Aurora Australis Marine Science Cruise AU0103, CLIVAR-SR3 Transect:

Oceanographic Field Measurements and Analysis

Mark Rosenberg

Antarctic Climate & Ecosystems CRC

Steve Rintoul

CSIRO Marine and Atmospheric Research

Stephen Bray

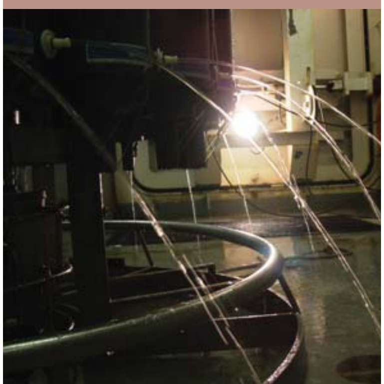
Antarctic Climate & Ecosystems CRC

Clodagh Moy

Antarctic Climate & Ecosystems CRC

Neale Johnston

CSIRO Marine and Atmospheric Research



Antarctic Climate & Ecosystems Cooperative Research Centre

Technical Report No. 4

Mark Rosenberg

Antarctic Climate & Ecosystems CRC
Private Bag 80
Hobart, Tasmania, 7005, Australia.
email: mark.rosenberg@utas.edu.au

Steve Rintoul

CSIRO Marine and Atmospheric Research
Castray Esplanade
Hobart, Tasmania, 7000, Australia.
email: steve.rintoul@csiro.au

Stephen Bray

Antarctic Climate & Ecosystems CRC
Private Bag 80
Hobart, Tasmania, 7005, Australia.
email: s.bray@utas.edu.au

Clodagh Moy

Antarctic Climate & Ecosystems CRC
Private Bag 80
Hobart, Tasmania, 7005, Australia.
email: clodagh.moy@utas.edu.au

Neale Johnston

CSIRO Marine and Atmospheric Research
Underwood Ave
Floreat, Western Australia, 6014, Australia.
email: neale.johnston@csiro.au

Cover photos courtesy of George Cresswell

ISSN: 1833-2404

ISBN: 1-921197-02-1

November 2006

Published by the Antarctic Climate & Ecosystems Cooperative Research Centre,
Hobart, Tasmania, Australia, 76 pp.

Established and supported under the Commonwealth
Governments Cooperative Research Centres Programme.

Aurora Australis Marine Science Cruise AU0103, CLIVAR-SR3 Transect: Oceanographic Field Measurements and Analysis

Contents

Tables

Figures

Abstract

Oceanographic measurements were conducted along CLIVAR Southern Ocean meridional repeat transect SR3 between Tasmania and Antarctica from October to December 2001. A total of 135 CTD vertical profile stations were taken, more than half to within 20 m of the bottom. Over 2200 Niskin bottle water samples were collected for the measurement of salinity, dissolved oxygen, nutrients, CFCs, CCl_4, dissolved inorganic carbon, alkalinity, DMS/DMSP/DMSO, halocarbons, barium, barite, ammonia, $\delta^{30}Si$, dissolved and particulate organic carbon, particulate silica, ^{15}N-nitrate, ^{18}O, ^{234}Th, ^{230}Th, ^{231}Pa, primary productivity and biological parameters, using a 24 bottle rosette sampler. Near surface current data were collected using a ship mounted ADCP. Two sediment trap moorings were serviced, and a third mooring was deployed at a new location. A summary of all CTD data and data quality is presented in this report.

1 Introduction

Marine science cruise AU0103 was conducted aboard the *RSV Aurora Australis* from October to December 2001. The major constituent of the cruise was the seventh complete occupation of the CLIVAR SR3 section south of Tasmania (Figure 1a), and the first full occupation during the southern spring. Springtime measurements had previously been made during the 1991 occupation of SR3, though not to the full station density (Rintoul and Bullister, 1999). Previous completions of the transect are summarised in Rosenberg et al. (1997).

The primary scientific objectives of the CLIVAR SR3 occupation were:

1. to measure changes in water mass properties and inventories throughout the full ocean depth between Tasmania and Antarctica;
2. to estimate the transport of mass, heat and other properties south of Australia, and to compare the results to previous occupations of the WOCE SR3 line;
3. to identify mechanisms responsible for variability in ocean climate south of Australia;
4. to observe the physical and biological properties of the upper ocean during the period of the spring bloom;
5. to use repeat measurements to assess the skill of ocean and coupled models.

Additional CTD profiles were taken at nine ‘particle station’ sites to support the biogeochemical work. Three high resolution mini sections were also completed across the Antarctic Slope Front, with an additional line of CTDs taken across a bathymetric exit trough at the northwest end of the Mertz Depression (Figure 1b). Note that intensive CTD and mooring measurements in this southern shelf region were made previously during the Mertz Polynya Experiment (Rosenberg et al., 2001). Two sediment trap moorings were serviced during the cruise, and a third sediment trap mooring was deployed at a new location (Figure 1b, Table 4).

This report describes the CTD, Niskin bottle, hull mounted ADCP and underway data and data quality for this cruise. All information required for use of the data set is presented in tabular and graphical form. Publications using the cruise data set include Aoki et al.(2005a), Aoki et al. (2005b), Cardinal et al. (2005a), Cardinal et al. (2005b), Jacquet et al. (2004) and Jacquet et al. (2005).

2 Cruise itinerary and summary

The ship departed Hobart on October 29th 2001, and a test CTD was done (station 1) in 1000 m of water. The SR3 transect then commenced, and 12 CTDs were completed. Note that throughout the SR3 line, double dips were taken at approximately every second or third location, not counting particle stations (Table 2). The double dipping involved taking both a shallow cast to 350 m and a full depth cast (in either order), to gain more vertical resolution for Niskin bottle samples in the upper profile.

After CTD station 13 the ship moved to the west of the transect line and the first particle station was occupied at ~142°E. Four CTDs were taken, and the sediment trap mooring SAZ-B (Figure 1a) was recovered then redeployed (complete details are described in the unpublished cruise mooring report). The SR3 transect was then resumed, continuing southward towards the Antarctic shelf. En route along the transect, a further 7 particle stations were occupied (Table 2), the sediment trap mooring at SAZ-C was recovered then redeployed, a new sediment trap mooring was deployed at SAZ-F (Figure 1a), a high resolution mini transect was taken across the slope front (station 95 to 99), and a mini transect was taken across the exit trough at the northwest end of the Mertz Depression (station 101 to 104). Station 107 and 108 were taken next to the Mertz Glacier, the first in Buchanan Bay and the second to the northeast. Iceshelf water was measured, with temperatures as low as -2.04°C. Unfortunately conductivity measurements were bad for both these casts, due to instrument hardware failure. Two more mini sections were taken upstream and downstream of the exit trough (Table 2, Figure 1b), and the ninth particle station was occupied over the slope at 2500 m depth.

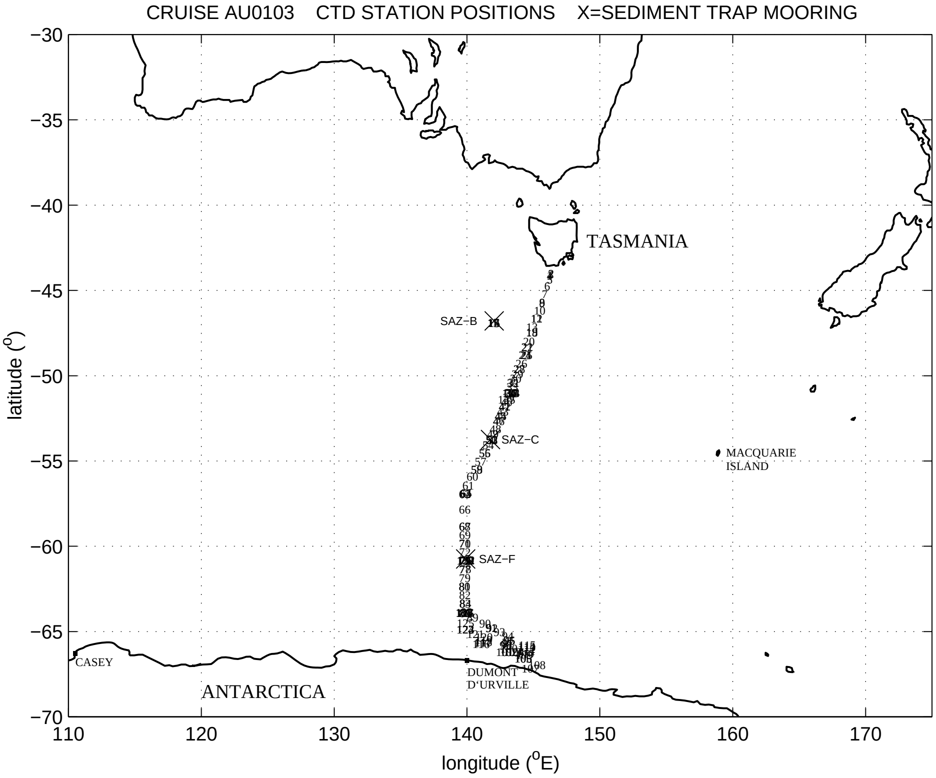
Conditions on the way south were remarkably ice free, and on the return northward the ship detoured specifically to seek out pack ice suitable for study. Continuing on the transit north back to Hobart, 3 of the particle stations were reoccupied (Table 2).

CTD station details are summarised in Table 2, while Table 3 summarises the major Niskin bottle sampling for each station. Mooring deployment and recovery details are summarised in Table 4. Principal investigators for CTD and water sampling measurements are listed in Table 5, while cruise participants are listed in Table 6.

Table 1: Summary of cruise itinerary

Expedition Designation	AU0103, voyage 3 2001/2002 (cruise acronym CLIVAR)
Cruise Determining Program	CLIVAR SR3 section
Chief Scientist	Steve Rintoul (CSIRO)
Ship	*RSV Aurora Australis*
Ports of Call	Hobart
Cruise Dates	October 29th to December 13th, 2001

(a)



(b)

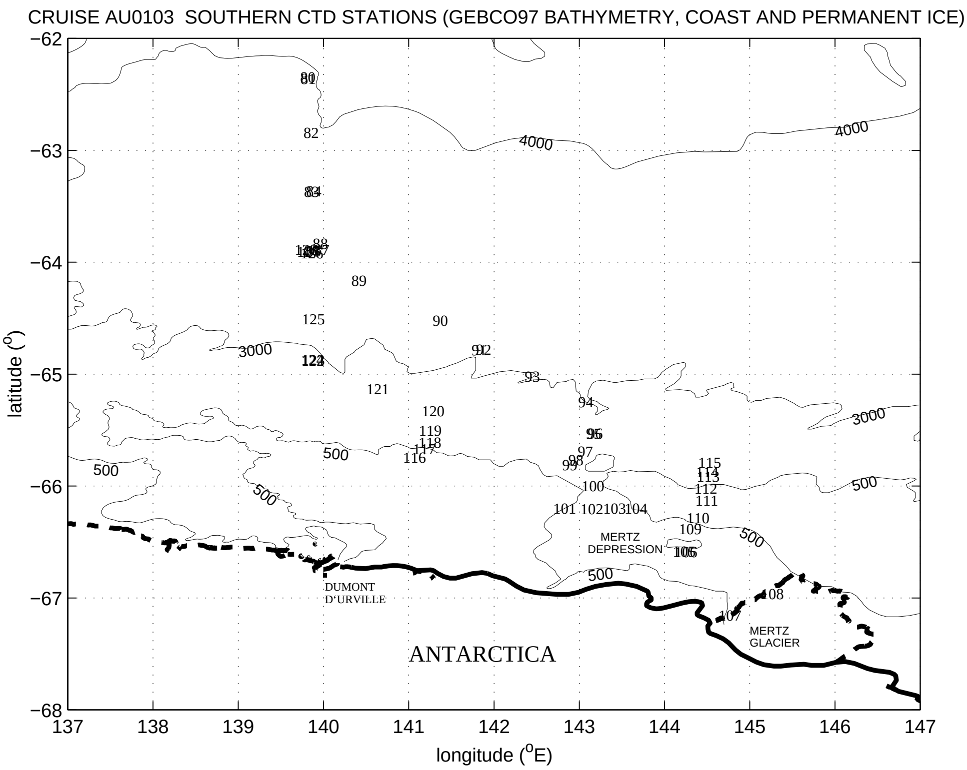


Figure 1a and b: CTD station positions and mooring locations for cruise AU0103.

3 Problems encountered

- During the test cast at station 1, the top few metres of seacable frayed badly and a retermination was required. A further electric retermination was required after station 6 as water was entering the cable join.
- Significant data noise was observed for the first 8 casts, and the problem was eventually traced to the CTD deck unit. The unit was replaced for station 9 onwards.
- The fluorometer was powered from a separate battery pack for CTD casts up to station 108. Electrical shorts to seawater flattened the batteries during stations 6 and 8.
- Near the bottom of the cast at station 13, the CTD winch was unable to haul and the package ended up sitting on the bottom for ~30 minutes in 4800 m of water. When finally retrieved, there was surprisingly little damage to the instruments beyond a mud-filled conductivity cell. It was decided that the winch drum was overfilled with wire, and after station 15 1000 m of wire were removed from the drum. At station 16, trouble was again experienced below 4000 m when attempting to haul the package. After the cast the pressure in the winch hydraulics was raised from 22 to 26 bar, which appeared to fix the problem, and there were no further hauling problems for the remainder of the cruise.
- During station 30, the ship lost head repeatedly in the heavy swell, and the cast was finally abandoned at 3200 dbar, with bottles tripped on the fly during retrieval. During the cast, the CTD room shipped lots of water and a set of sample containers and filter rigs were swept out the CTD door.
- The stern gantry failed during work from the stern at the time of CTD station 38 – the rack and pinion drive system could not be repaired at sea. The 2 gilsson winches were rigged via a series of blocks for pulling the gantry in and out. With this configuration, the gantry was usable for trawl deck operations on the remainder of the cruise, however 4 crew were required to drive the system.
- For Niskin bottle 19, a loose lanyard prior to station 60 allowed the bottom end cap to pre-trip on many occasions. As a result, Niskin bottle samples from bottle 19 were bad for many stations prior to station 60 (details given in section 5.2).
- Near the start of the cast at station 66, a single wire strand broke on the CTD wire, bunching up and jamming in the sheaf as recovery was attempted. Retermination was required.
- The aft CTD winch drum was used for 'in situ pump' casts (P.I. Tom Trull). When at the bottom of the pump cast after CTD station 88, with 3500 m of wire out, a single strand broke on the wire. During the recovery, ~150 m of this broken strand had to be cut away as it bunched up at the sheaf.
- The conductivity hardware on CTD serial 1193 failed during station 107. Replacement CTD serial 1103 was installed for station 109 onwards.

4 Field data collection methods

4.1 CTD instrumentation

General Oceanics Mark IIIC CTDs including dissolved oxygen sensor were used for the entire cruise, mounted on a 24 bottle rosette frame, together with a G.O. model 1015 24-position pylon. CTD serial 1193 was used for stations 1 to 108, and CTD serial 1103 was used for remaining stations. 10-litre Niskin bottles were used for sample collection. All bottles were G.O., with the exception of 3 NOAA bottles; one of the NOAA bottles was constructed of titanium, for low CFC blank levels. All Niskins were fitted with pre-baked neoprene o-rings and stainless steel springs (no teflon coating), again to lower CFC blank levels. A Benthos altimeter serial 142 was fitted for bottom location, and digital deep sea reversing thermometers (SIS model RTM4002X) were mounted on 3 bottles for checks of CTD temperature calibration (Table 16).

A Sea Tech fluorometer, borrowed from CSIRO and rated to 6000 m, was fitted to the rosette frame for most stations up to station 108 (Table 3). This instrument was powered from a separate battery pack, also fitted to the frame. After station 108, the Antarctic Division Sea Tech fluorometer (rated to only 3000 m) was used.

A Chelsea Instruments transmissometer, borrowed from CSIRO, was fitted to the frame for most stations up to station 52. The instrument was powered from the fluorometer battery pack, and data were fed through the licor channel. No good transmittance data were obtained in this configuration. Good data were however obtained after fitting the transmissometer to the CSIRO Seacat, deployed separately from the stern (B. Griffiths, pers. comm.).

A CSIRO copper ion selective electrode was fitted to the frame for station 76, with data fed through the fluorometer channel (P.I. Denis Mackey, CSIRO).

4.2 Niskin bottle sampling

Niskin bottles were sampled for numerous chemical and biological parameters throughout the cruise. Table 3 provides a summary of the main parameters sampled at each CTD station. Repeat shallow casts were taken at every second or third location on the main SR3 transect, both to increase vertical resolution for studies focusing on the upper water column, and to provide sufficient water volume for all the samples required. Several repeat casts were taken at particle station sites, with cast depths varying according to the needs of the samples required. In general, the core CTD parameters of salinity, dissolved oxygen and nutrients (orthophosphate, total nitrate+nitrite and reactive silicate) were sampled at every SR3 location. A strict order was followed for drawing of samples from Niskin bottles, with CFC, DMS/DMSP, dissolved organic carbon, halocarbons and dissolved oxygen coming first, and biological parameters generally coming later in the order.

4.3 CTD instrument and data calibration

Pre-cruise pressure, platinum temperature and pressure temperature calibrations (October 2001) were performed at the CSIRO Division of Marine Research calibration facility (Table 7). A full multi point laboratory temperature calibration was performed for the platinum temperature sensors, with points between the triple point of water and the melting point of gallium, and also including several subzero points down to ~-1.4°C. A quadratic fit to the sensor calibration data was used for CTD1193 (stations 1-108); a linear fit was used for

CTD1103 (stations 109-135). Calibration of the fluorometer channel for CTD1193 was done on the ship (Table 7), giving data output in volts; the same calibration was applied to fluorescence data for CTD1103. Chlorophyll-a concentration data are required to scale these voltages to fluorescence units.

Complete CTD conductivity and dissolved oxygen calibration results, derived from *in situ* Niskin bottle samples, are listed later in this report. Hydrochemistry laboratory methods are discussed in Appendix 1. Full details of CTD data processing and calibration techniques can be found in Appendix 2 of Rosenberg et al. (1995), with the following update to the methodology: the 10 seconds of CTD data prior to each bottle firing are averaged to form the CTD upcast burst data for use in calibration.

4.4 ADCP

The hull mounted ADCP on the *Aurora Australis* is described in Rosenberg (unpublished report, 1999). Logging and calibration parameters are summarised as follows:

ping parameters		*bottom track ping parameters*	
no. of bins:	60	no. of bins:	128
bin length:	8 m	bin length:	4 m
pulse length:	8 m	pulse length:	32 m
delay:	4 m		
ping interval:	minimum	ping interval:	same as profiling pings
reference layer averaging:		bins 8 to 20	
XROT:		822	
ensemble averaging duration:		3 min. (for logged data);	
		30 min. (for final processed data)	

calibration

α (± standard deviation)	1+β (± standard deviation)	no. of calibration sites
2.460 ± 0.575	1.0691 ± 0.011	124

Current vectors are plotted in Figure 2; the apparent vertical current shear error for different ship speed classes, discussed in Rosenberg (unpublished report, 1999), is plotted in Figure 3.

4.5 Underway measurements

Underway data, including meteorological data, bathymetry, GPS and sea surface temperature/salinity/fluorescence, were logged to an Oracle database on the ship. All data were quality controlled by the dotzapper. For bathymetry data, a sound speed of 1463 ms^{-1} was used for ocean depth calculation, and the ship's draught of 7.3 m was accounted for. For more information, see the AADC (Antarctic Division Data Centre) website, and the cruise dotzapper report:

Marine Science Support Data Quality Report, *RSV Aurora Australis* Season 2001-2002 Voyage 3 (CLIVAR), Ruth Lawless, Antarctic Division unpublished report (at web address http://aadc-maps.aad.gov.au/metadata/mar_sci/Dz200102030.html).

Underway data were dumped from the AADC website and are in the following files:

1 min. instantaneous values, text format:	clivar_underway.ora
1 min. instantaneous values, matlab format:	clivar_underway.mat

A correction was applied to the underway sea surface temperature and salinity data, derived by comparing the underway data with CTD temperature and salinity data at 8 dbar (Figure 4). The following corrections were applied:

$$T = 0.9943\, T_{dls} - 0.2361 \quad \text{(eqn 1)}$$

$$S = 0.9873\, S_{dls} + 0.4680 \quad \text{(eqn 2)}$$

for corrected underway temperature and salinity T and S respectively, and uncorrected values T_{dls} and S_{dls}. Note that in the final data set, a few underway sea surface salinity values near the start and end of the cruise appear to be suspiciously low.

5 CTD and bottle data results

CTD and Niskin bottle data quality are discussed in this section. Full details of the CTD data processing and calibration techniques are described in Rosenberg et al. (1995). Data file formats are described in Appendix 2, and historical data comparisons are made in Appendix 4. When using the data, the following data quality tables are important: Table 14 (questionable CTD data) and Table 15 (questionable nutrient data).

This was the second last cruise on the *Aurora Australis* where General Oceanics CTDs were still used. In late 2002, a year after the cruise, the CTD system on the ship was switched over to SeaBird 911plus instruments, with an accompanying improvement in data quality, in particular for CTD dissolved oxygen data.

5.1 CTD data

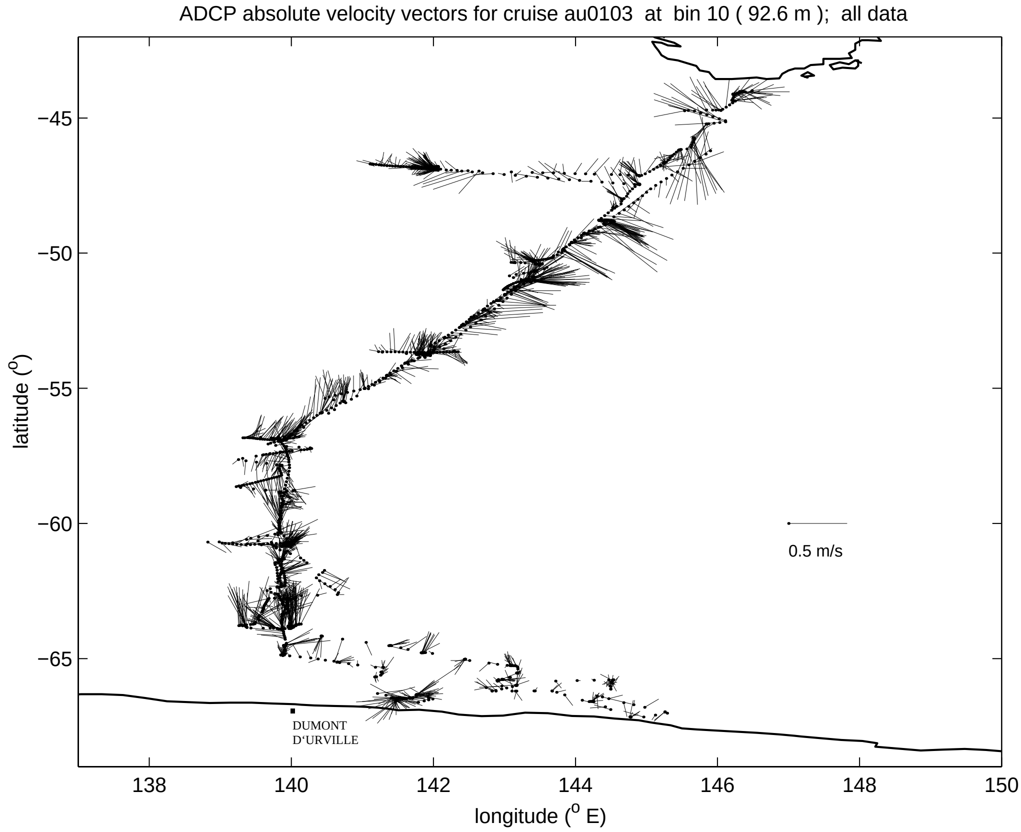
5.1.1 Conductivity/salinity and temperature

The conductivity calibration and equivalent salinity results for the entire cruise are plotted in Figures 5 and 6, and the derived conductivity calibration coefficients are listed in Tables 9 and 10. CTD temperature and reversing thermometer data are compared in Figures 8a and b.

CTD1193 was used for stations 1 to 108. The conductivity cell used for stations 1 to 12 performed very well, with CTD salinities accurate to less than 0.002 (PSS78). The cell was damaged during station 13 when the package hit the bottom, and a different cell was fitted for stations 14 to 108. This second conductivity cell performed well for stations 14 to 29. For stations 30 to 70, a very small biasing towards a positive ΔS (where ΔS = bottle salinity – calibrated CTD salinity) is evident deeper in the water column. This biasing, mostly of the order 0.001 (PSS78), is well within the 0.002 (PSS78) salinity accuracy and therefore no correction has been made to the data.

For stations 71 to 97, the positive biasing error in ΔS becomes significant (Figure 7a). The positive group of ΔS values to the lower right of Figure 7a represents data from the bottom end of CTD profiles. The depth of these values decreases southward as the bathymetry shoals, thus the biasing is not simply a pressure dependent error. The biasing does however appear simultaneously with the appearance of a locally colder fresher 'tail' of water at the bottom of each profile. The local vertical salinity gradients are steeper in these tails, and as the centre of the Niskin bottles on the rosette frame are ~0.5 m above the CTD sensors, the negative sign (i.e. freshening with depth) of the gradients would be expected to cause a small positive biasing in ΔS. Closer examination reveals that the positive ΔS values do not always correspond exactly with these local fresher tails of water, and indeed the gradients

(a)



(b)

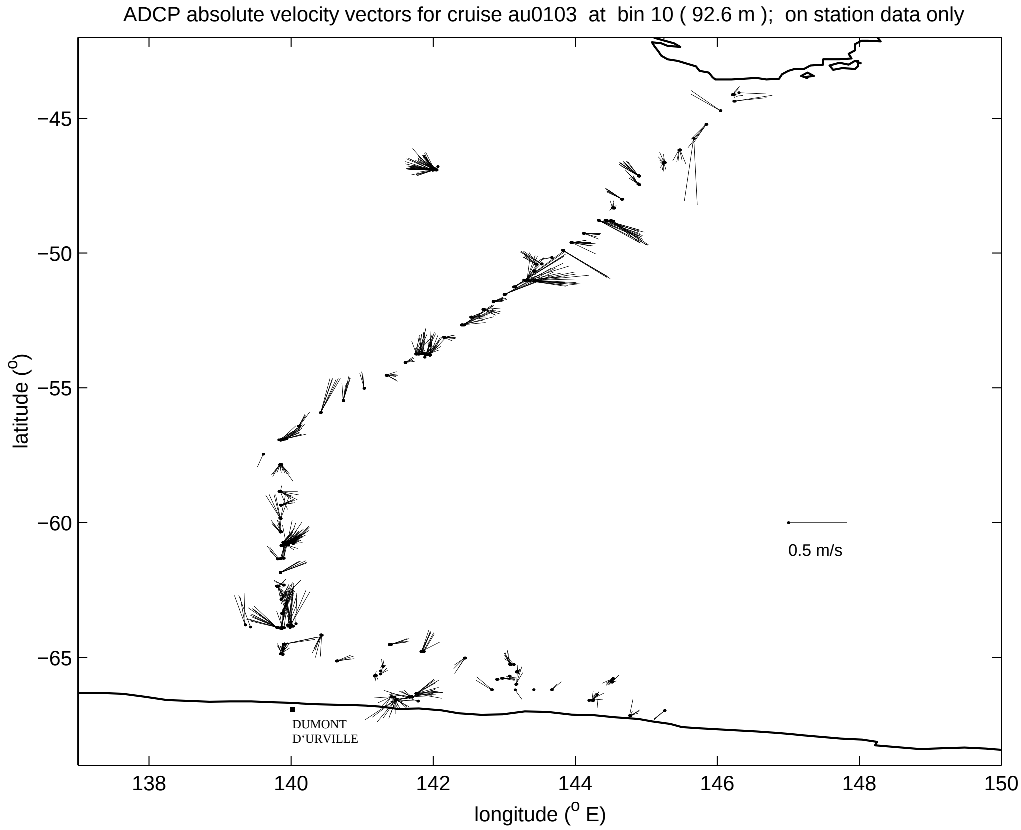
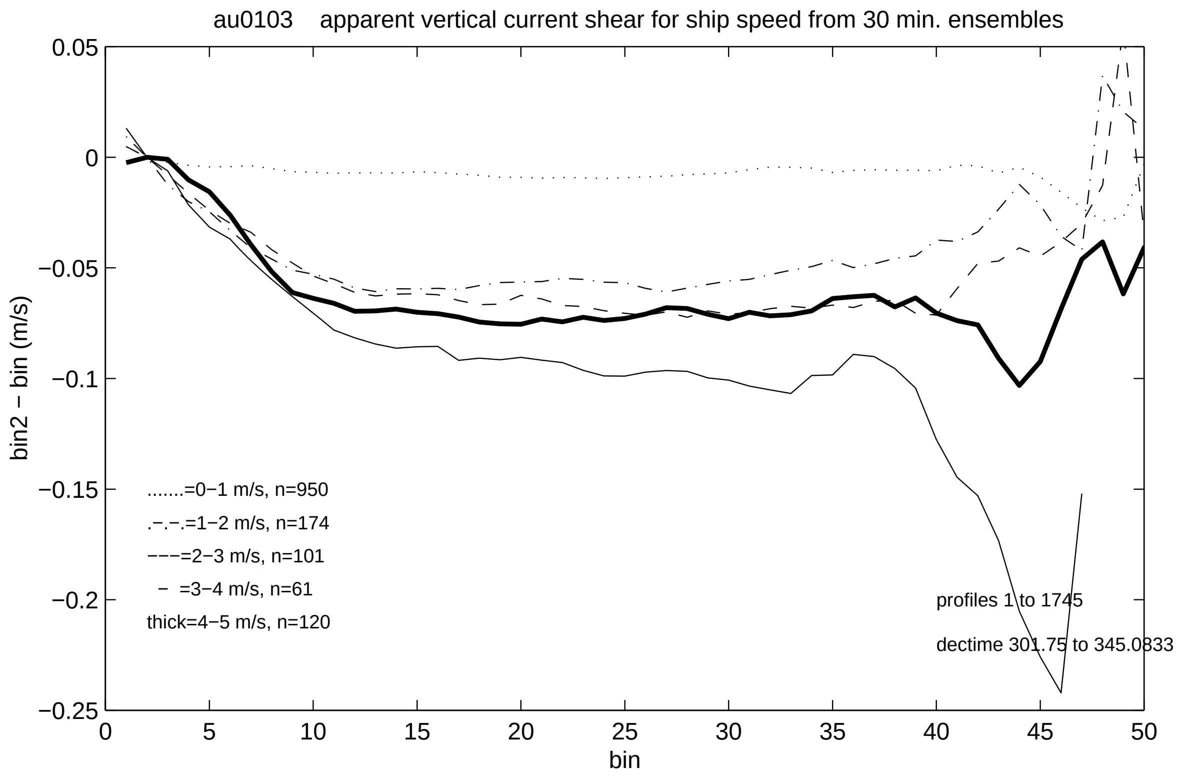


Figure 2: Hull mounted ADCP 30 minute ensemble data, for (a) all data, and (b) 'on station' (i.e. ship speed ≤ 0.35 m/s) data.



