COOPERATIVE RESEARCH CENTRE FOR THE ANTARCTIC AND SOUTHERN OCEAN ENVIRONMENT (ANTARCTIC CRC)

Mertz Polynya Experiment, Marine Science Cruises AU9807, AU9801, AU9905, AU9901 and TA0051 - Oceanographic Field Measurements and Analysis

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Mertz Polynya Experiment, Marine Science Cruises AU9807, AU9801, AU9905, AU9901 and TA0051 - Oceanographic Field Measurements and Analysis

ABSTRACT

Oceanographic measurements were conducted in the vicinity of the Mertz Polynya, encompassing 2 consecutive seasonal cycles from 1998 to 2000. In the southern winter of 1999, a total of 92 CTD/LADCP vertical profile stations were taken, most to within 20 m of the bottom, with 3 laps completed around the boundary of a box adjacent to the Mertz Glacier. Over 700 Niskin bottle water samples were collected for the measurement of salinity, dissolved oxygen, nutrients, oxygen 18, dimethyl sulphide, and biological parameters, using a 12 bottle rosette sampler mounted on a 24 bottle frame. Additional CTD vertical profiles were taken in April 1998, July 1998 and February 2000. Near surface current data were collected on all cruises using ship mounted ADCP. Two mooring arrays comprising thermosalinographs, current meters and upward looking sonars were deployed in the region of the Polynya. The first array of 7 moorings was deployed in April 1998. The second array of 4 moorings was deployed in the winter of 1999. All 11 Polynya moorings were recovered in February 2000. Two sediment trap moorings were also deployed in the winter of 1999, in the Subantarctic zone, with additional CTD’s taken at the two locations. A summary of all data and data quality is presented in the report.

PART 1 OCEANOGRAPHIC FIELD MEASUREMENTS AND ANALYSIS

1.1 INTRODUCTION

The oceanographic component of the Mertz Polynya Experiment comprised CTD and mooring work over three Antarctic marine science cruises. Two additional cruises were aborted while underway due to fires. The primary oceanographic aims of the experiment were:

* to monitor over one or more seasonal cycles the thermal structure of the Mertz Polynya and the outflow of bottom waters from the Mertz Depression lying adjacent to the Mertz Glacier, thought to be the source of Adelie Land Bottom Water;

* to assess the time variability of bottom water formation and the processes involved in bottom water formation, and to estimate the total formation rate of bottom water in the Mertz Polynya;

* calculate heat and brine fluxes from a closed volume on the shelf;

* assess heat and momentum exchanges between shelf and slope waters.

Marine science cruises AU9807, AU9801, AU9905 and AU9901 were conducted aboard the Australian Antarctic Division vessel RSV Aurora Australis. Cruise TA0051 took place aboard New Zealand’s National Institute for Water and Atmospheric Research (NIWA) vessel RV Tangaroa. Part 1 of this report describes the CTD, Niskin bottle, hull mounted ADCP and underway data and data quality. Part 2 describes the mooring data.

AU9807
Cruise AU9807 took place from April to May 1998 (Figure 1.1a), commencing the oceanographic component of the Polynya Experiment. An oceanographic mooring array was deployed in the vicinity of the Mertz Polynya, and CTD’s were taken at 3 of the mooring locations (Table 1.2b). The major component of the cruise was a mesopelagic fish survey between Australia and Antarctica (principal investigator R. Williams, Australian Antarctic Division).

AU9801
This cruise took place in July 1998 (Figure 1.1a), and was originally intended as the major marine science component of the Polynya Experiment. Measurements were to be complemented by mooring data from the array deployed on AU9807. Two test CTD’s were taken (Table 1.2b) (one before and one after Macquarie Island resupply), and some sea ice buoys were deployed, before an engine room fire occurred on 22nd July while the ship was in the pack ice. All marine science work was halted, and the ship returned slowly to Hobart.

AU9905
Cruise AU9905 sailed from Fremantle on 13th January 1999, with recovery of the polynya mooring array scheduled. An engine room fire occurred on 14th January, and the ship returned to Fremantle. No data were collected in the brief 40 hours at sea.

AU9901
Cruise AU9901, conducted from July to September 1999 (Figure 1.1b), was a rescheduling of the aborted AU9801. The major constituent of the cruise was the Polynya Experiment, conducted in and around the region of the Mertz Polynya (see Voyage 1 1999/2000 Voyage Leader’s report for a summary of the programs and work completed). Polynya CTD measurements were conducted approximately every 5 nautical miles around 3 flanks of a closed box in the pack ice near the Mertz

Glacier, with the southern boundary of the box closed by the ice shelf/continent. A lowered ADCP (LADCP) (Martin Visbeck, Lamont-Doherty Earth Observatory Columbia University, New York), was attached to the rosette frame for all casts. The box was sampled 3 times over a 17 day period, with either 24 or 25 CTD/LADCP profile stations sampled on each of the 3 completed circuits (Figure 1.2; Table 1.2a). Additional CTD stations were taken in the vicinity of the Mertz Glacier, and near 2 Subantarctic mooring locations (Figures 1.1b and 1.2; Table 1.2a). In lieu of the mooring array deployed on AU9807, a second array of 4 polynya moorings was deployed early in the cruise, at 3 repeat sites and at 1 new site, to provide measurements simultaneous to the CTD data.

TA0051

Cruise TA0051, on the NIWA vessel RV Tangaroa, took place from February to March 2000. This cruise ended the oceanographic component of the Polynya Experiment, with recovery of both mooring arrays. CTD's were taken at all of the 8 different mooring locations (Table 1.2b). The major component of the cruise was marine geoscience (principal investigators Peter Harris, Antarctic CRC, and Giuliano Brancolini, Osservatorio Geofisico Speriment).

1.2 CRUISE ITINERARIES AND SUMMARIES

For the various cruises, mooring deployments/retrievals and drifter deployments are summarised in Table 1.3. Principal investigators for CTD and water sampling measurements are listed in Table 1.4, while cruise participants are listed in Tables 1.5a to e.

AU9807

The ship departed south from Hobart on 3rd April 1998 and commenced fishing work, including midwater fish trawls with MIDOC multiple cod end equipment, neuston net trawls for surveying of plastic debris, and RMT target trawls. Bathymetry was surveyed just outside the ice edge, to find a suitable location for deployment of the polynya1 upward looking sonar (ULS) mooring. Depth at the target location was confirmed by taking a CTD, prior to deployment of the mooring. The ship then continued up the continental slope, deploying polynya2 close to the 1000 m isobath. Another bathymetry survey was taken to confirm suitability of the polynya3 ULS mooring site. A CTD was taken at the site before deploying polynya3. Bathymetry was then surveyed from east to west across a bathymetric trough running off the shelf, to find suitable locations for polynya4, 5 and 6. After deploying these 3 moorings, the ship continued into the Mertz depression near the glacier. A CTD was taken, before deploying polynya7 close to the 1000 m isobath within the depression. For complete information on mooring deployments, including bathymetry surveys, see Rosenberg and Helmond unpublished cruise mooring report.

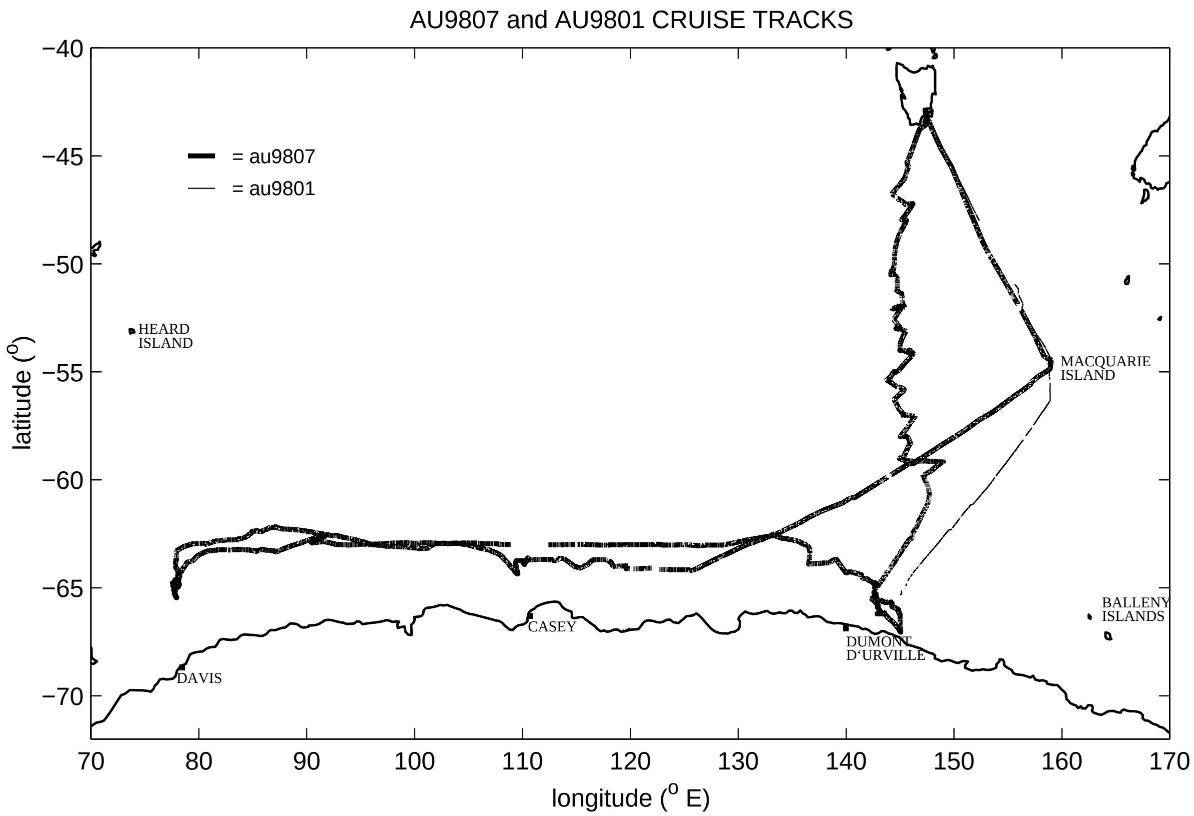
The ship then left the vicinity of the Mertz Polynya, and proceeded west to within 200 nautical miles of Davis for unscheduled retrieval of helicopters and personnel stuck at the station. Several days were spent waiting for suitable weather before the helicopters could be flown out. The ship was deployed in a similar fashion near Casey, again waiting several days before personnel could be flown out to the ship. In the end all personnel were retrieved, though much equipment was left at the bases. The ship then sailed for Macquarie Island, with some more trawling work en route. After resupply operations at Macquarie Island, the ship returned to Hobart, over 2 weeks later than the scheduled return.

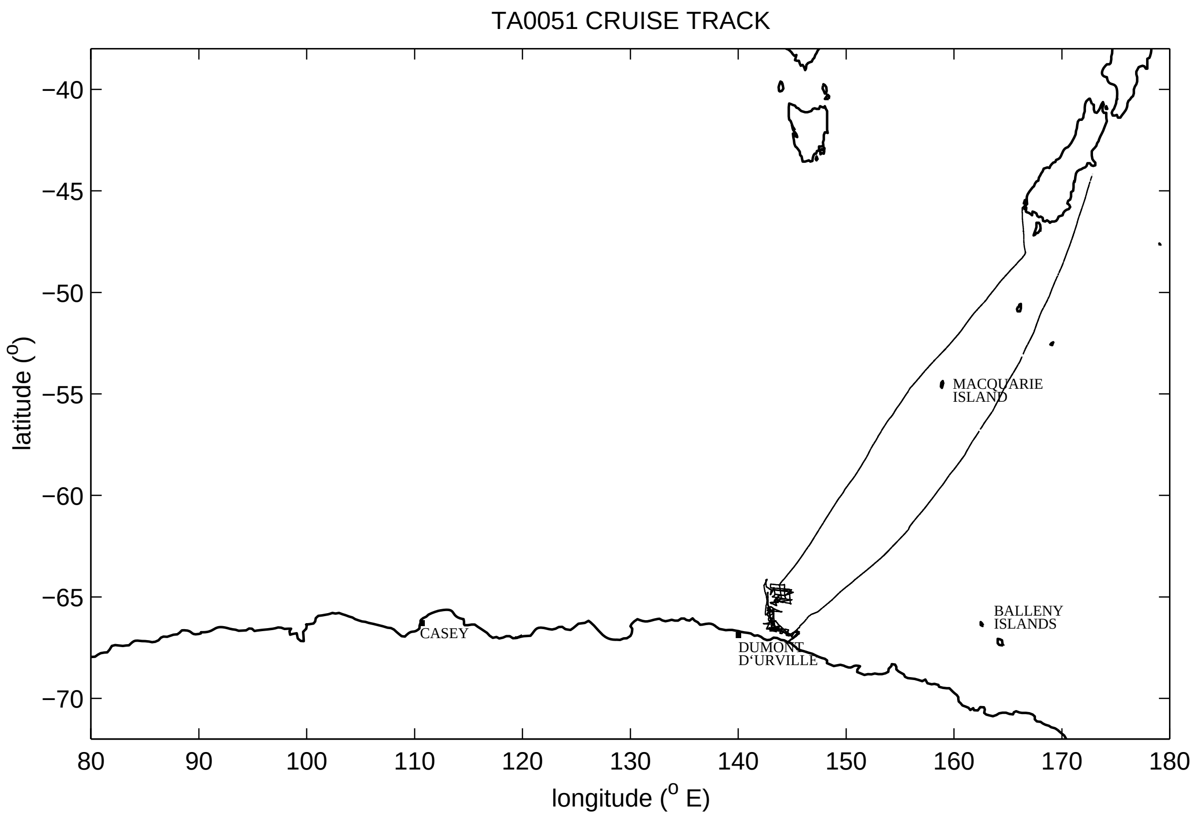
AU9901

The ship sailed from Hobart on the 13th July 1999 to Port Arthur. Several days were spent at Port Arthur calibrating the hull mounted hydroacoustic array (P.I. Tim Pauly). A single CTD was taken as part of the calibration in the ~30 m of water where the ship was moored. The ship left Port Arthur on 16th July, and a test CTD cast was completed on the way to the first sediment trap mooring location. Two sediment trap moorings were deployed in the Subantarctic Zone (SAZ) at previously occupied sites (P.I. Tom Trull), with a deep and shallow CTD cast taken at the first site, and a deep CTD at the second site. The ship then proceeded southward, encountering very hard consolidated ice south of

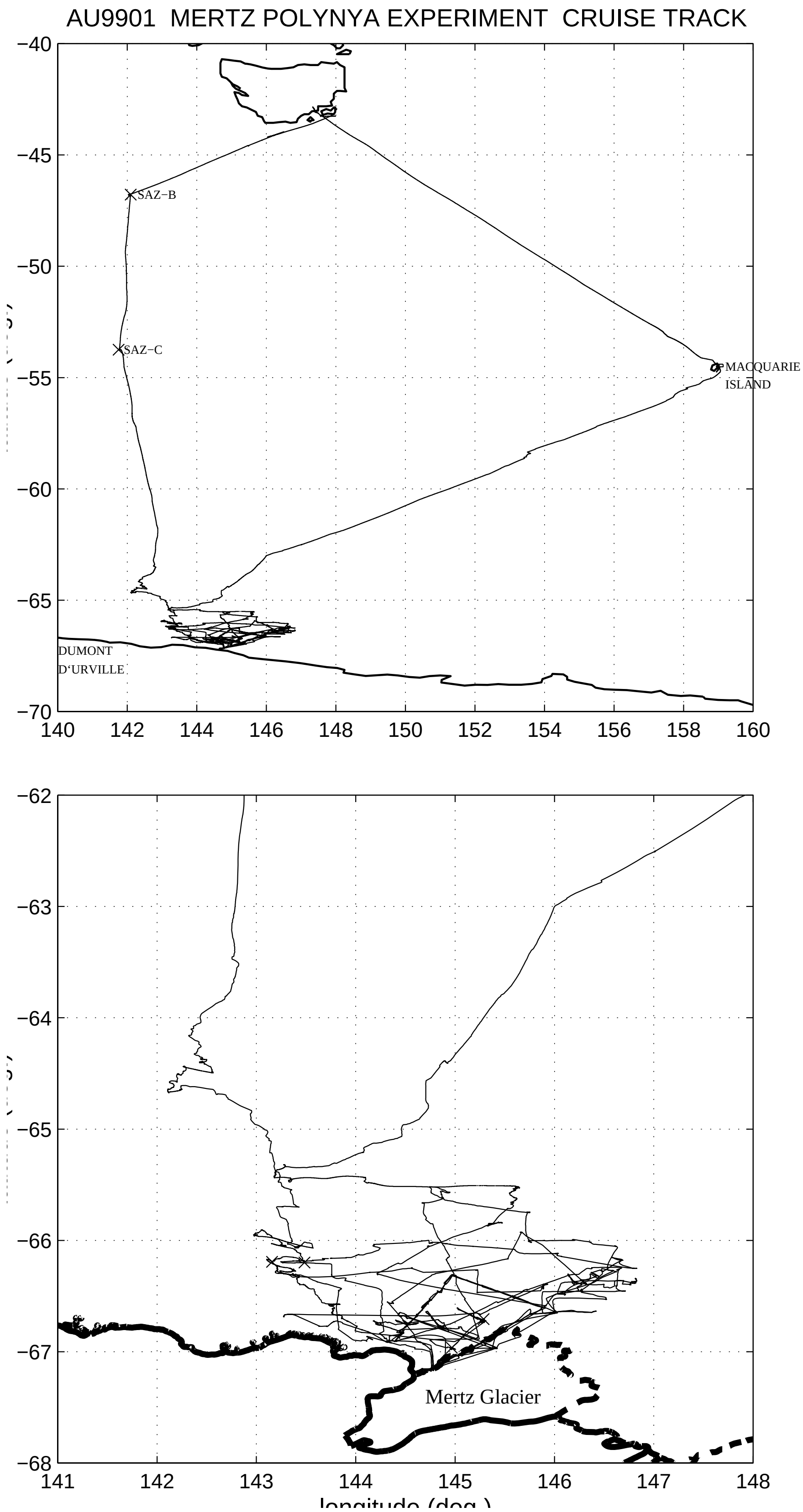
Table 1.1: Summary of cruise itineraries

AU9807	**AU9801**	**AU9905**	**AU9901**	**TA0051**
Expedition Designation	*Expedition Designation*	*Expedition Designation*	*Expedition Designation*	*Expedition Designation*
AU9807, voyage 7 1997/1998	AU9801, voyage 1 1998/1999	AU9905, voyage 5 1998/1999	AU9901, voyage 1 1999/2000	TA0051, voyage 5.1,1999/2000
(cruise acronym PICCIES)	(cruise acronym FIRE)	(no cruise acronym)	(cruise acronym IDIOTS)	(cruise acronym WEGA)
Chief Scientist	*Chief Scientists*	*Chief Scientists*	*Chief Scientists*	*Chief Scientists*
Dick Williams, Antarctic Division	Ian Allison, Antarctic Division	-	Ian Allison, Antarctic Division	Peter Harris, Antarctic CRC
	Nathan Bindoff, Antarctic CRC		Nathan Bindoff, Antarctic CRC	Giuliano Brancolini, Osservatorio Geofisico Speriment
Ship	*Ship*	*Ship*	*Ship*	*Ship*
RSV Aurora Australis	RSV Aurora Australis	RSV Aurora Australis	RSV Aurora Australis	RV Tangaroa
Ports of Call	*Ports of Call*	*Ports of Call*	*Ports of Call*	*Ports of Call*
Hobart	Hobart	Fremantle	Hobart	Wellington
Davis ice edge	Macquarie Island		Port Arthur	Milford Sound
Casey ice edge			Macquarie Island	
Macquarie Island				
Cruise Dates	*Cruise Dates*	*Cruise Dates*	*Cruise Dates*	*Cruise Dates*
April 3 - May 22, 1998	July 15 - July 31, 1998	January 13 - 15, 1999	July 13 - September 7, 1999	February 11 - March 20,2000





<u>Figure 1.1a:</u> AU9807, AU9801 and TA0051 cruise tracks (note: no data after 21/07/98 for AU9801; no data near start and end for TA0051).



<u>Figure 1.1b:</u> AU9901 cruise track and mooring positions. Note: position for Mertz Glacier from GEBCO97 bathymetry is inaccurate.

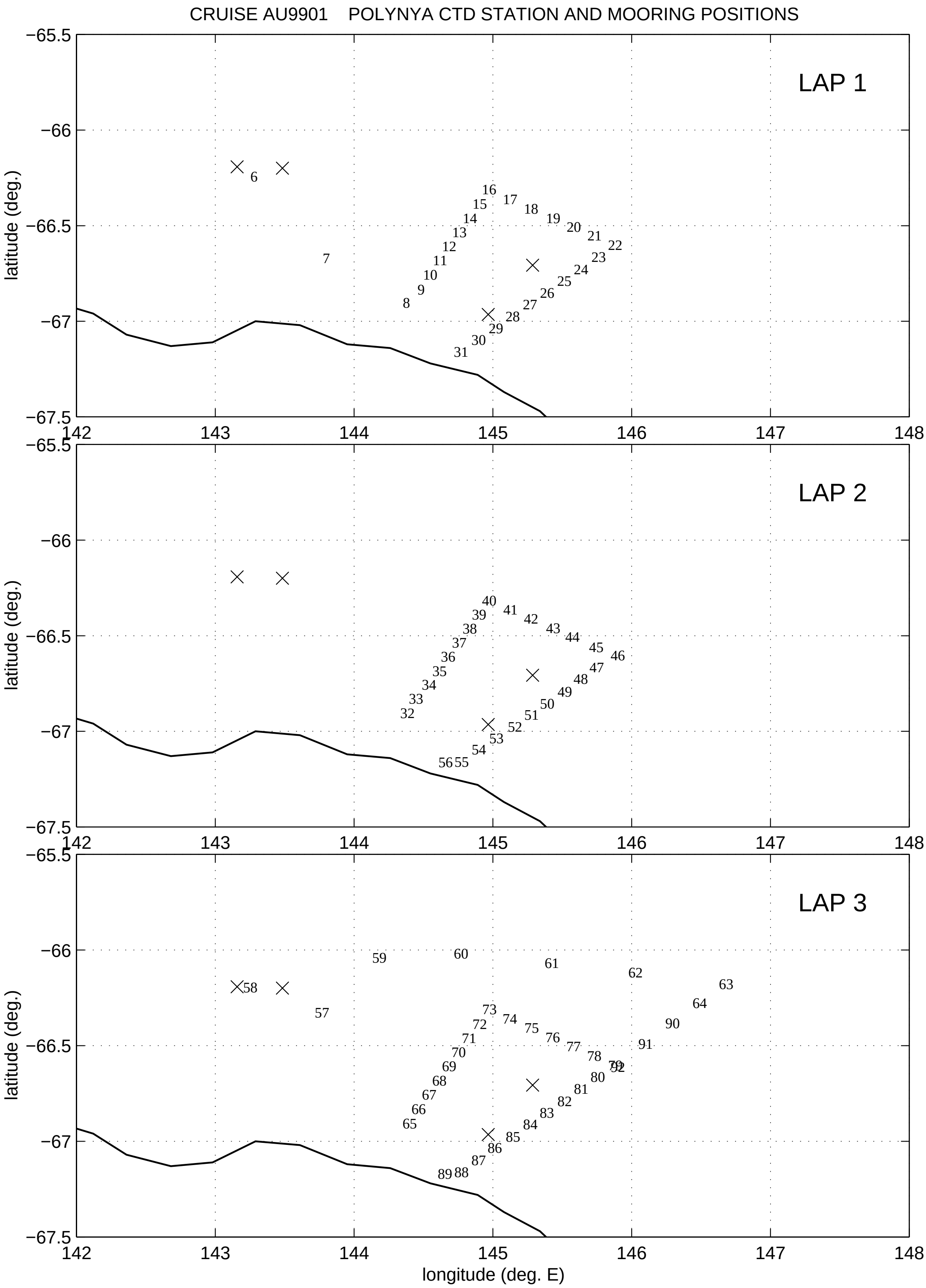


Figure 1.2: AU9901 CTD station (indicated by number) and mooring (indicated by X) positions in the vicinity of the Mertz Polynya.

64^o. Two moorings were deployed in the ice along a line spanning a bathymetric saddle, and adjacent to moorings already in position. A further 2 moorings were deployed near the Mertz Glacier, one of those adjacent to a pre-existing mooring (for complete information on mooring deployments, see Rosenberg and Bindoff unpublished cruise mooring report). The 3 CTD laps were then completed, interspersed with sea ice work and other programs. Difficult ice conditions were again encountered on the journey north, and the ship spent several days drifting with the pack. After escaping the ice, the ship sailed to Macquarie Island, then on to Hobart.

TA0051
The ship sailed from Wellington, New Zealand, on 11th February 2000, steaming down the east coast of the south island. Marine science work commenced with retrieval of the polynya moorings, retrieved in the order 8b, 7b and 7, 6b and 6, 5b and 5, 4, 3, 1, and 2. A CTD was taken at each site after retrieval of the mooring/mooring pair (for complete information on mooring recoveries, see Rosenberg and Miller unpublished cruise mooring report). Following successful recovery of all 11 moorings at the 8 different sites, geoscience work continued for the next month, including coring and seismic work over the shelf, then further out on the slope. A planned recovery attempt on pressure gauge Dumont96, to the west of the study area, was abandoned. After 4 years in the water, it was not expected that the acoustic release on this mooring would function, so it was judged not worthwhile steaming the ~80 miles to the site. Following completion of the geoscience, the ship steamed back to Wellington, via the west coast of the south island.

1.3 FIELD DATA COLLECTION METHODS

1.3.1 CTD Instrumentation

AU9807
General Oceanics Mark IIIC CTD, serial 1193, was used for the 3 CTD casts, mounted on a 24 bottle rosette frame along with a G.O. model 1016 24 position “intelligent” rosette, and 10 litre G.O. Niskin bottles. A Li-Cor model LI-192SA P.A.R. sensor and Benthos altimeter were also fitted to the array. Bottles were sampled for salinity only, and complete conductivity calibration results are listed later in the report. Salinity samples were returned to Hobart for analysis (~2 months after collection). Post cruise pressure, platinum temperature and pressure temperature calibrations were performed at the CSIRO Division of Marine Research Calibration Facility (Table 1.6). CTD oxygen data were not processed, as Niskin bottles were not sampled for oxygen.

AU9801
CTD equipment was problematic for the 2 test casts on this shortened voyage. G.O. Mark IIIC CTD’s were used for both casts, mounted on serial 1193 for the first cast, serial 1103 for the second. G.O. model 1015 12 position pylons were used, mounted on a 24 bottle rosette frame, together with a Sea Tech fluorometer and Benthos altimeter, and 10 litre G.O. Niskin bottles. A protective cold cover (described below) was fitted for both casts. Gohla-Precision deep sea reversing mercury thermometers were fitted on 2 of the Niskins. Bottles were all fired at the same depth for the first cast, and sampled for salinity, dissolved oxygen and nutrients (nutrient samples not analysed). The second cast was taken to 250 dbar, and sampled for salinity only. Pre cruise CTD pressure, platinum temperature and pressure temperature calibration coefficients are listed in Table 1.6.

AU9901
A General Oceanics Mark IIIC CTD, serial 1193, was used for the entire voyage. A protective cold cover (on loan from Eberhard Fahrbach and Gerd Rohardt, Alfred Wegener Institut fur Polar und Meeresforschung, Bremerhaven), was fitted to the instrument for all stations. This cover is fitted over the CTD conductivity and temperature sensors, and only opens when at a depth of ~20 dbar, thereby protecting sensors from freezing when exposed to the air. Note that temperature and conductivity

data are therefore not available for the top ~20 dbar of all casts i.e. when the cover is closed. Also note that fitting of the cover requires removal of the CTD oxygen sensor, thus dissolved oxygen data for this cruise are only available from Niskin bottle data. A 24 bottle rosette frame was used for the entire cruise, with a 24 position pylon fitted for stations 1 to 5, and a 12 position pylon for the remainder of the cruise (both pylons being General Oceanics model 1015). 10 litre G.O. Niskin bottles were used for sample collection. For all stations an LADCP and associated battery pack were mounted horizontally on opposite sides of the base of the rosette frame (data not discussed further in this report), while a Sea Tech fluorometer was attached for all stations except 2 to 4. A Benthos altimeter serial 142 was fitted for bottom location, and deep sea reversing mercury thermometers (Gohla-Precision) (Table 1.16) were mounted for checks of CTD temperature calibration. For stations 73 and 74 an internally recording FSI 3" MicroCTD was attached to the frame next to the G.O. CTD sensors (see Appendix 1.2).

Pre cruise pressure, platinum temperature and pressure temperature calibrations were performed at the CSIRO Division of Marine Research Calibration Facility (Table 1.6), while an Antarctic Division calibration was used for fluorometer data. Complete conductivity calibration results, derived from in situ Niskin bottle salinity samples, are listed later in this report.

Bottle samples for salinity, dissolved oxygen and nutrients (phosphate, nitrate, silicate) were taken at all stations except station 1. SAZ stations 3 to 5 were also sampled for dissolved inorganic carbon, alkalinity, carbon 13 and nitrogen 15 nitrate. Nitrogen 15 nitrate samples were also taken at an additional 2 stations in the Polynya. Numerous stations in the Polynya were sampled for DMS and biological parameters. Complete oxygen 18 profiles were sampled for CTD laps 1 and 2 in the Polynya.

Hydrology laboratory methods are discussed in Appendix 1.1, while full details of CTD data processing and calibration techniques can be found in Rosenberg et al. (1995).

TA0051

A SeaBird 911plus CTD was used for this cruise, with 1 temperature and conductivity sensor, an altimeter, and a Sea Tech 20 cm transmissometer, mounted on a 12 bottle frame with a 12 position SeaBird SBE32 carousel. Data were transmitted at 24 Hz via a SBE11plus deck unit, with data acquisition via seasave Win32 Version 1.13. 10 litre Ocean Test Equipment Niskin bottles were used. CTD underwater unit serial 09P17216-0495, with pressure sensor 68994, was used for stations 1 to 4. For the remaining stations, a second underwater unit was used, with pressure sensor 73293. All equipment belonged to NIWA, New Zealand. Bottles were sampled for salinity and biological parameters. Additional water was collected at station 7 for dissolved inorganic carbon work back in Hobart. Salinity samples were returned to Hobart for analysis (~3 months after collection). Pre cruise calibration coefficients from the manufacturer were used for CTD temperature, conductivity and pressure (Table 1.6), and for transmittance. Data processing and calibration for the SeaBird data are described later in the report.

CTD operations on the Tangaroa are conducted outside on the back deck. Prior to departure, a marine ply shelter was constructed forward of the starboard A frame, and heaters were mounted inside the shelter. On retrieval, the CTD package was manually dragged into the shelter. In the Antarctic waters, when the external temperature dropped below ~-5^{o}C, and/or during a following wind, the shelter and heating were not sufficient to prevent freezing of the CTD sensors and pump, and ice crystallization inside the Niskin bottles. CTD data for stations 6 to 10 were unusable as a result of the freezing problems.

