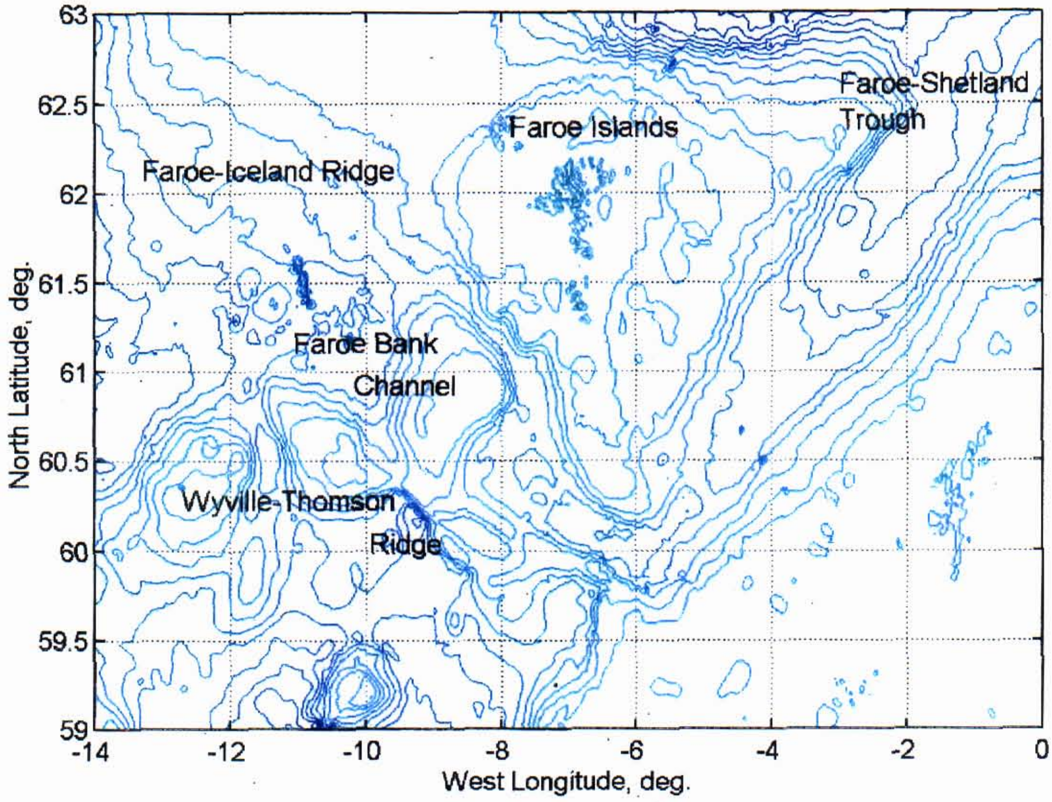
Cruise Report

RRS Discovery 247

A Process Study of the Faroe Bank Channel Overflow

3 July, 2000



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Cecilie Mauritzen, Woods Hole Oceanographic Institution
Mark Prater, Graduate School of Oceanography, Univ. of Rhode Island

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1) Overview and Goals of the Field Program (J. F. Price)

Faroe Bank Channel (FBC) is the deepest passage between the Norwegian-Greenland Sea and the North Atlantic Ocean. There is observed to be a quasi-steady overflow of dense water through FBC from the Norwegian-Greenland Sea into the abyssal North Atlantic at the rate of about 2 Sv. This dense overflow contributes significantly to the North East Atlantic Deep Water, which in turn is a major component of North Atlantic Deep Water. The FBC and its overflow have thus been of great interest to physical oceanography since its prominent role in deep water formation was appreciated in the 1950s.

The goal of our field program was to acquire finely sampled measurements of currents and hydrography in the region several hundred kilometers up and downstream of the sill in FBC sufficient to address three specific questions: 1) What is the transport and momentum balance of the overflow? 2) How does the overflow water approach the sill southwest of the Faroe Islands, and is the overflow hydraulically controlled? 3) Where and how does mixing occur in the descending overflow?

Our starting point for addressing these questions was to acquire a data set sufficient to allow estimation of the volume, momentum, energy and vorticity budgets along the path of the overflow. Bottom stress and vertical mixing with overlying North Atlantic water were expected to be of significant importance for these budgets. The strategy of our field program was to make measurements along a number of transverse sections that spanned the overflow from the Faroe-Shetland Trough (the approach) to the southern flank of the Faroe-Iceland Ridge (the descending overflow). Currents were measured by expendable current profilers (XCP), ship-mounted acoustic Doppler current profiler (ADCP) and lowered acoustic Doppler current profiler (LADCP). Hydrographic properties were measured by CTD, and by acquiring discrete water samples (oxygen and nutrients).

The instruments performed as expected, and there was only a very small data loss due to mechanical failure or operator error. In total, we made 217 CTD/LADCP profiles, and 114 XCP profiles. Underway measurements were made by ADCP, and by a variety of navigation sensors (most importantly, differential GPS (DGPS)) and meteorological sensors. Bottom-following drifters were also deployed. Some detail on the operations and data acquisition of each of these systems are given in the appendices.

2) Brief Chronology of the Sampling, and Maps (C. Mauritzen and J. F. Price)

Discovery departed Southampton on 5 June and steamed northward for the FBC region. The first task was to deploy a sound source at approx. 62N, 11W. Once this was accomplished, Discovery proceeded to the sill region of the FBC southwest of the Faroe Islands and began to sample along transverse sections labeled A, B, C, etc., in the order they were taken (see maps below). These sections were made up of closely spaced CTD/XCP stations. The usual course of events was that an XCP was taken upon arrival at a CTD station. However, when we were at the end of a section and no longer within the dense overflow, we sometimes chose to withhold the XCP. Sampling proceeded as planned until near the end of section D when a major low pressure system began to deepen and approach our area. Gale force winds caused the cessation of our work for a period of about 36 hrs (details of this are in the Ship's Operations Log). Once the winds abated, we resumed sampling to finish section D and then occupied section E. We judged that most of the mixing that was expected in the overflow had occurred by section E, and we never proceeded westward of about 10 40W.

Upon completion of E we returned to the sill section A, with the intent of continuing eastward to survey the approach of the overflow in the Faroe-Shetland Trough. We first reoccupied section A, calling the new section Ar, and discovered that there had been a noticeable change - a considerably thicker and slightly colder overflow layer than at the time of A. We then sampled section G, and for the first time noticed what appeared to be high frequency (tidal or inertial period) fluctuation of the currents and hydrographic fields. This impression of variability was confirmed at section H, where we found quite large tidal or inertial variability that required repeated sampling. In all, we spent three days sampling on section H, or about two days more than anticipated. As part of section H we went to the Wyville-Thomson Ridge and observed a small and evidently fluctuating overflow across the ridge. We then sampled the approach along section I, where there was much less tidal/inertial variability, and proceeded to section J, completing the approach survey.

Given the significant change in the overflow from A to Ar we decided to occupy section A two more times, and then repeated sections C, D and E (C for the third time). On this second occupation of the descending overflow sections we found a somewhat larger volume of colder overflow water, indicating that the overflow had a greater transport during the second half the field program.

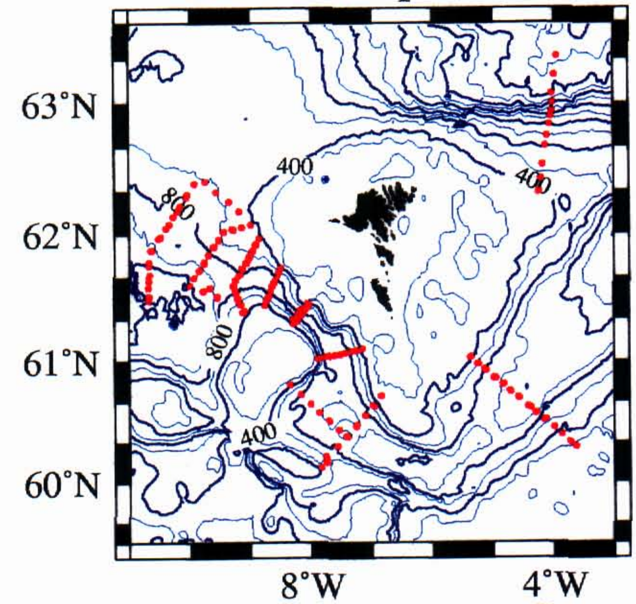
Compared to our original plan, we completed a slightly greater number of stations than anticipated. Also compared to the original plan, we used a greater fraction of these stations in a repeat sampling mode (e.g., we occupied section A four times vs. twice planned) on account of the evidence of temporal variability noted above. Similarly, we made seven sections on the approach; G twice, H three times, and I twice. Given the conditions we found, this repeat sampling seemed essential, though it was necessarily done at the expense of more extensive spatial coverage.

The analysis of this data set will require many months of concerted effort, and we will not attempt here to forecast scientific conclusions. We are confident, however, that the horizontal resolution along sections is generally sufficient to resolve the mesoscale, transverse structure of the overflow, including the relative vorticity (an exception to this may be section H, where tidal/inertial variability was very large, though repeatedly sampled). As well, the changes observed from one section to the next appear 'coherent' (mapable) and hence we believe that the goal of estimating mixing-induced changes along the path of the descending overflow will also be achievable.

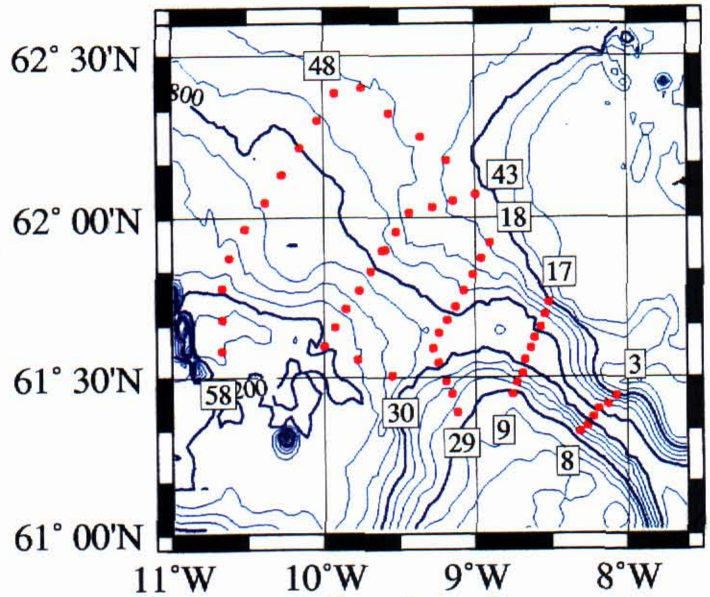
3) Acknowledgements (J. F. Price, T. B. Sanford and C. Mauritzen)

This field project was made possible by the efforts of many skilled and dedicated people. We are most grateful to Capt. Robin Plumley and the officers and crew of RRS Discovery for their steadfast support of all aspects of the project. The shipboard technical staff led by Jeff Benson was responsible for a flawless CTD and ADCP operation. Pre-cruise support provided by the Research Vessel Services staff, Edward Cooper, Andy Louch and Conor Mowltz, is greatly appreciated. Penny Foster organized travel and other pre-cruise administrative matters with efficiency and good humor. This project was funded by the U. S. National Science Foundation through grants OCE 99-06736 (to J. F. Price and C. Mauritzen) and OCE 99-11492 (to M. Prater).

