National Oceanography Centre, Southampton

Cruise Report No. 11

RRS *Discovery* Cruise 309-310

18 AUG – 05 SEP 2006

Cape Farewell and Eirik Ridge
(CFER-2)

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2006

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ABSTRACT

This report describes scientific activities during RRS *Discovery* cruise 309-310 in the vicinity of Cape Farewell, southern Greenland, during late summer 2006. A Deep Western Boundary Current array of seven moorings was recovered and a replacement array of five moorings was deployed. For IFREMER, one mooring and one glider were recovered; one IfM-GEOMAR and three NIOZ moorings were recovered, serviced and redeployed. Hydrographic work comprised 25 CTD/LADCP stations, and three tows of the Moving Vessel Profiler (MVP); water samples were captured on each station for the measurement of salinity. Continuous underway measurements comprised: navigation; currents, using ship-mounted ADCPs (75 and 150 kHz); meteorology; sea surface temperature and salinity; and bathymetry. D309-310 (CFER-2) is a part of the project "Cape Farewell and Eirik Ridge: Interannual to Millennial Thermohaline Circulation Variability", funded by the UK Natural Environment Research Council as part of its "Rapid Climate Change" Directed Research Programme.

KEYWORDS

ADCP, Atlantic Ocean, Cape Farewell, cruise D309-310 2006, CTD, deep western boundary current, *Discovery*, Eirik Ridge, Lowered ADCP, meteorology, moorings, Moving Vessel Profiler, MVP, shipboard ADCP

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As last year, sincere thanks to the senior NOCS scientific engineers, Ian Waddington (i/c Moorings), Steve Whittle (Technical Liaison Officer), and Dave Teare (electronics), and again as last year, I am personally very grateful to John Allen, as my "lieutenant", and to Steve Alderson, for their help and support during the cruise.

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1 INTRODUCTION

Sheldon Bacon

The reasons for the dual designation of D309-310 are obscure; the cruise will generally be known in this report as D309.

D309 was primarily a multinational mooring cruise. We recovered and redeployed three Dutch moorings (for NIOZ, Texel), recovered and redeployed one German mooring (the CIS mooring, for IfM-GEOMAR, Kiel), recovered one lander (for IFREMER, Brest). The main UK interest lay in the recovery and partial redeployment of a mooring array deployed the previous summer (2005) on RRS *Discovery* cruise 298. Seven moorings were recovered, four of which were redeployed, plus an extra one. It was gratifying to attain 100% mooring recovery rate; everything we intended to recover, we did recover, including an IFREMER glider.

Other measurements made as time permitted were 25 CTD/LADCP stations, some on the D298 Irminger Basin line, which lies near the NOC mooring array, and some on the WOCE AR7E line, plus a few for mooring calibration purposes, and one outside St. John's at the Canadian "Station 27" location. We also made some measurements with the MVP (Moving Vessel Profiler), a towed undulating CTD. Various underway measurements were made.

Figure 1 shows the cruise track and all moorings and station positions.

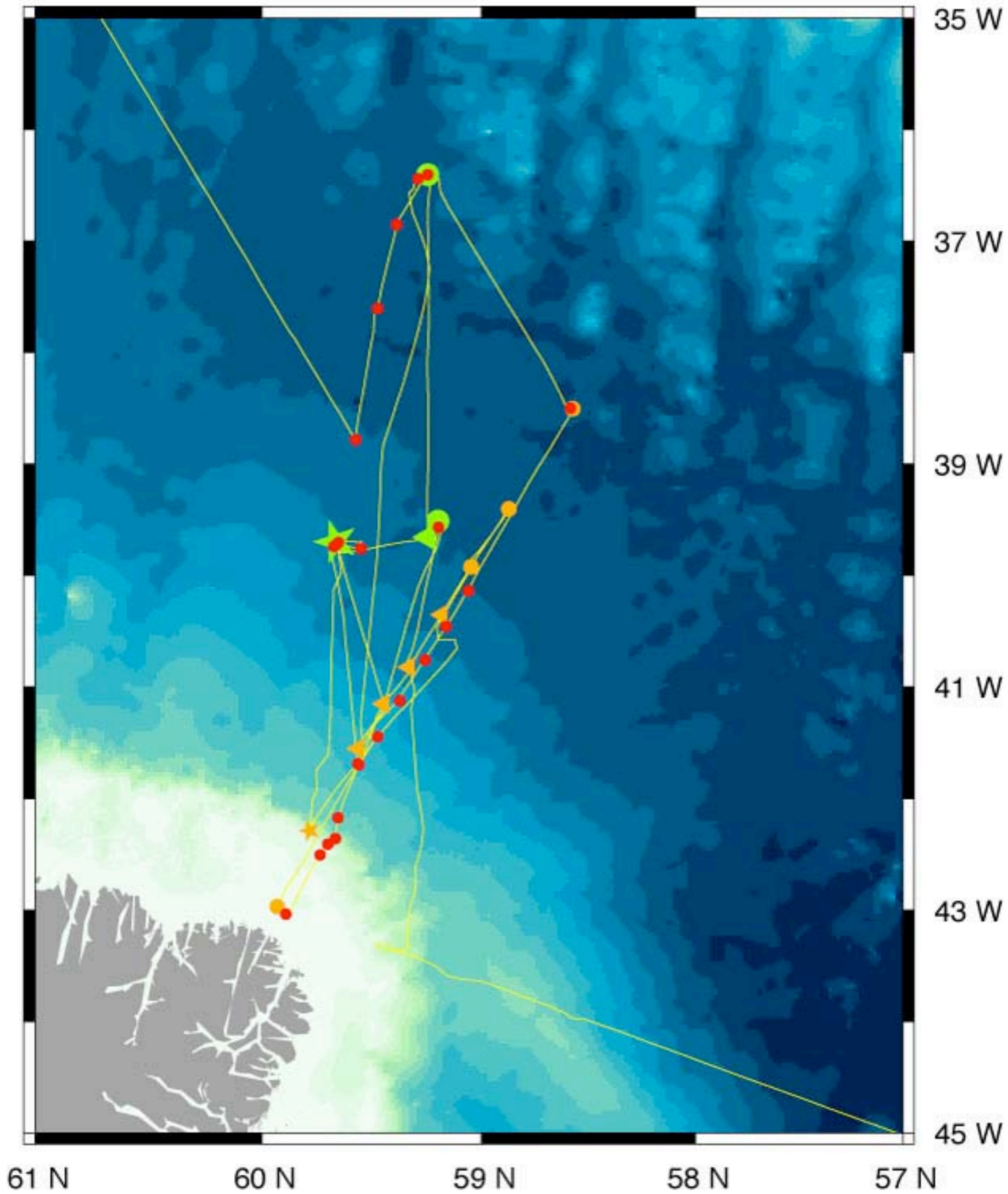


Figure 1: D309 track (yellow line) and stations (red dots). Moorings are: NIOZ sediment trap (green triangle); NIOZ moorings (green circles); CIS mooring (green star); NOC moorings recovered (orange circle), except the westernmost orange circle is IFREMER lander; NOC moorings recovered and redeployed (orange triangle); new NOC mooring (orange star). The track starts in St. John's, Newfoundland and ends in Reykjavik, Iceland. One station, off St. John's, is not shown.

2 NOC MOORINGS

Ian Waddington, Steve Whittle, Dan Comben and Sheldon Bacon

2.1 Summary

The objectives of the Mooring Team were to recover the Cape Farewell mooring array deployed in 2005 on D298 and to deploy a second modified array. In this all the objectives were achieved with all moorings being recovered and deployments completed.

Scientific ID	NMF No.	Date / Day
MOORINGS RECOVERED:		
MOORING B	2005/53	22 August 2006 - Day 234
MOORING A	2005/55	23 August 2006 - Day 235
MOORING H	2005/54	23 August 2006 - Day 235
MOORING D	2005/51	25 August 2006 - Day 237
MOORING C	2005/52	25 August 2006 - Day 237
MOORING E	2005/50	25 August 2006 - Day 237
MOORING G	2005/49	31 August 2006 - Day 243
MOORINGS DEPLOYED:		
MOORING F	2006/31	23 August 2006 - Day 235
MOORING B	2006/32	25 August 2006 - Day 237
MOORING C	2006/33	25 August 2006 - Day 237
MOORING A	2006/34	29 August 2006 - Day 241
MOORING H	2006/35	29 August 2006 - Day 241

As the RCM11 instruments were all supplied new for the project and no pre-cruise calibrations had been undertaken, thus calibration casts were carried out on CTD stations. These instruments will have calibrations carried out at the NOC Calibration lab on return to UK.

RCM7 and RCM8 instruments were predominantly turned around onboard and to facilitate post and pre-deployment calibrations, all the instruments were placed on calibration casts before servicing for turn-around or return to NOC.

IFREMER RCM8s were not calibrated as the instruments are to be calibrated on return to IFREMER.

Data Retrieval:

All data was retrieved onboard from the RCMs using Aanderaa program P5059 and a preliminary inspection made of data quality . Progressive vector and time series plots were derived for science purposes .

Instrument Problems:

RCM 11 426 - slight leak - overhauled and pressure tested ok, return to NOC.

RCM 11 381 - slight leak - overhauled and pressure tested ok, return to NOC.

RCM 8 6750 - slight leak - overhauled - pressure tested and re-deployed.

RCM 10280 – battery failure shortly after deploy – investigation of rcm to be done.

RCM 9686 – battery connection failed on deploy.

The leaks were investigated and evidence suggested minor leakage at low pressure from the pressure casing O-ring. All O-rings were replaced and pressure tested on CTD during calibration cast. There was no further leakage. The battery failure has still to be completely identified and further tests are required at NOC. The battery connection failure has been identified and all subsequent battery connections are secured in place with pvc tape around the battery pack.

Acoustic Releases:

The acoustic releases are all IXSEA AR861 types and performed well in recovery. All were serviced onboard for re-deployment or return to NOC. All battery packs were better than expected voltages.

Seabird 16 (IFREMER):

Recovered from mooring A, washed down and packaged for return to IFREMER as data could not be read onboard. Start time - Date set to 28 August 2005**;** Time Set to 12:13:00.

Mooring Deployments:

All moorings deployed buoy first, anchor last – freefall. The moorings were all hand-deployed from baskets requiring only a crane to lift over heavy buoyancy / instrument packs and the anchor. Descent rate monitored using the transpond function of the AR861.

Two moorings boomeranged before reaching seabed releasing the anchors and popping back up to surface – Sites D and H. This failure of 2 releases has not been resolved. Both were exchange releases from 26N Rapid array and had been tested on cruise 304; hooks were fully open on recovery.

2.2 Mooring Recoveries

The moorings recovered were all acoustic release pop up type. There were some poor reception problems onboard which caused one anxious moment at mooring site H. This however is now determined as positioning acoustic releases too close to the support glass buoyancy and the narrow beam angle of the PES single element transducer.

All the mooring buoyancy was allowed to rise completely to the surface before approach by *Discovery* for grappling. Several moorings were tangled at the glass buoyancy and recovery by pulling in bights was necessary. Mooring A wire was recovered complete but had to be hauled through the DBC winch as 4 wires in one pull. This due to entangling and severe twist in wire. Addition of extra wire swivelling would rectify this problem. All the recovered materials were in excellent condition with corrosion minimal and far less than expected. No strength loss in any component.

Recovered Instruments: the current meters in the array are Aanderaa RCM11, RCM8 and RCM7 types. The table below shows instrumentation and timing. Times are UTC, dates dd-mm-yyyy; Fate: N means returned to NOC; D means redeployed.

RCM Type	Serial #	First Data		Last Data		Notes	Fate
		Time	Date / Day	Time	Date / Day		
RCM8	7452	1900	27-08-2005 / 239	2251	25-08-2006 / 237		N
RCM8	9681	1600	30-08-2005 / 242	1258	23-08-2006 / 235		D
RCM8	12293	1900	27-08-2005 / 239	2255	25-08-2006 / 237		D
RCM8	10277	1900	27-08-2005 / 239	2304	25-08-2006 / 237		N
RCM8	12692	1400	27-08-2005 / 239	1704	23-08-2006 / 235	Note 4	D
RCM8	12691	1400	27-08-2005 / 239	1704	23-08-2006 / 235	Note 5	D
RCM8	12668	2100	27-08-2005 / 239	0003	01-09-2006 / 244		D
RCM8	10280	2100	27-08-2005 / 239	none	failed battery		D
RCM8	6750	1500	27-08-2005 / 239	1440	23-08-2006 / 235		D
RCM7	11678	1400	27-08-2005 / 239	1701	23-08-2006 / 235		N
RCM7	9598	1500	27-08-2005 / 239	2309	23-08-2006 / 235		D
RCM8	8248	1500	27-08-2005 / 239	2309	23-08-2006 / 235		D
RCM8	9686					Note 3	N
RCM11	443	1100	28-08-2005 / 240	1552	26-08-2006 / 238		N
RCM11	516	1630	29-08-2005 / 241	1606	26-08-2006 / 238		N
RCM11	520	1100	28-08-2005 / 240	1800	26-08-2006 / 238		N
RCM11	515	1100	28-08-2005 / 240	1606	26-08-2006 / 238		N
RCM11	381	1100	28-08-2005 / 240			Note 2	N
RCM11	518	1700	29-08-2005 / 241	1338	23-08-2006 / 235		N
RCM11	507	2100	27-08-2005 / 239	1336	23-08-2006 / 235		N
RCM11	399	2100	27-08-2005 / 239	2332	31-08-2006 / 243		N
RCM11	438	2100	27-08-2005 / 239	2326	31-08-2006 / 243		N
RCM11	428	1900	27-08-2005 / 239			Note 3	N
RCM11	395	1900	27-08-2005 / 239	1926	26-08-2006 / 238		N
RCM11	444	1900	27-08-2005 / 239	0027	27-08-2006 / 239		N
RCM11	510	1900	27-08-2005 / 239	0221	27-08-2006 / 239		N
RCM11	519	1500	27-08-2005 / 239	2253	22-08-2006 / 239		N
RCM11	426	1500	27-08-2005 / 239	2253	22-08-2006 / 234		N
RCM11	383	1400	27-08-2005 / 239	1709	23-08-2006 / 235		N

Note 1: RCM8 9686; set up for intercomparison; instrument failed.
Note 2: RCM11 381; last data time/date not recorded (water leak).

Note 3: RCM11 428; last data time/date not logged (dsu count error).
Note 4: RCM8 12692 on loan from IFREMER
Note 5: RCM8 12691 on loan from IFREMER

2.2.1 Mooring B

22 August 2006 - Day 234; Mooring B UKORS 2005/53.

Position 59 19.97N 40 49.26W; 1853 approaching site 11.3kts - tx ARM 14FO reply at 3125m. Surfaced port side 1930h. Pick up buoy across wind to mooring. Grappled from foredeck and transferred aft for winching onboard. 2007 Glass on deck. 2012 rcm 9598 on deck. 2012 glass and rcm 8248 onboard – tangled. Rest of mooring severely tangled and recovered by tying off on horns and hauling cut sections onboard. All instruments in good condition. Hardware clean and minimal corrosion. Shackles a mix of red and yellow pins. Release hook clean. Instruments allowed to warm before opening.

Data downloaded onboard; files ***_B_MRG.dsu, converted to Ascii, files ***_B_Mrg.asc, where *RCM_SER* is the current meter serial number.

Acoustic release serviced for wire test - new batts etc.

RCM11 519: 30 min sample - Last data 2253+25sec day 234
cpu 2258+09 dsu 2248+29
data downloaded - 519_B_MRG.dsu
Good data

RCM11 426: 30 min sample - Last data 2253 + 30sec day 234
cpu 0053 + 44sec dsu 0039+27sec day 235
LOW PRESSURE drip across terminals 3,4,5
dried as salt crystals, washed with wd40 to inhibit corrosion - will require further attention at NOC
data downloaded - 426_B_MRG.dsu (BAD DATA blocks early march then recovering to good data)

RCM 9686: intercomparison rcm - failed due to battery terminal disconnection; NO data.

RCM7 9598: 1 hour sample - Last data 2309+18sec day 234
cpu 0222+00sec dsu 0209+18sec 23 Aug
Good data; data downloaded - 9598_B_MRG.dsu

RCM8 8248: 1 hour sample - Last data 2309+14sec day 234
cpu 0153+28sec dsu 0144+29sec 23 Aug
Good data; data downloaded - 8248_B_MRG.dsu

2.2.2 Mooring H

22 August 2006 - Day 234; Mooring H UKORS 2005/54.

2320 interrogate mooring use ARM; 2322 2424m, position 59 26 55.64N 41 08 56.99W. Good replies and indicating upright

23 August 2006 - Day 235: 0658 tx release - 2928m 2926m; 0742 sighted on surface; 0806 grappled; 0813 6 x benthos onboard; 0816 rcm 507 onboard; 0829 rcm 10280 onboard – tangled; 0842 rcm 518 and rcm 9681 onboard - tangled badly - rotor broken on recovery; 0842 all onboard.

All instruments in good condition. Hardware clean and minimal corrosion. Shackles a mix of red and yellow pins. Release hook clean. Instruments allowed to warm before opening .

Data downloaded onboard - files ***_H_Mrg.dsu, converted to Ascii - files ***_H_Mrg.asc
Acoustic release serviced for wire test - new batts etc

RCM8 10280: very short record 1118 words. Battery 0.1V total collapse. No last data.
Data downloaded as 01280_H_MRG.dsu
Instrument requires full investigation on return to NOC to determine either battery or instrument fault.

RCM8 9681: Rotor missing on recovery - subsequent data check reveals rotor lost during recovery.
60 minute sample
Last data 1258+20 sec day 235
cpu 1253+47s dsu 1247+22 sec
Download - good data; 9681_H_MRG.dsu.

RCM11 518: 30 minute sample
Last data 1338+10 sec day 235
dsu time not recorded
Download - good data; 518_H_MRG.dsu.

RCM11 507: 30 minute sample
Last data 1336+20 sec
cpu 1419+29sec dsu 1404+44sec day 235
Download - good data; 507_H_MRG.dsu.

2.2.3 Mooring A

23 August 2006 - Day 235; Mooring A UKORS 2005/55

1012gmt tx ARM 2362m; 1017 tx release 2332m; 1043 grapple 48 inch sphere; 1050 48 inch inboard; 1052 rcm 12691 inboard; at rcm 11678 chains and shackles twisted with wire - wire kinked badly; all rope sections very tangled - recovered on horns as lengths; 1150 gmt all inboard and secure.

All materials although twisted and damaged during recovery were in good condition and showed little corrosion or bio-fouling.

RCM 6750: Turned off immediately on opening up as flood and lithium batts - no last data - 60 minute sample. Case soaked in sink freshwater - replaced side bar on instrument and thoroughly cleaned all parts - replacing terminals etc as necessary.
cpu 1814+20 sec dsu 1801+29 sec day 235
Data download - good data

RCM11 383: 30 min sample
Last data 1709+40 sec day 235
cpu 1816+48sec dsu 1759+04sec
Data download - good data

RCM8 12691: savonius rotor IFREMER
Last data 1704+30 sec day 235
Data downloaded day 236

RCM8 12692: savonius rotor IFREMER
Last data 1704+30 sec day 235
Data downloaded day 236

RCM7 11678
Last data 1701+47sec day 235
cpu time 1713+22sec dsu 1716+16sec day 235
Data download - good data

2.2.4 Mooring C

25 August 2006 - Day 237; Mooring C UKORS 2005/52

0808 gmt tx REL 2929m. 0809 erratic replies - no confirms. 0811 2742m. 0830 surfaced starboard side, 0905 grappled, 0917 rcm 443 inboard, 0925 rcm 381 inboard tangled - line cut to recover, 0936 rcm 516 inboard slight tangle, 0940 rcm 515 inboard, 0944 all inboard, all mooring in clean condition.

RCM11 381: WATER LEAK in base of pressure housing - traces of leak running down from connector ch 3. No apparent electronic damage.
Data words 156371. Lithium battery falls to 3.01volts recovers to 3.58 volts – DRAINED. Data download 17th August 2006 noisy ref starts, then channel drop outs. Last dsu record 20th August 2006 0250 gmt. Rotate pressure sensor by hand - NOT TIGHT - possible source of leak. Low pressure leak then sealed ?
CPU time 1548 + 32sec dsu 1535 + 00sec 26th August
Data looks good until drop out: 381_C_MRG.dsu

RCM11 516:
Temperature set to LOW. DSU display not working correctly

Last data on P5059 1520+00

CPU time 1634+08sec dsu 1622+49 sec

Data download - Data good: 516_C_MRG.dsu

RCM11 515: 159108 words

Last dsu record 1606 26 aug 2006

Data download - Data good: 515_C_MRG.dsu

RCM11 443: 159099 words

Last record 1552 26th Aug 2006

CPU time 1824+05 sec dsu 1813+34sec 26 Aug 06

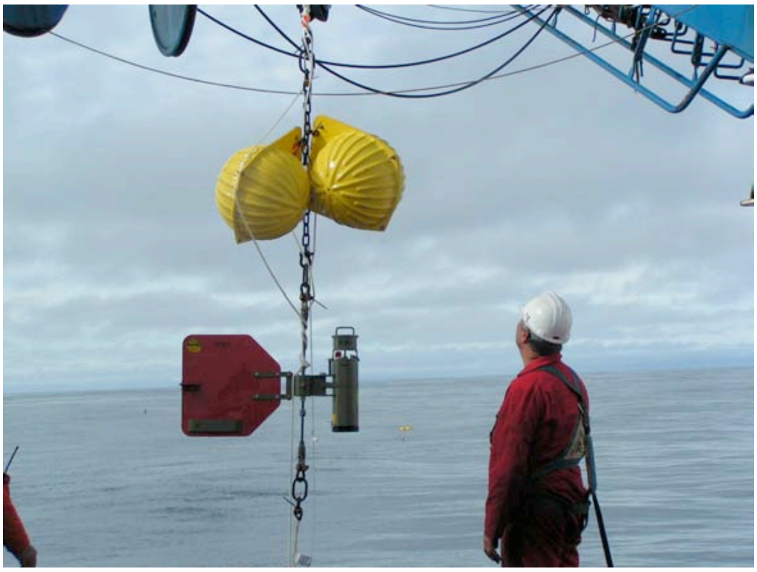
Data download - Data good: 443_C_MRG.dsu

RCM11 520: 159117 words

Last record 1800 26 Aug 06

CPU time 1914+45sec dsu 1911+05sec 26 Aug 06

Data download - Data good: 520_C_MRG.dsu



Recovering an RCM8 and Glass buoyancy - note tangled lines

2.2.5 Mooring D

25 August 2006 Day 237; MOORING D UKORS 2005/51

1332 gmt 59 03.05N 39 55.15W; 1335 2464m released; 1404 All surfaced; 1416 glass onboard; 1420 rcm 510 onboard; 1430 rcm 7452 onboard; 1440 rcm 444 onboard; 1444 rcm 10277 onboard and all secure inboard; all mooring in excellent condition

RCM11 444: 59570 words

Last data 0027 27 Aug 06, cpu time 0247+01sec dsu 0238+39 sec 27 Aug 06

Good data; Data file 444_D_MRG.dsu

RCM11 510:
Last data 0221 gmt 27th Aug 06
cpu time 0340+02sec dsu 0329+49sec 27th Aug 06
Data file: 510_D_MRG.dsu

RCM 7452: 54480 words
Last data 2305+20sec day 237, cpu time 23 37+32sec dsu 2332+56sec, dsu last data time 2251 25 aug 06
Download - good data: 7452_D_MRG.dsu

RCM 10277: 54480 words
Last data 2304+10 sec day 237, cpu time 2331+36 sec dsu 23 19+19 sec
Download - good data: 10277_D_MRG.dsu

2.2.6 Mooring E

25 August 2006 Day 237; MOORING E UKORS 2005/50

1647 gmt 3435m tx release 58 52 44N 39 24 48W; 1725 glass on surface; 1743 glass inboard; 1745 rcm 428 inboard; 1754 rcm 12293 inboard; 1801 all inboard; all mooring in excellent condition.

RCM11 428:
DSU 7872 faulty. Downloads to 0000s but continues to download to full record. Last data on dsu 1852 26 August 2006. CPU time 1954+33sec dsu 1945+15sec 26th august 2006
Data file: 428_E_MRG.dsu

RCM11 395: 59456 words
Last data 1926 26 aug 06; actual last time stamp on download 0106 gmt 27 Aug 06, cpu time 0201+02sec dsu 0151 +07sec 27 Aug 06.
Good data; Data file: 395_E_MRG.dsu

RCM 12293: 54480 words
Last data 2311+15 sec day 237, cpu 00 02+20sec dsu 2346+55sec, dsu last update time 2255+00 25 aug 06
Download - good data: 12293_E_MRG.dsu

2.2.7 Mooring G

31 August 2006 DAY 243; Mooring G UKORS 2005/49

2117, Slowed on approach; range 3207m; no replies to ARM + ARM NO COMMUNICATION; 2131 tx ARM + REL; range 3005m no rel confirm COMMUNICATION STARTS; 2155, sighted; 2208 Grappled and hauling; 2210 spheres on deck; 2334, all onboard and secure.

RCM11 438:

Last data observed at 2335 + 18 sec 31- 08 – 06. Last data on dsu 2326 31-08 -06. CPU 0015+45sec. DSU 0007+22sec 01-09-06

Data download - Good data: 438_G_MRG

RCM11 399:

Last data observed at 2332 +10 sec 31-08 – 06. Last data on dsu 0054+03 sec DSU 0043+41sec 01 - 09 06.

Data download - Good data: 399_G_MRG

RCM 8 12668:

Rotor missing on recovery - came onboard tangled - rotor lost on recovery. Last data observed at 0003+15sec 1st sept 2006, last data dsu 0043 01-09-06, Cpu 01 25 +35 sec, Dsu 0104+29 sec 1 sept 2006

Data download - Good data: 12668_G_MRG

2.3 Mooring Deployments

RCM8 and RCM11 current meters are used throughout .

Timing Table

MOORING ID	NMF MRG.NO.	CURRENT METER SERIAL NO.	FIRST DATA	DATE / DAY	SAMPLE INTERVAL
F	2006/31	12356	2300	19 AUGUST 2006 - 231	120MINS
F	2006/31	12363	2300	19 AUGUST 2006 - 231	120MINS
B	2006/32	524	1000	14 AUGUST 2006 - 226	120MINS
B	2006/32	525	1000	14 AUGUST 2006 - 226	120MINS
B	2006/32	9598	0830	25 AUGUST 2006 - 237	120MINS
B	2006/32	10280	1900	24 AUGUST 2006 - 236	120MINS
C	2006/33	9681	2100	24 AUGUST 2006 - 236	120MINS
C	2006/33	6750	1900	24 AUGUST 2006 - 236	120MINS
C	2006/33	427	1000	14 AUGUST 2006 - 226	120MINS
C	2006/33	526	1000	14 AUGUST 2006 - 226	120MINS
A	2006/34	514	1000	14 AUGUST 2006 - 226	120MINS
A	2006/34	8248	1900	24 AUGUST 2006 - 236	120MINS
A	2006/34	528	1000	14 AUGUST 2006 - 226	120MINS
H	2006/35	527	1000	14 AUGUST 2006 - 226	120MINS
H	2006/35	12293	1630	27 AUGUST 2006 - 239	120MINS
H	2006/35	522	1000	14 AUGUST 2006 - 226	120MINS

All RCM11s are set to 6 channel operation with burst sampling. As deployment is likely to extend to a 2 year duration a conservative 120 minute sampling period is used. All RCM8s are set 120 minutes.

Hardware:

For this series of moorings an extended duration to a possible 2 years can be anticipated - thus hardware is correspondingly prepared for this duration. All shackles used are GREEN PIN - fed spec screw pin BOW. Oval links are all mild steel galvanised -custom made by MES. Release links are all the 2005 increased type - each bound with pvc tape as insulator from release mechanism. Lines are all polyester 10mm - Gleistein - spliced and prepared by Gleistein. Recovery and handling line is all Gold Strand 3 strand polypropylene. Chain is all galvanised long link - 3/8" for buoyancy packs - 1/2" for in line chain - 5/8" for binder and connection of chain clumps. Anchors for moorings F, B, C are 3 x railway wheels on a steel centre spindle. Anchors for moorings A, H are chain clumps due to loss of railway wheels on boomerang moorings. Glass is all recycled from 2005 deployments.