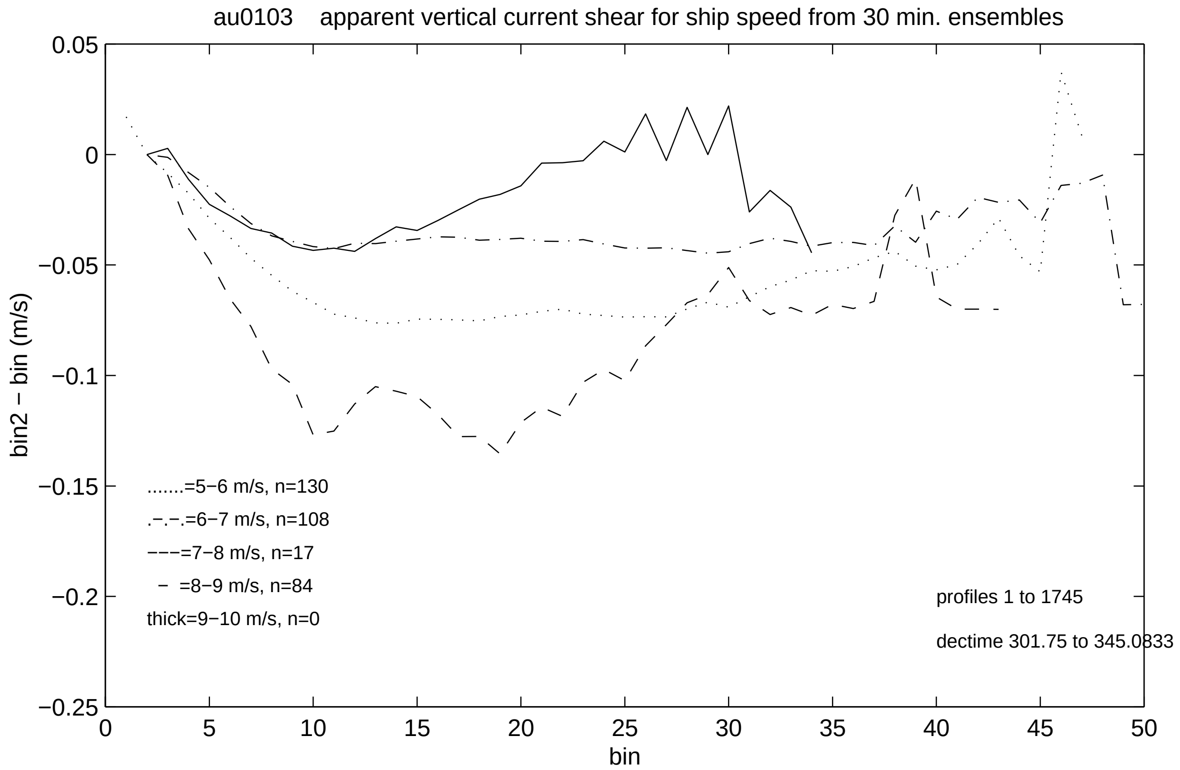


Figure 3: Apparent ADCP vertical current shear, calculated from uncorrected (i.e. ship speed included) ADCP velocities. The data are divided into different speed classes, according to ship speed during the 30 minute ensembles. For each speed class, the profile is an average over the entire cruise.

Table 2: Summary of station information for cruise AU0103. All times are UTC. In the station naming, 'particle' refers to particle station, 'downstream' refers to downstream section, 'upstream' refers to upstream section, 'exit trough' is the bathymetric feature at the northwest end of the Mertz Depression, and 'large volume' is a cast specifically to collect a large volume of water from a single depth.

station	START						BOTTOM					END			
number	time	date	latitude	longitude	depth (m)	maxP (dbar)	time	latitude	longitude	depth (m)	altimeter (m)	time	latitude	longitude	depth (m)
1 test	2104	29-OCT-01	44:07.18S	146:13.14E	995	1028	2140	44:07.30S	146:13.09E	1010	18.0	2221	44:07.23S	146:12.96E	997
2 SR3	0344	30-OCT-01	44:00.16S	146:20.09E	240	306	0400	44:00.33S	146:20.52E	302	15.0	0430	44:00.37S	146:21.01E	319
3 SR3	0609	30-OCT-01	44:03.22S	146:17.76E	556	522	0631	44:03.12S	146:17.95E	504	13.0	0714	44:03.17S	146:18.36E	468
4 SR3	0837	30-OCT-01	44:06.99S	146:13.84E	1015	1044	0902	44:06.96S	146:14.05E	1026	13.0	0941	44:06.64S	146:14.16E	1008
5 SR3	1247	30-OCT-01	44:22.15S	146:13.54E	2268	2312	1334	44:21.88S	146:13.96E	2215	11.3	1509	44:21.90S	146:15.07E	2187
6 SR3	1806	30-OCT-01	44:43.35S	146:02.71E	3151	3246	1934	44:43.18S	146:02.43E	3140	13.1	2116	44:42.92S	146:02.43E	3125
7 SR3	1630	31-OCT-01	45:13.15S	145:51.00E	2803	2898	1738	45:13.14S	145:50.34E	2808	10.2	1911	45:13.14S	145:49.67E	2800
8 SR3	0040	1-NOV-01	45:42.39S	145:39.00E	2085	354	0103	45:42.71S	145:38.91E	2125	-	0131	45:43.06S	145:38.58E	2237
9 SR3	0252	1-NOV-01	45:44.02S	145:39.98E	2777	2876	0415	45:44.77S	145:40.09E	2788	15.0	0530	45:45.44S	145:40.21E	2791
10 SR3	0850	1-NOV-01	46:10.12S	145:28.44E	2669	2758	0955	46:10.45S	145:28.16E	2656	15.0	1124	46:10.75S	145:27.31E	2664
11 SR3	1532	1-NOV-01	46:38.59S	145:15.36E	3270	3374	1644	46:38.55S	145:15.60E	3251	14.5	1826	46:38.95S	145:14.71E	3268
12 SR3	2034	1-NOV-01	46:39.39S	145:14.71E	3322	352	2056	46:39.40S	145:14.78E	3329	-	2129	46:39.61S	145:14.66E	3343
13 SR3	0106	2-NOV-01	47:08.88S	144:53.95E	4720	4900	0240	47:08.29S	144:53.76E	-	0.0	0725	47:07.20S	144:53.11E	-
14 particle	0331	3-NOV-01	46:55.02S	142:02.92E	4451	304	0355	46:54.93S	142:02.87E	4455	-	0414	46:54.87S	142:02.80E	4460
15 particle	0829	3-NOV-01	46:55.46S	141:59.42E	4450	1004	0852	46:55.44S	141:59.48E	-	-	0928	46:55.38S	141:59.40E	-
16 particle	2221	4-NOV-01	46:54.74S	142:02.38E	4470	4012	0023	46:54.58S	142:02.07E	4482	-	0144	46:54.31S	142:01.57E	-
17 particle	1041	5-NOV-01	46:52.21S	141:59.34E	4436	2002	1124	46:52.12S	141:58.85E	4420	-	1230	46:52.00S	141:58.16E	4402
18 SR3	2258	5-NOV-01	47:28.17S	144:54.04E	4289	352	2308	47:28.20S	144:53.95E	4298	-	2339	47:28.18S	144:53.84E	4292
19 SR3	0102	6-NOV-01	47:26.64S	144:53.83E	4070	4222	0238	47:26.16S	144:53.41E	4068	48.3	0347	47:26.17S	144:52.91E	4054
20 SR3	0730	6-NOV-01	47:59.96S	144:40.20E	4010	4404	0913	47:59.79S	144:39.21E	-	25.0	1107	48:00.06S	144:38.79E	4208
21 SR3	1321	6-NOV-01	48:19.12S	144:31.74E	3958	4202	1449	48:19.15S	144:31.57E	-	19.6	1640	48:19.41S	144:31.90E	-
22 SR3	1827	6-NOV-01	48:19.68S	144:32.82E	4050	354	1843	48:19.70S	144:32.86E	-	-	1910	48:19.78S	144:32.80E	-
23 particle	0029	7-NOV-01	48:47.32S	144:19.75E	3998	1004	0056	48:47.41S	144:19.98E	3993	-	0141	48:47.50S	144:20.62E	4005
24 SR3	0341	7-NOV-01	48:46.90S	144:25.00E	4033	4168	0512	48:47.16S	144:25.95E	-	16.2	0630	48:47.48S	144:26.38E	3968
25 SR3	0917	7-NOV-01	48:47.82S	144:29.78E	3918	604	0937	48:47.84S	144:30.13E	3907	-	1008	48:47.91S	144:30.37E	-
26 SR3	1612	7-NOV-01	49:16.29S	144:06.54E	4150	4358	1746	49:16.12S	144:07.04E	-	14.9	1928	49:16.14S	144:07.56E	-
27 SR3	2201	7-NOV-01	49:36.68S	143:56.31E	3595	354	2212	49:36.66S	143:56.38E	3573	-	2237	49:36.71S	143:56.58E	-
28 SR3	0001	8-NOV-01	49:36.50S	143:56.50E	3560	3722	0117	49:36.33S	143:57.06E	-	19.0	0230	49:36.41S	143:57.41E	-
29 SR3	0439	8-NOV-01	49:53.58S	143:48.49E	3580	3872	0605	49:53.59S	143:49.57E	3736	17.4	0730	49:53.76S	143:50.77E	3759
30 SR3	0936	8-NOV-01	50:09.72S	143:40.09E	3649	3228	1050	50:09.57S	143:39.80E	-	-	1130	50:10.06S	143:39.82E	-
31 SR3	2355	8-NOV-01	50:23.91S	143:31.89E	3370	352	0009	50:23.95S	143:31.63E	-	-	0037	50:24.06S	143:31.58E	-
32 SR3	0253	9-NOV-01	50:24.49S	143:26.89E	3644	3802	0414	50:24.45S	143:26.65E	3658	17.0	0556	50:24.37S	143:26.19E	3596
33 SR3	0847	9-NOV-01	50:40.31S	143:25.06E	3413	3524	1002	50:40.50S	143:24.80E	3417	18.9	1116	50:40.38S	143:24.64E	3429
34 particle	1447	9-NOV-01	51:00.13S	143:16.40E	3650	400	1455	51:00.16S	143:16.59E	-	-	1502	51:00.18S	143:16.77E	-
35 particle	1815	9-NOV-01	51:00.76S	143:17.79E	3680	1002	1842	51:00.80S	143:17.83E	-	-	1914	51:00.68S	143:18.20E	3704
36 particle	2043	9-NOV-01	51:01.27S	143:17.98E	3690	402	2101	51:01.37S	143:18.02E	-	-	2130	51:01.46S	143:18.54E	-

Table 2: (continued)

station number	START						BOTTOM					END			
	time	date	latitude	longitude	depth (m)	maxP (dbar)	time	latitude	longitude	depth (m)	altimeter (m)	time	latitude	longitude	depth (m)
37 SR3	2322	9-NOV-01	51:02.21S	143:20.36E	3736	3860	0053	51:02.04S	143:21.45E	-	16.7	0236	51:01.60S	143:22.62E	-
38 particle	0452	10-NOV-01	51:00.26S	143:25.18E	3870	800	0513	51:00.17S	143:25.48E	-	-	0536	51:00.26S	143:25.76E	-
39 SR3	0939	10-NOV-01	51:15.55S	143:07.87E	3679	3854	1056	51:15.33S	143:08.31E	3744	21.1	1220	51:14.98S	143:09.39E	-
40 SR3	1427	10-NOV-01	51:32.28S	142:59.71E	3645	3818	1541	51:31.83S	143:00.40E	3686	11.7	1723	51:31.47S	143:01.21E	3656
41 SR3	1928	10-NOV-01	51:48.57S	142:50.34E	3655	3784	2047	51:48.19S	142:50.69E	-	19.8	2225	51:48.07S	142:50.60E	-
42 SR3	2355	10-NOV-01	51:47.91S	142:50.62E	3680	350	0014	51:47.89S	142:50.64E	-	-	0034	51:47.85S	142:50.65E	-
43 SR3	0330	11-NOV-01	52:05.12S	142:41.80E	3428	3544	0428	52:05.05S	142:42.01E	3431	18.0	0550	52:04.98S	142:42.90E	-
44 large volume	0813	11-NOV-01	52:22.14S	142:31.93E	3490	16	0816	52:22.18S	142:31.85E	-	-	0823	52:22.18S	142:31.93E	-
45 SR3	0849	11-NOV-01	52:22.30S	142:31.90E	3370	3492	0957	52:22.35S	142:32.21E	3383	15.3	1132	52:22.49S	142:32.00E	-
46 SR3	1351	11-NOV-01	52:40.03S	142:23.60E	3300	3506	1512	52:39.88S	142:24.87E	-	15.8	1646	52:40.02S	142:26.29E	-
47 SR3	1829	11-NOV-01	52:39.80S	142:24.31E	3290	368	1839	52:39.83S	142:24.42E	-	-	1902	52:39.79S	142:24.67E	-
48 SR3	2204	11-NOV-01	53:07.87S	142:08.76E	3064	3178	2311	53:07.89S	142:09.14E	-	20.4	0045	53:07.66S	142:09.38E	-
49 SR3	0308	12-NOV-01	53:25.72S	141:57.11E	2775	2848	0404	53:25.70S	141:57.25E	2783	18.3	0530	53:25.60S	141:57.23E	2807
50 particle	0538	13-NOV-01	53:44.31S	141:50.53E	2850	1002	0600	53:44.18S	141:50.90E	-	-	0642	53:43.99S	141:50.88E	2958
51 SR3	0811	13-NOV-01	53:44.23S	141:51.09E	3000	3098	0916	53:44.19S	141:51.12E	-	19.0	1040	53:44.09S	141:50.97E	-
52 particle	1638	13-NOV-01	53:44.15S	141:53.64E	3091	3184	1749	53:43.86S	141:53.95E	3105	39.2	1856	53:43.73S	141:54.06E	-
53 particle	0143	14-NOV-01	53:46.60S	141:53.36E	3010	404	0153	53:46.63S	141:53.43E	-	-	0215	53:46.62S	141:53.53E	-
54 SR3	1353	14-NOV-01	54:04.12S	141:36.13E	2504	2594	1452	54:03.85S	141:36.18E	-	13.0	1621	54:03.38S	141:36.39E	2660
55 SR3	1934	14-NOV-01	54:31.78S	141:20.17E	2777	352	1947	54:31.77S	141:20.23E	2768	-	2009	54:31.71S	141:20.18E	2773
56 SR3	2120	14-NOV-01	54:31.92S	141:20.68E	2800	2868	2226	54:32.08S	141:21.04E	-	15.4	0000	54:32.00S	141:20.91E	-
57 SR3	0340	15-NOV-01	55:00.97S	141:01.59E	3175	3256	0437	55:00.82S	141:01.52E	-	20.0	0604	55:00.72S	141:01.68E	-
58 SR3	1116	15-NOV-01	55:29.64S	140:43.99E	3900	350	1127	55:29.56S	140:44.04E	-	-	1148	55:29.32S	140:43.95E	-
59 SR3	1255	15-NOV-01	55:28.81S	140:43.90E	3900	4102	1410	55:28.63S	140:43.86E	-	8.9	1557	55:28.26S	140:44.19E	-
60 SR3	1939	15-NOV-01	55:55.30S	140:24.78E	3550	3598	2043	55:54.91S	140:25.05E	-	12.3	2228	55:54.29S	140:25.09E	-
61 SR3	0152	16-NOV-01	56:25.56S	140:05.85E	3800	4070	0310	56:25.39S	140:06.52E	-	15.1	0428	56:25.16S	140:07.05E	-
62 SR3	0810	16-NOV-01	56:56.14S	139:50.42E	4100	402	0824	56:56.22S	139:50.63E	-	-	0849	56:56.26S	139:50.76E	-
63 SR3	1014	16-NOV-01	56:55.93S	139:51.32E	4100	4204	1124	56:55.62S	139:51.60E	-	16.8	1252	56:55.34S	139:51.97E	-
64 particle	1647	16-NOV-01	56:53.62S	139:54.91E	4000	1000	1720	56:53.59S	139:55.18E	-	-	1754	56:53.50S	139:55.40E	-
65 particle	1955	16-NOV-01	56:52.98S	139:56.14E	4000	302	2007	56:52.80S	139:55.93E	-	-	2029	56:52.72S	139:56.01E	-
66 SR3	2014	17-NOV-01	57:51.15S	139:50.67E	4100	4056	2150	57:50.81S	139:50.72E	-	13.9	2339	57:50.67S	139:50.35E	-
67 SR3	1534	18-NOV-01	58:50.96S	139:51.12E	3860	4012	1713	58:50.82S	139:50.97E	-	15.2	1840	58:50.55S	139:50.43E	-
68 SR3	2009	18-NOV-01	58:50.22S	139:49.59E	3800	354	2022	58:50.14S	139:49.59E	-	-	2046	58:50.11S	139:49.56E	-
69 SR3	2352	18-NOV-01	59:20.94S	139:51.26E	4100	4254	0125	59:21.01S	139:50.90E	-	17.5	0305	59:20.94S	139:51.39E	-
70 SR3	0609	19-NOV-01	59:50.87S	139:51.21E	4376	402	0622	59:50.76S	139:51.07E	4377	-	0643	59:50.58S	139:51.18E	4374
71 SR3	0753	19-NOV-01	59:50.20S	139:50.47E	4374	4534	0909	59:49.52S	139:50.24E	-	15.7	1038	59:49.24S	139:50.71E	-
72 SR3	1406	19-NOV-01	60:21.01S	139:50.94E	4340	4498	1539	60:20.25S	139:50.59E	4342	15.0	1744	60:20.16S	139:51.55E	4341

Table 2: (continued)

station	START						BOTTOM					END			
number	time	date	latitude	longitude	depth (m)	maxP (dbar)	time	latitude	longitude	depth (m)	altimeter (m)	time	latitude	longitude	depth (m)
73 particle	2150	20-NOV-01	60:51.13S	139:51.37E	4301	1000	2224	60:51.10S	139:51.73E	4302	-	2256	60:51.07S	139:51.67E	4303
74 particle	0027	21-NOV-01	60:50.88S	139:52.12E	4305	402	0042	60:50.87S	139:52.02E	-	-	0105	60:50.77S	139:51.82E	-
75 SR3	0239	21-NOV-01	60:50.17S	139:52.33E	4300	4464	0350	60:50.14S	139:52.42E	-	15.0	0522	60:50.12S	139:52.67E	-
76 particle	1233	21-NOV-01	60:48.82S	139:56.47E	4310	4466	1436	60:48.24S	139:56.02E	-	15.2	1634	60:47.90S	139:56.84E	-
77 SR3	0448	22-NOV-01	61:20.79S	139:50.65E	4240	352	0457	61:20.71S	139:50.85E	-	-	0521	61:20.61S	139:51.07E	-
78 SR3	0755	22-NOV-01	61:19.11S	139:53.58E	4260	4400	0914	61:18.84S	139:53.41E	-	17.0	1100	61:18.60S	139:52.41E	-
79 SR3	1436	22-NOV-01	61:51.01S	139:50.68E	4198	4346	1614	61:51.06S	139:50.94E	4201	14.9	1747	61:50.94S	139:50.77E	4201
80 SR3	2101	22-NOV-01	62:20.98S	139:49.03E	3870	4006	2238	62:21.19S	139:48.28E	3871	13.7	0027	62:21.20S	139:47.74E	-
81 SR3	0224	23-NOV-01	62:21.52S	139:49.26E	3865	352	0238	62:21.53S	139:49.48E	3859	-	0301	62:21.52S	139:49.67E	-
82 SR3	0503	24-NOV-01	62:50.59S	139:51.40E	3161	3246	0607	62:50.32S	139:51.57E	3162	21.6	0729	62:49.84S	139:51.81E	3165
83 SR3	1225	24-NOV-01	63:22.23S	139:51.64E	3718	3836	1346	63:21.74S	139:52.17E	3720	15.6	1526	63:21.58S	139:52.84E	3713
84 SR3	1648	24-NOV-01	63:21.85S	139:53.20E	3717	350	1706	63:21.79S	139:53.13E	3714	-	1739	63:21.66S	139:52.68E	3717
85 particle	2159	24-NOV-01	63:54.01S	139:52.89E	3636	1002	2226	63:53.82S	139:52.62E	3642	-	2302	63:53.65S	139:52.58E	3641
86 particle	0031	25-NOV-01	63:53.84S	139:51.65E	3640	400	0051	63:53.75S	139:51.52E	3640	-	0121	63:53.79S	139:51.35E	3635
87 SR3	0434	25-NOV-01	63:53.33S	139:58.85E	3638	3750	0546	63:52.47S	139:59.78E	3638	20.0	0721	63:51.07S	140:00.74E	3637
88 particle	1636	25-NOV-01	63:50.16S	139:57.88E	3649	3760	1759	63:49.48S	139:59.36E	-	18.4	1921	63:48.89S	140:00.11E	-
89 SR3	0750	26-NOV-01	64:09.87S	140:25.02E	3530	3632	0900	64:10.06S	140:25.32E	3532	14.5	1017	64:10.22S	140:25.84E	3531
90 SR3	1516	26-NOV-01	64:31.24S	141:22.27E	3403	3492	1632	64:31.11S	141:23.30E	3404	12.1	1754	64:31.30S	141:24.45E	3399
91 SR3	2049	26-NOV-01	64:47.12S	141:49.53E	3001	3086	2149	64:46.90S	141:50.05E	3011	14.0	2309	64:46.83S	141:50.95E	3030
92 SR3	0030	27-NOV-01	64:46.90S	141:52.74E	3060	352	0046	64:46.73S	141:52.99E	3058	-	0108	64:46.53S	141:53.52E	3066
93 SR3	0441	27-NOV-01	65:01.30S	142:26.98E	2797	2838	0525	65:01.37S	142:26.56E	2774	19.2	0630	65:01.40S	142:26.06E	2759
94 SR3	0938	27-NOV-01	65:14.98S	143:04.66E	2948	3008	1043	65:15.32S	143:04.81E	2942	18.3	1200	65:15.52S	143:04.66E	2935
95 SR3	1728	27-NOV-01	65:31.93S	143:10.21E	2662	2716	1824	65:31.96S	143:10.33E	2662	14.2	1952	65:32.18S	143:10.66E	2652
96 SR3	2130	27-NOV-01	65:31.81S	143:11.25E	2655	352	2141	65:31.75S	143:11.28E	2654	-	2202	65:31.83S	143:11.30E	2654
97 SR3	2323	27-NOV-01	65:41.57S	143:04.29E	2124	2168	0008	65:41.69S	143:04.48E	2112	13.2	0115	65:41.71S	143:04.51E	2101
98 SR3	0240	28-NOV-01	65:46.00S	142:57.68E	1679	1692	0315	65:46.04S	142:58.30E	1649	20.1	0419	65:46.29S	142:59.07E	1553
99 SR3	0741	28-NOV-01	65:48.68S	142:53.44E	1062	1052	0805	65:48.64S	142:54.00E	1026	18.0	0834	65:48.63S	142:54.71E	1017
100 SR3	1046	28-NOV-01	66:00.03S	143:09.70E	469	456	1054	65:59.95S	143:09.70E	469	16.7	1116	65:59.80S	143:09.99E	464
101 exit trough	1512	28-NOV-01	66:11.96S	142:49.74E	490	480	1529	66:11.95S	142:49.22E	490	8.0	1556	66:11.98S	142:49.14E	484
102 exit trough	1656	28-NOV-01	66:12.18S	143:08.88E	600	596	1713	66:12.18S	143:09.01E	598	14.9	1742	66:12.16S	143:09.10E	601
103 exit trough	1901	28-NOV-01	66:11.92S	143:24.90E	551	536	1917	66:11.92S	143:24.90E	547	14.5	1939	66:11.92S	143:25.02E	543
104 exit trough	2041	28-NOV-01	66:12.00S	143:39.99E	486	482	2100	66:11.88S	143:40.08E	477	14.9	2122	66:12.07S	143:40.50E	481
105 particle	0213	29-NOV-01	66:35.14S	144:13.93E	801	790	0230	66:35.13S	144:13.99E	801	17.1	0257	66:35.16S	144:14.05E	805
106 SR3	0716	29-NOV-01	66:35.30S	144:15.18E	803	790	0730	66:35.29S	144:15.22E	807	18.9	0755	66:35.15S	144:15.27E	804
107 BuchananBay	1535	29-NOV-01	67:09.42S	144:46.17E	484	470	1555	67:09.39S	144:46.00E	472	16.9	1632	67:09.03S	144:45.90E	474
108 Mertz Glacier	1919	29-NOV-01	66:57.88S	145:15.95E	940	960	1957	66:58.14S	145:15.34E	977	18.6	2034	66:58.34S	145:15.12E	998

Table 2: (continued)

station number	START time	date	latitude	longitude	depth (m)	maxP (dbar)	BOTTOM time	latitude	longitude	depth (m)	altimeter (m)	END time	latitude	longitude	depth (m)
109 upstream	0131	30-NOV-01	66:23.03S	144:18.12E	481	460	0145	66:22.95S	144:18.08E	476	20.2	0207	66:22.83S	144:17.94E	476
110 upstream	0310	30-NOV-01	66:17.08S	144:23.64E	417	408	0320	66:17.08S	144:23.57E	417	20.3	0341	66:17.04S	144:23.66E	418
111 upstream	0518	30-NOV-01	66:07.82S	144:29.81E	345	330	0527	66:07.76S	144:29.65E	344	17.3	0540	66:07.57S	144:29.69E	339
112 upstream	0705	30-NOV-01	66:01.16S	144:29.09E	293	286	0713	66:01.13S	144:29.06E	292	19.1	0726	66:01.03S	144:28.81E	292
113 upstream	0838	30-NOV-01	65:54.87S	144:30.82E	931	974	0900	65:54.80S	144:31.11E	959	20.3	0927	65:54.61S	144:31.06E	1023
114 upstream	1020	30-NOV-01	65:52.62S	144:29.99E	1725	1786	1056	65:52.60S	144:30.08E	1737	19.2	1150	65:52.65S	144:30.19E	1729
115 upstream	1308	30-NOV-01	65:47.35S	144:31.81E	2565	2618	1403	65:47.13S	144:31.62E	2563	12.8	1525	65:46.79S	144:31.99E	2607
116 downstream	1634	3-DEC-01	65:44.63S	141:04.06E	442	440	1649	65:44.61S	141:04.12E	447	14.5	1717	65:44.46S	141:04.29E	456
117 downstream	2013	3-DEC-01	65:40.27S	141:11.00E	772	768	2034	65:40.23S	141:11.45E	773	13.9	2106	65:40.22S	141:12.12E	770
118 downstream	2201	3-DEC-01	65:36.75S	141:14.99E	1137	1152	2227	65:36.61S	141:15.45E	1160	13.0	2307	65:36.41S	141:15.94E	1159
119 downstream	0031	4-DEC-01	65:30.20S	141:15.18E	1750	1824	0107	65:29.88S	141:15.59E	1819	18.4	0209	65:29.64S	141:15.13E	1833
120 downstream	0424	4-DEC-01	65:19.75S	141:17.18E	2256	2288	0522	65:19.48S	141:17.50E	2256	20.9	0627	65:19.23S	141:17.26E	2261
121 downstream	1015	4-DEC-01	65:08.03S	140:38.23E	2203	2234	1056	65:07.84S	140:38.63E	2207	19.6	1200	65:07.40S	140:39.00E	2277
122 particle	1545	4-DEC-01	64:52.67S	139:52.52E	2458	1002	1611	64:52.68S	139:52.40E	2464	-	1642	64:52.70S	139:52.50E	2467
123 particle	1824	4-DEC-01	64:52.59S	139:52.89E	2468	502	1841	64:52.54S	139:52.65E	2472	-	1908	64:52.38S	139:52.50E	2492
124 downstream	2103	4-DEC-01	64:52.11S	139:52.38E	2503	2552	2145	64:52.20S	139:52.08E	2490	13.9	2253	64:52.19S	139:51.67E	2481
125 downstream	0555	5-DEC-01	64:30.54S	139:52.92E	3043	3130	0702	64:30.48S	139:53.74E	3052	19.0	0809	64:30.48S	139:55.22E	3073
126 particle	1319	5-DEC-01	63:55.24S	139:51.76E	3633	500	1337	63:55.16S	139:51.56E	3629	-	1422	63:54.93S	139:50.92E	3632
127 particle	1552	5-DEC-01	63:54.29S	139:49.32E	3632	1002	1616	63:54.10S	139:49.02E	3638	-	1656	63:53.98S	139:48.58E	3637
128 particle	1857	5-DEC-01	63:53.18S	139:47.75E	3649	352	1910	63:53.07S	139:47.71E	3652	-	1936	63:52.99S	139:47.71E	3655
129 particle	1336	7-DEC-01	60:50.29S	139:52.65E	4311	354	1352	60:50.23S	139:52.98E	4306	-	1411	60:50.24S	139:53.23E	4302
130 particle	1529	7-DEC-01	60:50.21S	139:53.59E	4307	1002	1555	60:50.14S	139:53.73E	4304	-	1627	60:49.89S	139:53.79E	4304
131 particle	1756	7-DEC-01	60:49.78S	139:56.02E	4305	502	1813	60:49.71S	139:56.26E	4307	-	1850	60:49.68S	139:56.49E	4305
132 particle	2041	7-DEC-01	60:48.66S	139:56.61E	4307	154	2051	60:48.57S	139:56.70E	4307	-	2100	60:48.48S	139:56.70E	4308
133 particle	1730	10-DEC-01	51:00.40S	143:18.39E	3700	344	1742	51:00.34S	143:18.49E	-	-	1801	51:00.21S	143:18.60E	3721
134 particle	1841	10-DEC-01	50:59.97S	143:19.09E	3740	1002	1907	50:59.83S	143:19.10E	3745	-	1941	50:59.67S	143:19.31E	-
135 particle	0557	11-DEC-01	51:23.42S	142:58.61E	3700	52	0601	51:23.44S	142:58.94E	-	-	0607	51:23.44S	142:59.02E	-

