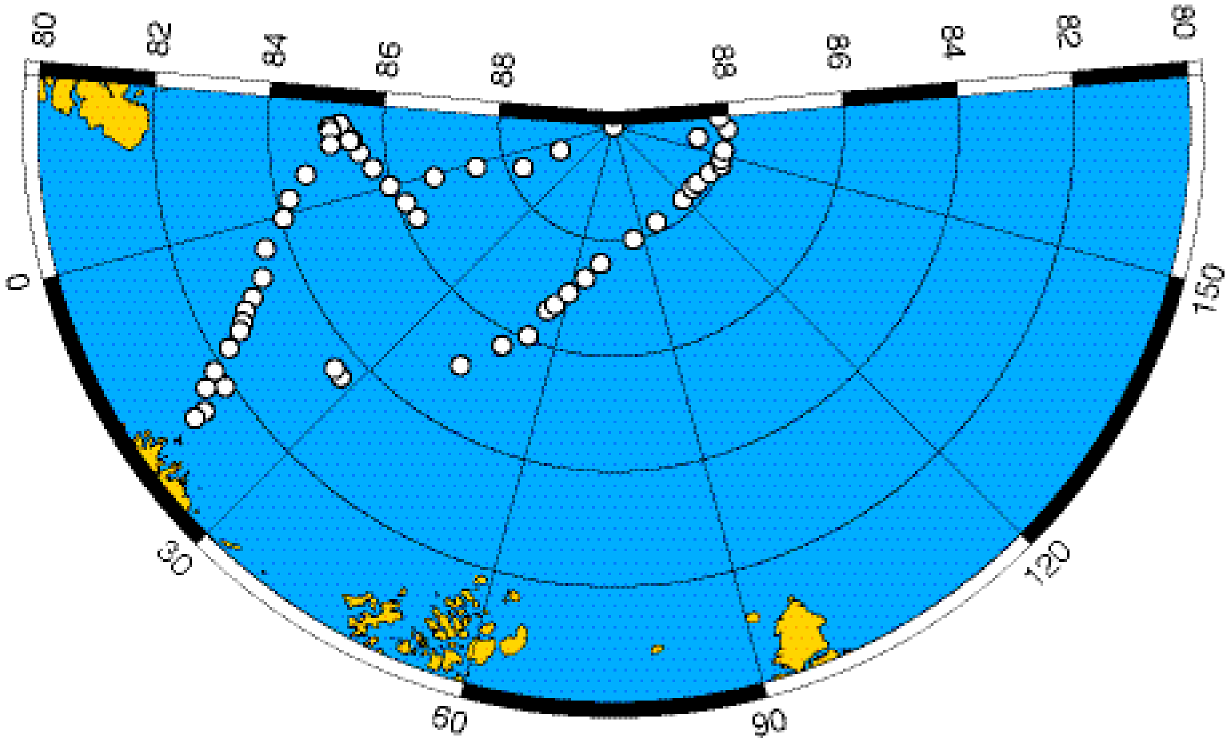
CRUISE REPORT: ODEN91

(Updated JUL 2009)



HIGHLIGHTS

Cruise Summary Information

Section designation	**ODEN91**
Expedition designation (ExpoCodes)	**77DN19910726**
Chief Scientists	**Leif Anderson, Goteborg University**
	J.-E. Hellsvik
Dates	17 August 1991 - 03 October 1991
Ship	Oden
Ports of call	Goteborg, Sweden
Geographic boundaries	90°N 15° 28'W 169° 41'E 81° 8'N
Stations	54
Floats and drifters deployed	unk.
Moorings deployed or recovered	unk.
Chief Scientists Contact Info	Leif Anderson, Professor • Dept. of Chemistry Göteborg University • 412 96 Göteborg • SWEDEN phone: +46 31-7722774 • fax: +46 31-7722785 email: leifand@chem.gu.se

LINKS TO TEXT LOCATIONS

Shaded sections are not relevant to this cruise or were not available when this report was compiled

Arctic Ocean Expedition 1991 (ODEN-91)

Revised Final Calibrated Pressure-Series CTD Data
(Pressure, Temperature, Conductivity, Salinity, Potential Temperature)