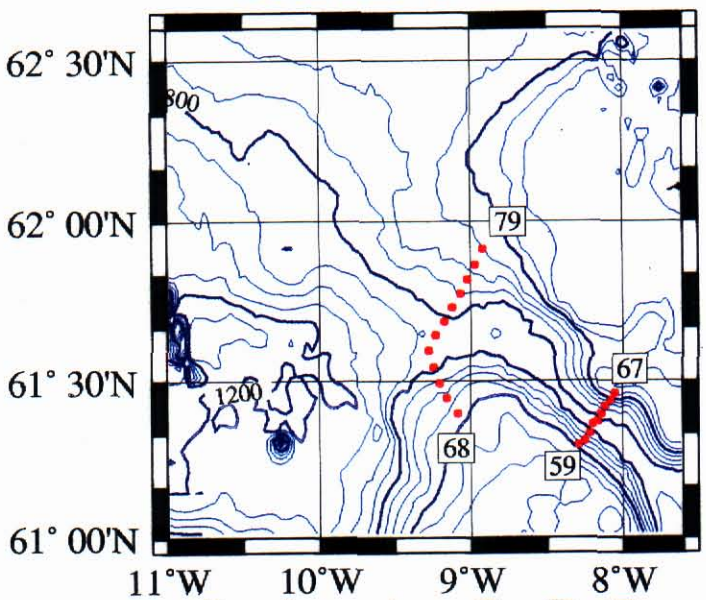
D247 CTD positions



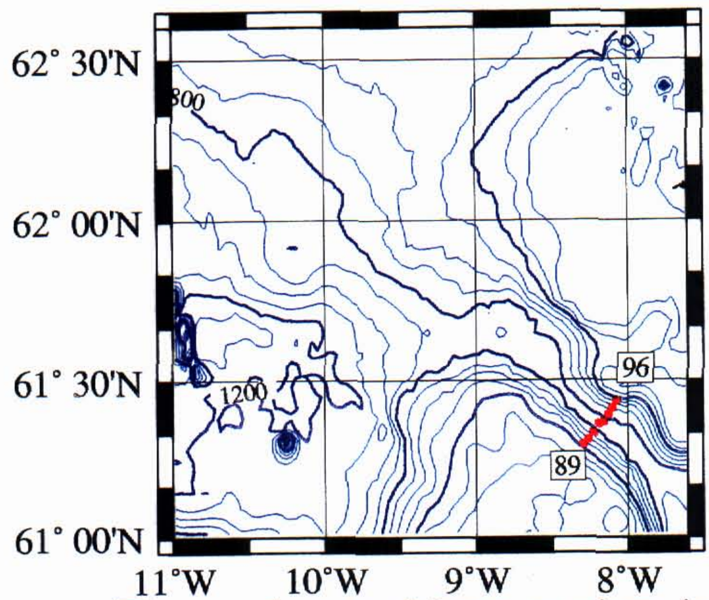
Sections A,B,C,D,E



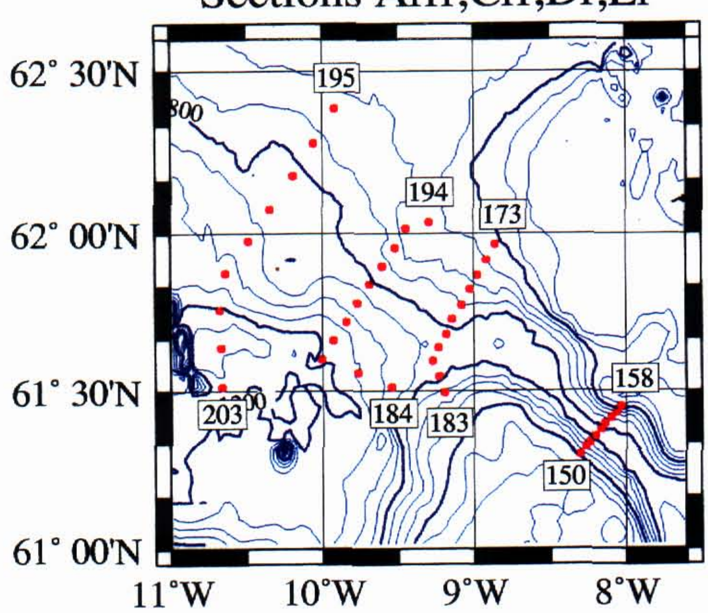
Sections Ar and Cr



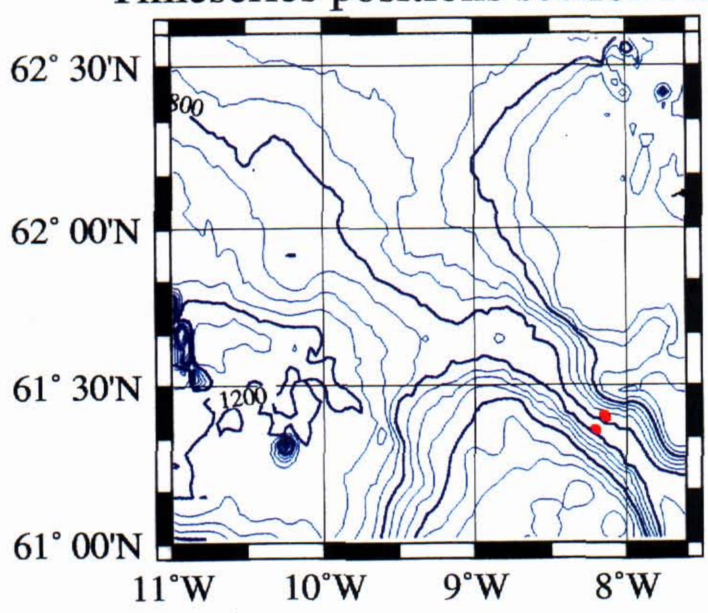
Section Arr



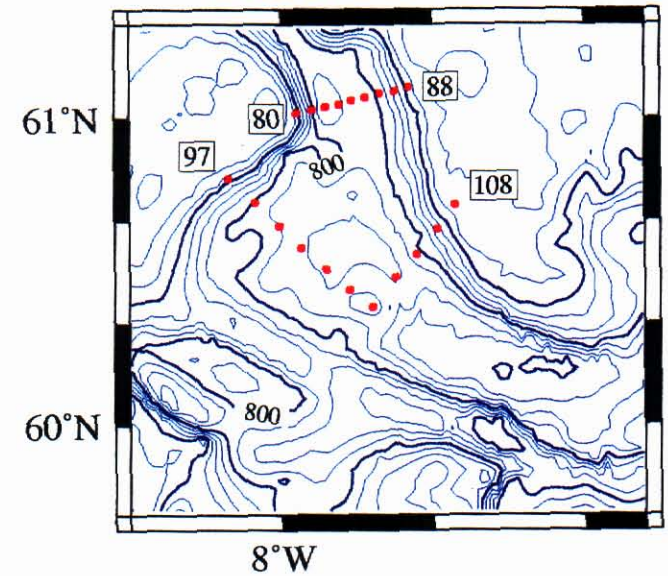
Sections Arrr,Crr,Dr,Er



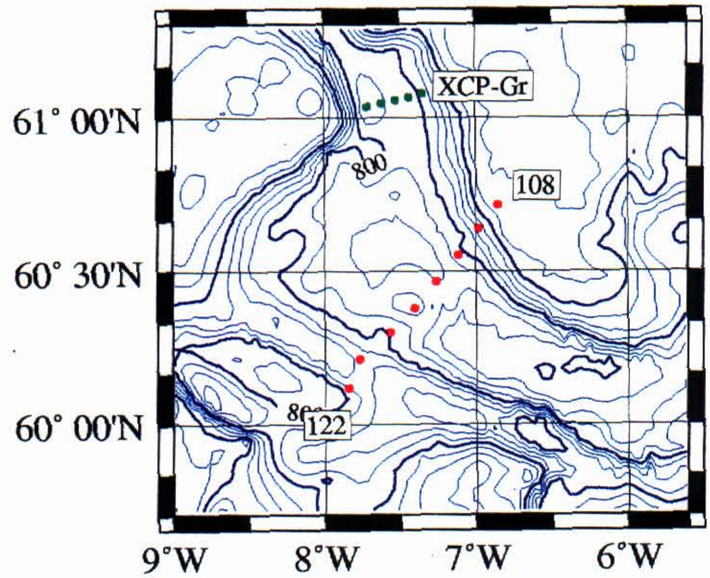
Timeseries positions section Arr



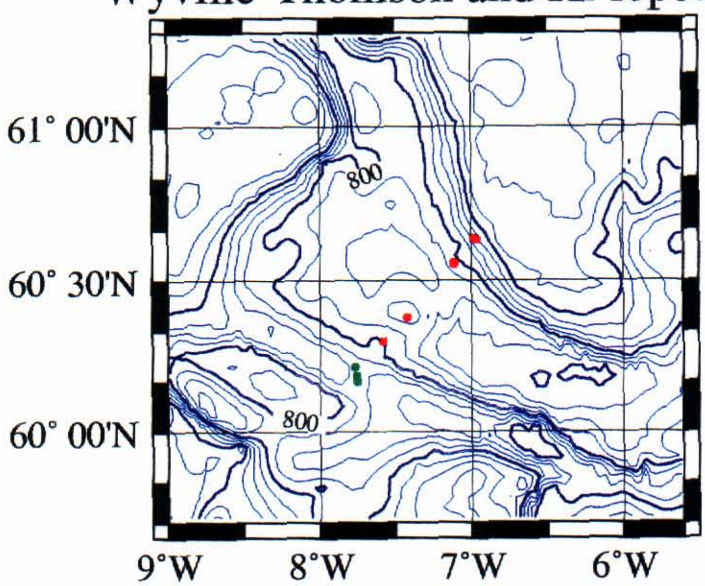
Sections G and H



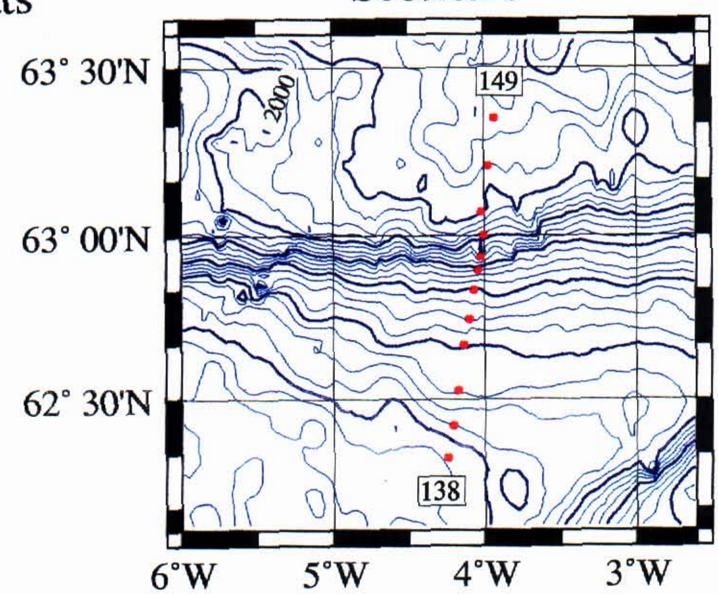
XCP section Gr, section Hr



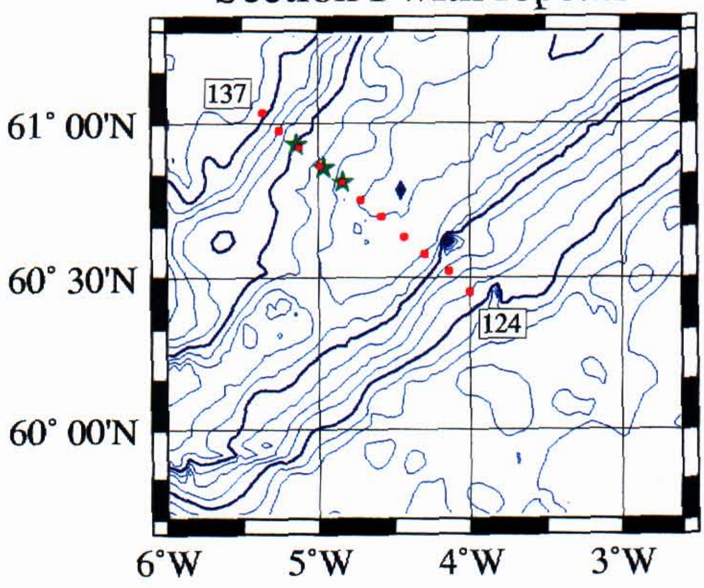
Wyville-Thomson and Hr repeats



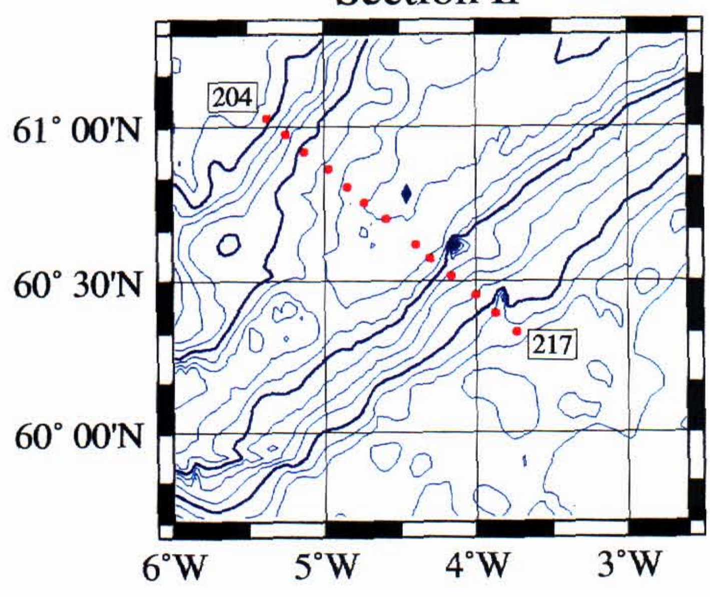
Section J



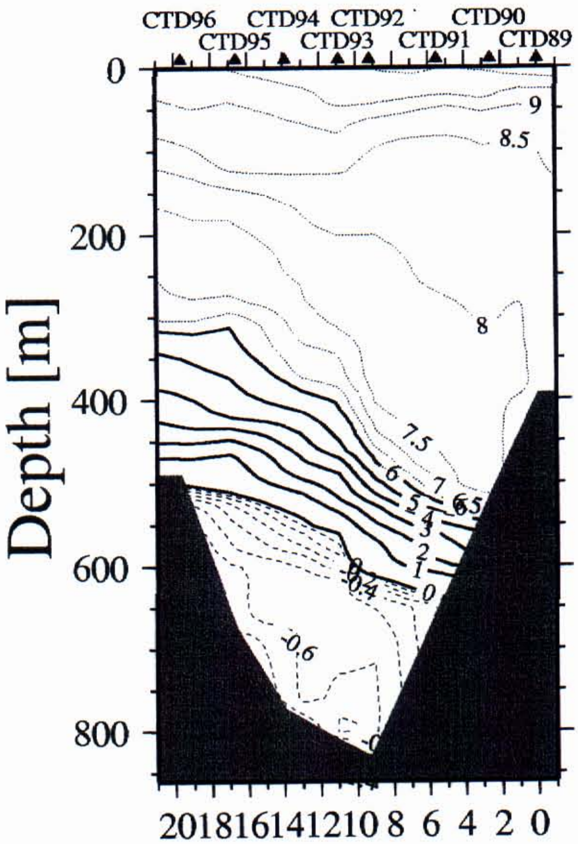
Section I with repeats



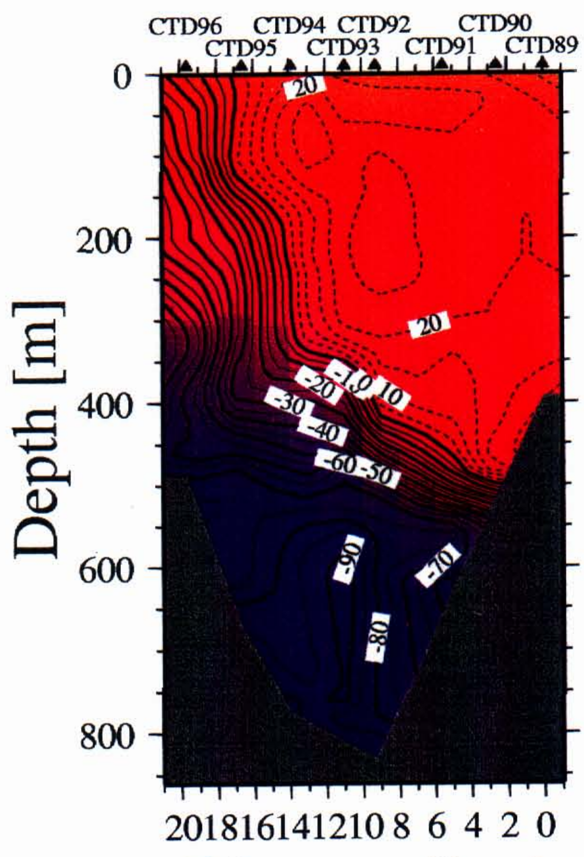
Section Ir

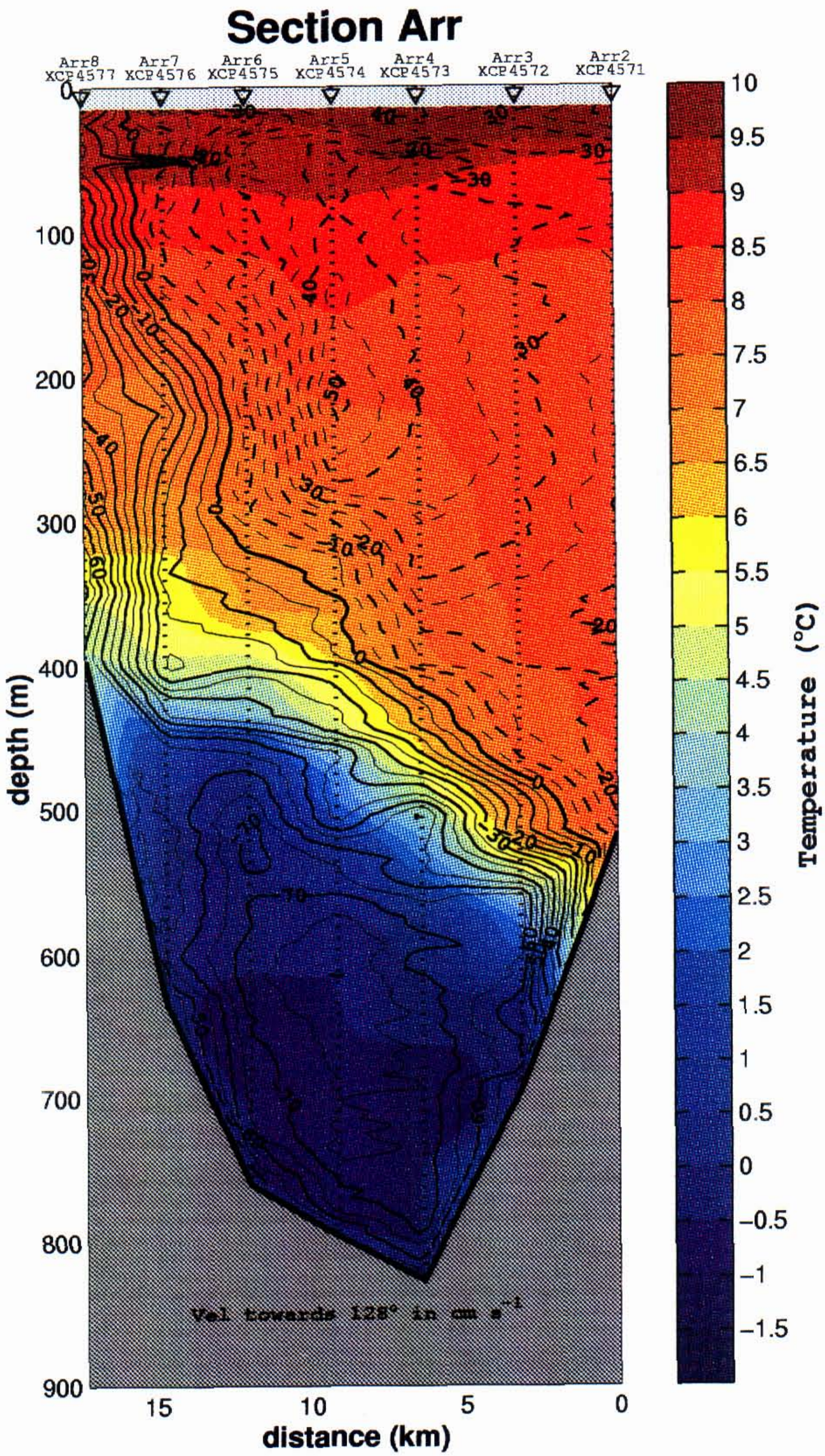


Theta - Section Arr

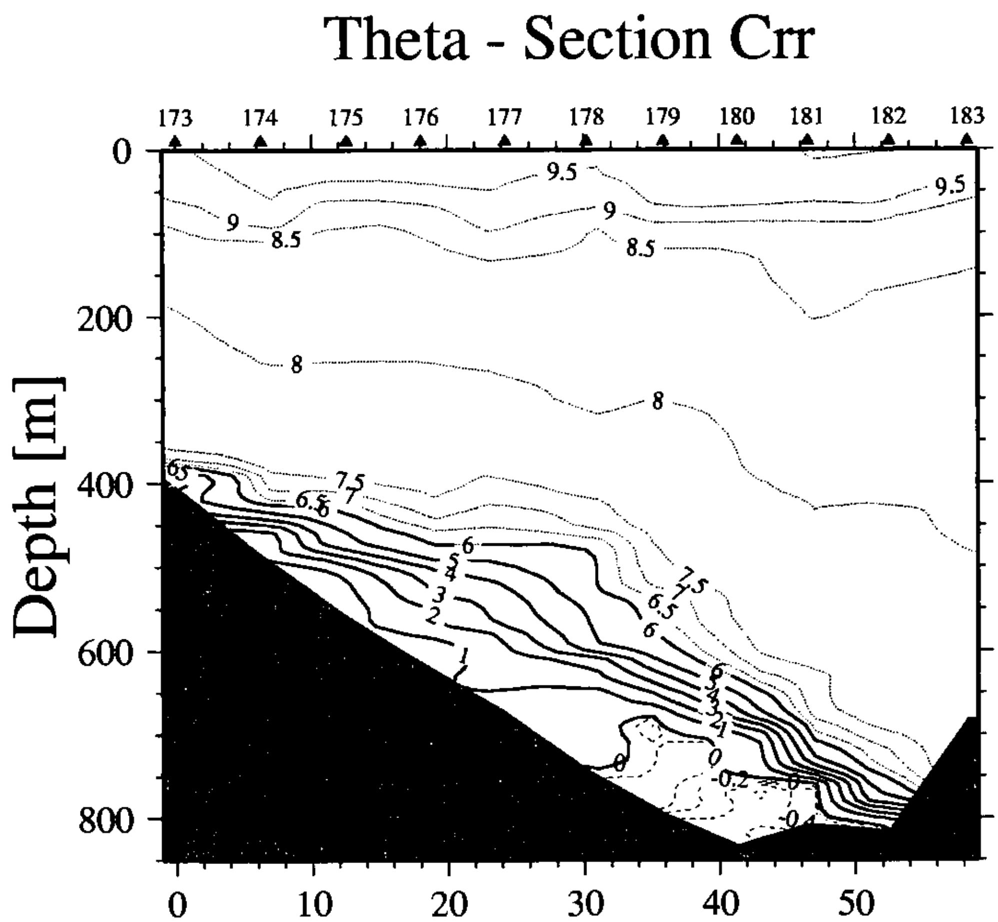


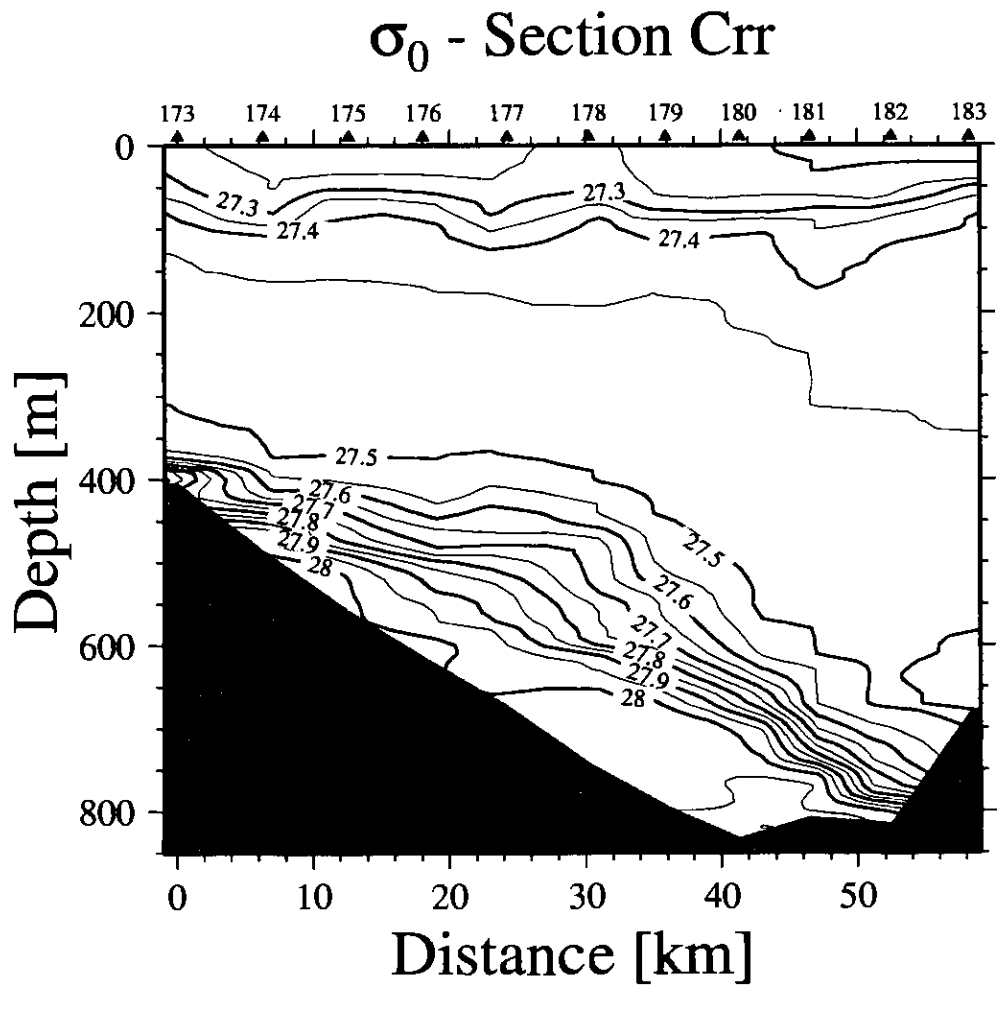
LADCP across-track [cm/s], pos SE





Section Arr
Arr8 XCP4577
Arr7 XCP4576
Arr6 XCP4575
Arr5 XCP4574
Arr4 XCP4573
Arr3 XCP4572
Arr2 XCP4571
depth (m)
distance (km)
Vel towards 128° in cm s⁻¹
Temperature (°C)


Theta - Section Crr
173
174
175
176
177
178
179
180
181
182
183
Depth [m]
Distance [km]


σ_0 - Section Crr
173
174
175
176
177
178
179
180
181
182
183
Depth [m]
Distance [km]

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Science Party of Discovery 247

Standing from left to right: Jim Price, Liz Hawker, Deb West-Mack, Cecilie Mauritzen, Peter Huybers, Dan Torres, John Dunlap, Tom Sanford, Mark Prater, Laura Cornick, and George Tupper. Sitting: Patricia Kassis, Heather Deese, James Girton, Avon Russell, and Dicky Allison

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Log of Science Operations RRS *Discovery* 5 June - 3 July 2000

Tom Sanford, Dicky Allison

Time (local)	Position (lat, long)		Depth	Operation	Comments
5 June 2000					
1150	50°53N,	1°23W	Harbor	Under way	Depart Empress dock, Soton, head W to Irish Sea
1430	50°35N,	2°00W	30 m	Science mtg	Desc. of planned work and instruments; Lounge
1615	50°20N,	2°20W	50 m	Boat drill	Muster w/ PFDs and enter lifeboats
6 June 2000					
0000	49°53N,	4°29W	Various	Under way	Steaming toward sound source mooring site
1028	51°01N,	5°53W	94 m	Deploy CTD000	Test station; full bottle suite
1115	51°01N,	5°53W	94 m	Recover CTD000	End station
7 June 2000					
0000	53°28N,	5°26W	Various	Under way	Steaming toward sound source mooring site
1032	55°22N,	5°55W	112 m	Deploy CTD001	Start test station
1106	55°22N,	5°55W	119 m	Recover CTD001	End test station
1200	55°22N,	5°55W	117 m	Under way	ADCP calibration run at 8 kt on steady course
1355	55°26N,	6°20W	116 m	Under way	End ADCP calibration run
8 June 2000					
0000	57°01N,	8°30W	Various	Under way	Steaming to sound source mooring
2354	61°34N,	9°39W	1007 m	Deploy XCP4501	Ch. 14. Good profile
9 June 2000					
0000	61°35N,	9°40W	1045 m	Under way	Maneuvering for CTD station
0018	61°35N,	9°40W	1045 m	Deploy CTD002	Deep water test station
0127	61°35N,	9°39W	1035 m	Recover CTD002	End station, head to mooring site at 0155
0808	62°08N,	11°02W	1024 m	Mooring ops	Begin mooring operations
0933	62°08N,	11°00W	1017 m	Mooring ops	Finish deployment and testing and ranging
1050	62°06N,	10°58W	1017 m	Under way	Steam to Section A
2124	61°20N,	8°10W	350 m	Deploy XCP4502	Ch. 12. Sec A;Bad. no data, only pop
2141	61°27N,	8°04W	434 m	Deploy CTD003	Station A1
2213	61°27N,	8°04W	434 m	Recover CTD003	CTD on board
2237	61°26N,	8°07W	622 m	Deploy XCP4503	Ch. 12. Good w/ strong NW flow at bottom
2254	61°25N,	8°07W	699 m	Deploy CTD004	Station A2
2350	61°25N,	8°08W	700 m	Recover CTD004	CTD on board
10 June 2000					
0000	61°25N,	8°08W	744 m	Under way	Steaming to CTD005
0001	61°24N,	8°10W	784 m	Deploy XCP4504	Ch. 16. Good w/ strong NW flow at bottom
0039	61°24N,	8°11W	786 m	Deploy CTD005	Station A3
0135	61°24N,	8°12W	788 m	Recover CTD005	CTD on board
0200	61°24N,	8°12W	790 m	Deploy RAFOS	RAFOS 591. Overboard; one strut broken
0228	61°23N,	8°13W	833 m	Deploy XCP4505	Ch. 12. Bad profile
0234	61°22N,	8°13W	836 m	Deploy XCP4506	Ch. 14. Good profile

