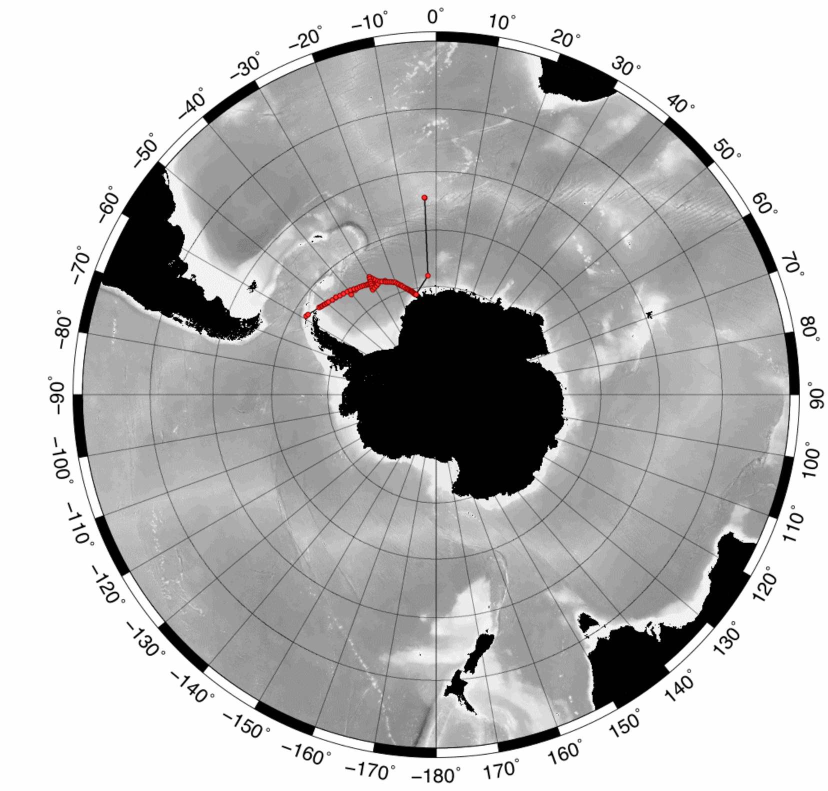
CRUISE REPORT: SR04

(Updated OCT 2013)



Highlights

Cruise Summary Information

WOCE Section Designation	**SR04**
Expedition designation (ExpoCodes)	**06AQANTIX_2**
Chief Scientists	**Eberhard Fahrbach / AWI**
Dates	1990 NOV 17 - 1990 DEC 30
Ship	*POLARSTERN*
Ports of call	Punta Arenas, Chile - Cape Town, S. Africa
Geographic Boundaries	54°19'59" S 58°53'12" W 3°20'42" W 71°6'47" S
Stations	82
Floats and drifters deployed	0
Moorings deployed or recovered	21 deployed, 7 recovered

Contact Information:

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Links To Select Topics

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

FOREWORD

V.Smetacek, U. Bathmann (AWI)

The ninth research cruise of RV "Polarstern" to the Antarctic (ANT IX) consisted of 4 Legs. The first Leg addressed chemical interactions between ocean and atmosphere during the southward voyage. The second Leg carried out investigations of the Weddell Gyre within the framework of the World Ocean Circulation Experiment (WOCE). The third Leg was planned as a broad-based, interdisciplinary study of the hitherto unexplored southwestern Weddell Sea but had to be reorganized with a new scientific program for the Lazarev Sea because of exceptionally heavy ice conditions in the Weddell Sea. The fourth Leg was the return journey and was primarily devoted to the geology of the South Atlantic.

RV "Polarstern" departed from Bremerhaven on October 20, 1990 and arrived in Punta Arenas on November 14. The intensive chemical research Programme was a continuation of previous Atlantic crossings and addressed hemispheric variability of metals and various natural and anthropogenic compounds in atmosphere and ocean.

The second Leg commenced on November 17 and proceeded first to King George Island where personnel and supplies were dropped off at the Bellingshausen station. From there, the transect across the Weddell Gyre first performed in the winter of 1989, was repeated. Twenty one current meter moorings were deployed and the 7 in the field since 1989 were successfully recovered and equipped with new Instruments. Water column measurements of physical, chemical and biological parameters were carried out; the data will aid in assessing seasonal differences in hydrography and their influence on the ecology of the Gyre. The current meter data will enable quantification of bottom water formation and transport of water out of and into the Gyre. Sediment traps attached to three of the current meter moorings were also serviced. The data obtained from them, together with results of specific studies on silica cycling, will further our knowledge on vertical particle flux and cycling of matter in the Weddell Sea. At the end of the cruise, equipment was dropped at the Georg-von-Neumeyer Station (GvN). Cape Town was reached on December 30, 1990.

The third leg left Cape Town on January 3, 1991 with personnel and equipment for GvN On board. Shortly after disembarkation and unloading of supplies at GvN, "Polarstern" helicopters rescued 5 South-African personnel who were stranded at 3,000 m elevation and 300 km inland. The unusually heavy and extensive ice cover prevented "Polarstern"'s southward journey and the ship was forced to drift for 2 weeks entrapped in thick, soft ice named"porridge ice" by Capt. Lawrence of RRS "Bransfield". Ice and under-ice physics and biology were investigated during the period of drift, and as ice conditions did not irnprove till the beginning of February alternate plans had to be made for work in the Lazarev Sea between GvN and Georg-Forster stations. On several transects along the shelf and into the deep-sea, all disciplines participating on this cruise - oceanography, biology and geology - investigated in closely interlocked programmes water rnass distribution, water chemistry as well as the morphology of the sea floor and cornposition of the sediments. GvN was visited on the return journey and personnel from here as well as the Georg-Forster-Station further to the East transported to Cape Town where "Polarstern" arrived on March 28, 1991.

The fourth Leg departed from Cape Town on March 30 and proceeded to Bouvet Island. The aim of this predorninantly geological Leg was to rnap and sample submarine elevations - the Agulhas Ridge, the Meteor Rise and the eastern flank of the southernrnost Mid-Atlantic Ridge - in order to refine existing models of the paleoceanography of the South Atlantic. "Polarstern" arrived in Brernerhaven on May 13, 1991.

1. ITINERARY AND SUMMARY

E. Fahrbach (AWI)

On 17 November 1990 "Polarstern" left Punta Arenas. In Drake Passage physical oceanography work was started with an XBT-transect (Expendable Bathythermograph) across the Antarctic Circumpolar Current. An Acoustic Doppler Current Profiler (ADCP) recorded the current field in the upper few hundred meters. The bathymetry and geology Programmes began with soundings of Hydrosweep and Parasound which were continued during the complete cruise. Chemical investigations from the first leg were continued with underway measurements. They concentrated on biogenic sulfur compounds and their reaction products in sea water and the marine atmosphere with particular interest in DMS (dimethyl sulfide). Concentrations of nitric acid, ammonia and ammonium nitrate and organobromine compounds were investigated in the marine atmosphere.

We reached the Polar Front on 19 November at 57°23'S, 61°14'W. The first logistic task of the cruise was to deposit three German scientists with more than 8 tons of supply goods at the Soviet station "Bellingshausen" on King George Island. One scientist returned with us after an eleven months stay. After measuring the first CTD-profile (conductivity, temperature, depth) and making a catch with the multinet, we approached Joinville Island at the northeastern tip of the Antarctic Peninsula. There, two hauls with the Agassiz-trawl provided material for comparative studies on the temperature dependence and kinetics of digestive enzymes in crustaceans.

Still in open water we reached the western end of our main hydrographic transect crossing the Weddell Gyre towards Kapp Norvegia (Figure 2.1) where the first of 21 current meter moorings was deployed and the first of seven recovered. On the shelf the first biology station took place including measurements with quantameter and Secchi disk, two CTD casts combined with a rosette water sampler and catches with multinet, bongo net, and plankton net. The water samples were used for biogeochemical investigations with special emphasis on the silica and nitrogen cycles. For this reason incubations were carried out to measure the uptake of radioactive ^{14}C, ^{32}Si and ^{32}P and stable ^{15}N. The nitrogen flux in the Antarctic food web could be determined from the water column to the zooplankton. In this context the phytoplankton biomass and species distribution as well as reproduction and life cycles of dominant copepods were studied.

On 22 November at about 150 km from the coast we met at 63°30'S, 51°30'W the ice edge. The winds calmed down with increasing distance from the coast and air temperatures did not drop below -4°C. Rather quickly the swell disappeared and the floes increased in size. However, due to a system of leads, we could proceed along our course as planned.

On 26 November at 65°34'S, 38°52'W we reached a deep sea channel which was surveyed with hydrosweep and parasound along 500-km profiles over a distance of 144 km. The structure is 1 to 3 km wide with a depth of 60 to 100 m below the adjacent sea level of about 4650 m. It extends with large meanders from westnorthwest to eastnortheast. Due to the heavy ice cover, consisting of floes a few kilometers in diameter and up to a meter thick, the track line could not be maintained as straight as desirable. Bottom samples were collected with a minicorer which was hung under the CTD. This instrument was newly developed. During initial trials a procedure was achieved which allowed its use without significant additional shiptime. After this phase it was used routinely on 37 stations.

The first recovery of a current meter mooring (208) within the ice (70% ice cover) occurred on 29 November. Before the acoustic release of the mooring the floes of up to 500 m in diameter were broken into smaller pieces to allow the floats to reach the surface. After the release 40 minutes of intensive search were necessary to sight a float before the recovery could be successfully finished. At mooring 209 on 3

December no float reached the surface and a time consuming acoustic ranging and breaking of ice floes finally permitted the detection and consequent recovery after 8 hours. This tedious technique had to be applied during all further recoveries, whereas the deployment of moorings could be accomplished without any problem.

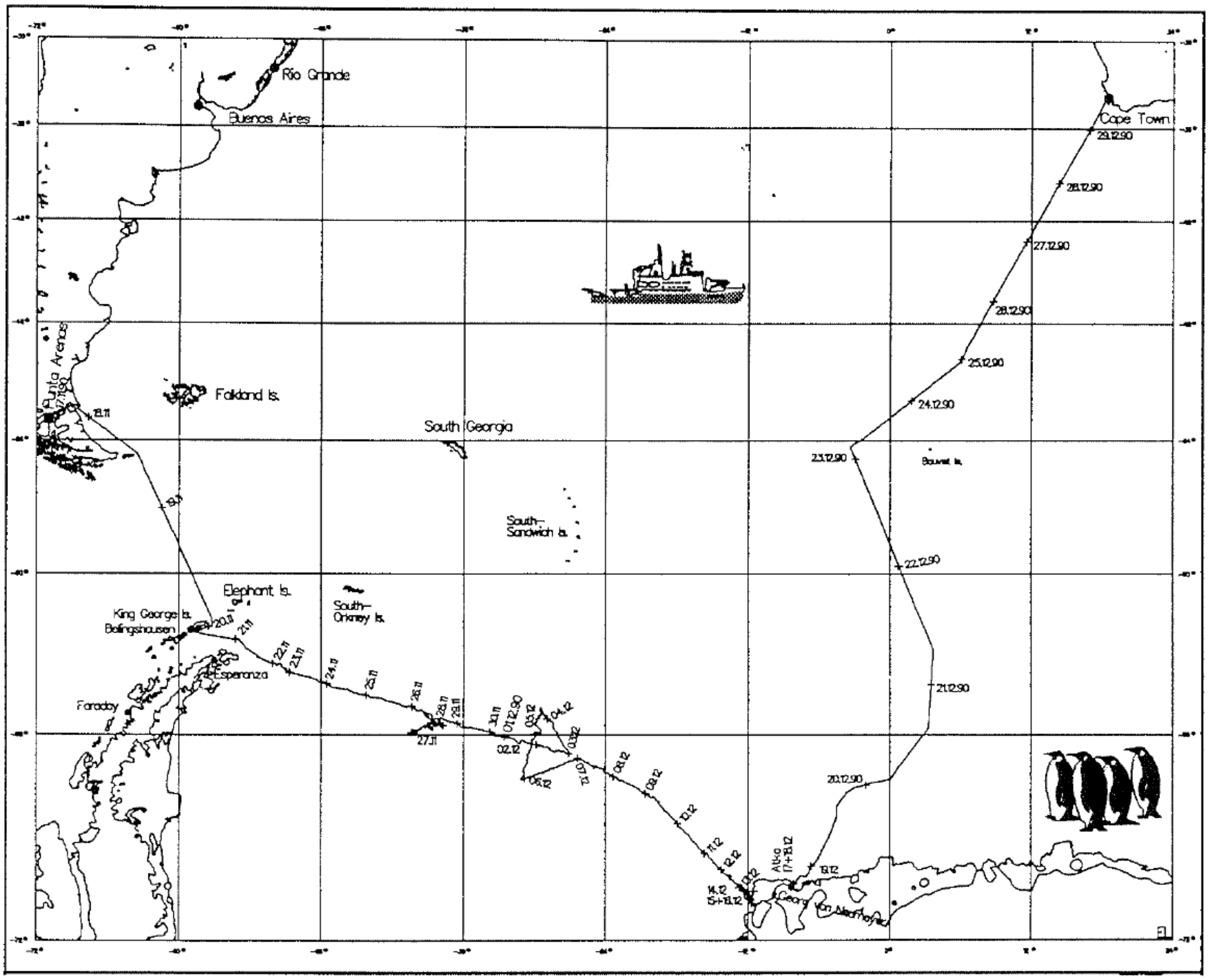


Figure 2.1: *Cruise track of "Polarstern" during ANT IX/2*

The center of the Weddell Gyre at about 66°16'S, 30°18' is marked by a relatively shallow surface mixed layer. It was reached on 2 December. For a better localization of the center a transect of 150 nm length consisting of 7 CTD-stations perpendicular to the main transect was carried out. On the basis of those data absolute velocities will be determined using the Beta spiral concept. During the Winter Weddell Gyre Study (WWGS) '89 higher mixed layer temperatures and more intense biological activity were found in that area. This was not observed during the present cruise possibly due to the different season. On 7 December the investigations in the "beta cross" area were terminated and the main transect was continued to the southeast with CTD-profiles, biology stations, mooring recoveries and deployments. The ice conditions became less favourable due to larger floes of less friable ice and closed leads because of colder temperatures.

The transect was finished on 15 December. The coastal polynya was only poorly established and highly variable. Because the biologists noted that there was no sign of a spring bloom, the planned stations were cancelled. The desert-like conditions in the water column, evidenced by a Secchi depth of 54 m were in sharp contrast to the abundant algae growth in the ice which gave rise to all coulors from yellow to brown. Although small the narrow polynya was large enough for a haul with the Agassiz-trawl. The offshore ice belt of the polynya confirmed the term "icefactory". It provided the heaviest ice conditions during the cruise and made the recovery of mooring 214 impossible. The last station on the transect was located in an inlet of 1 km length and 400 m width. In this inlet casts with CTD, multi- and bongo net were carried out in Open water in the vicinity of the 25 m high shelf ice front. After a hydrosweep survey of the continental slope in the area of the Explorer-Escarpment we left On 16 December towards the Georgvon- Neumayer-Station (GvN).

The work along the transect between Joinville Island and Kapp Norvegia amounted to 82 CTD and rosette stations, 7 biology stations, 21 mooring deployments and 7 recoveries. The established mooring network represents a gigantic flow meter which measures the volume of water and its heat content entering the Weddell Gyre in the northeast and leaving it in the northwest. South of our transect, cooling due to contact with the atmosphere and the shelf ice, together with salt release through ice formation, induces vertical descent of water masses to the bottom. Glacial meltwater has to be taken into account for a quantitative understanding of those processes. Because of the significance of deep reaching vertical mixing for the global abyssal circulation, our measurements are part of the World Ocean Circulation Experiment (WOCE).

The biogeochemical investigations of the cycles and budgets of various constituents represent a contribution to the international Joint Global Ocean Flux Study (JGOFS). They aim to explain the special role of the Weddell Gyre in the Southern Ocean and to estimate the significance of this area to the global carbon cycle. The contrast between the high nutrient availability and the low production remains unresolved. A chemical-biological project allowed for the first time, direct measurement of DMS-production of Antarctic phytoplankton and determination of the contributions of different species.

On 17 December we reached Atka-Bight. In the early morning "Polarstern" rammed into the fast ice to provide a safe platform for the unloading of about 100 tons of supply goods for the GvN-Station. First contacts with the female overwintering team had been established by a helicopter visit on 13 December to prepare the unloading procedure. The first trek with unloaded material left in the early afternoon towards the shelf ice edge and the station. Due to favourable conditions all loading was finished in the evening. "Polarstern" left the Atka-Bight at midnight of 18 December. On the way north air chemistry, XBT, hydrosweep and parasound measurements were continued. The ice edge was met at 68°00'S, 3°58'W where the ice concentration dropped within 30 nm from 70% to 10%. Here the last biology station was carried out. On 23 December we reached 54°20'S, 3°23'W about 200 nm west of Bouvet Island were mooring BO1 was deployed with two sediment traps. The Polar Front was crossed on 24 December at 51°45'S 2°24'E. Christmas Eve was celebrated with a merry ceremony in the "Blue Saloon" and a delightful buffet. The recovery of the last mooring PF3 and deployment of PF4 was achieved in the morning of the 25 December. When we reached the 200 nm limit research was terminated. On 30 December 1990 at 01.00 "Polarstern" reached the bunker pier of Cape Town.

Cruise Participants

Name	**Institution***
Baumann, Marcus	AWI
Behmann, Thomas	AWI
Bluszcz, Thäddaus	AWI
Brandini, Frederico	AWI
Brosin, Hans-Jürgen	IfMW
Buxhoeveden, Cristina Isabel	ITBA
Corradi, Pio Ante	AF
Dehn, Joachim	AWI
Dittrich, Birgit	AWI
Erdmann, Holger	DWD
Frhrback, Eberhard	AWI
Goeyens, Leo	VUB
Goldkamp, Ulrich	AWI
Harder, Markus	FPB
Heitmüller, Karl-Heinz	HSW
Hillebrandt, Oliver	HSW
Hinrichsen, Hans-Harald	FPB
Knoche, Martin	AWI
Köhler, Herbert	DWD
Krest, Jim	OSU
Kubrjeweit, Frank	AWI
Lengacher, Dieter	AF
Leynaert, Ande	IEM
Lindenmaier, Patrick	AF
Lindner, Louis	RUU
Markus, Thorsten	AWI
Monk, Jürgen	AWI
Papenbrock, Thomas	RUB
Pauls, Margarete	AWI
Pfeiffenberger-PertI, Hans	AWI
Plugge, Rainer	AWI
Quéguiner, Bernard	IEM
Ragueneau, Olivio	IEM
Rauschert, Martin	FiW to K.G.I
Riewesell, Christian	HSW
Ross, Andy	OSU
Schäfer, Hartmut	FPB
Schlumpf, Hans-Ulrich	AF
Schmidt, Martin	IfMW
Schoch, Roland	FPB
Schöffmann, Erhard	FGB
Schrerns, Otto	AWI
Schütt, Ekkehard	FPB
Segl, Monika	FGB
Simon, Bernd	FiW to K.G.I
Sonnabend, Hartrnut	DWD
Staubes, Regina	IfMG

Sterr, Uta	FPB
Stiller, Michael	AWI to K.G.I
Strass, Volker	AWI
Tins, Wolfgang	TA
Vucelic, Sonja	AWI
Wasserthal, Claus	HSW
Weber, Michael	AWI
Wisotzki, Andreas	FPB
Zippel, Detlev	FiW from K.G.I

List of Institutions

Abbreviation	Institution
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Columbusstrasse 2850 Bremerhaven Germany
DWD	Deutscher Wetterdienst Seewetteramt Bernhard-Nocht-Str. 76 2000 Hamburg 4 Germany
FGB	Universität Bremen Fachbereich Geowissenschaften FB5 Postfach 33 04 40 2800 Bremen 33 Germany
FiW	Forschungsstelle für Wirbeltierforschung Alfred-Kowalke-Str. 17 O-1136 Berlin Germany
FPB	Universität Bremen Fachbereich Physik FB1 Postfach 33 04 40 2800 Bremen 33 Germany
HSW	Helicopter-Service Wasserthal GmbH Kätnerweg 43 2000 Hamburg 65 Germany
IfMG	Johann Wolfgang Goethe-Universität Institut für Meteorologie und Geophysik Feldbergstr. 47 Postfach 11 19 32 6000 Frankfurt am Main 11 Germany

IfMW	Institut für Meereskunde Akademie der Wissenschaften der DDR Seestr. 15 O-2530 Rostock-Warnemünde Germany
RUB	Ruhr-Universität Bochum Fakultät für Chemie / Physikalische Chemie I Postfach 10 21 48 4630 Bochum 1 Germany
TA	TERRAQUA Indersdorfer Str. 16 8061 Arnbach Germany
ITBA	Instituto Technologico de Buenos Aies Avda Enardo Madero 351/99 1106 Buenos Aires Argentina
VUB	Vrije Universiteit Brussels Laboratory for Analytical Chemistry Pleinlaan 2 B-1050 Brussels Belgium
CBM	Centro de Biologia Marinha/UFPR AV. Beira Mar, Ponta do Sul Paranagua 83200 Pr Brazil
IEM	Institut d'Etudes Marines Université de Bretagne Occidentale 6 Avenue le Gorgeu F-29287 Brest Cedex France
RUU	Rijksuniversiteit te Utrecht Faculteit der natuur en sterrenkunde Princetonplein 5 NL-3508 TA Utrecht Netherlands
AF	Arian Film AG Postfach 835 CH-8025 Zürich Switzerland
OSU	Oregon State University College of Oceanography Oceanography Administration Building 104 Corvallis, Oregon 97331-5503

2. PHYSICAL OCEANOGRAPHY

2.1. Water masses and circulation

T. Behmann, E. Fahrbach, J. Dehn, M. Knoche, T. Markus, R. Plugge, V. Strass, (AWI) ; C. Buxhoeveden, (ITBA); M. Harder, H.-H. Hinrichsen, H. Schäfer U. Sterr, A. Wisotzki (FPB); E. Schütt, (FGB); H.-J. Brosin, M. Schmidt, (IfMW)

Objectives

The aim of the physical oceanography programme is to further understand the circulation in the Weddell Gyre and the related distribution of water masses. The operations contribute to a multiyear project, the Weddell Gyre Study, which is part of the World Ocean Circulation Experiment (WOCE). During this period a hydrographic survey along a transect from the northern tip of the Antarctic Peninsula to Kapp Norvegia (Figure 2.2) will be repeated four times, twice in summer and twice in winter, to measure the water mass distribution with its seasonal and interannual variability. The programme was initiated with a winter survey in 1989, the Winter Weddell Gyre Study (WWGS) '89, and will be continued with further surveys in austral winter 1992 and summer 1992/1993.

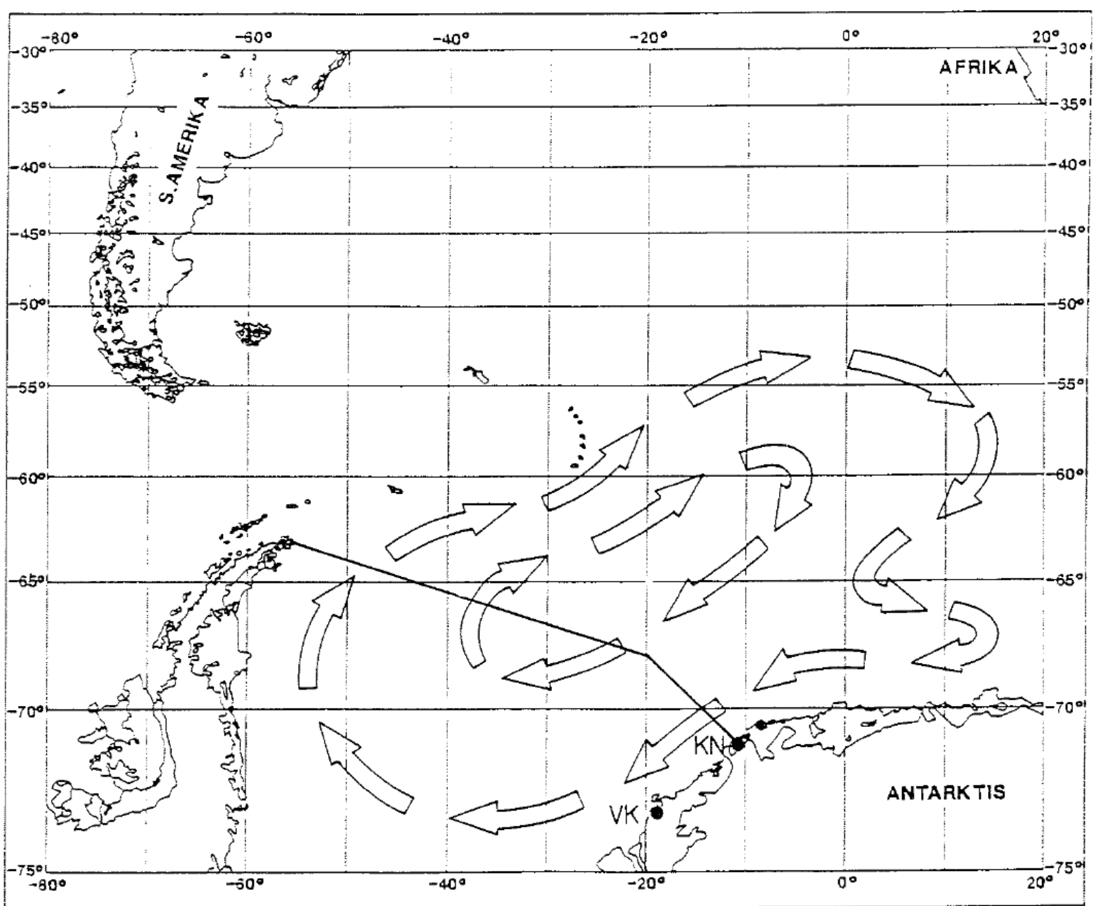


Figure 2.2: *Schematic representation of the Weddell Gyre and the transect from Joinville Island to Kapp Norvegia (KN).*

Simultaneously an extensive current meter mooring programme began with the deployment of seven current meter moorings. The data from those moorings will be used to estimate the volume transport in the Weddell Gyre. Direct current measurements are essential because they are the only way to obtain the barotropic flow which determines the net volume transport. From the measured mass, heat, and salt transports across the transect we can derive water mass formation rates.

The transformation of Winter Water (WW) and Warm Deep Water (WDW) in the inflow to Antarctic and Weddell Sea Bottom Water (AABW, WSBW) in the outflow is of special interest, because it results from a deep vertical exchange which is relevant to the large scale abyssal circulation of the world ocean. Present estimates show that about 70% of the Antarctic Bottom Water spreading into the world ocean obtains its water mass characteristics in the Weddell Sea. Because the salt budget of the area is strongly influenced by ice formation and melting, special interest is focused on the ice transport across the transect. Interaction with the ice shelves has to be taken into account for a quantitative understanding.

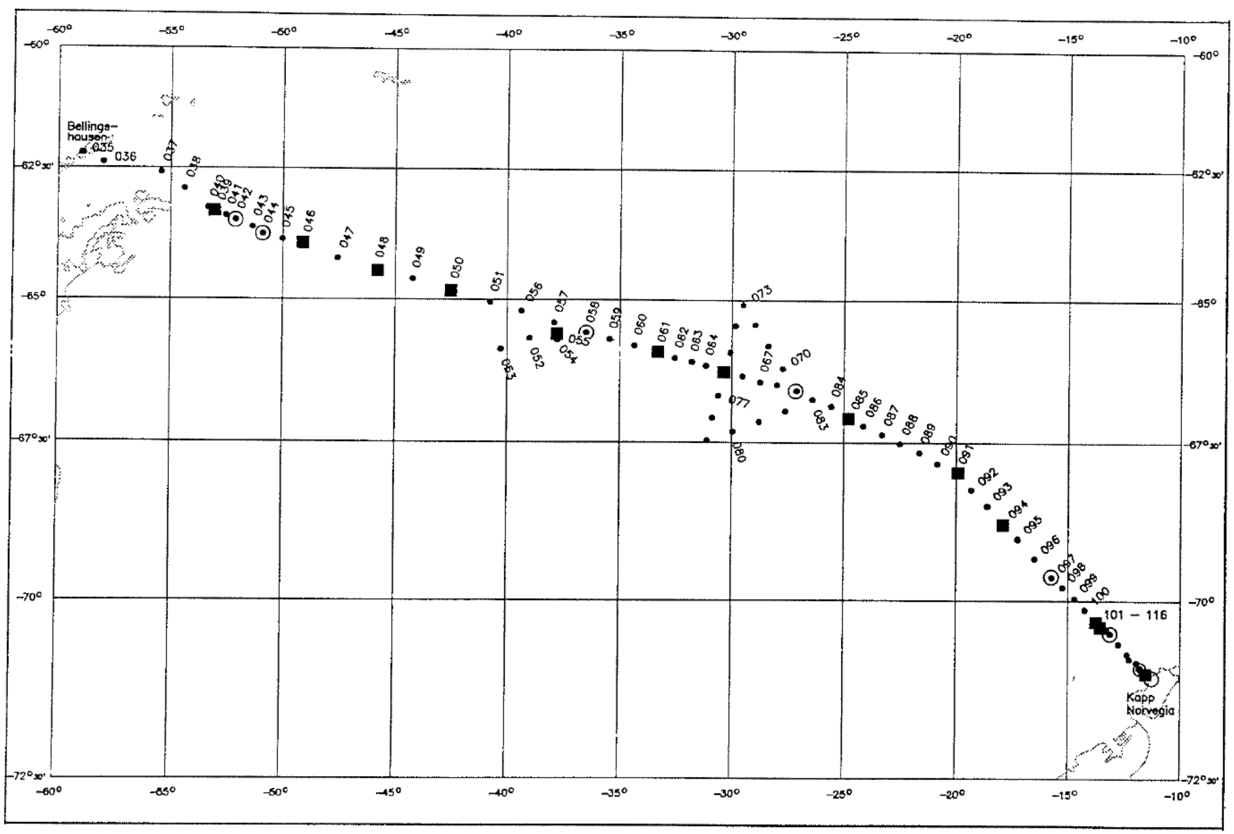


Figure 2.3: *Station map of "Polarstern"-cruise ANT IX/2. Small dots stand for CTD-stations, circles for recovered and Squares for deployed moorings.*

Work at sea

In order to obtain the water mass distribution, a hydrographic section was carried out with 74 CTD-profiles (conductivity, temperature, depth) and discrete casts for temperature, salinity, oxygen, nutrients and tracers (helium, tritium and ^{18}O). For the location of the stations see Figure 2.3 and the station list. On the eastern slope the station distance was small enough (Figure 2.4) to resolve topographic features such as the Explorer-Escarpment Seven current meter moorings were recovered and 21 were laid (Table 2.1 and 2.2, Figure 2.3). On six of them ice thickness will be measured by upward-looking Sonars (ULS). The moorings will stay in position for two years. Vertical temperature and electrical conductivity profiles were measured with a Neil Brown Mark III B CTD. The quality of the CTD-measurements was assured by reference measurements with a rosette sampler. Water samples were taken with a General Oceanic rosette composed of 24 bottles with 12 l volume each. Each time a water bottle was closed 50 cycles of pressure, temperature and conductivity were recorded with the CTD, quality controlled and averaged.

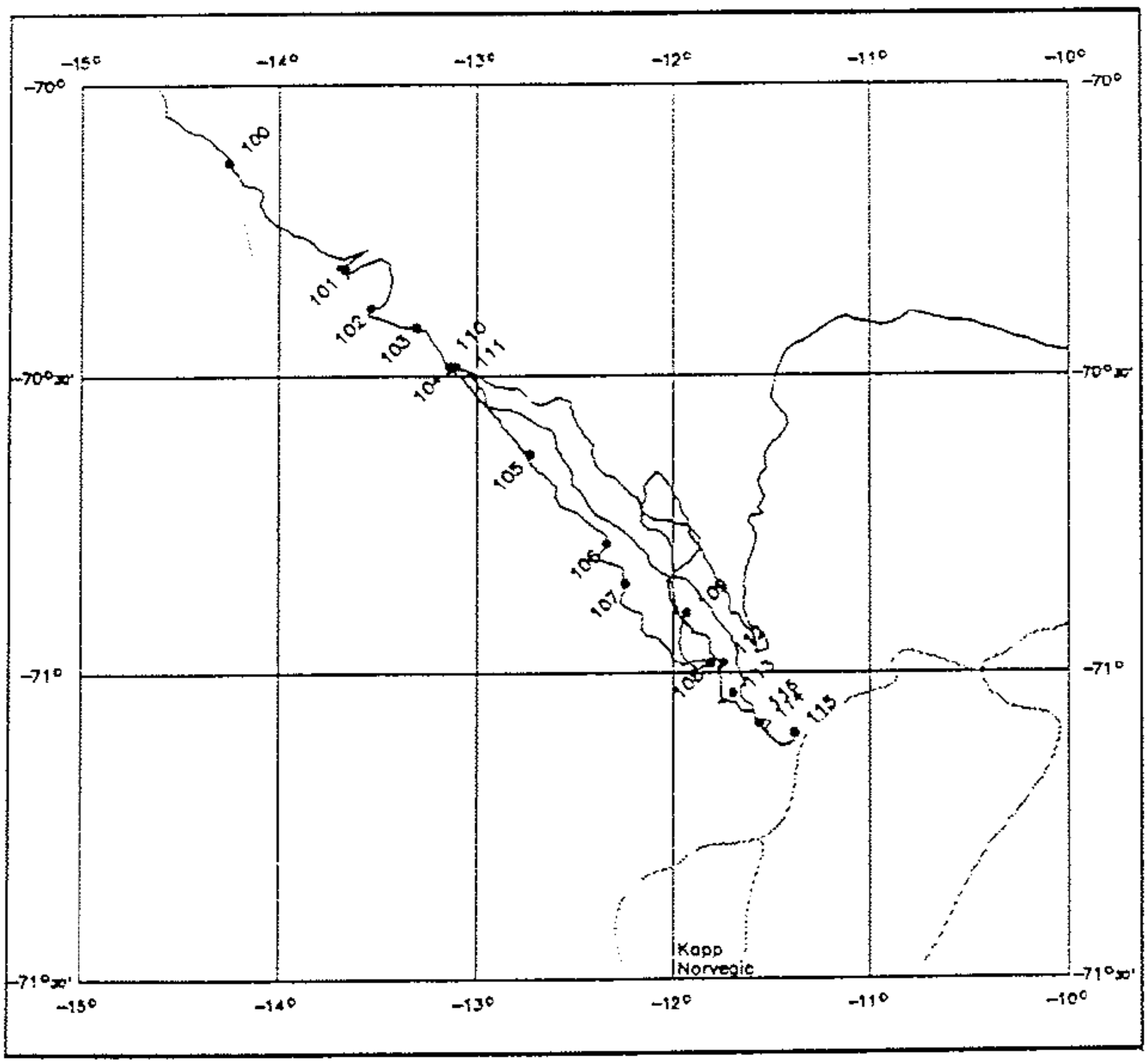


Figure 2.4: *Cruise-track and location of CTD-stations off Kapp Norvegia during "Polarstern"-cruise ANT IX/2.*

Pressure and temperature measurements were corrected by means of a laboratory calibration carried out in the Scripps Institution of Oceanography before the cruise. A second calibration will be done after the cruise. Both calibrations will lead to a more elaborate correction of the data. However, the control by electronic as well as mercury reversing thermometers and pressure meters gives us confidence that the preliminary data have errors of less than 5 mK in temperature and 5 db in pressure.