Cape Farewell D309 Equipment Deployed By Mooring

EQUIPMENT	MRG F	MRG B	MRG C	MRG A	MRG H
	2006/31	2006/32	2006/33	2006/33	2006/34
LRADCP 75	5080				
RCM8	12356 12363	9598 10280	9681 6750	8248	12293
RCM11		524 525	427 526	514 528	527 522

AR861	257	311	310	355	360
ARGOS	71620				
XENON FLASH	SO6-004				
GLASS 17 INCH	5	15	15	13	13

2.3.1 Mooring F

23 August 2006 - Day 235; Mooring F UKORS 2006/31

Thick fog deploy. Calm sea. Deployed buoy first - anchor freefall - monitor descent on PES single element. ARGOS checked when on surface using GONIO - good reception. When submerged no ARGOS detection. ADCP buoy floats upright with argos and light well clear of surface. 1540 lifting in rcm 12363. 1543 in water - towing on anchor. Anchor away - 1605gmt 59 47 07.5 N 42 17 30.8W lab. 59 47.15N 42 17.46W Bridge position. 1611 Vertical - 9.6V. 1616 getting underway

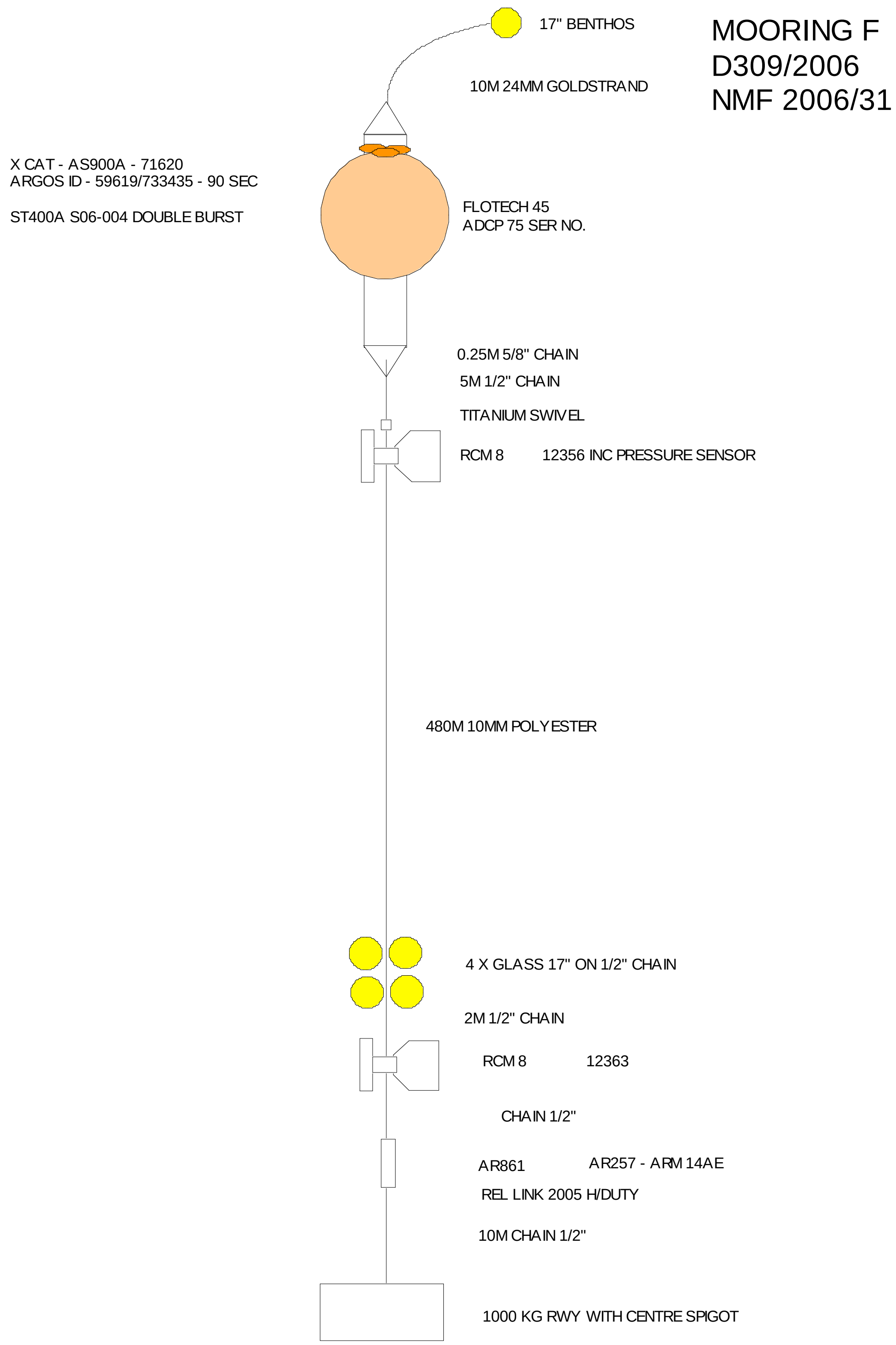
ADCP buoy showing line rigging - lift line , bypass line5/8" chain immediately beneath buoy and 1/2" to RCM.

Navigation Aids:

Mooring F is the only mooring fitted with navigation aids: an Argos SMM and xenon flasher. ARGOS ID – 733435

Long Ranger 75 ADCP:

Further detail information can be obtained from the Mooring Team Cruise 309/10 Final Report available from the Sensors and Moorings Group , NMF, NOC ,UK



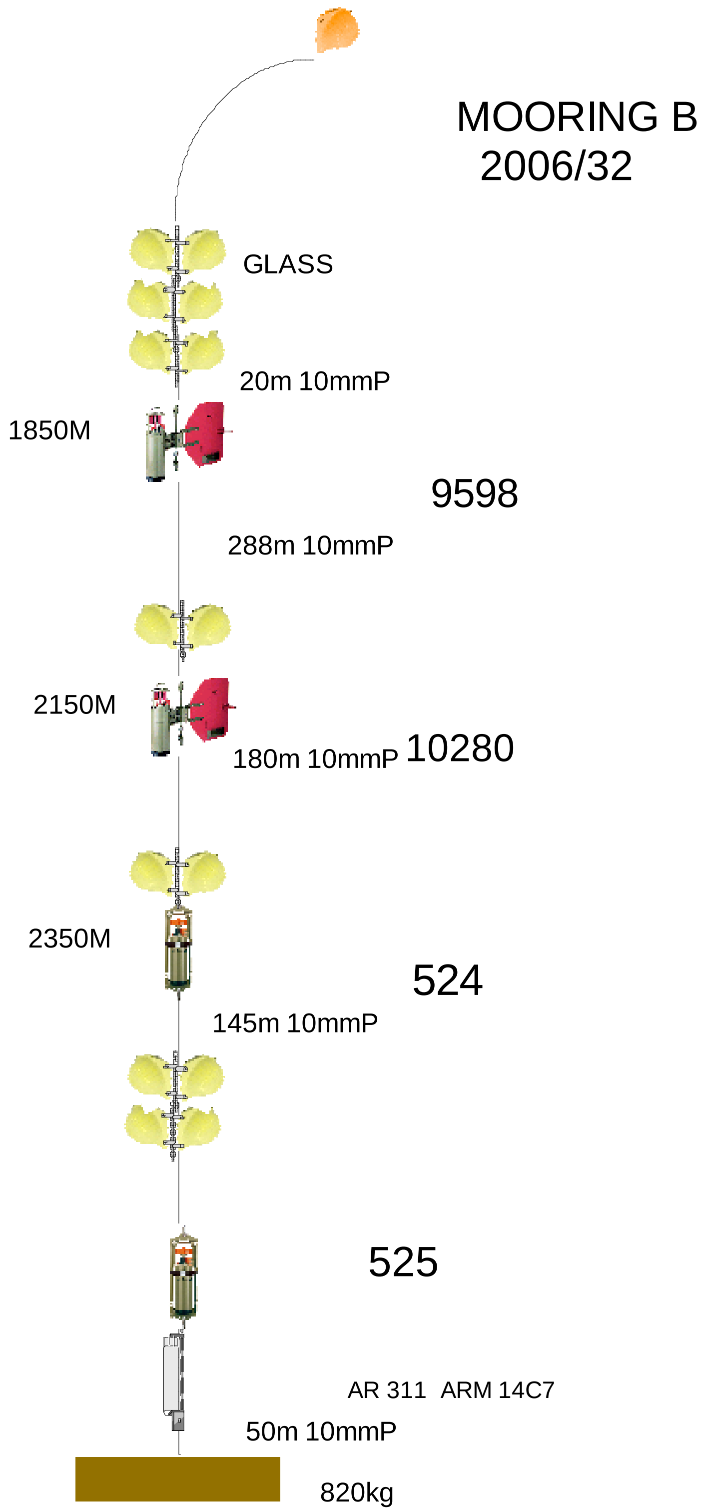
17" BENTHOS
MOORING F
D309/2006
NMF 2006/31
10M 24MM GOLDSTRAND
X CAT - AS900A - 71620
ARGOS ID - 59619/733435 - 90 SEC
ST400A S06-004 DOUBLE BURST
FLOTECH 45
ADCP 75 SER NO.
0.25M 5/8" CHAIN
5M 1/2" CHAIN
TITANIUM SWIVEL
RCM 8 12356 INC PRESSURE SENSOR
480M 10MM POLYESTER
4 X GLASS 17" ON 1/2" CHAIN
2M 1/2" CHAIN
RCM 8 12363
CHAIN 1/2"
AR861 AR257 - ARM 14AE
REL LINK 2005 H/DUTY
10M CHAIN 1/2"
1000 KG RWY WITH CENTRE SPIGOT

2.3.2 Mooring B

25 August 2006 - Day 237; Mooring B NMF 2006/32

Deployment conventional buoy first from baskets using crane for heavier lifts overside**.** 0552 gmt all mooring deployed - check release using pes fish - ranges 107m. 0553 4 cables to run in at 1 kt. 52 20 19N 40 49 13W. 0604+40s Anchor away 59 20 00.51N, 40 49 15.15W, lab water depth 2680.5m. 0625 2694m vertical 9.8v; all deployed.

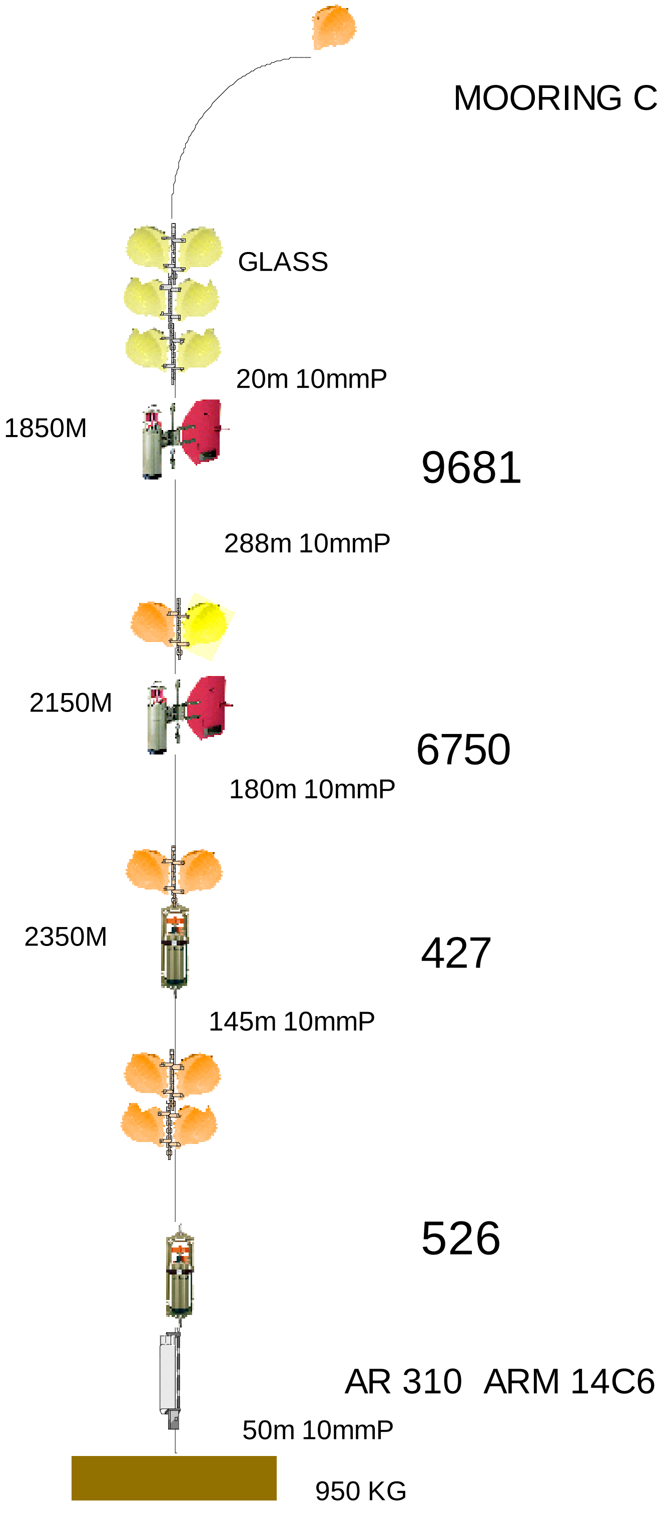
Deck layout for basket deployment


MOORING B
2006/32
GLASS
20m 10mmP
1850M
9598
288m 10mmP
2150M
180m 10mmP
10280
2350M
524
145m 10mmP
525
AR 311
ARM 14C7
50m 10mmP
820kg

2.3.3 Mooring C

25 August 2006 Day 237; MOORING C UKORS 2006/32

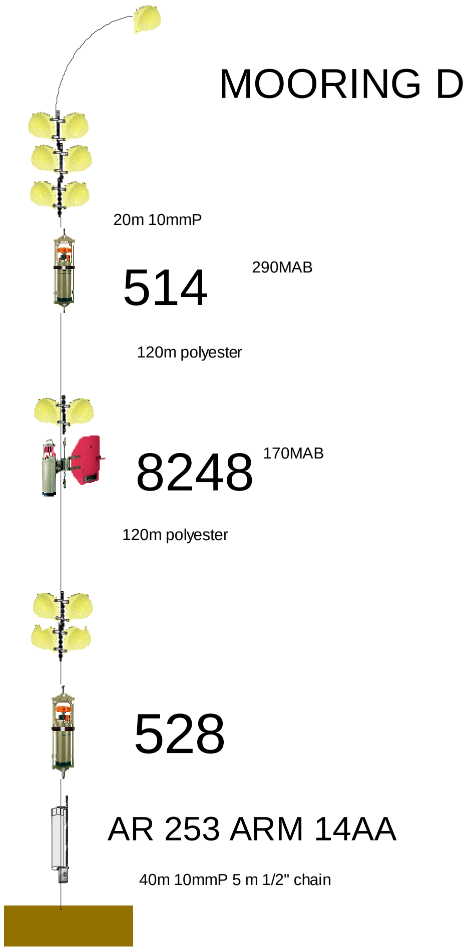
Deployment buoy first - anchor last from baskets, 1052 buoyancy outboard, 1121+45 sec anchor away; 1121+55sec 59 11 10.45N 40 21 20.58W, 2908 ucm, 1145, 2913 m, vertical 9.8v.



2.3.4 Mooring D (boomerang)

25 August 2006 Day 237; Mooring D No NMF number given as BOOMERANG

Deploy buoy first - anchor freefall - actually very freefall; 2012 buoys outboard; 2013 rcm 514 outboard; 2017 rcm 8248 outboard; 2023 rcm 528 and rel outboard; 2030 gmt all mooring astern and towing on anchor; check range and release test under tow 106m; 2035 anchor away, 59 03 06.97N 39 54 50.46W; 2038 583m; 2039 722m; 2044 1011m; 2047 779m coming up !!!!; 2048 755m; 2049 747m; Back on surface - recovery operation.



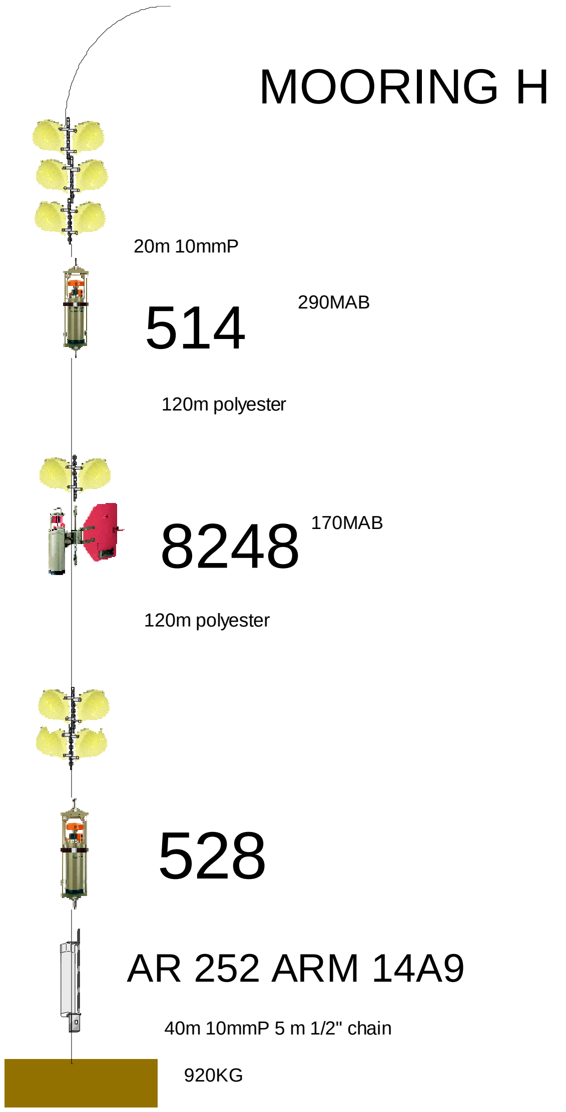
On recovery hook had released on AR253 - tested in lab, full examination, no fault can be found - return to NOC for further tests.

2.3.5 Mooring H (boomerang)

27 August 2006 Day 239; Mooring H No NMF number given as BOOMERANG

Again a boomerang - this time release of anchor occurred very near to surface !! Patience is wearing thin !! Deployment as baskets - then towing onto site; Anchor away 1258+30, 59 27 26.76N, 41 09 22.2W 2428m; 1302 318m; 1305 378m; 1309 418m; 1310 416m this on surface and only changes due to ships way.

Pick up rig and curse and swear a lot - release hook open - tested in lab - no cause can be found - return to NOC for further investigation - if time another wire test to be done onboard.

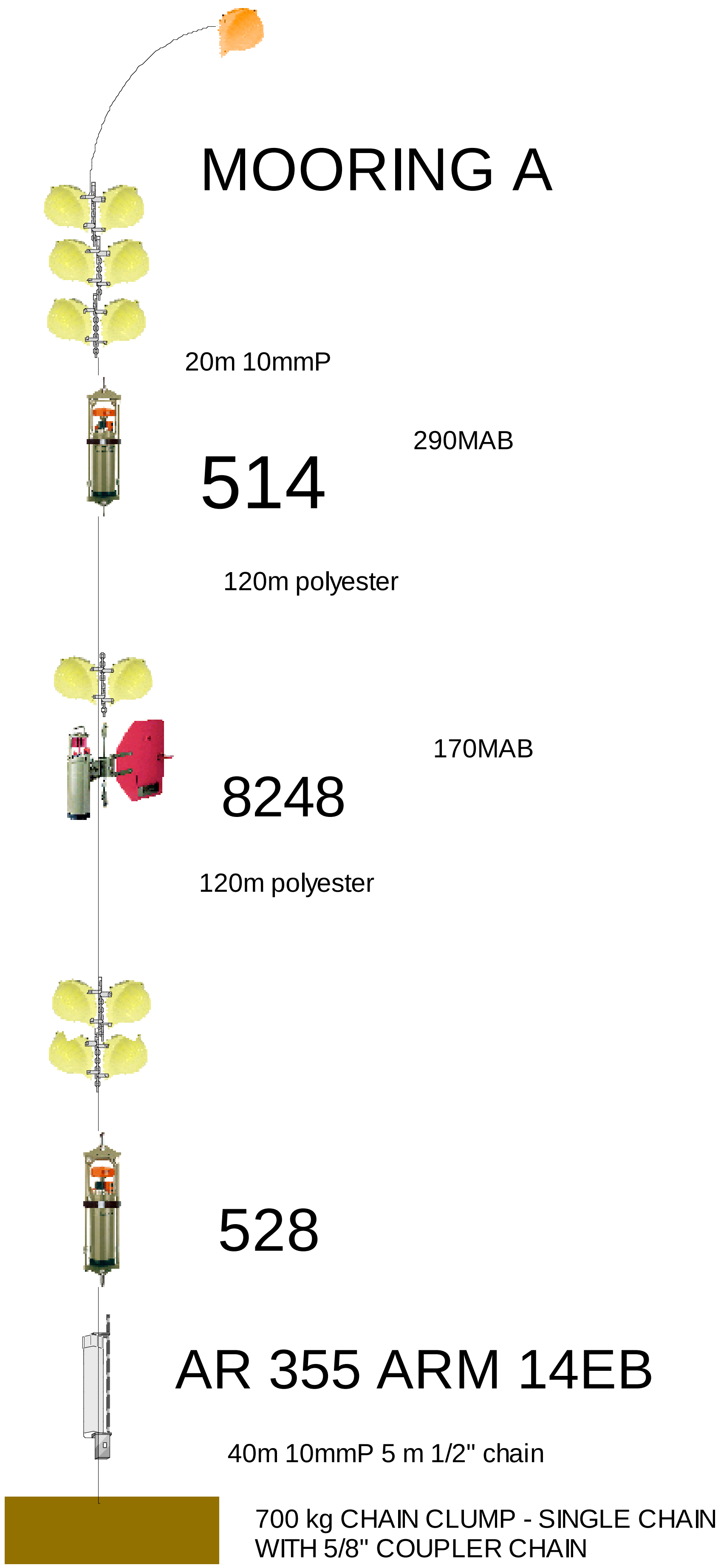


2.3.6 Mooring A

29 August 2006 - DAY 241 - Mooring A UKORS 2006/33

Mooring A deployed buoy first - anchor last from baskets as previous. On releasing the anchor no interrogation was made of the release until well clear of the ship and once buoys were seen to have submerged. 0920 commence deploy; 0918 rcm 8248 OB; 0930 all outboard; 0938 towing; 0939+30 Anchor away - 59 33.169N, 33 54.05W; 0941 spheres all submerged; Tx noisy - erratic or no replies using ARM + DIA; Traced to Benthos deck unit block connected onto Y harness - arcing across during txm; Signal then clears and good replies; 0957+30 2113 2112 VERTICAL 9.9v. The anchor was a clump chain type made up of one length of heavy steel chain connected to the mooring using a 5/8" galvanised steel binder chain with additional 1/2" chain to bind the anchor tightly together.

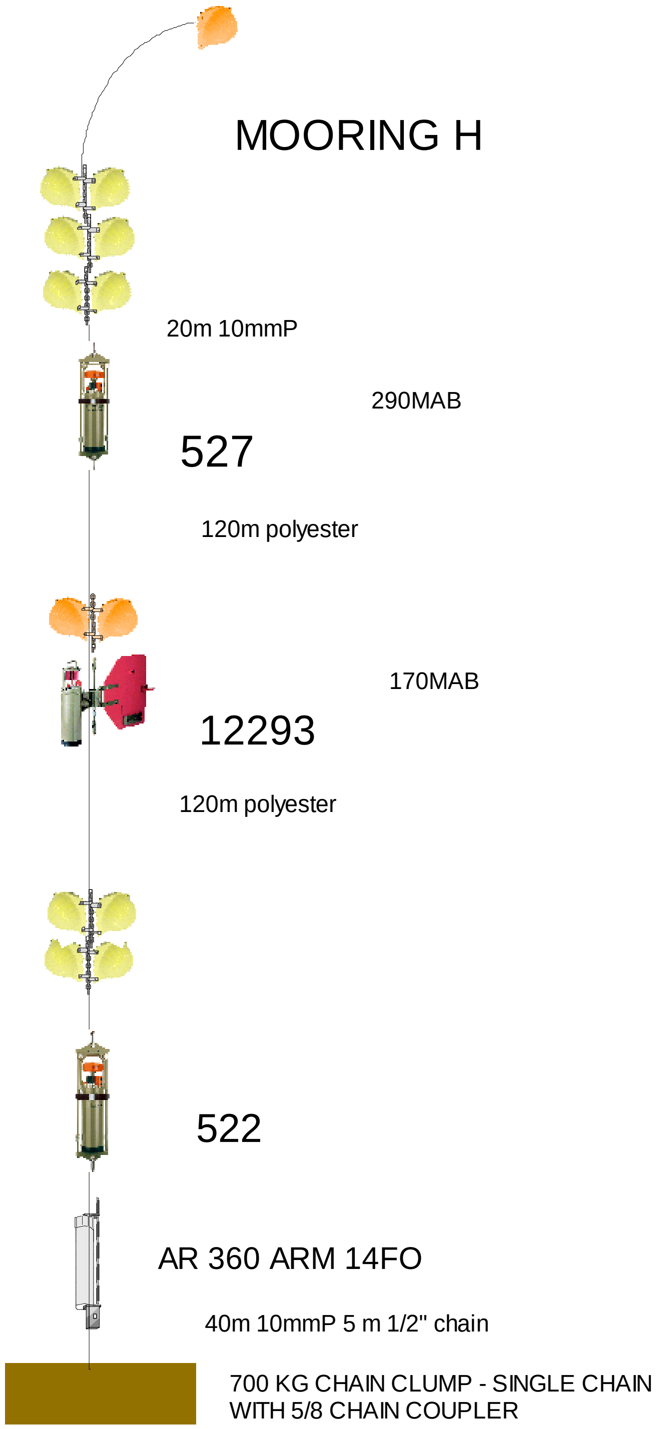
MOORING A


20m 10mmP
290MAB
514
120m polyester
170MAB
8248
120m polyester
528
AR 355 ARM 14EB
40m 10mmP 5 m 1/2" chain
700 kg CHAIN CLUMP - SINGLE CHAIN
WITH 5/8" COUPLER CHAIN

2.3.7 Mooring H

29 August 2006 DAY 241 - MOORING H UKORS 2006/34

Mooring H prepared during short steam from mooring A. Deployment buoy first - anchor last from baskets. Acoustic release monitoring as mooring A. 1131 Commence deploy; 1132 rcm 527 ob; 1137 rcm 12293 ob; 1142 all outboard; Towing; 1156 anchor away 59 26 33.36N, 41 09 34.71W, 2450M ucm; 1216, 2452 m, vertical 9.8v. The anchor was a clump chain type made up of one length of heavy steel chain connected to the mooring using a 5/8" galvanised steel binder chain with additional 1/2" chain to bind the anchor tightly together.



2.4 Calibrations

2.4.1 RCM7 and RCM8 Pre-D298 Calibrations

The tables below show pre-cruise (2005–D298) calibration coefficients for (i) conductivity and temperature, (ii) pressure for Aanderaa RCM7 and RCM8 instruments deployed during 2005 on D298 and recovered during D309.

	CONDUCTIVITY		TEMPERATURE			
Serial No.	A	B	A	B	C	D
6750	26.67217363	0.00991607	-0.97530432	0.00733859	-7.15E-08	5.04E-11
7452	26.60648376	0.009861133	-0.849042503	0.00729394	-8.28E-08	7.78E-11
9450	26.72282365	0.009852066	-0.776126019	0.00729872	-7.35E-08	1.69E-11
9598	26.72567425	0.009826446	-0.624383984	0.00732066	-1.69E-07	1.24E-10
9681	26.79870267	0.009800259	-0.981172956	0.00735465	-6.18E-08	4.44E-11
9686	26.79544999	0.009779594	-0.840249146	0.00727212	2.48E-08	8.27E-12
10277	26.48779445	0.00990674	-0.887769058	0.00737436	-1.87E-07	1.30E-10
10280	26.58637866	0.009835517	-0.943403674	0.00732406	-1.30E-07	8.91E-11
11678	NOT FITTED		-0.871071938	0.00732952	1.94E-08	-6.47E-12
12293	26.2024128	0.009932956	-0.846290418	0.00741922	-2.39E-07	1.43E-10
12668	26.67201753	0.009729307	-0.812841941	0.00740341	-1.79E-07	1.16E-10

	PRESSURE			
Serial No.	A	B	C	D
6750	4.26E+00	5.39E+00	-1.17E-03	6.54E-07
7452	-1.44E+02	5.31E+00	-2.47E-04	1.29E-07
8248	-1.10E+02	5.23E+00	-1.22E-04	2.68E-08
9450	NOT FITTED			
9598	-1.37E+02	3.04E+00	-4.39E-05	1.91E-08
9681	NOT FITTED			
9686	NOT FITTED			
10277	-3.11E+02	8.31E+00	1.23E-03	-5.68E-07
10280	-4.21E+02	8.44E+00	9.18E-04	-3.40E-07
11678	NOT FITTED			
12293	-1.73E+02	5.24E+00	-1.41E-04	7.02E-08
12668	-1.82E+02	5.22E+00	-1.11E-04	3.99E-08

2.4.2 RCM11 Instruments

Temperature Ranges:

510	ARCTIC	520	ARCTIC
444	ARCTIC	381	ARCTIC
516	LOW	428	ARCTIC
443	ARCTIC	426	ARCTIC
395	LOW	518	ARCTIC
515	ARCTIC	507	ARCTIC
383	ARCTIC	519	ARCTIC

ARCTIC: –3.01 to +5.92 degC

LOW: –2.70 to +21.77 degC

Conductivity Ranges:

All set to 30 – 35 mS/cm

Pressure:

All fitted: 0-60 MPa

2.4.3 RCM Calibration on CTD Stations

RCMs were strapped around the CTD frame as space permitted on several stations for direct comparison between CTD (P, T, C) sensors and RCM sensors as appropriate. All RCMs were set to sample at 1 minute intervals.