Log of Science Operations

Time (UTC)	Position (lat, long)		Depth	Operation	Comments
				10 June 2000 (cont.)	
0247	*61°22N,*	*8°13W*	*837 m*	*Deploy CTD006*	*Station A4*
0340	*61°23N,*	*8°13W*	*837 m*	*Recover CTD006*	*CTD on board*
0400	*61°24N,*	*8°12W*	*790 m*	*Deploy RAFOS*	*RAFOS 584. Launch aborted, broken strut*
0432	*61°21N,*	*8°16W*	*667 m*	*Deploy XCP4507*	*Ch. 16. Good profile*
0447	*61°21N,*	*8°16W*	*650 m*	*Deploy CTD007*	*Station A5*
0526	*61°21N,*	*8°15W*	*650 m*	*Recover CTD007*	*CTD on board*
0620	*61°20N,*	*8°18W*	*480 m*	*Deploy CTD008*	*Station A6*
0655	*61°19N,*	*8°18W*	*480 m*	*Recover CTD008*	*CTD on board*
0854	*61°27N,*	*8°45W*	*455 m*	*Deploy CTD009*	*Station B1; start Sec B*
0924	*61°27N,*	*8°46W*	*457 m*	*Recover CTD009*	*CTD on board*
0956	*61°29N,*	*8°43W*	*618 m*	*Deploy XCP4508*	*Ch. 12 Dud.*
1009	*61°29N,*	*8°43W*	*588 m*	*Deploy CTD010*	*Station B2*
1041	*61°29N,*	*8°43W*	*587 m*	*Recover CTD010*	*CTD on board*
1127	*61°31N,*	*8°41W*	*768 m*	*Deploy CTD011*	*Station B3*
1206	*61°30N,*	*8°41W*	*782 m*	*Recover CTD011*	*CTD on board*
1303	*61°33N,*	*8°40W*	*868 m*	*Deploy CTD012*	*Station B4*
1357	*61°33N,*	*8°41W*	*867 m*	*Recover CTD012*	*CTD on board*
1415	*61°33N,*	*8°41W*	*867 m*	*Deploy RAFOS*	*RAFOS 583. Mark added lines btwn arms + tube*
1422	*61°33N,*	*8°41W*	*857 m*	*Deploy XCP4509*	*Ch. 14. Good profile*
1457	*61°36N,*	*8°38W*	*874 m*	*Deploy XCP4510*	*Ch. 16. Good profile*
1516	*61°36N,*	*8°38W*	*875 m*	*Deploy CTD013*	*Station B5*
1608	*61°36N,*	*8°38W*	*875 m*	*Recover CTD013*	*CTD on board*
1624	*61°35N,*	*8°38W*	*875 m*	*Deploy RAFOS*	*RAFOS 587. Mark added lines and used soap*
1716	*61°38N,*	*8°36W*	*824 m*	*Deploy XCP4511*	*Ch. 14. Good profile*
1734	*61°38N,*	*8°36W*	*827 m*	*Deploy CTD014*	*Station B6*
1824	*61°38N,*	*8°37W*	*827 m*	*Recover CTD014*	*CTD on board*
1838	*61°38N,*	*8°37W*	*827 m*	*Deploy RAFOS*	*RAFOS 585. Mark added lines and soap*
1930	*61°40N,*	*8°34W*	*767 m*	*Deploy XCP4512*	*Ch. 16. Good profile*
1943	*61°40N,*	*8°34W*	*767 m*	*Deploy CTD015*	*Station B7*
2031	*61°40N,*	*8°34W*	*768 m*	*Recover CTD015*	*CTD on board*
2044	*61°40N,*	*8°34W*	*760 m*	*Deploy RAFOS*	*RAFOS 586. Mark added lines and soap*
2118	*61°42N,*	*8°32W*	*666 m*	*Deploy XCP4513*	*Ch. 14. Good profile*
2134	*61°42N,*	*8°32W*	*669 m*	*Deploy CTD016*	*Station B8*
2220	*61°42N,*	*8°32W*	*668 m*	*Recover CTD016*	*CTD on board*
2307	*61°44N,*	*8°31W*	*463 m*	*Deploy CTD017*	*Station B9*
2342	*61°44N,*	*8°30W*	*434 m*	*Recover CTD017*	*CTD on board; end Sec B*

Log of Science Operations

Time (UTC)	Position (lat, long)		Depth	Operation	Comments
				11 June 2000	
0000			*Various*	*Under way*	*Steaming to start of Section C*
0149	*61°55N,*	*8°55W*	*496 m*	*Deploy CTD018*	*Station C1, N end of Section*
0225	*61°55N,*	*8°54W*	*491 m*	*Recover CTD018*	
0311	*61°52N,*	*8°59W*	*563 m*	*Deploy XCP4514*	*Ch. 16. Good profile*
0324	*61°52N,*	*8°58W*	*564 m*	*Deploy CTD019*	*Station C2*
0402	*61°53N,*	*8°58W*	*548 m*	*Recover CTD019*	
0456	*61°50N,*	*9°02W*	*627 m*	*Deploy XCP4515*	*Ch. 14. Good profile*
0510	*61°50N,*	*9°01W*	*627 m*	*Deploy CTD020*	*Station C3*
0548	*61°49N,*	*9°01W*	*622 m*	*Recover CTD020*	
0639	*61°47N,*	*9°05W*	*688 m*	*Deploy XCP4516*	*Ch. 16. Good profile*
0658	*61°47N,*	*9°05W*	*700 m*	*Deploy CTD021*	*Station C4*
0746	*61°46N,*	*9°04W*	*766 m*	*Recover CTD021*	
0817	*61°44N,*	*9°09W*	*751 m*	*Deploy XCP4517*	*Ch. 14. Good profile*
0839	*61°44N,*	*9°08W*	*755 m*	*Deploy CTD022*	*Station C5*
0932	*61°43N,*	*9°07W*	*755 m*	*Recover CTD022*	
0944	*61°43N,*	*9°07W*	*755 m*	*Deploy RAFOS*	*RAFOS 592. Mark added lines and soap*
1024	*61°41N,*	*9°12W*	*806m*	*Deploy XCP4518*	*Ch. 16. Good profile*
1041	*61°41N,*	*9°11W*	*816m*	*Deploy CTD023*	*Station C6*
1126	*61°41N,*	*9°11W*	*816 m*	*Recover CTD023*	
1152	*61°41N,*	*9°10W*	*816 m*	*Deploy RAFOS*	*RAFOS 581. Mark added lines and soap*
1237	*61°39N,*	*9°15W*	*853 m*	*Deploy XCP4519*	*Ch. 14. Good profile*
1253	*61°38N,*	*9°14W*	*852 m*	*Deploy CTD024*	*Station C7*
1345	*61°39N,*	*9°14W*	*853 m*	*Recover CTD024*	
1431	*61°36N,*	*9°17W*	*827 m*	*Deploy XCP4520*	*Ch. 16. Good profile*
1447	*61°36N,*	*9°17W*	*822m*	*Deploy CTD025*	*Station C8*
1543	*61°36N,*	*9°16W*	*822 m*	*Recover CTD025*	
1631	*61°33N,*	*9°14W*	*835 m*	*Deploy CTD026*	*Start Station C9*
1717	*61°33N,*	*9°14W*	*834 m*	*Recover CTD026*	
1735	*61°33N,*	*9°14W*	*834 m*	*Deploy XCP4521*	*Ch. 14. Good profile*
1831	*61°30N,*	*9°12W*	*666 m*	*Deploy CTD027*	*Station C10*
1907	*61°29N,*	*9°11W*	*660 m*	*Recover CTD027*	
1950	*61°27N,*	*9°09W*	*539 m*	*Deploy CTD028*	*Station C11*
2019	*61°27N,*	*9°09W*	*540 m*	*Recover CTD028*	
2107	*61°24N,*	*9°07W*	*443 m*	*Deploy CTD029*	*Station C12*
2137	*61°23N,*	*9°07W*	*440 m*	*Recover CTD029*	
2147	*61°23N,*	*9°09W*	*470 m*	*Underway*	*Steaming to start of Section D*
2322	*61°31N,*	*9°33W*	*970 m*	*Deploy CTD030*	*CTD delayed due to warn. lt on winch*

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			12 June 2000	
0000	*61°31N, 9°33W*	*970 m*	*Hove to*	*CTD delayed due to winch overheating*
0202	*61°30N, 9°33W*	*977 m*	*Deploy CTD030*	*Start of station D1*
0251	*61°30N, 9°33W*	*972 m*	*Recover CTD030*	
0350	*61°33N, 9°47W*	*1135 m*	*Deploy CTD031*	*Start of station D2*
0444	*61°33N, 9°46W*	*1086 m*	*Recover CTD031*	
0548	*61°36N, 10°00W*	*1189 m*	*Deploy CTD032*	*Start of station D3*
0640	*61°36N, 9°59W*	*1181 m*	*Recover CTD032*	
0738	*61°40N, 9°55W*	*1158 m*	*Deploy CTD033*	*Start of station D4*
0829	*61°40N, 9°55W*	*1158 m*	*Recover CTD033*	
0837	*61°40N, 9°55W*	*1153 m*	*Deploy XCP4522*	*Ch. 16. Good profile at D4*
0911	*61°43N, 9°51W*	*1048 m*	*Deploy XCP4523*	*Ch. 14. Good profile at D5*
0925	*61°43N, 9°51W*	*1048 m*	*Deploy CTD034*	*Start of station D5*
1010	*61°43N, 9°51W*	*1048 m*	*Recover CTD034*	
1102	*61°47N, 9°46W*	*954 m*	*Deploy XCP4524*	*Ch. 16. Good profile at D6*
1115	*61°47N, 9°46W*	*957 m*	*Deploy CTD035*	*Start of station D6*
1215	*61°46N, 9°46W*	*957 m*	*Recover CTD035*	
1306	*61°50N, 9°41W*	*825 m*	*Deploy XCP4525*	*Ch. 14. Good profile at D7*
1320	*61°50N, 9°41W*	*827 m*	*Deploy CTD036*	*Start of station D7*
1405	*61°50N, 9°42W*	*827 m*	*Recover CTD036*	
1456	*61°54N, 9°37W*	*732 m*	*Deploy XCP4526*	*Ch. 16. Good profile at D8*
1508	*61°54N, 9°36W*	*726 m*	*Deploy CTD037*	*Start of station D8*
1553	*61°54N, 9°38W*	*726 m*	*Recover CTD037*	
1600	*61°54N, 9°38W*	*726m*	*Hove to*	*Securing all gear; storm coming; Force 10 poss.*
1700	*61°54N, 9°38W*	*726 m*	*Under way*	*Heading for north of Faroes for shelter*
			13 June 2000	
0008	*62°25N, 6°58W*	*135 m*	*Underway*	*Sailing N of Faroes; lee of storm*
0605	*62°25N, 6°53W*	*111 m*	*Underway*	*Sailing NW of Faroes; 968 mb*
1627	*62°12N, 6°21W*	*77 m*	*Hove To*	*Sailing W of Faroes; weather improv.*
2220	*61°44N, 7°13W*	*113 m*	*Underway*	*Transiting back to work area; rolling*
			14 June 2000	
0558	*61°54N, 9°36W*	*718 m*	*On Station*	*On station to repeat D8, assembling CTD*
0748	*61°54N, 9°36W*	*707 m*	*Deploy CTD038*	*Repeat station D8*
0823	*61°54N, 9°36W*	*707 m*	*Recover CTD038*	
0832	*61°54N, 9°35W*	*704 m*	*Launch XCP4527*	*Ch. 14, Good profile at D8*
0903	*61°57N, 9°31W*	*645 m*	*Launch XCP4528*	*Ch. 16, Good profile at D9*
0919	*61°57N, 9°31W*	*669 m*	*Deploy CTD039*	*Station D9*
0949	*61°57N, 9°31W*	*675 m*	*Recover CTD039*	
1033	*62°01N, 9°25W*	*560 m*	*Launch XCP4529*	*Ch. 14, Good profile at D10*
1045	*62°01N, 9°26W*	*571 m*	*Deploy CTD040*	*Station D10*
1114	*62°01N, 9°26W*	*568 m*	*Recover CTD040*	
1216	*62°02N, 9°17W*	*509 m*	*Launch XCP4530*	*Ch. 16, Good profile at D11*
1225	*62°02N, 9°17W*	*511 m*	*Deploy CTD041*	*Station D11*
1305	*62°02N, 9°16W*	*515 m*	*Recover CTD041*	

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			14 June 2000 (cont.)	
1406	62°03N, 9°09W	475 m	Deploy CTD042	Start of station D12
1434	62°03N, 9°09W	479 m	Recover CTD042	
1446	62°03N, 9°09W	475 m	Launch XCP4531	Ch. 14, Good profile leaving D12
1536	62°04N, 9°00W	437 m	Deploy CTD043	Start of station D13
1602	62°04N, 9°00W	441 m	Recover CTD043	End section D
1751	62°11N, 9°11W	492 m	Deploy CTD044	Start of station E1
1817	62°11N, 9°11W	492 m	Recover CTD044	
1915	62°15N, 9°21W	588 m	Deploy CTD045	Start of station E2
1950	62°15N, 9°22W	586 m	Recover CTD045	
1956	62°15N, 9°21W	585 m	Launch XCP4532	Ch. 12 on fishing line; good profile, E2
2114	62°19N, 9°34W	610 m	Deploy CTD046	Start of station E3
2145	62°20N, 9°34W	609 m	Recover CTD046	
2152	62°20N, 9°36W	608 m	Launch XCP4533	Ch. 12; good profile at E3
2241	62°23N, 9°44W	612 m	Launch XCP4534	Ch. 16; good profile at E4
2254	62°24N, 9°44W	609 m	Deploy CTD047	Station E4
2326	62°24N, 9°45W	612 m	Recover CTD047	
			15 June 2000	
0013	62°23N, 9°55W	638 m	Deploy CTD048	Start of station E5
0052	62°23N, 9°56W	638 m	Recover CTD048	
0100	62°23N, 9°56W	640 m	Launch XCP4535	Ch. 12; good profile at E5
0153	62°18N, 10°02W	721 m	Launch XCP4536	Ch. 12; good profile at E6
0210	62°18N, 10°02W	720 m	Deploy CTD049	Station E6
0249	62°18N, 10°02W	720 m	Recover CTD049	
0344	62°13N, 10°09W	825 m	Launch XCP4537	Ch. 16; good profile at E7
0354	62°13N, 10°09W	823 m	Deploy CTD050	Station E7
0434	62°13N, 10°10W	823 m	Recover CTD050	
0530	62°08N, 10°16W	852 m	Launch XCP4538	Ch. 12; good profile at E8
0540	62°08N, 10°17W	853 m	Deploy CTD051	Station E8
0620	62°08N, 10°16W	851 m	Recover CTD051	
0718	62°03N, 10°23W	862 m	Launch XCP4539	Ch. 14; good profile at E9
0728	62°03N, 10°23W	855 m	Deploy CTD052	Station E9
0806	62°03N, 10°23W	851 m	Recover CTD052	
0902	61°58N, 10°31W	964 m	Launch XCP4540	Ch. 12; good profile at E10
0912	61°58N, 10°31W	965 m	Deploy CTD053	Station E10
0952	61°58N, 10°31W	968 m	Recover CTD053	
1044	61°53N, 10°37W	1030 m	Launch XCP4541	Ch. 12; good profile at E11
1059	61°53N, 10°38W	1037 m	Deploy CTD054	Station E11
1141	61°53N, 10°38W	1037 m	Recover CTD054	
1238	61°47N, 10°40W	1169 m	Launch XCP4542	Ch. 12; good profile at E12
1251	61°47N, 10°40W	1178 m	Deploy CTD055	Station E12
1338	61°47N, 10°40W	1182 m	Recover CTD055	
1429	61°41N, 10°40W	1312 m	Launch XCP4543	Ch. 12; good profile at E13
1445	61°41N, 10°40W	1315 m	Deploy CTD056	Station E13
1536	61°41N, 10°40W	1316 m	Recover CTD056	

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			15 June 2000 (cont.)	
1626	*61°35N, 10°40W*	*1308 m*	*Launch XCP4544*	*Ch. 16; XCP failed; no profile at E1*
1637	*61°35N, 10°40W*	*1309 m*	*Deploy CTD057*	*Station E14*
1725	*61°35N, 10°40W*	*1309 m*	*Recover CTD057*	
1731	*61°35N, 10°40W*	*1310 m*	*Launch XCP4545*	*Ch. 12 on leaving Station E14*
1842	*61°29N, 10°40W*	*1217 m*	*Deploy CTD058*	*Station E15*
1929	*61°30N, 10°41W*	*1219 m*	*Recover CTD058*	*Concludes section E*
2017	*61°30N, 10°49W*	*1268 m*	*Bathymetry Survey*	*Looking for seamounts*
2257	*61°39N, 11°06W*	*1268 m*	*Bathymetry Survey*	*Crisscross pattern for search*
			16 June 2000	
0007	*61°37N, 10°49W*		*Transit*	*Stop survey; Head to line A for repeat.*
0654	*61°18N, 08°18W*	*398 m*	*Launch XCP4546*	*Ch. 14. Good profile at station Ar1*
0707	*61°18N, 08°18W*	*401 m*	*Deploy CTD059*	*Station Ar1*
0727	*61°18N, 08°17W*	*404 m*	*Recover CTD059*	
0758	*61°19N, 08°16W*	*517 m*	*Launch XCP4547*	*Ch. 16. Good profile at station Ar2*
0809	*61°19N, 08°15W*	*538 m*	*Deploy CTD060*	*Station Ar2*
0835	*61°19N, 08°14W*	*542 m*	*Recover CTD060*	
0902	*61°20N, 08°15W*	*636 m*	*Launch XCP4548*	*Ch. 12. Good profile at station Ar3*
0915	*61°20N, 08°14W*	*700 m*	*Deploy CTD061*	*Station Ar3*
0951	*61°20N, 08°12W*	*726 m*	*Recover CTD061*	
1022	*61°22N, 08°12W*	*839 m*	*Launch XCP4549*	*Ch. 14. Good profile at station Ar4*
1037	*61°21N, 08°11W*	*846 m*	*Deploy CTD062*	*Station Ar4*
1120	*61°21N, 08°10W*	*703 m*	*Recover CTD062*	
1144	*61°20N, 08°09W*	*703 m*	*Deploy RAFOS*	*RAFOS 582. Slow sinker.*
1227	*61°23N, 08°10W*	*824 m*	*Launch XCP4550*	*Ch. 12. Good profile at station Ar5*
1240	*61°23N, 08°10W*	*832 m*	*Deploy CTD063*	*Station Ar5*
1315	*61°23N, 08°10W*	*832 m*	*Recover CTD063*	
1328	*61°23N, 08°10W*	*828 m*	*Deploy RAFOS*	*RAFOS 589. Descended!!*
1358	*61°24N, 08°08W*	*793 m*	*Launch XCP4551*	*Ch. 16. Failed! Approaching station Ar6*
1419	*61°24N, 08°08W*	*789 m*	*Launch XCP4552*	*Ch. 12. Good profile at station Ar6*
1431	*61°24N, 08°08W*	*793 m*	*Deploy CTD064*	*Station Ar6*
1504	*61°24N, 08°09W*	*790 m*	*Recover CTD064*	
1516	*61°24N, 08°09W*	*781 m*	*Deploy RAFOS*	*RAFOS 590. Smooth descent.*
1546	*61°25N, 08°06W*	*668 m*	*Launch XCP4553*	*Ch. 14. Good profile at station Ar7*
1605	*61°25N, 08°06W*	*655 m*	*Deploy CTD065*	*Station Ar7*
1632	*61°26N, 08°07W*	*633 m*	*Recover CTD065*	
1732	*61°26N, 08°04W*	*478 m*	*Deploy CTD066*	*Start of station Ar8*
1754	*61°27N, 08°05W*	*450 m*	*Recover CTD066*	
1804	*61°27N, 08°05W*	*446 m*	*Launch XCP4554*	*Ch. 16. Good profile leaving station Ar8*
1845	*61°28N, 08°03W*	*263 m*	*Deploy CTD067*	*Start of station Ar9*
1858	*61°28N, 08°03W*	*255 m*	*Recover CTD067*	*Completes Section Ar. On to Cr!*
2231	*61°24N, 09°06W*	*441 m*	*Deploy CTD068*	*Begins station Cr1*
2258	*61°24N, 09°05W*	*431 m*	*Recover CTD068*	
2341	*61°27N, 09°10W*	*554 m*	*Deploy CTD069*	*Begins station Cr2*