The salinity data are given in PSU. They are based on the CTD conductivity measurements from which salinity was calculated using the Unesco Practical Salinity Scale (PSS78). The values were compared with salinities from water bottle samples measured with a Guildline Autosal 8400 A in reference to I.A.P.S.O. Standard Seawater. The number of samples per profile, the mean difference between the samples and the CTD measurements as well as its standard deviation are shown in Figure 2.5. Preliminary data presented in this report were corrected with a constant offset of 0.023 to an accuracy of 0.005. The final data will be corrected in conductivity for time and depth dependence of the deviations. Afterwards salinity will be recalculated.

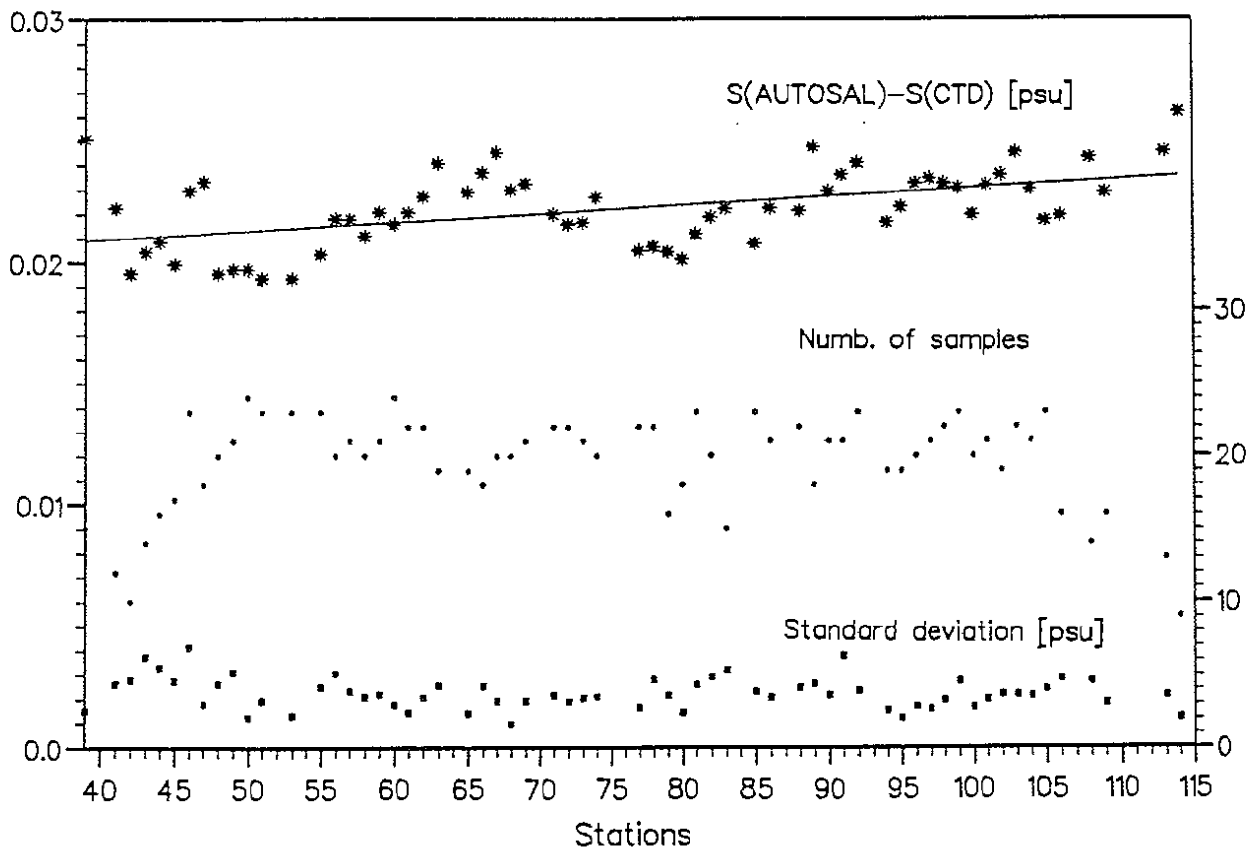


Figure 2.5: *Comparison between salinity measurements from water bottles with those from the CTD. Stars give the mean difference for each station between the bottle and CTD salinities, squares the standard deviation, and dots the number of samples per station.*

Oxygen was determined with an automatic titration unit, using the Winkler method with a photometric endpoint determination. The error in the oxygen determination is estimated to 1%. This results from intercomparisons at selected stations between the chemical oceanography group from the Oregon State University and the AWI group both using different instruments. Duplicate samples from the same water bottle were analysed during the complete cruise as a measure of precision. The obtained data are given in ml/l.

Table 2.1: *Moorings recovered during "Polarstern"-cruise ANT IX/2*

Mooring	Latitude Longitude	Date Time	Water Depth (m,corr.)	Instrument Type	Instrument Depth
206	63°29.6' S	13.09.89	946	AVT	229
	52°07.4' W	11.13		S	349
		22.11.90		AVT	876
		08.52			
207	63°45.8' S	14.09.89	2503	AVTPC	263
	50°54.3' W	10.39		AVTPC	952
		23.11.90		AVT	2162
		00.41		AVT	2410
208	65°36.3' S	24.09.89	4768	AVTPC	288
	36°29.9' W	18.30		AVTPC	1037
		29.11.90		S	1090
		13.00		(AVT)	2610
				S	4122
				AVT	4631
209	66°36.8' S	01.10.89	4863	AVTC	293
	27°07.4' W	10.28		AVTPC	993
		03.12.90		(AVT)	2653
		09.16		(AVT)	4725
210	69°38.9' S	05.10.89	4751	AVTC	289
	15°44.5' W	21.11		AVTPC	988
		11.12.90		AVT	2547
		14.29		AVT	4617
211	70°29.5' S	6./7.10.89	2402	AVTC	247
	13°07.0' W	00.13		AVTPC	856
		14.12.90		AVT	2066
		14.28		AVT	2313
212	70°59.2' S	08.10.89	1069	AVTPC	309
	11°49.4' W	16.55		AVT	999
		13.12.90			
		22.50			
PF3	50°07.6' S	09.11.89	3785	S	625
	05°50.0' E	10.34		AVT	645
		25.1 2.90		S	3200
		08.30		AVT	3220

AVTPC: Aanderaa current meter with temperature, pressure and conductivity sensor. In brackets instruments with poor data quality.
S: Sediment trap

Table 2.2: *Moorings deployed during "Polarstern"-cruise ANT IX/2.*

Mooring	Latitude (S) Longitude (W)	Date Time	Water depth (m,uncorr.)	Instrument Type	No.	Depth
215	63°19.89'	21.11.90	448	AVTP	10001	291
	52°59.07'	20:14		AVTP	9996	396
				WLR	1155	447
206/2	63°29.55'	22.11.90	942	AVTP	8402	253
	52°06.27'	14:54		AVTP	9786	891
207/2	63°45.05	23.11.90	2498	ULS	9/90	165
	50°54.32'	06:52		AVTP	9206	326
				TK	1569	
				ATR	1100	578
				AVTPC	8395	1037
				AVT	8417	2187
				TK	1570	
				ATR	1102	2439
				AVT	8418	2447
216	63°56.96'	24.11.90	3477	AVT	9182	2968
	49°09.21	00:34		AVT	9184	3426
217	64°25.10'	24.11.90	4424	ULS	13/90	141
	45°50.97'	21:26		AVTPC	9192	250
				S	890107	796
				AVTC	9211	1010
				AVT	9185	2510
				ACM-2	1281	4373
218	64°48.87'	25.11.90	4688	AVTP	10005	252
	42°29.28	21:15		TK	1427	
				ATR	944	505
				AVTP	9212	993
				AVT	9186	2503
				ACM-2	1284	4636
219	65°39.87'	28.11.90	4732	AVT	9187	4226
	37°42.45'	13:36		AVT	9188	4674
				AVT	9190	4722
208/2	65°38.14'	29.11.90	4776	ULS	11/90	171
	36°30.20'	18:27		AVTPC	9194	281
				AVTPC	9213	1040
				S	890106	1123
				AVT	9191	2533
				S	890108	4165
				ACM-2	1285	4725
220	65°58.19'	30.11.90	4799	AVT	9767	4300
	33°20.33'	15:43		AVT	9768	4748
221	66°16.63'	02.12.90	4784	ADCP		236
	30°17.78	10:49		AVTPC	9195	247
				TK	1426	
				ATR	943	499
				AVTPC	9214	985
				AVTPC	9215	2499
				ACM-2	1288	4732

209/2	66°37.35'	03.12.90	4862	ULS	14/90	147
	27°07.10	20:50		AVTP	9202	279
				AVTPC	9216	1015
				AVTPC	9217	2526
				ACM-2	1289	4809
222	67°03.56'	07.12.90	4836	AVT	9769	4336
	2452.11	22:54		ACM-2	1282	4785
223	67°59.84'	09.1 2.90	4885	AVTPC	9205	251
	19°57.64'	17:24		AVTPC	9218	1010
				AVT	9208	2520
				ACM-2	1290	4834
224	68°49.65'	10.12.90	4740	AVT	9770	4239
	17°54.49'	13:38		ACM-2	1291	4689
210/2	69°39.63'	11.12.90	4745	ULS	10/90	151
	15°42.90'	16:50		AVTP	9201	270
				TK	1571	
				ATR	1103	523
				AVTP	9995	1012
				AVT	9391	2521
				ACM-2	1297	4694
225	70°19.11'	12.12.90	4329	AVTP	10002	275
	13°39.61'	18:19		AVT	9783	1124
				AVT	9997	2625
				AVT	9782	4278
226	70°22.84	13.12.90	2943	AVTP	10003	231
	13°32.53	00:57		AVTP	9998	980
				AVT	9207	2892
212/2	70°54.67'	14.12.90	1555	ULS	12/90	135
	11°57.80'	07:34		AVTP	8367	254
				AVTC	9401	759
				AVT	9402	1504
211/2	70°29.67'	14.12.90	2381	AVTP	10004	270
	13°08.85'	22:17		TK	1572	
				ATR	1104	523
				AVTP	8396	1012
				AVT	9999	2222
				AVT	9392	2329
KN4	70°59.51'	15.12.90	892	S	860019	328
	11°46.86'	09:55		AVTP	9209	333
				S	860020	782
				AVTPC	9210	810
				UCM		811
214/2	71°02.93'	15.12.90	378	AVTP	8370	213
	11°41.25'	12:56		AVT	9403	318
				WLR	1044	377
BO1	54°20.3' S	23.12.90	2734	S	860024	423
	03°22.6' W	16.43		AVT	7727	474
				S	890005	2196
				AVT	8037	2217
PF4	50°07.6' S	25.12.90	3807	S	860038	625
	05°52.0' E	10.31		AVT	9803	646
				S	890009	3267
				AVT	9805	3290

Abbreviations:

ACM-2	Acoustic current meter, Neil Brown
ADCP	Acoustic doppler current meter
ATR	Recording unit for thermistor chain
AVTPC	Aanderaa current meter with temperature.pressure and conductivity sensor
S	Sediment trap
UCM	Acoustic current meter, Simtronics
ULS	Upward looking sonar
WLR	Water level recorder

2.2. CTD Measurements

```
CTD Measurements during AQANTIX/2
Instrument : Neil Brown CTD, Mark IIIB, Sn: 1069, BJ: 1984

             CTD temperature sensor : Rosemount Platinum
                                      Thermometer
             resolution :     0.0005 deg C
             accuracy   : +/- 0.005  deg C
             CTD pressure sensor    : Paine Model
             resolution :     0.1 dbar
             accuracy   : +/- 6.5 dbar
             CTD conductivity sensor : EG&G NBIS
             resolution :     0.001 mmho
             accuracy   : +/- 0.005 mmho

Software   : EG&G Oceansoft MkIII/SCTD Aquisition Version 2.01
                               CTD postprocessing Version 1.12
Time lag   : 0.13 s

Pressure pre-cruise calibration coefficients
a1 = -1.1552376e+1
a2 =  7.014388e-3
a3 = -1.236572e-5
a4 =  7.641595e-9
a5 = -2.052136e-12
a6 =  2.544142e-16
dp = a1 +a2*p +a3*p**2 +a4*p**3 +a5*p**4 +a6*p**5
 p = p + dp

Temperature pre-cruise calibration coefficients
a1 = -2.99299
a2 = -7.18462e-4
a3 =  4.44174e-5
a4 = -1.43668e-6
a5 =  2.67305e-8
dt = a1 +a2*t +a3*t**2 +a4*t**3 +a5*t**4
 t = t + dt
```

the post-cruise calibration data are the same

correction of the CTD-conductivity data with the bottle-samples
(conductivity of the salinometer data)
evaluation of the coefficients of each station

CD = (CONDUCTIVITY SALINO - CONDUCTIVITY CTD) * 1000
COND :== CONDUCTIVITY SALINOMETER

CD = A0 + A1*COND + A2*PRES + A3*PRES**2

----

station no.	A0	A1	A2	A3
03501	-0.51872E+02	0.24728E+01	-0.63940E-02	0.79995E-05
03601	-0.51872E+02	0.24728E+01	-0.63940E-02	0.79995E-05
03901	-0.51872E+02	0.24728E+01	-0.63940E-02	0.79995E-05
04001	-0.51872E+02	0.24728E+01	-0.63940E-02	0.79995E-05
04101	-0.51872E+02	0.24728E+01	-0.63940E-02	0.79995E-05
04201	-0.59161E+02	0.26925E+01	-0.35827E-02	-0.59052E-05

dc = A0 + A1*COND + A2*PRES + A3*PRES**2
C(ctd) = C(ctd) + dc/1000.

correction of the CTD-conductivity data with the bottle-samples
evaluation of the coefficients with the running mean of 10 stations

----

CD = A0 + A1*PRES + A2*PRES**2 + A3*PRES**3 + A4*PRES**4

----

station no.	A0	A1	A2	A3	A4
4301	0.16057E+02	-0.53003E-02	0.36477E-05	-0.77356E-09	0.43815E-13
4401	0.16057E+02	-0.53003E-02	0.36477E-05	-0.77356E-09	0.43815E-13
4501	0.16057E+02	-0.53003E-02	0.36477E-05	-0.77356E-09	0.43815E-13
4601	0.16060E+02	-0.52277E-02	0.35370E-05	-0.75885E-09	0.44722E-13
4701	0.16060E+02	-0.52277E-02	0.35370E-05	-0.75885E-09	0.44722E-13
4801	0.16275E+02	-0.59179E-02	0.41748E-05	-0.97715E-09	0.69451E-13
4901	0.16108E+02	-0.60083E-02	0.49328E-05	-0.13678E-08	0.12189E-12
5001	0.16102E+02	-0.54978E-02	0.43413E-05	-0.11653E-08	0.99760E-13
5101	0.16899E+02	-0.77574E-02	0.66678E-05	-0.20257E-08	0.20231E-12
5201	0.16881E+02	-0.59944E-02	0.44888E-05	-0.13842E-08	0.14902E-12
5501	0.17761E+02	-0.70108E-02	0.56046E-05	-0.17661E-08	0.19017E-12
5601	0.17937E+02	-0.75108E-02	0.63627E-05	-0.20726E-08	0.22755E-12
5701	0.18022E+02	-0.64782E-02	0.53523E-05	-0.16870E-08	0.17910E-12
5801	0.18156E+02	-0.62368E-02	0.50660E-05	-0.15814E-08	0.16690E-12
5901	0.18156E+02	-0.62368E-02	0.50660E-05	-0.15814E-08	0.16690E-12
6001	0.18178E+02	-0.63440E-02	0.54099E-05	-0.17589E-08	0.19218E-12
6101	0.18370E+02	-0.59355E-02	0.48751E-05	-0.15619E-08	0.16985E-12
6201	0.18148E+02	-0.42419E-02	0.30712E-05	-0.86105E-09	0.82874E-13
6301	0.17937E+02	-0.26588E-02	0.15897E-05	-0.37211E-09	0.30423E-13

6401	0.17782E+02	-0.17227E-02	0.63312E-06	0.26379E-11	-0.17070E-13
6501	0.17723E+02	-0.12923E-02	0.25428E-06	0.12091E-09	-0.28589E-13
6601	0.17461E+02	-0.67162E-03	0.21007E-06	-0.21894E-10	0.11939E-14
6701	0.17694E+02	-0.13889E-02	0.65721E-06	-0.12674E-09	0.94644E-14
6801	0.17450E+02	-0.97850E-03	0.27286E-06	-0.15240E-10	-0.48745E-15
6901	0.17563E+02	-0.15356E-02	0.71896E-06	-0.15865E-09	0.15453E-13
7001	0.17563E+02	-0.15356E-02	0.71896E-06	-0.15865E-09	0.15453E-13
7101	0.17479E+02	-0.96447E-03	-0.73640E-07	0.16015E-09	-0.23761E-13
7201	0.17006E+02	-0.11719E-03	-0.62758E-06	0.27564E-09	-0.29867E-13
7301	0.16916E+02	-0.78963E-03	-0.29516E-07	0.39261E-10	-0.17887E-15
7401	0.16904E+02	-0.21073E-02	0.12650E-05	-0.40022E-09	0.48944E-13
7501	0.16726E+02	-0.18753E-02	0.10196E-05	-0.34344E-09	0.46267E-13
7601	0.16753E+02	-0.19489E-02	0.99166E-06	-0.30502E-09	0.39144E-13
7701	0.16940E+02	-0.26189E-02	0.15238E-05	-0.44051E-09	0.49389E-13
7801	0.16764E+02	-0.97997E-03	-0.79946E-08	0.76954E-10	-0.96646E-14
7901	0.16953E+02	-0.13147E-02	0.11905E-06	0.74029E-10	-0.12693E-13
8001	0.16250E+02	-0.28762E-03	-0.63608E-06	0.30982E-09	-0.38113E-13
8101	0.16592E+02	-0.93415E-03	-0.59756E-07	0.10940E-09	-0.14970E-13
8201	0.16592E+02	-0.93415E-03	-0.59756E-07	0.10940E-09	-0.14970E-13
8301	0.16971E+02	-0.19752E-02	0.84813E-06	-0.16722E-09	0.12449E-13
8401	0.17508E+02	-0.21779E-02	0.61323E-06	0.24780E-10	-0.18108E-13
8501	0.17608E+02	-0.13212E-02	-0.44565E-06	0.46132E-09	-0.74966E-13
8601	0.17806E+02	-0.95871E-03	-0.10371E-05	0.69309E-09	-0.10154E-12
8701	0.17901E+02	-0.50715E-03	-0.16823E-05	0.97189E-09	-0.13764E-12
8801	0.17782E+02	-0.15468E-03	-0.16149E-05	0.82369E-09	-0.10936E-12
8901	0.17752E+02	-0.12688E-02	-0.54494E-06	0.46368E-09	-0.68610E-13
9001	0.17595E+02	-0.44907E-03	-0.13521E-05	0.75085E-09	-0.10213E-12
9101	0.17818E+02	0.10371E-02	-0.27966E-05	0.12559E-08	-0.16210E-12
9201	0.17739E+02	0.92340E-03	-0.21876E-05	0.93502E-09	-0.11655E-12
9301	0.17696E+02	0.18375E-02	-0.32648E-05	0.13364E-08	-0.16358E-12
9401	0.17379E+02	0.36388E-02	-0.52546E-05	0.21307E-08	-0.26343E-12
9501	0.16627E+02	0.44116E-02	-0.55975E-05	0.21872E-08	-0.26592E-12
9601	0.16501E+02	0.44658E-02	-0.55051E-05	0.21473E-08	-0.26200E-12
9701	0.16684E+02	0.44739E-02	-0.55477E-05	0.21310E-08	-0.25597E-12
9801	0.17031E+02	0.31220E-02	-0.38486E-05	0.14558E-08	-0.17342E-12
9901	0.16900E+02	0.39229E-02	-0.47820E-05	0.17983E-08	-0.21271E-12
10001	0.16896E+02	0.38833E-02	-0.53216E-05	0.21346E-08	-0.26184E-12
10101	0.16874E+02	0.37733E-02	-0.54502E-05	0.22433E-08	-0.27886E-12
10201	0.16902E+02	0.37003E-02	-0.55233E-05	0.23019E-08	-0.28783E-12
10301	0.17029E+02	0.29472E-02	-0.48717E-05	0.21078E-08	-0.26871E-12
10401	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
10501	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
10601	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
10801	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
10802	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
10901	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
11301	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
11401	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
11402	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
11501	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12

11502	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
12001	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
12101	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
12102	0.16995E+02	0.16188E-02	-0.32527E-05	0.15057E-08	-0.19816E-12
04502	0.16057E+02	-0.53003E-02	0.36477E-05	-0.77356E-09	0.43815E-13
04802	0.16275E+02	-0.59179E-02	0.41748E-05	-0.97715E-09	0.69451E-13
05602	0.17937E+02	-0.75108E-02	0.63627E-05	-0.20726E-08	0.22755E-12
06302	0.17937E+02	-0.26588E-02	0.15897E-05	-0.37211E-09	0.30423E-13
07502	0.16726E+02	-0.18753E-02	0.10196E-05	-0.34344E-09	0.46267E-13
09402	0.17379E+02	0.36388E-02	-0.52546E-05	0.21307E-08	-0.26343E-12

----

dc = A0 + A1*PRES + A2*PRES**2 + A3*PRES**3 + A4*PRES**4

C(ctd) = C(ctd) + dc/1000.

CTD-Files column 5 : number = -9 :== unknown data , it was not possible to restore this data

NOTES ON THE NUTRIENT DATA FILES FOR SWGS 90 (ANTIX/2)

From:
M. Consuelo Carbonell-Moore
Joe C. Jennings, Jr.
Louis I. Gordon

STATIONS WITH MISSING NUTRIENTS:

STATION	MISSING NUTRIENT	BOTTLE
040	NH4	ALL
043	PO4	3;13-16
044	NH4	1-4
046	NH4	ALL
062	NH4	3
066	NH4	14
067	PO4	6
067	N + N	6
072	PO4	ALL
073	PO4	5,6
075	N + N	14
078	Si(OH)4	10,11
083	NH4	ALL
084	PO4	ALL
087	N + N	4
087	NH4	1-8

090	N + N	6
090	NH4	4,6
091	PO4	ALL
092	PO4	ALL
092	NH4	4,7
093	NH4	21
096	PO4	18,19
098	NH4	ALL
099	NH4	ALL
105	PO4	ALL
106	PO4	ALL
106	NH4	1-4
115	PO4	ALL

NOTES ON NITRITE (NO2) AND AMMONIUM (NH4):

Because deep ocean nitrite and ammonium values are usually near the limit of detection, small shifts in baseline and/or blank levels can lead to the calculation of concentrations which are negative. Although these negative nitrite and ammonium values are physically impossible, we report them as an indication of the imprecision associated with the analysis.

NOTES ON PHOSPHATE (PO4):

Low phosphate values in stations 050 and 051 might be doubtful as there was and equipment change after station 049. Values at station 053 agree with those at station 049.

There is a wide spread in deep phosphate values: 2.19 micromol/liter to 2.42 micromol/liter, many stations showing high values, higher than those from Wepolex and Ant V/2 cruises in the same region, but lower than WWGS 89. Deep phosphates increase in concentration from station 60 through station 83, increase which we can not account for. These high values might be an artefact from a change in blank values due to changes in either the deionized water or in the low nutrient seawater used to prepare standards. There is no information in the laboratory notebooks, logs or recorder charts that allows us to either correct or delete these data. However, they are of doubtful quality. The increase of phosphate values in these stations is 0.1 micromol/liter. Nitrate concentration values did not show the same trend.

Preliminary results

The hydrographic features measured along the transect are presented as sections of potential temperature and salinity (Figure 2.6). Below a shallow surface layer of WW which deepens significantly towards the shelf edge, a temperature and salinity maximum due to the WDW is found. It is more pronounced at the boundaries than in the interior with temperatures up to 0.8% in the east and 0.4% in the west evidencing the inflow in the east and the outflow in the west. The largest part of the water column with potential temperatures between 0 and -0.8°C and salinities from 34.67 to 34.64 is classified as AABW. Below we find WSBW with temperatures colder than -0.8°C which extends in the West in a shallow layer over the continental slope indicating the outflow of this freshly formed water mass. The young age of this water mass is suggested by the high oxygen content (Figure 2.7). In the forthcoming analysis we will quantify the transformation which occurs south of our transect of inflowing water masses in the east into the outflowing ones in the west.

Seasonal changes on that transect are most evident in the near surface layers. Relatively warm air temperatures (Figure 2.8 top) and weak winds (Figure 2.8 bottom) indicate the onset of spring.

A comparison of surface layer temperatures and salinities measured in September and October during WWGS '89 with the ones obtained during the present cruise indicates a much more pronounced springtime warming in the west than in the east (Figure 2.9 top). The salinity decrease due to ice melting was more intense in the east than in the west (Figure 2.9 bottom). In the deeper layers fluctuations of a wide spectral range are expected to be at least as intense as the seasonal cycle. Consequently no seasonal change can be identified in the comparison of the two sections.

From CTD data on a straight section only geostrophic current shear can be estimated. Absolute currents can be obtained by the use of mass conservation of geostrophic currents in and out of a closed area or by the Beta-spiral method. Therefore, in the area of the gyre centre, which is indicated by the doming of the isotherms, a second section normal to the main section was carried out with a length of about 275 km (Figure 2.10, top).

The estimate of absolute geostrophic current velocities by use of the Beta-spiral method will yield additional information on the location of the gyre center complementary to the moored current meter data. However, this method requires the calculation of the second derivative of isopycnals with respect to horizontal and vertical coordinates and is very sensitive to fluctuations. Thus, quantitative estimates need to be carried out with the final data.

The transects of the potential temperature along the Beta-cross (Figure 2.10, top) show smoothly inclined isolines which seem to reflect the doming of the Weddell Gyre. The temperature maximum of the WDW increases towards the north. This can be taken as an indication that there is a southward component in this level and consequently the center of the gyre has to be located further to the west.

The interaction with the ice shelf was studied by means of a CTD profile which was measured in an inlet of the Quarisen northeast of Kapp Norvegia (Figure 2.11, top). The temperature profile shows cold WW above a slightly warmer layer centered at 200 m depth which tops a colder bottom layer (Figure 2.11, bottom). The salinity increases from top to bottom. Presently it is not possible to conclude if the deeper layer is the remnant of a WW-layer which reached to the bottom and is separated from a slightly warmed surface layer by an intrusion of warmer water from offshore, or if it represents water which emanates from under the ice shelf. Tracer data measured from the water samples will be used to answer this question.

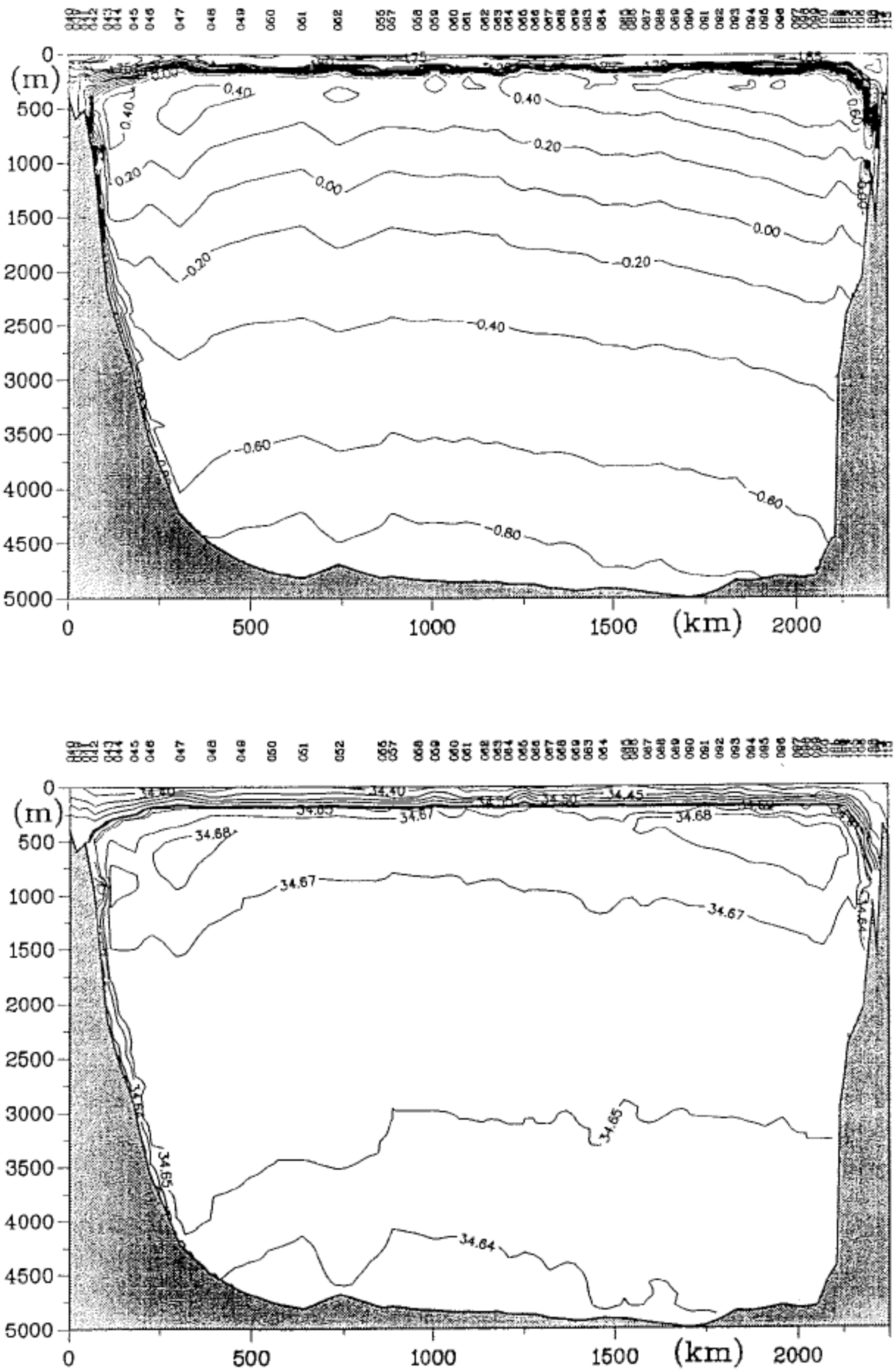


Figure 2.6: *Vertical section of potential temperature (top) and salinity (bottom) from Joinville Island (left) to Kapp Norvegia (right) carried out during Polarstern"-cruise ANT IX/2.*

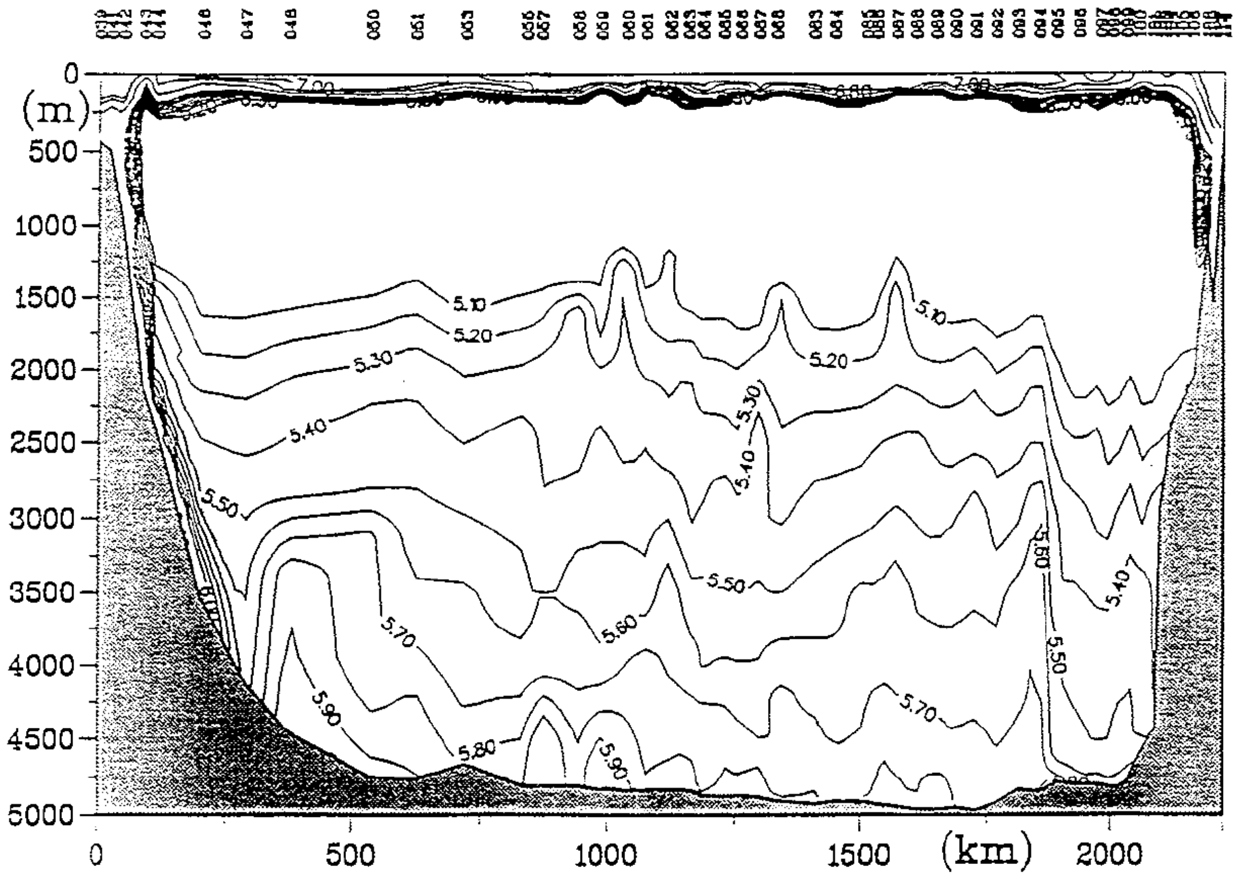


Figure 2.7: *Vertical section of dissolved oxygen from Joinville Island (left) to Kapp Norvegia (right) carried out during "Polarstern"-cruise ANT IX/2.*