Date (dd mm yyyy) Day #	Stn #	RCM type	RCM Serial #						
24 08 2006 - 236	3	RCM8	8248	9681	6750	10280			
24 08 2006 - 236	5	RCM7	9598	11678					
26 08 2006 - 238	11	RCM8	10277	7452	12293				
31 08 2006 - 243	20	RCM11	516	395	443	428	444	520	510
31 08 2006 - 243	21	RCM11	519	381	515	383	518	507	426
01 09 2006 - 244	23	RCM11	399	438	12668				

All output data files named *RCM-SER*_MRG_CAL.dsu, where *RCM_SER* is the RCM serial number as in the above table. Note that, as a precaution, the data acquired during the calibration CTD casts were appended after the data acquired during the year's deployment.

2.5 Acoustic Releases

2.5.1 Recovered Releases

Mooring A: AR354; Lab test - serviced batteries removed - return to NOC

Mooring H: AR355; Serviced onboard - new batteries - wire test carried out; REDEPLOYED Mooring A

Mooring B: AR360; Serviced onboard - new batteries - wire test carried out; REDEPLOYED Mooring H

Mooring C: AR325; Serviced onboard - new batteries - wire test carried out; Prepared for D312 - J Allen

Mooring D: AR364; Lab test - serviced batteries removed - return to NOC

Mooring E: AR327; Lab test - serviced batteries removed - return to NOC

Mooring G: AR316; Lab test - serviced batteries removed - return to NOC

2.5.2 Deployed Releases

All releases are IXSEA AR861 B2S DDL serviced and wire tested to operating depth onboard. Serial numbers 355 and 356 are recycled from the 2005 array to replace failed boomerang units 252 and 253. All releases are prepared for an endurance to 3 years. Conventional coding for all commands.

Mooring F: 257 NMF 2006/31 - deployment depth 1133m; ARM = 14AE

Mooring B: 311 NMF 2006/32 - deployment depth 2680m; ARM = 14C7

Mooring C: 310 NMF 2006/33 - deployment depth 2913m; ARM = 14C6

Mooring D: 253 No NMF number - boomeranged at 1100 metres; hook opened - triggered faulty release - Return to NOC

Mooring H: 252 No NMF number - boomeranged near surface; hook opened - triggered faulty release - Return to NOC

Mooring A: 355 - reworked release - full service onboard - new batteries - wire tested; ARM = 14EB

Mooring H: 360 - reworked release - full service onboard - new batteries - wire tested; ARM = 14F0

3 NIOZ MOORINGS

Hendrik van Aken

3.1 Introduction

According to satellite altimetry the Irminger Sea is particular in the aspect that the inter-annual change of the sea surface level (SSL) is larger in magnitude than either the seasonal or eddy contributions to the SSL variability. Comparison of the satellite derived SSL with the hydrography obtained along the WOCE AR7E section through the Irminger Sea has shown that the inter-annual changes of the SSL are correlated with shift in the main water mass properties in the Irminger Sea, in particular in the depth levels from 200 to 1500 m. Recently also the hydrographic structure below 1500 m has shown signs of inter-annual changes. However, the near-annual surveys of the AR7E section by German and Dutch research groups did not resolve the mechanism of the change of the water mass from year to year, being either of convective nature, driven by air-sea heat exchange in winter, by changes in the advection by the wind driven currents, or by near-isopycnal exchange.

In the framework of the Dutch Long-term Ocean Climate Observations (LOCO) programme two profiling CTD moorings have been deployed in 2003 in the Irminger Sea for a total period of at least 5 years. The purpose of these moorings is to monitor the variability of hydrographic properties on a range of time scales, not covered by the annual surveys of the AR7E line, focused on the intermediate water masses. The moorings were intended to record one T-S profile between 150 and 2400 m per day. The westernmost mooring position, LOCO-2, is located in the centre of the Irminger gyre near the 3000 m isobath, the easternmost mooring position is located along the AR7E section near the 3000 m isobath of the Reykjanes Ridge, LOCO-3. During the Discovery 309-310 cruise these moorings were recovered, serviced, and re-deployed. The recovered instruments in both moorings (Long-ranger ADCPs, a McLane CTD profiler and an SBE Seacat CTD) gave contained for the complete mooring period.

Near the LOCO-2 site a sediment trap has been deployed since 2003 (the IRM site). This mooring forms part of the RAPID UK/No/NL VAMOC programme (Variations of the Meridional Atlantic Overturning Circulation). The purpose of this mooring, fitted with two sediment traps, is to determined how the hydrographic variability in the deep Irminger Sea is imprinted as proxy into sediment properties, both from re-suspended and from newly arriving particles.

3.2 Mooring recovery

The moorings LOCO2-3 and LOCO3-3 were recovered without problems. The ADCPs and the CTD profilers appeared to have recorded data without any serious flaw. In both Seacats the pressure sensor was damaged. The recovered profilers and Seacats will be taken to Texel for a post cruise calibration and repair.

The motor of the near-bottom sediment trap in mooring IRM3 had leaked seawater. This happened early after deployment, so that all sediment from one year was collected in a single sample bottle. The upper sediment trap in this mooring, mounted 242 m above the bottom, did function without any problems.

The information on the sensors and instruments in the recovered moorings, including acoustic releases and ARGOS beacons, is given in Tables 3.1a to 3.1c. Additional to the physical sensors the LOCO moorings contained each 2 additional passive samplers to determine the concentration of hydrophobic organic substances (K, Booij, Royal NIOZ, PI).

Table 3.1a: The recovered mooring LOCO2-3.

Mooring LOCO 2-3	Latitude 59º12.20'N	Longitude 39º30.48'W	Corrected depth in water (m) 3029	deployment time 15-Sep-2005 19:17
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
bottom weight			3029	
releases				
OCEANO	#146	8	3021	
OCEANO	#352	8	3021	
Passive sampler	#28		3020	
Seacat	#2671	23	3006	1/4 min
Longranger ADCP	#3513	582	2447	1/20 min
McLane profiler	#11564-4		150-2400	1/day
Passive sampler	#11	2903	126	continuous
Longranger ADCP	#3514	2904	125	1/20 min
ARGOS beacon	#60676	2905	124	ID = 23123

Table 3.1b: The recovered mooring LOCO3-3.

Mooring LOCO 3-3	Latitude 59º14.90'N	Longitude 36º34.08'W	Corrected water depth (m) 3048	deployment time 14-Sep-2005 17:12
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
bottom weight			3048	
releases				
OCEANO	#148	8	3040	
OCEANO	#149	8	3040	
Passive sampler	#9		3039	
Seacat	#2667	23	3024	1/4 min
Longranger ADCP	#3652		2464	1/20 min
McLane profiler	#11564-2		150-2400	1/day
Passive sampler	#7		145	continuous
Longranger ADCP	#3597	2904	144	1/20 min
ARGOS beacon	#60678	2905	143	ID = 22119

Table 3.1c: The recovered mooring IRM3.

Mooring IRM 3	Latitude 59º15.39'N	Longitude 39º38.00'W	Corrected water depth (m) 2994	deployment time 15-Sep-2005 20:17
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
bottom frame			2994	
releases				
Benthos	#750	1	2993	
Benthos	#530	1	2993	
OBS data logger	#BC	1	2993	1/6 min
Technicap PPS-5 (sed trap)	#71	2	2992	
OBS data logger	#BB	241	2753	1/6 min
McLane Sed Trap		242	2752	
ARGOS beacon	#11635	293	2701	ID = 2050

3.3 Preliminary results

On board most of the data processing was carried out, apart from the final temperature and conductivity calibration of the profiling CTDs and the Seacat CTDs. As an example of the profiler data the temporal development of the potential temperature and salinity between 150 and 2400 m of mooring LOCO2-3 (Figures 1 and 2). Since near-isopycnal thermohaline fine-structure appeared to be the main cause of the hydrographic variability on time scales from 1 to 30 days, these data were smoothed with a 2-dimensional Bartlett filter with a horizontal width of 30 days, and a vertical extent of 100 dbar. A particular feature was a trend of increasing temperature and salinity at ~1100 m, the level of the salinity minimum connected with the presence of recently formed Labrador Sea Water. Next to the long term trends, the influence of meso-scale eddies with a characteristic time scale of 30 to 50 days is visible.

A first analysis of the profiler and Seacat data and comparison with data from previous years suggests that no serious problems can be expected with regard to the calibration of these sensors.

The low-pass filtered velocity data from the ADCPs show a dominantly columnar motion with only a small vertical shear (Figure 3 for examples of mooring LOCO2-3). The main features in the low-pass filtered velocity data are meso-scale eddies, also with characteristic time scales of 30 to 50 days. In the high-frequency motion internal waves with a semi-diurnal tidal frequency were dominant.

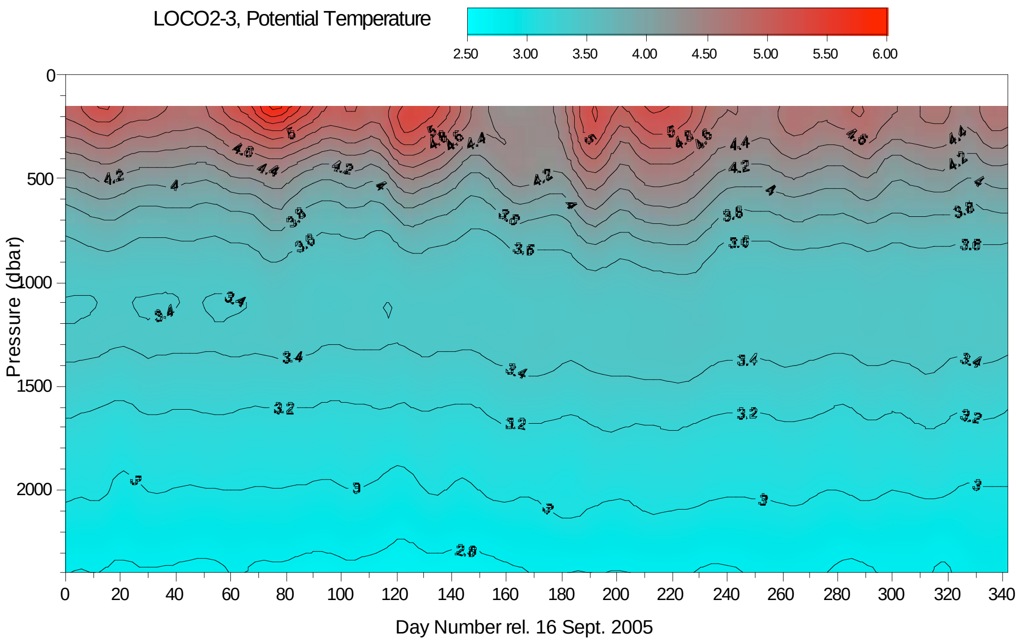


Figure 1. Time-pressure section of the smoothed development of the potential temperature at mooring LOCO2-3, observed with a McLane CTD profiler.

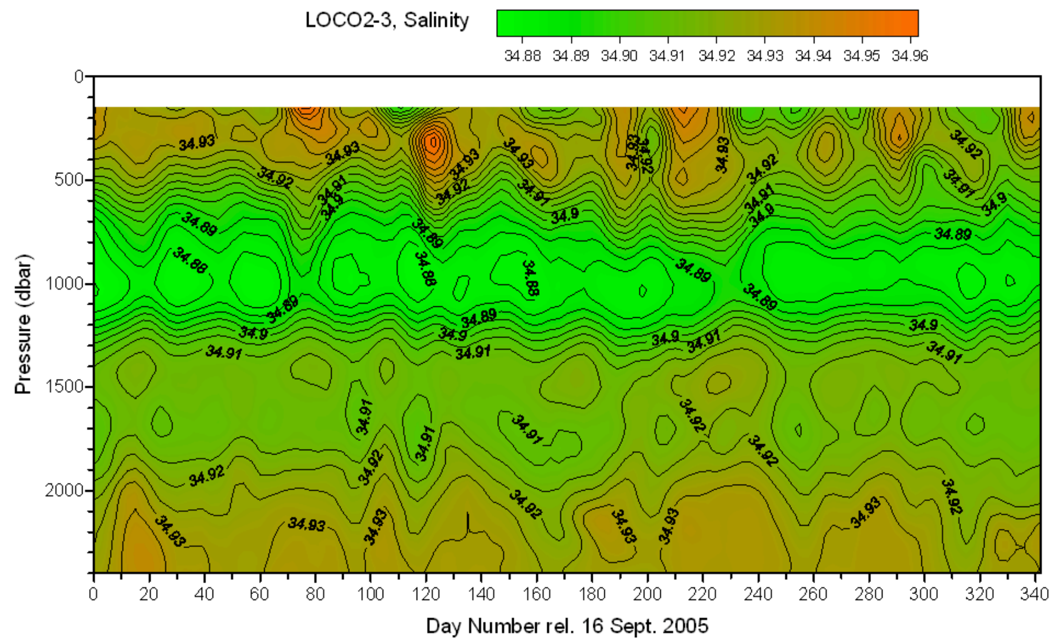


Figure 2. Time-pressure section of the smoothed development of the salinity at mooring LOCO2-3, observed with a McLane CTD profiler.

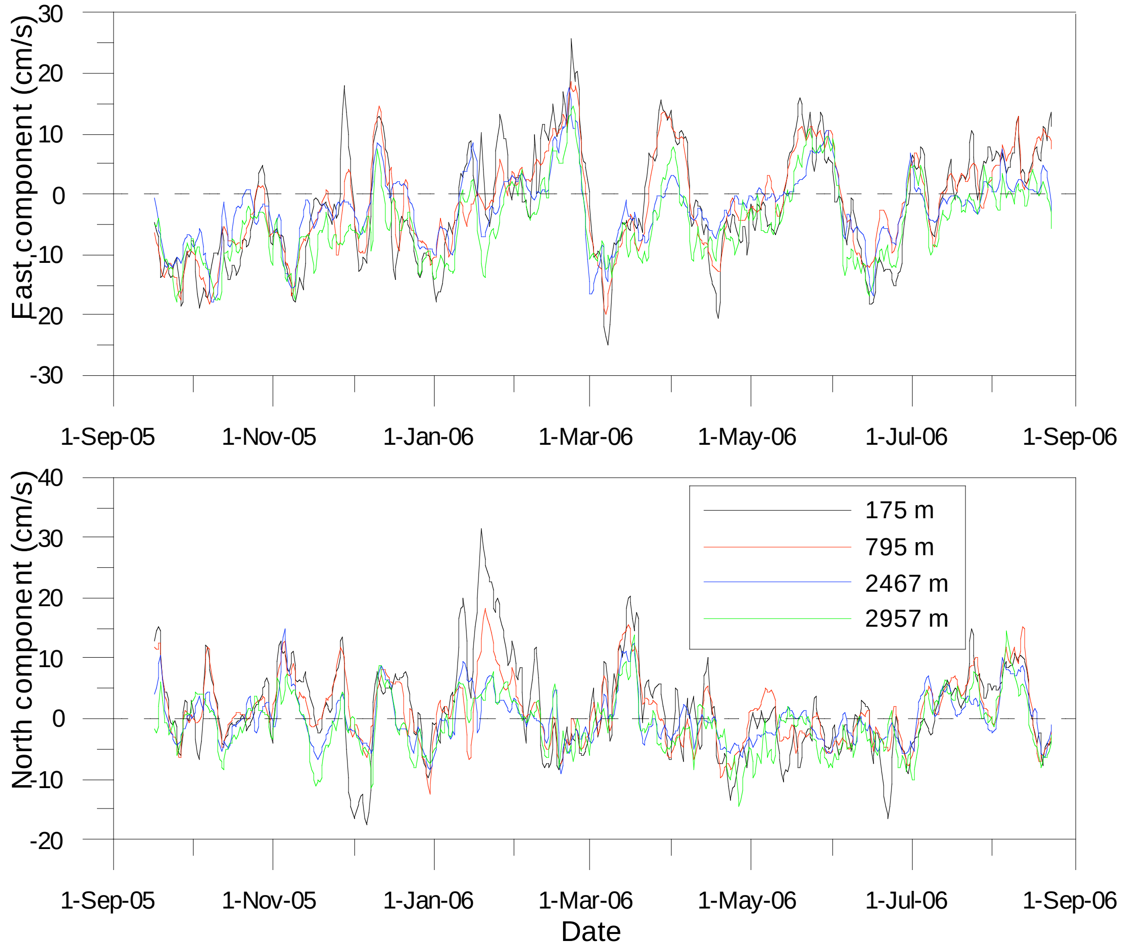


Figure 3. Low-pass filtered velocity components of four selected ADCP bins at mooring LOCO2-3

3.4 Deployment of moorings

All three NIOZ moorings have been re-deployed for the fourth observation period at approximately the same position where they were recovered. The configuration of the moorings (tables 2a to 2c) was nearly similar with a few exceptions. No passive sensors for organic substances ware mounted in the LOCO2-4 and LOCO3-4 moorings. No Seacat was mounted in mooring LOCO3-4. And an Aanderaa current meter was added to mooring IRM4, on short distance above the lower sediment trap. The deployments succeeded without particular problems.

Table 3.2a: Configuration of the deployed mooring LOCO2-4

Mooring LOCO 2-4	Latitude 59º11.76'N	Longitude 39º30.61'W	Corrected depth in water (m) 3019	deployment time 27-Aug-2006 20:10
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
bottom weight				
releases				
OCEANO	#146	8	3011	
OCEANO	#352	8	3011	
Longranger ADCP	#3699	581	2438	1/20 min
McLane profiler	11564-01		150-2400	1/day
Longranger ADCP	#7082	2900	119	1/20 min
ARGOS beacon	#60676	2911	108	ID=23123

Table 3.2b: Configuration of the deployed mooring LOCO3-4

Mooring LOCO 3-4	Latitude 59º14.21'N	Longitude 36º23.98'W	Corrected depth in water (m) 3016	deployment time 01-Sep-2006 13:20
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
bottom weight			3016	
releases				
OCEANO	#148	8	3008	
OCEANO	#149	8	3008	
Longranger ADCP	#3513	581	2435	1/20 min
McLane profiler	#12009-01		150-2400	1/day
Longranger ADCP	#3514	2900	116	1/20 min
ARGOS beacon	#60664	2911	105	ID=22179

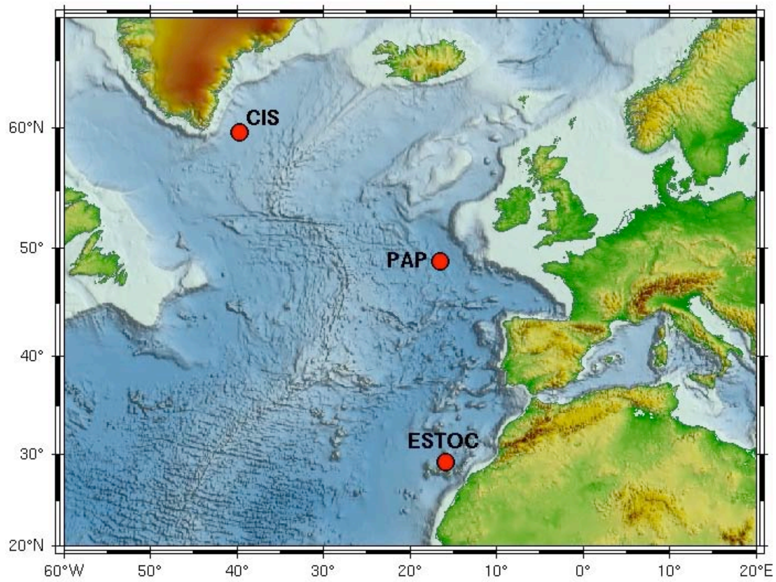
Table 3.2c: Configuration of the deployed mooring IRM4

Mooring IRM 3	Latitude 59º14.85'N	Longitude 39º39.47'W	Corrected water depth (m) 2989	deployment time 28-Aug-2006 00:41
instuments & cables	S/N	height above bottom	Corrected depth in water (m)	remarks
Technicap PPS-5 in frame	#70		2989	
releases				
Benthos	#708	1	2988	
Benthos	#1002	1	2988	
OBS data logger	#B7	1	2988	1/6 min
Technicap PPS-5 (sed trap)		2	2987	
Aandera RCM8	#1126	14	2975	1/30 min
OBS data logger	#B1	241	2748	1/6 min
Technicap PPS-5 (sed trap)	#71	242	2747	
ARGOS beacon	#11635	293	2696	ID = 2050

4 IFM–GEOMAR ACTIVITIES

Johannes Karstensen, Andreas Pinck, Gerd Niehus, Fritz Karbe

Task: CIS mooring exchange (6th); (recovery of SPRAY glider - different report)



4.1 Introduction

The Central Irminger Sea (CIS) mooring is one of three autonomous multidisciplinary time series stations established in 2002 in the northeast Atlantic Ocean as part of the EU funded ANIMATE (Atlantic Network of Interdisciplinary moorings and time series for Europe). The central observational strategy at the mooring sites is guided by improving our understanding of the interaction between physical and biogeochemical cycling in the ocean, in particular understanding the processes controlling the oceans uptake of carbon dioxide - the most important sink of the anthropogenic carbon release to the atmosphere.

The CIS mooring is equipped with a satellite link to send data in real-time to shore and make it available for assimilation into numerical models in the framework of the EU-project MERSEA (Marine environment and security for the European Area, http://www.mersea.eu.org/). The aim of MERSEA is to establish a European capacity to monitor and forecast the oceans physical and ecological state - similar to an ocean 'weather forecast'.

Details about the 6th maintenance visit to the CIS time series station are described here. Originally the time series station was composed by two single moorings close to each other and sharing the significant instrument load. However, since May 2004 a single mooring is at place. The nominal position of the time series site is 59°N 40' / 039°W 43' in about 2800m water depth. The recovery reported here took place on 24 Aug. 2006, and deployment on 29 Aug. 2006.

4.2 MicroCat

4.2.1 Recovered instruments

The CIS mooring contained 14 Microcats which have all been recovered during D309 (see table for an overview on the instruments). All instruments worked well during the deployment period and no specific problems could be identified.

Table 4.1: Summary of MicroCats recovered from the CIS mooring during D309

Serial #	Sample Interval [s]	Nom. Depth [m]	Pres.	Records from	Records to	Deck Pressure Offset pre/post
0959	1200	10	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	x / x
3411	1200	31	yes	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	-0.4 / -0.4
3414	1200	43	yes	17 Sep 2005, 18:00:01	25 Aug 2006, 09:20:00	0.2 / -0.3
0962	1200	73	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	x / x
1719	1200	112	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	x / x
2262	1200	156	yes	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	-0.9 / -1.0
1723	1200	198	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:01	x / x
0953	1200	268	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:01	x / x
2801	1200	373	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:01	x / x
2488	1200	548	yes	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:01	-1.0 / -1.0
2799	1200	741	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:00	x / x
2271	1200	995	yes	18 Sep 2005, 12:00:01	24 Aug 2006, 19:00:01	-6.1 / -6.2
2264	1200	1246	yes	18 Sep 2005, 12:00:01	24 Aug 2006, 19:20:01	-10.7 / -10.7
0950	1200	1497	no	18 Sep 2005, 12:00:01	24 Aug 2006, 19:40:01	x / x

Data recovery and processing:

The temperature data has been converted to IPTS-68. After allocating a pressure value (no pressure sensor trends have been detected) to all instruments a pressure correction has been applied to the conductivity cell (as recommended by SeaBird) and the salinity (PSS-78) was calculated. All instruments have been linear interpolated to a standard time grid.

Calibration cast:

Station D309 012 at 59°N 17.66 / 036°W 26.29; Water depth: 3117m (uncorrected). Cast D309003 was also in the vicinity of the mooring but no attached MircoCats.

A full depth CTD cast was performed with 13 MicroCats (#2271 was mounted but cast failed) attached to frame. Remaining bottles were used for salinity sampling. The cast was taken near the eastern most NIOZ profiler mooring. In addition to the MicroCats the releasers AR 641 & AR 435 were attached to the rosette.

As available time was an issue the batteries have been changed BEFORE the calibration cast, while anti-fouling cylinders were exchanged after the cast. The influence on the sensors is considered to be small. Stop time in homogeneous waters was >6 minutes to ensure a good sensor adaptation to the environment. The cast is considered to be the post calibration of the 5th and the pre-calibration of the 6th CIS deployment.

The preliminary calibration on conductivity **two cells (Cond1 was used)**:

Cond1= 0.99991758 * Cond1

Cond2 = 0.99983765 * Cond2

has been applied. No pressure or temperature calibration has been applied. Comparing pre-and post-calibration casts suggest that the pre-calibration was -0.002 colder and 0.005 higher in conductivity. It is unclear if this will change after the final calibration has been applied to the CTD data.

Table 4.2: Summary of results instrument bias: Post calibration cast during D309; pre-calibration stems from RV Pelagia cruise (Sep. 2005).

Serial #	***Sampling (s)***	T_{off} ***pre- | post-***		C_{off} ***pre- | post-***	
0959	10	– 0.002	+ 0.000	+0.007	+ 0.005
3411	10	– 0.003	– 0.001	+0.020	+ 0.015
3414	10	– 0.002	– 0.002	+0.005	– 0.023
0962	10	– 0.000	+ 0.003	+0.048	+ 0.038
1719	10	– 0.002	+ 0.000	+0.011	+ 0.008
2262	10	– 0.001	+ 0.000	+0.003	– 0.003
1723	10	– 0.002	+ 0.000	+0.012	+ 0.008
0953	10	+ 0.000	+ 0.002	+0.003	– 0.002
2801	10	– 0.005	– 0.003	+0.006	– 0.004
2488	10	– 0.002	– 0.001	-0.028	– 0.028
2799	10	– 0.005	– 0.004	+0.003	– 0.001
2271	10	– 0.001	n.a.	-0.007	n.a.
2264	10	– 0.001	+ 0.000	-0.005	– 0.008
0950	10	+0.001	+ 0.002	-0.005	+ 0.006

Six of the MicroCats are equipped with a pressure sensor. The correction was determined considering the pressure readings in comparison to the CTD as well as considering the deck values.

Table 4.3: Summary of pressure sensor calibration: Post calibration D309; pre-calibration Pelagia (Sep. 2005).