Table 1.2a: Summary of station information for cruise au9901. All times are UTC.

station	START					maxP	BOTTOM					END			
Number	time	date	latitude	longitude	depth(m)	(dbar)	time	latitude	longitude	depth(m)	altimeter(m)	time	latitude	longitude	depth(m)
1 TEST	0349	14-JUL-99	43:08.88S	147:52.71E	34	32	0355	43:08.88S	147:52.71E	34	-	0410	43:08.88S	147:52.71E	34
2 TEST	0406	17-JUL-99	44:35.38S	145:28.59E	3513	3644	0600	44:35.49S	145:29.18E	3521	37.8	0718	44:35.46S	145:29.35E	3528
3 SAZ-B	0426	18-JUL-99	46:50.04S	142:06.01E	3950	4184	0630	46:50.52S	142:05.07E	4341	-	0751	46:50.38S	142:04.60E	-
4 SAZ-B	1126	18-JUL-99	46:50.20S	142:05.85E	4000	256	1139	46:50.14S	142:05.64E	4028	-	1211	46:50.27S	142:05.43E	4062
5 SAZ-C	0154	20-JUL-99	53:45.10S	141:48.19E	2589	1502	0225	53:45.12S	141:48.45E	2655	-	0324	53:45.34S	141:49.38E	2899
6 EXTRA	2302	28-JUL-99	66:14.56S	143:16.83E	614	612	2327	66:14.64S	143:17.41E	615	14.4	2353	66:14.70S	143:17.93E	611
7 EXTRA	1323	31-JUL-99	66:40.24S	143:48.00E	837	834	1342	66:40.25S	143:48.10E	836	11.3	1413	66:40.30S	143:48.27E	839
8 LAP1.24	0210	5-AUG-99	66:54.20S	144:22.50E	238	238	0221	66:54.13S	144:21.98E	248	19.1	0240	66:54.01S	144:20.89E	263
9 LAP1.23	0349	5-AUG-99	66:50.16S	144:28.50E	995	984	0431	66:49.54S	144:27.33E	994	20.3	0515	66:49.41S	144:26.65E	985
10 LAP1.22	0619	5-AUG-99	66:45.34S	144:32.90E	871	854	0649	66:45.14S	144:32.77E	865	20.0	0730	66:44.75S	144:32.68E	856
11 LAP1.21	0847	5-AUG-99	66:40.80S	144:37.13E	826	806	0931	66:40.30S	144:36.88E	810	17.8	1007	66:39.88S	144:36.66E	797
12 LAP1.20	1154	5-AUG-99	66:36.45S	144:41.14E	608	596	1213	66:36.33S	144:41.14E	613	20.0	1252	66:36.14S	144:41.23E	616
13 LAP1.19	1507	5-AUG-99	66:32.09S	144:45.60E	511	500	1527	66:32.08S	144:45.58E	510	14.8	1552	66:32.05S	144:45.67E	505
14 LAP1.18	1650	5-AUG-99	66:27.58S	144:50.10E	443	434	1704	66:27.58S	144:50.10E	445	14.8	1726	66:27.58S	144:50.04E	441
15 LAP1.17	1816	5-AUG-99	66:23.14S	144:54.32E	419	412	1829	66:23.12S	144:54.26E	420	10.0	1851	66:23.05S	144:54.16E	414
16 LAP1.16	2014	5-AUG-99	66:18.56S	144:58.32E	393	392	2028	66:18.54S	144:58.28E	398	9.7	2048	66:18.57S	144:58.31E	390
17 LAP1.15	2135	5-AUG-99	66:21.71S	145:07.48E	373	362	2148	66:21.70S	145:07.45E	374	11.9	2210	66:21.71S	145:07.46E	372
18 LAP1.14	2355	5-AUG-99	66:24.66S	145:16.51E	360	354	0012	66:24.65S	145:16.52E	361	9.5	0032	66:24.65S	145:16.48E	359
19 LAP1.13	0124	6-AUG-99	66:27.60S	145:26.13E	324	318	0136	66:27.60S	145:26.17E	323	8.3	0156	66:27.60S	145:26.17E	323
20 LAP1.12	0247	6-AUG-99	66:30.42S	145:34.98E	340	324	0302	66:30.45S	145:34.97E	340	18.5	0328	66:30.46S	145:34.90E	337
21 LAP1.11	0438	6-AUG-99	66:33.21S	145:43.80E	319	308	0448	66:33.21S	145:43.77E	319	17.5	0508	66:33.18S	145:43.70E	321
22 LAP1.10	0625	6-AUG-99	66:36.00S	145:53.02E	304	296	0637	66:35.95S	145:53.02E	306	14.3	0701	66:35.83S	145:53.05E	306
23 LAP1.9	0852	6-AUG-99	66:39.72S	145:45.86E	375	362	0911	66:39.56S	145:45.87E	380	19.5	0935	66:39.34S	145:45.99E	366
24 LAP1.8	1025	6-AUG-99	66:43.60S	145:38.11E	445	440	1042	66:43.54S	145:37.87E	443	13.2	1106	66:43.45S	145:37.66E	446
25 LAP1.7	1216	6-AUG-99	66:47.07S	145:31.20E	534	520	1231	66:46.87S	145:31.16E	534	16.2	1259	66:46.50S	145:31.11E	544
26 LAP1.6	1414	6-AUG-99	66:50.97S	145:23.48E	637	624	1432	66:50.80S	145:23.48E	623	8.6	1458	66:50.49S	145:23.46E	623
27 LAP1.5	1601	6-AUG-99	66:54.65S	145:16.07E	818	808	1622	66:54.51S	145:16.04E	814	12.8	1649	66:54.39S	145:15.97E	815
28 LAP1.4	1852	6-AUG-99	66:58.42S	145:08.59E	1118	1110	1918	66:58.04S	145:08.64E	1109	12.4	2000	66:57.54S	145:09.22E	1067
29 LAP1.3	2054	6-AUG-99	67:02.25S	145:01.36E	697	744	2112	67:02.00S	145:01.09E	688	39.0	2137	67:01.95S	145:00.22E	674
30 LAP1.2	0037	7-AUG-99	67:05.79S	144:53.87E	492	476	0052	67:05.62S	144:53.81E	482	11.2	0117	67:05.19S	144:54.07E	497
31 LAP1.1	0232	7-AUG-99	67:09.59S	144:46.24E	470	460	0252	67:09.24S	144:45.83E	469	20.0	0319	67:09.10S	144:45.13E	463
32 LAP2.24	1754	11-AUG-99	66:54.18S	144:22.98E	256	246	1803	66:54.11S	144:22.70E	251	8.5	1819	66:53.91S	144:21.96E	271
33 LAP2.23	1929	11-AUG-99	66:49.75S	144:26.76E	976	964	1950	66:49.77S	144:26.29E	957	10.8	2023	66:49.61S	144:24.86E	892
34 LAP2.22	0739	12-AUG-99	66:45.28S	144:32.37E	866	856	0801	66:45.20S	144:32.02E	864	20.7	0846	66:44.95S	144:31.39E	869
35 LAP2.21	0939	12-AUG-99	66:41.02S	144:36.93E	827	814	1002	66:40.95S	144:36.84E	826	20.0	1039	66:40.74S	144:36.59E	828
36 LAP2.20	1224	12-AUG-99	66:36.50S	144:40.53E	622	614	1244	66:36.39S	144:40.33E	623	15.0	1318	66:36.18S	144:39.97E	624

Table 1.2a: (continued)

station	START					maxP	BOTTOM					END			
number	time	date	latitude	longitude	depth(m)	(dbar)	time	latitude	longitude	depth(m)	altimeter(m)	time	latitude	longitude	depth(m)
37 LAP2.19	1429	12-AUG-99	66:32.20S	144:45.52E	518	512	1444	66:32.18S	144:45.37E	510	7.8	1507	66:32.15S	144:45.22E	515
38 LAP2.18	1614	12-AUG-99	66:27.74S	144:50.03E	448	438	1626	66:27.82S	144:50.11E	446	10.4	1652	66:28.08S	144:50.29E	444
39 LAP2.17	1758	12-AUG-99	66:23.36S	144:54.10E	412	404	1809	66:23.43S	144:54.25E	415	7.0	1832	66:23.64S	144:54.37E	418
40 LAP2.16	1925	12-AUG-99	66:18.94S	144:58.44E	390	382	1936	66:19.02S	144:58.51E	392	13.3	1959	66:19.20S	144:58.54E	388
41 LAP2.15	2043	12-AUG-99	66:21.79S	145:07.63E	379	364	2052	66:21.84S	145:07.70E	375	14.0	2114	66:21.99S	145:07.74E	373
42 LAP2.14	2202	12-AUG-99	66:24.64S	145:16.50E	360	344	2212	66:24.72S	145:16.57E	357	11.2	2231	66:24.88S	145:16.44E	363
43 LAP2.13	2317	12-AUG-99	66:27.57S	145:26.09E	325	314	2326	66:27.60S	145:26.15E	328	7.1	2348	66:27.69S	145:26.33E	328
44 LAP2.12	0030	13-AUG-99	66:30.54S	145:34.86E	338	328	0042	66:30.61S	145:34.96E	337	9.3	0104	66:30.76S	145:34.88E	332
45 LAP2.11	0145	13-AUG-99	66:33.54S	145:44.71E	305	294	0154	66:33.68S	145:44.94E	310	14.8	0214	66:33.93S	145:45.21E	312
46 LAP2.10	0309	13-AUG-99	66:36.18S	145:54.07E	301	288	0319	66:36.29S	145:54.36E	287	6.8	0340	66:36.49S	145:54.63E	283
47 LAP2.9	0416	13-AUG-99	66:39.87S	145:44.85E	380	380	0429	66:39.98S	145:44.83E	387	15.0	0451	66:40.14S	145:44.59E	394
48 LAP2.8	0524	13-AUG-99	66:43.60S	145:38.00E	447	432	0544	66:43.79S	145:37.74E	443	15.5	0605	66:44.01S	145:37.11E	447
49 LAP2.7	0650	13-AUG-99	66:47.53S	145:31.07E	546	536	0708	66:47.70S	145:30.87E	547	14.0	0739	66:48.09S	145:30.38E	552
50 LAP2.6	0832	13-AUG-99	66:51.34S	145:23.43E	643	644	0851	66:51.69S	145:23.47E	653	13.8	0922	66:52.06S	145:24.10E	651
51 LAP2.5	1008	13-AUG-99	66:54.94S	145:16.62E	825	824	1029	66:55.26S	145:17.31E	829	15.1	1103	66:55.80S	145:18.48E	841
52 LAP2.4	1148	13-AUG-99	66:58.57S	145:09.47E	1118	1122	1226	66:58.90S	145:09.68E	1129	20.0	1314	66:59.41S	145:09.78E	1145
53 LAP2.3	1415	13-AUG-99	67:02.21S	145:01.54E	702	680	1443	67:02.67S	145:02.08E	685	15.2	1517	67:03.18S	145:02.33E	782
54 LAP2.2	1627	13-AUG-99	67:05.67S	144:53.93E	487	494	1641	67:05.65S	144:54.12E	498	9.2	1703	67:05.67S	144:54.22E	500
55 LAP2.1	1815	13-AUG-99	67:09.56S	144:46.54E	518	518	1829	67:09.46S	144:46.80E	522	14.8	1855	67:09.28S	144:47.44E	510
56 LAP2.0	2059	13-AUG-99	67:09.72S	144:39.54E	297	300	2112	67:09.66S	144:39.58E	292	6.8	2130	67:09.67S	144:39.55E	295
57 FENNEL	1407	16-AUG-99	66:19.57S	143:46.20E	539	540	1422	66:19.49S	143:45.99E	544	14.4	1447	66:19.37S	143:45.67E	541
58 DILL	1958	16-AUG-99	66:11.64S	143:15.13E	576	566	2014	66:11.58S	143:15.00E	574	9.5	2046	66:11.46S	143:14.74E	577
59 CINNAM.	0914	17-AUG-99	66:02.29S	144:10.83E	347	344	0924	66:02.25S	144:10.79E	344	11.0	0951	66:02.14S	144:10.72E	340
60 ENDIVE	1618	17-AUG-99	66:01.12S	144:46.29E	364	360	1629	66:01.09S	144:46.26E	367	10.2	1650	66:01.04S	144:46.18E	364
61 GINGER	2026	17-AUG-99	66:04.05S	145:25.48E	283	274	2037	66:04.03S	145:25.43E	280	9.5	2052	66:04.02S	145:25.35E	279
62 EXTRA	0005	18-AUG-99	66:07.01S	146:01.68E	282	268	0015	66:07.00S	146:01.55E	279	9.7	0041	66:07.00S	146:01.21E	276
63 GLAC.16	0900	18-AUG-99	66:10.62S	146:40.81E	232	218	0910	66:10.62S	146:40.75E	231	15.2	0934	66:10.71S	146:40.37E	228
64 GLAC.17	1207	18-AUG-99	66:16.64S	146:29.31E	245	230	1217	66:16.53S	146:28.88E	244	14.1	1240	66:16.31S	146:28.19E	248
65 LAP3.24	2114	19-AUG-99	66:54.36S	144:24.05E	276	262	2124	66:54.35S	144:23.92E	269	14.9	2139	66:54.32S	144:23.63E	267
66 LAP3.23	2229	19-AUG-99	66:49.81S	144:27.93E	989	988	2251	66:49.77S	144:27.75E	991	9.7	2320	66:49.68S	144:27.36E	988
67 LAP3.22	0050	20-AUG-99	66:45.30S	144:32.43E	865	860	0107	66:45.21S	144:32.21E	868	8.4	0135	66:45.03S	144:31.81E	865
68 LAP3.21	0215	20-AUG-99	66:40.89S	144:36.90E	821	824	0240	66:40.82S	144:36.62E	821	10.0	0323	66:40.74S	144:36.37E	822
69 LAP3.20	0509	20-AUG-99	66:36.41S	144:41.06E	615	608	0530	66:36.29S	144:40.75E	618	15.9	0600	66:36.08S	144:40.33E	611
70 LAP3.19	0730	20-AUG-99	66:32.02S	144:45.19E	502	504	0749	66:31.87S	144:44.88E	512	14.5	0821	66:31.62S	144:44.41E	504
71 LAP3.18	0922	20-AUG-99	66:27.57S	144:49.81E	450	442	0948	66:27.43S	144:49.51E	446	11.6	1018	66:27.20S	144:49.15E	441
72 LAP3.17	1151	20-AUG-99	66:23.23S	144:54.31E	418	412	1205	66:23.15S	144:54.16E	414	14.8	1231	66:23.01S	144:53.81E	416

Table 1.2a: (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)
73 LAP3.16	1337	20-AUG-99	66:18.59S	144:58.58E	390	378	1349	66:18.53S	144:58.38E	390	15.4	1409	66:18.43S	144:58.03E	391
74 LAP3.15	1457	20-AUG-99	66:21.54S	145:07.31E	374	364	1508	66:21.47S	145:07.11E	373	9.8	1531	66:21.31S	145:06.74E	372
75 LAP3.14	1625	20-AUG-99	66:24.42S	145:16.59E	352	350	1635	66:24.37S	145:16.45E	356	9.2	1655	66:24.16S	145:16.04E	358
76 LAP3.13	1746	20-AUG-99	66:27.32S	145:25.84E	325	324	1757	66:27.24S	145:25.57E	329	8.2	1811	66:27.11S	145:25.33E	330
77 LAP3.12	1858	20-AUG-99	66:30.23S	145:34.90E	336	328	1909	66:30.07S	145:34.77E	336	7.1	1924	66:29.82S	145:34.50E	335
78 LAP3.11	2013	20-AUG-99	66:33.13S	145:43.86E	311	306	2032	66:33.03S	145:43.53E	316	9.9	2043	66:33.00S	145:43.38E	321
79 LAP3.10	2134	20-AUG-99	66:36.09S	145:52.98E	305	286	2144	66:36.05S	145:52.77E	303	10.5	2155	66:36.09S	145:52.60E	305
80 LAP3.9	0454	21-AUG-99	66:39.84S	145:45.22E	372	362	0509	66:39.70S	145:45.12E	371	15.1	0530	66:39.48S	145:45.00E	378
81 LAP3.8	0705	21-AUG-99	66:43.56S	145:38.16E	446	434	0724	66:43.38S	145:38.03E	443	15.0	0754	66:43.02S	145:37.79E	439
82 LAP3.7	0844	21-AUG-99	66:47.43S	145:31.09E	544	532	0901	66:47.29S	145:31.02E	544	14.0	0927	66:46.99S	145:31.13E	538
83 LAP3.6	1012	21-AUG-99	66:50.96S	145:23.37E	631	622	1035	66:50.80S	145:23.46E	624	9.5	1111	66:50.48S	145:23.50E	624
84 LAP3.5	1350	21-AUG-99	66:54.70S	145:16.20E	821	806	1412	66:54.66S	145:16.36E	816	13.6	1438	66:54.64S	145:16.57E	812
85 LAP3.4	1545	21-AUG-99	66:58.51S	145:08.68E	1120	1118	1611	66:58.62S	145:08.32E	1122	12.3	1645	66:58.55S	145:07.92E	1119
86 LAP3.3	1733	21-AUG-99	67:01.94S	145:00.81E	647	644	1751	67:01.68S	145:00.60E	645	15.5	1809	67:01.42S	145:00.41E	698
87 LAP3.2	1900	21-AUG-99	67:05.92S	144:53.88E	491	478	1915	67:05.88S	144:53.89E	492	15.1	1929	67:05.85S	144:53.88E	487
88 LAP3.1	2014	21-AUG-99	67:09.66S	144:46.47E	482	476	2030	67:09.75S	144:46.33E	495	15.2	2045	67:09.70S	144:46.14E	467
89 LAP3.0	2134	21-AUG-99	67:10.20S	144:39.33E	304	334	2149	67:10.20S	144:39.33E	306	15.1	2200	67:10.18S	144:39.33E	317
90 GLAC.18	0848	23-AUG-99	66:22.89S	146:17.69E	255	246	0858	66:22.72S	146:17.56E	255	14.2	0917	66:22.39S	146:17.16E	265
91 GLAC.19	1109	23-AUG-99	66:29.35S	146:06.32E	225	216	1115	66:29.28S	146:06.35E	226	14.0	1134	66:29.09S	146:06.57E	225
92 GLAC.20	1351	23-AUG-99	66:35.56S	145:54.24E	282	260	1400	66:35.49S	145:54.26E	271	15.0	1420	66:35.28S	145:54.52E	266

Table 1.2b: Summary of station information for cruises au9807, au9801 and ta0051. All times are UTC.

station	START					maxP	BOTTOM					END			
number	time	date	latitude	longitude	depth(m)	(dbar)	time	latitude	longitude	depth(m)	altimeter(m)	time	latitude	longitude	depth(m)
AU9807															
1 polynya1	1002	17-APR-98	64:47.31S	142:44.19E	3248	3240	1122	64:47.25S	142:44.48E	3252	38.0	1256	64:47.25S	142:44.14E	3252
2 polynya3	1128	18-APR-98	65:53.03S	142:55.39E	420	400	1141	65:53.01S	142:55.30E	427	25.3	1206	65:52.98S	142:54.78E	424
3 polynya7	1745	19-APR-98	66:56.72S	144:57.33E	1048	1014	1815	66:56.46S	144:57.08E	1039	14.7	1928	66:55.83S	144:55.66E	1029
AU9801															
1 TEST	0645	18-JUL-98	54:30.90S	159:04.07E	2723	2304	0831	54:31.51S	159:03.31E	2624	-	0951	54:31.85S	159:02.64E	2460
2 TEST	0409	20-JUL-98	61:09.20S	151:41.69E	2716	254	0423	61:09.27S	151:41.55E	2732	-	0450	61:09.39S	151:41.11E	2713
TA0051															
1 polynya8b	2300	17-FEB-00	66:42.22S	145:17.36E	538	522	2314	66:42.08S	145:17.40E	540	23	2340	66:41.70S	145:17.55E	530
2 polynya7b	0626	18-FEB-00	66:57.64S	144:58.42E	1105	1076	0650	66:57.20S	144:57.49E	1093	30	0721	66:56.69S	144:57.30E	1068
3 polynya6b	2037	18-FEB-00	66:11.92S	143:28.79E	556	534	2050	66:11.57S	143:28.71E	557	29	2114	66:11.27S	143:28.29E	552
4 polynya5b	0220	19-FEB-00	66:11.67S	143:09.57E	600	580	0238	66:11.96S	143:10.18E	606	32	0255	66:11.97S	143:10.18E	601
5 polynya4	0653	19-FEB-00	66:12.16S	142:54.26E	560	522	0703	66:12.05S	142:54.35E	553	36	0725	66:11.92S	142:54.72E	551
6 polynya3	1056	19-FEB-00	65:52.71S	142:55.56E	428	408	1110	65:52.74S	142:55.61E	427	24	1130	65:52.79S	142:55.46E	425
7 polynya1	2350	19-FEB-00	64:47.30S	142:44.66E	3251	3152	0057	64:47.93S	142:44.16E	3251	154	0207	64:48.24S	142:42.84E	3251
8 polynya2	0017	21-FEB-00	65:48.33S	142:54.99E	1127	1104	0044	65:48.25S	142:55.07E	1142	52	0112	65:48.22S	142:55.03E	1152
9 BuchananBay	1050	23-FEB-00	67:10.84S	144:41.34E	426	422	1108	67:10.45S	144:42.36E	500	82	1125	67:10.30S	144:43.37E	430
10 mud core	0543	29-FEB-00	66:29.86S	143:09.57E	834	812	0600	66:29.78S	143:09.40E	834	31	0621	66:29.70S	143:10.06E	828

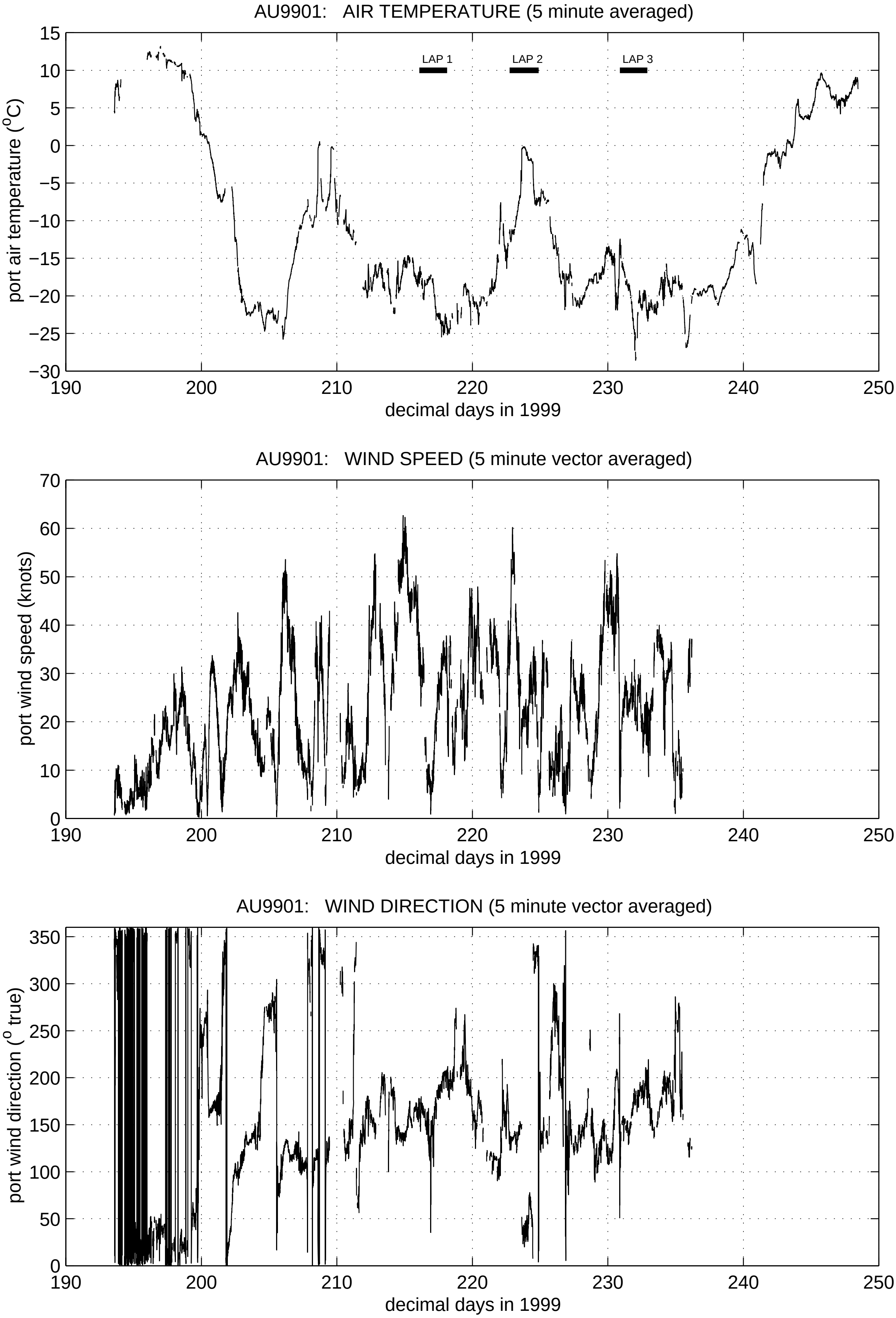


Figure 1.3: Air temperature, wind speed and wind direction for cruise AU9901, showing times for the 3 CTD laps in the Polynya (N.B. for decimal time, 0.0=midnight on 31st December).

Table 1.3: **Summary of mooring deployments and recoveries, and MetOcean drifter deployments. ULS=upward looking sonar; CM=current meter; 9311=a temperature logger; MC=SBE37SM microcat; SBE39=a temperature logger; VACM=vector averaging current meter.**

mooring	time (UTC)	position	depth (m)	mooring components
AU9807 mooring deployments				
polynya1	16:16, 17/04/98	64° 47.350'S, 142° 44.640'E	3213	ULS, Aanderaa CM, 9311's, MC
polynya2	05:58, 18/04/98	65° 48.066'S, 142° 54.954'E	1180	ADCP, MC's, 9311's, VACM
polynya3	14:02, 18/04/98	65° 52.960'S, 142° 55.487'E	421	ULS, Aanderaa CM
polynya4	00:30, 19/04/98	66° 12.127'S, 142° 54.086'E	552	MC's
polynya5	03:47, 19/04/98	66° 11.846'S, 143° 09.627'E	594	ADCP, MC's, VACM
polynya6	07:47, 19/04/98	66° 11.897'S, 143° 29.146'E	555	MC's
polynya7	22:34, 19/04/98	66° 56.651'S, 144° 56.268'E	1050	MC's, VACM, whale recorder
AU9807 MetOcean drifter deployments				
18646	08:55, 19/04/98	66° 12.730'S, 143° 37.171'E		
18653	07:00, 01/05/98	64° 48.580'S, 77° 41.673'E		
18654	09:02, 07/05/98	63° 00.00'S, 96° 01.00'E		
18655	07:16, 09/05/98	64° 20.15'S, 109° 34.58'E		
18656	09:14, 12/05/98	64° 00.40'S, 118° 25.75'E		
AU9901 mooring deployments				
SAZ-B	03:30, 18/07/99	46° 47.000' S, 142° 05.920' E	4226	sed. traps, Aanderaa CM's
SAZ-C	00:52, 20/07/99	53° 44.930' S, 141° 45.250' E	2181	sed. traps, Aanderaa CM's
polynya6b	02:50, 28/07/99	66° 11.972' S, 143° 29.037' E	550	MC's, VACM's
polynya5b	08:25, 28/07/99	66° 11.524' S, 143° 09.408' E	585	MC's, VACM's, SBE39's
polynya8b	07:29, 02/08/99	66° 42.399' S, 145° 17.164' E	525	MC's, VACM's
polynya7b	12:58, 02/08/99	66° 57.858' S, 144° 57.985' E	1071	MC's, VACM, SBE39's, whale rec.
AU9901 MetOcean drifter deployments				
10324	01:45, 15/08/99	65° 17.5'S, 146° 34.7'E		
18650	20:48, 23/08/99	66° 18.3'S, 144° 13.3'E		
18657	12:30, 24/08/99	65° 40.0'S, 145° 35.0'E		
TA0051 mooring recoveries (times at release)				
polynya8b	21:52, 17/02/00			
polynya7b	01:35, 18/02/00			
polynya7	04:15, 18/02/00			
polynya6b	18:07, 18/02/00			
polynya6	19:07, 18/02/00			
polynya5b	22:21, 18/02/00			
polynya5	23:23, 18/02/00			
polynya4	04:40, 19/02/00			
polynya3	09:38, 19/02/00			
polynya1	20:07, 19/02/00			
polynya2	20:32, 20/02/00			

Table 1.4: **Principal investigators (*=cruise participant) for water sampling programs.**

measurement	name	affiliation
AU9901		
CTD, salinity, O_2, nutrients	*Nathan Bindoff	Antarctic CRC
^{18}O	Russell Frew	University of Otago
biological sampling	Simon Wright/Harvey Marchant	Antarctic Division
D.M.S.	Graham Jones	James Cook University
D.I.C., ^{13}C, alkalinity	Bronte Tilbrook	CSIRO
^{15}N-nitrate	Daniel Sigman	Princeton University
AU9807, AU9801, TA0051		
CTD, salinity	Nathan Bindoff	Antarctic CRC

Table 1.5a: **Scientific personnel (cruise participants) for cruise au9807.**

Ian Helmond	CTD, moorings	CSIRO
Mark Rosenberg	CTD, moorings	Antarctic CRC
John Glazebrook	biological sampling	Antarctic Division
Simon Jarman	fishing	Antarctic Division
Andrew McEldowney	gear officer, deputy voyage leader	Antarctic Division
So Kawaguchi	fishing	Antarctic Division
Stuart Newman	fishing	Antarctic Division
Andrew Tabor	gear officer	Antarctic Division
Dick Williams	fishing, voyage leader	Antarctic Division
Karen Wilson	fishing	Marine Studies Centre (Tasmania)
Martin Field	whales	Ocean Research Foundation
Ari Friedlaender	whales	Ocean Research Foundation
Peter Gill	whales	Ocean Research Foundation
Keith Bailey	doctor	Antarctic Division
Robert Gratwick	electronics	Antarctic Division
Ian Higginbottom	hydroacoustics	Antarctic Division
Gordon Keith	programmer	Antarctic Division
Allen Smith	electronics	Antarctic Division
Arne Sorensen	ice pilot	P&O
Fiona Spruzen	birds	Antarctic Division
Annie Wong	dotzapper	Antarctic Division
Barry Batchelor	Macca	Parks and Wildlife
Dan Donohue	Macca	Parks and Wildlife
Gary Eagles	Macca	Antarctic Division
Rory O'Brien	Macca	Antarctic Division
Shane Procter	Macca	Antarctic Division
Ralph Purdon	Macca	Parks and Wildlife
Nigel Reid	Macca	Antarctic Division
Ian Williams	Macca	Parks and Wildlife

Table 1.5b: Scientific personnel (cruise participants) for cruise au9801.

Nathan Bindoff	CTD	Antarctic CRC	Craig Barnes	gear officer	Antarctic Division
Neil Holbrook	CTD	Antarctic CRC	Helen Douglass	doctor	Antarctic Division
Sarah Howe	CTD	Antarctic CRC	Rod Stephenson	electronics	Antarctic Division
Matt Perkins	CTD	Antarctic CRC	Peter Wiley	programmer	Antarctic Division
Mark Rosenberg	CTD	Antarctic CRC	Damien Dew	helicopters	Helicopters Australia
Moninya Roughan	CTD	Antarctic CRC	Simon Eder	helicopters	Helicopters Australia
Stephen Bray	hydrology	Antarctic CRC	Tony McNabb	helicopters	Helicopters Australia
Michael Grose	hydrology	Antarctic CRC	Magnar Aklestad	ice pilot	P&O
Neale Johnston	hydrology	Antarctic CRC	Matt Cadwallader	film crew	ABC
Ian Allison	sea ice, voyage leader	Antarctic Division	Michael Dillon	film crew	ABC
Ken Golden	sea ice	Antarctic Division	Jane Stevens	media	Discovery Channel
Petra Heil	sea ice	Antarctic CRC	Paul McClean	from Macca	Antarctic Division
Ian Knott	electronics, sea ice	Antarctic CRC			
Vicky Lytle	sea ice	Antarctic Division			
Rob Massom	sea ice	Antarctic CRC			
Matt Paget	sea ice	Antarctic CRC			
Mark Rapley	sea ice	Antarctic CRC			
Andrew Roberts	sea ice	Antarctic CRC			
Tony Worby	sea ice, deputy voyage leader	Antarctic Division			
Xingren Wu	sea ice	Antarctic Division			
Homero Haymussi	radiometry	CTTMar, UNIVALI			
Katrina Hill	radiometry	Antarctic CRC			
Clemente Hungria	radiometry	Antarctic CRC			
Kieran Jacka	meteorology	Antarctic CRC			
Mark Haye	meteorology	Bureau of Meteorology			
Rick van den Enden	biological sampling	Antarctic Division			
Graham Hosie	trawling	Antarctic Division			
John Kitchener	trawling	Antarctic Division			
Angela McGaffin	trawling	Antarctic Division			
Tim Pauly	hydroacoustics	Antarctic Division			
Stephen Burnell	whales	Ocean Research Foundation			
Karen Evans	whales	Ocean Research Foundation			
Peter Gill	whales	Ocean Research Foundation			
Deb Glasgow	whales	Ocean Research Foundation			
Rebecca Pirzl	whales	Ocean Research Foundation			
Emer Rogan	whales	University College Cork			
Deb Thiele	whales	Ocean Research Foundation			
Margie Morrice	seals	Antarctic Division			
Paul Webb	seals	Antarctic Division			
Andre Ancel	penguins	Centre National de la Recherche Scientifique			
Daniel Rodary	penguins	Centre National de la Recherche Scientifique			
Barbara Wienecke	penguins	Antarctic Division			
Jason Hamill	birds	Antarctic Division			
Stephani Zador	birds	US Geological Survey			

Table 1.5c: Scientific personnel (cruise participants) for cruise au9905.

Henk Brolsma	Antarctic Division	Kevin Miller	CSIRO
Sanae Chiba	Tokyo University of Fisheries	Stuart Newman	Antarctic Division
Helen Douglass	Antarctic Division	Warren Nicholas	Antarctic Division
Deb Glasgow	Ocean Research Foundation	Warren Papworth	Antarctic Division
Peter Jansen	Antarctic Division	Rebecca Pirzl	Ocean Research Foundation
John Kitchener	Antarctic Division	Cheri Recchia	Ocean Research Foundation
Simon Manser	Antarctic Division	Mark Rosenberg	Antarctic CRC
Peter Mantel	Antarctic Division	Johanna Turnbull	University of Wollongong

Table 1.5d: Scientific personnel (cruise participants) for cruise au9901.