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			17 June 2000	
0013	*61°27N, 09°09W*	*539 m*	*Recover CTD069*	
0048	*61°30N, 09°12W*	*689 m*	*Deploy CTD070*	*Begins station Cr3*
0124	*61°30N, 09°12W*	*670 m*	*Recover CTD070*	
0210	*61°33N, 09°15W*	*826 m*	*Launch XCP4555*	*Ch. 16. Good profile at station Cr4*
0222	*61°33N, 09°14W*	*833 m*	*Deploy CTD071*	*Station Cr4*
0301	*61°33N, 09°14W*	*834 m*	*Recover CTD071*	
0347	*61°36N, 09°17W*	*824 m*	*Launch XCP4556*	*Ch. 12 - probe failed arriving at Cr5*
0356	*61°36N, 09°17W*	*823 m*	*Deploy CTD072*	*Station Cr5*
0433	*61°36N, 09°17W*	*824 m*	*Recover CTD072.*	
0439	*61°36N, 09°17W*	*821 m*	*Launch XCP4557*	*Ch. 14. Good profile leaving station Cr5*
0530	*61°39N, 09°14W*	*864 m*	*Launch XCP4558*	*Ch. 16. Good profile at station Cr6*
0542	*61°39N, 09°14W*	*858 m*	*Deploy CTD073*	*Station Cr6*
0620	*61°39N, 09°14W*	*853 m*	*Recover CTD073*	
0708	*61°41N, 09°11W*	*812 m*	*Launch XCP4559*	*Ch. 12. Good profile approaching Cr7*
0718	*61°41N, 09°11W*	*822 m*	*Deploy CTD074*	*Station Cr7*
0754	*61°41N, 09°10W*	*825 m*	*Recover CTD074*	
0831	*61°44N, 09°08W*	*742 m*	*Launch XCP4560*	*Ch. 14. Good profile approaching Cr8*
0847	*61°44N, 09°08W*	*758 m*	*Deploy CTD075*	*Station Cr8*
0919	*61°44N, 09°07W*	*751 m*	*Recover CTD0745*	
1000	*61°47N, 09°06W*	*686 m*	*Launch XCP4561*	*Ch. 16. Good profile approaching Cr9*
1013	*61°47N, 09°04W*	*643 m*	*Deploy CTD076*	*Station Cr9*
1047	*61°46N, 09°04W*	*703 m*	*Recover CTD0746*	
1131	*61°49N, 09°01W*	*619 m*	*Launch XCP4562*	*Ch. 12. Good profile approaching Cr10*
1148	*61°49N, 09°01W*	*630 m*	*Deploy CTD077*	*Station Cr10*
1214	*61°49N, 09°01W*	*643 m*	*Recover CTD077*	
1300	*61°52N, 08°58W*	*630 m*	*Deploy CTD078*	*Station Cr11*
1325	*61°52N, 08°58W*	*568 m*	*Recover CTD078*	
1335	*61°52N, 08°59W*	*570 m*	*Launch XCP4562*	*Ch. 12. Good profile leaving Cr12*
1416	*61°55N, 08°55W*	*499 m*	*Deploy CTD079*	*Station Cr12*
1443	*61°54N, 08°55W*	*499 m*	*Recover CTD079*	
1450	*61°54N, 08°55W*	*500 m*	*Under way*	*Steaming to site on Section B for EM-POGO*
1648	*61°35N, 08°39W*	*881 m*	*EMPOGO Station*	*EMPOGO testing*
1923	*61°35N, 08°41W*	*Various*	*Underway*	*Transit to Section G*
2316	*61°01N, 07°53W*	*302 m*	*Deploy CTD080*	*Start station G1*
2335	*61°01N, 07°53W*	*299 m*	*Recover CTD080*	

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			18 June 2000	
0008	*61°02N, 07°47W*	*815 m*	*Deploy CTD081*	*Start station G2*
0052	*61°02N, 07°47W*	*825 m*	*Recover CTD081*	
0100	*61°02N, 07°47W*	*865 m*	*Launch XCP4564*	*Ch. 16. Good profile leaving station G2*
0128	*61°02N, 07°42W*	*938 m*	*Launch XCP4565*	*Ch. 12. Good profile at station G3*
0139	*61°02N, 07°42W*	*939 m*	*Deploy CTD082*	*Station G3*
0229	*61°02N, 07°42W*	*938 m*	*Recover CTD082*	
0300	*61°03N, 07°36W*	*905 m*	*Launch XCP4566*	*Ch. 14. Good profile at station G4*
0314	*61°03N, 07°37W*	*909 m*	*Deploy CTD083*	*Station G4*
0405	*61°03N, 07°36W*	*910 m*	*Recover CTD083*	
0442	*61°04N, 07°31W*	*875 m*	*Launch XCP4567*	*Ch. 16. Good profile at station G5*
0452	*61°03N, 07°32W*	*879 m*	*Deploy CTD084*	*Station G5*
0534	*61°03N, 07°32W*	*881 m*	*Recover CTD084*	
0621	*61°04N, 07°26W*	*848 m*	*Launch XCP4568*	*Ch. 12. Good profile at station G6*
0634	*61°04N, 07°26W*	*854 m*	*Deploy CTD085*	*Station G6*
0716	*61°04N, 07°26W*	*854 m*	*Recover CTD085*	
0803	*61°05N, 07°20W*	*778 m*	*Launch XCP4569*	*Ch. 14. Good profile at station G7*
0818	*61°05N, 07°21W*	*784 m*	*Deploy CTD086*	*Station G7*
0900	*61°05N, 07°21W*	*792 m*	*Recover CTD086*	
0936	*61°05N, 07°20W*	*792 m*	*Deploy EMPOGO*	*EMP009. First EM-POGO station*
1028	*61°05N, 07°19W*	*792 m*	*Recover EMPOGO*	*Back aboard.*
1057	*61°06N, 07°15W*	*597 m*	*Launch XCP4570*	*Ch. 12. Good profile at station G8*
1110	*61°05N, 07°15W*	*590 m*	*Deploy CTD087*	*Station G8*
1142	*61°05N, 07°14W*	*589 m*	*Recover CTD087*	
1221	*61°06N, 07°10W*	*350 m*	*Deploy CTD088*	*Station G9*
1244	*61°06N, 07°09W*	*349m*	*Recover CTD088*	
1504	*61°14N, 07°54W*	*Various*	*Underway*	*Transit to Section A*
1633	*61°18N, 08°17W*	*406 m*	*Deploy CTD089*	*Start station Arr1*
1653	*61°18N, 08°17W*	*401 m*	*Recover CTD089*	
1725	*61°19N, 08°16W*	*520 m*	*Deploy CTD090*	*Start station Arr2*
1748	*61°19N, 08°15W*	*524 m*	*Recover CTD090*	
1806	*61°19N, 08°15W*	*524 m*	*Launch XCP4571*	*Ch. 12. Good profile leaving station Arr2*
1841	*61°21N, 08°14W*	*695 m*	*Launch XCP4572*	*Ch. 14. Good profile at station Arr3*
1858	*61°20N, 08°14W*	*661 m*	*Deploy CTD091*	*Station Arr2*
1920	*61°20N, 08°13W*	*670 m*	*Recover CTD091*	
2006	*61°22N, 08°12W*	*843 m*	*Launch XCP4573*	*Ch. 16. Good profile at station Arr4*
2020	*61°21N, 08°12W*	*848 m*	*Deploy CTD092*	*Station Arr4*
2059	*61°21N, 08°11W*	*847 m*	*Recover CTD092*	
2122	*61°21N, 08°11W*	*847 m*	*Deploy RAFOS*	*RAFOS 580 - successful.*
2148	*61°23N, 08°10W*	*816 m*	*Launch XCP4574*	*Ch. 12. Good profile at station Arr5*
2201	*61°23N, 08°10W*	*833 m*	*Deploy CTD093*	*Station Arr5*
2245	*61°22N, 08°09W*	*842 m*	*Recover CTD093*	
2259	*61°22N, 08°09W*	*837 m*	*Deploy RAFOS*	*RAFOS 588 - copper wire*
2334	*61°24N, 08°08W*	*778 m*	*Launch XCP4575*	*Ch. 14. Good profile at station Arr6*
2350	*61°24N, 08°08W*	*792 m*	*Deploy CTD094*	*Station Arr6*

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			19 June 2000	
0031	*61°23N, 08°07W*	*796 m*	*Recover CTD094*	
0059	*61°25N, 08°06W*	*651 m*	*Launch XCP4576*	*Ch. 16. Good profile at station Arr7*
0112	*61°25N, 08°06W*	*690 m*	*Deploy CTD095*	*Station Arr7*
0142	*61°25N, 08°06W*	*694 m*	*Recover CTD095*	
0210	*61°26N, 08°04W*	*480 m*	*Launch XCP4577*	*Ch. 12. Good profile at station Arr8*
0219	*61°26N, 08°04W*	*512 m*	*Deploy CTD096*	*Station Arr8*
0247	*61°26N, 08°05W*	*504 m*	*Recover CTD096*	*Completes section Arr*
0250	*61°26N, 08°05W*	*Various*	*Underway*	*Transit to section H*
0710	*60°48N, 08°21W*	*248 m*	*Deploy CTD097'*	*Starts station H1*
0724	*60°48N, 08°21W*	*245 m*	*Recover CTD097*	
0951	*60°44N, 08°12W*	*776 m*	*CTD098*	*Aborted at H2, CTD problem; reterminating wire*
1008	*60°44N, 08°10W*	*810 m*	*Launch XCP4578*	*Ch. 14. Good profile at station H2*
1105	*60°44N, 08°10W*	*809 m*	*Launch EMPOGO*	*EMP010. Ac. on but no radio; other problems*
1131	*60°44N, 08°11W*	*809 m*	*Recover EMPOGO*	*Surfaced abeam. On board shortly after.*
1345	*60°45N, 08°10W*	*809 m*	*U/W ADCP run*	*Start of ADCP box survey; c/270°*
1457	*60°45N, 08°09W*	*809 m*	*U/W ADCP run*	*End of ADCP box survey; c/270°*
1519	*60°44N, 08°10W*	*816 m*	*Deploy CTD099*	*Station H2 repeat.*
1553	*60°43N, 08°10W*	*824 m*	*Recover CTD099*	
1652	*60°39N, 08°01W*	*938 m*	*Deploy CTD100*	*Station H3*
1734	*60°39N, 08°00W*	*939 m*	*Recover CTD100*	
1833	*60°35N, 07°52W*	*989 m*	*Deploy CTD101*	*Station H4*
1922	*60°34N, 07°52W*	*988 m*	*Recover CTD101*	
2011	*60°31N, 07°42W*	*1034 m*	*Deploy CTD102*	*Station H5*
2059	*60°30N, 07°42W*	*1036 m*	*Recover CTD102*	
2159	*60°26N, 07°33W*	*1067 m*	*Deploy CTD103*	*Station H6*
2247	*60°26N, 07°33W*	*1068 m*	*Recover CTD103*	
2345	*60°24N, 07°23W*	*1087 m*	*Deploy CTD104*	*Station H7*
			20 June 2000	
0034	*60°24N, 07°24W*	*1092 m*	*Recover CTD104*	
0129	*60°29N, 07°15W*	*1064 m*	*Deploy CTD105*	*Station H8*
0214	*60°29N, 07°15W*	*1059 m*	*Recover CTD105*	
0301	*60°33N, 07°07W*	*921 m*	*Launch XCP4579*	*Ch. 12. Good profile at station H9*
0315	*60°34N, 07°06W*	*901 m*	*Deploy CTD106*	*Station H9*
0358	*60°33N, 07°07W*	*901 m*	*Recover CTD106*	
0517	*60°38N, 06°59W*	*606 m*	*Launch XCP4580*	*Ch. 14. Good profile at station H10*
0525	*60°38N, 06°58W*	*559 m*	*Deploy CTD107*	*Station H10*
0559	*60°39N, 06°58W*	*552 m*	*Recover CTD107*	
0700	*60°43N, 06°51W*	*254 m*	*Deploy CTD108*	*Station H11*
0717	*60°43N, 06°51W*	*255 m*	*Recover CTD108*	
0827	*60°38N, 06°58W*	*544 m*	*Deploy CTD109*	*Station H10 repeat TS1*
0852	*60°38N, 06°57W*	*544 m*	*Recover CTD109*	
1014	*60°34N, 07°06W*	*909 m*	*Deploy CTD110*	*Station H9 repeat TS1*
1052	*60°34N, 07°06W*	*902 m*	*Recover CTD110*	
1201	*60°38N, 06°58W*	*559 m*	*Deploy CTD111*	*Station H10 repeat TS2*
1226	*60°38N, 06°58W*	*563 m*	*Recover CTD111*	
1357	*60°34N, 07°07W*	*914 m*	*Deploy CTD112*	*Station H9 repeat TS2*
1434	*60°34N, 07°07W*	*913 m*	*Recover CTD112*	

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			20 June 2000 (cont.)	
1534	60°38N, 06°59W	579 m	Deploy CTD113	Station H10 repeat TS3
1603	60°38N, 06°59W	579 m	Recover CTD113	
1745	60°33N, 07°07W	915 m	Deploy CTD114	Station H9 repeat TS3
1827	60°33N, 07°06W	915 m	Recover CTD114	
1939	60°28N, 07°16W	1074 m	Deploy CTD115	Station Hr8
2042	60°28N, 07°15W	1071 m	Recover CTD115	
2151	60°23N, 07°24W	1016 m	Deploy CTD116	Station Hr7
2238	60°23N, 07°23W	981 m	Recover CTD116	
2342	60°18N, 07°34W	974 m	Deploy CTD117	Station Hr6
			21 June 2000	
0032	60°18N, 07°35W	952 m	Recover CTD117	
0131	60°13N, 07°45W	652 m	Deploy CTD118	Station Hr5
0204	60°13N, 07°46W	647 m	Recover CTD118	
0209	60°13N, 07°46W	649 m	Launch XCP4581	Ch. 12. Good profile at station Hr5
0408	60°23N, 07°25W	1012 m	Deploy CTD119	Station Hrr7
0518	60°23N, 07°26W	1027 m	Recover CTD119	
0618	60°18N, 07°34W	956 m	Deploy CTD120	Station Hr6
0703	60°18N, 07°36W	926 m	Recover CTD120	
0811	60°11N, 07°45W	637 m	Deploy CTD121	Station Hrr5
0844	60°11N, 07°44W	642 m	Recover CTD121	
0851	60°11N, 07°44W	644 m	Launch XCP4582	Ch. 14. Good profile at station Hrr5
0953	60°07N, 07°51W	756 m	Deploy CTD122	Station Hr4
1026	60°07N, 07°50W	750 m	Recover CTD122	
1113	60°10N, 07°45W	630 m	Deploy CTD123	Station Hrrr5
1141	60°10N, 07°44W	640 m	Recover CTD123	
1200	60°10N, 07°44W	640 m	Launch EMPOGO	Drop 011 aborted at the rail.
1210	60°10N, 07°44W	Various	Underway	Transit to Section I
2223	60°27N, 04°00W	490 m	Deploy CTD124	Station I1
2251	60°27N, 03°58W	482 m	Recover CTD124	
2350	60°31N, 04°09W	702 m	Deploy CTD125	Station I2
			22 June 2000	
0027	60°31N, 04°07W	699 m	Recover CTD125	
0121	60°35N, 04°18W	1036 m	Deploy CTD126	Station I3
0213	60°35N, 04°17W	1028 m	Recover CTD126	
0309	60°38N, 04°26W	1094 m	Deploy CTD127	Station I4
0402	60°38N, 04°26W	1094 m	Recover CTD127	
0512	60°42N, 04°35W	1128 m	Deploy CTD128	Station I5
0603	60°42N, 04°35W	1128 m	Recover CTD128	
0700	60°45N, 04°43W	1117 m	Deploy CTD129	Station I6
0752	60°45N, 04°43W	1117 m	Recover CTD129	
0852	60°48N, 04°50W	1018 m	Deploy CTD130	Station I7
0940	60°49N, 04°51W	1010 m	Recover CTD130	
1043	60°52N, 04°59W	941 m	Deploy CTD131	Station I8
1126	60°52N, 05°00W	933 m	Recover CTD131	
1226	60°55N, 05°07W	826 m	Deploy CTD132	Station I9
1305	60°55N, 05°07W	824 m	Recover CTD132	

Log of Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			22 June 2000 (cont.)	
1444	60°48N, 04°50W	1016 m	Deploy CTD133	Station Ir7
1524	60°49N, 04°50W	1019 m	Recover CTD133	
1629	60°52N, 04°58W	949 m	Deploy CTD134	Station Ir8
1711	60°51N, 04°58W	950 m	Recover CTD134	
1829	60°55N, 05°08W	818 m	Deploy CTD135	Station Ir9
1904	60°55N, 05°09W	818 m	Recover CTD135	
2007	60°59N, 05°15W	652 m	Deploy CTD136	Station I10
2045	60°59N, 05°15W	656 m	Recover CTD136	
2136	61°02N, 05°22W	360 m	Deploy CTD137	Station I11
2156	61°02N, 05°22W	360 m	Recover CTD137	Finish Section I; underway for Section J
			23 June 2000	
0937	62°19N, 04°15W	325 m	Deploy CTD138	Station J1
0953	62°19N, 04°15W	330 m	Recover CTD138	
1112	62°25N, 04°12W	489 m	Deploy CTD139	Station J2
1135	62°25N, 04°12W	494 m	Recover CTD139	
1200	62°27N, 04°12W	494 m	Hove To	Suspended operations for bad wx
1530	62°34N, 04°10W	494 m	Underway	Heading for J3 now
1721	62°32N, 04°10W	655 m	Deploy CTD140	Station J3
1751	62°32N, 04°10W	655 m	Recover CTD140	
1937	62°40N, 04°08W	848 m	Launch XCP4583	Ch. 12 rebuilt; near Station J4
1949	62°40N, 04°07W	847 m	Deploy CTD141	Station J4
2029	62°40N, 04°08W	857 m	Recover CTD141	
2126	62°45N, 04°06W	1008 m	Deploy CTD142	Station J5
2211	62°45N, 04°06W	1033 m	Recover CTD142	
2310	62°50N, 04°04W	1287 m	Deploy CTD143	Station J6
			24 June 2000	
0009	62°51N, 04°03W	1297 m	Recover CTD143	
0048	62°54N, 04°03W	1515 m	Deploy CTD144	Station J7
0153	62°54N, 04°02W	1526 m	Recover CTD144	
0238	62°56N, 04°02W	1992 m	Deploy CTD145	Station J8
0406	62°56N, 04°00W	1901 m	Recover CTD145	
0452	63°00N, 04°06W	2284 m	Deploy CTD146	Station J9
0630	63°00N, 04°00W	2240 m	Recover CTD146	
0721	63°04N, 04°01W	2504 m	Deploy CTD147	Station J10
0900	63°04N, 04°02W	2509 m	Recover CTD147	
1022	63°12N, 03°58W	2554 m	Deploy CTD148	Station J11
1200	63°13N, 03°59W	2554 m	Recover CTD148	
1327	63°21N, 03°55W	2766 m	Deploy CTD149	Station J12
1515	63°21N, 03°56W	2753 m	Recover CTD149	Section J finished. On to mooring.
1700	63°15N, 04°34W	2570 m	Transit	Enroute to Mooring Site 'M'