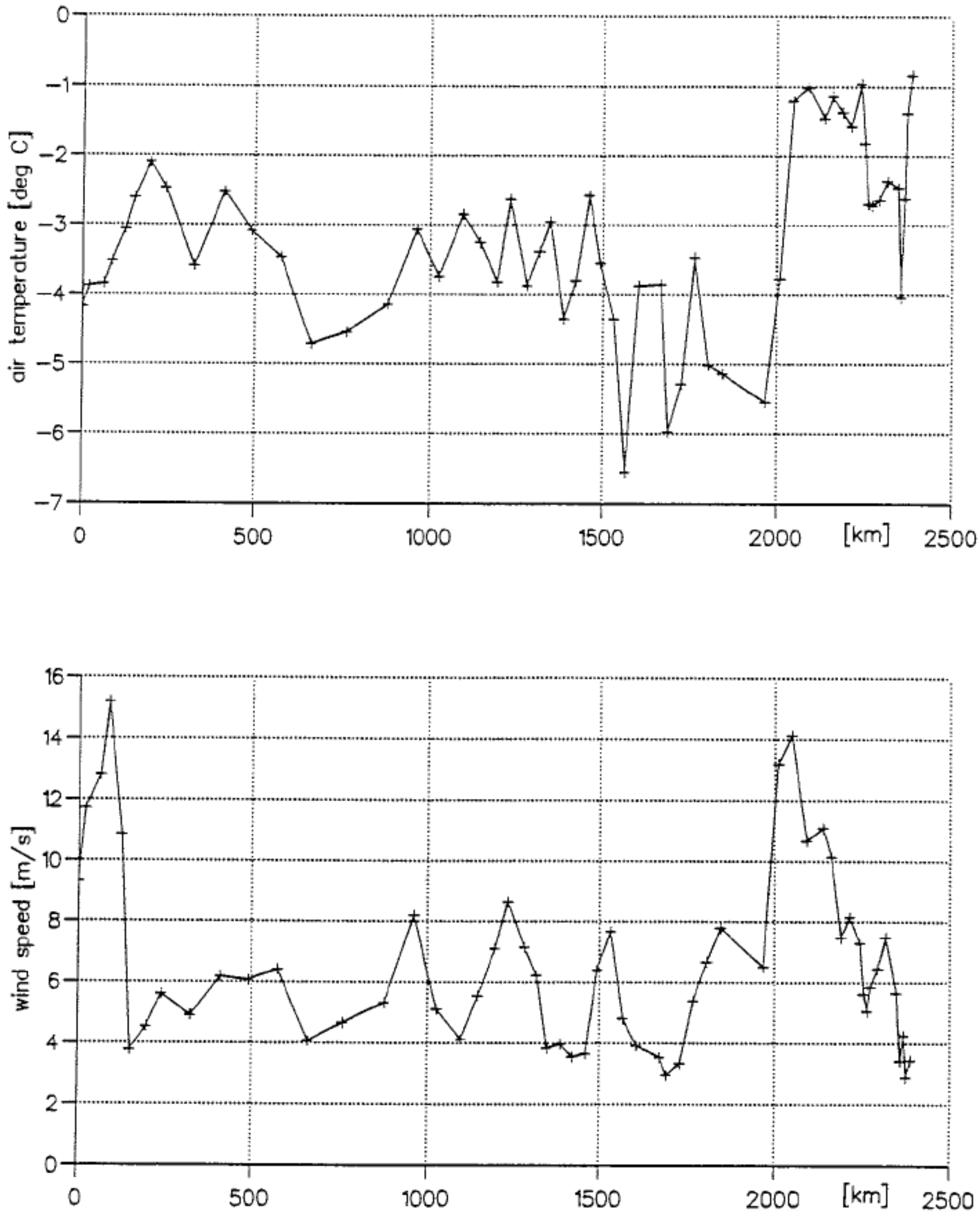


Figure 2.8: *Three-hour averages of air temperature (top) and wind speed (bottom) measured during CTD-stations on "Polarstern" during ANT IX/2.*

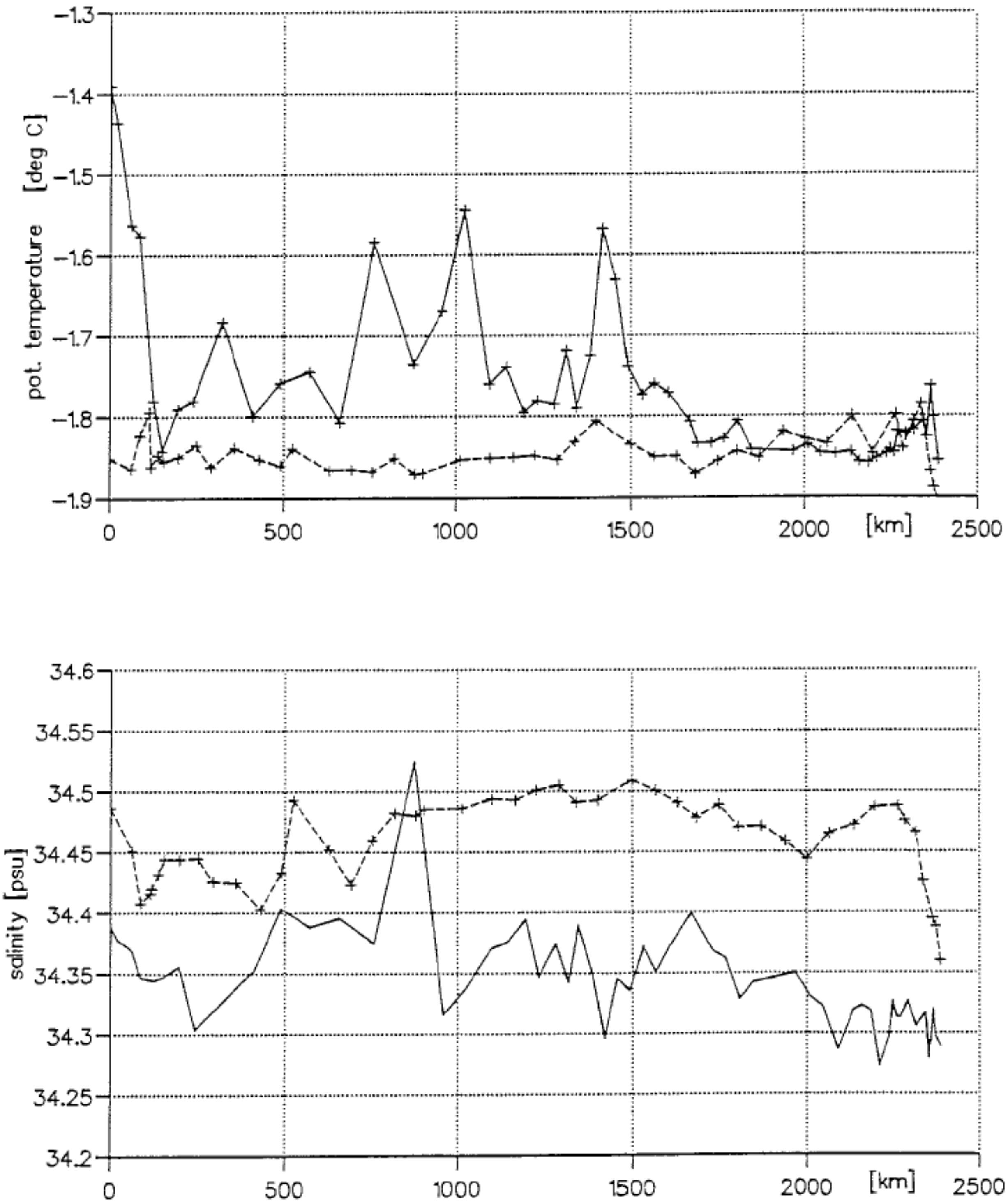


Figure 2.9: *Surface layer temperatures (top) and salinities (bottom) measured with the CTD in 10 m water depths during winter 1989 (WWGS '89, dotted line) and spring 1990 (ANT IX/2, solid line).*

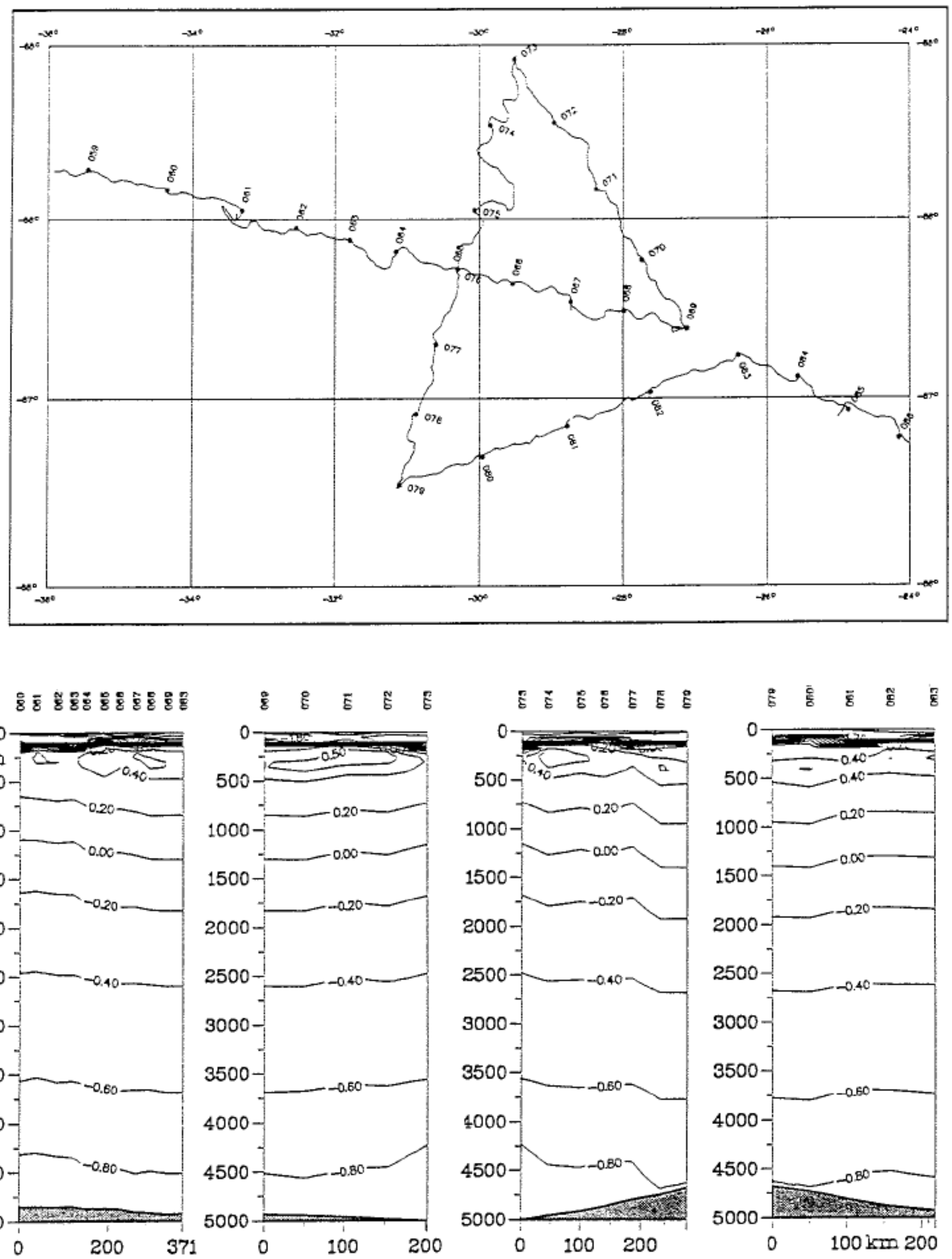


Figure 2.10: *Cruise track and station locations in the "Beta-cross" area during "Polarstern"-cruise ANT IX/2 (top) and vertical sections of potential temperature (bottom) along the track lines.*

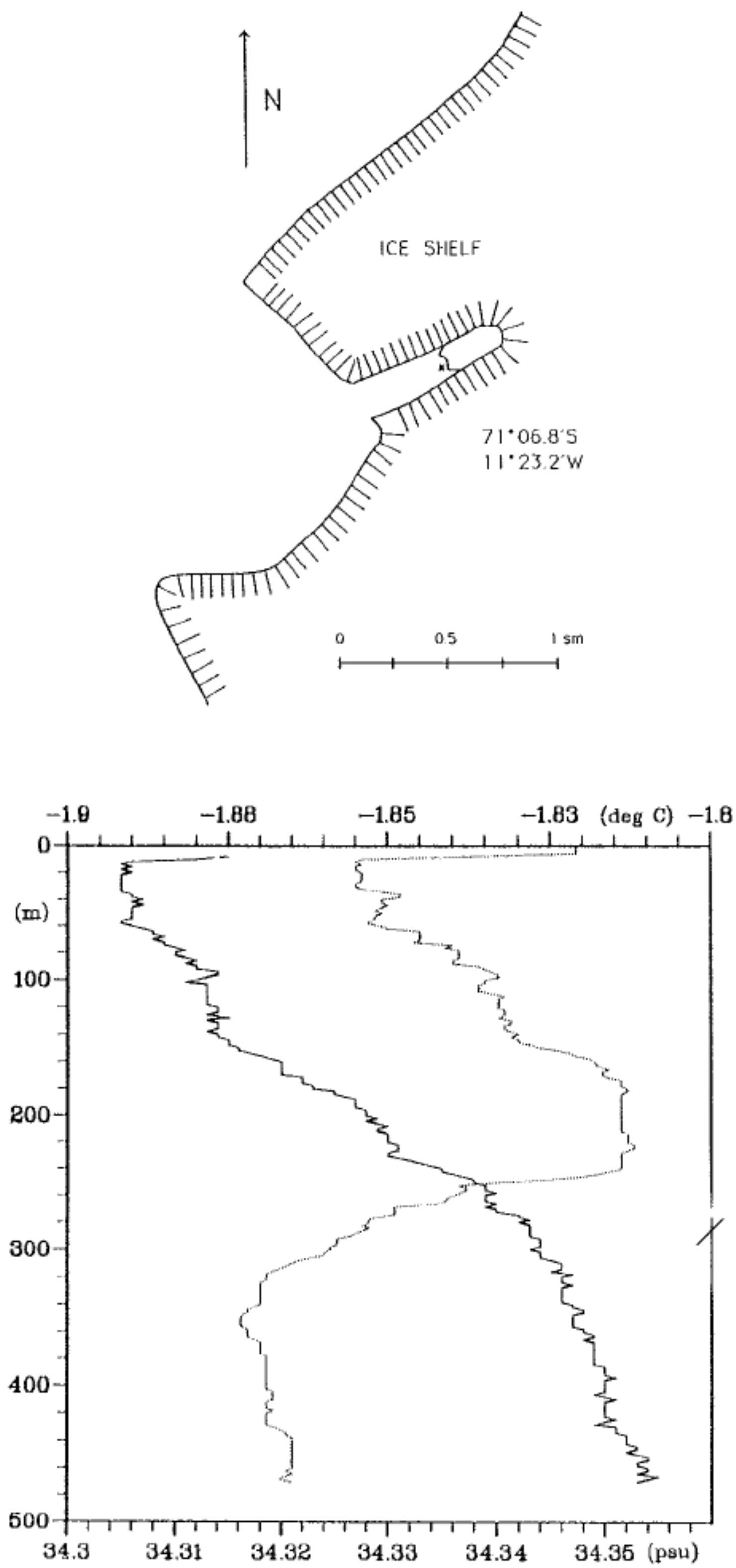


Figure 2.11: *Location of the station in the inlet of the Quarisen during "Polarstern"-cruise ANT IX/2 (top) and vertical profiles of potential temperature (stippled line) and salinity (solid line) in the inlet (bottom).*

2.3. Distribution of dissolved inorganic nutrients in the water column

J. M. Krest, A. A. ROSS (OSU)

Objectives

By obtaining high quality nutrient data from late winter and early spring, we will improve on the sparse historical data set of the central Weddell Sea. The repeated "Polarstern" transects should permit the seasonal and interannual variability of the major water masses to be assessed. This data set will be used to study the evolution of WW which is the mixed layer beneath the seasonal pack ice. WW properties change with length of time under the ice due to continuous mixing of warmer, higher nutrient waters (WDW) from just below the pycnocline. From the analysis of nutrients in this surface layer, we plan to extend and refine our earlier estimates of net primary productivity in the Weddell Sea.

Work at sea

At 88 CTD casts, water samples were taken and analyzed for silicic acid, phosphate (Ortho-Phosphate), nitrate + nitrite (N+N), nitrite, and ammonium. Analyses were performed using the ALPKEM RFA-300 continuous flow analysis System. The entire water column was sampled for nutrients, but at this time, only the surface water in the primary northwest-to-southeast transect has been examined for silicic acid, phosphate and N+N.

Preliminary Results

Contour plots of nutrients in the upper 500 meters (Figure 2.12) show a fairly well defined layer of WW from approximately 50°W to 14°W. In the WW-layer which occupies the top 100 meters of the water column silicic acid concentrations range from 70 to 80 µM, N+N concentrations from 28 to 30 µM, and phosphate concentrations from about 2.0 to 2.1 µM. Underlying this WW-layer is a reasonably strong nutricline, varying in depth from 100 to 150 meters. In this nutricline, silicic acid increases in concentration to 110 micromolar, N+N increases to 33 µM, and phosphate increases to 2.3 µM. For all three nutrients, concentrations are most elevated in the center of this gyre, indicating a general upwelling trend. At two locations, 40° and 32°W, the contour plots for all three nutrients indicate strong vertical mixing between the WW and the underlying water mass. At the Western and eastern boundaries, intense vertical mixing causes nearly vertical nutrient isolines. In the WSBW a tongue of low concentration silicic acid can be seen which extends laterally more than halfway across the Weddell Sea Basin at a depth of approximately 4500 to 5000 meters. Initial comparisons were made with data obtained by Oregon State University's group during WWGS '89 and show good agreement.

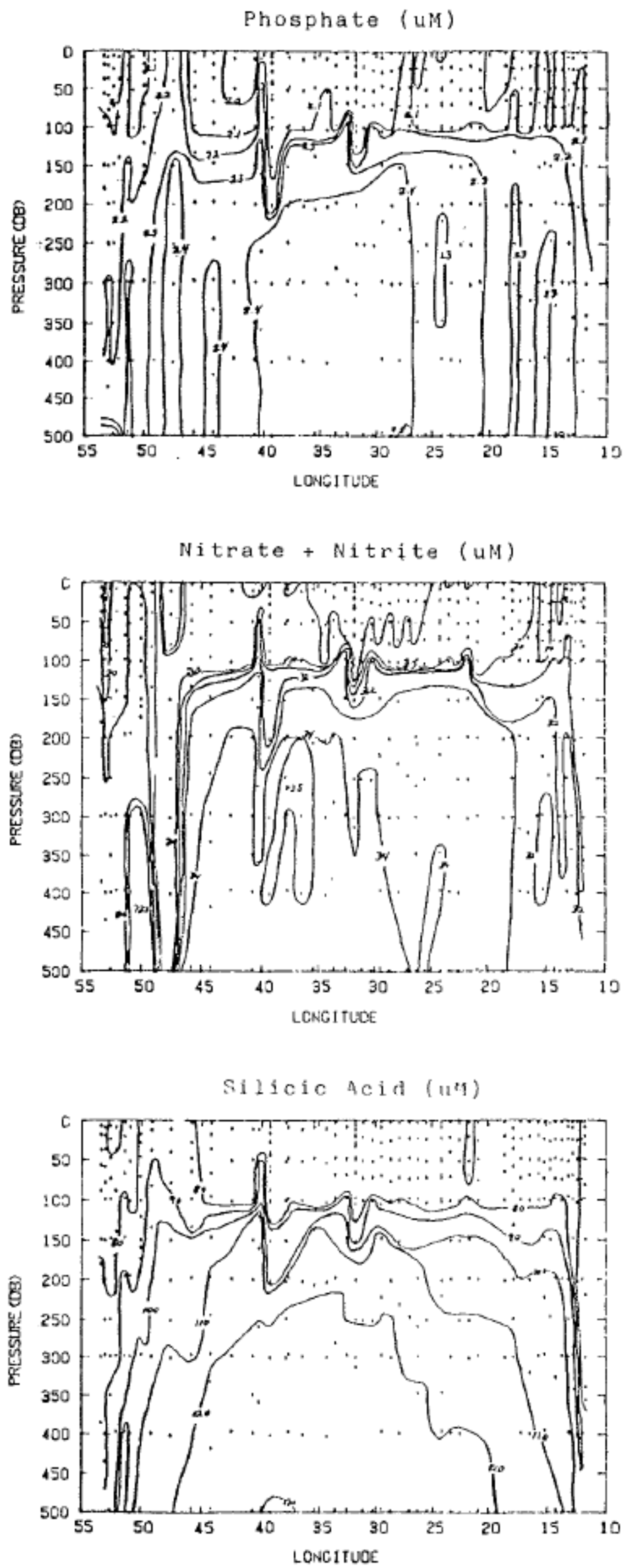


Figure 2.12: *Vertical sections of nutrients from Joinville Island to Kapp Norvegia carried out during "Polarstern'-cruise ANT IX/2.*

2.4. Tritium and Helium measurements

R. Well (FPB)

Objectives

Within the scope of the physical oceanography programme the tritium and helium-isotope contents of the water samples serve as tracers for water mass characteristics. In addition, they can yield information about the time scales of exchange of the water masses within the Weddell Gyre. On this cruise - for the first time - we degassed water samples at sea. This procedure is expected to reduce the contamination caused by longtime storage and can simplify the handling of the sample containers. For this purpose we tested new degassing equipment on board and will compare the results with those obtained with the traditional method.

Work at sea

We took water samples at 6 CTD-stations on the shelf and continental slope of the Antarctic Peninsula in water depths of about 400, 1000, 2200, 2500, 3550 and 4200 m, at 3 CTD-stations in the central Weddell Sea at water depths of about 4700, 4760 and 4860 m and at 4 CTD-stations on the eastern continental slope off Kapp Norvegia in water depths of about 4400, 2400, 1600 and 500 m. Altogether about 50 double-samples were taken. One half of them were degassed on board, the other half will be degassed after our return in the laboratory, the helium- and neon-isotope contents will be compared.

Preliminary Results

As the measurements of the samples have to be done with a mass spectrometer in the laboratory we can not present data or quantitative results of the intercomparison here. The degassing technique on board did not show serious technical problems. Some problems occurred with the melting off procedure of the glass ampoules so that presently we can not generally guarantee that the extracted gas is well caught in the glass ampoule.

2.5. Water level measurements

C. Buxhoeveden, (ITBA); E. Fahrbach, R. Plugge, (AWI); E. Schütt

Objectives

Water level measurements and deployments of water level recorders were carried out during ANT IX/2 for two reasons: to obtain further information on the tides in the Weddell Sea and to study low frequency fluctuations such as coastal trapped waves or basin modes, for a better understanding of the fluctuations observed in the moored current meter records.

Work at sea

To obtain time series long enough for a detailed tidal analysis and to study lower period fluctuations, two current meter moorings on the western and the eastern shelf respectively (215, 214/2) were equipped with Aanderaa water level recorders (WLR). It was planned to recover mooring 214/1 with a WLR, but due to the heavy ice conditions off the eastern shelf, this was not possible and the mooring had to be recovered during the following leg. During the stay in the Atka-Bight a short period study took place to check a tidal prediction made by members of the Meeresphysik section at AWI on the basis of previous measurements. With this aim soundings of the navigational echo sounder were evaluated and a current meter was moored 50m below the hull of "Polarstern" through the moon pool (Figure 2.13).

Preliminary results

The short term study over 36 hours allowed us to compare the predicted and observed tidal range as well as the times of high and low water. It appears that they agree to the accuracy of the measurements. The times of the extrema can be determined to about 10 min which corresponds to the difference in the predictions. The determination of the tidal range is affected by the influence of lower period fluctuations of the sea level and the motion of the ship due to the unloading and later ballasting which changes the location and inclination of the echosounder. Both effects add up to an uncertainty of about 15 cm in the determination of the tidal range which is about 10% of the observed range. Within this range predicted and measured data correlate. The correlation between tidal current and sea level is less clear. Whereas during 18 December high and low water seems to correlate with maximum and minimum tidal current, on the 17th no correlation is found. This agrees with observations from moored current meters where nontidal current variability is as strong as the tidal one.

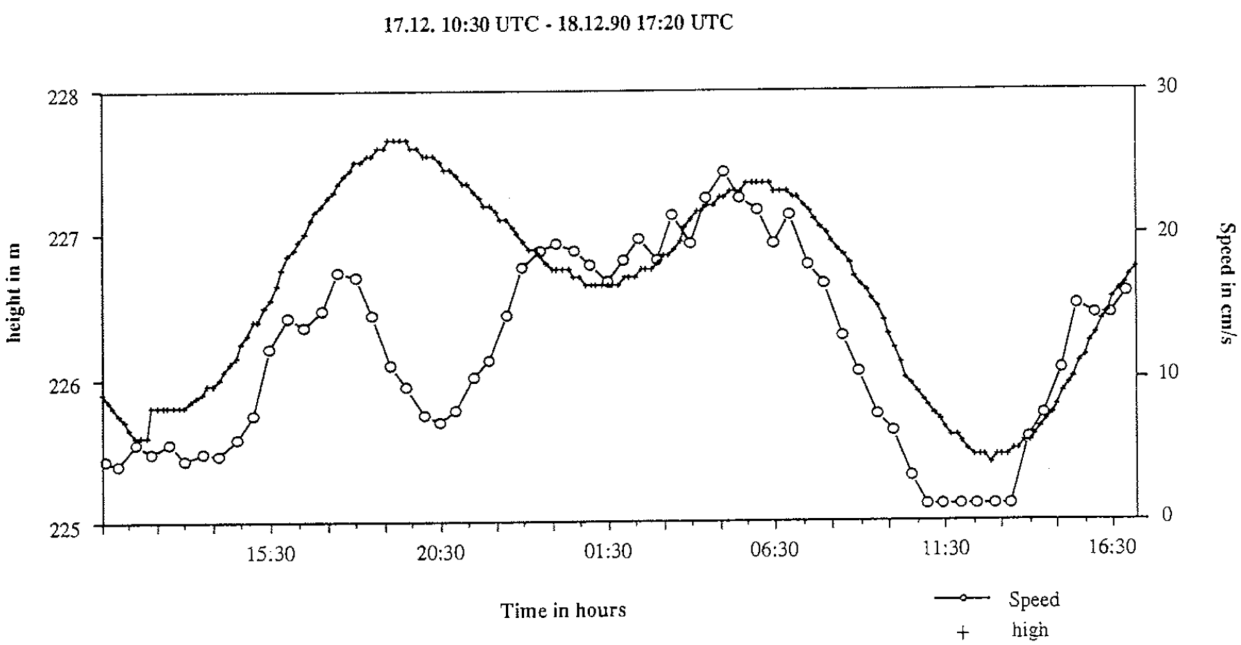


Figure 2.13: *Records of the current speed (open circles) in 50 m water depth and the navigational echo sounder from "Polarstern" during the visit to Atka-Bight.*

2.6. Optical properties of sea water

R. Plugge, V. Strass (AWI)

Objectives

The optical properties of sea water vary with its constituents of biological origin. Observational methods based on the variations of the optical properties allow measurements of biological variables at the same high sampling rate as temperature and salinity, and thus can be used for underway data recording. Data sets including both biological and physical variables collected in this way allow for statistical studies of the dependency of the biological realm on the physical environment. During the present cruise a sensor package for measuring temperature, salinity, chlorophyll, fluorescence, Mie backscatter and yellow substance was employed; the optical measurements allow determination of the concentration of phytoplankton biomass and particles and zooplankton concentration/activity.

Work at sea

The hydrographic-optical sensor package (named COMED, developed in the Meeresphysik section at the AWI) was mounted in the ship's well at hull depth (11 m), where the data were collected at a rate of 1 cycle per 10 seconds. Measurements were taken during two periods: the first starting on 18 November and ending on 22 November, the second period starting on 20 December and ending on 29 December. During both periods the ship crossed the Antarctic Circumpolar Current with the Polar Front: the first time on the southward leg from Punta Arenas towards Bellingshausen-Station, the second time on the northward leg from GvN-Station towards Cape Town. During the period in between the ice conditions required the COMED System to be switched off and to cover the sensor package with a protective lid in order to avoid damages.

2.7. Underway measurements of current profiles, XBTs and the thermosalinograph

T. Behmann, J. Dehn, E. Fahrbach. M. Knoche, T. Markus, V. Strass, (AWI); H.-J. Brosin, M. Schmidt, (IfMW); C. Buxhoeveden, (ITBA); M. Harder, H.-H. Hinrichsen, H. Schäfer U. Sterr, A. Wisotzki (FPB)

Objectives

The Antarctic Circumpolar Current is subject to a wide range of temporal and spatial variability. The repeated crossings of "Polarstern" are used to obtain a data set which is suitable to address longer term variability of the thermal field and spatial variability of the velocity field. The temperature profiles are inserted in the Integrated Global Ocean Services System (IGOSS).

Work at sea

This goal is approached by usage of the Vessel Mounted Acoustic Doppler Current Profiler (VM-ADCP, manufactured by RD Instruments, San Diego) which allows us to monitor the current profile in the upper 350m of the water column from the ship moving at full speed. The corresponding thermal structures were measured by means of XBTs using T-7 probes. Sea surface temperature and salinity is recorded by a thermosalinograph.

By use of the ADCP a cross section of the upper ocean velocity profile through the Circumpolar Current was recorded through Drake Passage to the Antarctic Peninsula. A set of calibration data were collected by running a cross-shaped course pattern on the shelf of the Antarctic Peninsula. During the calibration courses the ADCP was operated in its bottom track mode; a variety of control parameter settings were used during the measurements in order to optimise the instrument's performance. The data sampled were transferred to the ship's VAX Computer for processing and plotting. During the measurements the ADCP was run without the occurrence of major problems. However, during a later phase of the cruise no more data were obtained for two reasons. First, in its mode of operation the ADCP's transducer sits at hull depth (approx. 11 m) in the ship's well without any protection against mechanical damage by ice floes pushed under the ship. When the ship moves through the ice the transducer is protected by a lid consisting of two stainless steel sheets of 8 mm thickness. With the transducer behind the protective lid the ADCP not able to function. Consequently, no ADCP measurements of current profiles could be obtained along the Weddell Sea cross section. Second, it appeared that the protective lid was not strong enough to withstand the collisions with ice floes. When we tried to reactivate the ADCP in ice-free waters after having left the GvN-Station, we noticed that the lid was deformed by the impacts from ice floes and the transducer assembly was severely damaged. All four transducer heads were scoured off at their outer periphery, and in one case the metal cage embedding the transducer face was torn. Moreover, two of the transducer heads were loosened from their proper connection to the transducer electronics housing because the connecting bolts had been lengthened by leverage, leading to gaps of up to 3 mm wide between the transducer heads and the electronics housing. Through these gaps sea water flooded the electronics housing. Because of the severeness of the damages, there was no way of repairing the transducer assembly on board of the ship and to employ the ADCP during the further parts of the cruise.

The thermal structure of the upper 700 to 800 meters was measured by 194 XBT-profiles which were recorded with a Nautilus-system. Times and locations of the individual profiles are given in Table 2.3 and 2.4. Comparison between 8 XBT and CTD measurements at the same stations confirmed the accuracy of 0.2 K given by the manufacturer. The data obtained are depicted as vertical sections in Figure 2.14.

Sea surface temperature and salinity were recorded continuously in the bow thruster channel at about 5 m depth with a thermosalinograph supplied by Meerestechnik-Electronik (ME). The data were controlled by salinity samples taken at the inlet to the instrument and the temperature measurements of the CTD. The following corrections have to applied to the recorded data:

T_{true}=0.921 $T_{recorded}$- 0.253
S_{true}=0.949 $S_{recorded}$- 1.772

The corrected data will then be accurate to 0.03 K and 0.03. However, it has to be taken into account that occasionally a water-ice mixture is flowing in sensor head which results in erroneous data. The error is obvious by the reduced conductivity due to the ice. Therefore we do not use the thermosalinograph data along the transect but refer to the CTD-data in 10 m depth (Figure 2.9). The T/S-profiles across Drake Passage and from Antarctica to South Africa are shown in Figure 2.15.