Processing Summary and Comments

August 8, 1998

STS/ODF CTD Group

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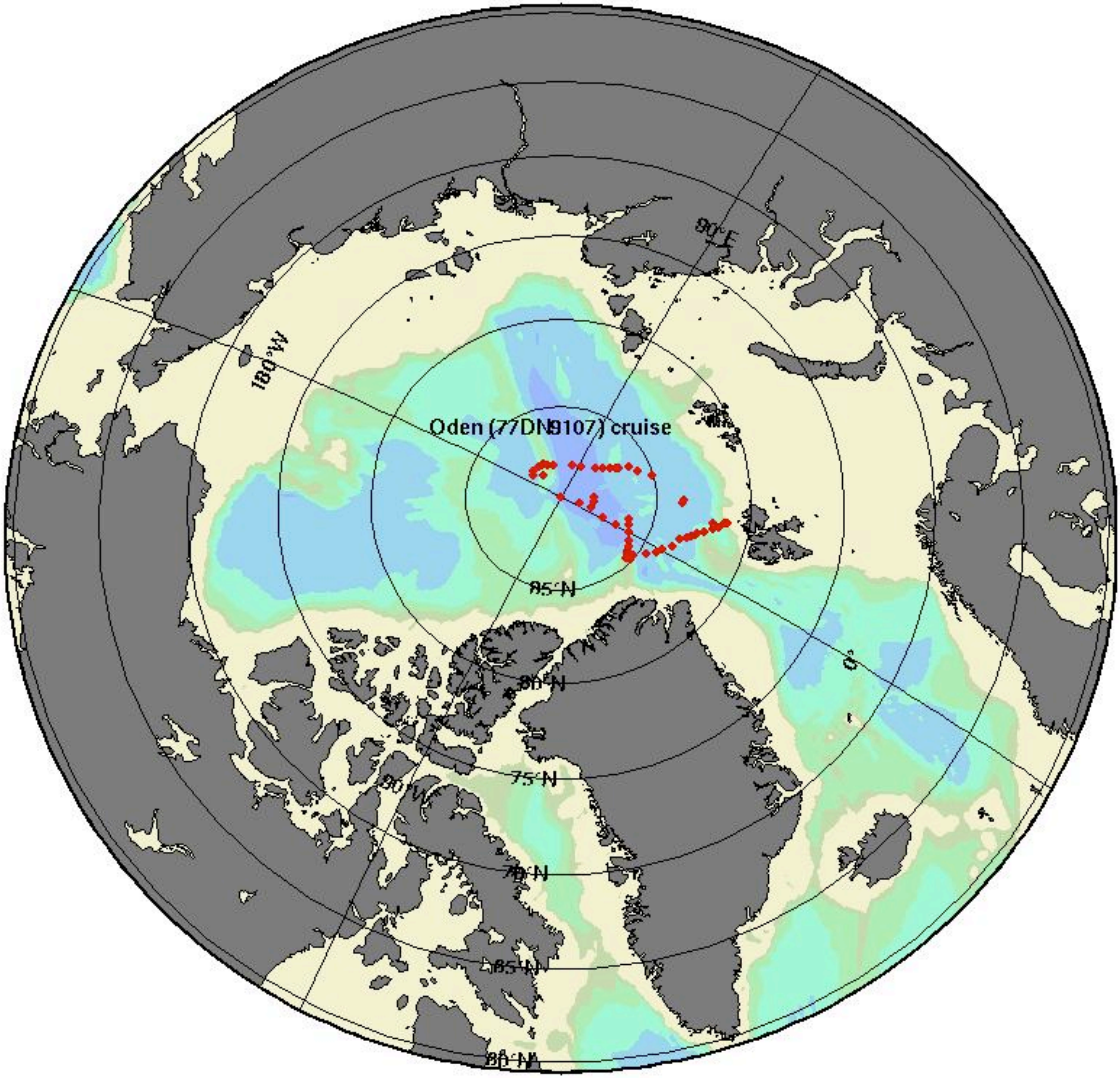
1. CTD Processing Summary

52 CTD casts were completed using a 24-bottle rosette sampling system. STS/ODF CTDs #4 and #6, modified NBIS Mark III- B instruments, were both used during ODEN-91; CTD #6 was used only for Station 5, cast 1 and CTD #4 was used for the rest of the casts. The CTD data were initially processed into a filtered, half-second average time-series during the data acquisition. The pressure and PRT temperature channels were corrected using laboratory calibrations. The conductivity/salinity data were calibrated to salinity check samples acquired on each cast. The CTD time-series data were then pressure-sequenced into 2-decibar pressure intervals.



Oden (77DN9107) cruise
90°E
180°W
90°W
0
85°N
80°N
75°N
70°N
65°N
60°N
Ocean Data View

2. CTD Laboratory Calibrations

Laboratory calibrations were done both pre- and post-cruise for CTD #4. CTD #6, which was used for only 1 cast at the beginning of the cruise, had only pre-cruise laboratory calibrations.

2.1. Pressure Transducer Calibration

Each CTD pressure transducer was calibrated in a temperature-controlled bath to the STS/ODF Ruska deadweight- tester pressure standard. The mechanical hysteresis loading and unloading curves were measured at cold temperature (-1.5 degrees C bath for CTD #4 and 0 degrees C bath for CTD #6) to a maximum of 8830 psi, and at warm temperature (30 degrees C bath for CTD #4 and 28 degrees C bath for CTD #6) to a maximum of 2030 psi.

