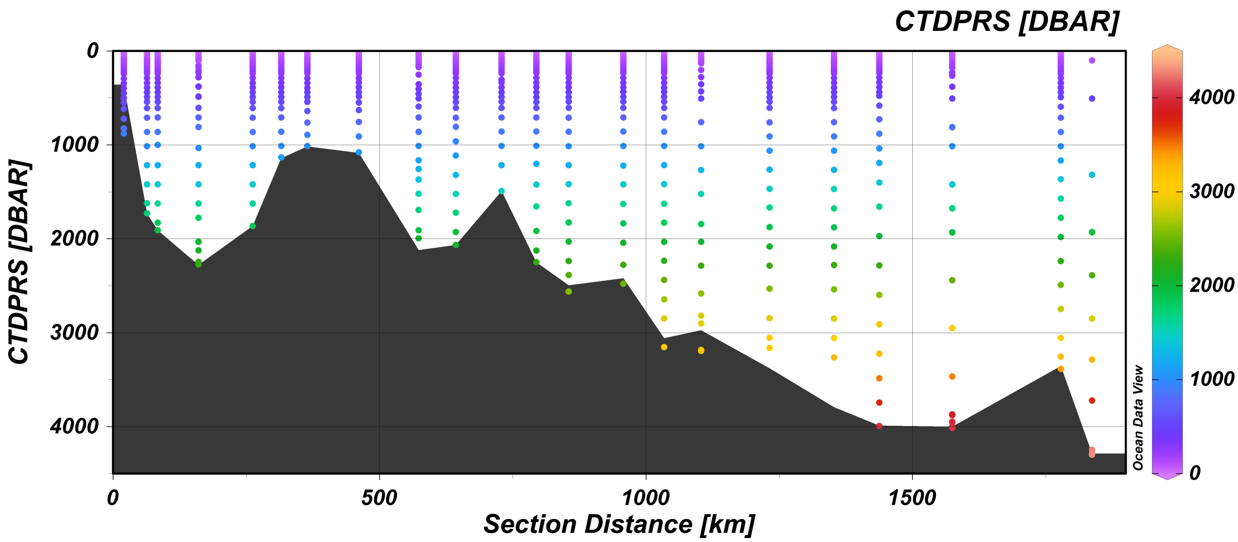

Fig. 1.4: 36 Place Rosette Bottle Cross Section, 34-38, 40-41 and 43-66

Program	Affiliation	Principal Investigator	Email
CTDO / Rosette Data, As, Se	*LDEO*	Greg Cutter	gcutter@odu.edu
Salinity, Nutrients	*SIO*	Jim Swift	jswift@ucsd.edu
Zn	*FSU*	Neal Wyatt, William Landing	mwyatt@fsu.edu, wlanding@fsu.edu
Co Speciation	*WHOI*	Mak Saito	msaito@whoi.edu
Dissolved Trace Metals/Colloids	*TAMU*, *Rutgers*	Jessica Fitzsimmons, Robert Sherrell	jessfitzsimmons@gmail.com, sherrell@marine.rutgers.edu
Fe Isotopes	*TAMU*, *USC*	Jessica Fitzsimmons, Seth John	jessfitzsimmons@gmail.com, sjohn@geol.sc.edu
Trace Metal Isotopes	*USC*	Seth John	sjohn@geol.sc.edu
Cr Isotopes, Cr(III)	*MIT*	Ed Boyle	eaboyle@mit.edu
Pb Isotopes	*UAF*, *MIT*	Rob Rember, Ed Boyle	rrember@iarc.uaf.edu, eaboyle@mit.edu
Th Isotopes	*LDEO*	Robert Anderson	boba@ldeo.columbia.edu
Ga, Ba, V, Mo	*USM*	Alan Shiller	alan.shiller@usm.edu
Fe, Mn, Al	*UH*	Mariko Hatta, Chris Measures	mhatta@hawaii.edu, chrism@soest.hawaii.edu
Hg Organic/Total/Colloids	*UCSC*	Carl Lamborg	clamborg@ucsc.edu
Fe(II)	*UCSC*	Maija Heller, Pheobe Lam	maijaheller@gmail.com, pjlam@ucsc.edu
Particulate/ Cellular Trace Metals	*Bigelow*	Benjamin Twining	btwining@bigelow.org
PIC/POC, Si Biological	*UCSC*	Pheobe Lam	pjlam@ucsc.edu

The following table outlines the shipboard science teams responsible for collecting and or analyzing data from the LDEO operated 24-place 12 liter rosette.

Duty	Name	Affiliation	Email Address
Chief Scientist	David Kadko	*FIU*	dkadko@fiu.edu
Co-Chief Scientist	William Landing	*FSU*	wlanding@fsu.edu
CTD, As, Se	Greg Cutter	*LDEO*	gcutter@odu.edu
As, Se	Zoe Wambaugh	*ODU*	zwanb001@odu.edu
GTC CTD	Kyle McQuiggan	*ODU*	kmcqu001@odu.edu
GTC CTD Data	Courtney Schatzman	term:*ODF*	cschatzman@ucsd.edu
Dissolved Trace metals/ Colloids, Fe Isotopes	Jessica Fitzsimmons	*TAMU*	jessfitzsimmons@gmail.com
Fe(II)	Majia Heller	*UCSC*	maijaheller@gmail.com
Fe, Mn, Al	Mariko Hatta	*UH*	mhatta@hawaii.edu
Fe, Mn, Al	Chris Measures	*UH*	chrism@soest.hawaii.edu
Ga, Ba, V, Mo	Laura Whitmore	*USM*	laura.whitmore@eagles.usm.edu
GTC Super Tech	Simone Moos	*MIT*	sbmoos@mit.edu
GTC Super Tech	Peter Morton	*FSU*	pmorton@fsu.edu
GTC Super Tech	Gabi Weiss	*UH*	weiss@hawaii.edu
GTC Management	Lisa Oswald	*OSU*	loswald@odu.edu
Hg Organics/Total/Coloids	Alison Agather	*Wright*	agather.2@wright.edu
Hg Organics/Total/Coloids	Katlin Bowman	*UCSC*	klbowman@ucsc.edu
Hg Organics/Total/Coloids	Carl Lamborg	*UCSC*	clamborg@ucsc.edu
Nutrients	Melissa Miller	*ODF*	melissa-miller@ucsd.edu
Nutrients	Susan Becker	*ODF*	sbecker@ucsd.edu
Pb Isotopes	Rob Rember	*UAF*	rrember@iarc.uaf.edu
Particuate/ Cellular Trace Metals	Sara Rauchenberg	*Bigelow*	srauchenberg@bigelow.org
PIC/POC, Si Biological	Pheobe Lam	*UCSC*	pjlam@ucsc.edu
PIC/POC, Si Biological	Yang Xiang	*UCSC*	yaxiang@ucsc.edu
Zn	Neal Wyatt	*FSU*	nwyatt@fsu.edu

1.2 SIO/ODF Operated 12 Place and 36 Place Rosette Analysis & Science Teams

The following table outlines data collected and analyzed from the SIO/ODF operated rosettes, the supporting institutions and principal investigators.

Program	Affiliation	Principal Investigator	Email
CTDO Data, Salinity, Nutrients, Dissolved O_2	*SIO*	Jim Swift, Susan Becker	jswift@ucsd.edu, sbecker@ucsd.edu
Total CO_2 (DIC), Total Alkalinity, pH, Density	*UM*, *RSMAS*	Frank Millero, Ryan Woosley	fmillero@rsmas.miami.edu, rwoosley@fsmas.miami.edu
^{3} He, ^{3} H, δ^{18}O	*LDEO*	Peter Schlosser	schlosser@ldeo.columbia.edu
CFCs, SF_6	*LDEO*	William Smethie, David Ho	bsmeth@ldeo.columbia.edu, ho@hawaii.edu
NO_3^-, δ^{15}N, δ^{18}O, NH_4^+, N_2 /Ar, N_2O, δ^{15}N-NH_3	*UCONN*, *UMASSD*	Julie Granger, Mark Altabet	julie.granger@uconn.edu, maltabet@umassd.edu
CH_4	*SMISS*	Alan Schiller	alan.shiller@usm.edu
^{13} C/^{14} C	*UW*	Paul Quay	pdquay@u.washington.edu
DOC	*RSMAS*	Dennis Hansell	dhansell@rsmas.miami.edu
Thiols	*UCSC*	Carl Lamborg	clamborg@ucsc.edu
Si Isotopes	*UCSB*	Mark Brzezinski	brzezins@lifesci.ucsb.edu
Th-Pa	*LDEO*	Robert Anderson	boba@ldeo.columbia.edu
Nd/Ree	*OSU*, *LDEO*	Brian Haley, Steve Goldstien	bhaley@coas.oregonstate.edu, steveg@ldeo.columbia.edu
Transmissometry	*TAMU*	Wilf Gardner	wgardner@ocean.tamu.edu
Chipod	*OSU*	Jonathan Nash	nash@coas.oregonstate.edu
UVP	*UAF*	Andrew McDonnell	amcdonnell@alaska.edu
STARC Support	*SIO*	Brett Hembrough	bhembrough@ucsd.edu

The following table outlines the shipboard science team responsible for collecting and or analyzing data from the SIO/ODF operated rosettes.

Duty	Name	Affiliation	Email Address
Chief Scientist	David Kadko	*FIU*	dkadko@fiu.edu
Co-Chief Scientist	William Landing	*FSU*	wlanding@fsu.edu
$^{13}C/^{14}C$, CH_4, $\delta^{15}N$-NH_3	Laura Whitmore	*USM*	laura.whitmore@eagles.usm.edu
CFCs, SF6, N_2 /Ar, N_2O	Eugene Gorman	*LDEO*	egorman@ldeo.columbia.edu
CFCs, SF6, N_2 /Ar, N_2O	Benjamin Hickman	*LDEO*	hickmanb@hawaii.edu
CFCs, SF6, ^3He, ^3H, $\delta^{18}O$, I-129	Angelica Pasqualini	*LDEO*	ap2776@columbia.edu
CTD Watchstander, Hydrographic Advisor	Jim Swift	*SIO*	jswift@ucsd.edu
CTD Watchstander, Dissloved O_2	Joseph Gum	*SIO*/*ODF*	jgum@ucsd.edu
CTDO Processing, Database Management	Courtney Schatzman	*SIO*/*ODF*	cschatzman@ucsd.edu
Dissolved O_2	Andrew Barna	*SIO*/*ODF*	abarna@gmail.com
DIC, pH, Total Alkalinity, Density	Ryan Woosley	*UM*, *RSMAS*	rwoosley@rsmas.miami.edu
DIC, pH, Total Alkalinity, Density	Fen Huang	*UM*, *RSMAS*	fhuang@rsmas.miami.edu.
DIC, pH, Total Alkalinity, Density, DOC	Andrew Margolin	*UM*, *RSMAS*	amargolin@rsmas.miami.edu
Nutrients, *ODF* supervisor	Susan Becker	*SIO*/*ODF*	sbecker@ucsd.edu
Nutrients	Melissa Miller	*SIO*/*ODF*	melissa-miller@ucsd.edu
NO_3^-, $\delta^{15}N$, $\delta^{18}O$, NH_4^+, Nd/Re, Th-P, Thiols, Si Isotopes	Martin Fleisher	*LDEO*	martyq@ldeo.columbia.edu
NO_3^-, $\delta^{15}N$, $\delta^{18}O$, NH_4^+, Nd/Re, Th-P, Thiols, Si Isotopes	Tim Kenna	*LDEO*	tkenna@ldeo.columbia.edu
Salinity	Ted Cumminsky	*SIO STS*	ted@ucsd.edu
STARC Tech, Chipod, UVP	Johna Winters	*OSU*	jwinters@coas.oregonstate.edu
STARC Tech, Chipod, UVP	Croy Carlin	*OSU*	carlincr@coas.oregonstate.edu
STARC Tech, Chipod, UVP	Brett Hembrough	*SIO STS*	bhembrough@ucsd.edu

1.3 Underwater Sampling Packages

CTDO/rosette casts were performed with 3 different rosette packages consisting of a 24-place 12 liter CTDO/rosette, a 12-place 30 liter CTDO/rosette, and a 36-place 10 liter CTDO/rosette/chipod/uvp rosette frame. The underwater electronic packages primarily consisted of a SeaBird Electronics pressure sensor and housing unit with dual exhaust, dual pumps, dual temperature, dual conductivity, dissolved oxygen, transmissometer, chlorophyll fluorometer and altimeter.

The temperature, conductivity, dissolved oxygen, respective pumps and exhaust tubing were mounted to the CTD and cage housing as recommended by SBE. The transmissometers were mounted horizontally. The fluorometers and altimeters were mounted vertically inside the bottom ring of the rosette frames.

LDEO 24-place 12 liter CTDO/rosette configuration was primarily the same for stations 1/1 - 46/5. The GEOTRACES package suffered an electronic failure due to on-deck over-exposure to the Arctic climate. The GTC CTDO deployments resumed after station 50 with the CTDO provided for by the Healy, CTD S/N: 638.

Equipment	Model	S/N	Cal Date	Sta	Resp Party
Rosette	24-place	12L	_	1/1-66/1	*LDEO*
CTD	SBE9+	888	_	1/1-46/9	*LDEO*
Pressure Sensor	Digiquartz	_	May 18, 2015	1/1-46/9	*LDEO*
CTD	SBE9+	638	_	48/1-66/1	*Healy*
Pressure Sensor	Digiquartz	83009	Feb 10, 2015	48/1-66/1	*Healy*
Primary Temperature	SBE3+	03P4817	May 27, 2015	1/1-46/9	*LDEO*
Primary Temperature	SBE3+	03P4789	May 08, 2015	48/1-66/1	*LDEO*
Primary Conductivity	SBE4C	04C3269	May 14, 2015	1/1-46/9	*LDEO*
Primary Conductivity	SBE4C	04C3270	May 14, 2015	48/1-66/1	*LDEO*
Secondary Temperature	SBE3+	03P4789	May 08, 2015	1/1-46/9	*LDEO*
Secondary Temperature	SBE3+	03P4817	May 27, 2015	48/1-66/1	*LDEO*
Secondary Conductivity	SBE4C	04C3270	May 14, 2015	1/1-46/9	*LDEO*
Secondary Conductivity	SBE4C	04C3269	May 14, 2015	48/1-66/1	*LDEO*
Transmissometer	Cstar	CST-1028DR	Jun 15, 2015	1/1-66/1	*LDEO*
Fluorometer Chloro	WetLabs	SCF-2933	_	1/1-66/1	*LDEO*
Primary Dissolved Oxygen	SBE43	431393	May 22, 2015	1/1-43/1	*LDEO*
Primary Dissolved Oxygen	SBE43	430458	Feb 24, 2015	46/6-66/1	*LDEO*
Carousel	SBE32	_	_	1-10, 26	*LDEO*

SIO/ODF 12-place 30 liter rosette configuration was the same general configuration as the LDEO rosette with the exception of a reference temperature sensor (SBE35RT). The reference temperature sensor was mounted between the primary and secondary temperature sensors at the same level as the intake tubes for the exhaust lines.

Equipment	Model	S/N	Cal Date	Sta	Resp Party
Rosette	12-place	30L	_	1-10, 26	*SIO/ODF*
CTD	SBE9+	638	_	1-10, 26	*SIO/ODF*
Pressure Sensor	Digiquartz	83009	Feb 10, 2015	1-10, 26	*SIO/ODF*
Primary Temperature	SBE3+	03P4213	May 12, 2015	1-10, 26	*SIO/ODF*
Primary Conductivity	SBE4C	04C3176	May 21, 2015	1-10, 26	*SIO/ODF*
Secondary Temperature	SBE3+	03P2165	May 14, 2015	1-10, 26	*SIO/ODF*
Secondary Conductivity	SBE4C	04C2036	May 21, 2015	1-10, 26	*SIO/ODF*
Transmissometer	Cstar	CST-1119DR	Apr 10, 2015	1-10, 26	*SIO/ODF*
Fluorometer Chloro	WetLabs	FLRTD-2050	_	1-10, 26	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	431129	May 16, 2015	1-10, 26	*SIO/ODF*
Biospherical PAR	QCP2300-HP	70444	Jun 22, 2015	1-10, 26	*SIO/ODF*
Carousel	SBE32	_	_	1-10, 26	*SIO/ODF*
Referense Temperature	SBE35	350034	Jan 15, 2014	1-10, 26	*SIO/ODF*

SIO/ODF 36-place 10 liter rosette configuration included additional instrumentation. UVP and chipods were deployed with the CTD/rosette package and their use is outlined in sections of this document specific to their titled analysis. The reference temperature sensor was mounted between the primary and secondary temperature sensors at the same level as the intake tubes for the exhaust lines.

Equipment	Model	S/N	Cal Date	Sta	Resp Party
Rosette	36-place	10L, Yellow	_	11-25, 27-32, 34-66	*SIO/ODF*
CTD	SBE9+	831	_	11-25, 27-32, 34-66	*SIO/ODF*
Pressure Sensor	Digiquartz	99676	Feb 6, 2015	11-25, 27-32, 34-66	*SIO/ODF*
Primary Temperature	SBE3+	03P2166	May 21, 2015	11-25, 27-32, 34-66	*SIO/ODF*
Primary Conductivity	SBE4C	04C3023	May 21, 2015	11-25, 27-32, 34-66	*SIO/ODF*
Secondary Temperature	SBE3+	03P4226	May 14, 2015	11-25, 27-32, 34-66	*SIO/ODF*
Secondary Conductivity	SBE4C	04C3057	May 21, 2015	11-25, 27-32, 34-66	*SIO/ODF*
Transmissometer	Cstar	CST-327DR	Jun 3, 2015	11-25, 27-32, 34-66	*TAMU*
Fluorometer Haardt Yellow	Haardt		_	11-25, 27-32, 34-66	Rainer
Seapoint Fluorometer	SCF	SCF3004	_	11-25, 27-32, 34-66	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	431138	Apr 18, 2015	11-25, 27-32/8	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	430848	May 16, 2015	34-37, 38/8, 41/1	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	430875	May 16, 2015	38/2-38/4, 40,43-57/1	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	430459	Feb 21, 2015	57/2-58/1	*SIO/ODF*
Primary Dissolved Oxygen	SBE43	430456	Feb 21, 2015	59-66/2	*SIO/ODF*
RINKOIII Optode	ARO-CAV	143	Jun 23, 2014	11-25, 27-32, 34-66	*SIO/ODF*
Biospherical PAR	QCP2300HP	70444	Jun 22, 2015	28-32, 34-66	*SIO/ODF*
Benthos Altimeter	PSA-916	1184	_	11	*SIO/ODF*
Tritech Altimeter	LRPA200	_	_	12-26, 27-32, 34-66	*SIO/ODF*
Carousel	SBE32	_	_	11-25, 27-32, 34-66	*SIO/ODF*
Referense Temperature	SBE35	350035	Jan 15, 2014	11-25, 27-32	*SIO/ODF*
Referense Temperature	SBE35	350034	Jan 15, 2014	34-66	*SIO/ODF*

1.4 SIO/ODF Packages & Deployment

Both SIO/ODF operated rosettes were deployed from the starboard staging bay. The rosettes were carted on-deck once on station. Both rosettes were deployed with a InterOcean Systems and Power Engineering and Mfg winch model:712176100. The rosette systems were suspended from an oceanographic three-conductor 0.322" electro-mechanical sea cable. The sea cable was terminated at the beginning of HLY1502. The deck watch prepared the rosette 10-30 minutes prior to each cast. The bottles were cocked and all valves, vents and lanyards were checked for proper orientation. The chipod battery was monitored for charge and connectors were checked for fouling and connectivity.

Recovering the package at the end of the deployment was essentially the reverse of launching. The rosette, CTD and carousel were rinsed with fresh water frequently. CTD maintenance included rinsing de-ionized water through both plumbed sensor lines between casts. On average, once every 20 stations, 1% Triton-x solution was also rinsed through both conductivity sensors. The rosette was routinely examined for valves and o-rings leaks, which were maintained as needed.

Initially these two rosette systems were utilized for HLY1502 mission. The 36-place 10 liter CTDO/rosette is typically used in the SIO US Repeat Hydrography program. The 12-place rosette was requested to satisfy GEOTRACES volume requirement of 30 liters. The 30 liter bottles were notably leaky due to insufficient spring tension for the volume of water collected. After station 26 the GEOTRACES program chose to use the 36-place 10 liter rosette exclusively throughout the rest of the cruise.

CHAPTER

TWO

CRUISE NARRATIVE

SIO Oceanographic Data Facility CTD/Hydrographic Support for the US Geotraces Arctic Ocean Expedition and Repeat Hydrography Program J. Swift (SIO)

2.1 Summary

A seven-person team from the Oceanographic Data Facility (ODF) of the Shipboard Technical Support group (STS) at the UCSD Scripps Institution of Oceanography carried out NSFfunded CTDO casts, salinity, oxygen, and nutrient analyses, data processing, and oceanographic interpretative activities on the US Geotraces Arctic Expedition on USCGC Healy, 09 August to 12 October 2015, Dutch Harbor, AK, round trip. The ODF team also supported extra casts at separate stations for an addon repeat hydrography component which improved the horizontal resolution provided by the relatively sparse Geotraces stations alone. The extra casts were sanctioned by the US Global Ocean Carbon and Repeat Hydrography Program (now US GOSHIP) and received supplementary NSF support; also, support for five additional days at sea was added. The budgets and work force for the CFC/SF6 and ocean carbon teams which were already part of the Geotraces work plan were also supplemented so that a more nearly complete repeat hydrography suite of measurements could be made at all stations.

The CTD/hydrographic group included: two nutrient analysts (Susan Becker ODF team leader and Melissa Miller), a data processor/analyst (Courtney Schatzman), an oxygen and data tech (Andrew Barna), a CTD and oxygen tech (Joseph Gum), a CTD/electronics/marine technician (John 'Ted' Cummiskey), and a scientist (James Swift), who was also the scientific leader for the repeat hydrography work. Gum and Swift ran the CTD console. Swift also assisted with data quality control and prepared data interpretation documents for use by the onboard Geotraces science team.

The CTD/hydrographic team provided at sea, in addition to basic CTD/hydrographic data collection: CTD and bottle data processing, oceanographic leadership of the CTD/hydrographic team, interpretation of the CTD/hydrographic data, and nutrient and salinity analyses for other Geotraces casts (e.g., from trace metal rosette casts, small boat casts, and ice samples). CTD/hydrographic data were processed and most documentation completed at sea, scientifically useful CTD/hydrographic data available to participants daily at sea, bottle data parameters analyzed at sea were merged with others at sea when provided in a timely manner to the ODF data specialist, and oceanographic interpretation of the CTD/hydrographic data was provided to the groups at sea.

The precruise plan was that ODF would operate two CTD/rosette systems, one equipped with 12 30liter bottles for all ODF casts at each Geotraces station and one equipped with 36 10liter bottles for the single cast at each repeat hydrography station. This would provide the large volumes per level needed on Geotraces casts, provide excellent singlecast vertical resolution at repeat hydrography stations, and avoid switching rosettes at any given station type. The original plan was to store one on deck, covered and with heaters, while the inuse rosette would be kept in the Healy's starboard staging bay. It was quickly realized both that it would be difficult to switch rosettes in and out of the staging bay, and also that there was adequate space and facilities in the staging bay to keep both in the bay in an inboardoutboard tandem, with just enough lateral (foreaft in ship direction) space to pass one by the other to switch them. [There was also a trace metal clean rosette system with 24 10liter GoFlo bottles, kept on the fantail with a specialized UNOLS trace metal clean winch, operated by a team supervised by Greg Cutter, Old Dominion University, which provided Geotraces samples and CTD data which were part of the ODF data processing responsibilities on the cruise.]

There were no serious problems with this plan, but experience quickly showed that the 10liter bottles were much less prone to leaking than were the 30liter bottles, and that three 10liter bottles delivered more water than did one 30liter bottle. It was also determined that in nearly all situations a lowvolume nutrient sample could be the only check sample needed when three 10liter bottles were closed at one level and one of them had salinity, oxygen, and nutrient samples. The samplers also stated that they preferred the 10liter bottles. Thus, at the cost of tripling the nutrient sample load for ODF casts at Geotraces stations, ODF switched to using only the 36x10liter rosette. One remaining issue was that there were two Geotraces instruments on the 12x30liter rosette that were not on the 36x10liter rosette, which was already thought to be 'full up' on sensors, but the STARC techs, working with ODF and also the SIO/STS engineers in San Diego, worked out an installation plan that placed all instruments onto the 36x10liter rosette, which was then used for the remainder of the cruise. (The 12x30liter rosette was disassembled and the frame stored on deck.)

Overall, ODF CTD operations went well, especially considering some of the operational challenges the expedition faced. There was a sizeable deck and MST force which took care of pushing the rosette in and out of the staging bay (the rosette was kept on a platform which slid on 'railroad tracks'), launch preparations, launch, and recovery. [Although the rosette frame was nearly as large as the cart, it never slipped off (which could have damaged some of the instruments close to the frame bottom).] The STARC tech on watch and/or ODF tech was responsible for seeing that the water sample bottles were prepared for deployment and all equipment mounted on the rosette frame was ready for the cast. The ship supplied winch operators from the deck crew, and the CTD computer operator (Gum or Swift) ran each cast from a seat near the winch operator, who could see the deck crew, Aframe, and water from the aft control room. The USCGC Healy's bridge staff sometimes required significant time to come onto station. Before this was understood, during some stations early in the expedition the rosette sat on deck longer than desirable, especially so when air temperatures started to reach well below freezing. Thus a procedure was developed to deal with this: the rosette was readied as usual, but the staging bay door was kept shut and deck crew did not open it to move the rosette out onto deck until permission to deploy had been received from the bridge. At that point the staging bay rollup door was opened and subsequent deployment was as rapid as could be managed. In very cold conditions, the STARC tech blew air from a large heaterfan onto the rosette while it was on deck. One complication which affected a small group of stations roughly in the middle of the cruise was that the staging bay door motor ceased functioning, and the manual rollup took about 10 minutes, during which time the CTD could become quite cold unless it was kept warm with the heater fan. Despite use of the heater fan there was some freeze damage to the CTD dissolved oxygen sensors and possibly a pump, but very little harm done to the CTD data. Warm air was ducted onto the rosette on recovery in an effort to keep any water sample freezing to the water in the spigots. As the ship worked south, air temperatures warmed a little and the engineers worked on the door mechanism one way or the other the door began working again.

On the final deep ODF cast at many of the Geotraces stations, the rosette was equipped with a monocorer device to capture a sediment sample. The monocorer was attached via a 26meter rope to the bottom of the rosette frame. The altimeter on the rosette would 'see' only the monocorer i.e. it would constantly report 26 meters 'height above bottom'. Based on past Geotraces experience a pyramidal device constructed from 4 plastic panels was attached above the monocorer to deflect sound impulses instead of reflecting them upward. This device, nicknamed 'the cone of silence', worked well, enabling normal altimeter function. Special cast procedures were used - deploy no faster than 40 meters/minute, slow to 10-20 meters per minute before the monocorer would hit the bottom, leave at bottom one minute, pull out slowly - were employed. Some monocorer casts were successful, some were not. The device caused no problems other than the extra time for the slower down cast.

Water sampling was carried out in the starboard staging bay, with the roll-up door in the closed position. The staging bay was kept cold (but well above freezing) during gas sampling: heaters in the staging bay were regulated to avoid all but a small degree of warming of the water in the 10-liter ODF bottles.

There were relatively few mishaps during ODF rosette casts other than continual concerns regarding effects of sub-freezing temperatures as noted above. The most serious incident occurred near the start of work in the ice when the CTD cable was snagged by an ice floe drifting aft and carried more than 100 meters aft. Eventually it was freed, at the only cost of needing to cut off damaged cable and reterminate. Another serious incident, near the end of the expedition, arose when the winch operator lowered the rosette, rather than raising it, after bottom approach. With tension off the wire, the wire kinked, and a retermination was required - there were no effects on the data.

It bears noting that the Arctic Ocean sea ice Healy traversed appeared to be mostly first-year ice. Good progress was often made on one engine in the ice, though on the heavier stretches two engines were sometimes used. Extra power appears to have been required remarkably few times for an expedition working in the central Arctic Ocean. Over the Alpha Ridge Healy traversed the heaviest ice overall encountered during the expedition, but the navigators in the aloft control station were always able to spot a feasible route, avoiding heavy, impassible pressure ridges. Sometimes it took some back-and-ram operations to get through a thicker, older ice floe, and there was one short instance when three engines were needed. In ice covered water during parts of the expedition where there was darkness the ship typically did not navigate the pack at night, but this affected only a small number of days of the expedition. Once the ship was south of the crest of the Alpha Ridge, there were many-miles-long, wide leads that Healy followed. Overall, progress through the ice was remarkable for a single icebreaker in this domain. For example, Healy made it solo through some areas that were too tough for Healy and Oden together in 2005, and was able to operate freely in areas out of the question during the 1994 expedition by two heavy icebreakers.

During the cruise there was a fair amount of snow, and the decks were often slippery. By mid-September there was some full darkness every night, and by the end of the month and early October there were beautiful aurora displays visible in open areas of the sky.

2.2 ODF Data Quality, Management and Availability

The ODF rosette casts meet a similar quality as for the at-sea temperature and salinity data from cruises for the US Global Ocean Carbon and Repeat Hydrography program, and provide usable CTD dissolved oxygen profiles (and CTD fluorometer and transmissometer profiles). ODF carried out analyses of inorganic nutrients (nitrate, nitrite, phosphate, and silicate) from every rosette bottle closed at every rosette level sampled (and from ice stations, samples from small boat casts, and niskins paired with McLane pumps), dissolved oxygen at every ODF rosette level sampled, and conductivity (salinity) check samples from every CTD/rosette cast (and from ice stations, samples from small boat casts, and niskins paired with McLane pumps).

Bottle data are indexed by cruise, station, cast, and sample/bottle, and Geotraces identifiers are used as per Geotraces policy. Each/every sample drawn is logged, and scans of the log sheets will be archived at STS/ODF. Experience during WOCE, CLIVAR, SBI, previous Geotraces cruises and many other programs has amply demonstrated that these procedures make it straightforward to merge disparate bottle parameter data from different laboratories.

The core ODF CTD/hydrographic data (CTD pressure, temperature, salinity, oxygen; bottle salinity, oxygen, and nutrients) from all ODF rosette casts from this expedition (both 12x30 and 36x10, from both Geotraces and repeat hydrography stations) are by NSF, US Geotraces, and US repeat hydrography (now US GOSHIP) policies officially "public" data. The CFC/SF6 and ocean carbon data in the hydrographic data files are also included in this data availability policy for all ODF rosette casts.

The data citation information for the water column CTD/hydrographic/CFC/carbon data is as follows: # Data Provided by: # # Program Affiliation PI email # # Chief Scientist FIU David Kadko dkadko@fiu.edu # CTDO UCSD/SIO James Swift jswift@ucsd.edu # (and Salinity, Oxygen, Nutrients) # CFCs/SF6 LDEO William Smethie bsmeth@ldeo.columbia.edu # Ocean Carbon UofMiami/RSMAS Frank Millero fmillero@rsmas.miami.edu # Dennis Hansell dhansell@rsmas.miami.edu # (Total Alkalinity, pH, DIC, DOC) # # The data included in these files are preliminary, and are # subject to final calibration and processing. They have been made # available for public access as soon as possible following # their collection. Users should maintain caution in their # interpretation and use. Following American Geophysical Union # recommendations, the data should be cited as: "data # provider(s), cruise name or cruise ID, data file name(s), # CLIVAR and Carbon Hydrographic Data Office, La Jolla, CA, # USA, and data file date." For further information, please # contact one of the parties listed above or cchdo@ucsd.edu. # Users are also requested to acknowledge the NSF/NOAAfunded # U.S. Repeat Hydrography Program and the NSFfunded Geotraces # program in publications and presentations resulting from their use.

CHAPTER

THREE

ODF CTDO AND HYDROGRAPHIC ANALYSIS

3.1 CTDO and Bottle Data Acquisition

The CTD data acquisition system consisted of an SBE-11+ (V2) deck unit and a networked generic PC workstation running Windows 7 2009 SBE SeaSave v.7.18c software was used for data acquisition and to close bottles on the rosette.

Once the bridge notified science operation in aft control that the ship was on station, CTD deployments began with the console watch operators (CWO). The watch maintained a CTD Cast log for each attempted cast containing a description of each deployment event.

Once the deck watch had deployed the rosette, the winch operator would lower it to 10 meters. The CTD sensor pumps were configured to start 5 seconds after the primary conductivity cell reports salt water in the cell. The CWO checked the CTD data for proper sensor operation, waited for sensors to stabilize, and instructed the winch operator to bring the package to the surface in good weather or 5 meters in high seas. The winch was then instructed to lower the package to the initial target wire-out at no more than 30m/min to 100m and no more than 60m/min after 100m depending on sea-cable tension and the sea state.

The CWO monitored the progress of the deployment and quality of the CTD data through interactive graphics and operational displays. The altimeter channel, CTD pressure, wire-out and center multi-beam depth were all monitored to determine the distance of the package from the bottom. The winch was directed to slow descent rate to 30m/min 100m from the bottom and 10m/min 30m from the bottom. The bottom of the CTD cast was usually to within 10-20 meters of the bottom determined by altimeter data. For each up-cast, the winch operator was directed to stop the winch at up to 36 predetermined sampling pressures. These standard depths were staggered every station using 3 sampling schemes. The CWO waited 30 seconds prior to tripping sample bottles, to ensure package shed wake had dissipated. An additional 15 seconds elapsed before moving to the next consecutive trip depth, which allowed for the SBE35RT to record bottle trip temperature.

After the last bottle was closed, the CWO directed winch to recover the rosette. Once the rosette was out of the water and on deck, the CWO terminated the data acquisition, turned off the deck unit and assisted with rosette sampling.

Additionally, the watch created a sample log for rosette/CTDO cast deployments used to record the depths the bottles were tripped as well as correspondence between rosette bottles and analytical samples drawn.

Normally the CTD sensors were rinsed after each station using syringes fitted with Tygon tubing and filled with a fresh solution of dilute Triton-X in de-ionized water. The syringes were left on the CTD between casts, with the temperature and conductivity sensors immersed in the rinsing solution.

Each bottle on the rosette had a unique serial number, independent of the bottle position on the rosette. Sampling for specific programs were outlined on sample log sheets prior to cast recovery or at the time of collection. The bottles and rosette were examined before samples were drawn. Any abnormalities were noted on the sample log, stored in the cruise database and reported in the APPENDIX.

A few complications impacted the CTD data acquisition. Station/cast 010/02 towards the end of the cast an ice floe caught the sea-cable the 12-place rosette was suspended from, causing the wire to fall out of the shiv and dragging the rosette package up 200m before the package was freed. SOn stations 019/01 and 032/08 the exhaust lines and pumps were frozen and it was necessary to have the package descend to 200+m to clear the lines before starting the cast.

3.2 CTDO Data Processing

Shipboard CTD data processing was performed after deployment using SIO/ODF CTD processing software v.5.1.0. CTD acquisition data were copied onto the Linux system and database, then processed to a 0.5-second time-series. CTD data at bottle trips were extracted, and a 2-decibar down-cast pressure series created. The pressure series data set was submitted for CTD data distribution after corrections outlined in the following sections were applied. A total of 66 CTD stations were occupied. 41 CTDO/rosette casts were completed with the 24-place 12 liter GEOTRACES rosette, 19 CTDO/rosette casts were completed with the 12-place 30 liter rosette and 87 CTDO/rosette casts were completed with the 36-place 10 liter rosette.

CTD data were examined at the completion of each deployment for clean corrected sensor response and any calibration shifts. As bottle salinity and oxygen results became available, they were used to refine shipboard conductivity and oxygen sensor calibrations.

Temperature, salinity and dissolved O_2 comparisons were made between down and up casts as well as between groups of adjacent deployments. Vertical sections of measured and derived properties from sensor data were checked for consistency.

3.3 Pressure Analysis

Laboratory calibrations of CTD pressure sensors were performed prior to the cruise. Dates of laboratory calibration are recorded on the Underway Sampling Package table and calibration documents are provided in the APPENDIX.

The Paroscientific Digiquartz pressure transducer S/N: 638-83009 was calibrated on February 10th, 2015 at the SBE Calibration Facility. The Paroscientific Digiquartz pressure transducer S/N: 831-99677 was calibrated on February 13th, 2015 at the SIO/ Calibration Facility. The lab calibration coefficients provided on the calibration report were used to convert frequencies to pressure. Initially SIO/STS pressure lab calibration slope and offsets coefficients were applied to cast data. A shipboard calibration offset was applied to the converted pressures during each cast. These offsets were determined by the pre- and post-cast on-deck pressure offsets. The pressure offsets were applied per configuration cast sets.

Ideal initial slope and offset for any sensor is 1.0 and 0.0 respectively. Factory calibrations indicated an initial slope and offset of 0.99990863 and 0.10746 for the CTD S/N: 638. On deck pressures were not ideal for this pressure sensor. Before additional offset was applied the pre-cast min and max values were 1.0 and 1.4 dbar to post-cast min and max values were 0.5 and 0.6 dbar. An additional offset of -0.90 was applied to every cast performed by CTD S/N: 638 and the improved pre and post-cast average differences were -0.2 and 0.2 dbar.

Other than the non-ideal on deck pre- and post-cast pressure readings, there were no other performance issues noted with the CTD: S/N 638-83009 digiquartz pressure sensor unit.

- CTD Serial Number 638-83009

	Start P (dbar)	End P (dbar)
Min	0.0	-0.4
Max	0.5	-0.2
Average	0.34	-0.33
Applied Offset		-0.90

Factory calibrations for the pressure sensor on the CTD S/N: 831 package indicated an initial slope and offset of 1.0 and 0.0. Before additional offset was applied the pre-cast min and max values were -0.2 and 0.5 dbar. The post-cast min and max values were -0.2 and 0.5 dbar. An additional offset of -0.430 was applied to every cast performed by CTD 831 and the improved pre- and post-cast average difference was near zero.

No issues were noted with the performance of the CTD S/N: 831-99677 digiquartz pressure sensor.

- CTD Serial Number 831-99677

	Start P (dbar)	End P (dbar)
Min	-0.5	-0.4
Max	1.1	0.2
Average	0.0	-0.04
Applied Offset		-0.430

3.4 Temperature Analysis

Laboratory calibrations of temperature sensors were performed prior to the cruise at the SIO/ Calibration Facility. Dates of laboratory calibration are recorded on the Underway Sampling Package table and calibration documents are provided in the APPENDIX.

The pre-cruise laboratory calibration coefficients were used to convert SBE3plus frequencies to ITS-90 standard temperatures. Additional shipboard calibrations were performed to correct sensor bias. Two independent metrics of calibration accuracy were used to determine sensor bias. At each bottle closure, the primary and secondary temperature were compared with each other and with a SBE35RT reference temperature sensor.

The SBE35RT Digital Reversing Thermometer is an internally recorded temperature sensor that operates independently of the CTD. The SBE35RT was located equidistant between the two SBE3plus temperature sensors. The SBE32 carousel in response to a bottle closure triggers the SBE35RT. According to the manufacturer's specifications, the typical stability is 0.001°C/year. The SBE35RT was set to internally average over a 5 second period.

An SBE3plus sensor typically exhibits consistent predictable well-modeled response. The response model is second order with respect to pressure, a first order with respect to temperature and a first order with respect to time. The functions used to apply shipboard calibrations are as follows.

$$T_{cor} = T + D_1 P_2 + D_2 P + D_3 T_2 + D_4 T + \text{Offset}$$

$$T_{90} = T + tp_1 P + t_0$$

$$T_{90} = T + aP_2 + bP + cT_2 + dT + \text{Offset}$$

Primary and secondary temperature data from S/N: 638 were consistent and stable for the 19 casts performed. Second order fit with pressure was applied to the entire depth of both primary and secondary sensors and again applied to depths of 500-3200 dbar range. CTD S/N: 638 did not perform enough casts to evaluate certain aspects of shipboard calibration. Specifically, S/N: 638 did not collect enough data for time dependent drift analysis or deep (pressure > 2000 dbar) data corrections. The following figures *SBE35RT-T1 by station (-0.002°C T1-T2 0.002°C).* through *Deep T1-T2 by station (Pressure 500dbar).* show the modified version of corrected temperature differences for CTD S/N: 638.

The temperature data for CTD S/N: 638 meets the WHP standards for CTD data *[Joyce91]*. The 95% confidence limits for the mean low-gradient (values -0.002°C $\leq$ T1-T2 $\leq$ 0.002°C) of CTD S/N: 638 differences are ±0.0074°C for SBE35RT-T1, ±0.0070°C for SBE35RT-T2 and ±0.0015°C for T1-T2. The standard deviation for the mean low-gradient (values -0.002°C $\leq$ T1-T2 $\leq$ 0.002°C) of CTD S/N: 638 differences are ±0.0038°C for SBE35RT-T1, ±0.0036°C for SBE35RT-T2 and ±0.0008°C for T1-T2. The 95% confidence limits for the deep temperature residuals (where pressure $\geq$ 500dbar) are ±0.0038°C for SBE35RT-T1, ±0.0029°C for SBE35RT-T2 and ±0.0014°C for T1-T2. The standard deviation for the deep temperature residuals (where pressure $\geq$ 500dbar) are ±0.0019°C for SBE35RT-T1, ±0.0015°C for SBE35RT-T2 and ±0.0007°C for T1-T2.

Primary and secondary temperature data from S/N: 831 were consistent and stable for the 87 casts performed. CTD S/N: 831 was not used until station 11 on this cruise. The following figures *SBE35RT-T1 by station (-0.002°C T1-T2*

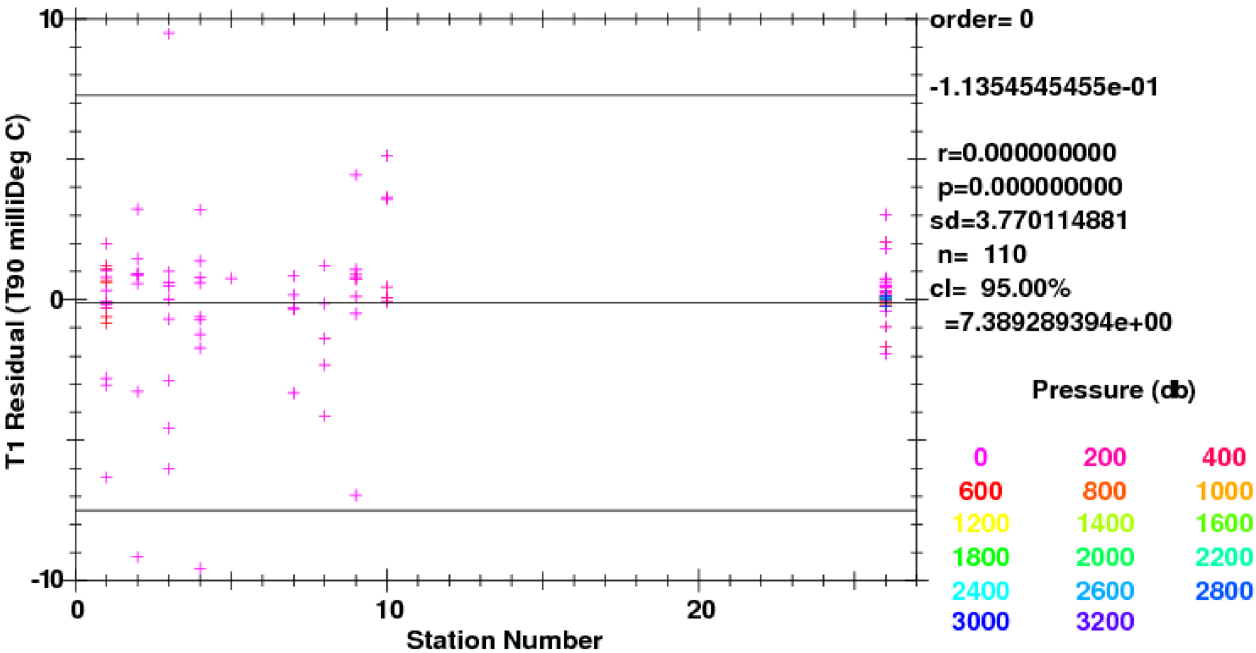

Fig. 3.1: SBE35RT-T1 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

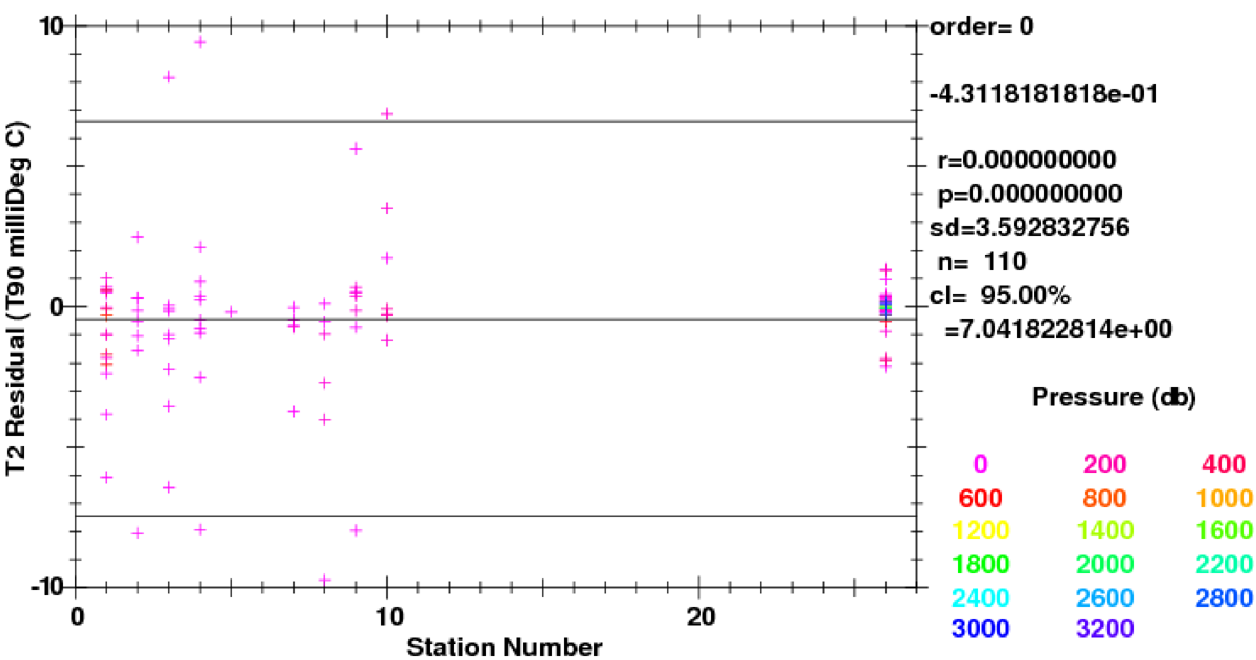

Fig. 3.2: SBE35RT-T2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

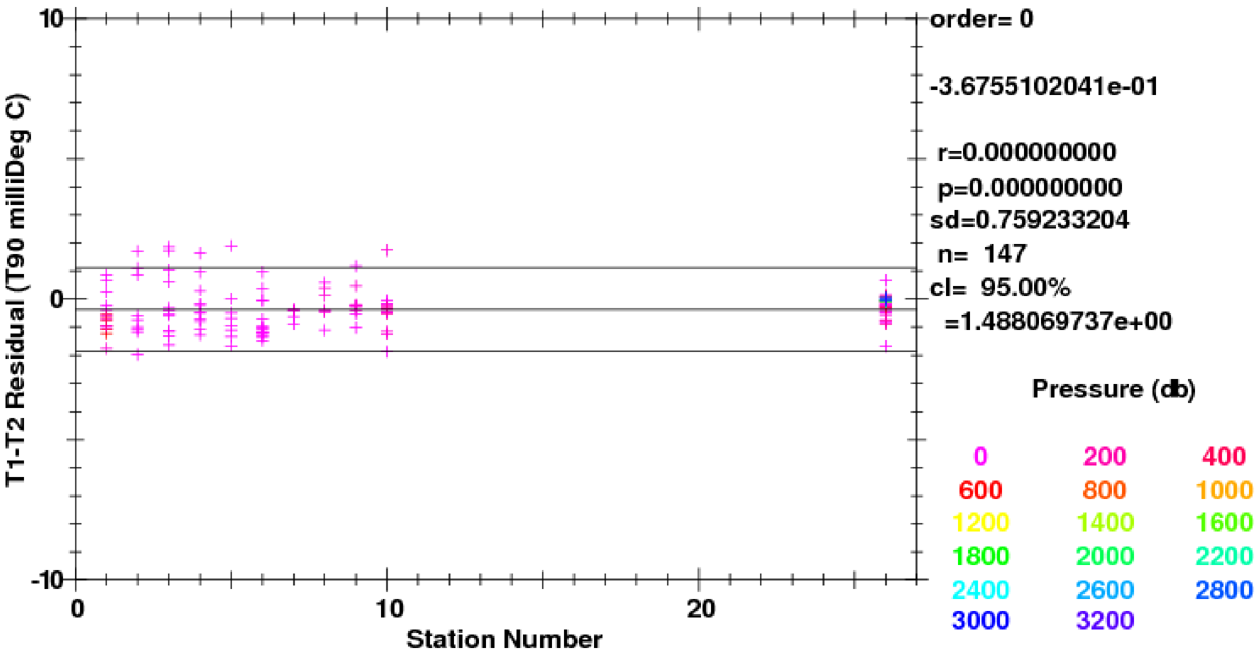

Fig. 3.3: T1-T2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

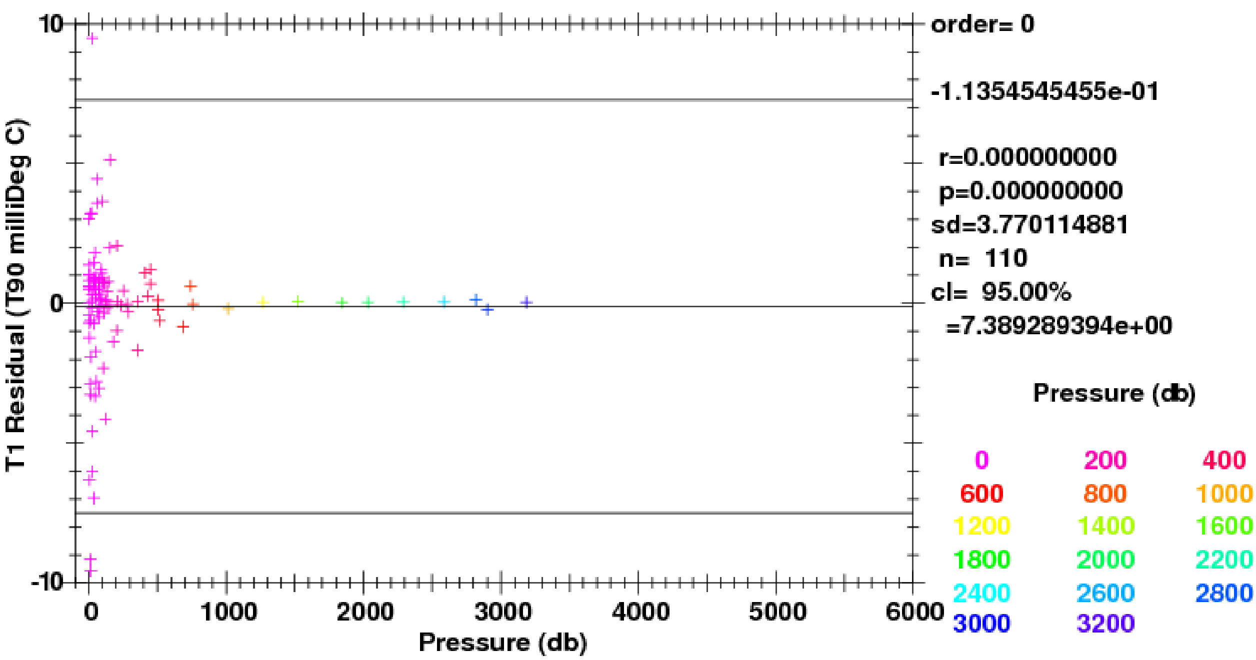

Fig. 3.4: SBE35RT-T1 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

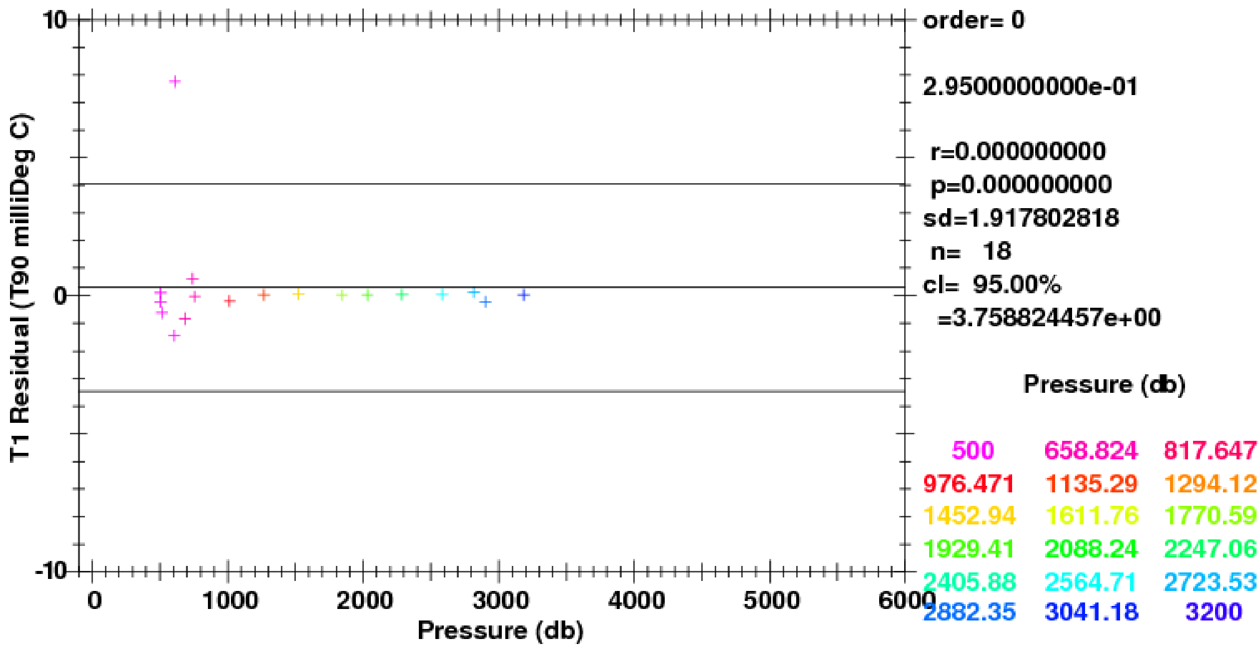

Fig. 3.5: Deep SBE35RT-T1 by station (Pressure ≥ 500dbar).