Nathan Bindoff	CTD	Antarctic CRC
Ann-Maree Catchpole	CTD, underway	Antarctic CRC
Neil Holbrook	CTD/LADCP	Antarctic CRC
Sarah Howe	CTD	Antarctic CRC
Matt Perkins	CTD	Antarctic CRC
Mark Rosenberg	CTD, moorings	Antarctic CRC
Quentin Smith	CTD, Macca	Antarctic CRC
Guy Williams	CTD/ADCP	Antarctic CRC
Stephen Bray	hydrology	Antarctic CRC
Clodagh Curran	hydrology	Antarctic CRC
Diana Whittington	hydrology	Antarctic CRC
Phil Mercurio	DMS	James Cook University
Ian Allison	sea ice	Antarctic Division
Ken Golden	sea ice	Antarctic Division
Julian Harrington	sea ice, Macca	Antarctic Division
Daniel Kamien	sea ice, Macca	Antarctic Division
Ian Knott	electronics, sea ice	Antarctic CRC
Vicky Lytle	sea ice	Antarctic Division
Rob Massom	sea ice	Antarctic CRC
Matt Paget	sea ice	Antarctic CRC
Anton Rada	sea ice	Antarctic Division
Mark Rapley	sea ice	Antarctic Division
Andrew Roberts	sea ice	Antarctic CRC
Tony Worby	sea ice	Antarctic Division
Xingren Wu	sea ice	Antarctic Division
Rick van den Enden	biological sampling	Antarctic Division
Megan Tierney	biological sampling, underway, Macca	Antarctic Division
Alice Parker	biological sampling, underway, Macca	Antarctic Division
Karen Westwood	biological sampling	Flinders University
Graham Hosie	trawling	Antarctic Division
John Kitchener	trawling	Antarctic Division
Angela McGaffin	trawling	Antarctic Division
Chris McKinley	trawling, Macca	Antarctic Division
Tim Pauly	hydroacoustics	Antarctic Division
Mark Haye	meteorology	Bureau of Meteorology
Ian McCarthy	meteorology	Bureau of Meteorology
Homero Haymussi	radiometry	CTTMar, UNIVALI
Katrina Hill	radiometry	Antarctic CRC
Sigrid Wuttke	radiometry	Antarctic CRC
Deb Glasgow	whales	Ocean Research Foundation
Paul Hodda	whales	Ocean Research Foundation
Joanna Alfaro Shigueto	whales	Ocean Research Foundation
Deb Thiele	whales	Ocean Research Foundation
Andrew Welling	whales, Macca	Antarctic Division
Bianca Priest	birds	Antarctic Division
Andre Ancel	penguins	Centre National de la Recherche Scientifique
Daniel Rodary	penguins	Centre National de la Recherche Scientifique
Barbara Wienecke	penguins	Antarctic Division
Tony Dorr	seals	Antarctic Division
Clive McMahon	seals, Macca	Antarctic Division
Craig Barnes	gear officer	Antarctic Division
Corey Bradshaw	Macca	Antarctic Division
John Cadden	doctor	Antarctic Division
Gary Kuehn	field training officer	Antarctic Division
Ruth Lawless	dotzapper	Antarctic Division
Rod Stephenson	electronics	Antarctic Division
Peter Wiley	programmer	Antarctic Division
Damien Dew	helicopters	Helicopters Australia
Simon Eder	helicopters	Helicopters Australia
Adrian Pate	helicopters	Helicopters Australia
Russell Hawkins	film crew, Macca	ABC
Wade Fairley	film crew, Macca	ABC

Table 1.5e: Scientific personnel (cruise participants) for cruise ta0051.

Kevin Miller	CTD, moorings	CSIRO
Mark Rosenberg	CTD, moorings	Antarctic CRC
Leanne Armand	biological sampling, mud cores	Antarctic CRC
Martina Busetti	mud cores	Osservatorio Geofisico Speriment
Giovanna Giorgetti	mud cores	Osservatorio Geofisico Speriment
Peter Harris	mud cores	Antarctic CRC
Alix King	mud cores, CTD	Antarctic CRC
Massimo Presti	mud cores	Osservatorio Geofisico Speriment
Lisette Robertson	mud cores, CTD	Antarctic CRC
Fabio Trincardi	mud cores	IGM Bologna
Suenor Woon	mud cores, CTD	Antarctic CRC
Giuliano Brancolini	seismics	Osservatorio Geofisico Speriment
Belinda Brown	seismics	Sydney University
Jon Childs	seismics	US Geological Survey
Tara Deen	seismics	Sydney University
Claudio Pelos	seismics	Osservatorio Geofisico Speriment
Lorenzo Sormani	seismics	Osservatorio Geofisico Speriment
Roberto Vidmar	seismics	Osservatorio Geofisico Speriment
Andrew Hislop	gear officer	Australian Geological Survey Organisation
Peter Weber	gear officer	Australian Geological Survey Organisation
Andy Hill	gear officer	NIWA
Steve Wilcox	gear officer	NIWA
Peter Sullivan	doctor, voyage leader	Antarctic Division
Bob Graham	ice pilot	NIWA

1.3.2 CTD data collection in cold conditions

AU9901

Extreme cold was experienced for many stations on cruise au9901 (Figure 1.3), causing problems with CTD operations. The cold protective cover worked well in general, opening at ~14 dbar in warm conditions. However during extreme cold, the cover would get iced and stiffen up, on occasion not fully opening till significantly deeper (e.g. 25 dbar). For stations 1 to 5 in warmer conditions, CTD data from 2 to 12 dbar have been rejected due to the closed cover. For stations 6 to 92 in colder conditions, data have been rejected from 2 to 18 dbar. Further suspicious data are indicated in Table 1.13, e.g. due to incomplete opening of the cold cover.

The CTD sensors were squirted with hypersaline prior to each deployment in the Polynya to help prevent freezing. For several stations the cover was filled with hypersaline - when this was done and the cover was stiff due to the cold, the hypersaline sometimes did not entirely flush away till depths up to 50 dbar (suspicious data indicated in Table 1.13).

During very cold conditions, problems were experienced during CTD retrieval - water on the wire would freeze and block up the sheaf with ice. This would impart torsion on the wire, causing the frame to spin when it left the water. On one occasion a retermination was required due to serious birdcaging of the wire caused by the spinning frame. On another occasion serious kinking occurred due to ice from the previous cast causing wire jam around the sheaf during deployment, and another retermination was required.

During retrievals in the coldest conditions, ice crystals would form inside the Niskins. For several stations on CTD laps 1 and 3, this freezing caused stratification of water inside the Niskin bottles, and resulted in bottle salinity samples saltier by up to 0.3 (PSS78) (these bottle data have been flagged as bad).

Overall, many freezing problems were experienced on CTD laps 1 and 3, and a heat gun was often required to unfreeze the spiggots prior to sampling. Air temperatures for lap 2 were significantly warmer, making CTD operations much easier.

TA0051
As already discussed, freezing problems seriously degraded CTD data for stations 6 to 10.

1.3.3 Underway measurements

AU9807 and AU9901
Underway data were logged to an Oracle database on the ship. Sensor changes to earlier cruises include a second anemometer, and pitch/roll and GPS data obtained by 3D-GPS. For more information, see the AADC (Australian Antarctic Division Data Centre) website, and the cruise dotzapper reports:

(for AU9807) Data Quality Report, Aurora Australis Season 1997-98, Voyage 7 “PICCIES”, Annie Wong, Antarctic Division unpublished report;
(for AU9901) Data Quality Report, RSV Aurora Australis Season 1999-2000, Voyage 1 “IDIOTS”, Ruth Lawless, Antarctic Division unpublished report.

For AU9807, a sound speed of 1498 ms^{-1} has been used for ocean depth calculation; for AU9901, a sound speed of 1463 ms^{-1} has been used. For both cruises, the ship’s draught of 7.3 m has been accounted for (i.e. depths from the water surface). Data were dumped from the AADC website, and are in the following files:

AU9807

10 sec. instantaneous values, text format:	piccies.ora
10 sec. instantaneous values, matlab format:	picciesora.mat
data format description	README9807

AU9901

10 sec. instantaneous values, text format:	polynya.ora
10 sec. instantaneous values, matlab format:	polynyaora.mat
5 minute averages, text format:	polynyaav5.ora
5 minute averages, matlab format:	polynyaav5ora.mat
data format description	README9901

TA0051
Underway data were logged by the Tangaroa’s “Data Acquisition System”, including 3D-GPS. Data were provided by NIWA as instantaneous values every 10 sec. A sound speed of 1500 ms^{-1} has been used for calculation of ocean depth; unknown whether ship’s draught has been accounted for. Additional qualtity control was applied to the data provided by NIWA, to remove bad data values. Data are in the following files:

10 sec. instantaneous values, text format:	wega10sec.dat
10 sec. instantaneous values, matlab format:	wega10sec.mat
data format description	README0051

1.3.4 ADCP

AU9807 and AU9901
ADCP data collected by the hull mounted instrument are discussed in Rosenberg (unpublished report, 1999), including instrumentation, logging parameters, and data problems.

TA0051
ADCP data on the Tangaroa were collected by a hull mounted RDI 150 kHz broad band instrument, using AshTech 3DF GPS data. Further ADCP logging and processing information is available from unpublished NIWA reports. Data were logged in 4 m bins by the RDI software BBADCP (Transect version 2.72) running on a 486 PC. Calibrated data were provided by NIWA as 100 sec. ensemble averages.

The calibrated 100 sec. ensembles provided by NIWA were further processed as follows:
* GPS velocities were merged into the 100 sec. ensembles.
* 20 minute ensemble averages were formed from the 100 sec. ensembles. The following quality control was applied during this averaging:
    - a minimum of 75% attendance of ensembles over the 20 minutes is required to form the average;
    - a minimum of 30% attendance in a bin over the 20 minutes is required to form the average for that bin.

Note that no reference layer averaging was used.
* Data where ship speed ≤ 1 ms^{-1} were extracted.

Note that in the files:
* all times are UTC
* time for each 20 minute ensemble is at the start of the ensemble
* decimal time is decimal days from 1st January 1998 (e.g. 0.5=midday on January 1st 1998)
* GPS data are average values over the 20 minute ensemble

Data are contained in the following files:
20 minute ensembles, text format: t0051dop.dat
20 minute ensembles, matlab format: t0051dop.mat
20 minute ensembles, ship speed ≤ 1 ms^{-1} , *text format:* t0051dop_slow.dat
20 minute ensembles, ship speed ≤ 1 ms^{-1} , *matlab format:* t0051dop_slow.mat

Current vectors are plotted in Figures 1.4a and b; apparent vertical current shear for different ship speed classes, as discussed in Rosenberg (unpublished report, 1999), is plotted in Figure 1.5.

1.3.5 Moorings and drifters

Mooring deployments and recoveries, and MetOcean drifter deployments, are summarised for all the cruises in Table 1.3. Mooring data are described in more detail in Part 2 of this report.

1.4 CTD AND HYDROLOGY RESULTS

CTD and hydrology data quality are discussed in this section. When using the data, the following data quality tables are important:

Table 1.13 - questionable CTD 2 dbar averages
Table 1.15 - questionable nutrient data

1.4.1 CTD data

AU9901
CTD data calibration and processing methods are described in detail in Appendix 2 of Rosenberg et al. (1995), with the following additions:

(i) The minimum number of data points required in a 2 dbar bin to form an average was set to 8 (i.e. jmin=8).

(ii) Due to the presence of the cold protective cover, conductivity and temperature data are not available near the surface, so the surface pressure offset for each station is calculated as follows: skip the first 500 data points, then average the pressure over the next 20 data points (ignoring bad pressure values).

(iii) Near surface data have been excluded due to the cold protective cover - 2 to 12 dbar for stations 1 to 5, and 2 to 18 dbar for the remainder of the cruise.

(iv) The 10 seconds of CTD data prior to each bottle firing are averaged to form the CTD upcast burst data for use in calibration.

The final calibration results for conductivity/salinity, and the performance check for temperature, are plotted in Figures 1.6 to 1.8. A good conductivity calibration was obtained for CTD1193 (Figures 1.6 and 1.7), with CTD salinity data over the whole cruise accurate to well within ±0.002 (PSS78) from the comparison with bottle salinities. Note that salinity bottle values sampled at depths where the cold protective cover was closed were flagged out for the CTD conductivity calibration (Table 1.14).

A large consistent difference was found between CTD platinum temperature and thermometer temperatures for all the different thermometers used (Figure 1.8). Only a narrow range of temperatures were encountered for the Polynya work, mostly below -1.7^{o}C. It is assumed that the large CTD/thermometer differences are due to poor thermometer calibration at these low temperatures. There may also be a small CTD temperature calibration error, as there is no CTD temperature calibration point below zero. Though the magnitude of this additional error is unkown, it is assumed to be much smaller than the error due to thermometer calibrations.

Noise in the pressure signal for CTD1193 was high, with spikes up to 1 dbar amplitude occurring, and with a large number of missing 2 dbar bins resulting. The number of missing bins was reduced by setting jmin to 8 (i.e. the minimum number of data points in a 2 dbar bin required to form an average). For remaining missing bins, values were linearly interpolated (Table 1.12), except where local vertical gradients were too high.

Cold conditions caused freezing of the pressure sensor during deployment at stations 25, 26, 27, 29, 31, 78, 87, 88 and 89. For the first 4 of these stations, data were lost as a result. For the remainder of these stations, after the pressure sensor had unblocked the CTD was "yoyo'ed" back to ~8 dbar to resample the profile.

For station 91, logging did not commence till the CTD was already in the water at ~11 dbar. The surface pressure offset value was determined by interpolation between the values at stations 90 and 92.

Fluorescence data is effectively uncalibrated, and should only be used quantitatively if linked to productivity data. Note that no fluorescence peaks were measured on any CTD casts in the Polynya region.

AU9807
CTD data calibration and processing methods are as for AU9901, except that no cold cover was fitted, so data starts at the surface. The final calibration results for salinity are plotted in Figure 1.10.

CTD and salinity bottle data compare only to within an accuracy of ±0.003 (PSS78), however this can be attributed to bottle rather than CTD inaccuracy. Bottles salinities were analysed ~2 months after collection, and it appears the sample lids were not sealed well, allowing some evaporation from the samples - all bottles from station 3 were rejected for CTD calibration for this reason. CTD dissolved oxygen data were not processed as no bottle oxygens were collected.

TA0051

Raw data from the SeaBird CTD were processed using a combination of Seasoft version 4.236 SeaBird programs, and the usual methods as for AU9901. The processing steps were as follows:

* Ran “seacon” (in Seasoft) to change data channel assigned to altimeter for all stations; also corrected transmissometer channel assignment for station 6.

* Ran “datcnv” (in Seasoft) to create ascii files with data scans in engineering units; also created upcast burst data files using 10 sec. of data previous to each bottle firing.

* In unix environment, checked cross correlation between temperature and conductivity - maximum correlation at zero offset, so no re-alignment of data required.

* Ran “rossum” (in Seasoft) to create bottle data files *.btl.

* Ran “seaplot” (in Seasoft) to find bad data scans (Table 1.10).

* Transferred data to unix environment. Found surface pressure offset for each station (Table 1.7) by taking the average of 50 data scans prior to deployment. For station 1, logging started when CTD already in water - applied surface pressure offset from station 2; for station 9, logging started when CTD already in water - applied surface pressure offset from station 8.

* Manually deleted bad data scans (Table 1.10) from files.

* Ran program which applies pressure offsets, removes pressure reversals from CTD downcast data files, and recalculates salinity with the new pressure values.

* Merged CTD upcast burst data and bottle salinity data. Calibrated conductivity/salinity data as per AU9901 processing methods - conductivity calibration coefficients obtained are listed in Tables 1.8 and 1.9. Final calibration results for salinity are plotted in Figure 1.11.

* Ran program to recalibrate conductivity/salinity in CTD downcast data files.

* Used “binavg” (in Seasoft) to create 2 dbar averaged CTD downcast data files.

* Date files:
t0051.bot - bottle data, column formatted ascii file, format as per Aurora Australis data
t0051.mat - CTD downcast 2 dbar averaged data, matlab file, arrays as per Aurora Australis data
ta51d***.all - CTD downcast 2 dbar averaged data, column formatted ascii files, where ***=station number (001 to 005). Each file has 62 header lines, followed by the data in the following columns:

column	parameter
1	scan number
2	pressure (dbar)
3	temperature (^{o}C, T90)
4	conductivity (mS/cm)
5	salinity (PSS78)
6	transmittance (%)
7	altimeter (m) - data in this column are unreliable
8	flag
9	number of scans in 2 dbar average

Null data are represented by -99.

1.4.2 Hydrology data

AU9901

A Guildline ‘Autosal’ salinometer serial no. 62549 and International Standard Seawater (ISS) batch P133 (11th November 1997) were used for all salinity analyses. As mentioned previously, some salinity bottle samples collected during very cold conditions were affected by freezing of water in the Niskins after recovery. The worst cases were from stations 10, 25 to 31, and 86, with bottle salinities too salty by up to 0.3 (PSS78). These samples are flagged as bad in the bottle data file.

Bottle oxygen data appear to be good for the whole cruise - no suspicious values were found.

Nutrient autoanalyser problems during the cruise resulted in considerable delay before nutrient samples were analysed, with samples stored in a freezer for up to 4 weeks. As a result of the delay, much of the silicate data for the cruise are unacceptably low. The only silicate data retained are for station 2 to 5, and stations 57 onwards.

Nitrate+nitrite samples for stations 14 to 19 were anomalously high. These values have been deleted from the bottle data file.

Further details on bottle sample analyses and data quality are provided in the cruise hydrochemistry laboratory report (Appendix 1.1).

AU9807, AU9801 and TA0051

Salinity analyses were as follows:

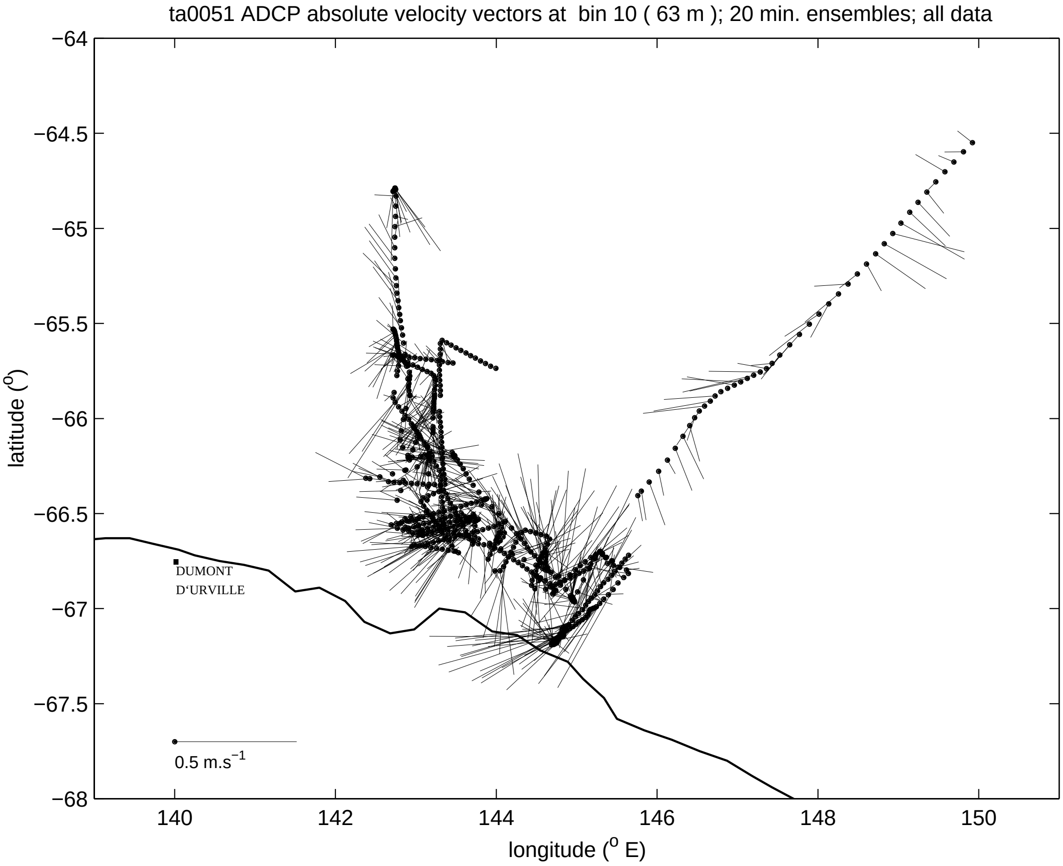
* AU9807 samples analysed back in Hobart ~2 months after collection; Guildline “Autosal” serial 62547; ISS batch P133.

* AU9801 samples analysed on ship; Guildline “Autosal” serial 62549; ISS batch P133.

* TA0051 samples analysed back in Hobart ~3 months after collection; Guildline “Autoal” serial 62547; ISS batch P133.

For AU9801, dissolved oxygen and nutrient samples were collected for station 1 only. Oxygen analyses were as per AU9901; nutrient samples were not analysed.

(a)



(b)

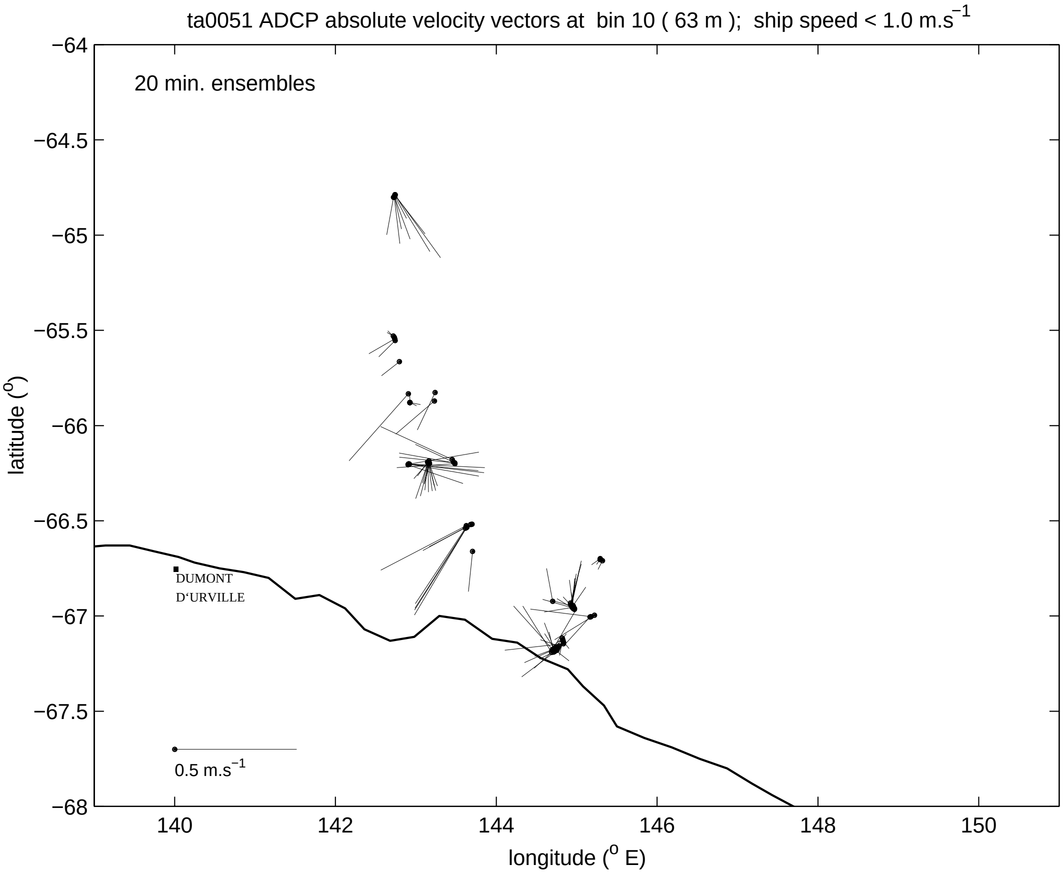
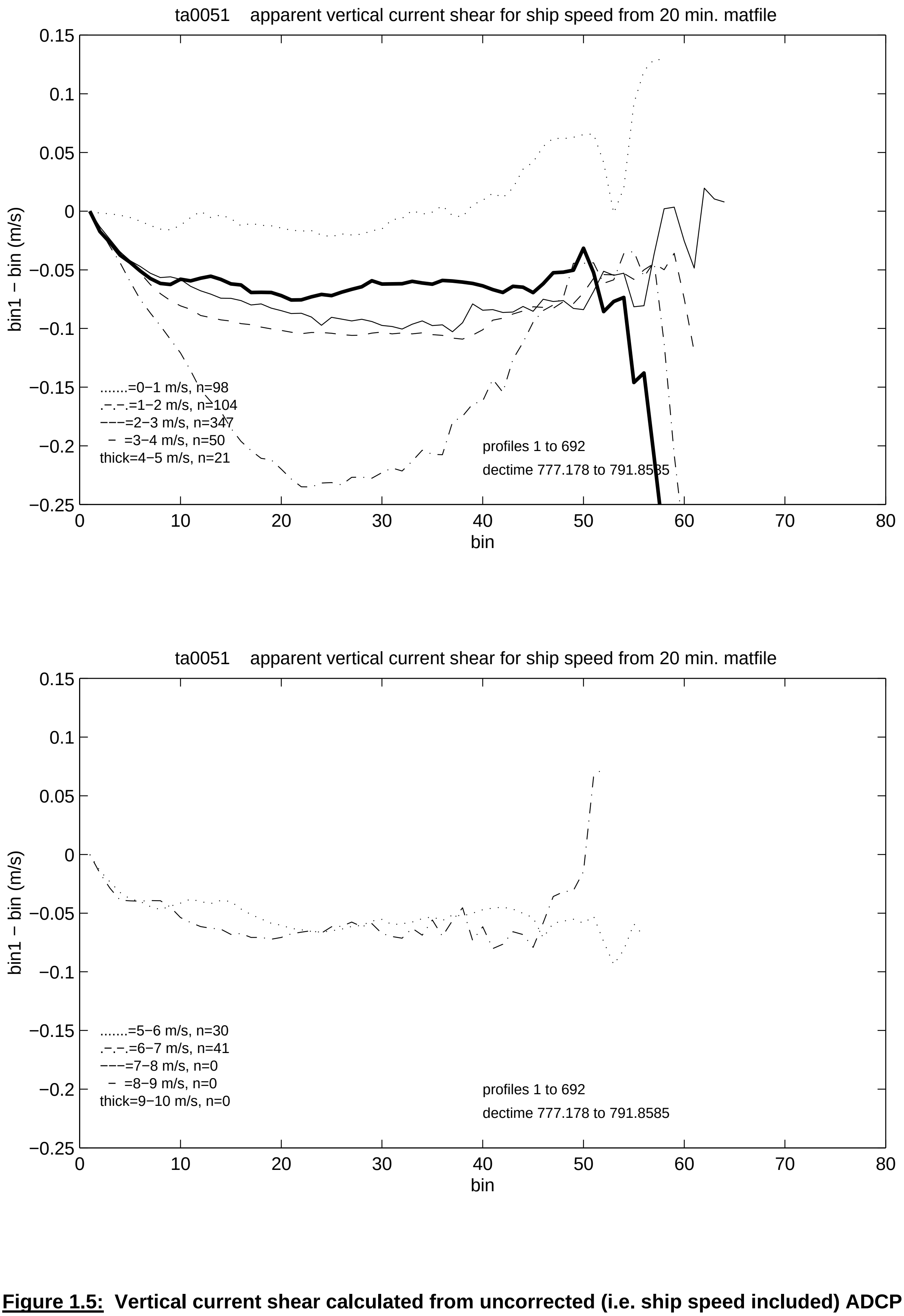
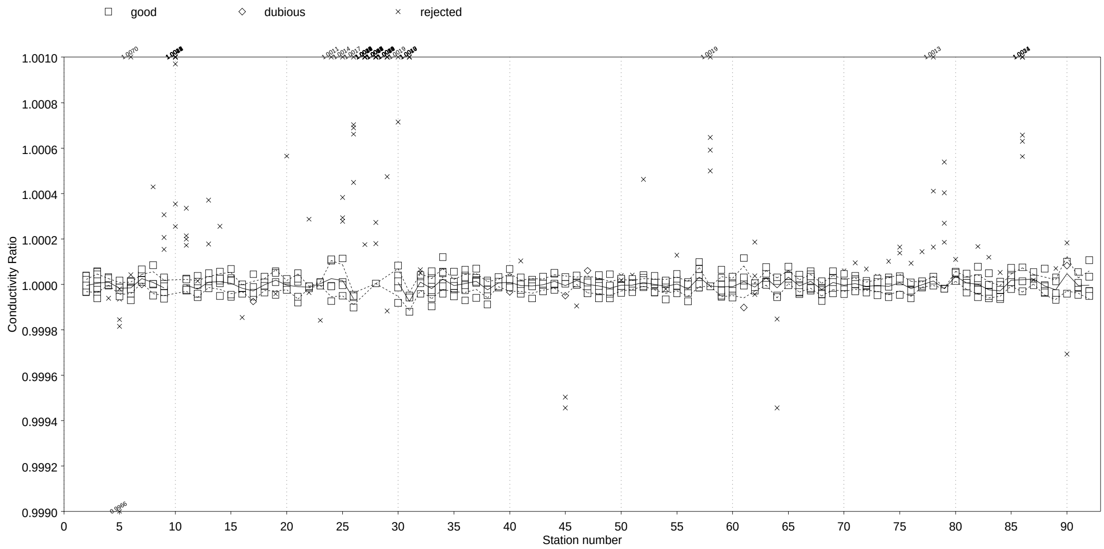


Figure 1.4: ADCP 20 minute ensembles for cruise ta0051;(a) all data, and (b) ship speed$\leq$1ms^{-1}



<u>Figure 1.5:</u> Vertical current shear calculated from uncorrected (i.e. ship speed included) ADCP velocities for cruise ta0051.



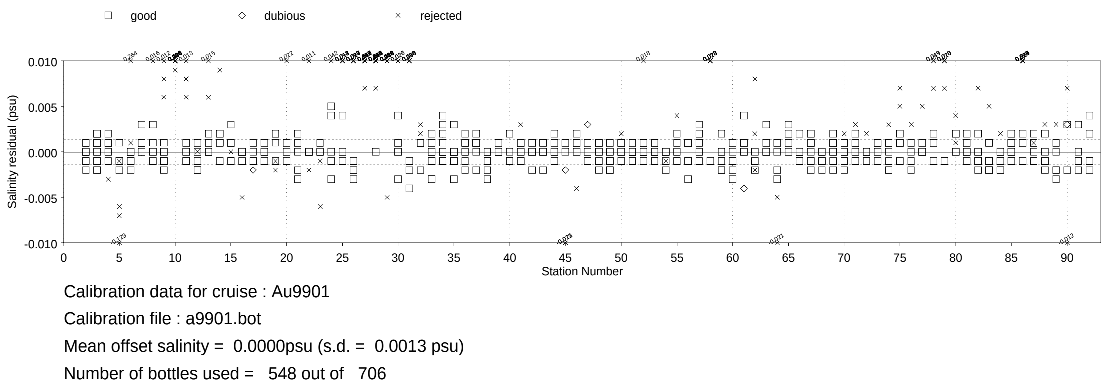
Calibration data for cruise : Au9901

Calibration file : a9901.bot

Conductivity s.d. = 0.00003

Number of bottles used = 548 out of 706 Mean ratio for all bottles = 1.00000

Figure 1.6: **Conductivity ratio c_{btl}/c_{cal} versus station number for cruise au9901. 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.**



Calibration data for cruise : Au9901

Calibration file : a9901.bot

Mean offset salinity = 0.0000psu (s.d. = 0.0013 psu)

Number of bottles used = 548 out of 706

Figure 1.7: **Salinity residual (s_{btl} - s_{cal}) versus station number for cruise au9901. The solid line is the mean of all the residuals; the broken lines are ± the standard deviation of all the residuals.**

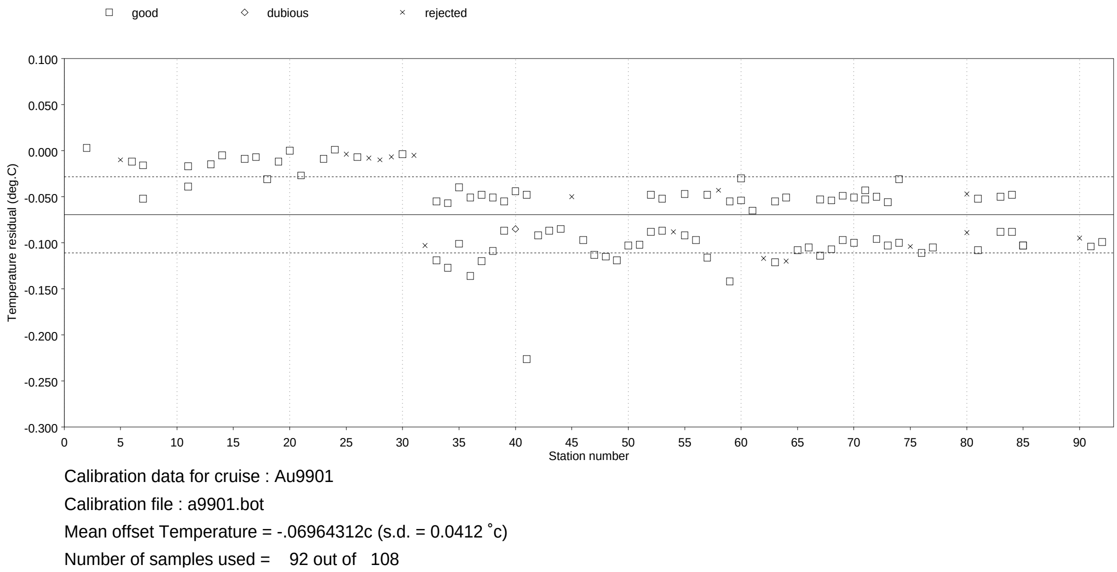


Figure 1.8: **Temperature residual (T_{therm} - T_{cal}) versus station number for cruise au9901. The solid line is the mean of all the residuals; the broken lines are ± the standard deviation of all the residuals. Note that the "dubious" and "rejected" categories refer to the conductivity calibration. Also note that the thermometers were changed after station 31.**

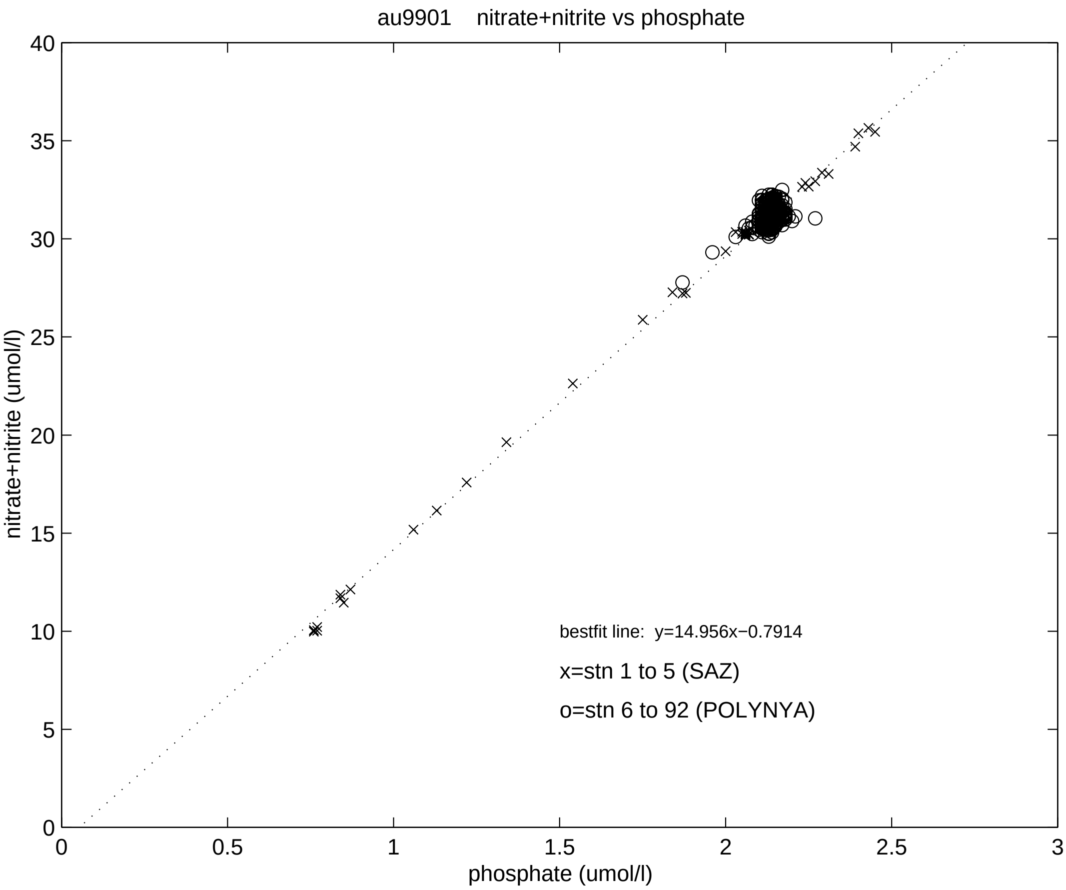
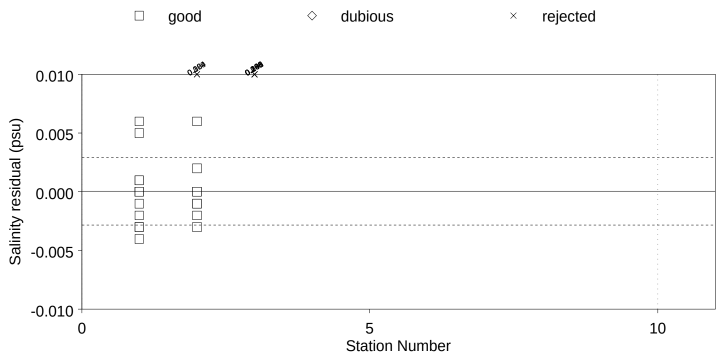


Figure 1.9: **Nitrate+nitrite versus phosphate data for au9901, together with linear best fit line.**



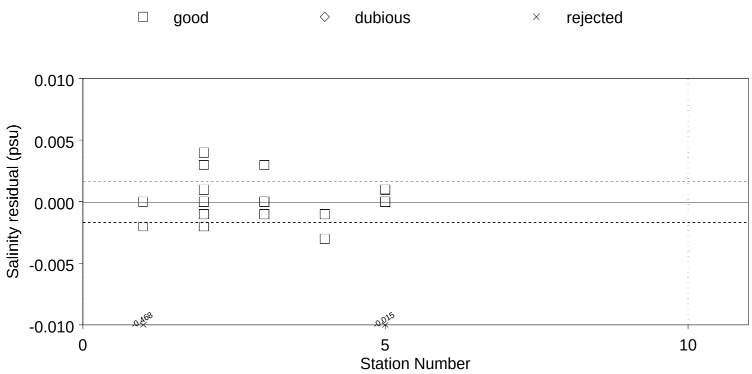
Calibration data for cruise : Au9807

Calibration file : histcal.lis

Mean offset salinity = 0.0000psu (s.d. = 0.0029 psu)

Number of bottles used =   20 out of   32

Figure 1.10: Salinity residual (s_{btl} - s_{cal}) versus station number for cruise au9807. The solid line is the mean of all the residuals; the broken lines are ± the standard deviation of all the residuals.