Log of Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			25 June 2000	
0000	*62°46N, 07°21W*	*<1000 m*	*Transit*	*Enroute to Mooring Site 'M'*
0935	*62°08N, 11°00W*	*1000 m*	*Mooring*	*Mooring released. Surfaced 3 min later..*
1100	*62°08N, 11°03W*	*1000 m*	*Mooring*	*Last of mooring lines aboard. u/w for section A*
1215	*62°02N, 10°42W*	*990 m*	*Deploy EMPOGO*	*EMP011c aborted at the rail - no GPS.*
1929	*61°18N, 08°18W*	*398 m*	*Deploy CTD150*	*Station Arrr1*
1954	*61°18N, 08°18W*	*398 m*	*Recover CTD150*	
2013	*61°19N, 08°16W*	*506 m*	*Launch XCP4584*	*Ch. 16 Deep. Good Profile near Arrr2*
2025	*61°19N, 08°16W*	*550 m*	*Deploy CTD151*	*Station Arrr2*
2051	*61°19N, 08°16W*	*555 m*	*Recover CTD151*	
2111	*61°20N, 08°15W*	*609 m*	*Launch XCP4585*	*Ch. 14 Deep. Good Profile near Arrr3*
2122	*61°20N, 08°14W*	*620 m*	*Deploy CTD152*	*Station Arrr3*
2154	*61°20N, 08°14W*	*618 m*	*Recover CTD152*	
2213	*61°21N, 08°12W*	*849 m*	*Launch XCP4586*	*Ch. 12 Deep. Good Profile near Arrr4*
2223	*61°21N, 08°12W*	*848 m*	*Deploy CTD153*	*Station Arrr4*
2259	*61°21N, 08°13W*	*847 m*	*Recover CTD153*	
2318	*61°22N, 08°11W*	*835 m*	*Launch XCP4587*	*Ch. 16 Deep. Good Profile near Arrr5*
2333	*61°23N, 08°10W*	*848 m*	*Deploy CTD154*	*Station Arrr5*
			26 June 2000	
0008	*61°23N, 08°09W*	*820 m*	*Recover CTD154*	
0037	*61°24N, 08°08W*	*807 m*	*Launch XCP4588*	*Ch. 14 Deep. Very noisy. Near Arrr6*
0054	*61°24N, 08°08W*	*799 m*	*Deploy CTD155*	*Station Arrr6*
0128	*61°24N, 08°08W*	*786 m*	*Recover CTD155*	
0157	*61°25N, 08°06W*	*719 m*	*Launch XCP4589*	*Ch. 12 Deep. Mostly good. Near Arrr7*
0208	*61°25N, 08°06W*	*679 m*	*Deploy CTD156*	*Station Arrr7*
0240	*61°25N, 08°06W*	*661 m*	*Recover CTD156*	
0306	*61°26N, 08°04W*	*574 m*	*Launch XCP4590*	*Ch. 16 Deep. Good profile. Near Arrr8*
0315	*61°26N, 08°04W*	*523 m*	*Deploy CTD157*	*Station Arrr8*
0342	*61°26N, 08°03W*	*523 m*	*Recover CTD157*	
0433	*61°28N, 08°02W*	*336 m*	*Deploy CTD158*	*Station Arrr9*
0453	*61°27N, 08°02W*	*338 m*	*Recover CTD158*	
0544	*61°24N, 08°08W*	*796 m*	*Deploy CTD159*	*Time series begins. Station Arrr6.1*
0618	*61°24N, 08°09W*	*804 m*	*Recover CTD159*	
0620	*61°24N, 08°09W*	*804 m*	*Deploy CTD160*	*Station Arrr6.1 still.*
0655	*61°24N, 08°09W*	*795 m*	*Recover CTD160*	
0821	*61°21N, 08°12W*	*846 m*	*Deploy CTD161*	*Station Arrr4.1*
0856	*61°22N, 08°12W*	*846 m*	*Recover CTD161*	
0944	*61°24N, 08°08W*	*792 m*	*Deploy CTD162*	*Station Arrr6.2*
1011	*61°24N, 08°09W*	*773 m*	*Recover CTD162*	
1015	*61°24N, 08°09W*	*767 m*	*Deploy CTD163*	*Station Arrr6.2(2)*
1047	*61°25N, 08°09W*	*767 m*	*Recover CTD163*	
1133	*61°22N, 08°12W*	*839 m*	*Deploy CTD164*	*Station Arrr4.2*
1207	*61°22N, 08°13W*	*840 m*	*Recover CTD164*	
1252	*61°24N, 08°08W*	*794 m*	*Deploy CTD165*	*Station Arrr6.3*
1319	*61°24N, 08°08W*	*794 m*	*Recover CTD165*	
1323	*61°24N, 08°08W*	*776 m*	*Deploy CTD166*	*Station Arrr6.3(2)*
1356	*61°25N, 08°09W*	*774 m*	*Recover CTD166*	

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			26 June 2000 (cont.)	
1448	*61°21N, 08°12W*	*847 m*	*Deploy CTD167*	*Station Arrr4.3*
1522	*61°21N, 08°12W*	*847 m*	*Recover CTD167*	
1602	*61°24N, 08°08W*	*801 m*	*Deploy CTD168*	*Station Arrr6.4*
1631	*61°24N, 08°08W*	*796 m*	*Recover CTD168*	
1634	*61°24N, 08°08W*	*789 m*	*Deploy CTD169*	*Station Arrr6.4(2)*
1706	*61°24N, 08°08W*	*789 m*	*Recover CTD169*	
1749	*61°21N, 08°12W*	*848 m*	*Deploy CTD170*	*Station Arrr4.4*
1824	*61°22N, 08°12W*	*848 m*	*Recover CTD170*	
1905	*61°24N, 08°08W*	*798 m*	*Deploy CTD171*	*Station Arrr6.5*
1935	*61°24N, 08°08W*	*798 m*	*Recover CTD171*	
1936	*61°24N, 08°08W*	*795 m*	*Deploy CTD172*	*Station Arrr6.5(2)*
2010	*61°24N, 08°09W*	*795 m*	*Recover CTD172*	*Time series ends. u/w for N end of Sec. C*
			27 June 2000	
0022	*61°58N, 08°52W*	*423 m*	*Deploy CTD173*	*Station Crr0; N end of Section C*
0047	*61°58N, 08°51W*	*423 m*	*Recover CTD173*	
0123	*61°55N, 08°55W*	*495 m*	*Launch XCP4591*	*Ch. 12. Good profile near Crr1*
0133	*61°55N, 08°55W*	*499 m*	*Deploy CTD174*	*Station Crr1*
0157	*61°55N, 08°55W*	*497 m*	*Recover CTD174*	
0228	*61°53N, 08°58W*	*561 m*	*Launch XCP4592*	*Ch. 14. Good profile near Crr2*
0241	*61°52N, 08°59W*	*579 m*	*Deploy CTD175*	*Station Crr2*
0310	*61°52N, 08°59W*	*579 m*	*Recover CTD175*	
0336	*61°50N, 09°01W*	*623 m*	*Launch XCP4593*	*Ch. 12. Good profile near Crr3*
0350	*61°50N, 09°02W*	*630 m*	*Deploy CTD176*	*Station Crr3*
0418	*61°49N, 09°01W*	*632 m*	*Recover CTD176*	
0448	*61°47N, 09°04W*	*690 m*	*Launch XCP4594*	*Ch. 14. Good profile near Crr4*
0459	*61°47N, 09°05W*	*698 m*	*Deploy CTD177*	*Station Crr4*
0529	*61°46N, 09°05W*	*704 m*	*Recover CTD177*	
0616	*61°44N, 09°08W*	*770 m*	*Deploy CTD178*	*Station Crr5 begins*
0648	*61°44N, 09°09W*	*772 m*	*Recover CTD178*	
0702	*61°44N, 09°10W*	*780 m*	*Launch XCP4595*	*Ch. 12.'hand-held' Good profile.*
0747	*61°41N, 09°11W*	*819 m*	*Deploy CTD179*	*Station Crr6 begins*
0823	*61°41N, 09°11W*	*820 m*	*Recover CTD179*	
0836	*61°41N, 09°11W*	*827 m*	*Launch XCP4596*	*Ch. 16.'hand-held' Good profile.*
0908	*61°39N, 09°14W*	*856 m*	*Deploy CTD180*	*Station Crr7 begins*
0946	*61°38N, 09°14W*	*855 m*	*Recover CTD180*	
0955	*61°38N, 09°14W*	*851 m*	*Launch XCP4597*	*Ch. 12.'hand-held' Good profile.*
1026	*61°36N, 09°17W*	*834 m*	*Launch XCP4598*	*Ch. 16. Deep, Good profile; ship too slow.*
1039	*61°36N, 09°17W*	*828 m*	*Deploy CTD181*	*Station Crr8 begins*
1117	*61°36N, 09°17W*	*827 m*	*Recover CTD181*	
1151	*61°33N, 09°15W*	*831 m*	*Launch XCP4599*	*Ch. 12. Deep, Good profile*
1203	*61°33N, 09°14W*	*836 m*	*Deploy CTD182*	*Station Crr9 begins*
1240	*61°33N, 09°13W*	*803 m*	*Recover CTD182*	
1318	*61°30N, 09°12W*	*694 m*	*Launch XCP4600*	*Ch. 14. Deep, Good profile*
1330	*61°30N, 09°12W*	*700 m*	*Deploy CTD183*	*Station Crr10 begins; S end of Section C*
1359	*61°30N, 09°12W*	*700 m*	*Recover CTD183*	*Steam to S end of Section D*

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			27 June 2000 (cont.)	
1712	*61°31N, 09°33W*	*970 m*	*Deploy CTD184*	*Station Dr1 begins, S end of Section D*
1750	*61°31N, 09°32W*	*970 m*	*Recover CTD184*	
1908	*61°34N, 09°46W*	*1077 m*	*Deploy CTD185*	*Station Dr2 begins,*
1954	*61°34N, 09°45W*	*1064 m*	*Recover CTD185*	
2109	*61°36N, 10°00W*	*1084 m*	*Deploy CTD186*	*Station Dr3 begins,*
2200	*61°36N, 10°00W*	*1188 m*	*Recover CTD186*	
2245	*61°40N, 09°56W*	*1154 m*	*Deploy CTD187*	*Station Dr4 begins,*
2335	*61°39N, 09°55W*	*1164 m*	*Recover CTD187*	
2343	*61°39N, 09°55W*	*1163 m*	*Launch XCP4601*	*Ch. 14. Deep, Good profile, going slow.*
			28 June 2000	
0033	*61°43N, 09°51W*	*1045 m*	*Launch XCP4602*	*Ch. 16. Deep. Near Dr5*
0043	*61°43N, 09°50W*	*1043 m*	*Deploy CTD188*	*Station Dr5*
0131	*61°43N, 09°50W*	*1044 m*	*Recover CTD188*	
0220	*61°47N, 09°46W*	*951 m*	*Launch XCP4603*	*Ch. 12. Deep. Noisy profile. Near Dr6*
0232	*61°47N, 09°46W*	*954 m*	*Deploy CTD189*	*Station Dr6*
0315	*61°47N, 09°46W*	*951 m*	*Recover CTD189*	
0358	*61°51N, 09°41W*	*827 m*	*Launch XCP4604*	*Ch. 14. Deep. Near Dr7*
0416	*61°50N, 09°41W*	*822 m*	*Deploy CTD190*	*Station Dr7*
0454	*61°51N, 09°42W*	*827 m*	*Recover CTD190*	
0544	*61°54N, 09°36W*	*731 m*	*Launch XCP4605*	*Ch. 16. Deep. Good profile, Hi VERR. Near Dr8*
0552	*61°54N, 09°36W*	*724 m*	*Deploy CTD191*	*Station Dr8*
0626	*61°54N, 09°36W*	*723 m*	*Recover CTD191*	
0716	*61°57N, 09°32W*	*683 m*	*Launch XCP4606*	*Ch. 12. Deep. Good profile. Near Dr9*
0727	*61°57N, 09°31W*	*661 m*	*Deploy CTD192*	*Station Dr9*
0758	*61°57N, 09°31W*	*668 m*	*Recover CTD192*	
0848	*62°01N, 09°27W*	*578 m*	*Deploy CTD193*	*Station Dr10*
0914	*62°01N, 09°26W*	*578 m*	*Recover CTD193*	
1005	*62°02N, 09°18W*	*509 m*	*Deploy CTD194*	*Station Dr11*
1027	*62°02N, 09°18W*	*508 m*	*Recover CTD194*	*Transit to N end of Section Er*
1322	*62°23N, 09°55W*	*637 m*	*Deploy CTD195*	*Station Er1 at N end of section*
1350	*62°23N, 09°55W*	*637 m*	*Recover CTD195*	
1357	*62°23N, 09°55W*	*638 m*	*Launch XCP4607*	*Ch. 14. Deep. Good profile. Leaving Er1*
1457	*62°17N, 10°04W*	*738 m*	*Launch XCP4608*	*Ch. 16. Deep. Good profile. Near Er2*
1508	*62°17N, 10°04W*	*738 m*	*Deploy CTD196*	*Station Er2*
1538	*62°17N, 10°03W*	*742m*	*Recover CTD196*	
1649	*62°11N, 10°12W*	*846 m*	*Launch XCP4609*	*Ch. 14. Deep. low S/N OK profile. Near Er3*
1702	*62°11N, 10°12W*	*849 m*	*Deploy CTD197*	*Station Er3*
1740	*62°11N, 10°11W*	*849 m*	*Recover CTD197*	
1854	*62°05N, 10°21W*	*827 m*	*Launch XCP4610*	*Ch. 12. Deep. Good profile. Near Er4*
1900	*62°04N, 10°20W*	*843 m*	*Deploy EMPOGO*	*011d almost. GPS unreliable. Drop cancelled.*
1914	*62°05N, 10°21W*	*843 m*	*Deploy CTD198*	*Station Er4*
1953	*62°04N, 10°20W*	*846 m*	*Recover CTD198*	
2052	*61°59N, 10°29W*	*958 m*	*Launch XCP4611*	*Ch. 14. Deep. Good profile. Near Er5*
2103	*61°59N, 10°29W*	*956 m*	*Deploy CTD199*	*Station Er5*
2146	*61°58N, 10°29W*	*950 m*	*Recover CTD199*	

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			28 June 2000 (cont.)	
2241	*61°53N, 10°38W*	*1034 m*	*Launch XCP4612*	*Ch. 16. Deep. Near Er6*
2254	*61°53N, 10°38W*	*1042 m*	*Deploy CTD200*	*Station Er6*
2336	*61°52N, 10°38W*	*1054 m*	*Recover CTD200*	
			29 June 2000	
0027	*61°46N, 10°40W*	*1217 m*	*Launch XCP4613*	*Ch. 12. Deep.Very very noisy. Near Er7*
0040	*61°46N, 10°40W*	*1232 m*	*Deploy CTD201*	*Station Er7*
0131	*61°45N, 10°41W*	*1239 m*	*Recover CTD201*	
0228	*61°39N, 10°40W*	*1315 m*	*Launch XCP4614*	*Ch. 14. Deep. Good profile. Near Er8*
0239	*61°38N, 10°40W*	*1312 m*	*Deploy CTD202*	*Station Er8*
0336	*61°38N, 10°40W*	*1312 m*	*Recover CTD202*	
0439	*61°31N, 10°40W*	*1249 m*	*Launch XCP4615*	*Ch. 16. Deep. Good profile. Near Er9*
0451	*61°31N, 10°40W*	*1241 m*	*Deploy CTD203*	*Station Er9*
0549	*61°31N, 10°39W*	*1228 m*	*Recover CTD203*	*Line Er ends. Transit to Ir*
1447	*61°02N, 7°42W*	*942 m*	*Launch XCP4616*	*Ch. 12. Deep. Good profile. Near G3; no CTD*
1511	*61°03N, 7°37W*	*914 m*	*Launch XCP4617*	*Ch. 16. Deep. Good profile. Near G4; no CTD*
1537	*61°04N, 7°31W*	*877 m*	*Launch XCP4618*	*Ch. 12. Deep. Good profile. Near G5; no CTD*
1603	*61°04N, 7°26W*	*852 m*	*Launch XCP4619*	*Ch. 14. Deep. Good profile. Near G6; no CTD*
1630	*61°05N, 7°21W*	*792 m*	*Launch XCP4620*	*Ch. 12. Deep. low S/N profile. Near G7; no CTD*
1630	*61°05N, 7°21W*	*792 m*	*Under way*	*Transit to Section Ir*
2157	*61°02N, 5°23W*	*351 m*	*Deploy CTD204*	*Station Ir1*
2217	*61°02N, 5°22W*	*354 m*	*Recover CTD204*	
2307	*60°59N, 5°15W*	*662 m*	*Deploy CTD205*	*Station Ir2*
2338	*60°58N, 5°15W*	*662 m*	*Recover CTD205*	
			30 June 2000	
0038	*60°55N, 5°07W*	*824 m*	*Deploy CTD206*	*Station Ir3*
0118	*60°55N, 5°08W*	*824 m*	*Recover CTD206*	
0215	*60°52N, 4°58W*	*941 m*	*Deploy CTD207*	*Station Ir4*
0258	*60°52N, 4°58W*	*941 m*	*Recover CTD207*	
0352	*60°48N, 4°51W*	*1015 m*	*Deploy CTD208*	*Station Ir5*
0436	*60°48N, 4°51W*	*1010 m*	*Recover CTD208*	
0559	*60°45N, 4°44W*	*1112 m*	*Deploy CTD209*	*Station Ir6*
0646	*60°46N, 4°44W*	*1110 m*	*Recover CTD209*	
0755	*60°42N, 4°35W*	*1131 m*	*Deploy CTD210*	*Station Ir7*
0840	*60°43N, 4°35W*	*1131 m*	*Recover CTD210*	
1013	*60°37N, 4°23W*	*798 m*	*Deploy CTD211*	*Station Ir8*
1057	*60°37N, 4°23W*	*1092 m*	*Recover CTD211*	
1144	*60°34N, 4°18W*	*1028 m*	*Deploy CTD212*	*Station Ir9; moved from drifting buoy*
1224	*60°34N, 4°18W*	*1028 m*	*Recover CTD212*	
1322	*60°31N, 4°09W*	*722 m*	*Deploy CTD213*	*Station Ir10*
1354	*60°31N, 4°10W*	*722 m*	*Recover CTD213*	
1506	*60°27N, 4°00W*	*491 m*	*Deploy CTD214*	*Station Ir11*
1527	*60°27N, 4°00W*	*495 m*	*Recover CTD214*	
1629	*60°24N, 3°52W*	*392 m*	*Deploy CTD215*	*Station Ir12*
1651	*60°24N, 3°52W*	*400 m*	*Recover CTD215*	
1750	*60°20N, 3°44W*	*237 m*	*Deploy CTD216*	*Station Ir13*
1801	*60°20N, 3°44W*	*237 m*	*Recover CTD216*	

Log of Science Operations

Time (UTC)	Position (lat, long)	Depth	Operation	Comments
			30 June 2000 (cont.)	
1846	*60°18N, 3°38W*	*146 m*	*Deploy CTD217*	*Station Ir14; last station*
1854	*60°18N, 3°38W*	*145 m*	*Recover CTD217*	*Group picture taken around CTD*
1917	*60°18N, 3°38W*	*146 m*	*Transit*	*Depart for Glasgow*
			1 July 2000	
1005	*57°57N, 6°20W*	*114 m*	*Transit*	*Underway for Glasgow*
1405	*57°16N, 6°47W*	*117 m*	*ADCP Cal.*	*Begin cal. run: 4 kts, 1/2 hr. legs*
1537	*57°12N, 6°49W*	*121 m*	*ADCP Cal.*	*End calibration run. Science completed.*

Appendix B/start

R.R.S. DISCOVERY

CRUISE TIMETABLE OF EVENTS D247/00 Robin Plumley

Date	Time (LT)	Event
31/05/00		Complete de-mobilisation for D246.
01/06/00		Radio survey completed by GEC-Marconi. Commence mobilisation for D247.
	1300	Scientific party join vessel. Basic Safety Familiarisation briefing completed for non-RVSM personnel joining in Southampton.
02/06/00		Continue mobilisation.
03/06/00		Continue mobilisation. Peto engineer attends v/l for Emergency generator breaker work.
	1230	Sperry engineer attends v/l for VMS work.
	1347	Failure of element in aft hangar crane motor/gearbox unit.
04/06/00		Continue mobilisation.
	1200	Dunlop Hiflex engineer attends v/l for crane inspection.
	1400-1700	Ship's engineers and deck ratings remove crane motor/gearbox unit.
05/06/00	0930	Dunlop Hiflex engineer attends v/l to blank off m/g unit pipework ends. Wrong fittings results in delay to sailing allied with failure of customs office to endorse equipment documentation.
	1049	Pilot on board.
	1139	Commence singling up.
	1146	Clear of berth.
	1158	Clear of Empress Dock.
	1255	Pilot away.
	1418	Clear of Needles Channel.
	1615-1630	Emergency Drill and Boat Muster.
06/06/00	0500-0535	Transit Land's End TSS.
	1025-1115	CTD test in 51-01.3N 5-53.4W
	1445-1600	Transit Small's TSS.
07/06/00	0200	Clocks retarded to GMT.
	0900-1020	Cruise Planning meeting.
	0900-1200	Transit North Channel TSS.
	1030-1109	CTD test in 55-21.9N 5-55.5W
	1039	PES deployed.
08/06/00	2358-	
09/06/00	0003	XCP launched 61-34.6N 9-39.5W
	0017-0126	CTD in 61-34.5N 9-39.9W
	0155-0638	Reposition to mooring site "M".
	0650-0800	Acoustic test in 62-07.8N 11-03.7W
	0808-0933	Deploy Sound Source mooring "M" in 62-07.91N 10-59.72W
	0936-1048	Acoustic survey of mooring position.
	1048-2124	Reposition to Section A .
	2124	Commence Section A in 61-26.7N 8-04.1W
10/06/00	0656	Complete Section A in 61-19.4N 8-18.4W
	0707-0857	Reposition to Section B .
	0857	Commence Section B in 61-26.9N 8-45.5W

	2342	Complete Section B in 61-44.4N 8-30.2W
	2342-	
11/06/00	0149	Reposition to Section C .
	0149	Commence Section C in 61-55.1N 8-54.5W
	2136	Complete Section C in 61-23.0N 9-07.3W
	2330-	
12/06/00	0200	CTD winch down time due to overheating hydraulic oil.
	0202	Commence Section D in 61-30.5N 9-33.1W
	1316	Severe storm warning received from Bracknell Met.
	1545	Decision made to seek shelter.