Serial #	***R/V PELAGIA (Sept. 2005)***		***RSS DISCOVERY D309 (August 2006)***	
	p_off=a*z+b	***Δp@nominal depth***	***p_off =a*z+b***	***Δp@nominal depth***
3411	a = - 0.0019; b = - 0.1152	- 0.2	a = - 0.0039; b = - 0.7843	- 0.9
3414	a = - 0.0017; b = + 0.4000	+ 0.3	a = - 0.0032; b = - 0.5989	- 0.7
2262	a = - 0.0000; b = - 0.6946	- 0.7	a = - 0.0016; b = - 1.5723	- 1.8
2488	a = + 0.002; b = - 1.2864	- 0.1	a = + 0.0001; b = - 1.7505	-1.7
2271	a = + 0.0012; b = - 2.9476	- 1.8	n.a.	n.a
2264	a = + 0.0032; b = - 9.5327	-5.6	a = + 0.0014; b = - 10.3968	- 8.6

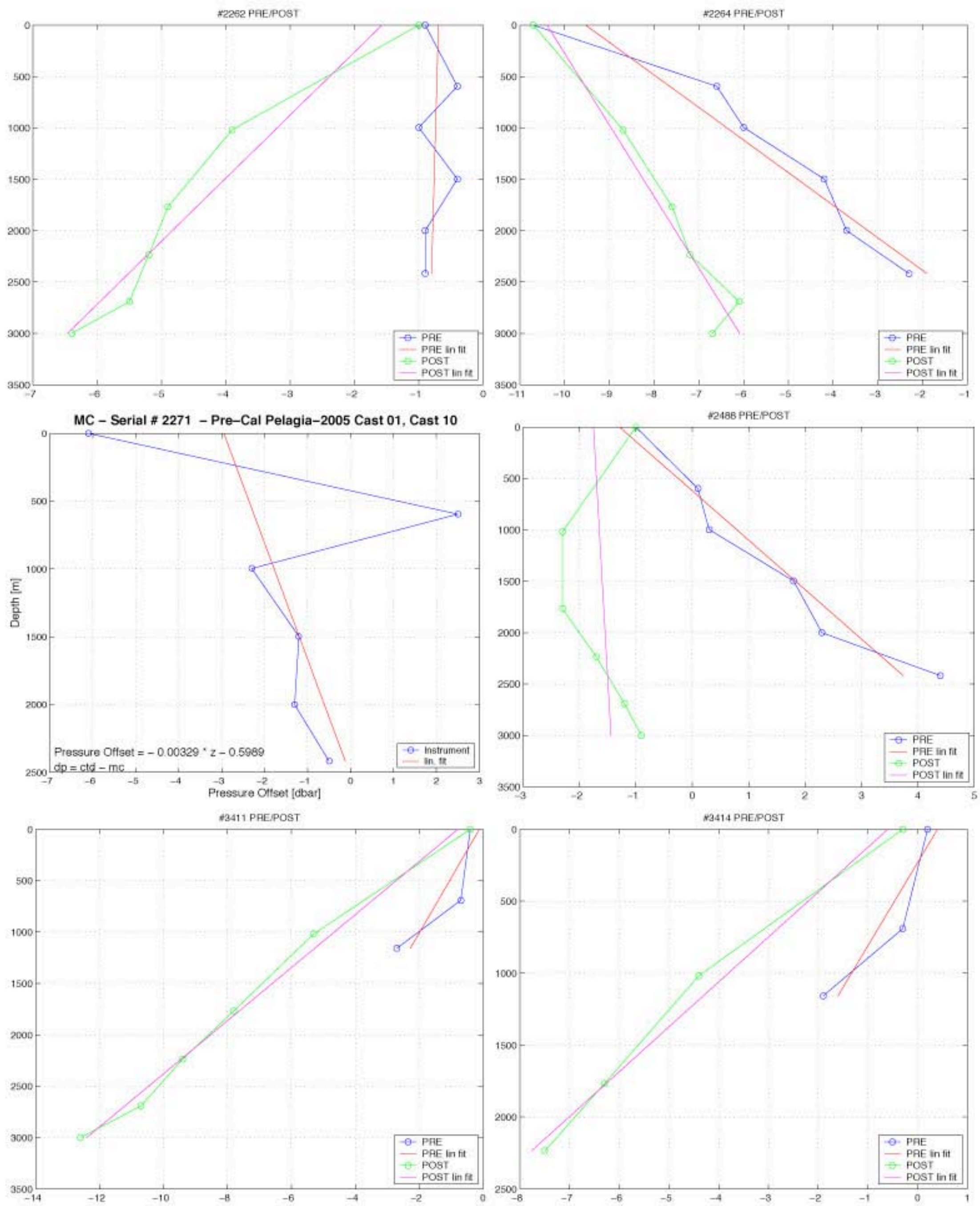


Figure 4.2: Pressure calibration and linear fit

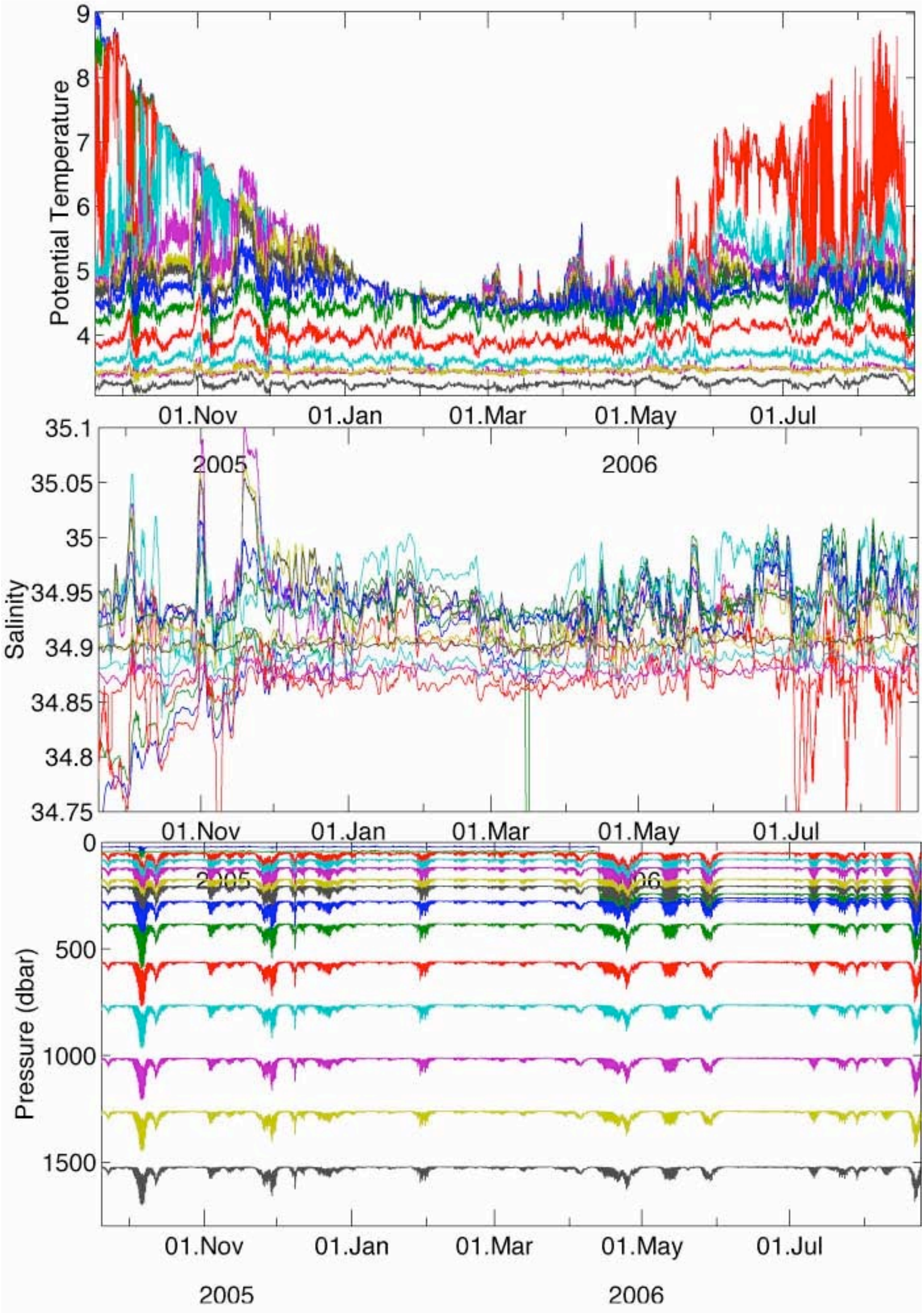


Figure 4.3: Timeseries of temperature (upper) and salinity (middle) and pressure (lower) from MC (processed data)

4.2.2 Deployed instruments:

All recovered instruments have been redeployed (table).

Table 4.4: Summary of MicroCats deployed at the CIS mooring site during D309

Serial #	***Sample Interval [s]***	***Nom. Depth [m]***	***Pres.***
0959	1200	10	no
3411	1200	31	yes
3414	1200	41	yes
0962	1200	71	no
1719	1200	110	no
2262	1200	154	yes
1723	1200	196	no
0953	1200	266	no
2801	1200	371	no
2488	1200	546	yes
2799	1200	747	no
2271	1200	999	yes
2264	1200	1244	yes
0950	1200	1495	no

Telemetry: 12 of the 14 instruments (all above the RCM at 1004m depth) have been integrated into the telemetry loop. The modem however is programmed to asked for all 14 with the hope that there is a 'way' the two underneath the RCM will find a way in communicate their reading - however, the first transmission do not suggest this to take place.

4.3 ADCP

4.3.1 Recovered instruments

Two ADCPs have been recovered: Workhorse (WH) 300kHz serial number #1972 (upward looking) and a long ranger (LR) 75kHz # 2330 (downward looking). Both instruments have been mounted in a 45" Floatation technology sphere and have been measuring the current from the surface to order 800m depth. The LR instrument has a full length record of 16361 samples, the WH had 4496 records as it stopped recording on 28.03.2006 (12:21). Several reboot attempts case a shift in the regularity of the time stamps. A summary of some of the ADCPs configuration is given in table below.

Data processing and recovery:

The binary data files have been read out with the RDI standard software (BBtalk, WinSC). Next the data was converted to speed and direction considering the 90° deviation between North and mathematical °0 and the direction was corrected for a local magnetic deviation of -25°. The depth of the ADCP depth-cells have corrected for nominal depth as well as mooring movements based on the calibrated pressure reading of the nearby MicroCat and based on the intensity maximum for the upward looking WH. The LR depth data was converted based on the WH maximum in intensity.

Table 4.5: Summary of ADCP configuration

	300 kHz WH (#1972)	*75 kHz LR (#2330)*
Number of samples	4496	16361
Pings per ensemble	70	10
sampling interval	60 minutes	30 minutes
Number of cells	22	40
Cell size	8m	16m
Cells range covered	9.93 - 177.93m	24.45 - 648.45m

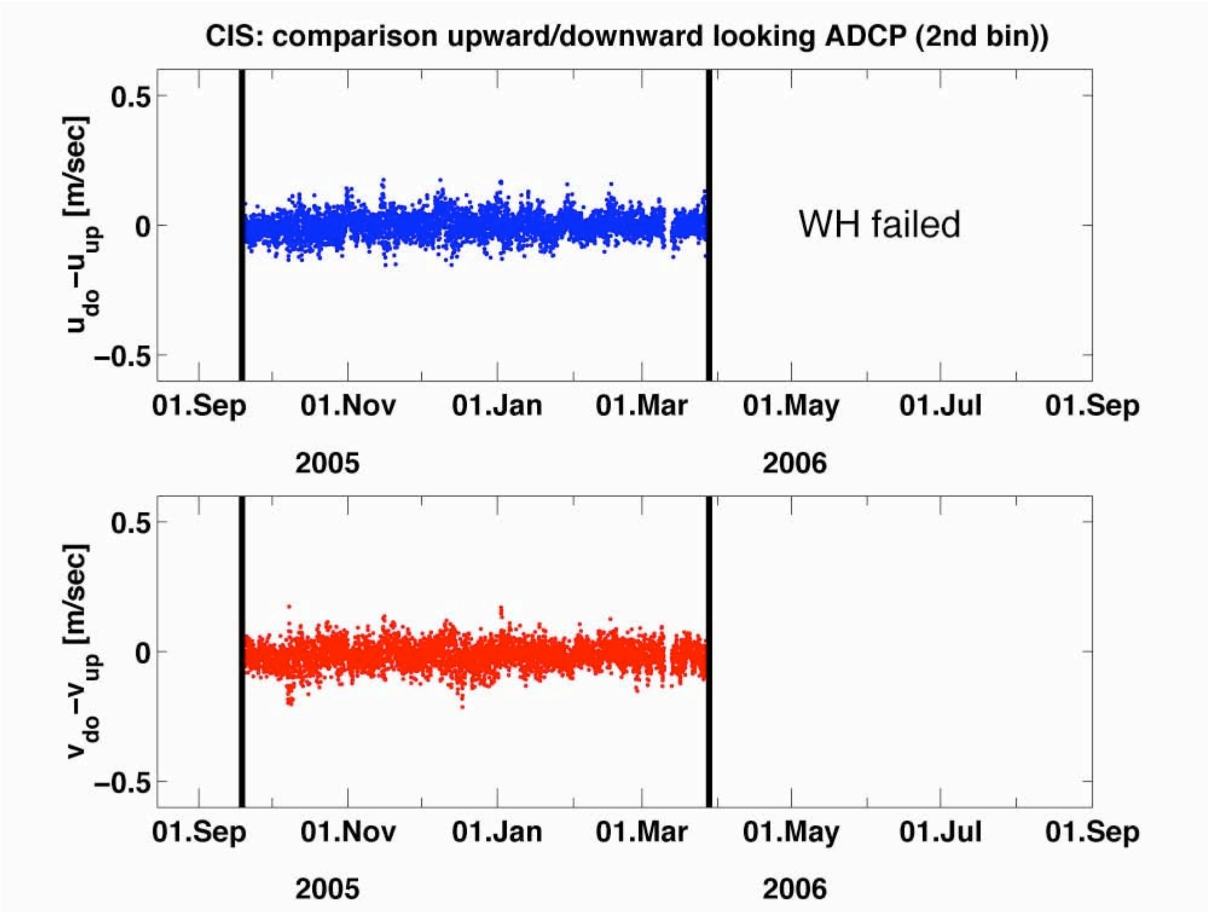


Figure 4.5: Comparison between east and northward velocity component from upward and downward looking ADCP

4.3.2 Deployed instruments:

Again two instruments have been deployed. Initially it was planned to deploy a spares instrument planned for this year PAP site but not deployed. However, it turned out that the instrument was likely equipped with yet another corrupt battery package and we changed the batteries. In addition the transducers looked blur and we decided to change the transducer head from the formed deployed WH#1972 and add them to the housing of the new instrument (WH# 2142). As the serial number appears on the housing the new deployed instrument is considered to be WH# 2142 although the electronic and the transducer stem from the WH#1972.

Telemetry:

No telemetry was planned for the ADCP current data. This will need higher data transmission rates (Iridium communication).

4.4 Rotor Current Meter (RCM)

4.4.1 Recovered instruments

Two instruments have been recovered an Aanderaa RCM-8 serial # 11442 (nominal depth at 1005m) equipped with pressure sensor and an Aanderaa RCM-8 serial # 9831 (nominal depth at 2326m) equipped with Arctic range temperature sensor. Both instruments recorded in 120minute interval.

Data recovery and processing:

Both instruments recorded data during the whole deployment period (see table for times). The binary data was converted to ascii and the calibration coefficients were applied. A drift of the internal clock was detected for the instruments (see table) and the records have been linear interpolated to compensate for it.

The local magnetic deviation of -25° have been added to the direction readings.

On 02-Sept-2006 the instruments internal DSU time was compared with UTC time:

Serial number	***nominal depth***	***out of water*** 24. Aug. 06	***DSU*** 02. Sep. 06	***UTC*** 02. Sep. 06	***Δt = DSU-UTC***
# 11442	1005	12:49	14:06	14:30	+ 24 Minutes
# 09831	2326	13:30	16:16	14:33	– 103 Minutes

Comments:

A comparison between the RCM speed and direction records and those from the deepest bin (~800m) of the downward looking ADCP revealed a good correlation. This is true even for the instrument at 2326m depth and emphasis the strong barotropic component of the currents.

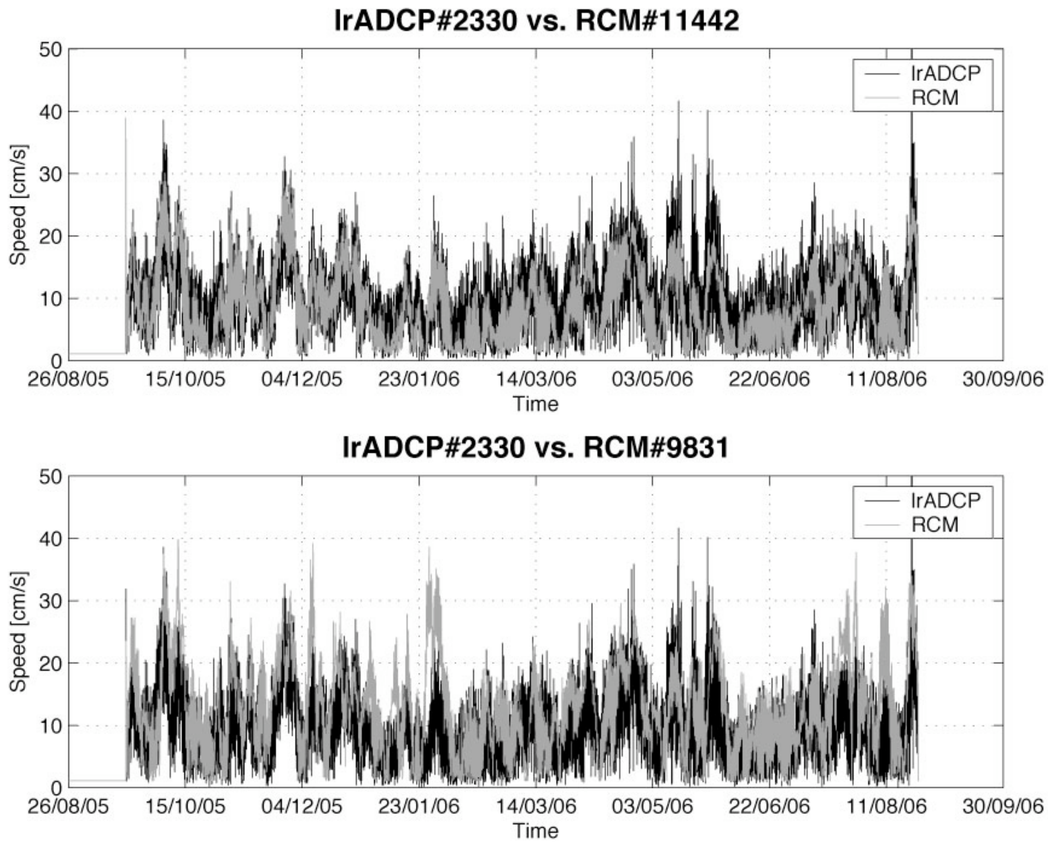


Figure 4.6: Timeseries of current speed from the RCM8 in 1005 m depth (#11442) and in 2326m depth (#9831) in grey. For comparison the speed and direction from the downward looking ADCP is shown (black line).

The temperature time series of AR and the LR indicates an offset of about 0.1K and a new calibration of the sensors is need. Spatial variability of the temperatures is surprisingly large and a temperature time series look very different to what is recorded at the NIOZ LOCO mooring (25 nautical miles away).

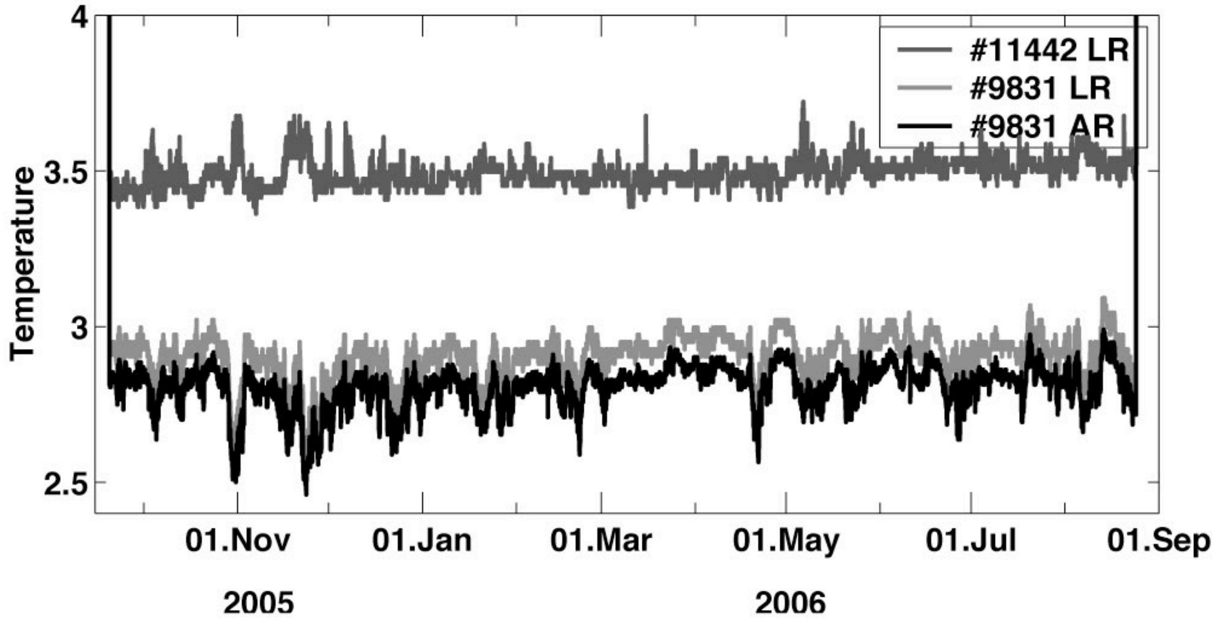


Figure 4.7: Timeseries of temperature at 1005 m depth and at 2326m depth (low range and Arctic range sensor)

4.4.2 Deployed instruments

Two RCM-8 have been deployed both are programmed to record in 120 minutes sampling interval. The nominal depth of the lower instrument was changed to record the deep water characteritics.

Serial number	***Start time*** 26. Aug. 06	***In water*** 29. Aug. 06	***nominal depth***	***add sensor***
# 02317	12:00	19:37	2659	Arctic range Temp.
# 09833	12:00	18:46	1003	No

4.5 SAMI

4.5.1 Recovered instrument

SAMI pCO_2 recorder #35 was recovered during D309. After being in the water for about one year not much biofouling was found and all parts looked intact.

Data recovery and processing:

Raw data was read out on the 26.08.2006. The instrument was not stopped after downloading the data. Raw data was converted to physical units based on the following calibration coefficients (from XLS Spreadsheet provided by Cory Beatty 11 Aug 2004) and using the sami2co2.m routine.

serial #	***Temperature***	***A***	***B***	***C***	***Blank***
35	+ 8.40°C	+ 0.40255	– 1.01812	+ 0.50806	2222

Calibration cast:

No post-calibration cast could be performed during D309. During the RV Pelagia cruise (Sept. 2005) a pre-deployment cast has been acquired.

Comment:

The instrument performed well during the whole deployment period. A nice seasonal signal can be seen from the records (see Figure). Starting with the cooling season at the end of September the pCO_2 gradually increases until mid January presumably through the entrainment of CO_2 rich waters during the deepening phase of the mixed layer. The few 'spikes' in the first month indicate periods when the instrument left the mixed layer due to strong mooring excursions presumably driven by strong current events. It confirms that the deeper waters are much higher in pCO_2 content. From mid April onwards first episodic but later permanent stratification is found above the instrument suppressing the air/sea pCO_2 exchange. By the end of May the pCO_2 drops to low values until mid July presumably due to biological activity.

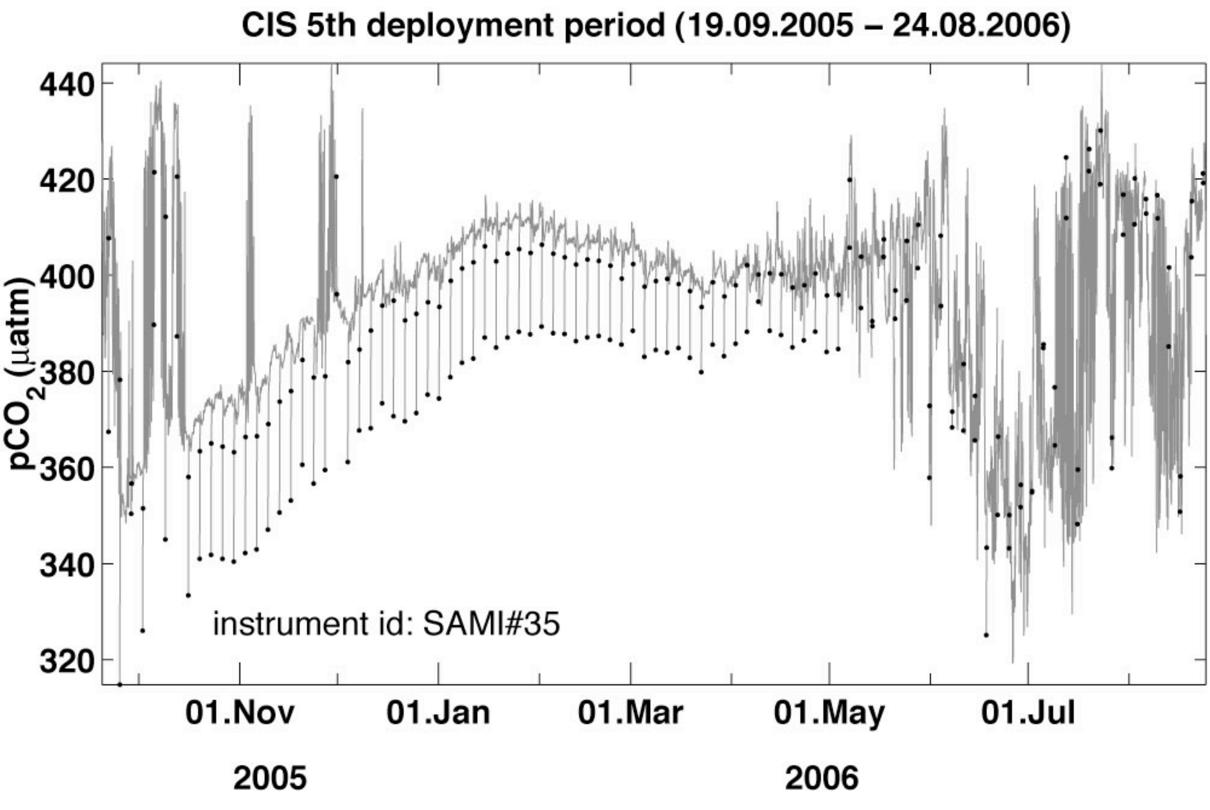


Figure 4.8: Time series of pCO_2 at nominal 42m depth. Black dots indicate first two measurements after blank measurement - apparently there is a 'memory effect' associated with the blank measurement.

4.5.2 Deployed instrument

During D309 the SAMI pCO2 recorder # 37 was deployed in the CIS mooring at nominal 41m depth. As mentioned, no pre/post CO_2 calibration cast could be performed. For technical reasons the instrument was started at SUNBURST Montana and was visually inspected (droplet at outlet).

Telemetry:

One big issue for the deployment was the integration of the instrument into the data telemetry. Several telemetry test have been performed during D309 and before deployment. The first data from the telemetry buoy (29.08.2006; 21:15 UTC) contained reasonable values (measured 21:00 UTC) and the implementation is considered to be successful.

4.6 NAS

4.6.1 Recovered instrument:

NAS 3X - Serial number # 2264; Started for deployment (RV Pelagia): 19.09.2005, 18:00 UTC

Data recovery and processing:

Stopped by disconnecting battery on 25.08.2006. Data was read out with NAS program. Data was not erased from memory.

Following the instructions (Marimar Villagarcia, ICCM) the instrument has been flushed (gray, blue) and with a given Intensity of 32.000 the source intensity was 31699, colour intensity was 65535, Temperature reading was 24317 (27.08.2006; 15:19 UTC).

The instrument recorded data over the whole period: 632 sample data, 98 standard data. Apparently it looks like the instrument performed well only during two periods: whole October 2005 and December to mid January 2005/2006. Reasons are unknown and need to be investigated. It looks like the instrument measures the blank only and not the sample.

4.6.2 Deployed instrument:

NAS 3X - Serial number # 2625

Tests:

Following instructions Marimar Villargarcia the instrument was flushed several times. The following standards have been found using deionized water. When first Bt was determined the instrument responded 4 times:

>>SPS device failed to respond<<

Later the following values appeared:

Bt=65.344 (recommended 60.000 ± 100)

Rt=50.751 (recommended 48.000 ± 500)

Bt=60.263 (recommended 60.000 ± 100)

Rt=32.813 (recommended 33.000 ± 500)

As the value did not matched the recommended values a new flushing was done 2 times giving an acceptable Bt=59.907 (recommended 60.000 ± 100).

Started for deployment:
29. Aug. 2006; First data acquisition was programmed for the

Calibration cast:
Station D309 014 (59°N 40.57'/39°W 44.23') very near the CIS mooring was used to collect water samples for nutrient analysis. Two times duplicate sample have been taken at the following depth: 5; 25; 40; 55; 80; 120; 225; 300; 500; 1000 m. Initially cast D309013 should have been used for that but the bottles failed.

Telemetry:

Telemetry of the data is energy consuming as each sample takes about 20 minutes and delivers continuous output to the serial port that has to be watched by the modem. A quick data out test mode for telemetry test purposes is required.

4.7 WetLab fluorometer

4.7.1 Recovered instrument:

Instrument serial number #0270 (with pressure). Sampling interval was every 90 minutes.

Data recovery and processing:

Data was recorded data only from the 17-Sep.-2005 to 19-Nov-2005 as the battery failed for unknown reasons. The data was downloaded using the ECOVIEW software. No further processing was done.

4.7.2 Deployed instrument:

Instrument serial number #0268

(with pressure - as telemetry requires the specifics of its output string)

Calibration cast:

D309 007; Position: 59°N 44.33' / 42°W 30.34'; Water depth: 310m, Cast depth: 300m

Duplicate samples taken at 12; 22; 52; 82; 152; 302 m depth (based on profile from CTD fluorometer) to be analysed at NOCS.

First comparison suggest that the given calibration coefficients do not agree for the temperature as well as pressure conversion. Chlorophyll- a and turbidity calibration is unknown and has to await the calibration using the samples.

4.8 Mooring design

Telemetry buoy:

The telemetry buoy became adrift on the 13. April 2006 between 10:00 and 10:30 UTC (according to the MicroCat # 3411). The buoy was recovered by M/T OLIVIA which is a supply tanker operated by O.W. Icebunker. The mooring was recovered at 61°N 40.48'/ 033°W 44.12' on the 02. May 2006. During the CIS recovery it became clear that the telemetry buoy that was broken at the point where the termination is set. This has happen before and one may think about a redesign in the future.

Conductive Swivel:

The telemetry of the buoy worked only for the two MicroCats (959, 3411) and the MiniT in the fin of the tele buoy (nominal 50 cm water depth) and only until the tele buoy broke-off in April 2006. After recovery it became clear that two of the three conductive swivels were not correctly connected. Hence the connection was interrupted at the top of the biogeochemical sensor frame and no data was available. This is a design error and a redesign is urgently needed.

Corrosion:

After recovery of the biogeochemical sensor frame heavy corrosion was identified which could have led to loss of the sensor frame sooner or later. The shackles at the top of the biogeochemical frame have been the most affected. Possibly the mechanical load "scratched" at the surface of the shackle removing the galvanized layer. In combination with a contact to the swivel (made out of titanium), rapid corrosion took place. To prevent this during the next deployment period we "coated" the critical points with Teflon foil and put a plastic hose in the inner side of the swivel.

4.9 SPRAY glider

4.9.1 Recovered instrument

See section 5.