Table 2.3: *XBT-Section C. San Juan - King George Island*

St. No.	Date	Time GMT	Position Lat S	Position Long W	Depth m (uncorr.)
1	18.11.90	2357	54°39'	63°31'	122
2	19.11.90	0112	54°54'	63°19'	>1800
3		0203	55°07'	63°08'	2639
4		0307	55°20'	62°57'	4171
5		0403	55°34'	02°48'	4141
6		0518	55°48'	62°35'	4090
7		0625	56°01'	62°25'	3953
8		0745	56°15'	62°11'	4040
9		0850	56°29'	62°00'	4100
10		0958	56°42'	61°48'	3000
11		1058	56°56'	61°39'	>3000
12		1158	57°09'	61°27'	3819
13		1258	57°23'	61°14'	3845
14		1405	57°38'	61°02'	3631
15		1456	57°50'	60°52'	3601
16		1601	58°04'	60°42'	4305
17		1739	58°28'	60°21'	3073
18		1831	58°31'	60°12'	3600
19		1930	58°44'	60°03'	3715
20		2035	58°58'	59°50'	6428
21		2135	59°11'	59°39'	4090
22		2250	59°25'	59°27'	4298
23	20.11.90	0004	59°40'	59°13'	2142
24		0108	59°52'	59°02'	5930
25		0209	60°06'	58°49'	3490
26		0321	60°20'	58°36'	3868
27		0421	60°33'	58°23'	3912
28		0526	60°47'	58°11'	4266
29		0633	61°00'	57°58'	4910
30		0739	61°14'	57°45'	2499
31		0840	61°27'	57°33'	903
32		0945	61°41'	57°18'	399
33		1042	61°54'	57°10'	259
34		1201	62°06'	57°26'	743
35		1315	62°13'	58°02'	1280
36		1403	62°17'	58°24'	1100
37		1501	62°17'	58°44	464

Table 2.4: *XBT-Section Antarctica - South Africa*

St. No.	Date	Time GMT	Position Lat S	Position Long W	Depth m (uncorr.)
106	20.12.90	0406	68°11'	04°28'	4086
107		1000	67°45'	03°09'	4283
108		1435	67°32'	01°04'	>4000
109		1717	67°15'	00°24'	3451
110		1920	67°00'	00°52'	>4500
111		2220	66°30'	01°49'	4080
112	21.12.90	0005	66°15'	02°21'	3680
113		0155	66°00'	02°51'	3390
114		0340	65°45'	03°17'	3669
115		0625	65°15'	03°21'	2627
116		0744	65°00'	03°23'	2530
117		0906	64°45'	03°26'	
118		1031	64°30'	03°29'	2177
119		1157	64°15'	03°31'	2600
120		1316	64°00'	03°34'	3159
121		1411	63°45'	03°36'	4365
122		1601	63°30'	03°37'	4940
123		1722	63°15'	03°41'	5055
124		1844	63°00'	03°44'	5360
125		2001	62°45'	03°31'	5340
126		2125	62°30'	03°16'	5378
127		2240	62°15'	03°02'	5372
128		2355	62°00'	02°49'	5380
129	22.12.90	0120	61°45'	02°34'	5378
130		0230	61°30'	02°20'	5376
131		0350	61°15'	02°07'	5122
132		0510	61°00'	01°53'	3341
133		0607	60°48'	01°42'	5400
134		0745	60°30'	01°27'	4181
135		0902	60°15'	01°15'	4303
136		1136	59°45'	00°51'	4924
137		1245	59°30'	00°39'	>4200
138		1517	59°00'	00°14'	4488
139		1637	58°45'	00°02'	4599
140		1800	58°29'	00°12'	4428
141		1905	58°15'	00°22'	3885
142		2010	58°00'	00°34'	3900
143		2135	57°45'	00°45'	4210
144		2250	57°30'	00°58'	3905
145	23.11.90	0006	57°15'	01°10'	3368
146		0235	56°45'	01°33'	3563
147		0350	56°30'	01°44'	4187
148		0504	56°15'	01°55'	4045
149		0640	55°58'	02°09'	3386

150		0745	55°44'	02°18'	3371
151		0855	55°30'	02°29'	2640
152		1013	55°15'	02°41'	2460
153		1124	55°01'	02°51'	3143
154		1244	54°45'	03°03'	2645
155		1356	54°30'	03°14'	2606
156		1835	54°20'	03°24'	2702
157		1915	54°15'	03°15'	2400
156		2120	54°00'	02°36'	2495
157		2317	53°45'	01°59'	2040
158	24.12.90	0110	53°30'	01°25'	2658
159		0305	53°15'	00°50'	2358
160		0416	53°05'	00°29'	2600
161		0454	53°00'	00°19'	2481
162		0645	52°45'	00°15'	2720
163		0820	52°30'	00°46'	2800
164		1015	52°15'	01°19'	2800
165		1204	52°00'	01°52'	2600
166		1355	51°45'	02°24'	3053
167		1545	51°30'	02°57'	3485
168		1735	51°15'	03°28'	3390
169		1825	51°00'	04°00'	3608
170		1950	50°57'	04°06'	3553
171		2125	50°45'	04°30'	3231
172		2314	50°30'	05°02'	3349
173	25.12.90	0145	50°15'	05°33'	3659
174		1120	50°00'	05°58'	3711
175		1300	49°45'	06°11'	3519
176		1440	49°30'	06°23'	3500
177		1625	49°13'	06°37'	3464
178		1830	49°00'	06°48'	3684
179		2036	48°45'	07°02'	3890
180		2245	48°29'	07°15'	2182
181	26.12.90	0039	48°15'	07°27'	2465
182		0247	47°59'	07°43'	4158
183		0430	47°45'	07°53'	3090
184		0630	47°30'	08°05'	2550
185		0819	47°15'	08°18'	1837
186		1004	47°00'	08°31'	3452
187		1152	46°45'	08°43'	3685
188		1337	46°30'	08°55'	4420
189		1520	46°15'	09°07'	4680
190		1655	46°01'	09°19'	4650
191		1850	45°45'	09°32'	4563
192		2230	45°30'	09°43'	4513
193		2220	45°15'	09°55'	4610
194	27.12.90	0005	45°00'	10°08'	4710
195		0144	44°45'	10°20'	4748
196		0321	44°30'	10°31'	4981
197		0509	44°15'	10°43'	4231

198		0647	44°00'	10°55'	4305
199		0930	43°45'	11°07'	4409
200		1120	43°28'	11°19'	4980
201		1250	43°15'	11°31'	4591
202		1430	43°00'	11°43'	4703
203		1610	42°45'	11°55'	4505
204		1742	42°30'	12°06'	4606
205		1933	42°13'	12°20'	3239
206		2048	42°00'	12°29'	5102
207		2217	41°45'	12°40'	3329
208		2349	41°30'	12°51'	2930
209	28.12.90	0013	41°15'	13°02'	2100
210		0140	41°00'	13°10'	4500
211		0322	40°45'	13°22'	4626
212		0506	40°30'	13°36'	4934
213		0652	40°15'	13°48'	4842
214		0835	40°00'	13°59'	4135
215		1010	39°45'	14°10'	4679
216		1321	39°29'	14°21'	4760
217		1453	39°13'	14°31'	4730
218		1514	39°00'	14°40'	4744
219		1657	38°57'	14°51'	4853
220		1830	38°29'	15°04'	4856
221		2253	37°51'	15°33'	4866
222		2335	37°45'	15°37'	4396
223	29.12.90	0104	37°30'	15°49'	4788
224		0229	37°15'	15°58'	4708

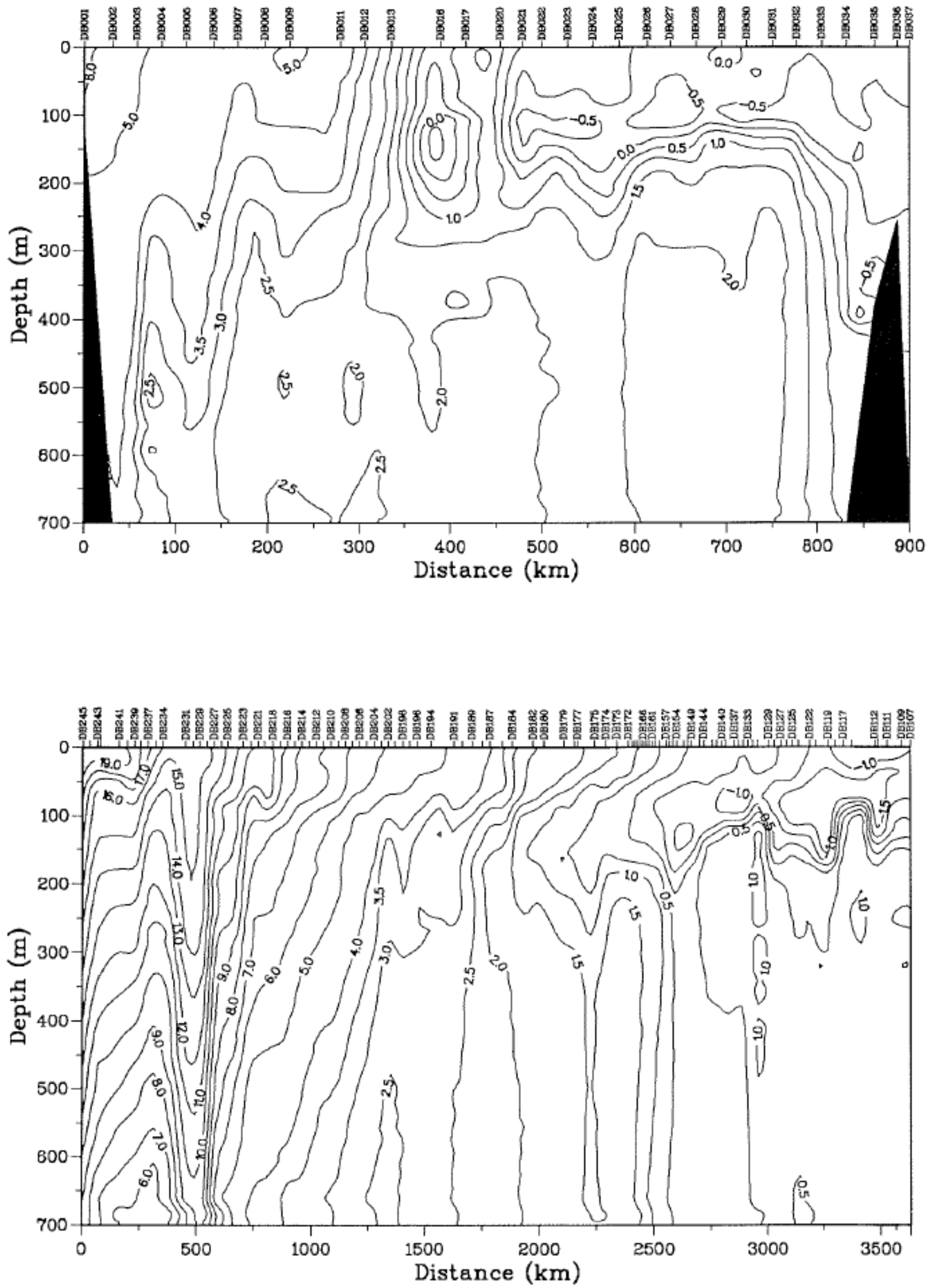


Figure 2.14: *XBT sections across Drake Passage (top) and from Antarctica to South Africa (bottom) carried out during ANT IX/2. For location see Figure 2.1.*

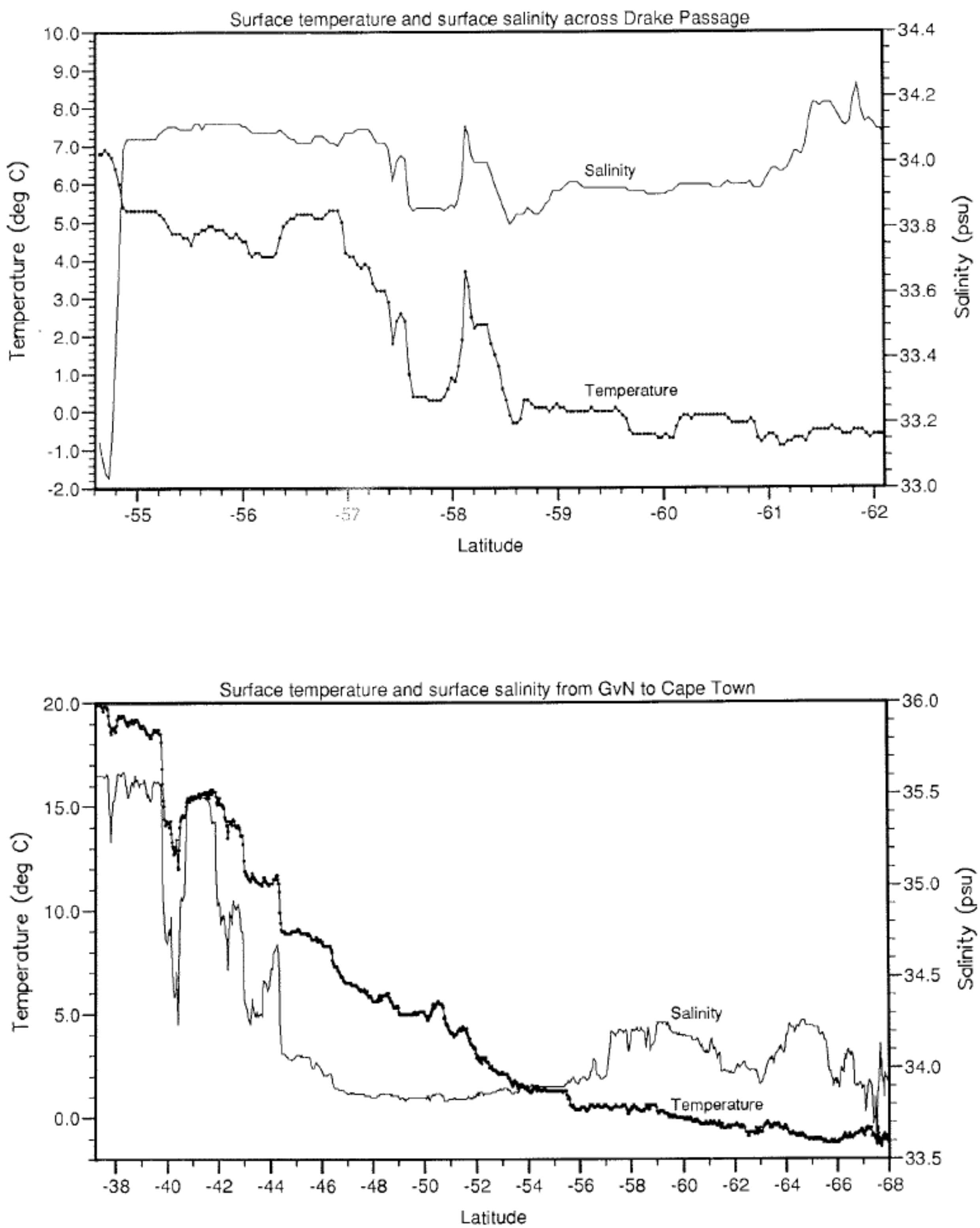


Figure 2.15: *T/S-profiles across Drake Passage (top) and from Antarctica to South Africa (bottom) measured with a thermosalinograph during ANT IX/2. For location see Figure 2.1.*

3. CHEMISTRY

3.1. Measurements of biogenic sulfur compounds and their reaction products in sea water and the marine atmosphere

R. Staubes (IfMG)

Objectives

Oceanic emissions of biogenic sulfur gases like dimethyl sulfide (DMS), carbonyl sulfide (COS), carbon disulfide (CS_2) and methyl mercaptan (CH_3SH) constitute a major flux of sulfur to the atmosphere, a source which is believed to be responsible for the background levels of SO_2, non-sea salt sulfate and methanesulfonic acid. These compounds are important factors in cloud chemistry and global climate as contributors to cloud condensation nuclei. The dominant sulfur compound released from the oceans and thus the most important precursor of non-sea salt sulfate is considered to be DMS which is produced from metabolic processes in certain algae.

Work at sea

During ANT IX/2 we performed simultaneous measurements of dimethyl sulfide (DMS), carbonyl sulfide (COS), carbon disulfide (CS_2) and methyl mercaptan (MeSH) in sea water and the atmospheric boundary layer. The concentrations of the main reaction products sulfate and methanesulfonate in aerosols in the atmosphere were determined. The air samples were collected at the front of the ship's upper deck; to minimize the influence of the ship two outriggers were fixed at the rail. Aerosols were sampled on filters; the analysis of the ion concentration in the aerosols will be carried out in the laboratory in Frankfurt. The seawater samples were taken from the ship's continuous seawater pumping System. The concentration of atmospheric and dissolved DMS, COS, CS_2 and MeSH were analyzed by means of a gas chromatographic system equipped with a flame photometric detector. Biological data of the seawater have been collected during the cruise to aid the Interpretation of the findings. Due to our participation in the cruise legs ARK Vll/2, ANT IX/1 and ANT IX/2 of "Polarstern" the concentration profiles of atmospheric and dissolved DMS, COS, CS_2 and MeSH could be examined from 82°N to 71°s.

Preliminary results

The data show that DMS is the dominant sulfur gas in all sea water samples examined, with smaller amounts of COS, CS_2 and MeSH in sum accounting for less than 20% of the observed sulfur in seawater. Atmospheric DMS in the boundary layer was characterized by a significant spatial variability, while COS was distributed fairly homogeneously along the cruise. Traces of biogenic sulfur gases other than DMS and COS were found only in a limited number of atmospheric samples.

3.2. Measurements of the concentration of Nitric acid, Ammonia and Ammonium Nitrate in the marine atmosphere

T. Papenbrock (RUB)

Objectives

Nitric acid (HNO_3) is a final, stable product of atmospheric NOx and HOx chemistry. One third of the acid rain is caused by nitric acid. Hence, nitric acid is an important indicator for two of the most important cycles in clean and polluted air. Ammonia (NH_3), one of the most important bases in air, is mainly produced by biological processes, It has been found in clean and polluted air, even in the marine atmosphere, for example in the Sargasso Sea. Ammonium nitrate participates in the acid-base equilibrium with gaseous nitric acid and ammonia. This equilibrium depends on temperature and relative humidity of the air masses. For a better understanding of the concentration distribution of these three components and the equilibrium in the atmosphere, it is important to do simultaneous measurements.

Work at sea

Our method for measuring the concentration of nitric acid and ammonia in air is based on laser photolysis yielding excited OH and NH radicals. The fluorescence intensities of the two species are taken as a measure for the nitric acid and ammonia mixing ratios in the atmosphere. At present the detection limits for long integration times (one hour) is 0.04 ppbv for nitric acid and 0.3 ppbv for ammonia, respectively. Our method allows direct and continuous measurements. To examine the concentration of ammonium nitrate in air we took Denuder probes with sampling times between 40 and 64 hours. The air was sampled at the front of the ship's upper deck and pumped through an 8-meter long Teflon tube to the photolysis cell. The analysis of the samples will be performed in our home laboratory after the cruise.

Preliminary results

The highest nitric acid and ammonia concentrations were measured in the Strait of Magellan after leaving Punta Arenas. The maximum values were 250 pptv for nitric acid and 600 pptv for ammonia, respectively. During the following days the concentrations slowly decreased with north-westerly winds. Then the wind changed direction and we measured air masses coming from the east. The concentrations decreased very quickly with the values often below the detection limits. Due to our participation in the cruise legs ARK VII/2 and ANT IX/1 and 2 of "Polarstern" in 1990, the concentration profiles of atmospheric gaseous nitric acid and ammonia could be examined from 82°N to 70°s.

3.3. Organobromine compounds in the ocean and atmosphere

T. Bluszcz, O. Schrems (AWI)

Objectives

A considerable amount of the bromine which is present in the atmosphere originates from natural sources. The oceans are important sources for methyl bromide (CH_3Br) and bromoform (CHB_3). These are compounds which are produced by marine macro-algae. Anthropogenic emissions of organobromine compounds like the halons 1301 (CF_3Br) and 1211 (CF_2ClBr), how- ever, are responsible for the increase of the bromine concentration in the stratosphere due to their long life times. So far, halons have very low concentrations in the atmosphere, but show an increasing tendency. Increasing production and emission rates of these chemicals can be expected in the future. Therefore, these anthropogenic source gases are a potential reservoir for stratospheric bromine radicals which are efficiently involved in the catalytic ozone depletion cycles. On the other hand a significant ozone depletion potential of the biogenic organobromine compounds has to be considered for the lower stratosphere. The objective of our work is to obtain horizontal concentration profiles of various volatile organobromine compounds during legs 1, 2 and 4 of the "Polarstern"-cruise ANT/IX. The profiles will provide information about the global distribution of these compounds, as well as information about the biogenic and anthropogenic contributions to stratospheric ozone depletion catalyzed by bromine radicals. In order to investigate the air-sea exchange of bromine compounds we collected also surface water samples for later analysis.

Work at sea

The air samples were taken 20 m above sea level through a short 1/4" Teflon tube. Gas chromatographic analyses of the samples were performed in the air chemistry container at the upper deck of the ship. During sampling the wind direction was carefully checked in order to avoid contamination of the air samples by the ship. The applied sampling method was cryogenic preconcentration of the samples by means of liquid argon as coolant. The air was pumped at a constant flow rate through a U-tube (filled with silylated glass wool) which was kept in a dewar containing liquid argon. In this way the trace gases were frozen out inside the U-tube. Prior to the condensation of the trace gases the air moisture was removed by means of a permeation gas dryer or a cold trap kept at -20°C The samples were transferred from the U-tube to a focusing column and from there injected into the GC. The gas chromatographic separation of the components was achieved with a fused silica capillary column. For the analyses of these halogen-containing samples the GC was equipped with a highly sensitive electron capture detector (ECD). During the leg ANT IX/2 about 120 air samples were directly measured with the gaschromatograph installed in the air chemistry container. For control measurements and application of other analytical methods in the home laboratories an additional air sample was collected daily, sealed and stored at low temperature. Gas chromatography-mass spectrometry (GC-MS) coupling and GC-FTIR coupling will be applied at home for the complete identification of the peaks in the gaschromatogrammes. For the investigation of the air-sea exchange of the bromine species water samples have been taken from the seawater line at about 60 stations and also kept at low temperature. These samples will also be analysed in the home laboratory.

Preliminary results

At the beginning of the cruise we tested several variations of our air sampling technique. Removal of the air moisture by means of a cold trap (-20°C) prior to the condensation of the trace gases turned out to be the most suitable procedure for preparing the air samples. By comparison with calibrated standards of CH_3Br, $CHBr_3$, CF_3Br and CF_2ClBr we could perform a preliminary quantification of the samples. It was found that these compounds are present in the marine troposphere at concentrations in the low pptv range. A listing of the compounds according increasing concentrations provides the following order: CF_3Br < CF_2ClBr < CH_3Br < $CHBr_3$. The final evaluation and statistical treatment of the gaschromatogrammes will be performed in the home laboratory.

3.4. Biogeochemistry of Silica

L. Goeyens, (VUB); J. Krest, A. ROSS, (OSU); A. Leynaert, B, Quéguiner, O. Ragueneau, (IEM); L. Lindner, (RUU)

Objectives

During EPOS Leg 2, high biogenic silica production rates have been measured in the marginal ice zone of the western part of the Weddell Sea and at one station in the Scotia Sea. Comparison with previous studies conducted in the Antarctic Circumpolar Current and in the Ross Sea indicated that the dynamics of silicon in the above mentioned subsystems are quite different. The present study was initiated to bring more information on the importance of the Weddell Sea ecosystem in the silicon budget of the Southern Ocean.

Work at sea

Eleven stations were sampled in the Weddell Sea (from 63°12'S, 53°41'W to 71°06'S, 11°23'W) at depths ranging from 0 to 300 m. For production experiments, sampling depths were determined with reference to quantameter profiles (respectively 100%, 25%, 10%, 3%, 1% and 0.1% of surface incident light measured as PAR). 24h incubations were conducted in a deckincubator where *in situ* light was simulated by using different transmission neutral filters. The deck-incubator was cooled by running surface water.

Additional depths were sampled to obtain complete profiles of particulate organic carbon, particulate organic nitrogen, biogenic silica, chlorophyll a and nutrients (silicate, nitrate, nitrite, ammonium, phosphate) in the upper 300 m at each station. At each photometric depth the production of biogenic silica was measured by means of stable silicon (^{30}Si) and radioactive silicon (^{32}Si) uptake experiments. For the latter, size-fractionation (on 0.4 and 10 µm filters) was performed at the 25% light level. The radioactive ^{32}Si-silicate enables us to measure phosphorus uptake rates also because it decays into radioactive ^{32}P-phosphate. Dissolution rates of biogenic silica were followed in parallel with production measurements by using the stable ^{29}Si method. The carbon production was measured with the classical ^{14}C method. The nitrogen production was measured only in surface water using the ^{15}N procedure. Phytoplankton samples were collected (lugol fixation) only at depths where production experiments were done and further phytoplankton samples were taken by means of a vertical net in order to estimate the Al/Si content of diatoms.

Preliminary results

For most of the stations production results must be considered as maximum potential production rates because of the importance of ice cover during the cruise (especially for Sta. B3 to B9). In those conditions natural phytoplankton populations experience a different light regime (with periods of darkness under ice) from the one used during incubations.

The distribution of major nutrients indicates weak biological activity during the study period. Surface water silicate, nitrate and phosphate concentrations were respectively about 80 µM Si-$Si(OH)_4$, 30 µM N-NO_3, 2 µM P-PO_4. As far as ammonium is concerned the measured concentrations were always very low. They almost never amount more then 0.2 µM N-NO4; some stations, near 65°s - 66°S, show, however, a slight increase in ammonium concentration and a corresponding decrease in surface nitrate. But still nitrate concentrations are as high as 27 µM N-NO_3 in this area. In general these stations were also characterized by a slightly increased phytoplankton production. Preliminary results of ^{14}C uptake experiments indicate low levels of primary production. Maximum uptake rates in a given depth were encountered in surface waters (range : 0.15-0.54 mmol C.$m^{-3}d^{-1}$). The lowest rates were observed at the ice-shelf station where the euphotic layer reached down to 138 m. Maximum rates were measured at station B5 (31°47' W, 66°07' S) and ice-edge station B11 (03°57' W, 68°00' S). Depth-integrated production rates (Table 2.5) ranged between 12.2 and 26.2 mmol C $m^{-2}d^{-1}$ (146-314 mg C $m^{-2}d^{-1}$). These low values can be related both to the importance of the ice cover and the low temperatures which must prevent the emergence of large phytoplankton developments at this period of the year. First results obtained by the ^{32}Si method indicate low uptake rates both for phosphorus and silicon (Table 2.5), as well as for carbon uptake. Silica production rates range between 0.62-8.02 mmol Si $m^{-2}d^{-1}$. The highest rate was observed at station B1 and must be taken as characteristic of coastal water rather than the Weddell

Sea. At this station the >10 µm fraction accounted for 86.1% of silica uptake rates. The other stations fall within the lower part of the range of production rates that were measured during EPOS Leg 2. The same trend is observed for phosphorus for which the uptake rates range between 0.08-0.61 mmol P $m^{-2}d^{-1}$. At station B7 the $^{32}Si/^{32}P$ uptake experiment was conducted on brine (incubated under daylight conditions) and indicated uptake rates one order of magnitude higher than in the water column. Preliminary assimilation ratios, calculated from depth-integrated production rates, are given in Table 2.6. With the exception of station B4, C/P ratios range between 101.5-168.8, close to the Redfield ratio (C/P = 106). Sta. B1 to B3 exhibit the highest Si/P ratios which suggest the dominance of diatoms in phytoplankton populations. This is also indicated by the high Si/C ratios measured at Sta. B2 and B3. Sta. B5 and B6 are quite different with regards to the three ratios and exhibit low silicon uptake as compared to carbon and phosphorus which can be related to different phytoplankton populations (dominance of non-siliceous phytoplankton). Sta. B4 is different from the other stations, showing high phosphorus uptake relative to carbon and silicon but the high Si/C ratio which suggests the dominance of diatoms in phytoplankton as for the first stations.

Table 2.5: *Depth-integrated carbon, silicon and phosphorus production rates (in mmol C $m^{-2}d^{-1}$, mmol Si $m^{-2}d^{-1}$, mmol P $m^{-2}d^{-1}$, respectively)*

N° Sta.	C prod.	Si prod.*	P prod.* (*data from ^{32}Si method)
B1	-	8.02	-
B2	13.9	1.64	0.14
B3	13.0	1.11	0.08
B4	17.9	2.35	0.38
B5	22.0	1.17	0.19
B6	18.1	0.62	0.11
B7	13.1	-	-
B8	22.5		0.33
B9	26.2		0.33
B10	19.8		0.38
B11	12.2		

Table 2.6: *C/Si/P assimilation ratios calculated from depth-integrated production rates*

No Sta.	Si/C	Si/P	C/P
B1	-	13.0	-
B2	0.12	12.0	101.5
B3	0.09	14.4	168.8
B4	0.13	6.1	46.5
B5	0.05	6.1	115.8
B6	0.03	5.4	157.4

3.5. Biogeochemistry of Barium

L. Goeyens (VUB)

Objectives

Particulate Ba, as well as other elements like Ca, Sr and Si, trace former biological activity in the marine environment. More than for particulate carbon or nitrogen, the longer turnover time of particulate barium is of interest for its tracer properties. Whether Ba is taken up by organisms in an active or passive way is still a matter of debate. On the one hand active uptake was described in the literature, but on the other hand it was stressed that Ba precipitates in small microenvironments of cell and detritus aggregates as barite crystals. In any case barite crystals represent the major part of particulate Ba in the total suspended matter. During the remineralization process the organic matrix (of cells and/or aggregates) decays and sets the barite crystals free in the sea water, where sedimentation and slow dissolution take place. The presence and distribution of particulate Ba in the marine environment is, however, very dependent on assimilation and break down processes. In general a vertical Ba profile shows peak concentrations in the surface water and very often secondary peaks near the oxygen minimum. For this reason the study of the biogeochemical cycle of Ba is of interest for other parameters such as nutrients, oxygen, particulate carbon and nitrogen, chlorophyll *a*, and species distributions, but also for flux studies such as nutrient assimilation and regeneration.

Work at sea

The filtration of total suspended matter for particulate Ba, Ca, Sr, AI and Si analysis demands large amounts of sea water. Normally 10 liters are filtered; on previous cruises even more than 20 l were filtered. The total suspended matter (TSM) is collected on membrane filters, Millipore cellulose acetate filters or Nuclepore polycarbonate filters. They are simply dried at 60°C on board and stored in Petri dishes until analysis in the home lab.

During the ANT IX/2 cruise samples for TSM were taken at 9 stations. At every station the samples were selected according to the plankton distribution study, carried out by Baumann and Brandini. In general sampling covered the upper 500 to 600 m. The analyses will be carried out in the home lab by dissolution of the samples (filters) after $LiBO_2$ fusion and determination of the Ba (Ca, Sr, AI and Si) concentrations by ICP.

4. MARINE BIOLOGY

4.1. Energy flux at the base of the Antarctic food web

M. Baumann, F. Brandini, F. Kurbjeweit, (AWI) L. Goeyens, (VUB); J. Krest, A. ROSS, (OSU); B. Quéguiner, (IEM)

Objectives

The information concerning the Antarctic food web is mostly based on descriptive work such as spatiotemporal distributions of nutrients, primary production, phytoplankton biomass (chlorophyll), and zooplankton. To our knowledge, the energy flux from the primary producers to the primary consumers within the pelagic ecosystem is estimated only by means of such a descriptive approach. As an attempt to gain a more precise picture of the trophic relationships among the planktonic communities in Antarctic regions, we focused on the quantitative nitrogen transfer at the first and second trophic level using the stable isotope ^{15}N as a tracer. This study was carried out in terms of unialgal culture experiments using the common Antarctic copepod *Metridia gerlachei* as a primary consumer and six ^{15}N-labelled algal species as primary producers.

Work at sea

Five diatoms (*Thalassiosira* spp., *Nitzschia curta*, *Porosira glacialis*, *Rhizoso- lenia alata*, *Chaetoceros socialis*) and a prymnesiophyte (*Phaeocystis* spp.) were isolated from the plankton in the Weddell Sea. The species were grown in natural sea water without the addition of nutrients etc., except EDTA as a chelator. To one liter of 0.2 µm filtered sea water, 3.72 mg of EDTA were added. The stock cultures were stored at 1°C and 30 $\mu E\ m^{-2}d^{-1}$ continuous light. The copepod *Metridia gerlachei* was caught by means of a bongo net with mesh width of 100 µm. The animals were transferred by pipette into filtered seawater and allowed to starve for 48 hours before starting the experiments. The experiments were carried out in 5-1 Duran flasks at 1°C and 30 $\mu E\ m^{-2}d^{-1}$ continuous light. Every 24 hours the unialgal cultures were spiked with about four micromoles of $^{15}NH_4^+$ (97% ^{15}N). It was assumed that after three days the algae were labeled through out. A mixture of 500-ml aliquots of each experimental vessel served as a seventh culture. For the grazing experiment, 20 female copepods were added to each bottle. Sampling was performed according to Table 2.7.

Table 2.7: *Sampling scheme during the phytoplankton grazing experiment*

Parameter	0h	24h	48h	72h[1)]	96h	120h
POC/PON, NH_4^+	x			x		x
nutrients	x	x	x	x	x	x
cell number	x	x	x	x	x	x
Chl *a*				x		x
^{15}N in PON				x		x
^{15}N in NH_4^+				x		x
^{14}C - Assimilation				x		x
$^{15}NH_4^+$ - Addition	x	x	x	x		

[1)] Addition of 20 animals to each culture.

Due to the fact that most of the analyses will be done in the home labs, no results can be given here.

However, we hope that the experiments will provide information on the ammonia uptake of 6 of the common Antarctic phytoplankton species and on the extent *Metridia gerlachei* feeds on these species.

4.2. Phytoplankton biomass and species distribution

M. Baumann, F. Brandini (AWI)

Objectives

In marine environments, the availability of light and nutrients are important preconditions for the onset of phytoplankton development. The melting of ice along the marginal ice zones of the Weddell Sea during the spring/summer period increases both the mean light penetration and the vertical stability of the water column. Therefore, phytoplankton cells are maintained within the euphotic layer for longer periods, increasing the primary production along the receding ice edge. Moreover due to intense upwelling of the Warm Deep Water, the Weddell Sea is considered as one of the nutrient-richest waters of the World Ocean and there seems to be no evidence that the macro-nutrient concentrations may ever limit phytoplankton growth. During ANT IX/2 our objective was to examine the distributions of phytoplankton, chlorophyll, and particulate organic carbon and nitrogen (PON and POC) on a large-scale northeast-southwest transect across the Weddell Sea with special regard to the marginal ice zone. Due to the almost complete ice Cover in the area of the transect we could not perform more stations within the ice edge in order to resolve precisely the spatial gradients of biological Parameters usually observed in these areas. Most of our stations were located in heavily ice covered areas (8/10 to 10/10) with very low biological activity in the water column compared to the ice edge zones and to the ice associated communities.

Work at sea

A total of 21 stations were vertically sampled (10 depths) by means of a rosette sampler with an integrated CTD system, to determine phytoplankton biomass in terms of chlorophyll, cell counts, and PON/POC measurements. For the microscopical analyses of species composition, samples were obtained by vertical net hauls, with a mesh size of 20 µm. The microscopic analy- ses of unpreserved net samples were performed immediately after sampling. Light attenuation was estimated at each station with the Secchi-disk, not in order to determine the euphotic zone, but to get an idea about cell abundance.

Preliminary results

At three stations (39, 43 and 101) no meaningful estimate of the Secchi depth could be determined due to darkness and/or rough sea. The lowest value (17 m) was obtained on the western shelf at station 40, indicating a more developed state of the phytoplankton community, and the highest (55 m) was found on the shelf off the Antarctic Peninsula (Figure 2.16). Net samples were very poor during the whole transect and usually dominated by diatoms. At the first stations of the northeastern Part (e.g. Sta. 40, 45), species were dominated by *Corethron criophilum, Thalassiosira, Odontella, Nitzschia, Porosira glacialis, Rhizosolenia, Chaetoceros, and Coscinodiscus.* In the deep waters of the gyre, *Nitzschia spp, Rhizosolenia alata, Chaetoceros socialis* and dinoflagellates, such as *Gyrodinium* and *Gymnodinium,* were most frequent, whereas in the southeastern sector mainly *Coscinodiscus, Chaetoceros* and *Rhizosolenia* appeared.