2.2. PRT Temperature Calibration

The CTD PRT temperature transducers were calibrated in a temperature-controlled bath to an NBIS ATB temperature standard. CTD #6 had 7 calibration temperatures measured, spaced across the range of 0 to 28 degrees C. CTD #4 had 9 points measured, from -1.8 to 30 degrees C. It should be noted that STS/ODF CTD PRT temperature transducers are offset approximately +1.5 degrees C in order to avoid a temperature response discontinuity that occurs at 0 degrees C; this offset is taken into account when correcting the data.

3. CTD Data Processing

3.1. CTD Data Acquisition

CTD data are acquired at a rate of 25 Hz. Seven data chan- nels (pressure, temperature, second temperature, conductivity, dissolved oxygen, altimeter and elapsed time) were acquired by CTD #4. CTD #6 had six channels, with only one temperature transducer. The FSK CTD signal was demodulated by an STS/ODF-designed deck unit and output to an RS-232 bus interface. An Inte- grated Solutions, Inc. (ISI) Optimum V computer served as the re- al-time data acquisition processor.

Data acquisition consisted of storing all raw binary data on hard disk, then on magnetic cartridge tape, and generating a corrected and filtered half-second average time-series. Data calculated from this time series were reported and plotted during the cast. A 3-second average of the time-series data was calculated to correspond with each water sample collected during the data acquisition.

Generating the half-second time-series data set involved applying single-frame absolute value and gradient filters, then performing a 4,2 standard-deviation data rejection to all channels. During the acquisition, the pre-cruise laboratory calibration data were applied to pressure and temperature. Pressure, conductivity and oxygen were matched to the thermal response of the PRT temperature transducer. This lag time was determined using raw CTD data from the cruise. The conductivity channel was corrected for thermal and pressure effects.

During post-cruise processing, the CTD data were re-block- averaged from the raw digital data and the CTD trip averages were re-calculated.

3.2. Pressure, Temperature and Conductivity/Salinity Corrections

A maximum of 24 salinity check samples, were collected during each CTD cast. Discrete salts were analyzed on a Guildline AUTOSAL using Wormley batch P-115 for standardization. A 3-second average of the CTD time-series data was calculated for each sample. The resulting data were then used to derive CTD conductivity/salinity corrections.

There were difficulties at sea with the calculation of CTD data averages at trip times. Since a single-conductor wire was used for the CTD casts, the bottle trip signals sent to the pylon temporarily cut off power to the CTD. It took several seconds for the signal to stabilize after the CTD powered back up. The time needed for the CTD signal to steady again after power-up was longer than normal due to a slightly improper CTD voltage/signal strength adjustment. Software was used to delay the CTD trip average until 3 seconds after resumption of the CTD signal; 3 seconds being determined to be the optimal time for this data set.

3.2.1. CTD Pressure Corrections

3.2.1.1. CTD #6

The CTD #6 pre-cruise laboratory pressure calibration was applied to the single CTD cast which used this CTD, since no post-cruise laboratory pressure calibration was done.

3.2.1.2. CTD #4

The CTD #4 pre- and post-cruise pressure calibrations were compared. The cold/deep calibration curve shifted slightly over 1 decibar pre- to post-cruise, and the warm/shallow curve by less than .5 decibar. Pre- to post-cruise, the warm/shallow calibration slopes were slightly different. The pre- and post- cruise pressure calibration data were averaged, and the resulting pressure corrections applied to the data. Offsets were adjusted automatically for each station at the point where the CTD entered the water.

3.2.2. CTD Temperature Corrections

3.2.2.1. CTD #6

The CTD #6 pre-cruise laboratory temperature calibration was applied to the single CTD cast which used this CTD, since no post-cruise laboratory temperature calibration was done. There was only one PRT for this CTD.

3.2.2.2. CTD #4 (Revised)

CTD #4 had two PRTs. PRT-1 was the main temperature sensor and was used exclusively in all data processing. PRT-2 was a secondary temperature sensor installed to provide a check for the primary PRT. A comparison of the pre- and post-cruise laboratory PRT temperature transducer calibrations showed an average +.0066 degree C shift for PRT-1, and no shift for PRT-2. An analysis was done of the temperature data between the two PRTs throughout the cruise to see if the relative difference between them changed. The differences between the two PRTs showed good agree- ment with the post-cruise laboratory temperature calibrations, as well as being consistent within a given station, and from station to station. This indicates that the shift in PRT-1 most likely happened before the cruise start, and that there was no further shifting of the PRTs during shipment home. Therefore the post- cruise laboratory temperature corrections were applied to the CTD data.

* * * Revision * * *

During the Arctic Ocean 94 expedition, the temperature cali- bration applied to CTD #4 data on Arctic Ocean Expedition 1991 was questioned. It was thought that there was too much difference in deep basin temperatures between the two cruises. As indicated in the above paragraph, there was some uncertainty as to when the PRT calibration shift occurred for CTD #4.