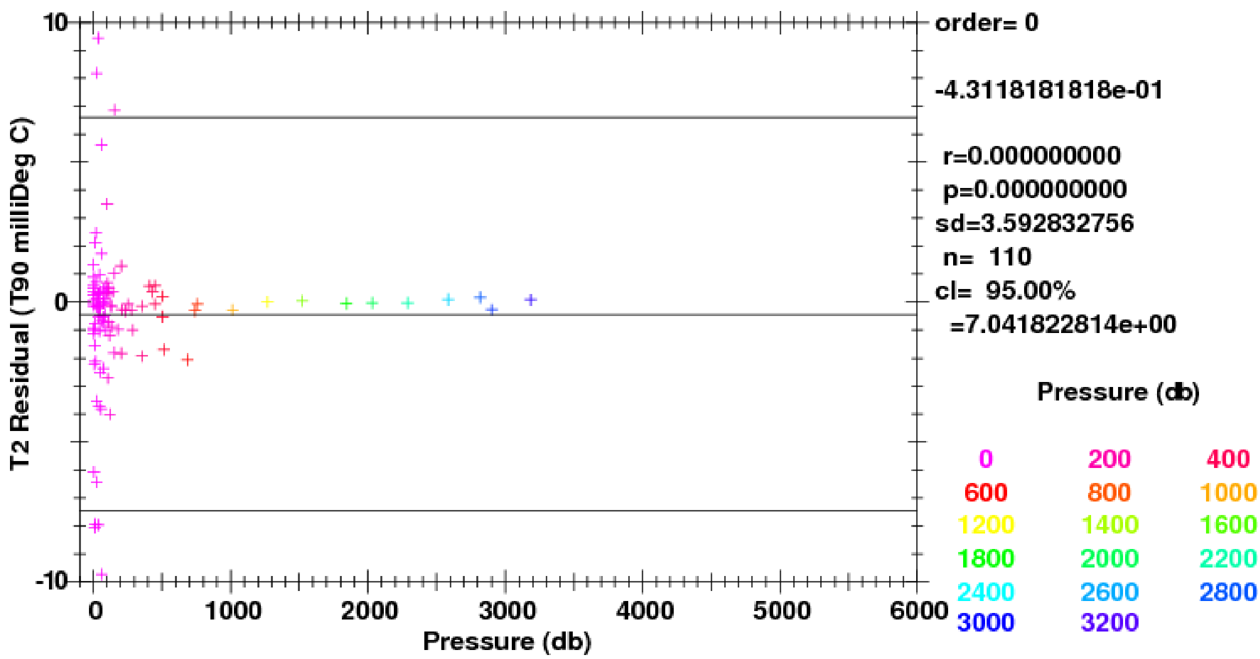

Fig. 3.6: SBE35RT-T2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

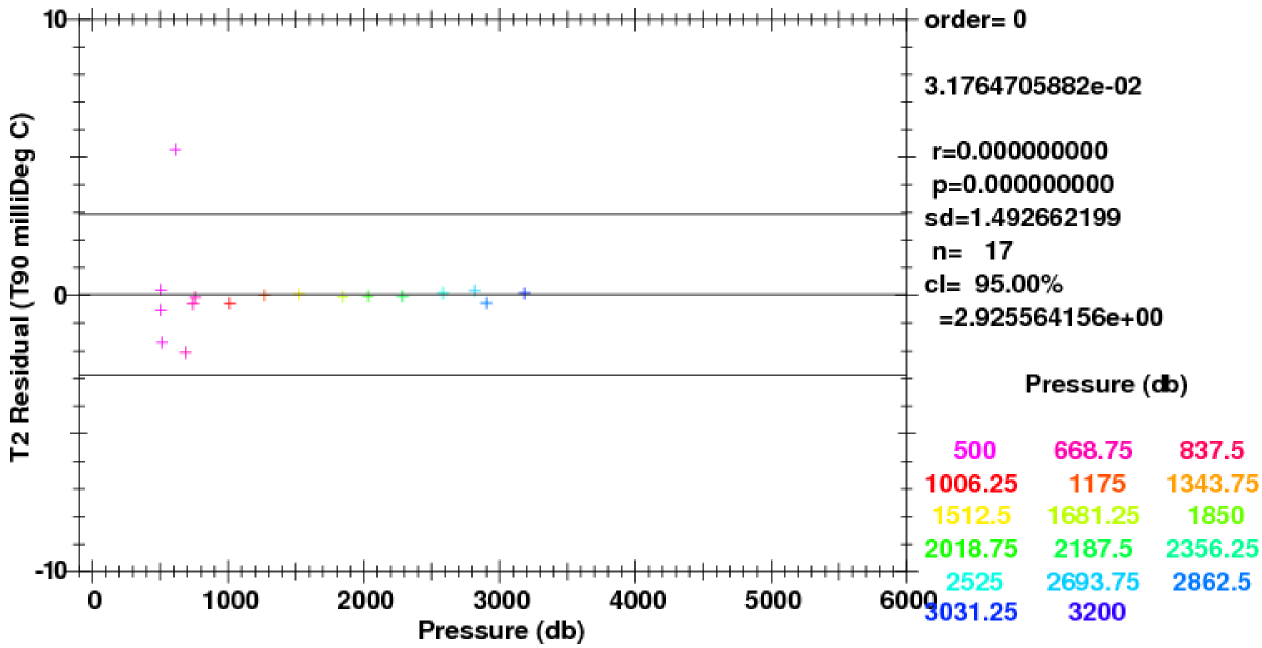

Fig. 3.7: Deep SBE35RT-T2 by station (Pressure ≥ 500dbar).

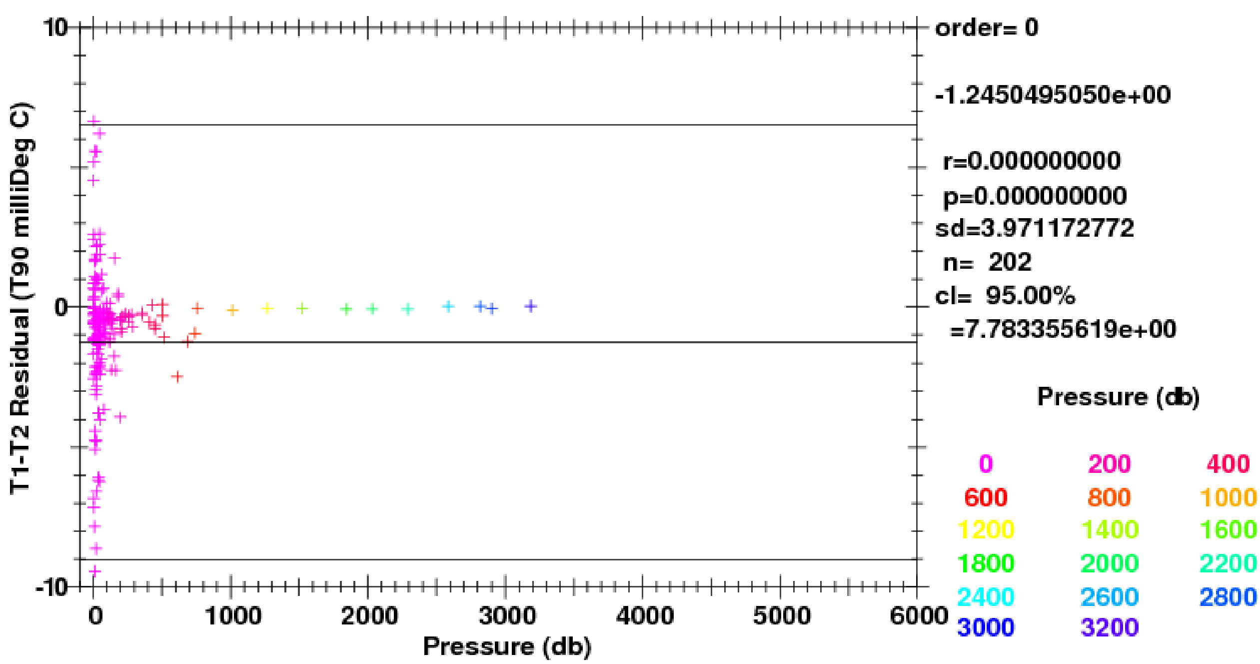

Fig. 3.8: T1-T2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

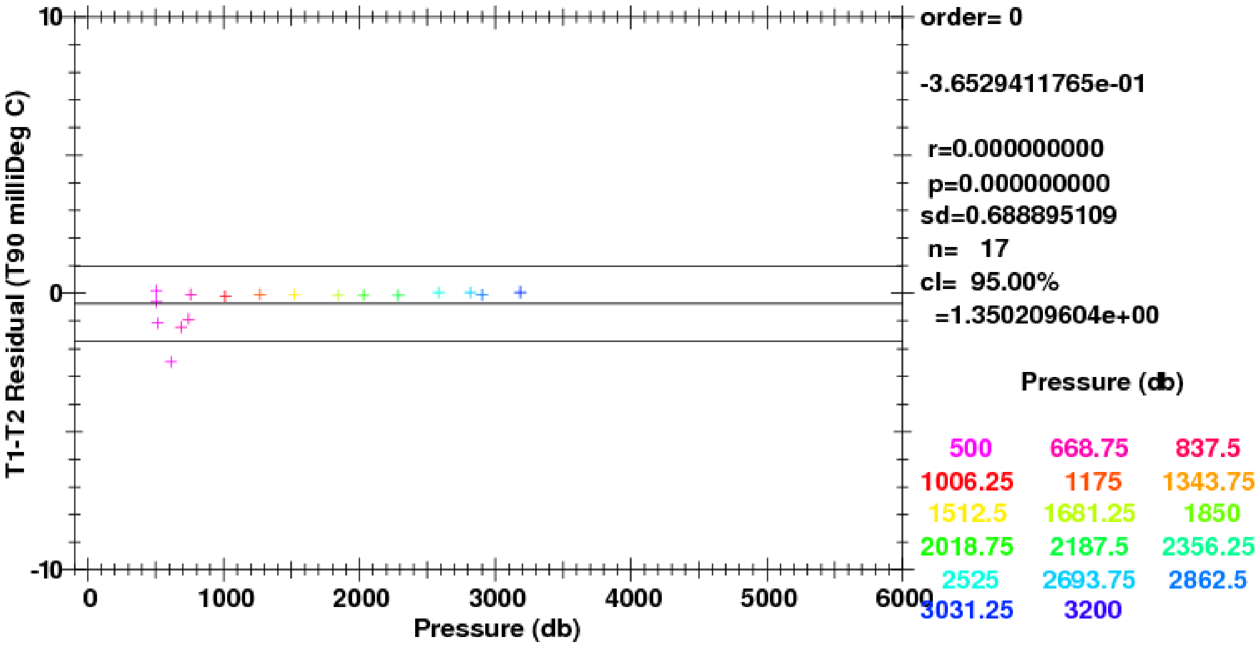

Fig. 3.9: Deep T1-T2 by station (Pressure ≥ 500dbar).

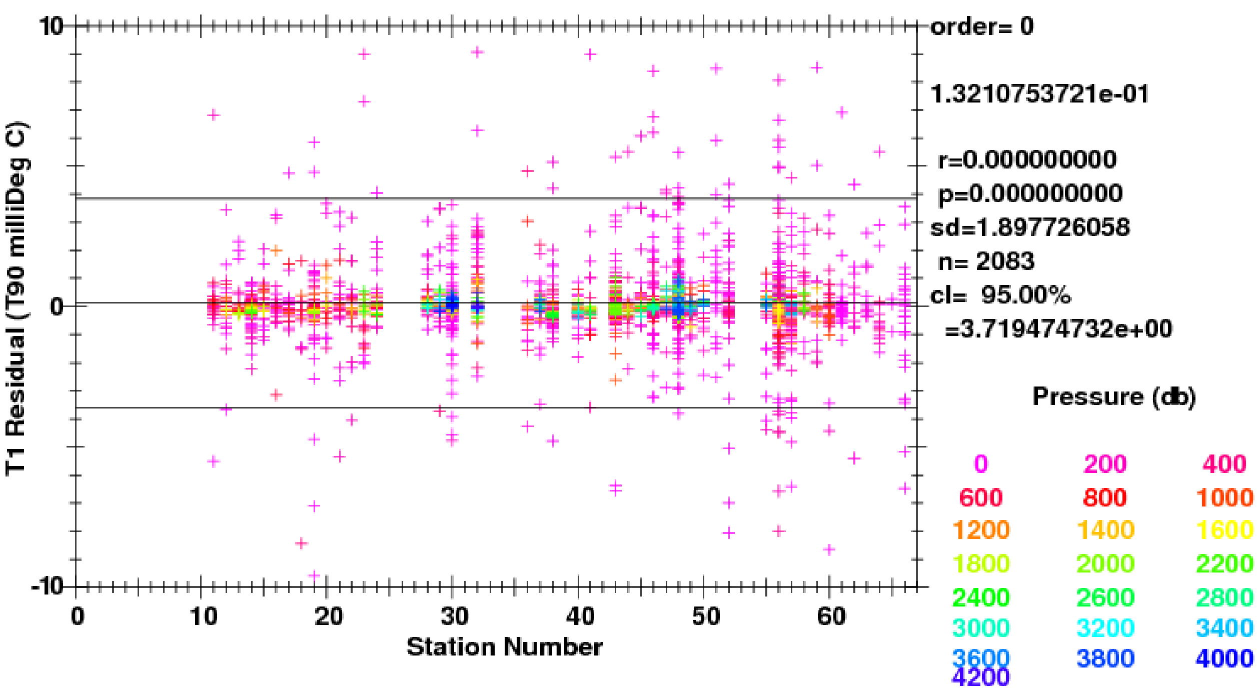

Fig. 3.10: SBE35RT-T1 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

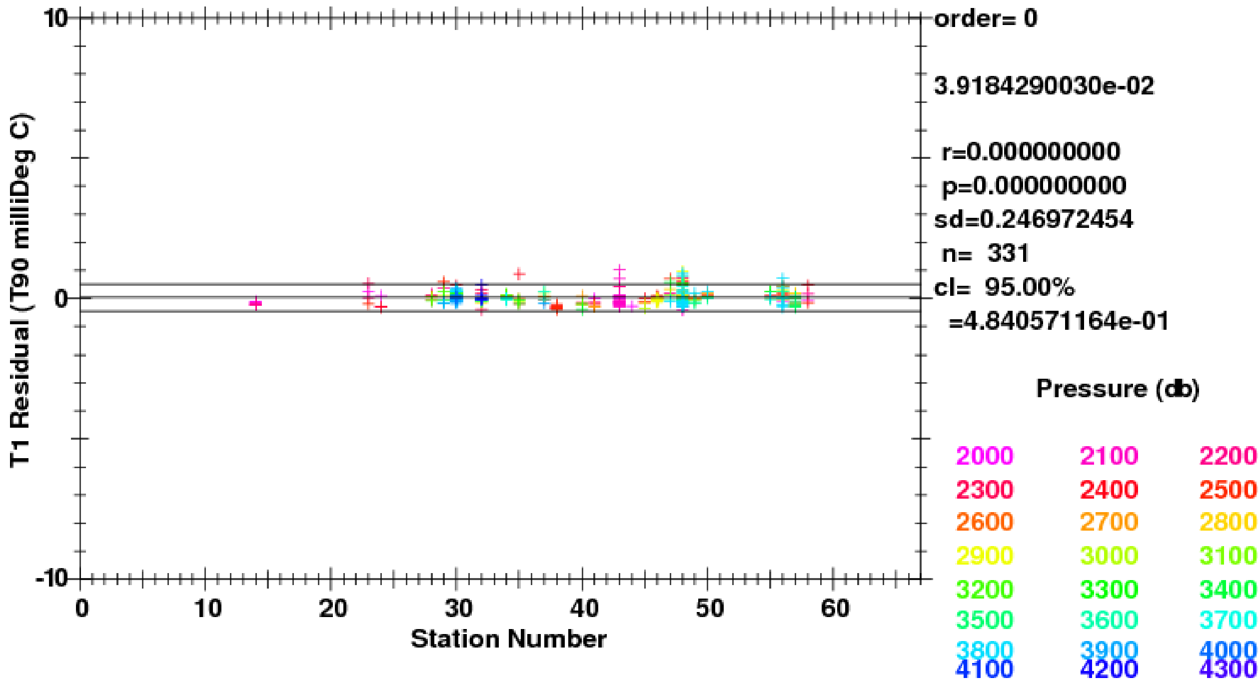

Fig. 3.11: Deep SBE35RT-T1 by station (Pressure ≥ 2000dbar).

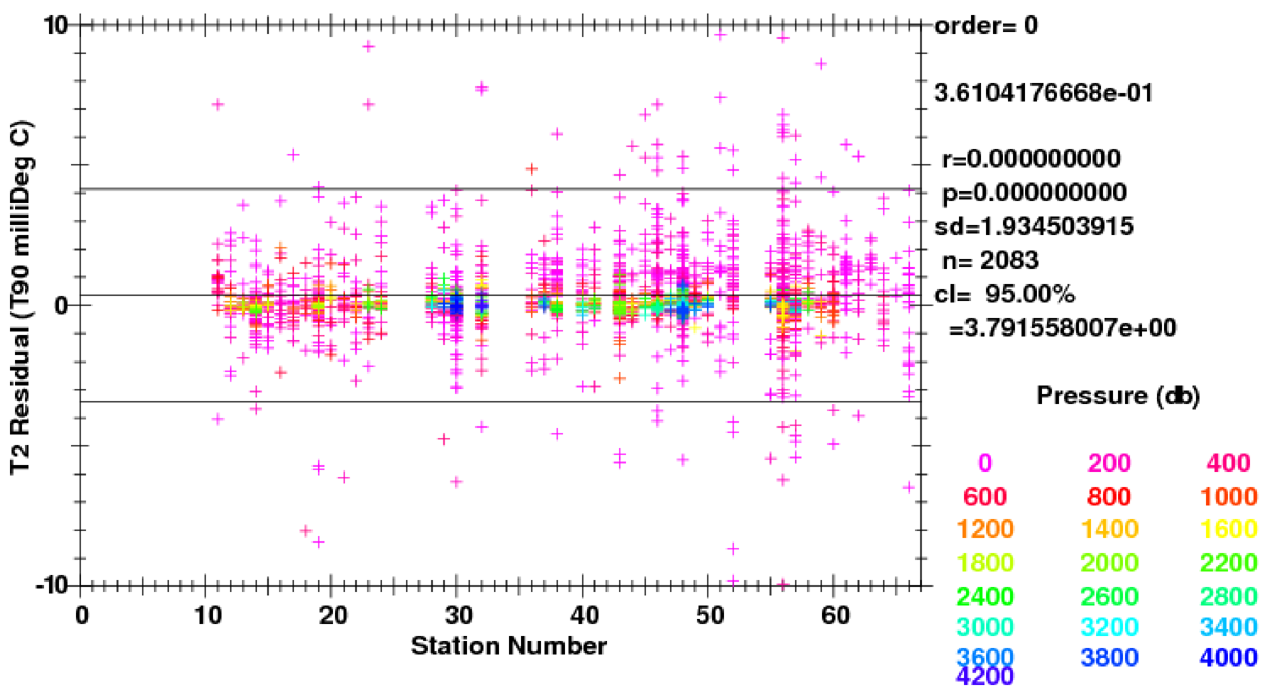

Fig. 3.12: SBE35RT-T2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

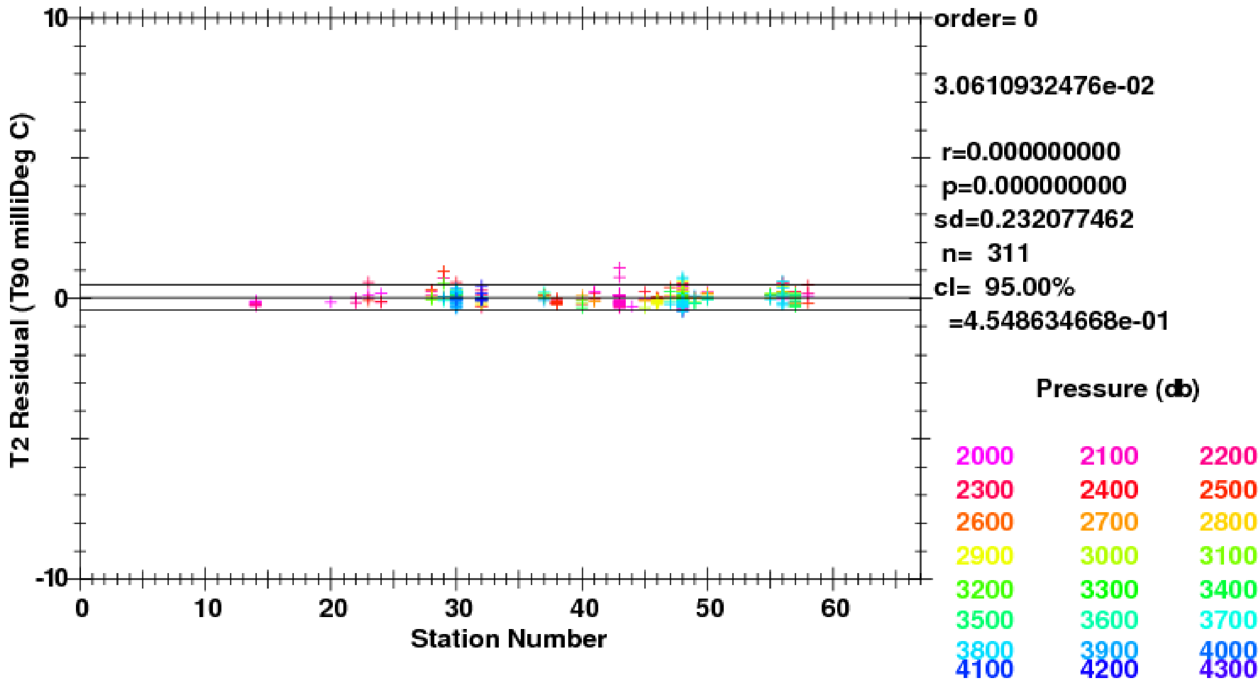

Fig. 3.13: Deep SBE35RT-T2 by station (Pressure ≥ 2000dbar).

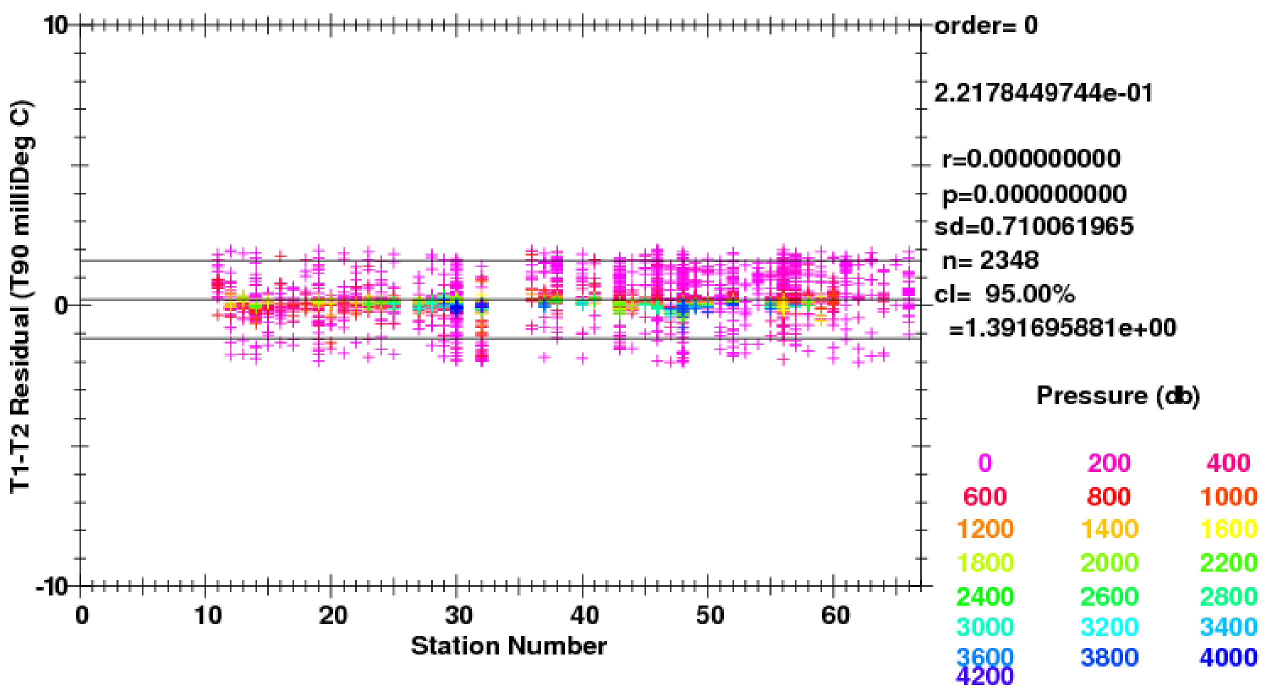

Fig. 3.14: T1-T2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

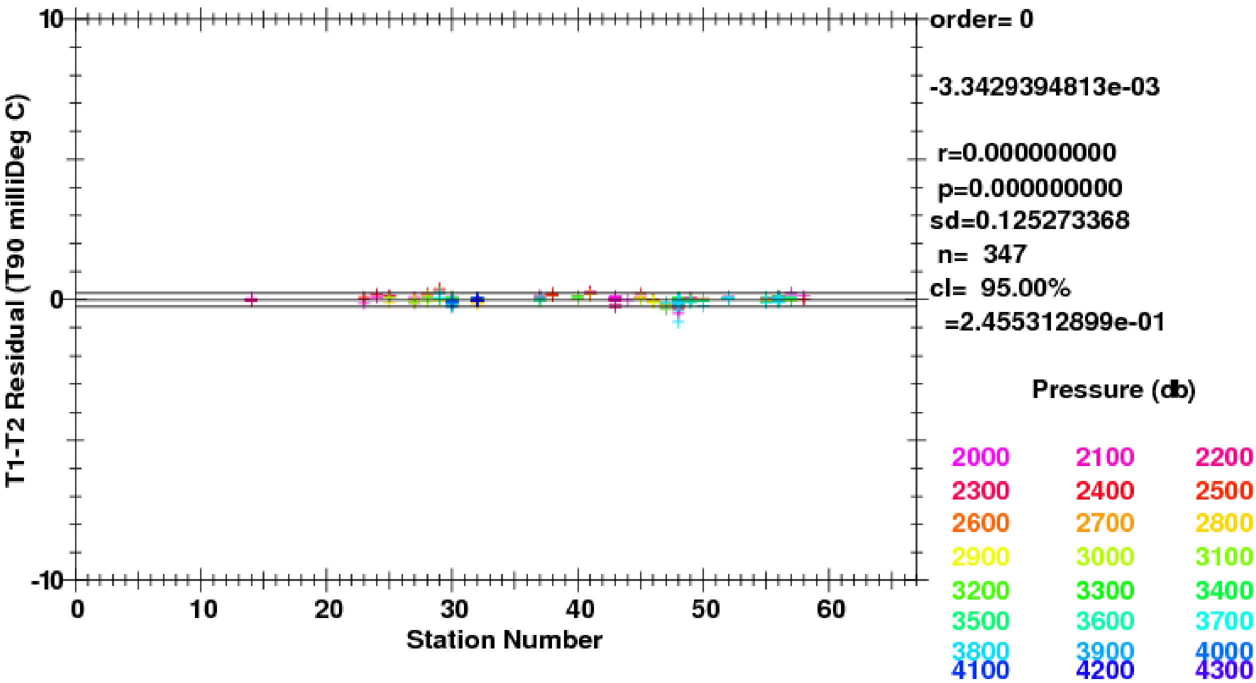

Fig. 3.15: Deep T1-T2 by station (Pressure ≥ 2000dbar).

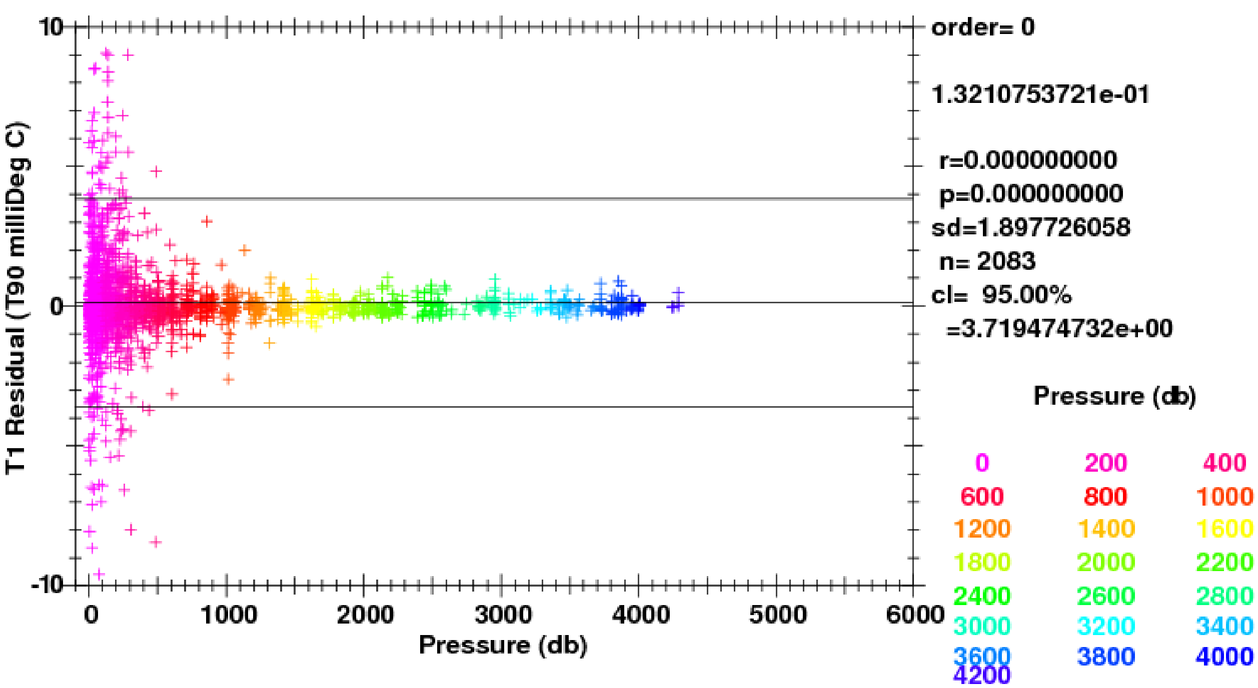

Fig. 3.16: SBE35RT-T1 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

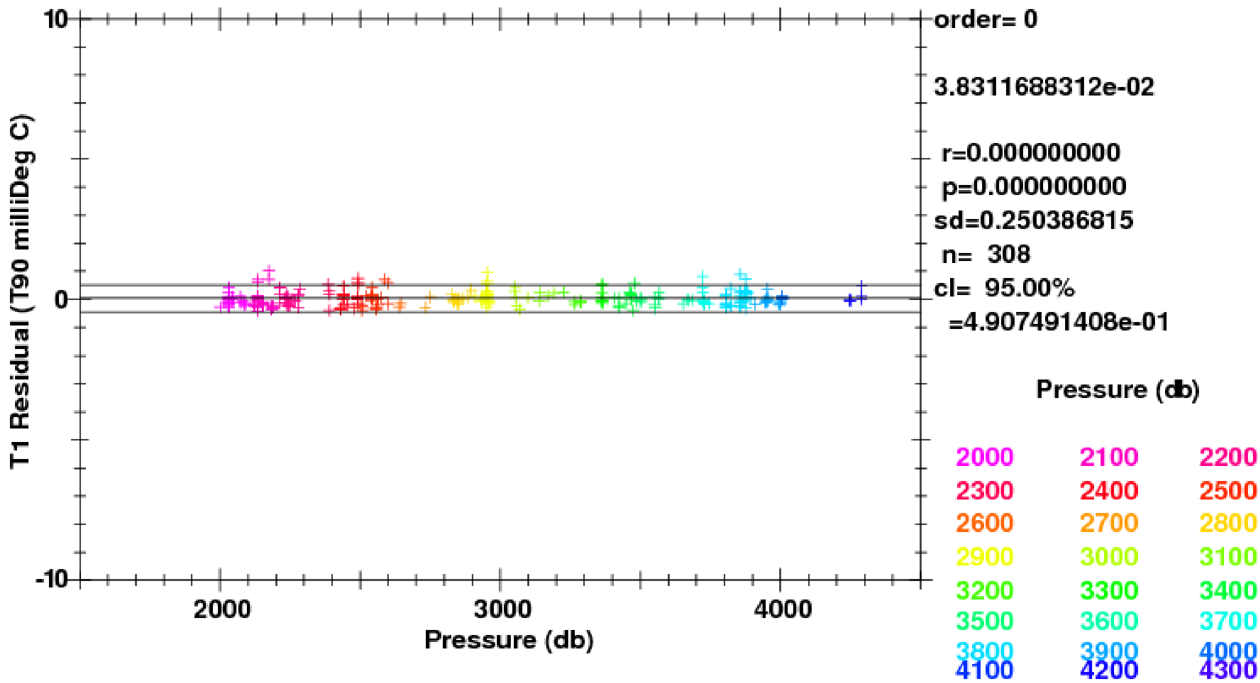

Fig. 3.17: SBE35RT-T1 by pressure (Pressure ≥ 2000dbar).

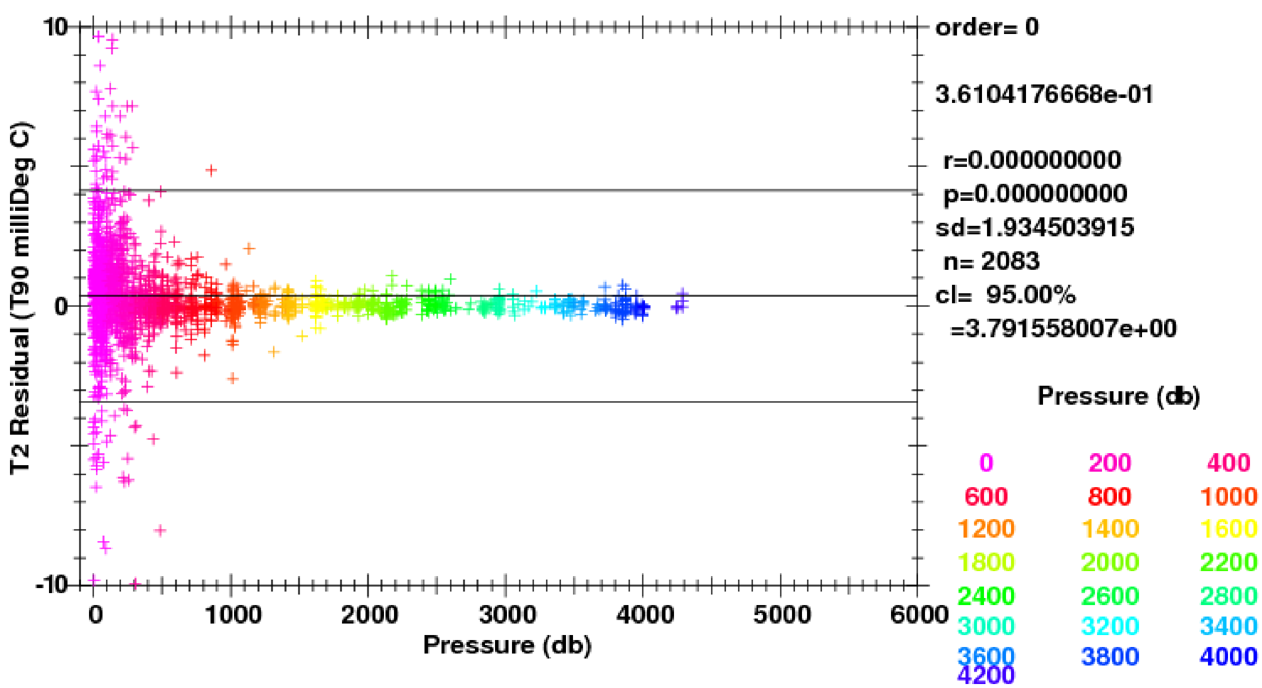

Fig. 3.18: SBE35RT-T2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

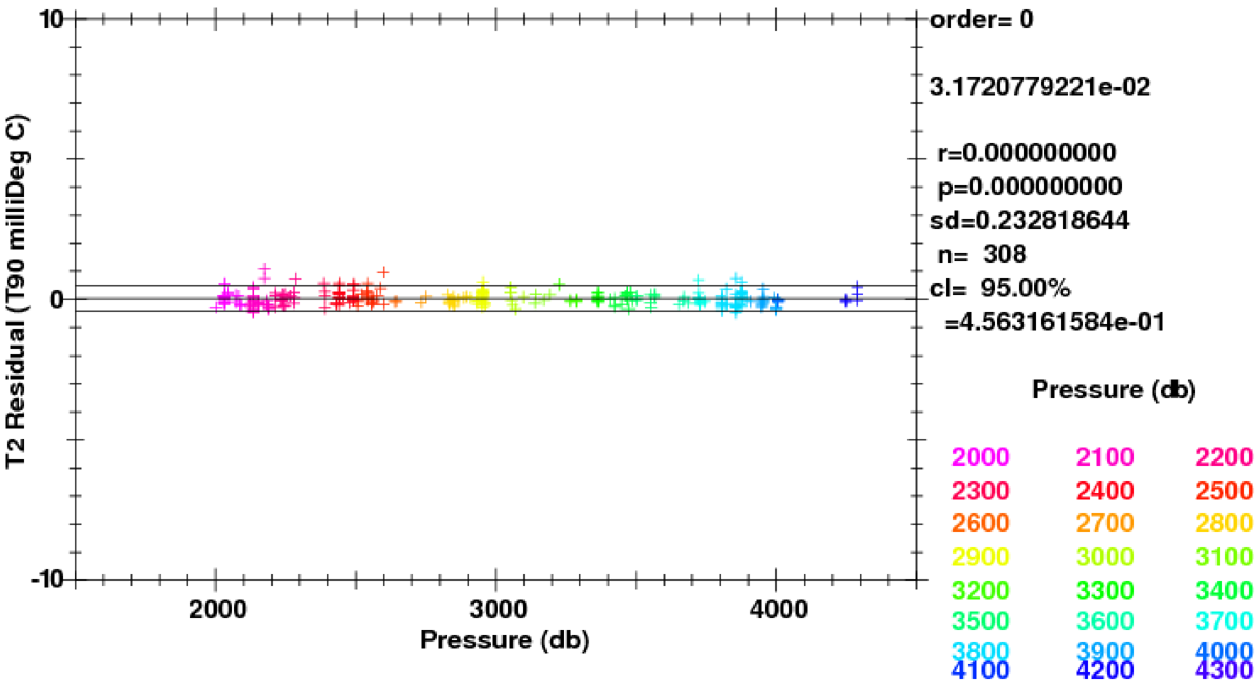

Fig. 3.19: SBE35RT-T2 by pressure (Pressure ≥ 2000dbar).

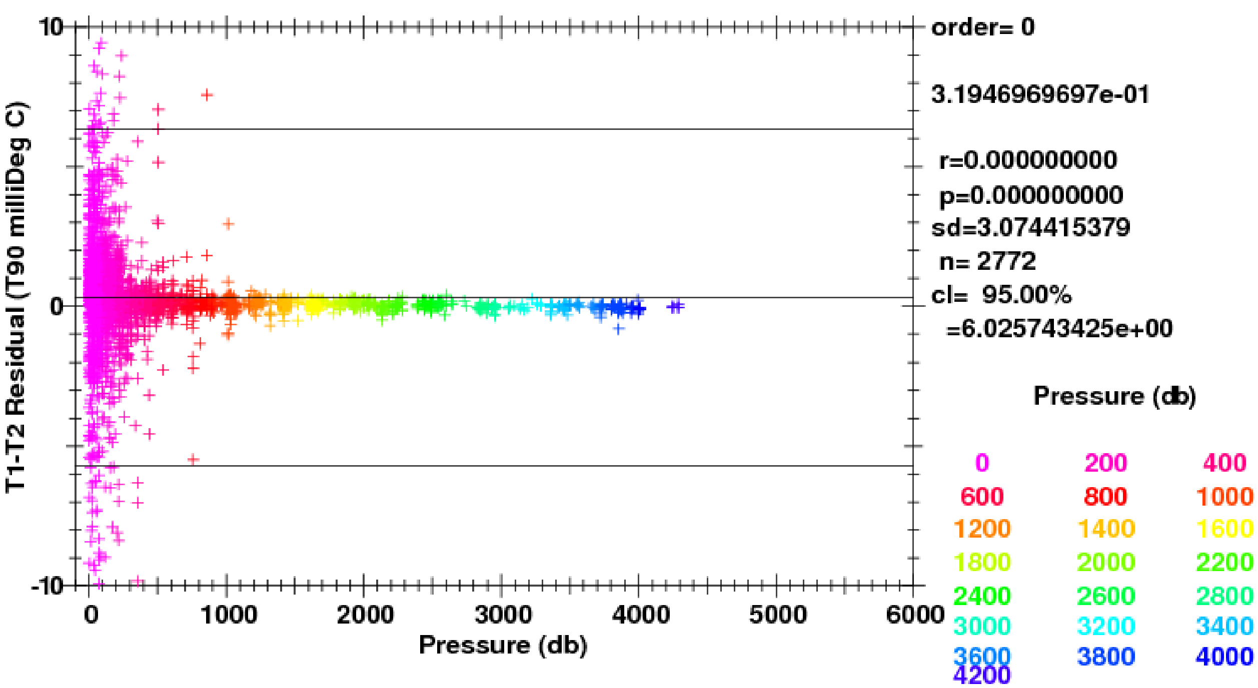

Fig. 3.20: T1-T2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

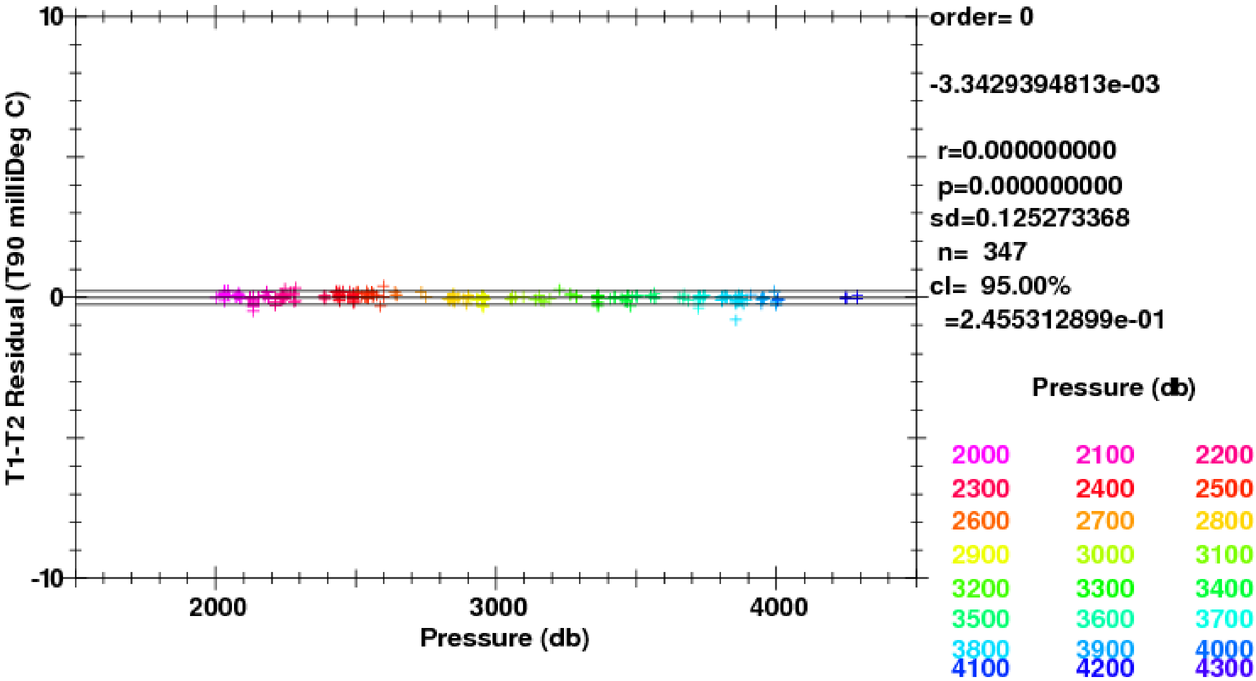

Fig. 3.21: T1-T2 by pressure (Pressure ≥ 2000dbar).

0.002°C). through *T1-T2 by pressure (Pressure 2000dbar).* the corrected temperature differences for CTD S/N: 831.

The temperature data for CTD S/N: 831 meets the WHP standards for CTD data [Joyce1991]. The 95% confidence limits for the mean low-gradient (values -0.002°C ≤ T1-T2 ≤ 0.002°C) of CTD S/N: 831 differences are ±0.0037°C for SBE35RT-T1, ±0.0038°C for SBE35RT-T2 and ±0.0060°C for T1-T2. The standard deviation for the mean low gradient (values -0.002°C ≤ T1-T2 ≤ 0.002°C) of CTD S/N: 638 differences are ±0.0019°C for SBE35RT-T1, ±0.0019°C for SBE35RT-T2 and ±0.0031°C for T1-T2. The 95% confidence limits for the deep temperature residuals (where pressure ≥ 500dbar) are ±0.0005°C for SBE35RT-T1, ±0.0005°C for SBE35RT-T2 and ±0.0002°C for T1-T2. The standard deviation for the deep temperature residuals (where pressure ≥ 500dbar) are ±0.0003°C for SBE35RT-T1, ±0.0002°C for SBE35RT-T2 and ±0.0001°C for T1-T2.

The 36-place 10 liter CTD S/N: 831 package had a few issues that affected data processing. The available memory for the SBE35RT unit was full and unable to record bottle trip temperatures for station 27, 34, and 35. The SBE35RT S/N: 350035 originally placed on the CTD S/N: 831 appeared to have communication issues. The result was a steady decline in the number bottle trips recorded for each cast by the SBE35RT sensor. The SBE35RT sensor (S/N: 350035) was replaced with S/N: 350034 on the 36-place 10 liter CTD S/N: 831 package after station 32.

3.5 Conductivity Analysis

Laboratory calibrations of conductivity sensors were performed prior to the cruise at the SeaBird Calibration Facility. Dates of laboratory calibration are recorded on the Underway Sampling Package table and calibration documents are provided in the APPENDIX.

The pre-cruise laboratory calibration coefficients were used to convert SBE4C frequencies to mS/cm conductivity values. Additional shipboard calibrations were performed to correct sensor bias. Corrections for both pressure and temperature sensors were finalized before analyzing conductivity differences. Two independent metrics of calibration accuracy were examined. At each bottle closure, the primary and secondary conductivity were compared with each other. Each sensor was also compared to conductivity calculated from check sample salinities using CTD pressure and temperature. After conductivity offsets were applied to all casts, response to pressure, temperature and conductivity were examined for each conductivity sensor.