Calibration cast:

D309 004; Position: 59°N 33.35' / 39°W 45.21'; Water depth: 2892m, Cast depth: 130m

Duplicate samples taken at 12; 27; 43; 58; 73; 92; 129 m depth (based on profile from CTD fluorometer) to be analysed.

Appendix I to section 4: V434-05/CIS05 Mooring inventory

Compiled: 17.10.2005 last up-date: 30. Aug. 2006, JK

Mooring design: 5-Sept-2005, TJM
Deployment:
Date: 19-Sep-2005 Time: 08:50 – 15:30 UTC Cruise: RV PELAGIA
PI onboard : Michael Busack, IFM-GEOMAR, Kiel, Germany
Position:
Lat: 59° 40.006'N Lon: 039° 41.942'W
Water depth:
Water depth, Furuno 3.5kHz : 2812m
Calibration not proceeded, same position (40m distance) as used last year on CD161

Recovery:
Date: 29. Aug. 2006 Time: 17:15 - 20:30 Cruise: DISCOVERY D309
PI onboard: J. Karstensen, IFM-GEOMAR, Kiel, Germany

Instrument			Calibration (lab/CTD cast/*in-situ*)		
Depth nom.	Type & Sensors (# indicates tele id)	S/N	Pre-deploy	Post-deploy	Remarks
0 m	Telemetry buoy	ID 17782			Inductive link failed at 40m, broken (13. April 2006, approx. 10:00), recovered
1 m	TD-Logger IM #20	77			
10 m	MC-IM #01	959	64PE240_001	D309 012	
30 m	MC-IMP #02	3411	64PE240_001	D309 012	15m deeper
41 m	WD	2263	-	-	no response during recovery (bridge)
42 m	Electrically cond. swivel	260401	-	-	
42 m	Sensor frame	-	-	-	
	SAMI CO_2	35	??	no	
	MC-IMP #03	3414	64PE240_001	D309 012	
	NAS-3X nutrient sensor	2264	64PE240_007	D309 014	
	WetLabs FLNTUSB	270	64PE240_007	D309 007	Shutter open after recovery
71 m	MC-IM #04	962	64PE240_001	D309 012	
110 m	MC-IM #05	1719	64PE240_001	D309 012	
151 m	Electrically cond. swivel			-	
	45' flotation			-	
	WH ADCP 300 kHz up	1972		-	
151 m	LR ADCP	2330		-	
151 m	Electrically cond. swivel			-	
154 m	MC-IMP #06	2262	64PE240_010	D309 012	
196 m	MC-IM #07	1723	64PE240_001	D309 012	
266 m	MC-IMP #08	953	64PE240_001	D309 012	
371 m	MC-IM #09	2801	64PE240_001	D309 012	
546 m	MC IMP #10	2488	64PE240_010	D309 012	
747 m	MC IM #11	2799	64PE240_010	D309 012	
993 m	MC IMP #12	2271	64PE240_010	cast failed	
1000 m	End telemetry			-	
1001 m	2x WD 17"	615, 12621		-	
1003 m	RCM8 T_{LR}	11442		-	
1244 m	MC-IMP #13	2264	64PE240_010	D309 012	Exact nominal position unknown
1495 m	MC-IM #14	950	64PE240_010	D309 012	Exact nominal position unknown
				-	
2326 m	RCM8 T_{AR}	9831			
2744 m	2x AR661	28, 30			

Appendix II to section 4: V434-06/CIS06 Mooring inventory

Compiled: 24-Aug-2006 last up-date: 30-Aug-2006, JK

Mooring design: 1-May-2006, TJM

Deployment:
Date: 29-Aug-2006 Time: 17:15 - 20:30 Cruise: RSS DISCOVERY D309
PI onboard: Johannes Karstensen, IFM-GEOMAR, Kiel, Germany

Position:
Latitude: 59° 40.053'N Longitude: 039° 43.363'W

Water depth:
Water depth (uncorrected): 2808m

Recovery:
Date: Aug. - Sept. 2007 (planned) Time: -- Cruise: PELAGIA
PI onboard: N.N., IFM-GEOMAR, Kiel, Germany

Instrument			Calibration (lab/CTD cast/*in-situ*)		
Depth nom.	Type & Sensors	S/N	Pre-deployment	Post-deployment	Remarks
0 m	Tele bouy	-	-		
10 m	MC-IM #01	0959	D309 012		
30 m	MC-IMP #02	3411	D309 012		
41 m	Electrically cond. swivel	-	-		
42 m	WD	ID: 6848	-		mounted in floatation
42 m	Sensor frame	-	-		
	SAMI CO_2	36	no		
	MC-IMP #03	2271	cast failed		
	NAS-3X nutrient sensor	2625	D309 014		
	WetLabs FLNTUSB	268	D309 007		
71 m	MC-IM #04	0962	D309 012		
110 m	MC-IM #05	1719	D309 012		
151 m	Electrically cond. swivel	-	-		
	45' flotation	-	-		
	WH ADCP 300 kHz up	1972	-		
151 m	LR ADCP	???	-		
151 m	Electrically cond. swivel	-	-		
154 m	MC-IMP #06	2262	D309 012		
196 m	MC-IM #07	1723	D309 012		
266 m	MC-IMP #08	0953	D309 012		
371 m	MC-IM #09	2801	D309 012		
546 m	MC IMP #10	2488	D309 012		
747 m	MC IM #11	2799	D309 012		
993 m	MC IMP #12	3414	D309 012		
1000 m	End telemetry	-	-		
1001 m	2x WD 17"	ID: 615, 12621	-		
1003 m	RCM8 T_{LR}	9833	-		
1244 m	MC-IMP #13	2264	D309 012		
1495 m	MC-IM #14	0950	D309 012		
2659 m	RCM8 T_{AR}	2317	-		
2745 m	2x AR	641, 435	-		

5 IFREMER ACTIVITIES

Stephane Leizour

This report describes the recovery of (i) a "Spray" glider, and (ii) IFREMER mooring E (the lander). Our container was supposed to have arrived by 17 August 2006 but unfortunately the it was stuck in Montreal, and we didn't have any tools with us. We were lucky that the other teams (British, German and Dutch) provided us all we needed to do the work, and some of the crew members built a recovery net just in case we had to recover the Glider in bad weather.

5.1 Spray recovery

The Spray was deployed on 17 June 2006 on board MARIA S MERIAN southeast of Greenland (59°N 46.12, 041°W 18.03 position after first dive). During its mission it recorded 314 profiles, travelling about 1600km.

On the morning of the 24 August06, the team on shore sent the abort commands to the Glider. At 07:45 UTC we received the first Argos signal from the Spray, the signal strength was 76 and heading 126°; at the same time, Thierry Terre called us to give us the GPS Position N 59° 33.76, W 39° 44.70. We monitored the Argos reception and the direction finder while the ship was heading to the GPS position. At 08:16 AM UTC the Spray was seen on the starboard side about 200 m from of the ship at N 59° 33' 39'', W 39° 44' 43''. Considering the good weather conditions, it was decided to use the rubber boat for the recovery. Stephane Leizour, Andreas Pinck and two crew members went on board.

The glider was picked up by hand using two ropes on each side of the wings. As there was no cradle available in the boat the glider was put on the knees of two people (illustration above).

The glider was lifted on deck using a crane and attaching a strap to it. Once on board, we visually inspected the Glider and no obvious damage could be found. The visual inspection following the instruction sheet was done here.

Next, the instrument was brought inside the ship and put on some soft cradles. Its comm. cable was plugged in and the next instruction sheet was followed.

Next the Spray glider was disassembled to inspect the interior. No server problems could be found. The only problem occurred with the CF card as it could not be read out. A disk copy was made using the UNIX dd command and the card was unmounted and packed into an antistatic box for direct shipping to IFREMER.

First attempts in reading out the data reveal that probably a large number of records are corrupt and only data from dive 243 (out of 312) is acquired on the card. This has to be further investigated.

The fluorometer was unmounted form the glider and put in a chemical glove with destilled water.

We put the glider into its shipping box.

A calibration cast for the fluorometer was performed next to the recovery position (st# D309 004; Position: 59°N 33.35' / 39°W 45.21'; water depth: 2892m, cast depth: 130m) and duplicate chlorophyll-a samples have been taken at 12; 27; 43; 58; 73; 92; 129 m depth (based on profile from CTD fluorometer). They will be shipped and analysed at NOCS (R. Lampitt).

5.2 Mooring E Recovery

The Lander was deployed in September 2005 on board Discovery D298 (see cruise report), at N 59°34,332, W 42°35,702. We were on position to begin recovery on Saturday 26 August06. The communication with the two acoustic releases was OK and we sent the release code at 13:00 UTC. We received the Argos signal (ID:11259) as it came to the surface. The lander was seen at the surface at 13:13 UTC (photograph below).

The Lander was recovered with a crane and on board at 13:30 UTC. Once on board, we visually inspected the Lander, everything seemed to be OK, no corrosion. We stopped all the instruments and retrieved all the data.

Microcat #3999

sampling interval 10 min,

check the time:

GPS time 14:00:30 UTC

Microcat time:14:03:00 UTC

Sample Number : 53293

ADCP 300Khz #3835

Sampling interval 10 min

Total bite 52912128

The *RBR XR-420 #10490* showed some biofouling on the conductivity sensor.

6 CTD

J. T. Allen, R. E. M. Pidcock, D. Teare, S.G. Alderson

As far as possible, the processing route for CTD data followed that used on RRS *Discovery* 298 in August/September 2005 (see D298 cruise report).

The CTD package comprised the following instruments: Seabird 911+ CTD with dual temperature and conductivity sensors; Seabird carousel type SBE 32; RDI 300kHz workhorse ADCPs, one upwardlooking and one downward looking; Chelsea instruments Alphatracka (transmissometer) and Aquatracka (fluorometer); Wetlabs light back sensor type BBRTD; Benthos altimeter type 915T; twenty four 10 litre OTE Water bottles. The Seabird primary T/C duct had an inline seabird oxygen sensor type SBE 43 fitted. The secondary T/C duct was mounted on the stabilising vane. Twenty five casts were completed (see Station List below), a number of which had current meters attached for calibration purposes. The package performed well with only minor problems. The CTD cable had to be re-terminated due to cable damage and the Aquatracka fluorometer cable was changed when the instrument data developed spikes. See the Appendix to this section for instrument calibration information.

Station List:

Station number	Code	Date YYYYMMDD	Time HHMMSS	Latitude	Longitude	Corrected depth (m)
1	1	20060818	171630	047 32.718 N	052 34.935 W	177.7
1	2	20060818	172724	047 32.754 N	052 34.934 W	177.4
1	3	20060818	175013	047 32.792 N	052 34.977 W	177.4
2	1	20060820	113331	054 17.670 N	046 45.238 W	3559.3
2	2	20060820	124454	054 17.701 N	046 45.348 W	3558.7
2	3	20060820	142232	054 17.708 N	046 45.673 W	3566.5
3	1	20060824	011614	059 39.380 N	039 42.328 W	2795.8
3	2	20060824	021055	059 39.365 N	039 42.203 W	2796.3
3	3	20060824	040907	059 39.289 N	039 41.967 W	2797.9
4	1	20060824	093354	059 33.312 N	039 45.302 W	2869.1
4	2	20060824	093915	059 33.301 N	039 45.330 W	2869.2
4	3	20060824	095947	059 33.319 N	039 45.334 W	2869.0
5	1	20060824	222151	059 12.039 N	039 33.774 W	3025.3
5	2	20060824	230735	059 11.952 N	039 33.869 W	3025.0
5	3	20060825	003339	059 12.013 N	039 33.990 W	3024.0
6	1	20060826	142302	059 53.837 N	043 2.056 W	165.6
6	2	20060826	143451	059 53.581 N	043 2.266 W	163.6
6	3	20060826	145558	059 53.332 N	043 2.390 W	168.2
7	1	20060826	211917	059 44.400 N	042 30.297 W	302.8
7	2	20060826	213207	059 44.378 N	042 30.339 W	303.3
7	3	20060826	215725	059 44.202 N	042 30.539 W	306.4
8	1	20060826	230203	059 42.625 N	042 23.779 W	1000.6
8	2	20060826	232327	059 42.306 N	042 24.431 W	996.2
8	3	20060827	000321	059 41.662 N	042 25.644 W	947.7
9	1	20060827	012334	059 40.387 N	042 21.002 W	1488.0

9	2	20060827	015738	059 40.114 N	042 21.584 W	1470.8
9	3	20060827	024312	059 39.665 N	042 22.172 W	1485.9
10	1	20060827	043924	059 39.507 N	042 10.358 W	1730.5
10	2	20060827	051550	059 39.521 N	042 10.316 W	1730.8
10	3	20060827	061627	059 39.347 N	042 10.351 W	1732.6
11	1	20060827	083117	059 34.031 N	041 41.443 W	2077.4
11	2	20060827	091407	059 34.105 N	041 41.281 W	2080.3
11	3	20060827	102033	059 33.737 N	041 42.654 W	2002.5
12	1	20060828	133401	059 17.196 N	036 25.960 W	3095.6
12	2	20060828	143724	059 17.679 N	036 26.290 W	3095.4
12	3	20060828	163555	059 18.360 N	036 26.247 W	3090.9
13	1	20060829	211440	059 40.023 N	039 43.377 W	2784.0
13	2	20060829	213637	059 40.053 N	039 43.575 W	2783.3
13	3	20060829	222607	059 40.372 N	039 43.774 W	2779.2
14	1	20060829	224933	059 40.510 N	039 44.074 W	2776.5
14	2	20060829	230953	059 40.565 N	039 44.251 W	2775.7
14	3	20060829	234952	059 40.799 N	039 44.310 W	2772.6
15	1	20060830	093427	059 33.929 N	041 41.817 W	2041.0
15	2	20060830	101449	059 33.765 N	041 41.772 W	2053.5
15	3	20060830	111343	059 33.708 N	041 42.119 W	2035.2
16	1	20060830	124109	059 28.800 N	041 26.675 W	2226.5
16	2	20060830	132605	059 28.714 N	041 26.743 W	2226.9
16	3	20060830	143218	059 28.746 N	041 26.659 W	2227.6
17	1	20060830	231209	059 22.664 N	041 6.286 W	2505.3
17	2	20060831	001029	059 22.609 N	041 7.329 W	2493.6
17	3	20060831	011548	059 22.687 N	041 7.698 W	2485.6
18	1	20060831	033203	059 15.603 N	040 45.028 W	2730.0
18	2	20060831	043641	059 15.718 N	040 45.233 W	2725.3
18	3	20060831	054426	059 15.731 N	040 45.366 W	2724.3
19	1	20060831	073942	059 9.820 N	040 26.903 W	2880.7
19	2	20060831	083635	059 9.832 N	040 27.368 W	2878.6
19	3	20060831	094512	059 9.556 N	040 27.269 W	2883.2
20	1	20060831	114509	059 3.653 N	040 8.086 W	2989.1
20	2	20060831	124222	059 3.753 N	040 8.185 W	2987.6
20	3	20060831	153800	059 3.778 N	040 8.800 W	2985.8
21	1	20060831	230749	058 35.299 N	038 29.983 W	3185.5
21	2	20060901	001255	058 35.315 N	038 29.863 W	3185.8
21	3	20060901	030224	058 35.736 N	038 30.907 W	3184.9
22	1	20060901	140922	059 14.930 N	036 23.944 W	3050.5
22	2	20060901	151215	059 14.982 N	036 24.016 W	3056.3
22	3	20060901	163937	059 15.264 N	036 24.355 W	3070.6
23	1	20060901	183625	059 23.423 N	036 50.455 W	3099.7
23	2	20060901	194435	059 23.446 N	036 50.886 W	3100.3
23	3	20060901	220352	059 23.157 N	036 50.849 W	3102.4
24	1	20060902	005908	059 28.626 N	037 36.537 W	3101.7
24	2	20060902	015927	059 28.713 N	037 36.193 W	3102.9
24	3	20060902	031831	059 28.570 N	037 36.067 W	3102.4
25	1	20060902	074951	059 34.629 N	038 46.410 W	2959.4
25	2	20060902	084914	059 34.628 N	038 46.764 W	2958.8
25	3	20060902	095954	059 34.483 N	038 46.700 W	2959.5

6.1 Data Processing

6.1.1 Data Processing using the SeaBird Software on the data-logging PC

Following each cast the logging was stopped and the data saved to the deck unit PC. The logging software output four files per CTD cast in the form D309nnn with the following extensions: .dat (raw data file), .con (data configuration file), .btl (contained record of bottle firing locations), and .hdr (a header file).

These files were manually backed up onto the UNIX network, via ftp to the file location /data32/d309/ctd/raw. The raw data files were then processed using SeaBird's own CTD data processing software, SBE.DataProcessing-Win32: v.5.34. SeaBird CTD processing routines were used as follows.

DatCnv: The Data Conversion routine, DatCnv, read in the the raw CTD data file (D309nnn.dat). This contained the raw CTD data in engineering units output by the SeaBird hardware on the CTD rosette. DatCnv requires a configuration file that defines the calibrated CTD data output so that it is in the correct form to be read into the pstar format on the UNIX system. The output file (D309nnn.cnv) format was set to binary and to include both up and down casts. A second output file (D309nnn.ros) contained bottle firing information, taking the output data at the instant of bottle firing.

AlignCTD: This program read in D309nnn.cnv and was set to shift the Oxygen sensor relative to the pressure data by 5 seconds compensating for lags in the sensor response time. The output was written over the input file.

WildEdit: A de-spiking routine, the input and output files again were D309nnn.cnv. The data was scanned twice calculating the standard deviation of a set number of scans, setting values that are outside a set number of standard deviations (sd) of the mean to bad data values. On this cruise, the scan range was set to 500, with 2 sd's on the first pass and 10 sd's on the second.

CellTM: The effect of thermal 'inertia' on the conductivity cells was removed using the routine Celltm. It should be noted that this routine must only be run after Wildedit or any other editing of bad data values. This routine uses the temperature variable to adjust the conductivity values, and if spikes exist in the former they are amplified in the latter. The algorithm used was:

$$dt = t_i - t_{i-7}$$
$$ctm_i = -b * ctm_{i-7} + a * \partial c \partial t * dt$$
$$c_{cor,i} = c_{meas,i} + ctm_i$$
$$a = \frac{2\alpha}{7\Delta * \beta + 2}$$
$$b = 1 - 2a/\alpha$$
$$\partial c \partial t = 0.8 * (1 + 0.006 * (t_i - 20))$$

where α, the thermal anomaly amplitude was set at 0.03 and β, the thermal anomaly time constant was set at 1/7 (the SeaBird recommended values for SBE911+ pumped system). Δ is the sample interval (1/24 second), dt is the temperature (t) difference taken at a lag of 7 sample intervals. $c_{cor,i}$ is the corrected conductivity at the current data cycle (i), $c_{meas,i}$ the raw value as logged and ctm_i is the correction required at the current data cycle, $\partial c \partial t$ is a correction factor that is a slowly varying function of temperature deviation from 20 ℃.

Translate: Finally, the D309nnn.cnv file was converted from binary into ASCII format so that it could be easily read into pstar format. The header information was checked at this stage to ensure that all of the processes had been performed on each station.

The .cnv and .ros files were then copied via ftp to /data32/cd309/ctd/raw so that data processing could be continued using PEXEC routines.

6.1.2 Data Processing on the UNIX system

The following c-shell UNIX scripts were used to process the data.

ctd0: This script read in the SeaBird processed ascii file (.cnv) and converted it into pstar format, also setting the required header information. The latitude and longitude of the ship when the CTD was at the bottom were typed in manually and added to the header. The output file contained the data averaged to 24hz. The output file was ctd309nn.24hz.

ctd1: This script operated on the .24hz file and used the PEXEC program *pmdian* to remove residual spikes from all of the variables. The data were then averaged into a 1hz file using *pavrge*. Absent data values in the pressure data were interpolated across using *pintrp*. Salinity, potential temperature, sigma0 and sigma2 (referenced to 2000 db) were calculated using *peos83* and finally a 10 second averaged file was also created. The output files were ctd309nn.1hz and ctd309nn.10s respectively.

ctd2: This script carried out a head and tail crop of the .1hz file to select the relevant data cycles for just the up and down casts of the CTD. Before running ctd2, the .1hz files were examined in *mlist* to determine the data cycles for i.) the shallowest depth of the CTD rosette after the initial soaking at 10m, ii.) the greatest depth, and iii.) the last good point before the

CTD is removed from the water. These values were then manually entered at the correct screen prompts in ctd2. The data were then cut out with *pcopya* and the files ctd309nn.ctu created. Finally, the data were averaged into two decibar pressure bins creating the files ctd309nn.2db.

ctd3: The script ctd3 was used to produce the users preferred raw plots of the data in the .ctu files.

fir0: This script converted the .ros file into pstar format. It then took the relevant data cycles from the .10s averaged file (secondary output from ctd1) and pasted it into a new file fir309nn containing the mean values of all variables at the bottle firing locations.

samfir: This script created the file, sam309nn containing selected variables from fir309nn so that the results from the bottle sampling analysis could be added.

Once salinity bottle data had been processed and excel files created for each ctd cast then the following scripts.

sal0: Read in the sample bottle excel files, that had been saved as tab delimited text only files, and converted some PC unique characters into UNIX friendly characters. Then sal0 created pstar format files with *pascin*: output file sal309nn.bot

passal: Pasted bottle file (sal309nn.bot) values into sam309nn files.

botcond: Calculated conductivity for bottle salinities using *peos83* and both primary and secondary temperatures. Conductivity differences were calculated using *parith*.

SeaBird claim that the correct in-situ calibration for their conductivity sensors is a linear function of conductivity with no offset. Plots of conductivity difference against conductivity added support to this and therefore *parith* and *allav* were used to calculate the mean square of the conductivity values and the mean product of the bottle and CTD conductivity values; to solve thus,

$$conductivity = A * (primary\ conductivity)$$
$$conductivity = B * (secondary\ conductivity)$$

where

$$A = \frac{\sum Cond_{bot} Cond_{ctd}}{\sum (Cond_{ctd})^2} = \frac{\overline{Cond_{bot} Cond_{ctd}}}{\overline{(Cond_{ctd})^2}}$$

and

$$B = \frac{\sum Cond2_{bot} Cond2_{ctd}}{\sum (Cond2_{ctd})^2} = \frac{\overline{Cond2_{bot} Cond2_{ctd}}}{\overline{(Cond2_{ctd})^2}}$$

and $cond2_{bot}$ is the sample bottle conductivity determined with the secondary temperature variable.

ctdcondcal: This script was used to calibrate the .ctu and .2db files and re-calculate salinity, potential temperature and sigma0/sigma2. A and B were set to 0.99991758 and 0.99983765 respectively.

Residual conductivity differences were 0.0000 with a standard deviation of 0.0013 for both primary and secondary conductivity sensors (see figure 6.1).

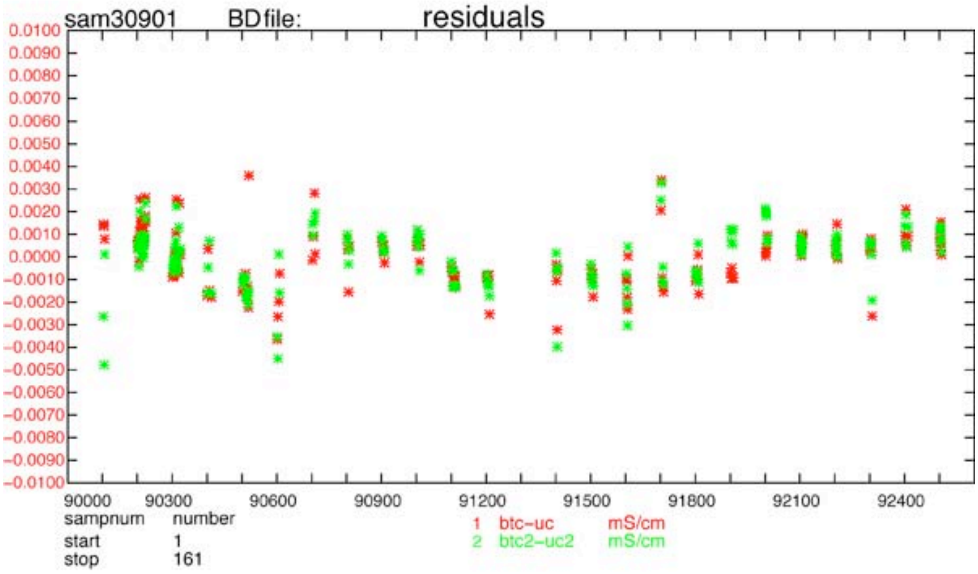


Figure 6.1: CTD primary (red) and secondary (green) post-calibration conductivity differences (bottle minus CTD).

6.2 Salinometry

John Allen, Roz Pidcock and Dave Teare

A Guildline Autosal salinometer (model 8400B, serial no. 65764) was installed in the controlled temperature laboratory (maintained at 21°C). According to the manual, the 8400B can operate successfully at lab temperatures between 4°C below and 2°C above the bath temperature, the preferred temperature being in the middle of this range. The bath temperature was set at 21°C. A thermometer was used to measure the temperature of the CT lab. which varied little (between 20.5°C and 21°C) throughout the cruise. Salinity samples were stored in the CT lab for at least 24hours prior to analysis. The salinometer was stable and behaved well throughout the cruise.

OSIL's Autosal software, SoftSal, was used throughout. On multidisciplinary cruises this expedites the entry of determined salinities into excel spreadsheets for merging with instrument data files. The software and the Autosal worked well and the stability of measurements, determined by monitoring the standard deviation of salinity measurements, was good. With few exceptions, the bottle samples were determined to a precision greater than 0.001. There are a couple of points worth noting about using this software however. Firstly the software encourages the operator to re-trim the salinometer after each standardisation to standard seawater. This is almost certainly because the measured salinity standard is not recorded in the output file (the second point to note), so no post measurement offset can be made. OSIL's latest software (advertised in the standard seawater boxes), looks as though it overcomes this limitation, furthermore it is designed to be directly compatible with spreadsheet software like MS Excel. Standard seawater samples were analysed after every crate as a quality check. Towards the end of the cruise, the PC began rebooting and shutting down unexpectedly, this was eventually blamed on a loose lower voltage power lead to the monitor, once pushed home firmly the problem appeared to have been rectified.

Salinity values were copied in to an Excel spreadsheet, then transferred to the Unix system in the form of a tab-delimited ASCII file. Data from the ASCII files were then incorporated into the sam files using the Pstar script `passal`. Initial calibrations of both the thermosalinograph and the SeaBird CTD were made successfully at the end of the cruise.

Appendix to Section 6: SeaBird sensor types, serial numbers and calibration dates

```
Date: 09/04/2006

ASCII file: C:\Program Files\Sea-Bird\Seasave-
Win32\D309_D310\Data\0782_main.con

Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : No
NMEA position data added      : Yes
Scan time added               : No

1) Frequency, Temperature

   Serial number : 03P-4489
   Calibrated on : 11 Jun 06
   G             : 4.36984824e-003
   H             : 6.45634691e-004
   I             : 2.27123309e-005
   J             : 1.98742574e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency, Conductivity

   Serial number : 04C-2407
   Calibrated on : 15 Jun 06
   G             : -9.75111418e+000
   H             : 1.41358420e+000
   I             : 5.80237014e-004
   J             : 3.19390955e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency, Pressure, Digiquartz with TC

   Serial number : 94756
   Calibrated on : 15 Apr 2004
   C1            : -4.722750e+004
   C2            : -1.465524e-001
   C3            : 1.449080e-002
   D1            : 3.863800e-002
   D2            : 0.000000e+000
   T1            : 3.011286e+001
   T2            : -2.710648e-004
   T3            : 4.095660e-006
   T4            : 2.377730e-009
   T5            : 0.000000e+000
   Slope         : 1.00000000
   Offset        : 0.00000
   AD590M        : 1.285020e-002
   AD590B        : -8.056957e+000
```

```
4) Frequency, Temperature, 2

   Serial number : 03P-4490
   Calibrated on : 11 Jun 06
   G             : 4.40570480e-003
   H             : 6.48469763e-004
   I             : 2.29513343e-005
   J             : 2.00503804e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency, Conductivity, 2

   Serial number : 04C-2450
   Calibrated on : 15 Jun 06
   G             : -1.05486233e+001
   H             : 1.67929419e+000
   I             : -1.02258454e-003
   J             : 1.86389112e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

   Serial number : 0612
   Calibrated on : 24 nov 05
   Soc           : 3.5720e-001
   Boc           : 0.0000

   Offset        : -0.5035
   Tcor          : 0.0011
   Pcor          : 1.35e-004
   Tau           : 0.0

7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

   Serial number : 1040
   Calibrated on :
   Scale factor  : 15.000
   Offset        : 0.000

9) A/D voltage 3, Fluorometer, Chelsea Aqua 3

   Serial number : 088108
   Calibrated on : 17 nov 2004
   VB            : 0.287100
   V1            : 1.978300
   Vacetone      : 0.331500
   Scale factor  : 1.000000
   Slope         : 1.000000
   Offset        : 0.000000

10) A/D voltage 4, Free

11) A/D voltage 5, Free
```

12) A/D voltage 6, User Polynomial

```
Serial number : 169
Calibrated on : 7 Jul 05
Sensor name   : BBRTD
A0            : -0.00025440
A1            : 0.00318000
A2            : 0.00000000
A3            : 0.00000000
```

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar

```
Serial number : 04-4223-001
Calibrated on : 8 dec 04
M             : 20.2870
B             : -1.0144
Path length   : 0.250
```

7 LOWERED ADCP

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Data from the Lowered Acoustic Doppler Current Meter was processed with the IfM-GEOMAR/LDEO Matlab LADCP-Processing system, version 10 beta. This is a new version of the LDEO software with a new interface, but with the same underlying processing code and theory.