During the final processing for Arctic Ocean 94, data com- parisons were done for the 2 cruises for stations in similar lo- cations, and the CTD #4 temperature correction applied for Arctic Ocean Expedition 1991 was re-examined. Data were also compared with preliminary results for Arctic Ocean 96 data. Examination of the PRT1-PRT2 differences during the cruise and between the laboratory temperature calibrations led to a revision of the CTD #4 temperature correction for Arctic 91 CTD data. The PRT1-PRT2 difference was .047 degrees for the pre-cruise laboratory cali- bration, and .054 degrees for the post-cruise laboratory calibra- tion. The PRT1-PRT2 differences during the cruise held steady at .052 degrees. During final Arctic 91 post-cruise processing, it was decided to use the post-cruise laboratory temperature correc- tions to apply to the CTD data, based on the interpretation of steady PRT1-PRT2 differences during the cruise which were much closer to post-cruise laboratory temperature calibration differ- ences than pre-cruise. It now seems likely that the calibration shift happened in 2 parts: +.0044 degrees during shipping out to the cruise, and the remaining +.002 degrees during shipping back. Therefore it was decided to change the temperature correction ap- plied to the Arctic 91 CTD data by +.002 degrees C (a less nega- tive correction), thus making the reported temperatures warmer by 2 millidegrees.

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3.2.3. CTD Conductivity Corrections

3.2.3.1. CTD #6

Check-sample conductivities were calculated from the bottle salinities using CTD pressures and temperatures. The differences between sample and CTD conductivities at all pressures were fit to CTD conductivity using a linear least-squares fit to generate a conductivity correction slope. Residual conductivity differences were then calculated and an offset was determined for the single CTD #6 cast.

3.2.3.2. CTD #4

Check-sample conductivities were calculated from the bottle salinities using CTD pressures and temperatures. The differences between sample and CTD #4 conductivities at all pressures were fit to CTD conductivity using a linear least-squares fit. Values greater than 2 standard deviations from the fit were rejected. The resulting conductivity correction slopes for each cast were fit to station number. It was determined to use a single, average conductivity slope for all the casts. Since the range of conductivities in this part of the ocean is very narrow, the conductivity slope correction does not have a great effect on the data.

Conductivity differences were calculated for each cast after applying the average conductivity slope correction. Residual conductivity offsets were then computed for each cast and fit to station number. These offsets were evaluated for all pressures, and for pressures below 950 decibars. There was essentially no difference, so the fit was calculated using all pressures. Smoothed offsets were determined using a 1st-order fit for all the stations. The resulting smoothed offsets were then applied to the data. Most offsets were then manually adjusted to account for discontinuous shifts in the conductivity transducer response, and to insure a consistent deep Theta-S relationship from station to station, particularly within individual basins. Station 9, cast 4 was the only cast which showed any discontinuity with surrounding stations in the conductivity transducer response, and it was adjusted to match its own bottle salinities, which also matched the deep Theta-S data to its surrounding basin stations.

The reason so many casts had to have additional manual adjustment of the conductivity offsets is related to the difficulties in calculating time-series data averages for the water samples collected. Even after using a "settle time" of 3 seconds, there remained a general positive bias for the bottle- minus-CTD differences: the averaged CTD conductivity was still slightly higher than it should have been by .0010 to .0030 mmho/cm. There did not seem to be a bias in the averaged CTD temperature. Since the bottle-minus-CTD conductivity differences were low, the calculated correction offsets were too high; most manual adjustments to the conductivity offsets were in the range of -.0015.

* * * Revision * * *

Due to a change in the temperature correction applied to the data, the conductivity corrections were also offset in August 1998 so that the salinities remained essentially unchanged from the August 1992 data release.

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3.2.3.3. Bottle vs. CTD Conductivity Statistical Summary

The ODEN-91 calibrated bottle-minus-CTD conductivity differ- ences yield the following statistical results: (NOTE that these include bottle salts which are known to have problems.)

cruise	pressure range (dbars)	mean conductivity diff'ce (bottle-CTD mmho/cm)	standard deviation	# values in mean
ODEN-91	all pressures	.00085	.01332	1185
	allp (4,2rej) *	.00069	.00204	1130
	press > 950	.00058	.00174	649
	p>950 (4,2rej)*	.00057	.00096	611

* "4,2rej" means a 4,2 standard-deviation rejection filter was applied tothe differences before generating the results.