Calibration data for cruise : ta0051

Calibration file : histcal.lis

Mean offset salinity = 0.0000psu (s.d. = 0.0017 psu)

Number of bottles used =   24 out of   26

Figure 1.11: Salinity residual (s_{btl} - s_{cal}) versus station number for cruise ta0051. The solid line is the mean of all the residuals; the broken lines are ± the standard deviation of all the residuals.

Table 1.6: Calibration coefficients and calibration dates for CTD's used during the different cruises. Note that platinum temperature calibrations are for the ITS-90 scale.

coefficient	value of coefficient	coefficient	value of coefficient
AU9807 (whole cruise) and AU9801 (station 1) - CTD serial number 1193 (unit no. 5)			
pressure calibration coefficients		*pressure temperature calibration coefficients*	
CSIRO Calibration Facility - 23/06/1998		*CSIRO Calibration Facility - 23/06/1998*	
pcal0	-1.037172e+01	Tpcal0	8.886587e+01
pcal1	1.008266e-01	Tpcal1	-3.214299e-04
pcal2	-2.719863e-10	Tpcal2	-3.679449e-08
pcal3	2.158565e-14	Tpcal3	0.0
pcal4	-2.153042e-19	Tpcal4	0.0
platinum temperature calibration coefficients		*coefficients for temperature correction to pressure*	
CSIRO Calibration Facility - 01/07/1998		*CSIRO Calibration Facility - 23/06/1998*	
Tcal0	-4.89410e-02	T_0	20.00
Tcal1	4.98720e-04	S_1	-2.91307e-05
Tcal2	2.75410e-12	S_2	-5.35723e-02
preliminary polynomial coefficients applied to fluorescence (Antarctic Division, January 1996) and photosynthetically active radiation (par) (supplied by manufacturer) raw digitiser counts			
fluorometer (AU9801 station 1):			
f0	-1.115084e+01		
f1	3.402400e-04		
f2	0.0		
par (AU9807):			
par0	-4.499860		
par1	1.373290e-04		
par2	-3.452156e-23		
AU9801 (station 2) - CTD serial number 1103 (unit no. 7)			
pressure calibration coefficients		*pressure temperature calibration coefficients*	
CSIRO Calibration Facility - 21/11/1997		*CSIRO Calibration Facility - 21/11/1997*	
pcal0	-2.135418e+01	Tpcal0	1.249257e+02
pcal1	1.003383e-01	Tpcal1	-2.014478e-03
pcal2	1.431076e-09	Tpcal2	-1.140718e-08
pcal3	1.149904e-13	Tpcal3	0.0
pcal4	-8.367567e-19	Tpcal4	0.0
platinum temperature calibration coefficients		*coefficients for temperature correction to pressure*	
CSIRO Calibration Facility - 25,27/11/1997		*CSIRO Calibration Facility - 21/11/1997*	
Tcal0	5.19290e-02	T_0	20.00
Tcal1	4.99750e-04	S_1	-1.20887e-05
Tcal2	3.50490e-12	S_2	-3.28884e-03
preliminary polynomial coefficients applied to fluorescence (Antarctic Division, January 1996) raw digitiser counts (AU9801 station 2)			
f0	-1.115084e+01		
f1	3.402400e-04		
f2	0.0		

Table 1.6: (continued)

AU9901 (whole cruise) - CTD serial number 1193 (unit no. 5)

coefficient	value of coefficient	coefficient	value of coefficient
pressure calibration coefficients		*pressure temperature calibration coefficients*	
CSIRO Calibration Facility - 16/04/1999		*CSIRO Calibration Facility - 16/04/1999*	
pcal0	-1.029232e+01	Tpcal0	9.64083e+01
pcal1	1.008675e-01	Tpcal1	-7.71093e-04
pcal2	-2.120908e-09	Tpcal2	-3.03966e-08
pcal3	3.835826e-14	Tpcal3	0.0
pcal4	-1.995706e-19	Tpcal4	0.0
platinum temperature calibration coefficients		*coefficients for temperature correction to pressure*	
CSIRO Calibration Facility - 25/05/1999		*CSIRO Calibration Facility - 16/04/1999*	
Tcal0	-4.91880e-02	T_0	20.00
Tcal1	4.98660e-04	S_1	-1.76403e-05
Tcal2	2.75410e-12	S_2	-1.08291e-01

preliminary polynomial coefficients applied to fluorescence (Antarctic Division, January 1996) raw digitiser counts

coefficient	value of coefficient
f0	-1.115084e+01
f1	3.402400e-04
f2	0.0

TA0051

coefficient	value of coefficient	coefficient	value of coefficient
pressure calibration coefficients		*pressure calibration coefficients*	
pressure unit 68994 (stations 1 to 4)		*pressure unit 73293 (stations 5 to 10)*	
manufacturer - 21/07/1997		*manufacturer - 22/07/1997*	
C1	-4.998026e+04	C1	-4.423237e+04
C2	5.008302e-01	C2	6.762650e-01
C3	1.510090e-02	C3	1.415010e-02
D1	4.036400e-02	D1	3.649300e-02
D2	0.0	D2	0.0
T1	2.998583e+01	T1	2.994385e+01
T2	-2.213453e-04	T2	-1.511720e-06
T3	4.209140e-06	T3	3.894610e-06
T4	1.695110e-09	T4	2.567680e-09
AD590M	1.281230e-02	AD590M	1.285347e-02
AD590B	-9.044939	AD590B	-9.533034
platinum temperature calibration coefficients		*coefficients for conductivity(prior to bottle calibration)*	
manufacturer - 04/02/2000		*manufacturer - 04/02/2000*	
G	4.35915620e-03	G	-1.05957459e+01
H	6.45940107e-04	H	1.40944489
I	2.35512131e-05	I	-4.23766132e-03
J	2.14600758e-06	J	3.76511271e-04
F0	1000.000	CTcor	3.2500e-06
		CPcor	-9.5700e-08

coefficients for transmittance
22/09/1997

coefficient	value of coefficient
M	20.177
B	-0.040
path length	0.20 metres

Table 1.7: **Surface pressure offsets. ** indicates value estimated from surrounding stations.**

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)
AU9807									
1	0.37	2	-0.54	3	-0.13				
AU9801									
1	0.00	2	-0.10						
AU9901									
1	-0.61	20	-1.47	39	-0.87	57	0.07	75	-1.12
2	-0.28	21	-1.45	40	-0.97	58	-0.94	76	-1.10
3	-0.37	22	-1.25	41	-0.79	59	-0.61	77	-1.21
4	-0.32	23	-1.44	42	-0.96	60	-0.80	78	-1.31
5	-0.47	24	-1.67	43	-0.73	61	-0.80	79	-1.19
6	-0.14	25	-1.33	44	-0.72	62	-0.78	80	-0.93
7	-0.85	26	-1.10	45	-0.71	63	-0.48	81	-0.88
8	-1.08	27	-1.41	46	-0.62	64	-1.14	82	-1.49
9	-0.22	28	-1.31	47	-0.43	65	-0.41	83	-1.42
10	-1.88	29	-1.39	48	-0.66	66	-0.78	84	-0.86
11	-1.43	30	-0.86	49	-0.45	67	-0.84	85	-1.05
12	-1.64	31	-0.71	50	-0.37	68	-1.37	86	-1.12
13	-1.20	32	-0.66	51	-0.68	69	-0.72	87	-1.08
14	-1.38	33	-1.13	52	-0.61	70	-0.92	88	-1.11
15	-1.34	34	-0.02	53	-0.54	71	-1.04	89	-1.03
16	-1.35	35	-0.05	54	-0.48	72	-1.27	90	-0.41
17	-1.74	36	0.31	55	-0.50	73	-1.17	91	-0.33**
18	-1.17	37	-0.26	56	-0.13	74	-1.22	92	-0.25
19	-1.46	38	-0.91						
TA0051									
1	-1.14**	3	-1.75	5	-0.45	7	-0.59	9	-0.02**
2	-1.14	4	-1.52	6	-0.40	8	-0.02	10	-0.31

Table 1.8: **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.**

station grouping	F_1	F_2	F_3	n	σ
AU9807					
001 to 003	0.23639619E-01	0.96554378E-03	0.11293596E-06	20	0.002121
AU9801					
001	2.1433816	0.90025213E-03	0	12	0.000656
002	0.88312308E-02	0.10061028E-02	0	11	0.001313
AU9901					
001 to 005 SAZ	0.26556125E-02	0.96644997E-03	-0.11554603E-07	35	0.001030
006 to 010 POL	-0.15240396	0.97215517E-03	-0.12888945E-07	32	0.000893
011 to 023 POL	-0.56402057E-03	0.96661067E-03	-0.73718584E-09	67	0.000863
024 to 034 POL	0.10017394E-02	0.96673341E-03	-0.54223631E-08	48	0.001475
035 to 039 POL	-0.55871535E-01	0.96841489E-03	0.32717657E-08	40	0.000913
040 to 055 POL	-0.30493171E-01	0.96760426E-03	0.62040794E-09	102	0.000676
056 to 063 POL	-0.61407714E-02	0.96691216E-03	-0.86745776E-09	42	0.001147
064 to 069 POL	-0.54590313E-02	0.96686815E-03	-0.13864262E-08	50	0.000963
070 to 079 POL	-0.38047637E-01	0.96812465E-03	-0.28524052E-08	51	0.000683
080 to 086 POL	-0.16912710E-01	0.96702354E-03	0.19750834E-08	49	0.000909
087 to 092 POL	-0.50708473E-02	0.96515725E-03	0.18030181E-07	32	0.001188
TA0051					
001 to 005	-0.81127744E-01	0.10031097E-02	-0.48343111E-08	24	0.001253

Table 1.9: 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	($F_2 + F_3 . N$)
AU9807					
1	0.96565671E-03				
2	0.96576965E-03				
3	0.96588259E-03				
AU9801					
1	0.90025213E-03				
2	0.10061028E-02				
AU9901					
1	0.96643841E-03	32	0.96655989E-03	63	0.96685751E-03
2	0.96642686E-03	33	0.96655447E-03	64	0.96677942E-03
3	0.96641530E-03	34	0.96654905E-03	65	0.96677803E-03
4	0.96640375E-03	35	0.96852940E-03	66	0.96677664E-03
5	0.96639219E-03	36	0.96853268E-03	67	0.96677526E-03
6	0.97207784E-03	37	0.96853595E-03	68	0.96677387E-03
7	0.97206495E-03	38	0.96853922E-03	69	0.96677248E-03
8	0.97205206E-03	39	0.96854249E-03	70	0.96792498E-03
9	0.97203917E-03	40	0.96762908E-03	71	0.96792213E-03
10	0.97202628E-03	41	0.96762970E-03	72	0.96791928E-03
11	0.96660256E-03	42	0.96763032E-03	73	0.96791643E-03
12	0.96660183E-03	43	0.96763094E-03	74	0.96791357E-03
13	0.96660109E-03	44	0.96763156E-03	75	0.96791072E-03
14	0.96660035E-03	45	0.96763218E-03	76	0.96790787E-03
15	0.96659961E-03	46	0.96763280E-03	77	0.96790502E-03
16	0.96659888E-03	47	0.96763342E-03	78	0.96790216E-03
17	0.96659814E-03	48	0.96763404E-03	79	0.96789931E-03
18	0.96659740E-03	49	0.96763466E-03	80	0.96718155E-03
19	0.96659667E-03	50	0.96763528E-03	81	0.96718352E-03
20	0.96659593E-03	51	0.96763590E-03	82	0.96718550E-03
21	0.96659519E-03	52	0.96763652E-03	83	0.96718747E-03
22	0.96659445E-03	53	0.96763714E-03	84	0.96718945E-03
23	0.96659372E-03	54	0.96763776E-03	85	0.96719142E-03
24	0.96660327E-03	55	0.96763839E-03	86	0.96719340E-03
25	0.96659785E-03	56	0.96686358E-03	87	0.96672587E-03
26	0.96659243E-03	57	0.96686271E-03	88	0.96674390E-03
27	0.96658701E-03	58	0.96686185E-03	89	0.96676193E-03
28	0.96658158E-03	59	0.96686098E-03	90	0.96677996E-03
29	0.96657616E-03	60	0.96686011E-03	91	0.96679799E-03
30	0.96657074E-03	61	0.96685924E-03	92	0.96681602E-03
31	0.96656532E-03	62	0.96685838E-03		
TA0051					
1	0.10031049E-02				
2	0.10031000E-02				
3	0.10030952E-02				
4	0.10030903E-02				
5	0.10030855E-02				

<u>Table 1.10:</u> CTD raw data scans deleted during data processing. For the raw scan number ranges, the lowest and highest scan numbers are not included in the action.

station no.	raw scan nos.	reason
AU9901		
1	7785-7787	spike
25	1500-6066	P sensor frozen
26	1500-8182	P sensor frozen
27	1500-7052	P sensor frozen
29	1500-8180	P sensor frozen
29	20000-30000	P sensor frozen causing bad data
31	1500-12996	P sensor frozen
68, upcast	921-924	spike
78	1500-20366	P sensor frozen
85, upcast	2382-2385	spike
87	1500-9323	P sensor frozen
88	1500-9987	P sensor frozen
89	1500-11989	P sensor frozen
TA0051		
1	0-1253	to allow more values in 2 dbar average
2	0-3838	yoyo to 11 dbar, bad data
3	0-5914	yoyo with bad data
3	15174	bad pressure value
4	0-9190	yoyo with bad data
5	0-5538	yoyo with bad data

<u>Table 1.11:</u> 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; F=fluorescence; PAR=photosynthetically active radiation; TR=transmittance. Note: no CTD oxygen for any of the cruises.

station no.	pressure (dbar) where data missing	T	S	F	PAR	TR
AU9807						
3	272-280				1	
AU9801						
1	680-682			1		
AU9901						
8	20	1	1	1		
19	20	1	1	1		
22	20	1	1	1		
24	20	1	1	1		
25	20-38	1	1	1		
26	20-26	1	1	1		
27	20-24	1	1	1		
28	20	1	1	1		
29	20-62	1	1	1		
32	20-26	1	1			
39	20	1	1	1		
40	20	1	1	1		
41	20	1	1	1		
44	20	1	1	1		
46	20	1	1	1		
55	20-86		1			
67	20	1	1	1		
71	20	1	1	1		
76	20	1	1	1		
77	20	1	1	1		
78	20	1	1	1		
85	20	1	1	1		
86	20	1	1	1		
89	20	1	1	1		
TA0051						
2	2	1	1			1
3	2-4	1	1			1
4	2-4	1	1			1
5	2	1	1			1

<u>Table 1.12:</u> 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
AU9901		
2	2648	T, S, F
5	582	T, S, F
11	386,388,390	T, S, F
26	184	T, S, F
28	796	T, S, F
79	36	T, S, F

Table 1.13: **Suspect 2 dbar averages for the indicated parameters: T=temperature; S=salinity, σ_T , specific volume anomaly and geopotential anomaly.**

station number	questionable 2 dbar value(dbar)	parameters	comment
AU9807			
3	2-8	S	-
AU9901			
2	14-16	S	-
3	14-20	S	-
3	1380	S	salinity spike in steep local gradient
7	20-32	T, S	-
13	20-46	S	-
33	20-22	T, S	-
34	20-22	T, S	-
36	20	T, S	-
36	22	S	-
37	20-26	S	-
38	20-32	S	-
41	22-26	S	-
53	20-36	S	-
54	20-34	S	-
57	20-50	T, S	-
58	20-40	S	-
59	20-34	S	-
60	20-30	S	-
61	20-22	T, S	-
61	24-26	S	-
62	20-24	T, S	-
62	26-36	S	-
65	20-22	T, S	-
65	24-32	S	-
66	20-36	S	-
67	22-34	S	-
69	20-24	T, S	-
69	26-30	S	-
70	20	T, S	-
70	22-30	S	-
71	22-32	S	-
72	20-24	S	-
74	20-38	S	-
75	20-44	S	-
76	22-40	S	-
77	22-26	S	-
79	20-36	S	-
80	20-26	T, S	-
81	20-22	S	-
83	20-26	S	-
84	20-24	T, S	-
84	26-28	S	-
85	22-28	S	-
91	20-24	S	-
92	20-24	T, S	-

Table 1.14: Cruise AU9901: bottle samples taken when CTD cold protective cover closed - bottle salinity samples are okay, but they are flagged as -1 in bottle data file for calibration of CTD conductivity data (i.e. not used in CTD conductivity calibration).

station number	rosette position	station number	rosette position	station number	rosette position
6	12	26	9	60	208
7	12	27	10	62	106
8	6	28	12	67	111
10	11	29	9	70	209
11	10	30	7	71	208
12	9	32	106	72	207
13	9	37	9	73	208
14	8	38	8	74	207
15	7	39	7	76	106
16	7	40	7	77	106
17	7	41	7	79	106
18	6	42	106	80	106
19	6	50	9	82	208
20	6	51	10	83	209
21	6	52	12	84	10
22	6	53	12	88	207
23	6	53	111	89	106
24	6	53	10		
25	8	53	9		

Table 1.15: Cruise AU9901: questionable nutrient sample values (not deleted from hydrology data file).

PHOSPHATE		NITRATE		SILICATE	
station number	rosette position	station number	rosette position	station number	rosette position
6	whole station	6	whole station		
		8	whole station		
		9	whole station		
				11	9
				12	8
				27	8
		30	whole station		
		31	whole station		
32	6				
34	1, 3				
49	6	49	6	49	6
				63	whole station
				64	whole station
		65	whole station		
		66	whole station		
		67	whole station		
		74	7		
		75	6		
		76	5		
				82	whole station
				84	whole station
				92	whole station

Table 1.16: Reversing thermometers used (serial numbers are listed).

AU9801

protected thermometers

stations 1 to 2	12094, 12095 on position 11;	12119, 12120 on position 2

unprotected thermometers

stations 1 to 2	11992 on position 2

AU9901

protected thermometers

stations 2 to 5	12094, 12095 on position 12;	12119, 12120 on position 2
stations 6 to 31	12094, 12095 on position 11;	12119, 12120 on position 2
stations 32 to 92	12104, 12105 on position 6;	12100, 12103 on position 2

unprotected thermometers

stations 2 to 5	11992 on position 12;	10136, 12120 on position 2
stations 6 to 31	11992 on position 11;	10136, 12120 on position 2

APPENDIX 1.1 AU9901 HYDROCHEMISTRY CRUISE LABORATORY REPORT

Stephen Bray and Clodagh Curran (Antarctic CRC)

On cruise AU9901, the laboratory analysed seawater samples for nutrient concentrations (nitrate plus nitrite, silicate, and phosphate), salinities, and dissolved oxygen concentrations. The samples were from 92 CTD stations, mostly from the Mertz Glacier Polynya area. The methods used are described in the Antarctic CRC hydrochemistry manual (Eriksen, 1997). Additional samples also were collected, as described later in this report.

A1.1.1 PERSONNEL

Stephen Bray, Antarctic CRC
Clodagh Curran, Antarctic CRC
Diana Whittington, volunteer, formerly an IASOS honours student

A1.1.2 NUMBER OF SAMPLES ANALYSED

Nutrients (nitrate plus nitrite, silicate, phosphate) : 704
Salinities : 717
Dissolved oxygens : 702

A1.1.3 NUTRIENTS

The phosphate method previously used (ammonium molybdate, sulfuric acid, ascorbic acid, antimony potassium tartrate (APT), at 37 °C) has suffered from tailing. APT functions to increase the sensitivity, but also causes the tailing. A new method was suggested (Cowley and Johnston, 1999) which uses no APT and elevated temperature (70-80 °C) to increase sensitivity. There were problems with this method on the cruise, and the method eventually employed used no APT at 37 °C, with increased detector gain to compensate for the lack of chemical sensitivity.

The chemistries and general system used are described in the table below, and more details are in a9901_system.xls.

MQ samples were run in an attempt to monitor the nutrient content of the carrier. The readings were reasonably noisy because of the large refractive index change, but should reveal moderate nutrient contamination of the carrier. Note that because of the large difference in optical density between MQ and seawater, the values of the peaks do not represent actual nutrient concentration i.e. the MQ does not have a phosphate concentration of 0.3 μM.

A measurement was made of the matrix blank by changing critical reagents to MQ. It was done for one run.

A1.1.3.1 Quality checks

A set of checks were made by rinsing and filling a Nalgene 20L carboy with filtered (47 mm diam. Whatman GF/F, 0.7 μm pore size) seawater from the underway line. This was shaken and the water decanted into nut tubes. These were stored as follows:
* several run fresh
* ~50 in the fridge
* ~20 in -20 °C freezer
* ~100 in -80 °C freezer

There were a number of checks run. Some statistics for these are in the table below. Full details are in the various spreadsheets.

<u>Table A1.1.1:</u> Various precision statistics for nutrients

	stat in	stat in	N	P	S	N	P	S	n
	% columns	µM columns	%	%	%	µM	µM	µM	
QC 9901 freezer	rsd %	stdev	1.1	0.6	2.3	0.3	0.01	1.3	14
QC 9901 fridge	rsd %	stdev	0.4	0.5	2.2	0.1	0.01	1.3	26
tops	rsd %	stdev	0.7	0.4	1.8	0.2	0.01	2.5	20
tops	max range %	max range	4.7	3.2	10	1.7	0.10	14.5	20
repeats	av diff %	av diff	-0.0	-0.1	-0.9	-0.0	0.00	-0.7	40,58,73[+]
repeats	rsd of diff%	rsd of diff	0.6	0.7	2.0	0.2	0.02	1.4	40,58,73
repeats	max diff %	max diff	1.3	3.2	6.5	0.5	0.07	4.4	40,58,73
standards residual		stdev				0.1	0.01	0.4	9

[+] number of values are 40 for N, 58 for P, and 73 for S

* Cd column efficiency
Calculated as percent (NO_2 / top)
av = 99.5%, stdev = 1.0%, n = 129
min and max range in a run = 0.6 and 5.2%, n = 20 runs

* MQ as sample
Phosphate : av = 0.30 µM, stdev = 0.07 µM, n = 19

* Matrix correction (from 'critical reagent to MQ' measurements)
Phosphate : av = 0.03 µM, stdev = 0.01 µM, n = 15
The values for nitrate+nitrite and silicate were negligible.

* Files:
a9901_nuts_notes.doc
a9901_nuts.xls, reagents
a9901_nuts.xls, tubes
a9901_nuts.xls, detectors
a9901_system.xls
a9901_runs.xls, run
a9901_runs.xls, stn
a9901_runs.xls, notes
a9901_runs.xls, repeats
a9901_runs.xls, stds
tops_a9901.xls
no2_a9901.xls
repeats_a9901.xls
qc_a9901.xls
mq_a9901.xls
critical_reagent_to_MQ.xls

A1.1.4 SALINITY

Salinity analyses were performed by Clodagh Curran. A Guildline salinometer, SN 62549 was used. Ocean Scientific IAPSO standard seawater, batch P133 (11 Nov 1997), was used to standardise the salinometer throughout the cruise. Repeat standardisations, i.e. P133 measured against P133, showed no difference (ie 2R of <0.00000) over 16 repeats during the cruise.

Six P130 standards were measured. They averaged 0.0004 +/- 0.0004 psu higher than their nominal value, assuming the P133 standards were correct.

* Files :
sal_std_check.xls
sal62549.xls

A1.1.5 DISSOLVED OXYGEN

Dissolved oxygen analyses were performed by Diana Whittington. There were no major problems. 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 4.396 +/- 0.003 ml of thiosulfate. This is 227.8 +/- 0.2 μmol/l of oxygen, or 0.07%.

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	

A1.1.6 GENERAL DATA HANDLING

Plots were made of property vs station and nitrate vs phosphate. They are based on the data in the CSV file, and can be opened via the macro CSV in A9901.XLM.
Data was backed up to Iomega Zip disks.

A1.1.7 LABORATORIES

The instruments were in the 'wet lab'. The lab was received in very clean condition, in contrast to many past cruises. The salinometer was on the outboard side of the aft bench, the nutrient autoanalyser was on the inboard side of the aft bench, and dissolved oxygen was on the outboard central bench. The MQ system was in the 'photolab'.

The laboratory was shared with biologists. There were some problems with the biologists using volatiles such as formalin in the open, rather than in a fume cupboard. There were also occasional problems with overcrowding which were mostly associated with onlookers observing the catch from trawls. Overcrowding in a shipboard lab using strong acids, alkalis, and other chemical hazards is a very serious safety concern.

A1.1.8 TEMPERATURE MONITORING AND CONTROL

Temperature was controlled by the lab air conditioner and by a CAL Controls Ltd 'CAL 9900' proportional derivative plus integral (PID) temperature controller. The ships air conditioning outlets above the instruments were taped closed.

The laboratory temperature was recorded by two Tinytalk units. One was positioned above the salinity crates for most of the cruise, while the other was moved around for shorter checks.
The temperature was also measured by a mercury thermometer and the temperature monitor of the PID controller. 'Indoor/outdoor' electronic thermometers were used to measure fridge, freezer, and air conditioner temperatures. The sea doors were occasionally opened for short periods by other users of the laboratory, but not while analyses were in progress.

The air temperature about the salinometer was generally 19.5 +/- 1 °C.

A1.1.9 PURIFIED WATER

About 750L (~30 x 25L carboys) of water was produced for this lab and for various other people on the cruise. The water system did not need any cartridges or tanks changed. Two 13 litre leased mixed bed deioniser (MBDI) tanks were used.

A1.1.10 ADDITIONAL SAMPLES COLLECTED

A number of different samples were collected, as described below:

* CTD 20L filters
20L samples of seawater taken from CTD stations 3, 4 and 5. They were pressure filtered through 47mm diam. Whatman GF/F filters. Filtered by Diana Whittington, Megan Tierney, and Alice Parker.
Log in file a9901_20L_filter.xls

* CTD water for next sediment trap deployment
Water collected from CTD station 2 (44:35S, 145:29E, 1000m) in 20L Nalgene carboys. They were poisoned with 30g $HgCl_2$.

* CTD samples for Sigman
Collected from CTD stations 3, 4, 5, 13 and 84. Unfiltered, poisoned with HCl, stored at ambient temperature.
Underway samples collected from underway seawater, collected from outflow of GFF filter, poisoned with HCl, stored at ambient temperature.
Log in Sigman_9901.xls

* Underway samples
Collected by Sarah Howe, Diana Whittington, and Ann-Maree Catchpole.
Samples collected for: salinity, nutrients, Sigman's nitrate every degree on the south and north legs.

* Underway water was filtered through 142mm diam Whatman GF/F at 4 sites on north leg.

* Bronte Tilbrook's samples
DIC, C13, Alkalinity

25L carboys
Bottom bungs were loose, so there was some leaking of carboys 1 and 2, which were not poisoned at the time, and later emptied and refilled on north leg

Table A1.1.2: Carboys filled for Bronte Tilbrook

#	Date UTC	Time UTC	Lat	Long	Poison	Sampler
3	20 Jul 99	5:38	54: 08.41S	141: 53.38	Hg	Sarah Howe/Ann-Maree Catchpole
4	20 Jul 99	5:38	54: 08.41S	141: 53.38	Hg	Sarah Howe/Ann-Maree Catchpole
5	22 Jul 99	9:34	62: 29.2S	142: 49.1E	Hg	Stephen Bray
6	22 Jul 99	9:34	62: 29.2S	142: 49.1E	Hg	Stephen Bray
1	5 Sep 99	12:47	47:4.3S	151: 20.7	Hg	Stephen Bray
2	5 Sep 99	12:55	47: 2.8S	151: 19.2	Hg	Stephen Bray

5,6 were a few hours into sea ice. About 1 hour between sampling and poisoning to check for leaks.

