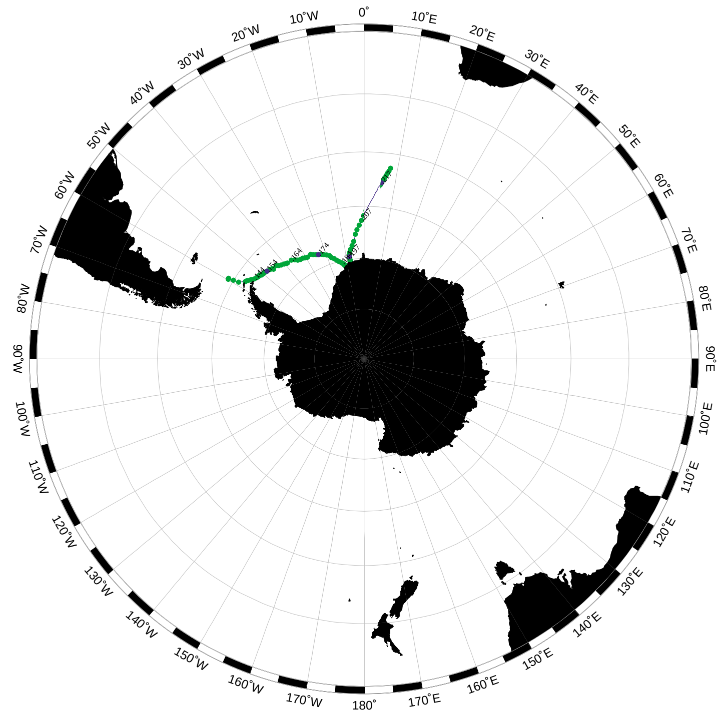
A. Cruise Narrative: SR02 & SR04



A.1. Highlights

WHP Cruise Summary Information

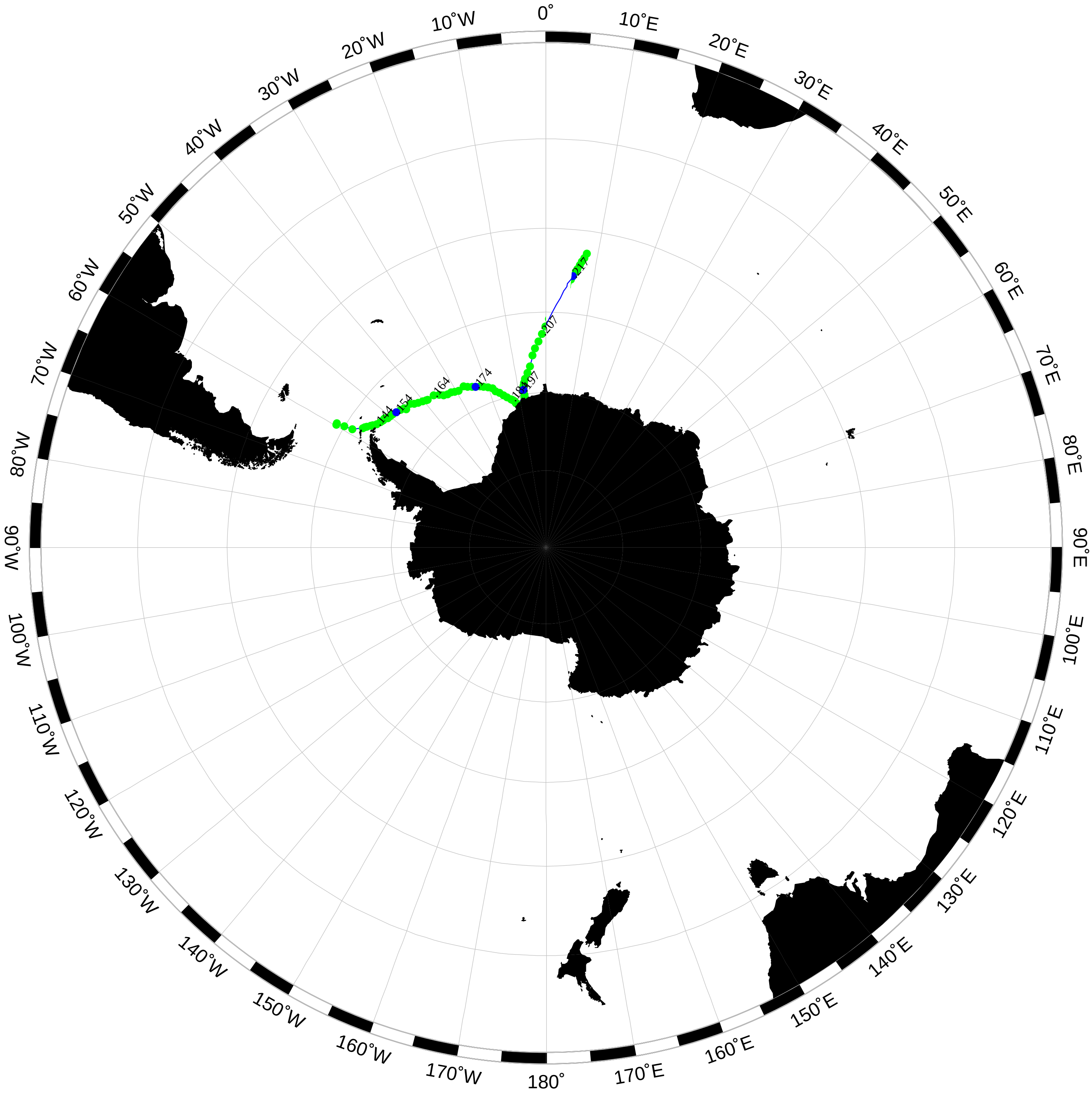
WOCE section designation	**SR02 & SR04**
Expedition designation (EXPOCODE)	**06AQANTVIII_2**
Chief Scientist/affiliation	**Eberhard Fahrbach/AWI***
Dates	1989.SEP.06 - 1989.OCT.30
Ship	*RV Polarstern*
Ports of call	Puerto Madryn, Argentina
	Cape Town, S. Africa
Number of stations	88
Geographic boundaries of the stations	52° 38'S 59° 45'W 7° 53'E 71° 04'S
Floats and drifters deployed	14 buoys (2 Argos arrays)
Moorings deployed or recovered	7 current meter moorings;
Contributing Authors	none cited

* Alfred-Wegener-Institut für Polar und Meeresforschung
Postfach 12 01 61• Columbusstrasse • D-27515 Bremerhaven • Germany
phone: 49-471-4831-501 • fax: 49-471-4831-149 or -425
e-mail: efahrbach@awi-bremerhaven.de

WHP Cruise and Data Information

Instructions: Click on headings below to locate primary reference or use navigation tools above. (Shaded headings were not available when this report was assembled or are not relevant to this cruise)

Station Locations for SR02_SR04 : FAHRBACH, 1989



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A.2 Scientific Programme and Methods

The physical oceanography programme was primarily concerned with a detailed quantitative description of the Weddell Gyre circulation and of the Atlantic part of the Antarctic Circumpolar Current (ACC). Additionally, measurements were carried out to derive the vertical turbulent fluxes of momentum, heat and salt under the sea ice cover.

Parameters:
The physical data are supplemented by oxygen, nutrient and stable isotope measurements (Carbon-13 and Oxygen-18) as well as by samples for tritium, Helium-3 and Helium-4 analyses.

A.3 Summary and Itinerary

The Winter Weddell Gyre Study 1989 (WWGS'89) was a joint research project of the German vessel Polarstern and the USSR vessel Akademik Fedorov to investigate the oceanic circulation of the Weddell Sea at the end of the Austral winter. This operation was the first of a total of four similar campaigns by which the mass, heat, salt and sea ice transports of the Weddell Gyre and the water mass modification in the southerly Weddell Basin will be quantitatively determined.

The oceanic core programme is complemented by detailed studies of sea ice dynamics, air- sea ice - water interactions, sea ice remote sensing, sea ice biota as well as the temporal and regional variations of the phyto- and zooplankton development in the Weddell Gyre regime.

The recent cruises have supported measurements along four transects perpendi-cular to the oceanic circulation of the Weddell Sea as portrayed in Fig.1. The zonal most southerly and the meridional most easterly track lines provide hydro-graphic sections across the entire gyre system while the two others cover the northwesterly part of the eastward branch of the flow. The scientific field work in 1989 was primarily directed towards:

- the determination of the baroclinic mass, heat and salt transports by the Weddell Gyre circulation
- the estimation of the water mass modification in the inner Weddell Basin
- the detection of oceanic mesoscale features caused by orographic forcing of Maud Rise
- the quantitative description of the concentration, thickness, physical and chemical properties as well as of the biota of sea ice
- the derivation of the oceanic and atmospheric kinematic and thermodynamic forcing on sea ice
- the analyses of the regional distribution of phyto- and zooplankton under the given availability of nutrients and the observed physical environmental conditions
- ground truth measurements and special microwave studies to improve satellite passive and active microwave remote sensing techniques for sea ice observations
- the detection of the ozone concentration of the atmospheric column within the polar vortex during the transition from winter to spring.

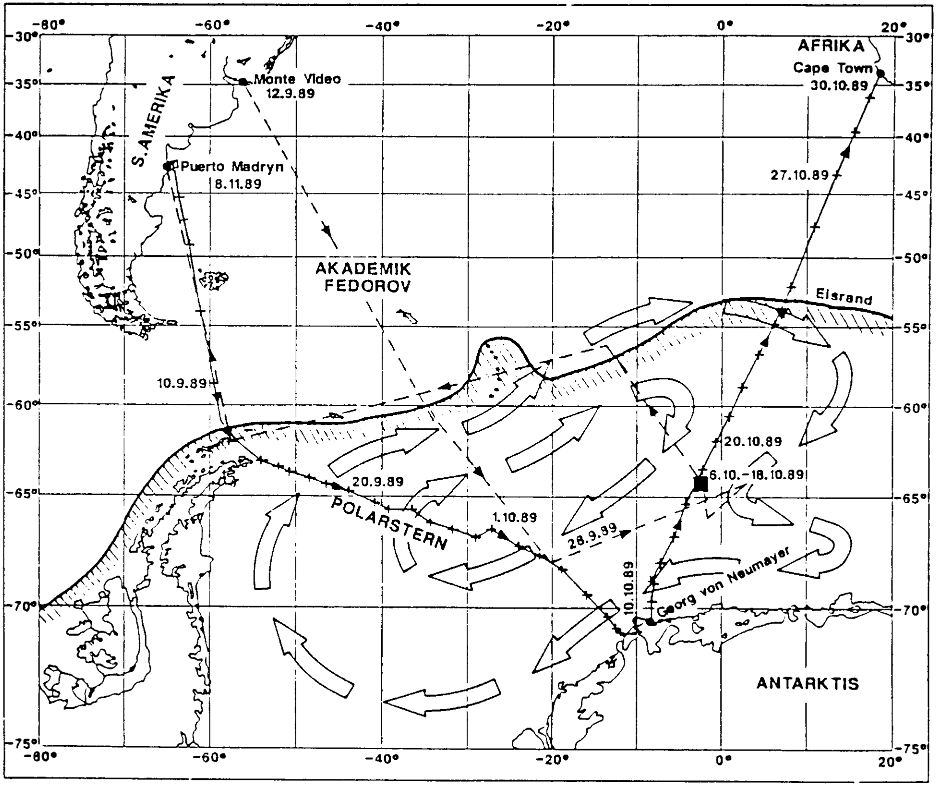


Figure 1: Cruise tracks of "Polarstem" (full lines and crosses) and of "Akademik Fedorov" (dashed lines) during WWGS '89

The 118 scientists and technicians participating in the cruises of Polarstern (56) and Akademik Fedorov (62) came from universities and research institutes of the Federal Republic of Germany, the USSR, the USA, Great Britain and Canada. The various subprogrammes on both ships were carried out jointly by multination-al groups. A close cooperation between the ships during the campaign was established through daily radio conferences of the chief scientists and representatives of the different research groups.

Polarstern departed from the port of Puerto Madryn, Argentina , on 6 September 1989 with 42 ship's crew, 56 scientists and technicians on board. The scientific observational programme commenced at latitude 54°S with daily radiosonde launches and XBT casts with 15 nm spacing. The first complete hydrographic vertical profile (CTD and rosette water sampler) was taken at 58°S on 10 September 1989. The ship encountered the ice edge at about 61°53'S latitude near King George Island one day later.

During the morning of 11 September a helicopter flight was carried out to the Chilean Antarctic station Teniente Marsh in order to collect a radiometer provided by NASA which had to be installed on board the ship. Meanwhile Polarstern was steaming towards the Bransfteld Strait to reduce the flight distance. When the helicopter was on board again the ship moved back to the edge of the inner marginal ice zone at 62°S/57°W to start a detailed hydrographic and biological survey across the Bransfteld Strait (see Fig. 1). The full observational programme started on 12 September 1989 with the subsequent work of the various disciplines:

- CTD profiles combined with water sampling (rosette of 24 Niskin bottles) from the sea surface to the ocean bottom on a horizontal grid of 30 nm width. The density of the hydrographic stations was significantly higher only over the continental shelf breaks on the western and eastern boundaries of the Weddell Basin. It was coarser (60 nm) on the meridional section from the Georg-von-Neumayer Station to the inner side of the marginal ice zone near 5°E. During the passage of the northern ice edge regime the 30 nm distance was chosen again for the CTD network.
- Deployment of seven current meter moorings to complement the hydrographic measurements along the zonal transect and recording of Doppler sonar profiles of the currents in the upper 200 m of the water column at most of the oceanographic stations within the ice belt.
- Measurements of the turbulent vertical momentum and heat fluxes above and below ice floes at 3 extended ice stations, located in the western and eastern coastal current regimes and in the central Weddell Sea. The atmospheric fluxes were additionally recorded during most of the ship's stops at a mast on ice floes and/or at a boom extending the ship's bow crane. The data of both instruments were generally in good agreement.
- Monitoring of the atmospheric surface pressure field and the movement (deformation) of the sea ice with the aid of two Argos buoy arrays, one in western branch and one in the center of the Weddell Gyre. The western network consisted of 8 and the central one of 6 buoys. In both cases the two inner stations were additionally equipped with sensors for air temperature and wind velocity as well as with thermistor strings through the ice and

through the water layer down to 250 m depth. The buoy systems are supposed to continue their operations during several months.

- Sea ice work to detect ice thickness, snow cover, bottom and top topography of ice floes along the ship's track line by drilling holes through the ice. Additionally ice cores were taken to determine the texture, physical and chemical properties of the sea ice. Strain measurements were executed to study the mechanical forces on the ice. Finally the small scale ice concentration, floe size distribution and top morphology was obtained by aerial photography, line scan camera data and video observations during helicopter flights.
- Active and passive microwave measurements from the ship together with ground truth data of the relevant snow and ice properties to improve actual and in near future available satellite observations. Visible and infrared AVHRR data of the entire Weddell Sea area have been recorded to derive the large scale ice concentration and ice motion.
- The regional and vertical distribution of the sea ice biota in relation to the texture and to the physical and chemical properties of the ice. Special emphasis was put on a detailed taxonomy of the sea ice species.
- Concentrations of nutrients, phyto- and zooplankton from the rosette water samples as well as from multinet and bongonet hauls, respectively
- Ozone concentration and aerosol content of the atmosphere with optical methods.

The above indicated work was carried out either from the ship and from ice floes or with the aid of two helicopters of the type BO-105. The cruise track and the station grid was primarily based on the requirements of the programmes in physical, chemical and biological oceanography. Nevertheless, all other projects could more or less smoothly adjust to the predetermined itinerary.

On her way through the pack ice Polarstern met different navigational conditions. The western side of the Weddell Sea was mainly occupied by large ice floes older than one year, as expected. But the concentration was mostly less than 90% so that the ship could keep the average speed above 5 knots by moving through suitable leads of open water. Ramming was necessary at a few occasions only. In the central and eastern part of the Weddell Basin first year ice with concentrations of more than 90% was predominant and the ships progress was somewhat reduced. The most unfavourable ice conditions were encountered near the east coast where northeasterly winds led to a remarkable compression particularly in the neighbourhood of grounded icebergs. Here Polarstern was caught twice in a shear zone of pack ice and she was forced along a distinct shear line which marked the front of the immobile ice trapped by the icebergs. Similar conditions were met in front of the Atka Bay near the German station Georg-von-Neumayer (GvN).

On the meridional transect to the north the ice concentration stayed above 90% from the coast to the transition from the inner to the outer marginal ice zone. The floe sizes and the ice thickness on this leg were largest southwest of Maud Rise. The most surprising finding was an extremely wide marginal ice zone covering a latitudinal belt of about 350 km with its most northerly ice band at 53°44'S / 07°18'E .

The total mean speed of Polarstern through the ice finally amounts to the relatively high value of 6.25 knots when station time is excluded. Since this result was much better than envisaged the working time at stations could be extended by roughly 25%.

A.4 Drifting Buoys

The two surface buoy arrays on Fig. 2 were deployed partly by the ship and partly by helicopters. Two of the three longer ice stations (2 to 4 days) were located within each of these buoy networks so that all programmes can later profit from the detailed information on the atmospheric forcing and on the mesoscale ice deformation. The third long ice station was set up in the eastern coastal current north of GvN.

On the transect from the Antarctic peninsula to Kapp Norwegia two clusters of drifting buoys were deployed on ice floes. The two central buoys of each cluster carried thermistor cables in the water (250m) and the ice (2.2m) and complete meteorological package, the other buoys only air pressure and temperature sensors.

A.5 Current Meter Moorings

The zonal hydrographic cross-section was complemented by 7 current meter bottom moorings (see Fig. 3). Two moorings are located each in the western and eastern boundary currents and three were deployed in the interior gyre regime. All 24 current meters are Aanderaa RCM 8 instruments which have been located according to Table 1. When these instruments will have been recovered at the end of 1990 the data shall be used for first estimates of the total mass transport within the Weddell Gyre.