3.3. CTD Dissolved Oxygen Data

Dissolved oxygen data were acquired using a Sensormedics dissolved oxygen sensor. There were numerous technical difficulties with the CTD oxygen sensor. For the majority of downcasts, the signal was bad for the top 200 decibars or so, after which it would steady out and seem to act in a normal fashion. The upcast CTD oxygen is unacceptable due to signal distortion following the CTD power-down at trips. In addition, the extreme cold conditions encountered in this part of the world oceans cause difficulties in processing CTD oxygen data. Current software cannot correct these problems and no CTD oxygen data are reported for the cruise.

3.4. Additional Processing

Some casts encountered transient signal glitches resulting in conductivity or pressure drop-outs. A software filter was used to remove/correct these. After filtering, the downcast portion of each time-series was pressure-sequenced into 2-decibar pressure intervals. A ship-roll filter was applied to each cast to disallow pressure reversals. Problems in the data set have been documented below and in the CTD Processing Comments table below.

4. General Comments/Problems

There were 52 STS/ODF CTD rosette casts. In addition there were 37 Swedish CTD rosette casts (usually to about 1000 decibars). Besides collecting Acoustic Doppler Current Profiler (ADCP) data, these casts were used to increase the resolution of the water column at each station by increasing the number of discrete samples. No CTD data is reported for them on this tape. There is one pressure-sequenced CTD data set for each of the 52 STS/ODF CTD casts. The data reported is all from downcasts, and all casts except for Station 8, cast 4, were to near the ocean floor.

Freezing of the CTD sensors or extreme cold caused problems at the start of most casts. Shortly after entering the water, the package was yo-yoed until the temperature and conductivity sensors appeared to be stable; then the cast was continued. For the last eight casts, we brought the package back up out of the water in an attempt to get a clean start to the cast. Most of the casts had surface levels extrapolated (up to the top 6 decibars) using a quadratic fit through the next three deeper levels. Recorded surface values were rejected only when it appeared that the drift was caused by sensors adjusting to the in-water transition or freezing. Extrapolated surface levels are documented in the CTD Processing Comments table below.

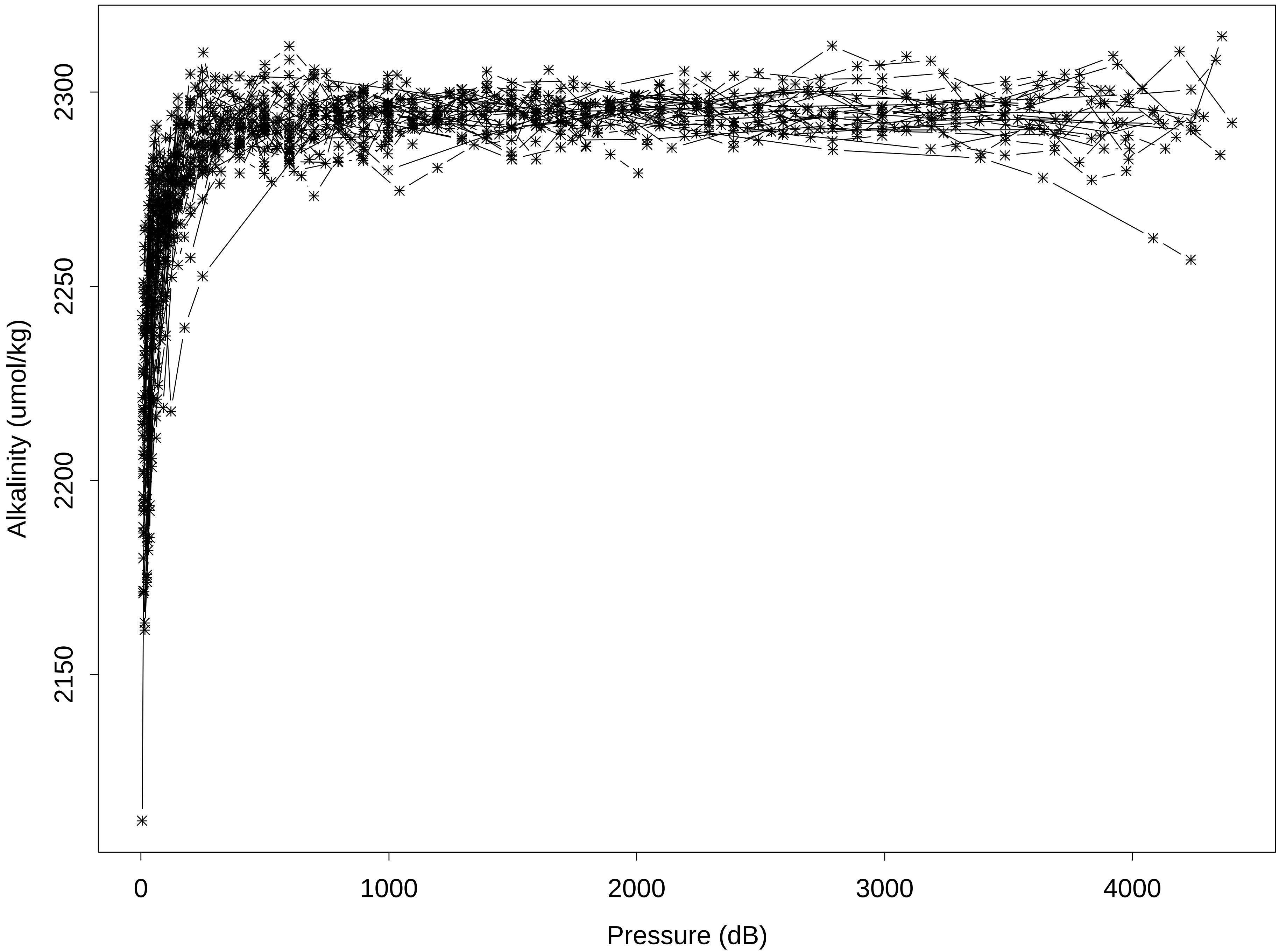
It should be kept in mind that the ship usually had the bow thrusters flushing during CTD casts to maintain ice-free conditions for the CTD wire.