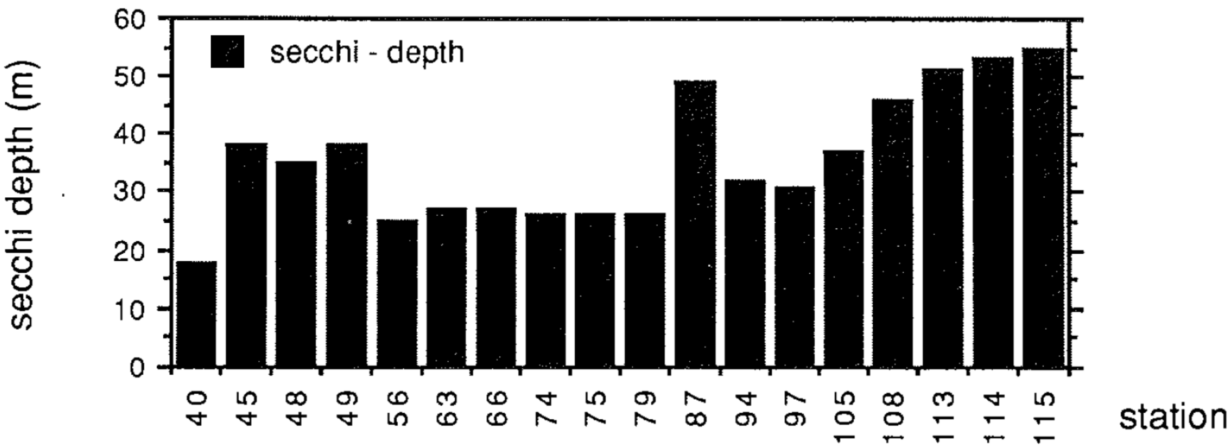


Figure 2.16: *Secchi depths measured during ANT IX/2.*

The nano-size cells were observed in the middle of the gyre (Sta. 66 and 75) after filtration of 500 ml of seawater from the euphotic zone on membrane filters (Sartorius Inc., 0.8 µm). The material was transferred to microscopic slides and observed under x1000 magnification. It turned out that mainly phytoflagellates of different groups (dinoflagellates, cryptophycean, prasinophycean) but also zooflagellates (choanoflagellates) dominated the samples. Within the smaller size category (< 10 µm) the diatoms were dominated by *Nitzschia cylindrus.* Ice algae samples were obtained at three different stations located in deep, near -slope, and the shelf areas along the cruise track. Ice algal communities over deep water were totally dominated by *Phaeocystis* spec. - no other algae could be found. The near-slope sample contained both *Phaeocystis* and diatoms, mainly *Nitzschia longissima, N. curta,* and other pennate species; the shelf sample was dominated by diatoms, the most characteristic species being *N. stellata, N. curta, N. closterium, Odontella weissflogii, Amphiprora spec.. Phaeocystis* could not be found in this sample. It might be suggested that species composition in the ice algae assemblages are related to depth of the water column, but this should be confirmed in further investigations.

4.3. DMS - Production by Antarctic phytoplankton species

M. Baumann, F. Brandini (AWI); R. Staubes (IfMG)

Objectives

It is well established that the oceans are a significant source of organic sulfur compounds, which are largely biogenic. The most important one is probably dimethyl sulfide (DMS), which is also produced by marine phytoplankton. It is suggested that DMS production is due mainly to dinophyceae and prymnesiophyceae. However, the importance of diatoms in this connection is still unclear and especially in polar regions has this aspect not been investigated. During ANT IX/2 the DMS production of eight dominant Antarctic phytoplankton species under several light- and temperature conditions was tested.

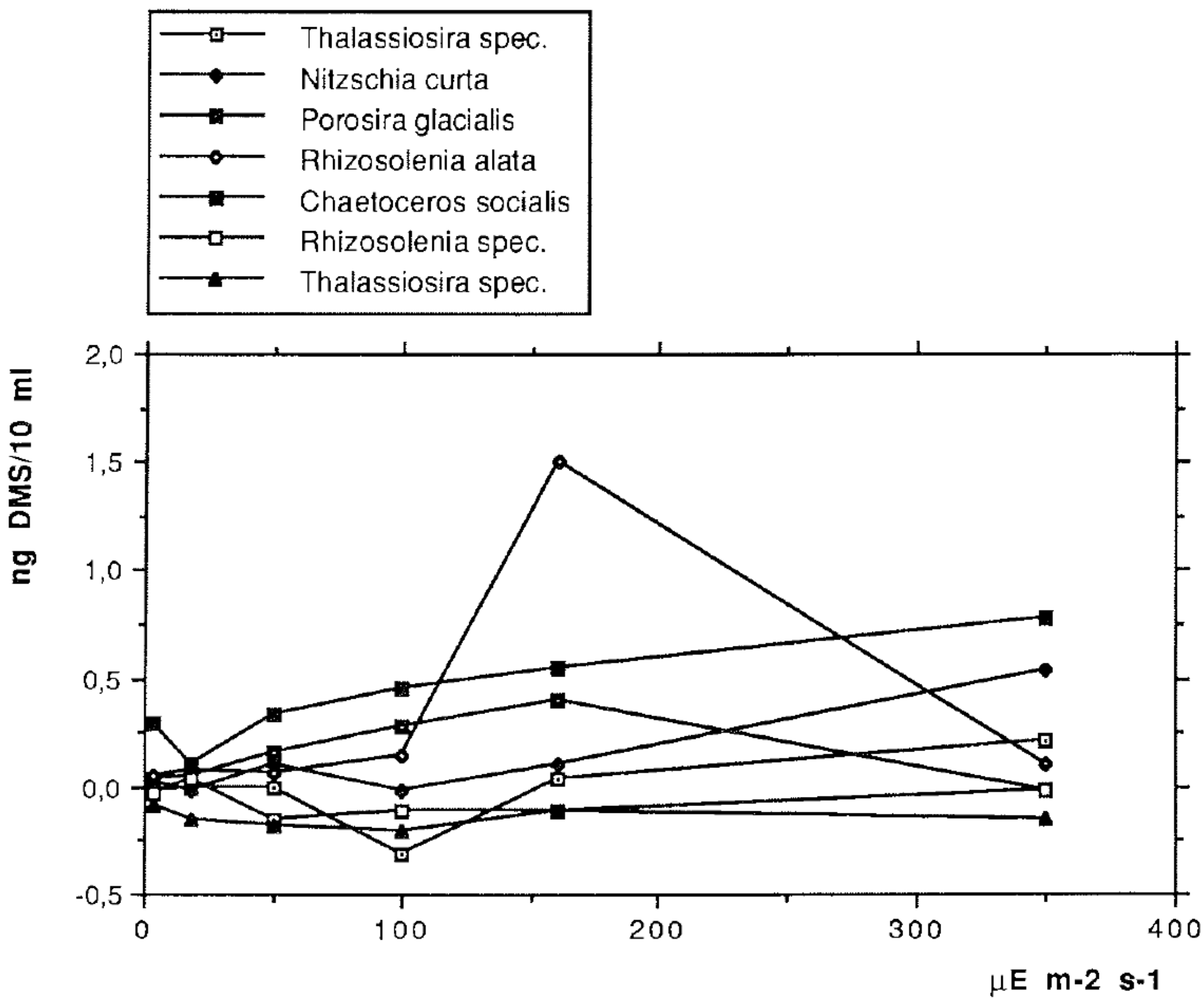


Figure 2.17: *Production of DMS by 7 Antarctic diatom species at 1°C and 6 different light conditions in 36 h. Because the initial value was subtracted, negative values occur in those samples where DMS was not produced.*

Work at sea

Seven diatom species (two *Thalassiosira* spp., *Nitzschia curta, Porosira glacialis, Rhizosolenia alata, Rhizosoleni* spp, *Chaetoceros socialis)* and a prymnesiophyte *(Phaeocystis* spp.) were isolated from the plankton of the Weddell Sea. The species were grown in natural seawater without the addition of nutrients etc., except EDTA as a chelator. 3.72 mg of EDTA were added. to one liter of sea water filtered with 0.2 µm. The stock cultures were stored at 1°C and 30 $\mu Em^{-2}s^{-1}$ continuous light. For the experiments, a 2 I culture medium with cells was shaken vigorously and distributed in 100 ml flasks. One aliquot was kept for a quantitative cell analysis and another for the determination of the initial DMS content. The experiments were carried out in an incubator which allowed the choice of six light conditions (350, 160, 100, 50, 18, and 3.5 $\mu Em^{-2}s^{-1}$) and two temperatures (1°C and -1.6°C). The DMS released by the algae after three days was analyzed according to the method described in 1.3.1.

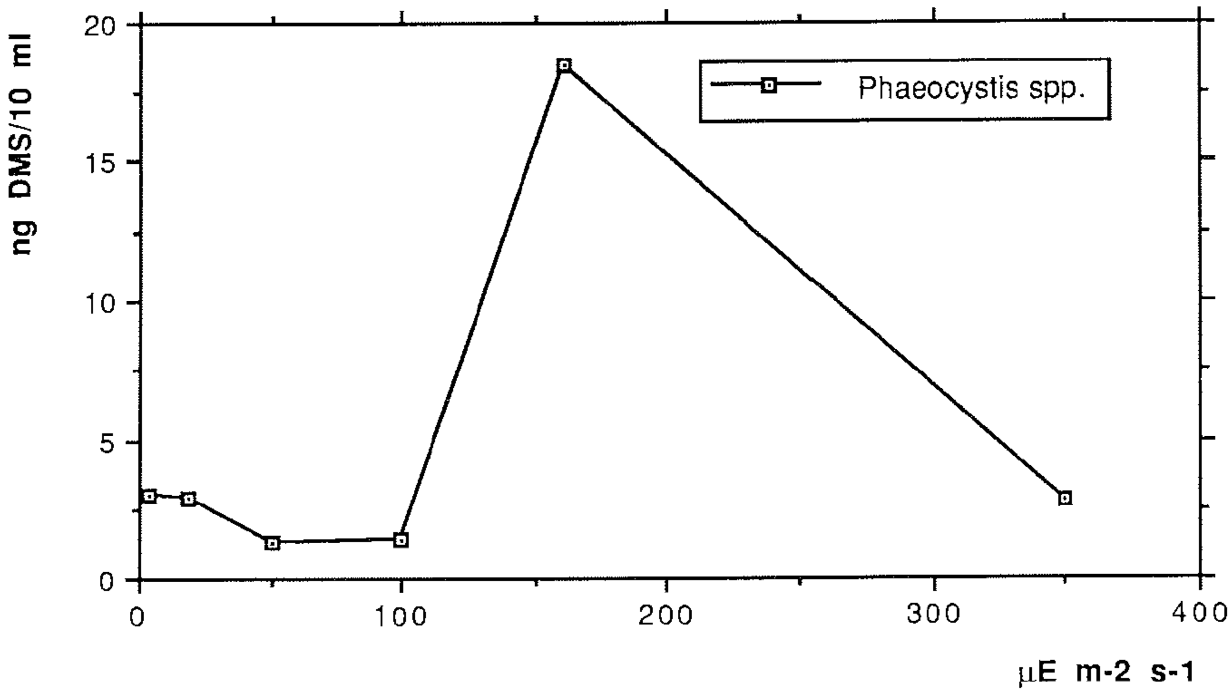


Figure 2.18: *Production of DMS by Phaeocystis spp. at 1°C and six different light conditions.*

Preliminary results

Figure 2.17 shows the preliminary results of DMS produced by the diatoms at 1°C Although the values still have to be related to cell numbers, one can see that except *Thalassiosira*- and the *Rhizosoleni* spp., all diatoms produced DMS; *Rhizosoleni alata* obviously released the greatest amount. Compared to diatoms, the prymnesiophyte *Phaeocystis* sp. produces significantly more DMS (Figure 2.18). While values for the diatoms range from 0.1 to 1.5 ng DMS/ 10 ml, the *Phaeocystis* culture produced up to 20 ng DMS/10 ml. Later we intend to express the results as DMS production per cell surface for better comparisons of production rates among species.

4.4. Effect of dissolved organic compounds derived from "brown ice" On the development of surface phytoplankton in the Weddell Sea

M. Baumann, F. Brandini, (AWI); J. Krest, A. ROSS (OSU)

Objectives

The blooming of phytoplankton cells in the ice edge zones of the Antarctic Ocean has been associated with a vertical stabilization of the surface water layers during ice melting. More recently, the seeding hypothesis has been claimed to be crucial for increasing phytoplankton biomass in the near surface layers, as algae from the brown ice are released in great quantities during the receding of the ice in early spring. However, it should be mentioned that the water column not only receives particulate material from the ice but also dissolved organic compounds making the seeding process much more complex than it is assumed.

According to recent studies on spatial distribution of phytoplankton in the ice edge zones, the dynamics of the blooming should be analyzed at two consecutive stages, starting with the ice associated species (*Nitzschia spp*., *Navicula spp., Amphiprora spp*., and *Fragillaria spp*.) immediately after the melting of the ice. Due to grazing pressure and the rapid sinking of cells - ice algae are strongly silicified and therefore heavier than planktonic species - the phytoplankton composition in the ice edge shifts from an ice algae characterized community to a more holoplanktonic community (*Thalassiosira spp*., *Rhizosoleni spp*., *Chaetoceros spp*., and *Corethron criophilum*). We believe that the development of this second stage is strongly related to the input of great amounts of dissolved organic compounds, derived from the "brown ice" community, into the surface water. The dissolved organic material possibly acts as chelators for essential trace metals (Fe, Mn, etc.), improving the development of planktonic diatoms. Although the stimulating effect of the melted "brown ice" on the phytoplankton development was previously mentioned, it seems that hitherto no proper attention has been paid to this. Therefore, during ANT IX/2 we decided to test the potential stimulating effect of dissolved organic material from "brown ice" on the development of the natural phytoplankton of the Weddell Sea.

Work at sea

For testing the effect of DOM from melted ice samples on the potential growth of natural phytoplankton populations, two different "brown ice" (BI 1, BI 2) samples were taken. The analysis of species composition and the contents of the macro-nutrients revealed that they differed both in microalgal community structure and nutrient contents. BI 1 was totally dominated by *Phaeocystis* colonies and BI 2 by a mixture of *Phaeocystis* and diatoms. The growth potential of natural phytoplankton from surface seawater was experimentally tested as follows:

1: 800 ml SSW[1)] + 200 ml FSW[2)]
2: 800 ml SSW + 200 ml FSW + EDTA
3: 800 ml SSW + 200 ml melted BI 1
4: 800 ml SSW + 200 ml melted BI 2

1) surface seawater
2) filtered seawater

All experiments were done in duplicates (A, B). 200 ml of SSW were added to the control (1 A/B) and EDTA flasks to avoid dilution effects of initial cell concentrations. The experimental flasks were kept at 1°C and 30 $\mu Em^{-2}s^{-1}$. Sampling for cell counts and nutrient concentrations (nitrate, phosphate and silicate) was performed every two days for two weeks. Cell numbers were estimated on board after filtration of 50 ml culture medium on cellulose acetate filters (pore size 0,8 µm). If performed very gently, the cells are not destroyed by this procedure and can be counted with a standard microscope directly on the filters. Total nano-size and macro-size diatoms were counted in the same unit area of the filters and hence results are expressed on a relative basis. Nutrient analyses were carried out on board with the aid of an autoanalyzer.

Preliminary results

Initial cell concentrations in all experimental flasks averaged 200 relative units, and were dominated by *Nitzschia curta*, *N. cylindrus*, *N. kerguelensis*, *Chaetoceros dichaeta*, *Chaetoceros spp*., *Pseudonitzschia spp*., *Corethron criophilum*, unidentified centric and pennate diatoms. Total diatoms and two different size classes of *Nitzschia spp*. were considered to represent biomass development. The nano-size *Nitzschia cylindrus* numerically dominated all the experimental approaches. Figure 2.19 shows clearly the stimulating effect of DOM, derived from both melted BI 1 and BI 2 on growth rates in comparison with the control and EDTA-added flasks. From the differences between cell concentrations after 12 days it might be assumed that DOM derived from diatom - dominated "brown ice" (4 A,B) had a stronger effect on cell doubling rates than DOM from *Phaeocystis* - dominated "brown ice". In contrast to that no significant differences can be observed when the control and the EDTA added bottles are compared.

Initial nutrient concentrations (Figure 2.20) may not be considered limiting for phytoplankton growth as phosphate, silicate, and total inorganic nitrogen averaged respectively 2.0, 66.9, and 27.8 µmol l^{-1}. Ammonium was significantly higher in the DOMIB II- flasks (4 A,B), but decreased to comparatively low concentrations in all experiments after 48 hours.

From these preliminary results it may be concluded that DOM released from the "brown ice" of the Weddell Sea certainly has a stimulating effect on cell growth that hitherto has been neglected. We believe that these results represent baselines for future experimental approaches to provide a more detailed picture of the seeding mechanism and its impact on the blooming of the phytoplankton along the receding ice edge zones of polar seas.

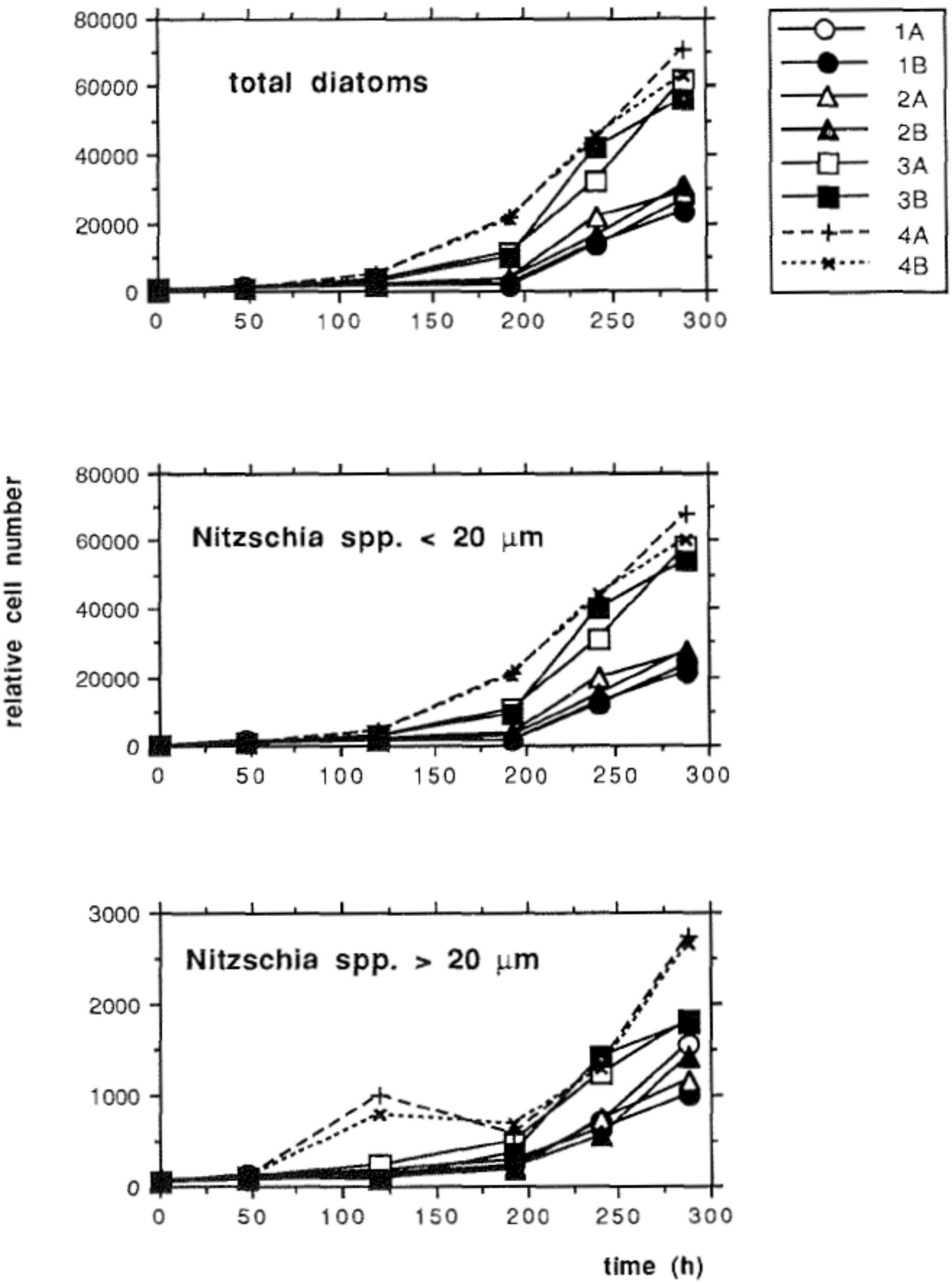


Figure 2.19: Cell increase during the DOM - experiment

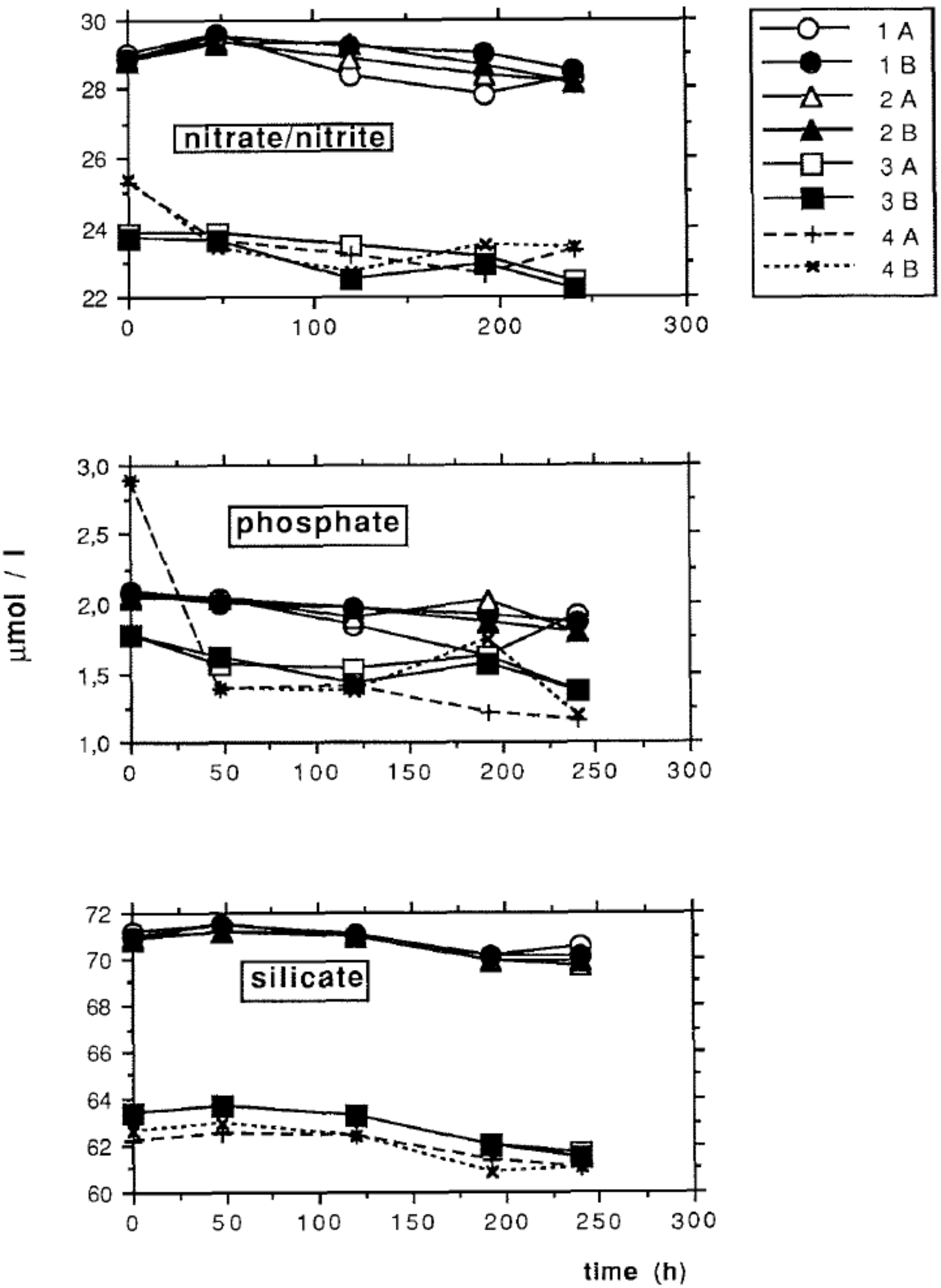


Figure 2.20: Changes in nutrient concentrations during the DOM-experiment

4.5. Reproduction and life cycles of dominant copepods in the Weddell Sea

F. Kurbjeweit (AWI)

Objectives

Besides krill (i.e. *Euphausia superba)* and salps, copepods play the most important role as secondary producers in the pelagic System of the Antarctic and the Weddell Sea. Several Papers have dealt with the distribution and abundance of calanoid copepods in the Antarctic in general, but our knowledge about their distribution, abundance, reproduction and their life cycles are sparse concerning the Weddell Sea. The first aim of this investigation is to examine the distribution and abundance of dominant calanoid copepods such as *Metridia gerlachei, Microcalanus pygmaeus, Stephos longipes, Calanus propinquus* and *Calanoides acutus* in space and time in the Weddell Sea during spring and summer. Due to the short period of primary production in this area, it is of major interest to investigate their reproduction Pattern and to obtain if their reproduction is food limited quantitatively as well as qualitatively. With additional biochemical Parameters and Information about the hydrography it might be possible to develop schemes for their life cycles and their role as secondary producers in the pelagic System.

Work at sea

During ANT IX/2 on the transect from the Antarctic Peninsula to Atka Bay the distribution and abundance of dominant copepods in the upper 1000m of the water column was examined on 13 stations by means of a multinet (100 µm mesh size, 0.25m2 opening area). Samples from five depth Strata at each station were preserved in 4% buffered formaldehyde for future investigation of Stage distribution of the above mentioned copepod species and the examination of gonadal development of their females. For the second part of the investigation a bongo net (10Opm mesh size; 60cm diameter) was lowered on 10 stations to 300m for getting undamaged females for reproduction experiments. Females from the most abundant copepod species were incubated on four stations under in situ conditions in surface water. In addition females of C. *acutus, M. gerlachei* and *S. longipes* were starved in 0.2 pm Nucleopore filtered seawater for up to two weeks. Later On, enhancement of reproduction was attempted with high concentrations of mixed algae, mainly diatoms and the prymnesiophyte *Phaeocystis* sp.. On two stations respiration of female copepods of S. *longipes, C. acutus, C. propinquus* and *M. gerlachei* were measured to evaluate their metabolic demands. As additional parameters for the Interpretation of the reproductive potential of the animals under investigation, samples were taken for dry weight, CIN-content, digestive enzymes (trypsin and amylase) and lipids, which will be examined in the laboratory at home.

Preliminary results

The small copepod species S. *longipes* was found on merely three stations in high numbers, namely on the first station (station 40) on the shelf of the Antarctic Peninsula and on the last two stations close to the ice shelf in the southeast (Sta. 108, 11 5). M. *pygmaeus,* the other small calanoid copepod of about one millimeter in length, was found only on two stations in low numbers (63 and 94), while C. *acutus* and *M. gerlachei* were abundant on almost all stations. *C. propinquus* was dominant only on stations in the central part of the Weddell Gyre. Besides these copepods on almost all stations cyclopoid copepods of the genera *Oncaea* spp. and *Oithona* spp. were predominant in the micro- and smaller meso-zooplankton size classes. However, radiolarians were also important on all stations, partly clogging nets and acting as a trap for most of the other zooplankton organisms. On station 115 in an inlet at the ice shelf juveniles of *Pleuragramma antarcticum* (pers. comm. Kellermann) dominated the haul.

In situ egg production experiments on five stations (63, 87, 94, 108, 115) carried out for over 24hrs in ambient surface water showed that *C. acutus,* C. *propinquus* and *M. gerlachei* produced well in the southeastern Weddell Sea close to the ice shelf (Sta. 108 and 115), whereas the reproduction of these species decreased with increasing distance from it (Figure 1.22). Except on station 63, where none of the four incubated copepod species reproduced (M. *Iongipes* was used only here) *C. propinquus* laid the most eggs followed by *C. acutus* and *M. gerlachei* (Figure 2.21). The maximum egg production per day of *C. propinquus* was 15.8, of *C. acutus* 10.1 and for *M. gerlachei* 7.6, respectively. Whether a correlation with chlorophyll concentrations in the water column exists, still has to be proved.

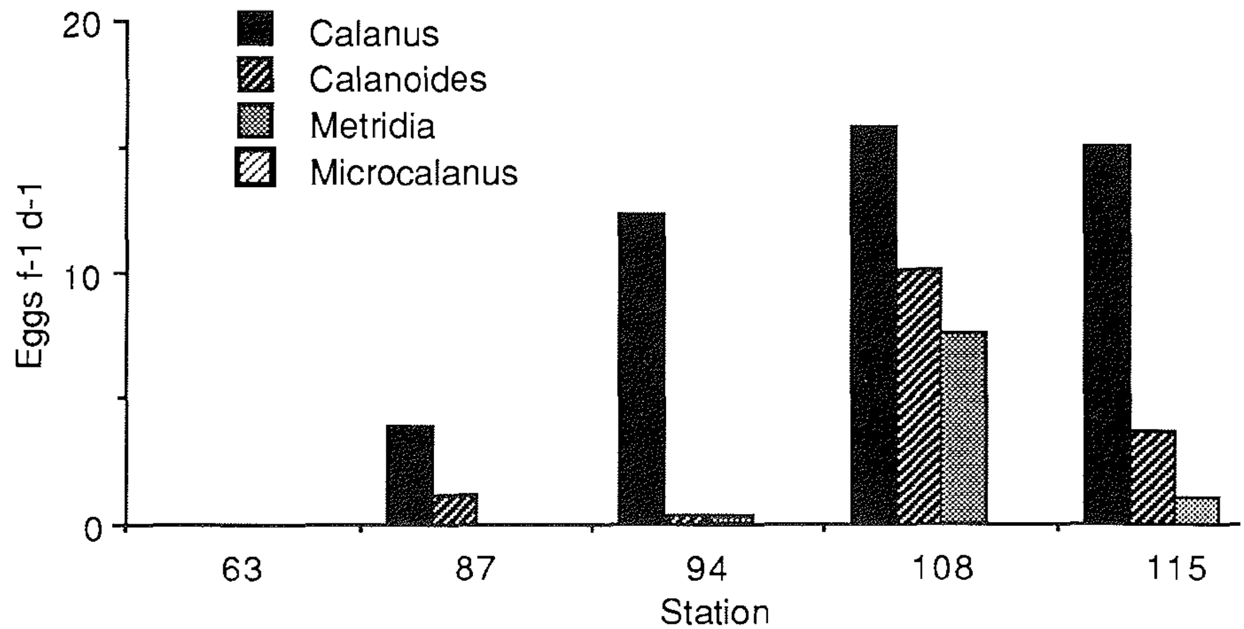


Figure 2.21: *Intubation of the four dominant copepods Calanus propinquus, Calanoides acutus, Metridia gerlachei and Microcalanus pygmaeus (only on Sta. 63) on a transect from the central part (Sta. 63) of the Weddell Sea to Atka Bay in the southeast (Sta. 115).*

Egg production experiments with *S. longipes* (station 40) under starvation in egg separation chambers showed no significant egg production within 7 days. After the addition of mixed algae, mainly diatoms a) without and b) with *Phaeocystis sp.,* the mortality rate was higher in the latter one, but in both incubation series no eggs were laid. In contrast, *S. longipes* was able to produce 2.8 eggs per day (sd = ±2.0) in tissue culture vessels of only about 3ml volume for three days with *Chaetoceros socialis* as food source. Its maximum clutch size was 8. Furthermore, *Microcalanus pygmaeus* produced an average of 7.5 eggs per day (sd = ±3.0) even without food supply to the culture vessels for four days. After that time the mortality rate increased dramatically and no eggs were produced anymore. Its maximum clutch size was 11.

On two stations, 45 and 48, 16 females of *C. acutus* were incubated in 0.2 µm Nucleopore filtered seawater to see for how long they could sustain egg production from preconsumed energy reserves. Although variability in egg production was high on both stations, the cumulative egg production for all females combined for each station leveled off after 10 to 11 days (Figure 2.22). The maximum number of eggs produced on station 45 and 48 was 1355 and 955, or 253 and 195 as maximum numbers for a single female, respectively.

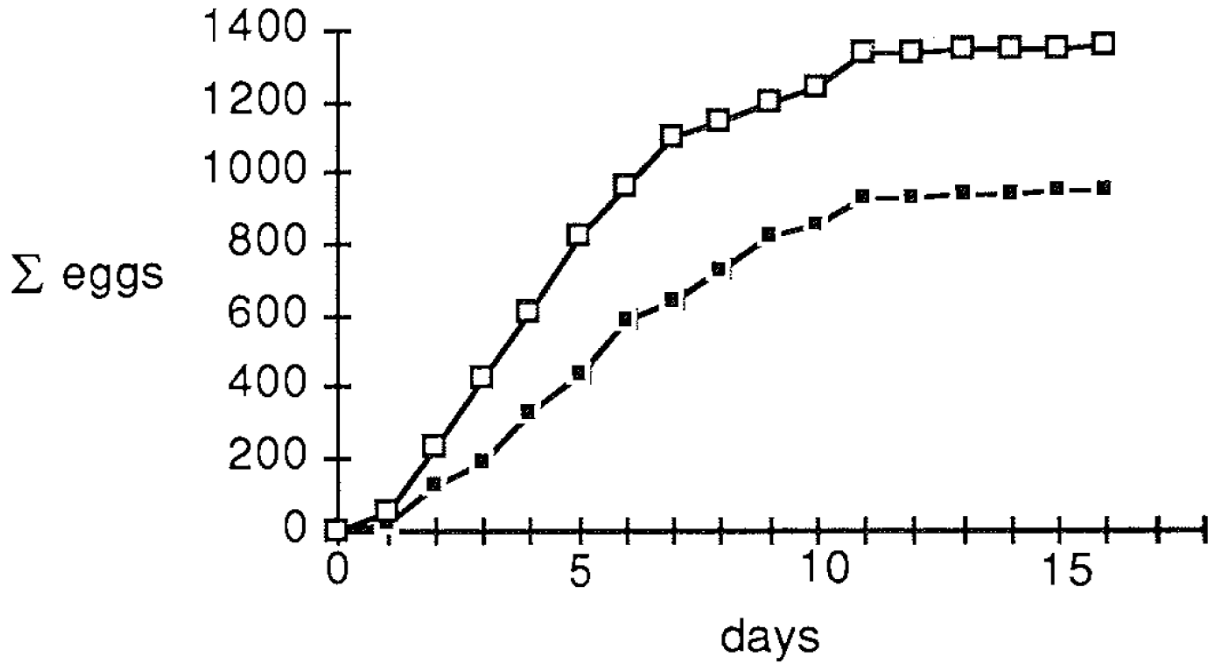


Figure 2.22: *Cumulative egg production of pooled females of Calanoides acutus On Sta. 45 (open squares) and 48 (filled squares).*

The respiration measurements showed that small calanoid copepods such as *S. longipes* respired between 0.065 and 0.081 µI O_2 per animal per hour, while large animals as *C. acutus* respired between 0.244 and 0.456 µI O_2 per animal and hour. Respiration of *C. propinquus* and *M. gerlachei* ranged somewhere in between.

Eggs from all five copepod species under investigation, incubated in filtered seawater at 0°C under dim light conditions (5µE$m^{-2}s^{-1}$) showed quite different developments. While eggs of *C. acutus* needed 8 to 10 days to reach 50% of the NI population, those of M. *gerlachei* needed 3 to 4, and *M. pygmaeus* only 1 to 2 days. Eggs of *C. propinquus* from several hatches did not develop at all.