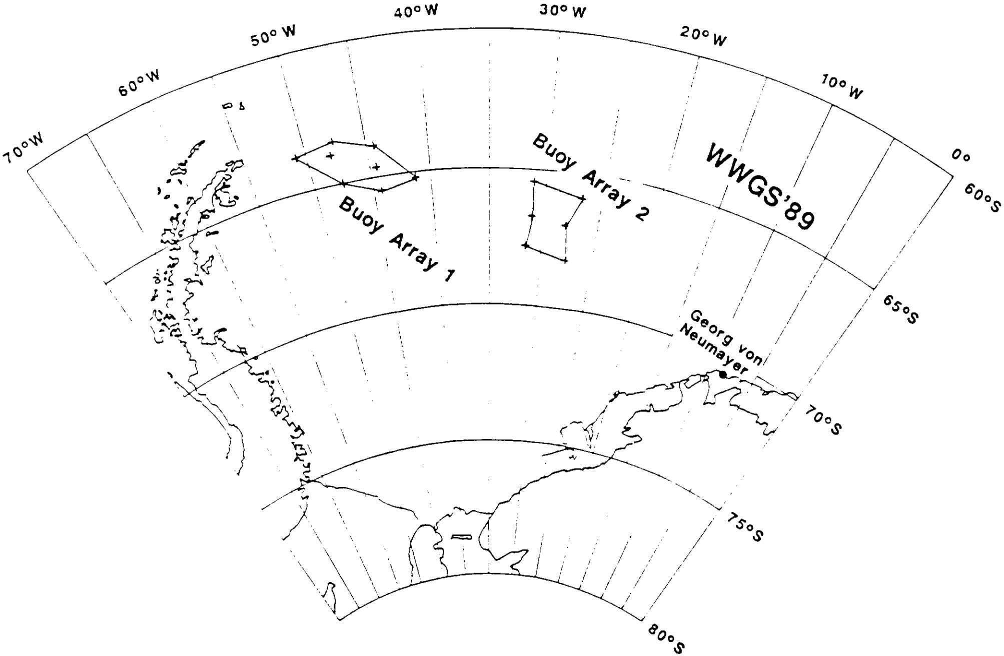


Figure 2: Deployment positions of the Argos surface buoy arrays

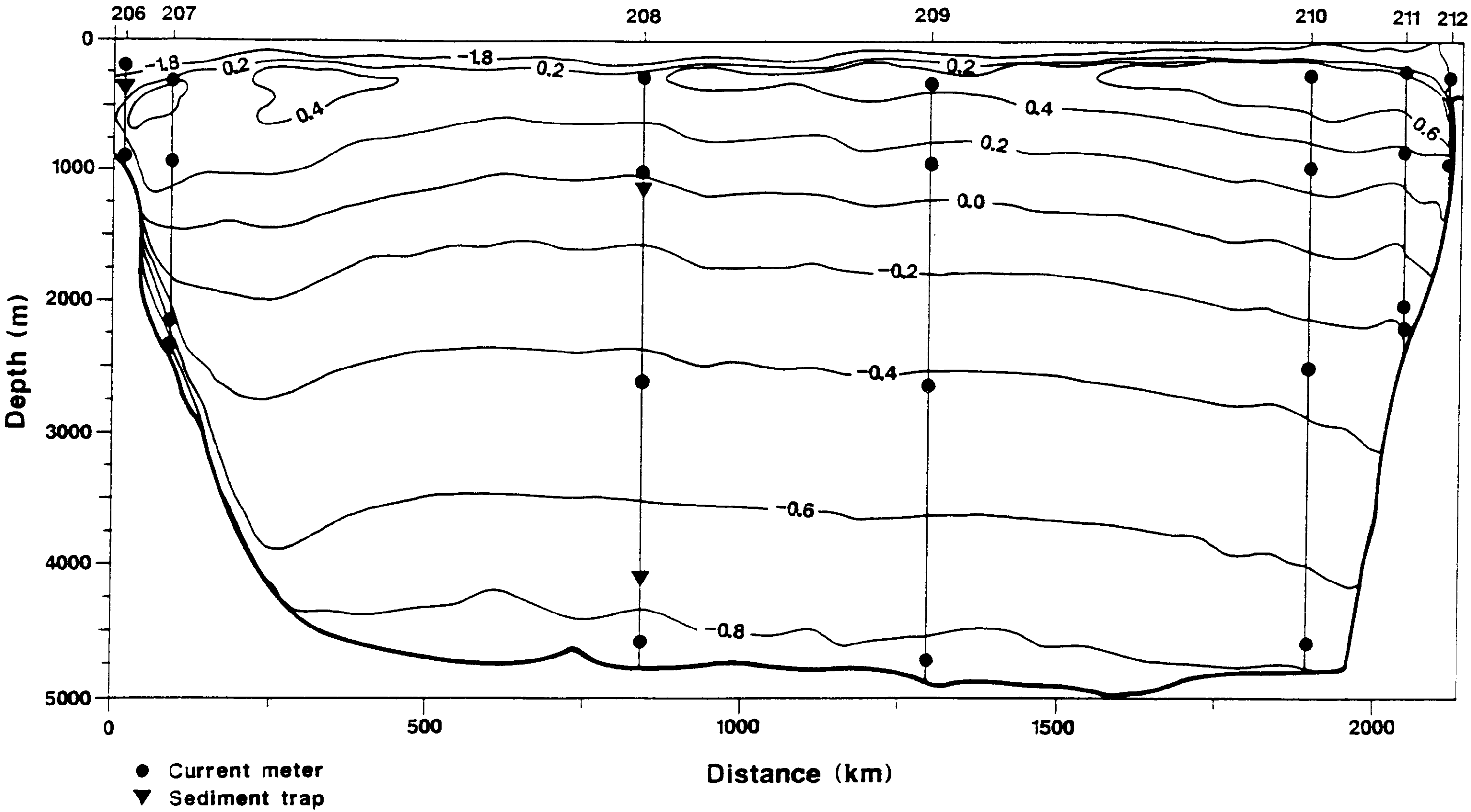


Figure 3: Deep sea moorings along the "Polarstern" section across the Weddell Gyre

TABLE 1: Mooring deployment during WWGS '89

Mooring	Latitude Longitude	Date Time	Water Depth (m,corr.)	Instrument Type	Depth
AWI 206	63 29.6'S	13.09.89	927	AVTP	229
	52 07.4'W	11.13		HDW-S	349
				AVT	876
AWI 207	63 45.8'S	14.09.89	2461	AVTPC	263
	50 54.3'W	10.39		AVTPC	952
				AVT	2162
				AVT	2410
AWI 208	65 36.3'S	24.09.89	4742	AVTPC	288
	36 29.9'W	18.30		AVTPC	1037
				HDW-S	1090
				AVT	2610
				HDW-S	4122
				AVT	4631
AWI 209	66 36.8'S	01.10.89	4836	AVTPC	293
	27 07.4'W	10.28		AVTPC	993
				AVT	2653
				AVT	4725
AWI 210	69 38.9'S	05.10.89	4728	AVTPC	289
	15 44.5'W	21.11		AVTPC	988
				AVT	2547
				AVT	4617
AWI 211	70 29.5'S	07.10.89	2364	AVTPC	247
	13 07.0'W	00.13		AVTPC	856
				AVT	2066
				AVT	2313
AWI 212	70 59.2'S	08.10.89	1050	AVTPC	309
	11 49.4'W	16.55		AVT	999

AVTPC: Aandreaa current meter with temp, pressure and conductivity sensor
HWD-S: HDW-sediment trap

A.6 Turbulent and Profile Measurements under the Ice

Three ice stations of two to three days duration were utilized to measure the turbulent fluxes of momentum, heat and to a limited extent salt across the oceanic boundary layer, with a new turbulence system. Additionally, three to five Aanderaa current meters were moored under the ice to detect the vertical current profiles between 0.2m and 6m depth. An acoustic current meter and a CTD were also applied to measure vertical profiles of the currents and of the density stratification.

The Antarctic Circumpolar Current (ACC)

Measurements across the Antarctic Circumpolar Current (ACC) were taken with the aid of XTB and ADCP profiles. These data will help to better identify mesoscale structures within the ACC which have been observed by satellite altimeter measurements and which also appear in recent eddy resolving model simulations.

A.7 Major Problems and Goals not Acheived

(Response from the Chief Scientist concerning the CTD DQE)

This was an Antarctic winter cruise and all kind offers for software are of little help when sensors or water in bottles freeze. We have tried since 1986 to prevent freezing, but only in 1990 did we achieve a somewhat satisfying system. However, for oxygen we did not find a solution at all and therefore there are no CTDOXY values.

As for the ANT VIII data our sensor protection was still not reliable and we had freezing problems as well as those fromour protection system. Therefore the data of that cruise required a particularly intensive correction. But even now we still have more problems with the CTDs than warm water oceanographers and therefore need special procedures. We hoped to experiences some improvement by using the FSI CTD but it seems as if we just exchanged one set of problems for another.

A.8 Other Incidents of Note

A short convenient break of the research work occurred during a stop of Polarstern at Atka Bay on 10 and 11 October to unload some equipment for the GvN Station. This opportunity was taken by many participants to visit the station and to contact the wintering team. At the end of the unloading procedure the GvN crew was invited on the ship for a farewell party.

A second social event took place during the intercomparison meeting with the Akademik Fedorov west of Maud Rise on 17 and 18 October. The meeting of the personnel of both ships was accompanied by meteorological, oceanographic and biological intercomparisons of instruments and sampling techniques. During a reception on the Akademik Fedorov it was agreed among the participants that 'the successful cooperation in the Antarctic should be extended to the Arctic in order to support the ongoing international global climate research activities.

A.9 List of Cruise Participants

Name	Institute	Name	Institute	Name	Institute
Augstein, E.	AWI	St. Germain, K.	UNIM	Ochsenhirt, W.-T.	IDWD
Bathmann, U.	AWI	Gradinger, R.	AWI	Olf, J.	IMH
Beyer, K.	AWI	Hehl, 0.	IMH	Reisemann, M.	AWI
Bredemeier, M.	If BG	Helmes, L.	AWI	Rohardt, G.	AWI
Carbonell, M. C.	0SU	Helwig, A.	HSW	Ross, A.	0SU
Casarini, M. P.	SPRI	Heusel, R.	UNIK	Schenk,C.	AWI
Claffey, K.	CRELL	Ibrahim, J.	HSW	Schröder, M.	AWI
Comiso, J.	GSFC	Jennings, J.	0SU	SchOtt, E.	UNIB
Crane, D.	SPRI	Lange, M.	AWI	Surkow, R.	IMH
Dittmer, K.-P.	DWID	Lemke, P.	MPI, HH	Viehoff, Th.	AWI
Eicken, H.	AWI	Lytle, V.	CRREL	Vogeler, A.	AWI
Engelbart, D.	IMH	Lyeleev, M.	AARI	Wadharns, P.	SPRI
Fahl, Kirsten	AWI	Mahler, G.	HSW	Weissenberger, J.	AWI
Fahrbach, E.	AWI	Mahnke, P.	AWI	Wicke, A.	UNIB
Frieden, W.	IMH	Makarov, R.	90	Wieser, Th.	UNIK
Fromme, J.-P.	AWI	Meyer, G.	AWI	Witte, H.	AWI
Garrity, C.	AES	Möhrke, H.	HSW	Wisotzki, A.	UNIB
Gerdes, A.	RB	Nikolaev, V.	IfB;	Wolf-Gladrow, D.	AWI
		Nöthig, E.-M.	AWI	Yurganov, L.	AARI

Participating Institutions

	Address	Number of participants
Federal Republic of Germany		
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Postfach 12 01 61 2850 Bremerhaven	37
DWD	Deutscher Wetterdienst Bernhard-Nocht Straße 76 2000 Hamburg 4	3
HSW	Helicopter Service Wasserthal GmbH Kätnerweg 43 2000 Hamburg 65	4
IfBG	Georg-August-Universität Forstwissenschaftlicher Fachbereich Institut für Bioklimatologie Büsgenweg 1 3400 Göttingen	2

IMH	Institut für Meteorologie und Klimatologie der Universität Hannover Herrenhäuserstraße 2 3000 Hannover 1	5
MPIfM	Max-Planck-Institut für Meteorologie Bundesstraße 55 2000 Hamburg 13	1
RB	Radio Bremen Heinrich-Hertz-Straße 2800 Bremen	1
RUB	Ruhr-Universität Bochum Fakultät für Chemie Lehrstuhl für Physikalische Chemie I Universitätsstraße 150 4630 Bochum 1	1
UNIB	Universität Bremen BibliothekstraBe 2800 Bremen	5
UNIK	Universität Konstanz Limnologisches Institut Mainaustraße 212 7750 Konstanz	2
Canada		
AES	AES/Cress Microwave Group Petrie 014-York University 4700 Keele Street North York, Ontario Canada M3J 1 P3	1
United Kingdom		
SPRI	Scott Polar Research Institute Lensfield Road Cambridge CB2 1 ER	3
United States of America		
CRREL	US Army Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, NH 03755	2
GSFC	NASA/Goddard Space Flight Center Lboratory for Oceans, Code 61 Greenbelt, Maryland, 20771	1
OSU	Oregon State University College of Oceanography Oceanography Admin. Bld. 104 Corvallis, Oregon 97331-5503	3

UNIM	University of Massachusetts Amherst, MA 01003	1
RUSSIA & THE COMMONWEALTH OF INDEPENDENT STATES		
AARI	Arctic and Antarctic Research Institute 38 Berin Street 19226 Leningrad	2
IFB	Institute for Botany Academy of Sciences 2 Popov Street 197022 Leningrad	1
IFO	Institute of Fishery and Oceanography 17 a Verkhnyaya Krasnoselskaya 107140 Moskau	1

Ship's Crew

Kapitan	Jonas
1. Off izier	Gerber
Naut. Off izier	Schiel
1. Offizier Ladung	Fahje
Naut. Off izier	Baumhoer
Arzt	Dr. Reimers
Ltd. Ingenieur	Schulz
1. Ingenieur	Erreth
2. Ingenieur	Delff
2. Ingenieur	Simon
Elektriker	Erdmann
Elektroniker	Thonhauser
Elektroniker	Hoops
Elektroniker	Both
Elektroniker	Muhle
Funkoffizier	Butz
Funkoffizier	MOller
Koch	Klasaen
Kochsmat	Klauck
Kochsmaat	Kröger
1. Steward	Peschke
Krankenschwester/	
Stewardess	Lieboner
Stewardess	Hoppe
Steward/Stewardess	Rusdam
Steward/Stewardess	Gollmann
2. Steward	Chi-Chun, Chang
2. Steward	Yiu-Sin, Chau
Wdscher	Tzyh-Shyang, Shyu
Bootsmann	Schwarz
Zimmermann	Kassubeck
Matrose	Meis Torres
Matrose	Martinez
Matrose	Willbrecht
Matrose	Novo Lovreira
Matrose	Prol Otero
Matrose	Pereira Portela
Lagerhalter	Barth
Maschinenwart	Jordan
Maschinenwart	Fritz
Maschinenwart	Heurich
Maschinenwart	Buchas
Maschinenwart	Reimann

B. Underway Measurements

B.1 Navigation and Bathymetry

B.2 Acoustic Doppler Current Profiler

The ADCP was applied when the ship stopped on stations within the pack ice and from the roving ship in open waters. The data quality of these measurements is still uncertain since special evaluation procedures have to be carried out after the cruise.

B.3 Thermosalinograph and related measurements

The thermosalinograph has recorded surface values of water temperature and salinity during 1500 h. For about 150 hours, i.e. 10% of the recording period, the sensor was blocked by ice, so that the data are erroneous. The thermosalinograph was continuously calibrated against CTD-temperatures and salinities of the water samples. The corrected data are accurate to 0.1 K in temperature and to 0.1 10*3.

B.4 XBT and XCTD

Ship-borne measurements were taken with the aid of CTD sondes, expendable bathythermographs (XBTs), a rosette water sampler, and acoustic Doppler current profiler (ADCP) and a thermosalinograph. Seven deep sea current meter moorings have been deployed on the track line from the Antarctic Peninsula to Kapp Norwegia.

B.5 Meteorological Observations

The Atmospheric Boundary Layer and Air-Sea Exchanges

The meteorological work concentrated on the heat and momentum exchanges between ocean and atmosphere and on the determination of the sea ice motion. For this purpose micrometeorological and turbulence measurements were carried out both at the ship's boom and on ice floes in the vicinity of Polarstern. Additionally, aerological soundings were performed, and helicopter flights with a laser altimeter provided data on the surface topography.

Atmospheric and oceanic surface values as well as the drift velocity of sea ice were determined with the aid of two arrays of Argos buoys. The first array was centered at 64.4°S, 45.7°W, the second at 66.7°S, 29.4°W Both of them consisted of two highly instrumented central buoys separated (at the beginning) by approximately 130 km and of six (first array) or four (second array) simpler ones surrounding the centre stations. The distance between the outer and the central buoys was between 80 and 140 km. The peripheral buoys provided air pressure and position only. The central buoys measured additionally the air temperature in two heights, the wind velocity and the vertical temperature profiles through the ice and in the oceanic upper layer down to 250 m depth. The drift of the first buoy array from 25.9. to 22.10.89 is displayed on Fig. 6. The starting point is indicated by the buoy number at the western end of the tracks. All buoys move eastward with slight undulations caused by the passages of low pressure systems.

The vertical turbulent fluxes of heat and momentum were derived from wind and temperature fluctuations, measured with sonic devices at the ship's boom and at a 5 m high mast on ice floes during station periods. A comparison of the fluxes measured at the two locations showed no significant differences when the wind direction was +60' from the bow (Fig. 7). Two 3-day ice stations in the centers of the buoy arrays will be used to compare the bulk aerodynamic flux method with the sonic eddy correlation technique to provide information on the reliability of the heat and momentum fluxes derived from the drifting buoy measurements. Since the turbulent fluxes of heat and momentum are supposed to vary with floe size distribution and surface roughness, helicopter flights with a laser altimeter have been performed to collect information on the surface topography. In addition to the turbulent transports, the downward shortwave and longwave radiation fluxes as well as the radiation surface temperature have been recorded to complement the surface information on the energy balance.

Upper air soundings were performed routinely 4 times per day. One sounding per day was transmitted into the GTS, in order to improve the input data of numerical models and of objective analysis products. Intensified measurements have been carried out at Polarstern, Akademik Fedorov and the Georg von Neumayer Station from 20 September to 4 October when the three stations formed a reasonable triangle for special analyses of large scale advection. Examples of the Polarstern measurements are shown in the Figs. 8, 9, 10.