A strict directory structure is imposed on the user, with a matlab script called create_cruise.m supplied to create it. This creates a set of directories corresponding to a particular cruise: in this case d309. Inside directory d309 there are two scripts called cruise_params.m and cast_params.m which need to be modified appropriately. When processing is started, all parameters are set to default values; the cruise specific parameters are reset; and finally cast specific parameters (eg if there is no bottom track data on one cast). This is accomplished using these two m-files. To find the parameter values that can be changed and their meanings, the user needs to examine script default_params.m in the m/ladcp sub-directory at the same level as the cruise directory (i.e. d309).

On this cruise cast_params.m was modified to get relevant information from a file called stations.dat via a second m-file called shipshape.m which simply parsed the stations file. The latter contains a header line followed by a line of data for each station containing in this order:

station number
start year (yyyy)
start month
start day
start hour
start minute
start second
stop year (yyyy)
stop month
stop day
stop hour
stop minute
stop seconds
depth of package at start (usually zero)
maximum depth of package
depth of package at end (usually zero)
start latitude as a real number (negative for southern hemisphere)
start longitude as a real number (negative for western hemisphere)
stop latitude

stop longitude
full pathname of PSTAR navigation file covering cast
full pathname of PSTAR ctd file
full pathname of ship ADCP PSTAR file if used

The full navigation file becomes large over the course of the cruise, so a section was extracted bracketing each cast and its name included here.

Inside directory d309 there is a sub-directory called 'm' containing five sample interface m-files: prepladcp.m, prepsadcp.m, prepnav.m, prepctdtime.m and prepctdprof.m. As their names suggest these are intended to prepare each source of data by reading any user supplied data sources and converting them into the correct form. They need to be edited to interface to the users own data. In practice, these m-files were held in another directory and symbolic links created in the working m directory. This was intended to avoid any accidental use of create_cruise.m which may have overwritten the edited versions.

To provide an interface directly to PSTAR files a set of matlab utilities were written to read directly from these binary format files (other flavours are I believe available). These are pstar.m and indata.m and a number of ancillary files.

Since version 10 is new, the edited versions of m-files used on this cruise are listed in the Appendix to this section. Note that since ship ADCP data was not used for LADCP processing, prepsadcp.m has been modified, but has not been tested.

A problem was encountered in plotting results which interrupted the processing in some cases. These were traced to points in the code where the position of the ship is plotted with respect to the position of the CTD. Commenting out the statements 'axis equal' in getinv.m and plot_result.m avoided this problem, but changed the aspect ratios of the resulting subplots.

A lot of warning messages are also issued because in calculating a vertical velocity from the CTD pressure and comparing it to the LADCP data there may be no data in one of the resulting fields. This problem, though annoying, seems to cause no problems in the results and was ignored.

Table 7.1 describes the 25 casts of this cruise.

Figure 7.1 shows a comparison of each resulting profile of velocity with the two ship ADCP's where data is available. Agreement is on the whole very good. The shears are clearly very well represented. In a number of cases there is a barotropic offset which needs to be corrected for. This should be done either by including the ship ADCP in the processing above, or by calculating an adjustment from the LADCP/SADCP mean differences.

Table 7.1: LADCP start and stop times, positions and depths. For each station, first row refers to *start* values, second row to *end* values; dates/times are mo (month), dd (day), hh (hour), mn (minute), ss (second), UTC.

stn	**Start /end year**	**mo**	**dd**	**hh**	**mn**	**ss**	**z1 (m)**	**zmax (m)**	**z2 (m)**	**start_lat end_lat**	**start_lon end_lon**	**Notes**
1	2006	08	18	16	52	18	0	165	0	47.5453	-52.5823	Note 1
	2006	08	18	18	09	00				47.5465	-52.5829	
2	2006	08	20	11	17	24	0	3560	0	54.2949	-46.7557	
	2006	08	20	14	28	23				54.2946	-46.7611	
3	2006	08	24	00	59	30	0	2820	0	59.6639	-39.7000	
	2006	08	24	04	18	50				59.6549	-39.6991	
5	2006	08	24	22	06	20	0	1980	0	59.2003	-39.5614	Note 2
	2006	08	25	00	42	00				59.2008	-39.5673	
7	2006	08	26	21	00	00	0	310	0	59.7390	-42.4998	
	2006	08	26	22	01	43				59.7359	-42.5095	
8	2006	08	26	22	45	15	0	1028	0	59.7122	-42.3953	
	2006	08	27	00	08	14				59.6930	-42.4301	
9	2006	08	27	01	04	00	0	1490	0	59.6751	-42.3431	
	2006	08	27	02	49	00				59.6603	-42.3718	
10	2006	08	27	04	27	20	0	1752	0	59.6580	-42.1723	
	2006	08	27	06	24	40				59.6541	-42.1635	
11	2006	08	27	08	16	43	0	2095	0	59.5661	-41.6903	
	2006	08	27	10	27	50				59.5624	-41.7146	
12	2006	08	28	13	21	49	0	3117	0	59.2826	-36.4304	
	2006	08	28	16	44	23				59.3091	-36.4429	
15	2006	08	30	09	14	40	0	2005	0	59.5649	-41.6953	
	2006	08	30	11	23	40				59.5625	-41.7000	
16	2006	08	30	12	28	50	0	2251	0	59.4797	-41.4424	
	2006	08	30	15	22	00				59.4799	-41.4442	
17	2006	08	30	23	00	00	0	2528	0	59.3778	-41.1012	
	2006	08	31	01	22	20				59.3787	-41.1284	
18	2006	08	31	03	16	00	0	2750	0	59.2584	-40.7501	
	2006	08	31	05	49	52				59.2624	-40.7570	
20	2006	08	31	11	25	40	0	3010	0	59.0610	-40.1355	
	2006	08	31	15	50	46				59.0674	-40.1432	
21	2006	08	31	22	47	51	0	3205	0	58.5881	-38.5008	
	2006	09	01	03	07	45				58.5961	-38.5159	
22	2006	09	01	13	34	10	0	3019	0	59.2441	-36.4012	
	2006	09	01	16	44	40				59.2550	-36.4062	
23	2006	09	01	18	22	15	0	3119	0	59.3901	-36.8381	
	2006	09	01	22	08	40				59.3862	-36.8473	
24	2006	09	02	00	45	40	0	3123	0	59.4769	-37.6102	Note 3

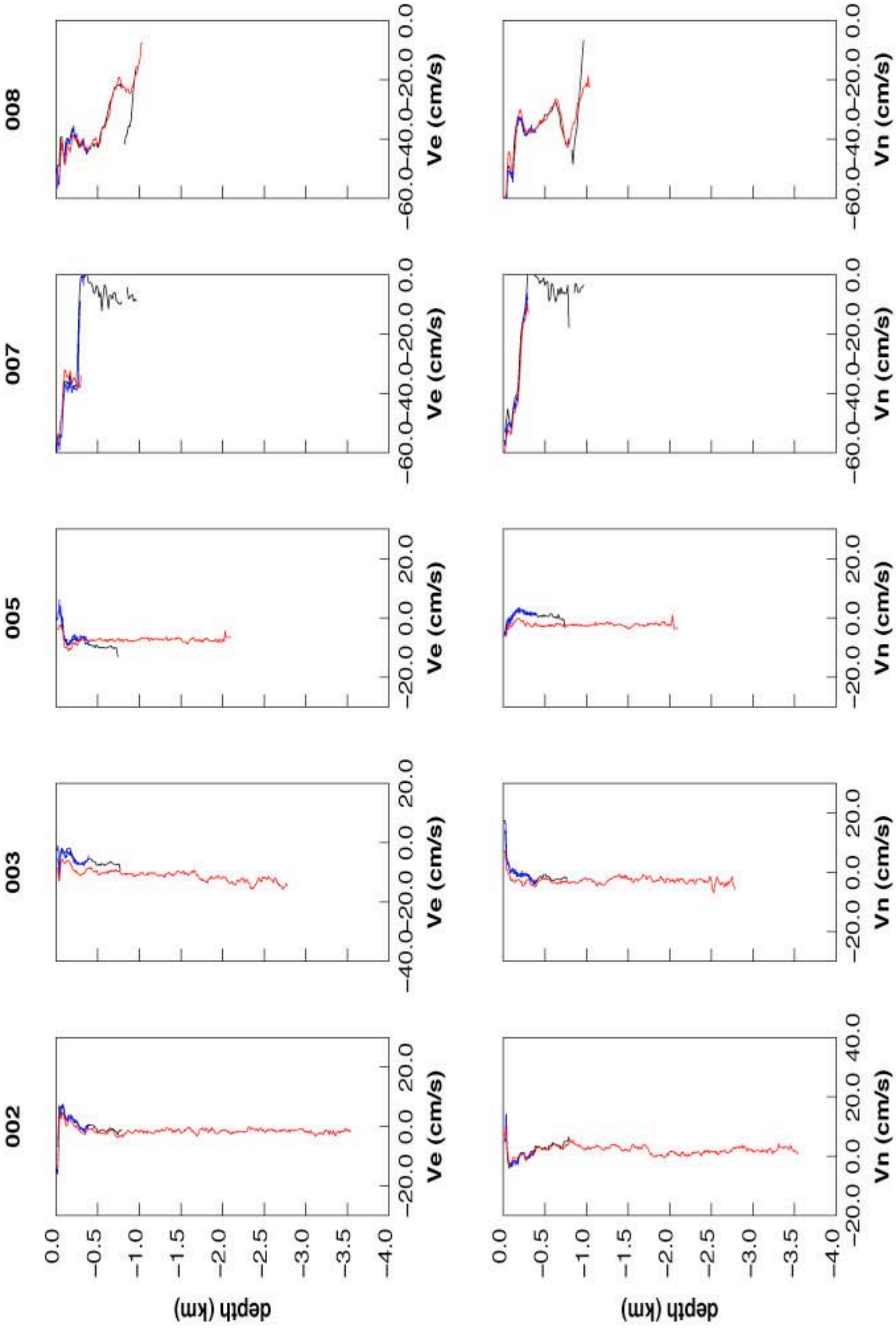
	2006	09	02	03	24	25				59.4760	-37.5997
25	2006	09	02	07	31	00	0	2981	0	59.5773	-38.7703
	2006	09	02	10	08	34				59.5750	-38.7784

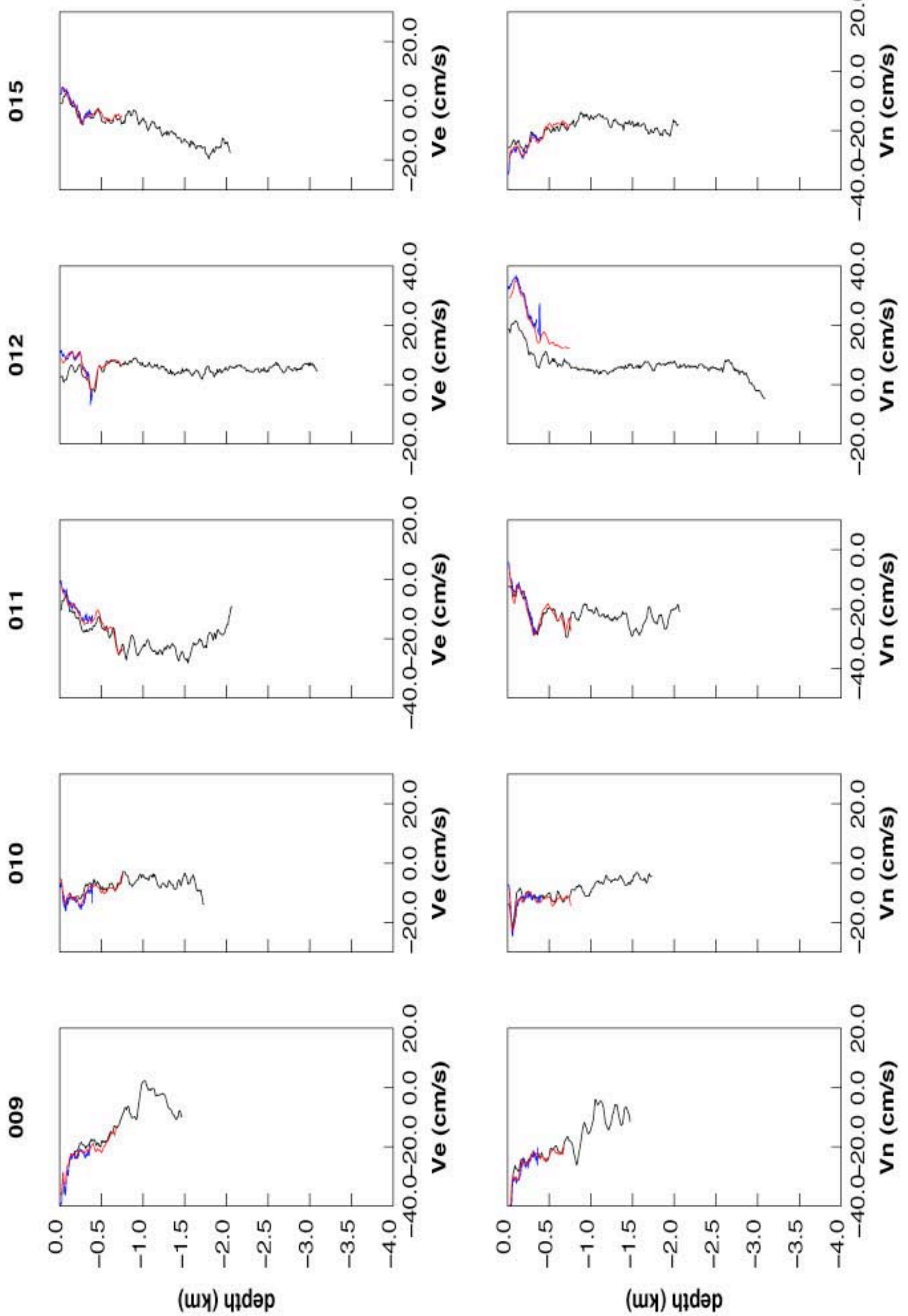
Note 1: Not processed

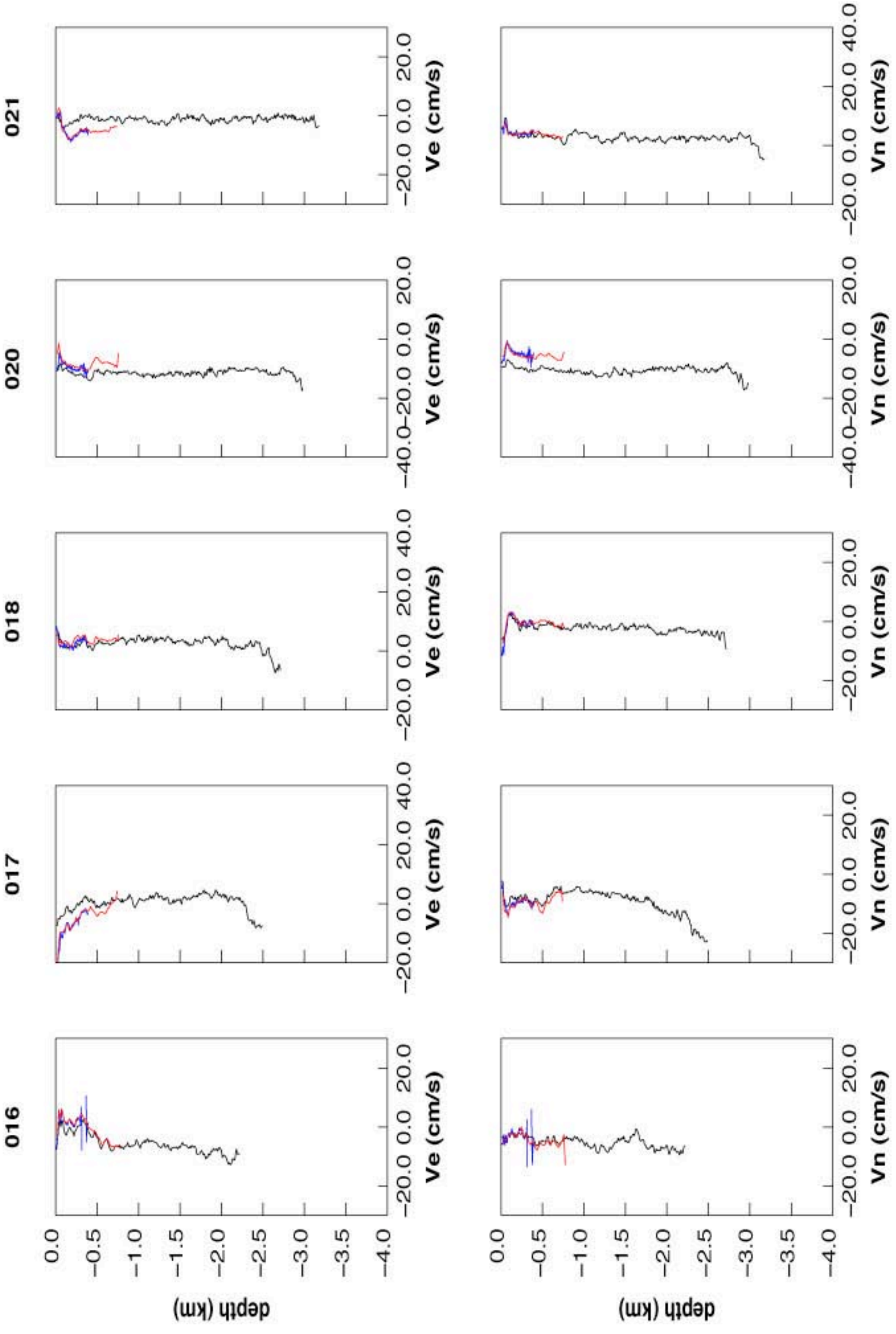
Note 2: No bottom track

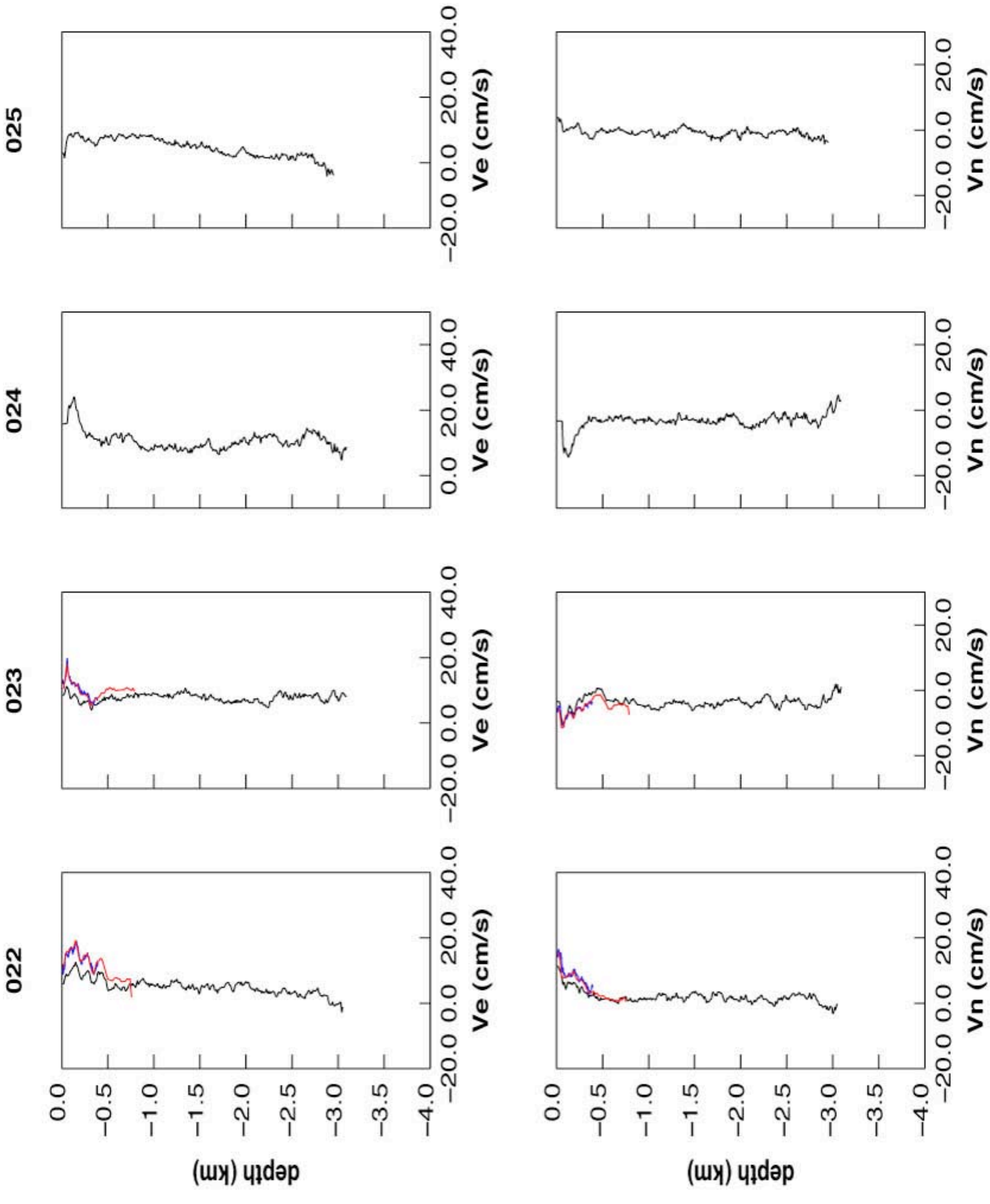
Note 3: Upward LADCP data not logged

Figure 7.1: The following four pages of figure panels show, for each station, comparison between the north (vn) and east (ve) velocity profiles for LADCP (black), and 150 (blue) and 75 (red) kHz ADCPs.


002
003
005
007
008
Ve (cm/s)
Vn (cm/s)
depth (km)


009
010
011
012
015
depth (km)
Ve (cm/s)
Vn (cm/s)


016
017
018
020
021
depth (km)
Ve (cm/s)
Vn (cm/s)



022
023
024
025
Ve (cm/s)
Vn (cm/s)
depth (km)

Appendix to Section 7: Version 10 m-files

cast_params.m

```
% Parameters setting files are called in this order
%
% default_params.m
% cruise_params.m
% cast_params.m     <--- you are here
%
% this is the location to enter special settings which apply
% only to a single or a few casts. E.g. positions and times
%
% parameters to consider setting here are:
%
% p.poss and p.pose
% p.zpar
% p.time_start and p.time_end
%
% descriptions of the formats can be found in m/ladcp/default_params.m


% remove the following two lines after modifying the parameters
% disp('edit  cruise_id/cruise_params.m')
% return

% this edit SGA D309 August 2006

[y1,m1,d1,h1,mi1,s1]              = shipshape(stn,'start_time');
[y2,m2,d2,h2,mi2,s2]              = shipshape(stn,'end_time');
[latdeg1,latmin1,londeg1,lonmin1] = shipshape(stn,'start_pos');
[latdeg2,latmin2,londeg2,lonmin2] = shipshape(stn,'start_pos');
[z1,z2,z3]                        = shipshape(stn,'depth');

p.time_start = [y1 m1 d1 h1 mi1 s1];
p.time_end   = [y2 m2 d2 h2 mi2 s2];
p.zpar       = [z1 z2 z3];
p.poss       = [latdeg1 latmin1 londeg1 lonmin1];
p.pose       = [latdeg2 latmin2 londeg2 lonmin2];

if stn == 5
  p.btrk_mode = 0
end
```

prepladcp.m

```
function [file] = prepladcp(stn)
% function [file] = prepladcp(stn)
%
% prepare LADCP data for LADCP processing
%
% we need the raw LADCP data to be in the correct place and
% have the correct names.
%
% THIS FILE IS CRUISE SPECIFIC
%
% to create a file for your own cruise, modify this file
%
```

```
% you will just need to copy and possibly rename the files
% In case of old BB and NB systems you might need to append
% the raw data files.
%
% the convention for filenames is
%
% xxxDN000.000  and  xxxUP000.000       with xxx the 3-digit station number
%
% they need to be copied into one directory per station
% data/raw_ladcp/xxx            with xxx the 3-digit station number

% G.Krahmann, IFM-GEOMAR, Aug 2005

% disp('YOU FIRST NEED TO EDIT THE FILE cruise_id/m/prepladcp.m !')
% return

% this edit SGA D309 August 2006

% assume master is downward looking
master = 'D309M';
slave  = 'D309S';
laddir = ['data/raw_ladcp/',int2str0(stn,3)];

if ~exist(laddir)
  eval(['!mkdir ',laddir])
  eval(['!ln          -s          $P_LAD/raw/',master,int2str0(stn,3),'.000
',laddir,'/',int2str0(stn,3),'dn000.000'])
  eval(['!ln       -s       $P_LAD/raw/',slave       ,int2str0(stn,3),'.000
',laddir,'/',int2str0(stn,3),'up000.000'])
end

% set file name
file = ['data/raw_ladcp/',int2str0(stn,3)];
```

prepnav.m

```
function prepnav(stn,values)
% function prepnav(stn,values)
%
% prepare navigational data for LADCP
% we an array 'data' containing the 2 columns
% latitude in decimal degrees    longitude in decimal degrees
% and the vector 'timnav' containing the time of the navigational
% data in Julian days
%
% THIS FILE IS CRUISE SPECIFIC
%
% to create a file for your own cruise, modify this file
%
% The navigational data should be at a resolution of 1 per second.
% Lower resolution will lead to worse processing results.

% G.Krahmann, IFM-GEOMAR, Aug 2005

% if you do no have navigational data to be used in the
% LADCP processing, uncomment the next line

% disp('YOU FIRST NEED TO EDIT THE FILE cruise_id/m/prepnav.m !')
% return
```

```
% first copy navigational data to the raw NAV data directory
% data/raw_nav

% this edit SGA D309 August 2006

% load this data and convert to standard format
%
% extract the lat and lon columns
% into 'data' and the time vector into 'timctd'
%
% make sure that the time is stored in Julian days

navname = shipshape(stn,'navigation');
disp(['navname: ',navname]);
pd = pstar(navname);

timnav = squeeze(indata(pd,'time'))';
lon = indata(pd,'lon');
lat = indata(pd,'lat');
data = [squeeze(lat);squeeze(lon)]';     % note transpose to get shape

fclose(pd.fid);

% To reduce the amount of data we crop the navigational data to
% the same time as the CTD-TIME data. In our example case that
% was an unnecessary exercise since they are the same data, but if
% you have independent navigational data (e.g. daily navigational files)
% this will reduce file size.

fprintf(2,'%10.2f %10.2f\n',values.start_cut,values.end_cut);
good = find(timnav>=values.start_cut & timnav<=values.end_cut);
timnav = timnav(good);
data = data(good,:);

% store data in the standard location
if str2num(version('-release'))>=14
  eval(['save data/nav/nav',int2str0(stn,3),' timnav data -v6'])
else
  eval(['save data/nav/nav',int2str0(stn,3),' timnav data'])
end
```

prepctdprof.m

```
function [values] = prepctdprof(stn,values)
% function [values] = prepctdprof(stn,values)
%
% prepare CTD profile for LADCP
% we need an array 'data' containing the 3 columns
% pressure in dbar    in situ temperature in degrees C    salinity in psu
%
%
% THIS FILE IS CRUISE SPECIFIC
%
% to create a file for your own cruise, modify this file
%
% the data should typically be a profile in 1dbar or 1m steps
% (a lower resolution of down to 10dbar or 10m might be sufficient)
% it will be used to calculate depth dependent sound speed corrections
%
```

```
% If such data is not available, a sound speed profile will be
% derived from the ADCP's temperature sensor, the integrated
% vertical velocity and a constant salinity.

% G.Krahmann, IFM-GEOMAR, Aug 2005

% if you do no have CTD profile data to be used in the
% LADCP processing, uncomment the next line

% disp('YOU FIRST NEED TO EDIT THE FILE cruise_id/m/prepctdprof.m !')
% return

% this edit SGA D309 August 2006

% load the data and convert to standard format
%
% in this example
% we extract the PTS columns and get position and time data from the header
%
% pressure in dbar

ctdname = shipshape(stn,'ctd');
disp(['ctdname: ',ctdname]);
pd = pstar(ctdname);

pres = indata(pd,'press');
temp = indata(pd,'temp');
salt = indata(pd,'salin');
ctdprof = [squeeze(pres);squeeze(temp);squeeze(salt)]';

% extract position and time
tctd = squeeze(indata(pd,'time'));

fclose(pd.fid);

values.ctd_time = 0.5*(tctd(1)+tctd(end));
fprintf(2,'%10.2f\n',values.ctd_time);

% the pressure data in the example had some spikes which
% could be removed by the following
% If your data quality is already good, you won't need the
% following lines
good = find(ctdprof(:,3)>1);
ctdprof = ctdprof(good,:);

% store data at the standard location
if str2num(version('-release'))>=14
  eval(['save data/ctdprof/ctdprof',int2str0(stn,3),' ctdprof -v6'])
else
  eval(['save data/ctdprof/ctdprof',int2str0(stn,3),' ctdprof'])
end

% save filename
file = ['data/ctdprof/ctdprof',int2str0(stn,3)];
```