4.6. Comparative studies on the temperature dependence and kinetics of digestive enzymes in crustaceans

B. Dittrich (AWI)

Objectives

As mediators between food uptake and metabolic turn-over, enzymes play a decisive role in ensuring long-term survival of a species as well as of an individual. As highly sensitive proteins their functioning depends not only on nutritional factors but also directly on environmental conditions. Although a variety of investigations has been devoted to nutritional adaptations in zooplankton organisms, few studies have been carried out on thermal acclimation of their digestive enzymes. Most of the proteases known today show an optimum of activity at about 40-50°C Generally, increasing as well as decreasing temperatures result in a decrease of activity which is - in temperate and tropical species - about zero when approaching the freezing point of water and when exceeding 60°C The main interest of the present study is focused on the question of how polar species cope with these extreme unfavorable conditions that exert a lethal effect on all other, not cold-adapted species. The postulation that the nutritional adaptability is a function of the metabolic needs is obviously valid also for thermal adaptability.

Work at sea

Crustaceans from different systematic groups - decapods, isopods and amphipods - as well as pantopods were obtained by means of an Agassiz-trawl, towed at a depth of 140 - 270 m near King George Island (62°35'S, 55°25'W and 62°54'S, 54°24'W) and near Kapp Norvegia (71°05'S 11°32'W) After collecting and sorting the animals, a large portion was dissected immediately; their midgut glands and gastric fluids were deep-frozen at -80°C and will remain stored at this temperature until further analyses on temperature dependence and kinetics will be carried out at the AWI. After arrival at Cape Town, some of the samples were transported on dry-ice to Germany while the others remained on board "Polarstern". Several individuals of isopods, collected from the Agassiz-trawl off King George Island, were kept individually without any food supply in a temperature-controlled container at 0°C; a small number of them was prepared after each week to obtain information on the resistance to starvation and the influence of such unfavorable nutritional conditions On the enzymatic equipment and activity.

Preliminary Results

Analysis on midgut glands and digestive fluids in the stomachs of crustaceans collected in the course of EPOS 3 in Austral summer 1988/89, were supplemented by samples from the Skagerrak, the German Bight and the coast of Kenya. The results indicate - at least in the trypsin-like Protease - characteristic differences in the temperature dependence and kinetics, which become obvious especially in the low-temperature range. Temperature optima of the investigated enzymes do not differ significantly from each other and were found at about 40-50°C. However, the most striking mechanisms of adaptation to permanent low temperatures in the predominantly cold-stenothermic Antarctic species were found to be (1) the high activity even at temperatures near freezing-point which may amount up to 15% of the maximum activity at the temperature optimum and (2) the reduction of activation energy which was found to be only a third of that in temperate and tropical species. Distinct species-specific changes in the enzyme activity after application of selected effectors suggest decisive alterations in the molecular structure of the enzyme protein. However, further detailed analyses on Antarctic species will prove if the results characterize a general phenomenon.

4.7. ^{32}Si applied to marine biology

M. Baumann, B. Dittrich, F. Kurbjeweit, (AWI); L. Lindner (RUU)

Objectives

During EPOS leg 2, pilot experiments had already been carried out to underscore the potential of radioactive ^{32}Si. This is a follow-up on the previous studies. ^{32}Si is a weak beta emitter (t1/2=174 y) and is the parent of radioactive ^{32}P (t1/2=14 d).

Work at sea

Part of the ^{32}Si waste (^{32}Si-silicate in radioactive equilibrium with daughter ^{32}P-phosphate contained in filtered sea water) produced in the course of the ^{32}Si uptake experiments (c.f. section 3.4) was used for labeling of a mixed culture of sea algae. This ^{32}Si-^{32}P-labelled culture was subsequently used for grazing studies with an amphipod, an isopod and a copepod, respectively.

Preliminary results

After 11 days of incubation, the first culture had taken up about one third of the available ^{32}P; the uptake of ^{32}Si was considerably less. A second culture (the first one with additional, nutrient rich, waste water) had after several days of incubation two thirds of the ^{32}P incorporated (and seemingly also more ^{32}Si than in case of the first culture). The results show again that with an adequate selection of the type of culture (preferably of diatoms only) ^{32}Si can be recovered from its waste solutions (however, with a lower specific activity). The previous EPOS experiments with krill had shown them to be a nearly ideal specimen for ^{32}Si studies. Unfortunately, due to the lack of krill during this cruise three other animals were tested. Instead we used an amphipod, an isopod and a copepod.

Contrary to all expectations, both starved benthic animals were happily feeding on (labeled) phytoplankton. Dissection of the animals after several days of grazing was followed by radioactive counting of the different tissues. The activities measured in the digestive systems were low, in contrast to that in the exoskeleton and the muscles combined. Only the amphipod produced several greenish slimy faecal pellets with considerable activity, much of it ^{32}P but also ^{32}Si.

The copepod (*Calanoides acufus,* 8 mm) was measured alive at regular intervals during the grazing/fasting cycles, counting the Cerenkov radiation of ^{32}P taken in. This made it possible to estimate the uptake of phytoplankton (on the order of 1% of the available biomass during a period of a week). No faecal pellets were observed to be produced.

The earlier hypothesis, given in the above mentioned krill studies, that the mechanical and physiological digestive processes of diatoms being grazed form a first and possibly important step in the remineralization of silicon, seems to find additional support in the present observations.

5. MARINE GEOLOGY

5.1. Bathymetry

U. Goldkamp, J. Monk, S. Vucelic (AWI)

Objectives

During "Polarstern"-cruise ANT V/4 in 1987 a channel-like structure was discovered at 65°40'S, 38°45'W by means of Seabeam fansweep system. The course of the channel was expected to run from SW to NE; accordingly, a rectangular pattern of measurements was planned to investigate the extent and the shape of the channel over a larger distance. From these data the origin of and significance to northeastward bottom water transport will be derived. In addition to this area of special interest, the cruise track was used to continue charting the Weddell Sea.

Work at sea

Starting November 19th the Hydrosweep system was put in operation and worked for more than 9000 profile-kilometers. Due to technical problems, no hydrosweep data were recorded from 29 November, 12.00 until 30 November, 21.30. After leaving the Georg-von-Neumayer-Station measurements were continued while passing Maud Rise and heading for Cape Town until the end of the leg. After reaching the known position of the channel at 65°40'S and 38°45'W and passing the first turning points of the survey pattern, the track had to be modified, because the ice conditions made it impossible to follow a prescribed course. Nevertheless, the width of the channel was recorded in its whole extent along the channel axis from east to west which was possible because frequently leads were aligned along the channel axis. At the eastern part of the survey, large ice floes prohibited following the course of the channel. The hydrosweep screen on the bridge allowed changes in the course to be made in a way, that the survey of this part of the channel was achieved despite the ice cover. The channel was surveyed over a total length of 144 kilometers with a track line of 500 kilometers.

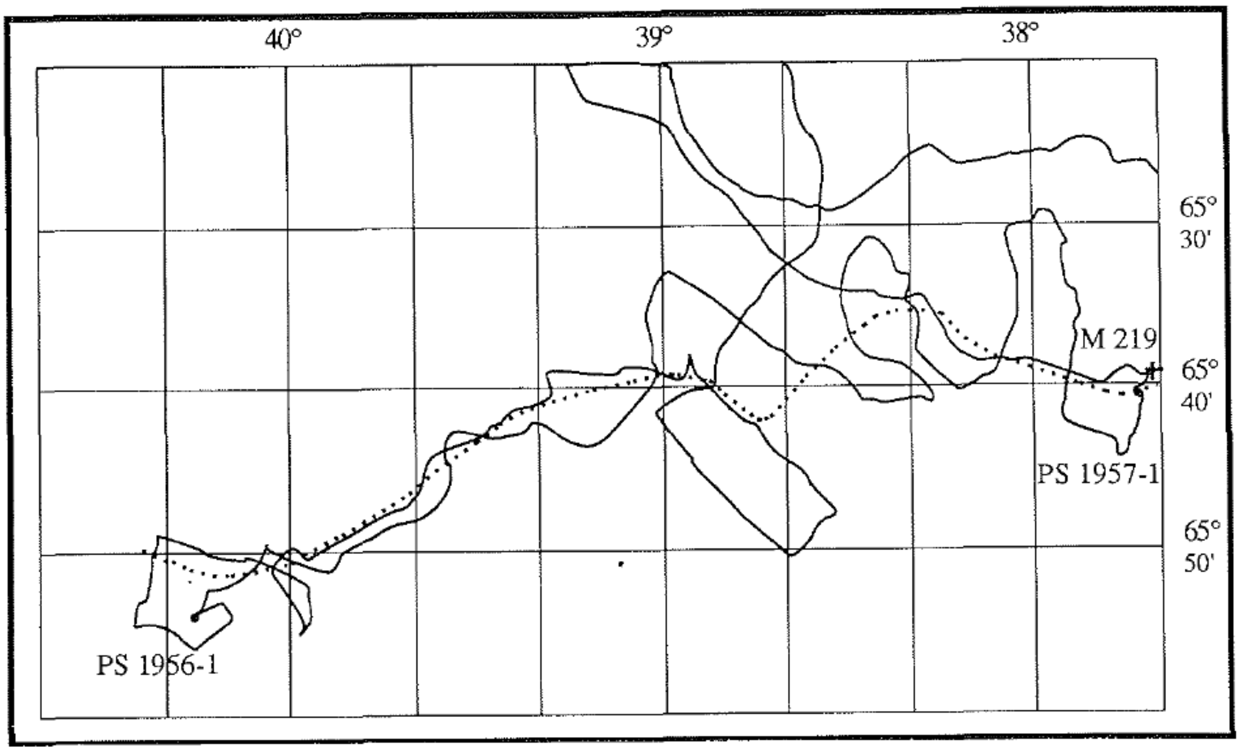


Figure 2.23: *Ships track (heavy line) and axis of the deep sea channel in the northwestern Weddell Sea M219 indicates the location of a current meter mooring and PS stand for minicorer samples.*

On the shelf and the continental slope off Kapp Norvegia, several hydrosweep profiles could be run in spite of unfavorable ice-conditions to supplement data in the area east of the Wegener Canyon. The route to Atka Bight was used to run a profile parallel to former courses. For the passage to Cape Town a course crossing over the eastern slope of Maud Rise from south to north was chosen. The online constructed isoline-plot showed small cone-like structures in this area, even above Maud Rise. During the complete leg, GPS satellites could be used for positioning. Offsets, positioning errors and failing data were recorded, which were due to changes in position of the satellite, inter-satellite constellation and the time free of GPS. Offsets and positioning errors were corrected within one day. Therefore, post processing resulted in an exact positioning of the fansweep profiles and isobaths crossings of Hydrosweep profiles.

5.2. Sediment distribution

M. Weber (AWI)

Objectives

The program can be subdivided in three parts: - a Parasound survey, carried out jointly with the bathymetric group, from Bellingshausen to the Agulhas Basin. - the investigation of the structure, origin and significance of a deep sea channel at 65°40'S, 38°45'W in the northwestern Weddell Sea with Hydrosweep and Parasound. - the development of a minicorer based on the principle of a multicorer, which is fixed under the CTD with a 20 m stainless steel wire, to obtain a large number of geological samples in combination with the oceanographic station with no need of additional ship time.

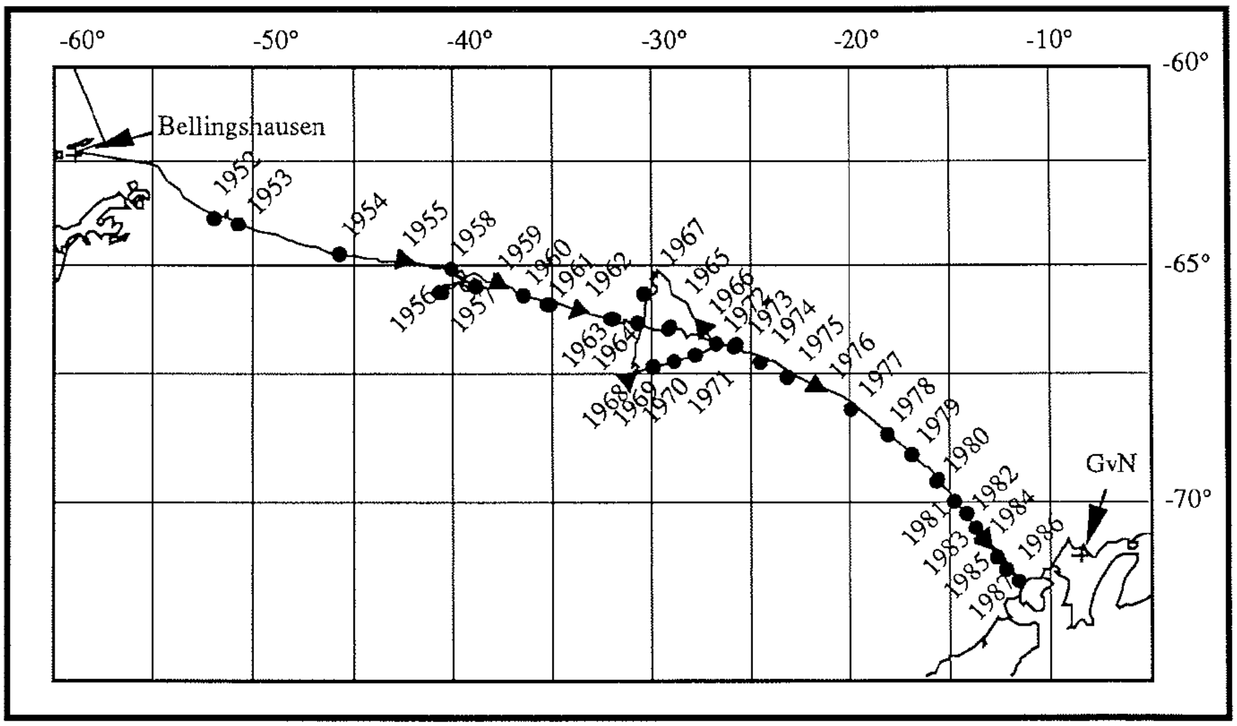


Figure 2.24: *Minicorer sampling stations during ANT IX/2. Circles stand for geological and triangles for geochemical sampling*

Work at sea

Parasound and Hydrosweep surveys were carried out in cooperation with the bathymetry group. In addition to the acoustic measurements, two sediment samples were taken using the minicorer and also the current meter mooring 219 was deployed in the center of the channel to get information about the flow velocity (Figure 2.23). This minicorer enabled us to take 37 samples from the sediment surface (Figure 2.24, Table 2.8), mostly on the transect between Bellingshausen and Kapp Norvegia. The use of the minicorer combined with the CTD saved more than four days of ship time normally needed for extra geological stations.

Preliminary results

Over the length of 144 km (Figure 2.23) the structure occurs at a water depth of about 4650 m. The channel depth relative to its surroundings increases from 60 m up to 100 m. Most of he channel has an asymmetric geometry with a steep and a smooth slope. In the middle and eastern part of the studied area it is a rather small meandering feature (1 to 3 km wide). In the western part, the channel axis straightens and the channel widens to more than 10 km. The quality of the surface samples from the minicorer is the same as from the multicorer. Further investigations including sedimentological, palaeontological and geochemical analysis will be done in the AWI.

Table 2.8: *Geological sampling during ANT IX/2*

Station Nb. Cruise 18/	AWIGELO Nb.	Date	Time	geogr. Latitude	geogr. Longitude	Water depth (m)	MIC Penetra-tion (m)	MIC Length (m)	MIC stored (m)
042	PS 1952-1	22.11.90	13:40	63°29,92' S	52°08,02' W	924	0,02	0,00	0,00
044	PS 1953-1	23.11.90	09:33	63°44,59' S	50°55,36' W	2413	0,20	0,20	0,04
048	PS 1954-1	24.11.90	23:30	64°24,37' S	45°48,21' W	4434	0,28	0,25	0,04
050	PS 1955-1	25.11.90	22:39	64°49,21' S	42°30,22' W	4684	0,26	0,25	0,25
053	PS 1956-1	27.11.90	15:07	65°54,32' S	40°15,47' W	4607	0,10	0,01	0,01
055	PS 1957-1	28.11.90	09:48	65°40,29' S	37°44,63' W	4727	0,12	0,12	0,04
056	PS 1958-1	28.11.90	20:48	65°11,99' S	39°22,31' W	4757	0,32	0,31	0,04
057	PS 1959-1	29.11.90	06:38	65°24,71' S	37°54,80' W	4736	0,28	0,25	0,25
058	PS 1960-1	29.11.90	19:52	65°38,27' S	36°28,42' W	4770	0,24	0,24	0,04
059	PS 1961-1	30.11.90	02:41	65°43,18' S	35°26,86' W	4777	0,25	0,24	0,04
061	PS 1962-1	30.11.90	22:34	65°59,51' S	33°24,71' W	4760	0,26	0,25	0,25
063	PS 1963-1	01.12.90	17:40	66°07,27' S	31°47.09' W	4786	0,25	0,24	0,04
065	PS 1964-1	02.12.90	06:26	66°16,60' S	30°17,80' W	4800	0,25	0,25	0,04
067	PS 1965-1	02.12.90	19:46	66°27,98' S	28°45,30' W	4850	0,25	0,25	0,04
069	PS 1966-1	03.12.90	06:15	66°37,58' S	27°07,48' W	4860	0,25	0,25	0,25
075	PS 1967-1	05.12.90	10:10	65°57,41' S	30°04,25' W	4847	0,21	0,20	0,04
079	PS 1968-1	06.12.90	09:31	67°28,70' S	31°06,61' W	4625	0,29	0,25	0,25
080	PS 1969-1	06.12.90	15:39	67°18,95' S	29°57,50' W	4682	0,25	0,24	0,04
081	PS 1970-1	06.12.90	22:10	67°08,54' S	28°47,76' W	4815	0,25	0,22	0,04
082	PS 1971-1	07.12.90	04:46	66°57,20' S	27°36,63' W	4819	0,24	0,23	0,04
083	PS 1972-1	07.12.90	11:19	66°45,47' S	26°24,15' W	4854	0,18	0,14	0,04
084	PS 1973-1	07.12.90	17:18	66°53,47' S	25°32,89' W	4841	0,25	0,25	0,04
086	PS 1974-1	08.12.90	06:59	67°13,33' S	24°08,78' W	4857	0,12	0,11	0,04
088	PS 1975-1	08.12.90	21:04	67°30,49' S	22°31,29' W	4893	0,27	0,26	0,04
090	PS 1976-1	09.12.90	09:41	67°50,47' S	20°50,65' W	4919	0,27	0,25	0,25
092	PS 1977-1	09.12.90	00:40	68°17,06' S	19°20,42' W	4838	0,27	0,25	0,04
094	PS 1978-1	10.12.90	15:28	68°50,37' S	17°53,60' W	4795	0,10	0,09	0,04
096	PS 1979-1	11.12.90	04:30	69°22,01' S	16°29,80' W	4735	0,08	0,07	0,04
098	PS 1980-1	12.12.90	02:29	69°48,23' S	15°14,07' W	4741	0,04	0,00	0,00
100	PS 1981-1	12.12.90	11:35	70°07,90' S	14°15,21' W	4526	0,26	0,25	0,04
101	PS 1982-1	12.12.90	19:53	70°18,75' S	13°42,09' W	4366	0,26	0,25	0,04
102	PS 1983-1	13.12.90	02:16	70°23,27' S	13°32,57' W	2968	0,26	0,25	0,04
104	PS 1984-1	13.12.90	08:09	70°29,80' S	13°08,31' W	2407	0,26	0,25	0,25
106	PS 1985-1	13.12.90	16:38	70°47,72' S	12°22,24' W	2074	0,22	0,20	0,04
108	PS 1986-1	14,12.90	00:25	70°59,39' S	11°50,73' W	1135	0,23	0,21	0,04
114	PS 1987-1	15.12.90	14:37	71°04,87' S	11°33,72' W	273	0,20	0,19	0,04
118	PS 1988-1	23.12.90	17:42	54°19,84' S	03°24,10' W	2704	0,17	0,17	0,17

5.3. Particle flux in the water column

E. Schöffmann M. Segl (FGB)

Objectives

To quantify the particle flux from the photic layer to the sediment and to monitor the seasonality of sediment build-up over several years.

Work at sea

At five positions moorings with sediment traps were deployed; two on the western and eastern slope (206 and KN4), one in the center of the Weddell Sea (208), west of Bouvet Island (B0 1) and in the area of the Polar Front (PF 4) (Figure 2.25). Three sediment trap moorings were recovered in the western and the central Weddell Sea and at the Polar Front (Figure 2.26).

On board, smear slides were prepared from the trap samples. The samples were then stored in a cool room at 4°C. Further investigations on the sediment trap material including biological, geological and isotopic analysis will be carried out at the AWI and at the FGB.

Preliminary results

The sediment traps in the Weddell Sea operated since 20 September 1989 (mooring 206) and 5 November 1989 (mooring 208), respectively. The sample bottles were changed every 15 days in spring and summer and every 30 days during the winter. The trap in mooring 206 sampled only until May 1990 because of electronic problems. The upper trap in mooring 208 worked well, the lower trap did not work at all. The flux to the traps showed a maximum during February and March. The traps in the Polar Front operated since November 1989. The maximum flux was in March. In the upper trap, the cups from the winter months contained about 118 to 114 of the material that was collected in the summer months. In the lower trap the winter cups were nearly empty. This leads to the conclusion that in winter most of the material present in the photic zone is reworked in the water column and does not reach the sediment.

5.4. Stable isotopes in the water column

E. Schöffmann M. Segl (FGB)

Objectives

Stable oxygen and carbon isotopes are used in marine geology to reconstruct the paleoceanographic history by measuring the $^{18}O/^{16}O$ and $^{13}C/^{12}C$ in the shells of marine organisms and the $^{13}C/^{12}C$ in the organic material, and to quantify the influence of bio-activity.

Work at sea

Samples to determine the isotopic composition of the dissolved CO_2 ($^{13}C/^{12}C$) and of the water itself ($^{18}O/^{16}O$) were taken from the rosette on all biological stations. Samples of 250 ml and 100ml were put into glass bottles, avoiding air bubbles in the sample. The 250 ml samples for ^{13}C measurements were poisoned with $HgCl_2$ to avoid further CO_2 production. These samples, as well as the 100 ml samples, were then sealed with wax and stored in a cool room at 4°C. The isotopic composition of the samples will be measured at the stable isotope laboratory of the AWI.

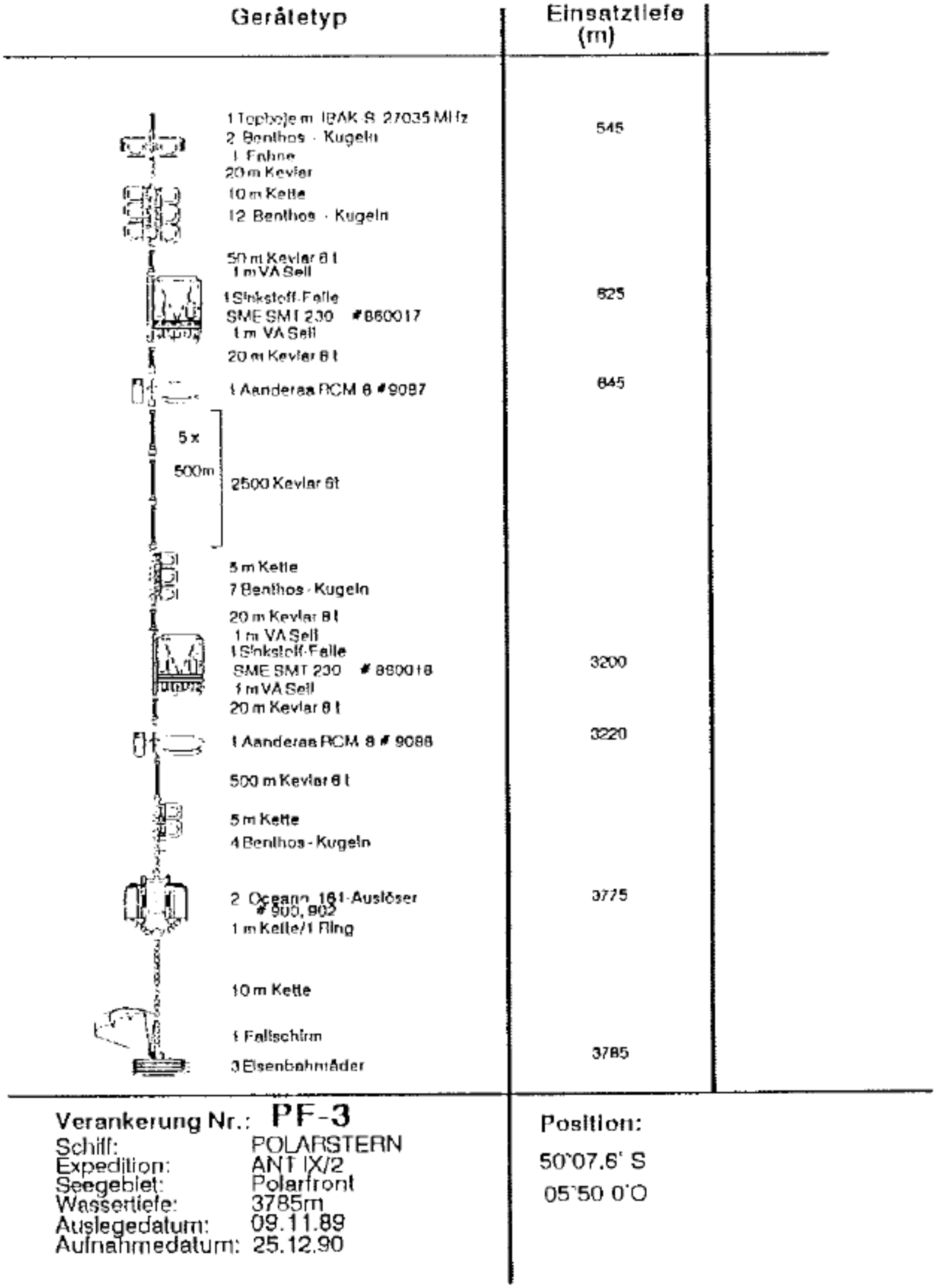


Figure 2.25: *Schematic representation of the mooring recovered in the Polar Front*

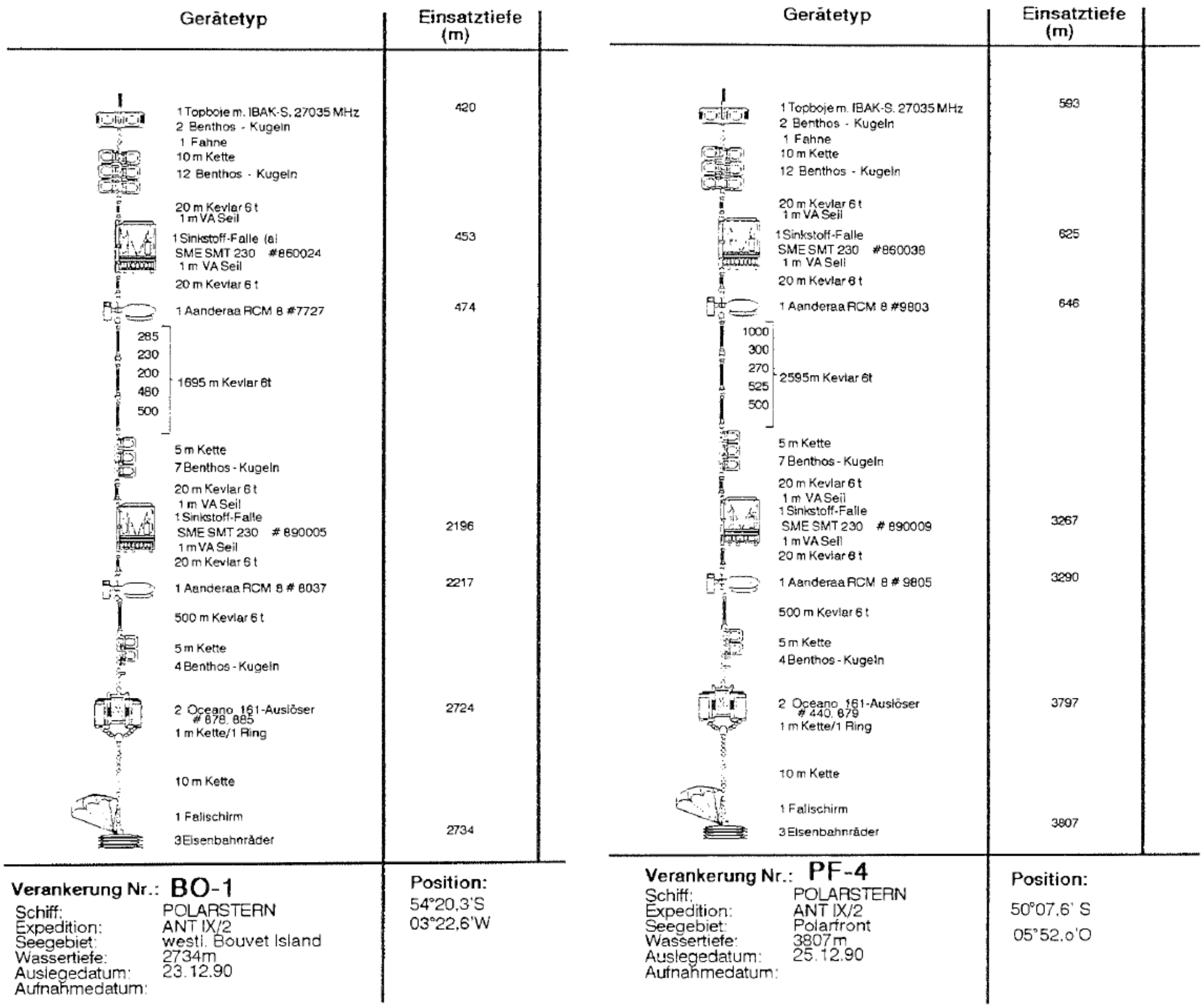


Figure 2.26: *Schematic representation of moorings deployed in the Polar Front and West of Bouvet Island*

5.5. Natural radioactive isotopes in the water column

E. Schöffmann M. Segl (FGB)

Objectives

Investigations on sediment samples from the area off West Africa and from the Polar Front show that in areas with high biological activity, the flux of radioisotopes such as ^{10}Be and ^{230}Th to the sediments increases the production of the isotopes. This is due to scavenging of the isotopes by settling particles. This causes a concentration gradient of the isotopes from high to less productive areas which might allow former biological activity to be deduced.

Work at sea

To quantify these effects, samples for ^{10}Be measurements were taken on 4 stations of the Weddell Sea transect. The investigations on these samples will be linked to investigations on ^{230}Th in the Weddell Sea by the geochemistry group of the AWI, and to results of measurements of ^{10}Be and ^{230}Th in the South Atlantic by the FBG. To get the 30 l of water needed for a ^{10}Be analysis, water from different depths within the same water layer was combined. A well known amount of ^{9}Be carrier was added and Be, together with Mg and other elements, was precipitated at a pH of 8 - 9. The water was decanted, and the precipitate will be prepared for measurements with the accelerator mass spectrometer of the ETH Zürich. Additionally at all the minicorer-stations ^{10}Be samples have been taken from the sediment surface.

6. POST INSTALLATION WORK ON THE COMPUTER SYSTEM

H. Pfeiffenberger-PertI (AWI)

Objectives

A new central computer system and two local area networks were installed aboard "Polarstern" in October 1990. Five VAX-VMS systems of different capabilities, configured as a duster, replace one older VAX-VMS computer. The local area networks, using ethernet and localtalk cabling, provide the possibility to connect PCs and Workstations in all locations used for scientific purposes to each other, the central system and its resources, i.e. printers, plotters, etc. The most important objective of the work at sea was to observe this rather complex system under real conditions, in order to see - if the concepts leading to its hardware and software configuration do work, - how the system is utilized by the scientists, how its utility could be improved, - which problems are encountered and how to fix them. The result of this work should be a users manual for scientists and support personnel on board that provides advice on this specific installation in the most compact way possible.

Work at sea

The information necessary to meet the objectives was collected while giving advice or help to scientific users and support personnel. Some programming was necessary to fix problems, support routine operation of the system and to meet requests from scientists for access to specific data. The documentation most urgently needed was written.

Preliminary results

In general the VAX systems worked as planned. The most important task, the quasi-realtime data logging and processing on one of these machines, worked without problems. The disc and file services for PCs were made available on board in the same way as at the institute. Due to a much higher data transfer demand between VAX-, IBM-compatible and Macintosh-systems, yet unknown problems appeared. They could be solved by a file conversion utility and some documentation giving recipes. Observations on the use of publicly available PCs led to the conclusion that these will produce more work for the support personnel (or less utility to the scientists) than the VAX-systems, if - their users are not very disciplined and - they are managed as personal PCs Further work has to be done on this problem.

7. WEATHER CONDITIONS

H. Erdmann, H. Köhler, H. Sonnabend (DWD)

At the beginning of the cruise the main cyclonic activity was located west of the Antarctic Peninsula. On 17 November, the steering cyclone moved slowly eastward with a minimum pressure below 960 hPa. Secondary lows passed the Drake Passage quickly and affected "Polarstern" with northwesterly winds Bft 8 and seas up to 5 m. South of the Polar Frontal Zone, visibility deteriorated due to northerly winds Bft 7. On 20 November, "Polarstern" reached Bellingshausen Station with northwesterly winds Bft 7 and Snow showers. Due to catabatic influence, the wind increased up to Bft 9 near the station; in spite of the unfavorable weather conditions, helicopter service was possible. Due to the permanent influence of the wide-spread and stable low-pressure System with minimum pressure still below 960 hPa at the southwestern part of Bransfield Strait, wind turned from northwest to southeast Bft 5 on 21 November, while "Polarstern" left Bransfield Strait heading for the Weddell Sea. Snowfall coming up caused bad visibly later on and a decrease of air temperature down to -4°C. In the early evening, "Polarstern" approached an area densely covered with sea ice. During the following next four days, the ship operated within a low pressure area between the steering Weddell Sea cyclone and secondary lows in the north and northeast. Therefore, the pressure gradient as well as the winds were generally weak. Cold air mass advection gave rise to good visibility but was accompanied by some snow showers. On 26 and 27 November, the dominant cyclone remained stable over the northwestern Part of the Weddell Sea and began to fill slowly. Therefore, "Polarstern" was affected by stronger cold air advection in the northwestern section accompanied by numerous polar cumulonimbus clouds and heavy snow showers.