An SBE4C sensor typically exhibits a predictable well-modeled response. Offsets for each C sensor were determined using C_{Bottle} - C_{CTD} differences in a deeper pressure range (500 or more dbars). The response model is second order with respect to pressure, a first order with respect to temperature, first order with respect to conductivity and a first order with respect to time. The functions used to apply shipboard calibrations are as follows.

Corrections made to all conductivity sensors are of the form:

$$C\ :sub:`cor` = C + cp\ :sub:`2`P\ :sup:`2` + cp\ :sub:`1`P + c\ :sub:`1`C + c\ :sub:`0`$$

The differences between primary and secondary temperature sensors on the CTD S/N: 638 were used as filtering criteria to reduce the contamination of conductivity comparisons by package wake. The coherence of this relationship is shown in the following figure.

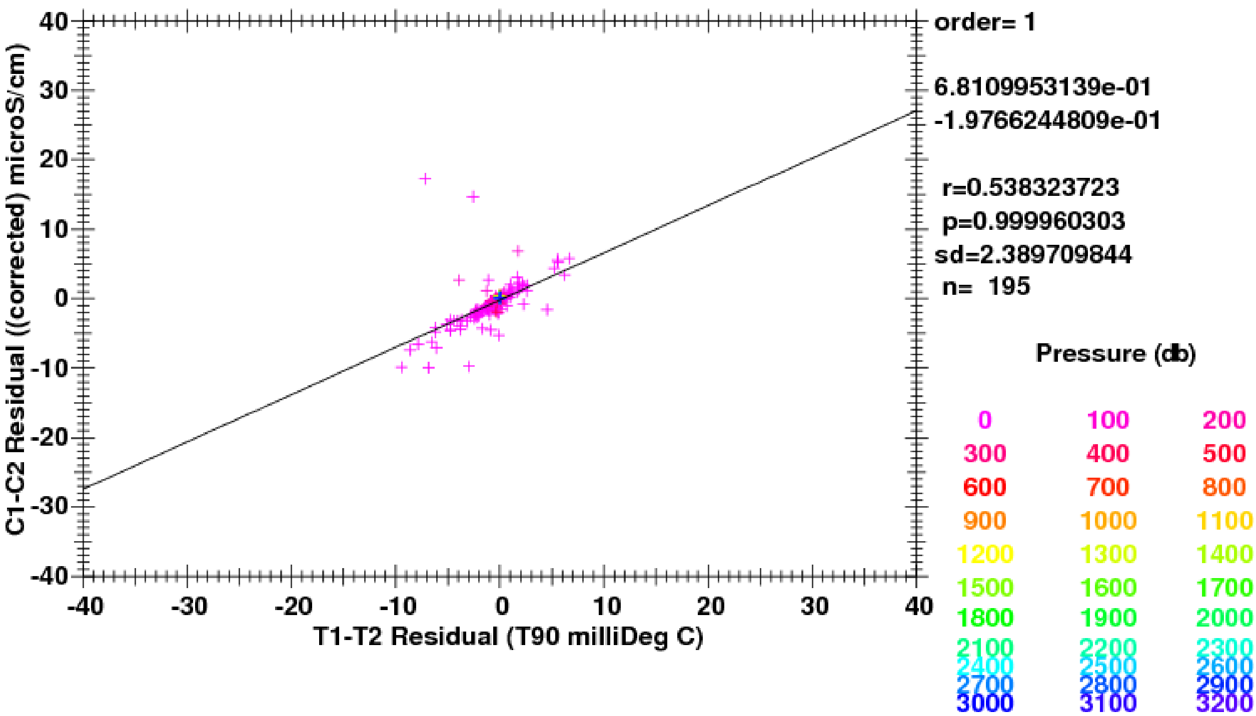

Fig. 3.22: Coherence of conductivity differences as a function of temperature differences.

Primary and secondary conductivity data from S/N: 638 were consistent and stable for the 19 casts performed. No issues were noted with either primary or secondary conductivity sensors on the CTD S/N: 638. However, CTD S/N: 638 did not perform enough casts or enough deep casts to evaluate certain aspects of shipboard calibration. Specifically, S/N: 638 did not collect enough data for time dependent drift analysis nor deep (pressure > 2000 dbar) data corrections. A modified deep pressure analysis (pressure > 500dbar) was adapted to correct for pressure dependent affects commonly noted in CTD sensors. The following figures *Corrected CBottle - C1 by station (-0.002°C T1-T2 0.002°C).* through *Modified Deep Corrected C1-C2 by pressure (Pressure >= 500dbar).* illustrate the modified version of residual conductivity differences for CTD S/N: 638 as best applied with a limited number of N samples.

Salinity residuals for CTD S/N: 638 after applying shipboard P/T/C corrections are summarized in figures *Salinity residuals by station (-0.002°C T1-T2 0.002°C).* through *Modified Deep Salinity residuals by pressure (Pressure >= 500dbar).*. Only CTD and bottle salinity data with "acceptable" quality codes are included in the differences.

The 95% confidence limits for the mean low-gradient (values -0.002°C $\leq$ T1-T2 $\leq$ 0.002°C) differences are $\pm$0.0013°C for salnity-S1. The 95% confidence limits for the modified deep salinity residuals (where pressure $\geq$

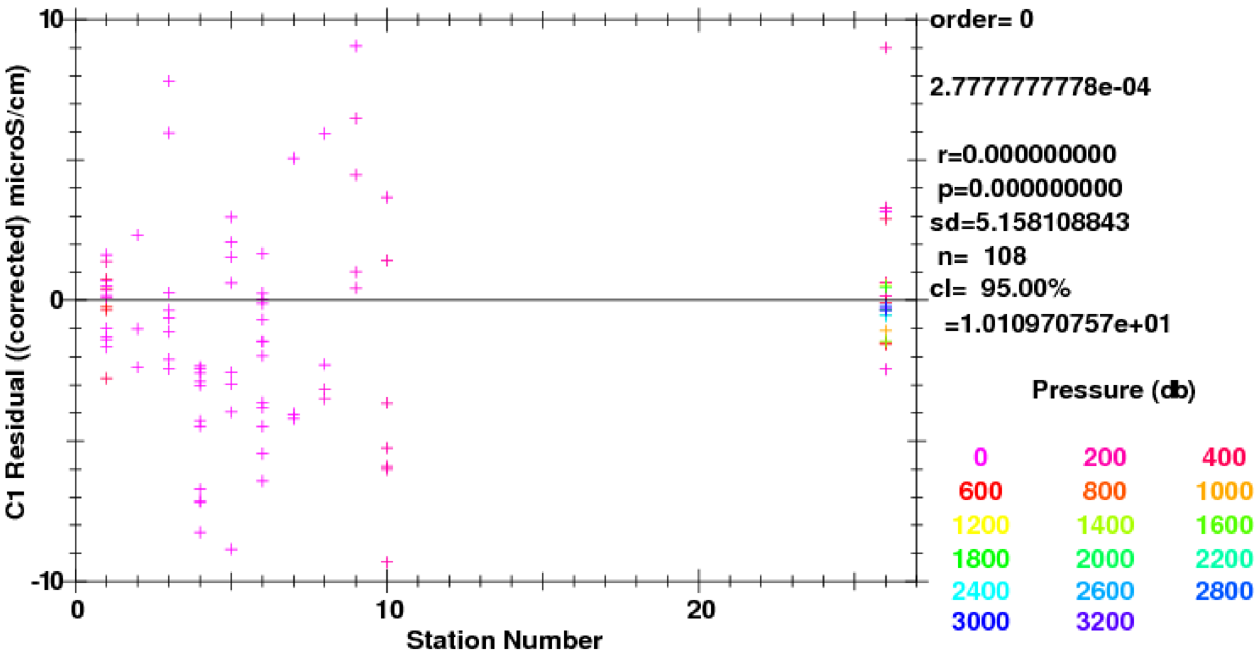

Fig. 3.23: Corrected C_{Bottle} - C1 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

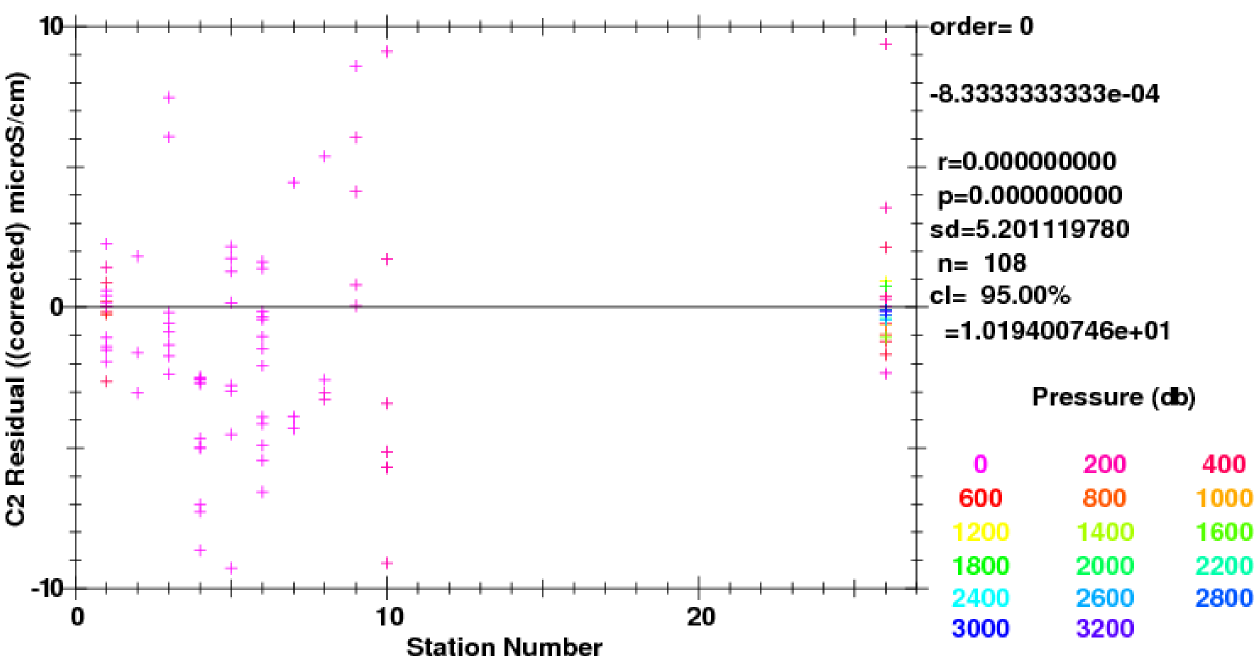

Fig. 3.24: Corrected C_{Bottle} - C2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

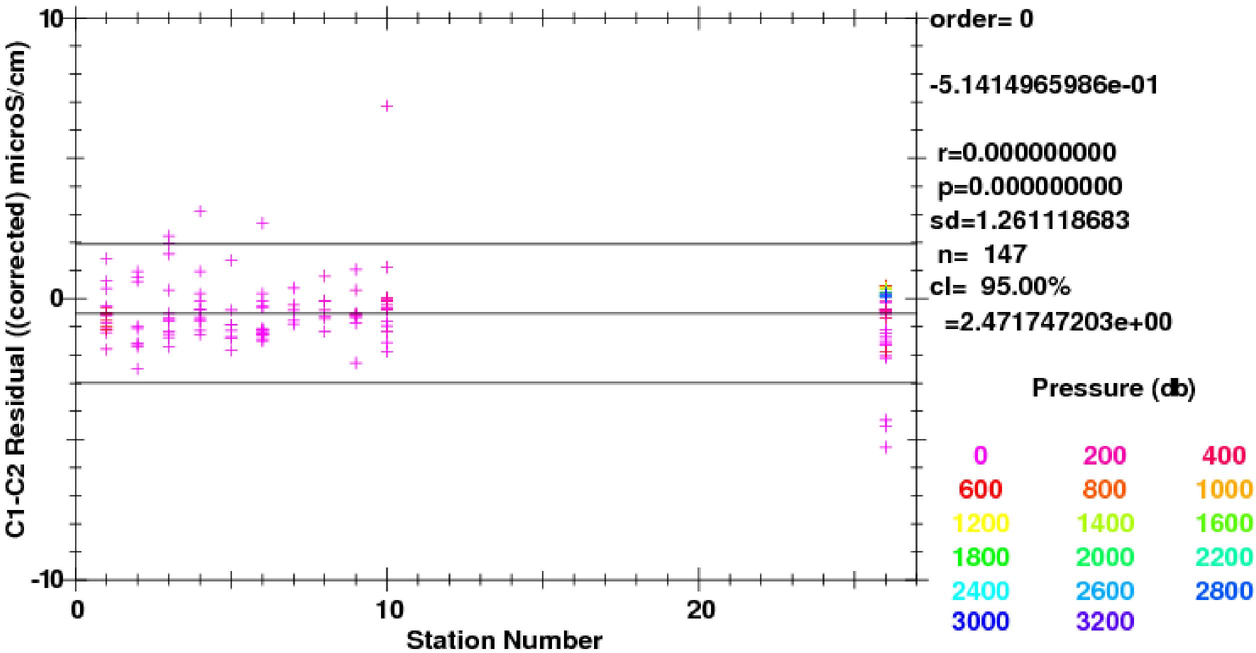

Fig. 3.25: Corrected C1-C2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

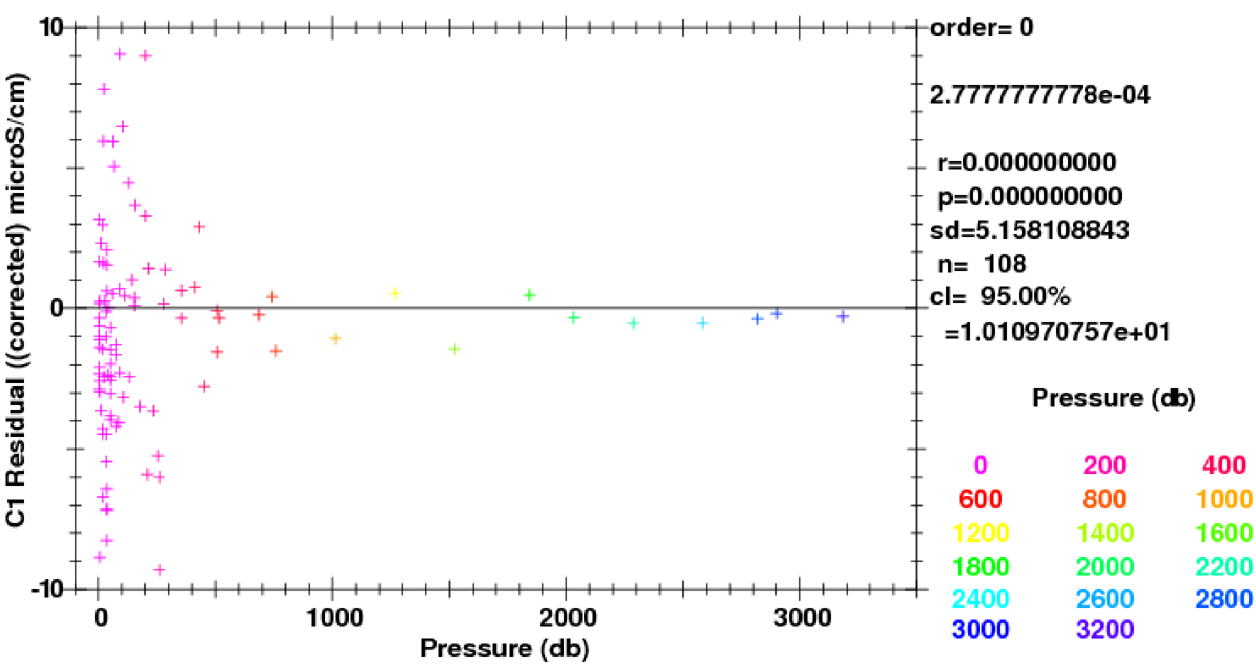

Fig. 3.26: Corrected C_{Bottle} - C1 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

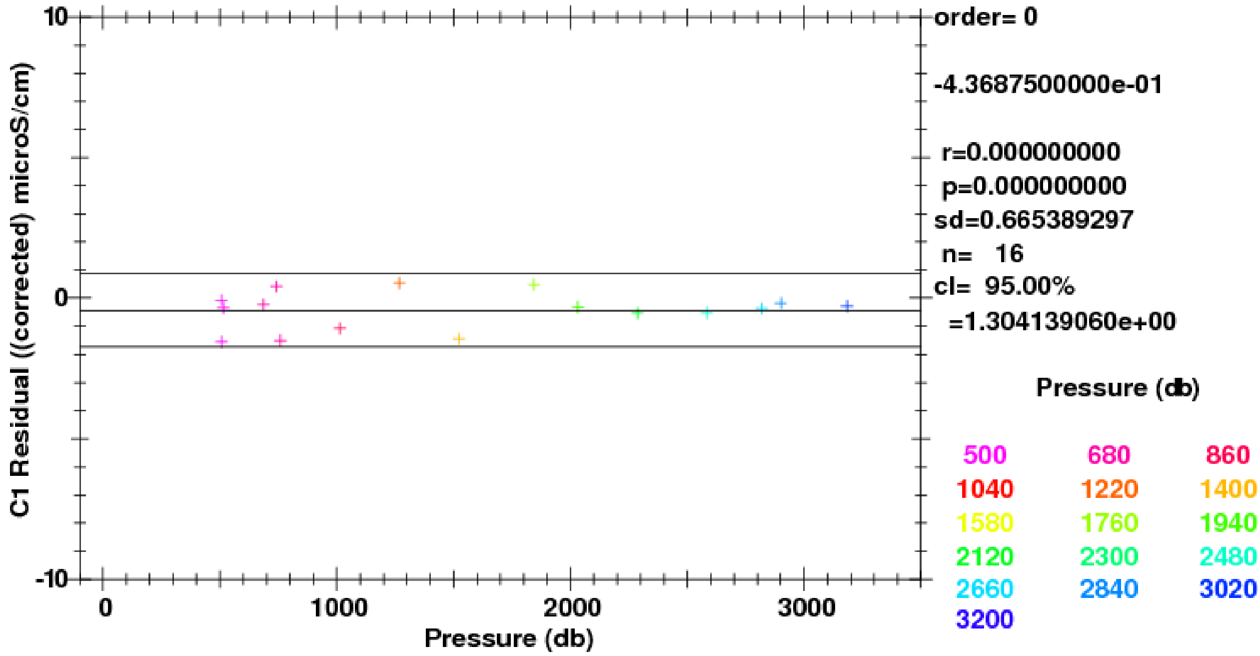

Fig. 3.27: Modified Deep Corrected C_{Bottle} - C1 by pressure (Pressure >= 500dbar).

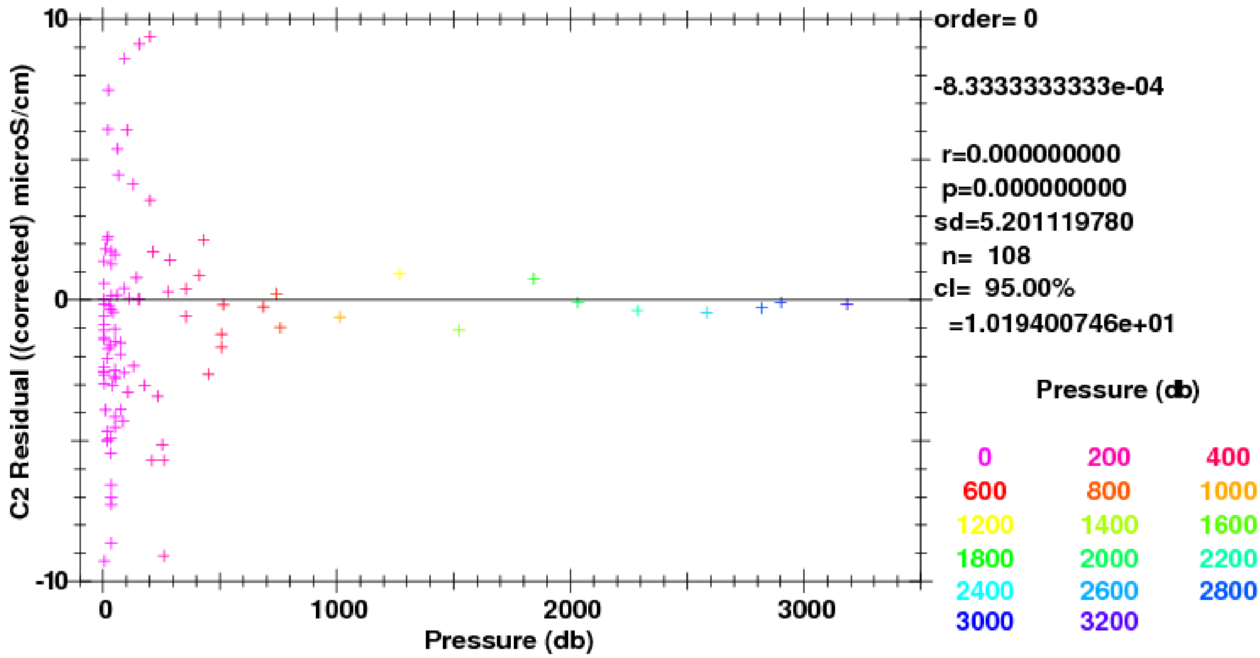

Fig. 3.28: Corrected C_{Bottle} - C2 by pressure (-0.002°C $\leq$ T1-T2 $\leq$ 0.002°C).

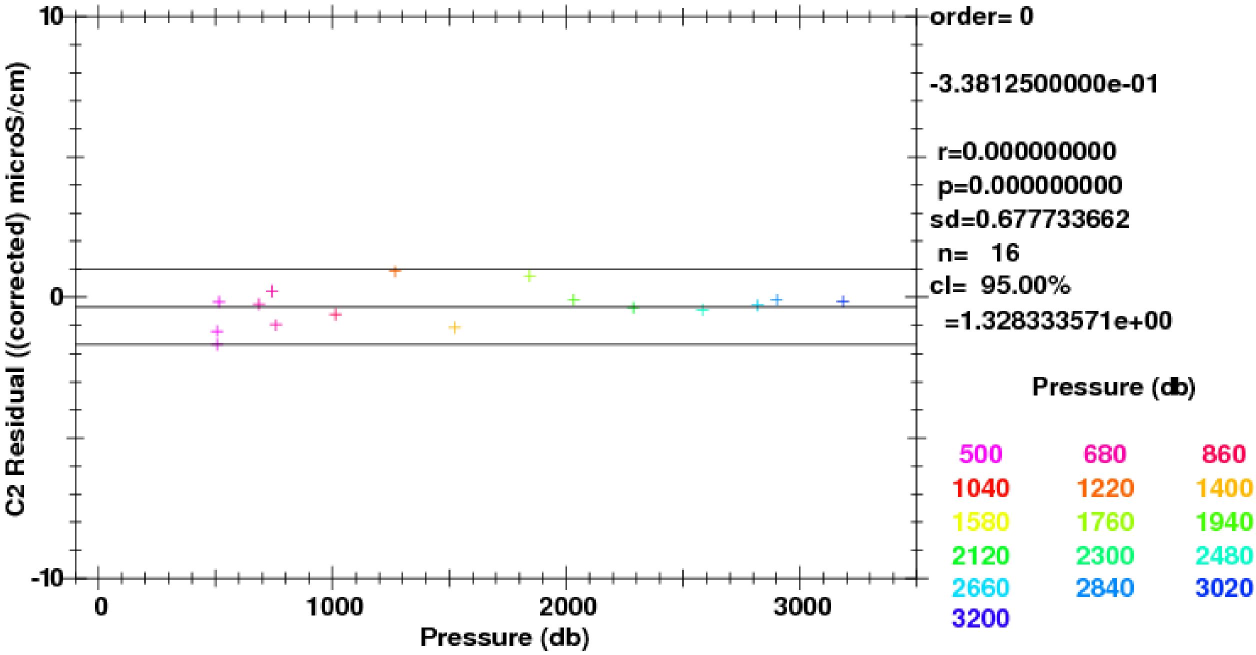

Fig. 3.29: Modified Deep Corrected C_{Bottle} - C2 by pressure (Pressure >= 500dbar).

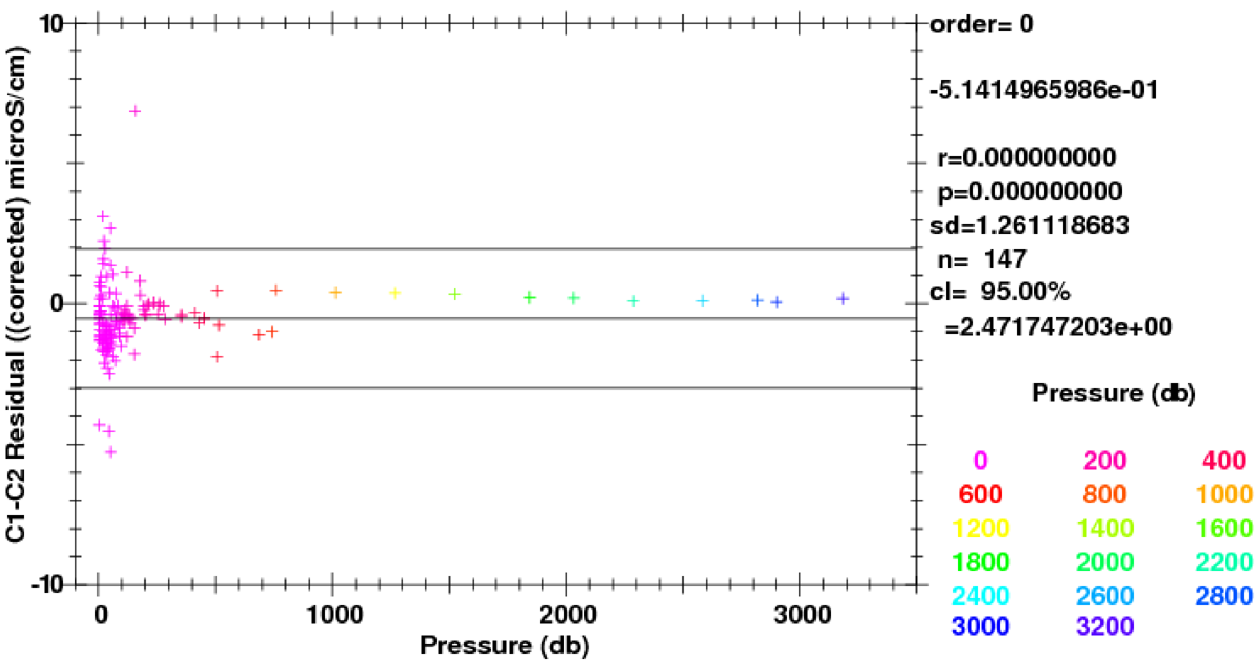

Fig. 3.30: Corrected C1-C2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

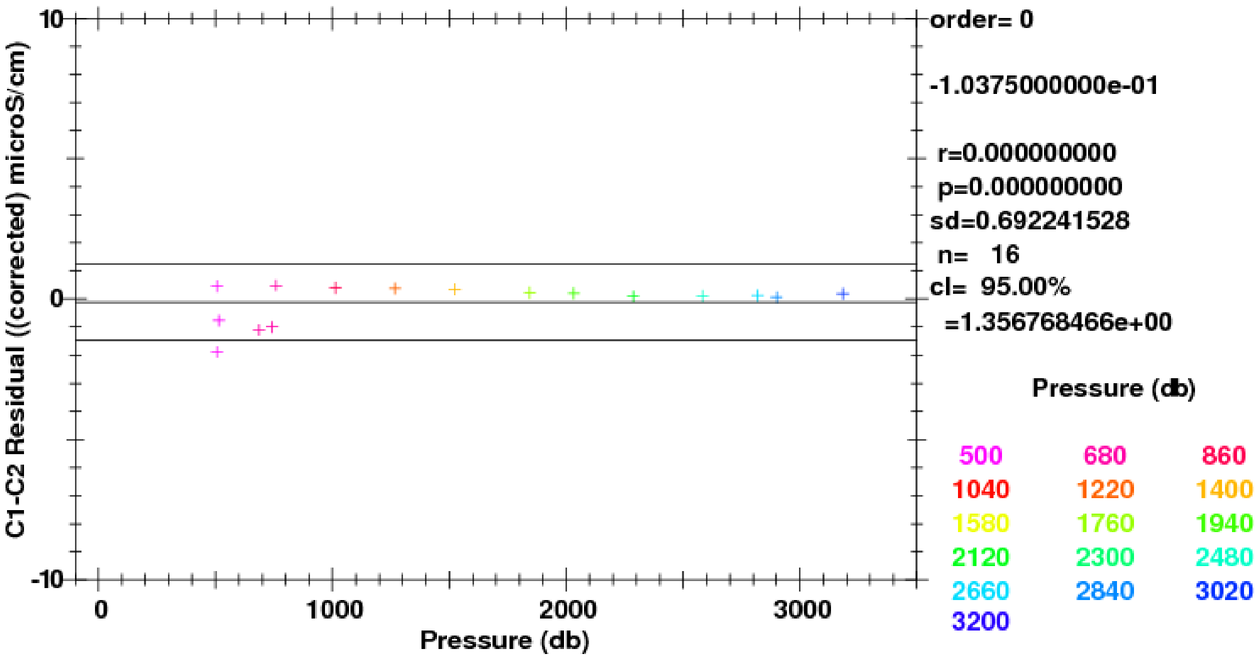

Fig. 3.31: Modified Deep Corrected C1-C2 by pressure (Pressure >= 500dbar).

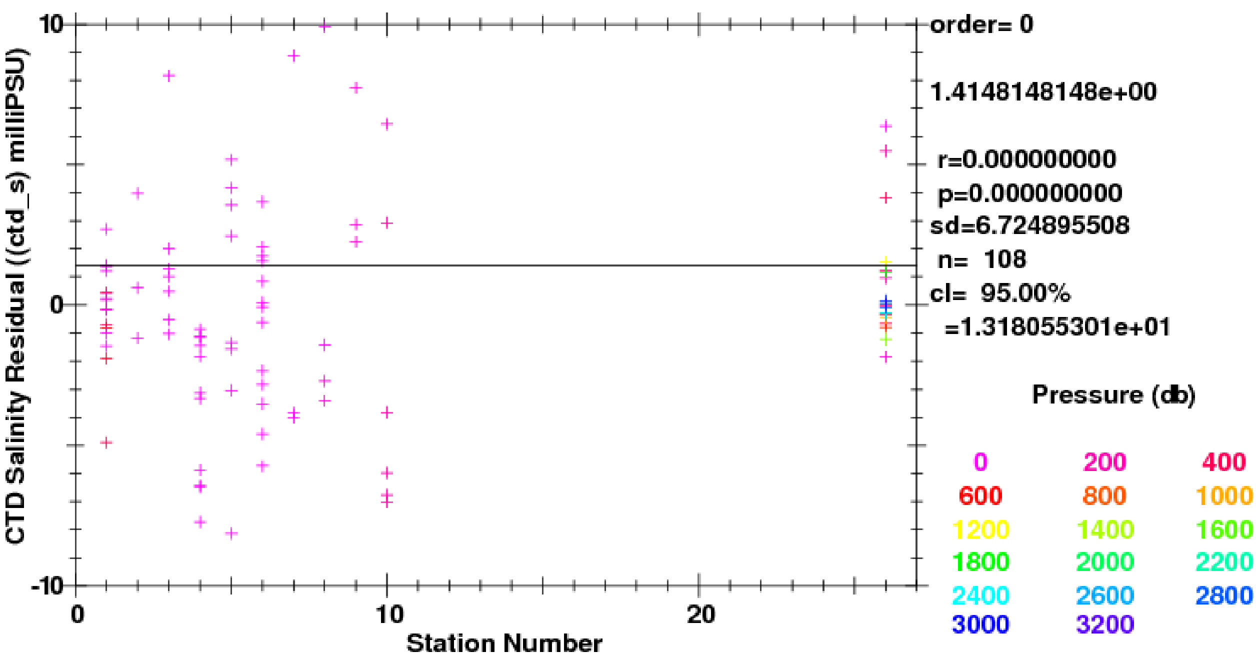

Fig. 3.32: Salinity residuals by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

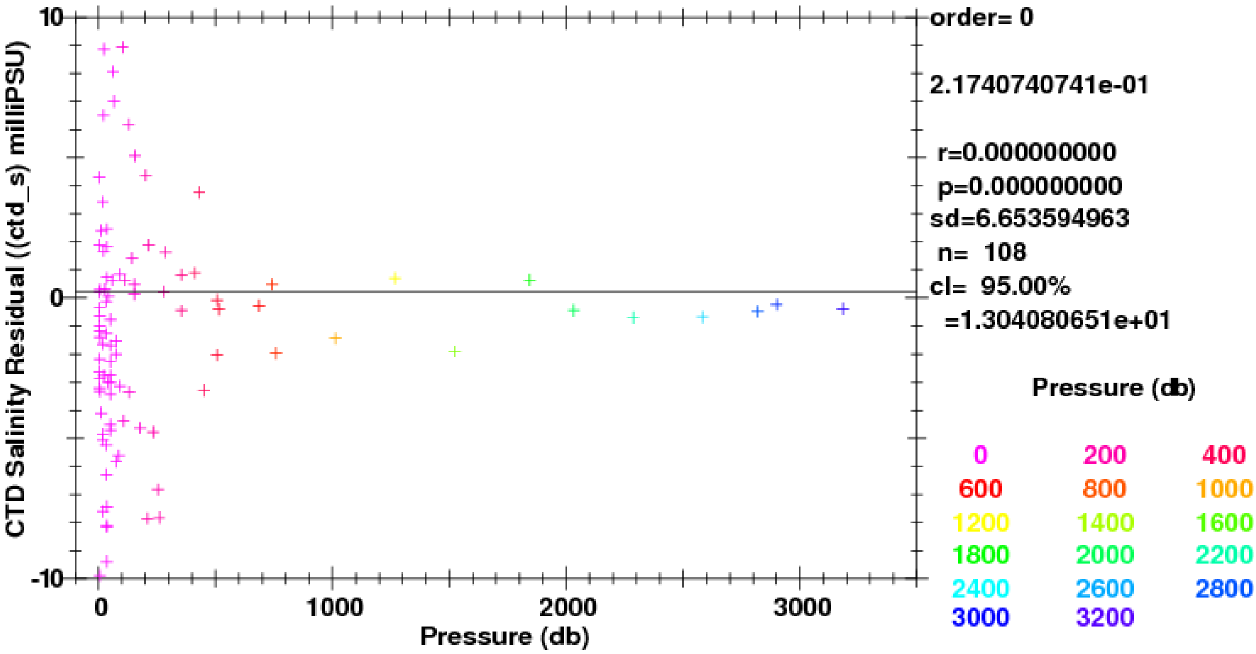

Fig. 3.33: Salinity residuals by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

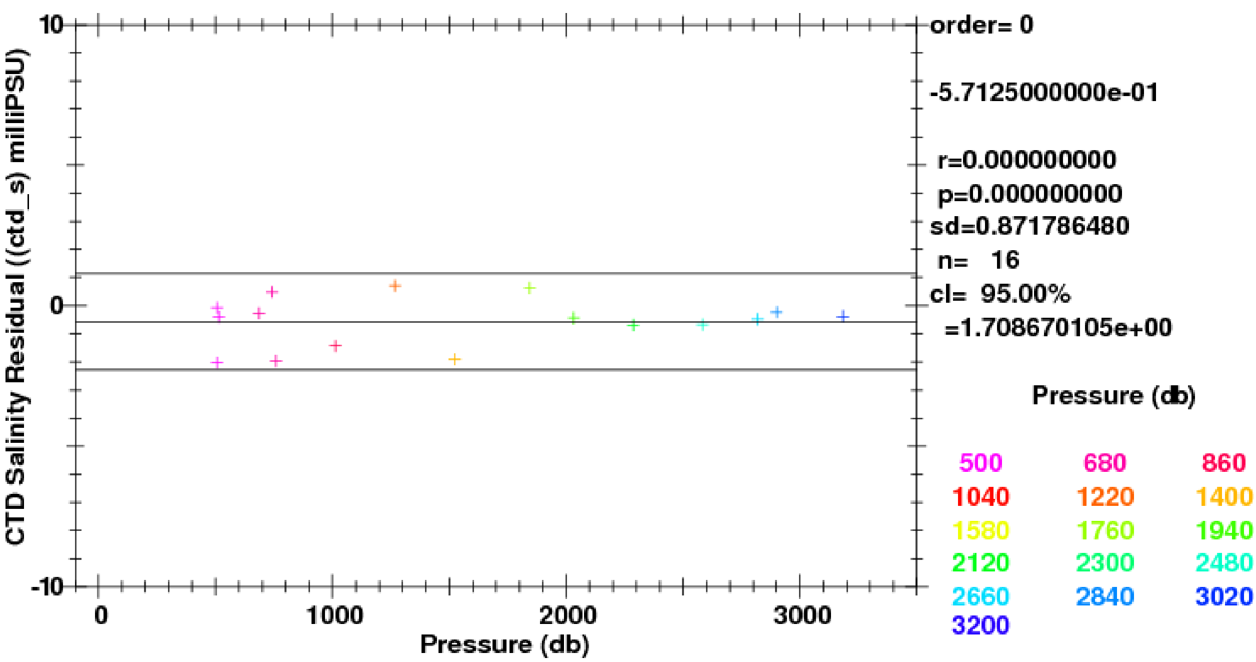

Fig. 3.34: Modified Deep Salinity residuals by pressure (Pressure >= 500dbar).

500dbar) are ±0.0017°C for salinity-S1. The standard deviation for the mean low-gradient (values -0.002°C ≤ T1-T2 ≤ 0.002°C) differences are ±0.0067°C for salnity-S1. The standard deviation for the modified deep salinity residuals (where pressure ≥ 500dbar) are ±0.0009°C for salinity-S1.

Primary and secondary conductivity data from CTD S/N: 831 were not completely consistent nor stable for the 87 casts performed during this cruise. The primary conductivity sensor S/N: 43023 on CTD S/N: 831 was replaced with S/N: 43176 after a significant drift was noted with respect to pressure. High gradient near surface salinity was present due to ice melt. This proved problematic in fitting conductivity data where conductivity sensor response time and conductivity cell sensitivity within the salinometer are not ideally suited to precisely measuring high gradient in a relatively shallow depths. In other words surface freshening of Arctic waters occur at a rate that proved problematic for the threshold limits of both the conductivity sensor and salinometer cell tolerances. Certain analytical methods can be adopted to modify the overall limited measurement response of either piece of equipment. The first is to increase the number of salinometer cell flushes before cell measurement from the standard 2 flushes to 3 or 4 depending on the sample volume. The second is to increase the poly-fit order of the conductivity measurements from the standard first order fit with response to temperature to a second order fit.

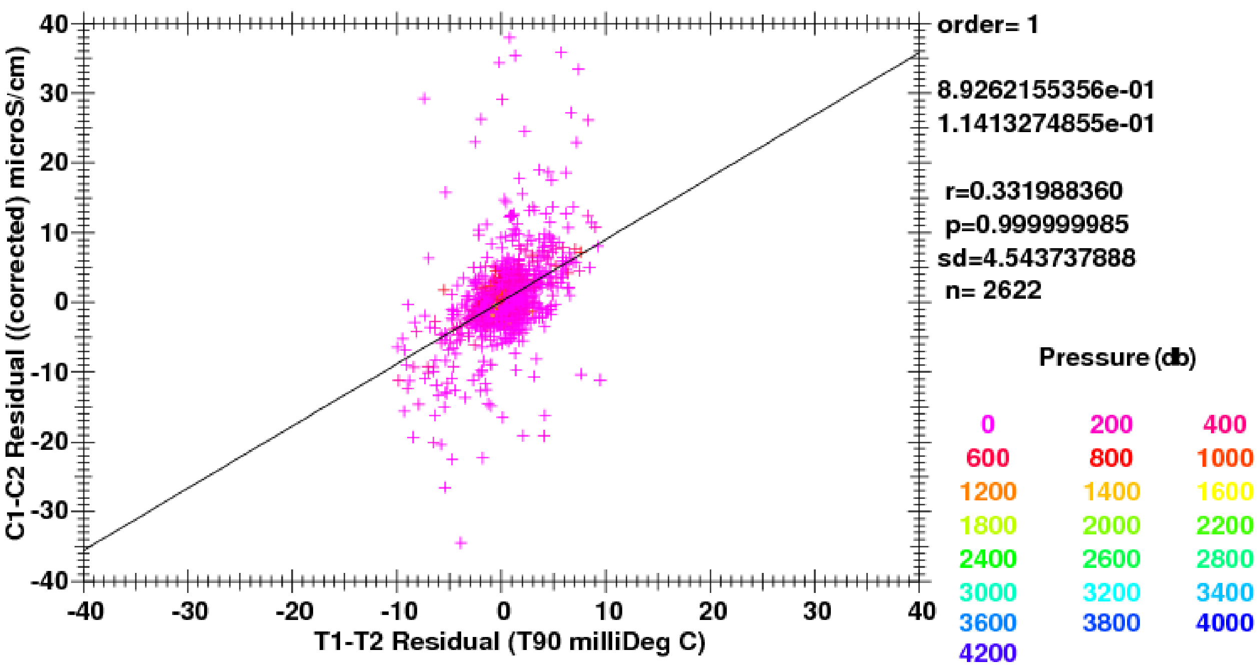

Fig. 3.35: Coherence of conductivity differences as a function of temperature differences.

The following figures *Corrected CBottle - C1 by station (-0.002°C T1-T2 0.002°C).* through *Deep Corrected C1-C2 by pressure (Pressure >= 2000dbar).* illustrate the residual conductivity differences for CTD S/N: 831.

Salinity residuals for CTD S/N: 831 after applying shipboard P/T/C corrections are summarized in figures *Salinity residuals by pressure (-0.002°C T1-T2 0.002°C)* through ref:*Corrected_36pl-s12*. Only CTD and bottle salinity data with "acceptable" quality codes are included in the differences.

The 95% confidence limits for the mean low-gradient (values -0.002°C ≤ T1-T2 ≤ 0.002°C) differences are ±0.010°C for salnity-S1. The 95% confidence limits for the modified deep salinity residuals (where pressure ≥ 2000dbar) are ±0.0016°C for salinity-S1. The standard deviation for the mean low-gradient (values -0.002°C ≤ T1-T2 ≤ 0.002°C) differences are ±0.0052°C for salnity-S1. The standard deviation for the modified deep salinity residuals (where pressure ≥ 500dbar) are ±0.0008°C for salinity-S1.

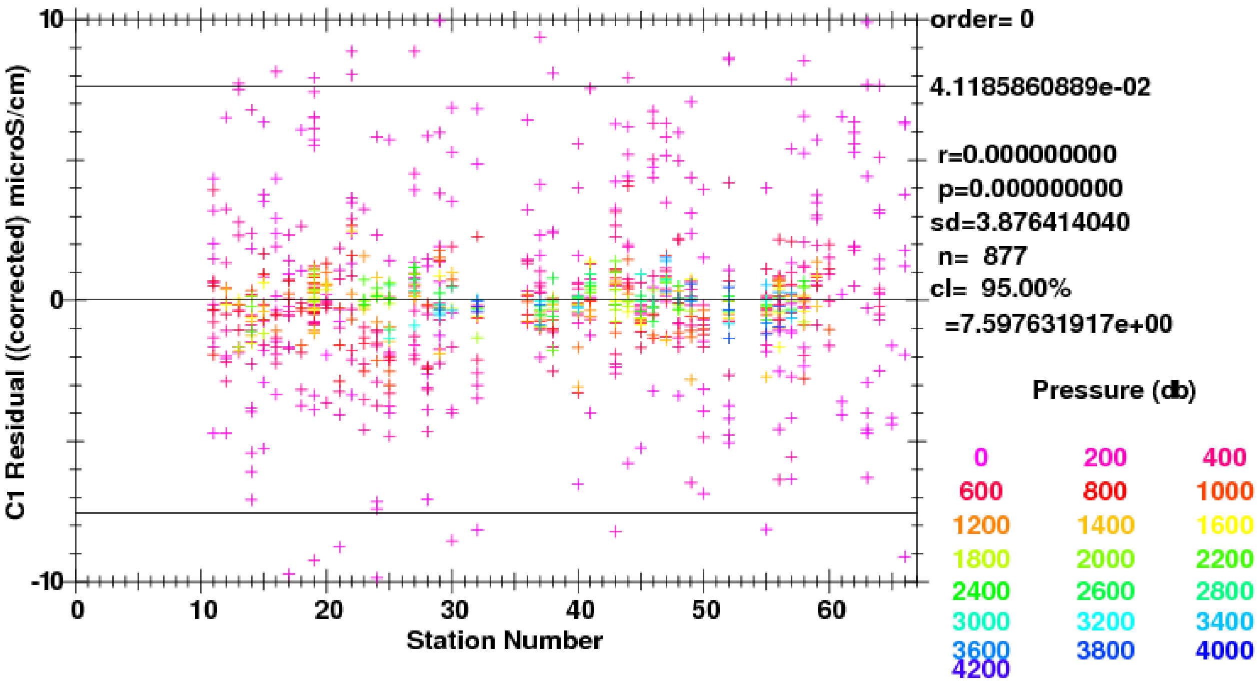

Fig. 3.36: Corrected C_{Bottle} - C1 by station (-0.002°C $\leq$ T1-T2 $\leq$ 0.002°C).

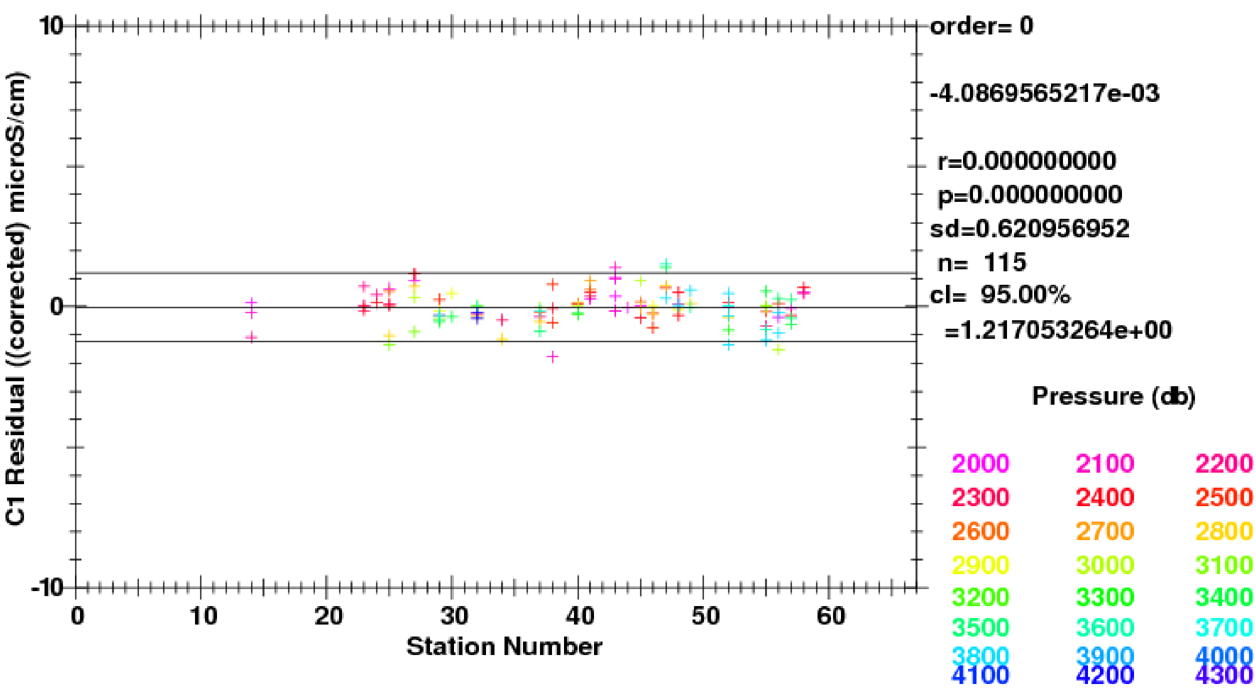

Fig. 3.37: Deep Corrected C_{Bottle} - C2 by station (Pressure >= 2000dbar).