Table 3: Summary of samples drawn from Niskin bottles at each station, including salinity (sal), dissolved oxygen (do), nutrients (nut), chlorofluorocarbons (CFC), carbon tetrachloride (CCl_4), dissolved inorganic carbon (dic), alkalinity (alk), dimethyl sulphide/dimethyl sulphoniopropionate/dimethyl sulphoxide (dms), halocarbons (hal), barium (bam), barite (bat), ammonia (NH_3), $\delta^{30}Si$, dissolved organic carbon (doc), particulate organic carbon (POC), particulate silicate (PSi), ^{15}N-nitrate, ^{18}O, ^{234}Th, $^{230}Th/^{231}Pa$, primary productivity (pp), bacterial production (bac), grazing dilution (grz), spectral absorbance (sa), HPLC pigments (pig), flow cytometry (fc) for phytoplankton and bacteria, coccolithophorid counts (coc), protist bulk fixes (pro), size-fractionated chlorophyll and primary production (frac), species ID by Dehairs group (sp.D), and bacterial groups sampled by Skerratt (baS). Note that 1=samples taken, 0=no samples taken, 2=surface sample only (i.e. from shallowest Niskin bottle), 3=one sample only from the profile. Also included are stations where trace metal casts for iron were taken from the stern (fe); stations where vertical fast repetition rate fluorometry (frrf) and transmittance (tran) were measured, using additional sensors; and stations where fluorescence was measured on the main rosette (fl) using a Sea Tech fluorometer from either CSIRO or Antarctic Division, denoted respectively by C or A in the table. Note that for stations 1 to 52 where the transmissometer was fitted to the main rosette package, no good transmittance data were obtained.

station		sal	do	nut	CFC	CCl_4	dic/ alk	dms	hal	bam	bat	NH_3	$\delta^{30}Si$	doc	POC/ PSi	$^{15}N\_NO_3$	^{18}O	^{234}Th	$^{230}Th/^{231}Pa$	pp	bac	grz	sa	pig	fc	coc	pro	frac	sp.D	baS	fe	frrf	tran	fl
1	test	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
2	SR3	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	C
3	SR3	1	1	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
4	SR3	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
5	SR3	1	1	1	0	0	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
6	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
7	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
8	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	C
9	SR3	1	1	1	1	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
10	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
11	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	0	0	1	0	A
13	SR3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
14	part.	1	1	1	0	0	0	1	0	0	0	1	0	1	1	0	0	1	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0	A
15	part.	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	C
16	part.	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	part.	1	1	1	1	0	1	0	0	0	0	1	1	1	0	1	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
18	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	1	1	1	0	1	0	0	0	0	1	C
19	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
20	SR3	1	1	1	1	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
21	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
22	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	1	C
23	part.	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	C
24	SR3	1	1	1	1	0	1	0	0	1	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
25	SR3	1	1	1	0	0	0	1	0	0	0	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	1	C
26	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C

Table 3: (continued)

station		sal	do	nut	CFC	CCl_4	dic/ alk	dms	hal	bam	bat	NH_3	$\delta^{30}Si$	doc	POC/ PSi	$^{15}N\_NO_3$	^{18}O	^{234}Th	$^{230}Th/^{231}Pa$	pp	bac	grz	sa	pig	fc	coc	pro	frac	sp.D	baS	fe	frrf	tran	fl
27	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	1	C
28	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
29	SR3	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C
30	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
31	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	1	0	1	1	1	1	0	1	0	0	0	0	1	C
32	SR3	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	C
33	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
34	part.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	C
35	part.	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
36	part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	1	C
37	SR3	1	1	1	1	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
38	part.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
39	SR3	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
40	SR3	1	1	1	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
41	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
42	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	0	1	C
43	SR3	1	1	1	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
44	l.vol.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	C
45	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
46	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
47	SR3	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	C
48	SR3	1	1	1	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	C
49	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
50	part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	C
51	SR3	1	1	1	1	0	1	0	1	1	0	0	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
52	part.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
53	part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	1	1	1	1	1	1	0	0	1	0	1	1	0	0	C
54	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	C
55	SR3	1	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	0	0	0	1	1	C
56	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
57	SR3	1	1	1	1	0	2	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0	C
58	SR3	1	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	0	0	C
59	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
60	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	C
61	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	C
62	SR3	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	C
63	SR3	1	1	1	1	0	1	0	0	1	0	0	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C

Table 3: (continued)

station		sal	do	nut	CFC	CCl_4	dic/ alk	dms	hal	bam	bat	NH_3	$\delta^{30}Si$	doc	POC/ PSi	$^{15}N\_NO_3$	^{18}O	^{234}Th	$^{230}Th/^{231}Pa$	pp	bac	grz	sa	pig	fc	coc	pro	frac	sp.D	baS	fe	frrf	tran	fl
64	part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	C
65	part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	1	1	0	1	1	1	0	0	1	0	1	0	1	0	C
66	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
67	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
68	SR3	1	1	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	1	0	0	1	0	1	0	0	0	C
69	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	C
70	SR3	1	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	0	1	C
71	SR3	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
72	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	C
73	part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	C
74	part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	C
75	SR3	1	1	1	1	0	1	0	1	1	0	0	1	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	C
76	part.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	SR3	1	1	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0	1	0	1	1	0	0	C
78	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
79	SR3	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C
80	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	C
81	SR3	1	1	1	1	1	1	1	0	0	0	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	1	0	1	C
82	SR3	1	1	1	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
83	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
84	SR3	1	1	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	1	C
85	part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	C
86	part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	1	1	1	1	1	1	0	0	1	0	0	0	0	1	C
87	SR3	1	1	1	1	0	1	0	1	1	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	C
88	part.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
89	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C
90	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
91	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
92	SR3	1	1	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1	1	0	1	1	1	0	0	1	0	0	0	1	0	C
93	SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C
94	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
95	SR3	1	1	1	1	0	1	0	0	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	C
96	SR3	1	1	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	1	1	0	1	1	1	0	0	1	0	0	0	0	0	C
97	SR3	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
98	SR3	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
99	SR3	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	C
100	SR3	1	1	1	1	1	1	0	1	0	0	0	0	0	0	1	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	C

Table 3: (continued)

station	sal	do	nut	CFC	CCl_4	dic/ alk	dms	hal	bam	bat	NH_3	$\delta^{30}Si$	doc	POC/ PSi	$^{15}N\_NO_3$	^{18}O	^{234}Th	$^{230}Th/^{231}Pa$	pp	bac	grz	sa	pig	fc	coc	pro	frac	sp.D	baS	fe	frrf	tran	fl
101 exit	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
102 exit	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
103 exit	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
104 exit	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
105 part.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	C
106 SR3	1	1	1	1	0	1	0	1	1	0	0	0	0	1	1	2	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	C
107B.Bay	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
108Mertz	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C
109 up	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
110 up	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
111 up	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
112 up	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
113 up	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
114 up	1	1	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
115 up	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
116 down	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	A
117 down	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	A
118 down	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	A
119 down	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	A
120 down	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	A
121 down	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	A
122 part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	A
123 part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	1	A
124 down	1	1	1	1	0	1	0	1	0	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A
125 down	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	A
126 part.	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	2	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	A
127 part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	A
128 part.	1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	1	0	1	1	0	1	1	1	0	0	1	0	0	0	0	1	A
129 part.	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	A
130 part.	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	A
131 part.	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	A
132 part.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	A
133 part.	1	0	1	1	0	2	0	0	0	0	0	0	0	0	0	2	0	0	1	1	0	1	1	1	1	0	0	0	0	0	0	0	A
134 part.	1	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	0	1	0	A
135 part.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	A

Table 4: Summary of mooring recovery and deployment information. Positions and depths are at the estimated landing sites (i.e. allowing for anchor 'dragback'). Depths are corrected for local sound velocity. For recoveries, 'release time' is the time release command was sent to acoustic release at the base of the mooring; for deployments, 'release time' is the time final component released from trawl deck. Suffixes '4' and '5' in mooring names refer respectively to the 4th and 5th deployment seasons in the SAZ program.

Mooring	position		depth	release time (UTC)	position (decimal degrees)	
RECOVERIES						
SAZB_4	46° 54.3'S	142° 02.7'E	4600 m	1935, 02/11/2001	46.905°S	142.045°E
SAZC_4	53° 44.47'S	141° 45.22'E	2120 m	0030, 13/11/2001	53.7412°S	141.7537°E
DEPLOYMENTS						
SAZB_5	46° 47.442'S	142° 02.430'E	4600 m	0407, 04/11/2001	46.79070°S	142.04050°E
SAZC_5	53° 44.472'S	141° 45.780'E	2040 m	0009, 14/11/2001	53.74120°S	141.76300°E
SAZF_5	60° 44.430'S	139° 53.970'E	4393 m	0249, 20/11/2001	60.74050°S	139.89950°E

Table 5: Principal investigators (*=cruise participant) for CTD water sampling programs.

Measurement	**Name**	**Affiliation**
CTD, salinity, O_2, nutrients	*Steve Rintoul	CSIRO
CFCs, CCl_4	*Mark Warner	University of Washington
DIC, alkalinity	*Bronte Tilbrook	CSIRO
DMS/DMSP/DMSO	*Jack Di Tullio	Grice Marine Laboratory, South Carolina
DMS/DMSP	*Graham Jones	Southern Cross University
halocarbons	James Butler	NOAA
barium, barite, NH_3	*Frank Dehairs	Vrije Universiteit, Brussels
$\delta^{30}Si$	*Damien Cardinal	Royal Museum for Central Africa, Belgium
DOC,POC,PSi	*Tom Trull	Antarctic CRC
^{15}N-$N0_3$	Danny Sigman	Princeton University
^{18}O of dissolved oxygen	Michael Bender	Princeton University
^{234}Th	*Ken Buesseler	WHOI
	*Nicolas Savoye	Vrije Universiteit, Brussels
^{230}Th, ^{231}Pa	Roger Francois	WHOI
iron (sampled from stern)	*Peter Sedwick	Bermuda Biological Station for Research
bacterial and primary production, microzooplankton grazing	*Brian Griffiths	CSIRO
phytoplankton community structure	*Phil Boyd	NIWA
phytoplankton	Simon Wright	Antarctic Division
	*Harvey Marchant	Antarctic Division
bacterial groups	Guy Abel	University of Tasmania

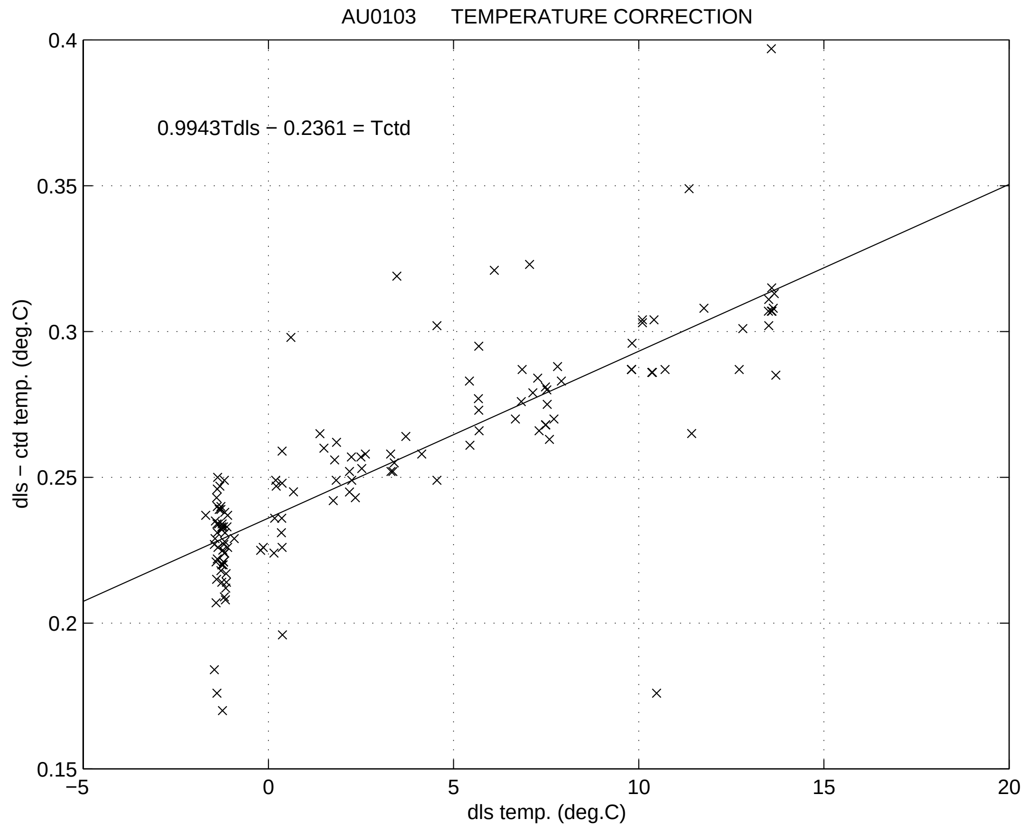
Table 6: Scientific personnel (cruise participants) for cruise AU0103.

Edward Abraham	phytoplankton community structure	NIWA
Margaret Appleton	organic carbon team	Antarctic CRC
Andrew Bowie	iron	Antarctic CRC
Philip Boyd	phytoplankton community structure	University of Otago
Stephen Bray	CTD hydrochemistry, moorings	Antarctic CRC
Ken Buesseler	thorium	Dept. of Marine Chemistry and Geochemistry, WHOI
Damien Cardinal	barium, NH_3, $\delta^{30}Si$, thorium	Royal Museum for Central Africa, Belgium
Alexis Chaigneau	CTD	Laboratory of Geophysical Studies and Spatial Oceanography, Toulouse
Kelvin Cope	electronics	Antarctic Division
Guido Corno	organic carbon team	Antarctic CRC
George Cresswell	CTD, moorings	CSIRO
Clive Crossley	flow cytometry	Antarctic CRC
Clodagh Moy	CTD, hydrochemistry	Antarctic CRC

Table 6: (continued)

Andrew Davidson	phytoplankton	Antarctic Division
Frank Dehairs	barium, NH_3, δ^{30}Si, thorium	Vrije Universiteit, Brussels
Jack Di Tullio	DMS/DMSP/DMSO	Grice Marine Laboratory, South Carolina
Esther Fischer	DMS/DMSP	Southern Cross University
Kelly Goodwin	halocarbons	CIMAS, University of Miami
Brian Griffiths	primary production, grazing	CSIRO
Clint Hare	Iron	College of Marine Studies, University of Delaware
Brian Hunt	CPR, zooplankton nets	Antarctic Division
Dave Hutchins	Iron	College of Marine Studies, University of Delaware
Neale Johnston	CTD hydrochemistry	CSIRO
Graham Jones	DMS/DMSP	Southern Cross University
Bronwyn Kimber	sea ice	CODES, University of Tasmania
Dan King	halocarbons	CIRES, University of Colorado
Alex Kozyr	DIC, alkalinity	Oak Ridge National Laboratory, U.S.
Ruth Lawless	dotzapper	Antarctic Division
Sophie Le Roux	organic carbon team	Antarctic CRC
Carsten Lemmen	organic carbon team	Antarctic CRC
Sandric Leong	light absorption of phytoplankton	Soka University, Japan
Harvey Marchant	voyage leader, phytoplankton	Antarctic Division
Richard Matear	DIC, alkalinity	CSIRO
Fred Menzia	CFC	PMEL, NOAA
Daniela Mersch	organic carbon team	Antarctic CRC
Gordon Mor	doctor	Antarctic Division
Angus Munro	sea ice	Antarctic CRC
Nobuaki Ohi	light absorption of phytoplankton	Soka University, Japan
Andrew Pankowski	sea ice	School of Agricultural Science, University of Tasmania
Naomi Petrie	organic carbon team	Antarctic CRC
Peter Pokorny	communications	Antarctic Division
Linda Popels	Iron	College of Marine Studies, University of Delaware
Mark Pretty	DIC, alkalinity	CSIRO
James Reid	sea ice	School of Plant Science, University of Tasmania
Malcolm Reid	phytoplankton community structure	University of Otago
Steve Rintoul	CTD, chief scientist	CSIRO
Sarah Riseman	DMS/DMSP/DMSO	Hollings Marine Laboratory, South Carolina
Mark Rosenberg	CTD, moorings	Antarctic CRC
Tilla Roy	CTD	Antarctic CRC
Karl Safi	bacterial production	NIWA
Nicolas Savoye	barium, NH_3, δ^{30}Si, thorium	Vrije Universiteit, Brussels
Bryan Scott	computing	Antarctic Division
Peter Sedwick	iron	Bermuda Biological Station for Research
Jenny Skerratt	microbial processes	Antarctic CRC
Serguei Sokolov	CTD	CSIRO
Robert Strzepek	phytoplankton community structure	The Harrison Lab, University of British Columbia
Kunio Takahashi	copepods	National Institute of Polar Research, Japan
Paul Thomson	phytoplankton	Antarctic Division
Bronte Tilbrook	DIC, alkalinity	CSIRO
Ryszard Tokarczyk	halocarbons	Dept. of Oceanography, Dalhousie University
Lianos Triantafillos	squid	Antarctic CRC
Tom Trull	organic carbon team leader	Antarctic CRC
Simon Ussher	Iron	School of Environmental Sciences, University of Plymouth
Rick Van Den Enden	phytoplankton, deputy voyage leader	Antarctic Division
Robert Van Hale	phytoplankton community structure	University of Otago
Tessa Vance	DMS/DMSP	Southern Cross University
Tony Veness	electronics	Antarctic Division
Robert Walsh	phytoplankton community structure	DPIWE, Tasmania
Mark Warner	CFC	School of Oceanography, University of Washington
Shari Yvon-Lewis	halocarbons	AOML, NOAA

(a)



(b)

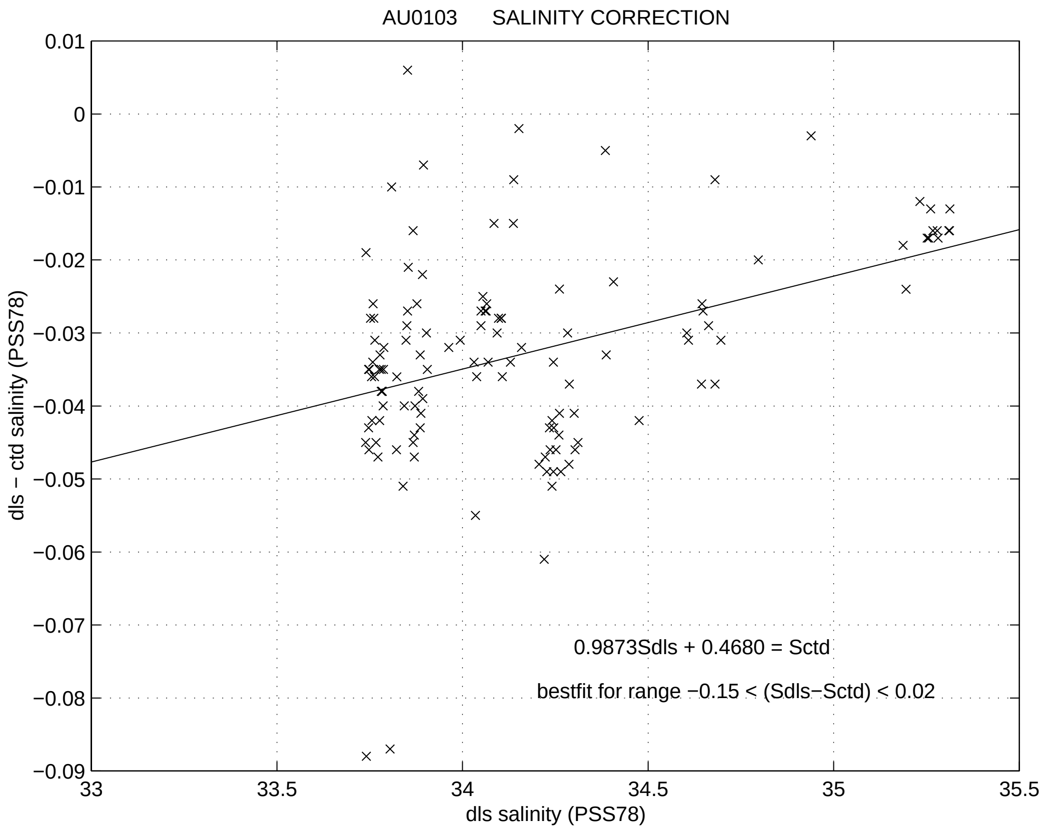


Figure 4a and b: Comparison between (a) CTD and underway temperature data, and (b) CTD and underway salinity data, including bestfit lines. Note: dls refers to underway data.

in these tails are not strong enough to account for the magnitude of the error of up to ~0.004 (PSS78) – thus these local features are only considered a minor component of the error. The major cause of the error appears to be temperature related. There is a close correspondence between the salinity residuals and subzero water temperatures at depth (Figure 7b). From the figure, there is a broad scatter in ∆S values for shallow samples (≤250 dbar in Figure 7b), however for deeper samples ∆S values are clearly positive for temperatures below 0°C.

For stations 98 to 106, the conductivity calibration results are good, and no consistent biasing in ∆S is evident. The conductivity cell malfunctioned for stations 107 and 108, and no CTD conductivity/salinity data are available for these two stations.

CTD1103 was used for station 109 and onwards, after failure of the conductivity hardware on CTD1193. For stations 109 to 113 and stations 126 to 135 the conductivity cell calibrated well, with CTD salinities accurate to within 0.002 (PSS78). For stations 114 to 125, a CTD salinity error similar to stations 71 to 97 (CTD1193) is evident from the positive ∆S values at depth (Figures 7c and d). There appears to be a small sensor calibration error for both CTD1103 and CTD1193 in subzero water at depth. From the available evidence it is not conclusive whether the source of the error is the temperature sensor calibrations, the conductivity cell responses, or both. Both CTDs show similar behaviour, and as there is a strong possibility that the temperature calibrations are a probable source of error, the following caution is given for both the temperature and salinity data. For stations 71 to 97 and 114 to 125 in subzero waters at depth (i.e. at the bottom end of the full depth profiles), at the local salinity and pressure values there is a possible error of the order +0.003°C (i.e. temperature a little high) for CTD temperature, and a CTD salinity error of the order -0.003 (PSS78) (i.e. salinity a little low). More specifically, the salinity error is in the range -0.001 to -0.004 (PSS78), with the larger error for lower negative temperatures. No correction has been made for these errors.

For many stations the salinity data are suspect for the top 2 bins (2 and 4 dbar), due to transient errors when the instrument first enters the water. As a general caution, salinity data down to 4 dbar should be treated as suspect.

As described in section 4.3, a multi point laboratory temperature calibration was performed prior to the cruise. Both linear and quadratic fits were attempted for the temperature calibration data for both CTDs, to obtain the best fit results. For CTD1193 (stations 1 to 108), a quadratic fit to the calibration data gave the best results over the entire temperature range (Table 7). For CTD1103 (stations 109 to 135), temperatures measured during these stations were mostly below ~2.3°C, with higher values up to only ~7.5°C encountered during stations 133 to 135. For this lower end of the temperature range, the best result from the laboratory temperature calibration came from a linear fit to the calibration data (Table 7).

CTD platinum temperature data are compared with digital reversing thermometer data in Figures 8a and b. The offsets in results for the different thermometers are due to calibration offsets between the thermometers. At positive temperatures, CTD temperature sensor performance appears to be fairly stable throughout the cruise, and data for the two CTDs appear to be consistent. At temperatures below 0°C there is a clear decrease in ∆T (i.e. thermometer – CTD temperature) with decreasing temperature (Figure 8b). This same pattern is evident for both CTDs. From the comparison to the thermometer data alone, it is not clear whether the source of the error is the CTD temperature calibrations or the thermometer calibrations. Changing response of Neil Brown platinum temperature sensors below 0°C is often reported (SCRIPPS Institution of Oceanography Calibration Facility, CSIRO Calibration Facility, pers. comms). It is therefore likely that there is at least some small calibration error in the CTD temperature data in subzero water, as discussed previously in this section.

5.1.2 Pressure

As described in previous data reports, noise in the pressure signal for CTD1193 (used for stations 1 to 108) was high, with spikes of up to 1 dbar amplitude occurring. When forming pressure monotonic data prior to 2 dbar averaging, these spikes cause low data point attendance for a significant number of 2 dbar pressure bins, resulting in missing bins in the 2 dbar averaged data. To reduce the number of missing bins, the minimum number of data points required in a 2 dbar bin to form a 2 dbar average was set to 8. To recover another ~20 missing bins from various stations, this minimum threshold value was reduced to 5. For most remaining missing bins, values were linearly interpolated between surrounding bins (Table 13), except where the local temperature gradient was too high. Further missing 2 dbar bins (Table 12) are due to quality control of the data.

For CTD1103 (stations 109 to 135) any noise in the pressure signal was very low, and the minimum number of data points required in a 2 dbar bin to form a 2 dbar average was set to 10.

For stations 24, 29, 62, 82 and 87, the surface pressure offset was obtained by manual inspection of the data. For stations 107 and 108, hypersaline water was placed in the sensor cover prior to commencement of logging to try to prevent sensor freezing during deployment; the surface pressure offset for these two stations was also obtained by manual inspection of the data. For station 100, logging commenced when the CTD was already in the water at ~4 dbar, and the surface pressure offset was estimated from values from surrounding stations. Surface pressure offset values applied to pressure data for each station are listed in Table 8.

5.1.3 Dissolved oxygen

CTD dissolved oxygen calibration results are shown in Figure 9, and the derived calibration coefficients are listed in Table 17. A new oxygen sensor was fitted to CTD1193 at the start of the cruise, and the same oxygen sensor was fitted to CTD1103 for station 109 onwards.

For the bulk of the water column the CTD dissolved oxygen data are good, and the standard deviation values for the CTD to bottle comparison are within 1% of full scale values (where full scale is approximately 380 µmol/l for data between 35 and 1000 dbar, and ~270 µmol/l for data below 1000 dbar). Much of the near surface part of the oxygen profiles is highly suspicious, in particular for the top 20 dbar, and often down to 30 dbar. In general, transient errors are common when CTD dissolved oxygen sensors (on General Oceanics CTDs) enter the water, and near surface oxygen data should be treated with caution.

5.1.4 Fluorescence and transmittance

All fluorescence data only have preliminary calibrations applied, to convert sensor output into voltages. These data should not be used quantitatively other than for linkage with primary productivity data. Note that fluorescence data for stations 7, 8 and 9 are suspect due to a flattening battery pack.

The transmissometer was fitted to the main CTD frame for most stations up to station 52, however all data are suspect. Good transmittance data were obtained after fitting the transmissometer to the CSIRO Seacat, deployed from the stern gantry - these data are not included here.

5.1.5 Conductivity signal noise

Close examination of the conductivity cell signal from General Oceanics CTDs reveals a signal noise large enough to generate spurious small scale vertical density inversions (Rosenberg et al., 1997, Tom Whitworth, pers. comm.). From previous cruises, CTD 1103 was found to generate the noisiest conductivity data. For this cruise, a comparison of conductivity signal noise was made between the two CTDs used, 1193 and 1103. Firstly, the full 25 Hz CTD data were extracted for a series of stations from approximately equivalent latitudes for both CTD 1193 and 1103. Steep parts of the vertical profile (i.e. near the top and bottom) were excluded. Data were then smoothed using a running mean average with a window size of ±5 data points. Lastly, variances were calculated for both the conductivity and temperature data. For the stations analysed in this way, there is no obvious difference in conductivity noise levels between the two CTDs (Figure 11) - for this cruise, evidently both CTDs are equally likely to give spurious vertical density inversions.

5.2 Niskin bottle data

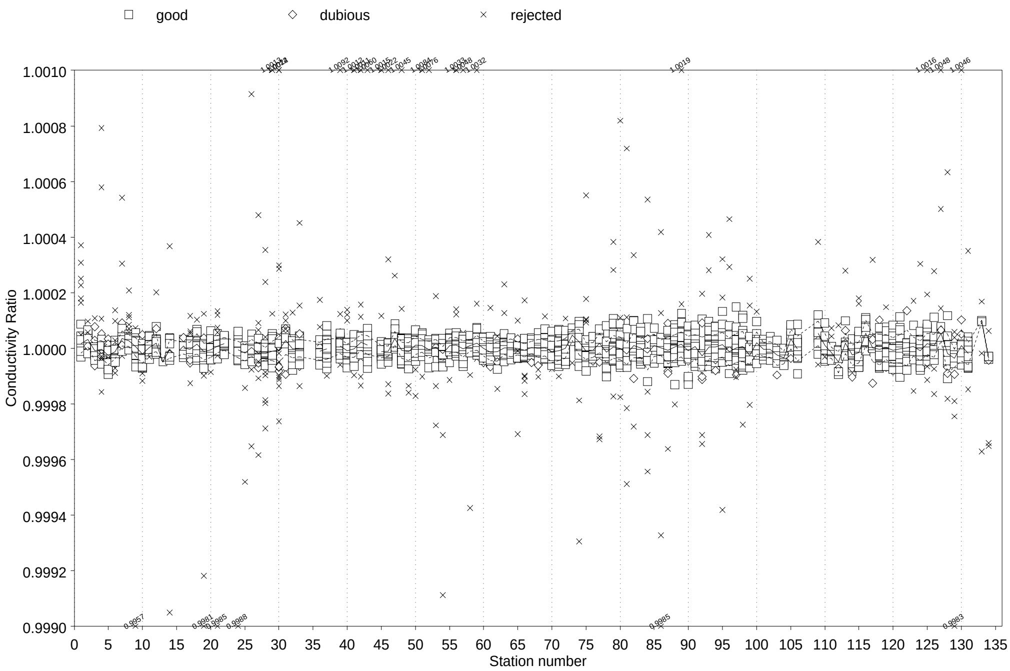
A Guildline 'Autosal' salinometer serial no. 62549 was used for analysis of all salinity bottle samples. International Standard Seawater batch numbers used are detailed in Appendix 1 (Table A1.1).

For Niskin bottle 19, a loose lanyard prior to station 60 allowed the bottom end cap to pre-trip on many occasions. As a result, Niskin bottle samples from bottle 19 were bad for all parameters for the following stations: 9, 19, 21, 23-27, 29, 30, 41-43, 45, 46, 48, 50-53, 56, 57, 59.

For stations 66 to 75, oxygen reagent 1 was accidentally topped up with Milli-Q instead of reagent 1, and oxygen bottle samples were pickled with this dilute reagent. These samples were analysed using a standardisation done with this same dilute reagent. Examination of the bottle oxygen concentrations and standardisation revealed no suspicious data - reagent volumes added to samples are in excess, thus the dilution of reagent 1 appears to have been within tolerance.