On 28 November a new gale center developed in the western part of the Drake Passage and moved to the South Shetlands. On 29 November its frontal systems approached "Polarstern" near 66°S, 37°W while activity was decreasing. Therefore, wind turned northeasterly while decreasing to Bft 3 to 4. Occasionally occurring snowfall diminished visibility until the end of November. At the beginning of December, a flat high developed in the central Weddell Sea. Therefore, the wind was light and varying, the visibility very good and the clouds dissolved. A small-ranged but heavy cyclonic development north of "Polarstern's" operating area caused heavy snowfall on 3 December, which was accompanied by strong easterly winds up to force Bft 7. Therefore helicopter service was not possible on this day. During the night of 4 December, the cyclone moved south while decreasing and crossed the position of "Polarstern" to the west. The wind was backing to the north and caused low level warm air advection with rising dew point near 0°C. As a consequence, fog persisted for about 4 hours. On the same day, another but stronger cyclonic development evolved near South Georgia. This new storm center moved quickly southeast; with its rear and southerly gales up to force Bft 9 it affected "Polarstern" in the central Weddell Sea during 4 December. The maximum wind speed measured on board at the marine meteorological station was 55 knots within gusts. The chill temperature was -27°C and rendered open air work almost impossible. A small wedge within the advanced polar air gave rise to better weather conditions on 5 December but caused decreasing temperatures with morning minimum temperatures near -8°C. In the course of the next 3 days, weather remained fair, sometimes even sunny with only light winds generally from west, due to the influence of a relatively high pressure center north of. the ship's position. During the night hours, ice covering fog patches developed due to heat loss and disappeared when sun rose.

In the eastern section of a quasi-stationary but developing low, strong warm air advection mainly in the upper troposphere produced widespread snowfall also in the operation area of "Polarstern" near 67°S, 23°W on 9 December. During the next 24 hours, temperatures rose to 0°C and wind turned northerly with force up to Bft 7. From 10 to 14 December, a dynamic high developed above the northern part of the Antarctic continent with its center (1004 hPa) near 70°S 05°W. Therefore, a strong Inversion near 1000 m-level caused overcast stratocumuli with some snow showers and light winds. On 15 December "Polarstern" reached Kapp Norvegia in sunshine and light winds produced by the still stationary high near

Neuschwabenland.

The weather conditions were still good when "Polarstern" was stationed at the shelf ice near Georg-von-Neumayer-Station for unloading. In spite of overcast sky with a ceiling near 800 feet and occasional "whiteout" conditions, helicopter service was not affected. When "Polarstern" left for Cape Town on 19 December, the synoptic situation changed. The dominant high at Neuschwabenland moved southwest while weakening and the low system east of South Georgia moved east. Therefore an easterly wind increased up to force Bft 6 accompanied with some snowfall and bad visibility.

On 20 December "Polarstern" left the closely packed sea ice near 68°S, 03°W. On the southern edge of a heavy steering low near 60°S 05°W (958 hPa), which moved eastsoutheast very slowly, wind increased up to force Bft 7 to 8 while turning from east to southeast for some hours. Next day wind turned southwest while decreasing slowly. Wind seas and swell of about 3 m affected the voyage of "Polarstern" only little. On 24 December a new low developed northeast of South Georgia moving southeast slowly. Its frontal systems affected "Polarstern" on 25 December north of Bouvet Island with northerly gales Bft 8 to 9 turning northwest but decreasing slowly. Shortly before arrival in Cape Town, light winds, sunshine and warm temperatures were encountered.

8. ICE CONDITIONS

H.-J. Brosin, D. Zippel (IfMW)

Visual observations of the ice conditions were performed between 22 November and 20 December according to instructions given by the Glaciological Section of the Alfred-Wegener-Institute. Altogether 236 observations were realized together with an additional 70 observations on the distribution of algae in the ice.

The first iceberg was observed on 20 November at the position 62°12'S, 57°56'W, the last one on 23 December. The ice edge was crossed at 63°30'S, 51°30'W 150 km distant from the nearest shoreline on 22 November. It was passed again at the position 68°S, 04°W on 20 December. The shelf ice edge was reached for the first time at 71°07'S, 11°23'W on 15 December.

The portion of white ice amounted to 40 to 100% of the total ice cover. The thickness mostly varied between 0.5 and 1.5 m and was estimated to be up to 2 m in a few cases. A distinct increase of the size of ice floes to a diameter of more than 1 km was observed at the position 65°39'S, 39°W, an evident reduction of the floe size occurred only close to the end of the observations at 70°25'S 13°25'W. The thickness of the snow cover on the ice varied between 20 and 50 cm. Marked melting effects at the bottom layers of ice floes were observed for the first time at the position 66°22'S, 29°32'W On 2 December. Local new ice formation (nilas, grey-white ice) were repeatedly observed after a larger decrease in air temperature.

A wide spread occurrence of icebergs was observed particularly at the western edge of the working area between 64° and 65°50'S, 49° and 40°W (up to 41 icebergs within the field of view) and at the southeastern edge from 69°15' to 70°30'S, 16°45' to 10°W (up to 52 icebergs seen simultaneously).

9. ACKNOWLEDGEMENTS

When we left "Polarstern" in Cape Town, we felt that we had had an extremely successful cruise and an enjoyable life on board. We are aware that master Jonas together with officers and crew took good care of our needs with a dedication and patience which guaranteed efficient work and good humour.

10. REFERENCES

Unesco, 1983. International Oceanographic tables. Unesco Technical Papers in Marine Science, No. 44.

Unesco, 1991. Processing of Oceanographic Station Data. Unesco memorgraph by JPOTS editorial panel.

11. WHPO SUMMARY

Several data files are associated with this report. They are the ANTIX.sum, ANTIX.hyd, ANTIX.csl and *.wct files. The ANTIX.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The ANTIX.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called ANTIX.wct.zip. The ANTIX.csl file is a listing of ctd and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the ANTIX.csl file:

Salinity, Temperature and Pressure: These three values were smoothed from the individual CTD files over the N uniformly increasing pressure levels. using the following binomial filter-

t(j) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) j=2....N-1

When a pressure level is represented in the *.csl file that is not contained within the ctd values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta(SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3): These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the Unesco publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature (GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and Fortran routines are described in Unesco publication 44.

Gradient Salinity (GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and Fortran routines are described in Unesco publication 44.

Potential Vorticity (POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. pv=fN2/g, where f is the coriolius parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy Frequency (B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and Fortran routines are described in Unesco publication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. Equations and Fortran routines are described in Unesco publication 44.

Neutral Density (GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

12. CTD DATA QUALITY EVALUATION

Robert Millard
November 27, 1995

ANTIX: CTD Data Quality Comments

General:

The range of potential temperature for the ANTIX data set is narrow (-1.87 to 1.89°C) and salinity varies from 33.92 to 34.72 psu. The potential temperature versus salinity plot for all stations is shown in figure 1. Removing station 121 reduces temperature/salinity range further with the warmest temperature below 0.9°C and the minimum salinity increased to 34.1 psu. I found the 2 decibar CTD data to be well calibrated to the water sample data and the data was also well edited to remove questionable data values.

The informal CTD data documentation (I'm not referring to the Cruise report 17 edited by Eberhard Fahrbach) that accompanied the CTD data was sketchy and contained little information on processing procedures. It would be helpful to have more information on calibration and processing methods used with this data set. Perhaps there is a technical report available that can be referenced? An overall assessment of the quality of the CTD and water sample data, including a few plots, would be helpful. There is one figure (2.5) in the cruise report (17) comparing the Autosal and CTD salinities. The data assessment might have information such as which water sample data were used in for the CTD conductivity calibration. A more detailed data report along with more extensive use of the quality word to flagged data that are either questionable or altered both in the water sample file and individual 2 decibar station files would be helpful to secondary users of the data.

There are no CTD oxygens in either the water sample or individual 2 decibar CTD data files. There is no assessment of the oxygen data in this report.

The down profile 2 decibar CTD data are free of spurious data values as the density inversion check below indicate. The data quality word in the 2 decibar CTD data files is not always utilized. For example, an interpolation on station 50 for salinity is carried out between 4000 & 4500 decibars without flagging in the quality word. The CTD salinity observations are very well matched to the water sample data except as noted below. The CTD salinity in the water sample file differs from the down-profile salinity data and water sample salinities for many stations, particularly in the deep water.

Specific comments on the CTD data processing documentation:

Note: This is a separate document from the formal cruise Report 17 (July 1991) edited by Eberhard Fahrbach.

The CTD conductivity calibration is varied on a station by station basis to matched the individual station water sample data. The conductivity calibration coefficients are smoothed over 10 stations without explanation. The correction of the CTD conductivity to match the water samples involves up to a fourth order polynomial in pressure. The coefficients of the conductivity correction polynomial are tabulated in the data documentation. I don't understand why it was necessary to use such a high order polynomial in pressure to obtain well calibrated CTD salinities. Are all of the pressure correction terms of these polynomials significant? Was the CTD conductivity cell geometry correction applied (see the formula below)? Were these corrections used and found not to work well? Again, more detailed in the data report would be useful.

CTD Conductivity Cell geometry corrections as recommended by the manufacture. Were these applied to this data set along with a fourth order polynomial in pressure??

The CTD conductivity cell pressure and temperature deformation effects for the Mark III with an alumina conductivity cell are:

C = G* (1+alpha* (T-T0) +beta* (P-P0))

where

G = CTD conductance
alpha = -6.5E-6
beta = 1.5E-8

T0 and P0 are expansion values. 2.8°C and 3000 dbars typically.

We find that the conductance G drift can be modeled with a linear station dependent change conductivity slope variation (not always necessary)

G = A+ B*g+C*g*s
"g" = is the observed CTD conductance and "s" is station related.
A = bias, B = slope and C = station dependent term.

I found the data report description of the terms in the formula (see below) to be confusing. The conductivity correction term is referred to as both "CD and "dc'). What is the definition of CONDUCTIVITY SALINO: Is it the conductivity of the lab salinometer or is it an "instu conductivity derived from the water sample salinity by using the CTD temperature and pressure?

`------------------- from informal CTD document ------------------`

The following is taken from the ANTIX data report section that I found to be confusing as indicated by (????).

dp = al +a2*p +a3*p**2 +a4*p**3 +a5*p**4 +a6*p**5

p = p + dp???? : This implies that dp = 0.0. (i.e. p-p=dp=0.0.)

The same is true for t-t+dt ????.

I think these corrections were meant to be p = pu + dp; where Pu is the uncorrected pressure.

correction of the CTD-conductivity data with the bottle-samples (conductivity of the salinometer data) evaluation of the coefficients of each station

----

CD = (CONDUCTIVITY SALINO ???? - CONDUCTIVITY CTD) * 1000

COND :== CONDUCTIVITY SALINOMETER

CD = A0 + A1*COND + A2*PRES + A3*PRES**2

----

station no.	A0	Al	A2	A3
03501	-0.51872E±02	0.24728E±01	-0.63940E-02	0.79995E-05

dc = A0 + A1*COND + A2*PRES + A3*PRES**2
C(ctd) = C(ctd) + dc/1000.

correction of the CTD-conductivity data with the bottle-samples

evaluation of the coefficients with the running mean of 10 stations

----

CD = A0 + A1*PRES + A2*PRES**2 + A3*PRES**3 + A4*PRES**4

Water sample file:

The CTD salinity data in the water sample file is compared to the water sample salinities (CTD minus WS) and displayed versus station number for all depth levels in figure 2a and for those below 900 decibars in figure 2b. Individual stations such as stations 46, 47, 69, 75, 76, and 93 show large differences but a closer examination indicates that the problem is with the water sample data as the potential temperature/salinity plot shown in figure 3 for stations 68-78 indicates. It is difficult to know which water sample data were used for the CTD calibration as all water sample salinity data (i.e. column labeled "SALNTY" are flagged with "3" indicating that they are considered questionable). A histogram of the salinity differences (CTD-WS) less than =/- 0.01 psu is given in figure 4 and appears to have a reasonable distribution. The mean difference is -0.0005 psu and the standard deviation is 0.0028 psu both again appear reasonable. The plot of salinity differences (CTD-WS) versus pressure, figure 5, shows a slightly odd behavior at and below 3000 dbars. A clustering of positive salt differences, mainly below 4000 dbars, is apparent. The down-profile CTD salinities show no corresponding systematic behavior indicating perhaps that the polynomial pressure correction for conductivity was developed for the down-profile (should be addressed in the data documentation) and doesn't necessarily work well for the up-profile salinity data. These CTD salinities in the water sample file should be flagged as questionable.

2-decibar CTD profiles (___.WCT)

The down-profile CTD salinities are well matched to the water sample salinities but this does not always carry over to the up-profile CTD salinities in the water sample file particularly in the deep waters (as mentioned already). A plot of down and up CTD and water sample salinities for stations 57-60 again illustrated the up salinity mismatch in figure 6 (circles are CTD salinity from WS file). These CTD salinities need to be flagged as questionable or bad (they are currently marked as good!!!). There are a number of salinity interpolations apparent in the 2 decibar data files. I found that stations 50, 58, 59, 64, and 74 had significant intervals in the deep water that appear to be interpolated (see figures 7a-d). There are probably others that I have missed. These need to flagged in the quality word (value =6) as described in the WHP Office Report 90-1 [see page 55]

Finally the stability of all data points were checked and a plot of unstable levels in excess of -.001 kg/m3/dbar (x) and -0.0015 kg/m3 per decibar (*) are indicated in figure 8. Note that in the table below the units of density gradient are given as kg/m3 per 2 decibars corresponding to the vertical pressure interval. A list of the 47 point with negative density gradients exceeding -.002 kg/m3 per 2 decibars are given below. The data set is remarkably free of density inversions as only 3 levels exceeding -0.003 kg/m3 per 2 decibar. This is due, in part, to the narrow range of salinity and temperature variations in the vertical. The station numbers in the table includes a decimal location within the station.

dsg/dp > -.002 kg/m3 per 2 decibar

dsg/dp	station #	Prs dbars
-4.1938465e-003	4.0111765e+001	5.9400000e+002
-3.8449577e-003	4.0140000e+001	7.3800000e+002
-2.2512519e-003	4.0143137e+001	7.5400000e+002
-2.0012428e-003	4.0152549e+001	8.0200000e+002
-2.2761947e-003	4.1328627e+001	1.6900000e+003
-2.2156429e-003	4.2094510e+001	5.0800000e+002
-2.0093994e-003	4.2159608e+001	8.4000000e+002
-2.0330352e-003	4.2175686e+001	9.2200000e+002
-2.0348226e-003	4.2204314e+001	1.0680000e+003
-2.0110160e-003	4.3222353e+001	1.1720000e+003
-2.0117508e-003	4.4061961e+001	3.5000000e+002
-2.0152598e-003	4.4666667e+001	3.4340000e+003
-2.0399616e-003	4.5290980e+001	1.5120000e+003
-2.0422801e-003	4.6274118e+001	1.4220000e+003
-2.4128358e-003	5.0011765e+001	1.0200000e+002
-3.1532004e-003	5.0012157e+001	1.0400000e+002
-2.9423388e-003	5.0014118e+001	1.1400000e+002
-2.0102297e-003	5.0050588e+001	3.0000000e+002
-2.1142905e-003	5.0091765e+001	5.1000000e+002
-2.0107781e-003	5.4066275e+001	3.7800000e+002

-2.0113735e-003	5.4103529e+001	5.6800000e+002
-2.0107581e-003	5.5083137e+001	4.6600000e+002
-2.0106812e-003	5.7069020e+001	3.9800000e+002
-2.0123969e-003	6.1210196e+001	1.1340000e+003
-2.1120462e-003	6.6076863e+001	4.5600000e+002
-2.0108038e-003	6.6121569e+001	6.8400000e+002
-2.9807854e-003	6.7989804e+001	1.4000000e+001
-2.0106718e-003	6.8101176e+001	5.8400000e+002
-2.7478252e-003	6.9962745e+001	4.9900000e+003
-2.0130675e-003	7.1242745e+001	1.3120000e+003
-2.4672703e-003	7.4006667e+001	1.1400000e+002
-2.3746039e-003	7.4009804e+001	1.3000000e+002
-2.5816618e-003	7.5010196e+001	1.3400000e+002
-2.6604134e-003	7.5014902e+001	1.5800000e+002
-2.0106403e-003	7.5127843e+001	7.3400000e+002
-2.8358944e-003	7.9002353e+001	1.1200000e+002
-2.1278849e-003	8.1022353e+001	2.2000000e+002
-2.0105649e-003	8.2118824e+001	7.1400000e+002
-2.7795357e-003	8.4012157e+001	1.7400000e+002
-2.0654205e-003	9.1005882e+001	1.5400000e+002
-2.1225245e-003	9.2053725e+001	3.9800000e+002
-2.0096993e-003	9.2153725e+001	9.0800000e+002
-2.0536578e-003	9.3014510e+001	2.0200000e+002
-2.0068535e-003	9.3068235e+001	4.7600000e+002
-2.0090439e-003	9.3144706e+001	8.6600000e+002
-2.0314412e-003	9.4152941e+001	9.1000000e+002
-2.0321519e-003	9.4164314e+001	9.6800000e+002
-2.0107911e-003	9.7218039e+001	1.2480000e+003
-3.8238614e-003	9.9976078e+001	8.0000000e+000
-2.0341040e-003	1.0017843e+002	1.0420000e+003
-2.0276837e-003	1.0111961e+002	7.5400000e+002

dsg/dp > **-.0015** kg/m3/dbar

dsg/dp	station #	Prs dbars
-4.1938465e-003	4.0111765e+001	5.9400000e+002
-3.8449577e-003	4.0140000e+001	7.3800000e+002
-3.1532004e-003	5.0012157e+001	1.0400000e+002
-3.8238614e-003	9.9976078e+001	8.0000000e+000

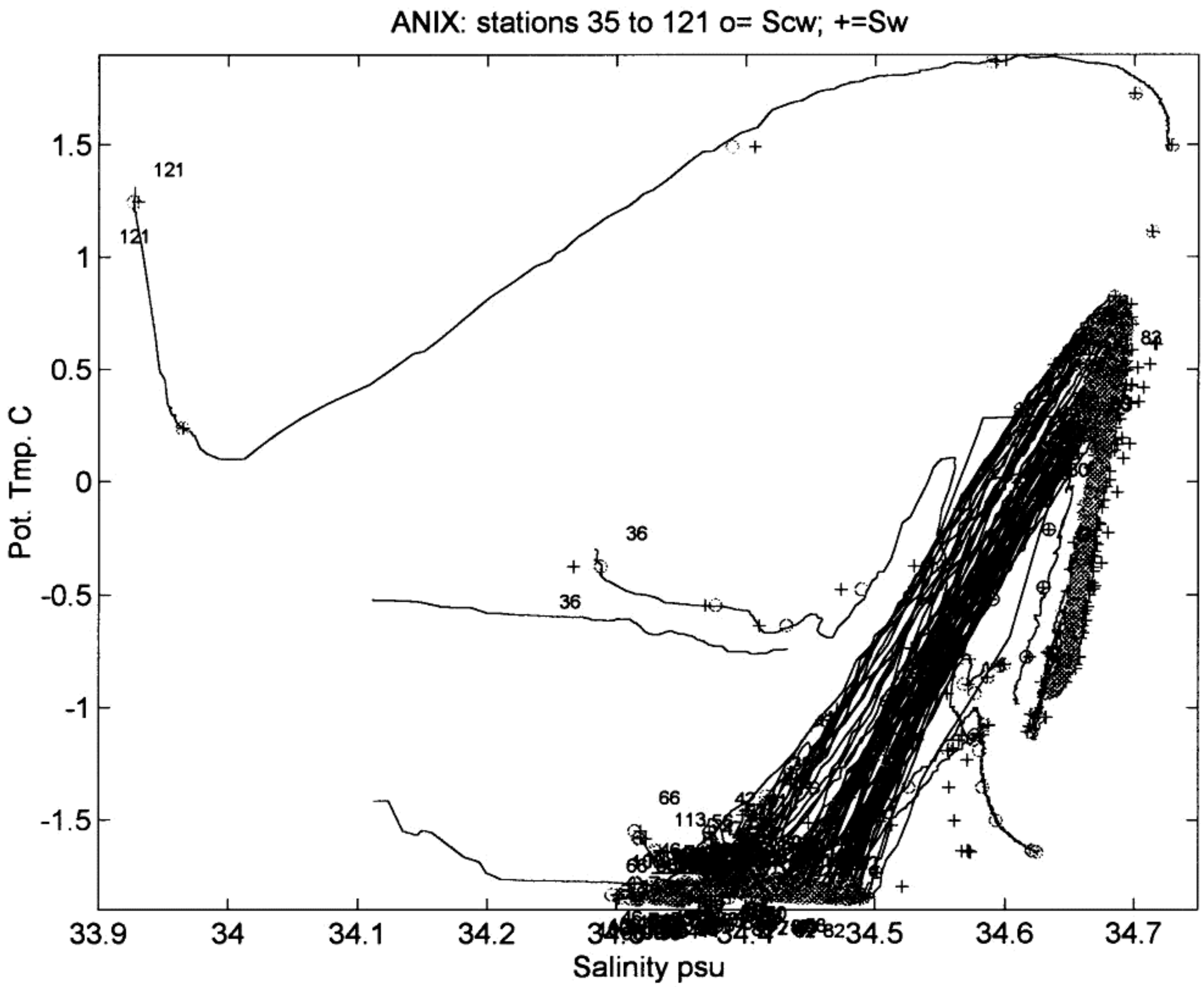

ANIX: stations 35 to 121 o= Scw; +=Sw
Pot. Tmp. C
Salinity psu
1.5
1
0.5
0
-0.5
-1
-1.5
33.9
34
34.1
34.2
34.5
34.6
34.7
121
121
36
36
66
113
82

Figure 1

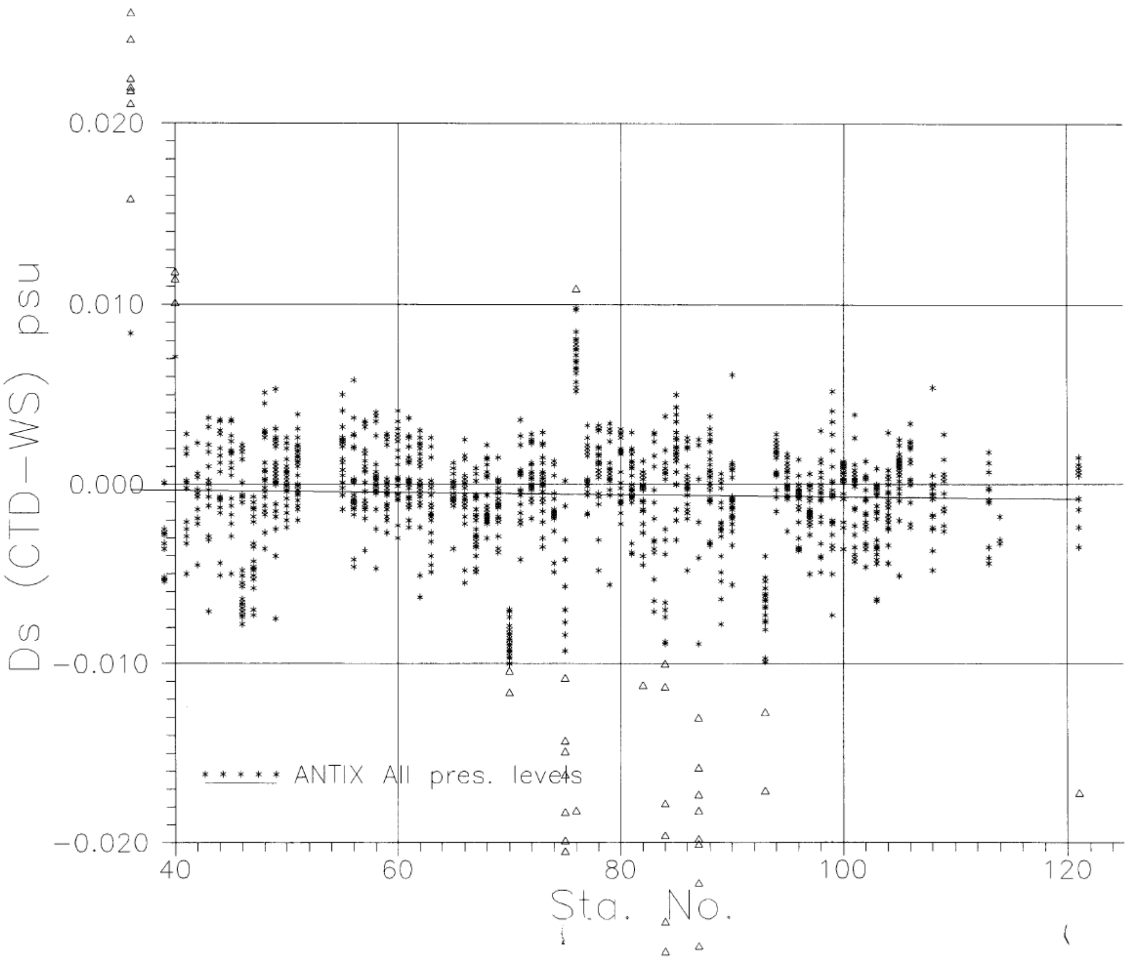

0.020
0.010
0.000
−0.010
−0.020
Ds (CTD−WS) psu
40
60
80
100
120
Sta. No.
ANTIX All pres. levels

Figure 2a

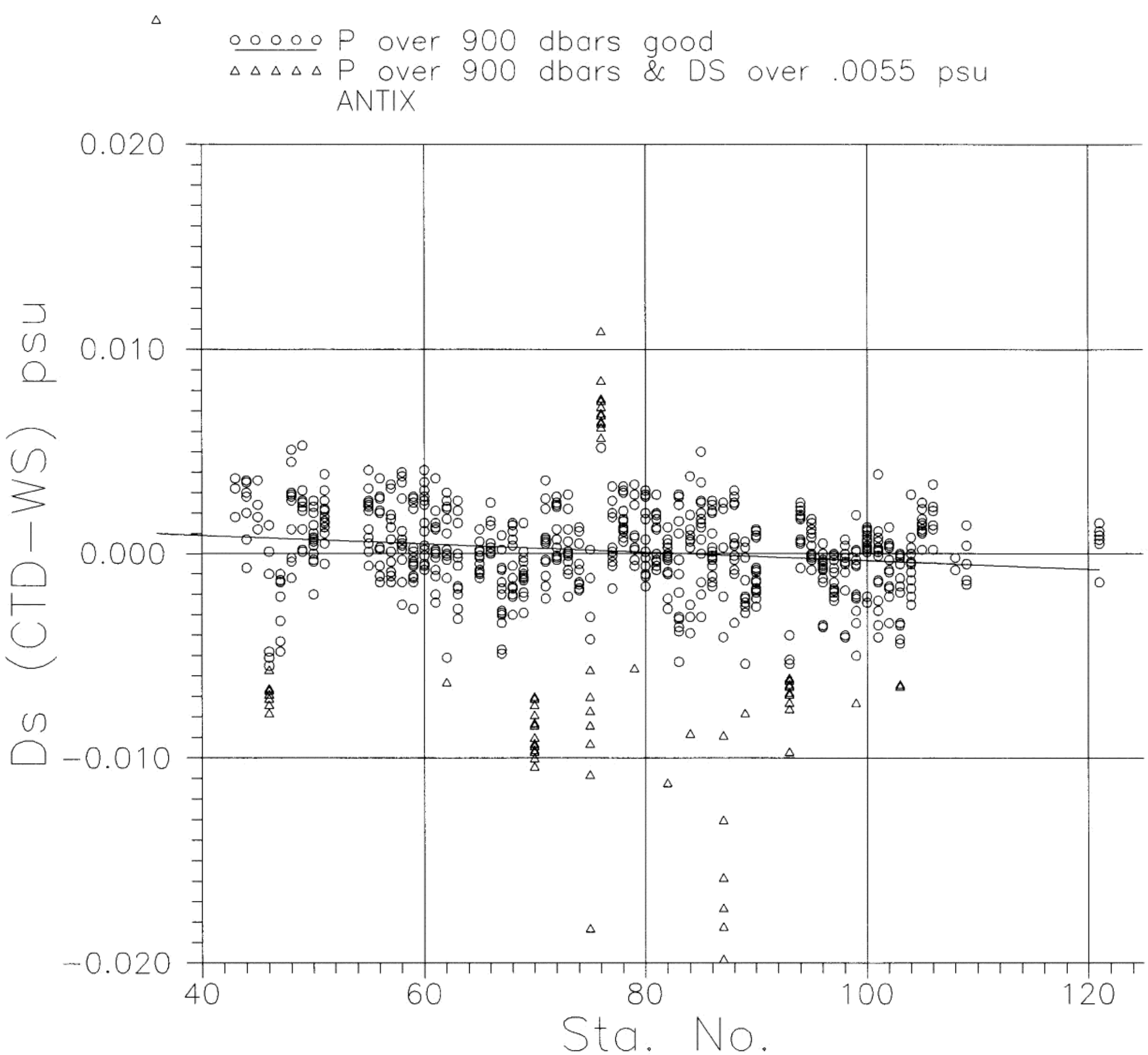
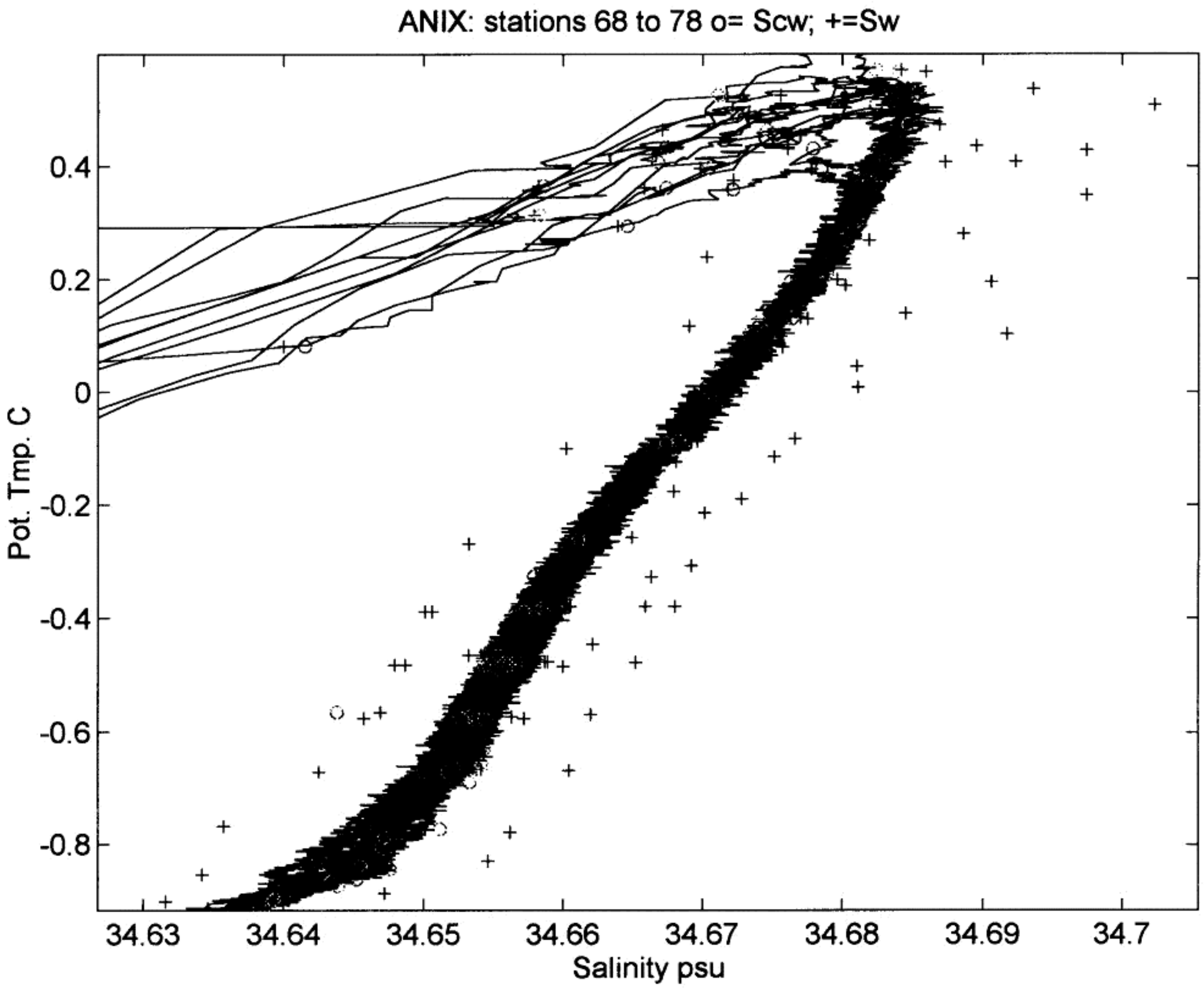
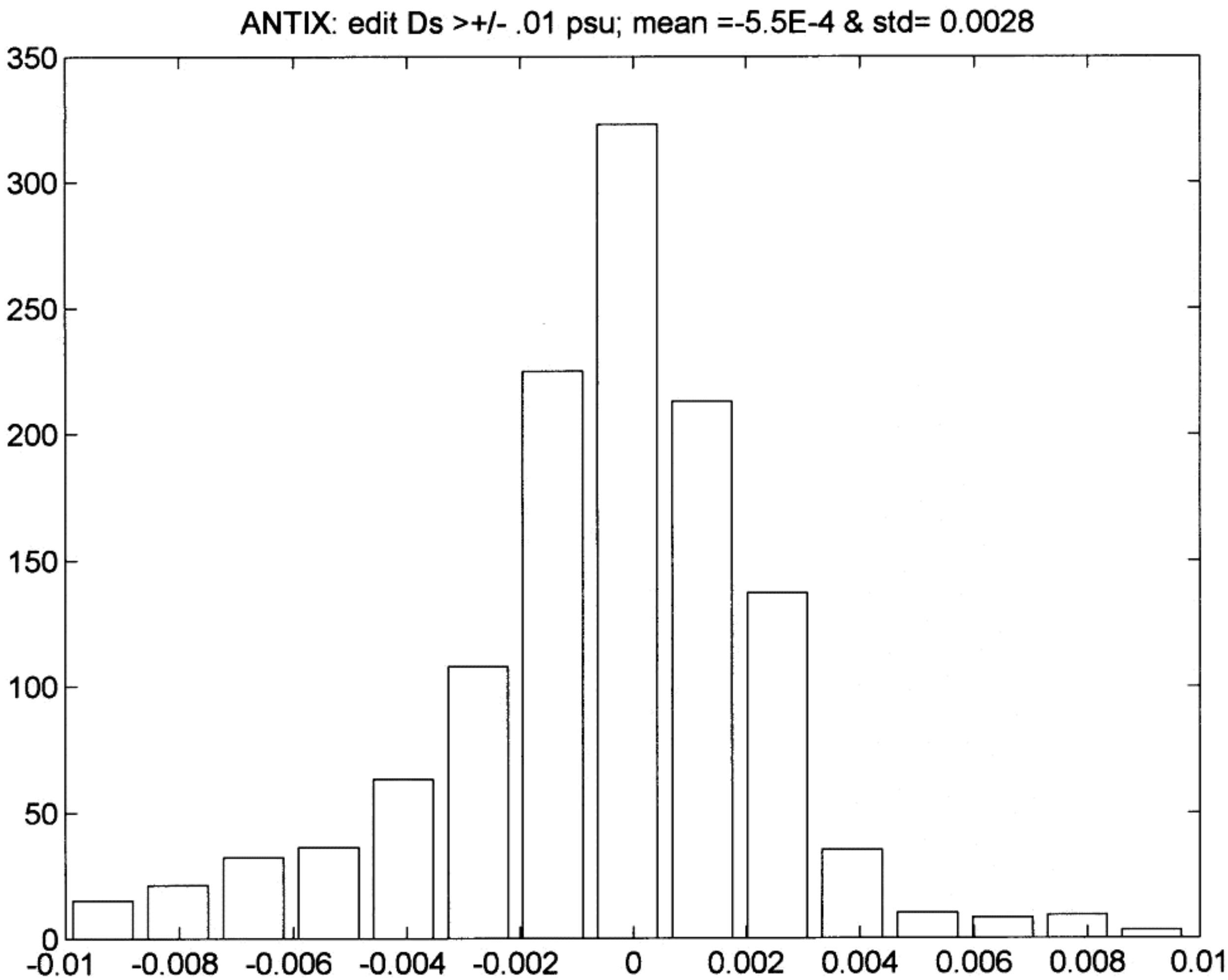

P over 900 dbars good
P over 900 dbars & DS over .0055 psu
ANTIX
0.020
0.010
0.000
−0.010
−0.020
Ds (CTD−WS) psu
40
60
80
100
120
Sta. No.