A1.1.11 NUTRIENTS SYSTEM

Table A1.1.3: Nutrient autoanalyser parameters used on au9901

	Description	Pump colour code	Flow rate ml/min	Vol	Conc	W. pak size	Surfactant	Comments
	NITRATE + NITRITE							
R1	Imidazole buffer	Blk/blk	0.32	2L	Immid : 4.25g/L ie 8.5g/2L HCl conc 1.125ml /L, 2.25 ml /2L, or HCl 50% v/v of bottle 2.25 ml/L	8.5g	2 drops/L brij ~5 drops/2L	meas.cyl, acid in Ep
	Nitrogen	Orn/yel	0.18					
	Sample	Orn/Orn	0.42					
R2	Sulfanilamide	Orn/yel	0.18	2L	Sulf. : 3.12g/L HCl conc : 31 ml/L, 62ml/2L, or HCl 50% v/v of bottle, 62 ml/L 124ml/2L	3.12g	5 drops/L brij ~12drops/2L	
R3	NEDD	Orn/yel	0.18	1L	0.31g/L	0.31g	none	Light sensitive amber bottle
	Debubbler	Wht/wht	0.60					
	SILICATE							
R1	Ammonium molybdate	Orn/orn	0.42	2L	Amm mol. : 10g/L H2SO4 : 14ml/L of 20% v/v of bottle, 28ml/2L	10g	SDS, 15% w/v 2ml/L	
	Air	Orn/grn	0.10					
	Sample	Wht/wht	0.56					
R2	Oxalic acid	Blk/blk	0.32	2L	50g/L	100g	SDS, 15% w/v 2ml/L	
R3	Ascorbic acid	Orn/orn	0.42	1L	17.6g/L	17.6g	none	Light sensitive amber bottle
	Debubbler	Gry/gry						
	PHOSPHATE							
R1	Ammonium molybdate	Red/red	0.80	1L	Amm. mol. (Stock 20.56 g/L) 38ml/L of stock H2SO4 '20% v/v of bottle' , 47ml/L		SDS, 15% w/v 2ml/L	10ml meas.cyl vol. flask
	Air	Orn/grn	0.10					
	Sample	Red/red	0.80					
R2	Ascorbic	Orn/wht	0.23	500ml	Stock 6.42 g/500ml 47ml/500ml		none	100ml meas. vol flask
	debubbler	orn/orn	0.42					

Pump : one 24 channel Ismatec at speed of 50%
Carrier to washpot : Pur/pur
Carrier 78g/L NaCl in MQ
washpot overflow : Blu/blu
sample/ wash times : 70 / 70 s

Temperature
N: ambient
S: 37 °C
P: 37 °C

<u>Table A1.1.4:</u> Detector and computer parameters

	N	S	P
Wavelength, nm	540	660	880
Rise time, s	3	3	3
Range, AUFS	0.5	0.1	0.02
Faspac range	0-1V	0-1V	0-500mV
Faspac channel	4	6	5

APPENDIX 1.2 ANTARCTIC DIVISION FSI 3” MICROCTD PERFORMANCE

Mark Rosenberg (Antarctic CRC)

3 test casts were done with the Antarctic Division FSI 3” MicroCTD serial 1571 on Aurora Australis Voyage 1 1999/2000, as follows:

file	UTC time (start of cast)	Neil Brown CTD station	FSI cast method
990812.dat	14:33, 12/08/99	37	from trawl deck on a sea cable
stat73.dat	13:17, 20/08/99	73	on rosette package, battery pack
stat74.dat	14:44, 20/08/99	74	on rosette package, battery pack

For the first cast, the FSI CTD was deployed simultaneously with a Neil Brown CTD cast. For the second 2 casts, the FSI was attached to the rosette frame with the sensors next to the Neil Brown CTD sensors.

FSI temperature and salinity data are compared with Neil Brown data in the 5 figures, as follows:

Figure A1.2.1: station 73 FSI and Neil Brown data
Figure A1.2.2: station 74 FSI and Neil Brown data
Figure A1.2.3: station 37 FSI and Neil Brown data
Figure A1.2.4: station 73 difference data, Neil Brown - FSI
Figure A1.2.5: station 74 difference data, Neil Brown - FSI

Also note:

* In all the figures, downcast and upcast data are plotted separately.
* Neil Brown data are fully calibrated i.e. salinity data calibrated with Niskin bottle salinity samples, temperature data with CSIRO laboratory calibration coefficients applied. FSI temperature and conductivity data have the FSI laboratory calibration coefficients applied, but the salinity data are not calibrated i.e. Niskin bottle data not applied.
* FSI data, originally a 2 Hz data stream, have been averaged into 2 dbar bins, in order to match the 2 dbar averaged Neil Brown data.

For stations 73 and 74 (Figures A1.2.1 and A1.2.2), the downcast comparison shows a temperature lag for the FSI sensor. This is most likely due to temperature equilibration of the internal electronics, rather than to the temperature sensor itself. Station 74 was taken very soon after station 73, so the FSI electronics would have remained cooled down, and thus the temperature lag for the station 74 downcast is smaller than for station 73. For both stations, the FSI has equilibrated by the end of the downcast, so that the comparison with Neil Brown temperature is very good on the upcast.

The temperature lag is also manifest in the salinity data: as FSI temperature cools down on the downcast, FSI salinity increases (as expected from calculation of salinity). A good example is on station 73 for downcast data between 100 and 300 dbar: salinity is approximately constant according to the calibrated Neil Brown data, whereas the FSI salinity value continues to increase, due to decreasing temperature as the electronics equilibrate.

From the difference plots (Figures A1.2.4 and A1.2.5), FSI and Neil Brown temperatures for the upcast mostly agree to ~0.001^{o}C, with FSI temperatures lower than the Neil Brown values. Again for upcast data, uncalibrated FSI salinity values are lower than calibrated Neil Brown salinity values by ~0.025 or less. So for cold water casts with the FSI CTD's, the following protocol is suggested:

* always use the upcast data
* if cast is 400 dbar or greater, no equilibration is necessary
* if cast is shallower than 400 dbar, equilibrate instrument for 5 minutes near the surface at the start of the cast

Thus the FSI data for station 37 (Figure A1.2.3) should not be used, as the instrument did not equilibrate.

These examples are for near constant profiles in cold water, and with an internal battery pack (for stations 73 and 74). Further tests are required in profiles where a larger range of temperatures occur, to determine whether equilibration of the FSI becomes a significant problem. Comparison casts are also need with the FSI powered by sea cable and with an internal battery pack, to determine whether underpowering of the instrument by the battery pack is causing the temperature lag.

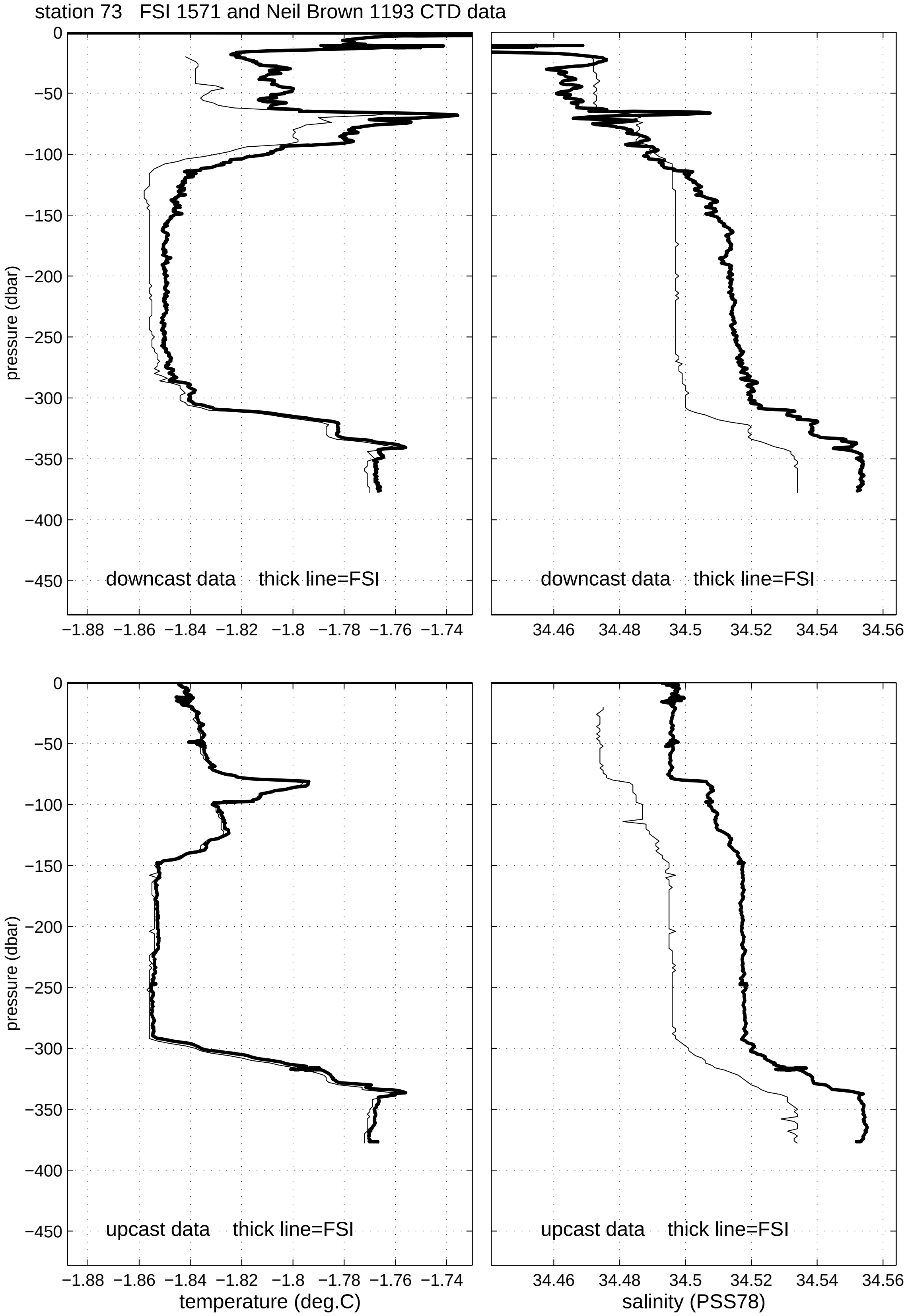
Temperature calibration points for high resolution temperature sensor

The following temperature values may be used for calibration checks of the hull mounted high resolution temperature sensor:

station	UTC time (from FSI)	~FSI depth (m)	FSI temperature (^{o}C)
73	14:09:53, 20/08/1999	7.5	-1.842
74	15:31:24, 20/08/1999	7.5	-1.840

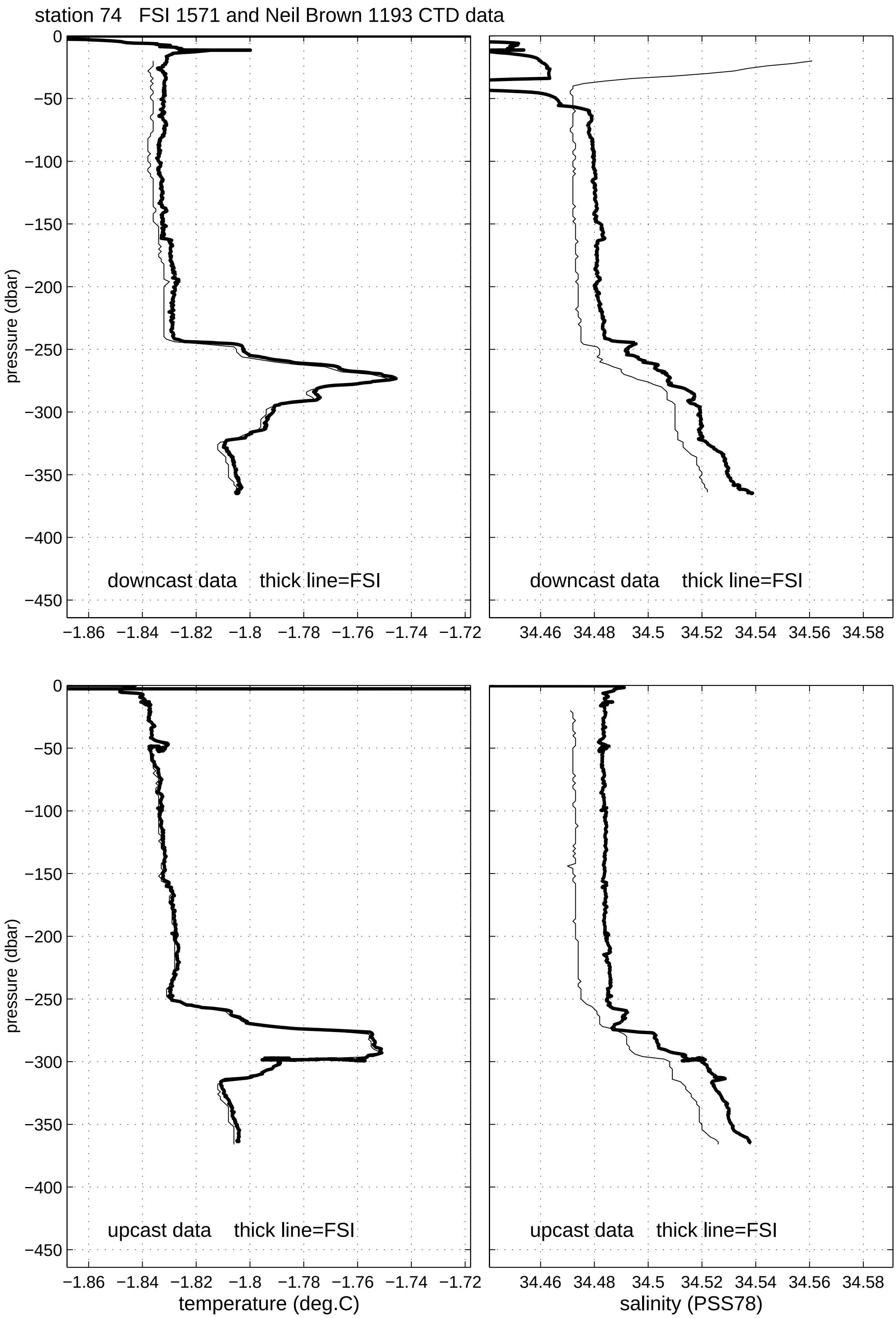
The following additional values, obtained from subantarctic Neil Brown CTD casts, assuming a mixed layer, can be used as **check values only.** At the depth of the hull mounted high resolution T sensor (i.e. 7.5 m), the cold protective cover on the Neil Brown CTD is closed, thus the Neil Brown sensors are not measuring the ambient water temperature. The values below are averages over the indicated pressures, where the cold protective cover has opened and the ambient water is being measured. The assumption is then that the water column above this is mixed, which may not be true. **Thus these values should only be considered good to ~0.015^{o}C:**

station	average UTC time (to nearest 10 sec.)	pressure bins used for T averaging (dbar)	average temperature (^{o}C)
2	04:14:50, 17/07/1999	14 to 24	10.846
3	04:29:30, 18/07/1999	14 to 24	10.919
4	11:30:00, 18/07/1999	14 to 24	10.817
5	02:19:50, 20/07/1999	14 to 18	1.888



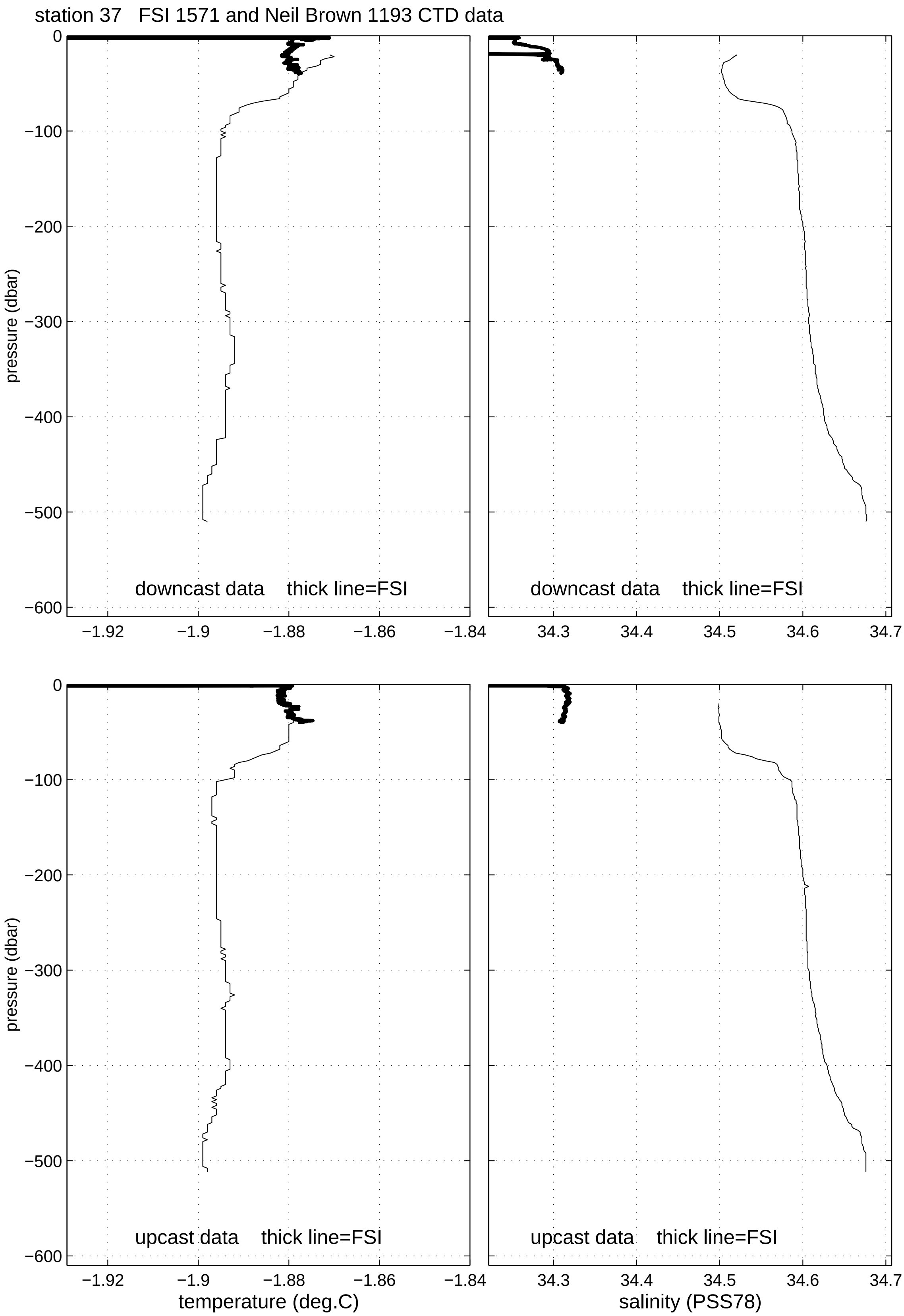
station 73 FSI 1571 and Neil Brown 1193 CTD data
pressure (dbar)
downcast data thick line=FSI
upcast data thick line=FSI
temperature (deg.C)
salinity (PSS78)

Figure A1.2.1



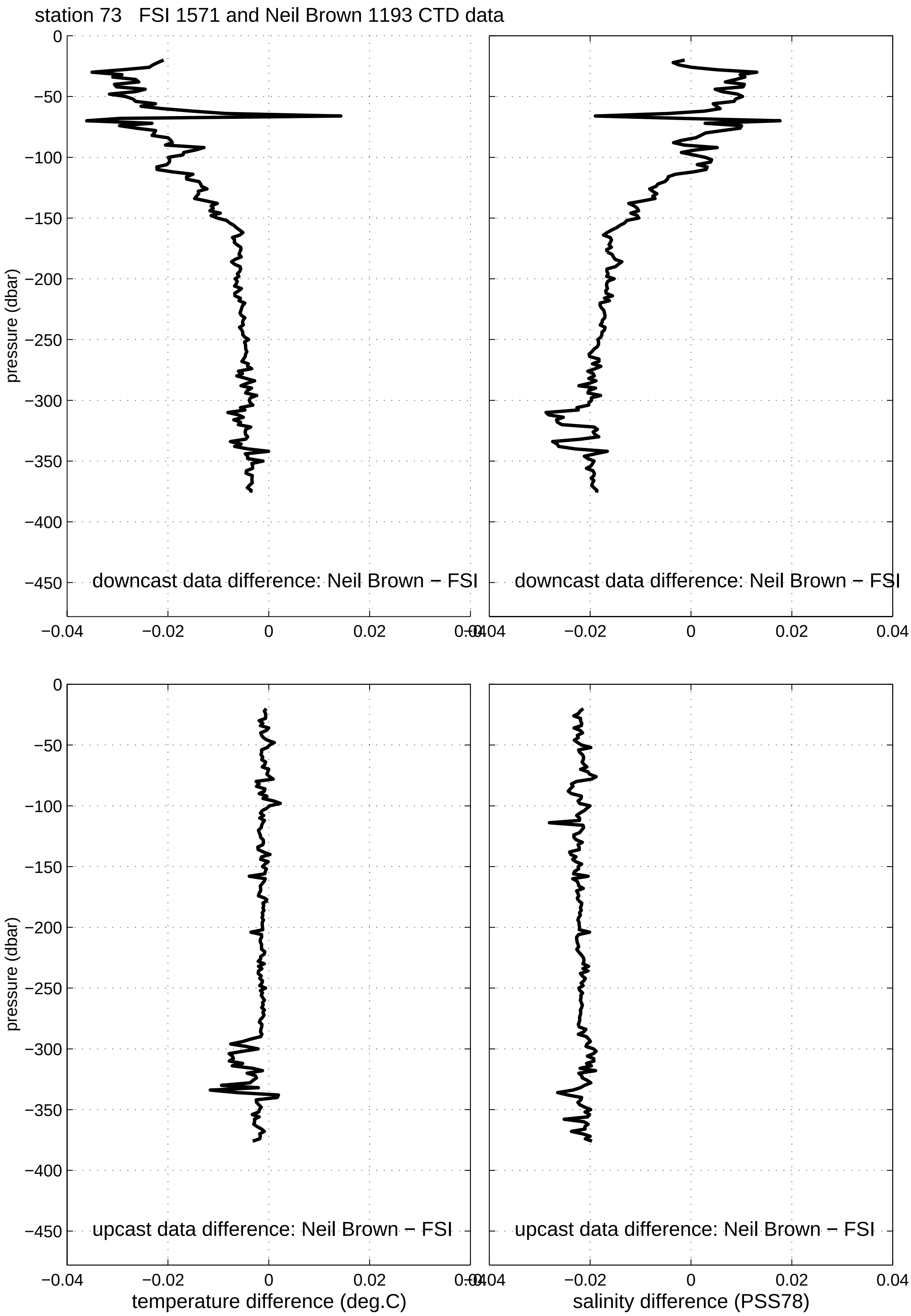
station 74 FSI 1571 and Neil Brown 1193 CTD data
pressure (dbar)
downcast data thick line=FSI
downcast data thick line=FSI
upcast data thick line=FSI
upcast data thick line=FSI
temperature (deg.C)
salinity (PSS78)

Figure A1.2.2



station 37 FSI 1571 and Neil Brown 1193 CTD data
pressure (dbar)
downcast data thick line=FSI
downcast data thick line=FSI
upcast data thick line=FSI
upcast data thick line=FSI
temperature (deg.C)
salinity (PSS78)

Figure A1.2.3



station 73 FSI 1571 and Neil Brown 1193 CTD data
pressure (dbar)
downcast data difference: Neil Brown − FSI
downcast data difference: Neil Brown − FSI
upcast data difference: Neil Brown − FSI
upcast data difference: Neil Brown − FSI
temperature difference (deg.C)
salinity difference (PSS78)

Figure A1.2.4

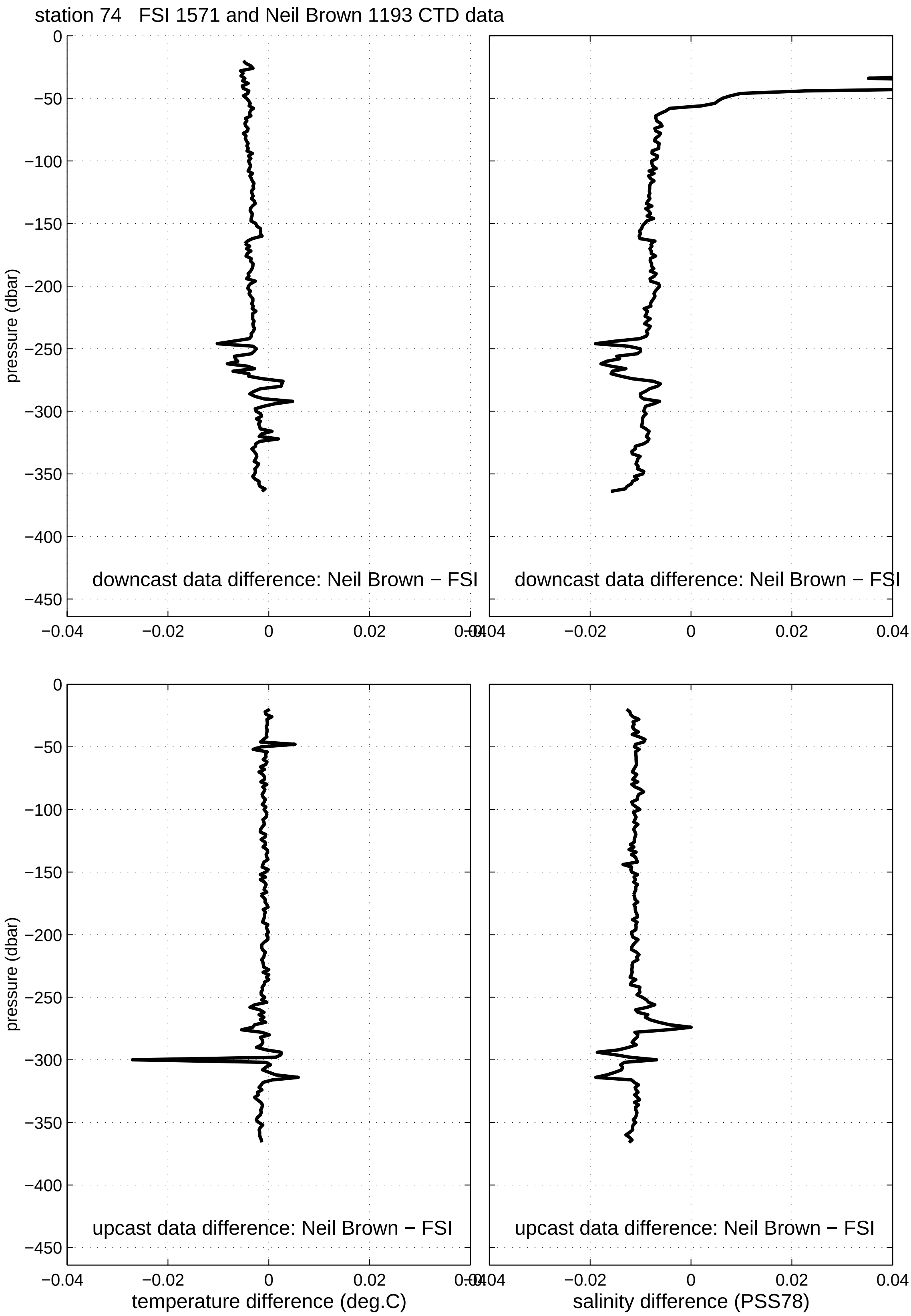

station 74 FSI 1571 and Neil Brown 1193 CTD data
pressure (dbar)
downcast data difference: Neil Brown − FSI
downcast data difference: Neil Brown − FSI
upcast data difference: Neil Brown − FSI
upcast data difference: Neil Brown − FSI
temperature difference (deg.C)
salinity difference (PSS78)
0
−50
−100
−150
−200
−250
−300
−350
−400
−450
−0.04
−0.02
0
0.02
0.04

Figure A1.2.5

APPENDIX 1.3 SUMMARY OF NUTRIENT ANALYSIS SYSTEMS FOR DIFFERENT CRUISES

Stephen Bray (Antarctic CRC) and Neale Johnston (CSIRO Division of Marine Research)

1995 SYSTEM

Pump at 50%

Description	Pump colour code	Flow rate (ml/min)	Conc
NITRATE + NITRITE			
Imidazole buffer	Blk/blk	0.32	4.25g/1000ml, 45ml of 2.5%HCl
Nitrogen	Orn/wht	0.25	
Sample	Blk/blk	0.32	
Sulphanilamide	Orn/yel	0.18	31ml conc HCl + 3.12g/1000ml
NEDD	Orn/yel	0.18	0.31g/1000ml + 1ml 30% Brij
Debubbler pull off	Orn/Orn		
SILICATE			
Ammonium molybdate	Orn/orn	0.41	H2SO4 conc 2.8ml/L 10g/L
Air	Orn/wht	0.25	
Sample	Wht/wht	0.56	
Oxalic acid	Blk/blk	0.32	100g/2L
Ascorbic acid Acetone	Orn/orn	0.41	17.6 g/L 50 ml
Debubbler pull off	Orn/orn0		
PHOSPHATE			
Dowfax	Red/red	0.71	
Air	Blk/blk	0.32	
Sample	Red/red	0.71	
Mixed colour reagent	Orn/grn	0.10	###Specify###
Debubbler pull off	Wht/wht		

Carrier : wht/pur, 78g/L NaCl
Washpot overflow : 2x pur/orn
sample/ wash times : ? / ?

NEALE'S SYSTEM 1997-98

PUMP 1 (at 50%)

	Description	**Pump colour code**	**Flow rate ml/min**	**Vol**	**Conc**	**Surfactant**	**W.pak size**	
	NITRATE + NITRITE							
R1	Imidazole buffer	Blk/blk	0.32	2L	Immid : 4.25g/L ie 8.5g/2L HCl conc 1.125ml /L, 2.25 ml /2L	5 drops/L brij	8.5g	
	Nitrogen	Orn/wht	0.25					
	Sample	Orn/Orn						
R2	Sulphanilamide	Orn/yel	0.18	2L	Sulph : 3.12g/L HCl conc : 31 ml/L	5 drops/L brij	3.12g	
R3	NEDD	Orn/yel	0.18	1L .	0.31g/L	5 drops/L brij	0.31g	Light sensitive amber bottle
	Debubbler	Wht/wht						
	SILICATE							
R1	Ammonium molybdate	Orn/orn	0.41	2L	Amm mol. : 10g/L H2SO4 : 14ml of 20%v/v /L	5 drops/L dowfax	20g	
	Air	Orn/wht	0.25					
	Sample	Wht/wht	0.56					
R2	Oxalic acid	Blk/blk	0.32	2L	50g/L	5 drops/L dowfax	100g	
R3	Ascorbic acid	Orn/orn	0.41	1L	17.6g/L	5 drops/L dowfax	17.6g	Light sensitive amber bottle
	Debubbler	Red/red						
	PHOSPHATE							
R1	Ammonium molbydate	Red/red		2L	Amm mol : 0.78g/L H2SO4 (20% v/v) 46.5ml /L	5 drops/L dowfax	1.56g	
	Air	Orn/wht						
	Sample	Red/red	0.71					
R2	Ascorbic acid APT	Orn/wht		500ml	Asc : 1.2g/L APT : 1ml 6.5% w/v (via Ep) ie 6.5g/100ml	5 drops/L dowfax	0.6g 1.2g asc	Light sensitive amber bottle
	debubbler	Grey/grey						

Carrier : Pur/orn
78g/L NaCl
washpot overflow : Pur/pur
sample/ wash times : ? / ? s

Temperature
N ambient
S 37 °C
P 37 °C

Stock concs:
###
Std range
###

Surfactant
N Brij 5 drops/L in every reagent
S & P dowfax 5 drops/L in every reagent.

S &P Can use extra drops in 1st reagent to stabilise flow.
P : too much Dowfax – noisy baseline
P Add too much SDS doesn't make much difference. (?)
S Add too much Dowfax – not much difference
S Add too much SDS – suppresses sensitivity (?)

N Don't use extra drops in first reagent (buffer) to stabilise flow, as it can decrease column effeciency. (possibly by sticking to Cd)

Cd Coil regeneration and storage ?
Normal (everyday)
2M HCl
MQ
1CuSO4
MQ
CuSO4
MQ

Stubborn
CSIRO HNO3 – but not a good idea
H2SO4 not a good idea either because too harsh – pitting

HCl
MQ
Acetone – good dose
MQ
Repeat HCl,MQ,acetone, MQ

Then 'normal' regeneration.

Bad bubbles from coil
1 Ultrasonic in dilute HCl
2 if ultrasonic doesn't work - cut off with hacksaw blade. Don't 'snip' – will crush. Sand down end with fine wet n dry

Storage
Overnight – MQ
Longer term – DRY, best with N2, can use air.
Air will cause oxidation, but this will come away with normal regeneration.

Cd wire
Insert Cd wire into tube.
Tube needs to be narrowest ID that will accept wire.
Need to avoid dead space. Both wire/ID being close, and deadspace at start and end of wire.
Regenerate as per normal. Can also take wire out and wipe with tissue, either dry, wet, or wet with acid.
Need to debubble before going into wire.

Notes
Standards, from primary to working.
Standard 5/top made up in same 500ml vol. flask.

Cleaning P lines:
Try NaOH solution firrst.
Then try hydrogen peroxide, followed by NaOH again Then MQ.
Then need to condition with at least 20-30 SW samples.

PEEK tubing P tailing ….

Background
Previously only done on wash solution on phosphate, using emasculated 'background' solution (MQ instead of ascorbic acid).
Now:
Pull out 'critical reagent' line and stick on MQ bottle.
Can run for all samples.
N : NEDD
S : ascorbic
P : R2 :ascorbic/APT

Do stds and ~10 seawater samples (UW or anything) to condition the system before running samples.
Also get first ~6 sampes after they've been run and stick at end to be rerun.

Differences
No acetone in silicate (used to help flow (?)) – not necessary. First thing to change!

Reagents made up to measuring cylinder accuracy only.
Previously made up to volumetric flask accuracy.
Justified as reagents are only weighed to top pan precision.
Drastically reduces amount of glassware, and eliminates a liquid transfer, so is efficient.

Further work
Concern about small tubes stretching. Flow rates change.
So increase diam and decrease conc. of solutions.