prepctdtime.m

```
% function prepctdtime(stn)
%
% prepare CTD data against time for LADCP
```

```
%
% we need a vector 'timctd' with the time of the CTD in Julian days
% and an array 'data' with the 3 columns
% pressure in dbar    in situ temperature in degrees C    salinity in psu
%
% THIS FILE IS CRUISE SPECIFIC
%
% to create a file for your own cruise, modify this file
%
% the data should typically be the data recorded during a CTD
% cast in about 1 second steps
% it will be used to calculate the depth of the LADCP system

% G.Krahmann, IFM-GEOMAR, Aug 2005

% if you do no have CTD time data to be used in the
% LADCP processing, uncomment the next line

% disp('YOU FIRST NEED TO EDIT THE FILE cruise_id/m/prepctdtime.m !')
% return

% this edit SGA D309 August 2006

%
% load this data and convert to standard format
% we need the data:
%
% time in decimal julian days ( January 1, 2000 = 2451545 )
% pressure in dbar
% in situ temperature in degrees C
% salinity in psu
%
% time is stored as acolumn vector in 'timctd'
% the other variables as columns PTS in the array 'data'
%
%
% in this example
% we skip the header of the file and extract the PTS columns
% into 'data' and the time vector into 'timctd'
%
% you might have to convert depth to pressure in dbar
% and/or conductivity to salinity
%
% and you will have to make sure that the time is stored in Julian days
%
% in this example we add the julian day January 0 of the year of the
% cast to the time stored in the file
% THIS IS APPROPRIATE FOR SEABIRD CNV FILES that contain the
% variable 'time in julian days'
%
ctdname = shipshape(stn,'ctd');
disp(['ctdname: ',ctdname]);
pd = pstar(ctdname);

pres = indata(pd,'press');
temp = indata(pd,'temp');
salt = indata(pd,'salin');
data = [squeeze(pres);squeeze(temp);squeeze(salt)]';

timctd = squeeze(indata(pd,'time'))';
```

```
fclose(pd.fid);

%
% the pressure data on one of our cruises had some spikes which
% could be removed by the following
% If your data quality is already good, you won't need the
% following lines. If it is bad you will need do create your
% own despiking.
%
good = find(data(:,3)>1);
data = data(good,:);
timctd = timctd(good);


%
% In our example the CTD cast recording began a bit before the
% actual down movement of the CTD. We want only the real
% down and uptrace of the cast. A good part of this will be
% done again in the main processing, but sometimes those
% routines failed and it was simple enough to do here.
%
% The extraction of this part is sometimes tricky. You might
% have to 'invent' your own methods to make sure that only the
% cast is extracted.
%
% Here we cut start and end of profiles to near sea surface.
% This is done by taking the maximum pressure
% finding the two values closest to half of this pressure
% on the up and the down casts and go towards the
% surface on up and down casts until one reaches either 2dbar or
% the last value
%
% uncomment the following only, if you experience problems with the
% determination of beginning and end of cast
%
%[pmax,indmax] = nmax(data(:,1));
%[dummy,mid1] = min( abs(pmax/2-data(1:indmax,1)) );
%[dummy,mid2] = min( abs(pmax/2-data(indmax+1:end,1)) );
%mid2 = mid2+indmax-1;
%inds = max( find( data(1:mid1,1)< 2 ) );
%if isempty(inds)
%  inds = 1;
%end
%inde = min( find( data(mid2:end,1)< 2 ) ) + mid2-1;
%if isempty(inde)
%  inde = size(data,1);
%end
%data = data(inds:inde,:);
%timctd = timctd(inds:inde);


%
% The following might not be necessary. But we needed it
% in some cases.
% Interpolate to a regular time stepping.
%
% uncomment the following only, if you experience problems with the
% CTD interpolation in the merging part of the processing
%
%min_t = min(timctd);
%max_t = max(timctd);
```

```
%delta_t = median(diff(timctd));
%data = interp1q(timctd,data,[min_t:delta_t:max_t]');
%timctd = [min_t:delta_t:max_t]';
%disp(sprintf('  interpolated to %d CTD scans; delta_t = %.2f seconds',...
%       length(timctd),median(diff(timctd))*24*3600));
%


%
% store data in the standard location
%
if str2num(version('-release'))>=14
  eval(['save data/ctdtime/ctdtime',int2str0(stn,3),' timctd data -v6'])
else
  eval(['save data/ctdtime/ctdtime',int2str0(stn,3),' timctd data'])
end
```

prepsadcp.m

```
function [] = prepsadcp(stn,values)
% function [] = prepsadcp(stn,values)
%
% prepare Ship-ADCP data for LADCP processing
%
% we need the vectors 'tim_sadcp' , 'lon_sadcp' , 'lat_sadcp'
% and 'z_sadcp'
% and the arrays 'u_sadcp' and 'v_sadcp'
%
% THIS FILE IS CRUISE SPECIFIC
%
% to create a file for your own cruise, modify this file
%
% the data should be the result of shipboard or later
% SADCP processing

% G.Krahmann, IFM-GEOMAR, Aug 2005

% if you do no have SADCP data to be used in the
% LADCP processing, uncomment the next line

disp('YOU FIRST NEED TO EDIT THE FILE cruise_id/m/prepsadcp.m !')
return

% this edit SGA D309 August 2006

% load data and convert to standard format
%
% in this example we load the velocity and position/time files
% (the processing of the SADCP was also done in matlab which
% made the loading of files easy)
% and extract the necessary information
%
% again make sure that the time is in Julian days
% In the example the cruise was in 2004 and the processing
% stored only the day of the year not the actual year !!!

adpname = shipshape(stn,'adcp');
disp(['adpname: ',adpname]);
pd = pstar(adpname);
```

```
lon_sadcp = indata(pd,'lon');
lat_sadcp = indata(pd,'lat');
tim_sadcp = indata(pd,'time');
u_sadcp = indata(pd,'absve');
v_sadcp = indata(pd,'absvn');
z_sadcp = indata(pd,'bindepth');

fclose(pd.fid);

% restrict the data to the time of the cast
good = find( tim_sadcp>values.start_time-0.1 &
tim_sadcp<values.end_time+0.1);
tim_sadcp = tim_sadcp(good);
lat_sadcp = lat_sadcp(good);
lon_sadcp = lon_sadcp(good);
u_sadcp = u_sadcp(:,good);
v_sadcp = v_sadcp(:,good);
z_sadcp = z_sadcp;


% store the data
if str2num(version('-release'))>=14
  eval(['save data/sadcp/sadcp',int2str0(stn,3),...
        ' tim_sadcp lon_sadcp lat_sadcp u_sadcp v_sadcp z_sadcp -v6'])
else
  eval(['save data/sadcp/sadcp',int2str0(stn,3),...
        ' tim_sadcp lon_sadcp lat_sadcp u_sadcp v_sadcp z_sadcp'])
end
```

pstar.m

```
function [pdata] = pstar(pname)

  % pdata = pstar(pname)
  % open pstar file named pname and return a struct containing
  % header information
  % related functions:
  %    indata(pdata, vname)
  %    pread(fid)

  fid = fopen(pname,'r');

  c6 = ['      '];

  pdata.fid = fid;
  c8 = fread(fid,8,'char');
  pdata.datnam = str2mat(c8)';

  pos = fseek(fid,14,'bof');
  c4 = fread(fid,4,'char');
  pdata.magic = str2mat(c4)';

  pos = fseek(fid,40,'bof');
  noflds = fread(fid,1,'int32');
  norecs = fread(fid,1,'int32');
  nrows = fread(fid,1,'int32');
  nplane = fread(fid,1,'int32');
  if nrows <= 0
    nrows = 1;
  end
```

```
  if nrows > norecs
    nrows = 1;
  end
  ncols  = floor(norecs/nrows);
  pdata.noflds = noflds;
  pdata.norecs = norecs;
  pdata.nrows = nrows;
  pdata.ncols = ncols;

  pdata.cent = fread(fid,1,'int32');
  pdata.ymd = fread(fid,1,'int32');
  pdata.hms = fread(fid,1,'int32');

  pos = fseek(fid,128,'bof');
  if pdata.magic == 'P*RV' | pdata.magic == 'P*DC'
    lat = pread(fid);
    pos = fseek(fid,136,'bof');
    lon = pread(fid);
  else
    lat = fread(fid,1,'float64');
    lon = fread(fid,1,'float64');
  end
  pdata.lat = lat;
  pdata.lon = lon;

  for i=1:noflds
    pos = fseek(fid,1024+(i-1)*8,'bof');
    c8=fread(fid,8,'char');
    name(i,1:8) = str2mat(c8);
  end
  pos = fseek(fid,5120,'bof');
  for i=1:noflds
    value = pread(fid);
    absnt(i) = value;
  end
  pdata.name = name;
  pdata.absent = absnt;

  return
```

indata.m

```
function [vdata] = indata(pdata, name)

  % vdata = indata(pdata, vname)
  % read variable named vname and return an array
  % containing the data
  % related functions:
  %    pstar(pname)
  %    pread(fid)

  fid = pdata.fid;
  magic = pdata.magic;
  nrows = pdata.nrows;
  ncols = pdata.ncols;
  noflds = pdata.noflds;
  norecs = pdata.norecs;
  vname = ['        '];
  for i = 1:length(name)
    vname(i) = name(i);
  end
```

```
iname = -1;
for i = 1:noflds
  if vname == pdata.name(i,1:8)
    iname = i;
    break
  end
end
if iname < 0
  disp(['variable ',name,' not found']);
  return
end
absnt = pdata.absent(iname);

vdata = zeros(nrows,ncols);

switch magic

  case 'P*RV'
    nblk=0;
    totblk=(floor((norecs-1)/1365)+1)*noflds;
    for k=iname:noflds:totblk
      blkvar = floor((k-iname)/noflds) + 1;
      n1 = (blkvar-1)*1365 + 1;
      n2 = n1 + 1364;
      if n2 > norecs
        n2 = norecs;
      end
      pos=fseek(fid,k*8192,'bof');      % this allows for header block
      for n = n1:n2
        j = floor((n-1)/nrows)+1;
        i = n - (j-1)*nrows;
        value = pread(fid);
        if value >= absnt-0.0001 & value <= absnt+0.0001
          value = NaN;
        end
        vdata(i,j)=value;
      end
    end

  case 'P*RD'
    disp('not yet coded')

  case 'P*V8'
    disp('not yet coded')

  case 'P*D8'
    disp('not yet coded')

  otherwise
    disp('unrecognized magic number')

end

if vname == 'time    '
  disp('converting time to full julian day');
  jul = prnjul(pdata.cent,pdata.ymd);
  sec = prnsec(pdata.hms);
  vdata = (vdata+sec) ./ 86400.0;
  vdata = vdata + jul;
end
```

prnhms.m

```
function [h,m,s] = prnhms(hms)

  % take hhmmss and convert to hh,mm,ss

  [h,m,s] = prnymd(hms);
```

prnjul.m

```
function jul = prnjul(cent,ymd)

  % take century, yymmdd and hhmmss and convert to full julian day
  % note that pstar century is one less than it should be

  % the algorithm works as follows:
  % 153 is no. of days in any 5 successive months
  % excluding feb (which is why feb is pushed to end of year)
  % 1461 is no. of days in 4 years (3*365+366)
  % 146097 is no. of days in 400 years (only the centuries
  % 0,400,800,1200,1600,2000 etc are leap years

  c = cent;
  [y,m,d] = prnymd(ymd);
  if c > 100
    c = floor(c/100);
  end

  if m <= 2
    m = m+9;
    y = y-1;
    if y < 0
      y = y+100;
      c = c-1;
    end
  else
    m = m-3;
  end
  jul = floor((146097*c)/4)+floor((1461*y)/4)+floor((153*m+2)/5)
+d+1721119;
```

prnsec.m

```
function sec = prnsec(hms)

  % take hour-minute-second as a six digit integer and convert to seconds

  h = floor(hms/10000);
  m = hms - 10000*h;
  m = floor(m/100);
  s = hms - 10000*h - 100*m;
  sec = s + 60*m + 3600*h;
```

prnymd.m

```
function [y,m,d] = prnymd(ymd)

  % take yymmdd and convert to yy,mm,dd
```

```
  y = floor(ymd/10000);
  m = ymd - 10000*y;
  m = floor(m/100);
  d = ymd - 10000*y - 100*m;
```

shipshape.m

```
function [varargout] = shipshape(num,set)

  % file of station information called 'stations.dat' in format:
  % stn,y1,m1,d1,h1,mi1,s1,y2,m2,d2,h2,mi2,s2,z1,z2,z3,
  % lat1,lon1,lat2,lon2,navname,adcpname,ctdname
  % this file should be in the same directory as this script

  % find my pathname and then strip off 'shipshape.m' ie 11 chars
  me = which('shipshape');
  fp = fopen([me(1:end-11),'stations.dat']);

  duff = fgetl(fp);
  while ~feof(fp)
    a = fscanf(fp,'%d',16);
    b = fscanf(fp,'%g',4);
    nav = fscanf(fp,'%s',1);
    ctd = fscanf(fp,'%s',1);
    adp = fscanf(fp,'%s',1);
    if a(1) == num
      break
    end
  end
  fclose(fp);
  if a(1) ~= num
    disp('station not found');
    return
  end

  switch set
    case 'start_time'
      if nargout ~= 6
        disp('wrong number of output arguments, 6 required');
        return
      end
      varargout{1} = a(2);
      varargout{2} = a(3);
      varargout{3} = a(4);
      varargout{4} = a(5);
      varargout{5} = a(6);
      varargout{6} = a(7);
    case 'end_time'
      if nargout ~= 6
        disp('wrong number of output arguments, 6 required');
        return
      end
      varargout{1} = a( 8);
      varargout{2} = a( 9);
      varargout{3} = a(10);
      varargout{4} = a(11);
      varargout{5} = a(12);
      varargout{6} = a(13);
    case 'depth'
      if nargout ~= 3
```

```
        disp('wrong number of output arguments, 3 required');
        return
      end
      varargout{1} = a(14);
      varargout{2} = a(15);
      varargout{3} = a(16);
    case 'start_pos'
if nargout ~= 4
        disp('wrong number of output arguments, 4 required');
        return
      end
      lat1 = b(1);
      lon1 = b(2);
      sgn = 1.0;
      if lat1 < 0.0
        lat1 = abs(lat1);
        sgn = -1.0;
      end
      varargout{1} = sgn*floor(lat1);
      varargout{2} = sgn*60*(lat1-floor(lat1));
      sgn = 1.0;
      if lon1 < 0.0
        lon1 = abs(lon1);
        sgn = -1.0;
      end
      varargout{3} = sgn*floor(lon1);
      varargout{4} = sgn*60*(lon1-floor(lon1));
    case 'end_pos'
      if nargout ~= 4
        disp('wrong number of output arguments, 4 required');
        return
      end
      lat2 = b(3);
      lon2 = b(4);
      sgn = 1.0;
      if lat2 < 0.0
        lat2 = abs(lat2);
        sgn = -1.0;
      end
      varargout{1} = sgn*floor(lat2);
      varargout{2} = sgn*60*(lat2-floor(lat2));
      sgn = 1.0;
      if lon2 < 0.0
        lon2 = abs(lon2);
        sgn = -1.0;
      end
      varargout{3} = sgn*floor(lon2);
      varargout{4} = sgn*60*(lon2-floor(lon2));
    case 'navigation'
      if nargout ~= 1
        disp('wrong number of output arguments, 1 required');
        return
      end
      varargout{1} = nav;
    case 'ctd'
      if nargout ~= 1
        disp('wrong number of output arguments, 1 required');
        return
      end
      varargout{1} = ctd;
    case 'adcp'
```

```
    if nargout ~= 1
      disp('wrong number of output arguments, 1 required');
      return
    end
    varargout{1} = adp;

  otherwise
    disp('unknown request');
end
```

8 MOVING VESSEL PROFILER

John Allen, Roz Pidcock, Dave Teare and Dan Comben

8.1 Tow Summary

Tow no.	start date	start time	stop date	stop time	duration hh:mm	distance run (km)			Notes
		UTC		UTC		start	end	total	
1	20/08/06	15:28	20/08/06	19:10	03:42	897	951	54	Note 1
2	21/08/06	23:24	22/08/06	04:51	05:15	1406	1457	51	Note 2
3	26/08/06	16:16	26/08/06	19:49	03:33	2552	2589	37	Note 3
				Total	**12:30**			**142**	

Note 1: Test deployment, Labrador basin

Note 2: Speed/depth/resolution tests, running in towards Cape Farewell

Note 3: High resolution observation of the East Greenland Coastal Current

8.2 Data

The BOT (Brooke Ocean Technologies) MVP 300 carried an AML micro CTD (Conductivity, Temperature, Depth) instrument (S/N 7027), a WETLabs fluorimeter, a SeaBird SBE23 oxygen sensor (S/N 230960) and two PAR sensors. On this cruise, three short tows were used to test the vehicle for the balance between ship speed, depth range and spatial resolution.

During MVP deployments, data were recovered, in near real time, through the BOT software on a PC in the main lab. A series of files are created after each down/up cycle. The principal file containing most of the data had the suffix '.m1'. Eight other files were written, most duplicating some of the data streams in the '.m1' file but in a specific format for feeding into other instruments. The PAR data were not in the '.m1' file and only seem to be present in a raw counts instrument file. No attempt was made to read the PAR data in during the cruise, but the raw files were archived with all the other cruise data for later reference if required.

With the exception of the 'user variables' channels, the data in the '.m1' files are in engineering units 'calibrated' using pre-set coefficients stored in the BOT software. The fluorimeter and the oxygen sensor were connected to the 'user variables' channels, U1 and U2/U3 for Oxy. Current/Temperature. The sensors sample at 25 Hz, and each data file (.m1) is time stamped with GPS time in the header only.

Owing to the short duration of this cruise, no attempt was made at in-situ calibration of either salinity, fluorescence or oxygen on board; the data therefore await this process post cruise.

8.3 Processing Steps

The following processing route was followed after each of the three MVP tows:

The PC files were transferred to the ship's UNIX computer system by ftp over the ship's ethernet.

mvpexec0: This read the '.m1' data files, typically 35-75 files for each tow, e.g D309001.001m1 – D309035.001m1, into PSTAR format files. The start time was extracted from the header information and placed in the PSTAR headers, then a relative 25 Hz time variable for each PSTAR file was created. Variables were calibrated as appropriate, and a temperature difference variable was created. The data were despiked and 1 Hz averaged files were created. Finally the script appended the 1 Hz files into a 1 Hz survey file, e.g. mvp30901.raw.

mvpexec1: The main steps to mvpexec1 were firstly *pcalc* to apply a temperature lag correction (see below) which, having experimented with a number of corrections, turned out to be 0.15 and this remained constant over all three tows. Secondly *peos83* was run to calculate potential temperature, salinity and density.

Pedita was then used to remove the worst surface salinity spiking. No attempt was made at this time to edit the fluorimeter spikes which are simply too numerous to hand edit. There is clearly a signal in the fluorimeter data, but some thought will have to be given to its cleaning. Further editing for spikes, and salinity offsets due to fouling of the conductivity cell was carried out by inspection with *plpred*, if necessary.

Temperature Correction

It is necessary to make a correction for the small delay in the response of the CTD temperature sensor for two reasons. Firstly, to obtain a more accurate determination of temperature for points in space and time. But, more importantly to obtain the correct temperature corresponding to conductivity measurements, so that an accurate calculation of salinity can be made.

A lag in temperature is apparent in the data in two ways. There is a difference between up and down profiles of temperature (and hence salinity) because the time rate of change of temperature has opposite signs on the up and down casts. The second manifestation is the "spiking" of salinity as the sensors traverse maxima in the gradients of temperature and salinity. The rate of ascent and descent of the MVP is greater (up to ~ 6 ms^{-1} during descent and at the beginning of ascent) than that of a lowered CTD package, thus the effects of the temperature lag are more pronounced. Thus, the following correction was applied to the temperature during ***mvpexec1*** before evaluating the salinity

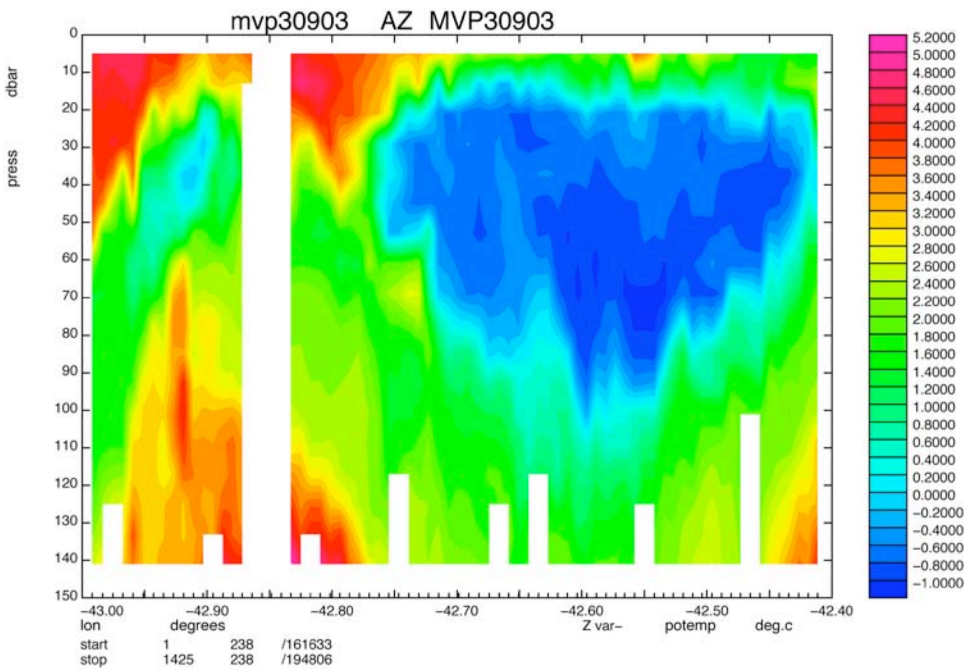
$$T_{corr} = T_{raw} + \tau.\Delta T$$

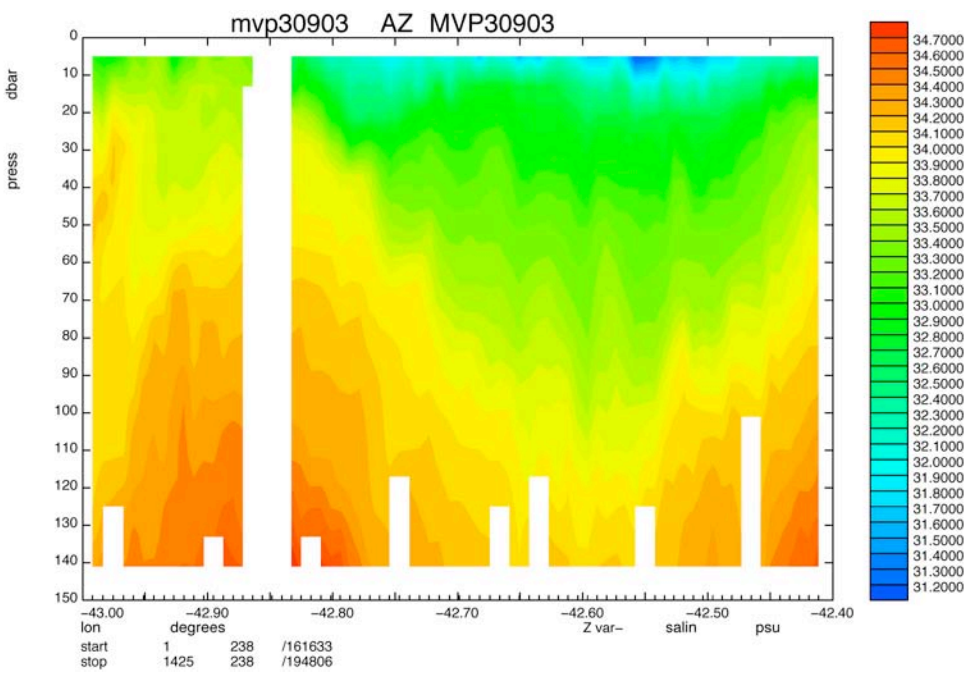
where ΔT is defined above and τ is constant.

The best value of τ was chosen so as to minimise the difference between up and down casts and noise in the salinity profile. The best value was found to be $\tau = 0.15$ second, similar but nonetheless different to the 0.12 valued used on D306.

8.4 Early results

At a tow speed of ~ 6 Knots and a depth range set to ~140 m, the third MVP tow was made at high spatial resolution (~ 0.5 km per up/down cast). These data, across the Greenland shelf break, indicated a rather uncharacteristic coastal current.





9 NAVIGATION AND SHIPBOARD ADCPS

R. E. M. Pidcock, J. T. Allen and P. Duncan

9.1 Introduction

Since the FISHES (D253) cruise in May/June 2001, two RDI Vessel-Mounted Acoustic Doppler Current Profilers (VM-ADCPs) have been in operation on RRS *Discovery*; the narrowband 150 kHz VM-ADCP and a 75 kHz Phased Array instrument (Ocean Surveyor). The majority of this report duplicates that of Penny Holliday and Helen Johnson for D253.

The 150 kHz ADCP is mounted in the hull 1.75 m to port of the keel, 33 m aft of the bow at the waterline and at an approximate depth of 5 m. The 75 kHz ADCP is also mounted in a in the hull, but in a second well 4.15 m forward and 2.5 m to starboard of the 150 kHz well.

This section describes the operation and data processing paths for both ADCPs. The navigation data processing is described first since it is key to the accuracy of the ADCP current data.

9.2 Navigation

9.2.1 Position

The ship's primary position instruments were the GPS Trimble 4000 system and the Ashtech G12 system. The GPS 4000 system had been determined to be the most accurate system on a number of preceding cruises. On preceding cruises, this accuracy was determined to be ~1.0 m for the GPS4000 system and ~ 2.0 m for the G12 system.

The RVS "Bestnav" failed to produce anything sensible on D309 and the routine was not fixed until the last few days of the cruise; see Ship's Fitted Systems report. However, the GPS4000 data stream did not suffer from the extended periods of duplicate times and positions experienced during D306. And, by relaxing the historic (10 years old at least) restriction on PDOP from 5.0 to 7.0, a high quality navigation file was obtained from just the GPS4000 (Trimble 4000 with Ashtech G12 differential corrections) file stream. Both of these systems had sufficient precision to enable a calculation of ship's velocities to better than 1 cms^{-1}, and therefore below the instrumental limits of the RDI ADCP systems.

Data were transferred daily from the GPS Trimble 4000 stream to the pstar navigation file, gp430901. The G12, Glonas and gyro (gyronmea) data streams were also transferred daily.

Scripts:

gyroexec0: transferred data from the RVS gyronmea stream to Pstar, a nominal edit was made for directions between 0-360° before the file was appended to a master file.

gp4exec0: transferred data from the RVS gps_4000 stream to Pstar, edited out pdop (position dilution of precision) greater than 7 and appended the new 24 hour file to a master file.

The master file was averaged to create an additional 30 second file and distance run was calculated and added to both.

gpsg12exec0: this was identical to gp4exec0, without a final 30 sec average routine, but transferred the RVS gps_g12 data stream to Pstar.

gpsglosexec0: as above to transfer the Glonass GPS stream.

9.1.2 Heading

The ship's attitude was determined every second with the ultra short baseline 3D GPS Ashtech ADU2 navigation system. Four antennae, 2 on the boat deck, two on the bridge top, measured the phase difference between incoming satellite signals from which the ship's heading, pitch and roll were determined. Configuration settings from previous calibrations (Trials cruise in April 2001) were used throughout the cruise, these were:

Adjusted Relative Antenna Positions (m), which require no pitch or roll offset angle.

	X(R)	Y(F)	Z(U)
1-2 Vector	0.000	6.492	0.167
1-3 Vector	-10.162	0.135	-4.337
1-4 Vector	-10.113	6.431	-4.193

The Ashtech data were used to calibrate the gyro heading information as follows:

ashexec0: transferred data from the RVS gps_ash stream to pstar.

ashexec1: merged the ashtech data from ashexec0 with the gyro data from gyroexec0 and calculated the difference in headings (hdg and gyroHdg); ashtech-gyro (a-ghdg).

ashexec2: edited the data from ashexec1 using the following criteria:

heading	0 < hdg < 360 (degrees)
pitch	-5 < pitch < 5 (degrees)
roll	-7 < roll < 7 (degrees)
attitude flag	-0.5 < attf < 0.5
measurement RMS error	0.00001 < mrms < 0.01
baseline RMS error	0.00001 < brms < 0.1
ashtech-gyro heading	-7 < a-ghdg < 7 (degrees)

The heading difference (a-ghdg) was then filtered with a running mean based on 5 data cycles and a maximum difference between median and data of 1 degree. The data were then averaged to 2 minutes and further edited for:

-2 < pitch <2

0 < mrms < 0.004

The 2 minute averages were merged with the gyro data files to obtain spot gyro values. The ship's velocity was calculated from position and time, and converted to speed and direction. The resulting a-ghdg should be a smoothly varying trace that can be merged with ADCP data to correct the gyro heading. Diagnostic plots were produced to check this. During ship manoeuvres, bad weather or around data gaps, there were spikes which were edited out manually (plxyed).