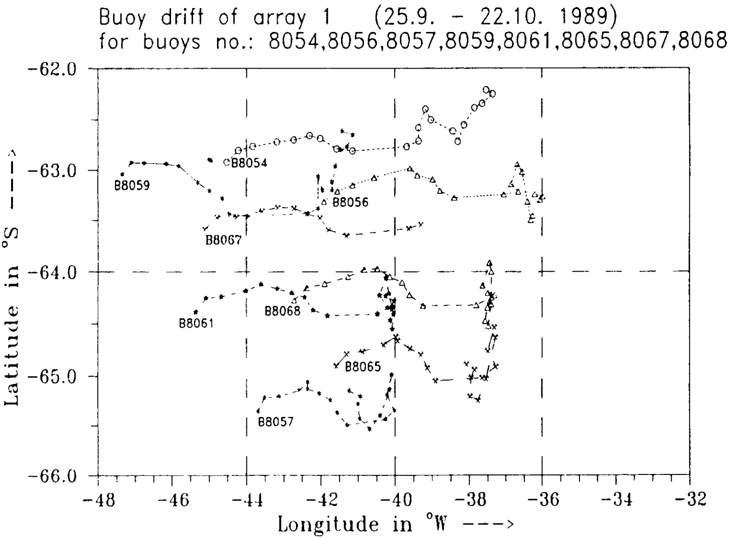


Figure 6: Drift of Argos surface buoys from 25 September to 22 October 1989

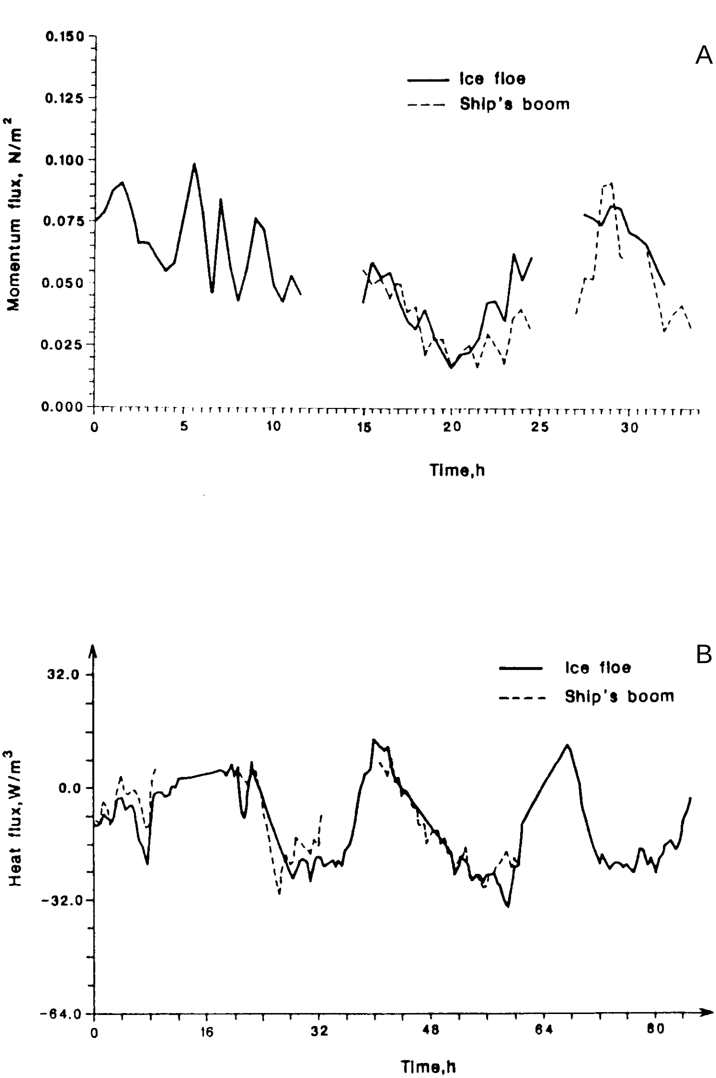


Figure 7: Turbulent fluxes of momentum (a) and of sensible heat (b) measured at the ship's boom (dashed line) and at a mast on an ice flow (full line)

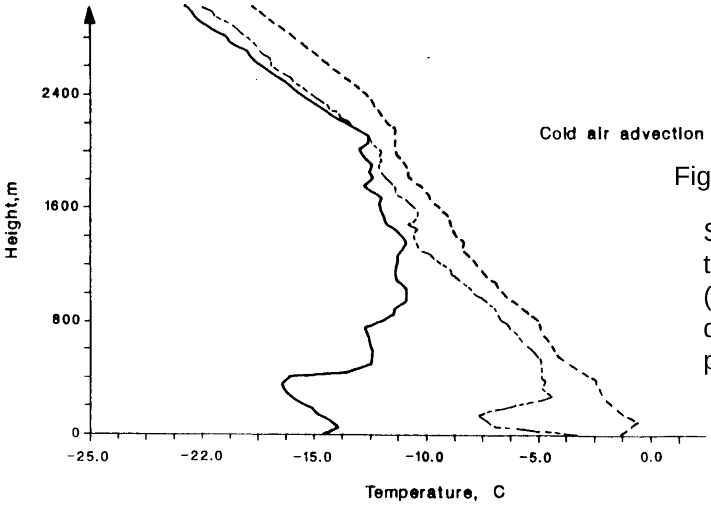


Figure 8:

Sequence of atmospheric temperature soundings before (dashed), during (long-short dashed) and after (full) the passage of a cold front

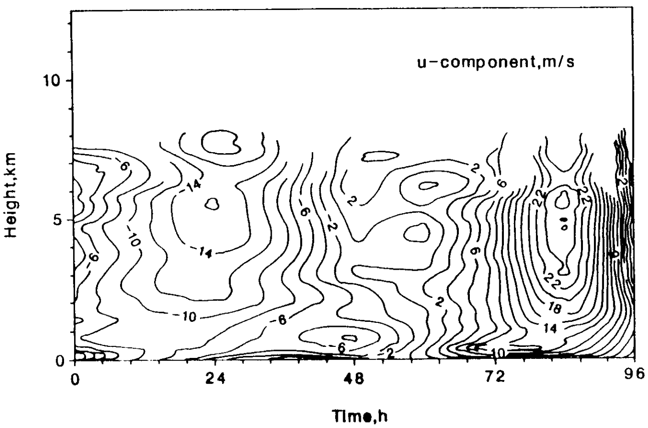


Figure 9:
Vertical distribution of the zonal wind component during a 4-day period

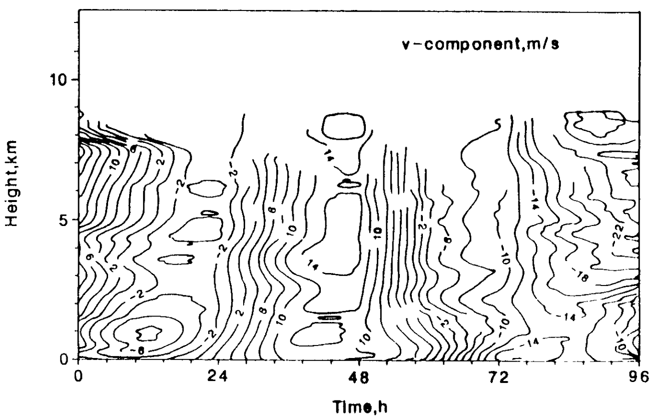


Figure 10:
Vertical distribution of the meridional wind component during a 4-day period

B.6 Atmospheric Chemistry Data

Atmospheric Physics and Chemistry (IfBG, IMH, MPIfM, AARI)

Atmospheric Ozone and Air Turbidity:

Measurements of the total content of ozone in the atmospheric column, concentrations of ozone in surface layer and turbidity of the whole atmosphere at different wavelengths of the visible spectral range have been carried out to study the spring decrease of atmospheric ozone in Antarctica and its influence on physical quantities of the lower atmosphere. A similar set of data was obtained simultaneously on board the Akademik Fedorov.

The total ozone has been determined with the aid of a filter ozone photometer M- 124. Concentrations of tropospheric ozone have been measured by a solid state chemiluminescent analyzer. Atmospheric spectral turbidity has been observed with a sunphotometer. The performance of the instruments was tested on the transect of the ship from Bremerhaven to Puerto Madryn. The measurements of total ozone started on 8 September 1989, at 49 °S latitude. In this latitudinal regional increased ozone levels were previously observed, especially during the period of depleted ozone in the central Antarctic. In consistency with these results an abrupt decrease of ozone was obvious on the passage from 49°S to 59°S (see Table 3.2).

During the remaining observational period (11 September to 16 October) large fluctuations of the total ozone concentration (from 166 DU to 320 DU) were detected . These fluctuations appear to be closely correlated with the temperature of the stratosphere. Reduced ozone is coupled with the cold air of the circumpolar stratospheric vortex. Comparing our values with measurements of the two preceding years at the Soviet station Novolazarevskaya we find that the conditions 1989 are rather similar to those of 1987 when the lowest values of total ozone were found over Antarctica. The ozone of the surface layer was measured during the entire expedition. Unfortunately a standard ozone generator, used for calibration did not work satisfactorily so that our data are of qualitative nature only. According to these measurements one can determine a few different levels of ozone which more or less characterize different air masses. In moderate latitudes ozone concentrations are higher than 30 ppb with small variations. In the subpolar latitudinal belt (south of 64°S), the variations of tropospheric ozone became larger reflecting the transition zone of air masses.

The measurements of spectral atmospheric transparency have been carried out during sunny days. Preliminary results show that the aerosol optical thickness varied around typical values for late winter in the Antarctic. For the final analyses the data of both ships and of coastal stations from the Weddell Sea area will be combined in order to delineate the late winter ozone variations of the year 1989.

TABLE 3.2: Daily averages of the ozone concentration in the atmospheric column.

Date (1989)	Latitude	Longitude	Total ozone DU	N	Observational conditions
SEPTEMBER					
08	49.41S	62.14 W	340	17	2
10	59.30S	59.14 W	204	26	3
11	62.06S	56.43 W	220	23	2,3
12	63.20S	52.59 W	284	27	3
13	63.29S	51.43 W	290	34	1,3
14	63.45S	50.45 W	253	56	1,2
15	64.07S	47.58 W	238	19	3
16	64.37S	44.13 W	296	48	1,2
17	64.36S	44.15 W	320	09	2
18	64.41S	44.00 W	308	10	2
19	64.44S	43.46 W	274	07	3
20	64.36S	43.35 W	237	07	1,2
22	65.25S	40.36 W	223	11	2,3
23	65.40S	38.46 W	196	03	2,3
24	65.36S	36.30 W	166	25	1,2
26	66.36S	31.34 W	220	35	1,2
27	66.53S	29.13 W	220	13	3
28	66.51S	27.39 W	269	33	1,2
30	66.44S	27.17 W	231	36	1,2
OCTOBER					
01	66.37S	27.08 W	243	32	1,2
02	67.17S	24.31 W	213	31	1,2
03	67.47S	21.15 W	210	29	3
04	68.35S	18.12 W	194	04	3
05	69.38S	15.43 W	208	20	3
06	70.21S	13.25 W	173	04	3
09	70.39S	10.11 W	185	04	3
10	70.20S	10.07 W	196	11	2
11	70.30S	08.09 W	183	24	1,2
12	69.45S	08.08 W	178	08	3
13	68.58S	07.57 W	206	18	3
14	68.55S	08.12 W	168	17	1,2

Observational Conditions: 1: direct sun
2: clear zenith
3: cloudy zenith

N: number of individual measurements
DU: Dobson Units

Reactive Nitrogen Compounds in the Boundary Layer over Water and Sea Ice

The gaseous atmospheric nitrogen compounds HN03 and NH3 as well as atmospheric aerosols, were sampled in order to determine their concentrations close to the sea and ice surfaces. Samples of precipitation and surface snow on ice floes were also collected to undergo chemical analyses for major ionic constituents. These measurements will provide a first orientation for the investigation of Nitrogen dynamics of the boundary layer over the open water and ice in the Southern Ocean and the Weddell Sea. Gaseous HN03 and NH3 were adsorbed and enriched on filters, which will be analyzed by ion chromatography.

The filter systems for air sampling were installed on the observation deck of Polarstern (24 m above sea level). Filterpacks were attached to a boom of 2 m length fixed horizontally to the rail and pointing towards the bow of the ship. Air samples were taken by two air pumps which were controlled by a vane-switch allowing only air from ± 450 relative to the bow of the ship to be filtered in order to minimize contamination.

HN03 and NH3 were absorbed and enriched by two filter systems, each of which consisted of a PTFE-filter (0.45 um pore size) followed by three gas absorption filters. This arrangement allows for separation of aerosol and gas phases of the sampled air and to control the absorption quality. HN03 was absorbed by nylon filters, while NH3 was collected on cellulose filters impregnated with 0.05 NH3PO4.

According to the very low concentrations which can be expected in the Antarctic atmosphere, high volumes had to be filtered by sampling periods of at least 24 hours. 168 filter samples during 21 sampling episodes (most of them on the Wed-dell Sea transect) were obtained. Additionally, nine samples of precipitation and 83 surface snow samples from ice floes were collected. Chemical analyses will be carried out in the home laboratory. The results will be interpreted in the context of surface water chemistry and meteorological data.

C. Hydrographic Measurements

The Large Scale Hydrography of the Weddell Gyre:

The aim of the large scale hydrography was to estimate the oceanic transports of mass, heat and salt associated with the Weddell Gyre circulation. Of particular interest is the southern part of the gyre, where an extensive water mass trans-formation is assumed to occur which determines the formation of Weddell Sea Bottom Water. The Polarstern data set is portrayed by two hydrographic sections (see Fig. 1) across the Weddell Gyre. The first one describes the transect from the tip of the Antarctic Peninsula to Kapp Norwegia (Fig. 4). It comprises 46 CTD profiles from the sea surface to the ocean bottom with a station distance of 20 to 60 km. The second one runs from the Atka Bay to the Mid-Ocean Ridge con-sisting of 31 stations with spacings from 14 to 125 km. With the exception of the marginal ice zone all profiles reached to the ocean bottom. The meridional temperature cross section is presented in Fig. 5. The physical data are supple-mented by oxygen, nutrient and stable isotope measurements (Carbon-13 and Oxygen-18) as well as by samples for Tritium, Helium-3 and Helium-4 analyses.

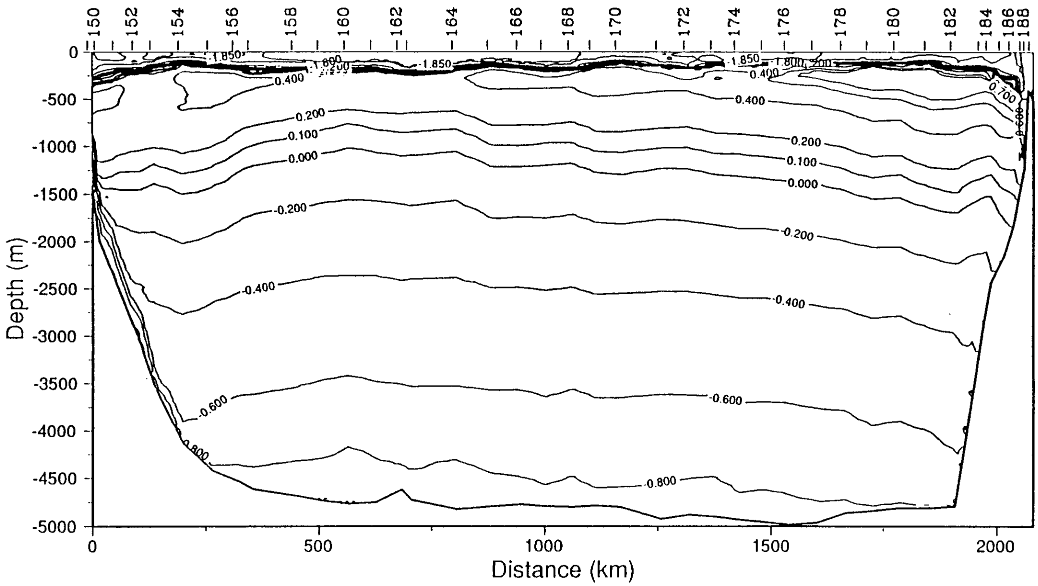


Figure 4: Potential temperature distribution on the zonal section of "Polarstern". Numbers on the top line indicate hydrographic stations

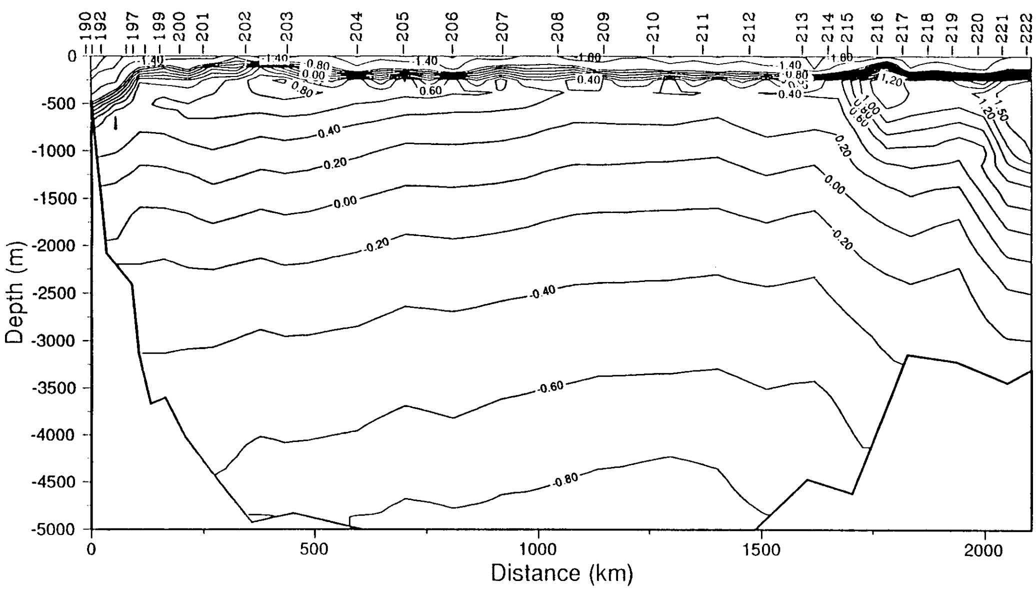


Figure 5: Potential temperature distribution on the meridional section of "Polarstern". Numbers on the top line indicate hydrographic stations

C.1 Nutrients and Dissolved Oxygen (OSU)

The inorganic nutrient and dissolved oxygen determinations were carried out in support of the hydrographic programme. Additionally, water samples were collect-ed for filtration and post-cruise determination of biogenic particulate silica. Nutrient measurements were also made on approximately 300 subsamples from ice cores and brine in support of algal culturing experiments.

The dissolved nutrients (orthophosphate, nitrate, silicic acid, nitrite, and ammonium) were measured in samples from the rosette bottles at all station loca-tions. The nutrient samples were analyzed with the aid of a continuous flow analyzer (an ALPKEM RFA model 300) using the chemical methods recommended by the manufacturer except for some modifications in the analyses of ammonium and phos-phate. In most cases these analyses were performed immediately after each hydrocast and were completed within 2-3 hours after the cast.

The analysis of dissolved oxygen concentration was made by the familiar Carpenter-Winkler method, but the actual titrations were carried out with a radiometer autotitrator. The method used is a dead-stop end-point amperometric titration in which a polarizing potential is applied across the electrodes, and the end-point potential is selected to correspond closely to the visual endpoint. This method was used successfully already during former cruises.