1999 SYSTEM

PUMP 1 (at 50%)

	Description	Pump colour code	Flow rate ml/min	Vol	Conc	W.pak size	Surfactant	
	NITRATE + NITRITE							
R1	Imidazole buffer	Blk/blk	0.32	2L	Immid : 4.25g/L ie 8.5g/2L HCl conc 1.125ml /L, 2.25 ml /2L, or HCl 50% v/v of bottle 2.25 ml/L	8.5g	2 drops/L brij	
	Nitrogen	Orn/wht	0.25					
	Sample	Orn/Orn	0.42					
R2	Sulphanilamide	Orn/yel	0.18	2L	Sulph : 3.12g/L HCl conc : 31 ml/L, 62ml/2L, or HCl 50% v/v of bottle, 62 ml/L	3.12g	5 drops/L brij	
R3	NEDD	Orn/yel	0.18	1L .	0.31g/L	0.31g	none	Light sensitive amber bottle
	Debubbler	Wht/wht	0.60					
	SILICATE							
R1	Ammonium molybdate	Orn/orn	0.42	2L	Amm mol. : 10g/L H2SO4 : 14ml/L of 20% v/v of bottle	20g	SDS, 15% w/v 2ml/L	
	Air	Orn/wht	0.25					
	Sample	Wht/wht	0.56					
R2	Oxalic acid	Blk/blk	0.32	2L	50g/L	100g	SDS, 15% w/v 2ml/L	
R3	Ascorbic acid	Orn/orn	0.42	1L	17.6g/L	17.6g		Light sensitive amber bottle
	Debubbler	Red/red	0.80					
	PHOSPHATE							
R1	Ammonium molbydate	Red/red	0.80	1L	Amm. mol. Stock 20.56 g/L 50ml stock to 1L ie 1.028 g/L H2SO4 170ml of 5N (10M)/L, or 120ml/L of '20% v/v of bottle'	20.56g	SDS, 15% w/v 2ml/L	
	Air	Orn/grn	0.10					
	Sample	Red/red	0.80					
R2	Ascorbic	Orn/grn	0.10	500ml	6.42 g/500ml	6.42g	SDS, 15% w/v 2ml/L	Light sensitive amber bottle
	debubbler	Blk-blk	0.32					

Carrier to washpot : Pur/pur
Carrier 78g/L NaCl in MQ
washpot overflow : Blu/blu
sample/ wash times : 70 / 70 s

Temperature
N ambient
S 37 °C
P 65 °C

Stock concs:
###
Std rang
###

Detector

	N	S	P
Wavelength nm	540	660	880
Rise time s	3	3	3
Range AUFS	0.5		
Faspac range			

NEW 1999 SYSTEM
Used on au9901
Phosphate is 37 dC, no APT. Had tried new 80dC system but had problems.
PUMP 1 (at 50%)

	Description	**Pump colour code**	**Flow rate ml/min**	**Vol**	**Conc**	**W.pak size**	**Surfactant**	**Comments**
	NITRATE + NITRITE							
R1	Imidazole buffer	Blk/blk	0.32	2L	Immid : 4.25g/L ie 8.5g/2L HCl conc 1.125ml /L, 2.25 ml /2L, or HCl 50% v/v of bottle 2.25 ml/L	8.5g	2 drops/L brij ~5 drops/2L	meas.cyl, acid in Ep
	Nitrogen	Orn/yel	0.18					
	Sample	Orn/Orn	0.42					
R2	Sulphanilamide	Orn/yel	0.18	2L	Sulph : 3.12g/L HCl conc : 31 ml/L, 62ml/2L, or HCl 50% v/v of bottle, 62 ml/L 124ml/2L	3.12g	5 drops/L brij ~12 drops/2L	
R3	NEDD	Orn/yel	0.18	1L .	0.31g/L	0.31g	none	Light sensitive amber bottle
	Debubbler	Wht/wht	0.60					
	SILICATE							
R1	Ammonium molybdate	Orn/orn	0.42	2L	Amm mol. : 10g/L H2SO4 : 14ml/L of 20% v/v of bottle, 28ml/2L	10g	SDS, 15% w/v 2ml/L	
	Air	Orn/grn	0.10					
	Sample	Wht/wht	0.56					
R2	Oxalic acid	Blk/blk	0.32	2L	50g/L	100g	SDS, 15% w/v 2ml/L	
R3	Ascorbic acid	Orn/orn	0.42	1L	17.6g/L	17.6g	none	Light sensitive amber bottle
	Debubbler	Gry/gry						
	PHOSPHATE							
R1	Ammonium molbydate	Red/red	0.80	1L	Amm. mol. (Stock 20.56 g/L) 38ml/L of stock H2SO4 '20% v/v of bottle' , 47ml/L		SDS, 15% w/v 2ml/L	10ml meas.cyl vol. flask
	Air	Orn/grn	0.10					
	Sample	Red/red	0.80					
R2	Ascorbic	Orn/wht	0.23	500ml	Stock 6.42 g/500ml 47ml/500ml		none	100ml meas. vol flask
	debubbler	orn/orn	0.42					

Carrier to washpot : Pur/pur
Carrier 78g/L NaCl in MQ
washpot overflow : Blu/blu
sample/ wash times : 70 / 70 s

Temperature
N ambient
S 37 °C
P 37 °C

Detector side

	N	S	P
Wavelength, nm	540	660	880
Rise time, s	3	3	3
Range, AUFS	0.5	0.1	0.02
Faspac range	0-1V	0-1V	0-500mV
Faspac channel	4	6	5

More details in a9901_system.xls

Stock concs:
###
Std range
###

Detector switch settings at back-

Name	**on/off**
Filter bypass	off
Int offset	on
Rec offset	off
Recorder full scale 10 mV	off
100 mV	off
1V	on

Don't use int. offset output, so having it offset or not should make no difference.

PART 2 MOORING DATA

2.1 INTRODUCTION

Two mooring arrays (Figure 2.1) were deployed as part of the Mertz Polynya Experiment, as outlined in Part 1 of this report. This section describes data processing and data quality for the Mertz Polynya moorings, and data are summarised graphically. Deployment and recovery details are described in unpublished cruise reports. The two SAZ moorings deployed on cruise au9901 are not discussed further.

Mooring diagrams are shown in Figures 2.2 to 2.5. Mooring details are summarised in Tables 2.1 and 2.2. Data file formats are summarised in Appendix 2.1.

Table 2.1: Instrument types used on Mertz Polynya moorings. For parameters, T=temperature, C=conductivity, P=pressure, SPD=current speed, DIR=current direction.

instrument type	parameters measured	recording interval
SeaBird SBE37SM microcat	T,C	5 minutes for 1998 array 7.5 minutes for 1999 array
SeaBird SBE39	T	3.75 minutes
Aanderaa RCM8 current meter	SPD,DIR,T,P	60 minutes
RDI 150kHz ADCP, upward looking orientation, convex 4 beam pattern	SPD,DIR,T,roll,pitch	45 minutes
Oregon Environmental Instruments 9407 vector averaging current meter (VACM)	SPD,DIR,T,P	45 minutes
Oregon Environmental Instruments 9311 temperature logger	T (+ P for serial 1403)	5 minutes
Upward looking sonar, Curtin University of Technology, Western Australia	ice thickness, T, P, tilt	varied bursts, according to season
whale recorder, CSIRO Division of Marine Research	ambient sound	various burst recordings giving 240 minutes total recording time

2.2 INITIAL DATA PROCESSING

2.2.1 General

All mooring data were assigned a consistent decimal time scheme, using decimal days as counted from midnight on December 31st 1997. So, e.g., midday on January 1st 1998 = 0.5 decimal time; midday on January 1st 2000 = 730.5.

Proximity of instruments to the south magnetic pole makes magnetic variation significant for current measurements. An average magnetic declination value was calculated for each mooring site, using

Table 2.2: **Summary of mooring details. Note: magdec=average magnetic declination.**

mooring	position	deployment time (UTC)	recovery (release) time (UTC)	ocean depth (m)	magdec (deg)	d(magdec)/dt (deg/year)	instrument	instrument position depth (m)	pressure (dbar)
polynya1	64° 47.350'S, 142° 44.640'E	16:16, 17/04/98	20:07, 19/02/00	3213	78.07	0.76	ULS-SOFAR	160	161.7
							RCM8-10867	190	192.0
							9311-0004	380	384.3
							9311-003C	550	556.4
							9311-0038	800	809.7
							microcat-380	3196	3252.6
polynya2	65° 48.066'S, 142° 54.954'E	05:58, 18/04/98	20:32, 20/02/00	1180	116.25	0.325	VACM-A5DAE	522	528.0
							microcat-315	560	566.5
							9311-1403	630	637.5
							9311-0002	680	688.1
							9311-0003	780	789.5
							microcat-316	877	887.9
							microcat-317	1139	1153.8
							microcat-318	1157	1172.1
							ADCP-0135	1175	1190.4
polynya3	65° 52.960'S, 142° 55.487'E	14:02, 18/04/98	09:38, 19/02/00	421	119.18	0.2783	ULS-SO-ON	160	161.7
							RCM8-10868	185	187.0
polynya4	66° 12.127'S, 142° 54.086'E	00:30, 19/04/98	04:40, 19/02/00	552	130.28	0.10	microcat-319	382	386.3
							microcat-320	535	541.2
polynya5	66° 11.846'S, 143° 09.627'E	03:47, 19/04/98	23:23, 18/02/00	594	127.41	0.1383	VACM-0E5B1	341	344.8
							microcat-321	358	362.0
							microcat-322	428	432.9
							microcat-323	561	567.6
							microcat-324	576	582.8
							ADCP-1143	589	595.9

Table 2.2: **(continued)**

mooring	position	deployment time (UTC)	recovery (release) time (UTC)	ocean depth (m)	magdec (deg)	d(magdec)/dt (deg/year)	instrument	instrument position depth (m)	pressure (dbar)
polynya5b	66° 11.524'S, 143° 09.408'E	08:25, 28/07/99	22:21, 18/02/00	585	127.28	0.14	microcat-911	365	369.1
							VACM-0C1B	385	389.4
							VACM-0E55	505	510.8
							microcat-912	520	526.0
							SBE39-111	535	541.2
							SBE39-115	550	556.4
							VACM-0D4D	550	556.4
							microcat-913	570	576.7
polynya6	66° 11.897'S, 143° 29.146'E	07:47, 19/04/98	19:07, 18/02/00	555	124.25	0.1733	microcat-325	385	389.4
							microcat-326	538	544.3
polynya6b	66° 11.972'S, 143° 29.037'E	02:50, 28/07/99	18:07, 18/02/00	550	124.31	0.1733	microcat-914	380	384.3
							VACM-0D3A	400	404.5
							VACM-0E5B2	515	521.0
							microcat-1119	535	541.2
polynya7	66° 56.651'S, 144° 56.268'E	22:34, 19/04/98	04:15, 18/02/00	1050	131.08	0.0583	VACM-1AF0	390	394.4
							whale recorder	410	414.7
							microcat-327	414	418.7
							microcat-328	487	492.6
							microcat-329	587	593.9
							microcat-330	737	746.0
							microcat-332	837	847.4
polynya7b	66° 57.858'S, 144° 57.985'E	12:58, 02/08/99	01:35, 18/02/00	1071	131.29	0.055	whale recorder	430	434.9
							VACM-1985	436	441.0
							microcat-1120	486	491.6
							SBE39-089	561	567.6
							SBE39-107	661	668.9
							SBE39-112	811	821.0
							microcat-1121	921	932.6
polynya8b	66° 42.399'S, 145° 17.164'E	07:29, 02/08/99	21:52, 17/02/00	525	123.23	0.1383	microcat-908	355	359.0
							VACM-0974	375	379.2
							VACM-0A5F	490	495.7
							microcat-909	510	515.9

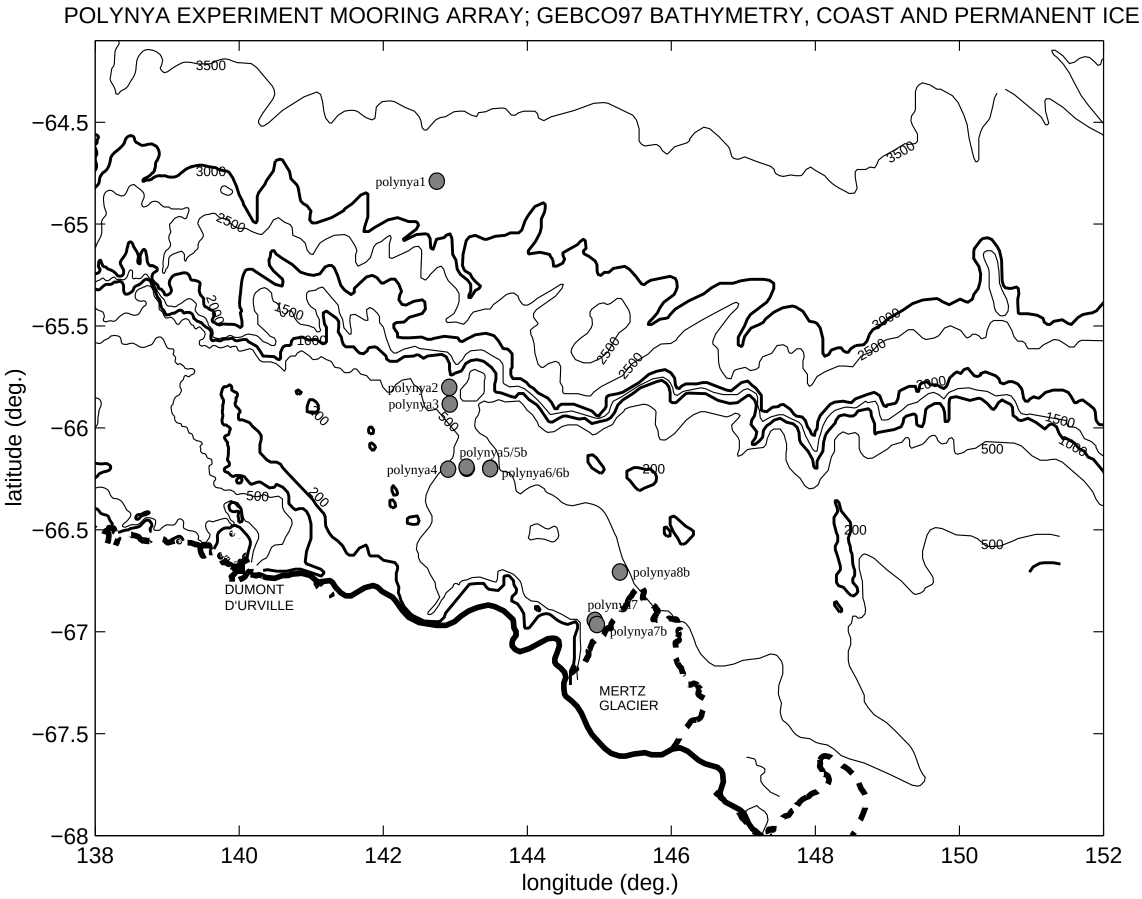


Figure 2.1: Polynya Experiment mooring array (note: GEBCO97 permanent ice positions are approximate only).

the International Geomagnetic Reference Field - 2000, as modelled by the International Association of Geomagnetism and Aeronomy Division V, Working Group 8. The program geomag31 was downloaded from the NOAA website www.ngdc.noaa.gov, and for each mooring location the program was run over the time interval 20th April 1998 to 20th February 2000, in 2 month time steps; an average at each location was calculated from the 2 month values. These average values were then applied as a constant correction to current meter measurements (Aanderaas, moored ADCP's, and VACM's).

The various instrumentation types are summarised in Table 2.1. Data from the upward looking sonars (ULS) (principal investigator Ian Allison, Antarctic CRC) and whale recorders (principal investigator Rudi Kloser, CSIRO) are not discussed further in this report.

2.2.2 Microcat and SBE39

Microcat and SBE39 data were initially dumped from the instruments while aboard the Tangaroa (cruise ta0051), using the Seasoft terminal programs term37 (for microcats) and term39 (for SBE39's) on K.M.'s laptop. When first communicating with each instrument, clock error was noted. 4 of the 27 microcats did not record successfully, as follows:

microcat 320 - probable dry joint in batteries, causing disconnection prior to deployment.

microcat 321 - batteries appear to have disconnected prior to deployment, and clock only started up again on initial communication attempt after recovery.

microcat 322 - short to seawater, draining the batteries after ~44 days of logging; corrosion of external bolts and bolt holes due to short.

microcat 914 - batteries appear to have momentarily disconnected prior to deployment, resetting the clock to Jan 1st 1980; start time was therefore never reached.

Numerous data stream errors occurred throughout the raw data files, so all microcat and SBE39 data were dumped again when back on shore using a different laptop (M.R.'s), to the files catxxxb.cap (for microcats) and sbexxxxb.cap (for SBE39's), where "xxx"/"xxxx" = microcat/SBE39 serial number. These files were then checked and corrected for missing characters. Note that for the 18 microcats serials 315 to 380, date 07 Dec 1998 appeared as "37 Nov 1998" in the dumped data files - this error was corrected.

The raw files were manually edited to remove out of water data at the start and end of files, then the program "catfix" was run to pad files at the start and end, fill data gaps, recalculate conductivity (for microcats only) using the correct deployment pressure, and calculate salinity (for microcats only). Note that there were no pressure sensors on any microcats - a constant pressure value was used for all conductivity and salinity calculations. Instruments from the 1998 deployment were padded to start from 00:00 on 17th April 1998, and to end at the last record on 16th May 1999. Instruments from the 1999 deployment were padded to start from 00:00 on 28th July 1999, and to end at the last record on 20th February 2000. Files produced after this step were catxxxb.fix and sbexxxx.new.

For microcats 909 and 911, the clock was set 2 hours early when setting up prior to deployment - 2 hours were therefore added to the data for these 2 instruments. Similarly, microcat 1120 was set 10 minutes early, and corrected by adding 10 minutes to times in cat1120b.fix.; SBE39-0111 was set 1 hour early, and was corrected by adding 1 hour to times in sbe0111.new.

The catxxxb.fix and sbexxxx.new files were loaded into matlab, and decimal times were corrected by compressing (or stretching) to correct for clock error. Note that microcat clocks were typically running 1 to 4 minutes fast after recovery (with the exception of microcat 328 which was running 99 seconds slow); SBE39 clocks were all running ~1 minute slow. Note that after correction of time, the data were **not** reinterpolated onto regular time intervals - interpolation would have led to aliasing problems. Any data error due to the resulting time mismatch is assumed to be very small, as clock errors were small. It should also be noted that this time correction results in irregular record intervals, and with slightly different intervals for the different time series (again, this time mismatch is small enough to be insignificant). Clock errors are summarised in Table 2.3. Further calibration corrections to microcat data are discussed in section 2.3.

2.2.3 VACM and 9311

VACM and 9311 data were dumped from the instruments while aboard the Tangaroa, using the "Hyperterminal" terminal program in Windows95 on K.M's laptop. When first communicating with each instrument, clock error was noted. Only 3 of the 11 VACM's contained data of significant length; 1 VACM wouldn't communicate; all remaining VACM's had either very short records, or no records. 3 of the 6 9311's contained long data records, while the other 3 wouldn't communicate. The status of VACM's and 9311's at the time of data download is summarised in Table 2.4.

The raw files were manually edited to remove out of water data at the start of the files. VACM files contained some lines with missing characters - these lines were corrected manually. The program "vacmfix" was then run to pad files at the start and end, and to fill data gaps. Instruments from the 1998 deployment were padded to start from 00:00 on 17th April 1998, and to end at the last record on 16th May 1999. Instruments from the 1999 deployment were padded to start from 00:00 on 28th July 1999, and to end at the last record on 20th February 2000.

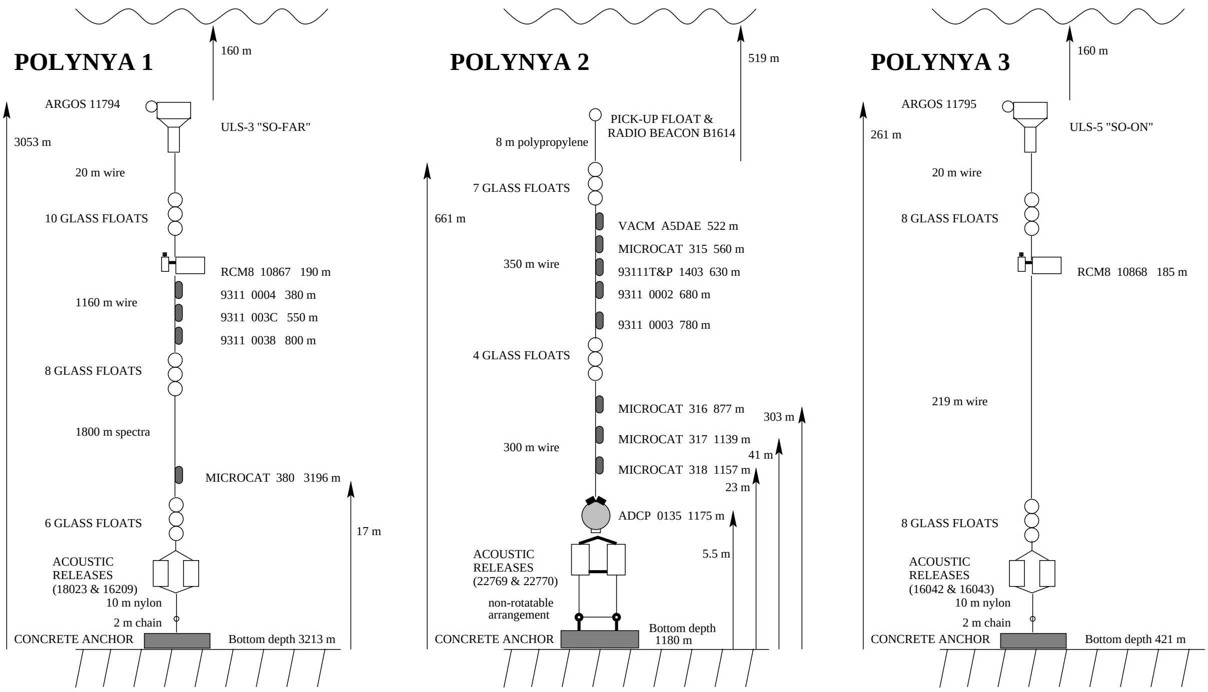


Figure 2.2: Polynya moorings 1, 2 and 3.

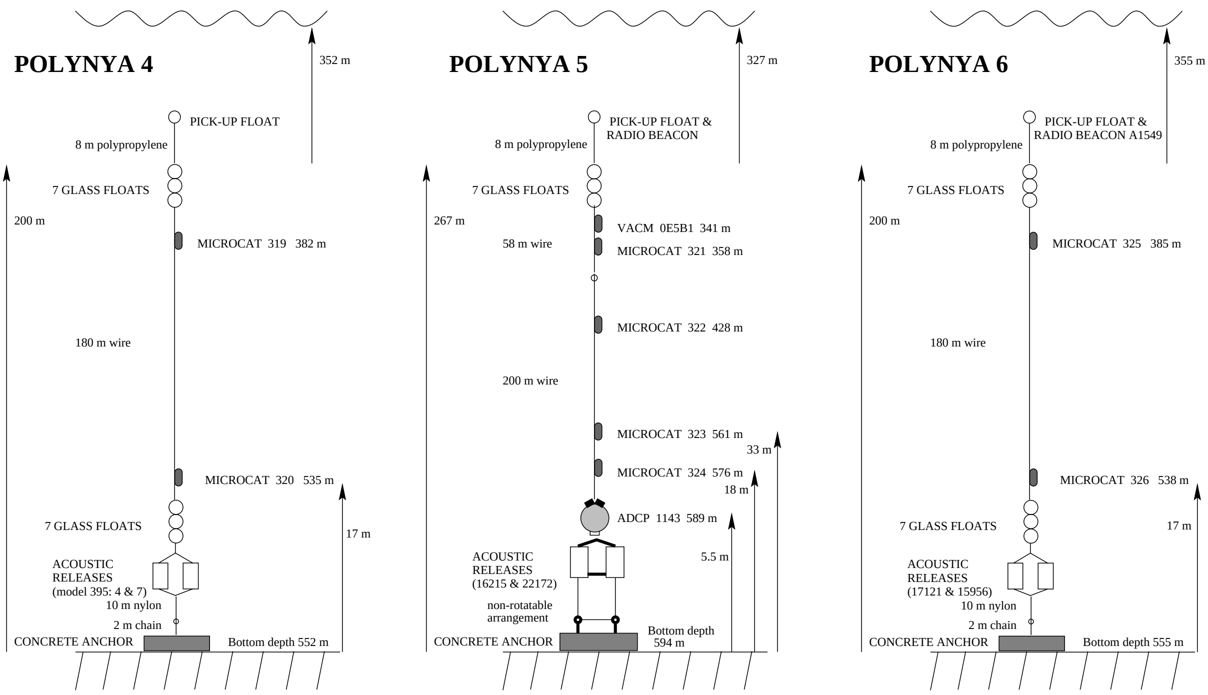


Figure 2.3: Polynya moorings 4, 5 and 6.

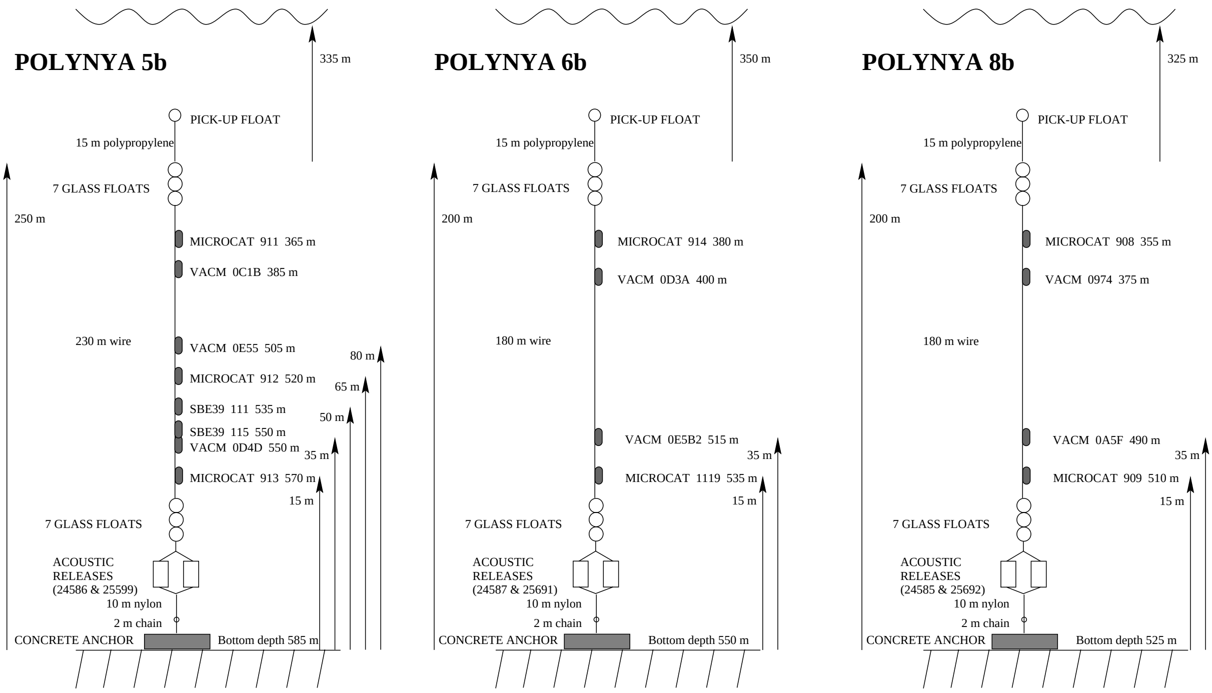


Figure 2.4: **Polynya moorings 5b, 6b and 8b.**

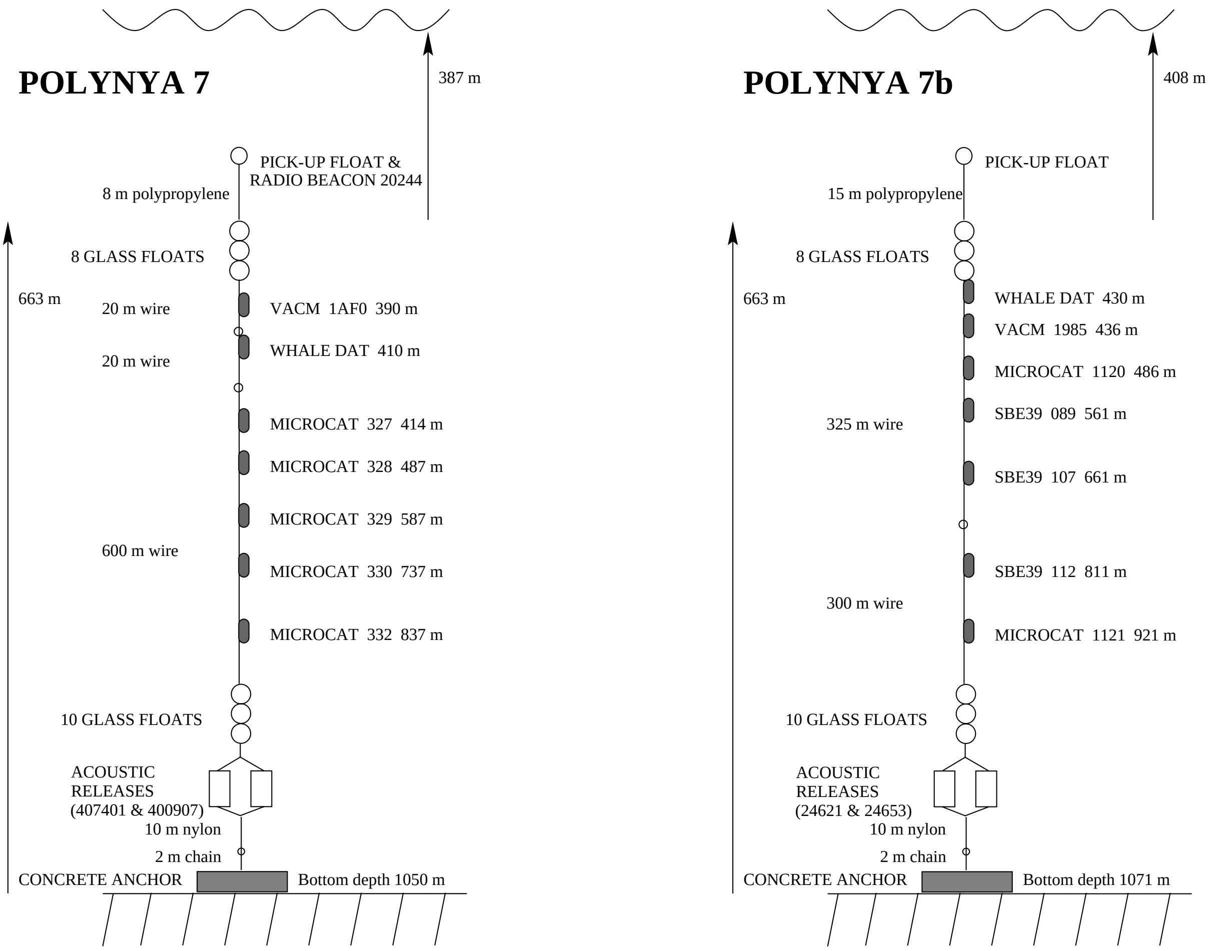


Figure 2.5: **Polynya moorings 7 and 7b.**

Table 2.3: Instrument clock errors.

instrument	no. of sec. fast	time (days) between start and clock check	instrument	no. of sec. fast	time (days) between start and clock check
microcat			*microcat*		
315	144	689.43125	1119	86	231.42072
316	68	689.26273	1120	108	231.45324
317	153	689.35694	1121	48	231.48021
318	228	690.01215			
319	194	689.92685	*SBE39*		
320	-	-	0089	-44	227.12708
321	-	-	0107	-53	227.23542
322	assume 0	-	0111	-57	227.31481
323	199	692.06858	0112	-59	227.27720
324	237	692.19792	0115	-58	227.36123
325	109	692.27083			
326	253	692.34421	*VACM*		
327	40	691.54809	0D3A	-505	223.12570
328	-99	690.44317	1985	-614	223.11181
329	180	690.13438	0E5B1	-1422	684.14769
330	195	691.62303			
332	45	690.29606	*9311*		
380	255	691.99514	0038	-2309	679.16528
908	17	231.55313	1403	-2483	679.12917
909	60	231.52604	003C	-2325	679.15313
911	94	232.00938			
912	116	232.09190	*ADCP*		
913	50	232.04398	0135	-1057	684.59028
914	-	-	1143	-1230	691.04514

Table 2.4: VACM and 9311 status at time of data download.

VACM

serial no.	vintage	lower lithium voltage (for 1999 vintage)	no. of 45 min. records	liquid in lower battery pack (for 1999 vintage)
A5DAE	1998	-	wouldn't communicate	-
0E5B1	1998	-	12016 (gap in Nov.1998)	-
1AF0	1998	-	0	-
0A5F	1999	dead	702	yes
0E5B2	1999	dead	503	yes
1985	1999	5	7023	yes
0C1B	1999	dead	534	no
0D3A	1999	9.1	7140	no
0974	1999	dead	612	yes
0D4D	1999	9.5	0	no
0E55	1999	9.5	423	no

9311

serial no.	no. of 5 min. records
1403	108864
003C	108864
0038	108864
0003	no communication
0004	no communication
0002	no communication

The program “vacmcal” was then run to apply pre-deployment calibration coefficients, and to correct currents for the local magnetic declination (Table 2.2). Matlab files vxxxxnew.mat (for VACM’s) and txxxxnew.mat (for 9311’s), where “xxxx”=instrument serial number, were created for the 3 VACM’s and 2 9311’s with usable data. Decimal times were corrected by stretching to correct for clock error (VACM and 9311 clocks were running slow after recovery). Note that after correction of time, the data were **not** reinterpolated onto regular time intervals - interpolation would have led to aliasing problems. Any data error due to the resulting time mismatch is assumed to be very small, as clock errors were small. It should also be noted that this time correction results in irregular record intervals, and with slightly different intervals for the different time series (again, this time mismatch is small enough to be insignificant). Clock errors are summarised in Table 2.3.

2.2.4 ADCP

ADCP data were dumped from the instruments while aboard the Tangaroa, using the RDI software on K.M’s laptop. When first communicating with each instrument, clock error was noted. At the time of data download, instrument 1143 was still active and recording data; instrument 0135 was still active, but the memory was full.