For station 43, faulty rosette pylon behaviour resulted in all rosette positions out of synch. by 1 position, with bottle 24 tripped at the deepest position. For station 94, the pylon was accidentally set to position 1 prior to the cast, thus bottle 2 was tripped at the deepest position, and bottle 1 at the shallowest.

Nitrate+nitrite versus phosphate nutrient data are shown in Figure 10.



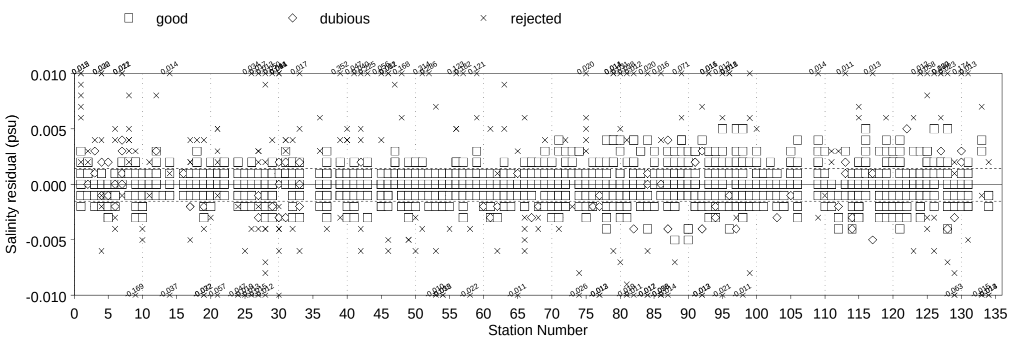
Calibration data for cruise : Au0103

Calibration file : a0103.bot

Conductivity s.d. = 0.00003

Number of bottles used = 1870 out of 2191 Mean ratio for all bottles = 1.00000

Figure 5: Conductivity ratio c_{btl}/c_{cal} versus station number for cruise AU0103. The solid line follows the mean of the residuals for each station; the broken lines are ± the standard deviation of the residuals for each station. c_{cal} = calibrated CTD conductivity from the CTD upcast burst data; c_{btl} = 'in situ' Niskin bottle conductivity, found by using CTD pressure and temperature from the CTD upcast burst data in the conversion of Niskin bottle salinity to conductivity.



Calibration data for cruise : Au0103

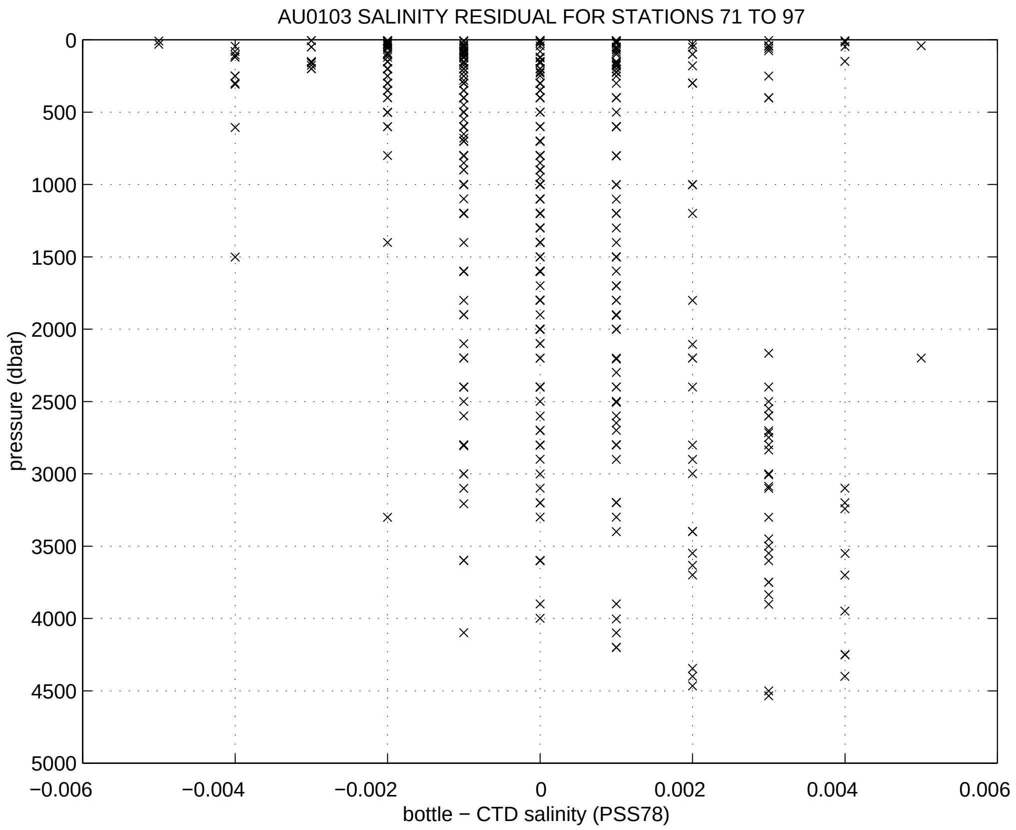
Calibration file : a0103.bot

Mean offset salinity = 0.0000psu (s.d. = 0.0015 psu)

Number of bottles used = 1870 out of 2191

Figure 6: Salinity residual (s_{btl} - s_{cal}) versus station number for cruise AU0103. The solid line is the mean of all the residuals; the broken lines are ± the standard deviation of all the residuals. s_{cal} = calibrated CTD salinity; s_{btl} = Niskin bottle salinity value.

(a)



(b)

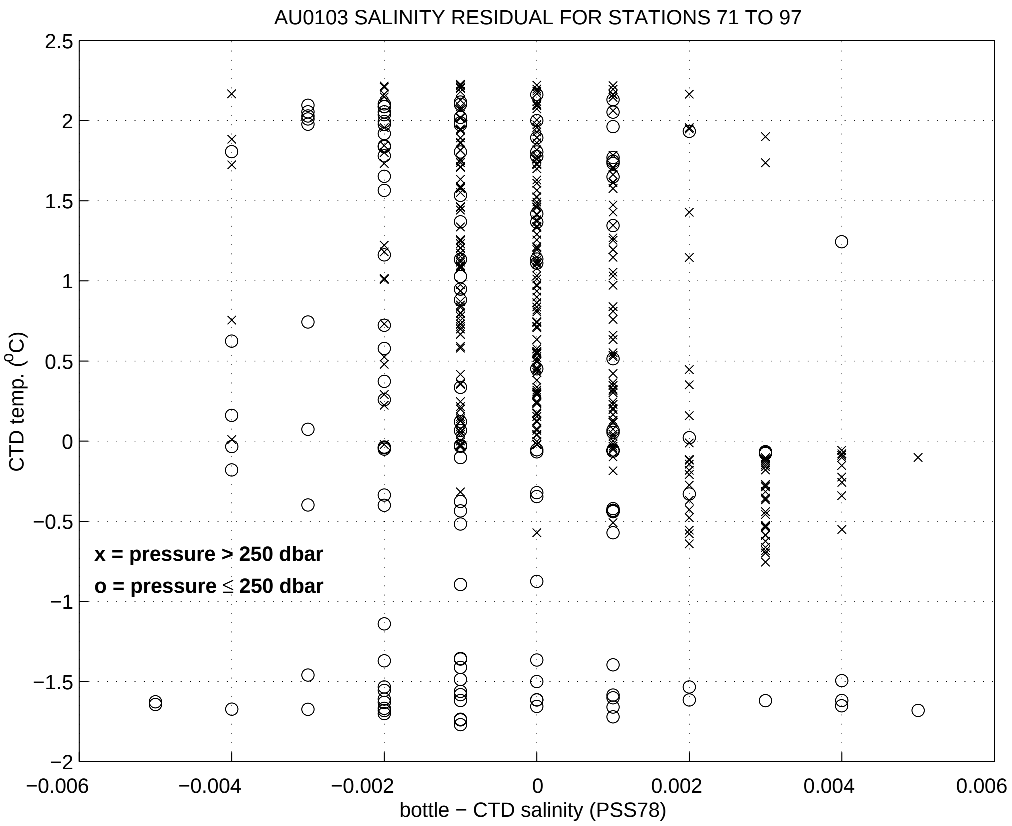
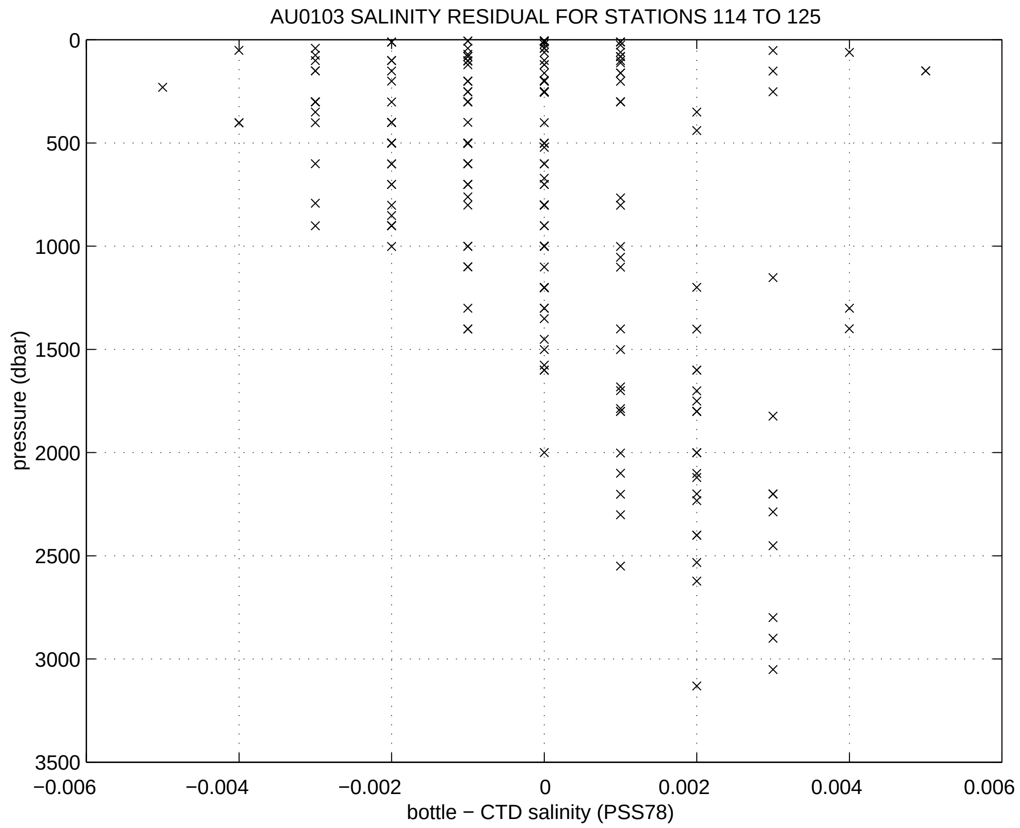


Figure 7a and b: Salinity residual versus (a) pressure, and (b) temperature, for stations 71 to 97. Note that only data with quality flag 1 (see Appendix 2 for definition) are plotted.

(c)



(d)

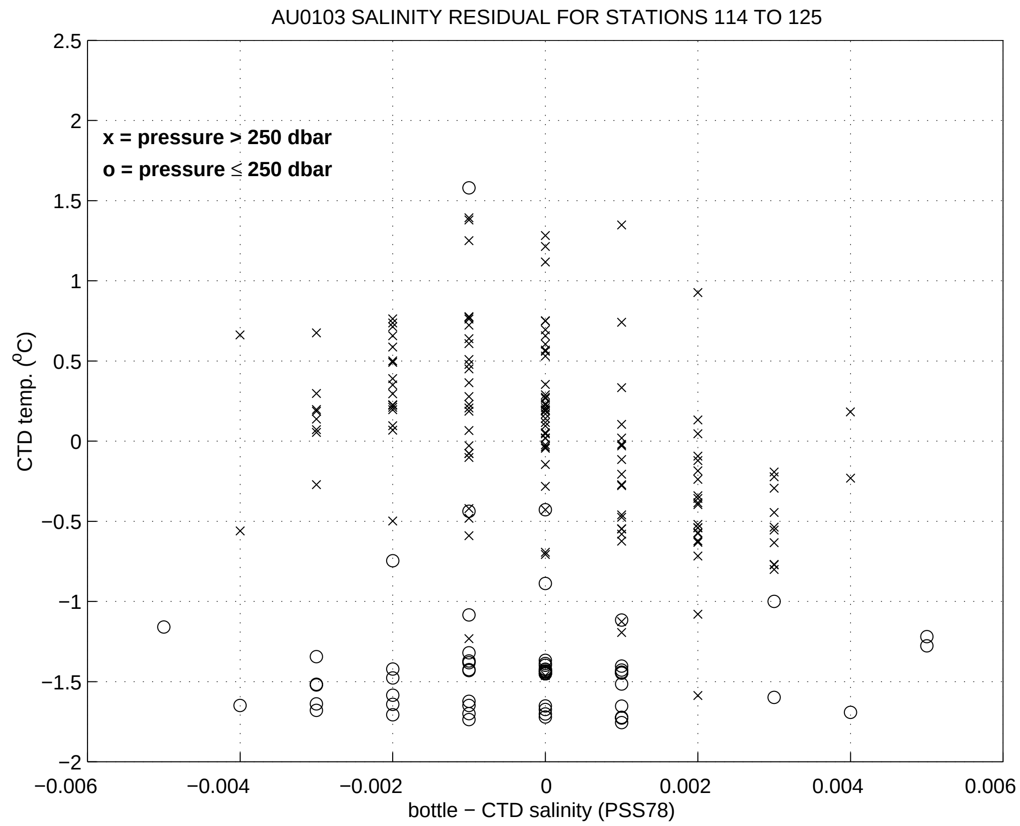
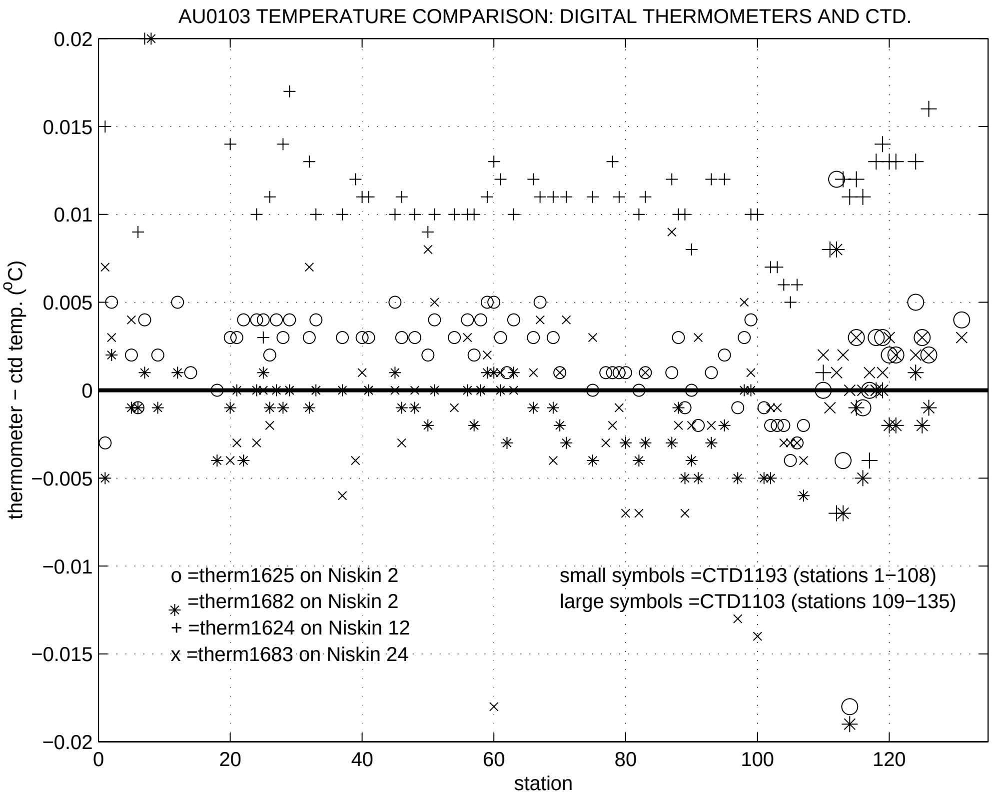


Figure 7c and d: Salinity residual versus (c) pressure, and (d) temperature, for stations 114 to 125. Note that only data with quality flag 1 (section Appendix 2 for definition) are plotted.

(a)



(b)

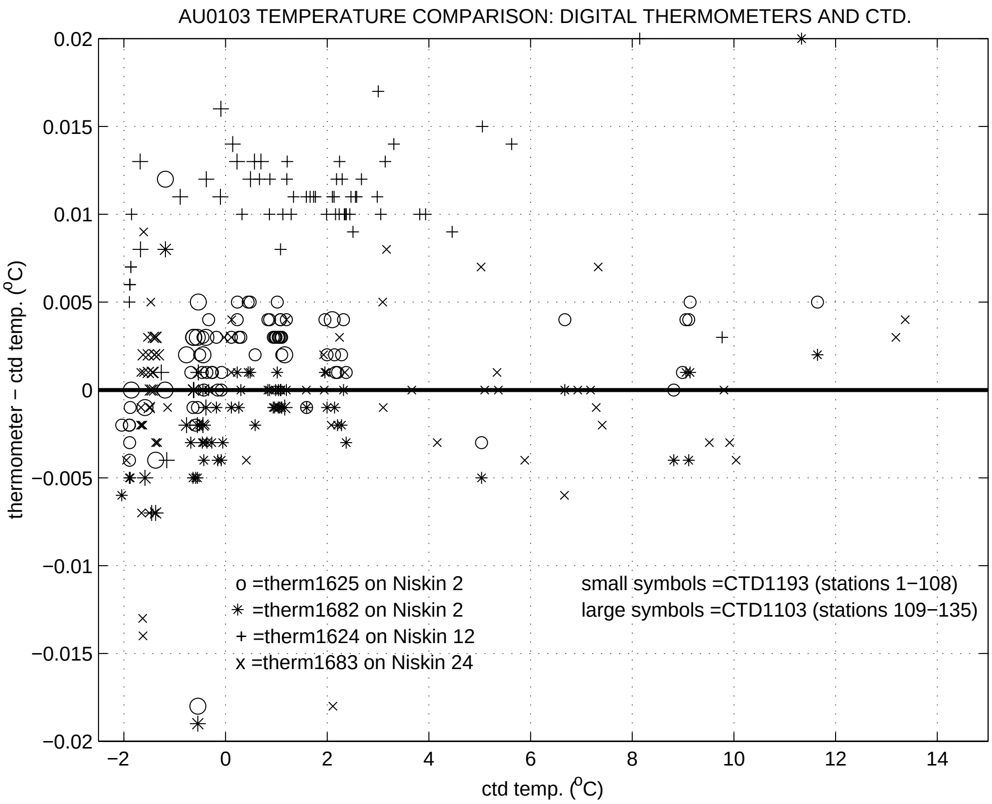


Figure 8a and b: Comparison between digital reversing thermometers and CTD platinum temperature for cruise AU0103: temperature difference versus (a) station number, and (b) CTD temperature.

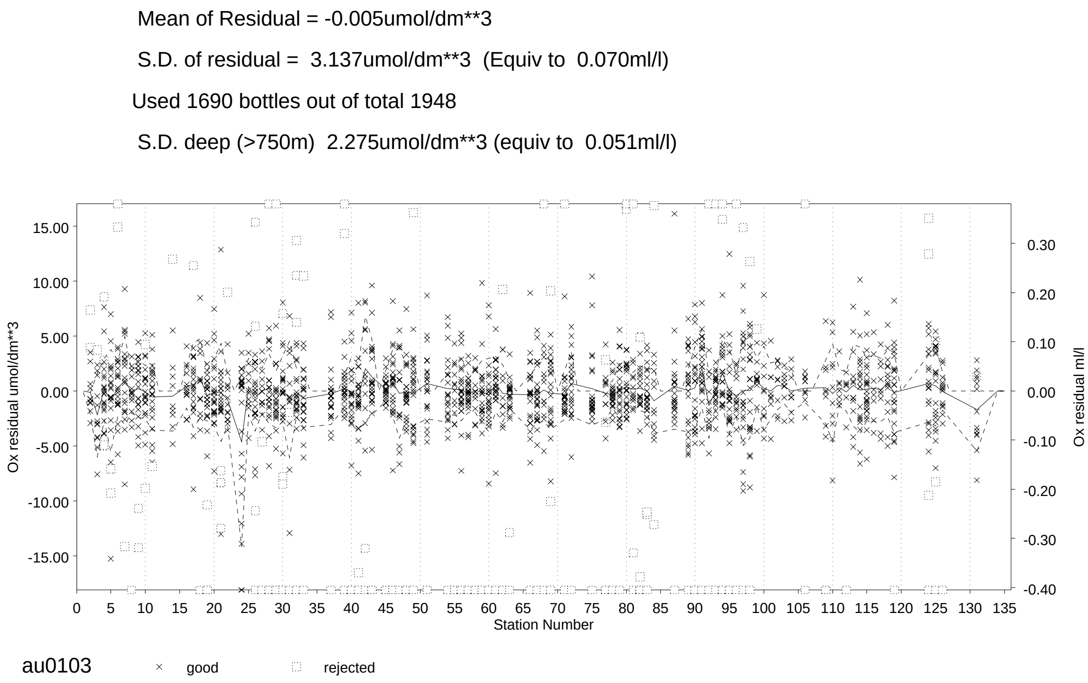


Figure 9: Dissolved oxygen residual (o_{btl} - o_{cal}) versus station number for cruise AU0103. The solid line follows the mean residual for each station; the broken lines are ± the standard deviation of the residuals for each station.

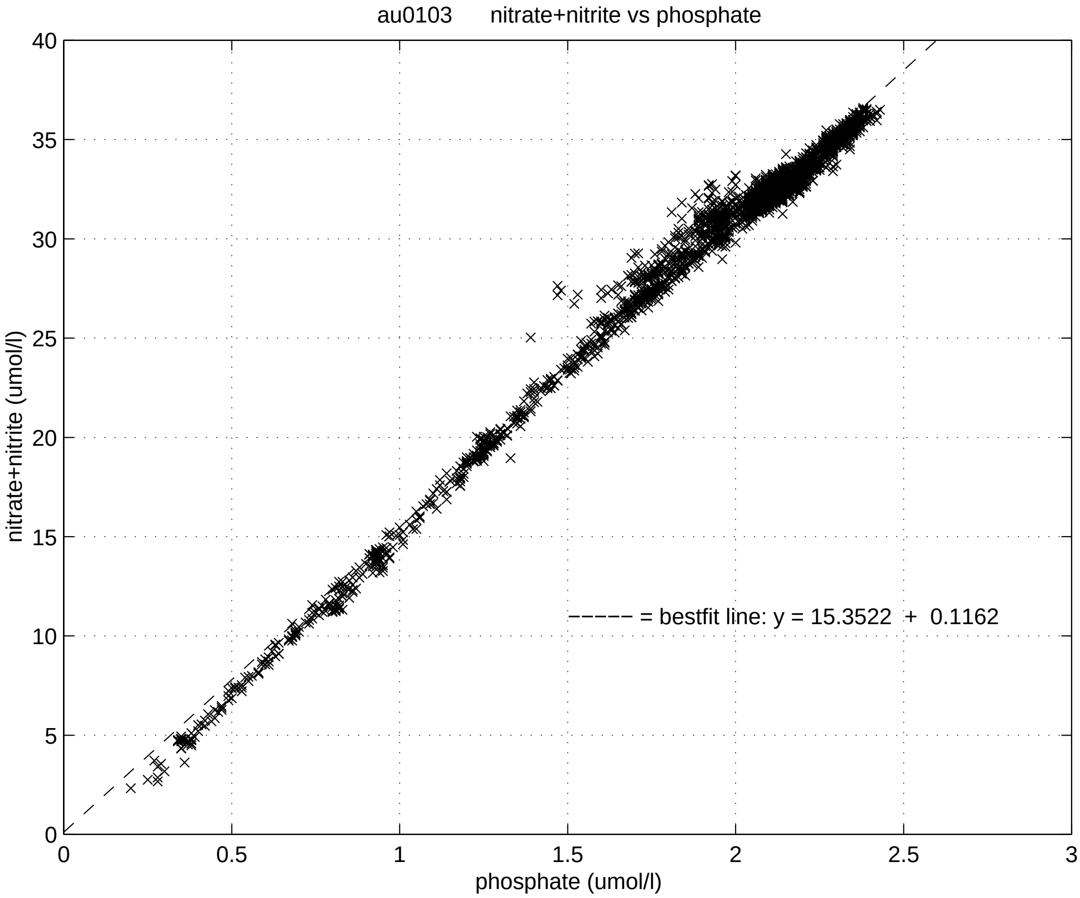


Figure 10: Nitrate+nitrite versus phosphate data for AU0103.

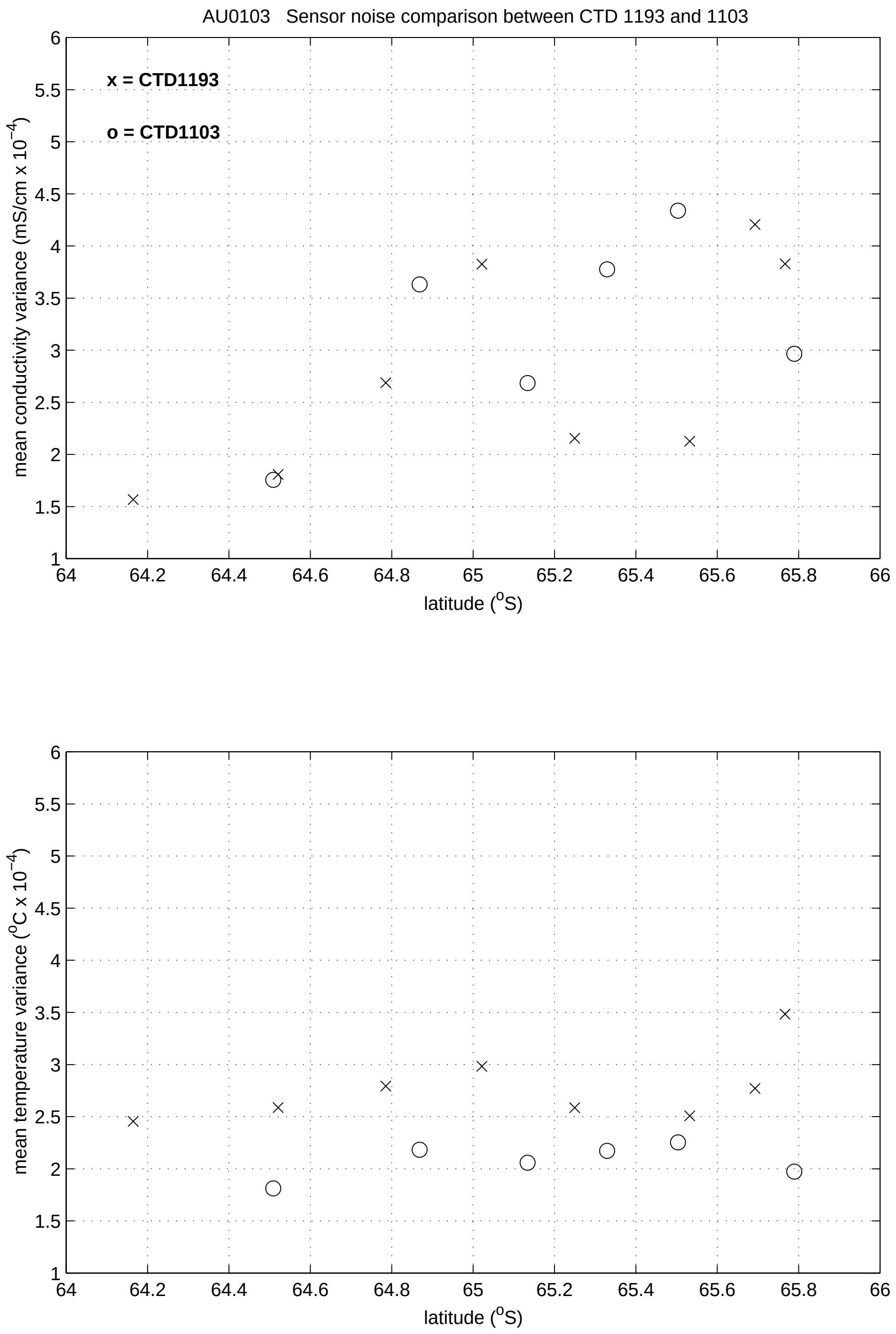


Figure 11: Conductivity and temperature signal noise for CTDs 1193 and 1103.