There were severe winch and wire problems throughout the cruise. These resulted in numerous stops, pauses or yoyos during casts. Luckily, these usually occurred during the upcasts.

Arctic Ocean Expedition 1991 (ODEN-91) CTD Processing Comments

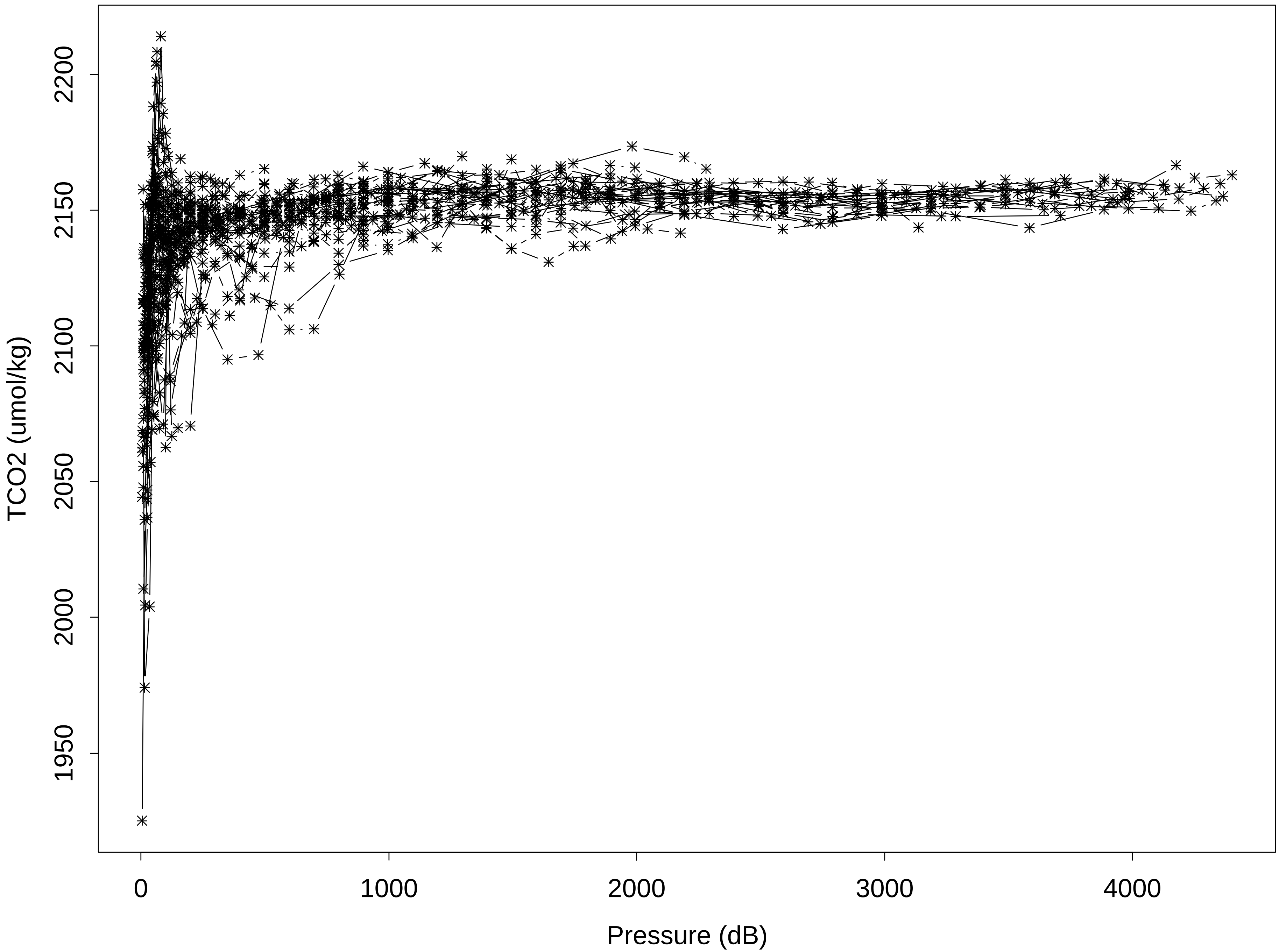
station 5	cast 1:	0,2-db levels extrapolated; CTD #6 cast
station 8	cast 4:	0,2,4-db levels extrapolated; test cast for CTD #4 to 390 db
station 9	cast 4:	0,2,4-db levels extrapolated
station 10	cast 2:	0,2,4-db levels extrapolated
station 11	cast 2:	0,2,4-db levels extrapolated
station 13	cast 2:	approx. -.0019 psu salinity offset from 1498 db to cast end
station 14	cast 3:	0-db level extrapolated
station 17	cast 2:	0,2-db levels extrapolated
station 19	cast 2:	0,2-db levels extrapolated
station 20	cast 3:	0,2,4-db levels extrapolated
station 21	cast 3:	0,2-db levels extrapolated
station 22	cast 2:	0,2-db levels extrapolated
station 23	cast 2:	0-db level extrapolated
station 24	cast 1:	0-db level extrapolated
station 25	cast 3:	0,2-db levels extrapolated
station 26	cast 2:	0,2,4,6-db levels extrapolated
station 27	cast 3:	0,2-db levels extrapolated
station 28	cast 2:	0-db level extrapolated