ADCP data were processed using the RDI “Transect” software (H. Beggs, CSIRO, pers. comm.), applying pitch, roll, heading and local magnetic declination corrections to give currents in earth coordinates. Out of water data were then removed manually from the start and end of the files. The program “adcpfix” was then run to pad files at the start and end, and to fill data gaps. Data were padded to start from 00:00 on 17th April 1998, and to end at the last record on 20th February 2000.

Matlab files dxxxx.mat (where “xxxx”=instrument serial number) were created, and decimal times were corrected by stretching to correct for clock error (clocks were running slow after recovery). As per other instruments, the data were **not** reinterpolated onto regular time, and this time correction results in irregular record intervals with slightly different intervals for the different time series. Clock errors are summarised in Table 2.3. Abbreviated matlab files dxxxx_smallnew.mat, containing only essential parameters, were created.

2.2.5 RCM8

Aanderaa RCM8 data were initially dumped from the instruments on the Tangaroa. Both instruments were still active and recording at the time of intial data downloading. These initial dumps failed to download all the data, so a repeat dump was done at NIWA in Wellington after the cruise. Pre-deployment calibration coefficients were applied to the raw data, then current values were corrected for the local magnetic declination (Table 2.2). Next, data gaps were filled and the files were padded to start from 00:00 on 17th April 1998, and to end at the last record on 20th February 2000. Lastly, the matlab files rcmxxxxx.mat (where “xxxxx”=instrument serial number) were created. Note that clock corrections were made during initial data processing by CSIRO.

2.3 DATA QUALITY AND FURTHER DATA PROCESSING

2.3.1 Temperature, conductivity and pressure data

Data comparisons were made between different moored instruments, and between moored instruments and CTD data from cruises au9807, au9901 and ta0051, to identify suspicious moored data. This section details moored instrument data quality, and further corrections made to the data. Note the abbreviations: T=temperature, C=conductivity, P=pressure. Also note that some of the P data have been retained, despite being quantitatively bad for all instruments: the qualitative records can still show variation in mooring tilt over time. Deleted data are summarised in Table 2.5; data quality cautions are summarised in Table 2.6; temperature and salinity data are plotted in Figures 2.9a to h.

Polynya1

microcat-380 T and C data okay; use pre-deployment cal. coefficients
9311-0038 T data okay
9311-003C bad data for entire record
9311-0004 instrument wouldn't communicate - no data obtained
RCM8-10867 T data okay, except for last week of record where numerous large -ve values occur - assume last week (after decimal time ~774.7) of T record is suspicious; P data are suspicious - P linearly decreases throughout the record

Polynya2

ADCP-0135 T data look very good qualitatively, but are low by ~0.4°C (when compared to other instruments) - T data are therefore unusable
microcat-318 T and C data okay; use pre-deployment cal. coefficients
microcat-317 T and C data okay; use pre-deployment cal. coefficients
microcat-316 T and C data okay for first couple of days i.e. from start to decimal time 111.8021 (record 1672); all T and C bad for the rest of the record (due to bad T); use pre-deployment cal. coefficients
9311-0003 instrument wouldn't communicate - no data obtained
9311-0002 instrument wouldn't communicate - no data obtained
9311-1403 T data okay; P data are bad
microcat-315 T and C data okay; use pre-deployment cal. coefficients
VACM-A5DAE instrument wouldn't communicate - no data obtained

Polynya3

RCM8-10868 T data okay; P data are suspicious - P linearly decreases throughout the record

Polynya4

microcat-320 no data obtained
microcat-319 T and C data okay; use pre-deployment cal. coefficients; deleted T and C data spike for records 17314 to 17348 (i.e. decimal time 166.1145 to 166.2325)

Polynya5

ADCP-1143 T data all bad
microcat-324 T and C data okay; use pre-deployment cal. coefficients; deleted C data spikes for record 110264(decimal time 488.8562), records 66752 to 66758 (decimal time 337.7734 to 337.7943), records 624 to 625 (decimal time 108.1632 to 108.1667)
microcat-323 T and C data okay; use pre-deployment cal. coefficients; deleted C data spikes for records 13107 to 13113 (decimal time 151.5069 to 151.5277), records 624 to 625 (decimal time 108.1633 to 108.1667)
microcat-322 T data okay; use pre-deployment cal. coefficients C data bad due to instrument short to seawater
microcat-321 no data obtained
VACM-0E5B1 T and P data all bad

Polynya5b

microcat-913 T and C data okay; use pre-deployment cal. coefficients; deleted C data spike for record 11282 (decimal time 631.7551)
VACM-0D4D no data obtained
SBE39-115/111 T data for both instruments agree with eachother, however T looks to be low by ~0.005°C when compared to all other instruments; use pre-deployment cal. coefficients; T data are usable, but probably low by ~0.005°C
microcat-912 T and C data okay; use pre-deployment cal. coefficients
VACM-0E55 instrument failed before going into the water - no data obtained
VACM-0C1B instrument failed after ~2.5 days in the water; data not used
microcat-911 T and C data okay; use pre-deployment cal. coefficients; deleted C data spike for records 70 to 76 (decimal time 573.3594 to 573.3906)

Polynya6

microcat-326 T and C data okay; use pre-deployment cal. coefficients; deleted C data spike for records 13588 to 13595 (decimal time 153.1769 to 153.2012)
microcat-325 T and C data okay; use pre-deployment cal. coefficients

Polynya6b

microcat-1119 T and C data okay; use pre-deployment cal. coefficients
VACM-0E5B2 instrument failed after ~1.5 days in the water; data not used
VACM-0D3A T and P data all bad
microcat-914 no data obtained

Polynya7

microcat-332 T and C data bad for entire record
microcat-330 T data okay; use pre-deployment cal. coefficients
C data okay at start, then fouling occurs at decimal time ~265; C data after decimal time 265 may be a bit suspicious; use pre-deployment cal. coefficients; deleted C data spike for record 12555 (decimal time 149.5902) and record 850 (decimal time 108.9480)
microcat-329 T and C data okay; use pre-deployment cal. coefficients
microcat-328 T data okay; use pre-deployment cal. coefficients
C data looks low (salinity low by ~0.1); C data are bad
microcat-327 T data okay; **use post-deployment cal. coefficients**
C data okay; use pre-deployment C cal. coefficients, with post-deployment T values; deleted C data spike for records 855 to 876 (decimal time 108.9654 to 109.0383)
VACM-1AF0 no data obtained

Polynya7b

microcat-1121 T and C data okay; use pre-deployment cal. coefficients; deleted C data spike for record 39374 (decimal time 778.0672)
SBE39-112/107/089 T data for all 3 instruments agree with eachother, however T looks to be low by ~0.005^{o}C when compared to all other instruments; use pre-deployment cal. coefficients; T data are usable, but probably low by ~0.005^{o}C
microcat-1120 T and C data okay; use pre-deployment cal. coefficients; deleted C data spikes for records 1057 to 1065 (decimal time 578.5017 to 578.5434) and records 39374 to 39386 (decimal time 778.0683 to 778.1308)
VACM-1985 T and P data all bad

Polynya8b

microcat-909 T and C data okay; use pre-deployment cal. coefficients; deleted C data spikes for record 1023 (decimal time 578.3229), record 38717 (decimal time 774.6452), record 38727 (decimal time 774.6765)
VACM-0A5F instrument failed after ~3 days in the water; data not used
VACM-0974 instrument failed after 1 record in the water; data not used
microcat-908 T and C data okay; use pre-deployment cal. coefficients; deleted C data spikes for records 1023 to 1025 (decimal time 578.3229 to 578.3333)

2.3.2 Current data

Moored ADCP and ship-based ADCP data comparisons are shown in Figures 2.6a to d. Current magnitudes compare favourably, however current directions are variable. The validity of these current directions, or else any possible error, cannot be determined from this isolated comparison. Moored ADCP instrument headings (every 4th data point) are plotted in Figure 2.8. The bulk of values vary over a ~10^{o} range, indicating the instruments were fixed fairly well in the moorings (i.e. only a small amount of rotation).

RCM8 moored current meter and ship-based ADCP data comparisons are shown in Figures 2.7a to c. Current magnitudes compare fairly well. For current directions, there are no exactly synchronous measurements, however the comparisons look reasonable.

Polynya1

RCM8-10867 All current flow in northeast quadrant - current data probably okay

Polynya2

ADCP-0135 Current data okay

Polynya3

RCM8-10868 Current data okay

Polynya5

ADCP-1143 Current data okay - some suspicious large positive v (i.e. N/S component) values occur (did not delete)

VACM-0E5B1 Current flow biased towards easterly direction, and current magnitudes seem high - treat current data with caution

Polynya6b

VACM-0D3A Current magnitudes seem high; directions look okay - treat current magnitudes with caution

Polynya7b

VACM-1985 Current data look suspicious - magnitudes are high, and directions are biased

Table 2.5: Summary of bad data deleted from files. T=temperature, C=conductivity, S=salinity, P=pressure.

instrument	*mooring*	*parameter*	*deleted records (decimal time)*	*comment*
9311-003C	polynya1	T	all data	bad sensor performance
ADCP-0135	polynya2	T	all data	no recent sensor calibration
microcat-316	polynya2	T,C,S	1673 to end (111.8056 to end)	bad T sensor performance
microcat-319	polynya4	T,C,S	17314-48 (166.1145-166.2325)	data spike
ADCP-1143	polynya5	T	all data	bad sensor performance
microcat-324	polynya5	C,S	624-5 (108.1632-108.1667)	conductivity spike
		C,S	66752-8 (337.7734-337.7943)	conductivity spike
		C,S	110264 (488.8562)	conductivity spike
microcat-323	polynya5	C,S	624-5 (108.1633-108.1667)	conductivity spike
		C,S	13107-13 (151.5069-151.5277)	conductivity spike
microcat-322	polynya5	C,S	all data	short to seawater
VACM-0E5B1	polynya5	T,P	all data	bad sensor performance
microcat-913	polynya5b	C,S	11282 (631.7551)	conductivity spike
microcat-911	polynya5b	C,S	70-76 (573.3594-573.3906)	conductivity spike
microcat-326	polynya6	C,S	13588-95 (153.1769-153.2012)	conductivity spike
VACM-0D3A	polynya6b	T,P	all data	bad sensor performance
microcat-332	polynya7	T,C,S	all data	bad T sensor performance
microcat-330	polynya7	C,S	850 (108.9480)	conductivity spike
		C,S	12555 (149.5902)	conductivity spike
microcat-328	polynya7	C,S	all data	sensor reading too low
microcat-327	polynya7	C,S	855-876 (108.9654-109.0383)	conductivity spike
microcat-1121	polynya7b	C,S	39374 (778.0672)	conductivity spike
microcat-1120	polynya7b	C,S	1057-65 (578.5017-578.5434)	conductivity spike
		C,S	39374-86 (778.0683-778.1308)	conductivity spike
VACM-1985	polynya7b	T,P	all data	bad sensor performance
microcat-909	polynya8b	C,S	1023 (578.3229)	conductivity spike
		C,S	38717 (774.6452)	conductivity spike
		C,S	38727 (774.6765)	conductivity spike
microcat-908	polynya8b	C,S	1023-5 (578.3229-578.3333)	conductivity spike

Table 2.6: Summary of cautions to data quality. T=temperature, C=conductivity, S=salinity, P=pressure, v=N/S current component, spd=current magnitude, dir=current direction.

instrument	mooring	parameter	caution
RCM8-10867	polynya2	T	suspicious data from decimal time 774.7 to end
		P	bad data - linearly decreases throughout the record
9311-1403	polynya2	P	bad data
RCM8-10868	polynya3	P	bad data - linearly decreases throughout the record
ADCP-1143	polynya5	v	some suspicious large positive values occur
VACM-0E5B1	polynya5	spd,dir	current flow biased towards easterly direction, and current magnitudes seem high - treat current data with caution
SBE39-111	polynya5b	T	low by ~0.005°C
SBE39-115	polynya5b	T	low by ~0.005°C
VACM-0D3A	polynya6b	spd	current magnitudes seem high - treat with caution
microcat-330	polynya7	C,S	data a bit suspicious from decimal time 265 to end, possibly due to gradual fouling
microcat-327	polynya7	T	post-deployment cal. coefficients used
SBE39-089	polynya7b	T	low by ~0.005°C
SBE39-107	polynya7b	T	low by ~0.005°C
SBE39-112	polynya7b	T	low by ~0.005°C
VACM-1985	polynya7b	spd,dir	current data suspicious - magnitudes are high, and directions are biased

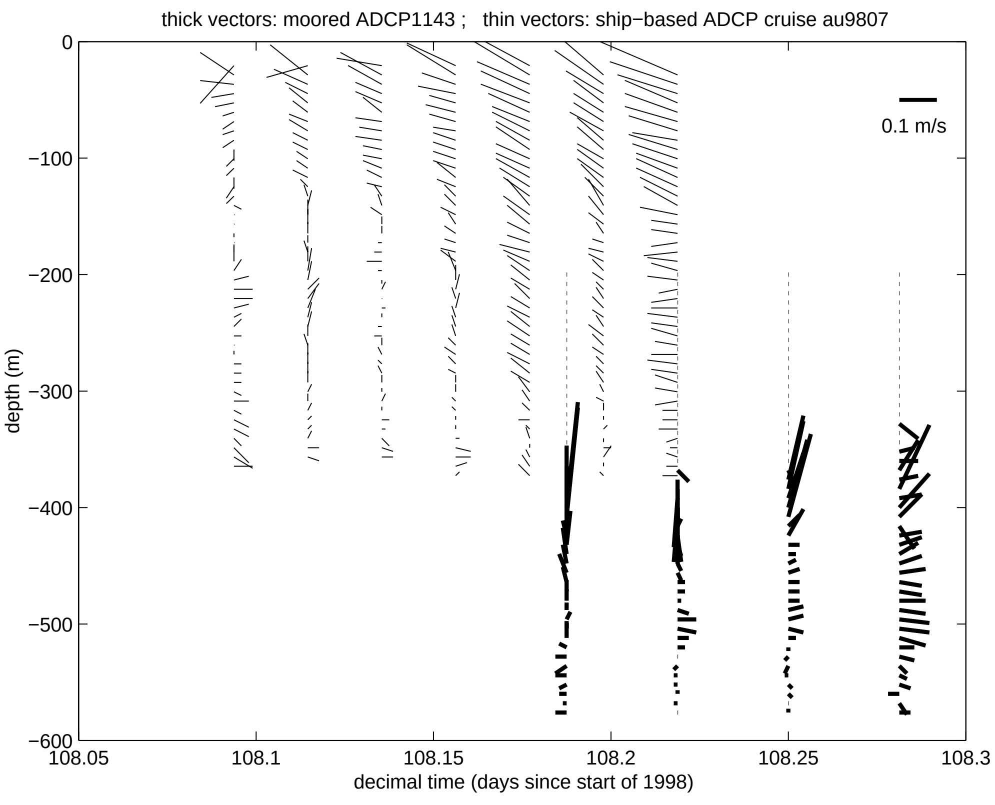


Figure 2.6a: Comparison of moored ADCP-1143 data and au9807 ship-based ADCP data.

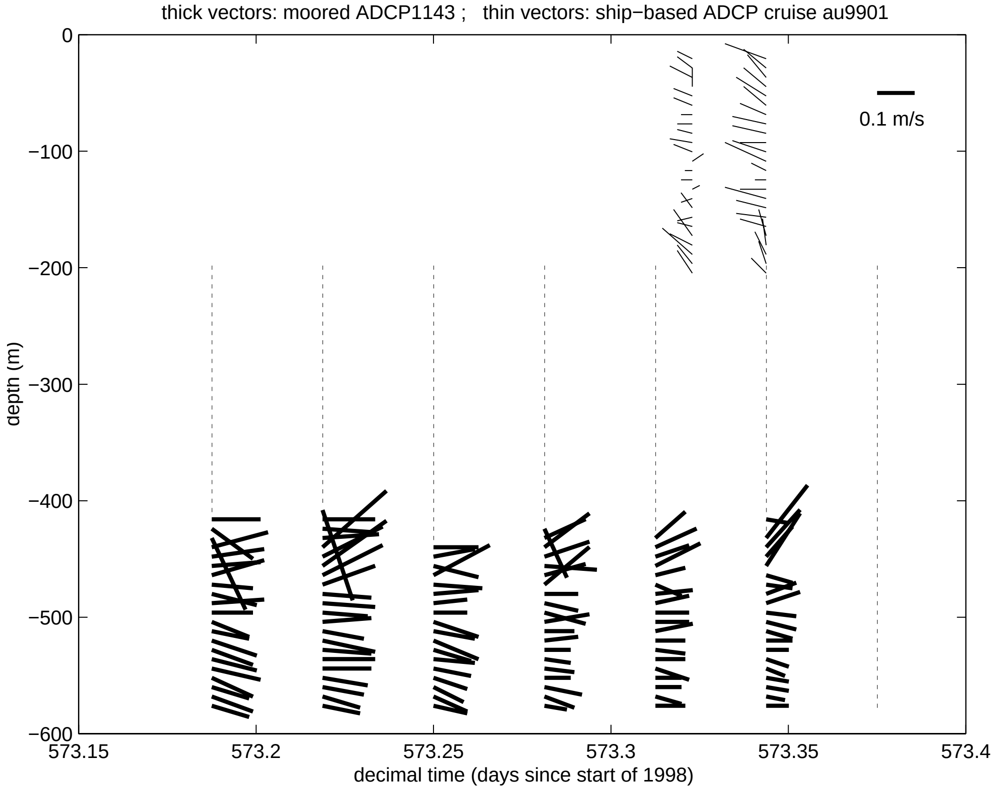


Figure 2.6b: **Comparison of moored ADCP-1143 data and au9901 ship-based ADCP data.**

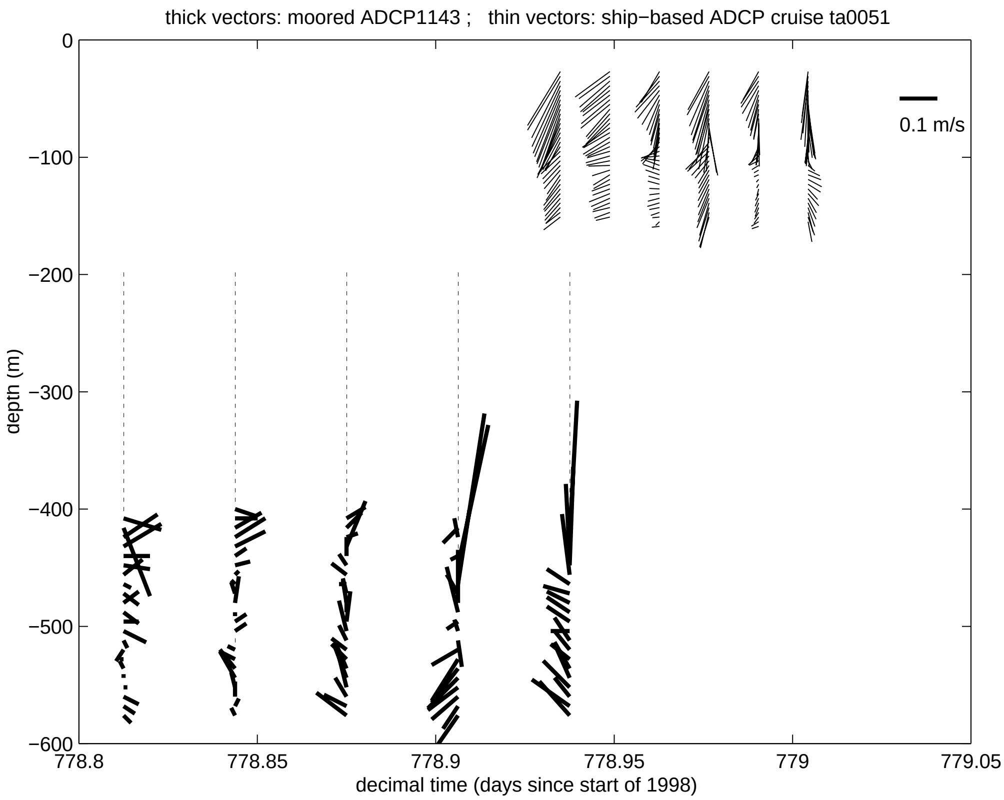


Figure 2.6c: **Comparison of moored ADCP-1143 data and ta0051 ship-based ADCP data.**

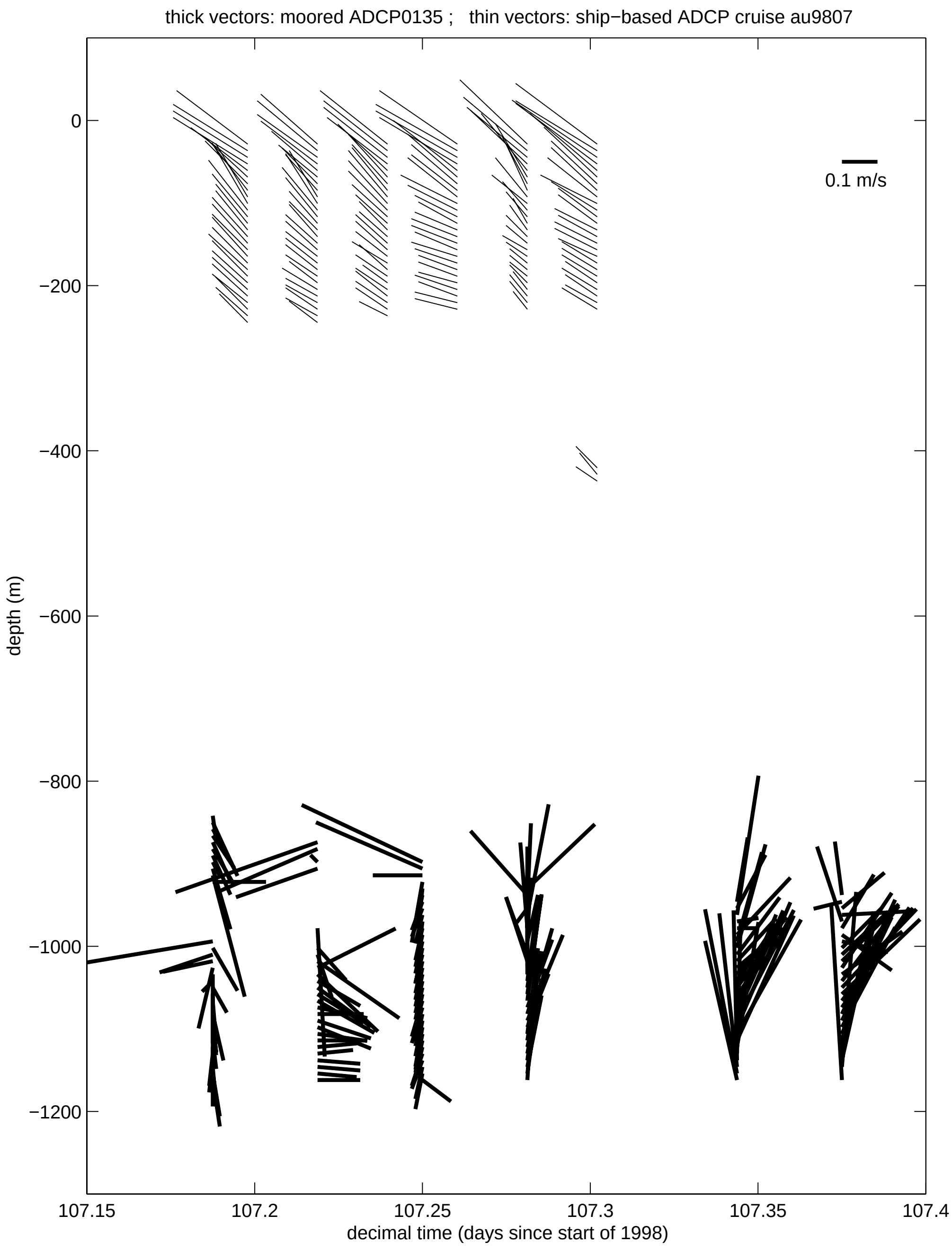


Figure 2.6d: Comparison of moored ADCP-0135 data and au9807 ship-based ADCP data.

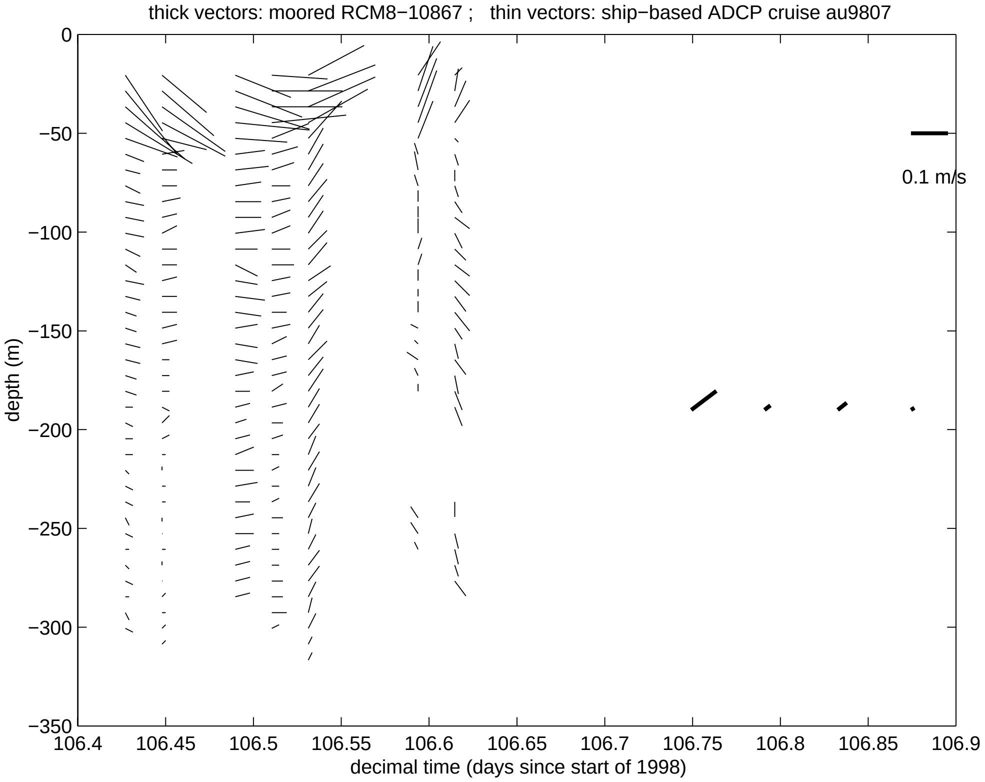


Figure 2.7a: Comparison of moored RCM8-10867 data and au9807 ship-based ADCP data.

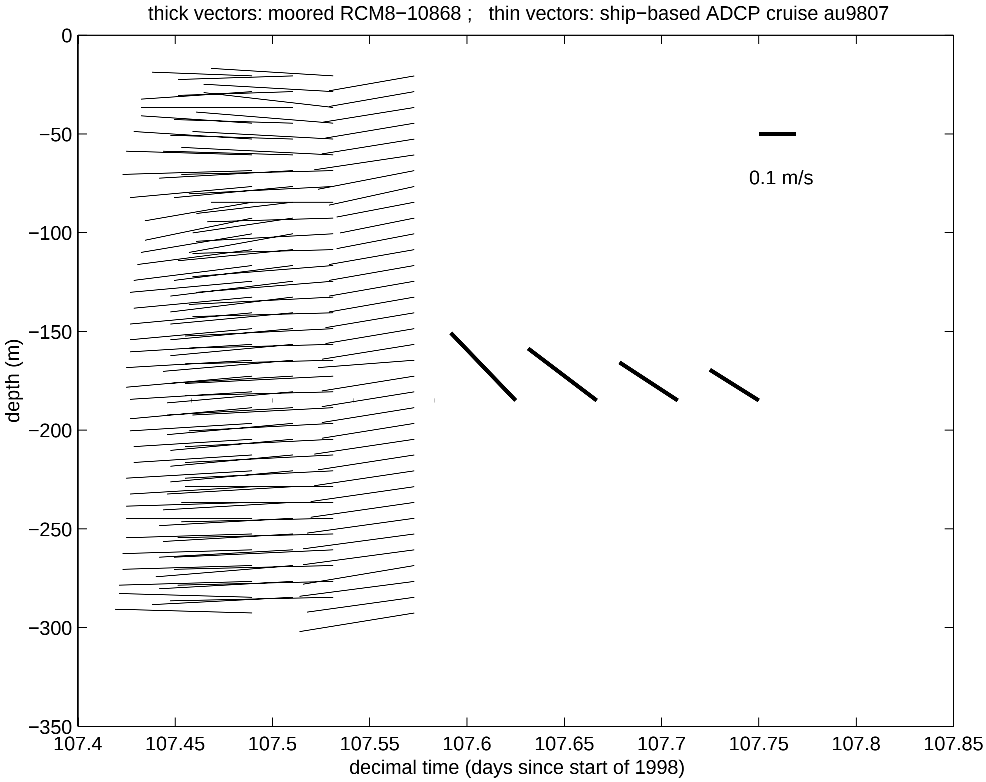
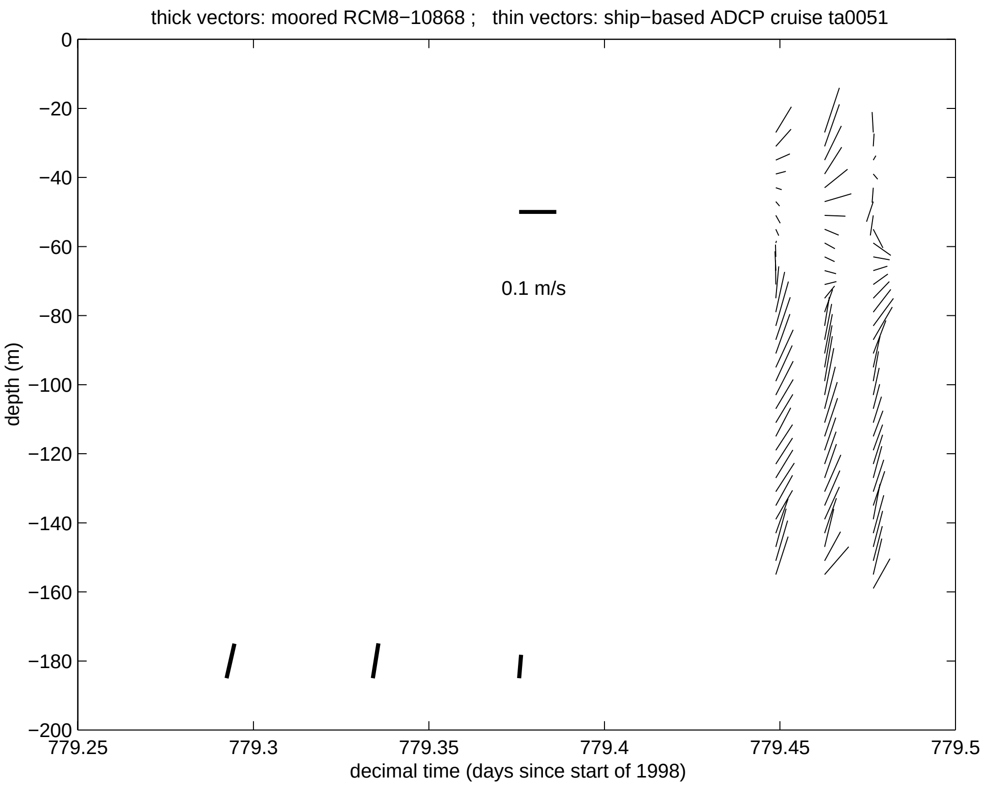
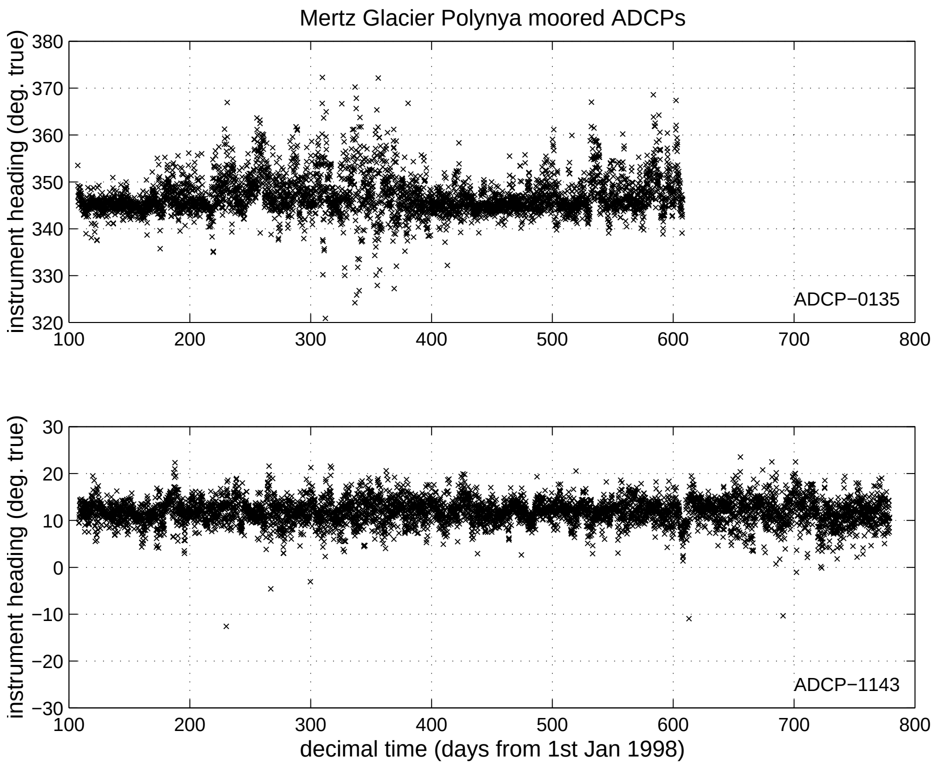


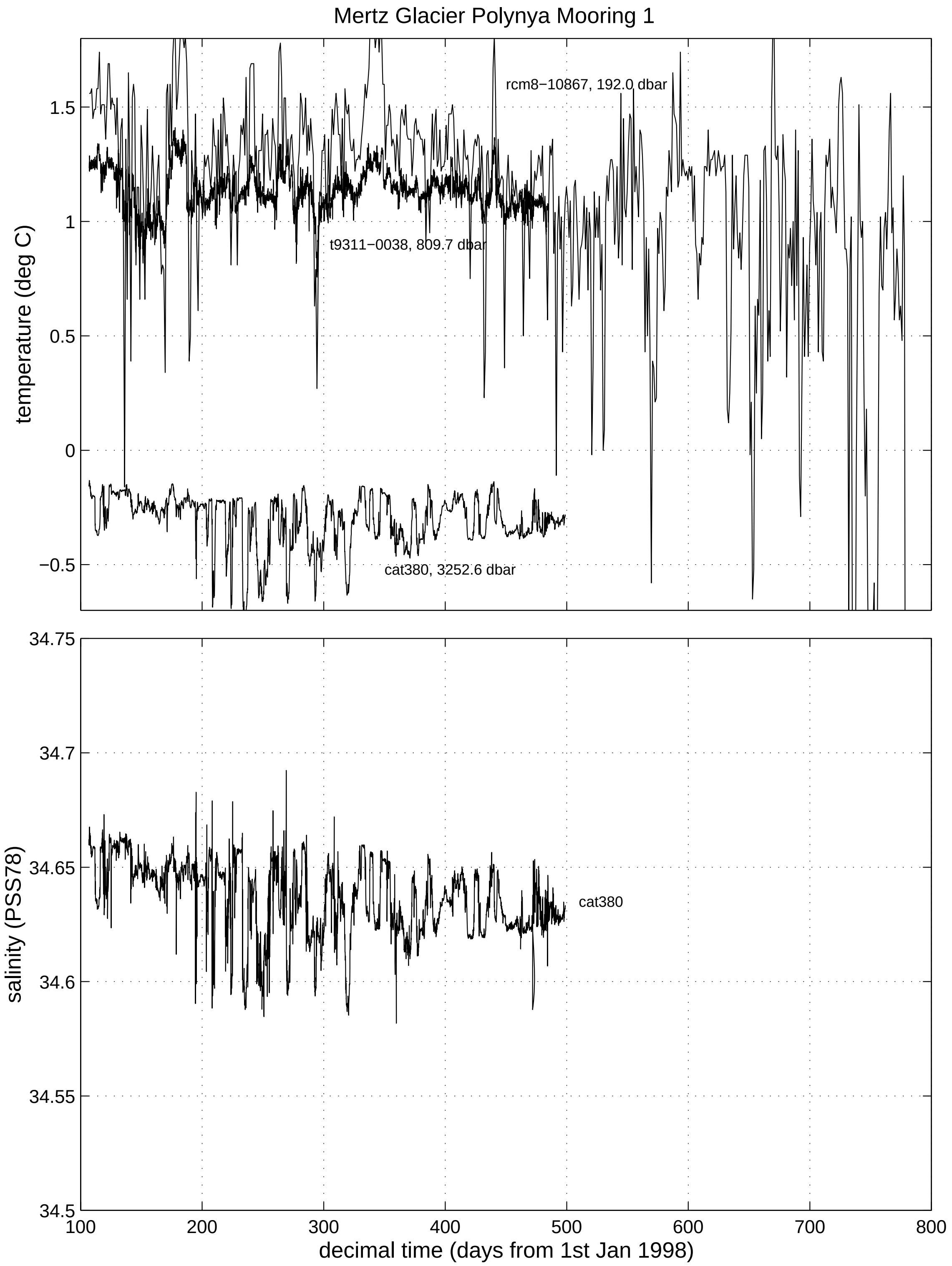
Figure 2.7b: Comparison of moored RCM8-10868 data and au9807 ship-based ADCP data.