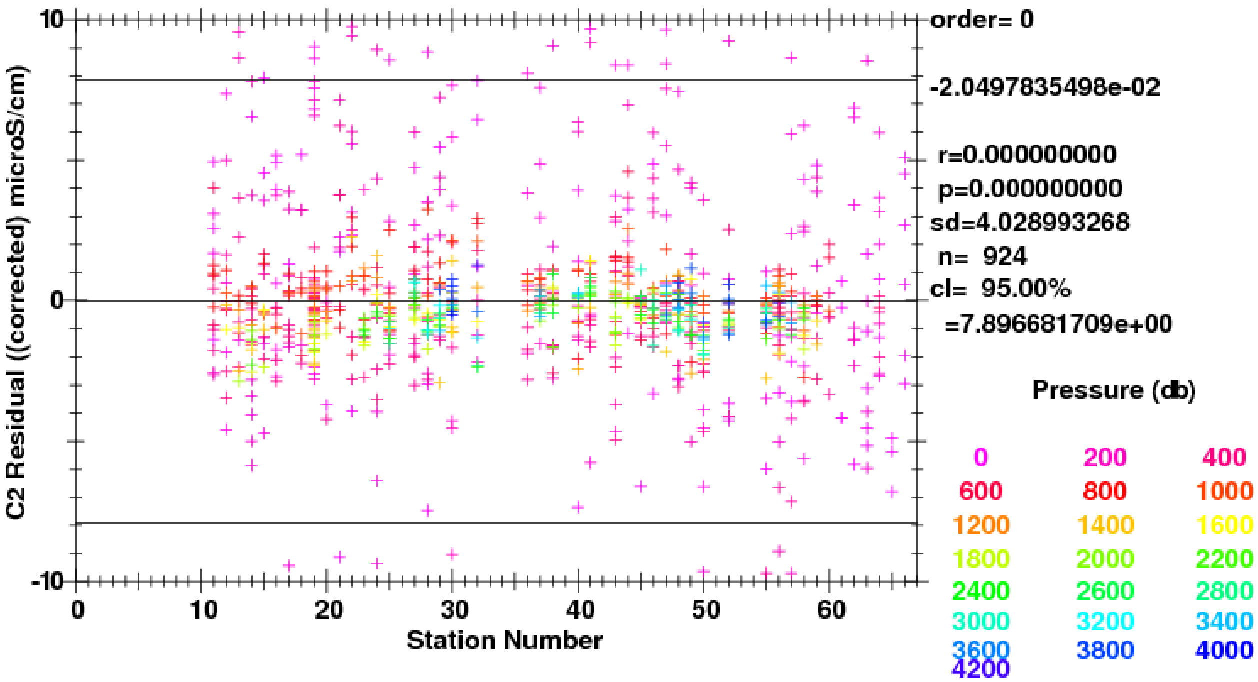

Fig. 3.38: Corrected C_{Bottle} - C2 by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

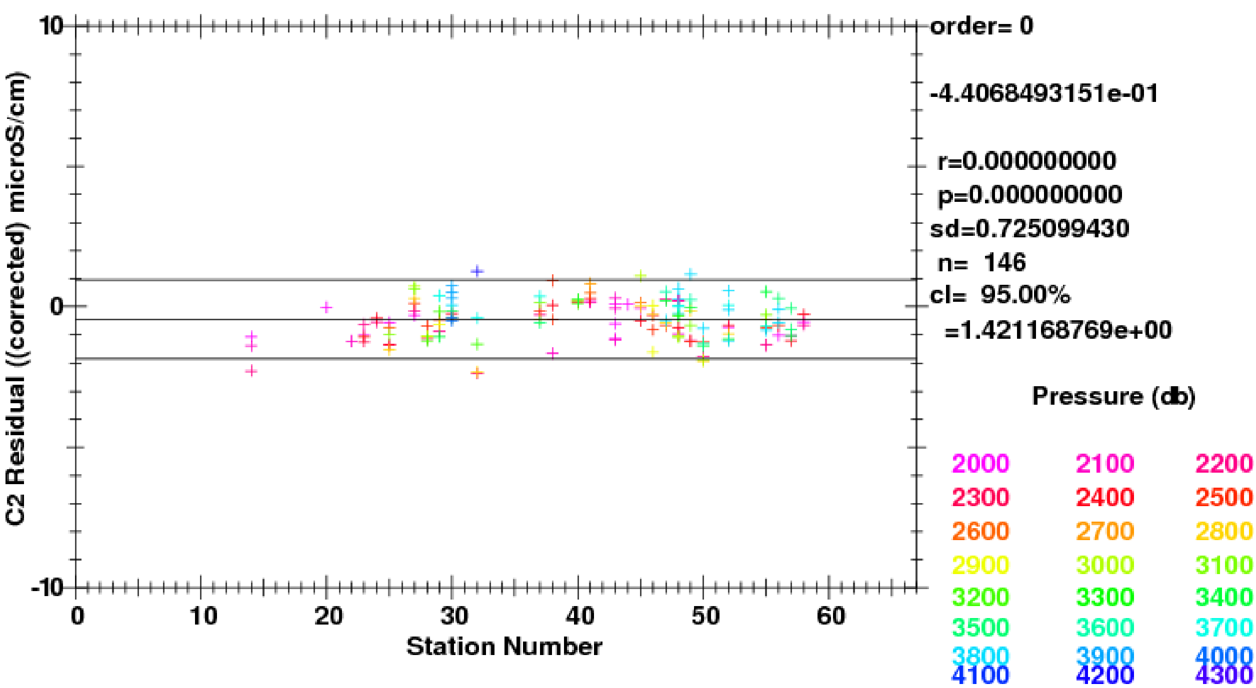

Fig. 3.39: Deep Corrected C_{Bottle} - C2 by station (Pressure >= 2000dbar).

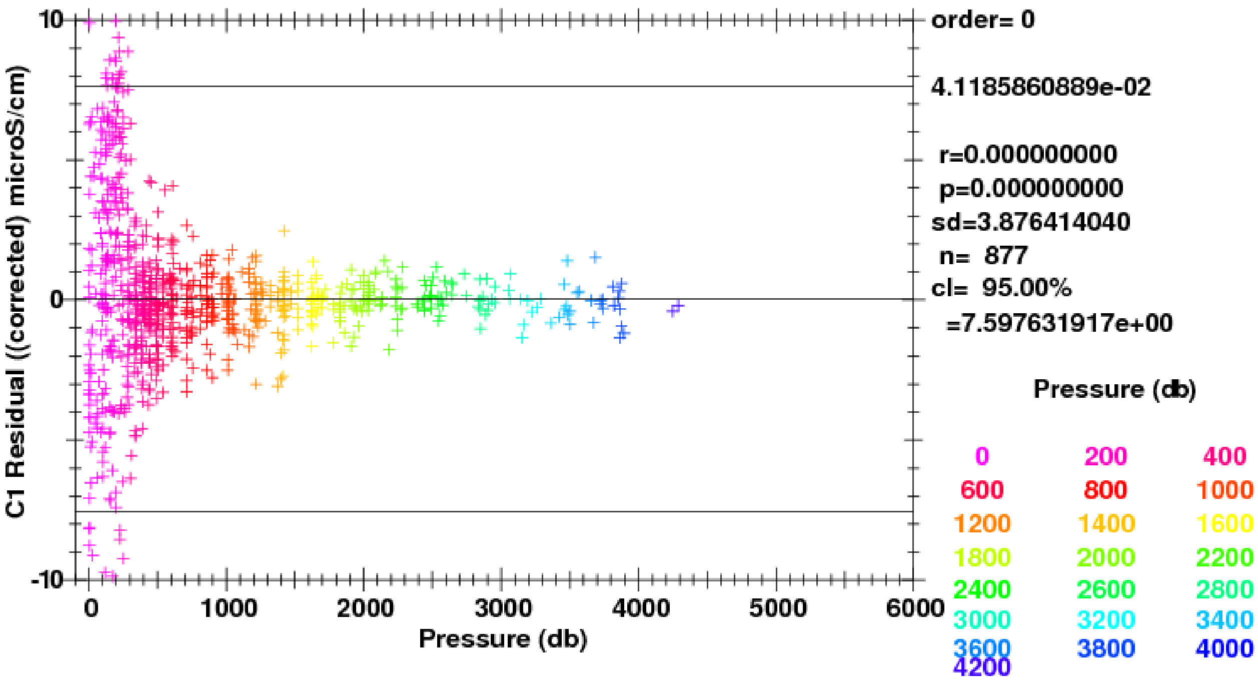

Fig. 3.40: Corrected C_{Bottle} - C1 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

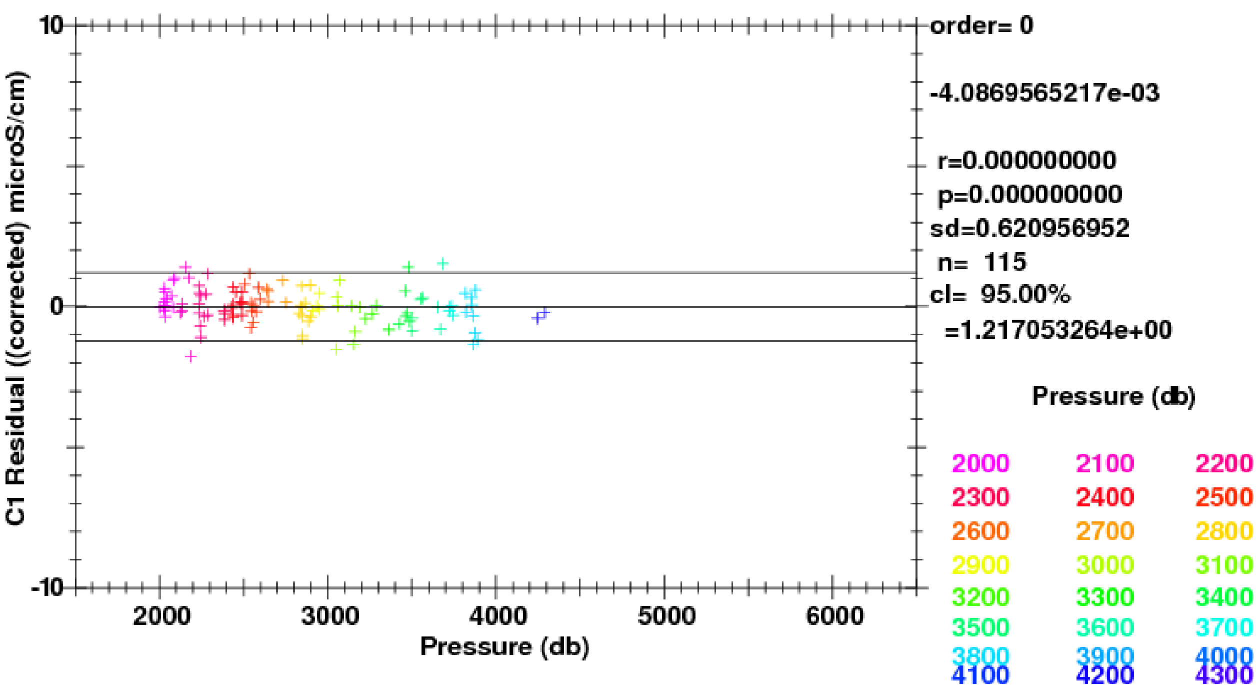

Fig. 3.41: Deep Corrected C_{Bottle} - C1 by pressure (Pressure >= 2000dbar).

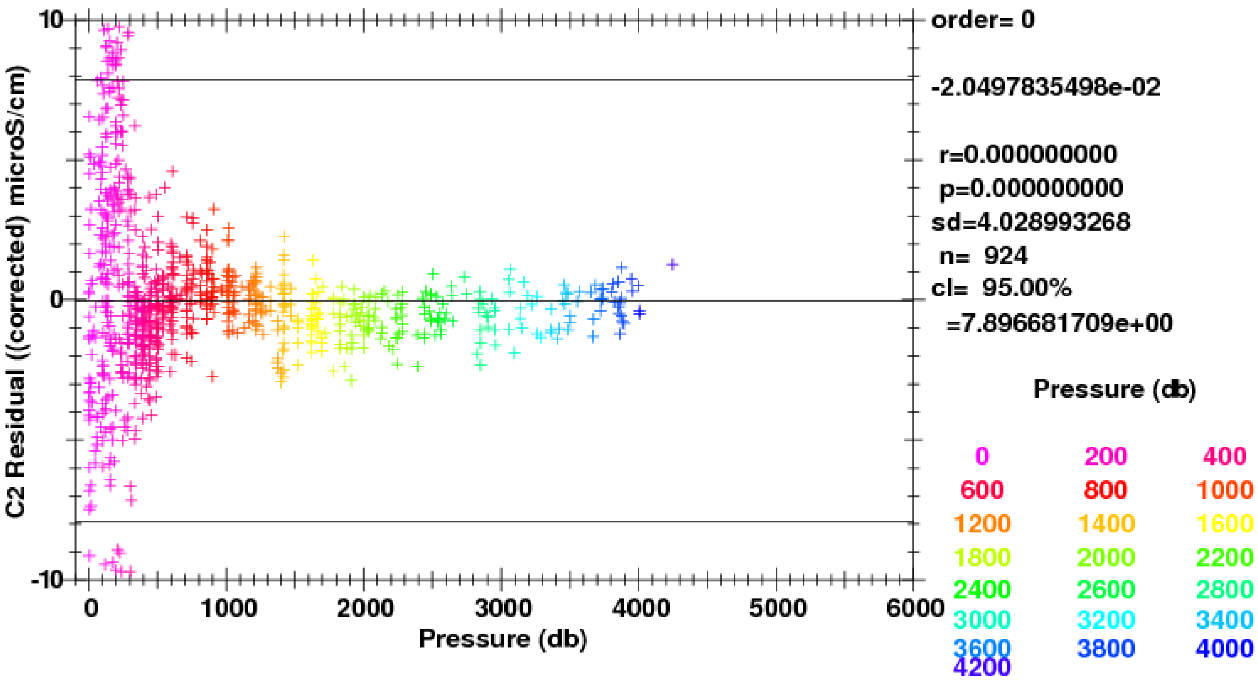

Fig. 3.42: Corrected C_{Bottle} - C2 by pressure (-0.002°C $\leq$ T1-T2 $\leq$ 0.002°C).

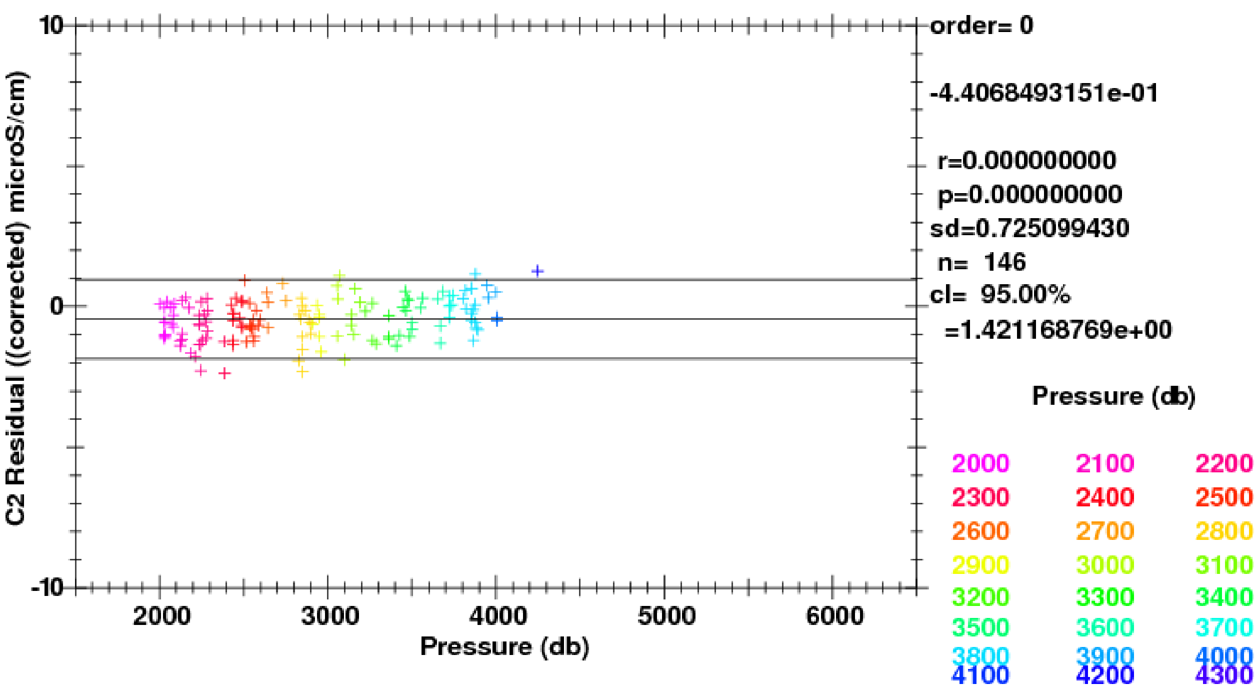

Fig. 3.43: Deep Corrected C_{Bottle} - C2 by pressure (Pressure >= 2000dbar).

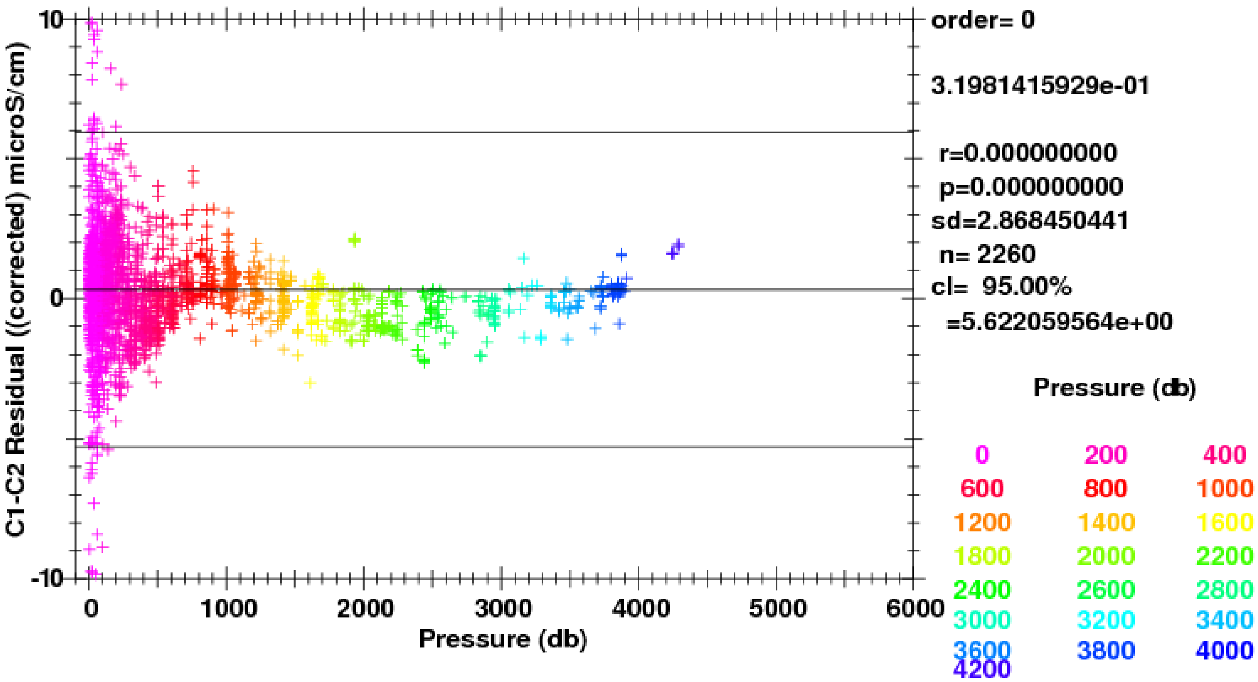

Fig. 3.44: Corrected C1-C2 by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

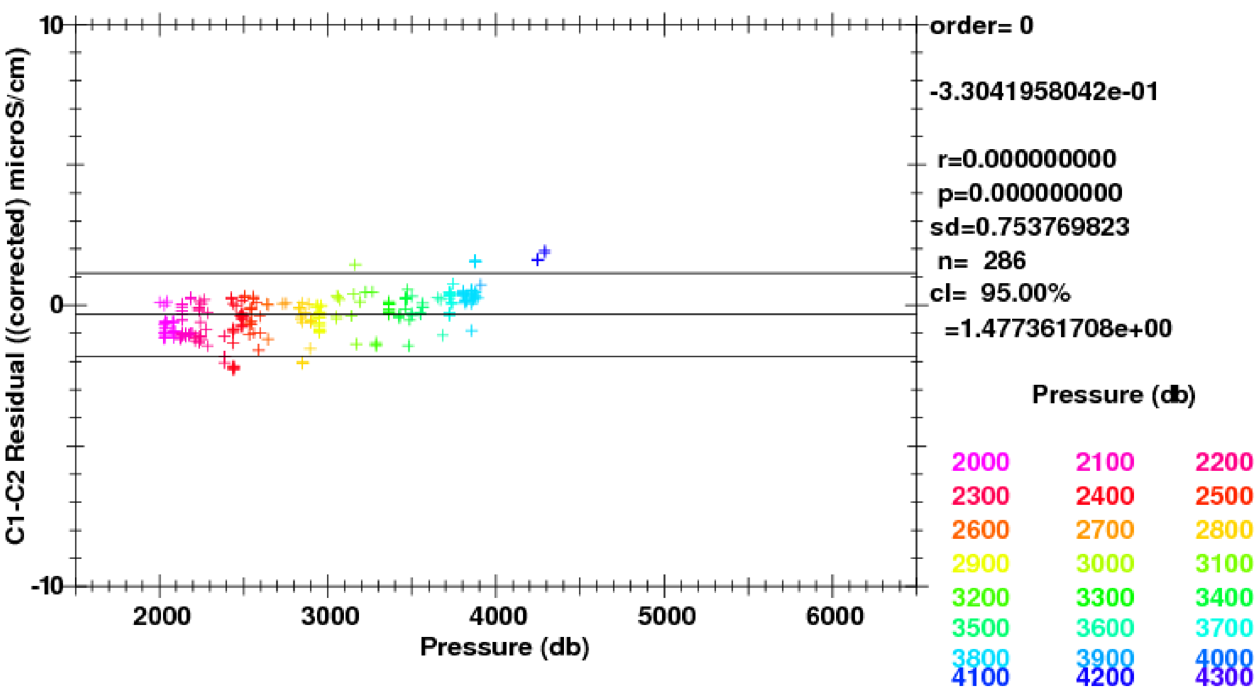

Fig. 3.45: Deep Corrected C1-C2 by pressure (Pressure >= 2000dbar).

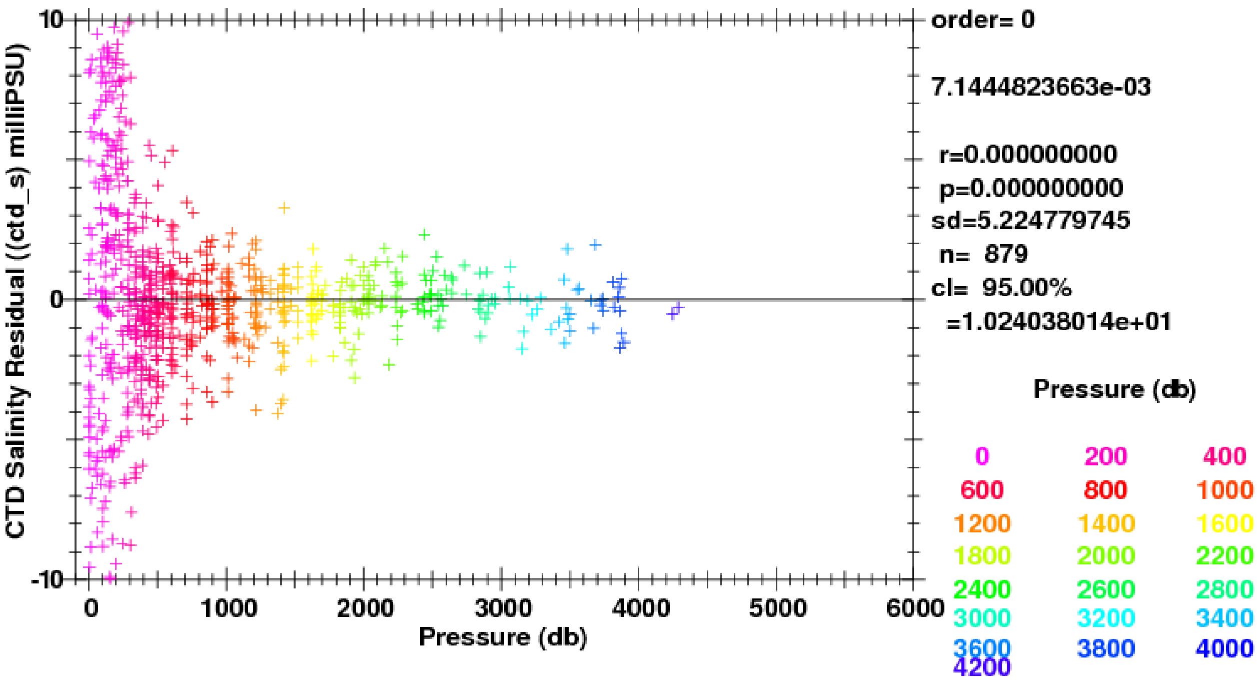

Fig. 3.46: Salinity residuals by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C)

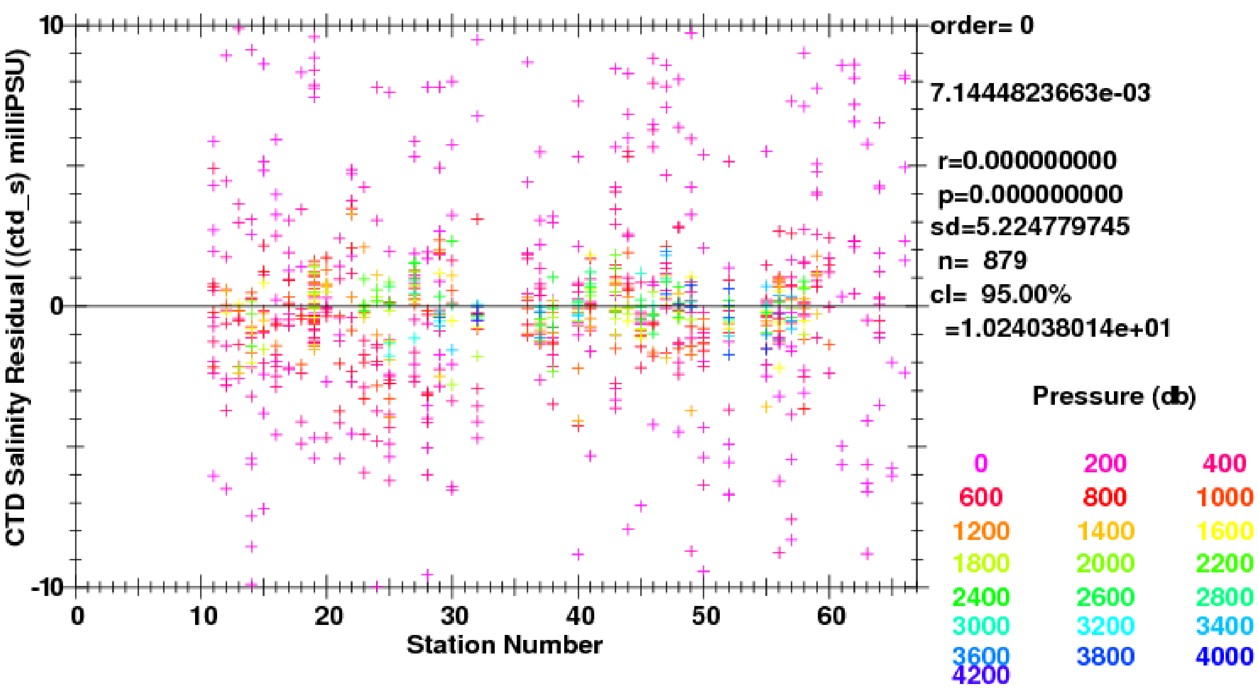

Fig. 3.47: Salinity residuals by station (-0.002°C ≤ T1-T2 ≤ 0.002°C)

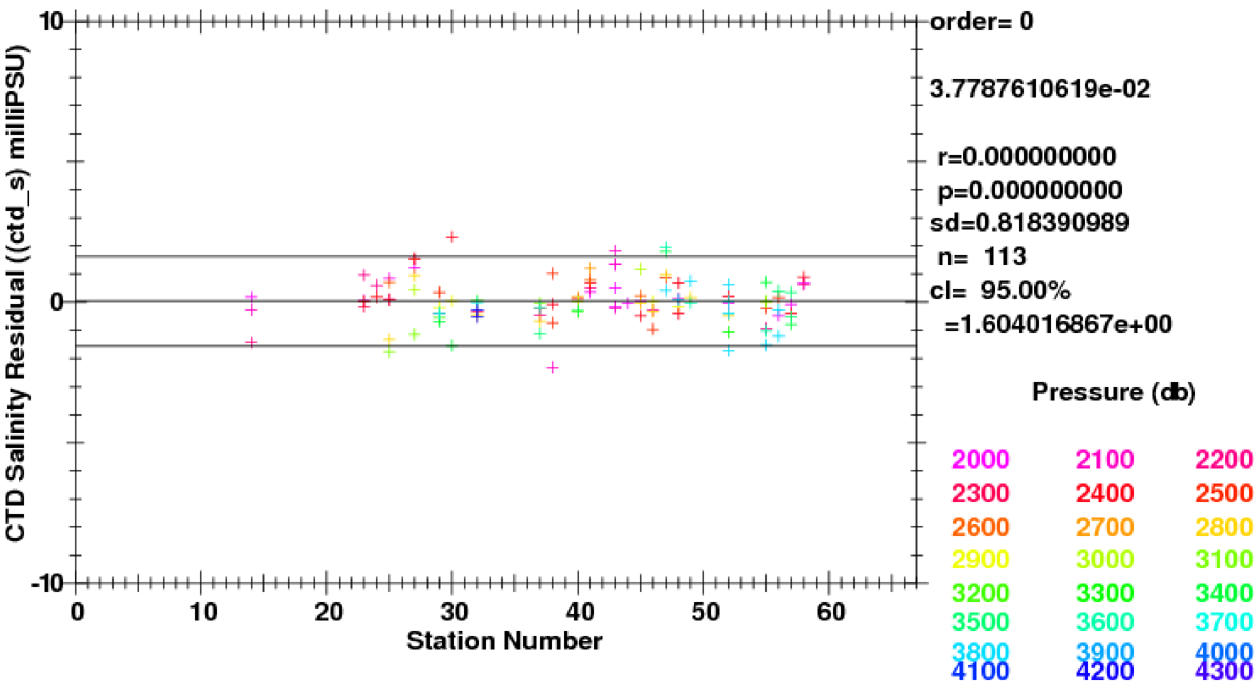

Fig. 3.48: Modified Deep Salinity residuals by station (Pressure >= 2000dbar)

3.6 CTD Dissolved Oxygen

Laboratory calibrations of the dissolved oxygen sensors were performed prior to the cruise at the SeaBird Calibration Facility. Dates of laboratory calibration are recorded on the Underway Sampling Package table and calibration documents are provided in the APPENDIX.

The pre-cruise laboratory calibration coefficients were used to convert SBE43 frequencies to µmol/kg oxygen values for acquisition only. Additional shipboard fitting was performed to correct for the sensors' non-linear response. Corrections for pressure, temperature and conductivity sensors were finalized before analyzing dissolved oxygen data. The SBE43 sensor data were compared to dissolved O_2 check samples taken at bottle stops by matching the down cast CTD data to the up cast trip locations along isopycnal surfaces. CTD dissolved O_2 was then calculated using Clark Cell MPOD O_2 sensor response model for Beckman/SensorMedics and SBE43 dissolved O_2 sensors. The residual differences of bottle check value versus CTD dissolved O_2 values are minimized by optimizing the SIO DO sensor response model coefficients with a Levenberg-Marquardt non-linear least squares fitting procedure.

The general form of the SIO DO sensor response model equation for Clark cells follows Owens and Millard *[Owen85]* CTD dissolved oxygen algorithm. SIO models DO sensor secondary responses with lagged CTD data. In-situ pressure and temperature are filtered to match the sensor responses. Time constants for the pressure response (τ_p), a slow τ_{Tf} and fast τ_{Ts} thermal response, package velocity τ_{dP}, thermal diffusion τ_{dT} and pressure hysteresis τ_h are fitting parameters. Once determined for a given sensor, these time constants typically remain constant for a cruise. The thermal diffusion term is derived by low-pass filtering the difference between the fast response T_s and slow response T_l temperatures. This term is intended to correct non-linearity in sensor response introduced by inappropriate analog thermal compensation. Package velocity is approximated by low-pass filtering 1st-order pressure differences, and is intended to correct flow-dependent response. Dissolved O_2 concentration is then calculated:

$$O_2\text{ml/l} = \left[C_1 \cdot V_{\text{DO}} \cdot e^{C_2 \frac{P_h}{5000}} + C_3\right] \cdot f_{\text{sat}}(T, P) \cdot e^{\left(C_4 t_l + C_5 t_s + C_7 P_l + C_6 \frac{dO_c}{dT} + C_8 \frac{dP}{dTt} + C_9 dT\right)}$$

Where:

- O_2 ml/l Dissolved O_2 concentration in ml/l

- V_{DO} Raw sensor output
- C_1 Sensor slope
- C_2 Hysteresis response coefficient
- C_3 Sensor offset
- f_{sat} (T , P)|O2| saturation at T,P (ml/l)
- T In-situ temperature (°C)
- P In-situ pressure (decibars)
- P_h Low-pass filtered hysteresis pressure (decibars)
- T_l Long-response low-pass filtered temperature (°C)
- T_s Short-response low-pass filtered temperature (°C)
- P_l Low-pass filtered pressure (decibars)
- dO_c / dt Sensor current gradient (µamps/sec)
- dP/dt Filtered package velocity (db/sec)
- dT Low-pass filtered thermal diffusion estimate (T_s - T_l)
- C_4 - C_9 Response coefficients

No sensor complications or issues affected analysis of dissolved oxygen sensor data of the CTD S/N: 638. As previously stated, CTD S/N: 638 did not perform enough casts or enough deep casts to evaluate certain aspects of shipboard calibration. A modified deep pressure (pressure > 500dbar) was adapted to complete partial analysis. The CTD S/N: 638 dissolved O_2 residuals are shown in the following figures *O2 residuals by pressure (-0.002°C T1-T2 0.002°C).* through *Deep O2 residuals by station (Pressure >= 500dbar).*.

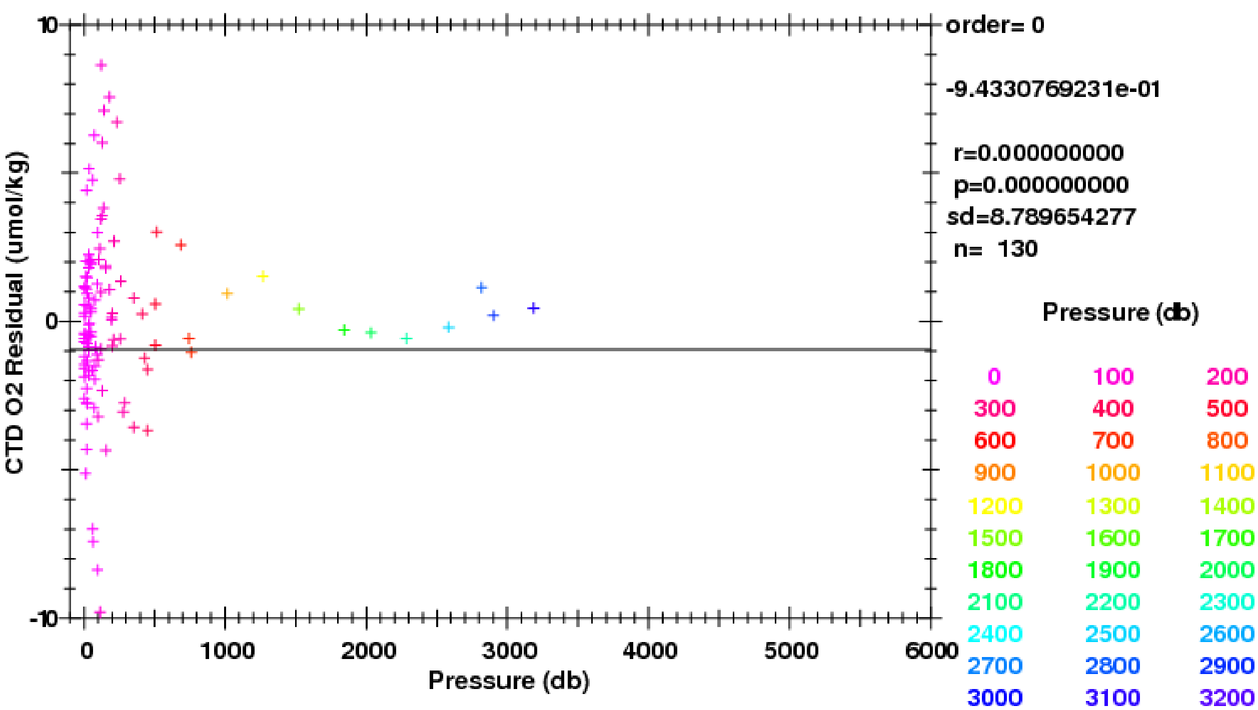

Fig. 3.49: O_2 residuals by pressure (-0.002°C $\leq$ T1-T2 $\leq$ 0.002°C).

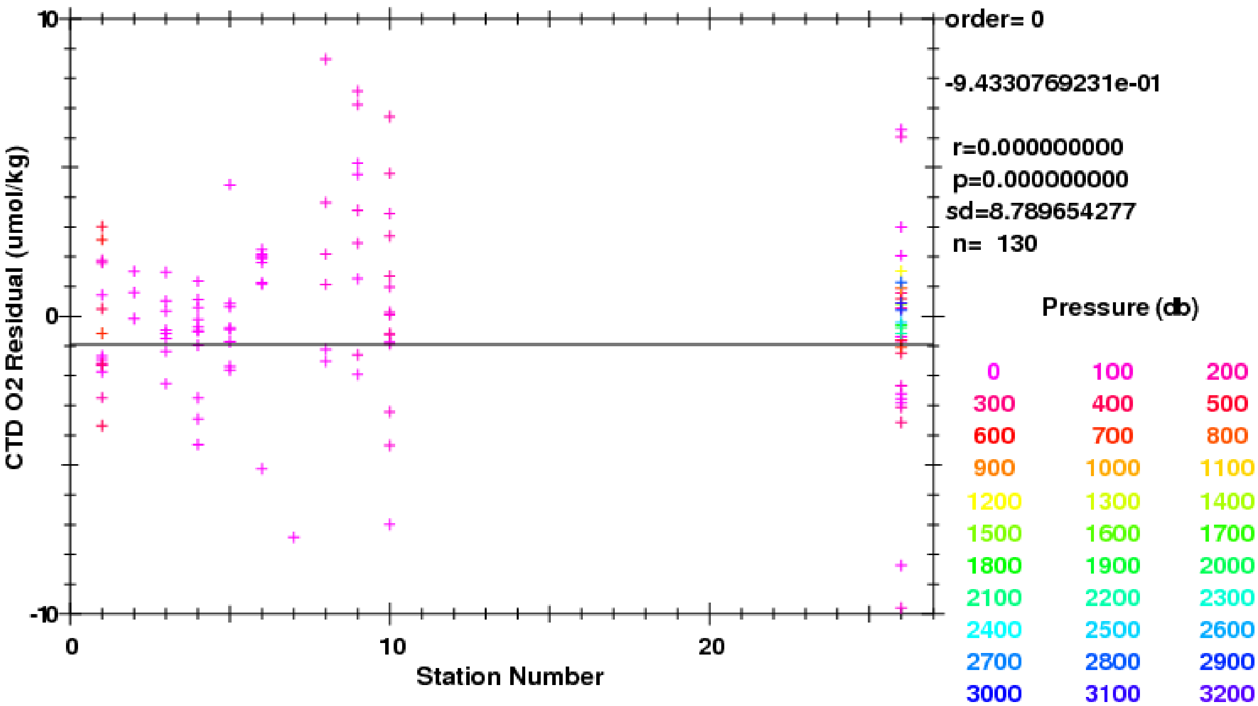

Fig. 3.50: O_2 residuals by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

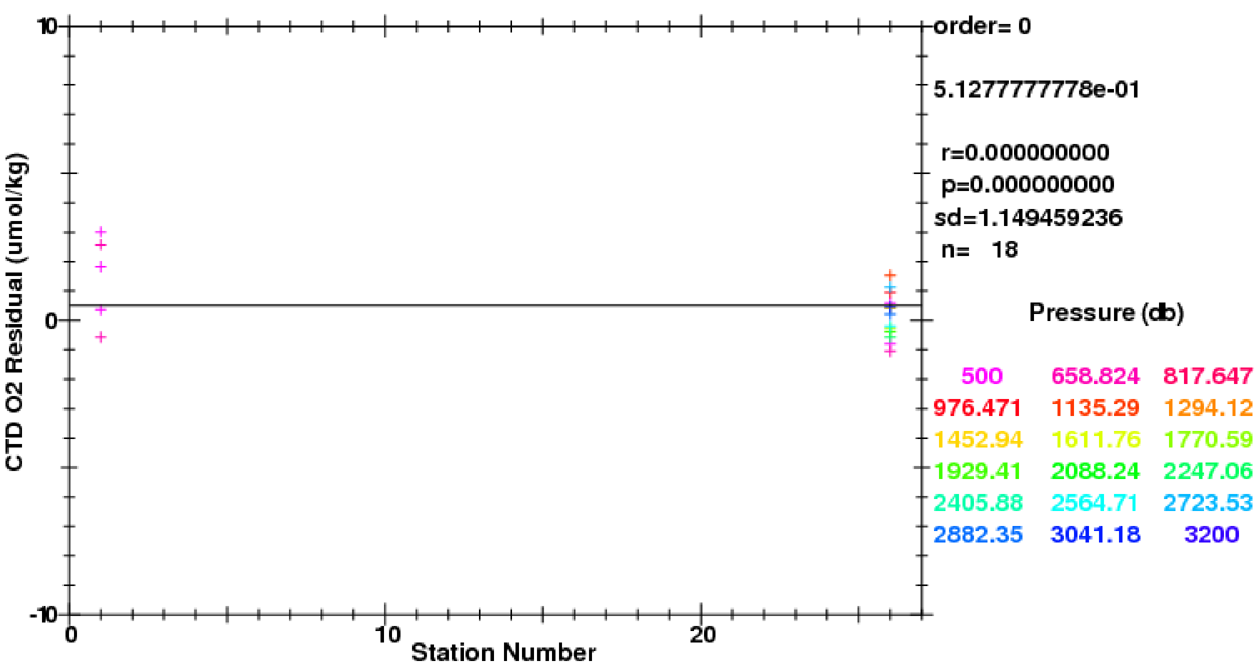

Fig. 3.51: Deep O_2 residuals by station (Pressure >= 500dbar).

The standard deviations are 8.79 (µmol/kg) for low gradient dissolved oxygen data values and 1.15 (µmol/kg) for deep dissolved oxygen values. CLIVAR GO-SHIP standards for CTD dissolved oxygen data are < 1% accuracy against on board Winkler titrated dissolved O_2 lab measurements *[Joyce91]*.

A number of complications arose with the acquisition and processing of CTD S/N: 831 dissolved oxygen data. Dissolved oxygen sensors were routinely replaced due to over-exposure to below freezing ambient artic air temperatures. SBE43 (S/N: 431138) was replaced with (S/N: 430848) prior to station 34 after sustaining damage when the staging bay hangar door was left open. SBE43 (S/N: 430848) was replaced with (S/N: 430875) after station 041/01 also due to over-exposure when left on deck prior to station/cast 041/01. Subsequent data profile appeared noisy and did not match bottle data. SBE43 (S/N: 430875) was replaced with (S/N: 430459) after station/cast 057/02 under similar circumstances. SBE43 (S/N: 430459) was replaced with (S/N: 430456) after station/cast 058/01 under similar circumstances.

CTD dissolved O_2 residuals are shown in the following figures *O2 residuals by pressure (-0.002°C T1-T2 0.002°C).* through *Deep O2 residuals by station (Pressure >= 2000dbar).*.

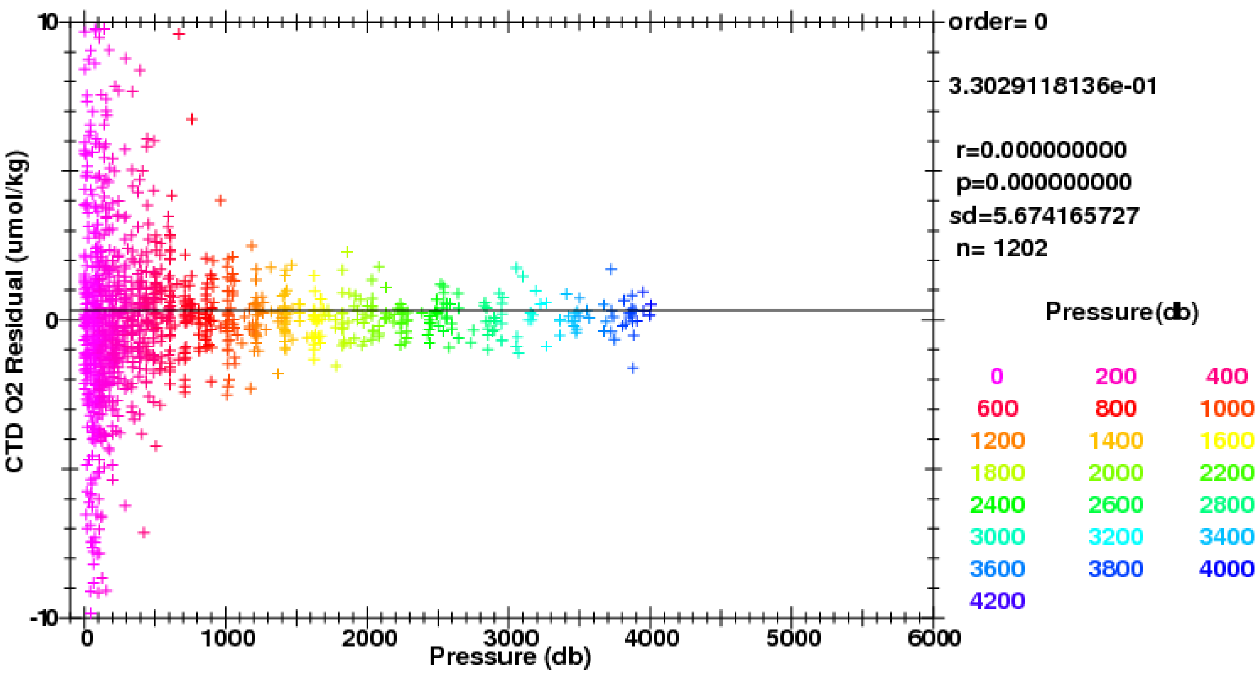

Fig. 3.52: O_2 residuals by pressure (-0.002°C ≤ T1-T2 ≤ 0.002°C).

The standard deviations of are 5.67 (µmol/kg) for low gradient dissolved oxygen data values and 0.57 (µmol/kg) for deep dissolved oxygen values. CLIVAR GO-SHIP standards for CTD dissolved oxygen data are < 1% accuracy against on board Winkler titrated dissolved O_2 lab measurements.

All compromised data signals were recorded and coded in the data files. The bottle trip levels affected by the signals were coded and are included in the bottle data comments section of the APPENDIX.

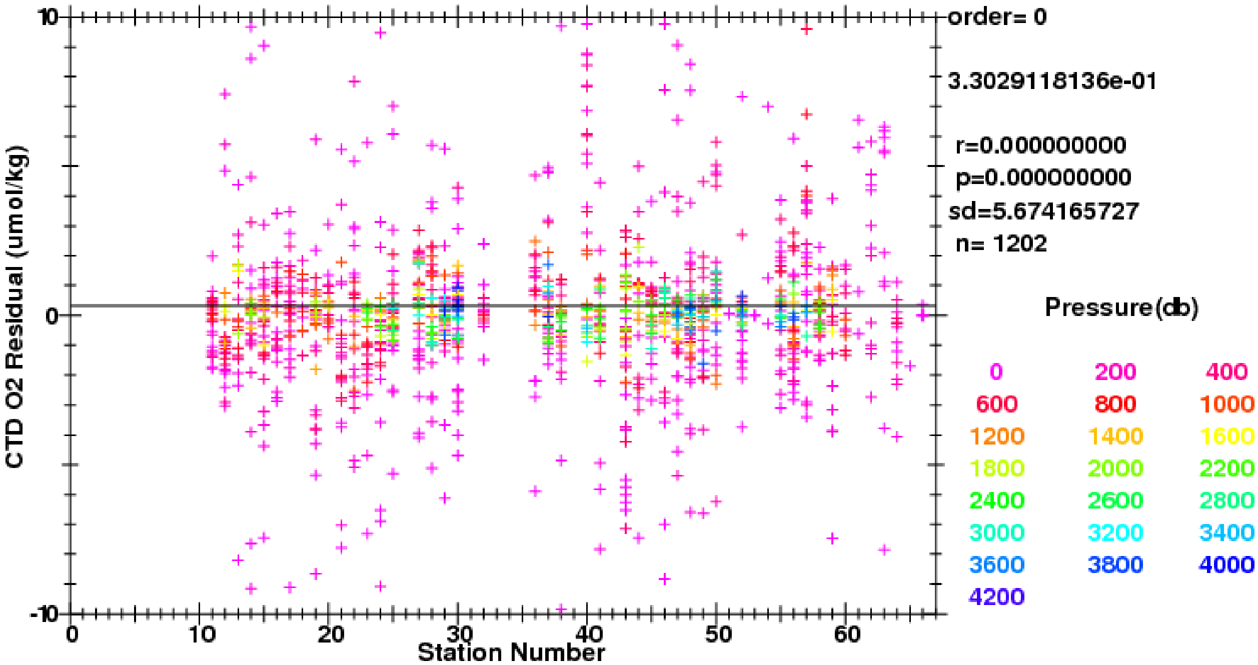

Fig. 3.53: O_2 residuals by station (-0.002°C ≤ T1-T2 ≤ 0.002°C).

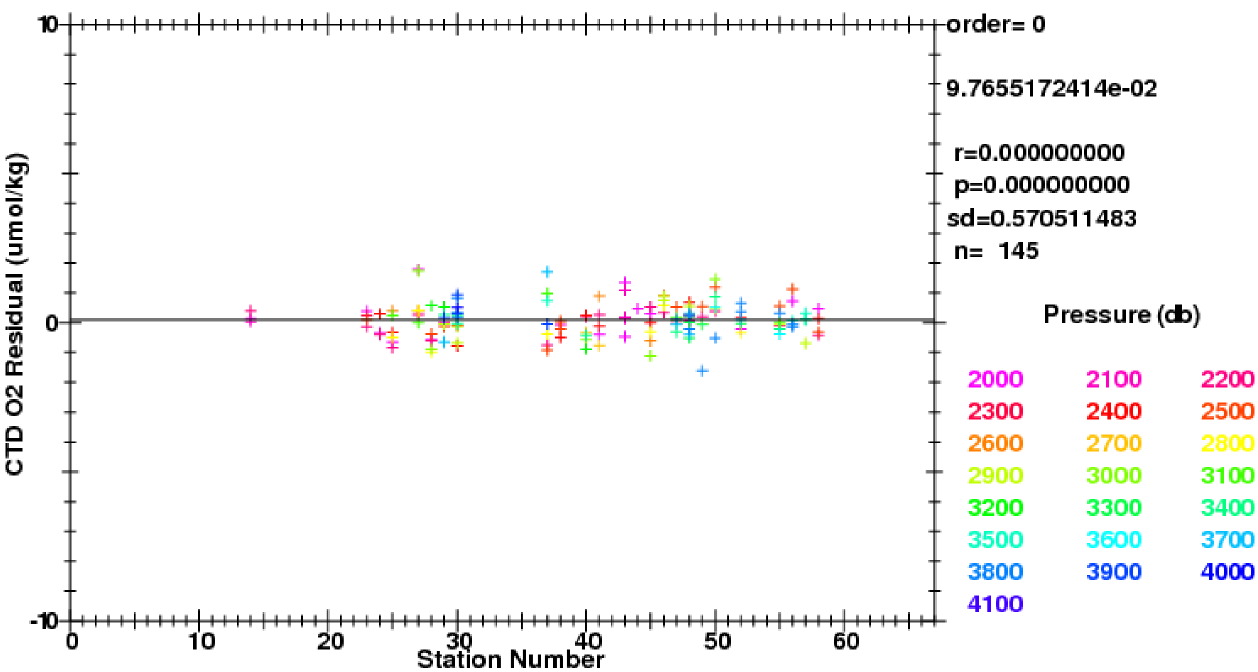

Fig. 3.54: Deep O_2 residuals by station (Pressure >= 2000dbar).