station 29	cast 3:	0-db level extrapolated
station 30	cast 2:	0-db level extrapolated
station 31	cast 2:	0,2,4-db levels extrapolated
station 32	cast 2:	0,2,4-db levels extrapolated
station 33	cast 2:	0,2,4-db levels extrapolated
station 34	cast 2:	0,2,4-db levels extrapolated
station 35	cast 2:	0,2,4-db levels extrapolated
station 36	cast 2:	0,2-db levels extrapolated
station 37	cast 2:	0,2-db levels extrapolated
station 38	cast 2:	0,2-db levels extrapolated
station 39	cast 2:	0,2-db levels extrapolated
station 40	cast 2:	0,2,4-db levels extrapolated
station 41	cast 2:	0,2-db levels extrapolated
station 43	cast 2:	0,2,4-db levels extrapolated
station 44	cast 3:	0,2-db levels extrapolated
station 45	cast 2:	0,2,4-db levels extrapolated
station 46	cast 3:	0-db level extrapolated
station 47	cast 2:	0-db level extrapolated
station 48	cast 1:	0-db level extrapolated
station 50	cast 2:	0,2-db levels extrapolated
station 51	cast 2:	0,2,4,6-db levels extrapolated
station 52	cast 2:	0,2-db levels extrapolated
station 54	cast 2:	0-db level extrapolated
station 58	cast 2:	0,2,4-db levels extrapolated; top 50 db questionable: temp sensor not responding properly 24-50 db
station 59	cast 2:	0-db level extrapolated