	1606	Stop science in 61-53.9N 9-37.7W and proceed towards N end of Faeroe Islands.
	2359	In sheltered waters to N of Faeroe Islands.
13/06/00	1000	Move to E side of islands.
	1700	Move to S end of islands and proceed towards work area.
	2000-2118	Transit Dimon Fjord.
14/06/00	0600	V/l on station, preparing CTD.
	0748	Resume Section D in 61-53.9N 9-35.6W
	1603	Complete Section D in 62-04.1N 8-59.8W
	1751	Commence Section E in 62-10.5N 9-11.1W
15/06/00	1931	Complete Section E in 61-29.6N 10-40.6W
	1950-	
16/06/00	0007	Seamount survey. Reposition to Section A.
	0706	Commence Section Ar in 61-17.9N 8-17.7W
	1905	Complete Section Ar in 61-28.1N 8-03.2W
	1905-2235	Reposition to Section Cr .
	2235	Commence Section Cr in 61-23.9N 9-05.4W
17/06/00	1441	Complete Section Cr in 61-54.5N 8-55.5W
	1441-1649	Reposition to POGO site in 61-35.3N 8-38.9W
	1708-2312	POGO device not ready. Reposition to Section G .
	2315	Commence Section G in 61-01.7N 7-53.2W
18/06/00	0936-1030	POGO deployed and recovered in vicinity of 61-04.8N 7-20.2W
	1245	Complete Section G in 61-05.7N 7-09.2W
	1245-1631	Reposition to Section Arr .
	1631	Commence Section Arr in 61-18.0N 8-17.6W
19/06/00	0248	Complete Section Arr in 61-26.2N 8-04.6W
	0248-0708	Reposition to Section H .
	0708	Commence Section H in 60-48.3N 8-20.6W
	0848	CTD cable fault. Suspend CTD activities on Section H .
	1105-1145	POGO deployed and recovered in vicinity of 60-43.8N 8-10.6W
	1345-1457	ADCP calibration.
	1512	CTD repaired.
	1515	Resume CTD activities on Section H in 60-44.7N 8-10.3W
20/06/00	0550	Avoiding action taken due to Faeroese naval vessel approaching on steady bearing.

	1615-1637	Emergency drill and boat muster.
	1222	Complete Section H in 60-10.3N 7-42.8W
	1222-2215	Reposition to Section I.
	2224	Commence Section I in 60-27.1N 3-59.5W
22/06/00	2157	Complete Section I in 61-02.1N 5-21.5W
23/06/00	2200-0910	Reposition to Section J.
	0934	Commence Section J in 62-19.2N 4-14.3W
	1248	Suspend Section J in 62-29.7N 4-11.0W
	1248-1718	Suspend activities due to adverse conditions. V/I hove to.
	1718	Resume Section J in 62-31.5N 4-10.0W
24/06/00	1516	Complete Section J in 63-21.1N 3-56.8W
25/06/00	1516-0930	Reposition to Mooring "M".
	1100	Mooring "M" recovered.
	1100-1929	Reposition to Section Arr.
	1929	Commence Section Arr in 61-18.0N 8-18W
26/06/00	2012	Complete Section Arr in 61-24.0N 8-09.2W
27/06/00	2012-0022	Reposition to Section Crr.
	0022	Commence Section Crr in 61-57.9N 8-51.5W
	1401	Complete Section Cr in 61-29.9N 9-1.4W
	1401-1712	Reposition to Section Dr.
	1712	Commence Section Dr in 61-30.7N 9-33.0W
28/06/00	1028	Complete Section Dr in 62-01.7N 9-17.5W
	1028-1320	Reposition to Section Er.
	1320	Commence Section Er in 62-23.1N 9-55.1W
29/06/00	0550	Complete Section Er in 61-30.8N 10-39.2W
	0550-2150	Reposition to Section Ir.
	2157	Commence Section Ir in 61-01.7N 5-22.7W
30/06/00	1856	Complete Section I in 60-17.0N 3-38.3W
	1718	All secure. Proceed towards Glasgow.

The XCP Velocity and Temperature Sections

by
Dicky Allison, John Dunlap, James Girton and Tom Sanford
University of Washington
RRS *Discovery*, Cruise 247
5 June - 3 July 2000

I. Introduction

The XCP is a free-fall velocity profiler operating on the principles of motionally induced electric fields. It measures the weak electric currents generated by the motion of sea water through the Earth's magnetic field. The measured electric currents are converted to ocean velocity. Basically, the XCP observes a velocity profile denoted as $\mathbf{v}(z) - \bar{\mathbf{v}}$, where $\mathbf{v}(z)$ is the horizontal velocity of the ocean at the depth z and $\bar{\mathbf{v}}$ is the horizontal velocity of the ocean averaged from the surface to the bottom. That is, the instrument determines the vertical profile of the horizontal velocity of the ocean relative to a constant. On this cruise the constant was determined by fitting the relative XCP velocity profile to the absolute VM-ADCP velocity profile.

II. The XCP

The instrument consists of two components: the surface unit and the falling probe. The probe senses electric currents and water temperature. Data are sent by the falling probe via fine wires to the surface unit which transmits the data to the ship on sonobuoy RF frequencies. The probe falls at a speed of 4.5 m/s and spins at a frequency of 16 Hz.

III. Operations

Because the observations can be contaminated by the ship's electric and magnetic fields, it is important to start the XCP profile > 3 ship lengths from the ship. To allow this separation, the probe is not released until about three minutes after the XCP enters the sea. In most instances the XCP was deployed as we approached a CTD station on a heading suitable for making the cast (e.g., into wind/sea), preferably from downwind. Once >300 m distant, the ship heaved to for the CTD station, keeping the XCP transmitter astern (±45°). The XCP profile is complete in < 11 min. (sooner in shallow water). Occasionally, the XCP was deployed on leaving a CTD station.

IV. Data Processing

The RF signals are received on an antenna on the ship and processed in the Deck Lab. A real-time display of the temperature and velocity profiles is provided by the Sippican MK10 processor and computer and displayed on a CRT. More refined processing is conducted a few minutes after the drop is completed. All processing computes probe depth from run time and a quadratic depth vs. time equation. Standard processing produces vertical resolutions of 1 to 5 m. The vertical resolution can made smaller than 1 m, such as when shear near the sea floor is computed.

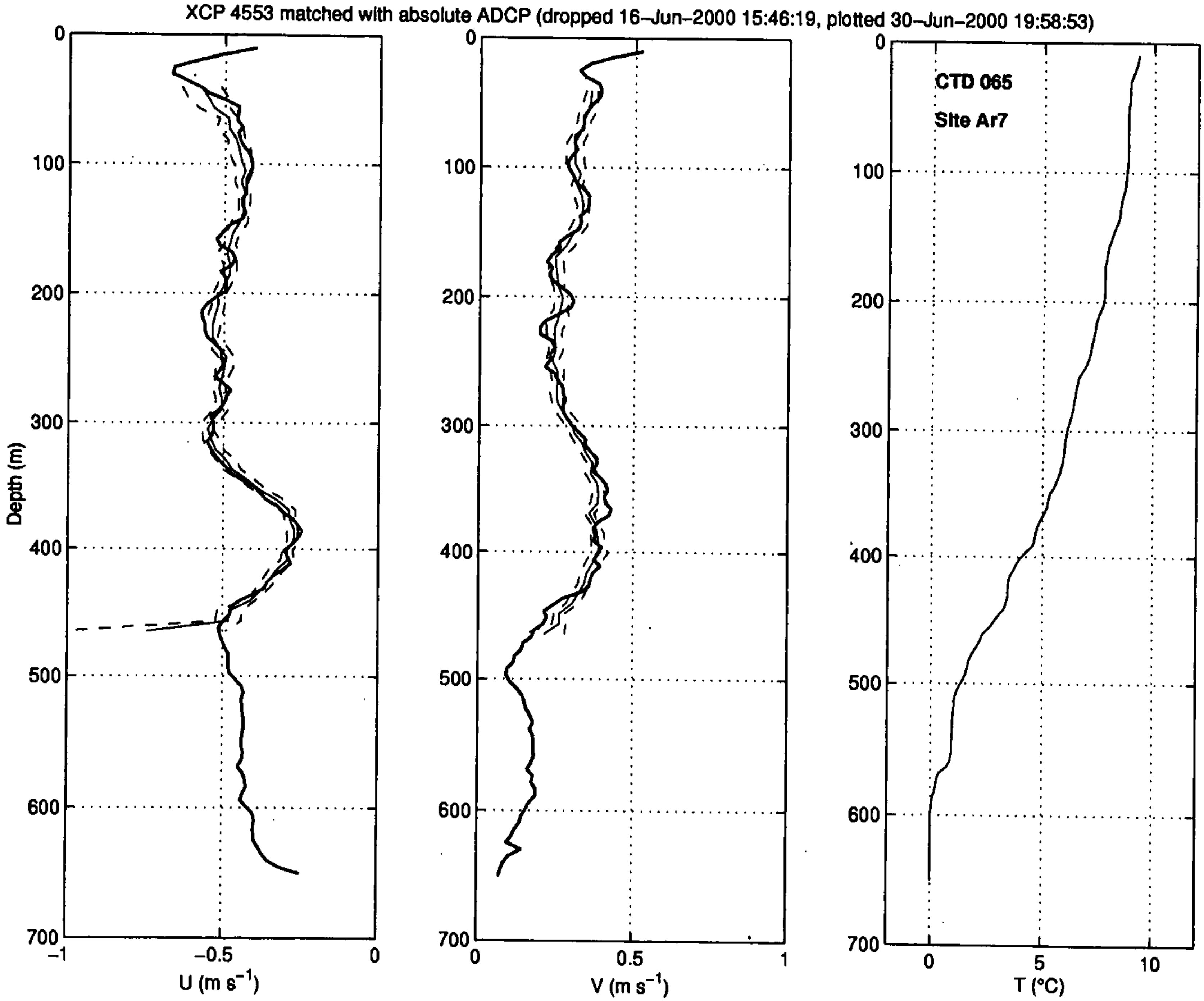
The relative velocity profile is fitted to a 15-minute average absolute VM-ADCP profile between about 50 and 500 m (depending on noise estimation criteria). The relative vessel-mounted acoustic Doppler profiler (VM-ADCP) velocity profiles are adjusted to be absolute by removing the velocity of the ship as determined by GPS observations (i.e., GPS, DGPS and heading data). An example of the combination of the adjustment of the XCP to absolute is shown in the first figure.

V. Sections of Temperature and Velocity in the FBC Overflow

The XCP was typically deployed at the same site as a CTD cast. Ultimately, the absolute XCP velocity and temperature profiles will be merged with those from the CTD. While at sea we contoured the XCP observations across all the sections. The second figure is an example of one of the sections from the Faroe Bank Channel. Later, we will estimate the bottom stress from fits of the velocity to the log profile expected in a homogenous turbulent BBL.

VI. Acknowledgments

We wish to thank Mark Prater of URI for his help in XCP operations and the Deck Officers for their skill placing us in the correct launch positions and for their patience in dealing with us during operations.



XCP 4553 matched with absolute ADCP (dropped 16–Jun–2000 15:46:19, plotted 30–Jun–2000 19:58:53)
Depth (m)
U (m s⁻¹)
V (m s⁻¹)
T (°C)
CTD 065
Site Ar7

Bottom-Following RAFOS Floats in the Faroe Bank Channel Overflow

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Discovery 247 – June 5 to July 3, 2000

Introduction: The RAFOS float is a subsurface, Lagrangian (water-following) drifter that is used to track ocean currents. The instrument has a glass pressure housing capable of withstanding depths of over 3500 m, and measures temperature and pressure at fixed intervals. The float navigation is provided by moored acoustic beacons – called "sound sources". These sources produce an 80-second tone at about 260 Hz at prescribed times; the source we are deploying on this cruise goes off every hour on the half-hour (00:30, 01:30, and so on). The float has a hydrophone to listen for the tone, and records the time-of-arrival (TOA) of the acoustic signal. Using TOAs from several sources, along with the positions of the sources and the appropriate speed of sound for our region, the location of the float can be computed using triangulation. All the data is stored internally until the end of the float mission, when the float releases a drop-weight, rises to the surface, and radios the data back to a land station via the ARGOS satellite system. The data is then received at GSO/URI via e-mail for post-processing. The float continues to transmit on the surface until its batteries are exhausted.

The RAFOS float, as typically used, remains at a constant depth (or pressure) level. The version used for this experiment has been modified so to stay a constant height off the bottom. Instead of putting all the ballast in the drop weight, a long monofilament (fishing) line following by either a 20 m braided stainless-steel wire or a 7 m #6 copper wire has been added to the bottom of the drop weight. The metal wire accounts for some of the float's ballast, and will be touching the bottom. If the float approaches too close to the bottom, then more wire will be supported on the bottom. If that happens, the float will become buoyant and lift the excess wire off. Similarly, if the float gets too far from the bottom, the wire is lifted off and the float is thus carrying more weight, which will caused the float to descend. The feedback between the float height and the amount of wire on the bottom keeps the float at a nearly constant depth off the bottom. The stainless steel wire is very flexible and will lie on the bottom, but might snag. The copper wire is much stiffer, and the hypothesis is that only the tip of the wire will be in contact with the bottom, thus reducing the opportunity for snags. The float also has a set of four wings to better couple the float to the overflow water and thus allow the float to overcome any drag from the bottom wire. The floats will carry 100 m of bottom line, and thus will nominally remain 100 m above the channel floor.

Sound Source Mooring: To provide acoustic navigation for the RAFOS floats, a sound source was deployed as the first major operation of the cruise. The source was a prototype "low-cost sound source" (LCSS) design developed by Tom Rossby and Jim Miller of URI, and this cruise provided the opportunity for its first field trial. While the floats are in the Faroe Bank Channel, the signals from the LCSS will provide one-dimensional along-channel ranging for the floats. After the floats enter the Iceland basin, the LCSS will supplement the existing sound source array maintained by Walter Zenk (Institut für Meereskunde).

The LCSS mooring operation began at 8:12 on Friday, June 9th with the deployment of the top floatation, and concluded at 9:39 with the dropping of the anchor. By 10:47, three ranges from the ship to the mooring's acoustic release had been made. Calculations showed the final anchor position to be at 62° 08.00′ N and 11° 00.05′ W. This operation owed its success to George Tupper (WHOI), who oversaw the mooring operations and the acoustic release preparations, and to the deck crew of the Discovery.

Float Deployment Procedures: The floats were deployed from the starboard side, using the CTD gantry. A block was placed on the aft ring, with a lift line threaded through. Typically, two people carried the float to the starboard deck. The bail line on the float was attached to a loop in the lift line with a "slippery-stick" at the end of a release line. The float was hoisted to near vertical, and the drop weight was attached. The bottom line was reeled out over the rail, after which the upper termination was attached to the float. The float was then lifted over the rail and the winch operator moved the gantry outboard. During this last step, a slight amount of tension was kept on the release line to prevent the float from spinning. The lift line was let out so that the float entered the water at which time the release line was pulled to remove the slippery-stick.

Deployment Comments: Floats were used sparingly (13 were brought on the cruise) and were typically deployed near the sill at locations where (1) the CTD cast showed a thick bottom layer of cold (below 1°C) outflow water and/or (2) the XCP profiles showed a thick (100 m) and strong (70 cm/s) bottom current and (3) the water was at least 750 m deep. Floats were deployed along three lines (or repeats thereof) where selected stations met the above criteria: A (Ar, Arr), B, and C. The floats were deployed within 10 minutes after the CTD was secured on deck. The nominal mission length for all the floats was 45 days, so the floats will surface and begin transmitting their data in late July.

During the first float deployment (#591), one of the bottom rods (or struts) which hold the wings in place broke at or near the time the float entered the water. The effected wing was visibly loose. We did not think that it was an unusually rough deployment. No attempt was made to recover the float. We suspect that the strut will slip out of the wing sleeve (if it hadn't already), and would then affect the ballasting of the float. The strut has a volume of 24 cc and a specific density of 1.4, which in turn would lead to a ballasting error of about 10 grams. The bottom-following version of the float is rather forgiving – the bottom wire has a linear density of 10 grams per meter so even this large change in ballasting should not greatly affect the float behavior.

Table of RAFOS Float Deployments

Date	Time	Float	Latitude	Longitude	Depth	CTD	XCP
06/10	02:00	591	61° 24.1′	8° 11.9′	786	5 (A3)	4504
06/10	04:00	584	aborted	-	-	-	-
06/10	14:15	583	61° 33.1′	8° 40.7′	868	12 (B4)	4509
06/10	16:24	587c	61° 35.4′	8° 38.0′	875	13 (B5)	4510
06/10	18:38	585	61° 37.6′	8° 36.9′	827	14 (B6)	4511
06/10	20:44	586c	61° 39.7′	8° 33.6′	768	15 (B7)	4512
06/11	09:44	592	61° 43.1′	9° 06.7′	755	22 (C5)	4517
06/11	11:52	581	61° 40.6′	9° 10.2′	816	23 (C6)	4518
06/16	11:44	582	61° 20.4′	8° 08.5′	703	61 (Ar4)	4549
06/16	13:28	589c	61° 22.7′	8° 09.9′	828	62 (Ar5)	4550
06/16	15:16	590	61° 24.2′	8° 08.7′	781	63 (Ar6)	4552
06/18	21:22	580	61° 20.8′	8° 10.6′	847	92 (Arr4)	4573
06/18	22:59	588c	61° 21.8′	8° 08.5′	837	93 (Arr5)	4574

'c' refers to the bottom line having the #6 copper wire instead of braided stainless steel

The second deployment (#584) had the identical problem, but occurred before the float was released. The float was brought on board after the bottom line was cut. The strut had broken cleanly at the hub, and was repaired, but spares were not available for part of the bottom line so the float was not redeployed.

Discussions with Tom Sanford and John Dunlap resulted in the idea that the mishap was not due to the deployment technique. Instead, the struts were too brittle for the loads on the wings when the float entered the water, and any appreciable force on the wing material caused large flexion of the struts. They recommended stiffening the struts and distributing the force by a system of guy wires. The final design had "wires" between the ends of the four bottom struts, between the ends of the four top struts, and then from the ends of the bottom struts downward to the glass about 25 cm below the bottom hub and held in place with glass-fiber tape. The same was done above the top set of struts. The "wire" was actually 50-lb test "TUF-LINE" (produced by Western Filament), which is made with Spectra Fiber and is about 0.5 mm in diameter.

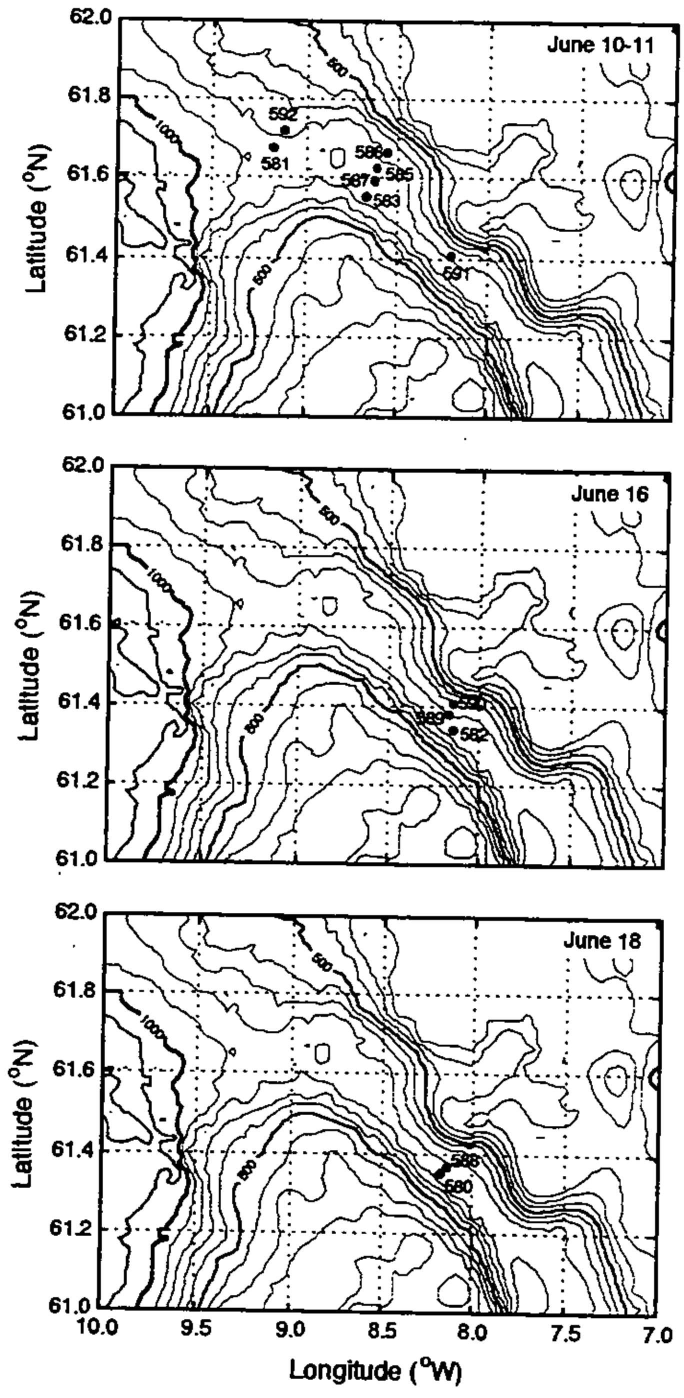
Approximately 7.5 m of Spectra line and 1 m of fiber tape were used per float. The rigging stiffened the struts considerably – very little "wiggle" in the struts remained. A simple "kitchen-sink" test indicated that the Spectra line has a very slight negative-buoyancy in fresh water.