Table 7: Calibration coefficients and calibration dates for CTD serial numbers 1193 and 1103 (unit numbers 5 and 7 respectively) used during cruise AU0103. Note that platinum temperature calibrations are for the ITS-90 scale.

coefficient	value of coefficient	coefficient	value of coefficient
CTD serial number 1193 (unit no. 5) (stations 1-108)		***CTD serial number 1103 (unit no. 7) (stations 109-135)***	
pressure calibration coefficients		*pressure calibration coefficients*	
CSIRO Calibration Facility – 08/10/2001		*CSIRO Calibration Facility – 03/10/2001*	
pcal0	-1.112466e+01	pcal0	-2.107754e+01
pcal1	1.007841e-01	pcal1	1.001927e-01
pcal2	2.329940e-09	pcal2	9.702446e-09
pcal3	-6.068648e-14	pcal3	-6.379487e-14
pcal4	5.809276e-19	pcal4	3.916767e-19
platinum temperature calibration coefficients		*platinum temperature calibration coefficients*	
CSIRO Calibration Facility – 02/10/2001		*CSIRO Calibration Facility – 12/10/2001*	
Tcal0	-5.448864e-02	Tcal0	6.705048e-02
Tcal1	4.989851e-04	Tcal1	4.998226e-04
Tcal2	-1.960000e-12	Tcal2	0.0
pressure temperature calibration coefficients		*pressure temperature calibration coefficients*	
CSIRO Calibration Facility - 08/10/2001		*CSIRO Calibration Facility - 03/10/2001*	
Tpcal0	8.43604e+01	Tpcal0	9.09870e+01
Tpcal1	-3.15992e-04	Tpcal1	-4.16256e-04
Tpcal2	-3.25000e-08	Tpcal2	-3.01003e-08
Tpcal3	0.0	Tpcal3	0.0
Tpcal4	0.0	Tpcal4	0.0
coefficients for temperature correction to pressure		*coefficients for temperature correction to pressure*	
CSIRO Calibration Facility - 08/10/2001		*CSIRO Calibration Facility - 03/10/2001*	
T_0	20.00	T_0	20.00
S_1	-1.88557e-05	S_1	-1.40716e-05
S_2	-1.08758e-01	S_2	-2.54401e-02
digitiser counts to voltage calibration for fluorescence channel		*digitiser counts to voltage calibration for fluorescence channel (used CTD1193 values)*	
Aurora Australis - 22/11/2001			
f0	-5.57687	f0	-5.57687
f1	1.70179e-04	f1	1.70179e-04
f2	0.0	f2	0.0

Table 8: Surface pressure offsets. ** indicates value estimated from manual inspection of data.

stn no.	surface p offset(dbar)	stn no.	surface p offset(dbar)	stn no.	surface p offset(dbar)	stn no.	surface p offset(dbar)	stn no.	surface p offset(dbar)
1	0.94	28	-0.01	55	-0.47	82	0.20**	109	0.00
2	1.00	29	-0.40**	56	0.41	83	-0.29	110	0.79
3	0.53	30	0.19	57	-0.03	84	-0.48	111	1.00
4	0.52	31	0.22	58	0.02	85	0.74	112	0.50
5	0.39	32	0.38	59	-0.11	86	0.31	113	0.77
6	0.11	33	0.32	60	-0.11	87	0.00**	114	0.85
7	0.21	34	0.15	61	-0.69	88	0.22	115	0.98
8	0.75	35	0.27	62	0.30**	89	-0.06	116	0.46
9	0.90	36	0.73	63	0.08	90	0.01	117	0.59
10	0.83	37	0.06	64	-0.17	91	0.17	118	0.99
11	0.18	38	-0.08	65	-0.67	92	0.06	119	0.91
12	0.15	39	0.09	66	-0.34	93	-0.20	120	0.40
13	0.52	40	0.25	67	-0.36	94	0.14	121	0.23
14	0.77	41	0.35	68	0.41	95	-0.16	122	0.36
15	0.03	42	0.00	69	0.42	96	-0.04	123	1.05
16	0.15	43	0.52	70	-0.17	97	0.47	124	0.65
17	0.15	44	0.21	71	-0.36	98	0.02	125	0.24
18	0.26	45	-0.33	72	-0.15	99	-0.40	126	-0.12
19	0.51	46	-0.89	73	0.15	100	-0.20**	127	0.93
20	-0.57	47	0.23	74	0.60	101	-0.05	128	0.55
21	0.03	48	-0.42	75	0.46	102	0.35	129	0.00
22	-0.09	49	0.46	76	-0.44	103	0.33	130	0.25
23	-0.11	50	-0.05	77	0.04	104	0.86	131	0.74
24	-0.20**	51	-0.22	78	-0.29	105	0.43	132	0.66
25	0.15	52	0.15	79	-0.44	106	0.36	133	-0.35
26	0.27	53	-0.56	80	0.09	107	-0.20**	134	-0.27
27	0.42	54	0.05	81	-0.47	108	-0.30**	135	0.23

Table 9: CTD conductivity calibration coefficients. F_1 , F_2 and F_3 are respectively conductivity bias, slope and station-dependent correction calibration terms. n is the number of samples retained for calibration in each station grouping; σ is the standard deviation of the conductivity residual for the n samples in the station grouping.

stn grouping	F_1	F_2	F_3	n	σ
001 to 007	-0.12400843E-01	0.96693175E-03	-0.12678197E-07	94	0.001331
008 to 013	-0.14229483E-01	0.96688131E-03	0.45234260E-08	81	0.001186
014 to 017	-0.51762480E-02	0.94845242E-03	-0.28958816E-07	35	0.000878
018 to 047	-0.11944275E-01	0.94817109E-03	0.22435385E-08	400	0.000996
048 to 062	0.96277611E-03	0.94791325E-03	-0.65411185E-09	258	0.000843
063 to 068	-0.87553383E-02	0.94830642E-03	-0.19967568E-08	89	0.000679
069 to 076	0.21653981E-02	0.94790089E-03	-0.85898836E-09	136	0.000976
077 to 083	0.27664169E-01	0.94705848E-03	0.39321052E-10	132	0.001127
084 to 099	0.35267267E-01	0.94685326E-03	-0.52840211E-09	279	0.001360
100 to 108	0.30957091E-01	0.94556130E-03	0.13561741E-07	66	0.001069
109 to 119	0.30445228E-01	0.10055224E-02	-0.11314836E-08	131	0.001265
120 to 129	0.23654117E-01	0.10055005E-02	0.79152735E-09	141	0.001313
130 to 135	-0.97232207E-02	0.10041337E-02	0.19756780E-07	24	0.001586

Table 10: Station-dependent-corrected conductivity slope term ($F_2 + F_3 . N$), for station number N, and F_2 and F_3 the conductivity slope and station-dependent correction calibration terms respectively.

station number	($F_2 + F_3 . N$)	station number	($F_2 + F_3 . N$)	station number	($F_2 + F_3 . N$)	station Number	($F_2 + F_3 . N$)
1	0.96691907E-03	35	0.94825236E-03	69	0.94784162E-03	103	0.94695816E-03
2	0.96690639E-03	36	0.94825458E-03	70	0.94784076E-03	104	0.94697172E-03
3	0.96689371E-03	37	0.94825679E-03	71	0.94783990E-03	105	0.94698528E-03
4	0.96688103E-03	38	0.94825901E-03	72	0.94783905E-03	106	0.94699885E-03
5	0.96686836E-03	39	0.94826122E-03	73	0.94783819E-03	107	0.94701241E-03
6	0.96685568E-03	40	0.94826344E-03	74	0.94783733E-03	108	0.94702597E-03
7	0.96684300E-03	41	0.94826566E-03	75	0.94783647E-03	109	0.10053662E-02
8	0.96691750E-03	42	0.94826787E-03	76	0.94783561E-03	110	0.10053654E-02
9	0.96692202E-03	43	0.94827009E-03	77	0.94706151E-03	111	0.10053647E-02
10	0.96692654E-03	44	0.94827230E-03	78	0.94706155E-03	112	0.10053639E-02
11	0.96693107E-03	45	0.94827452E-03	79	0.94706159E-03	113	0.10053631E-02
12	0.96693559E-03	46	0.94827674E-03	80	0.94706163E-03	114	0.10053624E-02
13	0.96694011E-03	47	0.94827895E-03	81	0.94706166E-03	115	0.10053616E-02
14	0.94804700E-03	48	0.94788185E-03	82	0.94706170E-03	116	0.10053608E-02
15	0.94801804E-03	49	0.94788120E-03	83	0.94706174E-03	117	0.10053600E-02
16	0.94798908E-03	50	0.94788055E-03	84	0.94680887E-03	118	0.10053593E-02
17	0.94796012E-03	51	0.94787989E-03	85	0.94680835E-03	119	0.10053585E-02
18	0.94821469E-03	52	0.94787924E-03	86	0.94680782E-03	120	0.10055955E-02
19	0.94821691E-03	53	0.94787858E-03	87	0.94680729E-03	121	0.10055963E-02
20	0.94821913E-03	54	0.94787793E-03	88	0.94680676E-03	122	0.10055971E-02
21	0.94822134E-03	55	0.94787727E-03	89	0.94680623E-03	123	0.10055979E-02
22	0.94822356E-03	56	0.94787662E-03	90	0.94680570E-03	124	0.10055987E-02
23	0.94822577E-03	57	0.94787597E-03	91	0.94680518E-03	125	0.10055995E-02
24	0.94822799E-03	58	0.94787531E-03	92	0.94680465E-03	126	0.10056003E-02
25	0.94823020E-03	59	0.94787466E-03	93	0.94680412E-03	127	0.10056011E-02
26	0.94823242E-03	60	0.94787400E-03	94	0.94680359E-03	128	0.10056018E-02
27	0.94823464E-03	61	0.94787335E-03	95	0.94680306E-03	129	0.10056026E-02
28	0.94823685E-03	62	0.94787270E-03	96	0.94680253E-03	130	0.10067021E-02
29	0.94823907E-03	63	0.94820530E-03	97	0.94680201E-03	131	0.10067219E-02
30	0.94824128E-03	64	0.94820372E-03	98	0.94680148E-03	132	0.10067416E-02
31	0.94824350E-03	65	0.94820215E-03	99	0.94680095E-03	133	0.10067614E-02
32	0.94824571E-03	66	0.94820057E-03	100	0.94691748E-03	134	0.10067812E-02
33	0.94824793E-03	67	0.94819899E-03	101	0.94693104E-03	135	0.10068009E-02
34	0.94825015E-03	68	0.94819742E-03	102	0.94694460E-03		

Table 11: CTD raw data scans deleted during data processing. For raw scan number ranges, the lowest and highest scan numbers are not included in the action (except for scan 1).

station no.	raw scan nos.	reason
1, upcast	1918-1920	P spike
4, upcast	2771-3, 2877-9	P spike
7, upcast	4173-6, 4212-4	P spike
8, upcast	644-6, 1519-21, 1854-7, 1874-81, 1935-9, 3519-21, 3569-71, 3586-9, 3605-7, 3631-3, 3654-6	P spike
24, downcast	1-450	CTD deck unit not warmed up
29, downcast	1-830	CTD deck unit not warmed up
62, downcast	1-1000	CTD deck unit not warmed up
82, downcast	1-520	CTD deck unit not warmed up
87, downcast	1-1300	CTD deck unit not warmed up
95, upcast	5348-52	P spike
107,downcast	1-4600	hypersaline water in sensor cover
108,downcast	1-1500	hypersaline water in sensor cover
128, upcast	4156-9	P spike

Table 12: Missing data points in 2 dbar-averaged files. '1' indicates missing data for the indicated parameters: T=temperature; S=salinity, σ_T , specific volume anomaly and geopotential anomaly; O=oxygen; F=fluorescence.

station no.	pressure (dbar) where data missing	T	S	O	F
1	whole stn			1	
6	2252-2352			1	1
6	2354-3246				1
7	1970-2066			1	1
7	2068-2898				1
11	whole stn				1
12	whole stn			1	
13	whole stn			1	1
15	whole stn			1	
16	whole stn				1
17	whole stn				1
20	2344-2348			1	
23	whole stn			1	
24	4040-4060			1	
28	180-184		1	1	
34	whole stn			1	
35	whole stn			1	
36	whole stn			1	
38	whole stn			1	
44	whole stn			1	
50	whole stn			1	
52	whole stn			1	
53	whole stn			1	
64	whole stn			1	
65	whole stn			1	
70	whole stn			1	
73	whole stn			1	
74	whole stn			1	
76	whole stn			1	
76	1672-1674		1		
85	whole stn			1	
86	whole stn			1	
88	whole stn			1	
89	2-48				1
90	50-52		1	1	
100	2-4	1	1	1	1
105	whole stn			1	
107	whole stn		1	1	
108	whole stn		1	1	
120	whole stn			1	
121	whole stn			1	
122	whole stn			1	
123	whole stn			1	
125	whole stn				1
126	whole stn				1
127	whole stn			1	
128	whole stn			1	
129	whole stn			1	
130	whole stn			1	
132	whole stn			1	
133	whole stn			1	
134	whole stn			1	
135	whole stn			1	

Table 13: 2 dbar averages interpolated from surrounding 2 dbar values, for the indicated parameters: T=temperature; S=salinity, σ_T , specific volume anomaly and geopotential anomaly; F=fluorescence.

station no.	interpolated 2 dbar values	parameters interpolated
6	1066, 1168	O
6	2254-2256	T, S
7	1304, 1410, 1458, 1466-1468, 1532	O
7	1970-1972, 1986-1988	T, S
30	2634	T, S, O
40	2694	T, S, O
45	1154	T, S, O
51	1464	T, S, O
60	2462	T, S, O
61	2280	T, S, O
71	1256, 2418	T, S, O
78	2368	T, S, O

Table 14: Suspect 2 dbar averages for the indicated parameters: T=temperature; S=salinity, σ_T, specific volume anomaly and geopotential anomaly; O=oxygen. * = general caution required, due to frequent transient sensor errors when the CTD enters the water.

station no.	questionable 2 dbar value(dbar)	parameters
16	4000-4012	O
*all stations	2-4	S
*all stations	2-20	O

Table 15: Questionable nutrient sample values (not deleted from bottle data file).

PHOSPHATE		NITRATE		SILICATE	
station number	rosette position	station number	rosette position	station number	rosette position
29	whole stn				
				43	4
				45	3
69	4				
				72	11
		78	12		
		97	9		
113	whole stn	113	whole stn		
117	whole stn				
118	whole stn				
122	whole stn	122	whole stn		
123	whole stn	123	whole stn		
124	whole stn	124	whole stn		

Table 16: Digital reversing protected thermometers used: serial numbers are listed.

stations 1 to 135	1683 on pos. 24	1624 on pos. 12	1625, 1682 on pos. 2

Table 17: CTD dissolved oxygen calibration coefficients. K_1, K_2, K_3, K_4, K_5 and K_6 are respectively oxygen current slope, oxygen sensor time constant, oxygen current bias, temperature correction term, weighting factor, and pressure correction term. dox is equal to 2.8σ (for σ as defined in Rosenberg et al., 1995); n is the number of samples retained for calibration in each station or station grouping.

station number	K_1	K_2	K_3	K_4	K_5	K_6	dox	n
2	6.912	4.00	-0.684	-0.03195	0.22430	0.17482E-04	0.12445	10
3	9.960	4.00	-1.607	-0.03173	0.71194	0.49421E-04	0.23750	12
4	9.475	4.00	-1.474	-0.03299	0.16668	0.57404E-04	0.17484	20
5	8.062	4.00	-1.251	-0.01867	0.83694	0.14405E-03	0.29252	21
6	8.129	9.00	-1.250	-0.02263	0.56242	0.13824E-03	0.16039	20
7	6.403	5.50	-0.913	-0.00744	0.46445	0.13388E-03	0.24943	21
8	6.115	5.50	-0.678	-0.01635	0.77336	0.66683E-04	0.11864	13
9	9.205	8.50	-1.498	-0.02543	0.69864	0.16783E-03	0.16433	20
10	7.921	5.50	-1.254	-0.01550	0.64807	0.18216E-03	0.15138	20
11	7.960	9.50	-1.213	-0.01700	0.02057	0.13327E-03	0.18890	22
14	9.300	4.00	-1.400	-0.03600	0.75000	0.15000E-03	0.21524	9
16	9.052	8.00	-1.442	-0.02344	0.74671	0.14595E-03	0.12373	12
17	8.795	4.00	-1.384	-0.02407	0.74967	0.14314E-03	0.24080	21
18	8.700	7.00	-1.200	-0.03600	0.75000	0.15000E-03	0.23160	12
19	8.919	4.50	-1.405	-0.02321	0.25903	0.14130E-03	0.14356	21
20	8.585	4.00	-1.333	-0.02092	0.91733	0.14039E-03	0.19361	24
21	9.961	5.00	-1.617	-0.02732	0.33264	0.14976E-03	0.27909	20
22	7.600	4.00	-0.746	-0.04166	0.01409	0.21553E-04	0.21020	14
24	9.485	5.50	-1.534	-0.02118	0.63844	0.15718E-03	0.15158	16
25	8.130	4.50	-1.043	-0.03220	0.67170	0.10759E-03	0.16108	12
26	8.067	4.50	-1.222	-0.01272	0.68518	0.13136E-03	0.18858	20
27	6.358	9.00	-0.581	-0.03279	0.90211	0.34873E-04	0.12788	12
28	10.035	4.00	-1.590	-0.03837	0.51531	0.12646E-03	0.19962	20
29	10.096	4.50	-1.602	-0.03871	0.30482	0.12998E-03	0.15828	19
30	10.485	7.00	-1.658	-0.05009	0.16197	0.11585E-03	0.18770	20
31	7.500	9.00	-0.900	-0.03600	0.75000	0.15000E-03	0.33576	12
32	8.648	4.50	-1.317	-0.02529	0.09250	0.12518E-03	0.13736	20
33	10.123	4.00	-1.611	-0.03645	0.11694	0.13034E-03	0.16474	22
37	9.071	4.50	-1.408	-0.02180	0.04434	0.13173E-03	0.17548	21
39	10.438	4.00	-1.678	-0.04284	0.82360	0.13394E-03	0.10882	20
40	10.559	4.00	-1.679	-0.04517	0.90224	0.12215E-03	0.19414	21
41	8.142	4.00	-1.218	-0.00863	0.39981	0.12397E-03	0.18955	22
42	9.400	10.00	-1.400	-0.03600	0.75000	0.15000E-03	0.33467	12
43	7.372	4.50	-1.073	-0.00119	0.72129	0.12954E-03	0.21126	22
45	8.612	5.00	-1.329	-0.00971	0.84397	0.14126E-03	0.07114	22
46	8.172	4.00	-1.238	-0.00299	0.08014	0.13609E-03	0.19217	22
47	8.055	4.00	-1.085	-0.03461	0.56014	0.11641E-03	0.25505	13
48	8.655	4.50	-1.299	-0.02892	0.29307	0.11950E-03	0.15894	22
49	8.419	4.00	-1.228	-0.03023	0.20057	0.10052E-03	0.18601	21
51	8.928	4.00	-1.355	-0.02495	0.65819	0.11629E-03	0.20093	22
54	8.735	4.50	-1.335	-0.01811	0.19625	0.12976E-03	0.19223	20
55	9.294	4.50	-1.416	-0.04027	0.33908	0.17025E-03	0.14452	12
56	8.572	4.00	-1.294	-0.02030	0.97227	0.13192E-03	0.17817	22
57	8.907	9.00	-1.369	-0.01761	0.80135	0.13222E-03	0.10672	22
58	8.629	4.00	-1.282	-0.03729	0.59448	0.22645E-03	0.12402	12
59	9.107	4.50	-1.395	-0.01977	0.68997	0.12267E-03	0.18267	21
60	9.272	5.00	-1.408	-0.04199	0.85654	0.11579E-03	0.20739	22
61	9.239	4.50	-1.394	-0.04204	0.97849	0.10763E-03	0.16084	21
62	8.899	8.00	-1.318	-0.03501	0.33276	0.15050E-03	0.16301	10
63	9.468	10.00	-1.495	-0.00804	0.98786	0.14314E-03	0.08236	21
66	9.377	4.00	-1.477	-0.01029	0.35603	0.13980E-03	0.20116	23

Table 17: (continued)

67	8.866	6.50	-1.302	-0.05731	0.38414	0.98862E-04	0.16167	23
68	9.666	7.00	-1.539	-0.05715	0.70477	0.60321E-03	0.17746	12
69	6.939	5.00	-0.789	-0.10126	0.65270	0.35727E-04	0.20522	21
71	8.420	7.00	-1.220	-0.03124	0.03001	0.10541E-03	0.13972	22
72	9.122	7.00	-1.377	-0.03174	0.62800	0.11280E-03	0.18488	20
75	9.600	4.00	-1.514	-0.00501	0.86646	0.14139E-03	0.20482	23
77	8.135	4.50	-1.118	-0.05922	0.94853	0.36330E-04	0.14840	10
78	9.515	4.00	-1.497	-0.00887	0.79461	0.14148E-03	0.07669	23
79	7.588	4.50	-0.996	-0.06477	0.00080	0.72885E-04	0.15632	22
80	7.352	11.50	-1.035	-0.00070	0.32658	0.12954E-03	0.12665	22
81	8.085	10.00	-1.123	-0.04882	0.09085	0.74130E-04	0.09479	12
82	8.978	4.00	-1.405	-0.01642	0.69154	0.15006E-03	0.12764	18
83	9.033	7.50	-1.400	-0.00065	0.74911	0.14806E-03	0.12517	20
84	2.204	5.50	0.290	-0.19604	0.31706	0.18185E-03	0.18605	11
87	9.579	4.00	-1.516	-0.00077	0.68334	0.15170E-03	0.24743	23
89	6.396	8.00	-0.850	-0.00155	0.70775	0.13731E-03	0.23418	23
90	6.692	5.50	-0.805	-0.06733	0.17446	0.61515E-04	0.23437	22
91	8.596	10.00	-1.300	-0.00013	0.60384	0.14717E-03	0.22087	23
92	8.347	5.00	-1.146	-0.04137	0.23471	0.14593E-04	0.18880	12
93	8.785	7.00	-1.336	-0.00028	0.80655	0.14838E-03	0.09346	22
94	9.532	7.00	-1.495	-0.00075	0.70964	0.15125E-03	0.19109	20
95	11.468	6.00	-1.911	-0.01291	0.77412	0.16731E-03	0.23867	22
96	6.409	7.00	-0.729	-0.03693	0.11306	0.10841E-04	0.12173	12
97	10.893	4.00	-1.730	-0.05168	0.57916	0.11548E-03	0.31288	22
98	5.557	4.00	-0.552	-0.09634	0.21763	0.52523E-04	0.27154	22
99	4.254	4.00	-0.258	-0.11902	0.29200	0.88222E-05	0.13664	11
100	9.801	6.00	-1.498	-0.02847	0.61098	0.31736E-03	0.24018	11
101	2.635	4.00	0.241	-0.02757	0.75817	0.11936E-03	0.15955	8
102	3.075	6.50	0.006	-0.13997	0.25742	0.14322E-03	0.13704	8
103	3.035	6.00	-0.046	-2.01790	0.47425	0.84172E-04	0.10521	8
104	4.181	4.00	-0.099	-0.04098	0.77975	0.10948E-03	0.11980	8
106	2.907	6.50	0.054	-0.09441	0.24966	0.11797E-03	0.07823	10
109	6.697	5.50	-0.869	-0.04593	0.19676	0.33967E-03	0.20713	8
110	4.637	4.50	-0.377	-0.07659	0.22883	0.34088E-03	0.27937	10
111	4.401	5.00	-0.267	-0.06183	0.22249	0.93693E-04	0.10553	7
112	12.962	5.00	-2.341	-0.01813	0.37623	0.10047E-02	0.10977	6
113	3.121	9.00	0.000	-0.11125	0.09626	0.32518E-04	0.23107	12
114	2.460	10.00	0.135	-0.19090	0.22880	0.29243E-04	0.24413	19
115	5.027	6.00	-0.416	-0.08754	0.09586	0.57401E-04	0.18011	24
116	1.771	10.00	0.319	-2.83890	0.48070	0.11283E-03	0.18744	8
117	3.608	4.00	-0.117	-0.23891	0.34958	0.56453E-04	0.17931	9
118	3.072	4.00	0.004	-0.17242	0.26132	0.31683E-04	0.18890	14
119	7.111	9.00	-0.901	-0.03454	0.08394	0.11226E-03	0.22834	23
124	4.554	10.00	-0.325	-0.07275	0.08706	0.54370E-04	0.21894	19
125	5.296	10.00	-0.580	-0.00038	0.36196	0.13564E-03	0.22973	21
126	7.715	4.50	-1.030	-0.00271	0.75214	0.41146E-04	0.10723	13
131	0.087	6.00	1.011	-0.31566	0.91766	0.21432E-04	0.23240	13

Appendix 1 Hydrochemistry cruise laboratory report

Clodagh Moy, Stephen Bray and Neale Johnston

This hydrochemistry was part of the CLIVAR program on Voyage 3 on the *Aurora Australis*. Seawater samples were analysed for salinity, nutrients (NO2+NO3, Si and P) and dissolved oxygen concentrations. Samples were collected from 135 stations in total, including 122 stations of a repeat north-south transect of the SR3 line (including 8 particle station sites) and a further 13 stations off the coast near the Mertz Glacier and across the continental shelf. Additional samples were analysed for some scientists on board, as described below. The methods used are described in the CRC hydrochemistry manual (Curran and Bray, 2003).

Number of samples analysed
Salinities: 2288 (2246 samples for SR3 and particle stations)
Dissolved Oxygens: 2002
Nutrients: 2746 (2269 samples for SR3 and particle stations)

A1.1 Salinity

Clodagh Moy and Neale Johnston analysed salinities over a 24-hour period each day in the wet lab. A Guildline Autosal salinometer SN 62549 was used. Ocean Scientific IAPSO standard seawater batches used to standardise the salinometer throughout the cruise are summarised in Table A1.1. Repeat standardisations (e.g. P137 measured against P137) showed no difference (i.e. 2R of < 0.00000) over 33 repeats during the cruise. P133 standards were also measured. They showed no difference, average being 0.0000 psu. Additional standards P140 were measured. They showed no difference, average being 0.0000 psu.

There were some problems controlling the temperature of the wet lab for a number of days during the cruise. The temperature ranged between 17 and 21 degrees. A PID temperature

Table A1.1: Summary of IAPSO Standard Seawater (ISS) batches used for salinometer standardisations during cruise AU0103.

CTD station number	ISS batch number
1-7	P133
8-9	P137
10-13	P133 and P137
14-29	P137
30	P133
31-36	P133 and P140
37-42	P140
43-45	P133
46-88	P140
89-115	P133
116-119	P140
120-125	P133
126-128	P140
129-135	P133

controller was used to control the temperature and an independent air-conditioner in the wet lab. Maintaining stable air temperature proved difficult with this air-conditioner, and a close eye was kept on the temperature at all times. Analysis stopped if fluctuations in ambient temperature exceeded 1 degree.

* Files updated:
sal_std_check.xls
sal62549.xls

A1.2 Dissolved oxygen

Dissolved oxygen analyses were performed by Stephen Bray in the wet lab. There were no major problems with the DO system. Standardisation and blank values were collated from this and previous cruises, and plotted to help identify outlying or suspicious values. The average standardisation value and average standard deviation was 4.425 +/- 0.002 ml of thiosulphate. This is 297.7 +/- 0.14 μmol/l of oxygen, or 0.04%. The average blank value and average standard deviation were 0.006 +/- 0.001 ml of thiosulphate.

Files:
do_std&blank.xls, a9901
do_std&blank.xls, all collation of DO standardisation values
do_std&blank.xls, charts   charts of standardisation values
do.xls, variable summary
do.xls, hydro_calc_check

A1.3 Nutrients

Clodagh Moy and Neale Johnston analysed nutrients, timing autoanalyser runs to keep the instrument running over the full 24 hours each day. Phosphate, silicate, nitrite + nitrate were analysed as per CSIRO methods (Cowley, 2001, and Cowley and Johnston, 1999). A new automatic switching valve system was used to change over from reagents to MQ and carrier etc., and included a baseline calibration. Standards were made up every couple of days in low nutrient seawater (collected from Maria Island and filtered and autoclaved, before going on the cruise). The Carrier was Artificial Seawater (or sodium chloride in MQ). New software called 'Winflow' was used, which was user friendly and flexible. A standard run included a baseline calibration using the switching valves, taking approximately 45 mins, followed by a set of standards, some SRMs (Standard Reference Material from Ocean Scientific) and QCs (LNSW spiked with nutrients), and a set of 48 samples followed by a second set of standards, SRMs and QCs. A run normally took about 3 hours to complete.

At the beginning of the cruise there were some problems with the nitrate analyses, resulting in bad peak shapes for NO_2/NO_3. After much experimentation to trace the problem, the batch of HCl and brij used to make up the reagents was changed - this fixed the problem. Trouble was also experienced with a bad batch of Cd coils (3 coils were used over a two week period). A separate batch brought from CSIRO was then used, with one coil lasting 2 weeks, as expected.

Near the end of the cruise the nitrite/nitrate line leaked over the nitrate detector near the exit of the flow cell. The detector began smoking and burning. The motherboard was destroyed and the detector was no longer usable, useful only for spare parts. An additional minor problem occurred with another detector – it would not zero and kept sitting on wait. The Antarctic Division electronics engineer replaced a transistor with one from the burnt detector, fixing the problem.

Data processing was time consuming, with the procedure as follows for each run:

- first the winflow files are tidied up;
- pick peaks and check the standards, SRMs and QCs;
- check the baselines;
- data are then exported to Excel to be further processed;
- using the Fyyvvrr.xlt macro to process the data, import the n,s,p files;
- check the 3-baseline median's (green boxes) and pick the median baseline number;
- check the standards, SRM and QC values;
- check the standard curves and % recovery of the cd coil for N.

When happy with the run, a summary sheet was produced and exported to a *.xlw file for import into HYDRO (a MS-Excel based program for hydrochemistry data handling). Once imported into HYDRO, a csv file was made.

A1.4 General data handling

Plots were made of property versus station to check for suspicious data or wrongly entered data. They were based on the data in the CSV file, and were opened via the macro CSV in A0103.XLM. Data was backed up to 250MB Iomega Zip disks.

A1.5 Laboratories

The salinometer, DO system and nutrient systems were all in the wet lab. The MQ system was in the photo lab. The wet lab and the photo lab were received in clean condition. The salinometer was on the aft bench, starboard side, near the porthole. The nutrient system was on the remaining aft bench. The DO system was on the starboard sorting bench. The port side bench near the door to the trawl deck was used to prepare reagents and runs for the nutrients. The fish bowl contained the data computer, stationary and manuals.

A1.6 Temperature monitoring and control

Temperature in the wet lab was controlled by an independent air conditioner on the starboard side bulkhead and by a CAL Controls Ltd 'CAL 9900' proportional derivative plus integral (PID) temperature controller. The photo lab had no temperature controller. The ships heating inlets above the salinometer were taped closed. The temperature from the air-conditioner fluctuated from 11 to 18 degrees. This caused the temperature controller to struggle when down at the lower temperatures, and resulted in one of the heaters blowing its fuse from over-heating. The air conditioner was monitored regularly to reduce large fluctuations in temperature. The photo lab was heated by the ship's air-conditioning and maintained a steady temperature.

Two Tinytalk units recorded the laboratory temperature in the wetlab. One was positioned beside the salinometer, while the other was positioned beside the DO system. The temperature was also measured by a digital thermometer above the salinometer and the temperature monitored by the PID controller in the wet lab. 'Indoor/outdoor' electronic thermometers were used to measure the fridge and freezer. The air temperature about the salinometer was generally 20.0 +/- 1°C.

A1.7 Purified water

A new RO system was bought before the voyage, instead of using the MBDI tanks. The system seemed to work well. However, some air locks were experienced from time to time and the tanks in the polisher emptied. A lot of people were using our MQ system and about 280L (~14 x 20L carboys) of water was produced for this cruise. Pre-filters were changed three times, and the polishers once.

A1.8 Additional samples analysed

Apart from the main CTD hydrochemistry program, a number of samples were analysed for other scientists on board, as described below:

Additional salinities were analysed for the following people:
Andrew Davidson, AAD: 1 sample; Kelly Goodwin, NOAA: 6 samples;
Nicolas Savoye, VUB: 11 samples; Bronte Tilbrook, CSIRO: 24 samples.
Additional nutrients were analysed for the following people:
Phil Boyd, Alkali: 49 samples; Pete Sedwick, BBSR: 120 samples;
Malcolm Reid, Alkali: 10 samples; Karl Safi, NIWA: 41 samples;
Guido Corno, IASOS: 15 samples; Frank Dehairs,VUB: 218 samples;
Bronte Tilbrook, CSIRO: 24 samples.