Ashtech 3D GPS coverage was generally good. Gaps over 1 minute in the data stream are listed below.

time gap : 06 231 06:52:50 to 06 231 06:56:48 (4.0 mins)

time gap : 06 238 12:43:08 to 06 238 14:32:48 (109.7 mins)

time gap : 06 243 00:33:36 to 06 243 02:49:15 (2.3 hrs)

9.3 150 kHz ADCP

The 150kHz RDI ADCP was logged using RDI Data Acquisition Software (DAS) version 2.48 with profiler firmware 17.20. The instrument was configured to sample over 120 second intervals with 96 bins of 4 m thickness, pulse length 4 m and a blank beyond transmit of 4m. The high vertical resolution was chosen to support the remote detection of zooplankton patchiness. At the beginning of the cruise, the ADCP was switched to bottom track mode over the continental shelf to enable calibration of the instrument. Spot gyro heading data were fed into the transducer deck unit where they were incorporated into the individual ping profiles to correct the velocities to earth co-ordinates before being reduced to a 2 minute ensemble.

The 150 KHz ADCP on RRS *Discovery* had been refitted in dry dock to a heading offset of ~45°. This offset was accounted for in the DAS software configuration on D309. On some previous cruises the ADCP PC clock had been synchronised with the ship's master clock, so removing the tedious need for logging the drift of the PC clock and correcting for it in the processing (old adpexec1). Sadly this was not available on D309 and adpexec1 remained resurrected for now.

The ADCP data were logged continually by the level C computer. From there they were transferred once a day to the Pstar data structure and processed using standard processing scripts in Pstar. These are presented below, where "##" indicates the daily file number.

Data processing:

adpexec0: transferred data from the RVS level C "adcp" data stream to Pstar. The data were split into two; "gridded" depth dependent data were placed into "adp" files while "non-gridded" depth independent data were placed into "bot" files. Velocities were scaled to cm/s and amplitude by 0.42 to db. Nominal edits were made on all the velocity data to remove both bad data and to change the DAS defined absent data value to the Pstar value. The depth of each bin was determined from the user supplied information. Output files: adp309##, bot309##

adpexec1: Clock correction applied to both, gridded and non-gridded files. The PC clock was found to have a fairly steady drift, ~ 4 seconds per day, so time checks were made every 24 hours and these offset values were used in adpexec1 to create a clock correction file for calibrating adcp time. Output files: adp309##.corr, bot309##.corr

adpexec2: this merged the adcp data (both files) with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: adp309##.true, bot309##.true.

adpexec3: applied the misalignment angle, ø, and scaling factor, A, to both adcp files. The adcp data were edited to delete all velocities where the percent good variable was 25% or less. Again, variables were renamed and re-ordered to preserve the original raw data. Output Files: adp309##.cal, bot309##.cal.

adpexec4: merged the adcp data (both files) with the GPS 4000 navigation file (gp430901) created by gps4exec0. Ship's velocity was calculated from spot positions taken from the gp430901 file and applied to the adcp velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from gp430901. Output Files: adp309##.abs, bot309##.abs.

A calibration of the 150 kHz ADCP was achieved using bottom tracking data available from our departure from St. John’s across the continental shelf. Using a long, straight, steady speed section of standard two minute ensemble profiles we obtained a calibration of $\tan\phi = 0.0153\,(\pm s.d. = 0.0060), \therefore \phi = 0.8740°$ and $A = 0.9983\,(\pm s.d. = 0.0057)$. These values followed a complete re-fit of the ADCP instruments in April 2005.

9.4 75 kHz ADCP

The RDI Ocean Surveyor 75 kHz Phased Array ADCP was configured to sample over 120 second intervals with 60 bins of 16m depth, pulse length 16m and a blank beyond transmit of 8m. The instrument is a narrow band phased array ADCP with 76.8 kHz frequency and a 30° beam angle. The PC was running RDI software VmDAS v1.3. Gyro heading, and GPS Ashtech heading, location and time were fed as NMEA messages into the software which was configured to use the Gyro heading for co-ordinate transformation. The software logs the PC clock time, stamps the data (start of each ensemble) with that time, and records the offset of the PC clock from GPS time. This offset was applied to the data in the processing path before merging with navigation. The ADCP was fitted in the forward well as previously noted. It was known to have a heading alignment offset of 60°, this offset was successfully fed into the RDI software configuration. Bottom tracking was switched at the beginning and at the end of the cruise for calibration purposes.

The 2 minute averaged data were written to the PC hard disk in files with a .STA extension, eg D309-D310005_000000.STA, D309-D310006_00000.STA etc. Sequentially numbered files were created whenever data logging was stopped and re-started. The software was set to close the file once it reached 100MB in size, though on D309 files were closed after ~24 hours, so they never became that large. All files were transferred to the unix directory /data32/d309/os75. Broadly speaking the processing path followed the steps outlined for the 150 kHz ADCP. In the following script description, "##" indicates the daily file number.

In parallel with the 150 KHz ADCP, a calibration of the 75 kHz ADCP was achieved using bottom tracking data available from our departure across the continental shelf from St. John's. Using a long, straight, steady speed section of standard two minute ensemble profiles (.STA files) we obtained a calibration of $\tan\phi = 0.0108\ (\pm s.d. = 0.0028), \therefore \phi = 0.6203°$ and $A = 1.0010\ (\pm s.d. = 0.0022)$. As with the 150kHz ADCP, these values follow a complete re-fit of the instruments in April 2005.

surexec0: data read into Pstar format from RDI binary file (psurvey2, new program written on D253 by S. Alderson). Water track velocities written into "sur" file, bottom track into "sbt" files if in bottom track mode. Velocities were scaled to cm/s and amplitude by 0.45 to db. The time variable was corrected to GPS time by combining the PC clock time and the PC-GPS offset. The depth of each bin was determined from the user supplied information. Output Files: sur309##.raw, sbt309##.raw.

surexec1: data edited according to status flags (flag of 1 indicated bad data). Velocity data replaced with absent data if variable "2+bmbad" was greater than 25% (% of pings where >1 beam bad therefore no velocity computed). Time of ensemble moved to the end of the ensemble period (120 secs added with pcalib). Output files: sur309##, sbt309##.

surexec2: this merged the adcp data (both files) with the ashtech a-ghdg created by ashexec2. The adcp velocities were converted to speed and direction so that the heading correction could be applied and then returned to east and north. Note the renaming and ordering of variables. Output files: sur309##.true, sbt309##.true.

surexec3: applied the misalignment angle, ø, and scaling factor, A, to both files. Variables were renamed and re-ordered to preserve the original raw data. Output Files: sur309##.cal, sbt309##.cal.

surexec4: merged the adcp data (both files) with the GPS 4000 navigation file (gp430901) created by gps4exec0. Ship's velocity was calculated from spot positions taken from the gp430601 file and applied to the adcp velocities. The end product is the absolute velocity of the water. The time base of the ADCP profiles was then shifted to the centre of the 2 minute ensemble by subtracting 60 seconds and new positions were taken from gp430901. Output Files: sur309##.abs, sbt309##.abs.

10 UNDERWAY SURFACE METEOROLOGY

10.1 High precision atmospheric O_2 and CO_2 measurements

Michael Patecki

The ocean is the largest sink for CO_2 emissions and therefore the most important system that can buffer the rise of atmospheric CO_2 concentrations. Despite growing research interest in the ocean carbon cycle, the quantification of the ocean carbon sink is still afflicted by uncertainties, arising from gaps in understanding the mechanisms and processes responsible for the short and long term uptake of CO_2 and its global air-sea exchange patterns.

Understanding the mechanisms which drive the air-sea exchange of CO_2 can not be achieved by measuring atmospheric CO_2 concentrations alone. Atmospheric O_2 helps to understand the oceans' role as carbon storage and can give an insight into the biogeochemical processes which are involved in the uptake of anthropogenic carbon.

Three processes are mainly responsible for varying CO_2 and O_2 concentrations in the atmosphere, which are photosynthesis, respiration and combustion. These processes represent CO_2 sinks and sources which are inversely linked to sources and sinks of O_2 (Keeling & Schertz, 1992). For the ocean, however, there is one process which is not linked to the release of O_2, and that is the uptake of atmospheric CO_2 by dissolution. This difference, caused by the different geochemical behaviour of the two gasses with water, can be used to quantify the uptake of atmospheric CO_2 by the ocean.

Atmospheric O_2 and CO_2 can also be used in combination. In 1998 Stephens et al. introduced a tracer called APO (Atmospheric Potential Oxygen), which eliminates the terrestrial influences in atmospheric O_2 and CO_2 signals, and focuses solely on changes induced by ocean biogeochemical processes (Stephens et al. 1998).

10.1.1 Atmospheric O_2 and CO_2 measuring system

To achieve in situ measurements of O_2 and CO_2, a system was built which is similar to the system used by Thompson 2005 and comprises three main components, a two stage cooling system, the CO_2 analyser and the O_2 analysing unit. Both analysers measure the difference between the incoming sample air stream and a reference gas. The measurements of O_2 are achieved by using fuel cells. In the cells a current is produced, which is the result of the oxidation process at the Anode and proportional to the partial pressure of O_2 at the sensor surface.

CO_2 is measured with an infra-red absorption method. The IR beam in the analyser channel is equally divided into two beams, a sample and a reference beam. Sample air passes through the sample cell were the beam is altered depending on the CO_2 concentration in the gas. The same happens to the beam passing the gas in the reference cell before reaching the detector cells, which are filled with a defined concentration of CO_2.

Both analysing methods are highly sensitive to the content of moisture in the gas stream, which has to be brought to a minimum. The implemented cooling system extracts the water from the sample and reference gas to below 1ppm and achieves minimisation of interference at the detector cells for CO_2 and O_2 in the corresponding analysers. Besides water, CO_2 and O_2 are sensitive to gradients in flow, pressure and temperature. This sensitivity is accounted for in the system by implementing a pressure regulation system, which stabilises the pressure between sample and reference line. For flow stability a mass flow controller is placed on the reference side together with a set of flow meters and needle valves, which is the same for both gas lines.

The analysers are calibrated ones a day with two gasses of high (high span, HS) and low (low span, LS) CO_2 and O_2 concentrations. The range given by these two gasses reflects the expected natural range of O_2 and CO_2 concentrations in the atmosphere. A third gas (zero air) is measured more frequently. The frequency of runs for this gas depends mainly on the variability of the temperature conditions in the systems environment (laboratory) and is usually between 3 and 8 hours.

All gas cylinders are stored in a wooden crate, called 'Blue Box', in horizontal position to minimise temperature depending concentration gradients.

10.1.2 System set-up on board the RRS Discovery

The measuring system is designed for the use on board a commercial vessel, which frequently travels between Felixstowe, United Kingdom and Cape Town, South Africa. It is built of three portable Aluminium shelves (Unit I – Unit III), which are connected during the measuring process (Picture 1). Unit I contains the fridge and pumps, a diaphragm pump for the air intake and peristaltic pumps to extract the water collected in the fridge traps. Unit II contains mainly the cryogenic bath and the power supply unit for flow, pressure and temperature sensors. Unit III is the analyser unit, containing a Siemens ULTRAMAT 6 for the CO_2 and Oxzilla II from Sable Systems International for the O_2 analysis, as well as the pressure control system. Reference and calibration gasses in the Blue Box (Picture 2) are connected to Unit III.

For the air supply an air inlet was installed on the foremast of the ship and two airlines of different diameter and with a length of about 50m were lined up to the chemistry laboratory. Afterwards this line was leak tested to assure that the air comes entirely from the foremast of the system and is not intercepted by inside air (e.g. from the laboratory). To log the ships position, speed and bearing a GPS was installed on the roof of the bridge and the power supply cable of about 30m length lined up to the chemistry lab as well.

10.1.3 System performance during the cruise

The first measurements were logged on 18 August. A calibration was run twice a day for the first two days, the ZERO calibration every 5 hours to account as best for daily variations in the laboratory temperature as possible, which were still unknown at this point.

The HS / LS calibration was set to ones a day from 20 August on and ZERO calibration to every 7 hours. Due to the long calibration time of over 1 hour the calibration was later on synchronised to times when the ship stopped for the recovery/deployment of moorings or at CTD stations.

The daily routine to investigate the system's performance was to have a look at the different flow rates, pressures and temperatures. A slight imbalance of the flowrate developed during the first week of system run was discovered between the sample and reference airline and had to be corrected. From 29 August onwards the flowrate was stable.

The system pressure had to be inspected every day for three reasons, to check if the air inlet filter is blocked (e.g. by salt), to check if the water trap of the cryogenic bath is blocked by ice and if the pressure control system is working properly. During the whole time of the cruise the pressure was well balanced before entering the gas analysers. There was no kind of blockage to either trap or air inlet. I discovered a very unusual decrease of pressure in the second air intake line, which was not in use and has usually pressure values around 1000 mbar. But in this line the pressure was constantly less than 900 mbar. A possible reason for that is a cross talk between the two air intake lines at the first 4-way valve of the system. The influence of this leak on the measurements (O_2 fractionation) has still to be evaluated.

The temperature of the laboratory was most of the time in an expectable range of variation (± 1°C·d^{-1}), with the exception on 26 and 27 August. The room temperature decreased throughout the whole day by 3°C and increased by the same amount on 27 August.

As expected there is a very high correlation of 90% between the temperature variability in the laboratory and changes in the Siemens internal temperature. For the final system setup this effect has to be minimised through insulation.

The oxygen analyser is not affected by room temperature changes due to an internal temperature control of high stability (± 0.04 °C variability over a period of 12 days).

10.1.4 Preliminary data set of atmospheric O_2 and CO_2 concentrations

O_2 and CO_2 concentrations have been analysed every day. The scientific value of this preliminary data set (Figure 1) has yet to be defined. For further data analysis an appropriate quality control will be implemented, which will take into account the effects of small leaks in the gas line on the measurements as well as a possible fractionation of O_2 at the air inlet, temperature variability and the influence of wind speed and direction.

It was one of the objectives for the cruise to find out about the influences of a ship environment on atmospheric O_2 and CO_2 measurements. Therefore a first simple statistical analysis was carried out during the cruise to investigate the relationship between the variability in O_2 and CO_2 measurements and the ship parameters like speed (Figure 2) and bearing. Despite a missing data set of the wind parameters it seems evident that there is a link between high variability in the concentration data and ship speed, especially for values around 20 km/h (e.g. 29 August).

But high data variability is not limited to those times of high ship speed. On 31 August for example we see a period of low ship speed and high variability in the measurements. That variability can be explained by a high variability in the ships bearing (Figure 3), which is in the case of a ship in resting position an artefact of the vertical ship movement induced by high waves. This find is supported by higher data variability during calibration runs, which is independent from the air intake.

A first conclusion is therefore that the scatter in the measurements can only be explained by a combination of effects linked mainly to the ships movement and most likely the meteorology. A further investigation of those effects including their quantification is of course necessary.

10.2 Surfmet data processing

Steve Alderson

Data from the surfmet system was transferred daily from the ship's computer system and calibrated to give along track surface properties such as sea surface temperature, air pressure and true wind speed. Two problems were encountered:

a) The surfmet system is using 0 as an absent data value which is difficult to identify when 0 is also a valid data value. On inspection these bad values occur in all variables and since air pressure is one of the few variables that does not include 0 in its acceptable range, all data records where air pressure is zero were removed.

b) The ship's data file contained duplicate records. This was corrected by taking the time difference between adjacent records and removing those where this difference was zero.

Four scripts were used in the processing:

smtexec0 convert data into PSTAR format; add in header information such as the name of the ship and preferred variable names

smtexec1a change absent data value from zero to -999; remove duplicate records; calculate salinity from a pseudo pressure variable of 0 db and temperature and conductivity; linearly calibrate data using the following coefficients:

Variable	Instrument number	Offset	slope
ppar	28558	0	100000
spar	28557	0	100000
ptir	47462	0	84459.5
stir	47463	0	94073.4
humidity	U1850012	1.78	1.0891
airtemp	U1850012	-0.05	1.0160
trans	CST-113R	-0.01310	0.21473

then despike data; convert wind vector to east and north components; average all variables to two minute values.

smtexec1b merge with Ashtech data to include corrected ship's heading.

smtexec2 convert wind speed and direction relative to the ship to east and north components; subtract ship speed components to give absolute wind components; convert these to absolute wind speed and direction

Water samples were occasionally taken from the non-toxic seawater feed passing through the thermosalinograph part of the system. These were then analysed on a salinometer. The resulting salinity values were compared with the simultaneous measurements obtained from surfmet for all data up to and including day 241. A linear correction was obtained of the form:

$$S_{true} = 0.98991 \text{ x } S_{measured} + 0.21109$$

with $r^2 = 0.9993$.

Figure 10.1 shows hourly averaged salinities from the instrument. The Greenland current is clearly shown as fresher water in the top left of the diagram (do I know what I'm talking about!)

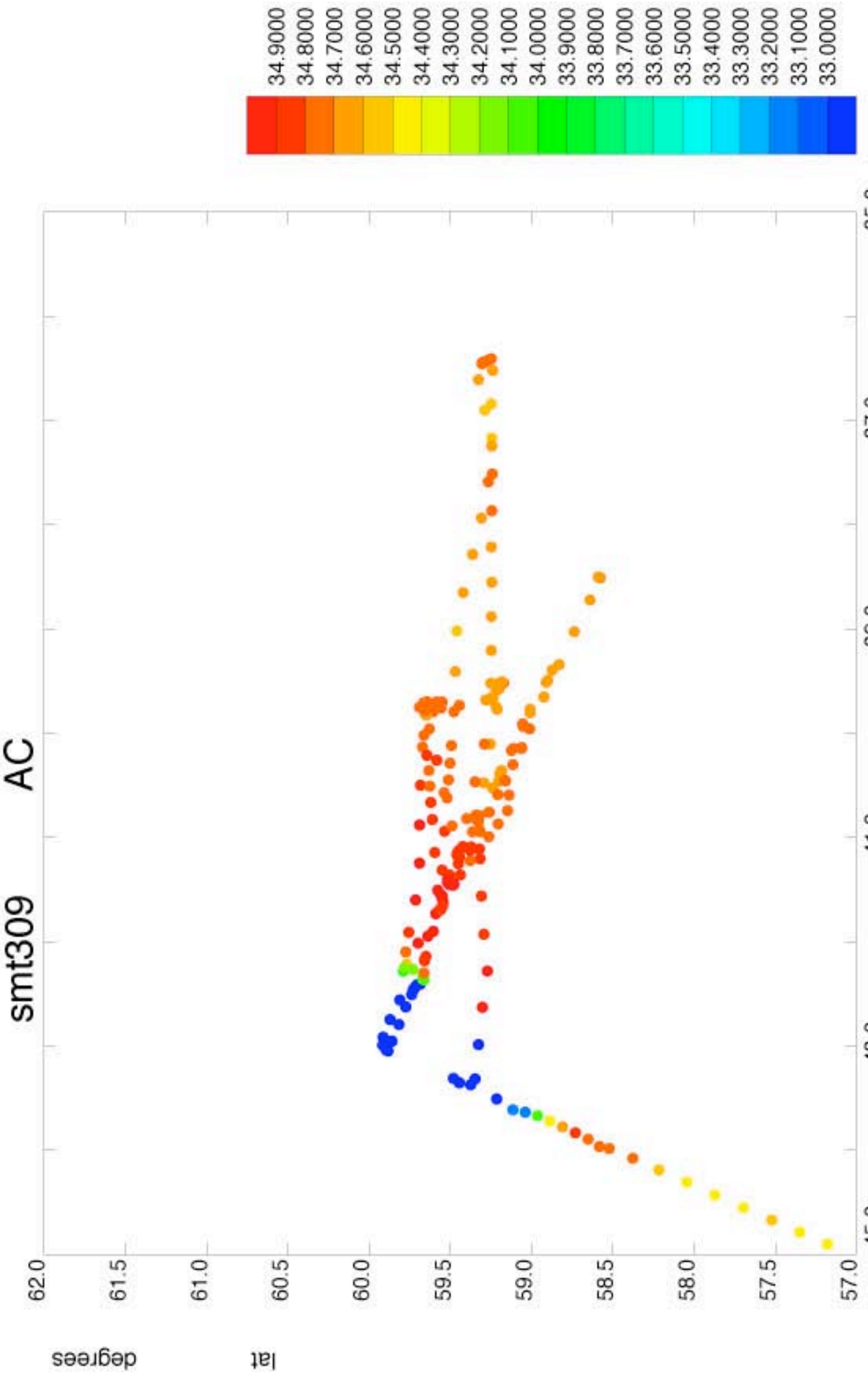


Figure 10.1: Surfmet salinity.

11 ECHOSOUNDER

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During this cruise, the RRS *Discovery* was equipped with a SIMRAD EA500 Echosounder. Measurements were made using a hull-mounted transducer and, for the majority of the cruise, a second transducer in the Precision Echosounder (PES) 'fish' suspended over the port side of the ship. The PES provides a quieter environment for determining water depth in deep water and poor sea states. It was deployed at 18:32 on 22 August and was removed from the water at 14:18 on 2 September. The output from the echosounder was displayed on two SIMRAD VDUs located in the main lab. The speed of sound in the water was set to 1500m/s for the initial output.

The raw data was logged into the *ea500d1* datastream containing values of uncorrected depth and time. At this stage the *ea500d1* data-stream was processed on the UKORS workstations. A correction taking into account the variability of sound speed in water was made and errors in the data-stream were visually identified and removed. A new data-stream was created named *prodep* containing uncorrected depth, corrected depth and measurement time. At the end of the cruise, these data-streams were then processed as follows using a series of UNIX shell scripts utilising PEXEC routines.

simexec0: This script took the raw data from the two data streams creating files of raw data (*sim30901*) and corrected data (*sim30901.cal*).

simexec1: This script took the corrected depths in sim30901.cal and merged it with the daily navigation data located in the gps4000 navigation file: *gps430901*. This created a file *sim309.nav*, which was then averaged into 5 minute bins using the pstar routine, *pavrge*. The final output was a file of depths, times and positions in 5 minute bins named *sim30901.5min*.

12 SHIP FITTED SYSTEMS

12.1 Computing

Sun Workstations

A Sun Blade 1500, "*discovery1*", was used as the main Level C system, where the majority of data eventually arrives. Basic navigation processing was also performed once every 24 hours, shortly after 20:00, although there were problems with this for most of the cruise due to bugs in the TECHSAS EM Log acquisition module (see below). This led to large gaps in the bestnav file during the majority of the cruise. Once the navigation was processed data from the echo sounder could be corrected for Carter Area, and absolute windspeed computed. These data are stored in the prodep and pro_wind files, respectively.

A Sun Blade 150, "*discovery2ng*", does all sorts of things for the ship, including NIS authentication, DNS resolution, sharing of various UNIX directories with Windows and Mac clients (SAMBA), printer serving, and package serving (Matlab and Uniras). As well as this it is used as a general purpose workstation by those scientists working with the Pstar system.

Another Sun Blade 1500, "*discovery3*" has a pair of 300GB external firewire drives attached. The system sees these as on hard disk, under a directory called /data32. Everything written to /data32 is written to both drives at the same time, and thus, you have an instant backup. Should the worst happen, and *discovery1* fail, the discovery3 hardware can be used to build a new *discovery1* system.

Another Sun Blade 150, "*discovery5*" is used as a general scientific workstation, but also runs a DHCP server which allocates IP addresses to visiting laptops and other computers that are temporarily attached to the ships network using either the wired or wireless network. It also hosts the SquirrelMail software (upgraded at the beginning of the cruise) which talks to the *discovery-comm* mail server and allows people to read and send E-mail using only a web browser.

An aging Sun Ultra 5, "*discovery6*" used to be one of the main places scientists would store their data, hence its external drives and DLT tape drive. The size of the drives (the largest is 18GB) show the age of this system, and it is rarely used for serious computing now, although it was used briefly for pstar work during this cruise. It is available most of the time for people to access the SquirrelMail system.

Backups of *discovery1* and the /data32 area on *discovery3* were performed every evening, shortly after the navigation was processed.

All Sun workstations had the latest Sun Alert patches installed at the beginning of the cruise. All except *discovery6*, which didn't have enough disk space, also had the Sun Recommended patch clusters installed.

Level A/B

The Level A and B systems, originally developed between 1990 and 1992 are still on the ship and were used to log the winch, surfmet, echo sounder and various GPS systems. The system in general worked very well this cruise and there were no black hole data losses. There seems to be a slight issue with logging the winch data, in that sometimes when the CLAM starts running the Level B will not pick the data up. This was "cured" by unplugging and plugging the data lead from the CLAM to the Level B, until the Level B saw the CLAM data.

TECHSAS

The techsas system is currently the only system that can log the ship's gyro and the Chernikeeff EM Log, since some of the Mk II Level A systems have totally failed. In addition it is logging the Surfmet, echo sounder and Trimble GPS 4000 in parallel with the Level A/B systems.

It turns out that there has been a bug in the EM Log acquisition module for some time. The bug caused the acquisition module not to log the port/starboard speed and to fail to log fore/aft speed when the ship was travelling at speeds over ten knots. Eventually after consultation via E-mail with Gael Quemener of IFREMER, who supplied the TECHSAS systems, a new acquisition module was installed, and the data logged correctly. This in turn allowed good relmov and bestnav data to be processed on the Level C – something that has obviously not been possible for some months.

E-mail Systems

The AMS (Antactic Messaging System), supplied by British Antarctic Survey continues to provide a fairly reliable ship-shore E-mail transfer system. However during this trip there have been a few E-mails that appear to have "gone missing". It is still uncertain what has caused this, but the system definitely needs updating, as the ship client software is running on Red Hat Linux V6.2, and requires modification in order to run on a newer version of Linux.

Tracker System

The old Pentium-based computer that used to be for the shipborne wave recorder has been pressed into service to run the Tracker application. This allowed a display of the ship's track, relative to the mooring positions to be seen close to the echo sounder, where the acoustic release deck units were positioned. The application also gave distance from the vessel to the mooring site.

Some people seem unaware of the Tracker application and its capabilities. The application can run on any Windows-based PC and can use NMEA navigation data supplied either over the network (wired, or wireless) which is broadcast by the computer room Dell PC, or over a serial port. The application shows the speed and heading of the ship and a history of the recent track. Targets can be entered either by typing in a latitude/longitude pair and assigning a label, or by selecting the target position by "spotting", or clicking on an area of the screen. Once you have a target, there is the option of getting an ETA and distance to the target.

Ship's Network

During the lengthening and rebuilding of RRS Discovery in 1990-1992, two sets of network media were installed. 10Base2 co-ax went almost everywhere, including all the lab spaces and scientific cabins, and this was also used to form the network backbone for the ship. In addition to this, fibre optic pairs were installed between key places such as the computer room, comms room, deck lab and wheelhouse. During the fourteen years since the Discovery conversion, the co-ax network has been heavily used and augmented with 10/100/1000baseT twisted pair connectivity in the lab spaces. There are also a very few cabins with 10baseT and some 10baseT connections in the comms room. The comms room is important because it is where the Dartcom computer and the NTP clock (which is used to synchronise the clocks of computers connected to the network) live. On previous cruises it has proved very difficult to get a reliable connection to the NTP clock because the data had to travel between decks on the aging co-ax network.

During an earlier cruise this year, photographs of the fibre-optic patch panels in both the computer room and the comms room were taken by Martin Bridger, and shown to Bryan Norman, the NOC network manager. He confirmed that the fibres, and their connectors, should be suitable for modern-day fibre optic networking equipment. We wanted to make sure of this before investing in equipment and luckily Bryan was able to lend us a pair of fibre-optic switches, along with their associated fibre optic patch cables. These were installed very easily at the start of the cruise and have given us a rock-solid link between the computer room and the comms room, thus allowing anyone to synchronise their computer's clock with GPS time.

12.2 Surfmet

The surfmet has been reasonably good on this trip, with the exception of the transmissometer on two counts. Firstly, it kept getting bubbles in it, and secondly its in-air reading at the beginning of the cruise was only 2.4V, instead of being in excess of 4.5V. We were assured that a spare transmissometer was on the vessel, but it could not be located in either of the Surfmet spares boxes. It was eventually located towards the end of the cruise.

12.3 Echo Sounder

Two sections of cable fairing were replaced prior to the cruise. The system appears to have worked well, and when the fish was recovered towards the end of the cruise, only a few clips (including one of the larger end clips) were found in need of replacement.

12.4 Vessel Mounted ADCP

Both the VMADCPs were looked after by the scientific party, with the 150 kHz narrowband being logged to the Level C ADCP stream, as normal. Data from the 75KHz wideband were transferred to the /data32 area on *discovery3*.

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