Subsequent deployments went smoothly, with no further damage to the float's wings upon entry into the water. However, the floats seemed to stay at the surface for a long time, and several floats went out of sight still on the surface. This was thought to be due to spaces in the wing sleeves where air could be trapped and only very slowly escape or dissolve. Tom Sanford suggested preparing the wing sleeves with a little soap to decrease the surface tension of any water that enters the sleeve, thereby perhaps allowing more efficient flushing of air bubbles. The first float for which this method was used (#585) descended immediately. Others bobbed near the surface, usually spending 80% of the time below the surface then briefly popping up until 10-20 cm of the float were exposed. It is thought that the floats will eventually descend once the sleeves and other air voids become saturated.

Sound Source Mooring Recovery: The recovery of the sound source mooring began on the morning of Sunday, June 25. The ship was positioned to be 1/4 mile downwind from the mooring, and George Tupper interrogated the release and sent the release codes at 09:35. At about 09:38 the upper floatation surfaced about 10m off the port side, much too close for comfort. The ship backed way until the yellow hardhats appeared, then moved forward with the mooring off to the starboard side. The upper floatation was hooked, and brought onboard. The mooring wire was winched in until 10:25, when the operation was suspended with the sound source 5-10 m below the surface off the stern so that I could listen for the 10:30 sound source transmission. Unfortunately I could not hear any signal. The recovery resumed, and the mooring was completely recovered and on deck by 11:00.

I disconnected the cable between the transducer within the resonating pipe and the power module at a connector on the power module endcap, and brought the power module (containing the batteries and the electronics) inside the deck lab. I immediately noticed moisture and signs of corrosion inside the connector, with one pin having a greenish tinge. The bottom face-seal 'O'-ring was missing, and the connector socket was chipped. I opened the power module, and verified that the inside was dry. I heard the electronics 'buzz' for the 11:30 transmission a minute early, which confirmed the electronics and software were still operational, but perhaps the clock was running fast. I communicated with the sound source computer via my laptop, and verified the clock was 58 seconds fast. I then proceeded to flush and clean the plug and receptacle of the connector with distilled water and 100% isopropyl alcohol.

To diagnose the sound source further, I plugged the transducer back in and ran a transmission at



RAFOS float deployment locations.

'deck' power level (10% full power). The source, with clean and dry connector, worked well. I replaced the transducer with a dummy load and transmitted at a series of power levels, measuring the battery voltages and AC voltage to the load. The battery levels seemed higher than expected: 17.24V at no load (1.44V per cell), and barely dropped to 16.5V at 50% load (1.38V per cell). The evidence (no audible signal from the sound source, a leak in the transducer connector, and minimal drain from the batteries) suggests that the sound source did not perform as expected. However, I will have to wait until the floats surface in late July to verify whether they heard any transmissions. Two simple procedures might have prevented this misfortune: first, the 'O'-rings should have been checked before the cable was connected, and second, the connector should have been sealed with a layer of self-vulcanizing tape and perhaps followed by a layer of black vinyl tape. These precautions might have prevented the connector from leaking.

Acknowledgements: My participation in this experiment is due to the generosity of the principal scientists: Jim Price and Cecilie Mauritzen (WHOI), and Tom Sanford (APL/UW). The bottom-following RAFOS float component was funded by NSF Grant OCE-9911492.

INSTRUMENTATION REPORT. RRS DISCOVERY CRUISE 247B.

SIMRAD EA500 ECHO SOUNDER.

The Simrad echo sounder was run throughout the cruise and gave no problems.
The 12khz transceiver was used with the fish transducer for depth sounding, whilst the 10khz transceiver was used with the hull transducer for pinger work. On long passage legs the fish transducer was switched over to the10khz transceiver for sounding work.
During POGO operations the fish was wired through to the deck lab for connection to an EPC recorder for 12 khz pinger monitoring. The Simrad 12khz transceiver connected through the hull transducer was used as a backup.
The serial output was configured to run off either transceiver and provide output to the ABC, CLAM and Ship Display systems.
Damaged fairing clips on the fish cable were replaced at the end of the cruise.

SOC/WS SHIPBORNE WAVE RECORDER.

The SBWR was run throughout the cruise and gave no problems.
The system had to be run with only one pressure sensor as the port pressure sensor was found to be defective. Data was recorded on the system pc. The system was removed at the end of the cruise and returned to SOC for calibration. A replacement pressure sensor has been requested.

RDI 150khz VMADCP.

The vessel mounted system was run continuously. Data was displayed and logged on the system pc using the RDI Transect software.
Two configurations D247d.cfg and D247s.cfg were used. Essentially these were the same, except D247s.cfg enabled bottom tracking. D247s.cfg was used at the begining and end of the cruise for 'on passage' calibration runs. The deep configuration D247d.cfg was used continuously in the work area. The system was set to profile down to 480m (60 8m bins) with 1 ping/ensemble and 0.5sec between pings. Typically a ping rate of just over one second was achieved. Under good conditions profiles down to 480m were obtained. In addition to beam velocity data, %good;spectral width;echo intensity and status data were recorded every ping. Raw navigation data (1/sec) and 30sec processed data were also recorded. The data was backed up (see attached log sheet) onto zip disc every couple of days, as and when data collection could be interrupted.
The deck unit o/p was buffered to allow independent processing on the University of Washingtons system. This system provided near real time data processing of both vmadcp and xcp data. By integrating vmadcp, xcp, differential gps and Ashtech data, full depth gps corrected profiles were obtained within minutes.
Some system BIT fail (beam error) problems were observed at the start of the cruise. These were found to be due to reflections from the ctd when it was near the surface. The use of non bottom tracking mode in depths of less than 500m also caused system BIT failures to be displayed. Raw adcp ping data was unnafected.

Phil Taylor 2nd. July 2000

CD247 VMADCP PROFILING LOG.

LOG #.	FILE.	START FILE.	END FILE.	FILES.	TOTAL KBYTES.	LOGGING START.	LOGGING STOP.	COMMENTS.
D247001	P	.000	.001	2		05/06/00 (17:12)	05/06/00 (19:16)	Test log. Processed data files only.
D247002	P	.000	.000	1		05/06/00 (19:18)	05/06/00 (19:18)	Test log. Processed data files only.
D247003	P	.000	.000	1		05/06/00 (19:31)	05/06/00 (19:31)	Test log. Processed data files only.
D247004	P	.000	.000	1		05/06/00 (19:32)	05/06/00 (19:32)	Test log. Processed data files only.
D247005	P	.000	.006	7		05/06/00 (21:48)	06/06/00 (08:51)	Test log. Processed data files only.
D247006	P	.000	.000	1		06/06/00 (08:58)	06/06/00 (08:58)	Test log. Processed data files only.
D247007	P	.000	.000	1		06/06/00 (09:27)	06/06/00 (09:27)	Test log. Processed data files only.
D247008	P	.000	.000	1		06/06/00 (09:34)	06/06/00 (09:34)	Test log. Processed data files only.
D247009	P	.000	.000	1		06/06/00 (09:47)	06/06/00 (09:47)	Test log. Processed data files only.
D247010	R	.000	.001	2	600	06/06/00 (10:06)	06/06/00 (10:18)	Test log. Processed and raw data files recorded.
	P	.000	.001	2				
D247011	R	.000	.131	132	39600	06/06/00 (10:42)	07/06/00 (10:49)	Bottom tracking. CTD test 001. D/U 131.
	P	.000	.131	132				Shallow setup. D247S.CFG.
D247012	R	.000	.031	32	9600	07/06/00 (11:11)	07/06/00 (16:41)	Bottom tracking. CTD test 001. D/U 150.
	P	.000	.031	32				Shallow setup. D247S.CFG.
D247013	R	.000	.078	79	23700	07/06/00 (17:41)	08/06/00 (09:07)	Bottom tracking on passage (calibration).
	P	.000	.078	79				Shallow setup. D247S.CFG D247.NAV (300sec velocity filter)
	N	.000	.078	79				
D247014	R	.000	.008	9	2700	08/06/00 (09:21)	08/06/00 (10:30)	Test log. (Checking pc memory usage).
	P	.000	.008	9				Deep setup. D247D.CFG D247.NAV (300sec velocity filter)
	N	.000	.008	9				
D247015	R	.000	.273	274	82200	08/06/00 (10:42)	09/06/00 (18:50)	On passage. (Modified D247D.CFG to include status and %good).
	P	.000	.273	274				Deep setup. D247D.CFG D247.NAV (300sec velocity filter)
	N	.000	.273	274				
D247016	R	.000	.429	430	129000	09/06/00 (20:34)	12/06/00 (00:44)	Start section A.
	P	.000	.429	430				Deep setup. D247D.CFG D247.NAV (300sec velocity filter)
	N	.000	.429	430				
D247017	R	.000	.141	142	42600	12/06/00 (01:27)	12/06/00 (18:28)	Start section D.
	P	.000	.141	142				Deep setup. D247D.CFG D247.NAV (300sec velocity filter)
	N	.000	.141	142				
D247018	R	.000	.115	116	34800	12/06/00 (22:29)	13/06/00 (12:10)	Sheltering behind Faeroes.
	P	.000	.115	116				Deep setup. D247D.CFG D247.NAV (300sec velocity filter)
	N	.000	.115	116				

CD247 VMADCP PROFILING LOG.

LOG #.	FILE.	START FILE.	END FILE.	FILES.	TOTAL KBYTES.	LOGGING START.	LOGGING STOP.	COMMENTS.
D247019	R	.000	.039	40	12000	13/06/00 (16:58)	14/06/00 (00:08)	Bottom tracking off Faeroes.
	P	.000	.039	40				Shallow setup. D247S.CFG D247A.NAV (5sec velocity filter).
	N	.000	.039	40				
D247020	R	.000	.410	411	123300	14/06/00 (00:13)	16/06/00 (01:30)	Returning to section D.
	P	.000	.410	411				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.410	411				
D247021	R	.000	.284	285	85500	16/06/00 (04:30)	17/06/00 (15:01)	On passage to section A.
	P	.000	.284	285				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.284	285				
D247022	R	.000	.777	778	2334	17/06/00 (16:01)	21/06/00 (14:58)	On passage to section B.
	P	.000	.777	778				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.777	778				
D247023	R	.000	.350	351	105300	21/08/00 (19:02)	23/06/00 (13:00)	On passage to section I.
	P	.000	.350	351				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.350	351				
D247024	R	.000	.216	217	65100	23/06/00 (14:33)	24/06/00 (16:34)	On passage to section J.
	P	.000	.216	217				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.216	217				
D247025	R	.000	.932	933	279900	24/08/00 (18:56)	29/06/00 (12:34)	On passage to mooring M.
	P	.000	.932	933				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.932	933				
D247026	R	.000	.023	24	7200	29/06/00 (13:59)	29/06/00 (16:51)	XCP Section on passage to section I.
	P	.000	.023	24				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.023	24				
D247027	R	.000	.193	194	58200	29/06/00 (19:58)	30/06/00 (19:24)	Passage to section I.
	P	.000	.193	194				Deep setup. D247D.CFG D247A.NAV (5sec velocity filter)
	N	.000	.193	194				
D247028	R	.000	.172	173	51900	30/06/00 (19:29)	02/07/00 (08:10)	Bottom tracking on passage to Glasgow. Calibration run 01/07/00.
	P	.000	.172	173				Shallow setup. D247S.CFG D247A.NAV (5sec velocity filter)
	N	.000	.172	173				

DGPS and GPS recording. John Dunlap

Data from two Ashtech model G12 12-channel GPS receivers and four differential GPS beacon receivers were recorded. The antenna for one G12 was mounted on the stern gantry while the other was on the monkey island (above the wheel house). The antennas for the beacon receivers were all mounted on the monkey island railing.

The recorded data from the G12s includes raw pseudo-ranges and carrier phases and each satellite's broadcast ephemeris. Other data recorded include the usual GPGGA NMEA latitude/longitude sentence and several other status sentences. The data from the beacon receivers is in RCTM SC-104 format. Data from all the sources was logged with a computer time stamp in 4-hour files on a Linux computer for 29 days.

Other sources of data also recorded on the Linux computer included many of the ship's systems: two GPS, two satellite delivered RTCM-DPGS, the ADCP deckbox, speed log, gyro-compass, echo sounder depth.

Discovery 247 data recording on gee, running Red Hat 6.1 Linux.

All data streams are time stamped with the computer time of gee.

The data is available from the files less than a second from the time it arrives at the serial port. The files are all 4 hours long with names having the year, month, day and hour modulo 4-hours.

gee:/a/fbc/raw has the following directories:

first 8-port serial mux

port	baud	directory	
ttyR0	4800	tr4k	Trimble 4000 GPS
ttyR1	4800	gg24	Ashtech GG24 GPS/Glonass
ttyR2	19200	adcpcmd	ADCP commands from PC to ADCP deck box
ttyR3	19200	adcp	ADCP data from ADCP deck box to PC
ttyR4	4800	fugro	Fugro satellite-delivered DGPS corrections
ttyR5	4800	racal	Racal satellite-delivered DGPS corrections
ttyR6	9600	shd	ship's speed heading and depth (buffer errors)
ttyR7	4800	adu	Ashtech ADU2 GPS heading, pitch and roll

second 8-port serial mux

port	baud	directory	
ttyR32	4800	sbx3b	Differential beacon receiver DGPS corrections
ttyR33	4800	sbx3a	Differential beacon receiver DGPS corrections
ttyR34	9600	mrb2a	Differential beacon receiver DGPS corrections
ttyR35	38400	g12b	Ashtech G12 GPS on monkey island
ttyR36	4800	sbx3bsec	secondary port of sbx3b
ttyR37	4800	sbx3csec	secondary port of sbx3c
ttyR38	38400	g12a	Ashtech G12 GPS on stern gantry
ttyR39	4800	sbx3c	Differential beacon receiver DGPS corrections

Both G12 GPS receivers collect standard NMEA position data (GGA format), satellite status info, pseudo range and carrier phase data as well as satellite ephemerides. All are output at a one second rate except the ephemerides which are provided every 15 minutes and whenever they change.

The G12 GPS receivers when used with a very nearby DGPS feed will report horizontal errors of about 0.4 meters rms.

sbx3c is forced to receive Sumburgh Head in the Shetlands.
sbx3b is forced to receive Butt of Lewis in the Hebrides.
sbx3a is allowed to receive the loudest and/or closest station, usually Torshavn, Faroe Island.
mrb2a is allowed to receive the loudest and/or closest station, usually Torshavn, Faroe Island. This receiver is not as "hot" as the sbx receivers.

DGPS from sbx3a feeds both g12a and gee via a Y-connection
DGPS from sbx3b feeds both g12b and gee via a Y-connection

CTD Calibration and Nutrient

Sampling on Discovery 247 – George Tupper

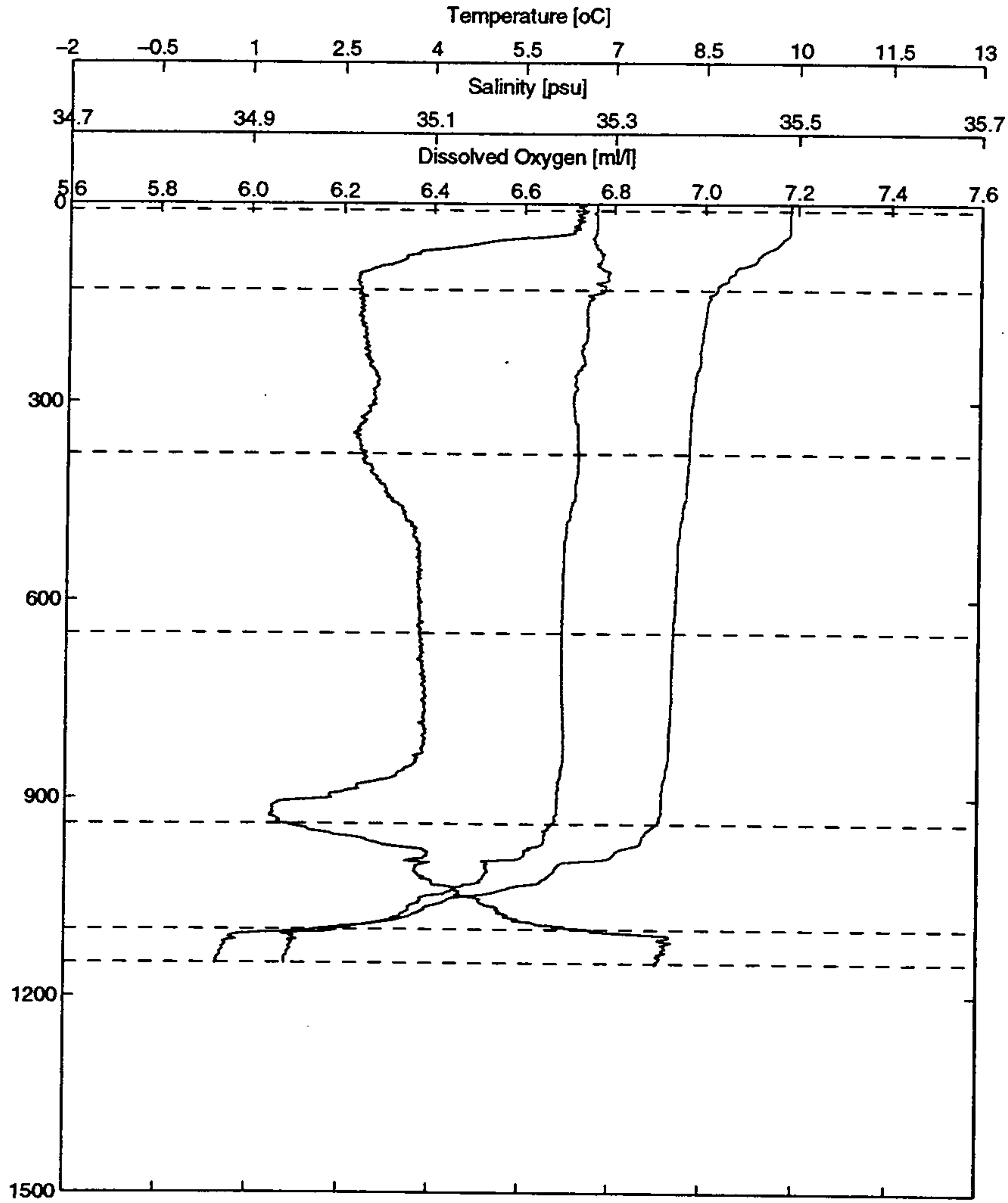
On 217 CTD stations occupied on this cruise, 1183 Niskin bottle samples were collected. Salt and oxygen analysis were done on all of them. Nutrient samples were collected from 580 selected bottles and frozen at –70 degrees C. for air shipment to Joe Jennings at Oregon State University for analysis there.

The constant temperature laboratory aboard RRS Discovery was used for the oxygen and salt sample processing. It was maintained at a constant temperature of 22 degrees C.