<u>Figure 2.7c:</u> Comparison of moored RCM8-10868 data and ta0051 ship-based ADCP data.



<u>Figure 2.8:</u> Heading of moored ADCP's (every 4th data point is plotted). Values >360 or <0 are rescaled values to fit within axes. A small number of outliers lie beyond axes limits.



<u>Figure 2.9a:</u> Temperature and salinity data for polynya1 mooring (note: not all data lie within plot axes).

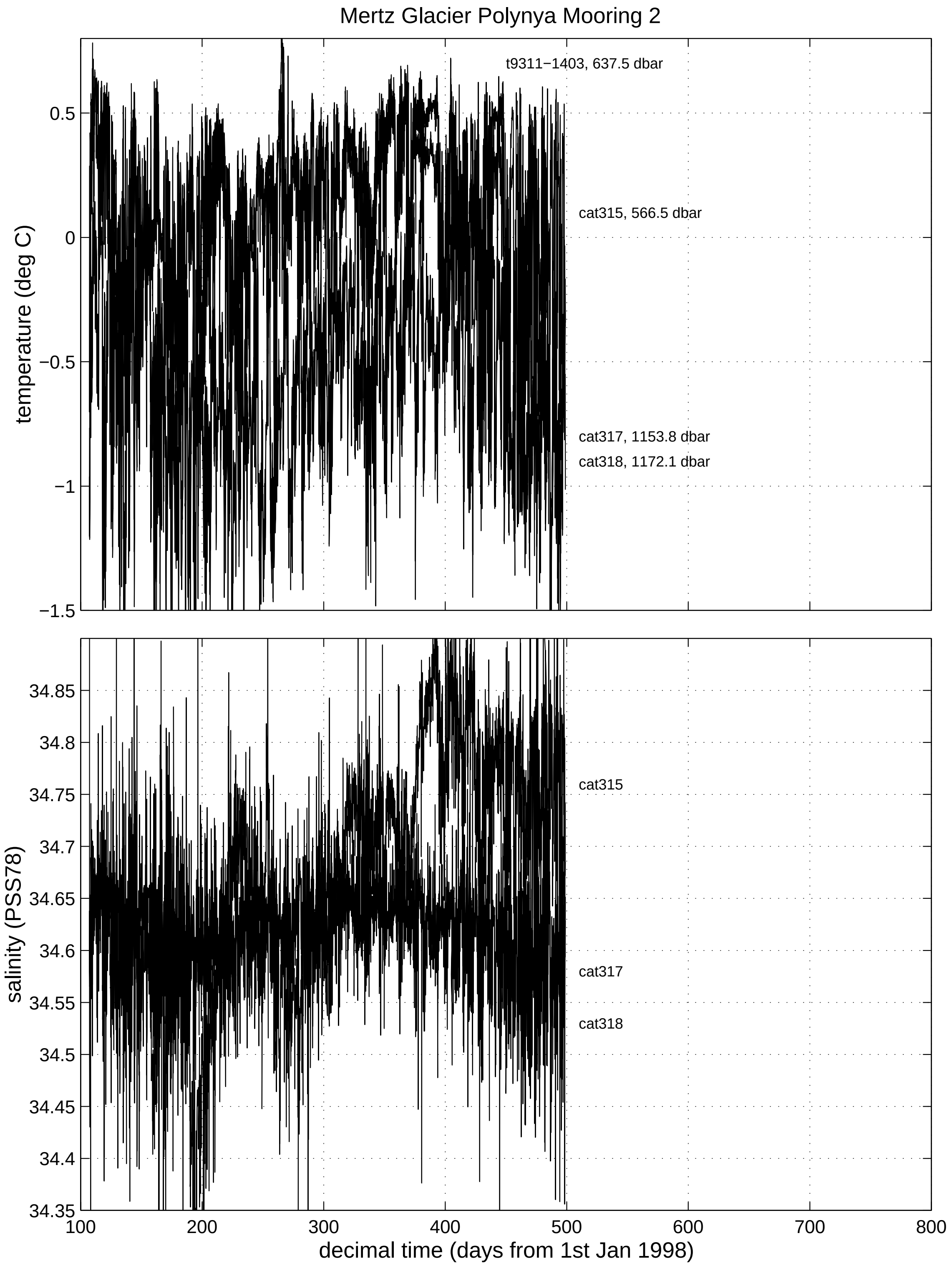
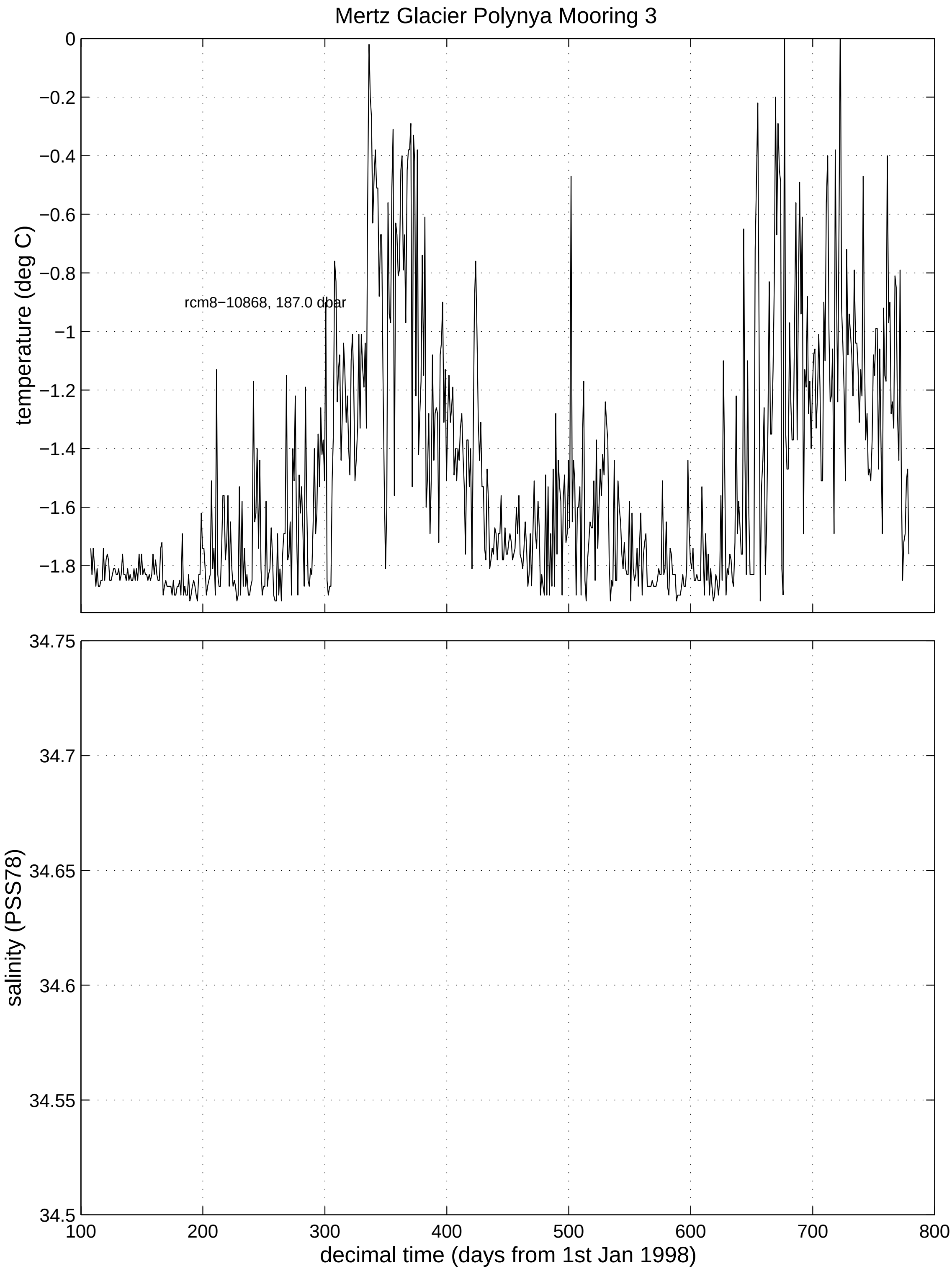
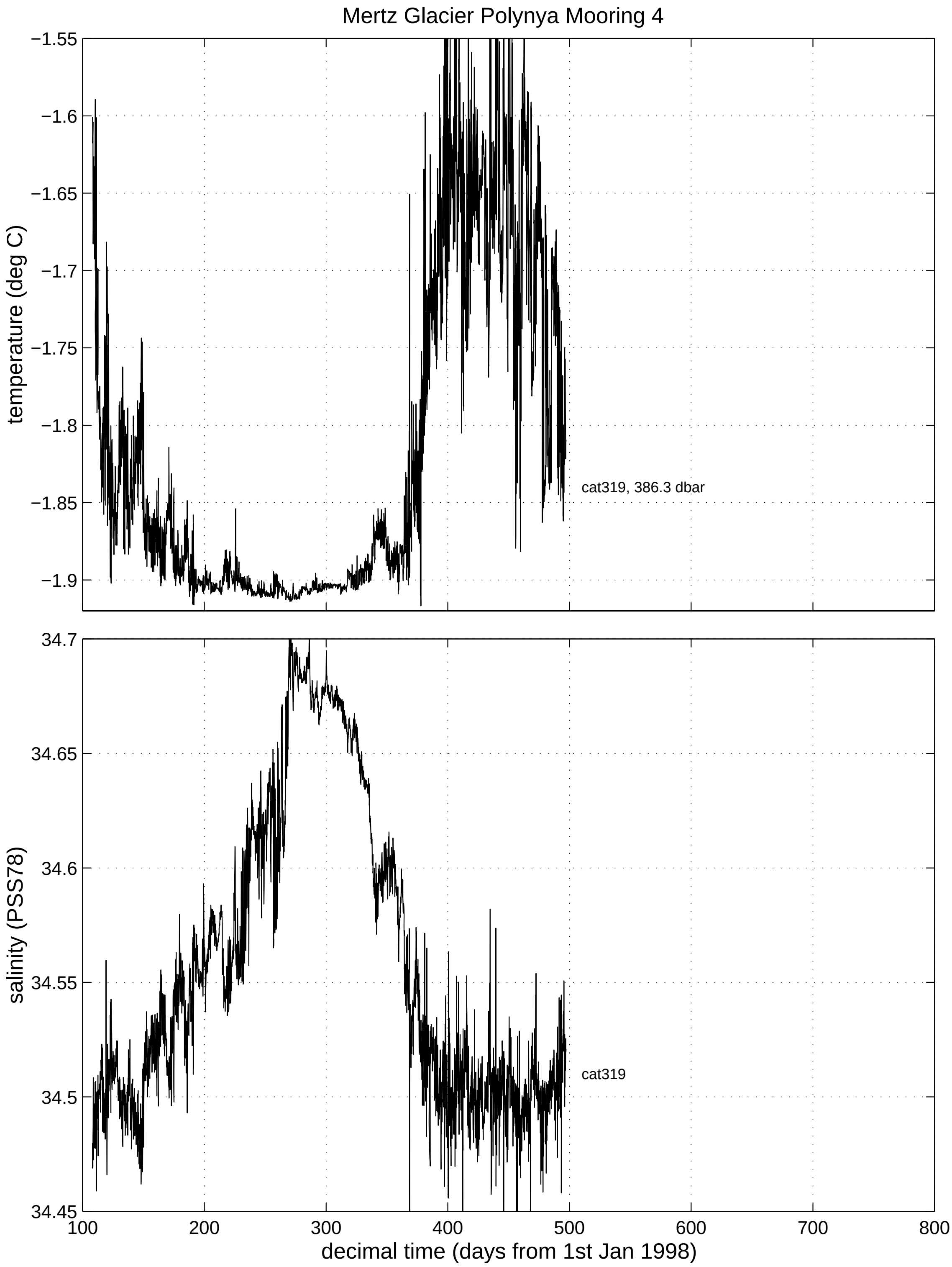


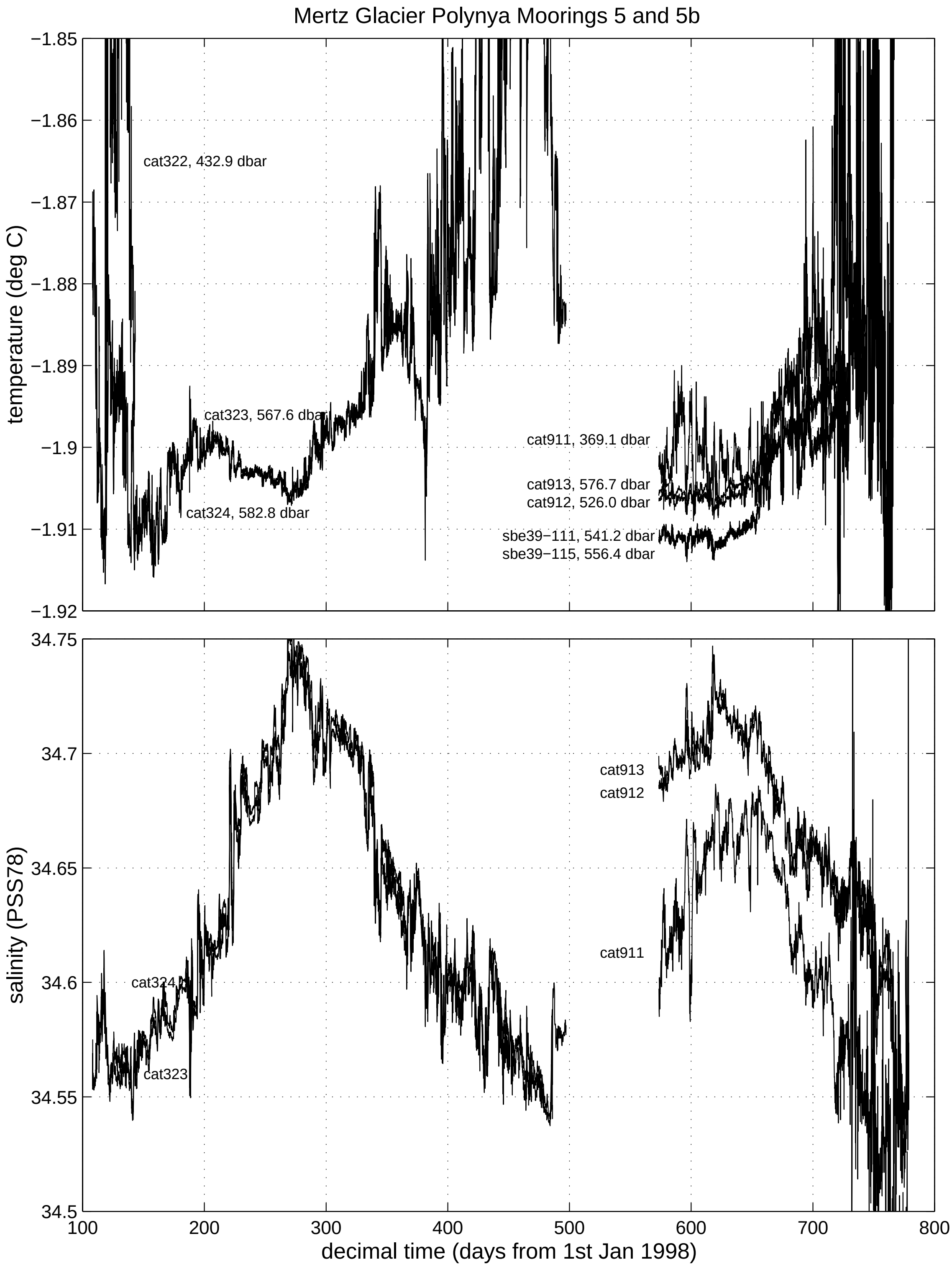
Figure 2.9b: Temperature and salinity data for polynya2 mooring (note: not all data lie within plot axes).



<u>Figure 2.9c:</u> Temperature and salinity data for polynya3 mooring (note: not all data lie within plot axes).



<u>Figure 2.9d:</u> Temperature and salinity data for polynya4 mooring (note: not all data lie within plot axes).



<u>Figure 2.9e:</u> Temperature and salinity data for polynya5 and 5b moorings (note: not all data lie within plot axes).

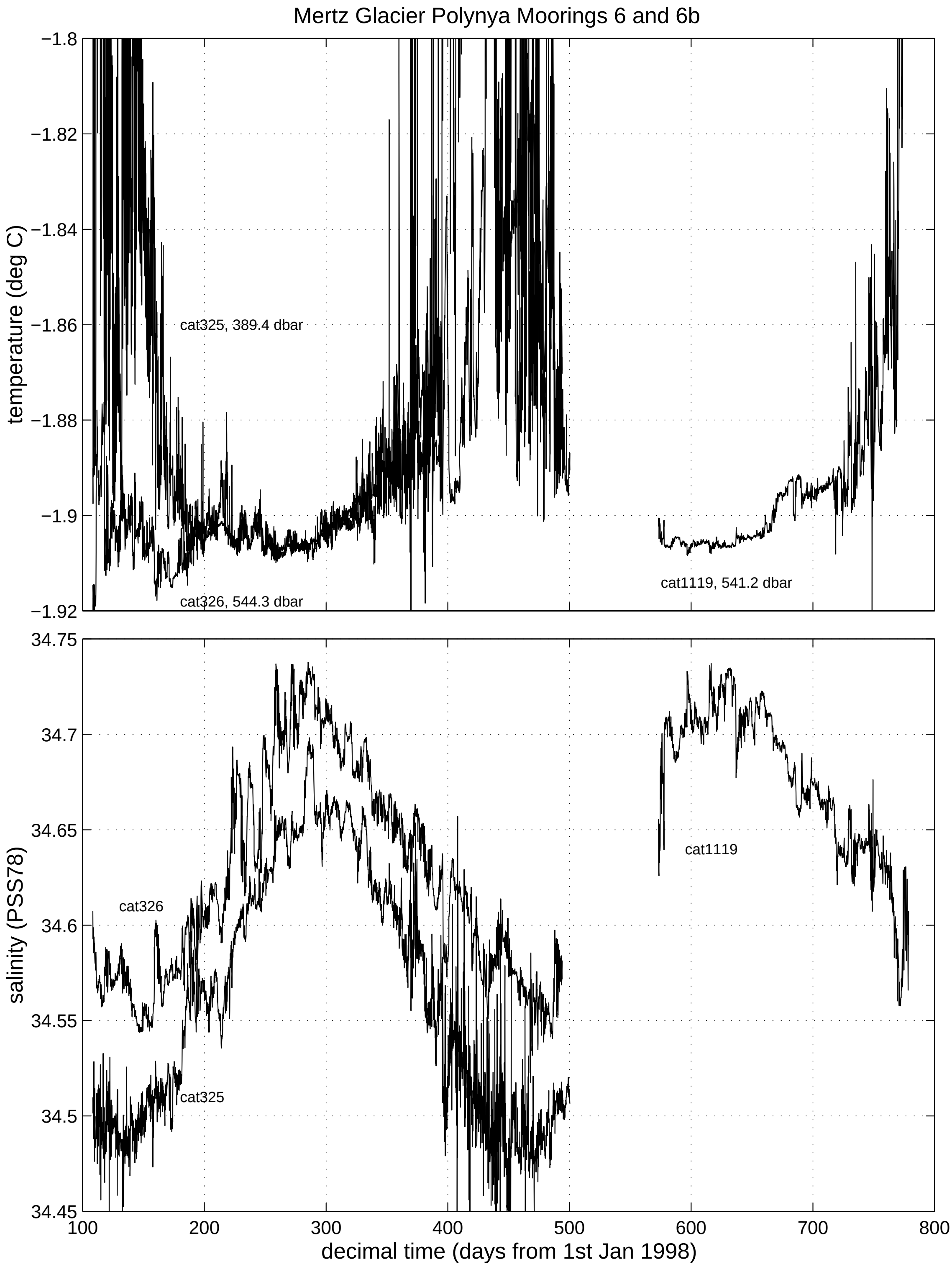
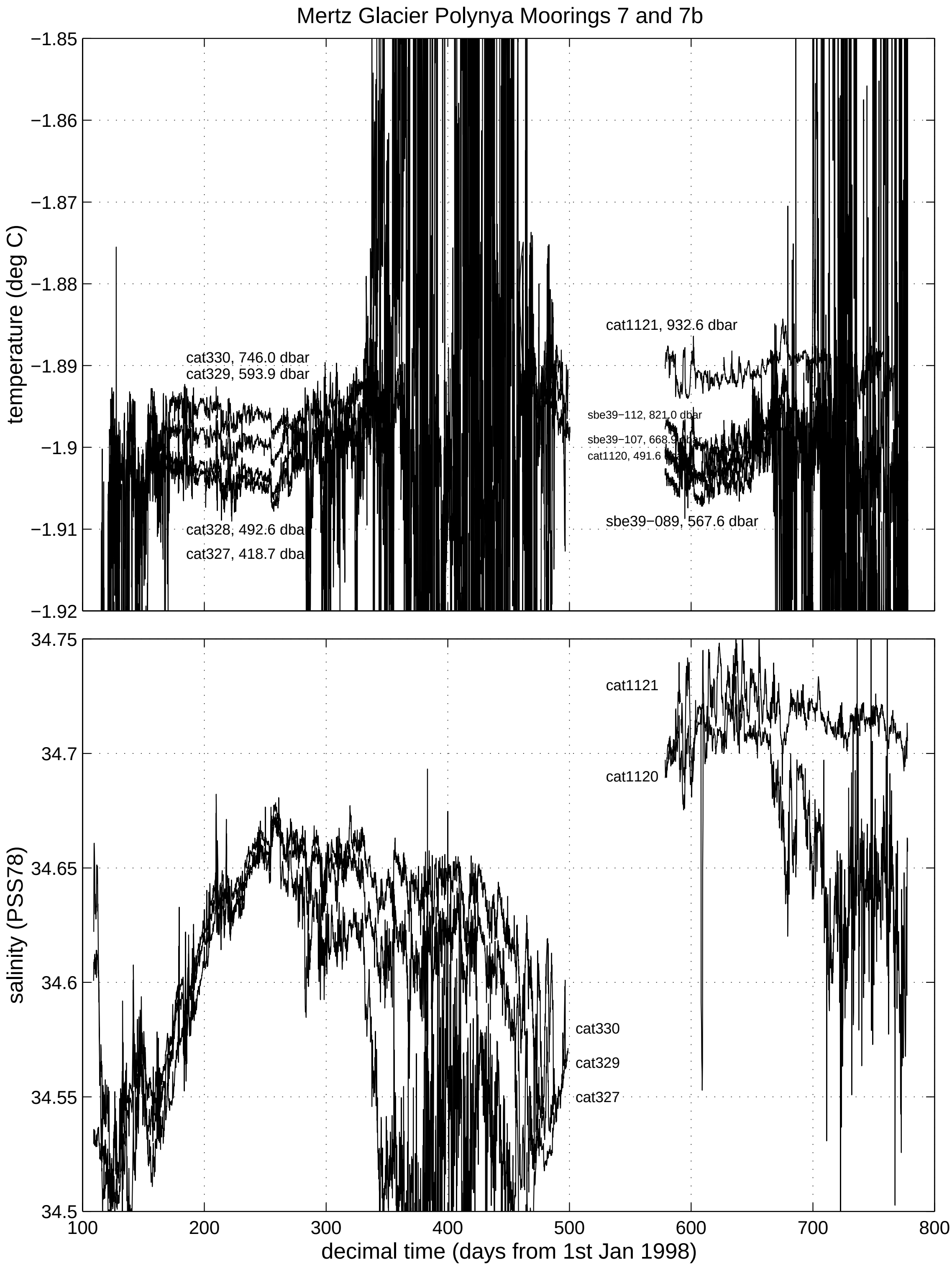
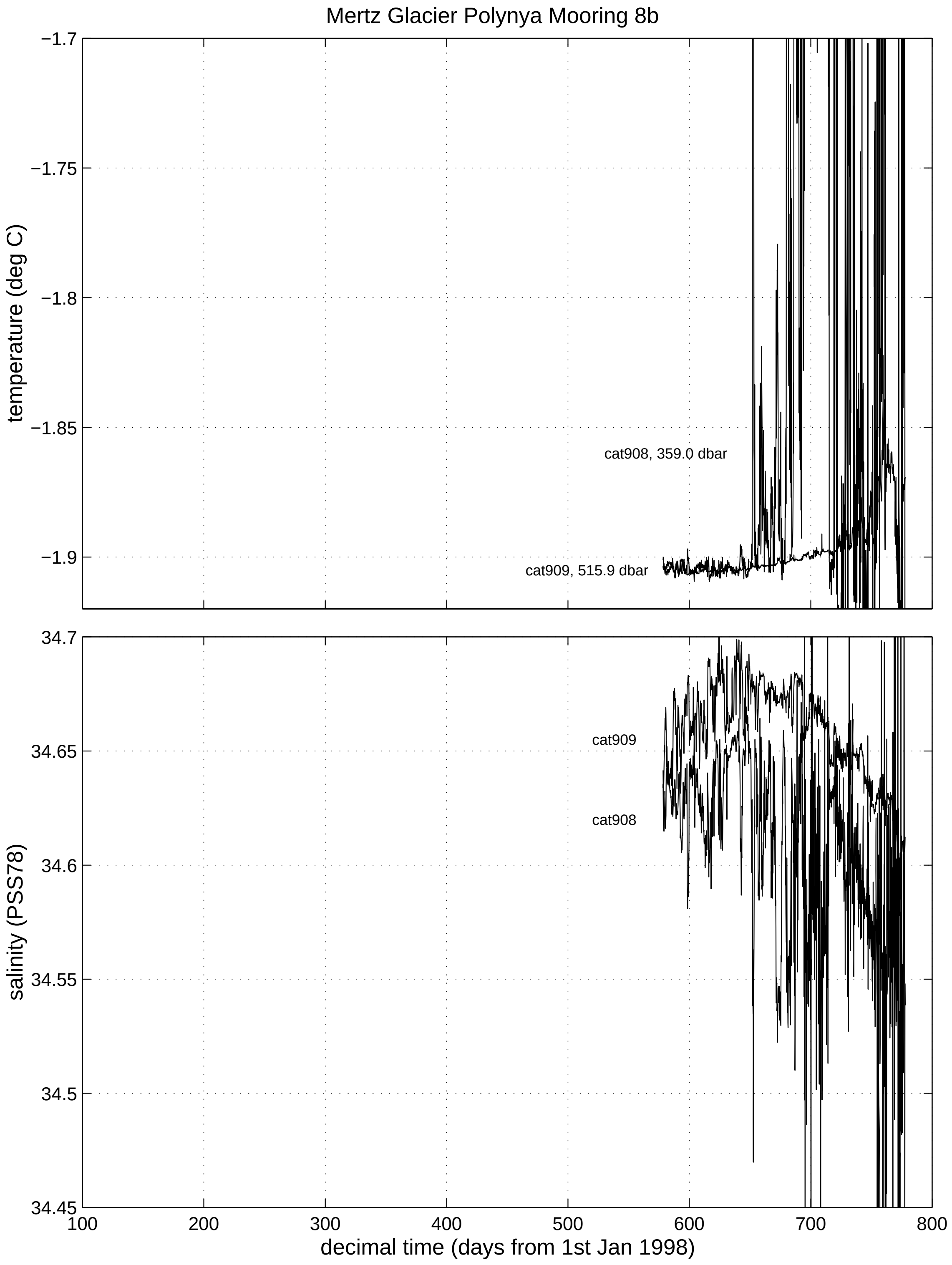


Figure 2.9f: Temperature and salinity data for polynya6 and 6b moorings (note: not all data lie within plot axes).



<u>Figure 2.9g:</u> Temperature and salinity data for polynya7 and 7b moorings (note: not all data lie within plot axes).



<u>Figure 2.9h:</u> Temperature and salinity data for polynya8b mooring (note: not all data lie within plot axes).

APPENDIX 2.1 MOORING DATA FILE FORMATS

For all instruments, the following definitions apply for matlab vectors (where xxx=instrument, e.g. cat318):

xxx_dectime	= decimal time (decimal days from midnight on December 31st 1997; so, e.g.,midday on January 1st 1998 = 0.5 decimal time; midday on January 1st 2000 = 730.5)
xxx_cond	= conductivity (mS/cm)
xxx_p	= instrument position (pressure in dbar)
xxx_press	= pressure (dbar)
xxx_sal	= salinity (PSS78)
xxx_temp	= temperature (^{o}C, ITS90)
xxx_spd	= current speed (cm/s)
xxx_dir	= current direction (^{o} true)
xxx_u	= E/W current component (cm/s, +ve towards the east)
xxx_v	= N/S current component (cm/s, +ve towards the north)

For the moored ADCP matlab files d0135_smallnew.mat and d1143_smallnew.mat, the following additional definitions apply:

xxx_bindep	= depth (m) to centre of each vertical bin
xxx_ensemble	= ensemble number
xxx_pitch	= pitch (^{o}) of instrument
xxx_roll	= roll (^{o}) of instrument
xxx_heading	= instrument heading (^{o} true) - not to be confused with current direction

Note the following for moored ADCP data:

* rows 1 to 48 in matlab matrices and vectors correspond to vertical bins 48 to 1;
* all currents are in earth co-ordinates (i.e. absolute current values);
* no. of bins=48
bin length=8.0 m
blank after transmit=4.0 m
distance to first bin=13.0 m
transmit length=8.1 m
pings per ensemble=15
time per ping=1.00 s

REFERENCES

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

Eriksen, R., 1997. *A practical manual for the determination of salinity, dissolved oxygen, and nutrients in seawater.* Antarctic CRC Research Report No. 11, January 1997, 83 pp.

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

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