Appendix 2 Data file types and formats

A2.1 CTD data

- CTD no.1193 was used for station 1 to 108. CTD no. 1103 was used for stations 109 to 135.
- CTD data are in text files named *.all, containing 2-dbar averaged data. An example of file naming convention:

a01035020.all a = Aurora Australis
01 = year
03 = cruise number
5 = CTD instrument number
020 = CTD station number

- The files consist of a 15 line header with station information (all times are UTC), followed by the data in column format, as follows:

column 1 - pressure (dbar)
column 2 - temperature (degrees C, T90 scale)
column 3 - salinity (PSS78)
column 4 - density-1000 kg/m^3
column 5 - specific volume anomaly
column 6 - geopotential anomaly
column 7 - dissolved oxygen (μmol/l)
column 8 - no. of data points used in the 2 dbar bin
column 9 - standard deviation of temperature data points in the bin
column 10- standard deviation of conductivity data points in the bin
columns 11,12 - fluorescence ((volts) and transmittance (if present)

- All files start at 2 dbar, and there is a line for each 2 dbar value. Any missing data is filled by blank characters.
- All CTD data are downcast data.
- For station 76, the data in the 'fluorescence' column is actually from the copper ion selective electrode (in volts).

A2.2 Niskin bottle data

- The bottle data are contained in the a0103.bot text file, with the following columns:

column 1 - station number
column 2 - ctd pressure (dbar)
column 3 - ctd temperature (deg. C, T90 scale)
column 4 - digital reversing thermometer temperature
column 5 - ctd conductivity (mS/cm)
column 6 - ctd salinity (PSS78)
column 7 - bottle salinity (PSS78)
column 8 - phosphate (μmol/l)

column 9 - nitrate (μmol/l) (i.e. total nitrate+nitrite)
column 10 - silicate (μmol/l)
column 11 - bottle dissolved oxygen (μmol/l)
column 12 - bottle flag (1=good,0=suspicious,-1=bad,mainly relevant
to bottle salinity values for CTD calibration, but not necessarily)
column 13 - niskin bottle number

- Columns 2, 3, 5 and 6 are all the averages of CTD upcast burst data (i.e. averages of the 10 seconds of CTD data prior to each bottle firing)
- Any missing data are filled by a decimal point '.'
- The file fluoro.lis contains the same data as a0103.bot, except that there is a line of data for all 24 rosette positions, and for all station numbers, with null values represented by -9. An additional last column contains CTD upcast burst data for fluorescence.

A2.3 Station information

A summary of the station information is contained in the a0103.sta file (this station information is also included in the matlab file a0103.mat), containing position, time, bottom depth and maximum pressure of cast for CTD stations. The CTD instrument number is specified in the file header. Position and time (UTC) are specified at the start, bottom and end of the cast, while the bottom depth is for the start of the cast.

A2.4 Matlab format

- CTD 2 dbar data and bottle data are also contained respectively in the matlab files a0103.mat and a0103bot.mat. a0103.mat includes station information.
- In the matlab files, column number for each array corresponds with CTD station number.
- In the matlab files, NaN is a null value.
- In the bottle file, the rows 1 to 24 are the shallowest to deepest Niskins respectively.
- For the file a0103.mat, the array names have the following meaning:

(all times are UTC)
'start' refers to start of cast
'bottom' refers to bottom of cast
'end' refers to end of cast
'decimal time' is decimal days from 2400 on 31st Dec. 2000 (so, for example, midday on 2nd January 2001 = decimal time 1.5).
'lat' is latitude (decimal degrees, where -ve = south)
'lon' is longitude (decimal degrees, where +ve = east)
'time' is hhmm time
botd = ocean depth (m)
maxp = maximum pressure of the CTD cast (dbar)
ctdunit = instrument serial number
'ctd' is the upcast CTD burst data, for the parameters:
fluoro = fluorescence
ga = geopotential anomaly

npts = number of data points used in the 2 dbar bin
ox=dissolved oxygen (µmol/l)
press=pressure (dbar)
sal=salinity (PSS78)
sigma_t=density-1000 (kg/m^3)
sva=specific volume anomaly
temp=temperature (deg.C T90)
transmiss=transmissometer data, mostly suspect

- For the file a0103bot.mat, the array names have the following meaning:

'ctd' refers to upcast CTD burst data, for the parameters:
cond = conductivity (mS/cm)
fluoro = fluorescence
press = pressure (dbar)
sal = salinity (PSS78)
temp = temperature (deg.C T90)
'hyd' refers to bottle data, for the parameters:
ox = dissolved oxygen (µmol/l)
sal = salinity (PSS78)
flag = the bottle flagged described under the bottle data section
niskin = niskin bottle number
nitrate, phosphate, silicate = µmol/l
station = station number
therm = digital reversing thermometer temperature (deg.C T90)

A2.5 WOCE data format

The data are also available as WOCE format files, following the standard WOCE format as described in Joyce and Corry (1994).

A2.5.1 CTD 2 dbar-averaged data files

- Data are contained in the files *.ctd
- CTD 2 dbar-averaged file format is as per Table 4.7 of Joyce and Corry (1994), except that measurements are centered on even pressure bins (with first value at 2 dbar).
- CTD temperature and salinity are reported to the third decimal place only.
- The quality flags for CTD data are defined in Table A2.1.

A2.5.2 Bottle data files

- Data are contained in the file a0103.sea, with the file a0103cfc.sea including CFC data.
- Bottle data file format is as per Table 4.5 of Joyce and Corry (1994), with quality flags defined in Tables A2.2 and A2.3.
- The total value of nitrate+nitrite only is listed.
- Silicate is reported to the first decimal place only.
- CTD temperature (including theta), CTD salinity and bottle salinity are all reported to the third decimal place only.

- CTD temperature (including theta), CTD pressure and CTD salinity are all derived from upcast CTD burst data; CTD dissolved oxygen is derived from downcast 2 dbar-averaged data.
- Raw CTD pressure values are not reported.
- SAMPNO is equal to the rosette position of the Niskin bottle.
- Salinity samples rejected for conductivity calibration, as per eqn A2.20 in Rosenberg et al. (1995), are not flagged in the .sea file.

A2.5.3 Conversion of units for dissolved oxygen and nutrients

A2.5.3.1 Dissolved oxygen

Niskin bottle data

For the WOCE format files, all Niskin bottle dissolved oxygen concentration values have been converted from volumetric units μmol/l to gravimetric units μmol/kg, as follows. Concentration C_k in μmol/kg is given by

$$C_k = 1000\, C_l / \rho(\theta,s,0) \qquad \text{(eqn A2.1)}$$

where C_l is the concentration in μmol/l, 1000 is a conversion factor, and $\rho(\theta,s,0)$ is the potential density at zero pressure and at the potential temperature θ, where potential temperature is given by

$$\theta = \theta(T,s,p) \qquad \text{(eqn A2.2)}$$

for the in situ temperature T, salinity s and pressure p values at which the Niskin bottle was fired. Note that T, s and p are upcast CTD burst data averages.

CTD data

In the WOCE format files, CTD dissolved oxygen data are converted to μmol/kg by the same method as above, except that T, s and p in eqns A2.1 and A2.2 are CTD 2 dbar-averaged data.

A2.5.3.2 Nutrients

For the WOCE format files, all Niskin bottle nutrient concentration values have been converted from volumetric units μmol/l to gravimetric units μmol/kg using

$$C_k = 1000\, C_l / \rho(T_l,s,0) \qquad \text{(eqn A2.3)}$$

where 1000 is a conversion factor, and $\rho(T_l,s,0)$ is the water density in the hydrochemistry laboratory at the laboratory temperature T_l = 20.5°C, and at zero pressure. Upcast CTD burst data averages are used for s.

A2.5.4 Station information file

- Data are contained in the file a0103.sum, with the file format as per section 3.3 of Joyce and Corry (1994).

- All depths are calculated using a uniform speed of sound through the water column of 1463 ms^{-1}. Reported depths are as measured from the water surface. Missing depths are due to interference of the ship's bow thrusters with the echo sounder signal.
- An altimeter attached to the base of the rosette frame (approximately at the same vertical position as the CTD sensors) measures the elevation (or height above the bottom) in metres. The elevation value at each station is recorded manually from the CTD data stream display at the bottom of each CTD downcast. Motion of the ship due to waves can cause an error in these manually recorded values of up to ±3 m.
- Wire out (i.e. meter wheel readings of the CTD winch) were unavailable.

Table A2.1: Definition of quality flags for CTD data (after Table 4.10 in Joyce and Corry, 1994). These flags apply both to CTD data in the 2 dbar-averaged *.ctd files, and to upcast CTD burst data in the *.sea files.

flag	definition
1	not calibrated with water samples
2	acceptable measurement
3	questionable measurement
4	bad measurement
5	measurement not reported
6	interpolated over >2 dbar interval
7	despiked
8	this flag not used
9	parameter not sampled

Table A2.2: Definition of quality flags for Niskin bottles (i.e. parameter BTLNBR in *.sea files) (after Table 4.8 in Joyce and Corry, 1994).

flag	definition
1	this flag is not used
2	no problems noted
3	bottle leaking
4	bottle did not trip correctly
5	not reported
6,7,8	these flags are not used
9	samples not drawn from this bottle

Table A2.3: Definition of quality flags for water samples in *.sea files (after Table 4.9 in Joyce and Corry, 1994).

flag	definition
1	this flag is not used
2	acceptable measurement
3	questionable measurement
4	bad measurement
5	measurement not reported
6	mean of replicate measurements
7	manual autoanalyser peak measurement
8	this flag not used
9	parameter not sampled

A2.6 ADCP data

ADCP data are available as 30 ensemble averages, contained in the following files:

au010301.cny - text format, all data
au0103_slow35.cny - text format, 'on station' data
(i.e. data for which ship speed ≤ 0.35 ms^{-1})
a0103dop.mat - matlab format, all data
a0103dop_slow35.mat - matlab format, 'on station' data
(i.e. data for whichship speed ≤ 0.35 ms^{-1})

Full file format description is given in the text file README_au0103_adcp, included with the data.

A2.7 Underway data

Ship's underway data (including meteorological data, bathymetry, GPS, and sea surface temperature/salinity/fluorescence), quality controlled by the dotzapper (Ruth Lawless, unpublished data quality control report), are contained in the following files:

clivar_underway.ora - text format, 1 minute instantaneous data
clivar_underway.mat - matlab format, 1 minute instantaneous data

See section 4.5 above for more details. Full file format description is given in the text file README_clivar_underway, included with the data. Note that there are a few suspiciously low sea surface salinity values near the start and end of the time series.

Appendix 3 CFC measurements on AU0103 (CLIVAR repeat of P12) - Preliminary shipboard report

Mark J. Warner, University of Washington, School of Oceanography, Box 355351, Seattle, WA 98195-5351 USA (Telephone: 206-543-0765, FAX: 206-685-3351, E-mail: mwarner@ocean.washington.edu)

Co-investigator: John L. Bullister, NOAA-PMEL, Building 3, 7600 Sand Point Way, Seattle, WA 98115 USA (Telephone: 206-526-6741, FAX: 206-526-6744, E-mail: bullister@pmel.noaa.gov)

A3.1 CFC sampling procedures and data processing

Analysts: Mark J. Warner, University of Washington

Fred A. Menzia, Joint Institute for the Study of Atmosphere and Ocean

Concentrations of three dissolved chlorofluorocarbons (CFC-11, CFC-12, and CFC-113) were measured in approximately 1350 samples during this section. The sampling procedure and analytical techniques are based upon those described by Bullister and Weiss (1988). Samples for CFC analyses were drawn from the 10-liter Niskins into 100 cm^3 ground glass syringes fitted with stainless steel syringe tips. These syringes were stored in a water bath until analyses. A portable laboratory on the heli-deck housed the analytical instrumentation. Underway measurement of atmospheric CFC concentrations was accomplished by pumping air from the bow through approximately 100 m of 3/8-in Dekaron tubing into the CFC portable laboratory. The separation of the CFCs was accomplished using a 46 cm Porasil B, 80/100 mesh precolumn followed by a 1.5 m Carbograph 1AC column in a Shimadzu Mini-2 gas chromatograph.

Shipboard electron capture gas chromatography was used to measure CFC concentrations in air, seawater, and gas standards during the expedition. In general, the precision of the measurements was outstanding during this expedition. The precisions for the response of the detector to injection of an approximately 3.7 cm^3 loop of gas standard 33790 (CFC-11: 265.04 parts per trillion, CFC-12: 525.04 ppt, CFC-113: 82.84 ppt) was 1.04% for CFC-11, 0.63% for CFC-12, and 3.14% for CFC-113 over the entire cruise. Two calibration curves were used for the cruise and show relatively small differences (less than 1% difference in sensitivity over most of the range). Atmospheric concentrations for the CFCs showed very little variation, either temporally or spatially, during the cruise. The mean atmospheric mixing ratios on the SIO93 calibration scale are:

CFC-11:	253.09±1.58 ppt
CFC-12:	538.03±1.95 ppt
CFC-113:	78.51±1.14 ppt

Seawater samples have been corrected for blanks introduced through the analytical system. A residual contamination existed in the valve at the top of the sparging chamber. These blanks, although relatively high, were also fairly constant and reduced during the course of the expedition. The preliminary measurements have not been corrected for any contamination introduced from the Niskin bottles or the sampling procedure. These will be determined from a careful examination of the seawater CFC concentrations at the northern end of the section. Approximately 35 duplicate syringes were sampled and analysed to determine precision for seawater measurements. The calculated precisions are listed below; whichever is smaller, the concentration or percentage, applies to the data:

CFC-11:	±0.0022 pmol kg-1 or 0.74%
CFC-12:	±0.0016 pmol kg-1 or 0.74%
CFC-113:	±0.0040 pmol kg-1 or 2.7%

These data exceed the precision established for CFC-11 and CFC-12 as WOCE standards. (No standard was set for CFC-113.)

A3.2 Analytical problems

Prior to CTD 17, a small leak existed in the portion of the system used for analyses of standard gas and bow air samples but not in the portion of the system used for seawater samples. This resulted in apparently high seawater concentrations and surface saturations of CFCs. Shortly before finding this leak, the electrometer on the Shimadzu Mini-2 Gas Chromatograph had been replaced due to poor temperature control for the oven. This complicates the ability to correct the seawater data from CTDs 1-12, since the new electrometer also altered the amplified signal from the ECD. For this preliminary data report, the post-leak calibration curve has been applied to all this data and the seawater concentrations multiplied by the ratio of the sensitivities for 1 large gas sample volume before the leak and after the leak. Prior to fixing the leak, the precision of measured CFC-113 concentrations in the gas standards was too poor to attempt to measure seawater concentrations. CFC-113 concentrations are only reported after CTD 16.

A small amount of contamination was introduced to the analytical system through the use of a lubricating spray in the deadbolt on the van door. The baseline drifted upward and became very noisy for 1.5 days. Low-concentration samples of CFC-113 are suspect (WOCE flag = 3) during this period (CTD 60-2) due to baseline noise. The signal-to-noise is much greater for both CFC-11 and CFC-12, so these gases appear to be unaffected by the problem.

A few samples showed obvious signs of contamination and have been flagged as bad (WOCE flag = 4). There may be other suspect data which have yet to be identified and flagged.

Appendix 4 Inter-cruise comparisons

A4.1 Introduction

Inter-cruise comparisons for data collected along the SR3 transect during the 1990s are described in Rosenberg et al. (1997). Comparisons are extended here to include this latest occupation of SR3. Brief comparisons of salinity, dissolved oxygen and nutrient data are made between au0103 data and data from cruises au9601 (August-September 1996) and au9404 (January-February 1995).

Overlapping stations from the three cruises (Table A4.1) were selected with the requirement of a spacial separation less than 3 nautical miles. In most cases, spacial separation is in fact less than 1 nautical mile. Meridional sections of neutral density (McDougall, 1987) are shown in Figures A4.1a to c, including CTD station positions.

Table A4.1: Stations from each cruise used for parameter comparisons (latitudes are for au0103).

latitude (degrees)	*au0103*	*au9601*	*au9404*	*latitude (degrees)*	*au0103*	*au9601*	*au9404*
-44.0027	2	69	106	-52.3717	45	37	-
-44.0537	3	68	-	-52.6672	46	36	83
-44.1165	4	67	105	-53.1312	48	35	82
-44.3692	5	66	-	-54.0687	54	33	80
-44.7225	6	65	103	-54.5320	56	32	79
-45.2192	7	64	102	-55.0162	57	31	78
-45.7337	9	63	101	-55.4802	59	30	77
-46.1687	10	62	100	-55.9217	60	29	-
-46.6432	11	61	99	-56.4260	61	28	-
-47.1480	13	60	-	-56.9322	63	27	75
-47.4440	19	59	97	-57.8525	66	25	-
-47.9993	20	58	-	-58.8493	67	23	-
-48.3187	21	57	95	-59.3490	69	22	-
-49.2715	26	55	93	-59.8367	71	21	71
-49.6083	28	54	-	-60.3502	72	20	-
-49.8930	29	46	-	-60.8362	75	19	-
-50.1620	30	45	-	-61.3185	78	18	69
-50.6718	33	43	89	-61.8502	79	17	68
-51.2592	39	41	-	-62.3497	80	16	67
-51.5380	40	40	-	-62.8432	82	15	66
-51.8095	41	39	85	-63.3705	83	-	65
-52.0853	43	38	-	-64.5207	90	12	-

A4.2 Salinity

The meridional variation of the salinity maximum (i.e. for Lower Circumpolar Deep Water, as defined by Gordon, 1967) is compared for the three cruises. Using the 2 dbar averaged CTD salinity data, differences are formed between the deep water salinity maxima for the cases au0103-au9601, au0103-au9404, and au9601-au9404 (Figure A4.2). A mean difference value is included with each figure. (Note that temperatures at the deep salinity maximum are above zero, thus au0103 salinities here are unaffected by the conductivity error at depth for subzero waters, discussed in section 5.1.1). For each cruise pairing, several outliers are omitted – these outliers are due either to curtailing of the vertical salinity profile by the bottom, or change in vertical profile character due to the movement of fronts (Figures A4.1a to c). Note that for au9601-au9404, a similar comparison was done in Rosenberg et al. (1997), giving a mean difference value of -0.004 (PSS78). The slightly different value here of -0.0033 (PSS78) is due to the omission of outliers.

The au0103-au9601 comparison (Figure A4.2) shows salinity correspondence between the 2 cruises within 0.001 (PSS78). For both these cruises, Guildline Autosal salinometers were used for analysis of salinity Niskin bottle samples. The au0103-au9404 and au9601-au9404 differences of approximately -0.003 (Figure A4.2) are larger. These consistently larger differences are due to the less accurate YeoKal salinometer used on au9404, as discussed in Rosenberg et al. (1997).

In an earlier comparison between cruises au9601 and me9706 (in Rosenberg et al., 1997), with Guildline salinometers used on both these cruises, a mean difference of -0.002 (PSS78) was found. The larger magnitude of this difference compared to the au0103-au9601 value is attributed to a standardisation offset on cruise me9706, possibly due to unstable laboratory temperature.

A4.3 Niskin bottle data

Dissolved oxygen and nutrient bottle data from cruises au0103, au9601 and au9404 are compared on neutral density surfaces. Neutral density values are calculated using a routine by David Jackett (CSIRO Division of Marine Research, Hobart); oxygen and nutrient bottle data are interpolated onto neutral density surfaces using a routine by Serguei Sokolov (CSIRO Division of Marine Research, Hobart) (using bilinear interpolation). Station pairings are as per Table A4.1. Note that only data below 1000 dbar are used – this excludes from the comparisons the most seasonally varying data, as well as data in the highest vertical gradients. Meridional variations of parameter differences on 10 neutral density (i.e. γ) surfaces are shown as follows:

- Figure A4.3 for dissolved oxygen,
- Figure A4.4 for phosphate,
- Figure A4.5 for nitrate+nitrite,
- Figure A4.6 for silicate.

For each parameter, differences are shown for the cases au0103-au9601, au0103-au9601, and au9601-au9404.

A4.3.1 Dissolved oxygen

For all three cruises, oxygen bottle samples were analysed using the automated titration system developed by Woods Hole Oceanographic Institution (Knapp et al., 1990).

From Figures A4.3a to c, au0103 oxygen values are mostly higher than values for au9601 and au9404, while au9601 values are mostly higher than au9404. For density surfaces 27.8 to 28.3 over the latitude range 47 to 64°S, the following mean differences (with standard deviations) are found:

au0103-au9601	2.2 µmol/l ± 2.29 µmol/l
au0103-au9404	4.2 µmol/l ± 1.73 µmol/l
au9601-au9404	2.1 µmol/l ± 2.33 µmol/l

From Appendix 1, oxygen standardisation values for au0103 were reasonably stable (±0.14 µmol/l). For au9601, a jump in standardisation values was noted after station 40 (Rosenberg et al., 1997), i.e. after latitude ~51.5°S. This jump, of the order 2 µmol/l, is not obvious in the comparisons shown in Figures A4.3a and c.

A4.3.2 Phosphate

From the inter-cruise comparisons in Rosenberg et al. (1997), au9601 phosphate values were found to be lower than all earlier cruises by ~0.1 µmol/l, and confirmation of the assumed improvement of phosphate data for au9601 was required from a future cruise. From Figures A4.4a to c, au0103 and au9601 phosphates are both consistently lower than au9404. For density surfaces 27.8 to 28.3 over the latitude range 47 to 64°S, the following mean differences (with standard deviations) are found:

au0103-au9601	0.00 µmol/l	± 0.046 µmol/l
au0103-au9404	-0.11 µmol/l	± 0.028 µmol/l
au9601-au9404	-0.11 µmol/l	± 0.046 µmol/l

Although there is some scatter about the mean zero au0103-au9601 phosphate difference (Figure A4.4a), the standard deviation value is only ~1.5% of full scale (where full scale = 3.0 µmol/l), and phosphate values appear mostly consistent for au0103 and au9601 south of 48°S. This confirms the improvement in phosphate analytical methods for au9601 and au0103, compared with earlier cruises, with the error in earlier cruises due to the phosphate analysis 'carryover effect' discussed in Rosenberg et al. (1997). North of ~48°S, au0103 phosphate is higher than au9601 by ~0.06 µmol/l (Figure A4.4a).

A4.3.3 Nitrate+nitrite

Inter-cruise comparisons for nitrate+nitrite (Figures A4.5a to c) are not as simple to summarise as phosphate. The clearest trends are north of 49°S and south of 61°S, where nitrate+nitrite concentrations are (from highest to lowest): au0103, au9404, au9601. Between 49 and 61°S, differences are in general scattered about zero, except for au0103-au9601 which is mostly positive between 54 and 61°S (Figure A4.5a). For all density surfaces over all latitudes, the following mean differences (±standard deviations) are found:

latitude range 45 – 49°S	au0103-au9601	1.07 µmol/l	± 0.40 µmol/l
	au0103-au9404	0.34 µmol/l	± 0.34 µmol/l
	au9601-au9404	-0.59 µmol/l	± 0.46 µmol/l
latitude range 49 - 54°S	au0103-au9601	0.23 µmol/l	± 0.69 µmol/l
	au0103-au9404	-0.09 µmol/l	± 0.74 µmol/l
	au9601-au9404	-0.02 µmol/l	± 0.66 µmol/l
latitude range 54 - 61°S	au0103-au9601	0.28 µmol/l	± 0.29 µmol/l
	au0103-au9404	0.12 µmol/l	± 0.38 µmol/l
	au9601-au9404	0.06 µmol/l	± 0.60 µmol/l
latitude range 61 - 65°S	au0103-au9601	1.15 µmol/l	± 0.26 µmol/l
	au0103-au9404	0.39 µmol/l	± 0.26 µmol/l
	au9601-au9404	-0.74 µmol/l	± 0.17 µmol/l

The largest scatter for all three cruises is between 49 and 54°S, where standard deviations in the above table are ~2% of full scale (where full scale = 35 µmol/l).

A4.3.4 Silicate

Silicate concentrations for au0103 are mostly higher than for au9601 and au9404 (Figures A4.6a and b), while values for au9601 and au9404 appear mostly consistent, with no significant offset (Figure A4.6c). For all density surfaces over all latitudes, the following mean differences (±standard deviations) are found:

au0103-au9601	4.0 μmol/l	± 3.5 μmol/l
au0103-au9404	5.8 μmol/l	± 3.2 μmol/l
au9601-au9404	0.9 μmol/l	± 4.0 μmol/l

For silicate, the standard deviation values are all higher than 2% of full scale (where full scale = 150 μmol/l). So overall the inter-cruise scatter of silicate values is higher than for the other nutrients, confirmed by close inspection of individual stations (Bronte Tilbrook, CSIRO Division of Marine Research, personal communication).

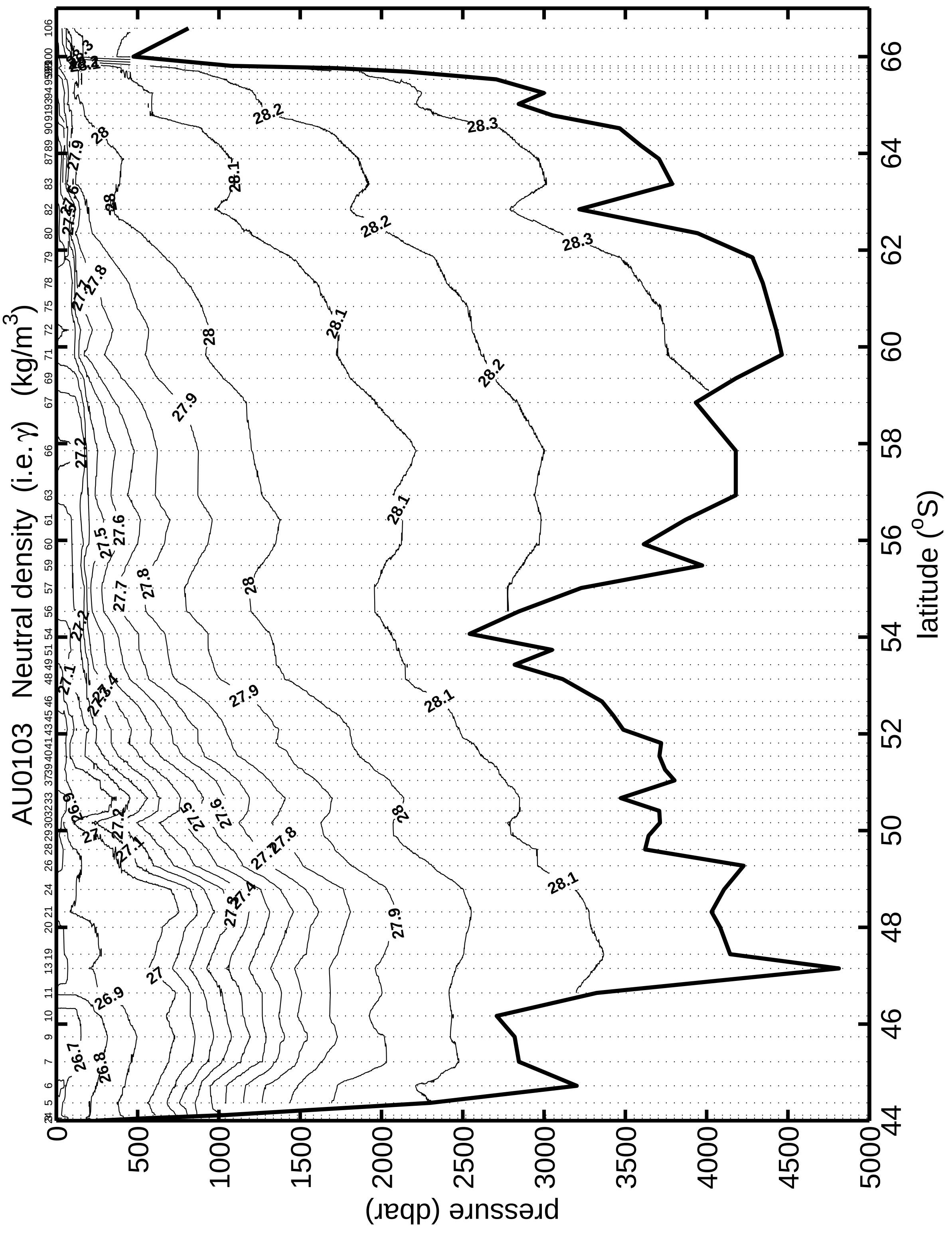


Figure A4.1a: Meridional section of neutral density for cruise au0103 along SR3 transect, including CTD station positions.

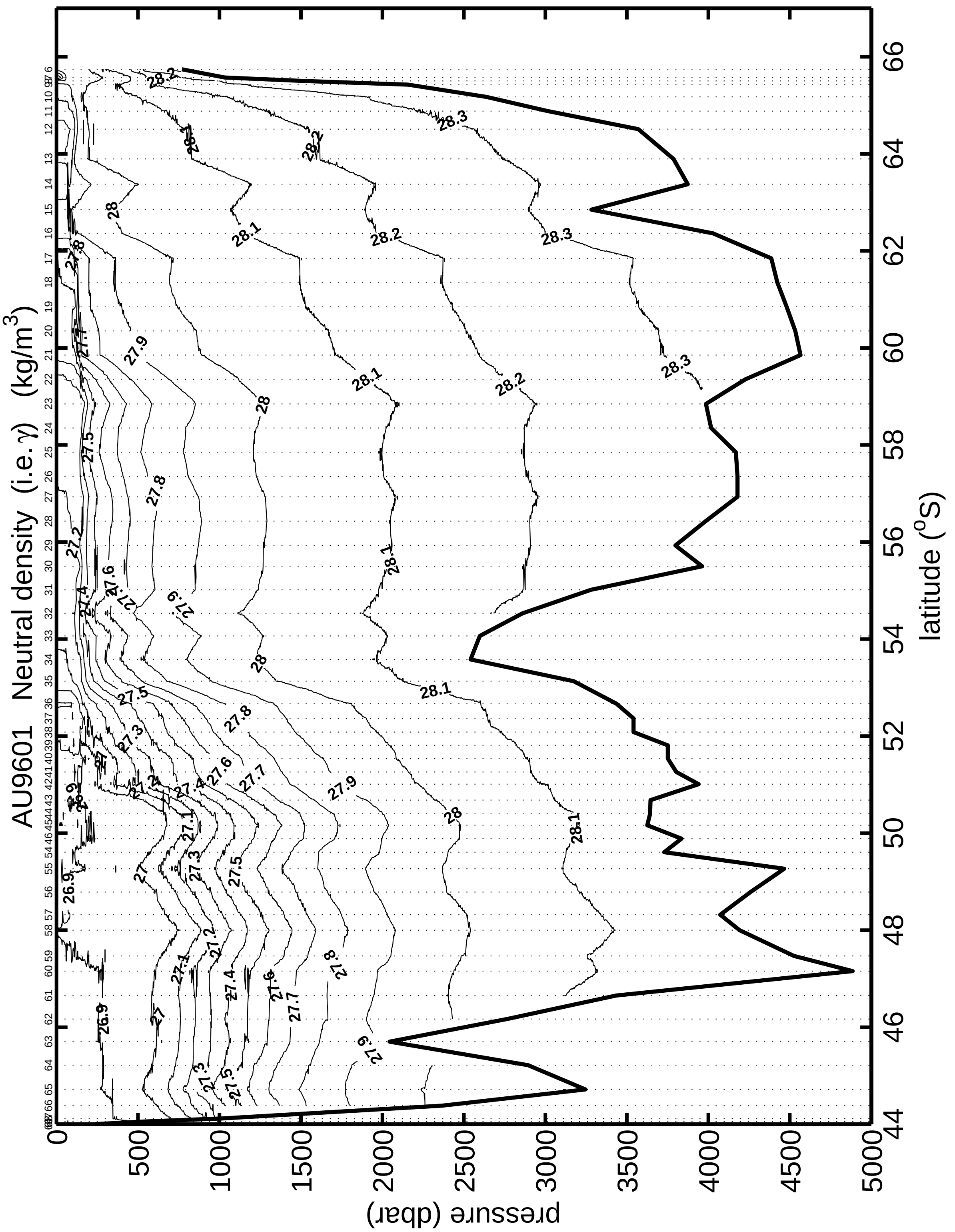


Figure A4.1b: Meridional section of neutral density for cruise au9601 along SR3 transect, including CTD station positions.