CHAPTER

FOUR

NUTRIENTS

PIs

- Susan Becker
- James Swift

Technicians

- Susan Becker
- Melissa Miller

4.1 Summary of Analysis

- 4,049 samples were analyzed from 66 stations.
- The cruise started with new pump tubes and they were changed 4 times, before stations 021, 034, 046, and 056.
- 6 sets of Primary/Secondary standards were made up over the course of the cruise.
- The cadmium column efficiency was checked periodically and ranged between 93%-100%. The column was replaced if/when the efficiency dropped below 97%.

4.2 Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate+nitrite, and nitrite) were performed on a Seal Analytical continuous-flow AutoAnalyzer 3 (AA3). The methods used are described by Gordon et al *[Gordon1992]* Hager et al. *[Hager1972]*, and Atlas et al. *[Atlas1971]*. Details of modification of analytical methods used in this cruise are also compatible with the methods described in the nutrient section of the GO-SHIP repeat hydrography manual (Hydes et al., 2010) *[Hydes2010]*.

4.3 Nitrate/Nitrite Analysis

A modification of the Armstrong et al. (1967) *[Armstrong1967]* procedure was used for the analysis of nitrate and nitrite. For nitrate analysis, a seawater sample was passed through a cadmium column where the nitrate was reduced to nitrite. This nitrite was then diazotized with sulfanilamide and coupled with N-(1-naphthyl)-ethylenediamine to form a red dye. The sample was then passed through a 10mm flowcell and absorbance measured at 540nm. The procedure was the same for the nitrite analysis but without the cadmium column.

REAGENTS

Sulfanilamide Dissolve 10g sulfamilamide in 1.2N HCl and bring to 1 liter volume. Add 2 drops of 40% surfynol 465/485 surfactant. Store at room temperature in a dark poly bottle.

Note: 40% Surfynol 465/485 is 20% 465 plus 20% 485 in DIW.

N-(1-Naphthyl)-ethylenediamine dihydrochloride (N-1-N) Dissolve 1g N-1-N in DIW, bring to 1 liter volume. Add 2 drops 40% surfynol 465/485 surfactant. Store at room temperature in a dark poly bottle. Discard if the solution turns dark reddish brown.

Imidazole Buffer Dissolve 13.6g imidazole in ~3.8 liters DIW. Stir for at least 30 minutes to completely dissolve. Add 60 ml of CuSO4 + NH4Cl mix (see below). Add 4 drops 40% Surfynol 465/485 surfactant. Let sit overnight before proceeding. Using a calibrated pH meter, adjust to pH of 7.83-7.85 with 10% (1.2N) HCl (about 10 ml of acid, depending on exact strength). Bring final solution to 4L with DIW. Store at room temperature.

NH4Cl + CuSO4 mix Dissolve 2g cupric sulfate in DIW, bring to 100 m1 volume (2%). Dissolve 250g ammonium chloride in DIW, bring to l liter volume. Add 5ml of 2% CuSO4 solution to this NH4Cl stock. This should last many months.

4.4 Phosphate Analysis

Ortho-Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (1967) *[Bernhardt1967]* method. Acidified ammonium molybdate was added to a seawater sample to produce phosphomolybdic acid, which was then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The sample was passed through a 10mm flowcell and absorbance measured at 820nm (880nm after station 59, see section on analytical problems for details).

REAGENTS

Ammonium Molybdate H2SO4 sol'n Pour 420 ml of DIW into a 2 liter Ehrlenmeyer flask or beaker, place this flask or beaker into an ice bath. SLOWLY add 330 ml of conc H2SO4. This solution gets VERY HOT!! Cool in the ice bath. Make up as much as necessary in the above proportions.

Dissolve 27g ammonium molybdate in 250ml of DIW. Bring to 1 liter volume with the cooled sulfuric acid sol'n. Add 3 drops of 15% DDS surfactant. Store in a dark poly bottle.

Dihydrazine Sulfate Dissolve 6.4g dihydazine sulfate in DIW, bring to 1 liter volume and refrigerate.

4.5 Silicate Analysis

Silicate was analyzed using the basic method of Armstrong et al. (1967). Acidified ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. The sample was passed through a 10mm flowcell and measured at 660nm.

REAGENTS

Tartaric Acid Dissolve 200g tartaric acid in DW and bring to 1 liter volume. Store at room temperature in a poly bottle.

Ammonium Molybdate Dissolve 10.8g Ammonium Molybdate Tetrahydrate in 1000ml dilute H2SO4. (Dilute H2SO4 = 2.8ml conc H2SO4 or 6.4ml of H2SO4 diluted for PO4 moly per liter DW) (dissolve powder, then add H2SO4) Add 3-5 drops 15% SDS surfactant per liter of solution.

Stannous Chloride stock: (as needed)

Dissolve 40g of stannous chloride in 100 ml 5N HCl. Refrigerate in a poly bottle.

NOTE: Minimize oxygen introduction by swirling rather than shaking the solution. Discard if a white solution (oxychloride) forms.

working: (every 24 hours) Bring 5 ml of stannous chloride stock to 200 ml final volume with 1.2N HCl. Make up daily - refrigerate when not in use in a dark poly bottle.

4.6 Sampling

Nutrient samples were drawn into 40 ml polypropylene screw-capped centrifuge tubes. The tubes and caps were cleaned with 10% HCl and rinsed 2-3 times with sample before filling. Samples were analyzed within 1-3 hours after sample collection, allowing sufficient time for all samples to reach room temperature. The centrifuge tubes fit directly onto the sampler.

4.7 Data collection and processing

Data collection and processing was done with the software (ACCE ver 6.10) provided with the instrument from Seal Analytical. After each run, the charts were reviewed for any problems during the run, any blank was subtracted, and final concentrations (micro moles/liter) were calculated, based on a linear curve fit. Once the run was reviewed and concentrations calculated a text file was created. That text file was reviewed for possible problems and then converted to another text file with only sample identifiers and nutrient concentrations that was merged with other bottle data.

4.8 Standards and Glassware calibration

Primary standards for silicate (Na2SiF6), nitrate (KNO3), nitrite (NaNO2), and phosphate (KH2PO4) were obtained from Johnson Matthey Chemical Co. and/or Fisher Scientific. The supplier reports purities of >98%, 99.999%, 97%, and 99.999 respectively.

All glass volumetric flasks and pipettes were gravimetrically calibrated prior to the cruise. The primary standards were dried and weighed out to 0.1mg prior to the cruise. The exact weight was noted for future reference. When primary standards were made, the flask volume at 20C, the weight of the powder, and the temperature of the solution were used to buoyancy-correct the weight, calculate the exact concentration of the solution, and determine how much of the primary was needed for the desired concentrations of secondary standard. Primary and secondary standards were made up every 7-10days. The new standards were compared to the old before use.

All the reagent solutions, primary and secondary standards were made with fresh distilled deionized water (DIW).

Standardizations were performed at the beginning of each group of analyses with working standards prepared prior to each run from a secondary. Working standards were made up in low nutrient seawater (LNSW). LNSW used for this cruise was deep water collected at a test station at the beginning of the cruise track. The actual concentration of nutrients in this water was empirically determined during the standardization calculations.

The concentrations in micro-moles per liter of the working standards used were:

-	N+N (uM)	PO_4 (uM)	SIL (uM)	NO_2 (uM)
0	0.0	0.0	0.0	0.0
3	15.50	1.2	60	0.50
5	31.00	2.4	120	1.00
7	46.50	3.6	180	1.50

4.9 Quality Control

All final data was reported in micro-moles/kg. NO^3, PO_4, NO_2 and NH_4 were reported to two decimals places and SIL to one. Accuracy is based on the quality of the standards the levels are:

NO^3	0.05 µM (micro moles/Liter)
PO_4	0.004 µM
SIL	2-4 µM
NO_2	0.05 µM

As is standard ODF practice, a deep calibration "check" sample was run with each set of samples to estimate precision within the cruise. The data are tabulated below.

Parameter	Concentration (µM)	stddev
NO^3	31.66	0.11
PO_4	1.18	0.01
SIL	22.5	0.1
NO_2	0.477	0.016

SIO/ODF has been using Reference Materials for Nutrients in Seawater (RMNS) on repeat Hydrography cruises as another estimate of accuracy and precision for each cruise since 2009. The accuracy and precision (standard deviation) for this cruise were measured by analysis of a RMNS with each run. The RMNS preparation, verification, and suggested protocol for use of the material are described by Aoyama *[Aoyama2006] [Aoyama2007]*, *[Aoyama2008]* and Sato *[Sato2010]*. RMNS batch BV was used on this cruise, with each bottle being used twice before being discarded and a new one opened. Data are tabulated below.

Parameter	Concentration	stddev	Assigned conc
-	(µmol/kg)	-	(µmol/kg)
NO^3	19.94	0.11	20.02
PO_4	1.45	0.01	1.45
Sil	37.3	0.2	36.9
NO_2	0.07	0.008	0.06

4.10 Analytical problems

No major analytical problems.

CHAPTER

FIVE

OXYGEN ANALYSIS

PIs

- Susan Becker
- James Swift

Technicians

- Andrew Barna
- Joseph Gum

5.1 Equipment and Techniques

Dissolved oxygen analyses were performed with an SIO/ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC LabView software. Thiosulfate was dispensed by a Dosimat 765 buret driver fitted with a 1.0 ml burette. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter *[Carpenter1965]* with modifications by *[Culberson1991]* but with higher concentrations of potassium iodate standard approximately 0.012N, and thiosulfate solution approximately 55 gm/l. Pre-made liquid potassium iodate standards were run every day (approximately every 4-5 stations), unless changes were made to the system or reagents. Reagent/distilled water blanks were determined every day or more often if a change in reagents required it to account for presence of oxidizing or reducing agents.

5.2 Sampling and Data Processing

1724 oxygen measurements were made. Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Using a silicone drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed 3 times with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample drawing temperatures were measured with an electronic resistance temperature detector (RTD) embedded in the drawing tube. These temperatures were used to calculate umol/kg concentrations, and as a diagnostic check of bottle integrity. Reagents ($MnCl_2$ then NaI/NaOH) were added to fix the oxygen before stoppering. The flasks were shaken twice (10-12 inversions) to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 30-40 minutes.

The samples were analyzed within 2-14 hours of collection, and the data incorporated into the cruise database.

Thiosulfate normalities were calculated for each standardization and corrected to 20 deg C. The 20 deg C normalities and the blanks were plotted versus time and were reviewed for possible problems. The blanks and thiosulfate normalities for each batch of thiosulfate were stable enough that no smoothing was necessary.

5.3 Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

5.4 Standards

Liquid potassium iodate standards were prepared in 6 liter batches and bottled in sterile glass bottles at ODF's chemistry laboratory prior to the expedition. The normality of the liquid standard was determined by calculation from weight. The standard was supplied by Alfa Aesar and has a reported purity of 99.4-100.4%. All other reagents were "reagent grade" and were tested for levels of oxidizing and reducing impurities prior to use.

5.5 Narrative

Setup in Dutch Harbor occurred on 2015-08-05, initial reagents were made. Reagents were allowed to settle for 24 hours before the first standardization runs were conducted. Reagents were stable throughout frequent initial standardization runs. Standards were run once a day regardless of station spacing.

A very wide range of oxygen concentrations were encountered at the early stations, from approximately 19 umol/kg to 480 umol/kg. The low concentrations required using the slower "LOW O2" titration option. The higher concentrations often needed over 1ml of thiosulfate for the titration, required a burette refill. The automatic titration would not always resume after a burette refill. If the burette refill occurred while the program was attempting to find the end point, the software would sometimes force an over titration. The thiosulfate concentration was increased after station/cast 026/03 by adding a few extra grains to the stock. Only two samples after the increased thiosulfate concentration required a burette refill. A new stronger batch of thiosulfate was utilized starting with station 47. No sample required over 1ml of thiosulfate since using the stronger batch.

The stir plate failed while running station/cast 044/01, resulting in the loss of a sample. The stir plate was immediately replaced with a spare. Upon rig reassembly, the UV pen lamp would not turn back on. Both the lamp and the power supply were evaluated for stability, it was found that the only stable combination was using a spare power supply with a spare lamp. The lamp was stable since replacement.

The day to day thiosulfate stability was excellent, averaging less than ±0.00015N per day with a small trend toward increasing concentration with age. The entire min/max range for any single batch of thiosulfate was approximately 0.00065 over a 20 day period. One standard run exceeded the day to day concentration change specification, this was likely the result of using an almost depleted KIO_3 standard. The out of spec standardization was removed during thiosulfate smoothing.

CHAPTER SIX

SALINITY

6.1 Equipment and Techniques

A Guildline Autosal 8400B salinometer (S/N 65-715), located in the wet lab, was used for salinity measurements. The salinometer was configured by SIO/STS to provide an interface for computer-aided measurement.

The salinity analyses were performed after samples had equilibrated to laboratory temperature, usually within 12-24 hours after collection. The salinometer was standardized for each group of analyses (usually 2-4 casts, up to approximately 75 samples using at least two fresh vials of standard seawater per group. Once it was determined that the salinometer was providing stable readings, standardization was performed every 24 hours and additionally if a bath temperature change occurred. Salinometer measurements were made by computer, the analyst prompted by the software to change samples and flush.

6.2 Sampling and Data Processing

A total of 2,726 salinity measurements were made and approximately 120 vials of standard seawater (IAPSO SSW batch P158) were used.

Salinity samples were drawn into 200 ml Kimax high-alumina borosilicate bottles, which were rinsed three times with 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 sample collection, inserts were inspected for proper fit and loose inserts replaced to insure an airtight seal. The draw time and equilibration time were logged for all casts. Laboratory temperatures were logged at the beginning and end of each run.

PSS-78 salinity *[UNESCO1981]* was calculated for each sample from the measured conductivity ratios. The difference (if any) between the initial vial of standard water and the next one run as an unknown was applied as a linear function of elapsed run time to the data. The corrected salinity data were then incorporated into the cruise database.

6.3 Laboratory Temperature

The water bath temperature was set to 24 degrees Celsius during setup. With lab temperatures around 22 degrees Celsius, the water bath temperature was lowered to 21 degrees Celsius before running samples from station 6, cast 2. The lab temperature then averaged higher, closer to 23-24 degrees Celsius, so the salinometer water bath temperature was changed back to 24 degrees Celsius before running samples from station 17, cast 7.

CHAPTER SEVEN

CFC CRUISE REPORT FOR HLY-1502

Analysts

- Eugene Gorman (LDEO)
- Ben Hickman (LDEO)
- Angelica Pasqualini (LDEO)

The Lamont CFC group measured F12,F11, F113, and SF6 on Geotraces 2015. A total of 1140 samples were collected on a 12 bottle and a 36 bottle rosette. A total of 66 stations were sampled. The samples were collected in 500 ml bottles and analyzed on a purge-and-trap system in tandem with a gas chromatograph.

CHAPTER

EIGHT

DISCRETE PH ANALYSES

PI

- Dr Frank Millero/ Ryan Woosley.

Cruise Participant

- Ryan Woosley
- Fen Huang
- Andrew Margolin

8.1 Sampling

Samples were collected in 50ml borosilicate glass syringes rinsing a minimum of 2 times and thermostated to 25 or 20°C before analysis. Two duplicates were collected from each repeat hydrography station. Due to water budget limitations, no duplicates could be collected on GEOTRACES station. Samples were collected on the same bottles as total alkalinity or dissolved inorganic carbon (DIC) in order to completely characterize the carbon system. One sample per station was collected and analyzed with double the amount of indicator in order to correct for pH changes as a result of adding the indicator, this correction has not been applied to the preliminary data. All data should be considered preliminary.

8.2 Analysis

pH (μmol/kg seawater) on the seawater scale was measured using an Agilent 8453 spectrophotometer according to the methods outlined by Clayton and Byrne (1993) *[Clayton1993]*. An RTE10 water bath maintained spectrophotometric cell temperature at 25 or 20°C. A 10cm micro-flow through cell (Sterna, Inc) was filled automatically using a Kloehn 6v syringe pump. The sulfonephthalein indicator m-cresol purple (mCP) was also injected automatically by the Kloehn 6v syringe pump into the spectrophotometric cells, and the absorbance of light was measured at four different wavelengths (434 nm, 578 nm, 730 nm, and 488 nm). The ratios of absorbances at the different wavelengths were input and used to calculate pH on the total and seawater scales using the equations of Liu et al (2011) *[Liu2011]*. The equations of Dickson and Millero (1987) *[Dickson1987]*, Dickson and Riley (1979) *[Dickson1979]*, and Dickson (1990) *[Dickson1990]* were used to convert pH from the total to seawater scale. The isobestic point (488nm) will be used for the indicator correction. Salinity data were obtained from the conductivity sensor on the CTD. These data were later corroborated by shipboard measurements. Temperature of the samples was measured immediately after spectrophotometric measurements using a Fluke Hart 1523 digital platinum resistance thermometer.

8.3 Reagents

The mCP indicator dye was a concentrated solution of ~2.0 mM. Purfied indicator batch 7 provided by Dr. Robert Byrne, University of South Florida was used.

8.4 Standardization

The precision of the data can be accessed from measurements of duplicate samples, certified reference material (CRM) Batch 146 (Dr. Andrew Dickson, UCSD) and TRIS buffers (Ramette et al. 1977 *[Ramette1977]*). The measurement of CRM and TRIS was alternated at each station. The mean and standard deviation for the CRMs was 7.8927 ± 0.0044 (n=32). For TRIS buffer there was a sudden jump in the value at station 32, before station 32 and after station 32 the mean and standard deviation was 8.0947 ± 0.0040 (n=15) and 8.1694 ? 0.0047 (n=22) respectively. The cause of the jump is currently unknown, but it was constant over the 3 bottles run after station 32.

8.5 Data Processing

Addition of the indicator affects the pH of the sample, and the degree to which pH is affected is a function of the pH difference between the seawater and indicator. Therefore, a correction is applied for each batch of dye. One sample from each station was measured twice, once normally and a second time with double the amount of indicator. The change in the ratio is then plotted verses the change in the isobestic point to develop an empirical relationship for the effect of the indicator on the pH. This correction has not yet been applied to the preliminary data.

Number of Samples	1274
Good (flag=2)	1141
Dup (flag=6)	58
Quetionable (flag=3)	12
Bad (flag=4)	42
Lost (flag=5)	21

8.6 Problems

One major problem occurred on the first station when the four water baths running the lab van caused the temperature to rise rapidly to 90± F (and still rising), causing bubbles to form in the cell and instruments to over heat. Due to the location of the van on the ship, the seawater air conditioning unit could not be connected. In order to maintain the temperature at a reasonable level the door to the van was left open whenever the instruments were run. Temperatures through out the cruise were maintained between 50-75°F.

On station 32 the water bath would not longer heat to 25°C, starting at this station through the remainder of the cruise samples were measured at 20°C and corrected to 25°C using the equation of Millero (2007) *[Millero2007]*.

CHAPTER NINE

TOTAL ALKALINITY

PI

- Frank Millero/Ryan Woosley

Technicians

- Ryan Woosley
- Fen Huang
- Andrew Margolin

9.1 Sampling

At each station total alkalinity (TA) samples are drawn from Niskin bottles into 500 ml borosilicate flasks using silicone tubing that fit over the petcock. Bottles are rinsed with a small volume, then filled from the bottom and allowed to overflowing half of the bottle volume. The sampler is careful not to entrain any bubbles during the filling procedure. Approximately 15 ml of water is withdrawn from the flask by halting the sample flow and removing the sampling tube, thus creating a reproducible headspace for thermal expansion during thermal equilibration. The sample bottles are sealed at a ground glass joint with a glass stopper. The samples are then thermostated at 25°C before analysis. Three duplicates are collected at each repeat hydrography station. Due to water budget issues, no duplicates could be taken on GEOTRACES stations. Samples are collected on the same bottles as pH or dissolved inorganic carbon (DIC) in order to completely characterize the carbon system.

9.2 Analyzer Description

The sample TA is then evaluated from the proton balance at the alkalinity equivalence point, 4.5 at 25°C and zero ionic strength. This method utilizes a multi-point hydrochloric acid titration of seawater (Dickson 1981i *[Dickson1981]*). The instrument program uses a Levenberg-Marquardt nonlinear least-squares algorithm to calculate the TA and DIC from the potentiometric titration data. The program is patterned after those developed by Dickson (1981) *[Dickson1981]*, Johansson and Wedborg (1982) *[Johansson1982]*, and U.S. Department of Energy (DOE) (1994) *[DOE1994]*. The least-squares algorithm of the potentiometric titrations not only give values of TA but also those of DIC, initial pH as calculated from the initial emf, the standard potential of the electrode system (E0), and the first dissociation constant of CO2 at the given temperature and ionic strength (pK1). Two titration systems, A and B are used for TA analysis. Each of them consists of a Metrohm 765 Dosimat titrator, an Orion 720A, or 720A+, pH meter and a custom designed plexiglass water-jacketed titration cell (Millero et al, 1993 *[Millero1993]*). The titration cell allows for the titration to be conducted in a closed system by incorporating a 5mL ground glass syringe to allow for volume expansion during the acid addition. Both the seawater sample and acid titrant are temperature equilibrated to a constant temperature of 25 ? 0.1°C with a water bath (Neslab, RTE-10). The electrodes used to measure the EMF of the sample during a titration are a ROSS glass pH electrode (Orion, model 810100) and a double junction Ag, AgCl reference electrode (Orion, model 900200). The water-jacketed cell is similar to the cells used by Bradshaw and Brewer (1988) *[Bradshaw1988]* except a larger volume (~200 ml) is employed to increase the precision. Each cell has a solenoid fill and drain valve which increases the reproducibility of the volume of sample contained in the cell. A typical titration records the stable solution EMF (deviation less than 0.09 mV) and adds enough acid to change the voltage a pre-assigned increment (~13 mV). A full titration (~25 points) takes about 20 minutes. A 6 port valve (VICI, Valco EMTCA-CE) allows 6 samples to be loaded into the instrument and successively measured.

9.3 Reagents

A single 50-l batch of ~0.25 m HCl acid was prepared in 0.45 m NaCl by dilution of concentrated HCl, AR Select, Mallinckrodt, to yield a total ionic strength similar to seawater of salinity 35.0 (I = 0.7 M). The acid is standardized with alkalinity titrations on seawater of known alkalinity (certified reference material, CRM, provided by Dr. Andrew Dickson, Marine Physical Laboratory, La Jolla, California. The calibrated molarity of the acid used was 0.24361 $\pm$ 0.0001 N HCl. The acid is stored in 500-ml glass bottles sealed with Apiezon® M grease for use at sea.

9.4 Standardization

The reproducibility and precision of measurements are checked using low nutrient surface seawater collected from the ship's underway seawater system, used as a substandard, and Certified Reference Material (Dr. Andrew Dickson, Marine Physical Laboratory, La Jolla, California). The CRM is utilized to account for instrument drift over the duration of the cruise and to maintain measurement precision. A CRM was measured on each system on all odd numbered station and a low nutrient surface water sample was measured on each. Duplicate analyses provide additional quality assurance, and three duplicates, 2 samples taken from the same Niskin bottle, at each repeat hydrography station. The duplicates are then analyzed on system A, system B, or split between systems A and B. This provides a measure of the precision on the same system and between systems. Laboratory calibrations of the Dosimat burette system with water indicate the systems deliver 3.000 ml of acid (the approximate value for a titration of 200 ml of seawater) to a precision of $\pm$ 0.0004 ml, resulting in an error of $\pm$0.3 μmol/kg in TA. All samples were analyzed less than 12 hours after collection.

9.5 Data Processing

Measurements were made on CRM bath 146. The difference between the measured and certified values on system A is -2.60 $\pm$ 2.43 (N=30) and on B is 0.65 $\pm$ 2.28 (N=39). System A tended to run low, no correction to the CRM has been made on the preliminary data. Nine different batches of low nutrient surface water were used. They generally had standard deviations of ~3 μmol/kg or less except for batch 1 which was slightly higher. The mean and standard deviations of the duplicates were 0.40 $\pm$ 1.80 (N=33), -0.46 $\pm$ 2.13 (N=36), and -2.04 $\pm$ 3.18 (N=21) on system A, system B, and one on each system respectively (A-B). The preliminary quality control results are shown in table 1.

Total Samples	1266
Good (flag=2)	1149
Dup (flag=6)	90
Quetionable (flag=3)	7
Bad (flag=4)	12
Lost (flag=5)	8

9.6 Problems

The only major problem occurred on the first station when the four water baths running the lab van caused the temperature to rise rapidly to 90± F (and still rising), causing bubbles to form in the acid and instruments to over heat. Due to the location of the van on the ship, the seawater air conditioning unit could not be connected. In order to maintain the temperature at a reasonable level the door to the van was left open whenever the instruments were run. Temperatures through out the cruise were maintained between 50-75°F.

CHAPTER

TEN

DISSOLVED INORGANIC CARBON (DIC)

PI's

- Frank Millero
- Ryan Woosley

Technicians

- Ryan Woosley
- Fen Huang
- Andrew Margolin

10.1 Analysis

The DIC analytical equipment (DICE) was designed based upon the original SOMMA systems (*[Johnson1985]*, *[Johnson1987]*, *[Johnson1992]*, *[Johnson1993]*). These new systems have improved on the original design by use of more modern National Instruments electronics and other available technology. In the coulometric analysis of DIC, all carbonate species are converted to CO2 (gas) by addition of excess hydrogen to the seawater sample using 8.5% H3PO4. The evolved CO2 gas is carried into the titration cell of the coulometer, where it reacts quantitatively with a proprietary reagent based on ethanolamine to generate hydrogen ions. These are subsequently titrated with coulometrically generated OH-. CO_2 is thus measured by integrating the total charge required to achieve this. (Dickson, et al 2007).

10.2 Standardization

The coulometer was calibrated by injecting aliquots of pure CO2 (99.995%) by means of an 8-port valve outfitted with two calibrated sample loops of different sizes (~1ml and ~2ml) *[Wilke1993]*. The instrument was calibrated at the beginning of each cell with a minimum of two sets of the gas loop injections. 256 loop calibrations were run during this cruise.

Secondary standards were run throughout the cruise. These standards are Certified Reference Materials (CRMs), consisting of poisoned, filtered, and UV irradiated seawater supplied by Dr. A. Dickson of Scripps Institution of Oceanography (SIO). Their accuracy is determined manometrically on land in San Diego. DIC data reported to the database have been corrected to the batch 146 CRM value. The reported CRM value for this batch is 2002.93 μmol/kg. The average and standard deviation measured values was 2000.72 ? 2.45 (N=61) μmol/kg. Tubing was replaced on valves 4 and 5, which may have altered the volume of the pipette. There was an increase in the CRM value after changing the tubing, and the volume will be recalibrated upon return to the lab.

10.3 Sample Collection

The DIC water samples were drawn from Niskin-type bottles into cleaned, pre-combusted 500mL borosilicate glass bottles using silicon tubing. Bottles were rinsed twice and filled from the bottom, overflowing by at least one-half volume. Care was taken not to entrain any bubbles. The tube was pinched off and withdrawn, creating a 5mL headspace, and 0.400mL of 100% saturated HgCl2 solution was added as a preservative. The sample bottles were sealed with glass stoppers lightly covered with Apiezon-L grease, and were stored in a 20°C water bath for a minimum of 20 minutes to bring them to temperature prior to analysis.

10.4 Data Processing

About 1,000 samples were analyzed for discrete DIC. Only about 8% of these samples were taken as replicates as a check of our precision. These replicate samples were typically taken from the surface, oxygen minimum, and bottom bottles. Due to water budget limits duplicates could not be taken on GEOTRACES stations, and were thus only collected on repeat hydrography stations. The replicate samples were interspersed throughout the station analysis for quality assurance and integrity of the coulometer cell solutions and no systematic differences between the replicates were observed. The mean and standard deviation between duplicates was -0.21 ± 2.77 (N=73)

The DIC data reported at sea is to be considered preliminary until further shore side analysis is undertaken.

10.5 Problems

One major problem occurred on the first station when the four water baths running the lab van caused the temperature to rise rapidly to 90± F (and still rising), causing bubbles to form in the cell and instruments to over heat. Due to the location of the van on the ship, the seawater air conditioning unit could not be connected. In order to maintain the temperature at a reasonable level the door to the van was left open whenever the instruments were run. Temperatures through out the cruise were maintained between 50-75°F.

On station 46 the pipette was not fully draining into the stripper. Tubing was replaced on valves 4 and 5. This could potentially change the volume of the pipette and it will be recalibrated once the instrument is returned to shore. After replacing the tubing CRMs averaged higher than before, but still within the uncertainty.

CHAPTER ELEVEN

DENSITY

PI

- Frank Millero
- Ryan Woosley

Technicians

- Ryan Woosley
- Fen Huang
- Andrew Margolin

11.1 Sampling

Over the course of ARC01, 5 stations were sampled for a total of 179 density samples. Each Niskin was sampled using a 125 mL HDPE bottle. The bottles were rinsed 3 times, allowed to fill until overflowing, capped, and sealed with Parafilm. This procedure leaves as little head space as possible to minimize evaporation until analysis.

11.2 Analyzer Description

The sealed samples will be shipped to our lab in Miami where the salinity will be re-measured on a salinometer (Guildline Portosal), and the density will be measured using an Anton-Paar DMA 5000 densitometer and compared to the calculated density to determine $\delta\ \rho$ and absolute salinity.

CHAPTER

TWELVE

$\delta^{18}O$ SAMPLING

PIs

- Peter Schlosser (LDEO)
- Angelica Pasqualini

During the U.S. Geotraces 2015/Hydro-ARC01 icebreaker expedition, a total of 1100* water samples were collected for measurement of $_{18}$ O / $_{16}$ O ratios in the top 500m of the water column. (1100 is an estimate; 895 bottles sampled after station 56). Water samples for the measurement of oxygen isotope ratios were collected in 50 ml glass bottles. The bottles were rinsed in water from the Niskin bottle to be sampled, filled, and sealed using polypro-lined caps and electrical tape. Oxygen isotope ratios will be measured at Lamont Doherty Earth Observatory using a Picarro L2130-i Analyzer.

In combination with salinity and nutrients, oxygen isotope ratios are useful to distinguish between freshwater components in the upper Arctic Ocean. Oxygen isotope ratios provide a useful tracer to separate the sea-ice melt-water from meteoric water (river runoff plus local precipitation/ evaporation (*[Newton2013]*; *[Newton2008]*; *[Schlosser2002]*; *[Schlosser1994]*).

CHAPTER

THIRTEEN

DISSOLVED ORGANIC CARBON

PI

- Dennis Hansell

Technician

- Andrew Margolin

DOC and total dissolved nitrogen (TDN) samples were collected from nearly all stations (excluding stations 2-6 and 34), including four ice stations (31, 33, 39 and 42). In total, 1350 samples (1692 including duplicates) were taken from 60 stations. Samples from depths of 250 m and shallower were filtered through GF/F filters (0.7 µm nominal pore size) using in-line filter holders, while samples from greater depths were not filtered. Filters were combusted at 450°C prior to the cruise, and polycarbonate (PC) filter holders and silicone tubing were cleaned with 10% HCl and rinsed with Milli-Q water before sampling. All primary samples were collected in 60 mL PC bottles, pre-cleaned with 10% HCl and rinsed with Milli-Q water. Duplicate samples were collected in 40 mL glass vials, combusted at 450°C prior to the cruise. All sampled bottles and vials were rinsed three times with the seawater before filling with 40-60 mL of seawater. Nitrile gloves were worn while sampling. Samples collected in PC bottles were frozen standing upright inside the ship's freezer, while duplicates collected in glass vials were stored in the dark at room temperature, stowed in the ship's science cargo hold. Frozen and room temperature samples will be shipped from Seattle to Miami for laboratory analysis.

CHAPTER FOURTEEN

WETLABS C-STAR TRANSMISSOMETER

PI

- Wilf Gardner
- Mary Jo Richardson

The WetLabs C-STAR transmissometer on the ODF rosette (and the one on the GEOTRACES rosette) measures the attenuation of light at 650 nm (red). The amount of attenuation is a proxy for particle concentration at each depth in the water column. Generally one sees high concentrations in surface waters due to phytoplankton with a rapid decrease in concentration in the upper 100 m. Much of the water column will show very low values. If sediment is resuspended near the bottom or advected laterally from shallower topography, attenuation increases. These resuspended sediments could affect benthic biogeochemical cycles and trace element scavenging. Our goal is to quantify the distribution of particulate matter in both surface and bottom Arctic waters to add to the 9000 plus profiles we have collected in all other oceans of the world. In addition to our past syntheses of particle regimes in surface waters, we are constructing the first global map of nepheloid layers - resuspended sediment. We will also compare the attenuation signal with the UVP data of Andrew McDonnell, who is measuring the abundance and size distribution of particles in the 64 μm to 2.5 cm range throughout the water column.

CHAPTER FIFTEEN

HAARDT

PI Dr. Rainer Amon

The Haardt fluorometer is a backscatter fluorescence sensor that excites at 350-460nm and measures the emission at 550nm HW 40nm. It was designed to measure the chromophoric dissolved organic matter (CDOM) that originates in the terrigenous environment, but also responds to CDOM produced in the ocean. The same sensor was used during AOS 2005 and will allow us to see changes in the distribution of the transpolar drift, riverine dissolved organic matter, as well as the CDOM maximum associated with the halocline. Sensor data will be complemented with measurements of optical properties and terrigenous and marine biomarkers on discrete water samples. The Haardt sensor is both an important water sampling guide as well as a water mass tracer for the upper Arctic Ocean. During the 2015 Healy cruise the Haardt sensor data and biomarker data will be paired with trace element (TE) measurements to understand the role of riverine DOM for the transport of TE in Arctic Ocean surface waters. We duplicated the same science plan on the 2015 Polarstern cruise covering the Eurasian Arctic to gain a pan-Arctic view comparable to 2005.

CHAPTER

SIXTEEN

CHI-POD MICROSCALE TEMPERATURE GRADIENT MEASUREMENTS

PI

- Jonathan Nash

Systematic Direct Mixing Measurements within the Global Repeat Hydrography Program (SYSDMM) is an NSF-funded project (Nash, Moum, and MacKinnon) to obtain repeated sequences of turbulent mixing, distributed broadly throughout the global oceans and over full-ocean depths. To this end, we have developed chi-pods, self-contained instruments that measure microscale temperature gradients using fast-response FP07 thermistors, along the sensor motion/trajectory using precision accelerometers. From these measurements, we are able to compute the dissipation rate of temperature variance (chi) and the eddy diffusivity of heat and other tracers. Unlike traditional microstructure/turbulence measurements based on shear probes, chi is not highly sensitive to vibration of the sensor itself, so it is possible to make these measurements from a standard CTD rosette, provided that the sensor tips can be placed in a part of the flow that is uncontaminated by the wake of the CTD rosette itself. For sensor calibration, we require the raw 24 Hz CTD data; computations also require knowledge of the background stratification and vertical temperature gradient. Chi-pods have now been used on several repeat hydrography cruises, including A16S, P16N and P16S, with an ultimate goal of obtaining a global dataset of microstructure observations.

CHAPTER SEVENTEEN

UNDERWATER VISION PROFILER

PI

- Andrew M. P. McDonnell

The Underwater Vision Profiler 5 (UVP5), serial number 009, was mounted onto the ODF CTD-Rosette in order to obtain in situ images of marine particles and plankton throughout the water column. It was positioned in the center of the rosette with the camera looking downward and the lighting units illuminating a volume of water several inches above the bottom of the rosette. The instrument was powered with an internal rechargeable battery and stores image and pressure data internally on hard drive, and data will be offloaded and analyzed after the cruise ends. The UVP5 was programmed in depth acquisition mode, taking advantage of the CTD's initial descent (@20 m/min) and pre-cast soak at 20 m below the surface as the signal to initiate image acquisition. Image acquisition was stopped (to conserve battery power and data storage space) after the UVP5 detected a 50 dbar upturn from the bottom of the cast. While the rosette was on deck, the UVP5 was connected to deck leads coming from the UVP deck box, providing battery charging. The image volume of UVP5 serial number 009 was calibrated in a tank and determined to be 0.930 L. Particle concentration was determined by counting the number of detected particles and normalizing with respect to the image volume. Particles detected by the UVP5 range in size between 0.064 mm and several cm (equivalent spherical diameter). The UVP5 was operated in mixed processing mode, meaning that particle characteristics were quantified in real time onboard the UVP5 and the images of the largest particles (greater than about 2 mm in ESD. were segmented out of the image files and saved as individual images with their corresponding metadata. The instrument and data processing are described in Picheral et al., 2010. Due to berthing restrictions, the UVP had no dedicated technician onboard to actively monitor the performance of the instrument and data. Deployments and basic maintenance were kindly carried out by Johna Winters, Croy Carlin, and Brett Hembrough.

CHAPTER

EIGHTEEN

STARC SUPPORT

Manager

- Dan Schuller

Techinicians

- Johna Winters
- Croy Carlin
- Brett Hembrough

STARC technicians in cooperation with ODF personnel assisted with installation and adjustment of CTD sensors and niskin bottles throughout the cruise. We had three instances of damage to the .322 wire, one caused by a snag on an ice floe, the other resulting from the wire getting pinched on deck (under the CTD cart rail) while moving the rosette in and out of the staging bay. The third occurred on cast 059 when the rosette was near bottom, the winch operator paid out rather than hauling in (~12-14 extra meters). When the rosette contacted the bottom, tension on the wire dropped causing it to hockle about 2m above the mechanical connection. The winch operator was quickly corrected and the wire hauled in. However, due to the hockling, when the wire again came under tension it developed a series of mild kinks/unlays as the wire straightened out. All three incidents required re-termination.

Initially the cruise plan called for using the 12 place 30L rosette for GeoTraces casts and the 36 place 10L rosette for the Repeat Hydrography casts. Throughout the first few stations the 30L rosette experienced frequent leaking from multiple niskin bottom caps. To stop the leaks required tapping the top/bottom caps closed with a rubber mallet as soon as the CTD was brought on deck. These issues were recorded on the cast data sheet and details for individual casts can be accessed there. Eventually (after station 26) it was decided that the 36 place rosette would replace the 12 place for both sampling programs and could provide the same water quantity from the more reliable 10L niskins. The altimeter and PAR sensor were switched from the 12 place to the 36 place. Once we switched over to the 36 place 10L rosette we experienced relatively few bottle closure problems. Bottle 35 failed to close at station 30 (cast 12). Between stations 47 and 52 bottle position #29 began having intermittent closure problems. The carousel would trigger, but the latch did not release immediately. This was addressed by changing the vertical position of the bottle and by replacing the latch with a spare. Other small adjustments were made when necessary, such as o-ring seating/replacement (bottles #3 #14, #23, #31), spigot repairs, and clearing obstructions from the lanyard path (#29). These instances are also detailed on the cast log data sheets.

The installed 02 sensors were susceptible to damage when exposed to sub-freezing temperatures, to counter this, a large, rolling heater fan was positioned near the rosette while it was staged on deck, pre deployment and upon recovery. The warm air from the fan helped to prevent freezing of the sensitive membrane inside the 02 sensor by keeping the surrounding air temps 1-2 degrees C above zero. Despite these efforts two oxygen sensors appear to have been damaged or at the least the data was suspect, resulting in a swap out for a spare sensor.

The UVP unit was recharged in between casts according to instructions provided by the technician (Andrew McDonald) who installed it. We did encounter rare instances when the unit would not accept a charge from the deck box. This required rigging up a small electric fan that would drain the battery to a lower threshold, then reconnecting the deck box to begin charging. On Station 43 Cast 2 the power shunt was accidentally not installed, this resulted in an electrical current arcing between 2 exposed pins and caused one pin to corrode away. The damaged cable was replaced with a spare. Throughout the cruise we had no indication that the unit was not working as intended. We kept in close contact with Andrew and provided him data on battery voltages and casts depths.

The 36 place rosette had two upward looking mini-chipods and two downward facing thermistors installed. These were installed in Seattle prior to sailing, plugged in at the first science station (only unplugged once to save battery during a multi-day break from using the 36 place rosette) and left powered and installed the remainder of the cruise. One of the the thermistors was damaged when the CTD was recovered at station 30. A piece of ice had fallen onto the pallet, (either brought aboard stuck inside the rosette or fell from the a-frame) and the thermistor happened to come down on top of this piece of ice when the rosette was placed on the pallet. This damaged thermistor was removed and a spare sensor tip swapped in.

At the request of a science party member, close inspection and cleaning of the transmissometer was initiated at each station and between casts. This included a thorough cleaning of the lenses with Kim wipes and Milli-Q water, after cleaning the lenses were kept capped until immediately prior to a cast. After cleaning the CTD was powered up and deck tested to observe the voltage readings for the transmissometer were at or above 4.6 volts.

APPENDIX

A

ABBREVIATIONS

AOML Atlantic Oceanographic and Meteorological Laboratory

AP Particulate Absorbtion Spectra

Bigelow Bigelow Laboratory for Ocean Sciences

CDOM Chromophoric Dissolved Organic Matter

CFCs Chlorofluorocarbons

CTDO Conductivity Temperature Depth Oxygen

DIC Dissolved Inorganic Carbon

DOC Dissolved Organic Carbon

ETHZ Edgenössische Technische Hochschule Zürich

FIU Florida International University

FSU Florida Stats University

Healy USGS Healy

HPLC High-Performance Liquid Chromatography

LDEO Lamont-Doherty Earth Observatory - Columbia University

LADCP Lowered Accoustic Doppler Profiler

NOAA National Oceanographic Atmospheric Administration

MBARI Monterey Bay Aquarium Research Institute

MIT Massachusetts Institute of Technology

ODF Ocean Data Facility

ODU Old Dominion University

OSU Oregon State University

PMEL Pacific Marine Environmental Laboratory

POC Particulate Organic Carbon

POM Particulate Organic Matter

Princeton Princeton University

Rutgers Rutgers University

RSMAS Rosenstiel School of Marine and Atmospheric Science - UM

SEG Shipboard Electronics Group

SF6 Sulfur Hexafluoride

SMISS University of Southern Mississippi

SIO Scripps Institution of Oceanography

SOCCOM The Southern Ocean Carbon and Climate Observations and Modeling project. http://soccom.princeton.edu/

STARC Ship-based Science Technical Support in the Arctic

STS Shipboard Technical Support - SIO

TAMU Texas Agricultural and Mechanical Engineering University

TDN Total Dissolved Nitorgen

U Colorado University of Colorado

U. Puerto Rico University of Puerto Rico

UAF University of Alaska Fairbanks

UCI University of California Irvine

UCSB University of California Santa Barbara

UCSC University of California Santa Cruz

UCSD University of California San Diego

UCONN University of Connecticut

UH University of Hawaii

UM University of Miami

UMASSD University of Massachusetts Dartmouth

UNSW University of New South Wales

USC University of South Carolina

USM University of Southern Mississippi

UVP Unerwater Vision Profiler

UW University of Washington

UWA University of Western Australia

U. Wisconsin University of Wisconson

VUB Vrije Universiteit Brüssel

WHOI Woods Hole Oceanographic Institution

Wright Wright State University

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BOTTLE QUALITY COMMENTS

Station	Cast	Bottle	Param	Code	Comment
1	2	01	pH	5	
1	2	02	Bottle	3	Leaker.
1	2	02	CTD Temperature 2	4	Flow through malfunction.
1	2	02	DIC	3	
1	2	02	pH	5	
1	2	02	Total Alkalinity	4	
1	2	03	Bottle	3	Leaker.
1	2	03	CTD Temperature 2	4	Flow through malfunction.
1	2	03	DIC	3	
1	2	03	pH	5	
1	2	03	Salinity	3	Bottle salt is 0.034 lower than CTDS. Bottles 01
1	2	03	Total Alkalinity	4	
1	2	04	CTD Temperature 2	4	Flow through malfunction.
1	2	04	pH	5	
1	2	05	CTD Temperature 2	4	Flow through malfunction.
1	2	05	DIC	3	
1	2	05	pH	3	
1	2	05	Reference Temperature	4	SBE35 value high. CTD watch-stander not aware of SBE35. Wait time not observed.
1	2	06	CTD Temperature 2	4	Flow through malfunction.
1	2	06	Salinity	2	Although salt D-C is a little large at -0.014
1	2	07	CTD Temperature 2	4	Flow through malfunction.
1	2	07	pH	5	
1	2	08	CTD Temperature 2	4	Flow through malfunction.
1	2	09	Bottle	3	Leaks at spigot.
1	2	09	CTD Temperature 2	4	Flow through malfunction.
1	2	09	DIC	3	
1	2	10	CTD Temperature 2	4	Flow through malfunction.
1	2	10	pH	5	
1	2	10	Reference Temperature	4	SBE35 value high. CTD watch-stander not aware of SBE35. Wait time not observed.
1	2	11	CTD Temperature 2	4	Flow through malfunction.
1	2	12	CTD Temperature 2	4	Flow through malfunction.
1	2	13	Bottle	9	Core sediment trap did not fire. Bottom too sandy. No samples drawn.
1	5	02	Bottle	3	Bottom leak when air vent opened
1	5	02	Salinity	2	Salt D-C of -0.010 is a little large

Continued on next page

Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
1	5	04	Bottle	3	Slow leak from btltom
1	5	05	NO_2	2	Nitrite of 0.03 is a little higher than near this depth at 00102. Suggest examination of data. If no problems are uncovered
1	5	07	Dissolved O_2	3	Bottle oxygen value does not match profile trend or adjacent cast. Code questionable.
1	5	09	Bottle	3	Badly leaking from btltom
1	5	09	Reference Temperature	4	SBE35 high vs CTDT1/CTDT2. Wait time not observed. Code bad.
1	5	10	Bottle	3	When spigot is pushed in
1	5	10	Reference Temperature	4	SBE35 high vs CTDT1/CTDT2. Wait time not observed. Code bad.
1	7	01	Salinity	4	Analytical error. Code bad..
1	7	02	Bottle	3	Leaking.
1	7	06	Dissolved O_2	5	Paper blocked window
1	7	07	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. Wait time not observed in this high gradient region of profile. Code bad..
1	7	08	Reference Temperature	4	Data upload from corrupted file.
1	7	09	Bottle	3	Leaking on recovery.
1	7	12	Bottle	3	Leaking.
1	7	13	Bottle	9	Core sediment trap did not fire. Bottom too sandy. No samples drawn.
2	4	04	Bottle	3	Leaking.
2	4	04	CTD Conductivity 2	4	Flow through obstruction.
2	4	04	CTD Temperature 2	4	Flow through obstruction.
2	4	04	Salinity	3	Value does not match profile. Code questionable.
2	4	05	CTD Conductivity 1	3	CTDC1 reading high. High gradient in low salinity area. Code questionable.
2	4	05	CTD Conductivity 2	4	Flow through obstruction.
2	4	05	CTD Temperature 2	4	Flow through obstruction.
2	4	05	Salinity	2	Value does not match profile. Code questionable.
2	4	06	CTD Conductivity 2	4	Flow through obstruction.
2	4	06	CTD Temperature 2	4	Flow through obstruction.
2	4	06	Salinity	3	Value does not match profile. Code questionable.
2	4	07	CTD Conductivity 2	4	Flow through obstruction.
2	4	07	CTD Temperature 2	4	Flow through obstruction.
2	4	07	Reference Temperature	4	Data upload file corrupted.
2	4	08	CTD Conductivity 2	4	Flow through obstruction.
2	4	08	CTD Temperature 2	4	Flow through obstruction.
2	4	08	Reference Temperature	4	Data upload file corrupted.
2	4	09	Bottle	3	Leaking from bottom.
2	4	09	CTD Conductivity 2	4	Flow through obstruction.
2	4	09	CTD Temperature 2	4	Flow through obstruction.
2	4	09	Reference Temperature	4	Data upload file corrupted.
2	4	10	Bottle	3	Leaking.
2	4	10	CTD Conductivity 2	4	Flow through obstruction.
2	4	10	CTD Temperature 2	4	Flow through obstruction.
2	4	11	CTD Conductivity 2	4	Flow through obstruction.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
2	4	11	CTD Temperature 2	4	Flow through obstruction.
2	4	11	Dissolved O_2	4	Bottle oxygen is 0.1 ml per liter higher than data from bottles 10 and 12 which were tripped at the same depth.
2	4	12	Bottle	3	Leaking.
2	4	12	CTD Conductivity 2	4	Flow through obstruction.
2	4	12	CTD Temperature 2	4	Flow through obstruction.
2	7	07	Reference Temperature	3	CTD value does not match profile. Code questionable.
2	7	09	Bottle	3	Niskins leaking when the top valve is released.
2	7	10	Bottle	3	Niskins leaking when the top valve is released..
3	2	02	Bottle	3	Small leak.
3	2	06	Reference Temperature	3	Value high vs CTDT1/CTDT2. Code questionable.
3	2	09	Bottle	3	Leaking on recovery.
3	2	10	Bottle	3	Leaking during leak test..
3	2	11	Dissolved O_2	4	Analyst moved tip out sample during titration
3	2	12	Bottle	3	Small leak.
3	5	03	Bottle	3	Small leak.
3	5	03	Reference Temperature	3	CTD value does not match profile. Code questionable.
3	5	05	Reference Temperature	3	SBE35 reads high vs CTDT1/CTDT2. Code questionable.
3	5	08	Reference Temperature	4	Wait time not observed.
3	5	09	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
4	4	04	Bottle	3	Small leak during leak test
4	4	10	Bottle	3	Slow leak from bottom cap.
5	2	01	Reference Temperature	4	Package moving. Wait time not observed.
5	2	03	Reference Temperature	4	Package moving. Wait time not observed.
5	2	05	Reference Temperature	5	SBE35 data over written.
5	2	07	Bottle	3	Tiny leak drop from end cap
5	2	07	Reference Temperature	5	SBE35 data over written.
5	2	09	Dissolved O_2	4	Bottle oxygen is 0.16 ml per liter higher than data for bottles 7 and 8
5	2	09	Reference Temperature	5	SBE35 data over written.
5	2	10	Bottle	3	Leaking from end cap
6	2	02	Bottle	3	Top cap not sealed. TECH BH: inspected
6	2	03	Bottle	3	Leak from bottom cap
6	2	10	Bottle	3	Good sized leak from bottom cap when vent opened. Sampled gases from niskin 11 instead. TECH BH: large spigot collar installed backwards
6	2	12	Bottle	3	Bottom end cap small leak
6	4	03	Bottle	3	Bottom cap leak when air vent opened
6	4	07	Dissolved O_2	2	Bottle value differs from downward profile and adjacent cast
7	1	01	Salinity	4	Salinity low vs CTDC1/CTDC2. code bad.
7	1	03	Bottle	3	Leaks at bottom

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
7	1	04	Bottle	3	Leaking from bottom after opening air vent. Fixed by mallet tap.
7	1	05	Bottle	3	Small drip from end cap after opening air vent. Fixed by mallet tap.
7	1	05	DIC	3	
7	1	05	Salinity	3	Value does not match profile. Code questionable.
7	1	07	Dissolved O_2	5	Analyst did not add acid before titration.
7	1	07	Reference Temperature	4	Package moving. Wait time not observed.
7	1	07	Salinity	4	Salinity high vs CTDC1/CTDC2. code bad.
7	1	07	Total Alkalinity	5	
8	2	02	Salinity	3	Value does not match profile. Code questionable.
8	2	03	Salinity	3	Value does not match profile. Code questionable.
8	2	04	Salinity	3	Value does not match profile. Code questionable.
8	2	05	pH	5	
8	2	07	Salinity	3	Value does not match profile. Code questionable.
8	2	09	Salinity	2	Value does not match profile. Code questionable.
8	2	10	Salinity	2	Value does not match profile. Code questionable.
8	2	11	CTD Temperature 1	4	CTDT1 value high vs CTDT2 & SBE35. Code bad.
8	2	11	pH	5	
8	2	11	Salinity	2	Value does not match profile. Code questionable.
8	2	12	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
8	2	12	Reference Temperature	2	Hold for calib.
8	2	12	Salinity	2	Value does not match profile. Code questionable.
9	1	01	Salinity	3	Value does not match profile. Code questionable.
9	1	02	Salinity	3	Value does not match profile. Code questionable.
9	1	03	Dissolved O_2	2	Bottle value differs from downward profile and adjacent cast
9	1	05	pH	5	
9	1	10	Salinity	3	Value does not match profile. Code questionable.
9	1	11	Dissolved O_2	2	Bottle value differs from downward profile and adjacent cast
9	1	11	Salinity	3	Value does not match profile. Code questionable.
9	1	12	Salinity	3	Value does not match profile. Code questionable.
10	2	03	Bottle	3	Leaking from bottom
10	2	04	Bottle	3	Leaking from bottom
10	2	05	Bottle	3	Top cap unseated on recovery
10	2	07	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	2	08	Bottle	3	Slow drop from bottom
10	2	08	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	2	09	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	2	10	Bottle	3	Leaking on leak test..
10	2	10	Dissolved O_2	3	Bottle oxygen low for cast and adjacent profile. Does not match upcast either. Code questionable..