Biogenic particulate silica, the amorphous silica contained in phytoplankton frustules, will be determined in the home laboratory after the cruise. Seawater samples were collected from nearly half of the CTD casts and filtered through 0.6 micron polycarbonate membrane filters. These filters are subsequently sub-jected to a hot, basic digestion which dissolves the particulate silica. After neutralization, the resulting solution can be analyzed for silicic acid. A total of nearly 600 such samples was obtained at stations throughout the cruise; about half of which were concentrated in the transits through the ice edge at the beginning and ending of the cruise. It is anticipated that the good spatial resolution in the marginal ice zones will complement similar sections made during other seasons, and provide an improved understanding of the seasonal fluctuations of phytoplankton biomass in the Weddell Sea. There were no serious technical problems during the cruise, so that the chemical data set should be of high standard once routine quality control has been completed.

As was the case in Austral winter 1986, the surface mixed layer was found to be nearly vertically homogeneous in oxygen and nutrient concentrations. The under-saturation of dissolved oxygen tended to increase southeastwards on the main transect from the Antarctic Peninsula to Kapp Norwegia. This observation might be related to the amount of entrained Warm Deep Water (WDW) and thus to the heat flux from the water to sea ice and to the atmosphere. Both oxygen and silicic acid concentrations in the VVDW are inversely correlated with tempera-ture. Because the gradients of phosphate and nitrate across the pycnocline are less strong than those of dissolved oxygen and silicic acid, they are less use-ful for entrainment calculations. Comparison with Austral summer data should allow to determine the increase in mixed layer nutrient concentrations. We expect to extend our earlier estimates of net annual phytoplankton productivity by using the summer/winter differences in mixed layer nutrients.

At the northwestern end of the transect, extremely cold and "fresh" Weddell Sea Bottom Water (WSBW) was found with potential temperatures of less than -1.O°C. In this very cold WSBW, the concentration of dissolved oxygen seems to be inversely proportional to the temperature while the unusually low silicic acid concentrations were directly proportional to temperature. Farther along the transect, in the mid-gyre, the variability in the silicic acid content of the WSBW and WDW increased, but the classical Antarctic Bottom Water (potential temperature from -0.1 to -0.4°C) did not exhibit this variability. The highest WSBW silicic acid concentrations were found at the southern end of the long transect, were the variability was much less. The data of the northward transect are not yet available.

The analyses of nutrient concentrations in ice core subsamples revealed con-siderable variability. Ammonium concentrations were usually much higher than in the underlying surface waters, and often higher than any normal seawater ammon-ium levels. Phosphate also exhibited greater variability than did the other nutrients, perhaps because it is microbially remineralized directly as phos-phate, while the nitrogen species undergo a series of oxidations before ending up in nitrate. The nutrient concentrations were obviously not correlated with the structure or texture of the ice.

During the rendezvous of Polarstern and Akademik Fedorov, samples were exchanged between the ships for analyses. The preliminary results of those determinations show an encouraging agreement. Oxygen and phosphate values were very similar. Only in the deep water silicic acid measurements was a significant disagreement. The Fedorov values were about 4-5 micromole per liter higher than the measure-ments onboard Polarstern. By prior arrangement, duplicate samples from six hydrographic stations had been collected and frozen during the Fedorov's cruise. These samples were analyzed onboard Polarstern after the two ships met for further comparison of the data in order to resolve any discrepancies.

C.2 CTD Measurements and Calibration

A total of 115 CTD-profiles were taken with two NB Mark IIIb profiles. The instruments have been calibrated at the Scripps Institution of Oceanography before the cruise, and they will be recalibrated afterwards. Any temporal changes of the temperature sensors during the cruise have been detected by electronic, and mercury reversing thermometers. Due to some nonlinearities in the time variations of the CTD sensors, the final accuracy of the data will amount to 5x10-3 K. The calibration of the CTD salinity data is achieved on the basis of salinity analyses from 1441 water samples which were measured with a Guildline Autosal 8400B. The CTD readings and the bottle values were fitted for each profile individually. The mean deviation of the applied corrections from the bottle data amounts 1.4 +/- 0.5x10*6. The accuracy of the bottle data was determined by a cross-check of 233 multiple samples at the same depth level resulting in a RMS error of 1.5x10-6. Adding the both errors, the corrected salinities will be accurate to +/-3x10*6.

CTD Measurements during AQANTVIII/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: EGLG Oceansoft MkIII/SCTD Acquisition Version 2.01
CTD postprocessing Version 1.12

Time lag: 0.13 s

Pressure pre-cruise calibration coefficients

```
al = -5.36104
a2 = 3.37749E-3
a3 = -5.39422E-6
a4 = 2.77279E-9
a5 = -5.14917E-13
a6 = 3.19093E-17
dp = al +a2*p +a3*p**2 +a4*p**3 +a5*p**4 +a6*p**5
 p = p + dp
```

no post-cruise calibration for the calibration data are the same

Temperature pre-cruise calibration coefficients

```
  t < 0
 al = 2.36822E-3
 a2 = 8.97448E-4
 dt = al +a2*t
 t >= 0
 al = 3.98859E-3
 a2 = -3.72724E-4
 a3 = 5.13898E-6
 a4 = 2.01451E-7
 dt = al +a2*t +a3*t**2 +a4*t**3
  t = t + dt
```

no post-cruise calibration of station 119 to 157, the calibration data are the same

then there was an offset in the temperature calibration data (a mistake in the handling of the heater of the CTD after station 157) the offset is:

t < 0 + 0.0054 ; t >= 0 + 0.006

the post-cruise calibration data station 158 to 189

t < 0 : t = t + 0.0054
t >= 0 : t = t + 0.006

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

CD = (CONDUCTIVITY SALINOMETER - CONDUCTIVITY CTD) * 1000
CD = A+B*pres+C*pres**2+D*pres**3+E*pres**4

station nbr.	A	B	C	D	E
11901	0.26489E+01	-0.12100E-01	0.10080E-03	-0.17599E-06	0.83084E-10
12901	0.95785E+00	-0.44826E-02	-0.24573E-04	0.50631E-07	-0.29500E-10
13401	-0.51364E+00	0.14605E-01	-0.51233E-04	0.73303E-07	-0.41039E-10
13801	-0.49001E+01	-0.33401E-02	0.17835E-04	-0.27326E-07	0.96256E-11
14101	0.10000E+01	0.55778E+00	-0.12717E-01	0.85457E-04	-0.17023E-06
14801	0.70402E-01	-0.48393E-01	0.87590E-03	-0.32856E-05	0.34951E-08
14901	-0.23983E+01	0.15051E-01	-0.27738E-04	0.11497E-07	-0.67334E-13
15001	-0.36856E+00	0.75274E-02	-0.22502E-04	0.12276E-07	-0.23921E-11
15101	0.26018E+01	-0.55187E-02	-0.42926E-05	0.14427E-08	-0.97049E-13
15201	-0.17166E+01	-0.86125E-02	0.84628E-05	-0.61916E-08	0.11884E-11
15301	0.27424E+01	0.64724E-03	-0.86694E-05	0.26282E-08	-0.29206E-12
15401	-0.35431E+01	0.24909E-02	-0.11729E-04	0.37914E-08	-0.38643E-12
15501	0.18313E+01	-0.10993E-0l	0.29221E-05	-0.12851E-08	0.16776E-12
15601	-0.33567E+01	-0.70345E-03	-0.70259E-05	0.20197E-08	-0.17722E-12
15701	0.32617E+00	0.44204E-03	-0.83863E-05	0.24405E-08	-0.22072E-12

15822	-0.26549E+01	-0.14053E-02	-0.36725E-05	0.41660E-09	0.20305E-13
15901	0.11476E+01	0.36484E-02	-0.80040E-05	0.19328E-08	-0.14914E-12
16001	-0.94296E+00	-0.33745E-02	-0.20970E-05	0.32876E-09	-0.12832E-13
16101	-0.38763E+01	0.19952E-02	-0.64797E-05	0.13988E-08	-0.87705E-13
16201	-0.24615E+00	-0.34274E-02	-0.33533E-05	0.61184E-09	-0.17788E-13
16301	-0.77448E+00	-0.15079E-02	-0.49513E-05	0.13047E-08	-0.11188E-12
16501	-0.36180E+01	0.88287E-02	-0.13471E-04	0.36728E-08	-0.32403E-12
16601	-0.24511E+01	0.16624E-02	-0.76632E-05	0.20041E-08	-0.16818E-12
16701	-0.24511E+01	0.16624E-02	-0.76632E-05	0.20041E-08	-0.16818E-12
16901	-0.58604E+01	0.29932E-02	-0.76714E-05	0.17793E-08	-0.12896E-12
17001	-0.48139E+01	0.25932E-02	-0.89125E-05	0.25237E-08	-0.22862E-12
17101	-0.48139E+01	0.25932E-02	-0.89125E-05	0.25237E-08	-0.22862E-12
17201	-0.36518E+01	-0.57060E-02	-0.98774E-06	-0.23763E-09	0.75877E-13
17301	-0.36518E+01	-0.57060E-02	-0.98774E-06	-0.23763E-09	0.75877E-13
17401	-0.33822E+01	-0.10843E-01	0.20754E-05	-0.84227E-09	0.11065E-12
17701	-0.53706E+01	-0.26876E-02	-0.41563E-05	0.80420E-09	-0.30720E-13
17801	0.51671E+00	-0.78134E-02	-0.15454E-05	0.50059E-09	-0.40489E-13
17901	-0.58760E+01	0.11643E-01	-0.14037E-04	0.31817E-08	-0.22414E-12
18001	-0.20344E+01	-0.11085E-01	0.16952E-05	-0.60963E-09	0.81916E-13
18101	-0.36668E+01	-0.13028E-02	-0.42558E-05	0.80916E-09	-0.38480E-13
18201	-0.48117E+01	0.36716E-02	-0.96794E-05	0.26367E-08	-0.22510E-12
18401	-0.40123E+01	-0.93511E-02	0.58159E-05	-0.31870E-08	0.34597E-12
18601	-0.83793E+01	0.63841E-02	-0.81239E-05	-0.33479E-08	0.24838E-11

correction of the CTD-conductivity data with the bottle-samples
evaluation of the coefficients with the running mean of 3 stations

18501	-0.55476E+01	0.36760E-02	-0.15761E-04	0.10041E-07	-0.23323E-ll
18901	-0.71793E+01	0.34575E-01	-0.18262E-03	0.20987E-06	-0.71818E-10

correction of the CTD-conductivity data with the bottle-samples
evaluation of the coefficients with the running mean of 5 stations

16401	-0.10333E+01	-0.39789E-02	-0.30427E-05	0.61439E-09	-0.28918E-13
16801	-0.45231E+01	-0.31205E-02	-0.24881E-05	0.41575E-09	-0.12775E-13
17501	-0.43311E+01	-0.36720E-02	-0.26480E-05	0.31709E-09	0.11953E-13
17601	-0.34968E+01	-0.40969E-02	-0.27559E-05	0.46347E-09	-0.11181E-13
18301	-0.37957E+01	-0.60158E-02	-0.96544E-06	0.65585E-10	0.17700E-13
18701	-0.57358E+01	-0.18285E-03	-0.21311E-04	0.20695E-07	-0.56833E-11
18801	-0.57358E+01	-0.18285E-03	-0.21311E-04	0.20695E-07	-0.56833E-11

correction of the CTD-conductivity data with the bottle-samples
evaluation of the coefficients with the running mean of 9 stations

12401	-0.13437E+01	0.16738E-01	-0.59865E-04	0.74693E-07	-0.35673E-10
13701	-0.13437E+01	0.16738E-01	-0.59865E-04	0.74693E-07	-0.35673E-10
13901	-0.10412E+01	0.38252E-02	-0.40983E-04	0.74626E-07	-0.43285E-10
14001	-0.10854E+01	0.30601E-02	-0.38106E-04	0.74531E-07	-0.45168E-10
14201	-0.16933E+01	0.36672E-01	-0.16119E-03	0.20167E-06	-0.83491E-10
14301	-0.76443E+00	0.13991E-01	-0.26504E-04	0.17822E-07	-0.56562E-12
14401	-0.76443E+00	0.13991E-01	-0.26504E-04	0.17822E-07	-0.56562E-12
14501	-0.76443E+00	0.13991E-01	-0.26504E-04	0.17822E-07	-0.56562E-12
14601	-0.76443E+00	0.13991E-01	-0.26504E-04	0.17822E-07	-0.56562E-12
14701	-0.76443E+00	0.13991E-01	-0.26504E-04	0.17822E-07	-0.56562E-12

CTD Measurements during AQANTVIII_2 Instrument:

```
Neil Brown CTD, Mark IIIB, Sn: 1123, 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 Acquisition Version 2.01
CTD postprocessing Version 1.12

Time lag : 0.15 8

Pressure pre-cruise calibration coefficients

```
al = -6.39481
a2 =  1.47747E-2
a3 = -1.53703E-5
a4 =  5.67588E-9
a5 = -8.97597E-13
a6 =  5.12516E-17
dp =  al +a2*p +a3*p**2 +a4*p**3 +a5*p**4 +a6*p**5 p = p + dp
```

Temperature pre-cruise calibration coefficients