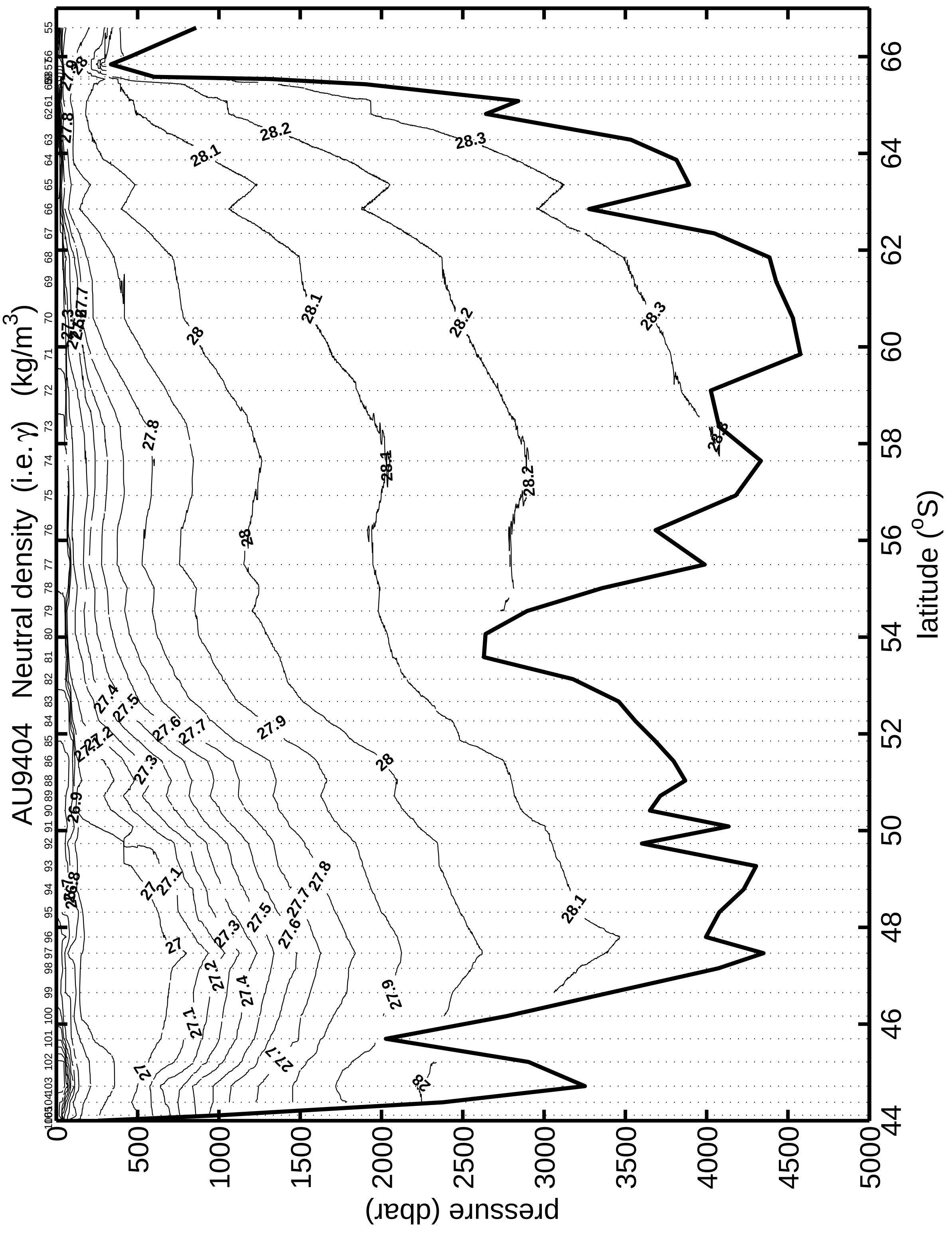


Figure A4.1c: Meridional section of neutral density for cruise au9404 along SR3 transect, including CTD station positions.

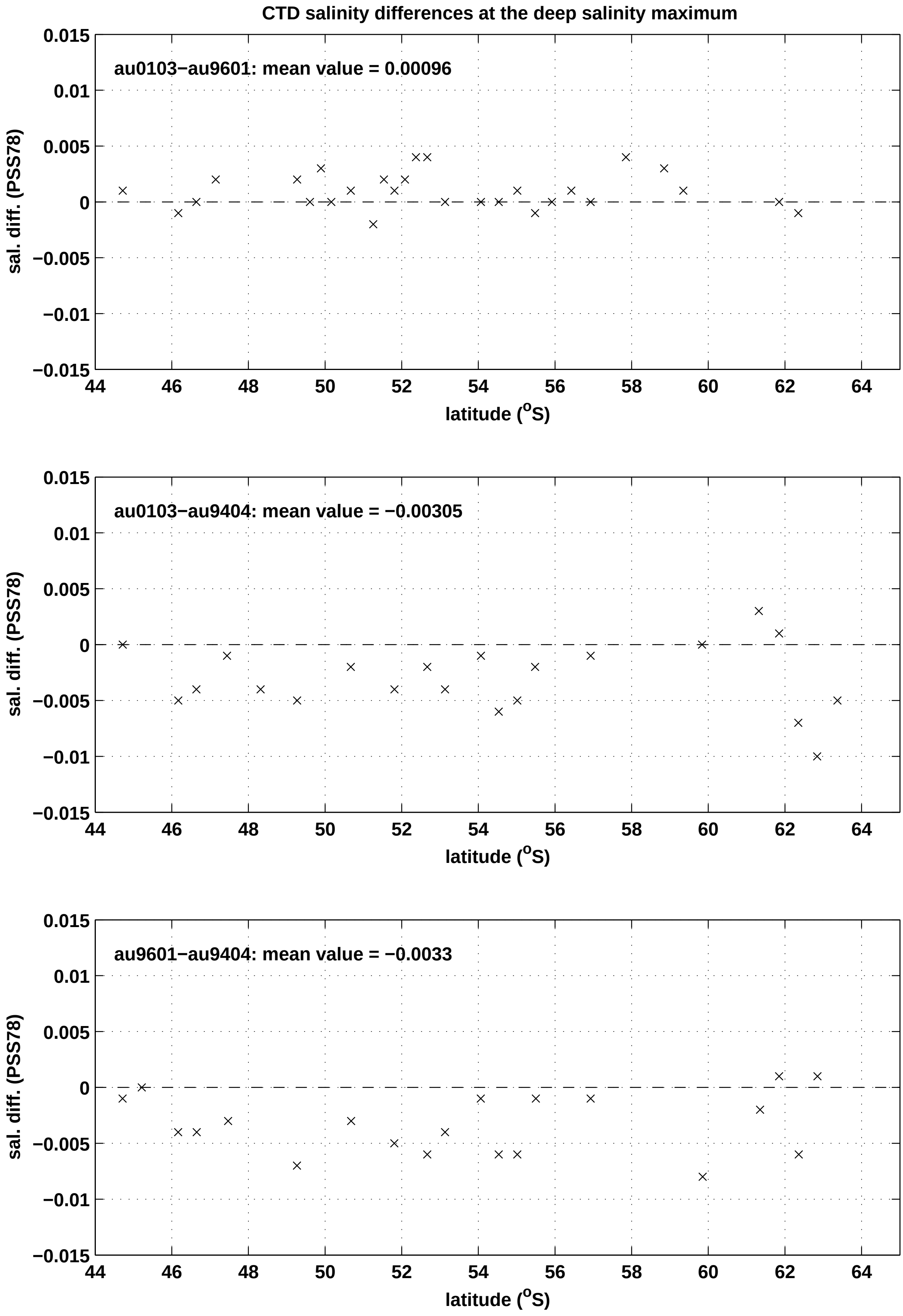


Figure A4.2: CTD salinity differences at the deep salinity maximum, along the SR3 transect. Differences shown for au0103-au9601, au0103-au9404, and au9601-au9404.

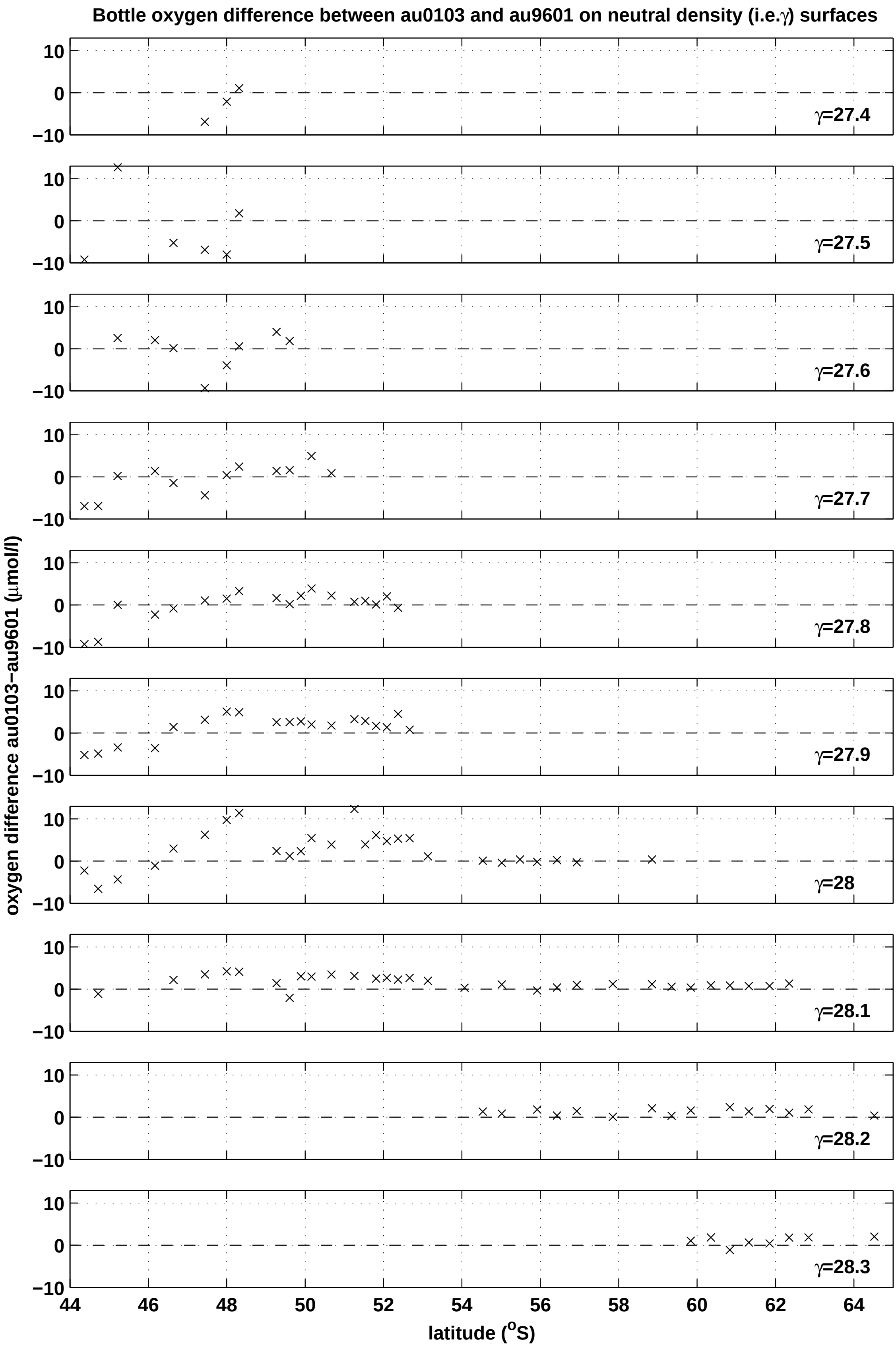


Figure A4.3a: au0103-au9601 bottle oxygen differences on neutral density surfaces.

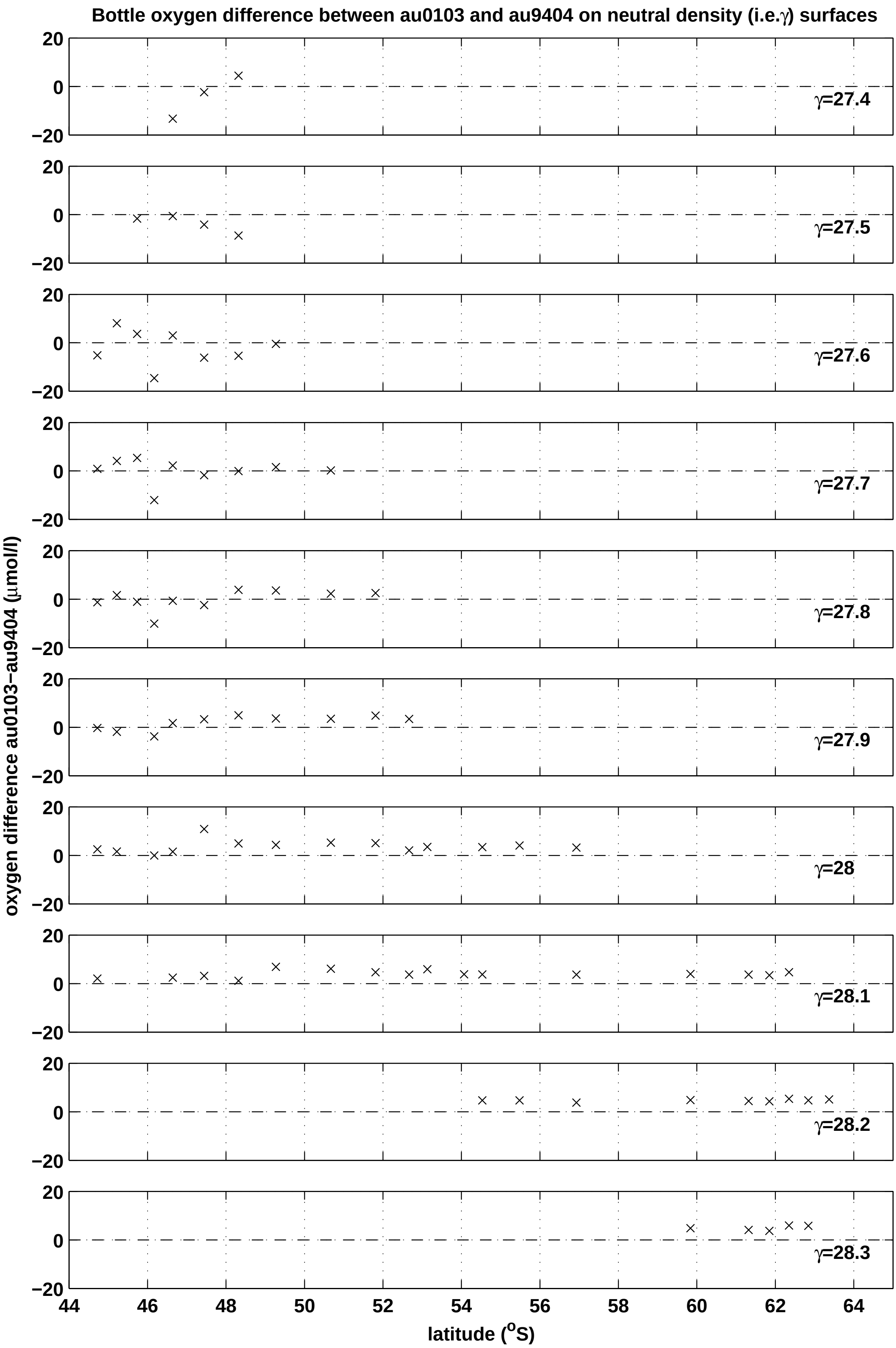


Figure A4.3b: au0103-au9404 bottle oxygen differences on neutral density surfaces.

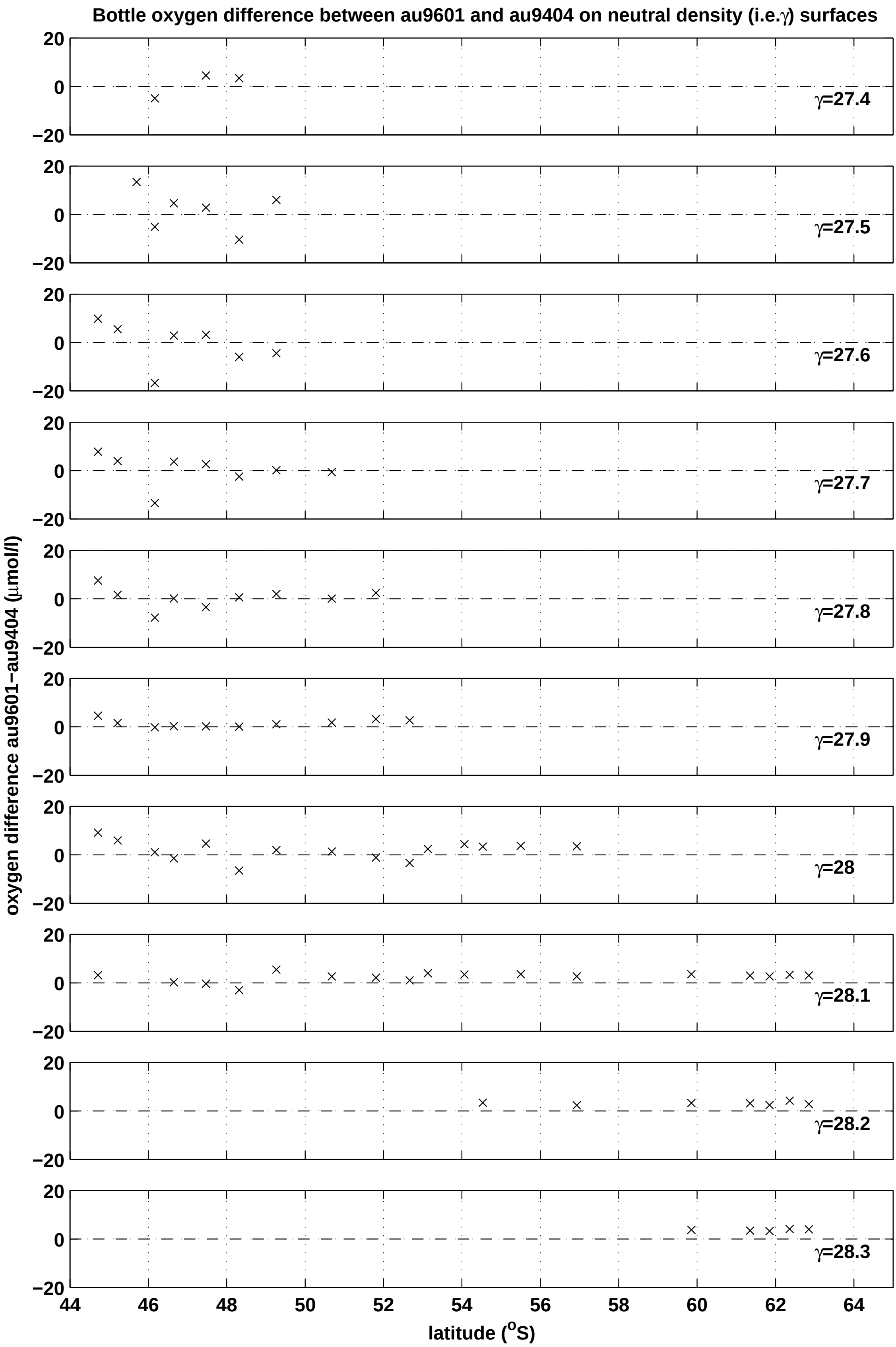


Figure A4.3c: au9601-au9404 bottle oxygen differences on neutral density surfaces.

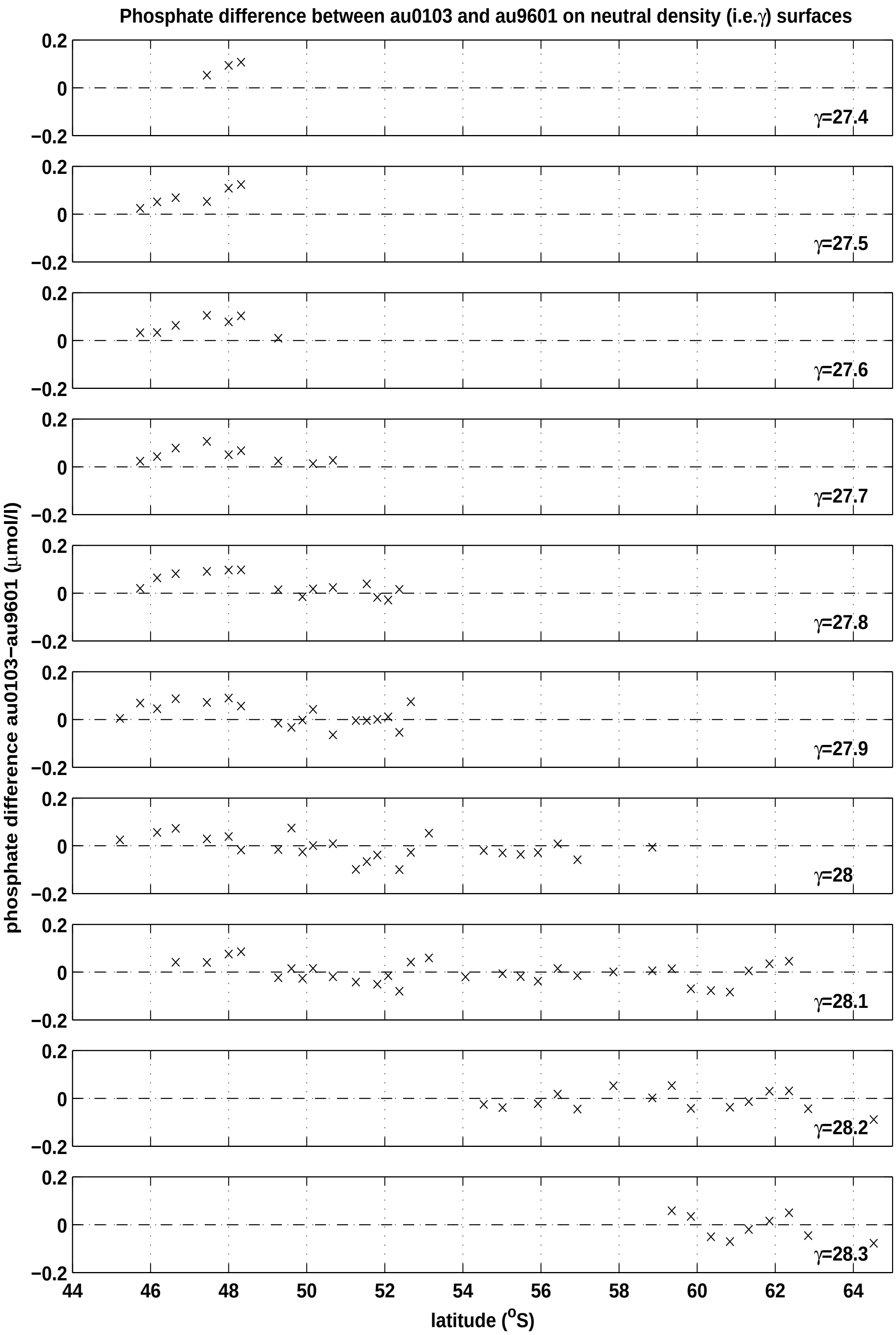


Figure A4.4a: au0103-au9601 phosphate differences on neutral density surfaces.

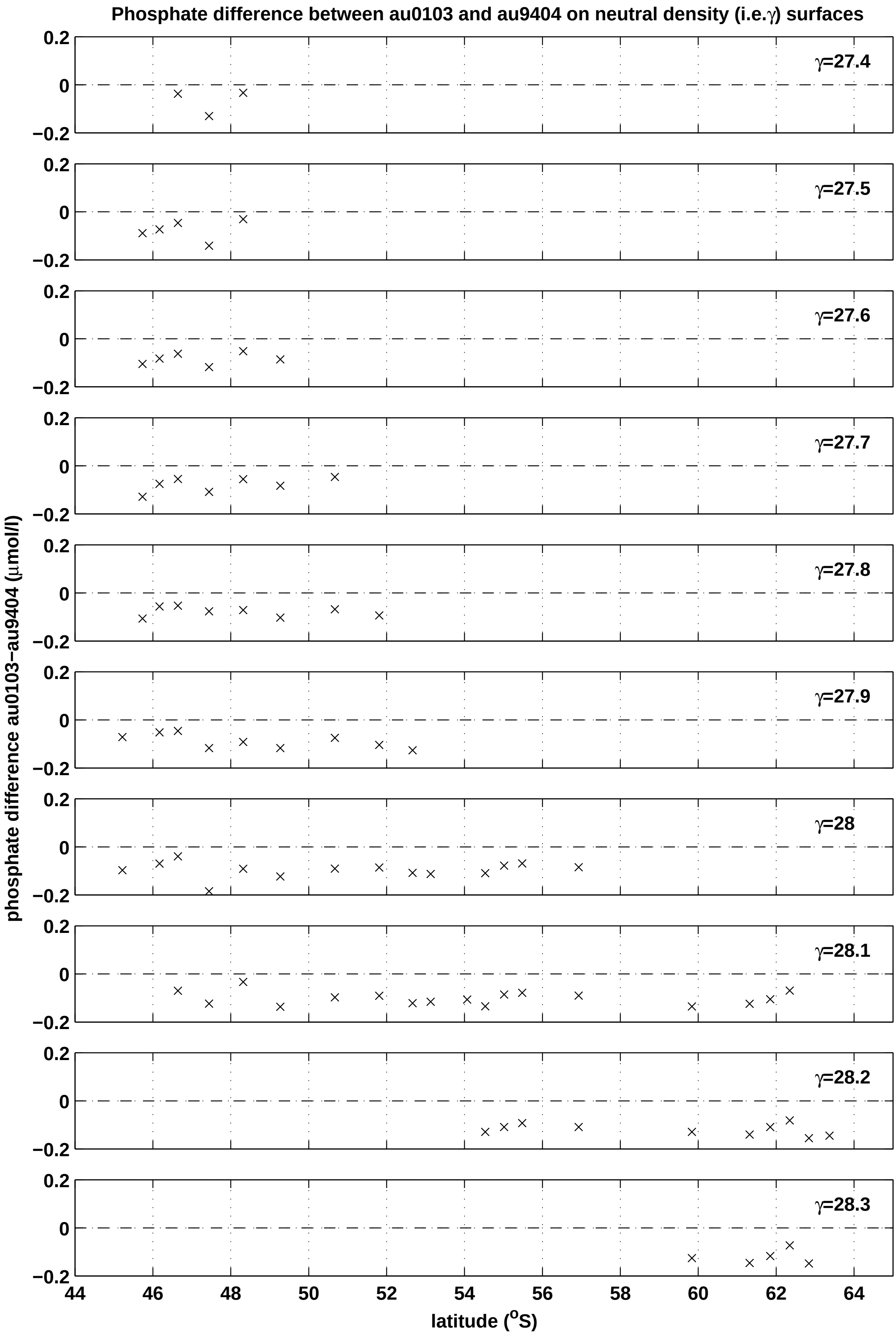


Figure A4.4b: au0103-au9404 phosphate differences on neutral density surfaces.