77DN9107

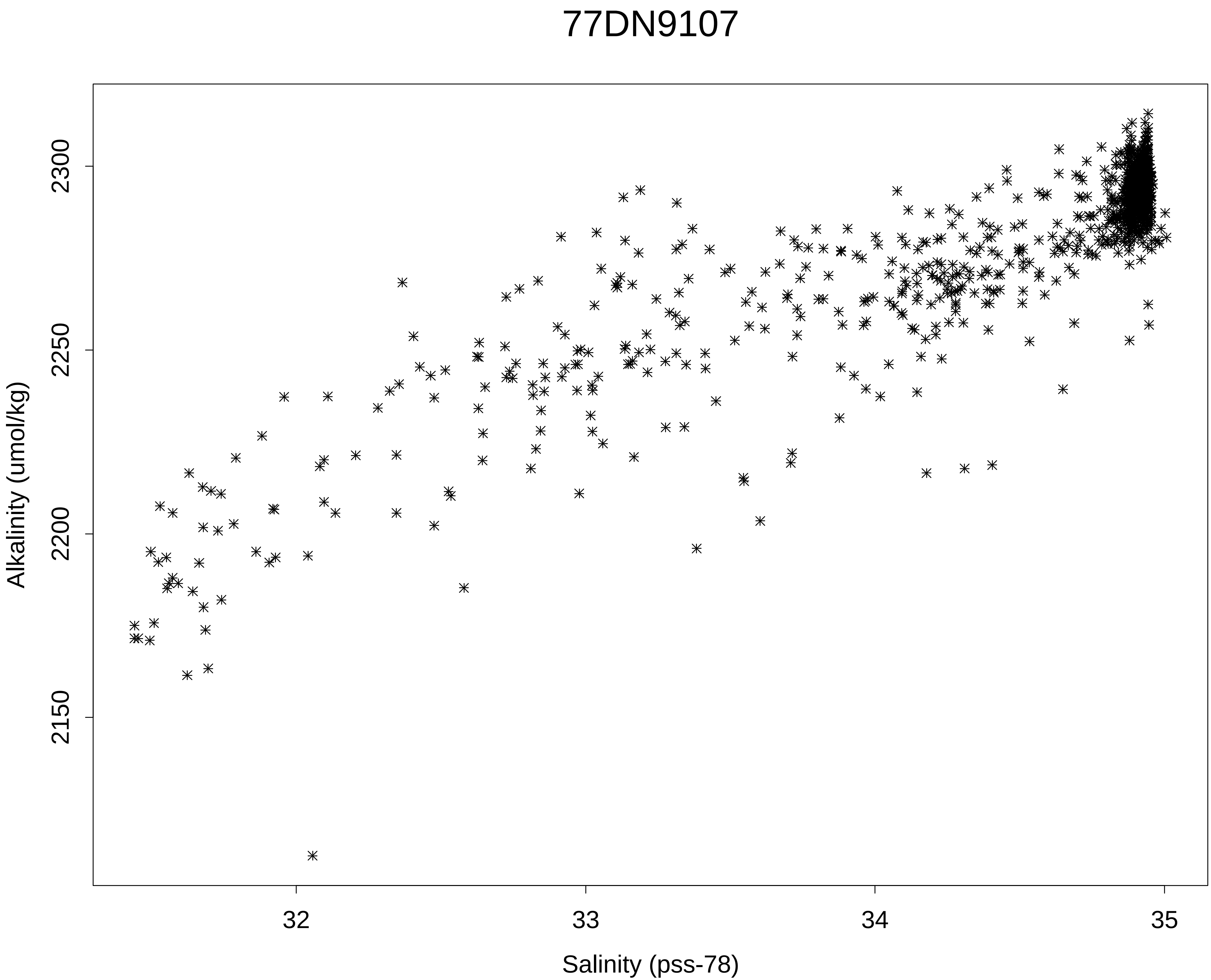


Alkalinity (umol/kg)
2150
2200
2250
2300
0
1000
2000
3000
4000
Pressure (dB)

77DN9107



TCO2 (umol/kg)
1950
2000
2050
2100
2150
2200
0
1000
2000
3000
4000
Pressure (dB)


77DN9107
Alkalinity (umol/kg)
2150
2200
2250
2300
32
33
34
35
Salinity (pss-78)

References:

Anderson, L.G., C. Haraldsson, and R. Lindegren, Gran linearization of potentiometric Winkler titrations. Marine Chemistry, 37, 179-190, 1992.

Johnson, K. M., Sieburth, J. M., Williams, P. J., & Br…ndstr˚m, L. (1987). Coulometric total carbon dioxide analysis for marine studies: automation and calibration. Marine Chemistry, 117-133.

Haraldsson, C., L.G. Anderson, M. Hassell˚v and S. Hult, Rapid, high-precision potentiometric titration of alkalinity in ocean and sediment pore waters, Deep-Sea Res., 44, 2031-2044, 1997.

DATA PROCESSING NOTES

Date	Contact	Data Type	Action	Summary
2007-06-11	Key	BTLNBR	Submitted	Corrected longitudes
	Thanks for the corrections. I've updated my files accordingly. The updated datafile and README are attached (with the final EXPOCODE). This cruise was part of the Jan. 07 CARINA distribution. - Key ODF did the CTD data this cruise and our longitude for station 19 cast 2 is 118 deg 29.8 min E and station 20 cast 3 longitude is 127 11.2 E. ODEN departed Goteborg, Sweden, July 26, 1991. Our date for station 4 is 8/17/1991 not 7/17/1991. - Muus			
2009-07-16	Muus	BTL	Website Update	BTL data online
	Notes on ODEN_1991 bottle data. EXPOCODE 77DN19910726 July 7,2009 D. Muus 1. Data file is an exact copy of CARINA: ODEN/ 77DN9107/77DN19910726_hy1.csv received from Bob Key Jan 26, 2009;Java Ocean Atlas was used to check the data. 2. DELO18 is used in place of O18O16. CCHDO parameter mnemonic changed to DELO18 to reflect its more accurate description of the values given. 3. SAMPNO equals BIONBR. 4. CTDSAL not included. Reason unknown. 5. DOC has some unusually high values that are flagged 2. e.g Sta 48, Ca 1, Btl#s 24-21 17.9,499-601db Sta 55 Ca 1, Btl#s 21-24 799-957db Sta 12 Ca 3 Btl#22 2499.8db is high with flag 3 so someone did check quality.			