Figure 2b



ANIX: stations 68 to 78 o= Scw; +=Sw
Pot. Tmp. C
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
34.63
34.64
34.65
34.66
34.67
34.68
34.69
34.7
Salinity psu

Figure 3



ANTIX: edit Ds >+/- .01 psu; mean =-5.5E-4 & std= 0.0028
350
300
250
200
150
100
50
0
-0.01
-0.008
-0.006
-0.004
-0.002
0
0.002
0.004
0.006
0.008
0.01

Figure 4

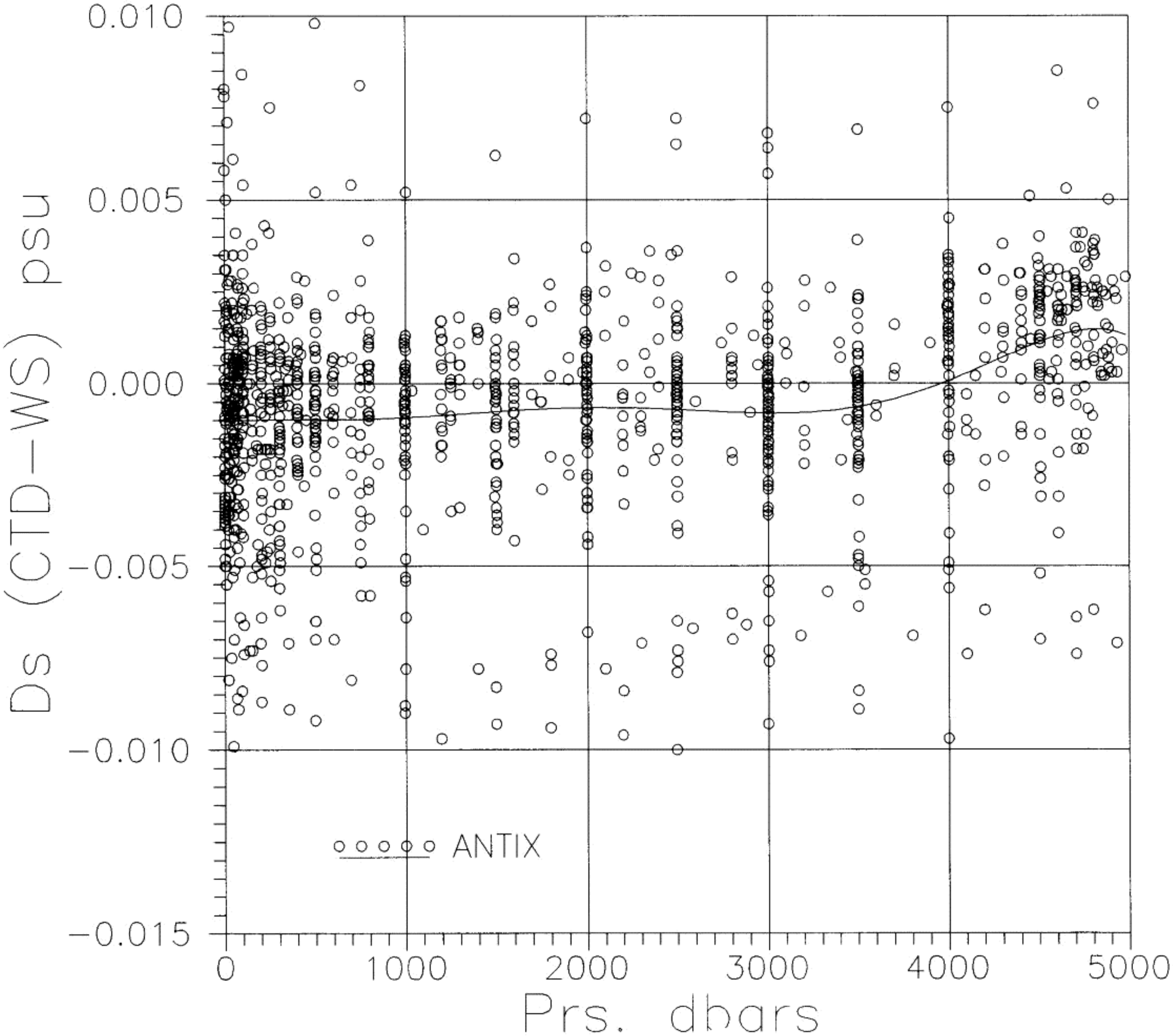

0.010
0.005
0.000
−0.005
−0.010
−0.015
Ds (CTD−WS) psu
0
1000
2000
3000
4000
5000
Prs. dbars
ANTIX

Figure 5

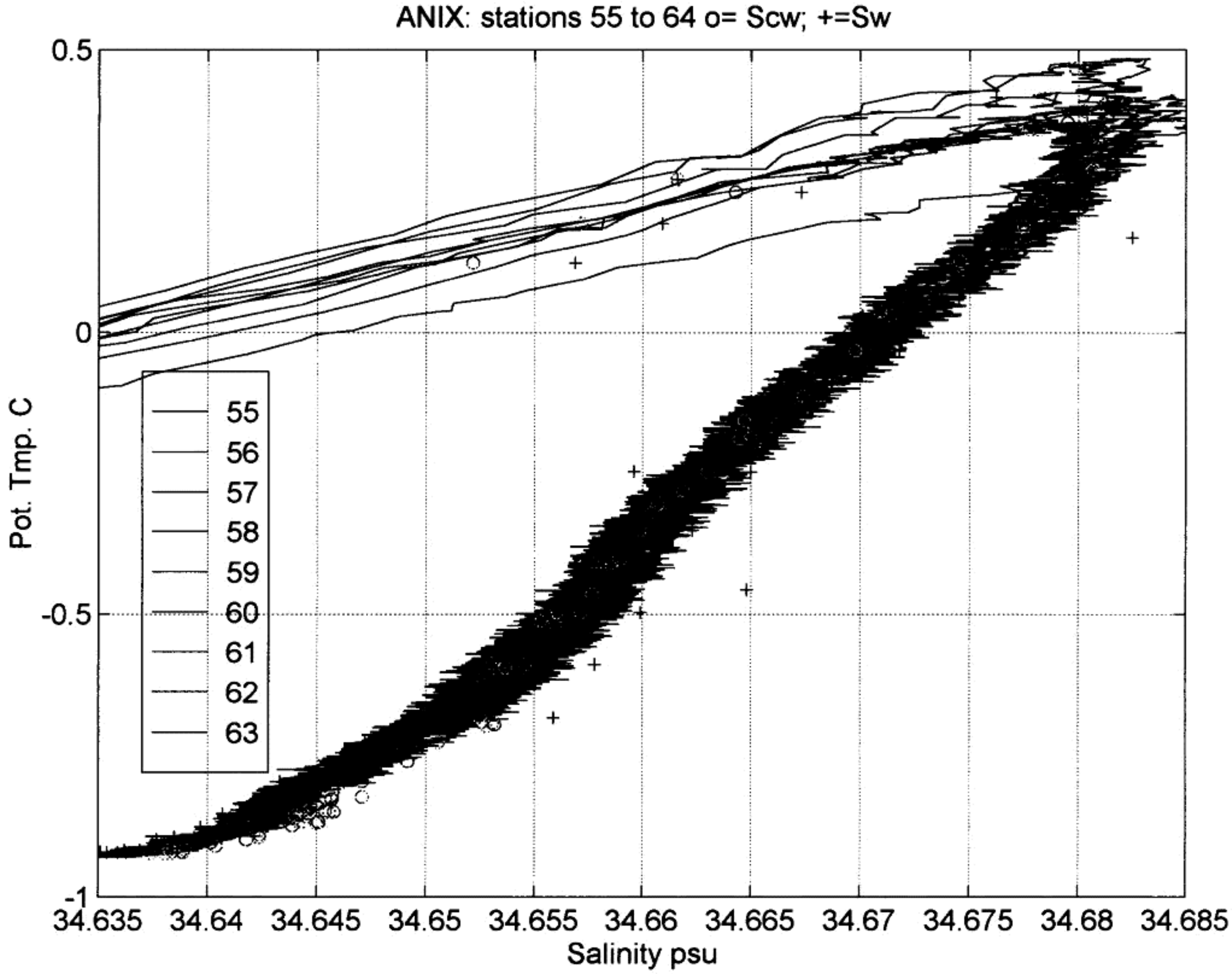

ANIX: stations 55 to 64 o= Scw; +=Sw
0.5
0
-0.5
-1
Pot. Tmp. C
55
56
57
58
59
60
61
62
63
34.635
34.64
34.645
34.65
34.655
34.66
34.665
34.67
34.675
34.68
34.685
Salinity psu

Figure 6

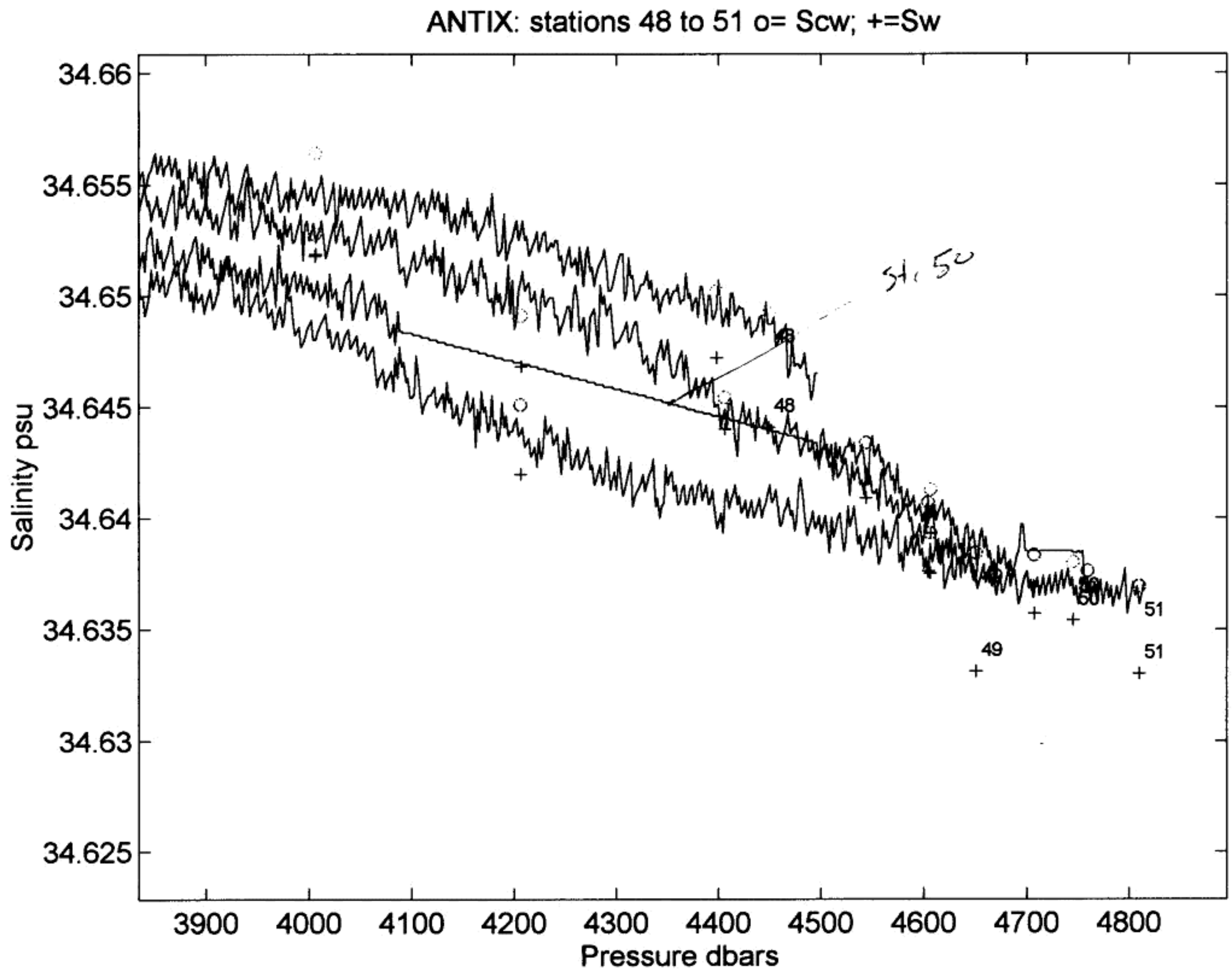

ANTIX: stations 48 to 51 o= Scw; +=Sw
Salinity psu
Pressure dbars
34.66
34.655
34.65
34.645
34.64
34.635
34.63
34.625
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
48
48
49
50
51
51
St. 50

Figure 7a

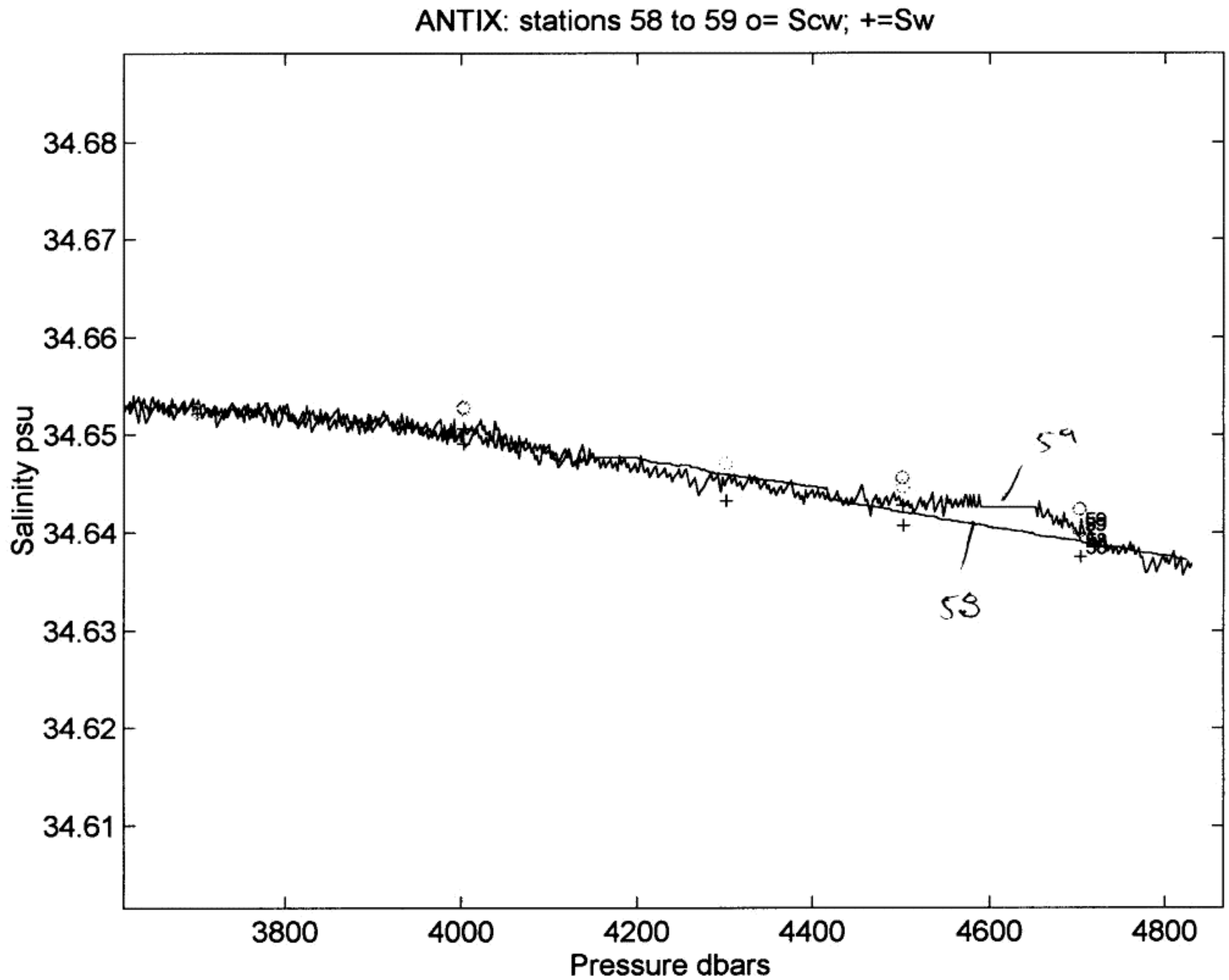

ANTIX: stations 58 to 59 o= Scw; +=Sw
Salinity psu
Pressure dbars
34.68
34.67
34.66
34.65
34.64
34.63
34.62
34.61
3800
4000
4200
4400
4600
4800
59
58

Figure 7b

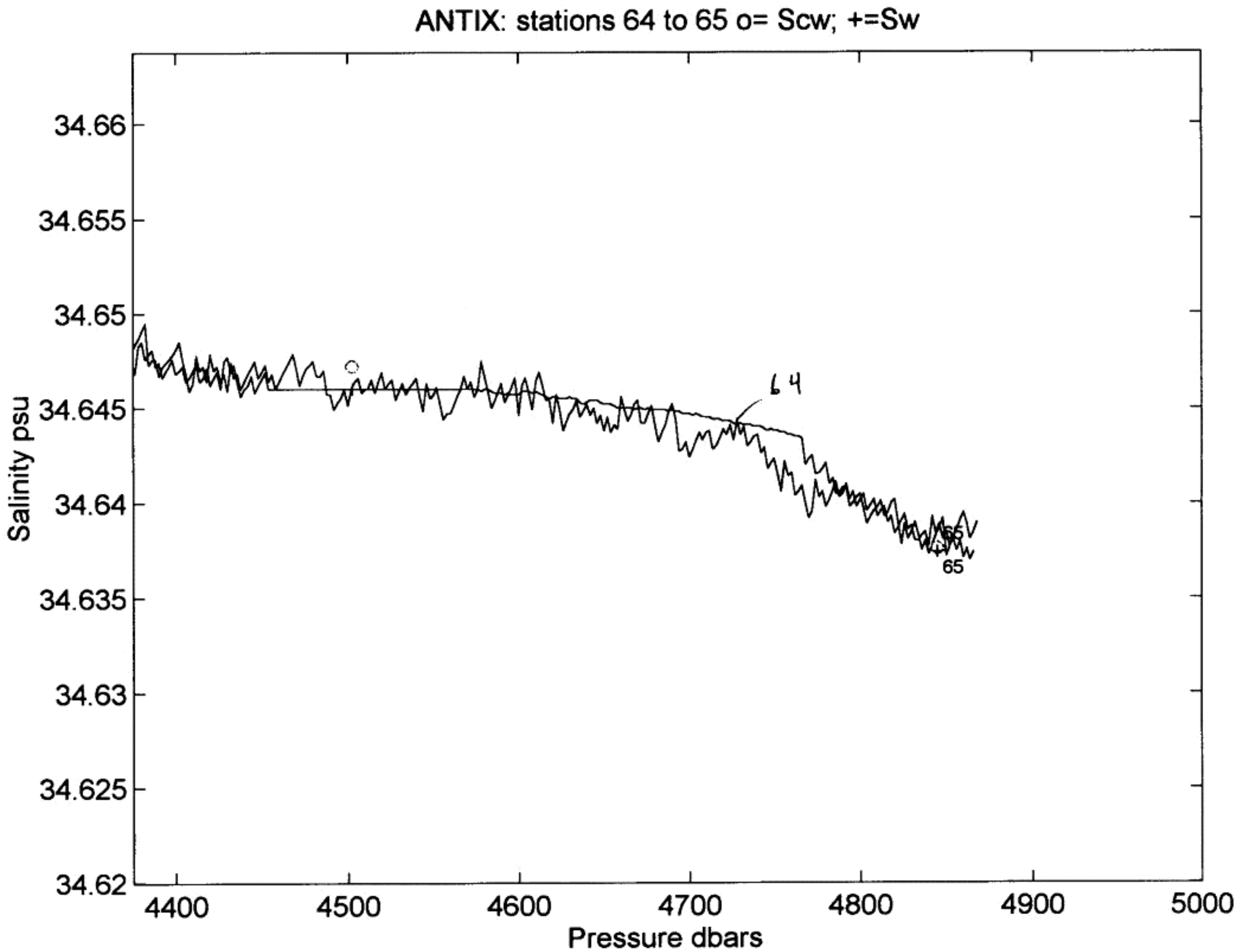

ANTIX: stations 64 to 65 o= Scw; +=Sw
Salinity psu
34.66
34.655
34.65
34.645
34.64
34.635
34.63
34.625
34.62
4400
4500
4600
4700
4800
4900
5000
Pressure dbars
64
65
65

Figure 7c

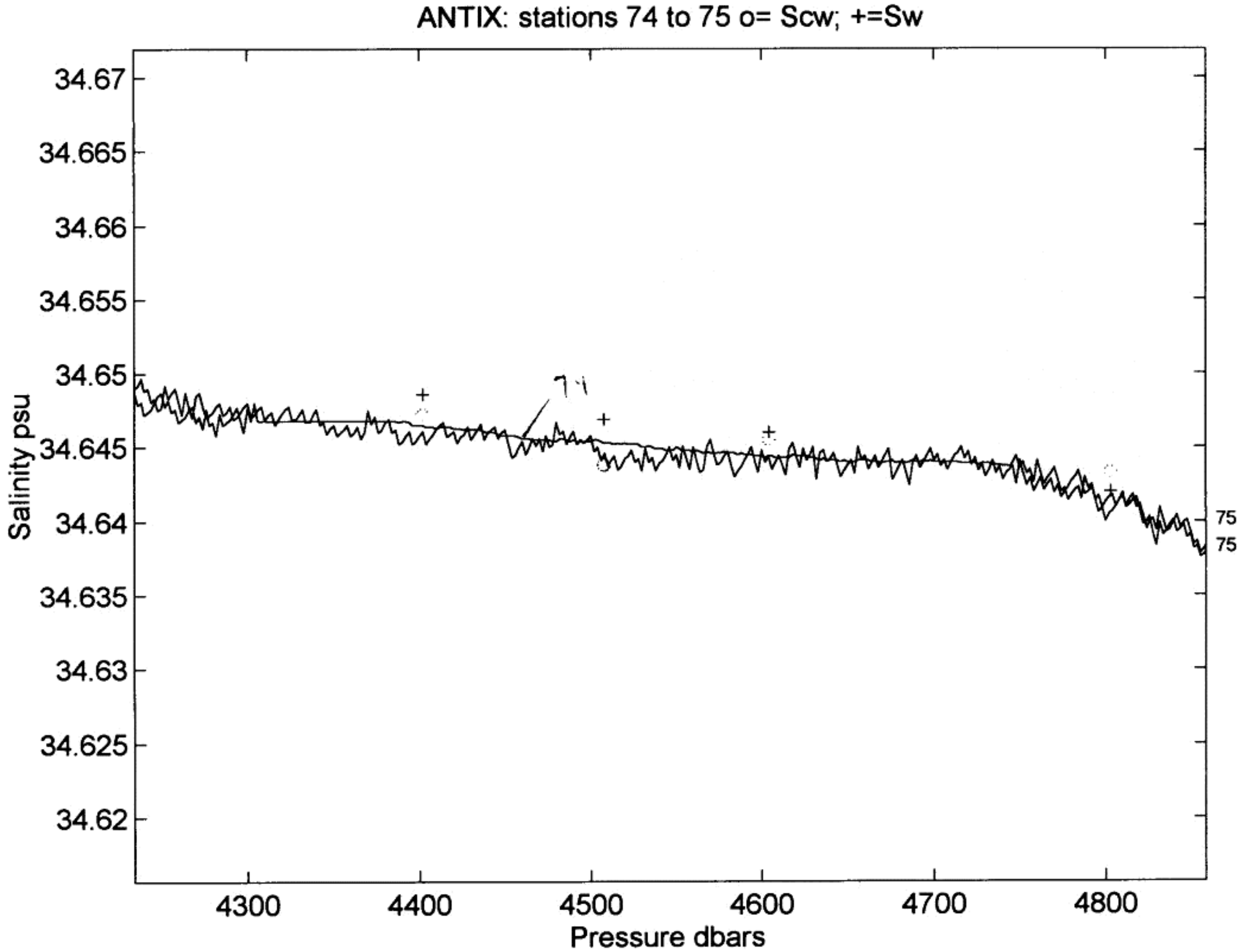
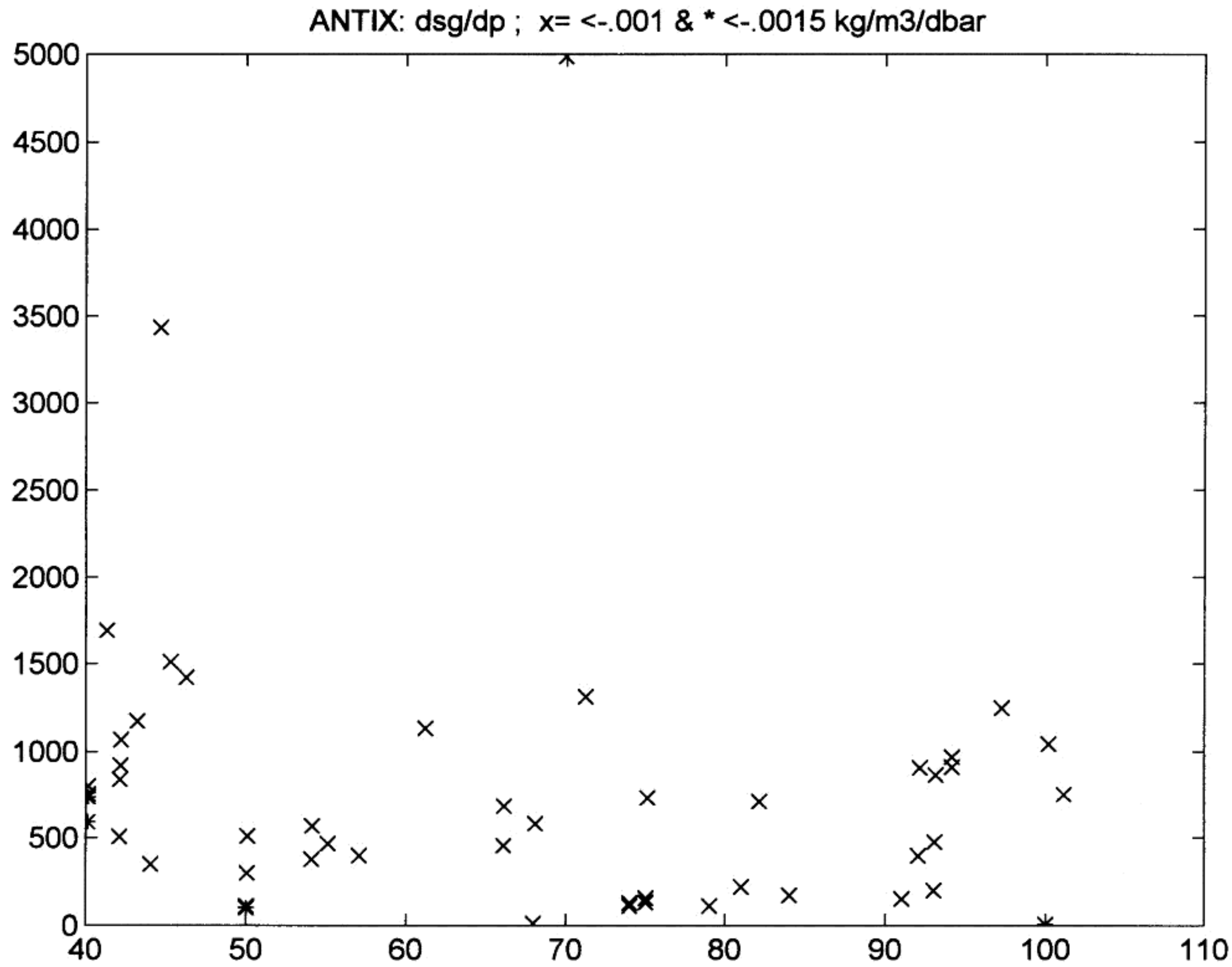

ANTIX: stations 74 to 75 o= Scw; +=Sw
Salinity psu
34.67
34.665
34.66
34.655
34.65
34.645
34.64
34.635
34.63
34.625
34.62
4300
4400
4500
4600
4700
4800
Pressure dbars
75
75

Figure 7d



ANTIX: dsg/dp ; x= <-.001 & * <-.0015 kg/m3/dbar
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
40
50
60
70
80
90
100
110

Figure 8

13. CCHDO DATA PROCESSING NOTES

Date	Person	Data Type	Action	Summary
1999-03-15	Diggs, Steve	He/Tr/Ne	Submitted	not yet merged w/ btl data

SR04 (06AQANTIX_2): we now have unmerged Helium, Neon and Tritium data for this repeat

Date	Person	Data Type	Action	Summary
2001-05-30	Uribe, Karla	BTL	Website Updated:	Exchange file online

Bottle has been put into exchange format. There was a station/cast number 121 not included in the bottle file which was removed from the sumfile in order to put the data into exchange. Bottle and sumfile links on website remain the same new exchange file has been added to website.

Date	Person	Data Type	Action	Summary
2001-12-12	Uribe, Karla	CTD	Website Updated:	Exchange file online

CTD has been converted to exchange using the new code and put online.

Date	Person	Data Type	Action	Summary
2012-08-15	Barna, Andrew	He/Tr	Website Updated	Available under 'Files as received'

File Ant9_2.woc containing Helium and Tritium data, submitted by Dr. Birgit Klein via email on 1999-03-12, available under 'Files as received', unprocessed by CCHDO.

Date	Person	Data Type	Action	Summary
2013-07-10	Berys, Carolina	He/Tr	Website Update	Exchange, NetCDF, WOCE files online

```
=========================================================
06AQANTIX_2 processing - BTL/merge - HELIUM, TRITUM, DELHE3
=========================================================
2013-07-10
C Berys
.. contents:: :depth: 2
Submission
==========
========== ============ ========== ========= ====
filename   submitted by date       data type id
========== ============ ========== ========= ====
Ant9_2.woc Birgit Klein 1999-03-12 He/Tr     None
========== ============ ========== ========= ====
Parameters
----------
Ant9_2.woc
~~~~~~~~~~
- CTDPRS
- CTDTMP
- CTDSAL [1]_
- SALNTY [1]_
- OXYGEN [1]_
- SILCAT [1]_
- NITRAT [1]_
- NITRIT [1]_
- PHSPHT [1]_
- TRITUM [1]_
- HELIUM [1]_
- DELHE3 [1]_
- NEON [1]_
- NEONER
- HELIER
- TRITER
- DELHER
.. [1] parameter has quality flag column
Process
=======
Changes
```

Ant9_2.woc
~~~~~~~~~~
- converted to WHP Exchange format
- TRITIUM changed to TRITUM
- DELHE3 and DELHER units changed from % to PERCNT
Merge

Ant9_2.woc
~~~~~~~~~~
Merged Ant9_2.woc into sr04_b_hy1.csv using hydro 0.8.0-10-ge326027
:New parameters: HELIUM, HELIUM_FLAG_W, NEON, NEON_FLAG_W, NEONER, TRITER, HELIER, TRITUM, TRITUM_FLAG_W, DELHER, DELHE3, DELHE3_FLAG_W
All comment lines from original file copied back in following merge. sr04_b_hy1.csv opened in JOA with no apparent problems.
Conversion

================= ======================== =======================
file converted from software
================= ======================== =======================
he-trit_hy1.csv Ant9_2.woc, sr04_bsu.txt hydro 0.8.0-10-ge326027
sr04_b_nc_hyd.zip sr04_b_hy1.csv hydro 0.8.0-10-ge326027
sr04_bhy.txt sr04_b_hy1.csv hydro 0.8.0-10-ge326027
================= ======================== =======================
All converted files opened in JOA with no apparent problems.
Directories
===========
:working directory:
/data/repeat/southern/sr04/sr04_b/original/2013.07.10_HE-TRIT_CBG
:cruise directory:
/data/repeat/southern/sr04/sr04_b
Updated Files Manifest
======================
- sr04_bhy.txt
- sr04_b_nc_hyd.zip
- sr04_b_hy1.csv

2013-07-12	Berys, Carolina	CTDTMP-UNITS	Website Update	Corrected Exchange, netCDF and WOCE files online

======================
06AQANTIX_2 processing
======================
2013-07-12
C Berys
.. contents:: :depth: 2
Process
=======
Changes

- CTDTMP units changed from 'ITS-90' to 'IPTS-68'
Conversion

================= ============== =======================
file converted from software
================= ============== =======================
sr04_b_nc_hyd.zip sr04_b_hy1.csv hydro 0.8.0-10-ge326027

================ ============= ======================
All converted files opened in JOA with no apparent problems.
Directories
===========
:working directory:
  /data/repeat/southern/sr04/sr04_b/original/2013.07.12_CTDTMP-UNITS_CBG
:cruise directory:
  /data/repeat/southern/sr04/sr04_b
Updated Files Manifest
=====================
- sr04_bhy.txt
- sr04_b_nc_hyd.zip
- sr04_b_hy1.csv

2013-10-17 Kappa, Jerry CrsRpt Website Update Updated PDF version online
I have added a new version of the cruise report:
  sr04_bdo.txt
to the directory
  http://cchdo.ucsd.edu/data/repeat/southern/sr04/sr04_b/
Updates include
• Forward (Description of Scientific Program)
• CTD data report,
• CTD DQE report by Robert Millard
• CCHDO Summary Page
• Data Processing Notes.