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
10	2	10	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	2	11	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
10	2	11	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	2	12	Bottle	3	Leaking from bottom with vent open
10	2	12	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	5	07	Salinity	4	Sample does not match profile or bottle value 6 drawn at same level. Code bad.
10	5	08	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	5	09	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	5	10	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	5	11	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
10	5	12	Bottle	3	Small bottom cap leak
10	5	12	Dissolved O_2	3	Analyst noted thio burette refill during endpoint
10	5	12	Salinity	3	Values do not match profile. Not used in calibrations code questionable.
11	1	01	Bottle	3	Top cap not seated correctly
11	1	01	pH	5	
11	1	05	pH	5	
11	1	06	Bottle	3	Top cap not seated correctly
11	1	12	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	13	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	14	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	15	Salinity	5	Sample run but data mysteriously missing from file..
11	1	16	Bottle	3	Top cap not seated correctly
11	1	16	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	18	pH	5	
11	1	21	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	22	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	23	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	24	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
11	1	25	Salinity	2	Value does not match profile. Not used in calibration. Code questionable.
12	3	01	Bottle	3	Leak

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
12	3	01	Salinity	4	D-C salinity difference is -0.0064
12	3	07	Salinity	4	SALINITY D-C salt is 0.004
12	3	15	Dissolved O_2	3	End point shaky
12	3	15	Salinity	3	Interleaving. Code questionable.
12	3	17	CTD Conductivity 2	3	Interleaving. Code questionable.
12	3	17	Salinity	2	Interleaving.
12	3	21	CTD Conductivity 2	3	Interleaving. Code questionable.
12	3	21	Salinity	2	Interleaving.
12	3	23	CTD Conductivity 2	2	Interleaving.
12	3	23	Salinity	3	Interleaving.
12	3	24	Bottle	9	Did not close.
12	3	25	Salinity	3	Interleaving. Code questionable.
12	3	25	Total Alkalinity	4	
12	3	26	Salinity	2	Interleaving.
12	3	27	Salinity	3	Interleaving. Code questionable.
12	3	28	Salinity	3	Interleaving. Code questionable.
12	3	29	Salinity	3	Interleaving. Code questionable.
12	3	30	Salinity	3	Interleaving. Code questionable.
12	3	31	Salinity	3	Interleaving. Code questionable.
12	3	32	Salinity	3	Interleaving. Code questionable.
12	3	33	Salinity	3	Interleaving. Code questionable.
12	3	34	Salinity	3	Interleaving. Code questionable.
12	3	35	Dissolved O_2	2	Thiosulfate refilled in the middle of titration plotting
12	3	35	Salinity	3	Interleaving. Code questionable.
12	3	36	Dissolved O_2	2	Thiosulfate refilled in the middle of titration plotting
12	3	36	Salinity	3	Interleaving. Code questionable.
13	1	01	Bottle	3	Bottle leak
13	1	01	Salinity	3	Salinity value questionable fit with profile. Code questionable.
13	1	02	Salinity	4	SALINITY D-C salt is over 0.004
13	1	06	Salinity	4	SALINITY D-C salt is over 0.006
13	1	10	Salinity	4	SALINITY D-C salt is -0.0058
13	1	16	Total Alkalinity	3	
13	1	18	Salinity	3	Value does not match bottle value. Not used in calibration. Code questionable.
13	1	19	CTD Temperature 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
13	1	24	CTD Temperature 2	2	CTD value does not match profile. Not used in calibration. Code questionable.
13	1	26	Salinity	3	Value does not match bottle value. Not used in calibration. Code questionable.
13	1	27	Salinity	3	Value does not match bottle value. Not used in calibration. Code questionable.
13	1	28	Bottle	3	Bottle leak
13	1	28	Salinity	3	Value does not match bottle value. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
13	1	29	Salinity	3	Value does not match bottle value. Not used in calibration. Code questionable.
14	2	01	Bottle	3	Leak
14	2	02	Dissolved O_2	2	Temperature taken from bottle trip info due to bad temp probe during sampling.
14	2	04	Dissolved O_2	2	Temperature taken from bottle trip info due to bad temp probe during sampling.
14	2	06	Bottle	3	Leak
14	2	06	CTD Temperature 1	4	Unstable temperatures in all three sensors. Package probably in motion.
14	2	06	CTD Temperature 2	4	Unstable temperatures in all three sensors. Package probably in motion.
14	2	06	Reference Temperature	4	Unstable temperatures in all three sensors. Package probably in motion.
14	2	07	Dissolved O_2	2	Temperature taken from bottle trip info due to bad temperature probe during sampling.
14	2	07	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	10	Dissolved O_2	2	Temperature taken from bottle trip info due to bad temperature probe during sampling.
14	2	10	pH	4	
14	2	13	pH	4	
14	2	16	pH	4	
14	2	22	NO^3	3	Nitrate value higher than bottles 23-24 which were tripped at the same depth. No analytical errors noted.
14	2	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	25	NO^3	3	Nitrate value higher than bottles 26-27 which were tripped at the same depth. No analytical errors noted.
14	2	25	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	28	Bottle	3	Leaking
14	2	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	29	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	31	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	34	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	2	35	Reference Temperature	5	Data file over written.
14	2	36	Reference Temperature	5	Data file over written.
14	4	01	Dissolved O_2	3	Weird endpoint
14	4	04	NO^3	3	Nitrate value higher than bottles 5-6 which were tripped at the same depth. No analytical errors noted.
14	4	19	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
14	4	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	4	23	NO^3	3	Value higher than bottles 22
14	4	23	PO_4	3	Value higher than bottles 22
14	4	23	SIO_3	3	Value higher than bottles 22
14	4	25	NO_2	3	Value lower than bottles 26-27 which were tripped at the same depth. No analytical errors noted.
14	4	25	NO^3	3	Value higher than bottles 26-27 which were tripped at the same depth. No analytical errors noted.
14	4	25	PO_4	3	Value higher than bottles 26-27 which were tripped at the same depth. No analytical errors noted.
14	4	25	Salinity	3	Value does not batch profile. Not used in calibration. Code questionable.
14	4	25	SIO_3	3	Value higher than bottles 26-27 which were tripped at the same depth. No analytical errors noted.
14	4	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	4	31	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
14	9	04	Salinity	4	Salinity value more closely matches bottle 10. Possible miss draw. Code bad..
14	9	07	Salinity	4	Salinity value more closely matches bottle 19. Possible miss draw. Code bad..
14	9	10	Salinity	4	Salinity value more closely matches bottle 25. Possible miss draw. Code bad..
14	9	22	Total Alkalinity	4	
14	9	34	Total Alkalinity	4	
14	9	37	Bottle	4	Corer did not capture a sample.
15	1	04	Total Alkalinity	3	
15	1	07	Salinity	4	JHS: D-C salinity difference is nearly 0.01. Suggest coding bad.
15	1	10	Bottle	3	Slow leak from bottom end cap.
15	1	13	Salinity	4	JHS: The D-C salinity difference is over 0.05
15	1	15	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	16	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
15	1	17	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration. Code questionable.
15	1	18	CTD Conductivity 2	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	18	Total Alkalinity	5	
15	1	20	CTD Conductivity 2	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
15	1	25	CTD Conductivity 1	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	27	Dissolved O_2	2	Bottle value matches upcast. Code good.
15	1	27	pH	4	
15	1	27	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	29	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
15	1	30	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
16	1	02	DIC	5	
16	1	02	Reference Temperature	3	SBE35 value does not match profile. Not used in calibration. Code questionable.
16	1	02	Salinity	4	The D-C salinity difference is -0.0066 which is large for this portion of the water column.
16	1	13	Salinity	3	Value does not match profile. Some interleaving
16	1	14	Salinity	3	Value does not match profile. Some interleaving
16	1	21	pH	4	
16	1	24	pH	4	
16	1	24	Salinity	3	Value does not match profile. Some interleaving
16	1	25	Salinity	3	Value does not match profile. Some interleaving
16	1	26	Salinity	3	Value does not match profile. Some interleaving
16	1	27	Salinity	3	Value does not match profile. Some interleaving
17	1	06	Dissolved O_2	2	Low endpoint voltage
17	1	13	Salinity	3	Value does not match profile. Not used in calibration . Code questionable.
17	1	14	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
17	1	15	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
17	1	16	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
17	1	17	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
17	1	18	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
17	1	19	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
17	1	20	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
17	1	21	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
17	1	21	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
17	1	22	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
17	1	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
17	1	23	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
17	1	24	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
17	1	25	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	06	DIC	3	
18	1	06	Salinity	4	The D-C salt difference is -0.0055
18	1	09	Dissolved O_2	5	Sample lost..
18	1	11	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	12	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	13	CTD Temperature 2	2	CTD value does not match profile. Not used in calibration. Code questionable.
18	1	14	DIC	3	
18	1	14	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	15	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
18	1	15	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	16	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration. Code questionable.
18	1	16	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	17	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration. Code questionable.
18	1	17	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	18	DIC	3	
18	1	18	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	19	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	20	CTD Temperature 1	4	Unstable temperatures in all three sensors. Code bad.
18	1	20	CTD Temperature 2	4	Unstable temperatures in all three sensors. Code bad.
18	1	20	Reference Temperature	4	Unstable temperatures in all three sensors. Code bad.
18	1	20	Salinity	2	Dynamic portion of water column. High gradient and interleaving. Code good.
18	1	21	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	23	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
18	1	24	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
18	1	25	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	01	pH	3	
19	2	13	CTD Temperature 2	3	CTD value does not match bottle value. Not used in calibration
19	2	14	Salinity	4	Salinity value does not match profile or bottle 13 tripped at same level. Nutrients look good. Code bad.
19	2	16	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
19	2	17	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
19	2	18	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
19	2	19	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
19	2	20	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
19	2	25	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	26	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
19	2	27	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	29	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	30	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	31	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	32	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	33	Reference Temperature	3	CTD value does not match profile. Not used in calibration
19	2	33	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	34	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	2	35	Bottle	9	Niskin empty
19	2	36	Salinity	3	Salinity value high vs CTDC1/CTDC2. Code questionable.
19	4	06	Reference Temperature	2	SBE35 value does not match profile. Not used in calibration
19	4	07	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
19	4	10	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	13	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	16	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	25	CTD Temperature 2	2	CTD value does not match profile. Not used in calibration
19	4	25	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.6uM which is outside normal acceptable deviation
19	4	25	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	26	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.6uM which is outside normal acceptable deviation
19	4	26	Reference Temperature	4	SBE35 reads high vs CTDT1 & CTDT2. Code bad.
19	4	27	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
19	4	27	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.6uM which is outside normal acceptable deviation
19	4	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	31	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	4	34	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
19	9	19	pH	4	
19	9	30	Salinity	4	The D-C salt difference is -0.0057
19	9	36	Salinity	5	Sample or analysis lost.
20	1	01	CTD Conductivity 1	3	Salinity difference is high for bottom of profile. Code questionable..
20	1	08	Total Alkalinity	4	
20	1	09	Salinity	3	CTD value does not match bottle value. Not used in calibration
20	1	18	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
20	1	19	Salinity	3	CTD value does not match bottle value. Not used in calibration
20	1	20	Total Alkalinity	5	
20	1	21	CTD Conductivity 2	3	CTD value does not match bottle value. Not used in calibration
20	1	22	Salinity	3	CTD value does not match bottle value. Not used in calibration
20	1	23	Salinity	3	CTD value does not match bottle value. Not used in calibration
20	1	27	CTD Conductivity 2	3	CTD value does not match bottle value. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
20	1	28	CTD Temperature 1	4	Unstable temperature in all three sensors. High gradient. Code bad.
20	1	28	CTD Temperature 2	4	Unstable temperature in all three sensors. High gradient. Code bad.
20	1	28	Reference Temperature	4	Unstable temperature in all three sensors. High gradient. Code bad.
20	1	29	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
20	1	29	Salinity	3	CTD value does not match profile. Not used in calibration
20	1	30	Salinity	3	CTD value does not match profile. Not used in calibration
20	1	31	CTD Temperature 1	4	Unstable temperature in all three sensors. High gradient. Code bad.
20	1	31	CTD Temperature 2	4	Unstable temperature in all three sensors. High gradient. Code bad.
20	1	31	Reference Temperature	4	Unstable temperature in all three sensors. High gradient. Code bad.
21	1	01	CTD Temperature 1	2	CTD value does not match profile. Not used in calibration
21	1	02	CTD Temperature 1	2	CTD value does not match profile. Not used in calibration
21	1	06	Salinity	4	The D-C salinity difference of -0.0055 is a little large for this part of the water column and there is no matching salinity feature in the CTDSAL profile.
21	1	07	Salinity	4	The D-C salinity difference of 0.0095 is large for this part of the water column and there is no matching salinity feature in the CTDSAL profile.
21	1	10	Salinity	4	D-C salinity difference is too large.
21	1	15	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	16	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	17	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	18	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	20	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	22	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration. Code questionable.
21	1	22	Salinity	2	CTD value does not match profile. Not used in calibration
21	1	23	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	24	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	25	Salinity	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
21	1	26	Salinity	3	CTD value does not match profile. Not used in calibration
21	1	27	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	01	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
22	1	01	Salinity	4	D-C salt difference is too large.
22	1	02	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
22	1	03	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
22	1	04	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
22	1	04	Salinity	4	D-C salt difference is too large.
22	1	12	Salinity	4	D-C salt difference is too large.
22	1	15	Bottle	3	Air vent not closed..
22	1	21	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	22	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	23	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	24	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	25	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	26	Salinity	2	Values match up-cast. Code good.
22	1	27	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	28	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	29	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	30	Salinity	3	CTD value does not match profile. Not used in calibration
22	1	31	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	07	Total Alkalinity	3	
23	1	09	Total Alkalinity	3	
23	1	16	Bottle	3	Air vent was left open.
23	1	17	Salinity	4	D-C salt difference is nearly 0.02 which is large for this portion of the water column.
23	1	22	Reference Temperature	4	SBE35 value read high vs CTDT1/CTDT2. Code bad.
23	1	24	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	25	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	26	Salinity	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
23	1	27	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	28	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	29	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	31	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	32	Salinity	3	CTD value does not match profile. Not used in calibration
23	1	33	pH	3	
23	1	33	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	01	Total Alkalinity	5	
24	1	03	Salinity	4	The D-C salt difference is 0.0061
24	1	09	Salinity	4	The D-C salt difference is -0.0034
24	1	10	Salinity	4	The D-C salt difference is -0.005
24	1	10	Total Alkalinity	4	
24	1	17	pH	4	
24	1	21	pH	3	
24	1	21	Salinity	2	Analyst believes the first reading is correct.
24	1	22	pH	3	
24	1	23	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
24	1	23	Salinity	2	CTD value does not match profile. Not used in calibration
24	1	24	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	25	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	25	Total Alkalinity	5	
24	1	26	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	27	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	28	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	29	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	30	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	31	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	32	Salinity	3	CTD value does not match profile. Not used in calibration
24	1	33	Dissolved O_2	3	Thiosulfate refilled during titration curve
24	1	33	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	03	Salinity	2	Sample run twice as it was high compared to ctd.
25	1	27	Dissolved O_2	2	Bottle value matches up cast. Code good..

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
25	1	27	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	28	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	29	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	30	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	31	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	32	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	33	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	34	Salinity	3	CTD value does not match profile. Not used in calibration
25	1	35	Salinity	3	Salinity value is high vs CTDC1/CTDC2. JEC: Fourth reading is keyboard entry of first reading.
25	1	36	Salinity	2	Fifth reading is keyboard entry of first reading. Third reading looked most reasonable but could not enter that value.
26	3	01	Salinity	2	Forth reading was keyboard entry of first reading.
26	3	02	Bottle	3	Top cap leak? Spigot drains without vent cap being open..
26	3	03	Bottle	3	Bottom end cap leak
26	3	04	Bottle	3	Bottom end cap leak
26	3	05	Bottle	3	Bottom end cap leak
26	3	06	Bottle	3	Bottom end cap leak
26	3	06	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	07	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	08	Bottle	3	Bottom end cap leak
26	3	08	Dissolved O_2	4	Bottle value does not match up or down profile or adjacent cast. Slow leak noted from bottle. Code bad..
26	3	08	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	09	Dissolved O_2	3	Bottle value fits lower depth. Possible ship heave cause lower depth collection.
26	3	09	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	10	Bottle	3	Slow leak from bottom end cap even before vent opened
26	3	10	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	11	Bottle	3	Bottom end cap leak
26	3	11	Salinity	3	CTD value does not match profile. Not used in calibration
26	3	12	Bottle	3	Serious bottom end cap leak

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
26	5	04	Bottle	3	Bottom cap leak doesn't completely fix with mallet tap
26	5	06	Salinity	3	CTD value does not match profile. Not used in calibration
26	5	07	Salinity	3	CTD value does not match profile. Not used in calibration
26	5	08	Bottle	3	Bottom cap leak doesn't completely fix with mallet tap
26	5	08	Salinity	3	CTD value does not match profile. Not used in calibration
26	5	09	Bottle	4	Bottle closed early
26	5	09	NO_2	4	Bottle closed early
26	5	09	NO^3	4	Bottle closed early
26	5	09	Dissolved O_2	4	Bottle closed early
26	5	09	PO_4	4	Bottle closed early
26	5	09	Salinity	4	Bottle closed early
26	5	09	SIO_3	4	Bottle closed early
26	5	10	Salinity	3	CTD value does not match profile. Not used in calibration
26	5	11	Bottle	3	Top cap not seated
26	5	11	Salinity	3	CTD value does not match profile. Not used in calibration
26	5	12	Bottle	3	Bottom cap leak doesn't completely fix with mallet tap
26	5	12	Salinity	4	Salinity value unstable vs CTDC1/CTDC2. Salinometer needed more flushing before measurement due to fresh water surface and high gradient conditions.
26	9	01	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	02	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	02	Salinity	2	Salinity value matches profile. Code good. JEC: Fourth reading was a keyboard entry.
26	9	03	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	04	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	05	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	06	CTD Conductivity 1	2	CTD value does not match bottle value. Not used in calibration
26	9	07	pH	4	
26	9	08	Total Alkalinity	4	
26	9	12	Bottle	3	Bottom cap leak after vent opened
26	9	13	Bottle	4	Corer did not capture a sample.
27	1	21	pH	4	
27	1	28	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
27	1	29	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	30	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	31	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	32	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	33	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	34	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
27	1	35	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
28	1	01	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	02	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	03	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	04	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	05	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	06	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	06	Salinity	4	The D-C salinity difference of 0.0093 is too large for this portion of the water column.
28	1	07	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	08	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	09	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	10	CTD Conductivity 1	3	CTD value does not match bottle value. Not used in calibration
28	1	11	CTD Conductivity 1	4	Offset in bottom sample values does not reflect actual salinity. Code bad.
28	1	12	Salinity	2	Fourth reading probably the best.
28	1	13	Salinity	2	Fifth reading was keyboard entry. Third and fourth readings were closest.
28	1	16	pH	4	
28	1	17	pH	4	
28	1	18	pH	3	
28	1	19	pH	3	
28	1	23	Salinity	3	CTD value does not match profile. Not used in calibration
28	1	26	Salinity	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
28	1	29	Salinity	4	The D-C salinity difference of 0.0868 is larger than for the bottles above and below..
28	1	30	Salinity	3	CTD value does not match profile. Not used in calibration
28	1	32	Salinity	3	CTD value does not match profile. Not used in calibration
28	1	33	Dissolved O_2	2	Bottle value matches upcast. Code good.
28	1	33	Salinity	3	CTD value does not match profile. Not used in calibration
28	1	34	Salinity	3	CTD value does not match profile. Not used in calibration
28	1	36	Salinity	2	Fifth reading was keyboard entry.
29	1	01	CTD Conductivity 1	4	D-C salinity difference is large for this level of the water column.
29	1	01	CTD Conductivity 2	4	D-C salinity difference is large for this level of the water column.
29	1	01	Salinity	4	D-C salinity difference is large for this level of the water column.
29	1	02	pH	4	
29	1	09	pH	4	
29	1	14	Salinity	4	D-C salinity difference is -0.0091
29	1	18	pH	3	
29	1	27	Salinity	3	CTD value does not match profile value. Not used in calibration
29	1	28	pH	4	
29	1	28	Salinity	3	CTD value does not match profile. Not used in calibration
29	1	31	Salinity	3	CTD value does not match profile. Not used in calibration
29	1	32	Salinity	3	CTD value does not match profile. Not used in calibration
29	1	33	Salinity	3	CTD value does not match profile. Not used in calibration
29	1	34	Salinity	3	CTD value does not match profile. Not used in calibration
29	1	35	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	01	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	07	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	16	CTD Conductivity 2	3	CTD value does not match profile. Not used in calibration
30	3	19	NO^3	2	Tripped at the same depth as bottles 20-21. Nutrients sampled after other parameters in a high gradient portion of the water column
30	3	19	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	22	Salinity	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
30	3	25	NO^3	2	Tripped at the same depth as bottles 26-27. Nutrients sampled after other parameters in a high gradient portion of the water column
30	3	25	pH	4	
30	3	25	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	28	Salinity	3	CTD value does not match profile. Not used in calibration
30	3	31	NO^3	2	Tripped at the same depth as bottles 32-33. Nutrients sampled after other parameters in a high gradient portion of the water column
30	3	31	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	01	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	01	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	02	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	03	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	04	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	05	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	06	NO^3	2	Bottles 1-6 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	07	CTD Temperature 2	3	CTD value does not match profile. Not used in calibration
30	5	07	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	07	Salinity	3	Salinity value is high vs CTDC1/CTDC2. JEC: Fourth reading is keyboard entry.
30	5	08	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	09	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	10	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
30	5	11	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	12	NO^3	2	Bottles 7-12 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	13	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	13	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	14	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	14	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	15	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	16	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	17	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	18	NO^3	2	Bottles 13-18 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
30	5	19	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	25	Salinity	3	CTD value does not match profile. Not used in calibration
30	5	31	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	01	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	02	Bottle	3	Air vent not closed.
30	8	07	Salinity	3	CTD value does not match bottle value. Not used in calibration
30	8	10	Salinity	2	Fourth reading was keyboard entry.
30	8	13	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	16	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	19	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	22	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	25	Salinity	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
30	8	28	Salinity	3	CTD value does not match profile. Not used in calibration
30	8	31	Salinity	3	CTD value does not match profile. Not used in calibration
30	10	01	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	02	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	03	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	04	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	05	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	06	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	07	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	07	pH	5	
30	10	07	Salinity	3	CTD value does not match profile. Not used in calibration
30	10	08	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	09	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	10	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	10	Salinity	4	D-C salinity difference is large for this portion of the water column.
30	10	11	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	12	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	13	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	13	Salinity	3	CTD value does not match profile. Not used in calibration
30	10	14	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	15	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	16	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	16	Salinity	4	D-C salinity difference is large for this portion of the water column.
30	10	17	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	18	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
30	10	19	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	20	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	21	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	22	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	23	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	24	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	25	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	26	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	27	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	28	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	28	pH	4	
30	10	29	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	30	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	31	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	31	Salinity	2	Fourth reading was keyboard entry.
30	10	32	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	33	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	10	34	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	12	01	CTD Conductivity 1	3	Primary measurement does not match others conductivity readings.
30	12	01	Dissolved O_2	3	Endpoint grapH not displayed until after titration was done
30	12	35	Bottle	9	Bottle did not close.
30	14	01	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	02	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	03	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	04	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	05	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
30	14	06	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	07	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	08	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	09	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	10	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	11	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	12	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	13	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
30	14	31	CTD Conductivity 1	3	Does not match other conductivity measurements.
32	2	01	pH	5	
32	2	16	Salinity	3	CTD value does not match profile. Not used in calibration
32	2	19	Salinity	3	CTD value does not match profile. Not used in calibration
32	2	28	Salinity	3	CTD value does not match profile. Not used in calibration
32	2	31	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration
32	4	13	Salinity	3	CTD value does not match bottle. Not used in calibration
32	4	14	CTD Temperature 2	3	CTD value does not match profile. Not used in calibration
32	4	14	Reference Temperature	4	Reft high vs CTDT2/CTDT1 for this part of profile. Wait time likely not observed. Code bad.
32	4	16	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	22	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	25	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	28	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	31	Dissolved O_2	2	Thiosulfate refilled in middle of titration curve
32	4	31	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	34	Reference Temperature	3	SBE35 value does not match profile. Not used in calibration
32	4	34	Salinity	3	CTD value does not match profile. Not used in calibration
32	4	35	Reference Temperature	3	SBE35 value does not match profile. Not used in calibration
32	4	36	CTD Temperature 1	4	CTDT1 low vs SBE35/CTDT2. Code bad.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
32	4	36	Reference Temperature	3	SBE35 value does not match profile. Not used in calibration
32	8	01	CTD Conductivity 2	3	Questionable.
32	8	01	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	01	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	02	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	02	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	03	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	03	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	04	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	04	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	05	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	05	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	06	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	06	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	07	Bottle	3	Frozen spigot.
32	8	07	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	07	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	08	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	08	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	09	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	09	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	10	CTD Dissolved O_2	4	SBE43 Sensor failed.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
32	8	10	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	11	Bottle	3	Frozen spigot.
32	8	11	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	11	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	12	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	12	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	13	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	13	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	14	Bottle	3	Frozen spigot.
32	8	14	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	14	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	15	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	15	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	16	Bottle	3	Frozen spigot.
32	8	16	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	16	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	17	Bottle	3	Frozen spigot.
32	8	17	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	17	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	18	Bottle	3	Frozen spigot.
32	8	18	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	18	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	19	CTD Conductivity 2	3	Questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
32	8	19	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	19	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	19	Dissolved O_2	2	Bottle value is low vs adjacent bottle values at this depth and does not match profile. Code questionable..
32	8	19	Reference Temperature	3	Temperature value is a little high for this portion of the water column. Code questionable.
32	8	20	Bottle	3	Frozen spigot.
32	8	20	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	20	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	21	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	21	CTD Temperature 1	3	CTDT1 value is low vs SBE35/CTDT2 for an arctic water column. Code questionable.
32	8	22	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	22	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	23	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	23	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	24	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	24	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	25	Bottle	3	Frozen spigot.
32	8	25	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	25	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	26	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	26	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	27	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	27	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
32	8	28	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	28	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	29	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	29	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	30	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	30	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	31	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	31	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	32	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	32	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	33	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	33	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	34	CTD Dissolved O_2	4	SBE43 Sensor failed.
32	8	34	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	35	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	36	CTD Temperature 1	2	Pump froze at surface. CTDT1 difference vs. SBE35/CTDT2 indicate pumps never fully recovered through out profile. Report secondary data for this cast.
32	8	37	Bottle	4	Corer did not capture a sample.
34	1	01	CTD Conductivity 2	4	Pumps malfunction.
34	1	01	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	01	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	01	CTD Temperature 2	4	Pumps malfunction.
34	1	02	CTD Conductivity 2	4	Pumps malfunction.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
34	1	02	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	02	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	02	CTD Temperature 2	4	Pumps malfunction.
34	1	03	CTD Conductivity 2	4	Pumps malfunction.
34	1	03	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	03	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	03	CTD Temperature 2	4	Pumps malfunction.
34	1	04	CTD Conductivity 2	4	Pumps malfunction.
34	1	04	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	04	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	04	CTD Temperature 2	4	Pumps malfunction.
34	1	05	CTD Conductivity 2	4	Pumps malfunction.
34	1	05	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	05	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	05	CTD Temperature 2	4	Pumps malfunction.
34	1	06	CTD Conductivity 2	4	Pumps malfunction.
34	1	06	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	06	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	06	CTD Temperature 2	4	Pumps malfunction.
34	1	07	CTD Conductivity 2	4	Pumps malfunction.
34	1	07	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	07	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	07	CTD Temperature 2	4	Pumps malfunction.
34	1	08	CTD Conductivity 2	4	Pumps malfunction.
34	1	08	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	08	CTD Temperature 1	4	CTD value does not match profile. Not used in calibration
34	1	08	CTD Temperature 2	4	Pumps malfunction.
34	1	09	CTD Conductivity 1	3	Does not match other cond measurements.
34	1	09	CTD Conductivity 2	4	Pumps malfunction.
34	1	09	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	09	CTD Temperature 2	4	Pumps malfunction.
34	1	10	CTD Conductivity 2	4	Pumps malfunction.
34	1	10	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	10	CTD Temperature 2	4	Pumps malfunction.
34	1	11	CTD Conductivity 2	4	Pumps malfunction.
34	1	11	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	11	CTD Temperature 2	4	Pumps malfunction.
34	1	12	CTD Conductivity 2	4	Pumps malfunction.
34	1	12	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	12	CTD Temperature 2	4	Pumps malfunction.
34	1	13	CTD Conductivity 1	3	Does not match other cond measurements.
34	1	13	CTD Conductivity 2	4	Pumps malfunction.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
34	1	13	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	13	CTD Temperature 2	4	Pumps malfunction.
34	1	14	CTD Conductivity 2	4	Pumps malfunction.
34	1	14	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	14	CTD Temperature 2	4	Pumps malfunction.
34	1	15	CTD Conductivity 2	4	Pumps malfunction.
34	1	15	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	15	CTD Temperature 2	4	Pumps malfunction.
34	1	16	CTD Conductivity 2	4	Pumps malfunction.
34	1	16	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	16	CTD Temperature 2	4	Pumps malfunction.
34	1	17	CTD Conductivity 2	4	Pumps malfunction.
34	1	17	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	17	CTD Temperature 2	4	Pumps malfunction.
34	1	18	CTD Conductivity 2	4	Pumps malfunction.
34	1	18	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	18	CTD Temperature 2	4	Pumps malfunction.
34	1	19	CTD Conductivity 2	4	Pumps malfunction.
34	1	19	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	19	CTD Temperature 2	4	Pumps malfunction.
34	1	20	CTD Conductivity 2	4	Pumps malfunction.
34	1	20	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	20	CTD Temperature 2	4	Pumps malfunction.
34	1	21	CTD Conductivity 2	4	Pumps malfunction.
34	1	21	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	21	CTD Temperature 2	4	Pumps malfunction.
34	1	22	CTD Conductivity 2	4	Pumps malfunction.
34	1	22	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	22	CTD Temperature 2	4	Pumps malfunction.
34	1	23	CTD Conductivity 2	4	Pumps malfunction.
34	1	23	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	23	CTD Temperature 2	4	Pumps malfunction.
34	1	24	CTD Conductivity 2	4	Pumps malfunction.
34	1	24	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	24	CTD Temperature 2	4	Pumps malfunction.
34	1	25	CTD Conductivity 2	4	Pumps malfunction.
34	1	25	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	25	CTD Temperature 2	4	Pumps malfunction.
34	1	26	CTD Conductivity 2	4	Pumps malfunction.
34	1	26	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	26	CTD Temperature 2	4	Pumps malfunction.
34	1	27	CTD Conductivity 2	4	Pumps malfunction.
34	1	27	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	27	CTD Temperature 2	4	Pumps malfunction.
34	1	28	CTD Conductivity 2	4	Pumps malfunction.
34	1	28	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	28	CTD Temperature 2	4	Pumps malfunction.
34	1	29	CTD Conductivity 2	4	Pumps malfunction.
34	1	29	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
34	1	29	CTD Temperature 2	4	Pumps malfunction.
34	1	30	CTD Conductivity 2	4	Pumps malfunction.
34	1	30	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	30	CTD Temperature 2	4	Pumps malfunction.
34	1	31	CTD Conductivity 2	4	Pumps malfunction.
34	1	31	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	31	CTD Temperature 2	4	Pumps malfunction.
34	1	32	CTD Conductivity 2	4	Pumps malfunction.
34	1	32	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	32	CTD Temperature 2	4	Pumps malfunction.
34	1	33	CTD Conductivity 2	4	Pumps malfunction.
34	1	33	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	33	CTD Temperature 2	4	Pumps malfunction.
34	1	34	CTD Conductivity 2	4	Pumps malfunction.
34	1	34	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	34	CTD Temperature 2	4	Pumps malfunction.
34	1	35	CTD Conductivity 2	4	Pumps malfunction.
34	1	35	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	35	CTD Temperature 1	3	CTD value does not match profile. Not used in calibration
34	1	35	CTD Temperature 2	4	Pumps malfunction.
34	1	35	NO^3	2	Tripped at same depth as bottle 36. Value is 0.4uM lower which is outside normal acceptable deviation
34	1	36	CTD Conductivity 2	4	Pumps malfunction.
34	1	36	CTD Dissolved O_2	4	Pumps malfunctioned and sensor failed.
34	1	36	CTD Temperature 2	4	Pumps malfunction.
35	1	01	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable
35	1	01	CTD Conductivity 2	4	Pump malfunction.
35	1	01	CTD Temperature 2	4	Pump malfunction.
35	1	02	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable
35	1	02	CTD Conductivity 2	4	Pump malfunction.
35	1	02	CTD Temperature 2	4	Pump malfunction.
35	1	03	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable
35	1	03	CTD Conductivity 2	4	Pump malfunction.
35	1	03	CTD Temperature 2	4	Pump malfunction.
35	1	04	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable
35	1	04	CTD Conductivity 2	4	Pump malfunction.
35	1	04	CTD Temperature 2	4	Pump malfunction.
35	1	05	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable
35	1	05	CTD Conductivity 2	4	Pump malfunction.
35	1	05	CTD Temperature 2	4	Pump malfunction.
35	1	06	CTD Conductivity 1	3	CTD value does not match bottle value. Code questionable

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
35	1	06	CTD Conductivity 2	4	Pump malfunction.
35	1	06	CTD Temperature 2	4	Pump malfunction.
35	1	07	CTD Conductivity 2	4	Pump malfunction.
35	1	07	CTD Temperature 2	4	Pump malfunction.
35	1	08	CTD Conductivity 2	4	Pump malfunction.
35	1	08	CTD Temperature 2	4	Pump malfunction.
35	1	08	pH	4	
35	1	09	CTD Conductivity 2	4	Pump malfunction.
35	1	09	CTD Temperature 2	4	Pump malfunction.
35	1	10	CTD Conductivity 2	4	Pump malfunction.
35	1	10	CTD Temperature 2	4	Pump malfunction.
35	1	10	Dissolved O_2	4	Sample value low for this part of profile. Bad.
35	1	11	CTD Conductivity 2	4	Pump malfunction.
35	1	11	CTD Temperature 2	4	Pump malfunction.
35	1	12	CTD Conductivity 2	4	Pump malfunction.
35	1	12	CTD Temperature 2	4	Pump malfunction.
35	1	13	CTD Conductivity 2	4	Pump malfunction.
35	1	13	CTD Temperature 2	4	Pump malfunction.
35	1	14	CTD Conductivity 2	4	Pump malfunction.
35	1	14	CTD Temperature 2	4	Pump malfunction.
35	1	14	Dissolved O_2	4	Sample value low for this part of profile. Bad.
35	1	15	CTD Conductivity 2	4	Pump malfunction.
35	1	15	CTD Temperature 2	4	Pump malfunction.
35	1	16	CTD Conductivity 2	4	Pump malfunction.
35	1	16	CTD Temperature 2	4	Pump malfunction.
35	1	17	CTD Conductivity 2	4	Pump malfunction.
35	1	17	CTD Temperature 2	4	Pump malfunction.
35	1	17	Salinity	4	D-C salinity difference is -0.007 which is higher than normal even in this moderately high gradient portion of the water column at this station.
35	1	18	CTD Conductivity 2	4	Pump malfunction.
35	1	18	CTD Temperature 2	4	Pump malfunction.
35	1	19	CTD Conductivity 2	4	Pump malfunction.
35	1	19	CTD Temperature 2	4	Pump malfunction.
35	1	20	CTD Conductivity 2	4	Pump malfunction.
35	1	20	CTD Temperature 2	4	Pump malfunction.
35	1	21	CTD Conductivity 2	4	Pump malfunction.
35	1	21	CTD Temperature 2	4	Pump malfunction.
35	1	22	CTD Conductivity 2	4	Pump malfunction.
35	1	22	CTD Temperature 2	4	Pump malfunction.
35	1	23	CTD Conductivity 2	4	Pump malfunction.
35	1	23	CTD Temperature 2	4	Pump malfunction.
35	1	24	CTD Conductivity 2	4	Pump malfunction.
35	1	24	CTD Temperature 2	4	Pump malfunction.
35	1	25	CTD Conductivity 2	4	Pump malfunction.
35	1	25	CTD Temperature 2	4	Pump malfunction.
35	1	26	CTD Conductivity 2	4	Pump malfunction.
35	1	26	CTD Temperature 2	4	Pump malfunction.
35	1	27	CTD Conductivity 2	4	Pump malfunction.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
35	1	27	CTD Temperature 2	4	Pump malfunction.
35	1	28	CTD Conductivity 2	4	Pump malfunction.
35	1	28	CTD Temperature 2	4	Pump malfunction.
35	1	29	CTD Conductivity 2	4	Pump malfunction.
35	1	29	CTD Temperature 2	4	Pump malfunction.
35	1	30	CTD Conductivity 2	4	Pump malfunction.
35	1	30	CTD Temperature 2	4	Pump malfunction.
35	1	31	CTD Conductivity 1	3	CTD value does not match bottle value or profile. Code questionable
35	1	31	CTD Conductivity 2	4	Pump malfunction.
35	1	31	CTD Temperature 2	4	Pump malfunction.
35	1	32	CTD Conductivity 1	3	CTD value does not match bottle value or profile. Code questionable
35	1	32	CTD Conductivity 2	4	Pump malfunction.
35	1	32	CTD Temperature 2	4	Pump malfunction.
35	1	33	CTD Conductivity 1	3	CTD value does not match bottle value or profile. Code questionable
35	1	33	CTD Conductivity 2	4	Pump malfunction.
35	1	33	CTD Temperature 2	4	Pump malfunction.
35	1	34	CTD Conductivity 1	3	CTD value does not match bottle value or profile. Code questionable
35	1	34	CTD Conductivity 2	4	Pump malfunction.
35	1	34	CTD Temperature 2	4	Pump malfunction.
35	1	35	CTD Conductivity 2	4	Pump malfunction.
35	1	35	CTD Temperature 1	3	Unstable temperatures in all three sensors.
35	1	35	CTD Temperature 2	4	Pump malfunction.
35	1	36	CTD Conductivity 2	4	Pump malfunction.
35	1	36	CTD Temperature 2	4	Pump malfunction.
36	1	04	NO_2	2	The oxygen and nutrients at this bottle are moderately anomalous. If this were only the nutrients
36	1	04	NO^3	2	The oxygen and nutrients at this bottle are moderately anomalous. If this were only the nutrients
36	1	04	Dissolved O_2	2	The oxygen and nutrients at this bottle are moderately anomalous. If this were only the nutrients
36	1	04	PO_4	2	The oxygen and nutrients at this bottle are moderately anomalous. If this were only the nutrients
36	1	04	SIO_3	2	The oxygen and nutrients at this bottle are moderately anomalous. If this were only the nutrients
36	1	06	Salinity	2	Runaway conductivity readings.
36	1	09	pH	5	
36	1	13	pH	3	
36	1	14	CTD Temperature 1	4	Unstable temperatures in all three sensors.
36	1	14	CTD Temperature 2	4	Unstable temperatures in all three sensors.
36	1	14	Reference Temperature	4	Unstable temperatures in all three sensors.
36	1	20	Salinity	3	CTD value does not match profile. Code questionable
36	1	21	Salinity	3	CTD value does not match profile. Code questionable

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
36	1	22	Salinity	3	CTD value does not match profile. Code questionable
36	1	23	Salinity	3	CTD value does not match profile. Code questionable
36	1	24	Salinity	3	CTD value does not match profile. Code questionable
36	1	25	Salinity	3	CTD value does not match profile. Code questionable
36	1	26	Salinity	3	CTD value does not match profile. Code questionable
36	1	27	Salinity	3	CTD value does not match profile. Code questionable
37	1	01	Salinity	4	Salinity value does not belong in this part of the water column. Possibly mis-sampled from a deeper bottle. JHS:D-C salinity difference is enormous
37	1	04	pH	4	
37	1	06	pH	4	
37	1	12	pH	5	
37	1	14	Bottle	3	Slow leak from bottom end cap.
37	1	19	pH	4	
37	1	27	Salinity	3	CTD value does not match profile. Code questionable
37	1	28	Salinity	4	D-C salinity difference is very large. It looks as though this may have been drawn from niskin 30.
37	1	29	Salinity	3	CTD value does not match profile. Code questionable
37	1	30	Salinity	3	CTD value does not match profile. Code questionable
37	1	31	Dissolved O_2	2	Bottle value does not match downcast. However
37	1	31	Salinity	3	CTD value does not match profile. Code questionable
37	1	32	Salinity	4	Salinity value does not belong in this part of the water column. Possibly mis-sampled from a deeper bottle. JHS:D-C salinity difference is enormous
37	1	33	Salinity	3	CTD value does not match profile. Code questionable
37	1	34	Salinity	3	CTD value does not match profile. Code questionable
37	1	35	Salinity	3	CTD value does not match profile. Code questionable
38	2	13	Salinity	4	Salinity value possibly anomalous. Given Nutrient statement
38	2	14	Bottle	3	Slow leak from bottom end cap.
38	2	19	Salinity	4	Salinity value possibly anomalous. Given Nutrient comment
38	2	22	NO^3	2	Tripped at the same depth as bottles 23-24. Nutrients sampled after other parameters in a high gradient portion of the water column

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
38	2	22	PO_4	2	Tripped at the same depth as bottles 23-24. Nutrients sampled after other parameters in a high gradient portion of the water column
38	2	22	Salinity	4	Salinity value possibly anomalous. Given Nutrient comment
38	2	22	SIO_3	2	Tripped at the same depth as bottles 23-24. Nutrients sampled after other parameters in a high gradient portion of the water column
38	2	25	CTD Conductivity 1	3	CTDC2 value low vs Salinity/CTDC1.
38	2	25	pH	5	
38	2	25	Total Alkalinity	5	
38	2	28	CTD Conductivity 2	3	CTDC2 value low vs Salinity/CTDC1.
38	2	28	NO^3	2	Tripped at the same depth as bottles 29-30. Nutrients sampled after other parameters in a high gradient portion of the water column
38	2	31	NO^3	2	Tripped at the same depth as bottles 32-33. Nutrients sampled after other parameters in a high gradient portion of the water column
38	2	31	Salinity	4	Salinity value possibly anomalous. Given Nutrient comment
38	2	34	pH	4	
38	4	01	Salinity	2	Runaway readings
38	4	16	Salinity	3	Salinity values at surface are inconsistent.
38	4	19	NO^3	2	Tripped at the same depth as bottles 20-21. Nutrients sampled after other parameters in a high gradient portion of the water column
38	4	19	PO_4	2	Tripped at the same depth as bottles 20-21. Nutrients sampled after other parameters in a high gradient portion of the water column
38	4	19	Salinity	3	Salinity values at surface are inconsistent.
38	4	19	SIO_3	2	Tripped at the same depth as bottles 20-21. Nutrients sampled after other parameters in a high gradient portion of the water column
38	4	22	Salinity	3	Salinity values at surface are inconsistent.
38	4	25	Salinity	3	Salinity values at surface are inconsistent.
38	4	27	NO^3	3	Value is 0.2uM lower than replicate bottles 25-26. No analytical errors noted.
38	4	28	Salinity	3	Salinity values at surface are inconsistent.
38	4	31	Salinity	3	Salinity values at surface are inconsistent.
38	8	01	pH	4	
38	8	19	DIC	3	
38	8	19	Total Alkalinity	3	
38	8	22	DIC	3	
38	8	25	DIC	3	
38	8	28	DIC	3	
38	8	29	Bottle	3	Top lanyard caught on chipod clamp
38	8	31	DIC	3	
38	8	31	pH	4	
38	8	34	DIC	3	

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
40	1	06	Salinity	4	D-C salinity difference is too high for the deep water.
40	1	09	Salinity	4	D-C salinity difference is too high for the deep water.
40	1	11	Salinity	2	Runaway salinometer readings
40	1	13	CTD Dissolved O_2	4	Sensor malfunction.
40	1	14	CTD Dissolved O_2	4	Sensor malfunction.
40	1	15	CTD Dissolved O_2	4	Sensor malfunction.
40	1	15	pH	4	
40	1	16	CTD Dissolved O_2	4	Sensor malfunction.
40	1	17	CTD Dissolved O_2	4	Sensor malfunction.
40	1	18	CTD Dissolved O_2	4	Sensor malfunction.
40	1	19	CTD Dissolved O_2	4	Sensor malfunction.
40	1	20	CTD Dissolved O_2	4	Sensor malfunction.
40	1	21	CTD Dissolved O_2	4	Sensor malfunction.
40	1	21	Total Alkalinity	3	
40	1	22	CTD Dissolved O_2	4	Sensor malfunction.
40	1	23	Bottle	3	Leaking without opening top vent..
40	1	23	CTD Dissolved O_2	4	Sensor malfunction.
40	1	24	CTD Dissolved O_2	4	Sensor malfunction.
40	1	25	CTD Dissolved O_2	4	Sensor malfunction.
40	1	26	CTD Dissolved O_2	4	Sensor malfunction.
40	1	27	CTD Dissolved O_2	4	Sensor malfunction.
40	1	27	Salinity	3	CTD value does not match profile. Code questionable.
40	1	28	Salinity	3	CTD value does not match profile. Code questionable.
40	1	29	Salinity	3	CTD value does not match profile. Code questionable.
40	1	30	Salinity	3	CTD value does not match profile. Code questionable.
40	1	31	Salinity	3	CTD value does not match profile. Code questionable.
40	1	32	Salinity	3	CTD value does not match profile. Code questionable.
40	1	33	Salinity	3	CTD value does not match profile. Code questionable.
40	1	34	Salinity	3	CTD value does not match profile. Code questionable.
40	1	35	pH	4	
40	1	36	Salinity	2	Runaway salinometer readings
41	1	01	Bottle	3	Spigot frozen.
41	1	02	Bottle	3	Spigot frozen.
41	1	02	Total Alkalinity	5	
41	1	03	Bottle	3	Spigot frozen.
41	1	04	Bottle	3	Spigot frozen.
41	1	05	Bottle	3	Spigot frozen.
41	1	06	Bottle	3	Spigot frozen.
41	1	09	pH	4	

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
41	1	15	Reference Temperature	4	SBE35 value low for this part of the water column vs CTDT1 & CTDT2. Package probably moving. Code bad.
41	1	20	Total Alkalinity	4	
41	1	21	Reference Temperature	3	SBE35 value does not match profile. Code questionable.
41	1	22	DIC	3	
41	1	23	DIC	3	
41	1	23	Reference Temperature	3	SBE35 high vs CTDT1 & CTDT2. Code questionable.
41	1	24	Salinity	3	CTD value does not match profile. Code questionable.
41	1	26	Salinity	3	CTD value does not match profile. Code questionable.
41	1	27	Dissolved O_2	2	Bottle value matches upcast not down cast. Code good.
41	1	27	pH	4	
41	1	27	Salinity	3	CTD value does not match profile. Code questionable.
41	1	28	Salinity	3	CTD value does not match profile. Code questionable.
41	1	29	Salinity	3	CTD value does not match profile. Code questionable.
41	1	30	Salinity	3	CTD value does not match profile. Code questionable.
41	1	31	Dissolved O_2	2	Bottle value matches upcast not down cast. Code good.
41	1	31	Salinity	3	CTD value does not match profile. Code questionable.
41	1	32	Salinity	3	CTD value does not match profile. Code questionable.
41	1	33	pH	3	
41	1	33	Salinity	3	CTD value does not match profile. Code questionable.
41	1	33	Total Alkalinity	3	
41	1	34	Salinity	3	CTD value does not match profile. Code questionable.
43	2	01	Salinity	4	Too low.
43	2	13	Salinity	3	CTD value does not match profile. Code questionable.
43	2	16	Salinity	3	CTD value does not match profile. Code questionable.
43	2	19	Salinity	3	CTD value does not match profile. Code questionable.
43	2	22	Salinity	3	CTD value does not match profile. Code questionable.
43	2	23	NO^3	2	Value is 0.25uM higher than bottles 22
43	2	23	SIO_3	2	Value is 0.25uM higher than bottles 22