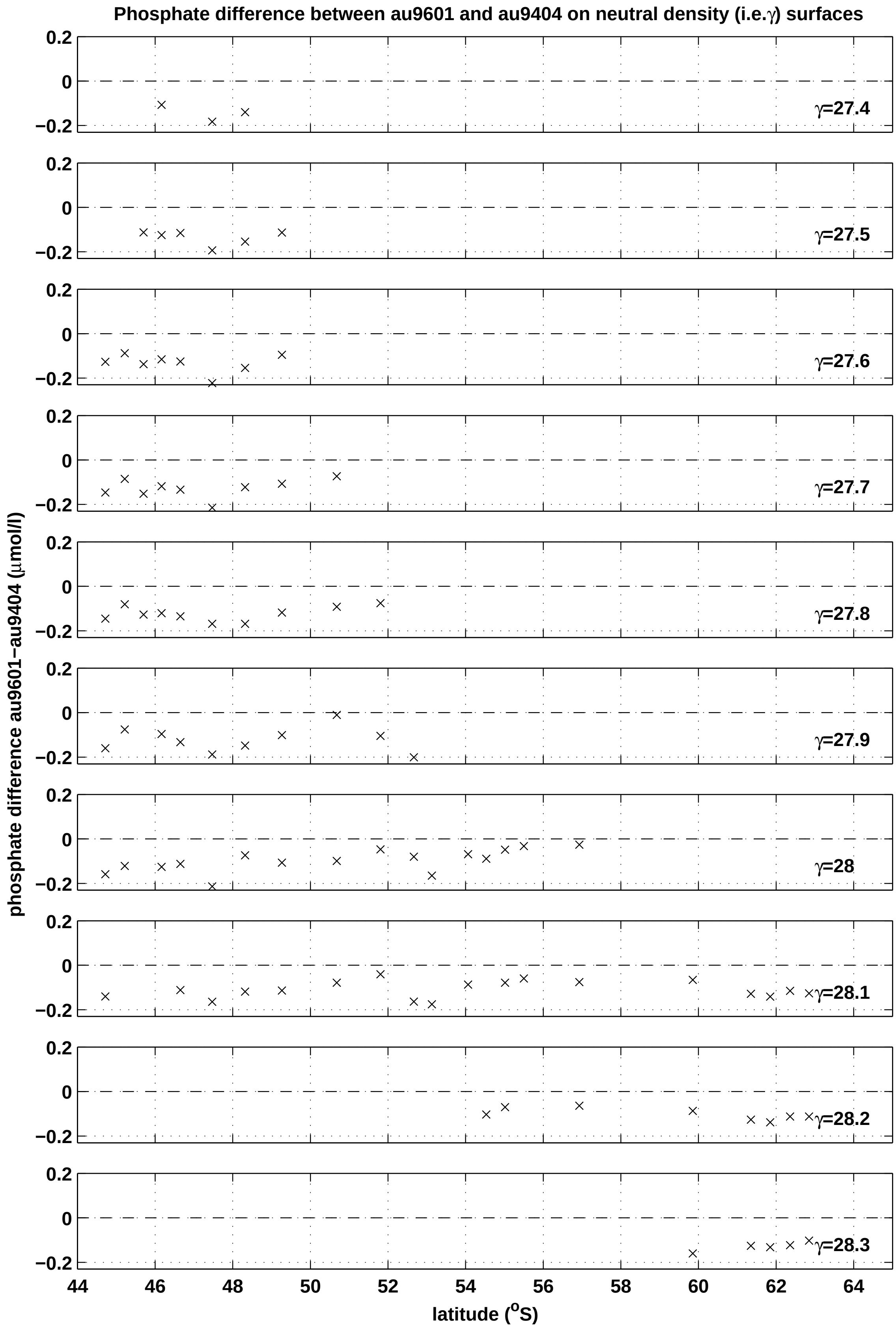


Figure A4.4c: au9601-au9404 phosphate differences on neutral density surfaces.

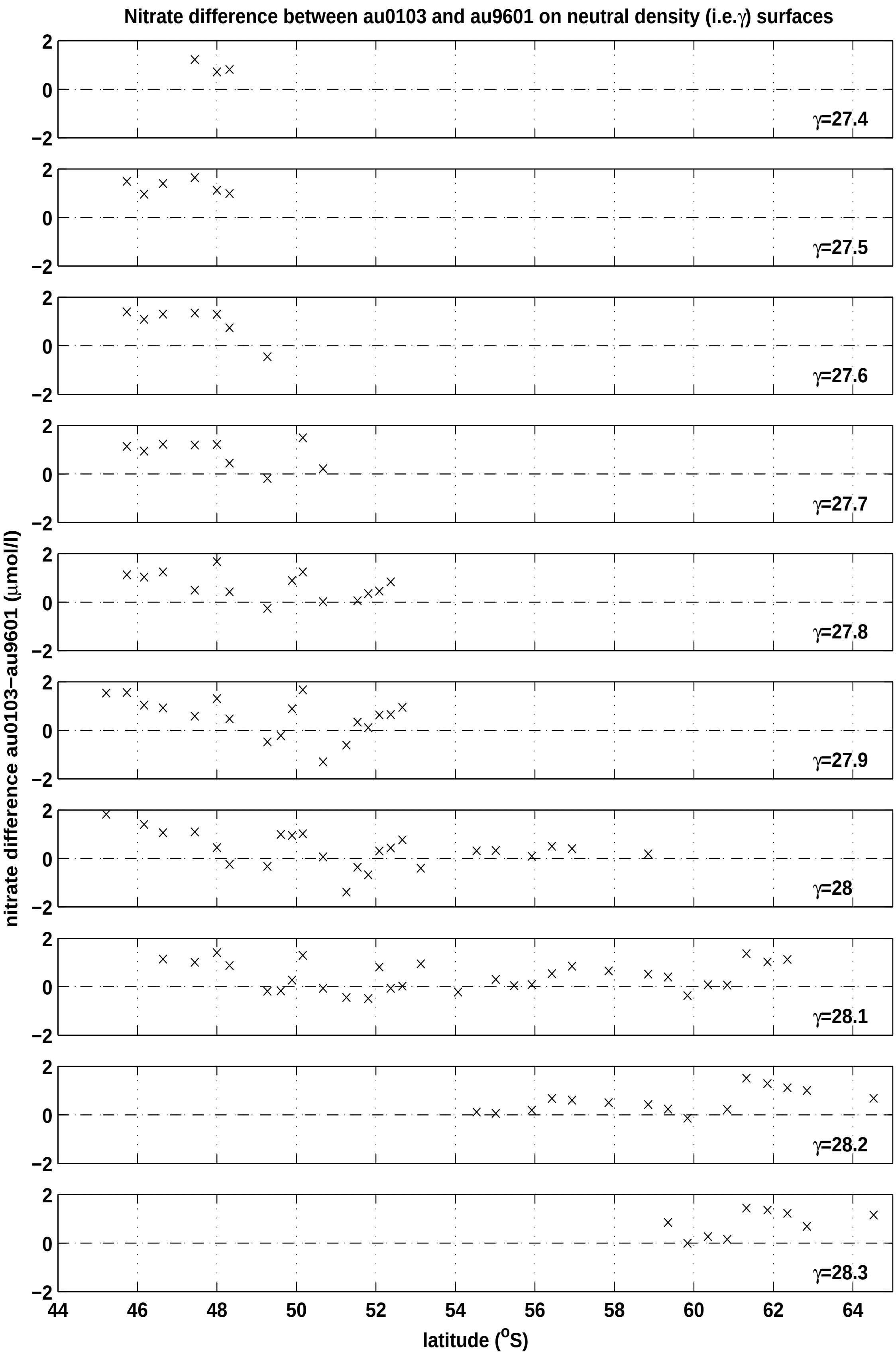


Figure A4.5a: au0103-au9601 nitrate+nitrite differences on neutral density surfaces.

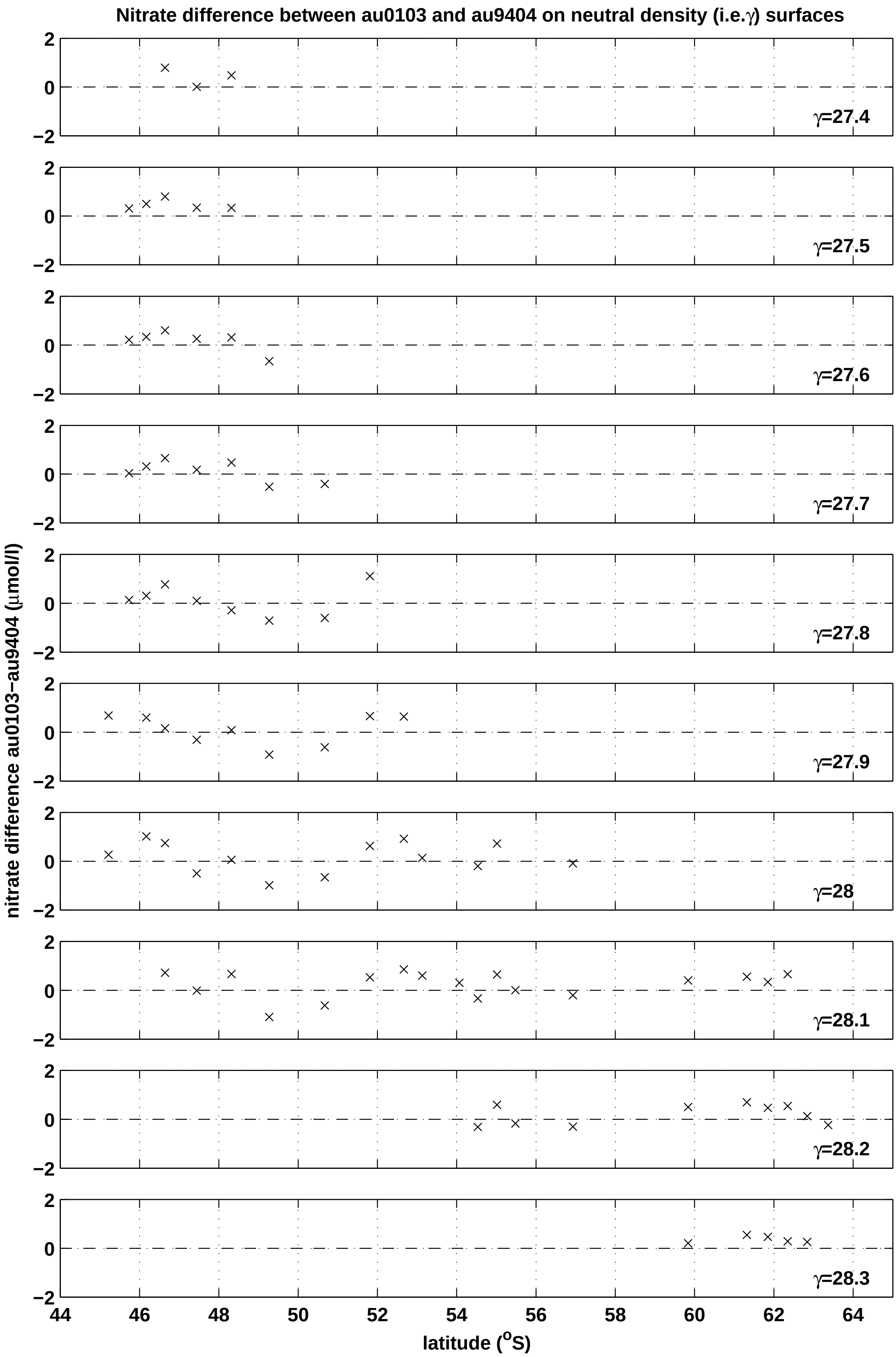


Figure A4.5b: au0103-au9404 nitrate+nitrite differences on neutral density surfaces.

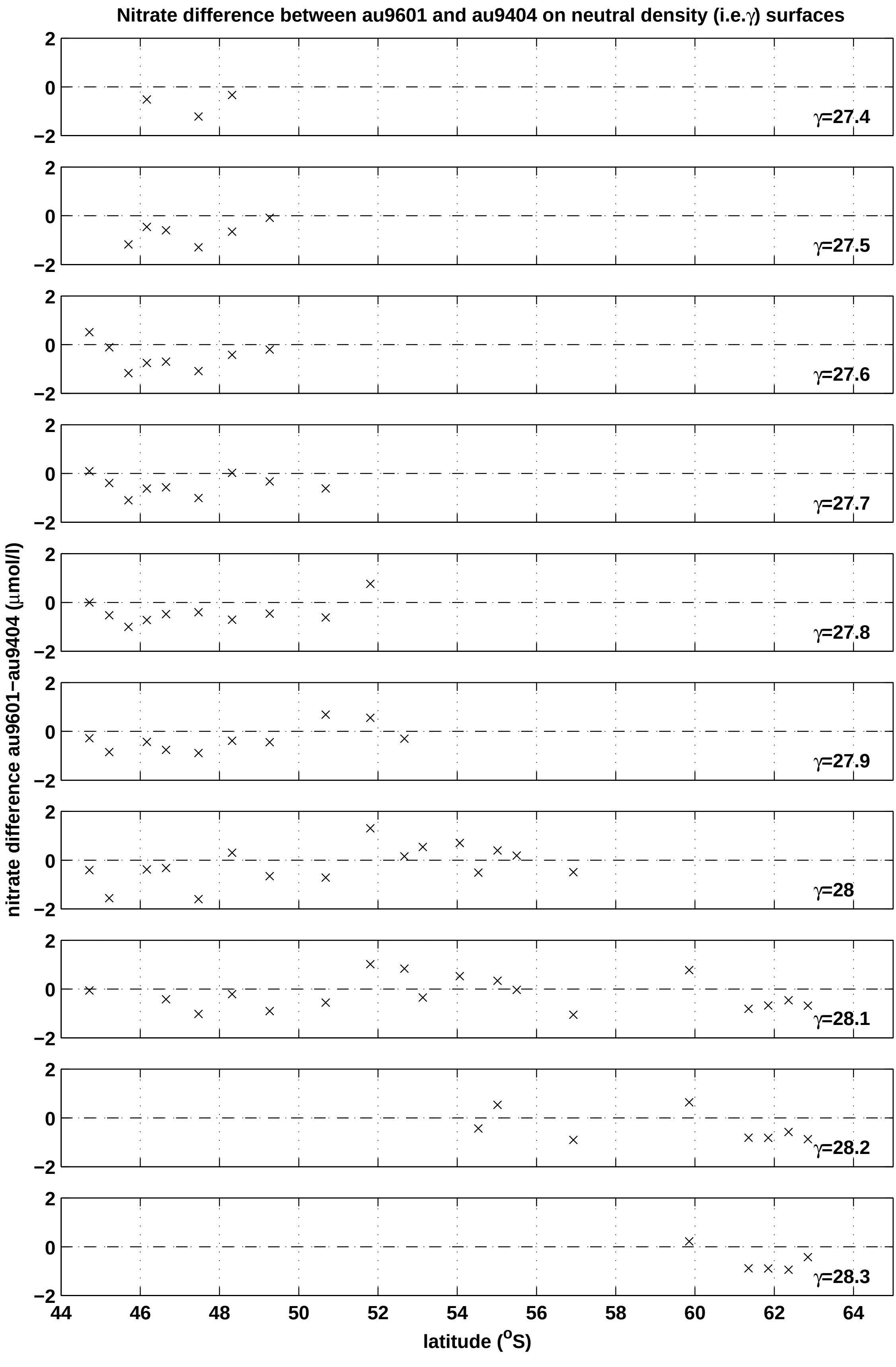


Figure A4.5c: au9601-au9404 nitrate+nitrite differences on neutral density surfaces.

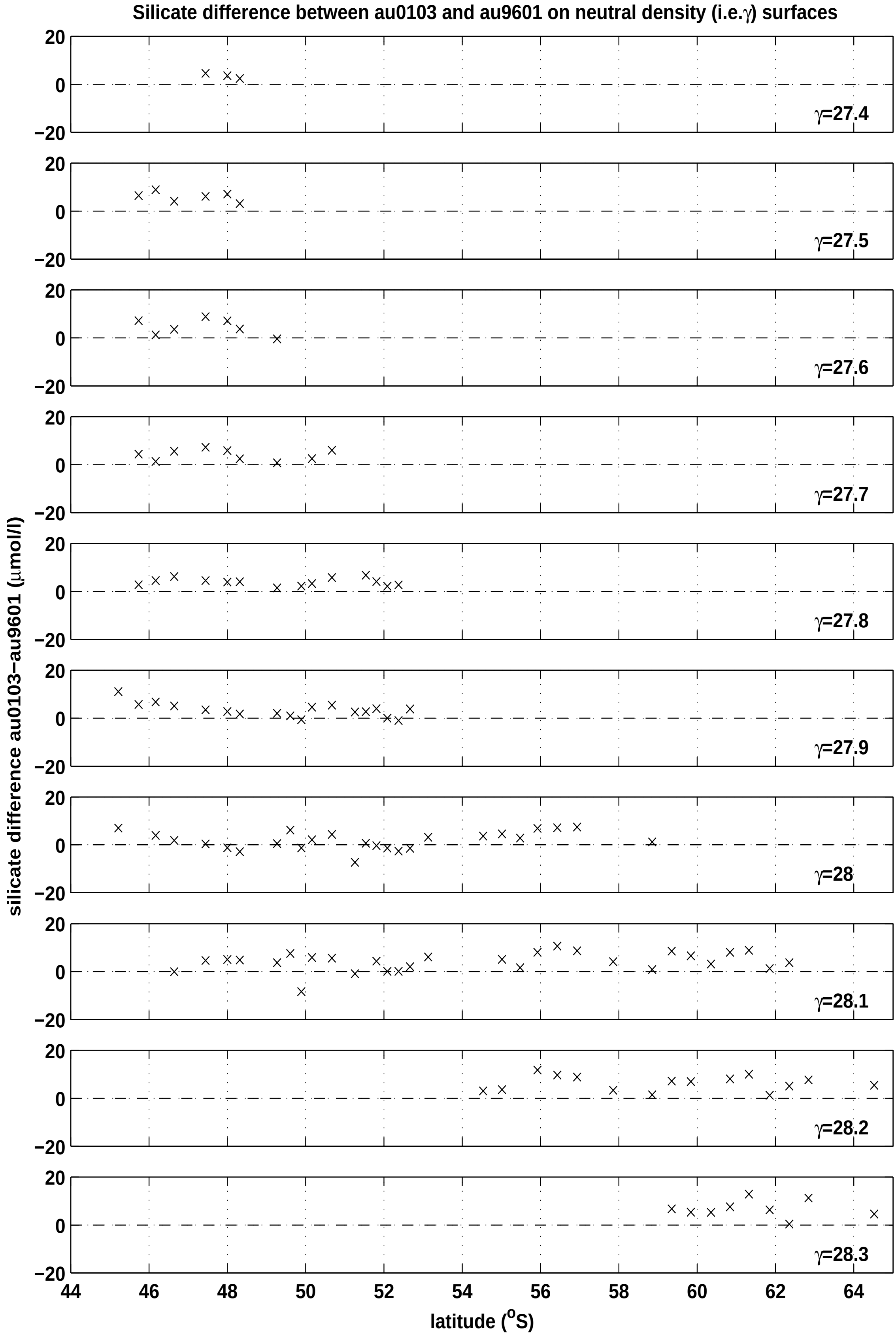


Figure A4.6a: au0103-au9601 silicate differences on neutral density surfaces.

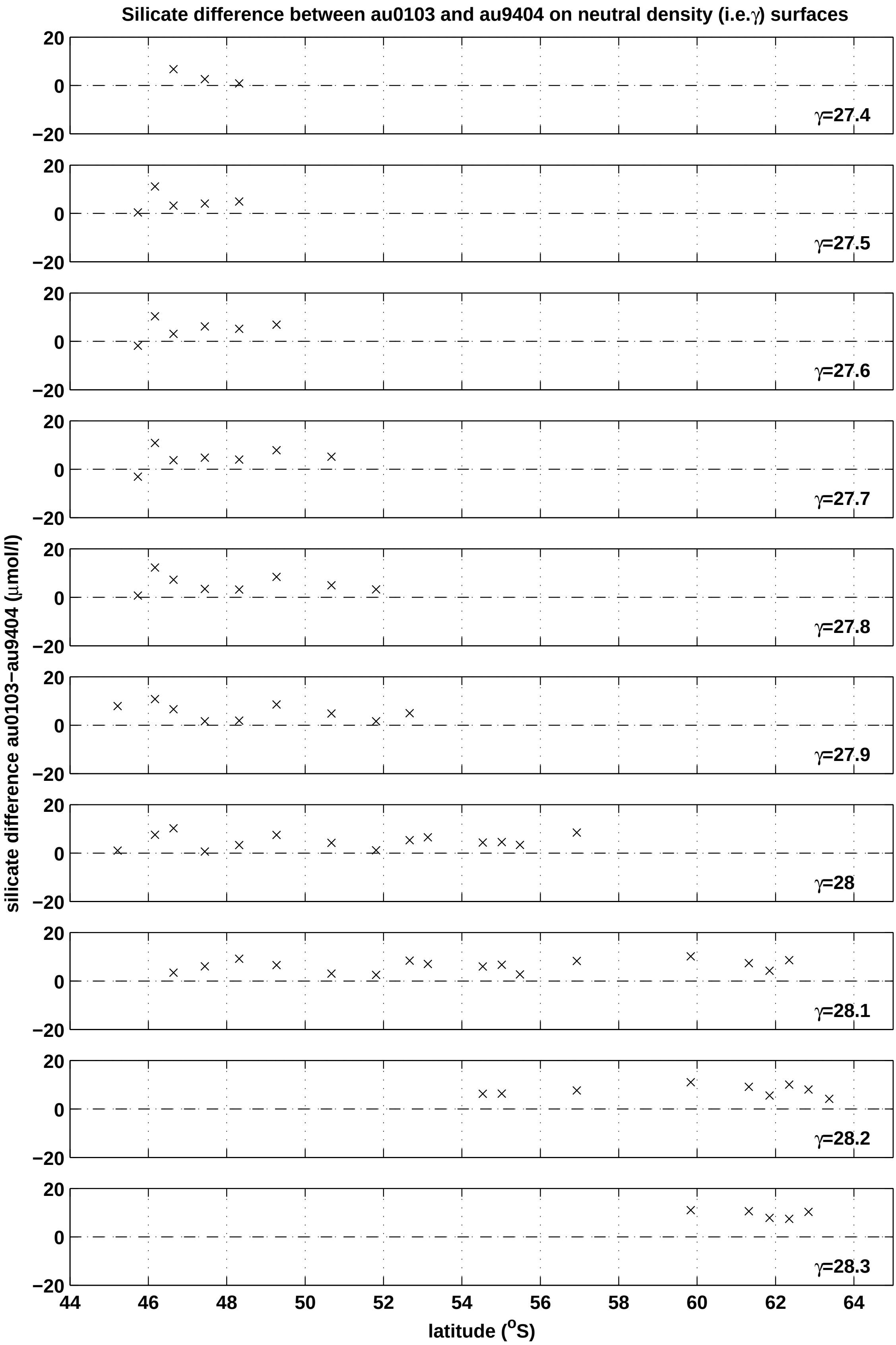


Figure A4.6b: au0103-au9404 silicate differences on neutral density surfaces.

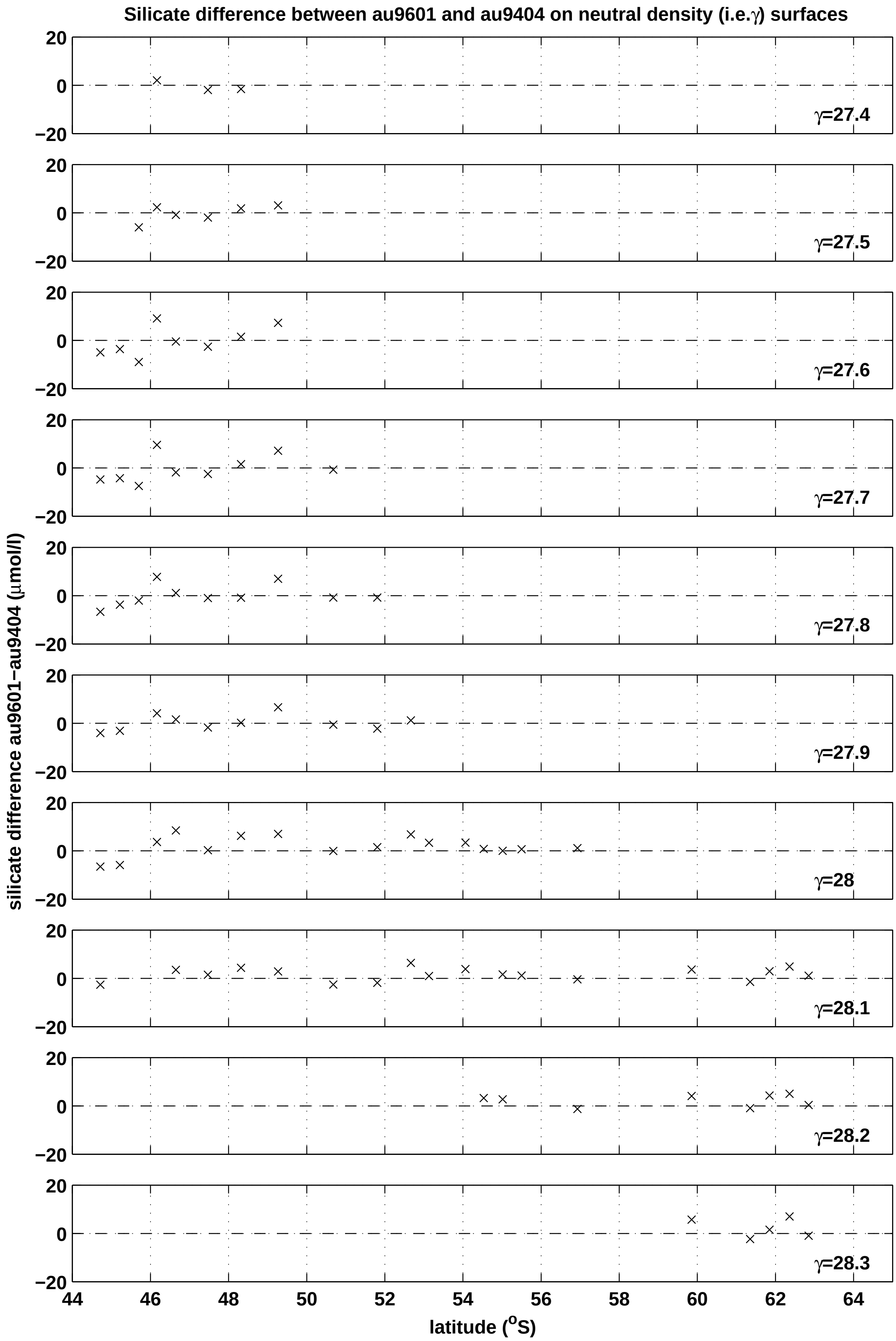


Figure A4.6c: au9601-au9404 silicate differences on neutral density surfaces.

References

Aoki, S., Rintoul, S.R. and Ushio, S., 2005a. Freshening of the Adelie Land Bottom Water along 140E. *Geophysical Research Letters* (submitted).

Aoki, S., Rintoul, S.R., Hasumoto, H. and Kinoshita, H., 2005b. Frontal positions and mixed layer evolution in the seasonal ice zone along 140E in 2001-2. *Deep-Sea Research* (submitted).

Bullister, J.L. and Weiss, R.F., 1988. Determination of CCl_3F and CCl_2F_2 in seawater and air. *Deep-Sea Research*, Vol. 35 (5), pp839-853.

Cardinal, D., Alleman, L.Y., Dehairs, F., Savoye, N., Trull, T.W. and André, L., 2005a. Relevance of silicon isotopes to fingerprint Si-nutrient utilization and water masses in the Southern Ocean. *Global Biogeochemical Cycles*, 19, GB2007, doi:10.1029/2004GB002364.

Cardinal, D., SAvoye, N., Trull, T.W., André, L., Kopczynska, E.E. and Dehairs, F., 2005b. Variations of carbon remineralisation in the Southern Ocean illustrated by the Baxs proxy. *Deep-Sea Research I* Vol. 52, pp355-370.

Cowley, R., 2001*. A practical manual for the determination of salinity, dissolved oxygen, and nutrients in seawater.* CSIRO Division of Marine Research report, 2001.

Cowley, R. and Johnston, N., 1999*. Investigations into the chemistry used for orthophosphate analysis in seawater.* CSIRO Division of Marine Research report, July 1999.

Curran, C and S. Bray, 2003. *A Practical manual for the determination of Salinity, Dissolved Oxygen and Nutrients in Seawater.* Antarctic CRC Research Report, 2003.

Gordon, A.L., 1967. *Structure of Antarctic waters between 20^{o}W and 170^{o}W.* Antarctic Map Folio Series, Folio 6, Bushnell, V. (ed.). American Geophysical Society, New York.

Jacquet, S.H.M., Dehairs, F. and Rintoul, S., 2004. A high resolution transect of dissolved barium. *Geophysical Research Letters*, Vol. 31 (14): Art. No. L14301.

Jacquet, S., de Brauwere, A., Dehairs, F., Elskens, M., Jeandel, C., Metzl, N., Rintoul, S. and Trull, T., 2005. Comparison of dissolved Barium with Nutrients and Physico-chemical conditions along 30^{o}E and 145^{o}E across the Southern Ocean, EGU 2005, Vienna, abstract.

Joyce, T. and Corry, C. (editors), 1994. *Requirements for WOCE Hydrographic Programme Data Reporting.* WHP Office Report WHPO 90-1, Revision 2, WOCE Report No. 67/91, Woods Hole Oceanographic Institution. 144 pp. (unpublished manuscript).

Knapp, G.P., Stalcup, M.C., and Stanley, R.J., 1990. *Automated Oxygen Titration and Salinity Determination*. Woods Hole Oceanographic Institution Technical Report WHOI-90-35.

McDougall, T.J., 1987. Neutral surfaces. *Journal of Physical Oceanography* Vol. 17, pp1950-1964.

Rintoul, S.R. and Bullister, J.L., 1999. A late winter hydrographic section from Tasmania to Antarctica. *Deep-Sea Research I* Vol. 46, pp1417-1454.

Rosenberg, M., Eriksen, R., Bell, S., Bindoff, N. and Rintoul, S., 1995. *Aurora Australis marine science cruise AU9407 - oceanographic field measurements and analysis*. Antarctic Cooperative Research Centre, Research Report No. 6, July 1995. 97 pp.

Rosenberg, M., Bray, S., Bindoff, N., Rintoul, S., Johnston, N., Bell, S. and Towler, P., 1997. *Aurora Australis marine science cruises AU9501, AU9604 and AU9601 - oceanographic field measurements and analysis, inter-cruise comparisons and data quality notes.* Antarctic Cooperative Research Centre, Research Report No. 12, September 1997. 150 pp.

Rosenberg, M., unpublished. *Aurora Australis ADCP data status.* Antarctic Cooperative Research Centre, unpublished report, November 1999. 51 pp.

Rosenberg, M., Bindoff, N., Bray, S., Curran, C., Helmond, I., Miller, K., McLaughlan, D. and Richman, J., 2001. *Mertz Polynya Experiment, marine science cruises AU9807, AU9801, AU9905, AU9901 and TA0051 - oceanographic field measurements and analysis*. Antarctic Cooperative Research Centre, Research Report No. 25, June 2001. 89 pp.

Acknowledgements

Thanks to all scientific personnel who participated in the cruise, and to the crew of the RSV Aurora Australis. The work was supported by the Australian Government's Cooperative Research Centre (CRC) Programme through the Antarctic Climate & Ecosystems CRC, the Australian Antarctic Division (ASAC Project Number 1335), and by the Australian Greenhouse Office of the Department of Environment and Heritage through the CSIRO Climate Change Science Program.

Core Participants

Australian Antarctic Division
University of Tasmania
CSIRO Marine & Atmospheric Research
Australian Bureau of Meteorology

Supporting Participants

Alfred Wegener Institute for Polar and Marine Research
Australian Greenhouse Office
Australian National University
National Institute of Water and Atmospheric Research
Silicon Graphics International
Tasmanian Department of Economic Development

Address

ACE CRC
Private Bag 80
Hobart, Tasmania Australia 7001
P +61 3 6226 7888
F +61 3 6226 2440
E enquiries@acecrc.org.au
www.acecrc.org.au

Established and supported under the
Australian Government's Cooperative
Research Centres Programme