```
al =  6.40438E-3
a2 =  1.39362E-4
a3 = -1.72346E-4
a4 =  1.13669E-5
a5 = -2.16557E-7
dt =  al +a2*t +a3*t**2 +a4*t**3 +a5*t**4 t = t + dt
```

no post-cruise calibration for the calibration data are the same

correction of the CTD-conductivity data with the bottle-samples
evaluation of the coefficients with the running mean of 5 stations

station nbr.	A	B	C	D	E
19201	0.21016E+02	-0.85613E-02	0.89466E-05	-0.38066E-08	0.53460E-12
19301	0.21016E+02	-0.85613E-02	0.89466E-05	-0.38066E-08	0.53460E-12
19401	0.21016E+02	-0.85613E-02	0.89466E-05	-0.38066E-08	0.53460E-12
19501	0.21016E+02	-0.85613E-02	0.89466E-05	-0.38066E-08	0.53460E-12
19701	0.20819E+02	-0.78373E-02	0.73628E-05	-0.28280E-08	0.36932E-12
19801	0.20528E+02	-0.87531E-02	0.77197E-05	-0.25710E-08	0.28331E-12
19901	0.19899E+02	-0.70755E-02	0.57684E-05	-0.17908E-08	0.18210E-12
20001	0.20114E+02	-0.45067E-02	0.30407E-05	-0.92389E-09	0.98674E-13
20101	0.20182E+02	-0.47537E-02	0.27874E-05	-0.69931E-09	0.63106E-13
20201	0.19457E+02	-0.17041E-02	0.13341E-06	0.12162E-09	-0.22397E-13

20301	0.19457E+02	-0.26634E-02	0.68603E-06	0.16645E-10	-0.16442E-13
20401	0.18789E+02	-0.24788E-02	0.72984E-06	-0.21136E-10	-0.11217E-13
20501	0.18457E+02	-0.32326E-02	0.16001E-05	-0.29042E-09	0.13308E-13
20601	0.18012E+02	-0.23984E-02	0.14500E-05	-0.39956E-09	0.36018E-13
20701	0.17721E+02	-0.30646E-02	0.18502E-05	-0.49363E-09	0.44527E-13
20801	0.17521E+02	-0.31284E-02	0.23777E-05	-0.75501E-09	0.76373E-13
20901	0.17898E+02	-0.33772E-02	0.23224E-05	-0.66040E-09	0.60876E-13
21001	0.17540E+02	-0.30990E-02	0.22935E-05	-0.69230E-09	0.67029E-13
21101	0.17637E+02	-0.39212E-02	0.27944E-05	-0.79787E-09	0.73811E-13
21201	0.17816E+02	-0.36911E-02	0.25327E-05	-0.70142E-09	0.62867E-13
21301	0.18066E+02	-0.32509E-02	0.19970E-05	-0.53160E-09	0.47490E-13
21401	0.18566E+02	-0.41001E-02	0.27505E-05	-0.80996E-09	0.78737E-13
21501	0.19137E+02	-0.38559E-02	0.19027E-05	-0.47603E-09	0.41168E-13
21601	0.19710E+02	-0.43751E-02	0.21908E-05	-0.56683E-09	0.53041E-13
21701	0.20660E+02	-0.69416E-02	0.35972E-05	-0.81763E-09	0.64650E-13
21801	0.19602E+02	0.18601E-03	-0.59247E-05	0.32556E-08	-0.47806E-12
21901	0.19632E+02	0.23606E-03	-0.47596E-05	0.24419E-08	-0.34287E-12
22001	0.19276E+02	0.36775E-02	-0.90849E-05	0.43123E-08	-0.60601E-12
22101	0.18744E+02	0.44870E-02	-0.94841E-05	0.43825E-08	-0.60857E-12
22201	0.18744E+02	0.44870E-02	-0.94841E-05	0.43825E-08	-0.60857E-12
22301	0.18744E+02	0.44870E-02	-0.94841E-05	0.43825E-08	-0.60857E-12

dc = A+B*pres+C*pres**2+D*pres**3+E*pres**4
C(ctd) = C(ctd) + dc/1000.

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

The CTD-temperature is IPTS-68

The CTD conductivity sensors of CTD-1069 and CTD-1123 were very sensitive to pressure so that the accuracy was less then +/- 0.005 mmho.

During the whole expedition there were many problems with the stepping motor. So the coordination in the *.SEA file between CTD-data and bottle data are questionable.

Station 198 bottle 18 - 24 and station 213 bottle 18 - 23 are closed during coming up without a stop (there was ice press).

D. ACKNOWLEDGMENTS

E. 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.

F. WHPO SUMMARY

Several data files are associated with this report. They are the ANTVIII.sum, ANTVIII.hyd, ANTVIII.csl and *.wct files. The ANTVIII.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The ANTVIII.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 ANTVIII.wct.zip. The ANTVIII.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 ANTVIII.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-

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

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.

G. Data Quality Evaluations

G.1 Nutrient and Dissolved Oxygen Data Quality Evaluation:

(J.C. Jennings)
8 May 1995

The following is a summary of quality observations made during the DQE analysis of the ANTVIII nutrient and dissolved oxygen data. They are based on an internal comparison between groups of stations except as noted below.

Overall impressions:

The nutrient and dissolved oxygen data from the pre - WOCE ANTVIII section appear to be of high quality; particularly the oxygen, silicate and nitrate data. Phosphate data is generally good, but there is relatively more spread in the phosphate / theta plots than in the nitrate / theta plots for the same station groups. Due to the presence of very "fresh" Weddell Sea Bottom Water at some of the stations and older bottom water inflowing from the Enderby Basin at others, there is a large concentration range in the near bottom silicate values. This real variability in the silicate concentrations makes it more difficult to assess the precision of these measurements, but for station groups exhibiting a "tight" silicate / theta relationship in the Circumpolar Deep Water, the relative precision seems to be Û 1% of the maximum concentrations.

There were very few samples which appear compromised by leaking hydro bottles. We have identified several stations where we felt that all of the phosphate or nitrate data was too high or low when compared to nearby stations and should be considered questionable. We assigned "Q2" data flags of "3" to these observations.

The data originator has assigned flags of "4" (bad data) to all nitrite concentrations which have values < 0. We recommend changing most of these flags to "2" (acceptable data) because the < 0 values are the result of uncertainty in the determination of zero. With deep water nitrite concentrations generally expected to be at or near zero, very small changes in detector sensitivity and/or in the reagent blank and refraction corrections which are part of the calculation of nutrient concentrations can result in the calculation of a negative concentration for a given sample. The result of analyzing large numbers of samples with undetectable nitrite concentrations should be a statistical spread of the calculated concentrations about a mean value of 0.0 which reflects the precision of the analysis at the detection limit.

We also made comparisons of the ANTVIII nutrient and dissolved oxygen data with data from three other Weddell Sea cruises. Groups of 5 - 10 stations within latitude ranges of 2 - 5 degrees were compared using plots of properties versus theta and pressure with emphasis on the deep water column where biological activity should be minimal. A summary of these comparisons is given in a separate document (WSEAHIST.WP for WordPerfect format or WSEAHIST.TXT for the same material in ASCII text).

Individual comments:

Comments referring to specific bottles include the pressures to the nearest whole decibar.

STATION 150:

Btl 3 @ 1398 db: High phosphate. Flag assigned: 3

STATION 151:

Btl 1 @ 2482 db: Phosphate looks too high, no corresponding changes in nitrate or oxygen. Flag assigned: 3

STATION 152:

Btl 1 @ 2995 db: High phosphate. Flag assigned: 3

Btl 16 @ 993 db: Both nitrate and phosphate look high. Flags assigned: 3

STATION 154:

Btls 2 @ 4100 through 10 @ 597 db: All phosphate values seem too high. Flags assigned: 3

STATION 157:

Btl 22 @ 98 db: All nutrients seem too high for the mixed layer. Oxygen is low. Flags assigned: 3

All bottles: Nitrate is low. Flags assigned: 3

STATION 159:

Btl 1 @ 4734 db: Phosphate is too high. Flag assigned: 3

STATION 161:

Btl 13 @ 398 db: phosphate seems a bit low; no corresponding drop in nitrate. Flag assigned: 3

STATION 163:

Btl 5 @ 4616 db: Nitrate looks too high. Flag assigned: 3

STATION 164:

All btls: Phosphate seems too high by about 0.05 relative to other stations. No similar increase in nitrate or drop in oxygen. Flags assigned: 3

STATION 168:

Btl 6 @ 3504 db: All nutrients look too high and oxygen is low. Flags assigned: 3

STATION 184:

All btls: Nitrate seems too high. Phosphate and silicate drop and oxygen increases as cruise track approaches cont. shelf, but nitrate goes up at this station. Flags assigned: 3

STATION 187:

Btl 2 @ 1127 db: Phosphate looks a bit too high. Flag assigned: 3

STATION 195:

Btls 1 - 6, 8, and 9 (2402 - 999 db): Phosphate is low relative to adjacent stations. No similar change in nitrate or oxygen. Flags assigned: 3

STATION 207:

Btls 1 - 5 (5303 - 3498 db) and 8 - 10 (1996 - 999 db): All phosphate seems too high. No increase in nitrate or decrease in oxygen at this station. Flags assigned: 3

G.2 CTD Data Quality Evulation

(Bob Millard/WHOI)
December 12, 1994

General observations on the CTD data calibration methods and documentation:

Pressure:
A 5th order (fourth power) calibration was applied to the pressure. I wonder if the 4th power coefficient contributes to the reduction of variance between CTD and deadweight tester. Such a high order polynomial isn't consistent with our experience at WHOI with the Mark III stainless steel pressure sensor. We have found that a 4th order (3rd power) set of calibration coefficients provides a fit consistent with the deadweight tester pressure values.

Conductivity*:*
It seems that an extrordinary effort was applied to the CTD conductivity calibrations to get the CTD to match the water sample salinities. The CTD conductivity was laborious calibrated to the water sample conductivities (salinities) on a station by station bases rather than developing CTD conductivity calibration coefficients from the water sample salinities over a group of stations perhaps with some provision for removing a systematic conductivity drift between stations. See the brief description of WHOI's conductivity fitting procedure below which provides for a linear drift of the CTD conductivity calibration. The CTD conductivity usually drifts towards lower values with time because of conductivity cell fouling.

The station by station conductivity calibration may have been nesessary to rectify CTD data collected with an errant CTD conductivity sensor that misbehaved or otherwise began to fail in an unpredictable manner. The CTD data documentation report doesn't mention any hardware problems but needs to if this is the case. A failing sensor may be explaination for applying a 5th order polynomial correction on a station by station bases in order to bring the CTD in alignment with the water sample salinities. This procedure has no bases in the behavior of the conductivity sensor and reduces the CTD conductivity correction to a curve fitting exercise. I wonder which conductivity/pressure terms are significant and/or necessary to correct the station dependent and vertical dependence of the CTD conductivity? Is there any reason to expect the vertical dependence to be varying from station to station (such as a failing conductivity cell). Many of the pressure coeffients of a station alternate signs suggesting they are tending to cancel out each other. Was the CTD conductivity corrected for the Alumuna cells deformation with temperature and pressure as shown in equation (1) below? Were these corrections found to be inadequate? I certainly would not recommend this polynomial conductivity correction versus pressure as a normal practice.

The basic conductance to conductivity correction is:

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

G = CTD conductance
alpha = -6.5 E-6
beta = 1.5 E-8
T0 = 2.8 C (or some other temperature)
P0 = 3000. dbars (or some other pressure)

At WHOI we fit the conductance G of the CTD to water sample conductivities C as shown in equation 1 above. We model the variations of the CTD (G) as follows to minimize (C-G)**2 with respect to A, B and if necessary C:

$$G = A + B * g + C * g * s$$

where

"g" is the measured CTD conductance and "s" is a lin ear station dependence.

This model sucesssfully describes most of our Mark III CTD observed conductivity drift. To date running the CTD into the bottom has been a primary reason for discontinuities in conductivity calibration.

General comments on the water sample/CTD data file comparisons:

Two histograms of the difference of the CTD and water sample salinities (Ds = Sctd-Sws), edited to remove difference greater than .01 psu, are given in figures 1a and 1b. The first histogram in figure 1a, contains salinity differences at all observations levels while the second has only differences for depths greater than 900 meters. The average salinity difference for all pressure levels is -0.0005 psu with a standard deviation of .0036 psu. For depths below 900 decibars, the average salinity difference increases to .001 psu while the scatter is reduced slightly to .003 psu. The scatter of salinity is reasonable.

Examining the salinity differences by station with the two cruise legs.The cruise is divided in to two legs. A plot of the salinity differences at all pressures is shown versus station number for Leg 1 in figure 2. The mean difference is nearly zero (Ds=-.0004 psu). The stations after 155 cluster around the zero line while earlier stations are in a different water mass and shallow as their absence on figure 3 suggests. The plot of CTD salinities below 900 decibars for leg 1 are saltier than the water samples by Ds = +.002 psu as indicated on figure 2. The leg 1 salinity differences also shows a somewhat larger scatter than those of leg 2. Looking at the leg 1 salinity differences versus pressure given on figure 3, we observe a pressure dependent deviation between the CTD and WS salts with the CTD salinity overestimated (to salty) at a depth of 1000 decibars but the difference decrease to near zero below 4000 decibars. The pressure dependent variation is of the same sense and magnitude the correction provided by the "Beta" term in equation 1. The mean salinity difference for all pressure levels is nearly zero on both legs For leg 1 Ds = -0.0004 psu, see figure 4, while on leg 2 Ds = -0.0002 psu, see figure 7.

Although the up profile CTD salinity data of leg 1 has systematic differences with the water sample salts, the 2 decibar down profile CTD salinity data seem to match the water sample data very well as shown in the overplot of water sample salinity with the down profile CTD data for stations 157-159 (figures 5) and for stations 177-179 (figures 6). Note the connected curves in fig. 5 & 6 are from the down profile 2 decibar data. There apparently is a down/up salinity difference in the down versus up profile CTD salinity data which suggests a hysterisis in one of the CTD variables (C, T , or P) required to calculate salinity but there isn't any mention of these in the data calibration documentation.

The CTD salinities from ANTVIII leg 2 (stations 188 through 222) appear to be well calibrated in both the water sample file and the 2 dbar individual station files as the plot of Ds versus station number at all depths and below 900 decibars as shown in figures 7 and 8. The salinity differences below 900 decibars are slightly fresher than the water samples by Ds = -0.00075 psu, as indicated on figure 8. As mentioned earlier, the scatter of salinity differences between CTD and water samples appears to be smaller on leg than on leg 1 throughout the water column and both below 900 decibars. The vertical dependence of the water sample file CTD salinities isn't apparent on leg 2 as figure 10 indicates. A check of stations 207 through 209's down profile CTD salinities shows the 2 decibar data given in figure 10 to be well matched to the up water sample salinities and also there appears to be no hysteresis between down and up profile CTD salts.

The quality control of the CTD and water sample salinities in the water sample file:

As already noted, the CTD salinity in the water sample file for stations 119 through 189 of leg 1 appear to be to salty at intermediate depths. The water sample salinities identified as questionable in the Quality word are the same as those I identify either as missing or with an absolute salinity difference (Sctd-Sws) greater than of equal to 0.01 psu. This is a reasonable method for flagging questionable water sample salinities which I arrived at independently. The only problem with this technique is that there is a systematic error in the up CTD salinity for stations 119 through 189 in this file as figures 5, 6 and 7 indicate so that some of the salty water samples at intermediate pressures may not be flagged correctly. The water sample file ANTVIII.QC2 has quality flags for the bottle (carried from the original DQE), CTD and water sample salinity. Where the water sample is flagged missing this is carried to the output and the CTD salt is flagged as questionable but when the difference of the CTD and water sample salinity are less than the questionable threshhold of 0.01 psu then both salinities are flagged as good. This is a departure from the the original DQE flagging scheme in which all salinities were marked as questionable.

The individual 2 decibar CTD profiles were averaged into a mean profile that excluded the frontal zone stations of leg 1 from stations 149 to 153. There were no oxygen measurements from the CTD. The individual stations were then compared to 5 times the standard deviation of the CTD measurements at each pressure level. The data of each station was also checked in the vertical aganist a stability parameter edit criteria of -1.0 E-4. This corresponds to a salinity decrease with increasing pressure of roughly .015 psu. All of the 2 decibar observations of the cruise fell within these data edit criteria as the table I below shows.