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
43	2	25	NO^3	2	Value is 0.2uM higher than bottles 26-27 which were tripped at the same depth. This is a high gradient portion of the water column.
43	2	25	Salinity	3	CTD value does not match profile value. Code questionable.
43	2	28	CTD Conductivity 2	4	CTDC2 high vs CTDC1 and salinity values. Code bad.
43	2	28	Salinity	3	CTD value does not match profile. Code questionable.
43	2	31	Salinity	3	CTD value does not match profile. Code questionable.
43	4	07	Reference Temperature	4	SBE35 low vs CTDT1/CTDT2. Code bad.
43	4	10	Reference Temperature	4	SBE35 low vs CTDT1/CTDT2. Code bad.
43	4	12	CTD Temperature 1	3	CTD value does not match bottle value. Code questionable.
43	4	13	CTD Temperature 1	4	Unstable reads in all three temperatures. Code bad.
43	4	13	CTD Temperature 2	4	Unstable reads in all three temperatures. Code bad.
43	4	13	Reference Temperature	4	Unstable reads in all three temperatures. Code bad.
43	4	14	CTD Temperature 1	4	Unstable reads in all three temperatures. Code bad.
43	4	14	CTD Temperature 2	4	Unstable reads in all three temperatures. Code bad.
43	4	14	Reference Temperature	4	Unstable reads in all three temperatures. Code bad.
43	4	15	CTD Temperature 1	4	CTDT1 low vs SBE35/CTDT2. Code bad.
43	4	16	Salinity	3	CTD value does not match profile. Code questionable.
43	4	19	Reference Temperature	3	SBE35 value does not match profile. Code questionable.
43	4	19	Salinity	4	Very sporaDIC salinometer readings.
43	4	20	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
43	4	22	Salinity	3	CTD value does not match profile. Code questionable.
43	4	25	Salinity	3	CTD value does not match profile. Code questionable.
43	4	28	Salinity	3	CTD value does not match profile. Code questionable.
43	5	04	Bottle	2	Air vent open.
43	5	13	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
43	5	13	NO^3	2	Value is low compared to bottles 14
43	5	13	Salinity	3	CTD value does not match profile. Code questionable.
43	5	13	SIO_3	2	Value is low compared to bottles 14
43	5	16	CTD Temperature 2	3	CTD value does not match profile. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
43	5	19	Salinity	3	CTD value does not match profile. Code questionable.
43	5	25	Salinity	3	CTD value does not match profile. Code questionable.
43	5	31	Salinity	3	CTD value does not match profile. Code questionable.
43	9	01	CTD Dissolved O_2	3	Measurement does not match trend.
43	9	01	Salinity	4	Salinity does not fit density profile for this station. Possibly a sample from another cast
43	9	04	Salinity	4	Salinity does not fit density profile for this station. Possibly a sample from another cast
43	9	22	DIC	4	
43	9	25	DIC	4	
43	9	31	Bottle	3	Leaks
43	9	31	Salinity	4	Salinity does not fit density profile for this station. Code bad.
43	11	103	Bottle	3	Top o-ring not seated
43	11	103	Salinity	4	Salinity doe not fit density profile for this station. Code bad.
43	11	131	Bottle	3	Top o-ring not seated
44	1	15	Dissolved O_2	4	Value high. Stir plate failed
44	1	19	DIC	4	
44	1	20	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
44	1	22	Salinity	3	CTD value does not match profile. Code questionable.
44	1	24	Salinity	3	CTD value does not match profile. Code questionable.
44	1	25	Salinity	3	CTD value does not match profile. Code questionable.
44	1	26	Salinity	3	CTD value does not match profile. Code questionable.
44	1	27	Salinity	3	CTD value does not match profile. Code questionable.
44	1	28	Salinity	3	CTD value does not match profile. Code questionable.
44	1	29	CTD Temperature 2	4	CTDT2 low vs SBE35 & CTDT1. Code bad.
44	1	29	Salinity	3	CTD value does not match profile. Code questionable.
44	1	30	Dissolved O_2	2	Thiosulfate refill at endpoint. Overtitrated endpoint looks good..
44	1	31	Salinity	3	CTD value does not match profile. Code questionable.
45	1	05	Salinity	4	D-C salinity difference of 0.0049 is high for this part of the water column. Suggest code 4 (bad) for this salinity value.
45	1	10	DIC	4	
45	1	13	Total Alkalinity	5	
45	1	21	Salinity	3	CTD value does not match profile. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
45	1	23	Salinity	3	CTD value does not match profile. Code questionable.
45	1	24	DIC	3	
45	1	24	Salinity	3	CTD value does not match profile. Code questionable.
45	1	25	DIC	3	
45	1	25	Salinity	3	CTD value does not match profile. Code questionable.
45	1	26	Salinity	3	CTD value does not match profile. Code questionable.
45	1	27	Salinity	3	CTD value does not match profile. Code questionable.
45	1	28	Salinity	3	CTD value does not match profile. Code questionable.
45	1	29	DIC	3	
45	1	29	Salinity	3	CTD value does not match profile. Code questionable.
45	1	30	Salinity	3	CTD value does not match profile. Code questionable.
45	1	31	Salinity	3	CTD value does not match profile. Code questionable.
45	1	32	Salinity	3	CTD value does not match profile. Code questionable.
45	1	33	Salinity	3	CTD value does not match profile. Code questionable.
45	1	34	Salinity	3	CTD value does not match profile. Code questionable.
45	1	35	Salinity	2	Runaway salinometer readings
46	1	01	DIC	4	
46	1	04	DIC	4	
46	1	13	Salinity	3	Salinity value high vs CTDC1/CTDC2. Possible bad trip..
46	1	19	NO^3	2	Value low compared to bottles 20
46	1	19	Salinity	3	Salinity value high vs CTDC1/CTDC2. Possible bad trip..
46	1	19	SIO_3	2	Value low compared to bottles 20
46	1	22	NO^3	2	Value low compared to bottles 23
46	1	22	SIO_3	2	Value low compared to bottles 23
46	1	25	NO^3	2	Value low compared to bottles 26
46	1	25	Salinity	3	Salinity value high vs CTDC1/CTDC2. Possible bad trip..
46	1	34	pH	4	
46	5	07	Bottle	3	Spigot frozen.
46	5	10	Salinity	3	CTD value does not match profile. Code questionable.
46	5	13	Salinity	3	CTD value does not match profile. Code questionable.
46	5	16	Salinity	3	CTD value does not match profile. Code questionable.
46	5	17	NO^3	2	Value low compared to bottles 16

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
46	5	19	Salinity	3	CTD value does not match bottle. Code questionable.
46	5	20	NO^3	2	Value high compared to bottles 19
46	5	22	Reference Temperature	4	SBE35 not equilibrated. Code bad.
46	5	22	Salinity	3	CTD value does not match bottle value. Code questionable.
46	5	23	NO^3	2	Value high compared to bottles 22
46	5	23	PO_4	2	Value high compared to bottles 22
46	5	23	Reference Temperature	4	SBE35 not equilibrated. Code bad.
46	5	24	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
46	5	25	Salinity	3	CTD value does not match profile. Code questionable.
46	5	28	Salinity	3	CTD value does not match profile. Code questionable.
46	5	31	Salinity	3	CTD value does not match profile. Code questionable.
46	5	33	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
46	7	01	CTD Conductivity 1	3	CTDC1 unstable value.
46	7	19	Salinity	3	Salinity value high for this part of profile. Code questionable.
46	7	37	Bottle	4	Corer did not capture a sample.
47	1	02	Dissolved O_2	2	Really high endpoint
47	1	04	Salinity	3	Runaway salinometer readings
47	1	07	CTD Conductivity 1	3	code questionable.
47	1	16	Total Alkalinity	4	
47	1	18	DIC	3	
47	1	19	DIC	3	
47	1	20	DIC	3	
47	1	21	DIC	3	
47	1	22	DIC	3	
47	1	24	Salinity	3	Code questionable.
47	1	25	Salinity	3	Code questionable.
47	1	26	Salinity	3	Code questionable.
47	1	29	Bottle	5	Bottle did not trip.
47	1	30	Salinity	3	Code questionable.
47	1	31	Salinity	3	Code questionable.
47	1	32	Salinity	3	Code questionable.
47	1	33	Salinity	3	Code questionable.
47	1	34	Salinity	3	Code questionable.
47	1	35	Salinity	3	Code questionable.
48	2	10	Salinity	2	CTD value does not profile. Code questionable.
48	2	16	Salinity	3	Salinity value unstable.
48	2	19	Salinity	3	Salinity value unstable.
48	2	22	Salinity	2	Hold for calib.
48	2	25	CTD Temperature 1	4	Irregular temp reads in all three sensors.
48	2	25	CTD Temperature 2	4	Irregular temp reads in all three sensors.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
48	2	25	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
48	2	25	Reference Temperature	4	Irregular temp reads in all three sensors.
48	2	25	Salinity	2	Hold for calib.
48	2	26	CTD Temperature 2	4	CTDT2 reads low vs CTDT1 & SBE35. Code bad.
48	2	26	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
48	2	27	CTD Temperature 2	4	CTDT2 reads low vs CTDT1 & SBE35. Code bad.
48	2	27	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.4uM which is outside normal acceptable deviation
48	2	28	pH	4	
48	2	28	Salinity	3	Bad value.
48	2	31	Reference Temperature	4	SBE35 reads low vs CTDT1 & CTDT2. Code bad.
48	2	31	Salinity	3	Bad value.
48	2	32	Reference Temperature	4	SBE35 reads low vs CTDT1 & CTDT2. Code bad.
48	2	33	CTD Temperature 1	3	CTD value does not profile. Code questionable.
48	2	34	pH	4	
48	4	01	Salinity	3	Value does not profile. Code questionable.
48	4	03	Bottle	3	Top cap not seated correctly
48	4	04	Salinity	3	Value does not profile. Code questionable.
48	4	07	Salinity	3	Value does not profile. Code questionable.
48	4	10	Salinity	3	Value does not profile. Code questionable.
48	4	13	Salinity	3	Value does not profile. Code questionable.
48	4	16	Salinity	3	Value does not profile. Code questionable.
48	4	19	Salinity	3	Value does not profile. Code questionable.
48	4	22	Salinity	3	Value does not profile. Code questionable.
48	4	25	CTD Temperature 2	4	CTDT2 low vs CTDT2/SBE35. High gradient. Suspect poor response time. Code bad.
48	4	25	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.3uM which is outside normal acceptable deviation
48	4	25	Reference Temperature	3	High gradient. SBE35 value does not profile. Code questionable..
48	4	25	Salinity	3	CTD value does not match profile. Code questionable.
48	4	26	CTD Temperature 2	4	CTDT2 low vs CTDT2/SBE35. High gradient. Suspect poor response time. Code bad.
48	4	26	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.3uM which is outside normal acceptable deviation
48	4	26	Reference Temperature	3	High gradient. SBE35 value does not profile. Code questionable..

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
48	4	27	CTD Temperature 2	4	CTDT2 low vs CTDT2/SBE35. High gradient. Suspect poor response time. Code bad.
48	4	27	NO^3	2	Bottles 25-27 tripped at the same depth. Values range over 0.3uM which is outside normal acceptable deviation
48	4	27	Reference Temperature	3	High gradient. SBE35 value does not profile. Code questionable..
48	4	28	Salinity	3	Value does not match profile. Code questionable.
48	4	31	Salinity	3	Value does not match profile. Code questionable.
48	5	01	Salinity	3	Value does not match profile. Code questionable.
48	5	07	Salinity	3	Value does not match profile. Code questionable.
48	5	13	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. Sensor not acclimated. Wait time needed to be longer in high gradient. Code bad.
48	5	13	Salinity	3	CTD value does not profile. Code questionable.
48	5	14	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. Sensor not acclimated. Wait time needed to be longer in high gradient. Code bad.
48	5	15	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
48	5	15	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
48	5	15	Reference Temperature	3	Unstable response in all three sensors. Code questionable.
48	5	16	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
48	5	16	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
48	5	19	Salinity	3	CTD value does not profile. Code questionable.
48	5	25	Salinity	4	Salinity value does not match profile. D-C difference is high even for surface value. Code bad.
48	6	01	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	02	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	03	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	04	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	05	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	06	Bottle	3	Must have leaked
48	6	07	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	08	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	09	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	10	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
48	6	11	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	12	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	13	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	14	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	15	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	16	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	17	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	18	Bottle	4	Bottles 17
48	6	19	Bottle	4	Bottles 19
48	6	20	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	21	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	22	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	23	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	6	24	Bottle	4	Cast data lost. Bottle trip information approximated from 048/08.
48	8	13	Salinity	3	Questionable
48	8	19	Salinity	3	Questionable
48	8	25	Salinity	3	Questionable
48	8	31	Salinity	3	Questionable
48	10	01	CTD Conductivity 1	3	Unstable
48	10	01	DIC	4	
48	10	04	CTD Conductivity 1	3	Unstable
48	10	04	DIC	4	
48	10	07	CTD Conductivity 1	3	Unstable
48	10	10	CTD Conductivity 1	3	Unstable
48	10	19	CTD Conductivity 1	3	Unstable
48	10	25	Salinity	3	Unstable
48	10	31	Salinity	4	Bad value
48	10	34	DIC	4	
48	10	34	Salinity	2	Runaway salinometer readings decreasing
48	11	06	Salinity	4	Likely contaminant. Code bad. JEC: Runaway salinometer readings
48	14	03	NO_2	5	No sample collected.
48	14	03	NO^3	5	No sample collected.
48	14	03	PO_4	5	No sample collected.
48	14	03	SIO_3	5	No sample collected.
48	14	07	Dissolved O_2	4	Analyst noticed a bubble in the flask
48	14	07	Salinity	3	Runaway salinometer values increasing

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
48	14	13	CTD Conductivity 1	3	Unstable
48	14	19	CTD Conductivity 1	3	Unstable
48	14	25	CTD Conductivity 1	3	Unstable
48	14	37	Bottle	4	Corer did not collect sample.
49	1	01	Salinity	2	Runaway conductivity readings
49	1	02	Dissolved O_2	4	Bottle value does not match profile. Code bad. JIG: Analyst noted a bubble in the flask
49	1	03	CTD Conductivity 1	3	Unstable values.
49	1	03	Dissolved O_2	2	Bottle value matches water column profile. Code good. JIG/ANALYST: Value may be high
49	1	04	CTD Conductivity 1	3	Unstable values.
49	1	04	Dissolved O_2	4	Value may be high
49	1	06	CTD Conductivity 1	3	Unstable values.
49	1	07	CTD Conductivity 1	3	Unstable values.
49	1	14	CTD Conductivity 1	3	Unstable values.
49	1	14	DIC	4	
49	1	23	Salinity	3	Code questionable.
49	1	28	Salinity	3	High gradient values questionable.
49	1	29	Salinity	3	High gradient values questionable.
49	1	30	Salinity	3	High gradient values questionable.
49	1	31	Salinity	3	High gradient values questionable.
49	1	32	Salinity	3	High gradient values questionable.
49	1	33	Salinity	3	High gradient values questionable.
49	1	34	pH	5	
49	1	34	Salinity	3	High gradient values questionable.
49	1	35	Salinity	3	High gradient values questionable.
50	1	02	CTD Conductivity 1	3	CTD value does not match profile. Not used in calibration. Code questionable.
50	1	04	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
50	1	05	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
50	1	13	Total Alkalinity	4	
50	1	22	Salinity	3	Value does not match profile. Not used in calibration. Code questionable.
50	1	26	Salinity	2	Runaway conductivity readings decreasing
50	1	29	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.
50	1	30	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.
50	1	31	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.
50	1	32	pH	5	
50	1	32	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
50	1	33	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.
50	1	34	Salinity	3	Unstable surface values in high gradient. Value does not match profile. Not used in calibration. Code questionable.
50	1	35	Salinity	4	The D-C salinity difference for this bottle is higher than for any others on this case
51	1	01	Bottle	2	Bottles 1-4 tripped at 55m but nutrient values are not consistent. This is a high gradient portion of the water column.
51	1	01	Salinity	2	Runaway conductivity readings
51	1	02	Bottle	2	Bottles 1-4 tripped at 55m but nutrient values are not consistent. This is a high gradient portion of the water column.
51	1	03	Bottle	2	Bottles 1-4 tripped at 55m but nutrient values are not consistent. This is a high gradient portion of the water column.
51	1	04	Bottle	2	Bottles 1-4 tripped at 55m but nutrient values are not consistent. This is a high gradient portion of the water column.
51	1	05	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	06	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	07	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	08	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	09	Salinity	4	The D-C salinity difference is too high even for this high gradient region.
51	1	10	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	11	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	12	Salinity	2	The D-C salinity differences for these bottles are high and not uniformly so. This is a high salinity gradient region.
51	1	13	Bottle	9	No sample collected.
51	1	14	Bottle	9	No sample collected.
51	1	15	Bottle	9	No sample collected.
51	1	16	Bottle	9	No sample collected.
51	1	17	Bottle	9	No sample collected.
51	1	18	Bottle	9	No sample collected.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
51	1	19	Bottle	9	No sample collected.
51	1	20	Bottle	9	No sample collected.
51	1	21	Bottle	9	No sample collected.
51	1	22	Bottle	9	No sample collected.
51	1	23	Bottle	9	No sample collected.
51	1	24	Bottle	9	No sample collected.
51	2	01	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. High gradient code bad.
51	2	01	Salinity	3	Value does not match profile. Code questionable.
51	2	02	CTD Temperature 1	4	CTDT1 value low vs SBE35/CTDT2. High gradient code bad.
51	2	02	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. High gradient code bad.
51	2	04	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. High gradient code bad.
51	2	10	Salinity	3	Value does not match profile. Code questionable.
51	2	19	Salinity	3	The D-C salinity difference is high but this is a high gradient region. Code questionable.
52	1	01	Bottle	3	Did not close completely at bottom ball
52	1	17	Salinity	3	The D-C salinity differences for this pair are high
52	1	18	Salinity	3	The D-C salinity differences for this pair are high
52	1	20	Salinity	2	Runaway conductivity readings
52	1	23	Salinity	3	The D-C salinity differences for this pair are high
52	1	24	Salinity	3	The D-C salinity differences for this pair are high
52	2	07	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
52	2	09	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
52	2	10	Salinity	3	Value does not match profile. Code questionable.
52	2	20	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. Sensor not equilibrated. Code bad.
52	2	22	Salinity	3	Salinity value high.
52	2	25	Salinity	3	Value does not match profile. Code questionable.
52	2	26	CTD Temperature 2	3	CTDT2 value low vs SBE35/CTDT1. Code not usable.
52	2	27	CTD Temperature 1	3	CTDT1 value low vs SBE35/CTDT2. Code not usable.
52	2	29	Bottle	4	Niskin closed during recovery
52	2	31	Salinity	3	Value does not match profile. Code questionable.
52	4	19	Salinity	3	Value does not match profile. Code questionable.
52	4	22	Salinity	3	Value does not match profile. Code questionable.
52	4	25	Salinity	3	Value does not match profile. Code questionable.
52	4	28	Salinity	3	Value does not match profile. Code questionable.
52	4	31	Salinity	4	Salinity value high for profile and CTDC1/CTDC2. Code bad.
52	6	12	Bottle	3	Slight leak through pressure valve.
52	8	01	pH	4	
52	8	03	Bottle	3	Top cap not seated correctly
53	1	01	Bottle	9	No samples collected.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
53	1	02	Bottle	9	No samples collected.
53	1	03	Bottle	9	No samples collected.
53	1	04	Bottle	9	No samples collected.
53	1	05	Bottle	2	Bottles 5-8 were tripped at 65m but nitrate values have a range over 2uM
53	1	06	Bottle	2	Bottles 5-8 were tripped at 65m but nitrate values have a range over 2uM
53	1	07	Bottle	2	Bottles 5-8 were tripped at 65m but nitrate values have a range over 2uM
53	1	08	Bottle	2	Bottles 5-8 were tripped at 65m but nitrate values have a range over 2uM
53	1	09	Bottle	9	No samples collected.
53	1	10	Bottle	9	No samples collected.
53	1	15	Bottle	9	No samples collected.
53	1	15	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	16	Bottle	9	No samples collected.
53	1	16	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	17	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	18	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	19	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	20	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	21	Bottle	9	No samples collected.
53	1	21	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	22	Bottle	9	No samples collected.
53	1	22	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	23	Bottle	9	No samples collected.
53	1	23	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	1	24	Bottle	9	No samples collected.
53	1	24	CTD Temperature 1	3	Temperature values mismatched.code bad.
53	2	01	Salinity	3	Value does not match profile. Code questionable.
53	2	06	pH	4	
53	2	06	Salinity	3	Value does not match profile. Code questionable.
53	2	11	pH	4	
53	2	11	Salinity	3	Value does not match profile. Code questionable.
54	1	07	Bottle	2	Bottles 7-10 were tripped at 60m but nitrate values range over 0.75uM difference. These were tripped on the fly in a high gradient portion of the water column.
54	1	08	Bottle	2	Bottles 7-10 were tripped at 60m but nitrate values range over 0.75uM difference. These were tripped on the fly in a high gradient portion of the water column.
54	1	08	Salinity	2	This value is a little higher than the other three tripped at the same level. This is a high gradient region.
54	1	09	Bottle	2	Bottles 7-10 were tripped at 60m but nitrate values range over 0.75uM difference. These were tripped on the fly in a high gradient portion of the water column.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
54	1	10	Bottle	2	Bottles 7-10 were tripped at 60m but nitrate values range over 0.75uM difference. These were tripped on the fly in a high gradient portion of the water column.
54	1	11	Bottle	9	No samples collected.
54	1	11	CTD Temperature 1	3	Temperature values mismatched. Code questionable.
54	1	11	CTD Temperature 2	3	Temperature values mismatched. Code questionable.
54	1	12	Bottle	9	No samples collected.
54	1	12	CTD Temperature 1	3	Temperature values mismatched. Code questionable.
54	1	12	CTD Temperature 2	3	Temperature values mismatched. Code questionable.
54	1	15	Salinity	2	This value is a little higher than the other three tripped at the same level. This is a high gradient region.
54	1	17	Bottle	9	No samples collected.
54	1	17	CTD Temperature 1	3	Temperature values mismatched. Code questionable.
54	1	17	CTD Temperature 2	3	Temperature values mismatched. Code questionable.
54	1	18	Bottle	9	No samples collected.
54	1	18	CTD Temperature 1	3	Temperature values mismatched. Code questionable.
54	1	18	CTD Temperature 2	3	Temperature values mismatched. Code questionable.
54	1	19	Salinity	2	Bottles 19-20 tripped at the same level as 21-22but salinity values are higher. This is a high gradient region..
54	1	20	Bottle	3	Loose bungee cord.
54	1	20	Salinity	2	Bottles 19-20 tripped at the same level as 21-22but salinity values are higher. This is a high gradient region..
54	1	21	Bottle	3	Ran out of volume very quickly
54	1	23	Bottle	9	No samples collected.
54	1	24	Bottle	9	No samples collected.
54	2	01	Salinity	3	Value does not match profile. Code questionable.
54	2	06	Salinity	3	Value does not match profile. Code questionable.
54	2	11	Salinity	3	Value does not match profile. Code questionable.
55	1	03	DIC	4	
55	1	08	Dissolved O_2	5	Sample lost
55	1	09	DIC	3	
55	1	09	pH	5	
55	1	22	Salinity	3	Value does not match profile. Code questionable.
55	1	29	Bottle	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	DIC	4	
55	1	29	NO_2	4	Mistrip. Nutrient data shows this bottle did not close at intended depth

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
55	1	29	NO^3	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	Dissolved O_2	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	PO_4	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	Salinity	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	SIO_3	4	Mistrip. Nutrient data shows this bottle did not close at intended depth
55	1	29	Total Alkalinity	4	
55	1	30	Salinity	3	Value does not match profile. Code questionable.
55	1	31	Salinity	3	Value does not match profile. Code questionable.
55	1	32	Salinity	3	Value does not match profile. Code questionable.
55	1	33	Salinity	3	Value does not match profile. Code questionable.
55	1	34	Salinity	3	Value does not match profile. Code questionable.
55	1	35	Salinity	3	Value does not match profile. Code questionable.
56	1	04	pH	4	
56	1	10	CTD Temperature 2	3	SBE35 value does not match profile. Code questionable.
56	1	22	Salinity	3	Value does not match profile. Code questionable.
56	4	10	CTD Conductivity 2	3	CTDC2 value reads high vs Salt/CTDC1. Code questionable.
56	4	16	Salinity	3	Value does not match profile. Code questionable.
56	4	22	Salinity	3	Value does not match profile. Code questionable.
56	4	25	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
56	4	26	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
56	4	27	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
56	4	28	Salinity	3	Value does not match profile. Code questionable.
56	4	29	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.
56	4	30	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.
56	5	13	Salinity	2	Salinity value matches density profile. Code good.
56	5	31	Salinity	2	Salinity value matches density profile. Code good.
56	6	01	Salinity	2	Runaway conductivity readings
56	6	19	Salinity	2	Salinity value matches density profile. Code good.
56	7	01	Dissolved O_2	4	Bottle value does not match profile nor adjacent casts. Probable analytic/sampling error. Code bad.
57	1	01	Salinity	4	Salinity value does not match profile.
57	1	03	Bottle	3	Leaker.
57	1	13	pH	5	
57	1	14	Bottle	3	Leaking from bottom cap.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
57	1	19	Reference Temperature	3	SBE35 value does not match profile. Code questionable.
57	1	25	pH	4	
57	1	25	Salinity	2	Salinity value matches density profile. Code good.
57	1	28	Reference Temperature	4	SBE35 data low vs CTDT1/CTDT2. Not equilibrated. Code bad.
57	1	31	Salinity	2	Salinity value matches density profile. Code good.
57	2	01	Salinity	4	Salinity value low for profile. Code bad. JEC:Analyst noted runaway conductivity readings first increasing then decreasing. Fifth was keyboard entry.
57	2	03	Bottle	3	Top cap not seated properly
57	2	10	Salinity	4	Salinity value low for profile. Code bad.
57	2	13	CTD Dissolved O_2	4	Sensor failed.
57	2	16	CTD Dissolved O_2	4	Sensor failed.
57	2	19	Salinity	4	Salinity value low for profile. Code bad.
57	2	24	Reference Temperature	3	SBE35 value high vs CTDT1/CTDT2 for the Arctic water column. Code questionable.
57	2	25	pH	4	
57	2	34	pH	4	
57	2	37	Bottle	4	Corer did not trip
57	4	06	Bottle	3	Large leak in top ball valve when shaking.
57	4	07	Bottle	3	Leaking heavily through pressure valve.
57	4	12	Salinity	2	Runaway conductivity readings increasing until fourth reading
57	4	14	Bottle	3	Leaky spigot.
57	4	19	Bottle	3	Slow
57	4	20	Bottle	3	Open spigot when retrieved.
57	4	23	Bottle	9	Did not close.
57	4	24	Bottle	9	Did not close.
57	5	09	Bottle	3	Pressure valve in
57	7	01	Bottle	3	Leaking bottom ball valve.
57	7	01	Salinity	3	Salinity value low vs CTDC1/CTDC2. Does not match salinity sample drawn at same level. Code questionable.
57	7	05	Bottle	9	No samples collected.
57	7	06	Bottle	9	No samples collected.
57	7	11	Bottle	9	No samples collected.
57	7	12	Bottle	9	No samples collected.
57	7	17	Bottle	9	No samples collected.
57	7	18	Bottle	9	No samples collected.
57	7	23	Bottle	9	No samples collected.
57	7	24	Bottle	9	No samples collected.
57	8	04	Dissolved O_2	2	A few drops of sample spilled when opening flask.
57	8	10	Salinity	3	Value does not match profile. Code questionable.
57	8	22	Salinity	3	Value does not match profile. Code questionable.
57	8	25	Salinity	3	Value does not match profile. Code questionable.
57	8	28	CTD Temperature 1	4	CTDT1 data low vs SBE35/CTDT2. Code bad.

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
57	8	28	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
57	8	28	Reference Temperature	2	Unstable temperatures in all sensors. Code questionable.
57	8	29	CTD Temperature 1	4	CTDT1 data high vs SBE35/CTDT2. Code bad.
57	8	30	CTD Temperature 2	4	CTDT2 data high vs SBE35/CTDT1. Code bad.
57	8	33	CTD Temperature 1	4	CTDT1 data high vs SBE35/CTDT2. Code bad.
57	8	33	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
57	8	33	Reference Temperature	3	Unstable temperatures in all sensors. Code questionable.
58	1	01	Salinity	3	Value does not match profile. Code questionable.
58	1	12	Salinity	4	Salinity value does not match profile.
58	1	19	Salinity	3	value does not match profile. Code questionable.
58	1	21	Salinity	3	value does not match profile. Code questionable.
58	1	26	pH	4	
58	1	27	Salinity	3	Value does not match profile. Code questionable.
58	1	28	Salinity	3	Value does not match profile. Code questionable.
58	1	29	pH	4	
58	1	29	Salinity	3	Value does not match profile. Code questionable.
58	1	31	Salinity	4	The D-C salinity difference is 0.7542 which is very large
59	1	01	Reference Temperature	4	SBE35 value low vs CTDT1/CTDT2. Package possibly still moving. Code bad..
59	1	01	Salinity	4	Likely contaminant. JEC: Fifth reading not keyboard entry
59	1	05	Salinity	3	Value does not match profile value. Code questionable.
59	1	09	pH	3	
59	1	09	Salinity	4	Does not fit profile.
59	1	14	Salinity	3	Value does not match profile. Code questionable.
59	1	18	Salinity	3	Value does not match profile. Code questionable.
59	1	20	Salinity	3	Value does not match profile. Code questionable.
59	1	23	Salinity	3	Value does not match profile. Code questionable.
59	1	24	Salinity	3	Value does not match profile. Code questionable.
59	1	25	Salinity	3	Value does not match profile. Code questionable.
59	1	26	Reference Temperature	3	SBE35 value does not match profile. Code questionable.
59	1	27	Salinity	3	Value does not match profile. Code questionable.
60	1	14	Salinity	2	Runaway conductivity readings increasing
60	1	18	Bottle	4	Must have leaked
60	1	18	NO_2	4	Bottles 17-18 tripped at 57m but salinity and nutrient values suggest 18 did not close at the intended depth
60	1	18	NO^3	4	Bottles 17-18 tripped at 57m but salinity and nutrient values suggest 18 did not close at the intended depth

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Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
60	1	18	PO_4	4	Bottles 17-18 tripped at 57m but salinity and nutrient values suggest 18 did not close at the intended depth
60	1	18	Salinity	4	Bottles 17-18 tripped at 57m but salinity and nutrient values suggest 18 did not close at the intended depth
60	1	18	SIO_3	4	Bottles 17-18 tripped at 57m but salinity and nutrient values suggest 18 did not close at the intended depth
60	1	19	Salinity	3	Salinity values do not match density profile. Code questionable.
60	1	20	Salinity	3	Salinity values do not match density profile. Code questionable.
60	1	21	Salinity	3	Salinity values do not match density profile. Code questionable.
60	1	22	Salinity	3	Salinity values do not match density profile. Code questionable.
60	3	14	Salinity	3	Value does not match profile. Code questionable.
60	3	15	CTD Temperature 1	4	SBE35 not equilibrated. High gradient. Code bad.
60	3	15	CTD Temperature 2	4	SBE35 not equilibrated. High gradient. Code bad.
60	3	17	Salinity	3	Value does not match profile. Code questionable.
60	3	18	Salinity	3	Value does not match profile. Code questionable.
60	3	21	NO^3	2	Bottles 21-25 were tripped at the same depth. Nitrate values range over 0.45uM which is outside normal acceptable deviation
60	3	22	NO^3	2	Bottles 21-25 were tripped at the same depth. Nitrate values range over 0.45uM which is outside normal acceptable deviation
60	3	23	NO^3	2	Bottles 21-25 were tripped at the same depth. Nitrate values range over 0.45uM which is outside normal acceptable deviation
60	3	24	NO^3	2	Bottles 21-25 were tripped at the same depth. Nitrate values range over 0.45uM which is outside normal acceptable deviation
60	3	25	NO^3	2	Bottles 21-25 were tripped at the same depth. Nitrate values range over 0.45uM which is outside normal acceptable deviation
60	3	26	Salinity	3	Value does not match profile. Code questionable.
60	3	27	Salinity	3	Value does not match profile. Code questionable.
60	3	32	CTD Temperature 1	4	CTDT1 low vs SBE35/CTDT2. Code bad.
60	3	32	CTD Temperature 2	3	Unstable temperatures in all sensors. Code questionable.
60	3	32	Reference Temperature	3	Unstable temperatures in all sensors. Code questionable.
60	3	32	Salinity	3	Value does not match profile. Code questionable.
60	3	33	CTD Temperature 1	3	Unstable temperatures in all sensors. Code questionable.
60	3	33	CTD Temperature 2	3	Unstable temperatures in all sensors. Code questionable.
60	3	33	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.

Continued on next page

Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
60	3	33	Salinity	3	Value does not match profile. Code questionable.
60	3	34	CTD Temperature 1	3	Unstable temperatures in all sensors. Code questionable.
60	3	34	CTD Temperature 2	3	Unstable temperatures in all sensors. Code questionable.
60	3	34	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.
60	3	35	CTD Temperature 1	3	Unstable temperatures in all sensors. Code questionable.
60	3	35	CTD Temperature 2	3	Unstable temperatures in all sensors. Code questionable.
60	3	35	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.
60	3	36	Salinity	3	Value does not match profile. Code questionable.
60	5	01	DIC	3	
60	5	01	pH	4	
60	5	04	DIC	3	
60	5	04	Salinity	4	The D-C salinity difference is 0.0079 which is large for 1027db.
60	5	07	DIC	3	
60	5	10	DIC	3	
60	5	13	DIC	3	
60	5	16	Salinity	3	Value does not match profile. Code questionable.
60	5	19	Salinity	3	Value does not match profile. Code questionable.
60	5	22	Dissolved O_2	2	Bottle value matches upcast feature in this dynamic area. Code good.
60	5	22	Salinity	3	Value does not match profile value. Code questionable.
60	5	25	CTD Temperature 1	4	Unstable temperature reads. Code bad.
60	5	25	CTD Temperature 2	4	Unstable temperature reads. Code bad.
60	5	25	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
60	5	25	Reference Temperature	4	Unstable temperature reads. Code bad.
60	5	26	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
60	5	26	Reference Temperature	4	SBE35 not equilibrated. High gradient. Code bad.
60	5	27	NO^3	2	Bottles 25-27 were tripped at the same depth. Nitrate values range over 0.3uM which is outside normal acceptable deviation
60	5	28	Bottle	3	Leaking
60	5	31	Salinity	3	Value does not match profile. Code questionable.
60	5	33	Reference Temperature	4	SBE35 not equilibrated. Code bad.
60	5	34	CTD Temperature 1	3	CTD value does not match profile. Code questionable.
60	5	34	CTD Temperature 2	3	CTD value does not match profile. Code questionable.
60	5	34	Reference Temperature	3	SBE35 value does not match profile. Code questionable.
60	5	36	Reference Temperature	4	SBE35 not equilibrated. Code bad.

Continued on next page

Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
61	1	05	Bottle	9	No samples collected.
61	1	06	Bottle	9	No samples collected.
61	1	07	Bottle	9	No samples collected.
61	1	08	Bottle	9	No samples collected.
61	1	13	Bottle	9	No samples collected.
61	1	14	Bottle	9	No samples collected.
61	1	15	Bottle	9	No samples collected.
61	1	16	Bottle	9	No samples collected.
61	1	17	Bottle	2	Bottles 17-20 tripped at 20m but nitrate values have a 0.3uM range which is larger than the normal acceptable deviation. This is a high gradient portion of the water column and these bottles were tripped on the fly.
61	1	18	Bottle	2	Bottles 17-20 tripped at 20m but nitrate values have a 0.3uM range which is larger than the normal acceptable deviation. This is a high gradient portion of the water column and these bottles were tripped on the fly.
61	1	19	Bottle	2	Bottles 17-20 tripped at 20m but nitrate values have a 0.3uM range which is larger than the normal acceptable deviation. This is a high gradient portion of the water column and these bottles were tripped on the fly.
61	1	20	Bottle	2	Bottles 17-20 tripped at 20m but nitrate values have a 0.3uM range which is larger than the normal acceptable deviation. This is a high gradient portion of the water column and these bottles were tripped on the fly.
61	1	21	Bottle	9	No samples collected.
61	1	22	Bottle	9	No samples collected.
61	1	23	Bottle	9	No samples collected.
61	1	24	Bottle	9	No samples collected.
61	4	01	Bottle	9	No samples collected.
61	4	02	Bottle	9	No samples collected.
61	4	03	NO^3	2	Value low compared to bottles 4-8 which were tripped at the same depth
61	4	22	Salinity	3	Value does not match profile. Code questionable.
61	4	28	CTD Temperature 1	4	CTDT1 high vs SBE35/CTDT2. Code bad.
62	1	06	Salinity	3	Value does not match profile. Code questionable.
62	1	10	pH	3	
62	1	10	Salinity	3	Value does not match profile. Code questionable.
62	1	11	Salinity	3	Value does not match profile. Code questionable.
62	1	12	Salinity	3	Value does not match profile. Code questionable.
62	1	16	CTD Temperature 1	4	Unstable temperatures in all three sensors. Code bad.
62	1	16	CTD Temperature 2	4	Unstable temperatures in all three sensors. Code bad.
62	1	16	Reference Temperature	4	Unstable temperatures in all three sensors. Code bad.
62	1	16	Salinity	3	Value does not match profile. Code questionable.

Continued on next page

Table B.1 – continued from previous page

Station	Cast	Bottle	Param	Code	Comment
63	1	01	Reference Temperature	4	SBE35 not equilibrated. Code bad.
63	1	01	Salinity	3	Value does not match profile. Code questionable.
63	1	09	Salinity	3	Value does not match profile. Code questionable.
63	1	11	Reference Temperature	4	SBE35 not equilibrated. Code bad.
63	1	11	Salinity	3	Value does not match profile. Code questionable.
64	1	09	Salinity	3	Value does not profile. Code questionable.
64	1	11	Salinity	3	Value does not profile. Code questionable.
64	1	15	Salinity	3	Value does not profile. Code questionable.
64	1	16	Reference Temperature	4	SBE35 not equilibrated. Code bad.
64	1	16	Salinity	3	Value does not profile. Code questionable.
64	1	18	CTD Temperature 1	4	Unstable temperatures in all three sensors. Code bad.
64	1	18	CTD Temperature 2	4	Unstable temperatures in all three sensors. Code bad.
64	1	18	Reference Temperature	4	Unstable temperatures in all three sensors. Code bad.
64	1	19	CTD Temperature 1	4	Unstable temperatures in all three sensors. Code bad.
64	1	19	CTD Temperature 2	4	Unstable temperatures in all three sensors. Code bad.
64	1	19	Reference Temperature	4	Unstable temperatures in all three sensors. Code bad.
64	1	19	Salinity	3	Value does not profile. Code questionable.
64	1	20	Salinity	3	Value does not profile. Code questionable.
65	1	03	Salinity	3	Value does not match profile. Code questionable.
65	1	04	Reference Temperature	4	SBE35 not equilibrated. Code bad.
65	1	04	Salinity	3	Value does not match profile. Code questionable.
66	1	07	Bottle	9	No samples collected.
66	1	08	Bottle	9	No samples collected.
66	1	15	Bottle	9	No samples collected.
66	1	16	Bottle	9	No samples collected.
66	1	21	Bottle	3	Leaked from bottom
66	1	23	Bottle	9	No samples collected.
66	1	24	Bottle	9	No samples collected.
66	2	01	Salinity	3	Value does not match profile. Code questionable.

APPENDIX

C

CALIBRATION DOCUMENTS

Pressure Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 0831
CALIBRATION DATE: 17-NOV-2015
Mfg: SEABIRD Model: 09P CTD Prs s/n: 99677

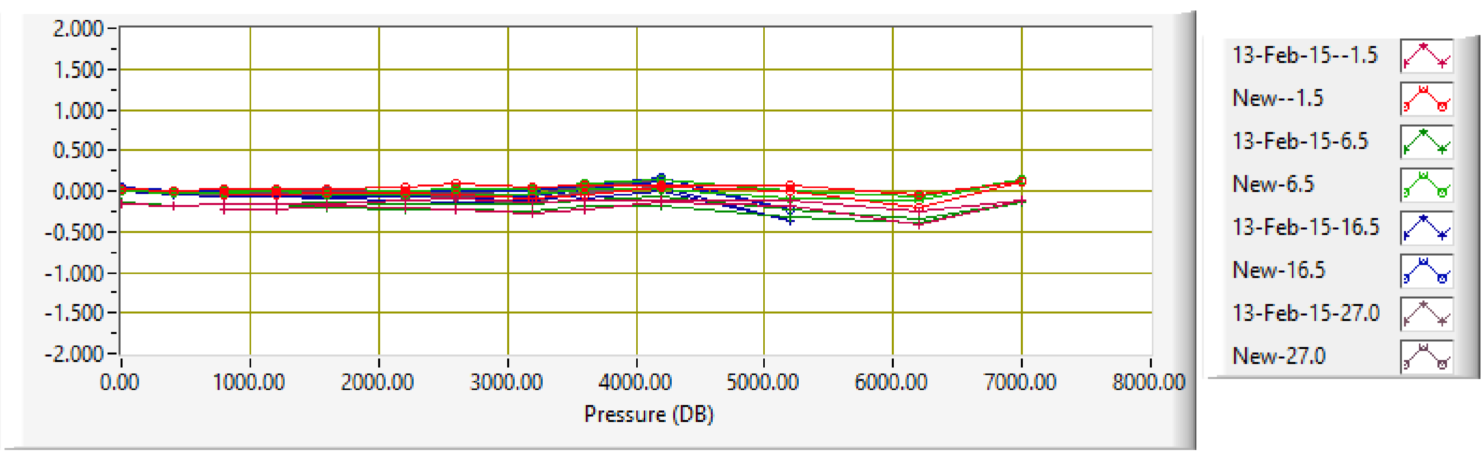
C1= -4.345638E+4
C2= -2.285116E-1
C3= 9.849962E-3
D1= 3.362284E-2
D2= 0.000000E+0
T1= 3.004593E+1
T2= -4.406140E-4
T3= 3.956775E-6
T4= 4.712297E-9
T5= 0.000000E+0
AD590M= 1.28916E-2
AD590B= -8.23481E+0
Slope = 1.00000000E+0
Offset = 0.00000000E+0

Calibration Standard: Mfg: FLUKE Model: P3125 s/n: 70856
t0=t1+t2*td+t3*td*td+t4*td*td*td
w = 1-t0*t0*f*f
Pressure = (0.6894759*((c1+c2*td+c3*td*td)*w*(1-(d1+d2*td)*w)-14.7)

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
33288.082	0.16	0.13	-0.16	0.03	0.01	-1.521
33509.413	400.20	400.20	-0.19	-0.00	0.03	-1.521
33729.050	800.22	800.21	-0.17	0.02	0.02	-1.520
33947.078	1200.23	1200.22	-0.17	0.01	0.03	-1.521
34163.522	1600.25	1600.23	-0.16	0.02	0.03	-1.521
34485.276	2200.29	2200.23	-0.13	0.06	0.03	-1.521
34697.885	2600.32	2600.23	-0.10	0.08	0.03	-1.521
35014.062	3200.34	3200.30	-0.14	0.04	0.03	-1.521
35222.998	3600.33	3600.27	-0.12	0.06	0.03	-1.520
35533.779	4200.32	4200.26	-0.12	0.06	0.03	-1.521
36044.903	5200.33	5200.25	-0.11	0.08	0.03	-1.521
36547.856	6200.33	6200.39	-0.26	-0.06	0.03	-1.521
36944.357	7000.29	7000.18	-0.11	0.11	0.03	-1.520
36547.916	6200.29	6200.51	-0.42	-0.22	0.03	-1.520
36044.950	5200.34	5200.34	-0.19	-0.00	0.03	-1.521
35533.806	4200.35	4200.31	-0.15	0.04	0.03	-1.521
35223.051	3600.33	3600.37	-0.22	-0.04	0.02	-1.521

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
35014.112	3200.32	3200.40	-0.26	-0.08	0.02	-1.520
34697.938	2600.30	2600.34	-0.22	-0.04	0.02	-1.521
34485.317	2200.29	2200.32	-0.21	-0.03	0.01	-1.520
34163.541	1600.27	1600.28	-0.19	-0.01	0.01	-1.520
33947.110	1200.24	1200.29	-0.24	-0.05	0.01	-1.520
33729.072	800.22	800.26	-0.22	-0.04	0.01	-1.521
33509.416	400.20	400.23	-0.22	-0.03	0.00	-1.521
33291.672	0.16	0.16	-0.14	0.01	7.90	6.487
33513.010	400.20	400.22	-0.18	-0.02	7.91	6.487
33732.673	800.22	800.24	-0.17	-0.01	7.91	6.487
33950.707	1200.23	1200.22	-0.15	0.01	7.91	6.487
34167.172	1600.25	1600.23	-0.14	0.02	7.93	6.487
34488.980	2200.29	2200.29	-0.17	0.00	7.93	6.487
34701.612	2600.31	2600.30	-0.17	0.01	7.93	6.487
35017.792	3200.35	3200.32	-0.16	0.03	7.93	6.487
35226.747	3600.36	3600.28	-0.11	0.08	7.94	6.487
35537.531	4200.37	4200.23	-0.06	0.15	7.94	6.487
36048.783	5200.39	5200.38	-0.22	0.01	7.95	6.488
36551.745	6200.37	6200.45	-0.34	-0.08	7.96	6.488
36948.251	7000.34	7000.19	-0.14	0.15	7.96	6.488
36551.759	6200.36	6200.48	-0.38	-0.12	7.96	6.488
36048.817	5200.36	5200.44	-0.31	-0.08	7.96	6.487
35537.586	4200.35	4200.32	-0.18	0.03	7.96	6.487
35226.779	3600.34	3600.32	-0.18	0.02	7.96	6.487
35017.842	3200.33	3200.38	-0.24	-0.05	7.97	6.487
34701.658	2600.30	2600.35	-0.23	-0.05	7.97	6.487
34489.025	2200.28	2200.33	-0.22	-0.05	7.98	6.487
34167.225	1600.25	1600.29	-0.20	-0.04	7.98	6.487
33950.743	1200.24	1200.24	-0.16	0.00	7.98	6.487
33732.706	800.23	800.24	-0.16	-0.01	7.98	6.487
33513.038	400.20	400.21	-0.16	-0.01	7.98	6.488
33295.454	0.16	0.12	-0.01	0.04	18.14	16.495
33516.821	400.20	400.19	-0.05	0.01	18.14	16.495
33736.523	800.23	800.23	-0.06	0.00	18.14	16.495
33954.594	1200.25	1200.24	-0.05	0.01	18.14	16.495
34171.091	1600.28	1600.27	-0.06	0.01	18.14	16.495
34492.935	2200.33	2200.32	-0.08	0.00	18.14	16.496
34705.598	2600.35	2600.35	-0.08	0.00	18.14	16.496
35021.828	3200.39	3200.39	-0.11	-0.01	18.14	16.496
35230.791	3600.40	3600.33	-0.04	0.07	18.14	16.496
35541.590	4200.40	4200.24	0.04	0.16	18.14	16.495
36053.018	5200.40	5200.62	-0.37	-0.22	18.14	16.496
35541.603	4200.38	4200.26	-0.01	0.12	18.14	16.495
35230.800	3600.36	3600.35	-0.09	0.02	18.14	16.495
35021.836	3200.35	3200.41	-0.16	-0.06	18.14	16.495

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
34705.601	2600.31	2600.35	-0.13	-0.04	18.14	16.495
34492.946	2200.30	2200.34	-0.12	-0.04	18.14	16.495
34171.103	1600.27	1600.30	-0.10	-0.02	18.14	16.495
33954.603	1200.25	1200.26	-0.08	-0.01	18.14	16.496
33736.529	800.24	800.25	-0.07	-0.01	18.13	16.495
33516.830	400.20	400.21	-0.07	-0.01	18.12	16.495
33298.301	0.16	0.11	0.00	0.06	28.52	27.002
33519.713	400.20	400.20	-0.04	0.01	28.53	27.002
33739.446	800.24	800.23	-0.05	0.00	28.53	27.002
33957.557	1200.25	1200.26	-0.06	-0.01	28.53	27.002
34174.078	1600.28	1600.28	-0.05	0.01	28.54	27.002
34495.975	2200.32	2200.34	-0.08	-0.02	28.55	27.001
34708.671	2600.34	2600.37	-0.09	-0.03	28.55	27.002
35024.945	3200.37	3200.42	-0.11	-0.04	28.56	27.002
35233.917	3600.38	3600.31	-0.00	0.07	28.57	27.001
35544.777	4200.38	4200.25	0.06	0.13	28.57	27.002
35233.928	3600.37	3600.32	-0.02	0.04	28.58	27.001
35024.954	3200.35	3200.42	-0.13	-0.07	28.58	27.002
34708.687	2600.32	2600.39	-0.13	-0.07	28.58	27.001
34495.996	2200.30	2200.36	-0.12	-0.07	28.58	27.001
34174.100	1600.26	1600.30	-0.09	-0.04	28.58	27.001
33957.567	1200.24	1200.26	-0.07	-0.02	28.59	27.001
33739.465	800.23	800.25	-0.07	-0.01	28.59	27.001
33519.731	400.20	400.20	-0.05	-0.00	28.59	27.001
33298.315	0.16	0.10	0.01	0.06	28.60	27.002



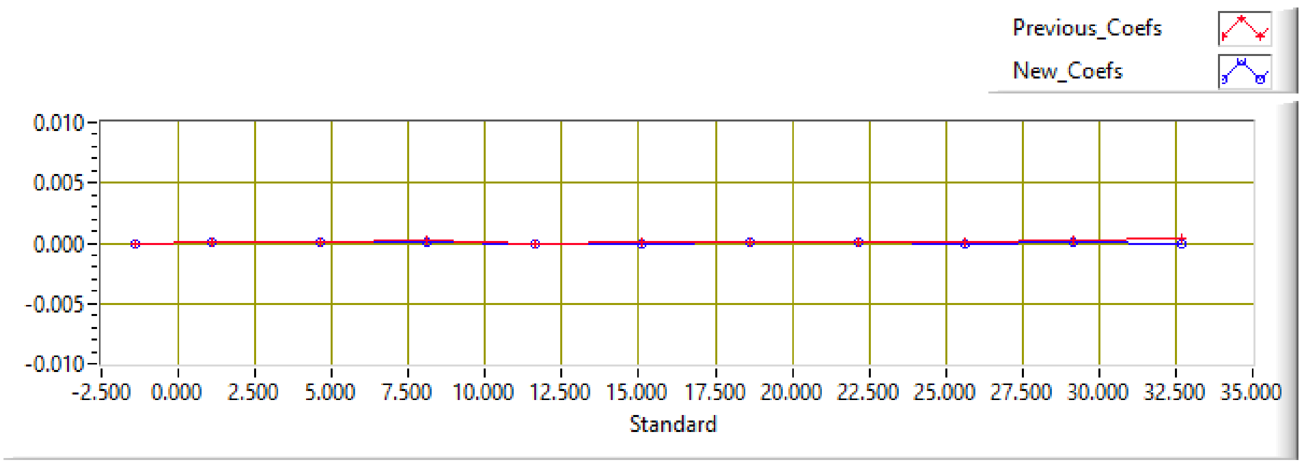
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 2166
CALIBRATION DATE: 17-Nov-2015
Mfg: SEABIRD   Model: 03
Previous cal: 21-May-15
Calibration Tech: CAL