The oxygen analysis was carried out using the automated Winkler titration apparatus designed and described by Knapp et al. in Woods Hole Oceanographic Institution Technical Report "WHOI-90-35". The thiosulphate solution used for titrations is calibrated each day against a solution of Potassium Iodate standard with a normality of exactly .01. This system measures the titrant needed to reach the endpoint with a resolution better than .001 ml. The standard deviation of replicate samples is .005 ml/l and the accuracy is about 0.02 ml/L

All salinity samples were processed using an Autosal 8400A salinometer No. 55358 supplied by SOC. It was standardized each morning using P-136 standard water from 7 to 12 June, changing to P-137 from 13 Jun until 1 July. Since the room temperature was controlled to + or – 1 degrees C., the absolute accuracy, as specified in the salinometer manual, should be + or – .001 P.S.U. It appeared to work flawlessly, needing no adjustments at all for the first week, then very few minor ones during the rest of the cruise. The figure shows the CTD profile with the location of the water samples collected for station 187

Faroe Banks CTD Profile   Station: 187   Date: 02–Jul–2000



Shipborne Data Logging and Processing and Computing Suite.

The UKORS data logging and processing system installed on the RRS Discovery comprises three distinct parts and is known as the A B C system. The level A is a 68000 microprocessor based system with four serial ports which collects and timestamps data with the highly accurate Radiocode clock, it also performs some limited filtering on data which doesn't fall within particular preset limits. Each Level A logs data from an individual piece of equipment. The equipment logged by the Level A's on cruise D247 was:

Depth data from the Simrad EA500.
GPS data from the Trimble 4000DS and Ashtec Glonass receivers.
GPS and attitude data from the Ashtec ADU reciever.
Sea Surface data from the Surfmet PC package.
Meteorological data from the Surfmet PC package.
Ships heading data from the ships gyrocompass.

The Level B is another 68000 based machine that has 32 serial inputs and an Ethernet output. This combines all of the data outputted from the Level A's into one stream that is sent over a 100 base T network to the Level C. The Level B also performs real-time backup operations using two onboard 9Gb hard disk drives and two onboard 150Mb quarter inch cartridge drives.

The Level C is a SUN Ultra 10 Unix workstation. This parses the incoming data stream from the Level B and stores it locally on the hard disk drive, each separate data stream having its own data file. This system then allows access to the data and also gives opportunity to process data (for instance the depth data is processed due to differing Carter areas). The Level C can also produce contour plots on two or three axes and two axes line graphs.

The RRS Discovery is also equipped with a 100 base T network in the computer room, plot and main laboratory with the other working spaces covered by a 10 base 2 network.

The RRS Discovery also provides an e-mail link to the outside world with individual user accounts sending e-mail around the world via the ships satellite telephone and a dedicated ISDN telephone lie (128kbps) at the Southampton Oceanography Centre.

Jonathan Short UKORS Computer Technician.

D247 Cruise Report **CTD and Associated Equipment Performance**

Terry Edwards

Instrumentation

All instrumentation and serial numbers as well as deployment records and calibration history are available from the sensor information file.

Additionally, 21 10 litre Niskin bottles were fitted to the frame.
Data acquisition was carried out using recently upgraded 333MHz Pentium PCs with Iomega Zip 100 for data backup storage.
Data was also backed up to a Marantz PMD 360 audio tape recorder

Cast 098, the sea cable failed, cause was traced to a centre conductor strand piercing the inner insulation and shorting the supply, blowing sea cable fuse (500mA QB). The cable was cut (20m) and reterminated. The new termination failed causing water ingress. The next termination was successful.

Individual Instrument Performance

CTD Primary Sensors
Performed as required with no reported problems. Sensor paths were flushed through with milliQ water during extended passages and in warm weather. Required occasional flushing with Triton detergent.
Day 179, the secondary conductivity sensor was monitored. The primary sensor was fairly noisy.

CTD Secondary Sensors
Performed as required with no reported problems. Sensor paths were flushed through with milliQ water during extended passages and in warm weather. Required occasional flushing with Triton detergent.
Day 179, the secondary conductivity sensor was monitored.

Oxygen Sensor
Re piped on 19 June 2000. Appeared to reduce hysterysis in up and down casts.

CTD Deck Unit
Generally performed as expected, but initially there were some problems with interfacing both the NMEA input and the remote output to the winch monitoring system (WMS). Incorrect data rate caused the NMEA transmission to reset the deck unit at irregular intervals. This problem was overcome by setting the input to 9600 baud. The NMEA message also caused problems when initialising the Seabird software and it was repeatedly necessary to restart due to lines on the display. Eventually, the function was

turned off within the Seabird software and no further problems of this nature were encountered.

Fuse in sea cable failed cast 119. No specific cause traced. This happened at irregular intervals, every 5-10 casts. Usually at about 500-600m depth, mostly on downcast but sometimes on upcast.
The Deck unit was swapped for the spare after the completion of section I to test for fuse blowing effects.

PC and Software
Occasional crashes, suspect windows / SBE software problem.
System crashed on cast number 074, data had to be retrieved from tape backup.

Seatech LS600
Performed as expected.

Altimeter
Performance appeared to be affected by acoustic interference from the pinger. This was removed early in the cruise and performance seemed to be better but not perfect.
Lowering it in the frame also increased performance.
Although the range is 0- 300m, it didn't really provide meaningful information above an altitude of about 150m. An estimated 40% of returns are false.
Poor bottom reflection on several casts made the altimeter virtually useless. The position in the frame is suspected to be affecting performance.
Working fine on section ARRR.

Pinger
The pinger performed as expected but was removed early in the cruise as it appeared to be interfering with the altimeter.
The pinger was replaced on Jday 174 due to the poor performance of the altimeter.

Carousel
Number 1 firing became sticky and did not fire correctly on cast 117. The arm was manually operated and lubricated and appeared to work ok. Dual bottles were fired for a few casts to test firing. This happened again later in the cruise.

Niskin Bottles
Leak tested at the beginning of the cruise. Several bottles had new valve O rings and 2 had new valve inner assemblies fitted. The lanyards were long type. Spring tensions were adjusted on about half the bottles to prevent leaks from the bottom opening.

Tape Backup (Supplied by WHOI)
No problems observed. A new tape was used every week.

Surface Sampling and Meteorological Monitoring (Surfmet) Performance

Terry Edwards

The met. system performed as expected. No problems reported.

The Thermosalinograph (TSG) and other surface sampling equipment performed as expected. Calibration samples were taken once on each watch.

Data was logged to the ships' computer system.

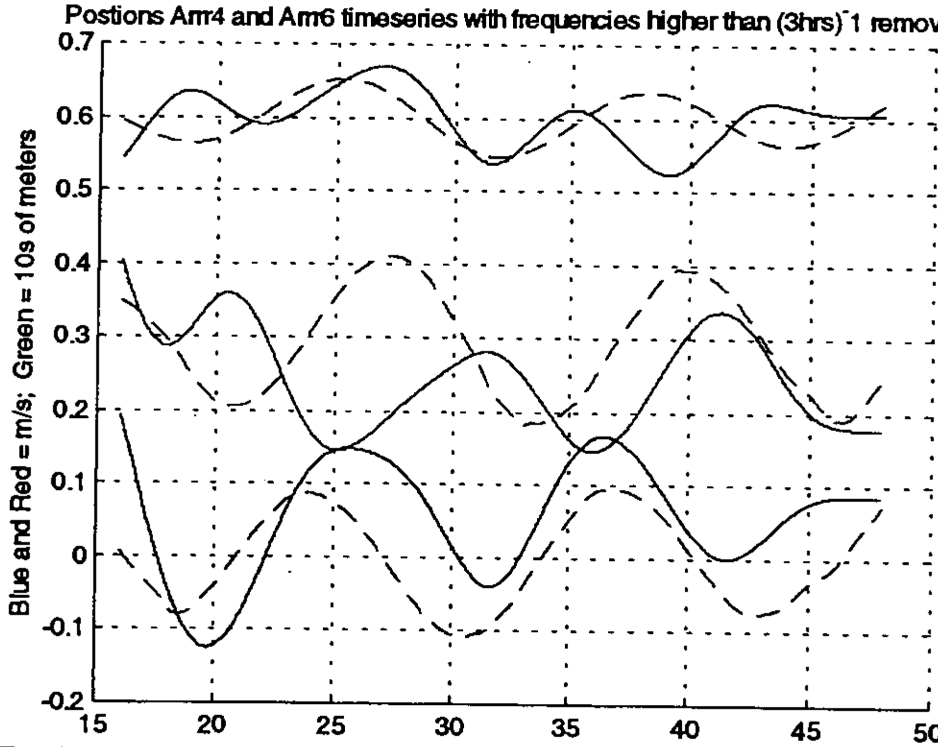
Discovery Cruise 247
Subject: GPS and ship mounted ADCP data
By: Peter Huybers

Measurements of the vertical component of the ship's GPS location were recorded at one-second intervals using two separate differential GPS arrays. Velocity profiles were collected by the ship mounted ADCP every 1.5 seconds. These measurements were compared with the OSU Topex/Poseidon version 0.3 tidal model predictions of sea surface height (SSH) and barotropic velocities for the time, latitude, and longitude of each GPS and ADCP measurement (see figure below).

There is good correspondence between the amplitudes in the measured data and the model in SSH and velocity. There is also good correspondence between the frequency of the oscillations in the ADCP data and model output. The SSH measurements may have roughly twice the frequency of the model predictions. The phase of the measured data is about 2 hours ahead of the model output for both SSH height and velocity. This information may be useful in diagnosing the variability observed in the lowered ADCP and XCP current profiles collected during the course of the cruise.

Coherent frequencies higher than the tidal frequency are also evident in both the ADCP and GPS records. Looking at this part of the spectrum, there is some possibility of identifying a regular wave-like behavior associated with the Faroe Channel through flow.

Postions Arrr4 and Arrr6 timeseries with frequencies higher than (3hrs)^-1 removed



Time in hours. Dashed = Model, Solid = Data; Blue = meridional, Red = zonal, Green = SSH

CTD Processing on Discovery 247 - Deborah West-Mack

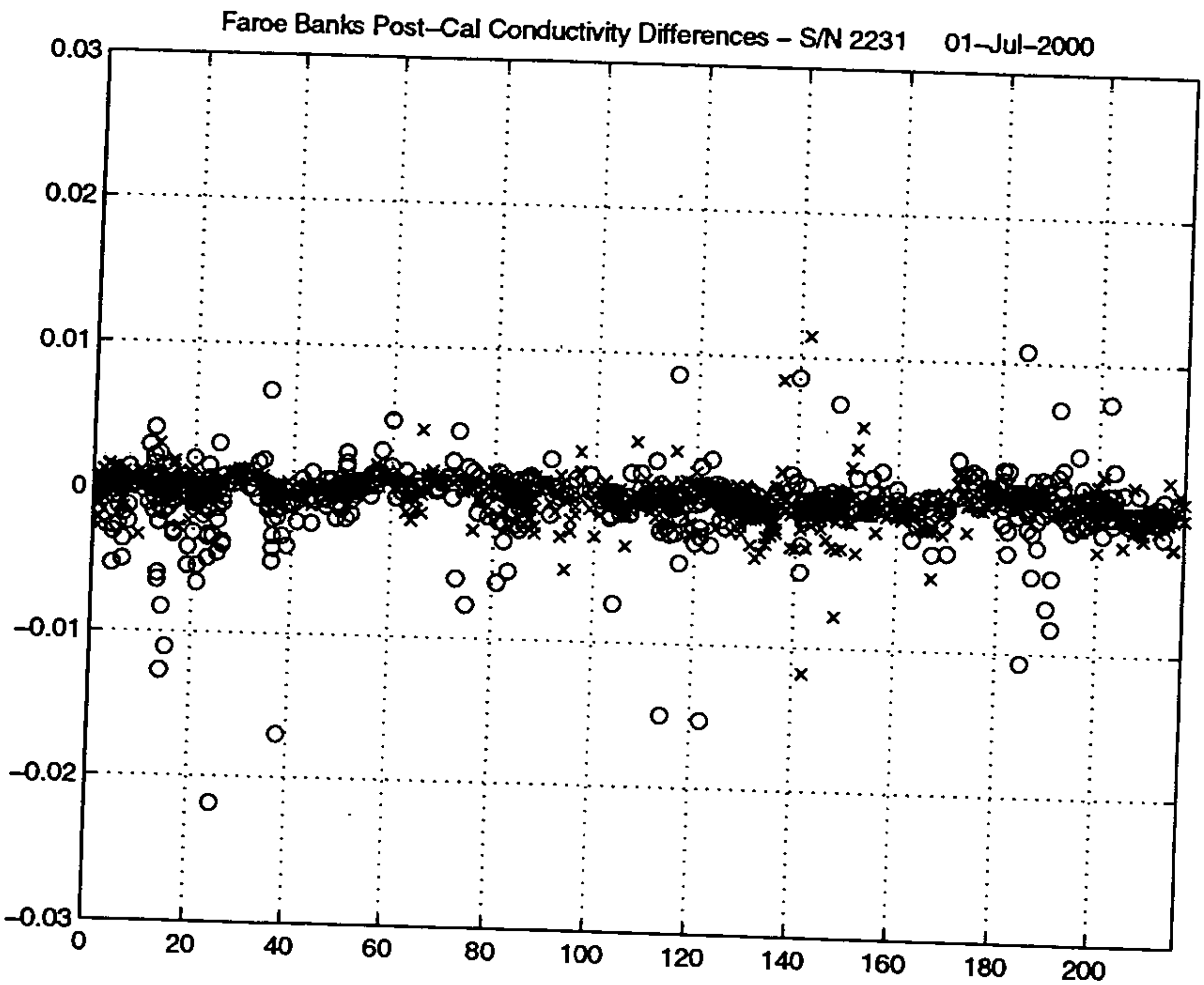
The raw CTD files acquired during the CTD cast were converted into engineering units using SeaBird software. The SeaBird modules were run in two batch files to produce a 2 db bin averaged data for CTD profiles and a 1 sec bin averaged data for LADCP time/pressure processing. Each station has the following set of files produced by the Seabird batch files.

BL Bottle firing file.
BTL Summarized CTD data with bottle fired.
CDN Converted engineering data file - down cast.
CNV Converted engineering data file - entire cast.
CUP Converted engineering data file - up cast.
CON Instrument configuration and calibration coefficients.
DAT Raw binary file.
HDR Header file.
LCN Converted engineering data file for LADCP.
ROS Scans marked with the bottle fire confirmation bit.

The oxygen and salt samples were matched with the appropriate CTD data for calibration. The up cast data was used for the salinity calibration and the down cast data used for the oxygen calibration. Preliminary salinity calibration for both sensors were performed during the cruise, final conductivity and oxygen calibrations will be performed onshore. The calibration uses fitting curves of various orders with and without pressure dependence to minimize the differences between the bottle conductivity and the CTD conductivity. (See the attached figure.)

The following set of files were produced during post-processing and calibration steps.

CAL Calibration files for conductivity sensors.
DCC Corrected conductivity files (oxygen not yet corrected).
SUB One page summary file of CTD profile data.
XNUT Merged file CTD, salts, and oxygen bottle data.

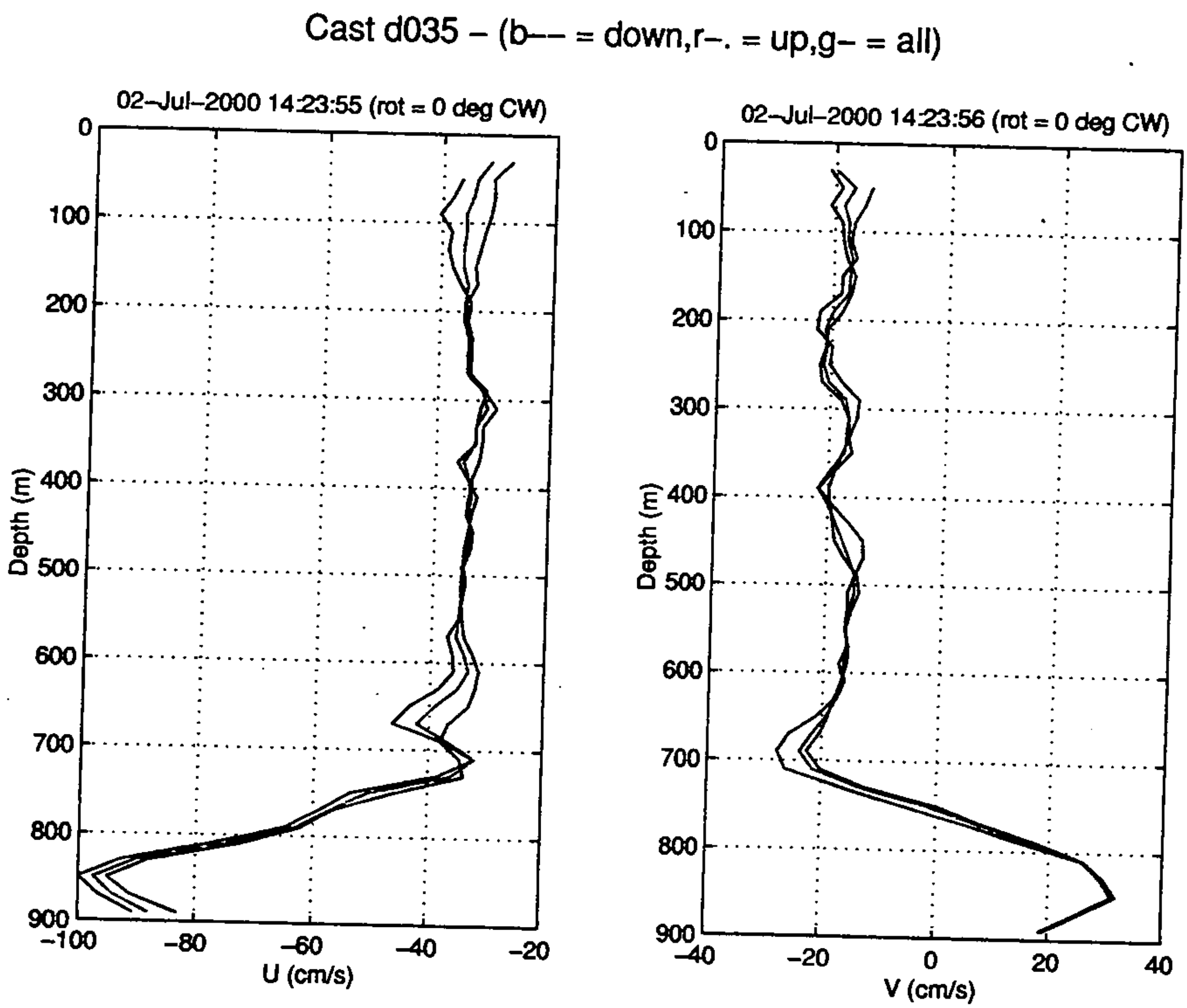

Faroe Banks Post–Cal Conductivity Differences – S/N 2231 01–Jul–2000
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
0
20
40
60
80
100
120
140
160
180
200

Daniel J. Torres
Woods Hole Oceanographic Institution

1. LADCP Operations

Lowered Acoustic Doppler Current Profiler (LADCP) measurements were part of the standard hydrographic instrumentation suite mounted on the CTD frame. A total of three ADCPs were fitted onto the frame along with two battery packs. The first was a downward facing RD Instruments 150 kHz broadband ADCP with 30° transducers. It was powered from a WHOI built 48 volt 8 amp-hour lead acid rechargeable battery pack. The second LADCP system on board the package consisted of two RD Instruments 300 kHz Workhorse ADCPs with 20° transducers; one downward facing and one upward facing. The dual Workhorse system was powered from a single battery pack (same as above). The 150 kHz ADCP was configured to collect 14 16 meter bins each ensemble. Ensemble times alternated between 1 and 1.6 seconds. The dual Workhorse system had two different configurations. For the first 76 stations, each Workhorse was set up to collect 10 16 meter bins each ensemble. Each 1.5 second ensemble consisted of 3 0.5 second pings. The remaining 141 stations were set up for 14 8 meter bins. A ping synchronization system was applied to ensure the pings of each Workhorse were simultaneous. All three ADCPs and battery cases were pressure rated to 6000 meters.

One of the primary objectives of this study was to determine the velocity structure of the overflow currents from the Nordic Seas through the Faroe Island Channel region. Since the overflow currents are generally bottom trapped and often quite narrow, it was important to measure velocities as close to the bottom as possible. A typical downward facing ADCP measuring 16 meter bins can only acquire valid data to about 50 meters from the bottom. The dual Workhorse system was designed to be able to acquire good data to about 20 meters from the bottom. Also, a dual system allows the continuous collection of data for the duration of the cast. This results in greater accuracies in the determination of absolute velocities. Below is one example of a typical LADCP cast from the downward facing 150 kHz Broadband ADCP.


Cast d035 – (b–– = down,r–. = up,g– = all)
02–Jul–2000 14:23:55 (rot = 0 deg CW)
02–Jul–2000 14:23:56 (rot = 0 deg CW)
Depth (m)
U (cm/s)
V (cm/s)
0
100
200
300
400
500
600
700
800
900
–100
–80
–60
–40
–20
–40
–20
0
20
40