Summary:

The 2 decibar CTD profile data looks to be free of spurious data points and the salinities are well matched to the water sample data. The water sample salinity data of leg 1 and leg 2 appear to be well quality controlled. The CTD salinities of leg 1 (119-189) appear to be systematically saltier than the water samples at intermediate depths. This bais may have effected the water sample quality control of the leg 1 water sample salts slightly.

A discussion of the instrumental problems leading to the station by station correction of the CTD conductivity with a pressure dependent polynomial is suggested as an addendum to the calibration documentation unless this a standard data processing procedure. It is recommended that the CTD conductivity correction on a station by station basis, particularly with the inclusion of a polynomial dependence on pressure, not be used as a standard part of the data processing procedure. I would encourage modifying the CTD data processing system to incorporate a conductivity fitting procedure with an optional linear station dependent conductivity slope change. I can supply a copy of the Fortran code for formatting and fitting CTD/water sample conductivity (salinity) data.

Table I

LEG 1 ANTVIII ____.WCT files

File name	Pmax	E_Tot	T_err	S_err	O2_err	E_err	Sd_fact	E_Min
AN01D124.WCT	1022.0	0	0	0	0	0	5.00	-0.10E-03
AN01D129.WCT	1022.0	0	0	0	0	0	5.00	-0.10E-03
AN01D134.WCT	1016.0	0	0	0	0	0	5.00	-0.10E-03
AN01D137.WCT	692.0	0	0	0	0	0	5.00	-0.10E-03
AN01D138.WCT	1000.0	0	0	0	0	0	5.00	-0.10E-03
AN01D139.WCT	420.0	0	0	0	0	0	5.00	-0.10E-03
AN01D141.WCT	184.0	0	0	0	0	0	5.00	-0.10E-03
AN01D142.WCT	180.0	0	0	0	0	0	5.00	-0.10E-03
AN01D144.WCT	210.0	0	0	0	0	0	5.00	-0.10E-03
AN01D145.WCT	436.0	0	0	0	0	0	5.00	-0.10E-03
AN01D146.WCT	496.0	0	0	0	0	0	5.00	-0.10E-03
AN01D147.WCT	1000.0	0	0	0	0	0	5.00	-0.10E-03
AN01D148.WCT	462.0	0	0	0	0	0	5.00	-0.10E-03
AN01D149.WCT	1474.0	0	0	0	0	0	5.00	-0.10E-03

File name	Pmax	E_Tot	T_err	S_err	O2_err	E_err	Sd_fact	E_Min
AN01D149.WCT	1474.0	0	0	0	0	0	5.00	-0.10E-03
AN01D151.WCT	2482.0	0	0	0	0	0	5.00	-0.10E-03
AN01D152.WCT	2998.0	0	0	0	0	0	5.00	-0.10E-03
AN01D153.WCT	3530.0	0	0	0	0	0	5.00	-0.10E-03

File name	Pmax	E_Tot	T_err	S_err	O2_err	E_err	Sd_fact	E_Min
AN01D154.WCT	4136.0	0	0	0	0	0	5.00	-0.10E-03
AN01D155.WCT	4418.0	0	0	0	0	0	5.00	-0.10E-03
AN01D156.WCT	4530.0	0	0	0	0	0	5.00	-0.10E-03
AN01D157.WCT	4614.0	0	0	0	0	0	5.00	-0.10E-03
AN01D158.WCT	4682.0	0	0	0	0	0	5.00	-0.10E-03
AN01D159.WCT	4734.0	0	0	0	0	0	5.00	-0.10E-03
AN01D161.WCT	4750.0	0	0	0	0	0	5.00	-0.10E-03
AN01D162.WCT	4618.0	0	0	0	0	0	5.00	-0.10E-03
AN01D163.WCT	4724.0	0	0	0	0	0	5.00	-0.10E-03
AN01D164.WCT	4820.0	0	0	0	0	0	5.00	-0.10E-03
AN01D165.WCT	4788.0	0	0	0	0	0	5.00	-0.10E-03
AN01D166.WCT	4774.0	0	0	0	0	0	5.00	-0.10E-03
AN01D167.WCT	4788.0	0	0	0	0	0	5.00	-0.10E-03
AN01D168.WCT	4796.0	0	0	0	0	0	5.00	-0.10E-03
AN01D169.WCT	4784.0	0	0	0	0	0	5.00	-0.10E-03
AN01D170.WCT	4800.0	0	0	0	0	0	5.00	-0.10E-03
AN01D171.WCT	4914.0	0	0	0	0	0	5.00	-0.10E-03
AN01D172.WCT	4880.0	0	0	0	0	0	5.00	-0.10E-03
AN01D173.WCT	4902.0	0	0	0	0	0	5.00	-0.10E-03
AN01D174.WCT	4928.0	0	0	0	0	0	5.00	-0.10E-03
AN01D175.WCT	4956.0	0	0	0	0	0	5.00	-0.10E-03
AN01D176.WCT	4980.0	0	0	0	0	0	5.00	-0.10E-03
AN01D177.WCT	4960.0	0	0	0	0	0	5.00	-0.10E-03
AN01D178.WCT	4860.0	0	0	0	0	0	5.00	-0.10E-03
AN01D179.WCT	4848.0	0	0	0	0	0	5.00	-0.10E-03
AN01D180.WCT	4818.0	0	0	0	0	0	5.00	-0.10E-03

Table I (continued)

LEG 1 ANTVIII ____.WCT files

AN01D181.WCT	4814.0	0	0	0	0	0	5.00	-0.10E-03
AN01D183.WCT	2948.0	0	0	0	0	0	5.00	-0.10E-03
AN01D184.WCT	2428.0	0	0	0	0	0	5.00	-0.10E-03
AN01D185.WCT	2136.0	0	0	0	0	0	5.00	-0.10E-03
AN01D186.WCT	1806.0	0	0	0	0	0	5.00	-0.10E-03
AN01D187.WCT	1180.0	0	0	0	0	0	6.00	-0.10E-03
AN01D188.WCT	386.0	0	0	0	0	0	5.00	-0.10E-03
AN01D189.WCT	502.0	0	0	0	0	0	5.00	-0.10E-03

LEG 2 ANTVIII ____.WCT files

File name	Pmax	E_Tot	T_err	S_err	O2_err	E_err	Sd_fact	E_Min
AN01D192.WCT	466.0	0	0	0	0	0	5.00	-0.10E-03
AN01D193.WCT	1164.0	0	0	0	0	0	5.00	-0.10E-03
AN01D194.WCT	2080.0	0	0	0	0	0	5.00	-0.10E-03
AN01D196.WCT	2404.0	0	0	0	0	0	5.00	-0.10E-03
AN01D197.WCT	3130.0	0	0	0	0	0	5.00	-0.10E-03
AN01D198.WCT	3660.0	0	0	0	0	0	5.00	-0.10E-03
AN01D199.WCT	3270.0	0	0	0	0	0	5.00	-0.10E-03
AN01D200.WCT	4016.0	0	0	0	0	0	5.00	-0.10E-03
AN01D201.WCT	4346.0	0	0	0	0	0	5.00	-0.10E-03
AN01D202.WCT	4918.0	0	0	0	0	0	5.00	-0.10E-03
AN01D203.WCT	4858.0	0	0	0	0	0	5.00	-0.10E-03
AN01D204.WCT	5088.0	0	0	0	0	0	5.00	-0.10E-03
AN01D205.WCT	5230.0	0	0	0	0	0	5.00	-0.10E-03
AN01D206.WCT	5302.0	0	0	0	0	0	5.00	-0.10E-03
AN01D207.WCT	5402.0	0	0	0	0	0	5.00	-0.10E-03
AN01D208.WCT	5440.0	0	0	0	0	0	5.00	-0.10E-03
AN01D209.WCT	5478.0	0	0	0	0	0	5.00	-0.10E-03
AN01D210.WCT	5088.0	0	0	0	0	0	5.00	-0.10E-03
AN01D211.WCT	2228.0	0	0	0	0	0	5.00	-0.10E-03
AN01D212.WCT	5256.0	0	0	0	0	0	5.00	-0.10E-03
AN01D213.WCT	4466.0	0	0	0	0	0	5.00	-0.10E-03
AN01D214.WCT	1018.0	0	0	0	0	0	5.00	-0.10E-03
AN01D215.WCT	4546.0	0	0	0	0	0	5.00	-0.10E-03
AN01D216.WCT	1030.0	0	0	0	0	0	5.00	-0.10E-03
AN01D217.WCT	3152.0	0	0	0	0	0	5.00	-0.10E-03
AN01D218.WCT	1020.0	0	0	0	0	0	5.00	-0.10E-03
AN01D219.WCT	3218.0	0	0	0	0	0	5.00	-0.10E-03
AN01D220.WCT	1034.0	0	0	0	0	0	5.00	-0.10E-03
AN01D221.WCT	3442.0	0	0	0	0	0	5.00	-0.10E-03
AN01D222.WCT	1008.0	0	0	0	0	0	5.00	-0.10E-03
AN01D223.WCT	1020.0	0	0	0	0	0	5.00	-0.10E-03

Quality control of Water sample data:

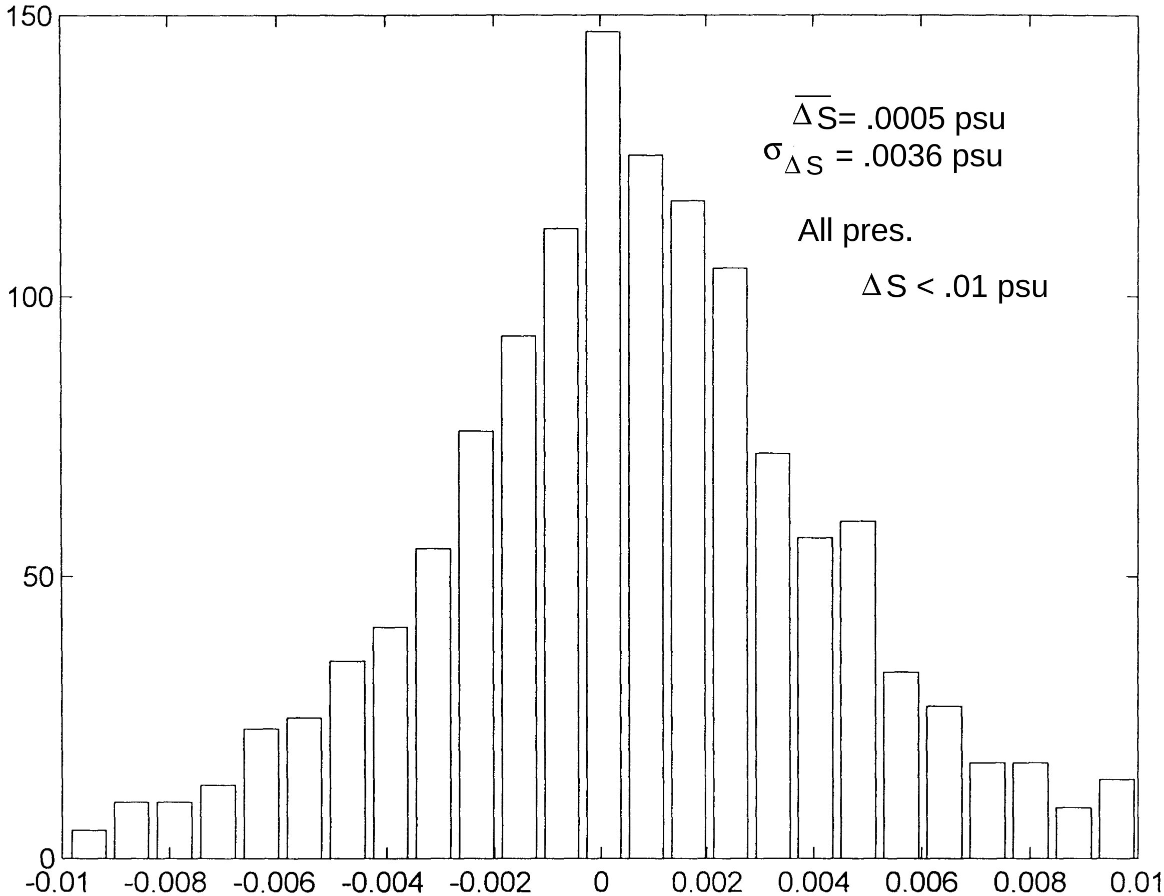
There were 127 questionable salinity obsevations identified. This doesn't include those water sample salinities that are missing. It is noted that the PI Quality word flags all CTD salinities as questionable.

Edit criteria for flagging questionable salinities for the DQE quality word is Ds = |SC-Sws| > .01 psu. The station / bottle values below were marked as questionable in the DQE quality word location. All missing bottles were carried across from the Quality word of the PI. The PI's quality word flag for the CTD salinity was marked throughout the water sample data file as questionable (ie. "3"). In the DQE quality word, when the salinity edit criteria (Ds = |SC-Sws| < .01 psu) was satisfied then both the CTD and water sample salinity were given a quality word value of "2" (ie marked as good).

Sta	btl	P	Theta	Sws	Oxws	Ds	QC	Sc,Sws
---	---	------	-------	-------	-------	-------	--	
119	16	79.7	-0.4443	33.9090	346.300	-0.0117	33	
119	13	99.5	-0.4130	34.0190	-9.000	-0.1145	33	
119	12	145.3	0.0608	34.0420	312.500	-0.0440	33	
119	10	196.8	1.0454	34.2420	254.500	-0.0133	33	
119	8	296.7	1.7456	34.4170	203.600	-0.0128	33	
124	2	1021.1	1.5255	34.7740	187.500	-0.0570	33	
129	12	149.3	0.0756	34.0640	300.800	-0.0211	33	
129	10	197.9	1.0843	34.2890	238.600	-0.0196	33	
134	6	498.7	1.8683	34.6550	176.900	0.0242	33	
137	10	199.5	-0.9988	34.2470	309.000	-0.0114	33	
137	2	700.6	0.1737	34.5340	239.200	0.0302	33	
138	24	8.9	-1.6659	34.0840	337.600	-0.0118	33	
138	18	38.7	-1.6735	34.1500	333.100	-0.0221	33	
138	10	146.4	-1.6718	34.3040	316.000	-0.0381	33	
138	8	254.2	-0.8008	34.4420	279.200	-0.0132	33	
139	12	150.1	-1.7300	34.4500	314.400	-0.0149	33	
140	8	148.3	-1.8968	34.5880	323.700	-0.0260	34	
143	20	39.6	-1.9005	34.5910	326.300	-0.0118	34	
145	23	9.3	-1.8701	34.5850	304.200	-0.1381	34	
145	5	250.0	-1.7663	34.5280	305.100	-0.0120	33	
146	9	149.9	-1.4172	34.5060	280.500	-0.0228	33	
146	8	200.7	-1.1268	34.5840	248.200	-0.0511	33	
146	1	496.1	-1.1563	34.5570	273.300	0.0396	33	
147	8	499.1	0.2419	34.6420	225.600	0.0113	33	
147	1	949.2	-0.9883	34.6090	274.500	0.0184	34	
149	9	397.1	0.3562	34.6710	213.500	-0.0218	33	
149	4	1297.7	-0.6148	34.6430	248.800	-0.0102	34	
152	19	97.6	-1.8258	34.4420	285.900	0.0120	33	
152	9	2750.7	-0.6852	34.6560	235.100	-0.0106	33	
152	6	2899.5	-1.0688	34.6180	-9.000	0.0137	34	
157	22	97.9	-1.7618	34.6380	209.100	-0.1710	34	
159	18	500.6	0.2742	34.6780	195.500	0.0105	33	
160	23	47.9	-1.8595	34.4880	297.300	-0.0309	34	
160	22	73.3	-1.8590	34.4930	297.000	-0.0354	34	
160	21	97.8	-1.8465	34.5100	297.000	-0.0513	34	
164	15	127.6	-1.7991	34.6800	-9.000	-0.1864	34	
164	9	498.9	0.2723	34.6730	-9.000	0.0110	33	

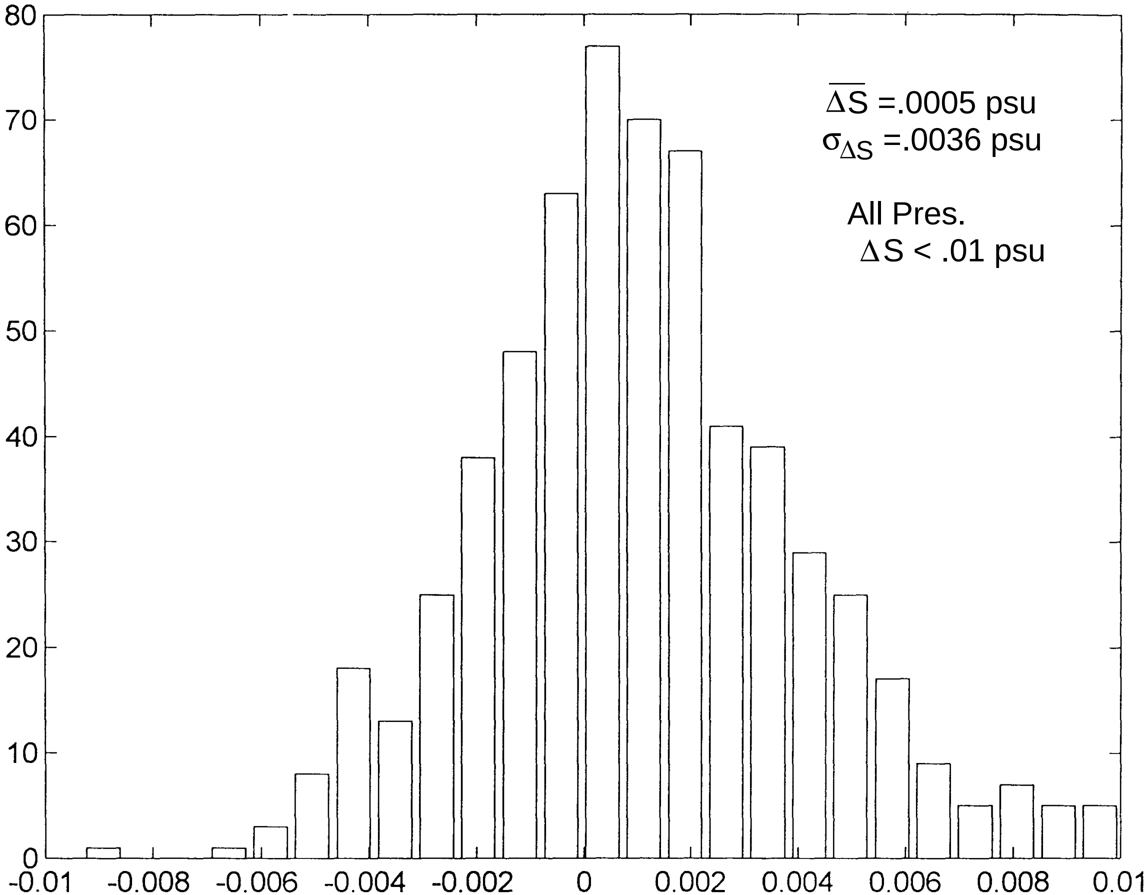
Sta	btl	P	Theta	Sws	Oxws	Ds	QC	Sc,Sws
---	---	------	-------	-------	-------	-------	--	
164	7	1004.5	0.0195	34.6620	-9.000	0.0142	33	
167	14	1497.9	-0.1135	34.6610	218.400	0.0105	33	
168	10	499.9	0.3251	34.6570	-9.000	0.0273	34	
168	2	4782.4	-0.9166	34.6500	250.500	-0.0107	33	
169	22	98.2	-1.7995	34.6890	293.700	-0.1936	34	
170	21	97.8	-0.7486	34.6000	231.600	0.0132	33	
171	16	97.1	-1.8015	34.5100	298.200	-0.0157	33	