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.34268728E-3	a = 4.34288064E-3	
h = 6.45929292E-4	b = 6.46139969E-4	
i = 2.32633976E-5	c = 2.32961239E-5	
j = 2.17044750E-6	d = 2.17200665E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech   Model: MicroK100   s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
2893.9333	-1.4091	-1.4091	-0.00013	-0.00004
3059.8115	1.0954	1.0953	0.00007	0.00004
3303.5425	4.6030	4.6030	0.00012	0.00001
3560.8636	8.1099	8.1099	0.00018	0.00006
3832.2692	11.6176	11.6177	-0.00001	-0.00011
4117.4450	15.1184	15.1185	0.00004	-0.00002
4418.1060	18.6288	18.6287	0.00010	0.00007
4733.6286	22.1367	22.1367	0.00006	0.00003
5064.6867	25.6464	25.6465	0.00001	-0.00007
5410.8338	29.1504	29.1503	0.00028	0.00005
5773.6901	32.6615	32.6615	0.00046	-0.00002



Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3399
CALIBRATION DATE: 10-Nov-15

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:
g = -1.01577650e+001
h = 1.53709781e+000
i = -2.63336443e-003
j = 2.84699598e-004

CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

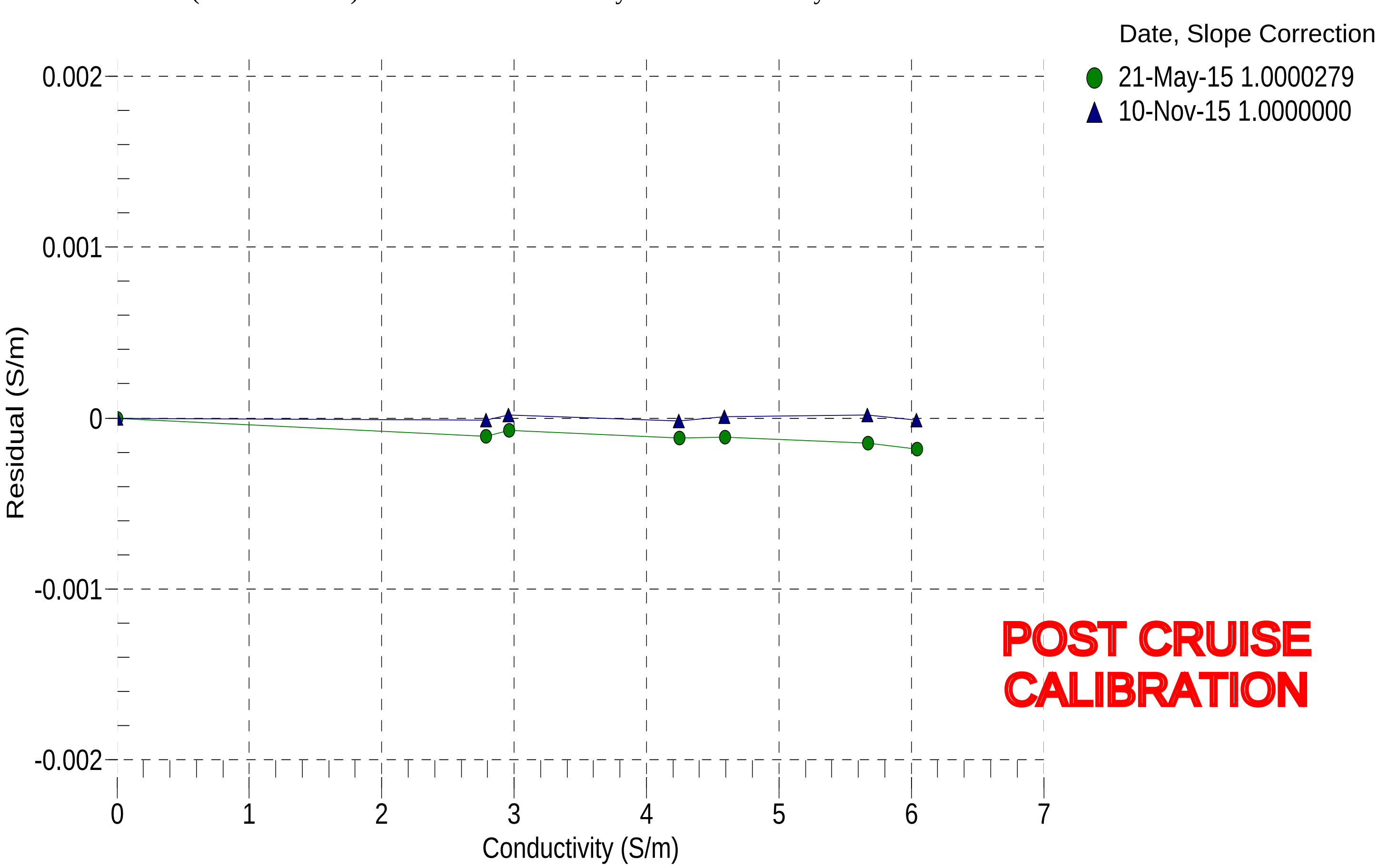
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.57478	0.00000	0.00000
-1.0001	34.5758	2.78699	4.98373	2.78698	-0.00001
0.9999	34.5759	2.95736	5.09414	2.95738	0.00002
14.9999	34.5765	4.24529	5.86130	4.24527	-0.00002
18.4999	34.5762	4.58993	6.05000	4.58994	0.00001
28.9999	34.5750	5.66722	6.60475	5.66723	0.00002
32.4999	34.5684	6.03762	6.78487	6.03761	-0.00001

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) / 10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3023
CALIBRATION DATE: 01-Dec-15

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:
g = -9.88423243e+000
h = 1.42709744e+000
i = 1.53440913e-004
j = 6.70552381e-005

CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

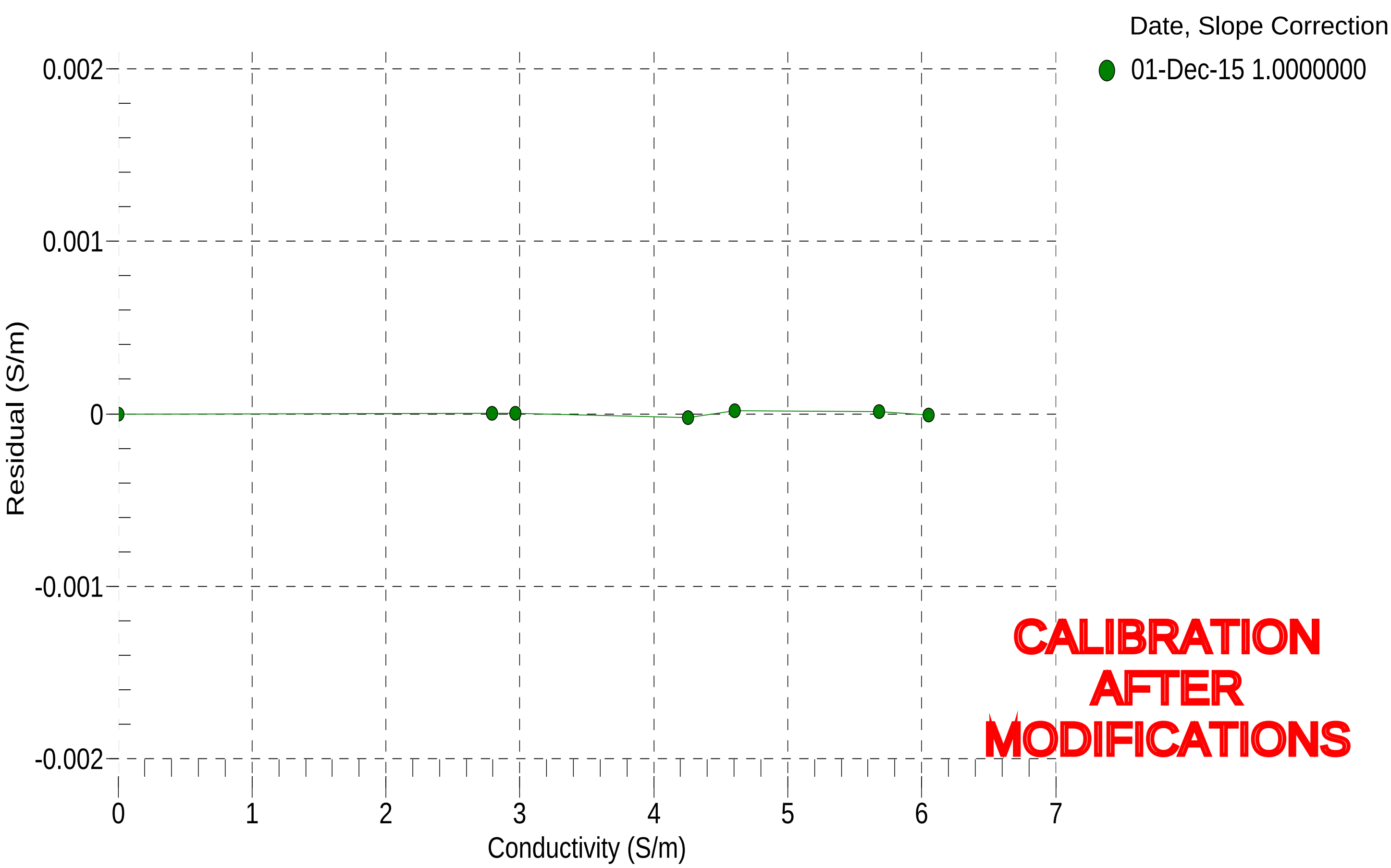
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.63095	0.00000	0.00000
-1.0001	34.6787	2.79451	5.14396	2.79452	0.00000
0.9999	34.6791	2.96534	5.25866	2.96534	0.00000
14.9999	34.6793	4.25657	6.05534	4.25655	-0.00002
18.4999	34.6789	4.60209	6.25125	4.60211	0.00002
28.9999	34.6761	5.68192	6.82702	5.68193	0.00001
32.4999	34.6658	6.05270	7.01373	6.05269	-0.00001

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) /10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3207
CALIBRATION DATE: 20-Jan-16

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -1.01377568e+001
h =   1.35969549e+000
i =   1.23096178e-004
j =   5.86808354e-005
```

```
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

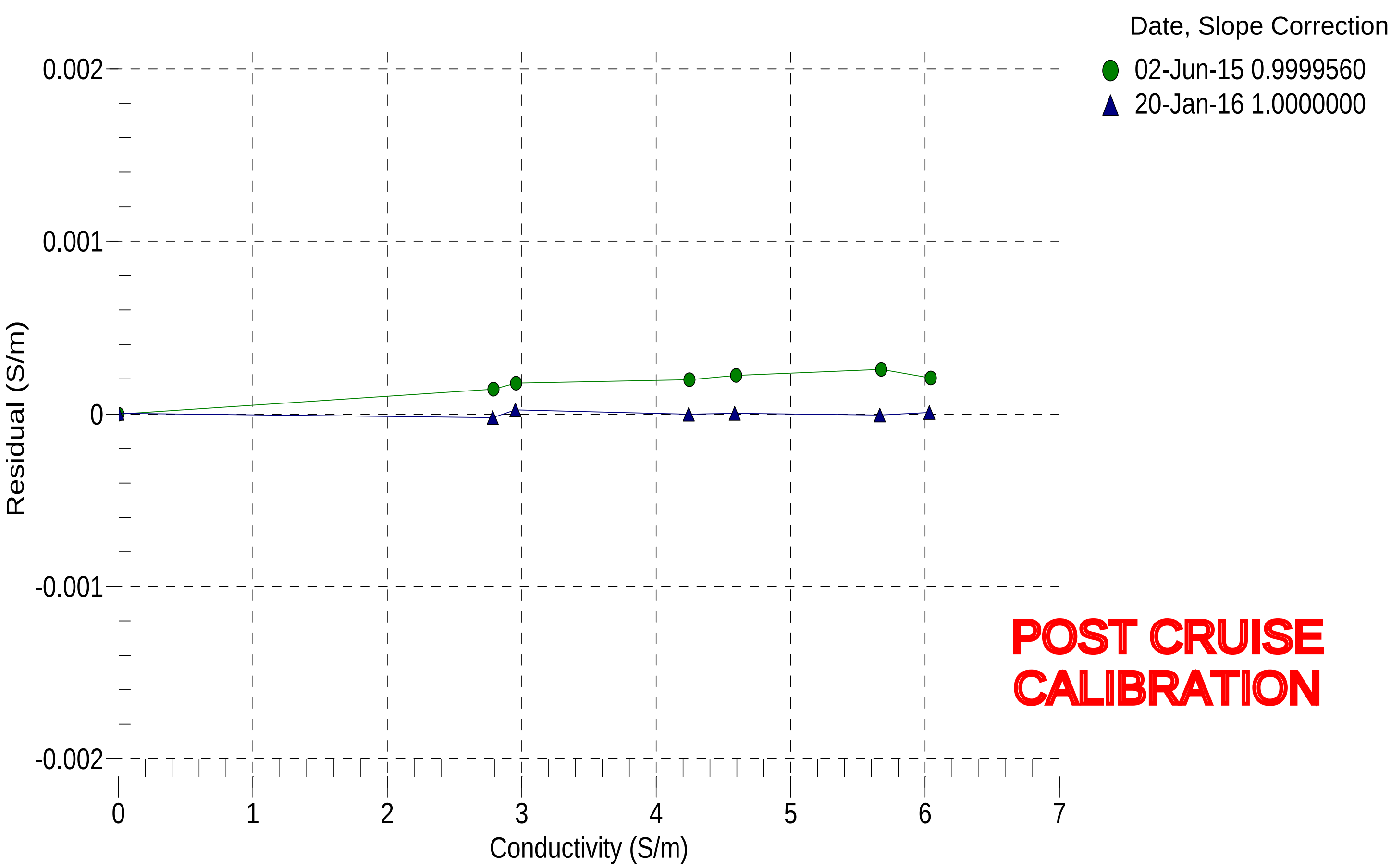
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.72977	0.00000	0.00000
-1.0000	34.5611	2.78593	5.28186	2.78590	-0.00002
1.0000	34.5611	2.95622	5.39880	2.95625	0.00002
15.0000	34.5617	4.24367	6.21143	4.24367	-0.00000
18.5000	34.5613	4.58818	6.41134	4.58818	0.00000
29.0000	34.5592	5.66493	6.99917	5.66492	-0.00001
32.5000	34.5490	6.03463	7.18984	6.03463	0.00001

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) /10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 2819
CALIBRATION DATE: 21-Jan-16

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -1.03801686e+001
h =   1.46094962e+000
i =  -2.97201593e-003
j =   3.06280201e-004
```

```
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

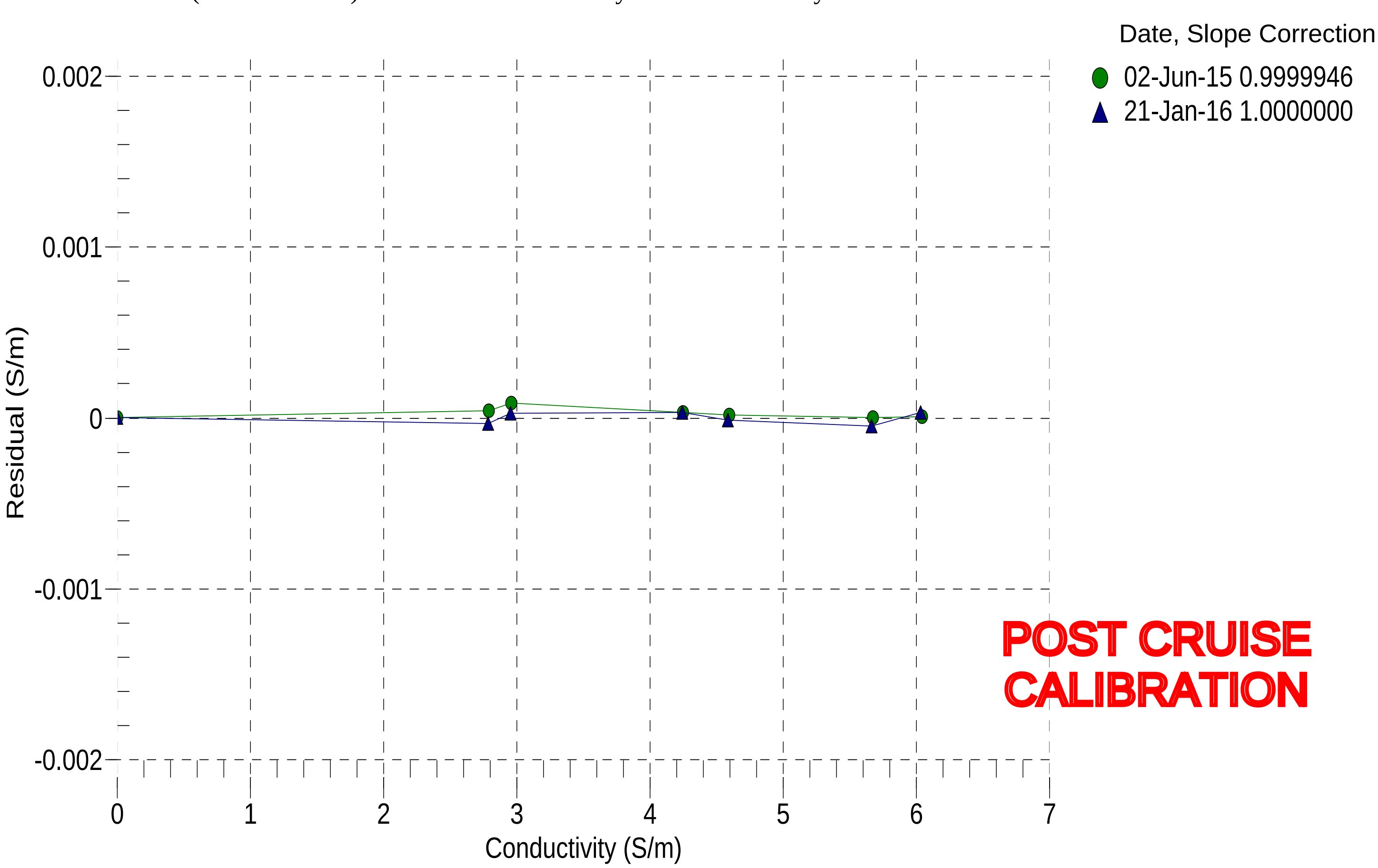
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.67080	0.00000	0.00000
-1.0000	34.5566	2.78560	5.12847	2.78556	-0.00003
1.0000	34.5566	2.95587	5.24143	2.95590	0.00003
15.0000	34.5564	4.24309	6.02651	4.24312	0.00003
18.5000	34.5558	4.58753	6.21961	4.58751	-0.00001
29.0000	34.5548	5.66429	6.78755	5.66424	-0.00005
32.5000	34.5494	6.03469	6.97211	6.03472	0.00003

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) /10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



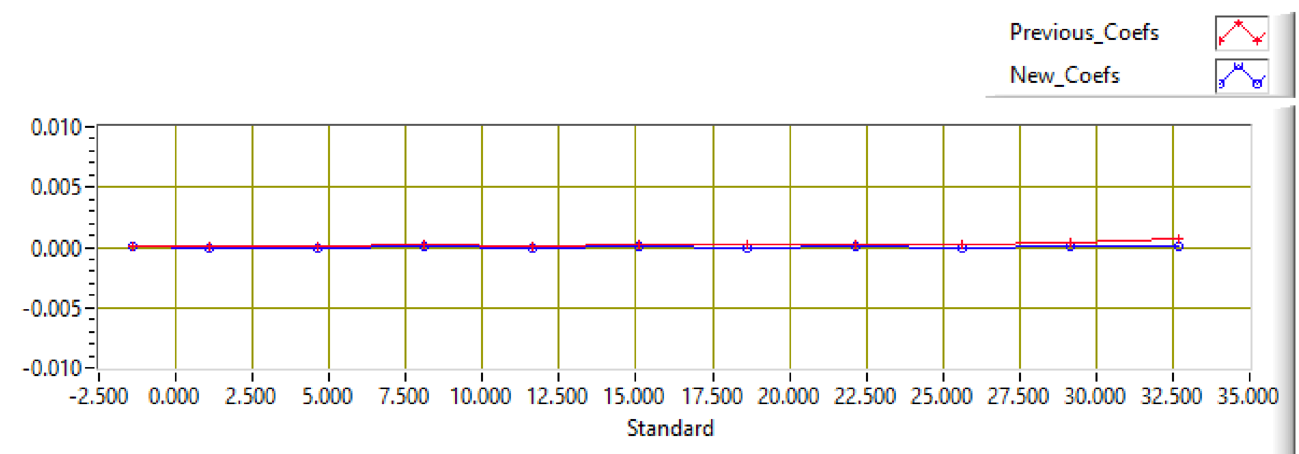
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 4226
CALIBRATION DATE: 17-Nov-2015
Mfg: SEABIRD   Model: 03
Previous cal: 14-May-15
Calibration Tech: CAL

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.38217647E-3	a = 4.38238291E-3	
h = 6.47346552E-4	b = 6.47561046E-4	
i = 2.28764202E-5	c = 2.29093466E-5	
j = 1.89272996E-6	d = 1.89426482E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: Isotech   Model: MicroK100   s/n: 291088-2
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
3081.2017	-1.4091	-1.4092	0.00007	0.00004
3258.0653	1.0954	1.0954	0.00006	-0.00002
3517.9631	4.6030	4.6031	0.00004	-0.00008
3792.3945	8.1099	8.1099	0.00018	0.00004
4081.9074	11.6176	11.6177	0.00006	-0.00008
4386.1673	15.1184	15.1183	0.00029	0.00014
4707.0602	18.6288	18.6288	0.00016	-0.00002
5043.8662	22.1367	22.1367	0.00027	0.00006
5397.3724	25.6464	25.6465	0.00016	-0.00013
5767.0877	29.1504	29.1504	0.00043	0.00001
6154.7606	32.6615	32.6615	0.00064	0.00003



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1919
CALIBRATION DATE: 10-Nov-15

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g =  -3.99264698e+000
h =   5.25774535e-001
i =  -1.02610382e-003
j =   8.04692089e-005
```

```
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

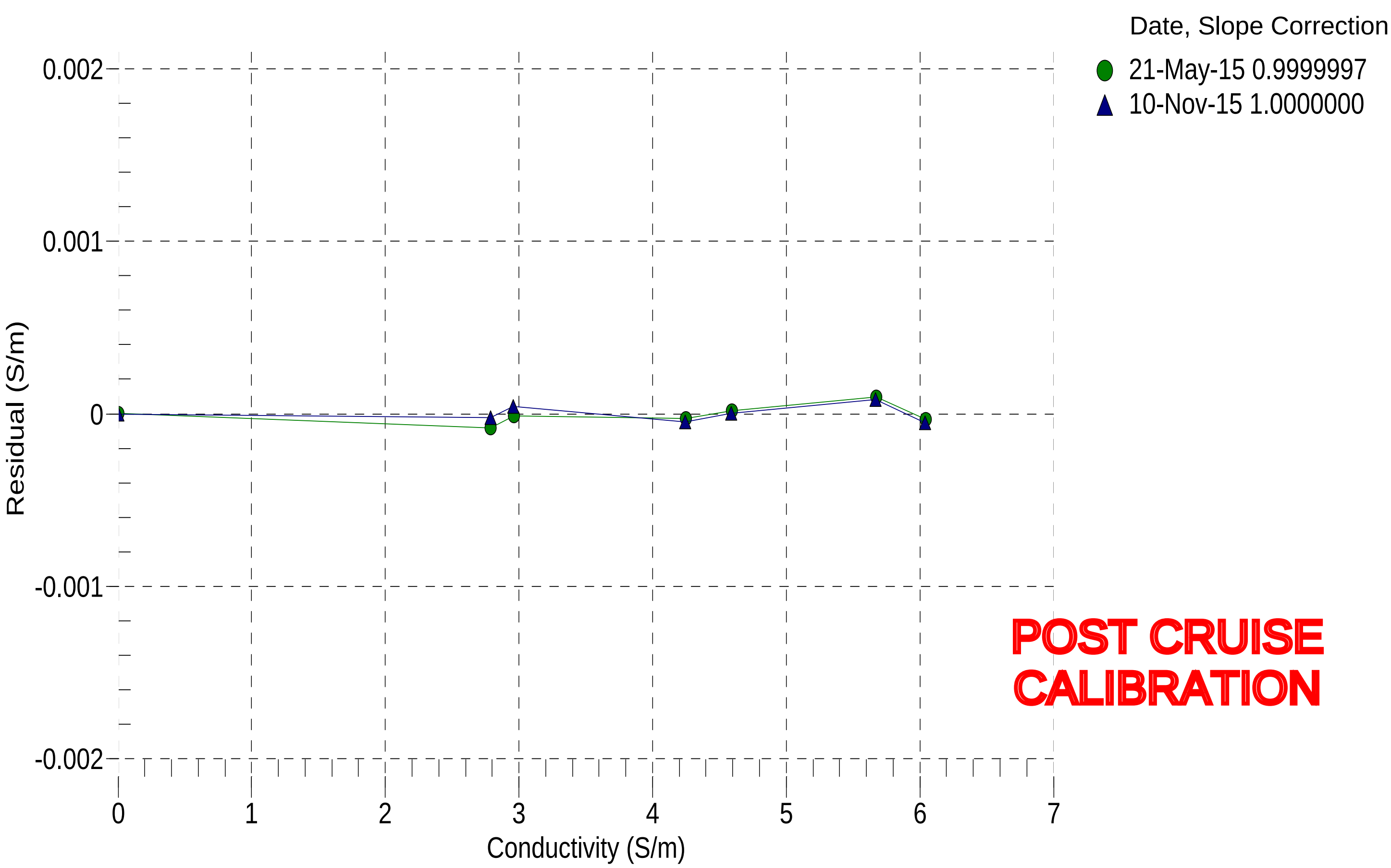
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.76153	0.00000	0.00000
-1.0001	34.5758	2.78699	7.80774	2.78697	-0.00002
0.9999	34.5759	2.95736	8.01347	2.95740	0.00004
14.9999	34.5765	4.24529	9.42160	4.24524	-0.00005
18.4999	34.5762	4.58993	9.76336	4.58993	0.00000
28.9999	34.5750	5.66722	10.75980	5.66730	0.00008
32.4999	34.5684	6.03762	11.08087	6.03757	-0.00005

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) /10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 3215
CALIBRATION DATE: 21-Jan-16

SBE 4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:
g = -1.01880327e+001
h = 1.54601574e+000
i = -2.45268171e-003
j = 2.72378595e-004

CPcor = -9.5700e-008 (nominal)
CTcor = 3.2500e-006 (nominal)

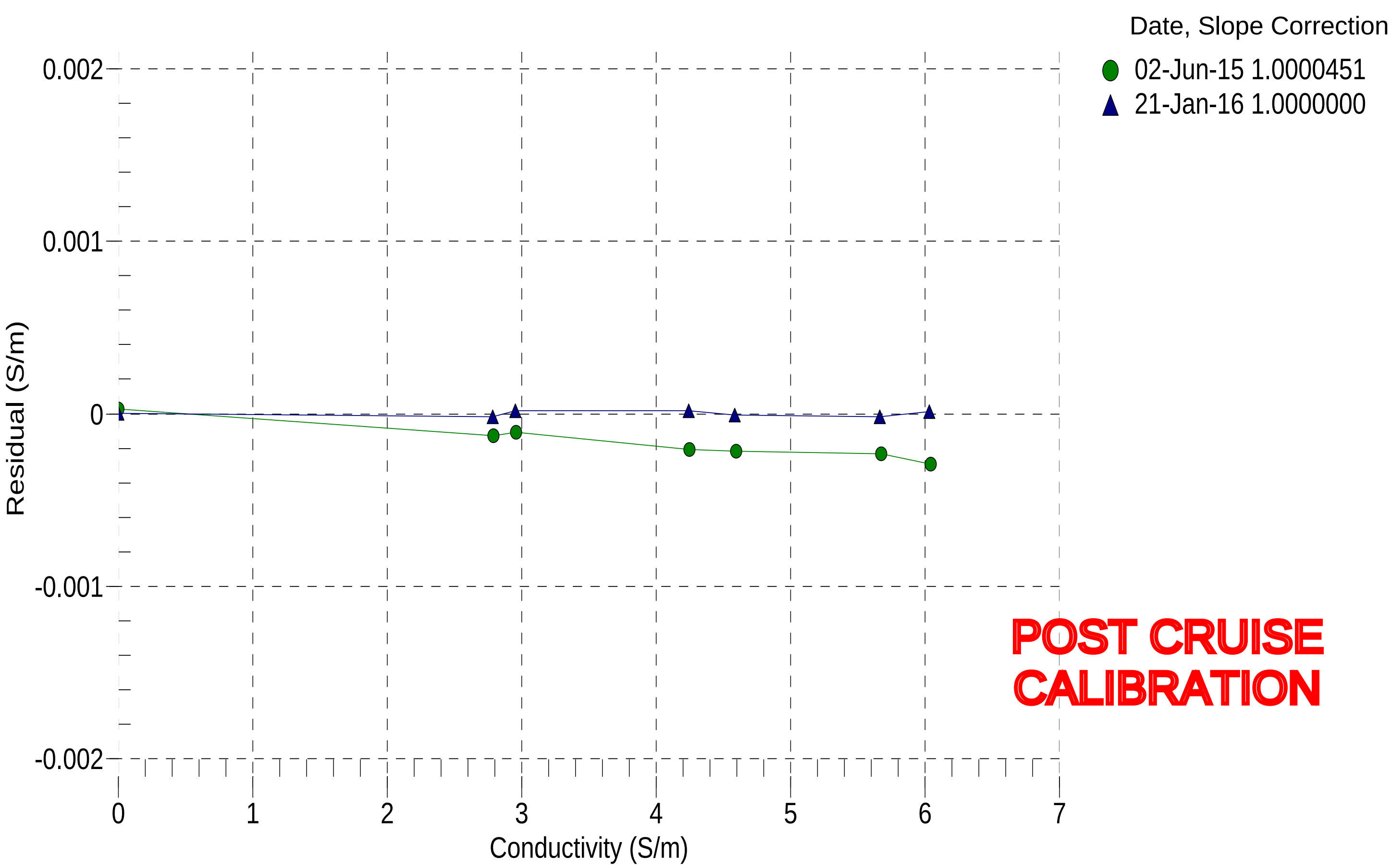
BATH TEMP (° C)	BATH SAL (PSU)	BATH COND (S/m)	INSTRUMENT OUTPUT (kHz)	INSTRUMENT COND (S/m)	RESIDUAL (S/m)
0.0000	0.0000	0.00000	2.57082	0.00000	0.00000
-1.0000	34.5566	2.78560	4.96939	2.78558	-0.00002
1.0000	34.5566	2.95587	5.07937	2.95589	0.00002
15.0000	34.5564	4.24309	5.84361	4.24311	0.00002
18.5000	34.5558	4.58753	6.03156	4.58752	-0.00001
29.0000	34.5548	5.66429	6.58429	5.66427	-0.00002
32.5000	34.5494	6.03469	6.76388	6.03470	0.00001

f = Instrument Output (kHz)

t = temperature (°C); p = pressure (decibars); δ = CTcor; ε = CPcor;

Conductivity (S/m) = $(g + h * f^2 + i * f^3 + j * f^4) /10 (1 + \delta * t + \varepsilon * p)$

Residual (Siemens/meter) = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

ECO Chlorophyll Fluorometer Characterization Sheet

Date: 11/24/2015 S/N: FLRTD-2050

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark Counts)

	Analog Range 1	Analog Range 2	Analog Range 4 (default)		Digital	
Dark Counts	0.064	0.034	0.019	V	48	counts
Scale Factor (SF)	6	12	24	µg/l/V	0.0074	µg/l/count
Maximum Output	4.98	4.98	4.98	V	16380	counts
Resolution	0.7	0.7	0.7	mV	1.0	counts

Ambient temperature during characterization 22.3 °C

Analog Range: 1 (most sensitive, 0–4,000 counts), 2 (midrange, 0–8,000 counts), 4 (entire range, 0–16,000 counts).

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations *in-situ* is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (*Thalassiosira weissflogii*). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1138
CALIBRATION DATE: 19-Nov-15

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.4348
Voffset = -0.5124
Tau20 = 1.41

A = -2.3647e-003
B = 1.1539e-004
C = -2.0257e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2

H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

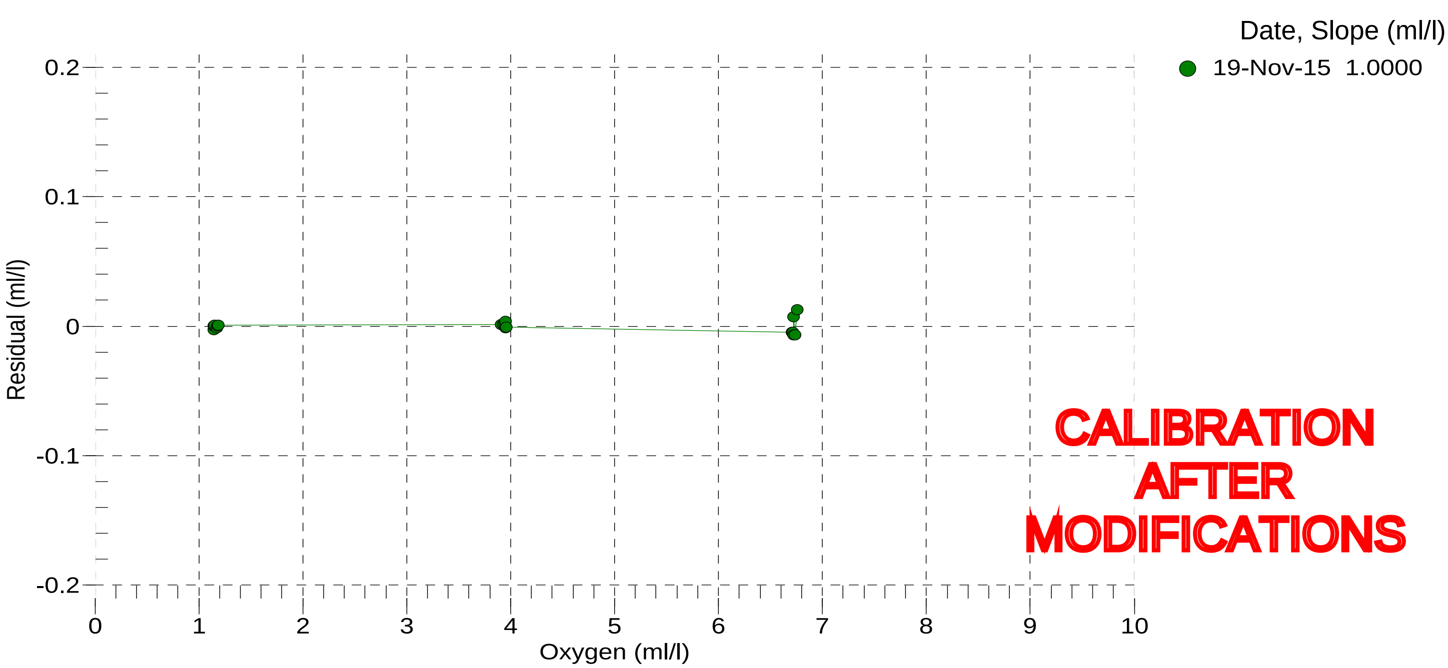
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.15	2.00	0.00	0.786	1.14	-0.00
1.15	12.00	0.00	0.868	1.15	0.00
1.15	6.00	0.00	0.819	1.15	0.00
1.17	20.00	0.00	0.944	1.17	-0.00
1.18	26.00	0.00	1.000	1.18	0.00
1.19	30.00	0.00	1.041	1.19	0.00
3.91	12.00	0.00	1.724	3.91	0.00
3.93	2.00	0.00	1.451	3.93	0.00
3.94	30.00	0.00	2.266	3.95	0.00
3.95	26.00	0.00	2.142	3.95	-0.00
3.95	6.00	0.00	1.568	3.96	0.00
3.96	20.00	0.00	1.967	3.95	-0.00
6.71	12.00	0.00	2.588	6.70	-0.00
6.71	2.00	0.00	2.113	6.71	-0.00
6.72	30.00	0.00	3.496	6.71	-0.01
6.72	6.00	0.00	2.308	6.73	0.01
6.74	20.00	0.00	2.989	6.73	-0.01
6.76	26.00	0.00	3.308	6.77	0.01

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsat(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * Oxsat(T,S) * exp(E * P / K)

Residual (ml/l) = instrument oxygen - bath oxygen



CALIBRATION AFTER MODIFICATIONS

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0848
CALIBRATION DATE: 19-Nov-15

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.4497
Voffset = -0.5207
Tau20 = 1.04

A = -3.5777e-003
B = 1.4405e-004
C = -2.3867e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

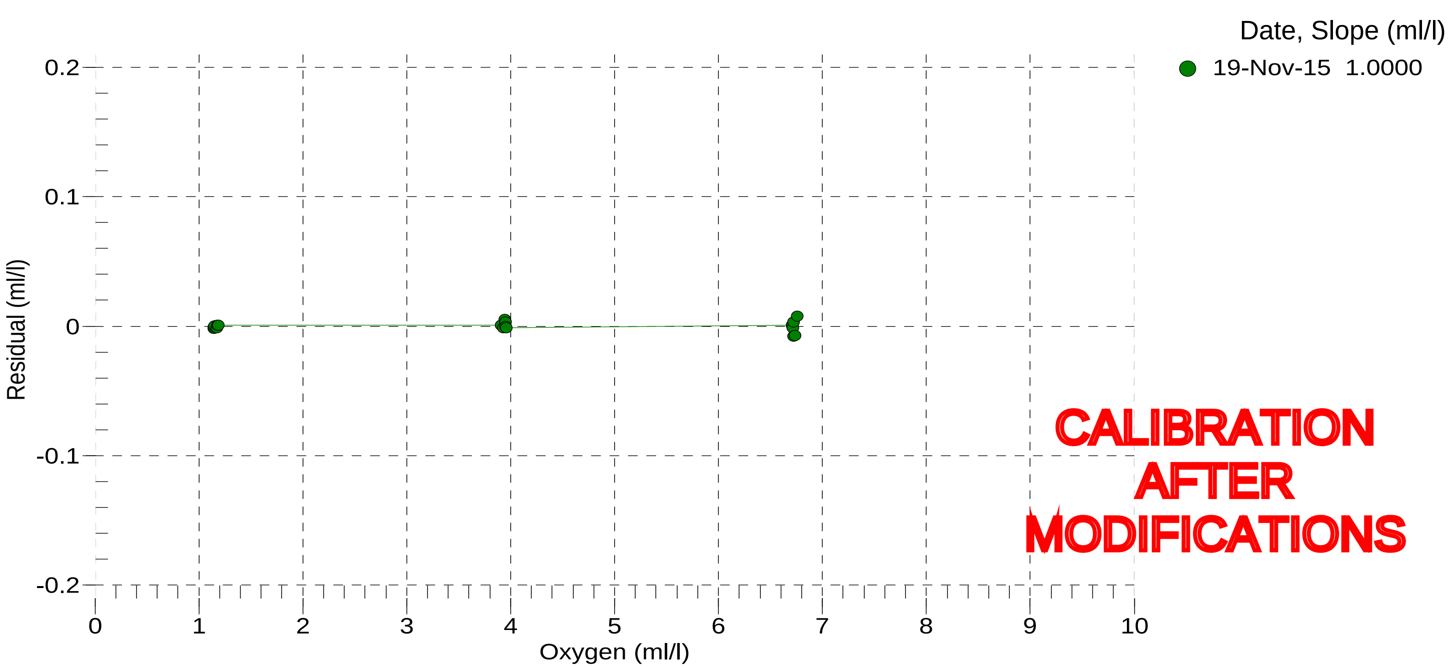
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.15	2.00	0.00	0.786	1.15	-0.00
1.15	12.00	0.00	0.868	1.15	-0.00
1.15	6.00	0.00	0.819	1.15	0.00
1.17	20.00	0.00	0.944	1.17	-0.00
1.18	26.00	0.00	1.001	1.18	0.00
1.19	30.00	0.00	1.042	1.19	0.00
3.91	12.00	0.00	1.705	3.91	0.00
3.93	2.00	0.00	1.430	3.93	-0.00
3.94	30.00	0.00	2.254	3.95	0.01
3.95	26.00	0.00	2.129	3.95	0.00
3.95	6.00	0.00	1.547	3.95	-0.00
3.96	20.00	0.00	1.950	3.95	-0.00
6.71	12.00	0.00	2.552	6.71	0.00
6.71	2.00	0.00	2.073	6.71	-0.00
6.72	30.00	0.00	3.466	6.71	-0.01
6.72	6.00	0.00	2.267	6.73	0.00
6.74	20.00	0.00	2.954	6.73	-0.01
6.76	26.00	0.00	3.274	6.77	0.01

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsat(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

Oxygen (ml/l) = Soc * (V + Voffset) * $(1.0 + A * T + B * T^2 + C * T^3)$ * Oxsat(T,S) * exp(E * P / K)

Residual (ml/l) = instrument oxygen - bath oxygen



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0197

CALIBRATION DATE: 09-Feb-16

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:

Soc = 0.3709

Voffset = -0.7133

Tau20 = 0.90

A = -8.5168e-003

B = 3.5080e-004

C = -3.3481e-006

E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4

D2 = -4.64803e-2

H1 = -3.300000e-2

H2 = 5.00000e+3

H3 = 1.45000e+3

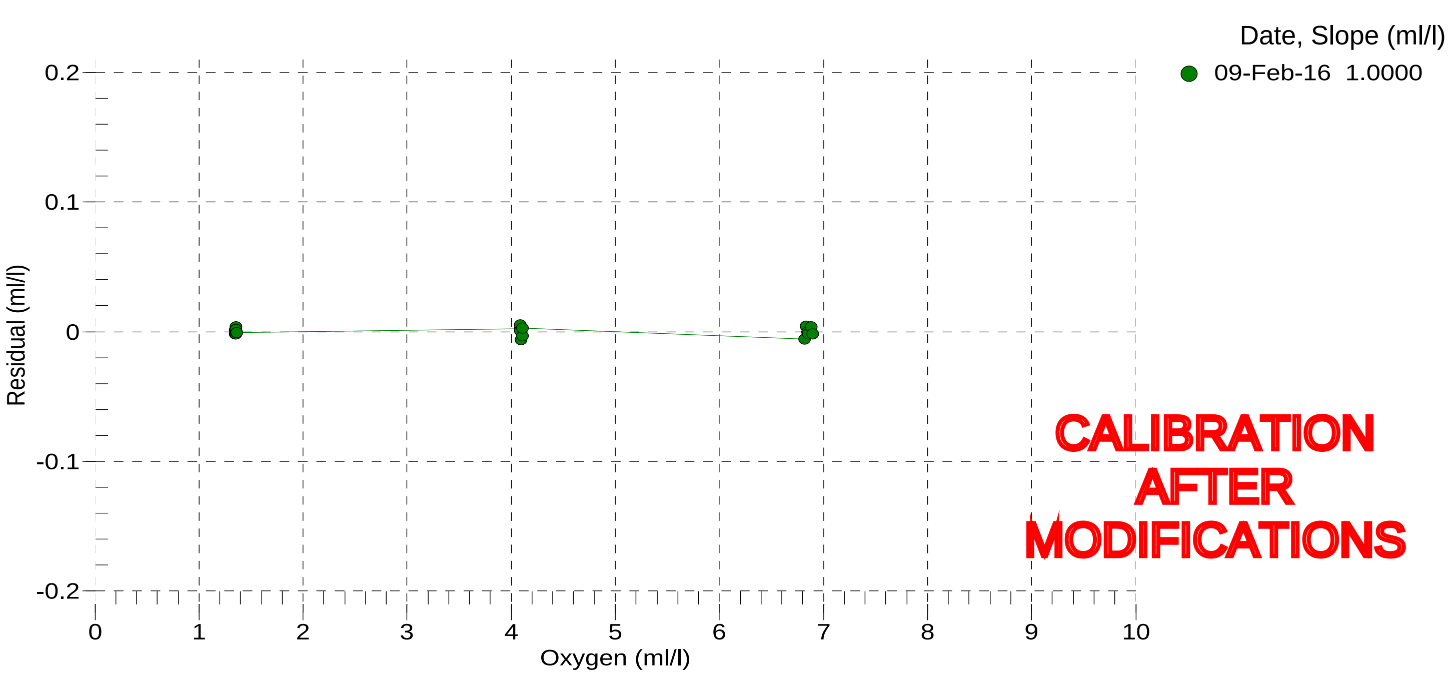
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.35	2.00	0.00	1.093	1.34	-0.00
1.35	20.00	0.00	1.319	1.35	0.00
1.35	6.00	0.00	1.148	1.35	-0.00
1.35	30.00	0.00	1.426	1.36	0.00
1.36	26.00	0.00	1.388	1.36	0.00
1.36	12.00	0.00	1.229	1.36	-0.00
4.09	30.00	0.00	2.862	4.09	0.00
4.09	26.00	0.00	2.745	4.09	0.01
4.09	12.00	0.00	2.265	4.09	0.00
4.10	20.00	0.00	2.551	4.09	-0.01
4.11	2.00	0.00	1.875	4.11	-0.00
4.11	6.00	0.00	2.038	4.11	0.00
6.82	30.00	0.00	4.294	6.81	-0.01
6.84	26.00	0.00	4.107	6.84	0.00
6.84	2.00	0.00	2.650	6.84	-0.00
6.85	20.00	0.00	3.791	6.85	-0.00
6.88	6.00	0.00	2.932	6.89	0.00
6.89	12.00	0.00	3.328	6.89	-0.00

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * Oxsol(T,S) * exp(E * P / K)

Residual (ml/l) = instrument oxygen - bath oxygen



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0275
CALIBRATION DATE: 21-Jan-16

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS:
Soc = 0.5378
Voffset = -0.5022
Tau20 = 1.36

A = -3.1385e-003
B = 1.0071e-004
C = -1.2897e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS
D1 = 1.92634e-4
D2 = -4.64803e-2
H1 = -3.300000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

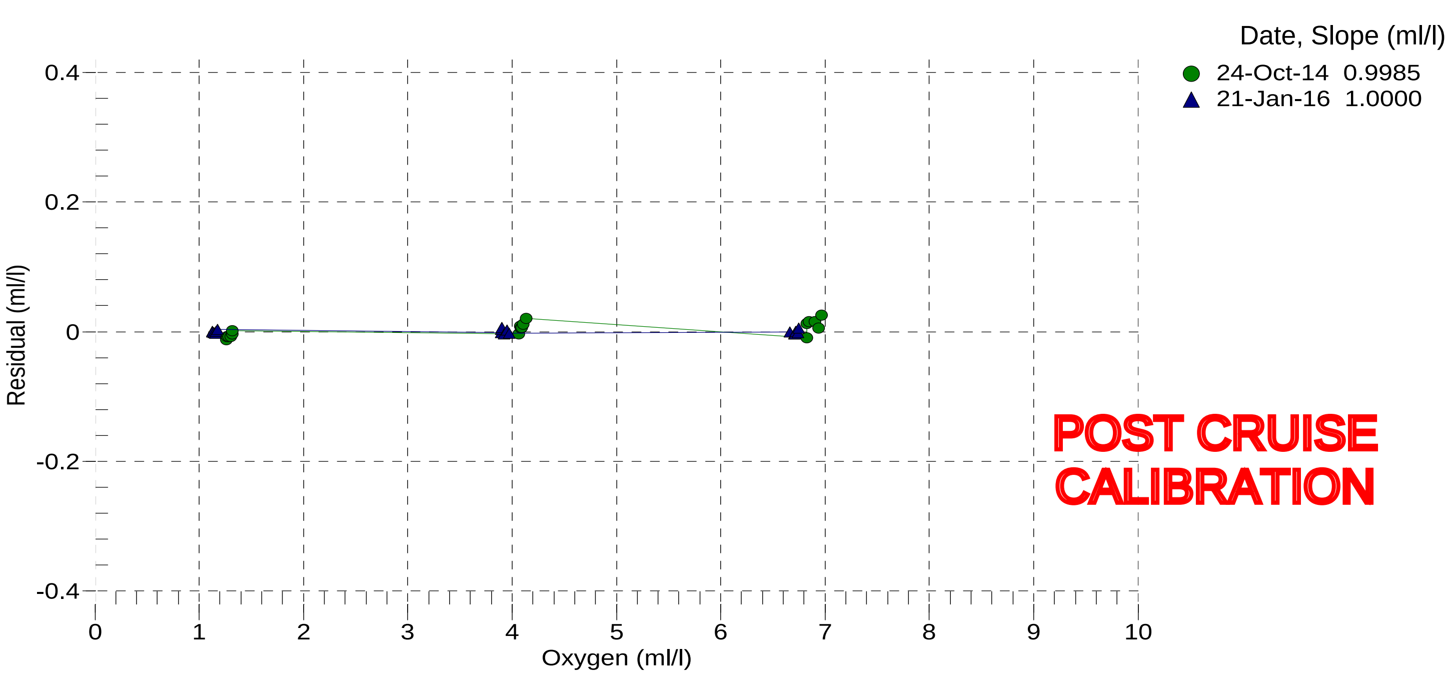
BATH OXYGEN (ml/l)	BATH TEMPERATURE (° C)	BATH SALINITY (PSU)	INSTRUMENT OUTPUT (volts)	INSTRUMENT OXYGEN (ml/l)	RESIDUAL (ml/l)
1.12	6.00	0.00	0.746	1.12	0.00
1.13	12.00	0.00	0.788	1.13	-0.00
1.14	2.00	0.00	0.723	1.14	-0.00
1.16	20.00	0.00	0.851	1.15	-0.00
1.17	26.00	0.00	0.898	1.17	0.00
1.18	30.00	0.00	0.934	1.18	0.00
3.89	2.00	0.00	1.254	3.89	-0.00
3.90	6.00	0.00	1.347	3.90	0.00
3.90	12.00	0.00	1.491	3.91	0.01
3.92	20.00	0.00	1.687	3.92	-0.00
3.95	26.00	0.00	1.846	3.95	0.00
3.98	30.00	0.00	1.954	3.97	-0.00
6.66	2.00	0.00	1.790	6.66	-0.00
6.70	12.00	0.00	2.197	6.70	-0.00
6.71	20.00	0.00	2.530	6.71	-0.00
6.72	6.00	0.00	1.959	6.72	0.00
6.74	30.00	0.00	2.965	6.74	-0.00
6.75	26.00	0.00	2.798	6.76	0.01

V = instrument output (volts); T = temperature (°C); S = salinity (PSU); K = temperature (°K)

Oxsol(T,S) = oxygen saturation (ml/l); P = pressure (dbar)

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * Oxsol(T,S) * exp(E * P / K)

Residual (ml/l) = instrument oxygen - bath oxygen



POST CRUISE CALIBRATION

V

W