171	10	495.6	0.3611	34.6760	193.800	0.0126	33	
172	21	147.3	-1.7836	34.5210	292.200	-0.0139	33	
173	24	10.4	-1.8608	34.4420	291.900	0.0227	33	
173	20	221.0	0.5032	34.6740	193.700	0.0111	33	
174	14	277.2	0.5217	34.4860	192.300	0.2005	34	
174	10	996.4	0.1469	34.6600	205.300	0.0186	34	
175	24	10.5	-1.8578	34.4790	300.500	0.0120	33	
177	15	1243.7	0.0695	34.6540	210.400	0.0241	34	
179	14	1244.4	0.1417	34.6770	208.500	0.0109	33	
180	21	118.5	-0.6622	34.6240	215.600	0.0164	34	
180	13	1496.0	0.0257	34.6620	214.000	0.0116	34	
181	20	49.8	-1.5724	34.4710	-9.000	0.0128	33	
181	18	68.8	-1.3808	34.6870	-9.000	-0.1941	34	
181	12	497.0	0.6925	34.6890	-9.000	0.0121	34	
182	19	298.0	0.7649	34.6790	204.500	0.0136	33	
182	18	298.0	0.7669	34.6810	205.200	0.0106	33	
183	10	997.9	0.2578	34.6530	212.900	0.0252	34	
185	17	141.8	-1.7874	34.4800	287.400	-0.0217	34	
187	22	18.9	-1.8710	34.3590	323.000	0.0375	34	
187	10	398.7	-1.8676	34.3790	324.300	0.0164	34	
192	17	18.8	-1.8714	34.4630	323.100	-0.1029	33	
192	12	39.0	-1.8678	34.4470	323.900	-0.0852	33	
192	11	59.1	-1.8642	34.4490	324.900	-0.0827	33	
192	10	79.9	-1.8636	34.4210	323.900	-0.0513	33	
192	9	100.2	-1.8640	34.4520	323.700	-0.0816	33	
192	8	147.3	-1.8640	34.4500	323.700	-0.0792	33	
192	7	200.5	-1.8632	34.4570	324.100	-0.0825	33	
192	3	400.4	-1.8252	34.3930	316.900	-0.0104	33	
193	17	19.2	-1.8695	34.5830	323.300	-0.1778	34	
193	12	80.1	-1.8626	34.5760	322.700	-0.1740	34	
193	11	200.3	-1.8293	34.5670	320.800	-0.1577	34	
193	10	336.0	-1.6919	34.5530	303.300	-0.1307	34	
193	9	370.6	-1.6259	34.5860	304.200	-0.1397	34	
193	8	504.6	-0.3771	34.6550	250.200	-0.1016	34	
193	7	599.9	0.0597	34.7050	233.500	-0.1030	34	
193	6	700.7	0.2496	34.7330	224.800	-0.1115	34	
193	5	801.3	0.3766	34.7550	218.500	-0.1167	34	
193	4	905.7	0.5089	34.7720	213.300	-0.1100	34	
193	3	1051.5	0.4153	34.7770	212.400	-0.1040	34	
193	2	1110.2	0.3862	34.7710	212.700	-0.0992	34	
193	1	1160.8	0.3673	34.7780	213.500	-0.1049	34	
194	16	181.7	-1.7419	34.4310	306.000	-0.0103	34	
194	14	300.3	-1.3327	34.4850	285.700	-0.0136	34	
194	13	380.8	-0.8067	34.5430	257.800	-0.0158	34	
194	6	1401.1	0.1748	34.7830	216.200	-0.1137	34	
194	5	1599.4	0.1020	34.7760	217.900	-0.1078	34	
194	4	1800.4	0.0492	34.7790	218.700	-0.1118	34	
194	3	1969.3	0.0071	34.7760	220.300	-0.1105	34	

Sta	btl	P	Theta	Sws	Oxws	Ds	QC	Sc,Sws
---	---	------	-------	-------	-------	-------	--	
194	2	2027.9	-0.0089	34.7780	220.300	-0.1118	34	
194	1	2076.5	-0.0231	34.7750	221.100	-0.1091	34	
195	14	201.6	0.1107	34.4720	227.700	0.1524	34	
195	13	320.6	0.3471	34.4790	220.200	0.1682	34	
195	12	441.3	0.3746	34.6290	219.500	0.0258	34	
195	10	539.0	0.4894	34.6570	213.600	0.0136	34	
197	24	19.3	-1.8015	34.4720	285.700	0.0119	34	
197	21	39.6	-1.7999	34.4950	285.600	-0.0114	34	
197	19	79.0	-1.7396	34.5190	276.200	-0.0317	34	
197	18	96.8	-1.3992	34.6010	237.100	-0.0890	34	
197	16	249.6	0.5957	34.6840	207.500	-0.0204	34	
198	1	3655.5	-0.4181	34.4810	236.300	0.1735	34	
200	21	41.1	-1.7899	34.4890	286.700	-0.0104	33	
201	14	268.0	0.4192	34.6880	202.100	-0.0316	34	
202	20	80.0	-1.4477	34.4770	285.100	-0.0191	33	
202	19	100.8	0.4403	34.6100	214.300	0.0146	33	
203	22	21.0	-1.7865	34.3650	301.600	0.0203	34	
203	10	1501.4	0.0717	34.6550	213.400	0.0175	34	
205	18	134.5	-1.5729	34.4300	280.700	-0.0425	33	
206	16	172.2	-1.2302	34.5190	244.300	-0.0874	33	
207	19	99.9	-1.5641	34.3600	-9.000	-0.0660	33	
207	18	124.4	0.3384	34.5950	-9.000	-0.0102	33	
208	23	21.7	-1.8335	34.3930	327.600	-0.1186	33	
208	21	61.8	-1.8223	34.3980	328.100	-0.1230	33	
208	19	102.3	-1.6612	34.4040	281.000	-0.1165	33	
210	4	4004.1	-0.7401	34.6360	247.300	0.0103	34	
215	19	100.3	-1.7261	34.2800	320.600	-0.0129	33	
218	16	150.7	-0.4464	34.4000	265.700	-0.0685	33	
219	17	151.3	-1.1037	34.2770	299.700	-0.0206	33	
220	14	151.0	-1.4244	34.2170	316.700	-0.0272	33	



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
$\overline{\Delta S}$= .0005 psu
$\sigma_{\Delta S}$ = .0036 psu
All pres.
ΔS < .01 psu

Figure 1a



80
70
60
50
40
30
20
10
0
-0.01
-0.008
-0.006
-0.004
-0.002
0
0.002
0.004
0.006
0.008
0.01
$\overline{\Delta S}$ =.0005 psu
$\sigma_{\Delta S}$ =.0036 psu
All Pres.
ΔS < .01 psu

Figure 1b

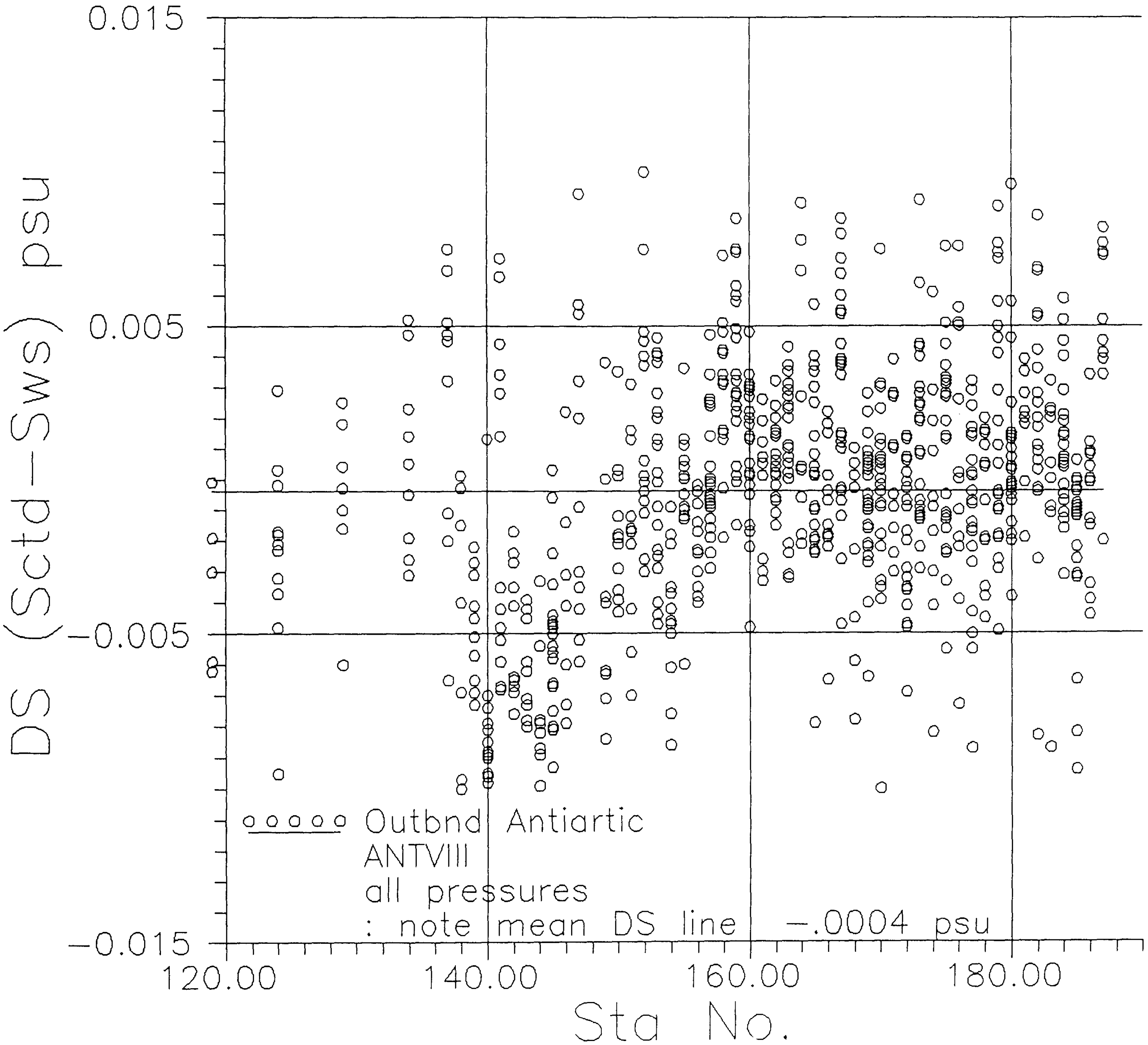

0.015
0.005
−0.005
−0.015
DS (Sctd−Sws) psu
120.00
140.00
160.00
180.00
Sta No.
Outbnd Antiartic
ANTVIII
all pressures
: note mean DS line −.0004 psu

Figure 2

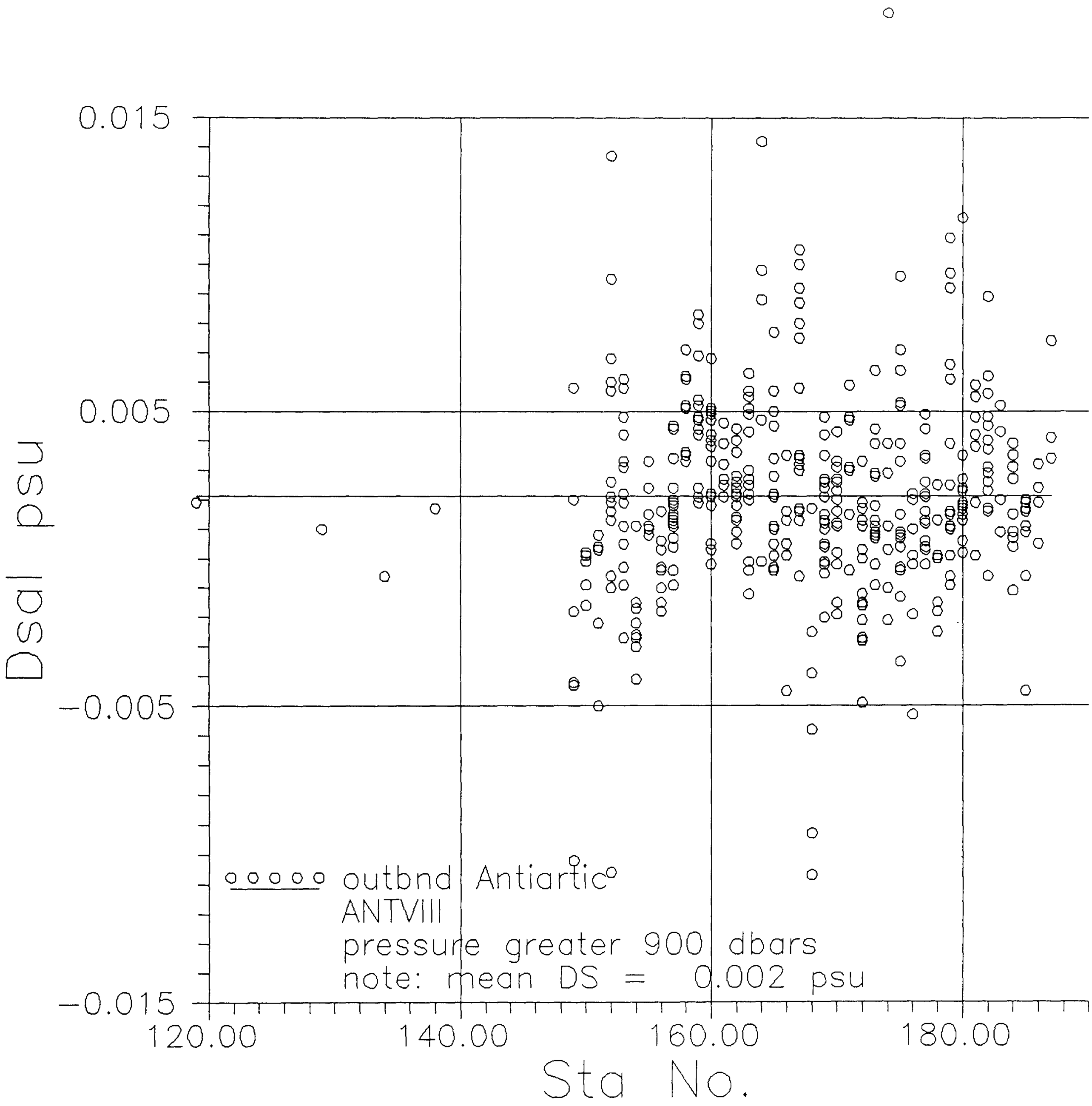

0.015
0.005
−0.005
−0.015
Dsal psu
120.00
140.00
160.00
180.00
Sta No.
outbnd Antiartic
ANTVIII
pressure greater 900 dbars
note: mean DS = 0.002 psu

Figure 3

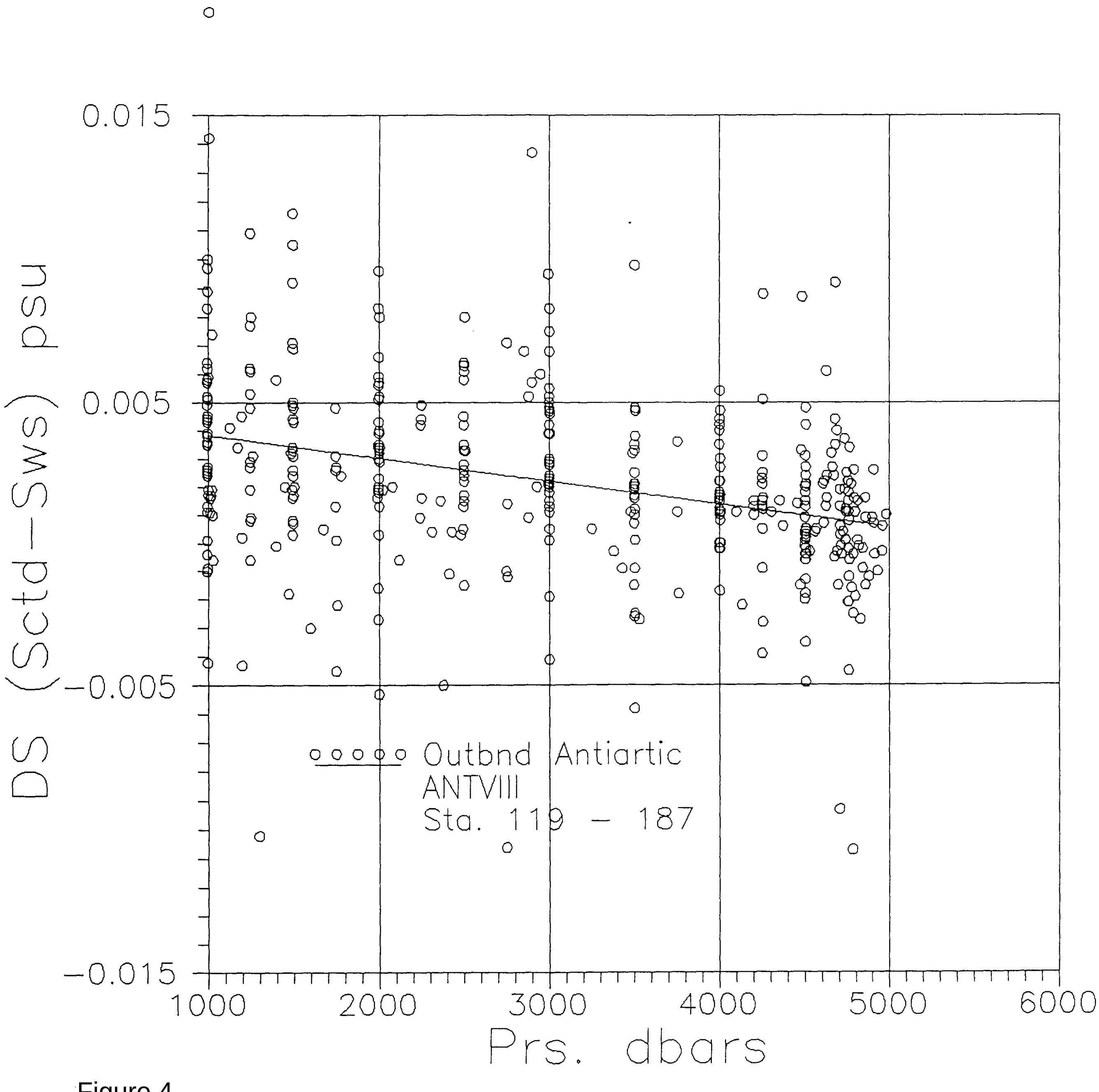

0.015
0.005
−0.005
−0.015
1000
2000
3000
4000
5000
6000
Prs. dbars
DS (Sctd−Sws) psu
Outbnd Antiartic
ANTVIII
Sta. 119 − 187

Figure 4

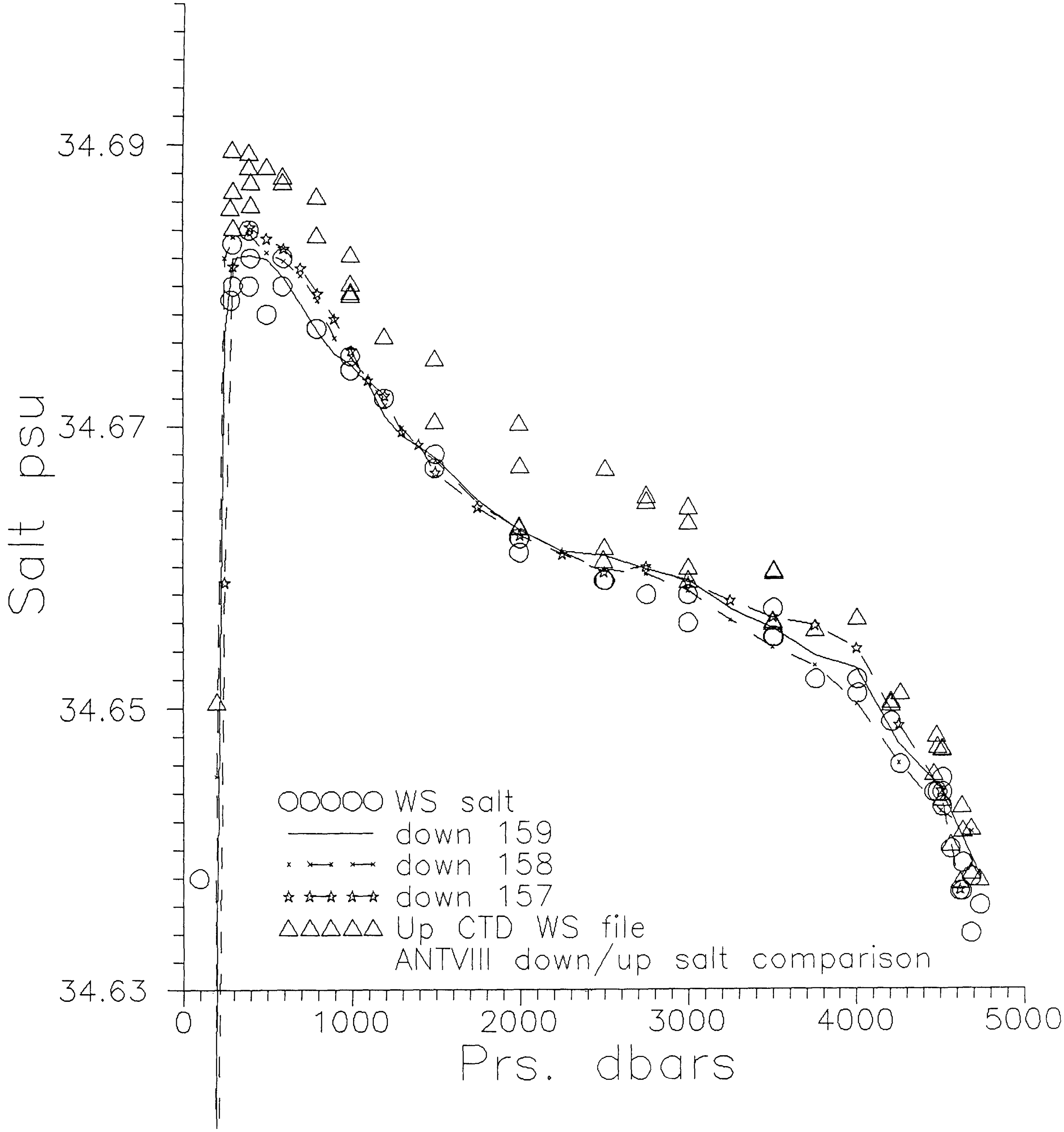

34.69
34.67
34.65
34.63
Salt psu
0
1000
2000
3000
4000
5000
Prs. dbars
WS salt
down 159
down 158
down 157
Up CTD WS file
ANTVIII down/up salt comparison

Figure 5

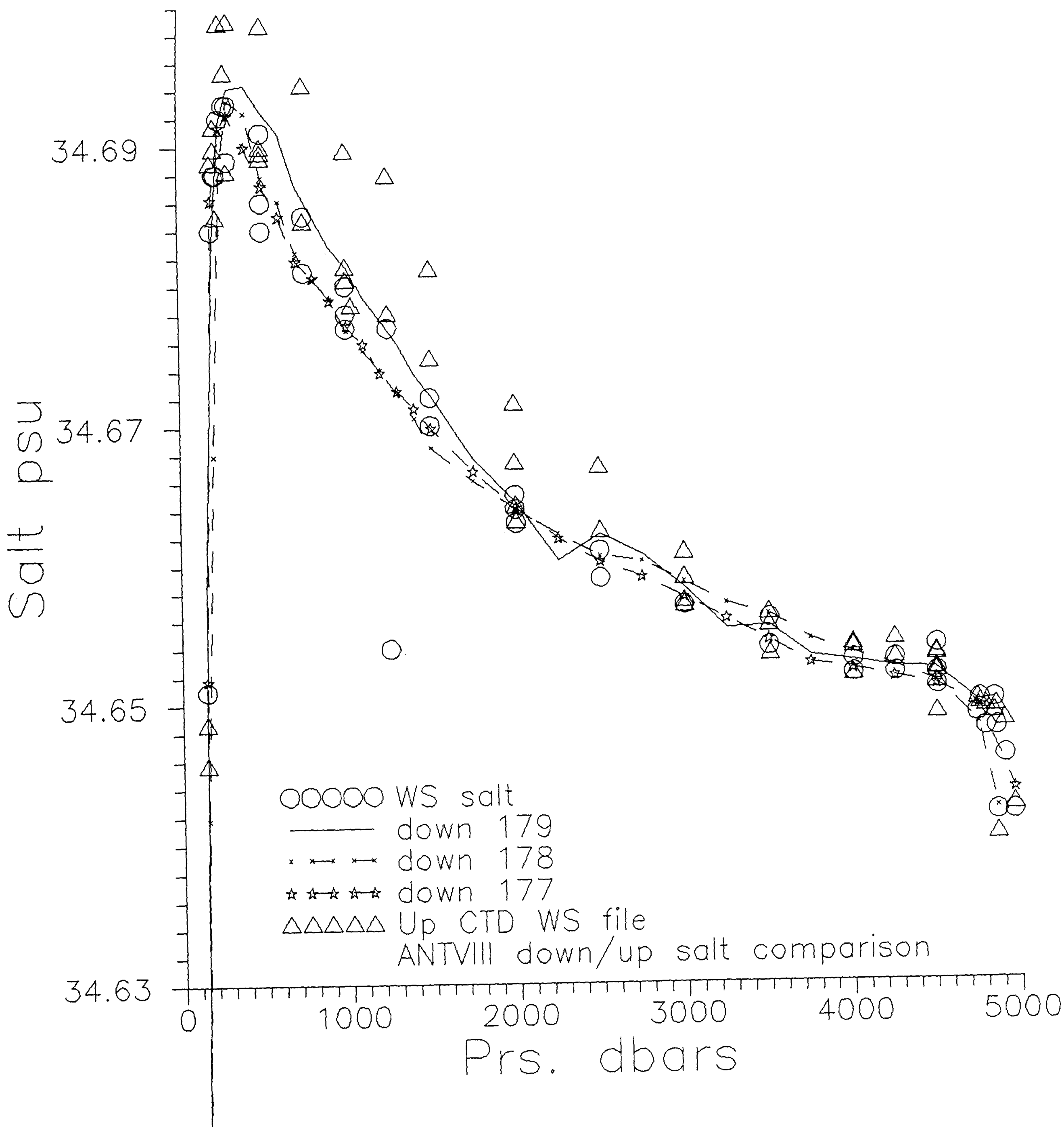
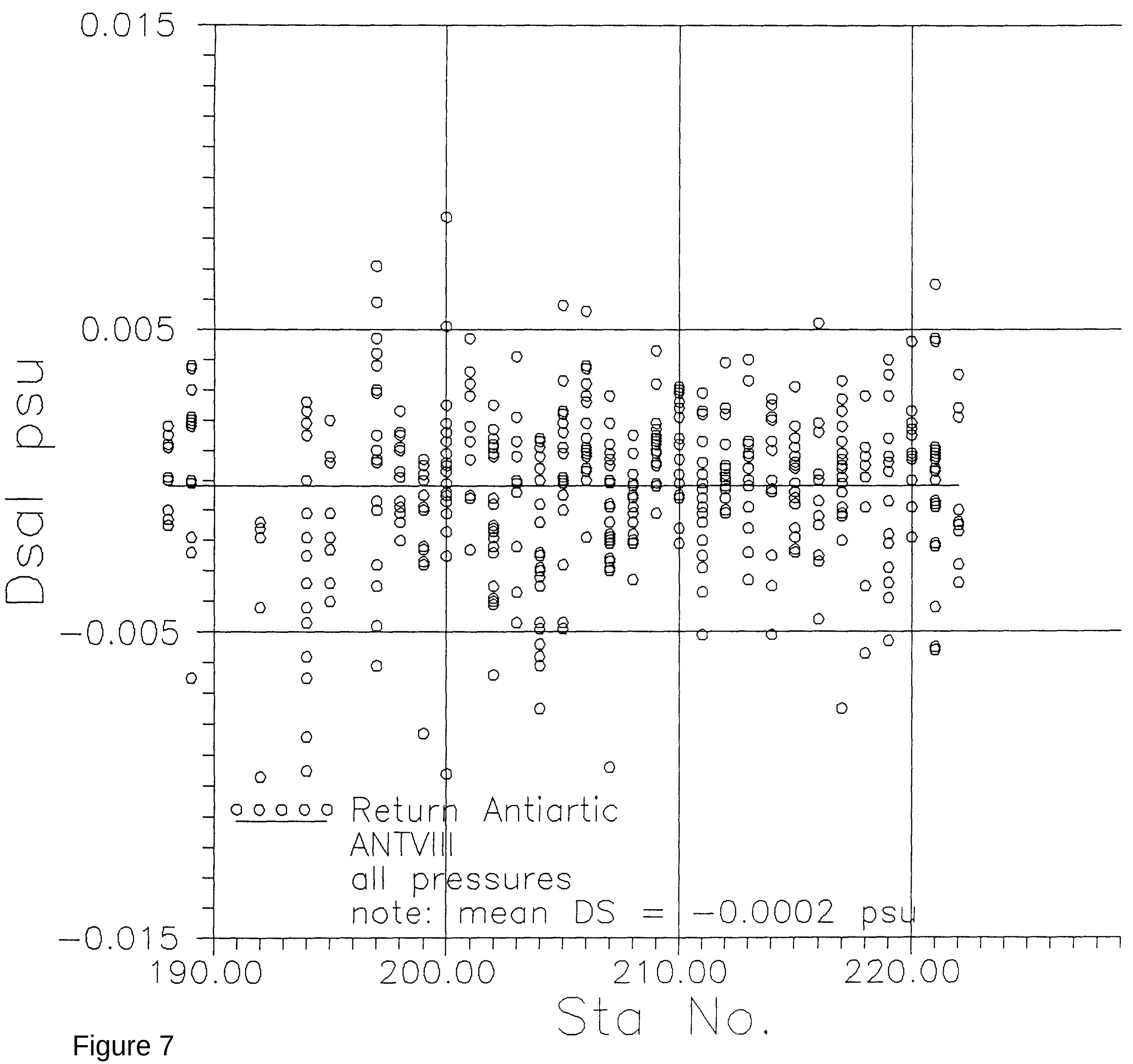

34.69
34.67
34.65
34.63
Salt psu
0
1000
2000
3000
4000
5000
Prs. dbars
WS salt
down 179
down 178
down 177
Up CTD WS file
ANTVIII down/up salt comparison

Figure 6



0.015
0.005
−0.005
−0.015
Dsal psu
190.00
200.00
210.00
220.00
Sta No.
Return Antiartic
ANTVIII
all pressures
note: mean DS = −0.0002 psu

Figure 7

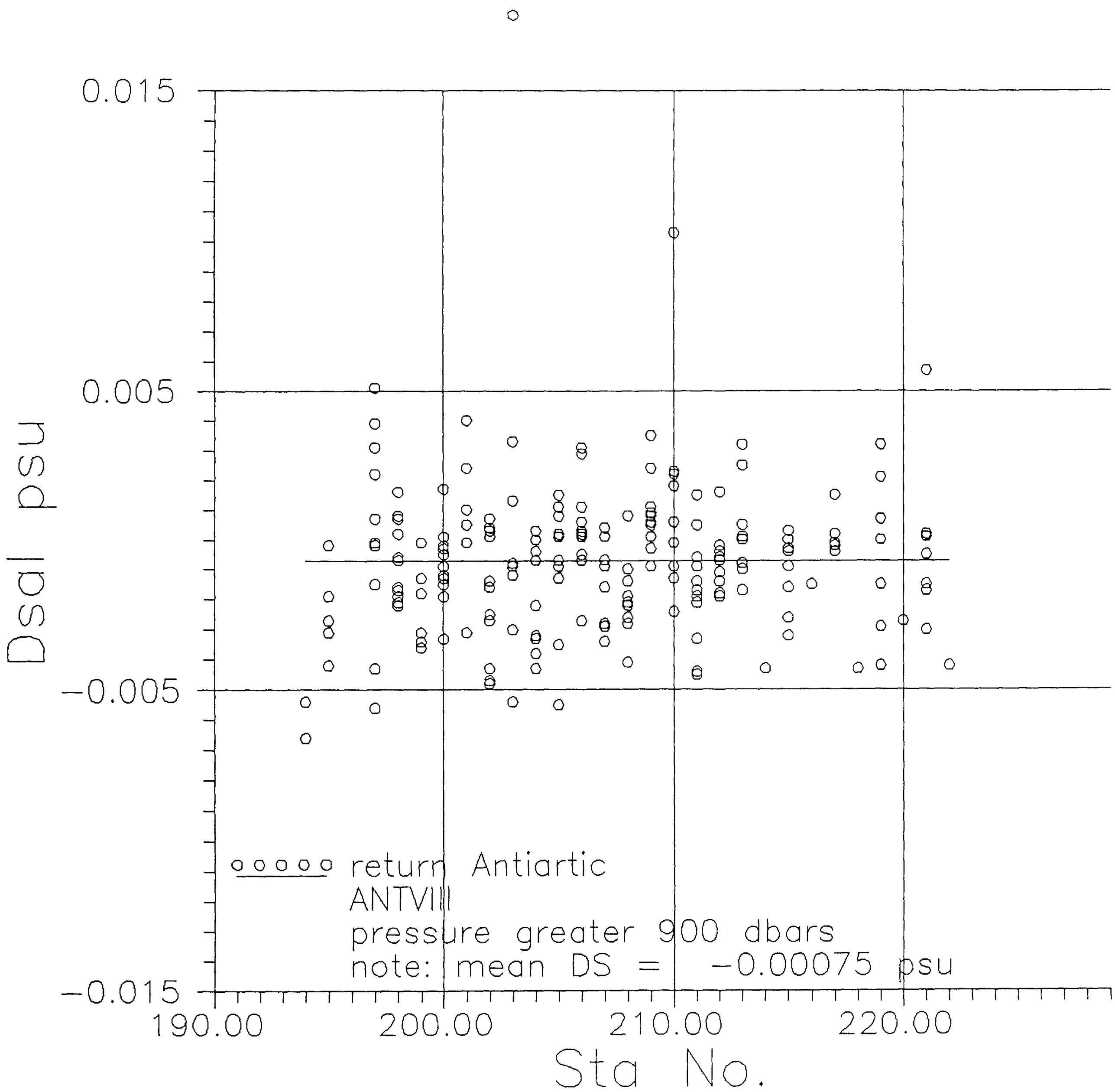

0.015
0.005
−0.005
−0.015
Dsal psu
190.00
200.00
210.00
220.00
Sta No.
return Antiartic
ANTVIII
pressure greater 900 dbars
note: mean DS = −0.00075 psu

Figure 8

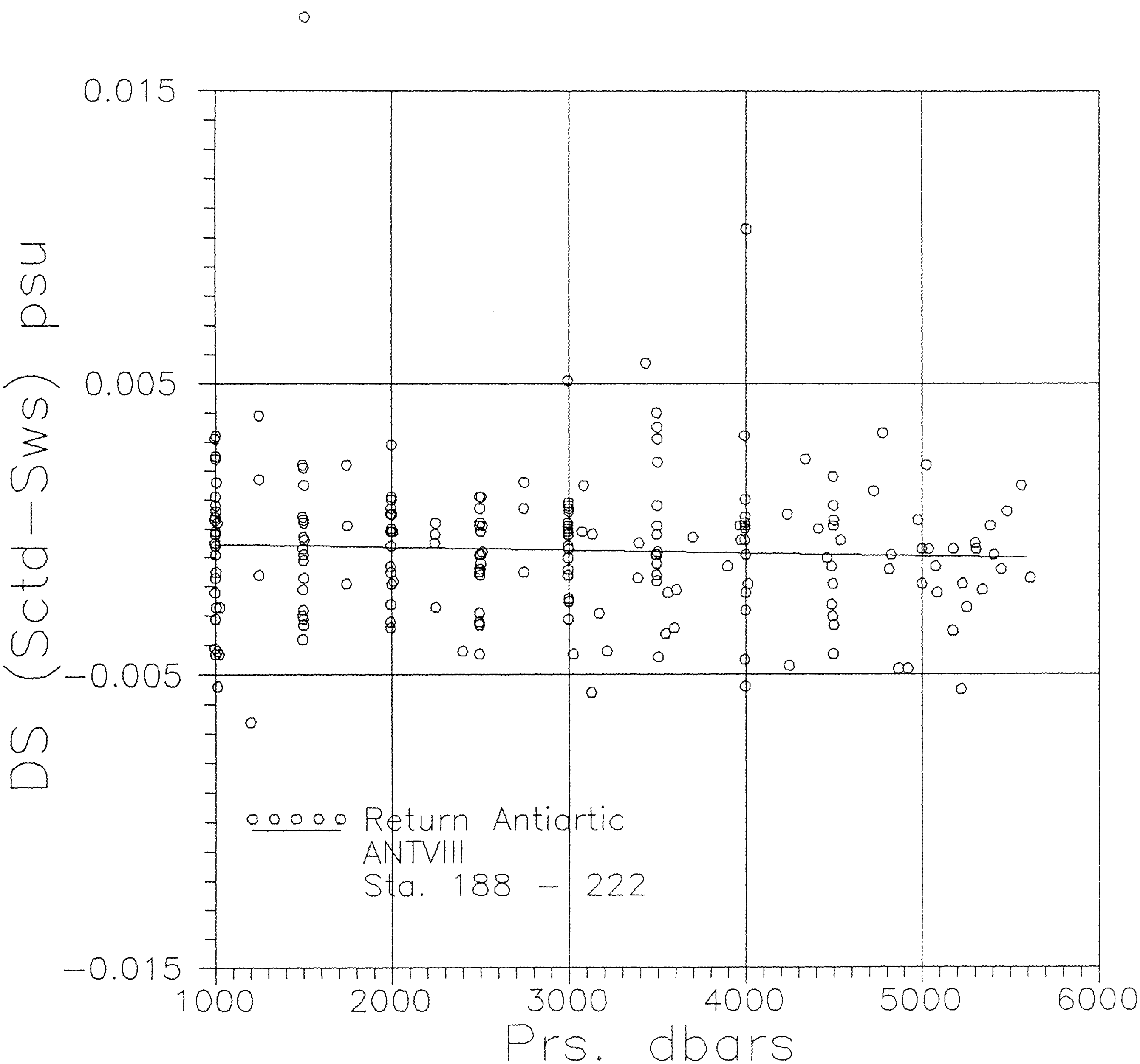
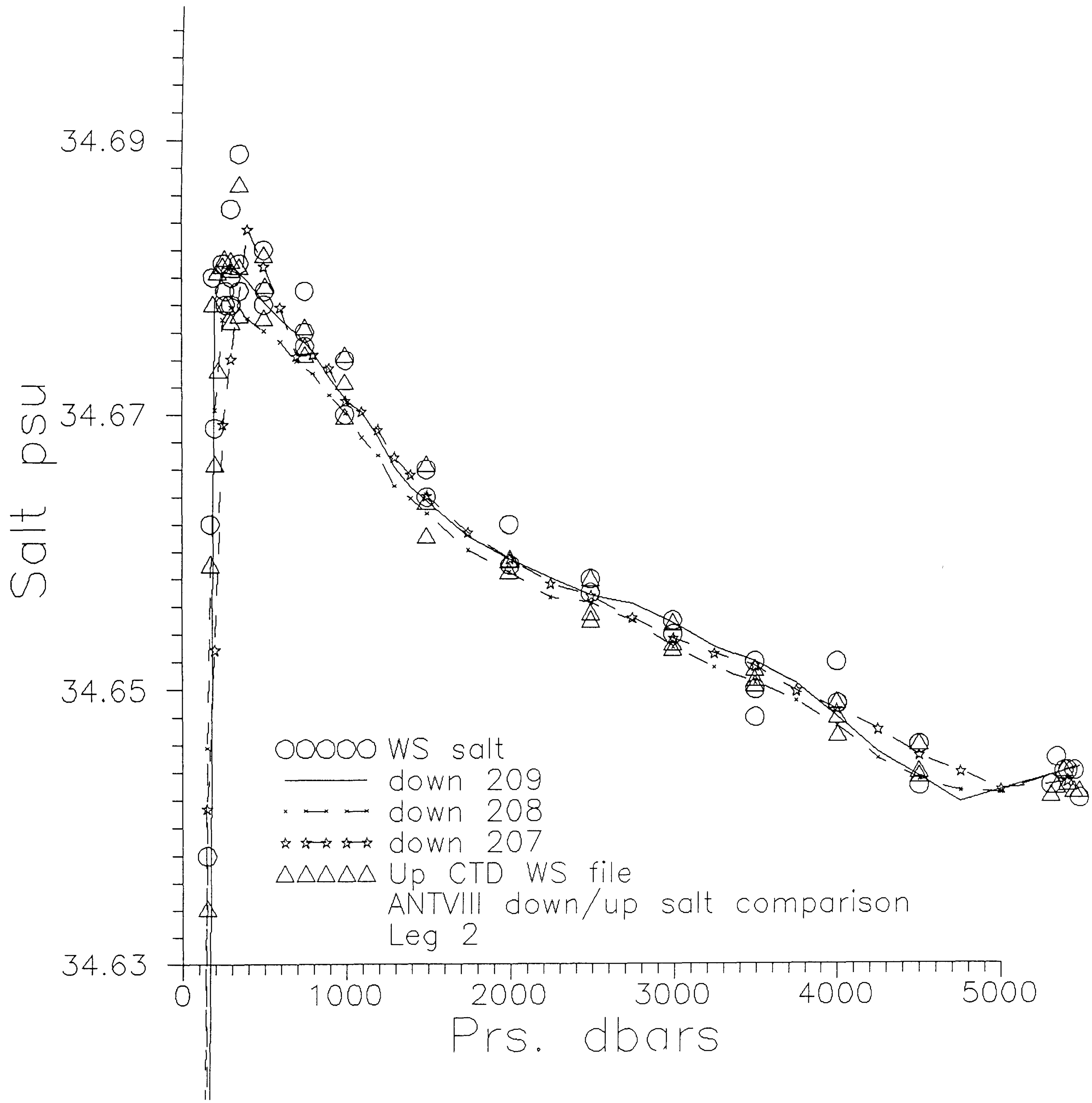

0.015
0.005
−0.005
−0.015
DS (Sctd−Sws) psu
Return Antiartic
ANTVIII
Sta. 188 − 222
1000
2000
3000
4000
5000
6000
Prs. dbars

Figure 9



Salt psu
34.69
34.67
34.65
34.63
0
1000
2000
3000
4000
5000
Prs. dbars
WS salt
down 209
down 208
down 207
Up CTD WS file
ANTVIII down/up salt comparison
Leg 2

Figure 10

G.2.1 Response from the Chief Scientist to CTD Data Quality Evaluation

This was an Antarctic winter cruise and all kind offers for software are of little help when sensors or water in bottles freeze. We have tried since 1986 to prevent freezing, bug only in 1990 did we achieve a somewhat satisfying system. However, for oxygen we did not find a solution at all and therefore there are no CTDOXY values.

As for the ANT VIII data our sensor protection was still not reliable and we had freezing problems as well as those fromour protection system. Therefore the data of that cruise required a particularly intensive correction. But even now we still have more problems with the CTDs than warm water oceanographers and therefore need special procedures. WE hoped to experiences some improvement by using the FSI CTD but it seems as if we just exchange one set of problems for another.

WHPO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
07/30/99	Bartolacci	SUM	Data Update
	I've replaced the sr04 (06AQANTVIII_2) sumfile with the most recently found version from the WHOI data directory. It has two line numbers included in it, SR04 and SR02, and also has beginning, bottom and ending event codes included in it where the current, online version does not. In short, the new sumfile is more complete, and does not need reformatting.		
05/03/01	Uribe	BTL	Website Updated; Exchange File Added
	Bottle file has been converted to exchange format and linked online. Bottle file indicated cast 22 for station 158, however sumfile indicated it was cast 2. Bottle file was modified in order to properly convert to exchange code.		
07/11/01	Uribe	CTD	Website Updated; Exchange File Added
	CTD have been converted to exchange format and put online.		
05/17/02	Tibbetts	DOC	Website Updated; txt versions online
	New txt doc online		
03/05/03	Kappa	DOC	Doc Update; Final PDF/TXT Reports Assembled

New text and pdf versions of the cruise documentation have been assembled. PDF version includes figures provided by chief scientist and the ctd data quality evaluator; as well as links from text to the table of contents, figures and tables.

In addition to the new pdf file, online documentation has the following changes:

- Greatly expanded discussion of the scientific program
- Nutrients report
- Bottle data DQE report
- CTD report
- Acoustic Doppler Current Profiler report
- Thermosalinograph report
- Dissolved oxygen report
- XBT and XCTD report
- Meteorological observations report
- Atmospheric chemistry report
- List of cruise participants
- List of ship's crew
- Major Problems and Goals not achieved
- Other Incidents of Note
- Report on buoys
- Report on moorings